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Annual European Union greenhouse gas inventory 1990–2019 and inventory report 2021

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Contact names	Andreas Pilzecker (DG Clima) Ricardo Fernandez (EEA) Nicole Mandl, Elisabeth Rigler (ETC/CME)
Organisation	European Commission, DG Climate Action European Environment Agency
European Comission adress	European Commission DG Climate Action BU 5 2/158 B-1049 Brussels
Fax	(32-2) 296 99 70
Telephone	(32-2) 29 58 219
E-Mail	Andreas.PILZECKER@ec.europa.eu
European Environment Agency adress	Kongens Nytorv 6 DK-1050 Copenhagen
Telephone	(45) 33 36 71 00
Fax	(45) 33 36 71 99
E-Mail	ricardo.fernandez@eea.europa.eu

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The coordinating authors were Nicole Mandl and Marion Pinterits (ETC). Other authors and contributors were, in alphabetical order,Simona Bosco (JRC), Lukas Emele (ETC), Michaela Gager (ETC), Michael Goll (Eurostat), Giacomo Grassi (JRC), Barbara Gschrey (ETC), Céline Gueguen (ETC), Bernd Gugele (ETC), Coralie Jeannot (ETC), Kristina Kaar (ETC), Elisabeth Kampel (ETC), Matina Kastori (ETC), Eva Krtkova (ETC), Francesca Lanza (DG Clima), Adrian Leip (JRC), Bradley Matthews (ETC), Giorgos Mellios (ETC), Lorenz Moosmann (ETC), Ils Moorkens (ETC), Markéta Müllerová (ETC), Andreas Pilzecker (DG Clima), Maria Purzner (ETC), Risto Juhana Saarikivi (ETC), Günther Schmidt (ETC), Efisio Solazzo (JRC), Janka Szemesova (JRC), Bogdan Voinea (DG Clima), Raul Abad Viñas (JRC), Julien Vincent (ETC) and Georg Wartecker (ETC).

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Annexes published on CD-ROM and the EEA website only:

Annex I: Key category analysis

Annex II: Uncertainty assessment (included in NIR section 1.6)

Annex III: Detailed methodological descriptions for individual source or sink categories

Annex IV: not included (see explanation in chapter 1.8.4)

Annex V: Additional information

ES-1 BACKGROUND INFORMATION ON GREENHOUSE GAS INVENTORIES AND CLIMATE CHANGE

The present report is the official inventory submission of the European Union (EU) for 2021 under the United Nations Framework Convention on Climate Change (UNFCCC) and also under the Kyoto Protocol (KP).

The European Union (EU), as a party to the UNFCCC, reports annually on greenhouse gas (GHG) inventories for the years between 1990 and the current calendar year (t) minus two (t-2), for emissions and removals within the area covered by its Member States (i.e. emissions taking place within its territory). Due to this lag in reporting, the 2021 inventory report does not yet reflect the effects of the COVID-19 pandemic.

The United Kingdom (UK) left the EU on February 1, 2020, but key provisions of Regulation (EU) No 525/2013 (“Mechanism for Monitoring and Reporting GHG”) and of Decision No 406/2009/EC (“Effort Sharing”) apply to the UK in respect of greenhouse gases emitted during 2019 and 2020. Article 5 of Commission Regulation (EU) No 389/2013 (“EU registry”) applies to the UK until the closure of the second commitment period of the KP[1].

The European Union, its Member States, Iceland and the UK fulfil their quantified emission limitation and reduction commitments for the second commitment period to the KP, reflected in the Doha Amendment, jointly. The EU, its Member States, Iceland and the UK agreed to a quantified emission reduction commitment that limits their average annual emissions of GHG during the second commitment period to 80 % of the sum of their base year emissions, which is reflected in the Doha Amendment. Article 4 of the KP requires parties that agree to fulfil their commitments under Article 3 of the KP jointly to set out in the relevant joint fulfilment agreement the respective emission level allocated to each of the parties. Council Decision (EU) 2015/1339 sets out the terms of the joint fulfilment agreement as well as the respective emission levels of each Party to that agreement. The emission levels define the Member States’, Iceland’s and UK’s assigned amounts for the second commitment period. These emission levels have been determined on the basis of the existing EU legislation for the period 2013-2020 under the ‘Climate and Energy package’.

The EU, Iceland and the UK jointly report their national greenhouse gases emissions during the second commitment period of the KP. The present report and the inventory presented here refer to the EU GHG inventory under the UNFCCC (scope EU-27+UK) and the KP (scope EU-27+ISL+UK = EU-KP). This report, therefore, presents the totals of the EU-27 plus Iceland, plus the UK (EU-KP)[2].

The legal basis for the compilation of the EU inventory is Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting GHG emissions and for reporting other information at national and EU level relevant to climate change and repealing Decision No 280/2004/EC[3].

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[1] Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community (2019/C 384 I/01), Article 96(5).

[2] ‚EU-27‘ refers to the current EU. For reasons of clarity, please note that in some cases the terms ‘Member States’ and ’EU’ and ‘Union’ may be used. As a general rule, these terms also refer to Iceland and the UK.

[3] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0525&qid=1527153180542&from=EN

This Regulation establishes a mechanism for:

a) ensuring the timeliness, transparency, accuracy, consistency, comparability and completeness of reporting by the EU and its Member States to the UNFCCC Secretariat;
b) reporting and verifying information relating to commitments of the EU and its Member States pursuant to the UNFCCC, to the KP and to decisions adopted thereunder, and evaluating progress towards meeting those commitments;
c) monitoring and reporting all anthropogenic emissions by sources, and removals by sinks, of GHGs not controlled by the Montreal Protocol on substances that deplete the ozone layer in Member States;
d) monitoring, reporting, reviewing and verifying GHG emissions and other information pursuant to Article 6 of Decision No 406/2009/EC;
e) reporting the use of revenue generated by auctioning allowances under Article 3d(1) or (2) or Article 10(1) of Directive 2003/87/EC, pursuant to Article 3d(4) and Article 10(3) of that Directive;
f) monitoring and reporting on the actions taken by Member States to adapt to the inevitable consequences of climate change in a cost-effective manner;
g) evaluating progress by the Member States towards meeting their obligations under Decision No 406/2009/EC.

The Monitoring Mechanism Regulation sets out the reporting rules on GHG emissions to meet the requirements arising from international climate agreements, it replaces and expands the previous Monitoring Mechanism Decision 280/2004/EC.

The EU GHG inventory comprises the direct sum of emissions from the national inventories compiled by the countries making up the EU-27 plus Iceland plus the UK. Energy data from Eurostat are used for the reference approach for CO_2 emissions from fossil fuels, developed by the Intergovernmental Panel on Climate Change (IPCC).

The main institutions involved in the compilation of the EU GHG inventory are the Member States plus Iceland and the UK, the European Commission Directorate-General for Climate Action (DG CLIMA), the European Environment Agency (EEA) and its European Topic Centre on Air Pollution and Climate Mitigation and Energy (ETC/CME), Eurostat, and the Joint Research Centre (JRC).

The annual process of compiling the EU GHG inventory is described below:

1. Member States/countries submit their annual GHG inventories by 15 January each year to the European Commission (DG CLIMA), with a copy to the EEA.
2. The EEA and its ETC/CME, Eurostat, and the JRC then perform initial checks on the data submitted. Specific findings from the initial quality assurance/quality control (QA/QC) checks are communicated to Member States by 28 February. In addition, the draft EU GHG inventory and inventory report are circulated to Member States for review and comments by 28 February.
3. Member States check their national data and the information presented in the EU GHG inventory report, respond to specific findings from the initial QA/QC checks by the EU inventory team, send updates if necessary and review the EU inventory report by 15 March.

4. The EEA and its ETC/CME review final inventory submissions from Member States and their responses to the initial checks, and prepare the final EU GHG inventory and inventory report by 15 April so that they can be submitted to the UNFCCC[4].
5. A resubmission is prepared by 27 May if needed.

ES-2 SUMMARY OF GREENHOUSE GAS EMISSIONS TRENDS IN THE EU

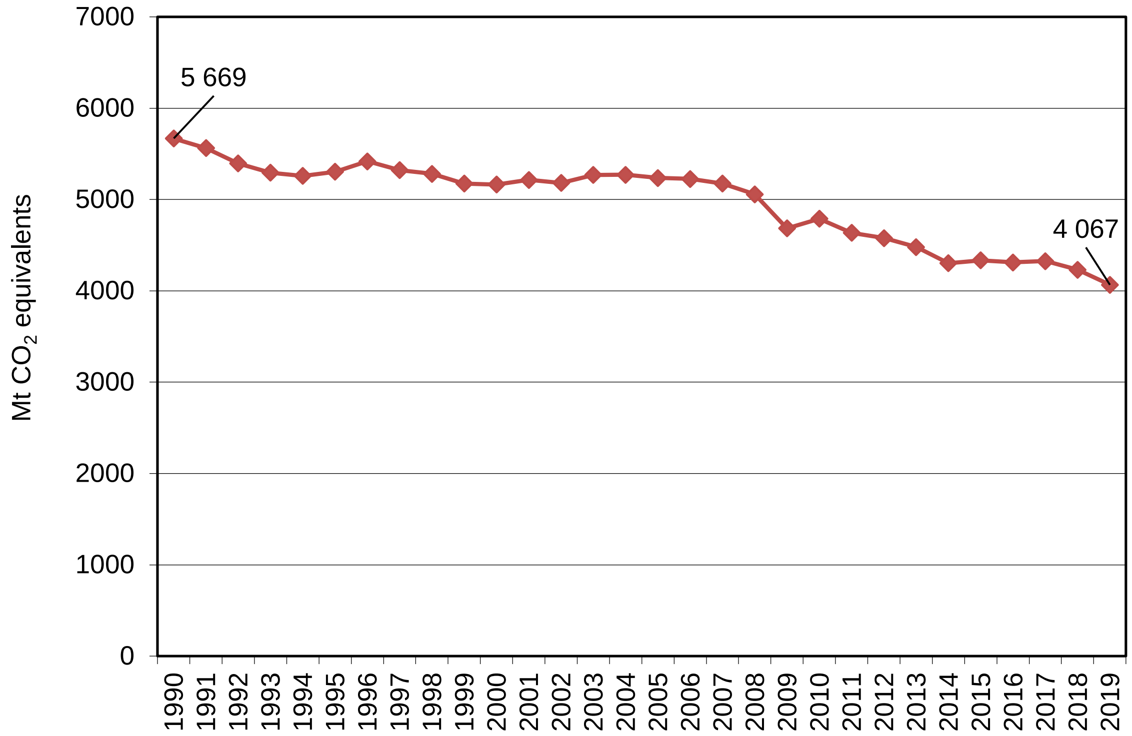
Total GHG emissions - excluding Land Use, Land Use Change and Forestry (LULUCF) - in the EU-KP amounted to 4 067 million tonnes CO_2 equivalent in 2019 (including indirect CO_2 emissions). All GHG emission totals provided in this report include indirect CO_2 emissions[5].

In 2019, total GHG emissions were 28.3 % (-1 602 million tonnes CO_2 equivalents) below 1990 levels. Emissions decreased by 3.9 % or 166 million tonnes CO_2 equivalent) between 2018 and 2019 (Figure ES. 1).

[4] The EU, as Party to the UNFCCC and the Kyoto Protocol, reports its GHG inventory according to UNFCCC Decision 24/CP.19 (reporting guidelines on annual GHG inventories). The EU should not be held liable for any errors caused by the UNFCCC CRF Reporter software during the technical review of the information submitted.

[5] According to the UNFCCC reporting guidelines, Annex I Parties may report indirect CO_2 from the atmospheric oxidation of CH_4, CO and NMVOCs. For Parties that decide to report indirect CO_2, the national totals will be presented with and without indirect CO_2. The EU national total includes indirect CO_2 emissions if Member States have reported these emissions. The CRF tables include national totals, including and excluding indirect CO_2 emissions.

Figure ES. 1 EU-27, Iceland and the UK (EU-KP) GHG emissions (excl. LULUCF)



Notes: The GHG emissions data shown in this figure include indirect CO_2 emissions, and do not include emissions and removals from LULUCF; nor do they include emissions from international aviation and international maritime transport. CO_2 emissions from biomass with energy recovery are reported as a Memorandum item according to UNFCCC guidelines and are not included in national totals. In addition, no adjustments for temperature variations or electricity trade are considered. The 100-year global warming potentials are those from the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) and are included in Annex III of UNFCCC Decision 24/CP.19.

Main trends by source category, 1990-2019

Total GHG emissions (excluding LULUCF and excluding international aviation) decreased by 1602 Mt CO_2 eq. since 1990 (or 28.3 %) reaching their lowest level during this period in 2019 (4067 Mt CO_2 eq.). There has been a progressive decoupling of gross domestic product (GDP) and GHG emission compared to 1990, with an increase in GDP above 64 % alongside a decrease in emissions of about 28 % over the period (-26 %, when including international aviation).

The reduction in GHG emissions over the 29-year period was due to a variety of factors, including the growing share in the use of renewables, the use of less carbon intensive fossil fuels and improvements in energy efficiency, as well as to structural changes in the economy. These have resulted in a lower energy intensity of the economy and in a lower carbon intensity of energy production and consumption in 2019 compared to 1990. Demand for energy to heat households has also been lower, as Europe on average has experienced milder winters since 1990, which has also helped reduce emissions.

GHG emissions decreased in the majority of sectors between 1990 and 2019, with the notable exception of transport, including international transport, and refrigeration and air conditioning. At the aggregate level, emission reductions were largest for manufacturing industries and construction, electricity and heat production, iron and steel production (including energy-related emissions) and residential combustion.

A combination of factors explains lower emissions in industrial sectors, such as improved efficiency and lower carbon intensity as well as structural changes in the economy, with a higher share of services and a lower share of more-energy-intensive industry in total GDP.

Emissions from electricity and heat production decreased strongly since 1990. In addition to improved energy efficiency there has been a move towards less carbon intense fuels. Between 1990 and 2019, the use of solid and liquid fuels in thermal power stations decreased strongly whereas natural gas consumption more than doubled. The use of renewable energy sources in electricity and heat generation has increased substantially in the EU since 1990. Improved energy efficiency and a less carbon intensive fuel mix have resulted in reduced CO_2 emissions per unit of fossil energy generated.

Emissions in the residential sector also represented one of the largest reductions. Energy efficiency improvements from better insulation standards in buildings, and a less carbon-intensive fuel mix, can partly explain lower demand for space heating in the EU over the past 29 years.

In terms of the main GHGs, CO_2 was responsible for the largest reduction in emissions since 1990. Reductions in emissions from N_2O and CH_4 have been substantial, reflecting lower levels of mining activities, lower agricultural livestock, as well as lower emissions from managed waste disposal on land and from reduced adipic and nitric acid production.

A number of policies (both EU and country-specific) have contributed to the overall GHG emission reduction, including key agricultural and environmental policies in the 1990s and climate and energy policies in the 2000s.

Almost all EU Member States reduced emissions compared to 1990 and thus contributed to the overall positive EU performance. The UK and Germany accounted for almost 50% of the total net reduction in the EU-KP of the past 29 years.

Table ES. 1 shows those sources that made the largest contribution to the change in total GHG emissions in the EU plus Iceland and UK between 1990 and 2019.

For a more detailed analysis of past GHG emissions trends in the EU, see the 2020 EEA report ‘Trends and drivers of EU greenhouse gas emissions’, available at

https://www.eea.europa.eu/publications/trends-and-drivers-of-eu-ghg

Table ES. 1 Overview of EU-KP source categories whose emissions increased or decreased by more than 20 million tonnes CO_2 equivalent in the period 1990–2019

Source category	Million tonnes (CO_2 equivalents)
Road Transportation (CO2 from 1.A.3.b)	176
Refrigeration and Air conditioning (HFCs from 2.F.1)	83
Aluminium Production (PFCs from 2.C.3)	-21
Cement Production (CO2 from 2.A.1)	-25
Fluorochemical Production (HFCs from 2.B.9)	-27
Agricultural soils: Direct N2O emissions (N2O from 3.D.1)	-28
Fugitive Emissions from Oil and Natural Gas (CH4 from 1.B.2)	-40
Enteric Fermentation: Cattle (CH4 from 3.A.1)	-41
Nitric Acid Production (N2O from 2.B.2)	-46
Fuels used Commercial/Institutional Sector (CO2 from 1.A.4.a)	-47
Adipic Acid Production (N2O from 2.B.3)	-57
Manufacture of Solid Fuels and Other Energy Industries (CO2 from 1.A.1.c)	-62
Fugitive Emissions from Solid Fuels (CH4 from 1.B.1)	-72
Managed Waste Disposal Sites (CH4 from 5.A.1)	-74
Iron and Steel Production (CO2 from 1.A.2.a + 2.C.1)	-126
Fuels used Residential Sector (CO2 from 1.A.4.b)	-136
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A.2.a)	-267
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-620
Total	**-1602**

Notes: As the table only presents sectors whose emissions have increased or decreased by at least 20 million tonnes CO_2 equivalent, the sum for each sector grouping does not match the total change listed at the bottom of the table.

Main trends by source category, 2018–2019

Total GHG emissions (excluding LULUCF) decreased in 2019 by 166 million tonnes, or 3.9 % compared to 2018, to reach 4067 Mt CO_2 equivalent in 2019. The reduction in GHG emissions in 2019 was the second largest in the EU since 1990 in the context of positive (+1.5%) economic growth. Germany, Spain and Poland accounted for more than half of the net reduction in GHG emissions in absolute terms in the EU-KP in 2019.

At EU level, almost 80 % of the net reduction in GHG emissions in 2019 took place in main activity producers of heat and electricity, including combined heat and power. EU ETS prices increased in 2019 compared to 2018, and relative gas prices decreased compared to coal, which encouraged the use of less carbon intensive fuels. CO_2 emissions from solid fuels decreased by 150 million tonnes compared to 2018. Natural gas input to power stations increased, with emissions 25 million tonnes above 2018 levels. In addition, based on Eurostat energy statistics, the use of renewable energy sources in electricity generation increased again in 2019, mostly from wind, solar and bioenergy, thus underpinning the ongoing decarbonisation trend in the sector.

Although less substantial than in the power sector, GHG emissions in 2019 also decreased in manufacturing industries and construction, iron and steel, residential buildings (due to a warmer winter and lower demand for heating) and coal mining. It is worth highlighting that HFC emissions from refrigeration and air conditioning decreased for the fifth consecutive year since 2014. CO_2 emissions from road transportation increased in 2019, mostly due to higher gasoline consumption in passenger cars.

Table ES. 2 shows the source categories making the largest contribution to the change in GHG emissions in the EU between 2018 and 2019.

Table ES. 2 Overview of EU-27 plus Iceland and UK source categories whose emissions increased or decreased by more than 3 million tonnes CO_2 equivalent in the period 2018–2019

Source category	Million tonnes (CO_2 equivalents)
Road Transportation (CO_2 from 1.A.3.b)	4
Fugitive Emissions from Solid Fuels (CH4 from 1.B.1)	-4
Fuels used Residential Sector (CO2 from 1.A.4.b)	-6
Iron and Steel Production (CO2 from 1.A.2.a + 2.C.1)	-7
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A.2.a)	-9
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-127
Total	**-166**

Notes: As the table only presents sectors whose emissions have increased or decreased by at least 3 million tonnes of CO_2 equivalent, the sum for each sector grouping does not match the total change listed at the bottom of the table.

Overview of total GHG emissions by countries

Table ES.3 gives an overview of total GHG emissions by countries, illustrating where the main changes occurred.

Table ES. 3 GHG emissions in million tonnes CO_2 equivalent (excl. LULUCF)

	1990 (million tonnes)	2019 (million tonnes)	2018 - 2019 (million tonnes)	Change 2018 - 2019 (%)	Change 1990-2019 (%)
Austria	78.4	79.8	1.2	1.5%	1.8%
Belgium	145.7	116.7	-1.2	-1.1%	-19.9%
Bulgaria	100.0	56.0	-1.3	-2.3%	-44.0%
Croatia	31.4	23.6	0.1	0.3%	-24.8%
Cyprus	5.6	8.8	0.0	0.3%	58.7%
Czechia	198.9	123.3	-6.0	-4.6%	-38.0%
Denmark	70.9	44.2	-3.9	-8.1%	-37.6%
Estonia	41.0	14.7	-5.5	-27.3%	-64.2%
Finland	71.2	53.1	-3.3	-5.8%	-25.5%
France	544.0	436.0	-8.6	-1.9%	-19.9%
Germany	1248.6	809.8	-46.1	-5.4%	-35.1%
Greece	103.3	85.6	-6.7	-7.2%	-17.1%
Hungary	94.8	64.4	-0.3	-0.5%	-32.0%
Ireland	54.4	59.8	-2.7	-4.4%	9.9%
Italy	518.7	418.3	-10.3	-2.4%	-19.4%
Latvia	25.9	11.1	-0.1	-1.1%	-57.0%
Lithuania	47.8	20.4	0.2	1.1%	-57.4%
Luxembourg	12.7	10.7	0.2	1.7%	-15.6%
Malta	2.6	2.2	0.1	6.5%	-16.2%
Netherlands	220.5	180.7	-6.0	-3.2%	-18.0%
Poland	475.9	390.7	-21.1	-5.1%	-17.9%
Portugal	58.9	63.6	-3.6	-5.4%	8.1%
Romania	266.4	113.9	-4.3	-3.6%	-57.3%
Slovakia	73.5	40.0	-2.2	-5.3%	-45.6%
Slovenia	18.6	17.1	-0.5	-2.6%	-8.2%
Spain	290.0	314.5	-18.7	-5.6%	8.5%
Sweden	71.2	50.9	-1.3	-2.4%	-28.5%
United Kingdom	791.4	449.2	-13.7	-3.0%	-43.2%
EU-27+UK	5662.3	4059.2	-165.6	-3.9%	-28.3%
Iceland	3.7	4.7	-0.1	-2.1%	28.2%
United Kingdom (KP)	794.1	452.3	-13.6	-2.9%	-43.0%
EU-KP	5668.7	4067.1	-165.5	-3.9%	-28.3%

ES-3 SUMMARY OF EMISSIONS AND REMOVALS BY MAIN GREENHOUSE GAS

Table ES. 4 gives an overview of the main trends in the EU-KP GHG emissions and removals for the period 1990–2019. By far the most important GHG is CO_2, which accounted for 81 % of total EU-KP emissions in 2019, excluding LULUCF. In 2019, EU-KP CO_2 emissions excluding LULUCF were 3 296 million tonnes, which was 27 % below 1990 levels. Compared to 2018, CO_2 emissions decreased by 4.4 %. During that period CH_4 and N_2O emissions decreased by 1.7 % and 0.7 % respectively,

Table ES. 4 Overview of EU-KP GHG emissions and removals from 1990 to 2019 in million tonnes CO_2 equivalent

GREENHOUSE GAS EMISSIONS	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Net CO_2 emissions/removals	4 276	3 909	3 866	3 996	3 624	3 485	3 421	3 329	3 173	3 214	3 199	3 248	3 167	3 029
CO_2 emissions (without LULUCF)	4 494	4 218	4 185	4 322	3 956	3 814	3 758	3 667	3 492	3 530	3 513	3 526	3 446	3 296
CH_4	729	673	612	552	496	486	483	472	464	464	458	460	451	443
N_2O	407	367	325	305	259	254	253	253	256	257	256	261	257	255
HFCs	29	43	53	73	99	103	106	110	112	106	106	105	99	94
PFCs	26	17	12	7	4	4	4	4	3	4	4	4	4	3
Unspecified mix of HFCs and PFCs	6	6	2	1	1	0	1	1	1	1	1	1	2	2
SF_6	11	15	10	8	6	6	6	6	6	6	6	7	7	7
NF_3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (with net CO_2 emissions/removals)	**5 485**	**5 031**	**4 881**	**4 943**	**4 490**	**4 339**	**4 274**	**4 174**	**4 015**	**4 052**	**4 030**	**4 085**	**3 985**	**3 833**
Total (without CO2 from LULUCF)	**5 702**	**5 340**	**5 200**	**5 269**	**4 821**	**4 668**	**4 611**	**4 512**	**4 335**	**4 367**	**4 345**	**4 363**	**4 265**	**4 100**
Total (without LULUCF)	**5 669**	**5 305**	**5 166**	**5 236**	**4 790**	**4 637**	**4 578**	**4 481**	**4 303**	**4 335**	**4 312**	**4 327**	**4 233**	**4 067**

Notes: CO_2 emissions include indirect CO_2. Please note that historical data may have changed from last year's Inventory Report due to recalculations

More detailed information can be found in Chapter 2.

ES-4 SUMMARY OF EMISSIONS AND REMOVALS BY MAIN SOURCE AND SINK CATEGORY

Table ES. 5 gives an overview of EU-KP GHG emissions in the main source categories for the period 1990–2019. The most important sector by far is energy (i.e. combustion and fugitive emissions), which accounted for 77 % of total EU emissions excluding LULUCF in 2019. The second largest sector is agriculture (11 %), followed by industrial processes (9 %). More detailed trend descriptions are included in the individual sector chapters (chapters 3-7).

Table ES. 5 Overview of EU-KP GHG emissions (in million tonnes CO_2-equivalent) in the main source and sink categories for the period 1990 to 2019

GHG SOURCE AND SINK	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1. Energy	4 358	4 081	4 012	4 123	3 801	3 656	3 615	3 521	3 336	3 376	3 357	3 361	3 282	3 132
2. Industrial Processes	530	506	463	473	397	395	383	383	389	381	381	390	380	370
3. Agriculture	537	469	459	437	423	422	422	424	432	433	434	437	432	429
4. Land-Use, Land-Use Change and Forestry	-184	-274	-285	-293	-300	-298	-304	-307	-288	-283	-282	-242	-247	-234
5. Waste	240	246	228	200	167	161	157	151	145	142	139	138	136	135
6. Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
indirect CO_2 emissions	4	4	3	3	2	2	2	2	2	2	2	2	2	2
Total (with net CO_2 emissions/removals)	**5 485**	**5 031**	**4 881**	**4 943**	**4 490**	**4 339**	**4 274**	**4 174**	**4 015**	**4 052**	**4 030**	**4 085**	**3 985**	**3 833**
Total (without LULUCF)	**5 669**	**5 305**	**5 166**	**5 236**	**4 790**	**4 637**	**4 578**	**4 481**	**4 303**	**4 335**	**4 312**	**4 327**	**4 233**	**4 067**

Notes: CO_2 emissions include indirect CO_2

ES-5 SUMMARY OF EU MEMBER STATE EMISSION TRENDS

Table ES. 6 gives an overview of countries' contributions to EU GHG emissions for the period 1990–2019. Countries show large variations in GHG emissions trends.

Table ES. 6 Overview of countries' contributions to total EU GHG emissions, excluding LULUCF and including indirect CO_2, from 1990 to 2019 in million tonnes CO_2-equivalent

Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Austria	78.4	79.2	80.1	92.1	84.3	82.1	79.4	79.8	76.2	78.5	79.5	81.9	78.6	79.8
Belgium	145.7	153.6	148.9	145.6	133.6	123.1	120.4	120.4	114.7	119.0	117.7	117.4	117.9	116.7
Bulgaria	100.0	72.9	57.9	62.7	59.8	65.1	60.1	54.9	58.0	61.3	58.8	61.1	57.3	56.0
Croatia	31.4	22.5	25.6	29.7	27.8	27.4	25.6	24.3	23.5	23.9	24.0	24.7	23.5	23.6
Cyprus	5.6	7.0	8.3	9.2	9.5	9.2	8.6	7.9	8.3	8.3	8.8	9.0	8.8	8.8
Czechia	198.9	157.8	150.5	148.8	140.6	139.0	135.1	129.5	127.4	128.8	130.3	131.2	129.3	123.3
Denmark	70.9	78.8	71.2	66.8	63.5	58.3	53.7	55.5	51.2	48.6	50.6	48.3	48.1	44.2
Estonia	41.0	20.3	17.5	19.3	21.2	21.3	20.1	22.0	21.2	18.1	19.8	21.1	20.2	14.7
Finland	71.2	71.8	70.3	69.9	75.7	67.9	62.5	62.9	58.7	55.1	58.1	55.3	56.3	53.1
France	544.0	536.6	548.4	551.2	508.2	483.4	484.8	485.8	454.6	457.7	460.0	463.5	444.6	436.0
Germany	1248.6	1120.6	1042.6	992.5	941.8	917.3	923.3	940.4	901.3	904.3	908.0	892.1	855.9	809.8
Greece	103.3	109.3	126.5	136.4	118.5	115.6	112.3	102.7	99.3	95.5	91.8	95.6	92.3	85.6
Hungary	94.8	77.2	74.9	76.7	66.1	64.4	61.0	58.1	58.4	61.5	62.3	64.7	64.7	64.4
Ireland	54.4	58.7	68.5	70.3	61.9	57.8	58.8	58.6	58.1	60.4	62.5	62.1	62.5	59.8
Italy	518.7	532.0	555.5	589.1	516.5	503.6	484.2	449.2	427.9	440.4	437.7	432.7	428.5	418.3
Latvia	25.9	12.5	10.1	11.0	11.8	11.0	10.9	10.8	10.7	10.7	10.7	10.8	11.3	11.1
Lithuania	47.8	22.2	19.4	22.7	20.7	21.3	21.3	20.0	20.0	20.3	20.3	20.5	20.2	20.4
Luxembourg	12.7	10.1	9.7	13.0	12.2	12.1	11.8	11.3	10.8	10.3	10.1	10.3	10.6	10.7
Malta	2.6	2.7	2.8	3.0	3.0	3.0	3.2	2.9	2.9	2.2	1.9	2.1	2.0	2.2
Netherlands	220.5	230.3	218.1	213.0	212.1	197.8	193.5	193.8	186.0	193.2	193.6	191.0	186.8	180.7
Poland	475.9	447.3	396.6	405.2	413.5	412.5	405.0	401.6	388.9	390.8	400.4	414.8	411.9	390.7
Portugal	58.9	68.8	81.9	85.9	68.9	67.5	65.6	63.7	63.6	67.8	65.9	71.0	67.3	63.6
Romania	266.4	187.4	141.7	149.1	118.3	126.4	123.9	115.0	115.2	116.4	113.5	117.0	118.2	113.9
Slovakia	73.5	53.0	48.7	50.4	45.4	44.6	42.4	41.9	39.9	40.8	41.2	42.3	42.2	40.0
Slovenia	18.6	18.7	18.6	20.4	19.6	19.5	18.9	18.2	16.6	16.8	17.6	17.7	17.5	17.1
Spain	290.0	329.4	388.2	442.1	357.9	357.6	350.3	323.5	325.6	337.0	325.5	338.7	333.3	314.5
Sweden	71.2	73.2	68.1	66.7	64.6	60.2	57.4	55.7	53.8	54.0	53.6	53.0	52.2	50.9
United Kingdom	791.4	744.8	708.1	686.2	604.9	559.8	576.6	562.7	522.7	505.3	480.5	469.6	462.9	449.2
EU-27+UK	**5662.3**	**5298.5**	**5158.6**	**5229.1**	**4781.9**	**4628.9**	**4570.6**	**4473.2**	**4295.6**	**4326.9**	**4304.6**	**4319.4**	**4224.8**	**4059.2**
Iceland	3.7	3.5	4.1	4.0	4.9	4.6	4.7	4.7	4.7	4.8	4.7	4.8	4.8	4.7
United Kingdom (KP)	794.1	747.7	711.2	689.2	607.8	562.8	579.6	565.8	525.8	508.3	483.4	472.6	465.9	452.3
EU-KP	**5668.7**	**5304.9**	**5165.8**	**5236.2**	**4789.7**	**4636.6**	**4578.3**	**4480.9**	**4303.4**	**4334.7**	**4312.2**	**4327.2**	**4232.6**	**4067.1**

The largest emitters in the EU-KP inventory in 2019 were Germany (20 % of EU-KP emissions), the UK (11 %) and France (11 %), followed by Italy (10 %), Poland (10 %) and Spain (8 %). Germany and the UK accounted for almost 50 % of the total EU GHG emission reduction between 1990 and 2019. Romania, France, Italy, Poland and the Czech Republic, together, contributed to almost another third to the total EU reduction since 1990.

The main reasons for the favourable trend in Germany were an increase in the efficiency of power and heating plants and the economic restructuring of the five new Länder after the German reunification, particularly in the iron and steel sector. Other important reasons include a reduction in the carbon intensity of fossil fuels (with the switch from coal to gas), a strong increase in renewable energy use and waste management measures that reduced the landfilling of organic waste. Lower GHG emissions in the UK were primarily the result of liberalising energy markets and the subsequent fuel switch from oil and coal to gas in electricity production. Other reasons include the shift towards more efficient combined cycle gas turbine stations, decreasing iron and steel production and the implementation of methane recovery systems at landfill sites.

A common driver to lower GHG emissions in most EU countries has been the use of less carbon intensive fuels, with a switch from coal to gas and a strong increase in the use of renewable energy sources, as well as significant improvements in energy efficiency, both in transformation and end use.

More information on GHG emission trends by country can be found in the relevant national inventory reports to UNFCCC https://unfccc.int/ghg-inventories-annex-i-parties/2021

ES-6 OTHER INFORMATION

INTERNATIONAL AVIATION AND MARITIME TRANSPORTATION

At EU-KP level, GHG emissions from international aviation increased by 144 % between 1990 and 2019 and GHG emissions from international shipping increased by 35 % during the same period. International aviation and navigation increased by 1.6 % and 0.1 %, respectively, in the last year. In 2019, international aviation accounted for 171 million tonnes CO_2 equivalent and international shipping for 149 million tonnes CO_2 equivalent.

For detailed information on emissions from international bunkers, see Chapter 3.7 of this report.

INFORMATION ON RECALCULATIONS

According to UNFCCC Reporting Guidelines, the inventory for the whole time series should be estimated using the same methodologies, and the underlying activity data and emissions factors should be used in a consistent manner, ensuring that changes in emissions trends are not introduced as a result of changes in estimation methods. Thus, recalculations of past emissions data occur every year based on GHG inventory improvements by countries, and should ensure the consistency of the time series and be carried out to improve the accuracy and/or completeness of the inventory.

Based on EU Member States', Iceland's and UK's GHG inventories in 2021, total EU GHG emissions (excluding LULUCF) for 2018 were 0.03 % lower than those reported in the 2020 GHG inventories. Total EU emissions in 1990, reported in 2021 GHG inventories, were 0.2 % higher than the 1990 emissions reported in 2020 inventories.

For detailed information on recalculations see Chapter 10 and the sector-specific recalculations in the sectoral chapters of the main report.

TABLE OF CONTENT

ES-1 BACKGROUND INFORMATION ON GREENHOUSE GAS INVENTORIES AND CLIMATE CHANGE I

ES-2 SUMMARY OF GREENHOUSE GAS EMISSIONS TRENDS IN THE EU III

ES-3 SUMMARY OF EMISSIONS AND REMOVALS BY MAIN GREENHOUSE GAS VIII

ES-4 SUMMARY OF EMISSIONS AND REMOVALS BY MAIN SOURCE AND SINK CATEGORY IX

ES-5 SUMMARY OF EU MEMBER STATE EMISSION TRENDS IX

ES-6 OTHER INFORMATION XI

1 INTRODUCTION TO THE EU GREENHOUSE GAS INVENTORY 1

1.1 BACKGROUND INFORMATION ON GREENHOUSE GAS INVENTORIES AND CLIMATE CHANGE 2
1.2 A DESCRIPTION OF THE INSTITUTIONAL ARRANGEMENTS 4
1.2.1 INSTITUTIONAL, LEGAL AND PROCEDURAL ARRANGEMENTS 4
1.2.2 OVERVIEW OF INVENTORY PLANNING, PREPARATION AND MANAGEMENT 11
1.2.3 QUALITY ASSURANCE, QUALITY CONTROL OF THE EUROPEAN UNION INVENTORY 18
1.2.4 CHANGES IN THE NATIONAL INVENTORY ARRANGEMENTS SINCE PREVIOUS ANNUAL GHG INVENTORY SUBMISSION 27
1.3 INVENTORY PREPARATION AND DATA COLLECTION, PROCESSING AND STORAGE 27
1.3.1 THE COMPILATION OF THE EU GHG INVENTORY 27
1.3.2 DOCUMENTATION AND ARCHIVING 28
1.4 BRIEF GENERAL DESCRIPTION OF METHODOLOGIES AND DATA SOURCES USED 29
1.4.1 USE OF DATA FROM EU ETS FOR THE PURPOSES OF THE NATIONAL GHG INVENTORIES IN EU MEMBER STATES 31
1.4.2 COOPERATION WITH EUROCONTROL 44
1.5 DESCRIPTION OF KEY CATEGORIES 45
1.6 GENERAL UNCERTAINTY EVALUATION 48
1.7 GENERAL ASSESSMENT OF THE COMPLETENESS 53
1.7.1 COMPLETENESS CHECKS OF MEMBER STATES' SUBMISSIONS 53
1.7.2 REPORTING OF NOTATION KEY "NE" 56
1.7.3 REPORTING OF CONFIDENTIAL DATA 56
1.7.4 DATA GAPS AND GAP-FILLING 57
1.7.5 GEOGRAPHICAL COVERAGE OF THE EUROPEAN UNION INVENTORY 58
1.7.6 COMPLETENESS OF THE EUROPEAN UNION SUBMISSION 61

2 EU GREENHOUSE GAS EMISSION TRENDS 62

2.1 AGGREGATED GREENHOUSE GAS EMISSIONS 62
2.1.1 MAIN TRENDS BY SOURCE CATEGORY, 1990-2019 62

2.1.2 MAIN TRENDS BY SOURCE CATEGORY, 2018-2019 64
2.2 EMISSION TRENDS BY GAS 67
2.3 EMISSION TRENDS BY SOURCE 76
2.4 EMISSION TRENDS BY MEMBER STATE 76
2.5 EMISSION TRENDS FOR INDIRECT GREENHOUSE GASES AND SULPHUR DIOXIDE 78

3 ENERGY (CRF SECTOR 1) 83

3.1 OVERVIEW OF SECTOR 83
3.2 SOURCE CATEGORIES 86
3.2.1 ENERGY INDUSTRIES (CRF SOURCE CATEGORY 1.A.1) 86
3.2.2 MANUFACTURING INDUSTRIES AND CONSTRUCTION (CRF SOURCE CATEGORY 1.A.2.) 131
3.2.3 TRANSPORT (CRF SOURCE CATEGORY 1A3) (EU-KP) 220
3.2.4 OTHER SECTORS (CRF SOURCE CATEGORY 1.A.4.) 278
3.2.5 OTHER (CRF SOURCE CATEGORY 1.A.5.) 327
3.2.6 FUGITIVE EMISSIONS FROM FUELS (CRF SOURCE CATEGORY 1.B) 342
3.2.7 CO_2 CAPTURE AND STORAGE (1.C) 388
3.2.8 ENERGY – NON-KEY CATEGORIES 389
3.3 METHODOLOGICAL ISSUES AND UNCERTAINTIES (EU-KP) 397
3.4 SECTOR-SPECIFIC QUALITY ASSURANCE AND QUALITY CONTROL 410
3.5 SECTOR-SPECIFIC IMPROVEMENTS 416
3.6 SECTOR-SPECIFIC RECALCULATIONS 416
3.7 COMPARISON BETWEEN THE SECTORAL APPROACH AND THE REFERENCE APPROACH (EU-KP) 417
3.8 INTERNATIONAL BUNKER FUELS (EU-KP) 420
3.8.1 AVIATION BUNKERS (EU-KP) 420
3.8.2 MARINE BUNKERS (EU-KP) 423
3.8.3 QA/QC ACTIVITIES 428
3.9 FEEDSTOCKS AND NON-ENERGY USE OF FUELS 428

4 INDUSTRIAL PROCESSES AND PRODUCT USE (CRF SECTOR 2) 443

4.1 OVERVIEW OF SECTOR 443
4.2 SOURCE CATEGORIES AND METHODOLOGICAL ISSUES 446
4.2.1 MINERAL INDUSTRY (CRF SOURCE CATEGORY 2A) 446
4.2.2 CHEMICAL INDUSTRY (CRF SOURCE CATEGORY 2B) 457
4.2.3 METAL INDUSTRY (CRF SOURCE CATEGORY 2C) 474
4.2.4 NON-ENERGY PRODUCTS FROM FUELS AND SOLVENT USE (CRF SOURCE CATEGORY 2D) 494
4.2.5 ELECTRONICS INDUSTRY (CRF SOURCE CATEGORY 2.E) 502
4.2.6 PRODUCT USES AS SUBSTITUTES FOR ODS (CRF SOURCE CATEGORY 2.F) 502
4.2.7 OTHER PRODUCT MANUFACTURE AND USE (CRF SOURCE CATEGORY 2G) 518
4.2.8 IPPU – NON-KEY CATEGORIES 524
4.3 METHODOLOGICAL ISSUES AND UNCERTAINTIES 525
4.3.1 GAP FILLING OF ACTIVITY DATA 525
4.3.2 UNCERTAINTY ESTIMATES 526
4.4 SECTOR-SPECIFIC QUALITY ASSURANCE AND QUALITY CONTROL 528

4.5 SECTOR SPECIFIC RECALCULATIONS 529

5 AGRICULTURE (CRF SECTOR 3) 531

5.1 OVERVIEW OF SECTOR 535
5.2 EMISSION TRENDS 537
5.3 SOURCE CATEGORIES AND METHODOLOGICAL ISSUES 539
5.3.1 ENTERIC FERMENTATION (CRF SOURCE CATEGORY 3.A) 540
5.3.2 MANURE MANAGEMENT - CH_4 (CRF SOURCE CATEGORY 3B1) 558
5.3.3 MANURE MANAGEMENT - N_2O (CRF SOURCE CATEGORY 3B2) 575
5.3.4 DIRECT EMISSIONS FROM MANAGED SOILS - N_2O (CRF SOURCE CATEGORY 3D1) 598
5.3.5 INDIRECT EMISSIONS FROM MANAGED SOILS - N_2O (CRF SOURCE CATEGORY 3D2) 608
5.3.6 AGRICULTURE- NON-KEY CATEGORIES 618
5.4 UNCERTAINTIES 619
5.5 SECTOR-SPECIFIC QUALITY ASSURANCE AND QUALITY CONTROL AND VERIFICATION 620
5.5.1 INTRODUCTION 620
5.5.2 QA/QC SYSTEM IN THE AGRICULTURE SECTOR 621
5.6 COMPARISON OF ACTIVITY DATA IN THE FAO GHG DATABASE ON THE NATIONAL INVENTORY REPORTS 625
5.6.1 3.A.1 ANIMAL POPULATIONS 627
5.6.2 3.B.2 NITROGEN EXCRETION 633
5.6.3 3.C RICE CULTIVATION 639
5.6.4 3.D NITROGEN INPUT TO AGRICULTURAL SOILS 640
5.6.5 3.D CULTIVATION OF HISTOSOLS 643
5.6.6 CONCLUSION 645
5.7 SECTOR-SPECIFIC RECALCULATIONS, INCLUDING CHANGES IN RESPONSE OF TO THE REVIEW PROCESS AND IMPACT ON EMISSION TREND 646

6 LULUCF (CRF SECTOR 4) 654

6.1 OVERVIEW OF THE SECTOR 654
6.1.1 TRENDS BY LAND USE CATEGORIES 655
6.1.2 CONTRIBUTION OF LAND USE CHANGES 659
6.1.3 COMPLETENESS OF THE SECTOR 660
6.1.4 DATA AND METHODS 665
6.1.5 KEY CATEGORIES 668
6.2 CATEGORIES AND METHODOLOGICAL ISSUES 668
6.2.1 FOREST LAND (CRF 4A) 668
6.2.2 CROPLAND (CRF 4B) 688
6.2.3 GRASSLAND (CRF 4C) 700
6.2.4 WETLANDS, SETTLEMENTS AND OTHER LAND (CRF TABLES 4D, 4E, 4F) 709
6.2.5 HARVEST WOOD PRODUCTS (CRF 4G) 728
6.2.6 LULUCF – NON-KEY CATEGORIES 730
6.2.7 OTHER SOURCES OF EMISSIONS: TABLES 4(I)-4(V) 733
6.2.8 EMISSIONS FROM ORGANIC SOILS IN THE EU GHG INVENTORY 745
6.3 UNCERTAINTIES 745

6.4 SECTOR-SPECIFIC QUALITY ASSURANCE AND QUALITY CONTROL AND VERIFICATION 746
6.4.1 TIME SERIES CONSISTENCY 746
6.4.2 QUALITY ASSURANCE AND QUALITY CONTROL 747
6.4.3 VERIFICATION 750
6.4.4 IMPROVEMENT STATUS AND PLAN 751
6.5 SECTOR-SPECIFIC RECALCULATIONS, INCLUDING CHANGES IN RESPONSE OF TO THE REVIEW PROCESS AND IMPACT ON EMISSION TREND. 751

7 WASTE (CRF SECTOR 5) 773

7.1 OVERVIEW OF SECTOR 775
7.2 SOURCE CATEGORIES AND METHODOLOGICAL ISSUES 778
7.2.1 SOLID WASTE DISPOSAL ON LAND (CRF SOURCE CATEGORY 5A) 779
7.2.2 BIOLOGICAL TREATMENT OF SOLID WASTE (CRF SOURCE CATEGORY 5B) 793
7.2.3 INCINERATION AND OPEN BURNING OF WASTE (CRF SOURCE CATEGORY 5.C) 799
7.2.4 WASTEWATER TREATMENT AND DISCHARGE (CRF SOURCE CATEGORY 5D) 799
7.2.5 WASTE – NON-KEY CATEGORIES 813
7.3 EU-KP UNCERTAINTY ESTIMATES 813
7.4 SECTOR-SPECIFIC QUALITY ASSURANCE AND QUALITY CONTROL 814
7.5 SECTOR-SPECIFIC IMPROVEMENTS 815

8 OTHER 816

9 INDIRECT CO_2 AND NITROUS OXIDE EMISSIONS 817

9.1 DESCRIPTION OF SOURCES OF INDIRECT EMISSIONS IN THE GHG INVENTORY 817
9.2 METHODOLOGICAL ISSUES 818
9.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY 819
9.4 CATEGORY SPECIFIC PLANNED IMPROVEMENTS 819

10 RECALCULATIONS AND IMPROVEMENTS 820

10.1 EXPLANATIONS AND JUSTIFICATIONS FOR RECALCULATIONS 820
10.2 IMPLICATIONS FOR EMISSION LEVELS 822
10.3 IMPLICATIONS FOR EMISSION TRENDS, INCLUDING TIME SERIES CONSISTENCY 828
10.4 RECALCULATIONS, INCLUDING IN RESPONSE TO THE REVIEW PROCESS, AND PLANNED IMPROVEMENTS TO THE INVENTORY 828
10.4.1 EU RESPONSE TO UNFCCC REVIEW 828
10.4.2 IMPROVEMENTS PLANNED AT EU LEVEL 864

11 KP-LULUCF 865

11.1 GENERAL INFORMATION 866
11.1.1 ELECTED ACTIVITIES UNDER ARTICLE 3(4) OF THE KYOTO PROTOCOL 866

11.1.2 Activity coverage under Article 3(3) and Article 3(4) (CRF table NIR-1) 867
11.1.3 Areas reported under the KP-LULUCF activities (KP CRF table NIR-2) 870
11.1.4 Summary overview of key categories for KP-LULUCF activities (KP CRF table NIR-3) 871
11.1.5 Summary of net emissions and removals (kt CO_2 eq.), and accounting quantities for KP-LULUCF activities (KP CRF table "Accounting") 872
11.1.6 Definition of forest and any other criteria 877
11.1.7 Information on how definitions of each activity under Article 3(3), and each mandatory and elected activity under Article 3(4) have been implemented and applied consistently over time. 879
11.1.8 Description of precedence conditions and/or hierarchy among elected Article 3(4) activities, and how they have been consistently applied in determining how each land has been classified. 879
11.2 Land-related information 880
11.2.1 Spatial assessment unit used for the determining the area of the units of land under Article 3(3) 880
11.2.2 Methodology used to develop the land transition matrix. 880
11.2.3 Maps and/or databases to identify the geographical locations, and the system of identification codes for the geographical locations. 881
11.3 Activity-specific information 883
11.3.1 Methods for carbon stock change and GHG emissions and CO_2 removal estimates 883
11.3.2 Description of the methodologies and the underlying assumptions used. 884
11.3.3 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article (3.3) and elected and mandatory activities under Article (3.4) 890
11.3.4 Information on whether or not indirect and natural CO_2 removals have been factored out. 894
11.3.5 Changes in data and methods since the previous submission (recalculations) 895
11.3.6 Improvement status and plan 898
11.3.7 Uncertainty estimates 899
11.3.8 Information on other methodological issues 899
11.3.9 The year of the onset of an activity, if after 2013 899
11.4 Article 3(3) 899
11.4.1 Information that demonstrates that activities under Article 3(3) began on or after 1 January 1990 and before 31 December of the last year of the commitment period and are direct human induced. 899
11.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation. 902
11.4.3 Information on the size and geographical location of forest areas that have lost forest cover, but which are not yet classified as deforested. 904
11.4.4 Information related to the natural disturbances provision under Article 3(3) 904
11.4.5 Information on Harvested Wood Products under Article 3(3) 906
11.5 Article 3(4) 907
11.5.1 Information that demonstrates that activities under Article 3(4) have occurred since 1 January 1990 and are human induced. 907
11.5.2 Information relating to Forest Management 907
11.5.3 Information related to the natural disturbances provision under article 3(4) 913
11.5.4 Information on Harvested Wood Products under Article 3(4) 914
11.5.5 Information relating to Cropland Management, Grazing Land Management and Revegetation, Wetland Drainage and Rewetting if elected, for the base year. 915

11.6 OTHER INFORMATION **916**
11.6.1 KEY CATEGORY ANALYSIS FOR ARTICLE 3(3) ACTIVITIES AND ANY ELECTED ARTICLE 3(4) ACTIVITY 916
11.6.2 INFORMATION RELATED TO ARTICLE 6 916

12 INFORMATION ON ACCOUNTING OF KYOTO UNITS **917**

12.1 BACKGROUND INFORMATION **917**
12.2 SUMMARY OF INFORMATION REPORTED IN THE SEF TABLES FOR THE EU REGISTRY **917**
12.3 SUMMARY OF INFORMATION REPORTED IN THE CP2 SEF TABLES OF THE EU REGISTRY. **918**
12.4 DISCREPANCIES AND NOTIFICATIONS **918**
12.5 PUBLICLY ACCESSIBLE INFORMATION **918**
12.6 CALCULATION OF COMMITMENT PERIOD RESERVE (CPR) **927**
12.7 KP-LULUCF ACCOUNTING **927**

13 INFORMATION ON CHANGES IN NATIONAL SYSTEM **928**

14 INFORMATION ON CHANGES IN NATIONAL REGISTRY **929**

15 INFORMATION ON MINIMIZING ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14 **931**

15.1 **INFORMATION ON HOW THE EU IS STRIVING, UNDER ARTICLE 3, PARAGRAPH 14, OF THE KYOTO PROTOCOL, TO IMPLEMENT THE COMMITMENTS MENTIONED IN ARTICLE 3, PARAGRAPH 1, OF THE KYOTO PROTOCOL IN SUCH A WAY AS TO MINIMIZE ADVERSE SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACTS ON DEVELOPING COUNTRY PARTIES, PARTICULARLY THOSE IDENTIFIED IN ARTICLE 4, PARAGRAPHS 8 AND 9, OF THE CONVENTION** **931**
15.2 **INFORMATION ON HOW THE EU GIVES PRIORITY, IN IMPLEMENTING THE COMMITMENTS UNDER ARTICLE 3, PARAGRAPH 14, TO SPECIFIC ACTIONS** **937**
15.3 EUROPEAN NEIGHBOURHOOD POLICY **946**

16 REFERENCES **948**

17 UNITS AND ABBREVIATIONS **955**

1 INTRODUCTION TO THE EU GREENHOUSE GAS INVENTORY

The present report is the official inventory submission of the European Union for 2021 under the UNFCCC and the Kyoto Protocol (KP).

The European Union (EU), as a party to the United Nations Framework Convention on Climate Change (UNFCCC), reports annually on greenhouse gas (GHG) inventories for the years between 1990 and the current calendar year (t) minus two (t-2), for emissions and removals within the area covered by its Member States (i.e. emissions taking place within its territory).

The UK left the EU on February 1, 2020, but applies EU law until the end of the transition period, December 31, 2020. Key provisions of Regulation (EU) No 525/2013 (“Mechanism for Monitoring and Reporting GHG”) and of Decision No 406/2009/EC (“Effort Sharing”) apply to the United Kingdom also in respect of greenhouse gases emitted during 2019 and 2020. Article 5 of Commission Regulation (EU) No 389/2013 (“EU registry”) applies to the United Kingdom until the closure of the second commitment period of the Kyoto Protocol.

In addition, the European Union, its Member States, Iceland and the United Kingdom (UK) have agreed to fulfil their quantified emission limitation and reduction commitments for the second commitment period to the Kyoto Protocol, reflected in the Doha Amendment, jointly. The Union, its Member States, the United Kingdom and Iceland agreed to a quantified emission reduction commitment that limits their average annual emissions of greenhouse gases during the second commitment period to 80 % of the sum of their base year emissions, which is reflected in the Doha Amendment. Article 4 of the Kyoto Protocol requires parties that agree to fulfil their commitments under Article 3 of the Kyoto Protocol jointly to set out in the relevant joint fulfilment agreement the respective emission level allocated to each of the parties. Council Decision (EU) 2015/1339 sets out the terms of the joint fulfilment agreement as well as the respective emission levels of each Party to that agreement. The emission levels define the Member States’, the United Kingdom’s and Iceland’s assigned amounts for the second commitment period. These emission levels have been determined on the basis of the existing Union legislation for the period 2013-2020 under the ‘Climate and Energy package’.

In this context, the EU, Iceland and the UK jointly report their national greenhouse gases emissions during the second commitment period of the Kyoto Protocol. As described above, the present report is under the UNFCCC and the Kyoto Protocol and as such the inventory presented here corresponds to the EU GHG inventory under both scopes. This report, therefore, refers to the totals of the EU-27 plus Iceland, plus the United Kingdom (EU-KP). For reasons of clarity, please note that in some cases the terms ‘Member States’ and ‘’EU’ and ‘Union’ may be used. As a general rule, these terms also include Iceland and the United Kingdom.

The EU should not be held liable for any remaining errors caused by the CRF Reporter in the review of the information submitted.

This report aims to present transparent information on the process and methods of compiling the EU GHG inventory. It addresses the relevant aspects at EU level, but does not describe detailed sectoral methodologies of the Member States’ GHG inventories. As the data used in the EU inventory are the aggregation of the scope-relevant data of the Member States inventories, the detailed sectoral methodologies used in the EU inventory are fully consistent with the methodologies reported by the Member States to the UNFCCC. As such, the complete details on the methodologies used by the

Member States are available in the national inventory reports of the Member States, which are submitted to the UNFCCC and published in the UNFCCC website. To facilitate the work of the expert review teams during the annual UNFCCC review process, and as follow up to previous review recommendations, the EU submission in 2021 includes an Annex (Annex III) with a summary description of the methodologies used by each Member State for the EU key categories. The more detailed descriptions can be found in Member State's own submissions. Note that all Member States' submissions (common reporting format (CRF) tables and inventory reports), are considered to be part of the EU inventory. Several chapters in this report refer to information provided by the Member States, where additional insights can be gained. In many cases this Member State information is presented in summary overview tables.

The EU greenhouse gas inventory has been compiled under Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC[6] (hereafter referred to as the Monitoring Mechanism Regulation or MMR). Decision No 280/2004/EC has been revised in order to enhance the reporting rules on GHG emissions to meet requirements arising from current and future international climate agreements as well as the 2009 EU Climate and energy package. The emissions compiled in the EU GHG inventory are the sum of the respective emissions in the respective national inventories, except for the Intergovernmental Panel on Climate Change (IPCC) reference approach for CO_2 emissions from the combustion of fossil fuels.

The EU-27 Member States are: Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden. Croatia is the newest Member State and accessed the EU in July 2013. Even though not all Member States were part of the European Union in 1990, GHG emissions in the EU are time-series consistent since 1990 and account for all sources and sinks of the current 27 EU MS.

1.1 Background information on greenhouse gas inventories and climate Change

The annual EU GHG inventory is required for two purposes.

Firstly, the EU, as the only regional economic integration organisation having joined the UNFCCC and the Kyoto Protocol as a Party, has to report annually on GHG inventories within the area covered by its Member States.

Secondly, under the EU GHG Monitoring Mechanism Regulation, the European Commission has to assess annually whether the actual and projected progress of Member States is sufficient to ensure fulfilment of the EU's commitments under the UNFCCC and the Kyoto Protocol, and with respect to EU legislation for reduction of GHG emissions[7]. For this purpose, the Commission has to prepare a

[6] OJ L 165, 18.06.2013, p. 13.

[7] Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (OJ L 140, 05.06.2009, p.136).

progress evaluation report, which has to be forwarded to the European Parliament and the Council. The annual EU inventory is used for the evaluation of actual progress.

The legal basis of the compilation of the EU inventory is the MMR. The MMR establishes a mechanism for inter alia: (1) ensuring the timeliness, transparency, accuracy, consistency, comparability and completeness of reporting by the Union and its Member States to the UNFCCC Secretariat; (2) reporting and verifying information relating to commitments of the Union and its Member States pursuant to the UNFCCC, to the Kyoto Protocol and to decisions adopted thereunder and evaluating progress towards meeting those commitments; (3) monitoring and reporting all anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol on substances that deplete the ozone layer in the Member States; (4) monitoring, reporting, reviewing and verifying greenhouse gas emissions and other information pursuant to Article 6 of Decision No 406/2009/EC; (5) evaluating progress by the Member States towards meeting their obligations under Decision No 406/2009/EC.

Under the provisions of Article 7 of the MMR, the Member States shall determine and report to the Commission by 15 January each year (year X) inter alia:

- their anthropogenic emissions of greenhouse gases listed in Annex I of the MMR (same as in Annex A to the Kyoto Protocol) for the year X-2, in accordance with UNFCCC reporting requirements
- data in accordance with UNFCCC reporting requirements on their anthropogenic emissions of carbon monoxide (CO), sulphur dioxide (SO2), nitrogen oxides (NOx) and volatile organic compounds, for the year X-2
- their anthropogenic greenhouse gas emissions by sources and removals of CO_2 by sinks resulting from LULUCF, for the year X-2, in accordance with UNFCCC reporting requirements
- any changes to the information referred to in points above relating to the years between 1990 and the year three-years previous (year X – 3);
- information from their national registry on the issue, acquisition, holding, transfer, cancellation, retirement and carry-over of AAUs, RMUs, ERUs, CERs, tCERs and lCERs for the year X-1;
- the elements of the national inventory report necessary for the preparation of the EU greenhouse gas inventory report, such as information on the Member State's quality assurance/quality control plan, a general uncertainty evaluation, a general assessment of completeness, and information on recalculations performed.

Submissions of updated or additional inventory data and complete national inventory reports by Member States shall be reported by 15 March.

Specific requirements on structure, format, submission processes under the MMR are detailed in an implementing Act since June 2014[8]. According to the MMR and its implementing decision the reporting requirements are exactly the same as for the UNFCCC, regarding content and format. The EU and its Member States prepare the inventory according to the relevant provisions under the UNFCCC.

[8] Commission Implementing Regulation (EU) No 749/2014 of 30 June 2014 on structure, format, submission process and review of information reported by Member States pursuant to Regulation (EU) No 525/2013 of the European parliament and of the Council (OJ L 203, 11.07.2014, p.23).

1.2 A description of the institutional arrangements

1.2.1 Institutional, legal and procedural arrangements

In accordance with the MMR Article 6(1), a Union Inventory system is established to ensure the timeliness, transparency, accuracy, consistency, comparability and completeness of national inventories with regard the Union greenhouse gas inventory. The Commission's Staff Working Document (SWD (2013) 308 final[9]) outlines the main elements of the Union inventory system. An overview is presented in Figure 1.1.

The Directorate General Climate Action of the European Commission has overall responsibility for the inventory of the European Union (EU) while each Member State is responsible for the preparation of its own inventory which is the basic input for the inventory of the European Union. DG Climate Action is supported in the establishment of the inventory by the following main institutions: the European Environment Agency (EEA) and its European Topic Centre on Climate Change Mitigation and Energy (ETC/CME) as well as the following other DGs of the European Commission: Eurostat, and the Joint Research Centre (JRC) [10].

9 https://ec.europa.eu/clima/sites/clima/files/strategies/progress/monitoring/docs/swd_2013_308_en.pdf

10 The Statistical Office of the European Communities (Eurostat) and the Joint Research Centre (JRC) are DGs of the European Commission. For simplicity reasons, these institutions are referred to as 'Eurostat' and the 'JRC' in this report.

Figure 1.1 Inventory system of the European Union

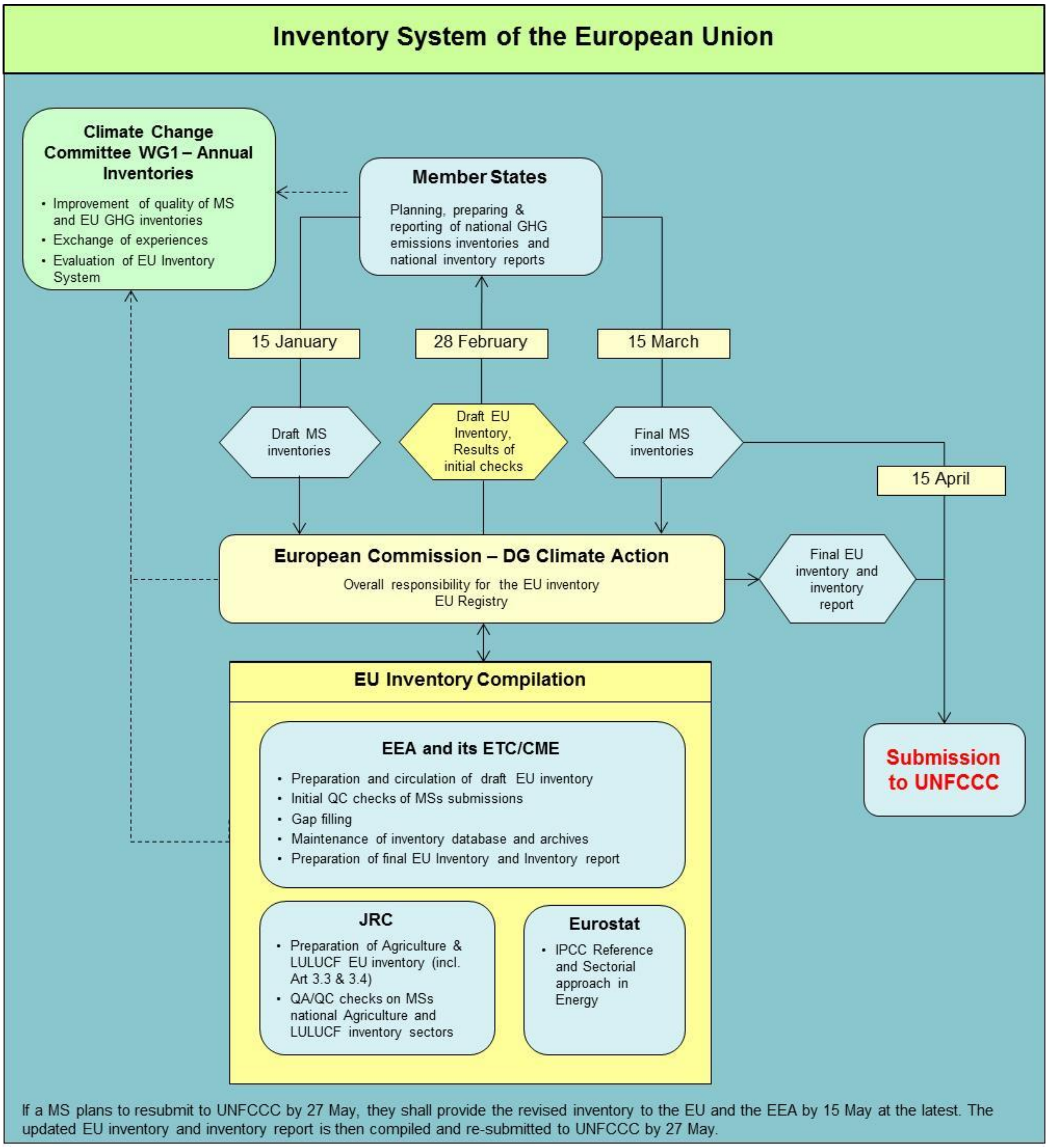


Table 1.1 shows the main institutions and persons involved in the compilation and submission of the EU inventory.

Table 1.1 List of institutions and experts responsible for the compilation of Member States' inventories and for the preparation of the EU inventory

Member State/EU institution	Contact address
Austria	Elisabeth Rigler Umweltbundesamt elisabeth.rigler@umweltbundesamt.at
Belgium	Peter Wittoeck

Member State/EU institution	Contact address
	Federal Department of the Environment
Bulgaria	Detelina Petrova Executive Environment Agency dpetrova@moew.government.bg
Croatia	Ms Vlatka Palčić and Tatjana Obučina Ministri of Environment and Energy vlatka.palcic@mzoe.hr Ms Iva Švedek Ekonerg - Energy and Environmental Protection Institute iva.svedek@ekonerg.hr
Cyprus	Theodoulos Mesimeris Department of Environment tmesimeris@environment.moa.gov.cy
Czech Republic	Ing. Eva Krtkova Czech Hydrometeorological Institute (CHMI) eva.krtkova@chmi.cz
Denmark	Ole-Kenneth Nielsen Aarhus University okn@envs.au.dk
Estonia	Anne Mändmets Ministry of the Environment Senior Officer, Climate Department anne.mandmets@envir.ee Cris-Tiina Türkson Adviser, Estonian Environmental Research Centre Cris-Tiina.Turkson@klab.ee
Finland	Riitta Pipatti Statistics Finland riitta.pipatti@stat.fi
France	Pascale Vizy Ministère de l'Environnement, de l'Energie et de la Mer (MEEM) Pascale.VIZY@developpement-durable.gouv.fr Jean-Pierre Chang Centre Interprofessionel Technique d'Etudes de la Pollution Atmosphérique (CITEPA) jean-pierre.chang@citepa.org
Germany	Dirk Günther Federal Environmental Agency Dirk.Guenther@uba.de
Greece	Mr. Kyriakos Psychas Ministry of Environment and Energy
Hungary	Mr. Gábor KIS-KOVÁCS Hungarian Meteorological Service kiskovacs.g@met.hu
Iceland	Nicole Keller, Environment Agency of Iceland, nicole.keller@umhverfisstofnun.is
Ireland	Paul Duffy Environmental Protection Agency p.duffy@epa.ie
Italy	M. Contaldi, R. de Lauretis, D. Romano National Environment Protection Agency (ANPA) riccardo.delauretis@isprambiente.it, daniela.romano@isprambiente.it

Member State/EU institution	Contact address
Latvia	Agita Gancone Ministry of Environmental Protection and Regional Development agita.gancone@varam.gov.lv
Lithuania	Ms. Jolanta Merkeliene Climate Change Policy Division of the Ministry of Environment Lithuanian Ministry of Environment j.merkeliene@am.lt
Luxembourg	Eric De Brabanter Département de l'Environnement Ministère du Développement durable et des Infrastructures eric.debrabanter@mev.etat.lu Dr. Marc Schuman Administration de l'Environnement marc.schuman@aev.etat.lu
Malta	Mr Saviour Vassallo Malta Resources Authority – Climate Change Unit Saviour.vassallo@mra.org.mt
Netherlands	Margreet van Zanten National Institute for Public Health and the Environment margreet.van.zanten@rivm.nlmailto:
Poland	Anna Olecka National Centre for Emissions Management Institute of Environmental Protection - National Research Institute anna.olecka@kobize.pl
Portugal	Eduardo Santos Agência Portuguesa do Ambiente, Departamento de Alterações Climáticas (DCLIMA)
Romania	Sorin Deaconu National Environmental Protection Agency sorin.deaconu@anpm.ro
Slovakia	Janka Szemesova Department of Emissions and Biofuels, Slovak Hydrometeorological Institute janka.szemesova@shmu.sk
Slovenia	Tajda Mekinda Majaron Environmental Agency of the Republic of Slovenia tajda.mekinda-majaron@gov.si
Spain	Maj Britt Larka Abellán Dirección General de Calidad y Evaluación Ambiental y Medio Natural Ministerio de Agricultura, Alimentación y Medio Ambiente
Sweden	Anne Wisten The Ministry of the Environment anne.wisten@regeringskansliet.se Frida Löfström The Swedish Environmental Protection Agency frida.lofstrom@naturvardsverket.se
United Kingdom	Neil Lambert Department for Business, Energy and Industrial Strategy UK Greenhouse Gas Inventory team **neil.lambert@beis.gov.uk**
European Commission	Andreas Pilzecker European Commission, DG Climate Action Andreas.PILZECKER@ec.europa.eu
European Environment Agency	Ricardo Fernandez, Claire Qoul, Melanie Sporer

Member State/EU institution	Contact address
(EEA)	European Environment Agency Ricardo.Fernandez@eea.europa.eu, Claire.Qoul@eea.europa.eu, melanie.sporer@eea.europa.eu
European Topic Centre on Climate Change Mitigation and Energy (ETC/CME)	Nicole Mandl, Günther Schmid, Elisabeth Rigler European Topic Centre on Climate Change Mitigation and Energy, Umweltbundesamt nicole.mandl@umweltbundesamt.at, michaela.gager@umweltbundesamt.at, elisabeth.rigler@umweltbundesamt.at
Eurostat	Michael Goll Statistical Office of the European Communities (Eurostat) Michael.Goll@ec.europa.eu
Joint Research Centre (JRC)	Giacomo Grassi, Adrian Leip Joint Research Centre, Directorate D – Sustainable Resources Giacomo.GRASSI@ec.europa.eu, Adrian.LEIP@ec.europa.eu

1.2.1.1 The Member States

All EU Member States are Annex I parties to the UNFCCC Therefore, all Member States have committed themselves to prepare individual national GHG inventories in accordance with UNFCCC reporting guidelines and to submit those inventories to the UNFCCC secretariat by 15 April.

In this context, all Member States are required to establish, operate and seek to continuously improve national inventory systems in accordance to Article 5 of the MMR. Detailed information on institutional arrangements/national systems of each Member State is included in the respective national inventory reports.

The European Union's inventory is based on the inventories supplied by Member States. The total estimate of the EU greenhouse gas emissions should accurately reflect the sum of Member States' national greenhouse gas inventories. Member States are responsible for choosing activity data, emission factors and other parameters used for their national inventories as well as the correct application of methodologies provided in the 2006 IPCC Guidelines. Member States are also responsible for establishing quality assurance/quality control (QA/QC) programmes for their inventories. The QA/QC activities of each Member State are described in the respective national inventory reports.

For the EU to be able to provide the GHG inventory to the UNFCCC on time, all Member States are required to report individual GHG inventories prepared in accordance with UNFCCC reporting guidelines to the European Commission and to the European Environment Agency (EEA) by 15 January every year.

After the submission of national GHG inventories and inventory reports, QA/QC checks are performed by the EU team. The outcome of these 'initial checks', together with the draft EU inventory report is sent to Member States for checking, reviewing and providing of comments. The Member States take part in the review and comment phase of the draft EU inventory report. The purpose of circulating the draft EU inventory report is to improve the quality of the EU inventory. The Member States check their national data and information used in the EU inventory report, answer to the initial checks findings and send updates, as relevant by the 15th March. In addition, they can comment on the general aspects of the EU inventory report by the same deadline.

During the UNFCCC review of the Union inventory, Member States are also required to provide answers related to the issues under their responsibility as soon as possible. In these cases, the issues are forwarded directly as requested by the EU team.

The inventory authorities of the Member States take part in the Working Group 1 'Annual Inventories' (WG1) of the Climate Change Committee established under the MMR. The purpose of the Climate Change Committee is to assist the European Commission in its tasks under the MMR. Information on the WG1 tasks and responsibilities can be found in the next paragraph, but the main task of the WG1 members is to ensure the coordination of inventory activities between the Union system and the national inventory systems.

1.2.1.2 The European Commission, Directorate-General Climate Action

The European Commission's DG Climate Action in consultation with the Member States has the overall responsibility for the EU inventory. Member States are required to submit their national inventories and inventory reports under the Monitoring Mechanism Regulation to the European Commission, DG Climate Action; and the European Commission, DG Climate Action itself submits the inventory and inventory report of the EU to the UNFCCC Secretariat, on behalf of the European Union. In the actual compilation of the EU inventory and inventory report, the European Commission, DG Climate Action, is assisted by the EEA including the EEA's ETC/ACM and by Eurostat and the JRC.

The consultation between the DG Climate Action and the Member States takes place in the Climate Change Committee established under Article 26 of the MMR. The Committee is composed of the representatives of the Member States and chaired by the representative of the DG Climate Action. Procedures within the Committee for decision-making, adoption of measures and voting are outlined in the rules of procedure, adopted in November 2003. In order to facilitate decision-making in the Committee, working groups have been established, one of which is Working Group 1 on 'Annual inventories'. The objectives and tasks of Working Group 1 under the Climate Change Committee include:

- the promotion of the timely delivery of national annual GHG inventories as required under the monitoring mechanism;
- the improvement of the quality of GHG inventories on all relevant aspects (transparency, consistency, comparability, completeness, accuracy and use of good practices);
- the exchange of practical experience on inventory preparation, on all quality aspects and on the use of national methodologies for GHG estimation;
- the evaluation of the current organisational aspects of the preparation process of the EU inventory and the preparation of proposals for improvements where needed.

1.2.1.3 The European Environment Agency

Under MMR Article 24 the role of the European Environment Agency (EEA) is defined as providing assistance to the Commission in its work. In relation to the inventories, this assistance includes the following:

(a) Compilation of the Union greenhouse gas inventory and preparation of the Union greenhouse gas inventory report;
(b) Performance of the quality assurance and quality control procedures for the preparation of the Union greenhouse gas inventory;
(c) Preparation of estimates for data not reported in the national greenhouse gas inventories;
(d) Conduction of the reviews of MS inventories.

The tasks of the EEA are facilitated by the European environmental information and observation network (Eionet), which consists of the EEA as central node (supported by European topic centres) and national institutions in the EEA member countries[11] (see http://eionet.eea.europa.eu). Member States report the information reported pursuant to Article 7 of the MMR to the Commission with a copy to the European Environment Agency, and for this reason they are making use of the EEA's ReportNet's Central Data Repository under the Eionet ('CDR', see http://cdr.eionet.europa.eu/).

Apart from the data capturing processes, and as part of its responsibility to compile the GHG inventory and prepare the Union GHG inventory report, the EEA is also responsible for the implementation of the QA/QC Programme of the EU, by performing inter alia a number of QA/QC checks focused on ensuring the completeness and consistency of the Union and Member States inventories.

Finally, in the end of the process the EEA is publishing the GHG inventory dataset and the EU National Inventory Report on its website. To facilitate the access of the GHG information to the general public, the EEA data viewer is also provided.

The EEA is further assisted by its European Topic Centre on Climate Change Mitigation and Energy (ETC/CME), which is an international consortium working with the EEA under a framework partnership agreement. The activities of the EEA's ETC/CME are further deployed in the next paragraph.

1.2.1.4 The European Topic Centre on Climate Change Mitigation and Energy

The EEA's European Topic Centre on Climate Change Mitigation and Energy (ETC/CME) was established by a contract between the lead organisation Vito (vision on technology) in Belgium and EEA for the years 2019-2021, continuing the work of the previous ETC on part of the work of the previous ETC on Air Pollution and Climate change Mitigation, which ended in 2018.

The EEA's ETC/CME involves 11 organisations and institutions in nine European countries. The technical annex of the work plan for the EEA's ETC/CME and a yearly action plan defines the specific tasks of the EEA's ETC/CME partner organisations with regard to the preparation of the EU inventory and inventory report. Environment Agency Austria is the task leader for the compilation of the EU annual inventory and inventory report in the EEA's ETC/CME. The specific tasks undertaken by EEA's ETC/CME in this task include:

- Implementation of the quality assurance and quality control (QA/QC) procedures of the EU GHG inventory national system for the compilation and submission of the Union GHG inventory to the UNFCCC. Initial QA/QC checks of Member States' submissions are performed in cooperation with Eurostat, and the JRC, and documented in the EEA review tool
- Performing the first step of the annual Effort Sharing Decision (ESD) review and identifying significant issues according to Art. 29 and 30 of the Commission Implementing Regulation (EU) No 749/2014 (MMR Implementing Regulation).
- Consultation with Member States in order to clarify data and other information provided;
- Preparation of the draft EU inventory and inventory report by 28 February based on Member States' submissions;
- Preparation of the final EU inventory and inventory report by 15 April (to be submitted by the Commission to the UNFCCC Secretariat);

[11] EEA member countries include the EU Member States, Iceland, Liechtenstein, Norway, Switzerland and Turkey.

The EEA's ETC/CME provides the CRF Aggregator developed to ensure the EU submission is fully consistent with member state's (MS) submissions. From the CRF aggregator the aggregated EU inventory is transferred into the CRF reporter software for preparing the official EU GHG inventory submission.

1.2.1.5 Eurostat

Eurostat collects national energy statistics reported under the EU Energy Statistics Regulation on an annual basis. These data are used for the estimation of the IPCC Reference Approach and the Sectoral Approach. The EEA compares the results of the two approaches with MS CRF submissions. These comparisons are sent to MS during the consultation on the Draft EU GHG inventory by 28 February. The Energy Statistics Regulation (Regulation EC/1099/2008) as amended by Commission Regulation (EU) No 147/2013 of 13 February 2013 is the basis for MS reporting of energy data to Eurostat. Article 6(2) of the Energy statistics regulation stipulates: 'Every reasonable effort shall be undertaken to ensure coherence between energy data declared in the energy statistics regulation, and data declared in accordance with Commission Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol'. The consistency of energy balances and CRF activity data is essential for good quality GHG estimates in the energy sector, and therefore it is at the core of the QA/QC activities at EU level.

1.2.1.6 Joint Research Centre

The Joint Research Centre (JRC) performs the QA/QC of the LULUCF and Agriculture sectors and is responsible of the writing of the respective chapters. The QA/QC main activity is the annual checking of early versions of the each national GHG inventory. Focus is on errors and inconsistencies, with numerous interactions with national representatives for clarifications and improvements. Specific completeness and consistency checks are also carried out. For LULUCF, additional efforts to help member states in improving their reporting include annual technical workshops (http://forest.jrc.ec.europa.eu/activities/lulucf/workshops/), dedicated EU-funded projects, the AFOLU database, and a forest growth model whose results which may be used by countries to compare with their estimates. More information is provided in the QAQC sections of the LULUCF and Agriculture chapters.

1.2.2 Overview of inventory planning, preparation and management

1.2.2.1 A description of the process of inventory preparation

The annual process of compilation of the EU inventory is summarised in Table 1.2 . The Member States submit their annual GHG inventory by 15 January each year to the European Commission's DG Climate Action using the EEA's ReportNet Central Data Repository. Then, EEA's ETC/CME, Eurostat and the JRC perform initial checks of the submitted data up to 28 February. The ETC/CME transfers the nationally submitted data from the xml-files into the CRF aggregator database which was developed for aggregating the EU submission from member state (MS) submissions. From the CRF aggregator the aggregated EU inventory is transferred into the CRF reporter software for preparing the official EU GHG inventory submission. Any information reported by MS in categories that do not have standardized UIDs or in categories for which several country settings are possible have to be included in the CRF Reporter manually.

Table 1.2 Annual process of submission and review of Member States inventories and compilation of the EU inventory

Element	Who	When	What
1. Submission of annual greenhouse gas inventories (complete common reporting format (CRF) submission and elements of the national inventory report) by Member States under Council Decision No 280/2004/EC	Member States	15 January	Elements listed in Article 7(1) of Regulation (EU) No 525/2013 and Article 3 of the implementing regulation (EU) No 749/2014
2. 'Initial checks' of Member States submissions	Commission (incl. Eurostat, the JRC), assisted by the EEA	For the Member State submission from 15 January at the latest until 28 February	Initial checks and consistency checks (by EEA). Comparison of energy data provided by Member States in the CRF with Eurostat energy data (sectoral and reference approach) by Eurostat and EEA. Check of Member States' agriculture and land use, land- use change and forestry (LULUCF) inventories by JRC (in consultation with Member States). The findings of the initial checks will be documented.
3. Compilation of draft EU inventory	Commission (incl. Eurostat, the JRC), assisted by the EEA	up to 28 February	Draft Union inventory and inventory report (compilation of Member State information), based on Member State inventories and additional information where needed (as submitted on 15 January).
4. Circulation of 'initial check' findings including notification of potential gap-filling	Commission (DG Climate Action) assisted by the EEA	28 February	Circulation of 'initial check' findings including notification of potential gap-filling and making available the findings
5. Circulation of draft **Union** inventory and inventory report	Commission (DG Climate Action) assisted by the EEA	28 February	Circulation of the draft Union inventory on 28 February to Member States. Member States check data.
6. Submission of updated or additional inventory data and complete national inventory reports by Member States	Member States	15 March	Updated or additional inventory data submitted by Member States (to remove inconsistencies or fill gaps) and complete national inventory reports.
7. Member State commenting on the draft Union inventory	Member States	15 March	If necessary, provide corrected data and comments to the draft Union inventory
8. Member State responses to the 'initial checks'	Member States	15 March	Member States respond to 'initial checks' if applicable.
9. Circulation of follow-up initial check findings	Commission assisted by EEA 31 March	Commission assisted by EEA 31 March	Circulation of follow-up initial check findings and making available the findings
10. Estimates for data missing from a national inventory	Commission (DG Climate Action) assisted by EEA	31 March	The Commission prepares estimates for missing data by 31 March of the reporting year, following consultation with the Member State concerned, and communicate these to the Member States.
11. Comments from Member States regarding the Commission estimates for missing data	Member States	7 April	Member States provide comments on the Commission estimates for missing data, for consideration by the Commission.
12. Member States responses to follow-up 'initial checks'	Member States	7 April	Member States provide responses to follow up of 'initial checks'.
13. Member States submissions to the UNFCCC	Member States	15 April	Submissions to the UNFCCC (with a copy to EEA)
14. Final annual Union inventory (incl. EU inventory report)	Commission (DG Climate Action) assisted by EEA	15 April	Submission to UNFCCC of the final annual Union inventory.
15. Any resubmissions by Member States	Member States	By 8 May	Member States provide to the Commission the resubmissions which they submit to the UNFCCC secretariat. The Member States must clearly specify which parts have been revised in order to facilitate the use for the Union

Element	Who	When	What
			resubmission. Resubmissions should be avoided to the extent possible. As the Union resubmission also has to comply with the time-limits specified in the guidelines under Article 8 of the Kyoto Protocol, the Member States have to send their resubmission, if any, to the Commission earlier than the period foreseen in the guidelines under Article 8 of the Kyoto Protocol, provided that the resubmission corrects data or information that is used for the compilation of the Union inventory.
16. **Union** inventory resubmission in response to Member States' resubmissions		27 May	If necessary, resubmission to UNFCCC of the final annual Union inventory.
17. Submission of any other resubmission after the initial check phase	Member States	When additional resubmissions occur	Member States provide to the Commission any other resubmission (CRF or national inventory report) which they provide to the UNFCCC secretariat after the initial check phase.

By 28 February, the draft EU GHG inventory and inventory report are circulated to the Member States for review and comment. The Member States check their national data and information used in the EU inventory report and send updates, if necessary, and review the EU inventory report by 15 March. This procedure should assure the timely submission of the EU GHG inventory and inventory report to the UNFCCC Secretariat and it should guarantee that the EU submission to the UNFCCC Secretariat is consistent with Member States' UNFCCC submissions.

The final EU GHG inventory and inventory report is prepared by the EEA's ETC/CME by 15 April for submission to the UNFCCC Secretariat. Resubmissions of the EU GHG inventory and inventory report are prepared by 27 May, if needed. By 8 May, Member States provide to the Commission any resubmission in response to the UNFCCC initial checks which affect the EU inventory, in order to guarantee that the EU resubmission to the UNFCCC Secretariat is consistent with the Member States' resubmissions. By the end of May the inventory and the inventory report are published on the EEA website (http://www.eea.europa.eu) and the data are made available through the EEA data service (http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-9) and the EEA GHG data viewer

(http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer.)

Table 1.3 summarises timeliness and completeness of the EU-27 Member States, Iceland and the United Kingdom (EU-KP) submissions in 2021 that were taken into account for the compilation EU GHG inventory.

Table 1.3 Date, mode and content of submission of EU-27 Member States, Iceland and the United Kingdom (EU-KP) in 2021 that were taken into account for the compilation of EU GHG inventory

MS	date	Submission mode	XML	CRF	NIR
AUT	16.04.2021	CDR	AUT_2021_2_16042021_05091683768097579647922 72.xml	1990-2019	x
BEL	14.04.2021	CDR	BEL_2021_1_13042021_02100889799703368883366 11.xml	1990-2019	x
BGR	15.04.2021	CDR	BGR_2021_1_15042021_05211860253148468377063 34.xml	1988-2019	x
CYP	16.03.2021	CDR	CYP_2021_2_12032021_20383061999357666948878 45.xml	1990-2019	
CYP	18.03.2021	CDR			x
CZE	14.04.2021	CDR	CZE_2021_1_07042021_10174623098013903792508 68.xml	1990-2019	x
DEU	03.03.2021	CDR	DEU_2021_1_01032021_10402258393639035360036 00.xml	1990-2019	
DEU	25.03.2021	CDR			x
DNM	15.04.2021	CDR	DNM_2021_1_11042021_19402667662504151392043 58.xml	1990-2019	
DNM	15.03.2021	CDR			x
ESP	07.05.2021	CDR	ESP_2021_1_09032021_23394735067899469447544 17.xml	1990-2019	x (es)
EST	15.03.2021	CDR	EST_2021_1_12032021_18220529939009286732740 57.xml	1990-2019	x
FIN	14.04.2021	CDR	FIN_2021_3_13042021_11141677451281430992210 0.xml	1990-2019	x
FRK	15.03.2021	CDR	FRK_2021_1_12032021_14060290716789789337489 36.xml	1990-2019	x (fr)
GBK	28.04.2021	CDR	GBK_2021_3_15042021_22270425435699049114490 87.xml	1990-2019	x
GRC	15.03.2021	CDR	GRC_2021_1_26022021_18300034564011842727129 26.xml	1990-2019	x
HRV	15.04.2021	CDR	HRV_2021_1_14042021_18560120309936734620103 67.xml	1990-2019	x
HUN	16.03.2021	CDR	HUN_2021_2_16032021_13083939540131495900675 81.xml	1986-2019	
HUN	22.03.2021	CDR			x
IRL	05.05.2021	CDR	IRL_2021_1_12042021_18222670695151725339368 95.xml	1990-2019	
IRL	15.03.2021	CDR			x
ITA	14.04.2021	CDR	ITA_2021_1_12042021_16592849625058998276493 56.xml	1990-2019	x
LTU	15.03.2021	CDR	LTU_2021_1_15032021_08554115267745522430553 93.xml	1990-2019	x
LUX	14.04.2021	CDR	LUX_2021_1_13042021_18390027361819174996309 29.xml	1990-2019	x
LVA	14.04.2021	CDR	LVA_2021_2_13042021_05174361718877872659494 81.xml	1990-2019	x
MLT	26.04.2021	CDR	MLT_2021_2_24032021_17214669005619147678518 72.xml	1990-2019	x
NLD	15.04.2021	CDR	NLD_2021_1_14042021_16375444888868747934128 28.xml	1990-2019	x
POL	07.05.2021	CDR	POL_2021_3_06052021_14242410090406853717359 15.xml	1988-2019	
PRT	15.03.2021	CDR	PRT_2021_1_12032021_15025888118620358608550 08.xml	1990-2019	x
ROU	29.04.2021	CDR	ROU_2021_5_21042021_09111720563230744091044 38.xml	1989-2019	
ROU	08.05.2021	CDR			x
SVK	15.03.2021	CDR	SVK_2021_3_03032021_07522313160785729645244 16.xml	1990-2019	x
SVN	15.04.2021	CDR	SVN_2021_3_11042021_22105937282057965688185 64.xml	1988-2019	x
SWE	19.02.2021	CDR	SWE_2021_1_03022021_16312132811320270335574 26.xml	1990-2019	
SWE	12.03.2021	CDR			x
ISL	15.04.2021	CDR	ISL_2021_1_12042021_19323367717255768911913 65.xml	1990-2019	x

Table 1.4 gives an overview on people involved in the compilation of the EU GHG inventory submission in 2021 and their individual responsibilities in this process.

Table 1.4 Responsibility list for the compilation of the EU GHG inventory submission in 2021

	Name	EU GHG inventory/inventory report compilation				Initial Checks			
		Overall responsibility	Project manager	Sector experts	Quality expert	Overall responsibility	QA/QC coordinator	Sector experts/ expert	Quality expert
	Andreas.PILZECKER (DG Clima) Andreas.PILZECKER@ec.europa.eu	X		Chapter 13 - Changes national system	Executive summary, chapter 1				
	Francesca LANZA (DG Clima) Francesca.LANZA@ec.europa.eu			Chapter 12 - Kyoto units, Chapter 14 - Changes to registry, EU-SEF Tables					
	BogdanVoinea (DG Clima) Bogdan.VOINEA@ext.ec.europa.eu			Chapter 14 Changes to registry, EU-SEF Tables					
	Adrian Leip (JRC) adrian.leip@ec.europa.eu				sector 3				sector3
	Simona Bosco (JRC) Simona.BOSCO@ec.europa.eu			sector 3				sector 3	
	SOLAZZO Efisio (JRC) Efisio.SOLAZZO@ext.ec.europa.eu			sector 3, plots				sector 3, plots	
	Janka Szemesova (JRC) janka.szemesova@shmu.sk				sector 3			sector 3	
	Giacomo Grassi (JRC) giacomo.grassi@ec.europa.eu				LULUCF and KP LULUCF				LULUCF and KP-LULUCF
	Raul Abad-Vinas (JRC) raul.abad-vinas@ec.europa.eu			LULUCF and KP LULUCF				LULUCF and KP LULUCF	
	Michael Goll (Eurostat) Michael.Goll@ec.europa.eu			1A Reference approach				1A Reference approach	
EEA and ETC-CME	Ricardo Fernandez (EEA) ricardo.fernandez@eea.europa.eu	X			Executive summary, chapter 1, trend chapter, chapter 10				
	Claire Qoul (EEA) claire.qoul@eea.europa.eu	X			Executive summary, chapter 1, trend chapter, chapter 10	X			
	Melanie Sporer (EEA) melanie.sporer@eea.europa.eu					X			
	Herdis Gudbrandsdottir (EEA) herdis.gudbrandsdottir@eea.europa.eu			Data checks					

Name	EU GHG inventory/inventory report compilation				Initial Checks			
	Overall responsibility	Project manager	Sector experts	Quality expert	Overall responsibility	QA/QC coordinator	Sector experts/ expert	Quality expert
Michaela Gager (ETC-CME; UBA-V) michaela.gager@umweltbundesamt.at		Data manager						
Günther Schmidt (ETC-CME; UBA-V) guether.schmidt@umweltbundesamt.at		Data manager						
Nicole Mandl (ETC-CME, UBA-V) nicole.mandl@umweltbundesamt.at		X	Executive summary, chapter 1, trend chapter			X	cross-cutting issues	cross-cutting issues
Marion Pinterits (ETC-CME; UBA-V) marion.pinterits@umweltbundesamt.at		X	1B, 1C, chapter 10			X	1B, 1C	1AB
Bernd Gugele (ETC-CME, UBA-V) bernd.gugele@umweltbundesamt.at			1AB				1AB	
Georg Wartecker (ETC-CME; UBA-V) georg.wartecker@umweltbundesamt.at			support					
Elisabeth Kampel (ETC-CME) e.kampel@klarfakt.com			support					
Eva Krtkova (ETC-CME;CHMI) eva.krtkova@chmi.cz			1A2, 1A4, 1A5	1A1, 1AB			1A2, 1A4, 1A5	1A1
Markéta Müllerová (ETC-CME; CHMI) marketa.mullerova@chmi.cz			1A2, 1A4, 1A5	1A1			1A2, 1A4, 1A5	1A1
SAARIKIVI RISTO JUHANA (ETC/CME; CHMI) ristojuhana.saarikivi@chmi.cz				sector 5				sector 5
Céline GUEGUEN (ETC-CME) celine.gueguen2@gmail.com			sector 5				sector 5	
Coralie JEANNOT (ETC-CME; CITEPA) coralie.jeannot@citepa.org			EU ETS, 2C				EU ETS, 2C	
Julien Vincent (ETC-CME; CITEPA) julien.vincent@citepa.org			1A1, 2D, 2G3-2G4, 2H	1A2, 1A4, 1A5; 1B, 1C			1A1, 2D, 2G3-2G4, 2H	1A2, 1A4, 1A5; 1B, 1C
Giorgos Mellios (ETC-CME; Emisia) giorgos.m@emisia.com			1A3 + bunkers, comparison with Eurocontrol					1A3 + bunkers
Matina Kastori (ETC-CME; Emisia) matina.k@emisia.com			1A3 + bunkers, comparison with Eurocontrol				1A3 + bunkers	
Barbara Gschrey (ETC-CME; Oeko Recherche) b.gschrey@oekorecherche.de			F-gases, 2B9 2E, 2F, 2G1-2				F-gases, 2B9 2E, 2F, 2G1-2	
Kristina Kaar (ETC-CME; Oeko Recherche) kristina.kaar@oekorecherche.de			F-gases 2E, 2F, 2G1-2				F-gases 2E, 2F, 2G1-2	
Lorenz Moosmann (ETC-CME; Oeko) l.moosmann@oeko.de			sectors 2A, 2B, Chapter 15				2A, 2B	

Name	EU GHG inventory/inventory report compilation				Initial Checks			
	Overall responsibility	Project manager	Sector experts	Quality expert	Overall responsibility	QA/QC coordinator	Sector experts/ expert	Quality expert
Lukas Emele (ETC-CME; Oeko) l.emele@oeko.de			sectors 2A, 2B,				2A, 2B,	
Bernd Gugele (ETC-CME, UBA-V) bernd.gugele@umweltbundesamt.at			1A Reference approach				1A Reference approach	
Bradley Matthews (ETC-CME, UBA-V) bradley.matthews@umweltbundesamt.at			uncertainties				uncertainties	
Maria Purzner (ETC/CME, UBA-V) maria.purzner@umweltbundesamt.at								sector 2 - f-gases only
Ils Moorkens (ETC-CME; VITO) ils.moorkens@vito.be				sector 2				sector 2 (excl. f-gases)

1.2.3 Quality assurance, quality control of the European Union inventory

1.2.3.1 Quality assurance and quality control procedures in the EU

The European Commission (Directorate General Climate Action) is responsible for coordinating QA/QC procedures for the EU inventory and ensures that the objectives of the QA/QC programme are implemented in the design of the QA/QC manual defining general and specific QC procedures for the EU GHG inventory submission. The European Environment Agency (EEA) is responsible for the annual implementation of these QA/QC procedures for the EU inventory.

The EU QA/QC programme is established in Chapter II of the Commission's Staff Working Document (SWD(2013) 308). In the EU QA/QC programme the general responsibilities for the QA/QC are defined as follows:

- The Member States are responsible for the quality of activity data, emission factors and other parameters used for their inventories, for adherence to the IPCC methodologies and the establishment of the national QA/QC programmes. As EU Member States inventories form part of the EU inventory submission information on the individual Member States QA/QC procedures can be found in their national inventory reports.
- The European Commission (DG Clima) is responsible for setting up the QA/QC Programme, ensuring the establishment and fulfilment of its objectives and ensuring the development of a QA/QC plan.
- The EEA, together with its ETC/CME, are responsible for the practical implementation and coordination of QA/QC procedures for the Union inventory, as well as for the archiving and documentation.

The following part focuses on QA/QC procedure at EU level.

The overall objectives of the EU QA/QC programme are:

- To establish quality objectives for the EU GHG inventory taking into account its specific nature of the EU GHG inventory as a compilation of MS GHG inventories:
- To implement the quality objectives in the design of the QA/QC plan defining general and specific QC procedures for the EU GHG inventory submission taking into account the specific nature of the EU GHG inventory:
- to provide an EU inventory of greenhouse gas emissions and removals consistent with the sum of Member States' inventories of greenhouse gas emissions and removals submitted to the EU and covering the EU geographical area:
- to ensure the timeliness of MS GHG inventory submissions to the EU for the compilation of the EU's GHG inventory;
- to ensure the completeness of the EU GHG inventory, inter alia by implementing procedures to estimate any data missing from the national inventories, in consultation with the MS concerned;
- to contribute to the improvement of quality of Member States' inventories and
- to provide assistance for the implementation of national QA/QC programmes.

A number of specific objectives have been elaborated in order to ensure that the EU GHG inventory complies with the UNFCCC inventory principles of transparency, completeness, consistency, comparability, accuracy and timeliness. The quality objectives are implemented via the QA/QC plan that, among others, aims at ensuring the consistency of the Union inventory with the sum of Member States inventories so that the inventory is complete in terms of both geographical and sectoral coverage. The QA/QC plan describes the quality control procedures that take place before the EU inventory compilation, for checking the consistency, completeness and correctness of the Member

States inventories, as well as during the compilation of the EU GHG inventory, for ensuring the correctness of the EU data prior to its submission. In addition, QA procedures, procedures for documentation and archiving, the time schedules for QA/QC procedures and the provisions related to the inventory improvement plan are also included.

Based on the EU QA/QC programme a quality management manual was developed which includes all specific details of the QA/QC procedures (in particular checklists and forms). The structure of the EU quality management manual has been developed on the basis of the Austrian quality management manual. The reason for using the Austrian manual as a template for the EU manual is that the EU GHG inventory is compiled by Environment Agency Austria and the implementation of the annual QA/QC procedures are coordinated by Environment Agency Austria. By using the Austrian quality manual as a template for the EU quality manual the EU can benefit from the experience made during the set-up of the Austrian quality management system which fulfils the requirements of EN ISO/IEC 17020 (Type A); procedures and documents from the Austrian system have been taken and adapted according to the need of the EU quality management system.

The EU quality management manual is structured along three main processes (management processes, inventory compilation processes and supporting processes) of the quality management system (Table 1.5).

Table 1.5 Structure of the EU quality management manual

Chapter		Chapter description
Management processes		
ETC 01	EU inventory system	Describes the organisation and responsibilities within the EU GHG inventory system
ETC 02	QA/QC programme	Describes the preparation and evaluation of the EU QA/QC programme by the European Commission
ETC 03	Quality management system	Describes the responsibilities and the structure of the quality management system and gives an overview of the forms and checklists used
ETC 04	Quality management evaluation	Describes the evaluation of the status and effectiveness of the quality management system
ETC 05	Correction and prevention	Describes the procedures for the correction and prevention of mistakes that occur in the EU inventory
ETC 06	Information technology systems	Describes the information technology systems used such as CIRCA, Reportnet and the systems set up at Environment Agency Austria
ETC 07	External communication	Describes the communication with Member States and other persons and institutions
Inventory compilation processes		
ETC 08	QC MS submissions	Describes the quality control activities performed on the GHG inventories submitted by the EU Member States
ETC 09	QC EU inventory compilation	Describes the quality control activities performed during the compilation of the EU GHG inventory including checks of database integrity
ETC 10	QC EU inventory report	Describes the checks carried out during and after the compilation of the EU GHG inventory report
Supporting processes		
ETC 11	Documents	Describes the production, change, proofreading, release and archiving of quality management documents
ETC 12	Documentation and archiving	Describes the procedure for preparing documentation and archiving

The quality checks performed during inventory compilation process are the central part of the quality manual. Quality checks are made at three levels:

QUALITY CONTROL MS SUBMISSIONS

The QC activities of MS submissions include:

Completeness checks

- Check if all gases (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3) are available for all years
- Check correct use of notation keys related to completeness
  - Check categories where a MS report the notation key "NE" and where the current guidelines include methods/emission factors
  - Check categories where MS report a notation key ("NE", "NO", "NA", "IE") and >= 20 MS report emissions
  - Check categories where MS report "NE" and in the previous years they reported emissions
- Check blank cells

Time series consistency checks

- Check time series of emissions
- Check time series of implied emission factors
- Check if identical values have been used for the last two reporting years.

Comparisons of implied emission factors across Member States

Recalculations

- Check categories where MSs provide recalculations and focus on those of more than 0.05% of national total emissions for each main gas and assess if there are potential over- or underestimates (excluding the effect of GWPs).
- Explanations for recalculations also need to be checked
- Check recalculations at more detailed category level compared to submission of the same year (e.g. recalculations between 15 January submission and 15 March submission of the same year)

EU ETS

- Check of consistency/transparency of EU ETS data with the CRF

Eurostat energy data

- Check of consistency of Eurostat energy data with the CRF

Recommendations

- Check whether recommendations from earlier Union or UNFCCC reviews, have been implemented by the Member State

Potential over- and underestimations in key categories

- Assess whether there are potential overestimations or underestimations relating to a key category in a Member State's inventory

For the communication with Member States and the documentation of the observations made by sector experts during the 'initial checks' phase the EEA Emission Review Tool (EMRT; https://emrt.eea.europa.eu/) is used. For this reason Member States nominations have been made to DG Clima and the EEA. The workflow in the tool allows the implementation of the 'four-eye' principle since the questions of the 'sectoral experts' are approved by the 'quality experts' team. Issues related to 'completeness', especially the ones that might need to be followed up by 'gap filling procedures' are also highlighted. All the issues identified in the EMRT are archived and can be accessed by the future EU sectoral and quality experts in the annual QA/QC procedures, to avoid repetition of questions on known issues.

According to the timeline provided above, the checks are performed between 15th January and 28th February.

On 28 February MS receive the EIONET/WG1 consultation package. In particular, Member States are asked to check:

1. the QA/QC findings flagged in the EMRT;
2. if the correct data/information has been included in the draft CRF tables/draft inventory report, including the information on methodologies and EFs used for the EU key categories (Annex III).

Both responses to the findings included in the EMRT and comments to the draft EU GHG inventory and inventory report are provided by latest 15 March to the EU inventory team. By that date Member States can resubmit their inventories, also correcting issues that came up during the initial checks. In order to follow up on significant issues, as provided for in the MMR, all the tools supporting the checks are re-produced and the findings in the EMRT are followed up. Between 15th March and 7th April follow-up questions and questions on new material received from MS may be asked in the EMRT.

Observations by the EU review team (first step ESD review[12]) that are not followed-up in step two and remain unresolved or partly resolved at the end of the QA/QC process in one submission year will be followed-up in the consecutive year.

QUALITY CONTROL EU INVENTORY COMPILATION

After the initial checks of the emission data, the ETC/CME transfers the national data from the xml-files into the ETC/CME CRF aggregator database. The ETC/CME CRF aggregator database is maintained and managed by Environment Agency Austria. The new CRF Aggregator has been designed in a way that the EEA can also perform the aggregation to ensure that there is always a back-up option and minimizing the risk of not submitting to the UNFCCC.

As the EU GHG inventory is compiled on the basis of the inventories of the EU Member States, the focus of the quality control checks performed during the compilation of the EU GHG inventory lays on checking if the correct MS data are used, if the data can be summed-up (same units are used) and that the summing-up is correct. Finally, the consistency and the completeness of the EU GHG inventory is checked. These checking procedures are performed by the EEA and the results are shared with the ETC/CME and are archived. Comments to these results are then provided and used as relevant for approving the inventory prior to its submission. All the checks are carried out for the original submission by 15 April each year and for any resubmission. Two checklists from the QA/QC manual are used for this purpose: 'Inventory preparation/consistency' and 'Data file integrity'.

QUALITY CHECKS EU INVENTORY REPORT

[12] See explanation of annual and comprehensive review within this chapter.

The checks carried out during and after the compilation of the EU GHG inventory report, are specified in the checklist 'EU inventory report' as defined in the QA/QC manual. They cover e.g. checks of data consistency between the inventory and the inventory report, data consistency between the tables and the text, but also layout checks. Since 2014 the EU team has also been reinforced by 'quality control' experts who have the additional task of reviewing the content and the consistency between the CRF data and tables and the NIR.

The circulation of the draft EU inventory and inventory report on 28 February to the EU Member States for reviewing and commenting also aims to improve the quality of the EU inventory and inventory report. The Member States check their national data and information used in the EU inventory report and send updates, if necessary, and review the EU inventory report. This procedure should assure the timely submission of the EU GHG inventory and inventory report to the UNFCCC secretariat and it should guarantee that the EU submission to the UNFCCC secretariat is consistent with the Member States UNFCCC submissions.

EU peer review

A collaborative internal review mechanism is established within the European Union such that all participants (MS, EEA, Eurostat, and JRC) may contribute to the identification of shortcomings and propose amendments to existing procedures. The review activities with experts from Member States are coordinated by the ETC/CME through WG1 and normally take place during the period from April through September each year. The synthesised findings of collaborative reviews provide a basis for the planned progressive development of inventories both at Member State and at EU level.

In 2014, such activities included the identification of areas where inconsistent reporting between different Member States could have taken place, in cases where the 2006 IPCC Guidelines are not sufficiently clear, and discussions on how the ETS data are used in the inventories. These discussions were followed up in 2016 and 2017, after analysing the inventory reporting of the Member States and the conclusions from the UNFCCC reviews.

In 2017, a team of Member States' experts reviewed the EU GHG NIR and provided recommendations for improvements. Several of these recommendations have been implemented in the current submission, whereas others will be taken into account in future submissions. See chapter 10 for more information.

EU internal reviews (Reviews under the 'Effort Sharing Decision')

Since 2012, seven EU internal inventory reviews have been carried out in order to determine the emission allocations 2013-2020 for the EU internal GHG emission reduction targets for 2020 and in order to determine compliance with the ESD targets. In the climate and energy package the European Union has committed itself to reduce greenhouse gas emissions by 20% below 1990 levels by 2020. The package comprises two pieces of legislation related to GHG emissions:

1. A revision and strengthening of the Emissions Trading System (ETS), the EU's key tool for cutting emissions cost-effectively. A single EU-wide cap on emission allowances will apply from 2013 and will be cut annually, reducing the number of allowances available to businesses to 21% below the 2005 level in 2020. The free allocation of allowances will be progressively replaced by auctioning, and the sectors and gases covered by the system will be somewhat expanded.

2. An 'Effort Sharing Decision' (ESD) governing emissions from sectors not covered by the EU ETS, such as transport, housing, agriculture and waste. Under the Decision each Member State has agreed to a binding national emissions limitation target for 2020 which reflects its relative wealth. The targets range from an emissions reduction of 20% by the richest Member States to an increase in emissions of 20% by the poorest. These national targets will cut the EU's overall emissions from the non-ETS sectors by 10% by 2020 compared with 2005 levels.

The ESD sets out the 2020 emission limit of a Member State in relation to its 2005 emissions, and its emission limits from 2013 to 2020 form a linear trajectory. In accordance with Article 3.2 of the ESD, the starting point of the linear trajectory is defined as the average annual ESD emissions during 2008, 2009 and 2010 in 2009 (for Member States with positive limits under Annex II of the ESD) or in 2013 (for Member State with negative limits). The annual emission allocations shall be determined using reviewed and verified emission data. Thus, complete emission inventories for the reference years (2005, and 2008-2010) had to be available and reviewed prior to determining the annual emission allocations in 2012. In order to determine compliance with the ESD targets accurate, reliable and verified information on annual greenhouse gas emissions is needed from the inventory year 2013 onwards.

The ESD reviews are coordinated by the EEA, and are carried out in two steps: Step 1 is implemented by the EU team and makes use of the procedures available in the EU QA/QC system, taking into account both the existing quality assurance/quality control procedures for Member States' emission inventory submissions under the MMR and the separate inventory review process occurring under the UNFCCC. Step 2 is implemented by independent review teams comprising of lead reviewers and sector experts. The ESD reviews are carried out either as comprehensive review or as annual review (see separate box). Further information on the ESD review can be found in the MMR (Article 19) and its implementing act (Chapter III).

The reviews under the ESD can be seen as a more robust and consistent QA of MS GHG inventories that have led to improvements in the quality of the EU and its Member States' GHG inventory submissions to UNFCCC in the years thereafter.

Specific activities for the LULUCF sector are described under Ch. 7.10 Quality Assurance and Quality control.

Annual and comprehensive ESD review

In 2012, the first comprehensive ESD review was carried out in order to determine the emission allocations 2013-2020 for the EU internal GHG emission reduction targets 2020 and respective trajectories. All 28 Member States have been reviewed by a team of 22 reviewers.

From 2015 onwards the GHG emission inventories are reviewed annually in the context of the "ESD review". The MMR enhanced the reporting rules on GHG emissions to meet reporting requirements to the UNFCCC Secretariat and introduced requirements concerning the monitoring, reporting, reviewing and verifying of GHG emissions and other information pursuant to Article 6 of the Effort Sharing Decision.
The ESD and the MMR introduced an annual compliance cycle requiring a review of Member States' greenhouse gas inventories within a shorter time frame than the current UNFCCC inventory review to enable the use of flexibilities and the application of corrective action, where necessary, at the end of each relevant year.
Article 19 of the MMR establishes an EU-internal review process to ensure that compliance with annual GHG emission limits is assessed in a credible, consistent, transparent and timely manner. The

reviewed inventory data is used to check Member States' compliance with their annual ESD targets. There are two types of reviews: annual and comprehensive. Comprehensive reviews have been carried out in 2016 and 2020 – for all other years an annual review is carried out. The annual review consists of two steps. The first step verifies the transparency, accuracy, consistency, comparability and completeness of the national inventory data. The checks of step 1 are made by the same team that carries out the initial checks before the compilation of the EU GHG inventory. If the first step of the annual review reveals a significant issue as defined by Article 19(4) of the MMR, such as overestimations or underestimations relating to a key category in a Member State's inventory, a review team performs the second step checks of the national inventory data of this Member State to identify cases where inventory data is prepared in a manner which is inconsistent with UNFCCC guidance documentation or Union rules. Where appropriate, the review team calculates the resulting technical corrections, in consultation with the concerned Member State, to correct originally submitted estimates.

In 2015, due to the problems with the CRF reporting software the annual review had to be postponed to 2016. However, the European Commission decided to organize a trial review in order to support Member States in improving their GHG inventories and to gain experience organizing reviews and reviewing under the new guidelines. In 2015, step 1 checks were made for all 28 Member States whereas step 2 was carried out only for 18 Member States which volunteered to participate in step 2.

In April-August 2016, the second comprehensive review was carried out. All 28 Member States have been reviewed by a team of 22 reviewers. As it was not possible to carry out the ESD review in 2015 due to the problems with CRF reporter software the ESD comprehensive review 2016 has been an extended review and covered the years 2005, 2008-2010 and 2013-2014. The review considered the six GHGs CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6. It did not consider NF_3 because NF_3 is not covered by the ESD. All sectors were considered with the exception of LULUCF; domestic and international aviation was also reviewed but no technical corrections were made because aviation is covered under the EU ETS and excluded under the ESD.

In 2017, 2018 and 2019 annual reviews have been performed. The annual review is a two steps process where all 28 MS have to undergo step 1 and only those Member States are subject to step 2 for which significant issues are identified during step 1.

- In 2017 15 MS were subject to step 2; the final review reports include 70 recommendations, 16 revised estimates provided by the Member States and four technical corrections calculated by the review team.
- In 2018 eleven MS were subject to step 2; the final review reports include 34 recommendations, ten revised estimates provided by the Member States and one technical correction calculated by the review team.
- In 2019 13 MS were subject to step 2. In addition Norway and Iceland participated in step 2 on a voluntary basis. The final review reports include 56 recommendations, 16 revised estimates provided by the Member States and four technical correction calculated by the review team.

In April-August 2020, the third comprehensive review was carried out. All 27 EU Member States + UK, Iceland and Norway were reviewed by a team of 28 reviewers. On the basis of the GHG inventories reviewed in 2020, the European Commission fixed the base year and the greenhouse gas emissions targets for 2030, and the trajectory years for 2021-2029. The review covered the years 2005 and 2016-2018, all gases and all sectors apart from LULUCF. The review resulted in 133 recommendations, 79 revised estimates received from countries and eight technical corrections calculated by the review team.

In 2021, an annual review is organized in order to assess compliance of the MS with the ESD targets for the inventory year 2019.

Capacity building activities based on the ESD reviews

After the ESD review in autumn, each year capacity building workshops/webinars are organized in order to discuss cases where MS had problems with implementing the 2006 IPCC guidelines and/or where the guidelines are not clear enough or where there are gaps and/or errors in the guidelines.

In 2017, four webinars were organized for following the sectors Energy, IPPU, Agriculture, and Waste. Overall experts from 26 Member States + Iceland and Norway participated in the webinars. The webinar conclusions include 55 issues, 47 of which were considered to be resolved by 30 November 2017. Eight issues have been subject to follow-up activities.

In 2018, four webinars were organized following the sectors Energy, IPPU, Agriculture, and Waste on four days. The IPPU webinar was split into two sessions following the (group of) subcategories of the ESD review 2018: (1) IPPU excluding F-gases and (2) IPPU F-gases. Overall experts from 23 Member States plus Iceland and Norway registered for the webinars. In total 110 experts registered for one or more webinars. During the webinars in 2018 the status of all open issues from previous webinars was presented and discussed. Seven out of eight follow-up issues from 2017 have been resolved and closed during 2018.

In 2019, four webinars were organized following the sectors Energy, IPPU, Agriculture, and Waste on four days. Overall 109 experts from 21 Member States registered for one or more webinars.

In 2020, four webinars were carried for the sectors Energy, IPPU, Agriculture, and Waste. As the ESD review 2020 was a comprehensive review covering all Member States a larger number of Member States' experts participated in the webinars. Overall, 176 experts from 23 Member States registered for one or more webinars.

As a result of the capacity building webinars guidance documents have been developed in order to support the Member States in improving their inventories. By April 2021 18 guidance documents are available: four for the Energy Sector; six for the IPPU Sector; four for the Agriculture Sector; four for the Waste Sector.

Apart from the capacity building webinars open to all Member States the ESD project team carried out additional capacity building targeted at specific countries in 2018, 2019 and 2020. In this context the experts:

- Provided support via e-mail or webinar for several MS related to the sectors energy, transport, F-gases, agriculture and waste;
- Organized five in-country visits in the sectors energy, transport, F-gases, agriculture and waste.

UNFCCC reviews

In addition, European Union QA procedures build on the issues identified during the independent UNFCCC inventory review of Member States' inventories. Quality assurance procedures based on outcomes of the UNFCCC inventory review consist of the:

- Annual compilation of issues identified during the UNFCCC inventory review related to sectors, key source categories and the major inventory principles transparency, consistency, completeness, comparability and accuracy for all Member States;

- Identification of major issues from the compilation and discussion of ways to resolve them in WG1, including identification and documentation of follow-up actions that are considered as necessary within WG1;
- Reviews of the extent to which issues identified through this procedure in previous years have been addressed by Member States;
- Ongoing investigations of ways to produce a more transparent inventory for the unique circumstances of the European Union.

In 2019 the European Union did not undergo an UNFCCC inventory review.

Improvement plan

Based on the findings of the UNFCCC reviews, the EU peer review, and the EU ESD review, and other recommendations the improvement plan for the EU GHG inventory and inventory report is compiled before the annual compilation process starts. After the finalisation of the annual EU GHG inventory, it is evaluated if the improvements planned have been implemented.

1.2.3.2 Further improvement of the QA/QC procedures

One of the most important activities for improving the quality of national and EU GHG inventories is the organisation of workshops and expert meetings under the EU GHG Monitoring Mechanism. Sector-specific workshops are conducted under the Monitoring Mechanism that aim to address specific inventory issues and develop follow-up activities with the aim to address problems, clarify approaches and to improve the quality of Member States' inventory submissions. The follow-up activities are subsequently addressed in meetings of WG 1 under the Climate Change Committee.

A number of other workshops and expert meetings have been organised in recent years with a focus on sector-specific quality improvements. Table 1.6 lists the most recent workshops.

Table 1.6 Overview of recent GHG inventory related workshops and expert meetings organised by the EU national

Workshop/expert meeting	Date and venue
JRC technical LULUCF workshop under the UNFCCC, the Kyoto Protocol (KP) and the EU LULUCF Decision No 529/2013	28-29 May 2019, Varese, Italy
JRC technical workshop on LULUCF reporting under the Kyoto Protocol	16-17 May 2018, Arona, Italy
Joint Workshop of the Eurostat Working Group Agro-Environmental Statistics and DG CLIMA Working Group 1	30 November 2017, ESTAT Luxembourg
JRC technical LULUCF workshop under the UNFCCC, the Kyoto Protocol (KP) and the EU LULUCF Decision No 529/2013	26-27 April 2017, Stresa, Italy
ESD capacity building webinars 2017	19 September (IPPU); 21 September (Energy); 25 September; 28 September & 6 November (Waste)
Joint workshop of the Eurostat Working Group Agro-Environmental Statistics and DG CLIMA Working Group 1	30 November 2017, Luxembourg

1.2.4 Changes in the national inventory arrangements since previous annual GHG inventory submission

There have been no major changes to the structure and functioning of the EU national inventory arrangements.

1.3 Inventory preparation and data collection, processing and storage

1.3.1 The compilation of the EU GHG inventory

The EU inventory is compiled in accordance with the recommendations for inventories set out in the 'UNFCCC guidelines for the preparation of national communications by parties included in Annex 1 to the Convention, Part 1: UNFCCC reporting guidelines on annual inventories' (FCCC/CP/2013/10/Add.3), to the extent possible. In addition, the *2006 IPCC guidelines for national greenhouse gas inventories* have been applied where appropriate and feasible. Finally, for the compilation of the EU GHG inventory, the Monitoring Mechanism Regulation and its implementing legislation is applicable.

The EU-KP GHG inventory is compiled on the basis of the inventories of the 27 Member States, Iceland and the United Kingdom. The emissions of each source category are the sum of the emissions of the respective source and sink categories of the Member States. For the reporting under the KP, this is also valid for the base year estimate of the EU-as fixed in the initial review report. As the information the initial report for the CP2 has not been included by the time of writing this report, this information cannot be provided yet.

The reference approach is calculated for the EU on the basis of Eurostat energy data (see Section 3.6) and the key category analysis (Section 1.5) is separately performed at EU level[13].

Since Member States use different national methodologies, national activity data or country-specific emission factors in accordance with IPCC and UNFCCC guidelines, these methodologies are reflected in the EU GHG inventory data. The EU believes that it is consistent with the UNFCCC reporting guidelines and the IPCC good practice guidance to use different methodologies for one source category across the EU especially if this helps to reduce uncertainty of the emissions data provided that each methodology is consistent with the IPCC good practice guidance.

In general, no separate methodological information is provided at EU level except summaries of methodologies used by Member States. The EU submission in 2016 includes an Annex with a summary description of the methodologies used by each Member State for the EU key categories. The more detailed descriptions can be found in Member State's own submissions, which are considered to be part of the EU inventory.

1.3.1.1 Internal consistency of the EU CRF tables

In principle every single EU value is aggregated from the respective value of the EU Member States. However, sometimes there are consistency problems when compiling the EU CRF tables (i.e. the sum of sub-categories is not equal to the category total) in those categories where Member States have

[13] However, the choice of the emission calculation methodology is made at Member State level and is based on the key category analysis of each individual Member State.

difficulties to allocate emissions to the sub-categories. Member States use notation keys like IE or C if they cannot provide an emission estimate for a certain sub-category. At Member State level, the use of the notation keys makes transparent the reason for not providing emission estimates. However, at EU-level, the sub-category emission value is the sum of Member States emission values and the information of the notation keys used by some Member States is lost in the EU CRF submission. In order to make this more transparent, the CRF tables now include the values or notation keys reported by the MS as comments. In order to address this problem, some source categories have been reallocated for the EU CRF tables.

A second problem is the reporting of Member States in "grey cells" or in categories that do not have standardized UIDs which then need to be included in the CRF reporter manually.

Table 1.7 lists the procedures applied for the EU-27, Iceland and the United Kingdom

Table 1.7 Manual changes in the CRF Reporter

Year	Sector	Source category	Parameter	Manual changes / inclusion in the CRF Reporter
1990-2019	Energy	1 AB, 1AC, 1AD	All	Enter Reference Approach data from Eurostat
2013-2019	Energy	1.A.1, 1.A.2, 1.B.1, 1.B.2, 2.C.1, 2.C.7	CO_2, CH_4, N_2O, NOx, NMVOC and CO	Shift differences due to SWE confidential data into 'Other fossil fuels' within the same sub-category, if the total emissions of the sub-category are available. Otherwise shift differences to 'Other' sub-category.
1990-2019	IPPU	2.B, 2.C, 2.E, 2.F, 2.G, 2.H	f gases	Enter country-specific f gases
1990-2019	IPPU	2.C.7, 2.G.4, 2.H	CO_2, CH_4, N_2O, NOx, NMVOC, SO2	Enter country-specific emissions and recovery data.
2019	IPPU	2.A.1, 2.A.2, 2.B.1	AD	Replace aggregated activity ('AD') data with gap-filled AD provided by sector experts
1990-2019	IPPU	2.A, 2.B, 2.C, 2.D, 2.G	AD	Replace aggregated AD with notation key 'NE' if an aggregation does not make sense due to inhomogeneous AD
1990-2019	Agriculture	3	CH_4, N_2O, NMVOC	Enter aggregated data from JRC
1990-2018	Agriculture	3	AD	Correct additional information with aggregated data from JRC
1990-2018	LULUCF	4.G	All	Enter aggregated data (approach B)
1990-2018	KP.LULUCF		All	Incorporate aggregated data and comments from JRC

1.3.2 Documentation and archiving

The documentation consists of quality management documentation in forms, checklists, inventory reports and correspondence. Archiving includes archiving of inventory documents and QM documents; a systematic archiving procedure is a prerequisite for a transparent inventory system.

All the material used for the compilation of the EU GHG inventory including inventory documents and QM documents are posted in the following directory:

\\Umweltbundesamt.at\projekte\1000\1840 ETC CME\Intern\0 ETC CME 2021\2.1.1.1 GHG inventory

There are four sub-directories under this directory:

1. \Inventory
2. \Archive
3. \Quality manual
4. \General

The Member States submissions and all correspondence are stored in the sub-directory\Archive. The central tool for documenting all the material received from MS (including correspondence) is the MS archive database which includes references, short characterisations and links to e-mails for all MS submissions. The MS archive database can be searched for documents (CRF, XML, NIR, etc.) or for mails. Each submission is numbered consecutively.

1.4 Brief general description of methodologies and data sources used

For the key categories (see Chapter 1.5) the most accurate methods for the estimation of the greenhouse gas inventory should be used. Table 1.8 gives an overview on the share of emissions for which higher tiers are used in the EU 27, Iceland and the United Kingdom for all key categories for which this estimation was possible.

Table 1.8 Share of higher tier methodologies used on the total of each EU key categories (excluding LULUCF)

Source category gas	Share of higher Tier
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	96.6 %
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	95.6 %
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	93.4 %
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	97.1 %
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	95.3 %
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	98.6%
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	95.3%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	94%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)	97%
1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)	99.8%
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	99.2%
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	99.9%
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	95.8%
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	93.1%
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	99.3%
1.A.2.c Chemicals: Liquid Fuels (CO_2)	92.8%
1.A.2.c Chemicals: Solid Fuels (CO_2)	99.9%
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	92.1%

Source category gas	Share of higher Tier
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)	86.5%
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)	96.3%
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	97.6%
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	58.4%
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	96.0%
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	98.7%
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	96.0%
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	69.8%
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	99.1%
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	98.7%
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	98.7%
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)	98.7%
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	93.7%
1.A.3.b Road Transportation: Diesel Oil (CO_2)	88.7%
1.A.3.b Road Transportation: Diesel Oil (N_2O)	88.7%
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	84.8%
1.A.3.b Road Transportation: Gasoline (CH_4)	92.2%
1.A.3.b Road Transportation: Gasoline (CO_2)	92%
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	96.8%
1.A.3.b Road Transportation: Other Fuels (CO_2)	70.1%
1.A.3.c Railways: Liquid Fuels (CO_2)	70.4%
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	82.5%
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	67.8%
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	95%
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	96%
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	98%
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	100%
1.A.4.b Residential: Biomass (CH_4)	62%
1.A.4.b Residential: Gaseous Fuels (CO_2)	100%
1.A.4.b Residential: Liquid Fuels (CO_2)	99%
1.A.4.b Residential: Solid Fuels (CH_4)	13%
1.A.4.b Residential: Solid Fuels (CO_2)	100%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	90%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	88%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	98%
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	100%
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	49%
1.B.1.a Coal Mining and Handling: Operation (CH_4)	82%
1.B.2.a Oil: Operation (CH_4)	55%
1.B.2.a Oil: Operation (CO_2)	82%
1.B.2.b Natural Gas: Operation (CH_4)	80%
1.B.2.c Venting and Flaring: Operation (CO_2)	77%
2.A.1 Cement Production: no classification (CO_2)	100%
2.A.2 Lime Production: no classification (CO_2)	99.98%

Source category gas	Share of higher Tier
2.A.4 Other Process Uses of Carbonates: no classification (CO_2)	96.22%
2.B.1 Ammonia Production: no classification (CO_2)	97.3%
2.B.2 Nitric Acid Production: no classification (N_2O)	88.0%
2.B.3 Adipic Acid Production: no classification (N_2O)	100.0%
2.B.8 Petrochemical and Carbon Black Production: no classification (CO_2)	66.6%
2.B.9 Fluorochemical Production: no classification (HFCs)	100.0%
2.B.9 Fluorochemical Production: no classification (Unspecified mix of HFCs and PFCs)	100.0%
2.B.10 Other chemical industry: no classification (CO_2)	81.1%
2.C.1 Iron and Steel Production: no classification (CO_2)	98,1%
2.C.3 Aluminium Production: no classification (PFCs)	100%
2.F.1 Refrigeration and Air conditioning: no classification (HFCs)	98%
2.F.4 Aerosols: no classification (HFCs)	93%
3.A.1 Enteric Fermentation: Cattle (CH_4)	99%
3.A.2 Enteric Fermentation: Other Sheep (CH_4)	91%
3.A.4 Enteric Fermentation: Other livestock (CH_4)	51%
3.B.1 CH_4 Emissions: Farming (CH_4)	96%
3.B.2 N_2O and NMVOC Emissions: Farming (N_2O)	97%
3.D.1 Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O)	41%
3.D.2 Agricultural Soils: Farming (N_2O)	26%
5.A.1 Managed Waste Disposal Sites: Waste (CH_4)	95,0%
5.A.2 Unmanaged Waste Disposal Sites: Waste (CH_4)	94.2%
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	42,0%
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	49.1%
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	20.6%

1.4.1 Use of data from EU ETS for the purposes of the national GHG inventories in EU Member States

1.4.1.1 Overview

In January 2005 the European Union Greenhouse Gas Emission Trading System (EU ETS) commenced operation as the largest multi-country, multi-sector Greenhouse Gas Emission Trading System world-wide, based on Directive 2003/87/EC (European Community 2003). The European emissions trading system (EU ETS) covers around 11,700 installations in 31 participating countries. Besides the 28 Member States of the European Union, Norway, Iceland and Liechtenstein joined the EU ETS in 2008.

Emissions trading under the EU ETS has taken place in three ‘trading periods’ so far (2005–2007, also referred to as Phase I; 2008–2012 or Phase II; 2013–2020 or Phase III). The EU ETS Directive was amended in 2009 to improve and extend the EU ETS. The main changes in the third trading period compared to previous trading periods are:

- A single, EU-wide cap on emissions applies in place of the previous system of national caps;

- Auctioning, not free allocation, is the default method for allocating allowances. For allowances allocated for free, harmonised allocation rules apply which are based on EU-wide benchmarks of emissions performance;

- Inclusion of additional activities and gases, such as N_2O from production of nitric, adipic, glyoxal and glyoxylic acid production, PFCs and CO_2 from primary and secondary aluminium production, CO_2 from production and processing of ferrous metals and non-ferrous metals, CO_2 from manufacture of mineral wool, CO_2 from drying and calcination of gypsum or plaster boards, CO_2 emissions from carbon back production, CO_2 from ammonia production, CO_2 from bulk organic chemicals production, CO_2 from hydrogen production, CO_2 from soda ash and sodium bicarbonate production and CO_2 from CO_2 capture, transport and storage in storage sites).

- The aviation sector has been included in the EU ETS since 1 January 2012. The aviation sector, in the EU ETS context covering flights internal to the European Economic Area, has a separate cap to power stations and other fixed installations which is reduced at a slower rate. Surrender of emission allowances and reporting for 2013 is not required until 2015, and the inclusion of flights to and from countries outside the European Economic Area has been postponed until after 31st December 2016 (EU 2014);

- Regulations for accreditation and verification (EU 2018a) and for monitoring and reporting were adopted (EU 2018b).

Articles 14 and 15 of the Emission Trading Directive require Member States to ensure that emissions are monitored, reported and verified in accordance with legal requirements in the monitoring and reporting regulation (MRR) (EU 2018b) and in the accreditation and verification regulation (AVR) (EU 2018a), starting from 1 January 2013 (Phase III). All installations covered by the EU ETS have been required to monitor and report their emissions annually. Data for the installations covered by the EU ETS are reported by operators to national competent authorities based on a monitoring plan, elaborated by the operator and approved by the national competent authority, in accordance with the methodologies established in the monitoring and reporting regulation. The reported emissions for each installation are included in an annual emission report that must be verified by accredited verifiers in accordance with the provisions of the regulation on the verification of GHG emission reports (EU 2018a).

Similar to the IPCC 2006 Inventory Guidelines, the EU ETS monitoring and reporting regulation is based on a tier system which defines a hierarchy of different ambition levels for methods, activity data, calculation factors (such as emission factors, oxidation or conversion factors). The operator must, in principle, apply the highest tier level established in the MRR for his installation category, unless he can demonstrate to the competent authority that this is technically not feasible or would lead to unreasonably high costs. The operator must periodically prepare and submit to the competent authorities an improvement report, aiming at improvement of the accuracy of the greenhouse gas emissions.

Thus, the EU ETS generates an EU-28 data set on verified installation-specific emissions for the sectors covered by the scheme. For 2019 the main activities, number of entities and verified emissions reported under the EU ETS are presented in Table 1.9.

Table 1.9 Activities and emissions covered by the EU ETS in 2019 (Member States and United Kingdom)

Main activity	**Activity code**	**Number of entities**	**Verified emissions (Mt CO_2-eq.)**
Combustion of fuels	20	7 576	941
Refining of mineral oil	21	138	121
Production of coke	22	20	10
Metal ore roasting or sintering	23	9	3
Production of pig iron or steel	24	244	118
Production or processing of ferrous metals	25	254	10
Production of primary aluminium	26	33	5
Production of secondary aluminium	27	34	1
Production or processing of non-ferrous metals	28	90	7
Production of cement clinker	29	259	120
Production of lime, or calcination of dolomite/magnesite	30	298	30
Manufacture of glass	31	370	18
Manufacture of ceramics	32	1 064	15
Manufacture of mineral wool	33	53	2
Production or processing of gypsum or plasterboard	34	40	1
Production of pulp	35	178	5
Production of paper or cardboard	36	586	22
Production of carbon black	37	18	2
Production of nitric acid	38	36	4
Production of adipic acid	39	3	0
Production of glyoxal and glyoxylic acid	40	1	0
Production of ammonia	41	29	20
Production of bulk chemicals	42	363	34
Production of hydrogen and synthesis gas	43	42	9
Production of soda ash and sodium bicarbonate	44	14	4
Capture of greenhouse gases under Directive 2009/31/EC	45	2	0,0002
Transport of greenhouse gases under Directive 2009/31/EC	46	1	0,0015
Other activity opted-in under Art. 24	99	249	1
All stationary installations		12 004	1 503

Source: EEA, 2021 (EU ETS data viewer)

1.4.1.2 Mapping table between EU ETS activities and CRF categories (Table 1.10)

The table below indicates the mapping between the EU ETS activities and the IPCC/CRF categories, with supporting comments. Such table is based on the scope of the EU ETS in the third phase and the CRF categories based on the revised UNFCCC reporting guidelines (decision 24/CP.19) that implemented the 2006 IPCC Guidelines.

The legal framework defining the scope and the methodologies for the reporting of greenhouse gas emissions under the EU ETS presents differences compared to the 2006 IPCC guidelines. These differences lead to a different way of reporting emissions under the EU ETS and in the GHG inventory. Some of these differences may also prevent inventory compilers from using verified emissions reported under the EU ETS directly for emission reporting in the national GHG inventory. In order to use greenhouse gas emissions reported under the EU ETS in the national inventories, the inventory compilers need to deal with these differences.

Table 1.10 Mapping table outlining the correspondence of CRF categories related to the EU ETS activities

EU ETS activity	CRF category	Comment
20 Combustion of fuels	1.A.1.a Public electricity and heat production 1.A.1.b Petroleum refining 1.A.2.a Iron and steel 1.A.2.b Non-ferrous metals 1.A.2.c Chemicals 1.A.2.d Pulp, paper and print 1.A.2.e Food processing, beverages and tobacco 1.A.2.f Non-metallic minerals 1.A.2.g Other 1.A.3.e Other transportation (pipeline transport) 1.A.4.a Commercial/ Institutional 1.A.4.c Agriculture/ Forestry / Fisheries 1.B Fugitive emissions from fuels	• For standalone combustion installations, EU ETS covers combustion of fuels in installation with a total rated thermal input exceeding 20 MW. For GHG inventories no such threshold applies. • In the GHG inventory, emissions are classified based on the purpose of the combustion activity, while such a differentiation does not exist in the definition of EU ETS activities. • Installations for the incineration of hazardous or municipal waste are excluded in the definition of 'combustion activities' under the EU ETS, but included in GHG inventories. Installations used for research, development and testing of new products and processes are also not covered by the ETS Directive according to Annex I paragraph 1. • In the EU ETS an installation with different types of activities is classified according to the activity with predominant emissions, while in the inventory such activities should be reported in separate categories if so defined. This difference mostly applies in cases of large integrated installations. • Usually a very small share of EU ETS emission from fuel combustion falls in the category of 1.A.4.a Commercial/ Institutional and 1.a.4.c Agriculture/ Forestry/ Fisheries as installations in these sectors mostly are below the EU ETS threshold.
21 Refining of mineral oil	1.A.1.b Petroleum refining 1.A.1.c Manufacture of solid fuels and other energy industries 1.A.2.c Chemicals 1.B.2.c Venting and flaring 1.B.2.a.iv Fugitive emissions from oil refining/ storage 2.B.8 Petrochemical and carbon black production	EU ETS activity covers CO_2 emissions from combustion and also fugitive and process emissions. Emission sources reported under these activities are allocated to different CRF categories in the inventory: • Combustion emissions →1.A.1.b Petroleum refining • Flaring emissions → 1.B.2.c Venting and flaring • Refining → 1.B.2.a.iv Oil Refining/ storage • Hydrogen production → may be reported in 1.B.2.a.iv refining/ storage or in 2.B.10 Other chemical industry • Coke production / calcination → 1.A.1.c.i Manufacture of solid fuels

EU ETS activity	CRF category	Comment
		• Flue gas scrubbing → 1.A.1.b Petroleum refining • Gasification of heavy fuel oil, methanol production → 2.B.8 Petro-chemical and carbon black production • Production of terephtalic acid → 2.B.10 Other chemical industry • Claus plants → 1.A.1.b Petroleum refining
22 Production of coke	1.A.1.c Manufacture of solid fuels and other energy industries 1.B Fugitive emissions 1.A.2 Manufacturing Industries 2.C.2 Iron and Steel	• Scopes of EU ETS and 2006 IPCC Guidelines are generally consistent, however EU ETS emissions may be allocated to several CRF categories in the inventory. • The use of mass balance approaches in integrated iron and steel installations may complicate allocation between iron and steel categories and coke production.
23 Metal ore roasting or sintering, including palletisation	1.A.2a Iron and steel 2.C.1 Iron and steel production 2.C.5 Lead production 2.C.6 Zinc production 2.C.7 Other metal production	• No clear separate category for this EU ETS activity in the inventory, allocation depends on the metal type • Combustion emissions should be allocated to 1.A.2a Iron and steel • Process emissions should be allocated to 2.C.1 Iron and steel production or other metal production categories under industrial processes
24 Production of pig iron or steel including continuous casting	1.A.2.a Iron and steel 2.C.1 Iron and steel production 1.B Fugitive emissions 1.A.1.c Manufacture of solid fuels and other energy industries	• Emissions are included in EU ETS only for those pig iron or steel installations with a capacity exceeding a threshold of 2.5 tonnes per hour while in GHG inventories there is no threshold. • EU ETS activity includes combustion and process emissions. • Combustion emissions should be allocated to 1.A.2a Iron and steel • Process emissions should be allocated to 2.C.1 Iron and steel production • Emissions from coke production should be allocated to 1.A.1.c Manufacture of solid fuels and other energy industries • Clear separation of combustion and process emissions is not always possible when mass balance approaches are used. • Comparability of emissions is influenced by the allocation of the transfer of CO_2 in the process gases (coke oven gas, blast furnace gas, basic oxygen furnace gas) to EU ETS activities as well as to CRF categories. Article 48 of the EU ETS MRR specifies the allocation of inherent CO_2 which results from an EU ETS activity and is contained in a gas which transferred to other installations as a fuel. If transfers of inherent CO_2 take place between EU ETS installations, the CO_2 transferred should not be counted as emissions for the installation of origin, but for the installation where it is finally emitted. However, if the transfer occurs to an installation outside the EU ETS scope, the transferring installation has to account for the emissions.
25 Production or processing of ferrous metals	1.A.2.a Iron and steel 2.C.1. Iron and steel production 2.C.2 Ferroalloys production 1.A.1.c Manufacture of solid fuels and other energy industries	• Emissions are included in EU ETS only for those ferroalloy production installations exceeding rated thermal input of 20 MW while in GHG inventories there is no threshold. • EU ETS scope of activity 25 covers CO_2 emissions related to the production or processing of ferrous

EU ETS activity	CRF category	Comment
		metals from: • conventional and alternative fuels, • reducing agents including coke, • graphite electrodes, • raw materials including limestone and dolomite, • carbon containing metal ores and concentrates, • secondary feed materials. • Combustion related emissions from EU ETS activity code 25 are included in in CRF 1.A.2.a. Iron and Steel • Process related emissions can be included in CRF 2.C.1 Iron and steel production or 2.C.2. Ferroalloys Production
26 Production of primary aluminium	2.C.3 Aluminium production 1.A.2.b Non-ferrous metals	• In EU ETS operators shall report emissions from the production of electrodes for primary aluminium smelting, including stand-alone-installations for the production of such electrodes. The operator shall considerCO_2 emissions from: fuels for the production of heat or steam, electrode production, reduction of Al2O3 during electrolysis which is related to electrode consumption, use of soda ash or other carbonates for waste gas scrubbing. • For PFC emissions resulting from anode effects the scope of the EU ETS activity and CRF category 2.C.3 are consistent. • CRF category 1.A.2.b Non-ferrous metals includes combustion emission and emission from waste gas scrubbing. • Emissions from electrode consumption in EU ETS activity code 26 are included in CRF 2.C.3 Aluminium Production. • PFC emissions are allocated to 2.C.3 Aluminium production.
27 Production of secondary aluminium	1.A.2.b Non-ferrous metals	• Emissions are included in EU ETS only for installations exceeding rated thermal input of 20 MW while in GHG inventories there is no threshold. • In secondary aluminium production no process emissions occur therefore all emissions in activity code 27 are from fuel combustion and are reported in CRF category 1.A.2.b Non-ferrous metals.
28 Production or processing of non-ferrous metals	1.A.2.b Non-ferrous metals 2.C.4 Magnesium production 2.C.5 Lead production 2.C.6 Zinc production 2.C.7 Other metal production	• Emissions are included in EU ETS only for non-ferrous metals production or processing installations exceeding rated thermal input of 20 MW (including reducing agents) while in GHG inventories there is no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 28 are included in CRF 2.C.4 Magnesium Production, 2.C.5 Lead production, 2.C.6 Zinc Production and 2.C.7 Other metal industry. • 2006 IPCC Guidelines do not provide methodologies for metals other than iron and steel, ferroalloys, aluminium, magnesium, lead and zinc while the EU ETS has a broader scope and covers, e.g. copper production.
29 Production of cement clinker in rotary kilns	2.A.1 Cement Production 1.A.2.f Non-metallic minerals	• Emissions are included in EU ETS only for installations with production capacity exceeding 500 tonnes per day or in other furnaces with capacity

EU ETS activity	CRF category	Comment
		exceeding 50 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 29 are included in CRF 2.A.1 Cement Production • Combustion related emissions from ETS activity code 29 are included in CRF 1.A.2.f. Non-metallic minerals
30 Production of lime, or calcination of dolomite/magnesite in rotary kilns or in other furnaces	2.A.2 Lime production 1.A.2.f Non-metallic minerals	• Emissions are included in EU ETS only for installations with production capacity exceeding 50 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 30 are included in CRF 2.A.2 Lime Production • Combustion related emissions from EU ETS activity code 30 are included in CRF 1.A.2.f. Non-metallic minerals • Non-marketed lime production in some industries such as iron and steel or sugar refining are included in the inventory in category 2.A.2, but may be included in the EU ETS in the dominant activity, e.g. iron and steel industry or fuel combustion.
31 Manufacture of glass including glass fibre	2.A.3 Glass production 1.A.2.f Non-metallic minerals	• Emissions are included in EU ETS only for installations with a melting capacity exceeding 20 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 31 are included in CRF 2.A.3 Glass Production • Combustion related emissions from EU ETS activity code 31 are included in CRF 1.A.2.f. Non-metallic minerals
32 Manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain	2.A.4 Other process uses of carbonates 1.A.2.f Non-metallic minerals	• Emissions are included in EU ETS only for installations with a production capacity exceeding 75 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 32 are included in CRF 2.A.4 Other process uses of carbonates • Combustion related emissions from EU ETS activity code 32 are included in CRF 1.A.2.f. Non-metallic minerals • EU ETS method A is based on carbonate input and is equivalent to IPCC tier 1 to 3 methods. EU ETS method B based on the alkali oxide output in the product has no equivalent method in the 2006 IPCC Guidelines. IPCC Guidelines also do not provide methods to estimate emissions from additives.
33 Manufacture of mineral wool insulation material using glass, rock or slag	2.A.3 Glass production 2.A.4 Other process uses of carbonates 2.A.5 Other	• Emissions are included in EU ETS only for installations with a melting capacity exceeding 20 tonnes per day. Inventory methodology has no threshold.

EU ETS activity	CRF category	Comment
	1.A.2.f Non-metallic minerals	• EU ETS activity includes combustion and process emissions. • 2.A.3 Glass Production includes emissions from the production of glass wool, a category of mineral wool, where the production process is similar to glass making. Where the production of rock wool is emissive these emissions should be reported under IPCC Subcategory 2A5.
34 Drying or calcination of gypsum or production of plaster boards and other gypsum products	1.A.2.f Non-metallic minerals	• EU ETS covers CO_2 emissions from this activity, where combustion units have a total rated thermal input exceeding 20 MW. For GHG inventories no such threshold applies. • EU ETS activity only includes combustion-related emissions
35 Production of pulp from timber or other fibrous materials	1.A.2.d Pulp, paper and print 2.A.4 Other process uses of carbonates (soda ash use)	• EU ETS activity includes combustion and process emissions. • Combustion related emissions from EU ETS activity code 35 are included in CRF 1.A.2.d. • Process related emissions are included in 2.A.4. Other process uses of carbonates
36 Production of paper or cardboard	1.A.2.d Pulp, paper and print 2.A.4 Other process uses of carbonates (soda ash use)	• EU ETS activity includes combustion and process emissions. • Threshold in EU ETS: installations involved in the production of paper or cardboard a production capacity exceeding 20 tonnes per day. Inventory methodology has no threshold. • Combustion related emissions from EU ETS activity code 36 are included in CRF 1.A.2.d. • Process related emissions are included in 2.A.4 Other process uses of carbonates
37 Production of carbon black involving the carbonisation of organic substances such as oils, tars, cracker and distillation residues	2.B.8 Petrochemical and carbon black production 1.A.2.c Chemicals	• EU ETS covers CO_2 emissions from this activity, where combustion units have a total rated thermal input exceeding 20 MW. For GHG inventories no such threshold applies. • EU ETS activity includes combustion and process emissions.
38 Production of nitric acid	2.B.2. Nitric acid production 1.A.2.c Chemicals	• Scopes of EU ETS and 2006 IPCC Guidelines for CO_2 emissions from nitric acid production are consistent. • EU ETS activity includes combustion and process emissions. • For EU ETS activity 38 all N_2O emissions are process-related and should be allocated to 2.B.2 Nitric acid production • CO_2 emissions in activity code 38 are from fuel combustion and should be allocated to 1.A.2.c Chemicals
39 Production of adipic acid	2.B.3. Adipic acid production (CO_2) 1.A.2.c Chemicals	• Scopes of EU ETS and 2006 IPCC Guidelines for CO_2 emissions from Adipic Acid production are consistent. • EU ETS activity includes combustion and process emissions. • For EU ETS activity 39 all N_2O emissions are process-related and should be allocated to CRF code 2.B.3 Adipic Acid Production • CO_2 emissions in activity code 38 are from fuel combustion and should be allocated to 1.A.2.c Chemicals

EU ETS activity	CRF category	Comment
40 Production of glyoxal and glyoxylic acid	2.B.4. Caprolactam, glyoxal and glyoxylic acid production 1.A.2.c Chemicals	• Scopes of EU ETS and 2006 IPCC Guidelines for N_2O emissions from glyoxal production and glyoxylic acid production are consistent. • EU ETS activity includes combustion and process emissions. • N_2O emissions should be allocated to CRF code 2.B.4 Caprolactam, glyoxal and glyoxylic acid production • CO_2 emissions in activity code 40 are from fuel combustion and should be allocated to 1.A.2.c Chemicals

41 Production of ammonia	2.B.1. Ammonia production
	CO_2 captured for urea production:
	3.H Urea Application
	1.A.3.b Road transport
	2.D.3 Other non-energy products from fuels and solvent use
		• EU ETS scope of activity code 41 ammonia production includes
		  • combustion of fuels supplying the heat for reforming or partial oxidation,
		  • fuels used as process input in the ammonia production process (reforming or partial oxidation),
		  • fuels used for other combustion processes including for the purpose of producing hot water or steam.
		• According to 2006 IPCC Guidelines to avoid double counting, fuel consumption in ammonia production should be reported under Ammonia production. In this regard EU ETS and IPCC scopes are consistent.
		• In the inventory CO_2 from ammonia production which is recovered and used for urea production is subtracted and reported by the users. Urea use can be reported in different CRF sectors, e.g. in 1.A.3.b Road transport, 3.H Urea application in agriculture, 2.D.3 Other (e.g. in industry catalysts). Under the EU ETS the CO_2 transfer via urea out of the EU ETS system cannot be deducted from ammonia production.

42 Production of bulk organic chemicals by cracking, reforming, partial or full oxidation or by similar processes	2.B.8 Petrochemical and carbon black production 2.B.10 Other chemical industry 1.A.2.c Chemicals	• Emissions are included in EU ETS only for installations with a production capacity exceeding 100 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • The combustion related emissions are allocated to CRF code 1.A.2.c Chemicals. • Some of the emissions reported under this EU ETS activity could be allocated to CRF category 2.B.8 Petrochemical and carbon black production (e.g. CO_2 process emissions) • Some of the emissions reported under this EU ETS activity could be allocated to CRF category 2.B.10 Other chemical industry (e.g. CO_2 emissions from flaring in chemical industry)
43 Production of hydrogen and synthesis gas by reforming or partial oxidation	1.A.2.c Chemicals 2.B.1. Ammonia production 2.B.8 Petrochemical and carbon black production 2.B.10 Other chemical industry 1.B.2.a.iv Fugitive emissions from oil refining/ storage	• Emissions are included in EU ETS only for installations with a production capacity exceeding 25 tonnes per day. IPCC methodology has no threshold. • EU ETS activity includes combustion and process emissions. • In the CRF, there is no separate reporting category for emissions from hydrogen production. Hydrogen and synthesis gas production are recognised as part of integrated chemical production. Therefore, MS

EU ETS activity	CRF category	Comment
		have chosen different approaches for the inclusion of emissions from hydrogen production (e.g. 2.B.8 or 2.B.10) • Some emissions may also be reported under CRF category 1.B.2.a.iv Fugitive emissions from oil subcategory refining/ storage
44 Production of soda ash and sodium bicarbonate	1.A.2.c Chemicals 2.B.7 Soda ash production	• EU ETS activity includes combustion and process emissions. • Combustion related emissions from EU ETS activity code 44 for production are included in CRF 1.A.2.c Chemicals • Process related emissions are included in 2.B.7. Soda Ash Production
45 Capture of greenhouse gases under Directive 2009/31/EC	Capture of emissions would be reported under the respective inventory sector e.g. 1.A.1.a Public electricity and heat production.	• Consistent with scope and methodologies of inventory
46 Transport of greenhouse gases by pipelines for geological storage in a storage site permitted under Directive 2009/31/EC	1.C.1 Transport of CO_2	• Consistent with scope and methodologies of inventory
47 Geological storage of greenhouse gases in a storage site permitted under Directive 2009/31/EC	1.C.2 Injection and storage	• Consistent with scope of inventory (currently no emissions reported under the EU ETS)
99 Other activity opted-in under Art. 24 of the ETS Directive	Depending on type of activity opted-in	Article 24 allows the unilateral inclusion of additional activities and gases under the EU ETS. These activities and gases are not allocated to a specific activity, but under a separate activity code.

In the GHG inventory, the emissions are reported per CRF categories (Annex V under the MMR). In the EU ETS a single installation can include several ETS activities as defined in Annex I of the EU ETS Directive. In the EU ETS emissions are attributed to a specific installation, independently from the Annex I activities covered. Nevertheless, the operator must report detailed information for each source stream of the installation, and include activities classification as per Annex I, in his annual report to the competent authorities. The different approaches can lead to differences in reported emissions if ETS activities and inventory categories are compared directly.

Scope of activities and installation boundaries

For several activities, the EU ETS includes installations only if they exceed certain capacity thresholds. Such capacity thresholds are not used for the inventory reporting. In addition, installation boundaries and the scope as to what constitutes an activity under the EU ETS may be different to a source category for the inventory reporting. Therefore the scope of activities and the installation boundaries need careful consideration before EU ETS data are used for inventory purposes.

Determination of tiers

Both IPCC guidelines are based on methodological tiers that require higher tier levels of accuracy for emission sources contributing to a significant extent to the total emissions in a country. In the inventory reporting, the key category analysis determines which methodological tier should be used which is based on the contribution of a source category to the total emission level and the emission trend. If a source category is determined as key, all emissions from this source/sector have to be estimated based the same minimum tier methodology.

In the EU ETS the tiers are related to the admissible level of uncertainty for each parameter involved in the reporting. In the EU ETS tiers apply at installation level for each source stream activity data and calculation factor, and are defined in legislation on the basis of the installation emissions (thresholds are < 50 kt, ≥ 50 kt and ≤ 500 kt and > 500 kt CO_2eq). EU ETS verified emissions, if aggregated at sectoral level, may include contributions from small, medium and large emitters and are therefore based on different EU ETS tiers. When ETS data are used for key categories in the GHG inventory, it therefore has to be checked carefully whether the EU ETS tiers used for the monitoring of emissions are in conformity with the IPCC guidance related to the IPCC tiers for a particular source category.

In GHG inventories time series consistency is a mandatory requirement which has also implications on the choice of methodology. While methodological consistency is also required under the EU ETS (Article 6 of Regulation No 2018/2066), the EU ETS only started in 2005 and plant-specific and measured data is often not available for the whole time series back to 1990 and it may be challenging to construct a consistent time series back to 1990.

The mapping table above shows that a direct comparison between verified emissions from EU ETS activities and emissions reported in CRF categories is not straightforward.

An analysis of data consistency between EU ETS and inventory data requires: (1) an assessment of the assignment of the detailed data reported by each individual EU ETS installation to national competent authorities with respect to the CRF categories; (2) a detailed comparison of the methodological parameters (methods, activity data, calculation parameters).

1.4.1.3 Use of EU ETS data in 2021

Under the MMR Article 7 (EU 2013), Member States are required to perform consistency checks between the emissions reported in the GHG inventories and the verified emissions reported under the EU ETS Directive. The installation-specific emissions data reported by operators under the EU ETS can be used in different ways for the purposes of the national GHG inventories:

1. Reported verified emissions can be directly used in the GHG inventory to report CO_2 emissions for a specific source category. This requires a number of careful checks, e.g. whether the coverage of the respective EU ETS emissions is complete for the respective source category and that EU ETS activities and CRF source categories follow the same definitions. If EU ETS emissions are not complete, the emissions for the remaining part of the source category not covered by the EU ETS have to be calculated separately and added to the EU ETS emissions.
2. Emission factors (or other parameters such as oxidation factors) reported under the EU ETS can be compared with emission factors used in the inventory and the latter can be harmonised if the EU ETS provides improved information.
3. Activity data reported under the EU ETS can be used directly for the GHG inventory, in particular for source categories where energy statistics face difficulties in disaggregating fuel

consumption to specific subcategories, e.g. to specific industrial sectors or for specific non-marketed fuels.

4. Data from EU ETS can be used for more general verification activities as part of national quality assurance (QA) activities without the direct use of emissions, activity data or emission factors.
5. Data from EU ETS can improve completeness of the estimation of IPCC source categories when additional data for sub-categories become available from EU ETS.
6. EU ETS data can improve the allocation of industrial combustion emissions to sub-categories under 1A2 Manufacturing Industries and Construction.
7. The comparison of the data sets can be used to improve the uncertainty estimation for the GHG inventories based on the uncertainties of data reported by installations.

Based on the information submitted in the national inventory reports (NIRs) in 2021 to the European Commission, all Member States indicated that they used EU ETS data at least for QA/QC purposes (Table 1.11). 25 Member States indicated to directly use the verified emissions reported by installations under the EU ETS (depending of the sectors). All Member States used EU ETS data to improve country-specific emission factors. And all Member States reported that they used activity data (e.g. fuel use) provided under the EU ETS in the national inventory (depending of the sectors).

Table 1.11 Use of EU ETS data for the purposes of the national GHG inventory

Member State	Use of emissions	Use of Activity data	Use of emission factors	Use for quality assurance
Austria	✓	✓	✓	✓
Belgium	✓	✓	✓	✓
Bulgaria	✓	✓	✓	✓
Croatia	✓	✓	✓	✓
Cyprus	✓	✓	✓	✓
Czech Republic	✓	✓	✓	✓
Denmark	✓	✓	✓	✓
Estonia		✓	✓	✓
France	✓	✓	✓	✓
Finland	✓	✓	✓	✓
Germany	✓	✓	✓	✓
Greece	✓	✓	✓	✓
Hungary	✓	✓	✓	✓
Ireland	✓	✓	✓	✓
Italy	✓	✓	✓	✓
Latvia	✓	✓	✓	✓
Lithuania	✓	✓	✓	✓
Luxembourg	✓	✓	✓	✓
Malta	✓	✓	✓	✓
Netherlands	✓	✓	✓	✓
Poland	✓	✓	✓	✓
Portugal	✓	✓	✓	✓
Romania	✓	✓	✓	✓
Slovakia		✓	✓	✓
Slovenia		✓	✓	✓
Spain	✓	✓	✓	✓
Sweden	✓	✓	✓	✓
United Kingdom	✓	✓	✓	✓

Source: NIR 2021 submissions of Member States

1.4.1.4 References

EC 2003: Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC (OJ L275, 25.10.2003, p. 32) amended by Directive 2004/101/EC of the European Parliament and of the Council of 27 October 2004, Directive 2008/101/EC of the European Parliament and of the Council of 19 November 2008 and Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009, Directive 2018/410 of the European Parliament and of the Council of 14 March 2018.

EEA (European Environment Agency) 2021: EU Emissions Trading System (ETS) data viewer https://www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1

EU 2012a: Commission Regulation (EU) No 600/2012 of 21 June 2012 on the verification of greenhouse gas emission reports and tonne-kilometre reports and the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council Text with EEA relevance (OJ L 181, 12.7.2012, p. 1–29).

EU 2012b: Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council (OJ L 181, 12.7.2012, p. 1-28).

EU 2014: Regulation No 421/2014 of the European Parliament and of the Council of 16 April 2014 amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in view of the implementation by 2020 of an international agreement applying a single global market-based measure to international aviation emission (OJ L 129, 30.4.2014, p. 1–4).

EU 2018a: Commission Implementing Regulation (EU) 2018/2067 of 19 December 2018 on the verification of data and on the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council (OJ L 334, 31.12.2018, p. 94–134)

EU 2018b: Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012 (OJ L 334, 31.12.2018, p. 1–93)

1.4.2 Cooperation with EUROCONTROL

At the end of 2010 the European Commission signed a framework contract with EUROCONTROL, the European organization for the safety of air navigation, regarding ‘the support to the European Commission in relation to climate change policy and the implementation of the EU ETS’. This support project is organized in different Work Packages (WP) corresponding to the different areas identified in the framework contract and has been regularly continued.

One of these Work Packages pertains to the improvement of GHG and air pollutant emissions inventories submitted by the 27 Member States and the European Union to the UNFCCC and to the UNECE. The main objective of the WP is to assist EU Member States improve the reporting of annual greenhouse gas (and other air pollutant) emission inventories by e.g., estimating the fuel split domestic/international using real flight data from EUROCONTROL. The European Environment Agency and its ETC/CME assist DG CLIMA regarding the technical requirements.

To support the inventory process for the submission in 2021, in October 2020 Member States received fuel and emissions data for the years 2005 to 2019 as calculated by EUROCONTROL using a TIER 3b methodology applying the Advanced Emissions Model (AEM). This is a follow up of ERT recommendations made to perform QA exercises and to make data from EUROCONTROL available to Member States on a regular basis. In November 2020 three webinars took place to exchange information between EUROCONTROL and Member States on the data provided.

In the course of the ‘initial checks’ of MS inventories in the first months of 2021 the comparison between Tier 3b calculations from EUROCONTROL and time series of MS inventories has been conducted with most actual inventories from Member States. In case of considerable differences between Member State results and those from EUROCONTROL, the European Environment Agency and its ETC/CME asked Member States via the EMRT about possible reasons. In addition, the European Environment Agency provided MS with a comparison between EUROCONTROL data and MS data on fuel consumption of civil and international aviation for the years 2015 and 2019, related CO_2 emissions and implied emission factors of CH_4 and N_2O. For more information on the results of the comparison, see chapter 3.2.

During the whole process countries have been encouraged to provide feedback to these EUROCONTROL results so that suggestions and questions could be taken into account in the next modelling exercise. Based on the experience gained during this QA/QC process, recommendations will be made to EUROCONTROL to safeguard and improve time-series calculations for use by MS. Under a new framework contract with DG CLIMA, EUROCONTROL will provide data for the year 2021 and eventually recalculate time series for the period 2005 to 2019 in case of considerable changes in the model.

As explained in the NIR 2014, comparing emissions reported by Member States with independent modelling results such as performed by EUROCONTROL is a genuine quality assurance exercise and assists in identifying areas in need for improvement of aviation emission calculations. In this sense, the EUROCONTROL results are used for identifying ways of checking and improving the accuracy of emission estimates for the EU and its Member States in accordance with the ARR of 2014.

1.5 Description of key categories

A key category analysis has been carried out according to the Tier 1 method (quantitative approach) described in the 2006 IPCC guidelines. A key category is defined as an emission source that has a significant influence on a country's GHG inventory in terms of the absolute level of emissions, the trend in emissions, or both.

In addition to the key category analysis at Union level, every Member State provides a national key category analysis which is independent from the assessment at Union level. The Union key category analysis is not intended to replace the key category analysis by Member States. The key category analysis at Union level is carried out to identify those categories for which overviews of Member States' methodologies, emission factors, quality estimates and emission trends are provided in this report. In addition, the Union key category analysis helps identifying those categories that should receive special attention with regard to QA/QC at EU level. The Member States use their key category analysis for improving the quality of emission estimates at Member State level.

To identify key categories of the EU-27, Iceland and the United Kingdom, the following procedure was applied:

- Starting point for the key category identification for this report was the EEA database. Most categories where GHG emissions/removals occur were listed, at an aggregation level such as 2.B.1 and split by gas, while for the sector Energy a less aggregated level such as 1.A.1.a, split by fuel and per gas was chosen. It makes sense for the EU to rely on this less aggregated level for the KCA as also the initial checks of the MS submissions are performed at this level of detail and therefore guarantee a more profound quality checking for all EU key categories (at fuel level). Additionally the EU KCA (at detailed level) is used in order to select the categories for which more detailed information is provided in the EU NIR. Although the more detailed EU approach differs from the KCA generated in the CRF overall the results are very similar.

- A level and a trend assessment was carried out for the years 1990 and 2019. The assessment was carried out for emissions excluding LULUCF and including LULUCF.
  The key category analysis excluding LULUCF resulted in the identification of 84 key categories for the EU cover 96 % of total EU GHG emissions in 2019 (see Annex I). The key category analysis including LULUCF resulted in 99 key categories (Table 1.12).

In Chapters 3 to 7 overview tables are presented for each EU key category showing the Member States' contributions to the EU-KP key category in terms of level and trend.

Table 1.12 Key categories for the EU-27, Iceland and the United Kingdom (Gg CO_2 equivalents)

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2019		1990	2019
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	107668	244052	T	L	L
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	176677	24673	T	L	L
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	10745	41137	T	L	L
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	9162	7388	0	L	L
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	1126227	492751	T	L	L
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	5276	28250	T	0	L
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	110883	85075	T	L	L
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	17424	19341	T	L	L
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)	91155	29713	T	L	L
1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)	31972	19661	0	L	L
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	8989	1140	T	L	0
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	132436	65680	T	L	L
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	3835	7498	T	0	L
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	7708	1433	T	0	0
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	55471	40527	0	L	L
1.A.2.c Chemicals: Liquid Fuels (CO_2)	41261	20814	T	L	L
1.A.2.c Chemicals: Solid Fuels (CO_2)	13900	8136	0	L	L
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	13249	19914	T	L	L
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)	11539	1826	T	L	0
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)	8052	2402	T	L	0
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	19437	32551	T	L	L
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	20340	3138	T	L	0
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	12237	4293	T	L	0
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	27929	31971	T	L	L
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	45758	22382	T	L	L
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	1422	15501	T	0	L
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	56871	16312	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	93029	89376	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	123698	52028	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)	93133	11653	T	L	L
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	12918	16797	T	L	L
1.A.3.b Road Transportation: Diesel Oil (CO_2)	303206	633726	T	L	L
1.A.3.b Road Transportation: Diesel Oil (N_2O)	1898	7822	T	0	L

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2019		1990	2019
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	508	4371	T	0	0
1.A.3.b Road Transportation: Gasoline (CH_4)	6030	860	T	0	0
1.A.3.b Road Transportation: Gasoline (CO_2)	406638	236848	T	L	L
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	7354	16340	T	0	L
1.A.3.b Road Transportation: Other Fuels (CO_2)	0	2892	T	0	0
1.A.3.c Railways: Liquid Fuels (CO_2)	12983	5444	T	L	L
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	17755	14053	0	L	L
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	10328	6315	0	L	L
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	65622	104298	T	L	L
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	79398	34010	T	L	L
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	748	6325	T	0	L
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	48484	3208	T	L	0
1.A.4.b Residential: Biomass (CH_4)	9413	10143	T	L	L
1.A.4.b Residential: Gaseous Fuels (CO_2)	184767	242196	T	L	L
1.A.4.b Residential: Liquid Fuels (CO_2)	180454	95518	T	L	L
1.A.4.b Residential: Solid Fuels (CH_4)	9226	2335	T	L	0
1.A.4.b Residential: Solid Fuels (CO_2)	135116	29698	T	L	L
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	12473	11882	T	L	L
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	71520	61405	T	L	L
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	9734	3279	T	L	0
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	5945	6	T	0	0
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	14259	4417	T	L	0
1.B.1.a Coal Mining and Handling: Operation (CH_4)	97099	24842	T	L	L
1.B.2.a Oil: Operation (CH_4)	6792	1104	T	0	0
1.B.2.a Oil: Operation (CO_2)	9451	11611	T	L	L
1.B.2.b Natural Gas: Operation (CH_4)	51519	20231	T	L	L
1.B.2.c Venting and Flaring: Operation (CO_2)	8665	6571	0	L	L
2.A.1 Cement Production: no classification (CO_2)	102698	77986	T	L	L
2.A.2 Lime Production: no classification (CO_2)	25242	18729	0	L	L
2.A.4 Other Process Uses of Carbonates: no classification (CO_2)	11834	9946	0	L	L
2.B.1 Ammonia Production: no classification (CO_2)	32487	21721	0	L	L
2.B.10 Other chemical industry: no classification (CO_2)	6888	12796	T	0	L
2.B.2 Nitric Acid Production: no classification (N_2O)	49630	3810	T	L	0
2.B.3 Adipic Acid Production: no classification (N_2O)	57555	294	T	L	0
2.B.8 Petrochemical and Carbon Black Production: no classification (CO_2)	14810	14390	T	L	L
2.B.9 Fluorochemical Production: no classification (HFCs)	29033	1807	T	L	0
2.B.9 Fluorochemical Production: no classification (Unspecified mix of HFCs and PFCs)	5567	47	T	0	0
2.C.1 Iron and Steel Production: no classification (CO_2)	108672	70719	T	L	L
2.C.3 Aluminium Production: no classification (PFCs)	21277	504	T	L	0
2.F.1 Refrigeration and Air conditioning: no classification (HFCs)	13	83366	T	0	L
2.F.4 Aerosols: no classification (HFCs)	2	3600	T	0	0
3.A.1 Enteric Fermentation: Cattle (CH_4)	198928	157894	T	L	L
3.A.2 Enteric Fermentation: Other Sheep (CH_4)	25226	17797	0	L	L
3.A.4 Enteric Fermentation: Other livestock (CH_4)	6022	5699	0	0	L

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2019		1990	2019
3.B.1 CH_4 Emissions: Farming (CH_4)	49791	40618	T	L	L
3.B.2 N_2O and NMVOC Emissions: Farming (N_2O)	30148	21887	0	L	L
3.D.1 Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O)	162715	135119	T	L	L
3.D.2 Agricultural Soils: Farming (N_2O)	37789	29285	T	L	L
3.G.1 Limestone CaCO3: Farming (CO_2)	7991	5190	0	L	0
4.A.1 Forest Land: Land Use (CO_2)	-320555	-315840	T	L	L
4.A.2 Forest Land: Land Use (CO_2)	-39013	-39588	T	L	L
4.B.1 Cropland: Land Use (CO_2)	32117	14490	T	L	L
4.B.2 Cropland: Land Use (CO_2)	48393	35726	0	L	L
4.C.1 Grassland: Land Use (CO_2)	54833	36208	0	L	L
4.C.2 Grassland: Land Use (CO_2)	-20772	-25381	0	L	L
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	5490	5672	0	0	L
4.D.1 Wetlands: Land Use (CO_2)	7444	9206	T	0	L
4.D.2 Wetlands: Land Use (CO_2)	2295	5351	T	0	L
4.E.2 Settlements: Land Use (CO_2)	34289	41830	T	L	L
4.G Harvested Wood Products: Wood product (CO_2)	-31260	-40412	0	L	L
5.A.1 Managed Waste Disposal Sites: Waste (CH_4)	158092	84087	T	L	L
5.A.2 Unmanaged Waste Disposal Sites: Waste (CH_4)	28037	12190	T	L	L
5.B.1 Waste Composting: Waste (CH_4)	611	3721	T	0	0
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	27292	11974	T	L	L
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	8208	6879	0	L	L
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	9274	6282	0	L	L

Note: EU totals for 2019 in sector Energy and IPPU may not include data for Sweden due to confidential reporting.

1.6 General uncertainty evaluation

The uncertainty analysis was made on basis of the Tier 1 uncertainty estimates, which were submitted by EU Member States, Iceland and United Kingdom under Article 7(1)(p) of Regulation (EU) 525/2013.

Uncertainties were estimated at detailed level and aggregated to six main sectors 'Energy', 'Fugitive emissions', Industrial processes and product use', 'Agriculture', 'LULUCF' and 'Waste'. Within these sectors the available MS uncertainty estimates were grouped by source categories. Then for each source category a range of uncertainty estimates was calculated: the lower bound of the range was calculated by assuming that all uncertainty estimates within a source category are uncorrelated; the upper bound of estimates was calculated by assuming that all uncertainty estimates within a source category are correlated. Then a single uncertainty estimate was calculated for each source category based on the assumption that MS uncertainty estimates are correlated if they use Tier 1 methods and/or default emission factors. After having calculated the uncertainty estimates for each source category, the uncertainty estimates for the sectors and for total GHG emissions were calculated. This is a more sophisticated approach than required under the IPCC guidelines. The EU team adopted this approach in order to obtain a more accurate uncertainty estimates than with the "simple" approach included in the IPCC guidelines.

Estimation of trend uncertainty: The EU uncertainty estimate is rather complicated due to potential correlations between MS uncertainties. Therefore, an analytical method, which allows more flexibility than IPCC Tier 1, was compiled.

Trend in MS n category x was defined as

Trendn,x = En,x(t)-En,x(0) (1)

Where E(t) denotes emissions in the latest inventory year and E(0) emissions in the base year.

Variance for each MS and source category was calculated by using the perceptual uncertainty estimates reported by MS, and assuming normal distributions. Uncertainties in trends of different MS and source categories were then calculated using first order approximation of error propagation.

The assumptions of correlation between years (0 and t) and between different MS are important for the estimation of trend uncertainty. However, there is not enough information about strengths of different correlations. Effect of correlation was tested both with the analytical method developed, and by using MC simulation, where Normal distribution was used in all the cases to ensure comparability with analytical estimates. Table 1.13 gives an example of such comparison made in 2006. The source category chosen for the example is 4D, N_2O emissions from agricultural soils, as this category has a major effect on inventory uncertainty in most MS. Both the effects of correlations between years and between Member States were tested.

Table 1.13 Trend uncertainty for EU emissions 2006 of N_2O from agricultural soils by using different assumptions of correlation estimated using Monte Carlo simulation

Years correlate	MS correlate	Trend uncertainty
YES	YES	-27 to +26
YES	NO	±13
NO	YES	-294 to +292
NO	NO	-116 to +115

Note: "YES" denotes full correlation between years or Member States. Trend uncertainty is presented as percentage points.

The results of the comparison revealed that correlations between years have a much larger effect on trend uncertainty than correlations between MS. In the IPCC GPG 2000, it is suggested to assume that emission factors between years are fully correlated, and activity data are independent. However, in the EU uncertainty estimate, it is assumed that activity data uncertainties also correlate to some extent between years, because typically the same data collection methods are used each year. Therefore, for the EU uncertainty estimate it was decided to assume that emissions between years are fully correlated, even though this may underestimate trend uncertainty to some extent.

In the example given in Table 1.13 uncertainty decreased when correlation between MS was added to the correlation between years. However, this is not always the case; in another example considering EU MS estimates for 1A1a CO_2, uncertainty was ±0.2% when it was assumed that years correlate and MS estimates are independent. When a correlation between MS was added, the uncertainty decreased to ±0.1%.

Correlation between MS is difficult to quantify, especially in case of trend uncertainty, where correlation between different MS in different years should also be quantified. Furthermore, effect of correlation on uncertainty (increasing or decreasing) depends on the direction and magnitude of trend for each MS and each source category. Therefore, a simple conservative assumption cannot be made. Therefore, for simplicity, it was assumed in trend uncertainty estimate that MS are independent.

In general, the caveats of the method used are the same as in IPCC Tier 1, i.e. the result gives the most reliable results when uncertainties are small, and it assumes normal distributions even though this cannot actually be the case when uncertainties are >100%. However, these issues do not seem to have any major effect on the results, as can be seen from Table 1.14, in which waste sector uncertainties are presented both with analytical method and Monte Carlo simulation: If uncertainty increases, also the difference between the two methods increases.

Table 1.14 .Comparison of trend uncertainty estimates 2005 for EU Waste Sector using the modified Tier 1 method and Monte Carlo simulation (Tier 2).

Sector	GHG	Tier 1	Tier 2
6A. Landfills	CH_4	±12	±12
6B. Wastewater	CH_4	±27	-28 to +27
6B. Wastewater	N_2O	±9	±9
6C. Waste incineration	CO_2	±7	±7
6C. Waste incineration	CH_4	±23	-23 to +24
6C. Waste incineration	N_2O	±18	±18
Waste Other	CH_4	±990	-976 to +993
Total Waste Sector		±11	±11

Note: Trend uncertainty is presented as percentage points.

Furthermore, trend uncertainty was calculated as in Equation 1, and the resulting confidence intervals were divided by base year estimate (best estimate) to obtain the relative change. The results would have been somewhat different, if trend uncertainty were calculated as in Equation 2:

$$\mathbf{Trend_{n,x} = [E_{n,x}(t)-E_{n,x}(0)]/ E_{n,x}(0)} \qquad \mathbf{(2)}$$

However, the effect of the choice between Eq 1 and 2 depends also on the direction and magnitude of trend in different MS, and without further consideration it cannot be stated whether choice of Eq 1 yielded a conservative estimate or not.

Lack of knowledge of different correlations, and many assumptions make the interpretation of EU trend uncertainty difficult, and therefore it should not be compared with uncertainty estimates of other countries. However, trend uncertainty calculations are internally consistent, and therefore the results can be used e.g. to assess which categories are the most important sources of trend uncertainty in the EU inventory.

Table 1.15 shows the main results of the Tier 1 uncertainty analysis for the EU-28 and Iceland. The lowest level uncertainty estimates are for fuel combustion activities (0.8 %) and the highest estimates are for Agriculture (49.4 %). Overall level uncertainty estimates including LULUCF of all EU-28 and Iceland GHG emissions is calculated at 6.0 %. If LULUCF is excluded, the total level uncertainty is lower at 5.5 %.

With regard to trend uncertainty estimates the lowest uncertainty estimates are for fuel combustion activities (+/-0.4 percentage points) and the highest estimates are for LULUCF (20.3 percentage points). Overall trend uncertainty (including LULUCF) of all EU-28 GHG and Iceland emissions is estimated to be 1.2 percentage points.

These results of the Tier 1 analysis of the trend and level uncertainties are similar to the results of the previous year. However, substantial decreases in the level uncertainties of LULUCF and Agriculture are worthy of note. The 2019 level uncertainty for LULUCF was estimated at 27.7 % compared to the 2018 level uncertainty of 22.4 % reported in the previous year. The increase in LULUCF uncertainty is due in part to the smaller net absolute total of the sector and the reduced contribution of the dominant subcategory 4A Forest land (the least uncertain subcategory in the LULUCF sector) to the overall sector balance. For Agriculture, the 2019 level uncertainty was estimated at 49.4 % compared to the 2018 level uncertainty of 45.1 % reported in the previous year. This increase in sector uncertainty has been due in large part to the increased uncertainties of prominent subcategories 3.D Agricultural Soils (N_2O) and 3.B Manure Management (N_2O and CH_4). Uncertainties of subcategory N_2O emissions from 3.D Agricultural Soils, a subcategory that contributes ca. 40% of the total sector emissions, have increased from 120 to 128 %. This increase is due to increased contributions from countries with high uncertainties (e.g. Romania) and due to increased subcategory uncertainty estimates of countries that significantly contribute to the EU subcategory total (e.g. France has revised its uncertainty estimate for 3Da from 142% to 154%). More detailed uncertainty estimates for the source categories are provided in Chapters 3-7.

Table 1.15 Tier 1 uncertainty estimates of EU-Member States, Iceland and the United Kingdom GHG emissions (in CO_2 equivalents) for the main sectors

Source category	Gas	Emissions Base Year	Emissions 2019	Emission trends Base Year-2019	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A Fuel combustion activities	all	4 305 882	3 049 110	-29.2%	0.8%	0.4%
1.B Fugitive emissions	all	208 531	75 572	-63.8%	28.9%	8.4%
2. Industrial processes	all	548 586	353 337	-35.6%	10.4%	2.7%
3. Agriculture	all	543 237	426 445	-21.5%	49.4%	3.7%
5. Waste	all	235 284	131 548	-44.1%	34.0%	19.5%
4. LULUCF	all	-164 503	-226 527	37.7%	27.7%	20.3%
Total (incl LULUCF)	**all**	**5 677 017**	**3 809 484**	**-32.9%**	**6.0%**	**1.2%**
Total (excl LULUCF)	**all**	**5 841 520**	**4 036 011**	**-30.9%**	**5.5%**	**1.0%**

Note: Sectoral EU emissions and total EU emissions for the Base Year and 2019 in the following uncertainty tables are not always identical to the final actual emissions reported elsewhere in the EU NIR and CRF Tables. These discrepancies are due to a number of factors such as confidential emission values and/or absence of LULUCF emissions and removals in the uncertainty estimates reported by certain countries as per Article 7(1)(p) of Regulation (EU) 525/2013. Discrepancies can also occur due to the revisions of inventory emissions estimates in the March and May CRF submissions of certain countries that are not accompanied by respective updated uncertainty estimates.

Table 1.16 gives an overview of information provided by EU Member States, Iceland and United Kingdom on uncertainty estimates in their 2021 national inventory reports and presents summarised results of these estimates.

Table 1.16 Overview of uncertainty estimates available from EU Member States, Iceland and the United Kingdom

Member State	Austria		Belgium	Bulgaria	Croatia			Cyprus	Czechia		Denmark	
Citation	NIR April 2021, pp.63-75		NIR April 2021, pp.49-50	NIR April 2021, pp.52-53	NIR April 2021, pp.51-52			NIR March 2021, p.50	NIR April 2021, pp.46		NIR March 2021, pp.59-65	
Method used	Tier 1		Tier 1	Tier 1	Tier 1 + Tier 2			Tier 1	Tier 1		Tier 1	
Documentation in NIR (according to IPCC 2006 GL)	Yes (Annex 2)		Yes (Annex 2)	Yes (Annex 2)	Yes (Annex 2)			Yes (Annex 2)	Yes (Annex 2)		Yes (pp.60-66)	
Years and sectors included	emissions: 2019; trends: 1990-2019; including LULUCF		emissions: 2019; trends: 1990-2019; including LULUCF	emissions: 2019; trends: 1988-2019; including LULUCF	emissions: 2019; trends: 1990-2019; including LULUCF			emissions: 2019; trends: 1990-2019*; excluding LULUCF	emissions: 2019; trends: 1990-2019; including LULUCF		emissions: 2019 trends: 1990-2019*; including LULUCF	
Uncertainty (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1	Tier 1 (i .L.)	Tier 2 (i .L.)	Tier 2 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2											5.50%	1.80%
CH_4											14.2%	
N_2O											35.8%	
F-gases											41.0%	
Total	15.70%	4.60%	3.72%	17.33%	61.15%	-13.57% +62.34%	-5.70% +8.04%	10.61%	7.27%	3.14%	6.2%	5.4%
Uncertainty in trend (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1	Tier 1 (i .L.)	Tier 2 (i .L.)	Tier 2 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2											1.80%	1.40%
CH_4											11.40%	
N_2O											9.50%	
F-gases											51.1%	
Total	3.47%	2.22%	2.14%	2.63%	9.29%	-19.81% +40.95%	-6.67% +7.04%	2.24%	6.57%	2.50%	1.80%	1.80%

Member State	Estonia		Finland				France		Germany				Greece		Hungary	Ireland	
Citation	NIR March 2021, p.47-48		NIR April 2021, pp.46-48				NIR March 2021, pp.83-86		NIR March 2021, pp.135				NIR March 2021, pp.69-73		NIR March 2021, pp.28	NIR March 2021, pp.19-21	
Method used	Tier 1		Tier 1 + Tier 2				Tier 1		Tier 1 + Tier 2				Tier 1		Tier 1	Tier 1	
Documentation in NIR (according to IPCC 2006 GL)	Yes (Annex 2)		Yes (Annex 2)				Yes (Annex 6)		Yes (Annex 7)				Yes (Annex 4)		Yes (Annex 2)	Yes (pp.19-21)	
Years and sectors included	emissions: 2019; trends: 1990-2019; including LULUCF		emissions: 2019; trends: 1990-2019; including LULUCF				emissions: 2019; trends: 1990-2019; including LULUCF		emissions: 2019; trends: 1990-2019; including LULUCF				emissions: 2019; trends: 1990-2019; including LULUCF		emissions: 2019; trends: 1990-2019; excluding LULUCF	emissions: 2019; trends: 1990-2019; including LULUCF	
Uncertainty (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (i .L.)	Tier 2 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (i .L.)	Tier 2 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2													3.1%	2.5%	2.5%		
CH_4													27.9%	28.2%	70.3%		
N_2O													103.6%	107.4%	143.7%		
F-gases													264.6%	264.6%	13.0%		
Total	12.64%	6.94%	±33%	±5%	-31% +37%	-3% +4%	12.6%	11.5%	3.57%	3.81%	-2,99% +3.41%	-2.19% +2,70%	13.1%	12.5%	14.2%	12.98%	3.85%
Uncertainty in trend (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (i .L.)	Tier 2 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (i .L.)	Tier 2 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2																	
CH_4																	
N_2O																	
F-gases																	
Total	4.23%	2.03%	±31%	±5%	-24% +33%	-3% +4%	2.3%	2.0%	4.20%	3.89%	- 12,64	- 9.73%	10.7%	10.5%	3.1%	10.64%	2.33%

Member State	Italy		Latvia		Lithuania		Luxembourg		Malta	Netherlands			Poland	
Citation	NIR April 2021, pp.45-46		NIR April 2020, pp.64-65		NIR March 2021, pp.41-42		NIR April 2021, pp.70-75		NIR April 2021, pp.47	NIR April 2021, pp.52-57			NIR April 2021, p.25/469	
Method used	Tier 1		Tier 1		Tier 1		Tier 1		Tier 1	Tier 1 + Tier 2			Tier 1	
Documentation in NIR (according to IPCC 2006 GL)	Yes (Annex 1)		Yes (Annex 2)		Yes (Annex 2)		Yes (pp.70-75)		Yes (pp. 47)	Yes (Annex 2)			Yes (Annex 8)	
Years and sectors included	emissions: 2019; trends: 1990-2019; including LULUCF		emissions: 2019; trends: 1990-2019; including LULUCF		emissions: 2019; trends: 1990-2019; including LULUCF		emissions: 2019; trends: 1990-2019; including LULUCF		emissions: 2019; trends: 1990-2019; including LULUCF	emissions: 2019; trends: 1990-2019*; including LULUCF			emissions: 2019; trends: 1988-2019; including LULUCF	
Uncertainty (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (e.L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2											2%	3%	4.5%	1.8%
CH_4											9%	9%	21.9%	21.9%
N_2O											38%	28%	42.7%	45.8%
F-gases											35%	26%		
Total	4.5%	2.9%	26%	5%	26.6%	9.7%	4.51%	3.99%	5.00%	3%	3%	3%	5.4%	3.9%
Uncertainty in trend (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (e.L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2											1%		2.60%	2.00%
CH_4											5%		25.50%	25.50%
N_2O											6%		39.20%	41.20%
F-gases											9%			
Total	3.4%	2.3%	13%	2%	5.8%	2.0%	5.49%	4.86%	5.62%	2%	2%		4.70%	4.30%

Member State	Portugal	Romania		Slovakia		Slovenia	Spain		Sweden		UK	Iceland	
Citation	NIR March 2021, pp."1-23"	NIR May 2021, pp.102-103		NIR April 2021, p.41		NIR April 2021, pp.32-33	NIR March 2021, pp.80 - 81		NIR March 2021, pp.66-68		NIR April 2021, p.97	NIR April 2021, p.17	
Method used	Tier 1	Tier 1		Tier 1		Tier 1	Tier 1		Tier 1		Tier 1 + Tier 2	Tier 1	
Documentation in NIR (according to IPCC 2006 GL)	Yes (Annex H)	Yes (Annex 2)		Yes (Annex 3)		Yes (Annex 2)	Yes (Annex 6)		Yes (Annex 7)		Yes (Annex 2)	Yes (Annex 2)	
Years and sectors included	emissions: 2019; trends: 1990-2019; including LULUCF **	emissions: 2019; trends: 1990-2019; including LULUCF		emissions: 2019; trends: 1990-2019; including LULUCF		emissions: 2019; trends: 1986-2019; including LULUCF	emissions: 2019; trends: 1990-2019*; including LULUCF		emissions: 2019; trends: 1990-2019*; including LULUCF		emissions: 2019; trends: 1990-2019*; including LULUCF	emissions: 2019; trends: 1990-2019*; including LULUCF	
Uncertainty (%)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2													
CH_4													
N_2O													
F-gases													
Total	7.80%	32.0%	22.2%	12.10%	60.00%	5.89%	12.5%	9.2%	45.00%	4.90%	3.0%	58.2%	8.7%
Uncertainty in trend (%)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2													
CH_4													
N_2O													
F-gases													
Total	5.00%	2.6%	2.0%	2.87%	1.20%	2.49%	0.8%	0.6%	27.26% ***	1.40%	-43.0%	17.8%	1.9%

1.7 General assessment of the completeness

1.7.1 Completeness checks of Member States' submissions

The EU GHG inventory is compiled on the basis of the inventories of the EU Member States. Therefore, the completeness of the EU inventory depends on the completeness of the Member States' submissions.

In response to the Saturday paper 2010 the EU implemented an action plan in 2011 aiming at improving the completeness regarding NEs of the EU greenhouse gas inventory.

1. Given the fairly wide interpretations and applications of notation keys, the identification of a "real" gap needs expert assessment which is provided by the UNFCCC review and which cannot be automated by existing EU internal procedures. Thus any action plan implemented by the EU needs to continue to be based primarily on the UNFCCC review reports. This is in particular evident with regards to the KP LULUCF, where a carbon pool can be not reported (‘NR’ should be used) provided that transparent and verifiable information is provided indicating that the pool is not a source, while notation keys such as NO and NA may also sometimes be linked to incomplete estimates. In this respect it needs to be stressed that the late availability of the review reports complicates the follow-up with Member States related to potential missing GHG estimates before the next EU inventory submission.
2. The notation key ‘NE’ is not in all cases an indication of a problem and neither the IPCC guidelines nor the UNFCCC review guidelines foresee an automatic procedure of gap filling when NEs are reported. For example, the notation "NE" can be used if there are no methods available in the 2006 IPCC Guidelines. Overall, a fair and complete analysis of the use of "NE" including the situations highlighted in point 1 above was considered to be indispensable (see chapter 1.7.1).

Given the above considerations the specific steps of the action plan followed since 2011 are as follows:

1. Member States are required by the Monitoring Mechanism Regulation to submit their national GHG inventories electronically to the European Commission by 15 January of each year. A software program was created by the EEA so that upon submission of the relevant XML/CRF files a report is generated containing a list of all non-estimated source categories per Member State, specifying which of these source categories have been flagged in the Saturday Papers and for which ones IPCC methods are available. This report is then immediately notified to each Member State. During February the experts of the EU inventory team consult and discuss with Member States’ experts inter alia:
    a. how MS have addressed and documented (or plan to address) the potential issues flagged in their Saturday Papers regarding missing estimates;
    b. the need for applying gap-filling procedures and the selection of the most appropriate methods;
    c. the need to use different notation keys.
2. Any finding with regard to the use of the notation key “NE” or relevant blank cells is communicated to the Member States' via the EMRT by 28 February latest. According to the procedures and time scales described in Annex IX of the Implementing Regulation, the Draft EU inventory is sent to MS also by 28 February. Updated or additional inventory data submitted by MS (to remove inconsistencies or fill gaps) and complete final national inventory reports are submitted to the European Commission by 15 March.
3. In cases where, even after the two preceding steps a Member State's GHG inventory as submitted to the European Commission by 15 March still contained NEs for categories where IPCC methods exist, and/or if such reporting has been identified as a problem in previous reviews, then the EU inventory experts, in close cooperation with Member States, prepare the missing GHG source estimates in accordance with the gap-filling provisions in articles 13-16 of Commission Decision 2005/166/EC. Article 16 requires Member States to use the gap-filled estimates in their national submissions to the UNFCCC to ensure consistency between the EU inventory and Member States’ inventories.

4. A general assessment of completeness is included in the EU Greenhouse Gas Inventory Report. For transparency reasons, since 2011 the EU's inventory submission contains an improved description of this section to reflect the additional improvements discussed above.
5. In addition to the steps detailed above the regular QA/QC procedures established to ensure the transparency, accuracy, comparability, consistency, and completeness of the EU inventory continue to be applied. The WG1 on annual inventories continues to address issues of completeness giving them priority and the EU peer reviews and the ESD reviews focus on identifying issues that may lead to an under- or overestimation of emissions.

Since 2012 the completeness checks have been extended to the use of the notation key NO and NA. All cases where less than seven Member States reported NO or NA and all other MS reported emission estimates were checked by the sector experts and clarified with Member States, if needed. With the implementation of the new 2006 IPCC Guidelines, there is an additional check regarding 'insignificance' as described in paragraph 37 of the UNFCCC Reporting Guidelines, which is also relevant for the ESD review.

Member States may only report NEs if:

1. There are no 2006 IPCC methods/EFs available.
2. Emissions are considered insignificant: below 0.05% of the NT & do not exceed 500 kt CO_2 eq. The sum of insignificant NEs shall remain below 0.1% of the NT.
    a. MS shall indicate in both the NIR and the CRF completeness table why such emissions/removals have not been estimated.
    b. MS should provide justifications for exclusion in terms of the likely level of emissions in the NIR, using approximated AD and default IPCC EFs.
3. Emissions have not been reported in a previous submission, otherwise they shall be reported in subsequent submissions.

➢ If MS report unjustified NEs (according to 1. 2. and 3. above) gap-filling rules will apply: art. 4 Delegated Act of the MMR.

For the sectors energy, industrial processes and product use, agriculture, LULUCF and waste sector-specific checks are performed by the EU sector experts using outlier tools similar to those of the UNFCCC and other QA/QC tools. The results of the consistency and completeness checks as well as the main findings of the sector specific checks are documented in the web-based EEA Emission Review Tool (EMRT). This tool is accessible for MS inventory coordinators and inventory experts. The Member States are asked to respond to findings in this tool and if needed provide revised emission estimates or additional information.

For every updated inventory submission provided by the MS by 15 March follow-up checks are performed by the sector experts and additional findings are documented in the EEA Emission Review Tool (EMRT). In addition it is checked if issues identified in the QA/QC communication tool (initial checks), which are relevant for the EU inventory (report) have been clarified by the MS. If this is not the case MS are contacted for clarification.

Since 2015 also cases where neither numeric values nor notation keys have been reported (blank cells) have been included in the checking procedure. EU experts have checked with Member States if blank cells have been caused by the new CRF reporter software or if in fact the blank cells should be replaced by notation keys or a numeric values.

1.7.2 Reporting of notation key "NE"

As the EU GHG inventory is the sum of MS inventories all categories reported as "NE" by Member States are also reflected in the EU GHG inventories. However, the EU CRF tables include only a small number of categories where "NE" is actually visible because the "NE" of a Member State is only visible in the EU CRF in a category where all EU MS report notation keys. Table 1.17 shows that 12 mandatory categories have "NE" visible in the CRF tables for 2019.

Table 1.17 Overview of the number of NE visible in the EU CRF tables for 2019

Sector	**Number of NE visible in the EU CRF for the year 2019 for mandatory categories (MS reporting NE)**
Energy	2 (CZE, GBK, POL)
IPPU	9 (CYP, ESP, FRK, PRT,, SWE)
Agriculture	0
Waste	1 (CZE, GBK)

1.7.3 Reporting of confidential data

According to the UNFCCC reporting guidelines Parties may report specific categories with the notation key C in case of confidentiality. In 2020 only two MS made use of this option; for the year 2019 Croatia reported CO_2, CH_4 and N_2O emission from 1D2 as confidential (Multilateral operations), while Sweden reported correct sector totals for all sectors but in the sectors Energy and IPPU on a less aggregated level the country reported 10 sub-categories as confidential. Manual changes have been performed in order to reflect this in the most appropriate way in the EU CRF tables. For further details refer to Table 1.7. Please note that the EU GHG inventory team – on request - obtains access to confidential MS data for quality checking purposes which has been the case for Sweden in 2020.

Therefore, in the relevant sector chapters, EU trends at fuel level do not always include Sweden for confidentiality reasons and also to preserve time series consistency for the EU. Consequently, the EU CRF tables at sub-category level and data shown on the same level in the NIR are not always consistent. Note that at sector level and at national totals level the EU NIR and the EU CRF tables are fully consistent.

As the EU GHG inventory is the sum of MS inventories all categories reported as confidential by Member States are also reflected in the EU GHG inventories. If Member States report confidential data the notation key "C" will be shown in the comments of the relevant cell in the CRF tables only.

In 2019 no "C"s were shown in the comments of the relevant cells in the CRF tables.

1.7.4 Data gaps and gap-filling

1.7.4.1 Gap filling of emissions

The EU GHG inventory is compiled by using the inventory submissions of the EU Member States. If a Member State does not submit all data required for the compilation of the EU inventory by 15 March of a reporting year, the Commission prepares estimates for data missing in collaboration with the relevant Member State. In the following cases gap filling is made:

- To complete specific years in the GHG inventory time-series for a specific Member State for example were a Member States does not provide new estimates for the latest reporting year.
- To complete individual source categories for individual Member States that did not estimate specific source categories for any year of the inventory time series and reported 'NE'. Gap filling methods are used for major gaps when it is highly certain that emissions from these source categories exist in the Member States concerned.

For data gaps in Member States' inventory submissions, the following procedure is applied by the ETC/CME in accordance with the implementing provisions under the MMR for missing emission data:

- If a consistent time series of reported estimates for the relevant source category is available from the Member State for previous years that has not been subject to adjustments under Article 5.2 of the Kyoto Protocol, extrapolation of this time series is used to obtain the emission estimate. As far as CO_2 emissions from the energy sector are concerned, extrapolation of emissions should be based on the percentage change of Eurostat CO_2 emission estimates if appropriate.
- If the estimate for the relevant source category was subject to adjustments under Article 5.2 of the Kyoto Protocol in previous years and the Member State has not submitted a revised estimate, the basic adjustment method used by the expert review team as provided in the 'Technical guidance on methodologies for adjustments under Article 5.2 of the Kyoto Protocol' is used without application of the conservativeness factor.
- If a consistent time series of reported estimates for the relevant source category is not available and if the source category has not been subject to adjustments under Article 5.2 of the Kyoto Protocol, the estimation should be based on the methodological guidance provided in the 'Technical guidance on methodologies for adjustments under Article 5.2 of the Kyoto Protocol' without application of the conservativeness factor.

The Commission prepares the estimates by 31 March of the reporting year, following consultation with the Member State concerned, and communicates the estimates to the other Member States. The Member State concerned shall use the estimates referred to for its national submission to the UNFCCC to ensure consistency between the EU inventory and Member States' inventories.

The methods used for gap filling include interpolation, extrapolation and clustering. These methods are consistent with the adjustment methods described in UNFCCC Adjustment Guidelines (Table 1) and in the 2006 IPCC guidelines[14].

1.7.4.2 Gap filling of emissions in GHG inventory submissions 2019

Since 2011 GHG inventory estimates have been complete for all EU Member States, and therefore no gap filling has been needed.

[14] ETC ACC technical note on gap filling procedures, December 2006.

1.7.4.3 Gap filling of activity data

In response to recommendations of the UNFCCC review team the EU elaborated and implemented a gap filling procedure for gaps in activity data (for further details on the methodology also see 4.3). Due to the large resource needs for gap filling the following rules apply:

- Only activity data for key categories will be gap-filled.
- If more than 75 % of the emissions are calculated on basis of consistent activity data.
- If the IEF has a reasonable degree of consistency (i.e. standard deviation divided by mean < 50 %).
- Only for the latest reporting year.

1.7.4.4 Gap filling of activity data in GHG inventory submissions 2021

Applying the rules mentioned above activity data of the following categories have been gap-filled in this inventory submission for the year 2019:

- Clinker Production 2A1
- Lime Production 2A2
- Ammonia Production 2B1

1.7.5 Geographical coverage of the European Union inventory

Table 1.18 shows the geographical coverage of the EU Member States' national inventories. Note that not all Member States have signed and ratified the UNFCCC and the Kyoto Protocol with the same geographical coverage. In addition, the EU territory of a country is not always equivalent to the territory of the Party to the UNFCCC or the Kyoto Protocol. For three countries/Member States there are differences in geographical coverage as UNFCCC Party, Kyoto Protocol Party and/or EU Member State (DK, FR and the UK). If there are differences in geographical coverage the respective country needs to prepare several inventories.

As the EU inventory is the sum of the Member States' inventories, the EU inventory covers the same geographical area as the inventories of the 27 Member States, Iceland and the United Kingdom for their respective EU territory. Note that Denmark, France and the United Kingdom submit GHG inventories to the UNFCCC that may differ from the GHG inventories used for the EU-28 inventory because these countries submit more than one inventory to the UNFCCC, which have different geographical coverages. However, the EU's submission under the Convention is fully consistent with MS GHG emissions by sources and sinks according to the EU territory. The EU's submission under the Kyoto Protocol is fully consistent with the joint ratification of the second commitment period of KP by the EU (see Table 1.18).

Table 1.18 Geographical coverage of the Union's GHG inventory

Member State	Geographical coverage	EU and MS Party coverage (Kyoto Protocol, second committment period)	EU-territory coverage (UNFCCC)	Party coverage (UNFCCC)	Country code
Austria	Austria	√	√	√	AUT
Belgium	Belgium consisting of Flemish Region, Walloon Region and Brussels Region	√	√	√	BEL

Member State	Geographical coverage	EU and MS Party coverage (Kyoto Protocol, second committment period)	EU-territory coverage (UNFCCC)	Party coverage (UNFCCC)	Country code
Bulgaria	Bulgaria	√	√	√	BGR
Croatia	Croatia	√	√	√	HRV
Cyprus	Area under the effective control of the Republic of Cyprus	√	√	√	CYP
Czechia	Czech Republic	√	√	√	CZE
Denmark	Denmark (excluding Greenland and the Faeroe Islands)	√	√		DNM
Estonia	Estonia	√	√	√	EST
Finland	Finland including Åland Islands	√	√	√	FIN
France	Metropolitan France, the overseas departments (Guadeloupe, Martinique, Guyana and Reunion) and the overseas communities (Saint-Martin and Mayotte), excluding the French overseas communities (French Polynesia, Wallis and Futuna, Saint-Pierre and Miquelon) and overseas territories (the French Southern and Antarctic Lands) and New Caledonia.	√	√		FRK
	Metropolitan France, the overseas departments (Guadeloupe, Martinique, Guyana and Reunion), the overseas communities (French Polynesia, Saint-Martin, Wallis and Futuna, Mayotte, Saint-Pierre and Miquelon) and overseas territories (the French Southern and Antarctic Lands) and New Caledonia.			√	FRA
Germany	Germany	√	√	√	DEU
Greece	Greece	√	√	√	GRC
Hungary	Hungary	√	√	√	HUN
Ireland	Ireland	√	√	√	IRE
Italy	Italy	√	√	√	ITA
Latvia	Latvia	√	√	√	LVA
Lithuania	Lithuania	√	√	√	LTU
Luxembourg	Luxembourg	√	√	√	LUX
Malta	Malta	√	√	√	MLT
Netherlands	The reported emissions are those that derive from the legal territory of the Netherlands. This includes a 12-mile zone out from the coastline and inland water bodies. It excludes Aruba, Curaçao and Sint Maarten, which are constituent countries of the Kingdom of the Netherlands. It also excludes Bonaire, Saba and Sint Eustatius, which since 10 October 2010 have been public bodies (openbare lichamen) with their own legislation that is not applicable to the European part of the Netherlands. Emissions from offshore oil and gas production on the Dutch part of the continental shelf are included	√	√	√	NLD
Poland	Poland	√	√	√	POL
Portugal	Mainland Portugal and the two Autonomous regions of Madeira and Azores Islands. Includes also emissions from air traffic and navigation bunkers realized between these areas.	√	√	√	PRT
Romania	Romania	√	√	√	ROU
Slovakia	Slovakia	√	√	√	SVK
Slovenia	Slovenia	√	√	√	SVN
Spain	Spanish part of Iberian mainland, Canary Islands, Balearic Islands, Ceuta and Melilla	√	√	√	ESP
Sweden	Sweden	√	√	√	SWE

Member State	Geographical coverage	EU and MS Party coverage (Kyoto Protocol, second committment period)	EU-territory coverage (UNFCCC)	Party coverage (UNFCCC)	Country code
European Union	EU-27+GBE		√	√	EUA
Iceland	Iceland	√		√	
United Kingdom	England, Scotland, Wales and Northern Ireland, and Gibraltar, excluding the UK Crown Dependencies (Jersey, Guernsey and the Isle of Man) and the UK Overseas Territories (except Gibraltar).		√		GBE
	England, Scotland, Wales and Northern Ireland and the UK Overseas Territories and UK Crown Dependencies to whom the UK's ratification of the Kyoto Protocol has been extended and whose emissions are included for the second commitment period (the Cayman Islands, the Falkland Islands, Gibraltar, Jersey, Guernsey and the Isle of Man).	√			GBK
	England, Scotland, Wales and Northern Ireland and the UK Overseas Territories and UK Crown Dependencies for whom the UK's ratification of the UN Framework Convention on Climate Change is extended (the Cayman Islands, the Falkland Islands, Gibraltar, Bermuda, Jersey, Guernsey and the Isle of Man).			√	GBR
European Union and Iceland	EU-27, Iceland and the relevant UK's Overseas Territories and Crown Dependencies (GBK).	√			EUC

1.7.6 Completeness of the European Union submission

1.7.6.1 National inventory report

The EU NIR follows – as far as possible - the annotated outline of the UNFCCC secretariat with the exception of the annexes. The main reason for this is the nature of the EU inventory being the sum of Member States' inventories. Therefore the main purpose of the annexes is to make transparent the EU emission estimates by providing the basic Member States tables for every CRF table. Table 1.19 provides information on what is included in the Annexes to the EU GHG inventory report and provides explanations where the EU does not follow the UNFCCC reporting guidelines.

Table 1.19 Annexes as outlined in the UNFCCC reporting guidelines and annexes included in the EU submission

Annex required in the UNFCCC reporting guidelines	Annex included in the EU submission
Annex I: Key categories	Included: Key category analyses Tier 1 including and excluding LULUCF
Annex II: Assessment of uncertainty	The uncertainty assessment is included in the NIR, section 1.6
Annex III: Detailed methodological descriptions for individual source or sink categories	Included: A summary description of the methodologies used by each Member State for the EU key categories
Annex IV: National energy balance of the most recent year	Not included: Due to the nature of the EU inventory being the sum of Member States' inventories there is no national energy balance which could be included in this annex.
Annex V: Additional information	Included: Summary Table 2 for all MS in order to make transparent the data basis of the EU inventory

1.7.6.2 Activity data in the EU CRF

The European Union cannot provide all data in the sectoral background tables. The main reasons for not completing all sectoral background data tables are: (1) limited data availability partly due to confidentiality issues; and (2) the use of different type of activity data by Member States. The latter is due to the fact that the Member States are responsible for calculating emissions. If they use country-specific methods they may also use different types of activity data. At EU-level these different types of activity data cannot be simply added up. It should be noted that at EU-level no emissions are calculated directly on the basis of activity data reported by MS. However, all the details for the calculation of MS emissions are documented in the Member States' CRF tables, as part of their national GHG inventories.

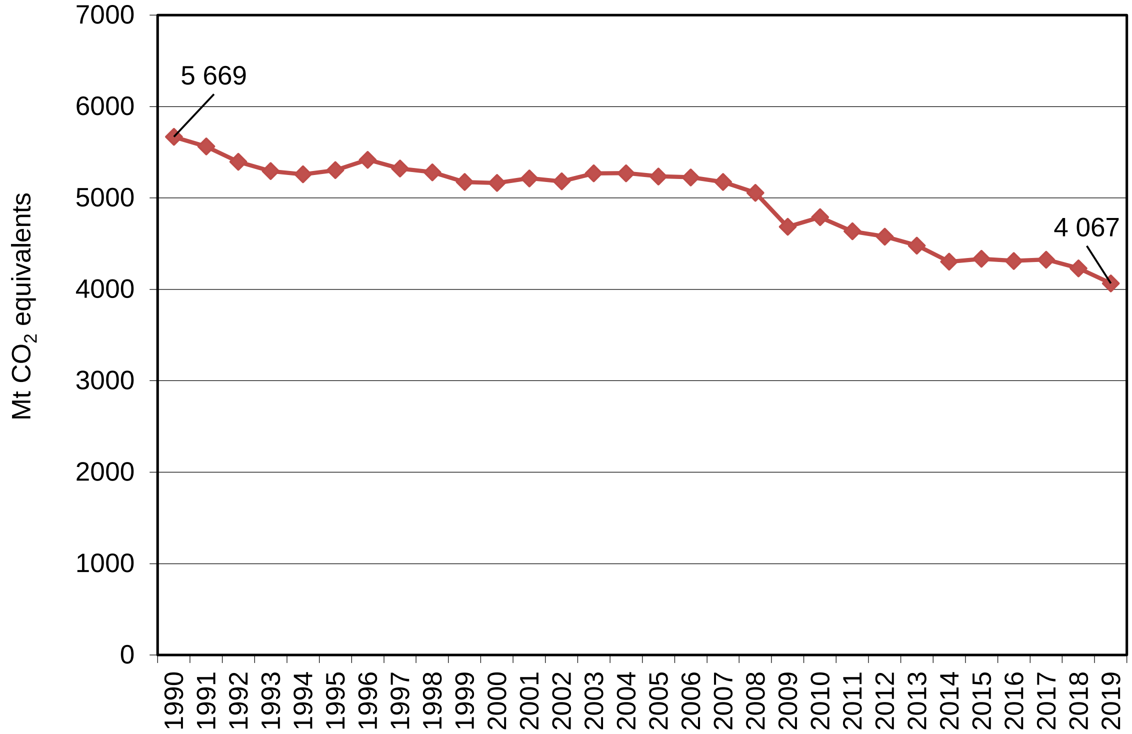
2 EU GREENHOUSE GAS EMISSION TRENDS

This chapter presents the main GHG emission trends in the EU-KP. Aggregated results are described as regards total GHG and emission trends are briefly analysed mainly at gas level. A short overview of countries contributions to total EU-KP GHG trends is given. Finally, the trends of indirect GHGs and SO_2 emissions are presented.

2.1 Aggregated greenhouse gas emissions

In 2019, total GHG emissions in the EU-KP, without LULUCF, were 28.3 % (-1 602 million tonnes CO_2 equivalents) below 1990 levels. Emissions decreased by 3.9 % (166 million tonnes CO_2 equivalents) between 2018 and 2019 (Figure 2.1).

Figure 2.1 EU-KP GHG emissions 1990–2019 (excl. LULUCF)



Notes: GHG emission data for the EU-KP as a whole refer to domestic emissions (i.e. within its territory), include indirect CO_2 and do not include emissions and removals from LULUCF; nor do they include emissions from international aviation and international maritime transport. CO_2 emissions from biomass with energy recovery are reported as a Memorandum item according to UNFCCC guidelines and are not included in national totals. In addition, no adjustments for temperature variations or electricity trade are considered. The global warming potentials are those from the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

2.1.1 Main trends by source category, 1990-2019

Total GHG emissions (excluding LULUCF and excluding international aviation) decreased by 1 602 Mt CO_2 eq. since 1990 (or 28.3 %) reaching their lowest level during this period in 2019 (4067 Mt CO_2 eq.). There has been a progressive decoupling of gross domestic product (GDP) and GHG emission compared to 1990, with an increase in GDP above 64 % alongside a decrease in emissions of about 28 % over the period (-26 %, when including international aviation).

The reduction in GHG emissions over the 29-year period was due to a variety of factors, including the growing share in the use of renewables, the use of less carbon intensive fossil fuels and improvements in energy efficiency, as well as to structural changes in the economy. These have resulted in a lower energy intensity of the economy and in a lower carbon intensity of energy production and consumption in 2019 compared to 1990. Demand for energy to heat households has also been lower, as Europe on average has experienced milder winters since 1990, which has also helped reduce emissions.

GHG emissions decreased in the majority of sectors between 1990 and 2019, with the notable exception of transport, including international transport, and refrigeration and air conditioning. At the aggregate level, emission reductions were largest for manufacturing industries and construction, electricity and heat production, iron and steel production (including energy-related emissions) and residential combustion.

A combination of factors explains lower emissions in industrial sectors, such as improved efficiency and lower carbon intensity as well as structural changes in the economy, with a higher share of services and a lower share of more-energy-intensive industry in total GDP.

Emissions from electricity and heat production decreased strongly since 1990. In addition to improved energy efficiency there has been a move towards less carbon intense fuels. Between 1990 and 2019, the use of solid and liquid fuels in thermal power stations decreased strongly whereas natural gas consumption more than doubled. The use of renewable energy sources in electricity and heat generation has increased substantially in the EU since 1990. Improved energy efficiency and a less carbon intensive fuel mix have resulted in reduced CO_2 emissions per unit of fossil energy generated.

Emissions in the residential sector also represented one of the largest reductions. Energy efficiency improvements from better insulation standards in buildings, and a less carbon-intensive fuel mix, can partly explain lower demand for space heating in the EU over the past 29 years.

In terms of the main GHGs, CO_2 was responsible for the largest reduction in emissions since 1990. Reductions in emissions from N_2O and CH_4 have been substantial, reflecting lower levels of mining activities, lower agricultural livestock, as well as lower emissions from managed waste disposal on land and from reduced adipic and nitric acid production.

A number of policies (both EU and country-specific) have contributed to the overall GHG emission reduction, including key agricultural and environmental policies in the 1990s and climate and energy policies in the 2000s.

Almost all EU Member States reduced emissions compared to 1990 and thus contributed to the overall positive EU performance. The UK and Germany accounted for almost 50% of the total net reduction in the EU-KP of the past 29 years.

Table 2.1 shows those sources that made the largest contribution to the change in total GHG emissions in the EU plus Iceland between 1990 and 2019.

For a more detailed analysis of past GHG emissions trends in the EU, see the 2020 EEA report 'Trends and drivers of EU greenhouse gas emissions', available at
https://www.eea.europa.eu/publications/trends-and-drivers-of-eu-ghg

Table 2.1 Overview of EU source categories whose emissions increased or decreased by more than 20 Million tonnes CO_2 equivalent in the period 1990-2019

Source category	Million tonnes (CO_2 equivalents)
Road Transportation (CO2 from 1.A.3.b)	176
Refrigeration and Air conditioning (HFCs from 2.F.1)	83
Aluminium Production (PFCs from 2.C.3)	-21
Cement Production (CO2 from 2.A.1)	-25
Fluorochemical Production (HFCs from 2.B.9)	-27
Agricultural soils: Direct N2O emissions (N2O from 3.D.1)	-28
Fugitive Emissions from Oil and Natural Gas (CH4 from 1.B.2)	-40
Enteric Fermentation: Cattle (CH4 from 3.A.1)	-41
Nitric Acid Production (N2O from 2.B.2)	-46
Fuels used Commercial/Institutional Sector (CO2 from 1.A.4.a)	-47
Adipic Acid Production (N2O from 2.B.3)	-57
Manufacture of Solid Fuels and Other Energy Industries (CO2 from 1.A.1.c)	-62
Fugitive Emissions from Solid Fuels (CH4 from 1.B.1)	-72
Managed Waste Disposal Sites (CH4 from 5.A.1)	-74
Iron and Steel Production (CO2 from 1.A.2.a + 2.C.1)	-126
Fuels used Residential Sector (CO2 from 1.A.4.b)	-136
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A.2.a)	-267
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-620
Total	**-1602**

Notes: As the table only presents sectors whose emissions increased or decreased by at least 20 million tonnes CO_2-equivalent, the sum of the source categories presented does not match the total change listed at the bottom of the table.

2.1.2 Main trends by source category, 2018-2019

Total GHG emissions (excluding LULUCF) decreased in 2019 by 166 million tonnes, or 3.9 % compared to 2018, to reach 4067 Mt CO_2 equivalent in 2019. The reduction in GHG emissions in 2019 was the second largest in the EU since 1990 in the context of positive (+1.5 %) economic growth. Germany, Spain and Poland accounted for more than half of the net reduction in GHG emissions in absolute terms in the EU-KP in 2019.

At EU level, almost 80 % of the net reduction in GHG emissions in 2019 took place in main activity producers of heat and electricity, including combined heat and power. EU ETS prices increased in 2019 compared to 2018, and relative gas prices decreased compared to coal, which encouraged the use of less carbon intensive fuels. CO_2 emissions from solid fuels decreased by 150 million tonnes compared to 2018. Natural gas input to power stations increased, with emissions 25 million tonnes above 2018 levels. In addition, based on Eurostat energy statistics, the use of renewable energy sources in electricity generation increased again in 2019, mostly from wind, solar and bioenergy, thus underpinning the ongoing decarbonisation trend in the sector.

Although less substantial than in the power sector, GHG emissions in 2019 also decreased in manufacturing industries and construction, iron and steel, residential buildings (due to a warmer winter and lower demand for heating) and coal mining. It is worth highlighting that HFC emissions from refrigeration and air conditioning decreased for the fifth consecutive year since 2014. CO_2 emissions from road transportation increased in 2019, mostly due to higher gasoline consumption in passenger cars.

Table 2.2 shows the source categories making the largest contribution to the change in GHG emissions in the EU between 2018 and 2019.

Table 2.2 Overview of EU-KP source categories whose emissions increased or decreased by more than 3 million tonnes CO_2 equivalent in the period 2018–2019

Source category	Million tonnes (CO_2 equivalents)
Road Transportation (CO_2 from 1.A.3.b)	4
Fugitive Emissions from Solid Fuels (CH4 from 1.B.1)	-4
Fuels used Residential Sector (CO2 from 1.A.4.b)	-6
Iron and Steel Production (CO2 from 1.A.2.a + 2.C.1)	-7
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A.2.a)	-9
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-127
Total	**-166**

Notes: As the table only presents sectors whose emissions have increased or decreased by at least 3 million tonnes of CO_2- equivalent, the sum of the source categories presented does not match the total change listed at the bottom of the table

Table 2.3 gives an overview on total GHG emissions by countries, illustrating where main changes occurred.

Table 2.3 Greenhouse gas emissions in CO_2 equivalent (excl. LULUCF)

	1990 (million tonnes)	2019 (million tonnes)	2018 - 2019 (million tonnes)	Change 2018 - 2019 (%)	Change 1990-2019 (%)
Austria	78.4	79.8	1.2	1.5%	1.8%
Belgium	145.7	116.7	-1.2	-1.1%	-19.9%
Bulgaria	100.0	56.0	-1.3	-2.3%	-44.0%
Croatia	31.4	23.6	0.1	0.3%	-24.8%
Cyprus	5.6	8.8	0.03	0.3%	58.7%
Czechia	198.9	123.3	-6.0	-4.6%	-38.0%
Denmark	70.9	44.2	-3.9	-8.1%	-37.6%
Estonia	41.0	14.7	-5.5	-27.3%	-64.2%
Finland	71.2	53.1	-3.3	-5.8%	-25.5%
France	544.0	436.0	-8.6	-1.9%	-19.9%
Germany	1248.6	809.8	-46.1	-5.4%	-35.1%
Greece	103.3	85.6	-6.7	-7.2%	-17.1%
Hungary	94.8	64.4	-0.3	-0.5%	-32.0%
Ireland	54.4	59.8	-2.7	-4.4%	9.9%
Italy	518.7	418.3	-10.3	-2.4%	-19.4%
Latvia	25.9	11.1	-0.1	-1.1%	-57.0%
Lithuania	47.8	20.4	0.2	1.1%	-57.4%
Luxembourg	12.7	10.7	0.2	1.7%	-15.6%
Malta	2.6	2.2	0.1	6.5%	-16.2%
Netherlands	220.5	180.7	-6.0	-3.2%	-18.0%
Poland	475.9	390.7	-21.1	-5.1%	-17.9%
Portugal	58.9	63.6	-3.6	-5.4%	8.1%
Romania	266.4	113.9	-4.3	-3.6%	-57.3%
Slovakia	73.5	40.0	-2.2	-5.3%	-45.6%
Slovenia	18.6	17.1	-0.5	-2.6%	-8.2%
Spain	290.0	314.5	-18.7	-5.6%	8.5%
Sweden	71.2	50.9	-1.3	-2.4%	-28.5%
United Kingdom	791.4	449.2	-13.7	-3.0%	-43.2%
EU-27+UK	5662.3	4059.2	-165.6	-3.9%	-28.3%
Iceland	3.7	4.7	-0.1	-2.1%	28.2%
United Kingdom (KP)	794.1	452.3	-13.6	-2.9%	-43.0%
EU-KP	5668.7	4067.1	-165.5	-3.9%	-28.3%

2.2 Emission trends by gas

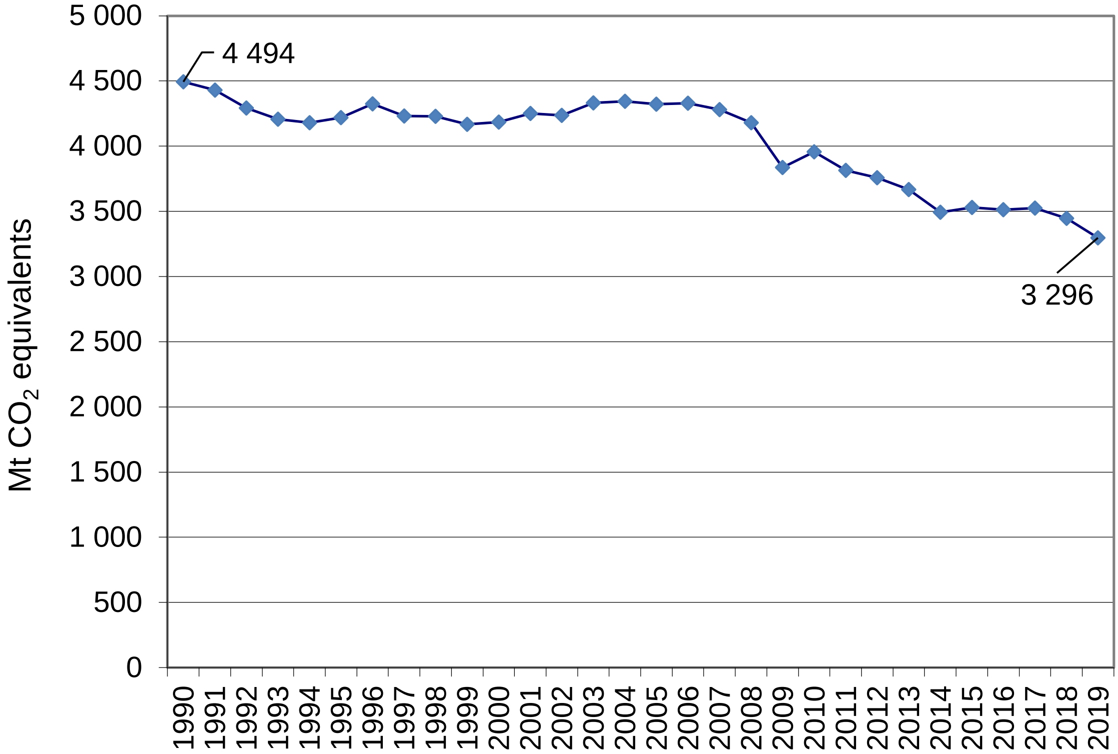
Table 2.4, Figure 2.2 and Figure 2.3 give an overview of the main trends in EU-KP GHG emissions and removals for 1990–2019. In the EU-KP the most important GHG is CO_2, accounting for 81 % of total EU-KP emissions in 2019 excluding LULUCF. In 2019, CO_2 emissions excluding LULUCF were 3 296 Mt, which was 27 % below 1990 levels. Compared to 2018, CO_2 emissions, N_2O emissions and CH_4 emissions decreased each by 4 %, 1 % and 2 %.

Table 2.4 Overview of EU-KP GHG emissions and removals from 1990 to 2019 in CO_2 equivalent

GREENHOUSE GAS EMISSIONS	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Net CO_2 emissions/removals	4 276	3 909	3 866	3 996	3 624	3 485	3 421	3 329	3 173	3 214	3 199	3 248	3 167	3 029
CO_2 emissions (without LULUCF)	4 494	4 218	4 185	4 322	3 956	3 814	3 758	3 667	3 492	3 530	3 513	3 526	3 446	3 296
CH_4	729	673	612	552	496	486	483	472	464	464	458	460	451	443
N_2O	407	367	325	305	259	254	253	253	256	257	256	261	257	255
HFCs	29	43	53	73	99	103	106	110	112	106	106	105	99	94
PFCs	26	17	12	7	4	4	4	4	3	4	4	4	4	3
Unspecified mix of HFCs and PFCs	6	6	2	1	1	0	1	1	1	1	1	1	2	2
SF_6	11	15	10	8	6	6	6	6	6	6	6	7	7	7
NF_3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (with net CO_2 emissions/removals)	**5 485**	**5 031**	**4 881**	**4 943**	**4 490**	**4 339**	**4 274**	**4 174**	**4 015**	**4 052**	**4 030**	**4 085**	**3 985**	**3 833**
Total (without CO2 from LULUCF)	**5 702**	**5 340**	**5 200**	**5 269**	**4 821**	**4 668**	**4 611**	**4 512**	**4 335**	**4 367**	**4 345**	**4 363**	**4 265**	**4 100**
Total (without LULUCF)	**5 669**	**5 305**	**5 166**	**5 236**	**4 790**	**4 637**	**4 578**	**4 481**	**4 303**	**4 335**	**4 312**	**4 327**	**4 233**	**4 067**

Notes: CO_2 emissions include indirect CO_2

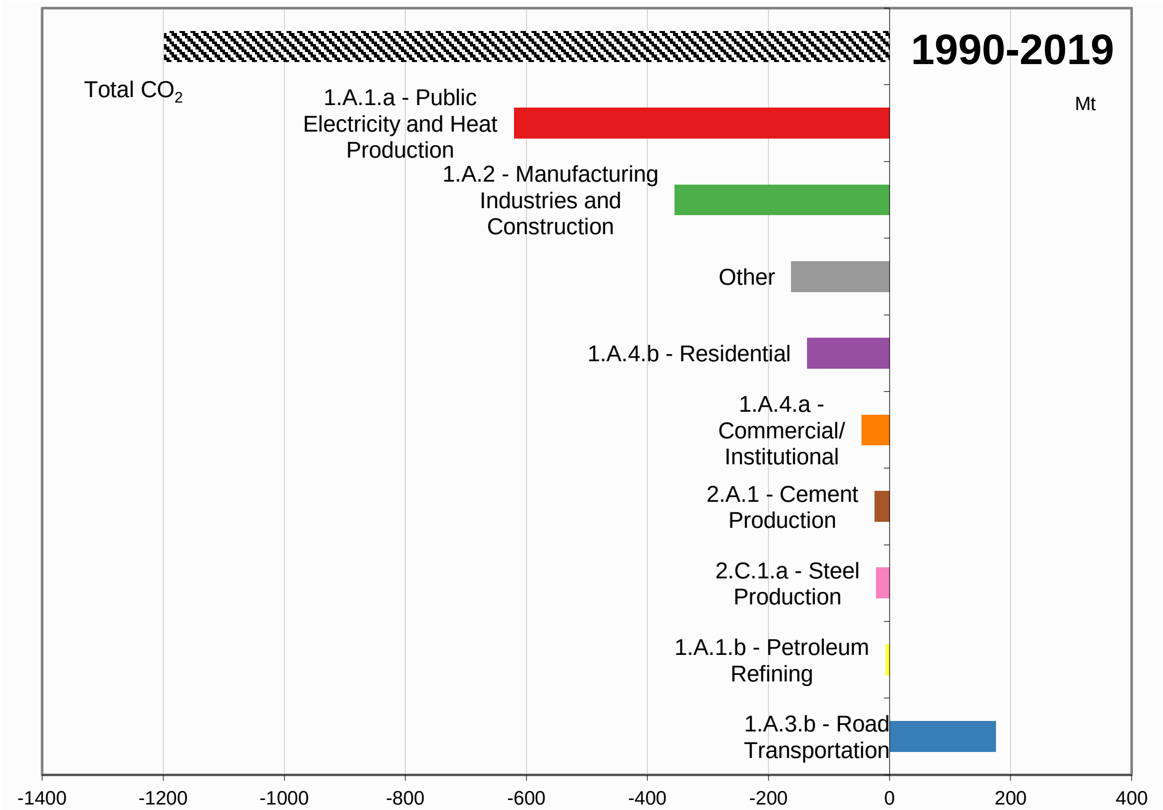
Figure 2.2 CO_2 emissions 1990 to 2019 (Mt)



Notes: CO_2 emissions include indirect CO_2

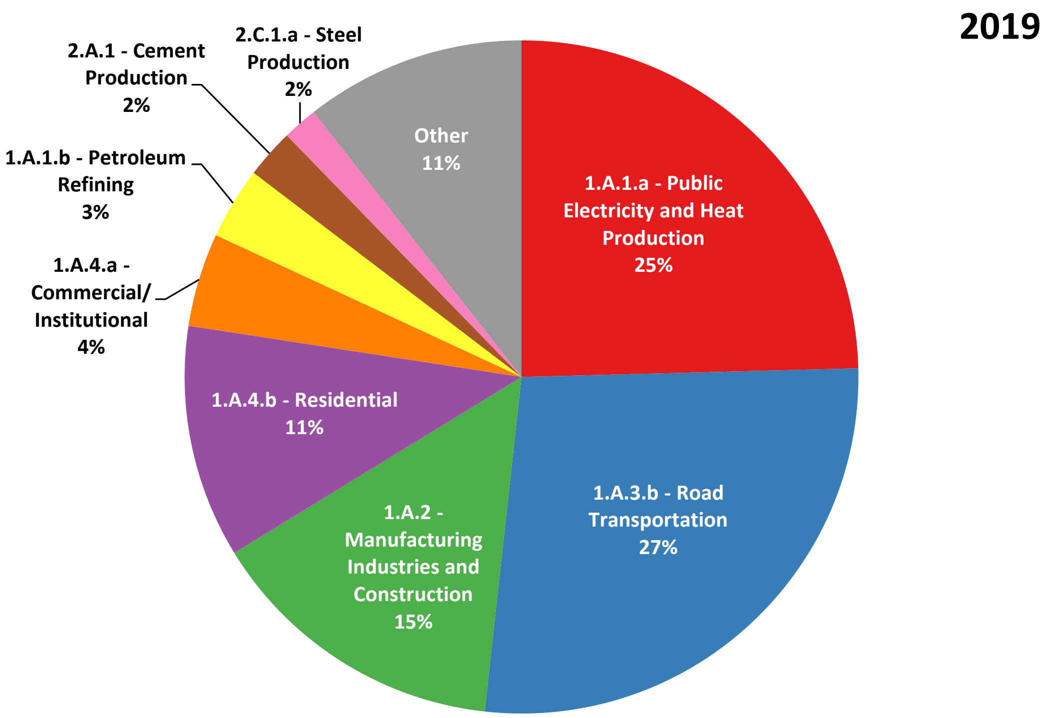
The largest key source categories for CO_2 emissions (Figure 2.3) have been reduced between 1990 and 2019 with the exception of 1.A.3.b Road transportation, which accounts for 27 % of CO_2 emissions in 2019.

Figure 2.3 Absolute change of CO_2 emissions by large key source categories 1990 to 2019 in CO_2 equivalents (Mt) for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 2.4 CO_2 emissions: Share of key source categories and all remaining categories in 2019 for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total
Percentages are rounded and may lead to a sum higher or lower than 100%

CH_4 emissions account for 11 % of total EU GHG emissions in 2019 and decreased by 39 % since 1990 to 443 Mt CO_2 equivalents in 2019 (Figure 2.5). The two largest key sources are enteric fermentation and anaerobic waste (Figure 2.7). They account for 55 % of CH_4 emissions in 2019.

Figure 2.5 CH_4 emissions 1990 to 2019 in CO_2 equivalents (Mt)

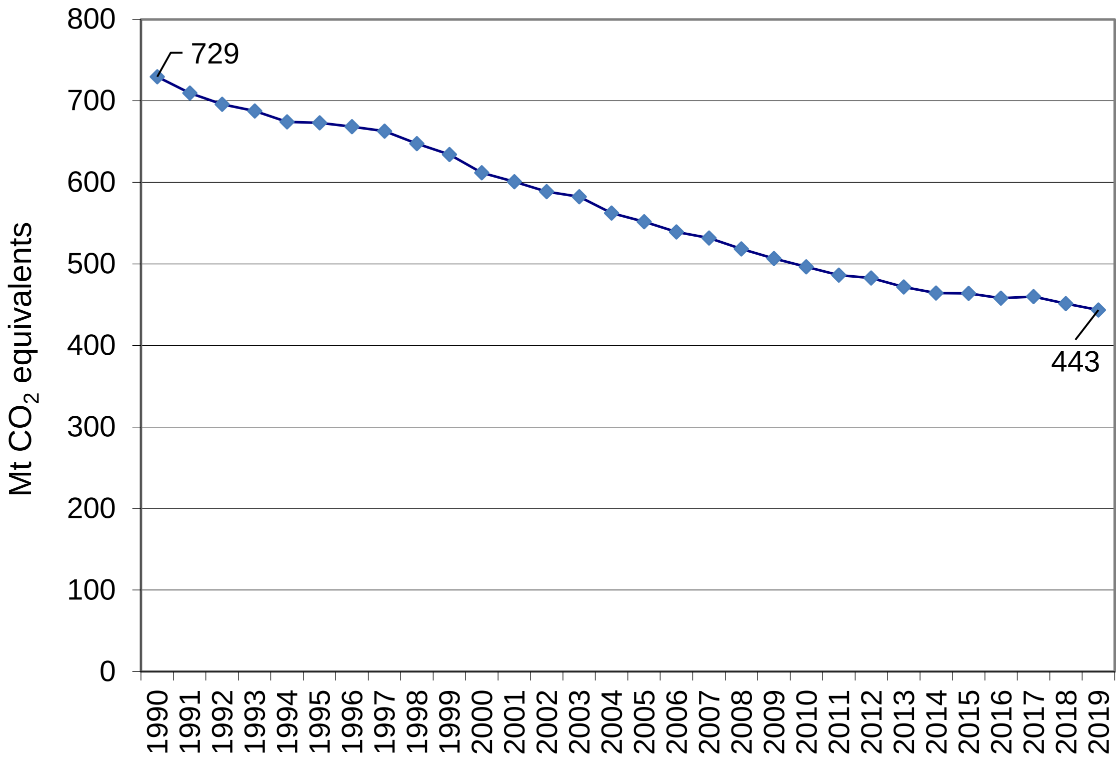
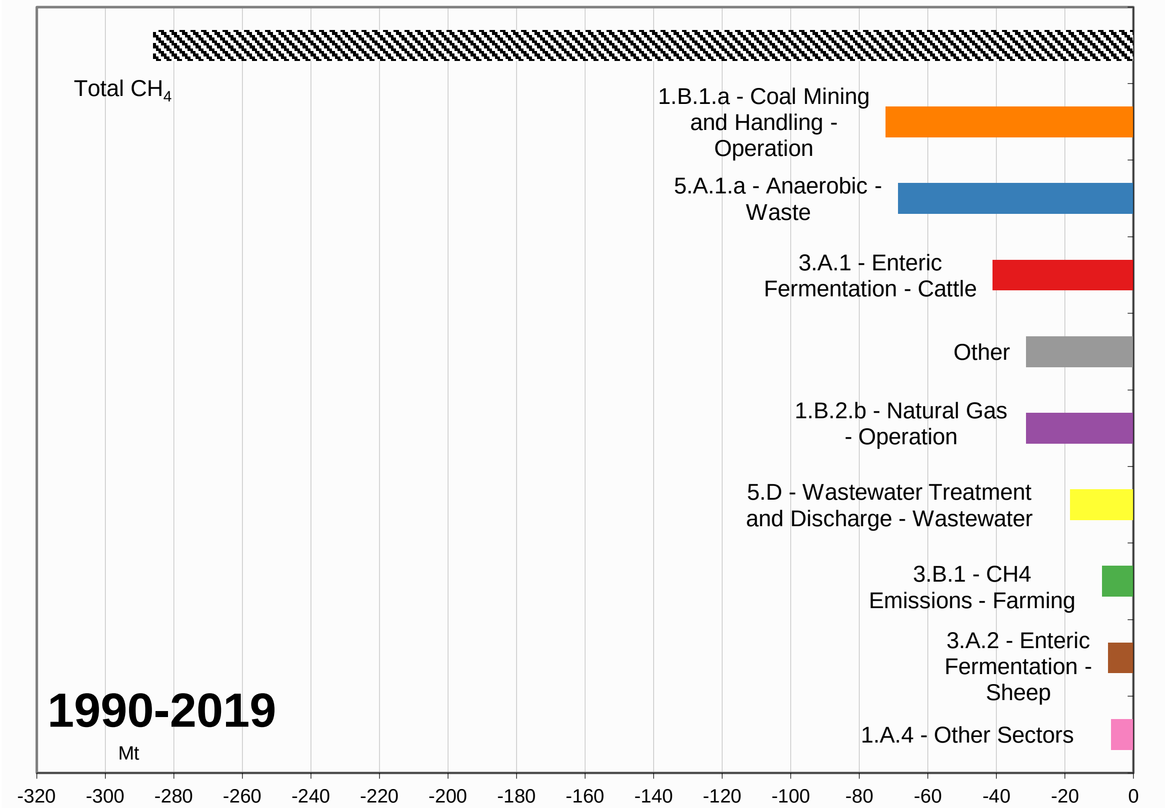


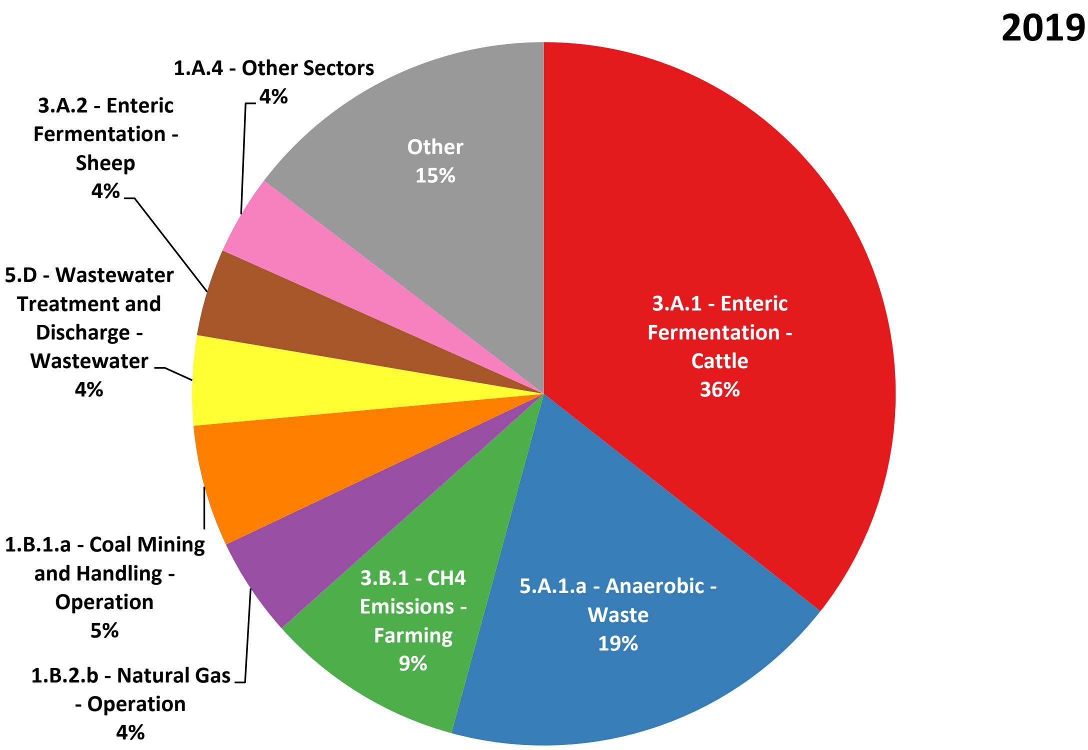
Figure 2.6 shows that the main reasons for declining CH_4 emissions were reductions in anaerobic waste and coal mining.

Figure 2.6 Absolute change of CH_4 emissions by large key source categories 1990 to 2019 in CO_2 equivalents (Mt) for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 2.7 CH_4 emissions: Share of key source categories and all remaining categories in 2019 for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total
Percentages are rounded and may lead to a sum higher or lower than 100%

N_2O emissions are responsible for 6 % of total EU GHG emissions and decreased by 37 % to 255 Mt CO_2 equivalents in 2019 (Figure 2.8). N_2O emissions derive mainly from the agriculture sector. The two largest key sources account for about 64 % of N_2O emissions in 2019 (Figure 2.10). Figure 2.9 shows that the main reason for large N_2O emission cuts were reduction in chemical industry and agricultural soils.

Figure 2.8 N_2O emissions 1990 to 2019 in CO_2 equivalents (Mt)

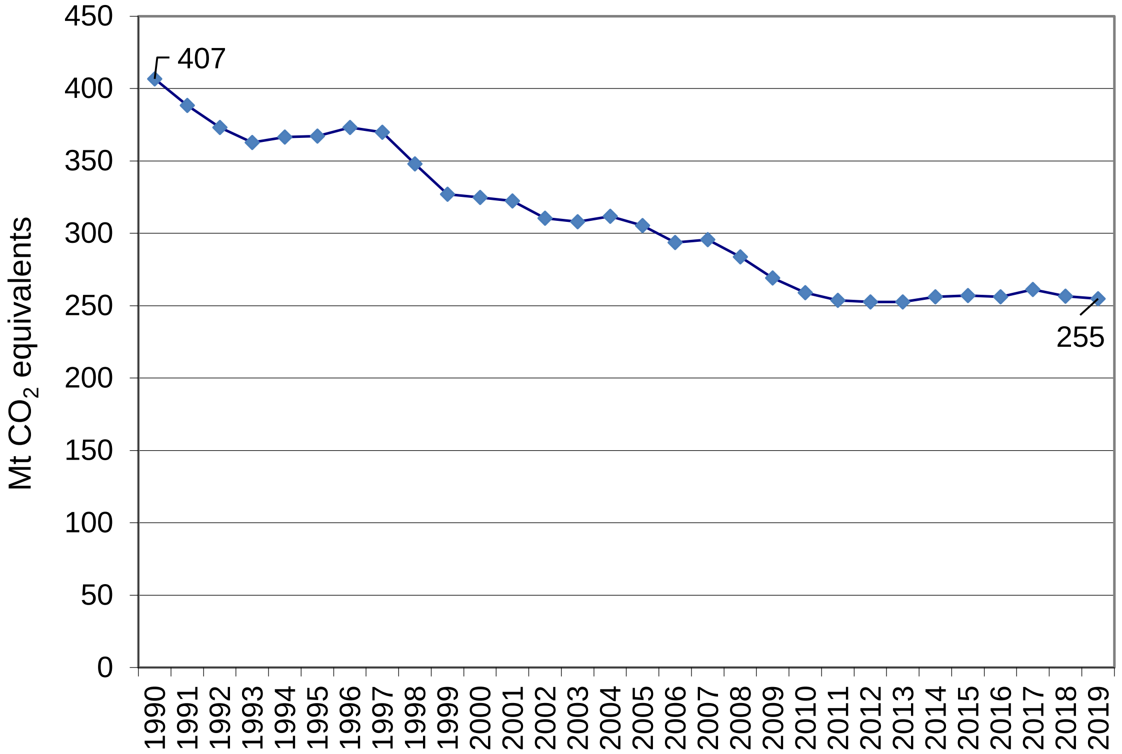
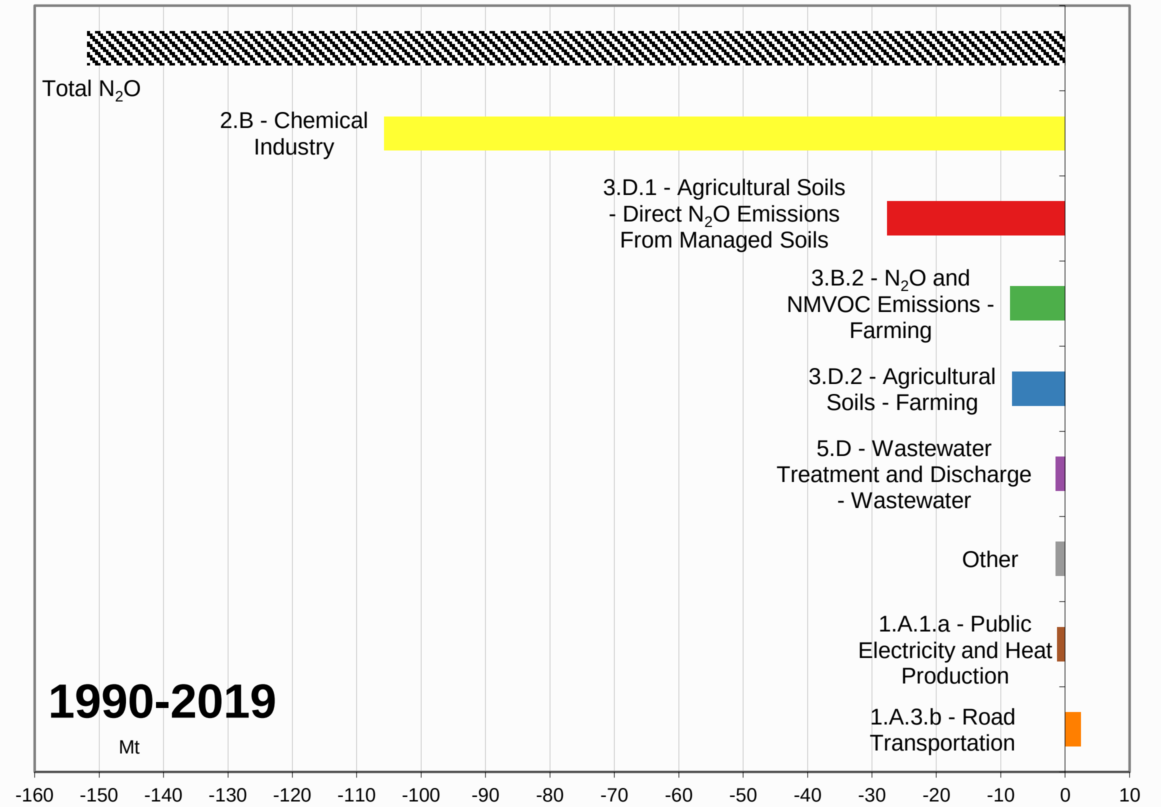
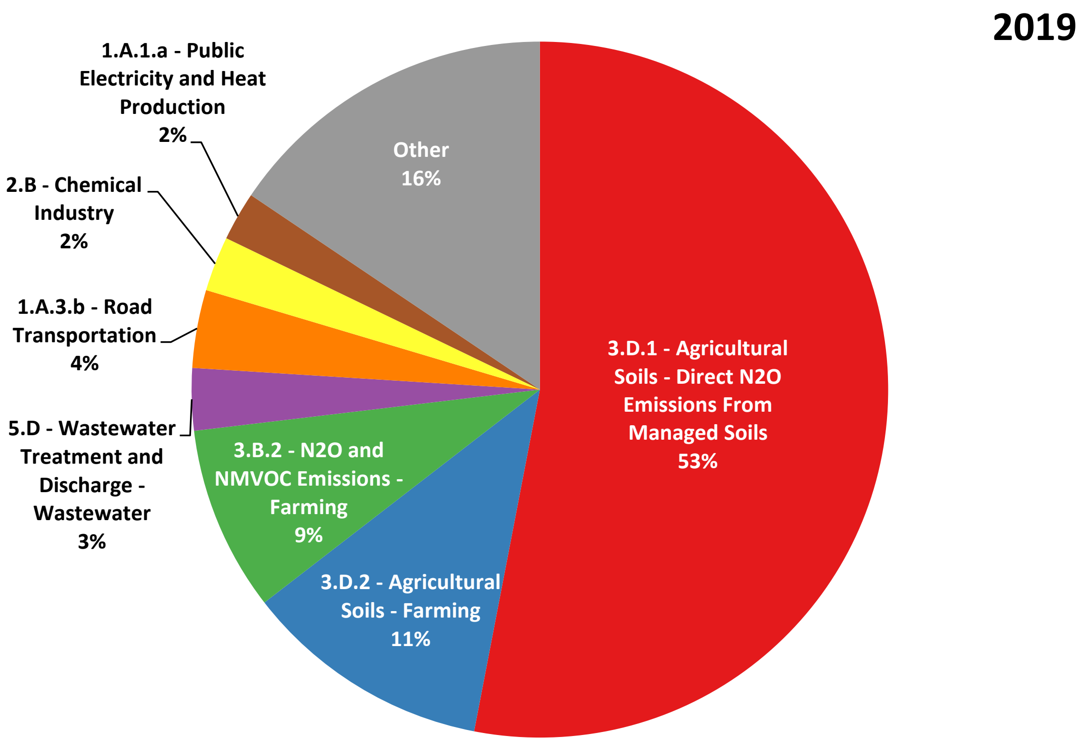


Figure 2.9 Absolute change of N_2O emissions by large key source categories 1990 to 2019 in CO_2 equivalents (Mt) for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 2.10 N_2O emissions: Share of key source categories and all remaining categories in 2019 for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total
Percentages are rounded and may lead to a sum higher or lower than 100%

Fluorinated gas emissions account for 2.6 % of total EU GHG emissions. In 2019, emissions amounted to 106 Mt CO_2 equivalents, which was 46 % above 1990 levels (Figure 2.11). Refrigeration and air conditioning, the largest key category, accounts for 79 % of fluorinated gas emissions in 2019. Figure 2.12 reveals that HFCs from refrigeration and air conditioning showed large increases between 1990 and 2019. The main reason for this is the phase-out of ozone-depleting substances such as chlorofluorocarbons under the Montreal Protocol and the replacement of these substances with HFCs (mainly in refrigeration, air conditioning, foam production and as aerosol propellants). On the other hand, the sum of HFC emissions from categories not presented individually in Figure 2.12 (Other in Figure 2.12) decreased substantially.

Figure 2.11 Fluorinated gas emissions 1990 to 2019 in CO_2 equivalents (Mt)

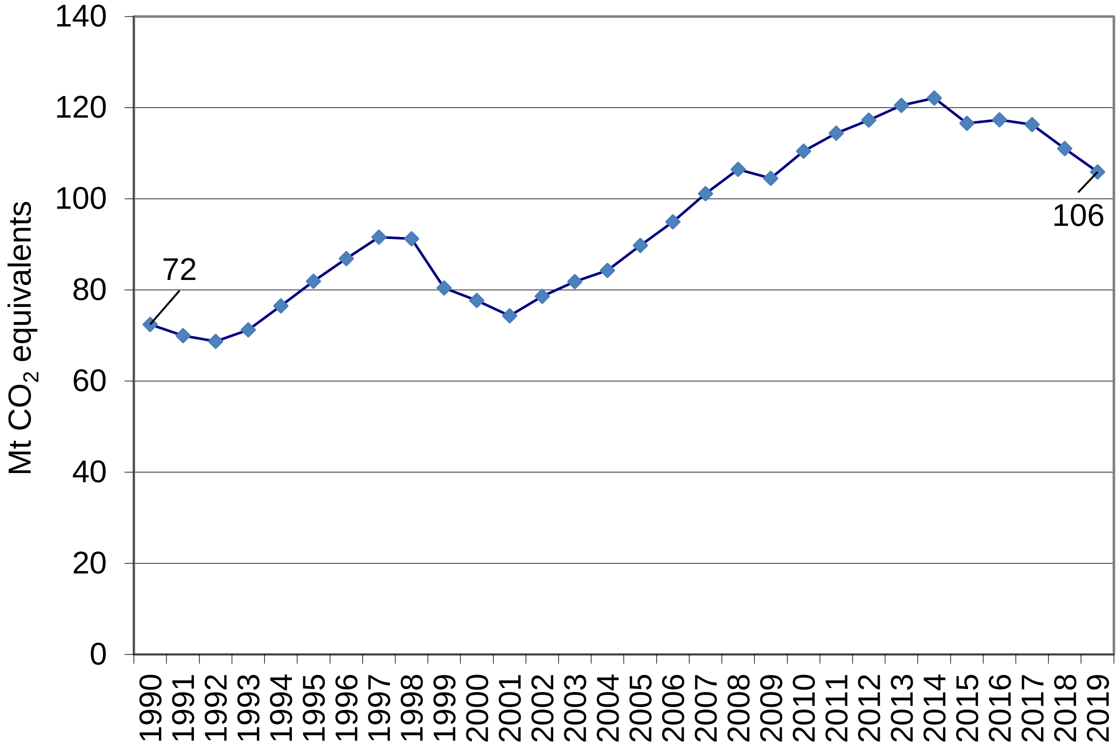
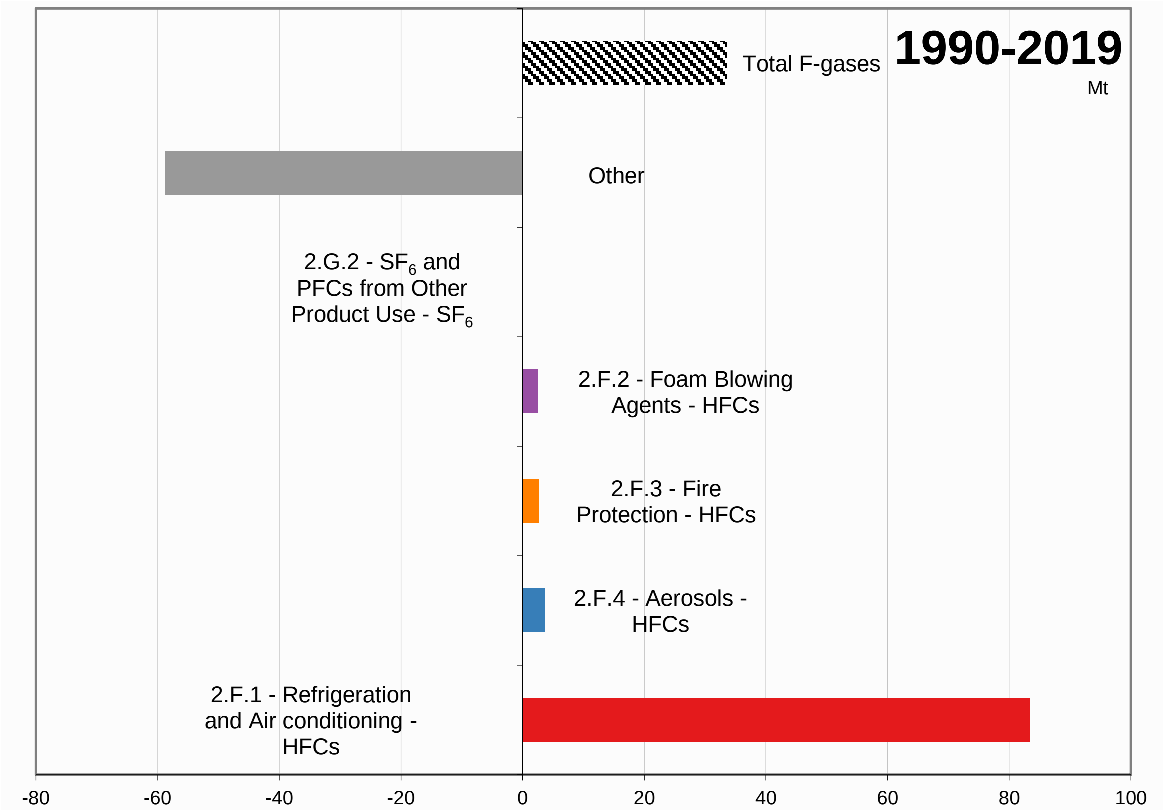
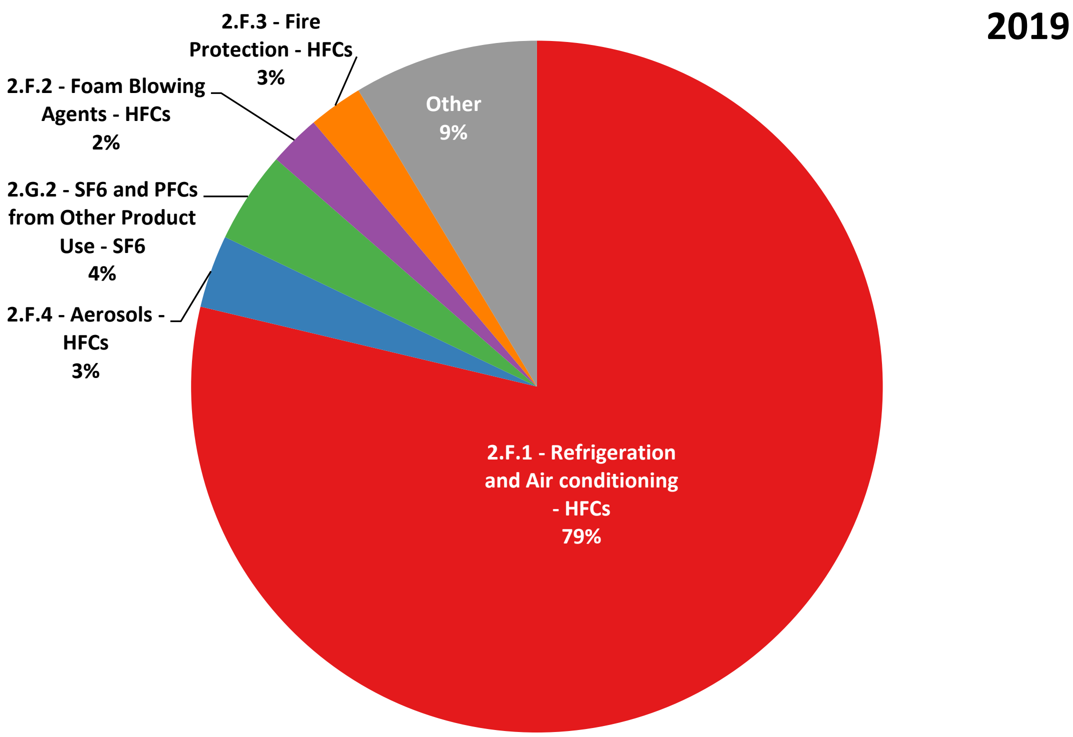


Figure 2.12 Absolute change of fluorinated gas emissions by large key source categories 1990 to 2019 in CO_2 equivalents (Mt) for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 2.13 Fluorinated gas: Share of key source categories and all remaining categories in 2019 for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total
Percentages are rounded and may lead to a sum higher or lower than 100%

2.3 Emission trends by source

Table 2.5 gives an overview of EU-KP emissions in the main source categories for 1990–2019. The most important sector by far is energy (i.e. combustion and fugitive emissions), which accounted for 77 % of total emissions in 2019. The second largest sector is agriculture (11 %), followed by industrial processes (9 %). More detailed trend descriptions are included in the individual sector chapters (chapters 3-7) and chapter 9 on indirect CO_2 emissions.

Table 2.5 Overview of EU-KP GHG emissions (in million tonnes CO_2 equivalent) in the main source and sink categories for the period 1990 to 2019

GHG SOURCE AND SINK	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1. Energy	4 358	4 081	4 012	4 123	3 801	3 656	3 615	3 521	3 336	3 376	3 357	3 361	3 282	3 132
2. Industrial Processes	530	506	463	473	397	395	383	383	389	381	381	390	380	370
3. Agriculture	537	469	459	437	423	422	422	424	432	433	434	437	432	429
4. Land-Use, Land-Use Change and Forestry	-184	-274	-285	-293	-300	-298	-304	-307	-288	-283	-282	-242	-247	-234
5. Waste	240	246	228	200	167	161	157	151	145	142	139	138	136	135
6. Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
indirect CO_2 emissions	4	4	3	3	2	2	2	2	2	2	2	2	2	2
Total (with net CO_2 emissions/removals)	**5 485**	**5 031**	**4 881**	**4 943**	**4 490**	**4 339**	**4 274**	**4 174**	**4 015**	**4 052**	**4 030**	**4 085**	**3 985**	**3 833**
Total (without LULUCF)	**5 669**	**5 305**	**5 166**	**5 236**	**4 790**	**4 637**	**4 578**	**4 481**	**4 303**	**4 335**	**4 312**	**4 327**	**4 233**	**4 067**

Notes: CO_2 emissions include indirect CO_2

2.4 Emission trends by Member State

Table 2.6 gives an overview of EU countries contributions to the EU-KP emissions for 1990–2019. Countries show large variations in GHG emission trends.

Table 2.6 Overview of countries contributions to total EU GHG emissions, excluding LULUCF, including indirect CO_2 emissions, from 1990 to 2019 in million tonnes CO_2-equivalent

Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Austria	78	79	80	92	84	82	79	80	76	78	79	82	79	80
Belgium	146	154	149	146	134	123	120	120	115	119	118	117	118	117
Bulgaria	100	73	58	63	60	65	60	55	58	61	59	61	57	56
Croatia	31	22	26	30	28	27	26	24	23	24	24	25	24	24
Cyprus	6	7	8	9	9	9	9	8	8	8	9	9	9	9
Czechia	199	158	150	149	141	139	135	130	127	129	130	131	129	123
Denmark	71	79	71	67	64	58	54	55	51	49	51	48	48	44
Estonia	41	20	17	19	21	21	20	22	21	18	20	21	20	15
Finland	71	72	70	70	76	68	62	63	59	55	58	55	56	53
France	544	537	548	551	508	483	485	486	455	458	460	463	445	436
Germany	1249	1121	1043	993	942	917	923	940	901	904	908	892	856	810
Greece	103	109	126	136	119	116	112	103	99	95	92	96	92	86
Hungary	95	77	75	77	66	64	61	58	58	62	62	65	65	64
Ireland	54	59	68	70	62	58	59	59	58	60	62	62	63	60
Italy	519	532	555	589	516	504	484	449	428	440	438	433	429	418
Latvia	26	12	10	11	12	11	11	11	11	11	11	11	11	11
Lithuania	48	22	19	23	21	21	21	20	20	20	20	21	20	20
Luxembourg	13	10	10	13	12	12	12	11	11	10	10	10	11	11
Malta	3	3	3	3	3	3	3	3	3	2	2	2	2	2
Netherlands	221	230	218	213	212	198	194	194	186	193	194	191	187	181
Poland	476	447	397	405	414	412	405	402	389	391	400	415	412	391
Portugal	59	69	82	86	69	67	66	64	64	68	66	71	67	64
Romania	266	187	142	149	118	126	124	115	115	116	114	117	118	114
Slovakia	73	53	49	50	45	45	42	42	40	41	41	42	42	40
Slovenia	19	19	19	20	20	20	19	18	17	17	18	18	18	17
Spain	290	329	388	442	358	358	350	324	326	337	325	339	333	315
Sweden	71	73	68	67	65	60	57	56	54	54	54	53	52	51
United Kingdom	791	745	708	686	605	560	577	563	523	505	480	470	463	449
EU-27+UK	**5662**	**5298**	**5159**	**5229**	**4782**	**4629**	**4571**	**4473**	**4296**	**4327**	**4305**	**4319**	**4225**	**4059**
Iceland	4	4	4	4	5	5	5	5	5	5	5	5	5	5
United Kingdom (KP)	794	748	711	689	608	563	580	566	526	508	483	473	466	452
EU-KP	**5669**	**5305**	**5166**	**5236**	**4790**	**4637**	**4578**	**4481**	**4303**	**4335**	**4312**	**4327**	**4233**	**4067**

The overall EU GHG emission trend is dominated by the three largest emitters Germany (20 %), the United Kingdom (11 %) and France (11 %), accounting for over forty percent of total EU-KP GHG emissions in 2019. Germany and the United Kingdom, the two countries with the highest absolute reductions, achieved total domestic GHG emission reductions of 781 million tonnes CO_2 equivalent compared to 1990, not counting carbon sinks and the use of Kyoto mechanisms.

The main reasons for the favourable trend in Germany were an increase in the efficiency of power and heating plants and the economic restructuring of the five new “Länder” after the German reunification, particularly in the iron and steel sector. Other important reasons include a reduction in the carbon intensity of fossil fuels (with the switch from coal to gas), a strong increase in renewable energy use and waste management measures that reduced the landfilling of organic waste.

Lower GHG emissions in the United Kingdom were primarily the result of liberalising energy markets and the subsequent fuel switch from oil and coal to gas in electricity production. Other reasons include the shift towards more efficient combined cycle gas turbine stations, decreasing iron and steel production and the implementation of methane recovery systems at landfill sites.

France's emissions were 20 % below 1990 levels in 2019. France achieved large reductions in N_2O emissions in the chemical industry, but CO_2 emissions from road transport and HFC emissions from electronics industry and product uses as substitutes of ODS increased considerably between 1990 and 2019. Italian GHG emissions increased since 1990 primarily from road transport, electricity and heat production and petrol refining.

Italy, Poland and Spain were the fourth, fifth and six largest emitters in the EU-KP with a share in total GHG emissions of 10 %, 10 % and 8 %, respectively.

Italy's GHG emissions were 19 % below 1990 levels in 2019. However, Italian emissions decreased significantly since 2007 with a significant drop in 2009, which was mainly due to the economic crisis and reductions in industrial output. Since 2010 emissions were decreasing continuously with one exemption in 2015.

Poland's GHG emissions were 18 % below 1990 levels in 2019. The main factors for decreasing emissions in Poland — as with other Member States — were the decline of energy-inefficient heavy industry and the overall restructuring of the economy in the late 1980s and early 1990s. The notable exception was transport (especially road transport), where emissions increased.

Spain increased emissions by 8.5 % between 1990 and 2019. This was largely due to emission increases from road transport, electricity and heat production, and households and services.

2.5 Emission trends for indirect greenhouse gases and sulphur dioxide

Emissions of CO, NO_x, NMVOC and SO_2 have to be reported to the UNFCCC Secretariat because they influence climate change indirectly: CO, NO_x and NMVOC are precursor substances for ozone which itself is a greenhouse gas. Sulphur emissions produce microscopic particles (aerosols) that can reflect sunlight back out into space and also affect cloud formation. Table 2.7 shows the total indirect GHG and SO_2 emissions in the EU-KP between 1990 and 2019. All emissions were reduced significantly from 1990 levels: the largest reduction was achieved in SO_2 (-92 %) followed by, CO (-73 %), NMVOC (-64 %). and NO_x (-64 %).

Table 2.7 Overview of EU-KP indirect GHG and SO_2 emissions for 1990–2019 (kt)

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NO_X	17876	15509	13440	12375	9834	9480	9191	8751	8404	8247	7934	7814	6712	6387
CO	64830	52506	40579	32077	27137	24753	24881	23846	21766	21972	21510	21228	18027	17780
NMVOC	17948	14548	11890	9918	8296	7892	7738	7501	7294	7260	7197	7268	6504	6430
SO_2	24070	15692	9619	7307	4314	4267	4027	3567	3350	3297	2848	2856	2103	1860

Table 2.8 shows the NO_x emissions of the EU-KP countries between 1990 and 2019. The largest emitters, Germany, France, the United Kingdom and Spain made up 55 % of total NO_x emissions in 2019. All countries reduced their NO_x emissions between 1990 and 2019.

Table 2.9 shows the CO emissions between 1990 and 2019. The largest emitters, France, Germany, Italy, Romania and the UK that made up 60 % of the total CO emissions in 2019, reduced their emissions from 1990 levels substantially. Also all other countries with the exception of Iceland reduced CO emissions.

Table 2.10 shows the NMVOC emissions of the EU-KP countries between 1990 and 2019. The largest emitters France, Germany, Italy and the UK that made up 59 % of the total NMVOC emissions in 2019, reduced their emissions from 1990 levels, together with most other countries.

Table 2.11 shows the SO_2 emissions of the EU-KP countries between 1990 and 2019. The largest emitters, Bulgaria, Germany, Romania, Spain and the UK that made up 61 % of the total SO_2 emissions in 2019, reduced their emissions from 1990 levels substantially, together with all other countries.

Table 2.8 Overview of Member States' contributions to EU-KP NOx emissions for 1990–2019 (kt)

Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Austria	216	197	210	245	203	194	189	188	180	177	169	161	149	142
Belgium	428	415	359	326	243	226	215	206	196	196	185	174	167	158
Bulgaria	258	173	145	157	139	149	136	121	128	136	127	130	121	118
Croatia	111	82	91	89	72	68	62	61	58	58	57	58	53	53
Cyprus	17	19	22	22	19	22	22	17	18	15	15	15	15	14
Czechia	729	369	280	272	231	218	206	192	187	181	173	170	164	153
Denmark	302	290	226	205	149	140	129	124	115	113	113	110	104	98
Estonia	102	52	45	43	45	44	41	38	39	39	40	41	40	35
Finland	298	266	235	200	179	163	155	151	143	132	128	124	120	114
France	2083	1924	1767	1564	1210	1153	1119	1098	1010	983	935	908	850	804
Germany	2854	2198	1907	1642	1470	1444	1435	1434	1389	1362	1338	1289	1207	1133
Greece	315	320	350	401	315	293	243	243	236	233	230	250	241	235
Hungary	245	189	186	177	146	136	129	126	124	126	119	120	118	113
Ireland	170	171	182	176	121	108	110	112	111	113	113	109	109	100
Italy	2128	1992	1511	1294	940	902	853	783	760	722	703	649	642	630
Latvia	96	51	41	44	39	37	37	36	35	35	33	33	34	32
Lithuania	152	73	61	62	55	53	54	50	51	52	52	50	51	50
Luxembourg	40	34	41	56	39	39	37	33	31	28	25	22	20	18
Malta	7	9	10	10	9	8	9	8	9	8	6	6	5	4
Netherlands	589	489	403	352	294	278	266	257	245	245	235	224	216	204
Poland	1090	1053	852	869	888	872	836	796	747	725	742	804	NO,IE, NA	NO,IE, NA
Portugal	251	288	291	276	196	179	165	161	158	161	154	157	151	144
Romania	485	390	376	323	276	299	318	265	260	263	249	244	237	228
Slovakia	127	108	108	104	86	78	76	74	75	73	68	67	67	60
Slovenia	73	74	59	54	48	47	46	43	39	35	34	34	32	29
Spain	1404	1458	1460	1451	993	983	935	829	828	838	796	801	765	721
Sweden	280	251	217	191	169	163	156	153	152	148	146	141	137	128
United Kingdom	2979	2522	1960	1728	1223	1148	1174	1115	1043	1011	915	886	860	833
EU-27+UK	**17830**	**15459**	**13392**	**12333**	**9796**	**9443**	**9153**	**8715**	**8366**	**8208**	**7901**	**7779**	**6677**	**6353**
Iceland	31	34	33	28	26	24	24	23	23	23	21	21	22	21
United Kingdom (KP)	2994	2537	1976	1742	1235	1161	1187	1128	1058	1027	927	900	873	846
EU-KP	**17876**	**15509**	**13440**	**12375**	**9834**	**9480**	**9191**	**8751**	**8404**	**8247**	**7934**	**7814**	**6712**	**6387**

Table 2.9 Overview of Member States' contributions to EU-KP CO emissions for 1990–2019 (kt)

Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Austria	1253	972	725	626	578	560	559	562	526	537	533	524	483	497
Belgium	1464	1245	980	794	497	398	342	515	320	369	354	287	331	368
Bulgaria	829	557	303	229	180	186	167	153	144	149	154	152	135	122
Croatia	547	440	462	413	324	301	287	276	244	265	256	250	230	215
Cyprus	43	37	29	26	18	16	15	14	14	14	14	13	12	10
Czechia	2060	1561	1070	925	930	899	884	887	858	844	846	844	842	819
Denmark	727	652	477	427	353	310	292	278	254	259	249	239	223	208
Estonia	238	177	168	138	133	117	118	112	112	109	111	113	114	110
Finland	730	647	576	508	434	393	392	378	373	358	366	359	352	344
France	10690	8969	6486	5212	4129	3418	3108	3146	2630	2593	2625	2568	2440	2391
Germany	13204	7181	5147	3921	3621	3555	3295	3255	3091	3194	3061	3082	2957	2881
Greece	1276	1103	1050	897	633	618	683	572	577	551	490	487	456	447
Hungary	1414	946	823	669	516	525	540	533	455	440	427	418	358	344
Ireland	347	290	246	216	144	133	126	119	112	110	103	90	81	67
Italy	6796	7071	4750	3467	3073	2433	2681	2504	2259	2270	2194	2260	2051	2061
Latvia	457	316	237	227	162	164	164	146	136	113	111	117	120	115
Lithuania	371	212	180	174	160	153	149	137	127	120	118	117	118	112
Luxembourg	469	213	46	39	29	27	28	27	26	21	22	22	20	21
Malta	20	20	14	11	8	7	6	7	7	6	6	9	5	5
Netherlands	1223	887	816	731	666	644	627	601	587	584	602	613	642	641
Poland	3641	4659	3356	3089	3077	2781	2787	2658	2387	2343	2456	2543	NO,IE, NA	NO,IE, NA
Portugal	795	825	680	520	398	366	352	332	314	322	308	324	282	289
Romania	2369	2331	3644	2501	2167	2103	2912	2097	2055	2158	2000	1716	1628	1691
Slovakia	1016	645	547	559	456	423	437	413	321	363	378	373	319	279
Slovenia	291	284	205	183	143	140	134	133	113	121	120	115	105	97
Spain	4006	3110	2604	1919	1675	1648	1411	1613	1438	1539	1516	1514	1661	1622
Sweden	1108	959	677	539	459	441	413	405	391	377	377	369	347	337
United Kingdom	7353	6116	4202	3042	2048	1870	1849	1852	1766	1721	1591	1584	1592	1569
EU-27+UK	**64735**	**52424**	**40499**	**32003**	**27012**	**24631**	**24759**	**23723**	**21636**	**21849**	**21389**	**21102**	**17902**	**17660**
Iceland	69	61	64	61	118	115	116	117	124	119	118	122	122	117
United Kingdom (KP)	7379	6137	4217	3055	2055	1877	1856	1858	1772	1726	1595	1588	1595	1572
EU-KP	**64830**	**52506**	**40579**	**32077**	**27137**	**24753**	**24881**	**23846**	**21766**	**21972**	**21510**	**21228**	**18027**	**17780**

Table 2.10 Overview of Member States' contributions to EU-KP NMVOC emissions for 1990–2019 (kt)

Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Austria	335	248	180	157	137	132	130	124	118	112	112	112	109	108
Belgium	348	306	232	182	144	132	129	125	118	117	117	115	114	113
Bulgaria	155	124	95	86	75	75	75	71	71	79	73	73	73	72
Croatia	160	113	97	110	89	84	78	74	68	69	71	68	69	73
Cyprus	10	10	9	8	7	6	6	5	5	5	5	5	5	5
Czechia	493	349	276	235	222	212	206	203	198	197	193	192	190	183
Denmark	215	213	185	153	131	125	119	120	112	115	111	108	108	103
Estonia	49	33	30	27	23	23	24	23	24	25	25	27	27	28
Finland	230	201	176	146	112	103	100	96	93	89	89	86	85	83
France	2922	2513	2072	1602	1223	1145	1092	1082	1066	1039	1017	1019	995	972
Germany	3891	2341	1804	1486	1361	1273	1257	1212	1174	1147	1142	1147	1125	1121
Greece	267	250	251	238	181	173	174	166	164	164	153	155	154	147
Hungary	306	210	190	173	131	134	135	133	124	128	128	125	120	118
Ireland	144	136	123	121	111	108	110	112	108	109	110	115	117	115
Italy	1994	2059	1630	1340	1117	1026	1031	999	928	901	884	925	897	894
Latvia	89	64	54	54	44	45	45	44	44	41	40	40	45	40
Lithuania	132	89	65	71	65	63	61	58	58	59	59	59	59	59
Luxembourg	28	21	16	15	12	12	12	11	11	10	10	11	10	11
Malta	2	2	2	2	2	2	2	3	3	3	3	4	4	4
Netherlands	401	262	196	149	136	135	131	130	125	124	122	119	112	108
Poland	706	825	732	721	712	694	676	633	631	641	672	686	NO,IE,N	NO,IE,N
Portugal	247	238	238	197	162	152	148	145	151	153	149	152	153	160
Romania	221	174	235	243	240	227	234	222	220	217	216	217	213	208
Slovakia	263	179	153	150	125	122	118	116	98	112	113	111	102	99
Slovenia	65	62	55	48	40	37	36	35	32	33	33	33	32	31
Spain	1056	985	965	811	633	607	582	568	569	589	598	611	624	621
Sweden	367	279	223	205	177	174	166	158	154	155	148	140	136	134
United Kingdom	2837	2250	1596	1177	877	863	852	824	819	818	798	806	819	811
EU-27+UK	**17932**	**14534**	**11878**	**9908**	**8288**	**7884**	**7730**	**7493**	**7286**	**7252**	**7189**	**7261**	**6497**	**6423**
Iceland	10	10	9	7	6	6	6	5	6	6	6	6	6	5
United Kingdom (KP)	2843	2255	1600	1180	879	865	854	826	821	821	800	808	822	814
EU-KP	**17948**	**14548**	**11890**	**9918**	**8296**	**7892**	**7738**	**7501**	**7294**	**7260**	**7197**	**7268**	**6504**	**6430**

Table 2.11 Overview of Member States' contributions to EU-KP SO2 emissions for 1990–2019 (kt)

Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Austria	74	47	32	26	16	15	15	14	14	14	13	13	12	11
Belgium	364	258	170	143	61	53	47	43	41	41	34	32	32	29
Bulgaria	446	379	336	373	411	493	429	369	393	428	379	410	360	323
Croatia	168	77	60	58	35	29	25	17	14	16	15	12	10	8
Cyprus	32	39	47	38	22	21	16	13	17	13	16	16	17	16
Czechia	1755	1059	233	208	164	167	160	145	134	129	115	110	97	80
Denmark	178	146	32	26	15	14	13	13	11	10	10	11	11	10
Estonia	219	103	81	66	75	65	31	27	32	25	29	33	27	14
Finland	250	105	81	69	67	60	51	49	43	42	40	36	33	30
France	1306	965	643	488	286	241	241	220	177	169	154	148	139	114
Germany	5475	1752	651	477	405	389	372	360	339	336	311	303	292	263
Greece	511	521	563	585	231	168	142	131	114	112	107	106	99	92
Hungary	830	614	427	43	30	34	30	29	26	24	23	28	23	17
Ireland	183	163	144	73	27	25	23	24	18	16	14	15	15	11
Italy	1784	1322	757	411	222	200	181	150	133	127	119	117	109	105
Latvia	100	49	18	9	4	4	4	4	4	4	3	4	4	4
Lithuania	202	77	39	27	18	19	17	14	13	15	14	13	13	12
Luxembourg	16	9	4	3	2	1	1	2	2	1	1	1	1	1
Malta	10	11	10	12	8	8	8	6	5	2	2	1	0	0
Netherlands	187	126	71	63	34	34	34	30	29	30	28	26	25	23
Poland	2652	2141	1411	1171	874	836	803	768	724	711	591	583	NO,IE, NA	NO,IE, NA
Portugal	318	322	295	190	63	57	52	48	43	46	46	47	45	44
Romania	829	698	497	515	339	413	382	296	302	296	256	264	252	228
Slovakia	140	120	117	86	68	67	57	52	44	67	26	28	20	16
Slovenia	202	124	92	39	10	11	10	9	7	5	4	4	4	4
Spain	2116	1819	1421	1229	260	295	298	232	251	269	227	234	212	165
Sweden	103	71	45	36	29	26	26	23	21	18	19	18	17	16
United Kingdom	3583	2542	1295	793	460	432	468	405	331	267	196	192	177	162
EU-27+UK	**24033**	**15657**	**9571**	**7259**	**4235**	**4180**	**3937**	**3492**	**3282**	**3232**	**2794**	**2803**	**2045**	**1799**
Iceland	24	22	39	43	76	84	87	72	65	61	52	50	55	58
United Kingdom (KP)	3597	2554	1304	799	463	435	471	407	334	271	199	195	181	166
EU-KP	**24070**	**15692**	**9619**	**7307**	**4314**	**4267**	**4027**	**3567**	**3350**	**3297**	**2848**	**2856**	**2103**	**1860**

3 ENERGY (CRF SECTOR 1)

This chapter starts with an overview on emission trends in CRF Sector 1 Energy. For each EU-KP key category as well as other important subsector specific categories, overview tables are presented including the countries' contributions to the category in terms of level and trend. This chapter includes also, the reference approach, and international bunkers.

3.1 Overview of sector

CRF Sector 1 Energy comprises of the three sectors Fuel combustion activities (1.A), Fugitive emissions from fuels (1.B) and CO_2 Transport and storage (1.C). The energy sector contributes 77% to total GHG emissions and is the largest emitting sector in the EU-KP. Total GHG emissions from this sector decreased by 28% from 4358 Mt in 1990 to 3132 Mt in 2019 (Figure 3.1). In 2019, emissions decreased by 5 % compared to 2018.

The most important energy-related gas is CO_2 that makes up 74% of the total EU-KP greenhouse gas emissions in 2019. CH_4 of the energy sector is responsible for 1.8% and N_2O for 0.7% of the total GHG emissions.

Figure 3.1 CRF Sector 1 Energy: EU-KP GHG emissions in CO_2 equivalents (Mt) for 1990–2019

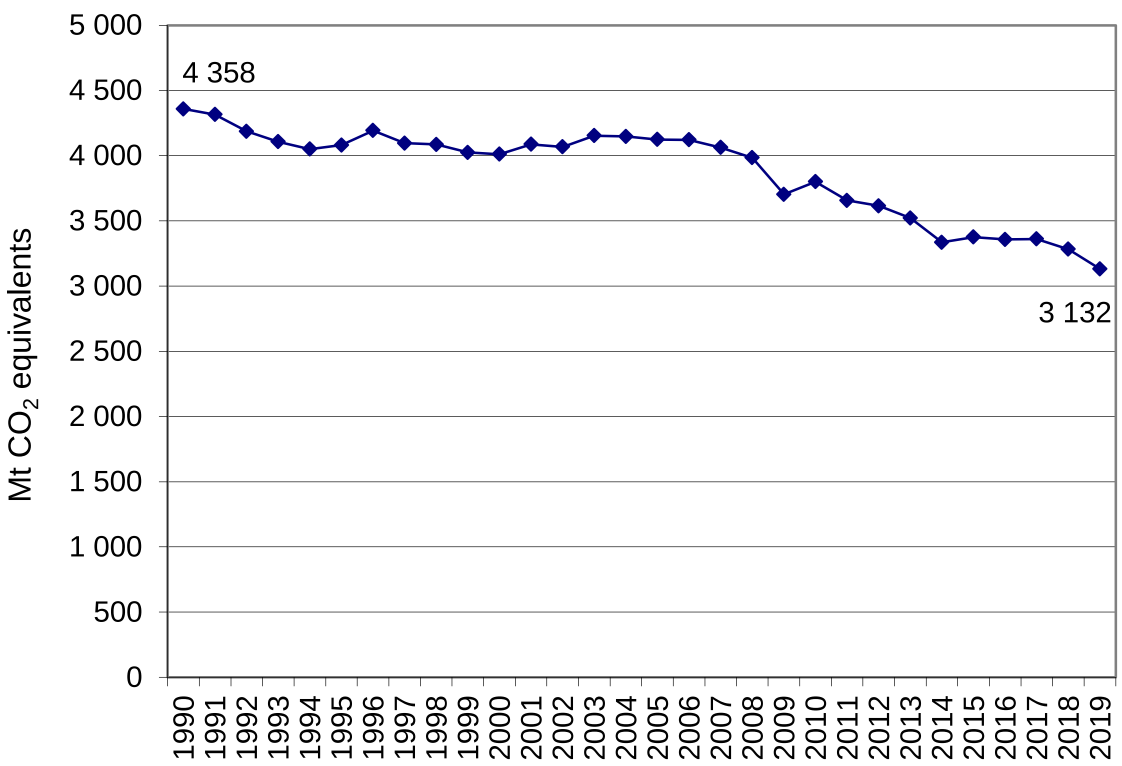
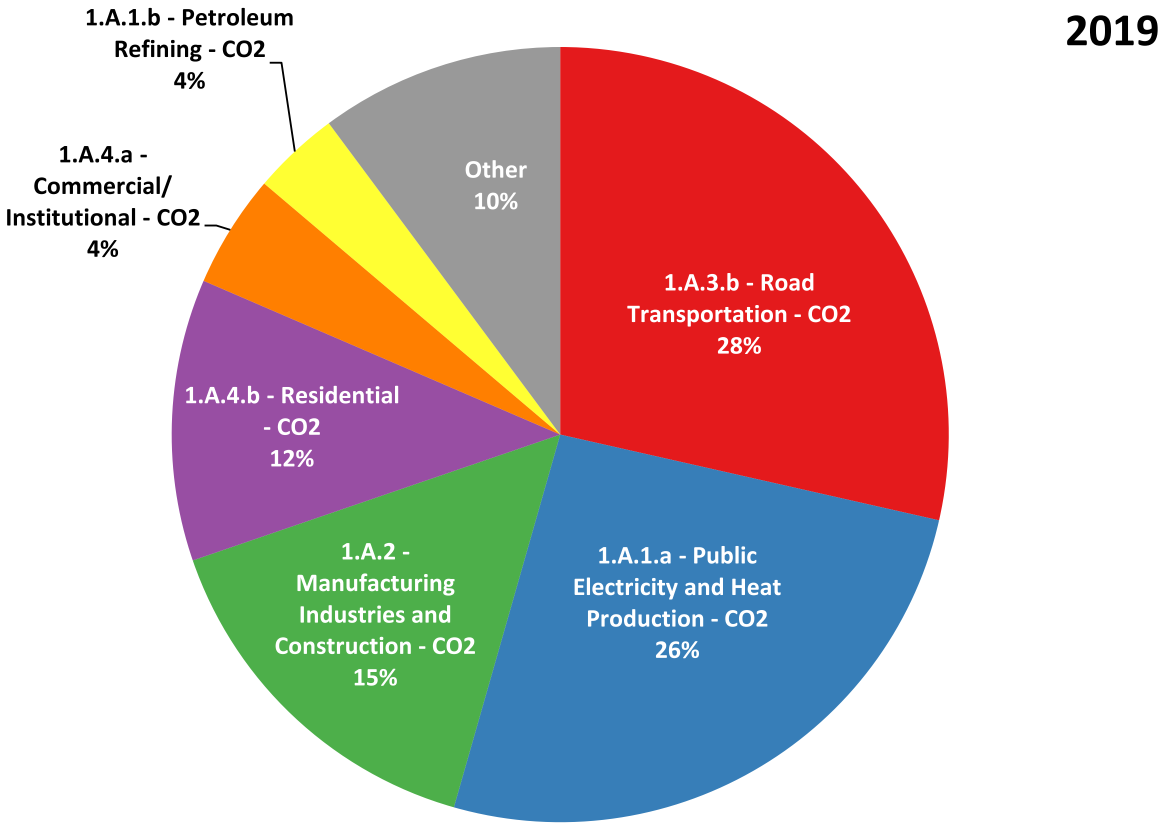


Figure 3.2 shows the share of the largest key categories in the sector Energy in 2019. The first chart illustrates that the three largest key categories account for 69 % and the largest six for 90 % of emissions in the whole sector 1. The two largest categories of the energy sector alone are responsible for 54 % of the total EU-KP emissions in 2019.

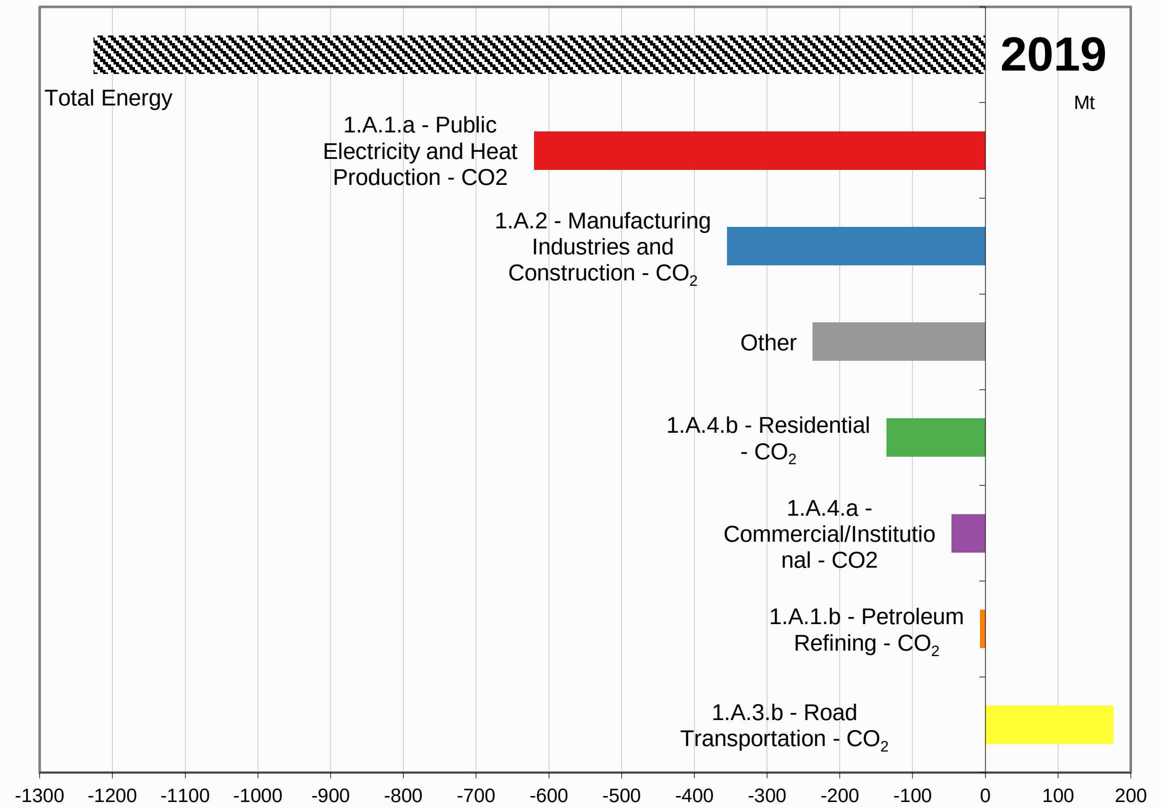
Figure 3.2 CRF Sector 1 Energy: Share of largest key source categories in 2019



Note: Remaining Energy categories is calculated by subtracting the presented categories (1.A.1.a, 1.A.1.b, 1.A.2, 1.A.3.b, 1.A.4.a and 1.A.4.b.) from the sector total

Furthermore, Figure 3.3 shows the absolute change of GHG emissions of these large key categories for the years 1990-2019. CO_2 emissions from Road Transportation had the highest increase in absolute terms of all energy-related emissions, while CO_2 emissions from 1.A.1.a Public Electricity and Heat Production as well as 1.A.2 Manufacturing Industries decreased substantially between 1990 and 2019. The decreases in Public Electricity and Heat Production and Manufacturing Industries as well as the increases in Road Transportation occurred in almost all countries. The decline of Fugitive Emissions from Fuels (CH_4) and decreasing CO_2 emissions from 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries are the main reasons for the large absolute emission reductions from "remaining Energy categories" in Figure 3.3.

Figure 3.3 CRF Sector 1 Energy: Absolute change of GHG emissions in CO_2 equivalents (Mt) by large key categories for 1990-2019



Note: Remaining Energy categories is calculated by subtracting the presented categories (1.A.1.a, 1.A.1.b, 1.A.2, 1.A.3.b, 1.A.4.a and 1.A.4.b.) from the sector total

The key categories in the energy sector are as follows:

- 1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)
- 1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)
- 1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)
- 1.A.1.a Public Electricity and Heat Production: Peat (CO_2)
- 1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)
- 1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)
- 1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)
- 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)
- 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)

- 1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)
- 1.A.2.a Iron and Steel: Liquid Fuels (CO_2)
- 1.A.2.a Iron and Steel: Solid Fuels (CO_2)
- 1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)
- 1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)
- 1.A.2.c Chemicals: Gaseous Fuels (CO_2)
- 1.A.2.c Chemicals: Liquid Fuels (CO_2)
- 1.A.2.c Chemicals: Solid Fuels (CO_2)
- 1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)
- 1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)

- 1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)
- 1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)
- 1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)
- 1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)
- 1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)
- 1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)
- 1.A.2.f Non-metallic minerals: Other Fuels (CO_2)
- 1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)
- 1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)
- 1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)
- 1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)
- 1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)
- 1.A.3.b Road Transportation: Diesel Oil (CO_2)
- 1.A.3.b Road Transportation: Diesel Oil (N_2O)
- 1.A.3.b Road Transportation: Gaseous Fuels (CO_2)
- 1.A.3.b Road Transportation: Gasoline (CH_4)
- 1.A.3.b Road Transportation: Gasoline (CO_2)
- 1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)
- 1.A.3.b Road Transportation: Other Fuels (CO_2)
- 1.A.3.c Railways: Liquid Fuels (CO_2)
- 1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)
- 1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)
- 1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)
- 1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)
- 1.A.4.a Commercial/Institutional: Other Fuels (CO_2)
- 1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)
- 1.A.4.b Residential: Biomass (CH_4)
- 1.A.4.b Residential: Gaseous Fuels (CO_2)
- 1.A.4.b Residential: Liquid Fuels (CO_2)
- 1.A.4.b Residential: Solid Fuels (CH_4)
- 1.A.4.b Residential: Solid Fuels (CO_2)
- 1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)
- 1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)
- 1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)
- 1.A.5.a Other Other Sectors: Solid Fuels (CO_2)
- 1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)
- 1.B.1.a Coal Mining and Handling: Operation (CH_4)
- 1.B.2.a Oil: Operation (CO_2)
- 1.B.2.a Oil: Operation (CH_4)
- 1.B.2.b Natural Gas: Operation (CH_4)
- 1.B.2.c Venting and Flaring: Operation (CO_2)

3.2 Source categories

3.2.1 Energy Industries (CRF Source Category 1.A.1)

Energy Industries (CRF 1.A.1) comprises emissions from fuels combusted by the fuel extraction or energy-producing industries and is subdivided in three categories: Public electricity and heat production (CRF 1.A.1.a), Petroleum-refining (CRF 1.A.1.b), and Manufacture of solid fuels and other energy industries (CRF 1.A.1.c). Each category is described in its own chapter.

Table 3.1 shows the nine key categories of sector 1.A.1, including information on whether the reasons for this categorization lie in their emission trend and/or level. Furthermore, it entails information on the share of higher tier methods used by the countries. In sector 1.A.1.a Germany, Poland, the United Kingdom and Italy have mainly been influencing this share of higher tier methods because of their weight of emissions. The same applies for Italy, Germany, the United Kingdom and Spain in sector 1.A.1.b and the United Kingdom, Germany, Italy and Czechia in sector 1.A.1.c.

Table 3.1: Key source categories for level and trend analyses and share of MS emissions using higher tier methods in sector 1.A.1

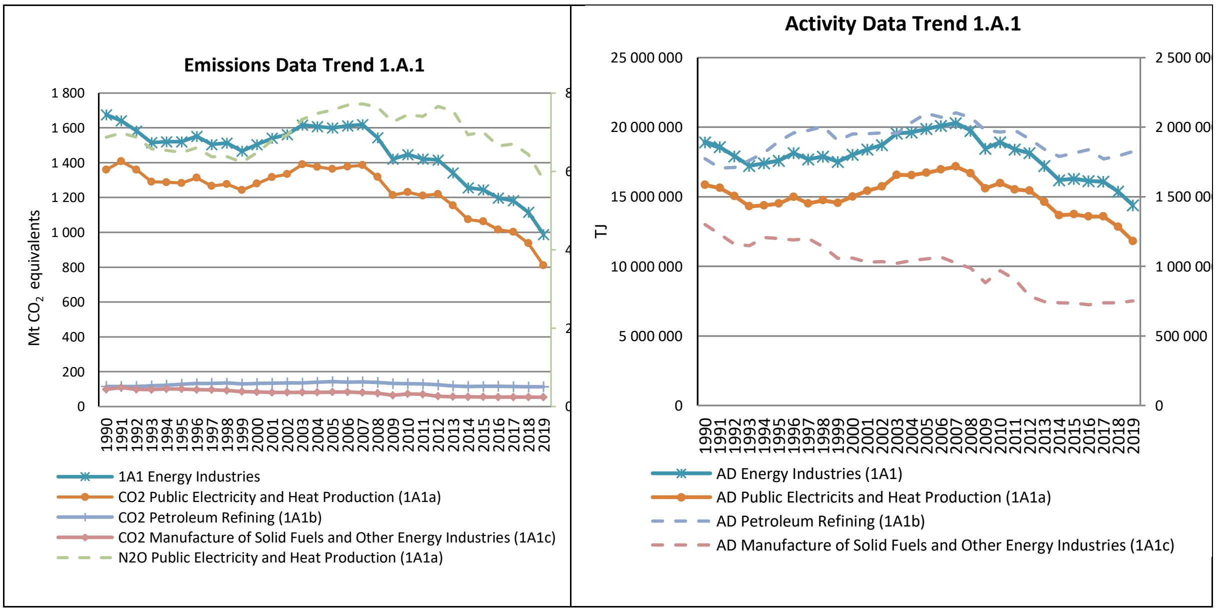
Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2019		1990	2019	
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	107 668	244 052	T	L	L	96.6 %
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	176 677	24 673	T	L	L	95.6 %
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	10 745	41 137	T	L	L	93.4 %
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	9 162	7 388	0	L	L	97.1 %
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	1 126 227	492 751	T	L	L	95.3 %
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	5 276	28 250	T	0	L	98.6%
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	110 883	85 075	T	L	L	95.3%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	17 424	19 341	T	L	L	94%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)	91 155	29 713	T	L	L	97%

Figure 3.4 shows the trends in emissions in Energy Industries for the EU-KP between 1990 and 2019, which was mainly dominated by CO_2 emissions from public electricity and heat production. Carbon dioxide from 1.A.1.a represented about 85% of total greenhouse gas emissions in 1.A.1 in 1990 (i.e. including methane and nitrous oxide) with a drop to 82% in 2019 due to the large decrease of emissions from 1.A.1.a.

Total greenhouse gas emissions from 1.A.1 decreased by 41%, between 1990 and 2019. This was mainly due to a decrease of CO_2eq emission from Public Electricity and Heat Production (-618.7 Mt CO_2eq) followed by -62 Mt CO_2eq of the manufacturing of solid fuels and -7 Mt CO_2eq from petroleum refining.

The decrease in fuel consumption since 2006 can be explained by the continuing effects of the economic downturn, the increased use of renewables, but also by enhanced energy efficiency in the newer EU Member States as well as mild winters.

Figure 3.4 1.A.1 Energy Industries: Total GHG, CO_2 and N_2O emission trends and Activity Data



Note: Data displayed as dashed line refers to the secondary axis.

Table 3.2 breaks down the information by country. Between 1990 and 2019, greenhouse gas emissions from energy industries increased in three countries and fell in 26. The highest absolute increase was accounted for by the Netherlands with 3.7 Mt CO_2eq. respectively 7%. Germany, the United Kingdom and Poland, followed by Romania and Italy account for the largest part of reductions (-505.5 Mt CO_2eq). The change in the EU-KP was a net decrease of about 687.8 Mt CO_2eq. The table shows the emissions of GHG, N_2O and CH_4 separately expressed in CO_2eq. The latter two greenhouse gases only contribute a very small part (combined approximately 1%) of the total emissions in energy industries.

In terms of absolute contributions to EU-KP greenhouse gas emissions from energy industries, this sector is clearly dominated by Germany, Poland, Italy and the United Kingdom. The first two combined are responsible for 41%, all four countries represent 59% and the top six countries account for 70% of the EU-KP's greenhouse gas emissions from energy industries.

Table 3.2 1.A.1 Energy industries: Countries' contributions to CO_2, N_2O and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2019 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2019 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)
Austria	14 011	10 289	13 961	10 167	42	97	8
Belgium	30 060	21 211	29 860	21 012	180	170	20
Bulgaria	36 540	22 513	36 402	22 383	124	109	13
Croatia	7 089	3 916	7 066	3 880	17	26	5
Cyprus	1 767	3 293	1 761	3 282	4	8	2
Czechia	56 855	49 182	56 594	48 933	245	230	16
Denmark	26 252	8 652	26 150	8 460	86	78	15
Estonia	28 294	8 234	28 271	8 166	17	44	6
Finland	18 969	16 252	18 843	15 947	116	273	10
France	66 350	38 212	65 835	37 897	448	268	66
Germany	427 353	249 696	423 906	244 822	3 167	2 073	280
Greece	43 253	31 978	43 094	31 886	145	80	14
Hungary	20 872	12 465	20 795	12 386	67	55	9
Ireland	11 223	9 368	11 145	9 218	71	139	7
Italy	137 646	91 797	136 941	91 312	477	362	227
Latvia	6 318	1 825	6 302	1 783	11	25	5
Lithuania	13 553	2 279	13 522	2 219	21	37	10
Luxembourg	36	235	33	224	1	7	1
Malta	1 766	740	1 759	739	6	0	1
Netherlands	53 364	57 085	53 147	56 637	148	326	69
Poland	235 395	150 707	234 294	149 912	1 018	691	82
Portugal	16 420	13 015	16 366	12 866	49	135	6
Romania	70 944	21 419	70 723	21 326	183	81	38
Slovakia	18 966	7 118	18 893	7 070	65	34	8
Slovenia	6 375	4 576	6 348	4 551	25	22	2
Spain	78 881	56 143	78 541	55 417	289	449	51
Sweden	9 928	8 144	9 792	7 863	120	234	17
United Kingdom	236 325	86 521	234 721	85 404	1 399	728	204
EU-27+ISL	**1 674 802**	**986 865**	**1 665 064**	**975 763**	**8 543**	**6 780**	**1 194**
Iceland	14	5	13	5	0	0	0
United Kingdom (KP)	237 016	87 368	235 410	86 248	1 401	731	205
EU-KP	**1 675 507**	**987 718**	**1 665 766**	**976 612**	**8 545**	**6 783**	**1 195**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Public heat and electricity production is the main source of emissions from energy industries. Furthermore, it is the largest source category in the EU-KP greenhouse gas inventory. Differences in the intensity of greenhouse gas emissions of heat and electricity production between the countries are to a large extent explained by the mix of fuels or technologies, which are used. Some countries rely more on coal than on gas. At the EU-KP level, 35.4% of the fuel used in energy industries comes from solid fuels. Its contribution has been declining in favour of the relatively cleaner natural gas, which is the first source of energy in 2019 with about 35.9% and biomass which has been constantly increasing with a share of 12.9% in 2019.

As can be seen in Figure 3.5 Germany, Poland, Italy and the United Kingdom contribute 58.6% of the total CO_2 emissions in sector 1.A.1 Energy industries in the year 2019. The relatively low share of greenhouse gas emissions from energy industries in France can be partly explained by the use of nuclear and hydro energy for power generation.

Figure 3.5 1.A.1 Energy Industries, all fuels: Emission trend and share for CO_2

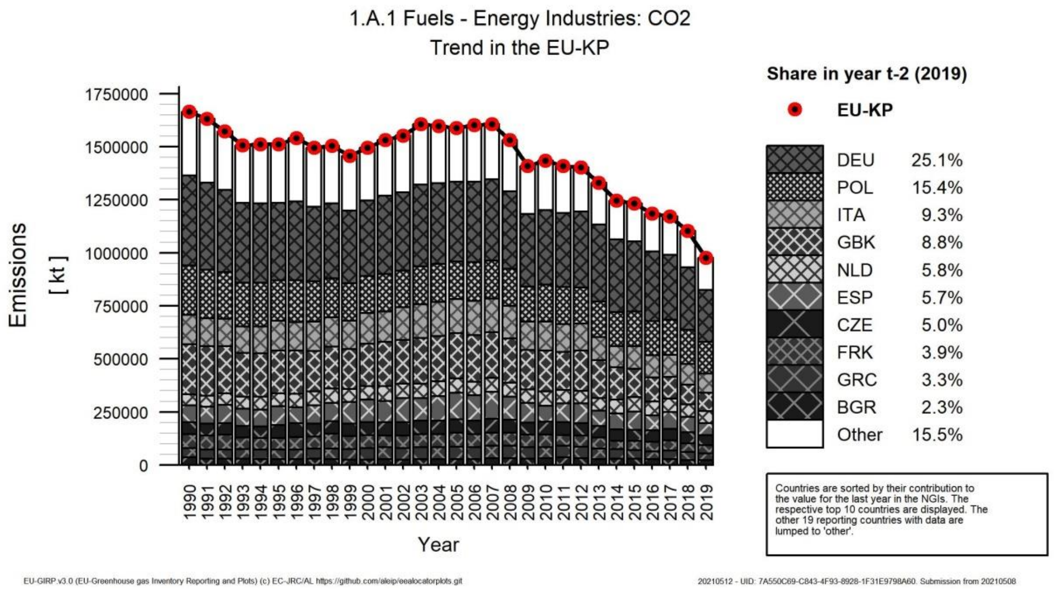


Table 3.3 provides information on the countries' contribution to EU-KP recalculations in CO_2 from 1.A.1 Energy Industries for 1990 and 2018 as well as the main explanations for the largest recalculations in absolute terms.

Table 3.3 1.A.1 Energy Industries: Contribution of countries to EU-KP recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 and percent)

	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-23	-0.2	-32	-0.3	Revision of energy balance
Belgium	-	-	53	0.3	Walloon region: correction of a mistake in two waste incineration plants in 2018 (+29.6 kt)
Bulgaria	-	-	0.0	0.0	
Croatia	17	0.2	-	-	
Cyprus	-	-	-	-	
Czechia	-0.0	-0.0	1 875	3.7	Updated activity data in CzSO balance
Denmark	-	-	-3.8	-0.0	
Estonia	-834	-2.9	-134	-1.0	Emissions were recalculated due to using Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, instead of national energy balance.
Finland	-	-	-4.6	-0.0	
France	-0.0	-0.0	-1 173	-2.9	The ratio of biomass C in waste was updated from 2013 to 2018 leading to a reduction of Other fossil fuels compared to Biomass.

	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
					AD for waste incineration with energy recovery has also been modified for 2018 based on the availability of new national statistics.
Germany	-	-	4 042	1.4	Updated activity data according to final energy balance
Greece	-	-	-	-	
Hungary	-45	-0.2	3.8	0.0	
Ireland	-	-	0	0.0	
Italy	144	0.1	263	0.3	Update of CO_2 EF for natural gas, coal, fuel oil, coke, refinery gases, other petrochemical gases, petcoke on the basis of more recent atomic weights for the elements involved in the calculation of the carbon content of fuels as carbon, oxigen and hydrogen
Latvia	74	1.2	-0.4	-0.0	
Lithuania	-	-	-	-	
Luxembourg	0.2	0.6	8.6	4.0	Revision of AD: error correction and energy balance revised
Malta	-	-	-	-	
Netherlands	-1.1	-0.0	-270	-0.5	Final energy statistics and improved allocation of the biogenic part of natural gas
Poland	-	-	61	0.0	
Portugal	8.7	0.1	3.3	0.0	
Romania	0.0	0.0	242	1.0	An error has been detected and solved in the context of the calculation file; this has been resulted in the update of emissions
Slovakia	-	-	-	-	
Slovenia	-	-	4.3	0.1	Use of different EF for industrial waste combustion.
Spain	-37	-0.0	16	0.0	
Sweden	-	-	79	0.9	Revised list of reporting facilities and revised emission factors for waste combustion
United Kingdom	-8.1	-0.0	-549	-0.6	Removal of double count identified for scrap tyres, already reported within UK energy statistics under waste. Small revision to CEF for upstream oil and gas sector. Revisions to DUKES
EU27+UK	**-705**	**-0.0**	**4 484**	**0.4**	
Iceland	-0.3	-2.2	-	-	
United Kingdom (KP)	-8.2	-0.0	-535	-0.6	
EU-KP	**-705**	**-0.0**	**4 499**	**0.4**	

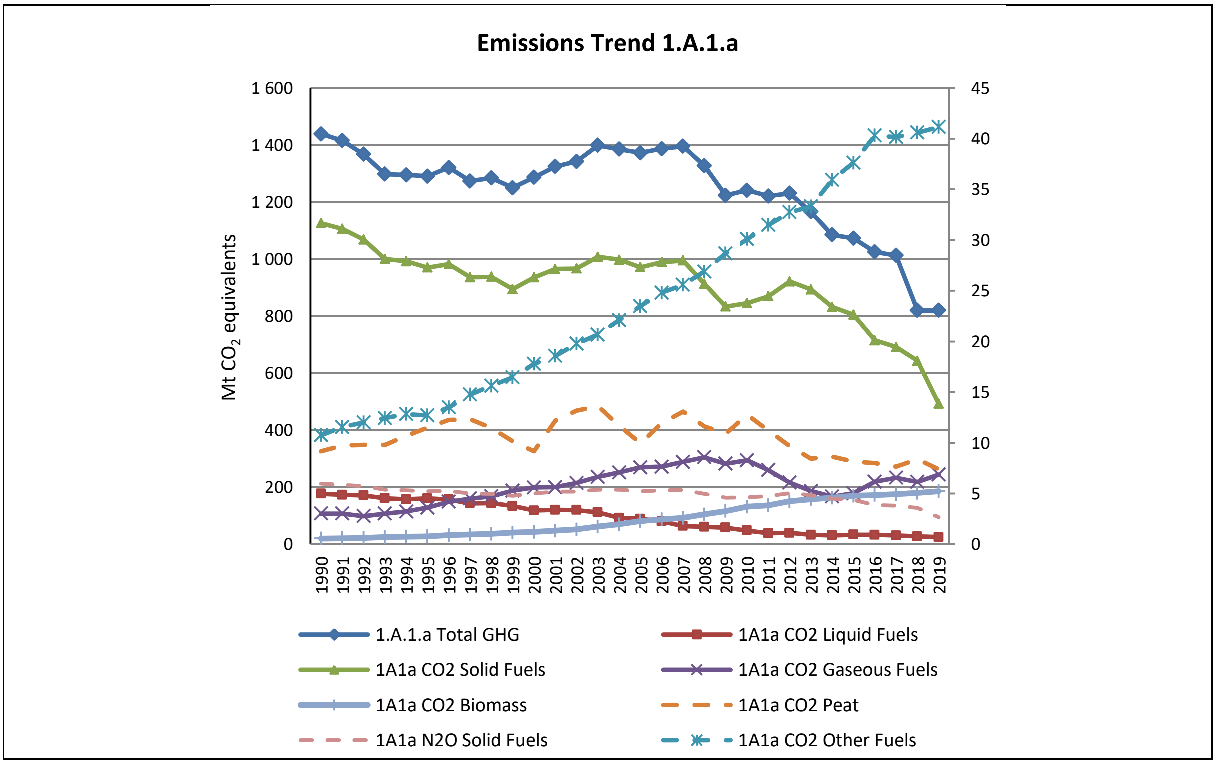
3.2.1.1 Public Electricity and Heat Production (1.A.1.a) (EU-KP)

According to the 2006 IPCC guidelines, emissions from public electricity and heat production (CRF 1.A.1.a) should include emissions from main activity producers of electricity generation, combined heat and power generation, and heat plants. Main activity producers (i.e. public utilities) are defined as those undertakings whose primary activity is to supply the public. They may be in public or private ownership. Emissions from own on-site use of fuel should be included. Emissions from autoproducers (undertakings which generate electricity/heat wholly or partly for their own use, as an activity that supports their primary activity) should be assigned to the sector where they were generated and not under 1.A.1.a. autoproducers may be in public or private ownership.

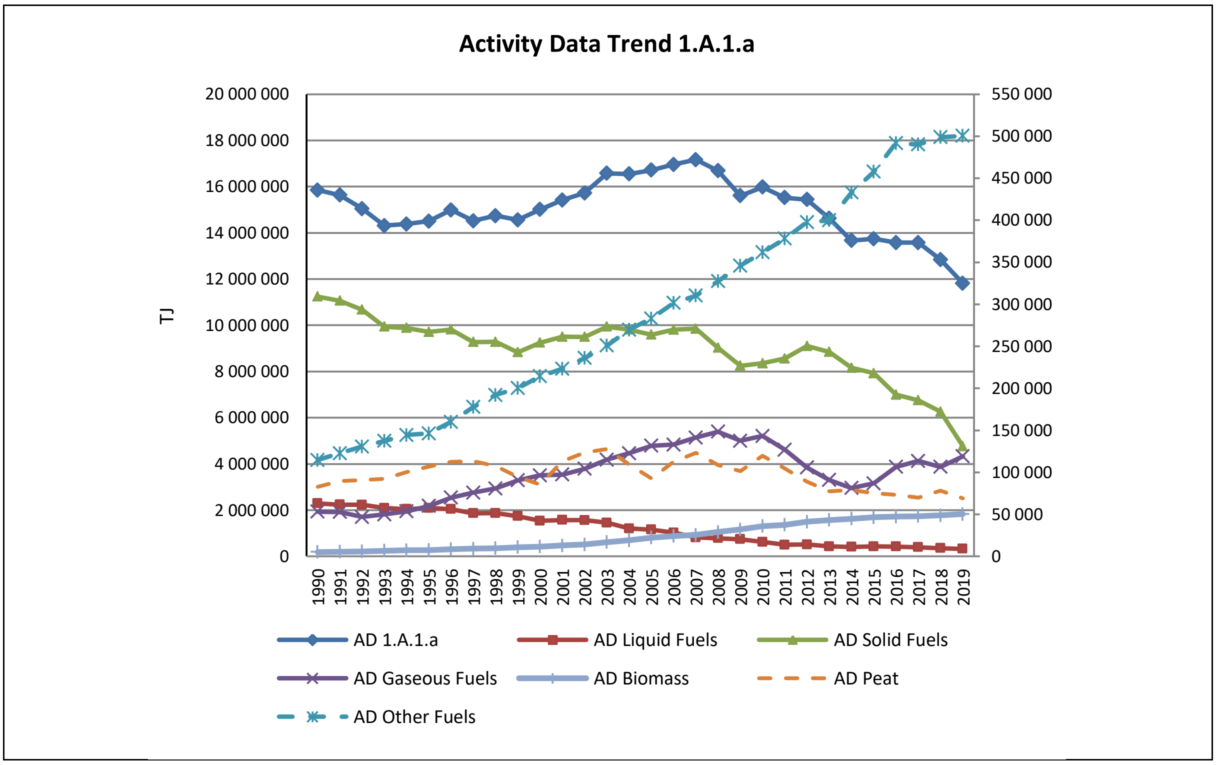
CO_2 emissions from electricity and heat production is the largest key category in the EU-KP accounting for 20.2% of total greenhouse gas emissions in 2019 and for 82% of greenhouse gas emissions of the Energy Industries Sector. Between 1990 and 2019, CO_2 emissions from electricity and heat production decreased by 43% in the EU-KP.

Figure 3.6 shows the trends in emissions originating from the production of public electricity and heat by fuel in the EU-KP between 1990 and 2019 as well as the underlying activity data[15].

Figure 3.6 1.A.1.a Public Electricity and Heat Production: Total, CO_2 and N_2O emission and activity data trends



[15] CO_2 emissions from the combustion of biomass fuels are reported as a memo item and are therefore not included in the emissions from public electricity and heat production. The biomass used as a fuel is however included in the national energy consumption (i.e. activity data). The fact that CO_2 emissions from biomass are treated differently from other fuel emissions does not imply emissions from the production of heat and electricity are due to fossil fuel combustion only. Biomass CO_2 emissions are just reported elsewhere. Non-CO_2 emissions from the combustion of biomass (CH_4 and N_2O) are reported under the energy sector.



Note: Data displayed as dashed line refers to the secondary axis.

Fuel used for public electricity and heat production decreased by 25.4% in the EU-KP between 1990 and 2019. Solid fuels still represent 40.3% of the fuel used in public conventional thermal power plants, although its combustion has been declining by 57.6% between 1990 and 2019. Gaseous fuels have increased very rapidly, by a factor of almost 3 between 1990 and 2010, declined until 2014 and now see a new increased use in the last years. In 2019 its share amounts to 36.6% of all the fuels used for the production of heat and electricity in the EU-KP. Liquid fuels still account for some 2.8%, but its use has declined gradually during the past 30 years. The use of biomass has increased even more rapidly than the use of gas: its share in the fuel mix is now at 15.5%. Finally, other fossil fuels consumptions have been multiplied by 4 between 1990 and 2019 and represent 4.2% of total consumptions. Peat remains marginal with a share of 0.6% in 2019.

Table 3.4 shows emissions arising from the production of public heat and electricity by country. Carbon dioxide emissions amount to 98.8% of greenhouse gas emissions from public electricity and heat production. These emissions increased in three Countries and fell in 26 compared to 1990. Of the three countries where emissions were higher in 2019 than in 1990, almost 70% of the increase was accounted for by the Netherlands alone. Of the countries, where emissions fell, 71% of the total reduction was accounted for by the United Kingdom (23.1%), Germany (19.9%), Poland (13.6%) and Romania (7.6%) and Italy (6.7%). The change in the EU-KP between 1990 and 2019 was a net decrease of 620.5 Mt CO_2 respectively of 43%.

Table 3.4 1.A.1.a Public Electricity and Heat Production: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	11 056	6 878	7 064	0.9%	-3 992	-36%	186	3%	T1,T2	CS,D
Belgium	23 537	15 230	15 251	1.9%	-8 285	-35%	21	0%	T1,T3	D,PS
Bulgaria	35 179	22 564	21 393	2.6%	-13 786	-39%	-1 172	-5%	T1,T2	CS,D
Croatia	3 729	2 385	2 645	0.3%	-1 084	-29%	260	11%	T1,T2	CS,D
Cyprus	1 676	3 342	3 282	0.4%	1 606	96%	-60	-2%	CS	CS
Czechia	54 585	46 343	42 955	5.3%	-11 630	-21%	-3 389	-7%	T1,T2	CS,D
Denmark	24 697	9 109	6 291	0.8%	-18 406	-75%	-2 818	-31%	T1,T2,T3	CS,D,PS
Estonia	28 192	12 039	6 557	0.8%	-21 635	-77%	-5 481	-46%	T1,T2,T3	CS,D,PS
Finland	16 453	16 423	13 962	1.7%	-2 491	-15%	-2 461	-15%	T3	CS,D,PS
France	49 161	30 830	28 805	3.6%	-20 356	-41%	-2 025	-7%	T2,T3	CS,PS
Germany	338 451	262 191	213 484	26.4%	-124 967	-37%	-48 707	-19%	CS	CS
Greece	40 617	33 174	27 243	3.4%	-13 374	-33%	-5 931	-18%	T1,T2	D,PS
Hungary	17 850	10 985	10 426	1.3%	-7 423	-42%	-559	-5%	T1,T2,T3	CS,D,PS
Ireland	10 876	9 958	8 836	1.1%	-2 041	-19%	-1 123	-11%	T1,T3	CS,D,PS
Italy	108 670	70 207	66 939	8.3%	-41 731	-38%	-3 268	-5%	T3	CS
Latvia	6 097	1 842	1 720	0.2%	-4 377	-72%	-122	-7%	T1,T2	CS,D
Lithuania	12 003	1 020	846	0.1%	-11 157	-93%	-174	-17%	T1,T2,T3	CS,D,PS
Luxembourg	33	224	224	0.0%	191	569%	0	0%	T2	CS
Malta	1 759	697	739	0.1%	-1 019	-58%	42	6%	T2	CS
Netherlands	40 026	47 405	44 147	5.5%	4 121	10%	-3 258	-7%	CS,T2	CS,D
Poland	227 279	155 120	141 949	17.5%	-85 330	-38%	-13 170	-8%	T1,T2	CS,D
Portugal	14 355	15 499	10 702	1.3%	-3 653	-25%	-4 797	-31%	T1,T3	D,PS
Romania	66 280	21 804	18 423	2.3%	-47 857	-72%	-3 381	-16%	T1,T2,T3	CS,D,PS
Slovakia	14 700	4 712	4 477	0.6%	-10 223	-70%	-235	-5%	T2	CS
Slovenia	6 096	4 778	4 551	0.6%	-1 545	-25%	-228	-5%	T1,T2	CS,D,PS
Spain	65 593	59 001	42 597	5.3%	-22 997	-35%	-16 404	-28%	T1,T2	S,D,OTH,PS
Sweden	7 714	6 787	5 721	0.7%	-1 993	-26%	-1 067	-16%	T2	CS
United Kingdom	203 114	65 911	57 924	7.2%	-145 190	-71%	-7 987	-12%	T1,T2	CS,D
EU-27+UK	**1 429 778**	**936 460**	**809 153**	**100%**	**-620 625**	**-43%**	**-127 307**	**-14%**	**-**	**-**
Iceland	13	2	5	0.0%	-8	-63%	3	110%	T1	D
United Kingdom (KP)	203 803	66 664	58 767	7.3%	-145 035	-71%	-7 897	-12%	T1,T2	CS,D
EU-KP	**1 430 480**	**937 216**	**810 001**	**100%**	**-620 479**	**-43%**	**-127 215**	**-14%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

N_2O emissions currently represent 0.7% of greenhouse gas emissions from public electricity and heat production. Between 1990 and 2019, emissions decreased by 18% (Table 3.5). The largest decline in emissions from this source category was reported by the United Kingdom (-719 kt CO_2eq) and Germany (-570 kt CO_2eq). The biggest increase occurred in Spain (+162 kt CO_2eq).

Table 3.5 1.A.1.a Public Electricity and Heat Production: Countries' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	39	96	93	1.6%	53	135%	-3	-3%	T1	D
Belgium	53	92	87	1.5%	34	65%	-5	-5%	T1,T3	D
Bulgaria	123	112	109	1.9%	-14	-11%	-3	-2%	T1	D
Croatia	13	21	24	0.4%	11	86%	4	18%	T1	D
Cyprus	4	8	8	0.1%	4	95%	0	-2%	T1	D
Czechia	242	229	212	3.7%	-29	-12%	-17	-7%	T1	D
Denmark	79	78	71	1.2%	-8	-10%	-7	-9%	T1,T2,T3	CS,D
Estonia	17	44	42	0.7%	25	142%	-3	-6%	T1,T2	CS,D
Finland	100	263	252	4.3%	151	151%	-11	-4%	T3	CS
France	420	251	263	4.6%	-156	-37%	13	5%	T2,T3	D,PS
Germany	2 407	2 205	1 838	31.7%	-570	-24%	-368	-17%	T2	CS
Greece	142	99	76	1.3%	-66	-47%	-24	-24%	T1	D
Hungary	63	58	53	0.9%	-10	-15%	-5	-8%	T1	D
Ireland	71	141	139	2.4%	68	96%	-3	-2%	T1,T2	D
Italy	308	250	215	3.7%	-92	-30%	-35	-14%	T3	CR,D
Latvia	11	24	25	0.4%	14	129%	1	5%	T1	D
Lithuania	19	36	36	0.6%	17	91%	-1	-1%	T1	D
Luxembourg	1	5	7	0.1%	6	384%	2	33%	T1	D
Malta	6	0	0	0.0%	-5	-92%	0	14%	T2	CS
Netherlands	133	245	231	4.0%	99	74%	-14	-6%	D,T1	D
Poland	1 002	722	682	11.8%	-321	-32%	-41	-6%	T1	D
Portugal	46	149	134	2.3%	88	194%	-15	-10%	T1	D
Romania	179	88	78	1.3%	-101	-56%	-10	-12%	T1	D
Slovakia	59	34	32	0.5%	-27	-46%	-3	-8%	T1	D
Slovenia	25	23	22	0.4%	-3	-12%	-1	-3%	T1	D
Spain	274	500	436	7.5%	162	59%	-64	-13%	T1,T2	D,OTH
Sweden	118	252	233	4.0%	114	97%	-19	-8%	T2	CS
United Kingdom	1 110	406	391	6.8%	-719	-65%	-15	-4%	T1,T2	CS,D
EU-27+UK	**7 061**	**6 432**	**5 787**	**100%**	**-1 274**	**-18%**	**-644**	**-10%**	**-**	**-**
Iceland	0	0	0	0.0%	0	-61%	0	108%	T1	D
United Kingdom (KP)	1 112	408	394	6.8%	-718	-65%	-14	-4%	T1,T2	CS,D
EU-KP	**7 063**	**6 434**	**5 790**	**100%**	**-1 273**	**-18%**	**-644**	**-10%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Finally, CH_4 emissions currently represent 0.5% of greenhouse gas emissions from public electricity and heat production. Between 1990 and 2019, emissions increased by 444%. The biggest increase was reported by Germany (2 448 kt CO_2eq), which is also responsible for 70.0% of the emissions EU--KP in 2019.

Table 3.6 1.A.1.a Public Electricity and Heat Production: Countries' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP	Change 1990-2019		Change 2018-2019		Method	Emission factor
	1990	2018	2019	Emissions in 2019	kt CO2 equiv.	%	kt CO2 equiv.	%		Informa-tion
Austria	6	22	22	0.6%	16	258%	0	-2%	T1,T2	CS,D
Belgium	11	24	24	0.7%	13	115%	0	2%	T1,T3	D
Bulgaria	12	18	20	0.5%	8	67%	3	14%	T1	D
Croatia	3	7	9	0.2%	6	170%	2	31%	T1	D
Cyprus	2	3	3	0.1%	2	92%	0	-2%	T1	D
Czechia	15	18	18	0.5%	2	16%	0	-1%	T1	D
Denmark	15	109	112	3.0%	97	667%	3	3%	T1,T2,T3	CS,D
Estonia	6	22	22	0.6%	16	259%	0	2%	T1,T2	CS,D
Finland	9	31	31	0.8%	22	245%	0	-1%	T3	CS
France	14	36	42	1.1%	29	211%	6	17%	T2	D
Germany	172	2 551	2 620	70.0%	2 448	1422%	70	3%	T2	CS
Greece	13	11	10	0.3%	-2	-17%	-1	-9%	T1	D
Hungary	7	25	24	0.6%	16	221%	-1	-4%	T1	D
Ireland	6	11	11	0.3%	4	64%	0	-3%	T1,T2	D
Italy	95	103	103	2.8%	8	9%	0	0%	T3	CR,D
Latvia	5	15	16	0.4%	11	239%	1	5%	T1	D
Lithuania	9	23	22	0.6%	13	150%	0	-1%	T1	D
Luxembourg	1	3	4	0.1%	4	386%	1	33%	T1	D
Malta	1	0	0	0.0%	-1	-71%	0	10%	T2	CS
Netherlands	39	84	101	2.7%	62	158%	17	20%	T1,T2	CS,D
Poland	75	92	100	2.7%	25	33%	8	9%	T1	D
Portugal	4	14	13	0.4%	9	227%	-1	-6%	T1	D
Romania	36	10	10	0.3%	-26	-72%	-1	-6%	T1	D
Slovakia	6	13	14	0.4%	8	135%	0	2%	T1	D
Slovenia	2	3	3	0.1%	1	80%	0	5%	T1	D
Spain	21	70	61	1.6%	40	195%	-9	-13%	T1,T2	CR,CS,D
Sweden	16	47	47	1.3%	31	200%	0	-1%	T2	CS
United Kingdom	88	262	280	7.5%	192	218%	18	7%	T1,T2	CS,D
EU-27+UK	**689**	**3 629**	**3 744**	**100%**	**3 055**	**444%**	**115**	**3%**	**-**	**-**
Iceland	0	0	0	0.0%	0	-61%	0	108%	T1	D
United Kingdom (KP)	89	263	281	7.5%	192	216%	18	7%	T1,T2	CS,D
EU-KP	**689**	**3 631**	**3 745**	**100%**	**3 056**	**443%**	**115**	**3%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

1.A.1.a Electricity and Heat Production - Liquid Fuels (CO_2)

CO_2 emissions arising from the combustion of liquid fuels for public electricity and heat generation account for about 3% of all greenhouse gas emissions from 1.A.1.a. Within the EU-KP, emissions fell by 86% respectively by 152 Mt CO_2 between 1990 and 2019 (Table 3.7).

Table 3.7 1.A.1.a Public Electricity and Heat Production, Liquid Fuels: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	1 229	95	45	0.2%	-1 184	-96%	-50	-53%		CS
Belgium	663	58	13	0.1%	-650	-98%	-46	-78%	T1, T3	D, PS
Bulgaria	3 245	60	49	0.2%	-3 197	-98%	-11	-18%	T1,T2	CS,D
Croatia	2 142	20	16	0.1%	-2 126	-99%	-3	-17%	T1	D
Cyprus	1 676	3 342	3 282	13.3%	1 606	96%	-60	-2%	CS	CS
Czechia	1 174	103	116	0.5%	-1 057	-90%	14	13%	T1	D, CS
Denmark	953	127	115	0.5%	-839	-88%	-12	-10%	T1,T2,T3	CS,D,PS
Estonia	3 519	170	105	0.4%	-3 414	-97%	-65	-38%	T2	CS
Finland	1 234	587	709	2.9%	-524	-42%	123	21%	T3	CS/PS/D
France	8 219	3 603	3 705	15.0%	-4 514	-55%	102	3%	T2,T3	CS,PS
Germany	8 637	1 302	1 034	4.2%	-7 603	-88%	-268	-21%	CS	CS
Greece	5 416	3 628	3 603	14.6%	-1 813	-33%	-25	-1%	T2	CS, PS
Hungary	1 443	59	43	0.2%	-1 399	-97%	-16	-26%	T1, T2	D, CS
Ireland	1 087	109	253	1.0%	-834	-77%	144	132%	T1,T3	CS,D,PS
Italy	64 597	886	916	3.7%	-63 681	-99%	30	3%	T3	CS
Latvia	3 079	6	3	0.0%	-3 076	-100%	-3	-51%	T1, T2	D, CS
Lithuania	6 021	92	45	0.2%	-5 976	-99%	-47	-51%	T1, T2, T3	CS, PS, D
Luxembourg	NO	1	1	0.0%	1	∞	0	-2%	T1/T2	D/CS
Malta	1 049	17	31	0.1%	-1 018	-97%	14	87%	T1, T2	CS, D
Netherlands	233	726	604	2.4%	370	159%	-122	-17%	CS,T2	CS,D
Poland	5 198	1 252	1 175	4.8%	-4 023	-77%	-78	-6%	T1/T2	D/CS
Portugal	6 434	692	729	3.0%	-5 705	-89%	36	5%	T1	D
Romania	20 356	613	257	1.0%	-20 099	-99%	-355	-58%	T1,T2	CS,D
Slovakia	1 033	12	9	0.0%	-1 025	-99%	-3	-25%	T2	CS
Slovenia	272	24	16	0.1%	-256	-94%	-8	-34%	T1	D
Spain	6 087	7 729	6 317	25.6%	230	4%	-1 412	-18%	T2	CS/PS
Sweden	1 277	377	290	1.2%	-987	-77%	-86	-23%	T2	CS
United Kingdom	19 716	751	584	2.4%	-19 133	-97%	-168	-22%	T1, T2	CS, D
EU-27+UK	**175 988**	**26 440**	**24 064**	**98%**	**-151 923**	**-86%**	**-2 375**	**-9%**		
Iceland	13	2	5	0.0%	-8	-63%	3	110%	T1	D
United Kingdom (KP)	20 393	1 266	1 188	4.8%	-19 205	-94%	-78	-6%	T1, T2	CS, D
EU-KP	**176 677**	**26 956**	**24 673**	**100%**	**-152 004**	**-86%**	**-2 283**	**-8%**		

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Table 3.7 also shows that about 95.6 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.7 shows the contribution to the emission trend for liquid fuels by the main countries. In 2019 Spain, France, Greece and Cyprus are responsible for about 68.5% of emissions in this category. The strongest decrease in emissions took place in Italy because less oil is used as a fuel in the power sector. In 1990 Italy was responsible for 36.6% of the emissions in this category and now in 2019 only for 3.7%.

Figure 3.7 1.A.1.a Public Electricity and Heat Production, Liquid Fuels: Emission trend and share for CO_2

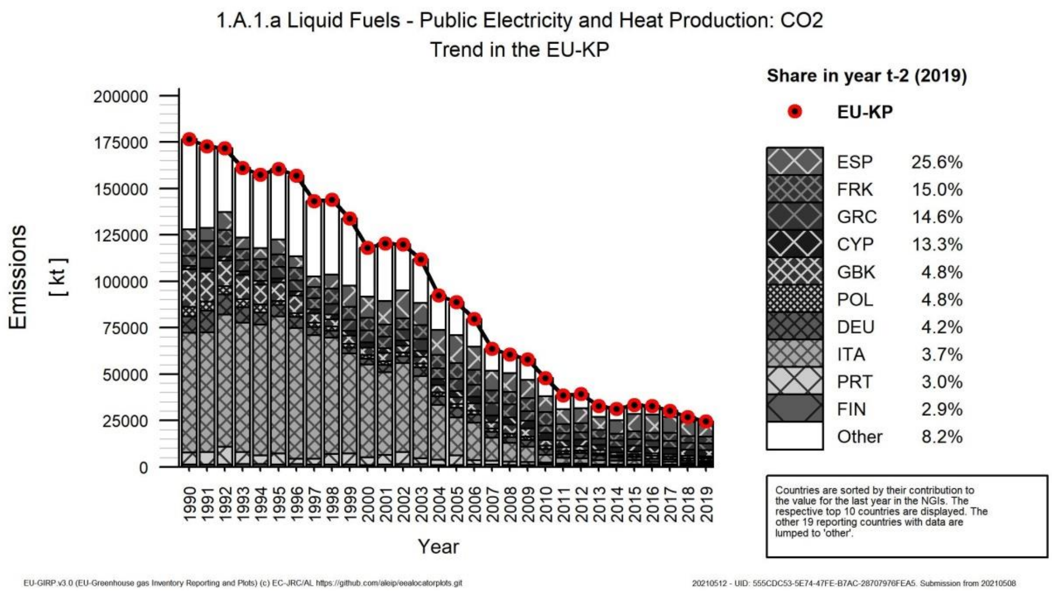
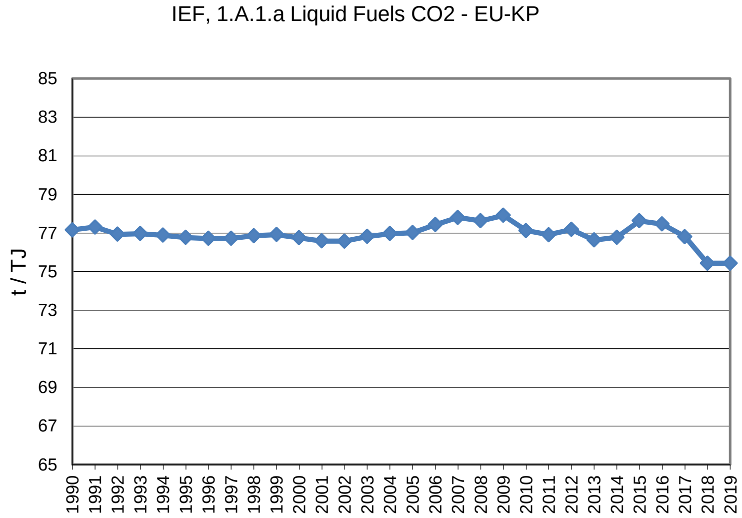
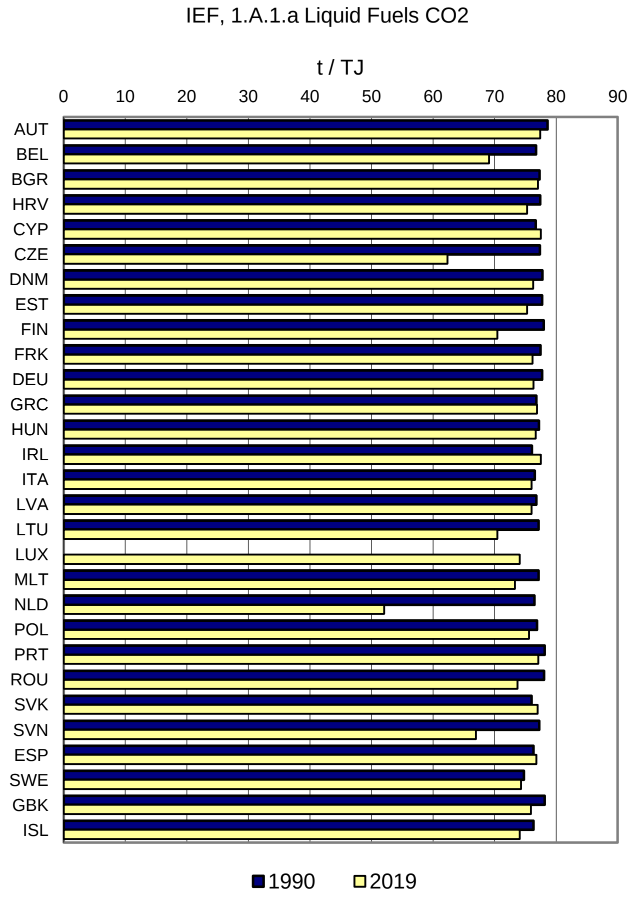


Figure 3.8 (on the next page) shows the implied emission factors for CO_2 emissions from liquid fuels used in public electricity and heat production. The IEFs in most countries range between 76 and 79 t/TJ on the entire time-series. The average IEF within the EU-KP is 75.4 t/TJ in 2019. The IEF from Netherlands is one of the lowest among the countries in the year 2019. The low IEF is caused by the high share of waste gas use in the liquid fuel mix, which has a comparatively low IEF (53.0 t/TJ). The same explanation can be given for Czechia which consumes a high share of Refinery gas with an EF of about 55 t CO_2/TJ).

Figure 3.8 1.A.1.a Public Electricity and Heat Production, Liquid Fuels: Implied Emission Factors for CO_2





1.A.1.a Electricity and Heat Production - Solid Fuels (CO_2)

CO_2 emissions from the combustion of solid fuels represented about 60% of all greenhouse gas emissions from public electricity and heat production. Within the EU-KP, emissions fell by 56% between 1990 and 2019 (Table 3.8). A reason for the recent decline is that coal is being phased out of the fuel mix especially in the United Kingdom, Germany as well as in Poland. Over the past 29 years, United Kingdom, Germany and Poland account for 64.1 % of the decline in the EU-KP.

Table 3.8 1.A.1.a Public Electricity and Heat Production, Solid Fuels: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	6 247	1 367	1 160	0.2%	-5 087	-81%	-208	-15%	T3	PS
Belgium	19 434	4 947	5 185	1.1%	-14 250	-73%	238	5%	T3	PS
Bulgaria	25 638	20 658	19 505	4.0%	-6 133	-24%	-1 154	-6%	T1,T2	CS,D
Croatia	595	1 141	1 306	0.3%	711	119%	165	14%	T2	CS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	52 368	43 360	39 207	8.0%	-13 162	-25%	-4 154	-10%	T1, T2	D, CS
Denmark	22 225	5 832	3 159	0.6%	-19 067	-86%	-2 674	-46%	T1,T2,T3	CS,D,PS
Estonia	22 017	11 169	5 862	1.2%	-16 155	-73%	-5 307	-48%	T2/T3	CS/PS
Finland	9 281	7 619	5 781	1.2%	-3 499	-38%	-1 837	-24%	T3	CS/PS/D
France	37 410	11 481	7 466	1.5%	-29 944	-80%	-4 015	-35%	T2,T3	CS,PS
Germany	307 246	216 071	164 256	33.3%	-142 990	-47%	-51 815	-24%	CS	CS
Greece	35 201	23 280	16 603	3.4%	-18 598	-53%	-6 678	-29%	T1,T2	D,PS
Hungary	12 266	6 436	5 513	1.1%	-6 753	-55%	-923	-14%	T1, T2, T3	D, CS, PS
Ireland	4 845	1 907	583	0.1%	-4 262	-88%	-1 324	-69%	T1,T3	CS,D,PS
Italy	27 756	24 936	17 199	3.5%	-10 557	-38%	-7 737	-31%	T3	CS
Latvia	211	11	10	0.0%	-201	-95%	-1	-7%	T1, T2	D, CS
Lithuania	174	7	7	0.0%	-167	-96%	1	13%	T1, T2, T3	CS, PS, D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	710	NO	NO	-	-710	-100%	-	-	NA	NA
Netherlands	25 862	26 035	18 947	3.8%	-6 915	-27%	-7 089	-27%	CS,T2	CS,D
Poland	220 132	147 439	133 455	27.1%	-86 676	-39%	-13 984	-9%	T1/T2	D/CS
Portugal	7 921	10 149	4 685	1.0%	-3 236	-41%	-5 464	-54%	T3	PS
Romania	25 123	15 440	12 979	2.6%	-12 144	-48%	-2 461	-16%	T1,T2	CS,D
Slovakia	11 542	3 157	2 504	0.5%	-9 038	-78%	-652	-21%	T2, T3	CS
Slovenia	5 712	4 487	4 232	0.9%	-1 479	-26%	-255	-6%	T3	PS
Spain	58 931	38 473	14 841	3.0%	-44 090	-75%	-23 632	-61%	T2	PS
Sweden	4 231	2 699	1 835	0.4%	-2 396	-57%	-864	-32%	T2	CS
United Kingdom	183 150	14 672	6 472	1.3%	-176 678	-96%	-8 200	-56%	T2	CS
EU-27+UK	**1 126 227**	**642 772**	**492 751**	**100%**	**-633 477**	**-56%**	**-150 022**	**-23%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	183 150	14 672	6 472	1.3%	-176 678	-96%	-8 200	-56%	T2	CS
EU-KP	**1 126 227**	**642 772**	**492 751**	**100%**	**-633 477**	**-56%**	**-150 022**	**-23%**		

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Table 3.8 also shows that about 95.3 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.9 shows the trend of emissions for solid fuels for main contributing countries. In 2019 Germany has the largest share of emissions from solid fuels in the EU-KP (33.3%), followed by Poland (27.1%) and then by a clear margin Czechia (8.0%) and Bulgaria (4.0%).

Figure 3.9 1.A.1.a Public Electricity and Heat Production, Solid Fuels: Emission trend and share for CO_2

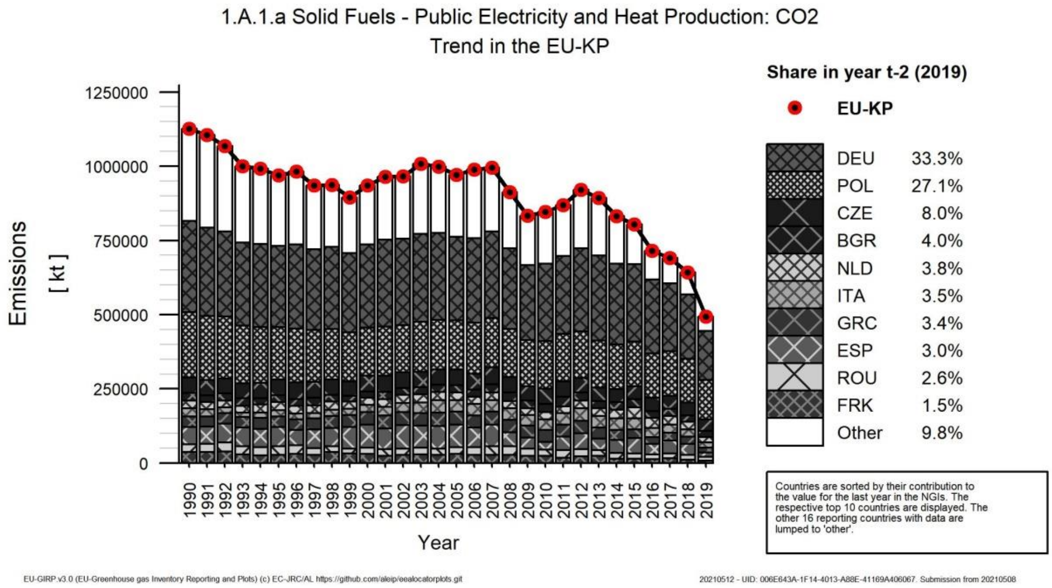
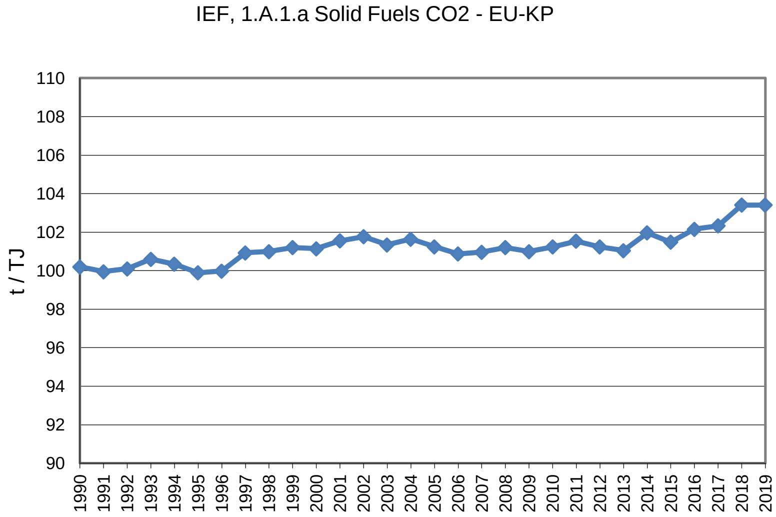
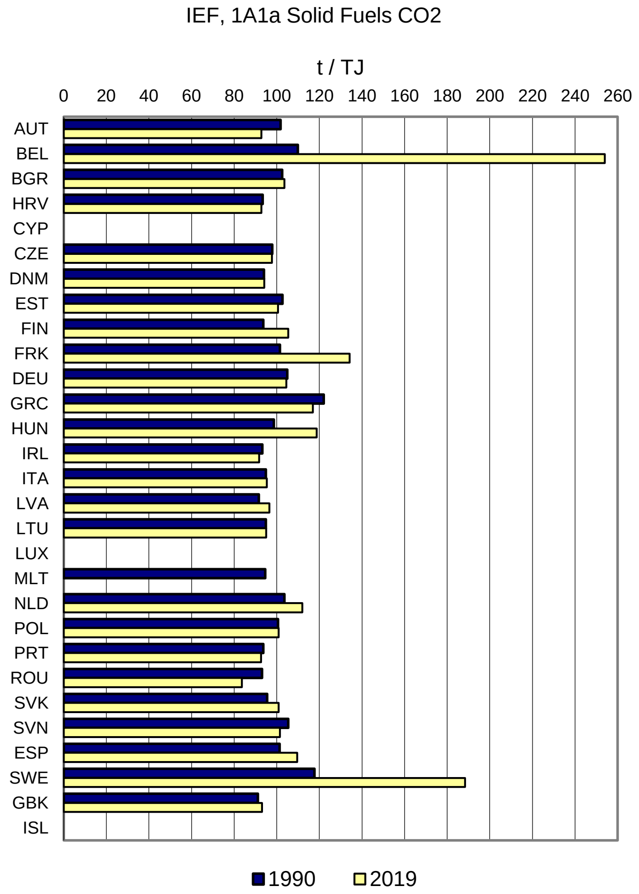


Figure 3.10 (on the next page) shows the relevant implied emission factors for solid fuels. The EU-KP implied emission factor has remained fairly stable between 100 t/TJ and 102 t/TJ on the entire time-series with a slight increase the last three years (103.4 t/TJ in 2019). The comparatively high IEF of Greece is due to the large importance of domestic lignite use for electricity production. The Greek IEF is based on verified carbon contents from EU-ETS reports, ranging from 33.74 to 35.37 tC/TJ. These values lie out of the range suggested by the 2006 IPCC Guidelines. However, given that the net calorific value of the Greek lignite is one of lowest a high value for the carbon content is expected. This is the same observation for Hungary which consumes domestic lignite with very low NCV as well as blast furnace gas. In Belgium, Sweden and France, the emission factors increased sharply since the late 1990s due to the use of blast furnace gas which has a much higher carbon content. A significant increase of the Belgian IEF since 2015 can be observed. The reason for this strong increase lies in the large decrease of the consumption of coals and at the same time an increase in energy consumption of blast furnace gas.

Figure 3.10 1.A.1.a Public Electricity and Heat Production, Solid Fuels: Implied Emission Factors for CO_2





1.A.1.a Electricity and Heat Production - Gaseous Fuels (CO_2)

CO_2 emissions from the combustion of gaseous fuels accounted for 29.8 % of all greenhouse gas emissions from public electricity and heat generation in 2019. Emissions increased by 127 % in the EU-KP between 1990 and 2019 (Table 3.9). The United Kingdom and Italy together were responsible for about 56.9% of the increase in the last 29 years.

Table 3.9 1.A.1.a Electricity and heat production, Gaseous Fuels: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Information
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	3 294	4 379	4 828	2.0%	1 534	47%	449	10%	T2	CS
Belgium	2 766	8 189	8 028	3.3%	5 263	190%	-161	-2%	T1, T3	D, PS
Bulgaria	6 295	1 847	1 840	0.8%	-4 456	-71%	-7	0%	T1,T2	CS,D
Croatia	991	1 225	1 323	0.5%	332	33%	98	8%	T2	CS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 019	2 632	3 379	1.4%	2 360	232%	747	28%	T1, T2	D, CS
Denmark	980	1 575	1 403	0.6%	423	43%	-172	-11%	T1,T2,T3	CS,D,PS
Estonia	1 815	412	360	0.1%	-1 455	-80%	-51	-12%	T2	CS
Finland	1 989	2 280	2 035	0.8%	46	2%	-246	-11%	T3	CS
France	974	9 894	12 260	5.0%	11 285	1158%	2 365	24%	T2,T3	CS,PS
Germany	18 447	30 870	34 347	14.1%	15 899	86%	3 477	11%	CS	CS
Greece	IE,NO	6 265	7 037	2.9%	7 037	∞	772	12%	T1,T2	D,PS
Hungary	4 111	4 321	4 668	1.9%	557	14%	347	8%	T1, T2	D, CS
Ireland	1 881	5 129	5 329	2.2%	3 448	183%	200	4%	T1,T3	CS,D,PS
Italy	16 173	44 183	48 660	19.9%	32 486	201%	4 476	10%	T3	CS
Latvia	2 658	1 816	1 707	0.7%	-951	-36%	-109	-6%	T1, T2	D, CS
Lithuania	5 797	703	592	0.2%	-5 204	-90%	-111	-16%	T1, T2	CS, D
Luxembourg	NO	117	115	0.0%	115	∞	-3	-2%	T1/T2	D/CS
Malta	NO	681	708	0.3%	708	∞	27	4%	T2	CS
Netherlands	13 329	17 787	21 874	9.0%	8 545	64%	4 086	23%	CS,T2	CS,D
Poland	1 197	5 598	6 322	2.6%	5 124	428%	724	13%	T2	CS
Portugal	NO	4 185	4 830	2.0%	4 830	∞	645	15%	T3/T2	PS/D
Romania	20 801	5 751	5 187	2.1%	-15 614	-75%	-564	-10%	T1,T2	CS,D
Slovakia	2 089	1 387	1 756	0.7%	-334	-16%	368	27%	T2	CS
Slovenia	112	246	282	0.1%	170	151%	36	15%	T2	CS
Spain	447	11 310	19 801	8.1%	19 354	4325%	8 491	75%	T2	CS/PS
Sweden	486	405	298	0.1%	-187	-39%	-106	-26%	T2	CS
United Kingdom	16	45 134	44 911	18.4%	44 895	281344%	-223	0%	T1, T2	CS, D
EU-27+UK	**107 668**	**218 324**	**243 878**	**100%**	**136 210**	**127%**	**25 554**	**12%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	16	45 308	45 085	18.5%	45 069	282433%	-223	0%	T1, T2	CS, D
EU-KP	**107 668**	**218 498**	**244 052**	**100%**	**136 384**	**127%**	**25 554**	**12%**		

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Table 3.9 also shows that about 96.6 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

In seven EU-KP the consumption of gaseous fuels was lower in 2019 than in 1990. Cyprus and Iceland are not utilising gaseous fuels for public electricity and heat production. In the other 20 countries, gas consumption has increased in the last 29 years. From 1990 until 2008 the use of gaseous fuels shows a steep increasing trend, followed by strong decreasing trend from 2009 until 2014, which was mainly attributed to the increased prices for natural gas. After this steep decrease the emissions of gaseous fuels increased again by about 40% in 2019 compared to 2014. Figure 3.11 shows the trend of emissions from gaseous fuels by the main contributing countries which are Italy (19.9%), the United Kingdom (18.5%) and Germany (14.1%). One of the reasons for the recent increase is that coal is in the process of being phased out of the fuel mix and replaced by gaseous fuels in many countries.

Figure 3.11 1.A.1.a Public Electricity and Heat Production, Gaseous Fuels: Emission trend and share for CO_2

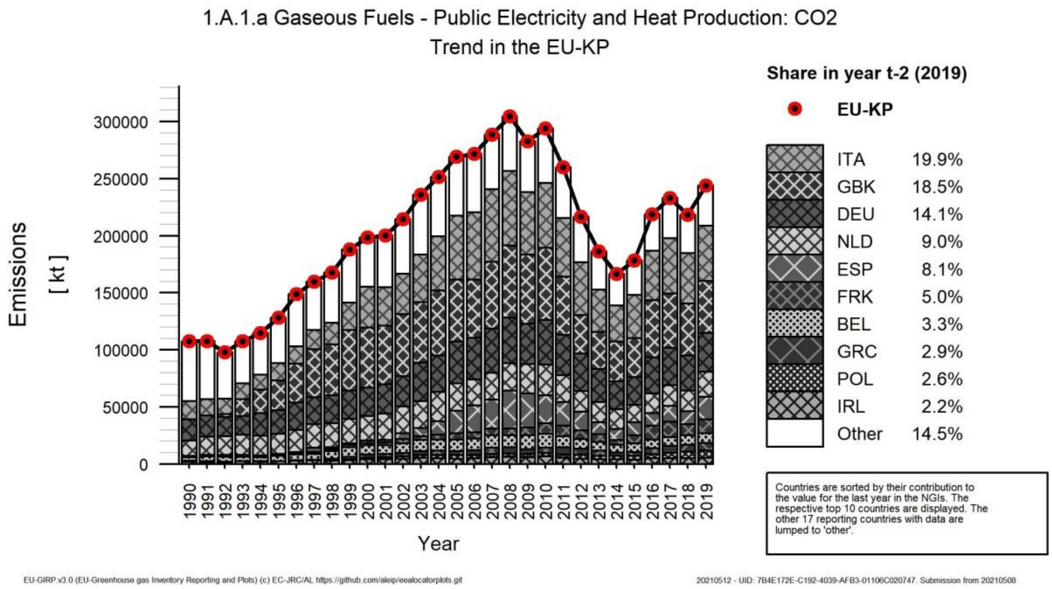
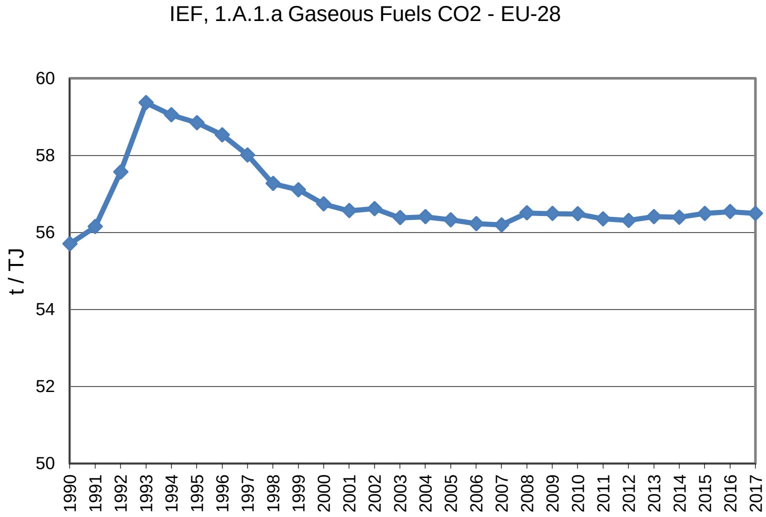
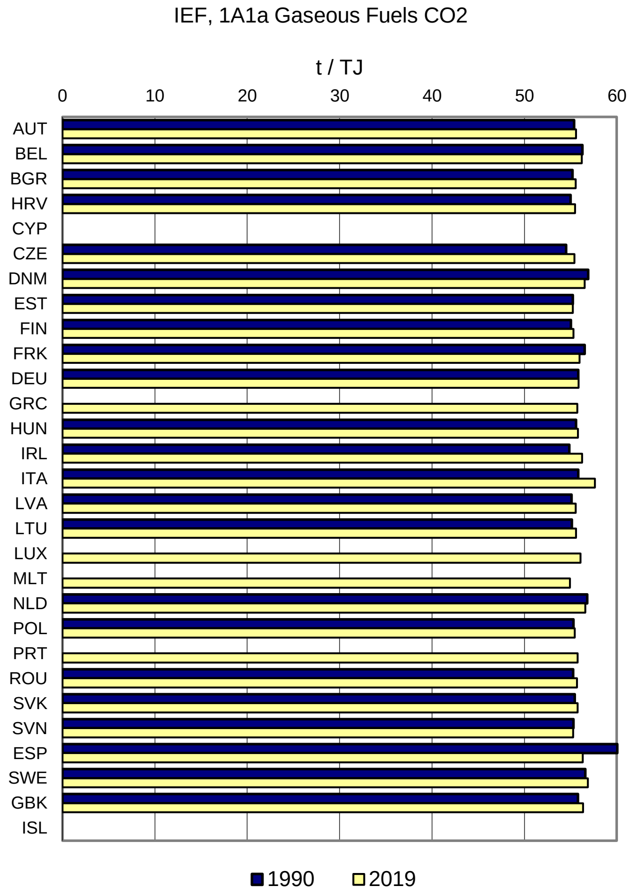


Figure 3.12 (on the next page) shows the implied emission factors from gaseous fuels for CO_2. The EU-KP implied emission factor has remained fairly stable (56.4 t/TJ in 2019) which is very close to the default emission factor of natural gas (56.1 t/TJ). The slight increase in the EU-KP factor observed in the early 1990s can be explained by the higher UK's gas share in the EU-KP and by an increase in the UK's implied emission factor. In the early 1990s, the IEF for Spain is also high. It is explained by the total CO_2 emissions allocation amongst fuels which does not impact total CO_2 emissions. The latter is the result of the commissioning of the Peterhead power station in Scotland, which uses sour gas, a fuel with a much higher factor than natural gas.

Figure 3.12 1.A.1.a Public Electricity and Heat Production, Gaseous Fuels: Implied Emission Factors for CO_2





1.A.1.a Electricity and Heat Production - Other Fuels (CO_2)

In 2019, the share of CO_2 emissions from other fuels amounts to 5.0 % of total greenhouse gas emissions from public electricity and heat generation. Other fuels cover mainly the fossil part of municipal solid waste incineration where there is energy recovery, including plastics, hazardous waste, bulky waste and waste sludge (Table 3.10). Emissions increased by 283 % at EU-KP level between 1990 and 2019 and increased in all countries except for Latvia. Germany alone is responsible for 32% of the increase in the whole EU-KP over the last 29 years.

Table 3.10 1.A.1.a Public Electricity and Heat Production, Other Fuels: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	286	1 036	1 031	2.5%	745	260%	-5	0%	T2	CS
Belgium	674	2 035	2 025	4.9%	1 351	200%	-10	0%	T3	PS
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	24	248	253	0.6%	229	951%	5	2%	T1	D
Denmark	539	1 574	1 615	3.9%	1 076	200%	41	3%	T1,T2,T3	CS,D,PS
Estonia	NO	138	128	0.3%	128	∞	-10	-7%	T3	PS
Finland	1	603	628	1.5%	627	62653%	26	4%	T3	CS
France	2 558	5 852	5 375	13.1%	2 817	110%	-478	-8%	T2,T3	CS,PS
Germany	4 121	13 949	13 847	33.7%	9 727	236%	-101	-1%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	30	169	202	0.5%	172	573%	33	19%	T1, T2, T3	D, CS, PS
Ireland	NO	606	633	1.5%	633	∞	28	5%	T1,T3	CS,D,PS
Italy	143	202	164	0.4%	21	15%	-37	-19%	T3	CS
Latvia	3	NO	NO	-	-3	-100%	-	-	NA	NA
Lithuania	NO	180	179	0.4%	179	∞	-1	0%	T1, T2	CS, D
Luxembourg	33	105	108	0.3%	75	223%	3	3%	T1/T2	D/CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	601	2 857	2 723	6.6%	2 122	353%	-134	-5%	CS,T2	CS,D
Poland	753	830	998	2.4%	245	33%	168	20%	T1	D
Portugal	NO	473	459	1.1%	459	∞	-14	-3%	T2	D/CS
Romania	NO	NO	NO	-	-	-	-	-	T1,T2	CS,D
Slovakia	36	157	209	0.5%	173	486%	52	33%	T2	CS
Slovenia	NO	21	21	0.0%	21	∞	-1	-4%	T1	D
Spain	128	1 488	1 637	4.0%	1 510	1184%	149	10%	T2	CS/PS
Sweden	570	2 662	2 879	7.0%	2 309	405%	217	8%	T2	CS
United Kingdom	232	5 354	5 957	14.5%	5 725	2468%	603	11%	T1, T2	CS, D
EU-27+UK	**10 733**	**40 539**	**41 072**	**100%**	**30 339**	**283%**	**533**	**1%**		
Iceland	NO	NO	NO	-	-	-	-	-	T1	D
United Kingdom (KP)	244	5 419	6 022	14.6%	5 778	2366%	603	11%	T1, T2	CS, D
EU-KP	**10 745**	**40 605**	**41 137**	**100%**	**30 392**	**283%**	**532**	**1%**		

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Table 3.10 also shows that more than 93.4 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.13 illustrates clearly the strong increase of emissions caused by other fuels over the past 29 years. The largest emitters of other fuels in 2019 were Germany (33.7%), the United Kingdom (14.6%) and France (13.1%). Together these three countries accounted for 61.4% of the total EU-KP emissions in this category.

Figure 3.13 1.A.1.a Public Electricity and Heat Production, Other Fuels: Emission trend and share for CO_2

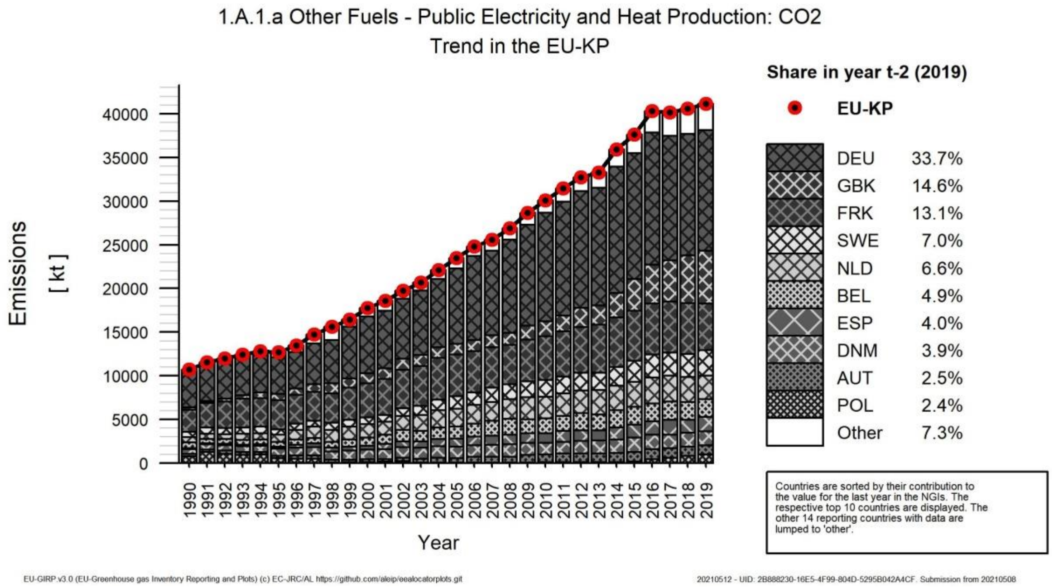
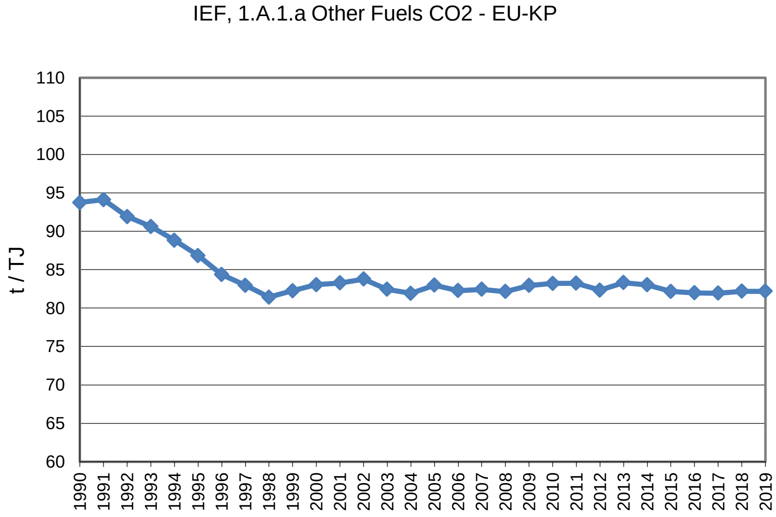
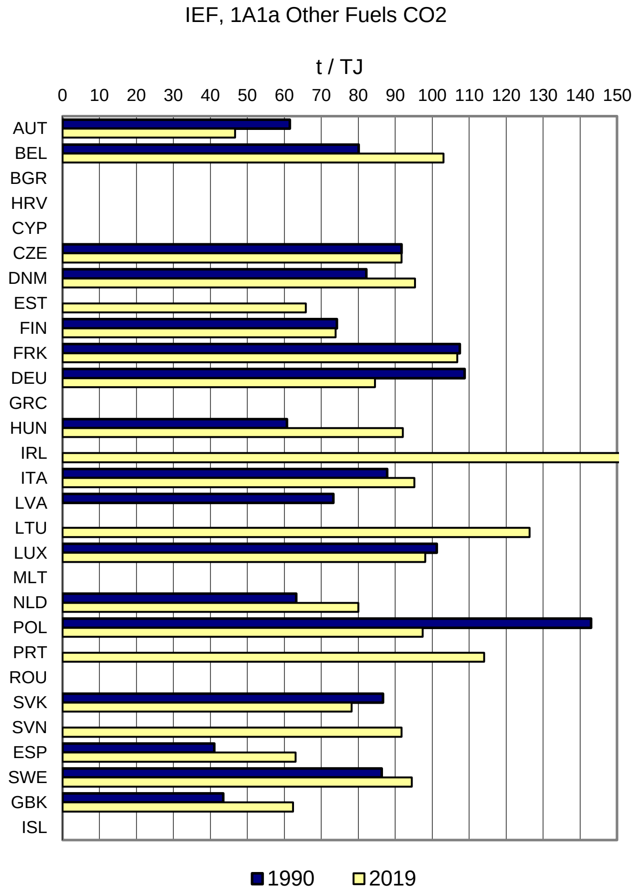


Figure 3.14 (on the next page) shows the implied emission factors of the category other fuels from CO_2. The EU-KP implied emission factor has gradually fallen until 1998, then levelled out between 80 and 85 t/TJ on the entire time-series. In Germany, the IEF declined continuously between 1990 and 2019 (from 109 to 84.5 t/TJ). This is because the combustion of industrial waste has been greatly reduced in the early 1990s whereas the combustion of residential waste for electricity and heat has increased in the complete reporting period; furthermore, the calorific value of the applied waste has increased due to a better national waste separation management. There is a large diversity in waste composition across countries leading to the differences in countries' IEFs.

Figure 3.14 1.A.1.a Public Electricity and Heat Production, Other Fuels: Implied Emission Factors for CO_2





1.A.1.a Electricity and Heat Production - Peat (CO_2)

CO_2 emissions from the combustion of peat represented 0.9% of all greenhouse gas emissions from public electricity and heat production. Peat in its raw state is a fossil sedimentary deposit of vegetal origin with high water content. Only 5 countries report emissions from peat combustion. Latvia does not consumed Peat anymore in 2019. Within the EU-KP, emissions declined by 19% respectively 1.8 Mt CO_2 between 1990 and 2019 and by 12% between 2018 and 2019 (Table 3.11).

Table 3.11 1.A.1.a Public Electricity and Heat Production, Peat: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	841	151	102	1.4%	-739	-88%	-48	-32%	T1/T2	D/CS
Finland	3 950	5 335	4 808	65.1%	859	22%	-527	-10%	T3	CS
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	NO	NO	NO	-	-	-	-	-	NA	NA
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	3 065	2 208	2 038	27.6%	-1 027	-34%	-170	-8%	T1,T3	CS,D,PS
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	146	9	NO	-	-146	-100%	-9	-100%	NA	NA
Lithuania	11	38	22	0.3%	11	99%	-16	-43%	T1, T2	CS, D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	-	-	-	-	-	-	-	-	NA	NA
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	1 150	645	418	5.7%	-732	-64%	-227	-35%	T2	CS
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-27+UK	**9 162**	**8 385**	**7 388**	**100%**	**-1 774**	**-19%**	**-997**	**-12%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**9 162**	**8 385**	**7 388**	**100%**	**-1 774**	**-19%**	**-997**	**-12%**		

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Note: Peat is not used as a fuel in the Netherlands. Nevertheless, the Netherlands did not report Peat as notation key

Table 3.11 also shows that about 97.1 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.15 illustrates the trend of peat emissions throughout the last 29 years, which is predominately influenced by the emission fluctuation over the years by Finland. Several parameters such as weather conditions greatly influence the peat consumption: in Finland, peat represents 4% of electricity production and is the third most important energy source in district heat production (with 15% of the district heat produced). In 2019, the two largest emitters, Finland and Ireland, are responsible for 92.7% of the total emissions in this category.

Figure 3.15 1.A.1.a Public Electricity and Heat Production, Peat: Emission trend and share for CO_2

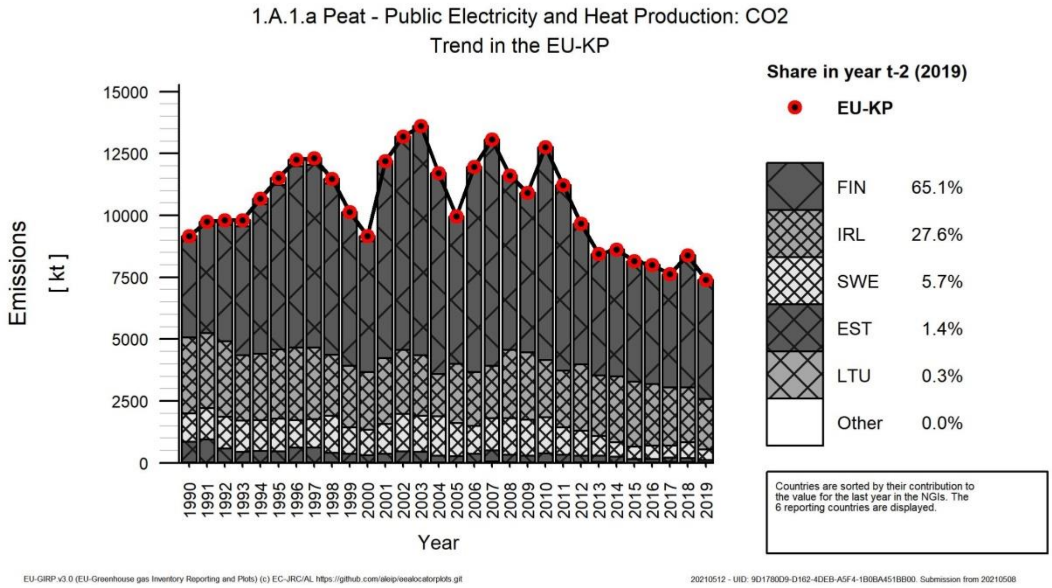
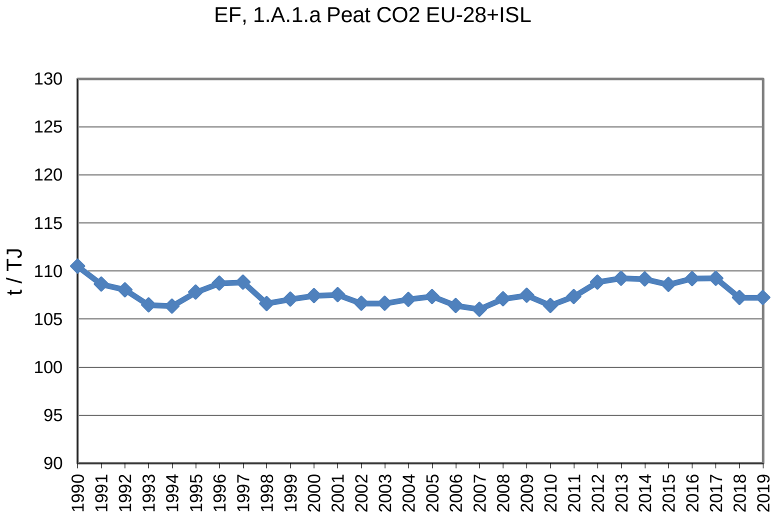
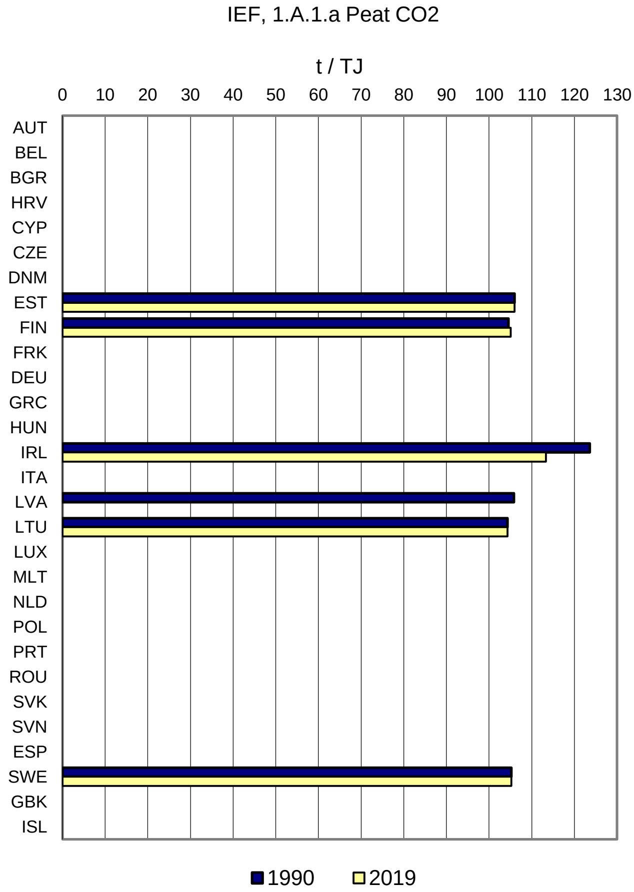


Figure 3.16 shows the implied emission factors of peat from CO_2. The EU-KP implied emission factor amounts to 107.2 t/TJ in 2019 and has been quite stable over the last 29 years. It is mainly influenced by the IEF of the two largest emitters (Finland and Ireland). The default emission factor for peat is 106 t/TJ according to the 2006 IPCC guidelines. Only Ireland has an IEF continuously above the default value. The reason for this is the use of the plant specific emission factor (112.9 t/TJ) for three milled peat power plants in use.

Figure 3.16 1.A.1.a Public Electricity and Heat Production, Peat: Implied Emission Factors for CO_2





3.2.1.2 Petroleum Refining (1.A.1.b) (EU-KP)

According to the 2006 IPCC guidelines, Petroleum Refining (CRF 1.A.1.b) should include all combustion activities supporting the refining of petroleum products including on-site combustion for the generation of electricity and heat for own use. It does not include evaporative emissions occurring at the refinery. These emissions should be reported separately under 1.B.2.a as well as venting and flaring under 1.B.2.c.

Total emissions from Petroleum Refining are accounting for 2.8% of total greenhouse gas emissions in year 2019. Between 1990 and 2019, EU-KP CO_2 emissions decreased by 6% (Table 3.12). Emissions in 2019 were above 1990 levels in 12 countries, whereas they were decreasing in 12 and reported as not occurring for the whole time series in five countries. Italy, Poland and Greece had the largest emission increases. In contrast France and the United Kingdom report the largest decreases together accounting for almost 60% of the decrease in emissions in this period. The decrease at European level can be explained by the reduction of Liquid fuels consumptions (-26% for sector 1A-Liquid fuels between 2000 and 2019).

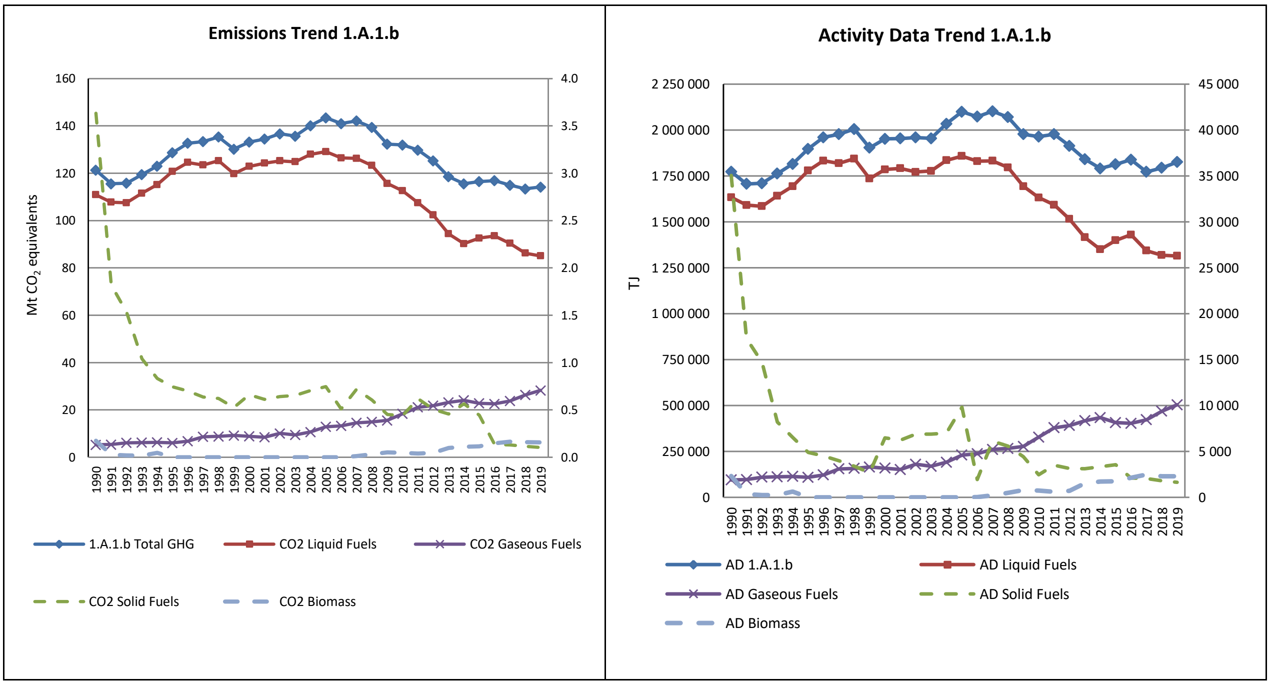
Table 3.12 1.A.1.b Petroleum Refining: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	2 394	2 824	2 791	2.5%	397	17%	-33	-1%	T2	CS
Belgium	4 299	4 502	5 611	4.9%	1 312	31%	1 109	25%	CS,T3	PS
Bulgaria	861	839	987	0.9%	125	15%	148	18%	T1,T2	CS,D
Croatia	2 425	1 317	991	0.9%	-1 434	-59%	-327	-25%	T1	D
Cyprus	86	NO	NO	-	-86	-100%	-	-	NA	NA
Czechia	493	505	540	0.5%	47	10%	35	7%	T1,T2	CS,D
Denmark	908	891	958	0.8%	49	5%	66	7%	T1,T2,T3	CS,D,PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	2 042	1 641	1 693	1.5%	-350	-17%	52	3%	T3	CS,PS
France	11 935	6 224	6 239	5.5%	-5 697	-48%	15	0%	T2,T3	CS,PS
Germany	20 166	21 297	21 757	19.1%	1 592	8%	460	2%	CS	CS
Greece	2 375	4 930	4 600	4.0%	2 225	94%	-331	-7%	T2	PS
Hungary	2 376	1 601	1 558	1.4%	-817	-34%	-43	-3%	T2,T3	CS,PS
Ireland	168	322	275	0.2%	106	63%	-47	-15%	T3	CS,PS
Italy	15 817	19 691	18 986	16.7%	3 169	20%	-705	-4%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 510	1 312	1 324	1.2%	-185	-12%	12	1%	T2,T3	CS,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	11 010	9 088	10 023	8.8%	-988	-9%	935	10%	T2	CS,D
Poland	2 169	4 351	4 605	4.0%	2 435	112%	253	6%	T1,T2	CS,D
Portugal	1 870	2 209	2 164	1.9%	294	16%	-45	-2%	T2	CR,D,PS
Romania	4 297	1 450	1 802	1.6%	-2 495	-58%	352	24%	T1,T3	D,PS
Slovakia	2 873	1 485	1 419	1.2%	-1 454	-51%	-66	-4%	T3	PS
Slovenia	170	NO	NO	-	-170	-100%	-	-	NA	NA
Spain	10 858	11 353	11 042	9.7%	184	2%	-311	-3%	T2,T3	PS
Sweden	1 778	2 056	1 755	1.5%	-23	-1%	-301	-15%	T2	CS
United Kingdom	17 831	13 049	12 628	11.1%	-5 203	-29%	-420	-3%	T2	CS
EU-27+UK	**120 713**	**112 939**	**113 746**	**100%**	**-6 967**	**-6%**	**807**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	17 831	13 049	12 628	11.1%	-5 203	-29%	-420	-3%	T2	CS
EU-KP	**120 713**	**112 939**	**113 746**	**100%**	**-6 967**	**-6%**	**807**	**1%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 3.17 shows the trends in activity data and the associated emissions originating from the refining of petroleum by fuel in the EU--KP between the years 1990 and 2019. Fuel used for petroleum refining increased by 3% in the EU-KP between 1990 and 2019. In the year 2019, liquid fuels represent 72% of all fuel used in the refining of petroleum. Gaseous fuels almost fully account for the remaining part (27.6%) of the activity data. Gaseous fuels use is more than five times higher in 2019 compared to 1990. There remains a small amount of solid fuels used accounting for 0.09% in petroleum refining; in Germany (lignite and coke oven gas) and Poland (hard coal and lignite) as well as 0.13% of biomass and 0.16% of other fuels use.

Figure 3.17 1.A.1.b Petroleum Refining: Total and CO_2 emission and activity trends



Note: Data displayed as dashed line refers to the secondary axis.

1.A.1.b Petroleum Refining - Liquid Fuels (CO_2)

CO_2 emissions from the combustion of liquid fuels used for petroleum refining accounted for 74.5% of all greenhouse gas emissions from petroleum refining in 2019. Emissions decreased by 23% between 1990 and 2019 (Table 3.13). Greece had the largest emission increases accounting for 46.3% of the whole increase between 1990 and 2019. In contrast the United Kingdom and France report the largest decreases together accounting for 46.3% of the whole decrease in emissions in this period.

Table 3.13 1.A.1.b Petroleum Refining, Liquid Fuels: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	1 958	2 348	2 287	2.7%	329	17%	-61	-3%	T2	CS
Belgium	4 285	2 663	2 968	3.5%	-1 317	-31%	305	11%	CS,T3	PS
Bulgaria	793	730	884	1.0%	91	11%	154	21%	T1	D
Croatia	2 411	856	601	0.7%	-1 810	-75%	-255	-30%	T1	D
Cyprus	86	NO	NO	-	-86	-100%	-	-	NA	NA
Czechia	176	304	317	0.4%	141	80%	13	4%	T1	CS,D
Denmark	908	862	940	1.1%	32	4%	78	9%	T1,T2,T3	CS,D,PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 383	1 383	1 447	1.7%	64	5%	64	5%	T3	CS,PS
France	11 413	4 839	4 802	5.6%	-6 611	-58%	-36	-1%	T2,T3	CS,PS
Germany	15 417	16 135	16 407	19.3%	990	6%	272	2%	CS	CS
Greece	2 375	4 930	4 600	5.4%	2 225	94%	-331	-7%	T2	PS
Hungary	1 683	981	928	1.1%	-755	-45%	-53	-5%	T3	PS
Ireland	168	309	263	0.3%	94	56%	-46	-15%	T3	CS,PS
Italy	15 656	15 726	14 762	17.4%	-894	-6%	-964	-6%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 510	1 310	1 205	1.4%	-305	-20%	-105	-8%	T2,T3	CS,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	9 968	6 243	7 163	8.4%	-2 805	-28%	920	15%	T2	CS,D
Poland	1 326	2 280	2 163	2.5%	837	63%	-117	-5%	T1,T2	CS,D
Portugal	1 870	1 153	1 085	1.3%	-785	-42%	-67	-6%	T2	CR,D,PS
Romania	4 297	1 246	1 555	1.8%	-2 742	-64%	309	25%	T3	PS
Slovakia	2 786	1 236	1 149	1.4%	-1 637	-59%	-87	-7%	T3	PS
Slovenia	43	NO	NO	-	-43	-100%	-	-	NA	NA
Spain	10 812	8 002	7 668	9.0%	-3 144	-29%	-334	-4%	T2,T3	PS
Sweden	1 778	1 941	1 628	1.9%	-150	-8%	-314	-16%	T2	CS
United Kingdom	17 782	10 775	10 253	12.1%	-7 529	-42%	-522	-5%	T2	CS
EU-27+UK	**110 883**	**86 252**	**85 075**	**100%**	**-25 808**	**-23%**	**-1 177**	**-1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	17 782	10 775	10 253	12.1%	-7 529	-42%	-522	-5%	T2	CS
EU-KP	**110 883**	**86 252**	**85 075**	**100%**	**-25 808**	**-23%**	**-1 177**	**-1%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Table 3.13 also shows that almost 98 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.18 illustrates that Germany, Italy and the United Kingdom are the countries contributing most in terms of CO_2 emissions in 2019. It also can be seen that the trend for liquid fuels was continuously decreasing since the year 2008 with a stabilization between 2014 and 2016.

Figure 3.18 1.A.1.b Petroleum Refining, Liquid Fuels: Emission trend and share for CO_2

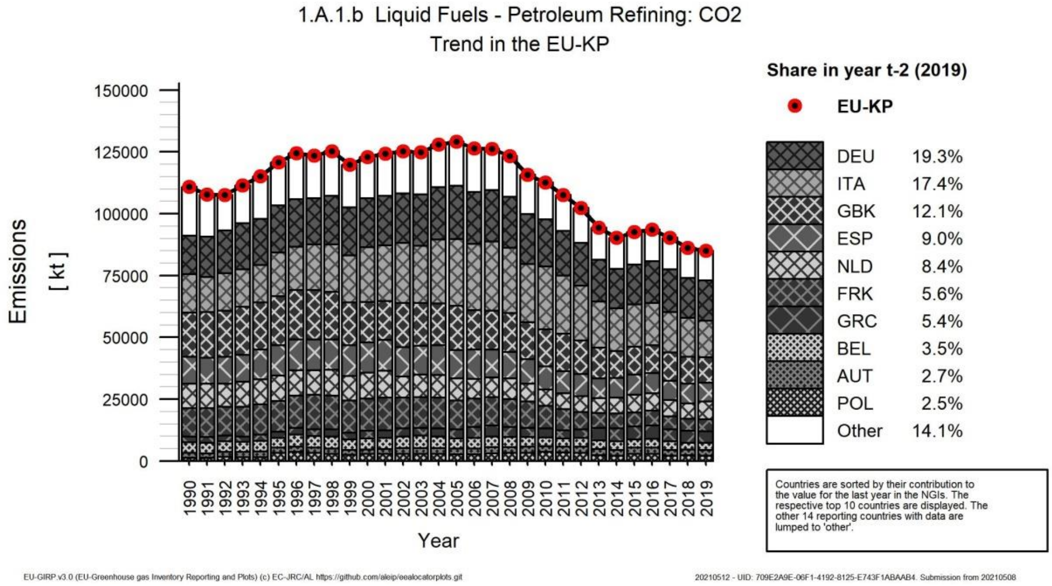
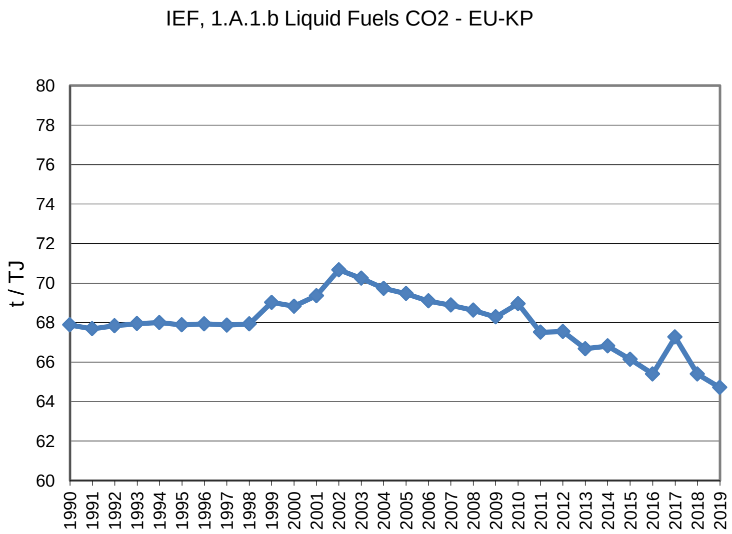
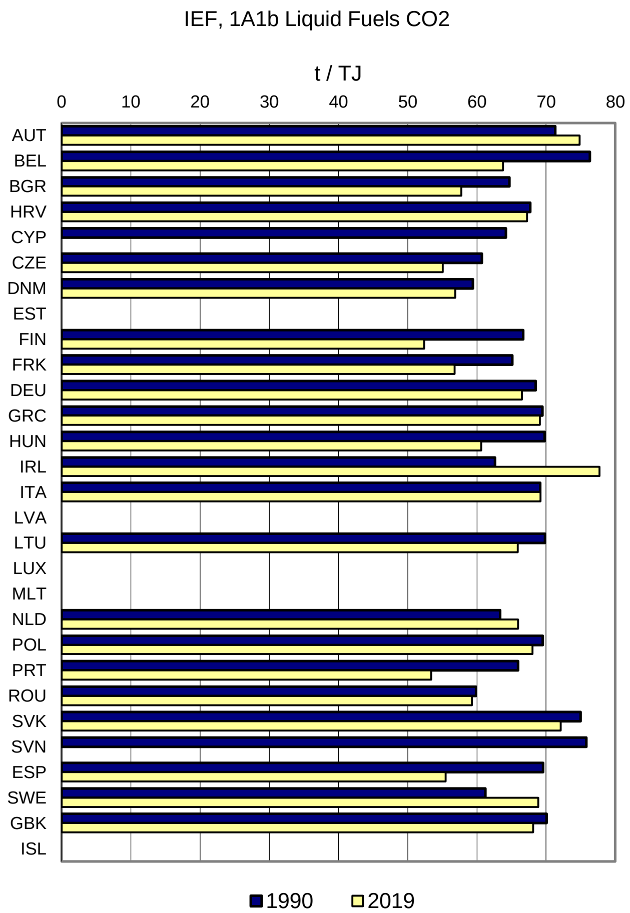


Figure 3.19 (on the next page) shows the emission factors for CO_2 emissions from liquid fuels. The EU-KP implied emission factor shows variations around 68 t/TJ over the time series and amounts 64.7 t/TJ in 2019, the lowest of the time-series. In general, the fluctuating IEF is due to the annual variations of fuel consumption with different carbon content. The IEF declining trend observed since 2002 is due to the higher share of refinery gas in the energy mix.

For example, in Italy the main fuels used are refinery gases, fuel oil and petroleum coke, which have very different emission factors, and every year the amount used changes resulting in an annual variation of the IEF. Ireland reports the highest IEF in 2019 which is due to differences in the data published in the national energy balance and the reported emissions under the EU ETS, concerning the single oil refinery in Ireland.

Figure 3.19 1.A.1.b Petroleum Refining, Liquid Fuels: Implied Emission Factors for CO_2





1.A.1.b Petroleum Refining - Solid Fuels (CO_2)

CO_2 emissions from the combustion of solid fuels in petroleum refining represented less than 0.1% of all greenhouse gas emissions from 1.A.1.b in 2019. There are only three countries reporting emissions in the EU-KP in 2019 (Poland, Germany and Romania). Thereof only Poland reports increasing emissions between 1990 and 2019. Poland is responsible for 59.5% of emissions in 2019 in the EU-KP. Over the whole times series emissions fell by 97% on average (Table 3.14).

Table 3.14 1.A.1.b Petroleum Refining, Solid Fuels: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	12	NO	NO	-	-12	-100%	-	-	NA	NA
France	486	NO	NO	-	-486	-100%	-	-	NA	NA
Germany	3 131	42	39	37.2%	-3 092	-99%	-3	-7%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	4	73	62	59.4%	58	1356%	-11	-15%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	4	3.4%	4	∞	4	∞	T3	PS
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-27+UK	**3 633**	**115**	**104**	**100%**	**-3 529**	**-97%**	**-11**	**-9%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**3 633**	**115**	**104**	**100%**	**-3 529**	**-97%**	**-11**	**-9%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Table 3.14 also shows that 94 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.20 illustrates the trend of emissions in 1.A.1.b for solid fuels for the past 29 years. The use of solid fuels in petroleum refining has declined drastically since 1990. Emissions are down by 97%. Germany is responsible for the strong declining trend in the 1990s and due to the recent overall trend, Poland is now responsible for 59.4% of the total emissions in the EU-KP for this category in 2019.

Figure 3.20 1.A.1.b Petroleum Refining, Solid Fuels: Emission trend and share for CO_2

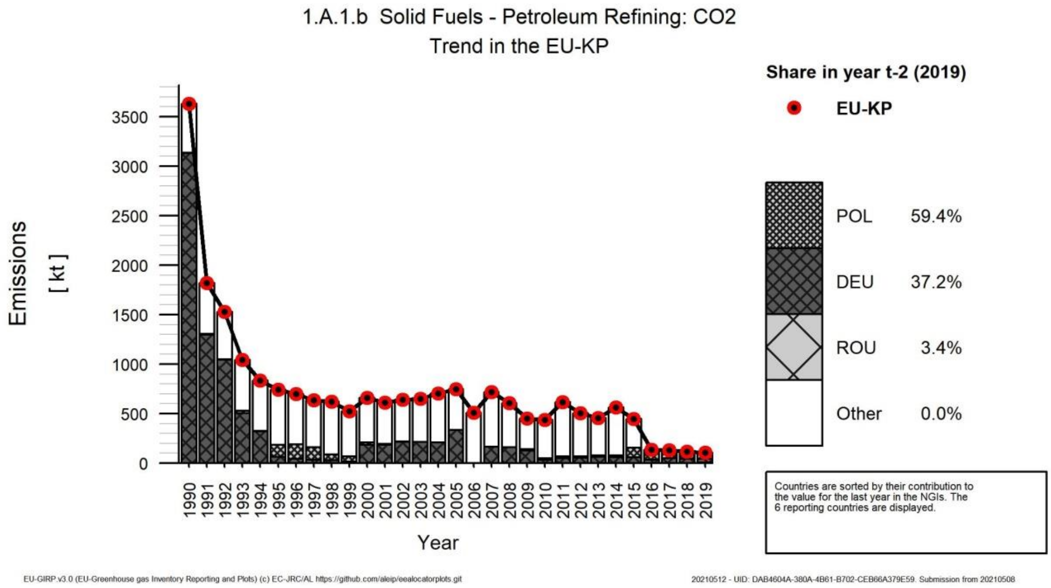
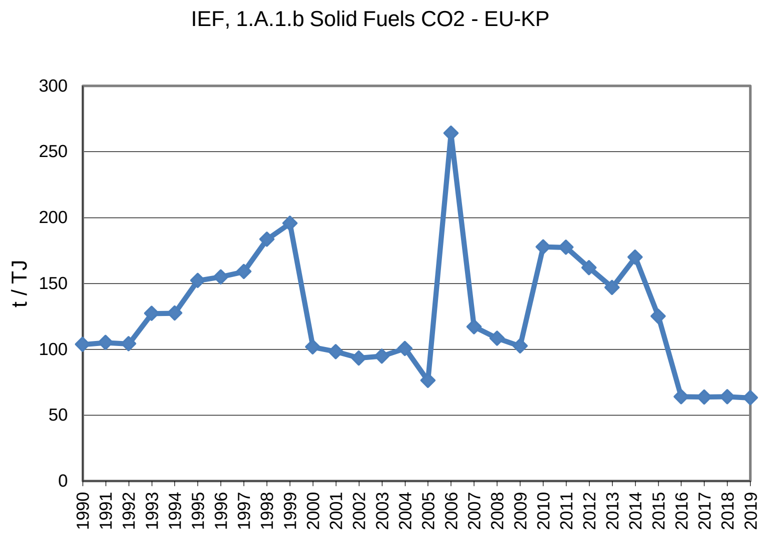
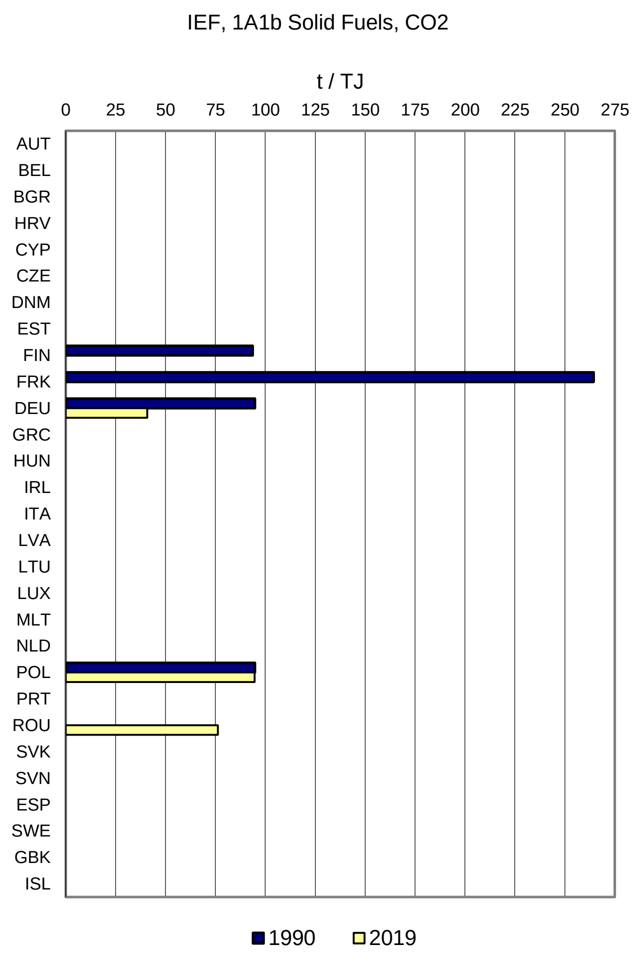


Figure 3.21 (on the next page) shows the relevant implied emission factors. The EU-KP implied emission factor showed strong fluctuations and amounts 63.1 t/TJ in 2019. One explanation for this is the low number of countries reporting this category. Apart from that, the variation in the EU-KP factor can be partly explained by the declining use of solid fuels in petroleum refining in Germany between 1990 and 1999. This explains the gradual increase of the EU-KP IEF up to 1999 through the growing weight of the much higher implied emission factor of France. The high emission factor in France was due to the use of blast furnace gas. In Germany, there was a decline in the IEF in the early 1990s compared to a rather stable IEF since the mid-1990s. The reason is that the use of - mainly - lignite has constantly been reduced in favour of coke oven gas. The increased EU-KP solid fuel combustion in 2000-2005 and 2007-2009 is due to an increase in fuel combustion in Germany in these years. The higher weight of the German IEF also explains the lower IEF at EU-KP level during these years. For 2006 Germany reports only negligible amounts of solid fuel use in petroleum refining. Therefore, the EU-KP IEF was almost entirely dominated by the high French IEF in this year. The drop in the implied emission factor since 2014 can be explained by the increased weight of Poland with their lower IEF (compared to France). Since there is no more solid fuel consumption in France since 2017, the average IEF is driven by Poland and Germany which have similar CO_2 EF.

Figure 3.21 1.A.1.b Petroleum Refining, Solid Fuels: Implied Emission Factors for CO_2





1.A.1.b Petroleum Refining - Gaseous Fuels (CO_2)

In 2019, CO_2 emissions from the combustion of gaseous fuels used for petroleum refining accounted for about 24.7% of total greenhouse gas emissions from 1.A.1.b. Emissions in the EU-KP increased by 435% between 1990 and 2019 (Table 3.15). Only four countries reduced their emissions: Czechia, Finland, Hungary and Slovenia over the whole time series. Belgium, Germany, Italy, Poland, Spain and the United Kingdom together account for 85% of the total increase between 1990 and 2019.

Table 3.15 1.A.1.b Petroleum Refining, Gaseous Fuels: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	437	476	504	1.8%	67	15%	28	6%	T2	CS
Belgium	14	1 709	2 394	8.5%	2 380	17134%	685	40%	CS,T3	PS
Bulgaria	69	109	103	0.4%	34	50%	-6	-6%	T2	CS
Croatia	14	462	390	1.4%	376	2694%	-72	-16%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	317	201	223	0.8%	-94	-30%	22	11%	T2	CS
Denmark	NO	29	18	0.1%	18	∞	-12	-40%	T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	648	258	246	0.9%	-401	-62%	-12	-5%	T3	CS
France	36	1 385	1 436	5.1%	1 400	3868%	51	4%	T2,T3	CS,PS
Germany	1 444	5 121	5 311	18.8%	3 867	268%	191	4%	CS	CS
Greece	NO	IE	IE	-	-	-	-	-	NA	NA
Hungary	693	603	614	2.2%	-79	-11%	11	2%	T3	PS
Ireland	NO	13	12	0.0%	12	∞	-1	-7%	T3	CS,PS
Italy	161	3 965	4 224	15.0%	4 063	2528%	259	7%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	3	119	0.4%	119	∞	117	4569%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 042	2 845	2 860	10.1%	1 818	174%	15	1%	T2	CS
Poland	92	1 998	2 380	8.4%	2 287	2474%	381	19%	T2	CS
Portugal	NO	1 056	1 078	3.8%	1 078	∞	22	2%	T2	CR,D,PS
Romania	NO	204	243	0.9%	243	∞	39	19%	T3	PS
Slovakia	88	249	270	1.0%	183	208%	21	9%	T3	PS
Slovenia	127	NO	NO	-	-127	-100%	-	-	NA	NA
Spain	46	3 275	3 322	11.8%	3 276	7124%	47	1%	T2,T3	PS
Sweden	NO	114	127	0.5%	127	∞	13	11%	T2	CS
United Kingdom	49	2 273	2 375	8.4%	2 326	4715%	102	4%	T2	CS
EU-27+UK	**5 276**	**26 349**	**28 250**	**100%**	**22 973**	**435%**	**1 901**	**7%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	49	2 273	2 375	8.4%	2 326	4715%	102	4%	T2	CS
EU-KP	**5 276**	**26 349**	**28 250**	**100%**	**22 973**	**435%**	**1 901**	**7%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Table 3.15 also shows that about 98.6 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS.

Figure 3.22 illustrates the trend of increasing emissions from gaseous fuels in category 1.A.1.b in the last 29 years. As can be seen the six largest contributors to CO_2 emissions in this sector account together for 72.7% of the total emissions in this category. Emissions have increased by 7% between 2018 and 2019 and are the highest of the time-series.

Figure 3.22 1.A.1.b Petroleum Refining, Gaseous Fuels: Emission trend and share for CO_2

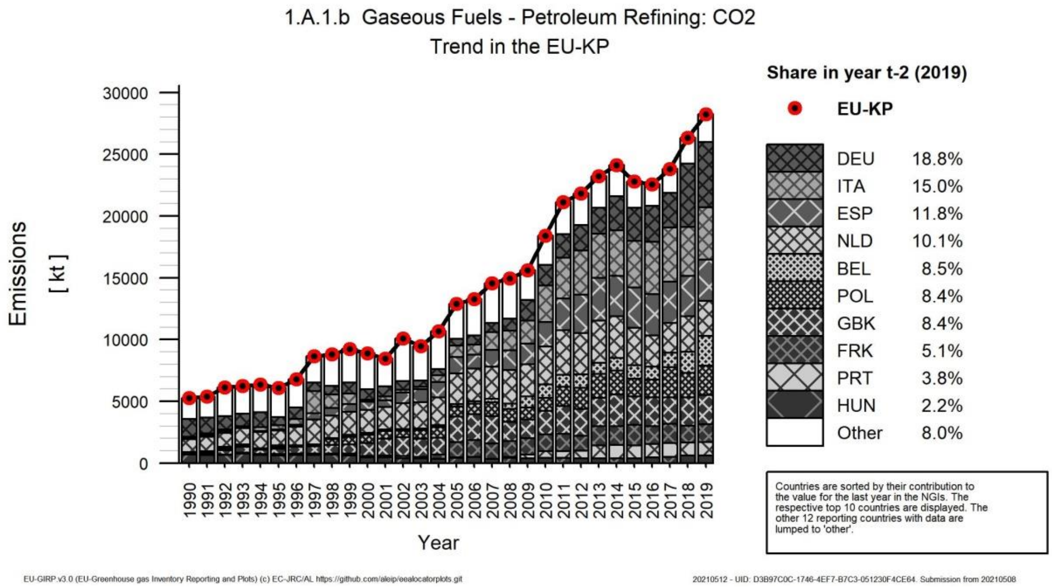
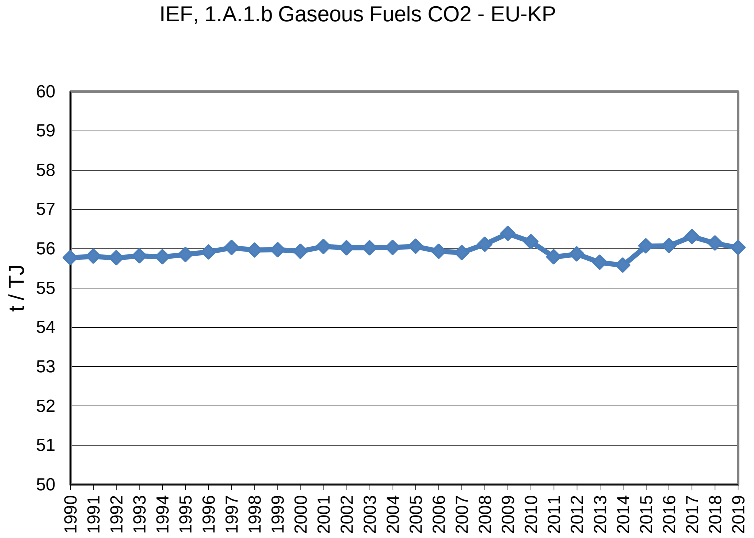
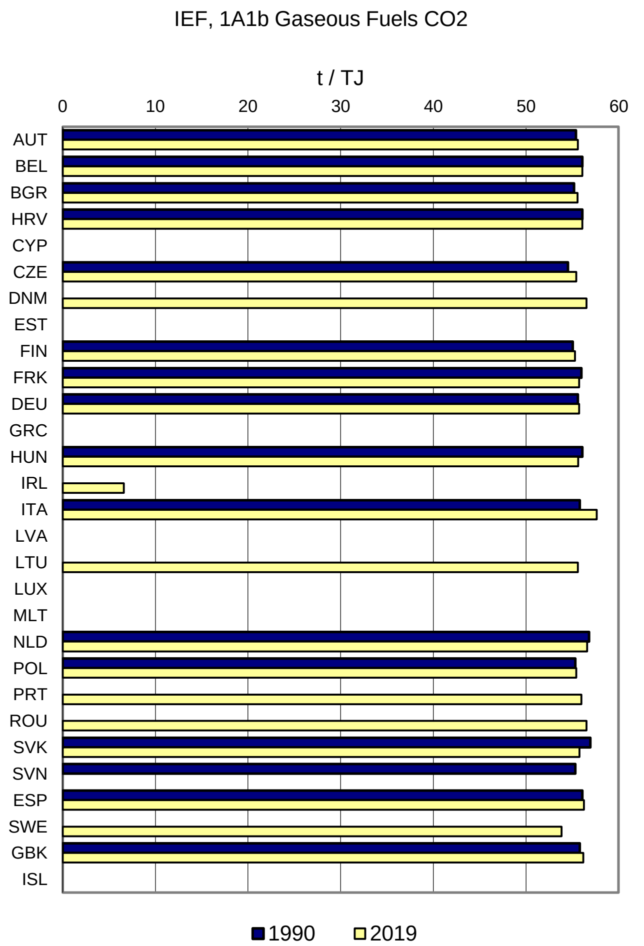


Figure 3.23 (on the next page) shows the implied emission factors for CO_2 emissions from gaseous fuels. The EU--KP implied emission factor has remained broadly stable around 56 t/TJ on the entire time-series. The very low IEF from Ireland is due to inconsistencies between CO_2 emissions originating from ETS data and activity data derived from the energy balance which aggregates different types of gases. This impacts only the IEF as total fuel reported under ETS is very similar to total fuel reported in the energy balance.

Figure 3.23 1.A.1.b Petroleum Refining, Gaseous Fuels: Implied Emission Factors for CO_2





3.2.1.3 Manufacture of Solid Fuels and Other Energy Industries (1.A.1.c) (EU-KP)

According to the 2006 IPCC guidelines, the manufacture of solid fuels and other energy industries includes combustion emissions from fuel use during the manufacture of secondary and tertiary products from solid fuels including production of charcoal. It comprises combustion emissions from the production of coke, brown coal briquettes and patent fuel. It can also cover the emissions from own-energy use in coal mining and gas extraction. Emissions from own on-site fuel use should be included. In addition, this category includes emissions from fuel combustion in oil and natural gas production.

Total emissions from this category accounted for 1.3% of total EU--KP greenhouse gas emissions in 2019. Between 1990 and 2019, CO_2 emissions fell by 54% in the EU-KP (Table 3.16). The United Kingdom, Germany, Czechia and Italy together are responsible for 66.7% of the total EU--KP emissions in 2019. Germany is responsible for almost 92% of the whole decrease in this category between 1990 and 2019.

Table 3.16 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Countries' contributions to CO_2 emissions

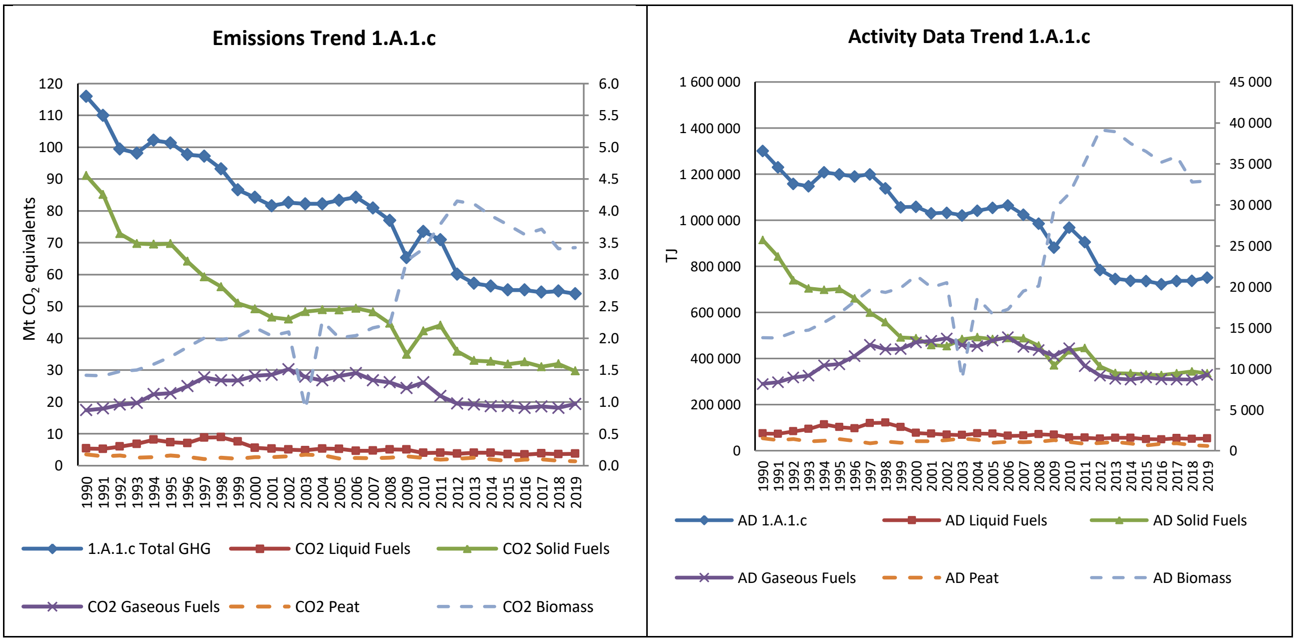
Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	510	240	312	0.6%	-198	-39%	73	30%	T2	CS
Belgium	2 024	152	150	0.3%	-1 874	-93%	-2	-1%	T3	PS
Bulgaria	362	6	4	0.0%	-359	-99%	-2	-38%	T2	CS
Croatia	912	205	245	0.5%	-667	-73%	39	19%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	T1	D
Czechia	1 516	5 827	5 438	10.3%	3 922	259%	-389	-7%	T1,T2	CS,D
Denmark	545	1 260	1 211	2.3%	666	122%	-48	-4%	T2,T3	CS,PS
Estonia	78	1 564	1 609	3.0%	1 531	1953%	46	3%	T3	PS
Finland	347	297	292	0.6%	-55	-16%	-5	-2%	T3	CS
France	4 738	2 920	2 853	5.4%	-1 886	-40%	-67	-2%	T2	CS
Germany	65 289	10 672	9 581	18.1%	-55 708	-85%	-1 091	-10%	CS	CS
Greece	102	45	43	0.1%	-59	-58%	-2	-4%	T2	PS
Hungary	570	422	401	0.8%	-169	-30%	-21	-5%	T1,T2	CS,D,PS
Ireland	100	119	108	0.2%	7	7%	-11	-10%	T3	CS
Italy	12 454	5 647	5 388	10.2%	-7 067	-57%	-259	-5%	T3	CS
Latvia	205	52	64	0.1%	-142	-69%	12	23%	T2	CS
Lithuania	9	54	49	0.1%	40	427%	-5	-10%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	2 110	3 004	2 467	4.7%	357	17%	-537	-18%	T2	CS,D
Poland	4 846	3 131	3 358	6.4%	-1 488	-31%	227	7%	T1,T2	CS,D
Portugal	141	NO	NO	-	-141	-100%	-	-	NA	NA
Romania	146	1 162	1 101	2.1%	954	653%	-61	-5%	T1,T2	CS,D
Slovakia	1 319	1 182	1 173	2.2%	-146	-11%	-9	-1%	T2	CS
Slovenia	82	0	0	0.0%	-82	-100%	0	113%	T2	CS
Spain	2 089	1 148	1 779	3.4%	-311	-15%	631	55%	T1,T2	CS,D,OTH,PS
Sweden	300	362	387	0.7%	87	29%	26	7%	T2	CS
United Kingdom	13 776	14 336	14 852	28.1%	1 076	8%	516	4%	T1,T2	CS,D
EU-27+UK	**114 573**	**53 804**	**52 865**	**100%**	**-61 709**	**-54%**	**-940**	**-2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	13 776	14 336	14 852	28.1%	1 076	8%	516	4%	T1,T2	CS,D
EU-KP	**114 573**	**53 804**	**52 865**	**100%**	**-61 709**	**-54%**	**-940**	**-2%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 3.24 shows the trends in emissions from this source category by fuel in the EU-KP between 1990 and 2019. The largest part of greenhouse gas emissions from the manufacture of solid fuels can be accounted to CO_2 emissions from solid (55%) and gaseous (36%) fuels. Emissions from solid fuels fell markedly during the 1990s and then stabilized for a few years. Since 2006 they began to decrease again. The strong drop in 2009 was due to the drop-in coke production associated with the iron and steel production triggered by the economic downturn.

Fuel used for manufacturing solid fuels fell by 42.2% in the EU-KP between 1990 and 2019. The strongest decline was reported for solid fuels (-63.3%), followed by liquid fuels (-29.3%). On the other hand, gaseous fuels and biomass increased in the period 1990 to 2019. Germany is responsible for the increase in energy consumption and emissions from biomass mainly driven by biogas used in gasification plants. In the year 2019 solid fuels and gaseous fuels represented 44.6% and 43.9% respectively of all fuel used. Almost no other fossil fuels and peat are used in this category; together accounting for less than 0.1% of the total fuel used in 2019.

Figure 3.24 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Total and CO_2 emission and activity trends



Note: Data displayed as dashed line refers to the secondary axis.

1.A.1.c Manufacture of Solid Fuels and Other Energy Industries – Solid Fuels (CO_2)

CO_2 emissions from the combustion of solid fuels used for the manufacture of solid fuels accounted for 55% of total greenhouse gas emissions from 1.A.1.c in 2019. Emissions in the EU-KP declined by 67% since 1990. This was mainly driven by a strong decline in emissions in Germany (-52 183 kt CO_2), which amounts to about 84.9% of the total decline in this category.

Table 3.17 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Solid Fuels: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	IE	IE	IE	-	-	-	-	-	NA	NA
Belgium	2 017	152	150	0.5%	-1 867	-93%	-2	-1%	T3	PS
Bulgaria	274	1	1	0.0%	-273	-100%	0	-21%	T1,T2	CS,D
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 352	5 805	5 413	18.2%	4 062	301%	-392	-7%	T1, T2	D, CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	78	1 564	1 609	5.4%	1 531	1953%	46	3%	T3	PS
Finland	347	297	292	1.0%	-55	-16%	-5	-2%	T3	CS
France	4 054	2 920	2 853	9.6%	-1 201	-30%	-67	-2%	T2	CS
Germany	61 101	10 027	8 918	30.0%	-52 183	-85%	-1 109	-11%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	220	263	247	0.8%	27	12%	-16	-6%	T1, T2, T3	D, CS, PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	10 891	4 739	4 500	15.1%	-6 391	-59%	-239	-5%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	916	1 449	1 044	3.5%	128	14%	-405	-28%	T2	CS
Poland	4 009	2 191	2 191	7.4%	-1 818	-45%	1	0%	T1/T2	D/CS
Portugal	91	NO	NO	-	-91	-100%	-	-	T1	D
Romania	NO	0	0	0.0%	0	∞	0	-81%	T1,T2	CS,D
Slovakia	1 319	1 144	1 134	3.8%	-185	-14%	-10	-1%	T2	CS
Slovenia	37	NO	NO	-	-37	-100%	-	-	NA	NA
Spain	1 809	243	220	0.7%	-1 589	-88%	-23	-9%	T1/T2	D/CS/PS
Sweden	300	362	387	1.3%	87	29%	26	7%	T2	CS
United Kingdom	2 339	800	752	2.5%	-1 586	-68%	-48	-6%	T1, T2	CS, D
EU-27+UK	**91 155**	**31 958**	**29 713**	**100%**	**-61 441**	**-67%**	**-2 244**	**-7%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 339	800	752	2.5%	-1 586	-68%	-48	-6%	T1, T2	CS, D
EU-KP	**91 155**	**31 958**	**29 713**	**100%**	**-61 441**	**-67%**	**-2 244**	**-7%**		

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Note: Austria includes the emissions from 1.A.1.c Solid fuels (occurring in coke ovens) in 1.A.2.a Iron and Steel Industries.

Table 3.17 also shows that than 97 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Solid fuels have fallen steadily to one third of the 1990 levels. The decline in emissions (see Figure 3.25 below) in Germany is mainly due to a large decline in lignite production in the 1990s. Lignite use decreased strongly in the new German Länder from usage levels of the industry of the former GDR. From raw lignite, a range of refined products used to be produced for industry, households and small commercial operations. A comprehensive transition from lignite to other fuels then took place until the end of the 1990s. The three largest emitters in 2019 were Germany, Czechia and Italy, jointly responsible for 63.3% of all EU-KP emissions in this category.

Figure 3.25 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Solid Fuels: Emission trend and share for CO_2

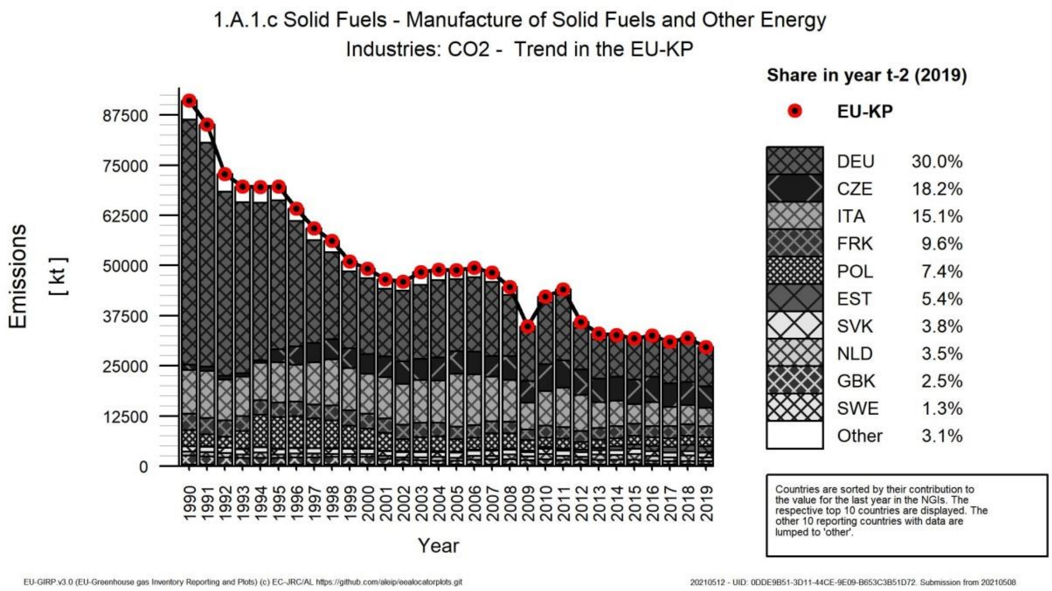
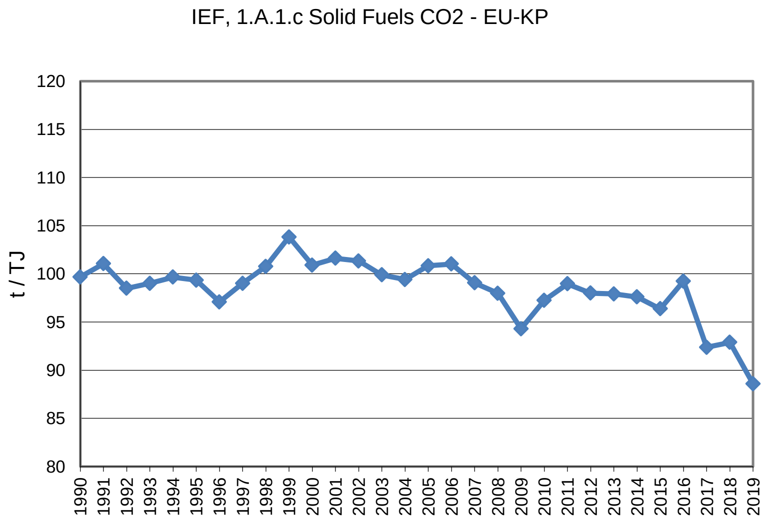
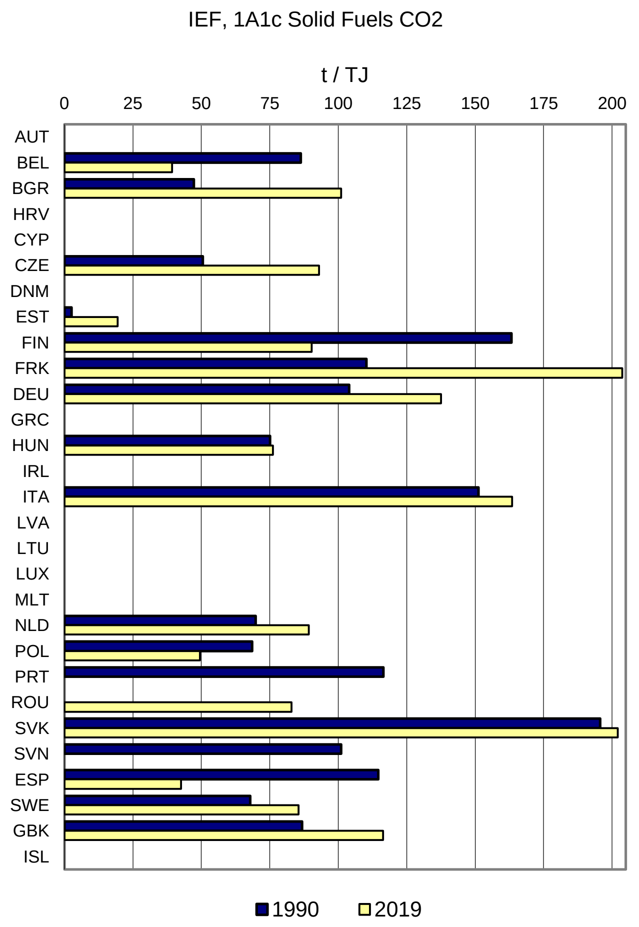


Figure 3.26 shows the relevant implied emission factors for solid fuels. The EU--KP implied emission factor amounted to 88.6 t/TJ in 2019: it is the lowest of the entire time-series. This drop can be partly explained by the decrease of 8% of IEF of Italy (third emitter with 15.1%) since 2016.

In general, the variation can be explained by the mix of different fuels and the shifts of their energy consumptions between years. The high implied emission factor for solid fuels in Slovakia and France can be explained with their use of blast furnace gas. Alike, the high implied emission factor for solid fuels in Italy is due to the large use of derived steel gases and in particular blast furnace gas to produce electricity in the iron and steel plant plants. Estonia has a low IEF, because the EF is calculated by using the carbon balance of the shale oil plant. The measured results are provided by the oil plants to the Estonian Ministry of Environment. To calculate the amount of carbon in flue gases into the atmosphere the carbon in the oil shale is subtracted from the carbon of shale oil, semi-coke gas, gasoil and black ash.

Figure 3.26 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Solid Fuels: Implied Emission Factors for CO_2





1.A.1.c Manufacture of Solid Fuels and Other Energy Industries – Gaseous Fuels (CO_2)

CO_2 emissions from the combustion of gaseous fuels used in category 1.A.1.c accounted for 35.8% of total greenhouse gas emissions from this category in 2019. Emissions in the EU-KP increased by 11% (Table 3.18 below) between the years 1990 and 2019. After a strong increase in the 1990s and stabilisation in the 2000s there has been a significant reduction in the last few years. The United Kingdom is the largest emitter in this category and is responsible for 59.2% of emissions in 2019 in the EU-KP. The top three countries (the United Kingdom, Spain and the Netherlands) together account for 74.4% of emissions in this category.

Table 3.18 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Gaseous Fuels: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	506	240	312	1.6%	-194	-38%	73	30%	T2	CS
Belgium	3	NO	NO	-	-3	-100%	-	-	NA	NA
Bulgaria	NO	1	1	0.0%	1	∞	0	34%	T1,T2	CS,D
Croatia	875	205	245	1.3%	-630	-72%	39	19%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	3	6	0.0%	6	∞	2	65%	T1, T2	D, CS
Denmark	545	1 260	1 211	6.3%	666	122%	-48	-4%	T3	CS,PS
Estonia	IE	IE	IE	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	531	NO	NO	-	-531	-100%	-	-	T2	CS
Germany	2 622	637	654	3.4%	-1 968	-75%	17	3%	CS	CS
Greece	102	45	43	0.2%	-59	-58%	-2	-4%	T2	PS
Hungary	311	157	153	0.8%	-158	-51%	-4	-3%	T1, T3	D, PS
Ireland	IE	41	44	0.2%	44	∞	3	8%	T3	CS
Italy	621	908	887	4.6%	267	43%	-21	-2%	T3	CS
Latvia	105	29	32	0.2%	-73	-70%	3	10%	T1, T2	CS, D
Lithuania	NO	41	37	0.2%	37	∞	-4	-9%	T1, T2	CS, D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 184	1 555	1 423	7.4%	239	20%	-132	-8%	T2	CS
Poland	684	832	1 030	5.3%	346	51%	198	24%	T2	CS
Portugal	NO	NO	NO	-	-	-	-	-	T1	D
Romania	NO	457	252	1.3%	252	∞	-206	-45%	T1,T2	CS,D
Slovakia	NO	38	40	0.2%	40	∞	2	4%	T2	CS
Slovenia	42	0	0	0.0%	-42	-100%	0	113%	T2	CS
Spain	89	859	1 516	7.8%	1 427	1601%	657	76%	T2	CS
Sweden	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
United Kingdom	9 206	10 851	11 455	59.2%	2 249	24%	604	6%	T1, T2	CS, D
EU-27+UK	**17 424**	**18 159**	**19 341**	**100%**	**1 917**	**11%**	**1 183**	**7%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	9 206	10 851	11 455	59.2%	2 249	24%	604	6%	T1, T2	CS, D
EU-KP	**17 424**	**18 159**	**19 341**	**100%**	**1 917**	**11%**	**1 183**	**7%**		

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Note: Estonia includes the emissions from 1.A.1.c in 1A1a.
Sweden includes emissions from 1.A.1.c in 1.A.2.g

Table 3.18 also shows that about 94 % of EU--KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.27 illustrates the emission trend for gaseous fuels split by countries over the last 29 years. Although the emissions in the year 2019 compared to 1990 increased by 11% over the whole time series, there was a strong increase in the 1990s and a decline after 2009. The increase in EU-KP emissions between 1990 and 2002 and the decline in recent years were heavily influenced by the trend in the United Kingdom, which is responsible for 59.2% of the total EU-KP emissions in this category in 2019. Between 2000 and 2019, natural gas production was reduced by 65% in GBK.

Figure 3.27 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Gaseous Fuels: Emission trend and share for CO_2

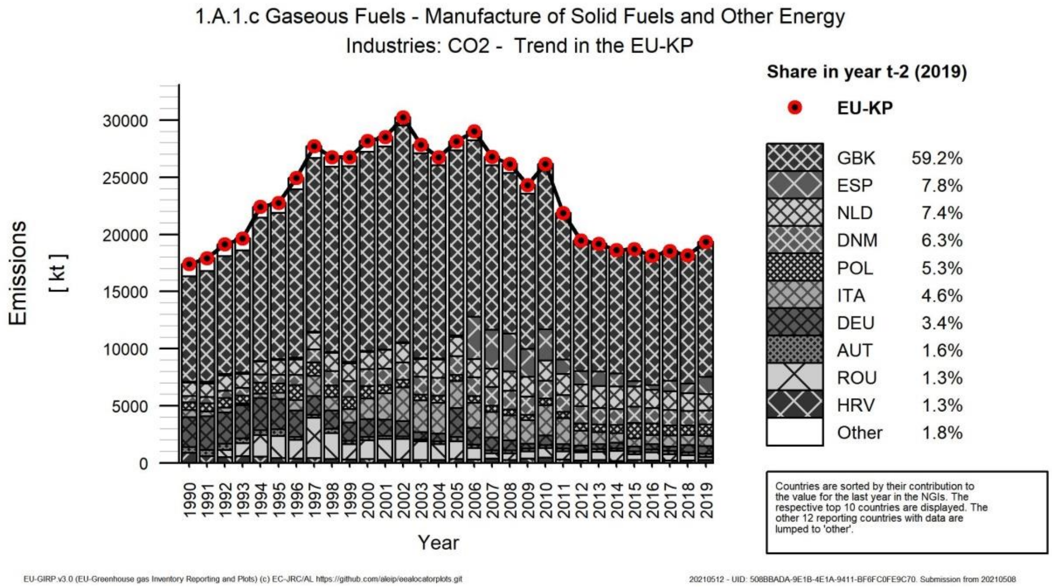
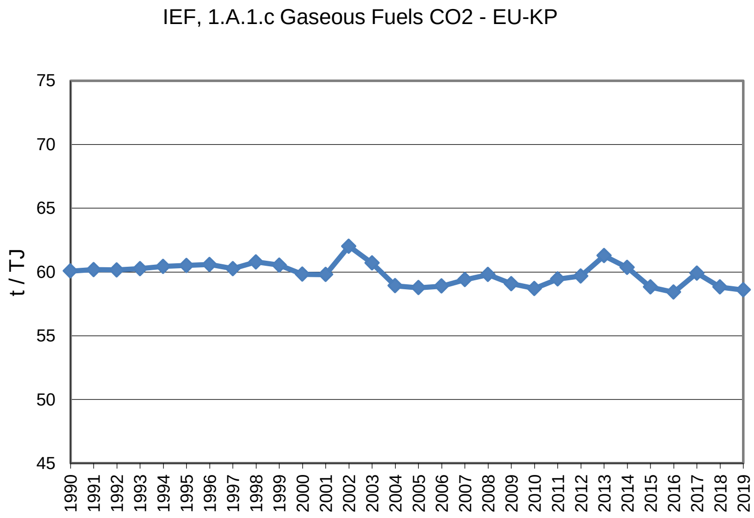
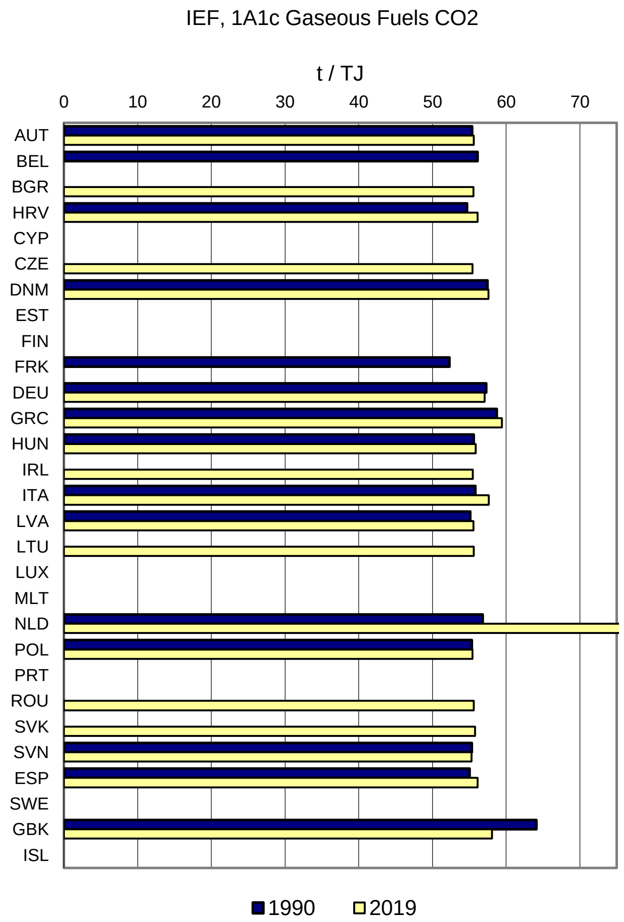


Figure 3.28 (on the next page) shows the implied emission factors for gaseous fuels. The EU-KP implied emission factor amounts 58.6 t/TJ in 2019 and remained fairly stable around 60 t/TJ over the last 29 years. The IPCC default values range between 54.3 t/TJ (lower) and 58.3 t/TJ (upper). The EU-KP IEF is dominated by the IEF of the United Kingdom and the Netherlands, which are comparatively high. In the United Kingdom emissions of gaseous fuels within this sector include colliery methane combustion and natural gas combustion, including offshore own gas use. The carbon emission factor for offshore own gas use is higher than the emission factor for other natural gas combustion. This higher emission factor is to be expected, as the unrefined gaseous fuels used in the upstream oil and gas sector will contain heavier hydrocarbons (which are removed in gas treatment prior to injection into natural gas supply infrastructure at onshore terminals). This source is responsible for the majority of the emissions within this sector in the United Kingdom and is therefore the main driver in the trend in the implied emission factor. The emission factor for this source is based on data supplied by the offshore operators. It decreases across the time series but remains higher than natural gas IEF in other sectors. The IEF of the Netherlands is comparatively high. The inter-annual variability in the EFs for CO_2 and CH_4 emissions from gas combustion is mainly due to a change in the statistics to estimate Activity Data which are not consistent with emissions reported in the AERs of individual companies. This leads to high IEF but it does not influence total emissions: this issue is under investigation.

Figure 3.28 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Gaseous Fuels: Implied Emission Factors for CO_2





3.2.2 Manufacturing industries and construction (CRF Source Category 1.A.2.)

Category 1A2. includes emissions from combustion of fuels in manufacturing industries and construction including fuel use of non-public electricity and heat generation (auto producers). According to the guidelines, emissions from fuel combustion in coke oven plants are reported under 1.A.1.c. Austria reports emissions from onsite coke ovens of integrated iron and steel plants under category 1.A.2.a. Some MS report emissions of blast furnace and coke oven gas combustion under categories 1.A.1.a public electricity and heat production or 1.A.4 other sectors and some MS are reporting emissions from refinery gas under 1.A.2. Emissions from category 1.A.2 are specified by the sum of subsectors that correspond to the International Standard Industrial Classification of All Economic Activities (ISIC, see listing below). Emissions from transport used by industry are reported under category 1.A.3 Transport. Most countries report emissions arising from off-road and other mobile machinery used in industry (e.g. construction machinery) under category 1.A.2.g. Emissions from non-energy fuel use (e.g. reducing agents used in blast furnaces or natural gas used for ammonia production) should be reported under category 2 Industrial Processes.

The following enumeration shows the correspondence of 1A2 subcategories and ISIC Rev 3.1 codes:

- 1 A 2 a Iron and Steel: ISIC Group 271 and Class 2731.
- 1 A 2 b Non-Ferrous Metals: ISIC Group 272 and Class 2732.
- 1 A 2 c Chemicals: ISIC Division 24.
- 1 A 2 d Pulp, Paper and Print: ISIC Divisions 21 and 22
- 1 A 2 e Food Processing, Beverages and Tobacco: ISIC Divisions 15 and 16.
- 1 A 2 f Non-metallic Minerals: ISIC Division 26
- 1 A 2 g Other manufacturing industries: ISIC Divisions 17 to 20, 25, 28 to 37 and 45.

The following table shows the share of specific tier methods used for each 1.A.2 category emission estimates. It can be seen that most countries use Tier 2 methodology for emission estimates.

Table 3.19: Share of Tier methods for 1.A.2 by type of reported method and method combinations.

Methods and method combinations	Share of emissions which are estimated by the specific Tier method'
CS	9.6%
T1	3.1%
T1,T2	8.5%
T1,T3	2.9%
T2	39.4%
T2,T3	6.8%
T3	1.3%
T1,T2,T3	13.2%
CS,T1	14.1%
CS,T1,T3	0.4%
Other combination	0.8%

Information about methodology used by countries for calculating emissions from category 1.A.2.g is not included in submission files for specific fuels but only as overall methodology information.

Table 3.20: Key categories for sector 1.A.2. (Table excerpt)

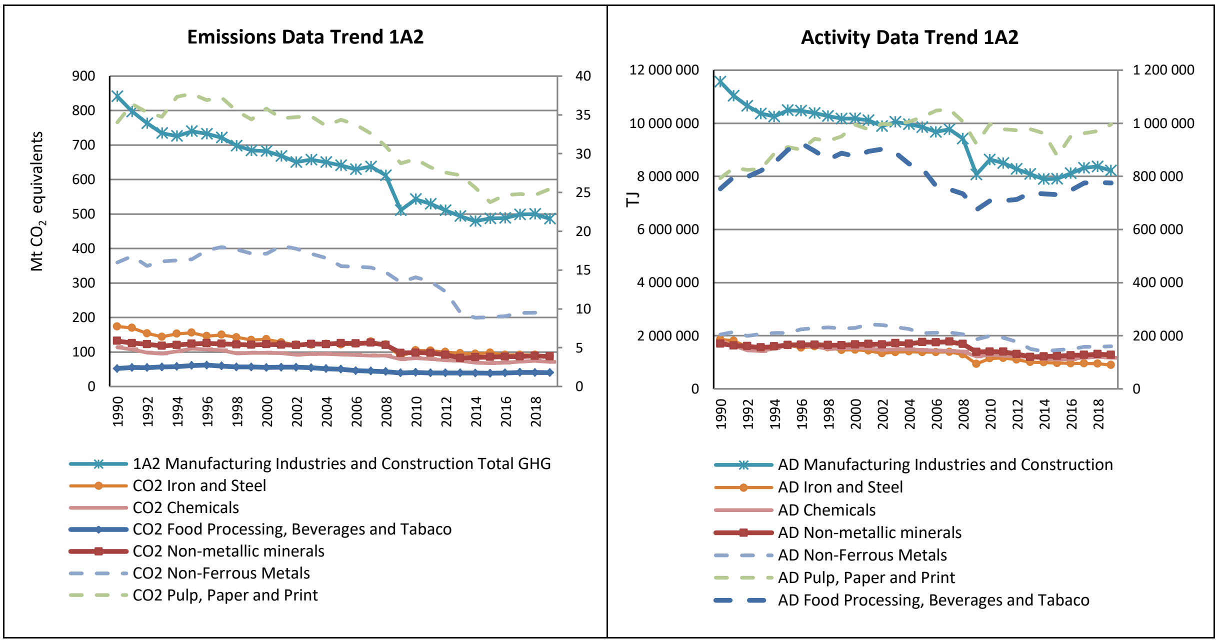
Source category gas	kt CO_2 equivalent		Trend	Level		Share of higher Tiers [%]
	1990	2019		1990	2019	
1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)	31 972	19 661	-	L	L	99.8
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	8 989	1 140	T	L	-	99.2
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	132 436	65 680	T	L	L	99.9
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	3 835	7 498	T	-	L	95.8
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	7 708	1 433	T	-	-	93.1
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	55 471	40 527	-	L	L	99.3
1.A.2.c Chemicals: Liquid Fuels (CO_2)	41 261	20 814	T	L	L	92.8
1.A.2.c Chemicals: Solid Fuels (CO_2)	13 900	8 136	-	L	L	99.9
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	13 249	19 914	T	L	L	92.1
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)	11 539	1 826	T	L	-	86.5
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)	8 052	2 402	T	-	-	96.3
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	19 437	32 551	T	L	L	97.6
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	20 340	3 138	T	L	-	58.4
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	12 237	4 293	T	L	-	96.0
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	27 929	31 971	T	L	L	98.7
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	45 758	22 382	T	L	L	96.0
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	1 422	15 501	T	-	L	69.8
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	56 871	16 312	T	L	L	99.1
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	93 029	89 376	T	L	L	98.7
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	123 698	52 028	T	L	L	98.7
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)	93 133	11 653	T	L	L	98.7

In 2019, category 1.A.2. contributed to 486 068 kt CO_2 equivalents of which 98.7% share belongs to CO_2 emissions, 0.8% to N_2O emissions and 0.5% to CH_4 emissions.

Figure 3.29 shows the emission trends within source category 1.A.2, which is dominated by CO_2 from category 1.A.2.g Other which contributes to total kt CO_2 equivalents emissions by 33% followed by 1.A.2.a Iron and steel contributing by 18%, 1.A.2.f Non-metallic Minerals contributing by 18%, 1.A.2.c Chemicals by 15%, 1.A.2.e Food processing, beverages and tobacco by 8%, 1.A.2.d Pulp, paper and print by 5% and 1.A.2.b Non-ferrous metals by 2%. Some Member States do not allocate emissions to all sub-categories under 1.A.2., which is one reason for 1.A.2.g being the largest sub-category within 1.A.2. source category.

Greece reports the rest of industrial sector emissions in category 1.A.2.f instead of category 1.A.2.g for whole time series. Germany reports some fuels of subcategories 1.A.2.a-1.A.2.e as included elsewhere (Notation key 'IE') and reports the specific emissions and activity data under 1.A.2.g. For the years 2013 to 2019 Sweden makes excessive use of confidential reporting (Notation key 'C'), which implies that sub-categories include emissions without providing detailed fuel specific emissions. However, all Swedish confidential emissions are included in the total emissions of 1.A.2. and have been included in 'other fossil fuels' of the EU inventory.

Figure 3.29: 1.A.2. Manufacturing Industries and Construction: Total and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Table 3.20 summarizes information by countries on GHG emissions and CO_2 emissions from 1.A.2 Manufacturing Industries and Construction in 1990 and 2019. The highest shares on total kt CO_2 equivalent emissions (above the average share calculated for EU-KP) are Germany (26%), United Kingdom (10%), Italy (10%), France (10%), Spain (10%), Poland (6%) and the Netherlands (6%). Together those countries contribute to 78% of total emissions from 1.A.2.

Table 3.21: 1.A.2. Manufacturing Industries and Construction: Member States, United Kingdom and Iceland contributions to total GHG and CO_2 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2019 (kt)
Austria	9 845	10 734	9 763	10 592
Belgium	23 222	13 523	23 075	13 386
Bulgaria	17 765	4 099	17 666	4 052
Croatia	5 235	2 432	5 209	2 421
Cyprus	515	566	512	559
Czechia	47 113	9 376	46 824	9 276
Denmark	5 428	3 738	5 362	3 658
Estonia	4 226	746	4 208	739
Finland	13 429	6 588	13 246	6 412
France	65 746	47 873	65 169	47 222
Germany	186 767	125 437	185 165	124 314
Greece	9 405	4 619	9 338	4 569
Hungary	13 551	5 161	13 515	5 116
Ireland	4 098	4 589	4 078	4 568
Italy	92 278	49 872	90 772	48 838
Latvia	3 971	676	3 910	626
Lithuania	6 165	1 302	6 108	1 283
Luxembourg	6 266	1 177	6 250	1 166
Malta	53	46	53	46
Netherlands	34 547	26 898	34 444	26 793
Poland	42 836	31 377	42 621	31 058
Portugal	9 011	7 848	8 853	7 684
Romania	68 243	14 550	68 084	14 480
Slovakia	16 097	6 329	16 027	6 279
Slovenia	3 088	1 728	3 057	1 704
Spain	45 286	47 162	44 933	45 984
Sweden	10 772	7 012	10 611	6 841
United Kingdom	95 619	50 378	95 187	49 992
EU-27+ISL	**840 575**	**485 836**	**834 042**	**479 655**
Iceland	373	91	358	84
United Kingdom (KP)	95 713	50 518	95 281	50 132
EU-KP	**841 042**	**486 068**	**834 494**	**479 879**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The difference between EU-27+UK and EU-KP is not only Iceland but also the different geographical coverage of the UK included in the EU-27+UK submission (GBE). The EU-27+UK numbers are the numbers submitted under the UNFCCC and include the EU territory for the UK. The EU-KP numbers are the numbers submitted under the Kyoto Protocol and include the Kyoto Protocol territory of the UK (GBK).

1.A.2. Manufacturing Industries and Construction is the fourth largest sector in the EU-KP accounting for 15% of total GHG emissions from Energy sector in 2019. Between 1990 and 2019, CO_2 emissions from 1.A.2. Manufacturing Industries and Construction declined by 43%. Decrease of total emissions is caused by decrease of fossil fuel consumption in category 1.A.2. Manufacturing Industries and Construction.

A shift from solid and liquid fuels to mainly natural gas took place and an increase of biomass CO_2 emissions by 120% and an increase of other fossil fuels CO_2 emissions by 183% have been recorded in 2019 compared to 1990.

Between 1990 and 2019, CO_2 emissions were significantly reduced by Latvia (84%), Estonia (82%), Luxembourg (81%), Czechia (80%), Lithuania (79%), Romania (79%) and Bulgaria (77%) compared to the level of CO_2 emissions in 1990. Only Austria, Cyprus, Ireland and Spain report emission increases.

The main reason for the decline of emissions in Latvia for 1990 to 2001 could be explained with recession of Soviet Union and following reformations and reorganizations within Latvia after that. Decrease of emissions in 2006 to 2008 were influenced by the features of national economy development when in-country industrial production already started to diminish due to increasing costs of the production and dominance of imported products. Crisis in national economy in the second part of 2008 also caused a significant decrease in total emissions. The main reasons for the large decline in Czechia were the loss of markets and the energy saving behavior of newly privatized enterprises, following the political changes in the country in the early 1990s. Main reasons of the decline in Romania were the transition to a market economy and the reduction of energy intensive activities. The main reason for the decline of emissions in Germany (33%) was the restructuring of the industry and efficiency improvements after German reunification.

Table 3.22 provides information on countries recalculations in CO_2 from 1.A.2. Manufacturing Industries for 1990 and 2018 and explanations for the recalculations in absolute terms. The largest recalculations in 1990 were reported by France. The largest recalculations in 2018 were reported by the France, Germany and United Kingdom. The reasons for year 2018 revisions are mostly changes in activity data/revised energy balances.

Table 3.22: 1.A.2. Manufacturing Industries and Construction: Recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 and percent)

	1990		2018		Main Explanations
	kt CO_2	%	kt CO_2	%	
Austria	1.3	0.0	-118	-1.1	Revision of energy balance (mainly -186 kt from gaseous fuels). Also: 76 kt CO_2 have ben reallocated from category 2.C.1
Belgium	1.4	0.0	-57	-0.4	All regions: revision of emissions of offroad in construction sector and update regional energy balances: Flemish region: -29.9 kt CO_2eq, Walloon region: -1.75 kt and Brussels region (-24.88 kt CO_2)
Bulgaria	-	-	6.8	0.2	Recalculation based on QA/QC
Croatia	-293	-5.3	-	-	Reallocation of emissions; industrial cogeneration plants in rafineries are not included in 1.A.2 any more (now part of 1.A.1.b category)
Cyprus	0.0	0.0	-0.9	-0.2	Recalculations have been carried out for 2011-2018 for the waste (non-renewable) emissions for 1A2f Non-metallic Minerals after the TERT recommendation and for the biomass consumption for the same subcategory, as well as inclusion of municipal waste emissions (biomass fraction) after recommendation FCCC/ARR/2020/CYP (E.20).
Czechia	-	-	-31	-0.3	Updated activity data in CzSO balance
Denmark	-	-	6.9	0.2	The allocation to industrial subsector has been revised for several plants. A number of plants have been reallocated from 1A2g Other manufacturing industries to 1A2f Non-metallic minerals. In addition, an updated disaggregation to industrial subsectors have been implemented for 2018. In the data reported last year, the disaggregation of the 2018 fuel consumption data were based on fuel consumption data in the industry in 2017.
Estonia	1 710	68	83	12	Emissions were recalculated due to using Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, instead of national energy balance

	1990		2018		Main Explanations
	kt CO_2	%	kt CO_2	%	
Finland	-	-	-45	-0.7	Updated data for construction machinery; minor updates of fuel data in many sectors
France	-12 913	-17	-1 658	-3.3	Increase in consumption linked to autoproduction for all fuels and change in the distribution of CMS between the various sectors following a change in methodology on 1A2a (allocation of consumption to the steel sector 2C1)
Germany	57	0.0	-3 671	-2.8	Updated activity data according to final energy balance
Greece	-	-	-	-	
Hungary	-72	-0.5	-128	-2.4	Changes due to the use of industry analysis project data
Ireland	136	3.4	-53	-1.1	Latest energy statistics, reallocation of autoproducer plants, removal of some double-counts
Italy	1 075	1.2	334	0.6	Update of glass and paper activity data
Latvia	7.7	0.2	-5.3	-0.8	Recalculated emissions from Coal after CO_2 emission factor correction
Lithuania	-	-	-	-	
Luxembourg	0	0.0	-1.9	-0.2	Revision of AD: energy balance revised
Malta	-	-	6.0	14	Recalculations were performed due to an update of activity data for Fuel Oil and Gas/Diesel Oil for year 2013 till 2018.
Netherlands	-1.5	-0.0	-98	-0.4	Final energy statistics and improved allocation biogenic part of natural gas
Poland	-	-	-20	-0.1	Update of the activity data according to Eurostat database
Portugal	65	0.7	81	1.1	1A2 - Update of the rate of incorporation of biofuels into liquid fuels 1A2c - Allocation of emissions from category 1B2c to 1A2c 1A2f - Update on energy consumption data
Romania	18 946	39	3 570	30	The recalculations were performed due to the activity data changes in this category
Slovakia	-	-	0.0	0.0	An issue with incorrect CH_4 and N_2O emission factor was identified in solid fuels in CRF category 1.A.2.b for year 2018. This issue was resolved in current submission
Slovenia	-62	-2.0	-51	-2.8	AD have been compared and harmonized as much as possible with the improved energy balance reported by SORS
Spain	15	0.0	2.4	0.0	Updated activity data
Sweden	-128	-1.2	63	0.9	Revision of AD and EF for one facility, Revision of AD from the Energy Balances 2013-2018 for biomass and solid fuels
United Kingdom	-61	-0.1	1 061	2.1	Revisions to UK energy statistics for natural gas use in autogeneration, for burning oil use in industrial sources, and a revision to the estimates of gas oil use in Industrial off-road mobile machinery
EU27+UK	8 486	1.0	-722	-0.1	
Iceland	-3.2	-0.9	0.1	0.1	For 1990-2002 some fuels were moved from 1A2gvii to 1A5 because of lack of reference of where these fuels were used.
United Kingdom (KP)	-76	-0.1	1 052	2.1	
EU-KP	8 468	1.0	-731	-0.1	

3.2.2.1 Iron and Steel (1.A.2.a)

This chapter provides information about European emission trend, Member States, United Kingdom and Iceland contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.a Iron and Steel.

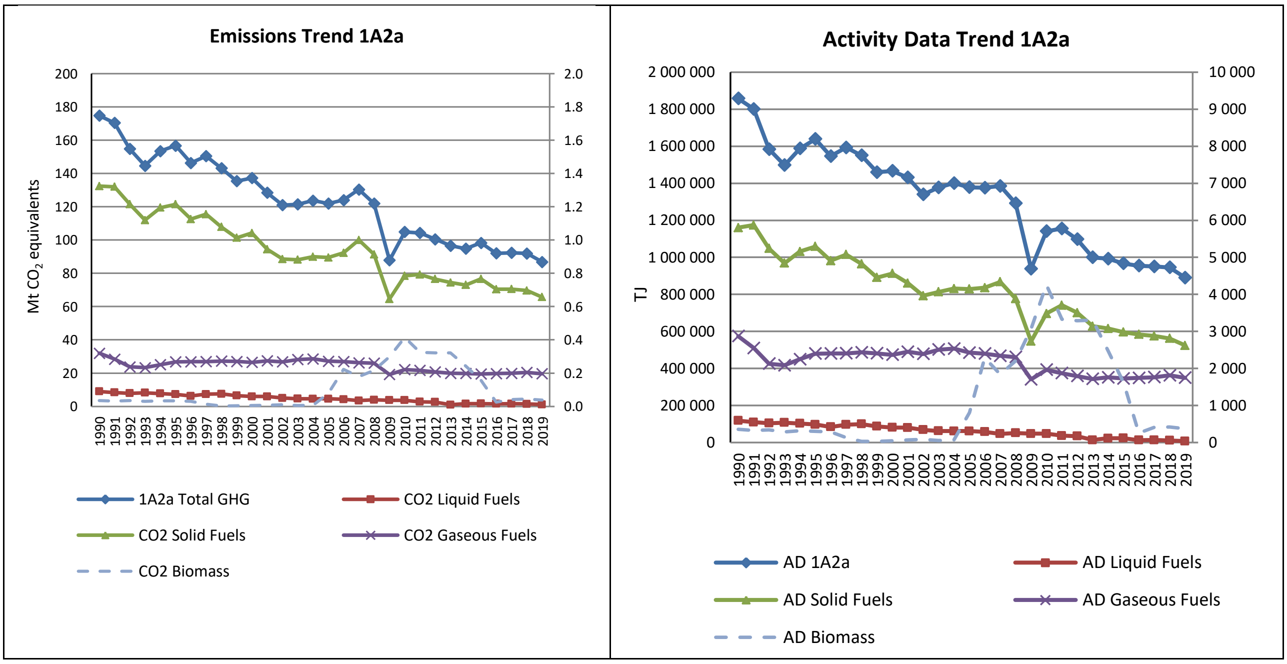
Category 1.A.2.a (more specifically CO_2 emissions from use of gaseous, liquid and solid fuels) was identified as a key category by level and trend and thus the following description focuses only on CO_2 emissions. CO_2 emissions trend and activity data trends can be observed in *Figure 3.30*. Detailed data related to countries CO_2 emissions and percentage differences is depicted in Table 3.23. CO_2 emissions have almost 100% share on total emissions from 1.A.2.a. The strong increase of emissions (17%) observed between 2009 and 2010 correlates with crude steel production which was higher by 24% in 2010. Between 1990 and 2019 CO_2 emissions decreased by 50%. Between 2018 and 2019 CO_2 emissions decreased by 5%.

Total CO_2 emissions from 1.A.2.a amounted to 86 501 kt CO_2 eq. in 2019. The trend of total CO_2 emissions for 1990 to 2019 from category 1.A.2.a is depicted in *Figure 3.30*. Total CO_2 emissions decreased by 50% since 1990, mainly due to improved efficiency of restructured iron and steel plants and ongoing consequences of the economic crisis in 2009. Total CO_2 emissions decreased by 5% between 2018 and 2019. CO_2 emissions from 1.A.2.a Iron and Steel accounted for 18% of 1.A.2. source category. The share of liquid fuels on CO_2 emissions from 1.A.2.a decreased from 5% in 1990 to 1% in 2019. The share of solid fuels on CO_2 emissions from 1.A.2.a was 76% in 1990 as well as in 2019. The share of gaseous fuels on CO_2 emissions from 1.A.2.a increased from 18% in 1990 to 23% in 2019.

Almost all countries reported lower level of CO_2 emissions in 2019 compared to 1990 except of Germany and Iceland. Highest shares on total EU-KP emissions concern Germany (41%) followed by Italy (11%) and France (6%). Most rapid decrease of emissions compared to 1990 can be observed for Latvia (100%), Ireland (99%), Croatia (96%), Bulgaria (96%), Luxembourg (95%) Hungary (92%) and Czechia (91%). Emissions are reported as 'NO' (not occurring) for Latvia, Lithuania and Malta. Cyprus reports emissions as 'NO, IE' (not occurring, included elsewhere).

A main driver of category 1.A.2.a CO_2 emissions is crude steel production which decreased from about 192 million tonnes in 1990 to 157 million tonnes in 2019 (www.worldsteel.org (Steel Statistical Yearbook)) as well as blast furnace iron production (BFI), which decreased from about 126 million tonnes to 86 million tonnes in 2019 (www.worldsteel.org).

Figure 3.30: 1.A.2.a Iron and Steel: CO_2 emissions and activity data trends



Data displayed as dashed line refers to the secondary axis.

Table 3.23: 1.A.2.a Iron and Steel: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	2 063	1 783	1 859	2.1%	-204	-10%	76	4%	T1,T2	CS,D
Belgium	5 662	1 265	1 234	1.4%	-4 427	-78%	-31	-2%	T1,T3	D,PS
Bulgaria	2 705	130	121	0.1%	-2 584	-96%	-9	-7%	T2	CS
Croatia	1 062	54	41	0.0%	-1 021	-96%	-13	-24%	T1	D
Cyprus	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Czechia	14 861	1 992	1 405	1.6%	-13 455	-91%	-587	-29%	T1,T2	CS,D
Denmark	125	109	99	0.1%	-26	-21%	-10	-9%	T1,T2,T3	CS,D
Estonia	NO	1	1	0.0%	1	∞	0	31%	T2	CS
Finland	2 499	905	821	0.9%	-1 678	-67%	-84	-9%	T3	CS,PS
France	11 899	6 300	5 149	6.0%	-6 750	-57%	-1 150	-18%	T2,T3	CS,PS
Germany	35 269	37 167	35 730	41.3%	460	1%	-1 437	-4%	CS	CS
Greece	447	91	96	0.1%	-351	-79%	5	6%	T2	CS,PS
Hungary	2 329	207	194	0.2%	-2 135	-92%	-14	-7%	T1,T2	CS,D
Ireland	175	2	2	0.0%	-173	-99%	0	0%	T2	CS
Italy	25 255	10 166	9 820	11.4%	-15 435	-61%	-346	-3%	T2	CS
Latvia	389	0	NO	-	-389	-100%	0	-100%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	5 404	306	297	0.3%	-5 108	-95%	-10	-3%	T1,T2,T3	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	5 599	5 034	4 886	5.6%	-712	-13%	-147	-3%	T2	CS
Poland	16 247	5 452	4 545	5.3%	-11 703	-72%	-907	-17%	T1,T2	CS,D
Portugal	373	98	94	0.1%	-279	-75%	-4	-4%	T2	CR,D,PS
Romania	7 059	929	847	1.0%	-6 212	-88%	-83	-9%	T1,T2,T3	CS,D,PS
Slovakia	2 682	3 424	2 442	2.8%	-239	-9%	-982	-29%	T2	CS
Slovenia	421	209	215	0.2%	-206	-49%	5	3%	T1,T2	CS,D
Spain	8 341	5 660	5 637	6.5%	-2 704	-32%	-23	0%	T1,T2,T3	CS,D,OTH,PS
Sweden	1 705	1 342	1 569	1.8%	-136	-8%	227	17%	T2	CS
United Kingdom	21 478	8 896	9 397	10.9%	-12 081	-56%	501	6%	T2	CS
EU-27+UK	**174 049**	**91 522**	**86 500**	**100%**	**-87 550**	**-50%**	**-5 023**	**-5%**	**-**	**-**
Iceland	0	1	2	0.0%	1	396%	0	18%	T1	D
United Kingdom (KP)	21 478	8 896	9 397	10.9%	-12 081	-56%	501	6%	T2	CS
EU-KP	**174 050**	**91 524**	**86 501**	**100%**	**-87 548**	**-50%**	**-5 022**	**-5%**	**-**	**-**

Cyprus reports an 'IE' for liquid fuels (included in 1.A.2.b) and a 'NO' for all other fuels. Malta includes emissions under 1.A.2.g.

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1.A.2.a Iron and Steel - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.a amounted 1 140 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 87% and compared to 2018 by 21%. Category has 0.2% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 94% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.24. Czechia, Estonia, Hungary, Ireland, Latvia, Lithuania, Malta and Netherlands report emissions as 'NO' (not occurring). Cyprus reports emissions as 'IE' (included elsewhere), consumption of fuels and emissions are included in 1.A.2.b Non-ferrous metals category. Two Member States and Iceland use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.a – Liquid Fuels (CO_2)). All countries reported lower level of emissions in 2019 than in 1990 (except of Iceland, but it should be noted that the share of Iceland on total EU-KP emissions is only 0.2%).

Table 3.24: 1.A.2.a Iron and Steel, liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	76	6	4	0.3%	-73	-95%	-3	-42%	T2	CS
Belgium	885	15	14	1.2%	-871	-98%	-1	-8%	T1,T3	D,PS
Bulgaria	37	1	1	0.0%	-37	-98%	0	-14%	NA	NA
Croatia	208	7	4	0.3%	-204	-98%	-3	-44%	T1	D
Cyprus	IE	IE	IE	-	-	-	-	-	NA	NA
Czechia	427	NO	NO	-	-427	-100%	-	-	NA	NA
Denmark	14	3	3	0.2%	-11	-80%	0	-7%	T1,T2	CS,D
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	305	263	12	1.1%	-293	-96%	-250	-95%	T3	CS
France	1 388	212	203	17.8%	-1 184	-85%	-9	-4%	T2,T3	CS,PS
Germany	916	15	17	1.5%	-898	-98%	2	14%	CS	CS
Greece	447	30	30	2.6%	-417	-93%	0	0%	T2	PS
Hungary	392	NO	NO	-	-392	-100%	-	-	NA	NA
Ireland	16	NO	NO	-	-16	-100%	-	-	NA	NA
Italy	156	1	6	0.5%	-150	-96%	5	778%	T2	CS
Latvia	92	0	NO	-	-92	-100%	0	-100%	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	48	3	4	0.4%	-44	-92%	1	25%	T1,T3	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	19	NO	NO	-	-19	-100%	-	-	NA	NA
Poland	870	18	17	1.5%	-853	-98%	0	-2%	T1,T2	CS,D
Portugal	109	0	0	0.0%	-109	-100%	0	-41%	T2	CR,D,PS
Romania	NO	2	0	0.0%	0	∞	-2	-97%	T3	PS
Slovakia	164	1	2	0.1%	-163	-99%	0	23%	T2	CS
Slovenia	54	5	4	0.3%	-51	-93%	-1	-26%	T1	D
Spain	1 070	131	148	12.9%	-923	-86%	16	12%	T1,T2,T3	CS,D,PS
Sweden	831	662	610	53.5%	-221	-27%	-52	-8%	T2	CS
United Kingdom	462	63	60	5.2%	-402	-87%	-4	-6%	T2	CS
EU-27+UK	**8 989**	**1 439**	**1 138**	**100%**	**-7 851**	**-87%**	**-301**	**-21%**	**-**	**-**
Iceland	0	1	2	0.2%	1	396%	0	18%	T1	D
United Kingdom (KP)	462	63	60	5.2%	-402	-87%	-4	-6%	T2	CS
EU-KP	**8 989**	**1 440**	**1 140**	**100%**	**-7 849**	**-87%**	**-301**	**-21%**	**-**	**-**

Cyprus reports an 'IE' for liquid fuels (included in 1.A.2.b).
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.31 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Sweden (54%), France (18%), Spain (13%) and United Kingdom (5%), which together represent 89% share on EU-KP emissions.

Figure 3.31: 1.A.2.a Iron and Steel, Liquid fuels: Emission trend and share for CO_2

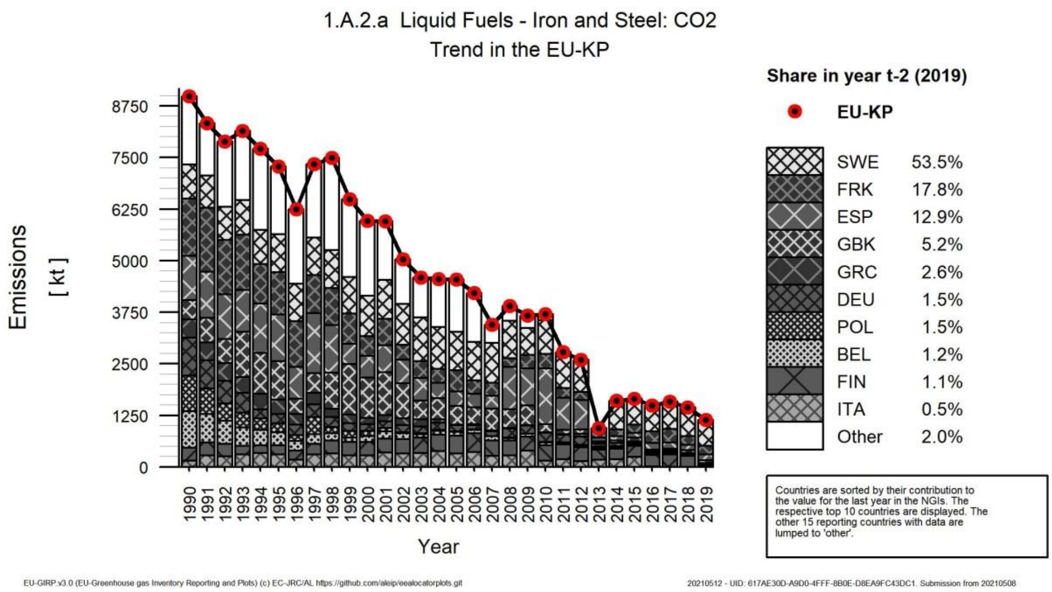
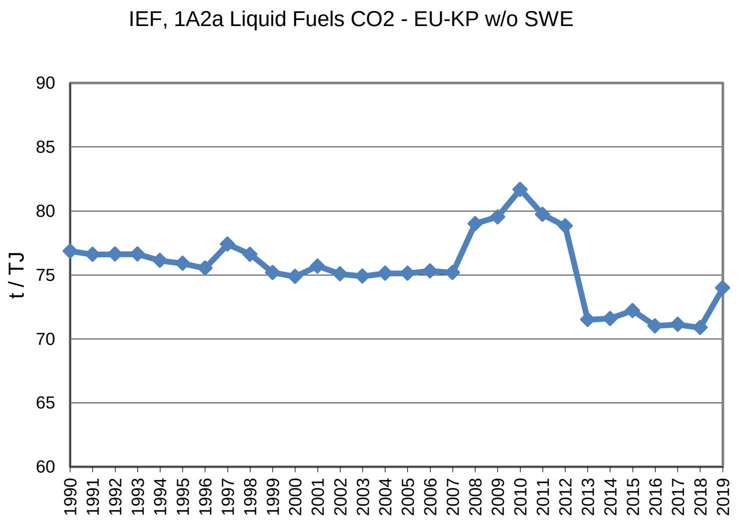


Figure 3.32 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. In the graph, data from Sweden aren't included due to reported confidential data. Nevertheless, Swedish emissions are included in the calculation of IEF in EU CRF. As Sweden does not report activity data in CRF since 2016, the EU IEF is much higher in the years 2016-2018 than in the years before in EU CRF.

The high CO_2 IEF reported for 2008–2012 is mainly due to the contribution of Spain's CO_2 emissions to the EU total (up to 5% between 2007 and 2008) and its high CO_2 IEF (ranging from 92.4 to 96.1 t/TJ) for those years. The EU CO_2 IEF equaled 73.98 t/TJ in 2019 excluding Sweden.

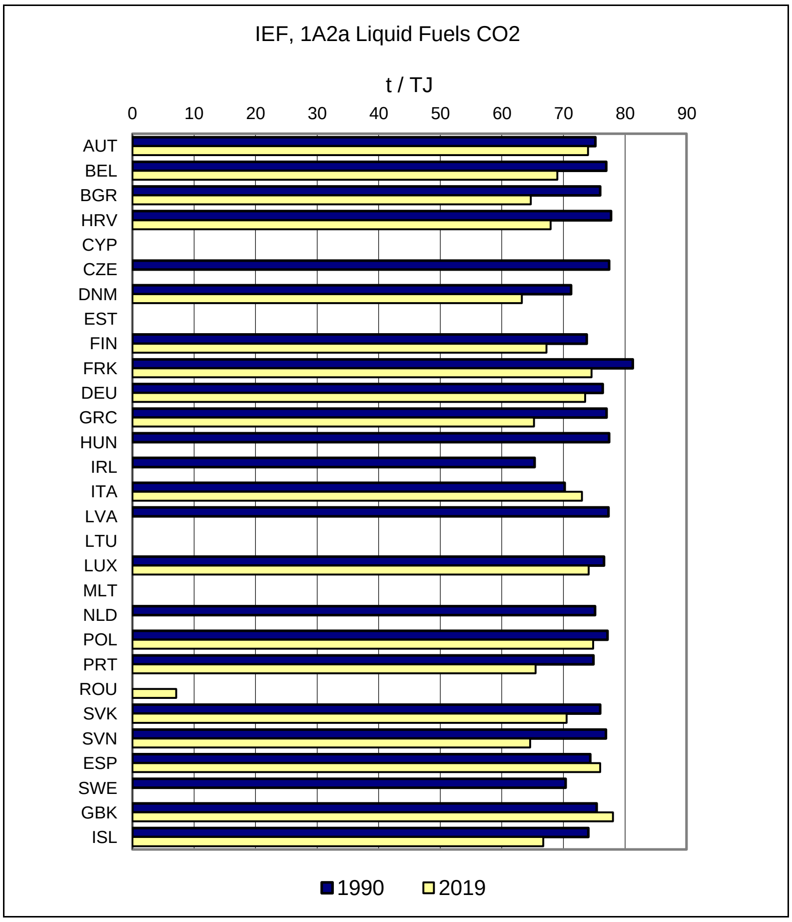
Figure 3.32: 1.A.2.a Iron and Steel, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



Note: The EU IEF for CO_2 emissions of category 1.A.2.a. liquid fuels displayed in this graph does not include data from SWE due to reported confidential data.

Figure 3.33 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. For year 2019, Sweden reports activity data as C ('confidential') and thus CO_2 IEF is not depicted in Figure 3.33.

Figure 3.33: 1.A.2.a Iron and Steel, Liquid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1.A.2.a Iron and Steel - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.a amounted 65 680 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 50% and decreased compared to 2018 by 6%. This category represents 14% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 55% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.25. Cyprus, Denmark, Estonia, Greece, Ireland, Latvia, Lithuania, Luxembourg, Malta, Portugal and Iceland report emissions as 'NO' (not occurring). Two Member States use for emission estimates Tier 1 methodology, the rest of the Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99.9% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.a – Solid Fuels (CO_2)). All Member States reported lower level of emissions in 2019 than in 1990 (except of Germany with a 50% share on total EU-KP emissions in 2019).

Table 3.25: 1.A.2.a Iron and Steel, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	1 337	599	722	1.1%	-615	-46%	123	21%	T2	CS
Belgium	3 284	17	18	0.0%	-3 266	-99%	1	8%	T3	PS
Bulgaria	1 631	0	0	0.0%	-1 631	-100%	0	-6%	NA	NA
Croatia	625	12	6	0.0%	-620	-99%	-7	-54%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	13 709	1 467	956	1.5%	-12 753	-93%	-511	-35%	T2	CS,D
Denmark	5	NO	NO	-	-5	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	2 084	488	481	0.7%	-1 603	-77%	-7	-1%	T3	CS,PS
France	7 718	2 923	1 822	2.8%	-5 896	-76%	-1 101	-38%	T2,T3	CS,PS
Germany	29 912	33 981	32 756	49.9%	2 844	10%	-1 225	-4%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	625	64	64	0.1%	-561	-90%	-1	-1%	T1,T2	CS,D
Ireland	115	NO	NO	-	-115	-100%	-	-	NA	NA
Italy	20 762	6 188	5 898	9.0%	-14 864	-72%	-290	-5%	T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	4 959	NO	NO	-	-4 959	-100%	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	4 913	4 405	4 235	6.4%	-678	-14%	-170	-4%	T2	CS
Poland	11 870	4 048	3 352	5.1%	-8 518	-72%	-696	-17%	T1,T2	CS,D
Portugal	264	NO	NO	-	-264	-100%	-	-	NA	NA
Romania	394	152	117	0.2%	-277	-70%	-36	-23%	T3	PS
Slovakia	2 296	3 236	2 280	3.5%	-17	-1%	-957	-30%	T2	CS
Slovenia	57	29	27	0.0%	-31	-53%	-2	-7%	T1	D
Spain	6 475	3 656	3 747	5.7%	-2 728	-42%	91	2%	T1,T2,T3	CS,PS
Sweden	849	528	795	1.2%	-54	-6%	267	51%	T2	CS
United Kingdom	18 553	7 858	8 405	12.8%	-10 148	-55%	547	7%	T2	CS
EU-27+UK	**132 436**	**69 652**	**65 680**	**100%**	**-66 756**	**-50%**	**-3 973**	**-6%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	18 553	7 858	8 405	12.8%	-10 148	-55%	547	7%	T2	CS
EU-KP	**132 436**	**69 652**	**65 680**	**100%**	**-66 756**	**-50%**	**-3 973**	**-6%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.34 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany (50%), United Kingdom (13%), Italy (9%), Netherlands (6%) and Spain(6%), which together represent 84% share on EU-KP emissions.

Figure 3.34: 1.A.2.a Iron and Steel, solid fuels: Emission trend and share for CO_2

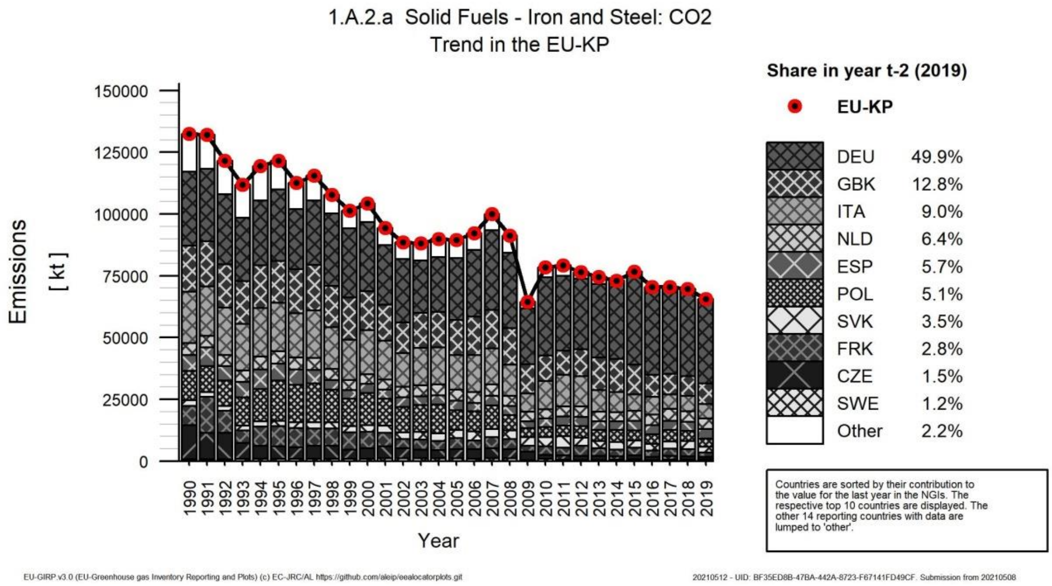


Figure 3.35 shows implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. It can be seen that CO_2 IEF fluctuate during the whole time series. Lowest CO_2 IEF was calculated for year 2011 and since that CO_2 IEF has increasing but still fluctuating trend. The main reason for the increase in the CO_2 IEF between 2012 and 2013 is Italy's decrease in CO_2 emissions. For these years, the share of Germany's CO_2 emissions in the EU total increased from 37% to 40%, and Germany's CO_2 IEF was one of the highest reported, increasing from 155.17 t/TJ in 2012 to 158.47 t/TJ in 2013. CO_2 IEF equalled to 125.34 t/TJ in 2019.

Figure 3.35: 1.A.2.a Iron and Steel, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

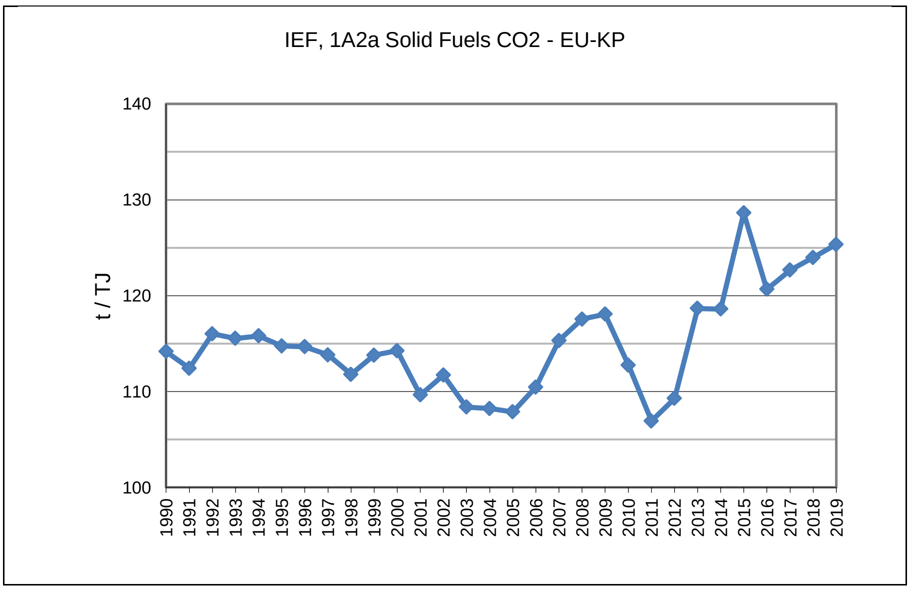
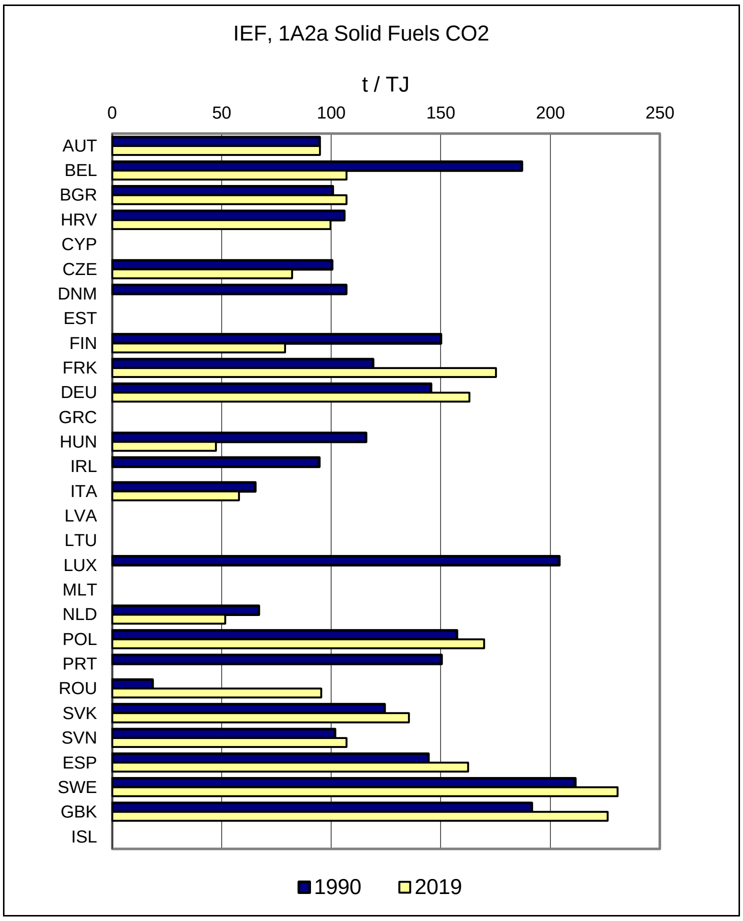


Figure 3.36 shows comparison of CO_2 IEF used by Member States, United Kingdom and Iceland for emission estimates in 1990 and 2019. The high variation of the CO_2 IEFs across MS is due to usage of

derived coal gases which have significant lower (coke oven gas) or higher carbon content (blast furnace gas) than coal.

Figure 3.36: 1.A.2.a Iron and Steel, Solid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1.A.2.a Iron and Steel - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.a amounted 19 661 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 39% and decreased compared to 2018 by 4%. This category represents 4% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 39% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.26. Cyprus, Latvia, Lithuania, Malta and Iceland report emissions as 'NO' (not occurring). Croatia uses for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99.8% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.a – Gaseous Fuels (CO_2)). Austria, Finland, France, Spain and Sweden report higher level of emissions in 2019 than in 1990. Highest increase of emissions (551%) is calculated for Sweden with a 0.8% share on total EU-KP emissions in 2019.

Table 3.26: 1.A.2.a Iron and Steel, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	650	1 178	1 134	5.8%	484	74%	-45	-4%	T2	CS
Belgium	1 493	1 228	1 197	6.1%	-296	-20%	-31	-3%	T1,T3	D,PS
Bulgaria	1 037	129	120	0.6%	-917	-88%	-9	-7%	T2	CS
Croatia	229	35	32	0.2%	-197	-86%	-3	-10%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	724	524	449	2.3%	-275	-38%	-75	-14%	T2	CS
Denmark	106	106	96	0.5%	-10	-9%	-10	-9%	T3	CS
Estonia	NO	1	1	0.0%	1	∞	0	31%	T2	CS
Finland	110	154	327	1.7%	217	198%	173	113%	T3	CS
France	2 786	3 149	3 112	15.8%	326	12%	-38	-1%	T2,T3	CS,PS
Germany	4 442	3 171	2 957	15.0%	-1 485	-33%	-214	-7%	CS	CS
Greece	NO	61	66	0.3%	66	∞	5	8%	T2	CS
Hungary	1 312	143	130	0.7%	-1 182	-90%	-13	-9%	T2	CS
Ireland	44	2	2	0.0%	-41	-95%	0	0%	T2	CS
Italy	4 338	3 977	3 916	19.9%	-422	-10%	-62	-2%	T2	CS
Latvia	236	0	NO	-	-236	-100%	0	-100%	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	397	303	292	1.5%	-104	-26%	-10	-3%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	667	629	651	3.3%	-16	-2%	23	4%	T2	CS
Poland	2 924	1 387	1 176	6.0%	-1 748	-60%	-211	-15%	T2	CS
Portugal	NO	98	94	0.5%	94	∞	-4	-4%	T2	CR,D,PS
Romania	6 665	771	726	3.7%	-5 939	-89%	-45	-6%	T3	PS
Slovakia	221	187	161	0.8%	-60	-27%	-25	-14%	T2	CS
Slovenia	310	175	184	0.9%	-125	-40%	9	5%	T2	CS
Spain	796	1 872	1 742	8.9%	946	119%	-130	-7%	T2,T3	CS,PS
Sweden	25	152	164	0.8%	139	551%	12	8%	T2	CS
United Kingdom	2 463	975	932	4.7%	-1 531	-62%	-43	-4%	T2	CS
EU-27+UK	**31 972**	**20 407**	**19 661**	**100%**	**-12 311**	**-39%**	**-746**	**-4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 463	975	932	4.7%	-1 531	-62%	-43	-4%	T2	CS
EU-KP	**31 972**	**20 407**	**19 661**	**100%**	**-12 311**	**-39%**	**-746**	**-4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.37 shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Italy (20%), France (16%), Germany (15%), Spain (9%), Belgium (6%), Poland (6%), Austria (6%) and United Kingdom (5%) which together represent 82% share on EU-KP emissions.

Figure 3.37: 1.A.2.a Iron and Steel, Gaseous fuels: Emission trend and share for CO_2

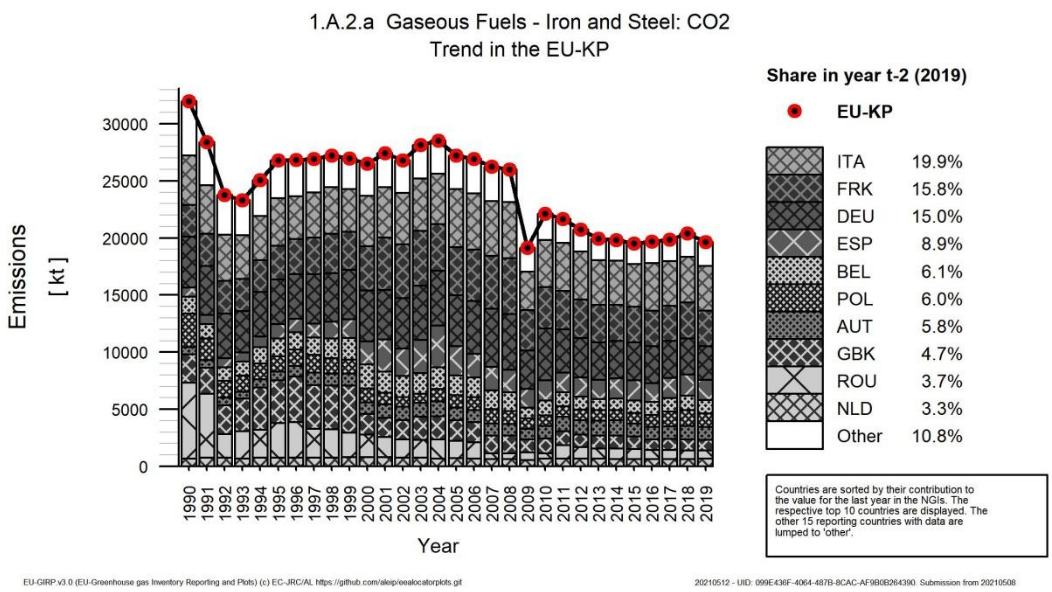


Figure 3.38 shows implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. It can be seen that the CO_2 IEF is fluctuating. The strong increase from 2011 to 2013 is caused by strong increase of Romania IEF in these years. Since 2016, CO_2 IEF has slightly decreasing trend. CO_2 IEF equaled to 56.28 t/TJ in 2019.

Figure 3.38: 1.A.2.a Iron and Steel, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

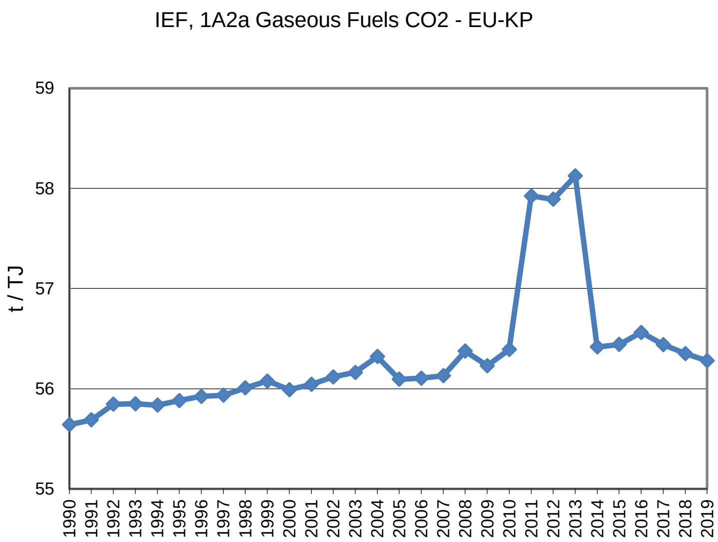
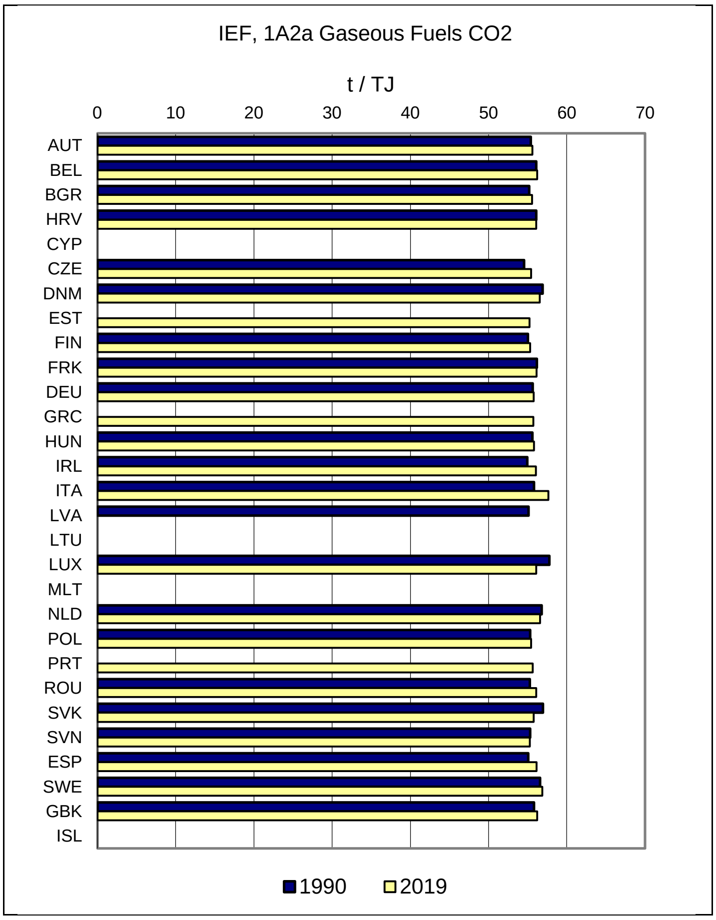


Figure *3.39* shows comparison of implied emission factors (CO_2 IEFs) used by countries for emission estimates in 1990 and 2019. No significant differences between CO_2 IEF used by EU-KP are not occurring as also no significant differences between CO_2 IEF used in 1990 and 2019 are occurring.

__Figure 3.39__: 1.A.2.a Iron and Steel, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



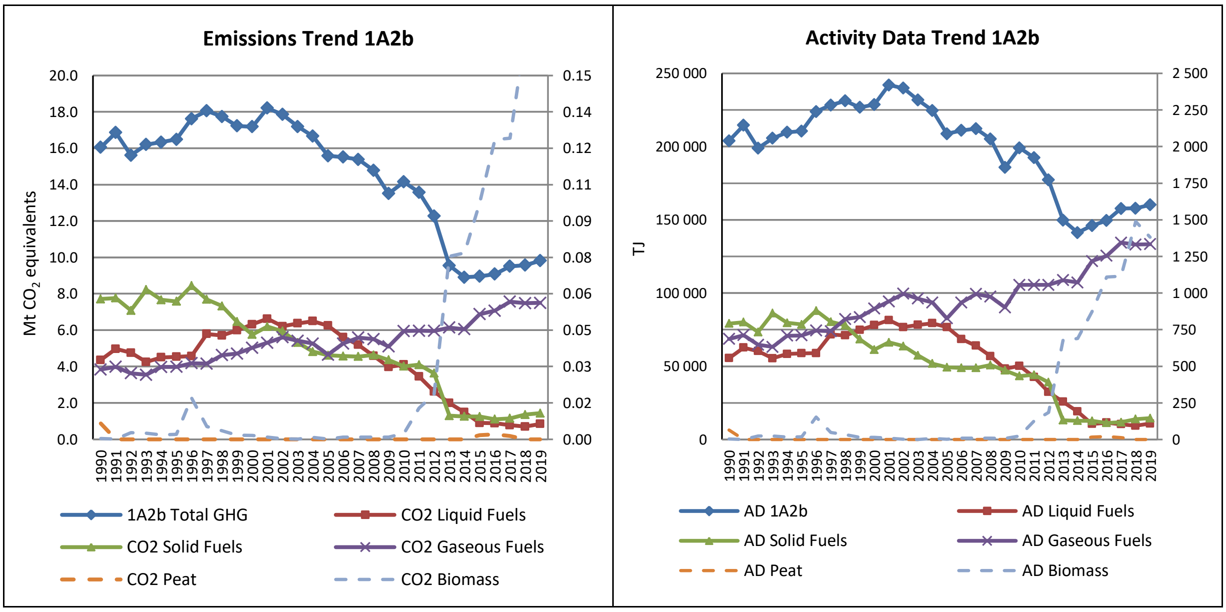
3.2.2.2 Non-Ferrous Metals (1.A.2.b)

This chapter provides information about European emission trend, Member States, United Kingdom and Iceland contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.b Non-Ferrous Metals.

Total CO_2 emissions from 1.A.2.b amounted to 9 768 kt CO_2 eq. in 2019. The trend of total emissions for 1990 to 2019 from category 1.A.2.b is depicted in Figure 3.40. Total CO_2 emissions decreased by 39% since 1990 and increased by 3% between 2018 and 2019. Total CO_2 emissions from 1.A.2.b Non-Ferrous Metals accounted for 2% of 1.A.2. source category.

Figure **3.40** shows the emission trend within the category 1.A.2.b, which is dominated by CO_2 emissions from gaseous fuels in 2019. The share of liquid fuels on CO_2 emissions from 1.A.2.b decreased from 27% in 1990 to 9% in 2019. The share of solid fuels on CO_2 emissions from 1.A.2.b decreased from 48% in 1990 to 15% in 2019. The share of gaseous fuels on CO_2 emissions from 1.A.2.b increased from 24% in 1990 to 77% in 2019.

Figure 3.40: 1.A.2.b Non-ferrous Metals: CO_2 emissions and activity data trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table.3.27. Denmark, Lithuania, Malta and Portugal report emissions as 'NO' (not occurring) or 'IE' (included elsewhere). For Portugal, emissions from non-ferrous metals are included in 1.A.2.g Other. Nine Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emissions was reported by Romania (384%), with a 3.6% share on total EU-KP emissions in 2019.

Table.3.27: 1.A.2.b Non-ferrous Metals: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	132	323	295	3.0%	163	123%	-29	-9%	T1,T2	CS,D
Belgium	629	444	427	4.4%	-202	-32%	-18	-4%	T1	D
Bulgaria	299	205	251	2.6%	-48	-16%	46	23%	T1,T2	CS,D
Croatia	17	27	27	0.3%	10	58%	0	0%	T1	D
Cyprus	5	2	2	0.0%	-3	-56%	0	-1%	T1	D
Czechia	102	153	148	1.5%	46	45%	-5	-3%	T1,T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	2	1	0.0%	1	∞	-1	-60%	T2	CS
Finland	338	118	105	1.1%	-232	-69%	-13	-11%	T3	CS,D
France	1 995	851	837	8.6%	-1 158	-58%	-14	-2%	T2,T3	CS,PS
Germany	1 377	148	150	1.5%	-1 227	-89%	1	1%	CS	CS
Greece	582	322	358	3.7%	-225	-39%	36	11%	T2	CS,PS
Hungary	238	189	180	1.8%	-58	-24%	-9	-5%	T2	CS
Ireland	809	1 372	1 380	14.1%	571	71%	8	1%	T1,T2,T3	CS,D
Italy	735	1 140	1 113	11.4%	377	51%	-27	-2%	T2	CS
Latvia	NO	1	1	0.0%	1	∞	0	-7%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	28	51	47	0.5%	19	67%	-4	-8%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	214	163	159	1.6%	-55	-26%	-4	-2%	T2	CS
Poland	1 053	1 255	1 330	13.6%	278	26%	76	6%	T1,T2	CS,D
Portugal	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Romania	73	421	352	3.6%	279	384%	-68	-16%	T3	PS
Slovakia	1 256	94	99	1.0%	-1 157	-92%	5	5%	T2	CS
Slovenia	439	123	99	1.0%	-339	-77%	-24	-20%	T1,T2	CS,D
Spain	1 192	1 307	1 594	16.3%	402	34%	287	22%	T1,T2,T3	CS,D,PS
Sweden	128	100	111	1.1%	-17	-13%	11	11%	T2	CS
United Kingdom	4 319	705	694	7.1%	-3 625	-84%	-11	-2%	T2	CS
EU-27+UK	**15 958**	**9 517**	**9 760**	**100%**	**-6 198**	**-39%**	**243**	**3%**	**-**	**-**
Iceland	14	8	8	0.1%	-5	-38%	0	3%	T1	D
United Kingdom (KP)	4 319	705	694	7.1%	-3 625	-84%	-11	-2%	T2	CS
EU-KP	**15 972**	**9 525**	**9 768**	**100%**	**-6 204**	**-39%**	**243**	**3%**	**-**	**-**

Malta and Portugal include emissions under 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1.A.2.b Non-Ferrous Metals - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.b amounted 837 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 81% and compared to 2018 increased by 21%. Category has 0.2% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 80% compared to 1990. The category was not identified as a key category for this submission but it was identified in previous submissions and thus the description of the category is still included in the reporting.

Detailed data related to the EU-KP submissions are depicted in *Table 3.28*. Czechia, Denmark, Estonia, Hungary, Latvia, Lithuania, Luxemburg, Malta and Netherlands report emissions as 'NO' (not occurring). Portugal reports emissions as 'IE' (included elsewhere). Five Member States and Iceland use for emission estimates Tier 1 methodology (approximately 87% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.b – Liquid Fuels (CO_2)). All Member States reported lower level of emissions in 2019 than in 1990 (except of Italy).

Table 3.28: 1.A.2.b Non-ferrous Metals, liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	35	6	7	0.8%	-28	-81%	0	3%	T2	CS
Belgium	220	44	39	4.6%	-182	-83%	-6	-13%	T1	D
Bulgaria	199	51	49	5.9%	-150	-75%	-1	-2%	T1	D
Croatia	17	4	3	0.3%	-14	-84%	-1	-25%	T1	D
Cyprus	5	2	2	0.3%	-3	-56%	0	-1%	T1	D
Czechia	3	NO	NO	-	-3	-100%	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	174	86	78	9.4%	-96	-55%	-8	-9%	T3	CS
France	642	36	34	4.1%	-607	-95%	-2	-5%	T2,T3	CS,PS
Germany	144	94	96	11.5%	-48	-33%	2	2%	CS	CS
Greece	582	17	22	2.7%	-560	-96%	5	29%	T2	PS
Hungary	143	NO	NO	-	-143	-100%	-	-	NA	NA
Ireland	766	25	32	3.8%	-735	-96%	7	27%	T1,T3	CS,D
Italy	18	32	33	3.9%	15	86%	2	5%	T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	15	NO	NO	-	-15	-100%	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	62	36	40	4.8%	-23	-36%	4	12%	T1,T2	CS,D
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	IE	0	3	0.3%	3	∞	2	718%	T3	PS
Slovakia	23	4	4	0.4%	-20	-85%	-1	-18%	T2	CS
Slovenia	120	19	4	0.4%	-117	-97%	-15	-80%	T1	D
Spain	931	141	287	34.3%	-644	-69%	145	103%	T1,T2,T3	CS,D,PS
Sweden	110	83	94	11.2%	-16	-14%	11	13%	T2	CS
United Kingdom	134	2	2	0.3%	-131	-98%	0	-4%	T2	CS
EU-27+UK	**4 344**	**683**	**828**	**99%**	**-3 516**	**-81%**	**145**	**21%**	**-**	**-**
Iceland	14	8	8	1.0%	-5	-38%	0	3%	T1	D
United Kingdom (KP)	134	2	2	0.3%	-131	-98%	0	-4%	T2	CS
EU-KP	**4 358**	**691**	**837**	**100%**	**-3 521**	**-81%**	**146**	**21%**	**-**	**-**

Portugal includes emissions under 1.A.2.g. Romania includes emissions under 1.A.2.a from 1990 to 2017 (except 2007). Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.41 shows CO_2 emissions trend as well as the share of the Member States with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Spain (34%), Germany (12%), Sweden (11%), Finland (9%) and Bulgaria (6%) which together represent 72% share of EU-KP emissions.

Figure 3.41: 1.A.2.b Non-ferrous Metals, liquid fuels: Emission trend and share for CO_2

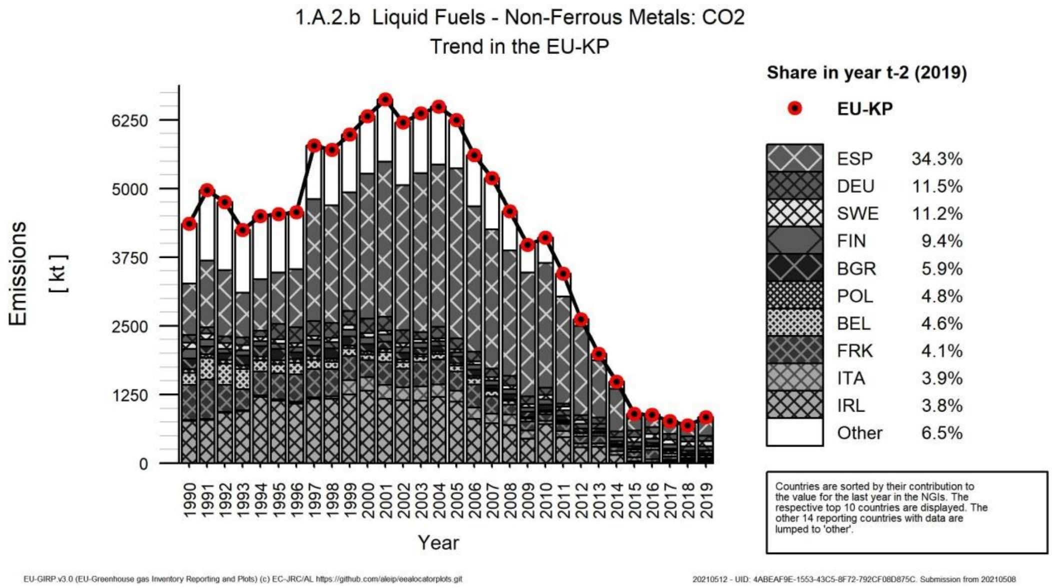


Figure 3.42 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. It can be seen that CO_2 IEF fluctuated at the beginning of the time series and since 2013 shows major fluctuations. The peak in the 2015 implied emission factor, as presented in the figure below, occurs because Sweden reported activity data as confidential. CO_2 IEF equaled to 77.12 t/TJ in 2019.

Figure 3.42: 1.A.2.b Non-ferrous Metals, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

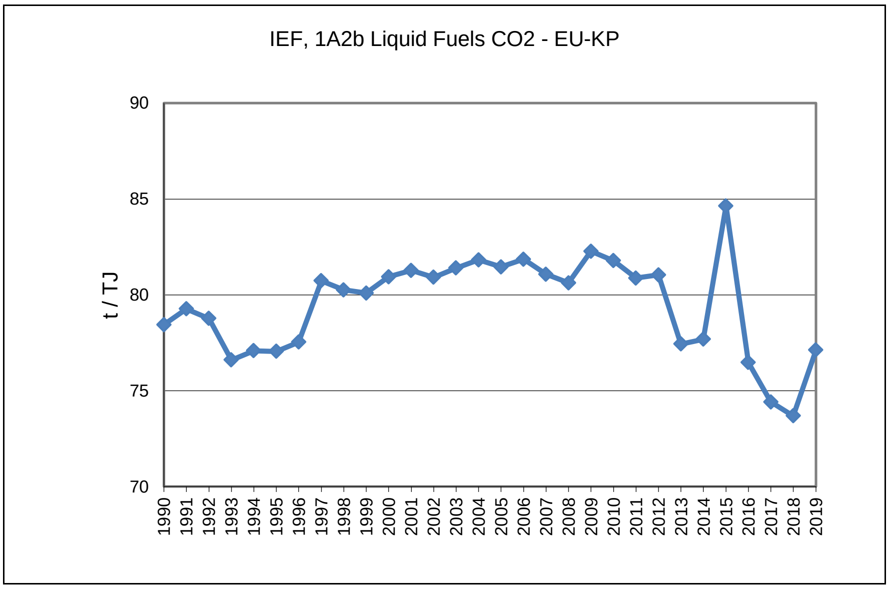
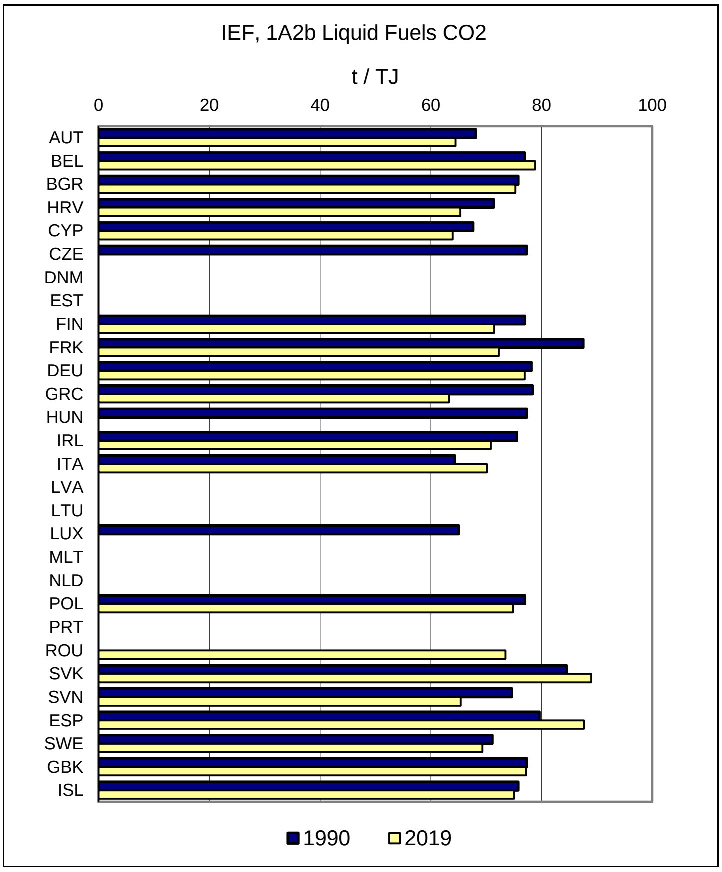


Figure 3.43 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. Particularly higher implied CO_2 emission factors are due to the use of petroleum coke, which has significantly higher carbon content than liquid oil products.

Figure 3.43: 1.A.2.b Non-ferrous Metals, liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.b Non-Ferrous Metals - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.b amounted 1 433 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 81% and compared to 2018 increased by 6%. Category has 0.3% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 82% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.29. Ten member states and Iceland report emissions as 'NO' (not occurring). Greece, Portugal and Romania report emissions as 'IE' (included elsewhere). Belgium uses for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 93% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.b – Solid Fuels (CO_2)). All Member States reported lower level of emissions in 2019 than in 1990 (except of Bulgaria and Poland with a 66% share on total EU-KP emissions in 2019).

Table 3.29: 1.A.2.b Non-ferrous Metals, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	22	7	12	0.8%	-10	-47%	4	55%	T2	CS
Belgium	147	102	98	6.9%	-49	-33%	-4	-4%	T1	D
Bulgaria	76	51	89	6.2%	13	17%	39	76%	T1,T2	CS,D
Croatia	0	NO	NO	-	0	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	46	14	15	1.0%	-31	-67%	1	7%	T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	155	29	24	1.7%	-131	-84%	-5	-18%	T3	CS
France	604	2	2	0.2%	-601	-100%	0	4%	T2,T3	CS,PS
Germany	1 233	54	53	3.7%	-1 179	-96%	-1	-1%	CS	CS
Greece	IE	IE	IE	-	-	-	-	-	NA	NA
Hungary	9	NO	NO	-	-9	-100%	-	-	NA	NA
Ireland	4	1	1	0.0%	-3	-85%	0	0%	NA	NA
Italy	152	133	122	8.6%	-29	-19%	-11	-8%	T2	CS
Latvia	NO	0	0	0.0%	0	∞	0	0%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	0	NO	NO	-	0	-100%	-	-	NA	NA
Poland	673	778	849	59.3%	176	26%	71	9%	T1,T2	CS,D
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	73	NO	NO	-	-73	-100%	-	-	NA	NA
Slovakia	798	26	28	2.0%	-770	-96%	3	11%	T2	CS
Slovenia	154	6	5	0.4%	-149	-96%	0	-2%	T1,T2	CS,D
Spain	188	49	38	2.6%	-150	-80%	-11	-22%	T1,T2	CS,D
Sweden	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom	3 366	101	94	6.6%	-3 271	-97%	-7	-7%	T2	CS
EU-27+UK	**7 708**	**1 353**	**1 433**	**100%**	**-6 275**	**-81%**	**79**	**6%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 366	101	94	6.6%	-3 271	-97%	-7	-7%	T2	CS
EU-KP	**7 708**	**1 353**	**1 433**	**100%**	**-6 275**	**-81%**	**79**	**6%**	**-**	**-**

Portugal includes emissions under 1.A.2.g. From 1991, Romania includes emissions under 1.A.2.a.
Greece includes emissions in the Industrial processes sector (as non-energy use of fuels).
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure ***3.44*** shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Poland (60%), Italy (9%) and Belgium (7%) which together have 75% share on EU-KP emissions.

The reason for the strong decrease of the emissions in 2013 is the reallocation of the UK power plant. Since then, emissions from this plant are reported under 1.A.1.a.

Figure 3.44: 1.A.2.b Non-ferrous Metals, solid fuels: Emission trend and share for CO_2

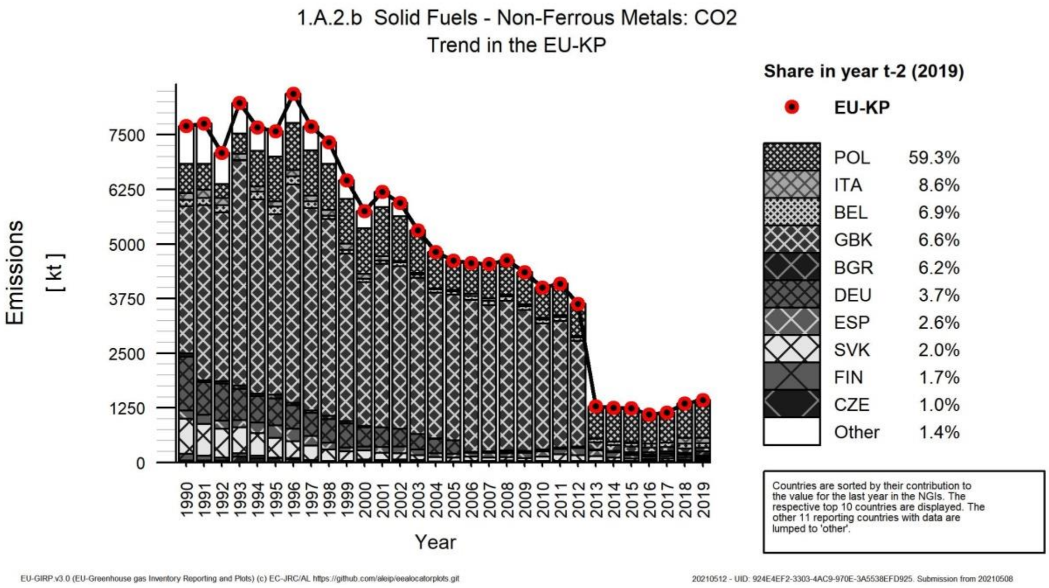


Figure 3.45 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. Since the beginning of the time series, the CO_2 IEF had relatively decreasing trend. In 2013 CO_2 IEF increased rapidly. The reason for the increase of the CO_2 IEF in 2013 is the reallocation of the UK power plant. As the UK IEF is lower than the EU average the declining weight of the UK in EU emissions leads to an increase in the IEF of the EU. CO_2 IEF equaled to 98.42 t/TJ in 2019.

Figure 3.45: 1.A.2.b Non-ferrous Metals, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

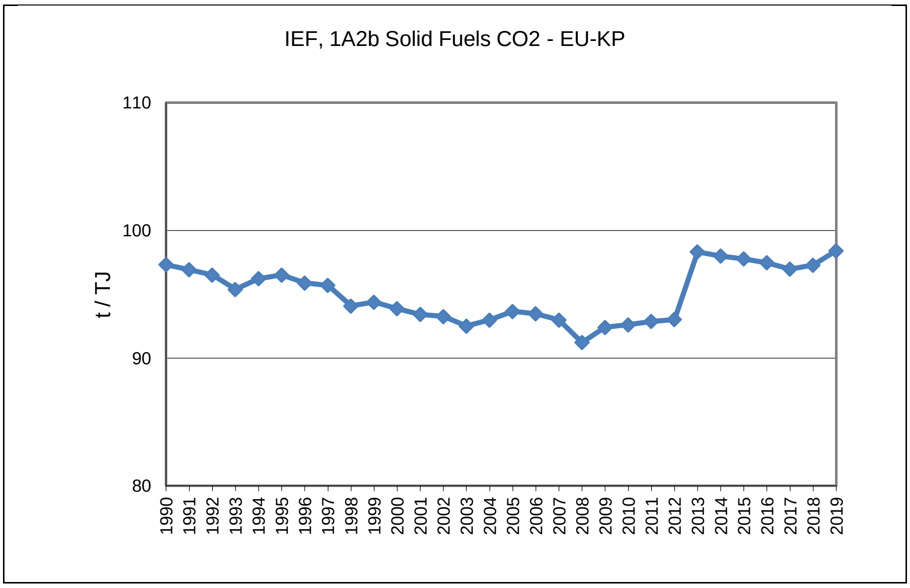
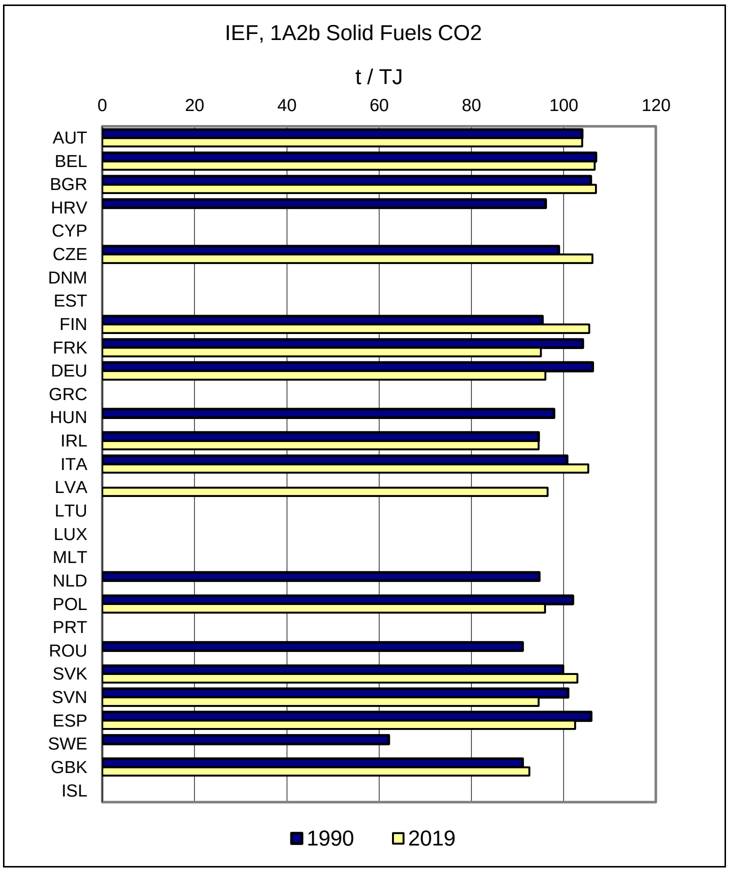


Figure 3.46 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019.

Figure 3.46: 1.A.2.b Non-ferrous Metals, solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.b Non-Ferrous Metals - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.b amounted 7 474 kt in 2019 for EU-KP. CO_2 emissions increased compared to year 1990 by 95% and compared to year 2018 increased by less than 1%. Category has 1.6% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption increased by 94% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.30. Cyprus, Denmark, Lithuania, Malta and Iceland report emissions as 'NO' (not occurring). Germany and Portugal report emissions as 'IE' (included elsewhere). For Germany, emissions from gaseous fuels from this category are reported in 1.A.2.g Other. Two Member States use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 96% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.b – Gaseous Fuels (CO_2)). Four countries reported lower level of emissions in 2019 than in 1990. Most rapid increase of emissions was reported by Ireland (3395%); Ireland has also the highest share on total CO_2 emissions from 1.A.2.b – Gaseous Fuels (CO_2).

Table 3.30: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	75	309	275	3.7%	200	267%	-34	-11%	T2	CS
Belgium	261	298	290	3.9%	29	11%	-8	-3%	T1	D
Bulgaria	23	104	112	1.5%	89	380%	9	9%	T2	CS
Croatia	NO	23	24	0.3%	24	∞	1	4%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	53	138	133	1.8%	80	150%	-6	-4%	T2	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	2	1	0.0%	1	∞	-1	-60%	T2	CS
Finland	NO	3	3	0.0%	3	∞	0	7%	T3	CS
France	749	812	800	10.7%	51	7%	-12	-1%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	304	335	4.5%	335	∞	31	10%	T2	CS
Hungary	86	189	180	2.4%	94	109%	-9	-5%	T2	CS
Ireland	39	1 347	1 348	18.0%	1 309	3395%	1	0%	T2	CS
Italy	566	975	957	12.8%	391	69%	-18	-2%	T2	CS
Latvia	NO	1	1	0.0%	1	∞	0	-8%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	13	51	47	0.6%	34	254%	-4	-8%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	213	163	159	2.1%	-55	-26%	-4	-2%	T2	CS
Poland	254	441	441	5.9%	187	73%	0	0%	T2	CS
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	IE	420	350	4.7%	350	∞	-71	-17%	T3	PS
Slovakia	435	65	67	0.9%	-368	-85%	3	4%	T2	CS
Slovenia	164	99	90	1.2%	-74	-45%	-9	-9%	T2	CS
Spain	73	1 117	1 269	16.9%	1 196	1630%	152	14%	T2,T3	CS,PS
Sweden	10	17	17	0.2%	7	63%	0	3%	T2	CS
United Kingdom	819	602	597	8.0%	-222	-27%	-4	-1%	T2	CS
EU-27+UK	**3 835**	**7 480**	**7 498**	**100%**	**3 663**	**96%**	**18**	**0%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	819	602	597	8.0%	-222	-27%	-4	-1%	T2	CS
EU-KP	**3 835**	**7 480**	**7 498**	**100%**	**3 663**	**96%**	**18**	**0%**	**-**	**-**

Portugal includes emissions under 1.A.2.g. From 1990 to 2017, Romania includes emissions under 1.A.2.a. Germany reported emissions under 1.A.2.g (unspecified industrial power plants) because of confidential data.

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.47 shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Ireland (18%), Spain (17%), Italy (13%), France (11%), United Kingdom (8%) and Poland (6%) which together have 72% share on EU-KP emissions.

Figure 3.47: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Emission trend and share for CO_2

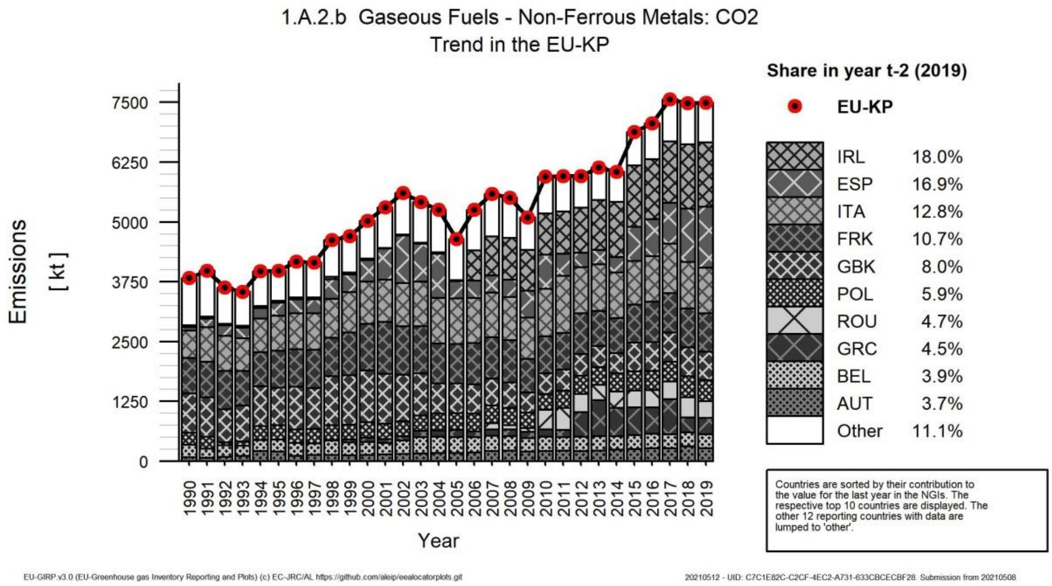


Figure 3.48 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. It can be seen that CO_2 IEF has stable trend for the whole time series. CO_2 IEF equaled to 56.21 t/TJ in 2019.

Figure 3.48: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

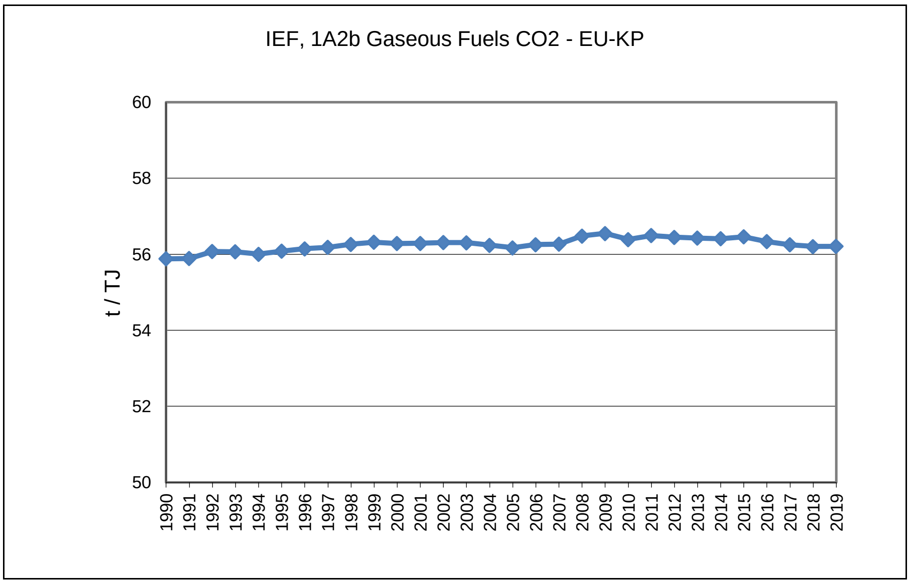
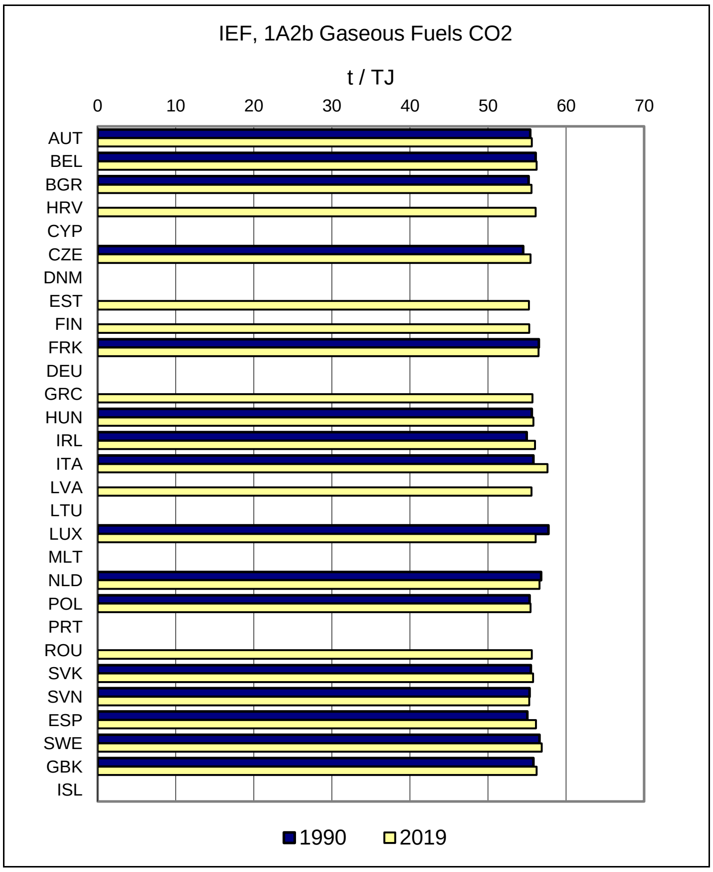


Figure 3.49 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. No significant differences between CO_2 IEF used by EU-KP are occurring and also no significant differences between CO_2 IEF used in 1990 and 2019 are occurring.

Figure 3.49: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



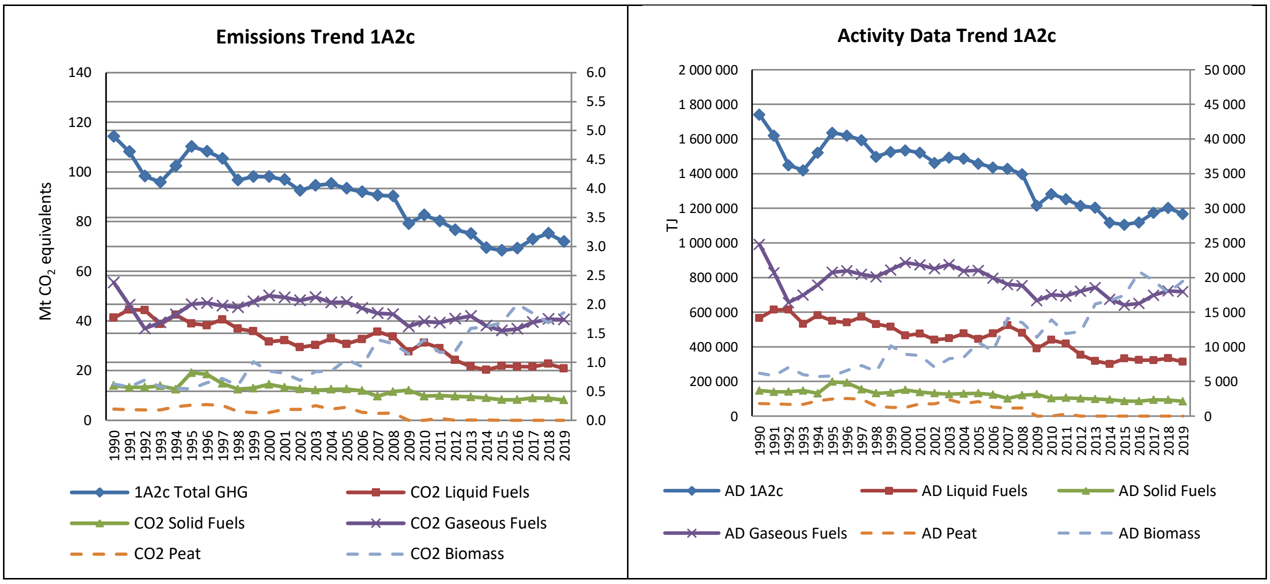
3.2.2.3 Chemicals (1.A.2.c)

This chapter provides information about European emission trend, Member States and United Kingdom contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.c Chemicals.

Total CO_2 emissions from 1.A.2.c amounted to 71 308 kt CO_2 eq. in 2019. The trend of total CO_2 emissions for 1990 to 2019 from category 1.A.2.c is depicted in Figure 3.50. CO_2 emissions decreased by 37% since 1990 and by 4% between 2018 and 2019. CO_2 emissions from 1.A.2.c Chemicals accounted for 15% of 1.A.2. source category.

Figure **3.50** shows the emission trend within the category 1.A.2.c, which is dominated by CO_2 emissions from gaseous fuels in 2019. The share of liquid fuels on CO_2 emissions from 1.A.2.c decreased from 36% in 1990 to 29% in 2019. The share of solid fuels on CO_2 emissions from 1.A.2.c slightly decreased from 12% in 1990 to 11% in 2019. The share of gaseous fuels on CO_2 emissions from 1.A.2.c increased from 49% in 1990 to 57% in 2019.

Figure 3.50: 1.A.2.c Chemicals: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table 3.31. Germany, Malta and Iceland report emissions as 'NO' (not occurring) or 'IE' (included elsewhere). For Germany, emissions from this category are reported in 1.A.2.g Other. Six Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emissions was reported by Cyprus (but it should be noted that the share of Cyprus emissions on total EU-KP emissions is minor compared to for example Poland and Spain which reported significant increase of emissions and have also high share on total EU-KP emissions).

Table 3.31: 1.A.2.c Chemicals: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	847	1 463	1 525	2.1%	678	80%	62	4%	T1,T2	CS,D
Belgium	4 786	3 488	3 436	4.8%	-1 350	-28%	-52	-1%	T1,T3	D,PS
Bulgaria	967	1 527	1 410	2.0%	443	46%	-117	-8%	T1,T2	CS,D
Croatia	738	280	292	0.4%	-446	-60%	12	4%	T1	D
Cyprus	2	8	8	0.0%	6	272%	0	5%	T1	D
Czechia	2 996	1 850	1 862	2.6%	-1 135	-38%	12	1%	T1,T2	CS,D
Denmark	315	301	270	0.4%	-45	-14%	-31	-10%	T1,T2,T3	CS,D
Estonia	390	19	20	0.0%	-370	-95%	1	3%	T1,T2	CS,D
Finland	1 245	736	726	1.0%	-519	-42%	-9	-1%	T3	CS,D
France	15 078	12 683	12 510	17.5%	-2 568	-17%	-173	-1%	T2,T3	CS,PS
Germany	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Greece	808	478	452	0.6%	-356	-44%	-26	-5%	T2	CS
Hungary	1 531	404	399	0.6%	-1 132	-74%	-5	-1%	T1,T2,T3	CS,D,PS
Ireland	410	416	425	0.6%	15	4%	8	2%	T2	CS
Italy	21 428	11 597	9 073	12.7%	-12 354	-58%	-2 524	-22%	T2	CS
Latvia	294	38	27	0.0%	-267	-91%	-12	-30%	T2	CS
Lithuania	399	288	314	0.4%	-86	-21%	26	9%	T2	CS
Luxembourg	170	124	122	0.2%	-48	-28%	-2	-2%	T1,T3	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	17 275	13 795	13 030	18.3%	-4 245	-25%	-765	-6%	T2	CS,D
Poland	4 003	6 583	6 612	9.3%	2 609	65%	29	0%	T1,T2	CS,D
Portugal	1 412	1 153	1 335	1.9%	-77	-5%	182	16%	T1,T3	D,PS
Romania	17 871	1 963	2 214	3.1%	-15 657	-88%	251	13%	T1,T2	CS,D
Slovakia	2 652	525	473	0.7%	-2 179	-82%	-52	-10%	T2	CS
Slovenia	209	64	61	0.1%	-148	-71%	-3	-4%	T1,T2	CS,D
Spain	5 364	9 152	9 273	13.0%	3 909	73%	121	1%	T1,T2	CS,D,PS
Sweden	601	555	489	0.7%	-112	-19%	-66	-12%	T2	CS
United Kingdom	12 058	5 113	4 950	6.9%	-7 107	-59%	-163	-3%	T2	CS
EU-27+UK	**113 849**	**74 603**	**71 308**	**100%**	**-42 541**	**-37%**	**-3 295**	**-4%**	**-**	**-**
Iceland	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom (KP)	12 058	5 113	4 950	6.9%	-7 107	-59%	-163	-3%	T2	CS
EU-KP	**113 856**	**74 603**	**71 308**	**100%**	**-42 549**	**-37%**	**-3 295**	**-4%**	**-**	**-**

Emissions of Germany and Malta are included in 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1.A.2.c Chemicals - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.c amounted 20 814 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 50% and compared to 2018 by 8%. Category has 4% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 45% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.32. Malta and Iceland report emissions as 'NO' (not occurring). Seven Member States use for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 93% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.c – Liquid Fuels (CO_2)). Bulgaria, Cyprus, Czechia, Netherlands and Poland reported higher level of emissions in 2019 than in 1990.

Table 3.32: 1.A.2.c Chemicals, Liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	97	32	27	0.1%	-70	-72%	-5	-15%	T2	CS
Belgium	1 852	292	282	1.4%	-1 570	-85%	-10	-3%	T1	D
Bulgaria	857	964	990	4.8%	134	16%	26	3%	T1	D
Croatia	291	10	6	0.0%	-285	-98%	-4	-39%	T1	D
Cyprus	2	8	8	0.0%	6	272%	0	5%	T1	D
Czechia	175	140	204	1.0%	29	17%	64	46%	T1	D
Denmark	198	1	0	0.0%	-198	-100%	-1	-88%	T1,T2	CS,D
Estonia	229	6	8	0.0%	-220	-96%	2	40%	T1,T2	CS,D
Finland	731	621	633	3.0%	-98	-13%	12	2%	T3	CS
France	6 254	3 447	3 981	19.1%	-2 274	-36%	534	15%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	639	66	41	0.2%	-598	-94%	-25	-38%	T2	CS
Hungary	380	3	3	0.0%	-377	-99%	0	0%	T1	D
Ireland	131	71	69	0.3%	-62	-47%	-2	-2%	T2	CS
Italy	13 125	6 345	3 866	18.6%	-9 259	-71%	-2 479	-39%	T2	CS
Latvia	270	11	10	0.0%	-260	-96%	-1	-10%	T2	CS
Lithuania	69	3	4	0.0%	-65	-95%	1	35%	T2	CS
Luxembourg	112	3	4	0.0%	-109	-97%	1	25%	T1,T3	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	6 493	7 741	7 005	33.7%	513	8%	-736	-10%	T2	CS,D
Poland	308	770	1 100	5.3%	792	257%	330	43%	T1,T2	CS,D
Portugal	1 373	616	752	3.6%	-621	-45%	136	22%	T1,T3	D,PS
Romania	NO	708	1 121	5.4%	1 121	∞	412	58%	T1,T2	D
Slovakia	51	2	2	0.0%	-49	-96%	0	-9%	T2	CS
Slovenia	32	10	9	0.0%	-23	-71%	-1	-12%	T1	D
Spain	2 852	367	270	1.3%	-2 582	-91%	-98	-27%	T1,T2	CS,D
Sweden	341	356	318	1.5%	-23	-7%	-38	-11%	T2	CS
United Kingdom	4 392	104	100	0.5%	-4 292	-98%	-4	-3%	T2	CS
EU-27+UK	**41 254**	**22 699**	**20 814**	**100%**	**-20 440**	**-50%**	**-1 885**	**-8%**	**-**	**-**
Iceland	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom (KP)	4 392	104	100	0.5%	-4 292	-98%	-4	-3%	T2	CS
EU-KP	**41 261**	**22 699**	**20 814**	**100%**	**-20 447**	**-50%**	**-1 885**	**-8%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.51 shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen, that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Netherlands (34%), France (19%), Italy (19%), Romania (5%), Poland (5%) and Bulgaria (5%) which together have 87% share on EU-KP emissions.

Figure 3.51: 1.A.2.c Chemicals, Liquid fuels: Emission trend and share for CO_2

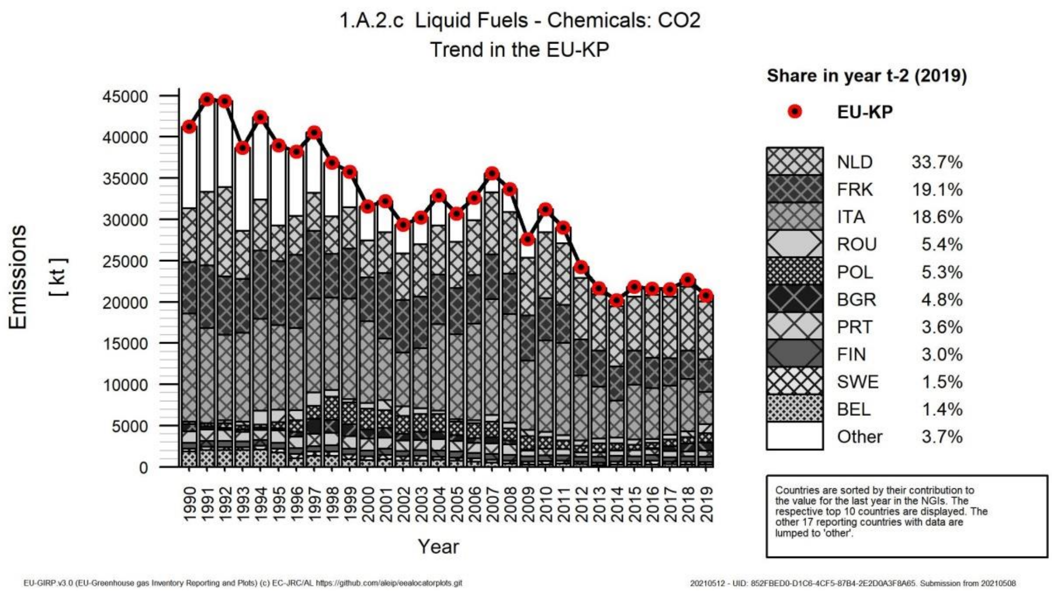


Figure 3.52 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. It can be seen, that CO_2 IEF fluctuates over the time period with decreasing trend. CO_2 IEF equaled to 66.50 t/TJ in 2019. The main reason for the declining trend of the IEF is the growing weight of the Netherlands (with a lower IEF) and the decreasing weight of Italy (with a higher IEF) in total EU-KP emissions.

Figure 3.52: 1.A.2.c Chemicals, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

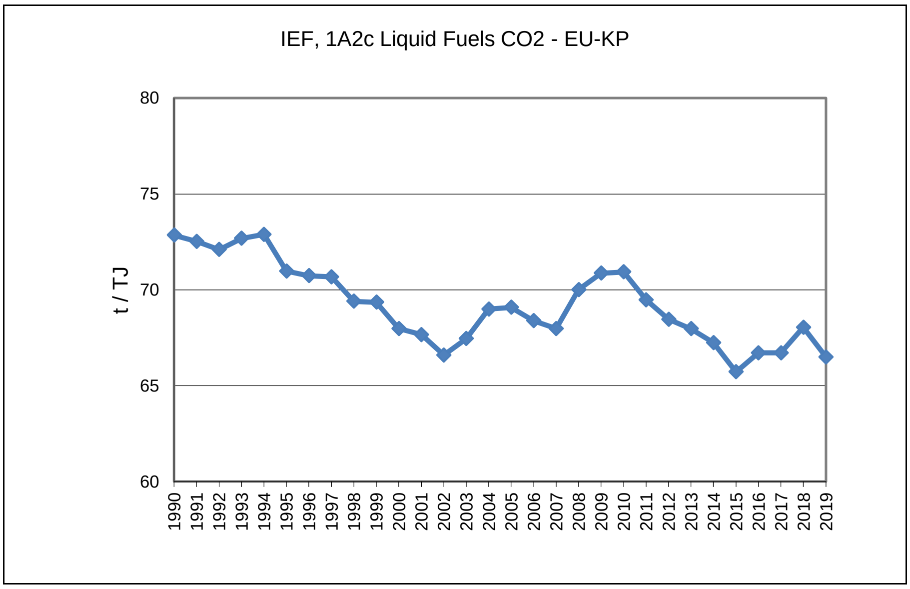
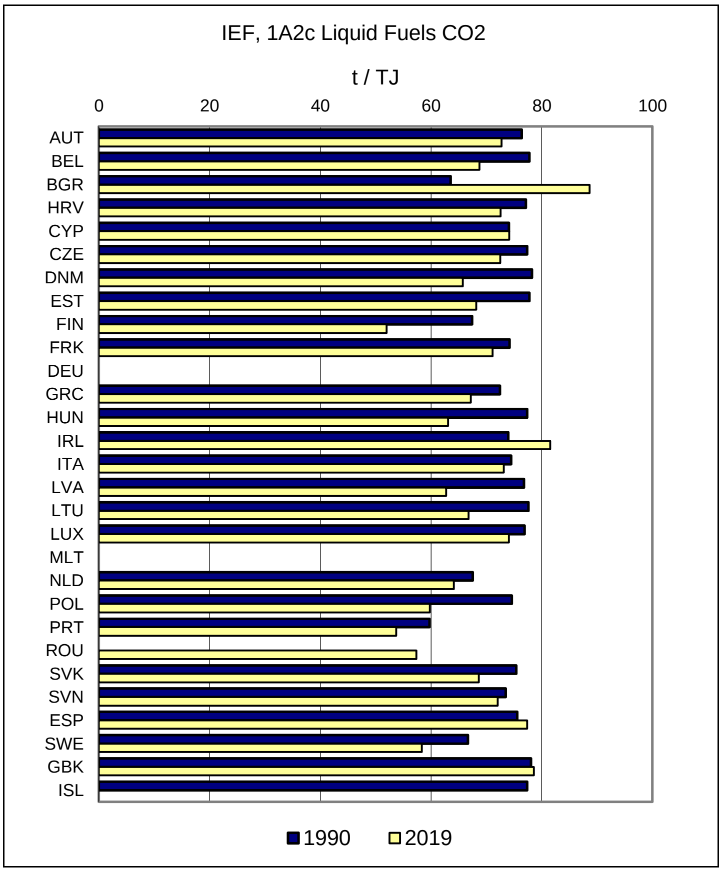


Figure 3.53 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. The main reason for the differences of IEFs across countries is differences in the fuel mix. Bulgaria has higher IEF compared to other countries which is caused by high share of petroleum coke.

Figure 3.53: 1.A.2.c Chemicals, Liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.c Chemicals - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.c amounted 8 136 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 41% and compared to 2018 by 8%. Category has 2% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 42% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.33. Fourteen Member States and Iceland report emissions as 'NO' (not occurring). Belgium uses for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99.9% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.c – Solid Fuels (CO_2)). Bulgaria, Denmark and Poland reported higher level of emissions in 2019 than in 1990. Poland has the highest share on total EU-KP emissions.

Table 3.33: 1.A.2.c Chemicals, Solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	106	120	58	0.7%	-49	-46%	-63	-52%	T2	CS
Belgium	402	3	3	0.0%	-398	-99%	0	-5%	T1	D
Bulgaria	80	249	169	2.1%	88	110%	-81	-32%	NA	NA
Croatia	101	NO	NO	-	-101	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	2 487	1 141	1 023	12.6%	-1 464	-59%	-118	-10%	T2	CS,D
Denmark	6	24	20	0.2%	14	215%	-4	-17%	T1	D
Estonia	5	NO	NO	-	-5	-100%	-	-	NA	NA
Finland	214	NO	NO	-	-214	-100%	-	-	NA	NA
France	1 632	1 371	1 290	15.9%	-341	-21%	-81	-6%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	169	NO	NO	-	-169	-100%	-	-	NA	NA
Hungary	96	NO	NO	-	-96	-100%	-	-	NA	NA
Ireland	72	NO	NO	-	-72	-100%	-	-	NA	NA
Italy	640	79	79	1.0%	-561	-88%	0	0%	T2	CS
Latvia	NO	0	NO	-	-	-	0	-100%	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 087	NO	NO	-	-1 087	-100%	-	-	NA	NA
Poland	1 012	4 866	4 626	56.9%	3 614	357%	-240	-5%	T1,T2	CS,D
Portugal	39	NO	NO	-	-39	-100%	-	-	NA	NA
Romania	581	141	98	1.2%	-483	-83%	-43	-31%	T1,T2	CS,D
Slovakia	1 584	64	49	0.6%	-1 535	-97%	-16	-24%	T2	CS
Slovenia	1	NO	NO	-	-1	-100%	-	-	NA	NA
Spain	691	635	593	7.3%	-98	-14%	-42	-7%	T1,T2	CS,D,PS
Sweden	100	32	C	-	-100	-100%	-32	-100%	T2	CS
United Kingdom	2 796	146	129	1.6%	-2 667	-95%	-17	-12%	T2	CS
EU-27+UK	**13 900**	**8 872**	**8 136**	**100%**	**-5 764**	**-41%**	**-736**	**-8%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 796	146	129	1.6%	-2 667	-95%	-17	-12%	T2	CS
EU-KP	**13 900**	**8 872**	**8 136**	**100%**	**-5 764**	**-41%**	**-736**	**-8%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.54 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Poland (57%), France (16%) and Czechia (13%) which together represent 85% share on EU-KP emissions.

Figure 3.54: 1.A.2.c Chemicals, Solid fuels: Emission trend and share for CO_2

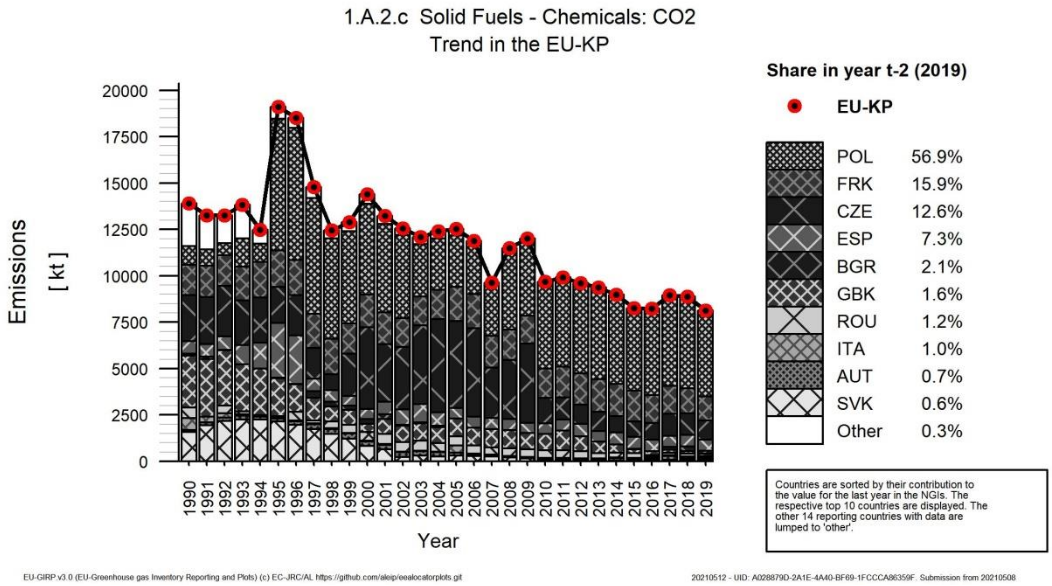


Figure 3.55 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. It can be seen that since 2010 CO_2 IEF fluctuates only slightly. CO_2 IEF equalled to 95.12 t/TJ in 2019.

Figure 3.55: 1.A.2.c Chemicals, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

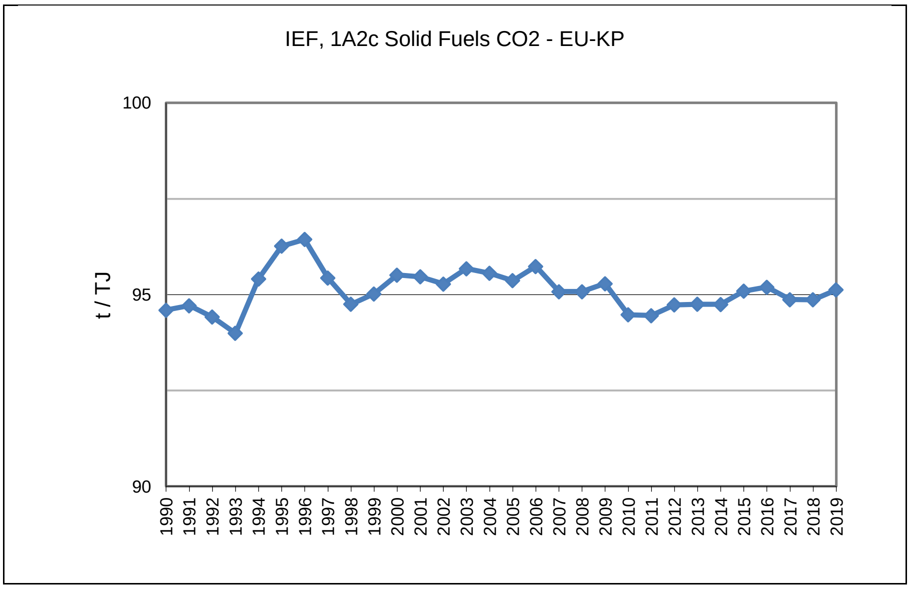
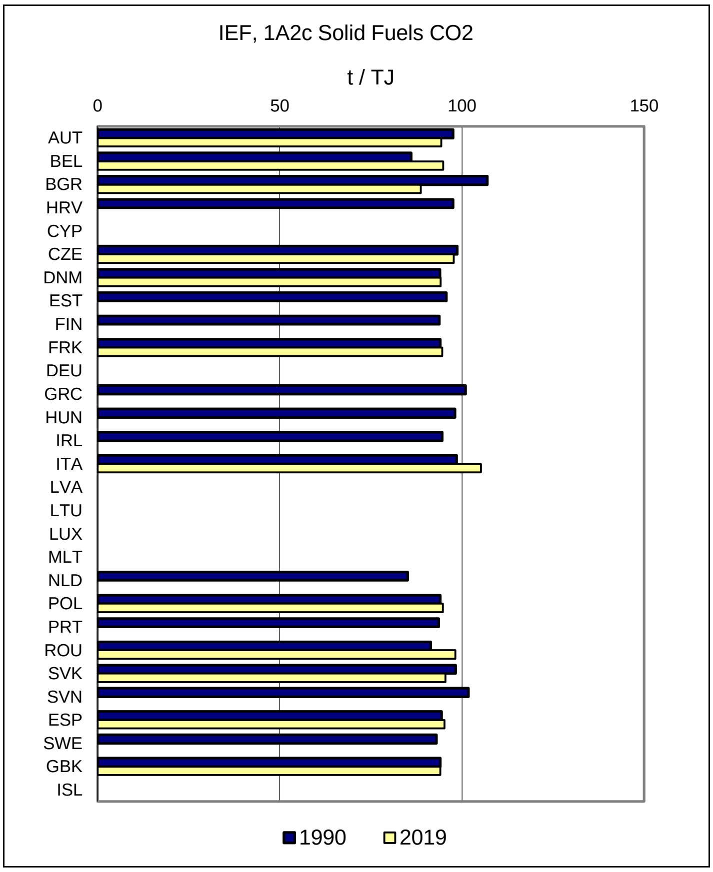


Figure 3.56 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019.

Figure 3.56: 1.A.2.c Chemicals, Solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.c Chemicals – Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.c amounted 40 527 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 27% and compared to 2018 by 0.5%. This category represents 8% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 28% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.34. Cyprus, Malta and Iceland report emissions as 'NO' (not occurring). Croatia uses for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.c –Gaseous Fuels (CO_2)). Nine Member States reported higher level of emissions in 2019 than in 1990. Noticeable higher level of emissions in 2019 compared to 1990 was reported by Bulgaria (731%) and Spain (362%).

Table 3.34: 1.A.2.c Chemicals, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	519	1 106	1 168	2.9%	649	125%	62	6%	T2	CS
Belgium	2 532	3 178	3 135	7.7%	603	24%	-43	-1%	T1,T3	D,PS
Bulgaria	30	314	251	0.6%	221	731%	-62	-20%	T2	CS
Croatia	346	269	286	0.7%	-60	-17%	17	6%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	334	569	634	1.6%	300	90%	65	11%	T2	CS
Denmark	110	275	250	0.6%	139	126%	-26	-9%	T3	CS
Estonia	157	13	12	0.0%	-145	-93%	-2	-13%	T2	CS
Finland	99	108	88	0.2%	-11	-11%	-20	-19%	T3	CS
France	6 718	6 045	5 932	14.6%	-786	-12%	-112	-2%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	412	412	1.0%	412	∞	-1	0%	T2	CS
Hungary	1 055	399	395	1.0%	-660	-63%	-5	-1%	T2	CS
Ireland	207	346	356	0.9%	148	72%	10	3%	T2	CS
Italy	7 663	5 173	5 129	12.7%	-2 534	-33%	-44	-1%	T2	CS
Latvia	24	27	17	0.0%	-7	-30%	-10	-38%	T2	CS
Lithuania	331	285	310	0.8%	-21	-6%	25	9%	T2	CS
Luxembourg	57	121	118	0.3%	61	106%	-3	-2%	T3	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	9 695	6 053	6 025	14.9%	-3 670	-38%	-29	0%	T2	CS
Poland	293	841	830	2.0%	537	184%	-11	-1%	T2	CS
Portugal	NO	537	583	1.4%	583	∞	46	9%	T1,T3	D,PS
Romania	17 290	1 041	933	2.3%	-16 357	-95%	-108	-10%	T2	CS
Slovakia	989	443	408	1.0%	-581	-59%	-34	-8%	T2	CS
Slovenia	176	54	52	0.1%	-124	-70%	-1	-3%	T2	CS
Spain	1 822	8 150	8 410	20.8%	6 588	362%	260	3%	T2	CS
Sweden	155	109	74	0.2%	-81	-52%	-35	-32%	T2	CS
United Kingdom	4 870	4 863	4 721	11.6%	-149	-3%	-142	-3%	T2	CS
EU-27+UK	**55 471**	**40 730**	**40 527**	**100%**	**-14 944**	**-27%**	**-203**	**0%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 870	4 863	4 721	11.6%	-149	-3%	-142	-3%	T2	CS
EU-KP	**55 471**	**40 730**	**40 527**	**100%**	**-14 944**	**-27%**	**-203**	**0%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.57 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Spain (21%), Netherlands (15%), France (15%), Italy (13%), United Kingdom (12%) and Belgium (8%) which together represent 82% share on EU-KP emissions.

Figure 3.57: 1.A.2.c Chemicals, Gaseous fuels: Emission trend and share for CO_2

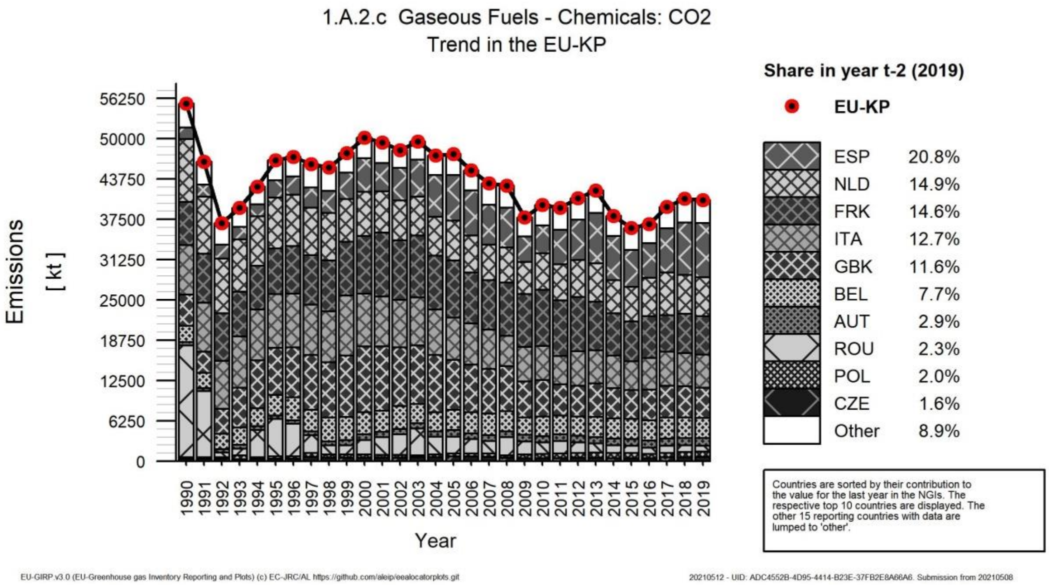


Figure 3.58 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. CO_2 IEF shows stable trend for the whole time series. CO_2 IEF equaled to 56.37 t/TJ in 2019.

Figure 3.58: 1.A.2.c Chemicals, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

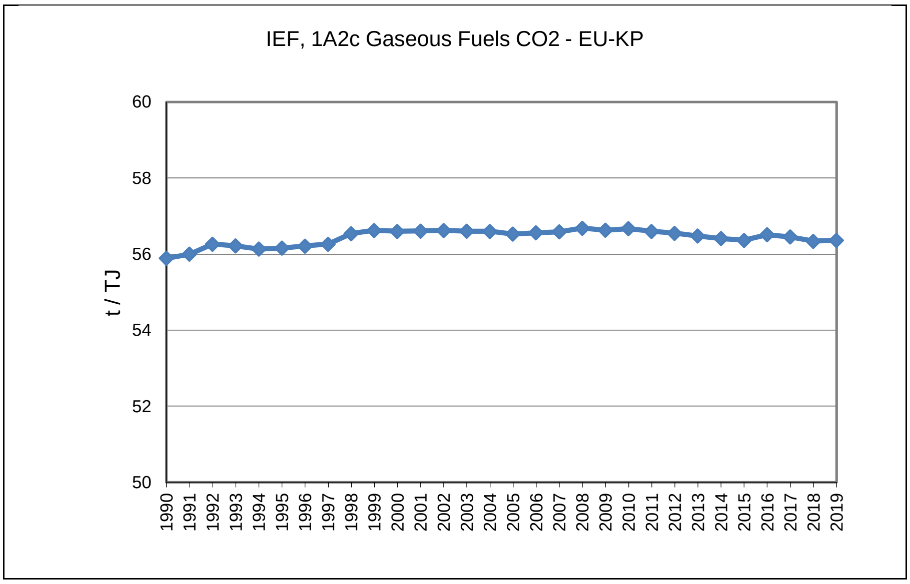
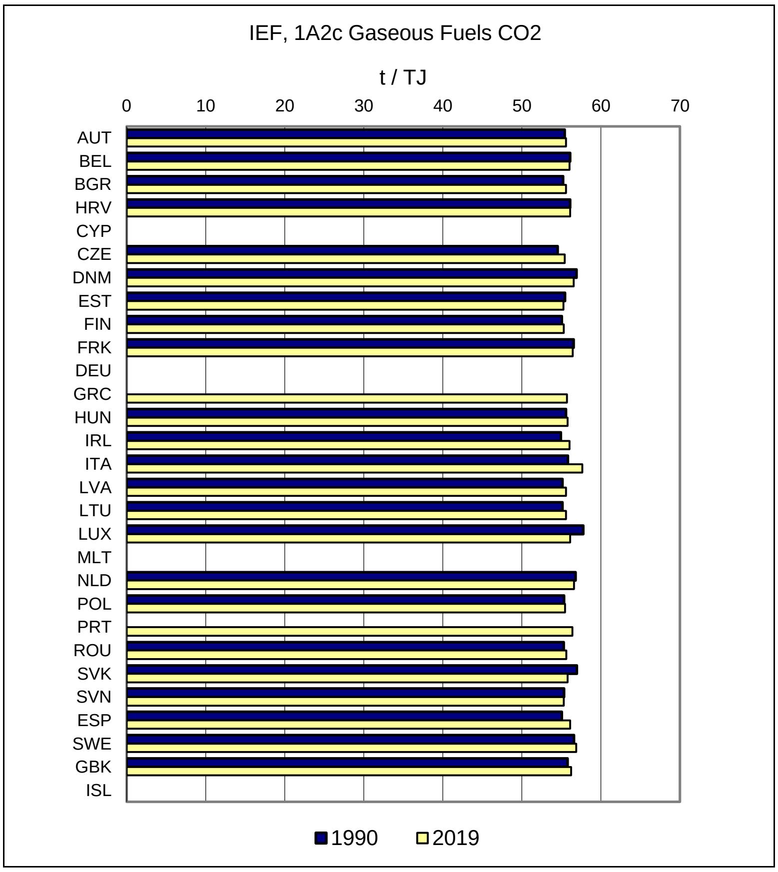


Figure 3.59 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. No significant differences between CO_2 IEF used by EU-KP are occurring as also no significant differences between CO_2 IEF used in 1990 and 2019 are occurring.

Figure 3.59: 1.A.2.c Chemicals, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



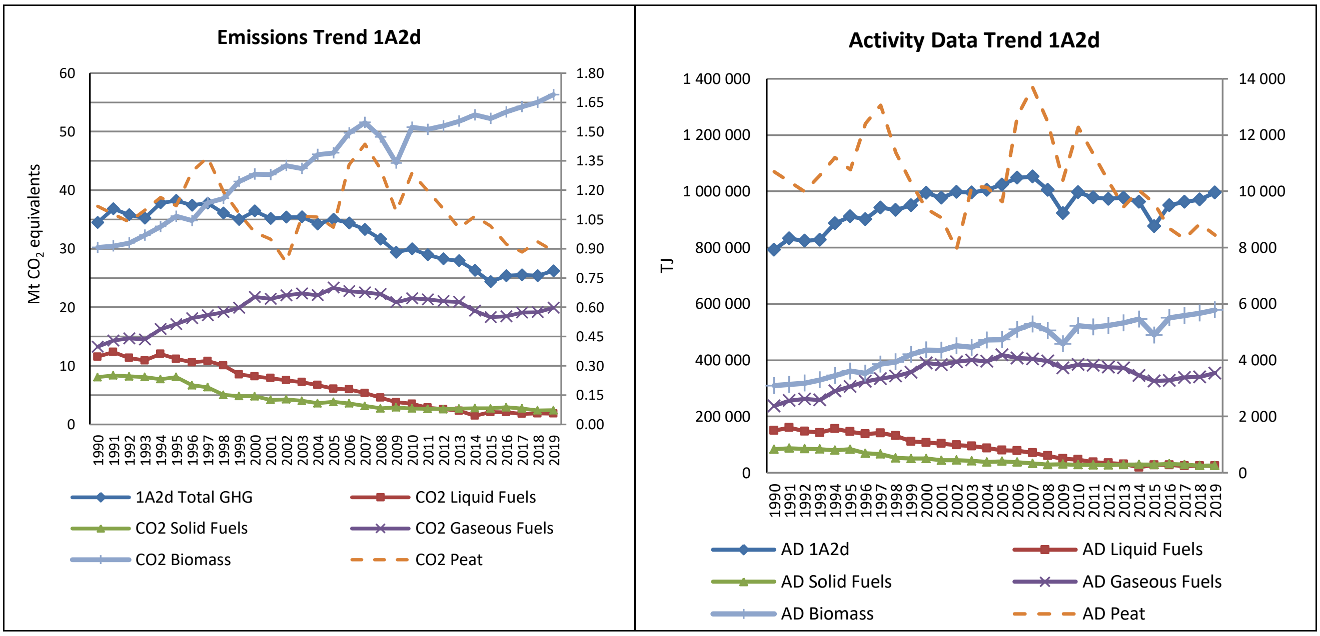
3.2.2.4 Pulp, Paper and Print (1.A.2.d)

This chapter provides information about European emission trend, Member States and United Kingdom contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.d Pulp, Paper and Print.

Total CO_2 emissions from 1.A.2.d amounted to 25 438 kt CO_2 eq. in 2019. The trend of total emissions for 1990 to 2019 from category 1.A.2.d is depicted in Figure **3.60**. Total CO_2 emissions decreased by 25% since 1990 and increased by 3% between 2018 and 2019. CO_2 emissions from 1.A.2.d Pulp, Paper and Print accounted for 5% of 1.A.2. source category.

Figure **3.60** shows the emission trend within the category 1.A.2.d, which is dominated by CO_2 emissions from gaseous fuels in 2019. The share of liquid fuels on CO_2 emissions from 1.A.2.d decreased from 34% in 1990 to 7% in 2019. The share of solid fuels on CO_2 emissions from 1.A.2.d decreased from 24% in 1990 to 9% in 2019. The share of gaseous fuels on CO_2 emissions from 1.A.2.d increased from 39% in 1990 to 78% in 2019. This sector includes a high amount of biomass consumption which is also gradually increasing since 1990. The activity data shows a strong switch from liquid and solid fuels to gaseous fuels and biomass.

Figure 3.60: 1.A.2.d Pulp, Paper and Print: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Note that total CO_2 emissions in the figure on the left side do not include CO_2 from biomass whereas total activity data in the figure on the right side includes AD biomass.

Detailed data related to the EU-KP submissions are depicted in Table 3.35. Malta and Iceland report emissions as 'NO' (not occurring). Seven Member States report increase of CO_2 emissions compared to level of emissions in 1990. The most significant increase of CO_2 emissions was reported by Bulgaria, Hungary and Poland (which together represent 8% share on total EU-KP emissions).

Table 3.35: 1.A.2.d Pulp, Paper and Print: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	2 208	1 880	1 943	7.6%	-265	-12%	63	3%	T1,T2	CS,D
Belgium	644	511	537	2.1%	-106	-17%	26	5%	T1,T3	D,PS
Bulgaria	16	107	102	0.4%	87	557%	-5	-4%	T1,T2	CS,D
Croatia	303	93	111	0.4%	-193	-64%	18	19%	T1	D
Cyprus	5	3	3	0.0%	-2	-36%	0	18%	T1	D
Czechia	2 285	409	444	1.7%	-1 842	-81%	35	9%	T1,T2	CS,D
Denmark	330	80	62	0.2%	-268	-81%	-18	-23%	T1,T2,T3	CS,D
Estonia	145	62	62	0.2%	-83	-57%	0	1%	T1,T2	CS,D
Finland	5 330	2 555	2 464	9.7%	-2 865	-54%	-91	-4%	T3	CS,D
France	4 009	2 646	2 542	10.0%	-1 467	-37%	-104	-4%	T2	CS
Germany	4	7	4	0.0%	1	20%	-2	-33%	CS	CS
Greece	306	91	93	0.4%	-213	-70%	2	2%	T2	CS
Hungary	74	423	469	1.8%	395	536%	46	11%	T1,T2,T3	CS,D,PS
Ireland	28	13	13	0.1%	-15	-53%	0	1%	T2	CS
Italy	3 108	4 916	4 965	19.5%	1 858	60%	49	1%	T2	CS
Latvia	168	6	6	0.0%	-163	-97%	-1	-10%	T2	CS
Lithuania	255	43	39	0.2%	-217	-85%	-4	-10%	T2	CS
Luxembourg	NO,IE	2	2	0.0%	2	∞	0	8%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 668	966	924	3.6%	-744	-45%	-41	-4%	T2	CS
Poland	284	1 307	1 461	5.7%	1 177	414%	154	12%	T1,T2	CS,D
Portugal	754	1 307	1 355	5.3%	601	80%	48	4%	T1	D
Romania	NO	156	213	0.8%	213	∞	57	36%	T1,T2	CS,D
Slovakia	2 329	346	434	1.7%	-1 895	-81%	89	26%	T2	CS
Slovenia	380	309	312	1.2%	-67	-18%	3	1%	T1,T2,T3	CS,D,PS
Spain	2 602	4 223	4 790	18.8%	2 188	84%	567	13%	T1,T2,T3	CS,D,PS
Sweden	2 189	777	691	2.7%	-1 498	-68%	-86	-11%	T2	CS
United Kingdom	4 624	1 420	1 394	5.5%	-3 230	-70%	-26	-2%	T2	CS
EU-27+UK	**34 049**	**24 656**	**25 438**	**100%**	**-8 611**	**-25%**	**782**	**3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 624	1 420	1 394	5.5%	-3 230	-70%	-26	-2%	T2	CS
EU-KP	**34 049**	**24 656**	**25 438**	**100%**	**-8 611**	**-25%**	**782**	**3%**	**-**	**-**

Emissions of Luxembourg from 1990 to 1999 are included in 1.A.2.g. Emissions of Malta are reported in 1.A.2.g. Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1.A.2.d Pulp, Paper and Print – Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.d amounted 1 826 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 84% and compared to 2018 by 2%. Category has 0.4% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 84% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.36. Malta, Netherlands and Iceland report emissions as 'NO' (not occurring). Germany reports emissions as 'IE' (include elsewhere) and reports them in 1.A.2.g Other. Six Member States use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 87% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.d – Liquid Fuels (CO_2)). All Member States reported lower level of emissions in 2019 than in 1990 (except of Poland, which has 7% share on total EU-KP emissions in 2019).

Table 3.36: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	853	13	8	0.4%	-845	-99%	-6	-43%	T2	CS
Belgium	235	8	7	0.4%	-227	-97%	-1	-7%	T1,T3	D,PS
Bulgaria	16	1	3	0.2%	-13	-82%	1	97%	NA	NA
Croatia	58	3	3	0.2%	-56	-95%	0	0%	T1	D
Cyprus	5	3	3	0.2%	-2	-36%	0	18%	T1	D
Czechia	461	10	3	0.2%	-457	-99%	-7	-67%	T1	CS,D
Denmark	81	4	4	0.2%	-77	-95%	0	3%	T1,T2	CS,D
Estonia	145	NO	1	0.1%	-144	-99%	1	∞	T1,T2	CS,D
Finland	1 138	484	474	26.0%	-664	-58%	-10	-2%	T3	CS
France	1 352	110	102	5.6%	-1 250	-92%	-8	-7%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	302	48	49	2.7%	-253	-84%	1	2%	T2	CS
Hungary	19	3	3	0.2%	-16	-84%	0	0%	T1	D
Ireland	28	3	2	0.1%	-26	-91%	0	-3%	T2	CS
Italy	1 017	35	18	1.0%	-999	-98%	-18	-50%	T2	CS
Latvia	16	0	0	0.0%	-15	-98%	0	33%	T2	CS
Lithuania	69	4	4	0.2%	-64	-94%	1	21%	T2	CS
Luxembourg	IE	0	0	0.0%	0	∞	0	25%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	2	NO	NO	-	-2	-100%	-	-	NA	NA
Poland	106	119	129	7.0%	23	21%	10	8%	T1,T2	CS,D
Portugal	754	159	231	12.7%	-523	-69%	72	45%	T1	D
Romania	NO	1	3	0.2%	3	∞	2	260%	T1,T2	CS,D
Slovakia	985	3	3	0.1%	-982	-100%	0	-7%	T2	CS
Slovenia	98	7	3	0.2%	-95	-97%	-4	-60%	T1	D
Spain	1 247	176	188	10.3%	-1 059	-85%	12	7%	T1,T2,T3	CS,D,PS
Sweden	1 786	660	578	31.7%	-1 208	-68%	-82	-12%	T2	CS
United Kingdom	769	7	6	0.3%	-763	-99%	0	-6%	T2	CS
EU-27+UK	**11 539**	**1 861**	**1 826**	**100%**	**-9 714**	**-84%**	**-35**	**-2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	769	7	6	0.3%	-763	-99%	0	-6%	T2	CS
EU-KP	**11 539**	**1 861**	**1 826**	**100%**	**-9 714**	**-84%**	**-35**	**-2%**	**-**	**-**

Emissions of Germany are included in 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.61 shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Sweden (32%), Finland (26%), Portugal (13%), Spain (10%), Poland (7%) and France (6%) which together represent 93% share on EU-KP emissions.

Figure 3.61: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Emission trend and share for CO_2

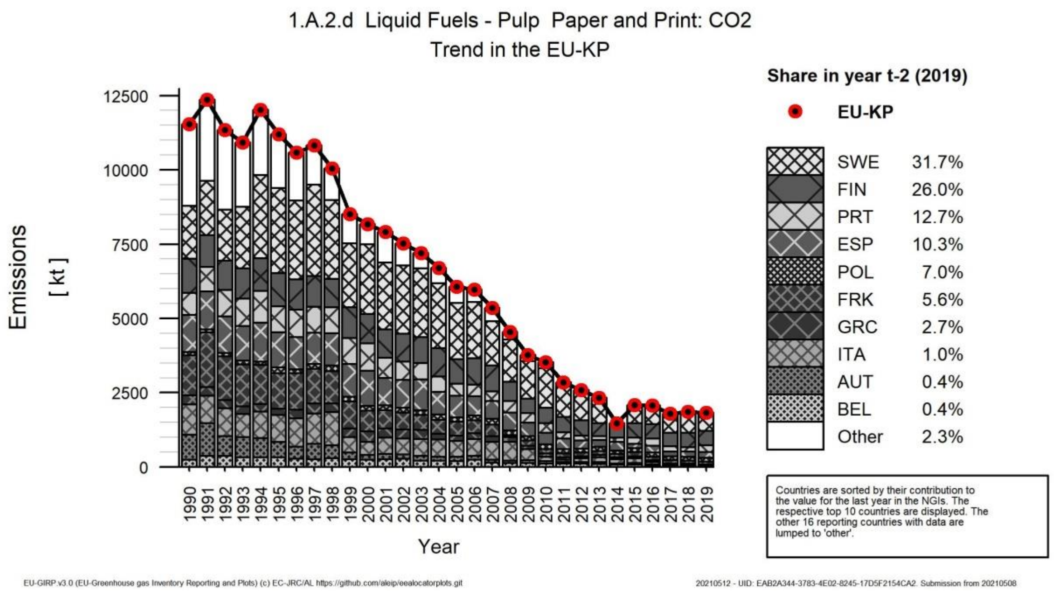


Figure.3.62 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. It can be seen that CO_2 IEF is decreasing during whole time period, which is caused by increasing consumption of Liquified Petroleum Gas with lower CO_2 IEF and decreasing consumption of Heavy Fuel Oil with higher CO_2 IEF. Slight fluctuation occurred during few last years. CO_2 IEF equaled to 75.06 t/TJ in 2019.

Figure.3.62: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

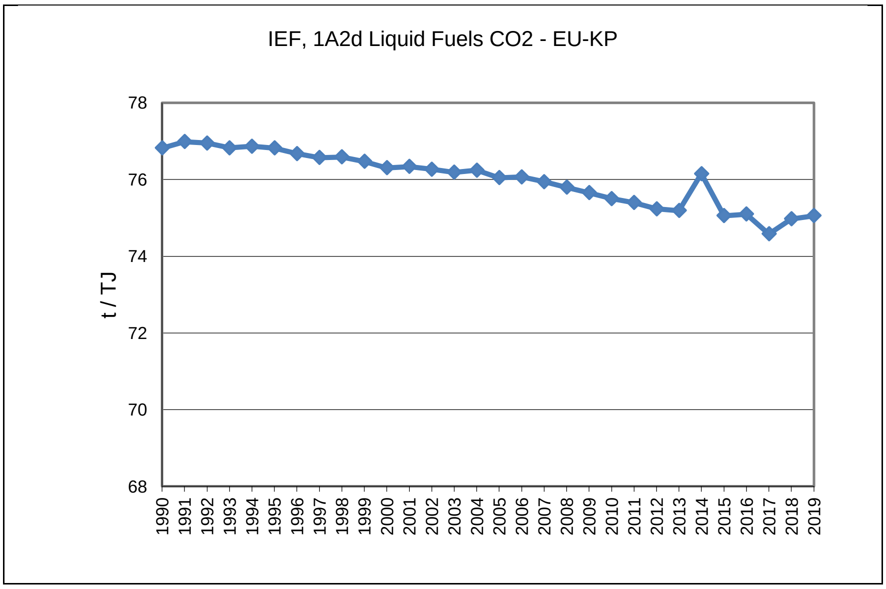
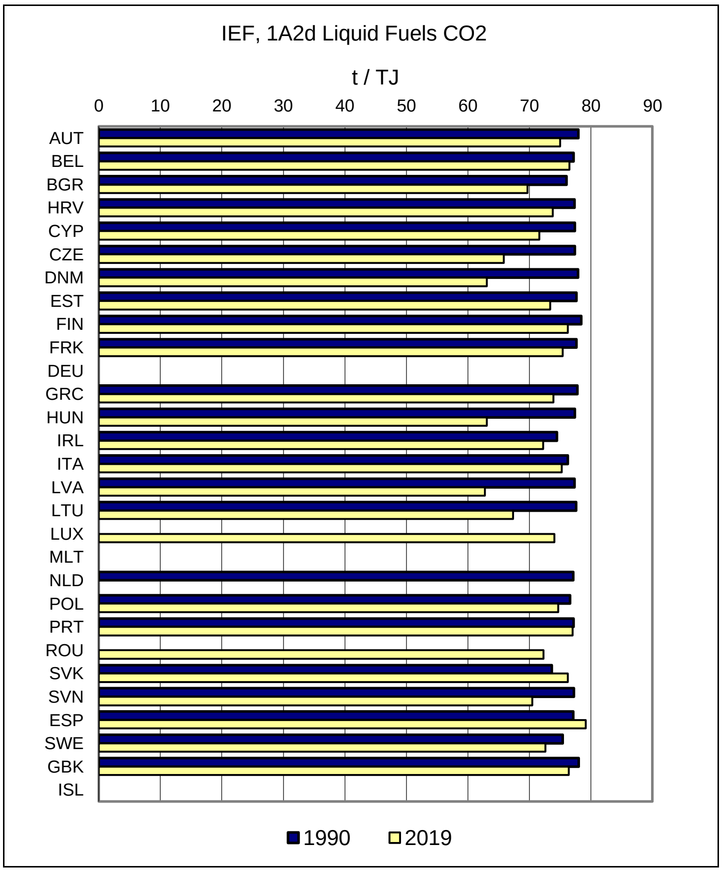


Figure.3.63 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. No major differences between countries CO_2 IEF occur.

Figure.3.63: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.d Pulp, Paper and Print - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.d amounted 2 402 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 70% and increased by 1% compared to 2018. This category represents 0.5% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 70% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table **3.37**. Fifteen Member States and Iceland report emissions as 'NO' (not occurring). Germany reports emissions as 'IE' (include elsewhere) and reports them in 1.A.2.g Other. Belgium uses for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 96% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.d – Solid Fuels (CO_2)). All Member States reported lower level of emissions in 2019 than in 1990 (except of Hungary and Poland which together have 41% share on EU-KP emissions).

Table 3.37: 1.A.2.d Pulp, Paper and Print, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	398	371	366	15.2%	-32	-8%	-5	-1%	T2	CS
Belgium	128	91	88	3.7%	-39	-31%	-3	-3%	T1	D
Bulgaria	NO	5	4	0.2%	4	∞	-1	-14%	T1,T2	CS,D
Croatia	68	NO	NO	-	-68	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 646	134	163	6.8%	-1 483	-90%	29	21%	T2	CS,D
Denmark	125	NO	NO	-	-125	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 318	181	171	7.1%	-1 147	-87%	-11	-6%	T3	CS
France	583	92	28	1.2%	-555	-95%	-64	-69%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	4	NO	NO	-	-4	-100%	-	-	NA	NA
Hungary	6	281	270	11.2%	265	4754%	-11	-4%	T3	PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	6	NO	NO	-	-6	-100%	-	-	NA	NA
Latvia	3	NO	NO	-	-3	-100%	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	8	NO	NO	-	-8	-100%	-	-	NA	NA
Poland	173	665	721	30.0%	548	317%	56	8%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	1 142	152	206	8.6%	-936	-82%	54	35%	T2	CS
Slovenia	172	107	108	4.5%	-65	-38%	0	0%	T3	PS
Spain	277	NO	NO	-	-277	-100%	-	-	NA	NA
Sweden	265	29	25	1.0%	-240	-91%	-5	-16%	T2	CS
United Kingdom	1 733	266	252	10.5%	-1 480	-85%	-13	-5%	T2	CS
EU-27+UK	**8 052**	**2 375**	**2 402**	**100%**	**-5 650**	**-70%**	**27**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 733	266	252	10.5%	-1 480	-85%	-13	-5%	T2	CS
EU-KP	**8 052**	**2 375**	**2 402**	**100%**	**-5 650**	**-70%**	**27**	**1%**	**-**	**-**

Emissions of Germany are included in 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.64 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen, that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Poland (30%), Austria (15%), Hungary (11%), United Kingdom (11%) and Slovakia (9%) which together represent 76% share on EU-KP emissions.

Figure 3.64: 1.A.2.d Pulp, Paper and Print, Solid fuels: Emission trend and share for CO_2

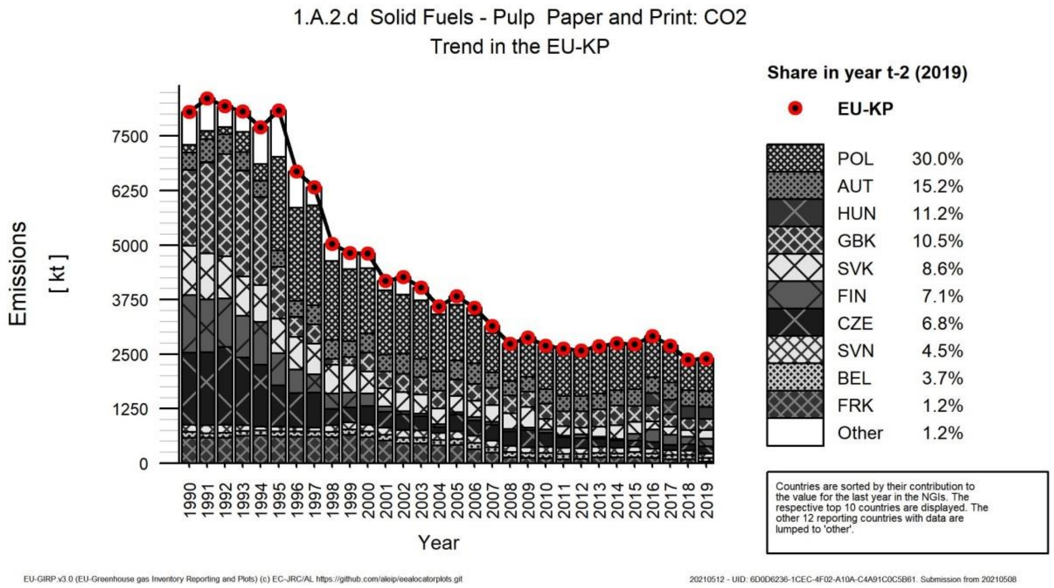


Figure 3.65 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. CO_2 IEF equaled to 94.23 t/TJ in 2019.

Figure 3.65: 1.A.2.d Pulp, Paper and Print, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

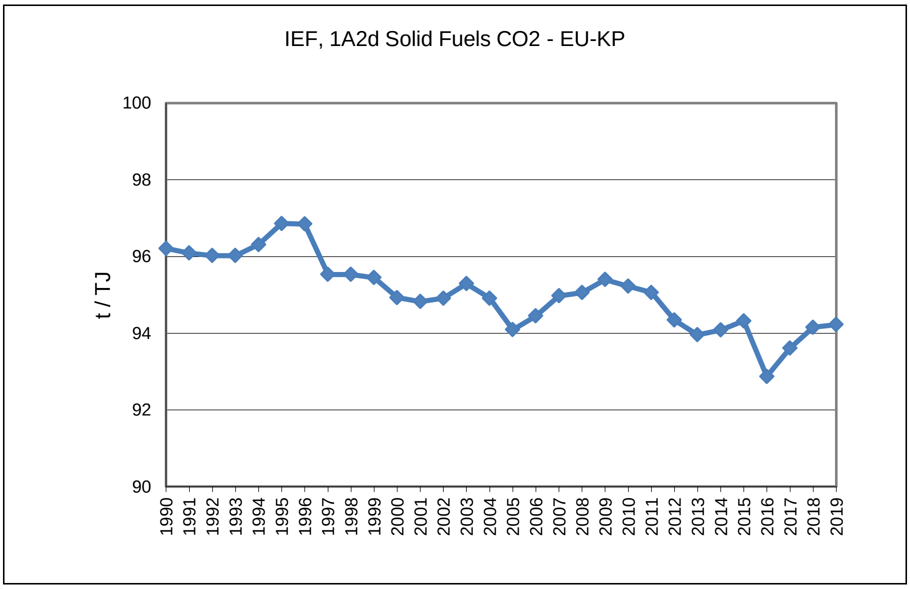
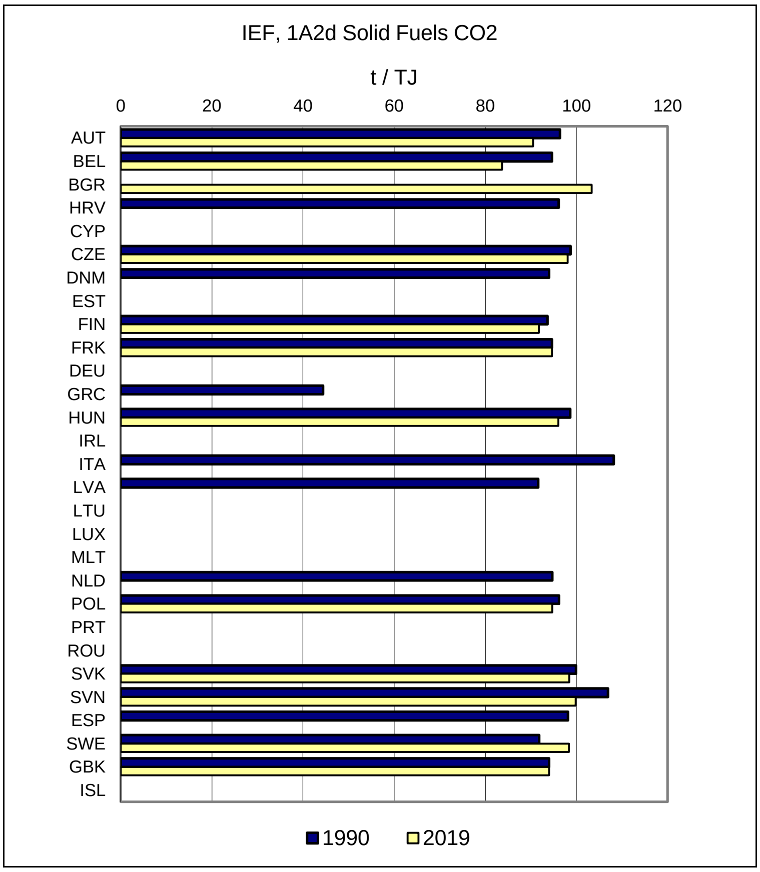


Figure 3.66 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019.

Figure 3.66: 1.A.2.d Pulp, Paper and Print, Solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.d Pulp, Paper and Print - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.d amounted 19 914 kt in 2019 for EU-KP. CO_2 emissions increased compared to year 1990 by 50% and compared to 2018 by 4%. This cCategory has 4% share on total CO_2 equivalent emissions from category 1.A.2.. Fuel consumption increased by 49% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.38. Cyprus, Malta and Iceland report emissions as 'NO' (not occurring). Germany reports emissions as 'IE' (include elsewhere) and reports them in 1.A.2.g Other. Belgium, Croatia and Portugal use for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 92% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.d – Gaseous Fuels (CO_2)). Six Member States and United Kingdom reported lower level of emissions in 2019 than in 1990, the rest of Member States reported increase of emissions compared to 1990. Most rapid increase of emissions compared to 1990 was reported by Poland, Spain, Italy and Hungary (which together have 51% share on total EU-KP emissions).

Table 3.38: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	943	1 473	1 562	7.8%	620	66%	89	6%	T2	CS
Belgium	282	315	335	1.7%	53	19%	20	6%	T1	D
Bulgaria	NO	100	95	0.5%	95	∞	-5	-5%	T2	CS
Croatia	177	90	108	0.5%	-69	-39%	18	20%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	179	265	278	1.4%	99	56%	13	5%	T2	CS
Denmark	124	77	58	0.3%	-66	-53%	-18	-24%	T3	CS
Estonia	NO	62	61	0.3%	61	∞	-1	-1%	T2	CS
Finland	1 757	879	840	4.2%	-916	-52%	-39	-4%	T3	CS
France	2 074	2 421	2 385	12.0%	311	15%	-36	-1%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	43	44	0.2%	44	∞	1	2%	T2	CS
Hungary	50	111	117	0.6%	68	136%	6	5%	T2	CS
Ireland	NO	11	11	0.1%	11	∞	0	3%	T2	CS
Italy	2 085	4 881	4 947	24.8%	2 863	137%	67	1%	T2	CS
Latvia	150	6	5	0.0%	-145	-96%	-1	-11%	T2	CS
Lithuania	187	39	34	0.2%	-152	-82%	-5	-13%	T2	CS
Luxembourg	IE	1	2	0.0%	2	∞	0	6%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 659	966	924	4.6%	-734	-44%	-41	-4%	T2	CS
Poland	6	472	551	2.8%	545	9778%	79	17%	T2	CS
Portugal	NO	1 147	1 124	5.6%	1 124	∞	-23	-2%	T1	D
Romania	NO	146	197	1.0%	197	∞	51	35%	T2	CS
Slovakia	203	181	222	1.1%	20	10%	41	23%	T2	CS
Slovenia	110	194	202	1.0%	92	84%	8	4%	T2	CS
Spain	1 078	4 046	4 602	23.1%	3 523	327%	555	14%	T2,T3	CS,PS
Sweden	66	75	74	0.4%	8	12%	-1	-2%	T2	CS
United Kingdom	2 122	1 147	1 135	5.7%	-987	-47%	-12	-1%	T2	CS
EU-27+UK	**13 249**	**19 148**	**19 914**	**100%**	**6 665**	**50%**	**766**	**4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 122	1 147	1 135	5.7%	-987	-47%	-12	-1%	T2	CS
EU-KP	**13 249**	**19 148**	**19 914**	**100%**	**6 665**	**50%**	**766**	**4%**	**-**	**-**

Emissions of Germany are included in 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.67 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Italy (25%), Spain (23%), France (12%), Austria (8%), United Kingdom (6%), Portugal (6%), Netherlands (5%) and Finland (4%) which together have 88% share on EU-KP emissions.

Figure 3.67: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Emission trend and share for CO_2

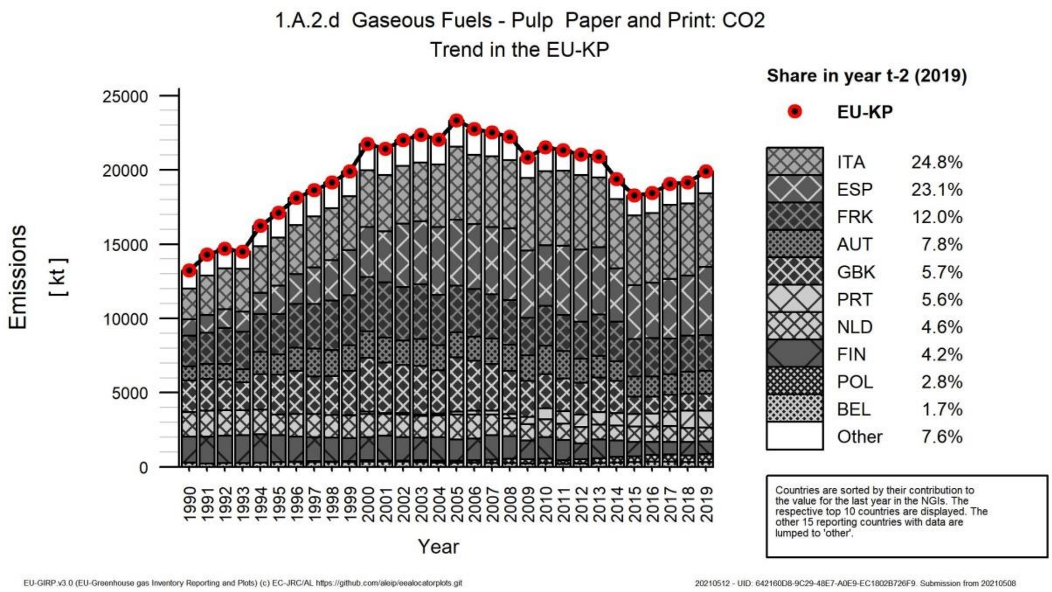


Figure 3.68 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. CO_2 IEF shows relatively stable slightly increasing trend without major fluctuations for whole time series. The main reason for increasing trend of the CO_2 IEF is the growing share of Italy and Spain on total EU-KP emissions; their CO_2 IEFs have been slightly growing since 1990. CO_2 IEF equaled to 56.58 t/TJ in 2019.

Figure 3.68: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

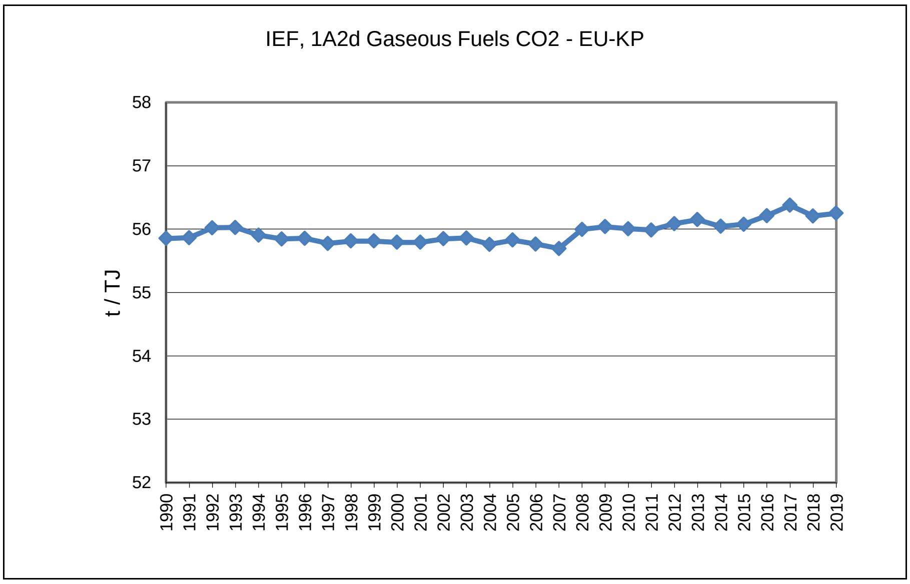
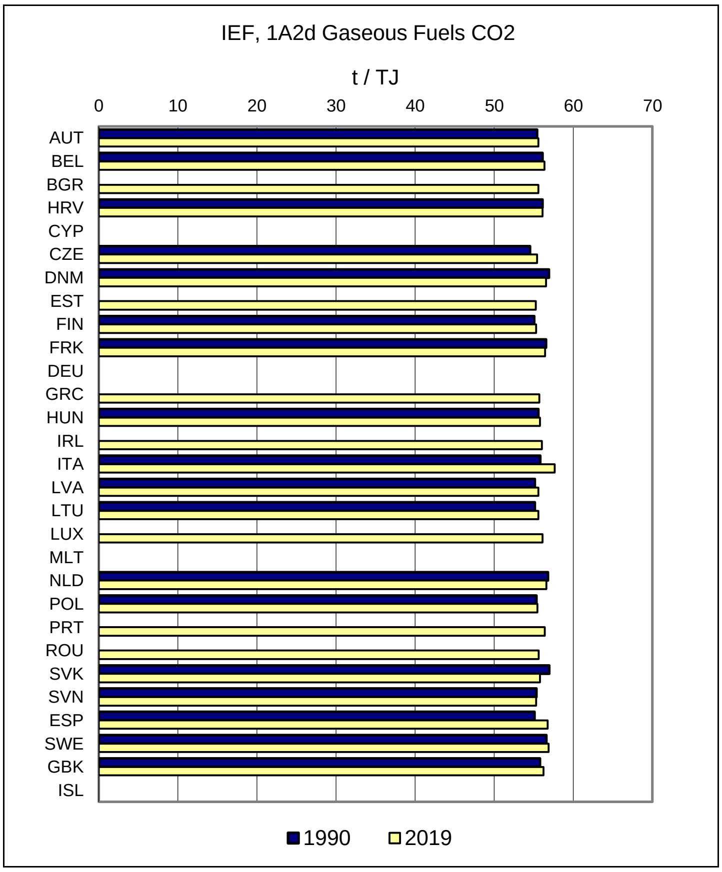


Figure 3.69 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. It can be seen that no major differences between CO_2 IEF used by countries occur, also no major differences between 1990 and 2019 CO_2 IEFs occur.

Figure 3.69: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



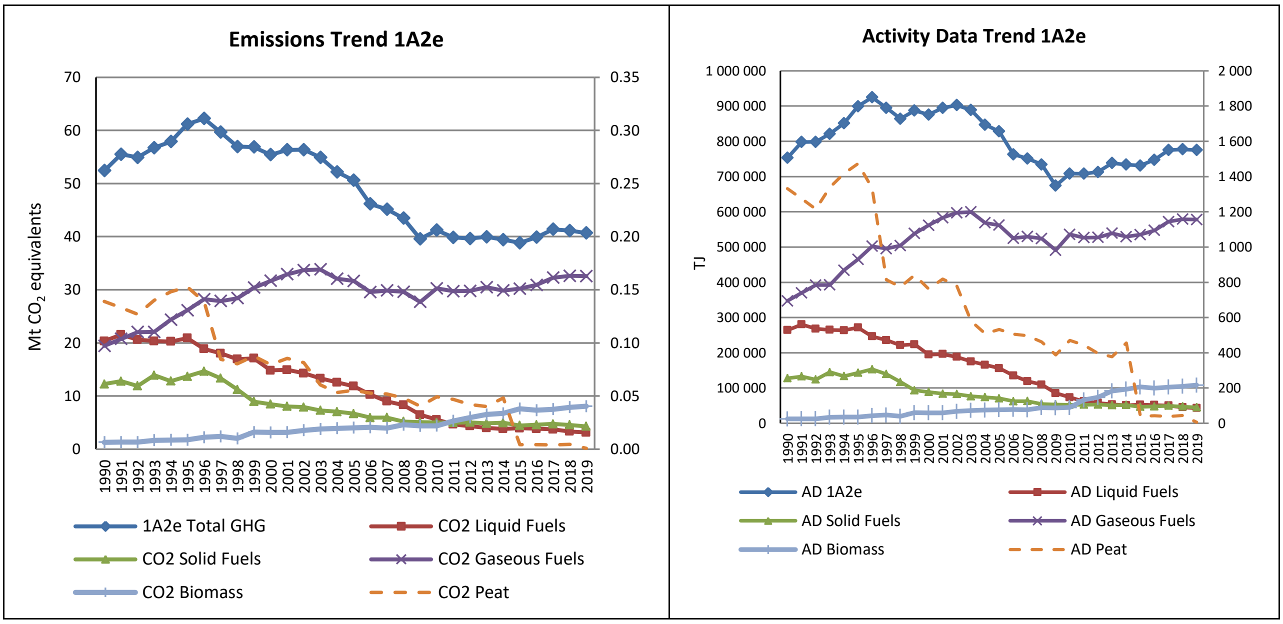
3.2.2.5 Food Processing, Beverages and Tobacco (1.A.2.e)

This chapter provides information about European emission trend, Member States, Iceland and United Kingdom contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.e Food Processing, Beverages and Tobacco.

Total CO_2 emissions from 1.A.2.e amounted to 40 033 kt CO_2 eq. in 2019. The trend of total CO_2 emissions for 1990 to 2019 from category 1.A.2.e is depicted in Figure 3.70. Total CO_2 emissions decreased by 23% since 1990 and by 1% between 2018 and 2019. CO_2 emissions from 1.A.2.e Food Processing, Beverages and Tobacco accounted for 8% of 1.A.2. source category.

Figure 3.70 shows the emission trend within the category 1.A.2.e, which is dominated by CO_2 emissions from gaseous fuels in 2019. The share of liquid fuels on CO_2 emissions from 1.A.2.e decreased from 39% in 1990 to 8% in 2019. The share of solid fuels on CO_2 emissions from 1.A.2.e decreased from 23% in 1990 to 11% in 2019. The share of gaseous fuels on CO_2 emissions from 1.A.2.e increased from 37% in 1990 to 81% in 2019.

Figure 3.70: 1.A.2.e Food Processing, Beverages and Tobacco: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table 3.39. Malta reports emissions as ‘NO’ (not occurring). Five Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emissions was reported by Romania which represent 2% share on total EU-KP emissions.

Table 3.39: 1.A.2.e Food Processing, Beverages and Tobacco: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	870	764	734	1.8%	-136	-16%	-30	-4%	T1,T2	CS,D
Belgium	3 023	2 424	2 466	6.2%	-557	-18%	42	2%	T1,T3	D,PS
Bulgaria	454	238	228	0.6%	-226	-50%	-10	-4%	T1,T2	CS,D
Croatia	729	334	336	0.8%	-394	-54%	2	0%	T1	D
Cyprus	73	66	67	0.2%	-6	-8%	1	2%	T1	D
Czechia	2 988	984	883	2.2%	-2 105	-70%	-101	-10%	T1,T2	CS,D
Denmark	1 540	1 073	899	2.2%	-641	-42%	-174	-16%	T1,T2,T3	CS,D
Estonia	695	67	94	0.2%	-602	-86%	27	41%	T1,T2	CS,D
Finland	828	128	146	0.4%	-682	-82%	18	14%	T3	CS,D
France	7 981	8 520	8 335	20.8%	354	4%	-185	-2%	T2	CS
Germany	2 016	199	196	0.5%	-1 820	-90%	-3	-1%	CS	CS
Greece	917	608	581	1.5%	-336	-37%	-27	-4%	T1,T2	CS,D
Hungary	1 877	860	799	2.0%	-1 078	-57%	-61	-7%	T1,T2	CS,D
Ireland	1 017	1 065	981	2.4%	-37	-4%	-84	-8%	T1,T2	CS,D
Italy	3 891	3 531	3 458	8.6%	-433	-11%	-73	-2%	T2	CS
Latvia	840	91	89	0.2%	-751	-89%	-2	-3%	T1,T2	CS,D
Lithuania	676	253	233	0.6%	-443	-65%	-20	-8%	T2	CS
Luxembourg	8	24	26	0.1%	18	220%	2	9%	T1,T2,T3	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	4 009	3 440	3 566	8.9%	-443	-11%	125	4%	T2	CS
Poland	3 715	4 526	4 495	11.2%	780	21%	-30	-1%	T1,T2	CS,D
Portugal	830	737	756	1.9%	-74	-9%	19	3%	T1	CR,D
Romania	110	780	872	2.2%	763	695%	92	12%	T1,T2	CS,D
Slovakia	1 140	323	345	0.9%	-795	-70%	22	7%	T2	CS
Slovenia	221	109	97	0.2%	-123	-56%	-12	-11%	T1,T2	CS,D
Spain	3 005	4 913	4 895	12.2%	1 890	63%	-18	0%	T1,T2	CS,D
Sweden	948	322	283	0.7%	-665	-70%	-39	-12%	T2	CS
United Kingdom	7 629	4 120	4 157	10.4%	-3 473	-46%	37	1%	T2	CS
EU-27+UK	**52 032**	**40 498**	**40 017**	**100%**	**-12 015**	**-23%**	**-480**	**-1%**	**-**	**-**
Iceland	128	26	15	0.0%	-113	-88%	-11	-42%	T1	D
United Kingdom (KP)	7 629	4 120	4 157	10.4%	-3 473	-46%	37	1%	T2	CS
EU-KP	**52 161**	**40 524**	**40 033**	**100%**	**-12 128**	**-23%**	**-491**	**-1%**	**-**	**-**

Emissions of Malta are included in 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.e amounted 3 138 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 85% and compared to 2018 by 5%. This category represent 0.7% share of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 84% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.40. Malta reports emissions as 'NO' (not occurring). Nine Member States and Iceland use for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 58% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.e – Liquid Fuels (CO_2)). All countries reported lower level of emissions in 2018 than in 1990 (except for Luxembourg which has 0.5% share on EU-KP emissions).

Table 3.40: 1.A.2.e Food Processing, Beverages and Tobacco, liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	345	31	17	0.5%	-328	-95%	-14	-45%	T2	CS
Belgium	1 689	52	51	1.6%	-1 637	-97%	-1	-1%	T1	D
Bulgaria	409	26	27	0.9%	-383	-93%	1	5%	T1	D
Croatia	342	52	51	1.6%	-292	-85%	-1	-2%	T1	D
Cyprus	73	66	67	2.1%	-6	-8%	1	2%	T1	D
Czechia	472	18	19	0.6%	-453	-96%	2	9%	T1	CS,D
Denmark	675	178	181	5.8%	-495	-73%	3	1%	T1,T2	CS,D
Estonia	695	6	37	1.2%	-659	-95%	31	493%	T1,T2	CS,D
Finland	365	46	53	1.7%	-311	-85%	7	16%	T3	CS
France	2 999	283	267	8.5%	-2 732	-91%	-17	-6%	T2	CS
Germany	908	26	26	0.8%	-882	-97%	0	-2%	CS	CS
Greece	863	490	474	15.1%	-389	-45%	-16	-3%	T2	CS
Hungary	463	23	23	0.7%	-440	-95%	0	0%	T1	D
Ireland	433	210	198	6.3%	-234	-54%	-12	-6%	T1,T2	CS,D
Italy	1 424	201	39	1.2%	-1 385	-97%	-163	-81%	T2	CS
Latvia	565	11	13	0.4%	-552	-98%	2	19%	T2	CS
Lithuania	174	31	36	1.1%	-138	-79%	5	15%	T2	CS
Luxembourg	4	14	17	0.5%	13	288%	3	23%	T1,T3	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	165	0	0	0.0%	-165	-100%	0	-57%	NA	NA
Poland	232	237	207	6.6%	-26	-11%	-30	-13%	T1,T2	CS,D
Portugal	829	213	200	6.4%	-630	-76%	-13	-6%	T1	CR,D
Romania	NO	96	130	4.1%	130	∞	33	35%	T1,T2	CS,D
Slovakia	359	1	1	0.0%	-358	-100%	0	-28%	T2	CS
Slovenia	146	25	24	0.8%	-121	-83%	-1	-2%	T1	D
Spain	2 251	822	831	26.5%	-1 420	-63%	9	1%	T1	D
Sweden	596	119	117	3.7%	-479	-80%	-2	-1%	T2	CS
United Kingdom	2 735	20	20	0.6%	-2 715	-99%	0	-2%	T2	CS
EU-27+UK	**20 211**	**3 298**	**3 124**	**100%**	**-17 087**	**-85%**	**-173**	**-5%**	**-**	**-**
Iceland	128	22	13	0.4%	-115	-90%	-9	-41%	T1	D
United Kingdom (KP)	2 735	20	20	0.6%	-2 715	-99%	0	-2%	T2	CS
EU-KP	**20 340**	**3 320**	**3 138**	**100%**	**-17 202**	**-85%**	**-183**	**-6%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.71 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Spain (26%), Greece (15%), France (9%), Poland (7%), Portugal (6%), Ireland (6%), Denmark (6%), Romania (4%) and Sweden (4%) which together represent 83% share on EU-KP emissions.

Figure 3.71: 1.A.2.e Food Processing, Beverages and Tobacco, Liquid fuels: Emission trend and share for CO_2

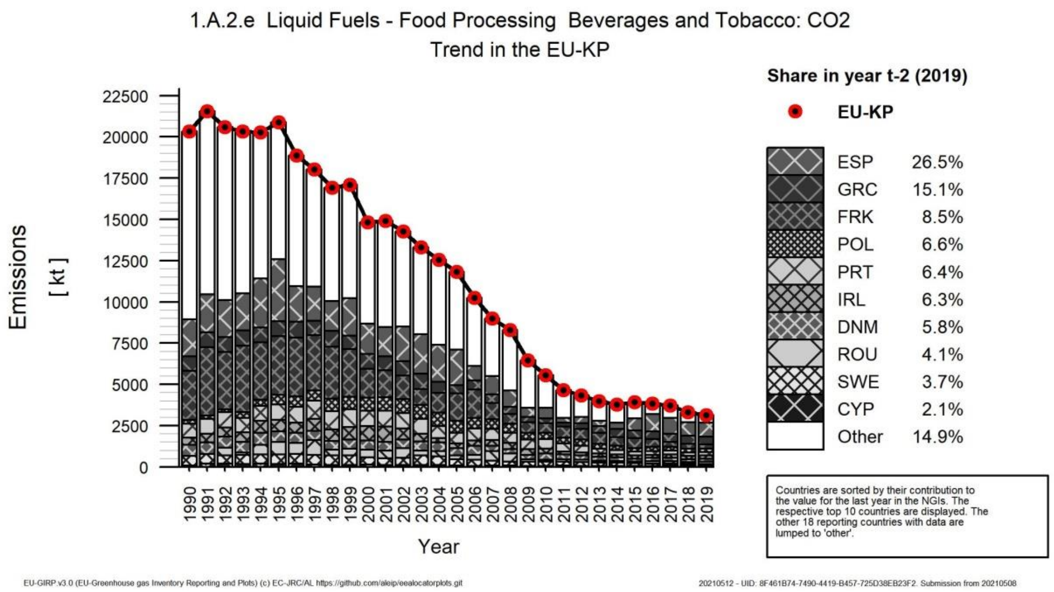


Figure 3.72 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. It can be seen that whole time series CO_2 IEF has decreasing trend with minor fluctuation between 2014 and 2018. CO_2 IEF equaled to 73.19 t/TJ in 2019.

Figure 3.72: 1.A.2.e Food Processing, Beverages and Tobacco, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

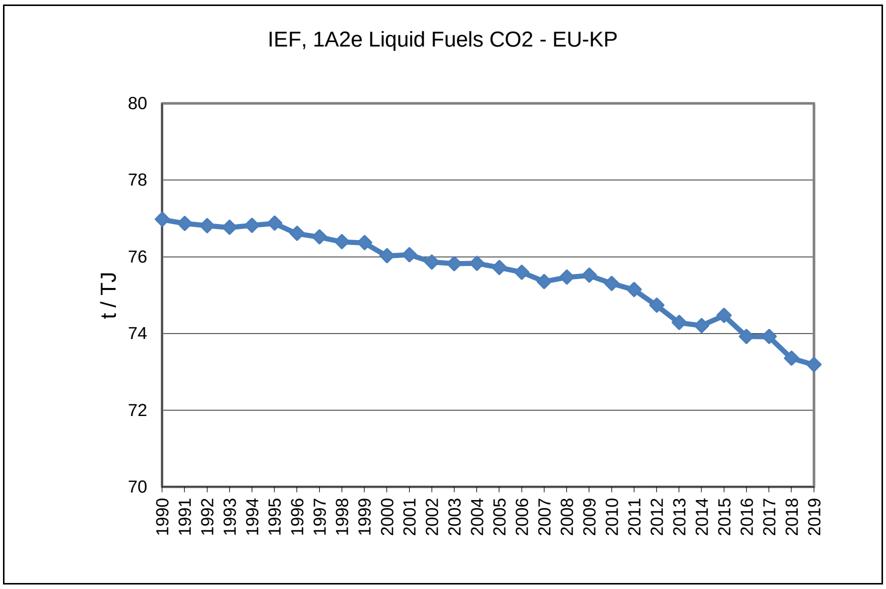
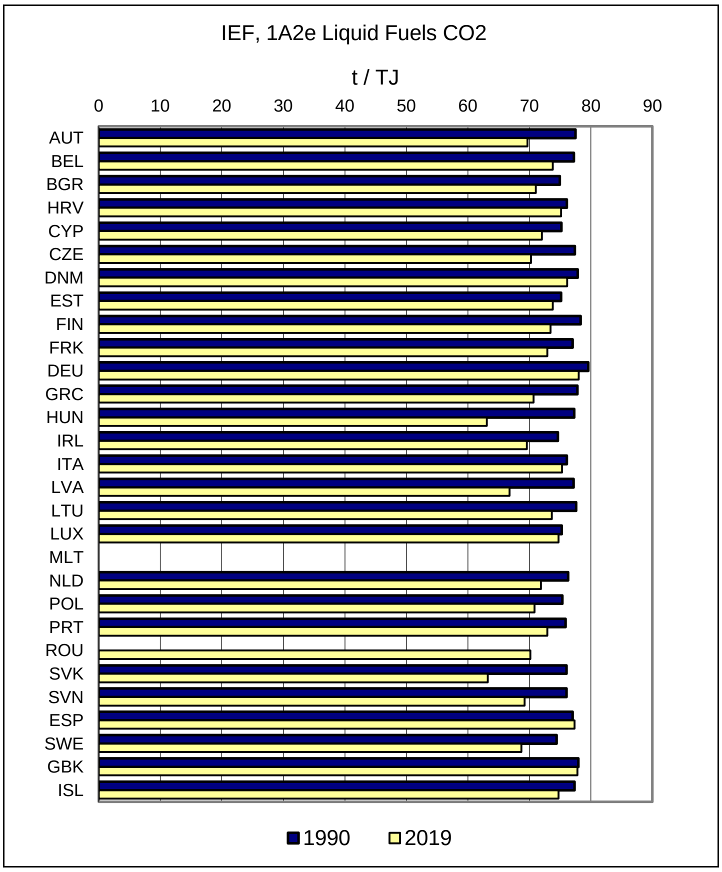


Figure 3.73 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. It can be seen that no major differences between CO_2 IEF used by countries occur. Also, no major differences between CO_2 IEF calculated in 1990 and 2019 occur.

Figure 3.73: 1.A.2.e Food Processing, Beverages and Tobacco, Liquid fuels: Implied Emissions for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.e Food Processing Beverages and Tobacco - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.e amounted 4 293 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 65% and compared to 2018 by 5%. This category represents 0.9% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 65% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.41. Eight Member States and Iceland report emissions as ‘NO’ (not occurring). Belgium, Croatia and Romania use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 96% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.e – Solid Fuels (CO_2)). All countries reported lower level of emissions in 2019 than in 1990.

Table 3.41: 1.A.2.e Food Processing, Beverages and Tobacco, Solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	18	14	13	0.3%	-5	-29%	-1	-9%	T2	CS
Belgium	651	118	118	2.7%	-533	-82%	0	0%	T1	D
Bulgaria	33	3	6	0.1%	-27	-83%	3	100%	T1,T2	CS,D
Croatia	207	62	49	1.1%	-158	-76%	-13	-21%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 789	201	176	4.1%	-1 613	-90%	-24	-12%	T2	CS,D
Denmark	399	156	80	1.9%	-319	-80%	-75	-48%	T1	D
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	257	71	75	1.8%	-181	-71%	4	5%	T3	CS
France	1 518	948	875	20.4%	-642	-42%	-72	-8%	T2	CS
Germany	1 108	173	170	4.0%	-938	-85%	-2	-1%	CS	CS
Greece	54	0	NO	-	-54	-100%	0	-100%	NA	NA
Hungary	185	9	6	0.1%	-179	-97%	-3	-34%	T1,T2	CS,D
Ireland	292	73	NO	-	-292	-100%	-73	-100%	NA	NA
Italy	87	14	10	0.2%	-77	-88%	-3	-25%	T2	CS
Latvia	100	2	1	0.0%	-99	-99%	0	-18%	T2	CS
Lithuania	33	9	7	0.2%	-26	-79%	-2	-20%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	227	144	142	3.3%	-85	-38%	-2	-1%	T2	CS
Poland	3 374	2 276	2 326	54.2%	-1 048	-31%	50	2%	T1,T2	CS,D
Portugal	1	NO	NO	-	-1	-100%	-	-	NA	NA
Romania	110	3	3	0.1%	-107	-97%	0	12%	T1	D
Slovakia	312	45	48	1.1%	-264	-85%	3	7%	T2	CS
Slovenia	9	NO	NO	-	-9	-100%	-	-	NA	NA
Spain	94	19	23	0.5%	-71	-76%	3	18%	T1,T2	CS,D
Sweden	90	8	9	0.2%	-81	-90%	2	21%	T2	CS
United Kingdom	1 289	195	154	3.6%	-1 135	-88%	-41	-21%	T2	CS
EU-27+UK	**12 237**	**4 542**	**4 293**	**100%**	**-7 944**	**-65%**	**-249**	**-5%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 289	195	154	3.6%	-1 135	-88%	-41	-21%	T2	CS
EU-KP	**12 237**	**4 542**	**4 293**	**100%**	**-7 944**	**-65%**	**-249**	**-5%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.74 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Poland (54%) and France (20%) which together represent 75% share on EU-KP emissions.

Figure 3.74: 1.A.2.e Food Processing, Beverages and Tobacco, solid fuels: Emission trend and share for CO_2

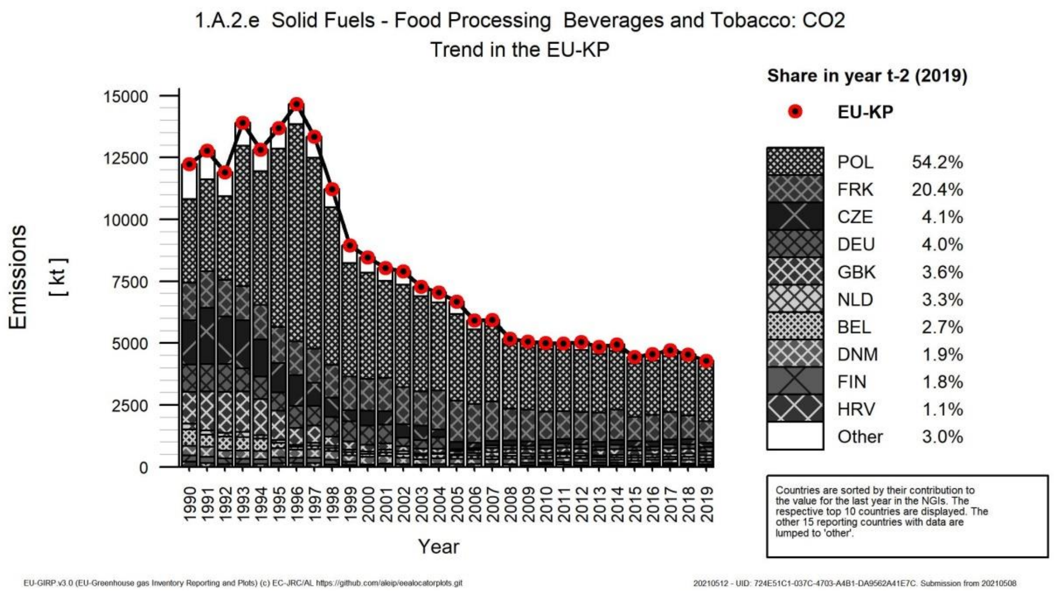


Figure 3.75 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. It can be seen that CO_2 IEF is relatively stable during whole time period with slightly increasing trend since 2006. CO_2 IEF equaled to 95.03 t/TJ in 2019.

Figure 3.75: 1.A.2.e Food Processing, Beverages and Tobacco, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

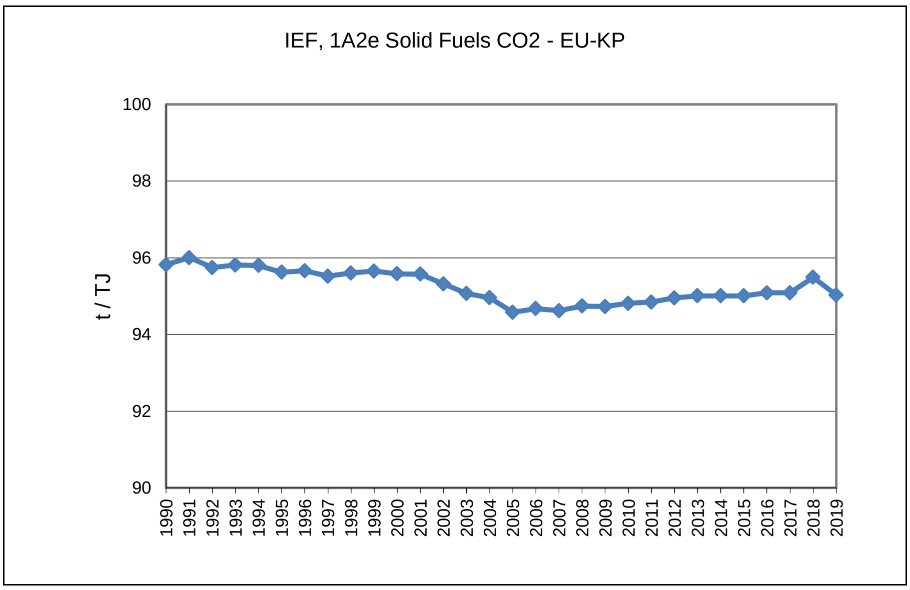
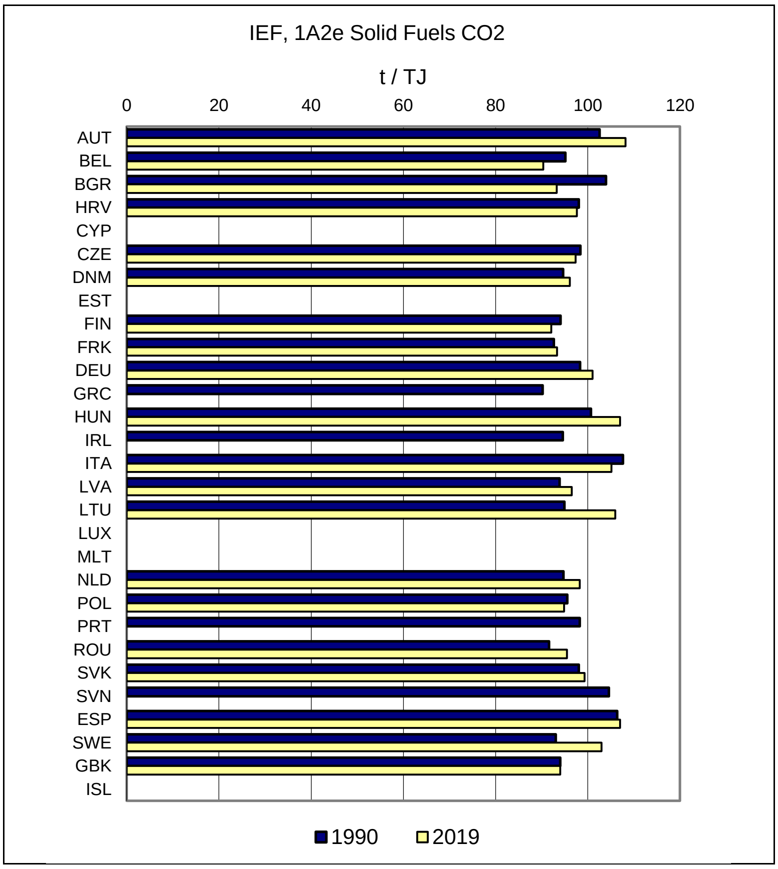


Figure 3.76 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019.

Figure 3.76: 1.A.2.e Food Processing, Beverages and Tobacco, Solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.e Food Processing Beverages and Tobacco - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.e amounted 32 551 kt in 2019 for EU-KP. CO_2 emissions increased compared to year 1990 by 67% and decreased by less than 1% compared to 2018. This category represents 6.8% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption increased by 67% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.42. Cyprus, Malta and Iceland report emissions as 'NO' (not occurring). For confidentiality reasons Germany reports emissions in 1.A.2.g. Croatia and Portugal use for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 98% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.e – Gaseous Fuels (CO_2)). Eight Member States reported lower level of emissions in 2019 than in 1990, the rest of countries reported increase of emissions.

Table 3.42: 1.A.2.e Food Processing, Beverages and Tobacco, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	507	719	704	2.2%	198	39%	-15	-2%	T2	CS
Belgium	684	2 254	2 297	7.1%	1 613	236%	43	2%	T1,T3	D,PS
Bulgaria	11	210	196	0.6%	184	1612%	-14	-7%	T2	CS
Croatia	180	220	236	0.7%	56	31%	16	7%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	727	766	687	2.1%	-40	-5%	-79	-10%	T2	CS
Denmark	466	738	638	2.0%	172	37%	-101	-14%	T3	CS
Estonia	NO	60	57	0.2%	57	∞	-3	-5%	T2	CS
Finland	67	11	17	0.1%	-50	-74%	7	60%	T3	CS
France	3 465	7 280	7 170	22.0%	3 705	107%	-110	-2%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	117	107	0.3%	107	∞	-10	-9%	T2	CS
Hungary	1 228	828	769	2.4%	-459	-37%	-58	-7%	T2	CS
Ireland	293	778	782	2.4%	489	167%	4	1%	T2	CS
Italy	2 380	3 316	3 409	10.5%	1 029	43%	93	3%	T2	CS
Latvia	175	77	74	0.2%	-101	-58%	-2	-3%	T2	CS
Lithuania	469	212	190	0.6%	-279	-60%	-22	-10%	T2	CS
Luxembourg	4	10	9	0.0%	5	142%	-1	-9%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 617	3 296	3 424	10.5%	-193	-5%	128	4%	T2	CS
Poland	109	2 013	1 963	6.0%	1 854	1701%	-50	-2%	T2	CS
Portugal	NO	524	557	1.7%	557	∞	33	6%	T1	D
Romania	NO	658	714	2.2%	714	∞	56	8%	T2	CS
Slovakia	470	277	296	0.9%	-174	-37%	19	7%	T2	CS
Slovenia	65	84	73	0.2%	7	11%	-11	-13%	T2	CS
Spain	661	4 072	4 042	12.4%	3 381	512%	-30	-1%	T2	CS
Sweden	254	195	157	0.5%	-97	-38%	-39	-20%	T2	CS
United Kingdom	3 605	3 905	3 983	12.2%	378	10%	78	2%	T2	CS
EU-27+UK	**19 437**	**32 620**	**32 551**	**100%**	**13 114**	**67%**	**-69**	**0%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 605	3 905	3 983	12.2%	378	10%	78	2%	T2	CS
EU-KP	**19 437**	**32 620**	**32 551**	**100%**	**13 114**	**67%**	**-69**	**0%**	**-**	**-**

Emissions of Germany included in 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.77 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to France (22%), Spain (12%), United Kingdom (12%), Netherlands (11%), Italy (10%), Belgium (7%) and Poland (6%) which together represent 81% share on EU-KP emissions.

Figure 3.77: 1.A.2.e Food Processing, Beverages and Tobacco, Gaseous fuels: Emission trend and share for CO_2

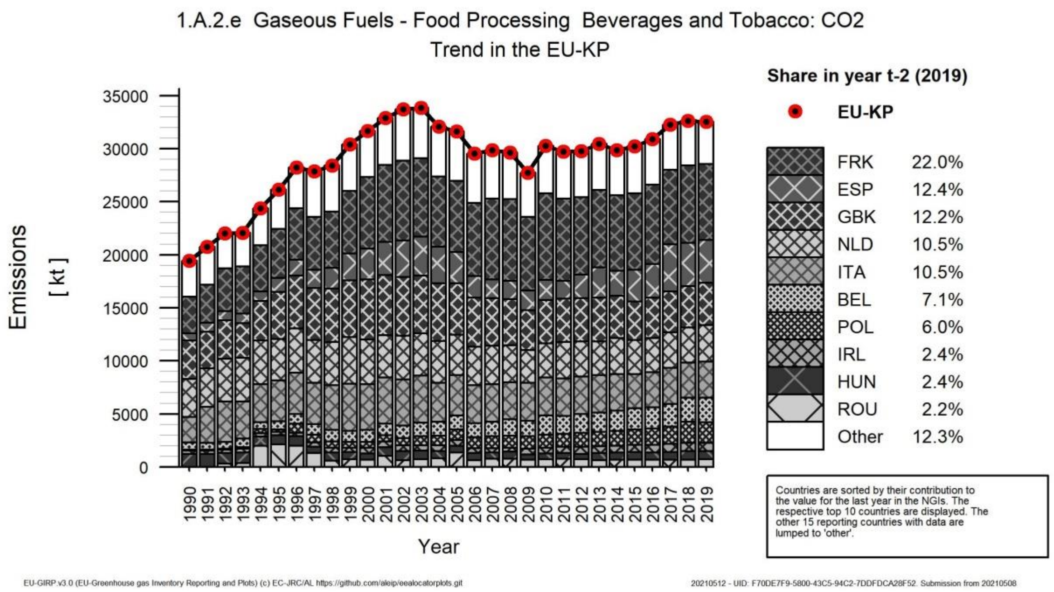


Figure 3.78 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019 which is stable during whole time period. CO_2 IEF equaled to 56.32 t/TJ in 2019.

Figure 3.78: 1.A.2.e Food Processing, Beverages and Tobacco, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

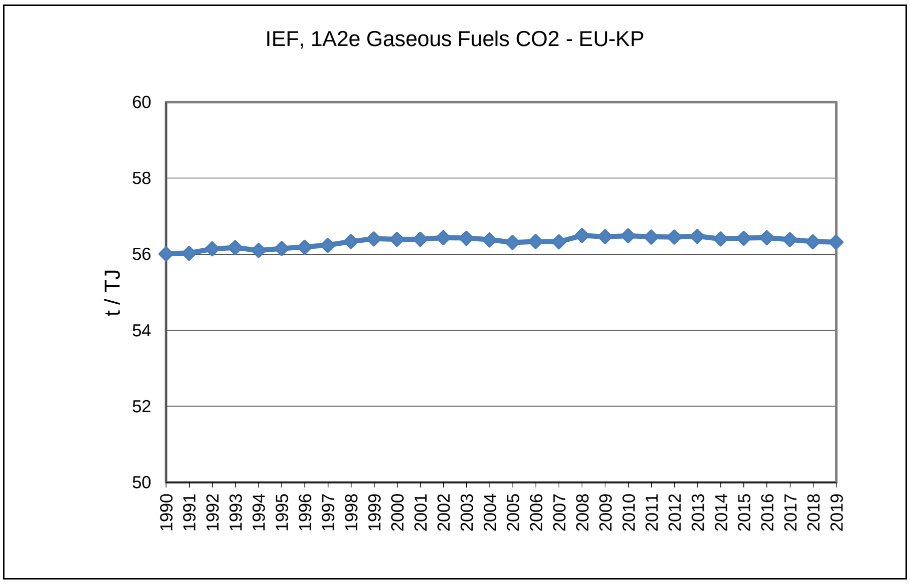
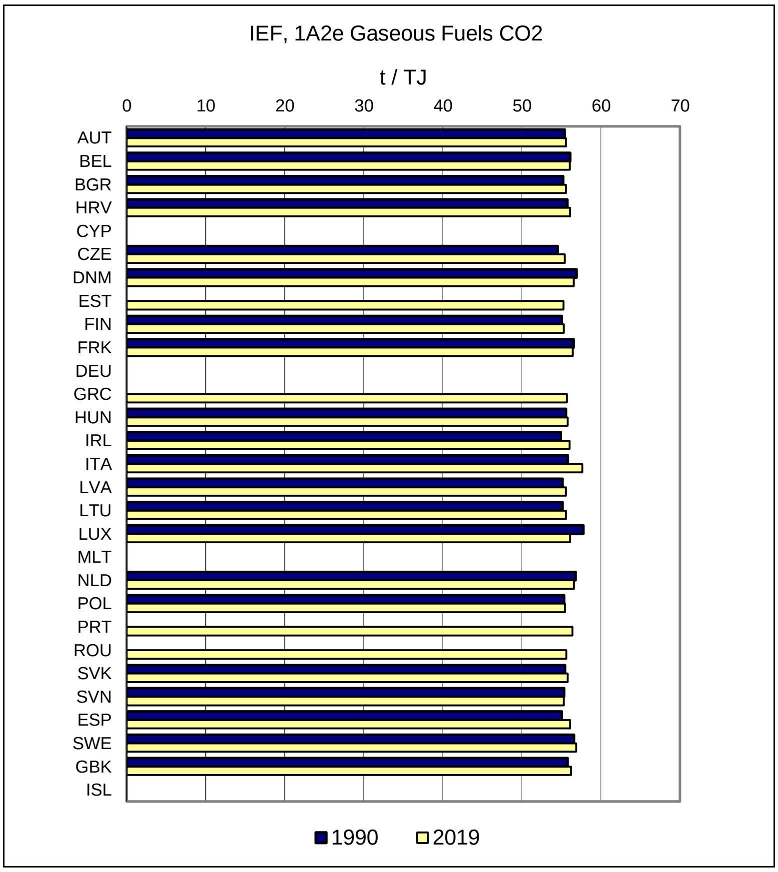


Figure 3.79 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. It can be seen that no major differences between CO_2 IEF used by countries occur, also no major differences between CO_2 IEF calculated by countries for 1990 and 2019 occur.

Figure 3.79: 1.A.2.e Food Processing, Beverages and Tobacco, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



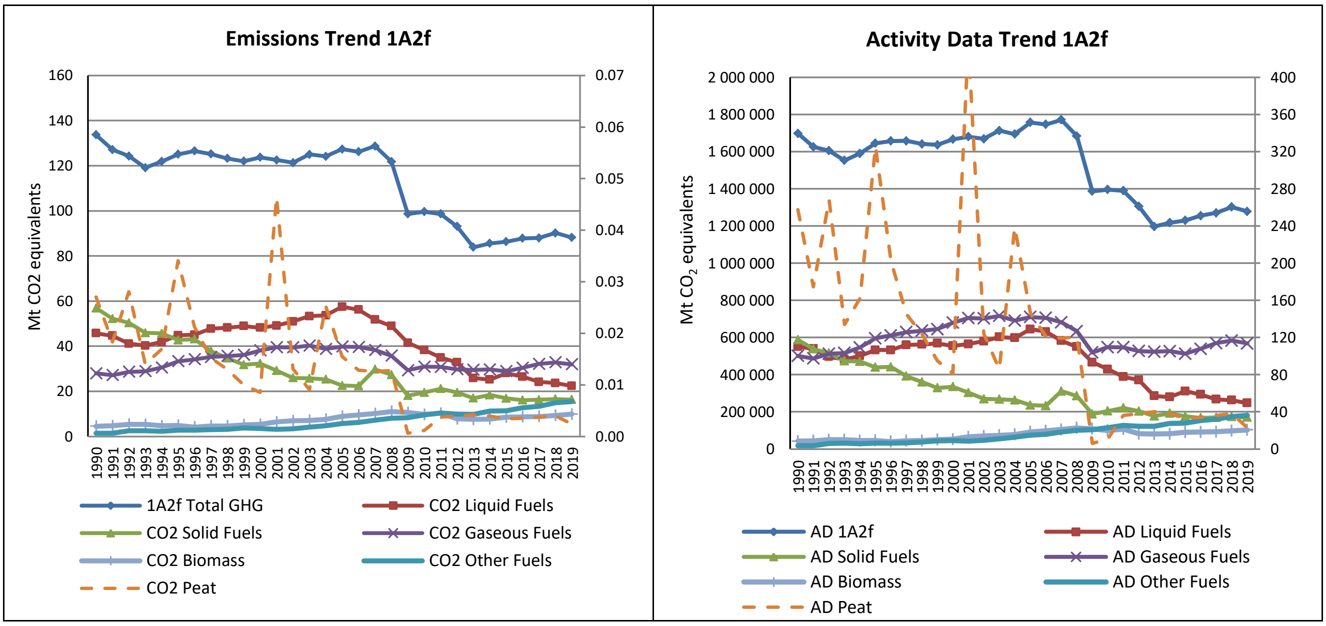
3.2.2.6 Non-metallic Minerals (1.A.2.f)

This chapter provides information about European emission trend, Member States, United Kingdom and Iceland contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.f Non-metallic Minerals.

Total CO_2 emissions from 1.A.2.f amounted to 86 944 kt CO_2 eq. in 2019. The trend of total emissions for 1990 to 2019 from category 1.A.2.f is depicted in Figure 3.80. Total CO_2 emissions decreased by 34% since 1990 and by 2% between 2018 and 2019. The sharp decline in 2009 is due to the economic crisis and sharp decline in building activity. CO_2 emissions from 1.A.2.f Non-metallic Minerals accounted for 18% of 1.A.2. source category.

Figure 3.80 shows the emission trend within the category 1.A.2.f, which is dominated by CO_2 emissions from gaseous fuels in 2019. The share of liquid fuels on CO_2 emissions from 1.A.2.f decreased from 35% in 1990 to 26% in 2019. The share of solid fuels on CO_2 emissions from 1.A.2.f decreased from 43% in 1990 to 19% in 2019. The share of gaseous fuels on CO_2 emissions from 1.A.2.f increased from 21% in 1990 to 37% in 2019.

Figure 3.80: 1.A.2.f Non-metallic Minerals: Activity data and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table.3.43. Malta reports emissions as 'NO' (not occurring). Five Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emission was reported by Romania (1098%) which represents 4% share on total EU-KP emissions.

Table.3.43: 1.A.2.f Non-metallic Minerals: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	1 669	1 694	1 664	1.9%	-5	0%	-30	-2%	T1,T2	CS,D
Belgium	5 525	3 484	3 420	3.9%	-2 106	-38%	-65	-2%	T1,T3	D,PS
Bulgaria	2 646	1 146	1 030	1.2%	-1 616	-61%	-116	-10%	T1,T2	CS,D
Croatia	1 924	1 309	1 280	1.5%	-644	-33%	-29	-2%	T1	D
Cyprus	380	420	413	0.5%	34	9%	-6	-1%	CS,T1	CS,D
Czechia	4 527	2 486	2 618	3.0%	-1 909	-42%	132	5%	T1,T2	CS,D
Denmark	1 292	1 446	1 480	1.7%	187	15%	33	2%	T1,T2,T3	CS,D,PS
Estonia	458	391	339	0.4%	-118	-26%	-52	-13%	T1,T2,T3	CS,D,PS
Finland	1 368	595	578	0.7%	-790	-58%	-17	-3%	T3	CS,D
France	14 016	9 975	9 811	11.3%	-4 205	-30%	-164	-2%	T2,T3	CS,PS
Germany	18 507	13 020	13 286	15.3%	-5 221	-28%	267	2%	CS	CS
Greece	6 278	3 459	2 989	3.4%	-3 289	-52%	-470	-14%	T1,T2	CS,D,PS
Hungary	2 311	1 212	1 260	1.4%	-1 051	-45%	47	4%	T1,T2,T3	CS,D,PS
Ireland	819	1 207	1 162	1.3%	343	42%	-45	-4%	T1,T2,T3	CS,D,PS
Italy	21 045	11 899	10 902	12.5%	-10 143	-48%	-996	-8%	T2	CS
Latvia	599	326	305	0.4%	-294	-49%	-21	-7%	T1,T2	CS,D,PS
Lithuania	3 210	446	491	0.6%	-2 719	-85%	45	10%	T2	CS,OTH
Luxembourg	537	401	417	0.5%	-120	-22%	16	4%	T1,T2,T3	CS,D,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	2 298	1 323	1 086	1.2%	-1 212	-53%	-237	-18%	T2	CS
Poland	10 340	9 375	9 707	11.2%	-633	-6%	332	4%	T1,T2	CS,D
Portugal	3 288	2 611	2 613	3.0%	-675	-21%	2	0%	T1,T3	D,PS
Romania	265	3 271	3 169	3.6%	2 904	1098%	-102	-3%	T1,T2	CS,D
Slovakia	3 408	1 496	1 446	1.7%	-1 962	-58%	-50	-3%	T2	CS
Slovenia	296	465	465	0.5%	169	57%	0	0%	T1,T2,T3	CS,D,PS
Spain	16 529	11 667	11 290	13.0%	-5 239	-32%	-377	-3%	T1,T2	CS,D,PS
Sweden	1 826	1 289	1 151	1.3%	-675	-37%	-138	-11%	T1,T2	CS
United Kingdom	6 599	2 532	2 573	3.0%	-4 026	-61%	41	2%	T2	CS
EU-27+UK	**131 959**	**88 944**	**86 944**	**100%**	**-45 016**	**-34%**	**-2 000**	**-2%**	**-**	**-**
Iceland	47	0	1	0.0%	-47	-99%	0	8%	T1	D
United Kingdom (KP)	6 599	2 532	2 573	3.0%	-4 026	-61%	41	2%	T2	CS
EU-KP	**132 007**	**88 945**	**86 944**	**100%**	**-45 063**	**-34%**	**-2 000**	**-2%**	**-**	**-**

Malta includes emissions under 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1.A.2.f Non-metallic Minerals - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.f amounted 22 382 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 50% and compared to 2018 by 5%. Category has 4.7% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 55% compared to 1990. One of the reasons for the decline is increase in the use of waste as a fuel.

Detailed data related to the EU-KP submissions are depicted in Table **3.44**. Sweden reports emissions as 'C' (confidential) since 2016 in order to comply with the Public Access to Information and Secrecy Act of the Swedish law. This decision was made based on the results of the internal review. Malta reports emissions as 'NO' (not occuring). Four Member States and Iceland use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 96% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.f – Liquid Fuels (CO_2)). Four Member States reported higher level of emissions in 2019 than in 1990.

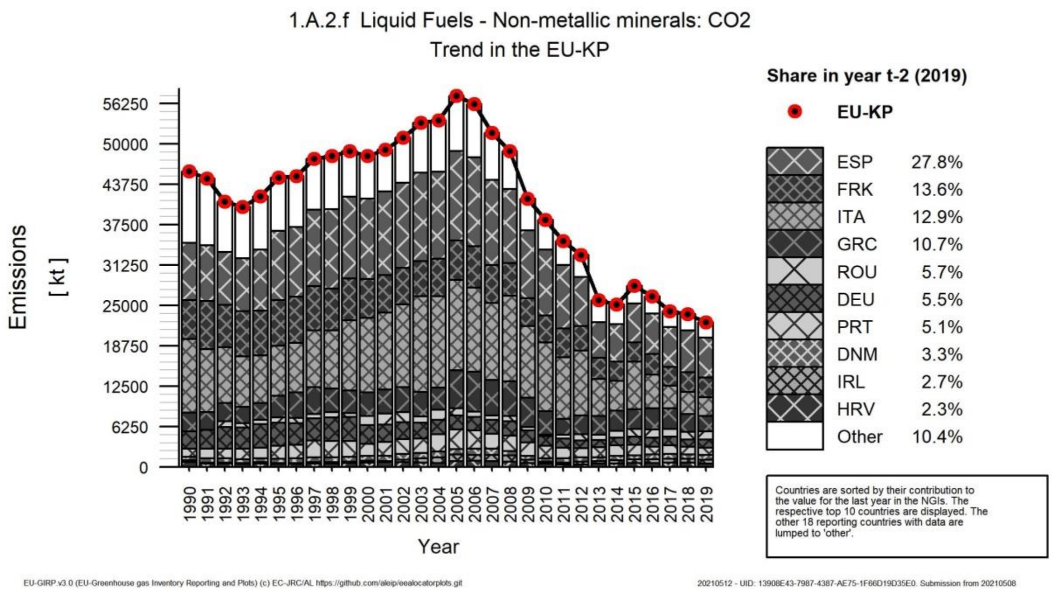
Table 3.44: 1.A.2.f Non-metallic Minerals , liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt				Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	1995	2018	2019		kt CO2	%	kt CO2	%		
Austria	508	348	132	106	0.5%	-402	-79%	-26	-20%	T2	CS
Belgium	1 509	1 932	370	320	1.4%	-1 189	-79%	-50	-14%	T1,T3	D,PS
Bulgaria	666	446	307	247	1.1%	-420	-63%	-60	-20%	T1	D
Croatia	745	415	671	512	2.3%	-233	-31%	-159	-24%	T1	D
Cyprus	148	432	269	219	1.0%	71	48%	-51	-19%	CS	CS
Czechia	1 029	920	46	19	0.1%	-1 011	-98%	-28	-60%	T1	CS,D
Denmark	481	639	674	745	3.3%	264	55%	71	10%	T1,T2	CS,D
Estonia	448	71	3	1	0.0%	-448	-100%	-2	-80%	T1,T2	CS,D
Finland	437	253	251	247	1.1%	-189	-43%	-3	-1%	T3	CS
France	6 039	7 043	3 065	3 042	13.6%	-2 997	-50%	-23	-1%	T2,T3	CS,PS
Germany	2 663	3 591	1 111	1 242	5.5%	-1 421	-53%	131	12%	CS	CS
Greece	2 914	3 417	2 741	2 393	10.7%	-521	-18%	-348	-13%	T2	PS
Hungary	423	425	364	392	1.8%	-31	-7%	28	8%	T1,T2	CS,D
Ireland	312	209	622	600	2.7%	288	92%	-21	-3%	T1,T2	CS,D
Italy	11 359	7 743	3 424	2 878	12.9%	-8 482	-75%	-546	-16%	T2	CS
Latvia	267	192	1	0	0.0%	-266	-100%	-1	-75%	T2	CS
Lithuania	2 750	604	7	10	0.0%	-2 741	-100%	3	35%	T2	CS
Luxembourg	23	28	9	12	0.1%	-11	-49%	2	25%	T2	CS
Malta	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	468	358	0	0	0.0%	-468	-100%	0	100%	T2	CS
Poland	394	582	329	368	1.6%	-27	-7%	39	12%	T1,T2	CS,D
Portugal	1 318	2 021	1 182	1 145	5.1%	-172	-13%	-37	-3%	T1,T3	D,PS
Romania	NO	755	1 183	1 271	5.7%	1 271	∞	88	7%	T1,T2	CS,D
Slovakia	1 219	376	206	219	1.0%	-1 001	-82%	12	6%	T2	CS
Slovenia	63	82	122	118	0.5%	55	87%	-4	-3%	T1	D
Spain	8 819	10 735	6 495	6 221	27.8%	-2 598	-29%	-275	-4%	T1,T2	CS,D
Sweden	625	727	C	C	-	-625	-100%	-	-	T1	CS
United Kingdom	127	474	71	56	0.3%	-71	-56%	-15	-21%	T2	CS
EU-27+UK	**45 130**	**44 088**	**23 657**	**22 381**	**100%**	**-22 749**	**-50%**	**-1 276**	**-5%**	**-**	**-**
Iceland	2	0	0	1	0.0%	-1	-73%	0	8%	T1	D
United Kingdom (KP)	127	474	71	56	0.3%	-71	-56%	-15	-21%	T2	CS
EU-KP	**45 132**	**44 089**	**23 657**	**22 382**	**100%**	**-22 751**	**-50%**	**-1 276**	**-5%**	**-**	**-**

EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure.3.81 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Spain (28%), France (14%), Italy (13%), Greece (11%), Romania (6%), Germany (6%) and Portugal (5%) which together have 81% share on EU-KP emissions.

Figure.3.81: 1.A.2.f Non-metallic Minerals, liquid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden.

Figure.3.82 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. It can be seen that CO_2 IEF increased significantly compared to CO_2 IEF calculated for 1990. The high CO_2 IEF in recent years is caused mainly due to the increased consumption of petrol coke in cement kilns. The decrease in 2012 is caused by significant decrease of Italy's CO_2 IEF which has a strong influence on total EU-KP CO_2 IEF. CO_2 IEF equaled to 90.53 t/TJ in 2019.

Figure.3.82: 1.A.2.f Non-metallic Minerals, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

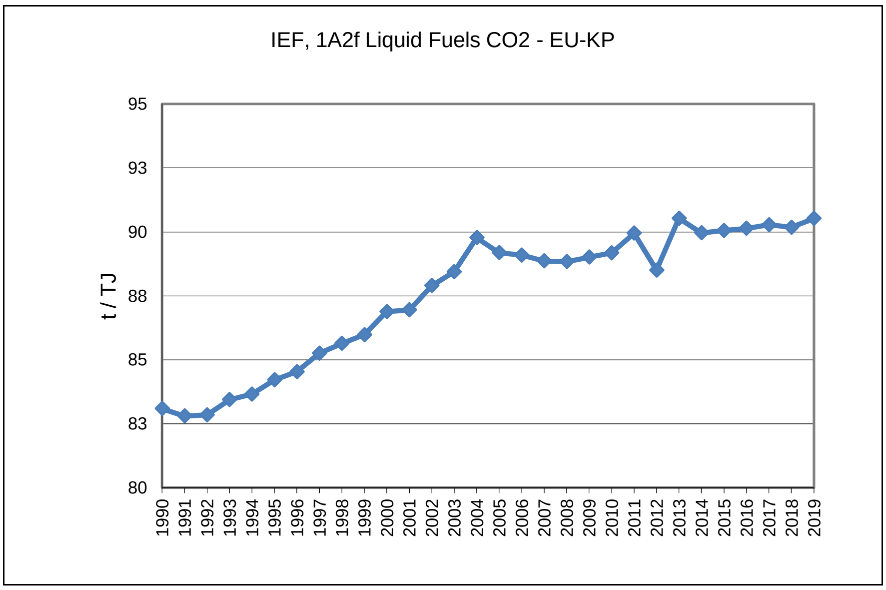
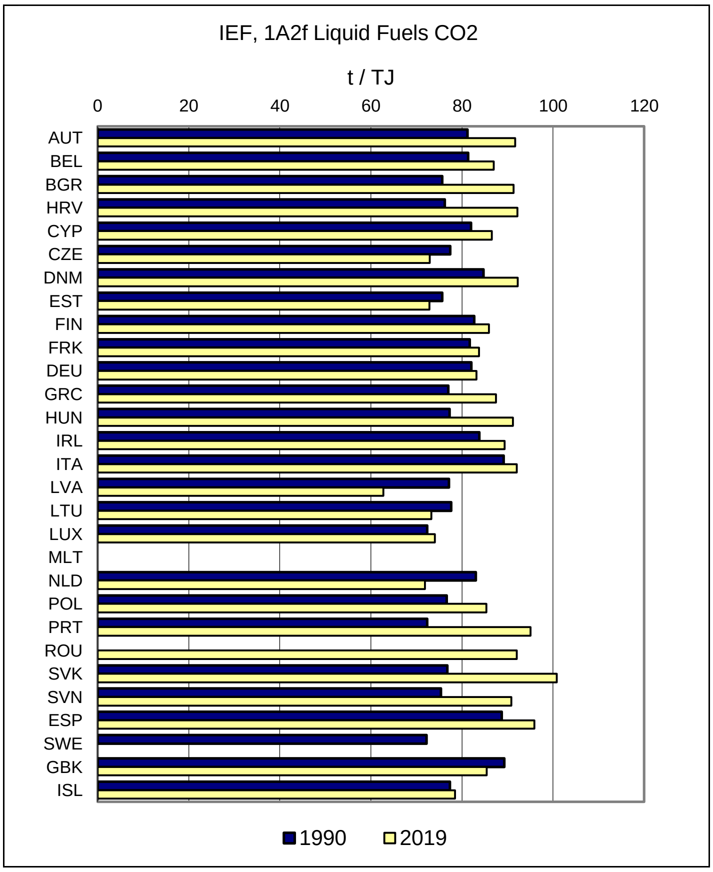


Figure 3.83 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. The CO_2 IEF is in many cases higher in 2019 than in 1990 which reflects reasons for relatively high CO_2 IEF mentioned above.

Figure 3.83: 1.A.2.f Non-metallic Minerals, liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.f Non-metallic Minerals - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.f amounted 16 312 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 71% and compared to 2018 by 2%. This category represents 3.4% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 71% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.45. Malta and Iceland report emissions as 'NO' (not occurring). Sweden reports emissions as 'C' (confidential). Luxembourg uses for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.f – Solid Fuels (CO_2)). Latvia, Lithuania and Romania reported higher level of emissions in 2019 than in 1990 (it should be noted that the share of their emissions on total EU-KP emissions is together only 5%).

Table 3.45: 1.A.2.f Non-metallic Minerals, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	535	230	234	1.4%	-301	-56%	4	2%	T2	CS
Belgium	2 466	1 505	1 465	9.0%	-1 002	-41%	-41	-3%	T1,T3	D,PS
Bulgaria	295	203	177	1.1%	-118	-40%	-26	-13%	T1,T2	CS,D
Croatia	535	216	303	1.9%	-232	-43%	87	40%	NA	NA
Cyprus	232	54	68	0.4%	-164	-71%	14	26%	CS	CS
Czechia	2 209	750	699	4.3%	-1 510	-68%	-52	-7%	T2	CS,D
Denmark	574	299	297	1.8%	-277	-48%	-2	-1%	T1,T3	D,PS
Estonia	NO	190	215	1.3%	215	∞	25	13%	T2,T3	CS,PS
Finland	806	236	222	1.4%	-584	-72%	-14	-6%	T3	CS
France	3 812	811	845	5.2%	-2 966	-78%	34	4%	T2,T3	CS,PS
Germany	12 053	4 445	4 449	27.3%	-7 604	-63%	4	0%	CS	CS
Greece	3 364	457	273	1.7%	-3 092	-92%	-185	-40%	T2	PS
Hungary	230	119	93	0.6%	-137	-60%	-26	-22%	T1,T2	D,PS
Ireland	375	344	313	1.9%	-61	-16%	-31	-9%	T2	CS
Italy	3 690	918	881	5.4%	-2 809	-76%	-37	-4%	T2	CS
Latvia	16	125	114	0.7%	98	614%	-11	-8%	T2	CS
Lithuania	60	370	416	2.6%	357	598%	46	12%	T2	CS
Luxembourg	312	135	149	0.9%	-163	-52%	14	10%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	346	206	130	0.8%	-216	-62%	-75	-37%	T2	CS
Poland	8 576	2 421	2 371	14.5%	-6 205	-72%	-50	-2%	T1,T2	CS,D
Portugal	1 958	1	11	0.1%	-1 947	-99%	10	1737%	T1,T3	D,PS
Romania	265	211	272	1.7%	7	3%	61	29%	T1,T2	CS,D
Slovakia	1 474	546	507	3.1%	-967	-66%	-39	-7%	T2	CS
Slovenia	113	47	47	0.3%	-66	-58%	0	0%	T1,T3	D,PS
Spain	5 221	183	181	1.1%	-5 040	-97%	-2	-1%	T1,T2	CS,D
Sweden	1 135	C	C	-	-1 135	-100%	-	-	T2	CS
United Kingdom	6 174	1 573	1 577	9.7%	-4 596	-74%	4	0%	T2	CS
EU-27+UK	**55 690**	**16 598**	**16 312**	**100%**	**-39 378**	**-71%**	**-286**	**-2%**	**-**	**-**
Iceland	45	NO	NO	-	-45	-100%	-	-	NA	NA
United Kingdom (KP)	6 174	1 573	1 577	9.7%	-4 596	-74%	4	0%	T2	CS
EU-KP	**55 736**	**16 598**	**16 312**	**100%**	**-39 424**	**-71%**	**-286**	**-2%**	**-**	**-**

EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.84 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany (27%), Poland (15%), United Kingdom (10%), Belgium (9%), Italy (5%), France (5%) and Czechia (4%) which together represent 75% share on EU-KP emissions.

Figure 3.84: 1.A.2.f Non-metallic Minerals, solid fuels: Emission trend and share for CO_2

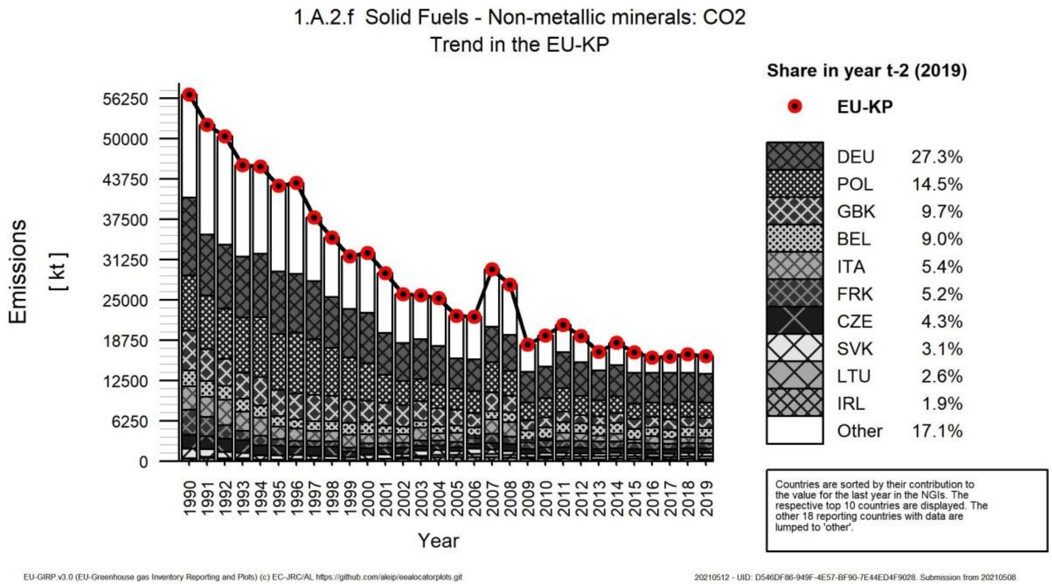


Figure 3.85 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. The IEF has slightly decreasing trend with minor fluctuations. CO_2 IEF equaled to 95.57 t/TJ in 2019.

Figure 3.85: 1.A.2.f Non-metallic Minerals, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

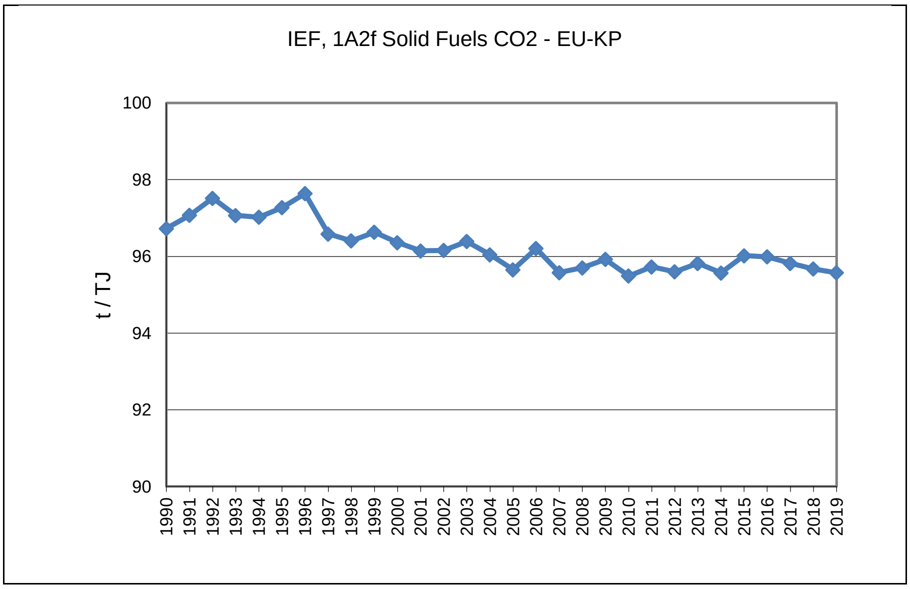
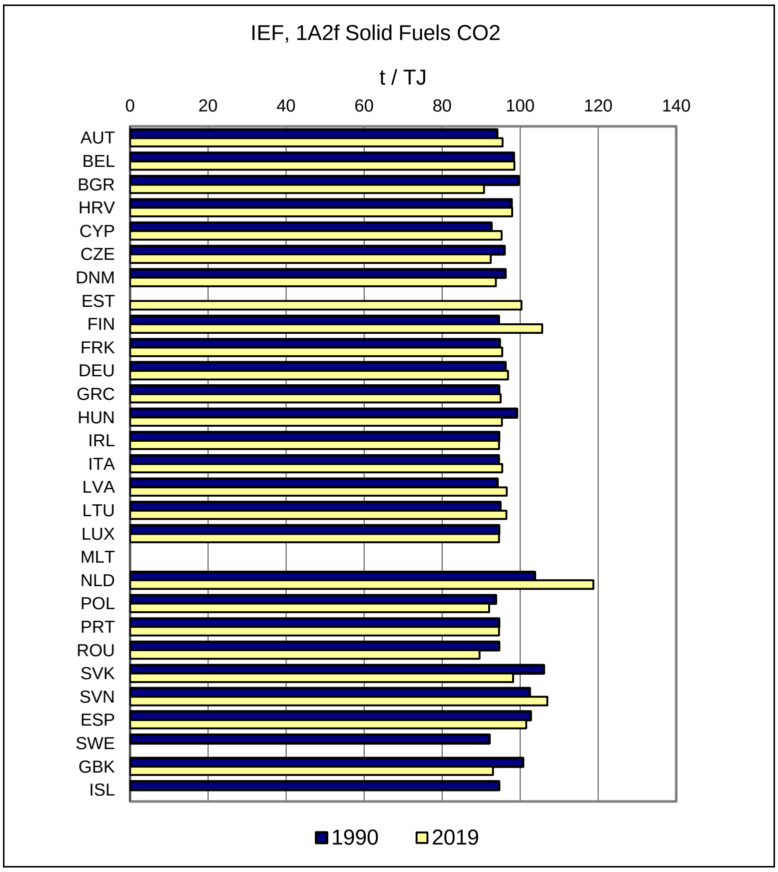


Figure 3.86 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. It can be seen that no major differences between CO_2 IEF used by countries occur, also no major differences between CO_2 IEF calculated by countries for 1990 and 2019 occur. Except for Netherlands where strong increase in 2019 IEF is caused by change in fuel composition; lignite consumption decreased by 92% and this resulted in bigger share of cokes with IEF 120 t/TJ in 2019.

Figure 3.86: 1.A.2.f Non-metallic Minerals, solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.f Non-metallic Minerals - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.f amounted 31 971 kt in 2019 for EU-KP. CO_2 emissions increased compared to year 1990 by 14% and decreased compared to 2018 by 3%. This category represents 6.7% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption increased by 13% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.46. Cyprus, Malta and Iceland report emissions as 'NO' (not occurring). Two Member States use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.f – Gaseous Fuels (CO_2)). Ten Member States reported higher level of emissions in 2019 than in 1990.

Table 3.46: 1.A.2.f Non-metallic Minerals, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	559	670	701	2.2%	142	25%	31	5%	T2	CS
Belgium	1 364	1 238	1 206	3.8%	-158	-12%	-32	-3%	T1,T3	D,PS
Bulgaria	1 684	635	606	1.9%	-1 078	-64%	-30	-5%	T2	CS
Croatia	645	305	304	0.9%	-341	-53%	-1	0%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 289	1 323	1 323	4.1%	34	3%	0	0%	T2	CS
Denmark	237	276	251	0.8%	14	6%	-25	-9%	T3	CS
Estonia	NO	40	26	0.1%	26	∞	-14	-35%	T2	CS
Finland	126	54	58	0.2%	-67	-54%	4	8%	T3	CS
France	3 842	4 861	4 775	14.9%	933	24%	-86	-2%	T2,T3	CS,PS
Germany	3 265	4 615	4 607	14.4%	1 342	41%	-8	0%	CS	CS
Greece	NO	133	145	0.5%	145	∞	13	10%	T2	CS
Hungary	1 658	474	488	1.5%	-1 169	-71%	14	3%	T2	CS
Ireland	132	48	49	0.2%	-83	-63%	1	3%	T2	CS
Italy	5 996	7 064	6 594	20.6%	598	10%	-471	-7%	T2	CS
Latvia	316	69	70	0.2%	-247	-78%	1	1%	T2	CS
Lithuania	382	56	53	0.2%	-330	-86%	-3	-5%	T2	CS
Luxembourg	201	169	166	0.5%	-35	-17%	-2	-1%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 484	1 117	956	3.0%	-528	-36%	-161	-14%	T2	CS
Poland	1 359	2 390	2 569	8.0%	1 209	89%	179	7%	T2	CS
Portugal	NO	1 151	1 178	3.7%	1 178	∞	27	2%	T1,T3	D,PS
Romania	NO	852	694	2.2%	694	∞	-159	-19%	T2	CS
Slovakia	542	435	391	1.2%	-151	-28%	-44	-10%	T2	CS
Slovenia	115	179	180	0.6%	65	57%	1	1%	T2	CS
Spain	2 370	4 293	4 199	13.1%	1 829	77%	-94	-2%	T2	CS
Sweden	65	116	115	0.4%	50	76%	-1	-1%	T1	CS
United Kingdom	297	268	267	0.8%	-30	-10%	-1	0%	T2	CS
EU-27+UK	**27 929**	**32 831**	**31 971**	**100%**	**4 042**	**14%**	**-860**	**-3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	297	268	267	0.8%	-30	-10%	-1	0%	T2	CS
EU-KP	**27 929**	**32 831**	**31 971**	**100%**	**4 042**	**14%**	**-860**	**-3%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.87 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Italy (21%), France (15%), Germany (14%), Spain (13%), Poland (8%) and Czechia (4%) which together represent 75% share on EU-KP emissions.

Figure 3.87: 1.A.2.f Non-metallic Minerals, gaseous fuels: Emission trend and share for CO_2

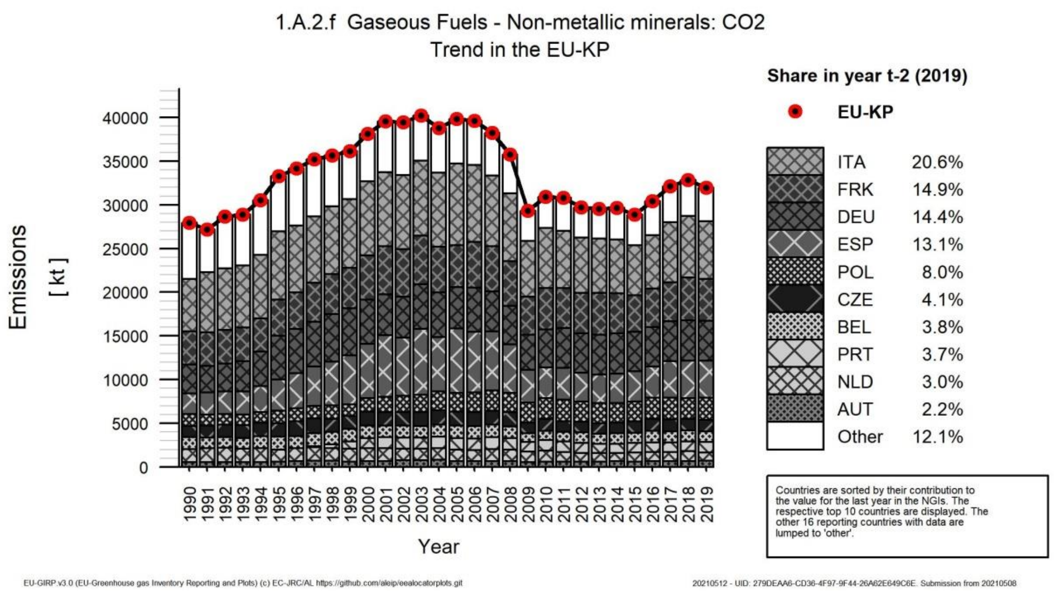


Figure 3.88 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. CO_2 IEF is stable during whole time period with slightly increasing trend. CO_2 IEF equaled to 56.27 t/TJ in 2019.

Figure 3.88: 1.A.2.f Non-metallic Minerals, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

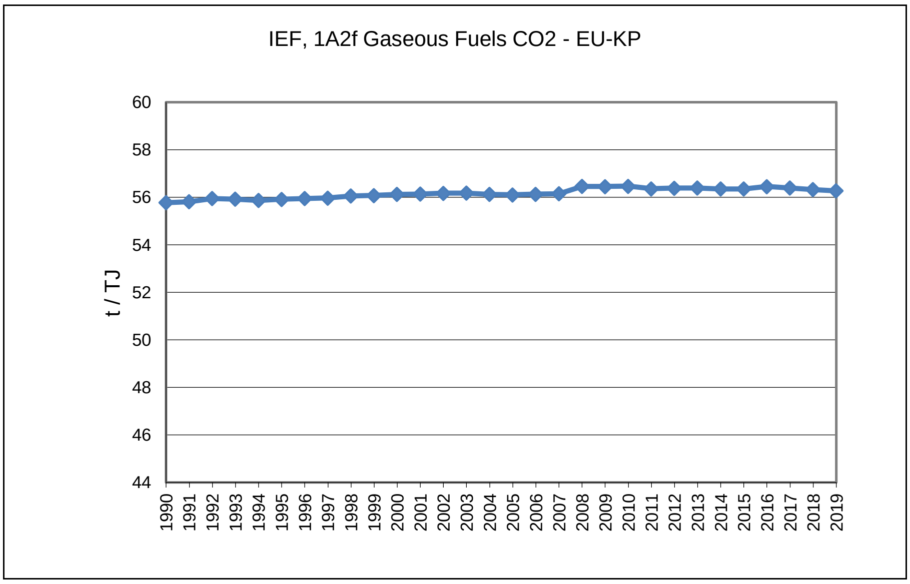
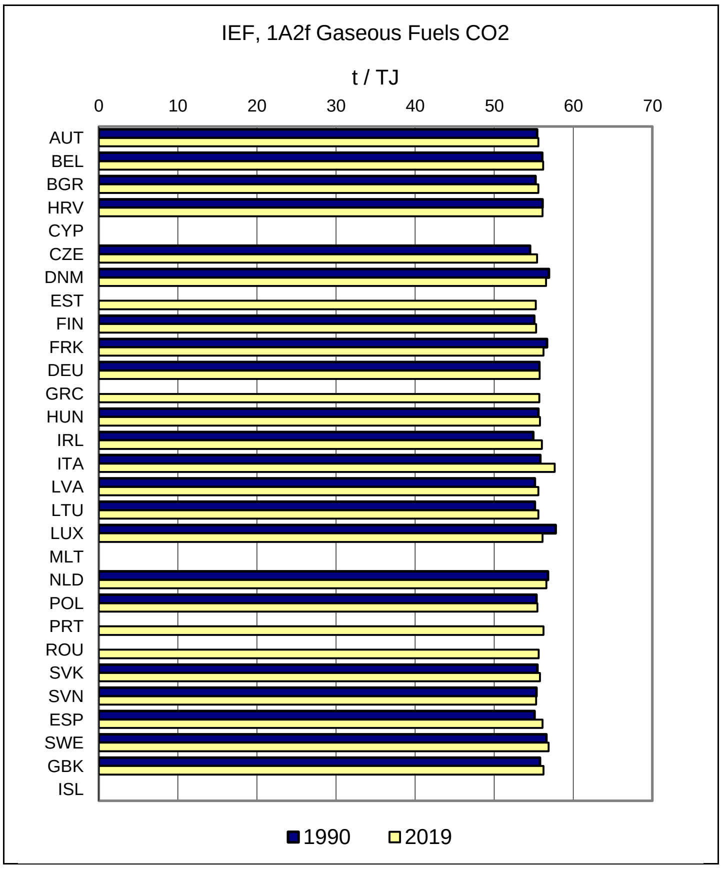


Figure 3.89 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. It can be seen that no major differences between CO_2 IEF used by countries occur, also no major differences between CO_2 IEF calculated by countries for 1990 and 2019 occur.

Figure 3.89: 1.A.2.f Non-metallic Minerals, gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.f Non-metallic Minerals – Other Fossil Fuels (CO_2)

CO_2 emissions from the use of other fossil fuels in category 1.A.2.f amounted 15 501 kt in 2019 for EU-KP. CO_2 emissions increased compared to year 1990 by 990% and compared to 2018 by 4%. This category represents 3.2% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption increased by 953% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3.47. Bulgaria, Malta, Netherlands and Iceland report emissions as 'NO' (not occurring). Three Member States use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 70% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.f – Other Fossil Fuels (CO_2)). All countries reported higher level of emissions in 2019 than in 1990. Most countries report emissions from industrial waste (co-) incineration and particularly incineration of municipal waste (e.g. Spain) under this category, especially from cement kilns. Examples of industrial wastes could be waste tyres, waste oil/lubricants, solvents, plastics waste and paper waste.

Table 3.47: 1.A.2.f Non-metallic Minerals, other fossil fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	67	662	623	4.0%	555	826%	-39	-6%	T2	CS
Belgium	186	370	428	2.8%	242	130%	58	16%	T1,T3	D,PS
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	117	161	1.0%	161	∞	45	38%	T1	D
Cyprus	NO	96	127	0.8%	127	∞	30	32%	T1	D
Czechia	NO	366	578	3.7%	578	∞	212	58%	T2	CS
Denmark	NO	198	187	1.2%	187	∞	-10	-5%	T2	CS
Estonia	NO	158	98	0.6%	98	∞	-60	-38%	T3	PS
Finland	NO	55	50	0.3%	50	∞	-4	-8%	T3	CS
France	323	1 238	1 148	7.4%	825	255%	-90	-7%	T2,T3	CS,PS
Germany	526	2 849	2 988	19.3%	2 463	469%	139	5%	CS	CS
Greece	NO	128	178	1.1%	178	∞	50	39%	T2	PS
Hungary	NO	254	286	1.8%	286	∞	32	12%	T3	PS
Ireland	NO	193	198	1.3%	198	∞	5	3%	T3	PS
Italy	NO	492	550	3.5%	550	∞	58	12%	T2	CS
Latvia	NO	131	120	0.8%	120	∞	-10	-8%	T2	PS
Lithuania	NO	9	10	0.1%	10	∞	1	17%	T2	OTH
Luxembourg	NO	88	89	0.6%	89	∞	2	2%	T1,T3	D,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	10	4 236	4 400	28.4%	4 390	45144%	164	4%	T1	D
Portugal	12	277	278	1.8%	266	2177%	1	0%	T1,T3	D,PS
Romania	NO	1 025	933	6.0%	933	∞	-92	-9%	T2	CS
Slovakia	173	308	329	2.1%	157	91%	21	7%	T2	CS
Slovenia	5	116	119	0.8%	114	2444%	3	2%	T1,T3	D,PS
Spain	120	695	688	4.4%	569	476%	-6	-1%	T2	CS,PS
Sweden	NO	247	260	1.7%	260	∞	13	5%	T2	CS
United Kingdom	1	620	673	4.3%	672	67065%	52	8%	T2	CS
EU-27+UK	**1 422**	**14 928**	**15 501**	**100%**	**14 079**	**990%**	**573**	**4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1	620	673	4.3%	672	67065%	52	8%	T2	CS
EU-KP	**1 422**	**14 928**	**15 501**	**100%**	**14 079**	**990%**	**573**	**4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.90 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Poland (28%), Germany (19%), France (7%), Romania (6%), Spain (4%), United Kingdom (4%) and Austria (4%) which together represent 74% share on EU-KP emissions.

Figure 3.90: 1.A.2.f Non-metallic Minerals, other fossil fuels: Emission trend and share for CO_2

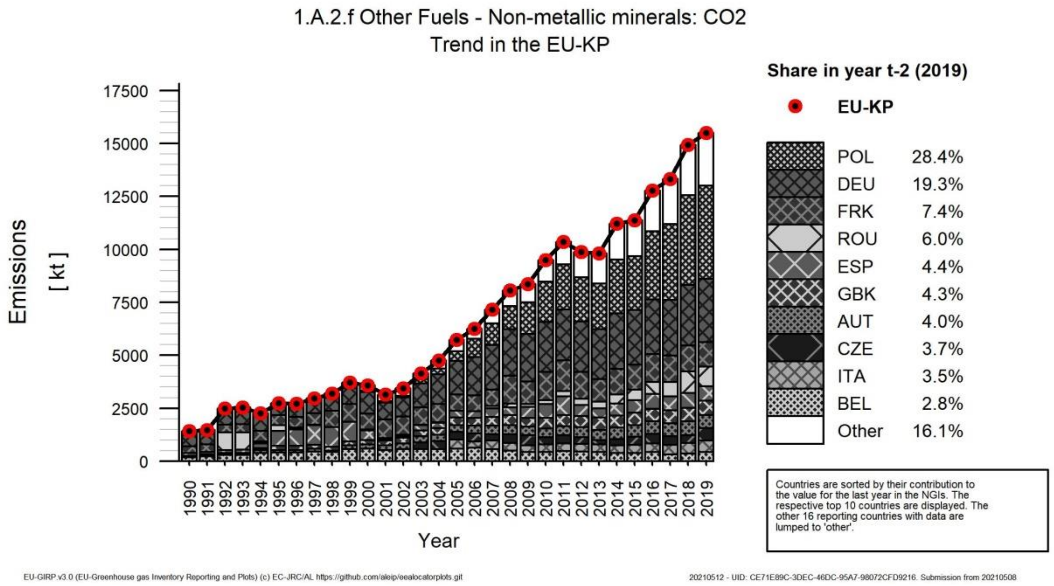


Figure 3.91 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. It can be seen that CO_2 IEF is fluctuating during whole time period, the lowest CO_2 IEF was calculated for 2002 and since then CO_2 IEF is increasing. CO_2 IEF equaled to 85.95 t/TJ in 2019.

Figure 3.91: 1.A.2.f Non-metallic Minerals, other fossil fuels: Implied Emission Factors for CO_2 (in t/TJ)

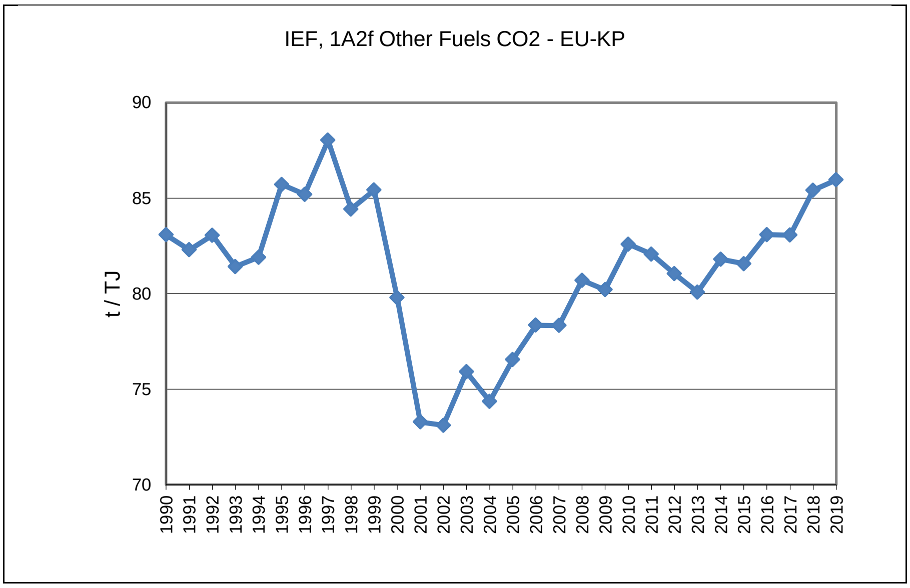
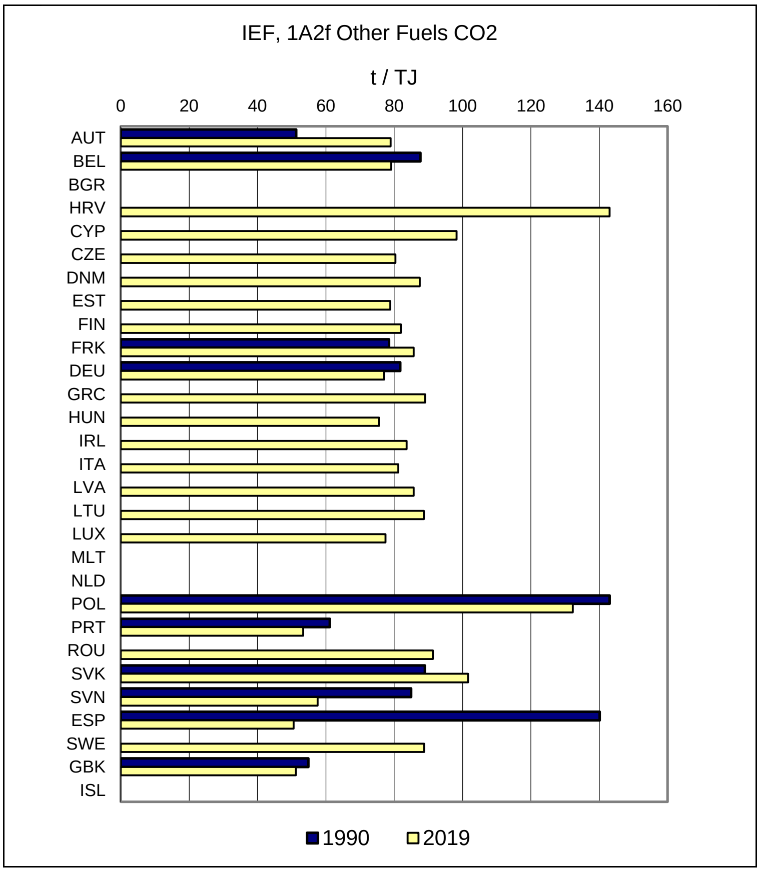


Figure 3.92 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. Croatia and Poland apply the default IPCC CO_2 emission factor (or a factor which is close to it) which is significantly higher than the country specific values used by almost all other countries. The comparatively low implied emission factor reported by almost all countries is mainly due to incineration of industrial waste.

Figure 3.92: 1.A.2.f Non-metallic Minerals, other fossil fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



3.2.2.7 Other (1.A.2.g)

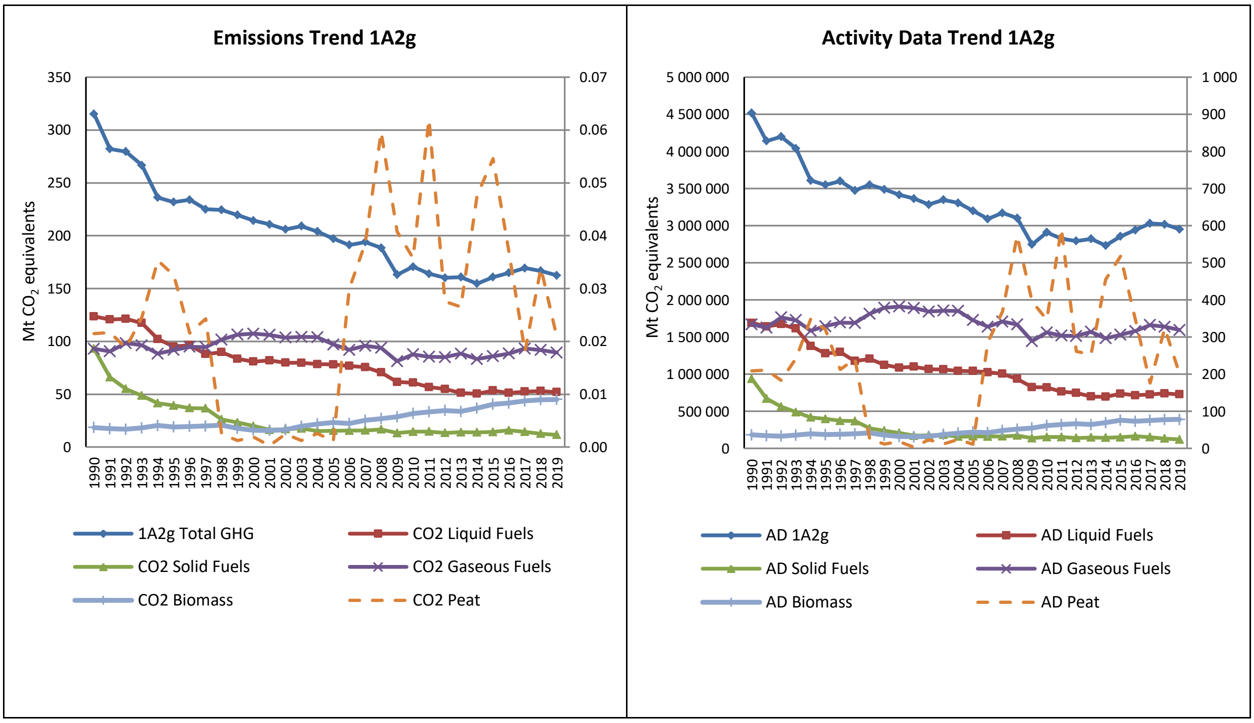
This chapter provides information about European emission trend, Member States, United Kingdom and Iceland contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.g Other.

This category includes emissions from stationary combustion but also may include emissions from mobile sources (e.g. construction machinery). Some countries use this category to report emissions which cannot be allocated to the categories 1.A.2.a to 1.A.2.f due to lack of detailed data, e.g. IEA data provides fuel consumption of Industrial Auto-producers (Electricity, CHP, Heat) for total industry only. This category is dominated by Germany; Germany reports all emissions from power and heat production in industry under this category.

Total CO_2 emissions from 1.A.2.g amounted to 159 887 kt CO_2 eq. in 2019. The trend of total CO_2 emissions for 1990 to 2019 from category 1.A.2.g is depicted in Figure 3.93. Total CO_2 emissions decreased by 49% since 1990 and by 3% between 2018 and 2019. CO_2 emissions from 1.A.2.g Other accounted for 32% of 1.A.2. source category.

Figure 3.93 shows the emission trend within the category 1.A.2.g, which is mainly dominated by CO_2 emissions from gaseous, liquid and solid fuels; the decrease in the early 1990s was mainly due to a decline of solid fuel consumption.

Figure 3.93: 1.A.2.g Other: Activity data and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table **3.48**. Greece report data as 'IE' (included elsewhere). Four Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emission was reported by Luxembourg (147%), but it should be noted that Luxembourg has minor share (approximately 0.2%) on total EU-KPs emissions.

Table 3.48: 1.A.2.g Other: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	1 974	2 763	2 573	1.6%	598	30%	-190	-7%	T1,T2,T3	CS,D
Belgium	2 807	1 920	1 866	1.2%	-940	-34%	-54	-3%	CS,T1,T3	D
Bulgaria	10 579	882	909	0.6%	-9 670	-91%	28	3%	T1,T2	CS,D
Croatia	435	314	335	0.2%	-100	-23%	21	7%	T1	D
Cyprus	48	52	66	0.0%	18	38%	14	27%	T1	D
Czechia	19 064	1 963	1 916	1.2%	-17 148	-90%	-46	-2%	T1,T2	CS,D
Denmark	1 759	878	848	0.5%	-912	-52%	-30	-3%	M,T1,T2,T3	CS,D
Estonia	2 519	218	221	0.1%	-2 298	-91%	3	1%	T1,T2	CS,D
Finland	1 639	1 600	1 571	1.0%	-68	-4%	-29	-2%	T3	CS,D
France	10 191	8 075	8 038	5.0%	-2 154	-21%	-37	0%	T2	CS
Germany	127 992	74 750	74 947	46.9%	-53 045	-41%	197	0%	CS,T1	CS,D
Greece	IE	IE	IE	-	-	-	-	-	NA	NA
Hungary	5 156	1 872	1 815	1.1%	-3 341	-65%	-57	-3%	T1,T2	CS,D
Ireland	819	586	605	0.4%	-215	-26%	19	3%	T1,T2	CS,D
Italy	15 310	9 973	9 507	5.9%	-5 803	-38%	-467	-5%	T2	CS
Latvia	1 620	241	199	0.1%	-1 421	-88%	-42	-18%	T1,T2	CS,D
Lithuania	1 567	217	206	0.1%	-1 362	-87%	-11	-5%	T1,T2	CS,D
Luxembourg	103	243	256	0.2%	152	147%	13	5%	T1,T2	CS,D
Malta	53	49	46	0.0%	-7	-13%	-4	-7%	T1	D
Netherlands	3 382	3 079	3 141	2.0%	-240	-7%	62	2%	T2	CS
Poland	6 979	2 909	2 907	1.8%	-4 072	-58%	-2	0%	T1,T2	CS,D
Portugal	2 196	1 572	1 531	1.0%	-665	-30%	-40	-3%	T1	D
Romania	42 707	8 148	6 813	4.3%	-35 895	-84%	-1 336	-16%	T1,T2	CS,D
Slovakia	2 560	1 373	1 039	0.6%	-1 520	-59%	-334	-24%	T2	CS
Slovenia	1 091	472	455	0.3%	-636	-58%	-17	-4%	T1,T2	CS,D
Spain	7 899	8 337	8 506	5.3%	606	8%	169	2%	T1,T2,T3	CS,D,M,PS
Sweden	3 214	2 421	2 547	1.6%	-667	-21%	126	5%	T1,T2	CS
United Kingdom	38 481	28 962	26 828	16.8%	-11 653	-30%	-2 135	-7%	T1,T2,T3	CS,D
EU-27+UK	**312 145**	**163 867**	**159 689**	**100%**	**-152 455**	**-49%**	**-4 178**	**-3%**	**-**	**-**
Iceland	161	102	58	0.0%	-103	-64%	-44	-43%	T1	D
United Kingdom (KP)	38 575	29 102	26 967	16.9%	-11 607	-30%	-2 135	-7%	T1,T2,T3	CS,D
EU-KP	**312 400**	**164 110**	**159 887**	**100%**	**-152 513**	**-49%**	**-4 222**	**-3%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.
Greece includes emissions of 1.A.2.g in category 1.A.2.f

1.A.2.g Other – Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.g amounted 52 028 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 58% and compared to 2018 decreased by 2%. This category represents 11% of total CO_2 equivalent emissions from category 1.A.2.

Detailed data related to the EU-KP submissions are depicted in Table.3.49. Sweden reports emissions as 'C' (confidential). Four Member States reported higher level of emissions (it should be noted that these countries have together 6% share on EU-KP emissions).

Table.3.49: 1.A.2.g Other, liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	866	1 357	1 366	2.6%	499	58%	9	1%	-	-
Belgium	1 569	775	793	1.5%	-776	-49%	19	2%	-	-
Bulgaria	8 632	306	323	0.6%	-8 310	-96%	17	6%	-	-
Croatia	435	314	335	0.6%	-100	-23%	21	7%	T1	D
Cyprus	48	52	66	0.1%	18	38%	14	27%	-	-
Czechia	2 935	141	70	0.1%	-2 864	-98%	-70	-50%	-	-
Denmark	1 145	637	616	1.2%	-529	-46%	-21	-3%	-	-
Estonia	701	142	147	0.3%	-554	-79%	5	4%	-	-
Finland	1 480	1 287	1 262	2.4%	-219	-15%	-25	-2%	T3	CS
France	5 896	3 953	3 986	7.7%	-1 909	-32%	33	1%	-	-
Germany	30 374	15 305	15 769	30.3%	-14 605	-48%	464	3%	-	-
Greece	IE	IE	IE	-	-	-	-	-	-	-
Hungary	1 900	801	766	1.5%	-1 134	-60%	-35	-4%	T1,T2	D,CS
Ireland	647	323	332	0.6%	-315	-49%	9	3%	-	-
Italy	5 707	2 427	2 245	4.3%	-3 462	-61%	-182	-7%	-	-
Latvia	1 066	143	126	0.2%	-940	-88%	-17	-12%	T1,T2	D,CS
Lithuania	812	69	72	0.1%	-740	-91%	3	4%	T2	CS
Luxembourg	59	197	205	0.4%	146	246%	8	4%	-	-
Malta	53	49	46	0.1%	-7	-13%	-4	-7%	NO	NO
Netherlands	1 630	1 633	1 670	3.2%	39	2%	37	2%	-	-
Poland	1 028	665	707	1.4%	-321	-31%	42	6%	T1/T2	D,CS
Portugal	2 147	592	547	1.1%	-1 600	-75%	-45	-8%	-	-
Romania	23 752	4 138	3 666	7.0%	-20 085	-85%	-472	-11%	-	-
Slovakia	66	15	12	0.0%	-55	-82%	-4	-24%	-	-
Slovenia	585	138	143	0.3%	-442	-76%	5	3%	T1	D
Spain	5 788	2 669	2 791	5.4%	-2 997	-52%	122	5%	T1,T2,T3	CS,D,PS
Sweden	3 007	C	C	-	-3 007	-100%	-	-	-	-
United Kingdom	21 113	14 605	13 769	26.5%	-7 344	-35%	-836	-6%	T2	CS
EU-27+UK	**120 436**	**52 734**	**51 830**	**100%**	**-68 606**	**-57%**	**-904**	**-2%**	**-**	**-**
Iceland	161	102	58	0.1%	-103	-64%	-44	-43%	-	-
United Kingdom (KP)	21 207	14 745	13 909	26.7%	-7 298	-34%	-836	-6%	T2	CS
EU-KP	**120 691**	**52 976**	**52 028**	**100%**	**-68 663**	**-57%**	**-948**	**-2%**	**-**	**-**

Greece includes emissions of 1.A.2.g in category 1.A.2.f
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.94 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany (30%), United Kingdom (27%), France (8%), Romania (7%), Spain (5%) and Italy (4%) which together represent 81% share on EU-KP emissions.

Figure 3.94: 1.A.2.g Other, liquid fuels: Emission trend and share for CO_2

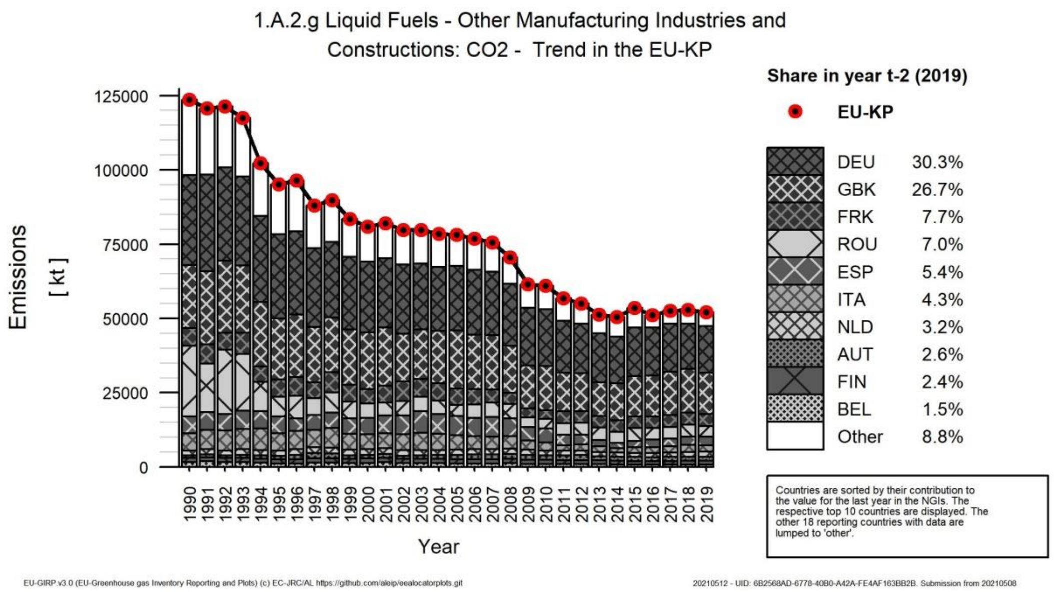


Figure 3.95 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. It can be seen that CO_2 IEF has decreasing trend with minor fluctuations since 2008. This trend is driven mainly by Germany and is caused by changes in fuel mix. CO_2 IEF equaled to 72.18 t/TJ in 2019.

Figure 3.95: 1.A.2.g Other, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

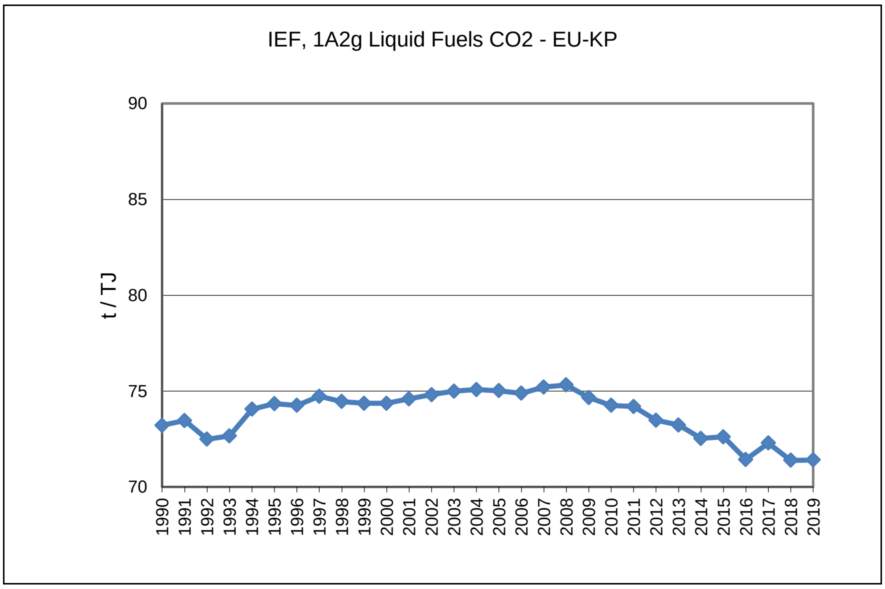
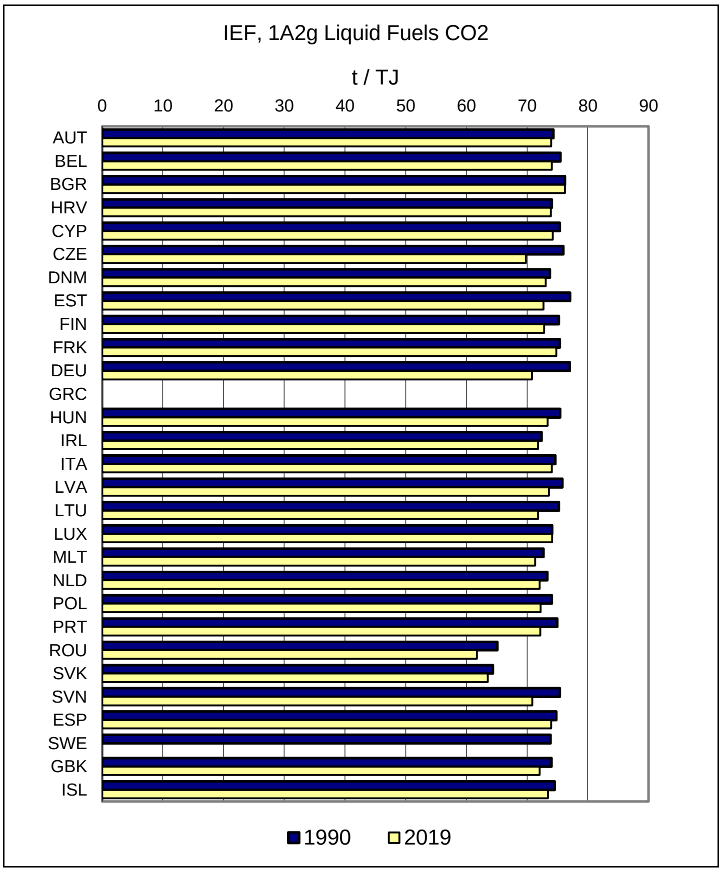


Figure 3.96 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019.

Figure 3.96: 1.A.2.g Other, liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.g Other – Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.g amounted 11 653 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 87% and compared to 2018 by 8%. This category represents 2% of total CO_2 equivalent emissions from category 1.A.2.

Detailed data related to the EU-KP submissions are depicted in Table 3.50. Eight Member States report emissions as 'NO' (not occurring). Sweden reports emissions as 'C' (confidential). All countries reported lower level of emissions in 2019 than in 1990 (except of Netherlands which has 1% share on EU-KP emissions).

Table 3.50: 1.A.2.g Other, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	91	0	NO	-	-91	-100%	0	-100%	-	-
Belgium	33	18	14	0.1%	-19	-58%	-4	-24%	-	-
Bulgaria	1 858	56	33	0.3%	-1 825	-98%	-23	-42%	-	-
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czechia	13 750	101	82	0.7%	-13 669	-99%	-20	-19%	-	-
Denmark	324	13	11	0.1%	-313	-97%	-2	-17%	-	-
Estonia	1 532	2	1	0.0%	-1 530	-100%	-1	-38%	-	-
Finland	8	0	NO	-	-8	-100%	0	-100%	T3	CS
France	262	6	NO	-	-262	-100%	-6	-100%	-	-
Germany	57 580	9 020	8 891	76.3%	-48 689	-85%	-129	-1%	-	-
Greece	IE	IE	IE	-	-	-	-	-	-	-
Hungary	677	24	20	0.2%	-657	-97%	-4	-18%	T1,T2	D,CS
Ireland	14	NO	NO	-	-14	-100%	-	-	-	-
Italy	396	438	105	0.9%	-291	-73%	-333	-76%	-	-
Latvia	27	3	1	0.0%	-25	-95%	-1	-48%	T1,T2	D,CS
Lithuania	79	5	4	0.0%	-75	-95%	-1	-15%	T2	CS
Luxembourg	20	18	18	0.2%	-2	-10%	0	0%	-	-
Malta	NO	NO	NO	-	-	-	-	-	NO	NO
Netherlands	42	83	87	0.8%	46	110%	5	5%	-	-
Poland	5 082	700	645	5.5%	-4 437	-87%	-54	-8%	T1/T2	D,CS
Portugal	49	21	23	0.2%	-26	-53%	2	9%	-	-
Romania	5 313	1	1	0.0%	-5 312	-100%	0	26%	-	-
Slovakia	1 422	523	344	2.9%	-1 079	-76%	-180	-34%	-	-
Slovenia	89	0	0	0.0%	-88	-100%	0	791%	T1	D
Spain	248	NO	NO	-	-248	-100%	-	-	T1,T2,T3	CS,D,PS
Sweden	94	C	C	-	-94	-100%	-	-	-	-
United Kingdom	4 144	1 596	1 373	11.8%	-2 771	-67%	-223	-14%	T2	CS
EU-27+UK	**93 039**	**12 629**	**11 653**	**100%**	**-81 386**	**-87%**	**-976**	**-8%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	-	-
United Kingdom (KP)	4 144	1 596	1 373	11.8%	-2 771	-67%	-223	-14%	T2	CS
EU-KP	**93 039**	**12 629**	**11 653**	**100%**	**-81 386**	**-87%**	**-976**	**-8%**	**-**	**-**

Greece includes emissions of 1.A.2.g in category 1.A.2.f
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure.3.97 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany (76%) and United Kingdom (12%) which together represent 88% share on EU-KP emissions.

Figure.3.97: 1.A.2.g Other, solid fuels: Emission trend and share for CO_2

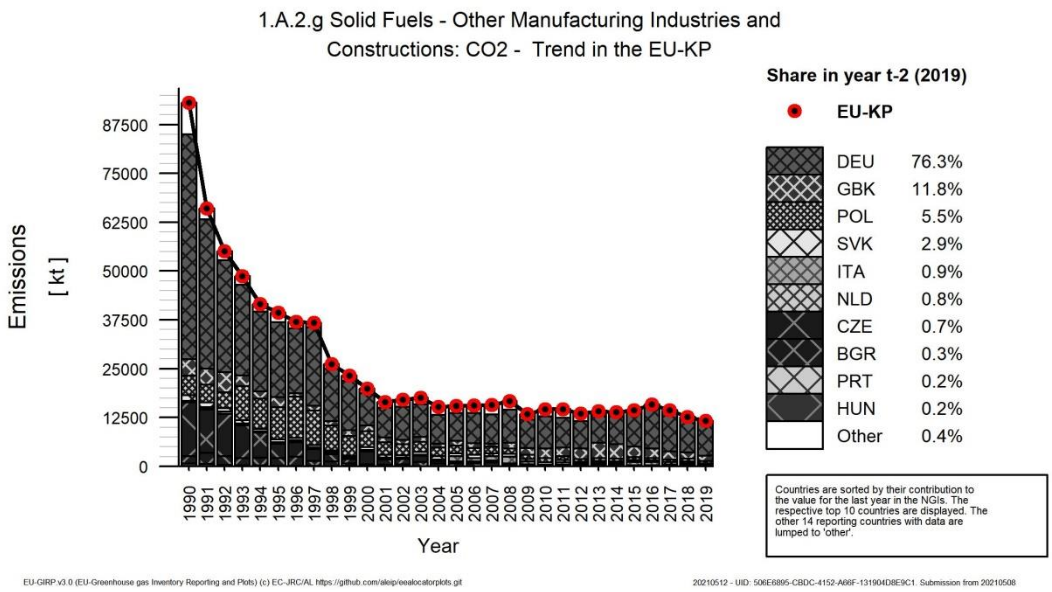


Figure 3.98 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019 which is fluctuating with slightly decreasing trend. CO_2 IEF equaled to 96.18 t/TJ in 2019.

Figure 3.98: 1.A.2.g Other, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

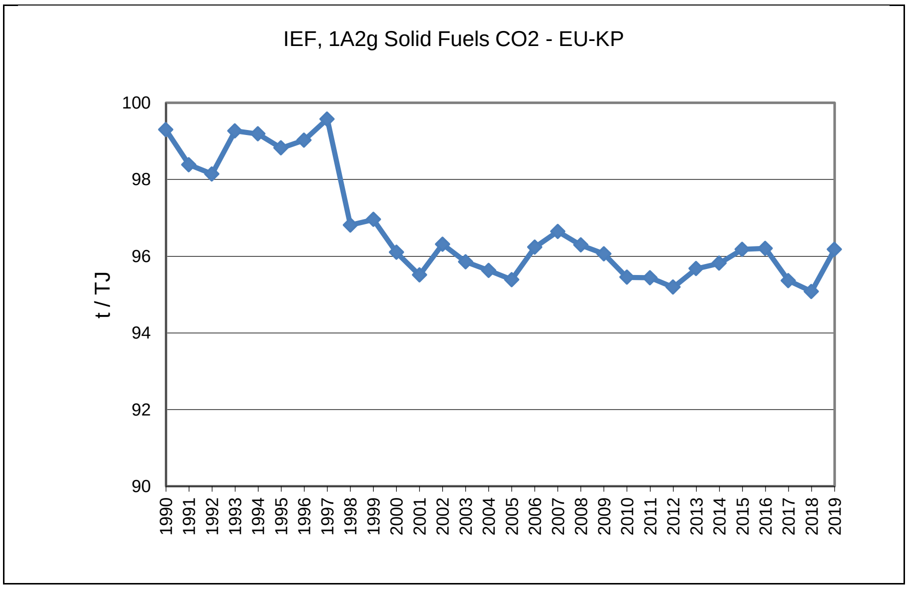
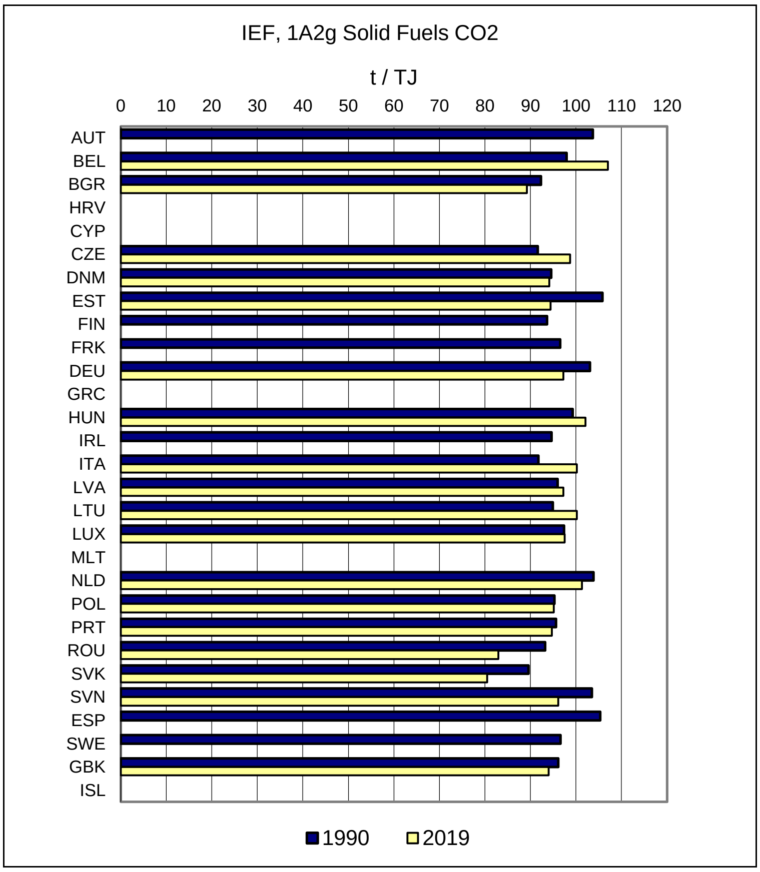


Figure **3.99** shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019.

Figure 3.99: 1.A.2.g Other, solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.g Other – Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.g amounted 89 376 kt in 2019 for EU-KP. CO_2 emissions decreased compared to year 1990 by 4% and compared to 2018 by 3%. This category represents 19% of total CO_2 equivalent emissions from category 1.A.2.

Detailed data related to the EU-KP submissions are depicted in Table 3.51. Croatia, Cyprus, Malta and Iceland report emissions as ‘NO’ (not occurring). Eight Member States reported higher level of emissions in 2019 than in 1990.

Table 3.51: 1.A.2.g Other, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	1 014	1 370	1 173	1.3%	159	16%	-197	-14%		
Belgium	1 204	1 110	1 042	1.2%	-162	-13%	-68	-6%		
Bulgaria	89	377	359	0.4%	270	304%	-18	-5%		
Croatia	NO	NO	NO	-	-	-	-	-		
Cyprus	NO	NO	NO	-	-	-	-	-		
Czechia	2 379	1 721	1 764	2.0%	-614	-26%	44	3%		
Denmark	289	228	221	0.2%	-69	-24%	-7	-3%		
Estonia	286	74	73	0.1%	-214	-75%	-2	-2%		
Finland	41	37	35	0.0%	-6	-13%	-1	-3%	T3	CS
France	4 024	4 088	4 028	4.5%	4	0%	-60	-1%		
Germany	37 693	46 682	46 553	52.1%	8 860	24%	-129	0%	T2	CS
Greece	IE	IE	IE	-	-	-	-	-		
Hungary	2 579	1 046	1 029	1.2%	-1 550	-60%	-17	-2%	T2	CS
Ireland	158	263	272	0.3%	115	73%	10	4%		
Italy	9 207	7 108	7 157	8.0%	-2 051	-22%	48	1%	T2	CS
Latvia	527	95	70	0.1%	-457	-87%	-25	-26%	T2	CS
Lithuania	677	132	120	0.1%	-557	-82%	-12	-9%	T2	CS
Luxembourg	24	28	32	0.0%	8	33%	4	15%		
Malta	NO	NO	NO	-	-	-	-	-		
Netherlands	1 710	1 363	1 384	1.5%	-325	-19%	21	2%		
Poland	865	1 529	1 547	1.7%	682	79%	19	1%	T2	CS
Portugal	NO,IE	954	956	1.1%	956	∞	2	0%		
Romania	13 643	4 008	3 144	3.5%	-10 499	-77%	-865	-22%		
Slovakia	1 071	834	684	0.8%	-387	-36%	-151	-18%		
Slovenia	417	327	302	0.3%	-115	-28%	-25	-8%	T2	CS
Spain	1 863	5 668	5 715	6.4%	3 851	207%	47	1%	T1, T2	CS, PS
Sweden	113	83	70	0.1%	-44	-38%	-13	-16%		
United Kingdom	13 155	12 719	11 647	13.0%	-1 508	-11%	-1 072	-8%	T2	CS
EU-27+UK	**93 029**	**91 843**	**89 376**	**100%**	**-3 653**	**-4%**	**-2 467**	**-3%**		
Iceland	NO	NO	NO	-	-	-	-	-		
United Kingdom (KP)	13 155	12 719	11 647	13.0%	-1 508	-11%	-1 072	-8%	T2	CS
EU-KP	**93 029**	**91 843**	**89 376**	**100%**	**-3 653**	**-4%**	**-2 467**	**-3%**		

Greece includes emissions of 1.A.2.g in category 1.A.2.f
Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level Only information from major emitters have been included to the table as well as voluntarily provided information by countries.

Figure 3.100 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany (52%), United Kingdom (13%), Italy (8%), Spain (6%) and France (5%) which together represent 84% share on EU-KP emissions.

Figure 3.100: 1.A.2.g Other, gaseous fuels: Emission trend and share for CO_2

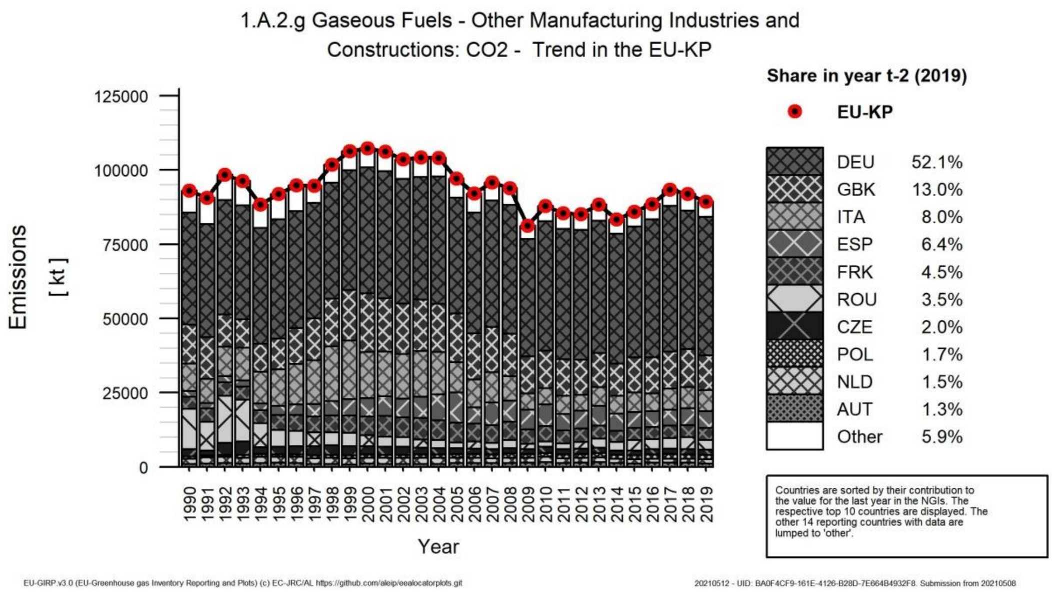


Figure 3.101 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. CO_2 IEF is relatively stable during reporting period. CO_2 IEF equaled to 56.03 t/TJ in 2019.

Figure 3.101: 1.A.2.g Other, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

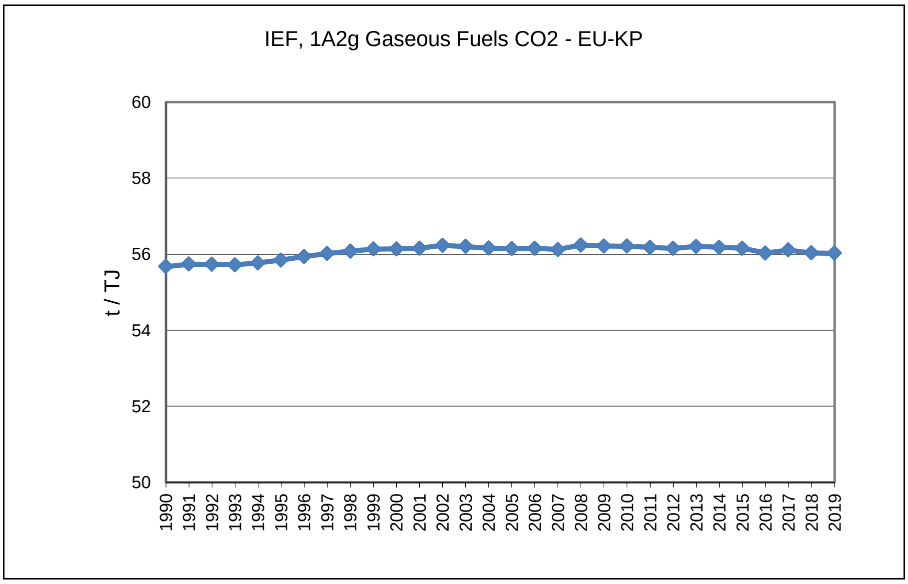
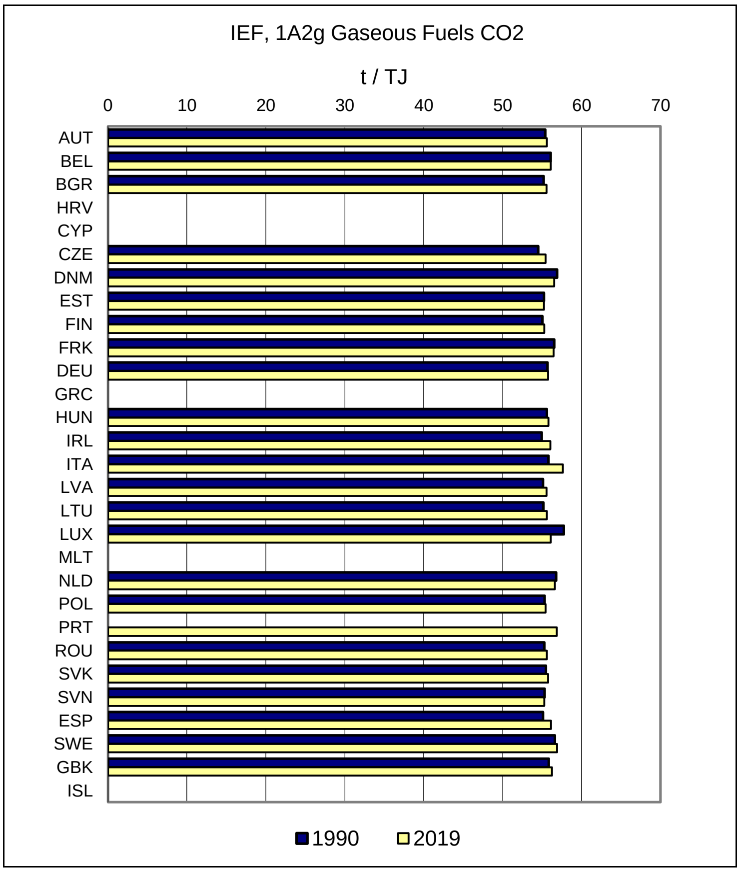


Figure 3.102 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. It can be seen that no major differences between CO_2 IEF used by countries occur, also no major differences between CO_2 IEF calculated by countries for 1990 and 2019 occur.

Figure 3.102: 1.A.2.g Other, gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.g Other – Other fossil fuels (CO_2)

CO_2 emissions from the use of other fossil fuels in category 1.A.2.g amounted 4 332 kt in 2019 for EU-KP. CO_2 emissions increased compared to year 1990 by 72% and compared to 2018 by 1%. This category represents 1% of total CO_2 equivalent emissions from category 1.A.2.

Detailed data related to the EU-KP submissions are depicted in Table 3.52. Thirteen Member States and Iceland report emissions as 'NO' (not occurring). All Member States reported higher level of emissions in 2019 than in 1990, only United Kingdom reported lower level of emissions.

Table 3.52: 1.A.2.g Other, other fossil fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	3	36	34	0.8%	31	897%	-2	-4%
Belgium	NO	17	17	0.4%	17	∞	0	-1%
Bulgaria	NO	143	195	4.5%	195	∞	52	37%
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	1	NO	NO	-	-1	-100%	-	-
Estonia	NO	NO	NO	-	-	-	-	-
Finland	88	245	256	5.9%	168	191%	11	5%
France	10	27	24	0.5%	14	141%	-3	-12%
Germany	2 344	3 742	3 734	86.2%	1 390	59%	-7	0%
Greece	-	-	-	-	-	-	-	-
Hungary	NO	NO	NO	-	-	-	-	-
Ireland	NO	NO	NO	-	-	-	-	-
Italy	NO	NO	NO	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	10	9	0.2%	9	∞	-1	-6%
Luxembourg	NO	1	1	0.0%	1	∞	0	3%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-
Poland	3	15	7	0.2%	4	128%	-8	-53%
Portugal	NO,IE	4	5	0.1%	5	∞	1	15%
Romania	NO	2	2	0.0%	2	∞	0	21%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	7	9	0.2%	9	∞	2	37%
Spain	NO	NO	NO	-	-	-	-	-
Sweden	NO	20	C	-	-	-	-20	-100%
United Kingdom	70	43	39	0.9%	-31	-44%	-4	-10%
EU-27+UK	**2 519**	**4 310**	**4 332**	**100%**	**1 813**	**72%**	**22**	**1%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	70	43	39	0.9%	-31	-44%	-4	-10%
EU-KP	**2 519**	**4 310**	**4 332**	**100%**	**1 813**	**72%**	**22**	**1%**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

Figure **3.31**Figure 3.103 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions correspond to Germany (86%) for 2019.

Figure 3.103: 1.A.2.g Other, other fossil fuels: Emission trend and share for CO_2

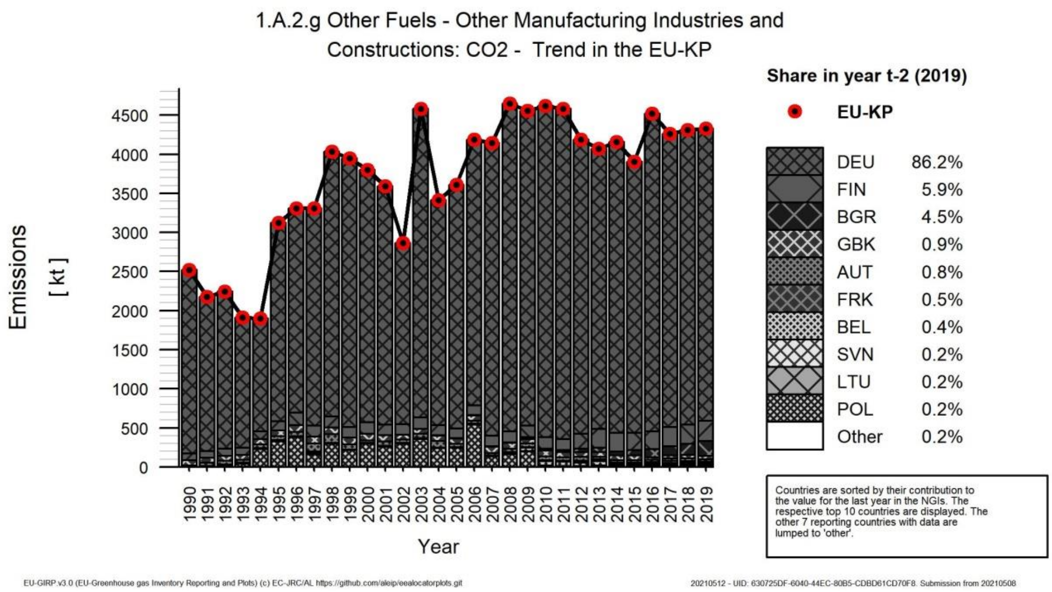


Figure 3.104 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2019. CO_2 IEF equaled to 73.88 t/TJ in 2019.

Figure 3.104: 1.A.2.g Other, other fossil fuels: Implied Emission Factors for CO_2 (in t/TJ)

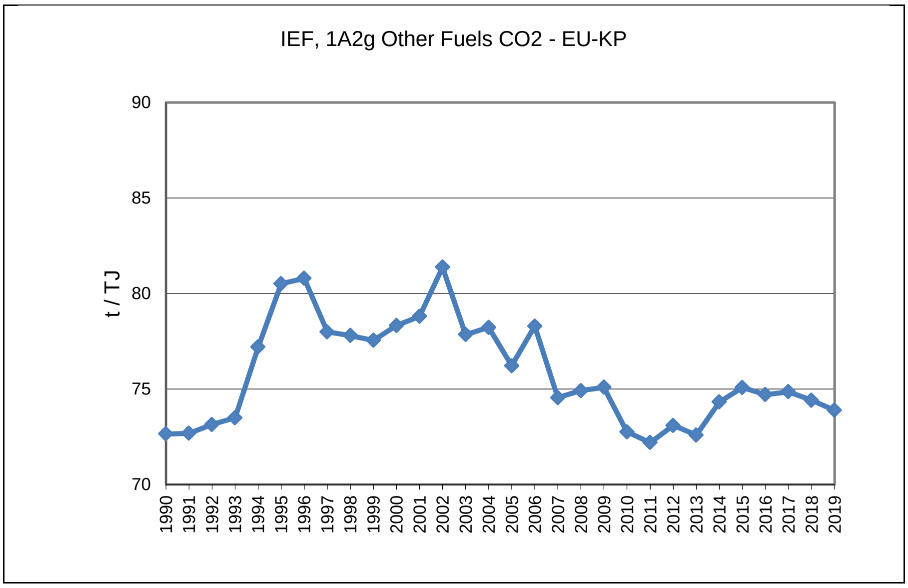
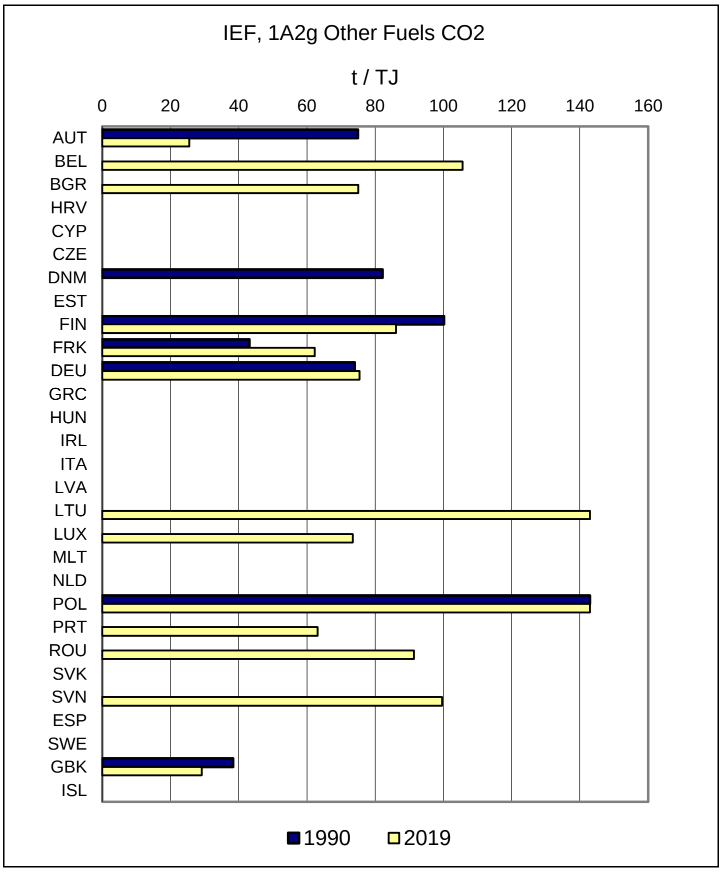


Figure 3.105 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2019. The comparatively low implied emission factor of Austria is mainly due to reporting of industrial waste where carbon content is taken into consideration. In the United Kingdom, low implied emission factor is mainly due to the use of waste solvents.

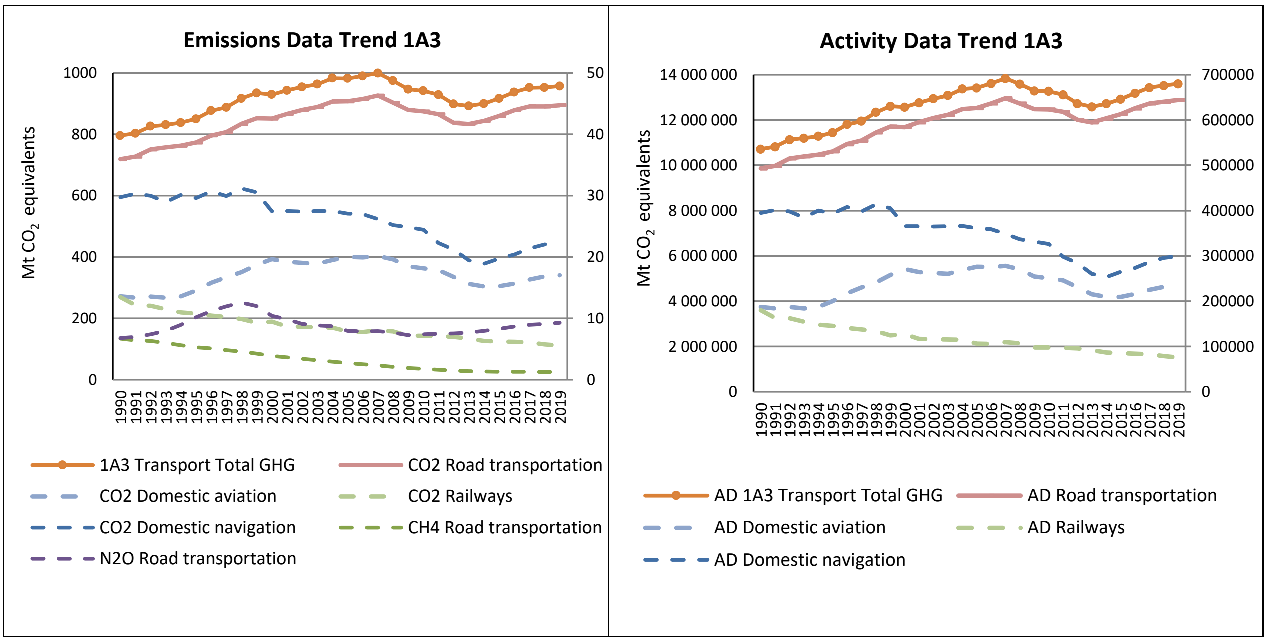
Figure 3.105: 1.A.2.g Other, other fossil fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



3.2.3 Transport (CRF Source Category 1A3) (EU-KP)

Greenhouse gas emissions from 1A3 Transport are shown in Figure 3.106. CO_2 emissions from this source category account for 23.2 %, CH_4 for 0.03 %, N_2O for 0.25 % of total GHG emissions (without LULUCF). Between 1990 and 2019, GHG from transport increased by 20 % in the EU-KP.

Figure 3.106   1A3 Transport: Greenhouse gas emissions in CO_2 equivalents (Mt) and Activity Data in TJ



Data displayed as dashed line refers to the secondary axis.

Table **3.58** summarizes the share of countries using higher tier methods for calculating emissions for the key categories of the transport categories. If the information on tier methods used is not available in the following tables of each subsector, the countries NIRs were reviewed so as to calculate the share of higher tiers. As presented, most countries use higher tiers, whereas the lower percentage is observed for 1A3d Domestic navigation: residual fuel oil, where most countries use T1 method for calculating corresponding emissions. It should be mentioned that as high tiers methods are categorised all used methods expect for the cases where only T1 method was used. In all cases, France, Germany, Italy, Spain and United Kingdom are mainly influencing the share of higher tiers.

Table 3.53: Key category analysis for the EU (1A3 sector excerpt): Key source categories for level and trend analyses and share of countries emissions using higher tier methods

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2019		1990	2019	
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	12918	16797	T	L	L	93.7%
1.A.3.b Road Transportation: Diesel Oil (CO_2)	303206	633726	T	L	L	88.7%
1.A.3.b Road Transportation: Diesel Oil (N_2O)	1898	7822	T	0	L	88.7%
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	508	4371	T	0	0	84.8%
1.A.3.b Road Transportation: Gasoline (CH_4)	6030	860	T	0	0	92.2%
1.A.3.b Road Transportation: Gasoline (CO_2)	406638	236848	T	L	L	92%
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	7354	16340	T	0	L	96.8%
1.A.3.b Road Transportation: Other Fuels (CO_2)	0	2892	T	0	0	70.1%
1.A.3.c Railways: Liquid Fuels (CO_2)	12983	5444	T	L	0	70.4%
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	17755	14053	0	L	L	82.5%
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	10328	6315	0	L	L	67.8%

Table 3.54 shows total GHG, CO_2, CH_4 and N_2O emissions from 1A3 Transport.

Table 3.54 1A3 Transport: Countries' contributions to CO_2 emissions, CH_4 and N_2O emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2019 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2019 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2019 (kt CO2 equivalents)
Austria	13 957	24 508	13 756	24 208	127	279	74	22
Belgium	20 944	25 967	20 626	25 667	177	276	142	23
Bulgaria	6 536	9 963	6 341	9 801	127	141	68	21
Croatia	3 896	6 594	3 787	6 517	68	67	41	10
Cyprus	1 254	2 149	1 216	2 124	31	22	7	3
Czechia	11 480	19 079	11 218	18 856	188	199	74	24
Denmark	10 769	13 134	10 592	12 986	98	139	79	10
Estonia	2 473	2 395	2 412	2 365	38	25	23	5
Finland	12 097	11 263	11 824	11 163	161	88	113	13
France	122 154	132 180	120 242	130 774	937	1 250	975	157
Germany	164 924	165 533	161 927	163 496	1 423	1 800	1 574	237
Greece	14 507	17 833	14 124	17 517	272	247	110	69
Hungary	8 917	14 702	8 721	14 513	127	165	69	24
Ireland	5 148	12 200	5 030	12 046	69	144	49	10
Italy	102 215	105 514	100 319	104 283	992	1 026	904	205
Latvia	3 041	3 331	2 940	3 283	81	45	20	3
Lithuania	5 816	6 290	5 685	6 210	91	74	40	6
Luxembourg	2 617	6 166	2 589	6 096	16	67	13	4
Malta	331	751	326	742	3	5	3	4
Netherlands	28 011	31 005	27 711	30 682	105	256	196	67
Poland	20 755	66 125	20 276	65 326	319	666	160	133
Portugal	10 820	17 748	10 618	17 552	102	174	99	22
Romania	12 439	18 935	12 059	18 650	285	252	94	33
Slovakia	6 824	8 074	6 693	7 976	100	91	30	7
Slovenia	2 737	5 635	2 673	5 563	36	68	28	5
Spain	58 649	91 372	57 743	90 301	524	976	383	94
Sweden	19 035	16 431	18 696	16 194	177	199	162	38
United Kingdom	121 351	119 818	118 659	118 474	1 444	1 240	1 248	105
EU-27+UK	**793 699**	**954 697**	**778 801**	**943 365**	**8 119**	**9 978**	**6 778**	**1 354**
Iceland	617	1 034	605	1 021	7	11	6	1
United Kingdom (KP)	122 168	120 654	119 459	119 301	1 452	1 246	1 257	106
EU-KP	**795 132**	**956 565**	**780 206**	**945 213**	**8 133**	**9 996**	**6 792**	**1 357**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3.55 provides information on the contribution of countries to EU-KP recalculations in CO_2 from 1A3 Transport for 1990 and 2018 and main explanations for the largest recalculations in absolute terms.

Table 3.55 1A3 Transport: Contribution of countries to EU-KP recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-21	-0.2	20	0.1	Revision of transport model (different allocation of total fuel sold to categories)
Belgium	13	0.1	-45	-0.2	Use of other COPERT version during submission 2021 COPERT 5.4.36 is used.
Bulgaria	-86	-1.3	48	0.5	Updated COPERT 5.4 Model. Revised vehicle fleet matrix – added new vehicle categories.
Croatia	0	0.0	0	0.0	Changes due to the use of Lubricant analysis project data
Cyprus	2	0.2	28	1.4	Change in methodology for road transport (biodiesel) and revised activity data
Czechia	-1	-0.0	-145	-0.8	Updated activity data based on information from Czech Car Registry
Denmark	19	0.2	11	0.1	Changes have been made in the Danish aviation emission model to accommodate for the fact that actual distance flown is larger than the ideal great circle distance between airports. In the road transport among

	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
					others: Fuel consumption factors for CNG fueled heavy duty trucks and buses, for Euro 3-5 two-wheelers updated. Updates have been made to cold-hot fuel consumption ratios. Also, there are changes in the total fleet numbers for mopeds in 2012-2018. In the navigation sector, due to methodological change the diesel related emissions for national sea transport increase slightly for the years 2015-2018.
Estonia	5	0.2	45	1.9	Emissions were recalculated due to using Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, instead of national energy balance.
Finland	-	-	7	0.1	Eurocontrol time series recalculation (1A3a), updated EFs and bioshares (1A3b), updated fuel estimate (1A3c)
France	-518	-0.4	-72	-0.1	Improvement in the accuracy of activity and comparability and accuracy in the emission and consumption factors.
Germany	120	0.1	287	0.2	(1A3a): Revision of the annual share of domestic flights. (1A3b): revision activity data as well as emission factors. (1A3c): Revision of activity data as well as emission factors. (1A3d): Recalculations based on updated activity data and emission factors.
Greece	0	0.0	-	-	-
Hungary	48	0.6	-66	-0.5	Latest energy statistics, latest version of the COPERT model
Ireland	-1	-0.0	0	0.0	The recalculations are either due to the national circumstances, revised activity data and or changes in country specific emission factors.
Italy	20	0.0	36	0.0	Update of road transport emissions due to the use of the new version of COPERT model
Latvia	-	-	-0	-0.0	Recalculations have been done due to switch from COPERT 5.2 model version to COPERT 5.3 model version and corrected distribution of vehicles fleet by sub-classes and average milage according to additional statistical information of the Road Traffic Safety Directorate of Latvia. Recalculations have been done due to corrected average specific fuel consumption of LTO (civil aviation).
Lithuania	-0	-0.0	-0	-0.0	Vehicles stock was allocated between 'ECE' and 'Euro' standards due to new available data from State Enterprise Regitra. The newly allocated stock configuration was used in model (COPERT 5.4.36) with newly corrected mileage according to fuel consumption by different standard of vehicles. Thus, by using the model estimated pollutant emissions, the amounts of sold diesel oil and gasoline in category were redistributed by type of vehicle and yearly IEF values were recalculated for N_2O for diesel oil (PC and LD) and LPG (N_2O and CH_4) for 1990-2018.
Luxembourg	-0	-0.0	-2	-0.0	Revision of AD: energy balance revised
Malta	-	-	-	-	-
Netherlands	1	0.0	11	0.0	Minor changes (<0.5%) were made in the activity data for road transport, railways and inland navigation. New data were derived from the Energy Balance. GHG emissions changed accordingly.
Poland	1	0.0	-134	-0.2	in 1A3b - AD data and the method of calculation from COPERT 5.3 to COPERT 5.4 was changed; in 1A3a AD data was change
Portugal	-1	-0.0	-0	-0.0	Update on Activity Data and Copert 5 version 5.4.36
Romania	-	-	-	-	-
Slovakia	0	0.0	-0	-0.0	-

	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
Slovenia	7	0.3	23	0.4	Transition from Copert 4 to Copert 5, improved AD.
Spain	-10	-0.0	-5	-0.0	EUROCONTROL database has changed fuel consumptions of the available period 2005 -2018, modifying all pollutant emissions. That also affects to the period 1990 -2004. Lubricant emissions have insignificantly changed respect to the last edition. The differences might be due to decimal differences during the calculation (period 1990 - 2018,1A3b). FE updated for diesel and fuel oil according to the latest version of EMEP/EEA (2019). Activity data updated for years 2017 and 2018. Provincial distribution updated for year 2018 and corrected for year 2010. All pollutants emissions have changed in the period 2014-2018 due to minor changes in the fuel consumption data of national statistics (1A3b, 2D1, 2D3d). Values of fuel characteristics have been corrected for the year 2015 (1A3b). Fuel consumption is updated taking into account the consumption of agriculture and forestry machinery (1A4cii), which is updated for the year n-1. Affects to all pollutants in the years 2017 and 2018 (1A3b).
Sweden	280	1.5	285	1.7	Switching from HBEFA 3.3 to HBEFA 4.1 affects all emissions for the entire time period (1990-2019).
United Kingdom	-4	-0.0	7	0.0	Minor change partially due to updated DfT data.
EU27+UK	-124	-0.0	339	0.0	
Iceland	-6	-1.0	-9	-0.8	For this submission Iceland has obtained a country-specific emission factor for fuels used in Road Transport, which decreased the emissions for the whole timeseries.
United Kingdom (KP)	-5	-0.0	4	0.0	Minor change partially due to updated DfT data.
EU-KP	-131	-0.0	328	0.0	

Table 3.57 provides information on the contribution of countries to EU-KP recalculations in CH_4 from 1A3 Transport for 1990 and 2018.

Table 3.56 1A3 Transport: Contribution of countries to EU-KP recalculations in CH_4 for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-0	-0.3	0	0.5	Revision of transport model (different allocation of total fuel sold to categories)
Belgium	0	0.2	1	7.1	Use of other COPERT version during submission 2021 COPERT 5.4.36 is used.
Bulgaria	-2	-3.2	-0	-0.0	Updated COPERT 5.4 Model. Revised vehicle fleet matrix – added new vehicle categories.
Croatia	0	0.0	-16	-60.6	Changes due to the use of Lubricant analysis project data
Cyprus	-0	-0.3	-0	-4.6	Change in methodology for road transport (biodiesel) and revised activity data
Czechia	-1	-1.8	1	2.5	Updated activity data based on information from Czech Car Registry
Denmark	-0	-0.1	-0	-0.2	Changes have been made in the Danish aviation emission model to accommodate for the fact that actual distance flown is larger than the ideal great circle distance between airports. In the road transport among others: Fuel consumption factors for CNG fueled heavy duty trucks and buses, for Euro 3-5 two-wheelers

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					updated. Updates have been made to cold-hot fuel consumption ratios. Also, there are changes in the total fleet numbers for mopeds in 2012-2018. In the navigation sector, due to methodological change the diesel related emissions for national sea transport increase slightly for the years 2015-2018.
Estonia	0	0.0	1	33.0	Emissions were recalculated due to using Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, instead of national energy balance.
Finland	0	0.0	-0	-0.1	Eurocontrol time series recalculation (1A3a), updated EFs and bioshares (1A3b), updated fuel estimate (1A3c)
France	-64	-6.1	9	6.4	Improvement in the accuracy of activity and comparability and accuracy in the emission and consumption factors.
Germany	-99	-5.9	7	3.2	(1A3a): Revision of the annual share of domestic flights. (1A3b): revision activity data as well as emission factors. (1A3c): Revision of activity data as well as emission factors. (1A3d): Recalculations based on updated activity data and emission factors.
Greece	-	-	-1	-1.2	Recalculations in CH_4 and N_2O emissions from biomass were carried out for years 2006- 2018. In our calculations, the IEFs that were being used for the calculation of CH_4 and N_2O from Biomass were found to be incorrect. Recalculations were carried out using the IEFs as provided by COPERT V.
Hungary	0	0.0	0	0.2	Latest energy statistics, latest version of the COPERT model
Ireland	0	1.0	0	4.3	The recalculations are either due to the national circumstances, revised activity data and or changes in country specific emission factors.
Italy	-2	-0.2	-1	-0.5	Update of road transport emissions due to the use of the new version of COPERT model
Latvia	-	-	-0	-0.3	Recalculations have been done due to switch from COPERT 5.2 model version to COPERT 5.3 model version and corrected distribution of vehicles fleet by sub-classes and average milage according to additional statistical information of the Road Traffic Safety Directorate of Latvia.
Lithuania	-13	-23.9	-13	-66.8	Vehicles' stock was allocated between 'ECE' and 'Euro' standards in Road transportation (1.A.3.b) due to new available data from State Enterprise Regitra. The newly allocated stock configuration was used in model (COPERT 5.4.36) with newly corrected mileage according to fuel consumption by different standard of vehicles. Thus, by using the model estimated pollutant emissions, the amounts of sold diesel oil and gasoline in category were redistributed by type of vehicle and yearly methane IEF values were recalculated for LPG.
Luxembourg	0	0.0	-0	-0.0	Revision of AD: energy balance revised
Malta	-	-	-4	-67.4	There was a bug in COPERT with regards to CH_4 emissions derived from Quad bikes & MTV's. We provided a revised estimate which was accepted by the reviewers
Netherlands	0	0.0	0	0.0	Minor changes (<0.5%) were made in the activity data for road transport, railways and inland navigation. New data were derived from the Energy Balance. GHG emissions changed accordingly.
Poland	-10	-5.9	-5	-3.7	In 1A3b - AD data and the method of calculation from COPERT 5.3 to COPERT 5.4 was changed; in 1A3a AD data was change
Portugal	1	1.2	0	0.4	Update on Activity Data and Copert 5 version 5.4.36
Romania	-	-	-	-	-
Slovakia	-	-	-	-	-
Slovenia	2	6.9	-0	-4.8	Transition from Copert 4 to Copert 5, improved AD

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Spain	-0	-0.0	0	0.1	EUROCONTROL database has changed fuel consumptions of the available period 2005 -2018, modifying all pollutant emissions. That also affects to the period 1990 -2004. FE updated for diesel and fuel oil according to the latest version of EMEP/EEA (2019). Activity data updated for years 2017 and 2018. Provincial distribution updated for year 2018 and corrected for year 2010. All pollutants emissions have changed in the period 2014-2018 due to minor changes in the fuel consumption data of national statistics (1A3b, 2D1, 2D3d). Values of fuel characteristics have been corrected for the year 2015 (1A3b). Fuel consumption is updated taking into account the consumption of agriculture and forestry machinery (1A4cii), which is updated for the year n-1. Affects to all pollutants in the years 2017 and 2018 (1A3b).
Sweden	7	4.3	9	48.5	Switching from HBEFA 3.3 to HBEFA 4.1 affects all emissions for the entire time period (1990-2019).
United Kingdom	0	0.0	4	3.7	Minor change partially due to updated DfT data.
EU27+UK	-180	-2.6	-7	-0.6	
Iceland	0	1.1	0	3.9	Small recalculations due to an update in COPERT
United Kingdom (KP)	0	0.0	4	3.7	Minor change partially due to updated DfT data
EU-KP	-180	-2.6	-7	-0.5	

Table 3.57 provides information on the contribution of countries to EU-KP recalculations in N_2O from 1A3 Transport for 1990 and 2018.

Table 3.57 1A3 Transport: Contribution of countries to EU-KP recalculations in N_2O for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	2	1.4	7	2.9	Revision of transport model (different allocation of total fuel sold to categories)
Belgium	0	0.2	4	1.4	Use of other COPERT version during submission 2021 COPERT 5.4.36 is used.
Bulgaria	19	17.8	43	48.6	Updated COPERT 5.4 Model. Revised vehicle fleet matrix – added new vehicle categories.
Croatia	13	24.1	1	2.0	Changes due to the use of Lubricant analysis project data
Cyprus	7	31.2	8	66.2	Change in methodology for road transport (biodiesel) and revised activity data
Czechia	-2	-1.3	-7	-3.3	Updated activity data based on information from Czech Car Registry
Denmark	-1	-0.6	1	0.7	Changes have been made in the Danish aviation emission model to accommodate for the fact that actual distance flown is larger than the ideal great circle distance between airports. In the road transport among others: Fuel consumption factors for CNG fueled heavy duty trucks and buses, for Euro 3-5 two-wheelers updated. Updates have been made to cold-hot fuel consumption ratios. Also, there are changes in the total fleet numbers for mopeds in 2012-2018. In the navigation sector, due to methodological change the diesel related emissions for national sea transport increase slightly for the years 2015-2018.
Estonia	-0	-0.1	3	11.8	Emissions were recalculated due to using Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, instead of national energy balance.

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Finland	-	-	0	0.1	Eurocontrol time series recalculation (1A3a), updated EFs and bioshares (1A3b), updated fuel estimate (1A3c)
France	-34	-3.5	-260	-17.1	Improvement in the accuracy of activity and comparability and accuracy in the emission and consumption factors.
Germany	-75	-5.0	11	0.6	(1A3a): Revision of the annual share of domestic flights. (1A3b): revision activity data as well as emission factors. (1A3c): Revision of activity data as well as emission factors. (1A3d): Recalculations based on updated activity data and emission factors.
Greece	-	-	-3	-1.3	Recalculations in CH_4 and N_2O emissions from biomass were carried out for years 2006- 2018. In our calculations, the IEFs that were being used for the calculation of CH_4 and N_2O from Biomass were found to be incorrect. Recalculations were carried out using the IEFs as provided by COPERT V.
Hungary	3	2.6	6	4.1	Latest energy statistics, latest version of the COPERT model
Ireland	2	3.2	11	8.8	The recalculations are either due to the national circumstances, revised activity data and or changes in country specific emission factors.
Italy	19	2.0	46	4.8	Update of road transport emissions due to the use of the new version of COPERT model
Latvia	-	-	-3	-5.2	Recalculations have been done due to switch from COPERT 5.2 model version to COPERT 5.3 model version and corrected distribution of vehicles fleet by sub-classes and average milage according to additional statistical information of the Road Traffic Safety Directorate of Latvia.
Lithuania	6	7.7	-21	-22.3	Vehicles' stock was allocated between 'ECE' and 'Euro' standards in Road transportation (1.A.3.b) due to new available data from State Enterprise Regitra. The newly allocated stock configuration was used in model (COPERT 5.4.36) with newly corrected mileage according to fuel consumption by different standard of vehicles. Thus, by using the model estimated pollutant emissions, the amounts of sold diesel oil and gasoline in category were redistributed by type of vehicle and yearly IEF values were recalculated for N_2O for diesel oil (PC and LD) and LPG.
Luxembourg	0	0.1	0	0.0	Revision of AD: energy balance revised
Malta	-	-	1	17.4	An error in the calculation of N_2O emissions from Domestic Navigation for the year of 2007 was identified. As a result, a revised estimate was submitted in the current submission. In addition, a revised estimate for N_2O emissions derived from road transportation [1.A.3.b.i Cars] [diesel oil], was also submitted.
Netherlands	-0	-0.0	0	0.0	Minor changes (<0.5%) were made in the activity data for road transport, railways and inland navigation. New data were derived from the Energy Balance. GHG emissions changed accordingly.
Poland	-9	-2.8	-49	-7.0	In 1A3b - AD data and the method of calculation from COPERT 5.3 to COPERT 5.4 was changed; in 1A3a AD data was change
Portugal	1	0.7	11	6.7	Update on Activity Data and Copert 5 version 5.4.36
Romania	-	-	-	-	-
Slovakia	-	-	-	-	-
Slovenia	-0	-0.2	-2	-3.4	Transition from Copert 4 to Copert 5, improved AD.
Spain	-0	-0.0	2	0.2	EUROCONTROL database has changed fuel consumptions of the available period 2005 -2018, modifying all pollutant emissions. That also affects to the period 1990 -2004. FE updated for diesel and fuel oil according to the latest version of EMEP/EEA (2019). Activity data updated for years 2017 and 2018. Provincial distribution updated for year 2018 and

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					corrected for year 2010. All pollutants emissions have changed in the period 2014-2018 due to minor changes in the fuel consumption data of national statistics (1A3b, 2D1, 2D3d). Values of fuel characteristics have been corrected for the year 2015 (1A3b). Fuel consumption is updated taking into account the consumption of agriculture and forestry machinery (1A4cii), which is updated for the year n-1. Affects to all pollutants in the years 2017 and 2018 (1A3b).
Sweden	0	0.3	38	24.0	Switching from HBEFA 3.3 to HBEFA 4.1 affects all emissions for the entire time period (1990-2019).
United Kingdom	3	0.2	12	1.0	Minor recalculations due updating to most recent EMEP/EEA emission factor.
EU27+UK	-45	-0.6	-139	-1.4	
Iceland	1	9.9	1	17.2	Small recalculations due to an update in COPERT
United Kingdom (KP)	3	0.2	12	1.0	Minor recalculations due updating to most recent EMEP/EEA emission factor.
EU-KP	-45	-0.5	-137	-1.4	

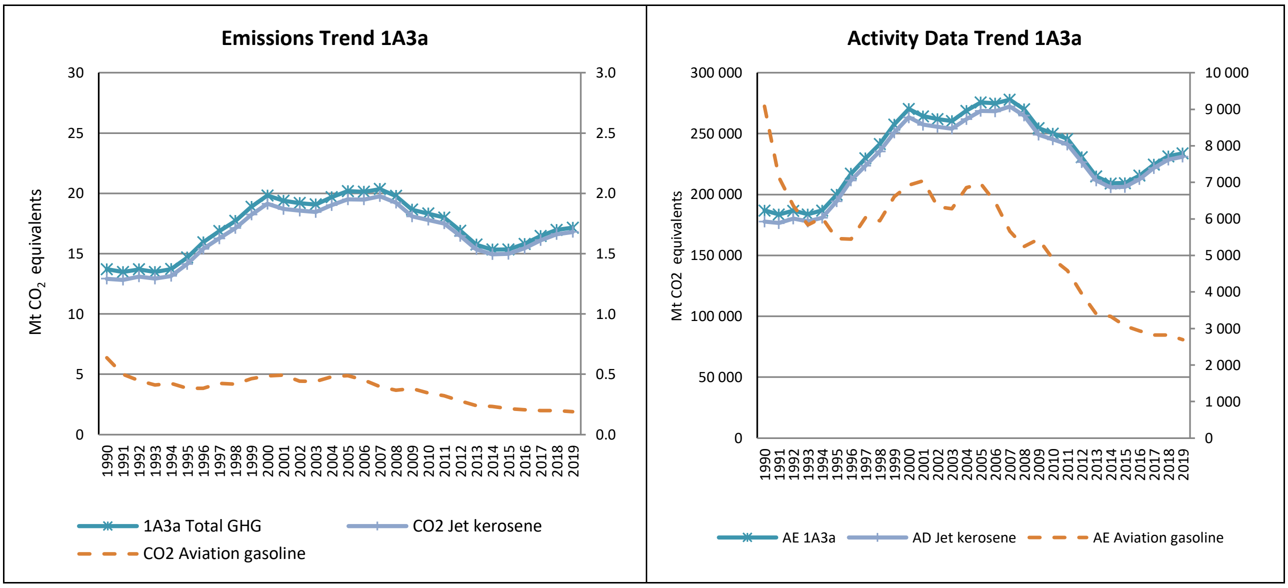
3.2.3.1 Domestic Aviation (1A3a) (EU-KP)

This source category includes emissions from civil domestic passenger and freight traffic that departs and arrives in the same country (commercial, private, agriculture, etc.), including take-offs and landings for these flight stages. It should be noted that emissions from military aviation should be reported under category 1A5b Other Mobile, which is the case for most countries. However, Poland, have stated that all military activities are reported and included in the country's energy balance. For confidentiality reasons, the military share is not reported separately. The corresponding explanation is also included in the NIR submission. Furthermore, Iceland does not report emissions under category 1A5b in the CRF. During the ESD checks Iceland informed the EU that there is no military in Iceland, thus emissions from military aviation are not occurring. Finally, Bulgaria informed the EU that emissions from military aviation have been reallocated under CRF category 1A5b in the submission of 2021.

CO_2 emissions from 1A3a Domestic Aviation account for 2 % of total transport related GHG emissions in 2019. Between 1990 and 2019, CO_2 emissions from domestic aviation increased by 25 % in the EU-KP (Table 3.58, Figure 3.107).

CO_2 emissions from Jet Kerosene account for 99 % of total CO_2 emissions from 1A3a Domestic Aviation. Between 2018 and 2019, CO_2 emissions from domestic aviation increased by 1 % in the EU-KP (Table 3.58, Figure 3.107).

Figure 3.107 1A3a Civil Aviation: CO_2 Emissions in CO_2 equivalents (Mt) and Activity data in TJ



Data displayed as dashed line refers to the secondary axis.

The countries France, Germany, Italy and Spain alone contributed 77 % to the emissions from this source. Fourteen countries in total increased emissions from civil aviation between 1990 and 2019 (Table 3.58). Based on the following table Germany and Italy used also T1 method for calculation emissions, but they used higher tier method for calculating emissions from jet kerosene, which contributes the most to this category. Thus, the total percentage of the share of higher tier methods amounts to 93.7%.

Table 3.58 1A3a Civil Aviation: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	38	46	46	0.3%	8	20%	0.1	0.2%	T2,T3	CS
Belgium	15	11	10	0.1%	-4	-30%	-1	-9%	T1	D
Bulgaria	49	22	21	0.1%	-29	-58%	-1	-5%	T1,T2	D
Croatia	7	32	32	0.2%	25	386%	0.3	1%	T1	D
Cyprus	26	1	0.4	0.002%	-26	-99%	-1	-58%	T1	D
Czechia	139	10	10	0.1%	-129	-93%	0	0.2%	T1	D
Denmark	224	148	150	0.9%	-75	-33%	2	1%	NA	NA
Estonia	6	4	4	0.02%	-2	-30%	-0.2	-4%	T2	D
Finland	385	210	206	1.2%	-179	-47%	-5	-2%	T1,T2	CS
France	3 871	5 245	5 326	31.4%	1 455	38%	81	2%	T3	M
Germany	2 412	2 181	2 218	13.1%	-194	-8%	37	2%	CS,T1,T2	CS,D,M
Greece	323	421	410	2.4%	87	27%	-11	-3%	T2,T3	D
Hungary	4	4	8	0.05%	4	109%	3	74%	T1,T2	CS,D
Ireland	48	17	17	0.1%	-30	-64%	1	5%	M,T3	CS
Italy	1 493	2 321	2 379	14.0%	886	59%	58	2%	T1,T2	CS
Latvia	0.1	4	2	0.01%	2	2407%	-2	-55%	T1	D
Lithuania	8	2	2	0.01%	-6	-76%	0.002	0.1%	T1	CS
Luxembourg	0.2	1	1	0.003%	0.3	136%	-0.1	-10%	T1	D
Malta	1	1	1	0.01%	0.1	8%	1	79%	T1,T3	M
Netherlands	85	32	32	0.2%	-53	-63%	0	-1%	T1	CS,D
Poland	63	129	128	0.8%	65	103%	-1	-1%	T1	D
Portugal	178	498	496	2.9%	318	179%	-2	-0.5%	T1,T3	D
Romania	25	166	194	1.1%	169	678%	27	16%	T1,T2	D,OTH
Slovakia	4	3	2	0.01%	-2	-51%	-1	-36%	T3	D
Slovenia	1	2	2	0.01%	1	83%	-0.04	-2%	T1	D
Spain	1 655	3 025	3 127	18.4%	1 472	89%	102	3%	T3	D
Sweden	673	523	470	2.8%	-203	-30%	-53	-10%	T1	D
United Kingdom	1 535	1 539	1 472	8.7%	-63	-4%	-67	-4%	T3	CS
EU-27+UK	**13 269**	**16 597**	**16 764**	**99%**	**3 495**	**26%**	**167**	**1%**	**-**	**-**
Iceland	33	25	28	0.2%	-6	-17%	3	13%	T1	D
United Kingdom (KP)	1 789	1 727	1 667	9.8%	-122	-7%	-60	-3%	T3	CS
EU-KP	**13 556**	**16 809**	**16 986**	**100%**	**3 430**	**25%**	**177**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3a Domestic Aviation – Jet Kerosene (CO_2)

In 2019 CO_2 emissions resulting from jet kerosene within the category 1A3a were responsible for 99 % of CO_2 emissions in 1A3a. Within the EU-KP the emissions increased between 1990 and 2019 by 30% (Table 3.59). The largest absolute increase occurred in France. Between 2018 and 2019, EU-KP emissions increased by 1 %.

Table 3.59 1A3a Civil Aviation, jet kerosene: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	31	39	39	0.2%	9	28%	0.4	1%	T3	CS
Belgium	12	10	9	0.1%	-3	-25%	-1	-10%	T1	D
Bulgaria	28	21	20	0.1%	-8	-29%	-1	-3%	T2	D
Croatia	6	30	31	0.2%	25	390%	0	1%	T1	D
Cyprus	26	1	0.4	0.002%	-26	-99%	-1	-58%	T1	D
Czechia	1	1	1	0.005%	-1	-42%	0.02	2%	T1	D
Denmark	216	144	147	0.9%	-69	-32%	3	2%	0	0
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	377	208	204	1.2%	-173	-46%	-4	-2%	T2	CS
France	3 775	5 194	5 277	31.4%	1 503	40%	83	2%	T3	M
Germany	2 276	2 156	2 197	13.1%	-79	-3%	41	2%	CS,T2	CS,M
Greece	311	415	403	2.4%	92	30%	-12	-3%	T3	D
Hungary	1	2	2	0.01%	1	50%	0	9%	T2	CS
Ireland	45	15	15	0.1%	-30	-66%	1	4%	M,T3	CS
Italy	1 459	2 310	2 367	14.1%	908	62%	57	2%	T1,T2	CS
Latvia	0.1	3	1	0.01%	1	2399%	-2	-58%	T1	D
Lithuania	7	0.4	1	0.003%	-7	-92%	0.1	33%	T1	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	1	1	1	0.01%	0.1	8%	1	79%	T1,T3	M
Netherlands	73	30	30	0.2%	-43	-59%	0.02	0.1%	T1	D
Poland	38	117	115	0.7%	77	201%	-2	-1%	T1	D
Portugal	176	497	495	2.9%	319	181%	-3	-1%	T3	D
Romania	25	163	188	1.1%	163	657%	25	16%	T2	OTH
Slovakia	4	3	2	0.01%	-2	-52%	-1	-37%	T3	D
Slovenia	NO	1	0.5	0.003%	0.5	∞	-0.1	-11%	T1	D
Spain	1 628	3 014	3 115	18.5%	1 487	91%	101	3%	T3	D
Sweden	658	520	468	2.8%	-190	-29%	-52	-10%	T1	D
United Kingdom	1 472	1 507	1 448	8.6%	-24	-2%	-59	-4%	T3	CS
EU-27+UK	**12 647**	**16 402**	**16 577**	**99%**	**3 930**	**31%**	**175**	**1%**	**-**	**-**
Iceland	28	24	27	0.2%	-2	-5%	3	13%	T1	D
United Kingdom (KP)	1 715	1 693	1 642	9.8%	-74	-4%	-52	-3%	T3	CS
EU-KP	**12 918**	**16 611**	**16 797**	**100%**	**3 878**	**30%**	**185**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

France, Germany, Italy, Spain and the UK account for 86.9 % of CO_2 emissions from jet kerosene in 2019 (Figure 3.109). Table **3.59** shows that the majority of emissions from Domestic Aviation jet kerosene were calculated using a higher tier method (93.7%) as presented in Table 6.1. Based on the table above, Italy, which is one of the major contributors to this category, mentions to use also T1 method. As stated in the NIR, T1 method is used for calculating emissions for N_2O and not CO_2 emissions. Thus, it was included in the share of the high tier methods calculation for CO_2 emissions. In Figure 3.108 the IEF is depicted, showing a mean value of around 73 t/TJ.

Figure 3.109 1A3a Civil Aviation, Jet Kerosene: Emission trend and share for CO_2

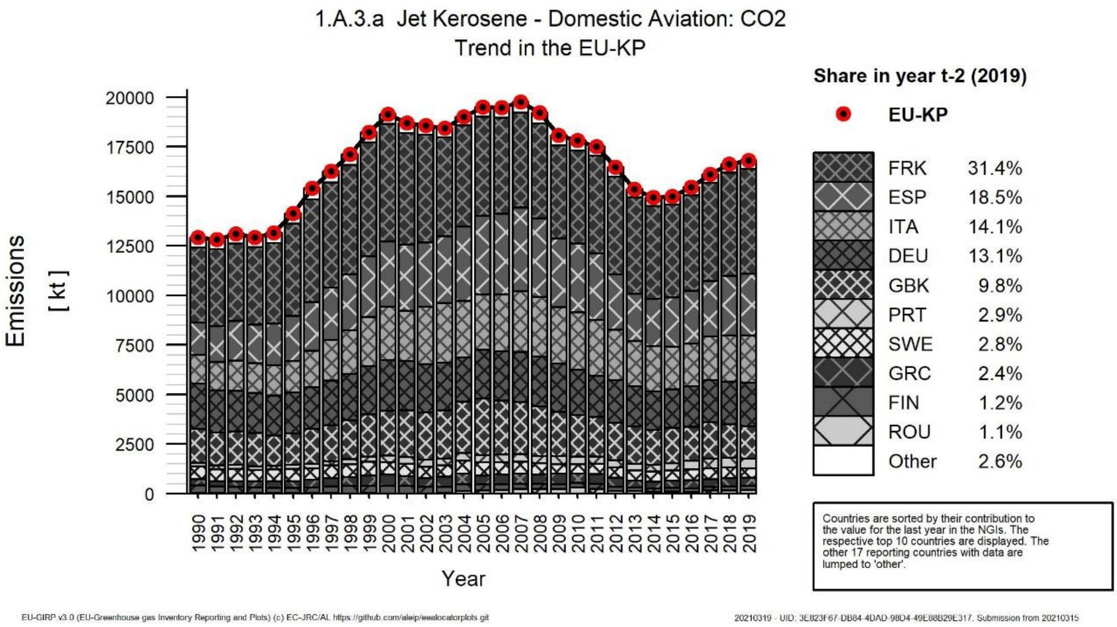
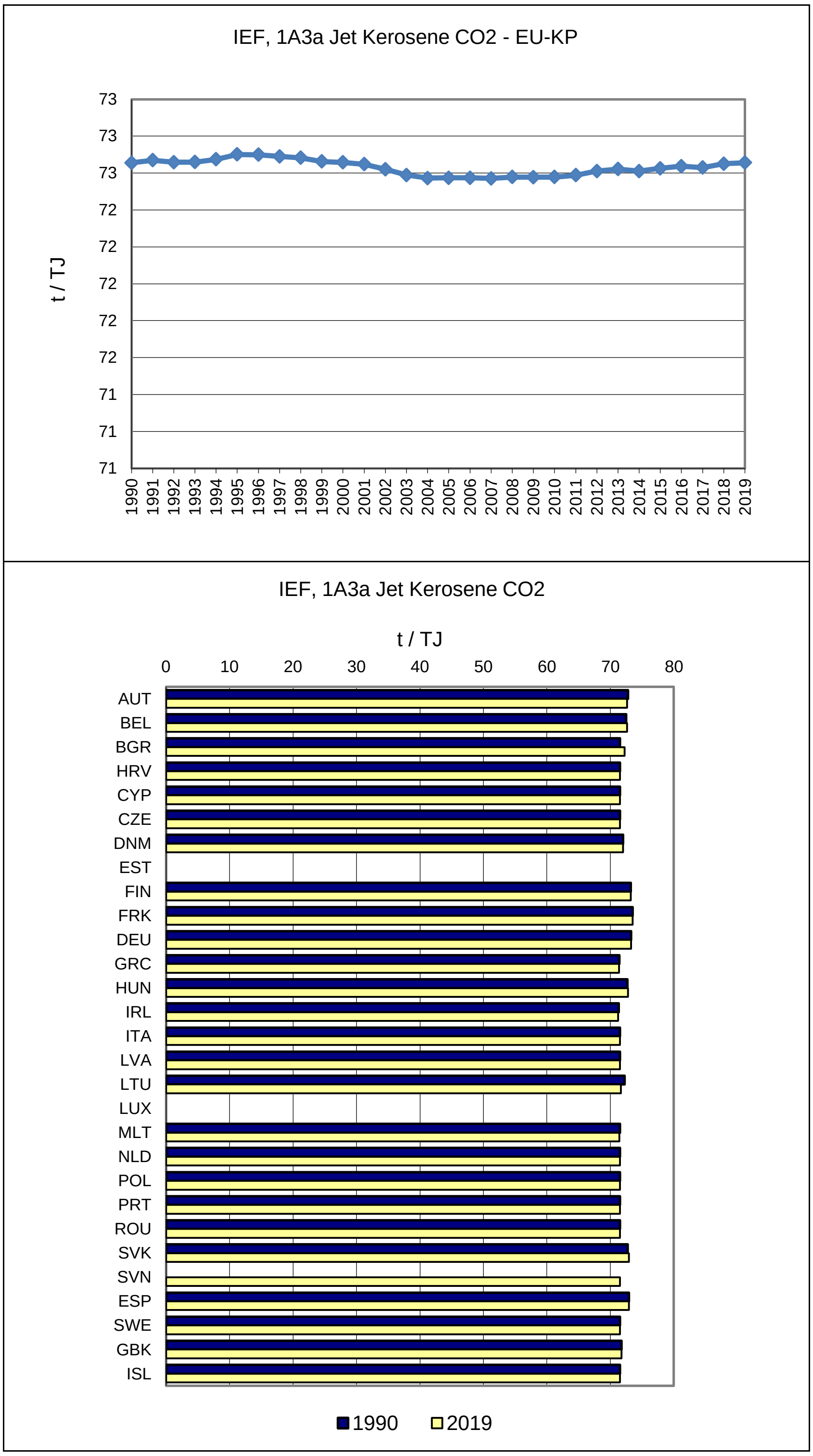


Figure 3.110 1A3a Civil Aviation, Jet Kerosene: Implied Emission Factors for CO_2 (in t/TJ)



3.2.3.2 Road Transportation (1A3b) (EU-KP)

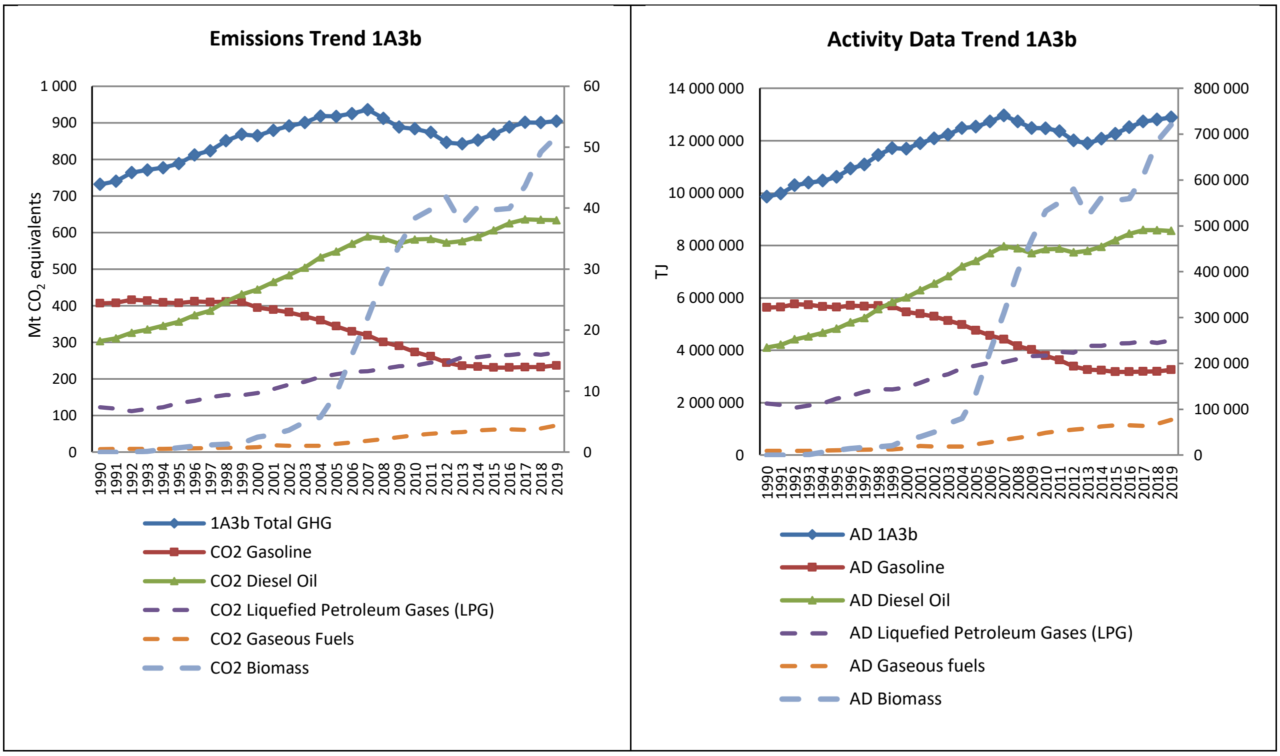
CO_2 emissions from 1A3b Road Transportation

The mobile source category Road Transportation includes all types of light-duty vehicles such as passenger cars and light commercial trucks, and heavy-duty vehicles such as tractors, trailers and buses, and two and three-wheelers (including mopeds, scooters, and motorcycles). These vehicles operate on many types of gaseous and liquid fuels.

CO_2 emissions from 1A3b Road Transportation is the second largest key source of all categories in the EU-KP accounting for 22 % of total GHG emissions in 2019. Between 1990 and 2019, CO_2 emissions from road transportation increased by 25 % in the EU-KP (Table 3.60). It is obvious that emissions dropped between 2007 and 2013 and the corresponding activity data, except for biomass, show a similar trend. This can be attributed to the economic crisis that Europe has gone through these years but also to the increased use of biofuels. The emissions from this key source are due to fossil fuel consumption in road transport, which increased by 24 % between 1990 and 2019.

Figure 3.111 gives an overview of the CO_2 trend caused by different fuels. The trend is mainly dominated by emissions resulting from the combustion of gasoline and diesel oil. The decline of gasoline and the increase of diesel show the gradual switch from gasoline to diesel passenger cars in several EU-KP countries.

Figure 3.111 1A3b Road Transport: CO_2 Emission Trend and Activity Data



Data displayed as dashed line refers to the secondary axis.

The countries Germany, France, Italy, Spain and the United Kingdom contributed most to the CO_2 emissions from this source (63.8 %). All countries, except Finland (-3%) and Sweden (-14%), show increased emissions from road transportation between 1990 and 2019. In the case of Sweden, the decreased emissions are explained by the total use of liquid biofuels (ethanol and FAME), which has increased by more than 850% since 2003. Ethanol is used by passenger cars, by ethanol buses and E85 vehicles. The total use of FAME has increased by 33-49% each year starting 2011 in the EU. The countries with the highest increases in absolute terms were Poland, Spain, Austria and France. The countries with the lowest increase in relative terms were United Kingdom, Estonia and Germany (Table 3.60).

Table 3.60 1A3b Road Transport: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	13 287	23 362	23 443	2.6%	10 156	76%	81	0.3%	T1,T2	CS,D
Belgium	19 692	25 026	24 729	2.8%	5 037	26%	-297	-1%	M,T2	CS,M
Bulgaria	5 780	9 257	9 617	1.1%	3 836	66%	360	4%	T2	CR
Croatia	3 506	6 113	6 284	0.7%	2 778	79%	171	3%	T1	D
Cyprus	1 188	2 077	2 122	0.2%	933	79%	45	2%	T1,T2	D,M
Czechia	10 252	18 350	18 518	2.1%	8 266	81%	167	1%	T2	M
Denmark	9 357	12 297	12 098	1.4%	2 742	29%	-199	-2%	NA	NA
Estonia	2 225	2 353	2 311	0.3%	85	4%	-42	-2%	T1,T2	CS,D
Finland	10 804	10 853	10 455	1.2%	-349	-3%	-398	-4%	T2	CS
France	114 060	123 167	123 317	13.8%	9 256	8%	149	0.1%	T3	M
Germany	151 886	155 928	157 720	17.6%	5 833	4%	1 792	1%	CS,M,T2,T3	CS,D
Greece	11 793	14 593	15 006	1.7%	3 213	27%	414	3%	T1,T2,T3	CS,D
Hungary	7 826	13 378	14 197	1.6%	6 371	81%	819	6%	T1,T2	CS,D
Ireland	4 690	11 553	11 488	1.3%	6 798	145%	-65	-1%	T2,T3	CS,M
Italy	92 332	95 777	96 606	10.8%	4 275	5%	830	1%	T2	CS,M
Latvia	2 402	3 107	3 134	0.4%	731	30%	27	1%	T1,T2	CS,D
Lithuania	5 247	5 756	5 993	0.7%	746	14%	237	4%	T1,T2	CS,D
Luxembourg	2 563	5 951	6 088	0.7%	3 525	138%	137	2%	T1,T2	CS,D
Malta	300	559	715	0.1%	415	139%	156	28%	T1,T3	M
Netherlands	26 451	29 993	29 584	3.3%	3 133	12%	-409	-1%	T1,T2	CS
Poland	18 438	62 920	64 063	7.2%	45 625	247%	1 143	2%	T2	D
Portugal	10 001	16 277	16 756	1.9%	6 755	68%	479	3%	T2	OTH
Romania	10 366	17 605	17 923	2.0%	7 557	73%	318	2%	T1,T3	D,OTH
Slovakia	4 503	7 255	7 490	0.8%	2 987	66%	235	3%	T2	CS,D
Slovenia	2 607	5 742	5 537	0.6%	2 930	112%	-205	-4%	M	M
Spain	50 433	82 663	83 514	9.3%	33 081	66%	850	1%	T1,T2	CS,D,M
Sweden	17 271	15 135	14 814	1.7%	-2 457	-14%	-321	-2%	T2	CS
United Kingdom	107 892	111 418	109 219	12.2%	1 328	1%	-2 199	-2%	T1,T3	CS,OTH
EU-27+UK	**717 152**	**888 464**	**892 738**	**100%**	**175 586**	**24%**	**4 274**	**0.5%**	**-**	**-**
Iceland	512	961	940	0.1%	429	84%	-20	-2%	T1,T2	D
United Kingdom (KP)	108 365	111 964	109 772	12.3%	1 406	1%	-2 192	-2%	T1,T3	CS,OTH
EU-KP	**718 137**	**889 970**	**894 231**	**100%**	**176 094**	**25%**	**4 261**	**0.5%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

In Table 3.61 the fuel share is presented per country. It is clear that diesel oil accounts for around 67% for EU-KP and gasoline for 25%. The highest LPG consumption is observed in Bulgaria (13.3 %) and Poland (9.6 %). The share of biomass is around 5% for EU-KP with Sweden having the highest percentage (21.7 %).

Table 3.61 1A3b Road Transport: Countries' share of different fuel in the total consumption

Member State	Gasoline (%)	Diesel oil (%)	LPG (%)	Gaseous fuels (%)	Biomass (%)
Austria	19.5%	75.4%	0.1%	0.2%	4.8%
Belgium	21.1%	72.4%	0.6%	0.2%	5.7%
Bulgaria	14.3%	64.4%	13.3%	2.7%	5.3%
Croatia	23.3%	70.1%	3.5%	0.2%	2.9%
Cyprus	50.7%	47.7%	0.1%	NO	1.5%
Czech Republic	24.3%	67.7%	1.5%	1.2%	5.3%
Denmark	31.3%	63.3%	0.0002%	0.2%	5.2%
Estonia	33.4%	60.5%	1.3%	0.2%	4.7%
Finland	31.6%	57.1%	NO,NA	0.1%	11.1%
France	18.0%	74.4%	0.1%	0.4%	7.1%
Germany	31.4%	62.5%	0.8%	0.3%	5.0%
Greece	44.7%	46.4%	4.8%	0.3%	3.8%
Hungary	31.2%	64.1%	0.4%	0.2%	4.0%
Ireland	19.6%	75.9%	0.04%	NO	4.5%
Italy	22.8%	64.9%	5.5%	2.9%	3.9%
Latvia	16.6%	75.2%	4.6%	0.02%	3.4%
Lithuania	11.8%	79.2%	5.1%	0.4%	3.4%
Luxembourg	16.3%	77.6%	0.02%	NO	6.0%
Malta	34.7%	60.7%	0.3%	NO	4.2%
Netherlands	40.0%	52.7%	1.0%	0.6%	5.7%
Poland	20.5%	64.4%	9.6%	0.1%	5.4%
Portugal	19.5%	75.0%	0.7%	0.3%	4.4%
Romania	21.8%	69.5%	1.7%	0.001%	7.1%
Slovakia	20.5%	71.8%	1.7%	0.2%	5.9%
Slovenia	21.6%	73.1%	0.8%	0.2%	4.3%
Spain	18.4%	75.1%	0.3%	0.7%	5.5%
Sweden	32.3%	45.8%	NO,IE	0.1%	21.7%
United Kingdom	31.8%	63.5%	0.2%	IE	4.4%
EU-28	**25.3%**	**66.6%**	**1.9%**	**0.6%**	**5.6%**
Iceland	37.5%	56.1%	NO	NO	6.4%
EU-KP	**25.3%**	**66.6%**	**1.9%**	**0.6%**	**5.6%**

1A3b Road Transportation – Gaseous Fuels (CO_2)

CO_2 emissions from Gaseous fuels account for 0,5 % of CO_2 emissions from 1A3b Road Transport in 2019 (Figure 3.111). Between 2018 and 2019 CO_2 emissions from Gaseous fuels have increased by 13 %, between 1990 and 2019 emissions show an increase of 761% in EU-KP. Most countries showed increased emissions, whereas six countries reported emissions as "Not occurring" or "Included elsewhere". United Kingdom includes the small amount of natural gas used for road transport with LPG consumption.

3.8 1A3b Road Transport, gaseous fuels: countries contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	NO	38	42	1.0%	42	∞	4	10%
Belgium	NO,IE	36	51	1.2%	51	∞	15	41%
Bulgaria	NO	184	205	4.7%	205	∞	21	12%
Croatia	NO	10	9	0.2%	9	∞	-1	-6%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	146	174	4.0%	174	∞	28	19%
Denmark	0	17	17	0.4%	17	111016%	0	-2%
Estonia	NO	9	3	0.1%	3	∞	-7	-70%
Finland	NO,NA	8	13	0.3%	13	∞	5	71%
France	0	313	384	8.8%	383	107675%	71	23%
Germany	NA	299	329	7.5%	329	∞	30	10%
Greece	NO	39	35	0.8%	35	∞	-4	-11%
Hungary	0	23	22	0.5%	21	7076%	-1	-5%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	487	2 078	2 316	53.0%	1 829	375%	238	11%
Latvia	17	0	0	0.0%	-16	-97%	0	300%
Lithuania	NO	18	17	0.4%	17	∞	-1	-3%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	150	151	3.5%	151	∞	2	1%
Poland	NO	31	41	0.9%	41	∞	11	34%
Portugal	NO	38	42	1.0%	42	∞	3	9%
Romania	NO	NO	0	0.0%	0	∞	0	∞
Slovakia	NO	10	9	0.2%	9	∞	0	-4%
Slovenia	NO	8	11	0.2%	11	∞	3	32%
Spain	NO	391	480	11.0%	480	∞	89	23%
Sweden	3	27	18	0.4%	15	535%	-8	-31%
United Kingdom	IE	IE	IE	-	-	-	-	-
EU-27+UK	**508**	**3 873**	**4 371**	**100%**	**3 863**	**761%**	**498**	**13%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	IE	IE	IE	-	-	-	-	-
EU-KP	**508**	**3 873**	**4 371**	**100%**	**3 863**	**761%**	**498**	**13%**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

The countries Germany, France, Italy and Spain contributed most to the CO_2 emissions from this source (80.3%). All countries, except for Latvia, show increased emissions from road transportation between 1990 and 2019. The countries with the highest increases in absolute terms were Italy, Germany, France and Spain. (Table 3.60).

In Figure **3**.7 it is depicted that the share of gaseous fuels is constantly increasing from 1990 to 2019. The reason for this increase is the increasing activity data and corresponing emissions of Italy, which is a high contributor to this source category. In Figure **3**.10 the IEF is depicted and the mean value is around 56 t/TJ until 2007, and 57t/TJ until 2019. The increase in the IEF value is mainly due to the correspodning increase in the IEF of Italy. As already mentioned, Italy dominates EU emissions, thus the IEF of EU almost follows the increasing trend of the IEF of Italy from 1990 to 2019.

Figure 3.112: 1A3b Road Transport, gaseous fuels: Emission trend and share for CO_2

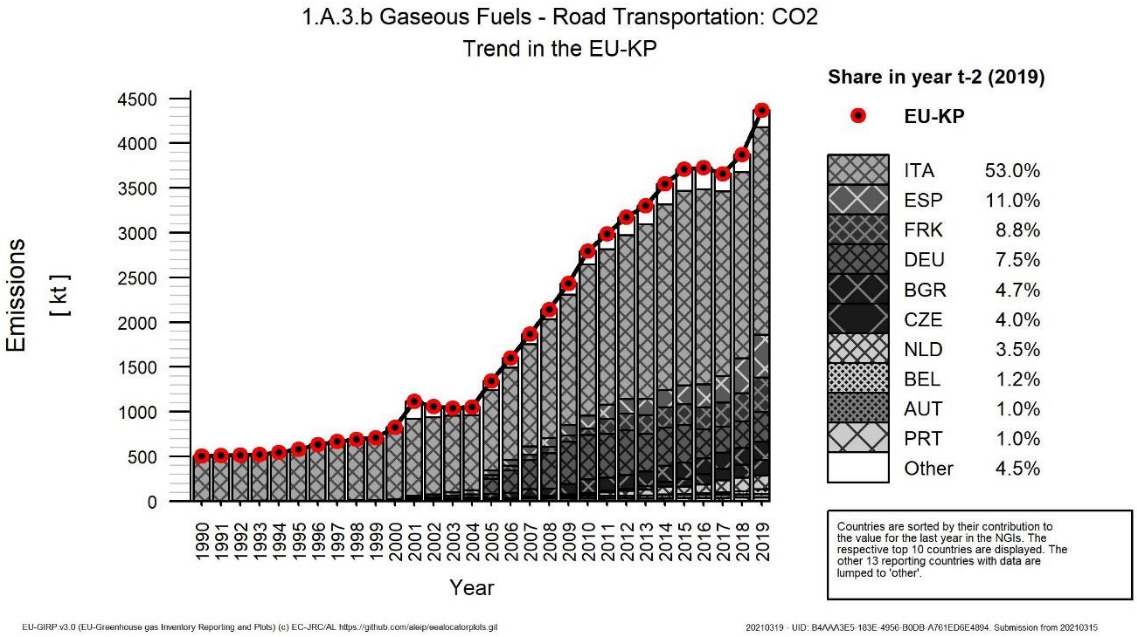
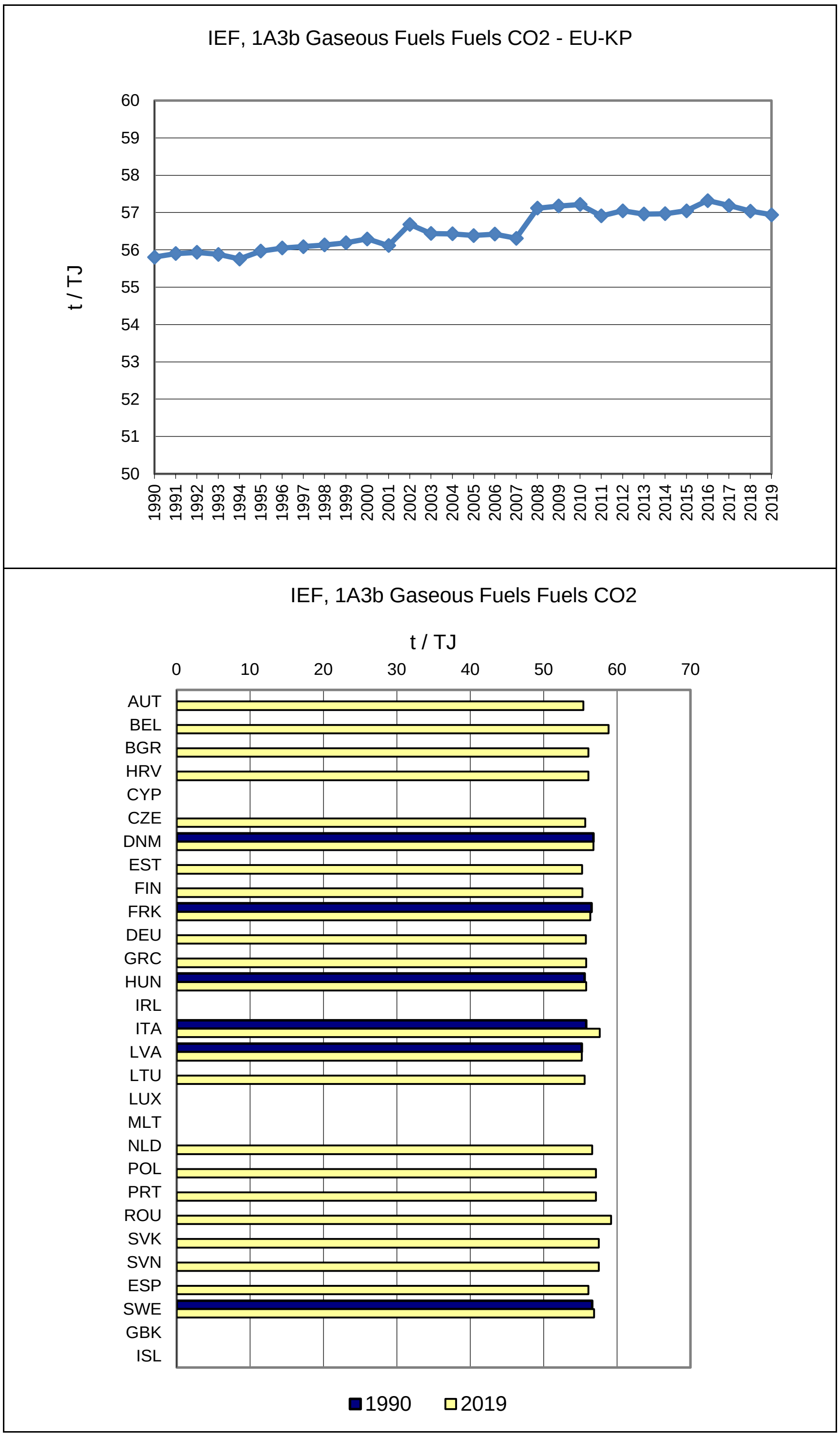


Figure 3.113 1A3b Road Transport, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



1A3b Road Transportation – Diesel Oil (CO_2)

CO_2 emissions from Diesel oil account for 70 % of CO_2 emissions from 1A3b Road Transport in 2019 (Figure 3.111). All countries show increased emissions from Diesel oil between 1990 and 2019 (Table 3.). Countries with the highest increase in per cent were Slovenia, Iceland, Ireland and Poland. Some of these increases are due to fuel bought in the respective countries but consumed abroad (fuel tourism).

*Table **3**.8 1A3b Road Transport, diesel oil: countries contributions to CO_2 emissions*

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	5 365	18 369	18 477	2.9%	13 112	244%	107	1%		
Belgium	11 027	19 938	19 039	3.0%	8 012	73%	-899	-5%		
Bulgaria	1 539	6 308	6 705	1.1%	5 166	336%	398	6%		
Croatia	1 159	4 383	4 632	0.7%	3 473	300%	249	6%		
Cyprus	669	981	1 042	0.2%	373	56%	61	6%	T1	D
Czechia	6 655	13 249	13 420	2.1%	6 765	102%	171	1%		
Denmark	4 436	8 308	8 099	1.3%	3 663	83%	-209	-3%		
Estonia	695	1 534	1 488	0.2%	793	114%	-47	-3%		
Finland	4 923	7 102	6 784	1.1%	1 860	38%	-318	-4%	T2	CS
France	54 622	99 771	98 466	15.5%	43 844	80%	-1 305	-1%	T3	M, CS
Germany	54 478	101 942	103 088	16.3%	48 611	89%	1 146	1%	T2	M, CS
Greece	4 264	6 738	7 266	1.1%	3 002	70%	528	8%		
Hungary	2 388	9 120	9 604	1.5%	7 215	302%	484	5%	T2	CS
Ireland	1 914	9 123	9 191	1.5%	7 277	380%	69	1%		
Italy	47 808	65 871	66 134	10.4%	18 327	38%	263	0%	T3	M, CS
Latvia	623	2 404	2 476	0.4%	1 853	298%	72	3%	T2	CS
Lithuania	2 134	4 738	4 959	0.8%	2 825	132%	220	5%	T2	CS
Luxembourg	1 269	4 933	5 024	0.8%	3 755	296%	91	2%		
Malta	119	312	458	0.1%	338	283%	146	47%	T3	D
Netherlands	13 012	17 115	16 487	2.6%	3 475	27%	-628	-4%		
Poland	8 769	43 989	44 424	7.0%	35 655	407%	434	1%	T2	D
Portugal	5 625	12 902	13 266	2.1%	7 640	136%	364	3%		
Romania	3 648	13 414	13 713	2.2%	10 064	276%	298	2%		
Slovakia	3 123	5 604	5 813	0.9%	2 691	86%	209	4%		
Slovenia	867	4 423	4 266	0.7%	3 400	392%	-157	-4%	T3	M
Spain	24 555	66 594	66 289	10.5%	41 734	170%	-305	0%	T1	M
Sweden	4 489	8 636	8 638	1.4%	4 149	92%	2	0%		
United Kingdom	32 772	76 327	73 689	11.6%	40 917	125%	-2 638	-3%	T3	CS
EU-27+UK	**302 947**	**634 130**	**632 936**	**100%**	**329 989**	**109%**	**-1 194**	**0%**		
Iceland	116	566	572	0.1%	456	394%	6	1%		
United Kingdom (KP)	32 916	76 553	73 908	11.7%	40 992	125%	-2 645	-3%	T3	CS
EU-KP	**303 206**	**634 921**	**633 726**	**100%**	**330 520**	**109%**	**-1 195**	**0%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level Only information from major emitters have been included to the table as well as voluntarily provided information by countries.

France, Germany, Italy, Spain and the UK account for 64.4 % of CO_2 emissions from diesel oil in 2019 (In Figure 3.114 the IEF is depicted and the mean value is around 74 t/TJ. For some countries the values of the IEF is outside the range of the upper and lower IPCC default value. This is due to the fact that in most cases these IEF are country specific. The case of Romania was investigated and it was concluded that the value of the IEF depends also on the country specific values for the Net Calorific Value (NCV).

Figure 3.115 1A3b Road Transport, Diesel Oil: Emission trend and share for CO_2

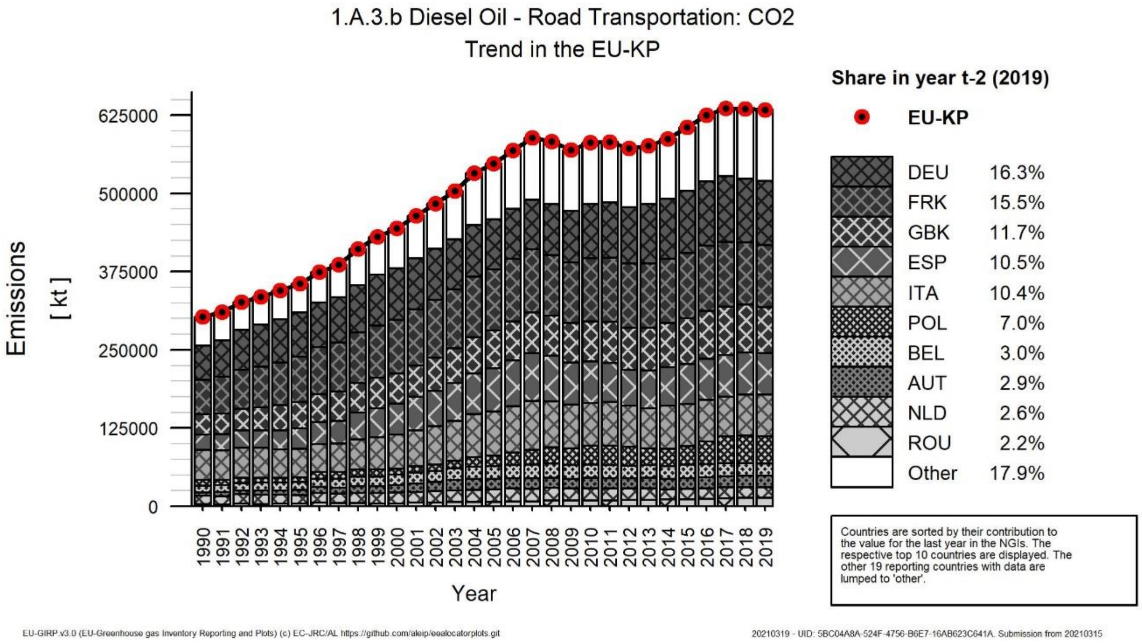
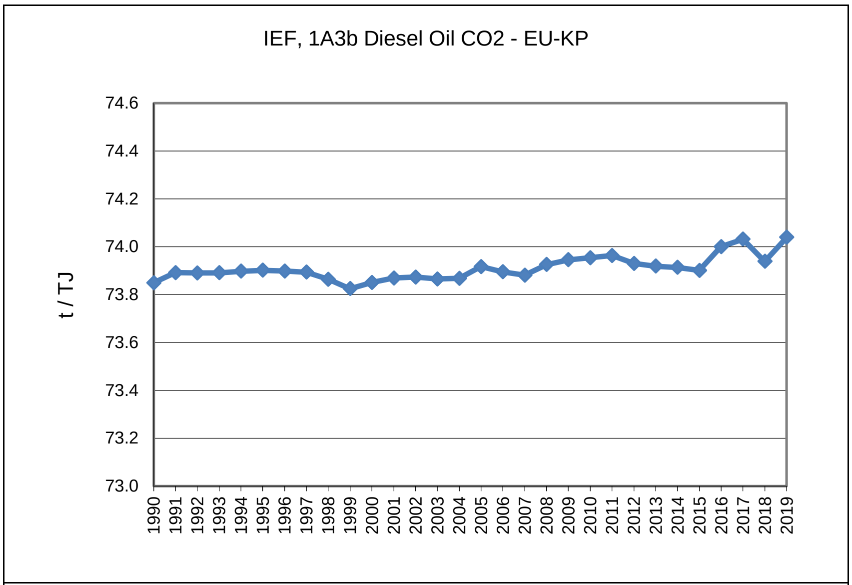
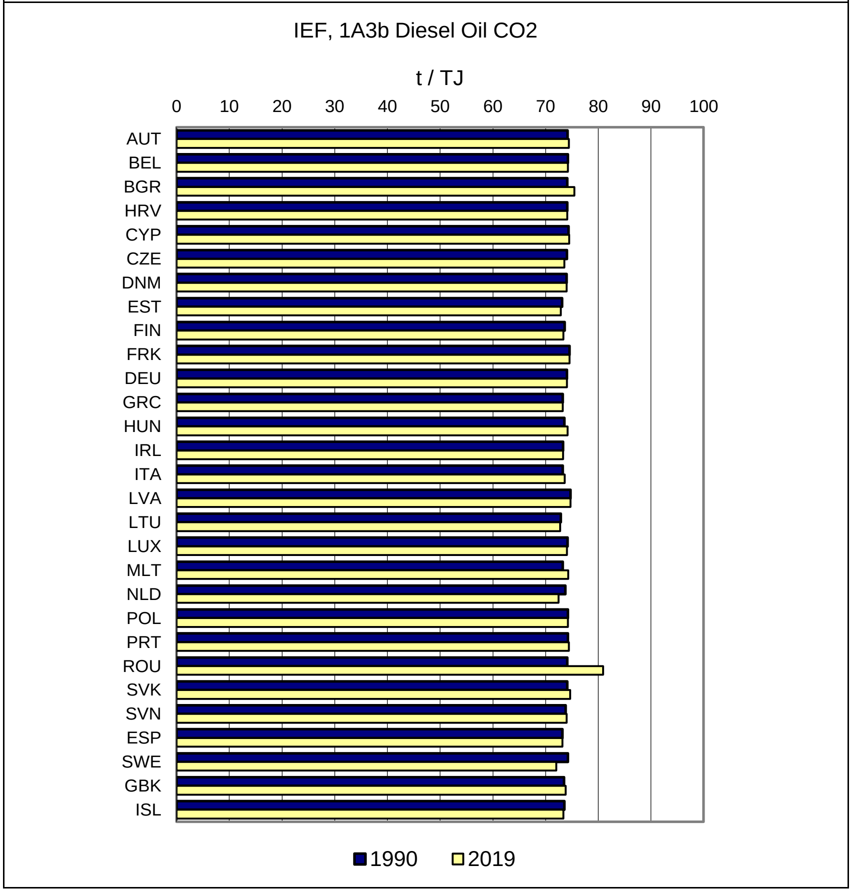


Figure 3.116   1A3b Road Transport, Diesel Oil: Implied Emission Factors for CO_2 (in t/TJ)





1A3b Road Transportation – Gasoline (CO_2)

Between 1990 and 2019, CO_2 emissions from gasoline decreased by 42 % in the EU-KP (Table 3.).

*Table **3**.9 1A3b Road Transport, gasoline: Member States' contributions to CO_2 emissions*

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	7 896	4 854	4 836	2.0%	-3 060	-39%	-18	0%		
Belgium	8 468	4 807	5 403	2.3%	-3 065	-36%	597	12%		
Bulgaria	4 241	1 486	1 477	0.6%	-2 765	-65%	-9	-1%		
Croatia	2 347	1 508	1 438	0.6%	-909	-39%	-70	-5%		
Cyprus	519	1 092	1 076	0.5%	557	107%	-17	-2%	T1	D
Czechia	3 597	4 643	4 621	2.0%	1 024	28%	-22	0%		
Denmark	4 911	3 942	3 950	1.7%	-961	-20%	9	0%		
Estonia	1 530	783	788	0.3%	-742	-49%	5	1%		
Finland	5 880	3 743	3 658	1.5%	-2 223	-38%	-85	-2%	T2	CS
France	59 279	21 739	23 139	9.8%	-36 140	-61%	1 400	6%	T3	M, CS
Germany	97 217	52 150	52 694	22.2%	-44 523	-46%	545	1%	T2	M, CS
Greece	7 438	7 167	7 002	3.0%	-437	-6%	-165	-2%		
Hungary	5 404	4 150	4 491	1.9%	-913	-17%	342	8%	T2	CS
Ireland	2 758	2 404	2 265	1.0%	-493	-18%	-139	-6%		
Italy	39 949	22 729	22 946	9.7%	-17 003	-43%	217	1%	T3	M, CS
Latvia	1 722	548	520	0.2%	-1 202	-70%	-28	-5%	T2	CS
Lithuania	3 053	682	712	0.3%	-2 341	-77%	29	4%	T2	CS
Luxembourg	1 282	999	1 044	0.4%	-238	-19%	46	5%		
Malta	180	245	254	0.1%	74	41%	10	4%	T3	D
Netherlands	10 799	12 368	12 610	5.3%	1 811	17%	242	2%		
Poland	9 669	13 241	13 693	5.8%	4 024	42%	452	3%	T2	D
Portugal	4 370	3 227	3 336	1.4%	-1 034	-24%	109	3%		
Romania	6 591	3 944	3 951	1.7%	-2 640	-40%	6	0%		
Slovakia	1 380	1 517	1 551	0.7%	170	12%	34	2%		
Slovenia	1 740	1 259	1 206	0.5%	-534	-31%	-53	-4%	T3	M
Spain	25 794	15 264	16 266	6.9%	-9 528	-37%	1 002	7%	T1	M
Sweden	12 779	6 389	6 091	2.6%	-6 688	-52%	-298	-5%		
United Kingdom	75 118	34 766	35 128	14.8%	-39 990	-53%	362	1%	T3	CS
EU-27+UK	**405 912**	**231 643**	**236 145**	**100%**	**-169 767**	**-42%**	**4 502**	**2%**		
Iceland	396	395	369	0.2%	-27	-7%	-26	-7%		
United Kingdom (KP)	75 447	35 086	35 461	15.0%	-39 986	-53%	376	1%	T3	CS
EU-KP	**406 638**	**232 358**	**236 848**	**100%**	**-169 790**	**-42%**	**4 490**	**2%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level Only information from major emitters have been included to the table as well as voluntarily provided information by countries.

France, Germany, Italy, Spain and the United Kingdom account for 63.6 % for CO_2 emissions from gasoline in 2019. In Figure 3.117 the IEF is depicted and the mean value is around 72 t/TJ. The increase of the IEF from 2014 to 2015 is due to an increase in the IEF of Germany, which has a share of 22.2% of emissions in this sector. After communiucation with Germany, it was explained that in order to keep inventory data consistent with the NEB, the NCV of gasoline was decreased, thus the energy related emission factor increased. For some countries the values of the IEF are outside the range of the upper IPCC default value (such as Austria and the Netherlands). This is due to the fact that in most cases these IEF are country specific.

Figure 3.118 1A3b Road Transport, Gasoline: Emission trend and share for CO_2

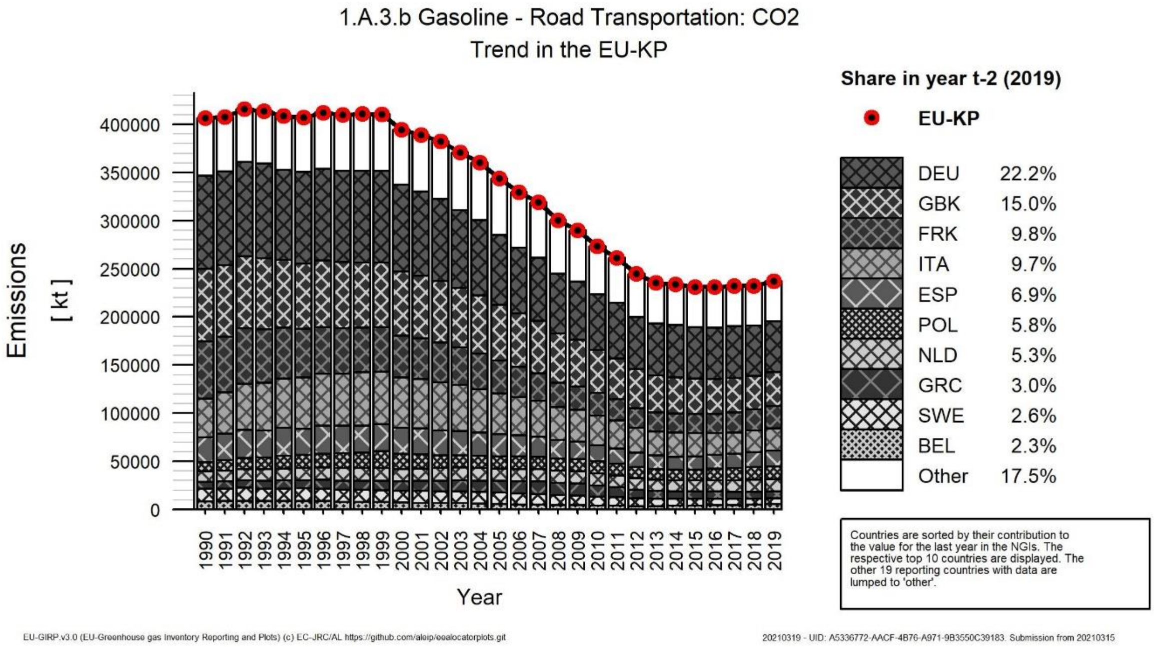
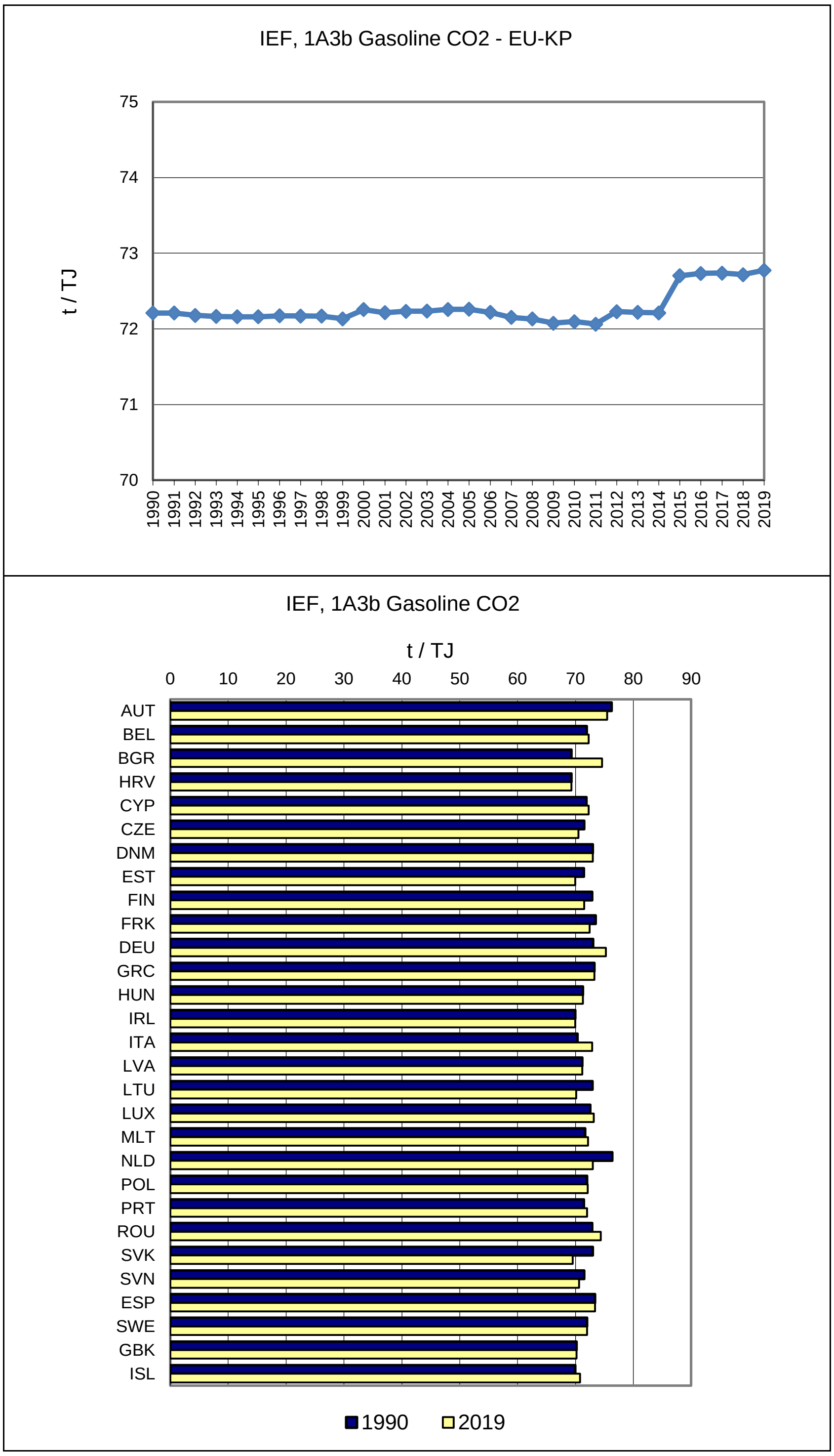


Figure 3.119 1A3b Road Transport, Gasoline: Implied Emission Factors for CO_2 (in t/TJ)



1A3b Road Transportation – LPG (CO_2)

Between 1990 and 2019, CO_2 emissions from LPG increased by 122 % in the EU-KP. Three countries report emissions as 'Not occurring'. Between 2018 and 2019 EU-KP emissions increased by 2 % (Table 3.).

Table 3.10   1A3b Road Transport, LPG: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	26	22	14	0.1%	-12	-47%	-8	-36%		
Belgium	196	147	146	0.9%	-50	-26%	-1	-1%		
Bulgaria	NO	1 258	1 207	7.4%	1 207	∞	-51	-4%		
Croatia	NO	208	195	1.2%	195	∞	-13	-6%		
Cyprus	NO	1	1	0.0%	1	∞	0	8%	T1	D
Czechia	NO	278	266	1.6%	266	∞	-12	-4%		
Denmark	9	0	0	0.0%	-9	-100%	0	-25%		
Estonia	1	24	29	0.2%	28	4739%	5	22%		
Finland	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
France	150	174	158	1.0%	8	5%	-16	-9%	T3	M, CS
Germany	9	1 071	1 150	7.0%	1 141	12608%	78	7%	T2	M, CS
Greece	91	648	661	4.0%	571	629%	13	2%		
Hungary	NO	61	52	0.3%	52	∞	-9	-14%	T2	CS
Ireland	19	5	4	0.0%	-14	-77%	-1	-12%		
Italy	4 026	4 885	5 003	30.6%	977	24%	118	2%	T3	M, CS
Latvia	37	145	127	0.8%	90	243%	-18	-12%	T2	CS
Lithuania	60	305	294	1.8%	234	389%	-11	-4%	T2	CS
Luxembourg	11	1	1	0.0%	-10	-92%	0	-12%		
Malta	NO	2	2	0.0%	2	∞	1	42%	T3	D
Netherlands	2 640	306	281	1.7%	-2 359	-89%	-25	-8%		
Poland	NO,IE	5 545	5 781	35.4%	5 781	∞	237	4%	T2	D
Portugal	0	108	111	0.7%	111	175179%	3	2%		
Romania	NO	246	259	1.6%	259	∞	13	5%		
Slovakia	NO	125	117	0.7%	117	∞	-8	-6%		
Slovenia	NO	41	39	0.2%	39	∞	-2	-4%	T3	M
Spain	79	187	260	1.6%	181	231%	73	39%	T1	M
Sweden	0	NO,IE	NO,IE	-	0	-100%	-	-		
United Kingdom	NO	173	180	1.1%	180	∞	7	4%	T3	CS
EU-27+UK	**7 354**	**15 967**	**16 340**	**100%**	**8 985**	**122%**	**373**	**2%**		
Iceland	NO	NO	NO	-	-	-	-	-		
United Kingdom (KP)	NO	173	180	1.1%	180	∞	7	4%	T3	CS
EU-KP	**7 354**	**15 967**	**16 340**	**100%**	**8 985**	**122%**	**373**	**2%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level Only information from major emitters have been included to the table as well as voluntarily provided information by countries.

Italy accounts for 30.6 % and Poland for 35.4 % of CO_2 emissions from LPG in 2019 whereas France, Germany, Spain and the United Kingdom account for only 10.7 % of CO_2 emissions (Table 3.).

1.A.3.b Road Transportation: Other Fuels (CO_2)

This category covers the CO_2 emissions from the fossil part of biofuels. According to the 2006 IPCC GLs (volume 2, chapter 3, section 'CO_2 emissions from biofuels' in page 3.17*): it is important to assess the biofuel origin so as to identify and separate fossil from biogenic feedstocks". In other words, a part of the carbon of biofuels (and the associated CO_2 emissions) may have a fossil origin. The IPCC GLs provide some examples about biofuels' fossil part: "biodiesel made from coal methanol with animal feedstocks has a non-zero fossil fuel fraction and is therefore not fully carbon neutral. Ethanol from the fermentation of agricultural products will generally be purely biogenic (carbon neutral), except in some cases, such as fossil-fuel derived methanol. Products which have undergone further chemical* *transformation may contain substantial amounts of fossil carbon ranging from about 5-10 percent in the fossil methanol used for biodiesel production upwards to 46 percent in ethyl-tertiary-butyl-ether (ETBE) from fossil isobutene (ADEME/DIREM, 2002). Some processes may generate biogenic by-products such as glycol or glycerine, which may then be used elsewhere*.

For this reason, all countries are encouraged to calculate these emissions and include them in the CRF under "Other fossil fuels". Based on ***Table 3.62*** seven countries report these emissions as 'Not occurring' or 'Not applicable'. France, Germany, Italy, Spain and United Kingdom contribute the most to this category, with a share of 77.6%.

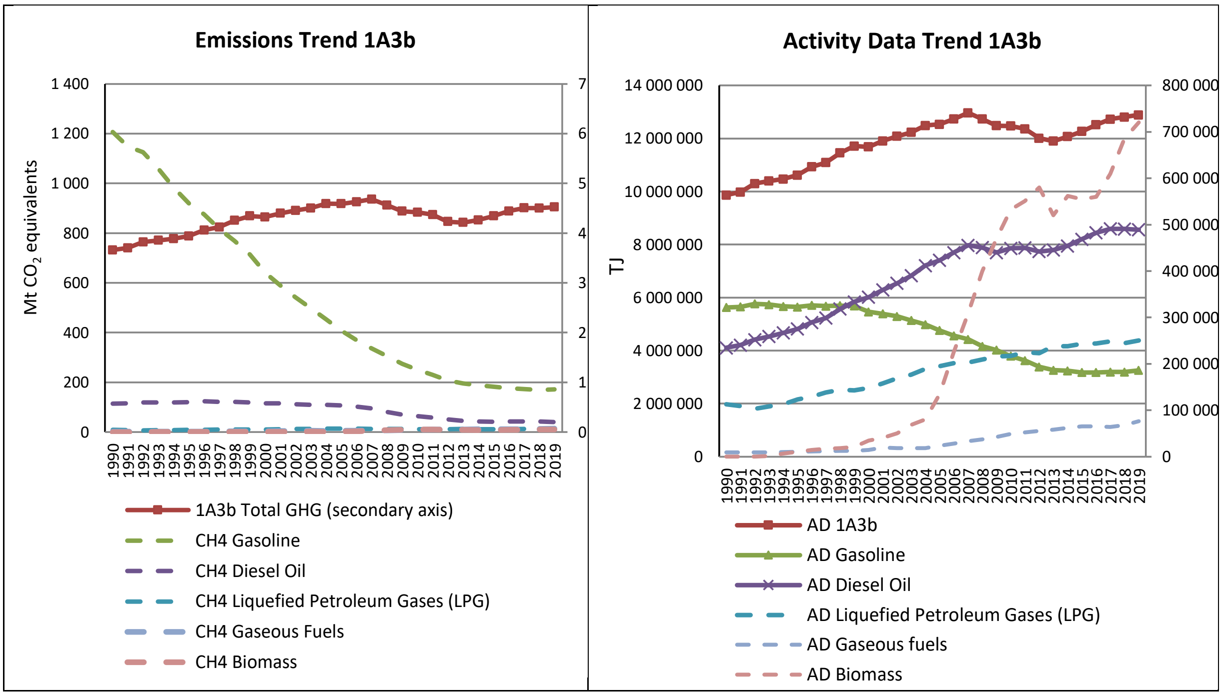
Table 3.62: 1A3b Road Transport, other fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	NO	78	74	2.6%	74	∞	-4	-5%
Belgium	NO	97	89	3.1%	89	∞	-8	-8%
Bulgaria	NO	22	23	0.8%	23	∞	1	3%
Croatia	NO	4	10	0.3%	10	∞	6	132%
Cyprus	NO	2	2	0.1%	2	∞	0	20%
Czechia	NO	34	37	1.3%	37	∞	3	10%
Denmark	NO	30	32	1.1%	32	∞	2	7%
Estonia	NO	2	4	0.1%	4	∞	1	59%
Finland	NA	NA	NA	-	-	-	-	-
France	NO	1 164	1 163	40.2%	1 163	∞	0	0%
Germany	NA	460	453	15.7%	453	∞	-8	-2%
Greece	NO	NO	42	1.5%	42	∞	42	∞
Hungary	NO	24	27	0.9%	27	∞	2	10%
Ireland	NO	22	28	1.0%	28	∞	6	28%
Italy	NO	189	187	6.5%	187	∞	-2	-1%
Latvia	NO	5	5	0.2%	5	∞	0	1%
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	18	19	0.6%	19	∞	0	1%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	54	55	1.9%	55	∞	1	1%
Poland	NO	114	123	4.3%	123	∞	9	8%
Portugal	NO	NO,IE	NO,IE	-	-	-	-	-
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	11	15	0.5%	15	∞	4	38%
Spain	NO	225	216	7.5%	216	∞	-8	-4%
Sweden	NO	84	67	2.3%	67	∞	-17	-20%
United Kingdom	NO	152	222	7.7%	222	∞	70	46%
EU-27+UK	**NA,NO**	**2 791**	**2 892**	**100%**	**2 892**	**∞**	**101**	**4%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	NO	152	222	7.7%	222	∞	70	46%
EU-KP	**NA,NO**	**2 791**	**2 892**	**100%**	**2 892**	**∞**	**101**	**4%**

CH_4 emissions from 1A3b Road Transportation

CH_4 emissions from 1A3b Road Transportation account for 0.03 % of total EU-KP GHG emissions in 2019. Figure 3.123 gives an overview of the CH_4 trend caused by different fuels, as well as the activity data trend, where it is clear that the gasoline share is decreasing, whereas the diesel oil is increasing.

Figure 3.120 1A3b Road Transport: CH_4 Emissions Trend and Activity Data Trend



Data displayed as dashed line refers to the secondary axis.

CH_4 emissions decreased between 1990 and 2019 by 81 % (Table 3.66). All countries, except for Malta (increase by 42 %) showed a decrease in CH_4 emissions from 1990 to 2019. Between 2018 and 2019, CH_4 emissions increased by 1 % in EU-KP. In the same time period, the largest decrease in relative terms was reported by Ireland, and Iceland.

Table 3.63 1A3b Road Transport: Member States' contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	73	20	21	1.7%	-52	-71%	1	3%	T3	CS
Belgium	140	19	22	1.8%	-118	-84%	3	17%	M,T3	CS,M
Bulgaria	68	22	21	1.7%	-46	-68%	-0.2	-1%	T2	CR
Croatia	41	10	10	0.8%	-31	-76%	-1	-5%	T1,T3	CR,D
Cyprus	7	3	3	0.3%	-3	-50%	-0.1	-2%	T1,T2	D,M
Czechia	73	25	23	1.9%	-50	-68%	-2	-6%	T3	M
Denmark	78.35	9	9	0.7%	-70	-89%	-0.5	-5%	NA	NA
Estonia	23	4	5	0.4%	-18	-79%	0.2	5%	T1,T3	CS,D
Finland	107	9	9	0.7%	-98	-92%	-1	-8%	T3	CR
France	953	129	132	10.6%	-821	-86%	3	3%	T3	M
Germany	1 561	224	227	18.2%	-1 334	-85%	3	1%	CS,M,T2,T3	CS,M
Greece	107	67	65	5.2%	-42	-39%	-2	-3%	M,T1	D,M
Hungary	67	23	24	1.9%	-44	-65%	1	3%	T1,T3	D,M
Ireland	49	10	9	0.7%	-40	-81%	-1	-10%	T3	M
Italy	867	180	186	14.9%	-682	-79%	6	3%	T3	M
Latvia	19	3	3	0.2%	-16	-84%	-0.3	-9%	T1,T3	CR,D,M
Lithuania	39	6	6	0.5%	-33	-85%	-0.2	-3%	T1,T3	CR,D
Luxembourg	12	3	4	0.3%	-9	-70%	0.3	7%	T3	M
Malta	3	1	4	0.4%	1	42%	3	197%	T1,T3	M
Netherlands	193	62	64	5.1%	-130	-67%	1	2%	T1,T3	CS
Poland	158	133	132	10.6%	-25	-16%	-0.5	-0.3%	T3	D
Portugal	97	22	21	1.7%	-76	-78%	-1	-3%	T3	OTH
Romania	90	33	32	2.5%	-59	-65%	-1	-4%	T1,T3	D,OTH
Slovakia	29	8	7	0.6%	-22	-75%	-1	-9%	T3	D
Slovenia	28	5	5	0.4%	-23	-83%	-0.2	-4%	M	M
Spain	369	83	85	6.8%	-284	-77%	2	3%	T3	M
Sweden	158	23	22	1.8%	-136	-86%	-1	-4%	M,T2	CS,D
United Kingdom	1 236	90	94	7.5%	-1 142	-92%	4	4%	T3	CS
EU-27+UK	**6 647**	**1 228**	**1 245**	**100%**	**-5 402**	**-81%**	**17**	**1%**	**-**	**-**
Iceland	6	2	1	0.1%	-4	-77%	0	-18%	T3	D
United Kingdom (KP)	1 244	91	96	7.7%	-1 148	-92%	4	5%	T3	CS
EU-KP	**6 660**	**1 230**	**1 247**	**100%**	**-5 412**	**-81%**	**17**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3b Road Transportation – Gasoline (CH_4)

Between 1990 and 2019, CH_4 emissions from gasoline decreased by 86 % in the EU-KP. All countries reported decreasing emissions, apart from Malta (increase by 53 %). Between 2018 and 2019 EU-KP emissions increased by 2 % (Table 3.). The largest decreases in per cent were reported by Iceland (-19 %) and Ireland (-9 %).

Table 3.64 1A3b Road Transport, gasoline: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	69	9	8	1.0%	-61	-88%	-1	-6%		
Belgium	116	14	17	2.0%	-99	-86%	3	21%		
Bulgaria	64	6	6	0.8%	-57	-90%	0	0%		
Croatia	38	7	6	0.7%	-31	-83%	0	-7%		
Cyprus	5	3	3	0.3%	-3	-49%	0	-2%	T1	D
Czechia	57	17	16	1.8%	-41	-72%	-1	-8%		
Denmark	69	8	7	0.8%	-61	-89%	0	-4%		
Estonia	21	3	3	0.3%	-18	-87%	0	3%		
Finland	93	7	6	0.7%	-87	-93%	0	-7%	T2	CS
France	845	92	97	11.2%	-749	-89%	5	5%	T3	M, CS
Germany	1 514	153	152	17.6%	-1 362	-90%	-1	-1%	T3	M
Greece	97	51	49	5.7%	-48	-50%	-2	-3%		
Hungary	61	15	17	2.0%	-44	-72%	2	11%	T2	CS
Ireland	44	8	7	0.8%	-37	-84%	-1	-9%		
Italy	733	125	128	14.9%	-605	-83%	3	3%	T3	M, CS
Latvia	16	2	1	0.2%	-15	-91%	0	-6%	T2	CS
Lithuania	33	2	2	0.2%	-30	-94%	0	2%	T2	CS
Luxembourg	12	1	1	0.1%	-11	-91%	0	-2%		
Malta	3	1	4	0.5%	1	53%	3	258%	T3	D
Netherlands	156	51	52	6.0%	-105	-67%	1	2%		
Poland	138	67	67	7.8%	-71	-51%	0	0%	T2	D
Portugal	84	15	14	1.7%	-70	-83%	0	-2%		
Romania	81	21	20	2.4%	-61	-75%	-1	-4%		
Slovakia	21	5	5	0.6%	-16	-76%	0	9%		
Slovenia	26	4	4	0.4%	-22	-85%	0	-4%	T3	M
Spain	321	61	64	7.4%	-257	-80%	2	4%	T1	M
Sweden	154	13	13	1.5%	-142	-92%	-1	-7%		
United Kingdom	1 149	83	88	10.2%	-1 061	-92%	5	6%	T3	CS
EU-27+UK	**6 018**	**842**	**857**	**100%**	**-5 161**	**-86%**	**15**	**2%**		
Iceland	5	1	1	0.1%	-4	-81%	0	-19%		
United Kingdom (KP)	1 155	84	89	10.4%	-1 066	-92%	5	6%	T3	CS
EU-KP	**6 030**	**845**	**860**	**100%**	**-5 171**	**-86%**	**15**	**2%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level Only information from major emitters have been included to the table as well as voluntarily provided information by countries.

France, Germany, Italy, Spain and the United Kingdom account for 61 % of CH_4 emissions from gasoline in 2019 (Table 3.). In Figure **3**.17 the IEF is depicted and the IEF decreased from 40 kg/TJ in 1990 to 10 kg/TJ in 2019. All countries show a similar trend in both the IEF and emission values, which is also linked to the decreasing trend of the corresponding activity data. CH_4 emissions and consequently CH_4 IEF have reduced along the time series due to the introduction of abatement devices on vehicles, in agreement with the legislation emission limits.

Figure 3.121 1A3b Road Transport, gasoline: Emission trend and share for CH_4 emission

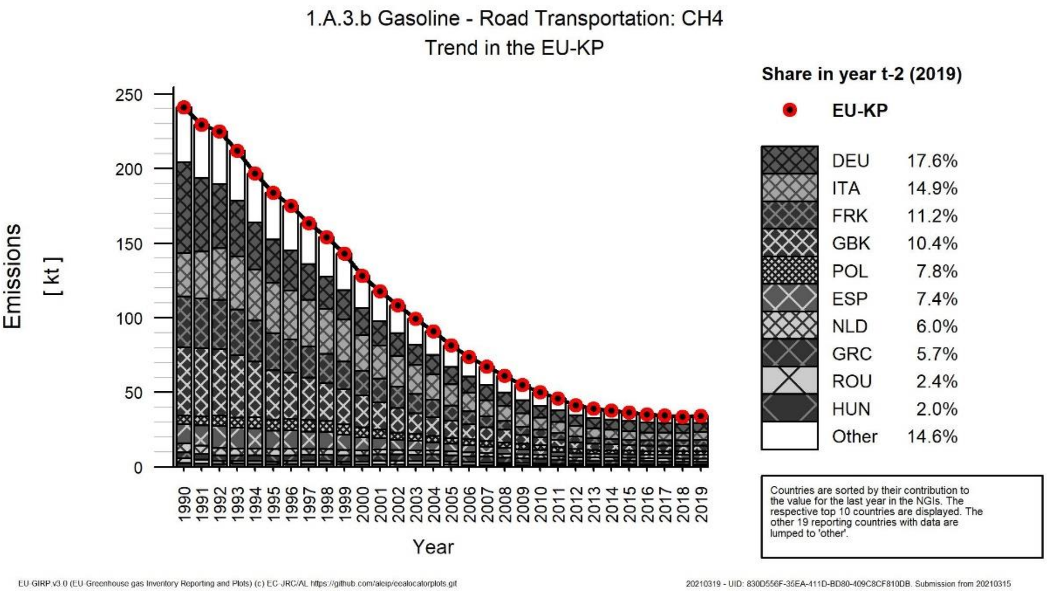
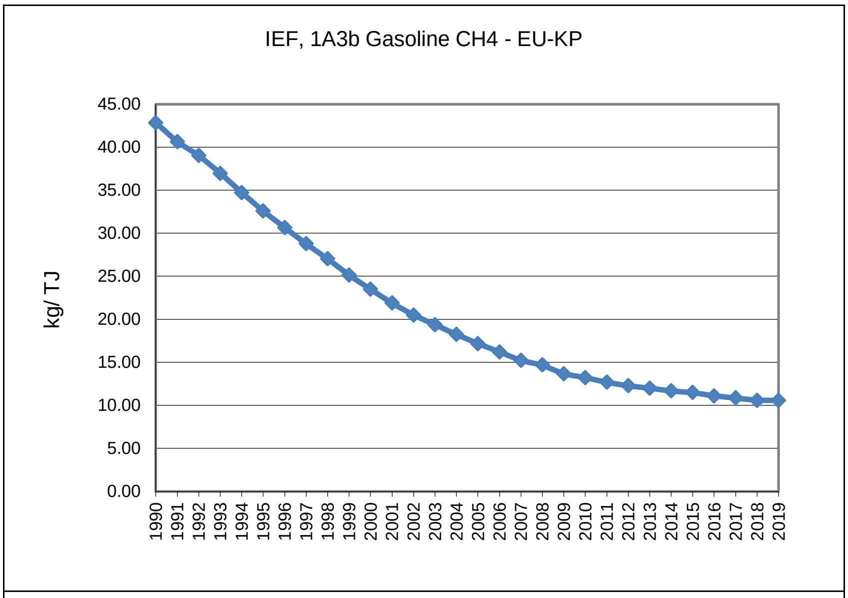
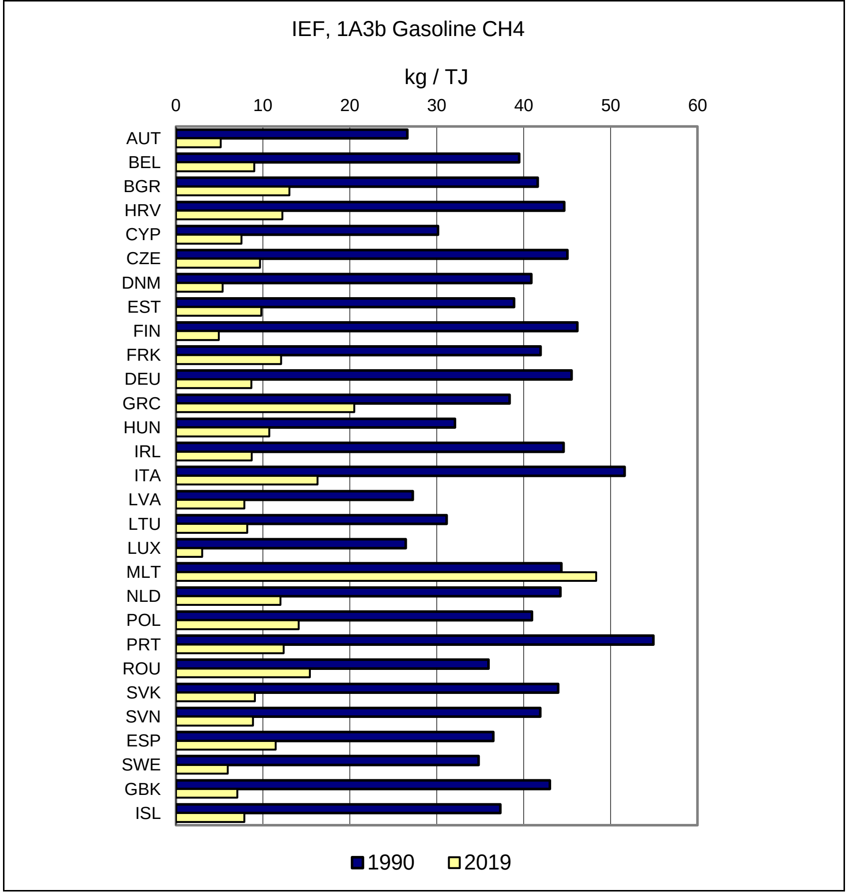


Figure 3.122 1A3b Road Transport, Gasoline: Implied Emission Factors for CH_4 (in kg/TJ)

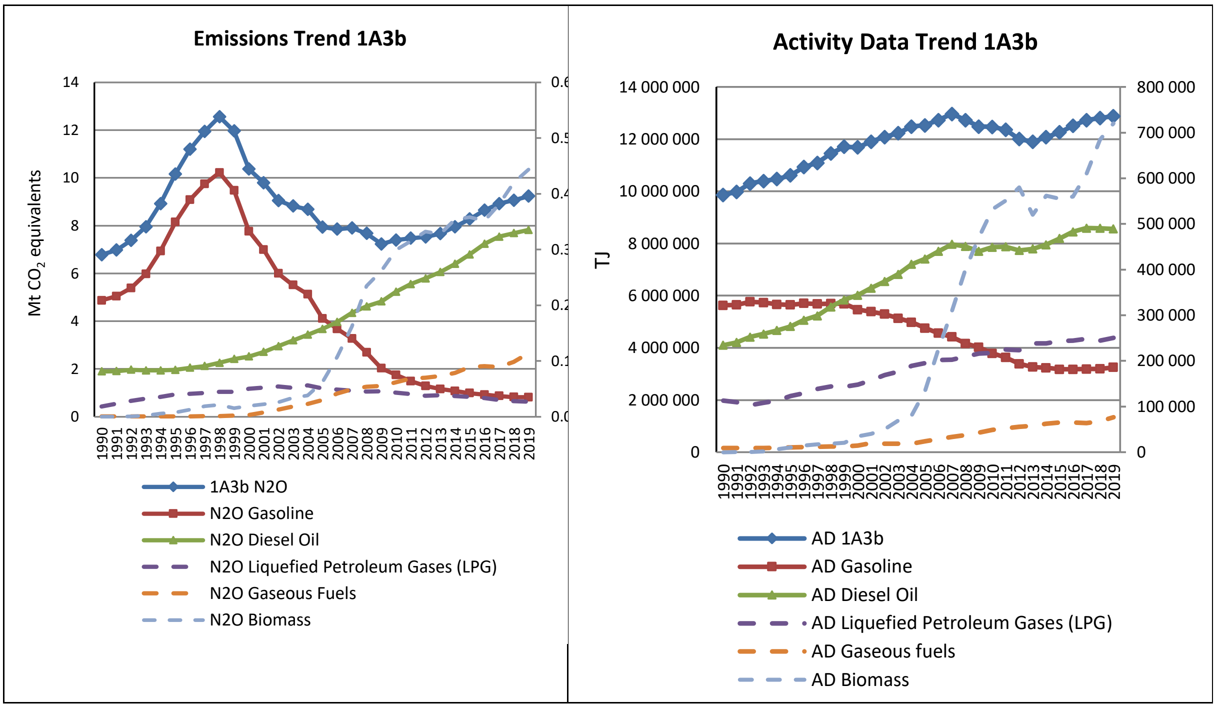




N_2O emissions from 1A3b Road Transportation

N_2O emissions from 1A3b Road Transportation account for 1% of total EU-KP Transport GHG emissions in 2019. Figure 3.123 gives an overview of the N_2O trend caused by different fuels. The trend is mainly dominated by emissions resulting from diesel oil, LPG and biomass in the recent years.

Figure 3.123 1A3b Road Transport: N_2O Emissions Trend



Data displayed as dashed line refers to the secondary axis.

N_2O emissions increased between 1990 and 2019 by 36 % (Table 3.66). N_2O emissions increased in the 1990s due to the implementation of the catalytic converter in the early Euro vehicles (mainly Euro 1), but decreased thereafter (for post Euro 2 vehicles). The reason for the existing various trends in N_2O emission are different estimates of N_2O emission factors. In principle, two different models/emission factor sources are being used in EU-KP countries to estimate N_2O emissions: (1) HBEFA - Handbook of emissions factors, (2) COPERT. The Emission Factors Handbook (Austria, Germany, the Netherlands and Sweden) estimates that the N_2O emission factors decrease for every technology generation (Euro 1, Euro 2 etc.). The emission factors included in COPERT are in line with the EMEP/EEA Guidebook 2016 and they decrease for every technology generation (similar approach as the HBEFA).

The treatment of N_2O emission factors in the COPERT model was as follows: N_2O emission factors were fully updated for passenger cars and light commercial vehicles with the launch of the first official COPERT 4 version 3.0 (November 2006) and were introduced in the rt070100 chapter of the emissions inventory guidebook dated September 2006. These emission factors introduced reductions in N_2O as the emission technology improved. In particular for gasoline vehicles, these emission factors also introduced an increase in the emission level as the vehicle grows older and a decrease as the fuel sulphur decreased. All emission factors were based on an extensive literature review and synthesis of the findings that was conducted in 2005. Use of the new emission factors over COPERT III should in general lead to reductions of the national N_2O levels.

In 2007, the HDV N_2O emission factors were updated based on a relevant report that was published by the Dutch Institute TNO (Report TNO 03.OR.VM.006.1/IJR). These emission factors were sensitive to vehicle size and driving conditions (urban, rural, highway). Depending on the national stock details, use of the emission factors could lead to both slight increases or slight decreases compared to the previous set. The new emission factors were introduced in COPERT 4 v5.0 (December 2007) but were then introduced in the AEIG with the original GB2009 revision (Technical report 9/2009 – June 2009).

Since June 2009 this basic methodology of N_2O calculation has remained without changes.

The COPERT 4 implementation of the methodology introduced some calculation errors that were fixed in the subsequent software versions. Also, a number of slight updates (extension of the methodology to other categories) have been incorporated. A summary of these updates and software fixes is provided in Table 3.65.

Table 3.65: N_2O and CH_4 relevant changes in the COPERT 4 and COPERT 5 methodology

Version: 4.3.0	Date: November 2006
METHODOLOGY: Update of the gasoline and diesel passenger car and light duty vehicle N_2O emission factors. Introduction of impact of vehicle technology, vehicle age and fuel sulphur.	
Reference: http://emisia.com/products/copert/versions	
Version: 4.5.0	Date: December2007
METHODOLOGY: Update of the diesel HDV emission factors based on Dutch study	
Reference: http://emisia.com/products/copert/versions	
Version: 4.5.1	Date: February 2008
SOFTWARE CORRECTION: Use of the cumulative mileage instead of annual mileage to calculate N_2O degradation. The correction should lead to an increase in emissions	
Reference: http://emisia.com/products/copert/versions	
Version: 4.6.1	Date: February 2009
METHODOLOGY: The Euro 5 and 6 passenger car and light duty trucks emission factors of CH_4, N_2O, NH_3 have been inherited by default from Euro 4. They were zero in the previous version. The revision will slightly increase total N_2O emissions.	
Reference: http://emisia.com/products/copert/versions	
Version: 4.7.0	Date: December 2009
SOFTWARE CORRECTION: There was a software bug during the calculation of N_2O, NH_3 and CH_4 hot and cold emissions. Because of this bug there was a misallocation between the hot and cold emissions of these pollutants. Furthermore, the N_2O cold emissions were stored in place of NH_3 cold emissions and vice versa. This is now corrected. The corrections are expected to lead to MS specific changes.	
Reference: http://emisia.com/sites/default/files/COPERT4_v7_0.pdf	
Version: 4.8.1	Date: May 2011
METHODOLOGY: N_2O hot and cold emission factors parameters for Euro 5 and Euro 6 LPG passenger cars are set equal to Euro 5 and Euro 6 gasoline ones. This is estimated to slightly increase N_2O in some MS were LPG vehicles are widespread.	
Reference: http://emisia.com/sites/default/files/COPERT4_v8_1.pdf	
Version: 4.9.0	Date: October 2011
METHODOLOGY: Bioethanol was introduced as a fuel. N_2O emissions are now split to a fossil and a non-fossil (biomass) part (for exporting to CRF).	
Reference: http://emisia.com/sites/default/files/COPERT4_v9_0.pdf	
Version: 4.10.0	Date: November 2012
METHODOLOGY: CH_4 emission factors for Euro 4, 5 and 6 gasoline passenger cars have been updated. This is estimated to slightly increase total CH_4 emissions.	
Reference: http://emisia.com/sites/default/files/COPERT4_v10_0.pdf	
Version: 4.11.0	Date: September 2014
METHODOLOGY: Updated N_2O emission factors for Euro 5/V and Euro 6/VI vehicles. The corrections are expected to lead to MS specific changes.	
Reference: http://www.emisia.com/sites/default/files/files/COPERT4_v11_0.pdf	
Version: 4.11.2	Date: January 2015
METHODOLOGY: Minor bug fixes to N_2O emission factors for Euro 5/V and Euro 6/VI vehicles. The corrections are expected to lead to MS specific changes.	
Reference: http://emisia.com/products/copert/versions	

Version: 5.1.0	Date: December 2017
METHODOLOGY: Corrected CH_4 Heavy Duty Trucks Hot Highway and Rural reduction factor to avoid negative results. Corrected CH_4 Hot-Cold emission factors for Diesel Passenger Cars Euro 5 and on. Corrected N_2O Hot Factors for LPG Passenger Cars Euro 5 and on. The corrections are expected to lead to MS specific changes.	
Reference: http://emisia.com/products/copert/versions	
Version: 5.2.0	Date: August 2018
METHODOLOGY: New L-category vehicles added (ATVs and diesel mini cars) with corresponding CH_4 and N_2O emission factors.	
Reference: http://emisia.com/products/copert/versions	
Version: 5.3.0	Date: September 2019
METHODOLOGY: Corrected CH_4 Hot Emission Factor for PC, LCV vehicles and revised Euro 6 LCV NOx emissions factors.	
Reference: http://emisia.com/products/copert/versions	
Version: 5.4.30	Date: September 2020
METHODOLOGY: Updated emission factors for Euro 6 PCs and LCVs. New vehicle categories and emission factors added (Petrol PHEV, Diesel PHEV, Busses Hybrid).	
Reference: http://emisia.com/products/copert/versions	

Table 3.66 1A3b Road Transport: Member States' contributions to N_2O emissions and information on method applied and emission factor

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	105	256	265	2.9%	159	151%	8	3%	T3	CS
Belgium	157	272	265	2.9%	108	69%	-7	-2%	M,T3	CS,M
Bulgaria	73	128	137	1.5%	63	86%	8	7%	T2	CR
Croatia	54	56	60	0.7%	7	13%	5	8%	T1,T3	CR,D
Cyprus	31	21	22	0.2%	-9	-30%	1	4%	T1,T2	D,M
Czechia	98	168	169	1.8%	72	73%	1	0.5%	T3	M
Denmark	87.10	133	131	1.4%	44	50%	-3	-2%	NA	NA
Estonia	21	21	21	0.2%	-0.1	-1%	0.1	0.5%	T1,T3	CS,D
Finland	154	81	83	0.9%	-71	-46%	1	1%	T3	CR
France	885	1 202	1 190	12.9%	305	34%	-12	-1%	T3	M
Germany	1 343	1 685	1 749	18.9%	405	30%	64	4%	CS,M,T2,T3	CS,M
Greece	117	118	123	1.3%	6	5%	6	5%	M,T1	D,M
Hungary	64	139	151	1.6%	87	136%	12	8%	T1,T3	D,M
Ireland	53	126	127	1.4%	74	141%	1	1%	T3	M
Italy	862	935	947	10.3%	85	10%	12	1%	T3	M
Latvia	20	27	28	0.3%	8	39%	1	4%	T1,T3	CR,D,M
Lithuania	50	50	52	0.6%	2	5%	2	5%	T1,T3	CR,D
Luxembourg	15	64	67	0.7%	51	332%	3	5%	T3	M
Malta	2	6	4	0.05%	2	79%	-2	-26%	T1,T3	M
Netherlands	98	251	248	2.7%	150	153%	-3	-1%	T1,T2	CS
Poland	165	613	633	6.9%	469	285%	20	3%	T3	D
Portugal	79	157	164	1.8%	85	109%	6	4%	OTH,T3	CR,OTH
Romania	227	187	203	2.2%	-24	-11%	16	9%	T1,T3	D,OTH
Slovakia	56	80	81	0.9%	25	44%	1	1%	T3	D
Slovenia	28	65	65	0.7%	37	129%	-0.3	-0.4%	M	M
Spain	468	915	924	10.0%	457	98%	10	1%	T3	M
Sweden	154	176	181	2.0%	27	17%	4	2%	M,T1,T2	CS,D
United Kingdom	1 306	1 112	1 127	12.2%	-179	-14%	16	1%	T3	CR,CS
EU-27+UK	**6 773**	**9 045**	**9 216**	**100%**	**2 443**	**36%**	**171**	**2%**	**-**	**-**
Iceland	6	9	10	0.1%	4	77%	1	12%	T3	D
United Kingdom (KP)	1 311	1 115	1 131	12.3%	-180	-14%	16	1%	T3	CR,CS
EU-KP	**6 784**	**9 058**	**9 230**	**100%**	**2 447**	**36%**	**172**	**2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3b Road Transportation – Diesel Oil (N_2O)

N_2O emissions from Diesel oil account for 85 % of N_2O emissions from 1A3b "Road Transportation" in 2019. Between 1990 and 2019 N_2O emissions from Diesel oil increased in all countries, except for Finland (decrease by 7 %) and Cyprus (decrease by 14 %); within the EU-KP the emission increased by 312 %. The largest increase in absolute terms was reported by France and Germany. Between 2018 and 2019, EU-KP emissions rose by 2 % (Table 3.67).

Table 3.67 1A3b Road Transport, diesel oil: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	12	228	237	3.0%	225	1861%	9	4%		
Belgium	59	243	235	3.0%	176	298%	-8	-3%		
Bulgaria	32	91	98	1.2%	66	204%	6	7%		
Croatia	13	46	52	0.7%	39	295%	5	12%		
Cyprus	21	17	18	0.2%	-3	-14%	1	5%	T1	D
Czechia	57	133	136	1.7%	80	140%	3	2%		
Denmark	30	113	111	1.4%	81	269%	-2	-2%		
Estonia	7	18	17	0.2%	10	143%	0	-1%		
Finland	65	61	61	0.8%	-4	-7%	0	0%	T2	CS
France	237	1 001	980	12.5%	743	313%	-21	-2%	T3	M, CS
Germany	145	1 482	1 547	19.8%	1 401	966%	65	4%	T3	M
Greece	39	58	62	0.8%	23	60%	5	8%		
Hungary	24	109	118	1.5%	94	386%	9	8%	T2	CS
Ireland	17	112	114	1.5%	97	557%	2	1%		
Italy	368	737	744	9.5%	377	103%	7	1%	T3	M, CS
Latvia	7	23	25	0.3%	18	249%	1	6%	T2	CS
Lithuania	23	45	47	0.6%	25	109%	3	6%	T2	CS
Luxembourg	3	58	61	0.8%	58	2289%	3	5%		
Malta	0	4	3	0.0%	3	705%	-1	-16%	T3	D
Netherlands	23	198	190	2.4%	167	713%	-7	-4%		
Poland	72	482	498	6.4%	426	588%	16	3%	T2	D
Portugal	29	119	126	1.6%	97	333%	7	6%		
Romania	31	143	155	2.0%	124	404%	12	9%		
Slovakia	41	67	70	0.9%	29	69%	3	5%		
Slovenia	8	55	54	0.7%	46	557%	-2	-3%	T3	M
Spain	195	850	856	10.9%	662	340%	6	1%	T1	M
Sweden	14	162	166	2.1%	152	1096%	5	3%		
United Kingdom	321	1 019	1 029	13.1%	708	220%	9	1%	T3	CS
EU-27+UK	**1 895**	**7 673**	**7 812**	**100%**	**5 917**	**312%**	**138**	**2%**		
Iceland	1	7	8	0.1%	6	448%	1	17%		
United Kingdom (KP)	322	1 022	1 032	13.2%	709	220%	10	1%	T3	CS
EU-KP	**1 898**	**7 683**	**7 822**	**100%**	**5 925**	**312%**	**140**	**2%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level Only information from major emitters have been included to the table as well as voluntarily provided information by countries.

France, Germany, Italy, Spain and the United Kingdom account for 66 % of N_2O emissions from diesel oil in 2019 (Figure 3.125). In Figure 3.124 the IEF is depicted and the EU IEF increased from 1.5 kg/TJ in 1990 to about 3 kg/TJ in 2019. A similar situation, increase in the values of the IEF, is observed for almost all countries. In most cases the IEF is country specific, thus a variation in the values of the IEF through the timeseries is observed. These IEF depend on the vehicle age, on the vehicle size and on driving conditions. In the case of Cyprus, during the initial checks, a question was raised to the country in order to give an explanation concerning the high value of N_2O IEF in the year 1990. Cyprus is still investigating the issue. Thus, the issue is considered partly resolved and we will be evaluated next year. Additionally, N_2O IEF for certain categories, such as heavy duty trucks and buses, have been increasing with more recent Euro standards (Euro IV-VI). All the above can lead to increased emission factors over the years.

Figure 3.125 1A3b Road Transport, diesel oil: Emission trend and share for N_2O emission

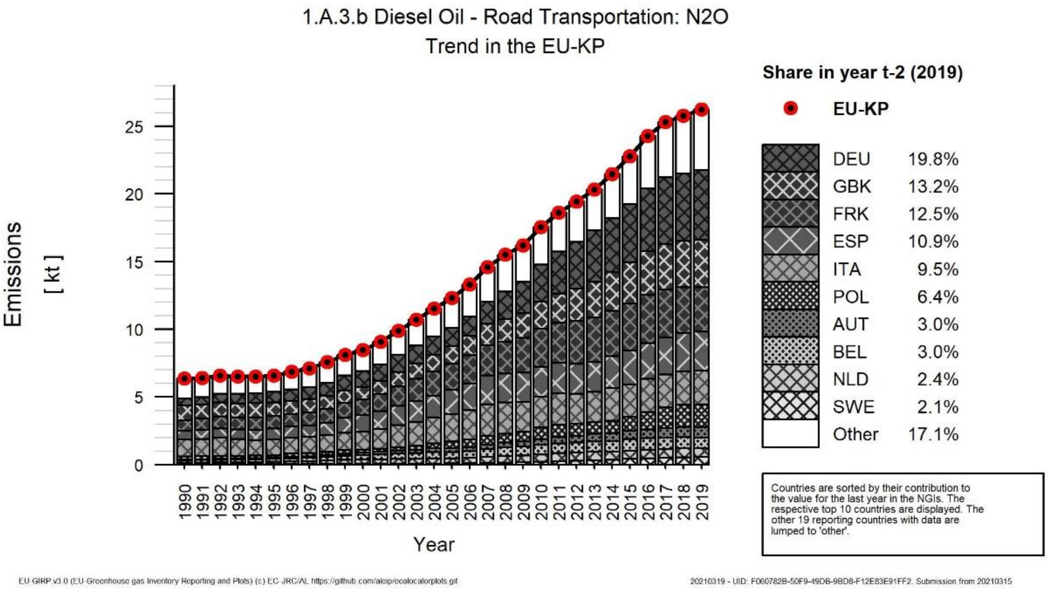
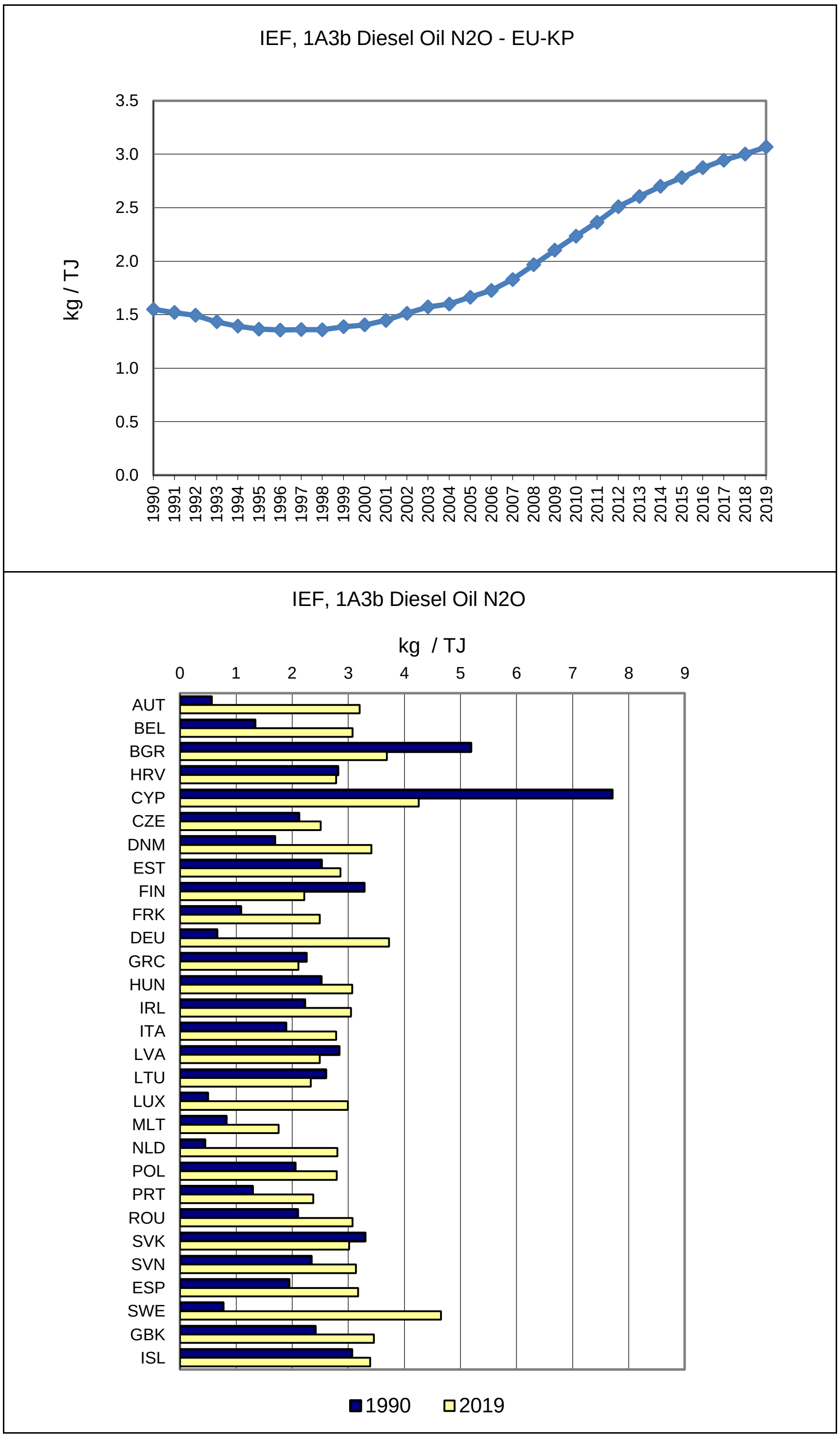


Figure 3.126 1A3b Road Transport, Diesel Oil: Implied Emission Factors for N_2O (in kg/TJ)



1A3b Road Transportation – Gasoline (N_2O)

N_2O emissions from Gasoline account for 9 % of N_2O emissions from 1A3b Road Transportation in 2019. Between 1990 and 2019, N_2O emissions from gasoline decreased by 83 % in the EU-KP with a peak in 1998. As explained above, this peak is due to the implementation of the catalytic converter in the early Euro vehicles and mainly Euro 1. Emissions decreased thereafter with the introduction of Euro 2 and later vehicle technologies. Between 2018 and 2019, almost all countries (except for Belgium, Estonia, France, Hungary, Luxembourg, Netherlands, Spain and United Kingdom), showed a decreasing trend. The EU-KP total N_2O emissions dropped by 1 % (Table 3.68).

Table 3.68 1A3b Road Transport, gasoline: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	93	10	9	1.1%	-84	-90%	-1	-9%		
Belgium	97	12	13	1.6%	-84	-87%	1	10%		
Bulgaria	41	10	10	1.2%	-31	-76%	0	0%		
Croatia	40	9	8	1.0%	-32	-80%	-1	-12%		
Cyprus	10	3	3	0.4%	-7	-70%	0	-4%	T1	D
Czechia	41	22	19	2.3%	-22	-54%	-3	-14%		
Denmark	57	12	11	1.3%	-46	-81%	-1	-8%		
Estonia	14	3	3	0.4%	-11	-77%	0	3%		
Finland	88	12	11	1.4%	-77	-87%	-1	-8%	T2	CS
France	648	97	107	13.1%	-542	-84%	10	10%	T3	M, CS
Germany	1 198	106	103	12.7%	-1 095	-91%	-3	-3%	T3	M
Greece	78	49	49	6.0%	-30	-38%	-1	-2%		
Hungary	39	22	24	2.9%	-16	-40%	2	9%	T2	CS
Ireland	35	9	7	0.8%	-29	-81%	-2	-19%		
Italy	494	97	93	11.4%	-402	-81%	-4	-4%	T3	M, CS
Latvia	12	2	2	0.2%	-10	-84%	0	-17%	T2	CS
Lithuania	27	2	2	0.2%	-25	-93%	0	-3%	T2	CS
Luxembourg	13	2	2	0.2%	-11	-87%	0	2%		
Malta	2	2	1	0.1%	-1	-50%	-1	-50%	T3	D
Netherlands	58	38	38	4.7%	-19	-33%	1	2%		
Poland	92	81	79	9.7%	-13	-14%	-2	-3%	T2	D
Portugal	49	22	21	2.6%	-28	-58%	-2	-7%		
Romania	196	27	25	3.1%	-170	-87%	-2	-6%		
Slovakia	15	7	5	0.6%	-10	-67%	-2	-26%		
Slovenia	20	5	4	0.5%	-16	-79%	-1	-11%	T3	M
Spain	273	55	56	6.8%	-217	-80%	1	2%	T1	M
Sweden	140	10	10	1.2%	-130	-93%	0	-3%		
United Kingdom	985	92	98	12.0%	-887	-90%	6	7%	T3	CS
EU-27+UK	**4 859**	**817**	**812**	**100%**	**-4 047**	**-83%**	**-5**	**-1%**		
Iceland	4	2	1	0.2%	-3	-71%	0	-27%		
United Kingdom (KP)	988	93	99	12.1%	-889	-90%	6	7%	T3	CS
EU-KP	**4 866**	**820**	**814**	**100%**	**-4 052**	**-83%**	**-5**	**-1%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level Only information from major emitters have been included to the table as well as voluntarily provided information by countries.

France, Germany, Italy, Spain and the United Kingdom accounted for 56 % of N_2O emissions (Figure **3.128**). In Figure 3.127 the IEF is depicted and it is clear that high variability exists for all countries through the whole time series. In the case of Romania, the high value of N_2O IEF is an issue still under investigation.

Figure 3.128 1A3b Road Transport, Gasoline: Emission trend and share for N_2O emissions

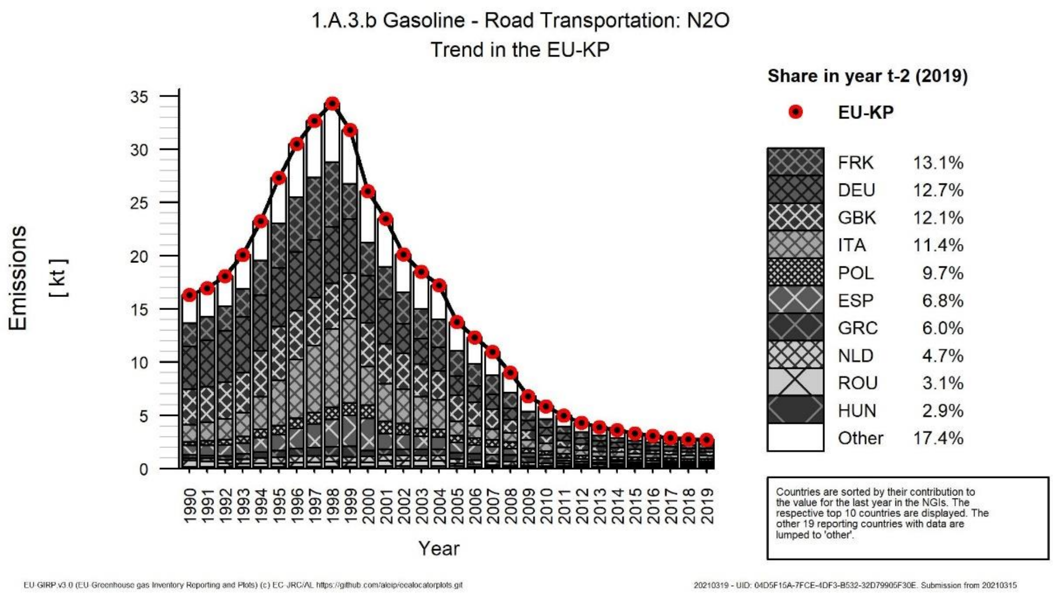
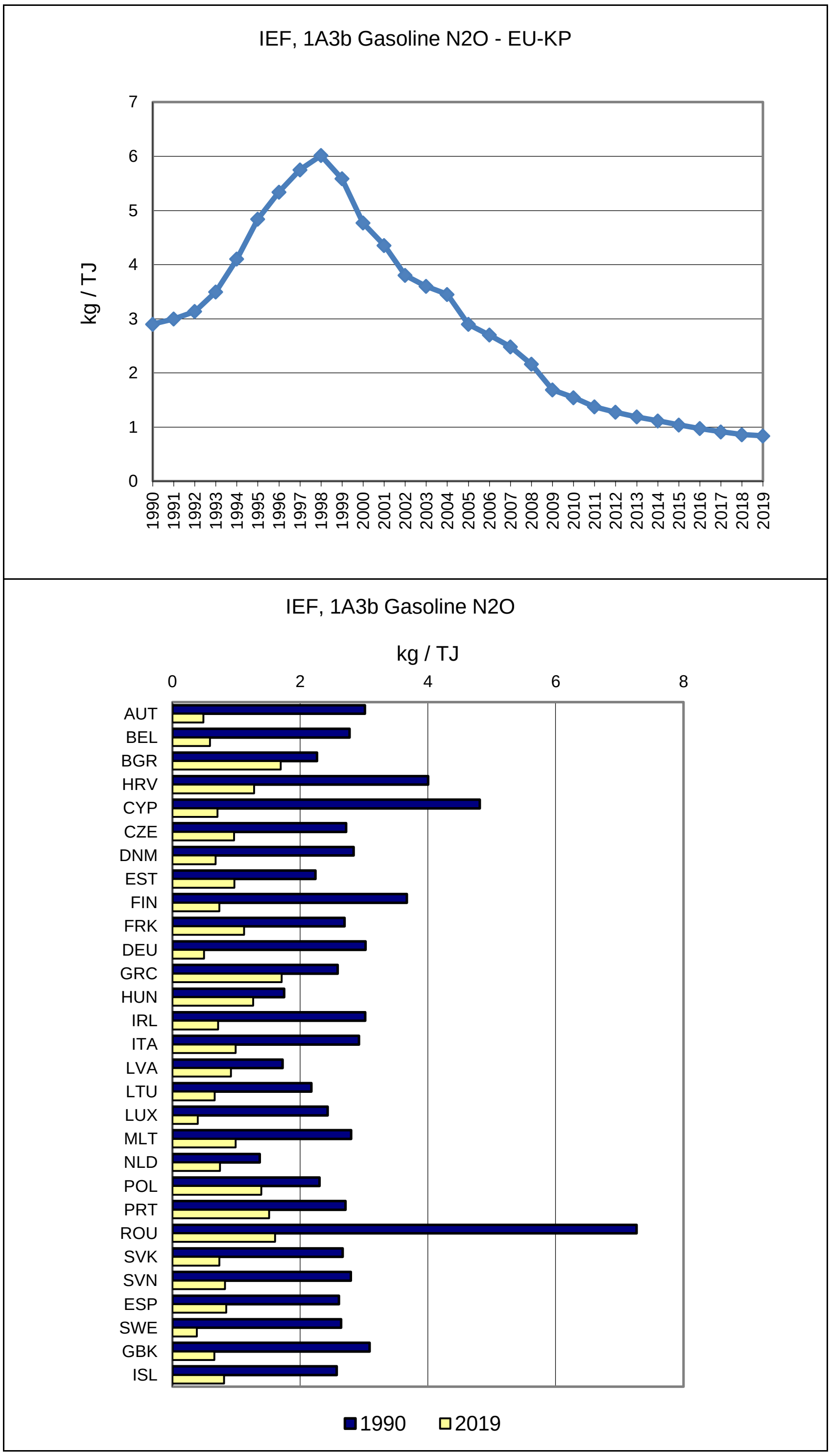


Figure 3.129 1A3b Road Transport, Gasoline: Implied Emission Factors for N_2O (in kg/TJ)

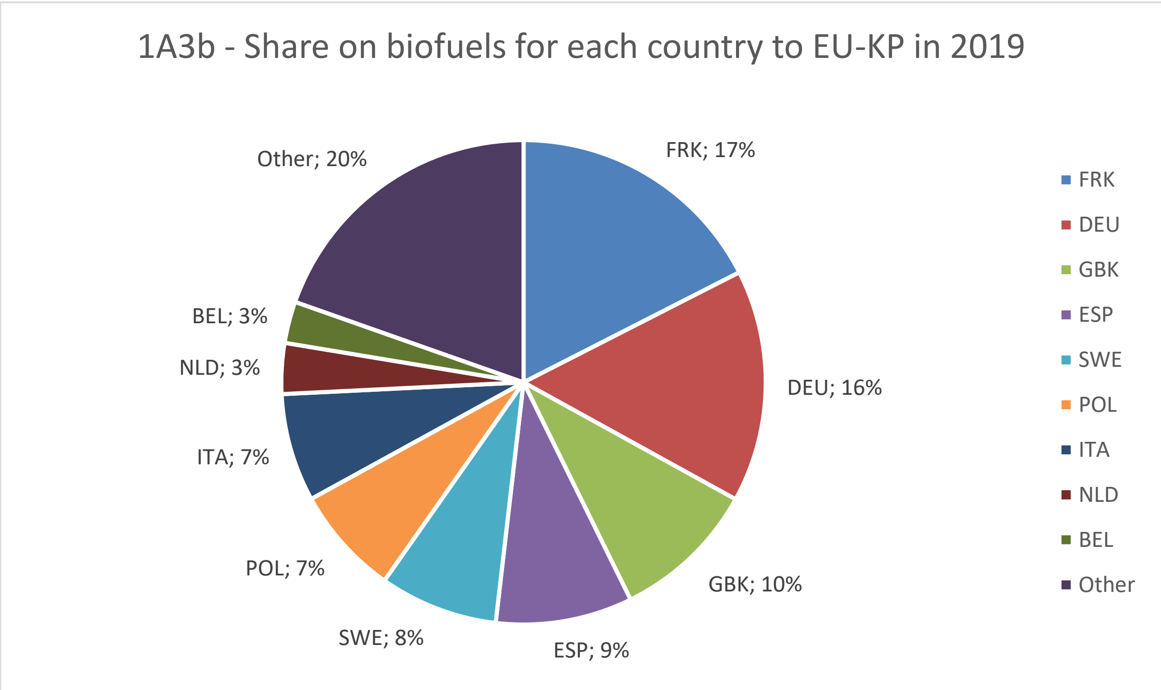


1A3b Road Transportation – Activity Data Biofuels

According to the European Directive on the promotion of the use of biofuels or other renewable fuels for transport (2003/30/EG), countries should ensure that a minimum proportion of biofuels and other renewable fuels is placed on their markets, and, to that effect, shall set national indicative targets, to reduce greenhouse gas emissions. Countries brought into force the laws, regulations and administrative provisions necessary to comply with this Directive by 31 December 2004. A reference value for these targets shall be 2 %, calculated on the basis of energy content, of all petrol and diesel for transport purposes placed on their markets by 31 December 2005. A reference value for these targets shall be 5.8 %, calculated on the basis of energy content, of all petrol and diesel for transport purposes placed on their markets by 31 December 2010. Due to the possibility of different national implementation the MS need to approach partly different targets.

Figure 3.130 shows the share on biofuels for each country to EU-KP in 2019. In this figure only the 9 countries, which contribute the most, are presented, whereas all remaining countries are presented together in category "Other" in this figure. France reports most of total amount of biofuels (17 % of total EU-KP activity in 2019), followed by Germany (16 %). All countries report biofuels activity under 1A3b for 2019.

Figure 3.130 1A3b Road Transport, Biofuels: Share on biofuels for each country



Furthermore, during the ESD checks the ERT recommends that the European Union provide summary information on how each member State has reported the emissions from use of lubricants under the transport (1.A.3) and/or lubricant use (2.D.1) categories and work with the member States to report emissions from lubricants combusted in two-stroke engines under the transport category in accordance with the 2006 IPCC Guidelines. Based on that the following table provides information on the status of the recommendation for all the Member States.

Table 3.69: 1A3b, Road Transport, Emissions from the use of lubricants combusted in two-engine stroke engines.

Member State	Are the emissions from lubricants combusted in two-stroke engines reported under the transport category?	Main explanation
Austria	No	Lubricants used for 2-stroke engines were not reported separately due to lack of data.
Belgium	Yes	Apart from 0.2-0.3% which is used in 2-stroke motor vehicles – emissions are in 1A3b.
Bulgaria	No	All emissions from lubricants (2-stroke and 4-stroke engines) are reported under CRF 2.D.1 sector, as the emissions from 2-stroke engines are only a minor share.
Cyprus	No	Spilt is not available in sub-categories (i.e. 1A3bii, 1A3biii etc.). The emissions related to lubricants are reported in 1.AD and 2.D.1 sections
Czech Republic	No	Emissions are considered insignificant. Emissions do not exceed the threshold of significance.
Germany	Yes	Emissions reported in CRF under the transport category.
Denmark	No	Emissions are considered negligible. Emissions do not exceed the threshold of significance.
Spain	Yes	Emissions reported in CRF under the transport category.
Estonia	No	It was concluded that the use of lubricants in 2-stroke engines is marginal.
Finland	No	There are no data on sales of 2-stroke oil separetely. The emissions are not separated from the use of 4 stroke oil and other lubricants.
France	Yes	Emissions reported in CRF under the transport category.
United Kingdom	Yes	Emissions reported in CRF under the transport category.
Greece	No	There are no 2-stroke motorcycles in Greece
Croatia	Yes	Emissions reported in CRF under the transport category.
Hungary	Yes	Emissions reported in CRF under the transport category.
Iceland	No	Currently available activity data does not allow to separate lubricants mixed in with other fuel in 2-stroke engines from lubricants used for their lubricating properties. Additionally, the amount of lubricant used as 2-stroke engine fuel is likely to be very small.
Ireland	No	There is no data in Ireland's vehicle bulletin statistics to indicate the use of 2 stroke 2 wheelers in Ireland. All 2 wheelers are assumed to be 4 stroke.
Italy	Yes	Emissions reported in CRF under the transport category.
Lithuania	No	Emissions from two-stroke engines are considered as insignificant, as these emissions do not exceed the threshold of significance. Based on these proportions, lubricants use in two-stroke engines in 2016 amounts only to 0,74-1,48 TJ, consequently emissions do not exceed threshold of significance.
Luxembourg	No	Emissions from lubricants reported exclusively under category 2.D.1. The activity data obtained from the national statistics institute (Statec) does not allow for a disaggregation of the lubricants consumption between 2-stroke engines and other applications. Furthermore, the number of 2-stroke engines in Luxembourg is very low; the consumption is below the threshold of significance.
Latvia	Yes	Emissions reported in CRF under the transport category.
Malta	No	The issue is under investigation.
Netherlands	Yes	Emissions reported in CRF under the transport category.
Poland	Yes	Emissions reported in CRF under the transport category.
Portugal	Yes	Emissions reported in CRF under the transport category.
Romania	No	Romania is considering reporting the emissions under the Energy Sector-Road Transportation category; The issue is under investigation.
Slovakia	Yes	Emissions reported in CRF under the transport category.
Slovenia	Yes	Emissions reported in CRF under the transport category. Emissions from combustion of lubricants in two-stroke engines are included in those of gasoline of 1A3b.
Sweden	No	The emissions from lubricants are still considered insignificant and not estimated separately.

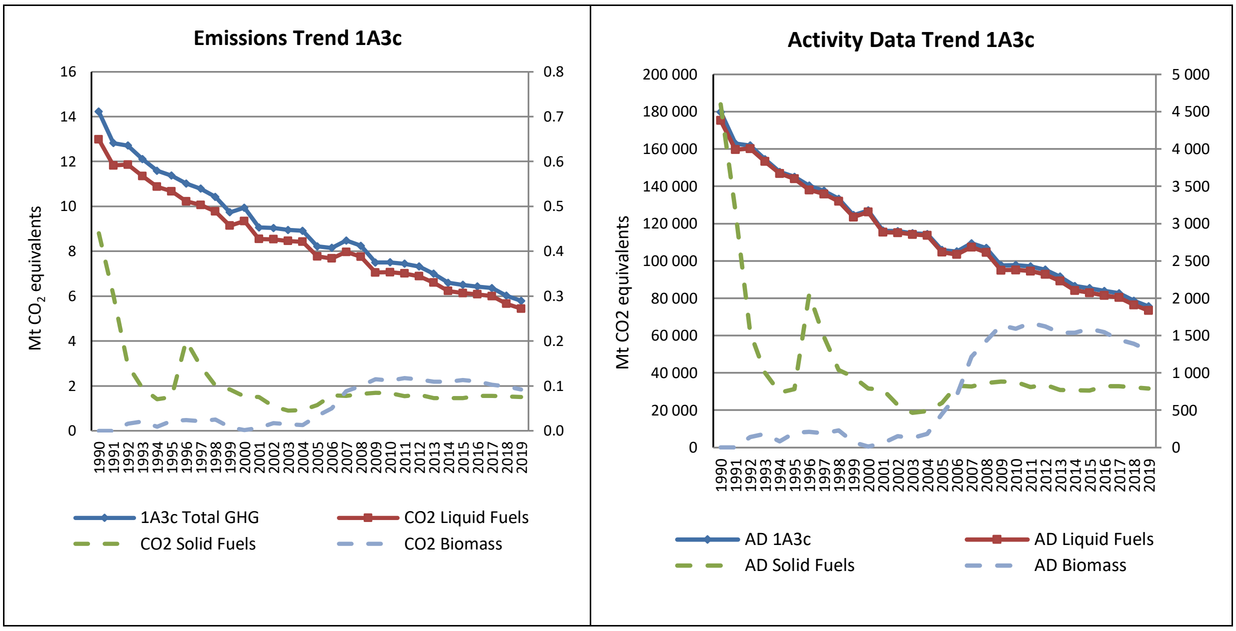
Furthermore, according to the 2006 IPCC Guidelines, Member States are recommended to estimate and provide in their emission inventories, the CO_2 emissions from the fossil part of biofuels (biodiesel and/or biogasoline). It is suggested to be reported under "1A3b Other fossil fuels" of the CRF report. Based on this, all countries of the European Union provide sufficient information concerning the CO_2 emissions from the fossil part of biofuels. Exemption to this are Malta, Romania and Iceland. Malta and Romania are in the process of investigating the issue, so next year the issue will be reviewed again by ERT. Iceland stated that "all of the biogasoline in Iceland is bioethanol and therefore does not include any fossil carbon (Sempos, 2018). The team for chemicals at the EA, which is responsible for monitoring reporting under the Quality Directive (Directive 2009/30/EC of the European Parliament and of the Council), has confirmed that no FAME biodiesel has been imported to Iceland, only HVO. Therefore, there is no carbon of fossil origin in biodiesel for which CO_2 emissions would need to be accounted for in this inventory".

3.2.3.3 Railways (1A3c) (EU-KP)

Railway locomotives generally are one of these types: diesel, coal, electric, or steam. Diesel locomotives generally use diesel engines in combination with an alternator or generator to produce the electricity required to power their traction motors. Emissions from Railways arise from the combustion of liquid and solid fuels.

CO_2 emissions from 1A3c Railways account for 0.14 % of total EU-KP GHG emissions in 2019. Between 1990 and 2019, CO_2 emissions from rail transportation decreased by 59 % in the EU-KP. The total trend is dominated by CO_2 emissions from liquid fuels (Figure 3.131). The emissions from this key category are due to fossil fuel consumption in rail transport, which decreased by 59 % between 1990 and 2019.

Figure 3.131 1A3c Railways: CO_2 Emission Trend and Activity Data



Data displayed as dashed line refers to the secondary axis.

The countries, France, Germany, Romania and the United Kingdom contributed most to the emissions from this source (58 %). Between 1990 and 2019, Germany had by far the highest decreases in absolute terms (Table 3.70).

Table 3.70 1A3c Railways: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	178	92	93	1.7%	-85	-48%	1	1%	T1,T2	CS,D
Belgium	222	78	77	1.4%	-145	-65%	-1	-1%	T3	CS,D
Bulgaria	323	34	31	0.6%	-292	-90%	-3	-9%	T1	D
Croatia	140	47	45	0.8%	-95	-68%	-1	-3%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	768	276	262	4.7%	-506	-66%	-14	-5%	T1	D
Denmark	297	224	224	4.0%	-73	-25%	-0.4	-0.2%	NA	NA
Estonia	159	45	34	0.6%	-126	-79%	-12	-26%	T2	CS
Finland	191	69	66	1.2%	-125	-65%	-2	-3%	T2	CS
France	1 078	394	395	7.2%	-683	-63%	1	0.3%	T1	OTH
Germany	2 901	732	740	13.4%	-2 161	-75%	8	1%	CS,M,T1	CS,D,M
Greece	199	116	33	0.6%	-166	-84%	-83	-72%	T2	CS
Hungary	533	133	121	2.2%	-412	-77%	-13	-10%	T2	CS
Ireland	133	117	122	2.2%	-11	-8%	5	5%	T2	CS
Italy	613	138	135	2.4%	-478	-78%	-3	-2%	T2	CS
Latvia	537	167	137	2.5%	-400	-74%	-30	-18%	T1,T2	CS,D
Lithuania	350	187	169	3.1%	-181	-52%	-17	-9%	T1,T2	CS,D
Luxembourg	25	7	7	0.1%	-18	-73%	-0.2	-3%	T1,T2	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	91	69	66	1.2%	-25	-27%	-3	-5%	T2	CS
Poland	1 624	322	268	4.9%	-1 356	-83%	-54	-17%	T1	D
Portugal	177	30	31	0.6%	-146	-83%	1	2%	T1	D
Romania	452	280	394	7.1%	-58	-13%	113	40%	T1,T2	CS,D
Slovakia	372	83	81	1.5%	-291	-78%	-2	-2%	T1	CS
Slovenia	65	26	23	0.4%	-42	-64%	-3	-12%	T1	D
Spain	422	252	245	4.4%	-176	-42%	-6	-2%	T1	D
Sweden	101	44	45	0.8%	-56	-55%	1	2%	T2	CS
United Kingdom	1 472	1 774	1 679	30.4%	207	14%	-95	-5%	T1,T2	CS
EU-27+UK	**13 424**	**5 737**	**5 524**	**100%**	**-7 900**	**-59%**	**-214**	**-4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 472	1 774	1 679	30.4%	207	14%	-95	-5%	T1,T2	CS
EU-KP	**13 424**	**5 737**	**5 524**	**100%**	**-7 900**	**-59%**	**-214**	**-4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3c Railways –Liquid Fuels (CO_2)

Between 1990 and 2019, CO_2 emissions from liquid fuels decreased by 58 % in the EU-KP. Between 2018 and 2019, EU-KP emissions decreased by 4 % (Table 3.71).

Table 3.71 1A3c Railways, liquid fuels: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	171	92	92	1.7%	-79	-46%	1	1%	T2	CS
Belgium	222	78	77	1.4%	-145	-65%	-1	-1%	T3	CS,D
Bulgaria	323	34	31	0.6%	-292	-90%	-3	-9%	T1	D
Croatia	119	47	45	0.8%	-74	-62%	-1	-3%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	768	274	261	4.8%	-507	-66%	-13	-5%	T1	D
Denmark	297	224	224	4.1%	-73	-25%	-0.4	-0.2%	0	0
Estonia	142	45	34	0.6%	-109	-76%	-12	-26%	T2	CS
Finland	191	69	66	1.2%	-125	-65%	-2	-3%	T2	CS
France	1 078	393	394	7.2%	-685	-63%	1	0.3%	T1	OTH
Germany	2 847	698	706	13.0%	-2 141	-75%	8	1%	CS,M	CS,M
Greece	199	116	33	0.6%	-166	-84%	-83	-72%	T2	CS
Hungary	528	133	121	2.2%	-408	-77%	-13	-10%	T2	CS
Ireland	133	117	122	2.2%	-11	-8%	5	5%	T2	CS
Italy	613	138	135	2.5%	-478	-78%	-3	-2%	T2	CS
Latvia	537	167	137	2.5%	-400	-74%	-30	-18%	T2	CS
Lithuania	350	187	169	3.1%	-181	-52%	-17	-9%	T1,T2	CS,D
Luxembourg	25	7	7	0.1%	-18	-73%	-0.2	-3%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	91	69	66	1.2%	-25	-28%	-3	-5%	T2	CS
Poland	1 319	322	268	4.9%	-1 051	-80%	-54	-17%	T1	D
Portugal	177	30	31	0.6%	-146	-83%	1	2%	T1	D
Romania	420	280	394	7.2%	-26	-6%	113	40%	T1,T2	CS,D
Slovakia	372	83	81	1.5%	-291	-78%	-2	-2%	T1	CS
Slovenia	65	26	23	0.4%	-42	-65%	-3	-11%	T1	D
Spain	422	252	245	4.5%	-176	-42%	-6	-2%	T1	D
Sweden	101	44	45	0.8%	-56	-55%	1	2%	T2	CS
United Kingdom	1 472	1 733	1 638	30.1%	166	11%	-95	-5%	T2	CS
EU-27+UK	**12 983**	**5 657**	**5 444**	**100%**	**-7 539**	**-58%**	**-212**	**-4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 472	1 733	1 638	30.1%	166	11%	-95	-5%	T2	CS
EU-KP	**12 983**	**5 657**	**5 444**	**100%**	**-7 539**	**-58%**	**-212**	**-4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

France, Germany, Poland, Romania and the United Kingdom account for 62 % of CO_2 emissions from liquid fuels in 2019 (Figure 3.133).

Table 3.71 shows that the majority of CO_2 emissions from the combustion of liquid fuels in railways were calculated using a higher tier method (70%). From the calculation of the higher tier methods, countries that use only T1 method were excluded. Romania, states that the IEF values for the calculation of CO_2 emissions are country specific, thus Romania was included in the calculation of the higher tier methods. In Figure 3.132 the IEF is depicted where the mean value is around 74 t/TJ. In 2016 and 2017 the IEF showed a slight increase, mainly due to the increased value of the IEF of Romania. The fluctuations in the IEF of Romania, is due to the fact that country specific EFs for CO_2 emissions have been determined.

Figure 3.133 1A3c Railways, Liquid Fuels: Emission trend and share for CO_2

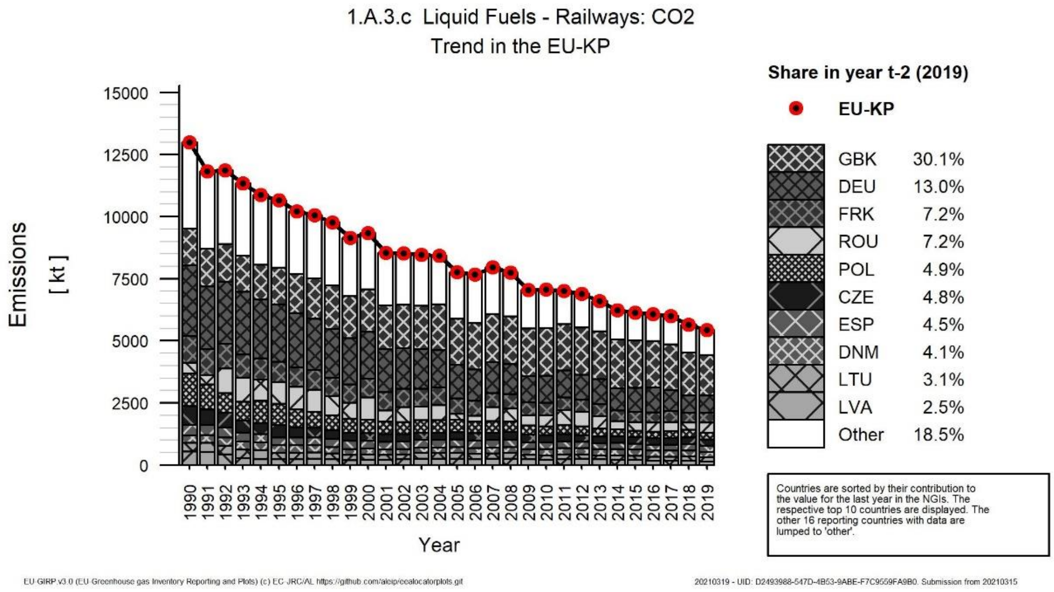
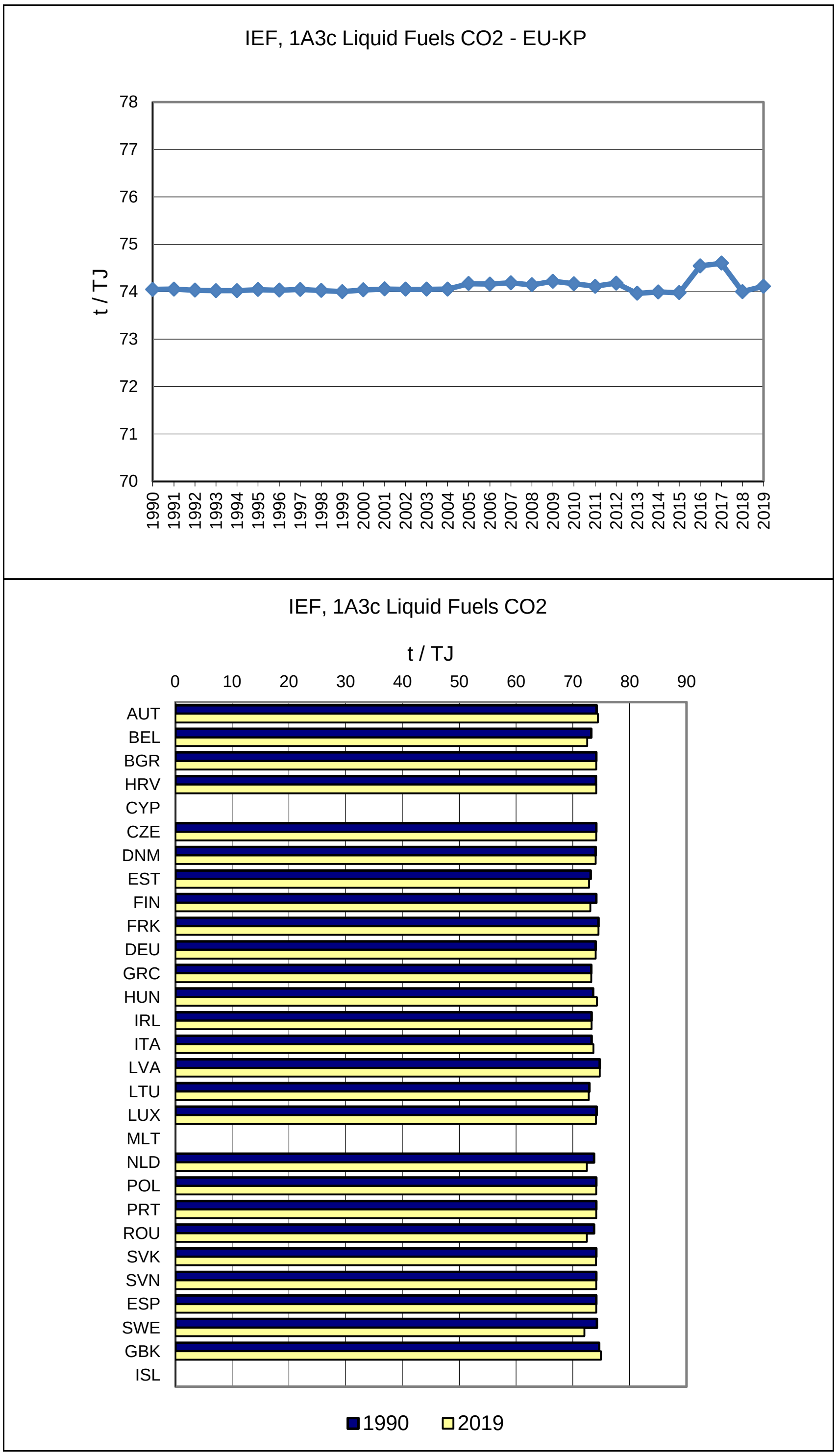


Figure 3.134 1A3c Railways, Liquid Fuels: Implied Emission Factors for CO_2 (in t/TJ)



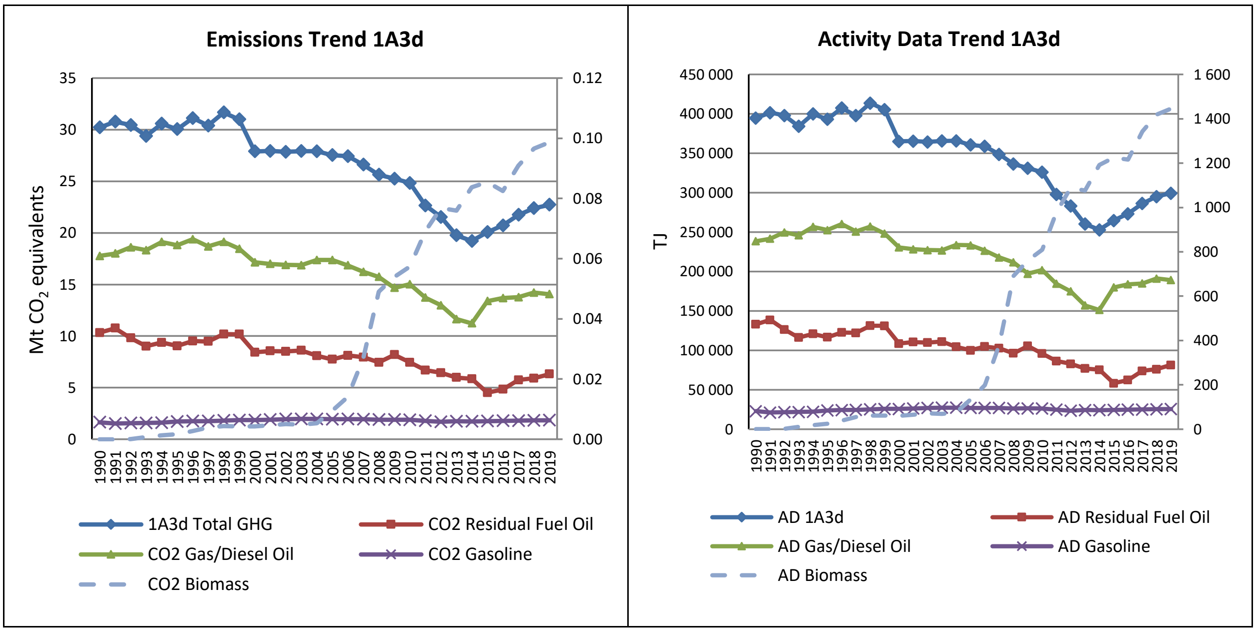
3.2.3.4 Domestic Navigation (1A3d) (EU-KP)

This source category covers all water-borne transport from recreational craft to large ocean-going cargo ships that are driven primarily by large, slow and medium speed diesel engines and occasionally by steam or gas turbines. Emissions arise from gas/diesel oil, residual oil or other.

CO_2 emissions from 1A3d Navigation account for 0.55 % of total EU-KP GHG emissions in 2019. Between 1990 and 2019, CO_2 emissions from navigation decreased by 25 % in the EU-KP (Table 3.72).

The emissions from this key category are due to fossil fuel consumption in navigation. The total CO_2 emission trend is dominated by emissions from gas/diesel oil and residual oil (Figure 3.135).

Figure 3.135 1A3d Domestic Navigation: CO_2 Emission Trend and Activity Data



Data displayed as dashed line refers to the secondary axis.

Five countries (Germany, Greece, Italy, Spain and the United Kingdom) contributed the most to the emissions from this source (76 %). Most countries (15 in total) had decreasing emissions from navigation between 1990 and 2019. The countries with the highest decreases in absolute terms were Germany, United Kingdom and Spain (Table 3.72).

Table 3.72 1A3d Domestic Navigation: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	28	75	84	0.4%	56	199%	9	12%	T1,T2	CS,D
Belgium	362	397	374	1.7%	12	3%	-23	-6%	T1,T3	CS,D
Bulgaria	56	5	6	0.03%	-50	-89%	1	26%	T1	D
Croatia	134	149	156	0.7%	21	16%	6	4%	T1	D
Cyprus	2	2	2	0.01%	0.1	2%	0.1	7%	T1	D
Czechia	54	10	16	0.1%	-38	-70%	6	67%	T1	D
Denmark	714	627	514	2.3%	-200	-28%	-113	-18%	NA	NA
Estonia	22	20	16	0.1%	-5	-24%	-3	-17%	T2	CS
Finland	441	425	429	1.9%	-13	-3%	4	1%	T2	CS
France	1 021	1 259	1 276	5.7%	255	25%	17	1%	T1	CS
Germany	3 645	1 781	1 624	7.3%	-2 020	-55%	-156	-9%	CS	CS,M
Greece	1 809	2 000	2 068	9.3%	259	14%	68	3%	T1	CS
Hungary	209	16	16	0.1%	-193	-92%	0	0%	T1	D
Ireland	85	258	274	1.2%	189	223%	17	7%	T2	CS
Italy	5 470	4 100	4 484	20.1%	-986	-18%	384	9%	T1,T2	CS
Latvia	1	20	10	0.05%	9	900%	-10	-50%	T1,T2	CS,D
Lithuania	15	15	16	0.1%	1	4%	1	9%	T1	CS
Luxembourg	1	1	1	0.00%	-0.3	-25%	-0.1	-13%	T1,T2	CS,D
Malta	25	92	26	0.1%	1	6%	-66	-72%	T1,T3	CS,D
Netherlands	743	988	916	4.1%	174	23%	-72	-7%	T2	CS
Poland	151	11	10	0.04%	-141	-94%	-2	-15%	T1	D
Portugal	263	263	270	1.2%	7	3%	7	3%	T2	D
Romania	1 151	122	135	0.6%	-1 016	-88%	13	10%	T2	CS
Slovakia	0.02	3	4	0.02%	4	18457%	2	63%	T1	D
Slovenia	0.01	0.05	0.1	0.0004%	0.1	705%	0.03	66%	T1	D
Spain	5 214	3 129	3 284	14.7%	-1 930	-37%	155	5%	T1	D
Sweden	452	707	682	3.1%	230	51%	-25	-4%	T2	CS
United Kingdom	7 536	5 418	5 498	24.6%	-2 038	-27%	80	1%	T2	CS
EU-27+UK	**29 604**	**21 892**	**22 192**	**99%**	**-7 412**	**-25%**	**300**	**1%**	**-**	**-**
Iceland	60	43	53	0.2%	-7	-11%	10	22%	T1	D
United Kingdom (KP)	7 608	5 496	5 578	25.0%	-2 030	-27%	82	1%	T2	CS
EU-KP	**29 736**	**22 014**	**22 325**	**100%**	**-7 411**	**-25%**	**311**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3d Domestic Navigation – Residual Fuel Oil (CO_2)

CO_2 emissions from residual oil account for 28 % of CO_2 emissions from 1A3d Navigation in 2019. Between 1990 and 2019, CO_2 emissions from residual fuel oil decreased by 39 % in the EU-KP. The countries with the highest decrease in absolute terms were Romania, United Kingdom and Germany. 17 countries reported emissions as 'Not Occurring' (Table 3.73) for 2019, whereas Belgium reported emissions as 'Included Elsewhere' and specifically, the aforementioned emissions are included in gas/diesel oil, since the amounts of residual fuel oil are very small.

Table 3.73 1A3d Navigation, residual fuel oil: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	IE	IE	IE	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	7	NO	NO	-	-7	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	357	118	118	1.9%	-239	-67%	-0.2	-0.2%	0	0
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	123	35	37	0.6%	-86	-70%	2	6%	T2	CS
France	159	54	47	0.7%	-112	-71%	-7	-13%	T1	CS
Germany	935	15	28	0.5%	-906	-97%	13	87%	CS	CS,M
Greece	746	1 146	1 142	18.1%	397	53%	-4	0%	T1	CS
Hungary	3	NO	NO	-	-3	-100%	-	-	NA	NA
Ireland	63	NO	NO	-	-63	-100%	-	-	NA	NA
Italy	2 576	1 842	2 040	32.3%	-535	-21%	198	11%	T1,T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	5	NO	NO	-	-5	-100%	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	70	NO	NO	-	-70	-100%	-	-	NA	NA
Portugal	190	190	195	3.1%	5	3%	5	3%	T2	D
Romania	1 025	NO	NO	-	-1 025	-100%	-	-	NA	NA
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1 254	1 596	1 834	29.0%	580	46%	238	15%	T1	D
Sweden	195	328	273	4.3%	78	40%	-55	-17%	T2	CS
United Kingdom	2 581	542	559	8.9%	-2 022	-78%	17	3%	T2	CS
EU-27+UK	**10 287**	**5 865**	**6 273**	**99%**	**-4 014**	**-39%**	**408**	**7%**	**-**	**-**
Iceland	22	16	15	0.2%	-7	-33%	-1	-7%	T1	D
United Kingdom (KP)	2 599	567	586	9.3%	-2 013	-77%	19	3%	T2	CS
EU-KP	**10 328**	**5 906**	**6 315**	**100%**	**-4 012**	**-39%**	**409**	**7%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Greece, Italy and Spain account for 79 % of CO_2 emissions from residual fuel oil in 2019 (Figure 3.137).

Table **3.73** shows that the majority of CO_2 emissions from the combustion of residual fuel oil in navigation were calculated using a higher tier method (67.8%). Spain was not included in this calculation, since they use T1 to calculate these emissions. Specifically, Spain was asked in the 2021 review about this issue, and they stated that "Spain has asked for better information and characterization of gas diesel oil and residual fuel oil consumed in water borne navigation. Unfortunately, it has not been possible to find adequate information.'' The issue is still under investigation by Spain and it was recommended that Spain should continue to put effort in moving to a higher tier methodology.

On the other hand, Italy stated that country specific IEF were used, thus they were considered in the calculation and Greece also includes in the NIR that country specific EF for CO_2 emissions were used. In Figure 3.136 the IEF is depicted where the mean value is around 78 t/TJ.

Figure 3.137 1A3d Navigation, Residual Fuel Oil: Emission trend and share for CO_2

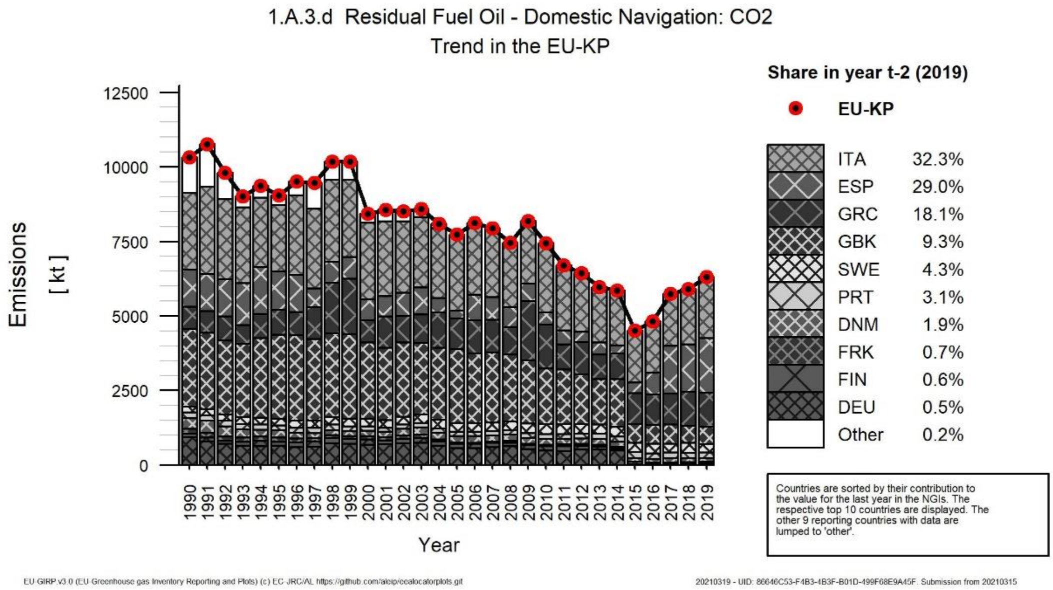
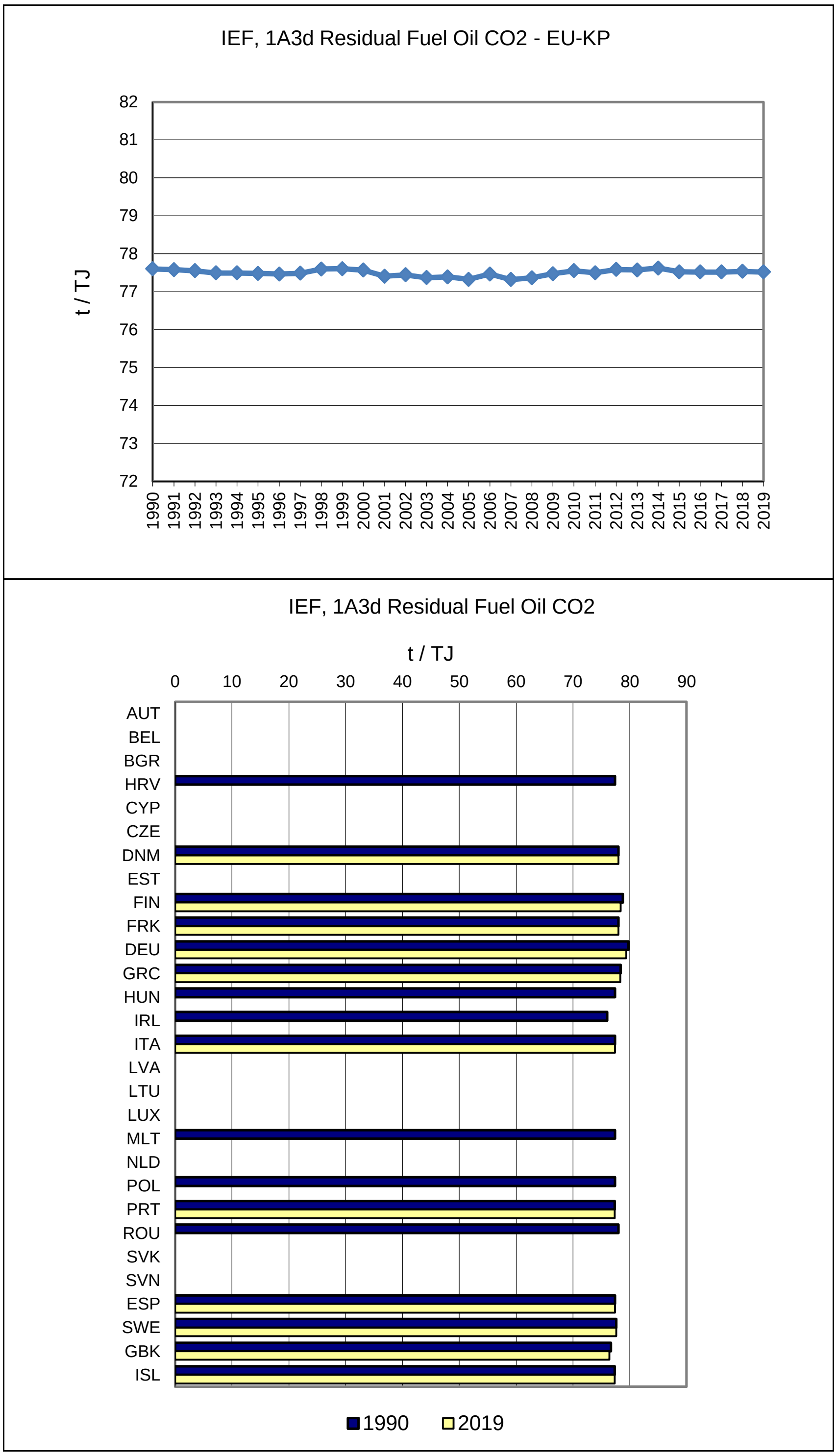


Figure 3.138 1A3d Navigation, Residual Fuel Implied Emission Factors for CO_2 (in t/TJ)



1A3d Navigation – Gas/Diesel Oil (CO_2)

CO_2 emissions from Gas/Diesel oil account for 62 % of CO_2 emissions from 1A3d Navigation in 2019 (Table 3.74). The CO_2 emissions from Gas/Diesel oil decreased by 21 % between 1990 and 2019.

Table 3.74 1A3d Navigation, gas/diesel oil: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	18	68	77	0.5%	58	317%	9	13%	T2	CS
Belgium	362	397	374	2.7%	12	3%	-23	-6%	T1,T3	CS,D
Bulgaria	56	5	6	0.0%	-50	-89%	1	26%	T1	D
Croatia	128	149	155	1.1%	28	22%	6	4%	T1	D
Cyprus	2	2	2	0.02%	0.1	2%	0.1	7%	T1	D
Czechia	54	10	16	0.1%	-38	-70%	6	67%	T1	D
Denmark	358	504	392	2.8%	34	10%	-113	-22%	0	0
Estonia	22	20	16	0.1%	-5	-24%	-3	-17%	T2	CS
Finland	186	263	261	1.9%	74	40%	-2	-1%	T2	CS
France	324	368	380	2.7%	56	17%	12	3%	T1	CS
Germany	2 710	1 765	1 596	11.4%	-1 114	-41%	-170	-10%	CS	CS,M
Greece	1 063	854	926	6.6%	-137	-13%	72	8%	T1	CS
Hungary	28	16	16	0.1%	-13	-44%	-0.01	-0.05%	T1	D
Ireland	22	258	274	2.0%	252	1134%	17	7%	T2	CS
Italy	2 326	1 955	2 145	15.3%	-181	-8%	189	10%	T1,T2	CS
Latvia	1	20	10	0.1%	9	1072%	-10	-51%	T2	CS
Lithuania	15	15	16	0.1%	1	4%	1	9%	T1	CS
Luxembourg	1	1	1	0.01%	-0.1	-13%	-0.1	-13%	T2	CS
Malta	19	90	25	0.2%	6	29%	-65	-72%	T1,T3	CS,D
Netherlands	697	923	851	6.1%	154	22%	-72	-8%	T2	CS
Poland	81	11	10	0.1%	-71	-88%	-2	-15%	T1	D
Portugal	73	73	75	0.5%	2	3%	2	3%	T2	D
Romania	125	120	132	0.9%	7	6%	12	10%	T2	CS
Slovakia	0.02	3	4	0.03%	4	18437%	2	63%	T1	D
Slovenia	0.01	0.04	0.07	0.001%	0.1	608%	0.03	81%	T1	D
Spain	3 960	1 533	1 450	10.3%	-2 510	-63%	-83	-5%	T1	D
Sweden	181	245	236	1.7%	56	31%	-8	-3%	T2	CS
United Kingdom	4 851	4 465	4 516	32.1%	-335	-7%	51	1%	T2	CS
EU-27+UK	**17 664**	**14 132**	**13 963**	**99%**	**-3 701**	**-21%**	**-169**	**-1%**	**-**	**-**
Iceland	37	27	38	0.3%	1	1%	11	40%	T1	D
United Kingdom (KP)	4 905	4 518	4 568	32.5%	-337	-7%	51	1%	T2	CS
EU-KP	**17 755**	**14 212**	**14 053**	**100%**	**-3 702**	**-21%**	**-159**	**-1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Germany, Greece, Italy, Netherlands, Spain and the United Kingdom account for 82 % of the CO_2 emissions from gas/diesel oil in 2019 (Figure 3.140).

Table 3.74 shows that the majority of CO_2 emissions from the combustion of gas/diesel oil in navigation were calculated using a higher tier method (82.5%). Spain was not taken into account for this calculation, since they are using only T1 method. Specifically, Spain was asked in the 2021 review about this issue, and they stated that they will keep on investigating the issue of gas/diesel oil emissions of the navigation sector, together with the method for the residual fuel oil emissions, as it is mentioned in the above chapter. Whereas Italy, using country specific emission factors, was included in the calculation of higher tier methods and Greece also includes in the NIR that country specific EF for CO_2 emissions were used. In Figure 3.139 the IEF is depicted where the mean value is around 74 t/TJ.

Figure 3.140 1A3d Navigation, Gas/Diesel Oil: Emission trend and share for CO_2

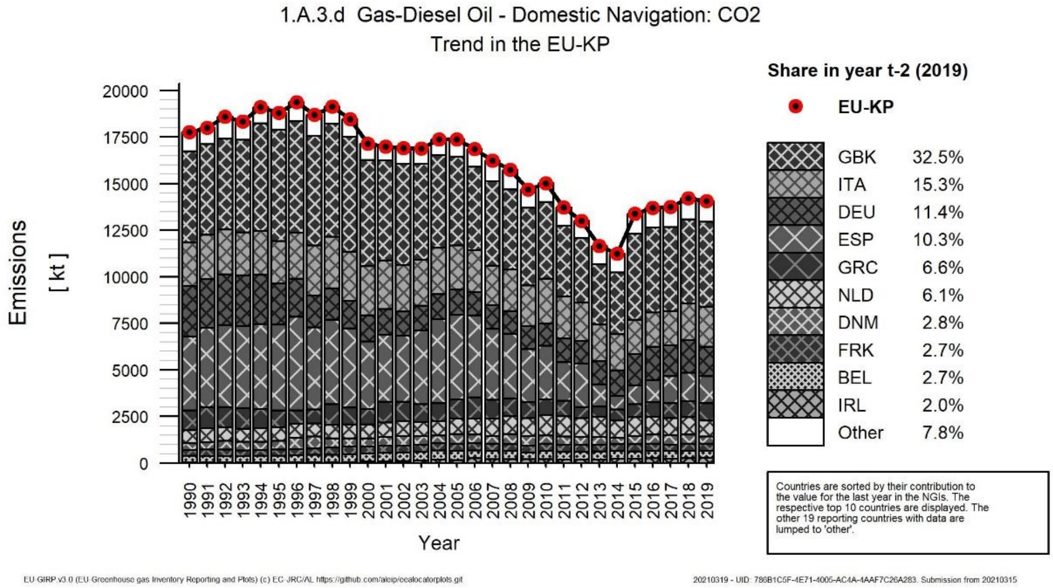
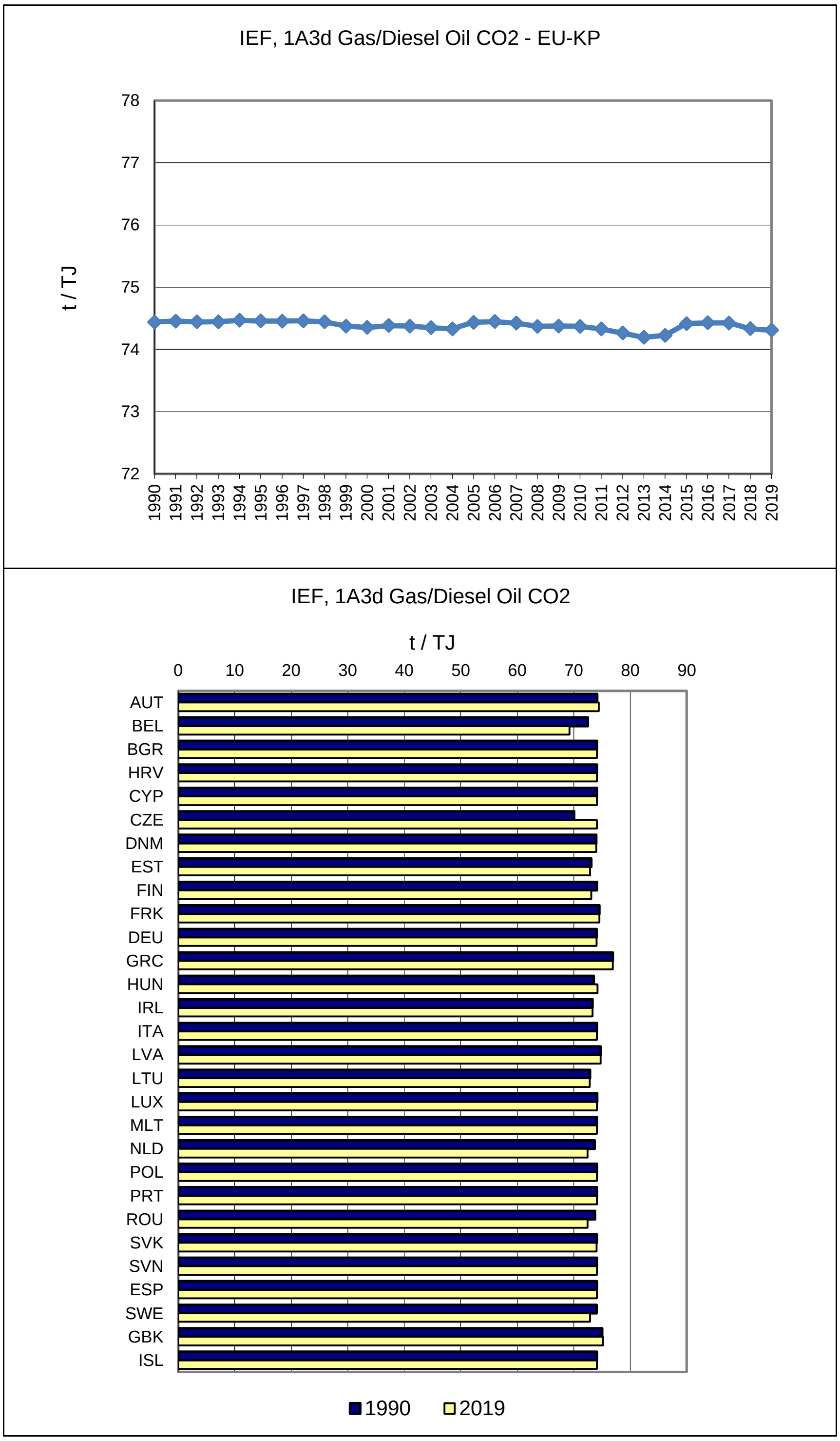


Figure 3.141 1A3d Navigation, Gas/Diesel Oil: Implied Emission Factors for CO_2 (in t/TJ)



3.2.3.5 Other (1A3e) (EU-KP)

CO_2 emissions from 1A3e Other account for only 0.15 % of total EU-KP GHG emissions in 2019. This source includes mainly pipeline transport and ground activities in airports and harbours. The emissions from this key source are due to fossil fuel consumption in other transportation, which increased by 18 % between 1990 and 2019.

Germany contributed 20 % and Poland 14 % to the EU-KP emissions from this source in 2019 (Table 3.75). Between 1990 and 2019 the EU-KP emissions increased by 15%. Seven countries report emissions as ‘Not occurring’. Iceland reports emissions as “Included elsewhere” and more specifically, these emissions are reported under 1A2gvii Industry and Construction since fuel sales statistics does not allow to disaggregate between fuel sold for airport and harbour ground-based activities and construction/off-road machinery. For Portugal, fuel consumption for 1.A.3.e.ii - Off-road activities is included in the category Commercial/Institutional (under Other Sectors – 1.A.4) because is not possible to separate the fuel consumption for these sectors in the Energy Balance.

Table 3.75 1A3e Other: Member States’ contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	224	587	542	8.8%	317	141%	-46	-8%	T2	CS
Belgium	334	396	477	7.8%	142	43%	80	20%	CS,T3	D
Bulgaria	132	319	126	2.1%	-6	-4%	-193	-61%	T2	CS
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	5	33	50	0.8%	45	830%	18	55%	T2	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	2	8	7	0.1%	5	224%	-1	-7%	T1	CS
France	212	376	460	7.5%	248	117%	84	22%	T2	CS
Germany	1 083	1 329	1 194	19.4%	111	10%	-135	-10%	CS	CS
Greece	NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Hungary	149	161	172	2.8%	23	16%	11	7%	T2	CS
Ireland	73	140	144	2.3%	70	96%	4	3%	T2	CS
Italy	411	797	678	11.0%	267	65%	-119	-15%	T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	64	37	30	0.5%	-35	-54%	-8	-21%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	342	90	85	1.4%	-258	-75%	-6	-7%	T2	CS
Poland	NO	947	858	14.0%	858	∞	-89	-9%	T1	D
Portugal	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Romania	66	4	5	0.1%	-60	-92%	1	36%	T1,T2	CS,D
Slovakia	1 814	296	398	6.5%	-1 416	-78%	102	35%	T2	CS
Slovenia	NO	1	1	0.01%	1	∞	-0.2	-24%	T2	CS
Spain	19	141	131	2.1%	112	585%	-10	-7%	T1	CS,D
Sweden	198	172	184	3.0%	-14	-7%	12	7%	T2	CS
United Kingdom	225	581	606	9.9%	381	170%	25	4%	T3	CS
EU-27+UK	**5 354**	**6 416**	**6 147**	**100%**	**794**	**15%**	**-269**	**-4%**	**-**	**-**
Iceland	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
United Kingdom (KP)	225	581	606	9.9%	381	170%	25	4%	T3	CS
EU-KP	**5 354**	**6 416**	**6 147**	**100%**	**794**	**15%**	**-269**	**-4%**	**-**	**-**

Abbreviations explained in the Chapter ‘Units and abbreviation’ Presented methods and emission factor information refer to the last inventory year.

3.2.4 Other Sectors (CRF Source Category 1.A.4.)

Category 1.A.4. mainly includes emissions from 'small scale fuel combustion' used for space heating and hot water production in commercial and institutional buildings, households, agriculture and forestry. It includes also emissions from mobile machinery used within these categories (e.g. mowers, harvesters, tractors, chain saws, motor pumps) as well as fuel used for grain drying, horticultural greenhouse heating or CO_2 fertilisation and stall heating. Category 1.A.4.c includes emissions from domestic inland, coastal, deep sea and international fishing. Emissions from transportation of agricultural goods are reported under category 1.A.3 Transport. The emissions reported under 1.A.4. can be generally defined as heat production processes for internal consumption.

The main driving force for CO_2 emissions in the 1.A.4. in energy consumption is the combustion for purposes of space heating. The fluctuations in consumption can be ascribed to difference in cold winter periods. The trend in eventually decreasing CO_2 emissions is a result of higher standards for new buildings and of successful execution of energy-efficiency-oriented modernization of existing buildings.

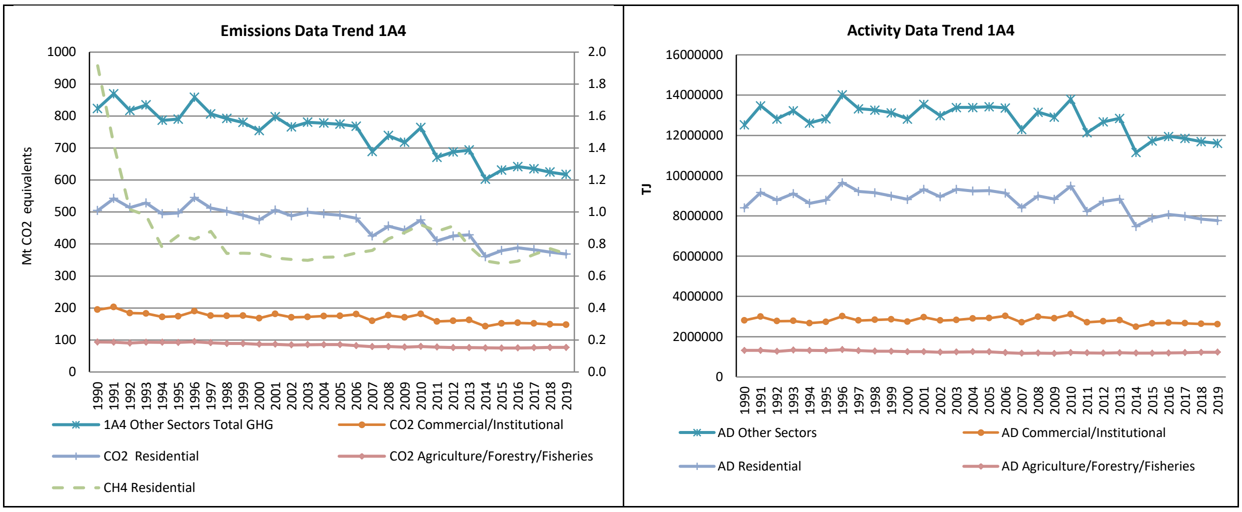
The following enumeration shows the correspondence of 1.A.4. subcategories and ISIC 3.1 rev codes:

- 1.A.4.a Commercial/Institutional: ISIC categories 4103, 42, 6, 719, 72, 8, and 91-96
- 1.A.4.b Residential: All emissions from fuel combustion in households
- 1.A.4.c Agriculture/Forestry/Fishing: ISIC categories 05, 11, 12, 1302

In 2019 category 1.A.4. contributed to 617 174 kt CO_2 equivalents of which 96.1% CO_2, 2.6% CH_4 and 1.3% N_2O.

Figure **3.142** shows the trend of total GHG emissions within source category 1.A.4. and the dominating sources which are CO_2 emissions from 1.A.4.b Residential and from 1.A.4.a Commercial/Residential. The emission trends of the large key sources show larger fluctuations between 1990 and 2019. Between 1990 and 2019, emissions from 1.A.4. decreased by 25%. From 2018 to 2019 emissions decreased by 1% (-7.5 Mt CO_2 equivalents) which is mainly due to a decrease of category 1.A.4.b CO_2 emissions which decreased by 2% and category 1.A.4.a CO_2 emissions which decreased by 1%. The trend of 1.A.4.a CO_2 emissions between 1990 and 2019 is mostly influenced by Germany (-31.5 Mt CO_2), and Czechia (-7.0 Mt CO_2). The decrease of 1.A.4.b CO_2 emissions between 1990 and 2019 is mostly influenced by Germany (-39.9 Mt CO_2) and France (-13.3 Mt CO_2).

Figure 3.142 1.A.4. Other Sectors: Total, CO_2 and CH_4 emission trends



Data displayed as dashed line refers to the secondary axis.

In 2019 GHG emissions from source category 1.A.4. accounted for nearly 17% of total GHG emissions. This source category includes twelve key sources which contributed to 98% of total 1.A.4. GHG emissions in 2019. The following list shows the key sources and their contribution to total 1.A.4 GHG emissions for the year 2019:

1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2) - 16.9%

1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2) - 5.5%

1.A.4.a Commercial/Institutional: Other Fuels (CO_2) - 1%

1.A.4.a Commercial/Institutional: Solid Fuels (CO_2) - 0.5%

1.A.4.b Residential: Biomass (CH_4) - 1.6%

1.A.4.b Residential: Gaseous Fuels (CO_2) - 39.2%

1.A.4.b Residential: Liquid Fuels (CO_2) - 15.5%

1.A.4.b Residential: Solid Fuels (CH_4) - 0.4%

1.A.4.b Residential: Solid Fuels (CO_2) - 4.8%

1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2) - 1.9%

1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2) - 9.9%

1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2) - 0.5%

The following table shows the share of higher tier methods used for each key source of category 1.A.4. It comprises all methods and method combinations as reported by countries for any of the 1.A.4. key sources.

Table 3.76: Key source categories for level and trend analyses and share of EU-KP emissions using higher tier methods for sector 1.A.4. (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		Share of higher Tier
	1990	2019		1990	2019	
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	65622	104298	T	L	L	95%
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	79398	34010	T	L	L	96%
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	748	6325	T	0	L	98%
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	48484	3208	T	L	0	100%
1.A.4.b Residential: Biomass (CH_4)	9413	10143	0	L	L	62%
1.A.4.b Residential: Gaseous Fuels (CO_2)	184767	242196	T	L	L	100%
1.A.4.b Residential: Liquid Fuels (CO_2)	180454	95518	T	L	L	99%
1.A.4.b Residential: Solid Fuels (CH_4)	9226	2335	T	L	0	13%
1.A.4.b Residential: Solid Fuels (CO_2)	135116	29698	T	L	L	100%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	12473	11882	0	L	L	90%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	71520	61405	T	L	L	88%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	9734	3279	T	L	0	98%

The following table shows the share of specific tier methods used for each 1.A.4 category emission estimates. It can be seen that most countries use combination of T1 and T2 method for emission estimates.

Table 3.77: Share of Tier methods for 1.A.4 by type of reported method and method combinations.

Methods and method combinations	Share of emissions which are estimated by specific Tier method
CS	0.3%
T1	3.0%
T1,T2	29.8%
T1,T3	0.0%
T2	23.4%
T2,T3	0.4%
T3	0.0%
T1,T2,T3	21.4%
CS,T1,T2	13.7%
CS,T1,T3	2.5%
CS,T1,T2,T3	5.1%
Other combination	0.4%

Table 3.78 shows total GHG, CO_2 and CH_4 emissions from 1.A.4. Other sectors. Between 1990 and 2019 CO_2 emissions from 1.A.4. Other Sectors decreased by 25%, CH_4 decreased by 29% and N_2O emissions decreased by 2%.

Table 3.78 1.A.4. Other Sectors: Member States' contributions to total GHG, CO_2 and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2019 (kt)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2019 (kt CO2 equivalents)
Austria	14 253	9 118	13 543	8 704	518	264
Belgium	28 155	24 316	27 809	23 785	256	419
Bulgaria	8 133	1 758	7 654	1 375	286	296
Croatia	4 218	3 106	3 719	2 659	358	327
Cyprus	434	542	430	530	2	10
Czechia	33 807	12 738	31 954	11 677	1 676	917
Denmark	9 262	3 967	9 042	3 783	157	107
Estonia	1 958	883	1 786	706	114	125
Finland	7 739	3 773	7 483	3 506	169	203
France	96 766	73 504	90 652	71 119	4 646	1 027
Germany	208 119	128 636	202 954	127 139	4 187	1 046
Greece	8 653	5 933	8 066	5 646	239	213
Hungary	22 057	11 994	21 099	11 447	858	457
Ireland	10 450	8 975	9 895	8 752	451	146
Italy	78 924	81 485	76 042	76 703	1 141	2 323
Latvia	5 918	1 505	5 493	1 261	268	164
Lithuania	7 300	1 462	6 903	1 266	210	155
Luxembourg	1 360	1 667	1 343	1 653	11	10
Malta	265	136	264	135	1	1
Netherlands	39 484	33 306	38 866	31 781	568	1 474
Poland	56 922	51 897	53 441	47 901	2 805	2 901
Portugal	4 111	4 513	3 463	4 138	431	214
Romania	11 310	11 807	10 847	10 485	417	1 036
Slovakia	11 502	4 760	11 067	4 476	389	223
Slovenia	1 891	1 330	1 686	1 172	161	113
Spain	26 330	37 794	25 291	36 477	828	1 029
Sweden	11 144	2 563	10 866	2 412	115	62
United Kingdom	111 587	92 397	109 606	91 090	1 588	1 053
EU-27+ISL	**822 053**	**615 863**	**791 266**	**591 776**	**22 849**	**16 316**
Iceland	783	557	775	549	2	1
United Kingdom (KP)	112 105	93 152	110 118	91 838	1 592	1 055
EU-KP	**823 354**	**617 174**	**792 552**	**593 073**	**22 854**	**16 319**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3.79 provides information on the contribution of Member States to EU-KP recalculations in CO_2 from 1.A.4. Other sectors for 1990 and 2018 and explanations for the recalculations.

Table 3.79 1.A.4. Other Sectors: Contribution of MS to EU-KP recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	27	0.2	22	0.3	Revision of energy balance (mainly natural gas)
Belgium	-15	-0.1	35	0.1	Inventory optimized with final regional energy balances; Optimization of the model to calculate the off-road emissions (OFFREM-model) in the category 1A4b (households) and 1A4c (agriculture)
Bulgaria	-	-	-	-	
Croatia	0	0.0	0.1	0.0	Changes due to the use of Lubricant analysis project data
Cyprus	-0.0	-0.0	-	-	
Czechia	-	-	0.0	0.0	Updated activity data in CzSO balance
Denmark	-0.1	-0.0	3.1	0.1	For stationary combustion plants, the emission estimates for the years 1990-2018 have been updated according to the latest energy statistics published by the Danish Energy Agency.

	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
Estonia	-94	-5.0	289	63	Emissions were recalculated due to using Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, instead of national energy balance.
Finland	-3.5	-0.0	-1.9	-0.1	Errors in calculation sheet corrected
France	-5 611	-5.8	-7 303	-9.1	Constant improvement in the inclusion of energy balance data in the inventory (overall completeness, by fuel and breakdown by sector). In particular, the use of energy balance data distinguished between tertiary and residential and no longer based on CPDP data. Allocation of part of the consumption of 1A4a in 1A5 for consistency with the energy balance.
Germany	-57	-0.0	-572	-0.5	Updated 2018 activity data according to final energy balance Correction of LPG in mobile combustion also affecting stationary combustion
Greece	-	-	-	-	
Hungary	-112	-0.5	17	0.1	Latest energy statistics, reallocation of autoproducer plants
Ireland	-136	-1.4	458	5.2	Redistribution of oil & natural gas as a result of improved source data. Less oil & natural gas in 1A4a & an increase in oil within 1A4b within latest submission compared to last year's submission for 2018
Italy	321	0.4	359	0.5	Update of waste fuel consumption activity data in commercial sector
Latvia	76	1.4	-1.8	-0.1	Recalculated emissions from Coal after CO_2 emission factor correction
Lithuania	-	-	0.0	0.0	Correction of activity data based on information provided by Statistics Lithuania.
Luxembourg	-0.0	-0.0	-6.6	-0.4	Revision of AD: energy balance revised
Malta	-	-	0.7	0.6	Recalculations were performed due to an update of activity data for Fuel Oil, Kerosene and Biogas for year 2013 till 2018.
Netherlands	1.5	0.0	461	1.4	Final energy statistics and improved allocation biogenic part of natural gas
Poland	-	-	-965	-1.8	Update of the activity data according to Euroststdatabase
Portugal	-	-	-	-	
Romania	429	4.1	84	0.8	An error has been detected and solved in the context of the calculation file; this has resulted in the update of emissions.
Slovakia	-	-	-	-	
Slovenia	40	2.4	24	2.1	Inclusion of emissions from Fishing
Spain	-0.8	-0.0	135	0.4	Updated activity data and IEFs
Sweden	-179	-1.6	-106	-4.4	The consumption of diesel/gasoline in HBEFA (road traffic) has changed for the whole time series. This effects the residual distributed to NRMM and fishery, which has decreased. The effect is a lower fuel consumption and emissions in sub2021 compared to sub2020.
United Kingdom	0.0	0.0	1 025	1.1	Revisions to UK energy statistics for natural gas use in public sector and commercial sectors; also an update to the estimates of petroleum coke used (in SSF) in domestic combustion.
EU27+UK	**-5 315**	**-0.7**	**-6 044**	**-1.0**	
Iceland	-10	-1.3	0.2	0.0	Recalculations were done for this sector as a part of the activity data review for 1990-2002; Increase in 2018 emissions is due to revision in input data from the NEA
United Kingdom (KP)	15	0.0	1 046	1.1	Revisions to UK energy statistics for natural gas use in public sector and commercial sectors; also an update to the estimates of petroleum coke used (in SSF) in domestic combustion.
EU-KP	**-5 311**	**-0.7**	**-6 022**	**-1.0**	

Table 3.80 provides information on the contribution of Member States to EU-KP recalculations in CH_4 from 1.A.4. Other sectors for 1990 and 2018.

Table 3.80 1.A.4. Other Sectors: Contribution of MS to EU-KP recalculations in CH_4 for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	2.7	0.5	-2.9	-1.1	
Belgium	-0.1	-0.0	-0.5	-0.1	Inventory optimized with final regional energy balances; Optimization of the model to calculate the off-road emissions (OFFREM-model) in the category 1A4b (households) and 1A4c (agriculture)
Bulgaria	-	-	-	-	
Croatia	0.0	0.0	0.0	0.0	
Cyprus	0.0	0.0	3.2	54.1	
Czechia	-	-	-1.5	-0.2	Updated activity data in CzSO balance
Denmark	-0.0	-0.0	-16	-12.0	The consumption of firewood applied in residential plants have been recalculated in the Danish energy statistics for the years 2017 (-2510 TJ) and 2018 (-5585 TJ).
Estonia	10	9.9	4.2	3.3	Emissions were recalculated due to using Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, instead of national energy balance.
Finland	-0.0	-0.0	0.0	0.0	
France	-147	-3.1	-145	-12.1	Constant improvement in the inclusion of energy balance data in the inventory (overall completeness, by fuel and breakdown by sector). In particular, the use of energy balance data distinguished between tertiary and residential and no longer based on CPDP data. Allocation of part of the consumption of 1A4a in 1A5 for consistency with the energy balance.
Germany	2.0	0.0	50	4.9	Updated 2018 activity data according to final energy balance Correction of LPG in mobile combustion also affecting stationary combustion
Greece	-	-	-	-	
Hungary	-0.1	-0.0	1.0	0.2	Latest energy statistics
Ireland	-0.5	-0.1	30	20.3	Redistribution of oil & natural gas as a result of improved source data. Less oil & natural gas in 1A4a & an increase in oil within 1A4b within latest submission compared to last year's submission for 2018
Italy	-	-	-0.0	-0.0	
Latvia	-0.1	-0.1	-	-	
Lithuania	-	-	4.2	2.6	Correction of activity data for 2018
Luxembourg	0.0	0.0	0.2	1.3	Revision of AD: energy balance revised
Malta	-	-	-0.0	-0.1	Recalculations were performed due to an update of activity data for Fuel Oil, Kerosene and Biogas for year 2013 till 2018
Netherlands	-4.1	-0.7	37	2.7	Model update for NRMM, final energy statistics and new CH_4 Effor stoves
Poland	-	-	-84	-2.5	Update of the activity data according to Eurostst database
Portugal	-	-	-	-	
Romania	33	8.6	36	3.6	An error has been detected and solved in the context of the calculation file; this has been resulted in the update of emissions
Slovakia	0.0	0.0	30	16.6	An improvement in biomass consumption was included in current submission. The activity data were modified for years 2012 – 2018.
Slovenia	-0.1	-0.1	15	14	Inclusion of emissions from Fishing, small correction of NCV for biomass used in the residential sector.
Spain	-0.0	-0.0	-7.2	-0.7	Updated activity data and IEFs
Sweden	-0.1	-0.0	-1.1	-1.7	The consumption of diesel/gasoline in HBEFA (road traffic) has changed for the whole time series. This effects the residual distributed to NRMM and fishery, which has decreased. The effect is a lower fuel consumption and emissions in sub2021 compared to sub2020.
United Kingdom	0.1	0.0	5.4	0.5	Revisions to DUKES.
EU27+UK	-104	-0.5	-41	-0.2	
Iceland	-1.0	-34.8	0.0	0.0	Recalculations were done for this sector as a part of the activity data review for 1990-2002
United Kingdom (KP)	0.1	0.0	5.5	0.5	Revisions to DUKES.

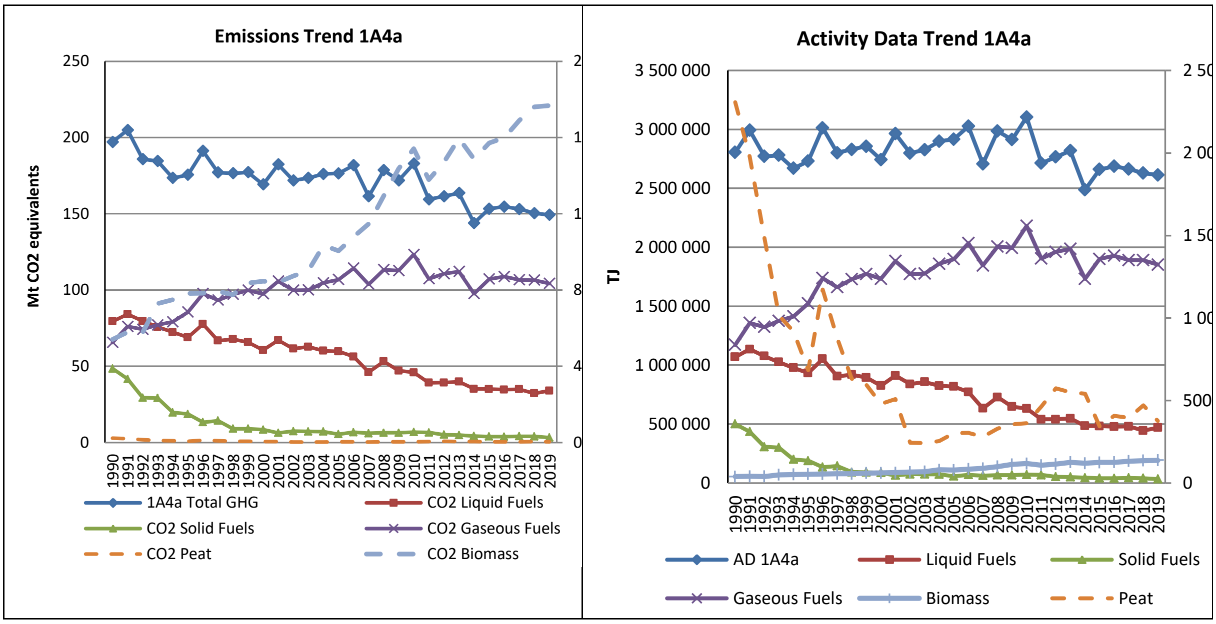
	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
EU-KP	-105	-0.5	-41	-0.2	

3.2.4.1 Commercial/Institutional (1.A.4.a)

CO_2 emissions from 1.A.4.a Commercial/Institutional accounted for 5% of total GHG emissions from 1.A Fuel Combustion in 2019. The subcategory 1.A.4.a. includes all combustion sources that utilize heat combustion for heating production halls and operational buildings in institutions, commercial facilities, services and trade.

Figure 3.143 shows the emission trend within the category 1.A.4.a, which is mainly dominated by CO_2 emissions from gaseous and liquid fuels. Between 1990 and 2019 CO_2 emissions decreased by 24% (see also the Table 3-70), mainly due to decreases in CO_2 emissions from solid (-93%) and liquid (-57%) fuels while CO_2 emissions from gaseous fuels increased by 59% and show a fluctuating trend since 2006. Between 2018 and 2019 the GHG emissions decreased by 1%, mainly driven by the decreases in solid fuels.

Figure 3.143 1.A.4.a Commercial/Institutional: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Main factors influencing CO_2 emissions from this source category are (1) outdoor temperature, (2) number and size of offices, (3) building codes, (4) thermal properties of building stock, (5) fuel split for heating and warm water, (6) use of renewable energy sources, e.g. biomass or solar panels, and (7) use of district heating. Fuel consumption in 1.A.4.a decreased by 7% between 1990 and 2019 and biomass consumption increased by 258%.

Germany, Italy, France and the United Kingdom contributed the most to the EU-KP CO_2 emissions from this source (66% together). Member States with the highest increases in absolute terms were Spain and Italy. The Member State with the highest reduction in absolute terms was Germany (Table 3.81).

Table 3.81 1.A.4.a Commercial/Institutional: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP	Change 1990-2019		Change 2018-2019		Method	Emission factor
	1990	2018	2019	Emissions in 2019	kt CO2	%	kt CO2	%		Informa-tion
Austria	2 292	1 364	1 400	0.9%	-892	-39%	36	3%	T1,T2	CS,D
Belgium	4 289	5 733	5 686	3.8%	1 397	33%	-47	-1%	T1	D
Bulgaria	3 117	314	312	0.2%	-2 805	-90%	-2	-1%	T1,T2	CS,D
Croatia	855	627	612	0.4%	-243	-28%	-15	-2%	T1	D
Cyprus	75	109	118	0.1%	42	56%	9	8%	T1	D
Czechia	9 907	2 778	2 942	2.0%	-6 965	-70%	164	6%	T1,T2	CS,D
Denmark	1 460	701	611	0.4%	-849	-58%	-90	-13%	M,T1,T2,T3	CS,D
Estonia	165	265	253	0.2%	88	53%	-13	-5%	T1,T2	CS,D
Finland	2 473	1 172	1 166	0.8%	-1 307	-53%	-6	-1%	T1,T2,T3	CS,D
France	26 238	21 681	21 282	14.4%	-4 956	-19%	-399	-2%	T1,T2	CS,D
Germany	64 111	29 826	32 635	22.1%	-31 477	-49%	2 809	9%	CS,T1,T2,T3	CS,D
Greece	519	683	734	0.5%	215	41%	51	7%	T1,T2	CS,D
Hungary	2 747	2 860	2 741	1.9%	-6	0%	-120	-4%	T1,T2	CS,D
Ireland	2 099	1 739	1 767	1.2%	-332	-16%	28	2%	T2	CS
Italy	11 902	24 931	24 561	16.6%	12 659	106%	-370	-1%	T2	CS
Latvia	2 726	385	359	0.2%	-2 367	-87%	-26	-7%	T1,T2	CS,D
Lithuania	3 059	363	316	0.2%	-2 743	-90%	-47	-13%	T2	CS
Luxembourg	639	589	689	0.5%	51	8%	100	17%	T1,T2	CS,D
Malta	165	72	74	0.0%	-91	-55%	2	3%	T1	D
Netherlands	8 297	7 464	7 183	4.9%	-1 114	-13%	-282	-4%	T2	CS,D
Poland	9 715	6 912	6 402	4.3%	-3 313	-34%	-510	-7%	T1,T2	CS,D
Portugal	704	1 213	1 134	0.8%	429	61%	-80	-7%	T1,T2	CS,D
Romania	NO	2 207	2 213	1.5%	2 213	∞	6	0%	T1,T2	CS
Slovakia	4 148	1 444	1 335	0.9%	-2 813	-68%	-109	-8%	T2	CS
Slovenia	623	329	336	0.2%	-288	-46%	7	2%	T1,T2	CS,D
Spain	3 811	12 468	10 558	7.1%	6 747	177%	-1 910	-15%	T1,T2	CS,D,OTH
Sweden	2 872	685	744	0.5%	-2 128	-74%	58	8%	T1,T2	CS
United Kingdom	25 402	19 953	19 690	13.3%	-5 712	-22%	-263	-1%	T2	CS
EU-27+UK	**194 407**	**148 870**	**147 850**	**100%**	**-46 557**	**-24%**	**-1 021**	**-1%**	**-**	**-**
Iceland	8	1	1	0.0%	-7	-85%	0	68%	T1	D
United Kingdom (KP)	25 472	19 981	19 720	13.3%	-5 752	-23%	-262	-1%	T2	CS
EU-KP	**194 485**	**148 899**	**147 881**	**100%**	**-46 605**	**-24%**	**-1 019**	**-1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4. a Commercial/Institutional – Liquid Fuels (CO_2)

In 2019 CO_2 emissions from liquid fuels had a share of 23% within source category 1.A.4.a (compared to 41% in 1990). Between 1990 and 2019, CO_2 emissions decreased by 57% (Table 3.82). Only four Member States increased the use of liquid fuels in the time series, the highest absolute increase is noted for Poland. It is important to note, however, that Poland hasn't been using the liquid fuels at the beginning of 90's. The highest absolute decreases were achieved in Germany and France. Generally, in number of Member States, there is apparent strong decrease from 2006 to 2007 due to low gasoil sales to end consumers. Many end consumers did not restock their oil tanks in 2007 because of high outdoor temperatures and rising oil prices. Additionally, end consumer gasoil stocks were comparatively high in 2007 due to a mild winter 2006. Between 2018 and 2019 EU-KP CO_2 emissions increased by 6%. According to the methodology as described in chapter 3.2.4 about 96% of EU-KP emissions are calculated by using higher tier methods in 2019.

Table 3.82 1.A.4.a Commercial/Institutional, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	1 420	502	501	1.5%	-919	-65%	-2	0%	T2	T2
Belgium	2 315	1 263	1 200	3.5%	-1 114	-48%	-63	-5%	T1	T1
Bulgaria	2 986	77	89	0.3%	-2 897	-97%	12	16%	T1	T1
Croatia	526	152	122	0.4%	-404	-77%	-31	-20%	T1	T1
Cyprus	75	109	118	0.3%	42	56%	9	8%	T1	T1
Czechia	2 000	43	40	0.1%	-1 960	-98%	-3	-7%	T1	T1
Denmark	1 055	270	168	0.5%	-887	-84%	-102	-38%	T1,T2	T1,T2
Estonia	140	85	79	0.2%	-61	-43%	-6	-7%	-	-
Finland	2 423	1 103	1 091	3.2%	-1 332	-55%	-12	-1%	T2	T2
France	16 363	7 255	7 041	20.7%	-9 321	-57%	-213	-3%	-	-
Germany	28 138	10 335	13 060	38.4%	-15 078	-54%	2 725	26%	CS	CS
Greece	499	346	361	1.1%	-138	-28%	15	4%	T2	T2
Hungary	1 124	108	102	0.3%	-1 022	-91%	-6	-6%	T1	T1
Ireland	1 737	775	779	2.3%	-958	-55%	4	0%	T2	T2
Italy	1 530	1 524	1 455	4.3%	-75	-5%	-69	-5%	-	-
Latvia	1 017	97	65	0.2%	-952	-94%	-32	-33%	T2	T2
Lithuania	1 166	12	7	0.0%	-1 159	-99%	-4	-38%	T2	T2
Luxembourg	469	352	439	1.3%	-30	-6%	87	25%	T2	T2
Malta	165	72	74	0.2%	-91	-55%	2	3%	T1	T1
Netherlands	438	390	391	1.2%	-46	-11%	1	0%	T2	T2
Poland	IE,NO	1 355	1 230	3.6%	1 230	∞	-125	-9%	T1,T2	T1,T2
Portugal	704	425	387	1.1%	-317	-45%	-38	-9%	T1	T1
Romania	NO	299	314	0.9%	314	∞	15	5%	T1,T2	T1,T2
Slovakia	384	25	25	0.1%	-358	-93%	0	2%	T2	T2
Slovenia	391	288	271	0.8%	-120	-31%	-18	-6%	T1	T1
Spain	3 284	3 849	3 572	10.5%	288	9%	-277	-7%	T2	T2
Sweden	2 786	488	491	1.4%	-2 295	-82%	3	1%	-	-
United Kingdom	6 188	558	510	1.5%	-5 677	-92%	-47	-8%	T2	T2
EU-27+UK	**79 321**	**32 156**	**33 980**	**100%**	**-45 340**	**-57%**	**1 825**	**6%**		
Iceland	8	1	1	0.0%	-7	-85%	0	68%	T1	T1
United Kingdom (KP)	6 257	585	539	1.6%	-5 718	-91%	-46	-8%	T2	T2
EU-KP	**79 398**	**32 184**	**34 010**	**100%**	**-45 387**	**-57%**	**1 827**	**6%**		

Notes: From 1990 to 1993 Poland does not report any liquid fuels for stationary sources and reports liquid fuels from 'Off-road vehicles and other machinery' under category 1A3 and therefore the notation key 'IE, NO' is reported. Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.144 and Figure **3.145** show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany, France, Spain, Italy, Poland and Belgium; together they cause 81% of the CO_2 emissions from liquid fuels in 1.A.4.a. Fuel consumption decreased by 56% between 1990 and 2019. The CO_2 implied emission factor for liquid fuels was 72.51 t/TJ in 2019.

Figure 3.144 1.A.4.a Commercial/Institutional, liquid fuels: Emission trend and share for CO_2

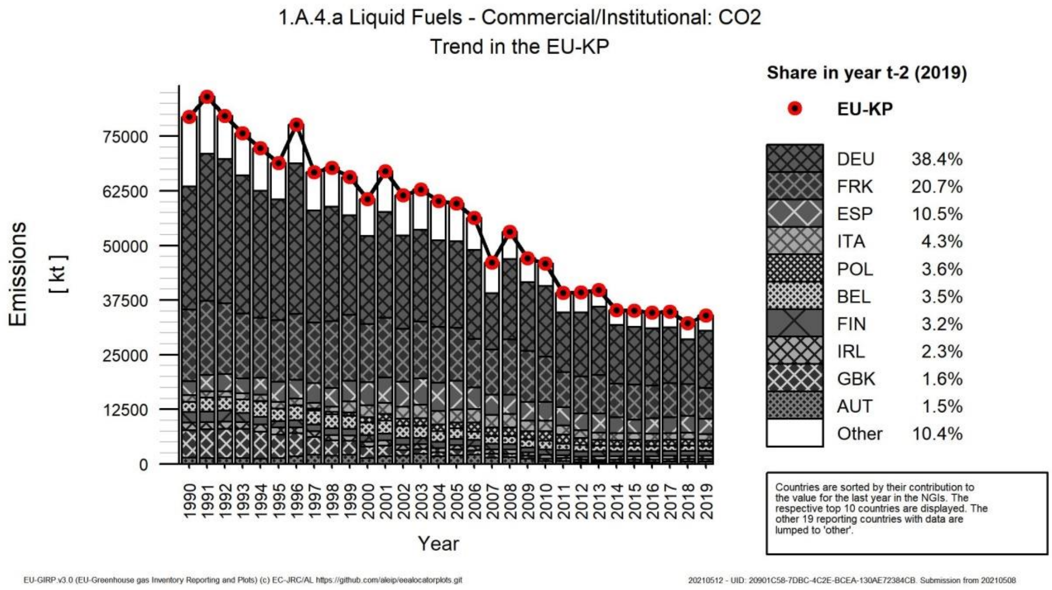
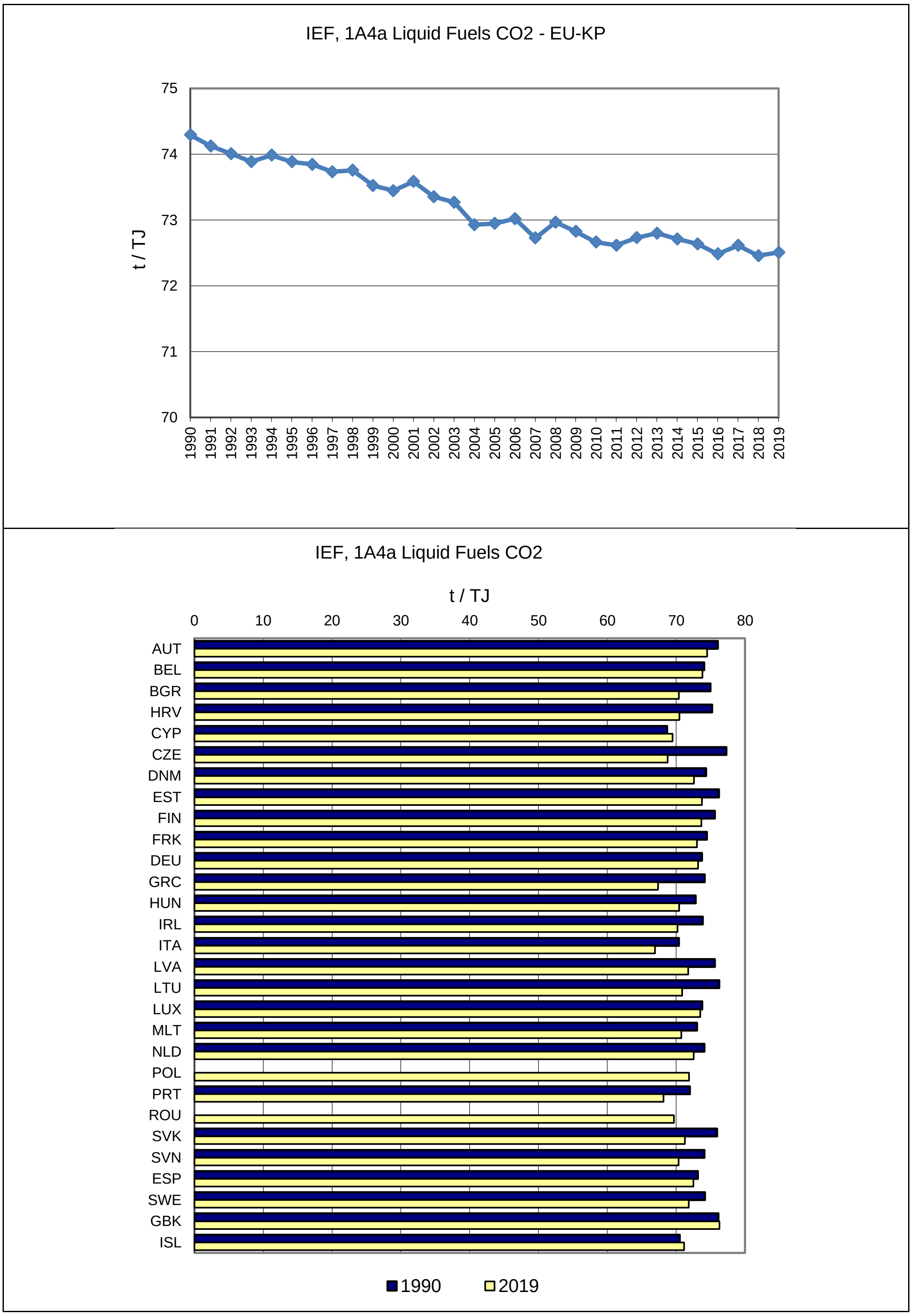


Figure 3.145 1.A.4.a Commercial/Institutional, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.a Commercial/Institutional – Solid Fuels (CO_2)

In 2019, CO_2 from solid fuels had a share of 2% within source category 1.A.4.a (compared to 25% in 1990). Between 1990 and 2019 CO_2 emissions decreased by 93% (Table 3.83). Twelve Member States and Iceland report emissions as 'Not occurring' or 'Included elsewhere' in 2019; all other Member States reduced emissions between 1990 and 2019 except Spain and Romania. Between 2018 and 2019

CO_2 emissions decreased by 19%. According to the methodology as described in chapter 3.2.1 about nearly 100% of EU-KP emissions are calculated by using higher tier methods in 2019.

Table 3.83 1.A.4.a Commercial/Institutional, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	91	NO	NO	-	-91	-100%	-	-	NA	NA
Belgium	9	0	0	0.0%	-9	-100%	0	0%	T1	T1
Bulgaria	89	10	15	0.5%	-74	-83%	5	48%	T1,T2	T1,T2
Croatia	88	0	NO,IE	-	-88	-100%	0	-100%	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	6 237	91	111	3.4%	-6 127	-98%	19	21%	T2	T2
Denmark	8	NO	NO	-	-8	-100%	-	-	NA	NA
Estonia	NO	4	4	0.1%	4	∞	0	-9%	-	-
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	1 938	150	144	4.5%	-1 794	-93%	-6	-4%	-	-
Germany	22 426	68	6	0.2%	-22 420	-100%	-62	-92%	CS	CS
Greece	20	NO,IE	NO,IE	-	-20	-100%	-	-	NA	NA
Hungary	475	6	6	0.2%	-469	-99%	0	-2%	T1,T2	T1,T2
Ireland	3	2	2	0.1%	0	-16%	0	0%	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	-	-
Latvia	1 366	16	13	0.4%	-1 353	-99%	-3	-20%	T2	T2
Lithuania	1 173	146	113	3.5%	-1 060	-90%	-33	-23%	T2	T2
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	101	8	9	0.3%	-93	-91%	1	13%	T2	T2
Poland	8 881	2 414	2 023	63.1%	-6 858	-77%	-391	-16%	T1,T2	T1,T2
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	2	1	0.0%	1	∞	-1	-45%	T2	T2
Slovakia	1 729	267	323	10.1%	-1 406	-81%	56	21%	T2	T2
Slovenia	203	NO	NO	-	-203	-100%	-	-	-	-
Spain	147	683	350	10.9%	204	139%	-333	-49%	T2	T2
Sweden	NO	NO	NO	-	-	-	-	-	-	-
United Kingdom	3 498	104	87	2.7%	-3 412	-98%	-17	-17%	T2	T2
EU-27+UK	**48 483**	**3 973**	**3 207**	**100%**	**-45 276**	**-93%**	**-766**	**-19%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 499	105	88	2.7%	-3 412	-97%	-17	-17%	T2	T2
EU-KP	**48 484**	**3 974**	**3 208**	**100%**	**-45 276**	**-93%**	**-766**	**-19%**		

Greece reports emissions from stationary combustion as 'NO' and emissions from mobile sources as 'IE'
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.146 and Figure 3.147 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Poland, Spain and Slovakia; together they cause 84% of the CO_2 emissions from solid fuels in 1.A.4.a. Fuel consumption in the EU27+UK decreased by 93% between 1990 and 2019. The CO_2 implied emission factor for solid fuels was 96.01 t/TJ in 2019. The comparatively low IEFs of Spain and Greece in 1990 are due to a high share of gas works gas consumption in the 1990s.

Figure 3.146 1.A.4.a Commercial/Institutional, solid fuels: Emission trend and share for CO_2

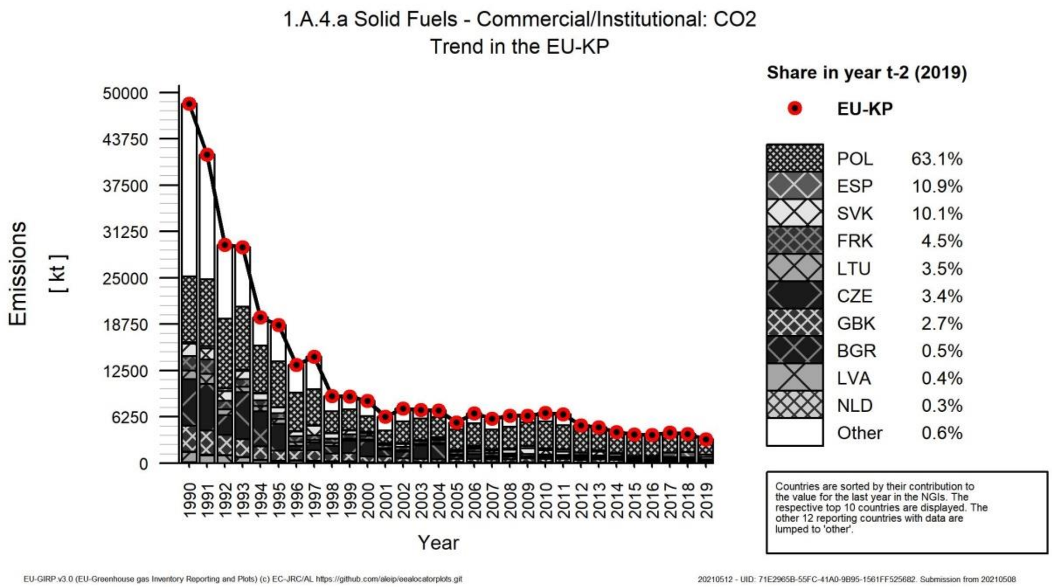
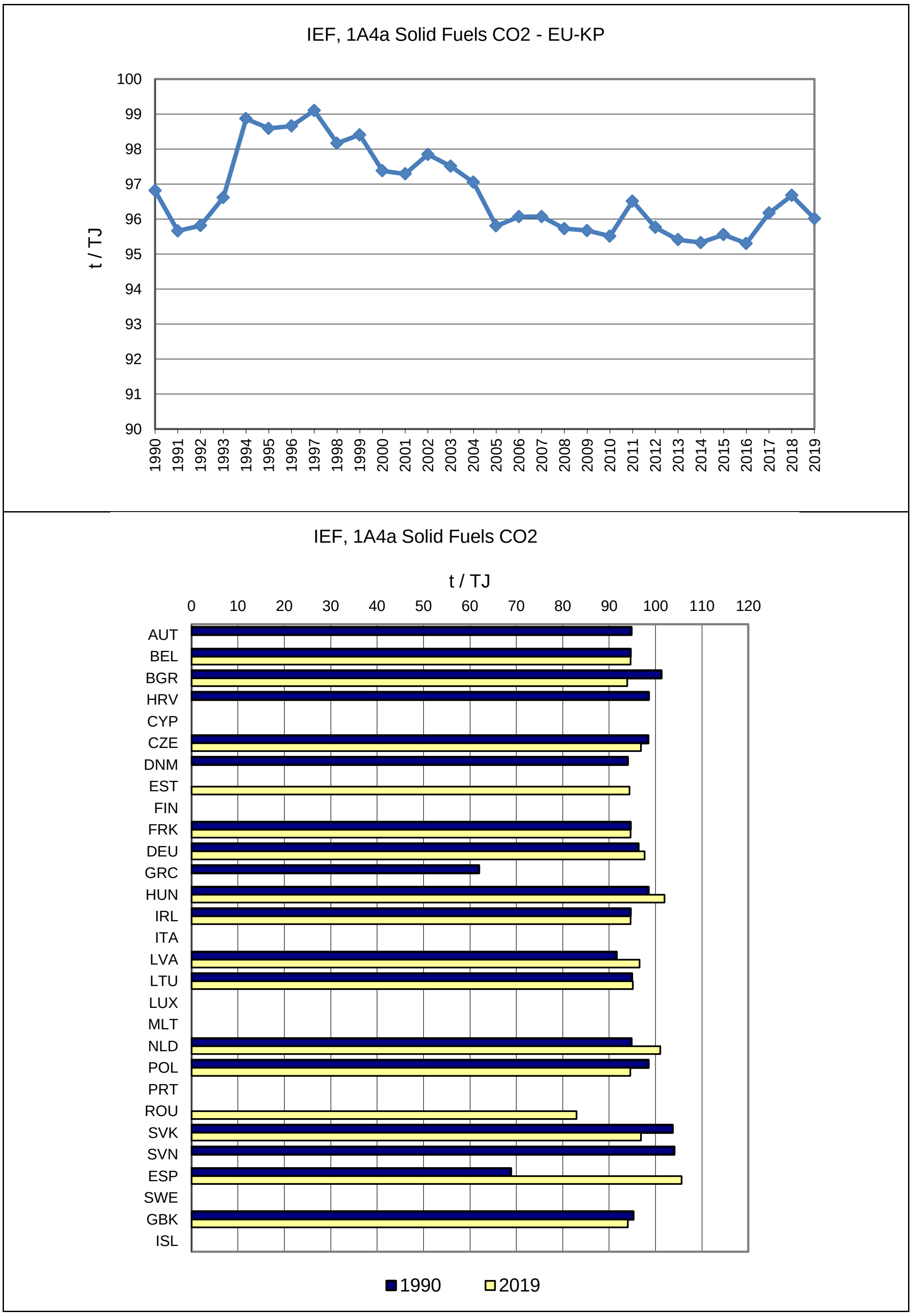


Figure 3.147 1.A.4.a Commercial/Institutional, solid fuels: of Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.a Commercial/Institutional – Gaseous Fuels (CO_2)

In 2019 CO_2 from gaseous fuels had a share of 71% within source category 1.A.4.a (compared to 34% in 1990). Between 1990 and 2019, the emissions increased by 59% (Table 3.84). All Member States except Lithuania, the Netherlands and Slovakia reported increasing emissions. The highest absolute increases occurred in Italy, Spain, France and Germany. Between 2018 and 2019 CO_2 emissions decreased by 2%. According to the methodology as described in chapter 3.2.4 about 95% of EU-KP emissions are calculated by using higher tier methods in 2019.

Table 3.84 1.A.4.a Commercial/Institutional, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	698	855	892	0.9%	194	28%	37	4%	T2	T2
Belgium	1 936	4 344	4 374	4.2%	2 437	126%	29	1%	T1	T1
Bulgaria	42	227	209	0.2%	166	396%	-19	-8%	T2	T2
Croatia	241	475	490	0.5%	250	104%	16	3%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 670	2 644	2 791	2.7%	1 121	67%	148	6%	T2	T2
Denmark	363	431	443	0.4%	80	22%	11	3%	T3	T3
Estonia	19	176	170	0.2%	151	810%	-7	-4%	-	-
Finland	37	59	65	0.1%	27	73%	6	10%	T2	T2
France	7 937	14 273	14 094	13.5%	6 156	78%	-180	-1%	-	-
Germany	13 547	19 422	19 568	18.8%	6 021	44%	146	1%	CS	CS
Greece	IE,NO	337	373	0.4%	373	∞	36	11%	T2	T2
Hungary	1 148	2 589	2 475	2.4%	1 327	116%	-114	-4%	T2	T2
Ireland	223	962	986	0.9%	763	341%	24	3%	T2	T2
Italy	9 842	17 561	17 101	16.4%	7 259	74%	-460	-3%	-	-
Latvia	276	269	279	0.3%	3	1%	11	4%	T2	T2
Lithuania	708	170	169	0.2%	-539	-76%	-1	-1%	T2	T2
Luxembourg	170	238	250	0.2%	81	48%	13	5%	T2	T2
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	7 758	7 065	6 781	6.5%	-977	-13%	-284	-4%	T2	T2
Poland	762	3 117	3 124	3.0%	2 363	310%	7	0%	T2	T2
Portugal	NO	788	747	0.7%	747	∞	-41	-5%	T2	T2
Romania	NO	1 894	1 886	1.8%	1 886	∞	-8	0%	T2	T2
Slovakia	2 035	1 153	987	0.9%	-1 048	-52%	-166	-14%	T2	T2
Slovenia	29	41	65	0.1%	36	124%	25	60%	-	#NV
Spain	381	7 936	6 636	6.4%	6 255	1644%	-1 300	-16%	T2	T2
Sweden	86	192	251	0.2%	165	192%	60	31%	-	-
United Kingdom	15 716	19 291	19 093	18.3%	3 377	21%	-199	-1%	T2	T2
EU-27+UK	**65 622**	**106 508**	**104 298**	**100%**	**38 676**	**59%**	**-2 211**	**-2%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	15 716	19 291	19 093	18.3%	3 377	21%	-199	-1%	T2	T2
EU-KP	**65 622**	**106 508**	**104 298**	**100%**	**38 676**	**59%**	**-2 211**	**-2%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.148 and Figure 3.149 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany, the United Kingdom, Italy, France, the Netherlands, Spain and Belgium; together they cause 84% of the CO_2 emissions from gaseous fuels in 1.A.4.a. Fuel combustion increased by 58% between 1990 and 2019. The CO_2 implied emission factor for gaseous fuels was 56.31 t/TJ in 2019.

Figure 3.148 1.A.4.a Commercial/Institutional, gaseous fuels: Emission trend and share for CO_2

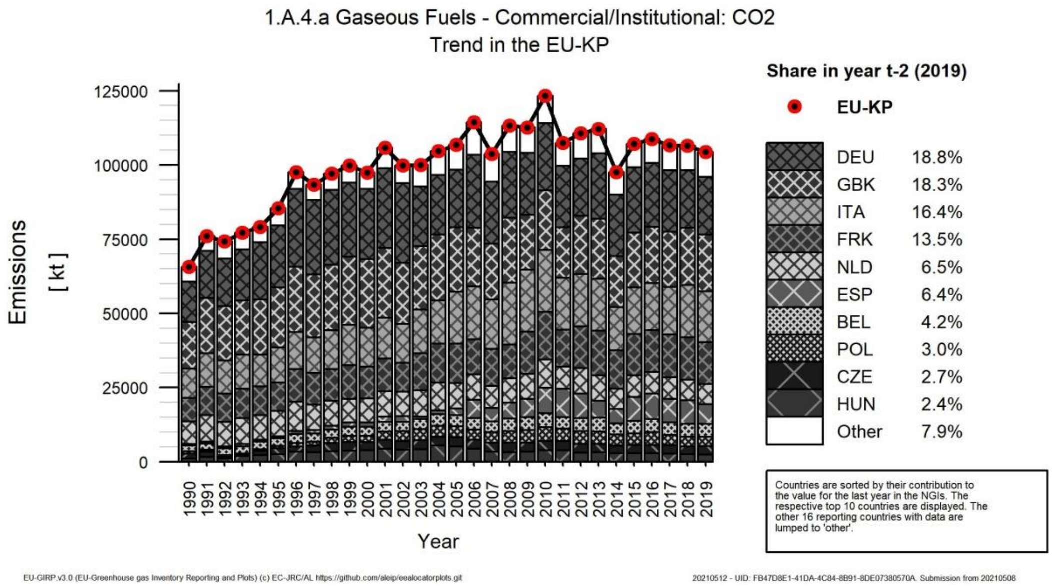
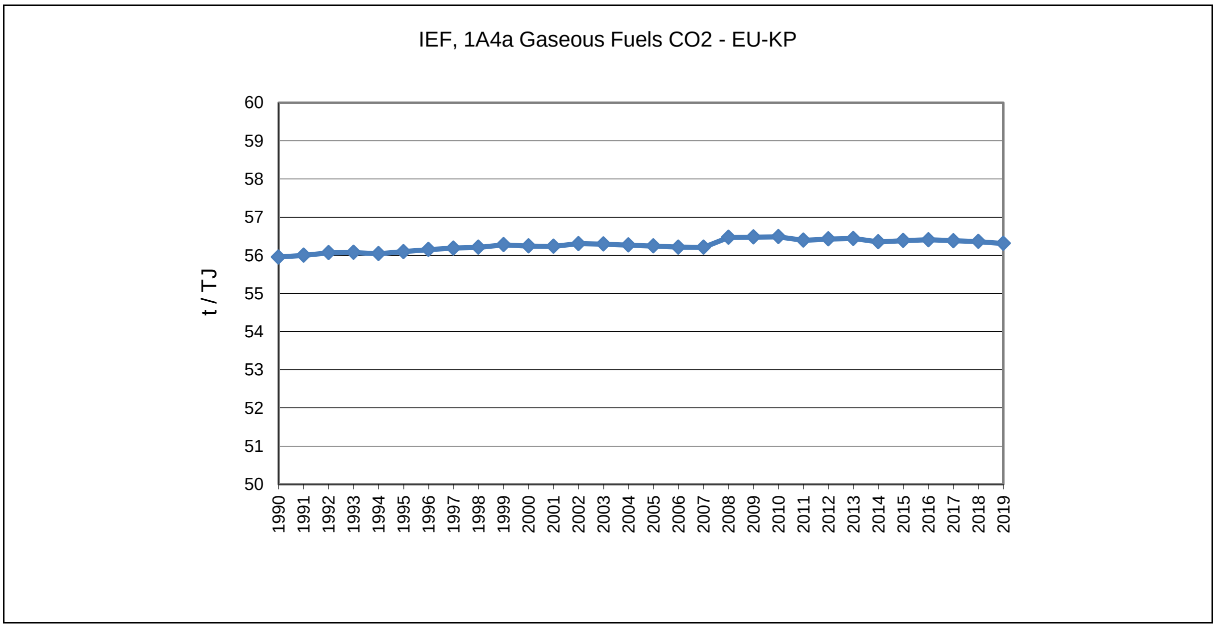
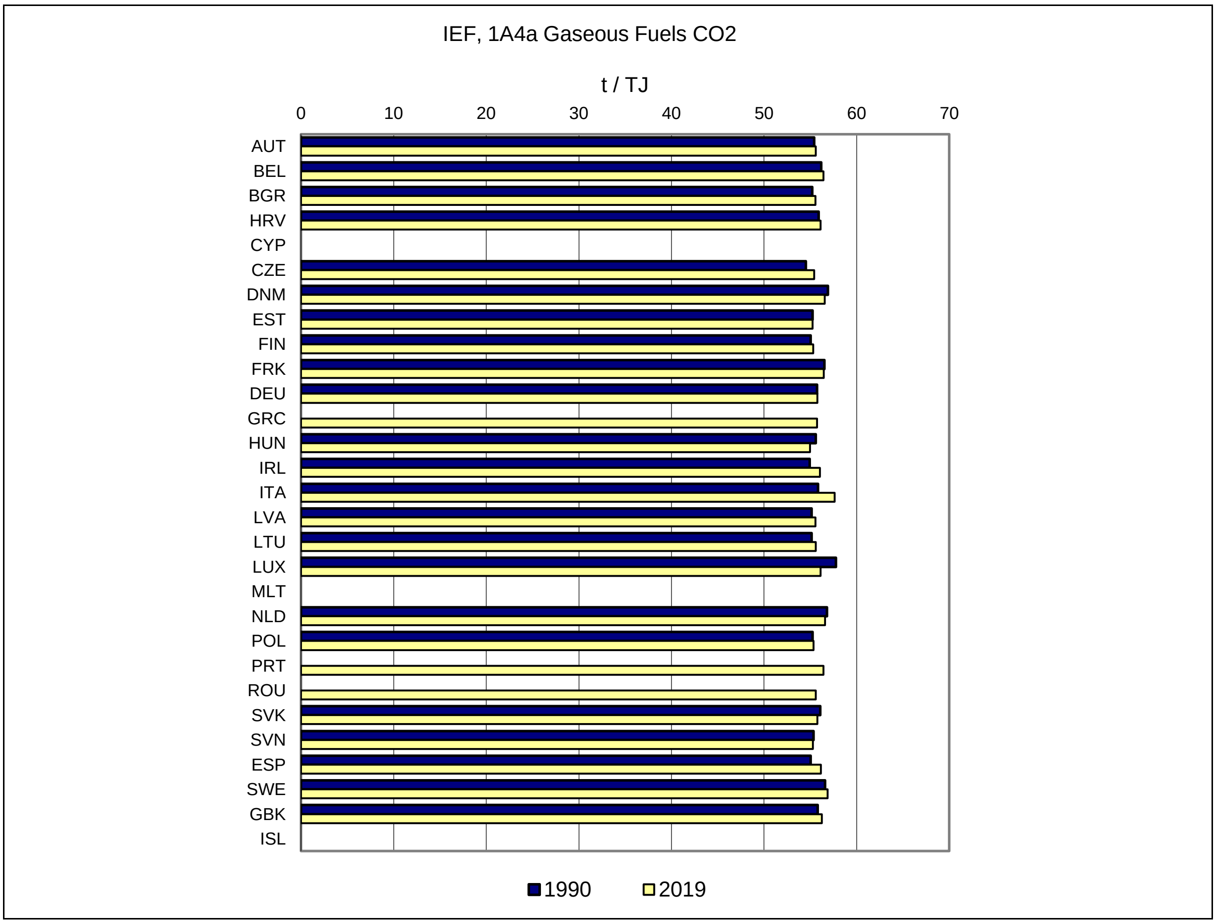


Figure 3.149 1.A.4.a Commercial/Institutional, gaseous fuels: Overview of outliers of Implied Emission Factors for CO_2 (in t/TJ)





1.A.4.a Commercial/Institutional – Other Fossil Fuels (CO_2)

Under this key category Member States report CO_2 emissions from waste incineration plants with energy recovery, whose main economic activity is the treatment of waste (as opposed to waste incineration plants with energy recovery whose main economic activity is power and heat production; these are reported under 1A1a).

In 2019, CO_2 from other fossil fuels had a share of 4% within category 1.A.4.a. Between 1990 and 2019 CO_2 increased by 745% (Table 3.85). Fifteen Member States, the United Kingdom and Iceland report emissions as 'Not occurring' in 2019; between 2018 and 2019 CO_2 increased by 2%. Level of emissions is strongly driven by Italy. In this category, Italy includes all emissions due to the non-renewable part of wastes used in electricity generation. According to the methodology as described in chapter 3.2.4 about 98% of EU-KP emissions are calculated by using higher tier methods in 2019.

Table 3.85: 1.A.4.a Commercial/Institutional, other fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	83	7	7	0.1%	-76	-92%	0	8%	T2	T2
Belgium	29	126	112	1.8%	83	285%	-14	-11%	T1	T1
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	34	NO	NO	-	-34	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	-	-
Finland	0	NO	NO	-	0	-100%	-	-	NA	NA
France	NO	3	3	0.1%	3	∞	0	6%	-	-
Germany	NO	1	1	0.0%	1	∞	0	-2%	NA	NA
Greece	IE,NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Hungary	NO	157	157	2.5%	157	∞	1	0%	T2	T2
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	530	5 846	6 004	94.9%	5 475	1033%	159	3%	-	-
Latvia	NO	0	0	0.0%	0	∞	0	-50%	T1	T1
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	1	1	0.0%	1	∞	0	6%	NA	NA
Poland	72	26	25	0.4%	-47	-65%	-1	-6%	T1	T1
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	11	12	0.2%	12	∞	0	1%	T2	T2
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	-
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	NO	6	2	0.0%	2	∞	-4	-68%	-	-
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-27+UK	**748**	**6 184**	**6 325**	**100%**	**5 577**	**745%**	**141**	**2%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**748**	**6 184**	**6 325**	**100%**	**5 577**	**745%**	**141**	**2%**		

Greece reports emissions from stationary combustion as 'NO' and emissions from mobile sources as 'IE'

Figure 3.151 shows CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) corresponds to Italy; it causes 95% of the CO_2 emissions from other fossil fuels in 1.A.4.a. The CO_2 implied emission factor for other fossil fuels was 95.62 t/TJ in 2019. The comparatively high implied emission factor is a calculated value from a mass balance calculation method and data from energy statistics.

Figure 3.150 1.A.4.a Commercial/Institutional, other fuels: Emission trend and share for CO_2

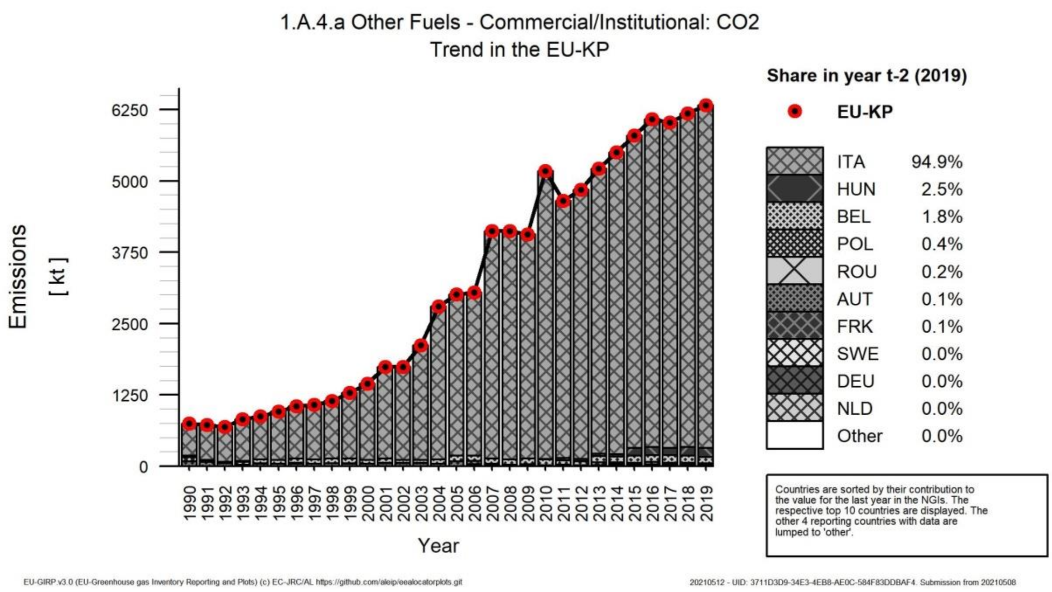
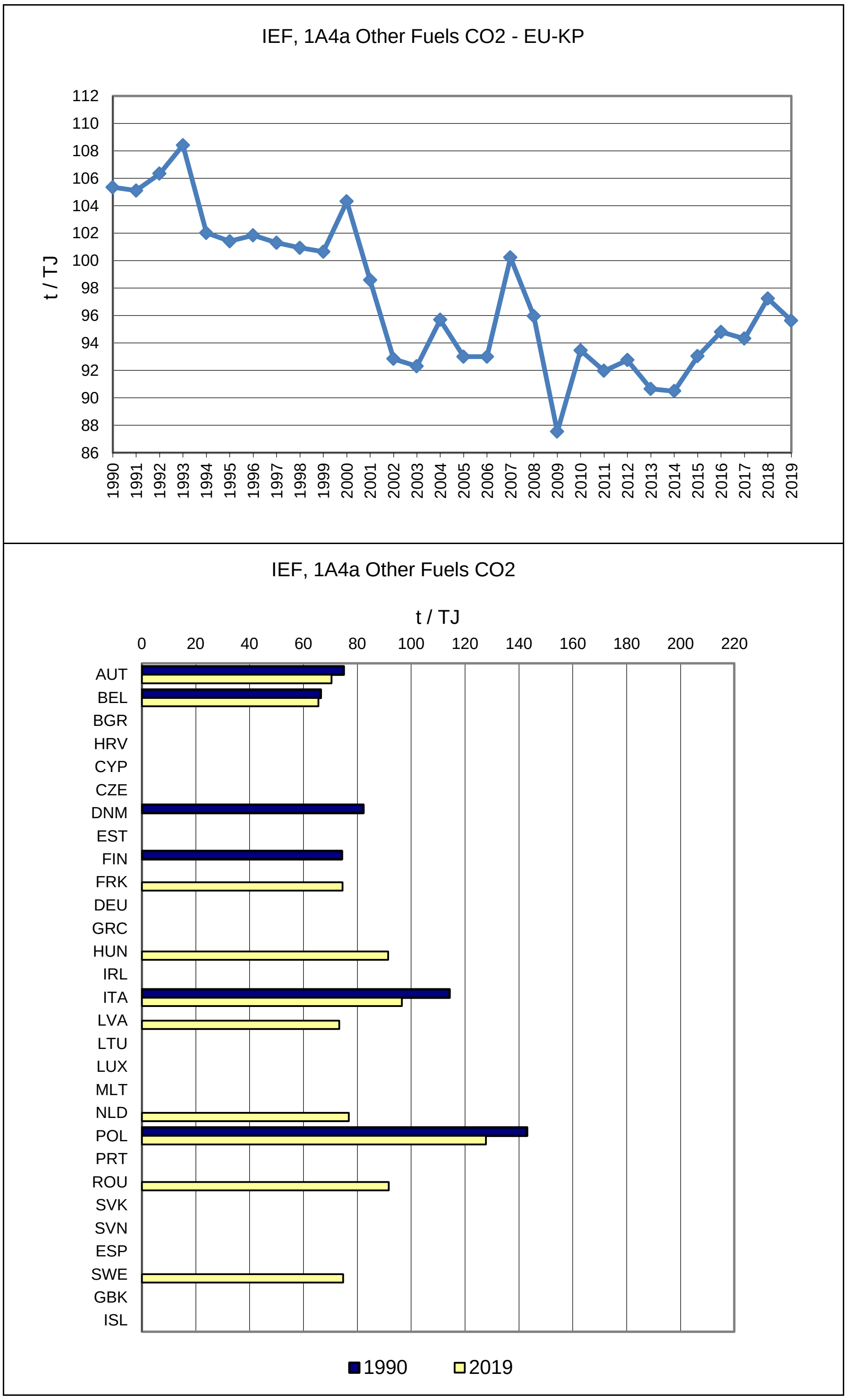


Figure 3.151 1.A.4.a Commercial/Institutional, other fuels: Overview of outliers of Implied Emission Factors for CO_2 (in t/TJ)



3.2.4.2 Residential (1.A.4.b)

CO_2 emissions from 1.A.4.b Residential account for 12% of total GHG emissions from 1A Fuels Combustion in 2019.

Figure 3.152 shows the emission trend within the category 1.A.4.b, which is mainly dominated by CO_2 emissions from gaseous and liquid fuels. Total GHG emissions decreased by 27% since 1990, although

CO_2 emissions from gaseous fuels increased strongly (+31%) which was counterbalanced by decreasing emissions from liquid and solid fuels. From 2018 to 2019 CO_2 emissions decreased by 2% and energy consumption decreased by 1% which is correlating with the trend in EU-27 heating degree days (-1%). Biomass consumption reached a share of 23% in the year 2019 (in 1.A.4.b) while the share of solid fossil fuels consumption dropped to 4%.

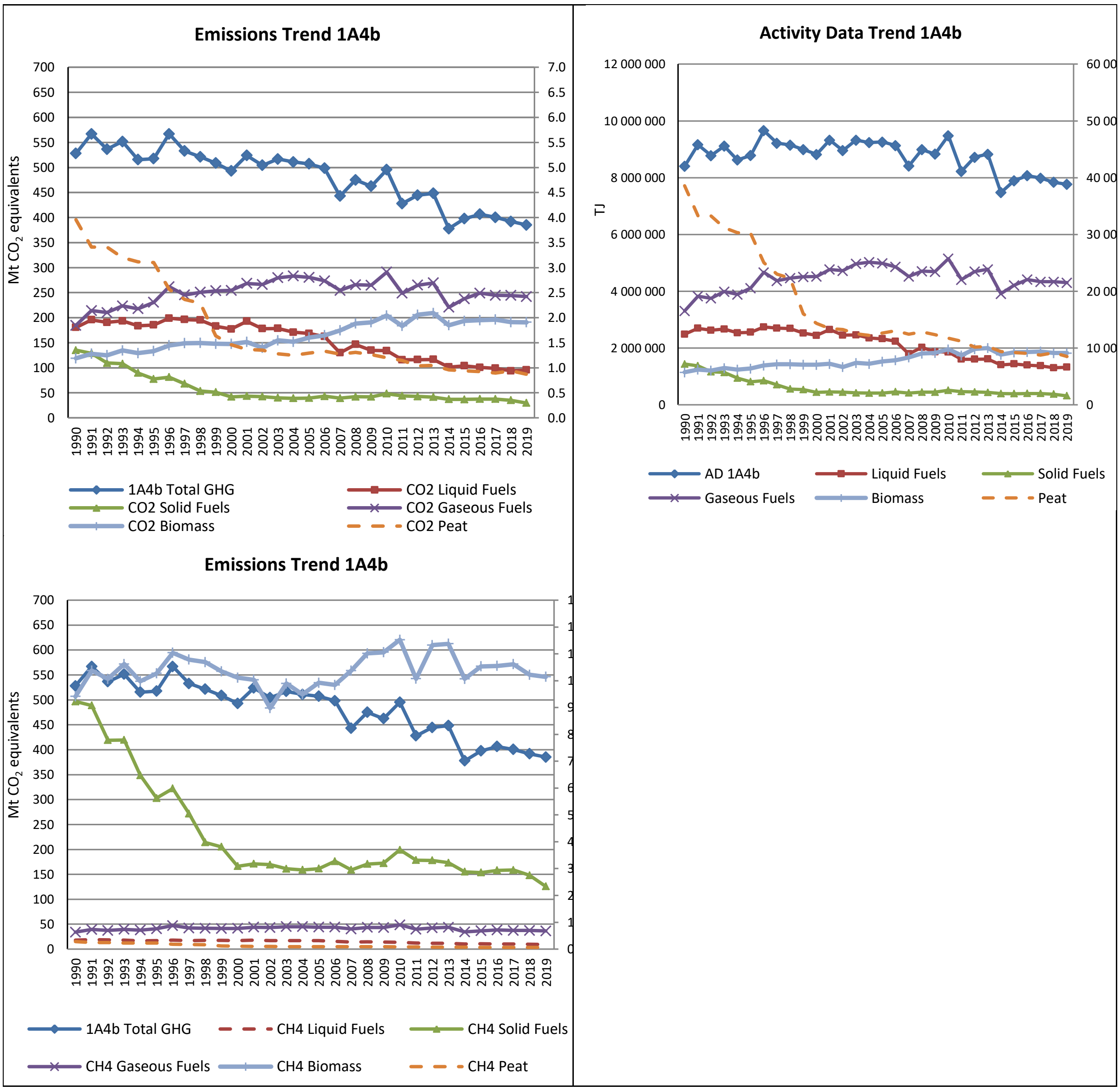
Trend in fuel consumption is usually decreasing, although some of the Member States have a slight increase for 1.A.4.b in 2019. Same trend is apparent for heating degree days, where more than half of the Member States also experienced decreasing trend. The following Table **3.86: EU-27 heating degree days 2018 and** 2019 and 1.A.4.b trend in total fuel consumption. presents the (15°/18°) heating degree days in 2018 and 2019 for Member States and trend in 1.A.4.b total fuel consumption.

Table 3.86: EU-27 heating degree days 2018 and 2019 and 1.A.4.b trend in total fuel consumption.

	2018	2019	Trend 2018 – 2019 [%]	Trend fuel consumption 1.A.4.b [%]
Austria	3194	3280	3	3
Belgium	2511	2532	1	-3
Bulgaria	2352	2153	-8	-7
Croatia	2140	2076	-3	-4
Cyprus	471	693	47	15
Czechia	2996	2998	0	-7
Denmark	3049	3027	-1	-4
Estonia	4065	3883	-4	-3
Finland	5350	5483	2	-8
France	2182	2247	3	-3
Germany	2775	2801	1	4
Greece	1372	1449	6	12
Hungary	2469	2381	-4	-2
Ireland	2754	2707	-2	-6
Italy	1747	1814	4	-3
Latvia	3862	3623	-6	-6
Lithuania	3688	3391	-8	-2
Luxembourg	2667	2754	3	-7
Malta	366	515	41	3
Netherlands	2529	2514	-1	-6
Poland	3123	2952	-5	-8
Portugal	1307	1109	-15	2
Romania	2748	2568	-7	1
Slovakia	2924	2899	-1	1
Slovenia	2580	2601	1	-2
Spain	1797	1671	-7	-2
Sweden	5122	5120	0	1
EU27 (weighted)	2941	2909	-1	-1

Source: Eurostat and EEA 2020

Figure 3.152 1.A.4.b Residential: Total, CO_2 and CH_4 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

CO_2 emissions from 1.A.4.b Residential

Between 1990 and 2019, CO_2 emissions from households decreased by 27% in the EU-KP (Table 3.87). Main factors influencing CO_2 emissions from this source category are (1) outdoor temperature, (2) number and size of dwellings, (3) building codes, (4) thermal properties of building stock, (5) fuel split for heating and warm water, (6) use of renewable energy sources, e.g. biomass or solar panels, and (7) the use of district heating. Fuel consumption of households decreased by 8% between 1990 and 2019, with a fuel shift from coal and oil to natural gas and biomass. Overall, the recently mild winters are apparent on the lower amount of fuel combustion.

Between 1990 and 2019, the largest CO_2 reduction in absolute terms was reported by Germany. Only four Member States show increases in their emissions. One reason for the performance of the Nordic countries is increased use of district heating. As district heating replaces heating boilers in households, an increase in the share of district heating reduces CO_2 emissions from households (but increases emissions from energy industries if fossil fuels are used). In Germany, efficiency improvements and the fuel switch in eastern German households are two reasons for the emission reductions. Between 2018 and 2019 the largest absolute increase in the emissions is reported by Greece which contribute to total EU-KP emissions with 1%.

Table 3.87 1.A.4.b Residential: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	10 000	6 222	6 422	1.7%	-3 578	-36%	200	3%	T1,T2	CS,D
Belgium	20 483	16 258	15 804	4.3%	-4 679	-23%	-454	-3%	CS,T1,T3	D
Bulgaria	2 887	674	617	0.2%	-2 270	-79%	-57	-8%	T1,T2	CS,D
Croatia	2 029	1 478	1 401	0.4%	-628	-31%	-77	-5%	T1	D
Cyprus	300	284	328	0.1%	28	9%	44	15%	T1	D
Czechia	18 375	8 115	7 486	2.0%	-10 889	-59%	-630	-8%	T1,T2	CS,D
Denmark	4 988	1 851	1 761	0.5%	-3 227	-65%	-91	-5%	M,T1,T2,T3	CS,D
Estonia	1 024	172	164	0.0%	-860	-84%	-7	-4%	T1,T2	CS,D
Finland	3 148	1 111	1 024	0.3%	-2 124	-67%	-87	-8%	T1,T2,T3	CS,D
France	53 199	41 238	39 932	10.8%	-13 267	-25%	-1 306	-3%	T1,T2	CS,D
Germany	128 636	84 566	88 719	24.1%	-39 917	-31%	4 152	5%	CS,T1,T2	CS
Greece	4 654	3 973	4 461	1.2%	-193	-4%	488	12%	T1,T2	CS,D
Hungary	15 700	7 404	7 153	1.9%	-8 547	-54%	-251	-3%	T1,T2	CS,D
Ireland	7 050	6 860	6 374	1.7%	-675	-10%	-485	-7%	T2	CS
Italy	55 788	46 382	44 642	12.1%	-11 146	-20%	-1 740	-4%	T2	CS
Latvia	1 182	466	435	0.1%	-748	-63%	-31	-7%	T1,T2	CS,D
Lithuania	2 361	770	735	0.2%	-1 626	-69%	-35	-5%	T2	CS
Luxembourg	670	1 029	941	0.3%	271	40%	-88	-9%	T1,T2	CS,D
Malta	95	40	42	0.0%	-53	-56%	1	3%	T1	D
Netherlands	20 733	16 348	15 422	4.2%	-5 311	-26%	-925	-6%	T1,T2	CS,D
Poland	35 222	34 306	30 753	8.3%	-4 470	-13%	-3 553	-10%	T1,T2	CS,D
Portugal	1 640	1 784	1 816	0.5%	176	11%	32	2%	T1,T2	CS,D
Romania	8 853	6 767	6 824	1.9%	-2 029	-23%	57	1%	T1,T2	CS,D
Slovakia	6 773	2 809	2 841	0.8%	-3 932	-58%	32	1%	T2	CS
Slovenia	896	630	621	0.2%	-276	-31%	-10	-2%	T1,T2	CS,D
Spain	12 802	14 682	14 168	3.8%	1 366	11%	-515	-4%	T2	CS,D,OTH
Sweden	6 296	466	472	0.1%	-5 824	-93%	6	1%	T1,T2	CS
United Kingdom	78 227	67 261	66 476	18.0%	-11 751	-15%	-785	-1%	T1,T2,T3	CS,D
EU-27+UK	**504 012**	**373 947**	**367 833**	**100%**	**-136 179**	**-27%**	**-6 115**	**-2%**	**-**	**-**
Iceland	28	7	7	0.0%	-21	-75%	0	-5%	T1	D
United Kingdom (KP)	78 482	67 711	66 932	18.2%	-11 550	-15%	-779	-1%	T1,T2,T3	CS,D
EU-KP	**504 295**	**374 405**	**368 295**	**100%**	**-136 000**	**-27%**	**-6 109**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4.b Residential – Liquid Fuels (CO_2)

In 2019 CO_2 from liquid fuels had a share of 26% within source category 1.A.4.b (compared to 36% in 1990). Between 1990 and 2019, emissions decreased by 47% (Table 3.88). Italy, Germany and France show the highest absolute decreases. Only three Member States and the United Kingdom reported increasing emissions since 1990. Between 2018 and 2019 EU-KP CO_2 emissions increased by 2%. The strong decrease from 2006 to 2007 for Germany is due to low gasoil sales to end consumers. Many end consumers did not restock their oil tanks in 2007 because of high outdoor temperatures and rising oil prices. Additionally, end consumer gasoil stocks were comparatively high in 2007 due to a mild winter 2006. It is assumed that the circumstances were similar for other MS (e.g. Austria). According to the methodology as described in chapter 3.2.4 about 99% of EU-KP emissions are calculated by using higher tier methods in 2019.

Table 3.88 1.A.4.b Residential, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	5 633	3 029	3 062	3.2%	-2 571	-46%	33	1%	T2	T2
Belgium	12 805	8 275	7 952	8.3%	-4 853	-38%	-323	-4%	T1	T1
Bulgaria	158	58	52	0.1%	-105	-67%	-6	-10%	T1	T1
Croatia	1 137	372	313	0.3%	-824	-72%	-59	-16%	T1	T1
Cyprus	300	284	328	0.3%	28	9%	44	15%	-	-
Czechia	239	145	130	0.1%	-109	-46%	-15	-10%	T1	T1
Denmark	3 928	489	446	0.5%	-3 482	-89%	-43	-9%	T1,T2	T1,T2
Estonia	247	40	26	0.0%	-221	-89%	-14	-35%	-	-
Finland	3 024	1 039	949	1.0%	-2 075	-69%	-91	-9%	T2	T2
France	30 059	13 918	13 043	13.7%	-17 016	-57%	-876	-6%	-	-
Germany	56 382	31 285	35 699	37.4%	-20 683	-37%	4 414	14%	CS	CS
Greece	4 565	3 185	3 549	3.7%	-1 017	-22%	363	11%	T2	T2
Hungary	3 540	220	214	0.2%	-3 326	-94%	-6	-3%	T1	T1
Ireland	1 173	3 610	3 488	3.7%	2 315	197%	-123	-3%	T2	T2
Italy	28 444	6 418	5 725	6.0%	-22 719	-80%	-693	-11%	T2	T2
Latvia	332	161	158	0.2%	-175	-53%	-4	-2%	T2	T2
Lithuania	397	159	172	0.2%	-225	-57%	12	8%	T2	T2
Luxembourg	474	457	364	0.4%	-110	-23%	-93	-20%	T2	T2
Malta	95	40	42	0.0%	-53	-56%	1	3%	T1	T1
Netherlands	778	178	177	0.2%	-601	-77%	-1	-1%	T2	T2
Poland	110	1 706	1 746	1.8%	1 635	1481%	40	2%	T1,T2	T1,T2
Portugal	1 640	1 137	1 143	1.2%	-497	-30%	6	1%	T1	T1
Romania	922	791	862	0.9%	-60	-6%	71	9%	T1,T2	T1,T2
Slovakia	93	20	17	0.0%	-75	-81%	-3	-14%	T2	T2
Slovenia	527	373	376	0.4%	-151	-29%	2	1%	-	-
Spain	9 855	7 902	6 794	7.1%	-3 061	-31%	-1 108	-14%	T2	T2
Sweden	6 210	377	418	0.4%	-5 792	-93%	41	11%	-	-
United Kingdom	7 133	7 764	7 866	8.2%	733	10%	102	1%	T2	T2
EU-27+UK	**180 200**	**93 435**	**95 108**	**100%**	**-85 092**	**-47%**	**1 672**	**2%**		
Iceland	28	7	7	0.0%	-21	-75%	0	-5%	T1	T1
United Kingdom (KP)	7 359	8 162	8 269	8.7%	911	12%	107	1%	T2	T2
EU-KP	**180 454**	**93 841**	**95 518**	**100%**	**-84 936**	**-47%**	**1 677**	**2%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.153 and Figure 3.154 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States and UK with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany, France, United Kingdom, Italy and Greece; together they cause 88% of the CO_2 emissions from liquid fuels in 1.A.4.b. Fuel consumption in the EU-KP decreased by 47% between 1990 and 2019. The CO_2 implied emission factor for liquid fuels was 72.16 t/TJ in 2019. Within the MS there is variation of specific fuels used, which is causing also the fluctuation of the IEF. Most often Residual fuel oil, LPG and other kerosene are used.

Figure 3.153 1.A.4.b Residential, liquid fuels: Emission trend and share for CO_2

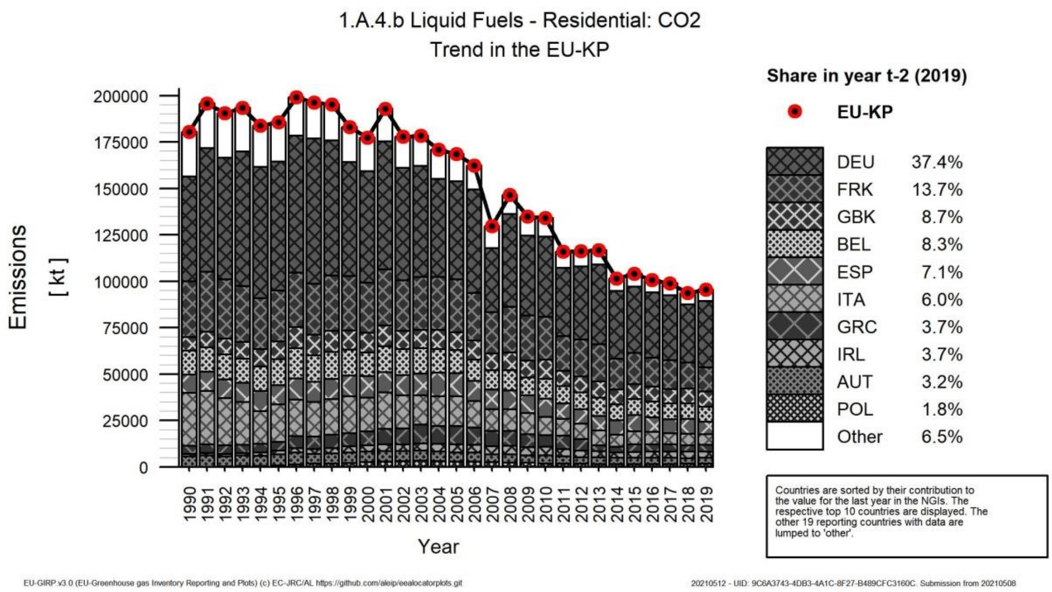
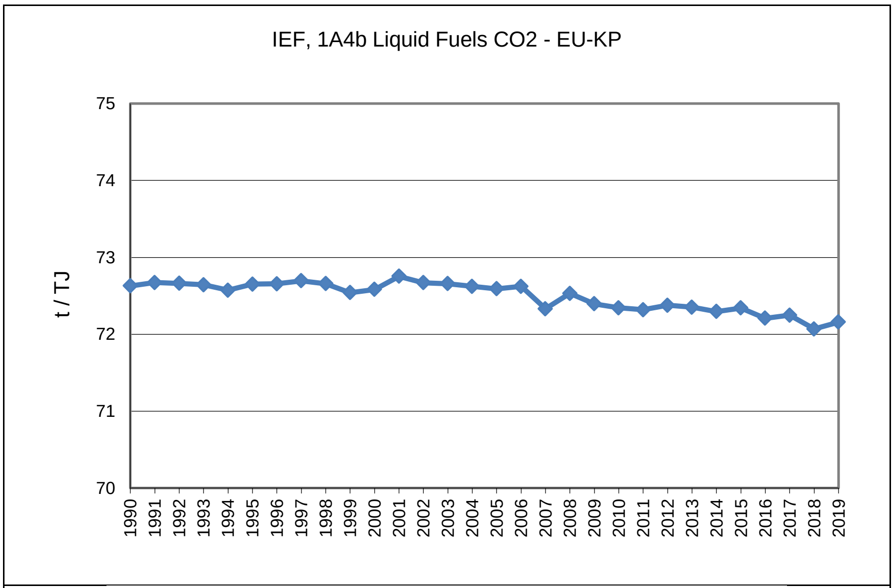
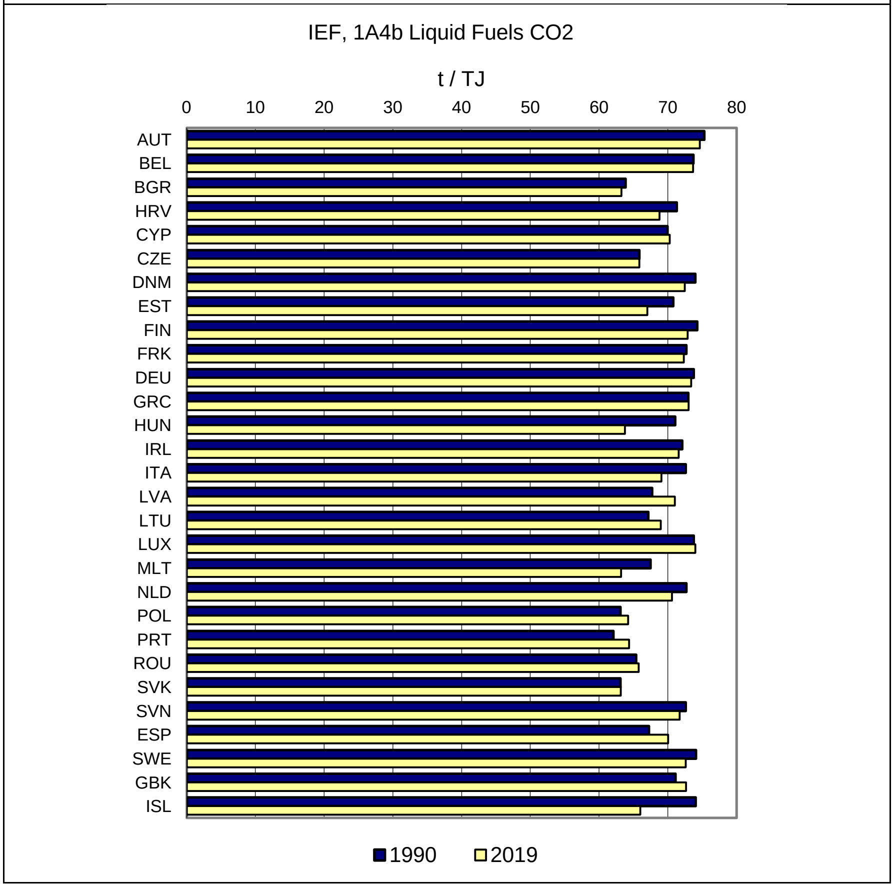


Figure 3.154 1.A.4.b Residential, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1.A.4.b Residential –Solid Fuels (CO_2)

In 2019, CO_2 from solid fuels had a share of 8% within source category 1.A.4.b (compared to 27% in 1990). Between 1990 and 2019 CO_2 emissions decreased by 78% (Table 3.89). All Member States reported decreasing emissions with the highest reductions in absolute terms in Germany, the United Kingdom and Czechia. Between 2018 and 2019 CO_2 emissions decreased by 16%. Six Member States and Iceland report emissions as 'Not occurring' in 2019. According to the methodology as described in chapter 3.2.4 almost 100% of EU-KP emissions are calculated by using higher tier methods in 2019.

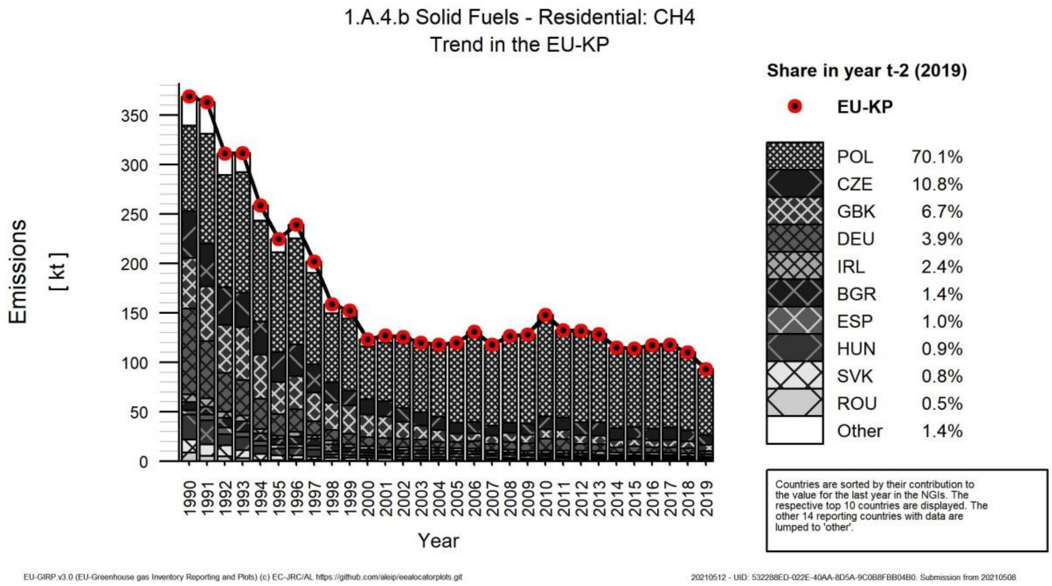
Table 3.89 1.A.4.b Residential, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	2 511	75	77	0.3%	-2 434	-97%	2	2%	T2	T2
Belgium	1 796	104	83	0.3%	-1 713	-95%	-21	-20%	T1	T1
Bulgaria	2 730	436	387	1.3%	-2 342	-86%	-49	-11%	T1,T2	T1,T2
Croatia	436	8	9	0.03%	-427	-98%	1	10%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czechia	16 038	3 598	3 179	10.7%	-12 858	-80%	-419	-12%	T2	T2
Denmark	72	NO	NO	-	-72	-100%	-	-	NA	NA
Estonia	337	4	5	0.02%	-332	-99%	1	14%	-	-
Finland	33	1	1	0.002%	-33	-98%	-0.2	-25%	T2	T2
France	1 969	104	97	0.3%	-1 872	-95%	-8	-7%	-	-
Germany	40 661	2 032	1 404	4.7%	-39 257	-97%	-629	-31%	CS	CS
Greece	89	15	16	0.1%	-73	-82%	1	7%	T2	T2
Hungary	8 107	408	302	1.0%	-7 805	-96%	-106	-26%	T1,T2	T1,T2
Ireland	2 483	997	712	2.4%	-1 771	-71%	-285	-29%	T2	T2
Italy	899	NO	NO	-	-899	-100%	-	-	NA	NA
Latvia	587	27	19	0.1%	-568	-97%	-8	-29%	T2	T2
Lithuania	1 440	151	126	0.4%	-1 314	-91%	-24	-16%	T2	T2
Luxembourg	26	1	1	0.003%	-25	-96%	0.04	5%	T1	T1
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	61	4	5	0.02%	-57	-92%	0.5	11%	T2	T2
Poland	28 362	24 347	20 577	69.3%	-7 785	-27%	-3 770	-15%	T1,T2	T1,T2
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	2 703	122	131	0.4%	-2 572	-95%	9	7%	T1,T2	T1,T2
Slovakia	5 122	242	261	0.9%	-4 861	-95%	19	8%	T2	T2
Slovenia	345	0.29	0.26	0.001%	-344	-100%	-0.02	-9%	T1	T1
Spain	2 035	337	327	1.1%	-1 707	-84%	-9	-3%	T2	T2
Sweden	NO	NO	NO	-	-	-	-	-	-	-
United Kingdom	16 247	2 171	1 979	6.7%	-14 267	-88%	-191	-9%	T2	T2
EU-27+UK	**135 087**	**35 184**	**29 698**	**100%**	**-105 389**	**-78%**	**-5 487**	**-16%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	16 276	2 171	1 979	6.7%	-14 297	-88%	-191	-9%	T2	T2
EU-KP	**135 116**	**35 184**	**29 698**	**100%**	**-105 419**	**-78%**	**-5 487**	**-16%**		

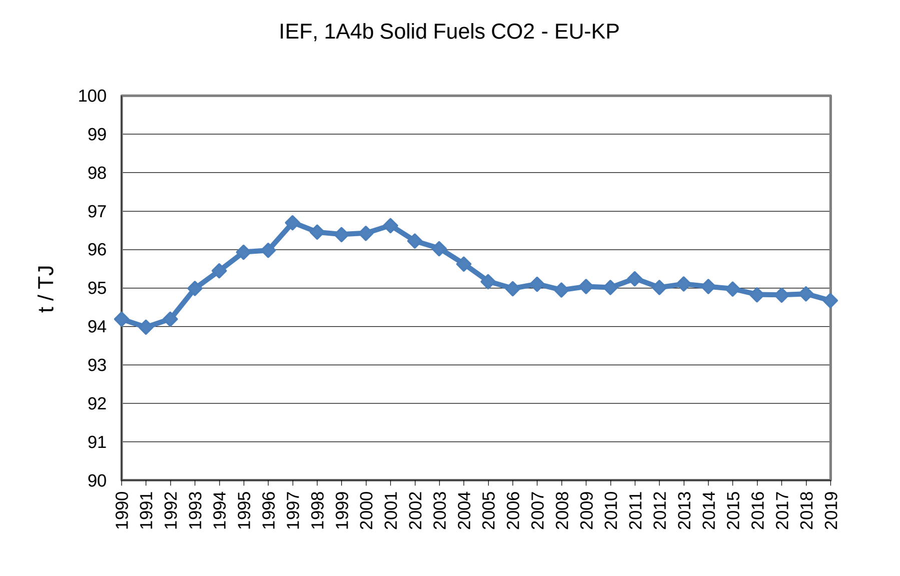
Abbreviations explained in the Chapter 'Units and abbreviations'.

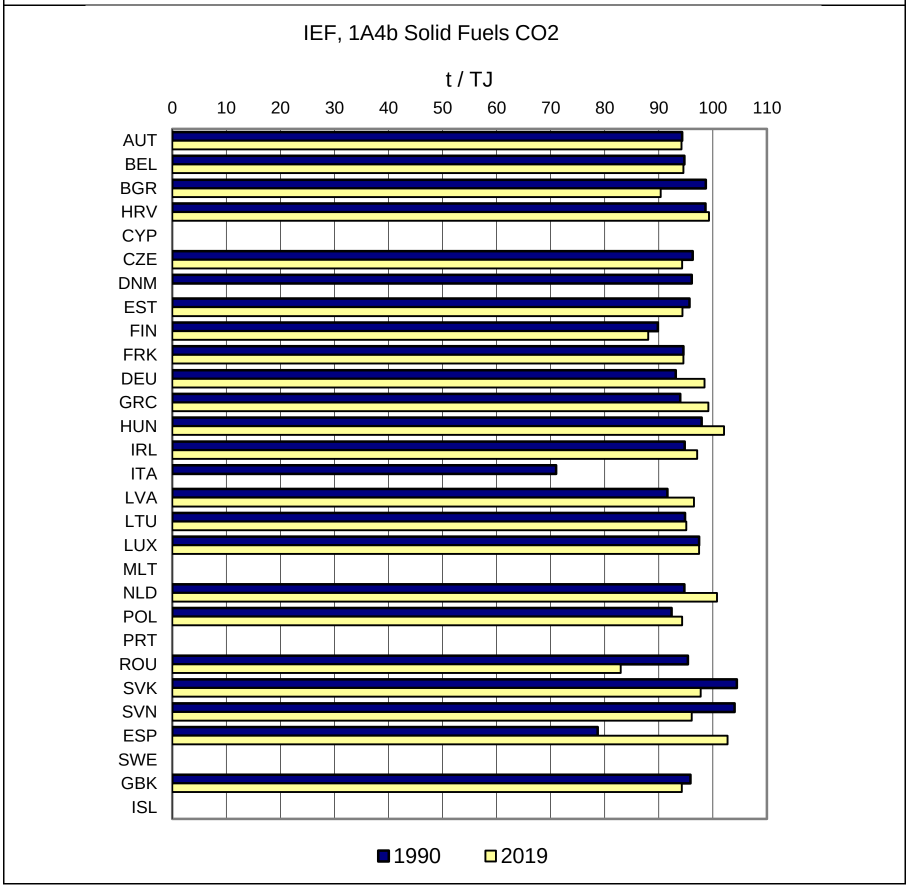
Figure 3.155 and igure 3.156 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Poland, Czechia and Germany; together they cause 91% of the CO_2 emissions from solid fuels in 1.A.4.b. Fuel consumption in the EU-KP decreased by 78% between 1990 and 2019. The CO_2 implied emission factor for solid fuels was 94.67 t/TJ in 2019. The comparatively low IEFs of Italy and Spain in 1990 are due to a high share of gas works gas consumption in the 1990s.

Figure 3.155 1.A.4.b Residential, solid fuels: Emission trend and share for CO_2



igure 3.156 1.A.4.b Residential, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1.A.4.b Residential – Gaseous Fuels (CO_2)

In 2019, CO_2 from gaseous fuels had a share of 66% within source category 1.A.4.b (compared to 37% in 1990). Between 1990 and 2019, the emissions increased by 31% (Table 3.90). All Member States except Lithuania, the Netherlands and Sweden reported increasing emissions from the gaseous fuels combustion. The highest absolute increase occurred in Germany and Italy. Between 2018 and 2019 EU-KP emissions decreased by 1%. According to the methodology as described in chapter 3.2.4 about 99.6% of EU-KP emissions are calculated by using higher tier methods in 2019.

Table 3.90 1.A.4.b Residential, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	1 856	3 118	3 283	1.4%	1 428	77%	165	5%	T2	T2
Belgium	5 882	7 879	7 768	3.2%	1 887	32%	-110	-1%	T1	T1
Bulgaria	NO	180	177	0.1%	177	∞	-2	-1%	T2	T2
Croatia	456	1 097	1 078	0.4%	622	137%	-19	-2%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czechia	2 098	4 372	4 176	1.7%	2 078	99%	-196	-4%	T2	T2
Denmark	988	1 362	1 315	0.5%	327	33%	-48	-4%	T3	T3
Estonia	132	127	134	0.1%	2	2%	6	5%	-	-
Finland	25	56	60	0.02%	34	135%	4	7%	T2	T2
France	21 171	27 204	26 782	11.1%	5 611	27%	-422	-2%	-	-
Germany	31 564	51 248	51 615	21.3%	20 051	64%	367	1%	CS	CS
Greece	IE,NO	773	897	0.4%	897	∞	124	16%	T2	T2
Hungary	4 054	6 777	6 637	2.7%	2 584	64%	-139	-2%	T2	T2
Ireland	270	1 411	1 387	0.6%	1 118	414%	-24	-2%	T2	T2
Italy	26 444	39 965	38 917	16.1%	12 473	47%	-1 047	-3%	T2	T2
Latvia	221	278	258	0.1%	37	17%	-19	-7%	T2	T2
Lithuania	509	383	374	0.2%	-135	-27%	-9	-2%	T2	T2
Luxembourg	170	571	576	0.2%	407	240%	5	1%	T2	T2
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	19 894	16 165	15 241	6.3%	-4 654	-23%	-925	-6%	T2	T2
Poland	6 750	8 253	8 430	3.5%	1 680	25%	177	2%	T2	T2
Portugal	NO	648	674	0.3%	674	∞	26	4%	T2	T2
Romania	5 228	5 853	5 831	2.4%	603	12%	-22	-0.4%	T2	T2
Slovakia	1 559	2 547	2 563	1.1%	1 004	64%	16	1%	T2	T2
Slovenia	25	257	245	0.1%	220	875%	-12	-5%	T2	T2
Spain	912	6 444	7 047	2.9%	6 135	673%	603	9%	T2	T2
Sweden	86	83	53	0.02%	-33	-39%	-30	-36%	-	-
United Kingdom	54 475	57 322	56 626	23.4%	2 151	4%	-696	-1%	T2	T2
EU-27+UK	**184 767**	**244 371**	**242 144**	**100%**	**57 377**	**31%**	**-2 227**	**-1%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	54 475	57 373	56 678	23.4%	2 203	4%	-695	-1%	T2	T2
EU-KP	**184 767**	**244 422**	**242 196**	**100%**	**57 429**	**31%**	**-2 226**	**-1%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.157 shows CO_2 emissions for EU-KP and the Member States as well as the share of the Member States and UK with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to the United Kingdom, Germany, Italy, France and the Netherlands; together they cause 78% of the CO_2 emissions from gaseous fuels in 1.A.4.b. Fuel consumption in the EU-KP rose by 30% between 1990 and 2019. The CO_2 implied emission factor for gaseous fuels was 56.30 t/TJ in 2019.

Figure 3.157 1.A.4.b Residential, gaseous fuels: Emission trend and share for CO_2

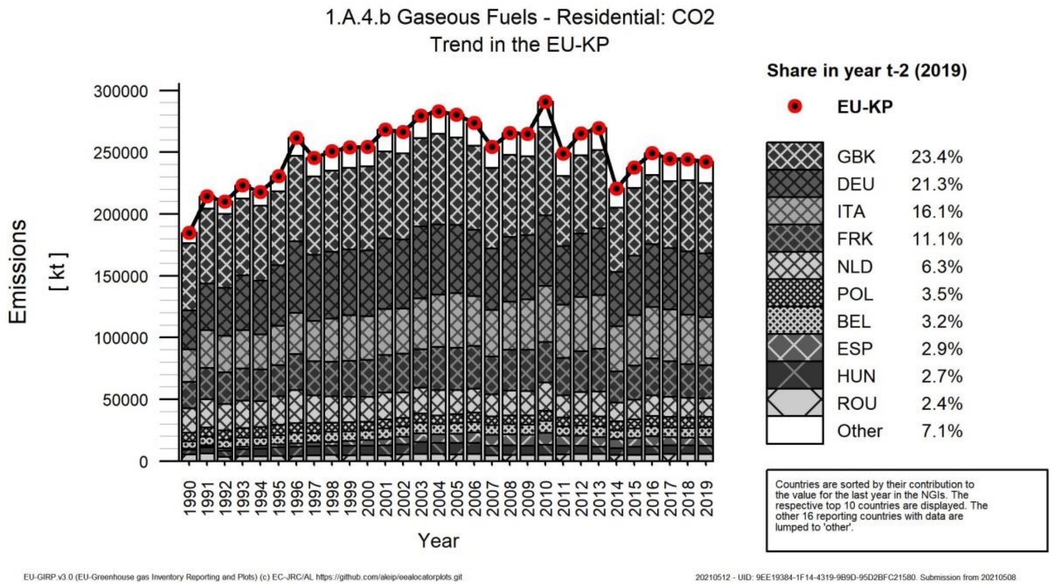
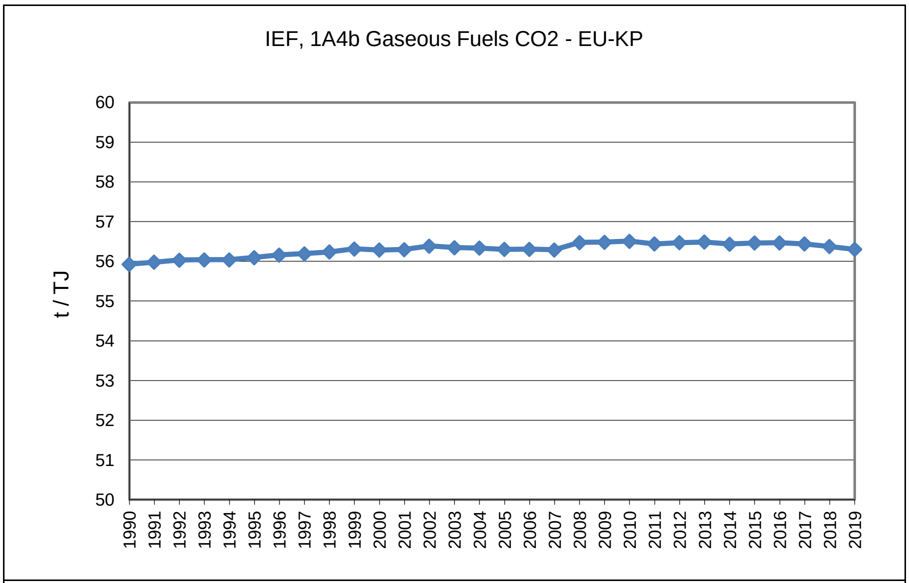
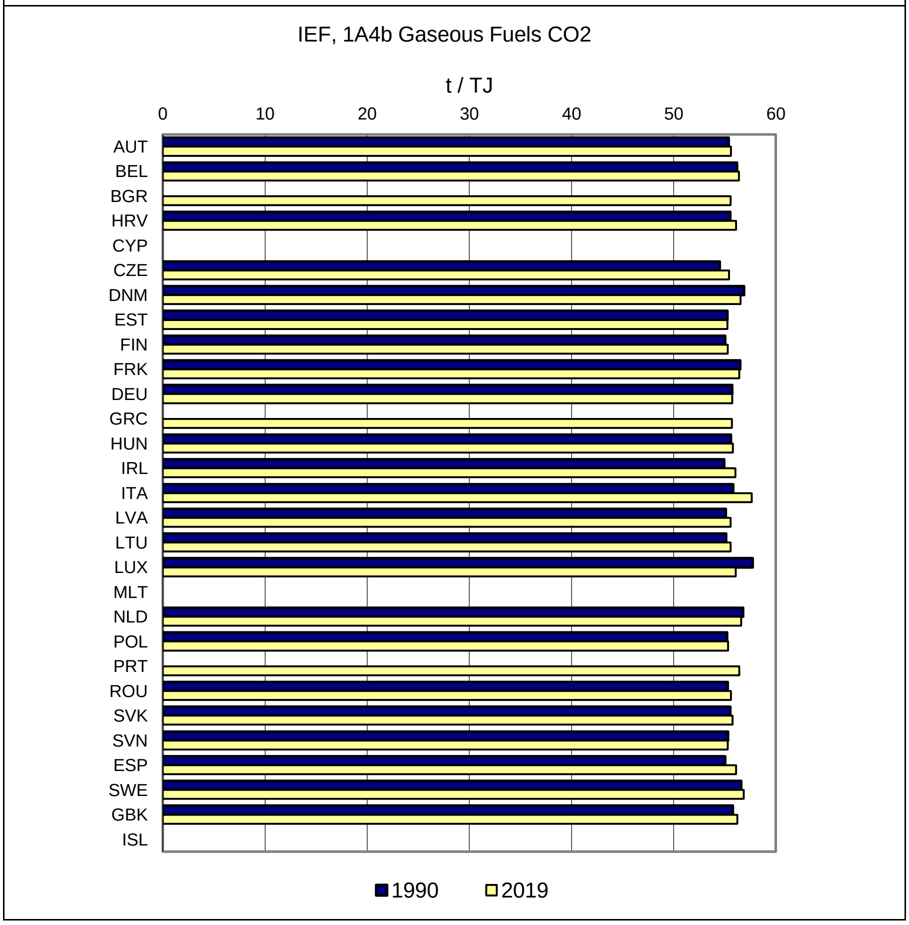


Figure 3.158 1.A.4.b Residential, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)





CH_4 emissions from 1.A.4.b Residential

CH_4 emissions mainly occur from incomplete biomass and coal combustion. CH_4 emissions from 1.A.4.b Residential accounted for 55% of total CH_4 emissions and 0.4% of total GHG emissions in 1A in 2019. Between 1990 and 2019, CH_4 emissions from households decreased by 33% in the EU-KP (Table 3.91). France and Germany reported the highest decrease in emissions while Italy reported the highest increase in emissions. Between 2018 and 2019 CH_4 emissions decreased by 4%.

Table 3.91 1.A.4.b Residential: Member States' contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	465	207	210	1.6%	-255	-55%	2	1%	T1,T2,T3	CS,D
Belgium	234	263	256	1.9%	22	9%	-8	-3%	CS,T1,T3	CR,D
Bulgaria	262	268	256	1.9%	-6	-2%	-13	-5%	T1	D
Croatia	354	331	320	2.4%	-33	-9%	-10	-3%	T1	D
Cyprus	2	7	8	0.1%	6	319%	1	7%	T1	D
Czechia	1 515	890	898	6.7%	-617	-41%	9	1%	T1	D
Denmark	120	79	69	0.5%	-51	-43%	-10	-13%	M,T1,T2,T3	CS,D,OTH
Estonia	90	125	120	0.9%	30	33%	-5	-4%	T1	D
Finland	154	195	192	1.4%	38	25%	-4	-2%	T1,T2,T3	CR,CS,D
France	4 547	981	958	7.2%	-3 589	-79%	-23	-2%	T1,T2	CS,D
Germany	2 484	778	754	5.6%	-1 731	-70%	-25	-3%	T2,T3	CS,M
Greece	229	209	202	1.5%	-27	-12%	-7	-3%	T1	D
Hungary	828	471	435	3.3%	-393	-47%	-36	-8%	T1	D
Ireland	443	164	136	1.0%	-307	-69%	-28	-17%	T1	D
Italy	1 095	2 146	2 141	16.0%	1 046	96%	-6	0%	T2	CR
Latvia	197	135	128	1.0%	-69	-35%	-7	-5%	T1,T2	CS,D
Lithuania	175	149	141	1.1%	-34	-19%	-8	-5%	T1,T2	CS,D
Luxembourg	9	11	8	0.1%	-2	-18%	-3	-30%	T1,T3	D,M
Malta	0	1	1	0.0%	0	131%	0	22%	T1	D
Netherlands	450	355	336	2.5%	-114	-25%	-20	-6%	T1,T2	CS,D
Poland	2 475	2 765	2 428	18.1%	-47	-2%	-337	-12%	T1	D
Portugal	428	213	210	1.6%	-218	-51%	-2	-1%	T1,T2	D,OTH
Romania	407	975	982	7.3%	575	141%	7	1%	T1	D
Slovakia	378	188	208	1.6%	-170	-45%	20	10%	T1	D
Slovenia	142	121	111	0.8%	-31	-22%	-11	-9%	T1,T2	CS,D
Spain	794	853	852	6.4%	58	7%	-1	0%	T2	D
Sweden	103	53	53	0.4%	-50	-48%	0	0%	M,T1	CS
United Kingdom	1 510	984	980	7.3%	-530	-35%	-4	0%	T1,T2,T3	CS,D
EU-27+UK	**19 890**	**13 920**	**13 392**	**100%**	**-6 499**	**-33%**	**-529**	**-4%**	**-**	**-**
Iceland	0	0	0	0.0%	0	-82%	0	-9%	T1	D
United Kingdom (KP)	1 513	985	982	7.3%	-531	-35%	-4	0%	T1,T2,T3	CS,D
EU-KP	**19 894**	**13 922**	**13 393**	**100%**	**-6 500**	**-33%**	**-528**	**-4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4.b Residential – Biomass (CH_4)

In 2019 CH_4 from biomass had a share of 76% within source category on the total CH_4 emissions from 1.A.4.b (compared to 47% in 1990). Between 1990 and 2019 CH_4 emissions increased by 8% (Table 3.92). France reported the highest absolute decrease, while CH_4 emissions of Italy increased significantly. Between 2018 and 2019, CH_4 emissions decreased by 1%. According to the methodology as described in chapter 3.2.4 about 62% of EU-KP emissions are calculated by using higher tier methods in 2019.

Table 3.92 1.A.4.b Residential, biomass: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	242	190	192	1.9%	-51	-21%	2	1%	T1,T2	T1,T2
Belgium	97	231	226	2.2%	129	132%	-5	-2%	T1	T1
Bulgaria	54	232	223	2.2%	169	312%	-9	-4%	T1	T1
Croatia	316	327	316	3.1%	0.2	0.1%	-10	-3%	T1	T1
Cyprus	1	7	7	0.1%	6	586%	0.4	6%	-	-
Czechia	324	593	636	6.3%	312	96%	42	7%	T1	T1
Denmark	110	77	66	0.7%	-44	-40%	-11	-14%	T1,T3	T1,T3
Estonia	38	124	119	1.2%	81	211%	-5	-4%	-	-
Finland	137	188	184	1.8%	47	35%	-3	-2%	T2	T2
France	4 239	859	840	8.3%	-3 398	-80%	-19	-2%	-	-
Germany	280	574	583	5.7%	303	108%	9	2%	T2	T2
Greece	220	207	200	2.0%	-21	-9%	-7	-3%	T1	T1
Hungary	186	425	397	3.9%	210	113%	-28	-7%	T1	T1
Ireland	14	10	8	0.1%	-6	-41%	-2	-16%	T1	T1
Italy	996	2 094	2 091	20.6%	1 095	110%	-3	0%	T2	T2
Latvia	145	132	125	1.2%	-20	-14%	-7	-5%	T2	T2
Lithuania	58	131	126	1.2%	67	115%	-5	-4%	T2	T2
Luxembourg	5	8	5	0.05%	0.02	0.4%	-3	-38%	T1	T1
Malta	NO	0.4	1	0.01%	1	∞	0.1	25%	T1	T1
Netherlands	91	63	60	0.6%	-31	-34%	-3	-5%	T1	T1
Poland	292	810	770	7.6%	478	164%	-41	-5%	T1	T1
Portugal	425	211	208	2.1%	-217	-51%	-3	-1%	T2	T2
Romania	181	950	956	9.4%	775	429%	6	1%	T1	T1
Slovakia	36	165	183	1.8%	147	409%	18	11%	T1	T1
Slovenia	115	120	109	1.1%	-6	-5%	-10	-9%	T2	T2
Spain	651	791	793	7.8%	141	22%	2	0.2%	T2	T2
Sweden	96	50	50	0.5%	-46	-47%	0.1	0.1%	-	-
United Kingdom	62	658	671	6.6%	609	986%	13	2%	T1	T1
EU-27+UK	**9 413**	**10 224**	**10 143**	**100%**	**730**	**8%**	**-80**	**-1%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	62	658	671	6.6%	609	985%	13	2%	T1	T1
EU-KP	**9 413**	**10 224**	**10 143**	**100%**	**730**	**8%**	**-80**	**-1%**		

Abbreviations explained in the Chapter 'Units and abbreviation'.

Figure 3.159 and

Figure 3.160 show CH_4 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CH_4 emissions correspond to Italy followed by Romania and France; together they cause 38% of the CH_4 emissions from biomass fuels in 1.A.4.b. Biomass fuel consumption in the EU-KP rose by 59% between 1990 and 2019. The CH_4 implied emission factor for biomass fuels was 222.73 kg/TJ in 2019.

The implied emission factors are decreasing because old biomass boilers, stoves and open fireplaces are replaced by modern technologies (pellets, automatic boilers), which have lower CH_4 (as well as NMVOC) emissions from incomplete combustion. However, this change in improved technologies is not reflected by the Member States which are using the default emission factor value (300 kg/TJ) for the whole time series.

Figure 3.159 1.A.4.b Residential, biomass: Emission trend and share for CH_4

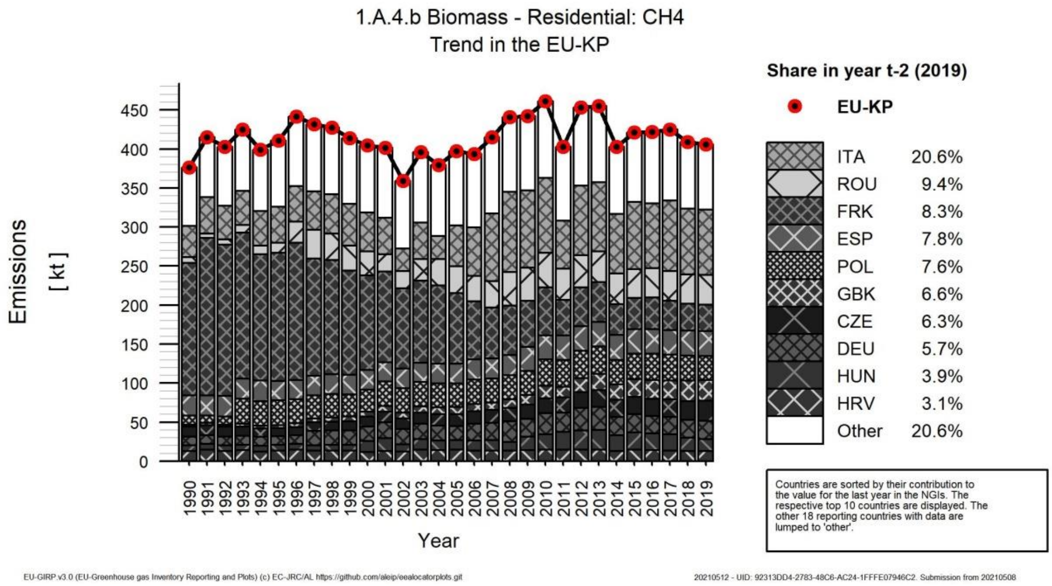
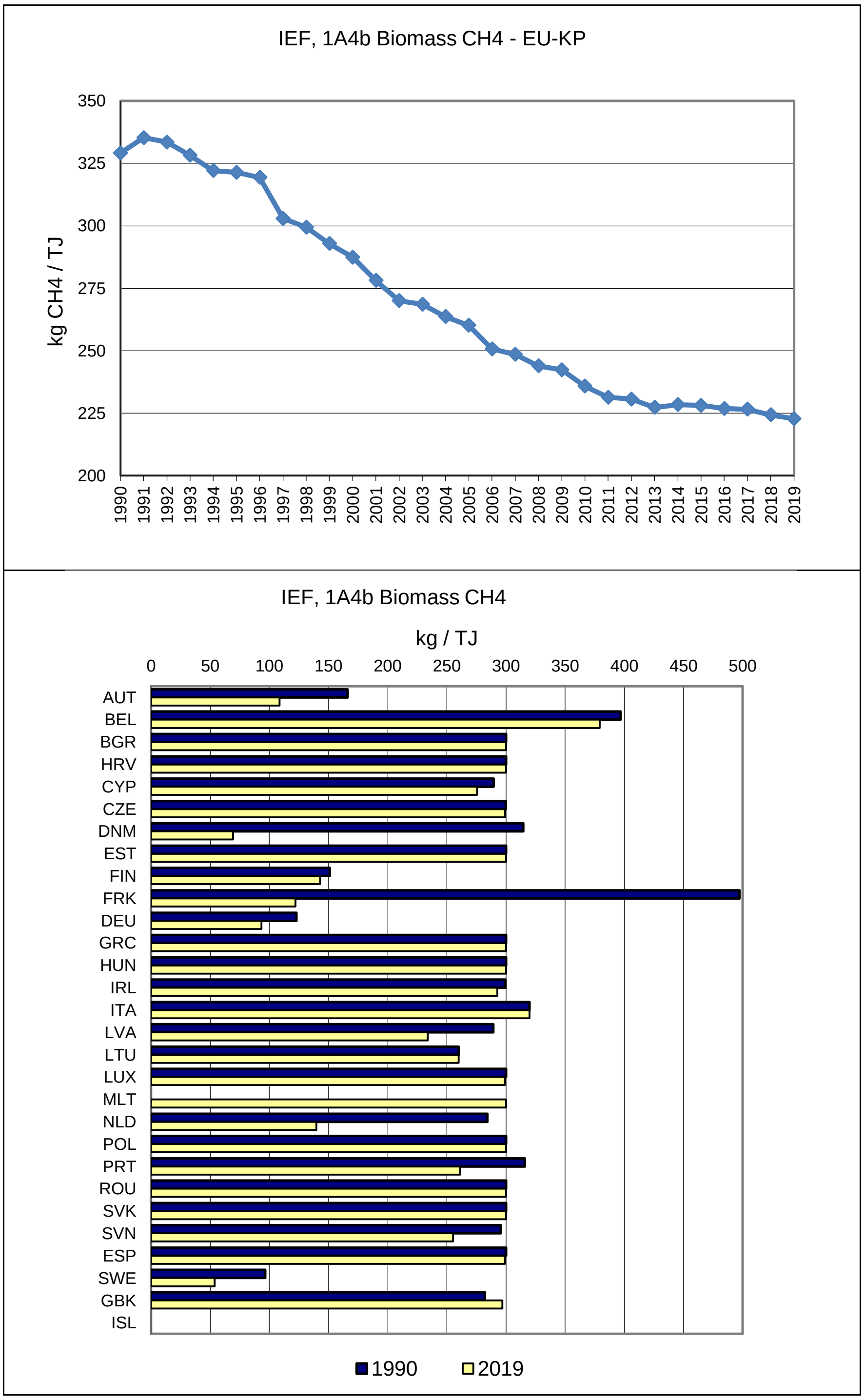


Figure 3.160 1.A.4.b Residential, biomass: Implied Emission Factors for CH_4 (in kg/TJ)



1.A.4.b Residential – Solid Fuels (CH_4)

In 2019, CH_4 from solid fuels had a share of 17% within source category 1.A.4.b (compared to 46% in 1990). Between 1990 and 2019 CH_4 emissions decreased by 75% (Table 3.92). All Member States reported decreasing emissions since 1990 with Germany and the United Kingdom showing the largest absolute decreases. Between 2018 and 2019 CH_4 emissions decreased by 15 %. According to the methodology as described in chapter 3.2.4, about 13% of EU-KP emissions are calculated by using higher tier methods in 2019.

Table 3.93: 1.A.4.b Residential, solid fuels: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	200	6	6	0.3%	-194	-97%	0.2	3%	T1	T1
Belgium	110	7	6	0.2%	-104	-95%	-2	-24%	T1	T1
Bulgaria	207	36	32	1.4%	-175	-85%	-4	-11%	T1	T1
Croatia	33	1	1	0.03%	-32	-98%	0.1	10%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czechia	1 186	286	253	10.8%	-933	-79%	-33	-12%	T1	T1
Denmark	6	NO	NO	-	-6	-100%	-	-	NA	NA
Estonia	26	0	0	0.02%	-26	-99%	0.04	13%	-	-
Finland	3	0	0	0.002%	-3	-98%	-0.01	-24%	T1	T1
France	156	8	8	0.3%	-148	-95%	-1	-7%	-	-
Germany	2 168	126	92	3.9%	-2 077	-96%	-34	-27%	T2	T2
Greece	7	1	1	0.1%	-6	-83%	0.1	7%	T1	T1
Hungary	621	30	22	0.9%	-599	-96%	-8	-26%	T1	T1
Ireland	197	77	55	2.4%	-141	-72%	-22	-29%	T1	T1
Italy	10	NO	NO	-	-10	-100%	-	-	NA	NA
Latvia	48	2	1	0.1%	-47	-97%	-1	-29%	T1	T1
Lithuania	114	12	10	0.4%	-104	-91%	-2	-16%	T1	T1
Luxembourg	2.02	0.07	0.08	0.003%	-2	-96%	0.003	5%	T1	T1
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	0.0078	0.0042	0.0048	0.0002%	-0.003	-39%	0.001	13%	T2	T2
Poland	2 168	1 933	1 636	70.1%	-532	-25%	-297	-15%	T1	T1
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	212	11	12	0.5%	-201	-94%	1	11%	T1	T1
Slovakia	339	18	19	0.8%	-319	-94%	2	9%	T1	T1
Slovenia	25	0	0	0.001%	-25	-100%	-0.002	-9%	-	
Spain	116	25	24	1.0%	-92	-79%	-1	-3%	T2	T2
Sweden	NO	NO	NO	-	-	-	-	-	-	-
United Kingdom	1 271	173	158	6.7%	-1 113	-88%	-15	-9%	T1,T2	T1,T2
EU-27+UK	**9 223**	**2 750**	**2 335**	**100%**	**-6 888**	**-75%**	**-415**	**-15%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 273	173	158	6.7%	-1 116	-88%	-15	-9%	T1,T2	T1,T2
EU-KP	**9 226**	**2 750**	**2 335**	**100%**	**-6 891**	**-75%**	**-415**	**-15%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.159 and

Figure 3.160 show CH_4 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CH_4 emissions (above the average share calculated for EU-KP) correspond to Poland, Czechia and the United Kingdom with a share of 88% of total CH_4 emissions from solid fuels in 1.A.4.b. Solid fuel consumption in the EU-KP decreased by 78% between 1990 and 2019. The CH_4 implied emission factor for solid fuels was 297.79 kg/TJ in 2019.

Figure 3.161: 1.A.4.b Residential, solid fuels: Emission trend and share for CH_4

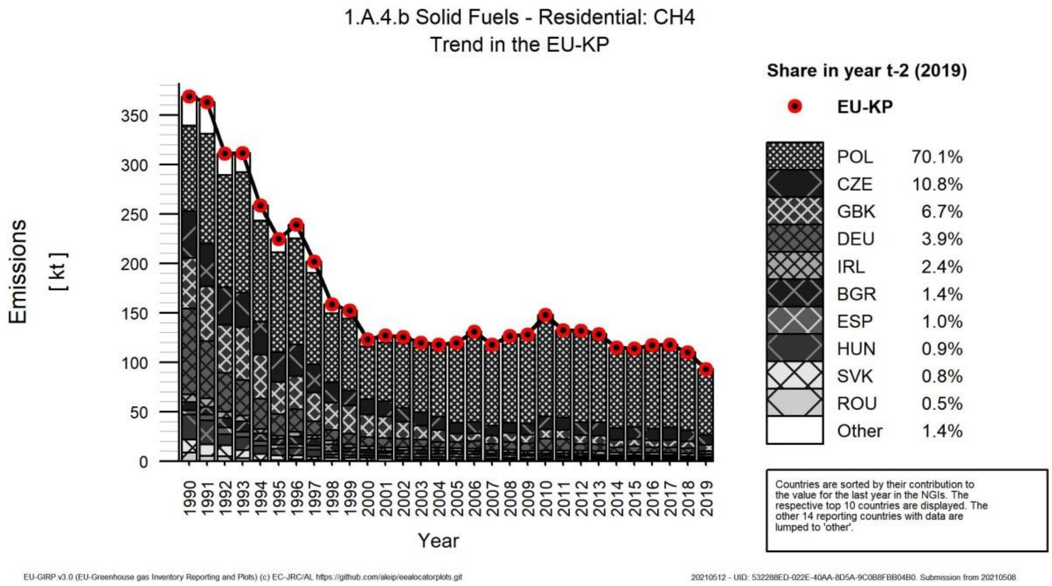
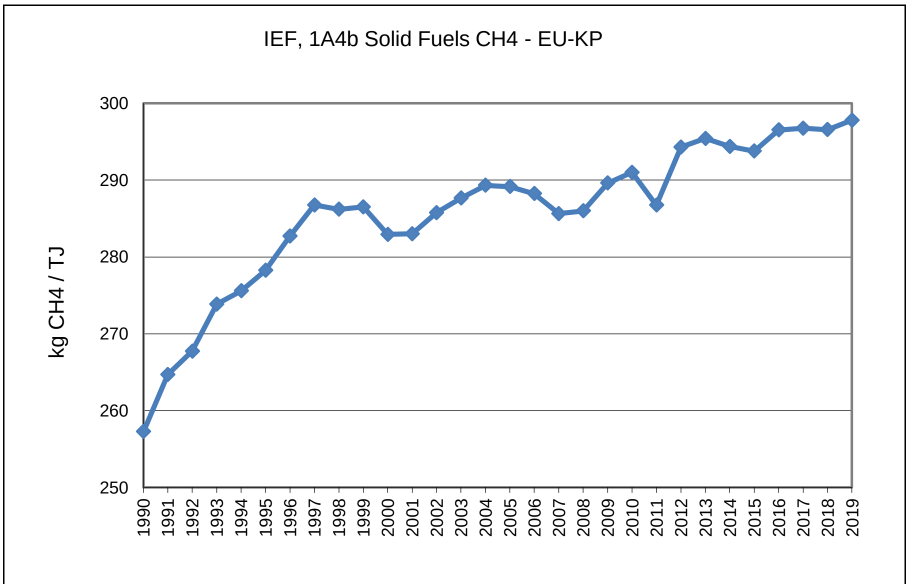
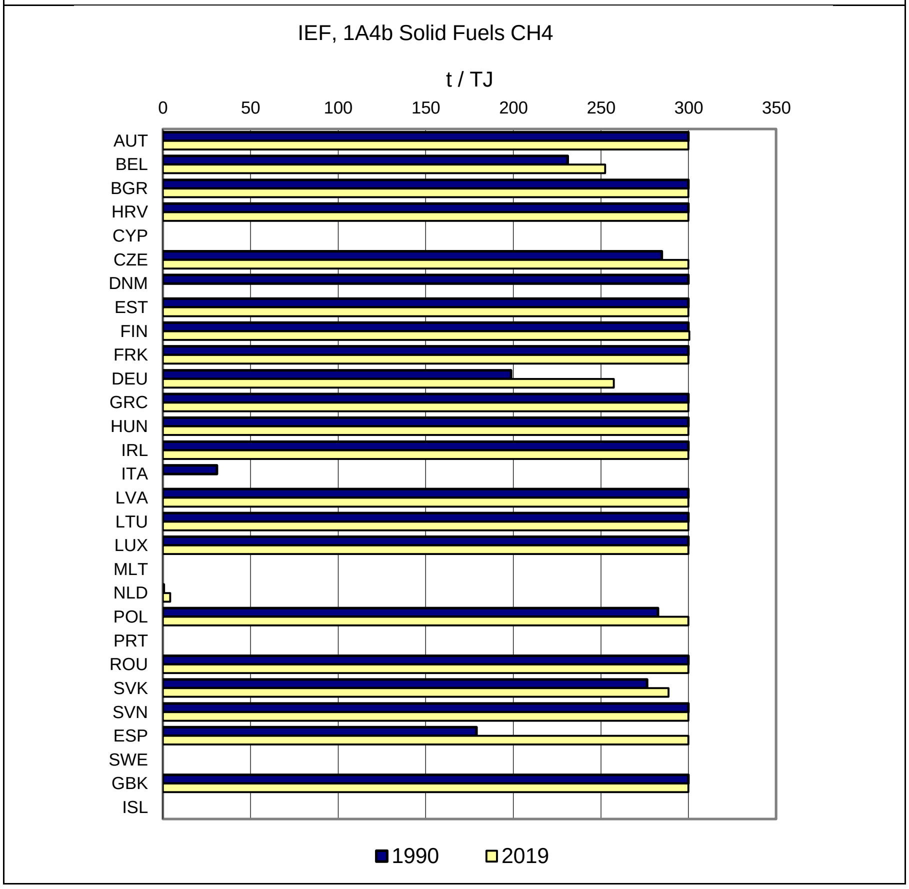


Table 3.94: 1.A.4.b Residential, solid fuels: Implied Emission Factors for CH_4 (in kg/TJ)



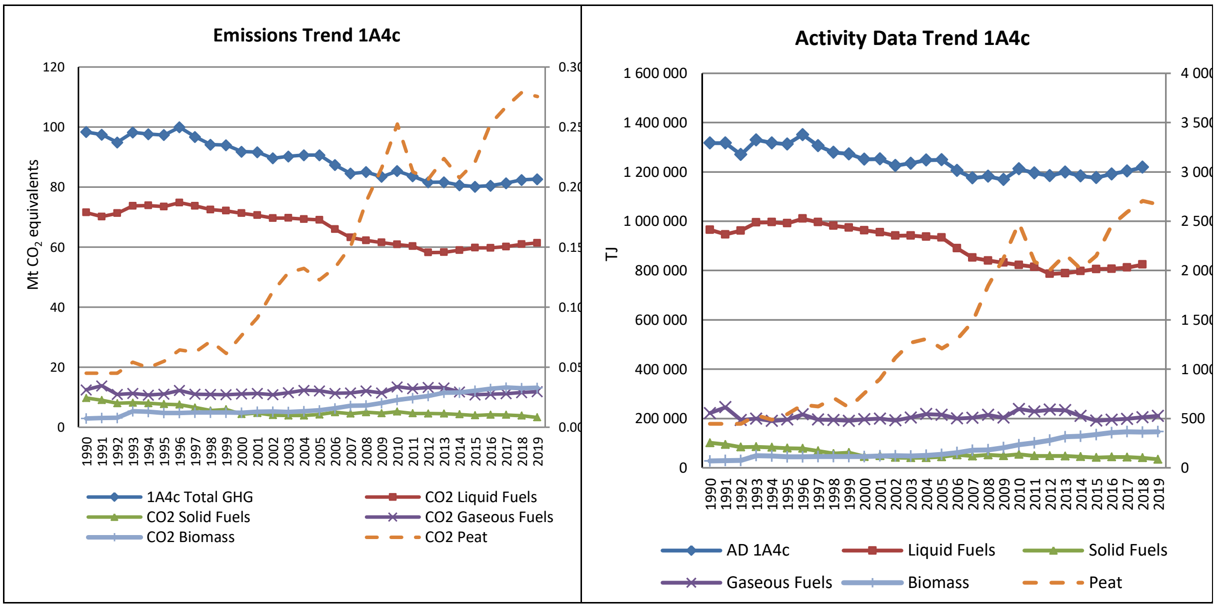


3.2.4.3 Agriculture/Forestry/Fisheries (1.A.4.c)

In this chapter information about emission trends, Member States' contribution and activity data is provided for category 1.A.4.c by fuels. CO_2 emissions from 1.A.4.c Agriculture/Forestry/Fisheries accounted for 2.5% of total EU-KP GHG emissions in 1.A Fuel Combustion in 2019. Between 1990 and 2019, CO_2 emissions from 1.A.4.c Agriculture/Forestry/Fisheries decreased by 18% in the EU-KP (Table 3.95).

Figure 3.162 shows the emission trend within source category 1.A.4.c, which is mainly dominated by CO_2 emissions from liquid fuels. Total GHG emissions decreased by 16%, mainly due to decreases in CO_2 emissions from liquid fuels.

Figure 3.162 1.A.4.c Agriculture/Forestry/Fisheries: Total and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Five Member States; Poland, Spain, France, the Netherlands and Italy together contributed 65% to the emissions from this source in 2019. Spain and Poland were the Member States with the highest increase in absolute terms between 1990 and 2019, while the highest decreases were achieved in Germany, Greece and Czechia.

Table 3.95 1.A.4.c Agriculture/Forestry/Fisheries: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	1 251	837	883	1.1%	-369	-29%	46	5%	IO,T1,T2,T3	CS,D,NO
Belgium	3 037	2 218	2 295	3.0%	-742	-24%	77	3%	CS,T1,T3	D
Bulgaria	1 649	457	446	0.6%	-1 204	-73%	-12	-3%	T1,T2	CS,D
Croatia	835	642	646	0.8%	-189	-23%	4	1%	T1	D
Cyprus	55	79	85	0.1%	29	53%	6	7%	T1	D
Czechia	3 672	1 206	1 250	1.6%	-2 422	-66%	44	4%	T1,T2	CS,D
Denmark	2 595	1 503	1 411	1.8%	-1 183	-46%	-92	-6%	M,T1,T2,T3	CS,D
Estonia	597	314	289	0.4%	-308	-52%	-25	-8%	T1,T2	CS,D
Finland	1 863	1 308	1 316	1.7%	-547	-29%	8	1%	T1,T2,T3	CS,D
France	11 216	9 949	9 905	12.9%	-1 310	-12%	-43	0%	T1,T2	CS,D
Germany	10 207	5 646	5 785	7.5%	-4 422	-43%	139	2%	:S,T1,T2,T3	CS,D
Greece	2 893	463	450	0.6%	-2 442	-84%	-13	-3%	T1,T2	CS,D,NO
Hungary	2 652	1 492	1 554	2.0%	-1 098	-41%	61	4%	T1,T2	CS,D
Ireland	747	622	611	0.8%	-137	-18%	-11	-2%	T1,T2	CS,D
Italy	8 352	7 428	7 500	9.8%	-852	-10%	71	1%	T2	CS
Latvia	1 585	433	466	0.6%	-1 119	-71%	34	8%	T1,T2	CS,D
Lithuania	1 483	204	215	0.3%	-1 269	-86%	10	5%	T2	CS
Luxembourg	34	23	23	0.0%	-11	-33%	0	0%	T1,T2	CS,D
Malta	4	18	20	0.0%	16	400%	1	7%	T1	D
Netherlands	9 836	9 196	9 176	11.9%	-660	-7%	-20	0%	T1,T2	CS,D
Poland	8 504	11 003	10 746	14.0%	2 242	26%	-257	-2%	T1,T2	CS,D
Portugal	1 119	1 156	1 188	1.5%	69	6%	32	3%	NO,T1,T2	CS,D,NO
Romania	1 994	1 467	1 448	1.9%	-546	-27%	-19	-1%	T1,T2	CS,D
Slovakia	146	334	300	0.4%	154	105%	-33	-10%	T1,T2	CS,D
Slovenia	166	218	216	0.3%	49	30%	-2	-1%	T1	D
Spain	8 678	11 620	11 752	15.3%	3 074	35%	132	1%	T1,T2,T3	S,D,M,OTH
Sweden	1 698	1 129	1 196	1.6%	-502	-30%	67	6%	T1,T2	CS
United Kingdom	5 978	4 932	4 924	6.4%	-1 054	-18%	-8	0%	T1,T2,T3	CS,D
EU-27+UK	**92 847**	**75 897**	**76 094**	**99%**	**-16 754**	**-18%**	**196**	**0%**	**-**	**-**
Iceland	739	546	541	0.7%	-198	-27%	-6	-1%	T1	D
United Kingdom (KP)	6 164	5 197	5 187	6.7%	-977	-16%	-11	0%	T1,T2,T3	CS,D
EU-KP	**93 772**	**76 709**	**76 897**	**100%**	**-16 875**	**-18%**	**188**	**0%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4.c Agriculture/Forestry/Fisheries – Liquid Fuels (CO_2)

In 2019, CO_2 from liquid fuels had a share of 80% within source category 1.A.4.c (compared to 76% in 1990). Between 1990 and 2019 CO_2 decreased by 14% (Table 3.96. Eight Member States reported increasing emissions with the highest increases in absolute terms in Poland and Spain. Between 2018 and 2019 EU-KP emissions increased by 1%. According to the methodology as described in chapter 3.2.4 88% of EU-KP emissions are calculated by using higher tier methods in 2019.

Table 3.96 1.A.4.c Agriculture/Forestry/Fisheries, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	1 180	782	818	1.3%	-362	-31%	36	5%	T2	T2
Belgium	2 757	1 064	1 052	1.7%	-1 706	-62%	-13	-1%	T1	T1
Bulgaria	1 498	387	383	0.6%	-1 115	-74%	-4	-1%	T1	T1
Croatia	788	596	594	1.0%	-194	-25%	-2	-0.3%	T1	T1
Cyprus	55	79	85	0.1%	29	53%	6	7%	T1	T1
Czechia	1 536	1 058	1 074	1.7%	-462	-30%	16	2%	T1	T1
Denmark	2 231	1 370	1 299	2.1%	-932	-42%	-71	-5%	T1,T2	T1,T2
Estonia	570	302	279	0.5%	-291	-51%	-24	-8%	T1,T2	T1,T2
Finland	1 778	1 087	1 097	1.8%	-680	-38%	11	1%	T1	T1
France	10 894	9 473	9 429	15.4%	-1 464	-13%	-44	-0.5%	T1,T2	T1,T2
Germany	6 864	5 017	5 163	8.4%	-1 701	-25%	145	3%	CS	CS
Greece	2 882	461	448	0.7%	-2 434	-84%	-13	-3%	T2	T2
Hungary	2 085	1 234	1 245	2.0%	-840	-40%	11	1%	T1	T1
Ireland	747	622	611	1.0%	-137	-18%	-11	-2%	T1,T2	T1,T2
Italy	8 300	7 097	7 158	11.7%	-1 142	-14%	61	1%	T2	T2
Latvia	701	404	440	0.7%	-260	-37%	36	9%	T2	T2
Lithuania	1 173	144	157	0.3%	-1 016	-87%	13	9%	T2	T2
Luxembourg	34	23	23	0.04%	-11	-34%	0.1	0.4%	NA	NA
Malta	4	18	20	0.03%	16	400%	1	7%	T1	T1
Netherlands	2 507	1 737	1 728	2.8%	-779	-31%	-9	-1%	T1,T2	T1,T2
Poland	4 724	7 334	7 622	12.4%	2 898	61%	288	4%	T1,T2	T1,T2
Portugal	1 119	1 134	1 157	1.9%	38	3%	23	2%	T1	T1
Romania	9	1 075	1 076	1.8%	1 067	11395%	1	0%	T1,T2	T1,T2
Slovakia	104	269	241	0.4%	136	131%	-28	-10%	T2	T2
Slovenia	166	218	216	0.4%	49	30%	-2	-1%	NA	-
Spain	8 635	11 264	11 290	18.4%	2 655	31%	27	0.2%	T2,T3	T2,T3
Sweden	1 508	1 111	1 179	1.9%	-329	-22%	68	6%	-	-
United Kingdom	5 747	4 749	4 719	7.7%	-1 028	-18%	-31	-1%	T2	T2
EU-27+UK	**70 595**	**60 109**	**60 602**	**99%**	**-9 994**	**-14%**	**493**	**1%**		
Iceland	739	546	541	0.9%	-198	-27%	-6	-1%	T1	T1
United Kingdom (KP)	5 933	5 015	4 982	8.1%	-951	-16%	-33	-1%	T2	T2
EU-KP	**71 520**	**60 921**	**61 405**	**100%**	**-10 115**	**-14%**	**484**	**1%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.163 and

Figure 3.164 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Spain, France, Poland, Italy Germany and the United Kingdom; together they cause 74% of the CO_2 emissions from liquid fuels in 1.A.4.c. Fuel consumption in the EU-KP decreased by 14% between 1990 and 2019. The CO_2 implied emission factor for liquid fuels was 73.93 t/TJ in 2019.

Figure 3.163 1.A.4.c Agriculture/Forestry/Fisheries, liquid fuels: Emission trend and share for CO_2

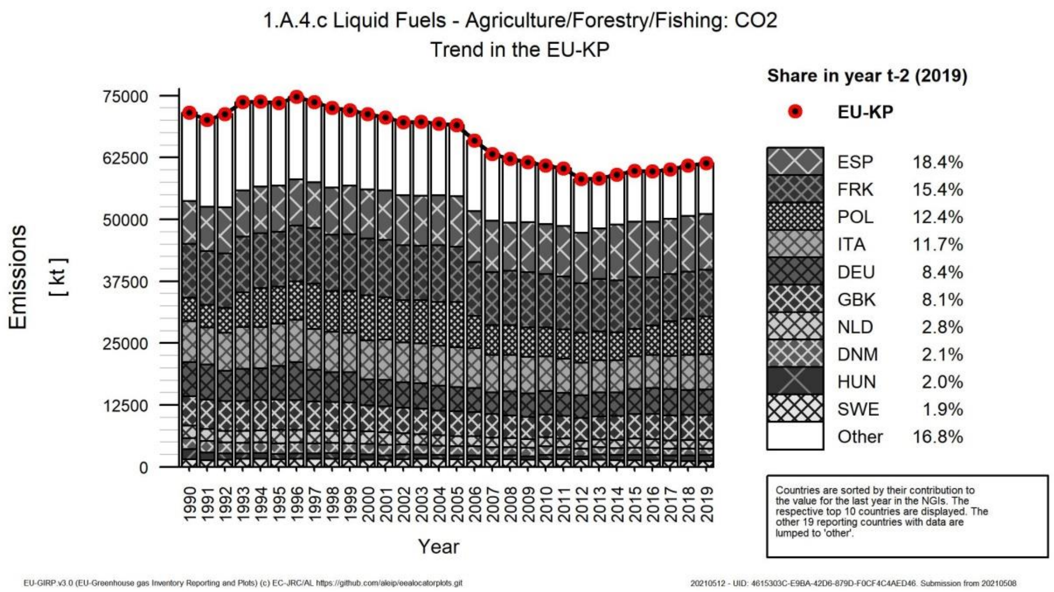
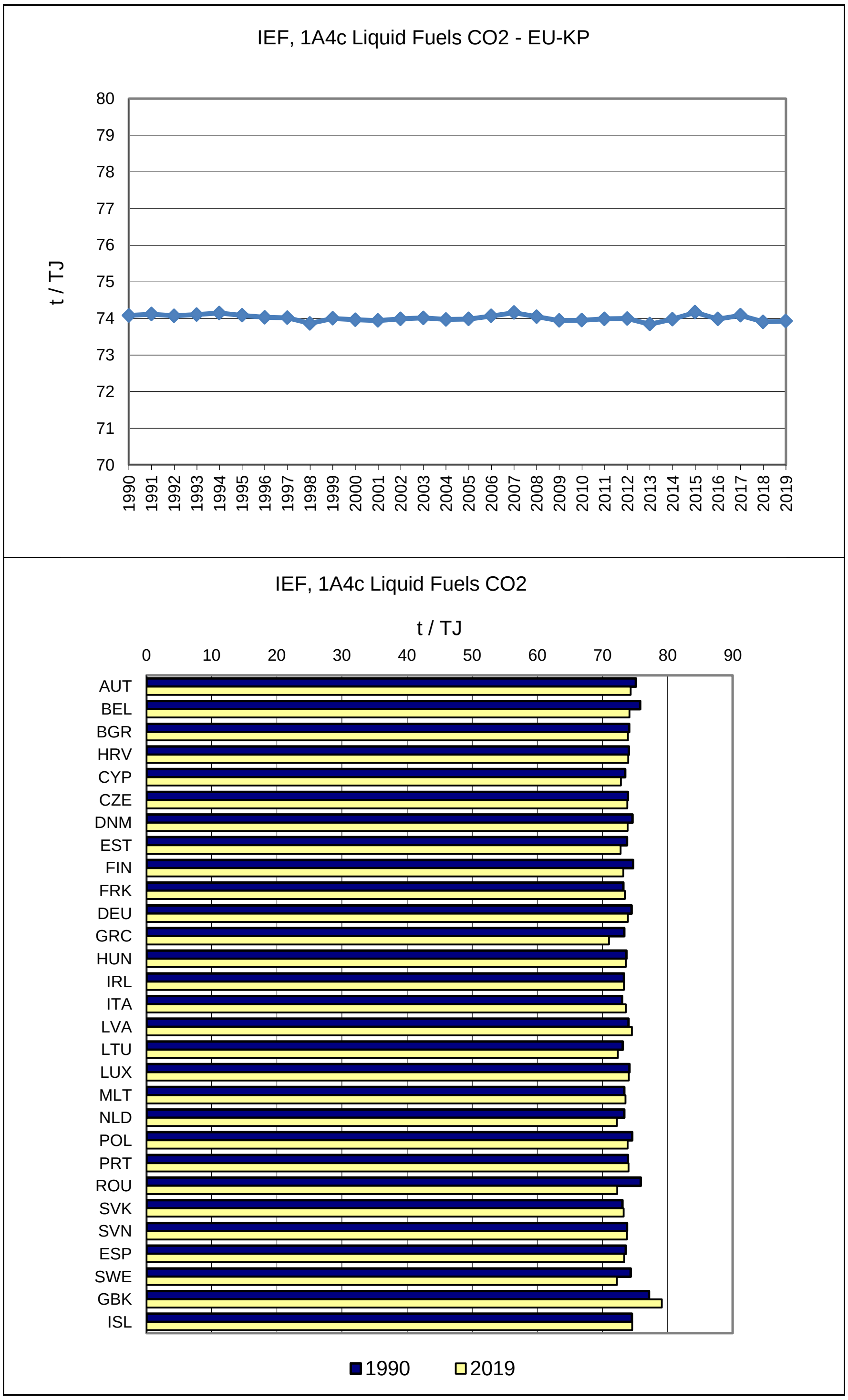


Figure 3.164 1.A.4.c Agriculture/Forestry/Fisheries, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.c Agriculture/Forestry/Fisheries – Solid Fuels (CO_2)

In 2019 CO_2 from solid fuels had a share of 4% within source category 1.A.4.c (compared to 10% in 1990). Between 1990 and 2019, CO_2 decreased by 66% (Table 3.97). Thirteen Member States, Iceland and the United Kingdom reported CO_2 emissions from this source category as 'Not occurring' in 2019. All Member States except Slovakia and Romania reported decreasing emissions between 1990 and

2019. Between 2018 and 2019, EU-KP emissions decreased by 15%, mainly due to the decrease reported by Poland. The decrease in 1990 to 1992 emissions is due to the strong decrease reported by Germany (which had 29% share on 1990 emissions). According to the methodology as described in chapter 3.2.4 98% of EU-KP emissions are calculated by using higher tier methods in 2019.

Table 3.97 1.A.4.c Agriculture/Forestry/Fisheries, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	51	2	2	0.05%	-49	-97%	-1	-30%	T2	T2
Belgium	212	63	63	1.9%	-150	-71%	0	0%	T1	T1
Bulgaria	151	37	39	1.2%	-112	-74%	3	8%	T1,T2	T1,T2
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 730	25	24	0.7%	-1 707	-99%	-2	-7%	T2	T2
Denmark	237	34	21	0.6%	-216	-91%	-13	-39%	T1	T1
Estonia	22	2	1	0.04%	-21	-95%	-1	-43%	T1,T2	T1,T2
Finland	13	9	8	0.2%	-5	-41%	-2	-17%	T3	T3
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	2 861	11	1	0.0%	-2 860	-100%	-10	-92%	CS	CS
Greece	11	2	3	0.1%	-8	-73%	0.5	18%	T2	T2
Hungary	134	4	6	0.2%	-128	-96%	2	61%	T1,T2	T1,T2
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	99	NO	NO	-	-99	-100%	-	-	NA	NA
Lithuania	148	9	7	0.2%	-141	-95%	-2	-20%	T2	T2
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	3 755	3 600	3 038	92.7%	-717	-19%	-561	-16%	T1,T2	T1,T2
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	65	66	65	2.0%	1	1%	-1	-2%	T1,T2	T1,T2
Slovakia	1	2	2	0.1%	1	40%	-0.1	-5%	T2	T2
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	37	NO	NO	-	-37	-100%	-	-	NA	NA
Sweden	157	NO	NO	-	-157	-100%	-	-	-	-
United Kingdom	50	NO	NO	-	-50	-100%	-	-	NA	NA
EU-27+UK	**9 734**	**3 866**	**3 279**	**100%**	**-6 455**	**-66%**	**-587**	**-15%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	50	NO	NO	-	-50	-100%	-	-	NA	NA
EU-KP	**9 734**	**3 866**	**3 279**	**100%**	**-6 455**	**-66%**	**-587**	**-15%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.165 and Figure **3.166** show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. Poland contributes to 93% of EU-KP emissions in 2019. Fuel consumption in the EU-KP decreased by 66% between 1990 and 2019. The CO_2 implied emission factor for solid fuels was 94.65 t/TJ in 2019.

Figure 3.165 1.A.4.c Agriculture/Forestry/Fisheries, solid fuels: Emission trend and share for CO_2

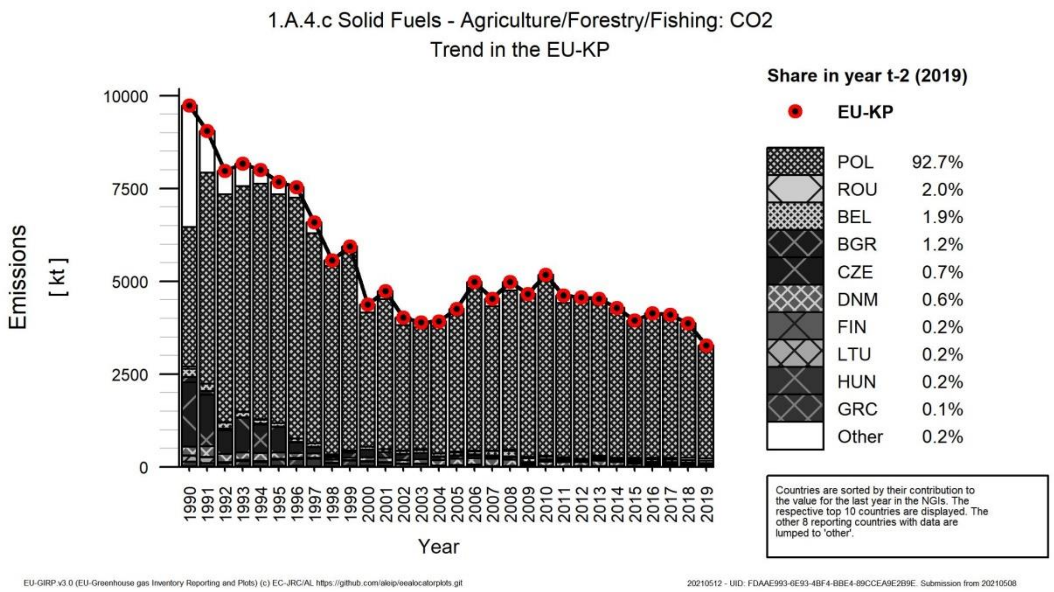
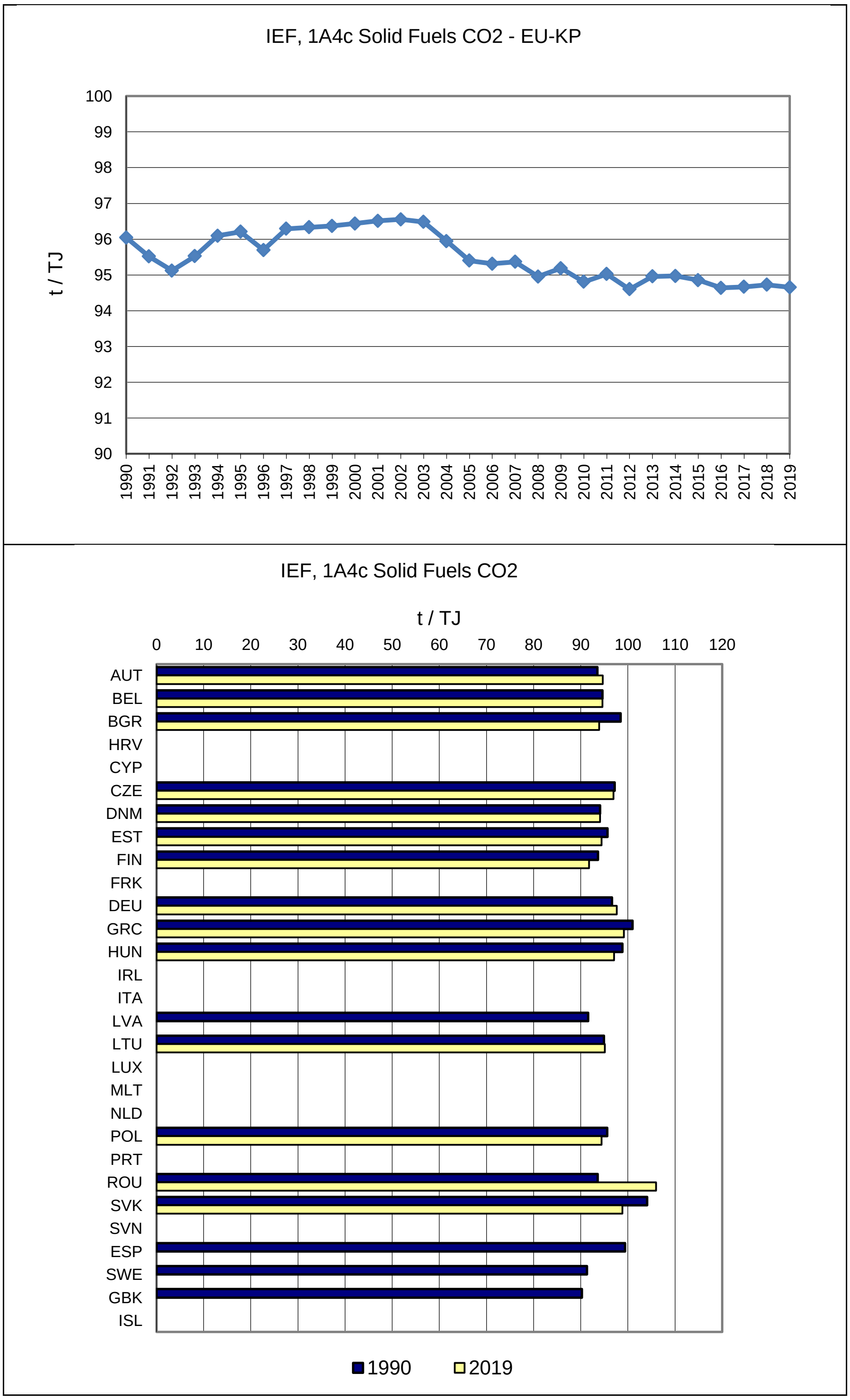


Figure 3.166 1.A.4.c Agriculture/Forestry/Fisheries, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.c Agriculture/Forestry/Fisheries –Gaseous Fuels (CO_2)

In 2019, CO_2 from gaseous fuels had a share of 15% within source category 1.A.4.c (compared to 13% in 1990). Between 1990 and 2019 CO_2 emissions decreased by 5% (Table 3.98). The highest absolute increase occurred in Belgium. Between 2018 and 2019, EU-KP emissions increased by 3%. This source of emissions is dominated by the Netherlands where natural gas is used for greenhouse horticulture.

According to the methodology as described in chapter 3.2.4 about 90% of EU-KP emissions are calculated by using higher tier methods in 2019.

Table 3.98 1.A.4.c Agriculture/Forestry/Fisheries, gaseous fuels: Member States' contributions to CO_2 emissions

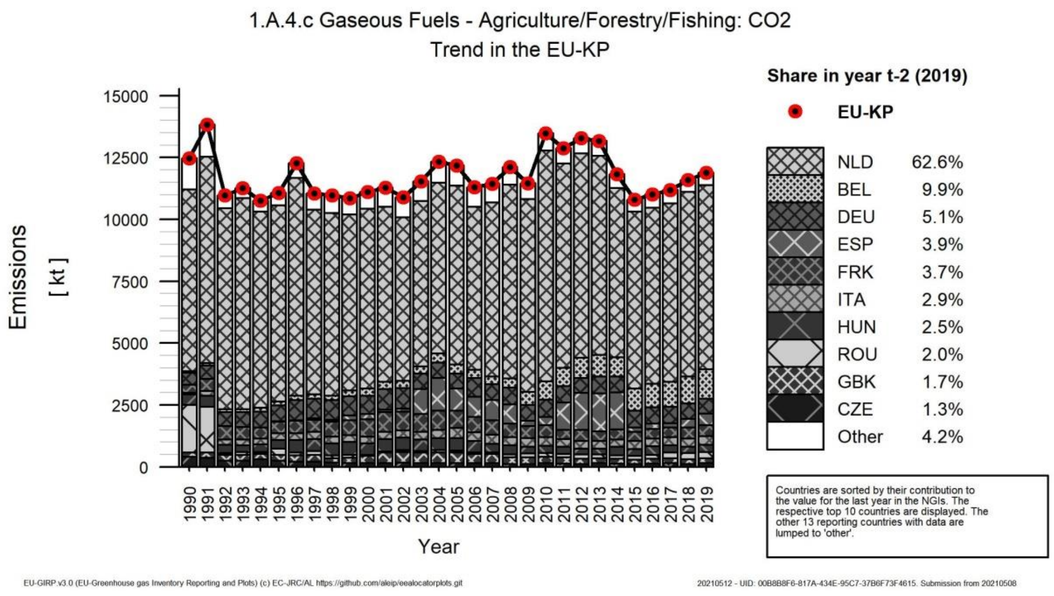
Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	20	50	60	0.5%	40	197%	10	20%	T2	T2
Belgium	67	1 091	1 181	9.9%	1 114	1651%	90	8%	T1	T1
Bulgaria	0	33	23	0.2%	23	11535%	-10	-31%	T2	T2
Croatia	48	46	52	0.4%	4	9%	6	14%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	405	123	152	1.3%	-254	-63%	29	24%	T2	T2
Denmark	126	99	91	0.8%	-36	-28%	-8	-8%	T3	T3
Estonia	4	10	9	0.1%	6	157%	0	-5%	T2	T2
Finland	32	2	2	0.0%	-30	-93%	0	0%	T2	T2
France	322	442	445	3.7%	123	38%	3	1%	T1,T2	T1,T2
Germany	483	605	609	5.1%	127	26%	5	1%	CS	CS
Greece	IE,NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Hungary	433	255	303	2.5%	-130	-30%	48	19%	T2	T2
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	52	331	342	2.9%	290	557%	11	3%	T2	T2
Latvia	782	28	25	0.2%	-757	-97%	-3	-10%	T2	T2
Lithuania	162	49	48	0.4%	-114	-70%	-1	-1%	T2	T2
Luxembourg	NO	0	0	0.0%	0	∞	0	5%	T2	T2
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	7 329	7 455	7 444	62.6%	115	2%	-12	0%	T1,T2	T1,T2
Poland	25	70	86	0.7%	61	248%	16	23%	T2	T2
Portugal	NO	22	30	0.3%	30	∞	9	41%	T2	T2
Romania	1 920	260	242	2.0%	-1 678	-87%	-18	-7%	T2	T2
Slovakia	41	63	58	0.5%	17	42%	-5	-8%	T2	T2
Slovenia	NO	NO	NO	-	-	-	-	-	-	-
Spain	6	356	462	3.9%	455	7393%	105	30%	T2	T2
Sweden	33	12	12	0.1%	-21	-64%	0	0%	-	-
United Kingdom	182	182	205	1.7%	23	13%	23	12%	T2	T2
EU-27+UK	**12 473**	**11 584**	**11 882**	**100%**	**-591**	**-5%**	**298**	**3%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	182	182	205	1.7%	23	13%	23	12%	T2	T2
EU-KP	**12 473**	**11 584**	**11 882**	**100%**	**-591**	**-5%**	**298**	**3%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.
Greece reports emissions from stationary combustion and off road machinery as 'NO' and emissions from fishing as 'IE.'

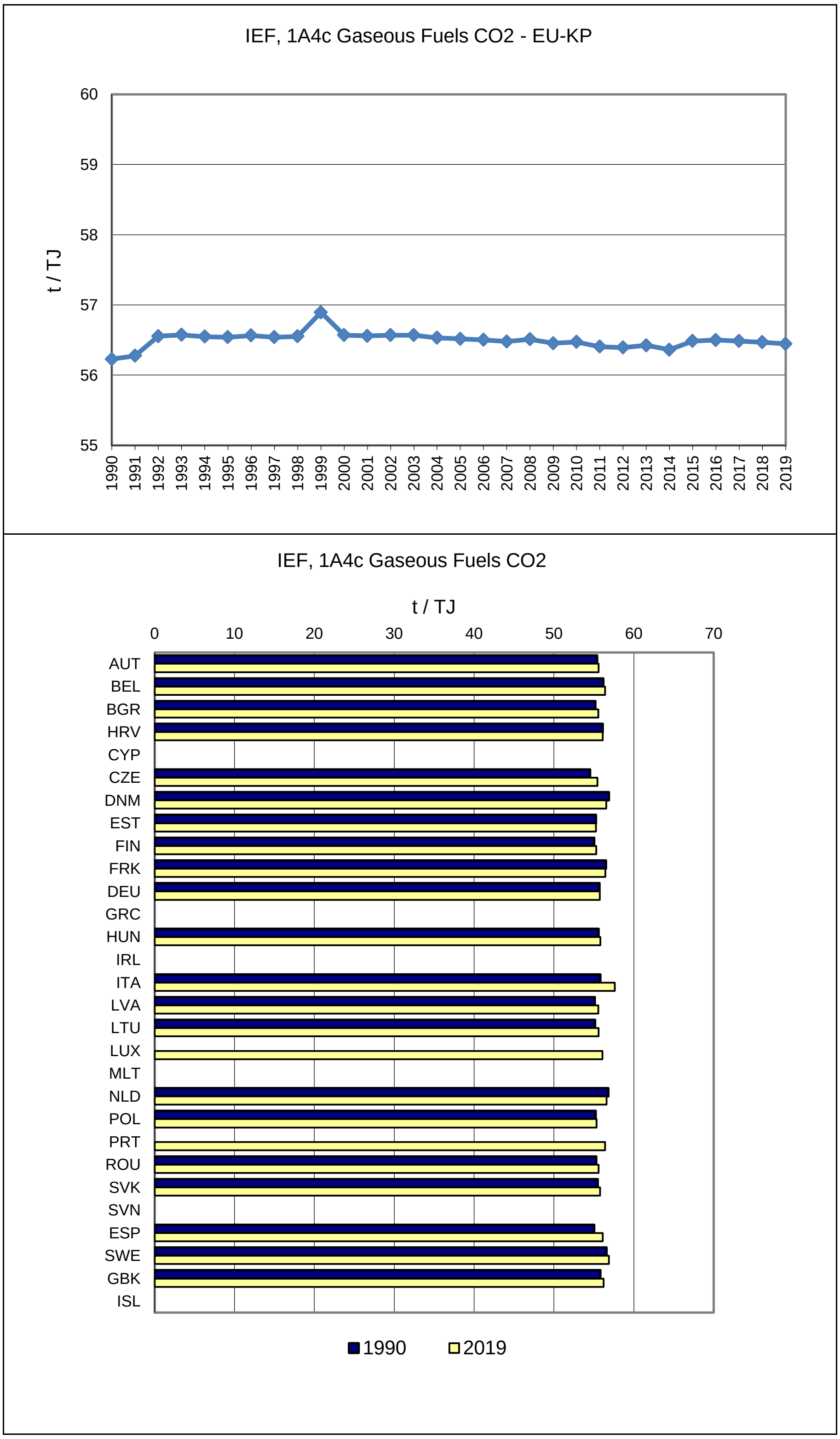
Figure 3.167 and

igure 3.168 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to the Netherlands, Belgium and Germany accounting for 78% of the CO_2 emissions from gaseous fuels in 1.A.4.c. Fuel consumption in the EU-KP decreased by 5% between 1990 and 2019. The CO_2 implied emission factor for gaseous fuels was 56.45 t/TJ in 2019.

Figure 3.167 1.A.4.c Agriculture/Forestry/Fisheries, gaseous fuels: Emission trend and share for CO_2



igure 3.168 1.A.4.c Agriculture/Forestry/Fisheries, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



3.2.5 Other (CRF Source Category 1.A.5.)

Source category 1.A.5. Other includes emissions from stationary and mobile military fuel use including aircraft. In 2019, category 1.A.5. contributed to 8 406 kt CO_2 equivalents of which 98.9% CO_2, 0.2% CH_4 and 0.9% N_2O.

Table 3.99: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 1.A.5. (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2019		1990	2019	
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	5945	6	T	0	0	100%
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	14259	4417	T	L	0	49%

Table 3.100 provides an overview of Member States' source allocation to Source Category 1.A.5 Other as reported in CRF Table1.A(a)s4.

Table 3.100 1.A.5. Other: Member States' allocation of sources

Member State	Source allocation to 1.A.5 Other
Austria	Stationary: Emissions are 'Not occurring' Mobile: Military use
Belgium	Stationary: Emissions are 'Not occurring' Mobile: Military use
Bulgaria	Stationary: Emissions are 'Not occurring' Mobile: Military aviation
Croatia	Stationary: Emissions are 'Not occurring' Mobile: Emissions are 'Not occurring' or 'Included elsewhere' (emissions from military aviation component and military water-borne component are reported under 1.A.3.b)
Cyprus	Stationary: Emissions reported from Liquid Fuels Mobile: aviation component
Czechia	Stationary: Emissions are 'Not occurring' Mobile: Other mobile sources not included elsewhere, Agriculture and Forestry and Fishing (emissions from aviation besides the public air transport, it is consumption of aviation fuels in the army in the state institutions (aerial vehicles from Integrated rescue system), or private air transport)
Denmark	Stationary: Emissions are 'Not occurring' Mobile: Military use, Recreational crafts
Estonia	Emissions are 'Not occurring'
Finland	Stationary: Includes emissions from non-specified consumption of fuels, military use and statistical corrections of fuel consumption Mobile: Emissions are 'Not occurring' or 'Included elsewhere' (notation key 'IE' is used instead of 'C' for confidential data in subcategory 1.A.5b)
France	Stationary: Other non specified Mobile: Emissions are 'Not occurring' or 'Included elsewhere' (under 1.A.5.a)
Germany	Stationary: Military use Mobile: Military use
Greece	Stationary: Emissions are 'Not occurring' Mobile: Other (not specified elsewhere)
Hungary	Stationary: Military use – Emissions from Gaseous Fuels Mobile: Military use – Emissions from Liquid Fuels
Ireland	Stationary: Emissions are 'Included elsewhere' (under 1.A.4.a) Mobile: Emissions are 'Included elsewhere' (under 1.A.3)
Iceland	Stationary: Other (not specified elsewhere) Mobile: Emissions are 'Not occurring'
Italy	Stationary: Emissions are 'Not occurring' Mobile: Military use
Latvia	Stationary: Emissions are 'Not occurring' Mobile: Aviation gasoline, diesel oil and jet kerosene, used in aircrafts and ships
Lithuania	Stationary: Emissions are 'Not occurring' Mobile: Military use

Member State	Source allocation to 1.A.5 Other
Luxembourg	Stationary: Building and Plant Site Fuel Powered Machinery. Emissions are reported for 1990-2003 and 'Not occurring' from 2004 on. Mobile: Military Vehicles
Malta	Stationary: Emissions are 'Not occurring' Mobile: Military use
Netherlands	Stationary: Emissions are 'Not occurring' Mobile: military use
Poland	Stationary: Emissions are 'Included elsewhere' (without specification of allocation) Mobile: Emissions are 'Not occurring'
Portugal	Stationary: Emissions are 'Not occurring' Mobile: Military aviation
Romania	Stationary: Other sectors - Not elsewhere specified Mobile: Emissions are 'Included elsewhere' (under 1.A.5.a)
Slovakia	Stationary: Other, emissions from fuel combustion in stationary sources that are not specified elsewhere Mobile: Military use Jet Kerosene, Gasoline, Diesel Oil
Slovenia	Stationary: Emissions are 'Not occurring' Mobile: Military use
Spain	Stationary: Emissions are 'Not occurring' or 'Included elsewhere' (Included in 1.A.4.a.i - Military reference activity data are not separated from civil data, and their emissions are estimated together with the same methodology) Mobile: Military use
Sweden	Stationary: Emissions are 'Not occurring' Mobile: Military use
United Kingdom	Stationary: Emissions are 'Included elsewhere' (Stationary combustion for military purposes is not reported separately in UK energy statistics and is allocated under 1.A.4.a.) Mobile: Military aviation and naval shipping

Figure 3.169 shows the total trend within source category 1.A.5. and the dominating emission sources: CO_2 emissions from 1.A.5.b Mobile and from 1.A.5.a Stationary. Total GHG emissions of source category 1.A.5. decreased by 70% between 1990 and 2019. Germany has the most influence on the overall trend; it reports minus 92% of CO_2 emissions since 1990 and contributes to 43% in 1990. The German NIR states that only military sources (incl. aircraft) are included in its inventory. Since 1996 the United Kingdom has a main share and contributes 21% of CO_2 emissions in 2019. The United Kingdom reports military aircraft and naval shipping within this category.

Figure 3.169 1.A.5 Other: Total and CO_2 emission and activity trends

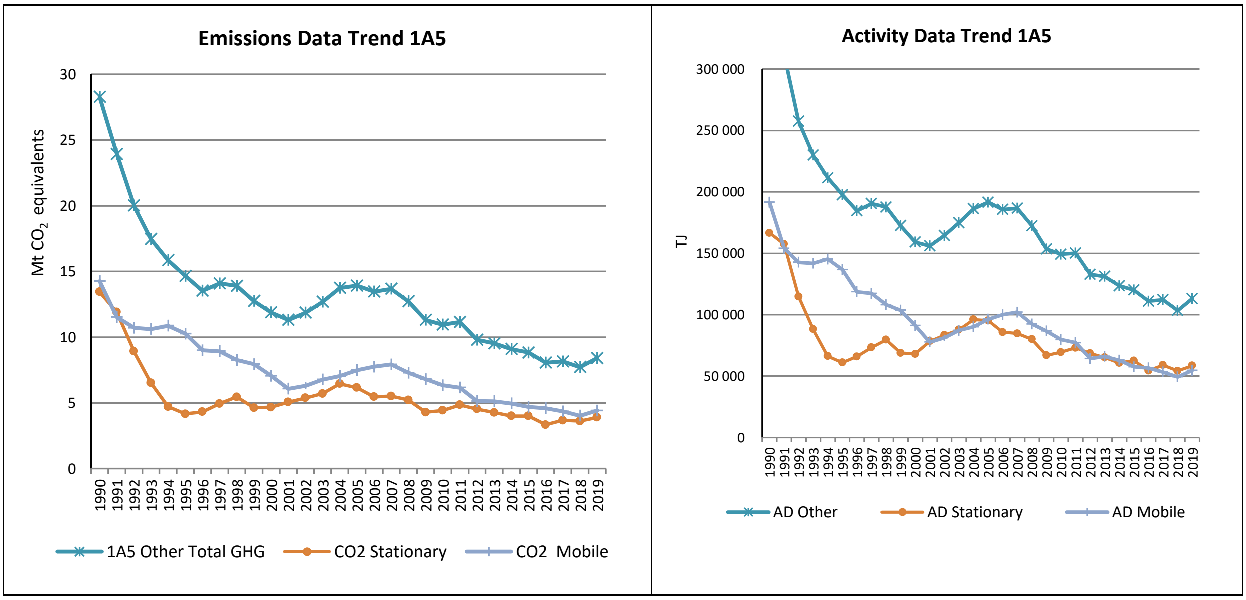


Table 3.101 shows total GHG and CO_2 emissions by Member State from 1.A.5. CO_2 emissions from 1.A.5 Other accounted for 0.2% of total EU-KP GHG emissions in 2019 in 1.A. Between 1990 and 2019, CO_2 emissions from this source decreased by 70% in the EU-KP. Between 1990 and 2019, the largest reduction in absolute terms was reported by Germany, which was partly due to reduced military operations after German reunification.

Table 3.101 1.A.5. Other: Member States' contributions to CO_2 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2019 (kt)
Austria	36	52	35	51
Belgium	174	104	172	103
Bulgaria	86	14	86	14
Croatia	IE,NO	IE,NO	NO,IE	NO,IE
Cyprus	11	26	11	26
Czechia	194	303	192	294
Denmark	170	200	167	198
Estonia	NO	NO	NO	NO
Finland	1 143	1 128	1 131	1 116
France	4 505	1 620	4 464	1 609
Germany	12 138	922	11 797	917
Greece	IE,NO	135	NO,IE	134
Hungary	15	65	15	65
Ireland	IE	IE	IE	IE
Italy	1 143	467	1 071	453
Latvia	NE,NO	24	NO,NE	24
Lithuania	0	29	0	29
Luxembourg	3	0	3	0
Malta	3	2	3	2
Netherlands	320	162	314	159
Poland	IE,NO	IE,NO	NO,IE	NO,IE
Portugal	97	61	96	61
Romania	1 220	630	1 212	628
Slovakia	479	84	476	83
Slovenia	32	4	32	4
Spain	301	452	298	448
Sweden	862	184	845	181
United Kingdom	5 353	1 735	5 293	1 716
EU-27+ISL	**28 286**	**8 404**	**27 712**	**8 313**
Iceland	0	2	0	2
United Kingdom (KP)	5 353	1 735	5 293	1 716
EU-KP	**28 286**	**8 406**	**27 713**	**8 315**

Croatia reports that 'military aviation component and military water-borne component' are included in 1.A.3.b.
Ireland reports that emissions of military use stationary combustion are included in 1.A.4.a and that emissions from 1.A.5.b military are included in 1.A.3
Poland reports emissions from stationary combustion as 'IE' without specification of the allocation.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3.102 provides information on the contribution of Member States to EU27+UK recalculations in CO_2 from 1.A.5 Other for 1990 and 2018 and main explanations for the largest recalculations in absolute terms.

Table 3.1021.A.5 Other: Contribution of MS to EU-KP recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

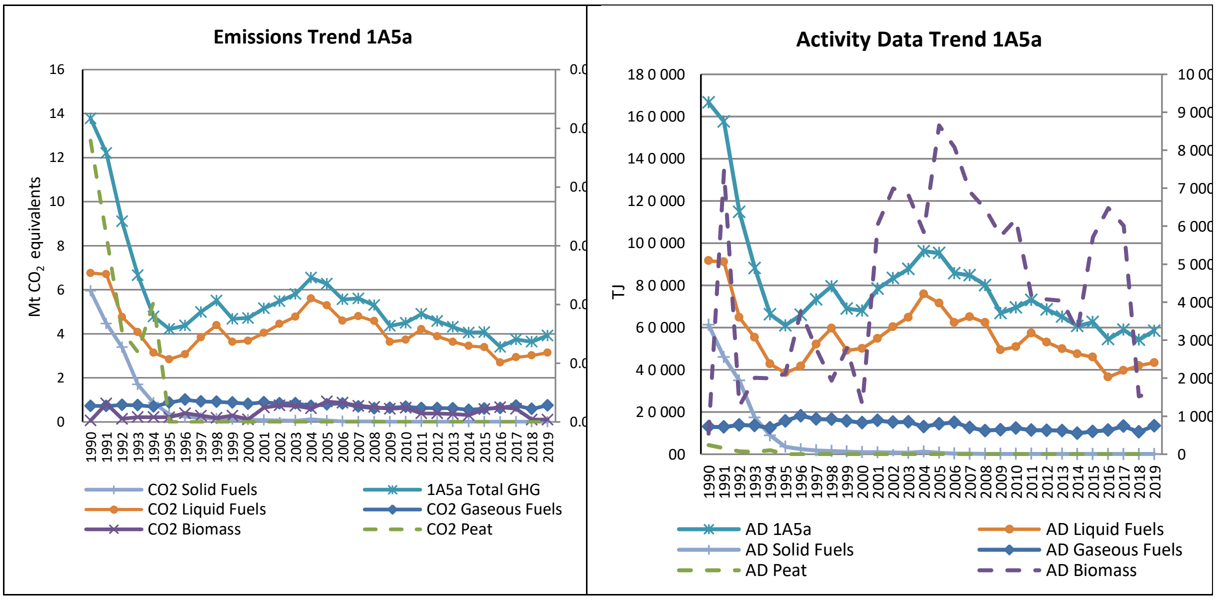
Member State	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-0.0	-0.0	
Belgium	0.0	0.0	8.3	7.8	Update in Walloon energy balance
Bulgaria	86	100	31	100	
Croatia	-	-	-	-	

Member State	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
Cyprus	-0.0	-0.0	2.7	11	The recalculation for the emissions for the total liquid fuels for 1.A.5.a was due to the inclusion of LPG for the years 2013-2018
Czechia	-0.0	-0.0	-	-	
Denmark	-	-	-	-	
Estonia	-43	-100	-50	-100	Emissions were recalculated due to using Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, instead of national energy balance. The fuel consumption and emissions are reported under 1.A.4.a category.
Finland	-	-	36	3.8	Corrections in other sectors are reflected here
France	4 464	100	1 417	100	Allocation of part of the 1.A.4.a consumption in the 1.A.5 for consistency with the energy balance this year (item 1.A.5 was not used in the previous edition).
Germany	-	-	0.9	0.1	Minor recalculations in the area of solid fuels were carried out for the year 2018, to take account of updating of net calorific values
Greece	-	-	-	-	
Hungary	-	-	45	159	Stationary combustion has been included (reallocated from 1.A.4.a)
Ireland	-	-	-	-	
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Luxembourg	-0.0	-0.0	0.0	0.0	
Malta	-	-	-0.0	-0.0	
Netherlands	-	-	-0.0	-0.0	
Poland	-	-	-	-	
Portugal	-0.0	-0.0	0.0	0.0	
Romania	-	-	11	1.7	An error has been detected and solved in the context of the calculation file; this has resulted in the update of emissions
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	0.0	0.0	-0.1	-0.0	All pollutants for the entire series: recalculations are mainly due to changes related to military air transport (corrections for year 2018 in aviation gasoline EF), maritime transport (update to EMEP 2019 EF) and road transport (changes in fuel specifications and also minor changes in lubricant consumption estimates).
Sweden	-	-	-	-	
United Kingdom	-	-	7.0	0.4	There are only minor recalculations to emission factors due to updated DfT port statistics used to derive the time-series.
EU27+UK	**4 507**	**19**	**1 509**	**25**	
Iceland	0.1	100	-0.2	-23	For previous submission this sector was reported as IE for 1990-2002. Now these years have been estimated. This does not increase the total emissions from the energy sector as these emissions were accounted under 1A2gvii in previous submissions.
United Kingdom (KP)	-	-	7.0	0.4	There are only minor recalculations to emission factors due to updated DfT port statistics used to derive the time-series.
EU-KP	**4 507**	**19**	**1 509**	**25**	

3.2.5.1 Stationary (1.A.5.a)

In this chapter information about emission trends, Member States' contribution, activity data, and emission factors is provided for category 1.A.5.a by fuels. CO_2 emissions from 1.A.5.a Stationary accounted for 0.1% of total GHG emissions in 1.A in 2019. Figure 3.170 shows the emission trend within the categories 1.A.5.a, which is mainly dominated by CO_2 emissions from solid and liquid fuels for 1990 to 1993 and dominated by liquid fuels from 1994 on. The reduction in the early 1990s was driven by CO_2 from solid fuels. Total emissions decreased by 71%, mainly due to decreases in emissions from solid fuels (-99.9%) and liquid fuels (-54%).

Figure 3.170 1.A.5.a Stationary: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Only seven Member States and Iceland reported emissions from this key source in 2019 (Table 3.103). Luxembourg reported emissions for 1990 - 2003. Hungary reports emissions since 2015. Between 1990 and 2019, Germany reported the highest absolute decrease which also affected overall decreasing trend. Between 2018 and 2019 CO_2 emissions increased by 8%.

Table 3.103 1.A.5.a Stationary: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	11	22	22	0.6%	11	98%	0	-1%	T1	D
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 131	981	1 116	28.6%	-14	-1%	135	14%	T2	CS
France	4 464	1 417	1 609	41.3%	-2 856	-64%	191	13%	NA	NA
Germany	6 227	444	409	10.5%	-5 818	-93%	-35	-8%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	IE	45	39	1.0%	39	∞	-6	-12%	T2	CS
Ireland	IE	IE	IE	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	3	NO	NO	-	-3	-100%	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	IE	IE	IE	-	-	-	-	-	NA	NA
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	1 212	628	628	16.1%	-584	-48%	0	0%	T1,T2	CS,D
Slovakia	406	76	72	1.8%	-334	-82%	-4	-5%	T2	CS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	IE	IE	IE	-	-	-	-	-	NA	NA
EU-27+UK	**13 454**	**3 614**	**3 895**	**100%**	**-9 558**	**-71%**	**281**	**8%**	**-**	**-**
Iceland	0	1	2	0.0%	2	1283%	1	222%	T1	D
United Kingdom (KP)	IE	IE	IE	-	-	-	-	-	NA	NA
EU-KP	**13 454**	**3 614**	**3 897**	**100%**	**-9 557**	**-71%**	**283**	**8%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Spain reports, that military reference activity data are not separated from civil data and that those emissions are estimated together in 1.A.4.a.i by applying the same methodology.
The United Kingdom reports, that stationary combustion for military purposes is not reported separately in UK energy statistics and that it is allocated under 1.A.4.a.
Ireland reports that emissions of military use stationary combustion are included in 1.A.4.a.

1.A.5.a Stationary – Solid Fuels (CO_2)

In 2019 CO_2 from solid fuels had a share of 0.1% within source category 1.A.5.a (compared to 44% in 1990). Between 1990 and 2019, CO_2 emissions decreased by nearly 100% (Table 3.104). In 2019, only Germany and Slovakia reported emissions for this key category. The main reason for the strong decline of emissions in the early 1990s was the closure of military barracks after the German reunification and the phase out of coal use for combustion in buildings.

Ireland reports that emissions of military use stationary combustion are included in 1.A.4.a. Spain reports, that military reference activity data are not separated from civil data and that those emissions are estimated together in 1.A.4.a.i by applying the same methodology. The United Kingdom reports, that stationary combustion for military purposes is not reported separately in UK energy statistics and that it is allocated under 1.A.4.a.

According to the methodology as described in chapter 3.2.1 100% of EU-KP emissions are calculated by using higher tier methods in 2019.

Table 3.104 1.A.5.a Stationary, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	NO	NO	NO	-	-	-	-	-
Estonia	NO	NO	NO	-	-	-	-	-
Finland	1	NO	NO	-	-1	-100%	-	-
France	NO	NO	NO	-	-	-	-	-
Germany	4 553	7	4	70.2%	-4 549	-100%	-3	-41%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	-	-	-	-	-	-	-	-
Ireland	IE	IE	IE	-	-	-	-	-
Italy	NO	NO	NO	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-
Poland	IE	IE	IE	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	1 174	NO	NO	-	-1 174	-100%	-	-
Slovakia	216	2	2	29.8%	-214	-99%	0	-14%
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	IE	IE	IE	-	-	-	-	-
Sweden	NO	NO	NO	-	-	-	-	-
United Kingdom	IE	IE	IE	-	-	-	-	-
EU-27+UK	**5 945**	**9**	**6**	**100%**	**-5 939**	**-100%**	**-3**	**-35%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	IE	IE	IE	-	-	-	-	-
EU-KP	**5 945**	**9**	**6**	**100%**	**-5 939**	**-100%**	**-3**	**-35%**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

Figure 3.171 shows CO_2 emissions for EU27+UK. Germany accounts for 70% of EU-KP CO_2 emissions from this source category. Fuel combustion in the EU-KP decreased by 99.9% between 1990 and 2019. The CO_2 implied emission factor for solid fuels was 99.3 t/TJ in 2019.

Figure 3.171 1.A.5.a Stationary, solid fuels: Emission trend and share for CO_2

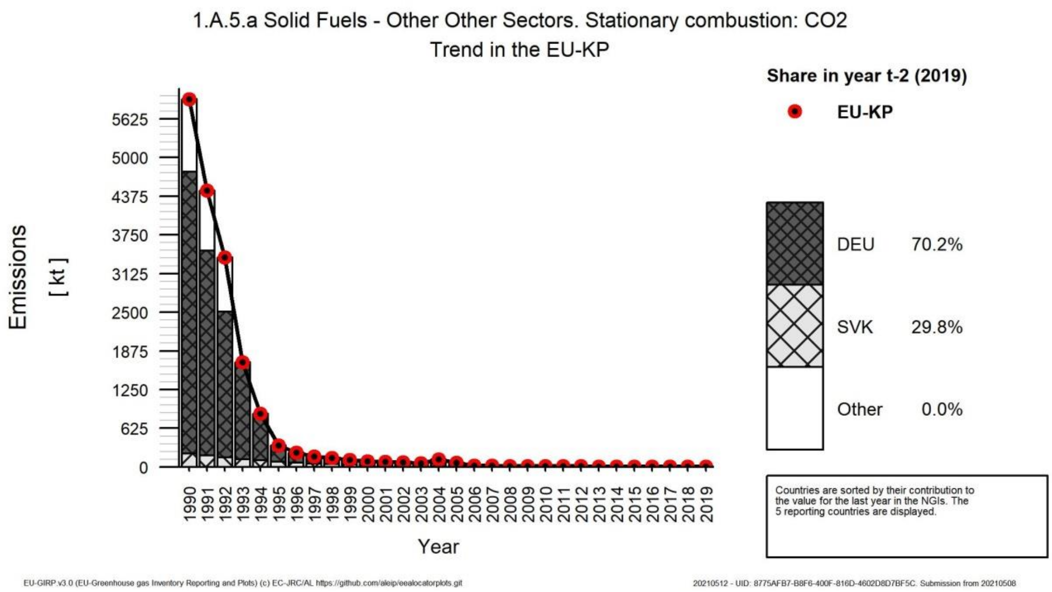
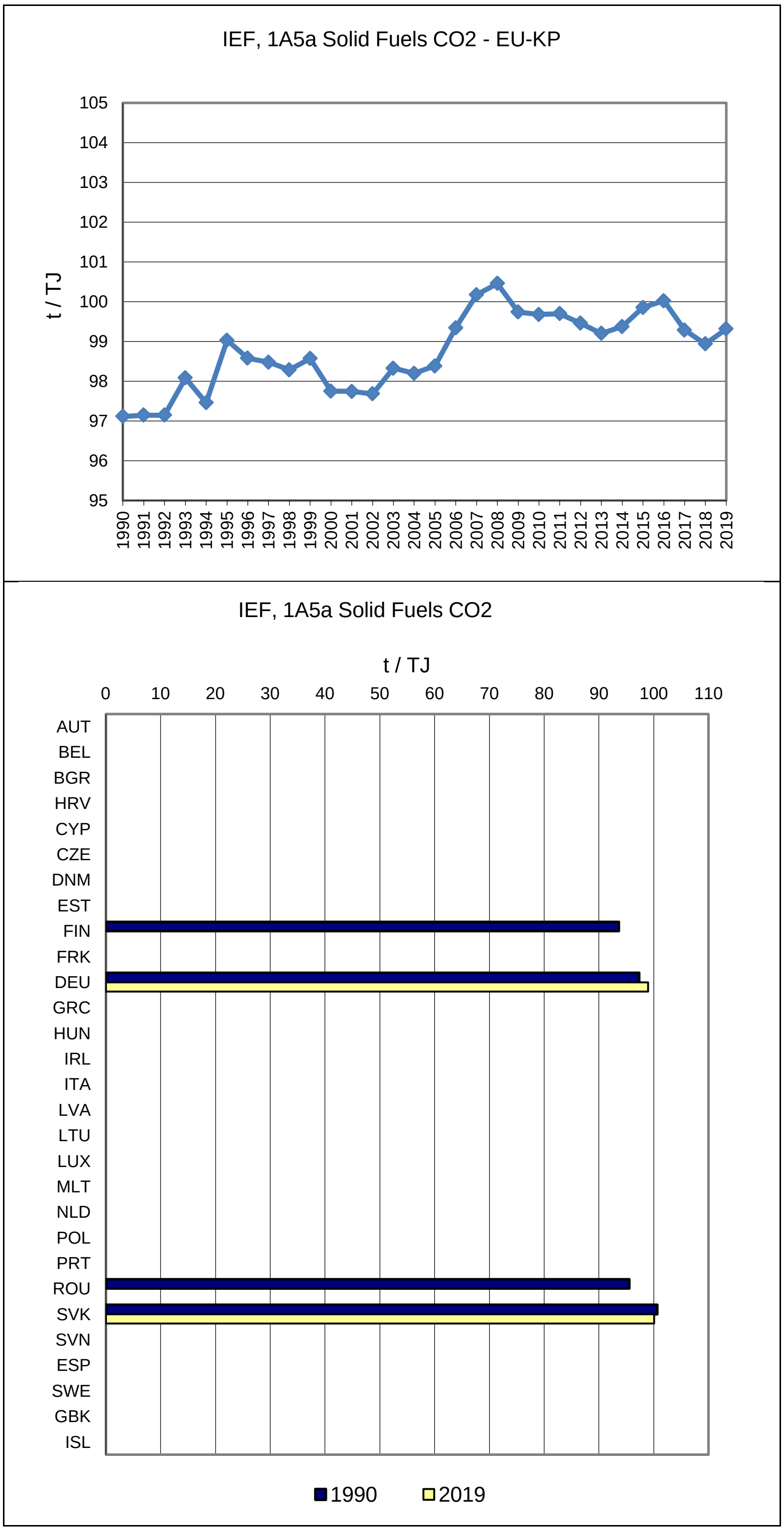


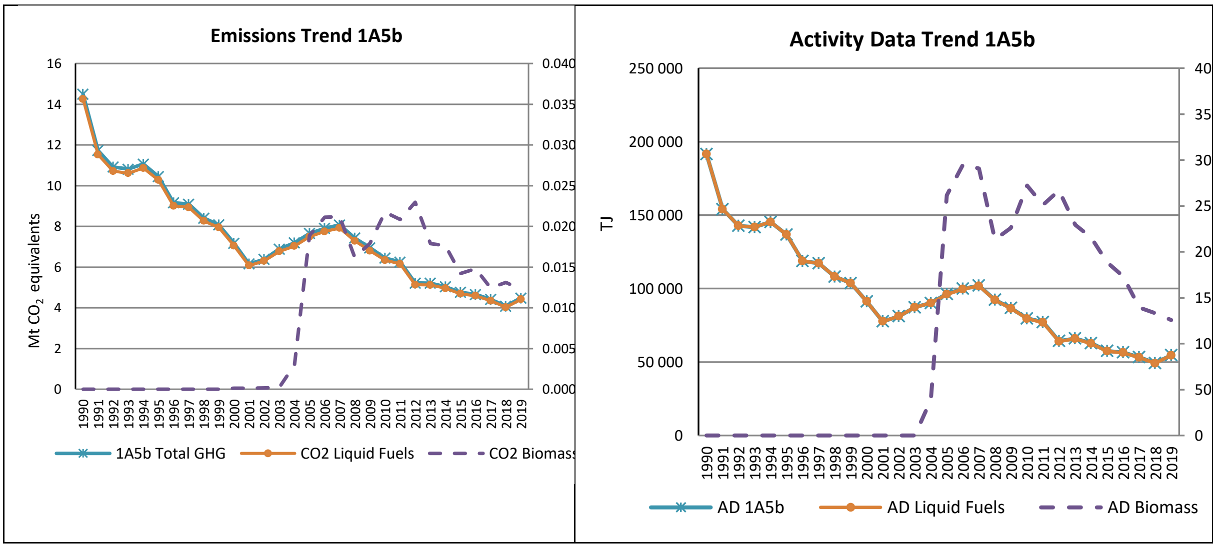
Figure 3.172 1.A.5.a Stationary, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)



3.2.5.2 Mobile (1.A.5.b)

In this chapter information about emission trends, Member States' contribution and activity data is provided for category 1.A.5.b by fuels. CO_2 emissions from 1.A.5.b Mobile accounted for 0.1% of total EU-KP GHG emissions in 1.A in 2019. Figure 3.173 shows the emission trend within the category 1.A.5.b, which is dominated by CO_2 emissions from liquid fuels. Total CO_2 emissions decreased by 69%.

Figure 3.173 1.A.5.b Mobile: Total and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Seven Member States and Iceland reported emissions as 'Not occurring' or 'Included elsewhere'. The United Kingdom had the highest share on emissions in 2019 and – together with Germany - decreased the most in absolute terms between 1990 and 2019. The EU-KP emissions increased by 10% between 2018 and 2019.

"Included elsewhere" often indicates, that the country reports these emissions under 1.A.3 Transport or 1.A.5.a.

Table 3.105 1.A.5.b Mobile: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	35	51	51	1.2%	16	47%	1	1%	T1,T2	CS,D
Belgium	172	114	103	2.3%	-69	-40%	-11	-10%	CS,T1,T3	D
Bulgaria	86	31	14	0.3%	-72	-84%	-17	-56%	T1	D
Croatia	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Cyprus	NO	5	4	0.1%	4	∞	-1	-12%	T1	D
Czechia	192	312	294	6.6%	102	53%	-19	-6%	T1	D
Denmark	167	215	198	4.5%	31	19%	-17	-8%	CR,M,T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
France	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Germany	5 570	305	508	11.5%	-5 063	-91%	203	67%	CS,D,M	CS,D
Greece	NO,IE	123	134	3.0%	134	∞	11	9%	T1	D
Hungary	15	28	25	0.6%	11	74%	-3	-11%	T2	CS
Ireland	IE	IE	IE	-	-	-	-	-	NA	NA
Italy	1 071	341	453	10.3%	-618	-58%	112	33%	T2	CS
Latvia	NO,NE	20	24	0.5%	24	∞	4	19%	T1	D
Lithuania	0	20	29	0.7%	29	7996%	9	44%	T2	CS
Luxembourg	0	0	0	0.0%	0	-11%	0	0%	T1,T2	CS,D
Malta	3	3	2	0.0%	-1	-37%	-2	-52%	T1,T3	CS,D
Netherlands	314	152	159	3.6%	-155	-49%	7	5%	T2	CS
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	96	59	61	1.4%	-36	-37%	2	3%	T1	D
Romania	IE	IE	IE	-	-	-	-	-	NA	NA
Slovakia	70	12	11	0.2%	-59	-84%	-1	-11%	T1,T2	D
Slovenia	32	4	4	0.1%	-28	-87%	0	3%	T1	D
Spain	298	447	448	10.1%	151	51%	1	0%	T1,T2	CS,D,M
Sweden	845	167	181	4.1%	-664	-79%	14	8%	NA	NA
United Kingdom	5 293	1 616	1 716	38.8%	-3 578	-68%	99	6%	T1	CS
EU-27+UK	**14 259**	**4 026**	**4 418**	**100%**	**-9 841**	**-69%**	**392**	**10%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	5 293	1 616	1 716	38.8%	-3 578	-68%	99	6%	T1	CS
EU-KP	**14 259**	**4 026**	**4 418**	**100%**	**-9 841**	**-69%**	**392**	**10%**	**-**	**-**

Croatia reports emissions from military aviation and navy in category 1.A.3.b.
Finland reports emissions from military activities as 'IE' for reasons of confidentiality.
France and Romania report emissions in category 1.A.5.a
Ireland reports emission from military activities in category 1.A.3.
Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.5.b Mobile – Liquid Fuels (CO_2)

In 2019, CO_2 from liquid fuels had a share of 99.9% within source category 1.A.5.b (compared to 100% in 1990). Between 1990 and 2019 CO_2 decreased by 69% (Table 3.106 **1.A.5.b Mobile, liquid** fuels: Member States' contributions to CO2 emissions). Seven Member States and Iceland reported emissions as 'Not occurring' or 'Included Elsewhere' in 2019. The highest decrease in absolute terms was achieved in Germany and the United Kingdom while Spain, Greece and Czechia had the largest increases.

According to the methodology as described in chapter 3.2.1 about 49% of EU-KP emissions are calculated by using higher tier methods in 2019.

Table 3.106 1.A.5.b Mobile, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	35	51	51	1.2%	16	47%	1	1%
Belgium	172	114	103	2.3%	-69	-40%	-11	-10%
Bulgaria	86	31	14	0.3%	-72	-84%	-17	-56%
Croatia	IE	IE	IE	-	-	-	-	-
Cyprus	NO	5	4	0.1%	4	∞	-1	-12%
Czechia	192	312	294	6.6%	102	53%	-19	-6%
Denmark	167	215	198	4.5%	31	19%	-17	-8%
Estonia	NO	NO	NO	-	-	-	-	-
Finland	IE	IE	IE	-	-	-	-	-
France	IE	IE	IE	-	-	-	-	-
Germany	5 570	304	507	11.5%	-5 063	-91%	203	67%
Greece	IE	123	134	3.0%	134	∞	11	9%
Hungary	15	28	25	0.6%	11	74%	-3	-11%
Ireland	IE	IE	IE	-	-	-	-	-
Italy	1 071	341	453	10.3%	-618	-58%	112	33%
Latvia	NE	20	24	0.5%	24	∞	4	19%
Lithuania	0	20	29	0.7%	29	7996%	9	44%
Luxembourg	0	0	0	0.0%	0	-11%	0	0%
Malta	3	3	2	0.0%	-1	-37%	-2	-52%
Netherlands	314	152	159	3.6%	-155	-49%	7	5%
Poland	NO	NO	NO	-	-	-	-	-
Portugal	96	59	61	1.4%	-36	-37%	2	3%
Romania	IE	IE	IE	-	-	-	-	-
Slovakia	70	12	11	0.2%	-59	-84%	-1	-11%
Slovenia	32	4	4	0.1%	-28	-87%	0	3%
Spain	298	447	448	10.1%	150	50%	1	0%
Sweden	845	167	181	4.1%	-664	-79%	14	8%
United Kingdom	5 293	1 616	1 716	38.8%	-3 578	-68%	99	6%
EU-27+UK	**14 259**	**4 025**	**4 417**	**100%**	**-9 842**	**-69%**	**392**	**10%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	5 293	1 616	1 716	38.8%	-3 578	-68%	99	6%
EU-KP	**14 259**	**4 025**	**4 417**	**100%**	**-9 842**	**-69%**	**392**	**10%**

*Information on methods and emission factors are identical with those described in Table **3.105** as emissions from this source only occur in liquid fuels*
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.174 shows CO_2 emissions for EU-KP and the Member States. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) correspond to the United Kingdom, Germany, Italy, Spain and Czechia; together they cause 77% of the CO_2 emissions from liquid fuels in 1.A.5.b. Fuel consumption in the EU-KP decreased by 69% between 1990 and 2019. The CO_2 implied emission factor for liquid fuels was 81.0 t/TJ in 2019. The IEF is comparably high because Spain reports activity data as confidential. This also explains the increasing trend of the EU IEF because the share of Spain in EU emissions increased from 2 % in 1990 to 10 % in 2019.

Figure 3.174 1.A.5.b Mobile, liquid fuels: Emission trend and share for CO_2

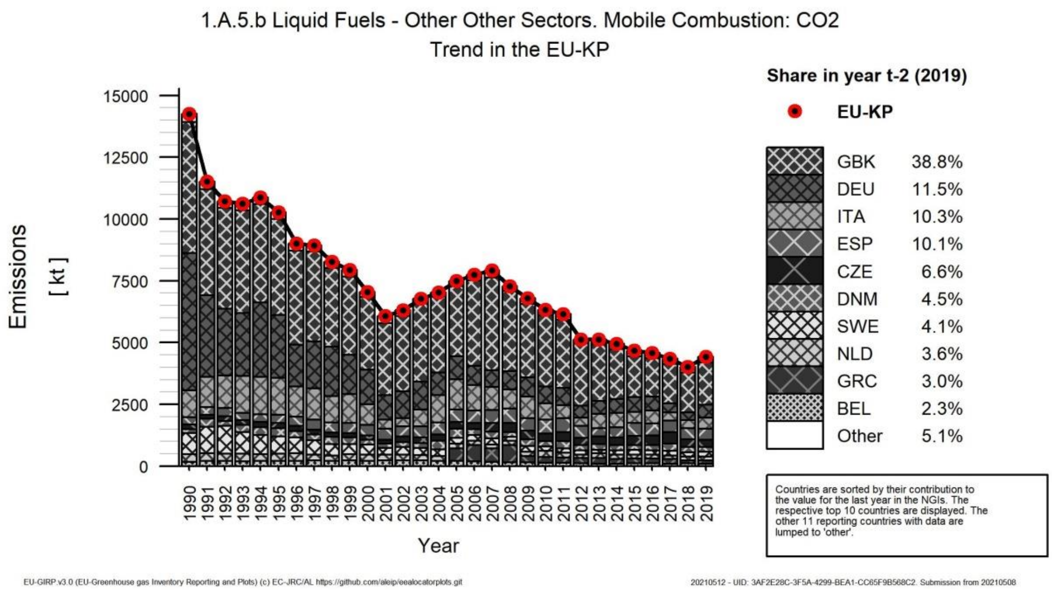
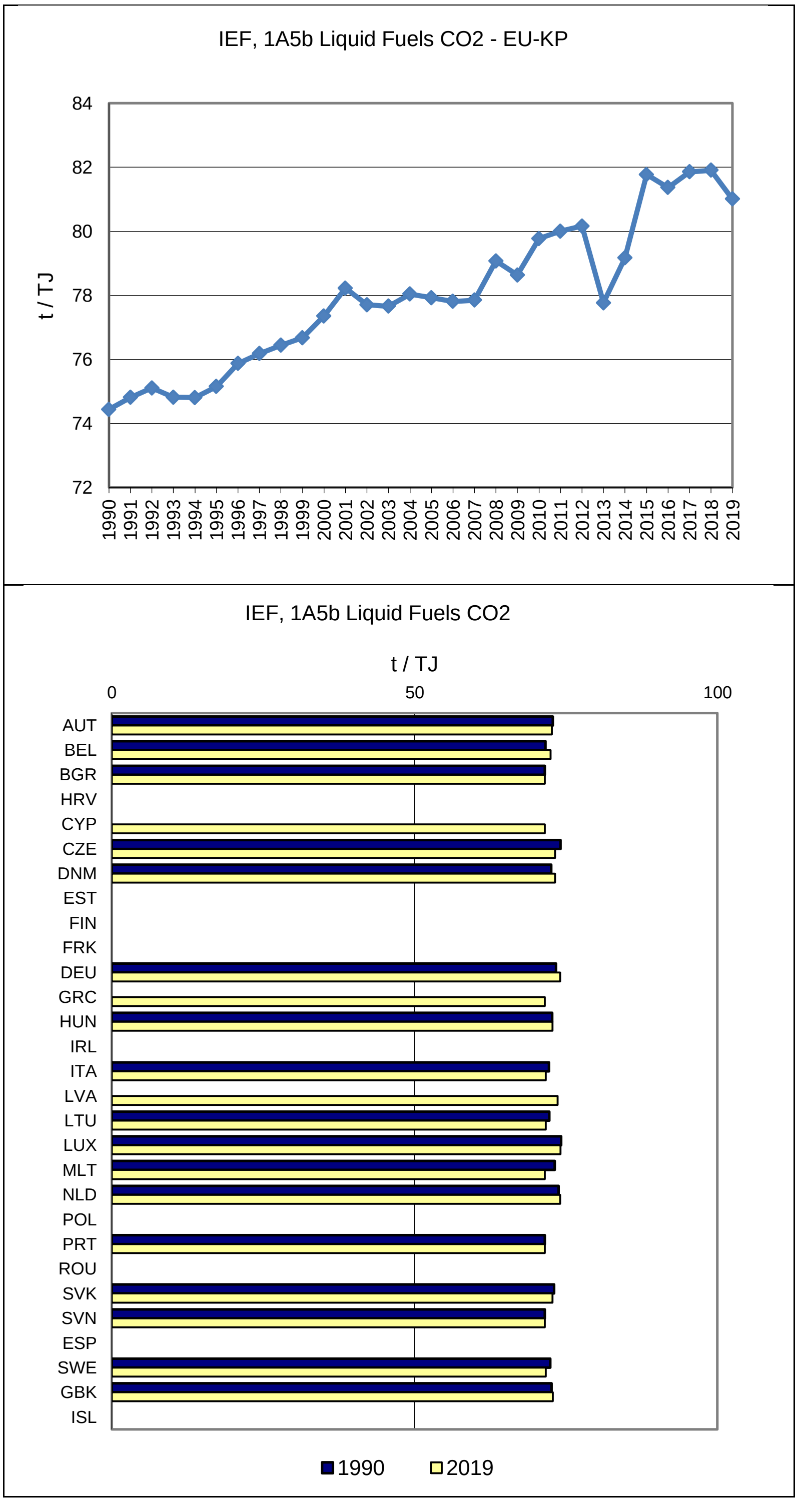


Figure 3.175 1.A.5.b Mobile, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

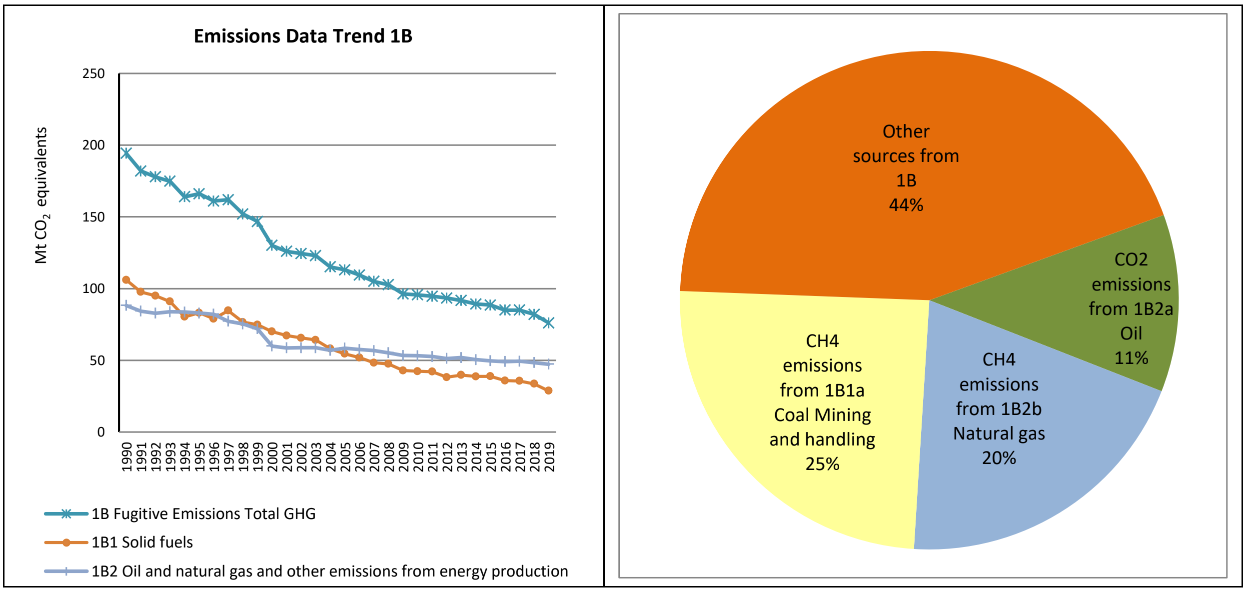


3.2.6 Fugitive emissions from fuels (CRF Source Category 1.B)

This chapter describes gaseous or volatile emissions, which occur during extraction, handling and consumption of fossil fuels. In the 2006 IPCC Guidelines fugitive emissions are defined as intentional or unintentional releases of gases from anthropogenic activities that in particular may arise from the production, processing, transmission, storage and use of fuels. Emissions from combustion are only included where it does not support a productive activity (e.g., flaring of natural gases at oil and gas production facilities). Evaporative emissions from vehicles are included under Road Transport as Subsection 1A3b v (2006 IPCC Guidelines).

In 2019, in terms of CO_2 equivalents, about 67% of emissions from source category 1.B were fugitive CH_4 emissions while 33% were fugitive CO_2 emissions. Together, they represent 2 % of total GHG emissions in the EU-KP. Fugitive GHG emissions have been steadily declining (Figure 3.176). Between 1990 and 2019, the total fugitive GHG emissions decreased by 61 %. This was mainly due to the decrease in underground mining activities: CH_4 emissions from underground mining activities have decreased by 77 % since 1990 (Figure 3.179) and decreases in CH_4 emissions from category 1B1a1i underground mines are responsible for 62 % of the total decrease of fugitive emissions. Between 1990 and 2019, GHG emissions from 1.B.1 Solid Fuels decreased by 73 % Figure 3.177), while emissions from 1.B.2 Oil and Natural Gas decreased only by 46 % (Figure 3.177). While emissions from 1.B.1 Solid Fuels and 1.B.2 Oil and Natural Gas each were responsible for roughly 55 % (1.B.1) and 45 % (1.B.2) of total fugitive emissions in 1990, fugitive emissions from 1.B.1 Solid Fuels represented only 38 % of total fugitive emissions in 2019 (Figure 3.176).

Figure 3.176 1.B Fugitive Emission from Fuel: GHG Emissions trend and proportion of fugitive emissions within source category



Fugitive emissions includes five key sources:

Table 3.107: Key source categories for level and trend analyses and share of countries emissions using higher tier methods in sector 1.B (table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2019		1990	2019	
1.B.1.a Coal Mining and Handling: Operation (CH_4)	97099	24842	T	L	L	82%
1.B.2.a Oil: Operation (CH_4)	6792	1104	T	0	0	55%
1.B.2.a Oil: Operation (CO_2)	9451	11611	T	L	L	82%
1.B.2.b Natural Gas: Operation (CH_4)	51916	20231	T	L	L	80%
1.B.2.c Venting and Flaring: Operation (CO_2)	8665	6571	0	L	L	77%

The two largest key sources (CH_4 emissions from 1.B.1.a Coal Mining and Handling and 1.B.2.b Natural Gas) account together for 59 % of total fugitive GHG emissions (Figure 3.176).

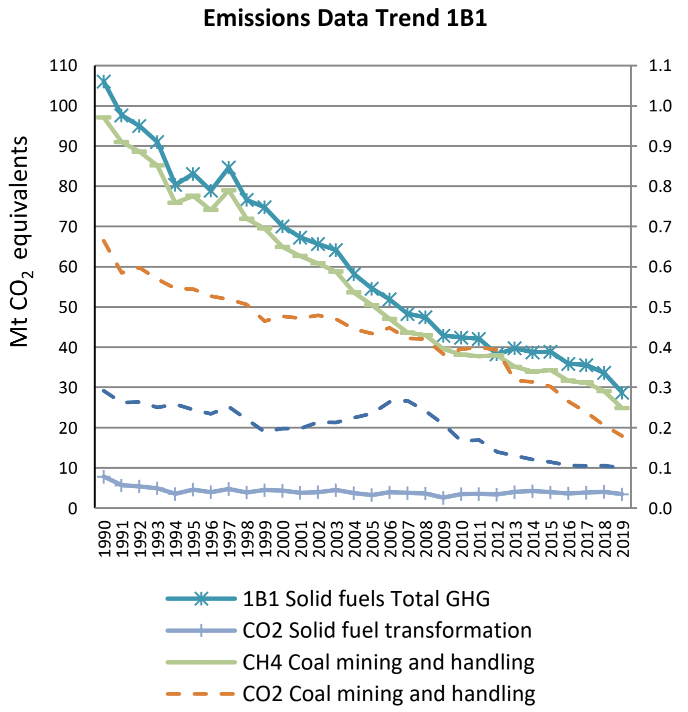
3.2.6.1 Fugitive emissions from Solid Fuels (1.B.1)

In the 2006 IPCC Guidelines fugitive emissions from solid fuels are defined as the intentional or unintentional release of greenhouse gases that may occur during the extraction, processing and delivery of fossil fuels to the point of final use. Combustion emissions from colliery methane recovered and used are excluded here and reported under Fuel Combustion Emissions. Coal mining data reported to the IEA include also peat extraction, which is not included in the CRF. Five countries (Denmark, Estonia, Finland, Latvia and Lithuania) have peat extraction but no coal mining.

In 2019 fugitive emissions from solid fuels accounted for 0.7 % of the total GHG emissions in the EU-KP and 38 % of total fugitive emissions:

- 86 % of fugitive emissions from solid fuels were CH_4 emissions from coal mining. The emissions arise due to the natural production of methane when coal is formed. Methane is partly stored within the coal seam and escapes when mined. Most CH_4 emissions resulted from underground mines; surface mines were a smaller source.
- 12 % of fugitive emissions from solid fuels were emissions due to solid fuel transformation
- Since 1990 fugitive CH_4 emissions from 1.B.1 Solid fuels have been steadily decreasing, caused by the reduction of coal mining activities

Figure 3.177 1.B.1 Fugitive Emissions from Solid Fuels: Trend



Note: Data displayed as dashed line refers to the secondary axis.

In 2019 three countries, Poland, Czechia and Romania represented 87 % of total fugitive GHG emissions from solid fuels (Table 3.108).

Table 3.108 1.B.1 Fugitive Emissions from Solid Fuels: Countries Contribution

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2019 (kt)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2019 (kt CO2 equivalents)
Austria	333	NA,IE,NO	NO,IE,NA	NO,IE,NA	333	NO,IE,NA
Belgium	433	40	0	NO,NA	432	40
Bulgaria	2 011	837	64	23	1 946	815
Croatia	60	NA,NO	NO	NO	60	NO
Cyprus	NO	NO	NO	NO	NO	NO
Czechia	10 779	2 323	456	78	10 323	2 245
Denmark	NO	NO	NO	NO	NO	NO
Estonia	NO	NO	NO	NO	NO	NO
Finland	NO	NO	NO	NO	NO	NO
France	4 810	15	NO,NA	NO,NA	4 810	15
Germany	27 386	768	1 833	615	25 553	153
Greece	1 130	596	NO	NO	1 130	596
Hungary	1 061	41	7	9	1 055	32
Ireland	56	18	NO	NO	56	18
Italy	132	32	0	NO,NA	132	32
Latvia	NA,NO	NA,NO	NO	NO	NO	NO
Lithuania	NO	NO	NO	NO	NO	NO
Luxembourg	NO	NO	NO	NO	NO	NO
Malta	NO	NO	NO	NO	NO	NO
Netherlands	121	78	110	73	11	5
Poland	25 356	17 225	4 188	2 627	21 167	14 598
Portugal	143	16	3	NO	140	16
Romania	5 867	5 514	NA,NO	NO,NA	5 867	5 514
Slovakia	699	261	19	18	680	243
Slovenia	461	339	101	124	361	215
Spain	1 638	23	18	7	1 620	16
Sweden	5	7	5	7	0	0
United Kingdom	23 525	622	1 699	137	21 827	484
EU-27+ISL	**106 007**	**28 755**	**8 503**	**3 718**	**97 504**	**25 037**
Iceland	NO	NO	NO	NO	NO	NO
United Kingdom (KP)	23 526	622	1 699	137	21 827	484
EU-KP	**106 008**	**28 755**	**8 503**	**3 718**	**97 504**	**25 037**

Abbreviations explained in the Chapter 'Units and abbreviations'
Austria includes emissions from 1.B.1.b – production of coke oven coke – in 1.A.2.a Iron and Steel
Hungary reports fugitive methane emissions released during coal mining and handling under sector 1.A.2. Fugitive emissions from solid fuel transformation are included in sector 1.A.1.c.

Nearly all fugitive CH_4 emissions from solid fuels originate from coal mining and handling (1B1a). Between 1990 and 2019 these emissions decreased by 74% (Table 3.109). Large reductions (in absolute terms) were observed in Czechia, Poland, Germany and the United Kingdom (Table 3.108).

CH_4 recovery from coal mining

The UK, which has a share of 98% of all reported CH_4 recovery in 2019 in category 1.B.1.a.1iii (Abandoned underground mines) in the EU GHG inventory, reports emissions from the utilisation of colliery methane under sectors 1A1ciii and 1A2gvii, of which almost all in 1A1ciii.

Romania has a share of 2% of all reported CH_4 recovery in category 1.B.1.a.1i (Mining activities) in the EU in 2019. The recovered CH_4 from Lupeni and Vulcan mines are used for energy purposes for the housework of the workers colonies and these information are included in '1.B.1.a Coal Mining and Handling, 1.B. 1.a.1 Underground Mines, 1.B.1.a.1.i Mining Activities, Recovery / Flaring CH_4' category.

Slovakia has reported CH_4 recovery in category 1.B.1.a.1 only for the reporting years 2007-2014. Emissions from cogeneration of mine gas is reported as other biogas from one facility in the category 1.A.1.c – Manufactured of Solid Fuels and Other Energy Industries.

CH_4 from Coal Mining (1.B.1.a)

Fugitive emissions from coal mining correspond to the total emissions from:

- underground mining (emissions from underground mines, brought to the surface by ventilation systems)
- surface mining (emissions primarily from the exposed coal surfaces and coal rubble, but also emissions associated with the release of pressure on the coal)
- post-mining (emissions from coal after extraction from the ground, which occur during preparation, transportation, storage, or final crushing prior to combustion)
- abandoned underground mines

CH_4 emissions from 1.B.1.a coal-mining accounted for 0.6 % of total GHG emissions in 2019 and for 33 % of all fugitive emissions in the EU-KP. CH_4 emissions from this source decreased by 74 % in the EU-KP between 1990 and 2019 and also a decrease by -15 % between 2018 and 2019 due to decreases in Germany, Poland, Czechia, Greece and Romania (Table 3.109). In 2019 Poland, Romania, Czechia and Greece accounted together for 92 % of CH_4 emissions from 1.B.1.a. They had substantially reduced their emissions between 1990 and 2019 due to the decline of coal mining (Figure 3.90).

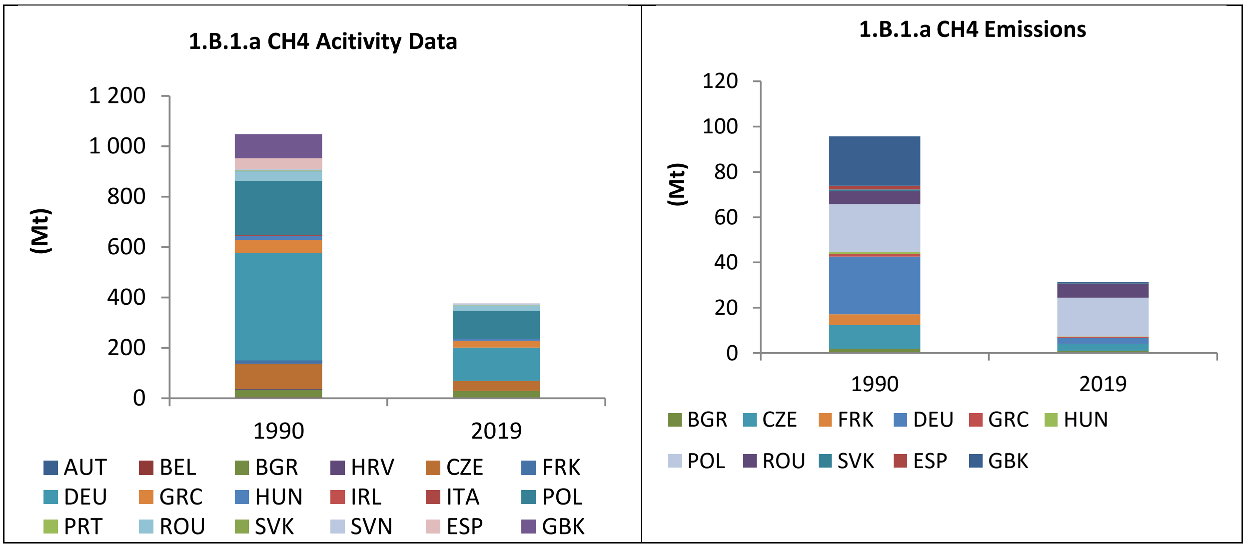
Table **3.109** shows that 82 % of EU-KP emissions are calculated using higher tier methods. In cases where countries report a mix of Tier 1 and higher Tier methods (BRG, CZE, HUN, POL, ROU) only emissions from subcategories of sector 1.B.1.a were taken into account, where the countries actually apply a higher tier method, according to the IPCC 2006 Guidelines.

Table 3.109 1.B.1.a Coal Mining: Countries contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	333	NO,NA	NO,NA	-	-333	-100%	-	-	NA	NA
Belgium	396	41	40	0.2%	-355	-90%	0	-1%	D	D
Bulgaria	1 931	902	813	3.3%	-1 118	-58%	-89	-10%	T1,T2	CS,D
Croatia	60	NO	NO	-	-60	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	10 322	2 534	2 241	9.0%	-8 081	-78%	-293	-12%	T1,T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	4 780	10	10	0.0%	-4 770	-100%	0	0%	T2,T3	CS,PS
Germany	25 494	1 612	101	0.4%	-25 394	-100%	-1 511	-94%	T2,T3	CS
Greece	1 130	795	596	2.4%	-534	-47%	-198	-25%	T1	D
Hungary	1 055	30	31	0.1%	-1 024	-97%	1	4%	T1,T2	CS,D
Ireland	56	19	18	0.1%	-37	-67%	0	-2%	T1	D
Italy	53	10	9	0.0%	-44	-84%	-1	-14%	T2	D
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	21 054	16 407	14 503	58.4%	-6 552	-31%	-1 905	-12%	T1,T3	D
Portugal	140	16	16	0.1%	-124	-89%	0	-1%	NO	NO
Romania	5 825	5 708	5 514	22.2%	-311	-5%	-194	-3%	T1,T2	D
Slovakia	680	227	243	1.0%	-437	-64%	15	7%	T2	CS
Slovenia	361	220	215	0.9%	-146	-41%	-5	-2%	T2,T3	CS,D,PS
Spain	1 620	75	16	0.1%	-1 605	-99%	-60	-79%	CS,T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	21 809	462	478	1.9%	-21 331	-98%	16	3%	T2,T3	CS
EU-27+UK	**97 099**	**29 067**	**24 842**	**100%**	**-72 257**	**-74%**	**-4 225**	**-15%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	21 809	462	478	1.9%	-21 331	-98%	16	3%	T2,T3	CS
EU-KP	**97 099**	**29 067**	**24 842**	**100%**	**-72 257**	**-74%**	**-4 225**	**-15%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.178 1.B.1.a Coal Mining and Handling: Contribution of countries to CH_4 emission and activity data



CH_4 from Underground mines (1.B.1.a.1)

In 2019, 83% of fugitive emissions from coal mines were due to underground mines. Within the EU-KP coal mining in underground mines decreased substantially between 1990 and 2019 (-77 %) (Table

3.110 and Figure 3.179). Largest decreases of CH_4 emissions in absolute terms were observed in Germany (-99.7 %) and the United Kingdom (-98 %). In Germany, emissions from this source have been decreasing due to decreases in utilizable extracted quantities and increases in pit-gas utilization since 2001 (DEU NIR 2021). The decreasing trend in the United Kingdom is caused by the closure of deep-mining collieries, which led to a reduction from 188 small deep-mining collieries in the year 1990 to 5 in 2017 (GBE NIR 2021).

Poland is contributing to 65% of methane emissions from this source applies a Tier 3 method based on direct measurements and calculations (POL NIR 2021). Romania has a share of 24% of CH_4 emissions from this source. 97% of CH_4 emissions from this category arise from subcategory 1B1aiii (abandoned coalmines), which is calculated with a Tier 2 methodology of the 2006 IPCC Guidelines (ROU NIR 2021). A Tier 2 method including country specific emission factors is applied by the Czechia, which is contributing almost 5% of methane emissions to this source (CZE NIR 2021) (Table **3.110**). For detailed information on countries methodologies please see Annex III.

Table 3.110 1.B.1.a.1 Coal Mining – underground mining: Countries contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	299	NO,NA	NO,NA	-	-299	-100%	-	-	NA	NA
Belgium	396	41	40	0.2%	-355	-90%	0	-1%	D	D
Bulgaria	1 325	244	203	1.0%	-1 122	-85%	-41	-17%	T2	CS
Croatia	60	NO	NO	-	-60	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	7 544	1 155	923	4.5%	-6 621	-88%	-232	-20%	T1,T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	4 734	10	10	0.0%	-4 724	-100%	0	0%	T2,T3	CS,PS
Germany	25 396	1 566	65	0.3%	-25 332	-100%	-1 502	-96%	T3	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	1 055	29	28	0.1%	-1 026	-97%	0	-2%	T1	D
Ireland	56	19	18	0.1%	-37	-67%	0	-2%	T1	D
Italy	20	10	9	0.0%	-11	-57%	-1	-14%	T2	D
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	19 583	15 132	13 407	64.8%	-6 176	-32%	-1 725	-11%	T3	D
Portugal	140	16	16	0.1%	-124	-89%	0	-1%	NO	NO
Romania	5 282	5 205	5 052	24.4%	-230	-4%	-153	-3%	T1,T2	D
Slovakia	680	227	243	1.2%	-437	-64%	15	7%	T2	CS
Slovenia	361	220	215	1.0%	-146	-41%	-5	-2%	T2,T3	CS,D,PS
Spain	1 620	69	16	0.1%	-1 604	-99%	-53	-77%	CS,T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	21 616	435	456	2.2%	-21 161	-98%	21	5%	T2,T3	CS
EU-27+UK	**90 164**	**24 377**	**20 699**	**100%**	**-69 465**	**-77%**	**-3 678**	**-15%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	21 616	435	456	2.2%	-21 161	-98%	21	5%	T2,T3	CS
EU-KP	**90 164**	**24 377**	**20 699**	**100%**	**-69 465**	**-77%**	**-3 678**	**-15%**	**-**	**-**

Figure 3.179 1.B.1.a.1.i Mining activities - Underground Mines: Emission trend and share for EU-28 and the emitting countries of CH_4

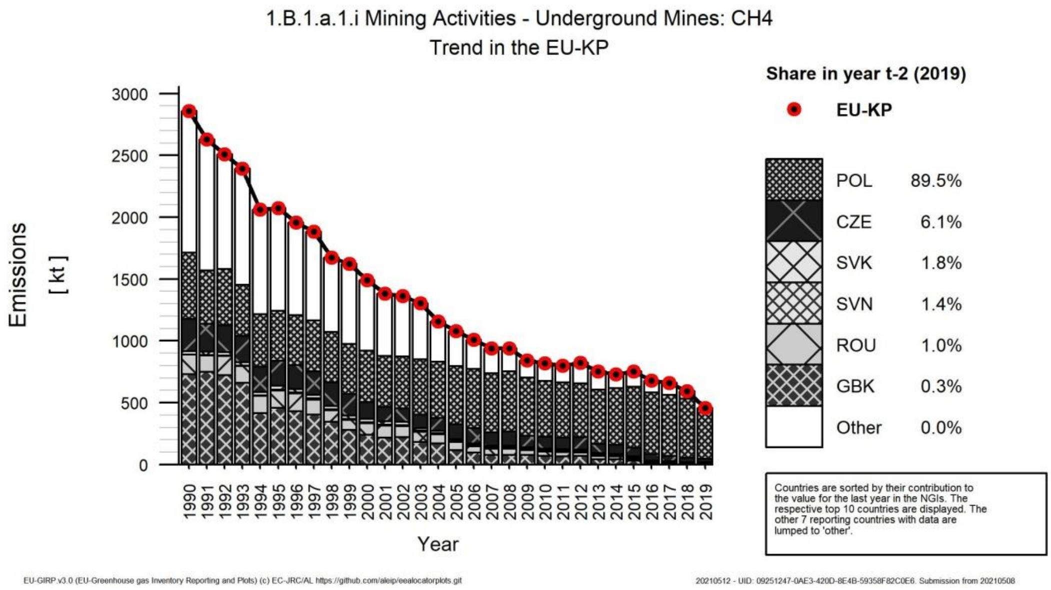
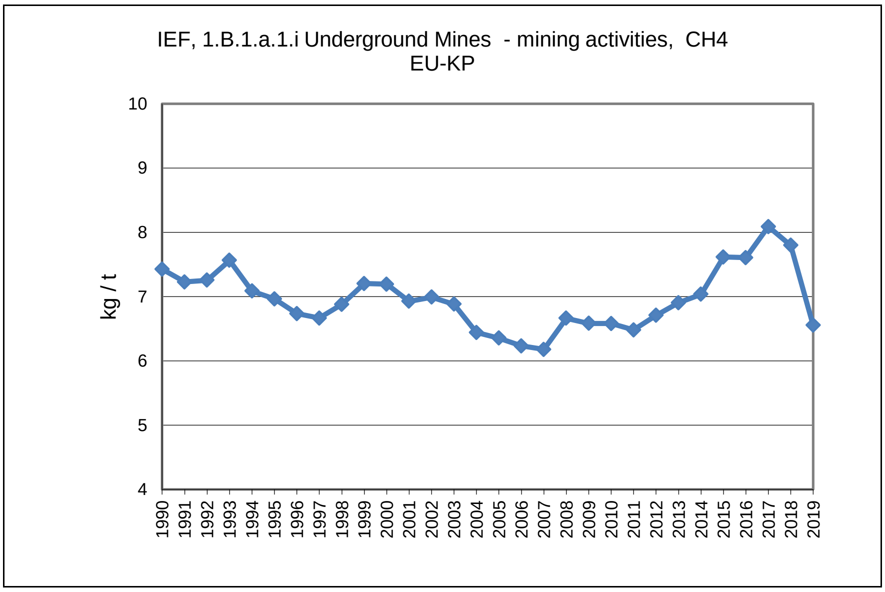
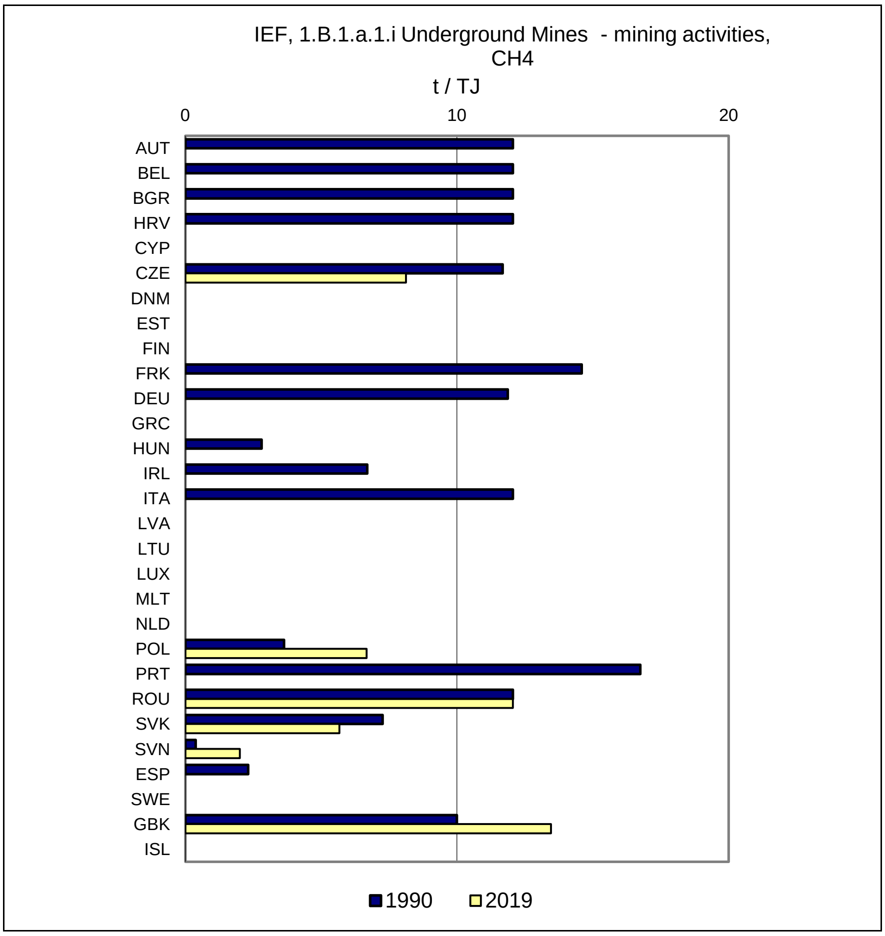


Figure 3.180 shows the implied emission factor of EU-KP and also the implied emission factor for each Member State for CH_4 emissions in 1B1a1i – underground mines, mining activities, which are responsible for 56 % of total GHG emissions from 1.B.1.a.1. The decrease of the implied emission factor is caused by the closure of underground mining in Germany. Between 1990 and 2018, Germany is calculating emissions from this source applying a Tier 3 methodology, which results in a higher emission factor, compared to the IEF of other countries; in 2019, Germany reports CH_4 emissions from this source as not occurring, which results in a decrease of the EU implied emission factor (see DEU NIR 2021).

Figure 3.180: 1.B.1.a.1.i Mining activities – Underground mines - Implied Emission Factors for CH_4 (in kg/t)





CH_4 from Surface mines (1.B.1.a.2)

In 2019, only 17% of emissions from coal mining originate from surface mining. Overall, the coal production from surface mines decreased by 40 % between 1990 and 2019 (Table **3.111** and Figure 3.181).

Czechia shows largest decreases of methane emissions in absolute terms between 1990 and 2019 (- 1 460 kt CO_2 equ.), which is caused by the closure of mines (CZE NIR 2021).

Together, Czechia and Poland account for 58% of emissions from this source. Both apply a Tier 1 methodology with a default emission factor as methane emissions from surface mining represents only a minor source of methane emissions from coal mining – in Poland, 8 % of total emissions from coal mining arise from category 1.B.1.a.2, the share in Czechia is 59%. For detailed information on countries methodologies please see Annex III. (Table **3.111**).

Table 3.111 1.B.1.a.2 Coal Mining – surface mining: Countries contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	34	NO	NO	-	-34	-100%	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	606	658	610	14.7%	4	1%	-48	-7%	T1,T2	D
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	2 778	1 379	1 318	31.8%	-1 460	-53%	-60	-4%	T1	D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	47	NO	NO	-	-47	-100%	-	-	NA	NA
Germany	98	46	36	0.9%	-62	-63%	-10	-21%	T2	CS
Greece	1 130	795	596	14.4%	-534	-47%	-198	-25%	T1	D
Hungary	NO	1	2	0.1%	2	∞	2	193%	T2	CS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	33	NO	NO	-	-33	-100%	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	1 472	1 275	1 096	26.5%	-376	-26%	-179	-14%	T1	D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	544	503	462	11.2%	-81	-15%	-41	-8%	T1	D
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1	6	NO	-	-1	-100%	-6	-100%	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	193	27	22	0.5%	-171	-89%	-5	-19%	T2	CS
EU-27+UK	**6 935**	**4 690**	**4 143**	**100%**	**-2 792**	**-40%**	**-547**	**-12%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	193	27	22	0.5%	-171	-89%	-5	-19%	T2	CS
EU-KP	**6 935**	**4 690**	**4 143**	**100%**	**-2 792**	**-40%**	**-547**	**-12%**	**-**	**-**

Figure 3.181 1.B.1.a.2.i Mining activities - Surface Mines: Emission trend and share for the emitting countries of CH_4

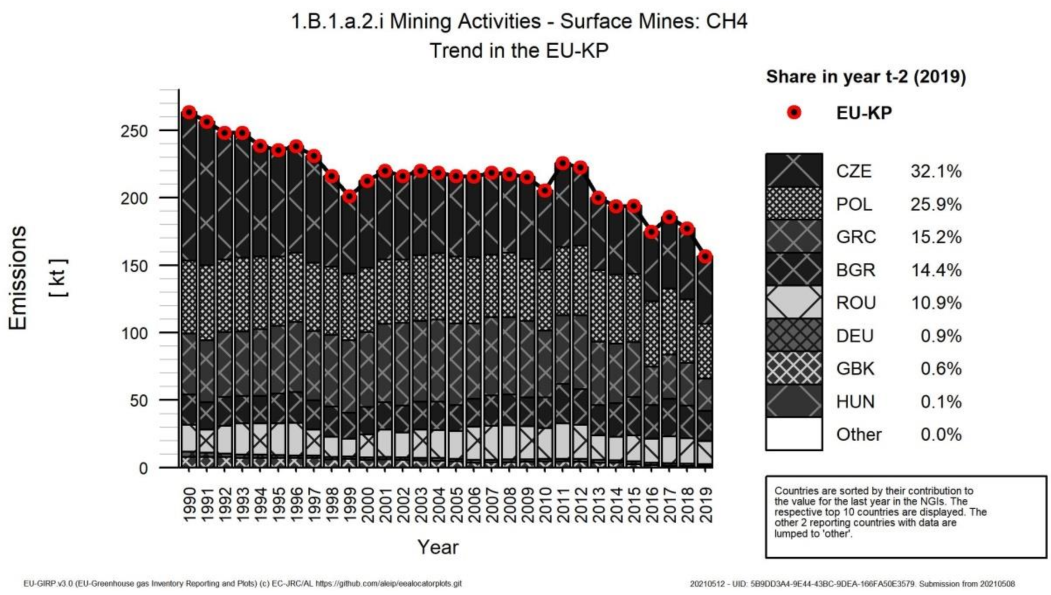
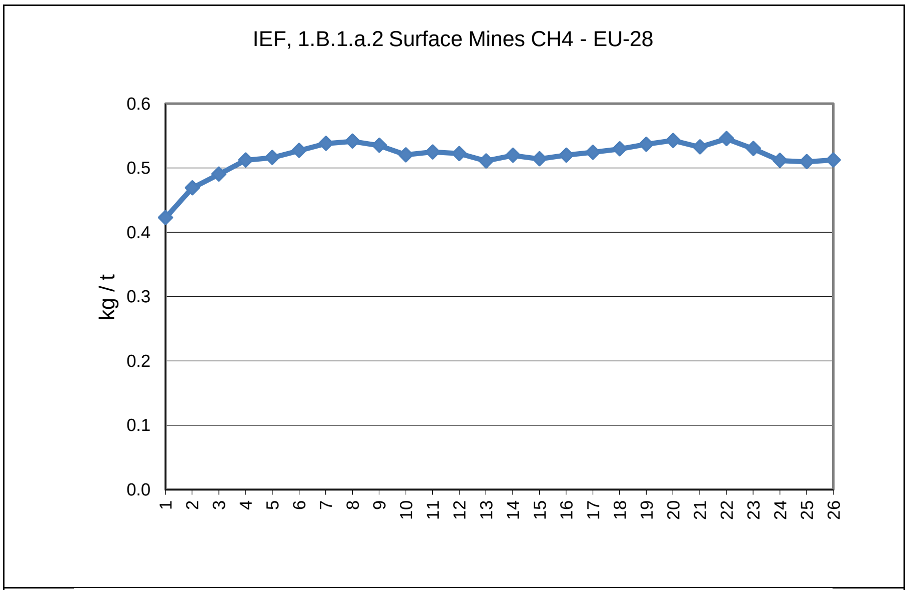
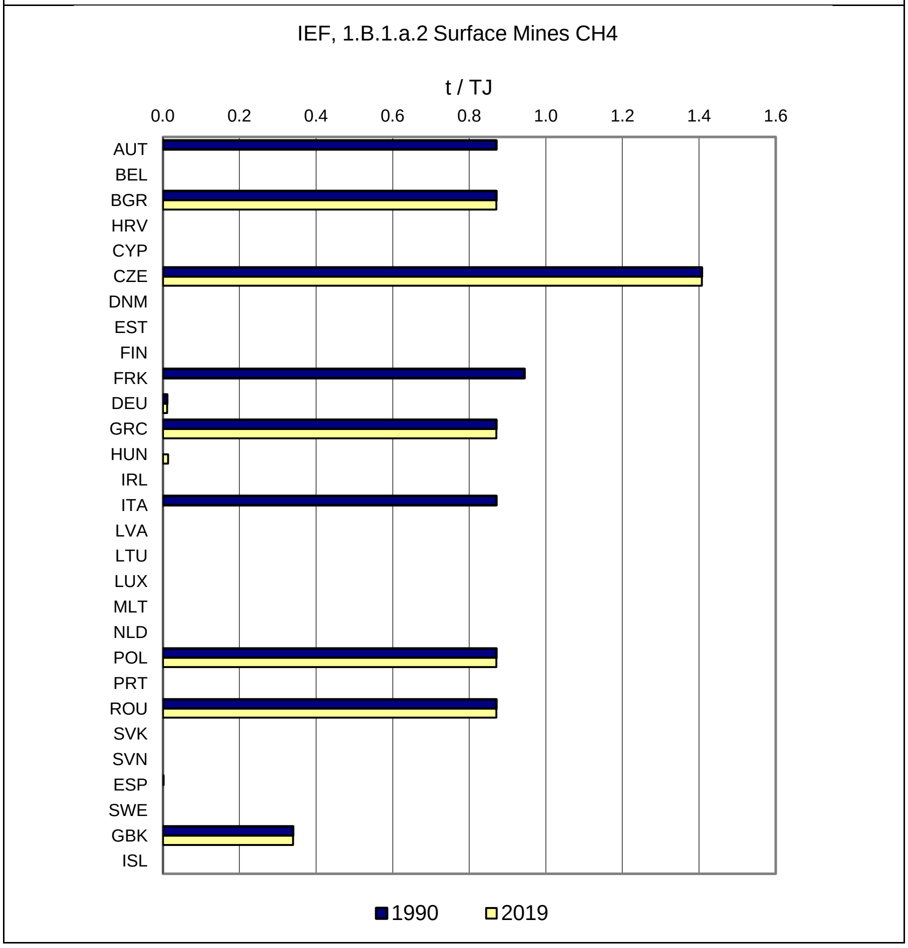


Figure **3.176** shows the Implied Emission factor of EU-KP and also the implied Emission factor for each Member State for CH_4 emissions in 1.B.1.a.2.i – mining activities from surface mines, which are responsible for 94 % of total GHG emissions from 1.B.1.a.2.

Czechia applies the high default emission factor from the IPCC 2006 Guidelines, which explains the outlier in Figure 3.182 (lower figure). Germany's low emission factor is caused by the application of a Tier 2 method with a country specific emission factor for CH_4 emissions from this source (0.016m3 CH_4/t). According to the German NIR, emission factors from the IPCC 2006 Guidelines cannot be applied to German lignite, as it does not exceed a temperature of 50°C during the coalification process, while significant methane releases occur only at temperatures higher than 80°C (for detailed information see Annex III of the EU GHG inventory and German NIR, 2020).

Figure 3.182: 1.B.1.a.2.i Mining activities – Surface mines - Overview of outliers of Implied Emission Factors for CH_4 (in kg/t)





Emissions from Other (1.B.1.c)

Poland and Sweden both report CH_4 and CO_2 emissions in this sector. Sweden additionally reports N_2O emissions. Slovenia reports CO_2 emissions in this subcategory. The description of the subcategories is presented in Table 3.112.

Table 3.112 Description of subcategories in sector 1.B.1c for CO_2- and CH_4-emissions for reporting countries

Member state	Emission	Subcategory
Poland	CO_2, CH_4	emissions from Coke Oven Gas Subsystem
Slovenia	CO_2	SO_2 scrubbing
Sweden	CO_2, CH_4, N_2O	Flaring of gas

Table 3.113 provides information on the contribution of countries to EU-KP recalculations in CH_4 from 1.B.1 Solid fuels for 1990 and 2018.

Table 3.1131.B.1 Fugitive Emissions from Solid Fuels: Contribution of countries to EU-KP recalculations in CH_4 for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	-	-	
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czechia	-	-	-76	-2.9	Recalculation due to response to the last review process
Denmark	-	-	-	-	
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	0.0	0.0	0.0	0.1	Improved accuracy and completeness.
Germany	0.0	0.0	47	2.9	Implementation of results of an expert assessment
Greece	-	-	-	-	
Hungary	-	-	-	-	
Ireland	-	-	-	-	
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-	-	-	-	
Poland	-	-	33	0.2	Update of the activity data concering coke production according to Eurostat database.
Portugal	-	-	-	-	
Romania	-	-	-	-	
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-	-	-	-	
Sweden	-	-	-	-	
United Kingdom	-	-	-0.3	-0.1	No significant recalculations.
EU27+UK	-	-	2.7	0.0	
Iceland	-	-	-	-	
United Kingdom (KP)	0.1	0.0	-0.2	-0.0	No significant recalculations.
EU-KP	**0.1**	**0.0**	**2.7**	**0.0**	

3.2.6.2 Fugitive emissions from oil and natural gas (1.B.2)

Fugitive emissions from oil and natural gas correspond to the total fugitive emissions from oil and natural gas activities. Fugitive emissions may arise from equipment leaks, evaporation losses, venting, flaring and accidental releases (2006 IPCC Guidelines).

Fugitive emissions from 1.B.2 Oil and natural gas include all emissions from exploration, production, processing, transport, and handling of oil and natural gas. They account for 1.2 % of the total GHG emissions in 2019 and for 62 % (Figure 3.183) of all fugitive emissions in the EU-KP.

Of all fugitive emissions from oil and natural gas, in 2019:

- 43 % were CH_4 emissions from natural gas (exploration, production, processing, transport and distribution)
- 25 % were CO_2 emissions from oil (exploration, production, transport, refining and storage and distribution)
- 14% were CO_2 emissions from venting and flaring
- 8% were CH_4 emissions from venting and flaring
- 4 % were CO_2 emissions due to Other emissions

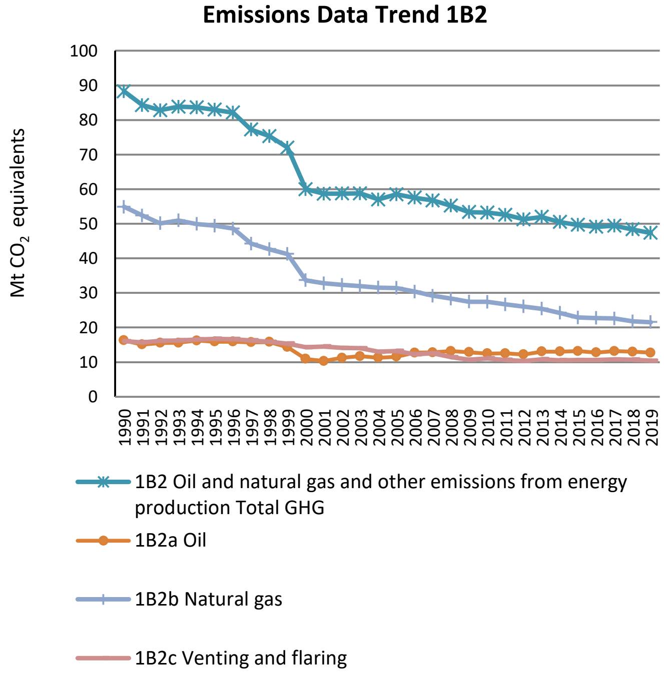
This source category includes four key categories:

Table 3.114: Key source categories for level and trend analyses and share of countries emissions using higher tier methods in sector 1.B.2 (table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2019		1990	2019	
1.B.2.a Oil: Operation (CH_4)	6792	1104	T	0	0	55%
1.B.2.a Oil: Operation (CO_2)	9451	11611	T	L	L	82%
1.B.2.b Natural Gas: Operation (CH_4)	51519	20231	T	L	L	80%
1.B.2.c Venting and Flaring: Operation (CO_2)	8665	6571	0	L	L	77%

Fugitive emissions from oil and natural gas occur in all countries but Malta (Table 3.115). Total greenhouse gas emissions from 1.B.2 decreased by 46 % between 1990 and 2019 (Figure **3.183**). This trend was mainly due to the reduction of fugitive CH_4 emissions from natural gas activities, which decreased by 61 % over that period.

Figure 3.183 1.B.2-Fugitive Emissions Oil and Natural Gas: Trend



In 2019, 57% of all fugitive GHG emissions from oil and natural gas were emitted by four countries: Germany, Italy, Poland and the United Kingdom (Table 3.115). The largest reductions (in absolute terms) were observed in Romania and the United Kingdom (both mainly CH_4 emissions), while emissions increased most in Poland (mainly CH_4 emissions) (Table 3.115).

Table 3.115 1.B.2 Fugitive emissions from oil and natural gas: Countries' contributions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2019 (kt)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2019 (kt CO2 equivalents)
Austria	369	347	102	118	266	229
Belgium	805	614	85	116	721	498
Bulgaria	219	1 043	60	804	158	238
Croatia	943	370	583	204	359	166
Cyprus	0	NE,NO	NO,NE	NO,NE	0	NO,NE
Czechia	1 082	598	2	3	1 080	594
Denmark	527	305	341	195	133	76
Estonia	64	21	0	0	64	21
Finland	124	92	111	65	11	26
France	6 189	3 593	4 362	2 588	1 801	993
Germany	10 310	6 369	2 008	1 381	8 300	4 987
Greece	79	133	43	9	36	124
Hungary	2 891	1 770	478	125	2 411	1 645
Ireland	49	59	0	0	49	59
Italy	12 985	7 475	4 047	2 757	8 926	4 709
Latvia	248	98	0	0	248	98
Lithuania	289	526	24	234	265	292
Luxembourg	20	31	0	0	20	31
Malta	NO	NO	NO	NO	NO	NO
Netherlands	2 707	1 445	775	989	1 932	456
Poland	1 130	4 555	46	1 717	1 084	2 838
Portugal	58	1 191	54	1 133	2	56
Romania	24 788	3 117	1 177	592	23 608	2 525
Slovakia	1 714	214	5	1	1 708	213
Slovenia	50	39	0	0	50	39
Spain	1 915	3 793	1 751	3 626	163	167
Sweden	424	586	331	529	92	56
United Kingdom	18 211	8 810	5 778	4 200	12 392	4 572
EU-27+ISL	**88 189**	**47 195**	**22 162**	**21 387**	**65 882**	**25 707**
Iceland	62	167	61	163	1	4
United Kingdom (KP)	18 211	8 810	5 778	4 200	12 392	4 572
EU-KP	**88 251**	**47 362**	**22 223**	**21 550**	**65 883**	**25 711**

Abbreviations explained in the Chapter 'Units and abbreviations'.
AUT: N_2O emissions from venting and flaring are included in 1.A.1.b (petroleum refining)
BEL: N_2O emissions are reported in 1.A.1.b (petroleum refining)
NLD: N_2O emissions from gas transmission are included in 1.A.3.e.i (pipeline transport gaseous fuels)

CH_4 recovery from Oil and Gas

Germany is the only country that reports the recovery of CH_4 emissions in subcategory 1.B.2. These emissions occur in category 1.B.2.c (Venting and Flaring). Gas recovery systems liquify most recovered CH_4 emissions and return them to refining processes or to refinery combustion systems. These emissions are reported under category 1.A.1.b. (DEU NIR 2021)

CO_2 from Oil (1.B.2.a)

Fugitive emissions from oil correspond to fugitive emissions from all sources associated with the exploration, production, transmission, upgrading and refining of crude oil and the distribution of crude oil products (2006 IPCC Guidelines).

CO_2 emissions from 1.B.2.a 'Fugitive emissions from oil' account for 0.3 % of total EU-KP GHG emissions in 2019 and for 15 % of all fugitive emissions. Between 1990 and 2019, CO_2 emissions from this source increased by 23 % in the EU-KP (Table 3.116). By contrast, during the same period 1990-2019, CH_4 emissions of this source category were reduced by 84 %.

Together France, Italy and Spain accounted for 65 % of the EU-KP total CO_2 emissions of 1.B.2.a 'Fugitive CO_2 emissions from oil' (Table 3.116, Figure 3.184). Main contributor to these emissions in all countries is subcategory 1.B.2.a.4 (Oil – Refining/Storage). Spain is applying a Tier 2 methodology with a plant specific emission factor in this subcategory. Italy also applies a Tier 2 methodology for CO_2 emissions from oil refining and storage, while the emission factor is country specific. France uses specific emission factors provided by the plant operator, for other processes, emissions are derived directly from annual emission reports (FRK NIR 2021). For detailed information on countries methodologies please see Annex III. Table **3.116** shows that 82 % of EU-KP CO_2 emissions from this source are calculated using higher tier methods. In cases where countries report a mix of Tier 1 and higher Tier methods (FRK, ITA, LTU, NLD ROU, ESP) only emissions from subcategories of sector 1.B.2.a were taken into account for the calculation, where the countries actually apply a higher tier method. Countries that report a Tier 1 method but a country specific or plant specific emission factor (HUN, POL, SVK) were calculated as a higher method, according to the IPCC 2006 Guidelines.

During the period 1990-2019, the largest decreases in CO_2 emissions (in absolute terms) were observed in Italy, Romania, France and the United Kingdom. (Table 3.116). Decreasing CO_2 emissions in Italy are mainly driven by the reduction in crude oil losses in refineries (ITA NIR 2021). In the UK, CO_2 emissions from this source decline mainly due to a decrease of 87% of CO_2 emissions in oil exploration (1.B.2.a.1).

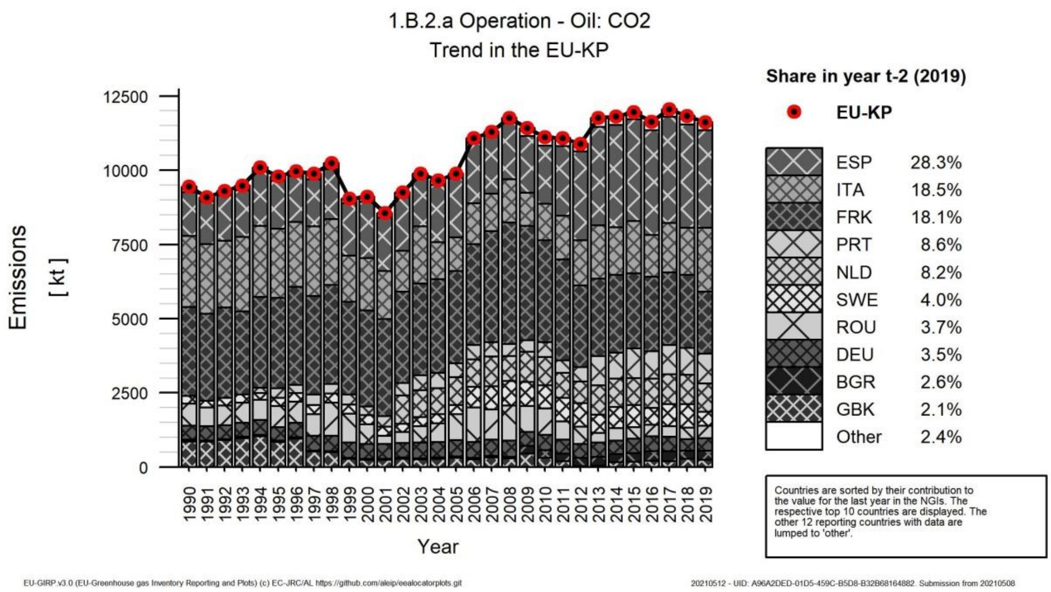
Largest increases between 1990-2019 are reported in the Netherlands, Portugal and Spain (Table 3.116). In all three countries, increases are mainly driven by increases in CO_2 emissions from subcategory 1.B.2.a.4 (Oil – Refining/Storage).

Table 3.116 1.B.2.a Fugitive CO_2 emissions from oil: Countries' contributions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	0.00	0.00	0.00	0.0%	0.00	25%	0.00	2%	T1	D
Belgium	0.01	0.02	0.02	0.0%	0.01	38%	0.00	5%	T1	D
Bulgaria	60	272	306	2.6%	246	413%	34	13%	T1	D
Croatia	158	43	41	0.4%	-116	-74%	-1.55	-4%	T1	D
Cyprus	NO,NE	NO,NE	NO,NE	-	-	-	-	-	NA	NA
Czechia	0.02	0.04	0.04	0.0%	0.01	48%	-0.01	-20%	T1	D
Denmark	4.70	0.00	0.00	0.0%	-4.70	-100%	0.00	-25%	T3	D,PS
Estonia	NO,NE	NO,NE	NO,NE	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	2 983	2 463	2 098	18.1%	-885	-30%	-365	-15%	T1,T2,T3	CS,D,PS
Germany	478	399	411	3.5%	-66	-14%	12	3%	T2	CS
Greece	0.00	0.00	0.00	0.0%	0.00	-78%	0.00	-18%	T1	D
Hungary	5.14	0.55	0.56	0.0%	-4.58	-89%	0.02	3%	T1	CS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	2 402	1 592	2 143	18.5%	-259	-11%	552	35%	T1,T2	CS,D
Latvia	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Lithuania	23	251	232	2.0%	209	896%	-19	-8%	T1,T3	D,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	0.02	983	953	8.2%	953	5295566%	-30	-3%	CS,T1	D,PS
Poland	0.06	0.26	0.25	0.0%	0.19	343%	-0.01	-4%	T1	CS,D
Portugal	0.43	912	999	8.6%	998	234636%	86	9%	D	D
Romania	746	388	428	3.7%	-319	-43%	39	10%	T1,T2	CS,D
Slovakia	0.03	0.01	0.01	0.0%	-0.02	-76%	0.00	-6%	T1	CS
Slovenia	0.03	0.07	0.07	0.0%	0.04	177%	0.00	1%	T1	D
Spain	1 477	3 472	3 283	28.3%	1 807	122%	-189	-5%	T1,T2	D,PS
Sweden	255	783	470	4.0%	215	84%	-313	-40%	T3	PS
United Kingdom	859	273	246	2.1%	-613	-71%	-27	-10%	T2	CS,PS
EU-27+UK	**9 451**	**11 833**	**11 611**	**100%**	**2 161**	**23%**	**-221**	**-2%**	**-**	**-**
Iceland	0.00	0.00	0.00	0.0%	0.00	69%	0.00	-4%	T1	D
United Kingdom (KP)	859	273	246	2.1%	-613	-71%	-27	-10%	T2	CS,PS
EU-KP	**9 451**	**11 833**	**11 611**	**100%**	**2 161**	**23%**	**-221**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.184 1.B.2.a Oil: Emission trend and share for the emitting countries of CO_2



CH_4 from Oil (1.B.2.a)

CH_4 emissions from 1.B.2.a 'Fugitive emissions from oil' account for 0.03 % of total EU-KP GHG emissions in 2019 and for 1.4 % of all fugitive emissions. Between 1990 and 2019, CH_4 emissions from this source decreased by 84 % in the EU-KP (Table 3.116).

Together Romania, Italy, Poland, Germany and the UK accounted for 73 % of the EU-KP total CH_4 emissions of 1.B.2.a 'Fugitive CH_4 emissions from oil' (Table 3.117). In Romania main contributions to CH_4 emissions come from subcategory 1.B.2.a.2 (Oil – Production). From 1990 to 2000 CH_4 emissions are estimated using a Tier 1 methodology with a default emission factor for developing countries of the 2006 IPCC Guidelines. From 2000 on the country applies a Tier 1 methodology with a default emission factor for developed countries, due to change of technology (ROU NIR 2021). This also explains the outlier in ***Figure 3.185***. CH_4 emissions from Germany arise mainly from subcategory 1.B.2.a.4 (Oil – Refining/Storage), a Tier 2 methodology with a country specific emission factor is applied. For detailed information on countries methodologies please see Annex III.

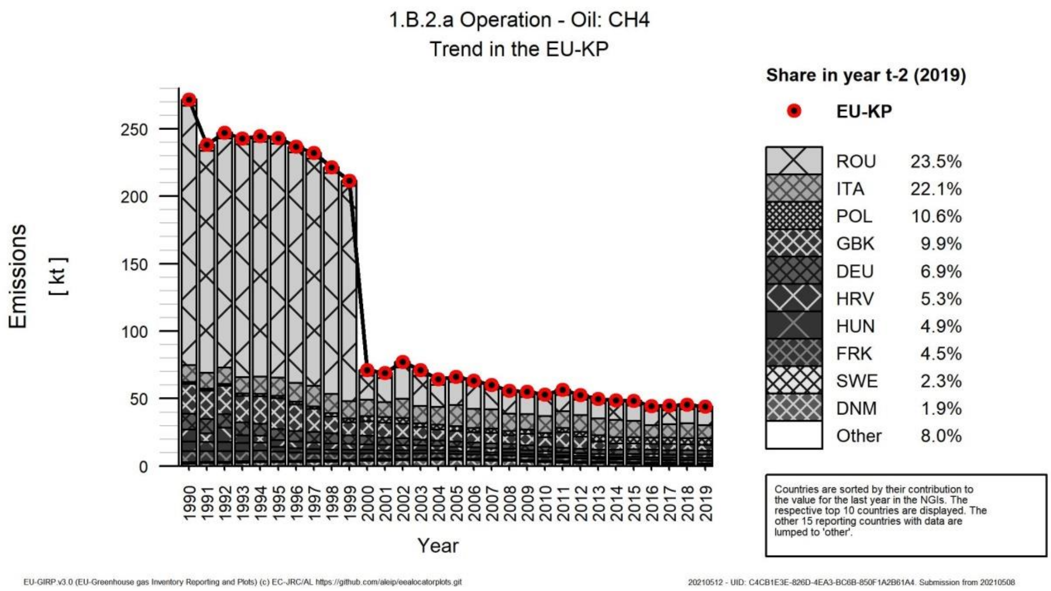
During the period 1990-2019, the largest decreases in CH_4 emissions (in absolute terms) were observed in the United Kingdom and Romania, caused by significant decreases in oil production (-95% in Romania, -81% in the UK). In the same period of time, emissions increased most in Poland due to an increase of 380% in oil production (Table 3.117).

Table 3.117 1.B.2.a Fugitive CH_4 emissions from oil: Countries' contributions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	7.37	8.42	8.57	0.8%	1.20	16%	0.15	2%	T1	D
Belgium	11	7.60	8.99	0.8%	-2.40	-21%	1.39	18%	CS,D	CS,D
Bulgaria	12	7.26	8.07	0.7%	-4.35	-35%	0.81	11%	T1	D
Croatia	220	62	59	5.3%	-162	-73%	-3.14	-5%	T1	D
Cyprus	0.40	NO,NE	NO,NE	-	0	-100%	-	-	NA	NA
Czechia	22.69	6.43	6.54	0.6%	-16	-71%	0.11	2%	T1,T2	CS,D
Denmark	43	24	21	1.9%	-22	-52%	-2.96	-12%	T2,T3	CS,D,OTH,PS
Estonia	NO,NE	NO,NE	NO,NE	-	-	-	-	-	NA	NA
Finland	6.30	9.20	9.14	0.8%	2.84	45%	-0.06	-1%	T1	D
France	206	54	50	4.5%	-156	-76%	-4.41	-8%	T1,T2,T3	CS,D,PS
Germany	301	76	76	6.9%	-225	-75%	-0.26	0%	T2	CS
Greece	10	16	15	1.3%	5.08	52%	-0.86	-5%	T1	D
Hungary	179	48	54	4.9%	-124	-70%	6.07	13%	T1	CS
Ireland	0.21	0.36	0.30	0.0%	0.09	40%	-0.06	-16%	T1	D
Italy	310	273	244	22.1%	-66	-21%	-29	-11%	T1,T2	CS,D
Latvia	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Lithuania	4.25	2.95	2.89	0.3%	-1.36	-32%	-0.06	-2%	T1	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	20	16	16	1.5%	-4.10	-20%	0.13	1%	T1,T1b	D
Poland	34	120	117	10.6%	83	243%	-3.45	-3%	T1	CS,D
Portugal	1.67	2.00	1.77	0.2%	0.10	6%	-0.23	-11%	CR,OTH	CR,OTH
Romania	4 811	257	259	23.5%	-4 552	-95%	2.02	1%	T1	D
Slovakia	15	7.50	7.02	0.6%	-7.77	-53%	-0.48	-6%	T1	CS
Slovenia	0.34	0.00	0.00	0.0%	-0.34	-100%	0.00	-2%	NA	NA
Spain	3.88	3.26	3.25	0.3%	-0.63	-16%	-0.01	0%	T1	D
Sweden	24	25	25	2.3%	0.92	4%	-0.07	0%	T1,T2	CS,D,PS
United Kingdom	547	106	110	9.9%	-437	-80%	3.35	3%	T2	CS,PS
EU-27+UK	**6 791**	**1 134**	**1 103**	**100%**	**-5 689**	**-84%**	**-31**	**-3%**	**-**	**-**
Iceland	0.49	0.79	0.64	0.1%	0.16	32%	-0.15	-18%	T1	D
United Kingdom (KP)	547	106	110	9.9%	-437	-80%	3	3%	T2	CS,PS
EU-KP	**6 792**	**1 134**	**1 104**	**100%**	**-5 688**	**-84%**	**-31**	**-3%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.185: 1.B.2.a Oil: Emission trend and share for the emitting countries of CH_4



CH_4 from Natural gas (1.B.2.b)

Fugitive emissions from natural gas correspond to emissions from all fugitive sources associated with the exploration, production, processing, transmission, storage and distribution of natural gas (associated and non-associated gas) (2006 IPCC Guidelines).

CH_4 emissions from 1.B.2.b 'Fugitive emissions from natural gas' account for 0.5 % of total EU-KP GHG emissions in 2019 and for 27 % of all fugitive emissions in the EU-KP. Between 1990 and 2019, CH_4 emissions from this source decreased by -61 % (Table 3.118).

In 2019, 67% of the EU-KP CH_4 emissions from 1.B.2.b were emitted by four countries: Germany, Italy, Romania and the United Kingdom (Table 3.118, Figure 3.186). In Germany, Italy and the United Kingdom, methane emissions are mainly contributed by natural gas distribution (1.B.2.b.5). Germany and the United Kingdom apply a Tier 3 methodology with country specific emission factors, while Italy uses a Tier 2 methodology and country specific emission factors to estimate emissions. Emissions from natural gas production (1.B.2.b.2) and other operations on natural gas (1.B.2.b.6) are the main sources for CH_4 emissions in Romania in this category. From 1990 to 2000 CH_4 emissions are estimated using a Tier 1 methodology with a default emission factor for developing countries of the 2006 IPCC Guidelines. From 2000 on the country applies a Tier 1 methodology with a default emission factor for developed countries, due to change of technology (ROU NIR 2021). This also explains the outlier in Figure 3.186. For detailed information on countries methodologies please see Annex III. Table 3.118 shows that 80 % of EU-KP emissions are calculated using higher tier methods. In cases where countries report a mix of Tier 1 and higher Tier methods (AUT, FIN, ESP) only emissions from subcategories of sector 1.B.2.b were taken into account for the calculation, where the countries actually apply a higher tier method. Countries that report a Tier 1 method but a country specific or plant specific emission factor (CZE, HUN, SVK) were calculated as a higher Tier method, according to the IPCC 2006 Guidelines.

The emission decreases between 1990 and 2019 observed in Romania (-92 %), the United Kingdom (-66 %), Germany (-39 %) and in Italy (-53 %) contributed most significantly to the overall reduction in the EU-KP between 1990 and 2019. The decrease was mainly caused by improvement of technology (United Kingdom), the improvement of pipeline network (Germany), the reduction of losses in gas distribution (Italy) and the decrease in production and the change of methodology (Romania).

Table 3.118 1.B.2.b Fugitive CH_4 emissions from natural gas: Countries' contributions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	259	235	220	1.1%	-39	-15%	-15	-6%	T1,T2	CS,D
Belgium	709	490	489	2.4%	-221	-31%	-1	0%	CS	CS
Bulgaria	146	226	230	1.1%	84	57%	4	2%	T1	D
Croatia	138	116	108	0.5%	-31	-22%	-8	-7%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 045	569	567	2.8%	-478	-46%	-2	0%	T1,T2	CS
Denmark	60	46	35	0.2%	-24	-41%	-10	-23%	T2,T3	CS,D
Estonia	56	20	18	0.1%	-38	-68%	-2	-8%	T1	D
Finland	4	20	17	0.1%	13	300%	-3	-15%	T1,T2	CS,D,PS
France	1 520	990	923	4.6%	-597	-39%	-67	-7%	T2,T3	CS,PS
Germany	7 997	4 805	4 911	24.3%	-3 087	-39%	105	2%	T2,T3	CS
Greece	9	78	82	0.4%	73	790%	4	5%	T1	D
Hungary	1 986	1 534	1 496	7.4%	-490	-25%	-38	-2%	T1,T2	CS
Ireland	20	48	47	0.2%	26	128%	-1	-3%	T3	CS,PS
Italy	8 236	4 149	3 861	19.1%	-4 375	-53%	-288	-7%	T2	CS
Latvia	177	84	84	0.4%	-94	-53%	0	-1%	T3	CS
Lithuania	261	265	289	1.4%	28	11%	23	9%	T2	CS
Luxembourg	19	31	31	0.2%	11	59%	0	0%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	421	257	243	1.2%	-178	-42%	-13	-5%	T3	CS
Poland	753	1 214	1 392	6.9%	639	85%	178	15%	T1	D
Portugal	NO	52	52	0.3%	52	∞	0	1%	CR,NO,OTH	CR,NO,OTH
Romania	16 184	1 307	1 309	6.5%	-14 874	-92%	2	0%	T1	D
Slovakia	1 103	161	165	0.8%	-939	-85%	4	2%	T1,T3	CS
Slovenia	42	33	33	0.2%	-9	-21%	0	0%	T1	D
Spain	136	147	143	0.7%	7	5%	-5	-3%	CS,T1	CS,D
Sweden	67	31	30	0.2%	-37	-55%	-1	-2%	T2,T3	CS,PS
United Kingdom	10 168	3 599	3 457	17.1%	-6 712	-66%	-142	-4%	T2,T3	CS,PS
EU-27+UK	**51 519**	**20 506**	**20 231**	**100%**	**-31 289**	**-61%**	**-275**	**-1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	10 168	3 599	3 457	17.1%	-6 712	-66%	-142	-4%	T2,T3	CS,PS
EU-KP	**51 519**	**20 506**	**20 231**	**100%**	**-31 289**	**-61%**	**-275**	**-1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.186 1.B.2.b Natural Gas: Emission trend and share for the emitting countries of CH_4

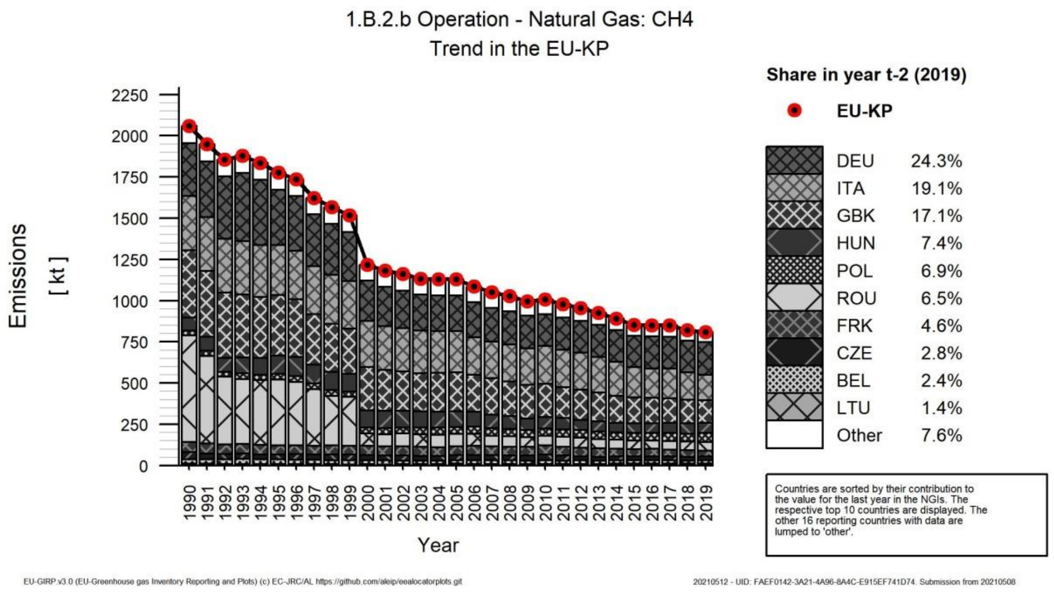


Table 3.119 and Table **3.120** provide an overview on activity data description and emission factors for all countries for sector 1.B.2.a and 1.B.2.b. CRF Tables do not include activity data for sector 1.B.2 because countries use different types of activity data which cannot be aggregated.

Table 3.119: 1.B.2.a Fugitive CO_2- and CH_4 emissions from natural gas: Information on activity data, emission factors by Member State

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil				**1990**					**2019**				
Country	**GHG source category**	**Activity data**			**CO_2 Implied emission factor (kg/unit)**	**CH_4 Implied emission factor (kg/unit)**	**CO_2 emissions (kt)**	**CH_4 emissions (kt)**	**AD**	**CO_2 Implied emission factor (kg/unit)**	**CH_4 Implied emission factor (kg/unit)**	**CO_2 emissions (kt)**	**CH_4 emissions (kt)**
		Description	**Unit**	**Value**					**Value**				
Austria	**Oil**						**0**	**0.29**				**0**	**0.34**
	1. Exploration	Mt crude oil	Mt	1	NO,IE	IE	IE	IE	0.65	NO,IE	IE	IE	IE
	2. Production	Mt crude oil	Mt	1	NO,IE	IE	IE	IE	0.65	NO,IE	IE	IE	IE
	3. Transport	1000 m3 crude oil	Mt	7 993	0.5	5	0.004	0.04	10 000	0.49	5	0	0.05
	4. Refining and storage	Mt crude oil Input	Mt	8	NA,NO	31 663	NA	0.25	9	NO,NA	31663	NA	0.29
	5. Distribution of oil products	Mt gasoline	Mt	3	NA,NO	NA	NA	NA	2	NO,NA	NA	NA	NA
	6. Other		Mt	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Belgium	**Oil**						**0**	**0.46**				**0.02**	**0.36**
	1. Exploration		PJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2. Production		PJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	3. Transport		PJ	1 051	14	150	0.01	0.16	1 445	14	150	0.02	0.22
	4. Refining and storage		PJ	1 251	NA,NO	238	NA	0.30	1 497	NO,NA	95	NA	0.14
	5. Distribution of oil products		PJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	6. Other		PJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Bulgaria	**Oil**						**60**	**0.50**				**306**	**0.32**
	1. Exploration	Indigenous production	103m3	C	4 400	20	0	0.00	C	4400	20	0	0.00
	2. Production	Indigenous production	103m3	C	44 990	2 910	3.15	0.20	C	44990	2910	1	0.07
	3. Transport	Indigenous production	103m3	C	2	25	0.0002	0.002	C	2	25	0	0.00
	4. Refining and storage	Refinery intake	103m3	9 667	5 850	30	57	0.29	7 978	38241	31	305	0.25
	5. Distribution of oil products		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	6. Other		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Cyprus	**Oil**						**NO,NE**	**0.02**				**NO,NE**	**NO,NE**
	1. Exploration		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2. Production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil				1990					2019				
Country	GHG source category	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	AD	CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
		Description	Unit	Value					Value				
	3. Transport			NE	NO,NE	NE	NE	NE	NO	NO	NO	NO	NO
	4. Refining and storage	Crude Oil refined (10^3 m3)	NO	743	NO,NE	22	NE	0.02	NO	NO	NO	NO	NO
	5. Distribution of oil products		NE	NE	NO,NE	NE	NE	NE	NE	NO,NE	NE	NE	NE
	6. Other		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Czechia	**Oil**						**0.02**	**0.91**				**0.04**	**0.26**
	1. Exploration	(e.g. number of wells drilled)	PJ	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	2. Production	(e.g. PJ of oil produced)	PJ	2	9 510	5 978	0.02	0.01	3	8860	4702	0.03	0.02
	3. Transport	(e.g. PJ oil loaded in tankers)	PJ	304	13	146	0.004	0.04	336	13	146	0.004	0.05
	4. Refining and storage	(e.g. PJ oil refined)	PJ	304	NE,NO	2 800	NE	0.85	336	NO,NE	585	NE	0.20
	5. Distribution of oil products	(e.g. PJ oil refined)	PJ	304	NE,NO	NE	NE	NE	336	NO,NE	NE	NE	NE
	6. Other	(NO)	PJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Germany	**Oil**						**478**	**12.05**				**411**	**3.04**
	1. Exploration	Number of wells drilled	number	12	0.5	64	0.00001	0.00	26	0.48	64	0.00001	0.00
	2. Production	oil produced	t	3 605 667	0.1	0.3	0.5	1.08	1 926 627	0.13	0.02	0.25	0.03
	3. Transport	oil transported	t	87 702 887	NO,NA	0.01	NA	0.59	87 917 267	NO,NA	0.01	NA	0.58
	4. Refining and storage	oil refined	t	214 116 000	2	0.0	477	10.38	87 000 000	5	0.03	411	2.43
	5. Distribution of oil products	oil products distributed	t	89 461 000	NO,NA	NA	NA	NA	81 114 729	NO,NA	NA	NA	NA
	6. Other	not occuring	TJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Denmark	**Oil**						**5**	**1.72**				**0.003**	**0.83**
	1. Exploration	Oil explored	m3	1 930	2 433	0	5	0.00	NO	NO	NO	NO	NO
	2. Production	Oil produced	10^3 m3	6 999	0	1	0	0.00	5 852	0.04	1	0.0003	0.00
	3. Transport	Oil loaded	Mg	3 370 410	NO,NA	0	NA	0.49	2 466 288	NO,NA	0	NA	0.04
	4. Refining and storage	Oil refined	Mg	7 263 000	0	0	0	1.23	7 625 000	0.0004	0.10	0.003	0.79
	5. Distribution of oil products	Gasoline distribution	Mg	1 734 295	NA	NA	NA	NA	1 317 883	NA	NA	NA	NA

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil					1990					2019				
Country	GHG source category	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	AD	CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
		Description	Unit	Value					Value				
	6. Other	Other	m3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Spain	**Oil**						**1477**	**0.16**				**3283**	**0.13**
Spain	1. Exploration	Crude oil produced	Tg	NA	NO,NA	NA	NA	NA	NA	NO,NA	NA	NA	NA
Spain	2. Production	Crude oil produced	Tg	1	64	783	0.00005	0.00	0	64.14	797	0.00000	0.00
Spain	3. Transport	Transport of crude oil	Tg	51	75	827	0.004	0.04	66	52.46	578	0.003	0.04
Spain	4. Refining and storage	Oil refined	Tg	54	27 571 240	2 107	1477	0.11	69	47806810	1337	3283	0.09
Spain	5. Distribution of oil products	Oil products	Tg	NA	NO,NA	NA	NA	NA	NA	NO,NA	NA	NA	NA
Spain	6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Estonia	**Oil**						**NO,NE**	**NO,NE**				**NO,NE**	**NO,NE**
Estonia	1. Exploration	Exploration	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Estonia	2. Production	Production	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Estonia	3. Transport	Transport	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Estonia	4. Refining and storage	Refining/Storage	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Estonia	5. Distribution of oil products	Distribution of oil products	kt	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Estonia	6. Other	Other	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Finland	**Oil**						**NO**	**0.25**				**NO**	**0.37**
Finland	1. Exploration		NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Finland	2. Production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Finland	3. Transport		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Finland	4. Refining and storage	kt oil refined	kt	9 884	NO	25	NO	0.25	14 332	NO	25	NO	0.37
Finland	5. Distribution of oil products		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Finland	6. Other		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
France	**Oil**						**2983**	**8.23**				**2098**	**1.98**
France	1. Exploration	Oil produced	PJ	127	252 097	5 373	32	0.68	30	252097	5373	8	0.16
France	2. Production	Oil produced	PJ	127	7 201	54 578	1	6.93	30	7201	54578	0.22	1.66

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil				1990					2019				
Country	GHG source category	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	AD	CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
		Description	Unit	Value					Value				
	3. Transport	Oil loaded	PJ	5 189	7	73	0.03	0.38	2 541	5	58	0.01	0.15
	4. Refining and storage	Oil refined	PJ	3 194	923 744	75	2950	0.24	2 048	1020282	5	2090	0.01
	5. Distribution of oil products	Oil refined	PJ	3 785	NA	NA	NA	NA	3 692	NA	NA	NA	NA
	6. Other	NO	PJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
United Kingdom	**Oil**						**859**	**21.88**				**246**	**4.39**
	1. Exploration	Exploration drilling: fuel use	t	234 422	3 185	16	747	3.67	30 431	3200	25	97	0.76
	2. Production	Oil produced	PJ	3 981	28 256	3 684	112	14.67	2 282	65218	1203	149	2.74
	3. Transport	Oil loading	t	222 791 650	NO	0.02	NO	3.40	71 608 415	NO	0	NO	0.88
	4. Refining and storage	Refinery throughput	PJ	3 862	NO	37	NO	0.14	2 583	NO	2	NO	0.01
	5. Distribution of oil products		NA	194 504 000	NO	NO	NO	NO	97 903 640	NO	NO	NO	NO
	6. Other		NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Greece	**Oil**						**0.00004**	**0.39**				**0.00001**	**0.59**
	1. Exploration			NE	NO,NE	NE	NE	NE	NE	NO,NE	NE	NE	NE
	2. Production		kt	773	0.1	1	0.00004	0.00	168	0.05	1	0.00001	0.00
	3. Transport		kt	773	NO,NE	27	NE	0.02	168	NO,NE	27	NE	0.00
	4. Refining and storage		kt	14 411	IE,NO	26	IE	0.37	23 027	NO,IE	26	IE	0.59
	5. Distribution of oil products		kt	2 450	NA,NO	NA	NA	NA	2 245	NO,NA	NA	NA	NA
	6. Other			NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Croatia	**Oil**						**158**	**8.82**				**41**	**2.35**
	1. Exploration	total oil production	1000 m3	3 135	9 102	194	29	0.61	821	9102	194	7	0.16
	2. Production	total oil production	1000 m3	3 135	41 225	2 546	129	7.98	821	41225	2546	34	2.09
	3. Transport	total oil transported by pipelines	1000 m3	9 949	0.49	5	0.00	0.05	6 945	0.49	5	0.003	0.04
	4. Refining and storage	oil refined	1000 m3	7 978	NO,NA	22	NA	0.17	3 017	NO,NA	22	NA	0.07
	5. Distribution of oil products	product transported	NA	NA	NO,NA	NA	NA	NA	NA	NO,NA	NA	NA	NA

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil					1990					2019				
Country	GHG source category	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	AD	CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
		Description	Unit	Value					Value				
	6. Other		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Hungary	**Oil**						**5**	**7.14**				**1**	**2.18**
Hungary	1. Exploration		NA	IE	IE,NO	IE	IE	IE	IE	NO,IE	IE	IE	IE
Hungary	2. Production	conventional oil production (thousand m3)	1000 m3	2 269	2 150	3 000	5	6.81	1 069	130	1801	0.1	1.92
Hungary	3. Transport	Oil transported by pipeline (thousand m3)	1000 m3	10 432	25	13	0.3	0.13	8 502	50	10	0.4	0.08
Hungary	4. Refining and storage	Oil refined (thousand m3)	1000 m3	9 357	NA,NO	22	NA	0.20	7 822	NO,NA	22	NA	0.17
Hungary	5. Distribution of oil products		NA	NA	NA,NO	NA	NA	NA	NA	NO,NA	NA	NA	NA
Hungary	6. Other		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Ireland	**Oil**						**NO**	**0.01**				**NO**	**0.01**
Ireland	1. Exploration		PJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Ireland	2. Production		PJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Ireland	3. Transport		PJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Ireland	4. Refining and storage		PJ	77	NO	110	NO	0.01	108	NO	110	NO	0.01
Ireland	5. Distribution of oil products		PJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Ireland	6. Other		PJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Iceland	**Oil**						**0.003**	**0.02**				**0**	**0.03**
Iceland	1. Exploration			NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Iceland	2. Production			NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Iceland	3. Transport			NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Iceland	4. Refining and storage			NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Iceland	5. Distribution of oil products	oil distributed	TJ	27 981	0.1	1	0.003	0.02	37 033	0.13	1	0.005	0.03
Iceland	6. Other			NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Italy	**Oil**						**2402**	**12.39**				**2143**	**9.77**
Italy	1. Exploration	Wells drilled	Number	6	1 900	112	0.01	0.00	NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil					1990					2019				
Country	GHG source category	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	AD	CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
		Description	Unit	Value					Value				
	2. Production	Oil produced	Gg	4 668	320	2 049	1	9.56	4 279	321	1872	1	8.01
	3. Transport	Oil transported	Gg	94 600	1	6	0.1	0.58	114 051	0.56	6	0.06	0.71
	4. Refining and storage	Oil refined	Gg	93 711	25 615	24	2400	2.24	77 605	27599	14	2142	1.05
	5. Distribution of oil products	Oil distributed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	6. Other	Other	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Lithuania	**Oil**						**23.3**	**0.17**				**232**	**0.12**
Lithuania	1. Exploration	Oil produced	thous.m3	14	9 102	194	0.1	0.00	47	9101.90	194	0	0.01
Lithuania	2. Production	Oil produced, thous.m3	thous.m3	14	0.1	2	0.000002	0.00	47	0.11	1	0.00001	0.00
Lithuania	3. Transport	Oil transported, thous.m3	thous.m3	25 577	0.5	5	0.01	0.14	14 366	0.49	5	0.01	0.08
Lithuania	4. Refining and storage	Oil refined	thous.m3	11 181	NO	3	NO	0.03	11 155	NO	3	NO	0.03
Lithuania	5. Distribution of oil products		NA	NA	NO,NA	NA	NA	NA	NA	NO,NA	NA	NA	NA
Lithuania	6. Other	Refinery gas	kt	8	2 870 000	NO	23	NO	81	2850640.00	NO	232	NO
Luxembourg	**Oil**						**NO**	**NO**				**NO**	**NO**
Luxembourg	1. Exploration	number of wells drilled	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Luxembourg	2. Production	oil produced	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Luxembourg	3. Transport	oil loaded in tankers	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Luxembourg	4. Refining and storage	oil refined	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Luxembourg	5. Distribution of oil products	oil refined	TJ	66 031	NO	NO	NO	NO	122 898	NO	NO	NO	NO
Luxembourg	6. Other	other n.i.e.	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Latvia	**Oil**						**NO,NA**	**NO,NA**				**NO,NA**	**NO,NA**
Latvia	1. Exploration	Exploration	kt	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Latvia	2. Production	Production	kt	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Latvia	3. Transport	Transport	kt	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Latvia	4. Refining and storage	Refining/Storage	kt	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Latvia	5. Distribution of oil products	Distribution of Oil Products	kt	609	NO,NA	NA	NA	NA	174	NO,NA	NA	NA	NA

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil					1990				2019				
Country	GHG source category	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	AD	CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
		Description	Unit	Value					Value				
	6. Other	Other	kt	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Malta	**Oil**						**NO**	**NO**				**NO**	**NO**
	1. Exploration	number of wells drilled	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2. Production	oil produced	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	3. Transport	oil loaded in tankers	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	4. Refining and storage	oil refined	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	5. Distribution of oil products	Gasoline	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	6. Other	Other Petroleum Product	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	**Oil**						**0.02**	**0.81**				**953**	**0.65**
	1. Exploration		NA	IE	NO,IE	IE	IE	IE	IE	NO,IE	IE	IE	IE
	2. Production		NA	IE	NO,IE	IE	IE	IE	IE	NO,IE	IE	IE	IE
	3. Transport		Mg	33 912	1	6	0.02	0.20	43 503	0.53	6	0.02	0.25
	4. Refining and storage		PJ	2 077	NO,IE	296	IE	0.61	2 497	381688	158	953	0.39
	5. Distribution of oil products		NA	NE	NA	NA	NA	NA	NE	NO,NA	NA	NA	NA
	6. Other		NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Poland	**Oil**						**0**	**1.36**				**0.25**	**4.68**
	1. Exploration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2. Production	Production	PJ	7	7 309	101 205	0	0.67	41	5642	78120	0.23	3.21
	3. Transport	oil ltransported by pipeline	Gg	13 286	1	6	0	0.08	27 595	0.57	6	0.02	0.17
	4. Refining and storage	oil refined	Gg	12 846	NA	48	NA	0.61	27 181	NA	48	NA	1.29
	5. Distribution of oil products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	6. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Portugal	**Oil**						**0.4**	**0.07**				**999**	**0.07**
	1. Exploration		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2. Production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil					1990					2019				
Country	GHG source category	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	AD	CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
		Description	Unit	Value					Value				
	3. Transport		Mt	0.00	578 512	6 375 442 739	0.00001	0.07	0	578512	6375442739	0.00001	0.07
	4. Refining and storage		Mt	0.04	9 571 940	6	0.4	0.00	0	15449109392	4	999	0.00
	5. Distribution of oil products		Mt	0.001	NO	NO	NO	NO	0	NO	NO	NO	NO
	6. Other		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Romania	**Oil**						**746**	**192.45**				**428**	**10.38**
Romania	1. Exploration	oil produced	PJ	322	2 245 932	47 534	724	15.32	146	259989	5541	38	0.81
Romania	2. Production	oil produced	PJ	322	69 542	547 400	22	176.40	146	7998	62841	1	9.18
Romania	3. Transport	oil refined	PJ	975	14	151	0.01	0.15	510	14	149	0.01	0.08
Romania	4. Refining and storage	oil refined	PJ	962	IE,NO	609	IE	0.59	502	NO,IE	613	IE	0.31
Romania	5. Distribution of oil products	oil refined	PJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Romania	6. Other	oil refined	kt	NO	NO	IE	NO	IE	131	2974204	IE	388	IE
Slovakia	**Oil**						**0.03**	**0.59**				**0.01**	**0.28**
Slovakia	1. Exploration		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Slovakia	2. Production	Production	kt	73	260	3 600	0.02	0.26	6	260	3600	0.002	0.02
Slovakia	3. Transport	Transfer	kt	13 581	0.5	5	0.01	0.07	8 998	0.49	5	0.004	0.05
Slovakia	4. Refining and storage	Refining/Storage	kt	6 221	NE	41	NE	0.26	5 109	NE	41	NE	0.21
Slovakia	5. Distribution of oil products		NA	NE	NO,NE	NE	NE	NE	NE	NO,NE	NE	NE	NE
Slovakia	6. Other		NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Slovenia	**Oil**						**0.03**	**0.01**				**0**	**0.00**
Slovenia	1. Exploration	NA	1000 m3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Slovenia	2. Production	Conventional oil produced	1000 m3	3	0.04	1	0.0000001	0.00	0	0.04	1	0	0.00
Slovenia	3. Transport	Consumption of LPG	1000 m3	58	430	NA	0.03	NA	162	430	NA	0.07	NA
Slovenia	4. Refining and storage	Oil refined	1000 m3	626	NO,NA	22	NA	0.01	NO	NO,NA	NO	NA	NO
Slovenia	5. Distribution of oil products	NA	1000 m3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil					1990					2019				
Country	GHG source category	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	AD	CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
		Description	Unit	Value					Value				
	6. Other	NA	1000 m3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sweden	**Oil**						**255**	**0.98**				**470**	**1.01**
	1. Exploration	Consumption of feedstock	TJ	NA	NA	NA	38	0.00	NA	C,NA	C	C	C
	2. Production	Oil production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	3. Transport	Transported amount of oil	PJ	711	NE	745	NE	0.53	842	NE	745	NE	0.63
	4. Refining and storage	Consumption of crude oil	Mt	17	12 497 656	25 612	217	0.44	17	C,NA	C	C	C
	5. Distribution of oil products	Distribution of oil products		NE	NA	NA	NA	NA	NE	NA	NA	NA	NA
	6. Other			NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table 3.120 1.B.2.b Fugitive CH_4 emissions from natural gas: Information on activity data, emission factors by Member State

1.B.2.b Fugitive CH_4 Emissions from Natural gas					1990		2019		
	GHG source category	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data	Implied emission factor (kg/unit)	CH_4 emissions (kt)
Country		Description	Unit	Value			Value		
Austria	**Natural Gas**					**10.36**			**8.80**
	1. Exploration	Mm3 natural gas	Mm3	248.09	IE	IE	227.56	IE	IE
	2. Production	Mm3 natural gas	Mm3	1288.00	4478.94	5.77	891.00	3993.81	3.56
	3. Processing	Mm3 natural gas	Mm3	1288.00	NA	NA	891.00	NA	NA
	4. Transmission and storage	km pipeline length	km	3628.00	718.43	2.61	7230.51	519.62	3.76
	5. Distribution	km distribution network length	km	11672.00	170.22	1.99	30279.23	48.94	1.48

1.B.2.b Fugitive CH_4 Emissions from Natural gas				1990			2019		
	GHG source category	Activity data					Activity data		
Country		Description	Unit	Value	Implied emission factor (kg/unit)	CH_4 emissions (kt)	Value	Implied emission factor (kg/unit)	CH_4 emissions (kt)
	6. Other	Mm3 natural gas stored	Mm3	1500.00	NO	NO	4669.38	NO	NO
Belgium	**Natural Gas**					**28.38**			**19.55**
	1. Exploration		PJ	NO	NO	NO	NO	NO	NO
	2. Production		PJ	NO	NO	NO	NO	NO	NO
	3. Processing		PJ	NO	NO	NO	NO	NO	NO
	4. Transmission and storage		PJ	341.55	16715.01	5.71	624.12	8229.05	5.14
	5. Distribution		PJ	341.55	66372.48	22.67	624.12	23091.99	14.41
	6. Other		PJ	NO	NO	NO	NO	NO	NO
Bulgaria	**Natural Gas**					**5.84**			**9.19**
	2. Exploration	Indigenous production	106m3	14.00	60.00	0.00	38.87	60.00	0.00
	3. Production	Indigenous production	106m3	14.00	2540.00	0.04	38.87	2540.00	0.10
	4. Processing	Indigenous production	106m3	14.00	570.00	0.01	38.87	570.00	0.02
	5. Transmission and storage	Pipeline length	km	1469.00	2123.34	3.12	2800.00	2117.12	5.93
	6. Distribution	Pipeline length	km	50.00	230.00	0.01	5157.00	230.00	1.19
	7. Other	Natural gas consumption at energy and industrial plants	106m3	6610.22	403.27	2.67	2466.50	791.64	1.95
Cyprus	**Natural Gas**					**NO**			**NO**
	2. Exploration		NO	NO	NO	NO	NO	NO	NO
	3. Production		NO	NO	NO	NO	NO	NO	NO
	4. Processing		NO	NO	NO	NO	NO	NO	NO
	5. Transmission and storage		NO	NO	NO	NO	NO	NO	NO
	6. Distribution		NO	NO	NO	NO	NO	NO	NO
	7. Other		NO	NO	NO	NO	NO	NO	NO
Czechia	**Natural Gas**					**41.80**			**22.69**
	2. Exploration		PJ	NE	NE	NE	NE	NE	NE
	3. Production	(e.g. PJ gas produced)	PJ	7.84	39365.45	0.31	7.21	38144.93	0.28

1.B.2.b Fugitive CH_4 Emissions from Natural gas				1990			2019		
	GHG source category	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data	Implied emission factor (kg/unit)	CH_4 emissions (kt)
Country		Description	Unit	Value			Value		
	4. Processing		PJ	NO	NA	NA	NO	NA	NA
	5. Transmission and storage	(e.g. PJ gas consumed)	PJ	1357.98	9296.21	12.62	1246.39	4906.03	6.11
	6. Distribution	(e.g. PJ gas consumed)	PJ	55.77	517563.35	28.86	128.15	127185.92	16.30
	7. Other	(e.g. PJ gas consumed)	PJ	29.68	IE	IE	123.42	IE	IE
Germany	**Natural Gas**					**319.90**			**196.42**
Germany	3. Exploration	number of wells drilled	number	IE	IE	IE	IE	IE	IE
Germany	4. Production	gas produced	1000 m³	15262000.00	0.38	5.80	6062981.16	0.04	0.27
Germany	5. Processing	gas produced	1000 m³	15262000.00	0.35	5.34	6062981.16	0.02	0.12
Germany	6. Transmission and storage	lenght of transmission pipelines	km	22696.00	1998.74	45.36	35476.00	2211.61	78.46
Germany	7. Distribution	lenght of distribution pipelines	km	282612.00	828.87	234.25	493175.00	177.82	87.70
Germany	8. Other	gas consumed	TJ	893519.00	32.62	29.15	1293608.00	23.09	29.87
Denmark	**Natural Gas**					**2.38**			**1.41**
Denmark	3. Exploration	Gas explored	m3	2892052.00	0.01	0.03	NO	NO	NO
Denmark	4. Production	Gas produced	10^6 m3	5137.00	380.00	1.95	3045.00	380.00	1.16
Denmark	5. Processing	Gas produced	10^6 m3	5137.00	NA	NA	3045.00	NA	NA
Denmark	6. Transmission and storage	Gas transmission	10^6 m3	2739.00	52.22	0.14	3635.00	38.41	0.14
Denmark	7. Distribution	Gas distributed	10^6 m3	1749.06	145.93	0.26	2329.31	48.64	0.11
Denmark	8. Other	Incl. In transmission	m3	NO	NO	NO	NO	NO	NO
Spain	**Natural Gas**					**5.42**			**5.70**
Spain	3. Exploration	Mm3 gas produced	Mm3	NO	NO	NO	NO	NO	NO
Spain	4. Production	Mm3 gas produced	Mm3	1254.88	464.56	0.58	142.65	2241.83	0.32
Spain	5. Processing	Mm3 gas produced	Mm3	1254.88	150.00	0.19	142.65	150.00	0.02
Spain	6. Transmission and storage	PJ gas (NCV)	PJ	198.34	5889.64	1.17	1293.67	1373.55	1.78
Spain	7. Distribution	PJ of gaseous fuels (natural gas, LPG, gas work gas or propanized air) distributed by networks	PJ	205.75	16936.99	3.48	1308.23	2740.40	3.59
Spain	8. Other	NO	NO	NO	NO	NO	NO	NO	NO

Country	1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990			2019		
	GHG source category	Activity data					Activity data		
		Description	Unit	Value	Implied emission factor (kg/unit)	CH_4 emissions (kt)	Value	Implied emission factor (kg/unit)	CH_4 emissions (kt)
Estonia	**Natural Gas**					**2.24**			**0.72**
	4. Exploration	Exploration	NA	NO	NO	NO	NO	NO	NO
	5. Production	Production	NA	NO	NO	NO	NO	NO	NO
	6. Processing	Processing	NA	NO	NO	NO	NO	NO	NO
	7. Transmission and storage	Amount of the transmission of Natural Gas	PJ	51.23	5734.64	0.29	16.44	5734.64	0.09
	8. Distribution	Amount of natural gas distributed	PJ	51.23	38000.60	1.95	16.44	38000.60	0.62
	9. Other	Other	NA	NO	NO	NO	NO	NO	NO
Finland	**Natural Gas**					**0.17**			**0.68**
	4. Exploration		NO	NO	NO	NO	NO	NO	NO
	5. Production		NO	NO	NO	NO	NO	NO	NO
	6. Processing		NA	NO	NO	NO	NA	NO	NO
	7. Transmission and storage	PJ gas consumed	PJ	91.58	1856.22	0.17	84.17	3924.18	0.33
	8. Distribution	PJ gas distributed	NO	NO	NO	NO	9.68	36142.09	0.35
	9. Other		NO	NO	NO	NO	NO	NO	NO
France	**Natural Gas**					**60.81**			**36.92**
	4. Exploration	NO	PJ	NO	NO	NO	NO	NO	NO
	5. Production	NO	PJ	IE	IE	IE	IE	IE	IE
	6. Processing	Gas processed	PJ	309.00	2376.20	0.73	6.33	303.96	0.00
	7. Transmission and storage	Gas consumed	PJ	1091.00	24425.57	26.65	1577.41	8379.74	13.22
	8. Distribution	Gas consumed	PJ	1091.00	30640.07	33.43	1577.41	15021.87	23.70
	9. Other	NO	PJ	NO	NO	NO	NO	NO	NO
United Kingdom	**Natural Gas**					**406.73**			**138.27**
	5. Exploration	Exploration drilling: fuel use	t	225517.62	15.66	3.53	38180.13	45.00	1.72
	6. Production	Gas produced	PJ	1709.37	IE	IE	1422.36	IE	IE
	7. Processing	Gas produced	PJ	1709.37	12756.73	21.81	1422.36	1323.01	1.88
	8. Transmission and storage	Natural gas supply	GWh	387730.56	23.58	9.14	512104.35	6.03	3.09

1.B.2.b Fugitive CH_4 Emissions from Natural gas				1990			2019		
Country	GHG source category	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data	Implied emission factor (kg/unit)	CH_4 emissions (kt)
		Description	Unit	Value			Value		
	9. Distribution	Natural gas supply	GWh	39963.99	9314.71	372.25	13937.66	9440.59	131.58
	10. Other		NA	NO	NO	NO	NO	NO	NO
Greece	**Natural Gas**					**0.37**			**3.28**
	5. Exploration			NE	NE	NE	NE	NE	NE
	6. Production		mil_m3	123.00	1930.00	0.24	8.90	1930.00	0.02
	7. Processing		mil_m3	123.00	IE	IE	8.90	IE	IE
	8. Transmission and storage		mil m3	123.00	298.00	0.04	5230.79	298.00	1.56
	9. Distribution		mil m3	86.24	1100.00	0.09	1553.08	1100.00	1.71
	10. Other			IE	IE	IE	IE	IE	IE
Croatia	**Natural Gas**					**5.54**			**4.30**
	5. Exploration	Natural gas production	1000000 m3	1982.30	IE	IE	1028.90	IE	IE
	6. Production	gas produced	1000000 m3	1982.30	1340.76	2.66	1028.90	1340.76	1.38
	7. Processing	gas produced	1000000 m3	1982.30	592.00	1.17	1028.90	592.00	0.61
	8. Transmission and storage	marketable gas	1000000 m3	2686.60	480.00	1.29	2908.00	480.00	1.40
	9. Distribution	utility sales	1000000 m3	379.30	1100.00	0.42	833.40	1100.00	0.92
	10. Other		NO	NO	NO	NO	NO	NO	NO
Hungary	**Natural Gas**					**79.43**			**59.84**
	6. Exploration		NA	IE	IE	IE	IE	IE	IE
	7. Production	Gas production (million m3)	million m3	4874.00	1340.00	6.53	1716.00	1340.00	2.30
	8. Processing	Sweet gas plants-raw gas feed (million m3)	million m3	1593.00	940.86	1.50	544.25	935.14	0.51
	9. Transmission and storage	Marketable gas (million m3)	million m3	11278.00	3990.34	45.00	20363.00	972.23	19.80
	10. Distribution	length of pipelines	km	22559.00	1170.00	26.39	84589.00	440.13	37.23
	11. Other		NO	NO	NO	NO	NO	NO	NO
Ireland	**Natural Gas**					**0.82**			**1.87**
	6. Exploration	Natural gas exploration	PJ	NO	NO	NO	NO	NO	NO

1.B.2.b Fugitive CH_4 Emissions from Natural gas				1990			2019		
	GHG source category	Activity data					Activity data		
Country		Description	Unit	Value	Implied emission factor (kg/unit)	CH_4 emissions (kt)	Value	Implied emission factor (kg/unit)	CH_4 emissions (kt)
	7. Production		PJ	78.58	0.32	0.00	89.89	60.07	0.01
	8. Processing		PJ	IE	IE	IE	IE	IE	IE
	9. Transmission and storage		PJ	78.93	2190.16	0.17	211.90	1855.06	0.39
	10. Distribution		PJ	37.35	17318.04	0.65	100.28	14668.34	1.47
	11. Other		PJ	NO	NO	NO	NO	NO	NO
Iceland	**Natural Gas**					**NO**			**NO**
Iceland	6. Exploration	Natural gas exploration	PJ	NO	NO	NO	NO	NO	NO
Iceland	7. Production		PJ	NO	NO	NO	NO	NO	NO
Iceland	8. Processing		PJ	NO	NO	NO	NO	NO	NO
Iceland	9. Transmission and storage		PJ	NO	NO	NO	NO	NO	NO
Iceland	10. Distribution		PJ	NO	NO	NO	NO	NO	NO
Iceland	11. Other		PJ	NO	NO	NO	NO	NO	NO
Italy	**Natural Gas**					**329.45**			**154.45**
Italy	6. Exploration	Wells explored	Number	36.00	158.15	0.01	NO	NO	NO
Italy	7. Production	Gas produced	Mm3	17296.39	1726.36	29.86	4983.20	906.05	4.52
Italy	8. Processing	Gas produced	Mm3	17296.39	773.26	13.37	4983.20	405.75	2.02
Italy	9. Transmission and storage	Gas transported	Mm3	45683.58	822.12	37.56	75370.00	330.81	24.93
Italy	10. Distribution	Gas distributed	Mm3	20632.00	12051.86	248.65	32527.94	3780.61	122.98
Italy	11. Other	other	NA	NO	NO	NO	NO	NO	NO
Lithuania	**Natural Gas**					**10.42**			**11.54**
Lithuania	7. Exploration		NO	NO	NO	NO	NO	NO	NO
Lithuania	8. Production		NO	NO	NO	NO	NO	NO	NO
Lithuania	9. Processing		NO	NO	NO	NO	NO	NO	NO
Lithuania	10. Transmission and storage	Natural gas leakages	kt	2.01	977699.00	1.97	3.62	948571.00	3.43
Lithuania	11. Distribution	Natural gas leakages	kt	8.65	977699.00	8.46	8.48	948571.00	8.05
Lithuania	12. Other	Natural gas leakages	NO	NO	NO	NO	0.07	948571.00	0.06

1.B.2.b Fugitive CH_4 Emissions from Natural gas				1990		2019		
	GHG source category	Activity data				Activity data		
Country		Description	Unit	Value	Implied emission factor (kg/unit)	CH_4 emissions (kt)	Value	Implied emission factor (kg/unit)	CH_4 emissions (kt)
Luxembourg	**Natural Gas**					**0.77**			**1.23**
	7. Exploration	gas exploration	NA	NO	NO	NO	NO	NO	NO
	8. Production	gas produced	NA	NO	NO	NO	NO	NO	NO
	9. Processing	NO	NA	NO	NO	NO	NO	NO	NO
	10. Transmission and storage	gas consumed	TJ	17933.32	13.12	0.24	28667.60	13.05	0.37
	11. Distribution	gas consumed	TJ	17933.32	30.07	0.54	28667.60	29.90	0.86
	12. Other	NO	NA	NO	NO	NO	NO	NO	NO
Latvia	**Natural Gas**					**7.09**			**3.35**
	7. Exploration	Exploration	m3	NO	NO	NO	NO	NO	NO
	8. Production	Production	m3	NO	NO	NO	NO	NO	NO
	9. Processing	Processing	m3	NO	NO	NO	NO	NO	NO
	10. Transmission and storage	Transmission and storage	m3	125172.00	0.69	0.09	12236.00	0.68	0.01
	11. Distribution	Distribution	m3	694188.00	0.69	0.48	738680.00	0.65	0.48
	12. Other	Other	m3	12435406.00	0.52	6.53	4401146.00	0.65	2.86
Malta	**Natural Gas**					**NO**			**NO**
	8. Exploration	NO	NO	NO	NO	NO	NO	NO	NO
	9. Production	gas produced	NO	NO	NO	NO	NO	NO	NO
	10. Processing	gas processed	no	NO	NO	NO	NO	NO	NO
	11. Transmission and storage	gas consumed	NO	NO	NO	NO	NO	NO	NO
	12. Distribution	gas consumed	NO	NO	NO	NO	NO	NO	NO
	13. Other	gas consumed	NO	NO	NO	NO	NO	NO	NO
Netherlands	**Natural Gas**					**16.84**			**9.74**
	8. Exploration		NA	NA	IE	IE	NA	IE	IE
	9. Production	Gas produced	mln m3	72131.00	IE	IE	31950.00	IE	IE
	10. Processing		NA	IE	IE	IE	IE	IE	IE

1.B.2.b Fugitive CH_4 Emissions from Natural gas				1990			2019		
	GHG source category	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data	Implied emission factor (kg/unit)	CH_4 emissions (kt)
Country		Description	Unit	Value			Value		
	11. Transmission and storage	Gas transmitted	PJ	2648.08	4121.34	10.91	3132.00	1352.81	4.24
	12. Distribution	Length distribution network	10^3 km	99.98	59294.88	5.93	125.35	43868.21	5.50
	13. Other		NA	NA	NO	NO	IE	NO	NO
Poland	**Natural Gas**					**30.13**			**55.68**
Poland	8. Exploration	NA	10^6m3	3218.20	0.19	0.00	4968.18	0.19	0.00
Poland	9. Production	Production	10^6m3	3218.20	2300.00	7.40	4968.18	2291.13	11.38
Poland	10. Processing		10^6m3	3218.20	1030.00	3.31	4968.18	1030.00	5.12
Poland	11. Transmission and storage	gas consumed	10^6m3	12096.03	505.00	6.11	24410.45	505.00	12.33
Poland	12. Distribution	gas consumed	10^6m3	12096.03	1100.00	13.31	24410.45	1100.00	26.85
Poland	13. Other	NA	NA	NO	NO	NO	NO	NO	NO
Portugal	**Natural Gas**					**NO**			**2.10**
Portugal	9. Exploration		NO	NO	NO	NO	NO	NO	NO
Portugal	10. Production		NO	NO	NO	NO	NO	NO	NO
Portugal	11. Processing		NO	NO	NO	NO	NO	NO	NO
Portugal	12. Transmission and storage		toe NG Transmitted	NO	NO	NO	5235.47	10.89	0.06
Portugal	13. Distribution		toe NG Distributed	NO	NO	NO	1771.40	1152.08	2.04
Portugal	14. Other		NO	NO	NO	NO	NO	NO	NO
Romania	**Natural Gas**					**647.35**			**52.38**
Romania	9. Exploration	gas produced	PJ	IE	IE	IE	IE	IE	IE
Romania	10. Production	gas produced	106m3	28336.00	12190.00	345.42	9959.02	1340.00	13.35
Romania	11. Processing	gas produced and processed	106m3	28336.00	250.00	7.08	9959.02	590.00	5.88
Romania	12. Transmission and storage	gas produced	106m3	35667.00	633.00	22.58	15434.57	228.10	3.52
Romania	13. Distribution	gas supplied	106m3	35667.00	1800.00	64.20	12640.09	1100.00	13.90
Romania	14. Other	gas consumed	PJ	809.19	257135.36	208.07	251.78	62483.97	15.73

1.B.2.b Fugitive CH_4 Emissions from Natural gas					1990		2019		
	GHG source category	Activity data					Activity data		
Country		Description	Unit	Value	Implied emission factor (kg/unit)	CH_4 emissions (kt)	Value	Implied emission factor (kg/unit)	CH_4 emissions (kt)
Slovakia	**Natural Gas**					**44.14**			**6.59**
	9. Exploration		NA	NO	NO	NO	NO	NO	NO
	10. Production	Production/Processing	mil m3	444.00	2300.00	1.02	124.00	2300.00	0.29
	11. Processing		mil m3	444.00	1030.00	0.46	124.00	1030.00	0.13
	12. Transmission and storage	Transfer	mil m3	73600.00	480.00	35.33	69060.00	11.70	0.81
	13. Distribution	Distribution	mil m3	6666.00	1100.00	7.33	4841.46	1100.00	5.33
	14. Other	Storage	mil m3	1.00	25.00	0.00	1922.00	25.00	0.05
Slovenia	**Natural Gas**					**1.70**			**1.34**
	10. Exploration	NA	1000 m3	NO	NO	NO	NO	NO	NO
	11. Production	Gas production	1000 m3	23631.00	12.19	0.29	4797.00	1.34	0.01
	12. Processing	NA	1000 m3	NO	NO	NO	NO	NO	NO
	13. Transmission and storage	Marketable gas	1000 m3	892000.60	0.48	0.43	901835.00	0.37	0.34
	14. Distribution	Utility sale	1000 m3	892000.60	1.10	0.98	901835.00	1.10	0.99
	15. Other	NA	1000 m3	NO	NO	NO	NO	NO	NO
Sweden	**Natural Gas**					**2.69**			**1.22**
	10. Exploration	Gas produced		NO	NO	NO	NO	NO	NO
	11. Production	Gas produced		NO	NO	NO	NO	NO	NO
	12. Processing	Gas produced		NO	NO	NO	NO	NO	NO
	13. Transmission and storage	Length of transmission pipelines	km	NA	NA	0.05	NA	NA	0.08
	14. Distribution	Length of distribution pipelines	km	NA	NA	2.65	NA	NA	1.14
	15. Other			NO	NO	NO	NO	NO	NO

3.2.6.3 CO_2 Emissions from Venting and Flaring (1.B.2.c)

Fugitive Emissions from this source correspond to Emissions from venting and flaring of associated gas and waste gas/vapour streams at oil and gas facilities.

CO_2 emissions from 1.B.2.c – Venting and Flaring – account for 0.2% of total EU-KP GHG emissions in 2019 and for 9 % of all fugitive emissions in the EU-KP. Between 1990 and 2019 CO_2 emissions from this source decreased by 24%.

All but three countries (Austria, Cyprus, Malta) - are reporting CO_2 emissions in this category.

In 2019, 55% of the EU-KP CO_2 emissions from 1.B.2.c were emitted by the UK (Table 3.121, Figure 3.187) Main source for CO_2 emissions from this category in the UK is the flaring of oil, which is estimated by applying a Tier 2 methodology with country specific and plant specific emission factors. Table 3.121 shows that 77 % of EU-KP emissions are calculated using higher tier methods. In cases where countries report a mix of Tier 1 and higher Tier methods (FRK, HUN, ESP) only emissions from subcategories of sector 1.B.2.b were taken into account for the calculation, where the countries actually apply a higher tier method. Countries that report a Tier 1 method but a countr specific or plant specific emission factor (SVK) were calculated as a higher Tier method, according to the IPCC 2006 Guidelines.

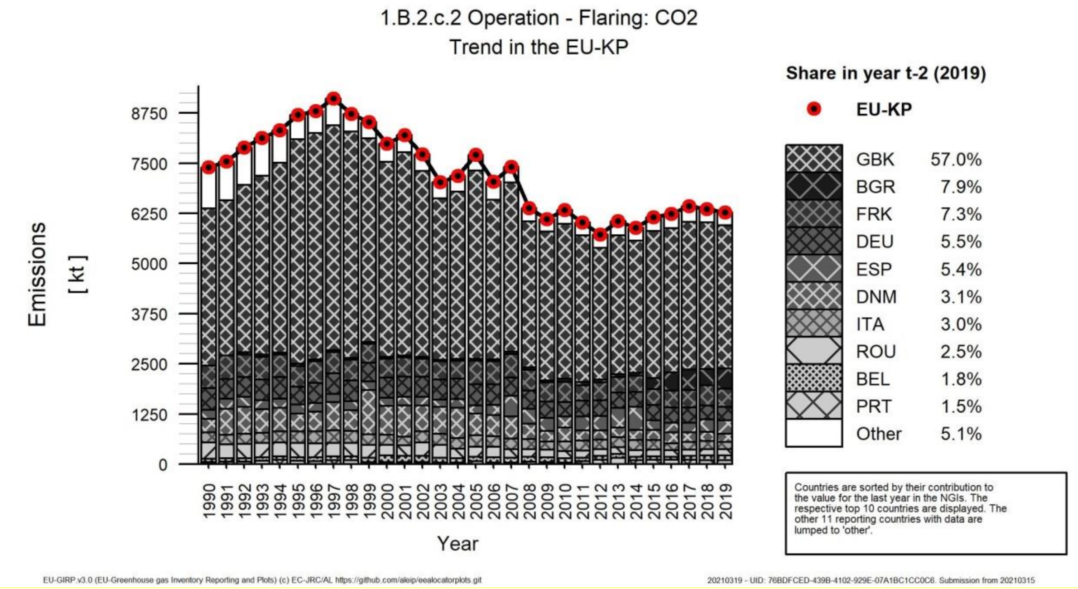
The emission decreases between 1990 and 2019 observed in the Netherlands (-95%), Italy (-59%), Germany (-37%), Hungary (-74%) and Romania (-62 %) contributed most significantly to the overall reduction in the EU-KP between 1990 and 2019.

Table 3.121: 1.B.2.c Fugitive CO_2 emissions from Other emissions: Countries' contributions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	IE	IE	IE	-	-	-	-	-	NA	NA
Belgium	84	121	116	1.8%	32	38%	-5.14	-4%	T3	PS
Bulgaria	NO,IE	413	497	7.6%	497	∞	83	20%	T1	D
Croatia	0.00	0.00	0.00	0.0%	0	-93%	0.00	-6%	T1	D
Cyprus	NO,NE	NO	NO	-	-	-	-	-	NA	NA
Czechia	2.02	4.56	3.36	0.1%	1	66%	-1.20	-26%	T1	D
Denmark	328	232	195	3.0%	-133	-41%	-38	-16%	T3	PS
Estonia	0.01	0.00	0.00	0.0%	0	-68%	0.00	-8%	T1	D
Finland	111	91	65	1.0%	-46	-41%	-26	-28%	CS	CS
France	560	504	456	6.9%	-104	-19%	-49	-10%	T1,T2,T3	CS,D,PS
Germany	544	342	345	5.2%	-199	-37%	3.23	1%	T2	CS
Greece	43	10	8.52	0.1%	-34	-80%	-1.94	-19%	T1	D
Hungary	471	138	124	1.9%	-347	-74%	-14	-10%	T1,T3	CS,D
Ireland	NO	0.18	0.25	0.0%	0.25	∞	0.07	36%	CS,T3	CS,PS
Italy	956	437	396	6.0%	-560	-59%	-42	-10%	T1	D
Latvia	0.00	0.00	0.00	0.0%	0	-33%	0.00	91%	T3	CS
Lithuania	0.58	2.22	1.92	0.0%	1.34	232%	-0.30	-13%	T1	D
Luxembourg	0.00	0.00	0.00	0.0%	0	23%	0.00	0%	CS	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	774	44	36	0.5%	-739	-95%	-8.40	-19%	T2	PS
Poland	44	76	88	1.3%	44	102%	12	17%	T1	D
Portugal	52	95	97	1.5%	44	84%	1.49	2%	NO	NO
Romania	424	161	161	2.5%	-262	-62%	0.56	0%	T1	D
Slovakia	4.57	0.75	0.85	0.0%	-3.72	-81%	0.09	13%	T1	CS
Slovenia	0.18	0.04	0.02	0.0%	-0.16	-87%	-0.01	-37%	T1	D
Spain	275	311	342	5.2%	68	25%	31	10%	CS,T1,T2	CS,D,PS
Sweden	73	37	59	0.9%	-15	-20%	21	57%	T2,T3	CS,PS
United Kingdom	3 920	3 700	3 581	54.5%	-339	-9%	-119	-3%	T2	CS,PS
EU-27+UK	**8 665**	**6 722**	**6 571**	**100%**	**-2 094**	**-24%**	**-151**	**-2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 920	3 700	3 581	54.5%	-339	-9%	-119	-3%	T2	CS,PS
EU-KP	**8 665**	**6 722**	**6 571**	**100%**	**-2 094**	**-24%**	**-151**	**-2%**	**-**	**-**

Note: Austria includes CO_2 emissions from venting and flaring in 1.A.1b Petroleum refining

Figure 3.187: 1.B.2.c Venting and Flaring: Emission trend and share for the emitting countries of CO_2



3.2.6.4 Emissions from Other (1.B.2.d)

Fugitive emissions from other correspond to emissions from geothermal energy production and all other energy production that is not included in categories 1.B.1 and 1.B.2.

Seven countries report CO_2 emissions in this sector, four are reporting CH_4 emissions and three countries report N_2O emissions. The description of the subcategories is presented inTable 3.122.

Table 3.122 Description of subcategories in sector 1.B.2.d for CO_2-, N_2O- and CH_4-emissions for reporting countries

Member state	Emission	Subcategory
Finland	CO_2, CH_4	Distribution of town gas
Greece	CO_2, N_2O	LPG transport
Hungary	CH_4, CO_2	Groundwater extraction and CO_2 mining
Iceland	CH_4, CO_2	Geothermal Energy
Italy	CH_4, CO_2, N_2O	Flaring in refineries
Poland	CO_2	Underground storage of gas
Portugal	CO_2	Geothermal
United Kingdom	N_2O	Natural gas exploration: N_2O emissions

Table 3.123 and Table 3.124 provide information on the contribution of countries to EU-KP recalculations in CO_2 and CH_4 from 1.B.2 'Oil and natural gas' for 1990 and 2018 and main explanations for the largest recalculations in absolute terms.

Table 3.1231.B.2 Fugitive CO_2 emissions from Oil and natural gas: Contribution of countries to EU-KP recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2018		Main Explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	-	-	0.00	0.0	no information available
Bulgaria	-0.3	-0.5	-0.1	-0.0	For the 2021 submission the Fugitive emission sector the updated methodologies and the default emission factors from 2019 Refinement to the 2006 IPCC Guidelines were applied.
Croatia	-18	-3.0	-11	-4.2	According to ESD rewiev double counting noticed in 1B2b1 category
Cyprus	-0.0	-100	-0.1	-100	After the recommendation with reference FCCC/ARR/2020/CYP (E.18), a unit conversion mistake and the CH_4 EF were corrected from 0.00335 kg CH_4/ m3 to 0.0218 kg CH_4/ m3 and implied a change of 550.7%.
Czechia	0.0	0.2	0.0	0.1	Recalculation for 1.B.2.a.iii.2 Mining oil, CH_4 emissions was done for the time serie from 1997 till 2009 and then from 2011-2012. This recalculation was necessary due to the wrong calorific value used for this category. Before NCV for transportation, refining and distribution was used not for the mining, which was discovered by the last review process. For the other years the NCV was equal, therefore the recalculation does not have to be for the whole time series. The amount of fuel consumption remain same, therefore no differences were calculated. The amount of fuel are there dor the calculation purposes.
Denmark	0.0	0.0	0.0	0.0	The activity data for gas transmission (snap 050601) is updated for the years 1990-2018 as new information has become available from the gas transmission company. Minor adjustments have been made for the calculation of emissions from gas distribution

	1990		2018		Main Explanations
	kt CO_2	%	kt CO_2	%	
Estonia	0.0	9.0	0.0	16	Emissions were recalculated due to using Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, instead of national energy balance.
Finland	-	-	-	-	
France	-	-	-10	-0.3	The most significant impacts come from the recalculations of CRF 1B2a1. Lesser impacts come from recalculations of CRF 1B2b and 1B2c.
Germany	-	-	1.0	0.1	Update of statistical data
Greece	-	-	-	-	
Hungary	0.0	0.0	-0.0	-0.0	In the previous submission, we applied a T1 methodology based on utility sales with a default IPCC emission factor of 1.1 t CH_4/million m3 of gas consumption. For this submission, our calculation is based on country-specific information on acknowledged distribution losses used for price regulation of gas distribution system operators. Technological losses were interpreted in the inventory as fugitive methane emissions, and all other elements as "real" natural gas consumption thus the latter was added as energy consumption (and the corresponding CO_2 emissions) to the source category 1A4b.
Ireland	0.0	0.0	-	-	Ireland has reallocated the emissions from natural gas transmission (category 1.B.2.b.4) and distribution (category 1.B.2.b.5), reporting emissions separately by applying the Gas Networks Ireland splits consistently and as accurately as possible across the whole time series.
Italy	-	-	0.0	0.0	The major recalculations are due to the updated emissions from natural gas transmission and distribution since 1990 sources following the update of the average content of CH_4 and CO_2 in the national natural gas mix due to an error which has been fixed. Moreover, the updated atomic 125 weights (NIST Chemistry WebBook, SRD 69 - National Institute of Standard and Technology, USA) for the elements involved in the calculation of the carbon content in the natural gas (Hydrogen, Carbon, Oxygen, etc.) have been used since 2005. The updated data affect the estimates of CO_2eq emissions between 0.016% and 0.019% for natural gas transmission and between 0.013% and 0.907% for natural gas distribution compared to the previous submission.
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Luxembourg	0.0	1.5	0.0	0.5	CO_2 and CH_4 emissions from natural gas venting of transmission and distribution networks (sub-category 1B2c – Venting) are first estimated in submission 2021v1. This category was added to the inventory following a review recommendation in the UNFCCC Review 2018 (ARR 2018, E.26), in the EU-ESD review 2020 (LU-1B2c-2020-0001) and recently in the UNFCCC Review 2020 (preliminary finding: 2020LUXQA38).
Malta	0.0	0.1	-5	-0.3	
Netherlands	-66	-55	-81	-7.1	
Poland	-	-	-	-	Update of the activity data according to Eurostst database; in 1b2b - AD data and the method of calculation from natural gas was changed;
Portugal	-	-	-	-	[1B2a Fugitive Emissions from Oil] - Allocation corrections in activity data; update on oxidation factors; update on Service Stations activity data; [1B2c Flaring] - Allocation of emissions from category 1B2c to 1A2c.
Romania	-	-	0.0	11.2	activity data: Oil and Natural Gas, Other, Other Leakage (1.B.2.b.6) category: recalculations of activity data values for 2007 – 2018 period have been made because the activity data values from the IEA/Eurostat Questionnaire 2019 according to EU – ETS data have been revised; emissions factors Oil and Natural Gas, Other, Other Leakage (1.B.2.b.6) category: the Default Emission Factor values for 2000 - 2018 period have been changed (EFs from Revised 1996 IPCC, RM, Table 1-6, page 1.121, "Former USSR, Central & Eastern Europe" column were replaced by Default Emission Factors from "Rest of the World" column;

	1990		2018		Main Explanations
	kt CO_2	%	kt CO_2	%	
Slovakia	2.6	0.2	-0.0	-0.0	
Slovenia	0.1	0.0	-0.0	-0.0	Inclusion of emissions from crude oil production.
Spain	-	-	-14	-0.3	New information available. Registration of new oil and gas wells not previously accounted for by the Inventory
Sweden	0.0	0.1	-5	-0.3	Correction in the calculation of facility-specific TJ flared gas for 1990-2004
United Kingdom	-66	-55	-81	-7.1	Correction to data for an upstream oil and gas facility.
EU27+UK	**-81**	**-0.4**	**-120**	**-0.5**	
Iceland	0.0	0.0	0.0	0.0	
United Kingdom (KP)	-	-	-14	-0.3	Correction to data for an upstream oil and gas facility.
EU-KP	**-81**	**-0.4**	**-120**	**-0.5**	

Table 3.1241.B.2 Fugitive CH_4 emissions from Oil and natural gas: Contribution of countries to EU-KP recalculations in CH_4 for 1990 and 2017 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2018		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	0.7	0.1	-0.1	-0.0	
Bulgaria	-	-	0.0	0.0	For the 2021 submission the Fugitive emission sector the updated methodologies and the default emission factors from 2019 Refinement to the 2006 IPCC Guidelines were applied.
Croatia	-10	-2.6	-6.0	-3.3	According to ESD rewiev double counting noticed in 1B2b1 category
Cyprus	-0.1	-18	-0.2	-100	After the recommendation with reference FCCC/ARR/2020/CYP (E.18), a unit conversion mistake and the CH_4 EF were corrected from 0.00335 kg CH_4/ m3 to 0.0218 kg CH_4/ m3 and implied a change of 550.7%.
Czechia	-	-	-	-	
Denmark	10	8.5	3.2	3.6	The implied emission factors for storage of crude (snap 050208) oil is updated. The activity data for gas transmission (snap 050601) is updated for the years 1990-2018 as new information has become available from the gas transmission company. Minor adjustments have been made for the calculation of emissions from gas distribution. An error in the calculation of emissions from town gas distribution (snap 050604) is updated for one town gas distribution company, leading to minor changes for the years 2014-2018.
Estonia	14	28	5.9	36	Emissions were recalculated due to using Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, instead of national energy balance.
Finland	0.0	0.2	0.0	0.1	Activity data corrected
France	-	-	-1.4	-0.1	
Germany	-	-	-18	-0.4	Update of statistical data
Greece	-	-	-	-	
Hungary	1 057	78	1 046	166	Default methodology has been replaced for methane emission from gas transmission, storage and distribution
Ireland	0.0	0.0	-0.0	-0.0	
Italy	191	2.2	595	13.3	Methane emissions from geothermal plants have been added for the whole time series
Latvia	-	-	-	-	
Lithuania	-	-	-	-	

	1990		2018		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Luxembourg	0.2	1.1	0.2	0.6	CO_2 and CH_4 emissions from natural gas venting of transmission and distribution networks (sub-category 1B2c – Venting) are first estimated in submission 2021v1. This category was added to the inventory following a review recommendation in the UNFCCC Review 2018 (ARR 2018, E.26), in the EU-ESD review 2020 (LU-1B2c-2020-0001) and recently in the UNFCCC Review 2020 (preliminary finding: 2020LUXQA38).
Malta	-	-	-	-	
Netherlands	-	-	-	-	
Poland	0.0	0.0	7.9	0.3	Update of the activity data according to Eurostst database; in 1b2b - AD data and the method of calculation from natural gas was changed;
Portugal	-0.0	-1.3	-0.0	-0.0	[1B2c Flaring] - Allocation of emissions from category 1B2c to 1A2c.
Romania	-578	-2.4	-1 101	-30.4	activity data: Oil and Natural Gas, Other, Other Leakage (1.B.2.b.6) category: recalculations of activity data values for 2007 – 2018 period have been made because the activity data values from the IEA/Eurostat Questionnaire 2019 according to EU – ETS data have been revised; emissions factors Oil and Natural Gas, Other, Other Leakage (1.B.2.b.6) category: the Default Emission Factor values for 2000 - 2018 period have been changed (EFs from Revised 1996 IPCC, RM, Table 1-6, page 1.121, “Former USSR, Central & Eastern Europe” column were replaced by Default Emission Factors from “Rest of the World” column;
Slovakia	-	-	-1 136	-84.7	According to the ERT recommendation to move to higher tier method, tier 3 approach was implemented into category 1.B.2 - natural gas transmission and storage. Time series was reconstructed back to base year and emissions were decreased.
Slovenia	-	-	0.0	0.0	Inclusion of emissions from crude oil production.
Spain	1.6	1.0	-0.0	-0.0	New information available. Registration of new oil and gas wells not previously accounted for by the Inventory
Sweden	-0.3	-0.3	0.1	0.1	The whole time series have been updated due to slight change in activity data for 1B2a_iii
United Kingdom	13	0.1	-84	-1.7	Site specific corrections to upstream oil and gas facilities.
EU27+UK	700	1.1	-688	-2.6	
Iceland	0.0	0.0	0	0.0	
United Kingdom (KP)	13	0.1	-84	-1.7	Site specific corrections to upstream oil and gas facilities.
EU-KP	700	1.1	-688	-2.6	

3.2.7 CO_2 capture and storage (1.C)

CO_2 capture and storage is not an EU key category (see Annex 1.1). Finland is the only Member State reporting captured CO_2 emissions in this category for the years 1993 to 2019.

The amount of CO_2 captured reflects the CO_2 captured in pulp and paper mills in Finland, where precipitated calcium carbonate (PCC) is formed and then used in the paper and paperboard industry. The final use of the CO_2 captured is considered as long-term storage except if the products are combusted. The resulting fossil CO_2 emissions from combustion of products containing PCC are taken into account in the corresponding categories in the greenhouse gas inventory of Finland. A detailed description of the methodology is provided in Finland’s NIR.

Captured CO_2 emissions reported in 1C 'CO_2 capture and storage' correspond to 0.003 % of total EU-KP GHG emissions in 2019. The emissions captured increased between 1993 and 2019 by 13 695%.

3.2.8 Energy – non-key categories

Table 3.125 provides an overview on the role of non-key categories in the Energy sector.

Table 3.125 Aggregated GHG emission from non-key categories in the energy sector

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.1.a Public Electricity and Heat Production: Biomass (CH_4)	50.9	2 281.3	2 331.1	0.07%	2 280.19	4478%	49.84	2%
1.A.1.a Public Electricity and Heat Production: Biomass (N_2O)	237.8	1 544.3	1 618.0	0.05%	1 380.23	581%	73.66	5%
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CH_4)	161.4	1 012.8	1 104.4	0.04%	943.06	584%	91.66	9%
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (N_2O)	150.7	665.9	848.6	0.03%	697.92	463%	182.71	27%
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CH_4)	165.4	27.0	25.3	0.00%	-140.18	-85%	-1.78	-7%
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (N_2O)	428.0	78.2	75.3	0.00%	-352.70	-82%	-2.84	-4%
1.A.1.a Public Electricity and Heat Production: Other Fuels (CH_4)	36.2	158.6	167.7	0.01%	131.53	363%	9.11	6%
1.A.1.a Public Electricity and Heat Production: Other Fuels (N_2O)	138.2	446.9	465.5	0.01%	327.32	237%	18.57	4%
1.A.1.a Public Electricity and Heat Production: Peat (CH_4)	8.1	9.4	8.3	0.00%	0.23	3%	-1.09	-12%
1.A.1.a Public Electricity and Heat Production: Peat (N_2O)	121.9	122.8	106.9	0.00%	-15.00	-12%	-15.91	-13%
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CH_4)	267.4	141.4	108.3	0.00%	-159.10	-59%	-33.07	-23%
1.A.1.a Public Electricity and Heat Production: Solid Fuels (N_2O)	5 986.5	3 575.9	2 675.5	0.09%	-3 311.03	-55%	-900.43	-25%
1.A.1.b Petroleum Refining: Biomass (CH_4)	1.9	0.1	0.1	0.00%	-1.81	-96%	0.00	6%
1.A.1.b Petroleum Refining: Biomass (N_2O)	3.5	1.2	1.1	0.00%	-2.33	-67%	-0.09	-8%
1.A.1.b Petroleum Refining: Gaseous Fuels (CH_4)	5.7	24.7	25.4	0.00%	19.73	347%	0.71	3%
1.A.1.b Petroleum Refining: Gaseous Fuels (N_2O)	135.3	65.3	65.4	0.00%	-69.86	-52%	0.10	0%
1.A.1.b Petroleum Refining: Liquid Fuels (CH_4)	74.0	50.2	50.2	0.00%	-23.87	-32%	-0.06	0%
1.A.1.b Petroleum Refining: Liquid Fuels (N_2O)	305.6	289.2	295.4	0.01%	-10.20	-3%	6.21	2%
1.A.1.b Petroleum Refining: Other Fuels (CH_4)	5.8	0.2	0.1	0.00%	-5.66	-98%	-0.02	-10%
1.A.1.b Petroleum Refining: Other Fuels (CO_2)	920.7	222.7	317.5	0.01%	-603.17	-66%	94.84	43%
1.A.1.b Petroleum Refining: Other Fuels (N_2O)	9.7	0.5	0.5	0.00%	-9.18	-95%	-0.03	-6%
1.A.1.b Petroleum Refining: Solid Fuels (CH_4)	0.5	0.0	0.0	0.00%	-0.50	-95%	0.00	-9%
1.A.1.b Petroleum Refining: Solid Fuels (CO_2)	3 633.0	115.1	104.4	0.00%	-3 528.61	-97%	-10.66	-9%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.1.b Petroleum Refining: Solid Fuels (N_2O)	29.9	0.5	0.5	0.00%	-29.47	-98%	-0.04	-9%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Biomass (CH_4)	82.2	159.0	159.1	0.01%	76.89	94%	0.02	0%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Biomass (N_2O)	3.8	49.7	49.8	0.00%	46.00	1203%	0.16	0%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CH_4)	160.3	273.8	314.8	0.01%	154.52	96%	41.01	15%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (N_2O)	216.6	278.4	364.5	0.01%	147.93	68%	86.12	31%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Liquid Fuels (CH_4)	14.0	10.4	9.0	0.00%	-4.94	-35%	-1.40	-13%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Liquid Fuels (CO_2)	5 363.0	3 608.5	3 743.6	0.12%	-1 619.37	-30%	135.14	4%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Liquid Fuels (N_2O)	75.7	60.6	59.6	0.00%	-16.12	-21%	-1.05	-2%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Other Fuels (CH_4)	4.9	0.0	0.0	0.00%	-4.95	-100%	-0.01	-92%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Other Fuels (CO_2)	456.1	1.7	0.1	0.00%	-455.93	-100%	-1.53	-92%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Other Fuels (N_2O)	9.1	0.0	0.0	0.00%	-9.07	-100%	-0.01	-92%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Peat (CH_4)	0.1	0.0	0.0	0.00%	-0.03	-51%	-0.01	-17%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Peat (CO_2)	175.5	77.9	66.2	0.00%	-109.23	-62%	-11.69	-15%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Peat (N_2O)	0.7	0.3	0.3	0.00%	-0.42	-61%	-0.05	-15%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CH_4)	156.5	19.4	19.8	0.00%	-136.71	-87%	0.31	2%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (N_2O)	692.2	164.6	155.7	0.00%	-536.55	-78%	-8.97	-5%
1.A.2.a Iron and Steel: Biomass (CH_4)	0.3	0.3	0.2	0.00%	-0.03	-12%	-0.04	-14%
1.A.2.a Iron and Steel: Biomass (N_2O)	0.4	0.6	0.6	0.00%	0.15	36%	-0.06	-10%
1.A.2.a Iron and Steel: Gaseous Fuels (CH_4)	19.2	17.0	13.9	0.00%	-5.33	-28%	-3.16	-19%
1.A.2.a Iron and Steel: Gaseous Fuels (N_2O)	126.2	133.8	44.5	0.00%	-81.72	-65%	-89.35	-67%
1.A.2.a Iron and Steel: Liquid Fuels (CH_4)	12.8	0.6	0.5	0.00%	-12.26	-96%	-0.09	-16%
1.A.2.a Iron and Steel: Liquid Fuels (N_2O)	29.2	4.8	3.7	0.00%	-25.56	-87%	-1.12	-23%
1.A.2.a Iron and Steel: Other Fuels (CH_4)	3.7	0.0	0.0	0.00%	-3.65	-99%	0.00	-10%
1.A.2.a Iron and Steel: Other Fuels (CO_2)	652.3	23.8	21.0	0.00%	-631.39	-97%	-2.81	-12%
1.A.2.a Iron and Steel: Solid Fuels (CH_4)	221.7	121.0	117.5	0.00%	-104.19	-47%	-3.46	-3%
1.A.2.a Iron and Steel: Solid Fuels (N_2O)	346.1	170.3	158.5	0.01%	-187.67	-54%	-11.84	-7%
1.A.2.b Non-Ferrous Metals: Biomass (CH_4)	0.0	1.1	1.0	0.00%	1.04	33233%	-0.06	-6%
1.A.2.b Non-Ferrous Metals: Biomass (N_2O)	0.0	1.8	1.7	0.00%	1.65	33725%	-0.13	-7%
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CH_4)	2.4	18.2	25.3	0.00%	22.90	970%	7.11	39%
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (N_2O)	5.1	9.2	9.9	0.00%	4.79	94%	0.64	7%
1.A.2.b Non-Ferrous Metals: Liquid Fuels (CH_4)	3.9	0.5	0.7	0.00%	-3.29	-83%	0.11	21%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.2.b Non-Ferrous Metals: Liquid Fuels (CO_2)	4 357.6	691.2	836.8	0.03%	-3 520.82	-81%	145.55	21%
1.A.2.b Non-Ferrous Metals: Liquid Fuels (N_2O)	12.4	3.1	3.3	0.00%	-9.03	-73%	0.25	8%
1.A.2.b Non-Ferrous Metals: Other Fuels (CO_2)	64.9	0.7	1.2	0.00%	-63.70	-98%	0.46	67%
1.A.2.b Non-Ferrous Metals: Other Fuels (N_2O)	0.5	0.0	0.0	0.00%	-0.51	-96%	0.01	55%
1.A.2.b Non-Ferrous Metals: Peat (CO_2)	6.5	0.0	0.0	0.00%	-6.50	-100%	0.00	0%
1.A.2.b Non-Ferrous Metals: Solid Fuels (CH_4)	9.1	2.6	2.9	0.00%	-6.29	-69%	0.24	9%
1.A.2.b Non-Ferrous Metals: Solid Fuels (N_2O)	46.4	6.0	6.3	0.00%	-40.05	-86%	0.35	6%
1.A.2.c Chemicals: Biomass (CH_4)	1.6	9.7	10.0	0.00%	8.48	545%	0.37	4%
1.A.2.c Chemicals: Biomass (N_2O)	8.4	20.6	22.4	0.00%	13.98	166%	1.75	8%
1.A.2.c Chemicals: Gaseous Fuels (CH_4)	52.1	370.3	381.4	0.01%	329.37	633%	11.16	3%
1.A.2.c Chemicals: Gaseous Fuels (N_2O)	48.1	53.5	53.8	0.00%	5.76	12%	0.28	1%
1.A.2.c Chemicals: Liquid Fuels (CH_4)	46.2	22.6	20.0	0.00%	-26.24	-57%	-2.67	-12%
1.A.2.c Chemicals: Liquid Fuels (N_2O)	162.5	74.0	55.1	0.00%	-107.38	-66%	-18.88	-26%
1.A.2.c Chemicals: Other Fuels (CH_4)	15.2	8.4	7.7	0.00%	-7.55	-50%	-0.75	-9%
1.A.2.c Chemicals: Other Fuels (CO_2)	3 033.7	2 301.8	1 734.0	0.06%	-1 299.67	-43%	-567.75	-25%
1.A.2.c Chemicals: Other Fuels (N_2O)	27.1	20.0	19.0	0.00%	-8.06	-30%	-1.01	-5%
1.A.2.c Chemicals: Peat (CH_4)	0.1	0.0	0.0	0.00%	-0.14	-100%	0.00	-100%
1.A.2.c Chemicals: Peat (CO_2)	191.1	0.1	0.0	0.00%	-191.13	-100%	-0.11	-100%
1.A.2.c Chemicals: Peat (N_2O)	3.8	0.0	0.0	0.00%	-3.80	-100%	0.00	-100%
1.A.2.c Chemicals: Solid Fuels (CH_4)	31.0	23.1	21.1	0.00%	-9.95	-32%	-1.96	-8%
1.A.2.c Chemicals: Solid Fuels (N_2O)	80.5	41.7	38.0	0.00%	-42.51	-53%	-3.74	-9%
1.A.2.d Pulp, Paper and Print: Biomass (CH_4)	46.6	117.5	124.8	0.00%	78.21	168%	7.28	6%
1.A.2.d Pulp, Paper and Print: Biomass (N_2O)	198.3	376.5	389.6	0.01%	191.24	96%	13.04	3%
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CH_4)	32.9	122.4	135.1	0.00%	102.21	311%	12.75	10%
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (N_2O)	29.9	48.0	48.3	0.00%	18.37	61%	0.29	1%
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CH_4)	13.3	6.9	6.8	0.00%	-6.44	-49%	-0.09	-1%
1.A.2.d Pulp, Paper and Print: Liquid Fuels (N_2O)	38.3	14.0	13.3	0.00%	-25.07	-65%	-0.72	-5%
1.A.2.d Pulp, Paper and Print: Other Fuels (CH_4)	0.1	2.0	2.7	0.00%	2.56	2084%	0.65	32%
1.A.2.d Pulp, Paper and Print: Other Fuels (CO_2)	90.9	336.4	406.4	0.01%	315.50	347%	69.99	21%
1.A.2.d Pulp, Paper and Print: Other Fuels (N_2O)	0.5	4.4	4.7	0.00%	4.13	792%	0.21	5%
1.A.2.d Pulp, Paper and Print: Peat (CH_4)	0.6	0.6	0.6	0.00%	0.00	0%	-0.03	-5%
1.A.2.d Pulp, Paper and Print: Peat (CO_2)	1 117.6	935.5	888.7	0.03%	-228.93	-20%	-46.77	-5%
1.A.2.d Pulp, Paper and Print: Peat (N_2O)	9.8	7.3	7.0	0.00%	-2.87	-29%	-0.38	-5%
1.A.2.d Pulp, Paper and Print: Solid Fuels (CH_4)	17.5	5.2	5.3	0.00%	-12.17	-70%	0.13	3%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.2.d Pulp, Paper and Print: Solid Fuels (N_2O)	45.8	25.9	26.4	0.00%	-19.41	-42%	0.50	2%
1.A.2.e Food Processing, Beverages and Tobacco: Biomass (CH_4)	6.9	227.8	244.4	0.01%	237.44	3424%	16.53	7%
1.A.2.e Food Processing, Beverages and Tobacco: Biomass (N_2O)	17.8	96.7	99.2	0.00%	81.42	458%	2.46	3%
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CH_4)	20.3	210.8	207.5	0.01%	187.18	920%	-3.23	-2%
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (N_2O)	18.8	37.3	36.9	0.00%	18.09	96%	-0.35	-1%
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CH_4)	19.4	3.5	3.3	0.00%	-16.11	-83%	-0.20	-6%
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (N_2O)	80.6	14.1	12.8	0.00%	-67.79	-84%	-1.31	-9%
1.A.2.e Food Processing, Beverages and Tobacco: Other Fuels (CH_4)	0.0	0.3	0.2	0.00%	0.21	2393%	-0.05	-20%
1.A.2.e Food Processing, Beverages and Tobacco: Other Fuels (CO_2)	8.3	37.7	50.9	0.00%	42.64	514%	13.21	35%
1.A.2.e Food Processing, Beverages and Tobacco: Other Fuels (N_2O)	0.0	0.5	0.4	0.00%	0.33	894%	-0.10	-21%
1.A.2.e Food Processing, Beverages and Tobacco: Peat (CH_4)	0.3	0.0	0.0	0.00%	-0.28	-100%	0.00	-87%
1.A.2.e Food Processing, Beverages and Tobacco: Peat (CO_2)	139.1	4.5	0.6	0.00%	-138.51	-100%	-3.85	-86%
1.A.2.e Food Processing, Beverages and Tobacco: Peat (N_2O)	1.5	0.0	0.0	0.00%	-1.51	-100%	-0.02	-87%
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CH_4)	30.8	11.0	10.4	0.00%	-20.38	-66%	-0.59	-5%
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (N_2O)	66.1	22.6	21.5	0.00%	-44.55	-67%	-1.05	-5%
1.A.2.f Non-metallic minerals: Biomass (CH_4)	21.9	49.2	51.6	0.00%	29.78	136%	2.47	5%
1.A.2.f Non-metallic minerals: Biomass (N_2O)	59.5	112.3	120.7	0.00%	61.23	103%	8.44	8%
1.A.2.f Non-metallic minerals: Gaseous Fuels (CH_4)	23.5	63.2	53.2	0.00%	29.70	126%	-9.95	-16%
1.A.2.f Non-metallic minerals: Gaseous Fuels (N_2O)	137.2	151.7	144.3	0.00%	7.14	5%	-7.37	-5%
1.A.2.f Non-metallic minerals: Liquid Fuels (CH_4)	53.3	25.3	24.9	0.00%	-28.39	-53%	-0.42	-2%
1.A.2.f Non-metallic minerals: Liquid Fuels (N_2O)	714.7	337.1	315.9	0.01%	-398.85	-56%	-21.26	-6%
1.A.2.f Non-metallic minerals: Other Fuels (CH_4)	4.3	83.1	85.4	0.00%	81.11	1899%	2.26	3%
1.A.2.f Non-metallic minerals: Other Fuels (N_2O)	13.9	209.1	218.8	0.01%	204.86	1469%	9.68	5%
1.A.2.f Non-metallic minerals: Peat (CH_4)	0.0	0.0	0.0	0.00%	-0.01	-91%	0.00	-39%
1.A.2.f Non-metallic minerals: Peat (CO_2)	27.0	4.0	2.4	0.00%	-24.62	-91%	-1.57	-39%
1.A.2.f Non-metallic minerals: Peat (N_2O)	0.1	0.0	0.0	0.00%	-0.10	-91%	-0.01	-39%
1.A.2.f Non-metallic minerals: Solid Fuels (CH_4)	134.8	32.6	32.5	0.00%	-102.24	-76%	-0.07	0%
1.A.2.f Non-metallic minerals: Solid Fuels (N_2O)	506.4	170.9	166.1	0.01%	-340.29	-67%	-4.77	-3%
1.A.2.g Other Manufacturing Industries and Constructions: Biomass (CH_4)	102.5	236.4	237.8	0.01%	135.32	132%	1.39	1%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.2.g Other Manufacturing Industries and Constructions: Biomass (N_2O)	209.2	443.2	445.6	0.01%	236.41	113%	2.38	1%
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CH_4)	81.1	396.2	395.5	0.01%	314.38	388%	-0.74	0%
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (N_2O)	165.4	284.6	282.5	0.01%	117.07	71%	-2.11	-1%
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CH_4)	155.6	68.2	68.2	0.00%	-87.48	-56%	-0.07	0%
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (N_2O)	1 252.4	863.5	879.9	0.03%	-372.44	-30%	16.44	2%
1.A.2.g Other Manufacturing Industries and Constructions: Other Fuels (CH_4)	12.0	4.6	5.1	0.00%	-6.93	-58%	0.55	12%
1.A.2.g Other Manufacturing Industries and Constructions: Other Fuels (CO_2)	2 519.3	4 309.9	4 331.9	0.14%	1 812.62	72%	22.06	1%
1.A.2.g Other Manufacturing Industries and Constructions: Other Fuels (N_2O)	29.2	51.7	52.7	0.00%	23.51	81%	1.04	2%
1.A.2.g Other Manufacturing Industries and Constructions: Peat (CH_4)	0.1	0.0	0.0	0.00%	-0.02	-36%	-0.01	-26%
1.A.2.g Other Manufacturing Industries and Constructions: Peat (CO_2)	21.5	33.9	20.8	0.00%	-0.64	-3%	-13.06	-39%
1.A.2.g Other Manufacturing Industries and Constructions: Peat (N_2O)	0.2	0.3	0.1	0.00%	-0.10	-42%	-0.11	-44%
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CH_4)	115.5	11.7	10.5	0.00%	-104.91	-91%	-1.15	-10%
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (N_2O)	736.5	144.2	138.4	0.00%	-598.15	-81%	-5.82	-4%
1.A.3.a Domestic Aviation: Aviation Gasoline (CH_4)	3.1	1.9	1.6	0.00%	-1.44	-47%	-0.25	-13%
1.A.3.a Domestic Aviation: Jet Kerosene (CH_4)	13.8	7.5	7.6	0.00%	-6.19	-45%	0.14	2%
1.A.3.a Domestic Aviation: Jet Kerosene (N_2O)	122.0	146.7	147.9	0.00%	25.87	21%	1.17	1%
1.A.3.b Road Transportation: Biomass (CH_4)	0.1	49.3	51.3	0.00%	51.25	75483%	1.99	4%
1.A.3.b Road Transportation: Biomass (N_2O)	0.1	419.9	443.5	0.01%	443.34	313174%	23.59	6%
1.A.3.b Road Transportation: Diesel Oil (CH_4)	574.1	210.5	203.5	0.01%	-370.64	-65%	-7.02	-3%
1.A.3.b Road Transportation: Gaseous Fuels (CH_4)	11.1	63.2	69.6	0.00%	58.47	527%	6.34	10%
1.A.3.b Road Transportation: Gaseous Fuels (N_2O)	0.6	98.5	113.9	0.00%	113.23	17722%	15.38	16%
1.A.3.b Road Transportation: Gasoline (N_2O)	4 866.4	819.6	814.2	0.03%	-4 052.14	-83%	-5.38	-1%
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CH_4)	43.2	59.0	59.5	0.00%	16.32	38%	0.52	1%
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (N_2O)	18.4	28.2	27.0	0.00%	8.56	46%	-1.18	-4%
1.A.3.b Road Transportation: Other Fuels (CH_4)	0.0	3.4	3.7	0.00%	3.74	100%	0.35	10%
1.A.3.b Road Transportation: Other Fuels (N_2O)	0.0	9.2	9.4	0.00%	9.35	100%	0.20	2%
1.A.3.b Road Transportation: Other Liquid Fuels (CH_4)	0.8	0.1	0.1	0.00%	-0.69	-90%	0.00	-4%
1.A.3.b Road Transportation: Other Liquid Fuels (CO_2)	431.0	60.5	55.5	0.00%	-375.47	-87%	-5.03	-8%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.3.b Road Transportation: Other Liquid Fuels (N_2O)	0.4	0.1	0.1	0.00%	-0.28	-73%	0.00	-1%
1.A.3.c Railways: Biomass (CH_4)	0.0	0.2	0.2	0.00%	0.16	100%	-0.01	-5%
1.A.3.c Railways: Liquid Fuels (CH_4)	19.5	6.2	5.9	0.00%	-13.51	-69%	-0.22	-4%
1.A.3.c Railways: Liquid Fuels (N_2O)	771.4	269.7	254.1	0.01%	-517.32	-67%	-15.62	-6%
1.A.3.c Railways: Other Fuels (CO_2)	0.0	4.2	4.1	0.00%	4.09	100%	-0.16	-4%
1.A.3.c Railways: Solid Fuels (CH_4)	0.2	1.0	1.0	0.00%	0.73	318%	0.00	0%
1.A.3.c Railways: Solid Fuels (CO_2)	440.3	76.4	75.1	0.00%	-365.20	-83%	-1.28	-2%
1.A.3.c Railways: Solid Fuels (N_2O)	2.2	0.3	0.3	0.00%	-1.91	-88%	-0.01	-3%
1.A.3.d Domestic Navigation: Biomass (CH_4)	0.0	2.3	2.3	0.00%	2.34	100%	0.01	1%
1.A.3.d Domestic Navigation: Biomass (N_2O)	0.0	1.3	1.3	0.00%	1.29	100%	0.03	3%
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CH_4)	24.1	17.4	17.4	0.00%	-6.70	-28%	0.02	0%
1.A.3.d Domestic Navigation: Gas/Diesel Oil (N_2O)	288.6	244.7	249.6	0.01%	-38.94	-13%	4.92	2%
1.A.3.d Domestic Navigation: Gaseous Fuels (CH_4)	0.0	0.0	11.8	0.00%	11.83	100%	11.78	26832%
1.A.3.d Domestic Navigation: Gaseous Fuels (CO_2)	0.0	4.3	46.6	0.00%	46.60	100%	42.34	993%
1.A.3.d Domestic Navigation: Gasoline (CH_4)	44.9	37.5	37.6	0.00%	-7.32	-16%	0.10	0%
1.A.3.d Domestic Navigation: Gasoline (CO_2)	1 647.2	1 820.4	1 840.7	0.06%	193.45	12%	20.26	1%
1.A.3.d Domestic Navigation: Gasoline (N_2O)	7.5	11.0	11.2	0.00%	3.75	50%	0.20	2%
1.A.3.d Domestic Navigation: Other Fuels (CH_4)	0.0	1.1	1.1	0.00%	1.12	100%	0.00	0%
1.A.3.d Domestic Navigation: Other Fuels (CO_2)	0.0	34.5	34.4	0.00%	34.42	100%	-0.10	0%
1.A.3.d Domestic Navigation: Other Fuels (N_2O)	0.0	0.3	0.3	0.00%	0.28	100%	0.00	0%
1.A.3.d Domestic Navigation: Other Liquid Fuels (CH_4)	0.1	0.3	0.3	0.00%	0.13	107%	0.00	0%
1.A.3.d Domestic Navigation: Other Liquid Fuels (CO_2)	5.7	35.8	34.9	0.00%	29.14	510%	-0.92	-3%
1.A.3.d Domestic Navigation: Other Liquid Fuels (N_2O)	0.0	0.2	0.2	0.00%	0.17	449%	0.00	-2%
1.A.3.d Domestic Navigation: Residual Fuel Oil (CH_4)	15.7	11.6	12.6	0.00%	-3.17	-20%	1.00	9%
1.A.3.e Other Transportation: Biomass (N_2O)	0.0	0.0	0.0	0.00%	0.00	0%	0.00	0%
1.A.3.e Other Transportation: Gaseous Fuels (CH_4)	9.9	11.4	9.4	0.00%	-0.47	-5%	-2.00	-17%
1.A.3.e Other Transportation: Gaseous Fuels (CO_2)	4 594.8	5 341.5	5 028.2	0.16%	433.38	9%	-313.25	-6%
1.A.3.e Other Transportation: Gaseous Fuels (N_2O)	23.6	27.3	24.7	0.00%	1.05	4%	-2.64	-10%
1.A.3.e Other Transportation: Liquid Fuels (CH_4)	1.1	0.5	0.5	0.00%	-0.59	-54%	-0.02	-4%
1.A.3.e Other Transportation: Liquid Fuels (CO_2)	704.2	1 074.1	1 118.2	0.04%	414.00	59%	44.12	4%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.3.e Other Transportation: Solid Fuels (CH_4)	0.4	0.0	0.0	0.00%	-0.41	-100%	0.00	0%
1.A.3.e Other Transportation: Solid Fuels (CO_2)	54.7	0.0	0.0	0.00%	-54.70	-100%	0.00	0%
1.A.3.e Other Transportation: Solid Fuels (N_2O)	0.7	0.0	0.0	0.00%	-0.65	-100%	0.00	0%
1.A.4.a Commercial/Institutional: Biomass (CH_4)	154.2	399.0	378.0	0.01%	223.81	145%	-20.98	-5%
1.A.4.a Commercial/Institutional: Biomass (N_2O)	43.7	185.3	179.4	0.01%	135.73	311%	-5.88	-3%
1.A.4.a Commercial/Institutional: Gaseous Fuels (CH_4)	125.2	261.6	253.8	0.01%	128.58	103%	-7.77	-3%
1.A.4.a Commercial/Institutional: Gaseous Fuels (N_2O)	106.2	180.3	177.4	0.01%	71.19	67%	-2.94	-2%
1.A.4.a Commercial/Institutional: Liquid Fuels (CH_4)	152.0	72.7	73.4	0.00%	-78.54	-52%	0.74	1%
1.A.4.a Commercial/Institutional: Liquid Fuels (N_2O)	325.3	110.1	109.3	0.00%	-215.94	-66%	-0.79	-1%
1.A.4.a Commercial/Institutional: Other Fuels (CH_4)	8.5	26.3	24.8	0.00%	16.33	193%	-1.55	-6%
1.A.4.a Commercial/Institutional: Other Fuels (N_2O)	18.0	165.1	168.1	0.01%	150.19	836%	3.09	2%
1.A.4.a Commercial/Institutional: Peat (CH_4)	0.7	0.2	0.2	0.00%	-0.48	-71%	-0.02	-10%
1.A.4.a Commercial/Institutional: Peat (CO_2)	232.8	48.8	39.1	0.00%	-193.72	-83%	-9.64	-20%
1.A.4.a Commercial/Institutional: Peat (N_2O)	1.1	0.2	0.2	0.00%	-0.86	-81%	-0.04	-17%
1.A.4.a Commercial/Institutional: Solid Fuels (CH_4)	1 474.1	11.7	7.7	0.00%	-1 466.41	-99%	-3.97	-34%
1.A.4.a Commercial/Institutional: Solid Fuels (N_2O)	172.4	22.9	15.3	0.00%	-157.07	-91%	-7.57	-33%
1.A.4.b Residential: Biomass (N_2O)	1 729.9	2 768.5	2 763.0	0.09%	1 033.07	60%	-5.53	0%
1.A.4.b Residential: Gaseous Fuels (CH_4)	633.1	694.7	676.7	0.02%	43.68	7%	-17.97	-3%
1.A.4.b Residential: Gaseous Fuels (N_2O)	281.2	389.8	384.7	0.01%	103.52	37%	-5.09	-1%
1.A.4.b Residential: Liquid Fuels (CH_4)	338.1	184.6	174.7	0.01%	-163.35	-48%	-9.85	-5%
1.A.4.b Residential: Liquid Fuels (N_2O)	650.3	253.2	251.5	0.01%	-398.82	-61%	-1.70	-1%
1.A.4.b Residential: Other Fuels (CH_4)	0.0	0.4	0.4	0.00%	0.37	100%	-0.01	-1%
1.A.4.b Residential: Other Fuels (CO_2)	0.0	18.0	12.8	0.00%	12.82	100%	-5.20	-29%
1.A.4.b Residential: Other Fuels (N_2O)	0.0	0.1	0.1	0.00%	0.08	100%	0.00	-2%
1.A.4.b Residential: Peat (CH_4)	283.6	67.8	62.7	0.00%	-220.96	-78%	-5.14	-8%
1.A.4.b Residential: Peat (CO_2)	3 957.6	938.4	870.1	0.03%	-3 087.41	-78%	-68.24	-7%
1.A.4.b Residential: Peat (N_2O)	16.9	3.9	3.7	0.00%	-13.23	-78%	-0.28	-7%
1.A.4.b Residential: Solid Fuels (N_2O)	1 101.3	218.0	176.6	0.01%	-924.72	-84%	-41.44	-19%
1.A.4.c Agriculture/Forestry/Fishing: Biomass (CH_4)	96.9	635.0	641.0	0.02%	544.11	562%	5.96	1%
1.A.4.c Agriculture/Forestry/Fishing: Biomass (N_2O)	20.4	179.0	180.7	0.01%	160.24	784%	1.71	1%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CH_4)	77.6	1 102.9	1 193.5	0.04%	1 115.96	1439%	90.57	8%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (N_2O)	8.5	8.5	8.7	0.00%	0.14	2%	0.15	2%

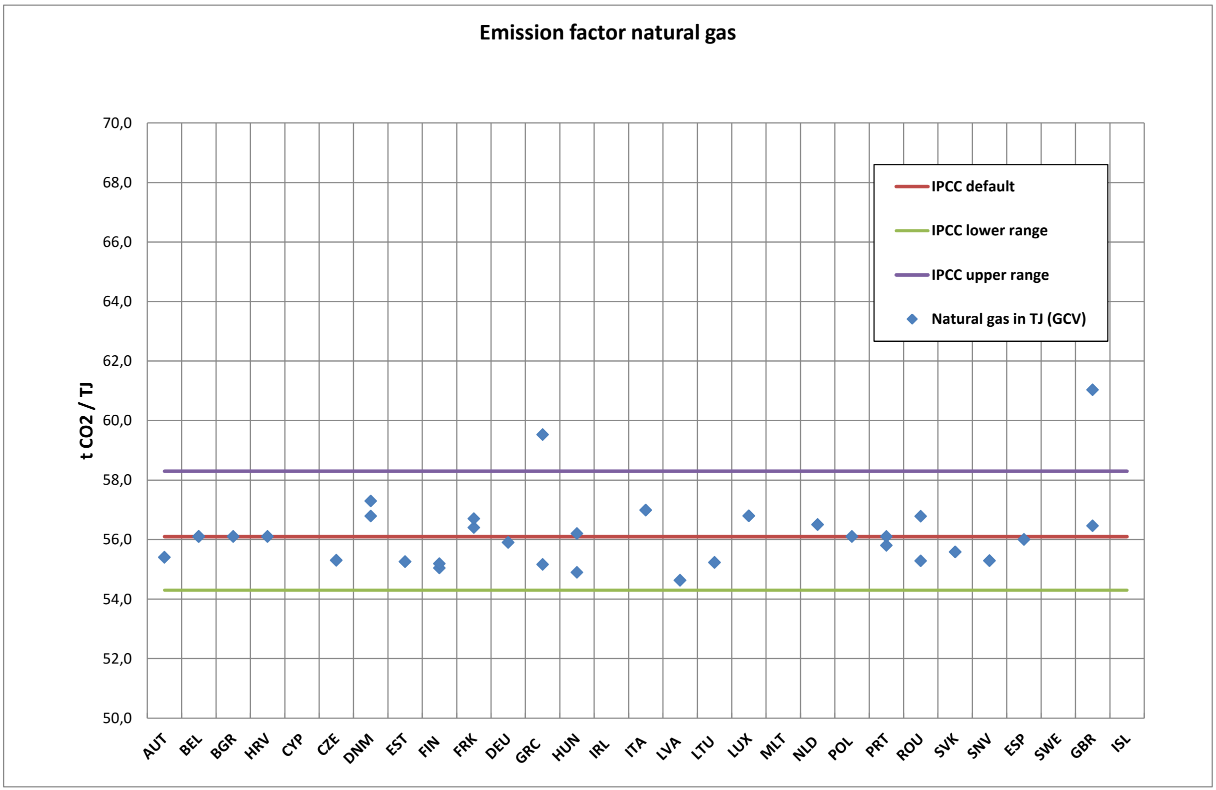
EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CH_4)	207.3	94.4	93.2	0.00%	-114.07	-55%	-1.22	-1%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (N_2O)	3 434.0	3 320.9	3 342.6	0.11%	-91.37	-3%	21.66	1%
1.A.4.c Agriculture/Forestry/Fishing: Other Fuels (CH_4)	0.0	0.2	0.2	0.00%	0.24	100%	0.06	35%
1.A.4.c Agriculture/Forestry/Fishing: Other Fuels (CO_2)	0.0	59.4	56.0	0.00%	55.96	100%	-3.42	-6%
1.A.4.c Agriculture/Forestry/Fishing: Other Fuels (N_2O)	0.0	3.4	3.1	0.00%	3.10	100%	-0.30	-9%
1.A.4.c Agriculture/Forestry/Fishing: Peat (CH_4)	0.9	7.4	7.3	0.00%	6.44	756%	-0.14	-2%
1.A.4.c Agriculture/Forestry/Fishing: Peat (CO_2)	45.0	278.6	275.3	0.01%	230.33	512%	-3.31	-1%
1.A.4.c Agriculture/Forestry/Fishing: Peat (N_2O)	0.5	2.7	2.7	0.00%	2.19	441%	-0.03	-1%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CH_4)	663.6	297.2	252.6	0.01%	-411.06	-62%	-44.64	-15%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (N_2O)	38.2	18.4	15.4	0.00%	-22.82	-60%	-3.01	-16%
1.A.5.a Other Other Sectors: Biomass (CH_4)	0.3	2.0	2.0	0.00%	1.69	484%	0.01	1%
1.A.5.a Other Other Sectors: Biomass (N_2O)	0.3	0.4	0.4	0.00%	0.17	66%	0.00	0%
1.A.5.a Other Other Sectors: Gaseous Fuels (CH_4)	0.4	0.4	0.8	0.00%	0.41	96%	0.41	93%
1.A.5.a Other Other Sectors: Gaseous Fuels (CO_2)	726.6	588.6	752.3	0.02%	25.70	4%	163.70	28%
1.A.5.a Other Other Sectors: Gaseous Fuels (N_2O)	1.2	1.3	1.3	0.00%	0.12	10%	0.05	4%
1.A.5.a Other Other Sectors: Liquid Fuels (CH_4)	8.9	4.4	4.7	0.00%	-4.22	-47%	0.34	8%
1.A.5.a Other Other Sectors: Liquid Fuels (CO_2)	6 758.3	3 016.8	3 138.8	0.10%	-3 619.58	-54%	121.98	4%
1.A.5.a Other Other Sectors: Peat (CH_4)	0.3	0.0	0.0	0.00%	-0.28	-100%	0.00	0%
1.A.5.a Other Other Sectors: Peat (CO_2)	24.0	0.0	0.0	0.00%	-23.97	-100%	0.00	0%
1.A.5.a Other Other Sectors: Peat (N_2O)	0.1	0.0	0.0	0.00%	-0.14	-100%	0.00	0%
1.A.5.a Other Other Sectors: Solid Fuels (CH_4)	253.4	0.3	0.2	0.00%	-253.18	-100%	-0.03	-12%
1.A.5.a Other Other Sectors: Solid Fuels (N_2O)	20.9	0.0	0.0	0.00%	-20.91	-100%	-0.03	-74%
1.A.5.b Other Other Sectors: Liquid Fuels (CH_4)	41.9	4.6	4.9	0.00%	-36.96	-88%	0.36	8%
1.A.5.b Other Other Sectors: Liquid Fuels (N_2O)	199.7	53.6	59.0	0.00%	-140.69	-70%	5.44	10%
1.A.5.b Other Other Sectors: Other Fuels (CO_2)	0.0	0.8	0.7	0.00%	0.72	100%	-0.06	-8%
1.B.1.b Solid Fuel Transformation: Operation (CH_4)	292.0	106.0	99.8	0.00%	-192.27	-66%	-6.22	-6%
1.B.1.b Solid Fuel Transformation: Operation (CO_2)	7 832.4	4 065.6	3 466.2	0.11%	-4 366.17	-56%	-599.40	-15%
1.B.1.b Solid Fuel Transformation: Operation (N_2O)	0.1	0.0	0.0	0.00%	-0.07	-83%	0.00	35%
1.B.1.c Other Solid fuel operation: Operation (CH_4)	113.0	99.3	95.6	0.00%	-17.39	-15%	-3.75	-4%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 equ.	%	kt CO_2 equ.	%
1.B.1.c Other Solid fuel operation: Operation (CO_2)	6.9	74.3	72.4	0.00%	65.43	945%	-1.92	-3%
1.B.2.a Oil: Operation (N_2O)	28.3	12.0	11.0	0.00%	-17.32	-61%	-1.05	-9%
1.B.2.b Natural Gas: Operation (CO_2)	3 363.5	1 277.7	1 327.4	0.04%	-2 036.09	-61%	49.68	4%
1.B.2.c Venting and Flaring: Operation (CH_4)	7 274.2	3 926.7	3 753.4	0.12%	-3 520.75	-48%	-173.24	-4%
1.B.2.c Venting and Flaring: Operation (N_2O)	104.1	89.6	81.2	0.00%	-22.87	-22%	-8.32	-9%
1.B.2.d Other emissions from energy production: Operation (CH_4)	297.5	646.8	622.7	0.02%	325.16	109%	-24.10	-4%
1.B.2.d Other emissions from energy production: Operation (CO_2)	743.7	2 225.4	2 040.2	0.07%	1 296.51	174%	-185.21	-8%
1.B.2.d Other emissions from energy production: Operation (N_2O)	12.6	9.5	9.3	0.00%	-3.32	-26%	-0.26	-3%

3.3 Methodological issues and uncertainties (EU-KP)

The previous section presented for each EU-KP key category in CRF Sector 1 an overview of the Member States' contributions to the key categories in terms of level and trend, and - for each key category - summary information on methodologies and emission factors using the notations T1, T2, D, etc. No detailed explanations of Member States methods used is included for 1A because for most categories the method used is simply multiplying activity data by (country-specific) emissions factors. The most relevant parameter for estimating the GHG emissions from 1A is the emission factor. Therefore, the following figures include overviews of emission factors used by the Member States for the most relevant fuels and also provide the uncertainty range of default emission factors. Where relevant, information from Member States is added that are using emission factors which are significantly outside the range of the default emission factors. The figures show that the large majority of country-specific emission factors used by the EU Member States are within the uncertainty range of the IPCC default emission factors. Note that Annex III of the EU NIR includes an extraction of the emission factors used by MS for each fuel; the following figures summarize this Annex. In addition the Member States' national inventory reports include more detailed information on national methods and circumstances.

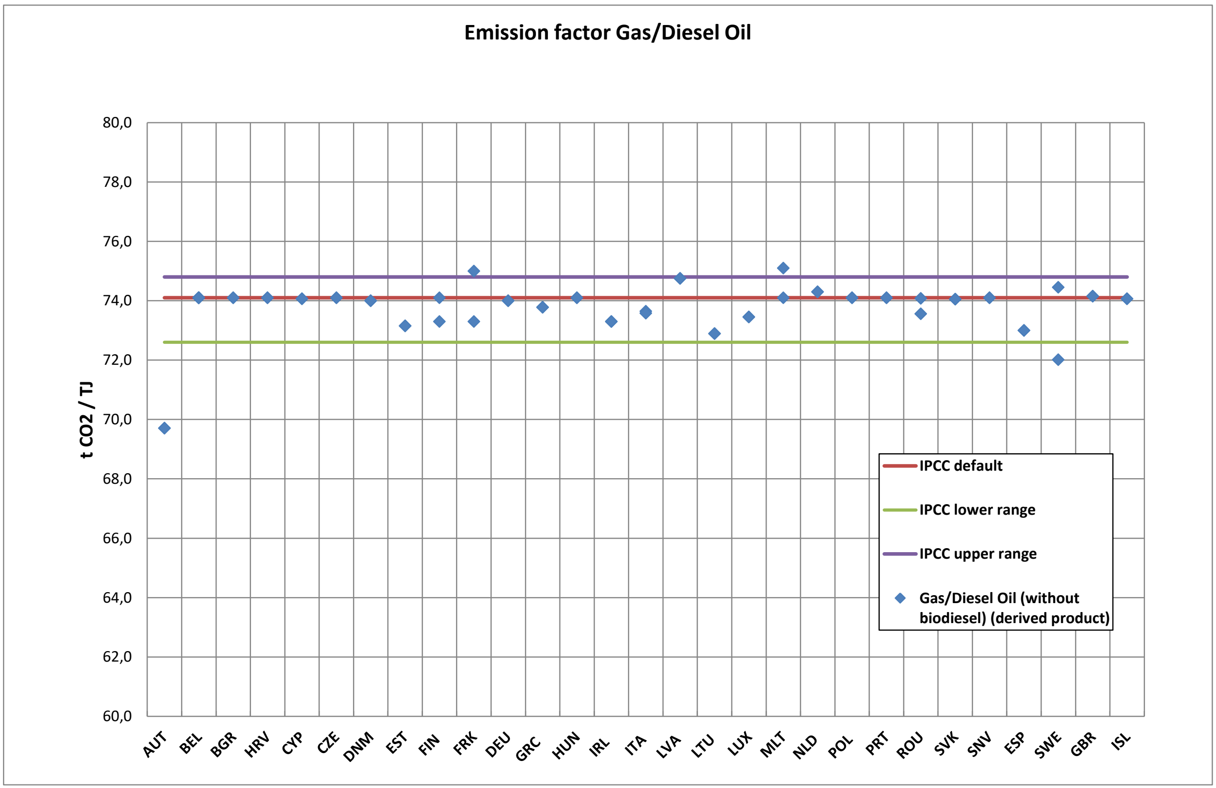
Figure 3.188 Emission factors used by Member States for natural gas



GRC: The higher value is used in 1A1c and is due to the following factors: 1. The consumption of natural gas in 1A1c sector corresponds almost 100% to natural gas produced within the country. 2. The EF is based on ETS reporting, therefore it is a plant specific EF which has been verified according to EU ETS rules. 3. As it was reported in the 2016 NIR, domestic natural gas is produced from two reservoirs, which have high carbon contents (e.g. the "Prinos" reservoir in 2014 had a carbon content of 16.22tC/TJ). 4. The inter-annual changes of the IEFs are caused by the inter-annual changes of the share of each reservoir in the total natural gas production.

GBR: The higher value is used in the 1A1c and it is due to the following fact: In the United Kingdom emissions of gaseous fuels within this sector include colliery methane combustion and natural gas combustion, including offshore own gas use. The carbon emission factor for offshore own gas use is higher than the emission factor for other natural gas combustion, particularly at the start of the time series. This higher emission factor is to be expected, as the unrefined gaseous fuels used in the upstream oil and gas sector will contain heavier hydrocarbons (which are removed in gas treatment prior to injection into natural gas supply infrastructure at onshore terminals).

Figure 3.189 Emission factors used by Member States for gas/diesel oil



AUT: This factor is used in the reference approach and reflects increasing share of biofuels in blend.

Figure 3.190 Emission factors used by Member States for LPG

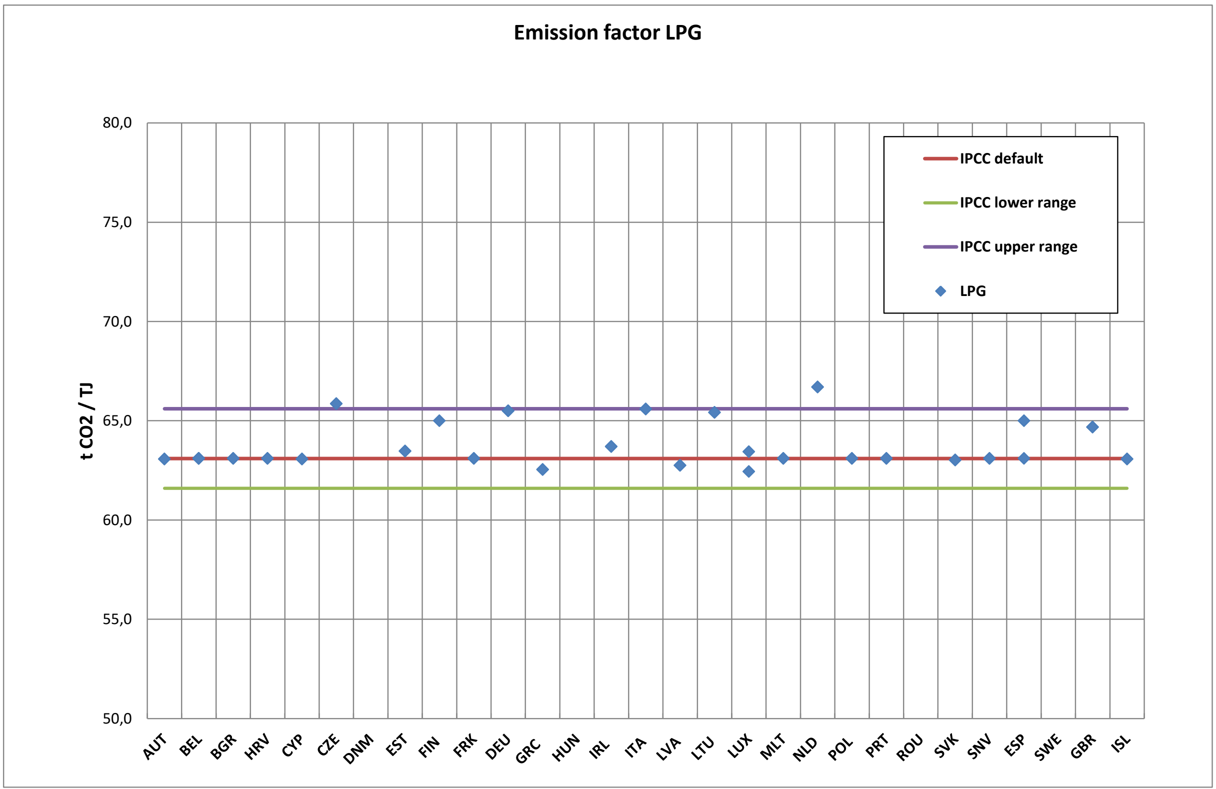
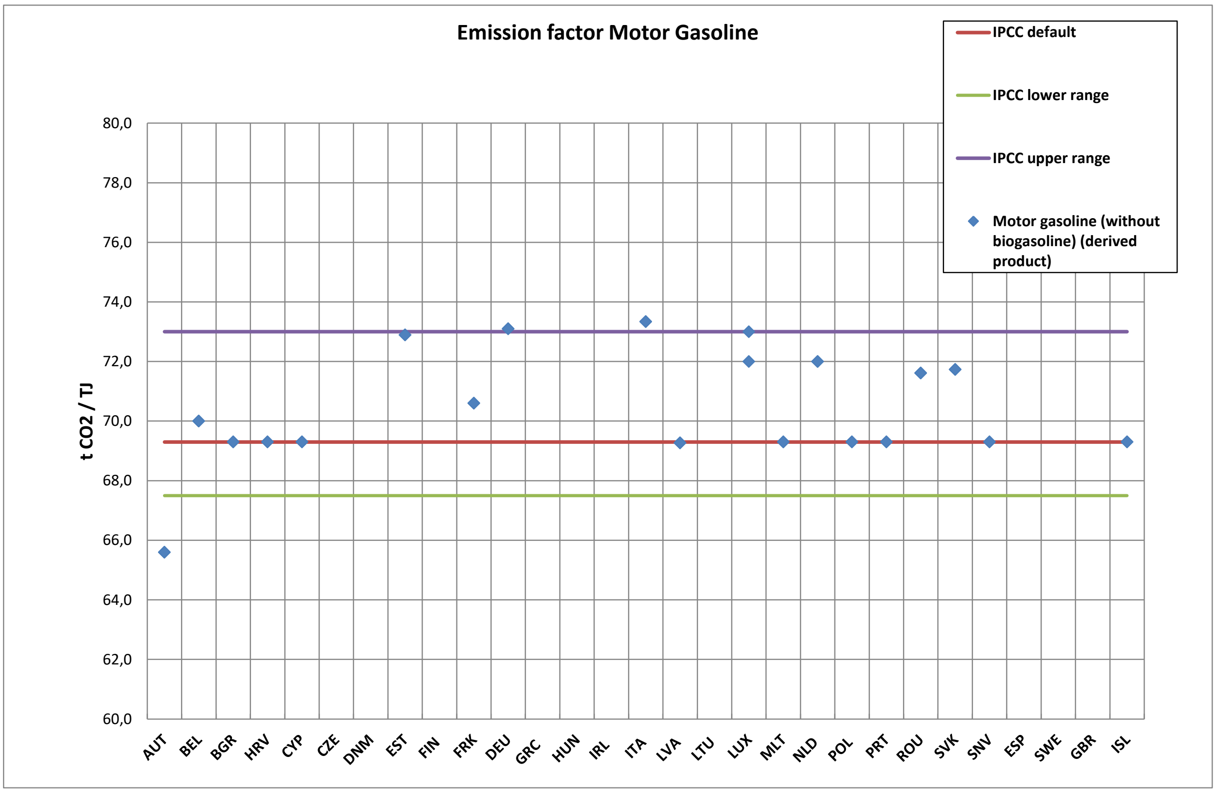


Figure 3.191 Emission factors used by Member States for natural gasoline



AUT: This factor is used in the reference approach and reflects increasing share of biofuels in blend.

Figure 3.192 Emission factors used by Member States for jet kerosene

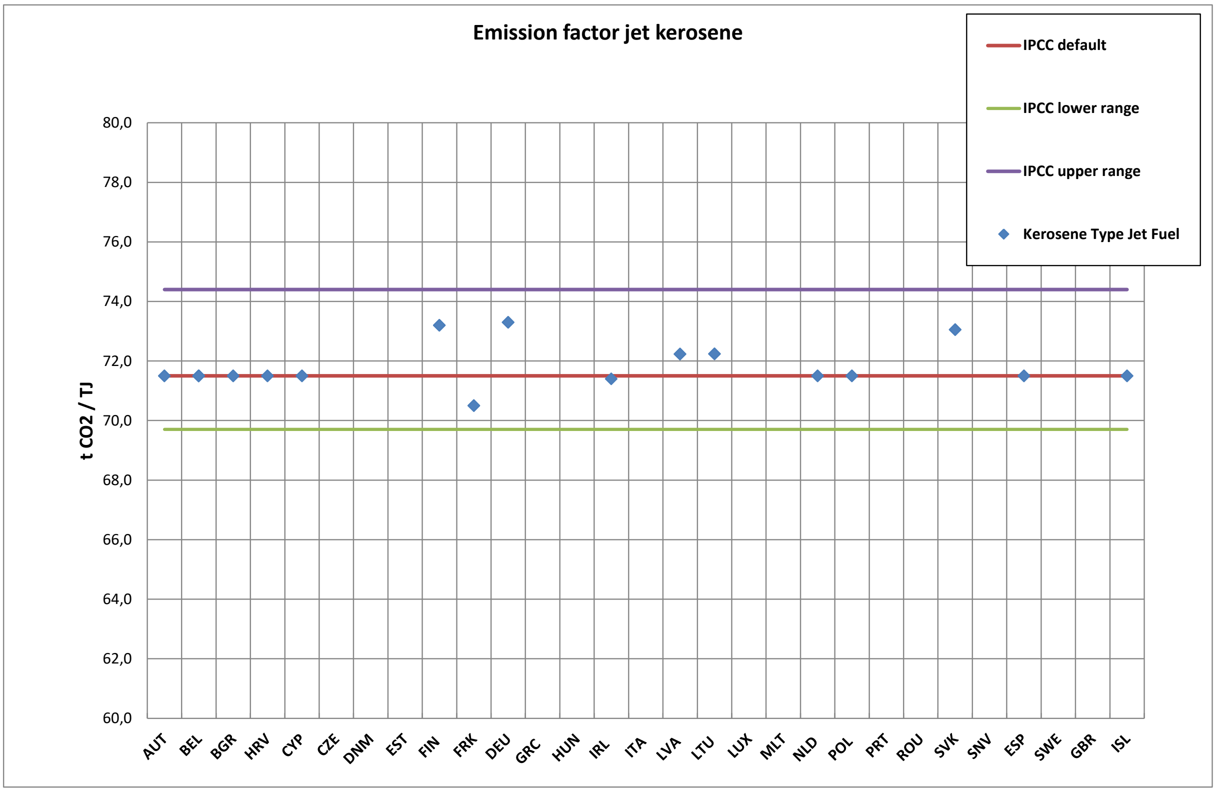
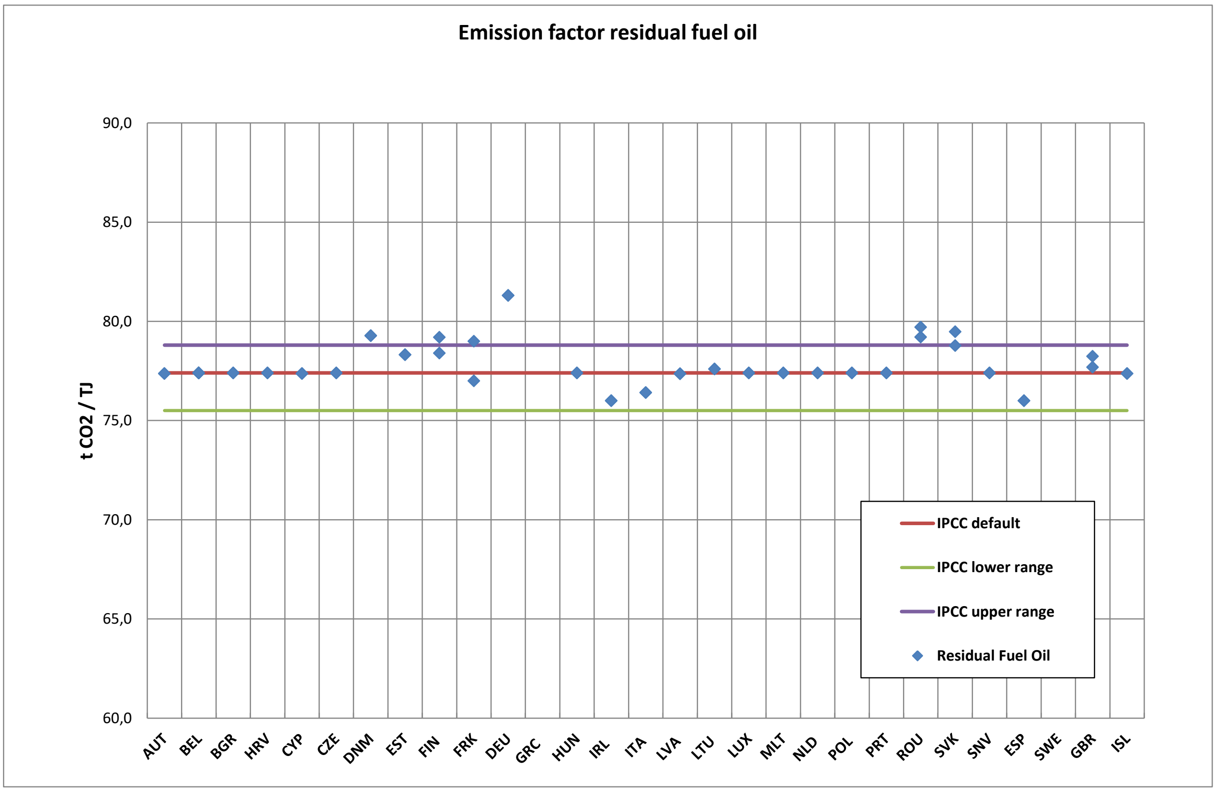


Figure 3.193   Emission factors used by Member States for residual fuel oil



DEU: This is the value for heavy residual fuel oil.

ROU: Romania has developed a specific methodology for the elaboration of national values of specific CO_2 emission factors and the energy sector. Primary data are collected from EU-ETS operators, the data are further processed and national values are developed, based on the previous mentioned methodology. Primarily, a number of 36 EU-ETS operators were considered.

Figure 3.194   Emission factors used by Member States for petroleum coke

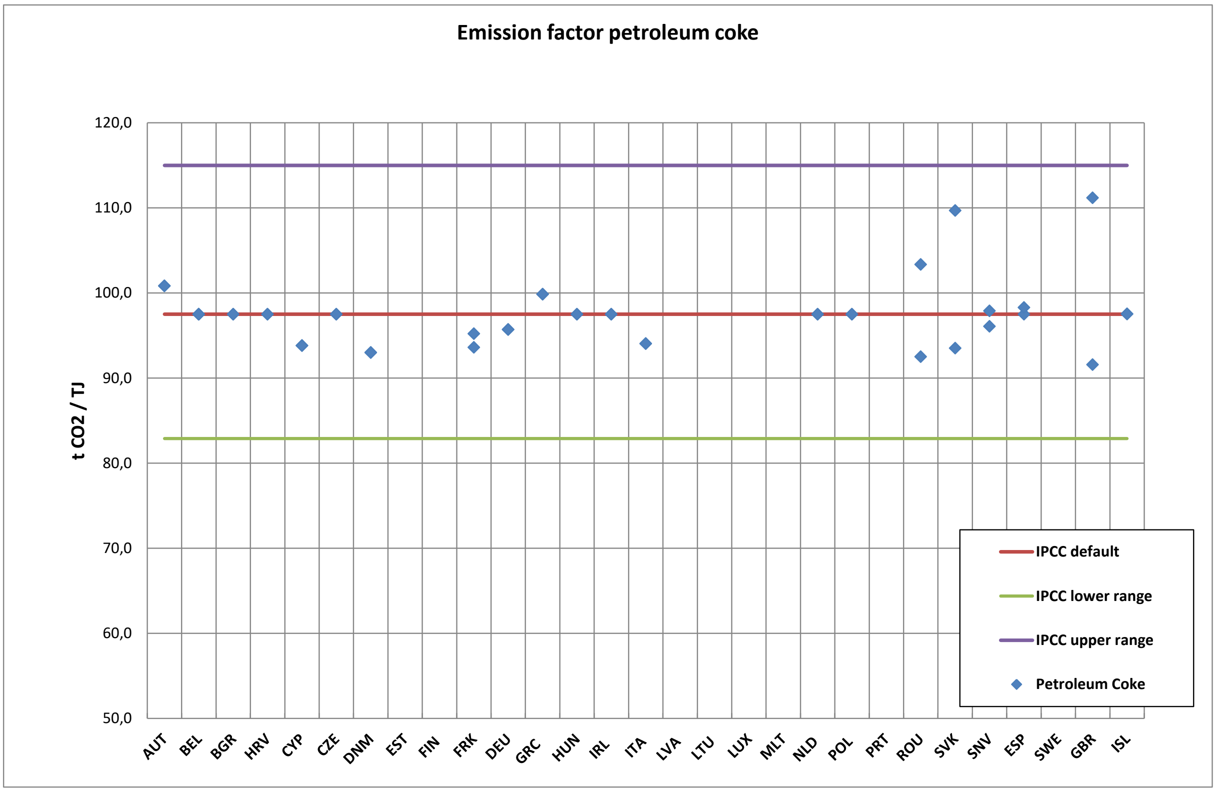


Figure 3.195 Emission factors used by Member States for refinery gas

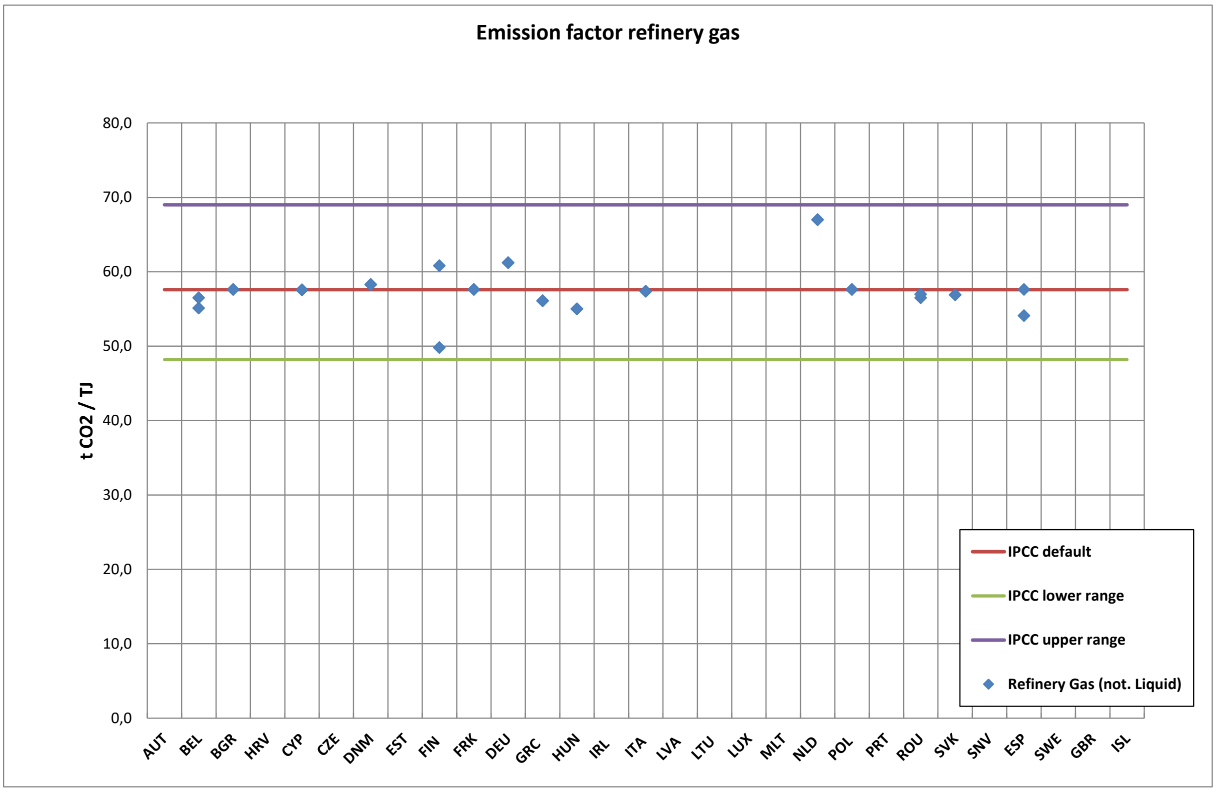


Figure 3.196 Emission factors used by Member States for bituminous coal

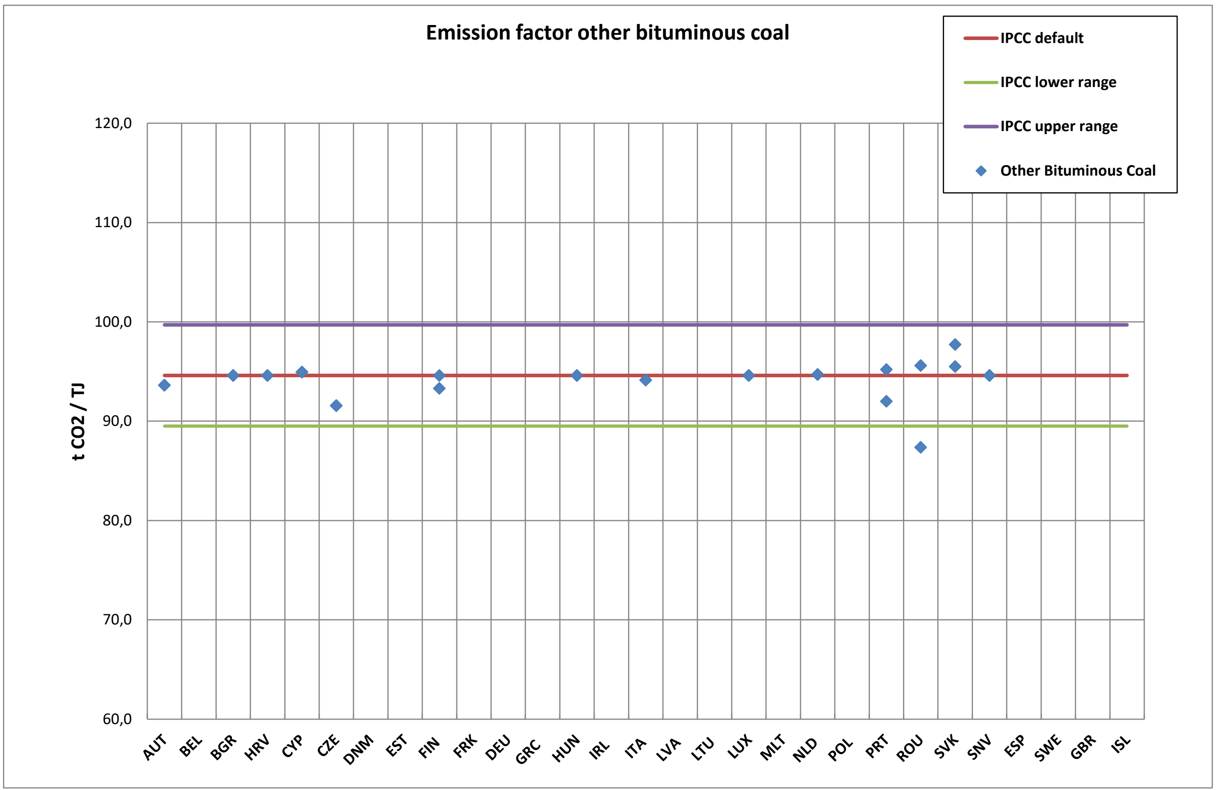
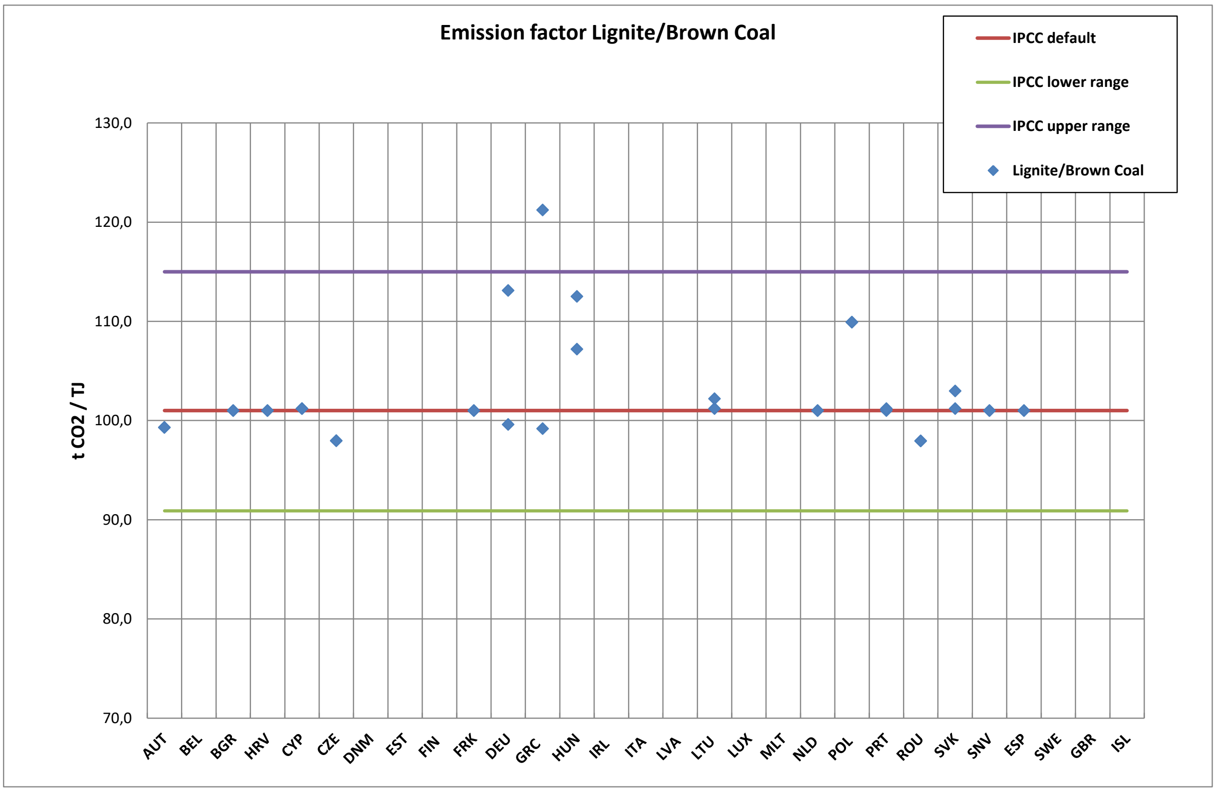


Figure 3.197 Emission factors used by Member States for lignite



__GRC:__ A country specific carbon content of lignite used for electricity production was used in emission calculations for the period 1990-2005 (33.95 tC/TJ), which is based on studies of the Public Power Corporation (PPC 1993). For the period 2006-2019 plant specific values for CC were used, based on verified EU-ETS reports, ranging from 33.74 to 35.37 tC/TJ. These values lies out of the range suggested by the 2006 IPCC Guidelines. However, given that the net calorific value of the Greek lignite is one of lowest (see Papanicolaou et al., 2004 for an overview of the properties of the Greek lignites) a high value for the carbon content is expected. Moreover, according to international literature (Fott, 1999) the suggested value by IPCC corresponds to a net calorific value of 13 TJ / kt, which is not representative of national circumstances (see Table 3.14 and Figure 3.5). -The oxidation factor 98% is used for the combustion of lignite for electricity production. This is based on a study of the Public Power Corporation (PPC 1993) and verified EU-ETS reports.

Figure 3.198 Emission factors used by Member States for coking coal

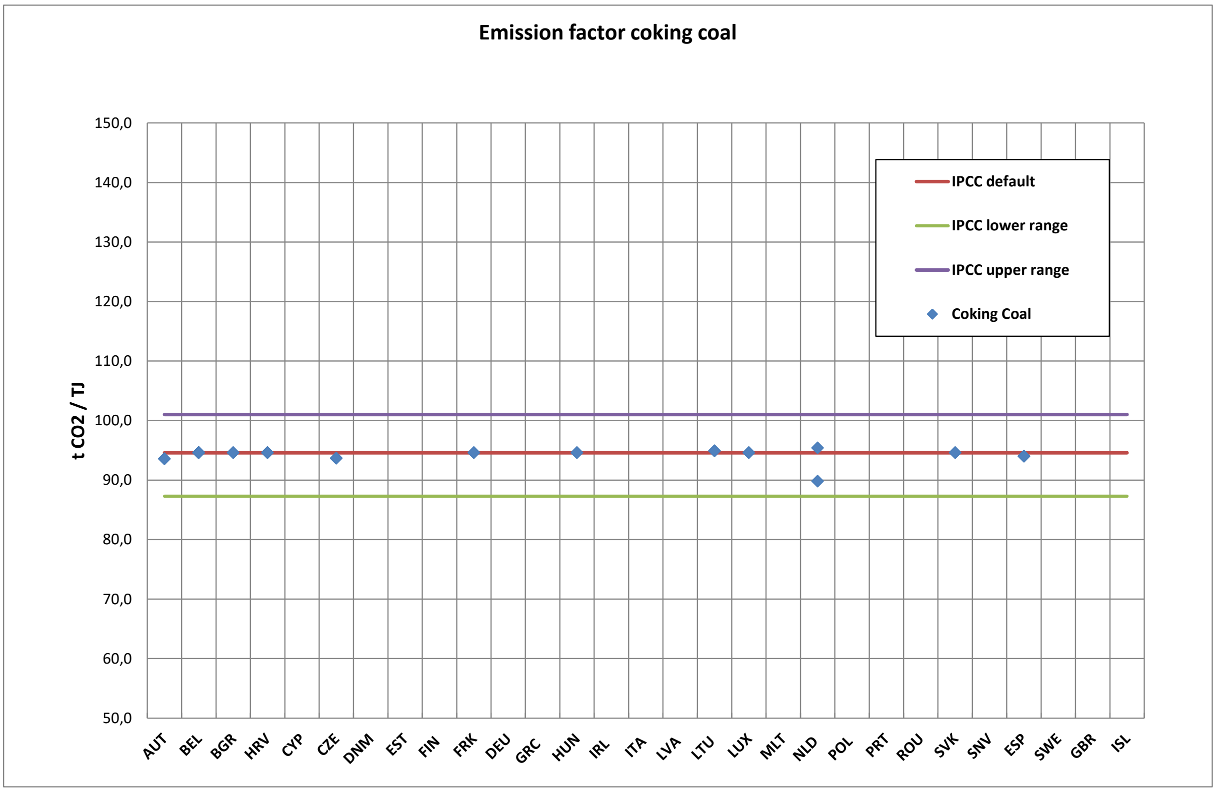


Figure 3.199 Emission factors used by Member States for coke oven coke

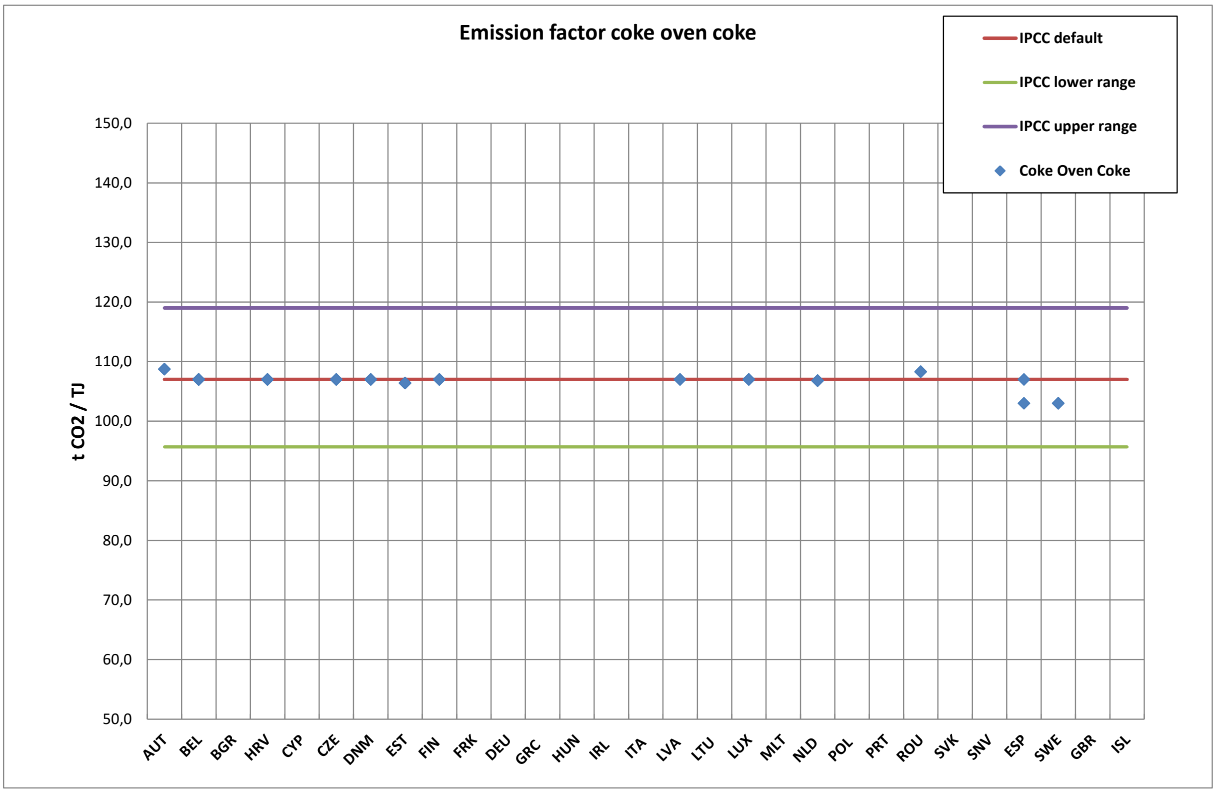
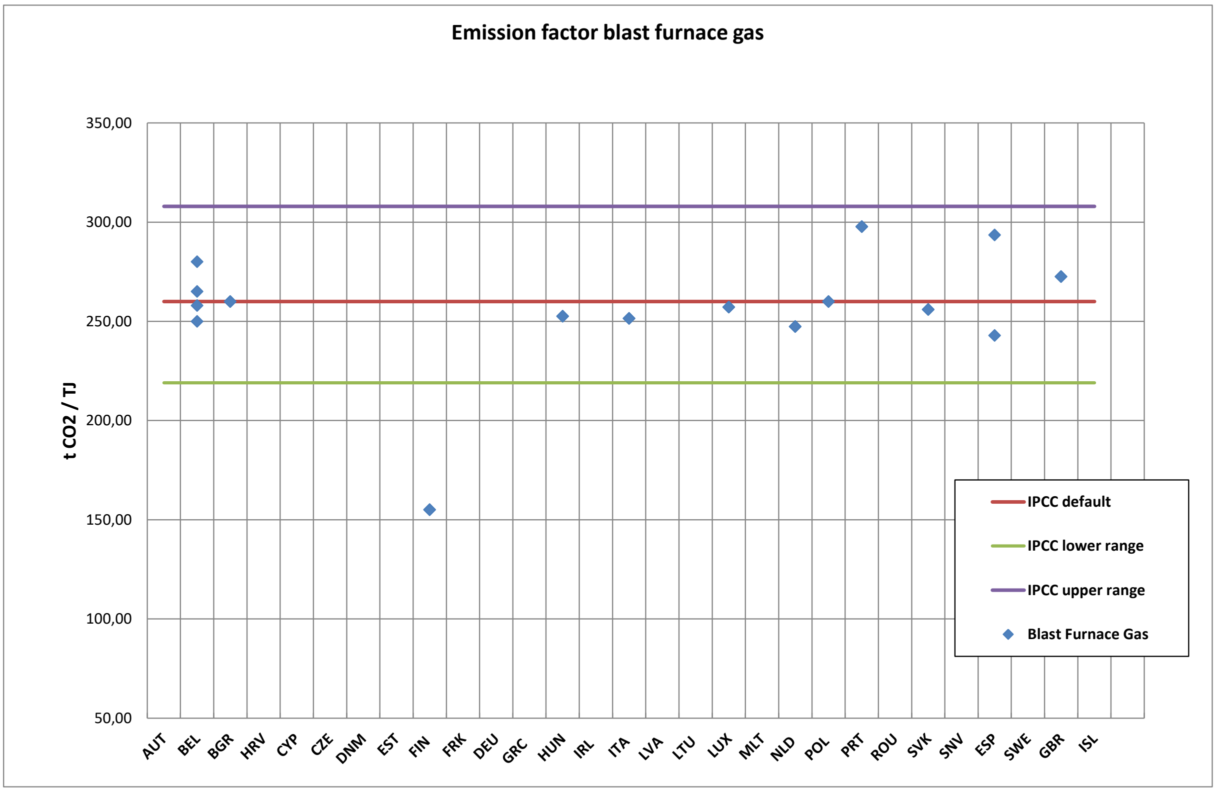


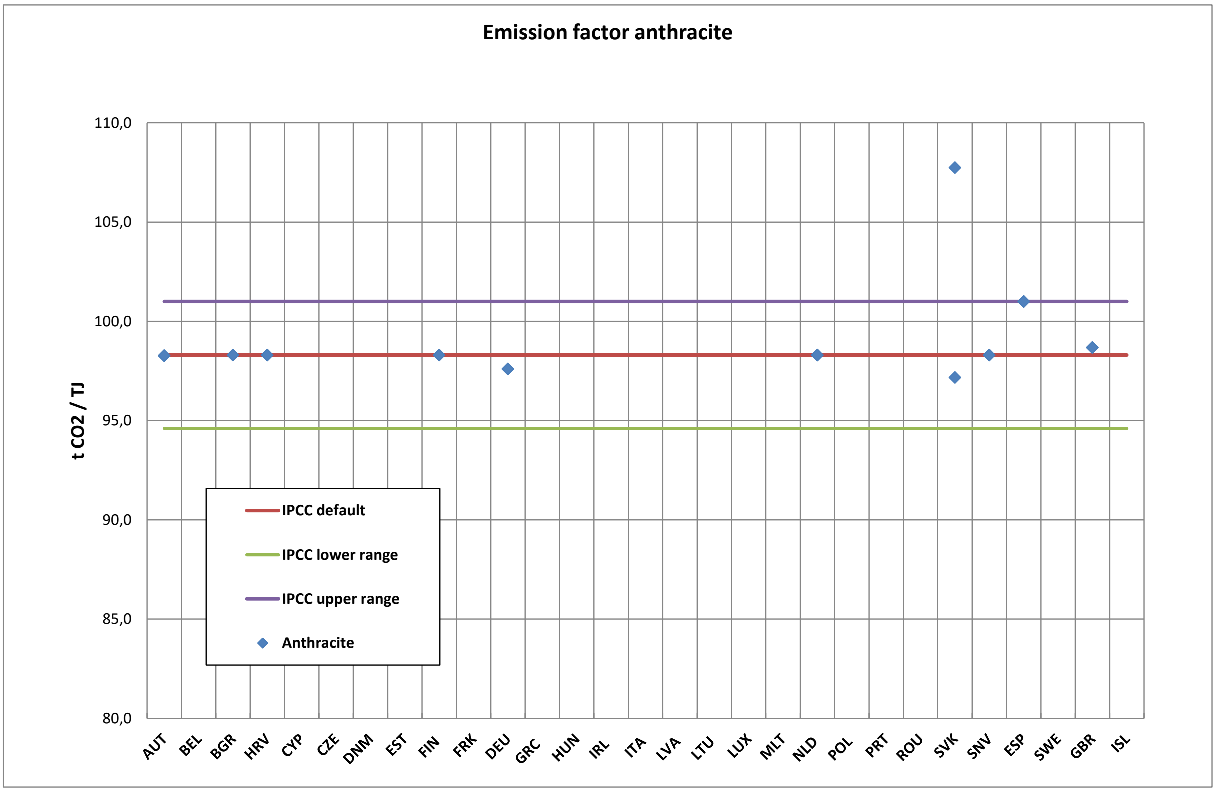
Figure 3.200 Emission factors used by Member States for blast furnace gas



* BEL: Highest value max. Wallonia, lowest value min. Flanders

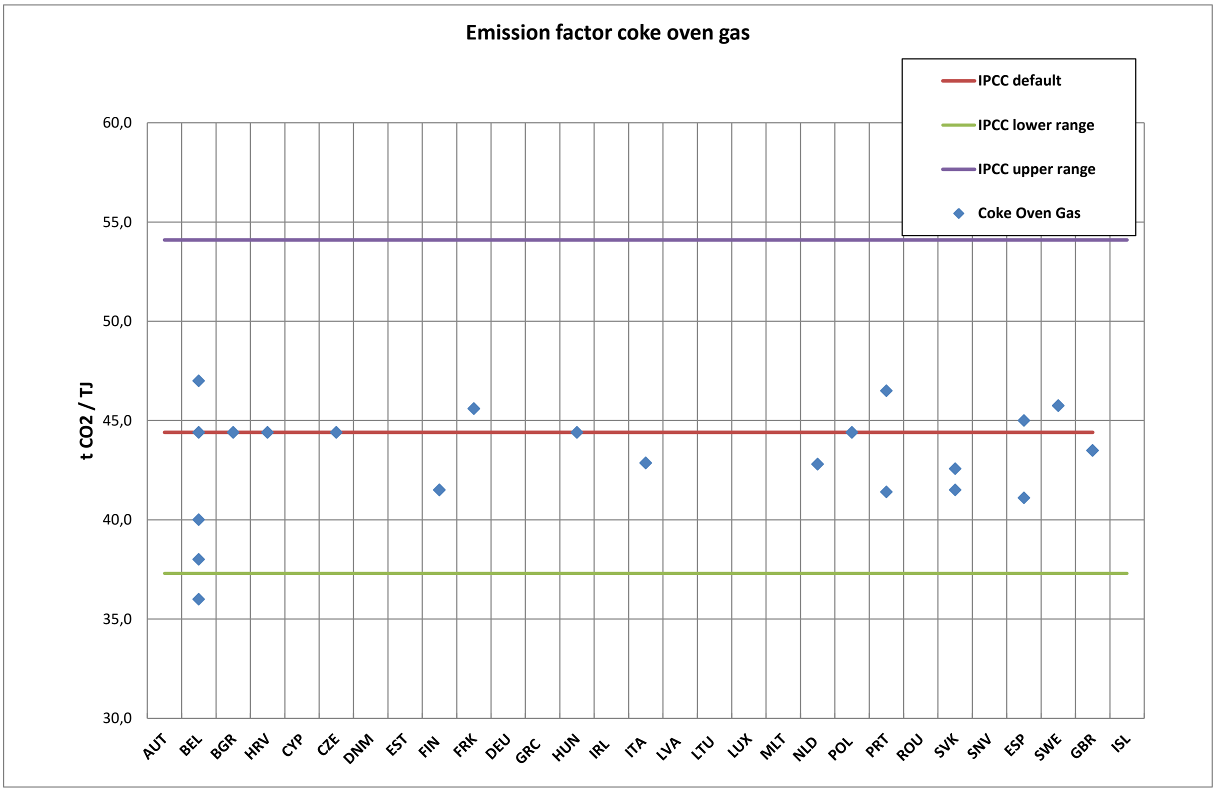
FIN: Because the number of plants is very small, we have to aggregate certain fuel types to more general categories. In this case, blast furnace gas includes actually two types of gas. One is more like carbon monoxide (EF 155), and the other actual blast furnace gas (EF around 265). Both EF values (or range for actual blast furnace gas) are based on plant-level data. In the calculations we use different fuel codes for each fuel type (each plant), but in reporting we aggregate them in the same group, which is named as blast furnace gas (it should probably be 'Blast furnace gas and other derived gases from metal industries').

Figure 3.201 Emission factors used by Member States for anthracite



SVK: The higher value is used for 1A2a, the lower value for 1A1a.

Figure 3.202 Emission factors used by Member States for coke oven gas



* BEL: Highest value max. Wallonia, lowest value min. Wallonia

Table 3.126 shows the total EU-KP uncertainty estimates for the sector 'Energy' excluding 1A3 'Transport' and the uncertainty estimates for the relevant gases for each source category. For those emissions for which no split by source category was available, uncertainty estimates were made for stationary combustion as a whole. The highest level uncertainty was estimated for N_2O from 1A5 and the lowest for CO_2 from 1A2c. With regard to trend CH_4 from 1A1a shows the highest uncertainty estimates, CO_2 from 1A2b the lowest. The results of this year's uncertainty analysis are very similar to the results in 2018. For a description of the Tier 1 uncertainty analysis carried out for the EU-KP see Chapter 1.6.

Table 3.126 Sector 1 Energy (excl. 1A3b and 1B): Uncertainty estimates for EU-KP

Source category	Gas	Emissions Base Year	Emissions 2019	Emission trends Base Year-2019	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A.1.a Public electricity and heat production	CO_2	586 805	352 328	-40.0%	2.3%	0.009%
1.A.1.a Public electricity and heat production	CH_4	244	2 740	1024.0%	59.5%	6.2%
1.A.1.a Public electricity and heat production	N_2O	2 842	2 302	-19.0%	23.5%	0.1%
1.A.1.b Petroleum refining	CO_2	53 513	52 849	-1.2%	4.2%	0.01%
1.A.1.b Petroleum refining	CH_4	19	19	-0.9%	19.7%	0.1%
1.A.1.b Petroleum refining	N_2O	230	154	-33.0%	24.8%	0.2%
1.A.1.c Manufacture of solid fuels and other energy industries	CO_2	74 412	18 301	-75.4%	5.1%	0.04%
1.A.1.c Manufacture of solid fuels and other energy industries	CH_4	102	170	66.3%	139.4%	1.0%
1.A.1.c Manufacture of solid fuels and other energy industries	N_2O	670	171	-74.6%	22.6%	0.2%
1.A.2.a Iron and Steel	CO_2	51 554	39 382	-23.6%	5.3%	0.005%
1.A.2.a Iron and Steel	CH_4	70	66	-5.0%	25.6%	0.03%
1.A.2.a Iron and Steel	N_2O	220	113	-48.5%	35.0%	0.5%
1.A.2.b Non-ferrous Metals	CO_2	2 615	2 526	-3.4%	7.6%	0.006%
1.A.2.b Non-ferrous Metals	CH_4	3	2	-9.7%	61.4%	0.2%
1.A.2.b Non-ferrous Metals	N_2O	20	10	-50.5%	67.7%	0.3%
1.A.2.c Chemicals	CO_2	29 216	6 097	-79.1%	1.5%	0.02%
1.A.2.c Chemicals	CH_4	19	21	10.8%	72.0%	0.5%
1.A.2.c Chemicals	N_2O	32	27	-15.3%	166.5%	0.7%
1.A.2.d Pulp, Paper and Print	CO_2	3 156	1 517	-51.9%	3.8%	0.04%
1.A.2.d Pulp, Paper and Print	CH_4	15	20	31.9%	48.2%	0.1%
1.A.2.d Pulp, Paper and Print	N_2O	77	99	28.0%	58.3%	0.1%
1.A.2.e Food Processing, Beverages and Tobacco	CO_2	8 010	4 146	-48.2%	1.6%	0.02%
1.A.2.e Food Processing, Beverages and Tobacco	CH_4	12	14	18.4%	68.0%	0.6%
1.A.2.e Food Processing, Beverages and Tobacco	N_2O	40	13	-68.3%	95.1%	0.4%
1.A.2.f Non-metallic minerals	CO_2	27 856	21 774	-21.8%	2.8%	0.01%
1.A.2.f Non-metallic minerals	CH_4	66	40	-39.1%	32.1%	0.2%

Source category	Gas	Emissions Base Year	Emissions 2019	Emission trends Base Year-2019	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A.2.f Non-metallic minerals	N_2O	234	194	-17.2%	34.9%	0.2%
1.A.2.g Other	CO_2	195 802	84 636	-56.8%	3.1%	0.01%
1.A.2.g Other	CH_4	229	239	4.4%	30.8%	0.1%
1.A.2.g Other	N_2O	1 224	681	-44.4%	25.7%	0.1%
1.A.4.a Commercial/Institutional	CO_2	82 213	48 942	-40.5%	5.9%	0.03%
1.A.4.a Commercial/Institutional	CH_4	1 588	187	-88.2%	68.2%	1.6%
1.A.4.a Commercial/Institutional	N_2O	277	141	-49.2%	79.6%	0.2%
1.A.4.b Residential	CO_2	186 444	128 057	-31.3%	6.5%	0.02%
1.A.4.b Residential	CH_4	4 050	2 673	-34.0%	70.7%	0.6%
1.A.4.b Residential	N_2O	1 017	637	-37.4%	97.1%	0.4%
1.A.4.c Agriculture/forestry/fishing	CO_2	35 377	22 586	-36.2%	5.8%	0.02%
1.A.4.c Agriculture/forestry/fishing	CH_4	460	1 552	237.7%	42.6%	1.1%
1.A.4.c Agriculture/forestry/fishing	N_2O	666	360	-46.0%	95.5%	0.2%
1.A.5 Other	CO_2	28 318	5 901	-79.2%	19.1%	0.1%
1.A.5 Other	CH_4	307	11	-96.4%	166.2%	1.4%
1.A.5 Other	N_2O	220	53	-76.0%	370.0%	1.9%
1.A (where no subsector data were submitted)	*all*	605 376	*335 258*	*-44.6%*	*1.4%*	*1.7%*
1.A.1 (where no subsector data were submitted)	*all*	*681 104*	*422 716*	*-37.9%*	*1.4%*	*0.7%*
1.A.2 (where no subsector data were submitted)	*all*	*432 522*	*252 152*	*-41.7%*	*2.0%*	*0.9%*
1.A.3 (where no subsector data were submitted)	*all*	*250 667*	*306 323*	*22.2%*	*3.0%*	*1.0%*
1.A.4 (where no subsector data were submitted)	*all*	*426 878*	*300 740*	*-29.5%*	*3.1%*	*1.5%*
Total - 1.A (where no subsector data were submitted)	**all**	**605 376**	**335 258**	**-44.6%**	**1.4%**	**1.7%**
Total - 1.A.1	**all**	**1 399 942**	**851 750**	**-39.2%**	**1.2%**	**0.6%**
Total - 1.A.2	**all**	**752 990**	**413 769**	**-45.0%**	**1.5%**	**0.6%**
Total - 1.A.3	**all**	**779 758**	**936 492**	**20.1%**	**1.6%**	**0.6%**
Total - 1.A.4	**all**	**738 971**	**505 875**	**-31.5%**	**2.6%**	**1.2%**
Total - 1.A.5	**all**	**28 845**	**5 965**	**-79.3%**	**4.9%**	**2.6%**
Total - 1.A	**all**	**4 305 882**	**3 049 110**	**-29.2%**	**0.8%**	**0.4%**

Note: Emissions are in kt CO_2 equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions because uncertainty estimates are not available for all source categories.

Table 3.127 shows the total EU-KP uncertainty estimates for the sector 1.B 'Fugitive emissions' and the uncertainty estimates for the relevant gases for each source category. The highest level uncertainties were estimated for N_2O from 1B2 and the lowest for CO_2 from 1B1; the highest trend uncertainties were estimated for N_2O from 1B1, the lowest for CO_2 and CH_4 from 1B1 and CO_2 from 1B2. Uncertainties analysis show very similar results as in 2018.

Table 3.127 1B Fugitive Emissions: Uncertainty estimates for EU-KP

Source category	Gas	Emissions Base Year	Emissions 2019	Emission trends Base Year-2019	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.B.1 Solid Fuels	CO_2	8 279	3 688	-55.5%	12.9%	0.1%
1.B.1 Solid Fuels	CH_4	103 037	24 404	-76.3%	81.9%	0.1%
1.B.1 Solid Fuels	N_2O	0.1	0.0	-82.7%	118.0%	1.0%
1.B.2. Oil and Natural Gas and other emissions from energy production	CO_2	18 230	18 450	1.2%	14.6%	0.1%
1.B.2. Oil and Natural Gas and other emissions from energy production	CH_4	64 557	20 835	-67.7%	36.8%	0.2%
1.B.2. Oil and Natural Gas and other emissions from energy production	N_2O	180	92	-48.9%	419.1%	1.0%
1.B (werhe no subsector data were submitted)	*all*	*14 248*	*8 103*	*-43.1%*	*42.2%*	*19.3%*
Total - 1.B	**all**	**208 531**	**75 572**	**-63.8%**	**28.9%**	**8.4%**

Note: Emissions are in Gg CO_2 equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions because uncertainty estimates are not available for all source categories.

Table 3.128 shows the total EU-KP uncertainty estimates for the sector 1A3 ‘Transport’ and the uncertainty estimates for the relevant gases for each source category. The highest uncertainty was estimated for N_2O from 1A3d and the lowest for CO_2 from 1A3b. With regard to trend N_2O from 1A3e show the highest uncertainty estimates, CO_2 from 1A3b the lowest. The results of this year’s uncertainty analysis are very similar to the results in 2018.

Table 3.128 1A3 Transport: Uncertainty estimates for EU-KP

Source category	Gas	Emissions Base Year	Emissions 2019	Emission trends Base Year-2019	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A.3.a Domestic aviation	CO_2	7 579	8 549	12.8%	12.4%	0.04%
1.A.3.a Domestic aviation	CH_4	10	5	-48.2%	66.2%	0.3%
1.A.3.a Domestic aviation	N_2O	70	60	-14.9%	155.0%	0.3%
1.A.3.b Road transport	CO_2	479 277	594 623	24.1%	1.8%	0.01%
1.A.3.b Road transport	CH_4	4 264	710	-83.4%	21.7%	0.2%
1.A.3.b Road transport	N_2O	4 331	5 510	27.2%	38.2%	0.3%
1.A.3.c Railways	CO_2	7 087	2 549	-64.0%	3.8%	0.03%
1.A.3.c Railways	CH_4	9	3	-59.9%	73.2%	0.3%
1.A.3.c Railways	N_2O	412	155	-62.3%	102.3%	0.5%
1.A.3.d Domestic navigation	CO_2	21 671	14 392	-33.6%	20.8%	0.1%
1.A.3.d Domestic navigation	CH_4	24	35	42.6%	93.1%	0.7%

Source category	Gas	Emissions Base Year	Emissions 2019	Emission trends Base Year-2019	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A.3.d Domestic navigation	N_2O	307	240	-21.9%	211.4%	0.2%
1.A.3.e Other transportation	CO_2	4 021	3 313	-17.6%	2.7%	0.02%
1.A.3.e Other transportation	CH_4	7	7	-9.2%	65.4%	0.1%
1.A.3.e Other transportation	N_2O	21	18	-13.0%	70.5%	0.2%
1.A.3 (where no subsector data were submitted)	*all*	*250 667*	*306 323*	*22.2%*	*3.0%*	*1.0%*
Total - 1.A.3	**all**	**779 758**	**936 492**	**20.1%**	**1.6%**	**0.6%**

Note: Emissions are in Gg CO_2 equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions because uncertainty estimates are not available for all source categories.

3.4 Sector-specific quality assurance and quality control

There are several activities for improving the quality of GHG emissions from energy: Before and during the compilation of the EU GHG inventory, several checks are made of the Member States data in particular for time series consistency of emissions and implied emission factors, comparisons of implied emission factors across Member States and checks of internal consistency. Table 3.129 summarizes the main checks carried out on Member States' submissions.

Table 3.129 Quality checks carried out on Member States' submissions

Issue	Check
Completeness	Check categories where Member States report the notation key NE for potential underestimations Check categories where Member States report a notation key and 20 or more Member States report emissions and assess if there are potential over- or underestimates Focus on the year 2019 (ESD) Focus on EU key categories
Time series of emissions	Check time series consistency of Member States' emission estimates for potential over- and underestimates: Focus on the year 2019 (ESD) Focus on EU key categories
Time series of IEFs	Check time series consistency of Member States' IEFs for potential over- and underestimates: Focus on the years 2019 (ESD) Focus on EU key categories
Outlier checks of IEFs	Compare IEFs across Member States and assess if there are potential over- and underestimations of emissions Compare Member States' IEFs with (range of) default EF from 2006 IPCC GL Focus on the years 2019 (ESD) Focus on EU key categories
Recalculations	Check categories where Member States provide recalculations and focus on those of more than 0.05% of national total emissions for each main gas and assess if there are potential over- or underestimates. Also explanations for recalculations were checked either from MS Annexes - MMR IR Art. 8 or NIR. Focus on the year 2018 Focus on EU key categories
Follow-up from 2018	Check if issues that were classified as "Unresolved" or "Partly resolved" in 2020 have been resolved by Member States in 2021.

Issue	Check
Implementation of UNFCCC and ESD review recommendations	Check if recommendations from the latest UNFCCC review reports have been implemented by Member States. Check if recommendations from ESD review 2020 have been implemented by Member States.
Reporting of non-energy use of fossil fuels	Check plausibility of reporting in CRF table 1A(d) as compares reporting in CRF table 1A(b), 1A(c) and the IPPU sector.

In the second half of the year, the EU internal review is carried out for selected source categories. In 2005, the EU internal review was carried out for the first time. In 2012 a comprehensive review was carried out for all sectors and all EU Member States in order to fix the base year for the 2020 targets under the EU Effort Sharing Decision (ESD review 2012). This review also covered the energy sector of the MS GHG inventories (peer review). In 2015, a few Member States volunteered to be reviewed under step 2 of the ESD trial review for the sector energy. In 2016, again a comprehensive review was carried out for all sectors and all EU Member States with a focus on the years 2005, 2008-2010, 2013 and 2014 in order to track progress of the EU Member States under the EU Effort Sharing Decision (ESD review 2016). In 2017-2019, annual reviews were carried out for all significant issues identified during the initial checks phase with a focus on the years 2015-2017 in order to track progress of the EU Member States under the EU Effort Sharing Decision. In 2020, again a comprehensive review was carried out for all sectors and all EU Member States with a focus on the years 2005, 2016-2018 in order to track progress of the EU Member States under the EU Effort Sharing Decision and in order to fix the base year for the 2030 targets under the EU Effort Sharing Regulation (ESD review 2020) In 2021 an annual review is carried out for all significant issues identified during the initial checks phase with a focus on the year 2019 in order to track progress of the EU Member States under the EU Effort Sharing Decision.

In addition, every year after the ESD review capacity building activities are organized. In 2020 the energy-related webinar had 56 participants from 21 EU Member States. Main issues discussed at the webinar were:

- Main findings from ESD review 2020
- Country-specific CO_2 emissions from transport
- Development of country-specific emission factors for key categories, using EU-ETS data
- Reporting in CRF table 1A(c) and CRF Table 1A(d)

EU ETS data

Since the inventory 2005 plant-specific data is available from the EU Emission Trading Scheme (EU ETS). This information has been used by EU Member States for quality checks and as input for calculating total CO_2 emissions for the sectors Energy and Industrial Processes in this report (see Section 1.4.2). During the ESD reviews and during the initial checks consistency checks have been carried out between EU ETS data and the inventory estimates.

Eurostat energy data

During the initial checks carried out before the compilation of the EU GHG inventory and during the ESD reviews Eurostat energy data is used for cross checking the sectoral and reference approach of the MS submissions. This cross check between the European energy reporting system and the EU GHG inventory system is an important QA/QC element of the EU GHG inventory compilation.

The quality of the EU GHG inventory is directly affected by the quality of Member States and EU energy statistics systems. EU energy statistics are collected by Eurostat on the basis of the EU energy statistics regulation[16]. The energy statistics regulation was adopted as part of the energy package and establishes a common framework for the production, transmission, evaluation and dissemination of comparable energy statistics in the EU.

This regulation aims at collecting detailed statistical data on energy flows by energy commodity at annual and monthly level. It ensures harmonised and coherent reporting of national energy data, which is indispensable for the assessment of EU energy policies and targets. The content and structure of this regulation reflects the essence of the existing European statistical system, a system that is part of the international energy statistical system, and is in direct link with the national statistical structures (classifications) and methodologies. It also has concrete links to other statistical domains, such as economic, environment, trade and business statistics. These links provide an additional dimension in safeguarding data quality assurance.

The European energy statistics system and the quality of the EU inventory are directly affected by this regulation that:

- ensures a stable and institutional basis for energy statistics in the EU
- guarantees long-term availability of energy data for EU policies
- reinforces available resources for the production of the basic energy statistics at national level

The energy statistics regulation helps improving the QA/QC of the EU inventory as it:

- makes available more detailed energy statistics by fuel
- allows the estimation of CO_2 emissions from energy with the reference and sectoral approach
- assures the quality of the underlying energy statistics
- improves timeliness of energy statistics
- provides a formal legal framework assuring consistency between national and Eurostat data

Moreover, Article 6, paragraph 2 stipulates that:

'Every reasonable effort shall be undertaken to ensure coherence between energy data declared in the energy statistics regulation, and data declared in accordance with Commission Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol'.

In addition, Article 7(1)(m)(iii) of the MMR in conjunction with Article 12 of the implementing regulation requires Member States to report to the European Commission textual information on the comparison between the reference approach calculated on the basis of the data included in the greenhouse gas inventory and the reference approach calculated on the basis of the data reported pursuant to the Energy Statistics Regulation. Member States with differences of more than +/- 2% in the total national apparent fossil fuel consumption have to provide quantitative information and explanations for the year X-2 in accordance with the tabular format set out in Annex VI of the implementing regulation.

[16] REGULATION (EC) No 1099/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 October 2008 on energy statistics as amended by Commission Regulation (EU) No 147/2013 of 13 February 2013.

Eurocontrol data

Since 2010 there are framework contracts in place between the European Commission and EUROCONTROL, the European organization for the safety of air navigation, pertaining to the improvement of GHG and air pollutant emissions inventories submitted by the 27 Member States and the European Union to the UNFCCC and to the UNECE. EU Member States shall be assisted to improve the reporting of annual greenhouse gas (and other air pollutant) emission inventories by e.g., estimating the fuel split domestic/international using real flight data from EUROCONTROL. For this, the European Environment Agency and its ETC/ACM is preparing comparisons between EUROCONTROL results and MS inventory data and is promoting discussions between EUROCONTROL and EEA Member States related to these results. For more information on the process refer to Chapter 1.4.2.

In October 2019 EUROCONTROL provided results on fuel consumption, emissions of CO_2, CH_4 and N_2O and other air pollutants for domestic and international aviation for the years 2005 to 2019 by EU Member States and other EEA member countries (United Kingdom, Iceland, Switzerland, Norway and Turkey). Recalculations took place to reflect i.e., corrections of aircraft types and their relation to engine Types and the calculation of taxi-in and taxi-out times.

The calculation of EUROCONTROL is a bottom-up modelling, applying the Advanced Emissions Model (AEM). This is a Tier 3b approach basing on EUROCONTROL information on flight plan data and flight trajectories (detailed documentation available upon request). Flight plan data is only available for flights under Instrumental Flight Rules. Flights which take place under Visual Flight Rules (VFR) are not included in the dataset of EUROCONTROL.

The comparison of EUROCONTROL results and MS inventory data for the time series 2005 to 2019 has been prepared by the European Environment Agency and its ETC/ACM in February 2021. Results have been shared with Member States during the 'initial checks' for aviation gasoline and kerosene consumption, domestic splits for kerosene and implied emission factors for CO_2, N_2O and CH_4. In addition, Member States have been contacted in case of considerable differences between inventory and EUROCONTROL results.

Due to the exclusion of flights under VFR in EUROCONTROL's calculations, the results for the consumption of aviation gasoline (which mainly takes place in smaller aircrafts under VFR) are considerably lower for most Member States in EUROCONTROL calculations than in inventories. In addition, most Member States allocate the total consumption of aviation gasoline to domestic aviation, following the recommendation of the IPCC 2006 guidelines, whereas EUROCONTROL displays some small amounts of aviation gasoline consumption for international aviation, too. EU-27 kerosene consumption in 2019 resulting from EUROCONTROL calculations is 4 % lower for domestic and 1% higher for international aviation compared to the aggregation of Member State results from inventories. The domestic split (as the share of kerosene consumption for domestic aviation on total kerosene consumption) for EU-27 is identical between EU inventory and EUROCONTROL results.

Obviously both the reporting of Member States but also the calculation of EUROCONTROL improved considerably during the years. The development of kerosene consumption along the time series 2005 to 2019 for EU-27 shows the same trends for both domestic and international aviation following EUROCONTROL results and EU inventory numbers. Differences are slightly higher in the years 2005 to 2007 due to different underlying datasets in EUROCONTROL calculations. With the new methodology applied for the calculation of N_2O and CH_4 emissions by EUROCONTROL, implied emission factors for these gases are now much more comparable with Member State results.

Absolute differences in kerosene consumption are partly higher for single Member States. The reasons for these differences are mainly due to the fact, that respective Member States are basing their estimates on fuel sales statistics and on different estimates of domestic splits. In addition, there are several general sources of possible differences: First there is the fact, that the consideration of flight trajectories for the calculation of cruise emissions is a method exclusively applied by EUROCONTROL. Furthermore, the use of different sources for flight statistics for bottom-up modelling, the allocation of aircraft types and engines to flights in statistics and the use of different emission factors for cruise and LTO lead to different results.

During the last years, it can be seen that EUROCONTROL information has increasingly been used by Member States, for checking purposes but also by using the numbers directly in inventory calculations. During the 'initial checks' 2016, 2017, 2018 and 2019 an intensive discussion with Member States took place to understand the reasons for differences on MS level. On the one hand, some of the outcomes could lead to eventual further improvement of inventories in next submissions or on the other hand for additional use of national information in EUROCONTOL calculations. In most cases the differences occur due to the need to align inventory numbers with the energy balance which might always lead to differences compared to a bottom-up calculation.

In Table 3.130 an overview is given on how EUROCONTROL data has been used by Member States, as it has been mentioned in their NIR 2021 version.

Table 3.130 Use of Eurocontrol data by Member States in their national inventory reports

	Use of Eurocontrol data for kerosene consumption				
	For comparison / verification	For possible planned improvements	Indirect use	Direct use	How has time series consistency been ensured?
Austria					
Belgium			Data per airport, to make distribution of emissions in the regions possible	In Flemish region for international flights. In Wallonia, for N_2O and CH_4	
Bulgaria			LTO per aircraft type for the period 1996-2017		
Cyprus				For domestic and international flights	Trend of domestic share from Eurocontrol data has been applied to years 1990-2004
Czechia		Eurocontrol Methodology for submission 12/2021			
Germany	yes				
Denmark			List of aircraft types provided by Eurocontrol used		
Spain				For domestic and international flights	An adaptation model has been applied to link results based on national statistic with Eurocontrol results (2005-2018).
Estonia					
Finland				For domestic flights from 2005 onwards	For the years before 2005, the own model (ILMI) has been used. ILMI was implemented by Finavia and calculated emissions partly until the year 2008, since 2010 the model was not updated. No specific adaptation.
France	not mentioned, but numbers match very closely				

	Use of Eurocontrol data for kerosene consumption				
	For comparison / verification	For possible planned improvements	Indirect use	Direct use	How has time series consistency been ensured?
United Kingdom			EMEP/EEA Eurocontrol cruise factors for generic aircraft are used		
Greece				For domestic and international flights	To keep timeseries consistency, emissions from 1990-2005 have been recalculated taking into account only international aviation fuel consumption and by applying Tier 1 methodology.
Croatia					
Hungary				For domestic flights	Fuel use (and consequently the emissions) of the years before 2005 have been adapted with built-in extrapolation procedures: The same share of kerosene use from Eurocontrol result 2005-2015 for domestic flights has been applied for the years 1985-2004.
Iceland	yes	It is planned to assess the use of the Eurocontrol dataset for estimating emissions from the aviation subsectors.			
Ireland				The fuel consumption based on origin and destination data for domestic air travel provided by EUROCONTROL using an Advanced Emission Model (AEM) (from 2005 to 2018).	
Italy				domestic	Emissions from aviation have been recalculated from 1990 on the basis of information on activity data and emission factors provided by Eurocontrol. A linear interpolation took place between 1999 (the year of a Tier 3 calculation) and 2005 for fuel consumption factors and emission factors.
Lithuania					
Luxembourg					
Latvia	Yes (2008-2018)				
Malta				For domestic aviation (from 2005 until 2018)	Recalculations would have been implemented for the whole timeseries, from 1990 until 2018, if possible but the EUROCONTROL model data started from 2005.
Netherlands					
Poland				For the share of domestic flights	A 5-years average from Eurocontrol data for years 2005-2009 has been assumed for the years 1988-2004.
Portugal					
Romania					

	Use of Eurocontrol data for kerosene consumption				
	For comparison / verification	For possible planned improvements	Indirect use	Direct use	How has time series consistency been ensured?
Slovakia				For the time series 2005 – 2018, EUROCONTROL data on the number of flights, fuels consumption and share of domestic and international flights was used.	For the years 1990-2004 summary information from the Eurocontrol database was used (emission factors and domestic share).
Slovenia				For domestic flights. Since 2017: Data on fuel consumption based on Eurocontrol from 2005	Only a small amount of domestic flights has been recorded by Eurocontrol. No adaptation took place for the years 1990-2004
Sweden					

Three Member States report a comparison or a verification of their results with EUROCONTROL data and two Member States mention possible improvements in future submissions using this data. Three Member States mention the indirect use of this data, using emissions factors or LTO information. Twelve Member States report direct use of EUROCONTROL data and most of them informed about related adaptation process to ensure time-series consistency.

3.5 Sector-specific improvements

The improvements implemented in 2020 were partly due to recommendations derived from an EU internal review and partly motivated by recommendations made by the UNFCCC review team. The major improvements are included in included in Table 10.7 in chapter 10.

3.6 Sector-specific recalculations

Table 3.131 shows that in the energy sector the largest recalculations in absolute terms in 1990 and in 2018 were made for CO_2. In relative terms, the recalculations made in 1990 were for N_2O (+ 0.4 %) and in 2018 they were largest for CH_4 (-0.9 %).

Table 3.131 Sector 1 Energy: Recalculations of total GHG emissions and recalculations of GHG emissions for the years 1990 and 2018 by gas in kt (CO_2-eq.) and percentage

1990	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6		Unspecified mix of HFCs and PFCs		NF3	
	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%
Total emissions and removals	72 922	1.7%	-11 395	-1.5%	9 888	2.5%	-72	-0.2%	-9	-0.03%	-53	-0.5%	9	0.2%	0	0.0%
Energy	6 746	0.2%	307	0.2%	133	0.4%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2018																
Total emissions and removals	15 195	0.5%	-5 009	-1.1%	5 132	2.0%	-410	-0.4%	3	0.1%	109	1.6%	75	4.3%	0	0.0%
Energy	-531	0.0%	-707	-0.9%	-160	-0.5%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

NO: not occurring

Table 3.132 provides an overview of Member States' contributions to EU-KP recalculations. In absolute terms, France had the most influence on CO_2 recalculations in the EU-KP for 2018. Explanations for recalculations by Member State are provided in Chapters 3.2 and 10.1.

Table 3.132 Sector 1 Energy: Contribution of Member States to EU-KP recalculations for 1990 and 2018 by gas (difference between latest submission and previous submission kt of CO_2 equivalents)

	1990								2018							
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF3	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF3
Austria	-15	2	2	NO	NO	NO	NO	NO	-107	-3	9	NO	NO	NO	NO	NO
Belgium	-1.3	0.9	0.3	NO	NO	NO	NO	NO	-6	0	4	NO	NO	NO	NO	NO
Bulgaria	-0.3	-2.2	19.8	NO	NO	NO	NO	NO	86	0	44	NO	NO	NO	NO	NO
Croatia	-293.8	-10.1	12.2	NO	NO	NO	NO	NO	-11	-22	1	NO	NO	NO	NO	NO
Cyprus	2.0	-0.1	7.4	NO	NO	NO	NO	NO	30	3	9	NO	NO	NO	NO	NO
Czechia	-0.6	-1.5	-2.4	NO	NO	NO	NO	NO	1 699	-91	2	NO	NO	NO	NO	NO
Denmark	19.3	10.0	-0.6	NO	NO	NO	NO	NO	17	-14	-7	NO	NO	NO	NO	NO
Estonia	742.6	25.7	10.0	NO	NO	NO	NO	NO	234	13	15	NO	NO	NO	NO	NO
Finland	-3.5	0.0	0.5	NO	NO	NO	NO	NO	-8	0	2	NO	NO	NO	NO	NO
France	-14 578	-339.1	112.9	NO	NO	NO	NO	NO	-8 799	-159	-363	NO	NO	NO	NO	NO
Germany	119.9	-96.5	-72.8	NO	NO	NO	NO	NO	87	133	32	NO	NO	NO	NO	NO
Greece	0.0	0.0	0.0	NO	NO	NO	NO	NO	0	-1	-3	NO	NO	NO	NO	NO
Hungary	-180.4	1 057.0	3.2	NO	NO	NO	NO	NO	-128	1 047	8	NO	NO	NO	NO	NO
Ireland	-0.7	0.2	2.1	NO	NO	NO	NO	NO	406	30	12	NO	NO	NO	NO	NO
Italy	1 559.3	188.6	19.3	NO	NO	NO	NO	NO	993	594	47	NO	NO	NO	NO	NO
Latvia	157.2	-0.1	0.0	NO	NO	NO	NO	NO	-8	0	-3	NO	NO	NO	NO	NO
Lithuania	0.0	-12.5	6.5	NO	NO	NO	NO	NO	0	-9	-20	NO	NO	NO	NO	NO
Luxembourg	0.2	0.2	0.0	NO	NO	NO	NO	NO	-2	1	0	NO	NO	NO	NO	NO
Malta	0.0	0.0	0.0	NO	NO	NO	NO	NO	7	-4	1	NO	NO	NO	NO	NO
Netherlands	0.2	-4.7	0.0	NO	NO	NO	NO	NO	104	37	1	NO	NO	NO	NO	NO
Poland	0.6	-10.0	-9.2	NO	NO	NO	NO	NO	-1 057	-44	-44	NO	NO	NO	NO	NO
Portugal	8.0	1.2	0.7	NO	NO	NO	NO	NO	3	0	11	NO	NO	NO	NO	NO
Romania	19 374.8	-524.6	34.7	NO	NO	NO	NO	NO	3 907	-1 063	11	NO	NO	NO	NO	NO
Slovakia	0.0	0.0	0.0	NO	NO	NO	NO	NO	0	-1 106	5	NO	NO	NO	NO	NO
Slovenia	-14.4	0.6	-17.2	NO	NO	NO	NO	NO	1	15	-4	NO	NO	NO	NO	NO
Spain	-29.5	1.7	0.1	NO	NO	NO	NO	NO	148	-9	5	NO	NO	NO	NO	NO
Sweden	-26.7	6.4	0.2	NO	NO	NO	NO	NO	321	10	39	NO	NO	NO	NO	NO
United Kingdom	-72.8	13.7	2.7	NO	NO	NO	NO	NO	1 537	-68	25	NO	NO	NO	NO	NO
EU27+UK	6 767.1	307.3	132.2	NO	NO	NO	NO	NO	-546	-708	-162	NO	NO	NO	NO	NO
Iceland	-19.8	-0.9	0.4	NO	NO	NO	NO	NO	-9	0	1	NO	NO	NO	NO	NO
United Kingdom (KP)	-73.8	14.0	2.7	NO	NO	NO	NO	NO	1 560	-68	25	NO	NO	NO	NO	NO
EU-KP	6 746.2	306.6	132.6	NO	NO	NO	NO	NO	-531	-707	-160	NO	NO	NO	NO	NO

Abbreviations explained in the Chapter 'Units and abbreviations'.

3.7 Comparison between the sectoral approach and the reference approach (EU-KP)

The IPCC reference approach for CO_2 from fossil fuels for the EU-KP is based on Eurostat energy data (Eurostat database, February 2021) for apparent consumption included in CRF table 1A(b) and data from MS CRF submissions for CRF table 1A(d). The reason for using Eurostat data in CRF table 1A(b) is that Eurostat provides a coherent data set for all Member States for apparent consumption in TJ whereas in the CRF submissions some MS use TJ and other MS use kt. Up to 2017 also for CRF table 1A(d) we used apparent consumption from Eurostat. The reason for having used Eurostat data in CRF table 1A(d) for many years was that also for non-energy use of fuels Eurostat provided a coherent data set for all 28 EU Member States. The drawback of Eurostat data was that the definition of non-energy use of fuels in energy statistics is narrower than the definition in the IPCC guidelines because fuels used as reductants are not classified as non-energy use of fuels in energy statistics. In addition, Member States may use other data than the energy balance for compiling the non-energy use data (e.g. EU ETS data, environmental reporting of companies, etc.). Therefore, the EU decided to change the reporting in CRF table 1A(d) and calculate all data as the sum of respective MS data. The drawback of this approach is that Member States may use different allocation of energy use and non-energy use of fuels (e.g. in iron and steel) depending on the allocation in the sectoral approach.

Energy statistics are submitted to Eurostat by Member States on an annual basis with the five joint Eurostat/IEA/UNECE questionnaires on solid fuels, oil, natural gas, electricity and heat, and renewables and wastes. On the basis of this information Eurostat provides the annual energy balances which can be used for the estimation of CO_2 emissions from fossil fuels by Member State and for the EU-KP as a whole.

The Eurostat data for the EU-KP IPCC reference approach includes activity data and net calorific values as available in the Eurostat database. For the calculation of CO_2 emissions, the IPCC default carbon emission factors are used.

The IPCC reference approach method at EU-KP level is a three-step process.

- The Energy Statistics Regulation (Regulation EC/1099/2008) is the basis for MS reporting of energy data to Eurostat as well as the basis for the EU's IPCC Reference Approach. For each of the EU Member States, annual data on energy production, imports, exports, international bunkers and stock changes by fuel are available from Eurostat's database http://ec.europa.eu/eurostat/data/database The energy data used for the Reference Approach in the EU-KP2021 inventory submission, and reported in table 1.A(b), corresponds to the sum of its Member States.
- The energy data in Eurostat's database can be exported in mass or volume units or in Terajoules. The latter is based on the calorific values reported by MS in the energy questionnaires, on a net basis. Table 1.A(b) was reported in Terajoules. The data was downloaded in February 2021.
- The carbon emission factors are those from the IPCC 2006 Guidelines http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
- The carbon excluded from table 1.A(b) is fully consistent with the data included in table 1.A(d).
- Eurostat data is not used for table 1.A(d). Instead we use the sum of the Member States CRF data because the definition of Eurostat non-energy use of fuels is narrower than in the IPCC guidelines and because the reporting in column I is closely linked to the inventories in IPPU sectors.
- The fractions of carbon oxidised reported in table 1.A(b) are the default 2006 IPCC factors of 1, thus assuming complete oxidation of emissions.

CRF table 1A(c) compares EU-KP CO_2 emissions calculated with the IPCC reference approach and the sectoral approach (Table 3.133). The percentage differences for both energy consumption and CO_2 emissions are very similar to previous submissions.

Table 3.133 Comparison of reference approach and sectoral approach for EU-KP

[1. Energy][1.AC Comparison of CO2 Emissions from Fuel Combustion]	Unit	1990	2000	2010	2015	2016	2017	2018	2019
Fuel consumption									
Sectoral approach	PJ	52.106	51.039	49.667	43.515	43.866	44.042	43.216	41.981
Apparent energy consumption (excluding non-energy use, reductants and feedstocks)	PJ	51.249	50.138	49.006	42.635	43.046	43.561	42.916	41.564
Energy consumption difference	%	-1,6	-1,8	-1,3	-2,0	-1,9	-1,1	-0,7	-1,0
CO2 emissions									
Reference approach	kt	3.990.363	3.714.434	3.566.997	3.148.618	3.142.394	3.163.109	3.111.157	2.962.267
Sectoral approach	kt	4.100.731	3.826.232	3.649.162	3.234.954	3.219.118	3.221.970	3.146.445	3.003.092
Difference	%	-2,7	-2,9	-2,3	-2,7	-2,4	-1,8	-1,1	-1,4

Table 3.134 provides an overview for EU-KP on differences between the Eurostat and national reference approach for apparent consumption in TJ for 2019. For EU-KP the differences are very small. However, for some Member States the two data sets show larger differences. The main reasons for diverging energy data are:

- the use of different calorific values (CV)
- differences in the basic energy balance data reported by Member States to Eurostat (in the joint questionnaires) and to the Commission and the UNFCCC (in the CRF tables)

Table 3.134 Comparison between Eurostat and national reference approach for apparent consumption for EU-KP for 2019 (CRF 1.A) [17]

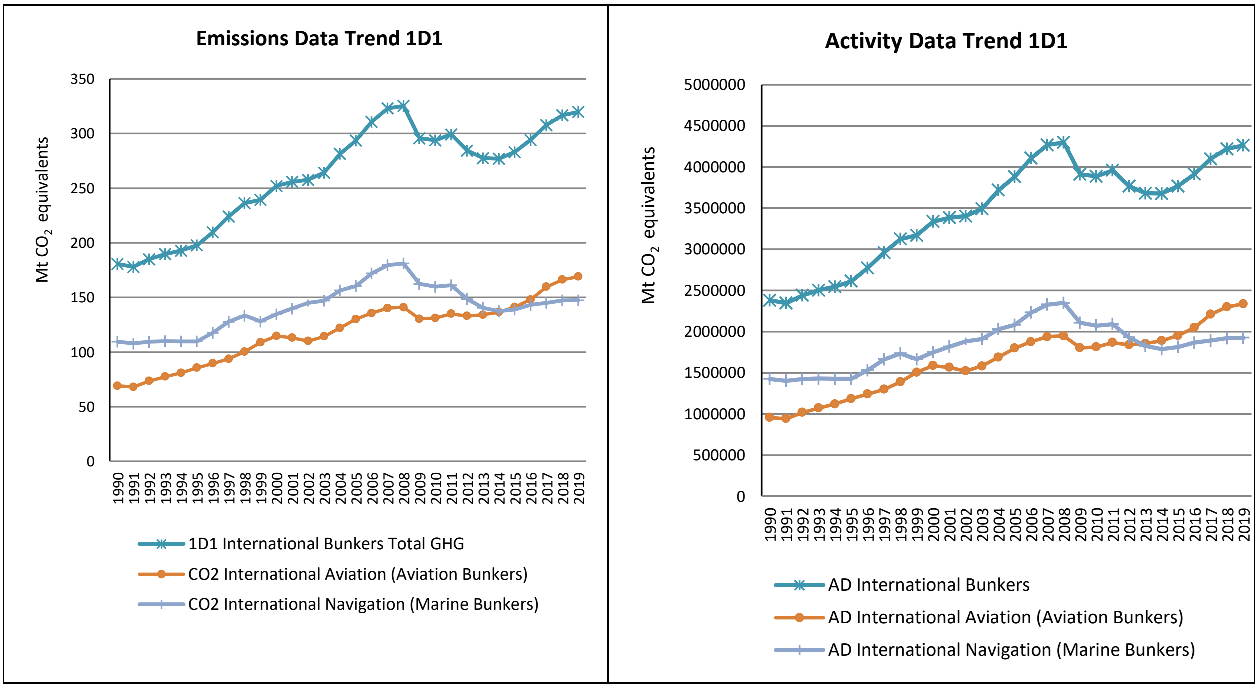
	Total gaseous			Total liquid			Total solid		
	Eurostat TJ	Crf TJ	Difference %	Eurostat TJ	Crf TJ	Difference %	Eurostat TJ	Crf TJ	Difference %
AT	321.403	321.403	0,0%	501.486	502.260	0,2%	117.492	117.465	0,0%
BE	636.416	636.416	0,0%	847.120	847.120	0,0%	127.797	128.554	0,6%
BG	102.234	102.234	0,0%	187.816	190.568	1,5%	211.606	211.924	0,2%
CY	- -	- -	0,0%	84.646	84.133	-0,6%	720	714	-0,8%
CZ	300.289	300.378	0,0%	394.849	389.444	-1,4%	593.096	594.386	0,2%
DE	3.166.075	3.199.916	1,1%	4.177.306	4.072.430	-2,5%	2.251.446	2.256.109	0,2%
DK	105.821	107.321	1,4%	246.510	248.756	0,9%	37.670	36.764	-2,4%
EE	15.917	16.436	3,3%	44.790	44.790	0,0%	124.046	136.268	9,9%
ES	1.293.590	1.296.475	0,2%	2.146.645	2.064.621	-3,8%	205.235	188.234	-8,3%
FI	89.086	89.161	0,1%	322.345	331.216	2,8%	89.444	87.804	-1,8%
FR	1.571.834	1.573.399	0,1%	2.977.633	2.987.816	0,3%	307.240	305.641	-0,5%
GR	187.956	187.956	0,0%	446.642	461.429	3,3%	133.814	149.910	12,0%
HR	100.733	100.733	0,0%	128.787	133.666	3,8%	17.519	17.822	1,7%
HU	354.384	354.384	0,0%	330.887	330.760	0,0%	76.577	77.064	0,6%
IE	190.865	191.372	0,3%	264.706	270.152	2,1%	15.945	15.927	-0,1%
IT	2.551.815	2.552.119	0,0%	2.095.942	2.151.549	2,7%	271.320	271.330	0,0%
LT	78.059	78.058	0,0%	120.478	120.574	0,1%	7.091	7.090	0,0%
LU	28.640	28.640	0,0%	98.337	98.323	0,0%	1.784	1.783	-0,1%
LV	46.194	46.334	0,3%	57.796	57.780	0,0%	1.645	1.644	0,0%
MT	12.820	12.820	0,0%	13.674	13.022	-4,8%	- -	- -	0,0%
NL	1.341.706	1.344.100	0,2%	1.078.522	1.053.463	-2,3%	268.770	269.000	0,1%
PL	708.601	709.545	0,1%	1.262.951	1.270.584	0,6%	1.824.495	1.829.935	0,3%
PT	222.012	221.545	-0,2%	392.086	395.831	1,0%	52.257	52.277	0,0%
RO	386.669	382.802	-1,0%	404.819	393.436	-2,8%	204.878	204.850	0,0%
SE	39.464	41.364	4,8%	410.172	398.854	-2,8%	77.783	69.462	-10,7%
SI	30.736	30.735	0,0%	98.065	98.403	0,3%	44.641	44.617	-0,1%
SK	171.082	171.436	0,2%	148.733	150.266	1,0%	114.297	113.636	-0,6%
IS	- -	0	0,0%	23.666	24.463	3,4%	4.447	4.294	-3,4%
UK	2.798.197	2.820.098	0,8%	2.480.615	2.485.633	0,2%	245.874	248.316	1,0%
EU-KP	16.852.599	16.917.181	0,4%	21.788.025	21.671.344	-0,5%	7.428.928	7.442.820	0,2%

[17] Minus means that Member State-based estimates are lower than the Eurostat-based estimates.

3.8 International bunker fuels (EU-KP)

International bunker emissions include emissions from Aviation bunkers and Marine bunkers. The emissions of the EU inventory are the sum of the international bunker emissions of the countries[18]. Between 1990 and 2019, greenhouse gas emissions from international bunker fuels increased by 77 % in the EU-KP. CO_2 emissions from "Marine bunkers" account for 46 % of total greenhouse gas emissions from international bunkers in 2019, CO_2 from "Aviation bunkers" accounts for 53 % (Figure 3.203).

Figure 3.203 1D1 International bunker fuels: GHG emission trend and activity data



3.8.1 Aviation bunkers (EU-KP)

This source category includes emissions from flights that depart in one country and arrive in a different country (include take-offs and landings for these flight stages).

CO_2 emissions from Aviation Bunkers equal 4 % of total GHG emissions in 2019 but are not included in the national total of GHG emissions (Table 3.135).

The countries France, Germany, Spain and the United Kingdom contributed more than 60 % to the EU-KP emissions from this source. All countries (expect for Lithuania and Romania) increased emissions from Aviation bunkers between 1990 and 2019.

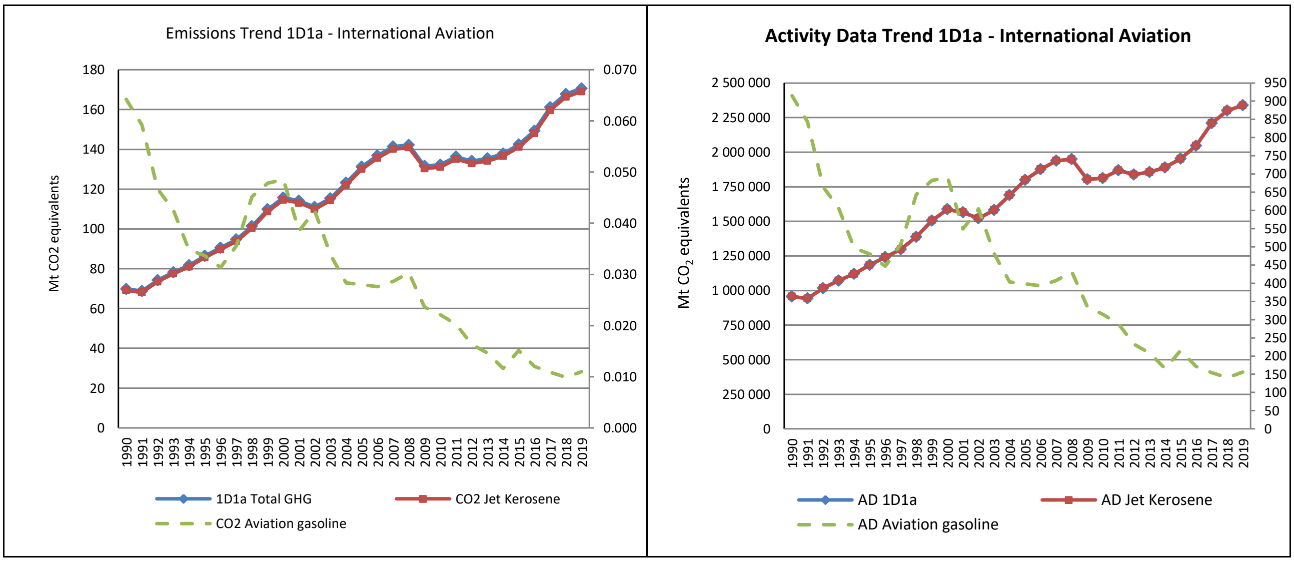
[18] The definitions in Tables 2.8 and 2.9 of the IPCC good practice guidance are based on activities within 'one country". This means domestic aviation is defined for individual countries. The decision tree in Figure 2.8 of the IPCC good practice guidance considers 'national fuel statistics' for domestic aviation. As the EU is neither a country nor a nation, the EU's interpretation of the good practice guidance is that the emission estimate at EU level has to be the sum of countries estimates for domestic air or marine transport as they are the countries or nations addressed in the definition and decision trees of the IPCC good practice guidance.

Table 3.135 1D1a Aviation bunkers: Countries' contributions to CO_2

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	880	2 530	2 907	1.7%	2 026	230%	377	15%
Belgium	3 125	5 144	5 175	3.1%	2 049	66%	31	1%
Bulgaria	713	767	728	0.4%	15	2%	-39	-5%
Croatia	497	560	606	0.4%	109	22%	46	8%
Cyprus	718	1 037	1 027	0.6%	309	43%	-10	-1%
Czechia	524	1 238	1 265	0.7%	742	142%	28	2%
Denmark	1 755	3 031	3 098	1.8%	1 343	77%	67	2%
Estonia	107	209	210	0.1%	104	97%	2	1%
Finland	1 008	2 388	2 574	1.5%	1 566	155%	186	8%
France	9 110	17 779	18 690	11.1%	9 581	105%	912	5%
Germany	11 921	29 874	29 633	17.5%	17 712	149%	-240	-1%
Greece	2 475	3 858	3 989	2.4%	1 514	61%	130	3%
Hungary	505	841	851	0.5%	346	68%	10	1%
Ireland	1 073	3 280	3 320	2.0%	2 247	209%	40	1%
Italy	4 285	11 964	12 403	7.3%	8 118	189%	438	4%
Latvia	221	467	481	0.3%	260	118%	14	3%
Lithuania	399	378	370	0.2%	-29	-7%	-8	-2%
Luxembourg	394	1 838	1 798	1.1%	1 404	356%	-40	-2%
Malta	197	472	514	0.3%	317	161%	43	9%
Netherlands	4 604	12 158	11 890	7.0%	7 285	158%	-269	-2%
Poland	640	2 981	3 194	1.9%	2 555	399%	213	7%
Portugal	1 533	4 120	4 367	2.6%	2 835	185%	247	6%
Romania	790	411	457	0.3%	-333	-42%	46	11%
Slovakia	67	184	186	0.1%	119	177%	1	1%
Slovenia	49	101	77	0.0%	28	58%	-24	-24%
Spain	4 741	18 343	18 984	11.2%	14 243	300%	642	3%
Sweden	1 335	2 787	2 644	1.6%	1 309	98%	-143	-5%
United Kingdom	15 342	36 261	36 628	21.7%	21 287	139%	367	1%
EU-27+UK	**69 006**	**165 002**	**168 067**	**99%**	**99 060**	**144%**	**3 065**	**2%**
Iceland	219	1 285	956	0.6%	737	336%	-329	-26%
United Kingdom (KP)	15 276	36 282	36 653	21.7%	21 377	140%	371	1%
EU-KP	**69 160**	**166 307**	**169 047**	**100%**	**99 888**	**144%**	**2 740**	**2%**

CO_2 emissions from jet kerosene account for 99 % of total emissions from "Aviation bunkers" in 2019 (Figure 3.204). All countries but Lithuania and Romania increased emissions from jet kerosene between 1990 and 2019. Countries with the highest increase between 1990 and 2019 in percent were Luxembourg, Poland, Spain and Iceland.

Figure 3.204 1D1a Aviation bunkers: Trend of CO_2 Emissions and Activity Data



Data displayed as dashed line refers to the secondary axis.

3.8.1.1 Aviation Bunkers – Jet Kerosene (CO_2)

Figure 3. provides an overview of emissions for EU-KP and the contribution of each country to EU-KP emissions. The United Kingdom, Germany, France and Spain are the countries that contributed most to the EU-KP emissions. Fuel combustion of EU-KP increased by 145 % between 1990 and 2019.

In Figure 3. the IEF is depicted, showing a mean value of around 72 t/TJ for 2019.

*Figure **3**.3 Aviation bunkers, Jet kerosene: Emission trend and share for CO_2*

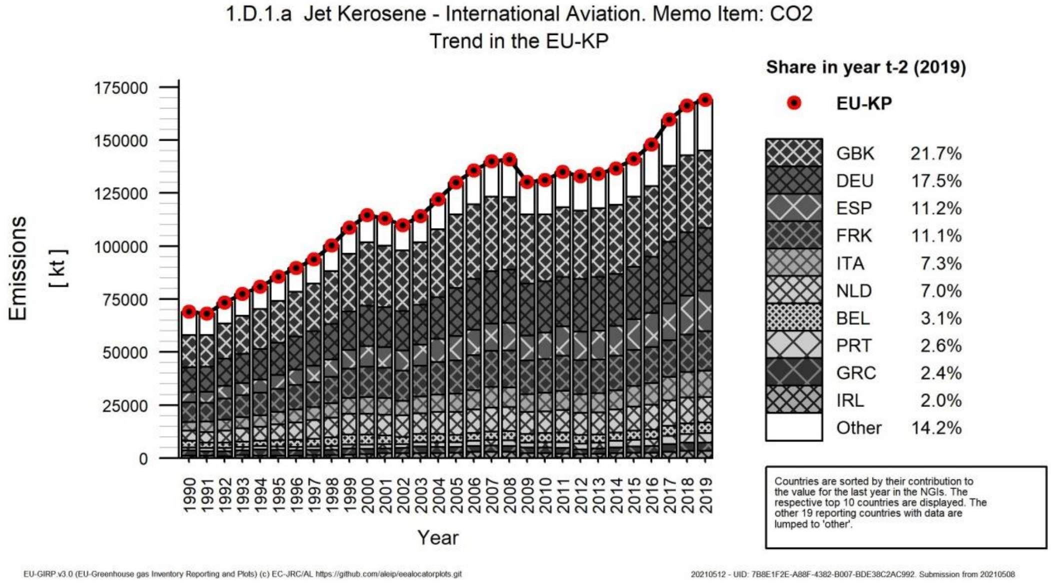
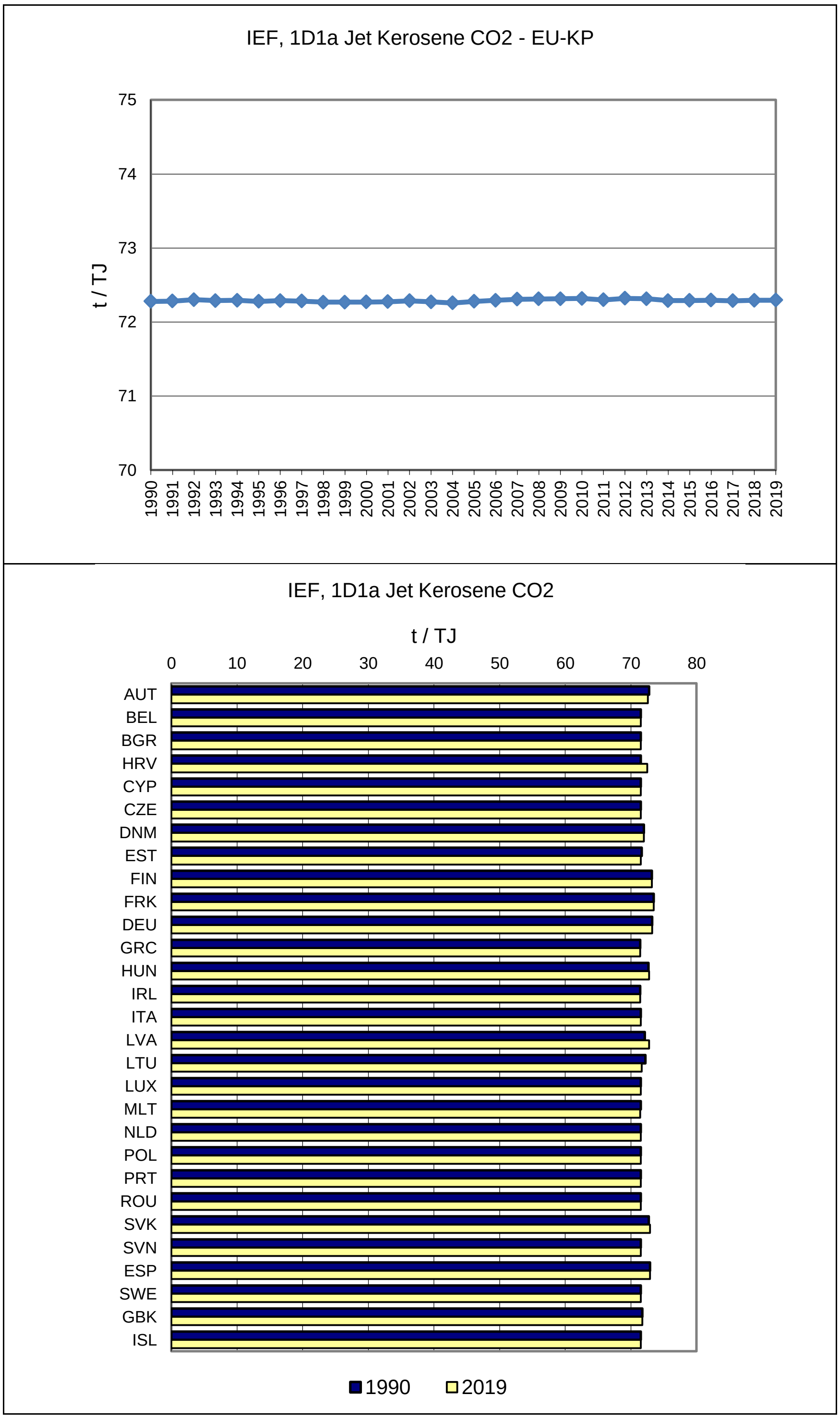


Figure 3.4: 1D1a Aviation bunkers – Jet kerosene: Implied Emission Factors for CO_2 (in t/TJ)



3.8.2 Marine bunkers (EU-KP)

This source category includes emissions from fuels used by vessels of all flags that are engaged in international water-borne navigation. The international navigation may take place at sea, on inland lakes and waterways and in coastal waters. Marine bunkers include emissions from journeys that depart in one country and arrive in a different country. Marine bunkers exclude consumption by fishing vessels (see Other Sector - Fishing).

CO_2 emissions from "Marine bunkers" equal 4 % of total GHG emissions in 2019 and are also not included in the national total of GHG emissions. Between 1990 and 2019, CO_2 emissions from Marine bunkers increased by 35 % in the EU-KP (Table 3.136).

The Netherlands, Spain and Belgium contributed most to the emissions from this source (59 %) in 2019. Between 1990 and 2019, most countries (18 in total) increased emissions from Marine bunkers. The countries with the highest increase in absolute terms were Belgium, Spain and Malta. Hungary stated that consumption in international navigation was not considered, because separate data on the uses for international navigation are not included in the national statistics.

Table 3.136 1D1b Marine bunkers: Countries' contributions to CO_2 emissions

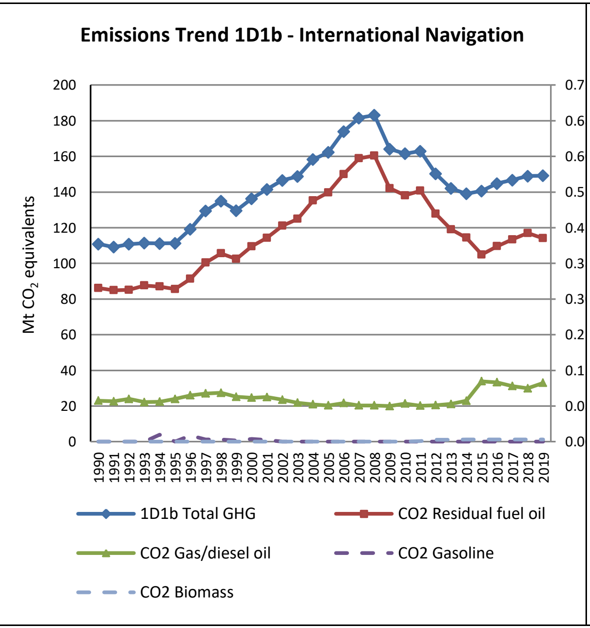
Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	46	39	45	0.0%	-1	-1%	6	15%
Belgium	13 313	30 291	26 747	18.1%	13 434	101%	-3 544	-12%
Bulgaria	183	257	234	0.2%	51	28%	-23	-9%
Croatia	147	65	78	0.1%	-69	-47%	13	19%
Cyprus	183	857	883	0.6%	700	383%	26	3%
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	3 012	1 727	2 222	1.5%	-790	-26%	495	29%
Estonia	543	926	544	0.4%	1	0%	-382	-41%
Finland	1 832	1 014	1 048	0.7%	-784	-43%	34	3%
France	7 961	6 291	5 537	3.8%	-2 424	-30%	-754	-12%
Germany	6 405	4 272	3 469	2.4%	-2 937	-46%	-803	-19%
Greece	8 106	7 137	8 250	5.6%	145	2%	1 114	16%
Hungary	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Ireland	57	499	437	0.3%	381	670%	-62	-12%
Italy	4 454	7 120	6 458	4.4%	2 004	45%	-662	-9%
Latvia	1 515	120	920	0.6%	-595	-39%	800	667%
Lithuania	302	636	616	0.4%	314	104%	-20	-3%
Luxembourg	0	0	0	0.0%	0	36%	0	-22%
Malta	895	7 161	7 278	4.9%	6 383	713%	117	2%
Netherlands	34 947	35 840	38 003	25.8%	3 055	9%	2 162	6%
Poland	1 265	848	866	0.6%	-399	-32%	18	2%
Portugal	1 400	2 657	3 069	2.1%	1 669	119%	412	15%
Romania	NO	54	104	0.1%	104	∞	50	93%
Slovakia	65	11	16	0.0%	-49	-76%	5	45%
Slovenia	NO,NA	727	613	0.4%	613	∞	-114	-16%
Spain	11 659	22 508	22 923	15.5%	11 264	97%	415	2%
Sweden	2 333	5 646	6 857	4.6%	4 524	194%	1 211	21%
United Kingdom	8 914	10 474	10 102	6.8%	1 188	13%	-372	-4%
EU-27+UK	**109 537**	**147 179**	**147 320**	**100%**	**37 783**	**34%**	**141**	**0%**
Iceland	19	242	205	0.1%	186	986%	-37	-15%
United Kingdom (KP)	8 885	10 448	10 076	6.8%	1 191	13%	-372	-4%
EU-KP	**109 528**	**147 394**	**147 498**	**100%**	**37 971**	**35%**	**104**	**0%**

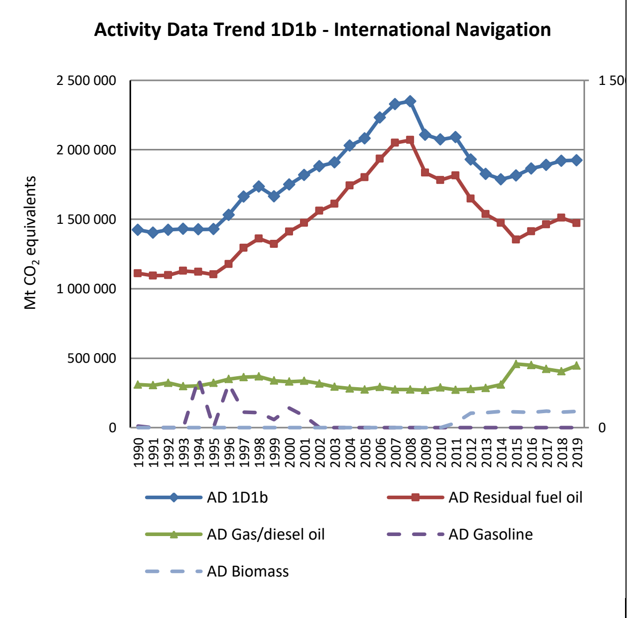
Austria, Croatia, Denmark, Finland, France, Germany, Latvia, Poland and Slovakia decreased their emissions. Czechia and Hungary reported in 1990 and/or 2019 notation keys. All other countries reported increased emissions from residual oil between 1990 and 2019. Countries with the highest increase in percent were Cyprus, Ireland, Malta and Iceland.

CO_2 emissions from residual fuel oil account for 76 % of total emissions from "Marine bunkers" in 2019 (Figure 3.). Between 1990 and 2019, CO_2 emissions from residual fuel oil increased by 32 % in the EU-KP.

CO_2 emissions from gas/diesel oil account for 22 % of total emissions from "Marine bunkers" in 2019. Between 1990 and 2019, CO_2 emissions from gas/diesel oil increased by 43 % in the EU-KP.

*Figure **3**.5 1D1b Marine bunkers: Trend of CO_2 Emissions and Activity Data*





Data displayed as dashed line refers to the secondary axis.

Table 3.135 and Table 3.136 provide an overview of emissions for residual oil and gas/diesel oil for EU-KP and those countries contributing most to EU-KP emissions.

Figure 3.205 Marine bunkers, residual fuel oil: Emission trend and share for CO_2

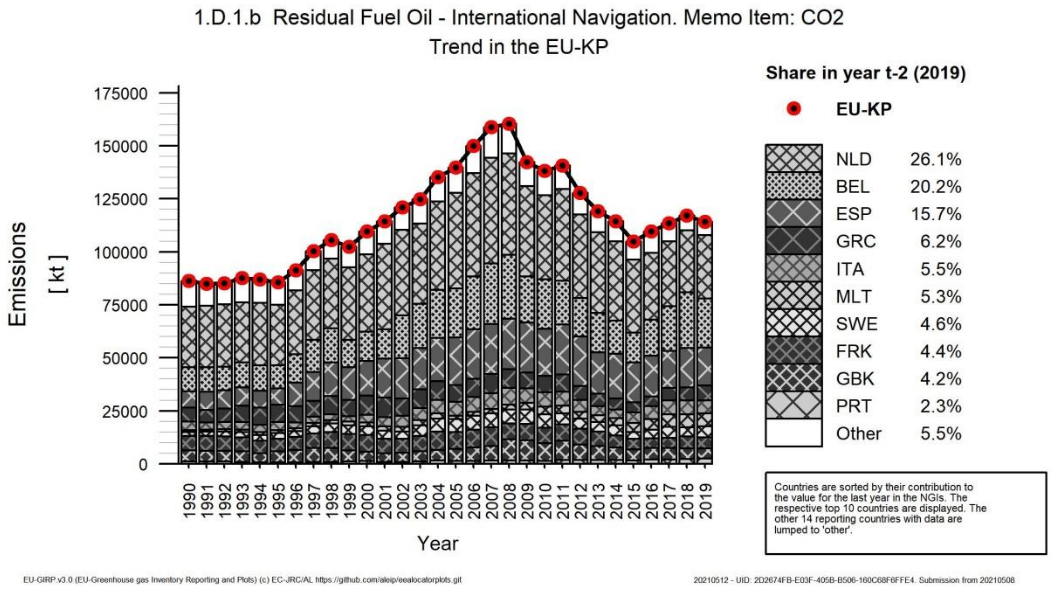
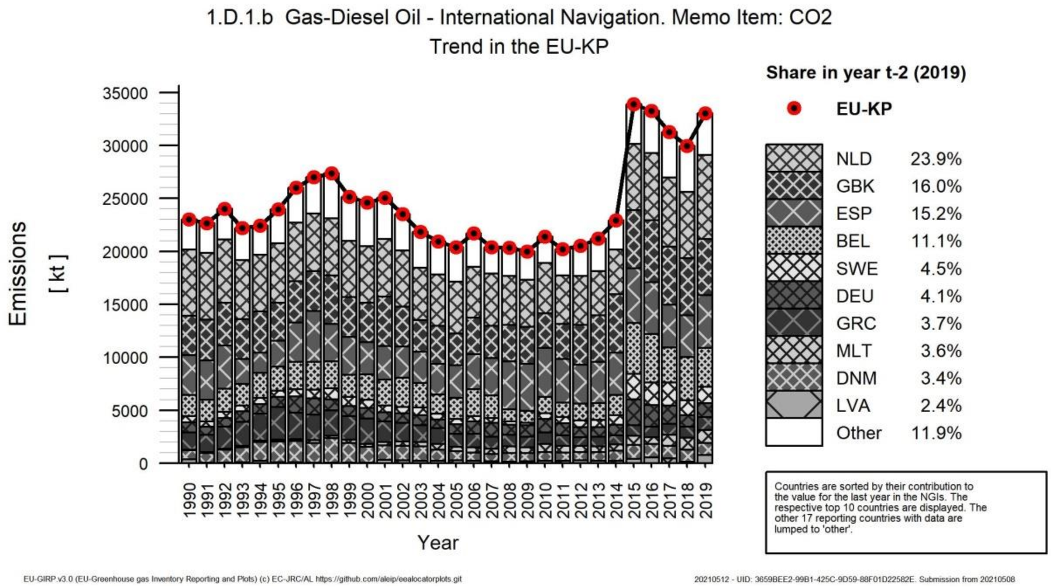


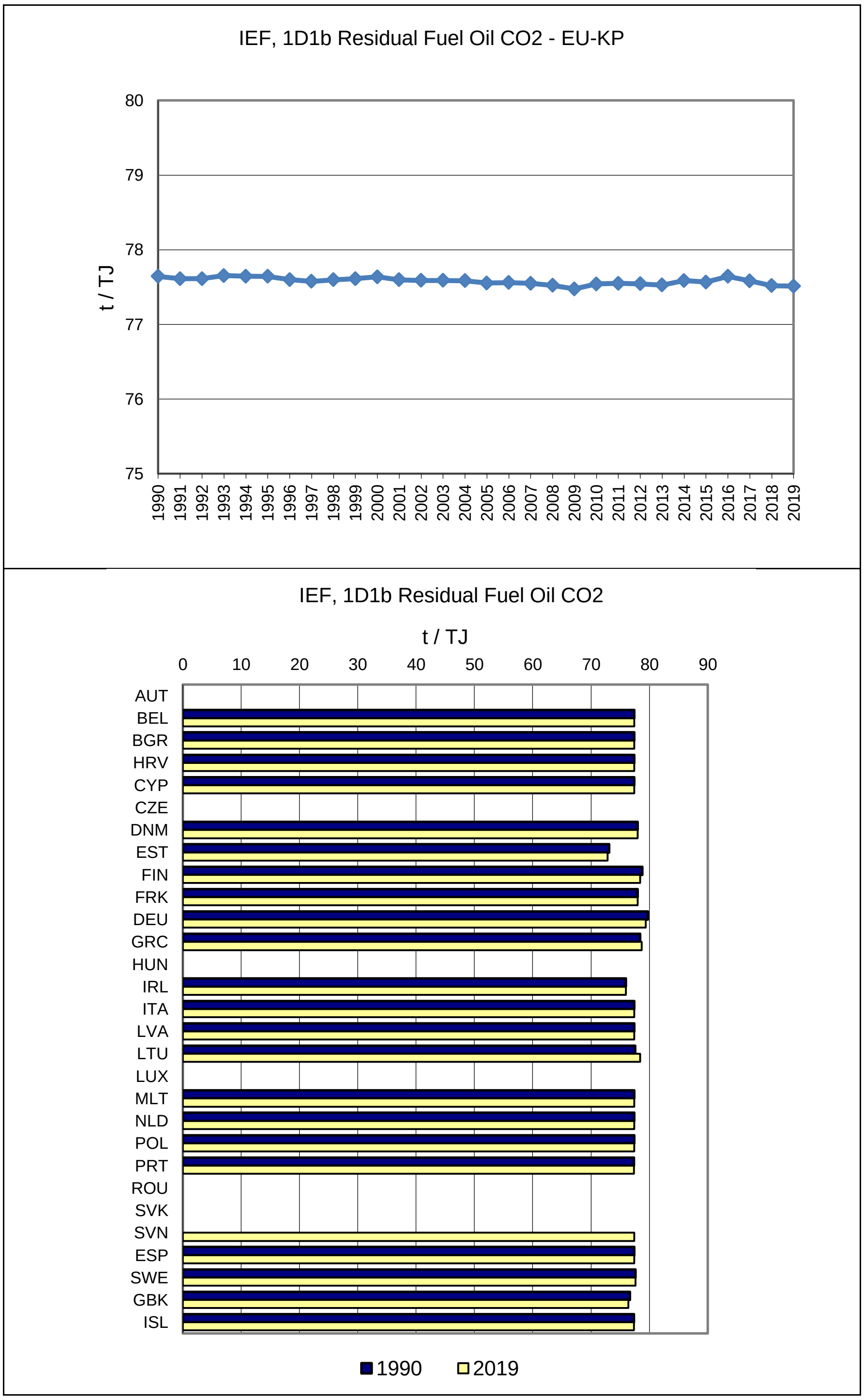
Figure 3.206 Marine bunkers, gas/diesel oil: Emission trend and share for CO_2



3.8.2.1 Marine Bunkers – Residual Oil (CO_2)

Combustion of residual oil in the EU-KP increased by 33 % between 1990 and 2019. In Figure 3. the IEF is depicted, with a mean value of 77.6 t/TJ.

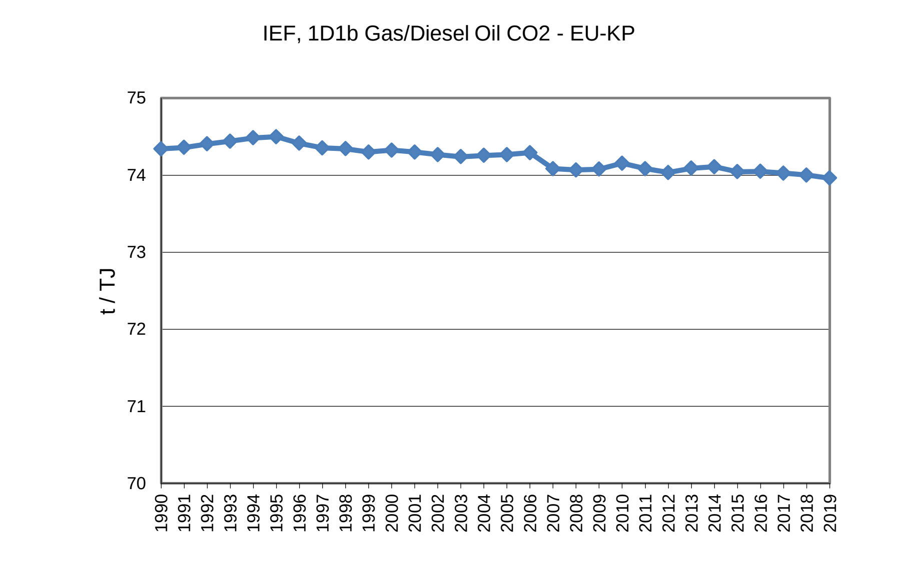
Figure 3.7: 1D1b Marine bunkers – Residual Oil: Implied Emission Factors for CO_2 (in t/TJ)

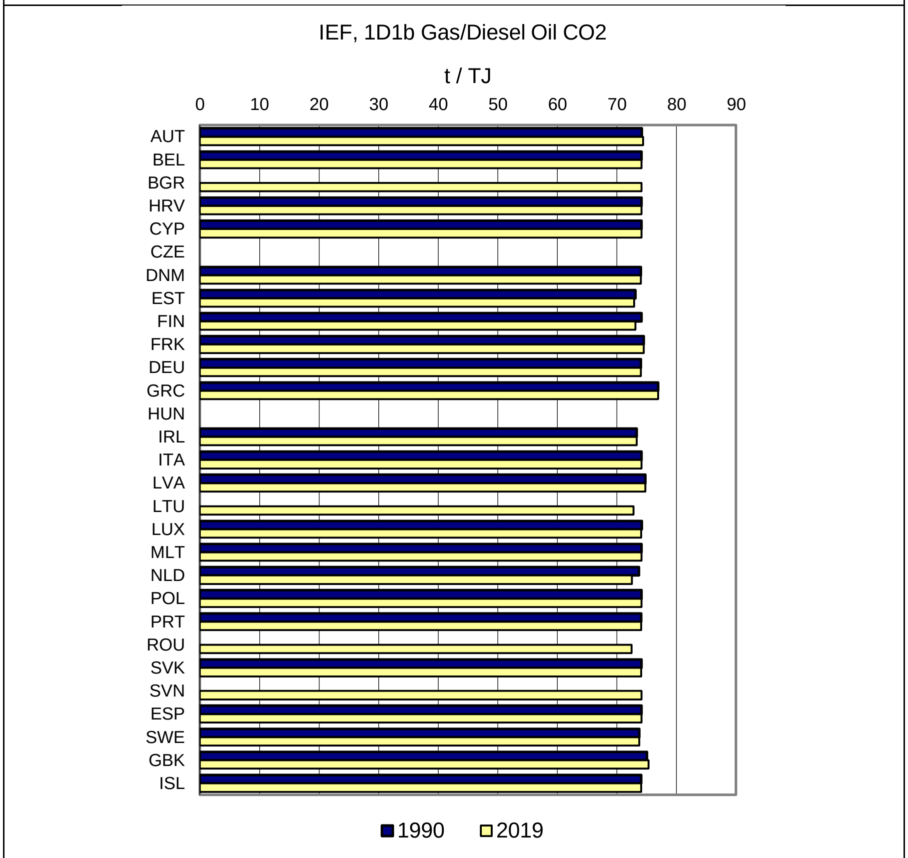


3.8.2.2 Marine Bunkers – Gas/Diesel Oil (CO_2)

Combustion of gas/diesel oil in the EU-KP increased by 44 % between 1990 and 2019. In Figure 3. the IEF is depicted, with a mean value of 74.4 t/TJ.

Figure 3.9: 1D1b Marine bunkers – Gas/Diesel Oil: Implied Emission Factors for CO_2 (in t/TJ)





3.8.3 QA/QC activities

For more information on QA/QC activities refer to chapter 3.4

3.9 Feedstocks and non-energy use of fuels

According to the 2006 IPCC guidelines non non-energy fuels is divided into three categories:

(1) Raw materials for the chemical industry (Feedstocks). These fossil fuels are used in particular in the production of organic compounds and to a lesser extent in the production of inorganic chemicals (e.g. ammonia) and their derivatives. For organic substances, normally part of the carbon contained in the feedstock remains largely stored in these products. Typical examples of raw materials are feedstocks for the petrochemical industry (naphtha), natural gas, or different types of oils (e.g. the production of hydrogen for the subsequent production of ammonia by partial oxidation).
(2) Reductants. Carbon is used as a reductant in metallurgy and inorganic technologies. Unlike the previous case, here when using fossil fuel as reductant only a very small amount of carbon remains fixed in the products for a longer time and the larger part of the carbon is oxidized during the reduction process. Metallurgical coke is a typical reductant.
(3) Non-energy products. Non-energy products are materials derived from fuels in refineries or coke plants which, unlike the previous two cases, are used directly for their conventional physical properties, specifically as lubricants (lubricating oils and petrolatum), diluents and solvents, bitumen (for covering roads and roofs) and paraffin. Emissions of CO_2 and other GHG occur only to a limited extent in the IPPU category (e.g. during the oxidation of lubricants and paraffin). Substantial emissions occur during their recovery and during disposal by incineration (in the sector Energy and in Waste).

The non-energy use of fuels is reported in CRF table 1.A(d). The purpose of CRF table 1A(d) is twofold:

(1) The table should make transparent the amount of carbon from non-energy use of fuels that is subtracted from the carbon included in all fuels (both energy and non-energy use) in order to make a meaningful comparison between sectoral and reference approach.
(2) The table should make transparent in which categories other than Energy CO_2 emissions from non-energy use of fuels are included in the inventory (mostly IPPU). Therefore, the table serves as a basis for consistency checks with the IPPU sector reporting.

Table **3.137** shows the fuels that were used for the purpose of non-energy use in the EU-KP in 2019. All data in CRF table 1A(d) is calculated as the sum of respective MS data. It shows that 68 % of non-energy use of fuels are liquid fuels with naphta, bitumen and LPG showing the largest contribution to NEU of liquid fuels. Naphta and LPG are mainly used as feedstock in the petrochemical industry. Bitumen is mainly used in the construction industry. Natural gas accounts for 15 % of non-energy use of fuels and is mainly used for feedstock in ammonia production. Coke oven / gas coke accounts for 10 % of NEU of fuels and is mainly used as reductant in the metal industry.

Table 3.137 Fuel quantity for non-energy use in TJ and % for the EU-KP

Fuel			TJ	%
Liquid fossil	Primary fuels	Crude oil	440	0,01%
		Natural gas liquids	61.000	1,2%
		Gasoline	100	0,002%
		Jet kerosene	NO	-
		Other kerosene	2.238	0,04%
		Gas/diesel oil	100.349	1,9%
		Residual fuel oil	75.888	1,5%
		Liquefied petroleum gases (LPG)	631.216	12,2%
		Ethane	51.801	1,0%
		Naphtha	1.427.554	27,5%
		Bitumen	624.218	12,0%
		Lubricants	174.961	3,4%
		Petroleum coke	52.616	1,0%
		Refinery feedstocks	10.980	0,2%
		Other oil	325.944	6,3%
Other liquid fossil			9.118	0,2%
Liquid fossil totals			**3.548.423**	**68,3%**
Solid fossil	Primary fuels	Anthracite	90.674	1,7%
		Coking coal	122.548	2,4%
		Other bituminous coal	82.846	1,6%
		Sub-bituminous coal	9.282	0,2%
		Lignite	358	0,01%
		Oil shale and tar sand	7.301	0,1%
		Coke oven/gas coke	541.846	10,4%
		Coal tar	26.636	0,5%
Solid fossil totals			**881.491**	**17,0%**
Gaseous fossil		Natural gas (dry)	762.146	14,7%
Gaseous fossil totals			**762.146**	**14,7%**
Waste (non-biomass fraction)			394	0,01%
Total			**5.192.060**	**100,0%**

Table **3.138**shows the associated CO_2 emissions from the NEU reported in the inventory for the year 2019. It shows that 49.5 % of the CO_2 emissions stem from solid fuels, 20.8% from liquid fuels and 29.6 % from natural gas. It has to be noted that the reporting in CRF table 1A(d) is still not fully coherent and work is ongoing between the EU and its Member States in order to improve the reporting in this table.

Table 3.138 CO_2 emissions from the NEU reported in the inventory kt CO_2 and % for the EU-KP

Fuel			kt	%
Liquid fossil	Primary fuels	Crude oil	15	0,01%
		Other kerosene	0,2	0,0002%
		Gas/diesel oil	14	0,01%
		Residual fuel oil	129	0,1%
		Liquefied petroleum gases (LPG)	3.383	3,0%
		Ethane	557	0,5%
		Naphtha	10.972	9,6%
		Bitumen	483	0,4%
		Lubricants	2.689	2,4%
		Petroleum coke	3.125	2,7%
		Other oil	2.176	1,9%
Other liquid fossil			282	0,2%
Liquid fossil totals			23.825	**20,8%**
Solid fossil	Primary fuels	Anthracite	12.592	11,0%
		Coking coal	11.085	9,7%
		Other bituminous coal	7.777	6,8%
		Sub-bituminous Coal	876	0,8%
		Lignite	6	0,0%
		Coke oven/gas coke	24.167	21,1%
		Coal tar	87	0,1%
Solid fossil totals			**56.591**	**49,5%**
Gaseous fossil		Natural gas (dry)	33.872	29,6%
Gaseous fossil totals			**33.872**	**29,6%**
Waste (non-biomass fraction)			71	0,1%
Total			**114.287**	**100,0%**

Table **3.139** shows the recalculations of non-energy use of fuels for the year 2018. A major recalculation can be seen for non-energy use of solid fuels which reflects the reporting of reductants used in iron and steel production in Table 1A(d). Across all fuels recalculations were at 4%. Most recalculations at fuel level were due to revisions in the energy balance.

Table 3.139 Recalculations of fuel quantity for non-energy use of fuels for the inventory year 2017

FUEL TYPE			ACTIVITY DATA AND RELATED INFORMATION			
			Fuel quantity for NEU (TJ)		Difference in TJ	Difference in %
			2020	2021		
Liquid fossil	Primary fuels	Crude oil	860	860	0	0%
		Orimulsion	IE,NO	IE,NO	0	-
		Natural gas liquids	72.600	72.600	0	0%
	Secondary fuels	Gasoline	103.111	100	-103.011	-100%
		Jet kerosene	1	NO	-1	-
		Other kerosene	2.025	2.025	0	0%
		Shale oil	NO	NO	0	-
		Gas/diesel oil	122.532	127.176	4.644	4%
		Residual fuel oil	80.719	80.847	128	0%
		Liquefied petroleum gases (LPG)	572.730	588.407	15.677	3%
		Ethane	52.525	70.511	17.986	34%
		Naphtha	1.547.215	1.546.255	-960	0%
		Bitumen	627.930	630.810	2.880	0%
		Lubricants	201.235	192.515	-8.721	-4%
		Petroleum coke	60.963	57.046	-3.917	-6%
		Refinery feedstocks	12.690	12.690	0	0%
		Other oil	255.100	321.992	66.893	26%
Other liquid fossil			5.267	9.092	3.825	73%
Liquid fossil totals			**3.717.502**	**3.712.924**	**-4.578**	**0%**
Solid fossil	Primary fuels	Anthracite	34.555	100.176	65.621	190%
		Coking coal	134.763	125.629	-9.134	-7%
		Other bituminous coal	90.639	92.478	1.839	2%
		Sub-bituminous Coal	8.325	9.104	779	-
		Lignite	375	374	-1	0%
		Oil shale and tar sand	7.972	7.527	-445	-6%
	Secondary fuels	BKB and patent fuel	NA,NO	NA,NO	0	-
		Coke oven/gas coke	460.725	550.240	89.515	19%
		Coal tar(7)	27.002	27.352	350	1%
Other solid fossil				0	0	-
		Other		0	0	-
Solid fossil totals			**764.356**	**912.879**	**148.523**	**19%**
Gaseous fossil		Natural gas (dry)	692.668	750.280	57.612	8%
Other gaseous fossil			NA,NO	NA,NO	0	-
Gaseous fossil totals			**692.668**	**750.280**	**57.612**	**8%**
Waste (non-biomass fraction)			219	219	0	0%
Other fossil fuels			NA,NO	NA,NO	0	-
Other fossil fuels totals			NA,NO	NA,NO	0	-
Total fossil fuels			**5.174.526**	**5.376.083**	**201.557**	**4%**

Table **3.140** provides information on feedstocks and non-energy use of fuels from Member States' NIRs.

Table 3.140 Information related to feedstocks and non-energy use from Member States' NIRs

MS	Information on feedstocks and non-energy use of fuels	Source
Austria	Non-energy use of fuels is considered in the national energy balance. Below explanations for the reported non-energy use is provided together with information on where CO_2 emissions due to the manufacture, use and disposal of carbon containing products are considered. **Lubricants** manufacture: emissions are assumed to be included in total emissions from category *1.A.1.b* petroleum refinery. use: VOC emissions from lubricants used in rolling mills are considered in category *2.C.1*. It is assumed that other uses of lubricants do not result in VOC or CO_2 emissions due to the low vapour pressure of lubricants. CO_2 from lubricants which are used in engines are considered in category *2.D.1* disposal: emissions from incineration of lubricants (waste oil) are either included in categories *1.A.1.a* and *1.A.2* if waste oil is used as fuel or to a minor degree reported under category *5.C* if energy is not recovered. **Bitumen** manufacture: emissions from the production of bitumen are assumed to be included in total emissions of category *1.A.1.b* petroleum refinery. use: indirect CO_2 emissions from the use of bitumen for road paving and roofing that should be reported in categories *2.A.5* and *2.A.6* are included in sector *3 solvent and other product use*. disposal: CO_2 emissions from the disposal from bitumen are assumed to be negligible. Recycling is not considered. **Naphtha** manufacture: Naphta is produced in the oil refinery and transferred to a petrochemical plant. Residues from the petrochemical plants are transferred back to the oil refinery steam cracker. use: Naphta is used for plastics production (e.g. ethylene). **Petroleum coke** In IEA JQ (2016) non energy use is reported for the manufacture of electrodes. manufacture: No information about emissions from manufacture of electrodes is currently available. Therefore it is not clear if emissions are not estimated or not applicable. use: Emissions from the use of electrodes are considered in category *2.B.4* carbide production and *2.C* metal production. **Residual fuel oil** use: Considerable amounts of residual fuel are used in blast furnaces. Emissions are considered in *2.C.1*. **Coking coal, Bituminous coal, Coke oven coke, Coal Tar** manufacture: emissions from the production of coke are considered in category *1.A.2.a*. use: CO_2 emissions from coal, coke and coal tar used in iron and steel industry are reported under *2.C*. **Natural Gas** use: emissions from the use of natural gas as a feedstock in ammonia production are accounted for in the industrial processes sector (category *2.B.1*). **Plastics waste** manufacture: Emissions from manufacture of plastics are considered in category *2.B*. use: plastics waste is used as a reductant in blast furnaces. Emissions are considered in *2.C.1*. Disposal: Any emissions from waste disposal are considered in category 5.A. Waste incineration with energy use is considered in *1.A – other fuels* and - to a minor degree - waste incineration without energy recovery is considered in category *5.C*. **Solvents** manufacture: emissions from the production of solvents are considered in sector *2.D.3* use: CO_2 emissions from solvent use are considered in sector *2.D.3*. disposal: emissions from the disposal of solvents are considered in 5.A. **Paraffin wax** use: CO_2 emissions from paraffin wax use are considered in sector *2.D.2*.	National Inventory Report, Chapter 3.2.3
Belgium	The emissions of non-energy use of fuels and related emissions (emissions from recovered fuels from processes) are reported under categories 2B1, 2B8 and 2B10. During the 2015 submission a re-allocation of the offgas-emissions/recovered fuels from cracking units (biggest part) plus some other processes (non-energy use) emissions (reported in the category 1A2c / other fuels before), were moved to the category 2B8b Industrial Processes and Product Use / Chemical Industry / Petrochemical and Carbon Black Production / Ethylene during this submission as prescribed in the new IPCC 2006 guidelines. In Flanders, a recalculation of the non-energy use and related CO_2 emissions was performed during the 2005 submission, based on the results of a study conducted in 2003. Belgium participated in a European network on the CO_2-emissions from non-energy use (see website http://www.chem.uu.nl/nws/www/nenergy/) and one of the conclusions of this network is that the new IPCC guidelines need to give more information on this subject. The result of the study made a recalculation possible for all years. The effect of the recalculation was greater in the more recent years because the petrochemical industry has expanded its activities in the beginning of the nineties (that's one of the reasons why this sector 2B8b is a key source for the trend assessment). Since the petrochemical industry is important in Flanders and Belgium and the emissions from the feedstocks are a key source in the Belgian inventory, the study mentioned above was conducted to get more detailed, country-specific information. A distinction is made between: 1. The use of recovered fuels from cracking units or other processes where a fuel is used as raw material and where part of this fuel (or transformed product) is recovered for energy purposes. These emissions are reported under category 2B8. This is the largest source of CO_2 emissions. This includes the recovered fuels in the steam cracking units in the petrochemical industry (approx. 2/3) and other recovered fuels from the chemical industry (approx. 1/3). These	National Inventory Report, Chapter 3.2.3

	recovered fuels are reported directly in the yearly surveys carried out by the chemical federation in cooperation with the VITO [1] and from emission estimates from 2013 on, these emissions are taken over from the reported emissions via the ETS-Directive. 2. CO_2 emissions occurring during chemical processes, for example, the production of ammonia based on natural gas or the production ethylene oxide (and production of acrylic acid from propene, production of cyclohexanone from cyclohexane, production of paraxylene/metaxylene, etc) where CO_2 is formed in a side reaction (reported respectively under 2B1 and 2B10). These CO_2 emissions result from the same surveys in the chemical sector in Flanders as those reported under 2B8 and are taken over from the reported emissions via the ETS-Directive from emission estimates from 2013 on. Emissions of flaring activities in the chemical industry are allocated to the category 5C1.2.b (Waste Incineration / Non-biogenic / Other / Flaring in the chemical industry) since last submission. 3. Waste treatment of final products was not included in the study. This is practically impossible due to import/export of plastic products, etc. (it is also not clear if the waste phase is included in the default IPCC carbon stored % or not). The emissions of waste incineration are therefore calculated separately and are reported under the sector of waste (category 5C) or under the sector of energy (category 1A1a), depending whether or not energy recuperation takes place during the process.	
Bulgaria	Non-energy use of fuels is reported for the following fuels: • Anthracite • Coke Oven Coke • Other bituminous coal • Lubricants • Bitumen • Naphtha • Paraffin waxes • White spirit • Residual Fuel Oil • Other Oil Products • Petroleum Coke • Natural Gas as Feedstock There are some fluctuations of the reported consumption for some of the fuels during the time series due to changes in the industrial production – differences in production volume, decommissioning of installations or shift from one fuel type to another. Some discrepancies with the quantities of fuels reported as non-energy use exist in the Energy balance – for some fuels only for the latest years is reported non-energy use, in addition some industrial plants do not properly report their non-energy use of fuels. In order to improve the consistency, additional data was collected from several chemical plants regarding the annual production of ammonia, soda ash and calcium carbide. The amounts of energy and non-energy use of natural gas, anthracite, other bituminous coal and coke oven coke we reallocated according to the quantities of fuels considered as emission sources in the Industrial Processes sector. The non-energy use of fuels is on average 8.1% of the total apparent energy consumption during the period 1988-2016 and 6.3% for 2016. The apparent consumption is calculated according to Equation 6.2 in Vol. 2, Ch. 6 of the 2006 IPCC Guidelines. The most significant fuels used as feedstock are bitumen, anthracite and natural gas. The use of naphtha has been discontinued since 2010. In general, most of the non-energy use of fuels is attributed to the industrial sector (lubricants, paraffin wax), chemical and petrochemical industry (anthracite, natural gas, naphtha, white spirit and other petroleum products) and construction (bitumen). All sources of emissions due to non-energy use of fuels (natural gas) are reported under category 2B Chemical Industry. The quantities of waste oils, which are used with energy recovery in the non-metallic minerals and other industrial plants, are reported as other fuels under category 1.A.2.g Other industries.	National Inventory Report, Chapter 3.3.3
Cyprus	In Cyprus fuels that are used for non-energy uses are Lubricants and Bitumen. Bitumen/asphalt is used for road paving and roof covering where the carbon it contains remains stored for long periods of time. Consequently, there are no fuel combustion emissions arising from the deliveries of bitumen within the year of the inventory. Lubricating oil statistics usually cover not only use of lubricants in engines but also oils and greases for industrial purposes and heat transfer and cutting oils. All deliveries of lubricating oil should be excluded from the Reference Approach. Non-energy use of fuels in Cyprus refers to the consumption of lubricants in transport and bitumen in construction. Data on the non-energy consumption of fuels was obtained from the national energy balance (Gross inland deliveries (Calculated)).	National Inventory Report, Chapter 3.2.10
Croatia	Non-energy fuel consumptions (fuels used as feedstock) and appropriate emissions, where onepart or even the whole carbon is stored in product for a longer time and the other part oxidizes and goes to atmosphere, are described here. The feedstock use of energy carriers occurs in chemical industry (natural gas consumption for ammonia production, production of naphtha, ethane, paraffin and wax), construction industry (bitumen production), and other products such as motor oil, industrial oil, grease etc. As a result of non-energy use of bitumen in construction industry there is no CO_2 emission because all carbon is bound to the product.	National Inventory Report, Chapter 3.2.3
Denmark	The consumption for non-energy purposes is subtracted in the reference approach, because non-energy use of fuels is included in other sectors (Industrial processes and Solvent use) in the Danish national approach. Three fuels are used for non-energy purposes: lubricants, bitumen and white spirit. The total consumption for non-energy purposes is relatively low – 10.5 PJ in 2016. The CO_2 emission from oxidation of lube oil during use was 31.7 Gg in 2016 and this emission is reported in the sector industrial processes and product use (sector 2.D). The reported emission corresponds to 20 % of the CO_2 emission from	National Inventory Report, Chapter 3.4.1

	lube oil consumption assuming full oxidation. This is in agreement with the methodology for lube oil emissions in the 2006 IPCC Guide-lines (IPCC, 2006). Methodology and emission data for lube oil are shown in NIR Chapter 4.5.2. For white spirit the CO_2 emission is indirect as the emissions occur as NMVOC emissions from the use of white spirit as a solvent. The indirect CO_2 emission from solvent use was 57.8 Gg in 2016. The methodology and emission data for white spirit are included in NIR Chapter 4.5.4. The CO_2 emission from bitumen is included in sector 2.D.3, Road paving with asphalt and Asphalt roofing. The total CO_2 emissions for these sectors are 0.84 Gg in 2016. Methodology and emission data for non-energy use of bitumen are shown in NIR Chapter 4.5.6.	
Estonia	The following fuels are reported under CRF category 1.AD Feedstocks and non–energy use of fuels: Lubricants; Bitumen; Natural gas; Other/Oil shale. Activity data on lubricants and bitumen consumption is received from Statistics Estonia (Joint Questionnaire that Statistics Estonia sends to IEA annually). Data on natural gas that is used for the category non-energy use, is taken from the national energy balance sheet. Activity data on oil shale reported in the CRF 1.AD is calculated on the basis of plant-specific data. This reported amount consists of oil shale semi coke – the by-product of shale oil production which contains a small amount of organic matter (carbon). Oil shale semi-coke is stored in the oil shale waste dumps (carbon stored). Natural gas for non-energy purposes was used for ammonia production and is reported in the CRF category 2.B.1. Natural gas was only used in the company Nitrofert AS. In 2010 and 2011 the factory was temporarily closed down due to low ammonia price in the World market. In 2012 the ammonia production factory was reopened and during 2013 it was closed again and has remained closed ever since.Lubricants are used in the Energy sector for lubricating (mainly in transport and manufacturing sub-sectors). Some used lubricants (waste oils) are incinerated and corresponding emissions are taken into account in the CRF 1.A.2.f/Other fuels.	National Inventory Report, Chapter 3.2.3
Finland	The emissions from the non-specified burning of feedstocks are calculated by a separate module in ILMARI. The ILMARI system includes point source (bottom-up) data on feedstock combustion in the petrochemical industry and these emissions are reported in corresponding subcategories of 1.A.2. These specified energy uses of feedstock are subtracted from the corresponding total amounts of feedstock. For the rest of the feedstock, 100% of carbon is estimated to be stored in products (mainly plastics). Residual fuel oil and coke are used as feedstocks in the metal industry and corresponding amounts are subtracted from the reference approach. All (100%) of this carbon is estimated to be released as CO_2 during the process and emissions are reported in category 2.C.1 (see section 4.4.2). Natural gas, heavy fuel oil, LPG, naphtha and other oil products are used as feedstock in the chemical industry. Carbon included in these feedstocks is subtracted from the reference approach. Most of carbon is stored in the products, but certain process emissions are reported in sector 2.B.10 (see section 4.3.5). From other feedstocks, only carbon from paraffin waxes is estimated to oxidise and these emissions are reported in sector 2.D.2 (section 4.5.3). The ILMARI system includes point source (bottom-up) data also on waste oil combustion in different branches of industry, and these emissions are reported in corresponding subcategories of 1.A.2. For the rest of lubricants we use top-down calculation methodology, presuming that 33% of carbon is stored in products (recycled lubricants) and 67% of carbon is released as CO_2 either in burning of lubricants in motors (two-stroke oil and part of motor oil in four-stroke engines) or illegal combustion of waste oil in small boilers. These non-specified emissions from burning of lubricants (excluding above mentioned emissions reported in 1.A.2) are included in category 2.D.1 (Section 4.5.2). According to IPCC 2006 Revised Guidelines emissions from 2-stroke oil should be reported in the Energy Sector. We do not have data on sales of 2-stroke oil separately, thus we have not separated these emissions from the use of 4-stroke oil and other lubricants. However, we have made a rough estimate for 2013, showing that CO_2 emissions from 2-stroke oil might be around (less than) 7 kt. To be able to reallocate these emissions to Energy Sector, we would have to split the figure to four subsectors (road transport, residential non-road machinery, commercial non-road machinery and leisure boats). As we do not have full time series of activity data to allocate these emissions to Energy subsectors, we are not able to do the split and have included them in 2.D.1, correspondingly to the top-down calculation methodology described above. This misallocation should not result in over- or underestimation of emissions.	National Inventory Report, Chapter 3.2.3

France	The fossil fuels are consumed for different purposes, for energy use and non-energy use (raw material, intermediate material as well as reducing agent). Emissions can occur in the sector of fuel combustion and industrial process. However, it is not always possible, partly for practical reasons, to separately report these two types of emissions. In the IPCC Guidelines, 2006, the following rule is formulated: Combustion emissions from fuels obtained directly or indirectly from the feedstock for an IPPU process will normally be allocated to the part of the source category in which the process occurs. These source categories are normally 2B and 2C. However, if the derived fuels are transferred for combustion in another source category, the emissions should be reported in the appropriate part of Energy Sector source categories (normally 1A1 or 1A2). In the French inventory, in order to preserve the coherence of the inventory of greenhouse gas emissions (under the UNFCCC) and the inventory of atmospheric pollutants (under the UNECE) on the one hand, and between the sectoral approach and the reference approach, on the other hand, it was decided to maintain the distinction between energy uses (reported in CRF 1A) and non-energy (in CRF 2). Finally, to ensure the completeness of the inventory, a feedback on total final consumption (energy + non-energy) energy balance is assured. With regard to the consumption of solid fuels (coal and coke coal) the energy balance accounts all types of use of these fuels as energy consumption and they are well distinguished after energy use and non-energy use in the inventory as well. The solid fuels which are used as reducing agents as well as intermediate material are considered in the CRF category 2C in steel and ferro-alloys production and 2B7 soda ash production. The petroleum products for non-energy use are principally consumed on site of petrochemical installations. This usage is well investigated by an exhaustive survey conducted by the national statistics authority. According to the survey approximately 14% of the consumption of petroleum products is used for non-energy use, mainly as primary material. This survey defines the quantities of different oil products that are consumed in steam crackers reported under CRF 2B (in particular naphta). Emissions from non-energy use of petroleum coke are reported in under 2C3 (aluminium production) and 2B6 (titanium dioxide production). Emissions which are related to the combustion of motor oil for 2-stroke engines are considered in CRF category 1A3 whereas emissions from 4-stroke engines are covered under 2D1. The emissions of recovered oil which is combusted during cement production are reported under category CRF 1A2. Those which are burned in waste incinerators are reported under CRF 6. The non-energy use of natural gas is mainly occurring in the ammonia and hydrogen production and is reported under CRF 2B. The emissions from energy use of natural gas in these industries is included in 1A2.	National Inventory Report, Chapter 3.2.3
Germany	The great majority of the coal, oil and gas that Germany uses is used for energy-related purposes. The remainder of the coal, oil and gas is used as feedstock for production processes. This consumption enters into the balance as "non-energy use" (NEU). In the German Energy Balance, this consumption is listed separately, in line 43. The chemical industry is the leading user of fossil fuels for non-energy-related purposes. It uses fossil fuels in steam crackers, in reforming, in synthetic-gas production and in the produciton of graphite electrodes. In crackers and reforming, the most important products resulting from such processes are ethylene, propylene, 1,3-butadiene, benzene, toluene and xylene; in production of synthetic gases, the most important such products are ammonia and methanol. Bitumen, lubricants and paraffin waxes are produced in refineries. Bitumen is used in a range of applications, including road surfaces and bitumen sheeting for roofs. Lubricants are used in road vehicles and machines (inter alia). Without suitable adjustments, the consumption figures listed in Energy Balance line 43 cannot be compared with the CO_2 and NMVOC emissions from use of fossil fuels, in non-energy-related uses, that are reported in the inventory under industrial processes. The reason is that for the industrial processes, only emissions from production or use of products are taken into account, while line 43 takes account of entire feedstocks, thereby including both product-specific emissions and the carbon quantities stored in products. The latter account for far and away the largest share of the feedstocks. Yet a more important difference is that import and export quantities are taken into account in calculation of emissions from use of products. In the interest of obtaining a complete balance, Table 477 (see below) also takes account of the fossil-fuel carbon quantities stored in products. The correlation between material-related applications and products and the various relevant fuels is oriented to Table 1.3 from Volume 3 of the 2006 IPCC GL, and is based on information provided by relevant associations, producers and experts. In some cases, we had to make our own estimates of the applicable correlation with individual fuels. The produced quantities of the products listed in the table have been obtained from data reported by the Federal Statistical Office and by the Federal Office of Economics and Export Control (BAFA) and have been converted into CO_2 equivalents. For methanol, ethylene, propylene, 1,3-butadiene, benzene, toluene and xylene, the conversions were carried out via the molar masses of the relevant products and the molar mass of CO_2. The pertinent CO_2 equivalent emissions were split among the three feedstocks used in Germany (naphta, LP gas and other petroleum products), in keeping with (internal) data provided by associations. In the case of carbon black, the product is assumed to consist of pure carbon. That carbon was also converted into CO_2 equivalents. The production quantities for bitumen, lubricants and paraffin waxes were obtained from the Official Mineral Oil Statistics, and they are based on gross refinery production. The production quantities have been converted into CO_2 equivalents with the help of the following IPCC standard values (Table 1.2 and Table 1.4 from Vol. 2 of the 2006 IPCC GL). For the year 2014, the sum of the carbon from the pertinent emissions and of the carbon stored in products amounts to 106 % of the non-energy-related consumption given in line 43 of the Energy Balance. Consequently, the relevant material-related use can clearly be shown to include the quantities listed in the Energy Balance as non-energy-related consumption. No gaps in determination of non-energy-related CO_2 emissions are apparent in the inventory.	National Inventory Report, Chapter 18.8

Greece	Non-energy fuel use concerns the consumption of fuels as raw materials (e.g. in chemical industry, metal production) for the production of other products, or the use of fuels for non-energy purposes (e.g. bitumen). Part of the carbon content of fuels is stored in final products and is not oxidized into carbon dioxide for a certain time period. The fraction of the carbon contained in final products and the time period for which carbon is stored in them, depend on the type of fuel used and of the products produced. The oxidation of the carbon stored in final products occurs either during the use of the product (e.g. solvents) or during their decomposition (e.g. through combustion). It should be noted that emissions during production processes (e.g. ammonia and hydrogen production) should be reported under the sector of IPPU, while emissions from burning of products should be reported under the waste sector or energy sector (as long as energy exploitation takes place).Non-energy use of fuels in Greece refers to the consumption of: • naphtha, natural gas, and lignite (for the period 1990 – 1991) in chemical industry, • petroleum coke in the production of non-ferrous metals, • lubricants in transport (including off-road transportation), • bitumen in construction and • other petroleum products in the industrial and residential sectors The calculation of carbon dioxide emissions from non-energy use of fuels is based on the relevant consumption by fuel type (Table 3.9) and the fraction of the carbon stored by fuel type (Table 3.10). Data on the non-energy consumption of fuels derive from the national energy balance. However, plant specific data derived from verified ETS reports and information provided by specific greek industries resulted to the improvement of reallocation of non-energy use fuels from the energy to the industrial processes sector: • The non-energy use of natural gas for ammonia production has been reallocated to industrial processes sector since the 2012 submission, by using data from ETS reports and plant specific information. Non-energy use of lignite is accounted in the industrial processes sector and refers only to ammonia production (in one installation for 1990 and 1991) and as a result the fraction of carbon stored is equal to 0. The operation of this installation ended at 1998 while itdid not produce ammonia for the period 1992 – 1998. • The non-energy use of natural gas for hydrogen production is included in the industrial processes sector, by using data from ETS reports and information from Public Gas Corporation. The associated CO_2 emissions from hydrogen production from liquid fuels are reported under the subcategory 1.A.1.b, because while disaggregated data on the amount of liquid fuels used for hydrogen production are available from the EU ETS reports for the period 2005–2016, for the period 1990–2004 the amount of liquid fuel used for hydrogen production is reported together with the amount of fuel combusted in the refineries as provided in the national energy balance. It is therefore not possible to report these emissions separately for the period 1990–2004. • CO_2 emissions from the use of fuels as reduction agents in the iron and steel industry, are only reported under the industrial processes sector. • Solid fuels consumption in the ferroalloys production industry is included (in the national energy balance) in the solid fuels consumption of the non-ferrous metals sector. However, by using data from ETS reports and plant specific information, emissions from solid fuels for ferroalloys production are reallocated to the industrial processes sector, as from 2010 submission. • The non-energy use of petroleum coke (see Table 3.9) refers exclusively to the primary aluminium production. Given that the relevant emissions are reported under the industrial processes sector, petroleum coke consumption is not taken into account in the energy sector. Since this submission, following 2006 IPCC GLs, all fuels with non-energy use were reallocated to the IPPU sector (e.g. other petroleum products, lubricants, etc). On the basis of the abovementioned clarifications, the possibility to double-count or underestimate CO_2 emissions from the non-energy use of fuels is minor.	National Inventory Report, Chapter 3.2.3
Hungary	All the fuels regarded as NEU in IEA Energy Statistics are allocated into IPPU sectors and also some amount from the quantities regarded as energy use in order to follow the suggestion of IPCC 2006. This is the case by Natural Gas use in sector 2B1 – Ammonia, Naphtha use in 2.B.8 Petrochemical and the Coke used in 2C1 – Iron and steel. Therefore, the Fuel quantities for NEU reported in CRF Table 1.A.(d) and QA/QC check Table for NEU included in Annex of the NIR are higher than the actual quantity reported in IEA Energy Statistics. However, the differences are well-known and documented. Carbon content of all fuels which are allocated under the Industrial Processes sector is taken as stored carbon in the 1.AD sector (and in the reference approach), however the calculation of emission in the IPPU sector is not based on a default carbon-stored approach, but usually plant-specific (EU ETS) data, except for Lubricant and Paraffin wax use source categories.	National Inventory Report, Chapter 3.2.3
Ireland	This category includes fossil fuels used for non-energy purposes; without the combustion and oxidation process. There are a number of fuel types applicable in Ireland: • Lubricants – IPCC default oxidation value of 0.2 is used, see category 2.D.1; • Bitumen – IPCC default value of 1.0 is used for the proportion of carbon stored; • Paraffin wax – IPCC oxidation value of 0.9 is used for candles and 0.2 for all other paraffin wax, see category 2.D.2; • White spirit – IPCC default value of 1.0 is used for the proportion of carbon stored; • Natural Gas – a significant amount of natural gas feedstock was used in ammonia production from 1990-2003. Emissions from the non-energy use of fossil fuels have been included in the Industrial Processes and Product Use sector, CRF Category 2.D (Chapter 4 of this report).	National Inventory Report, Chapter 3.2.3

Italy	The quantities of fuels stored in products in the petrochemical plants are calculated on the basis of information contained in a detailed yearly report, the petrochemical bulletin, by Ministry of Economic development (MSE, several years [b]). The report elaborates results from a detailed questionnaire that all operators in Italy fill out monthly. The data are more detailed than those normally available by international statistics and refer to: • input to plants; • quantities of fuels returned to the market; • fuels used internally for combustion; • quantities stored in products. National petrochemical balance includes information on petrochemical input entering the process and used for the production of petrochemical products, and petrochemical plants output, returns to the market, losses and internal consumption. Due to chemical reactions in the petrochemical transformation process, the output quantity of some fuels could be greater than the input quantity; in particular it occurs for light products as LPG, gasoline and refinery gas, and for fuel oil. Therefore for these fuels it is possible to have negative values of the balance. For this matter, with the aim to allow the reporting on CRF tables, these fuels have been added to naphta. The amount of fuels recovered from the petrochemical processes and returning on the market are considered as an output, because consumed for transportation or in the industrial sectors, and no carbon is stored. In Table 3.36 and Table 3.37 the overall results and details by product are reported respectively. In Table 3.36 the breakdown of total petrochemical process is reported; the percentages referring to the "net" input are calculated on the basis of the total input subtracting the quantity of fuels as gasoil, LPG, fuel oil and gasoline which return on the market because produced from the petrochemical processes. In Table 3.37 the input to the petrochemical processes in petrochemical plants and the relevant losses, internal consumption and return to the market are reported, at fuel level, allowing the calculation of the quantity stored in products, subtracting the output (returns to the market, losses and internal consumption) from the input (petrochemical input). Carbon stored, for all the fuels, is therefore calculated from the amounts of fuels stored (in tonnes) multiplied by the relevant emission factors (tC/t) reported in Table 3.37. Non-energy products amount stored from refineries, and other manufacturers, are reported in the National Energy Balance (MSE, several years [a]) and the carbon stored is estimated with emission factors reported in Table 3.38. For lubricants the net carbon stored results from the difference between the amount of lubricants and the amount of recovered lubricant oils. The energy content has been calculated on the basis of the IPCC default values. Minor differences in the overall energy content of these products occur if the calculation is based on national parameters instead of IPCC default values. In the CRF tables the fuel input amount is reported so that the fractions of carbon stored could be derived. As these fractions are derived from actual measurements they do not correspond to any default values and may vary over time. At national level, this methodology seems the most precise according to the available data. The European Project "Non Energy use-CO_2 emissions" ENV4-CT98-0776 has analysed our methodology performing a mass balance between input fuels and output products in a sample year. The results of the project confirm the reliability of the reported data (Patel and Tosato, 1997).	National Inventory Report, Chapter 3.8
Latvia	Under this category consumption of different types of fuels used as feedstock is reported. Emissions from these fuels are reported as "CO_2 not emitted" because it is assumed that in CO_2 emissions is captured and not emitted to the air. Consumption of Bitumen, Lubricants, Coke, White spirits and Paraffin wax is reported in 1.D tables for all years in time series 1990–2016. Carbon emission factors used in 2006 IPCC Guidelines were taken for all fuel types – Bitumen (22 t/TJ), Lubricants (20 t/TJ), Coke (29.2 t/TJ), White spirits (20 t/TJ) and Paraffin waxes (20t/TJ). Activity data prepared by CSB and available on CSB on-line database were used (Table 3.14). Constant increase of bitumen use since 2004 until 2008 is explained with development of construction sector and availability of financial resources from European Union (Latvia is a member of European Union since 2004) for building and improvement of transportation infrastructure. However, during the economic crisis the funding reduced and the amounts of bitumen used decreased in 2008-2010. After 2010 increase of bitumen use can be seen, it can be explained with increased financial resource to road paving. Lubricants are mainly used in transport sector and IPPU. Coke is used as ingredient in metallurgy to produce higher quality steel. Evident decrease in coke use can be explained with changes in metallurgy. Financial crisis in 2010 and bankruptcy of "Liepājas metalurgs" is the reason of reduced metal production and use of coke. Therefore in last three years there has been no usage of coke. Paraffin waxes and white spirits mainly are used as feedstocks in chemical industry and wood processing..	National Inventory Report, Chapter 3.2.3
Lithuania	Feedstocks and non-energy use of fuel are included in national Energy balances (see Annex III). Use of fuels for feedstocks and non-energy use is dominated by natural gas (Figure 3-14). In 2016, natural gas amounted about 80.4% in the structure of feedstocks and non-energy use of fuels. The natural gas is used for ammonia, calcium ammonium nitrate, organic products and nitric acid production in the JSC Achema. JSC Achema is a leading manufacturer of nitrogen fertilizers and chemical products in Lithuania and the Baltic states. The previous ERT recommended to cross-check the data reported as non-energy use in the energy sector and the data reported under the industrial processes as the calculated CO_2 non-emitted from the use of natural gas for non-energy purpose differs from CO_2 emissions from ammonia production. A cross-check between the natural gas data used in industrial processes and the data reported as non-energy use in the energy sector showed that difference occur due to the use of different calorific values for the natural gas. In the industrial processes sector a specific calorific value is based on average annual lower calorific value of natural gas which is calculated on the basis of reports from the natural gas supplier AB Lietuvos dujos, which measure the calorific value twice a month. In the energy sector calculations are based on the data provided by the Lithuanian Statistics where fuel consumption is calculated in terms of tonnes of oil equivalent and terajoules using the net calorific value. The data reported as non-energy use in the energy sector and the data reported under the industrial processes also differs because the data reported as non-energy use in the energy sector accounts not only feedstocks for ammonia production, but also feedstocks for calcium ammonium nitrate, organic products and nitric acid production. It is necessary to mentioned that JSC Achema revised data for non-energy use for	National Inventory Report, Chapter 3.2.3

	2005-2014 in 2016, therefore in this submission revised data are reported in CRF 1.AD Feedstocks, reductants and other non-energy use of fuels. The amounts of excluded carbon were calculated in accordance with the methodology provided in 2006 IPCC Guidelines Volume 2 (page 6.7). The amounts of excluded carbon are reported in CRF 1.AD Feedstocks, reductants and other non-energy use of fuels and linked to the CRF 1.AB Fuel Combustion - Reference Approach as excluded carbon.	
Luxembourg	Non-energy use of fuels is considered in the national energy balance. Below explanations for the reported non-energy use is provided together with information on where CO_2 emissions due to the manufacture, use and disposal of carbon containing products are considered. For the fraction of carbon stored, the IPCC default values are applied. Lubricants Manufacturing: manufacturing of lubricants does not occur in Luxembourg. Use: Lubricants are either used in road transportation (motor oil and greases) or in the manufacturing and construction industry (mainly greases). Emissions from lubricants use are reported under category 2D1 – Lubricant Use. Please refer to section 4.5.1 for more details on the estimation of emissions from lubricant use. Disposal: incineration of lubricants (waste oil) does not occur in Luxembourg. Waste oil is either recycled or exported. Bitumen Manufacturing: manufacturing of bitumen does not occur in Luxembourg. Use: by default the carbon contained in bitumen is considered to be entirely stored in the product, i.e. asphalt for road paving. Disposal: CO_2 emissions from the disposal of bitumen are assumed to be negligible. Recycling is not considered. Coke oven coke Manufacturing: not occurring. All coke used in the iron and steel industry is imported. Use: CO_2 emissions from coke used in iron and steel industry are reported under 2.C.1 – Iron and Steel Production. Disposal: not applicable. Other bituminous coal Manufacturing: Manufacturing of electrodes from anthracite used in the electric arc furnaces does not occur in Luxembourg. Use: Emissions from the use of electrodes in the iron and steel production are considered in category 2.C.1 – Iron and steel production. Disposal: not applicable. Other oil products Manufacturing: not occurring. All products such as white spirits, etc. are imported. Use: CO_2 emissions from solvent and other products use are considered in category 2.D.3. - Nonenergy products from fuels and solvent use – Other – Solvent use. Disposal: emissions from the disposal of plastics in landfills are considered in 6.A and emissions from incineration, with energy recovery, of waste plastics are considered in 1 A 1 a.	National Inventory Report, Chapter 3.2.3
Malta	Activity data on feedstocks and non-energy use of fuels has been obtained from the National Statistics Office. The non-energy fuels used locally are bitumen and lubricant, which are used for asphalting and to minimise friction between moving surfaces, respectively. Emissions from Lube oil used in 2-stroke engines are estimated using the COPERT 5 model and are included under sub-category 1A3b Road Transportation.	National Inventory Report, Chapter 3.2.3
Netherlands	Table 3.2 shows that a large share of the gross national consumption of petroleum products was used in non-energy applications. These fuels were mainly used as feedstock in the petro-chemical industry (naphtha) and in products in many applications (bitumen, lubricants, etc.). Also, a fraction of the gross national consumption of natural gas (mainly in ammonia production) and coal (mainly in iron and steel production) was used in non-energy applications and hence not directly oxidized. In many cases, these products are finally oxidized in waste incinerators or during use (e.g. lubricants in two-stroke engines). In the RA, these product flows are excluded from the calculation of CO_2 emissions.	National Inventory Report, Chapter 3.2.3
Poland	As the use of energy products for non-energy purposes can lead to emissions, Poland has calculated emissions from lubricant and paraffin waxes use and report them under category 2D Non-energy products from fuels and solvent use.For more description see chapter 4.5.	National Inventory Report, Chapter 3.2.3

Portugal	Emissions of greenhouse gas emissions from feedstock use are only clearly accounted in the inventory in the following situations: - emission of CO_2 resulting from use of feedstock sub-products as energy sources. That is the case of emissions from consumption of fuel gas in refinery and petrochemical industry; - emission of CO_2 liberated as sub-product in production processes such as ammonia production; - emission of NMVOC from fossil fuel origin, and occurring from solvent use and evaporation. Although in this case it is not possible to establish which part results from feedstock consumption in Portugal in the energy balance; However, some potential emissions are not estimated or are only partly estimated. Those that are estimated in the reference approach but not in sectoral approach are: - emissions from mineral oil use as lubricants; - emissions from wear of bitumen in roads.	National Inventory Report, Chapter 3.6.5
Romania	Non-energy use of fuels is reported in the Energy balance for the following fuels on the entire time-series: Lubricants; Bitumen; Naphtha; LPG; Refinery gas; Motor Gasoline; Kerosene Type Jet Fuel; Other Kerosene; Gas-Diesel Oil; Petroleum Coke; Residual Fuel Oil; Natural Gas as Feedstock; Other Products; Paraffin waxes; White spirit; Lignite; Brown Coal; Coal Oil and Tars (from coking coal); Other Bituminous Coal. For the liquid fuels reported on the EU-ETS, the national parameter of the NCVs were determined and used to calculate the non-energy use of the fuels: annualy for the EU-ETS period (2007-2012 years) and average of the EU-ETS period for the rest of the back time series; it is the case of the following fuels: Transport Diesel, Refinery Gas, Petroleum Coke, Residual Fuel Oil, Heating and Other Gasoil. Country specific values NCVs and CO_2 EFs have determined and used for 2015 and 2016 years. The following type of fuels have been added to the Table1.A(d), "Feedstocks, reductants and other non-energy use of fuels - Other fuels" category: Refinery gas, Paraffin waxes, White spirit. According to the IPCC 2006GL provisions, Volume 3, Chapter 5: Non-Energy Products from Fuels and Solvent Use, the following methodology to report in the CRF Table 1.A(d), Feedstocks, reductants and other non-energy use of fuels, was used: • Bitumen: the carbon is reported as being full stored in the final product; • Lubricants, Naphta, Refinery gas, Other kerosene, Gas Diesel-Oil, Petroleum Coke, Residual Fuel Oil, Other products, White spirit: the carbon was presumed that is fully emitted and not stored, having the full oxidation during use; • Paraffin Waxes: the fraction of carbon stored is 0.8, the rest of 0.2 being emitted. The non-energy use of fuels is an average of 11% from the total apparent energy consumption during the period 1999-2008, and arround 15% for the rest of the years. This could be in tight relation with the developing of the industry after 2000 until the economic crisis to have effects on the industry branches. In 2015 the share of the non-energy use of the fuels in total consumption is about 6%. In 2016 the share of the non-energy use of the fuels in total consumption is about 7%. The most significant fuels used as feedstock are natural gas, bitumen, naphtha and lubricants. Also, the Coke_Oven_Coke used as reduction agent in Blast Furnace, the associated emissions being accounted in Industrial Processes sector, represents an important non-energy use quantity. For coal oil and tars the assumption suggested in the methodology (5.91 % from the coking coal consumption is assumed to be stored in products) was applied.	National Inventory Report, Chapter 3.2.3
Slovakia	Using the IPCC 2006 Guidelines, the quantity of carbon excluded from reference approach (carbon used for ammonia production, petrochemicals production, carbide production, hydrogen production, iron and steel production, ferroalloys production, aluminium production as well as non-energy using of lubricants) was estimated. Total carbon excluded from reference approach was 1 974.5 Gg in 2016, which represents 7 239.9 Gg of CO_2. The emissions from the carbon excluded are reported in respective categories in the IPPU sector. The major share of carbon excluded represents the carbon from coking coal, both in fuel consumption and in amount of carbon (52.1% and 51.8%, respectively) The other significant source of carbon excluded is using of natural gas (21.8% in fuel consumption and 17.8% in quantity of carbon). Details on the share in fuel units and carbon units are presented on the Figures 3.33 and 3.34. The CO_2 emissions excluded from the RA are presented in Figure 3.35 for the whole time series 1990 – 2016. Liquid fuels (natural gas liquids, naphtha, and refinery feedstocks), solid fuels (coking coal, other bituminous coal) and gaseous fuels (natural gas) are used as feedstock in Slovakia. Lubricants and bitumen (liquid fuels) are used for non-energy purposes. The respective amounts of mentioned fuels are allocated in the IPPU sector and emissions are included there. The allocation of the fuels excluded from the reference approach and included in the IPPU sector is presented in the Table 3.66 and 3.67. The plant-specific (where available) and country-specific NCVs and EFs are used for estimation the volume of carbon excluded and respective CO_2 emissions excluded from the reference approach balance. The following fuels were balanced as feedstocks and non-energy use: natural gas, natural gas liquids, naphtha, lubricants, refinery feedstocks, coking coal, other bituminous coal. The quantities of the fuels and carbon used for non-energy purposes were provided directly by the plant operators or by the Statistical Office of the Slovak Republic.	National Inventory Report, Chapter 3.4

<table>
<tr><td>Slovenia</td><td>
The biggest fraction of non-energy usage of fuels was the consumption of natural gas for the production of methanol, amounting to 89,475 Sm3 of natural gas in 2010, when this production stopped, and there has been no methanol production in Slovenia since 2011. Natural gas was entirely used as the row material for transformation into methanol. In every cycle only a fifth of it is transformed to the product, while the remaining natural gas is returned into the process. Stored CO_2 has been calculated on the basis of the formula from IPCC guidelines. We have assumed that all methane used for methanol production is stored in the product or in CO in emitted gas. This fact was confirmed also by expert from the company Nafta-Petrochem. The remaining amount of non-energy use of natural gas is used in the chemical industry also as a row material for production of organic and inorganic chemicals and plastics.
According to the Statistical data all lubricants in Slovenia have been used for non-energy purpose only. Data about different types of use are not available. Likely, the largest applications for lubricants are in the form of motor oil. After the end of use, the lubricants which have been used in the engines are collected and mostly used as a fuel. In the line with the IPCC methodology emissions from lubricants used in the 2-stroke engines are reported in energy sector under road transport, while other emissions from lubricants are reported in the IPPU sector. The remaining amount of lubricants which is not combusted or oxidised during use is collected as waste oil.
Slovenia has been adhering to the basic system of collection, recovery and disposal of waste oil since 1998. Recovery is the preferred choice, if technically feasible and if its cost is not unreasonably higher than the cost of disposal One of the forms of recovery is the utilisation of waste oils for energy – co-incineration in accordance with recovery procedure R1. Records by the SEA show that most waste oils have been used for this purpose. The only evidence of such a use is in the cement production. Emissions are already included in the inventory and are reported in the CRF tables in “1.A.2.g.viii Manufacturing industry and construction/Other industries under other fossil fuels”.
A small portion of collected waste oils has also been incinerated (procedure R9) or reformed and then reused (procedure D10). We reported these emissions in waste sector under waste incineration in submission 2010 for the first time. No other use of lubricants as a fuel has been recorded in Slovenia until now.
The data on import and export as well as data from waste oil combusted in the industry have been obtained from SORS while the data on incineration of waste oils are from SEA.
Stored CO_2 has been calculated on the basis of the formula 6.4 from 2006, IPCC guidelines, Vol. 2, Ch.6 Reference Approach.
Other fuels
Coke and petroleum coke, used in industry as reduction agent or feedstock, have been subtracted from energy sector and emissions from these fuels are presented in industrial processes sector.
Before 1997, amount of coke, used for production of iron and steel, ferroalloys and carbide was reported as fuel consumption in relevant sectors. After 1997, this fuel started to be collected separately, but it took a while that all non-energy used fuel was reported correctly. Energy and non-energy use of fuel in industry have been presented separately in statistical data since 2000.
To avoid double counting we have subtracted all coke used in iron and steel, ferroalloys and carbide production from energy sector except coke in iron production in the base year 1986. In that time, pig iron was still produced and disaggregated into the consumption of fuel as an additive. Thus the consumption of fuel as an energy product was impossible. For consumption of coke, the decision was taken to attribute all coke, which is consumed in the production of iron and steel in this year, to the energy sector as fuel consumption and no emissions from coke used in iron and steel production are presented in industrial processes.
There are also other uses of fuel in chemical processes not emitting any GHGs, therefore no explanation is included in the CRF tables. In 2016, a small amount of fuel oil, LPG and white spirit was used, mostly for production of lacquers, paintings and other coatings. The same is valid also for bitumen which is used for road paving and for production of roofing material and during this use no GHG emissions occur.
</td><td>National Inventory Report, Chapter 3.2.3</td></tr>
<tr><td>Spain</td><td>
The consumption of fuel for non-energy use is accounted for in the energy balance. The quantities of each fuel type are included in the reference approach. For each fuel type a split into two parts is given: a) the part that stays in the product and b) the part that is set free and causes the corresponding CO_2 emissions.
Main sources are information directly from the plant or industry association about the use of fossil fuels, such as non-energy inputs following the sector/process to determine types of fuels, determined types of fuels from the quantity consumed for this purpose as retention carbon products, such as CO_2 emissions versus its complementing and replacing the figures reported in the above mentioned sources . Following sectors / processes - in most cases on individual plant level - are investigated: i) sodium carbonate; ii) calcium carbide and silicon ; iii) silicon ; iv) ferroalloys (ferrosilicon, ferromanganese and silicon manganese); v) ammonia ; vi) glass; vii) electrical steel mills ; viii) aluminum (anode manufacture); ix) hydrogen in the refining industry emplaced x) refinery plants. The exploitation of this information has led to a revision in the inventory figures for natural gas, petroleum coke, coal coke and coal (anthracite) and other fuels whose registered consumption for non-energy use is minor , such as coking coal , diesel , LPG, fuel oil, gas and refinery steel or wood.
</td><td>National Inventory Report, Chapter 3.1.4 translation</td></tr>
<tr><td>Sweden</td><td>
Activity data on feedstocks and non-energy use of fuels is collected from the environmental reports and the EU ETS statistics. Sweden uses the same data for CRF table 1.A.d, non-energy use (NEU) of fuels as for feedstocks and non-energy uses in the IPPPU sector (CRF 2) and Fugitive sector (CRF 1.B).
Net calorific values and carbon emission factors are the same as in CRF 1.A.b. The parameter “fraction of carbon stored” has been set to 1.00 for all fuels, which is in line with the 2006 IPCC Guidelines. Emissions from use of fuels reported in CRF 1.B or CRF 2 is reported as “CO_2 emissions from the NEU reported in the inventory” in the CRF-tables.
</td><td>National Inventory Report, Chapter 3.2.3</td></tr>
</table>

United Kingdom	The methodology for estimating emissions from fuels used for non-energy purposes is set out in the relevant sections of this NIR. A summary of the method, including all non-energy uses is included in **Annex 3**. The UK energy statistics (DUKES, 2016) contain an allocation for non-energy use for each fuel in the commodity balance tables. The UK inventory estimates emissions from fuels, including emissions arising from non-energy uses. In some cases, the inventory estimate for non-energy use does not agree with the DUKES allocation, and reallocations are made between energy and non-energy use for inventory reporting. In 2013, the Inventory Agency carried out research into non-energy uses of fuels; this was followed up by the DECC (now BEIS as of 2016) energy statistics team during 2014, and a series of revised allocations were introduced in the Digest of UK Energy Statistics 2014 (DECC, 2014), improving consistency between the inventory and the UK energy statistics. The activity data used for the national inventory and any deviations from the UK energy balance are presented and explained in **Annex 4**. The evidence that the Inventory Agency uses to make estimates for NEU includes: • annual reporting by plant operators (e.g. EU ETS returns include data on the use of process off-gases in the chemical and petrochemical production sector); • periodic surveys or research by trade associations / research organisations / environmental regulators, such as to assess the fate of coal tars and benzoles, petroleum coke or waste oils, or the impact of regulations on solvents, waste, product design and use; and, • information on the estimated split of stored: emitted carbon from feedstock chemicals in literature sources, including other country NIRs, where UK-specific information is not available. In many cases the energy statistics allocate fuels to non-energy use that are used in chemical and petrochemical production processes where either: • fossil carbon-containing off-gases are used for combustion in facility boilers; or • products containing the “stored” carbon are subsequently used / partly combusted / disposed and degraded with some proportion of the “stored carbon” in products ultimately emitted to atmosphere. In other instances, the allocation of fuels to “non-energy use” in the UK energy balance is contrary to other statistical evidence from industry or surveys that the Inventory Agency has access to in the compilation of the national inventory. For example, in the UK the allocation of petroleum coke to domestic and industrial combustion sources in the energy balance are missing for many years in the time series, whereas evidence from environmental reporting and research indicates that several industries use petroleum coke directly as a fuel or process input (e.g. cement kilns, chemical manufacturing processes, domestic fuel manufacturers), and that petroleum coke is supplied as a fuel for the residential market..	National Inventory Report, Chapter 3.2.3

4 INDUSTRIAL PROCESSES AND PRODUCT USE (CRF SECTOR 2)

This chapter starts with an overview on emission trends in CRF Sector 2 Industrial processes and Product Use. This chapter comprises the categories formerly reported under CRF Sector 2 (Industrial Processes) and Sector 3 (Solvents), which are now split as follows:

- Mineral Industry (CRF Source Category 2.A)
- Chemical Industry (CRF Source Category 2.B)
- Metal Industry (CRF Source Category 2.C)
- Non-Energy Products from Fuels and Solvent Use (CRF Source Category 2.D)
- Electronics Industry (CRF Source Category 2.E)
- Product Uses As Substitutes for Ozone Depleting Substances (CRF Source Category 2.F)
- Other Product Manufacture and Use (CRF Source Category 2.G)
- Other (CRF Source Category 2.H)

For each Union key category, overview tables are presented including the Member States' contributions to the key categories in terms of level and trend, and information on methodologies and emission factors.

4.1 Overview of sector

CRF Sector 2 Industrial Processes and Product Use is the third largest sector contributing 9 % to total EU-KP GHG (without LULUCF) emissions in 2019. The most important GHGs from this sector are CO_2 (6 % of total GHG emissions), HFCs (2 %) and N_2O (0.3 %). According to the IPCC 2006 guidelines, which have been applicable since the inventory compilation for 2014 (data for 2013), this sector now also entails the use of solvents and other product use. The use of solvents manufactured using fossil fuels as feedstocks can lead to evaporative emissions of various non-methane volatile organic compounds (NMVOC) which are subsequently further oxidised in the atmosphere.

The emissions from the sector Industrial Processes and Product Use decreased by 30 % from 530 Mt in 1990 to 370 Mt in 2019 (Figure 4.1). In 2019, the emissions decreased by 3 % compared to 2019. Factors for declining emissions in the early 1990s were lower economic activity in several sectors. The decrease in 2009 was driven by reductions in cement production and a significant drop in the iron and steel production as a consequence of the economic crisis. In 2010 emissions increased again, *inter alia* due to the recovery of steel production.

The key categories in this sector are:

- 2.A.1 Cement Production (CO_2)
- 2.A.2 Lime Production (CO_2)
- 2.A.4 Other Process Uses of Carbonates (CO_2)
- 2.B.1 Ammonia Production (CO_2)
- 2.B.2 Nitric Acid Production (N_2O)
- 2.B.3 Adipic Acid Production (N_2O)
- 2.B.8 Petrochemical and Carbon Black Production (CO_2)
- 2.B.9 Fluorochemical Production (HFCs)
- 2.B.9 Fluorochemical Production (Unspecified mix of HFCs and PFCs)

- 2.B.10 Other chemical industry (CO_2)
- 2.C.1 Iron and Steel Production (CO_2)
- 2.C.3 Aluminium production (PFCs)
- 2.D.3 Other non energy products (CO_2)
- 2.F.1 Refrigeration and Air Conditioning Equipment (HFCs)
- 2.F.4 Aerosols/ Metered Dose Inhalers (HFCs)

Figure 4.1: CRF Sector 2 Industrial Processes and Product Use: EU-KP GHG emissions for 1990–2019 in CO_2 equivalents (Mt)

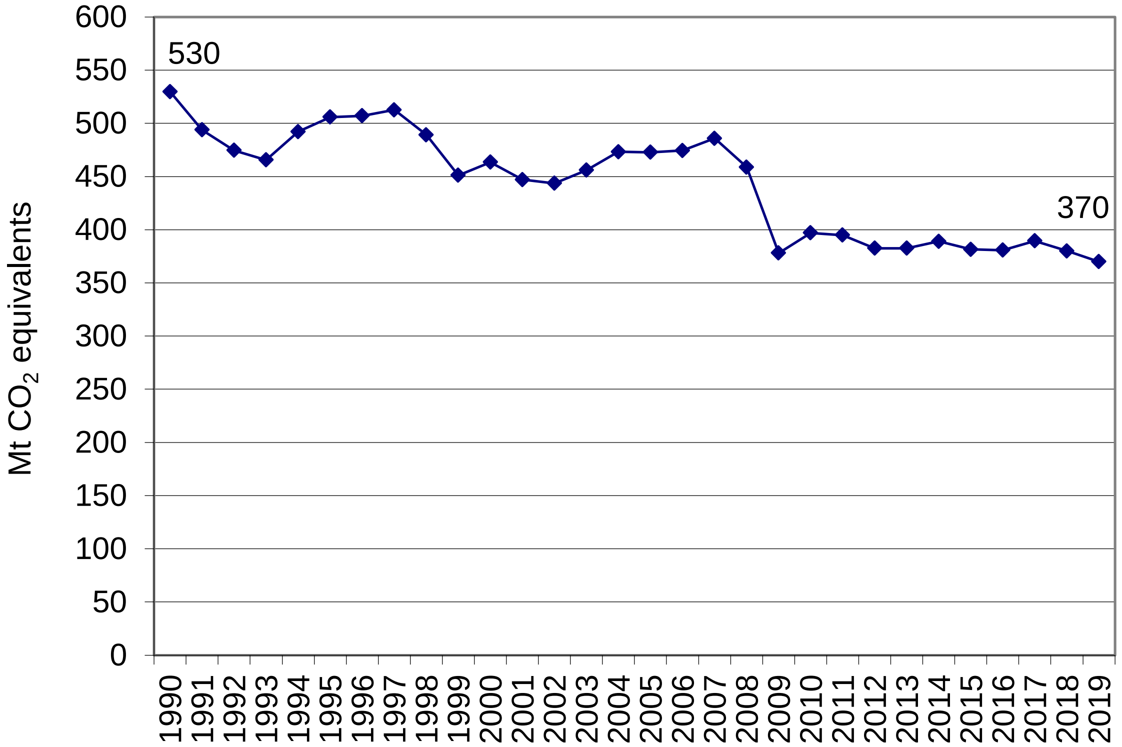
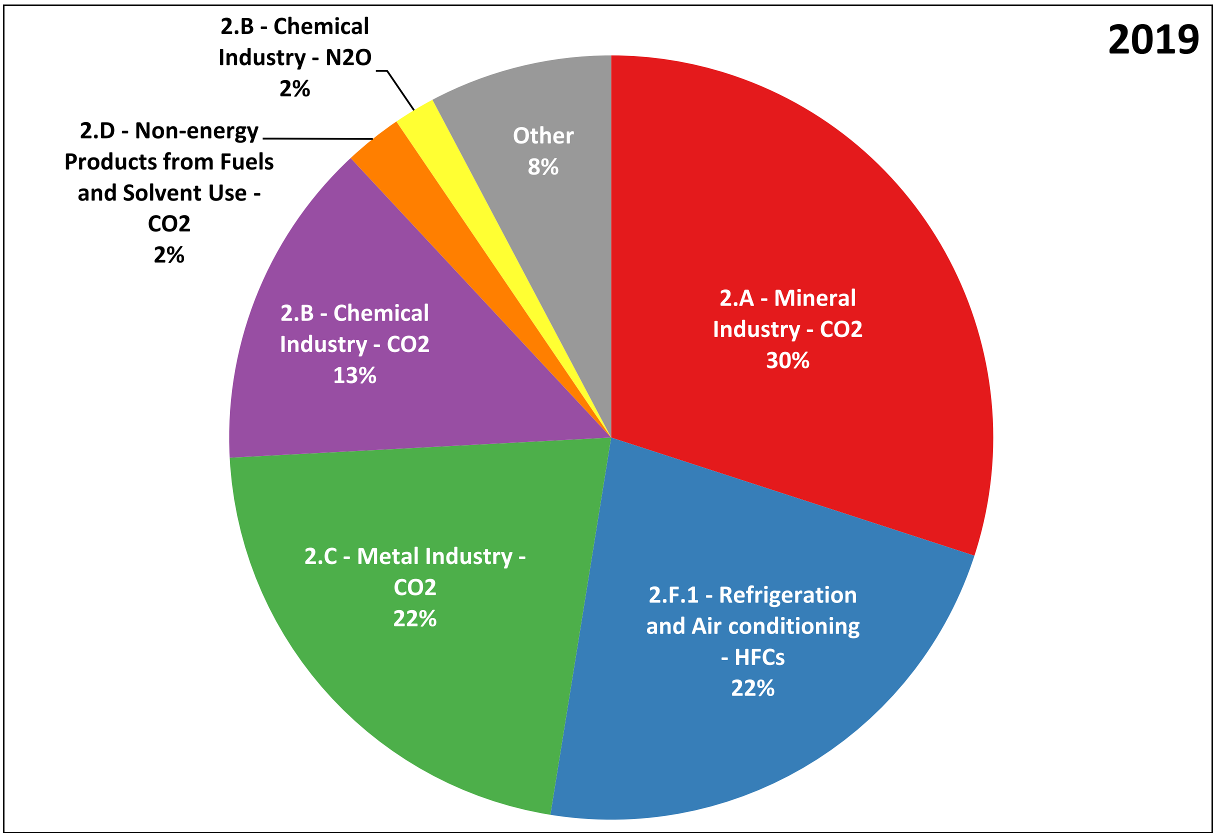
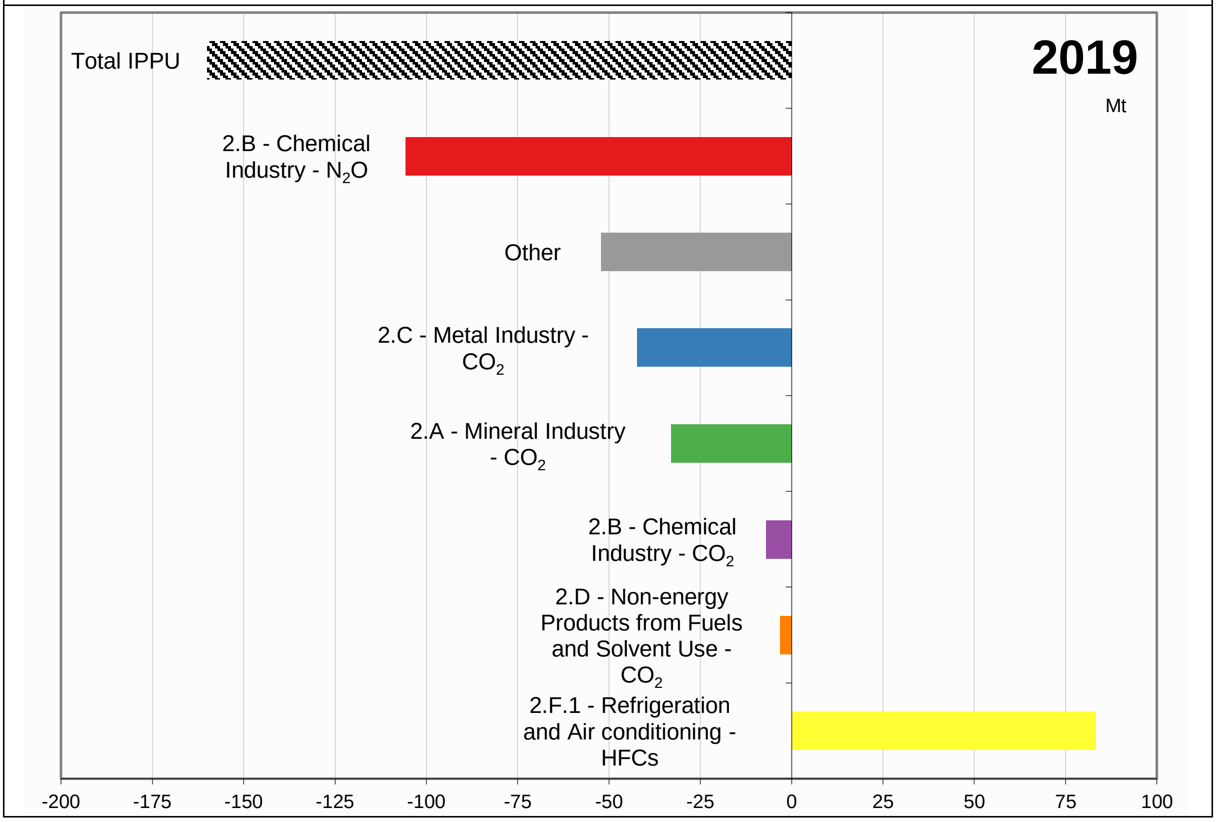


Figure 4.2: CRF Sector 2 Industrial processes and Product Use: Share of largest key categories in 2019 and absolute change of GHG emissions by large key categories 1990–2019 in CO_2 equivalents (Mt)





Note: Other is calculated by subtracting the presented categories from the sector total

4.2 Source categories and methodological issues

4.2.1 Mineral industry (CRF Source Category 2A)

The source category 2A Mineral industry includes three key categories:

Table 4.1: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 2A (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2019		1990	2019	
2.A.1 Cement Production (CO_2)	102698	77986	T	L	L	100%
2.A.2 Lime Production (CO_2)	25242	18729	0	L	L	99.98%
2.A.4 Other Process Uses of Carbonates (CO_2)	11834	9946	0	L	L	96.22%

This sector is dominated by cement production which contributes approx. 70% of mineral industry emissions. Cement production emissions occur during the production of clinker, an intermediate component in the cement manufacturing process. The source category 2A2 Lime production accounts for approx. 17% of the sector where CO_2 is emitted during the calcination of the calcium in limestone or dolomite for lime production. The source category 2A4 Other process uses of carbonates accounts for 9% of the sector and is composed of several sources with independent estimation methods. The remaining 4% of emissions is from 2A3 Glass production. All emissions from cement production are estimated using higher tier methods. The same is true for lime production, except for Cyprus, which uses a Tier 1 method for estimating its emissions from this category. Under category 2A4, all countries except Cyprus, Greece and Malta use higher tier methods.

Mineral industry emissions decreased during the 2009 economic crisis but remained mostly steady in recent years. Overall, these emissions have fallen by 23% since 1990 (Figure **4.3**). Seven countries (Croatia, Cyprus, Denmark, Ireland, Latvia, Poland and Sweden) have higher Mineral industry CO_2 emissions in 2019 compared to 1990 (Table 4.2).

Figure 4.3 2A Mineral industry CO_2 emissions

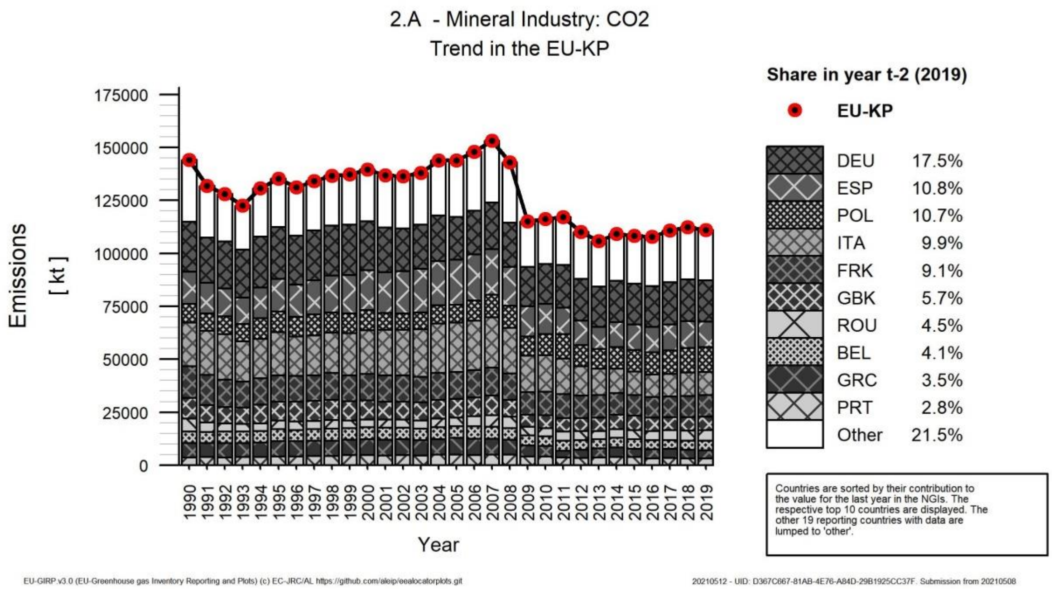


Table 4.2 2A Mineral industry: Member States total GHG and CO_2 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2019 (kt)
Austria	3 092	2 809	3 092	2 809
Belgium	5 319	4 550	5 319	4 550
Bulgaria	3 278	2 325	3 278	2 325
Croatia	1 303	1 325	1 303	1 325
Cyprus	717	814	717	814
Czechia	4 082	3 086	4 082	3 086
Denmark	1 082	1 250	1 082	1 250
Estonia	614	359	614	359
Finland	1 218	971	1 218	971
France	14 977	10 097	14 977	10 097
Germany	23 522	19 413	23 522	19 413
Greece	6 775	3 931	6 775	3 931
Hungary	2 890	1 466	2 890	1 466
Ireland	1 117	2 058	1 117	2 058
Italy	20 720	10 933	20 720	10 933
Latvia	537	571	537	571
Lithuania	2 130	602	2 130	602
Luxembourg	593	459	593	459
Malta	1	0	1	0
Netherlands	1 411	1 152	1 411	1 152
Poland	8 855	11 848	8 855	11 848
Portugal	3 696	3 115	3 696	3 115
Romania	6 083	4 956	6 083	4 956
Slovakia	2 714	2 285	2 714	2 285
Slovenia	694	566	694	566
Spain	15 120	11 974	15 120	11 974
Sweden	1 673	1 748	1 673	1 748
United Kingdom	9 778	6 320	9 778	6 320
EU-27+ISL	**143 994**	**110 985**	**143 994**	**110 985**
Iceland	52	1	52	1
United Kingdom (KP)	9 778	6 320	9 778	6 320
EU-KP	**144 046**	**110 986**	**144 046**	**110 986**

Abbreviations explained in the Chapter 'Units and abbreviations'.
For consistency with other sub-sectors this table shows both CO_2e and CO_2, however as there are no N_2O or CH_4 emissions for this category, the two sets of columns in this table show the same numbers.

Table 4.3 provides information on the countries' contribution to EU-KP recalculations in CO_2 from 2A Mineral industry for 1990 and 2018 as well as the explanations for recalculations provided by the countries.

Table 4.3 2A Mineral industry: Contribution of MS to EU-KP recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

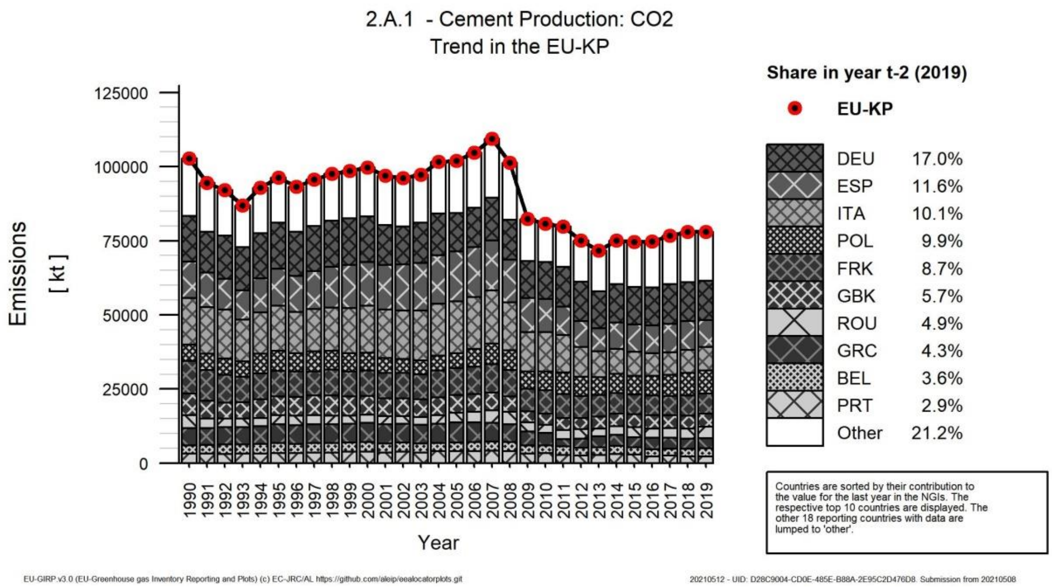
	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-0.9	-0.0	Previously, CO_2 emissions from urea used for denitrification had been reported under category 2.A.4.d alongside CO_2 emissions from limestone used for desulphurisation. The former are no longer reported under category 2.A.4.d, as they are reported under 2.B.1.
Belgium	-	-	-11	-0.2	Correction of emissions reported for 2018 in category 2A3.
Bulgaria	-	-	-	-	
Croatia	-3.9	-0.3	-6.4	-0.5	Emissions under category 2.A.4 were recalculated for the whole time series, based on research on soda ash used.
Cyprus	-	-	4.8	0.6	In category 2.A.1, bypass emissions had not been captured correctly for 2017 and 2018 and were now corrected.
Czechia	-	-	-6.6	-0.2	Updated activity data in 2.A.4.d.
Denmark	-	-	-2.3	-0.2	In category 2.A.4.b, an error was corrected, leading to lower emissions in 2018.
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	4.9	0.0	42	0.4	Update of activity data in categories 2A4a and 2A4b.
Germany	-	-	143	0.7	Update of activity data in category 2A3; update of emissions data in category 2A4b.
Greece	-	-	-0.3	-0.0	Update of activity data in category 2.A.1
Hungary	-	-	-	-	
Ireland	-	-	-	-	
Italy	-	-	0.0	0.0	Small difference due to rounding only.
Latvia	-	-	-0.5	-0.1	Update of activity data in category 2.A.1.
Lithuania	-	-	-0.0	-0.0	Small difference due to rounding only.
Luxembourg	-31	-4.9	-2.2	-0.5	Update of clinker conversion factor in category 2.A.1
Malta	-	-	-	-	
Netherlands	-	-	0.2	0.0	Correction of an error in the emission value under 2A2 for 2018.
Poland	-	-	-0.7	-0.0	Correction of activity data in category 2.A.3.
Portugal	-0.2	-0.0	4.0	0.1	Update of activity data in category 2.A.4.a.
Romania	-	-	-	-	
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	1.0	0.0	0.0	0.0	Update of activity data for 1990-2004 in category 2A2. Small difference in category 2A4 in 2018 due to rounding only.
Sweden	0.2	0.0	-0.4	-0.0	Update of CO_2 emissions reported from individual plants in category 2.A.2.
United Kingdom	19	0.2	45	0.7	Addition of emissions estimates for additives in category 2A3 throughout the time series; revision of ETS data in category 2A4 for 2018.
EU27+UK	**-10**	**-0.0**	**208**	**0.2**	
Iceland	-0.0	-0.0	-0.0	-0.0	Small difference due to rounding only.
United Kingdom (KP)	19	0.2	45	0.7	Addition of emissions estimates for additives in category 2A3 throughout the time series; revision of ETS data in category 2A4 for 2018.
EU-KP	**-10**	**-0.0**	**208**	**0.2**	

(*) contribution of the recalculation as percentage of the total emissions of category 2A for the respective year and MS

4.2.1.1 2A1 Cement production

CO_2 emissions from Cement production contributed 1.9% of total EU-KP (without LULUCF) emissions in 2019. In that year, emissions were almost at the same level as in 2018 and 24.1% below 1990 levels. This source is a key category of CO_2 emissions in terms of emissions level.

Figure 4.4 2A1 Cement production: EU-KP CO_2 emissions



Germany, Spain and Italy were the largest emitters accounting for respectively 17.0%, 11.6% and 10.1% of cement related emissions. (Figure 4.4 and Table 4.4). The three countries with the largest absolute growth (2018-2019) were Romania, Belgium and Italy. The three countries with the largest absolute reductions were Spain, Sweden and the Netherlands.

Table 4.4 2A1 Cement production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	2 033	1 827	1 771	2.3%	-263	-13%	-56	-3%	T3	PS
Belgium	2 824	2 534	2 819	3.6%	-4	0%	285	11%	T3	PS
Bulgaria	2 142	1 224	1 127	1.4%	-1 015	-47%	-96	-8%	T2	PS
Croatia	1 093	1 211	1 184	1.5%	91	8%	-27	-2%	T2,T3	PS
Cyprus	668	848	789	1.0%	122	18%	-59	-7%	CS	CS
Czechia	2 489	1 868	1 977	2.5%	-512	-21%	110	6%	T3	PS
Denmark	882	1 160	1 129	1.4%	247	28%	-31	-3%	T3	PS
Estonia	483	298	295	0.4%	-188	-39%	-2	-1%	T2	PS
Finland	729	602	583	0.7%	-146	-20%	-18	-3%	T3	PS
France	10 937	6 701	6 807	8.7%	-4 131	-38%	105	2%	T2,T3	CS,PS
Germany	15 297	13 228	13 287	17.0%	-2 011	-13%	59	0%	T2	CS
Greece	5 762	3 419	3 360	4.3%	-2 401	-42%	-59	-2%	CS	PS
Hungary	1 751	882	1 023	1.3%	-728	-42%	141	16%	T3	PS
Ireland	884	1 916	1 893	2.4%	1 009	114%	-23	-1%	T3	PS
Italy	15 846	7 757	7 912	10.1%	-7 934	-50%	155	2%	T2	CS,PS
Latvia	346	551	561	0.7%	216	62%	11	2%	T2	PS
Lithuania	1 668	511	578	0.7%	-1 090	-65%	67	13%	T2	PS
Luxembourg	539	369	395	0.5%	-145	-27%	25	7%	T2	CS,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	416	220	6	0.0%	-409	-98%	-214	-97%	T3	PS
Poland	5 453	7 655	7 692	9.9%	2 239	41%	37	0%	T2	CS
Portugal	3 176	2 251	2 225	2.9%	-951	-30%	-26	-1%	T3	OTH
Romania	4 445	3 505	3 828	4.9%	-617	-14%	323	9%	CS,T2	PS
Slovakia	1 464	1 347	1 404	1.8%	-60	-4%	58	4%	T2	PS
Slovenia	470	450	478	0.6%	7	2%	28	6%	T2	CS
Spain	12 279	9 667	9 064	11.6%	-3 215	-26%	-603	-6%	T2	CS
Sweden	1 272	1 607	1 349	1.7%	77	6%	-258	-16%	T3	PS
United Kingdom	7 295	4 364	4 448	5.7%	-2 847	-39%	85	2%	T3	CS
EU-27+UK	**102 647**	**77 972**	**77 986**	**100%**	**-24 660**	**-24%**	**14**	**0%**	**-**	**-**
Iceland	52	NO	NO	-	-52	-100%	-	-	NA	NA
United Kingdom (KP)	7 295	4 364	4 448	5.7%	-2 847	-39%	85	2%	T3	CS
EU-KP	**102 698**	**77 972**	**77 986**	**100%**	**-24 712**	**-24%**	**14**	**0%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.
The methods provided in this table are consistent with the information submitted by Members States in their national inventory submissions. Cyprus and Greece use a country-specific method and report 'CS' accordingly. The methods used by these countries correspond to methodological Tier 3 (T3).

Table 4.5 shows information on methods, activity data, and emission factors for CO_2 emissions from 2A1 Cement production for 1990 and 2019. All cement production emissions are estimated with higher Tier methods and most countries use plant-specific emission factors.

The implied emission factors per tonne of clinker produced in 2019 range from 0.49 t CO_2/t of clinker produced for Slovakia and Luxembourg to 0.59 t CO_2/t of clinker produced for Estonia. Countries use country-specific and plant-specific emission factors (typically based on raw meal carbon content characterization), they also provide data on clinker production which allows for the calculation of comparative IEFs. In 2019 the EU-KP IEF amounted to 0.53 t CO_2/t of clinker.

Table 4.5 2A1 Cement production: Information on methods applied and emission factors for CO_2 emissions

Member State	1990				2019				Method	Emission Factor Information
	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Clinker production	3 694	0.55	2 033	Clinker production	3 423	0.52	1 771	T3	PS
Belgium	Clinker production	5 292	0.53	2 824	Clinker production	5 038	0.56	2 819	T3	PS
Bulgaria	Clinker production	3 987	0.54	2 142	Clinker production	2 128	0.53	1 127	T2	PS
Croatia	Clinker production	2 062	0.53	1 093	Clinker production	2 272	0.52	1 184	T2,T3	PS
Cyprus	Clinker production	1 249	0.53	668	Clinker production	1 509	0.52	789	CS	CS
Czechia	Clinker production	4 726	0.53	2 489	Clinker production	3 722	0.53	1 977	T3	PS
Denmark	Clinker production	1 406	0.63	882	Clinker production	2 146	0.53	1 129	-	-
Estonia	Clinker production	790	0.61	483	Clinker production	504	0.59	295	T2	PS
Finland	Clinker production	1 470	0.50	729	Clinker production	1 142	0.51	583	T3	PS
France	Clinker production	20 854	0.52	10 937	Clinker production	13 005	0.52	6 807	T2,T3	CS,PS
Germany	Clinker production	28 863	0.53	15 297	Clinker production	25 069	0.53	13 287	T2	CS
Greece	Clinker production	10 645	0.54	5 762	Clinker production	6 429	0.52	3 360	CS	PS
Hungary	Clinker production	3 210	0.55	1 751	Clinker production	C	C	1 023	T3	PS
Ireland	Clinker production	1 610	0.55	884	Clinker production	3 462	0.55	1 893	T3	PS
Italy	Clinker production	29 786	0.53	15 846	Clinker production	15 119	0.52	7 912	T2	CS,PS
Latvia	Clinker production	669	0.52	346	Clinker production	1 091	0.51	561	T2	PS
Lithuania	Clinker production	3 058	0.55	1 668	Clinker production	1 074	0.54	578	T2	PS
Luxembourg	Clinker production	1 048	0.51	539	Clinker production	802	0.49	395	T2	CS,PS
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	Clinker production	770	0.54	416	Clinker production	13	0.50	6	T3	PS
Poland	Clinker production	10 309	0.53	5 453	Clinker production	14 178	0.54	7 692	T2	CS
Portugal	Clinker production	6 128	0.52	3 176	Clinker production	4 272	0.52	2 225	T3	OTH
Romania	Clinker production	8 379	0.53	4 445	Clinker production	7 299	0.52	3 828	CS,T2	PS
Slovakia	Clinker production	2 836	0.52	1 464	Clinker production	2 855	0.49	1 404	T2	PS
Slovenia	Clinker production	891	0.53	470	Clinker production	928	0.51	478	T2	CS
Spain	Clinker production	23 212	0.53	12 279	Clinker production	17 511	0.52	9 064	T2	CS
Sweden	Clinker production	2 348	0.54	1 272	Clinker production	2 539	0.53	1 349	T3	PS
United Kingdom	Clinker production	13 199	0.55	7 295	Clinker production	7 830	0.57	4 448	T3	CS
EU-27+UK		**NE**	**NE**	**102 647**	-	**147 293**	**0.53**	**77 986**	-	-
Iceland	Clinker production	495	0.10	52	Clinker production	NO	NO	NO	NA	NA
United Kingdom (KP)	Clinker production	13 199	0.55	7 295	Clinker production	7 830	0.57	4 448	T3	CS
EU-KP		**NE**	**NE**	**102 698**	-	**147 293**	**0.53**	**77 986**	-	-

Abbreviations are explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Some countries report activity data and IEF as confidential for this category. Values for the EU-27+UK and EU-KP have therefore been gap filled for 2019.
The methods used by Cyprus and Greece correspond to methodological Tier 3 (T3).

4.2.1.2 2A2 Lime production

CO_2 emissions from 2A2 Lime production account for 0.5% of total EU-KP (without LULUCF) emissions in 2019. Between 1990 and 2019, CO_2 emissions from this source decreased by 26%, and between 2018 and 2019, these emissions decreased by 4%. The largest decreases were -282kt in Germany and -166kt in Belgium. Increases occurred in four countries only, with the largest increase observed in Austria (Table 4.6).

Emissions from lime production typically show annual fluctuations of several percent; the largest decrease was observed between 2008 and 2009. Germany, France and Italy are the largest emitters contributing approx. 24.3%, 123% and 9.6% of the total respectively (Figure 4.5).

Figure 4.5 2A2 Lime production: EU-KP CO_2 emissions

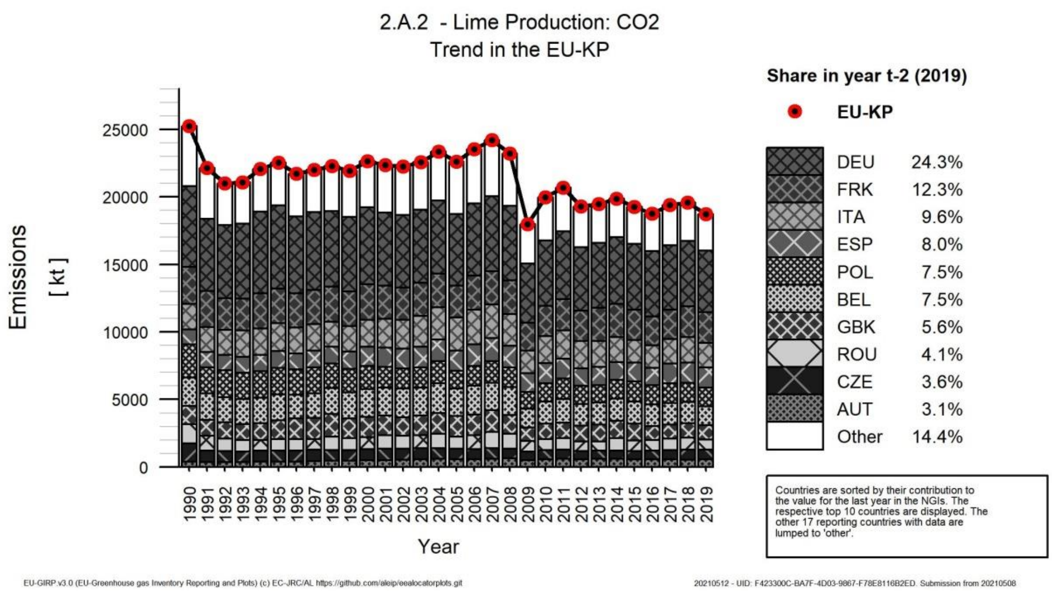


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Table 4.6 2A2 Lime production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	396	544	584	3.1%	188	47%	40	7%	T3	PS
Belgium	2 097	1 563	1 397	7.5%	-700	-33%	-166	-11%	T3	PS
Bulgaria	390	252	249	1.3%	-142	-36%	-3	-1%	T2	D
Croatia	157	89	93	0.5%	-64	-41%	4	4%	T3	PS
Cyprus	5	5	4	0.0%	-1	-26%	-1	-26%	T1	D
Czechia	1 337	749	681	3.6%	-656	-49%	-68	-9%	T3	PS
Denmark	105	37	34	0.2%	-72	-68%	-3	-8%	T2	CS,PS
Estonia	130	55	53	0.3%	-77	-59%	-2	-4%	T2	PS
Finland	401	309	262	1.4%	-139	-35%	-47	-15%	T3	CS
France	2 750	2 292	2 299	12.3%	-451	-16%	7	0%	T2,T3	CS,PS
Germany	5 987	4 832	4 549	24.3%	-1 437	-24%	-282	-6%	T2	D
Greece	404	210	199	1.1%	-205	-51%	-11	-5%	CS	PS
Hungary	614	173	145	0.8%	-469	-76%	-28	-16%	T3	PS
Ireland	214	177	164	0.9%	-50	-24%	-14	-8%	T3	PS
Italy	1 877	1 869	1 797	9.6%	-80	-4%	-71	-4%	T2	CS,PS
Latvia	122	NO	NO	-	-122	-100%	-	-	NA	NA
Lithuania	210	2	1	0.0%	-209	-99%	0	-9%	T2	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	1	NO	NO	-	-1	-100%	-	-	NA	NA
Netherlands	163	181	181	1.0%	18	11%	0	0%	CS	D
Poland	2 461	1 427	1 407	7.5%	-1 054	-43%	-19	-1%	T2	CS
Portugal	206	415	403	2.2%	197	96%	-11	-3%	T3	OTH
Romania	1 450	868	761	4.1%	-689	-48%	-107	-12%	T2	CS,D
Slovakia	795	523	489	2.6%	-306	-38%	-33	-6%	T2	PS
Slovenia	200	61	57	0.3%	-144	-72%	-4	-7%	T3	CS
Spain	1 109	1 485	1 494	8.0%	385	35%	9	1%	T3	PS
Sweden	332	388	373	2.0%	41	12%	-16	-4%	T3	D
United Kingdom	1 329	1 089	1 053	5.6%	-275	-21%	-35	-3%	T3	CS
EU-27+UK	**25 242**	**19 593**	**18 729**	**100%**	**-6 513**	**-26%**	**-864**	**-4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 329	1 089	1 053	5.6%	-275	-21%	-35	-3%	T3	CS
EU-KP	**25 242**	**19 593**	**18 729**	**100%**	**-6 513**	**-26%**	**-864**	**-4%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations are explained in the Chapter 'Units and abbreviations'.
The methods provided in this table are consistent with the information submitted by Members States in their national inventory submissions. Greece and the Netherlands use country-specific methods and report 'CS' accordingly. The

level of complexity of the methods applied by Greece and the Netherlands is Tier 3 (T3).
The table lists methods and emission factors used in the latest inventory year. As Latvia, Luxembourg, Malta and Iceland did not report emissions in that year, 'NA' is reported. Latvia and Malta reported emissions from lime production in 1990. The methodological tier used in that year is Tier 2 (T2) for Latvia and Tier 1 (T1) for Malta.

Table 4.7 shows information on the methods and emission factors for CO_2 emissions from 2A2 Lime production for 1990 and 2019. While production data is not necessarily explicitly used for emissions calculations (plant-specific emission factors are typically derived from raw meal carbon content characterization), countries that report emissions from lime production also report production activity data for calculating comparative IEFs. Lime production data is the combined figure for the three types of lime: quicklime (high-calcium lime), dolomitic lime and hydraulic lime production. The weighted average IEF in 2019 is 0.68 t CO_2/t of lime produced. The lime production activity data for each country reflect a mix of lime types, and so the implied emission factors per tonne of lime produced in 2018 range from 0.65 for France to 0.80 for Finland. Three countries report activity data other than lime production: The Netherlands report limestone used, and Portugal and the United Kingdom report carbonate used. Of the twenty-five countries which report lime production emissions, all but one use higher tier methodologies (Tier 2 or Tier 3) which accounts for more than 99.9% of emissions from this category.

Table 4.7 2A2 Lime production: Information on methods applied, activity data, emission factors for CO_2 emissions

Member State	1990				2019				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Lime Production	513	0.77	396	Lime Production	783	0.75	584	T3	PS
Belgium	Lime Production	2 660	0.79	2 097	Lime Production	1 804	0.77	1 397	T3	PS
Bulgaria	Lime Production	490	0.80	390	Lime Production	319	0.78	249	T2	D
Croatia	Lime Production	219	0.72	157	Lime Production	121	0.77	93	T3	PS
Cyprus	Lime Production	7	0.73	5	Lime Production	5	0.73	4	T1	D
Czechia	Lime Production	1 823	0.73	1 337	Lime Production	898	0.76	681	T3	PS
Denmark	Lime Production	134	0.79	105	Lime Production	43	0.79	34	T2	CS,PS
Estonia	Lime Production	185	0.70	130	Lime Production	73	0.72	53	T2	PS
Finland	Lime Production	488	0.82	401	Lime Production	327	0.80	262	T3	CS
France	Lime Production	3 589	0.77	2 750	Lime Production	3 514	0.65	2 299	T2,T3	CS,PS
Germany	Lime Production	7 927	0.76	5 987	Lime Production	6 061	0.75	4 549	T2	D
Greece	Lime Production	491	0.82	404	Lime Production	234	0.85	199	CS	PS
Hungary	Lime Production	831	0.74	614	Lime Production	192	0.75	145	T3	PS
Ireland	Lime Production	255	0.84	214	Lime Production	215	0.76	164	T3	PS
Italy	Lime Production	2 583	0.73	1 877	Lime Production	2 389	0.75	1 797	T2	CS,PS
Latvia	Lime Production	225	0.54	122	Lime Production	NO	NO,NA	NO	NA	NA
Lithuania	Lime Production	288	0.73	210	Lime Production	2	0.78	1	T2	D
Luxembourg	Lime Production	NO	NO	NO	Lime Production	NO	NO	NO	NA	NA
Malta	Lime Production	2	0.75	1	Lime Production	NO	NO	NO	NA	NA
Netherlands	Limestone used	372	0.44	163	Limestone used	414	0.44	181	CS	D
Poland	Lime Production	3 464	0.71	2 461	Lime Production	1 907	0.74	1 407	T2	CS
Portugal	Carbonate used	301	0.69	206	Carbonate used	523	0.78	403	T3	OTH
Romania	Lime Production	2 025	0.72	1 450	Lime Production	1 024	0.74	761	T2	CS,D
Slovakia	Lime Production	1 076	0.74	795	Lime Production	635	0.77	489	T2	PS
Slovenia	Lime Production	275	0.73	200	Lime Production	76	0.74	57	T3	CS
Spain	Lime Production	1 619	0.69	1 109	Lime Production	2 153	0.69	1 494	T3	PS
Sweden	Lime Production	439	0.75	332	Lime Production	500	0.75	373	T3	D
United Kingdom	Carbonate used	2 982	0.45	1 329	Carbonate used	2 365	0.45	1 053	T3	CS
EU-27+UK		**NE**	**NE**	**25 242**		**27 477**	**0.68**	**18 729**	-	-
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Carbonate used	2 982	0.45	1 329	Carbonate used	2 365	0.45	1 053	T3	CS
EU-KP		**NE**	**NE**	**25 242**		**27 477**	**0.68**	**18 729**	-	-

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Not all countries show lime production as the activity data for this emissions category. Gap-filled values are shown against Lime production for EU activity and the EU IEF for 2019.
The level of complexity of the methods applied by Greece and the Netherlands is Tier 3 (T3). The methodological tier used in 1990 is Tier 2 (T2) for Latvia and Tier 1 (T1) for Malta.

4.2.1.3 2A4 Other process uses of carbonates

CO_2 emissions from 2A4 Other process uses of carbonates contributed 0.2% of total EU-KP (without LULUCF) emissions in 2019. Emissions from this sector in 2019 were 16% lower than 1990 levels and 5% lower compared to 2018. It is not necessarily useful to compare specific shares of emissions due to the fact that each country's estimates are mostly composed of several sources with independent estimation methods, using partly higher tiers, partly default methods.

Table 4.8 2A4 Other process uses of carbonates: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	624	498	413	4.1%	-212	-34%	-86	-17%	T1,T3	D,PS
Belgium	136	185	198	2.0%	62	46%	13	7%	T3	CS,PS
Bulgaria	607	924	873	8.8%	267	44%	-50	-5%	T1,T2	D,PS
Croatia	9	28	19	0.2%	10	104%	-10	-34%	T3	PS
Cyprus	44	15	21	0.2%	-23	-52%	7	44%	CS,T1	CS,D
Czechia	114	306	284	2.9%	171	150%	-22	-7%	T1,T3	D,PS
Denmark	77	89	77	0.8%	0	0%	-11	-13%	CS,T3	CS,D
Estonia	NO,IE,NA	1	1	0.0%	1	∞	0	-45%	T1,T2	D,PS
Finland	67	147	124	1.2%	57	84%	-23	-16%	T1,T3	CS,D
France	488	426	453	4.6%	-35	-7%	27	6%	T1,T2,T3	CS,D,PS
Germany	1 458	747	710	7.1%	-748	-51%	-36	-5%	T1,T2	CS,D
Greece	590	361	355	3.6%	-234	-40%	-5	-2%	CS,T1	CS,D
Hungary	449	264	249	2.5%	-200	-45%	-15	-6%	T2,T3	CS,D,PS
Ireland	5	1	1	0.0%	-4	-73%	0	15%	T3	PS
Italy	2 544	671	627	6.3%	-1 916	-75%	-43	-6%	T2	CS,PS
Latvia	69	10	9	0.1%	-60	-87%	-1	-12%	T1,T2	D,PS
Lithuania	240	19	15	0.1%	-225	-94%	-5	-23%	T1,T2	CS,D,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	0	0	0	0.0%	0	0%	0	-10%	T1	D
Netherlands	690	1 023	896	9.0%	206	30%	-127	-12%	CS,T1,T2	D
Poland	771	2 083	2 190	22.0%	1 419	184%	108	5%	T1,T2	CS,D
Portugal	230	353	327	3.3%	98	42%	-26	-7%	T1,T3	OTH
Romania	38	353	325	3.3%	286	747%	-28	-8%	OTH,T2,T3	D,PS
Slovakia	447	394	373	3.8%	-73	-16%	-21	-5%	T3	PS
Slovenia	20	18	18	0.2%	-3	-12%	0	-1%	T2	D
Spain	1 358	1 025	925	9.3%	-433	-32%	-100	-10%	T1,T2,T3	CS,D,PS
Sweden	15	19	10	0.1%	-5	-33%	-8	-45%	T3	D
United Kingdom	743	507	449	4.5%	-294	-40%	-58	-11%	T3	CS
EU-27+UK	**11 833**	**10 465**	**9 945**	**100%**	**-1 889**	**-16%**	**-521**	**-5%**	**-**	**-**
Iceland	1	1	1	0.0%	0	38%	0	6%	T3	PS
United Kingdom (KP)	743	507	449	4.5%	-294	-40%	-58	-11%	T3	CS
EU-KP	**11 834**	**10 466**	**9 946**	**100%**	**-1 888**	**-16%**	**-520**	**-5%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.1.4 Non-key sources

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 equ.	%	kt CO_2 equ.	%
2.A.3 Glass production: no classification (CO2)	4 271.5	4 325.4	4 325.2	1.17%	54	1%	-0.1	0.0%

Glass production is the only non-key source in the mineral industry. CO_2 emissions from 2A3 Glass production contributed to only 0.1% of total EU-KP (without LULUCF) emissions in 2019. Emissions in that year were similar to 1990 levels (just 1% higher). CO_2 emissions from glass production remained almost steady between 2018 and 2019.

Table 4.10 shows information on the methods applied, activity data, and the emission factors for CO_2 emissions from 2A3 Glass production for 1990 and 2019.

Table 4.9 2A3 Glass production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	39	38	41	1.0%	3	7%	3	7%	T3	PS
Belgium	263	158	135	3.1%	-127	-48%	-23	-14%	T3	CS,PS
Bulgaria	138	79	76	1.8%	-62	-45%	-3	-4%	T1	CS
Croatia	43	30	29	0.7%	-14	-32%	-1	-4%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	143	148	144	3.3%	1	1%	-4	-3%	T3	PS
Denmark	16	10	10	0.2%	-7	-41%	-1	-6%	T3	PS
Estonia	1	10	10	0.2%	9	747%	1	8%	T3	PS
Finland	21	3	2	0.0%	-19	-90%	-1	-31%	T3	CS
France	802	562	538	12.4%	-264	-33%	-24	-4%	T2,T3	CS,PS
Germany	780	898	866	20.0%	86	11%	-32	-4%	T2	CS
Greece	20	17	17	0.4%	-3	-17%	0	-2%	CS	CS
Hungary	77	44	49	1.1%	-27	-36%	6	13%	T3	CS,PS
Ireland	13	NO	NO	-	-13	-100%	-	-	NA	NA
Italy	453	604	597	13.8%	143	32%	-7	-1%	T2	CS,PS
Latvia	0	1	1	0.0%	0	62%	0	-23%	T3	D,PS
Lithuania	12	7	8	0.2%	-4	-32%	1	10%	T2	D
Luxembourg	54	63	64	1.5%	10	19%	1	2%	CS	PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	142	71	69	1.6%	-73	-51%	-2	-3%	T3	PS
Poland	169	486	558	12.9%	389	230%	72	15%	T2	D
Portugal	84	157	159	3.7%	76	90%	3	2%	T3	OTH
Romania	150	51	42	1.0%	-108	-72%	-8	-17%	T2	CS,D
Slovakia	8	16	18	0.4%	10	130%	2	13%	T3	PS
Slovenia	3	12	13	0.3%	10	313%	2	14%	T3	D
Spain	374	480	492	11.4%	117	31%	12	2%	T3	CS,D,PS
Sweden	54	16	16	0.4%	-38	-70%	0	0%	T3	CS,D
United Kingdom	411	365	369	8.5%	-42	-10%	5	1%	T3	CS
EU-27+UK	**4 272**	**4 325**	**4 325**	**100%**	**54**	**1%**	**0**	**0%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	411	365	369	8.5%	-42	-10%	5	1%	T3	CS
EU-KP	**4 272**	**4 325**	**4 325**	**100%**	**54**	**1%**	**0**	**0%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
The methods provided in this table are consistent with the information submitted by Members States in their national inventory submissions. Greece and Luxembourg use country-specific methods and report 'CS' accordingly. The level of complexity of the methods is Tier 3 (T3) for Greece and Tier 2 (T2) for Luxembourg.

The table below shows that while most countries report glass production as activity data under this category, some report inputs (carbonate use). A gap-filled IEF was not calculated for EU glass production because the standard deviation of the countries' IEF for glass production was above 50%.

Table 4.10 2A3 Glass production: Information on methods applied, activity data, emission factors for CO_2 emissions

Member State	1990				2019				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Glass Production	399	0.10	39	Glass Production	526	0.08	41	T3	PS
Belgium	Glass Production	1 993	0.13	263	Glass Production	1 399	0.10	135	T3	CS,PS
Bulgaria	-	818	0.17	138	-	612	0.12	76	T1	CS
Croatia	Glass Production	99	0.44	43	Glass Production	68	0.43	29	T3	PS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czechia	Glass Production	1 237	0.12	143	Glass Production	1 179	0.12	144	T3	PS
Denmark	Glass Production	200	0.08	16	Glass Production	203	0.05	10	T3	PS
Estonia	Glass Production	12	0.10	1	Glass Production	87	0.12	10	T3	PS
Finland	Used Carbonates	45	0.47	21	Used Carbonates	5	0.40	2	T3	CS
France	Glass Production	4 333	0.19	802	Glass Production	3 365	0.16	538	T2,T3	CS,PS
Germany	Glass Production	6 562	0.12	780	Glass Production	7 378	0.12	866	T2	CS
Greece	Glass Production	135	0.15	20	Glass Production	118	0.14	17	CS	CS
Hungary	Glass Production	418	0.18	77	Glass Production	365	0.14	49	T3	CS,PS
Ireland	Carbonate Use	64	0.21	13	Carbonate Use	NO	NO	NO	NA	NA
Italy	Glass Production	3 779	0.12	453	Glass Production	6 033	0.10	597	T2	CS,PS
Latvia	Glass Production	44	0.01	0	Glass Production	C	C	1	T3	D,PS
Lithuania	Glass Production	66	0.18	12	Glass Production	52	0.15	8	T2	D
Luxembourg	Glass Production	377	0.14	54	Glass Production	403	0.16	64	CS	PS
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	-	1 095	0.13	142	-	1 541	0.04	69	T3	PS
Poland	Glass Production	1 058	0.16	169	Glass Production	3 490	0.16	558	T2	D
Portugal	-	615	0.14	84	-	1 788	0.09	159	T3	OTH
Romania	Glass Production	926	0.16	150	Glass Production	359	0.12	42	T2	CS,D
Slovakia	Used Carbonates	18	0.44	8	Used Carbonates	43	0.42	18	T3	PS
Slovenia	Glass Production	25	0.13	3	Glass Production	99	0.14	13	T3	D
Spain	Glass Production	2 866	0.13	374	Glass Production	4 765	0.10	492	T3	CS,D,PS
Sweden	-	NE	NE	54	-	NE	NE	16	T3	CS,D
United Kingdom	Glass Production	1 942	0.21	411	Glass Production	2 180	0.17	369	T3	CS
EU-27+UK	**-**	**NE**	**NE**	**4 272**	**-**	**NE**	**NE**	**4 325**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Glass Production	1 942	0.21	411	Glass Production	2 180	0.17	369	T3	CS
EU-KP	**-**	**NE**	**NE**	**4 272**	**-**	**NE**	**NE**	**4325**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
Not all countries show production as the activity data for this emissions category. A gap-filled IEF was not calculated for EU glass production because the standard deviation of the IEF of the other countries was above 50%.
The level of complexity of the methods is Tier 3 (T3) for Greece and Tier 2 (T2) for Luxembourg.

4.2.2 Chemical industry (CRF Source Category 2B)

The chemical industry includes seven key categories, which are presented in ***Table*** *4.11*.

Table 4.11: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 2B (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2019		1990	2019	
2.B.1 Ammonia Production (CO_2)	32487	21721	0	L	L	97.3%
2.B.2 Nitric Acid Production (N_2O)	49630	3810	T	L	0	88.0%
2.B.3 Adipic Acid Production (N_2O)	57555	294	T	L	0	100.0%
2.B.8 Petrochemical and Carbon Black Production (CO_2)	14810	14390	T	L	L	66.6%
2.B.9 Fluorochemical Production (HFCs)	29033	1807	T	L	0	100.0%
2.B.9 Fluorochemical Production (Unspecified mix of HFCs and PFCs)	5567	47	T	0	0	100.0%
2.B.10 Other chemical industry (CO_2)	6888	12796	T	0	L	81.1%

The key category 2B1 Ammonia production accounts for 34.9% of total GHG emissions in the chemical industry, followed by 2B8 Petrochemical and Carbon Black Production (23.1%), which includes the CO_2 emissions associated with the production of a wide range of petrochemicals including methanol and ethylene and carbon black. The category 2B10 Other chemical industry (20.6%) is the third most important category. Higher tier methods are used by most countries. However, as categories 2B8 and 2B10 comprise a variety of emission sources, including minor ones, several countries use Tier 1 methods to estimate emissions from these sources.

Figure **4.6** shows chemical industry CO_2 emissions while *Table 4.12* presents a summary of emissions of CO_2, N_2O, CH_4 and total emissions as CO_2 equivalents.

Figure 4.6 2B Chemical industry CO_2 emissions

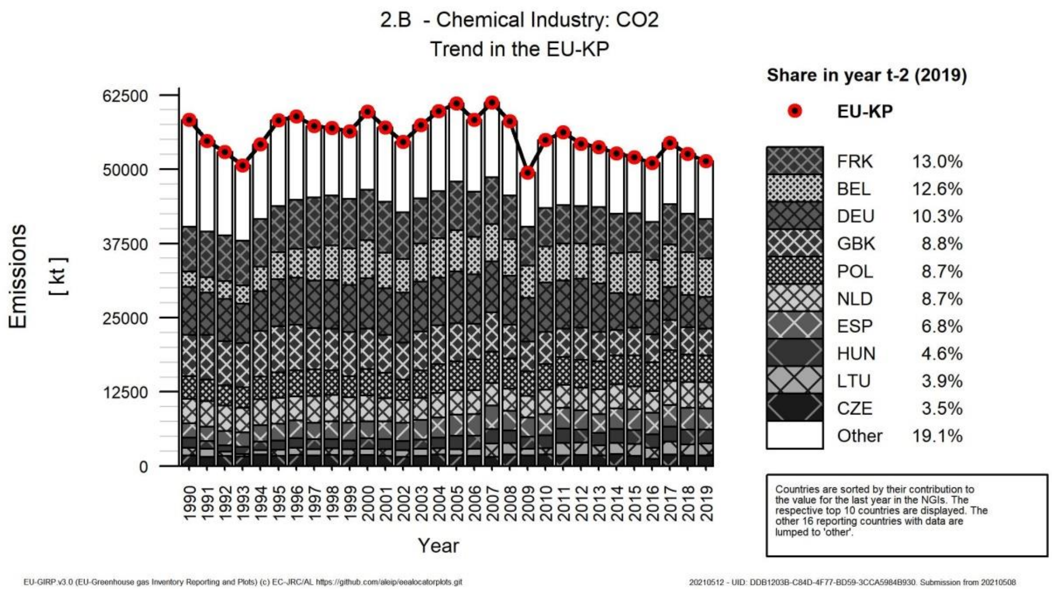


Table 4.12 shows chemical industry CO_2, CH_4, N_2O and total GHG emissions (which includes F-gases) as CO_2e. Between 1990 and 2019 GHG emissions from the chemical industry sector have decreased markedly largely due to the significant reduction in N_2O emissions which have decreased by approx. 94%. The greatest absolute decreases in N_2O emissions over the period were observed in France, Germany and the United Kingdom.

Table 4.12 2B Chemical industry: EU-KP CO_2, N_2O, CH_4 and total emissions as CO_2 equivalents

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2019 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2019 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2019 (kt CO2 equivalents)
Austria	1 555	851	644	724	877	81	35	47
Belgium	10 093	8 663	2 590	6 485	3 807	754	18	17
Bulgaria	4 943	1 900	3 283	1 120	1 647	780	13	NO,NA
Croatia	1 511	645	751	595	754	50	5	NO,NE,IE
Cyprus	NO	NO	NO	NO	NO	NO	NO	NO
Czechia	2 942	2 020	1 783	1 807	1 122	165	36	47
Denmark	1 003	1	1	1	1 003	NO,NA	NO,NA	NO,NA
Estonia	308	NO	308	NO	NO	NO	NO	NO
Finland	1 866	1 351	270	1 145	1 592	205	5	1
France	36 968	7 608	7 488	6 665	23 708	767	78	36
Germany	35 459	6 397	8 109	5 317	21 335	566	334	466
Greece	2 931	899	681	878	1 066	21	1	NO,NA
Hungary	4 812	2 463	1 704	2 388	3 090	32	18	43
Ireland	1 986	NO	990	NO	995	NO	NO	NO
Italy	10 493	2 310	2 524	1 315	6 418	121	61	4
Latvia	NA,NO	NA,NO	NO	NO	NO	NO	NO	NO
Lithuania	2 176	2 168	1 278	1 989	893	179	5	NO
Luxembourg	NO	NO	NO	NO	NO	NO	NO	NO
Malta	0	0	0	0	NO,NA	NO,NA	NO,NA	NO,NA
Netherlands	17 077	6 532	4 132	4 447	7 069	1 353	269	304
Poland	7 378	5 239	3 802	4 496	3 536	692	40	51
Portugal	1 959	744	1 435	681	498	36	26	27
Romania	9 748	1 096	5 563	972	4 135	119	50	5
Slovakia	2 020	1 499	878	1 407	1 142	91	0	1
Slovenia	88	60	83	60	NO	NO	4	NO,NA
Spain	8 409	4 007	2 430	3 497	2 855	408	84	102
Sweden	1 470	932	666	902	803	29	1	1
United Kingdom	45 399	4 740	6 976	4 511	23 797	40	222	68
EU-27+ISL	**212 593**	**62 126**	**58 369**	**51 403**	**112 142**	**6 491**	**1 305**	**1 217**
Iceland	47	NO	0	NO	46	NO	NO,NA	NO
United Kingdom (KP)	45 399	4 740	6 976	4 511	23 797	40	222	68
EU-KP	**212 640**	**62 126**	**58 369**	**51 403**	**112 188**	**6 491**	**1 305**	**1 217**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'. Note that emissions from F-gases are included in the total.

Table 4.13 provides information on recalculations in 2B Chemical industry for 1990 and 2018, including explanations.

Table 4.13 2B Chemical Industry: Contribution of MS to EU recalculated CO_2 emissions for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	0.2	0.0	Due to updated urea amounts used in road transport from 2005–2018, CO_2 emissions increased in sector 2.B.1.
Belgium	-	-	38	0.5	Re-allocation of emissions from non-energetic fuel gas use in categories 2B8 and 2B10.
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czechia	-	-	-	-	
Denmark	-	-	0.0	0.8	In category 2.B.10, an error was corrected, leading to a minor increase in emissions in 2018.
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	1.4	0.0	2	0.0	Update of activity data in category 2.B.10.
Germany	-	-	0.5	0.0	Update of emissions data in category 2B5b.
Greece	-	-	-	-	
Hungary	-55	-3.1	-25	-1.0	Emissions data were recalculated for the whole time series based on a urea balance. For emissions up to 2006, an updated carbon content factor was used.

	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
Ireland	-	-	-	-	
Italy	-53	-2.0	-37	-2.3	In the past, combustion-related emissions from titanium dioxide production had been reported under 2B6 by mistake. These are no longer reported under 2B6, leading to a reduction of process emissions in the chemical industry.
Latvia	-	-	-	-	
Lithuania	-	-	-0.4	-0.0	Recalculations in category 2.B.1, due to recalculation of urea use in categories 2.H and 2.D.3.
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-581	-12.3	-1 285	-22.8	Emissions from category 2B1 were corrected by subtracting CO_2 stored in urea, leading to lower emissions across the whole time series. Update of emissions from 2.B.10 based on ETS reports.
Poland	-	-	-	-	
Portugal	224	18.5	0.2	0.0	Methodological revision of category 2.B.1 in 1990. Minor updates of gross domestic product and gross value added in 2018.
Romania	-	-	42	3.9	Update of emissions from category 2B1 in 2018 due to an update of urea export data. Update of emissions from category 2B5b in 2018 due to updated calcium carbide import and export data.
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-	-	-42	-1.1	Update of emission factor in 2018 in category 2B7.
Sweden	56	9.2	36	4.2	Revision of the method for estimating emissions from category 2B5a for the whole time series.
United Kingdom	-10	-0.1	-8.3	-0.2	Revision of the calorific value for petroleum coke in category 2B6; correction for sequestered carbon in category 2B7; update of emissions data in category 2.B.8.g.
EU27+UK	-417	-0.7	-1 278	-2.4	
Iceland	-0.0	-0.0	-	-	Small difference due to rounding only.
United Kingdom (KP)	-10	-0.1	-8.3	-0.2	Revision of the calorific value for petroleum coke in category 2B6; correction for sequestered carbon in category 2B7; update of emissions data in category 2.B.8.g.
EU-KP	-417	-0.7	-1 278	-2.4	

(*) contribution of the recalculation as percentage of the total emissions of category 2B for the respective year and MS

Table 4.14 2B Chemical Industry: Contribution of MS to EU recalculated N_2O emissions for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Czechia	-2.5	-0.2	-	-	Update of emissions data in category 2B4a for 1990-2014.
Spain	26	0.9	-	-	Update of emission factor in category 2B2 for 1990-2000.
Sweden	-	-	-	-	
United Kingdom	-0.0	-0.0	0.2	0.9	Update monitored emissions data for 2018; update of emissions estimate for 1990.
EU27+UK	**23**	**0.0**	**0.2**	**0.0**	
Iceland	-	-	-	-	
United Kingdom (KP)	-0.0	-0.0	0.2	0.9	Update monitored emissions data for 2018; update of emissions estimate for 1990.
EU-KP	**23**	**0.0**	**0.2**	**0.0**	

4.2.2.1 2B1 Ammonia production

In most facilities, anhydrous ammonia is produced by catalytic steam reforming of natural gas (CH_4) or fuel oil. At plants using this process, CO_2 is primarily released during regeneration of the CO_2 scrubbing solution, with additional but relatively minor emissions resulting from condensate stripping.

CO_2 emissions from ammonia production contributed 0.5% of total EU-KP (without LULUCF) emissions in 2019. Emissions have decreased by approx. 33% since 1990, and by 2% from 2018 to 2019.

Figure 4.7 2B1 Ammonia production: CO_2 emissions

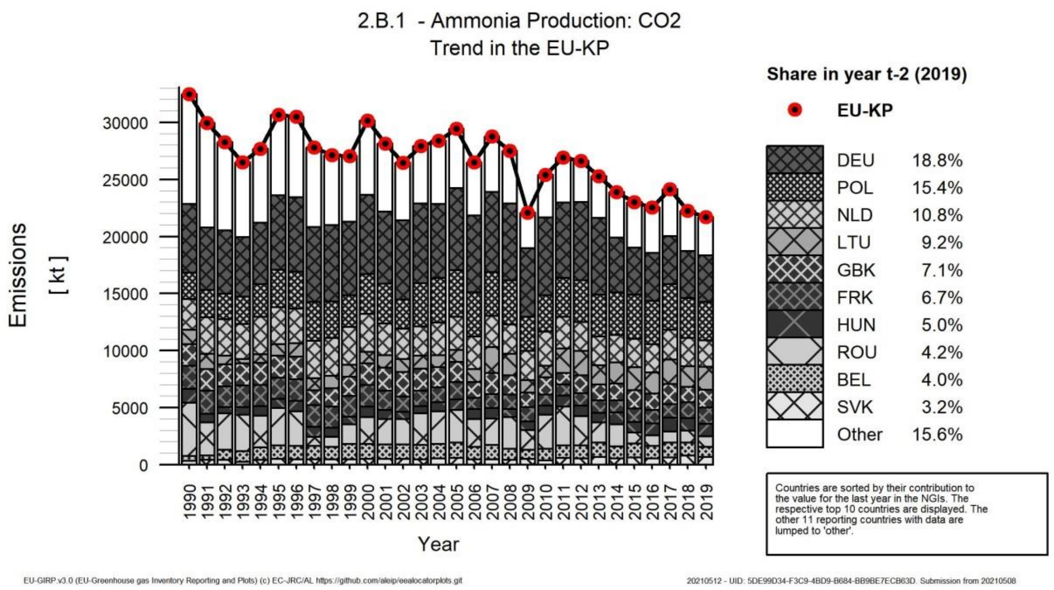


Figure 4.7 and Table 4.18 show that in 2019 Germany was responsible for 18.8% of this category's emissions. The next largest contributors are Poland and the Netherlands which contribute 15.4% and 10.8% respectively.

Bulgaria, Germany, Italy, Ireland and Romania have all had large reductions in absolute terms since 1990. The reasons for these reductions include shifting to low emitting technology and production decreases and the cessation of production in Ireland. The largest growth in absolute terms in emissions between 1990 and 2019 occurred in Belgium, Lithuania, Poland and Slovakia.

Table 4.15 2B1 Ammonia production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	467	357	512	2.4%	45	10%	155	43%	T2	PS
Belgium	423	1 146	877	4.0%	454	107%	-269	-23%	T3	D,PS
Bulgaria	2 508	784	601	2.8%	-1 907	-76%	-183	-23%	T2	PS
Croatia	559	513	595	2.7%	36	6%	82	16%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	991	586	583	2.7%	-408	-41%	-3	0%	T1	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	308	NO	NO	-	-308	-100%	-	-	NA	NA
Finland	93	NO	NO	-	-93	-100%	-	-	NA	NA
France	2 019	1 378	1 463	6.7%	-557	-28%	84	6%	T1,T2,T3	CS,D,PS
Germany	6 025	4 157	4 077	18.8%	-1 948	-32%	-80	-2%	T3	PS
Greece	652	245	224	1.0%	-428	-66%	-21	-9%	T1a	CS
Hungary	1 200	1 106	1 081	5.0%	-119	-10%	-25	-2%	T3	PS
Ireland	990	NO	NO	-	-990	-100%	-	-	NA	NA
Italy	1 892	679	531	2.4%	-1 360	-72%	-148	-22%	T2	PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 254	1 828	1 989	9.2%	735	59%	161	9%	T3	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	2 695	2 468	2 349	10.8%	-346	-13%	-118	-5%	T3	CS
Poland	2 344	3 485	3 349	15.4%	1 005	43%	-135	-4%	T2	CS
Portugal	763	NO	NO	-	-763	-100%	-	-	NA	NA
Romania	4 678	1 040	914	4.2%	-3 764	-80%	-126	-12%	T3	PS
Slovakia	332	790	688	3.2%	357	107%	-102	-13%	T3	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	400	371	340	1.6%	-60	-15%	-31	-8%	T3	PS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	1 895	1 339	1 548	7.1%	-347	-18%	209	16%	T3	CS
EU-27+UK	**32 487**	**22 271**	**21 721**	**100%**	**-10 767**	**-33%**	**-551**	**-2%**	**-**	**-**
Iceland	NA	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 895	1 339	1 548	7.1%	-347	-18%	209	16%	T3	CS
EU-KP	**32 487**	**22 271**	**21 721**	**100%**	**-10 767**	**-33%**	**-551**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.
The table lists methods and emission factors used in the latest inventory year. Estonia, Finland, Ireland and Portugal did not report emissions in that year, but they reported emissions in 1990. The methodological tier used in 1990 is Tier 3 (T3) for Estonia and Tier 1 (T1) for Finland, Ireland and Portugal.

In line with the IPCC guidelines all emissions (energy and non-energy use of feedstocks/fuels) from ammonia production should be reported in category 2B1. In a review of the inventory submission of the European Union, the ERT recommended that the European Union include in the NIR a table that includes the potentially combustion-related EU ETS emission values rather than only the process-related emissions reported for ammonia production. Table 4.16 aligns 2B1 Ammonia production against EU ETS reported emissions for Production of ammonia (EU ETS activity sector code 41). Of the seventeen countries which report emissions under 2B1 Ammonia production thirteen report against EU ETS activity Production of Ammonia and of these only nine report higher levels to the EU ETS than is reported in the inventory. The column labelled 'Potentially combustion related' shows differences between IPPU 2B1 and ETS reported emissions from production of ammonia where the ETS figure is greater.

Table 4.16 2B1 Ammonia production: inventory and relevant EU ETS reported CO_2 emissions for 2019 (kt CO_2 emissions)

Member State	IPPU 2B1. Ammonia production	EU ETS: Production of ammonia	Potentially combustion related [1]	EU ETS: Production of hydrogen and synthesis gas
Austria	357	962	605	-
Belgium	1 146	959	-	-
Bulgaria	784	667	-	-
Croatia	513	1 257	744	-
Cyprus	NO	-	-	-
Czech Republic	586	-	-	-
Denmark	NO	-	-	-
Estonia	NO	-	-	-
Finland	NO	-	-	-
France	1 378	1 644	265	531
Germany	4 157	4 363	206	3 123
Greece	245	245	0	-
Hungary	1 135	812	-	155
Ireland	NO	-	-	-
Italy	679	-	-	658
Latvia	NO	-	-	-
Lithuania	1 828	2 486	658	-
Luxembourg	NO	-	-	-
Malta	NO	-	-	-
Netherlands	3 757	3 447	-	2 255
Poland	3 485	1 308	-	-
Portugal	NO	-	-	58
Romania	998	-	-	46
Slovakia	790	986	195	-
Slovenia	NO	-	-	-
Spain	371	702	331	884
Sweden	NO	-	-	-
United Kingdom	1 339	1 612	272	561
EU-27+UK	**23 548**	**21 450**	**3 278**	**8 272**
Iceland	NO	-	-	-
United Kingdom (KP)	1 339	1 612	272	561
EU-KP	**23 548**	**21 450**	**3 278**	**8 272**

[1] Potentially combustion related: difference between IPPU 2B1 and EU ETS reported emissions from production of ammonia where the ETS figure is greater.
EU ETS data from: www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1

The different scopes, reporting thresholds and reporting obligations mean that it is not possible to make a detailed analysis of the differences visible in Table 4.16. To analyse the consistency between EU ETS and inventory data would require a detailed analysis of the data reported by each ETS installation to the national competent authorities and the allocation to the specific CRF categories, including the methods, activity data and calculation parameters used. Please refer to chapter 1.4.1 on 'the use of data from EU ETS for the purposes of the national GHG inventories'. See also the mapping table (Table 1.10 in section 1.4.1) between ETS activities and CRF categories (including on ammonia production).

It is worth observing that the EU ETS activity sector: Production of hydrogen and synthesis gas (code 43) does not have a direct counterpart in the inventory and is included here to illustrate the difficulty of comparing UNFCCC and EU ETS reported emissions. Note also that ammonia can be produced using hydrogen supplied by another company and that not all hydrogen producers are obliged to report within the framework of EU ETS.

Table 4.17 shows information on methods applied, activity data, emission factors for CO_2 emissions from 2B1 Ammonia production for 1990 and 2019. Not all countries show ammonia production as activity data for this emissions category but gap-filled values for the EU IEF have not been calculated because the data distribution does not appear to be normal (the standard deviation divided by mean is greater than 50%). In 2018, 97.3% of emissions from ammonia production are estimated with higher Tier methods (Tier 2 or Tier 3).

Table 4.17 2B1 Ammonia production: Information on methods applied, activity data, emission factors for CO_2 emissions

Member State	1990				2019				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Ammonia Production	461	1.22	467	Ammonia Production	553	1.22	512	T2	PS
Belgium	Ammonia Production	360	1.17	423	Ammonia Production	687	1.39	877	T3	D,PS
Bulgaria	-	C	C	2508	-	C	C	601	T2	PS
Croatia	Ammonia Production	345	2.24	559	Ammonia Production	481	1.96	595	T3	PS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czechia	Ammonia Production	336	3.27	991	Ammonia Production	178	3.27	583	T1	CS
Denmark	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Estonia	Ammonia Production	294	1.44	308	Ammonia Production	NO	NO	NO	NA	NA
Finland	Ammonia Production	28	3.27	93	Ammonia Production	NO	NO	NO	NA	NA
France	Ammonia Production	1928	1.05	2019	Ammonia Production	1075	1.36	1463	T1,T2,T3	CS,D,PS
Germany	Ammonia Production	2705	2.41	6025	Ammonia Production	2948	1.77	4077	T3	PS
Greece	Ammonia Production	313	2.08	652	Ammonia Production	135	1.66	224	T1a	CS
Hungary	Natural Gas Consumption	25334	0.06	1200	Natural Gas Consumption	20688	0.06	1081	T3	PS
Ireland	Natural Gas Feedstocks	430	2.30	990	Natural Gas Feedstocks	NO	NO	NO	NA	NA
Italy	Ammonia Production	1455	1.94	1892	Ammonia Production	465	1.88	531	T2	PS
Latvia	Ammonia Production	NO	NO	NO	Ammonia Production	NO	NO	NO	NA	NA
Lithuania	Ammonia Production	568	2.27	1254	Ammonia Production	1051	2.08	1989	T3	CS
Luxembourg	Ammonia Production	NO	NO	NO	Ammonia Production	NO	NO	NO	NA	NA
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	-	C	C	2695	-	C	C	2349	T3	CS
Poland	Ammonia Production	1532	1.90	2344	Ammonia Production	2452	1.71	3349	T2	CS
Portugal	-	C	C	763	-	NO	NO	NO	NA	NA
Romania	Natural Gas Consumption	2101	2.28	4678	Natural Gas Consumption	471	2.27	914	T3	PS
Slovakia	Ammonia Production	360	1.71	332	Ammonia Production	492	1.67	688	T3	PS
Slovenia	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Spain	Ammonia Production	573	1.22	400	Ammonia Production	534	1.22	340	T3	PS
Sweden	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom	Ammonia Production	1328	1.43	1895	Ammonia Production	960	1.61	1548	T3	CS
EU-27+UK	**-**	**NE**	**NE**	**32487**	**-**	**15552**	**1.40**	**21721**	**-**	**-**
Iceland	-	IE	NA,NO	NA	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Ammonia Production	1328	1.43	1895	Ammonia Production	959.7435	1.61	1548	T3	CS
EU-KP	**-**	**NE**	**NE**	**32487**	**-**	**15552**	**1.40**	**21721**	**-**	**-**

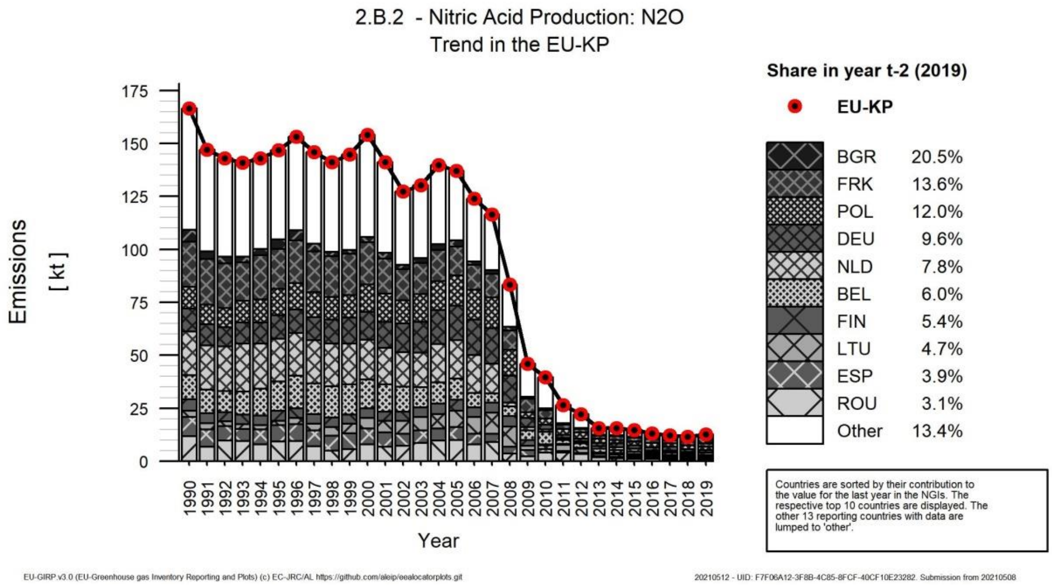
Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'. Not all countries show production as the activity data for this emissions category. Some countries report activity data and IEF as confidential for this category. Values for the EU-27+UK and EU-KP have therefore been gap filled for 2019.
The table lists methods and emission factors used in the latest inventory year. Estonia, Finland, Ireland and Portugal did not report emissions in that year, but they reported emissions in 1990. The methodological tier used in 1990 is Tier 3 (T3) for Estonia and Tier 1 (T1) for Finland, Ireland and Portugal.

4.2.2.2 2B2 Nitric acid production

N_2O can be emitted in the production of nitric acid as a by-product of the high temperature catalytic oxidation of ammonia (NH_3). Emissions have decreased by 92% since 1990. All countries have had marked reductions from this source notably post 2007 when pollution control measures were introduced and post 2013 under EU ETS reporting obligations. However, emissions increased by 12% between 2018 and 2019, mainly due to higher emissions from this source category in Bulgaria.

N_2O emissions from nitric acid production contributed less than 0.1% of total EU-KP (without LULUCF) emissions in 2018.(Figure **4.8** and Table 4.18). France and the Netherlands have had the greatest reductions in absolute terms, due to the implementation of technical measures at all Dutch nitric acid plants and due to the improvement of the process and catalyst efficiency in France. Production stopped in Denmark in 2004 and in Ireland in 2002.

Figure 4.8 2B2 Nitric acid production N_2O emissions



The substantial decrease in N_2O emissions seen since 2007 is largely due to technical measures that have been implemented at all nitric acid plants. Special catalysts and improvement of the process efficiency led to a continuation of the declining trend in emissions. This trend has slowed in recent years. Twenty countries reported these emissions in 2019, five of which reported emissions increases compared to the previous year.

Table 4.18 2B2 Nitric acid production: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	877	56	81	2.1%	-796	-91%	25	44%	T3	PS
Belgium	3 422	254	228	6.0%	-3 193	-93%	-25	-10%	T3	PS
Bulgaria	1 647	116	780	20.5%	-868	-53%	664	574%	T3	PS
Croatia	754	50	50	1.3%	-704	-93%	0	0%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 049	112	92	2.4%	-957	-91%	-20	-18%	T3	PS
Denmark	1 003	NO	NO	-	-1 003	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 592	211	205	5.4%	-1 386	-87%	-6	-3%	T3	PS
France	6 368	560	518	13.6%	-5 850	-92%	-41	-7%	T2,T3	CS,D,PS
Germany	3 258	382	366	9.6%	-2 893	-89%	-16	-4%	T3	PS
Greece	1 066	22	21	0.6%	-1 045	-98%	-1	-5%	CS	CS
Hungary	3 090	36	32	0.8%	-3 058	-99%	-4	-12%	T3	PS
Ireland	995	NO	NO	-	-995	-100%	-	-	NA	NA
Italy	2 005	56	43	1.1%	-1 962	-98%	-13	-23%	T3	D,PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	893	175	179	4.7%	-714	-80%	4	2%	T3	PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	6 085	282	297	7.8%	-5 788	-95%	15	5%	T2	PS
Poland	3 041	509	457	12.0%	-2 584	-85%	-53	-10%	T1	CS
Portugal	498	46	36	0.9%	-462	-93%	-10	-22%	T3	PS
Romania	3 473	231	119	3.1%	-3 354	-97%	-112	-49%	T3	PS
Slovakia	1 142	106	91	2.4%	-1 051	-92%	-15	-14%	T3	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	2 730	149	149	3.9%	-2 581	-95%	-1	0%	T3	PS
Sweden	782	31	28	0.7%	-754	-96%	-3	-9%	T2	PS
United Kingdom	3 860	25	38	1.0%	-3 822	-99%	13	55%	T3	CS
EU-27+UK	**49 630**	**3 411**	**3 810**	**100%**	**-45 820**	**-92%**	**399**	**12%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 860	25	38	1.0%	-3 822	-99%	13	55%	T3	CS
EU-KP	**49 630**	**3 411**	**3 810**	**100%**	**-45 820**	**-92%**	**399**	**12%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
The methods provided in this table are consistent with the information submitted by Members States in their national inventory submissions. Greece uses a country-specific method and reports 'CS' accordingly. The level of complexity of the method applied by Greece is Tier 3 (T3).
The table lists methods and emission factors used in the latest inventory year. As Cyprus, Denmark, Estonia, Ireland, Latvia, Luxembourg, Malta, Slovenia and Iceland did not report emissions in that year, 'NA' is reported. Denmark and Ireland reported emissions from nitric acid production in 1990. The methodological tier used in that year is Tier 2 (T2) for Denmark and Tier 3 (T3) for Ireland.

Table 4.19 shows information on methods applied, activity data and emission factors for N_2O emissions from 2B2 Nitric acid production for 1990 and 2019. The table shows that while most countries report nitric acid production as activity data, for some countries this information is confidential. The IEFs are shown as kg N_2O per tonne of production. A gap filled EU IEF has not been calculated because the standard deviation divided by mean is more than 50%. The low IEFs are mainly due to the implementation of improved abatement technologies in the various Member States and the closure of some older plants. The majority of emissions (88.0%) are estimated with higher tier methods (Tier 2 or Tier 3).

Table 4.19 2B2 Nitric acid production: Information on methods applied, activity data, emission factors for N_2O emissions

Member State	1990				2019				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn	N2O Emissions (kt CO2 equiv.)	Activity Data		Implied Emission Factor (t/t)	N2O Emissions (kt CO2 equiv.)		
	Description	(kt)			Description	(kt)				
Austria	Nitric Acid Production	530	0.01	877	Nitric Acid Production	575	0.00	81	T3	PS
Belgium	Nitric Acid Production	1 436	0.01	3 422	Nitric Acid Production	2 085	0.00	228	T3	PS
Bulgaria	-	C	C	1 647	-	C	C	780	T3	PS
Croatia	Nitric Acid Production	332	0.01	754	Nitric Acid Production	302	0.00	50	T3	PS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czechia	Nitric Acid Production	530	0.01	1 049	Nitric Acid Production	596	0.00	92	T3	PS
Denmark	-	450	0.01	1 003	-	NO	NO	NO	NA	NA
Estonia	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Finland	Nitric Acid Production	549	0.01	1 592	Nitric Acid Production	655	0.00	205	T3	PS
France	Nitric Acid Production	3 200	0.01	6 368	Nitric Acid Production	1 860	0.00	518	T2,T3	CS,D,PS
Germany	Nitric Acid Production	1 698	0.01	3 258	Nitric Acid Production	2 669	0.00	366	T3	PS
Greece	Nitric Acid Production	511	0.01	1 066	Nitric Acid Production	180	0.00	21	CS	CS
Hungary	Nitric Acid Production	732	0.01	3 090	Nitric Acid Production	746	0.00	32	T3	PS
Ireland	Nitric Acid Production	339	0.01	995	Nitric Acid Production	NO	NO	NO	NA	NA
Italy	Nitric Acid Production	1 037	0.01	2 005	Nitric Acid Production	421	0.00	43	T3	D,PS
Latvia	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Lithuania	Nitric Acid Production	355	0.01	893	Nitric Acid Production	1 158	0.00	179	T3	PS
Luxembourg	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	-	C	C	6 085	-	C	C	297	T2	PS
Poland	Nitric Acid Production	1 577	0.01	3 041	Nitric Acid Production	2 331	0.00	457	T1	CS
Portugal	-	C	C	498	-	C	C	36	T3	PS
Romania	Nitric Acid Production	1 261	0.01	3 473	Nitric Acid Production	C	C	119	T3	PS
Slovakia	Nitric Acid Production	401	0.01	1 142	Nitric Acid Production	571	0.00	91	T3	PS
Slovenia	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Spain	Nitric Acid Production	1 329	0.01	2 730	Nitric Acid Production	696	0.00	149	T3	PS
Sweden	Nitric Acid Production	374	0.01	782	Nitric Acid Production	271	0.00	28	T2	PS
United Kingdom	Nitric Acid Production	2 408	0.01	3 860	Nitric Acid Production	1 185	0.00	38	T3	CS
EU-27+UK	**-**	**19 049**	**2.61**	**49 630**	**-**	**16 302**	**0.23**	**3 810**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Nitric Acid Production	2 408	0.01	3 860	Nitric Acid Production	1 185	0.00	38	T3	CS
EU-KP	**-**	**19 049**	**2.61**	**49 630**	**-**	**16 302**	**0.23**	**3810**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
The level of complexity of the method applied by Greece is Tier 3 (T3). The table lists methods and emission factors used in the latest inventory year. The methodological tier used in 1990 is Tier 2 (T2) for Denmark and Tier 3 (T3) for Ireland.

4.2.2.3 2B3 Adipic acid production

Adipic acid production emits N_2O as a by-product when a cyclohexanone/cyclohexanol mixture is oxidized by nitric acid. N_2O emissions from adipic acid production now account for less than 0.01% of total EU-KP (without LULUCF) emissions. Between 1990 and 2019, N_2O emissions from this source decreased by 99% (Figure 4.9 and Table 4.20), and emission in 2019 were 25% lower than in 2018. Only Germany, Italy and France continue to produce adipic acid.

Figure 4.9 2B3 Adipic acid production N_2O emissions

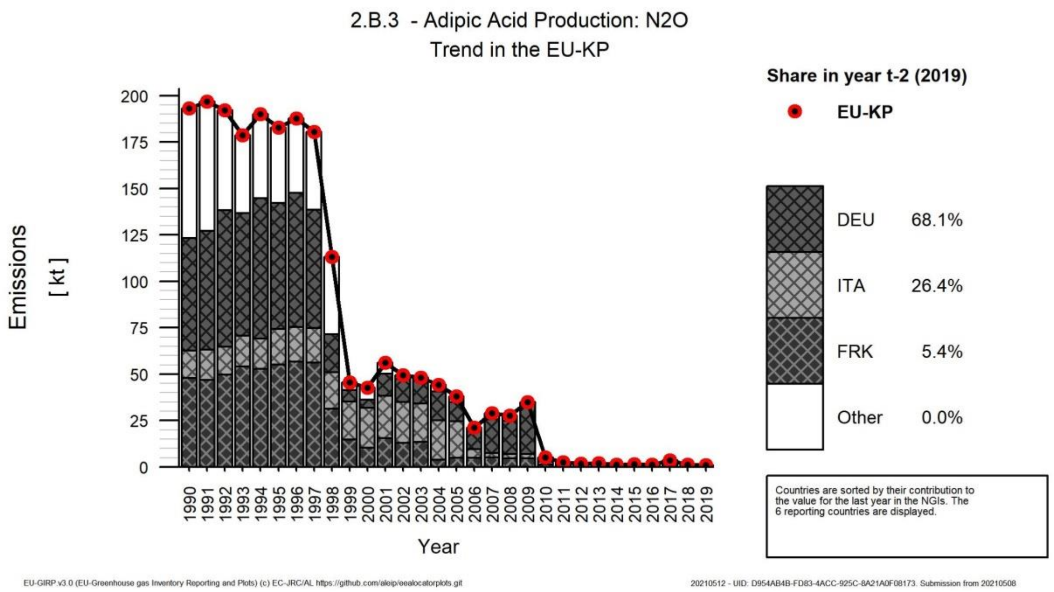


Table 4.20 2B3 Adipic acid production: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
France	14 232	60	16	5.4%	-14 217	-100%	-44	-74%	T2,T3	CS,D,PS
Germany	18 077	268	200	68.1%	-17 877	-99%	-67	-25%	T3	PS
Italy	4 402	64	78	26.4%	-4 324	-98%	14	22%	T3	D,PS
Poland	358	NO	NO	-	-358	-100%	-	-	NA	NA
Romania	552	NO	NO	-	-552	-100%	-	-	NA	NA
United Kingdom	19 935	NO	NO	-	-19 935	-100%	-	-	NA	NA
EU-27+UK	**57 555**	**392**	**294**	**100%**	**-57 261**	**-99%**	**-98**	**-25%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	19 935	NO	NO	-	-19 935	-100%	-	-	NA	NA
EU-KP	**57 555**	**392**	**294**	**100%**	**-57 261**	**-99%**	**-98**	**-25%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
The table lists methods and emission factors used in the latest inventory year. Poland, Romania and the United Kingdom did not report emissions from this category in 2019, but in 1990. The methodological tier used in that year is Tier 1 (T1) for Poland and Romania and Tier 3 (T3) for the United Kingdom.

Table 4.21 shows information on methods applied, activity data, emission factors for N_2O emissions from 2B3 Adipic acid production for 1990 to 2019. Adipic acid production is used as activity data but the information is confidential in France and Germany. The implied emission factors per tonne of adipic acid produced is only provided by Italy with 0.3 t/t for 1990 and 0.003 t/t for 2019. In 2019 all emissions are estimated with higher Tier methods.

Table 4.21 2B3 Adipic acid production: methods, activity data, emission factors for N_2O emissions

Member State	1990				2019				Method	Emission Factor Informa-tion
	Activity Data: Description	Activity Data: (kt)	Implied Emission Factorn (t/t)	N2O Emissions (kt CO2 equiv.)	Activity Data: Description	Activity Data: (kt)	Implied Emission Factor (t/t)	N2O Emissions (kt CO2 equiv.)		
Austria	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Belgium	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Bulgaria	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Croatia	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czechia	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Denmark	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Estonia	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Finland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
France	Adipic Acid Production	C	C	14 232	Adipic Acid Production	C	C	16	T2,T3	CS,D,PS
Germany	Adipic Acid Production	C	C	18 077	Adipic Acid Production	C	C	200	T3	PS
Greece	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Hungary	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Ireland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Italy	Adipic Acid Production	49	0.30	4 402	Adipic Acid Production	76	0.00	78	T3	D,PS
Latvia	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Lithuania	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Luxembourg	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Poland	Adipic Acid Production	4	0.30	358	Adipic Acid Production	NO	NO,NA	NO	NA	NA
Portugal	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Romania	Adipic Acid Production	6	0.30	552	Adipic Acid Production	NO	NO	NO	NA	NA
Slovakia	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Slovenia	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Spain	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Sweden	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom	Adipic Acid Production	C	C	19 935	Adipic Acid Production	NO	NO	NO	NA	NA
EU-27+UK	**-**	**59**	**968.82**	**57 555**	**-**	**76**	**3.85**	**294**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Adipic Acid Production	C	C	19 935	Adipic Acid Production	NO	NO	NO	NA	NA
EU-KP	**-**	**59**	**968.82**	**57 555**	**-**	**76**	**3.85**	**294**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
The methodological tier used in 1990 is Tier 1 (T1) for Poland and Romania and Tier 3 (T3) for the United Kingdom.

4.2.2.4 2B8 Petrochemical and carbon black production

Europe has a significant petrochemical industry, with production of all of the chemicals that are in the 2006 IPCC Guidelines. Eighteen countries report CO_2 emissions from this category for at least part of the period 1990-2018 with this source being a key category of CO_2 emissions in terms of emissions level and trend for EU-KP.

CO_2 emissions from 2B8 Petrochemical and carbon black production decreased by 6% between 2018 and 2019 and are now approx. 3% below 1990 levels. They contributed 0.35% of total EU-KP (without LULUCF) emissions in 2019. Belgium, the United Kingdom, Spain and Hungary contribute the largest share of emissions, respectively 23.0%, 18.5%, 13.2% and 9.1%. Trends vary widely between countries, due to increases and decreases in production of the various chemicals over the 29-year period.

Figure 4.10 2B8 Petrochemical and carbon black production: EU-28+ISL CO_2 emissions

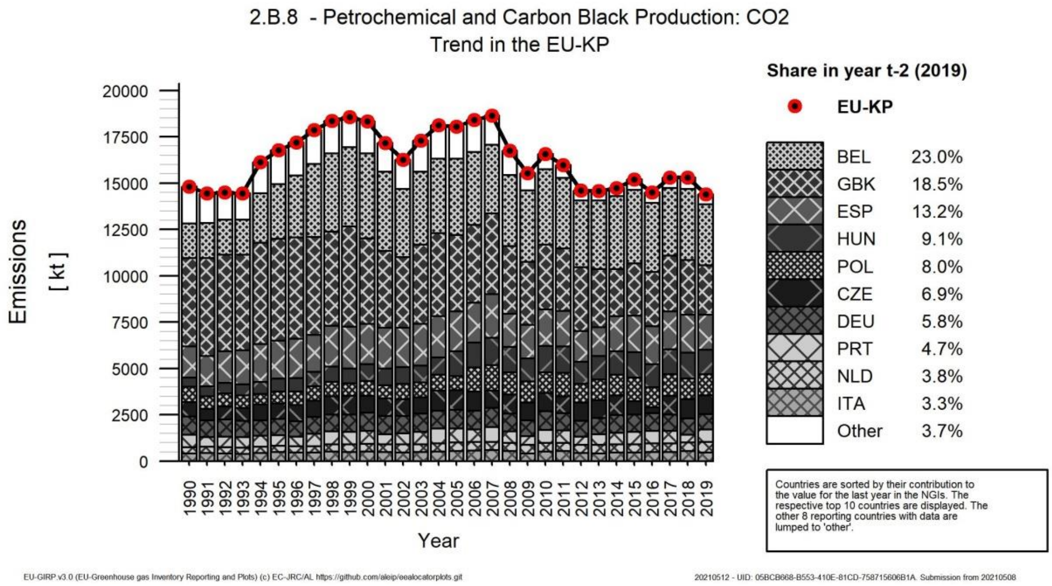


Table 4.22: 2B8 Petrochemical and carbon black production CO_2

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Belgium	1 882	3 852	3 308	23.0%	1 425	76%	-544	-14%	T3	PS
Bulgaria	346	NO,NA	NO,NA	-	-346	-100%	-	-	NA	NA
Croatia	192	NO,IE	NO,IE	-	-192	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	792	1 020	998	6.9%	206	26%	-21	-2%	T1	D,PS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
France	376	199	181	1.3%	-194	-52%	-17	-9%	T1,T2,T3	CS,D,PS
Germany	974	880	830	5.8%	-144	-15%	-50	-6%	T1,T2	CS,D
Greece	29	NO,NA	NO,NA	-	-29	-100%	-	-	NA	NA
Hungary	504	1 395	1 307	9.1%	802	159%	-88	-6%	T3	PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	422	542	477	3.3%	55	13%	-65	-12%	T2	CR,PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	24	NO	NO	-	-24	-100%	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	336	458	554	3.8%	218	65%	96	21%	CS	CS
Poland	806	1 136	1 147	8.0%	341	42%	12	1%	T1	D
Portugal	672	429	681	4.7%	9	1%	252	59%	NO	NO
Romania	574	NO	5	0.0%	-569	-99%	5	∞	D	D
Slovakia	429	399	344	2.4%	-85	-20%	-55	-14%	T2	CS,PS
Slovenia	16	NO	NO	-	-16	-100%	-	-	NA	NA
Spain	1 684	2 044	1 893	13.2%	210	12%	-150	-7%	T1,T3	D,PS
Sweden	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-	NA	NA
United Kingdom	4 752	2 936	2 665	18.5%	-2 086	-44%	-270	-9%	CS,T1	CS,D
EU-27+UK	**14 810**	**15 289**	**14 390**	**100%**	**-420**	**-3%**	**-899**	**-6%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 752	2 936	2 665	18.5%	-2 086	-44%	-270	-9%	CS,T1	CS,D
EU-KP	**14 810**	**15 289**	**14 390**	**100%**	**-420**	**-3%**	**-899**	**-6%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

The methods provided in this table are consistent with the information submitted by Member States in their national inventory submissions. The Netherlands use a country-specific method and report 'CS' accordingly. The level of complexity of the method applied by the Netherlands is Tier 1 (T1). Romania reports a default ('D') method, which corresponds to Tier 1 (T1).
The table lists methods and emission factors used in the latest inventory year. Bulgaria, Croatia, Greece, Lithuania and Slovenia reported emissions from petrochemical and carbon black production in 1990. The methodological tier used in that year is Tier 1 (T1) for Bulgaria, Greece, Lithuania and Slovenia and Tier 2 (T2) for Croatia.

4.2.2.5 Chemical industry – Fluorochemical production (CRF Source Category 2.B.9)

Table 4.23 Key categories for sector 2B9 (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2018		1990	2018	
2.B.9 Fluorochemical Production: no classification (HFCs)	29033	1807	T	L	0	100%
2.B.9 Fluorochemical Production: no classification (Unspecified mix of HFCs and PFCs)	5567	47	T	0	0	100%

In this subcategory, by-product emissions and fugitive emissions are to be reported.

As regards by-product emissions, the generation of HFC-23 as a by-product during the manufacture of HCFC-22 and HFC-32 is particularly relevant due to its high global warming potential of 14,800. HFC-23 is primarily generated during the fluorination of chloroform (trichloromethane, CHCl3 or R20). Since chloroform is a feedstock for chlorodifluoromethane (HCFC-22 or R22), HFC-23 is a by-product during the manufacture of this chemical which is nowadays mainly used as feedstock. The HFC-23 yield amounts to 2-3% of the amount of R22 produced. In addition, where R22 is used as an intermediate product or feedstock this may also lead to HFC-23 by-production. This is the case e.g. for some production pathways of difluoromethane (HFC-32 or R32). HFC-32 is widely used as a single substance refrigerant but has also been included in a number of frequently used refrigerant blends such as the R407 series (10-30% R32) and R410A (50% R32) for many years. Production of these blends may therefore also involve HFC-23 by-production. (EU Commission, 2015)

It is estimated that in 1990 the HFC-23 released from HCFC-22 plants was at most 4 percent of the global production of HCFC-22 (U.S. EPA, 20019), in the absence of abatement measures. Before the mid-1990s, ten HCFC-22 plants were operated in Europe. At that time, HFC-23 by-product emissions were partly captured and processed but emissions were also high. In the late 1990s, HFC-23 emissions accounted for about half of the EU's F-gas emissions. Due to the closure of several HCFC production plants and the installation of abatement systems in the remaining facilities, HFC-23 emissions were significantly reduced.

In fluorochemical manufacture also other fluorinated greenhouse gases can occur as by-products including e.g. CF4, C2F6, C3F8, C4F10, C5F12, C6F14 as well as SF_6. The type and amount of these by-product emissions depends on the applied production pathway and installed abatement technology.

Fugitive emissions are also released during the production process of F-gases. Hence certain amounts of emissions of all types of F-gases that are manufactured in the EU are reported in this subcategory.

[19] U.S. EPA (2001). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1999. United States Environmental Protection Agency, Report No. EPA 236-R-01-001, Washington, U.S.A., 2001.

In the last decades, the production processes have been optimized in all facilities so that this type of emissions has been significantly reduced as well.

Several Member States report “unspecified mix of HFCs and PFCs” from 2.B.9 since the waste gases still contain F-gas emissions after the abatement process.

Table 4.24: 2B9 Fluorochemical production – HFCs: Countries’ contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	-	-	-	-	-	-	-	-	-	-
Belgium	NO	1 620	1 288	71.3%	1 288	∞	-331	-20%	NA	NA
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	4 374	154	136	7.5%	-4 238	-97%	-18	-12%	T3	PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	1 183	NO	NO	-	-1 183	-100%	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	444	1	1	0.1%	-443	-100%	0	-19%	CS	PS
Latvia	NA	NA	NA	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Netherlands	5 606	247	381	21.1%	-5 225	-93%	134	54%	NA	NA
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	NO,NA	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	3 040	NO	NO	-	-3 040	-100%	-	-	NA	NA
Sweden	-	-	-	-	-	-	-	-	-	-
United Kingdom	14 387	NO	NO	-	-14 387	-100%	-	-	NA	NA
EU-27+UK	**29 033**	**2 022**	**1 807**	**100%**	**-27 227**	**-94%**	**-216**	**-11%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	14 387	NO	NO	-	-14 387	-100%	-	-	NA	NA
EU-KP	**29 033**	**2 022**	**1 807**	**100%**	**-27 227**	**-94%**	**-216**	**-11%**	**-**	**-**

Table 4.25: 2B9 Fluorochemical production: Countries' contributions to Unspecified mix of HFC and PFC emissions and information on method applied, activity data and emission factor

Member State	Unspecified mix of HFCs and PFCs Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	-	-	-	-	-	-	-	-	-	-
Belgium	-	-	-	-	-	-	-	-	NA	NA
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Germany	5 567	53	47	100.0%	-5 520	-99%	-6	-11%	T3	PS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	-	-	-	-	-	-	-	-	-	-
Latvia	NA	NA	NA	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NA	NA	NA	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	NO	NO	NO	-	-	-	-	-	NO	NO
Portugal	NO,NA	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	-	-	-	-	-	-	-	-	-	-
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-27+UK	**5 567**	**53**	**47**	**100%**	**-5 520**	**-99%**	**-6**	**-11%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**5 567**	**53**	**47**	**100%**	**-5 520**	**-99%**	**-6**	**-11%**	**-**	**-**

Table 4.26: 2B Chemical production: Contribution of MS to EU recalculations in HFCs for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2018		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Italy	-	-	-0.1	-9.4	NIR, p. 141/142: HFC23 emissions from HCFC22 had been drastically reduced since 1996 due to the installation of a second thermal oxidation system in the facility located in Spinetta Marengo (the only facility currently producing HCFC22 in Italy). Productions and emissions from 1990 to 1995 are constant as supplied by industry; from 1996, untreated leaks have been collected and sent to the thermal oxidation system, thus allowing reduction of emissions under 100 kg (E.F. 3.3 g of HFC23/t of HCFC22). CF4 by-product emissions in HCFC22 production process have been fully investigated, information supplied by the operator has allowed estimating emissions for the whole time series. This information about productions and emissions is yearly directly updated by the producer, and it is also reported in the framework of the national PRTR register, confirming that the technology is fully operating. In 2019 a drastic reduction of CF4 emission has occurred: as part of Solvay's commitment to reducing greenhouse gas emissions, a new project for the abatement of CF4 by thermo-oxidation has been developed. This project, as communicated by Solvay, has not yet been fully implemented, for this reason further reductions in emissions are expected. Emissions from fluorochemical production have been checked with data reported to the national EPER/EPRTR registry. CF4 emissions have been then accounted for along the whole time series for category 2B9.

	1990		2018		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
EU27+UK	-	-	**-0.1**	**-0.0**	
EU-KP	-	-	**-0.1**	**-0.0**	

4.2.3 Metal Industry (CRF Source Category 2C)

This source category includes two key sources for level and trend, namely CO_2 emissions from 2C1 Iron and Steel Production and PFC emissions from 2C3 Aluminium Production (*Table 4.27*).

Table 4.27: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 2C (Table excerpt).

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2019		1990	2019	
2.C.1 Iron and Steel Production: no classification (CO_2)	108663	70719	T	L	L	98,1%
2.C.3 Aluminium Production: no classification (PFCs)	21277	504	T	L	0	100%

Table 4.28 **2C Metal Industry: Countries' contributions to** total GHG, CO2, HFC, PFC and SF6 emissions

summarises information by countries on total GHG emissions, CO_2, SF_6 and PFC emissions from Metal Production. Between 1990 and 2019, CO_2 emissions from 2C Metal Production decreased by 35% of total EU-KP (without LULUCF). The absolute decrease of GHG emissions was largest in Romania, Germany, France, United Kingdom and Belgium (in decending order).

Table 4.28 2C Metal Industry: Countries' contributions to total GHG, CO_2, HFC, PFC and SF_6 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2019 (kt)	HFC emissions in 1990 (kt CO2 equivalents)	HFC emissions in 2019 (kt CO2 equivalents)	PFC emissions in 1990 (kt CO2 equivalents)	PFC emissions in 2019 (kt CO2 equivalents)	SF6 emissions in 1990 (kt CO2 equivalents)	SF6 emissions in 2019 (kt CO2 equivalents)
Austria	8 177	10 302	6 786	10 299	-	-	1 149	NO	242	3
Belgium	10 106	4 046	10 092	4 029	-	-	-	-	-	-
Bulgaria	1 629	161	1 603	161	NA	NA	NA	NA	NA	NA
Croatia	1 581	5	336	5	NO	NO	1 240	NO	NO	NO
Cyprus	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Czechia	9 670	6 221	9 655	6 207	NO	NO	NO	NO	NO	NO
Denmark	60	0	30	0	NO	NO	NO	NO	30	NO
Estonia	0	2	0	2	NO	NO	NO	NO	NO	NO
Finland	1 976	1 866	1 976	1 866	NO	-	NO	-	NO	NO
France	22 105	13 448	17 676	13 317	NO,IE	NO,IE	3 567	67	721	31
Germany	28 188	19 340	25 080	19 167	NA	10	2 889	91	180	50
Greece	1 203	1 111	1 012	1 006	NO	NO	190	105	NO	NO
Hungary	3 701	1 223	3 317	1 218	NO	NO	376	NO	NO	NO
Ireland	26	NO	26	NO	NO	NO	NO	NO	NO	NO
Italy	6 421	1 646	4 378	1 602	NO	6	1 975	NO	NO	NO
Latvia	70	NO	70	NO	NO	NO	NO	NO	NO	NO
Lithuania	17	2	17	2	NO	NO	NO	NO	NO	NO
Luxembourg	985	106	985	106	-	-	-	-	-	-
Malta	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	3 090	45	452	18	NO	NO	2 638	27	NO	NO
Poland	5 817	2 390	5 652	2 377	NA	NA	142	NO,NA	NA,NO	NO,NA
Portugal	447	94	446	94	NA	NO	NO,NA	NO	NO,NA	NO
Romania	16 049	4 192	13 220	4 183	NO	NO	2 808	4	NA,NO	NO,NA
Slovakia	4 901	4 074	4 586	4 068	NO	NO	315	5	NO	NO
Slovenia	551	190	343	178	NO	NO	208	12	NO	NO
Spain	4 730	2 556	3 537	2 493	NO,NA	NO,NA	1 164	41	NO,NA	NO,NA
Sweden	3 871	3 642	3 260	3 592	NO	1	569	49	23	NO
United Kingdom	9 366	2 413	7 371	2 247	NO	2	1 553	6	387	142
EU-27+UK	**144 736**	**79 075**	**121 907**	**78 238**	**NA,IE,NO**	**19**	**20 783**	**407**	**1 582**	**226**
Iceland	844	1 806	348	1 706	NO	NO	495	97	NO	NO
United Kingdom (KP)	9 366	2 413	7 371	2 247	NO	2	1 553	6	387	142
EU-KP	**145 580**	**80 881**	**122 255**	**79 944**	**NA,IE,NO**	**19**	**21 277**	**504**	**1 582**	**226**

Presented methods and emission factor information refer to the last inventory year.

Note: Total GHG emissions given in this table include CO_2, N_2O, CH_4, HFC, PFC and SF_6.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 4.11: 2C Metal Industry CO_2 – Trend in EU-KP

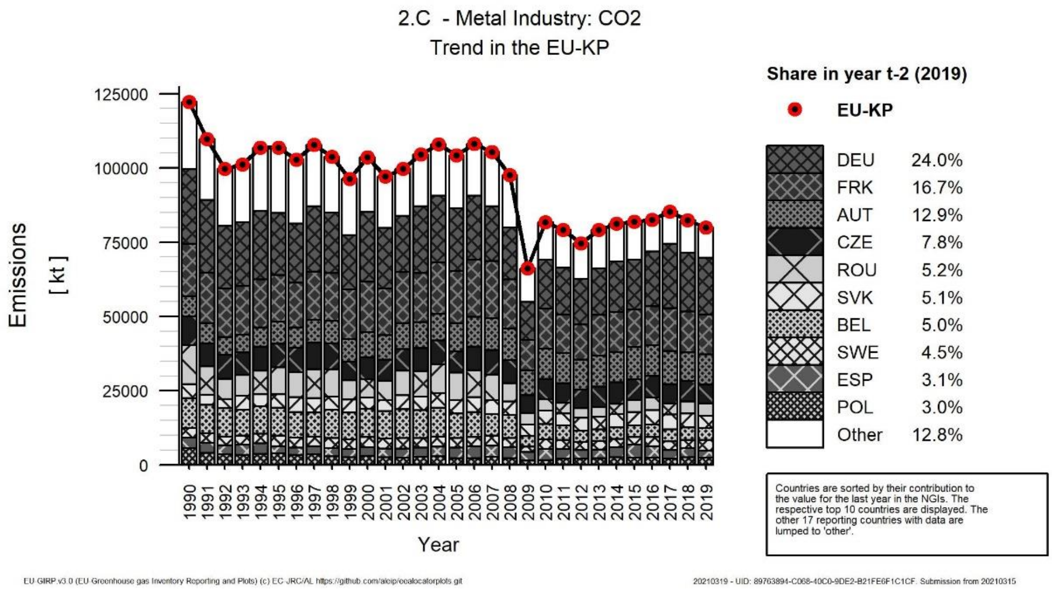


Table 4.29 provides information on the contribution of countries to EU recalculations of CO_2 emissions from 2C Metal Production for 1990 and 2018, including main explanations.

Table 4.29: 2C Metal Production: Contribution of countries to EU recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 and percent of sector total)

	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-77	-0.8	Revision of energy balance: 76 kt CO_2 have ben reallocated from category 2C1 to 1A2a
Belgium	-	-	0	0.0	Recalculations in category 2C are mainly due to, in the Flemish region, a reallocation from zinc production emissions from 2C7 to 2C6; a reallocation of casting of iron and processing of metals from 2C7 to 2C1f; a reallocation of casting of iron and processing of metals from 2B10 to 2C1f
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czechia	-	-	-	-	
Denmark	-	-	-	-	
Estonia	-	-	-	-	
Finland	0	0.0	8	0.4	Missing data for new fuel added, updated data, allocation between 2C and 1A2a
France	11 435	183.2	9 349	210.3	Change in the CO_2 emissions estimates. Reallocation of CO_2 emissions from solid fuels (for energy and non-energy use) from 1A2a to 2C1
Germany	0	0.0	-1 420	-6.7	Updated activity data according to final energy balance
Greece	-0	-0.0	-	-	
Hungary	0	0.0	-46	-3.3	Correction for double counts in steel production and sinter production
Ireland	-	-	-	-	

	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
Italy	-	-	-0	-0.0	Minor recalculations occurred in the period 1999-2009 for CO_2 emissions from zinc/lead production because of a first update of activity data due to the survey on data contained in the IPPC permits.
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Luxembourg	-	-	0	0.0	
Malta	-	-	-	-	
Netherlands	-	-	-	-	
Poland	-	-	-0	-0.0	AD correction for steel production in electric furnaces
Portugal	-	-	-	-	
Romania	1 840	16.2	14	0.4	Recalculations have been made for the 1989-2004 period due to improvement in activity data on steel production in EAF and OH. An error was identified in taking over the activity data regarding the steel productions from INS (for the period 1989-2004 for the steel productions in EAF and for the period 1989-1992 for the steel productions in OH). Also, for 2013 and for the period 2015-2018, an improvement was made on the activity data regarding the steel production from induction furnaces by identifying an economic operator that produces steel in this type of furnace, but these recalculations did not influence the value of CO_2 emissions because emissions from steel production in induction furnaces are calculated on the basis of the reducing agent and are included in the Energy sector. (CRF Category 2.C.1.a)
Slovakia	-	-	-	-	
Slovenia	-	-	0	0.0	Correction of C/CO_2 conversion factor
Spain	-	-	-8	-0.2	New information available for activity data of EAF (electric arc furnaces) for the year 2018, involving categories 2C1a and 1A2a. Update of CO_2 EF under category 2C1f for years 2015/16/17/18.
Sweden	-	-	-0	-0.0	
United Kingdom	-30	-0.4	-16	-0.7	Firstly, an improvement to the way that petroleum coke use in electric arc furnaces is extrapolated back to 1990 increases 1990 emissions by 2 ktonnes CO_2. Secondly, there have been revisions to input data for the carbon balance used to generate carbon emission factors for fuels (coke, blast furnace gas) generated in steelmaking processes. The revisions to inputs feeds through to outputs and emission estimates for flaring of blast furnace gas, and use of coke breeze in sinter plant are recalculated as a result. The overall change in these two areas is a 24 ktonne CO_2 reduction in 1990 and a reduction of 16 ktonnes CO_2 for 2018.
EU28	13 245	12.2	7 805	10.7	
Iceland	-0	-0.0	-0	-0.0	
United Kingdom (KP)	-30	-0.4	-16	-0.7	See above.
EU28+ISL	13 245	12.1	7 805	10.5	

In the current submission no recalculations were performed in PFC emissions from 2C – Metal production.

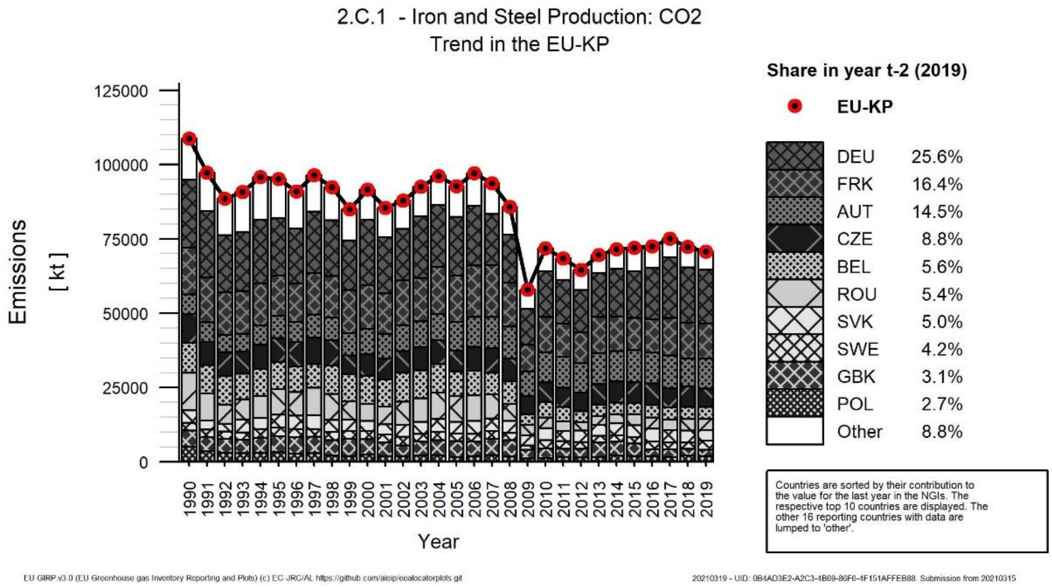
4.2.3.1 2C1 Iron and steel production

This source category includes emissions from the iron and steel industry. Crude iron is produced by the reduction of iron oxide ores mostly in blast furnaces, using coke or other forms of carbon as fuel and reducing agent. In most iron furnaces, the process is aided by the use of carbonate fluxes (limestone). Additional emissions occur as the limestone or dolomite flux releases CO_2 during reduction of pig iron in the blast furnace. Coke plays the dual role of fuel and reducing agent. Countries use different methods for the allocation of emissions that are described in Table 4.31.

CO_2 emissions from 2C1 Iron and Steel Production amounted to approximately 1.7 % of total GHG emissions (without LULUCF) in 2019. Germany accounts for 25.6 % of these emissions in the EU-KP, and France for 16.4% in 2019. Romania had the largest decrease in absolute terms between 1990 and 2019 while increases were encountered (in order of magnitude) in Austria, Sweden and Slovenia.

The overall emission trend between 1990 and 2019 roughly follows the trend of emissions that fluctuates due to varying production figures. Between 1990 and 2019, overall CO_2 emissions from iron and steel production decreased by 35% (Table 4.30). Between 2018 and 2019, emissions decreased by 2%.

Figure 4.12 2C1 Iron and Steel Production: CO_2 emissions – Trend in EU-KP



CO_2 emissions from iron and steel industry are reported by all countries except Cyprus, Estonia and Malta. Denmark, Ireland and Latvia reported emissions from this sector in 1990, but no more in 2019. All follow higher-tier methods and most use country or plant specific methods (see Table 4.30).

Table 4.30 2C1 Iron and Steel Production: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	6 610	9 419	10 271	14.5%	3 660	55%	852	9%	T1,T3	CS,PS
Belgium	10 048	4 122	3 925	5.6%	-6 123	-61%	-197	-5%	CS,T3	PS
Bulgaria	1 283	35	32	0.0%	-1 252	-98%	-4	-11%	T2	CS
Croatia	44	9	5	0.0%	-39	-89%	-4	-45%	OTH,T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	9 643	6 923	6 195	8.8%	-3 447	-36%	-728	-11%	CS,T2	CS,D,PS
Denmark	30	NO	NO	-	-30	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 967	2 060	1 844	2.6%	-124	-6%	-216.4	-11%	CS,T3	CS
France	15 786	11 924	11 588	16.4%	-4 197	-27%	-336.1	-3%	T2	CS
Germany	22 810	18 726	18 092	25.6%	-4 719	-21%	-635	-3%	T2	CS
Greece	105	91	81	0.1%	-23	-22%	-10	-11%	CS	PS
Hungary	3 155	1 356	1 218	1.7%	-1 937	-61%	-138	-10%	T3	PS
Ireland	26	NO	NO	-	-26	-100%	-	-	NA	NA
Italy	3 124	1 436	1 357	1.9%	-1 767	-57%	-79	-6%	T2	CR,CS,PS
Latvia	70	NO	NO	-	-70	-100%	-	-	NA	NA
Lithuania	17	2	2	0.0%	-15	-91%	0	-19%	T2	D
Luxembourg	985	112	104	0.1%	-881	-89%	-8	-8%	CS,T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	44	19	18	0.0%	-26	-59%	-1	-7%	T2	CS
Poland	4 959	2 152	1 897	2.7%	-3 062	-62%	-254	-12%	T2,T3	CS
Portugal	440	62	81	0.1%	-359	-82%	19	30%	T1,T3	D,PS
Romania	12 613	3 749	3 846	5.4%	-8 767	-70%	97	3%	T3	CS
Slovakia	4 168	4 188	3 554	5.0%	-614	-15%	-634	-15%	T2	PS
Slovenia	44	60	59	0.1%	15	35%	-1	-2%	T2	PS
Spain	2 501	1 606	1 398	2.0%	-1 103	-44%	-208	-13%	T2	CS,PS
Sweden	2 624	1 978	2 967	4.2%	343	13%	989	50%	T2,T3	PS
United Kingdom	5 570	2 270	2 186	3.1%	-3 384	-61%	-84	-4%	T2	CS
EU-27+UK	**108 663**	**72 299**	**70 719**	**100%**	**-37 945**	**-35%**	**-1 581**	**-2%**	**-**	**-**
Iceland	NO	NO,NA	NO,NA	-	-	-	-	-	NA	NA
United Kingdom (KP)	5 570	2 270	2 186	3.1%	-3 384	-61%	-84	-4%	T2	CS
EU-KP	**108 663**	**72 299**	**70 719**	**100%**	**-37 945**	**-35%**	**-1 581**	**-2%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

For this category, it is not relevant to analyse an average IEF across countries because of their varying emission allocation (the split between process and combustion related emissions for pig iron production, which is an important sub-category). Activity data, implied emission factors and CO_2 emissions for the various countries and sub-categories are provided in Table 4.31.

Table4.13 2C1 Iron and Steel Production: Implied emission factors

Member State	1990				Member State	2019				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
Austria	**Iron and steel production**			6610	**Austria**	**Iron and steel production**	-	-	10271		
	Steel	3921	1.68	6591		Steel	6882	1.49	10232	T1,T3	CS,PS
	Pig Iron	3444	NO,IE	IE		Pig Iron	5741	NO,IE	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NE	NO,IE	IE		Sinter	NE	NO,IE	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			20		Other	-	-	39		
	Electric Furnace Steel	370	0	20		Electric Furnace Steel	710	0.06	39	T3	PS
Belgium	**Iron and steel production**			10048	**Belgium**	**Iron and steel production**	-	-	3925		
	Steel	11570	0.73	8445		Steel	7698	0.50	3819	CS,T3	PS
	Pig Iron	9415	NA,IE	IE		Pig Iron	4934	IE,NA	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	13075	0.12	1589		Sinter	5349	0.02	101	CS,T3	PS
	Pellet	660	NO,IE	IE		Pellet	NO	NO	NO	NA	NA
	Other			14		Other	-	-	6		
	Use of electrodes	NA	NA	14		Use of electrodes	1486	0.00	6	CS,T3	PS
Bulgaria	**Iron and steel production**			1283	**Bulgaria**	**Iron and steel production**	-	-	32		
	Steel	2180	0.59	1283		Steel	580	0.05	32	T2	CS
	Pig Iron	1143	NO,IE	IE		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	C	NO,IE	IE		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NA		Other	-	-	NA		

Member State	1990				Member State	2019				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
Croatia	**Iron and steel production**			44	**Croatia**	**Iron and steel production**	-	-	5		
	Steel	424	0.05	20		Steel	69	0.07	5	T3	PS
	Pig Iron	209	0.12	24		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	0		
Cyprus	**Iron and steel production**			NO	**Cyprus**	**Iron and steel production**	-	-	NO		
	Steel	NO	NO	NO		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Czechia	**Iron and steel production**			9643	**Czechia**	**Iron and steel production**	-	-	6195		
	Steel	8190	IE,NA	IE		Steel	4603	IE,NA	IE	NA	NA
	Pig Iron	6106	IE,NA	IE		Pig Iron	3648	IE,NA	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	8469	IE,NA	IE		Sinter	5203	IE,NA	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			9643		Other	-	-	6195		
	Use of limestone and dolomite	891	1	462		Use of limestone and dolomite	2352	2.34	5502	CS	PS
	Metallurgical coke	7125	1	9180		Metallurgical coke	2352	2.34	5502	T2	CS,D
Denmark	**Iron and steel production**			30	**Denmark**	**Iron and steel production**	-	-	NO		

Member State	1990				Member State	2019				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
	Steel	614	0.05	30		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Estonia	**Iron and steel production**			NO	**Estonia**	**Iron and steel production**	-	-	NO		
	Steel	NO	NO	NO		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Finland	**Iron and steel production**			1967	**Finland**	**Iron and steel production**	-	-	1844		
	Steel	2861	0.69	1967		Steel	3444	0.54	1844	CS,T3	CS
	Pig Iron	NO	NO,IE	IE		Pig Iron	NO	NO,IE	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NA	IE,NO	IE		Sinter	NA	NO,IE	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
	Other Iron and Steel Production.Other non-specified	487	NO	NO		Other Iron and Steel Production.Other non-specified	836	NO	NO	NA	NA
France	**Iron and steel production**			15786	**France**	**Iron and steel production**	-	-	11588		
	Steel	19073	0.83	15786		Steel	14527	0.79	11542	T2	CS
	Pig Iron	IE	IE	IE		Pig Iron	IE	IE	IE	NA	NA

Member State	1990				Member State	2019				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	IE	IE	IE		Sinter	IE	IE	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	46		
Germany	**Iron and steel production**			22810	**Germany**	**Iron and steel production**	-	-	18092		
	Steel	43939	0.52	22810		Steel	39627	0.46	18092	T2	CS
	Pig Iron	32263	NO,IE	IE		Pig Iron	25996	NO,IE	IE	NA	NA
	Direct reduced iron	IE	IE	IE		Direct reduced iron	IE	IE	IE	NA	NA
	Sinter	IE	IE	IE		Sinter	IE	IE	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Greece	**Iron and steel production**			105	**Greece**	**Iron and steel production**	-	-	81		
	Steel	999	0.10	105		Steel	1350	0.06	81	CS	PS
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Hungary	**Iron and steel production**			3155	**Hungary**	**Iron and steel production**	-	-	1218		
	Steel	2963	0.12	348		Steel	1769	0.10	171	T3	PS
	Pig Iron	1697	1.65	2427		Pig Iron	1151	1.63	785	T3	PS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	72	5.28	380		Sinter	49	5.36	262	T3	PS
	Pellet	IE	IE	IE		Pellet	IE	IE	IE	NA	NA
	Other			NO		Other	-	-	NO		

Member State	1990				Member State	2019				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
Iceland	**Iron and steel production**			NO	**Iceland**	**Iron and steel production**	-	-	NO,NA		
	Steel	NO	NO	NO		Steel	NO	NO,NA	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NA		
Ireland	**Iron and steel production**			26	**Ireland**	**Iron and steel production**	-	-	NO		
	Steel	326	0.08	26		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Italy	**Iron and steel production**			3124	**Italy**	**Iron and steel production**	-	-	1357		
	Steel	25467	0.05	1346		Steel	23191	0.04	959	T2	CR,CS,PS
	Pig Iron	11852	0.15	1778		Pig Iron	4619	0.09	398	T2	CR,CS,PS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	13577	NO,NA	NA		Sinter	5332	NO,NA	NA	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Latvia	**Iron and steel production**			70	**Latvia**	**Iron and steel production**	-	-	NO		
	Steel	550	0.13	70		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA

Member State	1990				Member State	2019				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Lithuania	**Iron and steel production**			17	**Lithuania**	**Iron and steel production**	-	-	2		
	Steel	NO	NO	NO		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			17		Other	-	-	2		
	Cast Iron	106	0	17		Cast Iron	2	0.90	2	T2	D
Luxem-bourg	**Iron and steel production**			985	**Luxem-bourg**	**Iron and steel production**	-	-	104		
	Steel	3506	0.12	404		Steel	2104	0.05	104	CS,T2	CS
	Pig Iron	2645	0.08	200		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	4804	0.08	380		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Malta	**Iron and steel production**			NO	**Malta**	**Iron and steel production**	-	-	NO		
	Steel	NO	NO	NO		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		

Member State	1990				Member State	2019				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
Nether-lands	**Iron and steel production**			44	Nether-lands	**Iron and steel production**	-	-	18		
	Steel	5162	0.01	43		Steel	6857	0.00	18	T2	CS
	Pig Iron	NA	NO,IE	IE		Pig Iron	NA	NO,IE	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NA	NO,IE	IE		Sinter	NA	NO,IE	IE	NA	NA
	Pellet	NA	NO,IE	IE		Pellet	NA	NO,IE	IE	NA	NA
	Other			1		Other	-	-	NO		
	Other Iron and Steel Production.Other non-specified	NA	NA	1		Other Iron and Steel Production.Other non-specified	NA	NO	NO	NA	NA
Poland	**Iron and steel production**			4959	Poland	**Iron and steel production**	-	-	1897		
	Steel	IE	IE	IE		Steel	IE	IE	IE	NA	NA
	Pig Iron	8657	0.12	1043		Pig Iron	4242	0.15	655	T3	CS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	11779	0.07	841		Sinter	6468	0.05	310	T3	CS
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			3075		Other	-	-	933		
	Basic Oxygen Furnace Steel	7207	0	929		Basic Oxygen Furnace Steel	4185	NO,NA	NO	T2	CS
	Electric Furnace Steel	2309	0	85		Electric Furnace Steel	4185	NO,NA	NO	T2	CS
	Open-hearth Steel	3945	1	2060		Open-hearth Steel	4185	NO,NA	NO	NA	NA
Portugal	**Iron and steel production**			440	Portugal	**Iron and steel production**	-	-	81		
	Steel	746	0.10	73		Steel	2033	0.04	81	T1,T3	D,PS
	Pig Iron	339	0.88	298		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	344	0.20	69		Sinter	NO	NO	NO	NA	NA

Member State	1990 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Member State	2019 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Method	Emission factor informa-tion
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Romania	**Iron and steel production**			12613	Romania	**Iron and steel production**	-	-	3846		
	Steel	9769	1.29	12613		Steel	3617	1.06	3846	T3	CS
	Pig Iron	5916	NO,IE	IE		Pig Iron	C	NO,IE	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	11357	NO,IE	IE		Sinter	2458	NO,IE	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Slovakia	**Iron and steel production**			4168	Slovakia	**Iron and steel production**	-	-	3554		
	Steel	3562	1.17	4150		Steel	3609	0.98	3544	T2	PS
	Pig Iron	17	NO,IE	IE		Pig Iron	NO	NO,IE	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	IE	NO,IE	IE		Sinter	IE	NO,IE	IE	NA	NA
	Pellet	IE	NO,IE	IE		Pellet	IE	NO,IE	IE	NA	NA
	Other			18		Other	-	-	11		
	EAF production of steel	311	0	18		EAF production of steel	328	0.03	11	T2	PS
Slovenia	**Iron and steel production**			44	Slovenia	**Iron and steel production**	-	-	59		
	Steel	632	0.07	44		Steel	639	0.09	59	T2	PS
	Pig Iron	NO	NO,NA	NO		Pig Iron	NO	NO,NA	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Spain	**Iron and steel production**			2501	Spain	**Iron and steel production**	-	-	1398		

Member State	1990				Member State	2019				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
	Steel	13163	0.08	1045		Steel	13642	0.05	640	T2	CS,PS
	Pig Iron	C	C	246		Pig Iron	C	C	346	T2	CS
	Direct reduced iron	IE	IE,NA	IE		Direct reduced iron	IE	IE,NA	IE	NA	NA
	Sinter	C	C	538		Sinter	C	C	206	T2	CS
	Pellet	IE	IE,NA	IE		Pellet	IE	IE,NA	IE	NA	NA
	Other			672		Other	-	-	206		
	Flaring in iron and steel production	C	C	672		Flaring in iron and steel production	C	C	206	T2	PS
Sweden	**Iron and steel production**			2624	Sweden	**Iron and steel production**	-	-	2967		
	Steel	1755	0.09	156		Steel	1846	C,NA	C	T2	PS
	Pig Iron	2736	0.77	2094		Pig Iron	3172	0.80	2541	T3	PS
	Direct reduced iron	109	1.19	129		Direct reduced iron	95	C,NA	C	T3	PS
	Sinter	1058	0.20	212		Sinter	NO	NO	NO	NA	NA
	Pellet	13079	0.00	33		Pellet	24032	0.01	131	T2	PS
	Other			NO		Other	-	-	NO		
United Kingdom	**Iron and steel production**			5570	United Kingdom	**Iron and steel production**	-	-	2186		
	Steel	17904	0.01	223		Steel	7286	0.01	97	T2	CS
	Pig Iron	12463	0.15	1828		Pig Iron	5622	0.14	812	T2	CS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	C	0.28	3519		Sinter	C	0.23	1277	T2	CS
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

As shown in the table, several countries use the notation IE for some categories. This can be explained by the fact that they make use of carbon balances and several processes occur within the same industrial plant, which makes differentiation into the various sub-categories difficult. For example, several countries include emissions from the production of pig iron (which occurs at integrated iron and steel production plants) under “steel production”.

According to the 2006 IPCC guidelines, all emissions from iron and steel production should be reported under category 2.C.1, irrespective of their role as reducing agent or fuel for energy use.

However, some countries report emissions from blast furnace gas and from basic oxygen furnace gas under 1A2a instead of 2C1 because this can be interpreted as emissions from energy supply.

Thus, for an overview of total emissions it seems to be more convenient to take into account all emissions covered by the combined category 1A2a + 2C1. Resulting emissions for this combined category are given in Table 4.31.

Table 4.31 CO_2 Emissions (2019) from iron and steel production: 1A2a, 2C1 and combined (sum of both categories). The column "Share 2C1" denotes the ratio of emissions under 2C1 and combined emissions.

Member State	CO_2 emissions in kt			Share in EU-KP emissions in 2019	Share 2C1
	1A2a	2C1	Combined		
Austria	1 859	10 271	12 129	8%	85%
Belgium	1 234	3 925	5 159	3%	76%
Bulgaria	121	32	152	0.1%	21%
Croatia	41	5	46	0.03%	11%
Cyprus	NO,IE	NO	-	-	-
Czech Republic	1 405	6 195	7 601	5%	82%
Denmark	99	NO	99	0.1%	-
Estonia	1	NO	1	0.001%	-
Finland	821	1 844	2 665	2%	69%
France	5 149	11 588	16 737	11%	69%
Germany	35 730	18 092	53 821	34%	34%
Greece	96	81	177	0%	46%
Hungary	194	1 218	1 412	1%	86%
Ireland	2	NO	2	0.001%	-
Italy	9 820	1 357	11 177	7%	12%
Latvia	NO	NO	-	-	-
Lithuania	NO	2	2	0.001%	100%
Luxembourg	297	104	400	0.3%	26%
Malta	NO	NO	-	-	-
Netherlands	4 886	18	4 904	3%	0.4%
Poland	4 545	1 897	6 442	4%	29%
Portugal	94	81	175	0.1%	46%
Romania	847	3 846	4 692	3%	82%
Slovakia	2 442	3 554	5 997	4%	59%
Slovenia	215	59	274	0.2%	22%
Spain	5 637	1 398	7 035	4%	20%
Sweden	1 569	2 967	4 536	3%	65%
United Kingdom	9 397	2 186	11 583	7%	19%
EU-27+UK	**86 500**	**70 719**	**157 218**	**100%**	**45%**
Iceland	2	NO,NA	-	-	-
United Kingdom (KP)	9 397	2 186	11 583	7%	19%
EU-KP	**86 501**	**70 719**	**157 218**	**100%**	**45%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

It can be seen that the ratio of emissions under 2C1 and combined emissions (see column "Share 2C1" in Table **4.31**) varies across countries. This indicates that the boundary between 1A2a and 2C1 is not uniformly interpreted by countries. The eight countries with largest CO_2 emissions from iron and steel production allocate their emissions in the following ways in 2019:

- Germany: Approximately 34% of emissions are reported under 2C1. This category comprises process-related CO_2 emissions (including emissions from carbonate use). However, emissions from energy-related use of top gas and converter gas are reported under the respective sub-categories of sector 1.

- United Kingdom: Major share of emissions (81%) is reported under 1A2a. Emissions from sintering (coke breeze and carbonates), from flared blast furnace gas and from electric and ladle arc furnances are reported under 2C1.
- France: For the 2019 inventory, France changes its methodology of estimating and allocating CO_2 emissions in the iron and steel sector sub-categories (process and combustion), to be more compliant with the 2006 IPCC Guideines. While major share of emissions (84%) was reported under 1A2a in the 2018 inventory, 31% are now allocated in 1A2a and 69% are allocated in 2C1 in the 2019 inventory. Emissions from sinter production are reported under 1A2a.
- Austria: 85% of emissions are reported under 2C1. Generally, all emissions from iron and steel production are reported under this category, irrespective of their role as reducing agent or fuel, but emissions related to the coke oven and to on-site power plants are reported under category 1A2a.
- Italy: Major share of emissions (88%) is reported under 1A2a. CO_2 emissions due to the consumption of coke, coal and other reducing agents used in the iron and steel industry have been accounted for as fuel consumption and reported in the energy sector. In sector 2C1, emissions are reported from carbonates used in sinter plants and in basic oxygen furnaces, emissions related to steel and pig iron scraps and emissions from graphite electrodes consumed in electric arc furnaces.
- Czech Republic: 82% of emissions are reported under category 2C1. It also includes emissions from limestone and dolomite use.
- Spain: Major share of emissions (80%) is reported under 1A2a, including emissions from coke production.
- Poland: 29% of CO_2 emissions are reported in 2C1, including steel production (basic oxygen furnaces and electric arc furnaces), pig iron production, sinter production.

4.2.3.2 2C3 Aluminium production

This category includes PFC emissions from aluminium production. Two PFCs, tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6), are known to be emitted from the process of primary aluminium smelting. These PFCs are formed during the phenomenon known as the anode effect, when the aluminium oxide concentration in the reduction cell electrolyte is low.

Information on CO_2 emissions from Aluminium production can be found at the end of this section.

Table 4.32 summarises information by countries on emission trends for the key source PFCs from 2C3 Aluminium Production. PFC emissions from 2C3 Aluminium production account for 0.01 % of total EU-KP GHG emissions (without LULUCF) in 2019. Between 1990 and 2019, PFC emissions from this source decreased by 98 %. In 2019, Greece contributed the highest share among the EU-KPs, amounting to 20.8 % of overall emissions, followed by Iceland (19.2 %), Germany (18 %), and France (13.3%). Of the 12 countries reporting PFC emissions under this category in 2019, eight use plant or country-specifc emission factors.

Table 4.32 2C3 Aluminium Production: Countries' contributions to PFC emissions and information on method applied and emission factor

Member State	PFCs Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1 149	NO	NO	-	-1 149	-100%	-	-	NA	NA
Belgium	-	-	-	-	-	-	-	-	NA	NA
Bulgaria	-	-	-	-	-	-	-	-	NA	NA
Croatia	1 240	NO	NO	-	-1 240	-100%	-	-	NA	NA
Cyprus	-	-	-	-	-	-	-	-	0	0
Czechia	-	-	-	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	-	-	-	-	-	-	-	NA	NA
Finland	NO	-	-	-	-	-	-	-	NA	NA
France	3 567	65	67	13.3%	-3 500	-98%	2.5	4%	T2,T3	CS,PS
Germany	2 889	126	91	18.0%	-2 798	-97%	-35	-28%	T3	CS
Greece	190	99	105	20.8%	-85	-45%	6	6%	T3	PS
Hungary	376	NO	NO	-	-376	-100%	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	1 975	NO	NO	-	-1 975	-100%	-	-	NA	NA
Latvia	-	-	-	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	-	-	-	-	-	-	-	-	NA	NA
Malta	-	-	-	-	-	-	-	-	NA	NA
Netherlands	2 638	22	27	5.4%	-2 610	-99%	5	21%	NA	NA
Poland	142	NO	NO	-	-142	-100%	-	-	NA	NA
Portugal	NO,NA	NO	NO	-	-	-	-	-	NA	NA
Romania	2 808	5	4	0.8%	-2 805	-100%	-1	-23%	T2	D,PS
Slovakia	315	8	5	1.0%	-310	-98%	-3	-33%	T2	PS
Slovenia	208	16	12	2.3%	-196	-94%	-4	-24%	T3	D,PS
Spain	1 164	124	41	8.1%	-1 124	-96%	-83	-67%	T2	D
Sweden	569	62	49	9.8%	-519	-91%	-12	-20%	T2	D
United Kingdom	1 553	10	6	1.2%	-1 547	-100%	-4	-40%	T2	PS
EU-27+UK	**20 783**	**536**	**407**	**81%**	**-20 375**	**-98%**	**-129**	**-24%**	**-**	**-**
Iceland	495	76	97	19.2%	-398	-80%	21	27%	T2	D
United Kingdom (KP)	1 553	10	6	1.2%	-1 547	-100%	-4	-40%	T2	PS
EU-KP	**21 277**	**613**	**504**	**100%**	**-20 773**	**-98%**	**-108**	**-18%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

All countries reduced their emissions from this source between 1990 and 2019. France, Germany, the Netherlands, and Romania had the largest decreases in absolute terms. The decreasing trend of PFC emissions from this key source between 1990 and 2019 is due to production stop or decline and due to process improvements. The emission peak in 2002 (see Figure 4.14) can be explained by technological changes and sub-optimal conditions of operation (in France and in the Netherlands).

In the review of the 2014 inventory submission of the European Union, the ERT recommended that the European Union provide in the NIR adequate methodology overviews to enable the ERT to make a thorough review of the AD and EF used in the aluminium production emission estimations provided by Greece, the Netherlands and Sweden. This information is provided below. Additional information can be found in the individual NIRs (Greece: section 4.13, Netherlands: section 4.4, Sweden: section 4.4.3). An overview of methods can also be found in Annex III to this year's inventory submission.

Greece: The estimation of emissions from aluminium production is performed in close collaboration with the sole plant operating in Greece and since 2013 ETS verified reports are also provided to the inventory team. Carbon dioxide emissions from primary aluminium production are calculated using a highly detailed methodology, tracking the carbon content throughout the process. The methodology is based on the 2006 IPCC Tier 3 method, with small interventions that increase the certainty of the estimations. The equations are described in Greece's NIR.

Data are provided by the plant for years 2005-2012. Since detailed data for the previous years are not available, emissions of years 1990-2004 have been recalculated using the Overlap method in line with the IPCC GPG. It should be noted that the production methodology applied is Centre Worked Prebake with Feed Point System (PFPB methodology). Data since 2013 are provided by the verified ETS reports.

Aluminium production data are directly provided by the plant and are considered confidential. However, publicly available data from the US Geological Survey, the UN Commodity Statistics Database and the Greek Mining Enterprises Association are also used for QA/QC reasons. According to the recommendation made by the previous ERTs, Greece is reporting aluminium production based on these data, although the estimations are based on the more detailed and accurate production quantities provided directly by the plant. It should be mentioned that the reported values are the ones provided by the US Geological Survey, since they cover the whole of the time-series.

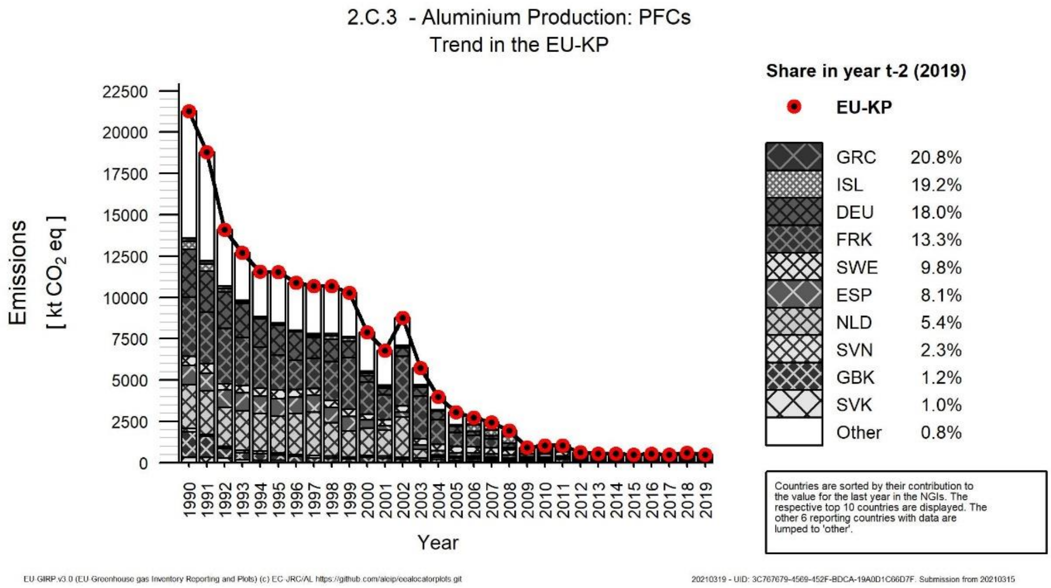
PFC emissions estimates are based on anode effect performance by calculating the anode effect overvoltage statistic (Overvoltage method) and are provided directly to the inventory team by the sole plant operating in Greece. This methodology concerns measurements and recordings that are being performed concerning the parameters of the equation used for the CF_4 emission's calculation, namely the overvoltage and the aluminium production process current efficiency. The EF is estimated based on Eq. 3.11 of Chapter 3/GPG (EF=Over-Voltage Coefficient*AEO/CE). The Over-Voltage Coefficient value used by the plant is 1.16 (the updated default one of 2006 IPCC Guidelines), while the Anode Effect Overvoltage (AEO) and Current Efficiency (CE) are measured for each series of electrolytic cells (there are three series). The C_2F_6 emissions are then calculated by using the following formula: $C_2F_6 = 0.1 \bullet CF_4$.

The Netherlands: Estimations of the PFC emissions from primary aluminium production reported by these two facilities are based on the IPCC Tier 2 method for the complete period 1990‑2019. Emission factors are plant-specific and confidential and are based on measured data.

Sweden: The two different processes for aluminium production, prebaked (CWPB) and Söderberg (VSS), have substantially different emission factors for PFCs. Estimates of emissions are based on the number of ovens and the number and duration of anode effects. This activity data is considered to be of good quality.

Activity data used for the PFC emission calculations, anode effects in min/oven day and production statistics, were provided by the company, and specified for the prebaked and Söderberg processes. The activity data and emissions can be found on section 4.4.3.2 of Sweden's NIR 2021.

Figure 4.14 2C3 Aluminium Production: PFC emissions



Besides PFC emissions, aluminium production is a source of CO_2 emissions. Of the thirteen countries which reported CO_2 emissions from aluminium production for 2019, three use a Tier 1 method, two use a Tier 2 method, seven use a Tier 3 method and one uses a country-specific method. One country uses the default emission factor, four use country-specific emission factors and seven use plant-specifc emission factors (Table **4.33**). Information on the reported CO_2 emissions can be found in the overview table in chapter ###. Information on activity data can be found in the CRF tables. Further details, e.g. on assumptions made by the various countries, can be found in the countries' NIRs.

Table 4.33 2C3 Aluminium Production: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	150	5	5	0.1%	-145	-97%	0	5%	T3	PS
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	119	NO	NO	-	-119	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	534	626	663	15.5%	130	24%	37	6%	T3	PS
Germany	1 012	723	694	16.2%	-318	-31%	-29	-4%	T3	CS
Greece	225	290	291	6.8%	66	29%	2	1%	CS	CS
Hungary	128	NO	NO	-	-128	-100%	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	359	NO	NO	-	-359	-100%	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	408	0	0	0.0%	-408	-100%	0	0%	T1a	D
Poland	78	NO	NO	-	-78	-100%	-	-	NA	NA
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	268	339	329	7.7%	61	23%	-10	-3%	T3	PS
Slovakia	121	276	275	6.4%	153	126%	-1	0%	T3	PS
Slovenia	170	133	111	2.6%	-60	-35%	-22	-17%	T2	D,PS
Spain	610	614	393	9.2%	-218	-36%	-222	-36%	T2,T3	D,PS
Sweden	133	188	177	4.1%	44	33%	-11	-6%	T2	PS
United Kingdom	450	68	61	1.4%	-390	-87%	-8	-11%	T1	CS
EU-27+UK	**4 767**	**3 261**	**2 999**	**70%**	**-1 768**	**-37%**	**-262**	**-8%**	**-**	**-**
Iceland	139	1 314	1 276	29.9%	1 137	817%	-38	-3%	T3	PS
United Kingdom (KP)	450	68	61	1.4%	-390	-87%	-8	-11%	T1	CS
EU-KP	**4 906**	**4 575**	**4 275**	**100%**	**-631**	**-13%**	**-300**	**-7%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'

4.2.3.3 2C7 Other

Under this category, various emissions are reported which cannot be attributed to another category under 2C. Specifically, this includes the process emissions from the non-ferro sector (including lead and zinc) in Belgium, Silicium production in Spain, Copper and nickel smelting in Finland, emissions of CO_2 from one plant producing copper, lead and zinc, and one metal recycling plant mainly producing lead by melting used batteries and recovering the lead in Sweden and CO_2 emissions from anode burn-off during the baking process of anodes (used for aluminium production) in Slovenia.

Information on the emissions from this category is given in the overview table in chapter 4.2.8.

4.2.4 Non-energy products from fuels and solvent use (CRF Source Category 2D)

This source category includes greenhouse gas emissions from non-energy products from fuel and solvent use. In 2021, this source category is not a key-category. However, this sector used to be a key category therefore this section is kept in the EU NIR. Table 4.28**2C Metal Industry: Countries' contributions to** total GHG, CO2, HFC, PFC and SF6 emissions summarises information by countries on total GHG emissions. Between 1990 and 2019, GHG emissions from 2D non-energy products from fuels and solvent use decreased by 25.4 %. The absolute decrease of GHG emissions was largest in France, Germany and Italy (in decending order).

Table 4.34: 2D Non-energy products from fuels and solvent use: countries' contributions to total GHG, CO_2, N_2O- and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2019 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2019 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2019 (kt CO2 equivalents)
Austria	349	146	349	146	NA	NA	NA	NA
Belgium	202	125	202	125	NO,NA	NO,NA	NO,NA	NO,NA
Bulgaria	169	101	169	101	NO,NA	NO,NA	NO,NA	NO,NA
Croatia	174	96	174	96	NA	NA	NA	NA
Cyprus	1	4	1	4	NE,NA	NE,NA	NE,NA	NE,NA
Czechia	126	149	126	149	NA,NO	NO,NA	NA,NO	NO,NA
Denmark	166	159	166	159	0.1	0.1	0.3	0.4
Estonia	36	27	36	27	NO	NO	NO	NO
Finland	220	155	218	154	2	1	0	0
France	2 041	1 015	2 038	1 013	1	2	1	0
Germany	2 984	2 028	2 983	2 027	1	1	NA	NA
Greece	130	36	130	36	NA,NO	NO,NA	NA,NO	NO,NA
Hungary	202	100	202	100	NA,NO	NO,NA	NA,NO	NO,NA
Ireland	94	101	94	101	NO	NO	NO	NO
Italy	1 712	1 091	1 712	1 091	NA,NO	NO,NA	NA,NO	NO,NA
Latvia	44	47	44	47	NO,NA	NO,NA	NO,NA	NO,NA
Lithuania	41	60	41	60	NO	NO	NO	NO
Luxembourg	21	34	21	34	NO	NO	NO	NO
Malta	4	5	4	5	NA	NA	NA	NA
Netherlands	188	325	188	324	NO,NA	NO,NA	0.2	0.3
Poland	375	671	375	671	NA,NO	NO,NA	NA,NO	NO,NA
Portugal	244	235	243	234	NO,NA	NO,NA	1	1
Romania	665	534	665	534	NO,NA	NO,NA	NO,NA	NO,NA
Slovakia	50	36	50	36	NO,NA,NE	NO,NE,NA	NO,NA,NE	NO,NE,NA
Slovenia	8	35	8	35	NA	NA	NA	NA
Spain	921	827	921	827	NO,NA	NA	NO,NA	NA
Sweden	393	409	393	409	NA	NA	NA	NA
United Kingdom	553	482	553	482	NO,NE,IE	NO,NE,IE	NO,IE	NO,IE
EU-27+UK	**12 114**	**9 032**	**12 107**	**9 025**	**4**	**5**	**3**	**2**
Iceland	7	6	7	6	NE,NA	NO,NE,NA	NE,NA	NO,NE,NA
United Kingdom (KP)	553	482	553	482	NO,NE,IE	NO,NE,IE	NO,IE	NO,IE
EU-KP	**12 121**	**9 037**	**12 114**	**9 031**	**4**	**5**	**3**	**2**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.28 2C Metal Industry: Countries' contributions to total GHG, CO2, HFC, PFC and SF6 emissions

provides information on the contribution of countries to EU recalculations of CO_2 emissions from 2D Non-energy products from fuels and solvent use for 1990 and 2018, including main explanations.

Table 4.35: 2D Non-energy products from fuels and solvent use: Contribution of countries to EU recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 and percent of sector total)

	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	4	2,8	
Belgium	0	0,0	1	0,8	
Bulgaria	-	-	0	0,3	
Croatia	-54	-23,6	0	0,6	
Cyprus	-7	-83,5	-28	-94,0	There was an error in the consumption of glue which were overestimated. Additinaly, emissions from category (2.D.3) are now reported under Chapter 9 (Indirect emissions).
Czechia	-	-	-0	-0,0	
Denmark	-0	-0,0	-0	-0,3	
Estonia	-	-	0	0,0	
Finland	-	-	-0	-0,0	
France	-105	-4,9	-73	-6,1	Update of emissions from thermal oxydizer on the entire time-series
Germany	-	-	-3	-0,1	
Greece	-	-	6	20,5	Updated data on the last year
Hungary	-4	-2,0	-4	-4,0	
Ireland	-	-	-18	-15,2	Updated activity data for Parrafin wax use
Italy	-9	-0,5	-4	-0,4	
Latvia	0	0,1	8	18,4	NMVOC emissions from Solvent use sector were recalculated taking into account that activity data for year 2018 was specified and therefore emissions were recalculated for this year. In 2.D.1 and 2.D.3 Urea use recalculations were done due to precised Activity data
Lithuania	-4	-9,0	26	83,3	CO_2 emissions were recalculated due to changes in NMVOC emission calculation methodology. In order to avoid underestimation, Tier 1 method has been used instead of Tier 2 since higher level method is not verified
Luxembourg	-	-	-0	-0,5	
Malta	-	-	-	-	
Netherlands	1	0,4	1	0,3	
Poland	-75	-16,7	-83	-10,7	Update of the activity data according to Eurostat database.
Portugal	0	0,1	-2	-1,1	
Romania	-675	-50,4	-236	-26,1	Recalculations have been made for the 1989-2018 period by using the value of the ODU factor from IPCC 2006, namely 0.2, for the calculation of CO_2 emissions from the use of lubricants. (CRF Category 2.D.1)
Slovakia	-157	-75,6	-58	-59,0	The recalculation is based on the recalculation made in CLRTAP inventory where NMVOC emissions were recalculated as well as a reallocation of CO_2 emissions into indirect emissions.
Slovenia	0	0,2	1	2,3	
Spain	9	1,0	-40	-4,6	All pollutant emissions have changed in the period 2014-2018 due to minor changes in the fuel consumption data of national statistics (1A3b, 2D1, 2D3d).
Sweden	-	-	-31	-7,0	Update of emission due to the one-year-delay of activity data

	1990		2018		Main explanations
	kt CO_2	%	kt CO_2	%	
United Kingdom	-	-	115	31,4	Methodology change to lubricants.
EU28	-1 081	-8,2	-418	-4,3	
Iceland	-0	-0,0	1	10,6	The emissions deriving from additives for SCR in diesel cars have been added to the inventory under 2D3 Urea based catalysts.
United Kingdom (KP)	-	-	115	31,4	Methodology change to lubricants.
EU28+ISL	-1 081	-8,2	-418	-4,3	

4.2.4.1 2D1 Lubricant Use

CO_2 emissions from this sector amounted to approximately 0.06% of total GHG emissions (without LULUCF) in 2019. CO_2 emissions from this sector decreased by 26.2% since 1990.

4.2.4.2 2D3 Other non-energy products from fuels and solvent use

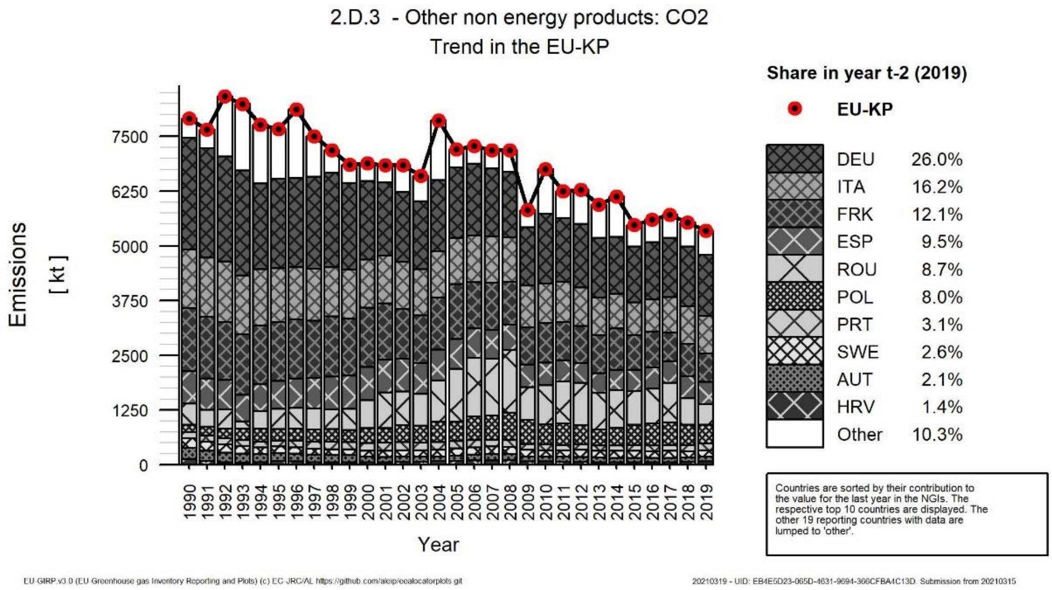
CO_2 emissions from this sector amounted to approximately 0.13% of total GHG emissions (without LULUCF) in 2019. France, Germany, Italy, Spain, Romania and Poland together account for 80% of all emissions in the EU 27+UK. CO_2 emissions from this sector decreased by 32% since 1990, the biggest reductions in absolute terms occurred in Germany and France (respectively -1 161 and -787 kt). CO_2 emissions decreased in eleven countries and increased in the remaining eighteen countries between 1990 and 2019. The peak in 2002 is due to an increase of CO_2 emissions in the United Kingdom. In addition, some countries do not report emissions in this category in 1990, but report emissions, mainly from urea use in the transport sector, for more recent years.

Table 4.36 2D3 Other non-energy products from fuels and solvent use: countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	252	106	110	2.1%	-141	-56%	5	4%	T1,T2	CS,D
Belgium	NO,NA	31	30	0.6%	30	∞	-1	-2%	M,T3	CS,OTH
Bulgaria	87	72	72	1.3%	-15	-18%	-0.2	-0.3%	T1,T3	CR,D
Croatia	133	63	76	1.4%	-57	-43%	13	20%	OTH,T1	D
Cyprus	NO,NE,IE	0.3	0.4	0.01%	0.4	∞	0.1	21%	CS	CS
Czechia	NO,NA	17	17	0.3%	17	∞	0.2	1%	T1	D
Denmark	94	70	68	1.3%	-26	-28%	-3	-4%	0	0
Estonia	18	20	22	0.4%	3	19%	2.4	12%	D,T2	D
Finland	NO	12	14	0.3%	14	∞	1.5	12%	T1	D
France	1 434	746	647	12.1%	-787	-55%	-99.3	-13%	T1,T2	CS,D,PS
Germany	2 552	1 367	1 391	26.0%	-1 161	-45%	24	2%	CS,D	D
Greece	NO,NA	7	8	0.1%	8	∞	1	17%	D	D
Hungary	116	69	70	1.3%	-46	-40%	1	2%	T1,T2	D
Ireland	51	56	55	1.0%	4	7%	-1	-2%	T1,T2	D
Italy	1 343	852	866	16.2%	-477	-35%	14	2%	CR,CS,T2	R,CS,M,PS
Latvia	21	33	26	0.5%	5	25%	-7	-21%	CS,D,T1,T2	D,PS
Lithuania	34	39	43	0.8%	8	24%	4	10%	T1,T3	CR,D
Luxembourg	14	24	27	0.5%	12	88%	3	11%	CS,M	CS,D
Malta	0	0.7	0.6	0.01%	1	2652%	-0.1	-9%	T1	CR,D
Netherlands	NO	21	21	0.4%	21	∞	0.0	0%	T3	CS
Poland	162	457	430	8.0%	268	165%	-27	-6%	T1,T3	D
Portugal	147	145	164	3.1%	17	11%	18	13%	CR,NO,T2	CS,NO,OTH
Romania	490	606	466	8.7%	-24	-5%	-140	-23%	CR,D	CR,CS,PS
Slovakia	NO	9.7	9.6	0.2%	10	∞	-0.1	-1%	CS	CS
Slovenia	NO,NA	6.6	6.5	0.1%	6	∞	-0.1	-1%	M	M
Spain	737	503	508	9.5%	-230	-31%	5	1%	T1,T2	D
Sweden	217	139	139	2.6%	-79	-36%	0	0%	T1,T3	CS,D
United Kingdom	NE,NO	62	60	1.1%	60	∞	-2	-3%	T3	CR,D
EU-27+UK	**7 904**	**5 534**	**5 344**	**100%**	**-2 559**	**-32%**	**-190**	**-3%**	**-**	**-**
Iceland	3	3	3	0.1%	1	26%	-0.2	-6%	D,T1	D
United Kingdom (KP)	NO,NE	62	60	1.1%	60	∞	-2	-3%	T3	CR,D
EU-KP	**7 906**	**5 538**	**5 348**	**100%**	**-2 558**	**-32%**	**-190**	**-3%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 4.15 2D3 Other non-energy products from fuels and solvent use: CO_2 emissions



For this category, it is not useful to give an average EF across the countries because of the different methods used, and because of the fact that this category is split into many subcategories with varying EFs. Table **4.36** provides an overview of countries' reporting of CO_2 emissions from 2D3 in 2019.

Table 4.37 2D3 Other non-energy products from fuels and solvent use: Reporting of CO_2 emissions by countries

MS	Category	kt
AUT	3. Other (please specify)	110.47
	Solvent use	71.27
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea used as a catalyst	39.20
BEL	3. Other (please specify)	30.27
	Solvent use	NA
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea used as a catalyst	30.27
	Unspecified	NO
BGR	3. Other (please specify)	71.93
	Solvent use	67.91
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Other chemical products	4.02
CYP	Other (please specify)	0.38
	Dry cleaning	IE
	Coating applications	IE
	Chemical products	IE
	Asphalt roofing	IE
	Domestic solvent use including fungicides	IE
	Road paving with asphalt	IE
	Printing	IE
	Urea-based catalysts	0.38
	Other	IE
CZE	3. Other (please specify)	16.75
	Solvent use	NO

MS	Category	kt
EST	3. Other (please specify)	21.94
	Solvent use	20.81
	Road paving with asphalt	0.04
	Urea based catalysts for motor vehicles	1.09
FIN	3. Other (please specify)	13.77
	Solvent use	NO
	Road paving with asphalt	NO
	Asphalt roofing	NO
	Use of urea-based catalysts	13.77
FRK	3. Other (please specify)	646.88
	Solvent use	312.02
	Road paving with asphalt	NA
	Asphalt roofing	NE
	Other incl. urea use in SCR	334.87
GBE	3. Other (please specify)	60.14
	Solvent use	NE
	Urea use (road transport)	60.14
	Petroleum coke use	NO
GRC	3. Other (please specify)	7.84
	Solvent use	NA
	Road paving with asphalt	NO
	Asphalt roofing	NO
	Urea used as a catalyst	7.84
HRV	3. Other (please specify)	75.61
	Solvent use	68.56
	Road paving with asphalt	0.06
	Asphalt roofing	0.01
	Urea based CC	6.98

MS	Category	kt
LTU	3. Other (please specify)	42.74
	Solvent use	41.68
	Road paving with asphalt	0.00
	Asphalt roofing	0.01
	Urea-based catalyst	1.05
LUX	3. Other (please specify)	26.50
	Solvent use	12.93
	Urea-based catalysts	13.57
LVA	3. Other (please specify)	26.17
	Urea use	1.31
	Solvent Use	24.76
	Asphalt roofing	0.05
	Road paving with asphalt	0.05
MLT	3. Other (please specify)	0.63
	Solvent use	NA
	Road paving with asphalt	0.01
	Urea for denoxification	0.63
NLD	3. Other *(please specify)*	20.68
	Ureum use in SCR	20.68
POL	3. Other (please specify)	429.60
	Solvent use	365.49
	Urea used as catalyst	64.11
PRT	3. Other (please specify)	163.84
	Solvent use	137.05
	Road paving with asphalt	16.99
	Urea-based catalysts	9.80
ROU	3. Other (please specify)	466.78
	Solvent use	97.93
	Road paving with asphalt	NA

MS	Category	kt
	Road paving with asphalt	NA
	Urea used as catalyst	16.75
DEU	3. Other (please specify)	1391.02
	Solvent use	1122.84
	Road paving with asphalt	NE
	Asphalt roofing	NE
	AdBlue	268.18
DNM	3. Other (please specify)	67.92
	Solvent use	57.93
	Road paving with asphalt	0.81
	Asphalt roofing	0.02
	Urea used in catalysts	9.15
ESP	3. Other (please specify)	507.67
	Solvent use	445.91
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea-based catalytic converter	61.76

MS	Category	kt
HUN	3. Other (please specify)	69.71
	Other (please specify)	69.71
	Indirect CO_2 from solvents	60.05
	Urea based catalysts	9.66
IRL	3. Other (please specify)	55.02
	Solvent use	41.54
	Urea used as a catalyst	13.48
ITA	3. Other (please specify)	866.31
	Solvent use	788.58
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea used in power plants	10.32
	Urea used in engines	67.41

MS	Category	kt
	Asphalt roofing	NA
	Petroleum coke use	367.25
	Urea use	1.61
SVK	3. Other (please specify)	9.60
	Solvent use	NO
	Road paving with asphalt	NO
	Asphalt roofing	NO
	Urea catalytic converters	9.60
SVN	3. Other (please specify)	6.49
	Asphalt roofing	NA
	Road paving	NA
	Solvent use	NA
	Urea based catalyst	6.49
SWE	3. Other (please specify)	138.56
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Solvent use	102.00
	Urea used as catalyst	36.56
ISL	Other (please specify)	3.20
	Chemical products	0.00
	Decreasing	0.13
	Dry cleaning	0.00
	Printing	0.28
	Coating applications	0.64
	Organic preservative	0.11
	Creosotes	NO
	Domestic solvent use including fungicide	1.44

4.2.5 Electronics Industry (CRF Source Category 2.E)

2.E Electronics Industry includes the following subcategories: 2.E.1 Integrated Circuit or Semiconductor, 2.E.2 TFT Flat Panel Display, 2.E.3 Photovoltaics, 2.E.4 Heat Transfer Fluid and 2.E.5 Other. Out of these, the most important emission source in Europe is the production of integrated circuits and semiconductors (2.E.1), which relates to highly specialized industrial processes.

Emissions from photovoltaics industry and heat transfer fluids are reported by very few Member States only. Manufacture of TFT Flat Panel Displays does not take place in the EU.

The gases emitted include in particular PFCs, SF_6 and NF_3, HFC emissions occur to relatively small extent only. Attempts have been made in recent years to reduce emissions through process optimization and replacement of certain high-GWP gases, when feasible.

4.2.6 Product uses as substitutes for ODS (CRF Source Category 2.F)

This emission source category relates to the consumption of halocarbons (HFCs and PFCs) in different applications.

HFCs are predominantly serving as alternatives to ozone depleting substances (ODS) that are being phased out under the Montreal Protocol, and have been introduced to the EU market first at the end of 1990. Due to their high global warming potentials, HFCs are addressed by the so-called MAC Directive, which bans the use of HFCs with a GWP >150 in new passenger cars since 2017, and the EU F-gas Regulation No. 517/2014, which establishes a phase down scheme for HFCs and other measures to limit use and emissions of F-gases. The EU F-gas Regulation is currently subject to review again and new measures are expected for the future.

The main applications of halocarbons include refrigeration and air conditioning, foam blowing, fire protection, aerosols, solvents as well as some other applications. PFCs are used to minor extent in this subcategory nowadays but mainly in semiconductor manufacture (2.E.1).

The source category 2.F Product uses as substitutes for ODS includes two key categories which occur in all countries: Refrigeration and air conditioning (2.F.1) and aerosols (2.F.4), especially MDIs. The use of HFCs as fire extinguishing agents (2.F.3) used to be common, but decreased widely in recent years due to restrictions at EU level through the F-gas Regulation and national rules.

Table 4.38: Key categories for sector 2F (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2019		1990	2019	
2.F.1 Refrigeration and Air conditioning: no classification (HFCs)	13	83366	T	0	L	98%
2.F.4 Aerosols: no classification (HFCs)	2	3600	T	0	0	93%

Table.**4.39** provides information on the contribution of countries to EU-KP recalculations in HFC from 2.F Product uses as substitutes for ODS for 1990 and 2018 and main explanations for the largest recalculations in absolute terms.

Table.4.39 2F Product uses as substitutes for ODS: Contribution of MS to EU recalculations in HFC for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	20	1,1	An in-depth research allowed an improved emission estimate for 2F1: previously a fixed share of total HFC consumption was attributed to large air conditioning installations (chillers and VRF). Now the amounts of refrigerants of these installations are estimated using a “bottom up” approach, applying market data and information on refrigerant type and amounts filled in. – First fillings of heating pumps are now subtracted from remaining national consumption that is assigned to the categories industrial and commercial refrigeration. In previous submissions these amounts – about 4% - were double counted. For 2F1a, this affected emissions from this sub category for the years from 1992 onwards (+25 kt CO_2e in 2018). For 1F1c, emissions were changed from 1994 onwards (+21 kt CO_2e in 2018). For 2F1f, the improvements explained resulted in recalculations for the years from 1992 onwards (–3.8 kt CO_2e in 2018). For 2F1d, the estimation of stock was revised using data and information from companies for the years from 2011 onwards (the years 2008-2010 were interpolated), for 2018 emissions are now 34 kt CO_2e lower. 2F3: Following an issue raised during the ESD Review 2020 a falsely reported notation key has now been eliminated and emissions are now reported correctly. (+12 kt CO_2e in 2018).
Belgium	-	-	-29	-1,0	2F1b: A small correction occurred to the stock of commercial hermetically sealed equipment in 2018 (impact +0.25 kt CO_2-eq). 2F2a Closed cell foam: a small correction was made for 2018 (impact: +0.5 kt CO_2-eq). 2F4b Other aerosols (technical aerosols): revised figure for 2018 based on per capita emissions from Germany (impact -29.95 kt CO_2-eq).
Bulgaria	-	-	-	-	
Croatia	-	-	53	10,7	In the previous submissions, manufacturing and disposal emissions in categories 2F1a and 2F1c were reported as "NO" for the whole time-series. According to TERT's recommendation during the 2020 ESD review, technical corrections were made. Corrected emissions proposed by TERT included the years 2005, 2016-2018, and estimates for the remaining years were performed using the same assumptions. In accordance with the abovesaid, recalculations of emissions for the period 2005-2018 were performed in categories 2F1a and 2F1c.
Cyprus	-80	-100,0	31	10,4	The emissions for the whole period have been recalculated for the following sub-categories: 2F1a: (i) Manufacturing emissions are reported for on-site assembly of large commercial refrigeration units, (ii) introductory year of refrigerants and gradual penetration to the market were taken into consideration and (iii) annual national GDP values were revised. 2F1b: (i) Refrigerants used for this category were corrected (R404A was removed from the calculation process of the emissions since this refrigerant has never been commonly used in domestic refrigeration) and (ii) introductory year of refrigerants and gradual penetration to the market were taken into consideration. 2F1c: (i) Manufacturing emissions are reported for on-site assembly of large commercial refrigeration units, (ii) introductory year of refrigerants and gradual penetration to the market were taken into consideration and (iii) annual national GDP values were revised. 2F1e: Means of transport (passenger cars, trucks and buses) were taken into consideration for estimating the emissions.

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					2F1f: (i) Introductory year of refrigerants and gradual penetration to the market were taken into consideration and (ii) annual national GDP values were revised. The emissions for the whole period have been recalculated due to revision of activity data for all categories – 2F2, 2F3 and 2F4.
Czechia	-	-	26	0,7	2.F.1 and 2.F.3: Updated activity data. 2.F.4: New subcategory 2.F.4.a Metered Dose Inhalers.
Denmark	-	-	8	1,6	2F1: Significant recalculations (i.e. larger than 0.01 kt CO_2 equivalents) occur for 2010-2018 (increase of 1.5-6.1 kt CO_2 equivalents) and for 2015-2018 for Aerosols (-2.5 to +2.4 kt CO_2 equivalents). For 2F1a, a lower emission factor for manufacturing is used from 2010 (1.5% to 0.5%). Also, for 2F1a, an increased contribution to emissions from stock from some sources for 2010-2018 occur as emission factors are increased from 3% to 10%. For all sources of 2F1f (not including heat pumps), is now used an emission factor for manufacturing of 1.5% until 2009 and 0.2% for 2010-2019. An emission factor for stock of 10% until 2009 and 3% for 2010-2019 is used. The category “large and medium commercial refrigeration and stationary air conditioning” for HFC-134a is divided into two categories throughout the time series – “large and medium commercial refrigeration (CRF 2.F.1.a)” and “stationary air condition (CRF 2.F.1.f)” because new emission factors are applied for 2F1f. For 2F4, activity data for HFC-134a for 2015-2018 were updated. In addition, HFC-227ea is reported for the first time in MDIs, resulting in increases for years 2015-2018. The overall recalculation is a decrease for 2015-2016 and increase for 2017-2018.
Estonia	-	-	-0	-0,0	2F1d: Amounts of refrigerants filled into new equipment were recalculated because of error in interpreting data.
Finland	-	-	-4	-0,3	In category 2F1c, HFC emissions from stock for 2001 to 2018 were recalculated due to correction of cell reference in the emission calculation sheet. In 2F4, HFC emissions for 2004 to 2018 were recalculated due to addition of product import data from two companies previously missing from the inventory.
France	-	-	-144	-0,9	2F1a: The entire time series has been impacted by the following adjustments: Changes of the refrigerants used for retrofit, increase of the charge size for hypermarkets and new data on vending areas, changes of emission factors for the charging in order to account for improved servicing practices, changes to recovery rates at end-of life for supermarkets and hypermarkets. 1F1c: Update of production data for chillers. 2F1d: The entire time series is affected by the update of emission estimates, especially on the following aspects: Changes to the refrigerant use and operation emission factor in reefer containers (R410a instead of R404A), changes of manufacturing emissions, increase of the share of R134a used in refrigerated vehicles, overall rise of the market of refrigerated vehicles. 2F1e: Changes relate to the update of activity data for refrigerant use in trains and the train stock, emission factors for trains, changes to emission factors and AC rates for special industrial vehicles. 2F2: Additional data for one new production site in 2018 and update of emission data.
Germany	-	-	-236	-2,3	2F2: The values for the domestic consumption of HFC-134a, HFC-152a and HFC-1234ze, for the production of XPS hard foam, for the period as of 2007, have been taken from surveys pursuant to the Environmental Statistics Act (UStatG). The domestic consumption of the previous year has to be recalculated annually, since the relevant data collected pursuant to the UStatG, for each year in question, do not become available until December of the following year. This regularly leads to changes in emissions from production and use for

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					the relevant previous year. In the case of polyurethane hard foam products and polyurethane integral foams, the domestic consumption figures, for production with HFC-227ea, HFC-245fa and HFC-365mfc, have been recalculated for the years 2009 through 2018, to take account of determination of the relevant propellants' applicable fractions via surveys pursuant to the UStatG. As a result, the emissions from production and use have changed for those years. 2F3: Correction of the EF for the period as of 2008. 2F4: Recalculation of aerosol emissions, 2001-2018. Recalculations in sub-categories of refrigeration and air-conditioning systems (2F1), for the period as of 1995.
Greece	-	-	-	-	
Hungary	0	100,0	675	49,7	In category 2F1, switched from the mass-balance method to the EF approach. For the latest years (between 2016 and 2019) used data of the actual reported equipment and before 2016 the import values were used, as basis for the new activity data. In addition, in category 2F1b/e, minor adjustments have been made because of the EF method. 2F2: Revision of activity data (import, export and production of foams). 2F3: Emission from disposal has been changed due to a calculation error.
Ireland	-	-	-255	-23,3	Updated recovery factor for Mobile air conditioning (MAC), updated assumptions for use of low GWP in MAC, updated activity data for 2F1 bulk imports of data.
Italy	-	-	-124	-0,8	2.F.1: Update of air conditioning activity data.
Latvia	-	-	25	10,3	During the centralized UNFCCC review in 2020 recalculations were made for 2F1 sector: 1) in 2F1c, 2F1d and 2F1f sectors were made extrapolations of activity data for historical years to make time series consistency therefore emissions of filled in new manufactured products were recalculated; 2) it also affected emissions from operating systems; 3) and based on extrapolations in 2F1c, 2F1d and 2F1f sectors were calculated disposal emissions. In 2F1, recalculations were done also due to precised activity data.
Lithuania	-	-	1	0,1	2F1: Recalculations in Mobile Air Conditioning have been done due to updated activity data on passenger carriages disposal. Recalculations in Stationary Air-Conditioning have been done due to updated activity data provided by EurObserv`ER Heat Pumps Barometer. 2F3: Recalculations have been done due to updated activity data on amount of HFC-236fa contained in fire protection systems installed in vehicles.
Luxembourg	-	-	-3	-4,7	2F1: Error correction of emission formula. 2F2: Revision of emission factors.
Malta	-	-	-147	-35,8	The following changes have been made to CRF sub-categories 2F1d and 2F1e: • A part of the disposal emissions of HFC-134a were erroneously being reported in tCO_2eq, instead of t. • The recovery rate has been updated to 0. • The amount of gas remaining in products at decommissioning has been estimated. • The following "charge at disposal", as recommended in the project for the improvement of the methodology of the national inventory report in the product uses as ozone depleting substances (ODS) substitutes sector conducted between 2012 and 2014, were used: cars and minibuses: 50%; buses: 50%; vans and trucks: 50%; and 2F1d: 85%. • The share of the different gases comprising the blends used in 2F1d has been corrected.

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					• The ratios of the different gases used in 2F1d were changed to reflect the introduction of the gases. The following ratios of HFC-134a/HFC-404A were used: pre-2001: 0:0; 2001-2003: 100:0; 2004: 50:50; 2005: 30:70; and 2006 to date: 10:90. • The amount of gas remaining in products at decommissioning and the emissions from disposal have been updated to reflect the ratios of the different gases used in 2F1d in the year the vehicles were introduced, rather than the ratio from the year of disposal of the vehicles. 2F1f: The data used to calculate the stock accumulated from F-gas in pre-charged equipment has been changed; from the annual data on the estimated national stock of split units, used previously, to the annual imports of split units, rectifying the former over-estimation. 2F1a, 2F1c and 2F1f: Data on local recovery of F-gas was received from the market. 2F1a: One of the components of one of the refrigerants used is R1234yf. Since it was not possible to generate a CRF table specifically for this refrigerant, a new table entitled "Unspecified mix of HFCs", referring solely to R1234yf, was added. In the 2020 GHG inventory, the GWP of the blend of the refrigerant was erroneously used, instead of the GWP of R1234yf. Hence, in the 2020 GHG inventory, the emissions of R1234yf, have been overestimated.
Netherlands	-	-	19	1,3	2F1: New activity data.
Poland	-	-	-369	-8,8	In 2F1, revised parameters (like leakage ratios) for some equipment in refrigeration and air conditioning on the basis of the reporting under F-gases regulation. In 2F2, ERT recommendation implemented. Corrected error in formula for years before 2004 and in result revised amount in stock. Revised outstanding parameters (decreased manufacture factor for HFC-152a, increased life factor for HFC-227ea).
Portugal	-	-	-166	-4,9	2F1a,b,c,d: Update on activity data regarding quantity remaining in the equipment at decommissioning. 2F1e: Methodological revision of the sector for the whole time series. 2F2 and 2F4: Update on activity data.
Romania	-	-	-40	-1,7	2F1a and 2F1c: Recalculations due to improvement in calculation formula for banks. 2F1e: Recalculations have been made for the 1999-2018 period; for the 2011-2018 period as a result of the recalculation of the values for "% new cars with AC units" for the 2011-2015 period for cars and for the 1999-2018 period as a result of taking into account emissions from rail transport. 2F1f: Recalculations due to the identification of an error in the formula for calculating the amount of agent used for servicing for heat-pumps and domestic air-conditioners, and also due to the recalculation by the National Institute of Statistics of the activity data regarding the import and export of heat-pumps and stationary air-conditioning equipment. 2F3: Recalculations due to improvement in activity data regarding the quantity of banks in the fire protection equipment.
Slovakia	-	-	-	-	
Slovenia	-	-	27	9,2	2F1: In the inventory for the year 2018 corrected a mistake in the amount of HFC in the transport refrigerator and use improved data from the service companies on amount filled in the new equipment and during the maintenance of the old equipment. 2F4, HFC-134a: Included additional MDI which contained HFC in the list of MDIs and corresponding emissions since 2010 were included in the inventory. 2F3, HFC-227ea: Emissions have been recalculated for the entire period 1997-2018 due to the availability of a better data on amount in the existing equipment as well as emissions during firefighting.

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Spain	-	-	120	2,6	Following the indications of the ESD review report of August 30, 2020, the emissions of the end-of-life period of sub-activities 2F1a, 2F1b, 2F1c and 2F1d have been estimated. The data of the vehicle fleet used to estimate the end-of-life emissions of the 2F1e3 sub-activity has been updated and this has generated recalculation in this and other 2F1 sub-activities. 2F2: Emission data registered according to the F-gas Regulation has been added. 2F3: New data received from one of the information source companies. 2F4: The focal point corrects the activity data for 2018.
Sweden	-	-	3	0,3	2F1a, 2F1c and 2F1f: Updated activity data from the Products Register from the Swedish Chemicals Agency. Updated number of installed air-to-air heat pumps.
United Kingdom	8	2 240,3	105	0,8	2F1: Implementation of new HFC outlook model for Refrigeration, Air Conditioning, and Heat Pumps (RACHP). 2F4: Alignment of methodology to IPCC default approach.
EU27+UK	-72	-82,6	-406	-0,4	
Iceland	-0	-0,3	-4	-2,3	2F1: Changes in MAC with low GWP refrigerants for 2016-2018 in accordance with revised estimate from the 2020 comprehensive review. 2F4: Added a small amount of MDIs containing HFC-227ea which were not accounted for in previous submissions and updated HFC-134a amounts in each inhaler with reference data from the Icelandic Medicine Agency.
United Kingdom (KP)	8	2 240,3	105	0,8	2F1: Implementation of new HFC outlook model for Refrigeration, Air Conditioning, and Heat Pumps (RACHP). 2F4: Alignment of methodology to IPCC default approach.
EU-KP	-72	-82,3	-410	-0,4	

For 2.F Product uses as substitutes for ODS, table 1 summarizes information by Member States on emission trends of total GHG emissions as well as on HFCs and PFCs. SF_6 and NF_3 are not used in this subcategory. It should be noted that the amounts reported by Member States as “unspecified mix of HFCs and PFCs” are not shown in the table but also need to be taken into account in the total greenhouse gas emission estimates.

Table.4.40 2F Product uses as substitutes for ODS in 1990 and 2019: Member States and EU GHG emissions from this category and their split into HFC and PFC emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	HFC emissions in 1990 (kt CO2 equivalents)	HFC emissions in 2019 (kt CO2 equivalents)	PFC emissions in 1990 (kt CO2 equivalents)	PFC emissions in 2019 (kt CO2 equivalents)
Austria	NO	1 746	NO	1 746	NO	NO,IE
Belgium	NO	2 603	NO	2 603	NO	0.02
Bulgaria	NO	1 819	NO	1 819	NO	0.01
Croatia	NO	553	NO	553	NO	NO
Cyprus	NE,NO	342	NO,NE	342	NO	-
Czechia	NO	3 752	NO	3 751	NO	1
Denmark	NO	336	NO	336	NO	0.01
Estonia	NO	224	NO	224	NO	-
Finland	0.01	1 133	0.01	1 132	NO	1
France	IE,NO	14 011	NO,IE	14 011	-	-
Germany	NA,IE,NO	9 580	NO,IE,NA	9 576	IE,NA	4
Greece	NO	5 479	NO	5 447	NO	32
Hungary	0.002	2 137	0.002	2 134	NO	3
Ireland	NO	813	NO	813	NO	NO
Italy	NO	16 784	NO	16 784	NO	NO
Latvia	NO	255	NO	255	NO	NO
Lithuania	NO	569	NO	569	NO	NO
Luxembourg	0.0001	59	0.0001	59	-	-
Malta	NE,IE,NO	257	NO,NE,IE	257	NO	NO
Netherlands	IE,NO	1 436	NO,IE	1 436	NO	NO
Poland	NO	3 755	NO	3 745	NO	11
Portugal	NA	3 394	NA	3 373	NA	21
Romania	0.2	2 256	0.2	2 256	NO	0.01
Slovakia	NO	721	NO	721	NO	NO
Slovenia	NO	296	NO	296	NO	NO
Spain	NO	5 947	NO	4 493	NO	12
Sweden	6	988	6	988	NO	0.1
United Kingdom	8	12 482	8	12 482	NO	NO
EU-27+UK	**15**	**93 727**	**15**	**92 199**	**NA,IE,NO**	**85**
Iceland	0.3	207	0.3	207	NO	0.1
United Kingdom (KP)	8	12 564	8	12 564	NO	NO
EU-KP	**15**	**94 017**	**15**	**92 489**	**NA,IE,NO**	**85**

Abbreviations explained in the Chapter 'Units and abbreviations'. In 2019 Spain also reported 1442 kt CO_2 equivalents as unspecified mix of HFC and PFC emissions. It is the only country reporting this and therefore no extra column for the mix of HFC and PFC emissions have been included in the table. Pease note that consequently HFC and PFC emissions for the year 2019 do not add up to the total GHG emissions for Spain and EU-27+UK or EU-KP.

F-gas emissions from 2.F Product uses as substitutes for ODS account for 2.3% of total EU-KP GHG emissions (without LULUCF) in 2019. HFC emissions account for the lion's share of 2.F emissions (98%) and were in 2019 about 6200 times higher than in 1990. The main reason for this is the phase-out of ODS such as chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and halons under the Montreal Protocol and the subsequent replacement of these substances by HFCs (mainly in refrigeration, air conditioning, foam production, fire protection and as aerosol propellants). Moreover, refrigeration and air conditioning sectors have also grown to some extent in Europe in the last decades.

Table.**4.40** shows the sub-categories of HFC-gas emissions from 2.F Product uses as substitutes for ODS by countries. It highlights that 2.F.1 Refrigeration and Air Conditioning is by far the largest sub-category accounting for 90% (EU-27+UK) of HFC emissions in this source category. While ODS were formerly widely used as aerosols and foam blowing agents, the subcategories 2.F.4 Aerosols/Metered Dose Inhalers contribute today 3.9% and 2.F.2 Foam blowing agents approximately 2.8%. Emissions from fire protection relate to 2.9% of HFC emissions from 2.F.1 in 2019.

The EU F-gas Regulation 517/2014 sets out several measures to reduce use and emissions of F-gases with a focus on HFCs. These measures include restrictions of the bulk supply of HFCs on the EU market (the so called HFC phase down) starting from 2015. The following schedule for supply reductions was established: 100% in 2015, 93% in 2016-2017, 63% in 2018-2020, 45% in 2021-2023, 31% in 2024-2026, 24% in 2027-2029, 21% in 2030. This mechanism led to significant price increases for HFCs on the EU market and promoted the uptake of alternatives to HFCs in many applications.

Other important measures of the F-gas Regulation relate to placing on the market bans for certain products (Annex III), for example stationary refrigeration equipment containing high-GWP gases, which were partly implemented by industry ahead of the prohibition dates and possibly due to the price increases under the HFC phase down scheme.

Table.4.41 2F Product uses as substitutes for ODS: Countries' sub-categories of HFC emissions (kt CO_2 equivalents)

Member State	**2.F Product uses as substitutes**	2.F.1 Refrigeration and air conditioning	2.F.2 Foam blowing agents	2.F.3 Fire protection	2.F.4 Aerosols	2.F.5 Solvents	2.F.6 Other applications
Austria	**1 746**	1 686	18	14	28	NO	-
Belgium	**2 603**	2 498	42	12	50		NO
Bulgaria	**1 819**	1 786	10	9	14	-	-
Croatia	**553**	539	NO	5	9	-	-
Cyprus	**342**	324	1	11	4	-	-
Czech Republic	**3 751**	3 714	4	31	2	NO	-
Denmark	**336**	323	1	NO	12	NO	NO
Estonia	**224**	215	2	2	5		0
Finland	**1 132**	1 107	5	NO,IE,NA	20	0	0
France	**14 011**	13 015	282	54	628	32	NO,IE
Germany	**9 576**	8 536	581	105	353	IE	-
Greece	**5 447**	5 043	199	160	45	-	-
Hungary	**2 134**	1 963	129	7	35	NO	NO
Ireland	**813**	672	NO	32	109	NO	NO
Italy	**16 784**	14 326	587	1 609	262	-	-
Latvia	**255**	250	1	0	5	-	-
Lithuania	**569**	516	41	4	7	NO	NO
Luxembourg	**59**	54	2	-	3	-	-
Malta	**257**	248	5	3	1	NO	NO
Netherlands	**1 436**	1 261	NO,IE	-	NO	-	175
Poland	**3 745**	3 434	75	108	127	1	-
Portugal	**3 373**	3 238	47	70	18		-
Romania	**2 256**	2 203	2	5	46	NO	NO
Slovakia	**721**	687	2	23	9	NO	NO
Slovenia	**296**	289	1	0	5	-	-
Spain	**4 493**	4 013	48	107	324	NO	NO
Sweden	**988**	939	29	1	18	-	-
United Kingdom	**12 482**	10 209	439	311	1 453	16	53
EU-27+UK	**92 199**	**83 090**	**2 554**	**2 687**	**3 592**	**49**	**228**
United Kingdom (KP)	**12 564**	10 279	441	314	1 460	16	54
Iceland	**207**	206	-	-	1	-	-
EU-KP	**92 489**	**83 366**	**2 556**	**2 690**	**3 600**	**49**	**229**

Abbreviations explained in the Chapter 'Units and abbreviations'. Note: NLD reports HFC emissions from 2.F.2, 2.F.3, 2.F.4 and 2.F.5 in 2.F.6.

Table **4.42** to Table.**4.45** shows the contribution of each country to EU-KP HFC emissions from 2.F.1 as well as information on the method applied, activity data and emission factor.

Table 4.42 2F1 Refrigeration and Air conditioning: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2019	Change 1990-2019		Change 1995-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	1995	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	33	1 779	1 686	2.0%	1 686	∞	1 654	5058%	-93	-5%	T2	D
Belgium	NO	93	2 703	2 498	3.0%	2 498	∞	2 406	2599%	-204	-8%	T2	CS,D,PS
Bulgaria	NO	3	2 218	1 786	2.1%	1 786	∞	1 783	53560%	-432	-19%	T2	D
Croatia	NO	31	533	539	0.6%	539	∞	508	1660%	5	1%	T2	D
Cyprus	NO	33	311	324	0.4%	324	∞	291	883%	13	4%	T2	D
Czechia	NO	14	3 724	3 714	4.5%	3 714	∞	3 700	26407%	-11	-0.3%	T2	CS
Denmark	NO	48	479	323	0.4%	323	∞	275	578%	-156	-33%	NA	NA
Estonia	NO	10	222	215	0.3%	215	∞	206	2067%	-7	-3%	T2	CS
Finland	0.01	147	1 144	1 107	1.3%	1 107	10482442%	959	652%	-37	-3%	T2	CS,D
France	NO	465	13 864	13 015	15.6%	13 015	∞	12 549	2697%	-849	-6%	T2	CS
Germany	NA	589	9 168	8 536	10.2%	8 536	∞	7 947	1349%	-632	-7%	T2	CS,D
Greece	NO	42	5 510	5 043	6.0%	5 043	∞	5 001	11808%	-467	-8%	IE,T2	D,IE
Hungary	0.002	24	1 863	1 963	2.4%	1 963	82889220%	1 938	7953%	100	5%	T2	CS,D
Ireland	NO	5	700	672	0.8%	672	∞	667	13396%	-28	-4%	T2,T3	CS
Italy	NO	356	13 944	14 326	17.2%	14 326	∞	13 970	3921%	382	3%	T2	CS,D
Latvia	NO	17	257	250	0.3%	250	∞	233	1399%	-8	-3%	T2	CS,D,OTH
Lithuania	NO	5	523	516	0.6%	516	∞	511	9604%	-6	-1%	T2	CS,D,PS
Luxembourg	0.0001	3	56	54	0.1%	54	76072963%	51	1557%	-1	-2%	T2	CS,M,PS
Malta	NO,IE	0.002	258	248	0.3%	248	∞	248	13174697%	-10	-4%	T2	CS
Netherlands	NO	47	1 238	1 261	1.5%	1 261	∞	1 214	2589%	23	2%	T2	CS
Poland	NO	154	3 497	3 434	4.1%	3 434	∞	3 280	2123%	-63	-2%	T2	D
Portugal	NA	32	3 117	3 238	3.9%	3 238	∞	3 206	9872%	121	4%	NO,T2	D,NO
Romania	NO	2	2 208	2 203	2.6%	2 203	∞	2 201	113665%	-5	-0.2%	T2	CS,D
Slovakia	NO	11	671	687	0.8%	687	∞	676	6020%	16	2%	T2	CS
Slovenia	NO	3	313	289	0.3%	289	∞	286	9671%	-24	-8%	T1,T2	CS,D
Spain	NO	NO	4 177	4 013	4.8%	4 013	∞	4 013	∞	-164	-4%	T2	CS
Sweden	5	128	983	939	1.1%	934	18475%	811	634%	-44	-4%	T2	CS,D
United Kingdom	8	214	10 615	10 209	12.2%	10 201	126946%	9 996	4680%	-406	-4%	T2	CS
EU-27+UK	**13**	**2 510**	**86 076**	**83 090**	**100%**	**83 076**	**633869%**	**80 579**	**3210%**	**-2 986**	**-3%**	**-**	**-**
Iceland	NO	3	163	206	0.2%	206	∞	204	7514%	44	27%	T2,T3	D
United Kingdom (KP)	8	216	10 685	10 279	12.3%	10 271	127820%	10 063	4654%	-406	-4%	T2	CS
EU-KP	**13**	**2 516**	**86 308**	**83 366**	**100%**	**83 353**	**635979%**	**80 850**	**3214%**	**-2 942**	**-3%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

In 2019, HFC emissions from 2.F.1 were more than 33 times higher than in 1995 (Table **4.42** and ***Figure 4.16*** to Figure 4.19) but decreased by 3% compared to 2018 (EU-27+UK).

France, Germany, Italy and the UK were responsible for 55% of total EU-KP emissions from this source in 2019.

Figure 4.16: 2F1 Refrigeration and Air conditioning: EU-KP HFC emissions

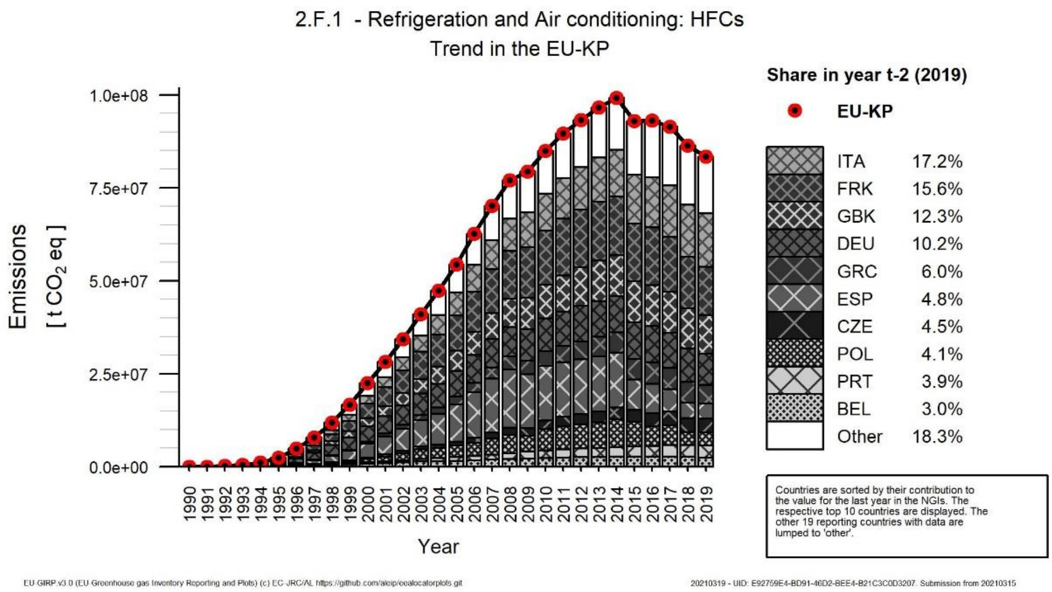


Figure 4.16 shows that emissions in sector 2.F.1 decreased again in 2019.

The main HFCs reported in this subcategory are HFC-32, HFC-125, HFC-134a and HFC-143a. They can be used as pure substances (such as HFC-32 and HFC-134a) and in mixtures (e.g. a refrigerant blend commonly used in stationary air conditioning is called “R410A” and is composed of 50% HFC-32 and 50% HFC-125).

Major developments in category 2.F.1 are driven by the subcategories 2.F.1.a Commercial refrigeration, 2.F.1.e Mobile air conditioning and 2.F.1.f Stationary air conditioning.

Emission plots for these three prominent subcategories are provided in the following graphs. Please note that 2.F.1.a often includes emissions from all types of stationary equipment in Member States (i.e. also industrial refrigeration and partly also stationary air conditioning). After a peak in 2014, emissions from 2.F.1.a decreased in 2015, 2017, 2018 and 2019. This is in line with the policies and measures of the EU F-gas Regulation No. 517/2014 and the EU MAC Directive.

Figure 4.17: 2F1a Commercial refrigeration: EU-KP HFC emissions

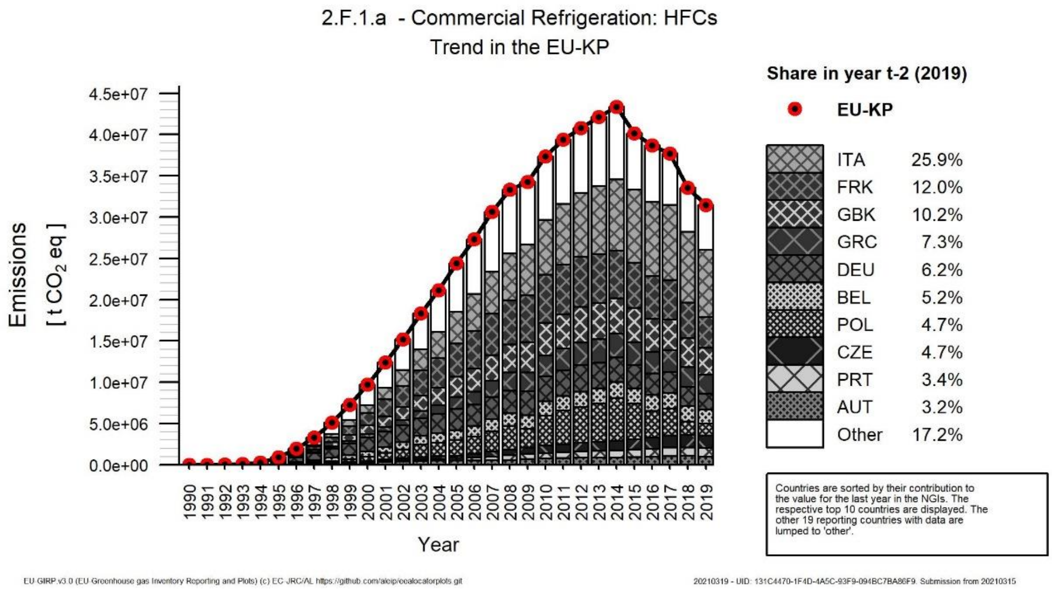


Figure 4.18: 2F1e Mobile air conditioning: EU-KP HFC emissions

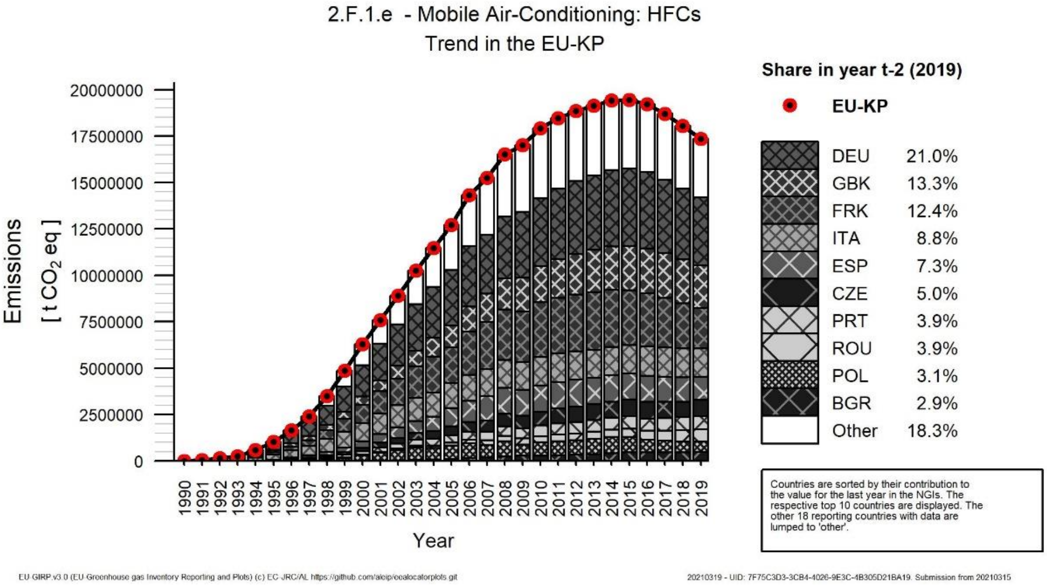


Figure 4.18 shows emission trends for mobile air-conditioning: The EU reported HFC-134a emissions from disposal in the subcategory mobile air conditioning (2.F.1.e) in CRF table 2(II)B-Hs2. The disposal loss factor related to HFC-134a emissions from disposal in mobile air conditioning (2.F.1.e) was 99.8% for the year 1995. HFC-134a was introduced in the early 1990s, and 1995 was the first year in which it was used on a large scale for mobile air conditioning in passenger cars. The very small amounts in 1995 relate to particularities of the inventories of France and Latvia, which run models of the vehicle stock that assume end of life of a certain share of vehicles each year, in line with a Gaussian normal distribution. Some cars reached their end of life in the first year of widespread use of HFC-134a in mobile air conditioning. The 2018 ERT considered the assumption that not every car reaches an average lifespan and that some are disposed of earlier (e.g. owing to damage in an accident) as realistic; and considered acceptable the assumption that in the first year when disposal emissions occurred, there was no (or only minor) recovery of emissions. Emissions from 2.F.1.e decreased in 2017, 2018 and 2019. This relates to the introduction of the low-GWP refrigerant R1234yf in air-conditioning systems of new passenger cars. Germany accounts for 21% of emissions from 2.F.1.e followed by the UK (13.3%) and France (12.4%).

Figure 4.19: 2F1f Stationary air conditioning: EU-KP HFC emissions

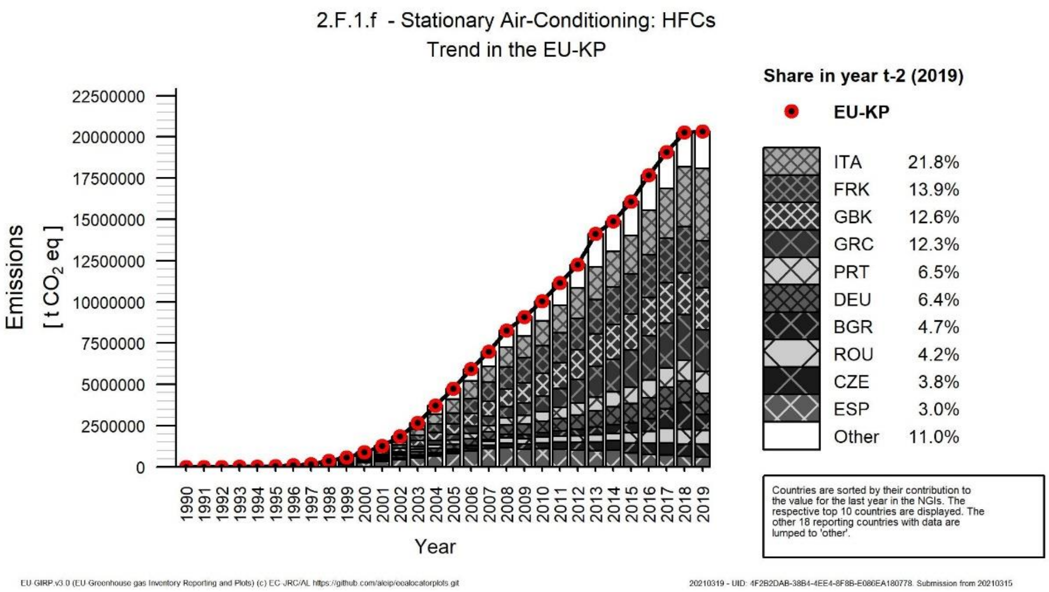


Figure 4.19 shows a consistent trend for sector 2.F.1.f with increasing emissions until 2018. This development reflects the growing use of air conditioning equipment, in particular in Southern Europe, and the delayed uptake of alternatives to HFCs in this sub-category. It should also be noted that some Member States allocate emissions from 2.F.1.f under the 2.F.1.a subcategory. In 2019, emission trend stabilized compared to 2018.

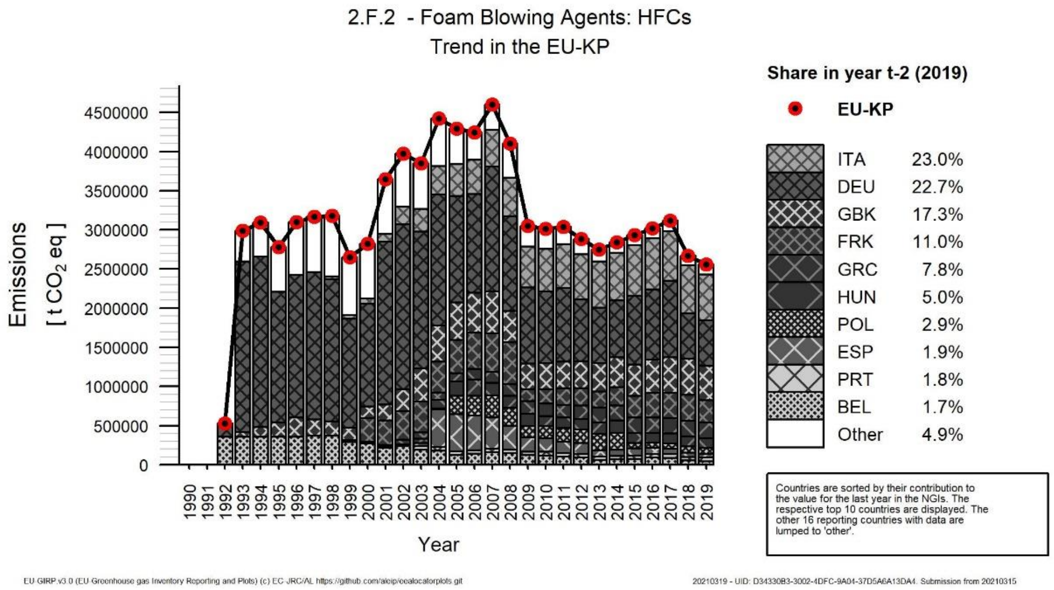
Table 4.43 2F2 Foam Blowing: Countries' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2019	Change 1990-2019		Change 1995-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	1995	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	301	16	18	0.7%	18	∞	-283	-94%	1	8%	T2	D
Belgium	NO	357	55	42	1.7%	42	∞	-314	-88%	-12	-22%	T2	CS,D,PS
Bulgaria	NO	NO	13	10	0.4%	10	∞	10	∞	-3	-26%	T2	D
Croatia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Cyprus	NO,NE	NO,NE	1	1	0.1%	1	∞	1	∞	0.1	4%	CS	CS
Czechia	NO	0.01	7	4	0.2%	4	∞	4	27984%	-3	-41%	NO,T1	D
Denmark	NO	210	1	1	0.03%	1	∞	-210	-100%	-0.1	-10%	NA	NA
Estonia	NO	18	2	2	0.1%	2	∞	-16	-89%	0.2	9%	T2	CS
Finland	NO	1	5	5	0.2%	5	∞	4	847%	-0.4	-8%	T2	D
France	NO	NO	332	282	11.0%	282	∞	282	∞	-51	-15%	T2	CS,D
Germany	IE,NA	1 666	577	581	22.7%	581	∞	-1 085	-65%	4	1%	T2	CS
Greece	NO	NO	197	199	7.8%	199	∞	199	∞	2	1%	T2	D
Hungary	NO	NO	129	129	5.0%	129	∞	129	∞	0.1	0.1%	T2	CS
Ireland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Italy	NO	NO	614	587	23.0%	587	∞	587	∞	-27	-4%	T2	D
Latvia	NO	0.4	1	1	0.03%	1	∞	0.4	88%	0.1	9%	T1a	D,OTH
Lithuania	NO	NO	38	41	1.6%	41	∞	41	∞	3	9%	T2	D
Luxembourg	NO	10	2	2	0.1%	2	∞	-8	-78%	1	36%	T1	CS
Malta	NO	NO	5	5	0.2%	5	∞	5	∞	0.3	7%	T1	D
Netherlands	NO,IE	NO,IE	NO,IE	NO,IE	-	-	-	-	-	-	-	T2	CS
Poland	NO	NO	76	75	2.9%	75	∞	75	∞	-1	-2%	T2	D
Portugal	NA	1	46	47	1.8%	47	∞	46	6145%	1	2%	T2	D
Romania	NO	NO	2	2	0.1%	2	∞	2	∞	0.5	30%	T2	D
Slovakia	NO	NO	2	2	0.1%	2	∞	2	∞	-0.01	-1%	T2	D
Slovenia	NO	30	2	1	0.1%	1	∞	-28	-95%	-0.1	-5%	T2	CS,D
Spain	NO	NO	55	48	1.9%	48	∞	48	∞	-7	-12%	T2	D
Sweden	NO	NO	30	29	1.2%	29	∞	29	∞	-0.3	-1%	T2	PS
United Kingdom	NO	184	462	439	17.2%	439	∞	255	139%	-23	-5%	T2	CS
EU-27+UK	**E,NA,IE,NO**	**2 777**	**2 668**	**2 554**	**100%**	**2 554**	**∞**	**-224**	**-8%**	**-114**	**-4%**	**-**	**-**
Iceland	-	-	-	-	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	184	464	441	17.3%	441	∞	257	139%	-23	-5%	T2	CS
EU-KP	**E,NA,IE,NO**	**2 778**	**2 670**	**2 556**	**100%**	**2 556**	**∞**	**-222**	**-8%**	**-114**	**-4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Note: NLD reports HFC emissions from 2.F.2, 2.F.3, 2.F.4 and 2.F.5 in 2.F.6.

In 2019, HFC emissions from 2.F.2 (Table **4.43** and ***Figure 4.20***) decreased slightly by 4% compared to the previous year. The HFC foam blowing agents reported in 2.F.2 are HFC-152a, HFC-134a, HFC-227ea, HFC-245fa and HFC-365mfc. The biggest contributors to emissions from this sector are Italy (23.0%), Germany (22.7%), UK (17.3%) and France (11.0%) and those four countries account for 73.9% of the share in EU-KP emissions in this sector.

Figure 4.20: 2F2 Foam Blowing Agents: EU-KP HFC emissions



This ***Figure 4.20*** displays that emissions from sector 2.F.2 varied noticeable until 2008 but are rather stable since then. Major foam manufacturers converted their production to non-HFC blowing agents (usually hydrocarbons) which resulted in a drop of emissions from this subcategory in the last ten years. The F-gas Regulation further limits the use of F-gases for this subcategory as the placing on the market of foams containing HFCs with GWP of 150 or more is banned from 2020 for extruded polystyrene (XPS) foams and for other foams from 2023, unless HFCs with higher GWPs are needed to meet national safety requirements (Annex III, point 16).

Table4.44 2F3 Fire protection: Countries' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2019	Change 1990-2019		Change 1995-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	1995	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	25	14	0.5%	14	∞	14	∞	-11	-44%	T2	D
Belgium	NO	1	12	12	0.5%	12	∞	12	1975%	0.1	1%	T2	CS
Bulgaria	NO	NO	8	9	0.3%	9	∞	9	∞	1	9%	T2	D
Croatia	NO	0.1	5	5	0.2%	5	∞	5	4101%	0.2	4%	T2	D
Cyprus	NO,NE	0.1	11	11	0.4%	11	∞	11	21457%	0.2	2%	CS	CS
Czechia	NO	NO	28	31	1.2%	31	∞	31	∞	3	10%	D	D
Denmark	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Estonia	NO	NO	2	2	0.1%	2	∞	2	∞	-0.2	-8%	T2	CS
Finland	NO	NO	NO,IE,NA	NO,IE,NA	-	-	-	-	-	-	-	NA	NA
France	NO	5	68	54	2.0%	54	∞	49	1077%	-14	-21%	T1	CS
Germany	NA	NA	106	105	3.9%	105	∞	105	∞	-1	-1%	CS	CS,D
Greece	NO	NO	156	160	6.0%	160	∞	160	∞	5	3%	CS	D
Hungary	NO	NO	7	7	0.3%	7	∞	7	∞	0.1	1%	T1	D
Ireland	NO	NO	32	32	1.2%	32	∞	32	∞	0.01	0.04%	T2	CS
Italy	NO	16	1 612	1 609	59.8%	1 609	∞	1 594	10200%	-3	-0.2%	T2	CS
Latvia	NO	NO	0.003	0.003	0.0001%	0.003	∞	0.003	∞	0.0	0%	T2	D
Lithuania	NO	NO	4	4	0.1%	4	∞	4	∞	0.2	5%	T1b	D
Luxembourg	-	-	-	-	-	-	-	-	-	-	-	-	-
Malta	NO	NO	0.3	3	0.1%	3	∞	3	∞	3	1166%	CS	D
Netherlands	-	-	-	-	-	-	-	-	-	-	-	T2	CS
Poland	NO	NO	103	108	4.0%	108	∞	108	∞	6	5%	T2	D
Portugal	NA	NO	64	70	2.6%	70	∞	70	∞	6	9%	-	-
Romania	NO	NO	5	5	0.2%	5	∞	5	∞	-0.01	-0.1%	T2	D
Slovakia	NO	2	21	23	0.8%	23	∞	21	991%	2	9%	T1a	CS
Slovenia	NO	NO	0.5	0.2	0.01%	0.2	∞	0.2	∞	-0.3	-56%	T2	CS,D
Spain	NO	1	118	107	4.0%	107	∞	106	11607%	-11	-9%	T1a	CS,D
Sweden	NO	NO	1	1	0.05%	1	∞	1	∞	-0.2	-13%	T1	CS
United Kingdom	NO	1	316	311	11.6%	311	∞	310	32106%	-5	-2%	T2	CS
EU-27+UK	**NE,NA,NO**	**25**	**2 707**	**2 687**	**100%**	**2 687**	**∞**	**2 662**	**10665%**	**-20**	**-1%**	**-**	**-**
Iceland	-	-	-	-	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	1	319	314	11.7%	314	∞	313	32235%	-5	-2%	T2	CS
EU-KP	**NE,NA,NO**	**25**	**2 710**	**2 690**	**100%**	**2 690**	**∞**	**2 665**	**10674%**	**-20**	**-1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

In 2019, HFC emissions from 2.F.3 (Table4.44) did hardly change compared to 2015, 2016, 2017 and 2018 – but increased dramatically since 1995. This development was caused by the phase-out of ozone depleting substances, especially halons, as fire extinguishing agents under the Montreal Protocol and the subsequent introduction of HFCs and other ODS alternatives as replacements. The HFCs reported in this subcategory are HFC-23 (banned in new equipment in the EU since 2015), HFC-227ea and HFC-236fa. In Denmark, Luxembourg and Iceland HFCs are not used as fire extinguishing agents. Instead, other chemicals or not-in-kind alternatives, e.g. water mist, fluorinated ketones etc., have been applied for many years. In the Netherlands, emissions from this subcategory are included in the 2.F.6 subcategory.

The biggest contributors to this sector are Italy (59.8%), UK (11.7%) and Greece (6.0%), those three countries account for 77.3% of the share in EU-KP emissions in this sector. Relevant increases of emissions from this subcategory compared to 2018 were reported by Malta (+1166%) and Czechia (+10%), while certain decreases were reported by Slovenia (-56%), Austria (-44%), France (-21%) and Sweden (-13%).

Figure 4.21: 2F3 Fire Protection, EU-KP: HFC emissions

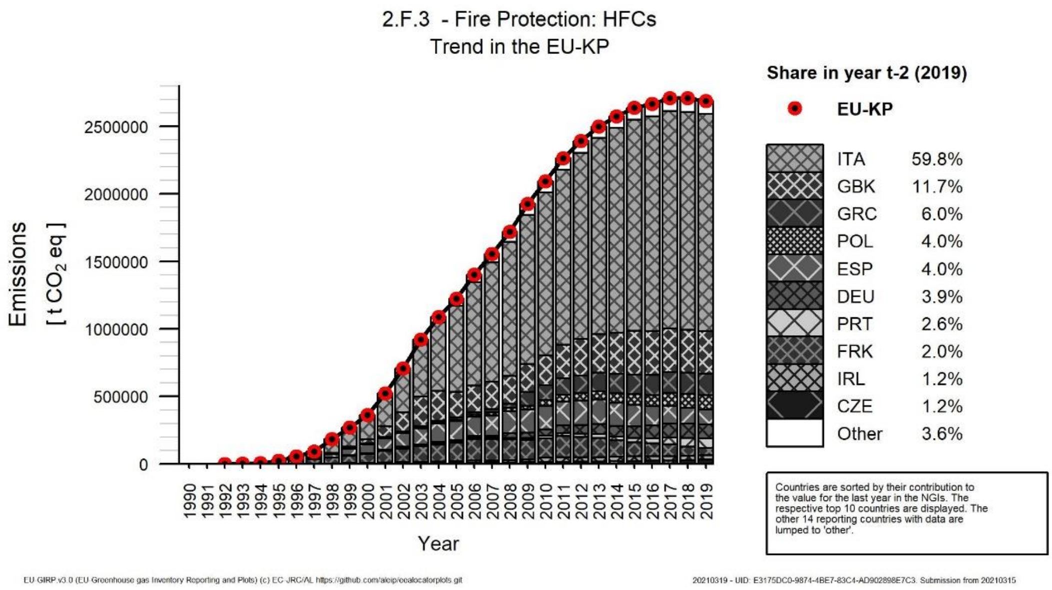


Figure 4.21 illustrates that emissions from fire protection were stable in recent years.

Table.4.45 2F4 Aerosols/ Metered Dose Inhalers: Countries' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2019	Change 1990-2019		Change 1995-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	1995	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	4	28	28	0.8%	28	∞	24	532%	0.2	1%	T2	D
Belgium	NO	41	50	50	1.4%	50	∞	9	21%	0.2	0.4%	T2	CS,D,PS
Bulgaria	NO	NO	13	14	0.4%	14	∞	14	∞	1	4%	T2	D
Croatia	NO	NO	9	9	0.2%	9	∞	9	∞	-0.1	-1%	T2	D
Cyprus	NO	0.001	4	4	0.1%	4	∞	4	669762%	0.4	10%	CS	CS
Czechia	NO	0.00001	2	2	0.1%	2	∞	2	19964977%	0.1	2%	T1	D
Denmark	NO	NO	15	12	0.3%	12	∞	12	∞	-3	-19%	0	0
Estonia	NO	0.1	5	5	0.1%	5	∞	5	9008%	0.01	0.3%	T2	CS
Finland	NO	2	23	20	0.6%	20	∞	18	896%	-3	-14%	T2	D
France	NO	623	1 284	628	17.4%	628	∞	6	1%	-655	-51%	T2	CS,PS
Germany	NO,IE,NA	342	356	353	9.8%	353	∞	11	3%	-3	-1%	CS,T2	CS
Greece	NO	0.03	45	45	1.3%	45	∞	45	140881%	0.1	0.2%	T2	D
Hungary	NO	12	35	35	1.0%	35	∞	23	200%	0.5	1%	T2	CS,D
Ireland	NO	38	108	109	3.0%	109	∞	71	187%	1	1%	T1,T2	CS
Italy	NO	NO	257	262	7.3%	262	∞	262	∞	4	2%	T2	CS
Latvia	NO	0.1	5	5	0.1%	5	∞	4	7320%	-0.4	-8%	T1a	D
Lithuania	NO	1	7	7	0.2%	7	∞	7	769%	-0.1	-2%	T1a	D
Luxembourg	NO	2	3	3	0.1%	3	∞	1	74%	-0.1	-3%	T1,T2	CS
Malta	NO,NE	NO,NE	1	1	0.0%	1	∞	1	∞	-0.1	-16%	T1	CS
Netherlands	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Poland	NO	18	128	127	3.5%	127	∞	109	625%	-1	-1%	T1a,T1b,T2	D
Portugal	NA	27	18	18	0.5%	18	∞	-9	-33%	0	1%	T2	D,NO
Romania	0.2	1	41	46	1.3%	46	25256%	45	6277%	5	12%	T2	D
Slovakia	NO	NO	9	9	0.3%	9	∞	9	∞	0.2	3%	T1a	D
Slovenia	NO	NO	5	5	0.1%	5	∞	5	∞	0.2	3%	T1	D
Spain	NO	NO,NA	328	324	9.0%	324	∞	324	∞	-4	-1%	T2	CS
Sweden	1	7	23	18	0.5%	16	1143%	10	144%	-5	-23%	T2	D
United Kingdom	NO	446	1 645	1 453	40.4%	1 453	∞	1 007	226%	-192	-12%	T2	CS
EU-27+UK	**2**	**1 563**	**4 446**	**3 592**	**100%**	**3 590**	**222835%**	**2 029**	**130%**	**-854**	**-19%**	**-**	**-**
Iceland	0.3	1	1	1	0.03%	1	167%	0.2	28%	-0.02	-2%	NA	NA
United Kingdom (KP)	NO	449	1 652	1 460	40.6%	1 460	∞	1 011	225%	-192	-12%	T2	CS
EU-KP	**2**	**1 567**	**4 454**	**3 600**	**100%**	**3 598**	**184015%**	**2 034**	**130%**	**-854**	**-19%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

In 2019, HFC emissions from 2.F.4 grew by 130% compared to 1995 (Table.**4.45** and ***Figure 4.21***). This partly relates to the phase-out of ODS in this subcategory but also to increased use of medical aerosols throughout Europe, especially for asthma treatment. The HFCs reported in 2.F.4 are HFC-134a (medical and technical aerosols), HFC-227ea (medical aerosols only) and HFC-152a (technical aerosols). Emissions from technical aerosols play a minor role from 2018 onwards as the EU F-gas Regulation bans the placing on the market of technical aerosols containing HFCs with GWP of 150 or more, except when required to meet national safety standards or when used for medical applications since 1 January 2018 (Annex III, point 17). This is reflected in a 19% decrease of EU-KP emissions in 2019 compared to 2018.

UK (40.6%), France (17.4%) and Germany (9.8%) accounted for 67.6% of total EU-KP emissions from this source. A significant relative decrease between 2018 and 2019 was reported by France (-51%) and Sweden (-23%); the biggest increase was reported by Romania (+12%) and Cyprus (+10%).(Table.**4.45**). It should be noted that emissions from this subcategory have been decreasing slowly since 2006 despite the growing number of patients in need of MDI treatment in most EU Member States. This is mainly due to increased application of dry powder inhalers and other alternative treatment measures.

Figure 6 4 2F4 Aerosols/Metered Dose Inhalers: EU-KP HFC emissions

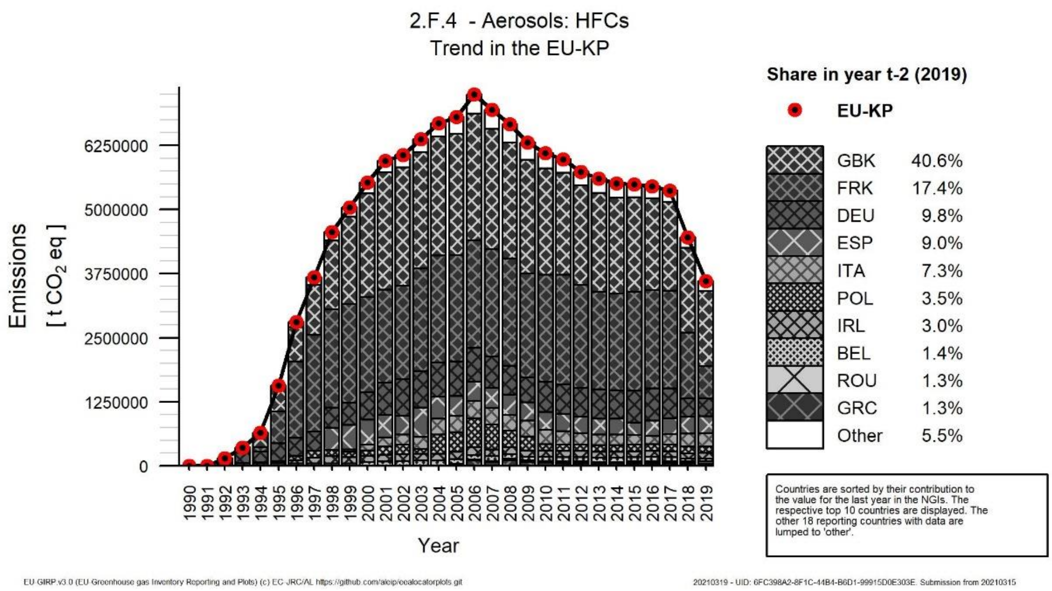


Figure 4.21 shows the significant emission reductions in 2019 compared to previous years.

The subcategories 2.F.5 Solvents and 2.F.6 Other applications are not described in detail in this submission. Emission estimates from these subcategories are confidential in several Member States because the relevant industrial processes are only performed by very few companies. Emissions are thus reported together with other subcategories.

4.2.7 **Other product manufacture and use (CRF Source Category 2G)**

PFCs and SF_6 have been used for certain applications within this category for many decades. SF_6 is a particularly potent greenhouse gas (GWP 22800) that is used predominantly in insulated switch gear for transportation and distribution of electric power (2.G.1). Emissions also occur from other product use (2.G.2), for example military applications (SF_6), particle accelerators (SF_6), applications of adiabatic properties - shoes and tyres (SF_6, PFCs), sound proof windows (SF_6), medical and cosmetic applications (SF_6, PFCs), other (SF_6, PFCs) etc.

Table 8 shows that all Member States report GHG emissions in 2.G Other product manufacture and use for the year 2019. SF_6 emissions from the subcategory electrical equipment (2.G.1) are reported by all Member States except the Netherlands where the share of non-F-gas alternatives is particularly high and SF_6 emission estimates are included elsewhere.

Table.4.46 2G Other: Overview of sources reported under this source category

Country	2.G Other product manufacture and use	HFC emissions [kt CO_2 equivalents]	PFC emissions [kt CO_2 equivalents]	SF_6 emissions [kt CO_2 equivalents]	NF_3 emissions [kt CO_2 equivalents]	Unspecified mix of HFCs and PFCs [kt CO_2 equivalents]	Total emissions [kt CO_2 equivalents]	Share in EU-KP Total
AUT	Electrical equipment (SF_6); Soundproof windows (SF_6); Other (SF_6)	NO	NO	400			400	5.6%
BEL	Electrical equipment (SF_6); Soundproof windows (SF_6); Other (C6F14)	NO	NO	82	NO	NO	82	1.1%
BGR	Electrical equipment (SF_6)		NO	18			18	0.3%
HRV	Electrical equipment (SF_6)	NO	NO	5	NO	NO	5	0.1%
CYP	Electrical equipment (SF_6)		0	15			15.0	0.2%
CZE	Electrical equipment (SF_6); Accelerators (SF_6); Soundproof windows (SF_6); Other (SF_6)			65			65	0.9%
DNM	Electrical equipment (SF_6); Soundproof windows (SF_6); Other (SF_6)	NO,NA	NO,NA	71	NO,NA	NO,NA	71	1.0%
EST	Electrical equipment (SF_6); Accelerators (SF_6)	NO	NO	3	NO	NO	3	0.0%
FIN	Electrical equipment (SF_6)	0	NO,IE	14	0	0	14	0.2%
FRK	Electrical equipment (SF_6); Accelerators (SF_6); Other (SF_6, Unspecified mix of PFCs)	1	467	346			814	11.4%
DEU	Electrical equipment (SF_6); Military applications (SF_6 => Notation Key C); Accelerators (SF_6); Soundproof windows (SF_6); Adiabatic properties: shoes and tyres (SF_6, C3F8 => Notation Key C); Other (SF_6 => partly Notation Key C, C10F18 => Notation Key C); 4. Other (HFC-134a, HFC-245fa => Notation Key C, HFC-365mfc => Notation Key C)	11	IE,NA	3845	NA	NA	3856	54.1%
GRC	Electrical equipment (SF_6)		NO	5			5	0.1%
HUN	Electrical equipment (SF_6); Other (SF_6)	NO	NO	101	NO	NO	101	1.4%

Country	2.G Other product manufacture and use	HFC emissions [kt CO_2 equivalents]	PFC emissions [kt CO_2 equivalents]	SF_6 emissions [kt CO_2 equivalents]	NF_3 emissions [kt CO_2 equivalent s]	Unspecified mix of HFCs and PFCs [kt CO_2 equivalents]	Total emissions [kt CO_2 equivalent s]	Share in EU-KP Total
IRL	Electrical equipment (SF_6); Soundproof windows (SF_6); Adiabatic properties: shoes and tyres (SF_6); Other (SF_6)	NO	NO	10	NO	NO	10	0.1%
ITA	Electrical equipment (SF_6); Accelerators (SF_6)	NO	NO	384	NO	NO	384	5.4%
LVA	Electrical equipment (SF_6)	NO	NO	14	NO	NO	14	0.2%
LTU	Electrical equipment (SF_6); Accelerators (SF_6)	NO	NO	1	NO	NO	1	0.0%
LUX	Electrical equipment (SF_6); Soundproof windows (SF_6), Other (HFC-43-10mee)	2		10			12	0.2%
MLT	Electrical equipment (SF_6), Other (SF_6, C3F8)		0.00	0.27			0.27	0.004%
NLD	Other (SF_6)	NO	NO	111			111	1.6%
POL	Electrical equipment (SF_6)	NA	NA	91	NA	NA	91	1.3%
PRT	Electrical equipment (SF_6)	NO	NO	24	NO	NO	24	0.3%
ROU	Electrical equipment (SF_6)	NO	NO	77	NO	NO	77	1.1%
SVK	Electrical equipment (SF_6)	NO	NO	9	NO	NO	9	0.1%
SVN	Electrical equipment (SF_6)	NO	NO	16	NO	NO	16	0.2%
ESP	Electrical equipment (SF_6); Accelerators (SF_6), Other (SF_6)	NO	NO	228	NO	NO	228	3.2%
SWE	Electrical equipment (SF_6); Soundproof windows (SF_6)		NO	33			33	0.5%
GBE	Electrical equipment (SF_6); Military applications (SF_6); Accelerators (SF_6); Other (CF4, C2F6, C3F8, c-C4F8, SF_6)		218	448			665	9%
EU-27+UK	**TOTAL**	14	685	6427	0	0	7125	
GBK	Electrical equipment (SF_6); Military applications (SF_6); Accelerators (SF_6); Other (CF4, C2F6, C3F8, c-C4F8, SF_6)		218	448			665	9.3%

Country	2.G Other product manufacture and use	HFC emissions [kt CO_2 equivalents]	PFC emissions [kt CO_2 equivalents]	SF_6 emissions [kt CO_2 equivalents]	NF_3 emissions [kt CO_2 equivalent s]	Unspecified mix of HFCs and PFCs [kt CO_2 equivalents]	Total emissions [kt CO_2 equivalent s]	Share in EU-KP Total
ISL	Electrical equipment (SF_6)		NO	2			2	0.03%
EU-KP	**TOTAL**	14	685	6429	0	0	7127	**100%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 4.22 and Table 4.47 summarize information by Member State on SF_6 emissions for the key source 2.G. Emissions have been relatively stable since 2002 with a small but rather steady increase since 2014. The development of emissions from this category is dominated by the emission trend in Germany (59.8% of SF_6 emissions from EU-KP in 2019), where the disposal of sound proof windows containing SF_6 represents a particularly high emission source.

Table 4.47: 2G - Member States' contributions to SF_6 emissions

Member State	SF6 Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2019	Change 1990-2019		Change 1995-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	1995	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	132	268	352	400	6.2%	268	204%	131	49%	47	13%	T2	D
Belgium	135	135	87	82	1.3%	-53	-39%	-53	-39%	-6	-7%	T1,T2	D
Bulgaria	4	5	18	18	0.3%	15	394%	13	273%	0.3	1%	NO,T2	D,NO
Croatia	10	11	6	5	0.1%	-5	-49%	-6	-52%	-0.2	-3%	T2	CS
Cyprus	3	6	16	15	0.2%	12	466%	9	160%	-1	-9%	T1	D
Czechia	84	89	68	65	1.0%	-19	-22%	-23	-26%	-2	-3%	D,T1	D
Denmark	13	70	73	71	1.1%	58	458%	2	2%	-2	-3%	NA	NA
Estonia	NO	3	3	3	0.04%	3	∞	-0.3	-11%	0.2	7%	T3	CS
Finland	45	27	13	14	0.2%	-31	-70%	-13	-48%	1	6%	T2	CS
France	1 249	1 479	372	346	5.4%	-902	-72%	-1 132	-77%	-25	-7%	T1,T2	CS,D
Germany	4 050	6 072	3 756	3 845	59.8%	-205	-5%	-2 227	-37%	89	2%	CS,D,T3	CS,D
Greece	3	3	5	5	0.1%	2	68%	2	44%	-0.02	-0.4%	CS	CS
Hungary	12	51	97	101	1.6%	89	716%	50	98%	5	5%	T1,T2	D
Ireland	33	38	19	10	0.2%	-23	-69%	-28	-73%	-9	-46%	T1,T2	CS
Italy	294	551	396	384	6.0%	90	31%	-167	-30%	-12	-3%	CS,T2	CS,PS
Latvia	NO	0.2	11	14	0.2%	14	∞	14	7873%	3	31%	T1	D
Lithuania	NO	0.05	0.5	1	0.01%	1	∞	1	1328%	0.2	35%	T3	CS
Luxembourg	1	2	10	10	0.2%	9	713%	9	496%	0.2	2%	D,T1,T3	CS,D,M,PS
Malta	0.01	1	0.3	0.3	0.004%	0.3	2426%	-1	-81%	-0.03	-10%	CS	CS,PS
Netherlands	207	261	124	111	1.7%	-95	-46%	-150	-57%	-12	-10%	T1,T3	CS
Poland	NA,NO	13	107	91	1.4%	91	∞	78	624%	-17	-15%	T1	D
Portugal	NO,NA	14	24	24	0.4%	24	∞	10	71%	0.1	0.3%	T1	NO
Romania	0.5	1	62	77	1.2%	77	16137%	76	7800%	15	24%	T2	D
Slovakia	0.1	10	9	9	0.1%	9	15088%	-1	-13%	-1	-6%	T3	CS
Slovenia	10	12	16	16	0.2%	6	61%	4	31%	0.04	0.3%	T2	CS
Spain	64	100	227	228	3.5%	164	256%	128	128%	1	0.5%	T2,T3	CS,D
Sweden	79	108	33	33	0.5%	-46	-58%	-75	-69%	0.2	1%	T2,T3	CS,PS
United Kingdom	928	927	460	448	7.0%	-481	-52%	-479	-52%	-13	-3%	TH,T1,T2,T3	CS,D
EU-27+UK	**7 356**	**10 255**	**6 364**	**6 427**	**100%**	**-929**	**-13%**	**-3 828**	**-37%**	**63**	**1%**	**-**	**-**
Iceland	1	1	3	2	0.0%	1	82%	1	60%	-1	-39%	T2	CS
United Kingdom (KP)	928	927	460	448	7.0%	-481	-52%	-479	-52%	-13	-3%	TH,T1,T2,T3	CS,D
EU-KP	**7 357**	**10 257**	**6 367**	**6 429**	**100%**	**-928**	**-13%**	**-3 828**	**-37%**	**61**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 4.22: 2G - Other Product Manufacture and Use: SF_6 Trend in the EU-KP

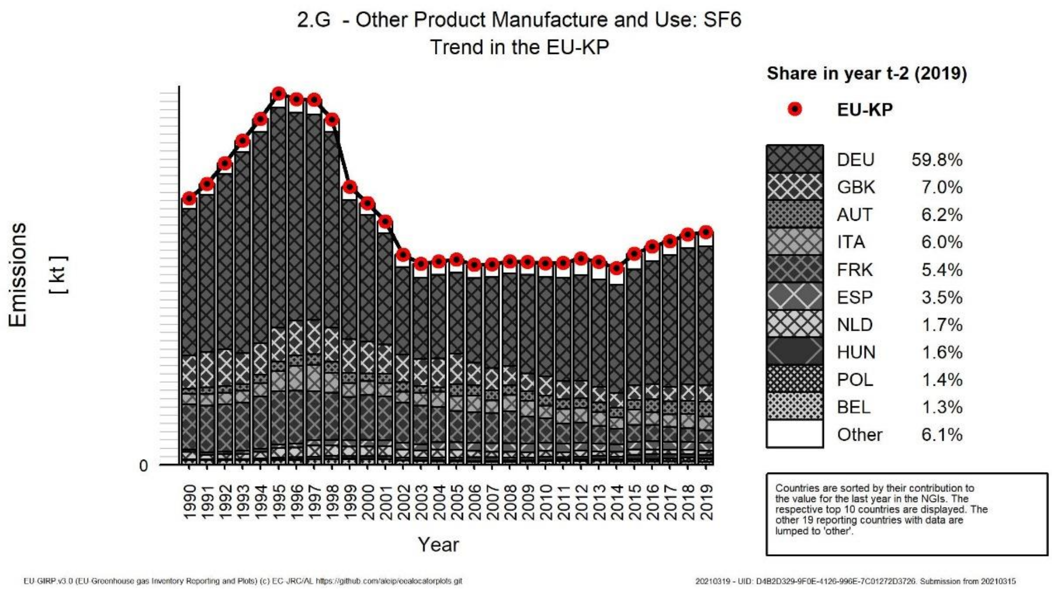


Figure 4.22 shows a stable trend for emissions from SF_6 in sector 2.G in the period 2002-2014, after a considerable decrease since 1995. Since 2014 smaller but steady increases took place (+1% in 2019 compared to 2018).

4.2.8 IPPU – non-key categories

Table 4.48 provides an overview on the role of non-key categories in the IPPU sector.

Table 4.48 Aggregated GHG emission from non-key categories in the IPPU sector

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 equ.	%	kt CO_2 equ.	%
2.A.3 Glass production: no classification (CO2)	4 271.5	4 325.4	4 325.2	1.17%	54	1%	-0.1	0%
2.B.1 Ammonia Production: no classification (CH4)	2.1	2.9	2.3	0.00%	0.2	10%	-0.6	-21%
2.B.1 Ammonia Production: no classification (N2O)	0.6	0.8	0.8	0.00%	0.1	20%	-0.1	-10%
2.B.10 Other chemical industry: no classification (CH4)	293.4	103.7	118.8	0.03%	-175	-60%	15	15%
2.B.10 Other chemical industry: no classification (N2O)	875.4	445.7	491.4	0.13%	-384	-44%	46	10%
2.B.3 Adipic Acid Production: no classification (CO2)	17.7	18.9	17.3	0.00%	-0.4	-2%	-1.6	-9%
2.B.4 Caprolactam, Glyoxal and Glyoxylic Acid Production: no classification (N2O)	4 127.2	2 111.2	1 894.4	0.51%	-2 233	-54%	-217	-10%
2.B.5 Carbide Production: no classification (CH4)	5.6	10.4	8.5	0.00%	3.0	53%	-1.9	-18%
2.B.5 Carbide Production: no classification (CO2)	1 798.6	270.9	265.6	0.07%	-1 533	-85%	-5.3	-2%
2.B.6 Titanium Dioxide Production: no classification (CO2)	126.2	231.3	205.8	0.06%	80	63%	-26	-11%
2.B.7 Soda Ash Production: no classification (CO2)	2 242.1	2 152.4	2 007.7	0.54%	-234	-10%	-145	-7%
2.B.8 Petrochemical and Carbon Black Production: no classification (CH4)	1 003.7	1 079.8	1 087.6	0.29%	84	8%	7.7	1%
2.B.9 Fluorochemical Production: no classification (PFCs)	4 331.8	1 778.2	1 159.6	0.31%	-3 172	-73%	-619	-35%
2.B.9 Fluorochemical Production: no classification (SF6)	1 845.5	1.0	1.1	0.00%	-1 844	-100%	0.1	6%
2.C.1 Iron and Steel Production: no classification (CH4)	393.7	150.2	143.7	0.04%	-250	-64%	-6.6	-4%
2.C.2 Ferroalloys Production: no classification (CH4)	27.5	23.4	22.8	0.01%	-4.6	-17%	-0.5	-2%
2.C.2 Ferroalloys Production: no classification (CO2)	4 868.5	3 478.6	2 983.5	0.81%	-1 885	-39%	-495	-14%
2.C.3 Aluminium Production: no classification (CO2)	4 906.1	4 574.6	4 274.7	1.16%	-631	-13%	-300	-7%
2.C.3 Aluminium Production: no classification (SF6)	13.7	0.1	0.0	0.00%	-14	-100%	-0.1	-93%
2.C.4 Magnesium Production: no classification (HFCs)	0.0	32.2	19.5	0.01%	19	100%	-13	-40%
2.C.4 Magnesium Production: no classification (SF6)	847.7	247.7	195.3	0.05%	-652	-77%	-52	-21%
2.C.5 Lead Production: no classification (CO2)	391.0	208.3	208.8	0.06%	-182	-47%	0.5	0%
2.C.6 Zinc Production: no classification (CO2)	2 961.0	1 097.4	1 089.9	0.29%	-1 871	-63%	-7.4	-1%
2.C.7 Other Metal Industry: no classification (CO2)	464.8	254.2	220.7	0.06%	-244	-53%	-34	-13%
2.C.7 Other Metal Industry: no classification (N2O)	44.6	21.9	20.9	0.01%	-24	-53%	-1.0	-5%
2.C.7 Other Metal Industry: no classification (SF6)	720.6	57.5	30.6	0.01%	-690	-96%	-27	-47%
2.D.1 Lubricant Use: no classification (CH4)	1.7	0.4	0.4	0.00%	-1.3	-76%	0.0	1%
2.D.1 Lubricant Use: no classification (CO2)	3 542.8	2 643.6	2 615.4	0.71%	-927	-26%	-28	-1%
2.D.1 Lubricant Use: no classification (N2O)	3.0	3.2	3.3	0.00%	0.2	8%	0.0	1%
2.D.2 Paraffin Wax Use: no classification (CH4)	0.2	0.4	0.4	0.00%	0.2	114%	0.0	1%
2.D.2 Paraffin Wax Use: no classification (CO2)	664.7	1 097.8	1 067.4	0.29%	403	61%	-30	-3%
2.D.2 Paraffin Wax Use: no classification (N2O)	0.7	1.4	1.4	0.00%	0.6	83%	-0.1	-5%
2.D.3 Other non energy products: no classification (CH4)	1.2	1.3	1.3	0.00%	0.1	10%	0.0	-3%
2.E.1 Integrated Circuit or Semiconductor: no classification (HFCs)	86.2	65.8	67.7	0.02%	-19	-21%	1.9	3%
2.E.1 Integrated Circuit or Semiconductor: no classification (NF3)	23.8	68.3	57.8	0.02%	34	143%	-11	-15%
2.E.1 Integrated Circuit or Semiconductor: no classification (PFCs)	433.4	522.6	531.3	0.14%	98	23%	8.7	2%
2.E.1 Integrated Circuit or Semiconductor: no classification (SF6)	237.7	146.9	156.5	0.04%	-81	-34%	9.5	6%
2.E.4 Heat Transfer Fluid: no classification (HFCs)	0.0	0.1	0.2	0.00%	0.2	100%	0.0	33%
2.E.5 Other electronics industry: no classification (PFCs)	0.0	0.0	1.1	0.00%	1.1	100%	1.1	100%
2.F.1 Refrigeration and Air conditioning: no classification (PFCs)	0.0	72.8	74.6	0.02%	75	100%	1.8	2%
2.F.1 Refrigeration and Air conditioning: no classification (Unspecified mix of HFCs and PFCs)	0.0	1 621.4	1 442.0	0.39%	1 442	100%	-179	-11%
2.F.3 Fire Protection: no classification (HFCs)	0.0	2 709.8	2 689.6	0.73%	2 690	100%	-20	-1%
2.G.2 SF6 and PFCs from Other Product Use: no classification (PFCs)	322.0	731.3	684.9	0.19%	363	113%	-46	-6%
2.G.2 SF6 and PFCs from Other Product Use: no classification (SF6)	4 494.4	4 414.1	4 553.9	1.23%	60	1%	140	3%
2.G.3 N2O from Product Uses: no classification (N2O)	5 575.2	3 412.8	3 634.0	0.98%	-1 941	-35%	221	6%
2.G.4 Other unspecifed product manufacture and use: no classification (CH4)	56.8	83.5	78.6	0.02%	22	38%	-4.9	-6%
2.G.4 Other unspecifed product manufacture and use: no classification (CO2)	789.8	592.5	560.9	0.15%	-229	-29%	-32	-5%
2.G.4 Other unspecifed product manufacture and use: no classification (HFCs)	0.0	15.9	13.6	0.00%	14	100%	-2.3	-14%
2.H Other Industrial Process and Product Use: no classification (CH4)	37.2	13.5	13.8	0.00%	-23	-63%	0.3	2%
2.H Other Industrial Process and Product Use: no classification (CO2)	112.9	116.7	115.4	0.03%	2.4	2%	-1.3	-1%
2.H Other Industrial Process and Product Use: no classification (HFCs)	0.0	1.9	1.2	0.00%	1.2	11892%	-0.6	-34%
2.H Other Industrial Process and Product Use: no classification (PFCs)	0.2	0.9	1.1	0.00%	0.9	441%	0.2	22%
2.H Other Industrial Process and Product Use: no classification (SF6)	7.5	7.1	4.5	0.00%	-3.0	-40%	-2.6	-37%
2.H Other Industrial Process and Product Use: no classification (Unspecified mix of HFCs and PFCs)	282.9	135.9	156.7	0.04%	-126	-45%	21	15%

4.3 Methodological issues and uncertainties

The previous section presented for each EU-KP key source in CRF Sector 2 an overview of the Member States' contributions to the key source in terms of level and trend, information on methodologies, emission factors, completeness and qualitative uncertainty estimates. Detailed information on national methods and circumstances is available in the Member States' national inventory reports.

4.3.1 Gap filling of Activity data

It is important to explain the reasons why the EU is not always able to provide EU-level AD or IEFs but has instead opted to transparently document what the MS have reported.

Because of the differences in methodological approaches used by countries the EU NIR provides overview tables for the activity data used by countries and the corresponding IEFs. Some of these tables do include a calculation of EU-level implied emission factors based on a number of countries. In those cases where (a) more than 75% of the emissions are calculated on basis of consistent activity data, and (b) the IEF has a reasonable degree of consistency (i.e. standard deviation divided by mean < 50%) we gap-filled activity data in the CRF. In these cases we are confident that the IEF included in the CRF provides reliable information to reviewers and adds to the transparency of the EU inventory. In all other cases we believe that an IEF in the CRF would be misleading because it would be based on a limited number of countries or based on very different methodological approaches which cannot be meaningfully aggregated. Due to the significant amount of time required, the CRF only includes gap filled activity data for 2019 and only for the EU key categories where the criteria above apply. In 2021 the following categories have been gap-filled:

- Cement Production 2.A.1
- Lime production in 2.A.2
- Ammonia Production in 2.B.1

The method for gap filling includes four steps:

1. Emissions have been aggregated for those MS that are using the same activity data and that are reporting activity data and emissions (i.e. not using notation keys for either activity data or emissions. Usually the geographical coverage of these MS is smaller than EU-KP.
2. These emissions have been divided by the aggregated activity data of those MS in order to derive an IEF for those MS.
3. The total emissions of the EU-KP have been divided by this IEF in order to derive a gap-filled estimate for activity data for EU-KP.

Table **4.49** shows the details for the gap filling of activity data for the four categories in particular the geographical coverage of MS used as a basis for calculating the IEF.

Table 4.49 Documentation of gap filling of activity data

Category	Geographical coverage	2019			
		Activity data Description	(kt)	IEF (t/t)	Emissions (kt)
2.A.1	EUA	Clinker production	147 293	0.53	77 986
	EUC	Clinker production	147 293	0.53	77 986
2.A.2	EUA	Lime Production	27 477	0.68	18 729
	EUC	Lime Production	27 477	0.68	18 729
2.B.1	EUA	Ammonia Production	15 552	1.40	21 721
	EUC	Ammonia Production	15 552	1.40	21 721

4.3.2 Uncertainty estimates

Table 4.50 shows the total EU-KP uncertainty estimates for the sector 'Industrial processes' and the uncertainty estimates for the relevant gases of each source category. The highest level uncertainty was estimated for PFCs from 2.F (156.5%) and the lowest for SF_6 from 2.B (3 %). With regard to trend HFC from 2.H shows the highest uncertainty estimates, CO_2 from 2.A and 2.C the lowest. For a description of the Tier 1 uncertainty analysis carried out for the EU-KP see Chapter 1.6.

Table 4.50 Sector 2 Industrial processes: Uncertainty estimates for the EU-KP

Source category	Gas	Emissions Base Year	Emissions 2019	Emission trends Base Year-2019	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.A Mineral Industry	CO_2	147 054	109 393	-25.6%	3.1%	0.0%
2.A Mineral Industry	CH_4	31	5	-82.8%	100.0%	0.8%
2.A Mineral Industry	N_2O	0	0		0.0%	
2.B Chemical Industry	CO_2	62 049	51 544	-16.9%	5.6%	0.0%
2.B Chemical Industry	CH_4	1 193	1 112	-6.8%	30.6%	0.1%
2.B Chemical Industry	N_2O	116 774	5 853	-95.0%	12.4%	0.0%
2.B Chemical Industry	HFC	35 144	1 807	-94.9%	24.1%	0.1%
2.B Chemical Industry	PFC	4 428	1 113	-74.9%	48.3%	0.1%
2.B Chemical Industry	Unspecified mix of HFCs and PFCs	0	0		0.0%	0.0%
2.B Chemical Industry	SF_6	1 891	1	-99.9%	3.0%	0.2%
2.B Chemical Industry	NF_3	0	0		0.0%	0.0%
2.C Metal Industry	CO_2	132 475	78 401	-40.8%	3.7%	0.0%
2.C Metal Industry	CH_4	412	144	-65.0%	12.5%	0.1%
2.C Metal Industry	N_2O	45	21	-53.1%	82.5%	0.4%
2.C Metal Industry	HFC	4 446	23	-99.5%	31.2%	0.5%
2.C Metal Industry	PFC	15 931	500	-96.9%	14.9%	0.1%

Source category	Gas	Emissions Base Year	Emissions 2019	Emission trends Base Year-2019	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.C Metal Industry	Unspecified mix of HFCs and PFCs	0	0		0.0%	0.0%
2.C Metal Industry	SF_6	1 406	176	-87.5%	9.6%	0.2%
2.C Metal Industry	NF_3	0	0		0.0%	0.0%
2.D Non-energy products from fuels and solvent use	CO_2	12 676	8 276	-34.7%	36.5%	0.2%
2.D Non-energy products from fuels and solvent use	CH_4	3	2	-32.3%	85.3%	0.4%
2.D Non-energy products from fuels and solvent use	N_2O	4	5	22.7%	74.5%	0.3%
2.E Electronics industry	CO_2	0	0		0.0%	
2.E Electronics industry	CH_4	0	0		0.0%	
2.E Electronics industry	N_2O	0	0		0.0%	
2.E Electronics industry	HFC	58	992	1611.5%	23.5%	3.5%
2.E Electronics industry	PFC	552	468	-15.2%	22.4%	0.1%
2.E Electronics industry	Unspecified mix of HFCs and PFCs	0	0		0.0%	0.0%
2.E Electronics industry	SF_6	200	133	-33.4%	16.4%	0.8%
2.E Electronics industry	NF_3	99	54	-45.7%	18.7%	0.1%
2.F Product uses as substitutes for ODS	CO_2	0	2 253		51.0%	
2.F Product uses as substitutes for ODS	CH_4	0	0		0.0%	
2.F Product uses as substitutes for ODS	N_2O	0	0		0.0%	
2.F Product uses as substitutes for ODS	HFC	3 758	84 468	2147.7%	42.8%	3.6%
2.F Product uses as substitutes for ODS	PFC	21	38	83.4%	156.5%	2.8%
2.F Product uses as substitutes for ODS	Unspecified mix of HFCs and PFCs	0	0		0.0%	0.0%
2.F Product uses as substitutes for ODS	SF_6	0	0		0.0%	0.0%
2.F Product uses as substitutes for ODS	NF_3	0	0		0.0%	0.0%
2.G Other product manufacture and use	CO_2	794	579	-27.1%	11.0%	0.0%
2.G Other product manufacture and use	CH_4	57	79	38.3%	31.4%	0.1%
2.G Other product manufacture and use	N_2O	3 238	2 893	-10.7%	47.6%	0.1%
2.G Other product manufacture and use	HFC	54	72	34.8%	38.7%	0.3%
2.G Other product manufacture and use	PFC	401	727	81.4%	34.3%	0.2%
2.G Other product manufacture and use	Unspecified mix of HFCs and PFCs	0	0		0.0%	0.0%
2.G Other product manufacture and use	SF_6	3 223	2 050	-36.4%	26.0%	0.1%
2.G Other product manufacture and use	NF_3	0	0		0.0%	0.0%
2.H Other	CO_2	92	50	-45.1%	12.3%	0.1%
2.H Other	CH_4	6	8	39.5%	29.1%	0.1%

Source category	Gas	Emissions Base Year	Emissions 2019	Emission trends Base Year-2019	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.H Other	N_2O	64	88	38.3%	28.9%	0.1%
2.H Other	HFC	0	1	11063.2%	60.4%	66.8%
2.H Other	PFC	0	1	441.0%	59.9%	2.6%
2.H Other	Unspecified mix of HFCs and PFCs	0	0		0.0%	0.0%
2.H Other	SF_6	7	4	-40.0%	60.8%	0.2%
2.H Other	NF_3	0	0		0.0%	0.0%
2 (where no subsector data were submitted)	*all*	0	0		0.0%	0.0%
Total - 2	**all**	**548 586**	**353 337**	-35.6%	**10.4%**	**2.7%**

Note: *Emissions are in Gg CO_2 equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions because uncertainty estimates are not available for all source categories*

4.4 Sector-specific quality assurance and quality control

There are several arrangements for improving the quality of GHG emissions from industrial processes: (1) Before and during the compilation of the EU GHG inventory, a number of assessments are made of the Member States data in particular for time series consistency of emissions and implied emission factors, comparisons of implied emission factors across countries and checks of internal consistency. Table 3.129 (in Energy chapter), summarizes the main checks carried out on Member States' submissions. Internal reviews are carried out for selected source categories. In 2006 the following source categories were reviewed by countries experts: 2A Mineral Products, 2B Chemical Industry, 2C Iron and Steel Production and Fluorinated Gases, 2E Production of Halocarbons and SF_6 and 2F Consumption of Halocarbons and SF_6. In 2008, completeness and allocation issues were reviewed by countries experts for all source categories in Industrial Processes. In 2012 a comprehensive review was carried out for all sectors and all EU countries in order to fix the base year emissions under the EU Effort Sharing Decision. (ESD review 2012). For the inventory 2005 plant-specific data was available from the EU ETS for the first time. This information was used by EU Member States for quality checks and as an input for calculating total CO_2 emissions for the sectors Energy and Industrial Processes in the 2005 report (see Section 1.4.2). During the ESD review 2012 consistency checks were carried out between EU ETS data and the inventory estimates.

In 2013 two workshops were organized in the context of the MS assistance project with the aim of supporting Member States in improving their inventories related to the use of EU ETS data and related to F-gases.

In 2014, the initial checks for F-gases were extended: (1) the time series of HFC emissions of the EU Member States was checked at 3-digit level (2.F.1, 2.F.2,…) and at 4-digit level for 2.F.1 (i.e. 2.F.1.1, 2.F.1.2,…); (2) time series and comparability across EU Member States was checked for per capita HFC emissions of category 2-F.1 and its subcategories (2.F.1.1, 2.F.1.2, …). As a result of the checks, 74 issues were clarified with EU Member States. Furthermore, in 2014 additional quality checks of the EU

NIR chapter waste were carried out in order to improve the consistency between the CRF tables and the EU NIR and consistency of tables and figures with text in the EU NIR.

In recent years, comprehensive ESD reviews were performed in 2016 and 2020, and annual ESD reviews were conducted in 2017, 2018, 2019 and 2021.

Since 2016, additional focus is put on the introduction of alternatives to F-gases in the quality checks of Member States' submissions. This is relevant in the context of the HFC phase-down under the EU F-gas Regulation.

4.5 Sector Specific Recalculations

Table 4.51 shows that in the industrial processes sector the largest recalculations in absolute terms were made for CH_4 in 1990 and 2018.

Table 4.51 Recalculations of total GHG emissions and recalculations from industrial processes and product use for 1990 and 2018 by gas (kt CO_2 equivalents) and percent of sector total)

1990	**CO_2**		**CH_4**		**N_2O**		**HFCs**		**PFCs**		**SF_6**		**Unspecified mix of HFCs and PFCs**		**NF3**	
	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%
Total emissions and removals	72 922	1.7%	-11 395	-1.5%	9 888	2.5%	-72	-0.2%	-8.6	0.0%	-53	-0.5%	9.3	0.2%	0.0	0.0%
Industrial Processes and Product Use	11 723	3.6%	156	9.3%	1 919	1.7%	-72	-0.2%	-8.6	0.0%	-53	-0.5%	9.3	0.2%	0.0	0.0%
2018																
Total emissions and removals	15 195	0.5%	-5 009	-1.1%	5 132	2.0%	-410	-0.4%	2.6	0.1%	109	1.6%	75	4.3%	0.0	0.0%
Industrial Processes and Product Use	6 272	2.5%	44	3.1%	-188	-1.8%	-410	-0.4%	2.6	0.1%	109	1.6%	75	4.3%	0.0	0.0%

Table 4.52 provides an overview of Member States' contributions to EU-KP recalculations.

Table 4.52 Sector 2 Industrial processes: Contribution of Member States to EU-KP recalculations for 1990 and 2018 by gas (difference between latest submission and previous submission kt of CO_2 equivalents)

	1990								2018							
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF3	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF3
Austria	0	0	-92	0	0	0	0	0	-74	0	-92	20	0	4	0	0
Belgium	0	18	0	0	0	0	0	0	29	17	0	-29	0	0	0	0
Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Croatia	-58	0	0	0	0	0	0	0	-6	0	0	53	0	0	0	0
Cyprus	-7	0	-43	-80	0	3	0	0	-24	0	-58	31	0	16	0	0
Czechia	0	0	-2	0	0	0	0	0	-6	0	0	26	1	0	0	0
Denmark	0	0	0	0	0	0	0	0	-3	0	0	8	0	0	0	0
Estonia	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Finland	0	5	0	0	0	0	0	0	8	2	0	-4	0	0	0	0
France	11 336	133	0	0	0	-60	0	0	9 326	24	0	-144	0	23	0	0
Germany	0	0	2 029	0	-9	0	9	0	-1 279	0	-23	-236	0	0	2	0
Greece	0	0	0	0	0	0	0	0	9	0	3	0	0	0	0	0
Hungary	-59	0	0	0	0	0	0	0	-75	0	0	675	2	-5	0	0
Ireland	0	0	0	0	0	0	0	0	-18	0	0	-255	0	0	0	0
Italy	-62	0	0	0	0	0	0	0	-41	0	9	-124	0	0	2	0
Latvia	0	0	2	0	0	0	0	0	8	0	1	25	0	0	0	0
Lithuania	-4	0	0	0	0	0	0	0	25	0	0	1	0	0	0	0
Luxembourg	-31	0	0	0	0	0	0	0	-2	0	0	-3	0	0	0	0
Malta	0	0	0	0	0	0	0	0	0	0	0	-147	0	0	0	0
Netherlands	-580	0	0	0	0	0	0	0	-1 301	0	0	19	0	0	0	0
Poland	-75	0	0	0	0	0	0	0	-84	0	0	-369	0	0	0	0
Portugal	224	0	0	0	0	0	0	0	2	0	0	-166	0	0	0	0
Romania	1 164	0	0	0	0	0	0	0	-179	0	0	-40	0	0	0	0
Slovakia	-157	0	0	0	0	0	0	0	-58	0	0	0	0	0	0	0
Slovenia	0	0	0	0	0	0	0	0	1	0	0	27	0	0	0	0
Spain	10	0	26	0	0	0	0	0	-89	1	1	120	0	0	71	0
Sweden	56	0	0	0	0	0			5	0	-28	3	0	1		
United Kingdom	-35	0	0	8	0	5	0	0	98	0	0	105	0	70	0	0
EU27+UK	11 723	156	1 919	-72	-9	-53	9	0	6 271	44	-188	-406	3	109	75	0
Iceland	0	0	0	0	0	0	0	0	1	0	0	-4	0	0	0	0
United Kingdom (KP)	-35	0	0	8	0	5	0	0	98	0	0	105	0	70	0	0
EU-KP	11 723	156	1 919	-72	-9	-53	9	0	6 272	44	-188	-410	3	109	75	0

5 AGRICULTURE (CRF SECTOR 3)

Half the European Union's land is farmed. This fact alone highlights the importance of farming for the EU's natural environment. Farming and nature exercise a profound influence over each other. Farming has contributed over the centuries to creating and maintaining a variety of valuable semi-natural habitats. Today these shape the majority of the EU's landscapes and are home to many of the EU's richest wildlife. Farming also supports a diverse rural community that is not only a fundamental asset of European culture, but also plays an essential role in maintaining the environment in a healthy state[20].

The links between the richness of the natural environment and farming practices are complex. While many valuable habitats in Europe are maintained by extensive farming, and a wide range of wild species rely on this for their survival, agricultural practices can also have an adverse impact on natural resources. Pollution of soil, water and air, fragmentation of habitats and loss of wildlife can be the result of inappropriate agricultural practices and land use.

Agriculture in Europe is determined by the Common Agricultural Policy (CAP) of the European Union. The CAP dates from 1957, and its foundations are entrenched in the Treaty of Rome. Initially, the emphasis of the CAP was to increase agricultural productivity, partly for food security reasons, but also to ensure that the EU had a viable agricultural sector and that consumers had a stable supply of affordable food (Gay et al., 2005). With the MacSharry reform of 1992 several steps were taken by the EU to shift CAP subsidies away from price and market support towards direct support for farmers. This was further pursued with the Agenda 2000 reform, as signified by the shift in focus towards the maintenance and enhancement of the rural environment and the growing recognition of agriculture as a multifunctional activity. In environmental terms, the focus is on less-favoured areas and areas with environmental restrictions, and on agricultural production methods designed to protect the environment and to maintain the countryside.

However, price support and income payments, together with milk quotas, remained the dominant support measures. The 2003 CAP reform made further progress in the direction initiated by the Agenda 2000 reform, by aiming to make European agriculture more market oriented and giving a stronger focus to environmental protection. With the CAP reform, cross-compliance became an obligatory element of the CAP. Cross compliance links direct payments to respecting a number of statutory management requirements and to maintain all agricultural land in good agricultural and environmental conditions (EC 2003)[21].

- "Statutory management requirements" (SMR, Annex III of Regulation (EC) No 1782/2003) which are set in 19 community legislative acts on environment, food safety, animal health and welfare.
- The obligation to maintaining land in good agricultural and environmental conditions (GAECs) and maintaining permanent pasture at level at 1.5.2004. Definitions of GAEC are specified at national or regional level and should warrant appropriate soil protection, ensure a minimum level of maintenance of soil organic matter and soil structure and avoid the deterioration of habitats.

In 2013, the Council of the EU Agriculture Ministers adopted four Basic Regulations for a reformed CAP following a CAP Health Check[22] in 2008 and a Commission Communication on the CAP towards 2020[23] in 2011. The four legislative texts that regulate the post-2013 CAP are (i) Rural Development: Regulation

20 http://ec.europa.eu/agriculture/envir/index_en.htm

21 http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32003R1782

22 http://ec.europa.eu/agriculture/healthcheck/index_en.htm

23 https://ec.europa.eu/agriculture/cap-post-2013_en

1305/2013[24]; (ii) "Horizontal" issues such as funding and controls: Regulation 1306/2013[25]; (iii) Direct payments for farmers: Regulation 1307/2013[26]; (iv) Market measures: Regulation 1308/2013[27].

With the adoption of the 2013 CAP reform, the environment concerns received an enhanced focus being materialised by explicitly linking the agricultural support to "agricultural practices beneficial to the climate and environment" (so called 'CAP greening'). Agro-environmental indicators have been identified as useful tools to perform this task, especially since they allow for the assessment of territorial impacts. The monitoring and evaluation of CAP performance is carried out through indicators (EC 2006[28], 2001[29], 2000[30]). Green direct payments account for 30% of EU countries' direct payment budgets. Farmers receiving an area-based payment have to make use of various straightforward, non-contractual practices that benefit the environment and the climate. These require action each year. They include:

- diversifying crops;
- maintaining permanent grassland; and
- dedicating 5% of arable land to ecologically beneficial elements ('ecological focus areas').

Currently, the next reform of the CAP is under discussion enabling agriculture in Europe by its modernisation and simplification to face new challenges, such related to economic prospects and care for the environment including action over climate change and maximise its contribution to the Commission's priorities and to the Sustainable Development Goals[31].

The **Nitrates Directive** (Council Directive 91/676/EEC) is the SMR with the largest impact on greenhouse gas emissions from agriculture. The directive aims at reducing and preventing water pollution caused by nitrates from agricultural sources with the goal that nitrate concentrations in groundwater will not exceed 50 mg NO_3^- l^{-1} and listing codes of good practice (Annex II A) to be implemented by the farmers on a voluntary basis. Nitrate vulnerable zones (NVZ) must be designated on the basis of monitoring results which indicate that the groundwater and surface waters in these zones are or could be affected by nitrate pollution from agriculture. The action program must contain mandatory measures relating to: (i) periods when application of animal manure and fertilisers are prohibited; (ii) capacity of and facilities for storage of animal manure; and (iii) limits to the amounts of animal manure and fertilisers applied to land.

The action programmes need to be implemented by farmers within NVZs on a compulsory basis. These programmes must include measures already included in Codes of Good Agricultural Practice, which become mandatory, and other measures, such as limitation of fertiliser application (mineral and organic), taking into account crop needs and all nitrogen inputs and soil nitrogen supply, with maximum amount of livestock manure to be applied. Every four years countries are required to report on nitrates concentrations in groundwaters and surface waters; eutrophication of surface waters; assessment of the impact of action programme(s) on water quality and agricultural practices; revision of NVZs and action programme(s); estimation of future trends in water quality.

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24 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0487:0548:en:PDF

25 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0549:0607:en:PDF

26 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0608:0670:en:PDF

27 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0671:0854:en:PDF

28 EC (2006). Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy. Communication from the Commission to the Council and the European Parliament. COM(2006) 508 final. Commission of the European Communities, Brussels.

29 EC (2001). Statistical Information needed for Indicators to monitor the Integration of Environmental concerns into the Common Agricultural Policy. Communication from the Commission to the Council and the European Parliament. COM(2001) 144 final. Commission of the European Communities.

30 EC (2000). Indicators for the Integration of Environmental Concerns into the Common Agricultural Policy. Commission of the European Communities.

31 https://ec.europa.eu/agriculture/consultations/cap-modernising/2017_en

This has affected emissions in most countries:

- In Belgium, Manure Action Plans (MAP, based on the Nitrate Directive) in Flanders affected NH_3 volatilization from manure application. The first action plan in 1991 regulated the reduced period in which manure can be spread and foresaw low-emission techniques for the application of manure on land. The MAP2bis in 2000 focused on the reduction of the manure surplus and manure processing in order to reduce the NH_3 emissions from manure application on land. Other MAP's followed, which have had a positive effect on the NH_3 and N_2O emissions.
- In Denmark, the environmental policy has introduced a series of measures to prevent loss of nitrogen from agricultural soils to the aquatic environment. The measures include improvements to the utilisation of nitrogen in manure, a ban on manure application during autumn and winter, increasing area with winter-green fields to catch nitrogen, a maximum number of animals per hectare and maximum nitrogen application rates for agricultural crops. All farmers are obliged to do N-mineral accounting at farm and field level with the N-excretion data from FAS (Faculty of Agricultural Sciences). The N figures also include the quantities of mineral fertilisers bought and sold. Suppliers of mineral fertilisers are required to report all N sales to commercial farmers to the Plant Directorate. An active environmental policy has brought about a decrease in the N-excretion and a decrease of emission per produced animal, because of more efficient feeding. As a result of increasing requirements to reduce the nitrogen loss to the environment, the consumption of nitrogen in synthetic fertiliser has more than halved since 1990.
- In the Netherlands, manure and fertiliser policy influences livestock numbers. Especially young cattle, pigs and poultry numbers decreased by the introduction of measures like buying up part of the so-called pig and poultry production rights (ceilings for total animal numbers) by the government and lowering the maximum nutrient application standards for manure and fertiliser. However, greater compliance to standards and requirements for animal welfare and the housing of animals may contribute to increasing emissions (so-called pollution swapping).

Beside the environmentally-targeted directives, also the first pillar of the CAP (dealing with market support in contrast to pillar two covering rural development measures) had a strong impact on the greenhouse gas emissions from agriculture in Europe, namely through the milk quota system, which lead to a strong reduction of animal numbers in the dairy sector to compensate for the increasing animal performance during the last decades. The milk quota system ended in 2015.

Other important policies affecting greenhouse gas emissions from agriculture, particularly by addressing the abatement of air pollution through the control of NO_x and NH_3 emissions include, amongst others:

- The 1999 Gothenburg Protocol under the Convention on Long Range Transboundary Air Pollution (CLRTAP[32]) to 'Abate Acidification, Eutrophication and Ground-level Ozone', revised in 2012 setting national emission reduction commitments to be achieved by 2020 and beyond;
- The National Emission Ceilings Directive (NEC - Directive 2016/2284/EC[33]) sets upper limits for each country for the total emissions in 2010 of the four pollutants responsible for acidification,

32 http://www.unece.org/env/lrtap/multi_h1.html

33 https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1554903780611&uri=CELEX:32016L2284

eutrophication and ground-level ozone pollution. It has been updated in 2016[34] setting new objectives for EU air policy for 2020 and 2030;

- The Industrial Emission Directive (IED[35][36]), which was established in 1996, and aims at minimizing pollution from point sources, i. e., intensive animal production facilities (pig and poultry farms, with more than 2000 fattening pigs (over 30 kg); more than 750 sows or more than 40,000 head of poultry). These are required under the directive to apply control techniques for preventing NH_3 emissions according to Best Available Technology (BAT).

Legislation related with animal health may also affect emissions through changes in specific parameters. That is the case of Spain, where the methane conversion factor (Ym), and therefore the implied emission factor for CH_4 emissions from enteric fermentation from swine decreased in 2006, partly due to the ban of the use of growth-promoting antibiotics in animal feeding. This resulted in a radical change in feeding conditions: raw materials with lowest digestibility were removed and replaced by carbohydrates (mainly cereals). To increase higher digestibility and quality protein supply, the soybean flour 44 was systematically replaced by soybean 47 which has higher protein content. Also, affordable synthetic amino acids and digestive enzymes were systematically introduced. In addition, during the same year, the regulation on additives used in animal feeding was published, thus forcing the withdrawal of products that were being used to date, in order to make the digestion of other diet components easier.

Structural changes are caused also by the general development of countries. For example, in Finland, the membership in the EU resulted in changes in the economic structure followed by an increase in the average farm size and a decrease in the number of small farms (Pipatti, 2001), causing also a decrease in the livestock numbers for most animal types. Swedish agriculture has undergone radical structural changes and rationalizations over the past 50 years. One fifth of the Swedish arable land cultivated in the 1950s is no longer farmed. Closures have mainly affected small holdings and those remaining are growing larger. In 1999, some 31,000 agricultural holdings were livestock farms, 14,000 were purely crop husbandry farms, and only 5,000 were a combination of the two. Livestock farmers predominately engage in milk production and the main crops grown in Sweden are grain and fodder crops. The decrease of agricultural land area has continued since Sweden joined the European Union in 1995 and the acreages of land for hay and silage has increased. Organic farming increased from 3% of the arable land area in 1995 to 17% in 2007.

In the case of Croatia, we can observe livestock population drops in 1992 due to the beginning of the Croatian War of Independence in 1991/1992, which significantly influenced animal production for most animal categories. The countries which formed part of the communist block suffered structural changes when they changed regime, mainly due to privatizations. Lithuania shows an important decrease of non-dairy cattle population in 1993-1994, after the collapse of the Soviet Union and the restoration of independence in 1990, when changes in economy and significant reforms occurred. The reform included the re-establishment of private ownership and management in agriculture sector. Legislation defined dismemberment of collective farms, but they did not definitively ensure their replacement by at least equally productive private farms and corporations. The decrease in cattle population occurred also due to high costs in production, product differences in prices and lack of market for meat and milk. Similarly, Bulgaria shows a decline in cattle numbers in 1992-1995, after the communist period, due to the reforms in agricultural holdings, together with a decrease in the quantities of inorganic fertilisers. Poland, in turn, had a significant drop in cattle population since mid-1990s up to 2002 due to intentional limitations of cattle breeding related to weakening demand for beef meat. Further increase in population could be connected with the prospect of inclusion of Poland into the EU planned for 2004 and joining the common

34 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016L2284&from=EN

35 http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075

36 http://ec.europa.eu/environment/industry/stationary/index.htm

agricultural policy, with expectations for stable agricultural production. An increase in population in 2012 was probably triggered by the improved economic situation for the agricultural markets. The economic situation seems to highly influence the use of fertilisers in the EU countries, especially for liming and urea fertilization. In Poland, limestone/dolomite fertiliser use dramatically decreased after 2004 as a result of a cut in their subsidies for farmers. In 2006, limestone use was lower by 40% than in previous year, despite remaining high need of soils. In Lithuania, a sharp increase of N input from application of other organic fertilisers took place in 2013, caused by changes in national circumstances when using financial resources of 2004-2006 EU ISPA/Cohesion funds Lithuania started to improve municipal solid waste management system. Also in Italy, fertiliser use was affected by the economic crisis (2009-2011), which led to a reduction in the application of all synthetic fertilisers, in particular urea. In 2012, a recovery from the sharp decline was recorded. In the same line, Slovenia reports a strong decrease in urea fertilisers in 1991 and 2008 due to the economic crisis and high prices of fertilisers.

Similarly, the area used for rice cultivation suffers large changes for both continuous flooded and intermittently flooded rice as consequences of economic and environmental pressures. For emissions at EU-level, the combination of emissions from rice from different countries and cultivation systems contributes additionally to fluctuations. Emissions from burning of agricultural residues also have fluctuating trends due to the heterogeneity of the emission source: it is a composite emission categories over countries and crops with different shares of residues burned and different shares of agricultural area and, consequently, large fluctuations are to be expected.

5.1 Overview of sector

In the year 2019, CO_2, CH_4 and N_2O emissions from CRF sector 3 Agriculture were 48.3%, 72.7%, and 0.3% of total CO_2, CH_4 and N_2O EU-KP emissions, respectively. Total emissions from agriculture were 429 Mt CO_2-eq with contributions from CO_2, CH_4, and N_2O of 11 Mt CO_2-eq, 231 Mt CO_2-eq (9.2 Mt CH_4) and 187 Mt CO_2-eq (627 kt N_2O), respectively. Thus, CH_4, N_2O, and CO_2 contributed with 5.1%, 4.1% and 0.24% to total EU-KP GHG emissions. They make 53.8%, 43.6% and 2.6% of total agricultural emissions.

Figure 5.1 shows the development of total GHG emissions from agriculture from 537 Mt CO_2-eq in 1990 to 429 Mt CO_2-eq in 2019. The reduction of emissions was most pronounced for CO_2 with a decrease of 28.3%, followed by CH_4 with a decrease of 20.5% and N_2O with a decrease of 19.2%. The cut was most pronounced in the first decade with a total reduction of 14.4% between 1990 and 2000, a further decrease by between 2000 and 2005, while remaining constant since 2005 (change -2%).

Figure 5.2 shows that largest reductions occurred in the largest key sources CH_4 from *3.A.1: Cattle* and N_2O from *3.D.1: Direct emissions from managed soils*. The main reasons for this are decreasing use of fertiliser and manure and declining cattle numbers in most countries. Figure 5.3 shows the distribution of agricultural GHG emissions among the different source categories for the year 2019.

Figure 5.1: **EU-KP GHG emissions for 1990-2019 from CRF Sector 3: 'Agriculture' in CO_2 equivalents (Mt)**

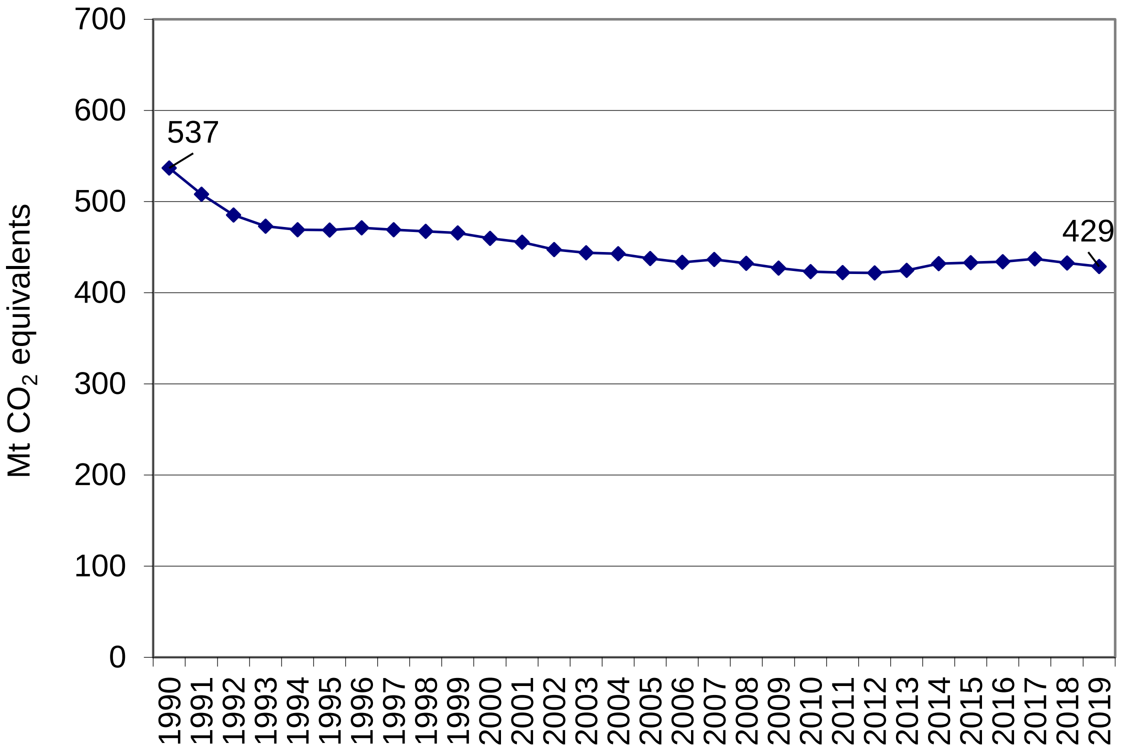


Figure 5.2: **Absolute change of GHG emissions by large key source categories 1990-2019 in CO_2 equivalents (Mt) in CRF Sector 3: 'Agriculture'**

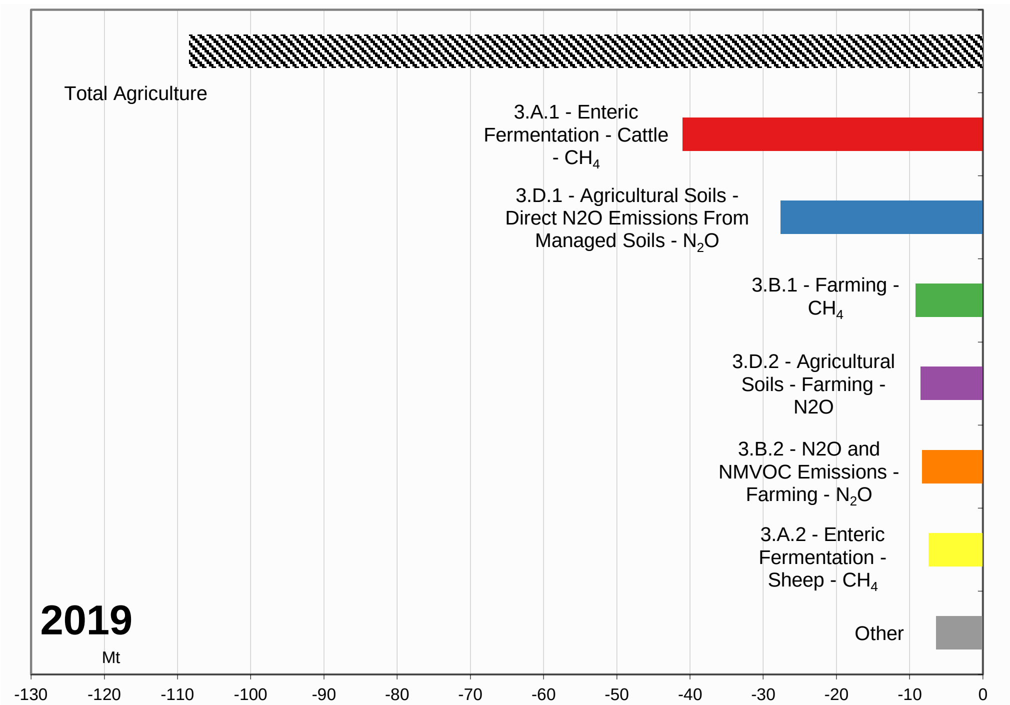
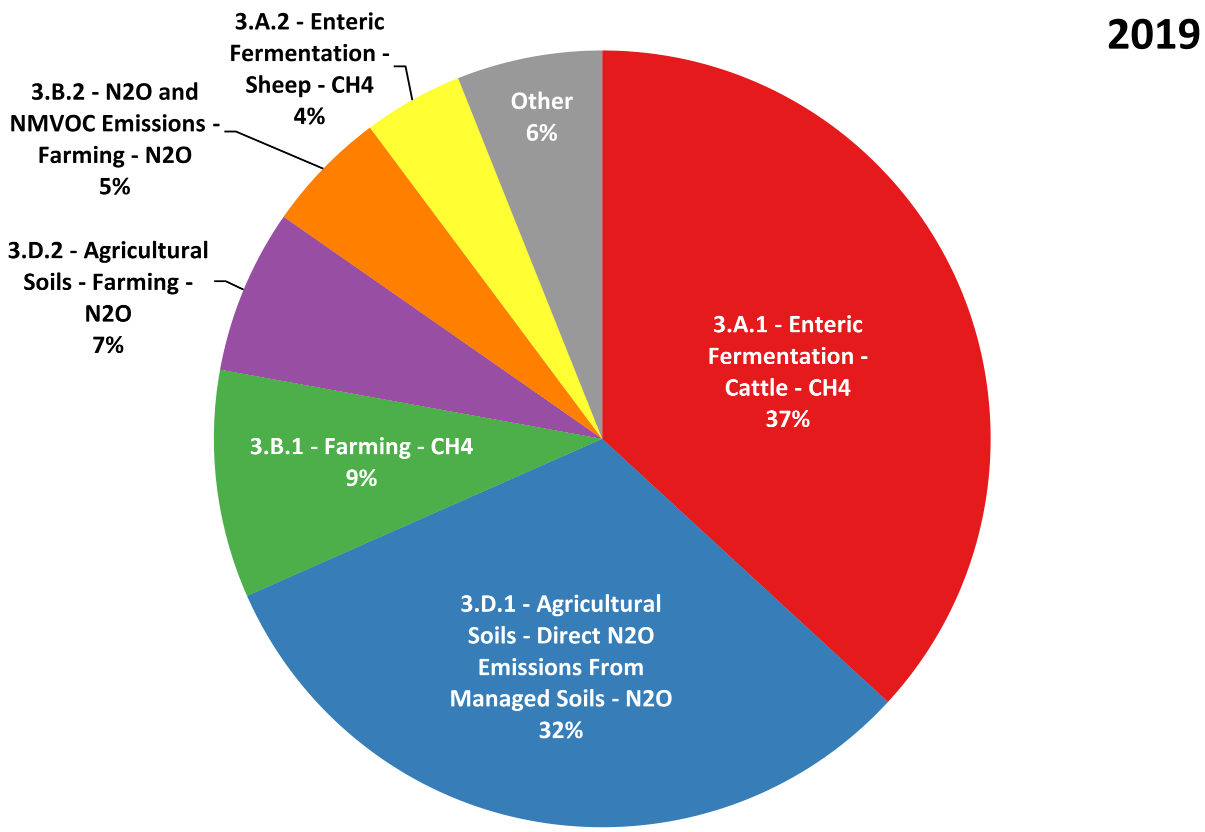


Figure 5.3: **Distribution of agricultural GHG emissions among the different source categories for the year 2019**



5.2 Emission trends

In this section we analyse the contribution of the different emission categories and the individual countries to the overall trend of emissions from the EU agricultural sector. Table 5.1 shows the different emission categories, their contribution to total emissions in the EU sector and their contribution to the trend 1990-2019 and 2018-2019. A negative share of the trend means that the emissions in that category are evolving in the opposite direction to those of the EU.

Total emissions from agriculture have decreased by 20.5% compared to 1990, and 46% of this reduction is due to sector 3.A. Another important sector in determining long-term emission trends is 3.D.1 which accounts for 25% of the total decrease in agricultural emissions, followed by 3.B.1 (8%), 3.B.2 (8%), and 3.D.2 (8%), while all the other categories contribute less. The decrease in emissions is due to the decrease in the cattle population (27.9% between 1990 and 2019) and the decrease in the quantities applied of fertilisers, both synthetic and organic (25.1% and 12.8% decrease, respectively). Only emissions from follow the opposite trend, contributing to compensate the emission decrease but with a very low impact (% of agriculture total trend).

Table 5.1 Contribution of the different emission categories to the total trend in emissions from the agricultural sector, compared to the share of emissions of those categories from the total of the sector

Emission category	Gas	Contribution to total agricultural emissions (2019)	Share of trend 1990-2019	Share of trend 2018-2019
3.A	CH_4	0.44	0.46	0.38
3.B.1	CH_4	0.10	0.08	0.05

Emission category	Gas	Contribution to total agricultural emissions (2019)	Share of trend 1990-2019	Share of trend 2018-2019
3.B.2	N_2O	0.05	0.08	0.10
3.C	CH_4	0.01	0.00	0.00
3.D.1	N_2O	0.32	0.25	0.29
3.D.2	N_2O	0.07	0.08	0.11
3.F	CH_4	0.00	0.01	-0.01
3.F	N_2O	0.00	0.00	0.00
3.G	CO_2	0.01	0.04	-0.03
3.H	CO_2	0.01	0.00	0.08
3.I	CO_2	0.00	0.00	0.04

Looking at the data by country in Table 5.2, we can see that the shares of the trend 1990-2019 are close to the shares in emissions. Different figures are observed for the short-term trends, where the contribution of the emission categories is not linked to their weight in total emissions, and some of them have different sign from changes in the overall emissions of the sector. For the whole sector, there was a very slight increase of emissions between 2018 and 2019 (1% of total emissions), with 7 categories increasing emissions (3.A, 3.B.1, 3.B.2, 3.D.1, 3.D.2, 3.H, 3.I) and 2 decreasing (2 categories decreasing (3.F, 3.G), resulting in an overall increase of emissions for the whole sector. The main contributor to the total increase in agricultural emissions from last year is category 3.A (0.38 of the total trend), followed by 3.D.1, 3.D.2%, and 3.B.2% (0.29%, 0.11%, and 0.1%, respectively). The contribution of the other categories is approximately 13% of total change.

Table 5.2 Contribution to EU emission trends (2018-2019) per country and emission (%)

Country	3.A	3.B.1	3.B.2	3.D.1	3.D.2	3.G	3.H	Share of total EU emissions from agriculture in 2019
FRK	13.90	2.13	1.47	3.31	1.28	1.62	0.50	17.15
DEU	6.97	2.07	1.01	3.91	1.90	-1.40	2.11	14.13
GBK	-0.75	-0.76	0.19	-2.59	-0.38	-6.57	-0.54	9.80
ESP	0.67	-4.33	0.02	1.97	0.33	-0.17	1.52	8.86
POL	-3.04	1.35	-0.22	21.23	7.00	-0.37	2.37	7.67
ITA	0.42	0.26	0.90	1.76	0.20	-0.02	0.23	6.92
IRL	8.09	1.19	1.17	8.01	1.09	3.02	-0.08	4.80
ROU	2.25	0.24	0.03	6.11	1.63	-0.14	0.06	4.41
NLD	3.40	-0.64	0.75	3.16	0.58	-0.07	0.15	4.14
DNM	1.25	2.45	1.39	-5.28	-1.74	1.51	0.02	2.55
BEL	0.47	0.20	0.33	-0.71	-0.10	0.02	0.02	2.20
CZE	0.12	0.18	2.66	3.14	1.29	-0.81	0.94	1.92
GRC	0.61	-0.01	-0.02	-1.51	-0.43	NA	-0.05	1.85
AUT	1.43	0.16	0.13	0.64	0.18	-0.07	0.12	1.68
HUN	0.06	0.10	-0.18	0.42	-0.02	0.04	-0.09	1.67
SWE	1.22	-0.15	0.00	-3.13	0.08	0.00	0.04	1.63
PRT	-1.04	-0.04	-0.01	-0.90	-0.13	0.00	0.30	1.61
FIN	0.19	-0.07	0.02	-3.27	-0.65	0.32	-0.02	1.55
BGR	1.13	0.36	0.10	-0.83	-0.26	NA	0.02	1.46
LTU	0.78	0.21	0.20	-1.28	-0.25	-0.02	-0.01	1.00

Country	3.A	3.B.1	3.B.2	3.D.1	3.D.2	3.G	3.H	Share of total EU emissions from agriculture in 2019
SVK	0.64	0.17	0.12	-1.87	-0.31	0.04	0.06	0.65
HRV	-0.15	0.16	-0.03	0.07	0.03	0.03	-0.15	0.63
LVA	0.00	-0.11	-0.01	-1.91	-0.41	-0.26	0.00	0.52
SVN	-0.32	0.02	0.01	-0.11	-0.01	-0.04	0.00	0.40
EST	-0.17	0.01	0.00	-1.55	-0.37	0.10	0.00	0.35
LUX	0.05	0.02	0.01	-0.04	-0.01	0.02	0.00	0.17
ISL	0.11	0.03	0.01	0.19	0.05	-0.06	-0.01	0.15
CYP	-0.23	0.01	-0.04	-0.07	-0.01	NA	0.00	0.12
MLT	0.00	0.00	0.00	0.00	0.00	NA	NA	0.02
Total	38.10	5.20	10.00	28.90	10.60	-3.30	7.50	100.00

5.3 Source categories and methodological issues

In this section, we present the information relevant for EU-KP key source categories in the sector 3 Agriculture.

Key source categories identified are:

1. CH_4 emissions from source category 3.A.1 - Cattle.
2. CH_4 emissions from source category 3.A.2 - Sheep.
3. CH_4 emissions from source category 3.A.4 - Other livestock.
4. CH_4 emissions from source category 3.B.1 - Manure management.
5. N_2O emissions from source category 3.B.2 - Manure management.
6. N_2O emissions from source category 3.D.1 - Direct N_2O emissions from managed soils.
7. N_2O emissions from source category 3.D.2 - Indirect emissions from managed soils

Table 5.3 shows emissions from key categories in the base year and in the last reported year, whether they are identified as key due to the level or to the trend in emissions and the share of emissions in the category which are calculated using higher tiers (Tier 2 or Tier 3). CH_4 emissions from enteric fermentation from dairy and non-dairy cattle are calculated with sophisticated methods in all countries, with only Cyprus using partially T1 for non-dairy cattle. For enteric fermentation of sheep, the situation is more divided with 13 countries use Tier 1 methods and 15 using higher tiers (including those with higher emissions). For sector 3.A.4, only two countries (Romania and France) are using higher tiers, with all the others combining different methods. In 3.B.1 and 3.B.2 it is also more mixed, with Germany, Denmark, Finland, France, Croatia and Portugal using exclusively higher tiers in both categories. For the calculation of emissions from soils, the share of high tiers is very low; only Denmark and Sweden use solely higher tiers in 3.D.2, while there are no countries using only high tiers in 3.D.1, but only some combining high with low tier methods.

Table 5.3 Key categories for the EU (Agriculture - sector excerpt). Emissions in kt CO_2 eq.

Source	Emissions 1990 [kt CO_{2eq}]	Emissions 2019 [kt CO_{2eq}]	Trend	Level 1990	Level 2019	Share higher tiers 1990	Share higher tiers 2019
3.A.1 Enteric Fermentation: Cattle (CH_4)	198928	157894	T	L	L	0.99	0.99
3.A.2 Enteric Fermentation: Other Sheep (CH_4)	25,226	17,797	0	L	L	0.90	0.91
3.A.4 Enteric Fermentation: Other livestock (CH_4)	6,022	5,699	0	0	L	0.45	0.51
3.B.1 CH_4 Emissions: Farming (CH_4)	49,791	40,618	T	L	L	0.95	0.96
3.B.2 N_2O and NMVOC Emissions: Farming (N_2O)	30,148	21,889	0	L	L	0.97	0.97
3.D.1 Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O)	162,715	135,131	T	L	L	0.41	0.41
3.D.2 Agricultural Soils: Farming (N_2O)	37,789	29,289	0	L	L	0.23	0.26

Other source categories are not identified as key source in the analysis at EU-KP level and are therefore not further discussed here. Emissions from source category 3.J - other agriculture emissions are reported only from Germany (digestion of energy crops) and the UK (emissions from liming in oversee territories and crown dependencies).

For each of the above-mentioned source categories, data on the countries contributing most to EU-KP emissions and to EU-KP emission trends are provided, as well as information on relevant activity data and IEFs and other parameters, if relevant.

Many countries recognize that in the agriculture sector the emissions from the different categories are inherently linked and are best estimated in a comprehensive model that covers not only greenhouse gases (CH_4 and N_2O) in a consistent manner, but also ammonia. Estimations of ammonia emissions are required for reporting under the Convention on Long-Range Transboundary Air Pollution and are needed to estimate indirect N_2O emissions. Hence, several countries have developed comprehensive models covering consistently different source categories and different gases.

5.3.1 Enteric fermentation (CRF Source Category 3.A)

In 2019 CH_4 emissions in source category *3.A - Enteric Fermentation* in EU-KP were 185601 kt CO_2 equivalent. This corresponds to 4.1% of total EU-KP GHG emissions and 39% of total EU-KP CH_4 emissions. They make 43.3% of total agricultural emissions and 80% of total agricultural CH_4 emissions. It is thus the largest GHG source in agriculture and the largest source of CH_4 emissions. The main sub-categories are 3.A.1.2 (Non-Dairy Cattle), 3.A.1.1 (Dairy Cattle) and 3.A.2 (Sheep) as shown in Figure 5.4. Emissions are also reported for 3.A.4 (Other Livestock) and 3.A.3 (Swine). CH_4 emissions from Enteric Fermentation for 'Other Livestock' are reported for the categories Buffalo, Deer, Goats, Horses, Mules and Asses, Poultry, and "Other Other Livestock".

Regarding the origin of emissions in the different countries, Figure 5.5 shows the distribution of CH_4 emissions from enteric fermentation by livestock category in all countries and in the EU-KP. Each bar represents the total emissions of a country in the current emission category, where different shades of blue correspond to the emitting animal types.

Figure 5.4: Share of source category 3.A on total EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2019.

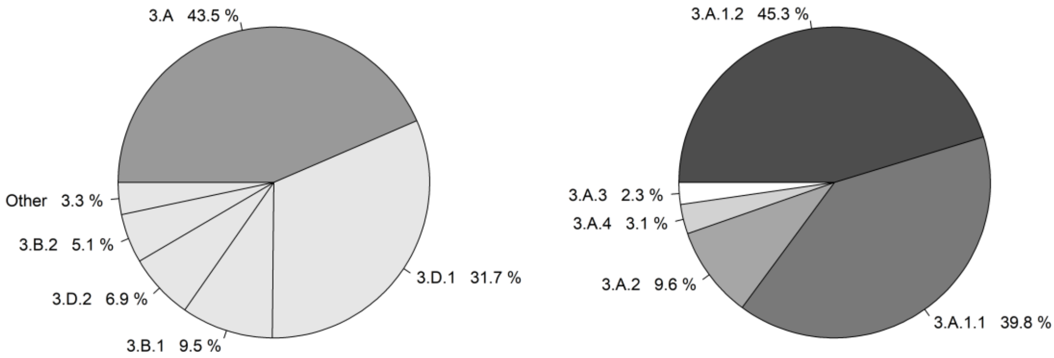
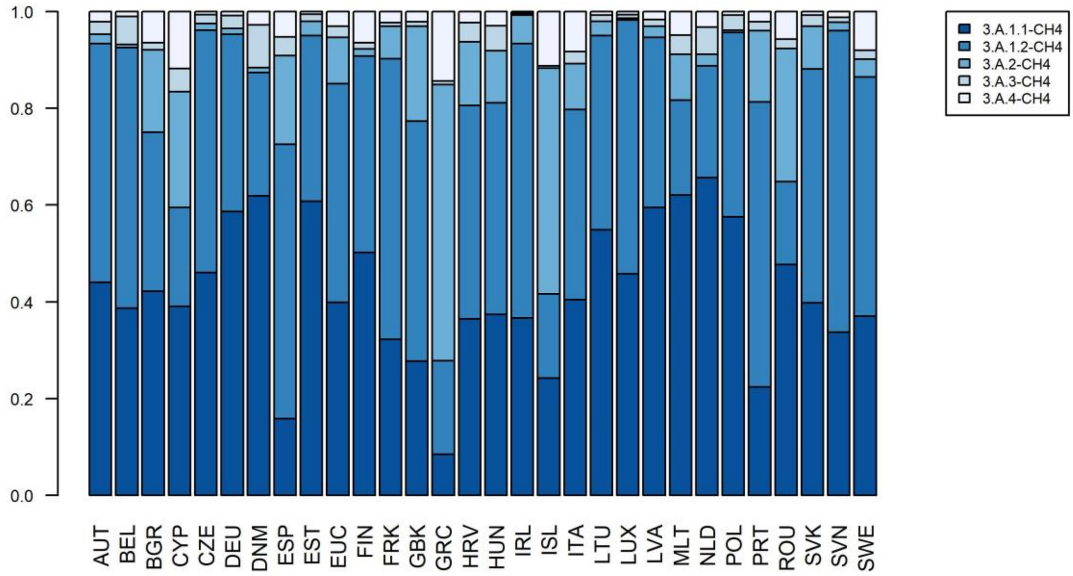


Figure 5.5: Decomposition of emissions in source category 3.A - Enteric Fermentation into its sub-categories by country in the year 2019.



Total GHG and CH_4 emissions by country from 3.A *Enteric Fermentation* are shown in Table 5.4 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2019). Values are given in kt CO_2-eq. In this category GHG and CH_4 columns have the same values, as no other greenhouse gases are produced in the enteric fermentation process. Between 1990 and 2019, CH_4 emission in this source category decreased by 21% or 50.2 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (70%) and in Germany in absolute terms (9.1 Mt CO_2-eq). From 2018 to 2019 emissions in the current category decreased by 0.8%.

Table 5.4 3.A - Enteric Fermentation: Countries' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	4,821	4,118	4,062	2.2%	-758	-16%	-55	-1%	T1,T2	CS,D
Belgium	4,769	4,103	4,085	2.2%	-684	-14%	-18	0%	T1,T2	CS,D
Bulgaria	4,805	1,479	1,435	0.8%	-3,370	-70%	-44	-3%	T1,T2	CS,D
Croatia	2,121	989	995	0.5%	-1,126	-53%	6	1%	T1,T2	CS,D
Cyprus	197	262	271	0.1%	74	37%	9	3%	T1,T2	CS,D
Czechia	5,737	3,098	3,094	1.7%	-2,643	-46%	-5	0%	T1,T2	CS,D
Denmark	4,039	3,767	3,719	2.0%	-321	-8%	-48	-1%	0	0
Estonia	1,230	540	546	0.3%	-684	-56%	7	1%	D,T1,T2	CS,D,OTH
Finland	2,421	2,078	2,071	1.1%	-350	-14%	-7	0%	,OTH,T1,T2	CS,D,OTH
France	38,632	34,203	33,665	18.1%	-4,967	-13%	-538	-2%	T2,T3	CS
Germany	32,815	23,980	23,710	12.8%	-9,105	-28%	-270	-1%	T1,T2,T3	CS,D
Greece	4,024	3,669	3,646	2.0%	-378	-9%	-24	-1%	T1,T2	CS,D
Hungary	3,668	2,051	2,048	1.1%	-1,619	-44%	-2	0%	T1,T2	CS,D
Ireland	10,466	12,465	12,151	6.5%	1,685	16%	-313	-3%	CS,T1,T2	CS,D
Italy	15,497	13,257	13,241	7.1%	-2,256	-15%	-16	0%	T1,T2	CS,D
Latvia	2,222	850	850	0.5%	-1,371	-62%	0	0%	T1,T2	CS,D,OTH
Lithuania	4,291	1,513	1,483	0.8%	-2,808	-65%	-30	-2%	T1,T2	CS,D,OTH
Luxembourg	388	403	402	0.2%	14	4%	-2	0%	T1,T2	CS,D
Malta	47	34	34	0.0%	-13	-28%	0	0%	T1,T2	CS,D
Netherlands	9,231	8,268	8,136	4.4%	-1,096	-12%	-132	-2%	T1,T2,T3	CS,D
Poland	19,650	12,582	12,699	6.8%	-6,951	-35%	118	1%	T1,T2	CS,D
Portugal	3,520	3,503	3,543	1.9%	22	1%	40	1%	T1,T2	CS,D
Romania	14,975	7,416	7,328	3.9%	-7,646	-51%	-87	-1%	T1,T2	CS,D
Slovakia	2,797	994	969	0.5%	-1,828	-65%	-25	-3%	T1,T2	CS,D
Slovenia	935	927	940	0.5%	4	0%	12	1%	T1,T2	CS,D
Spain	14,367	16,035	16,009	8.6%	1,642	11%	-26	0%	CS,T2,T3	CS,D
Sweden	3,277	3,007	2,960	1.6%	-317	-10%	-47	-2%	CS,T1	CS,D
United Kingdom	24,537	21,184	21,214	11.4%	-3,323	-14%	29	0%	T1,T3	CS,D
EU-27+UK	**235,478**	**186,774**	**185,304**	**100%**	**-50,174**	**-21%**	**-1,470**	**-1%**	**-**	**-**
Iceland	326	301	297	0.2%	-30	-9%	-4	-1%	T1,T2	CS,D
United Kingdom (KP)	24,537	21,184	21,214	11.4%	-3,323	-14%	29	0%	T1,T3	CS,D
EU-KP	**235,804**	**187,075**	**185,601**	**100%**	**-50,203**	**-21%**	**-1,474**	**-1%**	**-**	**-**

Total GHG and CH_4 emissions by country from *3.A.1 - Cattle Enteric Fermentation* are shown in Table 5.5 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2019). Values are given in kt CO_2-eq. Between 1990 and 2019, CH_4 emission in this source category decreased by 21% or 41 Mt CO_2-eq. The decrease was largest in Slovakia in relative terms (66%) and in Germany in absolute terms (8.8 Mt CO_2-eq). From 2018 to 2019 emissions in the current category decreased by 0.8%.

Table 5.5 3.A.1 - Cattle: Countries' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	4,579	3,846	3,791	2.4%	-788	-17%	-55	-1%	T2	CS
Belgium	4,469	3,798	3,781	2.4%	-688	-15%	-17	0%	T2	CS
Bulgaria	2,958	1,119	1,077	0.7%	-1,881	-64%	-43	-4%	T2	CS
Croatia	1,868	799	801	0.5%	-1,067	-57%	2	0%	T2	CS
Cyprus	101	154	161	0.1%	60	59%	7	4%	T1,T2	CS,D
Czechia	5,454	2,977	2,973	1.9%	-2,481	-45%	-4	0%	T2	CS
Denmark	3,662	3,287	3,251	2.1%	-411	-11%	-36	-1%	0	0
Estonia	1,172	511	519	0.3%	-653	-56%	8	2%	T2	CS,D
Finland	2,221	1,887	1,880	1.2%	-340	-15%	-7	0%	T2	CS
France	34,130	30,898	30,392	19.2%	-3,738	-11%	-506	-2%	T2,T3	CS
Germany	31,403	22,850	22,599	14.3%	-8,804	-28%	-251	-1%	T2,T3	CS,D
Greece	1,184	1,013	1,015	0.6%	-170	-14%	1	0%	T2	CS,D
Hungary	2,876	1,653	1,662	1.1%	-1,214	-42%	10	1%	T2	CS
Ireland	9,210	11,651	11,346	7.2%	2,135	23%	-305	-3%	CS,T2	CS
Italy	13,164	10,559	10,553	6.7%	-2,611	-20%	-6	0%	T2	CS
Latvia	2,118	803	804	0.5%	-1,314	-62%	1	0%	T2	CS
Lithuania	4,146	1,436	1,409	0.9%	-2,737	-66%	-26	-2%	T2	CS
Luxembourg	384	396	395	0.2%	11	3%	-2	0%	T2	CS
Malta	38	28	28	0.0%	-11	-27%	0	0%	T2	CS
Netherlands	8,195	7,356	7,219	4.6%	-976	-12%	-136	-2%	T2,T3	CS
Poland	17,642	11,994	12,151	7.7%	-5,491	-31%	158	1%	T2	CS
Portugal	2,460	2,838	2,881	1.8%	421	17%	43	2%	T2	CS
Romania	11,213	4,858	4,750	3.0%	-6,463	-58%	-108	-2%	T2	CS
Slovakia	2,517	869	854	0.5%	-1,663	-66%	-14	-2%	T2	CS
Slovenia	904	890	903	0.6%	-2	0%	13	1%	T2	CS
Spain	8,978	11,539	11,608	7.4%	2,630	29%	70	1%	CS,T2	CS,D
Sweden	2,884	2,598	2,558	1.6%	-326	-11%	-40	-2%	CS	CS
United Kingdom	18,887	16,493	16,410	10.4%	-2,477	-13%	-83	-1%	T3	CS
EU-27+UK	**198,819**	**159,097**	**157,771**	**100%**	**-41,048**	**-21%**	**-1,326**	**-1%**	**-**	**-**
Iceland	109	124	124	0.1%	14	13%	0	0%	T2	CS
United Kingdom (KP)	18,887	16,493	16,410	10.4%	-2,477	-13%	-83	-1%	T3	CS
EU-KP	**198,928**	**159,221**	**157,894**	**100%**	**-41,034**	**-21%**	**-1,327**	**-1%**	**-**	**-**

Total GHG and CH_4 emissions by country from *3.A.2 - Sheep Enteric Fermentation* are shown in Table 5.6 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2019). Values are given in kt CO_2-eq. Between 1990 and 2019, CH_4 emission in this source category decreased by 29% or 7.4 Mt CO_2-eq. The decrease was largest in Poland in relative terms (93%) and in France in absolute terms (1.3 Mt CO_2-eq). From 2018 to 2019 emissions in the current category decreased by 0.2%.

Table 5.6 3.A.2 - Sheep: Countries' contributions to total EU-GHG and CH_4 emissions

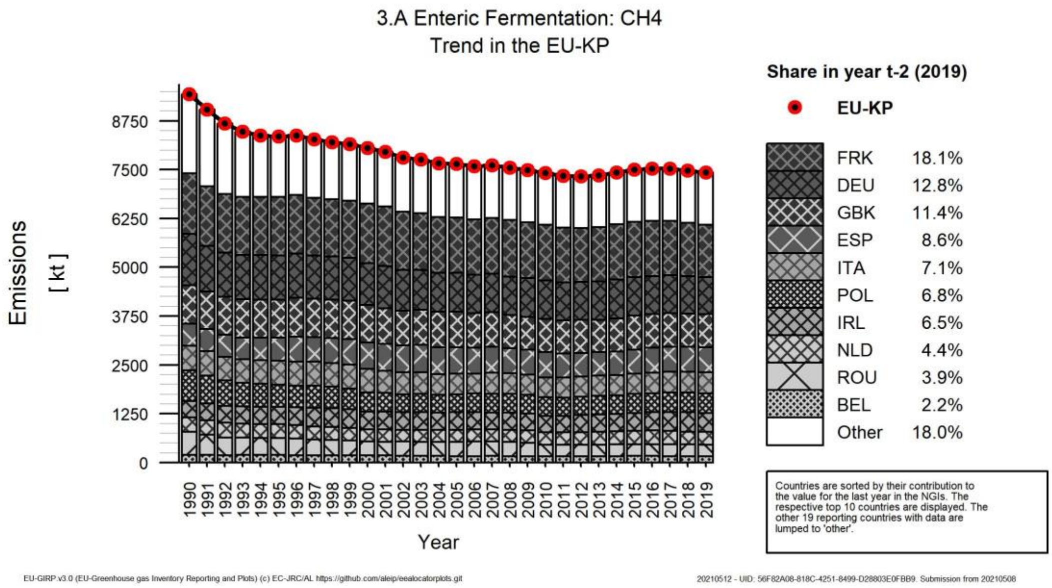
Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	62	81	81	0.5%	19	30%	-1	-1%	T1	D
Belgium	38	26	28	0.2%	-11	-28%	2	6%	T1	D
Bulgaria	1,454	247	245	1.4%	-1,209	-83%	-2	-1%	T2	CS
Croatia	150	127	131	0.7%	-19	-12%	4	3%	T1	D
Cyprus	58	62	65	0.4%	7	12%	3	4%	T1	D
Czechia	86	44	43	0.2%	-43	-50%	-1	-3%	T1	D
Denmark	39	34	37	0.2%	-2	-4%	2	7%	0	0
Estonia	32	17	16	0.1%	-15	-49%	-1	-6%	D,T1	D
Finland	21	33	31	0.2%	10	46%	-2	-7%	CS	CS
France	3,533	2,279	2,253	12.7%	-1,280	-36%	-26	-1%	T2,T3	CS
Germany	518	294	289	1.6%	-230	-44%	-5	-2%	T1	CS,D
Greece	2,054	2,109	2,082	11.7%	28	1%	-27	-1%	T2	CS,D
Hungary	392	229	220	1.2%	-172	-44%	-9	-4%	T1	D
Ireland	1,176	718	711	4.0%	-466	-40%	-8	-1%	T1	D
Italy	1,504	1,282	1,265	7.1%	-240	-16%	-18	-1%	T2	CS
Latvia	33	21	20	0.1%	-13	-39%	-2	-7%	T1	D
Lithuania	18	45	44	0.2%	25	139%	-1	-3%	T2	CS
Luxembourg	1	1	1	0.0%	0	30%	0	1%	T2	CS
Malta	4	3	3	0.0%	0	-10%	0	1%	T2	CS
Netherlands	340	190	198	1.1%	-142	-42%	8	4%	T1	D
Poland	832	55	55	0.3%	-777	-93%	-1	-1%	T1	D
Portugal	794	523	522	2.9%	-272	-34%	-1	0%	T2	CS
Romania	2,778	1,984	2,019	11.3%	-759	-27%	35	2%	T2	CS
Slovakia	178	94	85	0.5%	-92	-52%	-9	-9%	T2	CS
Slovenia	3	16	16	0.1%	13	473%	0	-1%	T1	D
Spain	3,791	3,009	2,937	16.5%	-854	-23%	-72	-2%	CS,T2	CS
Sweden	81	117	110	0.6%	29	35%	-8	-7%	T1	D
United Kingdom	5,074	4,048	4,154	23.3%	-920	-18%	107	3%	T3	CS
EU-27+UK	**25,044**	**17,691**	**17,659**	**99%**	**-7,385**	**-29%**	**-32**	**0%**	**-**	**-**
Iceland	182	144	138	0.8%	-44	-24%	-6	-4%	T2	CS
United Kingdom (KP)	5,074	4,048	4,154	23.3%	-920	-18%	107	3%	T3	CS
EU-KP	**25,226**	**17,835**	**17,797**	**100%**	**-7,429**	**-29%**	**-37**	**0%**	**-**	**-**

Trends in Emissions and Activity Data

3.A - Enteric Fermentation - Emissions

Emissions in source category *3.A - Enteric Fermentation* decreased considerably in EU-KP by 21% or 50.2 Mt CO_2-eq in the period 1990 to 2019. Figure 5.6 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 82% of the total in 2019. Emissions decreased in 23 countries and increased in six countries. The three countries with the largest decreases were Germany, Romania and Poland with a total absolute decrease of 23.7 Mt CO_2-eq. The largest increases occurred in Spain and Ireland, with a total absolute increase of 3.3 Mt CO_2-eq.

Figure 5.6: 3.A: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



3.A.1 - Cattle - Emissions

Emissions in source category *3.A.1 - Cattle* decreased considerably in EU-KP by 21% or 41 Mt CO_2-eq in the period 1990 to 2019. The ten countries with the highest emissions accounted together for 82.9% of the total in 2019.Emissions decreased in 23 countries and increased in six countries. The three countries with the largest decreases were Germany, Romania and Poland with a total absolute decrease of 20.8 Mt CO_2-eq. The largest increases occurred in Ireland and Spain, with a total absolute increase of 4.8 Mt CO_2-eq.

Emissions in source category *3.A.1.1 - Dairy Cattle* decreased strongly in EU-KP by 27% or 26.9 Mt CO_2-eq in the period 1990 to 2019. Figure 5.7 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 83.1% of the total in 2019.Emissions decreased in 24 countries and increased in five countries. The three countries with the largest decreases were Poland, Romania and Germany with a total absolute decrease of 12.3 Mt CO_2-eq. The largest increases occurred in the Netherlands and Ireland, with a total absolute increase of 1.2 Mt CO_2-eq.

Emissions in source category *3.A.1.2 - Non-Dairy Cattle* decreased clearly in EU-KP by 14% or 14.2 Mt CO_2-eq in the period 1990 to 2019. Figure 5.8 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 84.6% of the total in 2019.Emissions decreased in 21 countries and increased in eight countries. The largest decreases occurred in Germany and Romania with a total absolute decrease of 7.5 Mt CO_2-eq. The three countries with the largest increases were Portugal, Ireland and Spain, with a total absolute increase of 5.2 Mt CO_2-eq.

3.A.1 - Cattle - Population

The main driver for the decrease of CH_4 emissions from enteric fermentation was the decrease in animal numbers that we can see in Figure 5.9 and Figure 5.10.

Cattle population decreased strongly in EU-KP by 28% or 33.7 million heads in the period 1990 to 2019. The ten countries with the highest population accounted together for 84.2% of the total in 2019.Population decreased in 24 countries and increased in five countries. The largest decreases occurred in Germany and Poland with a total absolute decrease of 11.6 million heads. The three countries with the largest increases were Ireland, Portugal and Spain, with a total absolute increase of 2.1 million heads.

Figure 5.7: 3.A.1.1 Dairy Cattle: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019

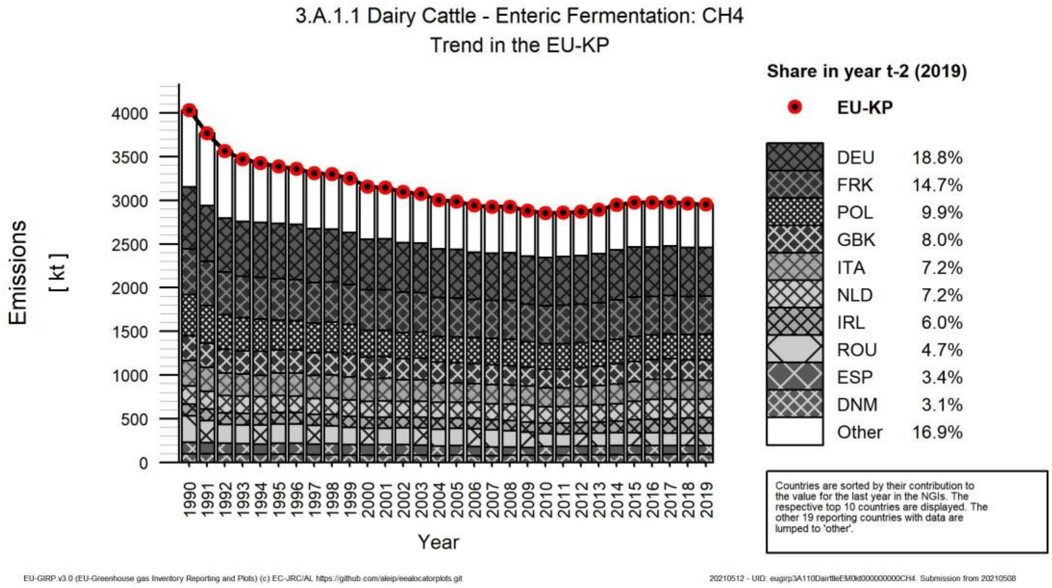


Figure 5.8: 3.A.1.2 Non-Dairy Cattle: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019

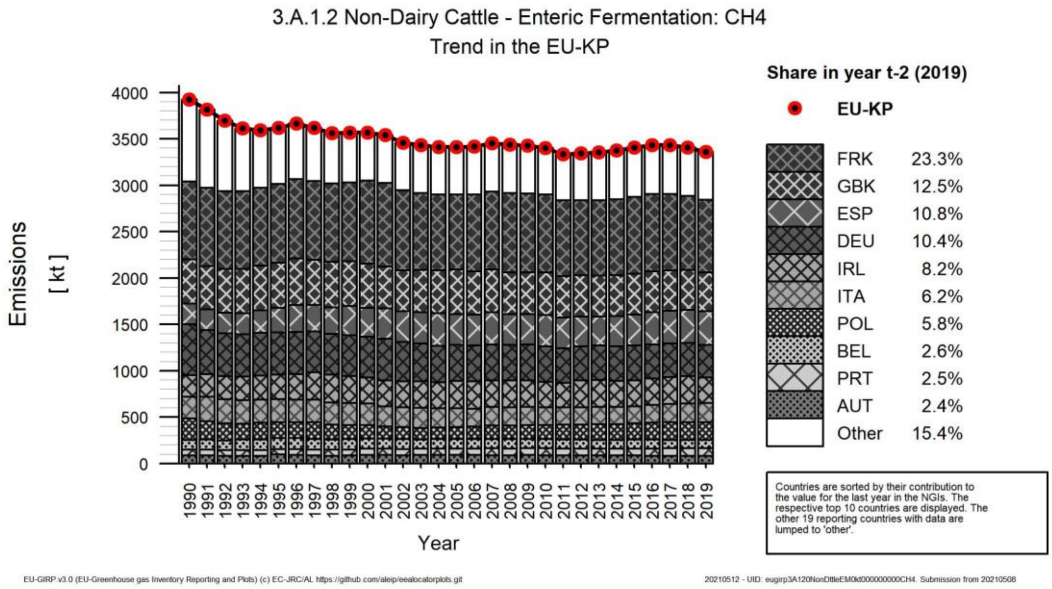


Figure 5.9: **3.A.1 Dairy Cattle: Trend in cattle population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019**

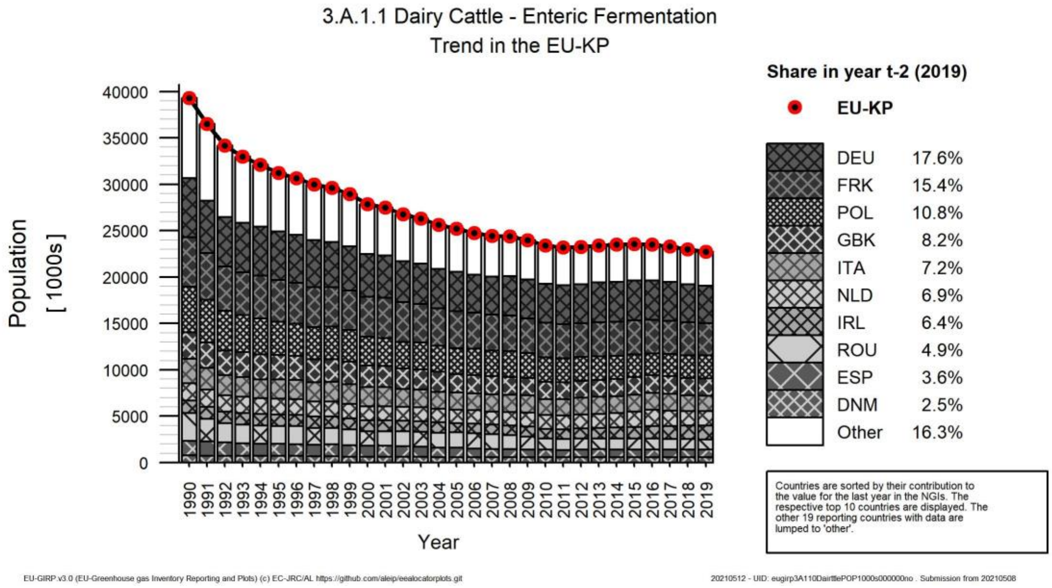
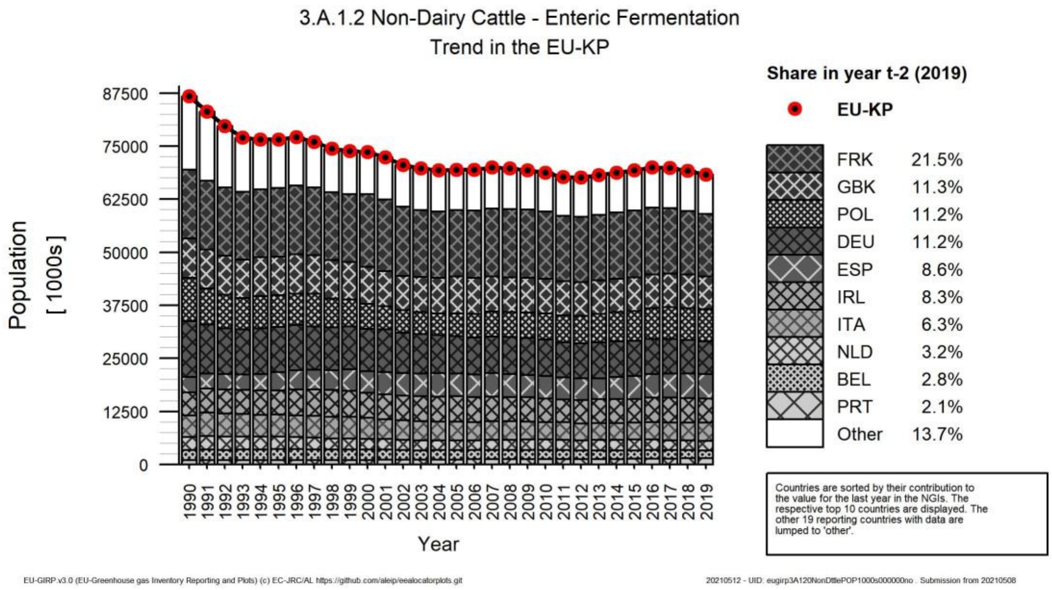


Figure 5.10: **3.A.1 Non-Dairy Cattle: Trend in cattle population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019**



3.A.2 - Sheep - Emissions

Emissions in source category *3.A.2 - Sheep* decreased strongly in EU-KP by 29% or 7.4 Mt CO_2-eq in the period 1990 to 2019. Figure 5.11 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 92.6% of the total in 2019.Emissions decreased in 21 countries and increased in eight countries. The six countries with the largest decreases were France, Bulgaria, the United Kingdom, Spain, Poland and Romania with a total absolute decrease of 5.8 Mt CO_2-eq. The five countries with the largest increases were Slovenia, Austria, Lithuania, Greece and Sweden, with a total absolute increase of 114 kt CO_2-eq.

3.A.2 - Sheep - Population

The main driver for the decrease of CH_4 emissions from enteric fermentation for sheep was the decrease in animal numbers shown in Figure 5.12.

Sheep population decreased strongly in EU-KP by 32% or 48 million heads in the period 1990 to 2019. Figure 5.12 shows the trend of sheep population indicating the countries contributing most to EU-KP total. The figure represents the trend in sheep population for the different countries along the inventory period. The ten countries with the highest population accounted together for 93.6% of the total in 2019.Population decreased in 21 countries and increased in eight countries. The three countries with the largest decreases were the United Kingdom, Spain and Bulgaria with a total absolute decrease of 26.8 million heads. The five countries with the largest increases were Slovenia, Austria, Lithuania, Greece and Sweden, with a total absolute increase of 540 thousand heads.

Figure 5.11: 3.A.2: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019

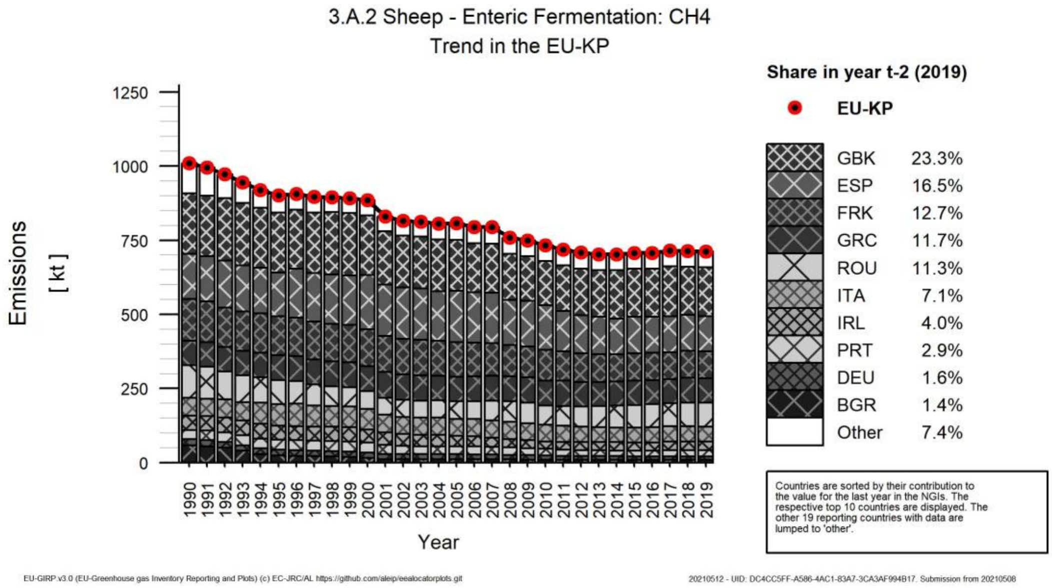
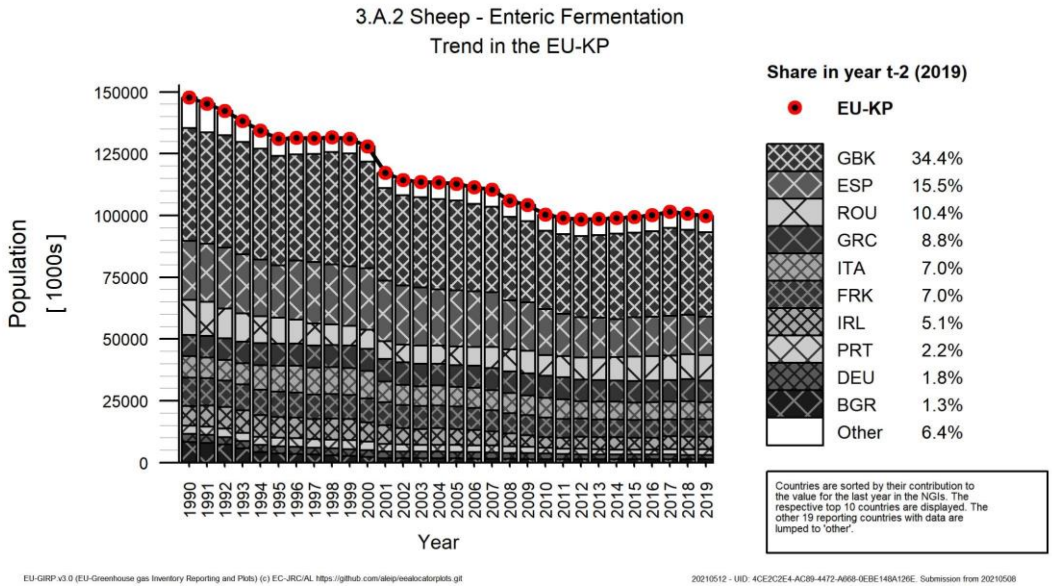


Figure 5.12: 3.A.2: Trend in sheep population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



Implied EFs and Methodological Issues

Information for cattle, sheep and swine are reported using national classification of the animals. For example, it is possible to report cattle numbers using one of three options:

- Option A distinguishes 'Dairy Cattle' and 'Non-Dairy Cattle'.

- Option B distinguishes ‘Mature Dairy Cattle’, ‘Other Mature Cattle’ and ‘Growing Cattle’.
- Option C allows for any national classification.

To obtain values that can be aggregated to EU-KP level, data reported under Option B and Option C were converted to Option A categories. ‘Mature Dairy Cattle’ is taken for ‘Dairy Cattle’ and the other two categories under Option B are used for ‘Non-Dairy Cattle’. Also in Option C, dairy cattle can be identified (e.g. ‘Dairy Cows’, ‘Other Dairy Cattle’ etc.) and all other cattle categories have been grouped to the animal type ‘Non-Dairy Cattle’.

In case data were aggregated, this was done on the basis of a weighted average using population data as weighting factors.

In the cases for ‘Sheep’ and ‘Swine’, all animal types reported by countries are aggregated to one single parent category using the same approach.

In this section we discuss the Implied Emission Factor for the main animal types. Furthermore, we present data on the average gross energy intake and - for dairy cattle - also the milk yield.

3.A.1 - Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1 - Cattle* increased in EU-KP clearly between 1990 and 2019 by 10.1% or 6.6 kg/head/year. Table 5.7 shows the implied emission factor for CH_4 emissions in source category *3.A.1 - Cattle* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in three countries and increased in 26 countries. Decreases occurred in Croatia, Portugal and Spain with a mean absolute value of 6 kg/head/year. The four countries with the largest increases were Latvia, Finland, Denmark and the Czech Republic with a mean absolute value of 22 kg/head/year.

Table 5.7 3.A.1 - Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2019		Country	1990	2019
Austria	71	81	|	Ireland	54	64
Belgium	55	63	|	Iceland	58	61
Bulgaria	74	83	|	Italy	68	71
Cyprus	74	87	|	Lithuania	70	86
Czech Republic	62	84	|	Luxembourg	71	82
Germany	64	78	|	Latvia	59	81
Denmark	65	87	|	Malta	73	79
Spain	70	70	|	Netherlands	67	77
Estonia	62	82	|	Poland	70	77
Finland	65	88	|	Portugal	72	69
France	63	67	|	Romania	84	100
United Kingdom	62	69	|	Slovakia	64	79
Greece	68	74	|	Slovenia	68	75
Croatia	91	76	|	Sweden	67	70
Hungary	71	74	|	**EU-KP**	**66**	**72**

3.A.1.1 - Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1.1 - Dairy Cattle* increased in EU-KP strongly between 1990 and 2019 by 26.8% or 28 kg/head/year. Table 5.8 shows the implied emission factor for CH_4 emissions in source category *3.A.1.1 - Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in one country and increased in 28 countries. A decrease occurred in Croatia with an absolute value of 5 kg/head/year. The four countries with the largest increases were the Czech Republic, Estonia, Finland and Latvia with a mean absolute value of 51 kg/head/year.

Figure 5.13: 3.A.1.1 - Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

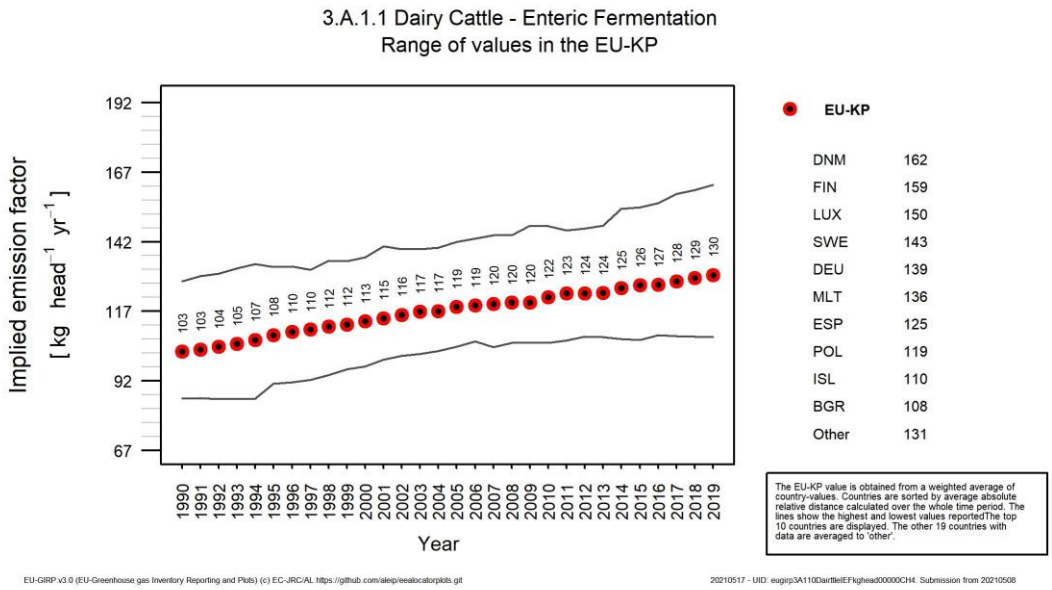


Table 5.8 3.A.1.1 - Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2019	Country	1990	2019
Austria	105	137	Ireland	101	122
Belgium	89	127	Iceland	90	110
Bulgaria	105	108	Italy	111	130
Cyprus	99	121	Lithuania	100	131
Czech Republic	98	156	Luxembourg	112	150
Germany	112	139	Latvia	103	146
Denmark	128	162	Malta	116	136
Spain	86	125	Netherlands	110	135
Estonia	101	156	Poland	96	119
Finland	112	159	Portugal	97	133
France	99	124	Romania	100	124
United Kingdom	98	125	Slovakia	85	123
Greece	93	127	Slovenia	92	126
Croatia	117	112	Sweden	112	143
Hungary	105	125	**EU-KP**	**103**	**130**

3.A.1.1 - Dairy Cattle - Gross energy

The gross energy, a parameter used for calculating CH_4 emissions in source category *3.A.1.1 - Dairy Cattle*, increased in EU-KP strongly between 1990 and 2019 by 32.2% or 76.1 MJ/day. Figure 5.14 shows the trend of the gross energy in EU-KP indicating also the range of values used by the countries. Table 5.9 shows the gross energy in source category *3.A.1.1 - Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. The reported gross energy increased in all reporting 26 countries. The four countries with the largest increases were Estonia, Finland, Denmark and Latvia with a mean absolute value of 112 MJ/day.

Figure 5.14: 3.A.1.1 - Dairy Cattle: Trend in gross energy in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

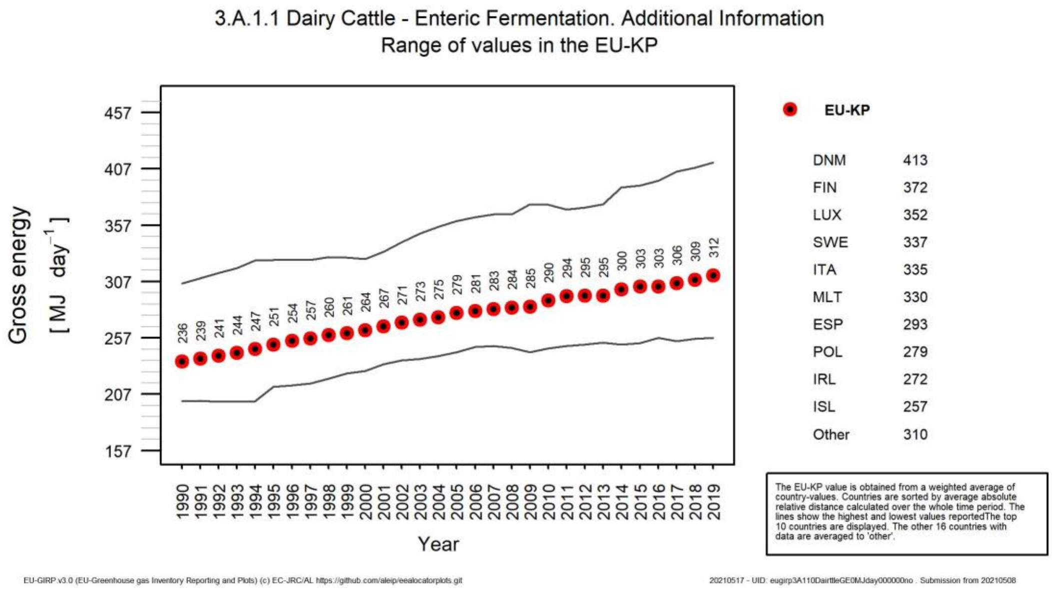


Table 5.9 3.A.1.1 - Dairy Cattle: countries' gross energy (MJ/day)

Country	1990	2019	Country	1990	2019
Austria	247	320	Iceland	212	257
Belgium	222	318	Italy	261	335
Cyprus	232	283	Lithuania	234	307
Germany	241	337	Luxembourg	263	352
Denmark	305	413	Latvia	242	343
Spain	201	293	Malta	271	330
Estonia	237	366	Poland	225	279
Finland	263	372	Portugal	227	313
France	242	310	Romania	233	292
United Kingdom	212	298	Slovakia	200	288
Greece	217	299	Slovenia	215	295
Croatia	256	275	Sweden	271	337
Hungary	255	314	EU-KP	236	312
Ireland	226	272			

3.A.1.1 - Dairy Cattle - Milk yield

The milk yield, a parameter used for calculating CH_4 emissions in source category *3.A.1.1 - Dairy Cattle* increased in EU-KP very strongly between 1990 and 2019 by 80.6% or 9 kg/head/day. Figure 5.15 shows the trend of the milk yield in EU-KP indicating also the range of values used by the countries. Table 5.10 shows the milk yield in source category *3.A.1.1 - Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. The reported milk yield increased in all reporting 27 countries . The four countries with the largest increases were Spain, Estonia, Slovakia and the Czech Republic with a mean absolute value of 14 kg/head/day. The range of milk yield values increased over time, the lowest value was 3.6 kg/day and 9.6 kg/day in 1990 and 2019 while highest value was 17.8 kg/day and 28.6 kg/day in 1990 and 2019. The range of values is plausible, since there are countries with low values in 1990 that still have low milk yield (Romania, Bulgaria) and countries with high yield already in 1990 that increased over time (Denmark, Sweden).

Figure 5.15: 3.A.1.1 - Dairy Cattle: Trend in milk yield in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

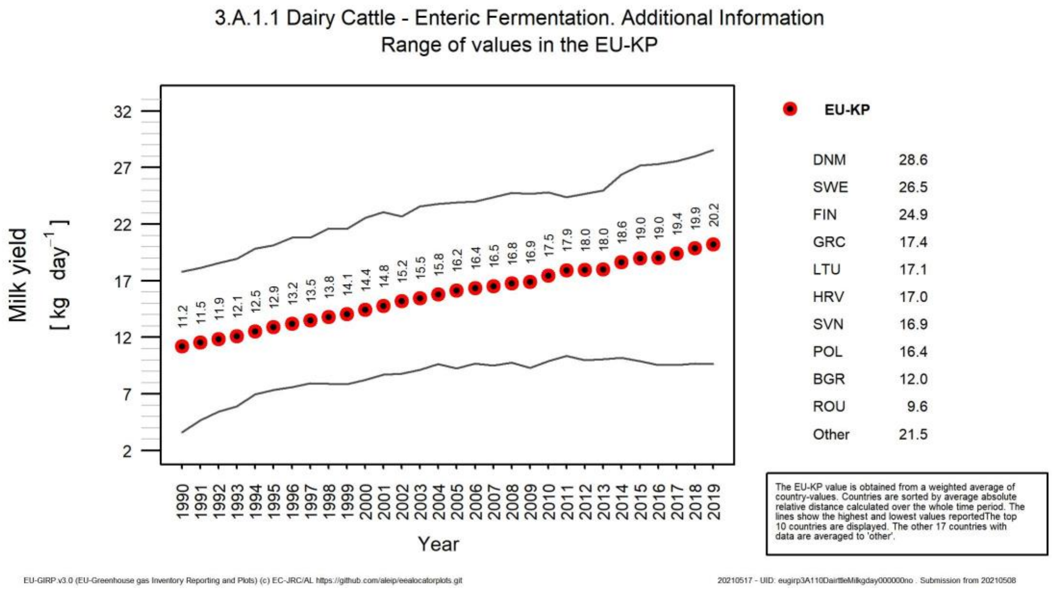


Table 5.10 3.A.1.1 - Dairy Cattle: countries' milk yield (kg/head/day) [37] [38]

Country	1990	2019		Country	1990	2019
Austria	10.4	19.7	|	Hungary	13.8	22.1
Belgium	11.2	23.4	|	Ireland	11.5	15.9
Bulgaria	11.1	12.0	|	Iceland	11.3	17.4
Cyprus	12.2	18.7	|	Italy	11.5	22.9
Czech Republic	11.0	23.9	|	Lithuania	10.2	17.1
Germany	12.9	22.6	|	Latvia	11.3	22.6
Denmark	17.7	28.6	|	Malta	10.0	19.3
Spain	10.1	25.2	|	Poland	8.9	16.4
Estonia	11.4	26.4	|	Portugal	12.2	22.9
Finland	15.7	24.9	|	Romania	3.6	9.6
France	13.1	19.7	|	Slovakia	7.0	20.2

[37] Note that the Netherlands does not report milk yield in their CRF, but such data are available in their NIR (see also Annex III).

[38] Note that data from Luxembourg are not included in the plot as they are reported in a different unit.

United Kingdom	14.1	22.3	|	Slovenia	7.6	16.9
Greece	7.6	17.4	|	Sweden	17.8	26.5
Croatia	7.8	17.0	|	EU-KP	11.2	20.2

3.A.1.2 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1.2 - Non-Dairy Cattle*increased in EU-KP moderately between 1990 and 2019 by 8.4% or 4 kg/head/year. Figure 5.16 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.11 shows the implied emission factor for CH_4 emissions in source category *3.A.1.2 - Non-Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in five countries and increased in 24 countries. The three countries with the largest decreases were Malta, the Netherlands and Portugal with a mean absolute value of 5 kg/head/year. The three countries with the largest increases were Finland, the Czech Republic and Latvia with a mean absolute value of 15 kg/head/year.

Figure 5.16: 3.A.1.2 - Non-Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

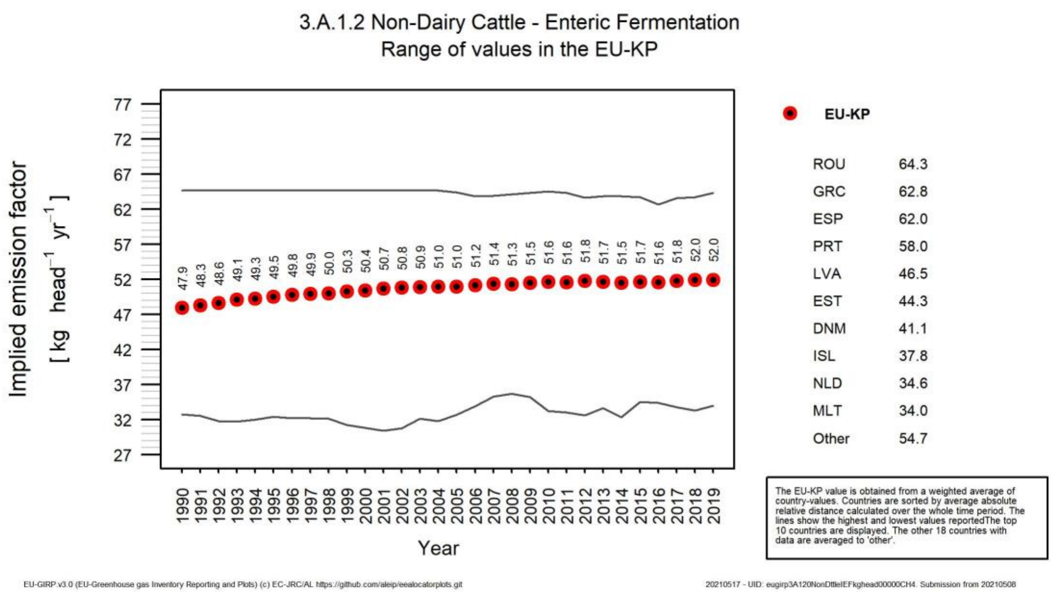


Table 5.11 3.A.1.2 - Non-Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2019		Country	1990	2019
Austria	52	59	|	Ireland	42	49
Belgium	43	47	|	Iceland	35	38
Bulgaria	55	64	|	Italy	46	48
Cyprus	57	57	|	Lithuania	53	58
Czech Republic	44	59	|	Luxembourg	55	58
Germany	42	46	|	Latvia	33	47
Denmark	34	41	|	Malta	39	34
Spain	63	62	|	Netherlands	40	35
Estonia	39	44	|	Poland	46	50
Finland	39	56	|	Portugal	62	58
France	52	53	|	Romania	65	64

United Kingdom	51	55	|	Slovakia	57	61
Greece	57	63	|	Slovenia	50	56
Croatia	57	60	|	Sweden	44	50
Hungary	53	54	|	EU-KP	48	52

3.A.1.2 – Non-Dairy Cattle – Average gross energy intake

The average gross energy intake, a parameter used for calculating CH_4 emissions in source category *3.A.1.2 – Non-Dairy Cattle* increased in EU-KP moderately between 1990 and 2019 by 7.7% or 9 MJ/head/day. Figure 5.17 shows the trend of the average gross energy intake in EU-KP indicating also the range of values used by the countries. Table 5.12 shows the average gross energy intake in source category *3.A.1.2 – Non-Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. Average gross energy intake decreased in five countries and increased in 23 countries. No data were available for Cyprus. The three countries with the largest decreases were Malta, the Netherlands and Portugal with a mean absolute value of 9 MJ/head/day. The three countries with the largest increases were Finland, the Czech Republic and Latvia with a mean absolute value of 34 MJ/head/day.

Figure 5.17: 3.A.1.2 – Non-Dairy Cattle: Trend in average gross energy intake in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

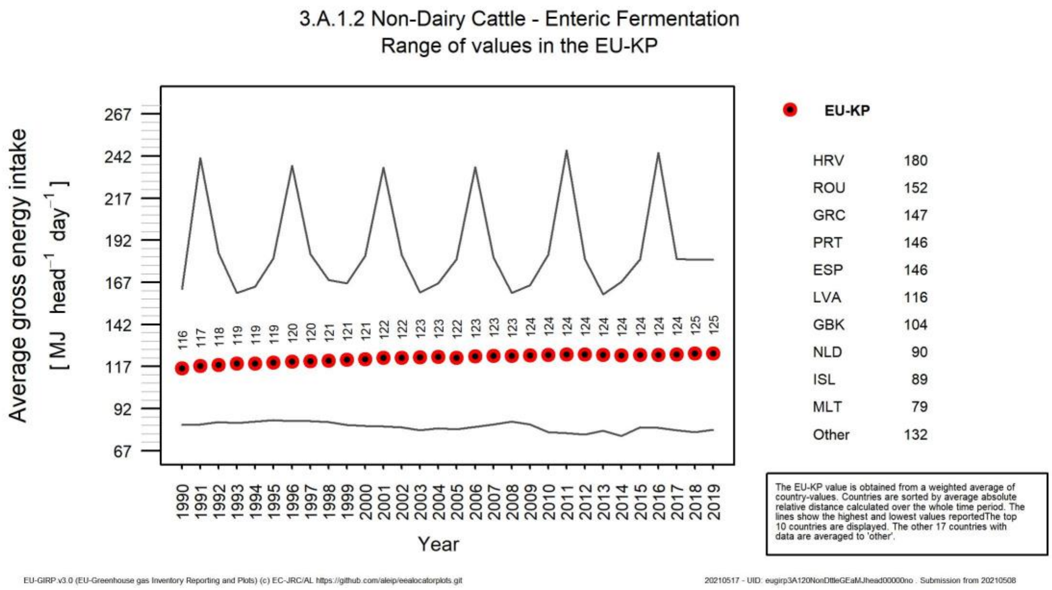


Table 5.12 3.A.1.2 – Non-Dairy Cattle: countries' average gross energy intake (MJ/head/day)

Country	1990	2019		Country	1990	2019
Austria	123	139	|	Iceland	82	89
Belgium	112	122	|	Italy	141	144
Bulgaria	129	151	|	Lithuania	125	133
Czech Republic	116	148	|	Luxembourg	129	137
Germany	100	109	|	Latvia	86	116
Denmark	107	130	|	Malta	92	79
Spain	148	146	|	Netherlands	99	90
Estonia	97	107	|	Poland	107	118
Finland	92	132	|	Portugal	151	146

Country	1990	2019		Country	1990	2019
France	122	126	|	Romania	153	152
United Kingdom	94	104	|	Slovakia	136	146
Greece	135	147	|	Slovenia	111	123
Croatia	163	180	|	Sweden	129	140
Hungary	134	138	|	EU-KP	116	125
Ireland	128	132	|			

The factors driving the average methane implied emission factor for dairy cattle are the share of dairy cattle population in each country and the relative change of their implied emissions factor. The increase in the EU-IEF from 1990 to 2019 iby27% is in line with the increase in the IEF of the four countries with the highest population (Germany, France, Poland, United Kingdom) covering together 52% of the EU dairy cattle population. In thirteen countries IEF of dairy cattle increased between 30% and 60% from 1990 to 2019 but they cover only the 15% of dairy cattle population in 2019. The nine countries with the lowest increase of the IEF (less than 23%) represented 23% of the dairy cattle population in 2019.

Table 5.13 Change in dairy cattle population and dairy cattle implied emission factor from 1990 to 2019. Countries are ordered by the share of EU dairy cattle population in 2019

	1990			2019			1990-2019 change	
	POP	POP	IEF	POP	POP	IEF	POP	IEF
Party	1000s	%	kg/head	1000s	%	kg/head	%	%
Germany	6354.6	16.2	111.5	4011.7	17.6	138.6	-36.9	24.3
France	5309.9	13.5	99.1	3490.8	15.4	124.4	-34.3	25.5
Poland	4919.0	12.5	95.8	2461.0	10.8	118.8	-50.0	24.0
United Kingdom	2848.3	7.2	98.4	1874.7	8.2	125.4	-34.2	27.5
Italy	2641.8	6.7	111.1	1643.1	7.2	130.2	-37.8	17.2
Netherland	1877.7	4.8	110.4	1578.0	6.9	135.3	-16.0	22.5
Ireland	1341.0	3.4	101.4	1465.3	6.4	121.6	9.3	19.9
Romania	3002.1	7.6	99.5	1124.8	4.9	124.3	-62.5	24.9
Spain	1587.8	4.0	85.6	814.1	3.6	124.8	-48.7	45.8
Denmark	753.1	1.9	127.7	566.6	2.5	162.4	-24.8	27.1
Austria	904.6	2.3	105.2	524.1	2.3	136.6	-42.1	29.8
Belgium	838.7	2.1	88.7	497.1	2.2	127.2	-40.7	43.4
Czechia	1206.2	3.1	97.8	364.3	1.6	156.4	-69.8	59.9
Sweden	576.4	1.5	112.2	305.6	1.3	143.3	-47.0	27.7
Finland	489.9	1.2	112.0	262.3	1.2	158.6	-46.5	41.5
Lithuania	844.9	2.1	99.6	248.5	1.1	131.1	-70.6	31.7
Hungary	563.6	1.4	105.3	243.9	1.1	125.5	-56.7	19.2
Portugal	394.3	1.0	96.8	237.7	1.0	133.4	-39.7	37.8
Bulgaria	619.1	1.6	104.7	224.6	1.0	107.7	-63.7	2.9
Latvia	535.1	1.4	103.0	138.4	0.6	146.1	-74.1	41.9
Croatia	462.7	1.2	117.0	130.0	0.6	111.6	-71.9	-4.6
Slovakia	401.1	1.0	85.2	125.8	0.6	122.6	-68.6	43.9
Slovenia	225.3	0.6	91.7	100.8	0.4	125.7	-55.3	37.0
Greece	210.0	0.5	92.5	96.4	0.4	127.4	-54.1	37.7
Estonia	280.7	0.7	100.8	85.0	0.4	156.2	-69.7	54.9

	1990			2019			1990-2019 change	
Luxemburg	58.8	0.1	112.3	49.0	0.2	149.9	-16.7	33.5
Cyprus	22.4	0.1	98.8	35.0	0.2	120.5	56.2	22.0
Island	31.6	0.1	90.5	26.2	0.1	109.7	-17.0	21.2
Malta	9.3	0.0	115.7	6.2	0.0	135.9	-32.9	17.5
EU-KP	**39309.9**		**102.6**	**22731.0**		**130.1**		**26.8**

3.A.2 - Sheep - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.2 - Sheep* increased in EU-KP slightly between 1990 and 2019 by 4.5% or 0.31 kg/head/year. Figure 5.18 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.14 shows the implied emission factor for CH_4 emissions in source category *3.A.2 - Sheep* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in eight countries and increased in twelve countries. It was in 2019 at the level of 1990 in nine countries. The three countries with the largest decreases were Slovakia, Portugal and Ireland with a mean absolute value of 1 kg/head/year. The three countries with the largest increases were Spain, Malta and France with a mean absolute value of 1 kg/head/year.

Figure 5.18: 3.A.2 - Sheep: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

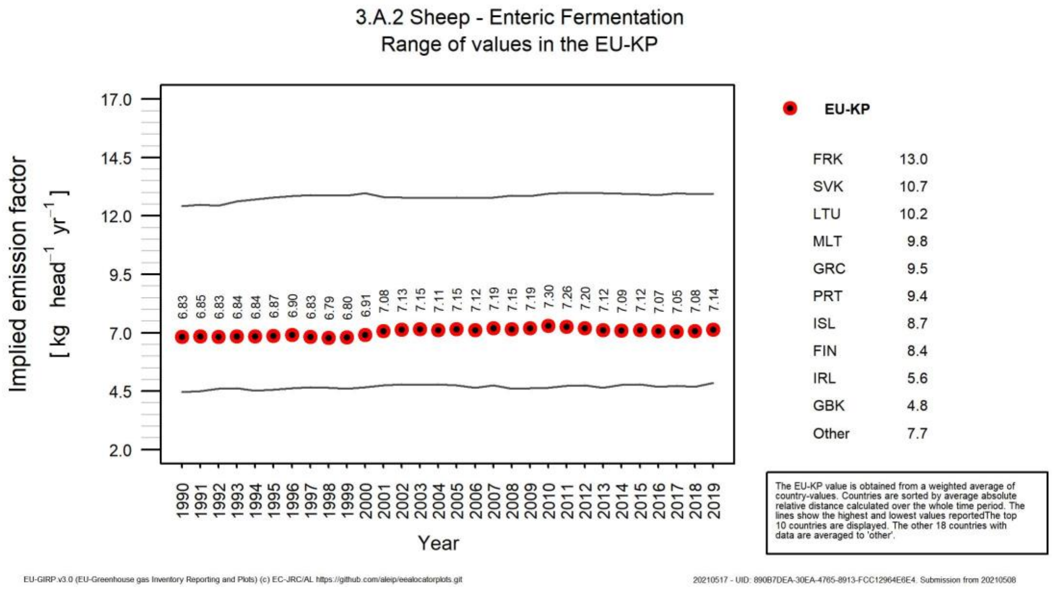


Table 5.14 3.A.2 - Sheep: countries' implied emission factor (kg/head/year)

Country	1990	2019	Country	1990	2019
Austria	8.0	8.0	Ireland	5.9	5.6
Belgium	8.0	8.0	Iceland	8.5	8.7
Bulgaria	6.9	7.4	Italy	6.9	7.2
Cyprus	8.0	8.0	Lithuania	10.2	10.2
Czech Republic	8.0	8.0	Luxembourg	7.4	7.8
Germany	6.3	6.4	Latvia	8.0	8.0
Denmark	6.7	6.7	Malta	9.0	9.8

Country	1990	2019		Country	1990	2019
Spain	6.3	7.6	|	Netherlands	8.0	8.0
Estonia	8.0	8.0	|	Poland	8.0	8.0
Finland	8.1	8.4	|	Portugal	9.7	9.4
France	12.4	13.0	|	Romania	7.9	7.8
United Kingdom	4.5	4.8	|	Slovakia	11.8	10.7
Greece	9.5	9.5	|	Slovenia	8.0	8.0
Croatia	8.0	8.0	|	Sweden	8.0	8.0
Hungary	8.0	8.0	|	EU-KP	6.8	7.1

3.A.2 - Sheep - Average gross energy intake

The average gross energy intake, a parameter used for calculating CH_4 emissions in source category *3.A.2 - Sheep*, increased in EU-KP moderately between 1990 and 2019 by 8.2% or 1.4 MJ/head/day. Figure 5.19 shows the trend of the average gross energy intake in EU-KP indicating also the range of values used by the countries. Table 5.15 shows the average gross energy intake in source category *3.A.2 - Sheep* for the years 1990 and 2019 for all countries and EU-KP. Average gross energy intake decreased in six countries and increased in seven countries. It was in 2019 at the level of 1990 in two countries. No data were available for fourteen countries (Poland, Austria, Belgium, Cyprus, the Czech Republic, Germany, Estonia, Finland, France, Croatia, Hungary, Latvia, the Netherlands and Slovenia). The three countries with the largest decreases were Slovakia, Portugal and Romania with a mean absolute value of 1 MJ/head/day. The three countries with the largest increases were Spain, Malta and the United Kingdom with a mean absolute value of 2 MJ/head/day.

Figure 5.19: 3.A.2 - Sheep: Trend in average gross energy intake in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

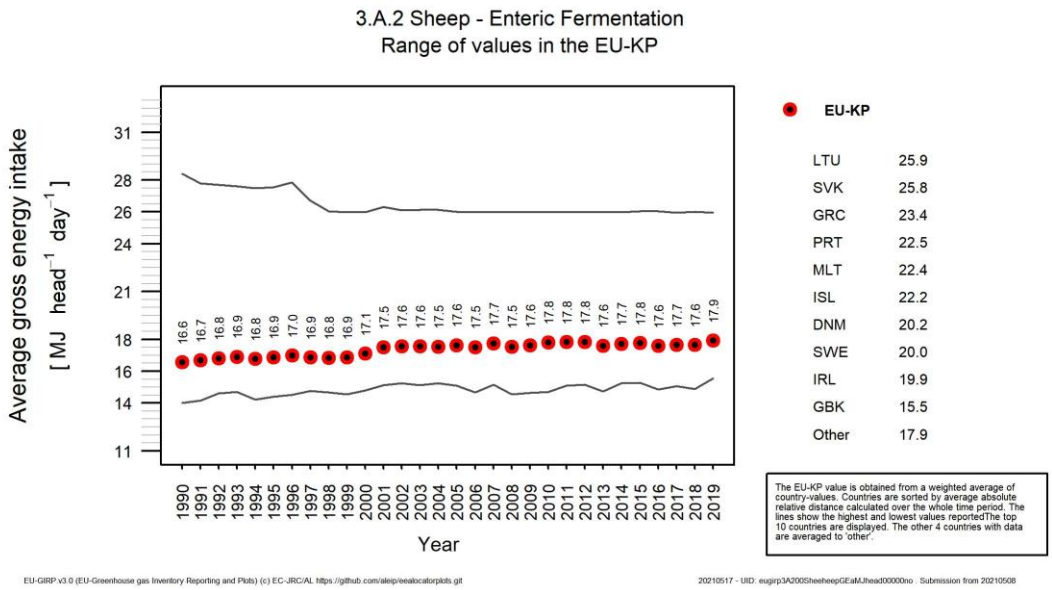


Table 5.15 3.A.2 - Sheep: countries' average gross energy intake (MJ/head/day)

Country	1990	2019		Country	1990	2019
Bulgaria	17	18	|	Lithuania	26	26
Denmark	20	20	|	Luxembourg	19	19

Spain	15	18	|	Malta	20	22
United Kingdom	14	16	|	Portugal	23	22
Greece	23	23	|	Romania	19	18
Ireland	20	20	|	Slovakia	28	26
Iceland	21	22	|	Sweden	20	20
Italy	16	17	|	EU-KP	17	18

5.3.2 Manure Management - CH_4 (CRF Source Category 3B1)

In 2019 CH_4 emissions in source category *3.B.1 - Manure Management* in EU-KP were 40617.8 kt CO_2 equivalent. This corresponds to 0.9% of total EU-KP GHG emissions and 8.5% of total EU-KP CH_4 emissions. They make 9.5% of total agricultural emissions and 18% of total agricultural CH_4 emissions. The main sub-categories are 3.B.1.3 (Swine), 3.B.1.1.1 (Dairy Cattle) and 3.B.1.1.2 (Non-Dairy Cattle) as shown in Figure 5.20. Emissions are also reported for 3.B.1.4 (Other Livestock and 3.B.1.2 (Sheep). CH_4 emissions from Manure Management for 'Other Livestock' are reported for the categories Buffalo, Deer, Goats, Horses, Mules and Asses, Poultry, and Other Other Livestock. Regarding the origin of emissions in the different countries, Figure 5.21 shows the distribution of CH_4 emissions from manure management by livestock category in all countries and in the EU-KP. Each bar represents the total emissions of a country in the current emission category, where different shades of blue correspond to the emitting animal types.

Figure 5.20: Share of source category 3.B.1 on total EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2019.

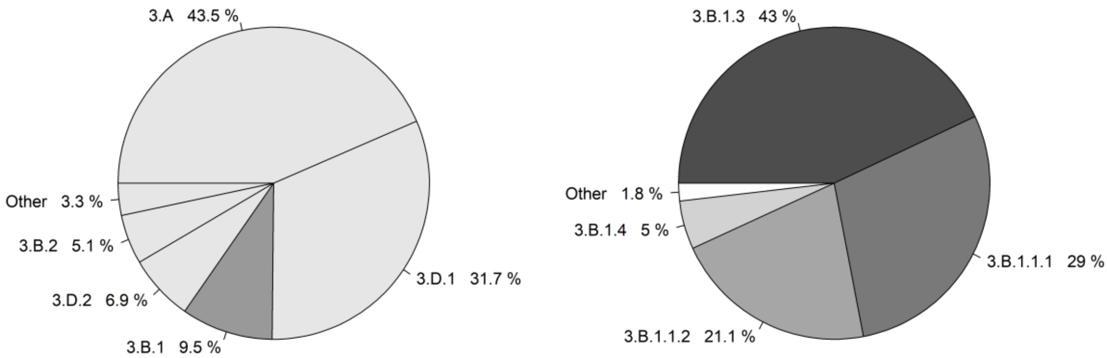
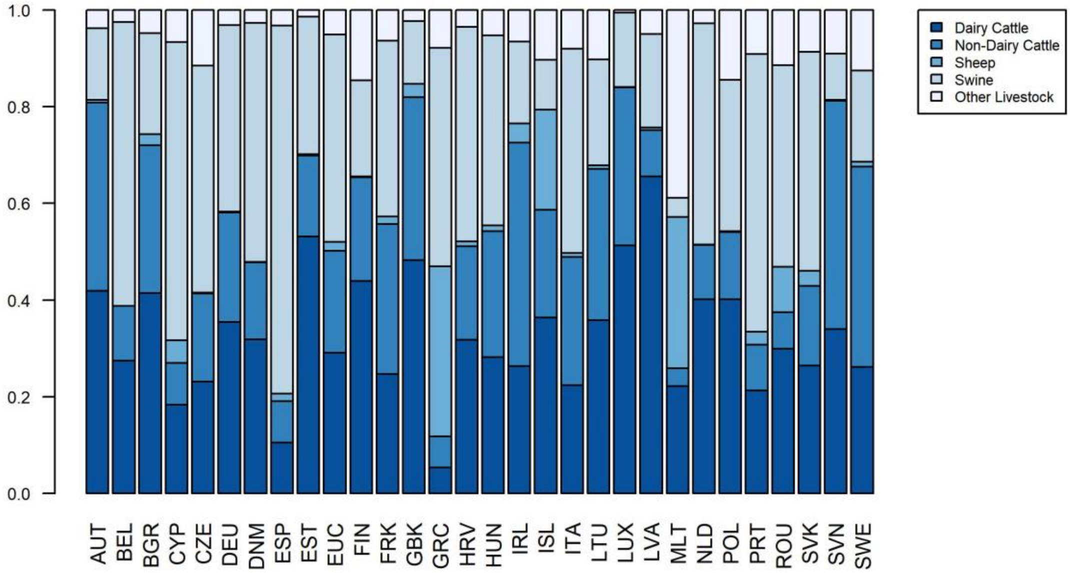


Figure 5.21: Decomposition of emissions in source category 3.B.1 - Manure Management into its sub-categories by country in the year 2019.



Total GHG and CH_4 emissions by country from 3.B.1 *Manure Management* are shown in Table 5.16 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2019). Values are given in kt CO_2-eq. Between 1990 and 2019, CH_4 emission in this source category decreased by 18% or 9.2 Mt CO_2-eq. The decrease was largest in Slovakia in relative terms (77%) and in the Netherlands in absolute terms (1.6 Mt CO_2-eq). From 2018 to 2019 emissions in the current category decreased by 0.5%.

Table 5.16 3.B.1 - Manure Management: Countries' contributions to total EU-GHG and CH_4 emissions

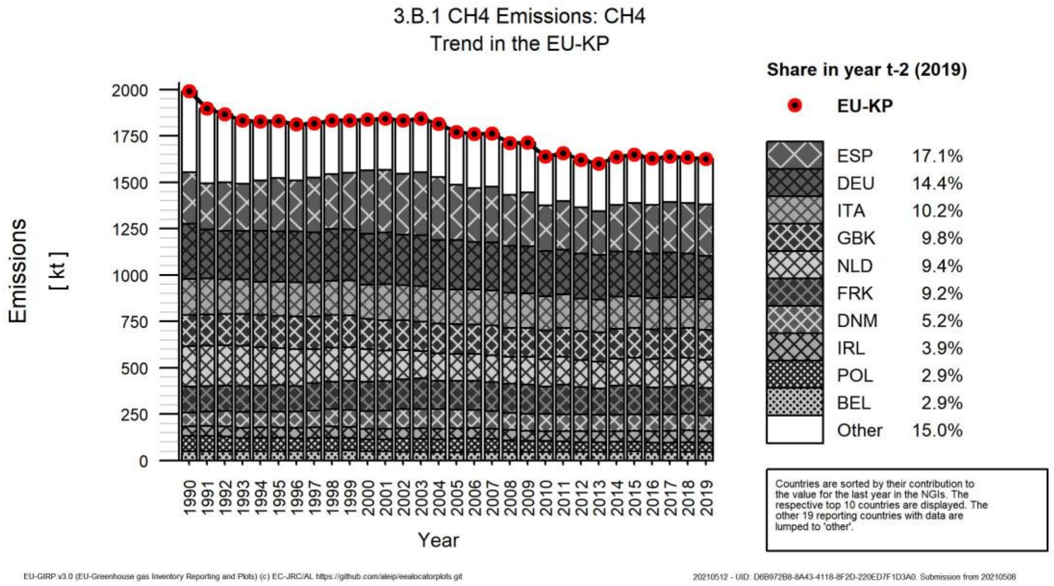
Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	544	544	538	1.3%	-6	-1%	-6	-1%	T1,T2	CS,D
Belgium	1,230	1,189	1,181	2.9%	-49	-4%	-8	-1%	T1,T2	CS,D
Bulgaria	1,083	317	303	0.7%	-780	-72%	-14	-4%	T1,T2	CS,D
Croatia	427	393	386	1.0%	-41	-10%	-6	-2%	T2	CS,D
Cyprus	69	50	49	0.1%	-20	-29%	0	-1%	T1,T2	D
Czechia	1,744	521	514	1.3%	-1,230	-71%	-7	-1%	T1,T2	CS,D
Denmark	1,853	2,212	2,118	5.2%	264	14%	-95	-4%	0	0
Estonia	155	135	135	0.3%	-21	-13%	-1	0%	D,T1,T2	CS,D
Finland	368	450	452	1.1%	84	23%	3	1%	T2	CS
France	3,475	3,810	3,728	9.2%	253	7%	-82	-2%	T2	CS
Germany	7,416	5,914	5,834	14.4%	-1,582	-21%	-80	-1%	T2	CS,D
Greece	774	642	642	1.6%	-132	-17%	0	0%	T1,T2	CS,D
Hungary	1,161	654	650	1.6%	-511	-44%	-4	-1%	T1,T2	CS,D
Ireland	1,288	1,618	1,572	3.9%	284	22%	-46	-3%	T1,T2	CS,D
Italy	4,843	4,142	4,132	10.2%	-711	-15%	-10	0%	T1,T2	CS,D
Latvia	190	90	94	0.2%	-95	-50%	4	5%	T1,T2	CS,D
Lithuania	666	241	232	0.6%	-433	-65%	-8	-3%	T1,T2	CS,D
Luxembourg	48	63	62	0.2%	14	30%	-1	-1%	T1,T2	CS,D
Malta	14	11	11	0.0%	-3	-22%	0	-1%	T1,T2	CS,D
Netherlands	5,442	3,803	3,828	9.4%	-1,615	-30%	25	1%	T1,T2	CS,D
Poland	2,088	1,238	1,186	2.9%	-902	-43%	-52	-4%	T1,T2	CS,D
Portugal	814	727	728	1.8%	-86	-11%	1	0%	T2	CS,D
Romania	1,847	645	636	1.6%	-1,211	-66%	-9	-1%	T1,T2	CS,D
Slovakia	433	106	99	0.2%	-334	-77%	-7	-6%	T1,T2	CS,D
Slovenia	325	236	235	0.6%	-90	-28%	-1	0%	T1,T2	CS,D
Spain	6,927	6,784	6,952	17.1%	25	0%	168	2%	T1,T2,T3	CS,D
Sweden	245	263	269	0.7%	24	10%	6	2%	T1,T2	CS,D
United Kingdom	4,262	3,966	3,995	9.8%	-267	-6%	29	1%	T1,T2	CS,D
EU-27+UK	**49,732**	**40,763**	**40,562**	**100%**	**-9,170**	**-18%**	**-201**	**0%**	**-**	**-**
Iceland	59	57	56	0.1%	-3	-6%	-1	-2%	T1,T2	CS,D
United Kingdom (KP)	4,262	3,966	3,995	9.8%	-267	-6%	29	1%	T1,T2,T3	CS,D
EU-KP	**49,791**	**40,820**	**40,618**	**100%**	**-9,173**	**-18%**	**-202**	**0%**	**-**	**-**

Trends in Emissions and Activity Data

3.B.1 - Manure Management - Emissions

Emissions in source category *3.B.1 - Manure Management* decreased considerably in EU-KP by 18% or 9.2 Mt CO_2-eq in the period 1990 to 2019. Figure 5.22 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 85% of the total in 2019.Emissions decreased in 22 countries and increased in seven countries. The four countries with the largest decreases were the Netherlands, Germany, the Czech Republic and Romania with a total absolute decrease of 5.6 Mt CO_2-eq. The three countries with the largest increases were France, Denmark and Ireland, with a total absolute increase of 802 kt CO_2-eq.

Figure 5.22: **3.B.1: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019**



3.B.1.1 - Cattle - Emissions

In 2019 CH_4 emissions in source category *3.B.1.1 - Cattle* in EU-KP were 20388.1 kt CO_2 equivalent. This corresponds to 0.45% of total EU-KP GHG emissions and 4.3% of total EU-KP CH_4 emissions. They make 4.8% of total agricultural emissions and 8.8% of total agricultural CH_4 emissions. Figure 5.23 and Figure 5.24 show the trend of emissions for Dairy and Non-Dairy Cattle indicating the countries contributing most to EU-KP.

Total GHG and CH_4 emissions by country from 3.B.1.1 *Manure Management* are shown in Table 5.17 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2019). Values are given in kt CO_2-eq. Between 1990 and 2019, CH_4 emission in this source category decreased by 14% or 3.4 Mt CO_2-eq. The decrease was largest in the Czech Republic in relative terms (76%) and in Germany in absolute terms (1.2 Mt CO_2-eq). The three countries with the largest decreases were Germany, Italy and the Czech Republic with a total absolute decrease of 2.7 Mt CO_2-eq. The three countries with the largest increases were Denmark, Ireland and the Netherlands, with a total absolute increase of 705 kt CO_2-eq. From 2018 to 2019 emissions in the current category decreased by 0.8%. The ten countries with the highest emissions accounted together for 84.9% of the total in 2019. Emissions decreased in sixteen countries and increased in thirteen countries.

Table 5.17 3.B.1.1 - Cattle: Countries' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	400	441	435	2.1%	35	9%	-6	-1%	T2	CS
Belgium	420	452	457	2.2%	38	9%	6	1%	T2	CS
Bulgaria	455	227	218	1.1%	-237	-52%	-9	-4%	T2	CS
Croatia	224	200	197	1.0%	-26	-12%	-2	-1%	T2	CS,D
Cyprus	10	12	13	0.1%	4	39%	1	6%	T2	D
Czechia	877	213	212	1.0%	-665	-76%	-1	-0.4%	T1,T2	CS
Denmark	886	1 037	1 013	5.0%	127	14%	-24	-2%	0	0
Estonia	50	93	94	0.5%	44	89%	1	2%	T2	CS,D
Finland	232	295	296	1.5%	64	27%	1	0.4%	T2	CS
France	2 104	2 133	2 077	10.2%	-27	-1%	-56	-3%	T2	CS
Germany	4 580	3 422	3 387	16.6%	-1 193	-26%	-35	-1%	T2	CS
Greece	95	76	76	0.4%	-19	-20%	-0.02	-0.03%	T2	CS,D
Hungary	566	349	352	1.7%	-214	-38%	3	1%	T2	CS
Ireland	921	1 189	1 141	5.6%	220	24%	-48	-4%	T2	CS
Italy	2 841	2 023	2 019	9.9%	-823	-29%	-5	-0.2%	T2	CS
Latvia	111	66	71	0.3%	-40	-36%	5	7%	T2	CS
Lithuania	252	155	156	0.8%	-96	-38%	1	0.4%	T2	CS
Luxembourg	39	52	52	0.3%	13	35%	0.01	0.01%	T2	CS
Malta	4	3	3	0.0%	-1	-33%	0.01	0.2%	T2	CS
Netherlands	1 608	1 984	1 967	9.6%	359	22%	-17	-1%	T2	CS
Poland	959	650	641	3.1%	-318	-33%	-9	-1%	T2	CS
Portugal	199	221	224	1.1%	25	13%	3	1%	T2	CS
Romania	651	244	238	1.2%	-413	-63%	-6	-2%	T2	CS
Slovakia	127	44	42	0.2%	-85	-67%	-1	-3%	T2	CS
Slovenia	163	189	191	0.9%	28	17%	2	1%	T2	CS
Spain	1 652	1 303	1 326	6.5%	-326	-20%	23	2%	T2	CS,D
Sweden	156	180	182	0.9%	26	17%	2	1%	T2	CS
United Kingdom	3 182	3 258	3 275	16.1%	93	3%	17	1%	T2	CS,D
EU-27+UK	**23 763**	**20 511**	**20 356**	**100%**	**-3 407**	**-14%**	**-155**	**-1%**	**-**	**-**
Iceland	33	33	33	0.2%	-0.3	-1%	-0.2	-0.5%	T2	CS,D
United Kingdom (KP)	3 182	3 258	3 275	16.1%	93	3%	17	1%	T2	CS,D
EU-KP	**23 796**	**20 543**	**20 388**	**100%**	**-3 408**	**-14%**	**-155**	**-1%**	**-**	**-**

Figure 5.23: 3.B.1.1: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019

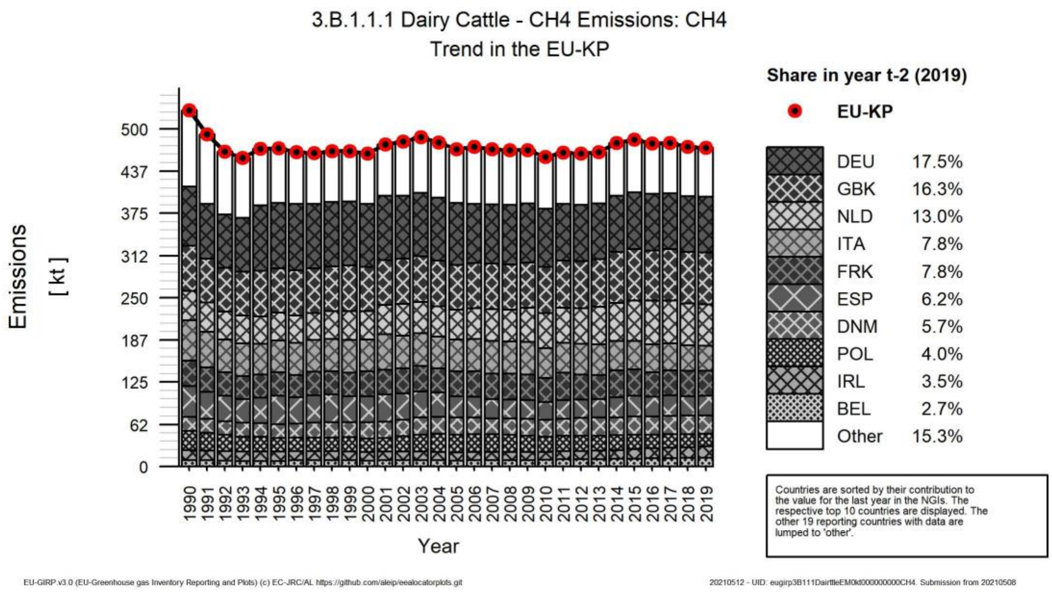
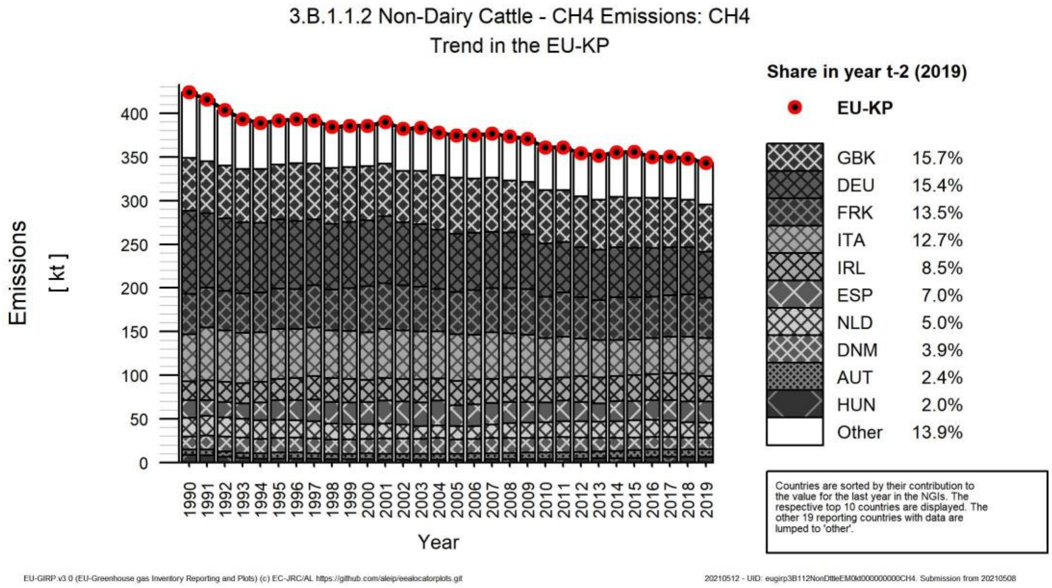


Figure 5.24: 3.B.1.1: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



3.B.1.1 - Cattle - Activity Data

The main activity data for CH_4 emissions from manure management - cattle are the animal numbers. Cattle numbers are already discussed under source category 3.A Enteric Fermentation and therefore not further discussed here.

Other relevant activity data are the allocation by climate region and the allocation by manure management system (MMS).

3.B.1.3 - Swine - Emissions

In 2019 CH_4 emissions in source category *3.B.1.3 - Swine* in EU-KP were 17438 kt CO_2 equivalent. This corresponds to 0.39% of total EU-KP GHG emissions and 3.6% of total EU-KP CH_4 emissions. They make 4.1% of total agricultural emissions and 7.6% of total agricultural CH_4 emissions.

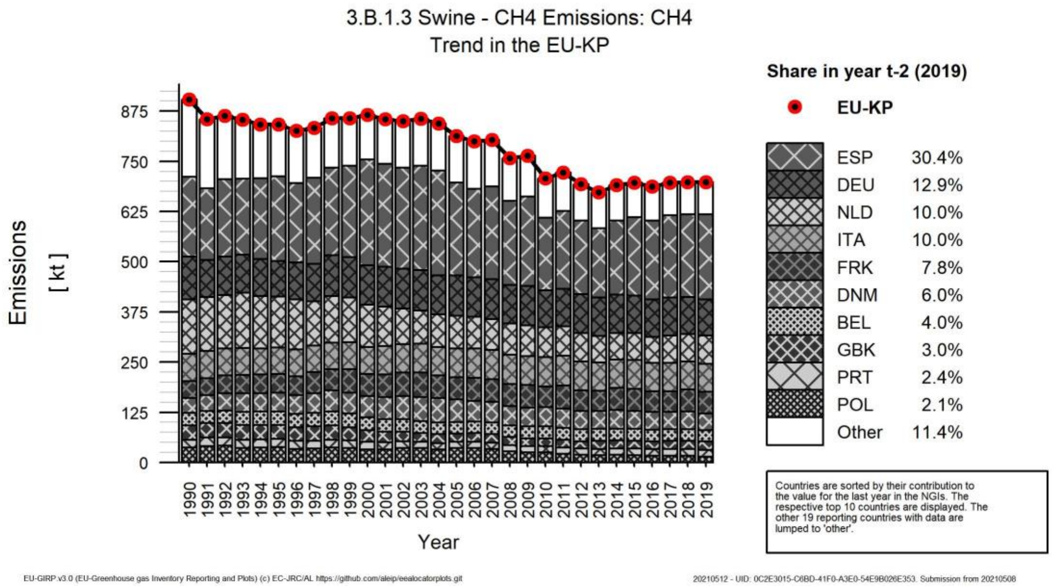
Total GHG and CH_4 emissions by country from 3.B.1.3 *Manure Management* are shown in Table 5.18 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2019). Values are given in kt CO_2-eq. Between 1990 and 2019, CH_4 emission in this source category decreased by 23% or 5.2 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (88%) and in the Netherlands in absolute terms (1.6 Mt CO_2-eq). From 2018 to 2019 emissions in the current category decreased by 0.1%. Figure 5.25 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 88.6% of the total in 2019.Emissions decreased in twenty countries and increased in nine countries. The largest decreases occurred in the Netherlands and Romania with a total absolute decrease of 2.4 Mt CO_2-eq. The three countries with the largest increases were Denmark, France and Spain, with a total absolute increase of 764 kt CO_2-eq.

Table 5.18 3.B.1.3 - Swine: Countries' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	129	80	80	0.5%	-49	-38%	0	0%	T1	D
Belgium	793	707	694	4.0%	-99	-13%	-13	-2%	T2	CS
Bulgaria	543	69	63	0.4%	-480	-88%	-5	-8%	T2	CS
Croatia	167	176	172	1.0%	5	3%	-5	-3%	T2	CS,D
Cyprus	55	32	30	0.2%	-24	-44%	-1	-4%	T2	D
Czechia	762	244	242	1.4%	-520	-68%	-2	-1%	T1	D
Denmark	922	1 111	1 047	6.0%	125	14%	-64	-6%	0	0
Estonia	97	40	38	0.2%	-58	-60%	-1	-3%	T2	CS,D
Finland	68	88	90	0.5%	23	33%	2	2%	T2	CS
France	1 054	1 379	1 357	7.8%	304	29%	-22	-2%	T2	CS
Germany	2 685	2 293	2 249	12.9%	-436	-16%	-44	-2%	T2	CS
Greece	398	288	291	1.7%	-107	-27%	3	1%	T1	D
Hungary	500	262	256	1.5%	-244	-49%	-6	-2%	T2	CS
Ireland	206	264	266	1.5%	60	29%	2	1%	T2	CS,D
Italy	1 703	1 740	1 743	10.0%	40	2%	3	0%	T2	CS
Latvia	66	19	18	0.1%	-47	-72%	-0.3	-2%	T2	CS
Lithuania	329	55	51	0.3%	-278	-85%	-4	-8%	T2	CS
Luxembourg	9	10	10	0.1%	1	9%	-1	-6%	T2	CS
Malta	1	0.5	0.4	0.003%	-1	-65%	0	-2%	T2	CS,D
Netherlands	3 369	1 709	1 751	10.0%	-1 617	-48%	42	2%	T2	CS
Poland	913	420	371	2.1%	-541	-59%	-48	-12%	T1	CS
Portugal	506	420	418	2.4%	-88	-17%	-1	-0.3%	T2	CS
Romania	1 021	270	265	1.5%	-755	-74%	-4	-2%	T2	CS
Slovakia	288	49	45	0.3%	-243	-84%	-5	-9%	T2	CS
Slovenia	128	24	22	0.1%	-106	-82%	-2	-7%	T1	D
Spain	4 959	5 147	5 294	30.4%	335	7%	147	3%	T2,T3	CS,D
Sweden	59	48	51	0.3%	-8	-14%	3	5%	T2	CS
United Kingdom	879	509	517	3.0%	-362	-41%	8	2%	T2	D
EU-27+UK	**22 607**	**17 454**	**17 432**	**100%**	**-5 175**	**-23%**	**-21**	**-0.1%**	**-**	**-**
Iceland	4	6	6	0.03%	1	29%	-0.3	-5%	T1	D
United Kingdom (KP)	879	509	517	3.0%	-362	-41%	8	2%	T2	D
EU-KP	**22 611**	**17 460**	**17 438**	**100%**	**-5 173**	**-23%**	**-22**	**-0.1%**	**-**	**-**

Note that some countries are using Tier 1 and default emission factors for 3.B.1.3 category. Although this is a key category for the EU, is not a key category for all countries. For those countries using Tier 1, source category 3.B.1.3 is not a key category.

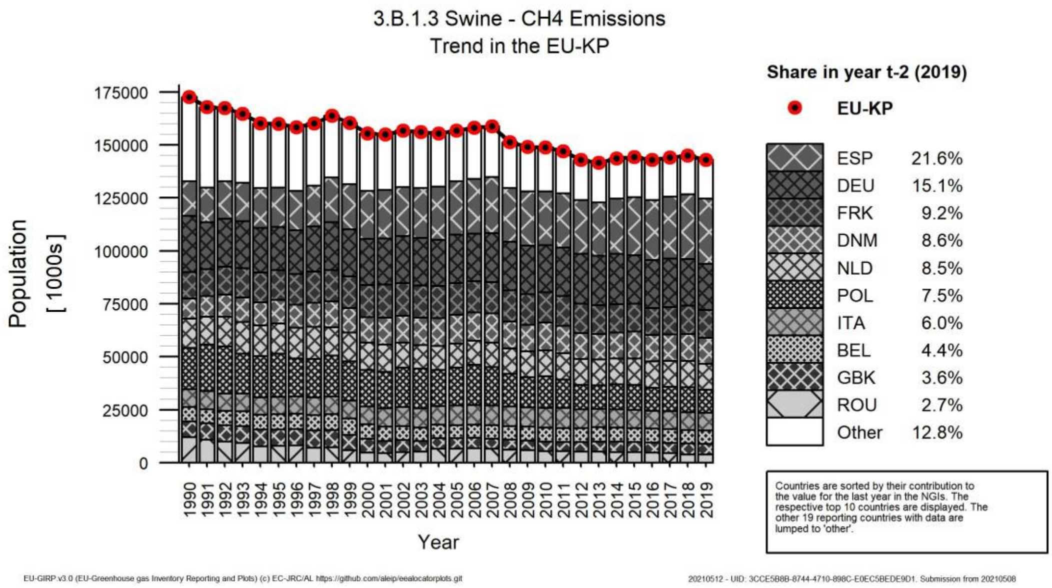
Figure 5.25: 3.B.1.3: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



3.B.1.3 - Swine - Population

The main activity data for CH_4 emissions from manure management - swine are the animal numbers. As swine are not a main animal type in the source category 3.A Enteric Fermentation its population data is discussed here. Swine population decreased considerably in EU-KP by 17% or 29.7 million heads in the period 1990 to 2019. Figure 5.26 shows the trend of swine population indicating the countries contributing most to EU-KP total. The figure represents the trend in swine population for the different countries along the inventory period. The ten countries with the highest population accounted together for 87.2% of the total in 2019.Population decreased in 21 countries and increased in eight countries. The four countries with the largest decreases were Poland, Romania, Hungary and Germany with a total absolute decrease of 27.7 million heads. The largest increases occurred in Denmark and Spain, with a total absolute increase of 17.3 million heads.

Figure 5.26: 3.B.1.3: Trend in swine population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



Implied EFs and methodological issues

In this section, we discuss the implied emission factor for the category 3.B.1 for the main animal types. Furthermore, we present data on the typical animal mass as reported in CRF Tables 3B(a)s1 and average volatile solid (VS) daily excretion.

3.B.1.1 - Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.1 - Cattle* increased in EU-KP considerably between 1990 and 2019 by 18.8% or 1.5 kg/head/year. Table 5.19 shows the implied emission factor for CH_4 emissions in source category *3.B.1.1 - Cattle* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in six countries and increased in 23 countries. The largest decreases occurred in Spain and the Czech Republic with a mean absolute value of 4 kg/head/year. The four countries with the largest increases were Estonia, Denmark, Croatia and the Netherlands with a mean absolute value of 10 kg/head/year.

Table 5.19 3.B.1.1 - Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2019		Country	1990	2019
Austria	6.2	9.3	|	Ireland	5.4	6.4
Belgium	5.2	7.7	|	Iceland	17.6	16.1

Country	1990	2019		Country	1990	2019
Bulgaria	11.4	16.9	|	Italy	14.7	13.5
Cyprus	7.0	7.2	|	Lithuania	4.2	9.5
Czech Republic	10.0	6.0	|	Luxembourg	7.1	10.8
Germany	9.4	11.6	|	Latvia	3.1	7.2
Denmark	15.8	27.2	|	Malta	8.3	8.2
Spain	12.9	8.0	|	Netherlands	13.1	21.0
Estonia	2.6	14.8	|	Poland	3.8	4.1
Finland	6.8	13.8	|	Portugal	5.8	5.3
France	3.9	4.6	|	Romania	4.9	5.0
United Kingdom	10.5	13.7	|	Slovakia	3.3	3.9
Greece	5.5	5.5	|	Slovenia	12.3	15.8
Croatia	10.9	18.8	|	Sweden	3.6	5.0
Hungary	14.0	15.6	|	EU-KP	7.9	9.3

3.B.1.1.1 - Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.1.1 - Dairy Cattle* increased in EU-KP very strongly between 1990 and 2019 by 54.7% or 7.3 kg/head/year. Figure 5.27 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.20 shows the implied emission factor for CH_4 emissions in source category *3.B.1.1.1 - Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in three countries and increased in 26 countries. Decreases occurred in the Czech Republic, Cyprus and Italy with a mean absolute value of 0.5 kg/head/year. The four countries with the largest increases were Estonia, Croatia, Denmark and Finland with a mean absolute value of 23 kg/head/year.

Figure 5.27: 3.B.1.1.1 - Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

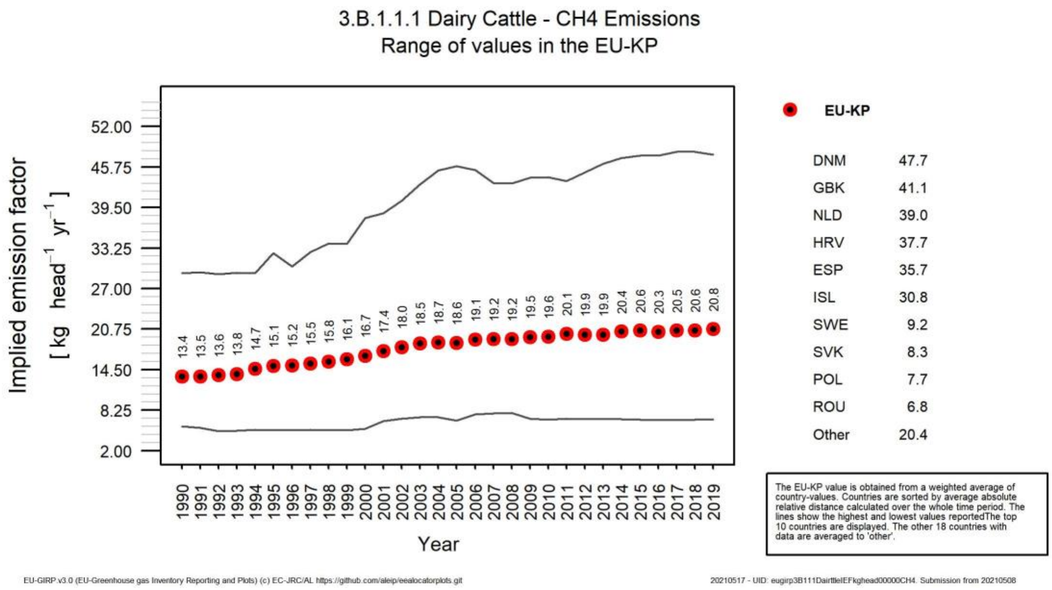


Table 5.20 *3.B.1.1.1 - Dairy Cattle: countries' implied emission factor (kg/head/year)*

Country	1990	2019		Country	1990	2019
Austria	10.8	17.2	|	Ireland	11.2	11.3
Belgium	11.2	26.1	|	Iceland	29.4	30.8
Bulgaria	16.5	22.4	|	Italy	22.6	22.5
Cyprus	10.6	10.3	|	Lithuania	6.0	13.4
Czech Republic	14.1	13.0	|	Luxembourg	12.4	26.0
Germany	13.8	20.6	|	Latvia	6.4	17.9
Denmark	27.2	47.7	|	Malta	15.3	16.0
Spain	28.8	35.7	|	Netherlands	23.1	39.0
Estonia	4.7	33.7	|	Poland	5.8	7.7
Finland	12.4	30.3	|	Portugal	14.6	26.0
France	7.2	10.5	|	Romania	6.5	6.8
United Kingdom	23.4	41.1	|	Slovakia	6.2	8.3
Greece	10.4	14.3	|	Slovenia	19.6	31.7
Croatia	13.9	37.7	|	Sweden	6.6	9.2
Hungary	24.6	30.0	|	EU-KP	13.4	20.8

3.B.1.1.1 - Dairy Cattle - Typical animal mass

The typical animal mass, a parameter used for calculating CH_4 emissions in source category *3.B.1.1.1 - Dairy Cattle*, increased in EU-KP moderately between 1990 and 2019 by 5.1% or 30 kg. Figure 5.28 shows the trend of the typical animal mass in EU-KP indicating also the range of values used by the countries. Table 5.21 shows the typical animal mass in source category *3.B.1.1.1 - Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. Typical animal mass decreased in three countries and increased in sixteen countries. It was in 2019 at the level of 1990 in ten countries. No data were available for EU-KP. Decreases occurred in Austria, France and France with a mean absolute value of 14 kg. The largest increase occurred in Finland with an absolute value of 161 kg.

Figure 5.28: 3.B.1.1.1 - Dairy Cattle: Trend in typical animal mass in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

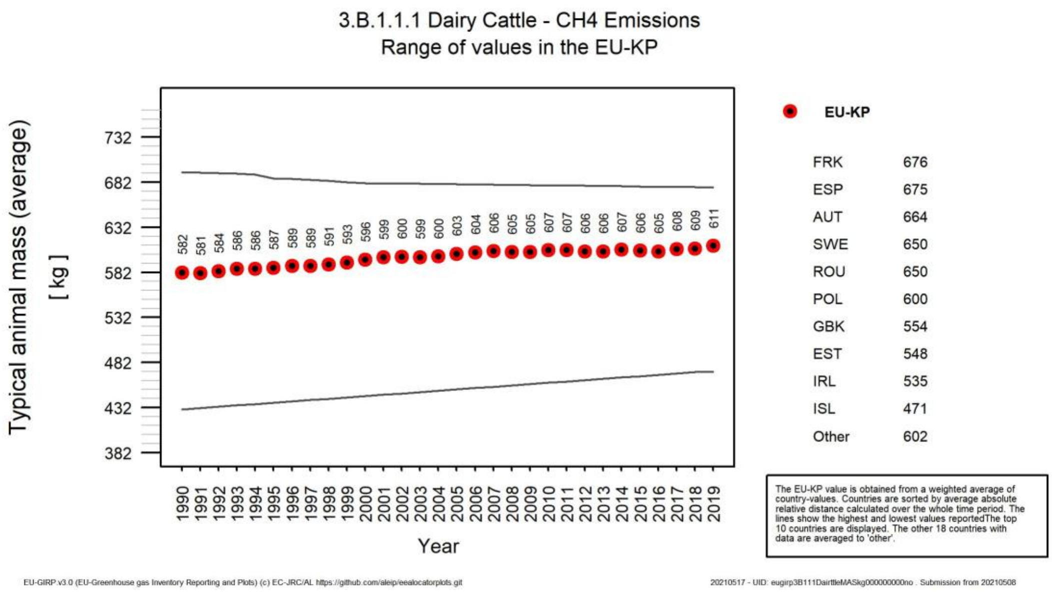


Table 5.21 3.B.1.1.1 - Dairy Cattle: countries' typical animal mass (kg)

Country	1990	2019		Country	1990	2019
Austria	693	664	|	Ireland	535	535
Belgium	623	619	|	Iceland	430	471
Bulgaria	588	588	|	Italy	603	603
Cyprus	550	550	|	Lithuania	575	629
Czech Republic	520	650	|	Luxembourg	650	650
Germany	567	596	|	Latvia	550	570
Denmark	550	580	|	Malta	550	550
Spain	652	675	|	Netherlands	555	589
Estonia	545	548	|	Poland	500	600
Finland	520	681	|	Portugal	600	600
France	685	676	|	Romania	650	650
United Kingdom	466	554	|	Slovakia	589	599
Greece	600	600	|	Slovenia	510	624
Croatia	550	563	|	Sweden	650	650
Hungary	633	643	|	EU-KP	582	611

3.B.1.1.1 - Dairy Cattle - VS daily excretion

The VS daily excretion, a parameter used for calculating CH_4 emissions in source category *3.B.1.1.1 - Dairy Cattle*, increased in EU-KP considerably between 1990 and 2019 by 17.7% or 0.73 kg dm/head/day. Figure 5.29 shows the trend of the VS daily excretion in EU-KP indicating also the range of values used by the countries. Table 5.22 shows the VS daily excretion in source category *3.B.1.1.1 - Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. VS daily excretion decreased in one country and increased in 26 countries. It was in 2019 at the level of 1990 in two countries. A decrease occurred in Italy with an absolute value of 1 kg dm/head/day. The four countries with the largest increases were the Czech Republic, Estonia, Finland and the United Kingdom with a mean absolute value of 2 kg dm/head/day.

Figure 5.29: 3.B.1.1.1 - Dairy Cattle: Trend in VS daily excretion in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

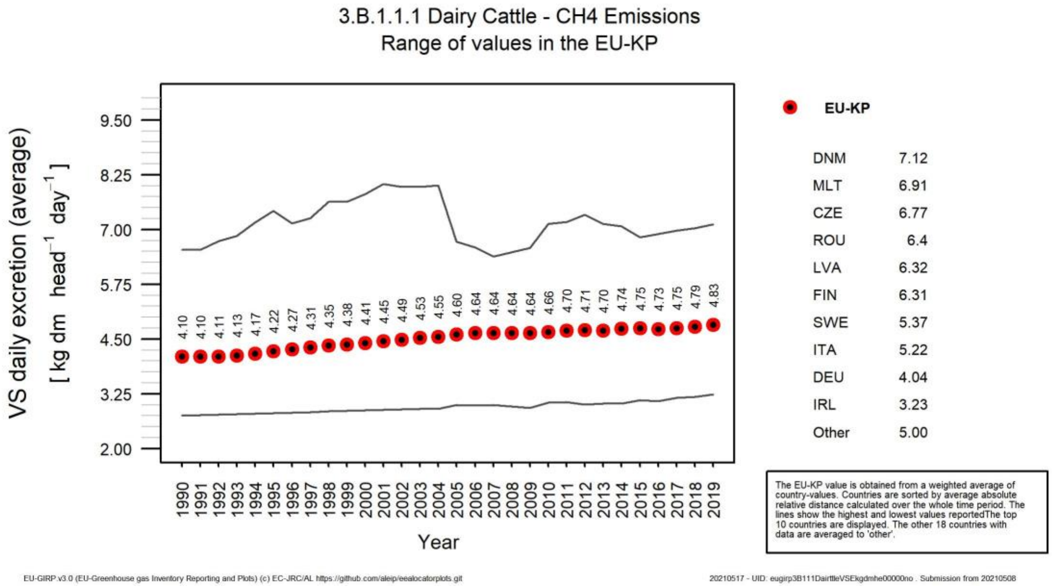


Table 5.22 3.B.1.1.1 - Dairy Cattle: countries' VS daily excretion (kg dm/head/day)

Country	1990	2019	Country	1990	2019
Austria	4.5	5.0	Ireland	2.8	3.2
Belgium	3.2	4.6	Iceland	3.8	4.2
Bulgaria	4.0	4.2	Italy	6.4	5.2
Cyprus	4.5	4.5	Lithuania	4.5	6.0
Czech Republic	4.2	6.8	Luxembourg	4.5	6.0
Germany	2.9	4.0	Latvia	4.7	6.3
Denmark	5.7	7.1	Malta	6.5	6.9
Spain	3.9	5.2	Netherlands	3.8	4.9
Estonia	4.4	6.8	Poland	4.5	4.8
Finland	4.4	6.3	Portugal	3.5	4.9
France	3.5	4.2	Romania	5.1	6.4
United Kingdom	4.0	5.7	Slovakia	3.6	4.5
Greece	3.7	5.1	Slovenia	4.5	5.3
Croatia	5.1	5.1	Sweden	5.1	5.4
Hungary	4.4	5.3	EU-KP	4.1	4.8

3.B.1.1.2 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.1.2 - Non-Dairy Cattle* increased in EU-KP slightly between 1990 and 2019 by 2.3% or 0.11 kg/head/year. Figure 5.30 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.23 shows the implied emission factor for CH_4 emissions in source category *3.B.1.1.2 - Non-Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in eleven countries and increased in eighteen countries. The largest decreases occurred in the Czech Republic and Spain with a mean absolute value of 3 kg/head/year. The four countries with the largest increases were Denmark, Bulgaria, Estonia and Lithuania with a mean absolute value of 4 kg/head/year.

Figure 5.30: 3.B.1.1.2 - Non-Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

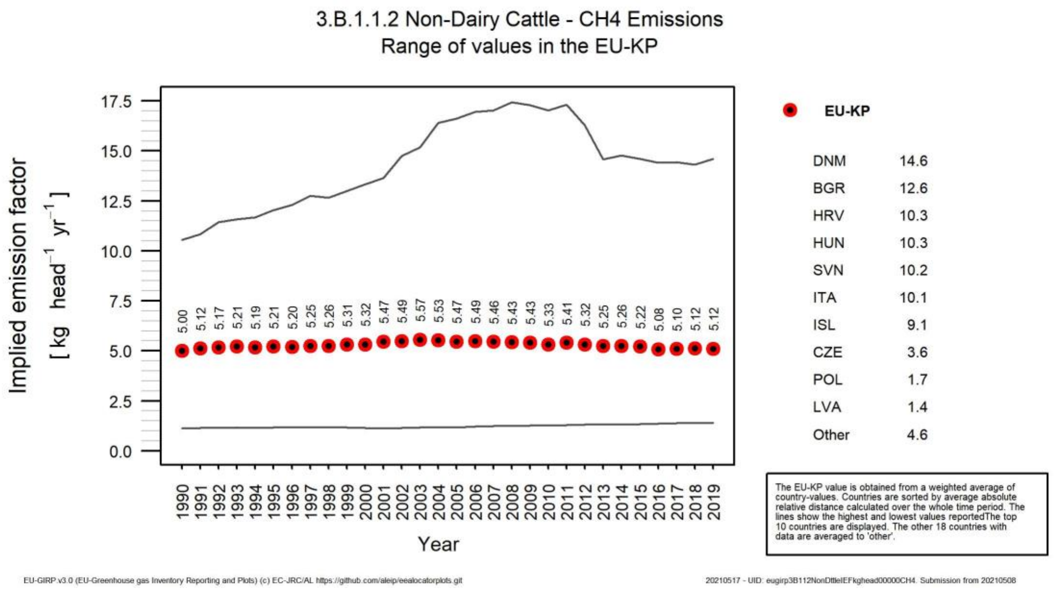


Table 5.23 3.B.1.1.2 - Non-Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2019		Country	1990	2019
Austria	3.7	6.2	|	Ireland	4.0	5.1
Belgium	3.1	2.8	|	Iceland	9.0	9.1
Bulgaria	8.2	12.6	|	Italy	10.6	10.1
Cyprus	4.5	4.4	|	Lithuania	3.3	7.1
Czech Republic	7.9	3.6	|	Luxembourg	5.2	5.6
Germany	7.3	6.9	|	Latvia	1.1	1.4
Denmark	10.1	14.6	|	Malta	2.7	2.1
Spain	5.8	4.1	|	Netherlands	6.9	7.9
Estonia	1.4	5.3	|	Poland	2.0	1.7
Finland	3.7	6.5	|	Portugal	2.2	1.9
France	2.8	3.2	|	Romania	2.9	2.5
United Kingdom	6.5	7.0	|	Slovakia	2.2	2.1
Greece	3.3	3.7	|	Slovenia	6.9	10.2
Croatia	7.0	10.3	|	Sweden	2.1	3.8
Hungary	8.3	10.3	|	EU-KP	5.0	5.1

3.B.1.1.2 - Non-Dairy Cattle - Typical animal mass

The typical animal mass, a parameter used for calculating CH_4 emissions in source category *3.B.1.1.2 - Non-Dairy Cattle*, increased in EU-KP clearly between 1990 and 2019 by 11.3% or 41 kg. Figure 5.31 shows the trend of the typical animal mass in EU-KP indicating also the range of values used by the countries. Table 5.24 shows the typical animal mass in source category *3.B.1.1.2 - Non-Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. Typical animal mass decreased in five countries and increased in 23 countries. No data were available for Sweden and EU-KP. The three countries with the largest decreases were Cyprus, the Netherlands and Malta with a mean absolute value of 28 kg.

The four countries with the largest increases were Finland, Bulgaria, Poland and the Czech Republic with a mean absolute value of 115 kg.

Figure 5.31: 3.B.1.1.2 - Non-Dairy Cattle: Trend in typical animal mass in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

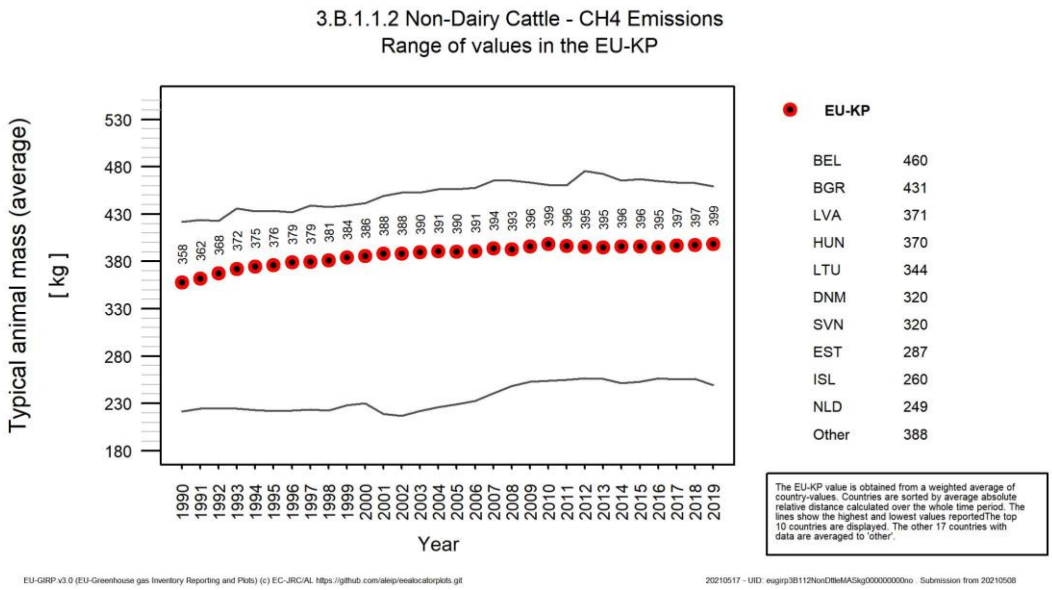


Table 5.24 3.B.1.1.2 - Non-Dairy Cattle: countries' typical animal mass (kg)

Country	1990	2019		Country	1990	2019
Austria	364	413	|	Hungary	327	370
Belgium	422	460	|	Iceland	241	260
Bulgaria	298	431	|	Italy	376	387
Cyprus	359	319	|	Lithuania	327	344
Czech Republic	326	418	|	Luxembourg	422	440
Germany	318	346	|	Latvia	298	371
Denmark	290	320	|	Malta	374	352
Spain	413	419	|	Netherlands	272	249
Estonia	222	287	|	Poland	316	411
Finland	278	418	|	Portugal	399	444
France	431	442	|	Romania	338	345
United Kingdom	369	422	|	Slovakia	330	357
Greece	375	427	|	Slovenia	289	320
Croatia	330	327	|	EU-KP	358	399
Ireland	362	352				

3.B.1.1.2 - Non-Dairy Cattle - VS daily excretion

The VS daily excretion, a parameter used for calculating CH_4 emissions in source category *3.B.1.1.2 - Non-Dairy Cattle*, increased in EU-KP slightly between 1990 and 2019 by 2% or 0.039 kg dm/head/day. Figure 5.32 shows the trend of the VS daily excretion in EU-KP indicating also the range of values used by the countries. Table 5.25 shows the VS daily excretion in source category *3.B.1.1.2 - Non-Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. VS daily excretion decreased in eight countries and increased in twenty countries. It was in 2019 at the level of 1990 in one country. The three countries with the largest decreases were Portugal, Italy and Malta with a mean absolute value of 0.4 kg dm/head/day. The four countries with the largest increases were Denmark, Finland, the Czech Republic and Latvia with a mean absolute value of 1 kg dm/head/day.

Figure 5.32: 3.B.1.1.2 - Non-Dairy Cattle: Trend in VS daily excretion in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

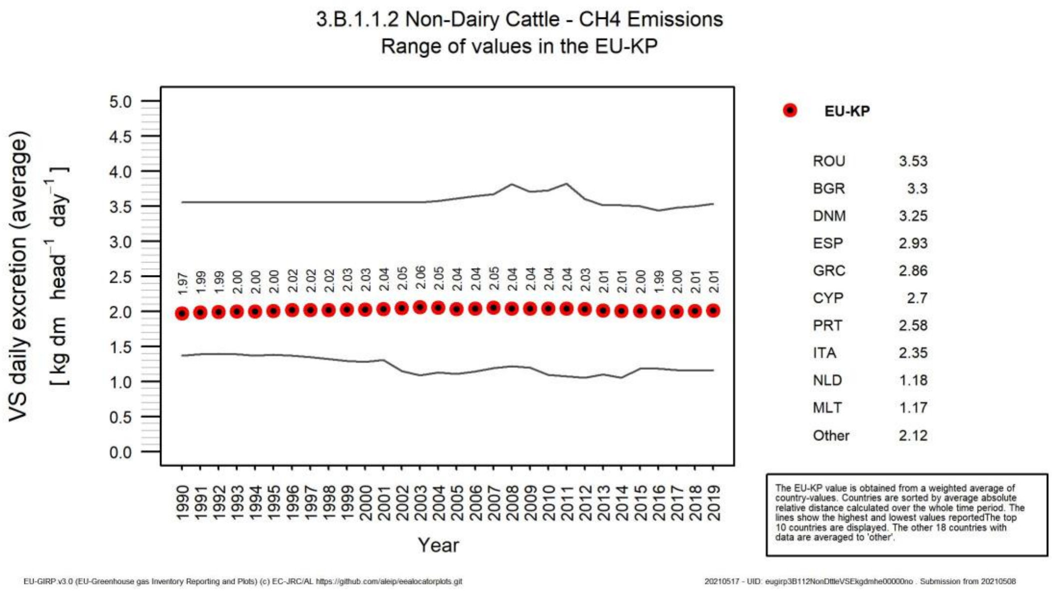


Table 5.25 3.B.1.1.2 - Non-Dairy Cattle: countries' VS daily excretion (kg dm/head/day)

Country	1990	2019		Country	1990	2019
Austria	1.8	2.1	|	Ireland	1.6	1.6
Belgium	1.5	1.5	|	Iceland	1.5	1.6
Bulgaria	2.8	3.3	|	Italy	2.8	2.3
Cyprus	2.7	2.7	|	Lithuania	2.4	2.6
Czech Republic	2.3	2.9	|	Luxembourg	2.2	2.3
Germany	1.3	1.4	|	Latvia	1.7	2.3
Denmark	2.4	3.3	|	Malta	1.5	1.2
Spain	3.2	2.9	|	Netherlands	1.4	1.2
Estonia	2.0	2.2	|	Poland	2.0	1.8
Finland	1.5	2.3	|	Portugal	3.2	2.6
France	1.9	1.9	|	Romania	3.6	3.5
United Kingdom	1.8	2.0	|	Slovakia	2.5	2.6
Greece	2.6	2.9	|	Slovenia	2.1	2.3
Croatia	2.7	2.7	|	Sweden	1.6	1.8
Hungary	2.5	2.6	|	EU-KP	2.0	2.0

3.B.1.3 - Swine - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.3 - Swine* decreased in EU-KP moderately between 1990 and 2019 by 6.8%. Figure 5.33 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.26 shows the implied emission factor for CH_4 emissions in source category *3.B.1.3 - Swine* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in eighteen countries and increased in ten countries. It was in 2019 at the level of 1990 in one country. The four countries with the largest increases were Croatia, Finland, Hungary and Sweden with a mean absolute value of 1 kg/head/year.

Figure 5.33: 3.B.1.3 - Swine: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

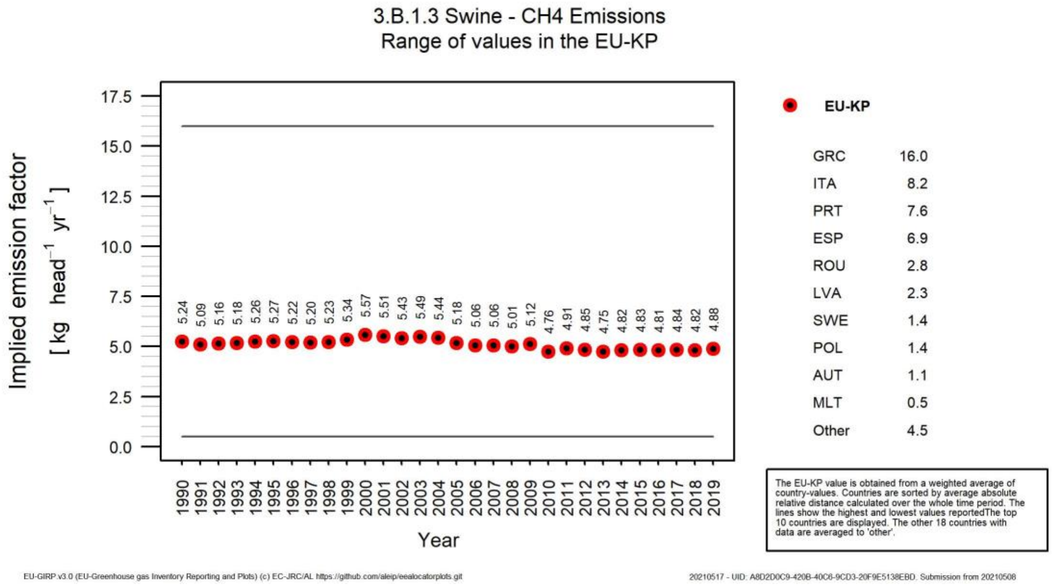


Table 5.26 3.B.1.3 - Swine: countries' implied emission factor (kg/head/year)

Country	1990	2019	Country	1990	2019
Austria	1.4	1.1	Ireland	6.8	6.6
Belgium	4.7	4.5	Iceland	6.0	6.0
Bulgaria	5.1	4.4	Italy	8.1	8.2
Cyprus	7.9	3.5	Lithuania	5.1	3.6
Czech Republic	6.4	6.3	Luxembourg	5.8	5.0
Germany	4.1	4.2	Latvia	1.9	2.3
Denmark	3.9	3.4	Malta	0.5	0.5
Spain	12.1	6.9	Netherlands	9.7	5.7
Estonia	4.5	5.1	Poland	1.9	1.4
Finland	2.0	3.4	Portugal	8.0	7.6
France	3.4	4.1	Romania	3.4	2.8
United Kingdom	4.7	4.1	Slovakia	4.6	3.0
Greece	16.0	16.0	Slovenia	8.7	3.7
Croatia	4.3	6.5	Sweden	1.0	1.4
Hungary	2.3	3.7	EU-KP	5.2	4.9

3.B.1.3 - Swine - Typical animal mass

The typical animal mass, a parameter used for calculating CH_4 emissions in source category *3.B.1.3 - Swine*, decreased in EU-KP slightly between 1990 and 2019 by 1.6%. Figure 5.34 shows the trend of the typical animal mass in EU-KP indicating also the range of values used by the countries. Table 5.27

shows the typical animal mass in source category *3.B.1.3 - Swine* for the years 1990 and 2019 for all countries and EU-KP. Typical animal mass decreased in twelve countries and increased in eight countries. It was in 2019 at the level of 1990 in one country. No data were available for eight countries (Austria, Cyprus, Finland, the United Kingdom, the Netherlands, Poland, Slovenia and Sweden). The three countries with the largest decreases were Luxembourg, Latvia and Belgium with a mean absolute value of 10 kg. The three countries with the largest increases were Denmark, Estonia and Italy with a mean absolute value of 6 kg.

Figure 5.34: 3.B.1.3 - Swine: Trend in typical animal mass in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

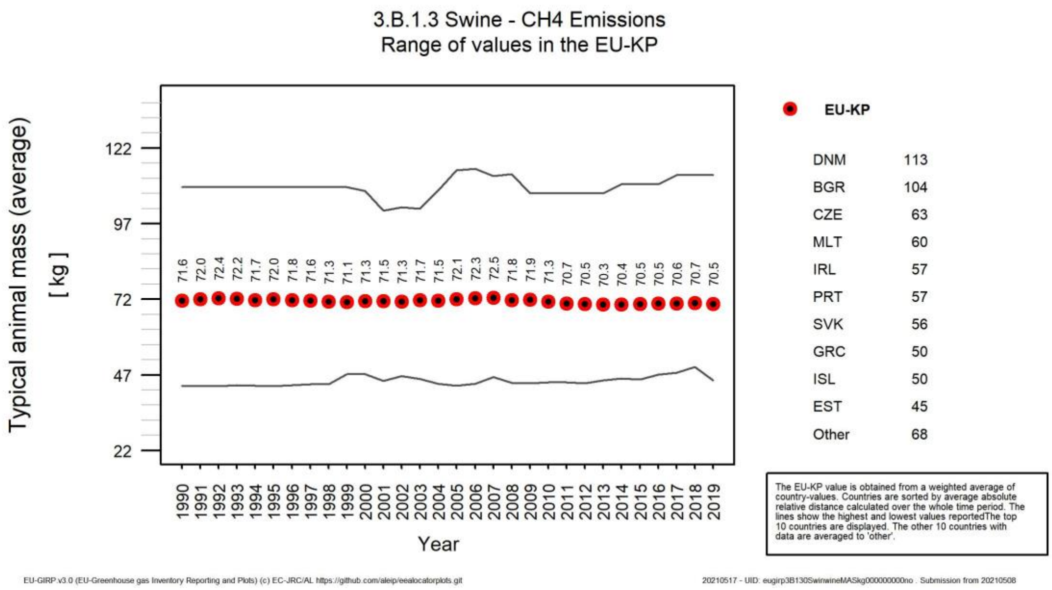


Table 5.27 3.B.1.3 - Swine: countries' typical animal mass (kg)

Country	1990	2019		Country	1990	2019
Belgium	69	63	|	Ireland	63	57
Bulgaria	109	104	|	Iceland	52	50
Czech Republic	62	63	|	Italy	79	81
Germany	67	63	|	Lithuania	65	62
Denmark	98	113	|	Luxembourg	87	72
Spain	64	62	|	Latvia	75	65
Estonia	43	45	|	Malta	59	60
France	65	65	|	Portugal	62	57
Greece	50	50	|	Romania	82	79
Croatia	72	72	|	Slovakia	61	56
Hungary	63	64	|	EU-KP	72	70

3.B.1.3 - Swine - VS daily excretion

The VS daily excretion, a parameter used for calculating CH_4 emissions in source category *3.B.1.3 - Swine*, decreased in EU-KP moderately between 1990 and 2019 by 6.7%. Figure 5.35 shows the trend of the VS daily excretion in EU-KP indicating also the range of values used by the countries. Table 5.28 shows the VS daily excretion in source category *3.B.1.3 - Swine* for the years 1990 and 2019 for all countries and EU-KP. VS daily excretion decreased in eighteen countries and increased in six countries.

It was in 2019 at the level of 1990 in two countries. No data were available for three countries (Iceland, the Czech Republic and Greece). The three countries with the largest decreases were Slovakia, the Netherlands and Denmark with a mean absolute value of 0.1 kg dm/head/day. The three countries with the largest increases were Germany, Sweden and Estonia with a mean absolute value of 0.03 kg dm/head/day.

Figure 5.35: 3.B.1.3 - Swine: Trend in VS daily excretion in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

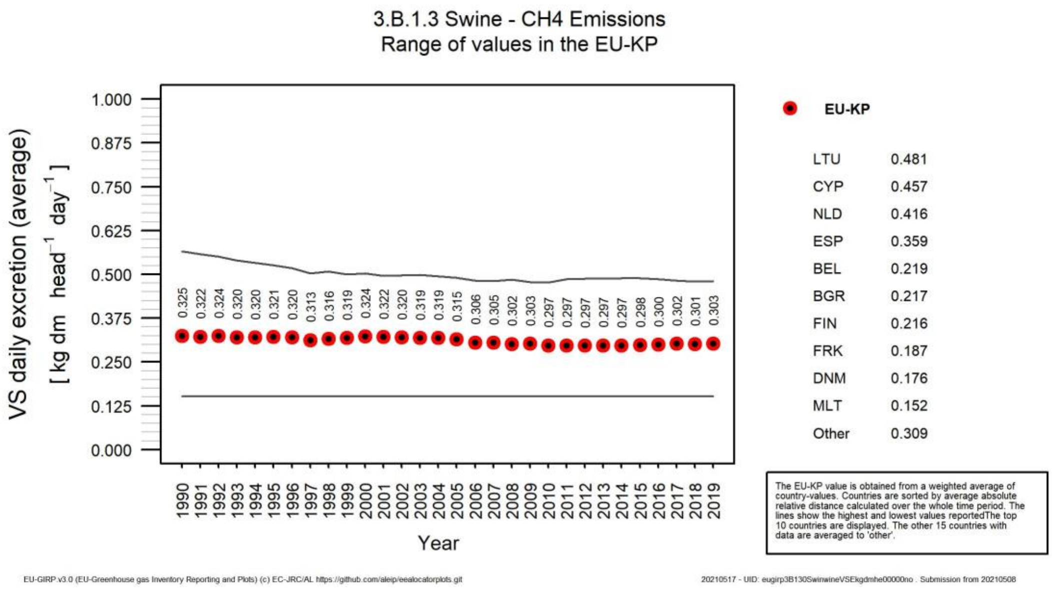


Table 5.28 3.B.1.3 - Swine: countries' VS daily excretion (kg DM/head/day)

Country	1990	2019		Country	1990	2019
Austria	0.30	0.30	|	Ireland	0.36	0.35
Belgium	0.23	0.22	|	Italy	0.37	0.33
Bulgaria	0.25	0.22	|	Lithuania	0.50	0.48
Cyprus	0.45	0.46	|	Luxembourg	0.32	0.31
Germany	0.26	0.31	|	Latvia	0.40	0.35
Denmark	0.24	0.18	|	Malta	0.15	0.15
Spain	0.44	0.36	|	Netherlands	0.57	0.42
Estonia	0.26	0.28	|	Poland	0.32	0.31
Finland	0.22	0.22	|	Portugal	0.28	0.26
France	0.17	0.19	|	Romania	0.29	0.28
United Kingdom	0.32	0.32	|	Slovakia	0.45	0.29
Croatia	0.32	0.32	|	Slovenia	0.32	0.31
Hungary	0.30	0.30	|	Sweden	0.29	0.31
			|	EU-KP	0.32	0.30

5.3.3 Manure Management - N_2O (CRF Source Category 3B2)

In 2019 N_2O emissions in source category *3.B.2 - Manure Management* in EU-KP were 21887.2 kt CO_2 equivalent. This corresponds to 0.48% of total EU-KP GHG emissions and 8.5% of total EU-KP N_2O emissions. They make 5.1% of total agricultural emissions and 12% of total agricultural N_2O emissions. The main sub-categories are 3.B.2.5 (Indirect Emissions), 3.B.2.1.2 (Non-Dairy Cattle) and 3.B.2.1.1

(Dairy Cattle) as shown in Figure 5.36, but substantial emissions are also reported for Swine, and Poultry.

Regarding the origin of emissions in the different countries, Figure 5.37 shows the distribution of N_2O emissions from manure management by livestock category in all countries and in the EU-KP. Each bar represents the total emissions of a country in the current emission category, where different shades of blue correspond to the emitting animal types.

Regarding the handling of manure in the different countries, Figure 5.38 shows the distribution of total manure nitrogen by manure system in all countries and in the EU-KP. Each bar represents the total manure nitrogen handled in the current system for the country, where different shades correspond to the emitting manure systems.

Figure 5.36: Share of source category 3.B.2 on total EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2019.3.B.2.1-3.B.3.4: emissions by animal types (cattle, sheep, swine, other livestock); 3.B.2.5:Indirect emissions from manure management.

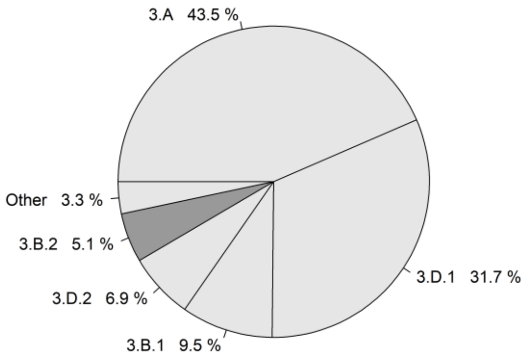


Figure 5.37: Decomposition of emissions in source category 3.B.2 - Manure Management into its sub-categories by country in the year 2019.

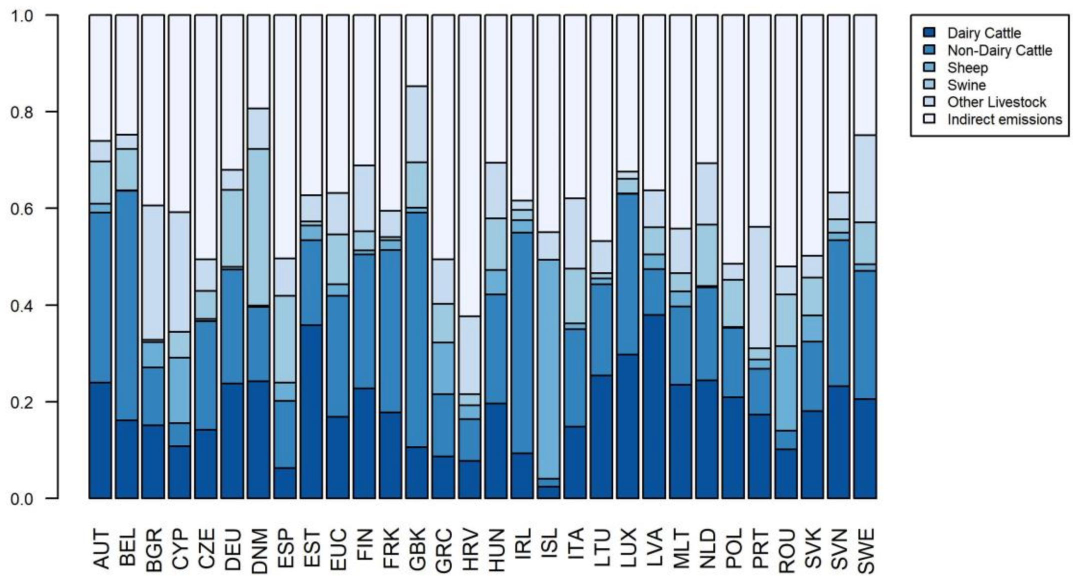
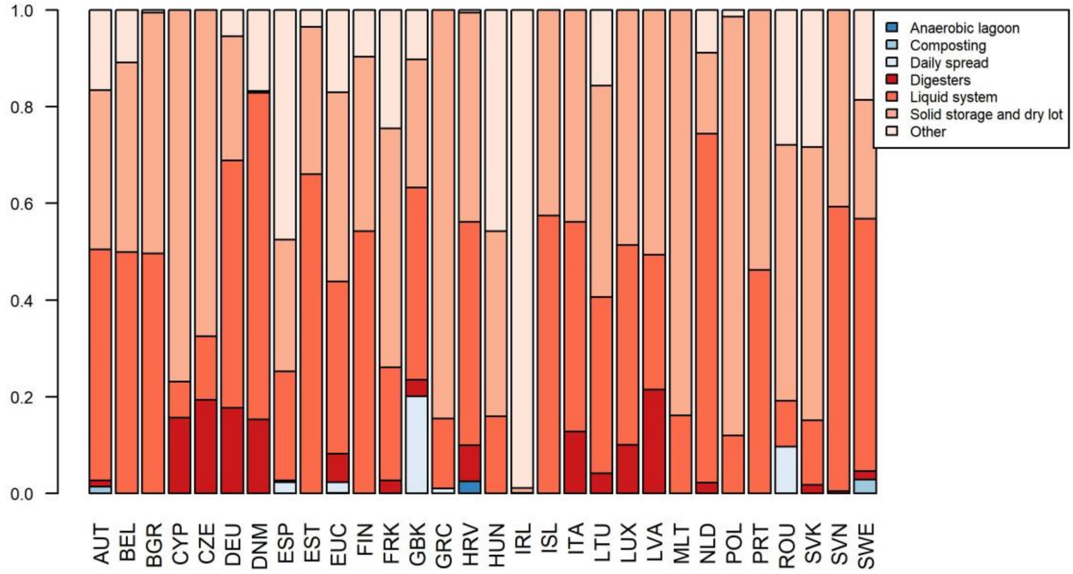


Figure 5.38: Decomposition of manure nitrogen handled in source category 3.B.2 - Manure Management into the different manure management systems by country in the year 2019.



Total GHG and N_2O emissions by country from 3.B.2 *Manure Management* are shown in Table 5.29 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2019). Values are given in kt CO_2-eq. Between 1990 and 2019, N_2O emission in this source category decreased by 27% or 8.3 Mt CO_2-eq. The decrease was largest in Latvia in relative terms (72%) and in Poland in absolute terms (1.3 Mt CO_2-eq). From 2018 to 2019 emissions in the current category decreased by 1.7%.

Table 5.29 3.B.2 - Manure Management: Countries' contributions to total EU-GHG and N_2O emissions

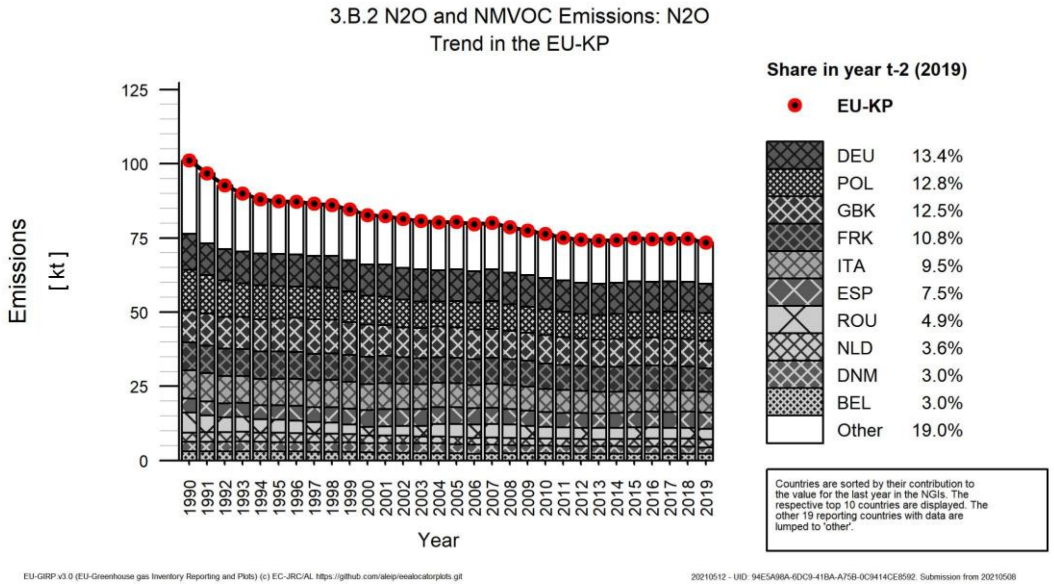
Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	436	441	436	2.0%	0	0%	-5	-1%	T2	CS
Belgium	911	667	654	3.0%	-257	-28%	-13	-2%	T2	D
Bulgaria	914	297	293	1.3%	-621	-68%	-4	-1%	T1,T2	D
Croatia	329	146	147	0.7%	-182	-55%	1	1%	T2	CS,D
Cyprus	66	68	70	0.3%	3	5%	1	2%	T1	D
Czechia	1,397	547	444	2.0%	-953	-68%	-103	-19%	T2	CS,D
Denmark	966	714	660	3.0%	-306	-32%	-54	-8%	NA	NA
Estonia	151	66	66	0.3%	-85	-56%	0	0%	T1,T2	CS,D
Finland	283	277	276	1.3%	-7	-2%	-1	0%	T2	D
France	2,819	2,418	2,361	10.8%	-458	-16%	-57	-2%	T2	CS,D
Germany	3,623	2,976	2,937	13.4%	-686	-19%	-39	-1%	T2	CS,D
Greece	324	286	287	1.3%	-37	-11%	1	0%	D	D
Hungary	854	456	463	2.1%	-391	-46%	7	1%	T1,T2	CS,D
Ireland	489	642	597	2.7%	108	22%	-45	-7%	T2	CS,D
Italy	2,817	2,117	2,082	9.5%	-734	-26%	-35	-2%	T2	CS,D
Latvia	282	78	78	0.4%	-204	-72%	0	1%	T1,T2	D
Lithuania	581	190	183	0.8%	-398	-69%	-8	-4%	T1,T2	D
Luxembourg	31	28	27	0.1%	-3	-11%	-1	-2%	T2	CS
Malta	18	12	12	0.1%	-5	-30%	0	-1%	T1,T2	CS,D
Netherlands	940	815	786	3.6%	-154	-16%	-29	-4%	T1	D
Poland	4,075	2,790	2,799	12.8%	-1,277	-31%	9	0%	T1,T2	CS,D
Portugal	269	186	186	0.9%	-83	-31%	1	0%	T2	CS,D
Romania	1,982	1,078	1,079	4.9%	-904	-46%	1	0%	T2	D
Slovakia	458	168	163	0.7%	-295	-64%	-5	-3%	T1,T2	CS
Slovenia	92	81	81	0.4%	-11	-12%	0	0%	T1,T2	CS,D
Spain	1,433	1,643	1,642	7.5%	209	15%	-1	0%	T1,T2	D
Sweden	369	333	333	1.5%	-36	-10%	0	0%	CS,T2	CS,D
United Kingdom	3,216	2,735	2,728	12.5%	-488	-15%	-7	0%	T2	CS,D
EU-27+UK	**30,126**	**22,257**	**21,871**	**100%**	**-8,255**	**-27%**	**-386**	**-2%**	**-**	**-**
Iceland	23	19	18	0.1%	-4	-19%	0	-3%	T1,T2	CS,D
United Kingdom (KP)	3,216	2,735	2,728	12.5%	-488	-15%	-7	0%	T2	CS,D
EU-KP	**30,148**	**22,276**	**21,889**	**100%**	**-8,259**	**-27%**	**-386**	**-2%**	**-**	**-**

Trends in Emissions and Activity Data

3.B.2 - Manure Management - Emissions

Emissions in source category *3.B.2 - Manure Management* decreased strongly in EU-KP by 27% or 8.3 Mt CO_2-eq in the period 1990 to 2019. Figure 5.39 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 81% of the total in 2019.Emissions decreased in 25 countries and increased in four countries. The three countries with the largest decreases were Poland, the Czech Republic and Romania with a total absolute decrease of 3.1 Mt CO_2-eq. The largest increases occurred in Ireland and Spain, with a total absolute increase of 317 kt CO_2-eq.

Figure 5.39: 3.B.2 Manure Management: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



3.B.2.1 - Cattle - Emissions

In 2019 N_2O emissions in source category *3.B.2.1 - Cattle* in EU-KP were 9173.5 kt CO_2 equivalent. This corresponds to 0.2% of total EU-KP GHG emissions and 3.6% of total EU-KP N_2O emissions. They make 2.1% of total agricultural emissions and 4.9% of total agricultural N_2O emissions.. Figure 5.40 and Figure 5.41 show the trend of emissions indicating the countries contributing most to the EU-KP total. The figures represent the trend in N_2O emissions from manure management for the different countries along the inventory period.

Total GHG and N_2O emissions by country from 3.B.2.1 *Manure Management* are shown in Table 5.30 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2019). Values are given in kt CO_2-eq. Between 1990 and 2019, N_2O emission in this source category decreased by 27% or 3.3 Mt CO_2-eq. The decrease was largest in Croatia in relative terms (76%) and in Germany in absolute terms (557 kt CO_2-eq). The four countries with the largest decreases were Germany, Italy, Poland and the Czech Republic with a total absolute decrease of 1.8 Mt CO_2-eq. The three countries with the largest increases were Finland, Spain and Ireland, with a total absolute increase of 97 kt CO_2-eq. From 2018 to 2019 emissions in the current category decreased by 1.8%. The ten countries with the highest emissions accounted together for 83% of the total in 2019.Emissions decreased in 22 countries and increased in seven countries.

Table 5.30 3.B.2.1 - Cattle: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	258	262	258	2.8%	0	0%	-4	-1%	T2	CS
Belgium	621	425	416	4.5%	-205	-33%	-9	-2%	T2	D
Bulgaria	213	82	79	0.9%	-133	-63%	-3	-4%	T2	D
Croatia	99	25	24	0.3%	-75	-76%	-1	-3%	T2	CS,D
Cyprus	8	10	11	0.1%	2	30%	1	6%	T1	D
Czechia	516	202	162	1.8%	-353	-69%	-40	-20%	T2	CS
Denmark	322	275	262	2.9%	-61	-19%	-13	-5%	0	0
Estonia	71	35	35	0.4%	-36	-50%	0	1%	T2	CS,D
Finland	127	139	139	1.5%	12	9%	0	0%	T2	D
France	1,429	1,249	1,214	13.2%	-215	-15%	-35	-3%	T2	CS,D
Germany	1,947	1,403	1,391	15.2%	-557	-29%	-12	-1%	T2	CS,D
Greece	79	62	62	0.7%	-17	-22%	0	0%	D	D
Hungary	281	187	195	2.1%	-85	-30%	9	5%	T2	CS
Ireland	258	360	328	3.6%	71	27%	-32	-9%	T2	CS,D
Italy	1,201	740	728	7.9%	-473	-39%	-13	-2%	T2	CS,D
Latvia	121	36	37	0.4%	-84	-69%	1	3%	T2	D
Lithuania	206	82	81	0.9%	-125	-61%	-1	-1%	T2	D
Luxembourg	20	17	17	0.2%	-3	-16%	0	-1%	T2	CS
Malta	8	5	5	0.1%	-3	-35%	0	0%	T1,T2	CS,D
Netherlands	342	361	343	3.7%	1	0%	-18	-5%	NA	NA
Poland	1,412	964	987	10.8%	-424	-30%	23	2%	T2	CS
Portugal	78	50	50	0.5%	-28	-36%	0	1%	T2	CS,D
Romania	330	154	152	1.7%	-178	-54%	-2	-2%	T2	D
Slovakia	152	53	53	0.6%	-100	-65%	0	0%	T2	CS
Slovenia	37	43	43	0.5%	7	18%	0	1%	T1,T2	CS,D
Spain	317	332	332	3.6%	15	5%	-1	0%	T2	D
Sweden	176	161	157	1.7%	-19	-11%	-4	-3%	CS,T2	CS,D
United Kingdom	1,894	1,625	1,613	17.6%	-280	-15%	-11	-1%	T2	CS,D
EU-27+UK	**12,523**	**9,339**	**9,174**	**100%**	**-3,348**	**-27%**	**-165**	**-2%**	**-**	**-**
Iceland	1	1	1	0.0%	0	2%	0	-1%	T2	CS,D
United Kingdom (KP)	1,894	1,625	1,613	17.6%	-280	-15%	-11	-1%	T2	CS,D
EU-KP	**12,523**	**9,340**	**9,175**	**100%**	**-3,348**	**-27%**	**-165**	**-2%**	**-**	**-**

Figure 5.40: 3.B.2.1 - Dairy cattle: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019

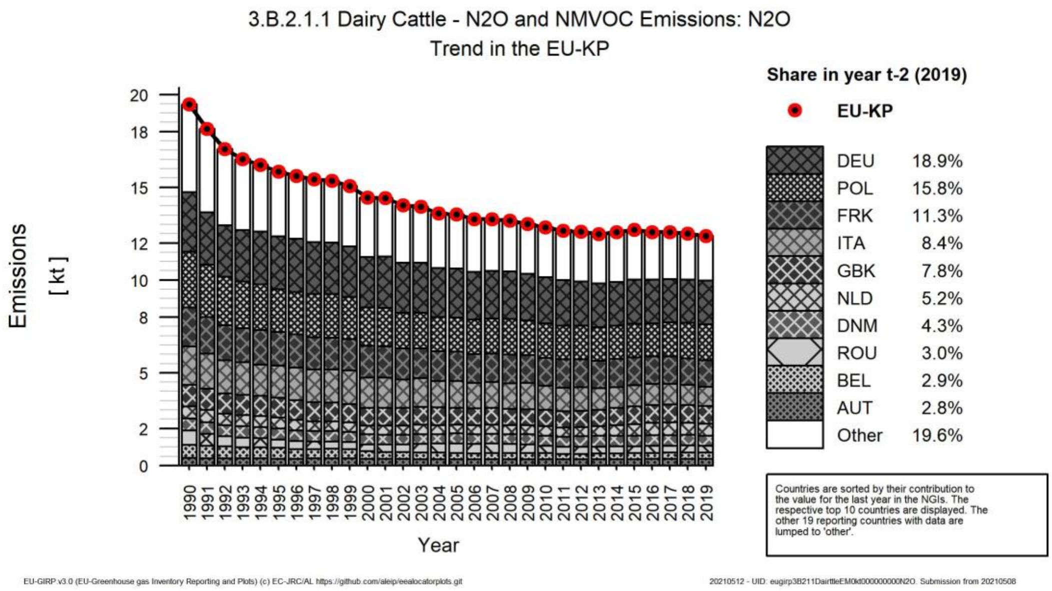
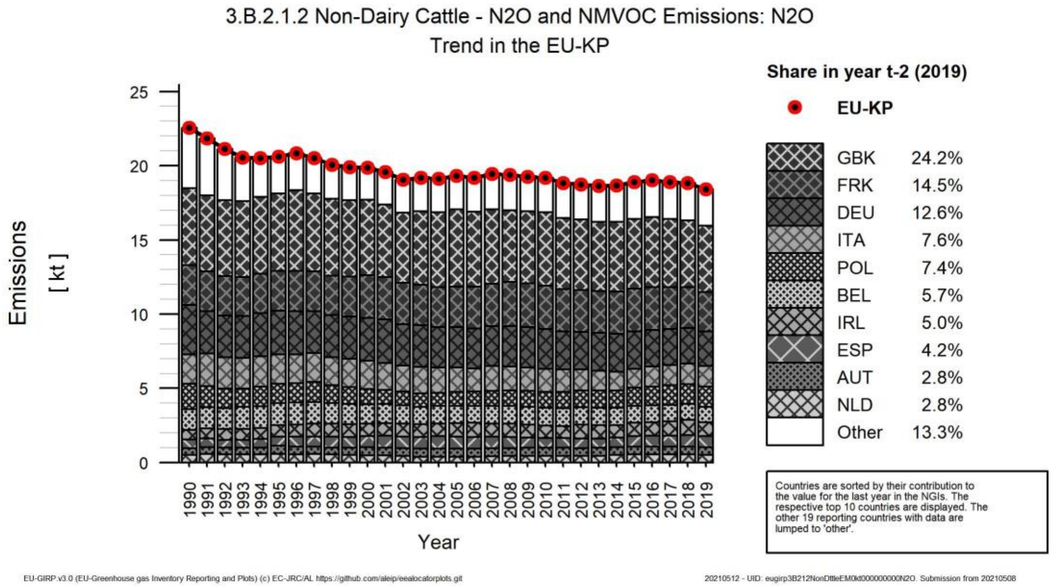


Figure 5.41: 3.B.2.1 - Non-dairy cattle: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



3.B.2.1 - Cattle - population

One of the main activity data for N_2O emissions from manure management - cattle is the animal numbers. Cattle numbers are already discussed under source category 3.A Enteric Fermentation and therefore not further discussed here.

Other activity data is:

- N-allocation by MMS.

3.B.2.3 - Swine - Emissions

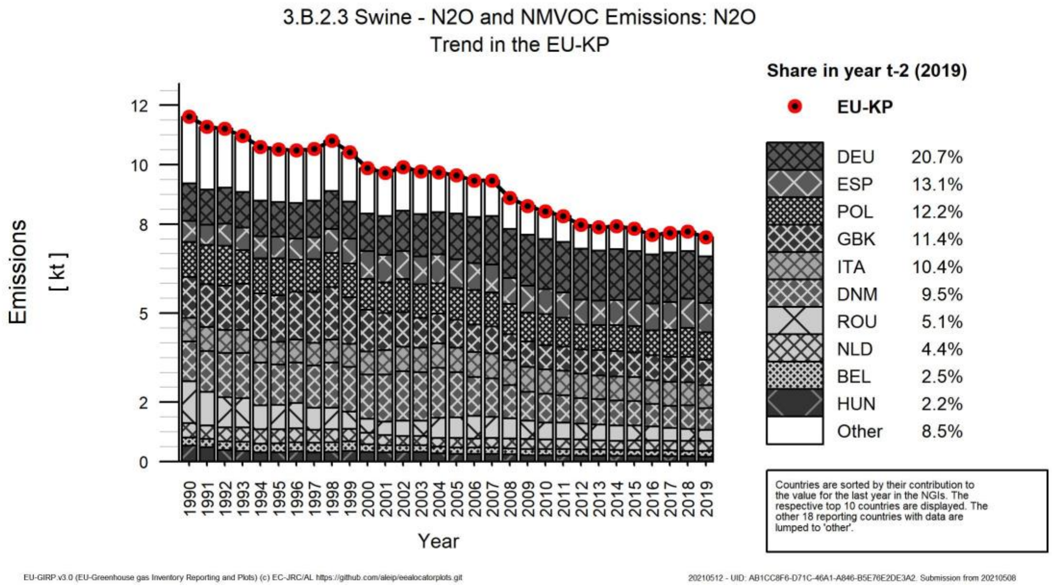
In 2019 N_2O emissions in source category *3.B.2.3 - Swine* in EU-KP were 2250.7 kt CO_2 equivalent. This corresponds to 0.05% of total EU-KP GHG emissions and 0.88% of total EU-KP N_2O emissions. They make 0.53% of total agricultural emissions and 1.2% of total agricultural N_2O emissions. Figure 5.43 shows the trend of emissions indicating the countries contributing most to the EU-KP total. The figure represents the trend in N_2O emissions from manure management for the different countries along the inventory period.

Total GHG and N_2O emissions by country from 3.B.2.3 *Manure Management* are shown in Table 5.31 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2019). Values are given in kt CO_2-eq. Between 1990 and 2019, N_2O emission in this source category decreased by 35% or 1.2 Mt CO_2-eq. The decrease was largest in Lithuania in relative terms (98%) and in Romania in absolute terms (307 kt CO_2-eq). From 2018 to 2019 emissions in the current category decreased by 2.5%. The ten countries with the highest emissions accounted together for 91.5% of the total in 2019.Emissions decreased in 24 countries and increased in four countries. The four countries with the largest decreases were Romania, Denmark, the United Kingdom and the Czech Republic with a total absolute decrease of 797 kt CO_2-eq. The largest increases occurred in Spain and Germany, with a total absolute increase of 172 kt CO_2-eq.

Table 5.31 3.B.2.3 - Swine: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	61	38	38	1.7%	-23	-38%	0	0%	T2	CS
Belgium	85	57	56	2.5%	-29	-34%	-1	-2%	T2	D
Bulgaria	10	1	1	0.1%	-9	-87%	0	-8%	T2	D
Croatia	24	3	3	0.1%	-20	-86%	0	-4%	T2	CS,D
Cyprus	8	4	4	0.2%	-4	-53%	0	-4%	T1	D
Czechia	174	33	26	1.1%	-149	-85%	-7	-23%	T2	CS
Denmark	398	236	213	9.5%	-185	-46%	-22	-9%	0	0
Estonia	2	1	1	0.0%	-2	-77%	0	-12%	T2	CS,D
Finland	26	11	11	0.5%	-15	-58%	0	3%	T2	D
France	46	16	16	0.7%	-30	-65%	0	-1%	T2	CS,D
Germany	376	478	467	20.7%	91	24%	-11	-2%	T2	CS,D
Greece	31	23	23	1.0%	-8	-27%	0	1%	D	D
Hungary	158	51	50	2.2%	-108	-69%	-2	-3%	T2	CS
Ireland	10	12	13	0.6%	2	25%	0	1%	T2	CS,D
Italy	236	234	234	10.4%	-2	-1%	0	0%	T2	CS,D
Latvia	40	5	4	0.2%	-36	-89%	0	-5%	T2	D
Lithuania	110	2	2	0.1%	-108	-98%	0	-9%	T1	D
Luxembourg	1	1	1	0.0%	0	16%	0	-9%	T2	CS
Malta	1	0	0	0.0%	-1	-64%	0	-3%	T1	D
Netherlands	140	101	100	4.4%	-40	-29%	-1	-1%	NA	NA
Poland	353	293	275	12.2%	-78	-22%	-18	-6%	T2	CS
Portugal	11	4	4	0.2%	-7	-61%	0	0%	T2	CS,D
Romania	422	119	115	5.1%	-307	-73%	-4	-3%	T2	D
Slovakia	64	13	13	0.6%	-51	-80%	-1	-5%	T2	CS
Slovenia	7	2	2	0.1%	-5	-69%	0	-7%	T1	D
Spain	213	290	294	13.1%	81	38%	4	1%	T2	D
Sweden	42	28	29	1.3%	-13	-32%	1	3%	CS,NA,T2	CS,D,NA
United Kingdom	413	251	257	11.4%	-156	-38%	5	2%	T2	CS,D
EU-27+UK	**3,463**	**2,309**	**2,251**	**100%**	**-1,212**	**-35%**	**-58**	**-3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	413	251	257	11.4%	-156	-38%	5	2%	T2	CS,D
EU-KP	**3,463**	**2,309**	**2,251**	**100%**	**-1,212**	**-35%**	**-58**	**-3%**	**-**	**-**

Figure 5.42: 3.B.2.3 - Swine: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



3.B.2.4 - Other Livestock - Emissions

In 2019 N_2O emissions in source category *3.B.2.4 - Other Livestock* in EU-KP were 1882.6 kt CO_2 equivalent. This corresponds to 0.042% of total EU-KP GHG emissions and 0.73% of total EU-KP N_2O emissions. They make 0.44% of total agricultural emissions and 1% of total agricultural N_2O emissions.

Total GHG and N_2O emissions by country from 3.B.2.4 *Manure Management* are shown in Table 5.32 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2019). Values are given in kt CO_2-eq. Between 1990 and 2019, N_2O emission in this source category decreased by 9% or 176 kt CO_2-eq. The decrease was largest in Estonia in relative terms (72%) and in Bulgaria in absolute terms (120 kt CO_2-eq). From 2018 to 2019 emissions in the current category decreased by 0.6%. Figure 5.44 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 80.1% of the total in 2019.Emissions decreased in thirteen countries and increased in sixteen countries. The four countries with the largest decreases were Bulgaria, Poland, the Czech Republic and Hungary with a total absolute decrease of 328 kt CO_2-eq. The four countries with the largest increases were Germany, the Netherlands, Spain and the United Kingdom, with a total absolute increase of 156 kt CO_2-eq.

Table 5.32 3.B.2.4 - Other Livestock: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	9	19	19	1.0%	9	98%	0	0%	T2	CS
Belgium	10	19	19	1.0%	9	90%	0	0%	T2	D
Bulgaria	202	80	82	4.3%	-120	-60%	2	3%	T1,T2	D
Croatia	33	22	24	1.3%	-9	-28%	1	6%	T2	CS,D
Cyprus	17	17	17	0.9%	0	0%	0	2%	T1	D
Czechia	100	29	29	1.5%	-71	-71%	-1	-2%	T2	CS,D
Denmark	45	65	55	2.9%	10	22%	-9	-14%	NA	NA
Estonia	13	4	4	0.2%	-9	-72%	-1	-13%	T1	D
Finland	29	38	38	2.0%	9	31%	0	0%	T2	D
France	123	128	127	6.7%	4	3%	-1	-1%	T2	CS,D
Germany	99	124	123	6.6%	25	25%	-1	-1%	T2	CS,D
Greece	30	26	27	1.4%	-3	-11%	0	0%	D	D
Hungary	103	54	53	2.8%	-50	-48%	0	-1%	T1,T2	CS,D
Ireland	11	12	12	0.6%	1	6%	0	-2%	T2	CS,D
Italy	292	307	303	16.1%	11	4%	-4	-1%	T2	CS,D
Latvia	20	6	6	0.3%	-14	-70%	0	1%	T1,T2	D
Lithuania	16	14	12	0.6%	-4	-26%	-2	-17%	T1	D
Luxembourg	0	0	0	0.0%	0	139%	0	-1%	T2	CS
Malta	1	1	1	0.1%	0	5%	0	-3%	T1,T2	CS,D
Netherlands	62	96	100	5.3%	39	63%	4	4%	T1	D
Poland	178	90	92	4.9%	-86	-48%	3	3%	T1,T2	CS,D
Portugal	60	47	47	2.5%	-13	-22%	0	0%	T2	CS,D
Romania	80	61	62	3.3%	-17	-22%	1	1%	T2	D
Slovakia	9	8	7	0.4%	-2	-18%	0	-6%	T1	CS
Slovenia	4	4	4	0.2%	0	12%	0	0%	T1	D
Spain	89	130	128	6.8%	39	44%	-2	-2%	T1,T2	D
Sweden	46	57	60	3.2%	14	32%	3	5%	T2	D
United Kingdom	377	434	430	22.8%	53	14%	-4	-1%	T2	CS,D
EU-27+UK	**2,057**	**1,893**	**1,882**	**100%**	**-176**	**-9%**	**-12**	**-1%**	**-**	**-**
Iceland	1	1	1	0.1%	0	-13%	0	2%	T1	D
United Kingdom (KP)	377	434	430	22.8%	53	14%	-4	-1%	T2	CS,D
EU-KP	**2,058**	**1,894**	**1,883**	**100%**	**-176**	**-9%**	**-12**	**-1%**	**-**	**-**

3.B.2.4.7 - Poultry - Emissions

Largest contribution to other livestock emissions comes from sub-category poultry with 55% of total N_2O emissions. Other animal types with high emissions are horses with a share of 23% and Goats with a share of 10%. Here only the most important animal type Poultry is discussed.

Emissions in source category *3.B.2.4.7 - Poultry* decreased considerably in EU-KP by 17% or 214 kt CO_2-eq in the period 1990 to 2019. Figure 5.45 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 84.9% of the total in 2019.Emissions decreased in nineteen countries and increased in ten countries. The largest decreases occurred in Bulgaria and the Czech Republic with a total absolute decrease of 184 kt CO_2-eq. The largest increases occurred in Sweden and Germany, with a total absolute increase of 45 kt CO_2-eq.

3.A.4.7 - Poultry - Population

As population data for poultry have not yet been discussed, this will be done here. Poultry population increased slightly in EU-KP by 5% or 80.9 million heads in the period 1990 to 2019. Figure 5.46 shows the trend of poultry population indicating the countries contributing most to EU-KP total. The figure represents the trend in poultry population for the different countries along the inventory period. The ten countries with the highest population accounted together for 84.5% of the total in 2019.Population decreased in thirteen countries and increased in sixteen countries. The three countries with the largest decreases were Romania, Hungary and Bulgaria with a total absolute decrease of 97 million heads. The three countries with the largest increases were France, the United Kingdom and Germany, with a total absolute increase of 140 million heads.

Other activity data related to this emission category are:

- Nitrogen managed on each manure management system

Figure 5.44: 3.B.2.4 - Other Livestock: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019

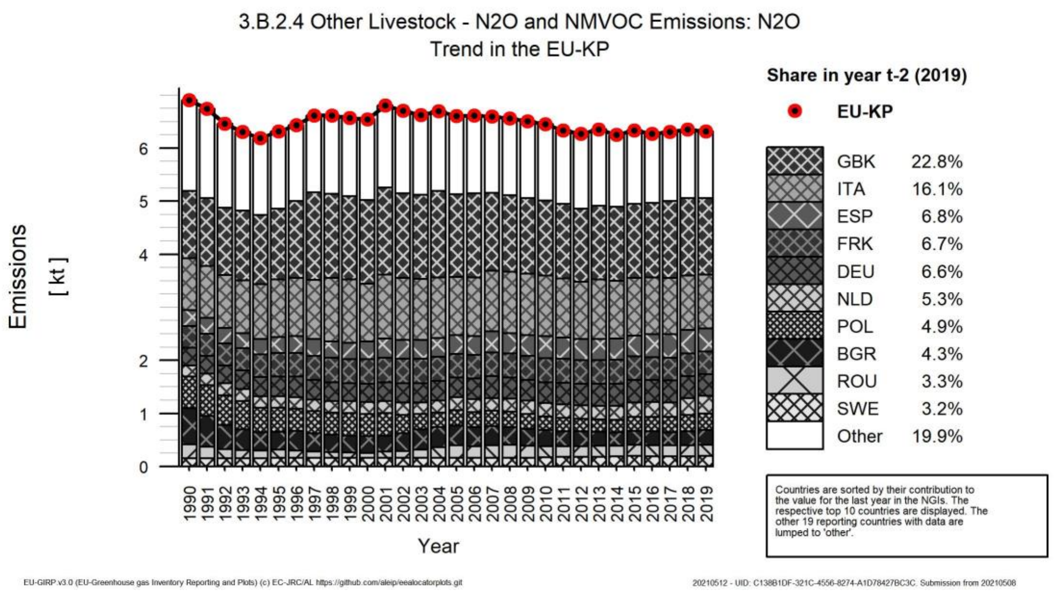


Figure 5.45: 3.B.2.4.7 - Poultry: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019

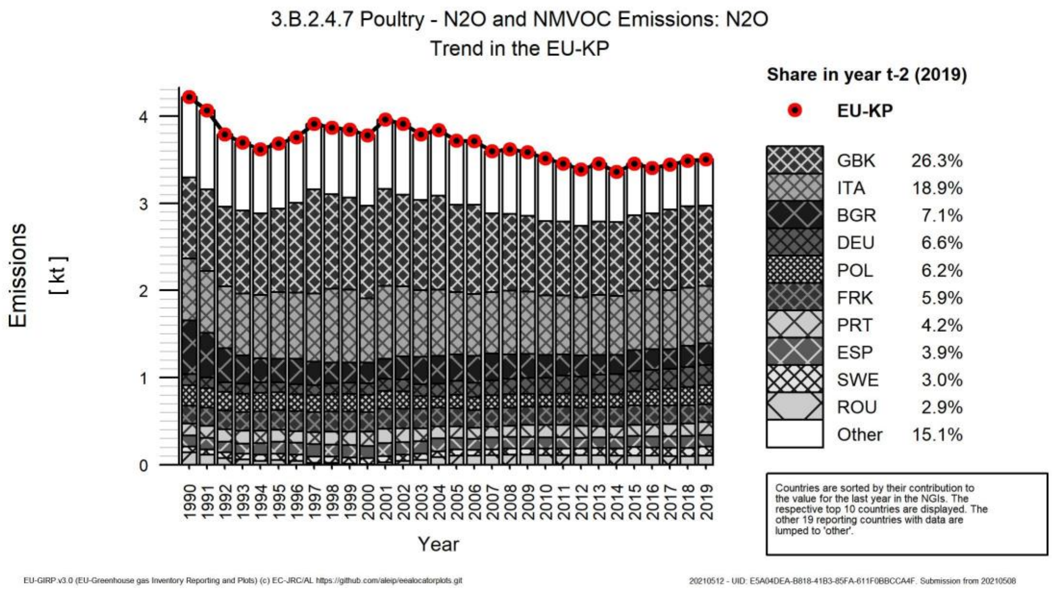
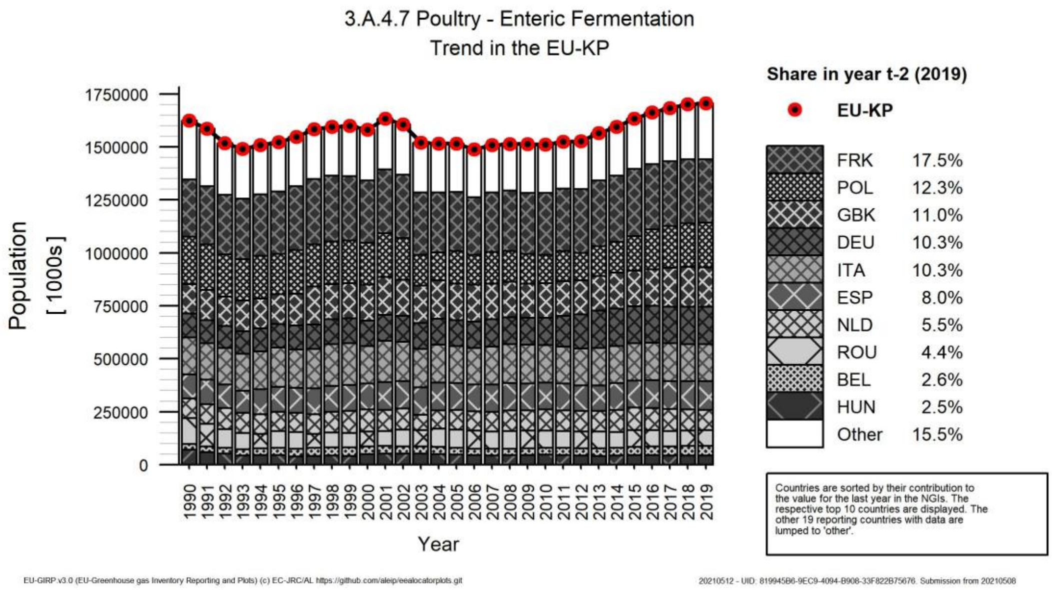


Figure 5.46: 3.A.4.7 - Poultry: Trend in poultry population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



Implied EFs and Methodological Issues

In this section, we discuss the implied emission factor for the main animal types. Furthermore, we present data on the nitrogen excretion rate for the different animal types.

3.B.2.1 - Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.1 - Cattle* increased in EU-KP slightly between 1990 and 2019 by 1.6%. Table 5.33 shows the implied emission factor for N_2O emissions in source category *3.B.2.1 - Cattle* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in eleven countries and increased in eighteen countries. The largest decreases occurred in Croatia and Portugal with a mean absolute value of 0.2 kg/head/year. The four countries with the largest increases were Finland, Estonia, Hungary and Austria with a mean absolute value of 0.2 kg/head/year.

Table 5.33 3.B.2.1 - Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2019		Country	1990	2019
Austria	0.335	0.460	|	Ireland	0.127	0.155
Belgium	0.642	0.585	|	Iceland	0.033	0.031
Bulgaria	0.448	0.514	|	Italy	0.520	0.409
Cyprus	0.511	0.492	|	Lithuania	0.290	0.413
Czech Republic	0.494	0.385	|	Luxembourg	0.316	0.299
Germany	0.335	0.401	|	Latvia	0.281	0.315
Denmark	0.483	0.589	|	Malta	1.199	1.163
Spain	0.207	0.167	|	Netherlands	0.233	0.307
Estonia	0.315	0.466	|	Poland	0.471	0.526
Finland	0.315	0.545	|	Portugal	0.191	0.100
France	0.222	0.224	|	Romania	0.208	0.265
United Kingdom	0.524	0.566	|	Slovakia	0.327	0.410
Greece	0.381	0.379	|	Slovenia	0.230	0.300
Croatia	0.405	0.193	|	Sweden	0.343	0.359
Hungary	0.582	0.725	|	EU-KP	0.347	0.353

3.B.2.1.1 - Dairy Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.1.1 - Dairy Cattle* increased in EU-KP moderately between 1990 and 2019 by 10% or 0.049 kg/head/year. Table 5.34 shows the implied emission factor for N_2O emissions in source category *3.B.2.1.1 - Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in nine countries and increased in twenty countries. The largest decrease occurred in Croatia with an absolute value of 0.2 kg/head/year. The four countries with the largest increases were Estonia, Hungary, Finland and Slovenia with a mean absolute value of 0.3 kg/head/year.

Figure 5.47: 3.B.2.1.1 - Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

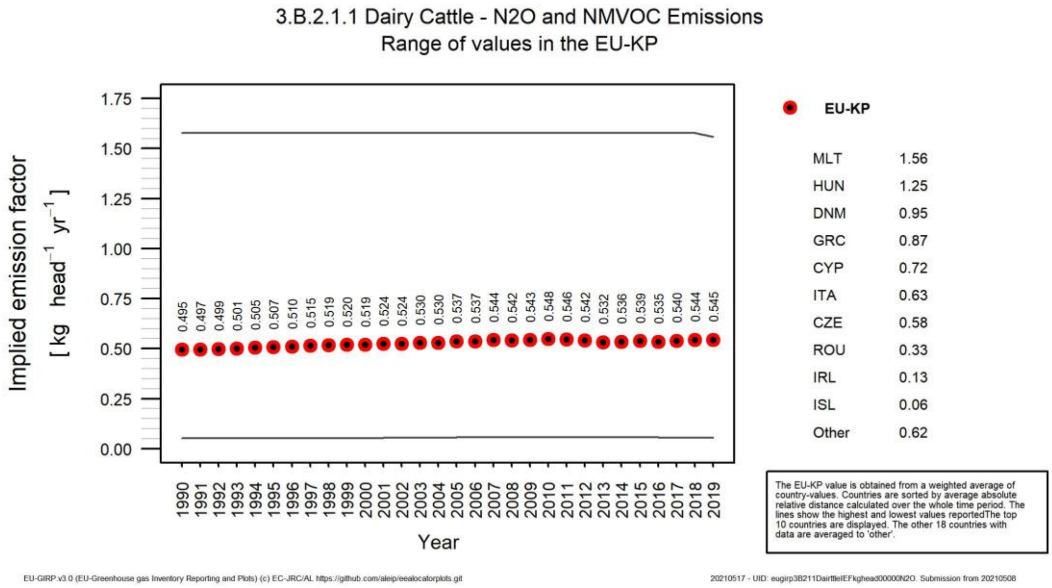


Table 5.34 3.B.2.1.1 - Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2019		Country	1990	2019
Austria	0.444	0.668	|	Ireland	0.140	0.127
Belgium	0.845	0.713	|	Iceland	0.051	0.055
Bulgaria	0.617	0.663	|	Italy	0.783	0.631
Cyprus	0.759	0.719	|	Lithuania	0.375	0.627
Czech Republic	0.724	0.579	|	Luxembourg	0.559	0.558
Germany	0.505	0.583	|	Latvia	0.596	0.718
Denmark	0.864	0.945	|	Malta	1.577	1.558
Spain	0.314	0.421	|	Netherlands	0.340	0.408
Estonia	0.551	0.934	|	Poland	0.613	0.796
Finland	0.477	0.802	|	Portugal	0.472	0.455
France	0.393	0.402	|	Romania	0.261	0.326
United Kingdom	0.412	0.516	|	Slovakia	0.520	0.782
Greece	0.704	0.868	|	Slovenia	0.311	0.624
Croatia	0.538	0.292	|	Sweden	0.609	0.750
Hungary	0.883	1.249	|	EU-KP	0.495	0.545

3.B.2.1.1 - Dairy Cattle - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.2.1.1 - Dairy Cattle*, increased in EU-KP considerably between 1990 and 2019 by 19.2% or 19 kg/head/year. Figure 5.48 shows the trend of the nitrogen excretion rate in EU-KP indicating also the range of values used by the countries. Table 5.35 shows the nitrogen excretion rate in source category *3.B.2.1.1 - Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. Nitrogen excretion rate decreased in one country and increased in 26 countries. It was in 2019 at the level of 1990 in two countries. A decrease occurred in the Netherlands with an absolute value of 3 kg/head/year. The four countries with the largest increases were Finland, Slovakia, Hungary and Estonia with a mean absolute value of 43 kg/head/year.

Figure 5.48: 3.B.2.1.1 - Dairy Cattle: Trend in nitrogen excretion rate in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

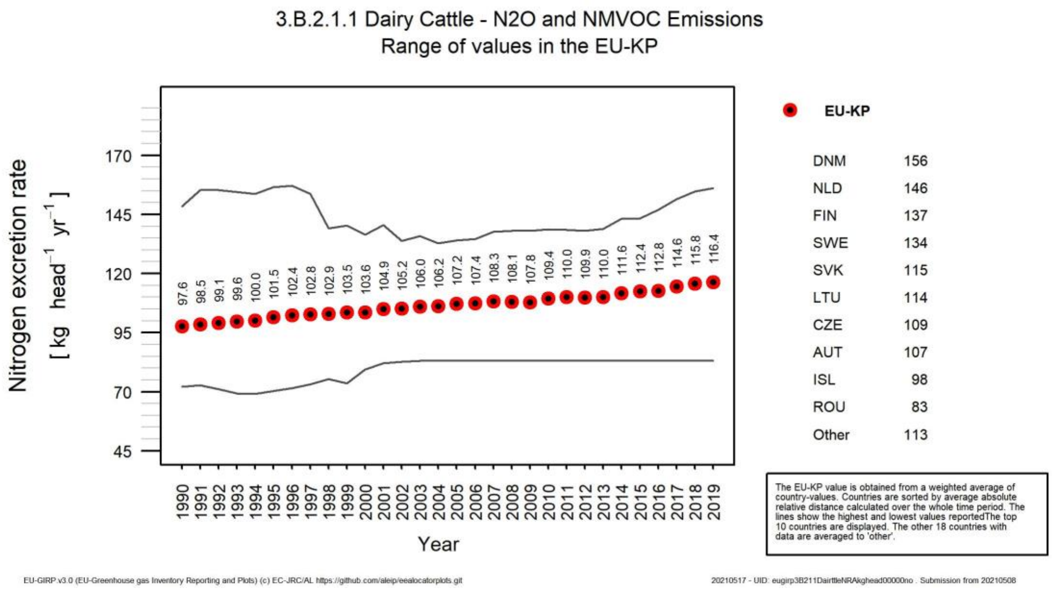


Table 5.35 3.B.2.1.1 - Dairy Cattle: countries' nitrogen excretion rate (kg/head/year)

Country	1990	2019		Country	1990	2019
Austria	77	107	|	Ireland	98	109
Belgium	114	121	|	Iceland	87	98
Bulgaria	98	98	|	Italy	105	106
Cyprus	96	96	|	Lithuania	80	114
Czech Republic	99	109	|	Luxembourg	110	123
Germany	92	120	|	Latvia	86	117
Denmark	129	156	|	Malta	100	100
Spain	85	113	|	Netherlands	148	146
Estonia	85	125	|	Poland	102	113
Finland	90	137	|	Portugal	86	118
France	102	116	|	Romania	83	83
United Kingdom	87	113	|	Slovakia	72	115
Greece	97	120	|	Slovenia	82	117
Croatia	96	109	|	Sweden	102	134
Hungary	83	125	|	EU-KP	98	116

3.B.2.1.2 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.1.2 - Non-Dairy Cattle* increased in EU-KP slightly between 1990 and 2019 by 3.4%. Figure 5.49 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.36 shows the implied emission factor for N_2O emissions in source category *3.B.2.1.2 - Non-Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in eleven countries and increased in eighteen countries. The largest decreases occurred in Croatia and Portugal with a mean absolute value of 0.1 kg/head/year. The four countries with the largest increases were Finland, Hungary, Austria and Denmark with a mean absolute value of 0.1 kg/head/year.

Figure 5.49: 3.B.2.1.2 - Non-Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

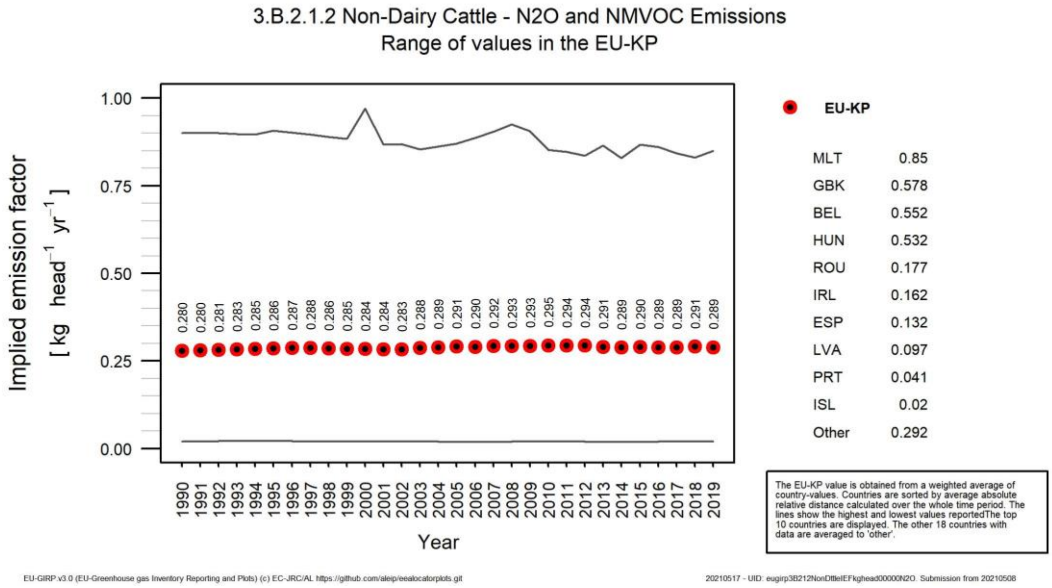


Table 5.36 3.B.2.1.2 - Non-Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2019		Country	1990	2019
Austria	0.276	0.380	|	Ireland	0.123	0.162
Belgium	0.571	0.552	|	Iceland	0.020	0.020
Bulgaria	0.340	0.400	|	Italy	0.384	0.325
Cyprus	0.340	0.287	|	Lithuania	0.242	0.282
Czech Republic	0.373	0.317	|	Luxembourg	0.226	0.211
Germany	0.253	0.305	|	Latvia	0.095	0.097
Denmark	0.290	0.370	|	Malta	0.900	0.850
Spain	0.160	0.132	|	Netherlands	0.167	0.233
Estonia	0.175	0.231	|	Poland	0.336	0.353
Finland	0.223	0.431	|	Portugal	0.078	0.041
France	0.167	0.182	|	Romania	0.140	0.177
United Kingdom	0.559	0.578	|	Slovakia	0.261	0.257
Greece	0.241	0.275	|	Slovenia	0.171	0.219
Croatia	0.234	0.148	|	Sweden	0.209	0.256
Hungary	0.422	0.532	|	EU-KP	0.280	0.300

3.B.2.1.2 - Non-Dairy Cattle - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.2.1.2 - Non-Dairy Cattle*, increased in EU-KP moderately between 1990 and 2019 by 7.7% or 3.7 kg/head/year. Figure 5.50 shows the trend of the nitrogen excretion rate in EU-KP indicating also the range of values used by the countries. Table 5.37 shows the nitrogen excretion rate in source category *3.B.2.1.2 - Non-Dairy Cattle* for the years 1990 and 2019 for all countries and EU-KP. Nitrogen excretion rate decreased in five countries and increased in 23 countries. It was in 2019 at the level of 1990 in one country. The largest decrease occurred in the Netherlands with an absolute value of 17 kg/head/year.

The three countries with the largest increases were Finland, Portugal and Latvia with a mean absolute value of 14 kg/head/year.

Figure 5.50: 3.B.2.1.2 - Non-Dairy Cattle: Trend in nitrogen excretion rate in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

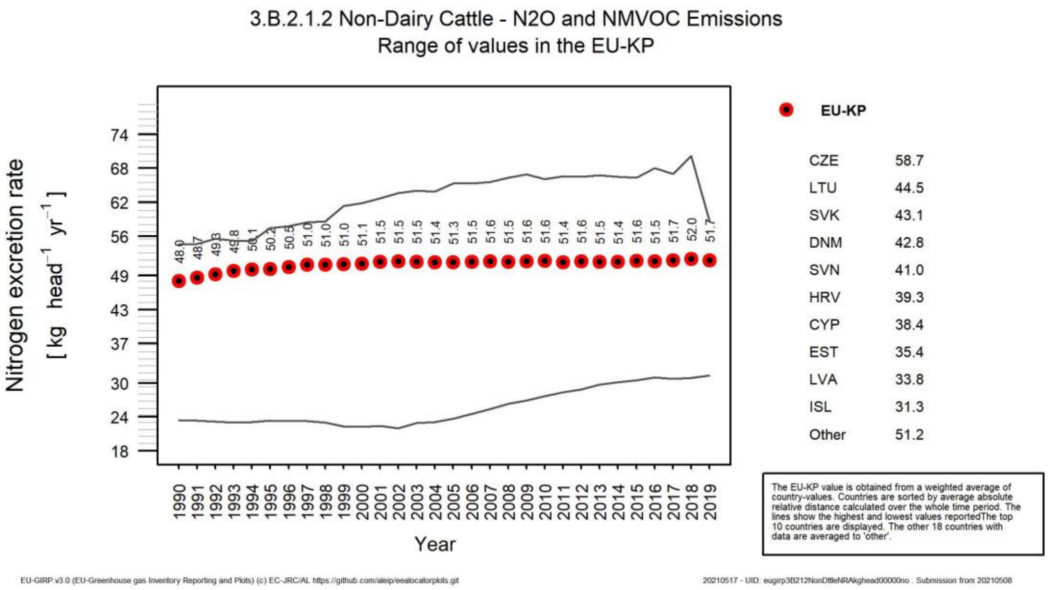


Table 5.37 3.B.2.1.2 - Non-Dairy Cattle: countries' nitrogen excretion rate (kg/head/year)

Country	1990	2019		Country	1990	2019
Austria	40	45	|	Ireland	52	57
Belgium	54	54	|	Iceland	29	31
Bulgaria	54	59	|	Italy	50	52
Cyprus	43	38	|	Lithuania	41	44
Czech Republic	55	59	|	Luxembourg	57	59
Germany	38	43	|	Latvia	23	34
Denmark	36	43	|	Malta	57	54
Spain	57	57	|	Netherlands	57	39
Estonia	32	35	|	Poland	54	51
Finland	34	55	|	Portugal	44	56
France	58	60	|	Romania	43	44
United Kingdom	40	44	|	Slovakia	39	43
Greece	48	55	|	Slovenia	41	41
Croatia	40	39	|	Sweden	39	43
Hungary	44	52	|	EU-KP	48	52

3.B.2.3 – Swine – Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.3 - Swine* decreased in EU-KP considerably between 1990 and 2019 by 21.5%. Figure 5.51 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.38 shows the implied emission factor for N_2O emissions in source category *3.B.2.3 – Swine* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in 23 countries and increased in four countries. It was in 2019 at the level of 1990 in one country. No data were available for Iceland. The largest increases occurred in Germany and Poland with a mean absolute value of 0.025 kg/head/year.

Figure 5.51: 3.B.2.3 – Swine: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

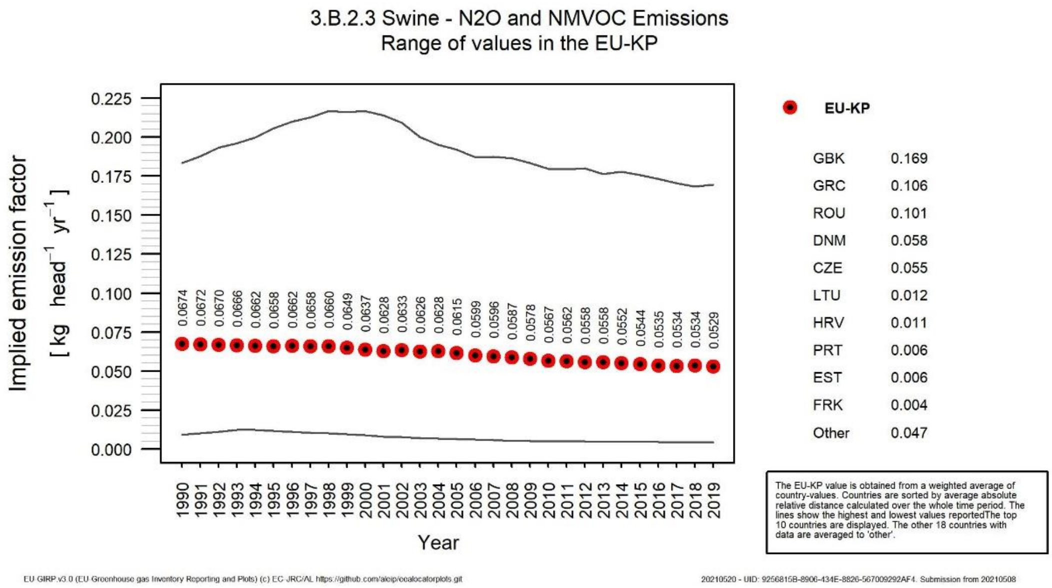


Table 5.38 3.B.2.3 – Swine: countries' implied emission factor (kg/head/year)

Country	1990	2019	Country	1990	2019
Austria	0.0554	0.0460	Ireland	0.0277	0.0261
Belgium	0.0425	0.0301	Italy	0.0944	0.0924
Bulgaria	0.0079	0.0076	Lithuania	0.1437	0.0117
Cyprus	0.0935	0.0356	Luxembourg	0.0393	0.0367
Czech Republic	0.1221	0.0555	Latvia	0.0964	0.0468
Germany	0.0477	0.0726	Malta	0.0435	0.0442
Denmark	0.1407	0.0582	Netherlands	0.0338	0.0274
Spain	0.0437	0.0320	Poland	0.0608	0.0855
Estonia	0.0092	0.0060	Portugal	0.0145	0.0065
Finland	0.0653	0.0342	Romania	0.1180	0.1005
France	0.0124	0.0041	Slovakia	0.0847	0.0726
United Kingdom	0.1835	0.1695	Slovenia	0.0407	0.0308
Greece	0.1061	0.1061	Sweden	0.0626	0.0665
Croatia	0.0503	0.0106	EU-KP	0.0674	0.0529
Hungary	0.0609	0.0596			

3.B.2.3 - Swine - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.2.3 - Swine*, decreased in EU-KP clearly between 1990 and 2019 by 12.4%. Figure 5.52 shows the trend of the nitrogen excretion rate in EU-KP indicating also the range of values used by the countries. Table 5.39 shows the nitrogen excretion rate in source category *3.B.2.3 - Swine* for the years 1990 and 2019 for all countries and EU-KP. Nitrogen excretion rate decreased in 21 countries and increased in eight countries. The largest decreases occurred in Denmark and Belgium with a mean absolute value of 4 kg/head/year. The three countries with the largest increases were Sweden, Germany and Poland with a mean absolute value of 1 kg/head/year.

Sweden explains the large increase by an update of nitrogen production data for sows and pigs in 2002, due to more intense swine production. The time trend also shows steps because surveys are only done biannually and small percentage differences in the survey have a significant effect on emissions, as emission factors are differing considerably between the different systems.

Figure 5.52: 3.B.2.3 - Swine: Trend in nitrogen excretion rate in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

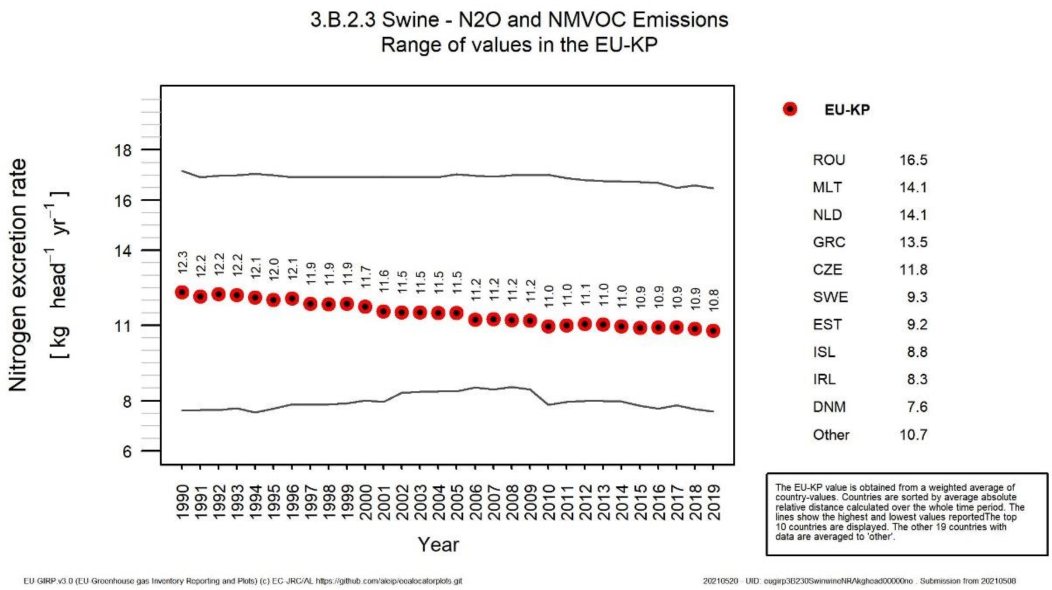


Table 5.39 3.B.2.3 - Swine: countries' nitrogen excretion rate (kg/head/year)

Country	1990	2019		Country	1990	2019
Austria	9.8	9.3	|	Ireland	8.8	8.3
Belgium	12.5	8.8	|	Iceland	9.2	8.8
Bulgaria	12.5	11.7	|	Italy	12.0	12.2
Cyprus	11.9	11.3	|	Lithuania	12.4	11.9
Czech Republic	15.4	11.8	|	Luxembourg	10.6	9.9
Germany	12.1	13.3	|	Latvia	12.3	10.9
Denmark	11.9	7.6	|	Malta	13.8	14.1
Spain	11.9	9.4	|	Netherlands	17.2	14.1
Estonia	8.9	9.2	|	Poland	10.0	10.9
Finland	12.2	12.1	|	Portugal	10.3	9.1
France	10.7	9.5	|	Romania	16.9	16.5
United Kingdom	13.3	10.2	|	Slovakia	10.4	8.9
Greece	13.5	13.5	|	Slovenia	12.7	12.2
Croatia	12.4	12.5	|	Sweden	7.6	9.3
Hungary	9.5	9.4	|	EU-KP	12.3	10.8

3.B.2.4.7 - Poultry - Implied emission factor

The implied emission factor for N_2O emissions in source category 3.B.2.4.7 - Poultry slightly decrease between 1990 and 2019 by 17.9% or 0.00056 kg/head/year. Figure 5.53 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.40 shows the implied emission factor for N_2O emissions in source category *3.B.2.4.7 - Poultry* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in 21 countries and increased in seven countries. It was in 2019 at the level of 1990 in one country.

Figure 5.53: 3.B.2.4.7 - Poultry: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

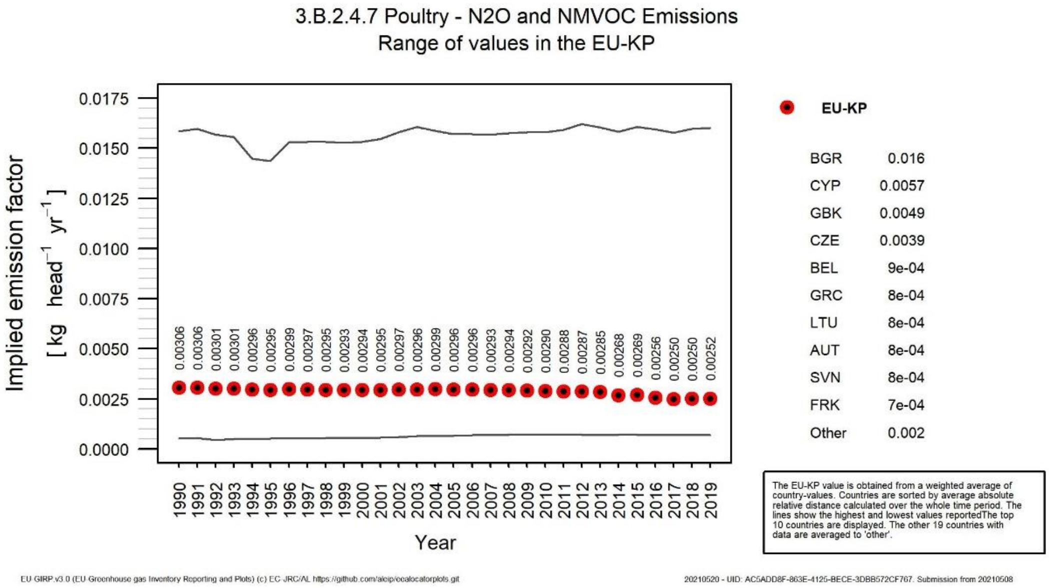


Table 5.40 3.B.2.4.7 - Poultry: countries' implied emission factor (kg/head/year)

Country	1990	2019		Country	1990	2019
Austria	0.00090	0.00079	|	Ireland	0.00109	0.00104
Belgium	0.00094	0.00088	|	Iceland	0.00211	0.00110
Bulgaria	0.01585	0.01603	|	Italy	0.00409	0.00377
Cyprus	0.00715	0.00571	|	Lithuania	0.00053	0.00082
Czech Republic	0.01047	0.00387	|	Luxembourg	0.00113	0.00114
Germany	0.00109	0.00132	|	Latvia	0.00342	0.00178
Denmark	0.00112	0.00071	|	Malta	0.00131	0.00136
Spain	0.00112	0.00099	|	Netherlands	0.00110	0.00094
Estonia	0.00383	0.00341	|	Poland	0.00107	0.00103
Finland	0.00288	0.00162	|	Portugal	0.00435	0.00406
France	0.00074	0.00069	|	Romania	0.00119	0.00136
United Kingdom	0.00671	0.00492	|	Slovakia	0.00155	0.00149
Greece	0.00085	0.00085	|	Slovenia	0.00068	0.00076
Croatia	0.00448	0.00417	|	Sweden	0.00473	0.00446
Hungary	0.00232	0.00199	|	EU-KP	0.00313	0.00257

3.B.2.4.7 - Poultry - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category 3.B.2.4.7 - Poultry, decreased in EU-KP slightly between 1990 and 2019 by 9% or 0.061 kg/head/year. Figure 5.54 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.41 shows the nitrogen excretion rate in source category *3.B.2.4.7 - Poultry* for the years 1990 and 2019 for all countries and EU-KP. Nitrogen excretion rate decreased in nineteen countries and increased in seven countries. It was in 2019 at the level of 1990 in three countries. The largest increase occurred in Lithuania with an absolute value of 0.1 kg/head/year.

Figure 5.54: 3.B.2.4.7 - Poultry: Trend in nitrogen excretion rate in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

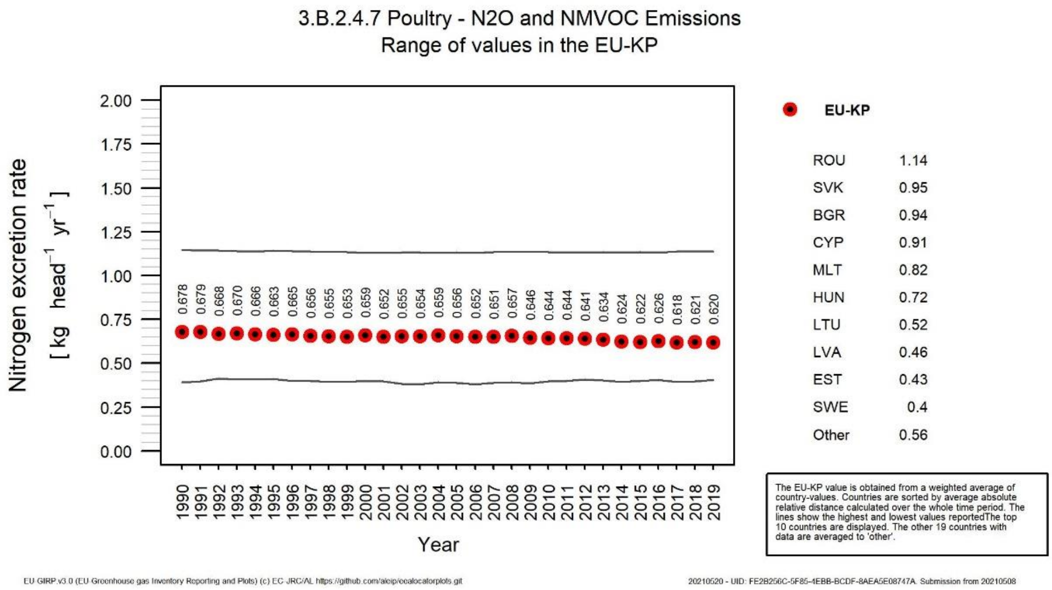


Table 5.41 3.B.2.4.7 - Poultry: countries' nitrogen excretion rate (kg/head/year)

Country	1990	2019		Country	1990	2019
Austria	0.59	0.55	|	Ireland	0.60	0.55
Belgium	0.60	0.56	|	Iceland	1.21	0.63
Bulgaria	0.94	0.94	|	Italy	0.52	0.49
Cyprus	0.91	0.91	|	Lithuania	0.39	0.52
Czech Republic	0.73	0.51	|	Luxembourg	0.72	0.73
Germany	0.69	0.74	|	Latvia	0.45	0.46
Denmark	0.63	0.46	|	Malta	0.82	0.82
Spain	0.71	0.63	|	Netherlands	0.68	0.59
Estonia	0.44	0.43	|	Poland	0.68	0.65
Finland	0.50	0.54	|	Portugal	0.55	0.53
France	0.49	0.47	|	Romania	1.15	1.14
United Kingdom	0.78	0.57	|	Slovakia	0.99	0.95
Greece	0.50	0.50	|	Slovenia	0.46	0.50
Croatia	0.67	0.50	|	Sweden	0.43	0.40
Hungary	0.83	0.72	|	EU-KP	0.68	0.62

3.B.2.5 - Manure Management - Indirect Emissions - Emissions

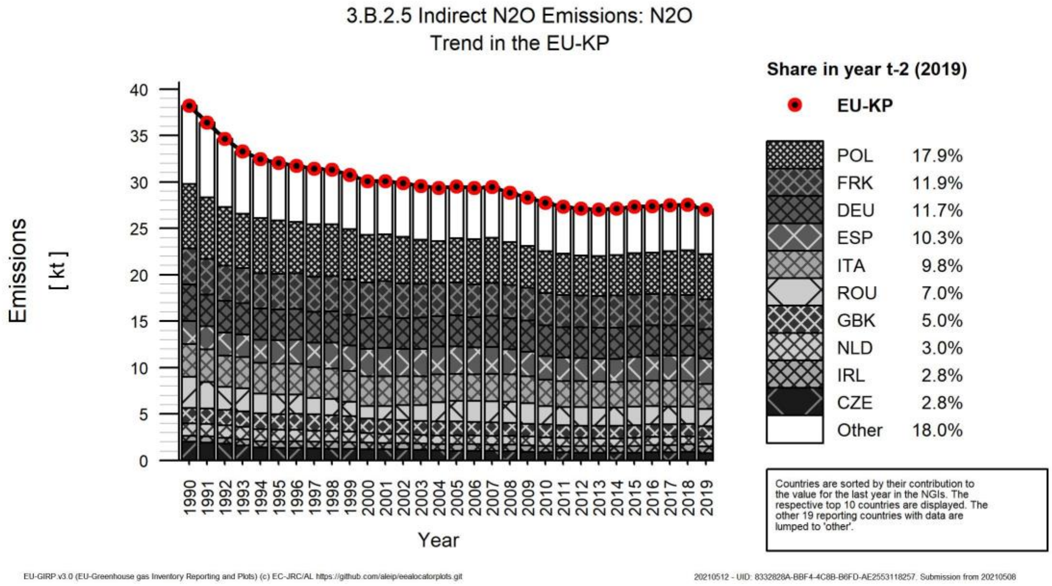
In 2019 N_2O emissions in source category *3.B.2.5 - Manure Management - Indirect Emissions - Indirect N_2O emissions* in EU-KP were 8060.9 kt CO_2 equivalent. This corresponds to 0.18% of total EU-KP GHG emissions and 3.1% of total EU-KP N_2O emissions. They make 1.9% of total agricultural emissions and 4.3% of total agricultural N_2O emissions.

Total GHG and N_2O emissions by country from 3.B.2.5 *Manure Management - Indirect Emissions* are shown in Table 5.42 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2019). Values are given in kt CO_2-eq. Between 1990 and 2019, N_2O emission in this source category decreased by 29% or 3.3 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (71%) and in Poland in absolute terms (637 kt CO_2-eq). From 2018 to 2019 emissions in the current category decreased by 1.8%. Figure 5.55 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from manure management - indirect emissions for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 82% of the total in 2019. Emissions decreased in 25 countries and increased in four countries. The three countries with the largest decreases were Poland, Romania and the Czech Republic with a total absolute decrease of 1.5 Mt CO_2-eq. The largest increases occurred in Ireland and Spain, with a total absolute increase of 125 kt CO_2-eq.

Table 5.42 3.B.2.5 - Manure Management - Indirect Emissions: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	101	115	114	1.4%	12	12%	-1	-1%
Belgium	194	165	162	2.0%	-32	-16%	-3	-2%
Bulgaria	394	118	116	1.4%	-278	-71%	-3	-2%
Croatia	169	91	92	1.1%	-78	-46%	1	1%
Cyprus	24	28	28	0.4%	4	16%	0	1%
Czechia	603	278	224	2.8%	-379	-63%	-53	-19%
Denmark	198	137	128	1.6%	-70	-35%	-9	-7%
Estonia	61	24	25	0.3%	-36	-60%	0	1%
Finland	99	87	86	1.1%	-13	-13%	-1	-1%
France	1,146	978	958	11.9%	-189	-16%	-20	-2%
Germany	1,172	955	940	11.7%	-232	-20%	-15	-2%
Greece	154	144	145	1.8%	-9	-6%	1	1%
Hungary	279	141	142	1.8%	-138	-49%	1	1%
Ireland	187	242	229	2.8%	42	22%	-13	-5%
Italy	1,054	809	791	9.8%	-263	-25%	-19	-2%
Latvia	96	28	28	0.4%	-68	-71%	0	0%
Lithuania	248	90	86	1.1%	-162	-65%	-4	-5%
Luxembourg	9	9	9	0.1%	0	-5%	0	-2%
Malta	7	6	5	0.1%	-2	-26%	0	-3%
Netherlands	390	255	241	3.0%	-148	-38%	-14	-6%
Poland	2,078	1,440	1,441	17.9%	-637	-31%	2	0%
Portugal	108	81	82	1.0%	-26	-24%	0	0%
Romania	1,003	560	561	7.0%	-442	-44%	2	0%
Slovakia	216	84	81	1.0%	-135	-62%	-3	-3%
Slovenia	44	30	30	0.4%	-15	-33%	0	-1%
Spain	744	826	827	10.3%	83	11%	1	0%
Sweden	103	82	83	1.0%	-20	-20%	1	1%
United Kingdom	501	399	401	5.0%	-100	-20%	2	0%
EU-27+UK	**11,382**	**8,202**	**8,053**	**100%**	**-3,329**	**-29%**	**-148**	**-2%**
Iceland	10	8	8	0.1%	-1	-14%	0	-2%
United Kingdom (KP)	501	399	401	5.0%	-100	-20%	2	0%
EU-KP	**11,392**	**8,210**	**8,062**	**100%**	**-3,330**	**-29%**	**-149**	**-2%**

Figure 5.55: 3.B.2.5 - Manure Management - Indirect Emissions: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



3.B.2.5 - Manure Management - Indirect N_2O emissions - Atmospheric deposition

The implied emission factor for N_2O emissions in source category *3.B.2.5 - Manure Management - Indirect N_2O emissions* decreased in EU-KP slightly between 1990 and 2019 by 1.7%. Figure 5.56 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.43 shows the implied emission factor for N_2O emissions in source category *3.B.2.5 - Manure Management - Indirect N_2O emissions* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in seven countries and increased in four countries. It was in 2019 at the level of 1990 in eighteen countries.

Table 5.43 3.B.2.5 - Manure Management: countries' implied emission factor (kg N_2O/kg N)

Country	1990	2019		Country	1990	2019
Austria	0.016	0.016	|	Ireland	0.016	0.016
Belgium	0.016	0.016	|	Iceland	0.016	0.016
Bulgaria	0.016	0.016	|	Italy	0.016	0.016
Cyprus	0.016	0.016	|	Lithuania	0.016	0.016
Czech Republic	0.016	0.016	|	Luxembourg	0.016	0.016
Germany	0.016	0.016	|	Latvia	0.016	0.016
Denmark	0.016	0.016	|	Malta	0.016	0.016
Spain	0.013	0.012	|	Netherlands	0.016	0.016
Estonia	0.016	0.016	|	Poland	0.016	0.016
Finland	0.016	0.016	|	Portugal	0.016	0.016
France	0.016	0.015	|	Romania	0.016	0.016
United Kingdom	0.016	0.016	|	Slovakia	0.016	0.016
Greece	0.016	0.016	|	Slovenia	0.016	0.016
Croatia	0.016	0.016	|	Sweden	0.016	0.016
Hungary	0.016	0.016	|	EU-KP	0.016	0.016

3.B.2.5 - Manure Management - Implied emission factor - Leaching and run-off

The implied emission factor for N_2O emissions in source category *3.B.2.5 - Manure Management - Indirect N_2O emissions* decreased in EU-KP barely between 1990 and 2019 by 0.12%. Figure 5.56 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.44 shows the implied emission factor for N_2O emissions in source category *3.B.2.5 - Manure Management - Indirect N_2O emissions* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in six countries and increased in six countries. It was in 2019 at the level of 1990 in five countries. No data were available for twelve countries (Austria, Bulgaria, Germany, Denmark, Ireland, Iceland, Luxembourg, Malta, the Netherlands, Slovakia, Slovenia, Sweden)

Figure 5.57: 3.B.2.5 - Manure Management: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

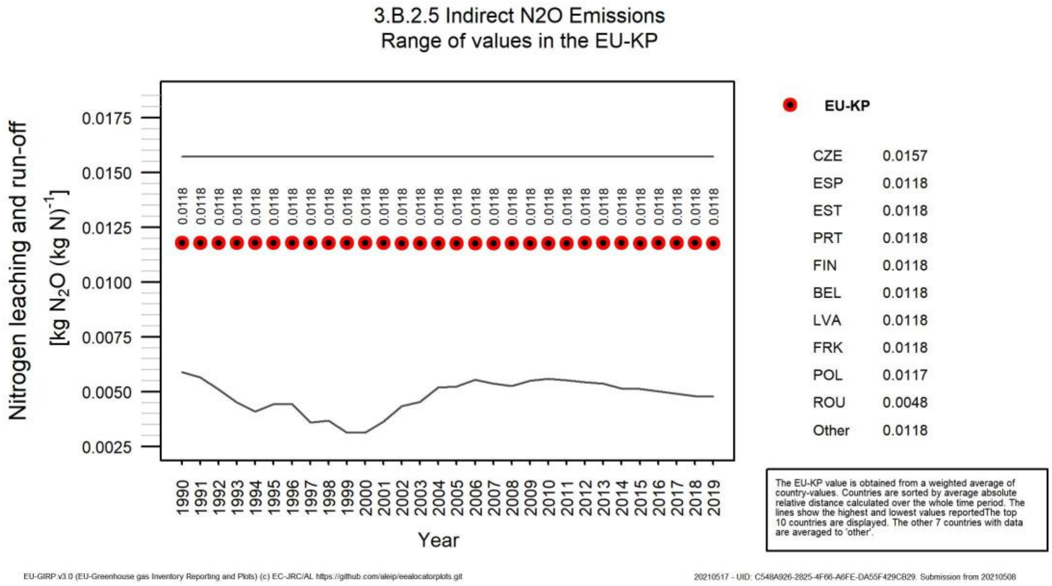


Table 5.44 3.B.2.5 - Manure Management: countries' implied emission factor (kg N_2O/kg N)

Country	1990	2019		Country	1990	2019
Belgium	0.0118	0.0118	|	Croatia	0.0118	0.0118
Cyprus	0.0118	0.0118	|	Hungary	0.0118	0.0118
Czech Republic	0.0157	0.0157	|	Italy	0.0118	0.0118
Spain	0.0118	0.0118	|	Lithuania	0.0118	0.0118
Estonia	0.0118	0.0118	|	Latvia	0.0118	0.0118
Finland	0.0118	0.0118	|	Poland	0.0117	0.0117
France	0.0118	0.0118	|	Portugal	0.0118	0.0118
United Kingdom	0.0118	0.0118	|	Romania	0.0059	0.0048
Greece	0.0118	0.0118	|	EU-KP	0.0118	0.0118

5.3.4 Direct Emissions from Managed Soils - N_2O (CRF Source Category 3D1)

In 2019 N_2O emissions in source category *3.D.1 - Direct N_2O Emissions From Managed Soils* in EU-KP were 135118.7 kt CO_2 equivalent. This corresponds to 3% of total EU-KP GHG emissions and 53% of total EU-KP N_2O emissions. They make 31.5% of total agricultural emissions and 72% of total agricultural N_2O emissions. The main sub-categories are 3.D.1.1 (Inorganic N Fertilizers), 3.D.1.2 (Organic N Fertilizers) and 3.D.1.4 (Crop Residues) as shown in Figure 5.58. Regarding the origin of emissions in the different countries, Figure 5.59 shows the distribution of direct N_2O emissions from managed soils by emission source in all countries and in the EU-KP. Each bar represents the total emissions of a country in the current emission category, where different shades of blue correspond to the emitting sub-categories.

Figure 5.58: Share of source category 3.D.1 on total EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2019. Categories 3.D.1.1-3.D.1.5: direct N_2O emissions by N source (inorganic fertilizers, organic fertilizers, urine and dung deposited by grazing animals, crop residues and mineralization of soil organic matter); category 3.D.1.6: cultivation of histosols.

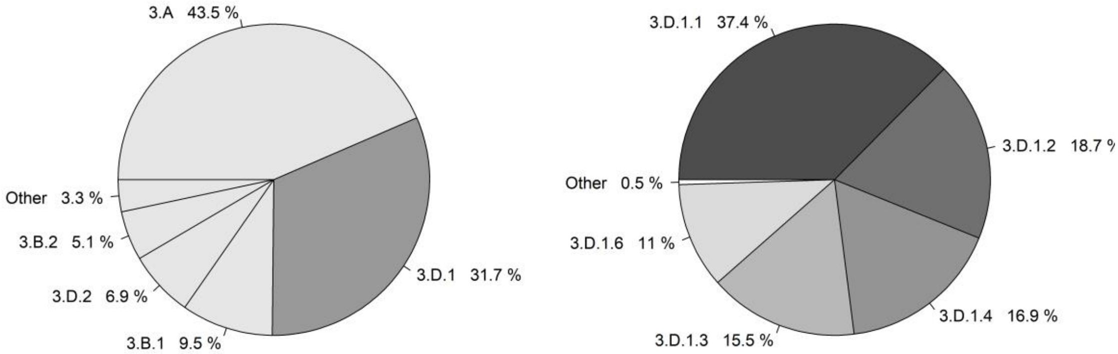
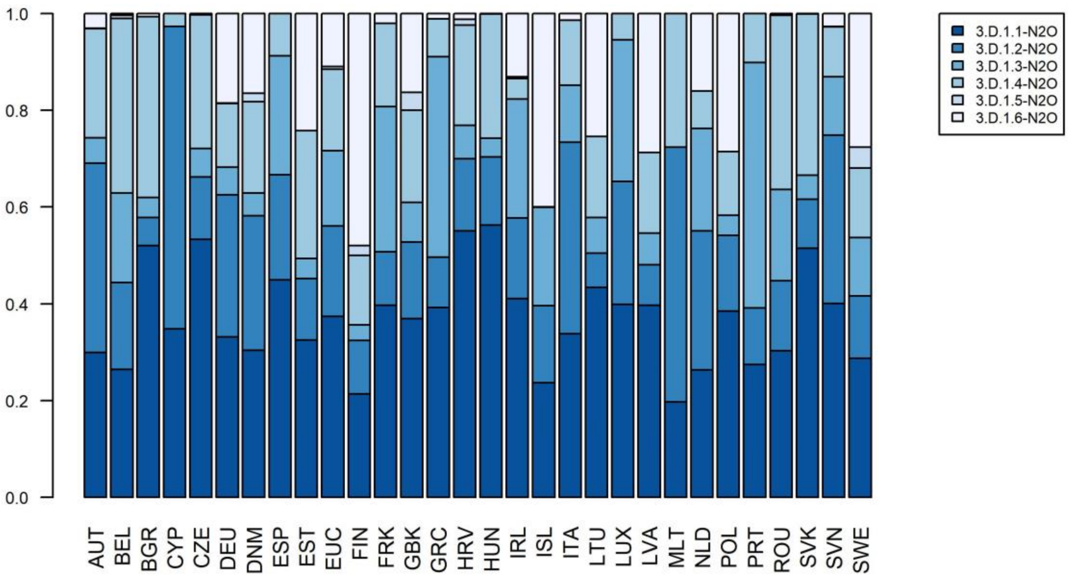


Figure 5.59: Decomposition of emissions in source category 3.D.1 - Direct N_2O Emissions From Managed Soils into its sub-categories by country in the year 2019. 3.D.1.1 inorganic N fertilisers, 3.D.1.2 organic N fertilisers, 3.D.1.3 urine and dung deposited by grazing animals, 3.D.1.4 crop residues incorporated in the soil, 3.D.1.5 mineralisation/immobilisation associated with loss/gain of soil organic matter, and 3.D.1.6 cultivation of organic soils (histosols).



Total GHG and N_2O emissions by country from 3.D.1 *Direct N_2O Emissions From Managed Soils* are shown in Table 5.45 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2019). Values are given in kt CO_2-eq. Between 1990 and 2019, N_2O emission in this source category decreased by 17% or 27.6 Mt CO_2-eq. The decrease was largest in Latvia in relative terms (41%) and in Poland in absolute terms (4.4 Mt CO_2-eq). From 2018 to 2019 emissions in the current category decreased by 0.8%.

Table 5.45 3.D.1 - Direct N_2O Emissions From Managed Soils: Countries' contributions to total EU-GHG and N_2O emissions

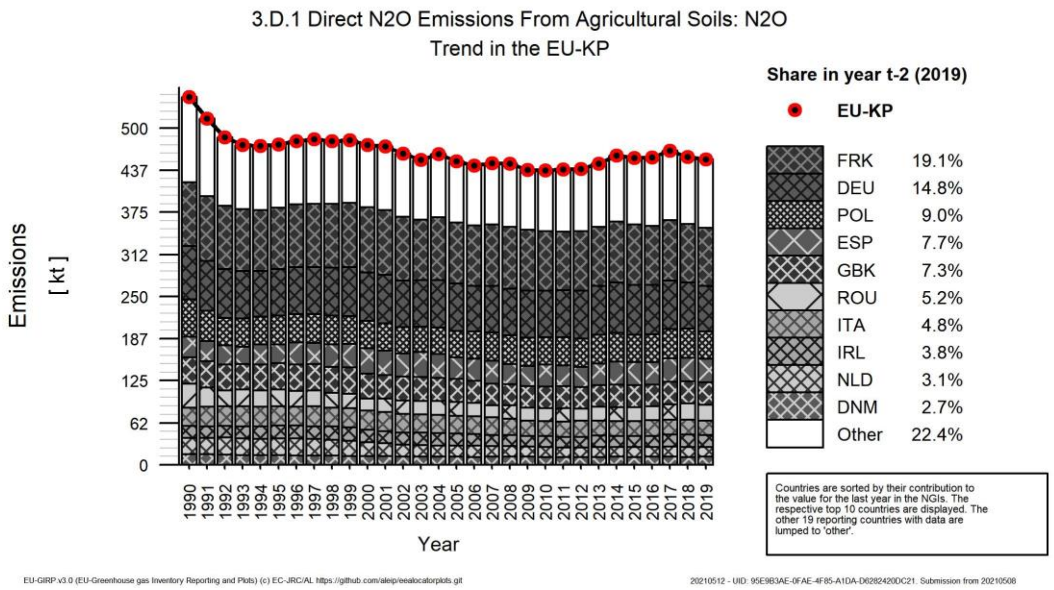
Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1,884	1,679	1,654	1.2%	-230	-12%	-25	-1%	T1	D
Belgium	3,350	2,549	2,577	1.9%	-773	-23%	27	1%	T1	D
Bulgaria	4,085	3,141	3,173	2.3%	-912	-22%	32	1%	T1	D
Croatia	1,076	832	829	0.6%	-247	-23%	-3	0%	T1	D
Cyprus	118	102	105	0.1%	-13	-11%	3	3%	T1	CS,D
Czechia	4,219	3,040	2,918	2.2%	-1,301	-31%	-122	-4%	T1,T2	CS,D
Denmark	4,738	3,463	3,668	2.7%	-1,070	-23%	205	6%	NA	NA
Estonia	911	537	597	0.4%	-314	-34%	60	11%	T1	D
Finland	3,303	3,088	3,214	2.4%	-89	-3%	127	4%	T1,T2	CS,D
France	28,401	25,926	25,798	19.1%	-2,603	-9%	-128	0%	T1,T2	D
Germany	23,562	20,205	20,053	14.8%	-3,509	-15%	-151	-1%	T1,T2	CS,D
Greece	3,569	2,208	2,266	1.7%	-1,303	-36%	59	3%	T1	D
Hungary	3,474	3,478	3,461	2.6%	-12	0%	-16	0%	T1,T2	D
Ireland	5,265	5,461	5,151	3.8%	-114	-2%	-310	-6%	T1	D
Italy	8,108	6,545	6,476	4.8%	-1,631	-20%	-68	-1%	CS,T1	CS,D
Latvia	1,615	878	952	0.7%	-663	-41%	74	8%	T1	D
Lithuania	2,522	1,864	1,913	1.4%	-608	-24%	50	3%	T1	D
Luxembourg	188	160	162	0.1%	-26	-14%	1	1%	T1	CS,D
Malta	16	14	14	0.0%	-2	-13%	0	0%	T1	D
Netherlands	7,122	4,364	4,241	3.1%	-2,881	-40%	-122	-3%	T1,T1b,T2	CS,D
Poland	16,555	12,929	12,107	9.0%	-4,448	-27%	-822	-6%	T1	CS,D
Portugal	1,799	1,729	1,764	1.3%	-35	-2%	35	2%	T1	D
Romania	10,619	7,289	7,065	5.2%	-3,555	-33%	-225	-3%	T1	D
Slovakia	1,757	1,097	1,169	0.9%	-588	-33%	72	7%	T1	CS,D
Slovenia	332	324	328	0.2%	-4	-1%	4	1%	T1,T2	D
Spain	8,985	10,464	10,388	7.7%	1,404	16%	-76	-1%	CS,T1	D
Sweden	3,222	2,857	2,978	2.2%	-243	-8%	121	4%	T1,T2	CS,D
United Kingdom	11,715	9,801	9,902	7.3%	-1,814	-15%	100	1%	T1,T2	CS,D
EU-27+UK	**162,509**	**136,024**	**134,925**	**100%**	**-27,584**	**-17%**	**-1,099**	**-1%**	**-**	**-**
Iceland	205	213	205	0.2%	0	0%	-8	-4%	T1,T1b,T2	CS,D
United Kingdom (KP)	11,715	9,801	9,902	7.3%	-1,814	-15%	100	1%	T1,T2	CS,D
EU-KP	**162,715**	**136,237**	**135,131**	**100%**	**-27,584**	**-17%**	**-1,106**	**-1%**	**-**	**-**

Trends in Emissions and Activity Data

3.D.1 - Direct N_2O Emissions From Managed Soils - Emissions

Emissions in source category *3.D.1 - Direct N_2O Emissions From Managed Soils* decreased considerably in EU-KP by 17% or 27.6 Mt CO_2-eq in the period 1990 to 2019. Figure 5.60 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from direct N_2O emissions from managed soils for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 77.6% of the total in 2019.Emissions decreased in 27 countries and increased in two countries. The three countries with the largest decreases were Poland, Romania and Germany with a total absolute decrease of 11.5 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 1.4 Mt CO_2-eq.

Figure 5.60: 3.D.1 Direct N_2O Emissions From Managed Soils: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



The main driving force of direct N_2O emissions from agricultural soils is the use of nitrogen fertiliser and animal manure, which were 25% and 13% below 1990 levels in 2019, respectively. N_2O emissions from agricultural land can be decreased by overall efficiency improvements of nitrogen uptake by crops, which should lead to lower fertiliser consumption on agricultural land. The decrease of fertiliser use is partly due to the effects of the 1992 reform of the Common Agricultural Policy and the resulting shift from production-based support mechanisms to direct area payments in arable production. This has tended to lead to an optimisation and overall reduction in fertiliser use. In addition, reduction in fertiliser use is also due to directives such as the Nitrate Directive and to the extensification measures included in the Agro-Environment Programmes (EC, 2001).

Another policy affecting GHG emissions, in this case through the application of sewage sludge, is the Urban Wastewater Treatment Directive[39]. In the UK, the input from sewage sludge sharply increased in 2001. This is explained by a step in the UK's estimates of sewage sludge collected around 2001, linked to the Urban Wastewater Treatment Directive, which enforced that all large wastewater treatment plants use secondary treatment. This additional treatment reduces the organic load in the effluent, and to achieve this a higher proportion of the organic load in the wastewater treatment plants as sewage sludge. A similar trend is observed in Ireland, where a significant increase (over double) in the quantity of sewage sludge applied to agricultural land took place around 1998 as a result of its diversion away from disposal at solid waste disposal sites.

3.D.1.1 - Direct N_2O emissions from inorganic N fertilisers - Emissions

Emissions in source category *3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers* decreased strongly in EU-KP by 26% or 17.4 Mt CO_2-eq in the period 1990 to 2019. Figure 5.61 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from inorganic N fertilisers for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 79% of the total in 2019.Emissions decreased in 26 countries and increased in three countries. The three countries with the largest decreases were Germany, the United Kingdom and France with a total absolute decrease of 8.1 Mt CO_2-eq. The largest increases occurred in Hungary, with a total absolute increase of 271 kt CO_2-eq.

39 http://ec.europa.eu/environment/water/water-urbanwaste/legislation/directive_en.htm

3.D.1.1 - Direct N_2O emissions from inorganic N fertilisers - Application of inorganic fertilizers

Application of inorganic fertilizers decreased strongly in EU-KP by 25% or 3.7 kt N/year in the period 1990 to 2019. Figure 5.62 shows the trend of application of inorganic fertilizers indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O application of inorganic fertilizers from inorganic N fertilisers for the different countries along the inventory period. The ten countries with the highest application of inorganic fertilizers accounted together for 79.5% of the total in 2019.Application of inorganic fertilizers decreased in 26 countries and increased in three countries. The three countries with the largest decreases were Germany, the United Kingdom and France with a total absolute decrease of 1.7 kt N/year. The largest increases occurred in Hungary, with a total absolute increase of 58 kt N/year.

Figure 5.61: 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019

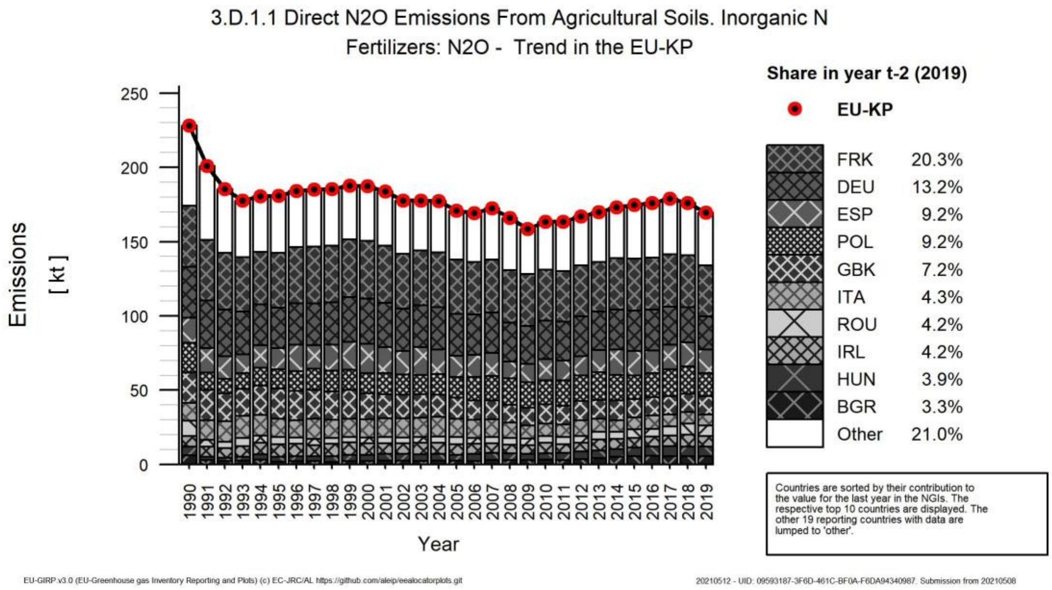
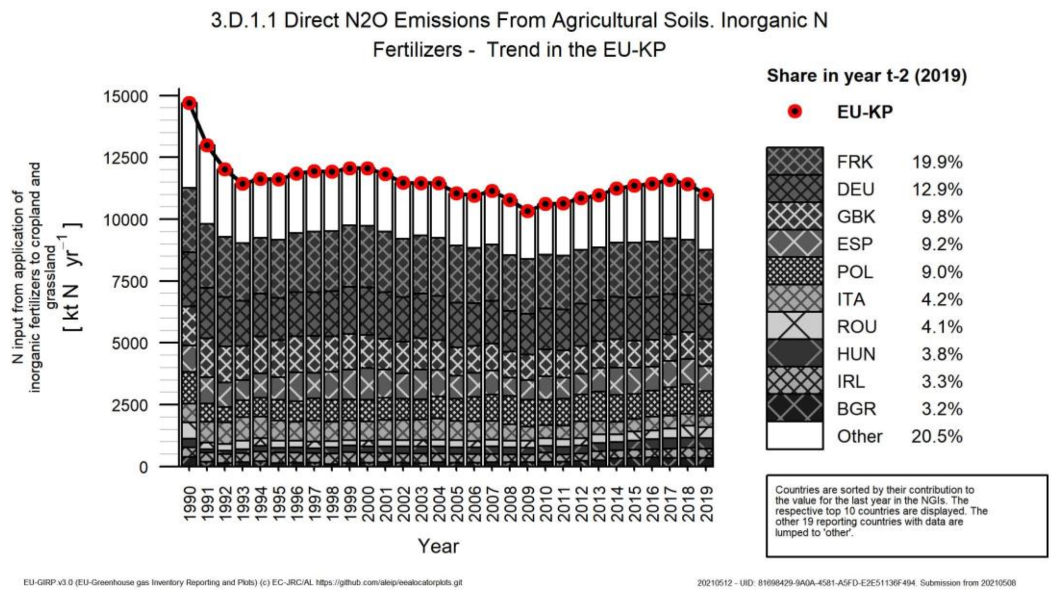


Figure 5.62: 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Trend in application of inorganic fertilizers in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



3.D.1.2 - Direct N_2O emissions from organic N fertilisers - Emissions

Emissions in source category *3.D.1.2 - Direct N_2O Emissions from organic N fertilisers* decreased clearly in EU-KP by 10% or 2.9 Mt CO_2-eq in the period 1990 to 2019. Figure 5.63 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from organic N fertilisers for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 83.7% of the total in 2019.Emissions decreased in twenty countries and increased in nine countries. The largest decreases occurred in Romania and Poland with a total absolute decrease of 2.3 Mt CO_2-eq. The four countries with the largest increases were the United Kingdom, Spain, the Netherlands and Germany, with a total absolute increase of 1.8 Mt CO_2-eq.

3.D.1.2 - Direct N_2O emissions from organic N fertilisers - amount of N applied

N from applied organic N fertilizers decreased clearly in EU-KP by 13% or 835 kt N/year in the period 1990 to 2019. Figure 5.64 shows the trend of N from applied organic N fertilizers indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O N from applied organic N fertilizers from organic N fertilisers for the different countries along the inventory period. The ten countries with the highest N from applied organic N fertilizers accounted together for 84.4% of the total in 2019.N from applied organic N fertilizers decreased in 21 countries and increased in eight countries. The largest decreases occurred in Romania and Poland with a total absolute decrease of 489 kt N/year. The four countries with the largest increases were the United Kingdom, Ireland, Spain and Germany, with a total absolute increase of 305 kt N/year.

Figure 5.63: 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019

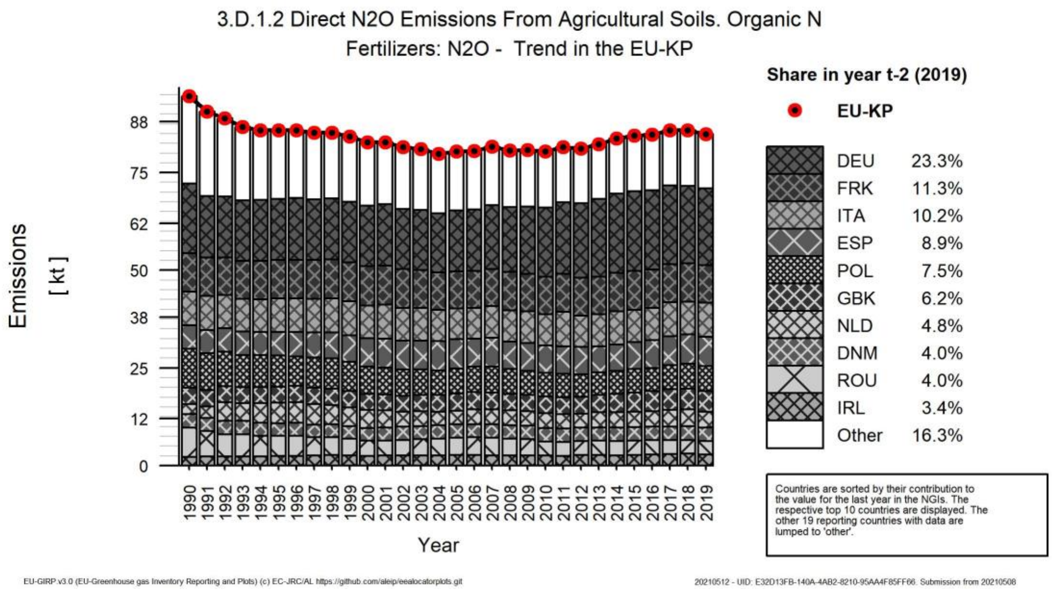
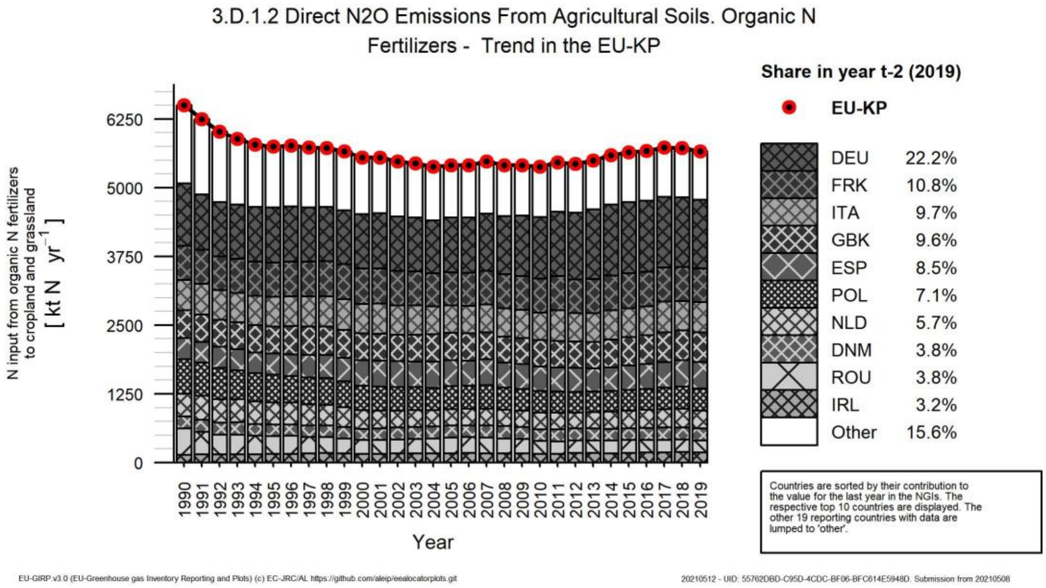


Figure 5.64: **3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019**



3.D.1.3 - Urine and Dung Deposited by Grazing Animals - Emissions

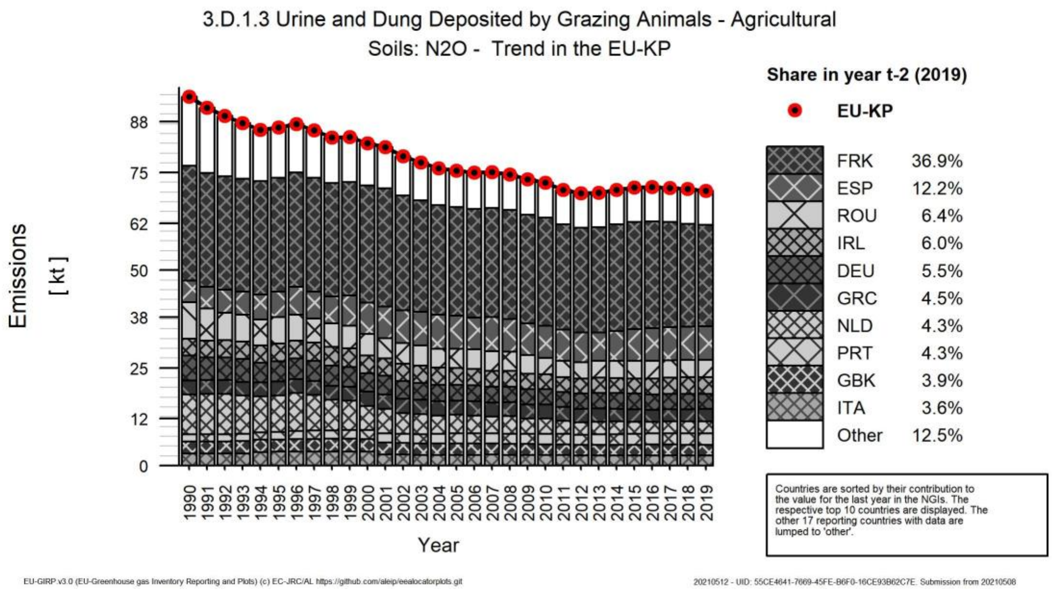
In 2019 N_2O emissions in source category *3.D.1.3 - Urine and Dung Deposited by Grazing Animals* in EU-KP were 20965 kt CO_2 equivalent. This corresponds to 0.46% of total EU-KP GHG emissions and 8.2% of total EU-KP N_2O emissions. They make 4.9% of total agricultural emissions and 11% of total agricultural N_2O emissions.

Total GHG and N_2O emissions by country from 3.D.1.3 *Grazing Animals* are shown in Table 5.46 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2019). Values are given in kt CO_2-eq. Between 1990 and 2019, N_2O emission in this source category decreased by 26% or 7.2 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (79%) and in the Netherlands in absolute terms (2.1 Mt CO_2-eq). The ten countries with the highest emissions accounted together for 87.5% of the total in 2019.Emissions decreased in 23 countries and increased in four countries. The four countries with the largest decreases were the Netherlands, Romania, Poland and France with a total absolute decrease of 5.7 Mt CO_2-eq. The largest increases occurred in Portugal and Spain, with a total absolute increase of 1.3 Mt CO_2-eq. From 2018 to 2019 emissions in the current category decreased by 0.6%. Figure 5.65 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from grazing animals for the different countries along the inventory period.

Table 5.46 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	147	87	86	0.4%	-62	-42%	-1	-2%	T1	D
Belgium	691	482	477	2.3%	-215	-31%	-6	-1%	T1	D
Bulgaria	616	132	129	0.6%	-486	-79%	-2	-2%	T1	D
Croatia	137	55	57	0.3%	-80	-58%	2	3%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	237	205	173	0.8%	-63	-27%	-32	-16%	T1	D
Denmark	298	175	173	0.8%	-125	-42%	-3	-1%	0	0
Estonia	89	25	25	0.1%	-64	-72%	-0.1	-0.3%	T1	D
Finland	150	105	105	0.5%	-45	-30%	-0.4	-0.3%	T1	D
France	8 760	7 851	7 738	36.9%	-1 022	-12%	-113	-1%	T1,T2	D
Germany	1 916	1 158	1 151	5.5%	-764	-40%	-6	-1%	T1	D
Greece	1 058	945	939	4.5%	-118	-11%	-6	-1%	T1	D
Hungary	193	131	133	0.6%	-60	-31%	3	2%	T1	D
Ireland	1 273	1 282	1 266	6.0%	-7	-1%	-17	-1%	T1	D
Italy	920	767	758	3.6%	-162	-18%	-8	-1%	T1	CS,D
Latvia	150	61	62	0.3%	-88	-58%	2	3%	T1	D
Lithuania	420	144	141	0.7%	-279	-67%	-3	-2%	T1	D
Luxembourg	49	48	47	0.2%	-2	-4%	-1	-2%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 028	900	900	4.3%	-2 128	-70%	-0.1	0.0%	T1	D
Poland	1 589	498	505	2.4%	-1 085	-68%	6	1%	T1	CS,D
Portugal	538	885	896	4.3%	358	66%	11	1%	T1	D
Romania	2 785	1 330	1 342	6.4%	-1 443	-52%	11	1%	T1	D
Slovakia	109	59	57	0.3%	-52	-47%	-1	-2%	T1	CS
Slovenia	20	40	40	0.2%	20	103%	0.2	0.4%	T1	D
Spain	1 656	2 529	2 555	12.2%	898	54%	26	1%	CS,T1	D
Sweden	356	351	358	1.7%	3	1%	8	2%	T1	D
United Kingdom	928	804	814	3.9%	-114	-12%	11	1%	T2	CS
EU-27+UK	**28 113**	**21 050**	**20 928**	**100%**	**-7 185**	**-26%**	**-121**	**-1%**	**-**	**-**
Iceland	48	42	42	0.2%	-6	-12%	-1	-1%	T1	D
United Kingdom (KP)	928	804	814	3.9%	-114	-12%	11	1%	T2	CS
EU-KP	**28 161**	**21 092**	**20 970**	**100%**	**-7 191**	**-26%**	**-122**	**-1%**	**-**	**-**

Figure 5.65: 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



Implied EFs and Methodological Issues

In this section we discuss the implied emission factor for the main N sources contributing to direct N_2O emissions from managed soils.

3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers* decreased in EU-KP barely between 1990 and 2019 by 0.74%. Figure 5.66 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.47 shows the implied emission factor for N_2O emissions in source category *3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in six countries and increased in two countries. It was in 2019 at the level of 1990 in 21 countries.

Figure 5.66: 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

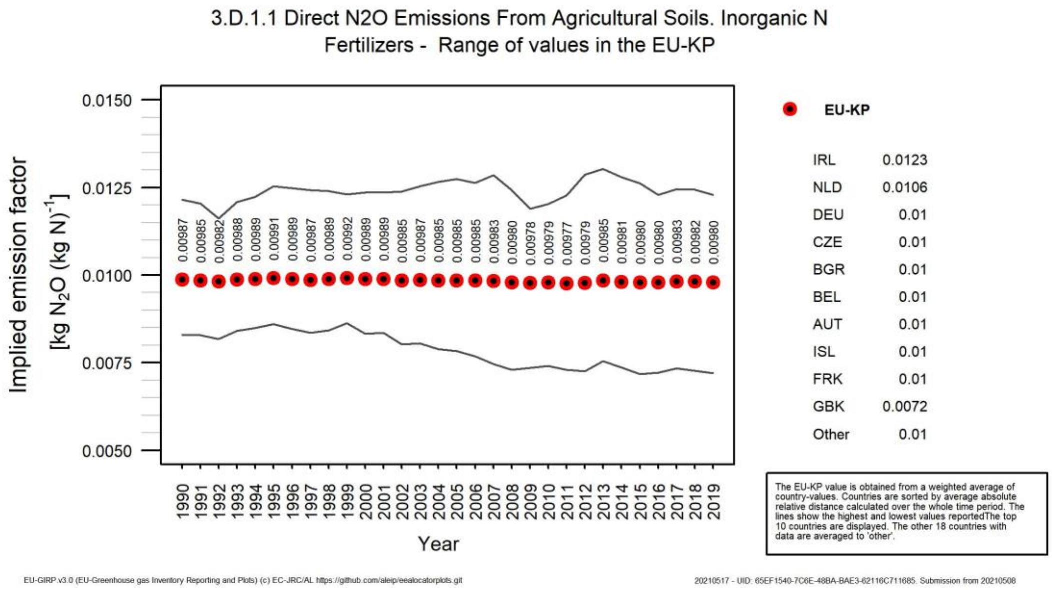


Table 5.47 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2019		Country	1990	2019
Austria	0.0100	0.0100	|	Ireland	0.0122	0.0123
Belgium	0.0100	0.0100	|	Iceland	0.0100	0.0100
Bulgaria	0.0100	0.0100	|	Italy	0.0100	0.0100
Cyprus	0.0100	0.0100	|	Lithuania	0.0100	0.0100
Czech Republic	0.0100	0.0100	|	Luxembourg	0.0100	0.0100
Germany	0.0100	0.0100	|	Latvia	0.0100	0.0100
Denmark	0.0100	0.0100	|	Malta	0.0100	0.0100
Spain	0.0099	0.0099	|	Netherlands	0.0103	0.0106
Estonia	0.0100	0.0100	|	Poland	0.0100	0.0100
Finland	0.0100	0.0100	|	Portugal	0.0098	0.0098
France	0.0100	0.0100	|	Romania	0.0100	0.0100
United Kingdom	0.0083	0.0072	|	Slovakia	0.0100	0.0100
Greece	0.0100	0.0100	|	Slovenia	0.0100	0.0100

Country	1990	2019		Country	1990	2019
Croatia	0.0100	0.0100	|	Sweden	0.0100	0.0100
Hungary	0.0100	0.0100	|	EU-KP	0.0099	0.0098

3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers* increased in EU-KP slightly between 1990 and 2019 by 2.9%. Figure 5.67 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.48 shows the implied emission factor for N_2O emissions in source category *3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in two countries and increased in six countries. It was in 2019 at the level of 1990 in 21 countries. The largest increase occurred in the Netherlands with an absolute value of 0.0041 kg N_2O-N/kg N.

Figure 5.67: 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

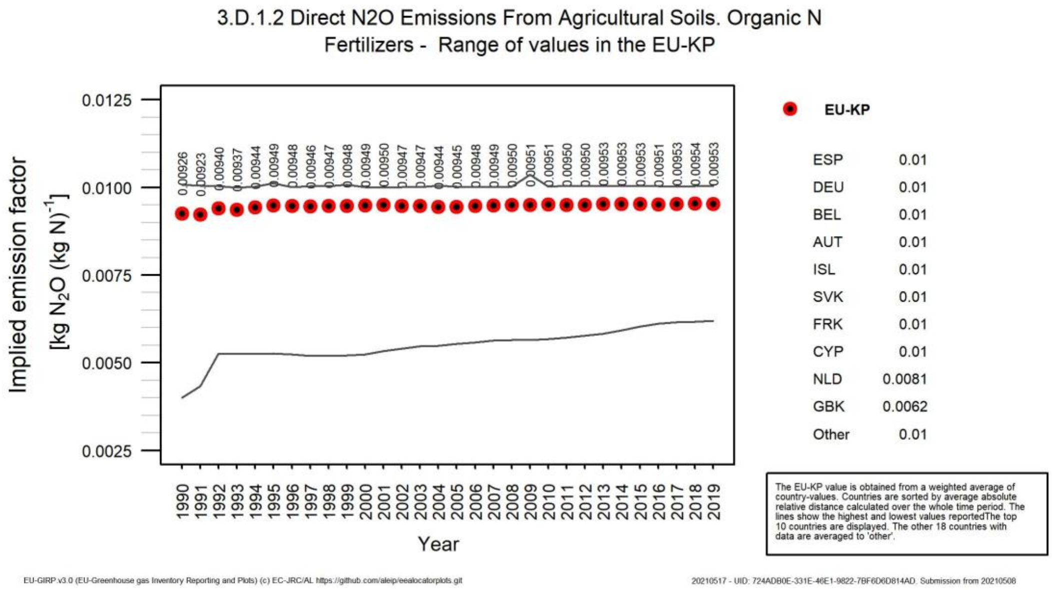


Table 5.48 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2019		Country	1990	2019
Austria	0.0100	0.0100	|	Ireland	0.0100	0.0100
Belgium	0.0100	0.0100	|	Iceland	0.0100	0.0100
Bulgaria	0.0100	0.0100	|	Italy	0.0100	0.0100
Cyprus	0.0100	0.0100	|	Lithuania	0.0100	0.0100
Czech Republic	0.0100	0.0100	|	Luxembourg	0.0100	0.0100
Germany	0.0100	0.0100	|	Latvia	0.0100	0.0100
Denmark	0.0100	0.0100	|	Malta	0.0100	0.0100
Spain	0.0101	0.0100	|	Netherlands	0.0040	0.0081
Estonia	0.0100	0.0100	|	Poland	0.0100	0.0100
Finland	0.0100	0.0100	|	Portugal	0.0100	0.0100

Country	1990	2019		Country	1990	2019
France	0.0100	0.0100	|	Romania	0.0100	0.0100
United Kingdom	0.0053	0.0062	|	Slovakia	0.0100	0.0100
Greece	0.0100	0.0100	|	Slovenia	0.0100	0.0100
Croatia	0.0100	0.0100	|	Sweden	0.0100	0.0100
Hungary	0.0100	0.0100	|	EU-KP	0.0093	0.0095

3.D.1.3 - Urine and Dung Deposited by Grazing Animals - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.D.1.3 - Urine and Dung Deposited by Grazing Animals* decreased since 1990 from 0.0152 to 0.0150 kg N_2O-N/kg N at EU-KP level. Table 5.49 shows the implied emission factor for N_2O emissions in source category *3.D.1.3 - Urine and Dung Deposited by Grazing Animals* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in seventeen countries and increased in ten countries. No data were available for two countries (Cyprus and Malta). The three countries with the largest decreases were Croatia, Romania and Austria with a mean absolute value of 0.0024 kg N_2O-N/kg N. The three countries with the largest increases were Spain, Portugal and the Czech Republic with a mean absolute value of 0.0019 kg N_2O-N/kg N.

Table 5.49 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2019		Country	1990	2019
Austria	0.0186	0.0167	|	Ireland	0.0088	0.0087
Belgium	0.0197	0.0195	|	Iceland	0.0109	0.0113
Bulgaria	0.0120	0.0125	|	Italy	0.0111	0.0111
Czech Republic	0.0174	0.0190	|	Lithuania	0.0190	0.0190
Germany	0.0191	0.0190	|	Luxembourg	0.0198	0.0197
Denmark	0.0187	0.0177	|	Latvia	0.0196	0.0188
Spain	0.0152	0.0174	|	Netherlands	0.0330	0.0314
Estonia	0.0182	0.0167	|	Poland	0.0185	0.0194
Finland	0.0179	0.0170	|	Portugal	0.0163	0.0182
France	0.0189	0.0191	|	Romania	0.0155	0.0129
United Kingdom	0.0035	0.0037	|	Slovakia	0.0158	0.0156
Greece	0.0104	0.0105	|	Slovenia	0.0185	0.0174
Croatia	0.0136	0.0109	|	Sweden	0.0176	0.0173
Hungary	0.0138	0.0151	|	EU-KP	0.0148	0.0146

5.3.5 Indirect Emissions from Managed Soils - N_2O (CRF Source Category 3D2)

In 2019 N_2O emissions in source category *3.D.2 - Indirect Emissions from Managed Soils* in EU-KP were 29285 kt CO_2 equivalent. This corresponds to 0.65% of total EU-KP GHG emissions and 11% of total EU-KP N_2O emissions. They make 6.8% of total agricultural emissions and 16% of total agricultural N_2O emissions. The main sub-categories are 3.D.2.2 (Nitrogen Leaching and Run-off), and 3.D.2.1

(Atmospheric Deposition) as shown in Figure 5.68. Regarding the origin of emissions in the different countries, Figure 5.69 shows the distribution of indirect N_2O emissions from managed soils by emission source in all countries and in the EU-KP. Each bar represents the total emissions of a country in the current emission category, where different shades of blue correspond to the emitting sub-categories.

Figure 5.68: Share of source category 3.D.2 on total EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2019.

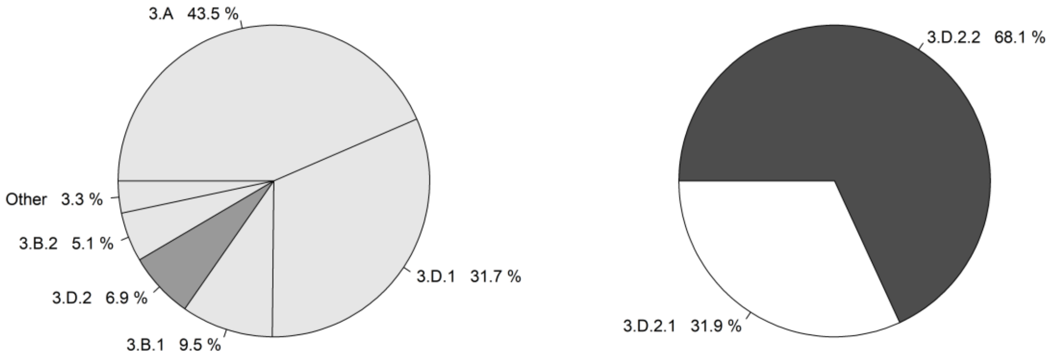
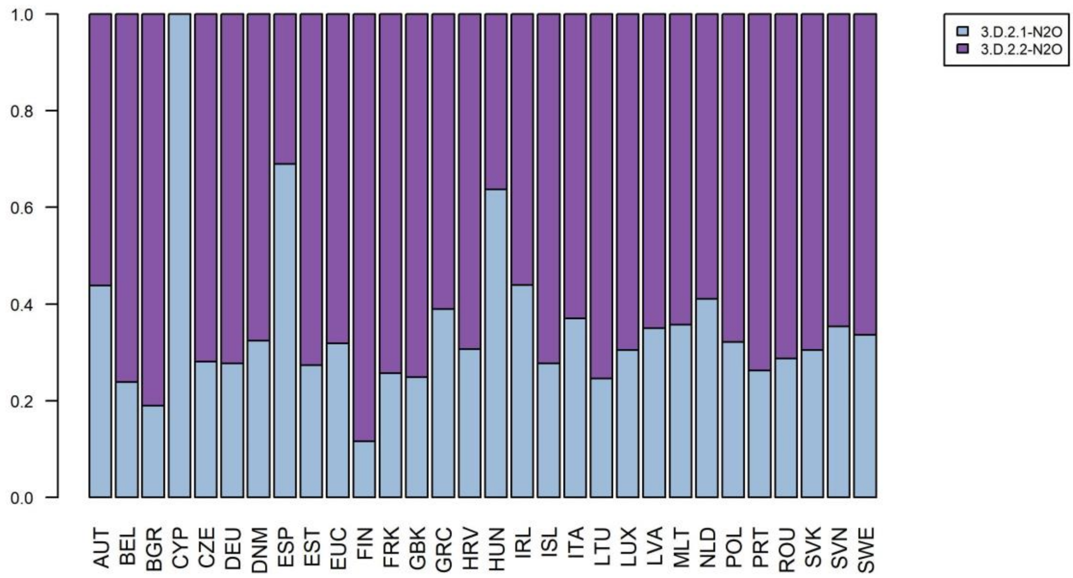


Figure 5.69: Decomposition of emissions in source category 3.D.2 - Indirect Emissions from Managed Soils into its sub-categories by country in the year 2019. 3.D.2.1 Atmospheric Deposition and 3.D.2.2 Nitrogen Leaching and Run-off.



Total GHG and N_2O emissions by country from 3.D.2 *Indirect Emissions from Managed Soils* are shown in Table 5.50 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2019). Values are given in kt CO_2-eq. Between 1990 and 2019, N_2O emission in this source category decreased by 23% or 8.5 Mt CO_2-eq. The decrease was largest in the Netherlands in relative terms (64%) and in Poland in absolute terms (1.3 Mt CO_2-eq). From 2018 to 2019 emissions in the current category decreased by 1.4%.

Table 5.50 3.D.2 - Indirect Emissions from Managed Soils: Countries' contributions to total EU-GHG and N_2O emissions

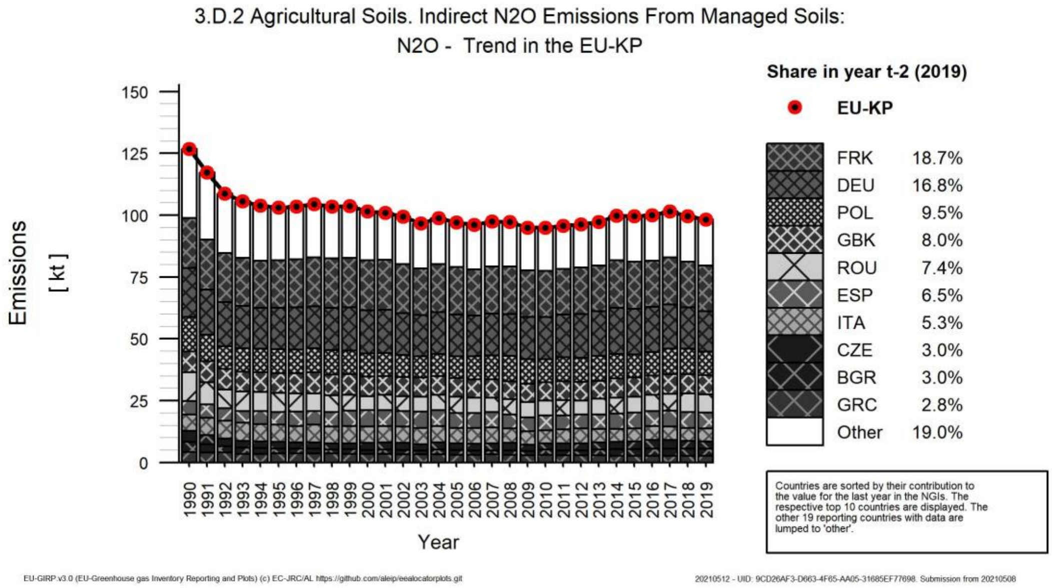
Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	353	325	318	1.1%	-36	-10%	-7	-2%	T1	D
Belgium	1 086	686	690	2.4%	-397	-36%	4	1%	T1	D
Bulgaria	1 242	857	868	3.0%	-374	-30%	10	1%	T1	D
Croatia	350	265	264	0.9%	-86	-25%	-1	-0.4%	T1	D
Cyprus	17	17	17	0.1%	-0.1	-0.4%	0.3	2%	T1	D
Czechia	1 319	937	887	3.0%	-431	-33%	-50	-5%	T1	D
Denmark	870	476	543	1.9%	-328	-38%	67	14%	0	0
Estonia	235	123	137	0.5%	-98	-42%	14	12%	D,T1	D
Finland	481	379	404	1.4%	-77	-16%	25	7%	T1	D
France	6 023	5 517	5 467	18.7%	-556	-9%	-50	-1%	T1,T2	CS,D
Germany	5 901	4 984	4 911	16.8%	-990	-17%	-74	-1%	T1	D
Greece	1 242	794	810	2.8%	-432	-35%	17	2%	T1	D
Hungary	360	274	275	0.9%	-85	-24%	1	0.3%	T1	D
Ireland	556	615	572	2.0%	16	3%	-42	-7%	T1	CS,D
Italy	2 003	1 562	1 554	5.3%	-449	-22%	-8	-1%	T1	CS,D
Latvia	312	157	172	0.6%	-139	-45%	16	10%	T1	D
Lithuania	572	396	406	1.4%	-166	-29%	10	2%	T1	D
Luxembourg	51	44	45	0.2%	-6	-11%	0.4	1%	T1,T2	D
Malta	6	5	5	0.02%	-1	-15%	-0.03	-1%	T1	D
Netherlands	1 607	602	580	2.0%	-1 028	-64%	-23	-4%	T1	D
Poland	4 120	3 060	2 789	9.5%	-1 331	-32%	-271	-9%	T1	D
Portugal	483	414	419	1.4%	-65	-13%	5	1%	T1,T2	CS,D
Romania	3 455	2 240	2 181	7.4%	-1 274	-37%	-59	-3%	T1	D
Slovakia	488	287	299	1.0%	-188	-39%	12	4%	T1,T2	CS,D
Slovenia	114	106	107	0.4%	-7	-6%	0.4	0.4%	T1	D
Spain	1 588	1 916	1 903	6.5%	315	20%	-13	-1%	CS,T1,T2	D
Sweden	368	284	281	1.0%	-87	-24%	-3	-1%	CS	D
United Kingdom	2 543	2 334	2 349	8.0%	-194	-8%	15	1%	T1	D
EU-27+UK	**37 746**	**29 656**	**29 252**	**100%**	**-8 494**	**-23%**	**-404**	**-1%**	**-**	**-**
Iceland	43	39	37	0.1%	-6	-14%	-2	-5%	T1b	D
United Kingdom (KP)	2 543	2 334	2 349	8.0%	-194	-8%	15	1%	T1	D
EU-KP	**37 789**	**29 695**	**29 289**	**100%**	**-8 500**	**-22%**	**-406**	**-1%**	**-**	**-**

Trends in Emissions and Activity Data

3.D.2 - Indirect Emissions from Managed Soils - Emissions

Emissions in source category *3.D.2 - Indirect Emissions from Managed Soils* decreased considerably in EU-KP by 23% or 8.5 Mt CO_2-eq in the period 1990 to 2019. Figure 5.70 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from indirect emissions from managed soils for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 81% of the total in 2019.Emissions decreased in 27 countries and increased in two countries. The four countries with the largest decreases were Poland, Romania, the Netherlands and Germany with a total absolute decrease of 4.6 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 315 kt CO_2-eq.

Figure 5.70: 3.D.2 Indirect Emissions from Managed Soils: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition - Emissions

Emissions in source category *3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition* decreased strongly in EU-KP by 27% or 3.5 Mt CO_2-eq in the period 1990 to 2019. Figure 5.71 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from atmospheric deposition for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 81.2% of the total in 2019.Emissions decreased in 27 countries and increased in two countries. The three countries with the largest decreases were the Netherlands, Romania and Poland with a total absolute decrease of 1.7 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 185 kt CO_2-eq.

3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition - Volatilized N from agricultural N inputs

Volatilized N from agricultural N inputs decreased strongly in EU-KP by 27% or 745 kt N/year in the period 1990 to 2019. Figure 5.72 shows the trend of volatilized N from agricultural N inputs indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O volatilized N from agricultural N inputs from atmospheric deposition for the different countries along the inventory period. The ten countries with the highest volatilized N from agricultural N inputs accounted together for 81.6% of the total in 2019.Volatilized N from agricultural N inputs decreased in 27 countries and increased in two countries. The three countries with the largest decreases were the Netherlands, Romania and Poland with a total absolute decrease of 358 kt N/year. The largest increases occurred in Spain, with a total absolute increase of 40 kt N/year.

Figure 5.71: 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019

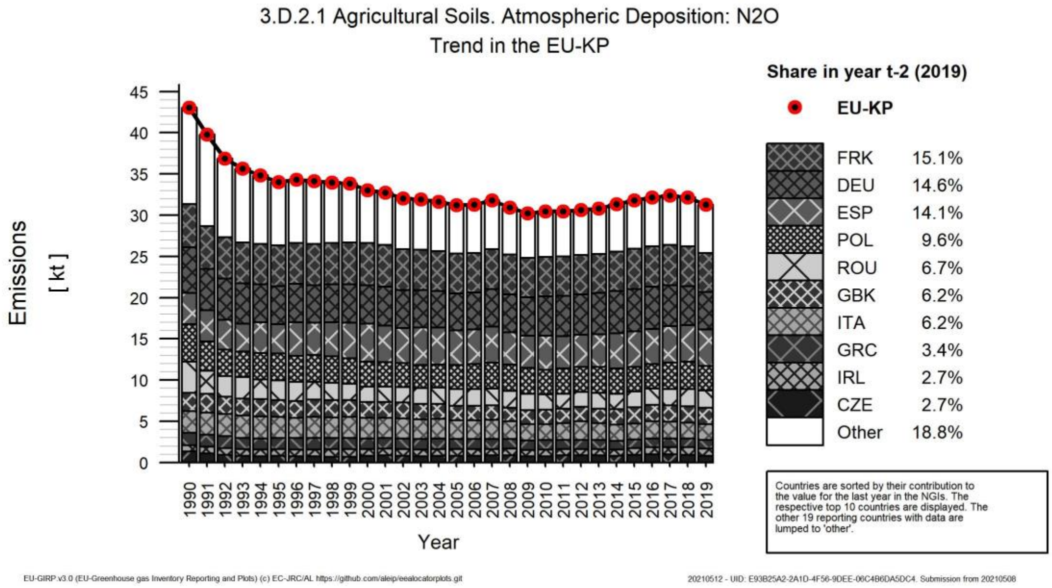
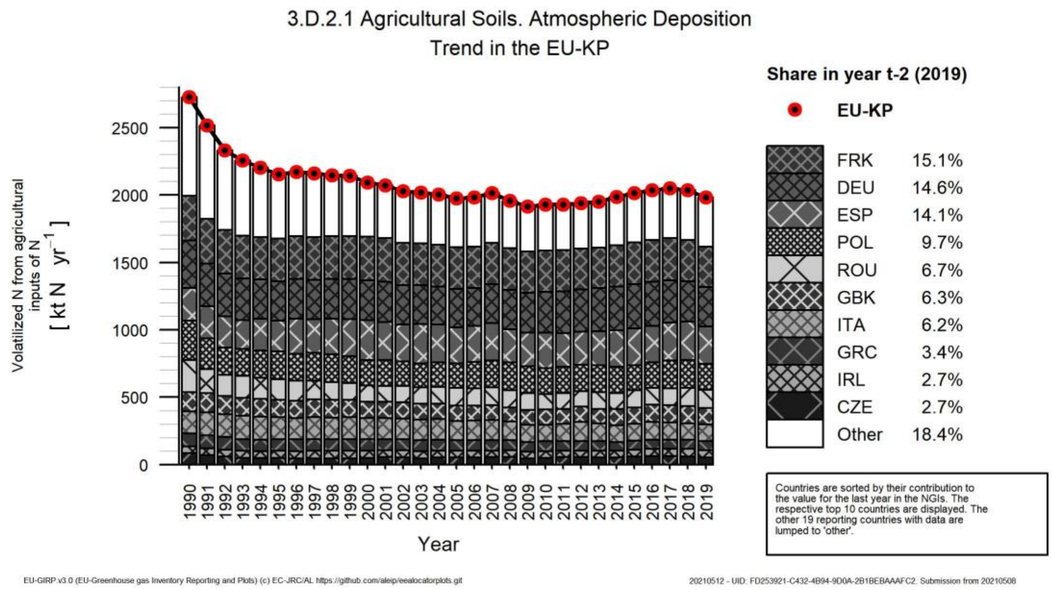


Figure 5.72: 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off - Emissions

Emissions in source category *3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off* decreased considerably in EU-KP by 20% or 5 Mt CO_2-eq in the period 1990 to 2019. Figure 5.73 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 81.5% of the total in 2019.Emissions decreased in 27 countries and increased in one country. The three countries with the largest decreases were Poland, Romania and Germany with a total absolute decrease of 2.3 Mt CO_2-eq. Emissions increased in Spain, with a total absolute increase of 129 kt CO_2-eq.

3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off - N from fertilizers and other agricultural inputs that is lost through leaching and run-off

N from fertilizers and other agricultural inputs that is lost through leaching and run-off decreased considerably in EU-KP by 21% or 1.7 kt N/year in the period 1990 to 2019. Figure 5.74 shows the trend of N from fertilizers and other agricultural inputs that is lost through leaching and run-off indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O N from fertilizers and other agricultural inputs that is lost through leaching and run-off for the different countries along the inventory period. The ten countries with the highest N from fertilizers and other agricultural inputs that is lost through leaching and run-off accounted together for 82.3% of the total in 2019.N from fertilizers and other agricultural inputs that is lost through leaching and run-off decreased in 27 countries and increased in one country. The four countries with the largest decreases were the Czech Republic, Poland, Romania and Germany with a total absolute decrease of 941 kt N/year. N from fertilizers and other agricultural inputs that is lost through leaching and run-off increased in Spain, with a total absolute increase of 37 kt N/year.

Figure 5.73: 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019

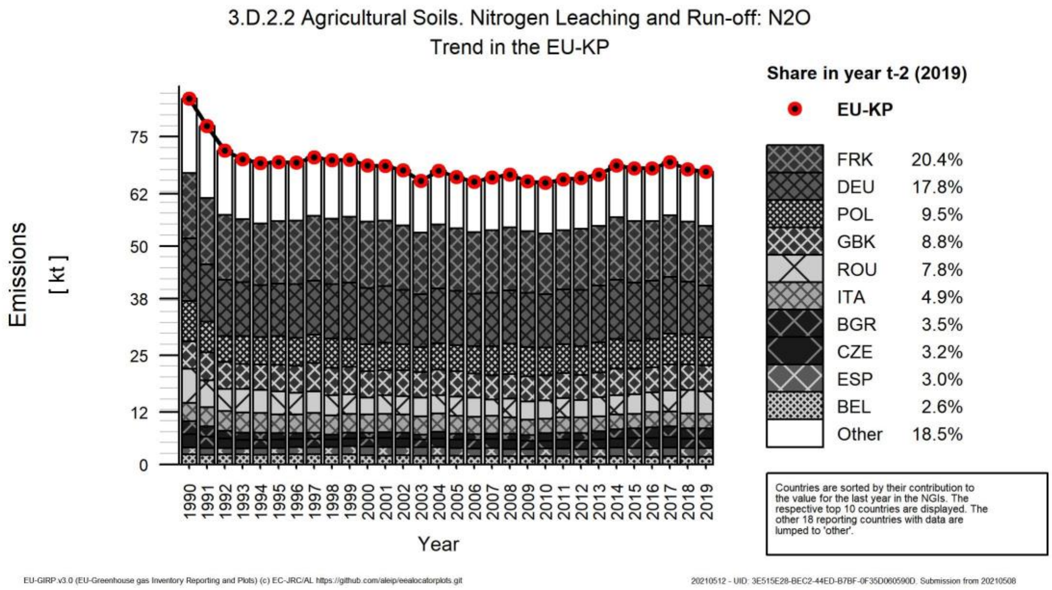
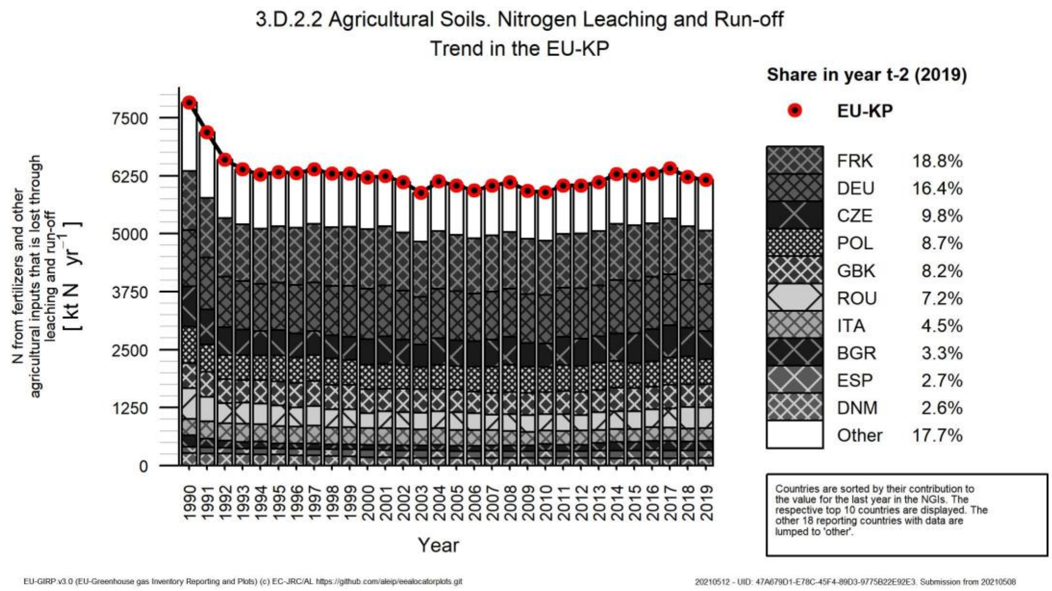


Figure 5.74: 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: Trend N leached from fertilisers and other agricultural inputs in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2019



Implied EFs and Methodological Issues

In this section we discuss the implied emission factor for the main N sources contributing to indirect N_2O emissions from managed soils. Furthermore, we present the most relevant parameters related with indirect N_2O emissions:

- $Frac_{GASF}$: Fraction of synthetic fertiliser N applied to soils that volatilises as NH_3 and NO_X
- $Frac_{GASM}$: Fraction of livestock N excretion that volatilises as NH_3 and NO_X
- $Frac_{LEACH}$: Fraction of N input to managed soils that is lost through leaching and run-off.

3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition

The implied emission factor for N_2O emissions in source category *3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition* decreased in EU-KP barely between 1990 and 2019 by 0.0089%. Figure 5.75 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.51 shows the implied emission factor for N_2O emissions in source category *3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in two countries and increased in six countries. It was in 2019 at the level of 1990 in 21 countries.

Figure 5.75: 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

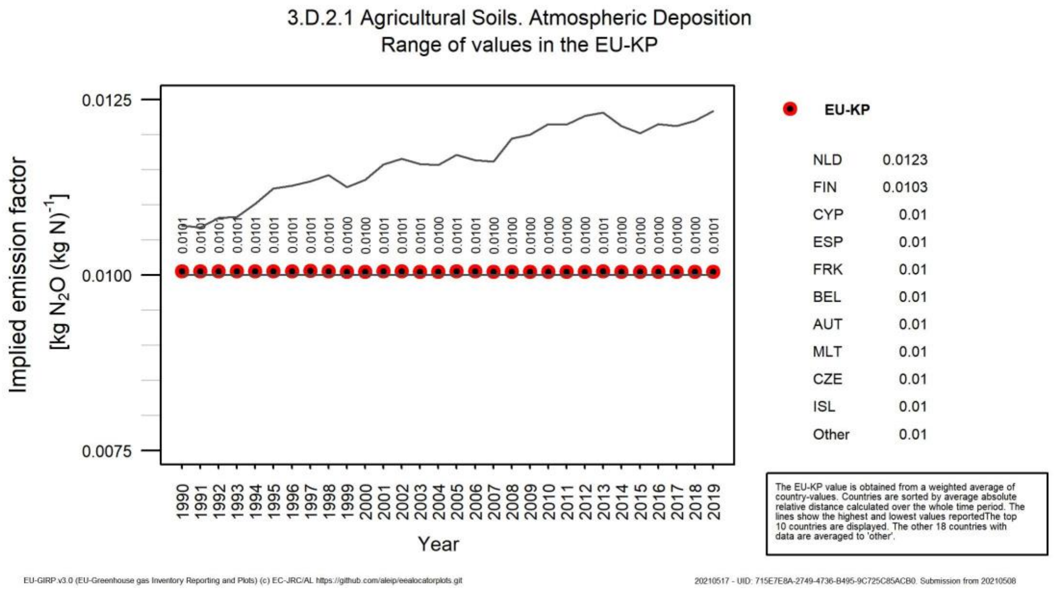


Table 5.51 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2019		Country	1990	2019
Austria	0.010	0.010	|	Ireland	0.010	0.010
Belgium	0.010	0.010	|	Iceland	0.010	0.010
Bulgaria	0.010	0.010	|	Italy	0.010	0.010
Cyprus	0.010	0.010	|	Lithuania	0.010	0.010
Czech Republic	0.010	0.010	|	Luxembourg	0.010	0.010
Germany	0.010	0.010	|	Latvia	0.010	0.010
Denmark	0.010	0.010	|	Malta	0.010	0.010
Spain	0.010	0.010	|	Netherlands	0.011	0.012
Estonia	0.010	0.010	|	Poland	0.010	0.010

Finland	0.010	0.010	|	Portugal	0.010	0.010
France	0.010	0.010	|	Romania	0.010	0.010
United Kingdom	0.010	0.010	|	Slovakia	0.010	0.010
Greece	0.010	0.010	|	Slovenia	0.010	0.010
Croatia	0.010	0.010	|	Sweden	0.010	0.010
Hungary	0.010	0.010	|	EU-KP	0.010	0.010

3.D.2.1 - Indirect emissions from Atmospheric Deposition - $Frac_{GASF}$

The $Frac_{GASF}$, a parameter used for calculating N_2O emissions in source category *3.D.2.1 - Indirect emissions from Atmospheric Deposition*, increased in EU-KP slightly between 1990 and 2019 by 1.7% or 0.033. Table 5.52 shows the $Frac_{GASF}$ in source category *3.D.2.1 - Indirect emissions from Atmospheric Deposition* for the years 1990 and 2019 for all countries and EU-KP. The $Frac_{GASF}$ decreased in six countries and increased in ten countries. It was in 2019 at the level of 1990 in thirteen countries. The three countries with the largest decreases were Hungary, Ireland and Portugal with a mean absolute value of 0.0078. The three countries with the largest increases were Italy, Germany and the Netherlands with a mean absolute value of 0.01.

Table 5.52 3.D.2.1 - Indirect emissions from Atmospheric Deposition: countries' $Frac_{GASF}$ (-)

Country	1990	2019		Country	1990	2019
Austria	0.049	0.053	|	Ireland	0.030	0.025
Belgium	0.064	0.068	|	Iceland	0.022	0.022
Bulgaria	0.064	0.064	|	Italy	0.088	0.101
Cyprus	0.100	0.100	|	Lithuania	0.063	0.069
Czech Republic	0.100	0.100	|	Luxembourg	0.032	0.037
Germany	0.042	0.052	|	Latvia	0.100	0.100
Denmark	0.053	0.061	|	Malta	0.100	0.100
Spain	0.100	0.100	|	Netherlands	0.041	0.049
Estonia	0.100	0.100	|	Poland	0.100	0.100
Finland	0.016	0.016	|	Portugal	0.052	0.047
France	0.060	0.064	|	Romania	0.100	0.100
United Kingdom	0.035	0.035	|	Slovakia	0.100	0.100
Greece	0.100	0.100	|	Slovenia	0.057	0.053
Croatia	0.100	0.100	|	Sweden	0.022	0.020
Hungary	0.064	0.051	|	EU-KP	1.953	1.986

3.D.2.2 - Indirect emissions from Atmospheric Deposition - $Frac_{GASM}$

The $Frac_{GASM}$, a parameter used for calculating N_2O emissions in source category *3.D.2.2 - Indirect emissions from Atmospheric Deposition*, decreased in EU-KP slightly between 1990 and 2019 by 3%. Table 5.53 shows the $Frac_{GASM}$ in source category *3.D.2.2 - Indirect emissions from Atmospheric Deposition* for the years 1990 and 2019 for all countries and EU-KP. The $Frac_{GASM}$ decreased in seven countries and increased in eight countries. It was in 2019 at the level of 1990 in thirteen countries. No data were available for the Netherlands. The largest decrease occurred in Denmark with an absolute value of 0.1. The three countries with the largest increases were Iceland, Belgium and Finland with a mean absolute value of 0.013.

Table 5.53 3.D.2.2 - Indirect emissions from Atmospheric Deposition: countries' $Frac_{GASM}$ (-)

Country	1990	2019		Country	1990	2019
Austria	0.159	0.162	|	Ireland	0.086	0.090
Belgium	0.156	0.169	|	Iceland	0.143	0.158
Bulgaria	0.200	0.200	|	Italy	0.238	0.212
Cyprus	0.200	0.200	|	Lithuania	0.200	0.200
Czech Republic	0.200	0.200	|	Luxembourg	0.164	0.172
Germany	0.196	0.156	|	Latvia	0.200	0.200
Denmark	0.146	0.075	|	Malta	0.200	0.200
Spain	0.200	0.200	|	Poland	0.200	0.200
Estonia	0.200	0.200	|	Portugal	0.134	0.123
Finland	0.076	0.087	|	Romania	0.200	0.200
France	0.109	0.109	|	Slovakia	0.200	0.200
United Kingdom	0.037	0.039	|	Slovenia	0.229	0.196
Greece	0.200	0.200	|	Sweden	0.173	0.159
Croatia	0.200	0.200	|	EU-KP	4.786	4.644
Hungary	0.142	0.136	|			

3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off

The implied emission factor for N_2O emissions in source category *3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off* increased in EU-KP slightly between 1990 and 2019 by 1.7%. Figure 5.76 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.54 shows the implied emission factor for N_2O emissions in source category *3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off* for the years 1990 and 2019 for all countries and EU-KP. The implied emission factor decreased in three countries and increased in five countries. It was in 2019 at the level of 1990 in twenty countries. No data were available for Cyprus.

Figure 5.76: 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: Trend in implied emission factor in the EU-KP and range of values reported by countries. The lines show the highest and lowest values reported by the countries.

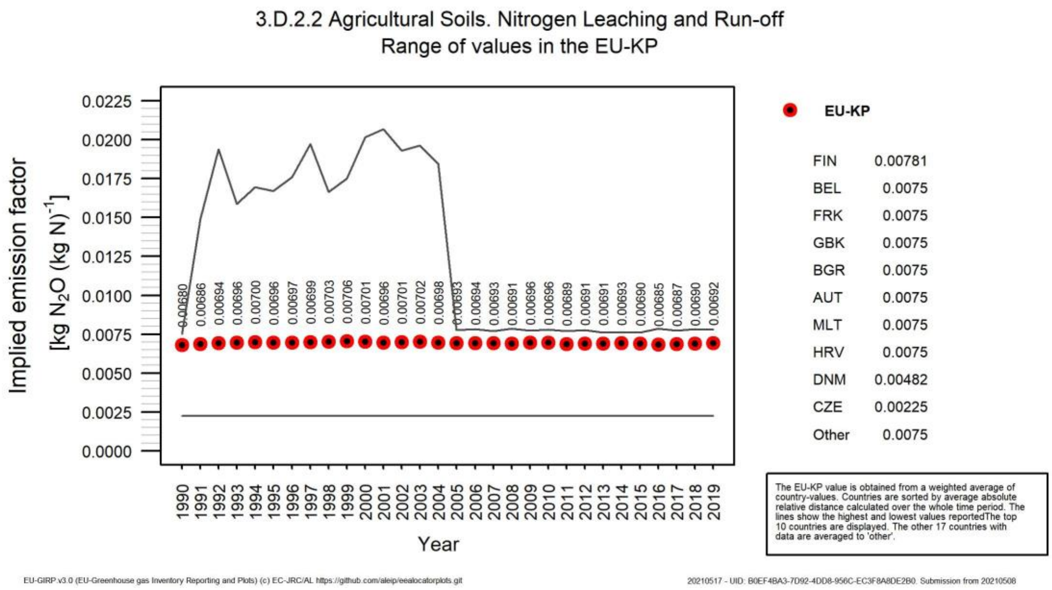


Table 5.54 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2019		Country	1990	2019
Austria	0.0075	0.0075	|	Iceland	0.0075	0.0075
Belgium	0.0075	0.0075	|	Italy	0.0075	0.0075
Bulgaria	0.0075	0.0075	|	Lithuania	0.0075	0.0075
Czech Republic	0.0022	0.0022	|	Luxembourg	0.0075	0.0075
Germany	0.0075	0.0075	|	Latvia	0.0075	0.0075
Denmark	0.0043	0.0048	|	Malta	0.0075	0.0075
Spain	0.0075	0.0075	|	Netherlands	0.0075	0.0075
Estonia	0.0075	0.0075	|	Poland	0.0075	0.0075
Finland	0.0075	0.0078	|	Portugal	0.0075	0.0075
France	0.0075	0.0075	|	Romania	0.0075	0.0075
United Kingdom	0.0075	0.0075	|	Slovakia	0.0075	0.0075
Greece	0.0075	0.0075	|	Slovenia	0.0075	0.0075
Croatia	0.0075	0.0075	|	Sweden	0.0075	0.0075
Hungary	0.0075	0.0075	|	EU-KP	0.0068	0.0069
Ireland	0.0075	0.0075	|			

3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off - $Frac_{LEACH}$

The $Frac_{LEACH}$, a parameter used for calculating N_2O emissions in source category *3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off*, decreased in EU-KP slightly between 1990 and 2019 by 3.7%. Table 5.55 shows the $Frac_{LEACH}$ in source category *3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off* for the years 1990 and 2019 for all countries and EU-KP. $Frac_{leach}$ decreased in four countries and increased in two countries. It was in 2019 at the level of 1990 in 22 countries. No data were available for Cyprus. The largest decreases occurred in Slovakia and Sweden with a mean absolute value of 0.1. Increases occurred in the United Kingdom and Spain with a mean absolute value of 0.012.

Table 5.55 3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off: countries' $Frac_{LEACH}$ (-)

Country	1990	2019		Country	1990	2019
Austria	0.152	0.152	|	Iceland	0.300	0.300
Belgium	0.300	0.300	|	Italy	0.207	0.207
Bulgaria	0.300	0.300	|	Lithuania	0.300	0.300
Czech Republic	0.300	0.300	|	Luxembourg	0.300	0.300
Germany	0.300	0.300	|	Latvia	0.230	0.230
Denmark	0.331	0.255	|	Malta	0.300	0.300
Spain	0.077	0.083	|	Netherlands	0.150	0.130
Estonia	0.300	0.300	|	Poland	0.300	0.300
Finland	0.300	0.300	|	Portugal	0.300	0.300
France	0.251	0.251	|	Romania	0.300	0.300
United Kingdom	0.178	0.195	|	Slovakia	0.241	0.088
Greece	0.300	0.300	|	Slovenia	0.300	0.300
Croatia	0.300	0.300	|	Sweden	0.166	0.124
Hungary	0.300	0.300	|	EU-KP	7.182	6.915
Ireland	0.100	0.100	|			

5.3.6 Agriculture- non-key categories

Table 5.56 shows the aggregated GHG emissions of non-key categories from source categories 3C, 3E, 3F and 3G-I by each country for the year 2019. Total CO_2 emissions is around 12.6 kt, with the highest CO_2 emissions by Germany. CH_4 emissions from 'Rice Cultivation' is the largest by Italy (63.3kt), followed by Spain (17.0kt). Total CH_4 emissions from 'Rice Cultivation' is 99.6 kt. CH_4 emissions from 'Field burning of agricultural residues', is the largest by Romania (11.8 kt), whilst total EU-KP is 19.32 kt. Total CH_4 EU-KP emissions ('Rice Cultivation' and Field burning of agricultural residues') is 118.9 kt, with the highest top emitters being Italy, Romania, Spain. Total N_2O emissions for EU-KP is 0.6 kt in 2019, with Romania having the highest emissions (0.36 kt). CH_4 and N_2O emissions from 'Prescribed burning of savannas' are not reported by the countries.

Table 5.56 Aggregated GHG emissions from non-key categories in the agriculture sector

Country	2019	CO_2 (kt)	CH_4 (kt) Rice Cultivation	CH_4 (kt) Field burning of agricultural residues	N_2O (kt) Field burning of agricultural residues
Austria		143.24	-	0.02	0.00
Belgium		182.37	-	-	-
Bulgaria		33.04	4.26	1.17	0.03
Cyprus		0.22	-	0.02	0.00
Czech Republic		341.93	-	-	-
Germany		2,821.10	-	-	-
Denmark		185.21	-	0.15	0.00

Country	2019	CO_2 (kt)	CH_4 (kt) Rice Cultivation	CH_4 (kt) Field burning of agricultural residues	N_2O (kt) Field burning of agricultural residues
Spain		446.25	16.97	0.90	0.02
Estonia		15.60	-	-	-
Finland		200.18	-	0.08	0.00
France		2,091.23	1.56	1.26	0.03
United Kingdom		1,628.41	-	0.00	0.00
Greece		34.80	6.12	1.08	0.03
Croatia		76.97	-	-	-
Hungary		216.83	0.71	0.01	0.00
Ireland		435.88	-	-	-
Iceland		5.87	-	-	-
Italy		429.81	63.33	0.59	0.01
Lithuania		28.61	-	-	-
Luxembourg		14.55	-	-	-
Latvia		54.87	-	-	-
Malta		-	-	-	-
Netherlands		80.12	-	-	-
Poland		1,122.67	-	0.92	0.04
Portugal		40.89	5.47	1.31	0.06
Romania		128.58	1.16	11.80	0.36
Slovakia		75.56	-	-	-
Slovenia		28.18	-	-	-
Sweden		127.11	-	-	-
EU-KP		**12,618.50**	**99.58**	**19.32**	**0.59**

5.4 Uncertainties

Table 5.57 shows the total EU-KP uncertainty estimates for the sector Agriculture and the uncertainty estimates for the relevant gases of each source category. The highest level uncertainty was estimated for N_2O from 3D and the lowest for CH_4 from sector 3A. With regard to the uncertainty on trend N_2O from sector 3J shows the highest uncertainty estimates, CH_4 from sector 3A the lowest. For a description of the Tier 1 uncertainty analysis carried out for the EU-KP see Chapter 1.6.

Table 5.57 Sector Agriculture: EU-KP uncertainty estimates

Source category	Gas	Emissions Base Year	Emissions 2019	Emission trends Base Year-2018	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
3.A Enteric Fermentation	CO2	0	0		0.0%	
3.A Enteric Fermentation	CH4	238 847	185 341	-22.4%	11.0%	0.01%
3.A Enteric Fermentation	N2O	0	0		0.0%	
3.B Manure Mangement	CO2	0	0		0.0%	
3.B Manure Mangement	CH4	50 279	40 801	-18.9%	20.2%	0.04%
3.B Manure Mangement	N2O	30 350	21 818	-28.1%	67.4%	0.1%
3.C Rice Cultivation	CO2	0	0		0.0%	
3.C Rice Cultivation	CH4	2 502	2 065	-17.5%	22.9%	0.2%
3.C Rice Cultivation	N2O	0	0		0.0%	
3.D Agricultural Soils	CO2	0	0		0.0%	
3.D Agricultural Soils	CH4	0	0		0.0%	
3.D Agricultural Soils	N2O	205 120	163 865	-20.1%	127.6%	0.1%
3.E Prescribed burning of savannas	CO2	0	0		0.0%	
3.E Prescribed burning of savannas	CH4	0	0		0.0%	
3.E Prescribed burning of savannas	N2O	0	0		0.0%	
3.F Field Burning of Agricultural Residues	CO2	0	0		0.0%	
3.F Field Burning of Agricultural Residues	CH4	1 644	482	-70.7%	49.8%	0.3%
3.F Field Burning of Agricultural Residues	N2O	360	168	-53.4%	50.5%	0.2%
3.G Liming	CO2	9 651	5 960	-38.2%	19.8%	0.1%
3.G Liming	CH4	0	0		0.0%	
3.G Liming	N2O	0	0		0.0%	
3.H Urea application	CO2	3 542	3 729	5.3%	21.4%	0.02%
3.H Urea application	CH4	0	0		0.0%	
3.H Urea application	N2O	0	0		0.0%	
3.I Other carbon-containing fertilizers	CO2	941	642	-31.8%	16.1%	0.0%
3.I Other carbon-containing fertilizers	CH4	0	0		0.0%	
3.I Other carbon-containing fertilizers	N2O	0	0		0.0%	
3.J Other	CO2	0	0		0.0%	0.0%
3.J Other	CH4	0	1 316	476698.0%	22.4%	1065.9%
3.J Other	N2O	0	258	206768.1%	97.6%	2017.4%
3 (where no subsector data were submitted	all	0	0		0.0%	0.0%
Total - 3	**all**	**543 237**	**426 445**	**-21.5%**	**49.4%**	**3.7%**

Note: Emissions are in Gg CO_2 equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions of the EU-NIR because uncertainty estimates are not available for all source categories in each of this 28 EU countries

5.5 Sector-specific quality assurance and quality control and verification

5.5.1 Introduction

This section gives an overview of the QA/QC procedures applied specifically for the agriculture sector of the EU GHG inventory. It first gives an overview of the development of the agriculture QA/QC system with an outlook of further improvements to be discussed and/or implemented in coming years. A brief description of the QA/QC procedures used to process the data and interact with the countries is given. A brief summary of selected activities that have been carried out in the past to improve and/or verify national and EU wide GHG emissions from agriculture in the frame of the EU GHG inventory system is found in the inventory report of 2020[40].

Main improvements since 2019

Since the 2019 submission, a new check has been introduced on the correlation between milk yield versus feed digestibility and nitrogen excretion rates. Several parts of the code have been revised to align with current programming libraries the system implemented in 2015 was further developed. In 2021, an analysis of the contribution of each member state to the total dairy cattle population of the EU

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40 https://www.eea.europa.eu/publications/european-union-greenhouse-gas-inventory-2020

as a driver for the CH_4 IEF for enteric fermentation from dairy cattle was added (Table 5.13), in order to address a recommendation received from the UNFCCC's expert review team (ERT). The following further improvements are foreseen for the next submission: * Further addition of sector-specific checks that could not be performed for the current submission; * Further development of the comparison with FAO and CAPRI data.

5.5.2 QA/QC system in the agriculture sector

Quality checks

Several quality checks are performed in the EU-GIRP[41] software. They are documented in various modules of EU-GIRP and can be examined in the open source repository. The checks include:

- **Recommendations**: Country were checked if they had implemented last years' recommendations from the ESD review and from the UNFCCC review.
- **Check on NEs**[42] and empty cells has been done by extracting all reported 'NE's from the data base.
- **Notation keys**: we identified emission categories where a country reported a notation key, while **please update** 22 or more countries reported emission estimates, in order to assess the potential over/underestimations (these also contained in NE checks and reporting of identical values as in previous submission).
- **Outliers in activity data and emissions**: Data were checked on outliers in AD and emissions. For each source category the share of AD and emissions by the countries to total EU-KP values were determined. A share above 95% was further assessed and in case this was not linked to a source category which is dominated by single countries (such as emissions from buffalo, which are dominated by Italy) the country was notified
- **Check on erroneous units**: In several case, countries report background data using different units (e.g. fractions insteat of percent values or vice versa; values per day instead of per year of vice versa; absolute values instead of values per head etc.). While these inconsistencies do not influence the reported emission estimates, a harmonization (at EU-KP level) is important to ensure correct comparison of countries' values and a correct calculation of EU-KP background data. An automated check[43] is carried out detecting *seven* cases which can easily be recognised. Other 'mistakes' in units used were detected following the outlier analysis (see below). The countries were notified via the review tool and in many cases corrections have already been implemented.
- **Within-country outliers**: within-country outliers in IEFs and other parameters are detected on the basis of the distribution of the values provided[44]. We used the method based on the mean values and the standard deviation. Specifically, those values were identified as outliers which were more distant from than 1.5 time the standard deviation in the data from the mean (both in positive and negative direction). As an additional criterium, the relation to the median was used. In case the value was within 10% of the median it was not considered as an outlier. This

41 EU-GIRP: EU-Greenhouse gas Inventory Reporting and Plots, see https://github.com/aleip/eealocatorplots.git

42 https://github.com/aleip/eealocatorplots/blob/master/eugirp_checknes.r

43 https://github.com/aleip/eealocatorplots/blob/master/eugirp_checkunits.r

44 https://github.com/aleip/eealocatorplots/blob/master/eugirp_checkoutliers.r

removed cases where a country uses a country-specific parameter while most countries use the default value.

- **Identification of potentially significant issues**: For each of the outliers identified it was determined whether or not this could be a potentially significant issue based on the criterium of a share of 0.5% of national total GHG emissions. The 'size' of the possible over- or under-estimation was quantified comparing the reported value with an estimate using the median IEF or parameter as reported by all countries[45]. All outliers were 'manually' cross-checked and analysed. Countries were notified on the results of the analysis.
- **Time series outliers/inconsistencies**: Time series outliers were detected on the basis of the same method as also used for the within-country-outlier check. Basis for the underlying distribution of data in this case, however, was not the values reported from all countries during the whole time series, but only the data reported by the country assessed. Only growth rates larger than ±3% could qualify as 'outliers'. However, this generated a large number of potential outliers which require further assessment. The following types of 'issues' were identified, which might be linked either to an inconsistent time series or be the consequence of 'real' trends:

– *Period outphased*: Relative constant trend with few years above/below the trend that 'looks plausible'.

– *Trend break*: Timeseries in steps, in a stair shape: a few similar values, then a jump, and the same again.

– *One break group trend*: Regular timeseries with a different trend for a group of years, and a step when jumping from/coming back to the general trend.

– *Inflection point*: Trend suddenly changes from a specific year from which the growth of the values changes sign.

– *Single outlier*: One or few isolated year(s) where the value is out of the general trend

– *Smooth group trend change*: A series of years where the trend changes compared to the rest of the time series, but without any jumps

– *Trend jump*: There is a jump at some point in the time trend but it continues running parallel to the first section, after the jump.

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45 See function `ispotentialissue()` in the file https://github.com/aleip/eealocatorplots/blob/master/eugirp_functions.r

- *Jump and shape*: There is a jump at some point in the time trend and, after the jump, the trend changes shape

- **Sector-specific checks**: Several checks were performed tailored to the reporting in the sector agriculture[46,47]. First, the data are checked on consistency in reporting of activity data throughout the tables. Further, several other tests are performed:

- Difference between the sum of nitrogen excreted and reported in the different manure management system (MMS) versus the total reported nitrogen excreted

- Difference between the total nitrogen excreted and the product of animal population and nitrogen excretion rate

- Difference of the sum of N handled in MMS over animal type vs. total N handled in each MMS

- Check of the reported IEF per MMS with the total N excreted and the reported emissions

- Calculation and evaluation of the IEF in category 3.B.2 by animal type and in relation to the total N excreted

- Check that the sum of manure allocated to climate regions adds up to 100% over all MMS and climate regions

- Check that compares the Manure 'managed' in Pasture Range and Paddock in category 3.B.2 with AD in 3.D.1.3 (Urine and Dung Deposited by Grazing Animals). The sum of FRPR over all animal types should therefore equal the AD in category 3.D.1.3.

- Comparison of the IEF in 3.D.1.3 (N_2O emissions from Urine and Dung Deposited by Grazing Animals) with default IEFs EF3_RPR_CPP for Cattle - Pigs and Poultry (0.02) and, EF3_RPR_SO for Sheep and other animals (0.01) using the shares FracRPR_CPP and FracRPR_SO of manure deposited by the two animal groups.

- Comparison of the fraction of N lost in MMS (via volatilization of NH_3+NO_x) versus total managed manure. According to IPCC Table 50.22[48] most of the loss fractions are between 20% and 45% of N in managed manure and N loss ratios are identified that are higher than 45% or lower than 20%.

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46 https://github.com/aleip/eealocatorplots/blob/master/agrichecks1ADs.r

47 https://github.com/aleip/eealocatorplots/blob/master/agrichecks2Nex.r

48 IPCC Guidelines 2006, Vol. 4, Chapter 10.

– Comparison of the manure 'managed' and not lost as NH_3+NO_x or leaching in MMS (3B2) with Animal manure applied to soil (3D12a). Manure available for application is obtained from N managed in MMS and not lost (FracLOSSMS) according to IPCC Table 50.23[49] plus any addition of bedding material. The loss fractions in Table 50.23 include also losses of N2, which are not included in the indirect emissions-volatilisation. Therefore, FAM is expected to be smaller than N managed in MMS minus N lost as NH_3+NO_x+leaching unless bedding material has been accounted for. In case of crop residues as bedding material care has to be taken to avoid double counting.

- **Recalculation**: Countries were asked for justifications of recalculations of more than 0.5% of national total emissions (excluding LULUCF) and above or below the mean recalculations across all MS ±1.5 standard deviations.

A moderately lower number of issues were identified (135 for 2021) compared to last year (189 issues were identified in 2020):

- 50 completeness issues (related to 'NE'/'empty'/'notation keys'/'same values reported for 2018 and 2019)
- 12 country-outlier issues
- 13 recalculation issues
- 12 time trend issues
- 28 recommendations (ESD and UNFCCC review)
- 18 agricheck issues
- 2 other issue (e.g. wrong units, general issues)

The status of responses as of May 20, 2021 is given in Table 5.57:

Table 5.58 Status of issues as of May 20, 2020

Check	Resolved	Partially resolved	Unresolved	Not yet responded
Completeness	74%	26%	0%	0%
Outliers	25%	50%	25%	0%
Recalculations	92%	8%	0%	0%
Time series	75%	25%	0%	0%
Recommendations	46%	50%	4%	0%
Agrichecks	33%	67%	0%	0%
Other issues	50%	0%	50%	0%

Calculation of EU background data

EU-wide background data were calculated as weighted averages of the parameters provided by the countries, using activity data (animal numbers in category 3A and 3B and N input in category 3D) as weighting factors[50].

[49] IPCC Guidelines 2006, Vol. 4, Chapter 10.

[50] https://github.com/aleip/eealocatorplots/blob/master/eugirp_euweightedaverages.r

Care is being taken to not include in the calculation erroneous values:

- Data which had been identified as being reported with a different unit than the values reported by other countries (see above) were *converted* into the appropriate unit before calculating EU-KP weighted averages
- Data which *obviously* wrong (very large outliers) but for which no clear correction could be identified were *eliminated* from the calculation of the EU-KP weighted averages to avoid biases in the results. Therefore, the EU-KP weighted averages - in some cases - could not represent 100% of EU-KP activity data.

Compilation of the chapter agriculture for the EU-GHG inventory report

The agriculture chapter of the EU-GHG inventory report takes advantage of the data base generated by EU-GIRP. All numeric data presented in the chapter are calculated directly using the processed data as described above, thus eliminating the risk of transcription or copy errors. This does not eliminate the possibility of mistakes completely. Therefore, all values are cross-checked.

5.6 Comparison of activity data in the FAO GHG database on the national inventory reports

The Food and Agriculture Organization of the United Nations (FAO) has developed a database of greenhouse gas emissions, contained in FAOSTAT, which provides estimations of the emissions of main gases in the agricultural sector (CH_4 and N_2O) and statistics on the activity data related to these emissions that generally cover the period 1990-2019. The database can be consulted at the following link:

http://faostat3.fao.org/faostat-gateway/go/to/download/G1/*/E

Emissions are specified for the different agricultural sub-domains, estimated by FAO following Tier 1 approach from the 2006 IPCC Guidelines for National GHG Inventories (IPCC, 2006), using activity data provided by countries and default emission factors by IPCC. The data provided by FAO does not necessarily match the numbers reported by countries to the UNFCCC in their national inventory reports.

The FAOSTAT database is intended primarily as a service to help member countries assess and report their emissions, as well as a useful international benchmark. FAOSTAT emissions data are disseminated publicly to facilitate continuous feedback from member countries. The following table presents total GHG emissions of the agricultural sector by emission source category for the whole EU-KP+Iceland and year 2019 (last year available in FAOSTAT). It compares emission values and the share of emissions by category in FAOSTAT database vs. UNFCCC values reported by countries in their National Inventory Reports (NIR).

Table 5.59 GHG emissions from the agricultural sector by emission source category, in kt CO_2-eq/year and % of total emissions, for the whole EU-KPEU-KP, averaged over the years 2000 to 2018, for which reported data from all countries are available in both the FAOSTAT and the UNFCCC databases are available.

Source category	Gas	NIR [kt CO_2-eq yr^{-1}]	NIR [%]	FAO [kt CO_2-eq yr^{-1}]	FAO [%]
3.A - Enteric Fermentation	CH_4	189,542	43.6	168,369	40.0
3.B.1 - CH_4 Emissions	*CH_4*	*42,892*	*9.9*	*46,488*	*11.0*
3.B.2 - N_2O Emissions	*N_2O*	*23,164*	*5.3*	*12,553*	*3.0*

Source category	Gas	NIR [kt CO_2-eq yr^{-1}]	NIR [%]	FAO [kt CO_2-eq yr^{-1}]	FAO [%]
3.C - Rice Cultivation	*CH_4*	*2,627*	*0.6*	*5,350*	*1.3*
3.D.1.1 - Direct N_2O Emissions - Inorganic N Fertilizers	N_2O	51,516	11.9	45,164	10.7
3.D.1.2 - Direct N_2O Emissions - Organic N Fertilizers	N_2O	24,501	5.6	22,121	5.3
3.D.1.3 - Urine and Dung Deposited by Grazing Animals	N_2O	22,086	5.1	18,432	4.4
3.D.1.4 - Crop Residues	N_2O	21,183	4.9	13,717	3.3
3.D.1.5 - Mineralization of Soil Organic Matter	N_2O	652	0.2	0	0.0
3.D.1.6 - Cultivation of Organic Soils	N_2O	15,085	3.5	24,422	5.8
3.D.2 - Indirect N_2O Emissions	N_2O	29,254	6.7	64,681	15.4
3.F - Field Burning of Agricultural Residues	CH_4	791	0.2	0	0.0
3.F - Field Burning of Agricultural Residues	N_2O	287	0.1	0	0.0
3.G - Liming	CO_2	5,872	1.4	0	0.0
3.H - Urea Application	CO_2	3,949	0.9	0	0.0
3.I - Other Carbon-containing Fertilizers	CO_2	848	0.2	0	0.0
Total	GHGs	434,248	100.0	421,295	100.0

Comparing both databases, we can see that UNFCCC reports slightly higher total emissions than FAOSTAT (434.2 versus 421.3 Mt CO_2-eq yr^{-1}), even if categories 3.D.1.5, 3.G, 3.H and 3.I are not estimated in FAOSTAT (422.9 versus 421.3 Mt CO_2-eq yr^{-1}). Looking at the individual emission categories, we can also identify differences between the two databases, which can be due to different reasons:

- Differences in the methodology used for the estimation of emissions. While countries apply tier 1 to tier 3 approaches, depending on the emission category, FAOSTAT estimations are based on a tier 1 approach, using always default emission factors.
- The use of different activity data, coming from different sources or suffering different processing after data collection.

Comparing the estimations of FAOSTAT with the UNFCCC inventory data, we find that the biggest absolute difference corresponds to:

- indirect N_2O emissions from category 3.D.2 (-35427 kt CO_2-eq yr^{-1}, with larger emissions reported by FAO), followed by
- CH_4 emissions from category 3.A - Enteric Fermentation (21173 kt CO_2-eq yr^{-1}, with larger emissions reported by NIR) and
- N_2O emissions from category 3.B.2 (10611 kt CO_2-eq yr^{-1}, with larger emissions reported by NIR).

These three emission categories represent a significant share of the total agricultural emissions in the NIR and FAO databases, accounting for 6.7-14.9%, 38.8-43.6% and 2.9-5.3%, respectively.

The largest three differences in relative terms are:

- indirect N_2O emissions from category 3.D.2 (-121.1 %, with larger emissions reported by FAO), followed by
- CH_4 emissions from category 3.C - Rice Cultivation (-103.7 %, with larger emissions reported by FAO) and
- N_2O emissions from category 3.D.1.6 - Cultivation of organic soils (62 %, with larger emissions reported by FAO).

In the next sections, we will focus on the comparison of activity data, trying to find out if the differences found in both databases can explain the differences in emissions, analysing the trends of livestock population, fertiliser use and cultivated area along the inventory years (1990-2019).

We will employ two types of figures throughout this section. Figure of the type as in Figure 5.77 show the trend of EU-KPKP for both NIR and FAO, similar to the Figures used also in Section 5.2. The upper panel of the figure shows the trend in the data from NIR, and the lower panel shows the trend in the FAO data. The 10 most important countries are plotted explicitly with the pattern used also in the previous sections. The share of AD in the last reported year given next to the legend, and all other countries lumped together into the category 'Other'. This category contains only the 'other' countries with respect to the database, thus the countries could be different for NIR and FAO.

Figures of the type as in Figure 5.78 show three different perspectives on the comparison of the two data sets, using the average of data for the years 1990-2019: the chart on the left side shows the reported values in absolute units for both NIR and FAO; the chart in the middle shows the relative difference between both data sets, calculated as (FAO-NIR)/NIR. Thus, positive values indicate that the value from FAO are larger than the value from NIR, and negative values indicate that the values from NIR are larger. Large relative differences indicate a problem in data reporting by the countries, but is not necessarily an indication that this has a large impact for the overall total EU emissions. Therefore, the chart on the right side shows the importance of the difference observed in each country, as compared to the EU-KP total: $(FAO_{country}-NIR_{country})/NIR_{EU}$.

5.6.1 3.A.1 Animal populations

Trends of population data in the two data sets and a comparison of average data in the period 1990 to 2019 are shown for dairy Cattle (Figure 5.77 and Figure 5.78), non-dairy Cattle (Figure 5.79 and Figure 5.80), sheep (Figure 5.81 and Figure 5.82), swine (Figure 5.83 and Figure 5.84) and poultry (Figure 5.85 and Figure 5.86). The trends in the NIR data are discussed in detail in Section 5.2.

Dairy cattle population data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 3822 thousand heads or -14.1% of the average value in the EU. The three countries with the largest differences in single years are Romania, Italy and Poland. The largest deviations (FAO minus NIR) are -1048 thousand heads (Romania, in 1990), corresponding to 2.7% of total EU dairy cattle population in this year (NIR), -532 thousand heads (Romania, in 1991), and -503 thousand heads (Romania, in 1993).

Non-dairy cattle population data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 12646 thousand heads or -18.3% of the average value in the EU. The three countries with the largest differences in single years are Ireland, Romania and Germany. The largest deviations (FAO minus NIR) are 2354 thousand heads (Germany, Y1991), corresponding to 3% of total EU non-dairy cattle population in this year (NIR), 2022 thousand heads (Romania, in 1990), and 1610 thousand heads (Romania, in 1991).

Sheep population data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 42040 thousand heads or -36.1% of the average value in the EU. The three countries with the largest differences in single years are Ireland, Italy and Spain. The largest deviations (FAO minus NIR) are -2995 thousand heads (Ireland, 1998), corresponding to 2.3% of total EU sheep population in this year (NIR), -2988 thousand heads (Ireland, in 1999), and -2868 thousand heads (Ireland, in 1993).

Swine population data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 12526 thousand heads or -8.11% of the average value in the EU. The three countries with the largest differences in single years are Germany, Romania and Spain. The largest deviations (FAO minus NIR) are 8636 thousand heads (Germany, in 1991), corresponding to 5.1% of total EU swine population in this year (NIR), 7675 thousand heads (Germany, in 1990), and 4927 thousand heads (Germany, in 1994).

Poultry population data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 419440 thousand heads or -26.7% of the average value in the EU. The three countries with the largest differences in single years are Poland, Italy and France. The largest deviations (FAO minus NIR) are -157671 thousand heads (Poland, in 1991), corresponding to 9.9% of total EU poultry population in this year (NIR), -154788 thousand heads (Poland, 1990), and -151691 thousand heads (Poland, 1996).

Figure 5.77: 3.A.1: Comparison of dairy cattle population in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.

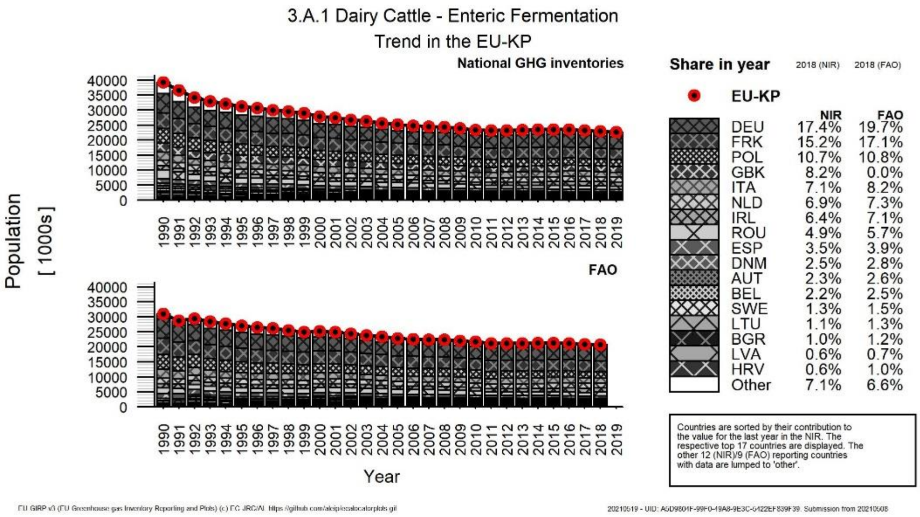


Figure 5.78: 3.A.1: (a) Average Dairy Cattle population in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.

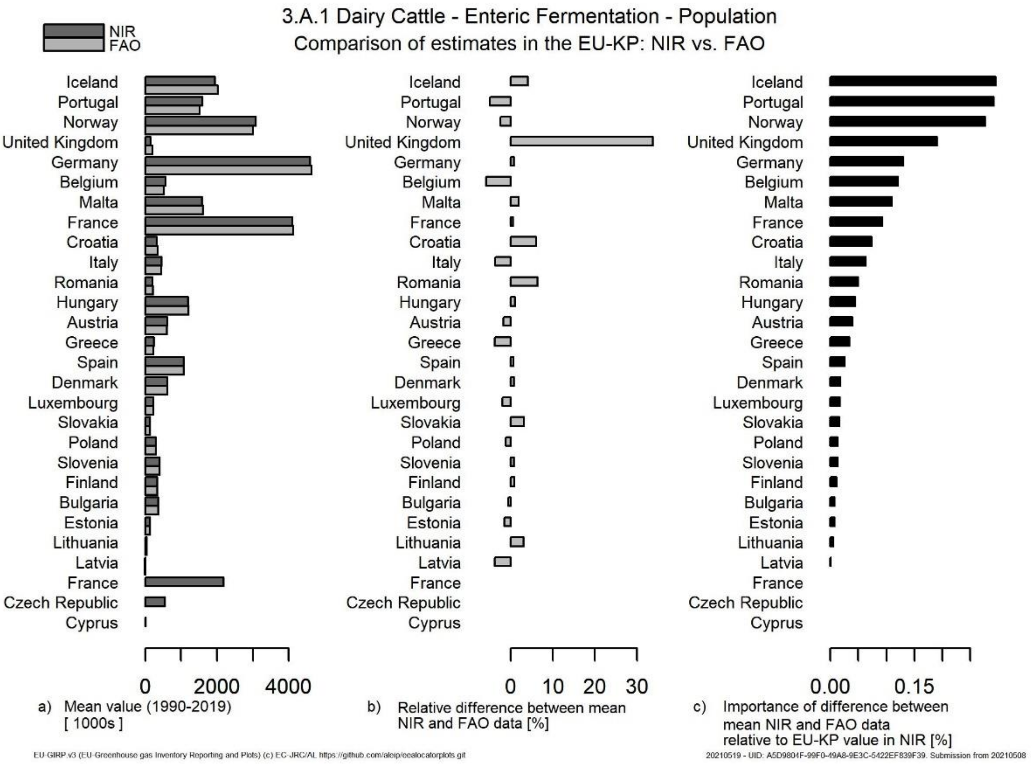


Figure 5.79: 3.A.1: Comparison of non-dairy cattle population in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.

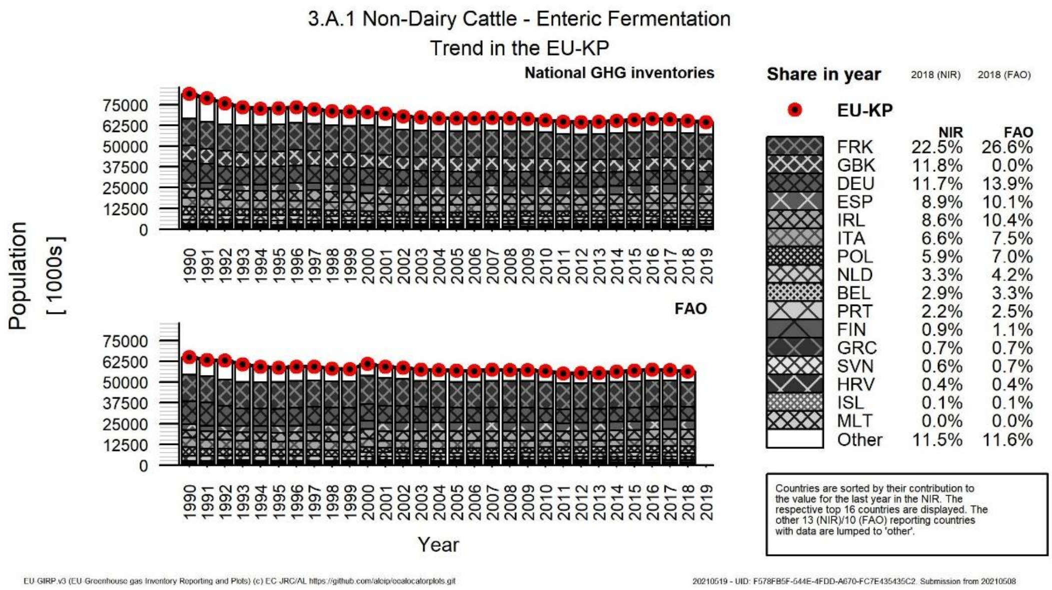


Figure 5.80: 3.A.1: (a) Average Non-Dairy Cattle population in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.

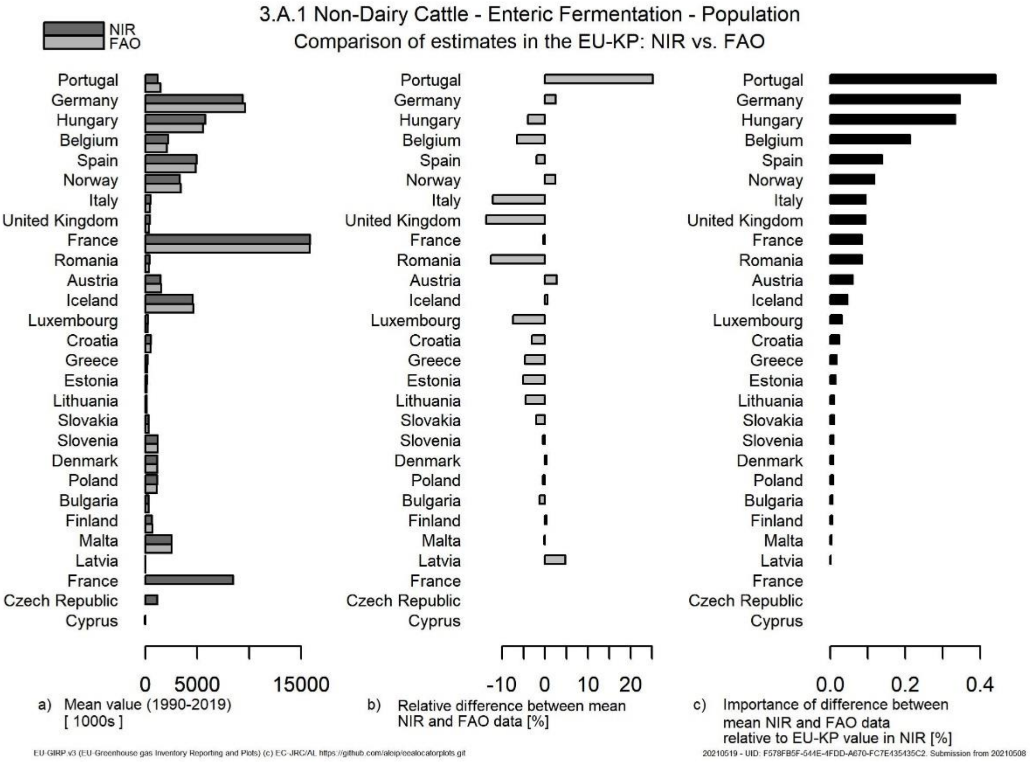


Figure 5.81: 3.A.1: Comparison of sheep population in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.

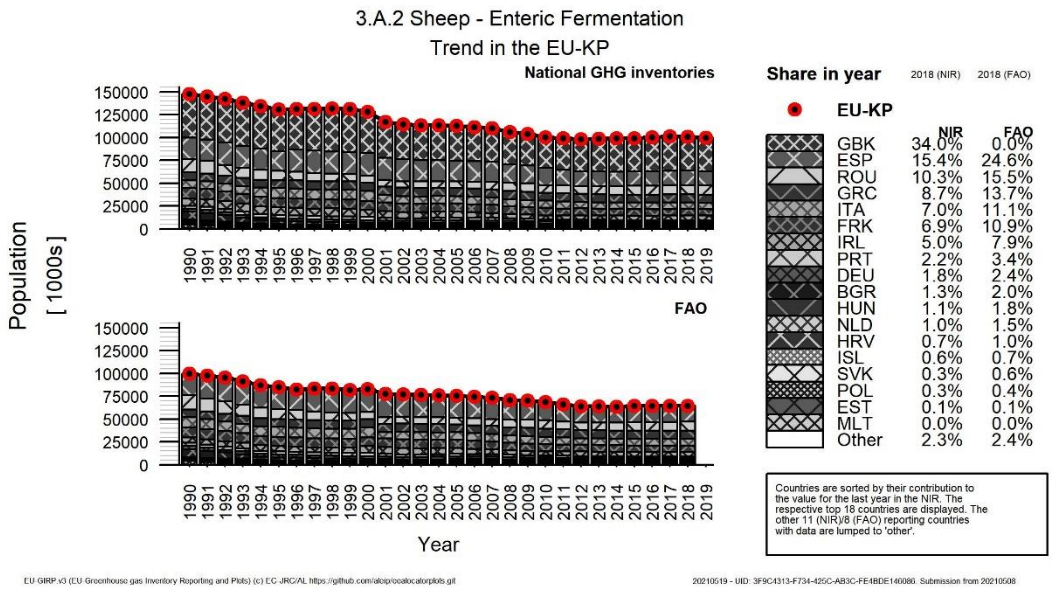


Figure 5.82: 3.A.1: (a) Average Sheep population in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.

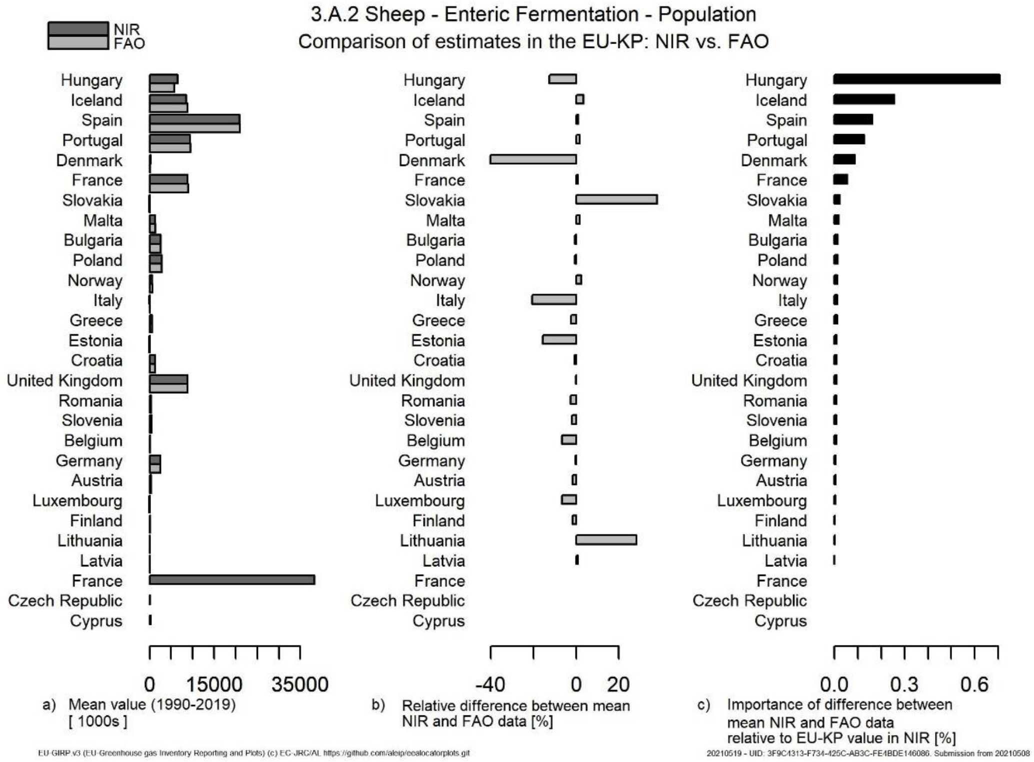


Figure 5.83: 3.A.1: Comparison of swine population in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.

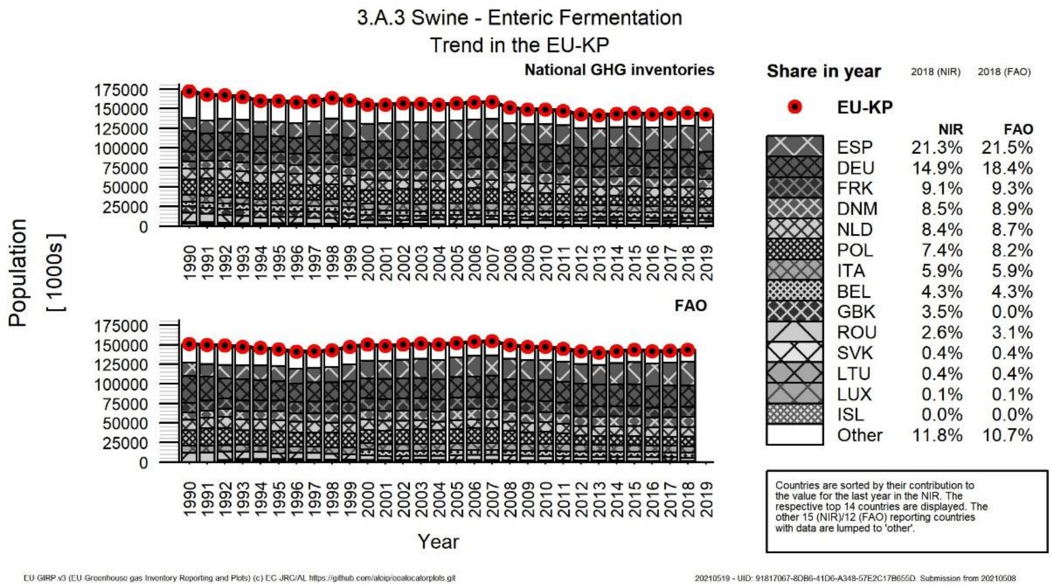


Figure 5.84: 3.A.1: (a) Average Swine population in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.

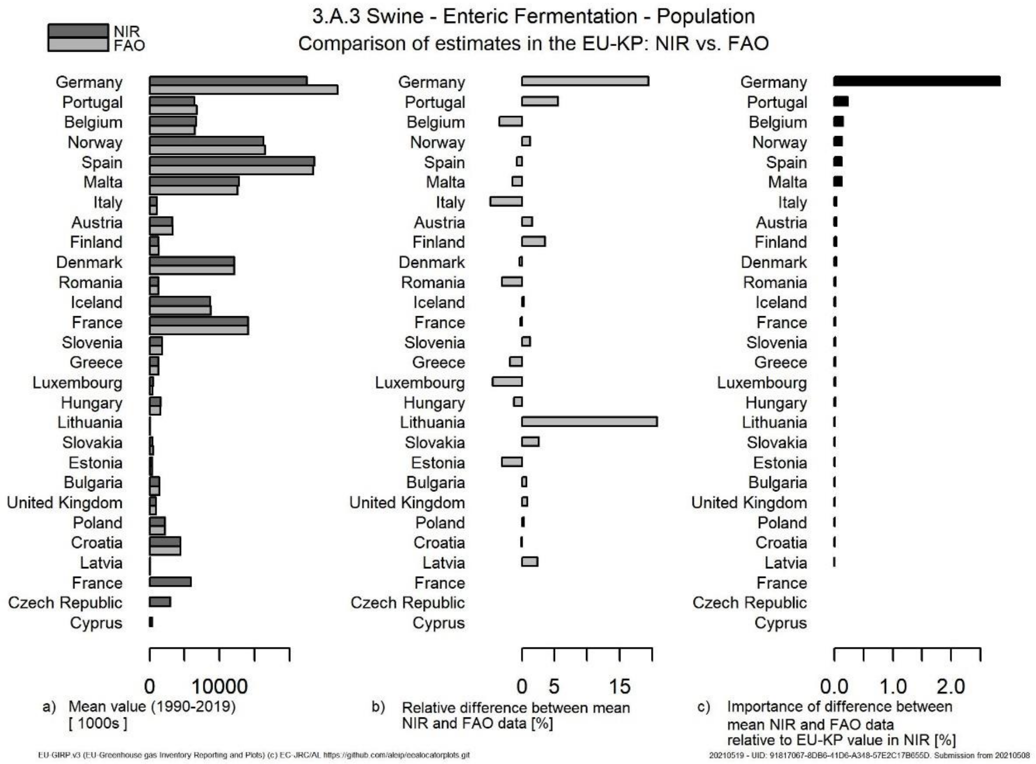


Figure 5.85: 3.A.1: Comparison of poultry population in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.

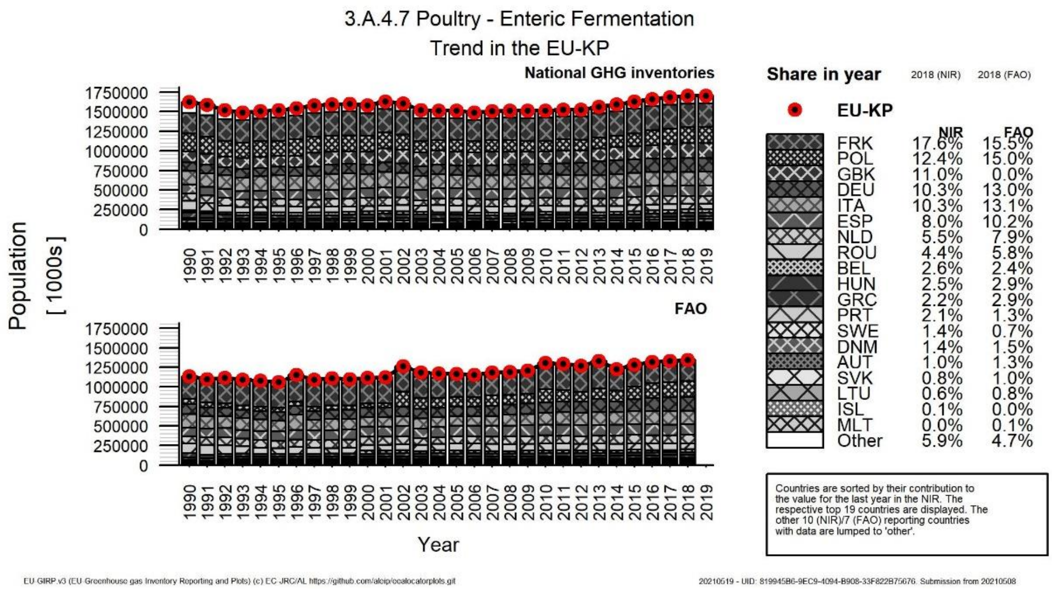
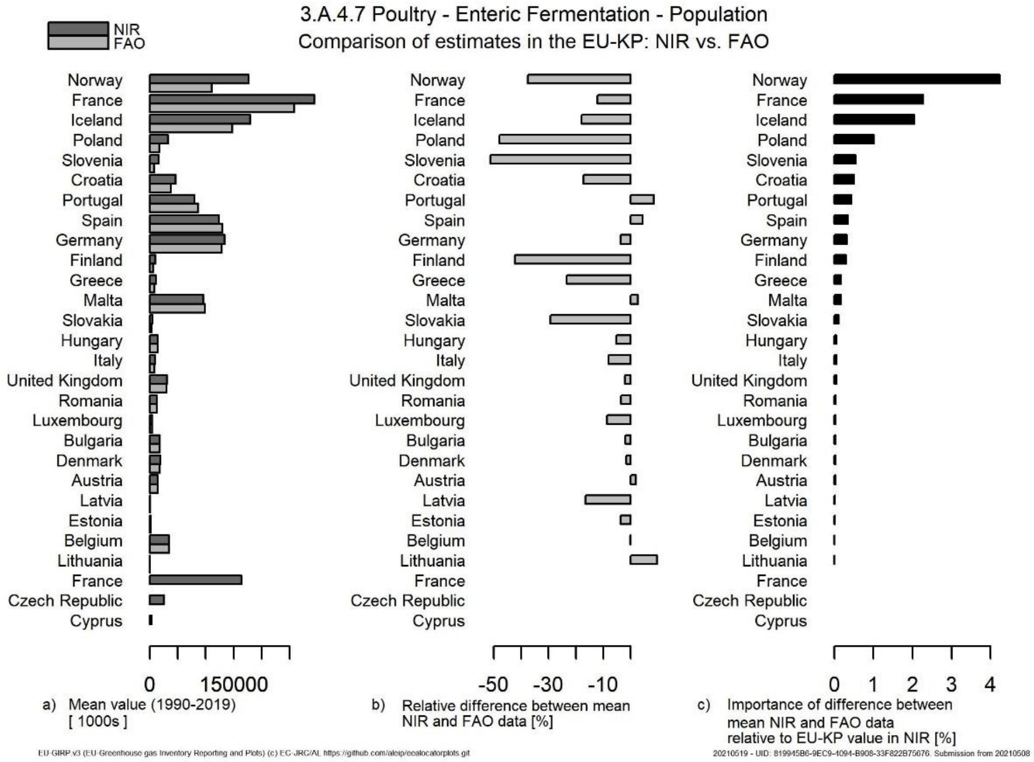


Figure 5.86: **3.A.1: (a) Average Poultry population in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.**



5.6.2 3.B.2 Nitrogen excretion

In addition to population data, nitrogen excretion data is another parameter with a high influence on emissions, notably on N_2O emissions from manure in various emission categories. FAOSTAT calculates N excretion based on default typical animal mass and nitrogen excretion per animal mass unit, while UNFCCC provides national data, calculated with different methodologies. Figure 5.87 to Figure 5.96 compare UNFCCC vs. FAOSTAT data related to N excretion rate for the main livestock categories: dairy cattle, non-dairy cattle, sheep, swine and poultry.

Figure 5.87: **3.B.2: Comparison of dairy cattle total nitrogen excretion in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.**

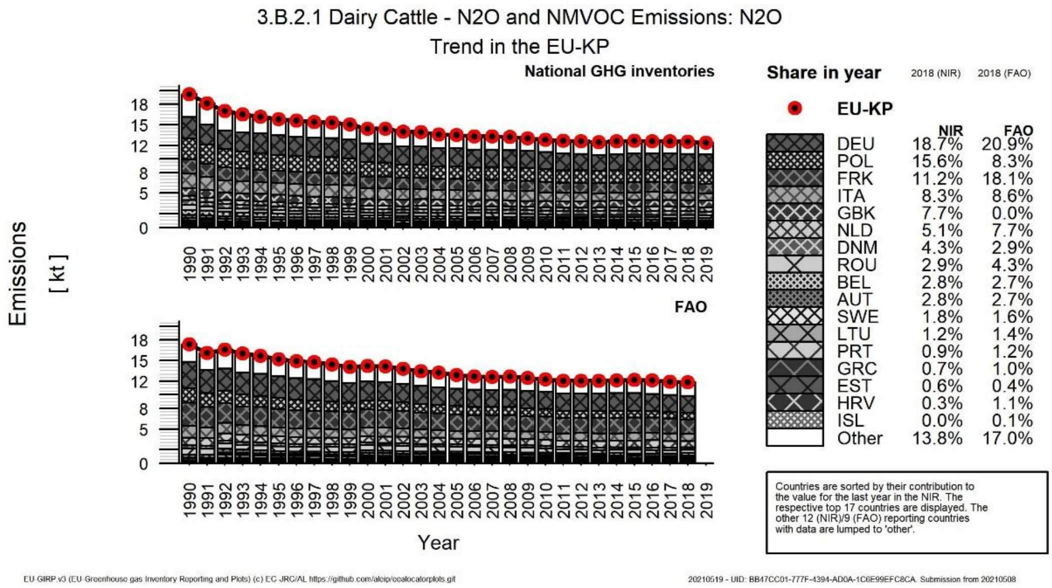


Figure 5.88: 3.B.2: (a) Average Dairy Cattle total nitrogen excretion in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.Ana

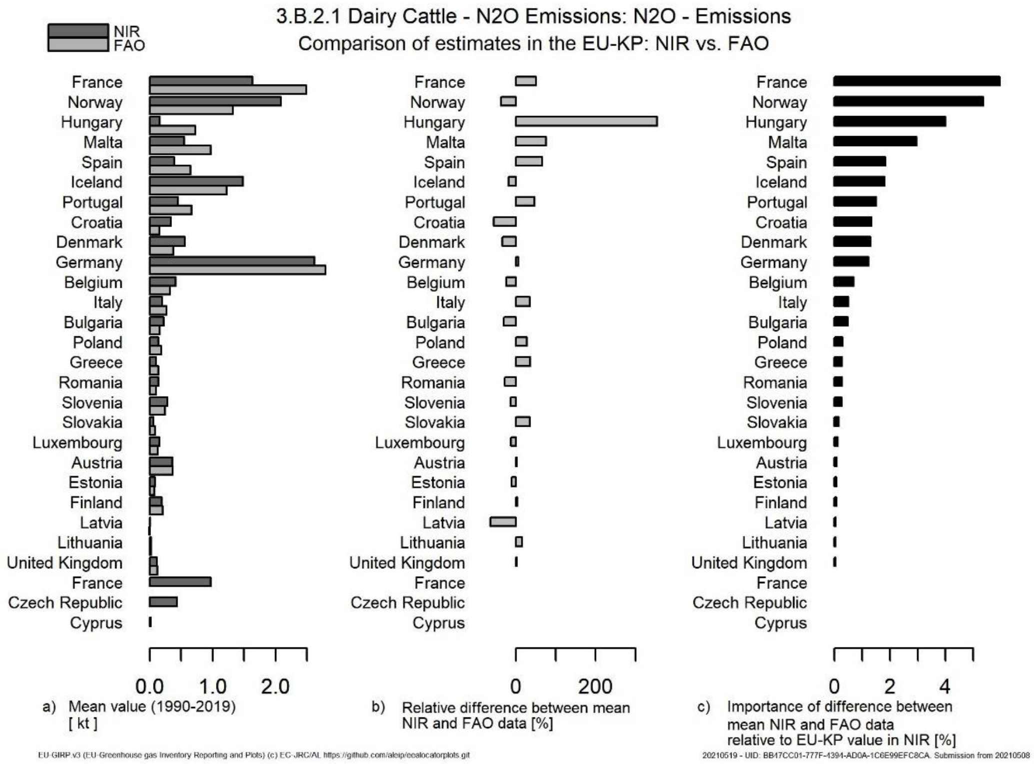


Figure 5.89: 3.B.2: Comparison of non-dairy cattle total nitrogen excretion in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.

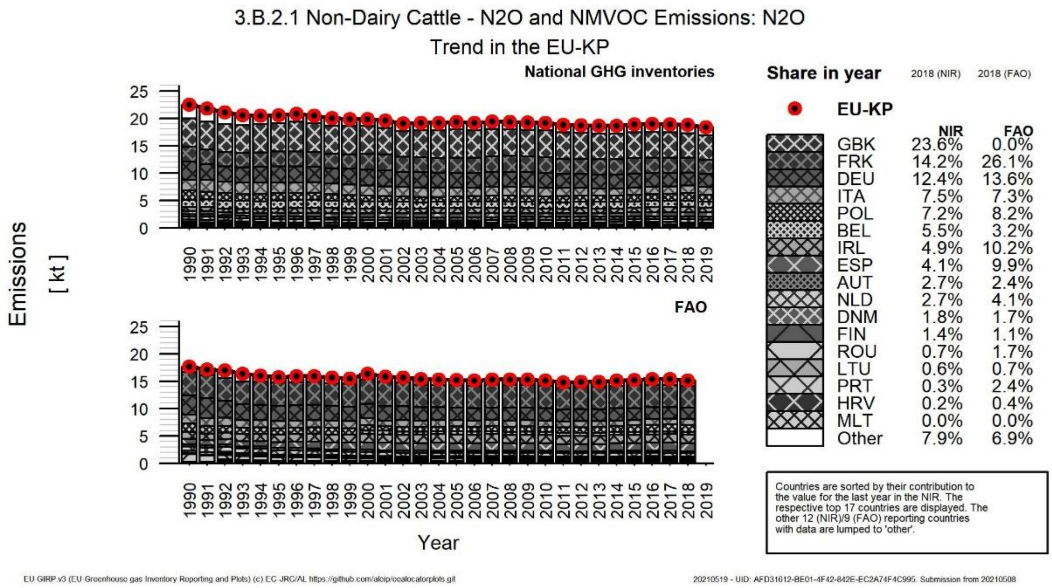


Figure 5.90: 3.B.2: (a) Average Non-Dairy Cattle total nitrogen excretion in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.

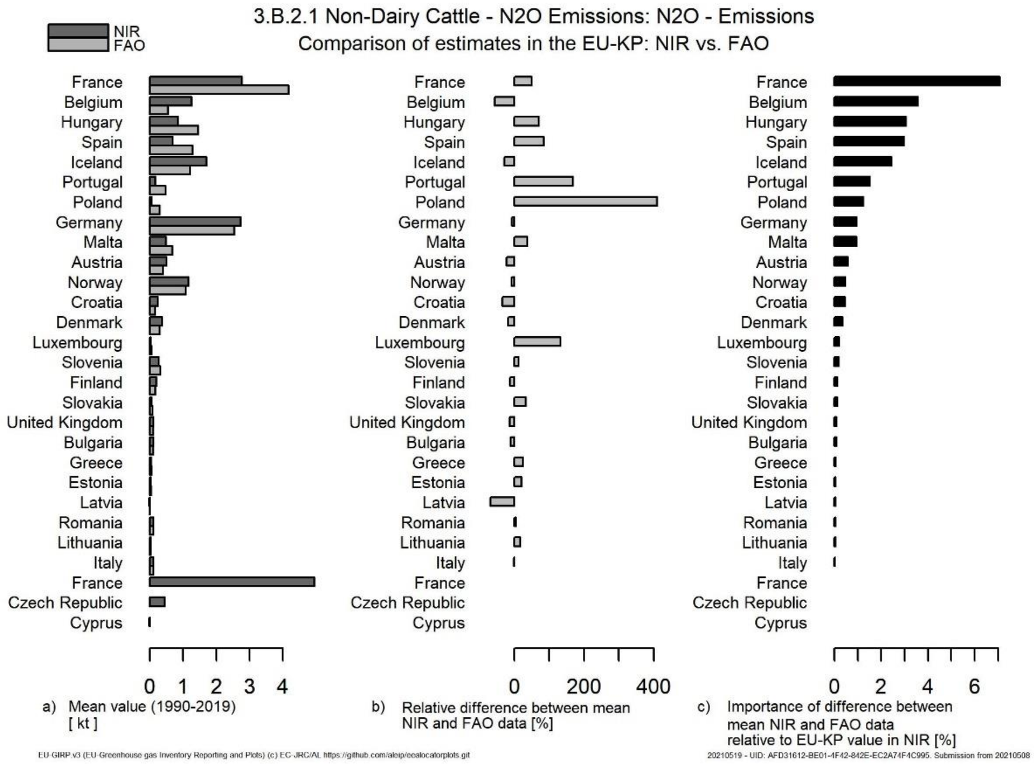


Figure 5.91: 3.B.2: Comparison of sheep total nitrogen excretion in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.

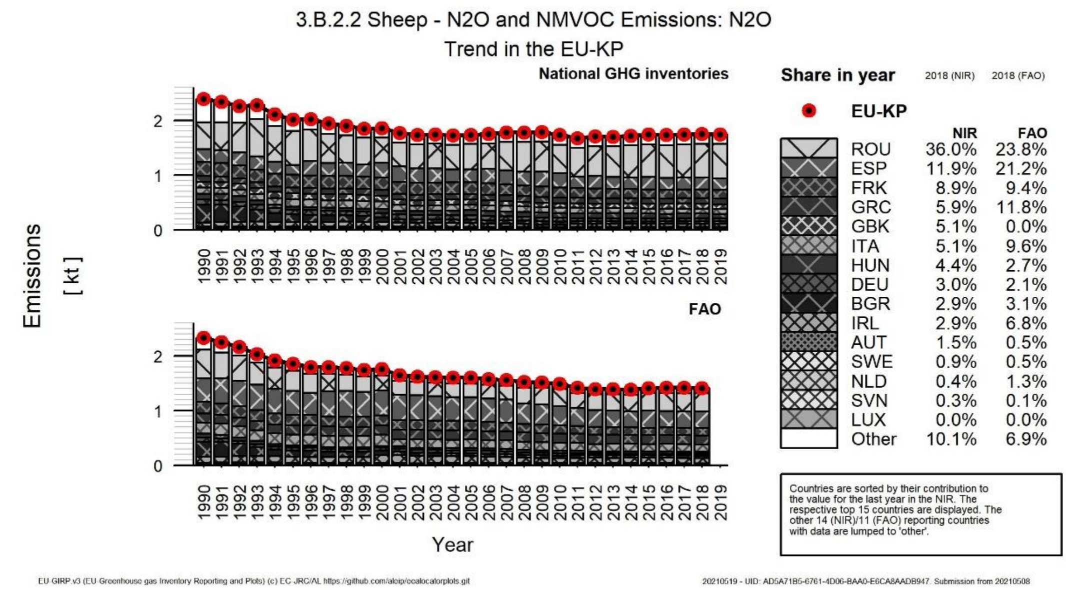


Figure 5.92: 3.B.2: (a) Average Sheep total nitrogen excretion in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.

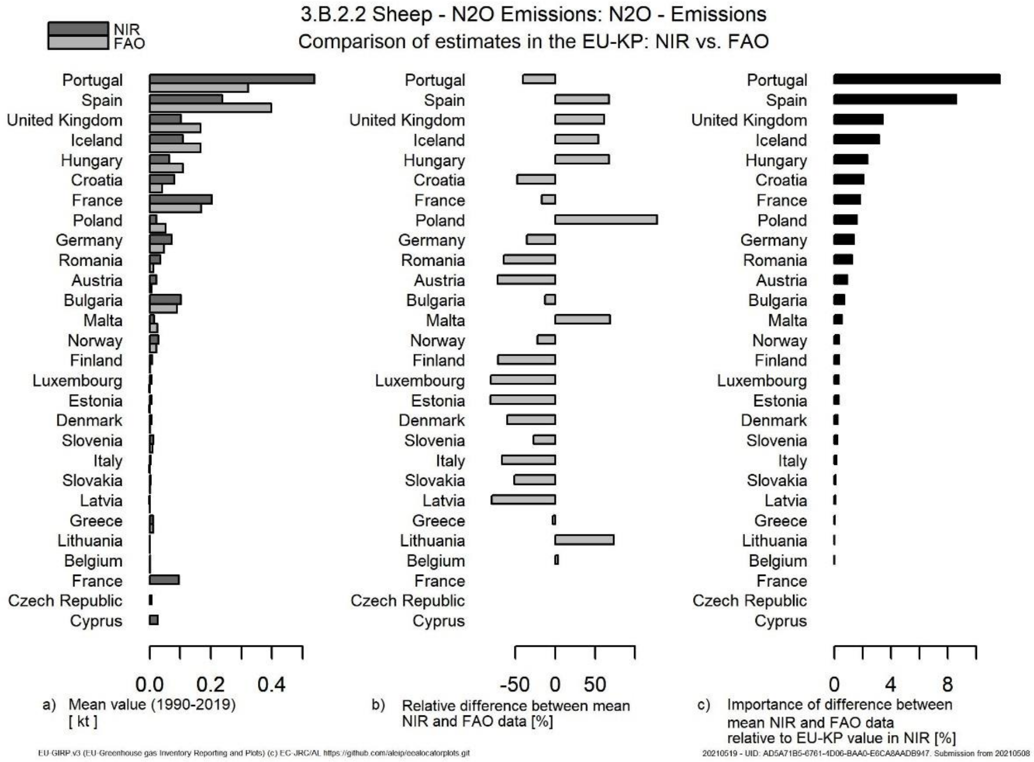


Figure 5.93: 3.B.2: Comparison of swine total nitrogen excretion in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.

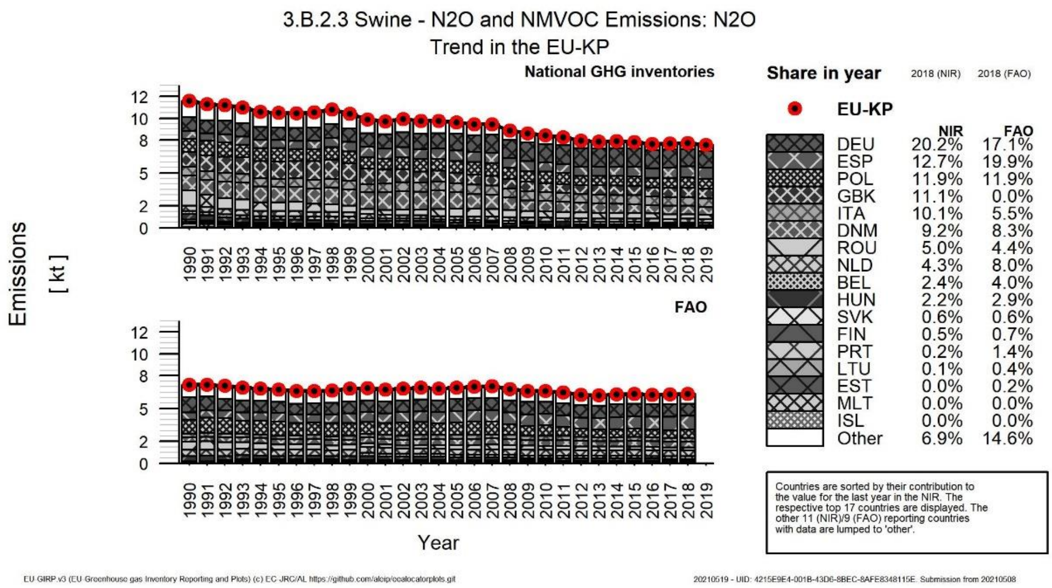


Figure 5.94: 3.B.2: (a) Average Swine total nitrogen excretion in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.

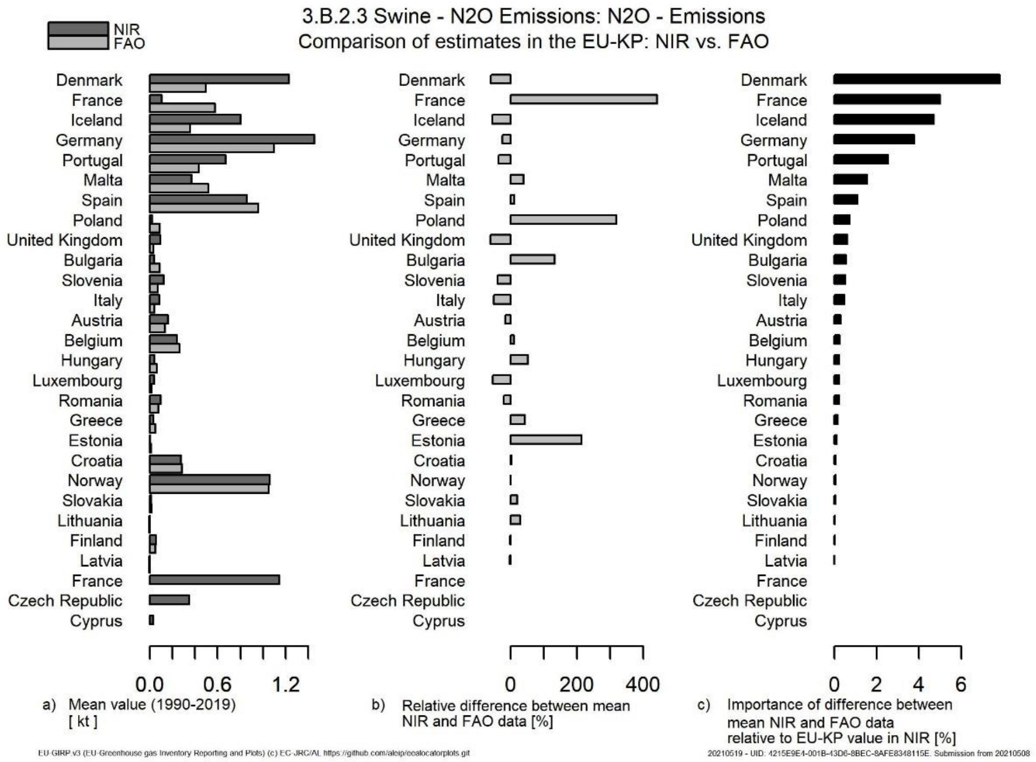


Figure 5.95: 3.B.2: Comparison of poultry total nitrogen excretion in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.

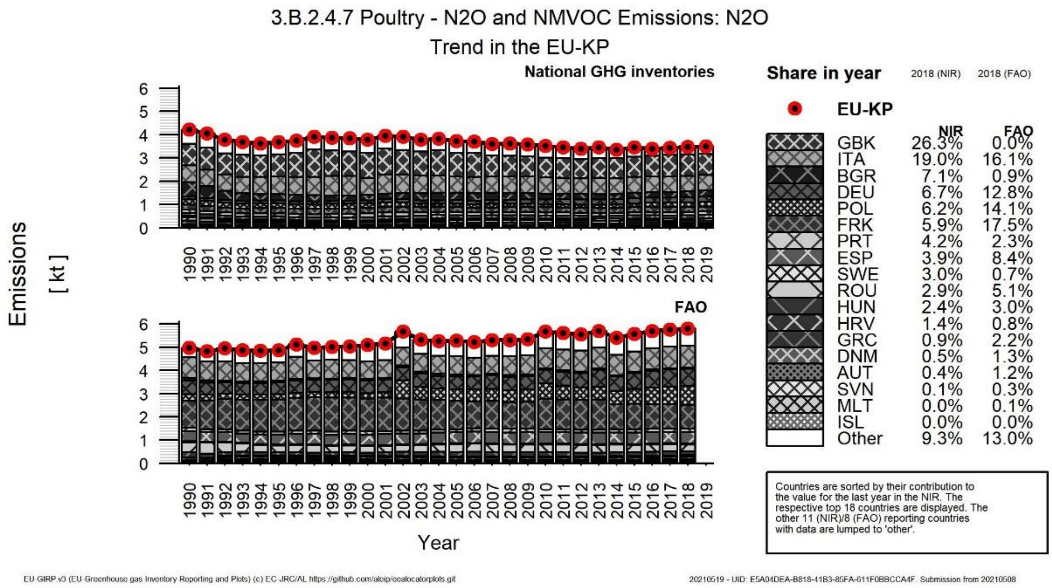
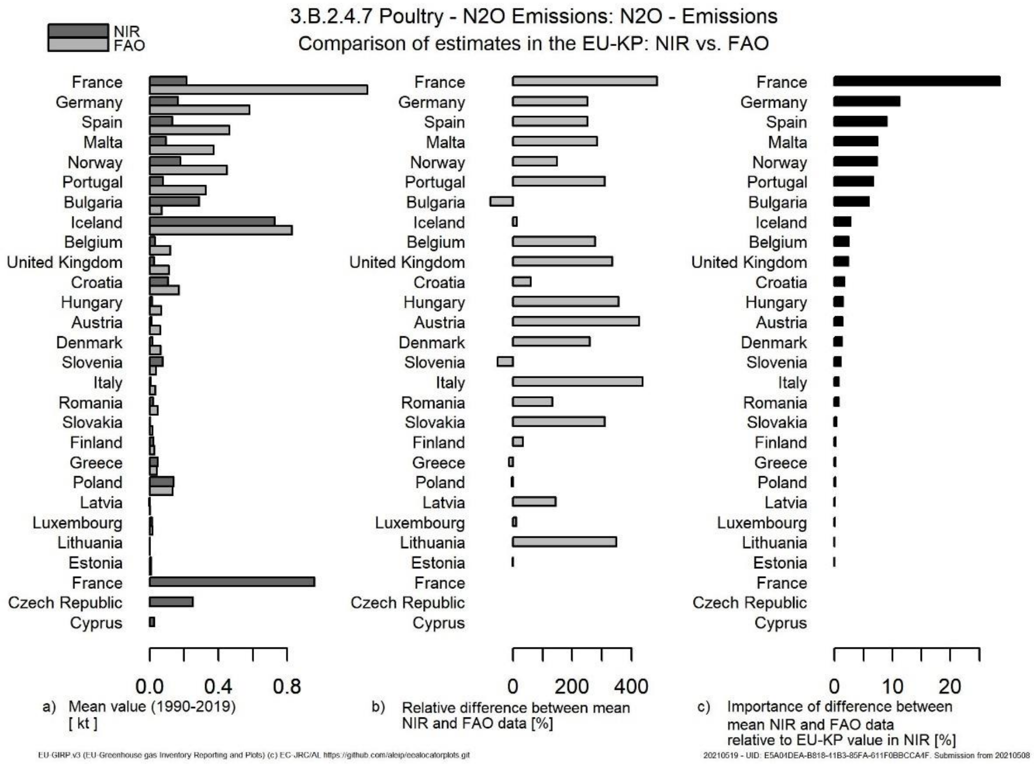


Figure 5.96: **3.B.2: (a) Average Poultry total nitrogen excretion in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.**



Comparing N excretion from the different livestock categories between the two databases, we can see that, for most of them, FAOSTAT presents lower values, being these differences highest for dairy cattle, non-dairy cattle, sheep, swine, poultry the EU-KP average. Only for swine, approximately half of the countries are reporting higher values in their NIR than FAOSTAT. Individual differences by country for dairy cattle range from -50 to 5%, with a much more defined decrease time trend in the NIR data and differences between databases getting smaller along time for the EU-KP totals. For most the countries NIR values are larger, being Greece the only country with larger numbers in FAO (5%). Germany holds the highest difference share in absolute values (4% of total EU-KP), followed by France and the Netherlands (3.2 and 3.0%, respectively). Similarly, for N excretion from non-dairy cattle most countries present higher values in the NIR, where data is also (but more smoothly) decreasing in time and decreasing differences with FAO, which shows more stable values. Differences in individual countries range from -40 to 50% (Romania) for the average of the time series. Compared to EU-KP totals, France is, by far, responsible for the highest share in the total differences FAO-NIR (10% of the total), followed by United Kingdom (4%) and Ireland (3%). Not only differences for the EU totals but also for individual countries are highest for sheep, always bigger in the NIR database and ranging from nearly 0% in Romania to around 80% in many of the countries. Countries with the highest shares of Nex are also the responsible for the highest shares of total EU differences between databases: France, UK, Italy and Greece (15%, 15%, 14% and 12% of total EU-KP differences, respectively). N excretion from swine also shows a decreasing trend in the UNFCCC database, while FAO data is more stable in time. For the individual countries, differences in the average values along the total period range from -30% in the Czech Republic to 40% in Croatia and Luxemburg. Regarding their contribution to total EU-KP differences, Poland is in the first place with 2%, followed by Romania (1.8%). The contribution to the total differences is more equally distributed than in previous livestock categories. Regarding poultry, total N excretion for EU-KP is slightly increasing in time in FAO database and more irregularly fluctuating according to NIR data, but it is also lower in FAO, both for EU totals and for most of the countries. Individual country differences range from -40% in Romania and Slovakia to 85% in Luxemburg. Regarding country contribution to total EU differences, the biggest share corresponds to Romania with

7%, followed by Poland with 3.5%, and United Kingdom with 3%. Only for non-dairy cattle there is one country clearly dominating the differences in EU-KP N excretion, while the other livestock categories do not have one only main contributor.

5.6.3 3.C Rice cultivation

Regarding CH_4 emissions from rice cultivation, the related activity data is the rice cultivated area. Figure 5.97 and Figure 5.98 compare rice area of both databases, UNFCCC inventories and FAOSTAT, first total values for all EU-KP countries together, and then differences between databases by country.

Rice harvested area data from FAO are sometimes smaller and sometimes larger than NIR data. Differences are in the range between -100% and 3.4%, with 19 years showing values that are larger in NIR (on average by 0.3 thousand km^2 $year^{-1}$) and 11 years when FAO data are larger (on average by 0.02 thousand km^2 $year^{-1}$). Nevertheless, the data show very similar trends for both datasets. Comparing all years, NIR is larger by 0.17 thousand km^2 $year^{-1}$ or -4.03% of the average value in the EU. The three countries with the largest differences in single years are Portugal, France and Italy. The largest deviations (FAO minus NIR) are 0.12 thousand km^2 $year^{-1}$ (Italy, 2018), corresponding to 3% of total EU rice harvested area in this year (NIR), -0.092 thousand km^2 $year^{-1}$ (France, 2004), and -0.089 thousand km^2 $year^{-1}$ (France, 2000).

Figure 5.97: 3.C: Comparison of rice area in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.

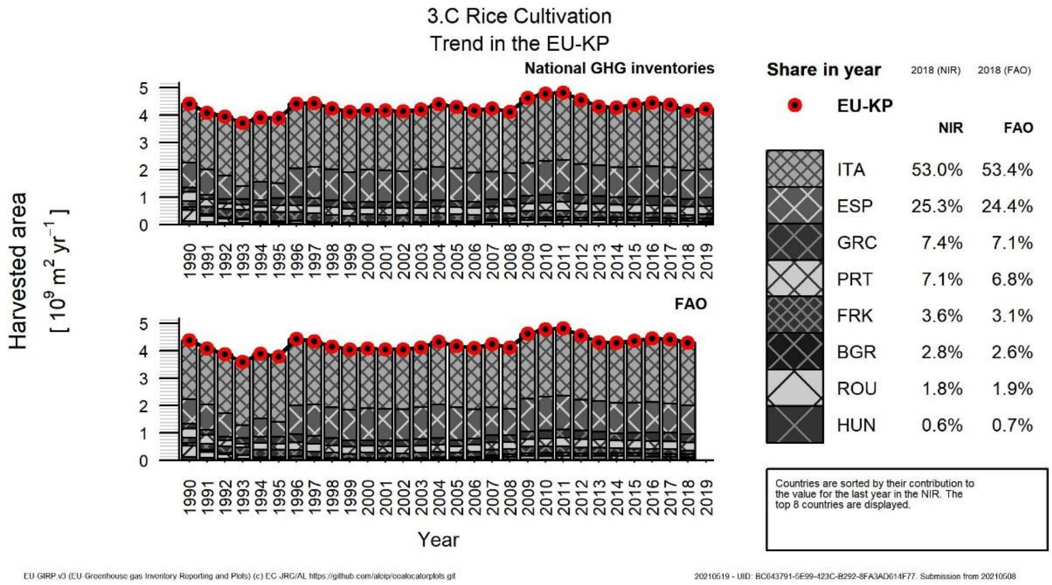
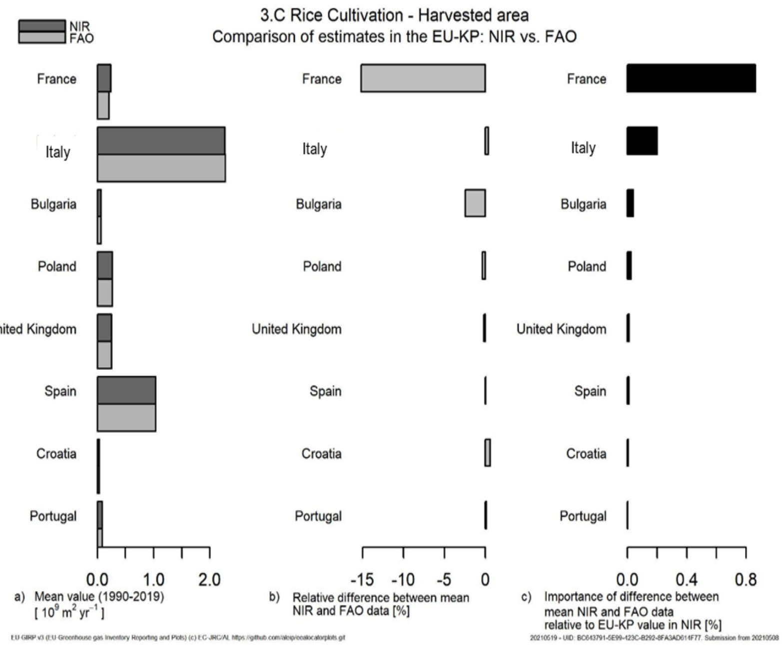


Figure 5.98: 3.C: (a) Average Rice area in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.



5.6.4 3.D Nitrogen input to agricultural soils

Nitrogen input to agricultural soils is an important factor both direct and indirect N_2O emissions from managed soils. New nitrogen is added with synthetic fertilisers, while other nitrogen sources are recycling nitrogen that comes from livestock and manure management systems, food or other organic waste (compost) or from sewage systems. In the following we compare nitrogen input agricultural soils as mineral fertilisers (Figure 5.99 and Figure 5.100), applied organic fertilisers (Figure 5.101 and Figure 5.102), and crop residues (Figure 5.103 and Figure 5.104).

Figure 5.99: 3.D: Comparison of Inorganic N fertilizers N input in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.

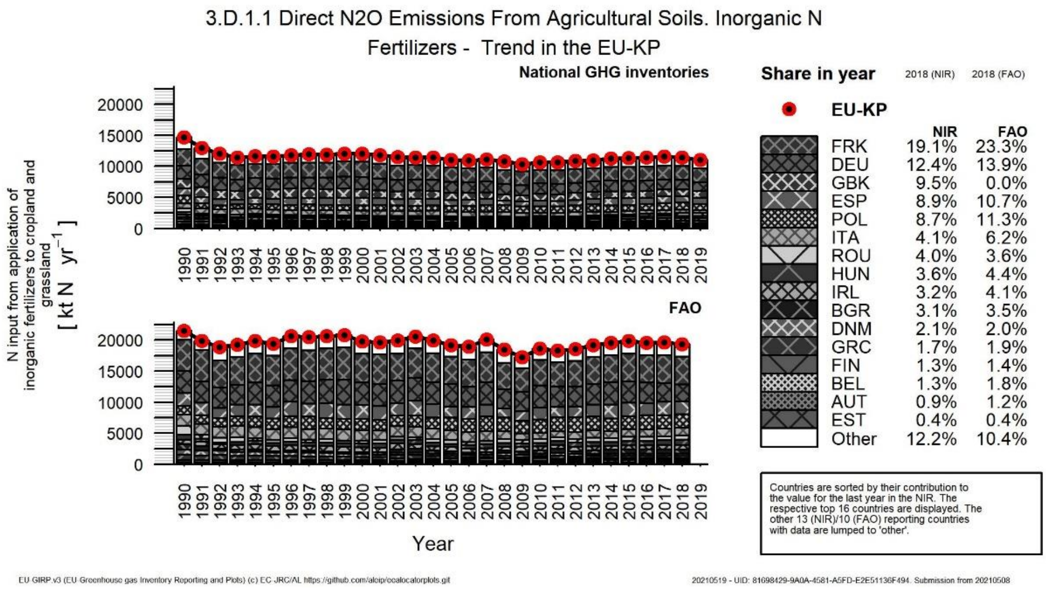


Figure 5.100: 3.D: (a) Average Inorganic N fertilizers N input in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.

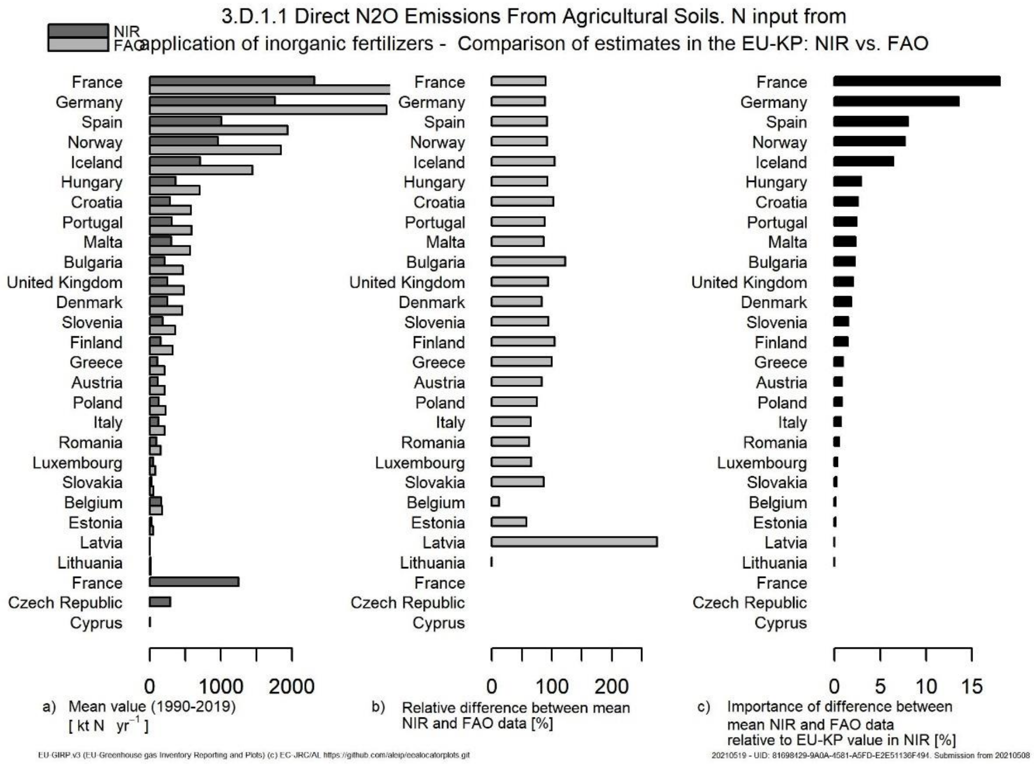


Figure 5.101: 3.D: Comparison of Organic N fertilizers N input in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.

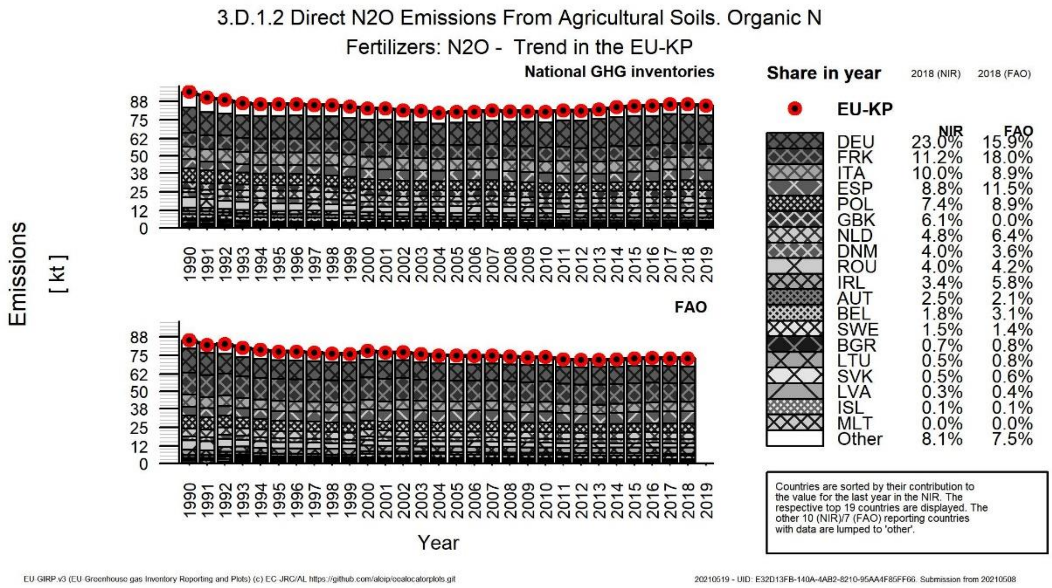


Figure 5.102: 3.D: (a) Average Organic N fertilizers N input in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.

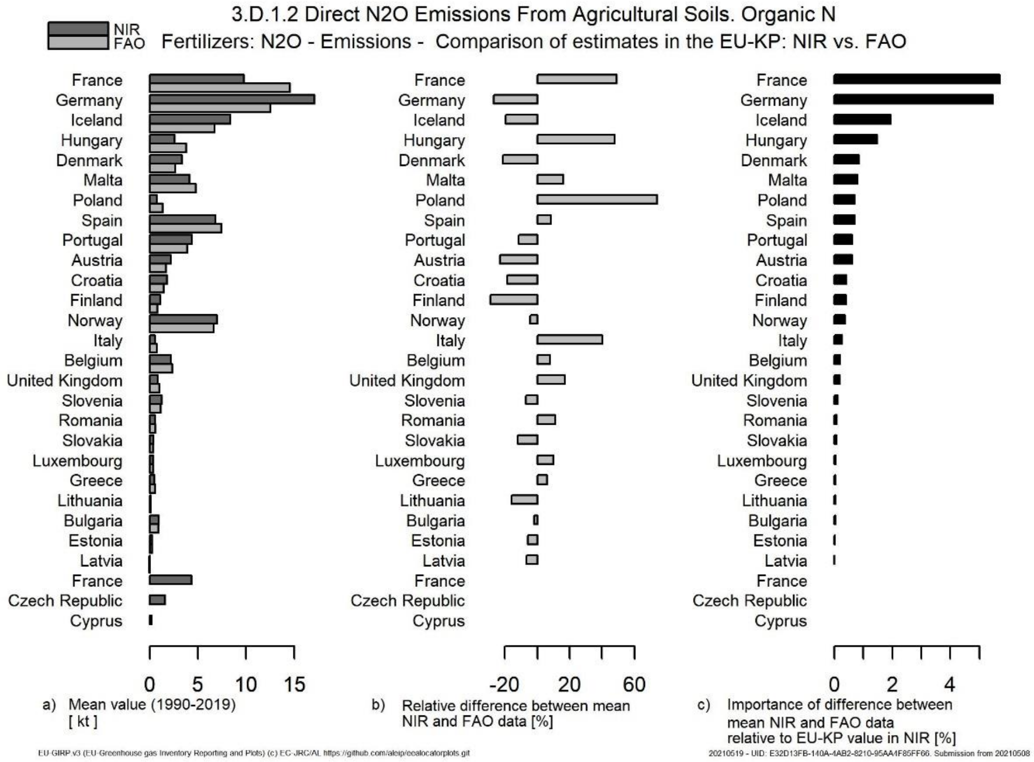


Figure 5.103: 3.D: Comparison of crop residues N input in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.

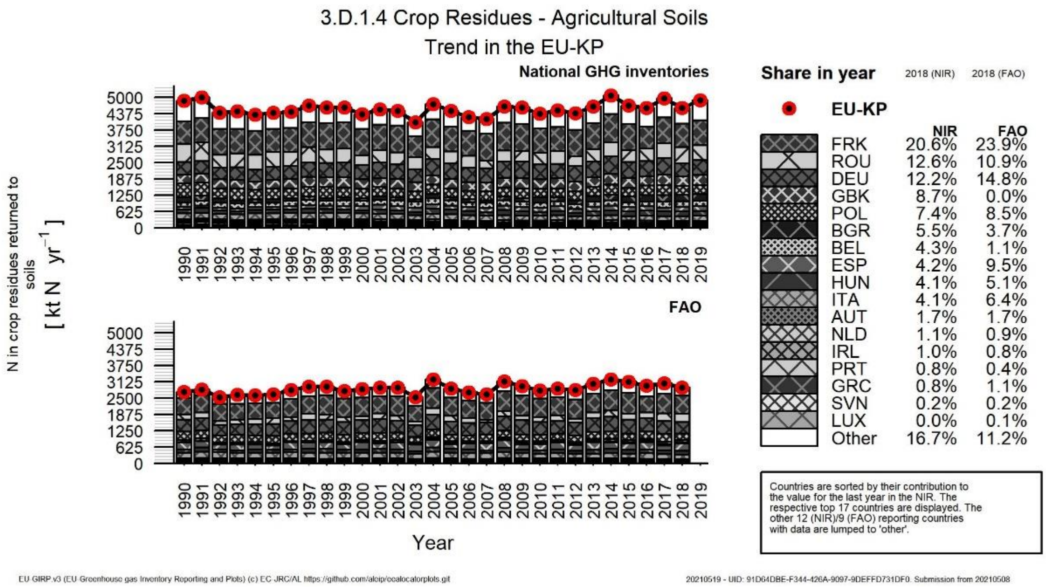
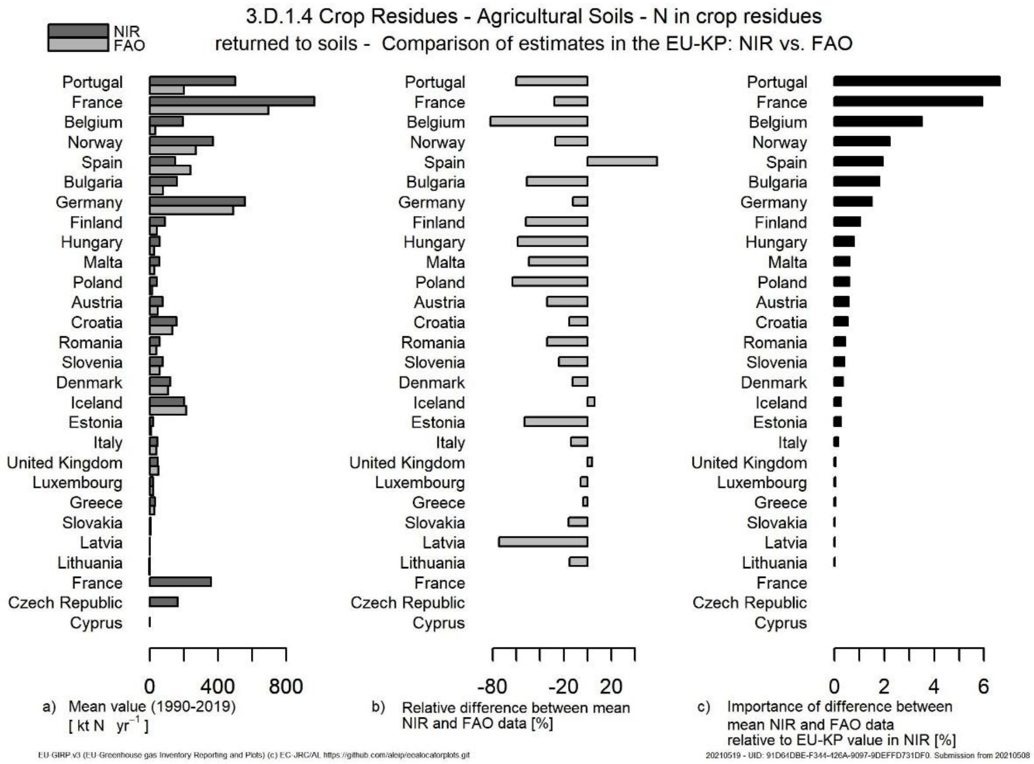


Figure 5.104: 3.D: (a) Average Crop residues N input in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.



From the three nitrogen sources analysed above, all three present higher total values in the NIR data, but differences are highest in synthetic fertilisers applied. Time trends are quite smooth in the first two cases, with some sudden steps in crop residues applied to soils, which are probably due to climatic reasons and captured by both databases.

5.6.5 3.D Cultivation of histosols

Focusing on the area of cultivated organic soils, we can see in Figure 5.105 and Figure 5.106 that total EU-KP area provided by FAOSTAT is higher than the area reported by countries to UNFCCC, constant in both databases for nearly the whole time series. Comparing all years, NIR is smaller by 1728937 ha/year or 35.9% of the average value in the EU. The largest deviations (FAO minus NIR) are 1301670 ha/year (EU-KP, 2019), corresponding to 28% of total EU area of cultivated organic soils in this year (NIR), 1296950 ha/year (EU-KP, 2018), and 1242081 ha/year (EU-KP, 2017).

Figure 5.105: **3.D.1.6: Comparison of histosols area in the EU-KP and range of values reported by countries in the UNFCCC and the FAO.**

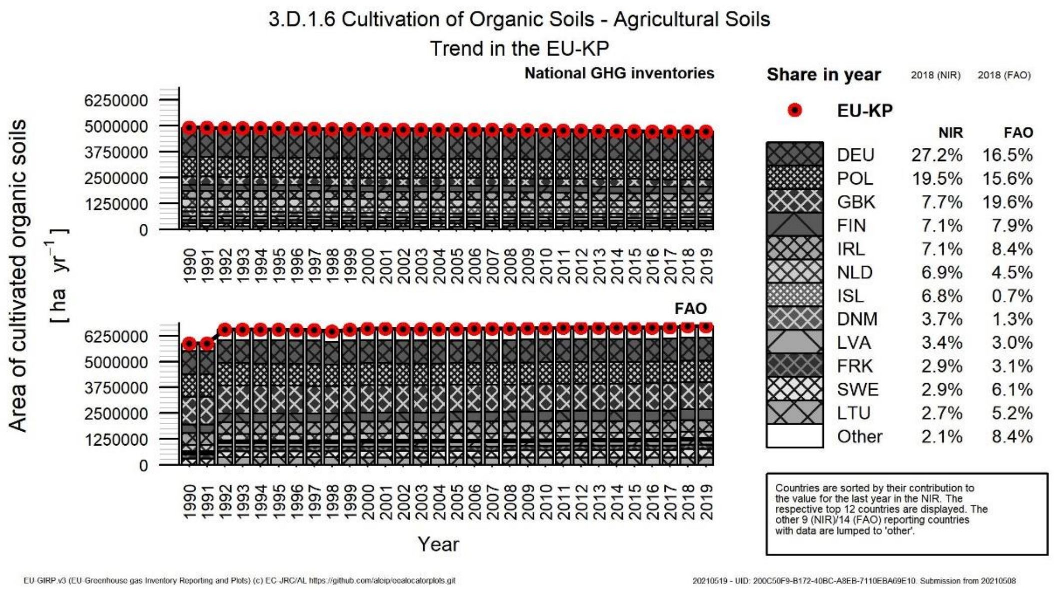
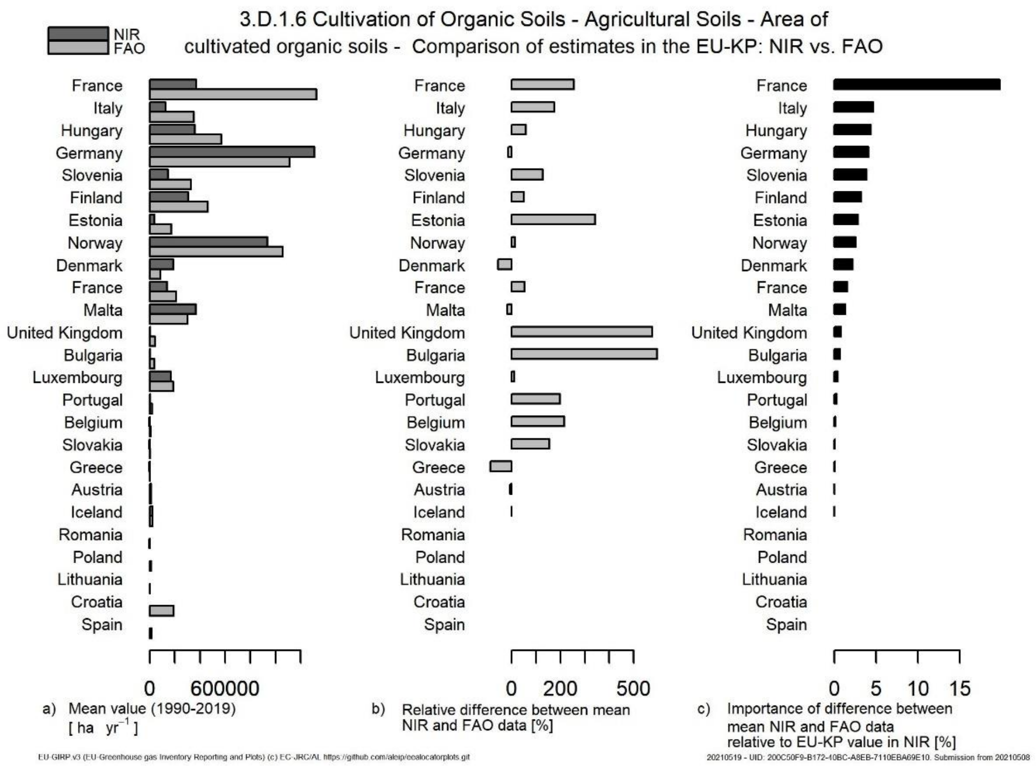


Figure 5.106: **3.D.1.6: (a) Average Histosols area in the EU-KP in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU-KP value and (c) Relative difference of mean values by country.**



An in-depth comparison of the area of cultivated organic soils as reported by the FAO, in the NIRs, and with calculations done at the JRC has been performed by JRC in October 2013.

The FAO (FAO, 2103) provides area of cultivated organic soils on country level. The analysis is based on the Harmonized World Soil Database - HWSD - (FAO/IIASA/ISRIC/ISSCAS/JRC, 2009) and the Global Land Cover data set for the year 2000 (GLC2000).

At JRC the area of cultivated organic soils for the single countries in EU27 has been derived from overlaying the HWSD with the CORINE Land Use/Cover data set - CLC2006 (EEA, 2011) for the year 2006 (for some countries 2000). Both data sets have been resampled to a 1km by 1km raster cell size.

Definition of organic soils as given in IPCC (2006) based on FAO (1998): Soils are organic if they satisfy the requirements 1 and 2, or 1 and 3 below (FAO, 1998):

1. Thickness of 10 cm or more. A horizon less than 20 cm thick must have 12 percent or more organic carbon when mixed to a depth of 20 cm;
2. If the soil is never saturated with water for more than a few days, and contains more than 20 percent (by weight) organic carbon (about 35 percent organic matter);
3. If the soil is subject to water saturation episodes and has either: (i) at least 12 percent (by weight) organic carbon (about 20 percent organic matter) if it has no clay; or (ii) at least 18 percent (by weight) organic carbon (about 30 percent organic matter) if it has 60 percent or more clay; or (iii) an intermediate, proportional amount of organic carbon for intermediate amounts of clay (FAO, 1998).

FAO gave larger area of organic soils cultivated compared to JRC results for all countries except Germany Figure 5.31. This was mainly due to different source data sets for delineation of cropland area and the assumptions regarding the land use classification.

In the JRC approach Soil Typological Units (STU) of the HWSD are defined as 'organic soils'

(1) if the topsoil organic carbon content is > 18% or

(2) if the topsoil organic carbon content is higher than the topsoil clay content * 0.1 + 12. All STUs in the EU-KP of the HWSD which have been classified as 'organic soils' showed an organic carbon content of >30%, thus de facto only criterion (1) was applied.

To delineate 'cropland area' in the land use/cover map, FAO considers pure cropland classes as well as mixed cropland/other land use classes. For the latter, assumptions were made on the share of cropland within these mixed classes. However, the JRC approach takes assumes that in case of mixed land use classes the probability of the different land uses happening on organic soils are not the same, in contract to the approach of the FAO, which distribute land cover proportionally. As some crops do not grow well on organic soils it might occur that the land uses are not distributed equally on the mineral and organic soil but that 100% of the forest is grown an organic soil and the crops are cultivated only on mineral soils.

In the JRC analysis mixed land use classes are not taken into account as the shares of cropland within these classes are given as ranges in the legend of CORINE. The cropland/other land use shares in the mixed land use classes might also vary between regions. Thus, by excluding mixed land use classes, the estimate of cropland area on organic soils can be considered as conservative compared to the FAO approach.

5.6.6 Conclusion

Overall, the two datasets showed a difference of about 3% in the total averaged emissions from 1990 to 2019, with indirects soil N_2O emissions, CH_4 emissions from enteric fermentation and N_2O emissions from manure management being those with highest differences.

Regarding category 3.A - enteric fermentation, the lower animal population for all animal categories in the FAO data could be the most important activity data affecting the lower CH_4 emissions in FAO data (-11%), in particular data for dairy cattle, non-dairy cattle and sheep. The lower animal population in FAO inventory caused also a lower estimate for N_2O emissions from category 3.B.2 - manure management (-46%), together with a generally lower nitrogen excretion rate for all animal categories, except for swine. N_2O emissions from category 3.D.1.6 – cultivation of organic soils are higher in FAO inventory (+62%) due to the lower area of organic soils considered in NIR data (-35%). The factor affecting this difference is the distribution of organic soils in mixed land use classes.

5.7 Sector-specific recalculations, including changes in response of to the review process and impact on emission trend

Table 5.58 to Table 5.61 provide information on the contribution of Member States to EU-KP recalculations in sectors 3A (CH_4), 3B (CH_4 and N_2O) and 3D (N_2O) for 1990 and 2019 and main explanations for the largest recalculations in absolute terms.

Table 5.58 3A Enteric fermentation: Contribution of MS to EU-KP recalculations in CH_4 emissions for 1990 and2019 (difference between latest submission andprevious submissions in kt CO_2 equivalents and percent)

Country	1990		2018		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
Austria	-	-	-1	-0.1	No explanations given, recalculation lower than 1%.
Belgium	-69	-5.3	-65	-5.2	Correction of the weight gain factor for dairy cows, brood cows and non-dairy cattle >2years (correction made in all the regions).
Bulgaria	368	51.5	197	164.8	Correction of technical mistake in activity data for young cattle.
Croatia	1	0.2	-9	-2.2	Update of annual emission factors for dairy cattle which are now based on year-specific activity data. Inclusion of emissions from the rabbit population.
Cyprus	-	-	-1	-1.1	Updated number of horses.
Czechia	13	0.7	-12	-2.2	Update of activity data were used for milk production and methane conversion factor (Ym) for calves' categories.
Denmark	-0	-0.0	-7	-0.3	Small changes in number of animals.
Estonia	-	-	0	0.0	Corrected rounding errors for calculating the average fur population.
Finland	-	-	-2	-0.4	Data used for the calculation of enteric fermentation of sheep were harmonized and the method developed. Fur animal numbers were updated for the year 2018.
France	11	0.3	-16	-0.4	Update of milk production for dairy cattle. Update of number of heads for other cattle and horses. Correction of the formula dividing pigs by sub-categories.
Germany	-684	-8.4	-218	-3.6	Changes in the modelling of energy demand and feeding of cows and pigs
Greece	-	-	18	2.9	Update of activity data.
Hungary	-	-	-	-	NA
Ireland	-118	-8.4	191	13.4	Updated methane models for cattle (dairy and non-dairy) developed in collaboration with Teagasc (Ireland's national agriculture and food development authority) in 2019 to more accurately reflect recent changes in farming practices in Ireland. In addition, updated data on crude protein content in concentrate feeds and trends over time was obtained from a survey conducted by DAFM (Department of Agriculture, Food & Marine) in 2019 (previous data source was from a survey in 2003).
Italy	895	22.7	662	19.0	Update of parameters values DE and Ym from 2004 for dairy cattle on the basis of the 2019 IPCC Refinement guidelines and country specific information
Latvia	-	-	-	-	NA
Lithuania	0	0.0	17	7.7	No explanation given.
Luxembourg	1	2.9	3	4.7	Correction of GE for cattle and sheep.

Country	1990		2018		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
Malta	9	173.2	7	141.6	Revised the methodologies to reflect the 2019 IPCC Refinements. Feed Digestibility for Cattle and Sheep were also updated. The cow milk quantity for 2018 was revised down.
Netherlands	-	-	-4	-0.1	No explanations given, recalculation lower than 1%.
Poland	-190	-8.4	-267	-17.7	Update of CH_4 emissions from cattle based on new country analysis on breeding parameters following ERT 2018 and EU review 2020 recommendations.
Portugal	-0	-0.0	1	0.2	Milk production from dairy cows in 2018 was reviewed by the National Statistics Authority.
Romania	-2 714	-59.5	-734	-53.2	Recalculations were made for the entire period 1989-2018 for CH_4 emissions for following reasons: - the calculation method for gross energy intake (GE) for sheep was modified. It was used the equation 10.16; - the calculation method for buffalo, goats, horses, mules and asses and poultry was modified.
Slovakia	-4	-1.0	-2	-1.4	Correction of some errors for sheep and non-dairy cattle categories. The bodyweight in non-dairy cattle category (Calves and Heifers) were revised.
Slovenia	-17	-4.8	-17	-6.7	
Spain	-56	-0.8	-11	-0.2	New information available from the source. Update for the years 2013-2018. The default value IPCC 2006 Guidebook for Ym, (6.5%) has been applied in substitution of the values applied in the last edition based on a national study.
Sweden	-	-	0	0.0	Correction of the emission factor for suckler cows.
United Kingdom	-471	-9.9	-236	-5.6	
EU27+UK	-3 025	-5.7	-502	-1.2	
Iceland	-0	-0.0	-0	-0.0	NA
United Kingdom (KP)	-471	-9.9	-236	-5.6	Scaled value for 2018 replaced with actual value from model run for all livestock categories; Minor revisions to live weights and livestock numbers; Revisions to milk yield from 2005 for dairy cattle. Change in distribution of animals between hill, upland and lowland systems and increase in maintenance energy requirement and grazed grass quality for sheep. Increase in maintenance energy requirement and grazed grass quality for sheep.
EU-KP	-3 025	-5.7	-502	-1.2	

Table 5.59 3B Manure Management: Contribution of MS to EU-KP recalculations in CH_4 emissions for 1990 and2019 (difference between latest submission andprevious submissions in kt CO_2 equivalents and percent)

Country	1990		2018		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
Austria	-	-	-1	-0.1	New information on input materials for Austria's biogas plants.
Belgium	-69	-5.3	-65	-5.2	Revision of the milk production per cow, the weight gain factor for milk cows, brood cows and cattle more than 2yrs, update of the animal number.
Bulgaria	368	51.5	197	164.8	Revision of manure management system for cattle and swine after a potential technical correction in 2020.
Croatia	1	0.2	-9	-2.2	Update of annual emission factors which are now based on year-specific activity data. Inclusion of emissions from the rabbit population.
Cyprus	-	-	-1	-1.1	No explanations given, small recalculation with 1.1%..

Country	1990		2018		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
Czechia	13	0.7	-12	-2.2	Update of activity data for manure management systems for dairy cattle and swine.
Denmark	-0	-0.0	-7	-0.3	Small changes in number of animals and allocation in housing types changes the emission for all years 1990-2018. Moreover, the emission of CH_4 from manure management has decreased with less than 1 % in all years 1990-2018.
Estonia	-	-	0	0.0	Corrected rounding errors for calculating the average fur population.
Finland	-	-	-2	-0.4	Fur animal numbers were updated for the year 2018.
France	11	0.3	-16	-0.4	Update of milk production, number of heads for other cattle and horses. Correction of the formula dividing pigs by sub-categories. Implementation of the estimate at regional level.
Germany	-684	-8.4	-218	-3.6	Changes in the modelling of energy demand and feeding of cows and pigs.
Greece	-	-	18	2.9	Update of activity data for all livestock categories.
Hungary	-	-	-	-	NA
Ireland	-118	-8.4	191	13.4	Manure management data has been updated to reflect current practices based on the National Farm Survey.
Italy	895	22.7	662	19.0	Update of average temperatures at provincial levels on the basis of the national database which results in a change of emission estimates from manure storage
Latvia	-	-	-	-	NA
Lithuania	0	0.0	17	7.7	Update of data on manure management systems for dairy cattle.
Luxembourg	1	2.9	3	4.7	Revised manure management systems.
Malta	9	173.2	7	141.6	Revised the methodologies to reflect the 2019 IPCC Refinements. the Feed Digestibility for Cattle and Sheep were also updated.
Netherlands	-	-	-4	-0.1	No explanations given, small recalculation with 0.1%..
Poland	-190	-8.4	-267	-17.7	Update of emission abatement measures related to cover of tanks with liquid manure for cattle and swine.
Portugal	-0	-0.0	1	0.2	Milk production from dairy cows in 2018 was reviewed by the National Statistics Authority.
Romania	-2 714	-59.5	-734	-53.2	Recalculations were made for the entire period 1989-2018 for CH_4 emissions for following reason: - was modified the calculation method for gross energy intake (GE) for sheep. Was use equation 10.16; - was modified the calculation method for buffalo, goats, horses, mules and asses and poultry.
Slovakia	-4	-1.0	-2	-1.4	Revision of the maximum methane producing Capacity (Bo) for manure by livestock category in m3 CH_4/kg of VS excreted in suckler cows.
Slovenia	-17	-4.8	-17	-6.7	Update of the average temperature in selecting MCF values for an entire reporting period.
Spain	-56	-0.8	-11	-0.2	Update of activity data on goats and slight corrections in population categories in white pigs, non-dairy cattle, horses and poultry.
Sweden	-	-	0	0.0	Minor differences in the reindeer population due to an updated time series.
United Kingdom	-471	-9.9	-236	-5.6	Scaled value for 2018 replaced with actual value from model run; Minor revisions to live weights and livestock numbers; Revisions to milk yield from 2005; Full representation of anaerobic digestion of livestock manure in the model at the manure storage and digestate

Country	1990		2018		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
					spreading stages including revision to EFs; Minor changes in VS excretion due to changes in liveweight.
EU27+UK	-3 025	-5.7	-502	-1.2	
Iceland	-0	-0.0	-0	-0.0	NA
United Kingdom (KP)	-471	-9.9	-236	-5.6	
EU-KP	-3 025	-5.7	-502	-1.2	

Table 5.60 3B Manure Management: Contribution of MS to EU-KP recalculations in N_2O emissions for 1990 and2019 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

Country	1990		2018		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
Austria	-	-	-0	-0.0	New information on input materials for Austria's biogas plants.
Belgium	-1	-0.1	-9	-1.4	Update of FracGASM, correction animal number, revision of the weight (gain) parameters impacts GE parameter. The Nex has been revised.
Bulgaria	-345	-27.4	-177	-37.3	Changes made about applied default emission factor for N_2O to the proportion of manures that were reported as dry lot for all category of cattle instead of liquid storage.
Croatia	-46	-12.3	10	7.2	Correction of an error in emission of solid storage MMS from the sum of total MMS for sheep animal category. Corrected values for of Frac (GasMS) and Frac (LossMS). Inclusion of estimate of indirect N_2O emissions associated with leaching and run-off; inclusion of rabbits as a new animal category of N_2O emissions.
Cyprus	-	-	0	0.0	NA
Czechia	4	0.3	29	5.6	Adoption of country specific nitrogen excretion rate and revision of the manure management systems,
Denmark	-13	-1.3	-19	-2.6	N_2O from manure management decreases for all years 1990-2018, due to changes in emission factors for slurry. The emission factor has been updated to a weighted value of coved and not covered slurry tanks. Indirect emission of N_2O from manure management increases in 1990-2018, due to updated emission factors for NOx. The conversion of NOx to NOx-N has been changed due to an error. The emission of N_2O from manure management has decreased with 1-3 % in all years 1990-2018.
Estonia	3	1.7	2	3.5	Corrected rounding errors for calculating the average fur population. The indirect N_2O emissions from atmospheric deposition and leaching and run-off were recalculated in 1990-2018 due to the updates made in the Estonian Informative Inventory Report 1990–2019, compiled by the EstEA which changed the input data of NH_3, NOx and N2 from manure management.
Finland	-0	-0.1	-2	-0.6	Data used for the calculation of nitrogen excretion of sheep were harmonized and the method developed. Fur animal numbers were updated for the year 2018.
France	-52	-1.8	-84	-3.4	Update of milk production, number of heads for other cattle and horses. Correction of the formula dividing pigs by sub-categories. Update of the calculation method for methanised effluents now set at 0.
Germany	-290	-7.4	-221	-6.9	Changes in the modelling of energy demand and feeding of cows and pigs.

Country	1990		2018		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
Greece	-9	-2.6	-0	-0.2	Update of activity data for all livestock categories. Update of nitrogen excretion rates for dairy cattle.
Hungary	-0	-0.0	-0	-0.0	NA
Ireland	-9	-1.9	100	18.3	Manure management data has been updated to reflect current practices based on the National Farm Survey.
Italy	-1	-0.0	-73	-3.3	Update of the N excreted for dairy cattle and the nitrogen quantities in livestock manure sent to anaerobic digestion.
Latvia	-13	-4.4	-1	-1.3	Corrected numbers of nitrogen that is lost due to volatilisation of NH_3 and NOx due to use EMEP/EEA 2019 Guidelines instead of EMEP/EEA 2016 Guidelines.
Lithuania	-0	-0.0	12	6.6	Update of data on manure management systems for dairy cattle.
Luxembourg	-2	-5.6	1	2.2	Revised manure management systems, updated Nex for suckler cows and revised N-flow.
Malta	4	32.4	2	22.4	Revised the methodologies to reflect the 2019 IPCC Refinements. the Feed Digestibility for Cattle and Sheep were also updated.
Netherlands	-	-	38	4.9	No explanation given.
Poland	1 075	35.8	580	26.3	update of Nex parameteres for cattle and poultry
Portugal	-8	-2.7	-4	-2.1	Update of the NH_3 emission factors included in the EMEP/EEA Guidebook 2019, for housing and storage manure and also due to the change of the N fraction leached from manure management systems.
Romania	779	64.7	479	79.9	Change of the formula of calculation on the N excretion (Nex) values by dairy cattle, non dairy cattle, sheep and goats. Change of the value on MS% for anaerobic lagoon for swine with the 0 value and was moved the percentage from anaerobic lagoon at liquid slurry.
Slovakia	-9	-2.0	-4	-2.1	Correction of nitrogen from manure management systems, average nitrogen excretion rate, distribution of manure management systems.
Slovenia	6	7.0	-0	-0.2	Update of the N excretion rates for suckling cows, other cattle and various poultry species/categories with EMEP/EEA 2019 values. New EMEP/EEA 2019 methodology was implemented for assessment of nitrous oxide emissions from manure management. The changes relate to ammonia emission factors for animal housing and manure storage and for consecutive emissions of nitrous oxide.
Spain	-178	-11.0	-263	-13.8	Update of nitrogen excretion rate of goats, slight corrections in population categories in white pigs, non-dairy cattle, horses and poultry. Update of amounts of volatilized nitrogen calculated with mass balance following the EMEP 2019 methodology.
Sweden	-	-	-	-	NA
United Kingdom	-227	-6.6	-67	-2.4	No explanation given.
EU27+UK	668	2.3	329	1.5	
Iceland	-1	-3.9	-1	-3.4	
United Kingdom (KP)	-227	-6.6	-67	-2.4	
EU-KP	667	2.3	329	1.5	

Table 5.61 3D Agricultural Soils: Contribution of MS to EU-KP recalculations in N_2O emissions for 1990 and2019 (difference between latest submission andprevious submissions in kt CO_2 equivalents and percent)

Country	1990		2018		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
Austria	0	0.0	4	0.2	New information on input materials for Austria's biogas plants and harvested amounts of sugar beet and salad in Austria's official harvest statistics.
Belgium	-7	-0.2	-46	-1.4	Update of amount of inorganic fertilizer and compost applied on land, amount of animal manure processed and/or exported, FracGASM, Nex rates.
Bulgaria	-177	-3.2	-165	-4.0	New country specific data for area of cultivated organic soils for the whole time series.
Croatia	-26	-1.8	-27	-2.4	Minor changes in activity data on crop production; corrections of estimate in for 3B source;
Cyprus	-	-	-0	-0.1	Animal population (horses), compost and sewage sludge data revised.
Czechia	-89	-1.6	-252	-6.0	New country specific annual nitrogen excretion (Nex, kg N/animal/year) for all animal categories, updated amount of urea applied to farmland, validation of nitrogen losses due to the volatilization (FracGASMS) and manure management (FracLOSSMS).
Denmark	-60	-1.1	-134	-3.3	Changes in allocation of manure application for goats. Updated value for the amount of N from sewage sludge applied to soil. Emissions from biomass (other than manure) treated in biogas facilities has been included.
Estonia	-13	-1.1	-20	-2.9	The N_2O emissions from mineralization/Immobilization Associated with the Loss/Gain of Soil Organic Matter and from Cultivation of organic soils – data on areas of organic soils cultivated were updated in the framework of the NFI. The N_2O emission from compost were recalculated in 1990-2018 due to the corrected activity data use in compost calculations – compost data of dry weight are used instead of formerly used compost data of wet weight. The N_2O emissions from manure applied to soils in 2017 and 2018 and in 1990-2018 due to the updates made in the Estonian Informative Inventory Report 1990–2019, compiled by the EstEA which changed the input data of NH_3 , NOx and N2 from manure management. Indirect N_2O emissions from agricultural soils were revised due to the recalculations under the Manure management subcategory and direct N_2O emissions from managed soils subcategory.
Finland	5	0.1	-74	-2.1	The recalculation of sheep N excretion and the updates in animal numbers change the N input in manure applied to soils and the N input in manure on pasture. Updated, comprehensive time series from the Finnish Food Authority of the manufacture of meat and bone meal as fertiliser. Calculation of the biomass input in crop residues was harmonised with the LULUCF sector. Crop area update for the years 2014 to 2018. Cover crops included in the biomass input. New area estimates due to the updating of NFI data. Update of soil C stock changes in the LULUCF sector.
France	-927	-2.6	-661	-2.1	Addition of digestate (excluding livestock effluents) to spreading for the entire period. Correction of an error on the nitrogen content of the compost (upward revision). Update of the FRAC leach parameter from the value of IPCC 2006 to a national data on irrigated areas and areas where leaching. The share of leached nitrogen has been revised downward from 30% to 25%. Modification amounts of nitrogen from beet and potato residues that were overestimated by counting the residues linked to the root biomass. Update of production from 2000 and modification of the burning rate of potato and beet

Country	1990		2018		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
					residues. Updated Fracleach parameter used for calculating indirect N_2O emissions from managed soils.
Germany	708	2.5	542	2.2	Updated emission factors especially for grassland, and increased area resulting in higher emissions from organic soils.
Greece	-11	-0.2	-24	-0.8	Update of activity data from manure application.
Hungary	5	0.1	1	0.0	Revision of NH_3 emissions from 3.D resulted in changes in the N_2O emissions from 3.D.2.1 Indirect N_2O emissions from managed soils/ Atmospheric deposition. amount of the straw used for bedding was revised resulting in negligible changes in the emissions.
Ireland	-51	-0.9	182	3.1	Revised estimates of emissions and removals for 4.B Croplands and 4.C Grasslands which are used as the activity data for direct N 2 O emissions from managed soils (3.D.a.1.5).
Italy	25	0.3	-215	-2.6	Update of the amount of nitrogen applied with manure and synthetic fertilizers.
Latvia	-595	-23.6	-511	-33.1	Recalculations were done due to updated information about other organic N (including digestate) amount used to managed soils in 2018. Implementation of new country-specific emission factor for drained organic soils.
Lithuania	-166	-5.1	-80	-3.4	Update of activity data on inorganic fertilizers, manure application, parameters for emissions from crop residues.
Luxembourg	10	4.5	16	8.5	Update of manure management systems, quantities of animal manure applied to soil, digestate originating from energy crops and other waste. Update of indirect N_2O emissions from ammonia.
Malta	-0	-0.3	-0	-0.2	Revisions in the N rate(T) as well as livestock weights resulted also in recalculations for the sector Agricultural Soils. Additionally, revisions in the methodologies adopted within the LULUCF sector for the estimation of direct and indirect N 2 O emissions associated with the SOC losses in Mineralised soils have given raise to recalculations within the Agricultural Sector.
Netherlands	-545	-5.9	-380	-7.1	Organic and mineral soils emit different quantities of N 2 O when fertilised. To calculate these emissions a weighted average based on the number of ha of both soil types was used. This has been changed to two separate EF.
Poland	1 645	8.6	622	4.0	Update of Nex parameters for cattle and poultry resulting in change in manure application.
Portugal	-20	-0.9	-9	-0.4	Change in the N_2O emission factor for N Fertilizer applications in rice fields, following ESD review 2020; Change of the N fraction leached from manure management systems, which leaded to more available manure for application; update of the NH_3 emission factors, manure application and grazing, included in the EMEP/EEA Guidebook 2019.
Romania	4 821	52.1	3 037	46.8	1. Was made recalculations for all period on N_2O emissions from N in crop residues (FCR) in the following reasons: -was changed the formula of the calculation using equation 11.7A for the calculation of the N_2O emissions from N in FCR; - was recalculated AGDM and Crop T(kg d.m); -has been corrected FracRemove fot following plants: wheat, barley and barley, oats, maize, sorghum, pea beans, dry bean, other leguminous for dry beans, rape, sunflower, flax for oil, other textile plants- cotton, sugar beet, vegetables, root vegetables- edible roots; - was added to the calculations the plant maize green. 2. Was made recalculations on N_2O emissions from N in urine and dung deposited by grazing animals on pasture, range and paddock and animal manure N applied to soils (FAM) due to changing values of Nex.

Country	1990		2018		Main explanations
	kt CO_2 eq.	%	kt CO_2 eq.	%	
					3. Was made recalculations on N_2O emissions from sewage N applied to soils, changing and the emissions from organic N fertiliser applied to soils (FON).
Slovakia	-9	-0.4	-9	-0.6	Update of the activity data for animal manure applied to soils and correction of the calculated N-losses from the manure management systems. Tier 2 approach in Nitrogen leaching category was implemented.
Slovenia	6	1.4	-8	-1.9	New EMEP/EEA 2019 methodology was implemented for assessment of indirect nitrous oxide emissions from agricultural soils. The changes relate to ammonia emission factors for application of animal manures and for grazing, as well as to consecutive emissions of nitrous oxide.
Spain	-248	-2.3	63	0.5	Variations in the nitrogen applied to agricultural soils with goat manure, sludge and compost. Update of N_2O EF for rice from 0.01 to 0.003 kg N_2O-N/kg. Update of amounts of volatilized nitrogen calculated with mass balance following the EMEP 2019 methodology.
Sweden	18	0.5	82	2.7	Change in the methodology to estimate emissions from mineralization of soil organic matter. Digestate of manure from co-digestion is included in other organic fertilizers from 1997 and onwards. Updated time series on other organic fertilizers
United Kingdom	648	4.8	742	6.5	Scaled value replaced with actual values based on updated and improved activity data; Implementation of the Wetland supplement; full inclusion of anaerobic digestion in the model
EU27+UK	4 949	2.5	2 677	1.6	
Iceland	-21	-7.8	1	0.3	
United Kingdom (KP)	648	4.8	742	6.5	
EU-KP	4 928	2.5	2 677	1.6	

6 LULUCF (CRF SECTOR 4)

Europe is a fine-grained mosaic of different land uses resulting in a highly fragmented landscape, with almost all its lands under more or less intensive management. This variety is well recognized as valuable in terms of biodiversity and culture but may represent a challenge when compiling a greenhouse gas (GHG) inventory.

Land use, Land-use change, and Forestry (LULUCF) covers anthropogenic GHG emissions, and CO_2 removals that result from land management practices. The impact of these practices on the carbon stock depends on several factors. While certain patterns prevent the release of carbon, or enhance the carbon sink, others enhance the release of carbon stored in carbon pools.

With more than three-quarters of the European Union (EU) territory covered by forests and agricultural lands, the EU‘s environmental and agricultural policies have had a paramount impact on the current landscape for many years.

In particular, over the last years, the Common Agricultural Policy and the rural development programs have stimulated also less intensive agricultural practices and have implemented measures towards sustainability and enhancement of rural environments. Furthermore, with the aim of protecting ecosystems and enhancing their services, the EU environmental policy (e.g., Natura 2000 network) has resulted in an increase of the area under conservation and contributing to preservation of the biodiversity and landscapes.

Overall, throughout the reporting period the land use trends have shown a decrease of arable lands while the area of forests, and to a lesser extent, urban areas, has increased. This land use development is itself one of the main drivers of the final carbon balance on the LULUCF sector. However, of utmost importance is also the fact that at the EU level, wood felling is about one third less than the net annual wood increment. This management practice has led to a build-up of biomass over time in the forests and is also shown as notable annual net carbon removals by the forests in the EU.

6.1 Overview of the sector

Complying with relevant EU provisions (e.g., Regulation No 525/2013[51]), the LULUCF sector is a compilation of the inventories submitted by individual EU Member States (MS), UK and Iceland. Individual submissions are used as the primary source of data and information, unless otherwise specified and referenced in the text.

This LULUCF chapter provides the general trends of GHG emissions and CO_2 removals from LULUCF in the EU, UK and Iceland. It provides general information on the methods used by the countries, and describes the efforts carried out to harmonize and improve the quality of the inventories. More detailed information can be found in national inventory reports (NIRs) and common reporting format (CRF) tables submitted by each EU MS, UK, and Iceland.

In particular, this chapter includes: an overview of LULUCF sector and overall trends, the contribution of land use changes, the completeness of the sector in the individual inventories, the key categories analysis of the EU GHG inventory, general methodological information used to derive GHG emissions by sources and removals by sinks, the trends of net CO_2 emissions

[51] *https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013R0525*

or removals, activity data for each land use category, specific methodological information for relevant categories; as well as an overview of cross-cutting issues including uncertainties, QA/QC procedures, time series consistency, recalculations and verification.

6.1.1 Trends by land use categories

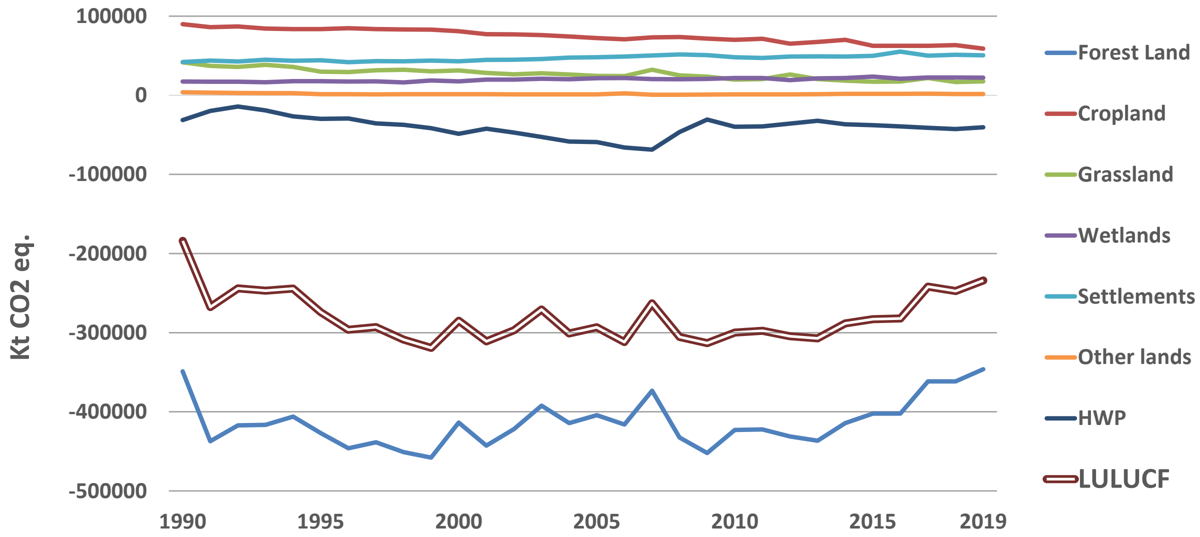
Within the EU GHG inventory, the LULUCF sector shows higher removals by sinks than emissions by sources, resulting in an overall net carbon sink. In terms of land use categories, the only net carbon sink is Forest land. In addition, the carbon pool of Harvested Wood Products also results in a carbon sink. Other land use categories are net sources: Cropland is the largest source of emissions, followed by the conversion of lands to Settlements. Grasslands, along with the other land use categories, represent a smaller source of emissions.

In 2019, the LULUCF sector of the EU MS, UK and ISL results in a total net sink of -266.874 kt CO_2, which represents an increase of 23% as compared to the net sink reported for the year 1990 (Table 6. 1). Within the sector, the carbon pool Harvested Wood Products is in 2019 reported as a net carbon sink of -40.412 kt CO_2. On the other hand, emissions of CH_4 and N_2O equal in 2019 about 12% of total annual net carbon removals.

In terms of CO_2 equivalent this sector results for the year 2019 in -233.948 kt CO_2 equivalent.

Few EU MS have also reported other GHG emissions in the CFR table 4, under the category “Other”, . For instance, France reports CO_2 and CH_4 emissions from Reservoir of Petit-Saut in French Guiana, and biogenic NMVOC emissions from managed forest.

Figure 6.1 *Sector 4 LULUCF: EU MS, UK and ISL GHG net emissions (+) / removals (-) for 1990–2019, in CO_2 eq. (kt).*



Source: EU MS, UK and ISL submissions 2021, CRF Table10s1

The overall trend of the LULUCF sector since 1990 is largely driven by the Forest Land category.

An increase of the forest carbon sink took place during the 90s mainly due to forest area expansion and to an increase of net forest increment, which has been followed by a slight decline resulting from a general increase in harvest rates. In the late 2000s harvest rates decreased, mainly due to the economic crisis, and the sink increased again. The last years of the time series are affected by the increasing maturity of the forests leading to lower increment, and by higher harvest rates.

Inter-annual variations are mainly related to natural disturbance events. Major wind storms took place in central-western Europe (e.g,1990, 2000, 2005, 2007 and 2009) and there were severe wildfires (e.g.,1990, 2003, 2005, 2007, 2016 and 2017) in Mediterranean countries. In the recent years, droughts followed by bark beetle infestations have also increased the amount of salvage logging in central Europe. Natural disturbances also explain the abrupt change in the sink observed in the base year, resulting largely from Germany's reporting. In spring 1990, Germany faced a very high amount of windfall (about 70 million m^3), and following this Germany reports a notably low LULUCF sink in 1990. The economic crisis of 2008 is also reflected in lower harvest rates that were gradually getting back to normal rates in subsequent years.

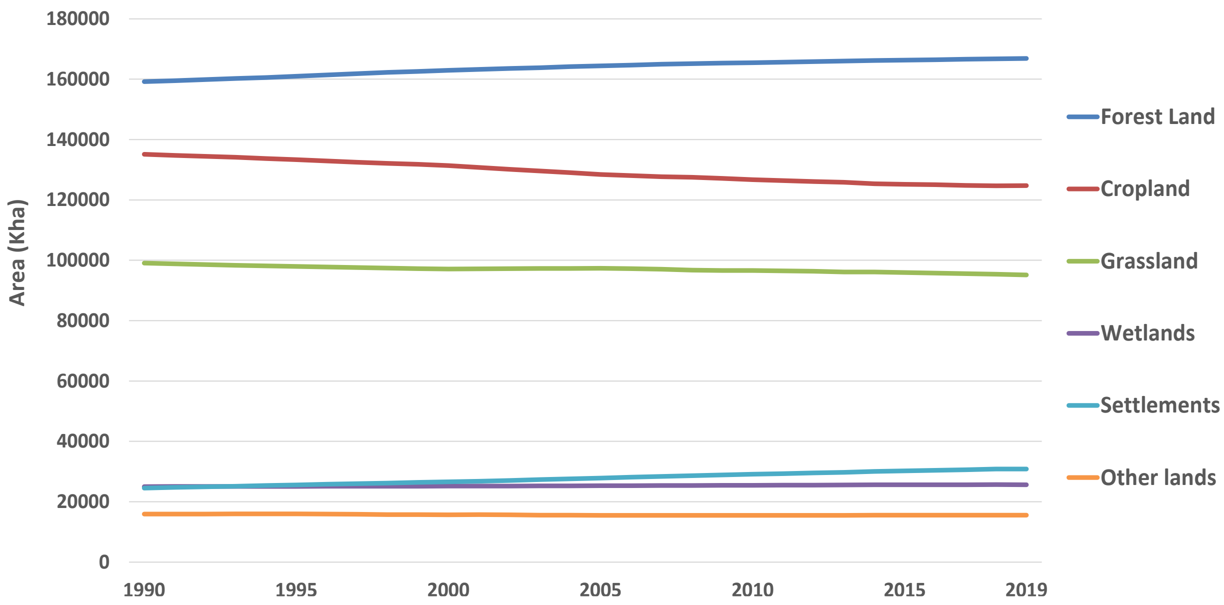
Moreover, in some specific years the methods implemented by countries to derive carbon stock changes also impact the EU trend, for instance when the stock-difference method is applied. Additional category-specific information on trends and inter-annual variability is provided in the following sections of this document.

The total reported area of the different land use categories is ca. 459.000 kha. The trend on these categories (

Figure 6. *2*) are in line with the trends known from other EU statistics (e.g., Eurostat). However, absolute numbers may be slightly different due to different definitions used under each dataset.

As compared with the base year, the changes in total area reported in the current inventory for each land use category are: Settlements (+26%), Croplands (-8%), Forest land (+5%), Grassland (-4%), Wetlands (2%), Other lands (-2%).

Figure 6. 2 Total area for each of the land use categories (kha), as reported in EU MS, UK, and ISL in 2021.



Although the LULUCF sector results in a net carbon sink at the level of EU MS, UK, and Iceland, the LULUCF sector reported by individual countries' inventories ranges from a net source to a large net sink. Compared to 1990, individual inventories report this year in some cases a significant increase in the carbon sink, while in other cases there is a substantial reduction. Changes are driven mainly by forest harvest rates and the impact of natural disturbances.

Table 6. 1 **Sector 4 LULUCF: individual contributions to net CO_2 removals (CRF table 4)**

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	-12 348	-5 278	-4 788	1.8%	7 560	61%	490	9%
Belgium	-3 415	-1 225	-1 214	0.5%	2 201	64%	12	1%
Bulgaria	-19 307	-9 951	-9 937	3.7%	9 371	49%	14	0%
Croatia	-6 497	-5 517	-5 682	2.1%	815	13%	-165	-3%
Cyprus	-219	-401	-385	0.1%	-166	-76%	16	4%
Czechia	-7 055	4 079	13 515	-5.1%	20 571	292%	9 436	231%
Denmark	6 175	3 193	2 132	-0.8%	-4 043	-65%	-1 061	-33%
Estonia	-3 293	-944	-1 084	0.4%	2 208	67%	-141	-15%
Finland	-17 212	-10 997	-17 489	6.6%	-277	-2%	-6 492	-59%
France	-26 129	-35 019	-35 057	13.1%	-8 928	-34%	-38	0%
Germany	22 307	-21 694	-19 805	7.4%	-42 112	-189%	1 889	9%
Greece	-2 177	-4 127	-3 626	1.4%	-1 449	-67%	501	12%
Hungary	-2 738	-4 711	-5 629	2.1%	-2 891	-106%	-919	-19%
Ireland	4 526	3 920	3 620	-1.4%	-906	-20%	-301	-8%
Italy	-5 702	-36 608	-42 235	15.8%	-36 533	-641%	-5 627	-15%
Latvia	-13 402	-1 733	-2 581	1.0%	10 821	81%	-848	-49%
Lithuania	-5 582	-6 679	-5 620	2.1%	-37	-1%	1 059	16%
Luxembourg	64	-201	-322	0.1%	-386	-608%	-121	-60%
Malta	6	0	0	0.0%	-6	-97%	0	-61%
Netherlands	5 994	4 536	4 420	-1.7%	-1 574	-26%	-116	-3%
Poland	-32 263	-38 055	-17 036	6.4%	15 227	47%	21 019	55%
Portugal	353	-7 130	-8 290	3.1%	-8 643	-2448%	-1 160	-16%
Romania	-26 708	-28 629	-32 775	12.3%	-6 067	-23%	-4 146	-14%
Slovakia	-9 783	-5 728	-6 411	2.4%	3 372	34%	-682	-12%
Slovenia	-4 480	945	-132	0.0%	4 348	97%	-1 076	-114%
Spain	-36 682	-39 091	-37 991	14.2%	-1 309	-4%	1 100	3%
Sweden	-38 220	-37 078	-37 222	13.9%	998	3%	-143	0%
United Kingdom	10 309	-1 383	-1 025	0.4%	-11 334	-110%	358	26%
EU-27+UK	**-223 478**	**-285 507**	**-272 650**	**102%**	**-49 171**	**-22%**	**12 858**	**5%**
Iceland	5 720	5 723	5 684	-2.1%	-36	-1%	-39	-1%
United Kingdom (KP)	10 359	-1 292	-934	0.3%	-11 293	-109%	358	28%
EU-KP	**-217 707**	**-279 693**	**-266 874**	**100%**	**-49 167**	**-23%**	**12 819**	**5%**

At the EU level, the LULUCF sector offsets about 8% of the total emissions from other sectors ("Total without LULUCF"), with significant differences among MS (Table 6. 2, column a).

Forest Land category is the main driver in the LULUCF sector, offsetting itself about 10% of total emissions from other sectors. This year, the category resulted (in terms of CO_2 equivalent) a net sink for all MS with the exception of Slovenia and Czechia (Table 6. 2, column b). The most significant contributors to the total net sink reported for the EU under the category 4A are Germany, France, Sweden, Italy, Poland and Spain (Table 6. 2, column c).

Table 6. 2 Sector 4 LULUCF: Contribution of Sector 4 (column a) and category 4A -Total Forest land - (column b) to total MS emissions without LULUCF (CO_2 eq); and MS contribution to total EU category 4A (column c). Information is also presented for UK and ISL.

Country	LULUCF over total inventory excluding LULUCF	Category 4A over total inventory excluding LULUCF	MS contribution to total EU category 4A
	(a)	(b)	(c)
Austria	-5,8%	-5,4%	1,2%
Belgium	-0,9%	-1,6%	0,6%
Bulgaria	-17,1%	-14,8%	2,5%
Croatia	-23,5%	-24,5%	1,6%
Cyprus	-4,3%	-1,8%	0,0%
Czech Republic	11,1%	12,3%	-4,3%
Denmark	5,5%	-5,8%	0,7%
Estonia	-3,4%	-14,2%	0,8%
Finland	-27,7%	-43,2%	6,5%
France	-7,1%	-11,7%	14,5%
Germany	-2,0%	-7,0%	16,2%
Greece	-4,2%	-2,0%	0,5%
Hungary	-8,6%	-8,7%	1,6%
Ireland	7,4%	-7,4%	1,3%
Italy	-9,9%	-8,9%	10,6%
Latvia	-10,4%	-35,2%	1,1%
Lithuania	-26,7%	-32,6%	1,9%
Luxembourg	-2,9%	-3,5%	0,1%
Malta	0,0%	NO,NA	-----
Netherlands	2,5%	-1,0%	0,5%
Poland	-3,8%	-3,8%	4,5%
Portugal	-12,4%	-16,2%	2,9%
Romania	-26,5%	-23,4%	8,1%
Slovakia	-15,9%	-11,6%	1,3%
Slovenia	-0,6%	1,4%	-0,1%
Spain	-11,9%	-10,5%	9,4%
Sweden	-69,7%	-74,1%	10,7%
EU 27	**-7,5%**	**-9,7%**	**100%**
United Kingdom	1,3%	-3,6%	-----
Iceland	192,1%	-9,4%	-----

Source: EU MS, UK and ISL submissions 2021, CRF Table10s1

6.1.2 **Contribution of land use changes**

The conversion of lands in the territory of the EU MS, UK and ISL results in net emissions of 27.994 kt CO_2 equivalent (Table 6. 3).

Land use changes represent 9% of the total reported land area. The carbon sink resulting from conversions to Forest Land and Grassland is by far counterbalanced by emissions from conversions to Cropland, Wetlands, Settlements and Other land.

Table 6. 3 Contribution of land use changes in 2019 for EU MS, UK and ISL, in terms of area (columns a-b) and net CO_2eq. (Columns c-d) (As aggregation of data from CRF Table 4.)

Land use conversions	(a) land area (Kha)	(b) Area % of the corresponding category[1]	(c) Emissions (+) and removals (-) (Kt CO_2eq.)	(d) Net emissions % of the corresponding category[1,2]
4A2. Land converted to Forest Land	7 017	4%	-39 062	10%
4B2. Land converted to Cropland	11 655	9%	39 880	73%
4C2. Land converted to Grassland	15 495	16%	-25 139	217%
4D2. Land converted to Wetlands	1 483	6%	5 487	37%
4E2. Land converted to Settlements	6 865	22%	46 341	92%
4F2. Land converted to Other Land	770	5%	486	100%
Total land use changes	**43 284**	**9%**	**27 994**	**28%**

[1] The corresponding category is 4A (4.A1 + 4.A2 for Forest land) for 4A2, 4B (4.B1 + 4.B2 for Cropland) for 4B2, etc.

[2] The contribution of emissions from land use changes to the total of each category was obtained by considering separately the absolute values of each subcategory, i.e. (abs 4A2)/(abs 4A1+ abs 4A2) x 100.

On average for this year, from total area under conversion, 36% is reported as converted to Grassland, 27% as converted to Cropland, 16% as converted to Forest land, 15% as converted to Settlements, 3% as converted to Wetlands, and 2 % to Other lands.

6.1.3 Completeness of the sector

Table 6. 4 shows the current status of reporting in terms of quantitative estimates for each of the land use sub-categories. Information is taken from the individual inventories submitted this year.

This table, along with Table 6. 5, aims to provide an overview of the completeness status. Empty cells should not be unequivocally associated with an incomplete reporting because in many cases the carbon stock changes are assumed in balance, in line with the 2006 IPCC guidelines, or no methods exist for their estimation (in these cases, such pools are marked in grey in table 6.4 and 6.5 to facilitate the assessment of the completeness).

It should also be noted that the tables provide information for the main sub-categories "remaining" and "land converted to". Under the subcategories "land converted to" there are a wide range of methods and status of completeness. For instance, certain carbon pool can be a source in forest converted to cropland, and a sink in grassland converted to cropland. This large variety cannot be displayed given the length that would be required for the tables. However, more information is provided, with a different format, in other sections of this chapter, such as the tables providing information on implied emission factors. Moreover, it is pertinent to highlight here that more detailed explanations can be found in the individual inventories submitted by countries.

For the three main land uses categories, Forest Land, Cropland and Grassland, including their sub-categories, the reporting is mostly complete, and quantitative estimates are reported. However, under certain subcategories of other land uses, there are still some gaps that are largely associated with the lack of IPCC methods for estimating GHG emissions (e.g., Flooded land remaining flooded land, under Wetlands), the assumption of equilibrium under Tier 1 methods (e.g., Dead organic matter in Cropland), or the implementation of the *insignificance* provision in accordance with the Decision 24 CP/19 (e.g., for living woody biomass under Grassland remaining Grassland). Finally, in many cases the lack of quantitative estimates is also associated with an actual absence of lands being converted to certain subcategories or the absence of organic soils.

Thus, any judgement on completeness would require a comprehensive case by case assessment. In this inventory, it is not possible to include such a detailed set of information, and therefore we refer to the country-specific information of the individual GHG inventories.

Table 6. 4 Sector 4 LULUCF: Coverage of CO_2 emissions and removals for each of the LULUCF sub-categories for the inventory year, as derived from individual 2021 GHGI submissions.

Country	Reporting category												
	Forest land		Cropland		Grassland		Wetland		Settlements		Other land		HWP
	4. A.1. F-F	4. A.2. L-F	4. B.1. C-C	4. B.2. L-C	4. C.1. G-G	4. C.2. L-G	4. D.1. W-W	4. D.2. L-W	4. E.1. S-S	4. E.2. L-S	4. F.1. O-O	5. F.2. L-O	
Austria	R	R	R	E	E	R		E		E		E	R
Belgium	R	R	E	E	R	R		R		E			E
Bulgaria	R	R	R	E	E	R		E		E			R
Croatia	R	R	E	E	E	R		E		E			R
Cyprus	R	R	R	R	R	R				E		E	E
Czech Republic	E	R	E	E	R	R		E		E			R
Denmark	R	R	E	E	E	E	E	E		E			R
Estonia	R	R	E	E	E	R	E	E		E		E	R
Finland	R	R	E	E	E	E	E	E		E			R
France	R	R	R	E	R	R		E	E	E			R
Germany	R	E	E	E	E	R	E	E	E	E			R
Greece	R	R	R	E	E	R		E		E		E	R
Hungary	R	R	R	E	E	R	E	R		E		E	R
Ireland	R	R	R		E	E	E	E		E		E	R
Italy	R	R	R	E	R	R		E		E			R
Latvia	R	R	E	E	E	E	E	E	R	E			R
Lithuania	R	R	R	E		R	E	E		E		E	R

Country	Reporting category												
	Forest land		Cropland		Grassland		Wetland		Settlements		Other land		HWP
	4. A.1. F-F	4. A.2. L-F	4. B.1. C-C	4. B.2. L-C	4. C.1. G-G	4. C.2. L-G	4. D.1. W-W	4. D.2. L-W	4. E.1. S-S	4. E.2. L-S	4. F.1. O-O	5. F.2. L-O	
Luxembourg	R	R	E	E		R		E		E		E	E
Malta			R	R	R	E				E		E	
Netherlands	R	R	E	E	E	R	R	E	E	E		E	E
Poland	R	R	R	E	E	R	E	E	R	E			R
Portugal	R	R	R	E	R	E		E		E		R	R
Romania	R	R	R	R	R	E		E		E		E	R
Slovakia	R	R	R	E		R				E		E	R
Slovenia	E	R	E	E	R	R		E	R	E		E	R
Spain	R	R	R	E		E	E	E		E		E	R
Sweden	R	R	E	E	E	E	E		E	E		E	R
United Kingdom	R	R	E	E	E	R	E	E	E	E			R
Iceland	R	R	E	E	E	R	R	E		E			R

R = Carbon stock changes in the pool result in net Removals.
E = Carbon stocks change in the pool results in net Emissions.
Empty cells = Quantitative estimates were included elsewhere, or no quantitative estimates are provided in line with Tier 1 assumption, the provision of insignificance, because no land use changes took place, or due to the lack of IPCC methods.

Overall, the reporting of Wetlands, Settlements and Other lands categories is associated with lower Tier methods, in comparison to the main land use categories. This is especially the case when looking at their subcategories “land remaining in”. On the contrary, carbon stock changes are typically estimated and reported for land use changes involving such categories.

Table 6. 5 shows with more detail the completeness of the reporting on carbon stock changes by carbon pools, for the three most important land use categories as reported this year in individual submissions. Compared to the previous years, several MS have increased the number of carbon pools estimated and reported.

As for table 6.4, empty cells in table 6.5 represent carbon pools which are not reported with quantitative estimates (e.g., based on the Tier 1 assumptions, demonstrating the insignificance of the resulting carbon stock changes, because of the lack of 2006 IPCC methods, because of the absence of organic soils, or because the pool is included elsewhere).

Table 6. 5 **Sector 4 LULUCF: Quantitative estimates of carbon stock changes on carbon pools for the most important land use subcategories for the current inventory year.**

COUNTRY	Reporting category																									
	Forest land										Cropland								Grassland							
	4.A.1. F-F					4.A.2. L-F					4.B.1. C-C				4.B.2. L-C				4.C.1. G-G				4.C.2. L-G			
	LB	DW	LT	SOC min	SOC org	LB	DW	LT	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org
AUT	R	R		E		R	R	R	R		R		R		E	E	E				R	E	E	E	R	
BEL	R					R	R	R	R		E		E	E	R		E				R	E	E	E	R	
BGR	R	R				R	R				E		R		R		E		R		E					
HRV	R					R	R	R	E		E		E	E	R		E					E	E		R	
CYP	R					R	E	R	R		R				R	E	R		R				R	R	R	
CZE	E	R				R	R	R	R		R		E		E	E	E				R		R	E	R	
DNM	R	R	R		E	R	R	R	R	E	E		E	E	R	E	E		E			E	E	E	R	E
EST	R	R		R	E	R	R	R	R	E	E		R	E	E	E	E	E	R			E	R	E	R	E
FIN	R			R	E	R			R	E	R		E	E	E	E	E	E	R			E	E		R	E
FRA	R	E				R	R	R	R		E		R		E	E	E		R		E		E	E	R	
DEU	R	R	E	R	E	E	R	R	R	E	R		E	E				E	R		R	E				E
GRC	R					R					R			E	R		E		E				E			
HUN	R	R			E	R	R	R	R		E		R		E	E	E				E		E	E	R	
IRL	R		E	E	E	R			R	E	E		R								R	E	E	E	R	E
ITA	R	R	R			R	R	R	R		E		R	E	E		E		R	R	R	R			R	
LVA	R	R			E	R	R	R		E	R	E		E	E	E	E	E	R	R		E	E	E		E
LTU	R	R				R		R	R		E		R		E	E	E						R	R	R	
LUX	R	R				R	R	R	R		E		R		E	E	E						E	E	R	
MLT											R		E						R		R				E	
NLD	R	R			E	R			R	E				E	E	E	E	E	R		R	E	E	E	R	E
POL	R			R	E	R			R	E	R		E	E			E	E			E	E	R		R	E
PRT	R		E	E		R		R	R		R		R		E	E	E				R		E	E	E	
ROU	R				E	R	R		R		R	E	R	E	R	E	R		R			E	E	E	R	
SVK	R					R		R	R		R		R				R						E	E	R	

COUNTRY	Reporting category																									
	Forest land										Cropland								Grassland							
	4.A.1. F-F					4.A.2. L-F					4.B.1. C-C				4.B.2. L-C				4.C.1. G-G				4.C.2. L-G			
	LB	DW	LT	SOC min	SOC org	LB	DW	LT	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org
SLV	E	R				R	R	R	R		E	R	R	E	E		E	E	R	R	E		R			
ESP	R					R	R	R	R		R		R		R	E	E						E	E	R	
SWE	R	R	E	R	E	R	R	R	E	E	R	R	E	E	E	E	E	E	R	R	E	E	E	E	R	E
UK	R	R	R	R	R	R	R	R	E	E	E		E	E				E	E		R	E				
ISL	R				E	R				E			R	E			R	E	R	R	R	E				E

Pools: DW-Dead Wood, LT- Litter, LB – Living Biomass, SOCmin – Soil Organic Carbon in mineral soils, SOCorg – Soil Organic Carbon in organic soils.
R: net Removal;
E: net Emission;
Empty cells: Quantitative estimates were included elsewhere, or no quantitative estimates are provided in line with Tier 1 assumption (grey cells indicate carbon pools for which the IPCC tier 1 methods assume the net carbon stock changes in equilibrium), the provision of insignificance, or because the pool is not present (i.e. absence of organic soils under certain land use categories). Only in a few cases the lack of quantitative estimates could be associated with incompleteness. See more details in following sections.

Source: EU MS, UK and Iceland submissions 2021, CRF table 4A-4C

6.1.4 Data and methods

This section provides an overview of the information on methods and data used by the EU MS, UK and Iceland for reporting on emissions by sources and removals by sinks from the three main land use categories. More detailed information regarding methodological issues is included as an annex to this report, and a complete description can be found in individual national inventory reports, which are considered also part of this submission.

Given the heterogeneity among countries in terms of ecological and socio-economic conditions, there is no common definition of land use categories. Methods used to estimate GHG emissions and CO_2 removals from the LULUCF sector also differ among countries and land use categories. The underlying assumption of the EU GHG inventory is that the implementation of country-specific definitions and methods that reflect and capture specific national circumstances (as long as they are in accordance with IPCC guidelines) is likely to result in more accurate estimates than the implementation of a single EU wide approach.

Table 6. 6 is a summary of relevant information on methodologies applied for each individual carbon pool under the three main land use categories of the LULUCF sector as included in individual GHG inventories.

Usually, for reporting carbon stock changes in "lands remaining in the same category", a single data source is used, which facilitate the categorization of the methodologies under a single Tier. By contrast, multiple data sources are often used to derive emissions from “land converted to” which prevents an easy categorization of the methods under a single Tier. For instance, for estimating carbon stock changes in living biomass from forest land converted to cropland, MS may implement country-specific values for forest land and default factors for cropland.

Furthermore, because the categorization of methods under a single tier for “land converted to” depends also on the categories involved in the conversion (e.g., different approaches and data sources are often used for forest converted to grassland compared to those used for cropland converted to grassland), Table 6. 6 shows a summary of the main information on methods and carbon stock change factors used by individual inventories.

Finally, because of different underlying methods applied by each country, and due to their own national circumstances, the comparison of absolute levels, or trends, of emissions across them should be done carefully to avoid erroneous interpretations. Indeed, in some cases, large differences may be attributable to the different estimating methodologies. For example, (i) the gain-loss and stock-difference methods may lead to different trends in the short term, or (ii) the resulting implied carbon stock change factors may be significantly affected by new areas entering in a given category.

Table 6. 6 Summary of methods and carbon stock change factors used by the EU MS, UK and ISL to calculate CO_2 emissions and removals of different carbon pools in the LULUCF sector, as reported in this year GHGI submissions.

COUNTRY	Forest land								Cropland								Grassland							
	FL-FL				L-FL				CL-CL				L-CL				GL-GL				L-GL			
	LB	DOM (1)	SOC Min	SOC Org (2)	LB	DOM	SOC Min	SOC Org (2)	LB (3)	DOM	SOC Min (4)	SOC Org (2)	LB (5)	DOM	SOC Min	SOC Org (2)	LB	DOM	SOC Min (4)	SOC Org (2)	LB	DOM	SOC Min	SOC Org (2)
AT	CS	CS,CS	CS	NO	CS	CS	CS	NO	CS	D	CS	NO	CS,CS	CS	CS	NO	D	D	CS	CS	CS	CS	CS	NO
BE	CS	CS,CS	D	NO	CS	D	CS	NO	CS	D	CS	D	CS,NO	CS	CS	NO	D	D	CS	D	CS	CS	CS	NO
BG	CS	D,D	D	NO	CS	CS	CS	NO	D	D	CS	NO	CS,CS	NO	CS	NO	D	D	NO	NO	CS	NO	CS	NO
CY	D	D,D	D	NO	CS	CS	CS	NE	D	NE	NE	NE	CS, D	NE	CS	NE	D	NE	NE	NE	CS	CS	CS	NE
CZ	CS	D,D	D	NO	CS	D	CS	NO	D	D	CS,D	NO	CS,D	CS	CS	NO	D	D	CS,D	NO	CS	CS	CS	NO
DE	CS	CS,CS	CS	CS	CS	CS	CS	CS	NO	D	NO	CS	CS,CS	CS	CS	CS	CS	D	CS	CS	CS	CS	CS	CS
DK	CS	CS,CS	D	CS	CS	CS	CS	CS	CS	D	CS	CS	CS,CS	CS	CS	CS	CS	D	NO	CS	CS	CS	CS	CS
EE	CS	CS,D	CS	CS	CS	CS	CS	CS	CS	D	CS,D	D	CS,CS	CS	CS	CS	CS	CS	CS,D	CS	CS	CS	CS	CS
ES	CS	D,D	D	NO	CS	CS	CS	NO	CS	D	CS,D	NO	CS,CS	CS	CS	NO	D	D	NE	NO	CS	CS	CS	NO
FI	CS	CS,CS	CS	CS	CS	CS	CS	CS	CS	D	CS	CS	CS,CS	CS	CS	CS	CS	D	NO	CS	CS	CS	CS	CS
FR	CS	CS,D	D	NO	CS	CS	CS	CS	D	D	CS	NO	CS,NO	CS	CS	NO	D	D	NO	NO	CS	CS	CS	CS
GR	CS	D,D	D	NO	CS	D	NO	NO	CS	D	NE	D	CS,CS	CS	CS	NO	D	D	NO	NO	NO	NO	CS	NO
HR	CS	D,D	D	NO	CS	D	CS	NO	D	D	CS,D	CS	CS,CS	NO	CS	NO	D	D	NO	CS	CS	NO	CS	NO
HU	CS	D,D	D	CS	CS	CS	CS	NO	CS	D	CD,D	NO	CS,D	CS	CS	NO	D	D	CS,D	NO	CS	CS	CS	NO
IE	CS	CS,CS	D	CS	CS	CS	NO	CS	CS	D	CS,D	NO	NO,NO	NO	NO	NO	D	D	CS,D	CS	CS	CS	NO	CS
IT	CS	CS,CS	D	NO	CS	CS	CS	NO	CS	NO	NO	D	NO,D	NO	CS	NO	CS	CS	NO	NO	CS	NO	CS	NO
LT	CS	CS,D	D	D	CS	D	NO	D	D	D	CS,D	D	NO,CS	D	CS	D	NO	NO	NO	D	NO	NO	CS	D
LU	CS	D,D	D	NO	CS	D	CS	NO	CS	D	CS,D	NO	CS,CS	CS	CS	NO	D	D	NO	NO	CS	CS	CS	NO
LV	CS	CS,D	D	D	CS	CS	NO	CS	CS	CS	NO	D	NO,NO	NO	CS	D	CS	CS	NO	D	NO	NO	CS	D
MT	D	D,D	D	NO	NO	NO	NO	NO	D	D	NO	NO	NO,NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NL	CS	CS,D	D	NE	CS	D	CS	CS	NE	D	NO	CS	CS,CS	CS	CS	CS	D	D	NO	CS	CS	CS	CS	CS

COUNTRY	Forest land								Cropland								Grassland							
	FL-FL				L-FL				CL-CL				L-CL				GL-GL				L-GL			
	LB	DOM (1)	SOC Min	SOC Org (2)	LB	DOM	SOC Min	SOC Org (2)	LB (3)	DOM	SOC Min (4)	SOC Org (2)	LB (5)	DOM	SOC Min	SOC Org (2)	LB	DOM	SOC Min (4)	SOC Org (2)	LB	DOM	SOC Min	SOC Org (2)
PL	CS	D,D	D	D	CS	D	D	D	D	D	D,D	D	NO	NO	D	NO	D	D	D,D	D	CS	NO	D	NO
PT	CS	CS,CS	CS	NO	CS	CS	CS	NO	CS	D	CS	NO	CS,CS	CS	CS	NO	D	D	CS	NO	CS	CS	CS	NO
RO	CS	D,D	D	D	CS	CS	CS	NO	CS	CS	CS	CS	CS,CS	CS	CS	NO	CS	D	NO	D	CS	CS	CS	NO
SE	CS	CS,CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS,CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS
SK	CS	D,D	D	NO	CS	CS	CS	NO	D	D	CS,D	NO	CS,CS,	CS	CS	NO	D	D	NO	NO	CS	CS	CS	NO
SV	CS	CS,D	D	NO	CS	D	CS	NO	D	D	CS,D	D	CS,CS	CS	CS	NO	D	D	NO	NO	CS	CS	CS	NO
UK	CS	CS,CS	CS	CS	CS	CS	CS	CS	D	D	CS	CS	CS,CS	CS	CS	CS	D	D	CS	CS	CS	CS	CS	CS
IS	CS	D,D	D	D	CS	CS	CS	D	D	D	NE	D	CS,CS	CS	CS	D	CS	CS	CS	D	CS	CS	CS	D

Source: submissions 2021, CRF table 4A-4C

(D: default; CS: country-specific; NA: not applicable; NE: not estimated; NO: not occurring). Grey field means that for these carbon pools IPCC TIER 1 allows to assume no net change in C stock. "CS" country-specific data associated either with IPCC method tier 2 or country-specific method tier 3 if data are highly disaggregated or derived using models. Note that sometimes not all parameters involved in the estimation are truly "CS" (e.g., root/shoot ratio and BEF are often taken from IPCC guidelines). However, it is expected that if "CS" is reported in table 6.6, the most important parameters are truly "CS."

"D" means that the default IPCC emission factors are used in the estimation. D is typically associated with IPCC default method (tier 1).
"NE" means either country assumes insignificant emission/removal or not enough data is available for the estimation.
"NO" means emissions or removals "not occurring" in a country (it includes also "NA" - not applicable)
(1) For DOM under "FL r FL" the two notation keys separated by a comma mean: dead wood and litter respectively.
(2) For SOCorg any notation key used under carbon stock changes, if areas of organic soils are reported, should, in principle, be seen as NE. D refers to the use of IPCC default emissions factors
(3) For LB carbon stock change in CL-CL, estimates generally refer only to perennial woody crops. Biomass of annual crops is generally assumed in balance.
(4) For SOCmin on CL and GL, the two notation keys separated by a comma mean that the country uses IPCC default method (which is tier 1 if associated with D data or tier 2 if associated with CS data). In this case, the first notation key refers to "reference C stock", and second to "C stock change factors" (see 2006 IPCC GL for details). A cell with a single "CS" indicates a country-specific method and data (i.e. tier 3 if data are highly disaggregated)
(5) For LB under L – CL, "conversion to cropland", the two notation keys used mean: the first one refers to FL-CL and the second one to GL-CL.

6.1.5 Key categories

The following LULUCF subcategories of the EU GHG inventory were identified to be key categories (Table 6. 7) for the trend (T) and the level assessment (L).

Table 6. 7 Key category analysis for the EU (LULUCF sector excerpt)

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2019		1990	2019
4.A.1 Forest Land: Land Use (CO_2)	-320555	-315840	T	L	L
4.A.2 Forest Land: Land Use (CO_2)	-39013	-39588	T	L	L
4.B.1 Cropland: Land Use (CO_2)	32117	14490	T	L	L
4.B.2 Cropland: Land Use (CO_2)	48393	35726	0	L	L
4.C.1 Grassland: Land Use (CO_2)	54833	36208	0	L	L
4.C.2 Grassland: Land Use (CO_2)	-20772	-25381	0	L	L
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	5490	5672	0	0	L
4.D.1 Wetlands: Land Use (CO_2)	7444	9206	T	0	L
4.D.2 Wetlands: Land Use (CO_2)	2295	5351	T	0	L

6.2 Categories and methodological issues

6.2.1 Forest land (CRF 4A)

6.2.1.1 Overview of the Forest land category

Forest land category is the main driver in the LULUCF sector. In terms of area, it represents about 36% of the entire reported area. Based on individual submissions reported this year, total forest area reached 166.895 kha in 2019, which represents an increase of 5% as compared with 1990.

About 4% of the total forest area is represented by lands under conversion to forest land. This trend of increasing forest land area, which is also reflected in different official statistics of the EU, is a result of the expansion of forests due to less grazing pressure and the abandonment of agricultural activities, which promote natural forest expansion. But an important driver behind the forest area increase has been also the promotion of national afforestation programs, including grant-aid.

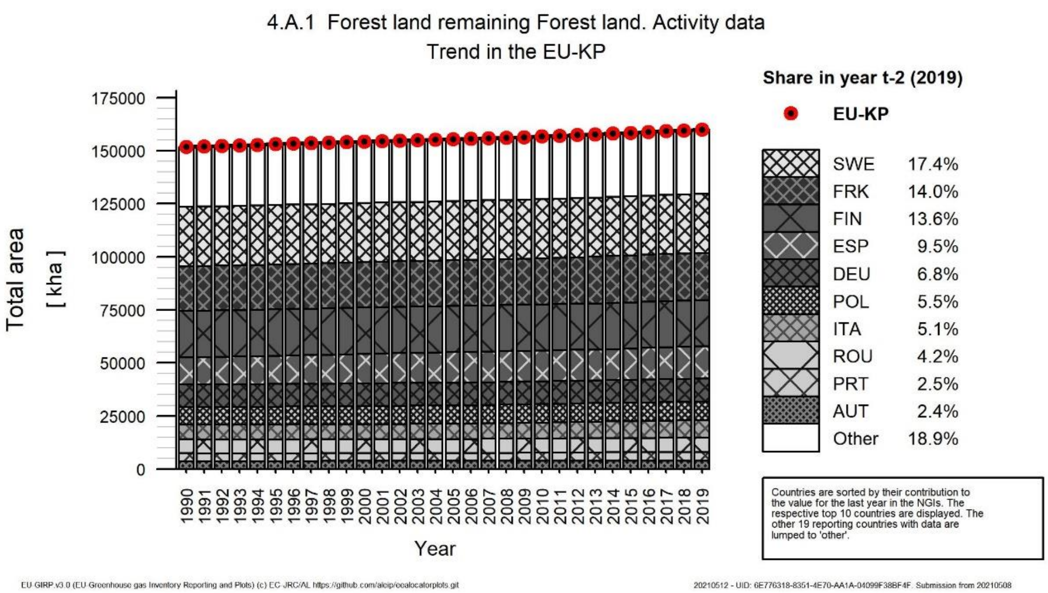
The largest forest areas are reported by Sweden, France and Finland, which together report about 45% of the total forest area at EU level. Deforestation does not appear to be a major issue in Europe. Moreover, the absolute area under conversion from forest is by far compensated by new afforested areas and natural forest expansion.

6.2.1.2 Forest Land remaining Forest Land (CRF 4A1)

Overview of Forest Land remaining Forest Land category

As with the main category, the area of Forest Land remaining Forest Land reported for the inventory year increased by 5% as compared with 1990. However, at the level of individual submissions there are significant differences. For instance, UK reports an increase of about 39%, while Ireland reports a decrease of about 4% respective to the year 1990. The major contributors in terms of area for this subcategory are Sweden, France, and Finland (Figure 6. 3)

Figure 6. 3 Trend of activity data in subcategory 4A1 "Forest land remaining Forest Land" in EU-KP



For this inventory year, the total land area reported under the sub-category 4.A1 by EU MS, UK and ISL reached 159.878 kha, out of which about 80% is attributed to the 10 MS with the higher contribution.

In terms of GHG emissions the category 4.A1 resulted in a net sink of -315.840 kt CO_2, decreasing by 5% as compared in 1990. The largest contributors are Germany, France, and Sweden (Table 6. 8).

Table 6. 8 **4A1 Forest Land remaining Forest Land: EU-KP contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)**

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	-7 865	-2 602	-2 602	0.8%	5 263	67%	1	0%
Belgium	-1 903	-1 745	-1 746	0.6%	157	8%	0	0%
Bulgaria	-16 317	-6 797	-6 784	2.1%	9 532	58%	12	0%
Croatia	-6 716	-5 318	-5 531	1.8%	1 185	18%	-213	-4%
Cyprus	-33	-130	-129	0.0%	-96	-293%	1	1%
Czechia	-5 378	6 129	15 604	-4.9%	20 982	390%	9 475	155%
Denmark	-268	-1 167	-1 209	0.4%	-940	-351%	-42	-4%
Estonia	-4 116	-1 961	-1 965	0.6%	2 151	52%	-4	0%
Finland	-22 734	-17 652	-25 248	8.0%	-2 514	-11%	-7 596	-43%
France	-33 382	-43 255	-43 848	13.9%	-10 466	-31%	-592	-1%
Germany	-22 322	-58 703	-58 072	18.4%	-35 750	-160%	631	1%
Greece	-1 142	-2 079	-1 603	0.5%	-461	-40%	476	23%
Hungary	-3 158	-3 271	-4 421	1.4%	-1 263	-40%	-1 151	-35%
Ireland	-3 856	-534	-1 117	0.4%	2 738	71%	-583	-109%
Italy	-15 002	-27 212	-31 164	9.9%	-16 162	-108%	-3 951	-15%
Latvia	-17 547	-4 620	-4 747	1.5%	12 800	73%	-126	-3%
Lithuania	-7 365	-6 570	-5 961	1.9%	1 404	19%	609	9%
Luxembourg	115	-203	-335	0.1%	-449	-392%	-132	-65%
Malta	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Netherlands	-1 531	-1 388	-1 371	0.4%	160	10%	17	1%
Poland	-32 608	-34 030	-13 242	4.2%	19 365	59%	20 787	61%
Portugal	-4 088	-6 948	-8 208	2.6%	-4 120	-101%	-1 261	-18%
Romania	-26 819	-23 064	-23 625	7.5%	3 194	12%	-562	-2%
Slovakia	-6 347	-3 432	-4 307	1.4%	2 040	32%	-874	-25%
Slovenia	-4 524	1 705	647	-0.2%	5 171	114%	-1 058	-62%
Spain	-21 396	-29 502	-29 630	9.4%	-8 234	-38%	-129	0%
Sweden	-40 374	-38 719	-38 202	12.1%	2 171	5%	517	1%
United Kingdom	-13 851	-17 202	-16 955	5.4%	-3 104	-22%	247	1%
EU-27+UK	**-320 527**	**-330 271**	**-315 772**	**100%**	**4 756**	**1%**	**14 499**	**4%**
Iceland	-16	-37	-35	0.0%	-19	-124%	2	5%
United Kingdom (KP)	-13 863	-17 235	-16 988	5.4%	-3 125	-23%	247	1%
EU-KP	**-320 555**	**-330 341**	**-315 840**	**100%**	**4 715**	**1%**	**14 501**	**4%**

For the year 2019, with the exception of Czechia and Slovenia, individual submissions report a net carbon sink under Forest Land remaining Forest Land.

Important changes in terms of reported amounts, as compared with 1990, are mainly due to the increase in harvesting rates as reported by Czechia (esp. salvage logging after recent bark beetle infestations), Bulgaria and Latvia, or due to the impact of natural disturbances in forest in 1990 as reported by Germany. By contrast, France, Italy and Spain report a significant increase of the carbon sink driven by a steady increase of the forest area that results in a net carbon accumulation on Forest Land remaining Forest Land.

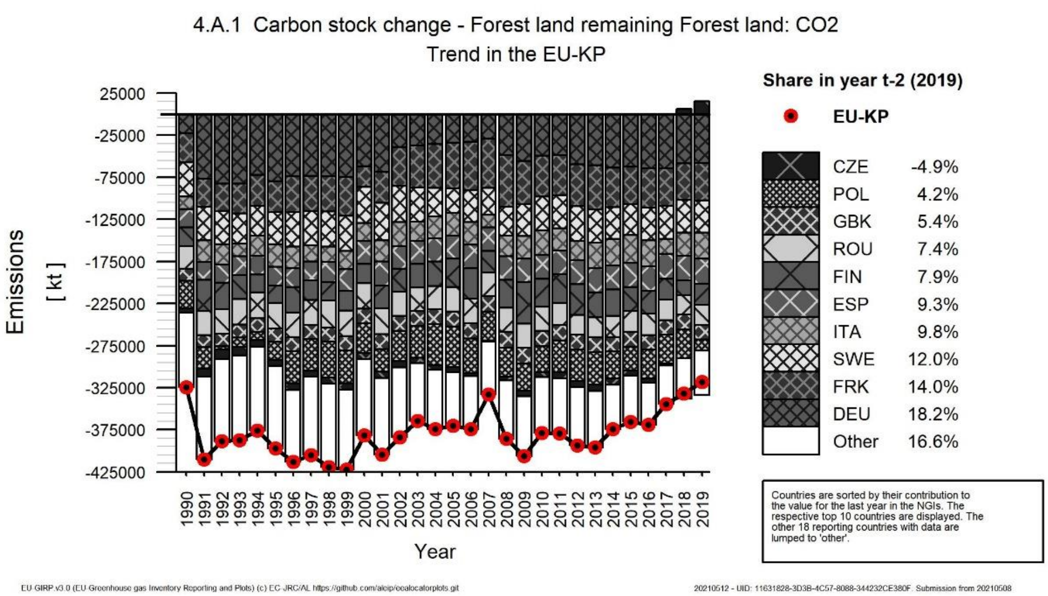
In some cases, this category has shifted throughout the years from a net sink to a net source of carbon. This is explained by the impact of natural disturbances and to the age distribution of the forests.

A particularity is given by Malta that having small areas of forests (0.072 Kha) does not report the carbon stock changes in this land use category, following a recommendation of the UN´s expert review team (ERT). Indeed, the ERT noted that the use of IPCC factors, which are not suited for its conditions, results in the absurd estimate of an indefinite net carbon accumulation across time, while carbon pools have physical limits to the amount of carbon stock they may store.

In the meantime, Malta has stated to be working on the acquisition of new data that will allow the reporting of this category in future submissions. Moreover, Malta stated that no wildfires were identified in the mentioned woodlands and that controlled burning cannot occur due to the protection regime that applies to its forest areas.

In a good match with the share in total areas, the 10 MS with the largest contribution to the total net carbon sink account for about 90% of the EU removals (Figure 6. 4).

Figure 6. 4 Trend of emissions (+)/removals (-) in subcategory 4A1 "Forest land remaining Forest Land" in EU-KP (kt CO_2)



Inter-annual variations in this subcategory are closely related to natural disturbances. In this respect, wildfires, in southern European countries, and windstorms and insect infestations, in several central European countries, resulted in a significant source of GHG emissions or the transfer of the carbon to other pools that are reflected in the trend at EU level.

The reporting by Portugal and Italy for the year 2017 reflects large forest areas affected by wildfires. The impact of these events is a reduction of the forest sink by about 22.550 kt CO_2 due to wildfires which is well reflected in the EU trend of this sector. Moreover, in Germany the forests biomass in 1990 was affected by a massive storm (Vivian) that caused an estimated loss of about 70 Mm3.

The CO_2 emissions from biomass burning are, in many cases, implicitly reported in CRF table 4.A, as a loss of carbon stock, while related non-CO_2 emissions are reported in CRF table 4(V).

Estimation of emissions from forest fires is made with Tier 1 method in case of small emissions or with higher Tiers where such annual emissions have a significant share within the overall carbon budget of the category (e.g., Portugal, Spain).

In general, emissions from natural disturbances are not easy to quantify in terms of biomass loss (e.g. insect outbreaks), and therefore they are practically not explicitly mentioned in the individual national inventory reports but reflected in the long term estimation through the national forest inventories.

The largest inter-annual variability in GHG estimates that affect the EU trend are due to:

- Forest fires (e.g., Portugal in 1990, 2003, 2005 and 2017; Italy in 1990, 1993, 2007 and 2017).
- Windstorms (e.g., Germany 1990, France in 1999 and 2009, and Denmark in 2000, Sweden in 2005, Italy in 2018).

Methodological issues for Forest Land remaining Forest Land category

Forest land definitions are reported by all individual submissions (Table 6. 9; Table 6. 10). The consistency of these definitions with the land representation system is ensured within the national inventory systems in terms of time and space. The forest definitions among countries slightly differ in terms of the quantitative parameters (i.e. crown cover, tree height and minimum land area).

In general, these forest definitions are consistent with definitions used under other international reporting processes (e.g. Global Forest Resources Assessments FRA (FAO)). For forest administrative purposes, lands without tree cover may be included or not within forest land, and thus, additional qualitative criteria complement the forest definitions provided (i.e., treatment of forest roads, nurseries, willow crops, etc.).

Few countries have changed their forest definition since 1990, but recalculations of the whole time series ensured the consistency on activity data (see dedicated section on this chapter). For example, Denmark changed from a questionnaire-based forestry information system to national forest inventory (NFI) but implemented methods for ensuring the consistency of the time series (i.e. reassessment of base year data based on earth observation information).

The overall effect of different forest definitions on carbon stock changes at EU level is difficult to assess because it depends on several factors (e.g. land fragmentation, land use change frequency, transition period, land registry systems, GHG estimation methodology, etc.), but is considered small.

Table 6. 9 **Quantitative thresholds used to define forests as selected by individual EU MS, UK and Iceland**

Country	Crown cover (%)	Height (m)	Area (ha)	Minimal width (m)
Austria	30	2	0.05	10
Belgium	20	5	0.5	-
Bulgaria	10	5	0.1	10
Croatia	10	2	0.1	-
Cyprus	10	5	0,3	-
Czech Republic	30	2	0.05	-
Denmark	10	5	0.5	20
Estonia	30	2	0.5	-
Finland	10	5	0.25 (0.5)*	20
France	10	5	0.5	20
Germany	10	5	0.1	-
Greece	25	2	0.3	-
Hungary	30	5	0,5	-
Ireland	20	5	0.1	20
Italy	10	5	0.5	-
Latvia	20	5	0.1	20
Lithuania	30	5	0.1	10
Luxembourg	10	5	0.5	-
Malta	30	5	1	-
Netherlands	20	5	0.5	30
Poland	10	2	0.1	10
Portugal	10	5	1	20
Romania	10	5	0.25	20
Slovakia	20	5	0.3	20
Slovenia	10	5	0.25	-
Spain	20	3	1.0	25
Sweden	10	5	0.5	-
United Kingdom	20	2	0.1	20
Iceland	10	2	0,5	20

**Finland uses 0.25 for southern territories and 0.5 for northern*

Table 6. 10 **Additional qualitative criteria used to define forests complementing quantitative thresholds.**

Country	Forest land definition
Austria	Permanently unstocked basal areas that are directly connected with forest in terms of space and forestry enterprise and contribute directly to its management (such as forestal hauling systems, wood storage places, forest glades, forest roads) also represent forests. Areas which are used in short rotation with a rotation period of up to thirty years as well as forest arboretums, forest seed orchards. Christmas tree plantations and plantations of woody plants for the purpose of obtaining fruits such as walnut or sweet chestnut do not account as forests. Rows of trees (except shelter belts for wind protection) and areas with woody plants in a park structure are not forest land.

Country	Forest land definition
Belgium	This category includes all land with woody vegetation consistent with thresholds used to define forest land as described in paragraph 6.1 of the NIR. It also includes systems with vegetation that currently fall below, but are expected to exceed, the threshold of the forest land category.
Bulgaria	Areas of natural forest regeneration outside urban areas with a size of more than 0.1 ha also represent “forest”. Forests are also: areas which are in a process of recovering and are still under the parameters, but it is expected to reach forest crown cover over 10% and tree height 5 meters; areas, which as the result of anthropogenic factors or natural reasons are temporarily deforested, but will be reforested; protective forest belts, as well as tree lines with an area over 0.1 ha and width over 10 meters; cork oak stands. City parks with trees, forest shelter belts, and single row trees do not fall under the category “forests.
Croatia	Forest includes land under forest management (forest land without tree cover): Productive forest land without tree cover, non-productive forest land without tree cover, barren wooded land (e.g., forest roads wider than 3 meters, quarries)
Cyprus	Forests include forest roads, cleared tracts, firebreaks and other small open areas within the forest as well as reforested areas or burnt areas or other areas that temporarily have low plant cover due to human intervention or natural causes, but does not include municipal parks and gardens.
Czechia	Forests excludes the areas of permanently unstocked cadastral forest land, such as forest roads, forest nurseries and land under power transmission lines.
Denmark	Temporarily non-wooded areas, fire breaks and other small open areas, that are an integrated part of the forest, are also included. Christmas trees are also included.
Estonia	All temporarily unstocked forest areas and regeneration areas which have yet to reach a crown density of 30 per cent and a tree height of 2 meters are also included as forest, as are areas which are temporarily unstocked as a result of human intervention such as harvesting, or natural causes (fires, etc.) but which are expected to revert to forest.
Finland	Productive forest land, part of the poorly productive forest land and forest roads. Parks and yards are excluded regardless of whether they meet the forest definition.
France	Forest roads, forest openings less than 20 m wide (e.g., for fire control), windbreaks and forest belts, as well as the poplar plantations and short rotations woody crops, if the criteria for Forest land are met. 5% of France’s European forests are unmanaged on lands such as strong slopes or used for loisir, esthétique, cultural or military. Also, 40% of France’s dependencies Forest land is considered as unmanaged.
Germany	Any area of ground covered by forest vegetation, irrespective of the information in the relevant cadastral survey or similar records. “Forest” also refers to cutover or thinned areas, forest tracks, firebreaks, openings and clearings, forest glades, feeding grounds for game, landings, rides located in the forest, further areas linked to and serving the forest including areas with recreation facilities, overgrown heaths and moorland, overgrown former pastures, alpine pastures and rough pastures, as well as areas of dwarf pines and green alders. Heaths, moorland, pastures, alpine pastures and rough pastures are considered to be overgrown if the natural forest cover has reached an average age of five years and if at least 50% of the area is covered by forest. Forested areas of less than 1,000 m2 located in farmland or in developed regions, narrow thickets less than 10 m wide, watercourses up to 5 m wide do not break the continuity of a forest area.
Greece	No additional criteria available.
Hungary	Forest land (includes FL-FL, L-FL sub-categories) includes areas covered by trees, as well as roads and other areas that are under forest management but that are not covered by trees.
Ireland	All public and private plantation forests. Includes recently clear-felled areas. Tree grown for fruits or flowers, and shrub species (furze, rhododendron) are excluded. Includes open areas within forest boundaries.
Italy	Forest roads, cleared tracts, firebreaks and other open areas within the forest as well as protected forest areas are included in forest. Plantations, mainly poplars, characterized by short rotation coppice system and used for energy crops are included and also other plantation as chestnut and cork oak, have been included in forest land.
Latvia	Young natural stands and all plantations established for the forestry purposes, which have to reach a crown density of 20 % or tree height of 5 m are considered under forest land; as well as the areas normally forming part of the forest area, which are temporarily unstocked as a result of human intervention or natural causes, but which are expected to revert to forest.
Lithuania	Tree lines up to 10 meters of width in fields, at roadsides, water bodies, in living areas and cemeteries or planted at the railways protection zones as well as single trees and bushes, parks planted and grown by man in urban and rural areas are not defined as forests.

Country	Forest land definition
Malta	No additional criteria available.
Luxemburg	Permanently unstocked basal areas that are directly connected with forest in terms of space and forestry enterprise and contribute directly to its management (such as forestal hauling systems, wood storage places, forest glades, forest roads) also represent forests. Areas which are used in short rotation with a rotation period of up to thirty years as well as forest arboretums, forest seed orchards, Christmas tree plantations and plantations of woody plants for the purpose of obtaining fruits such as walnut or sweet chestnut do not account as forests but represent cropland. Rows of trees (except shelter belts for wind protection) and areas with woody plants in a park structure are not forest land.
Netherlands	The Netherlands has chosen to define the land-use category “Forest Land” as all land with woody vegetation, now or expected in the near future (e.g., clear-cut areas to be replanted, young afforestation areas)
Poland	Young stands and all plantations that have yet to reach a crown density of 10 percent, or a tree height of 2 m are included under forest. Areas normally forming part of the forest area that are temporarily un-stocked as a result of human intervention, such as harvesting or natural causes such as wind-throw, but which are expected to revert to forest are also included.
Portugal	Forests (areas occupied by forests and woodlands which can be used for the production of timber or other forest products) and agro-forestry areas (annual crops or grazing land under the wooded cover of forestry species). The forest trees are under normal climatic conditions higher than 5 m with at least 30% canopy closure.
Romania	It comprises deciduous forest, coniferous forest, mixt forests, clear-cut areas and nurseries, as defined by presence of deciduous trees, coniferous trees, deciduous and resinous trees, dead trees, clear-cuts and forest nursery.
Slovakia	This category includes the land covered by all tree species serving for the fulfilment of forest functions and the lands on which the forest stands were temporarily removed with aim of their regeneration or establishment of forest nurseries or forest seed plantation.
Slovenia	It includes abandoned agricultural land with natural expansion of forest. Abandoned agricultural land on area more than 0.5 ha, which have been abandoned for more than 20 years, with minimal tree height 5.00 m and have a tree crown cover between up to 75 % are defined as forests.
Spain	Any land having woody vegetation with no agricultural use/activities fulfilling the threshold of forest and any other land which is expected achieve these parameters (including for “dehesa” where tree cover meet the thresholds)
Sweden	Land which hosts a potential yield of stem-wood exceeding one cubic meter per hectare and year. Meanwhile, the Land which hosts a potential yield of stem-wood lower than one cubic metre per hectare and year are classified as mire (under Wetlands). Permanent forest roads (width>5m) are not considered as forest land. All country forests are considered managed.
United Kingdom	Forestry statistics definition used for GHG inventory includes integral open space and felled areas that are waiting restocking.
Iceland	All forested lands, not belonging to Settlement, that is presently covered with trees or woody vegetation that reach the defined thresholds. Natural birch woodland is included in the IFR national forest inventory (NFI). In the NFI the natural birch woodland is defined as one of the two predefined strata to be sampled. The other stratum is the cultivated forest consisting of tree plantation, direct seeding or natural regeneration originating from cultivated forest.

National forest inventories provide fundamental data inputs for both the estimation of areas and for the estimation of carbon stock changes in various pools. In very few cases, this information is also taken from forest management plan databases (especially the information used to derive activity data and emissions for the base year, e.g., Slovakia).

Data collection in national forest inventories is typically based on repeated measurements of permanent sampling plots, but the sampling design differs among MS in terms of spatial density and frequency of field surveys (e.g., Austria 3 years, Spain 10 years, Lithuania 5 years).

In the last years, countries have made considerable efforts to adjust their forest inventories to the specific requirements of UNFCCC/KP reporting, but also there were some steps toward some harmonization at European scale (e.g. COST E43 Action).

Given that annual data are barely available for this sector, efforts are devoted to adjusting the timing of inventory cycles to the timeline of the Kyoto Protocol's accounting frequency. To meet reporting requirements of the time series, annual values are usually obtained by interpolation and extrapolation of available data sets. The main data source for forest land area, the national forest inventories are in many instances complemented with auxiliary information in the form of national statistics (i.e. surveys) or remotely sensed products (i.e. satellite images, aerial photographs) including their derivatives products, such as Copernicus products or Corine Land Cover data.

Furthermore, countries usually have disaggregated forest areas in various subdivisions according to available datasets. The breakdown criteria differ across countries, although they are consistent across time series: forest type (e.g. broadleaved/coniferous; evergreen/deciduous; species based classification – beech, oak, pine, spruce, etc.); by climate (e.g. temperate moist or temperate dry,); by soil and site type (e.g. lowlands, mountains), administrative or geographical boundaries (e.g. northern, southern territories), and management type (e.g. coppice, high forest).

For Forest land, definitions of carbon pools are reported by most of the MS (Table 6. 11). Among them, there are slight variations. The impact on the estimates of such variability, even if difficult to assess in quantitative terms, is considered small.

For instance, forest inventories define above-ground biomass carbon pool according to the threshold of minimal diameter (i.e. DBH– diameter at breast height) of sampled trees as ranging from 0 to 7,5 cm. Concerning the below-ground biomass, the information on what exactly is included on this carbon pool is sparse. Dead wood mostly differs in terms of decay time and thresholds of diameters and height/length of wood pieces included in the pool. Litter is either independently assessed or included with soils. In soil organic matter, carbon stock changes are computed according to various methods and transition periods. Usually, carbon stock in understory biomass is only accounted in principle for estimating forest fires emissions.

Table 6. 11 Explicit information on forest carbon pools definitions as reported by EU MS, UK and Iceland.

Country	***Description***
Aboveground biomass	
Austria	All living biomass (DBH > 5cm) above the soil including stem, stump, branches, seeds, bark and foliage (foliage only of evergreen trees). At ARD sites and LUC from and to forests all forest biomass (shrubs, forest understory) with a DBH > 0 cm to 5 cm is also taken under consideration.
Belgium	Tree and shrub species with circumference exceeding 20/22 cm at 1.50 m height (i.e., 7 cm in diameter), while in coppices the stems under 7 cm diameter are also included.
Denmark	Living trees with a height over 1.3 m, under different recording schemes (i.e., trees larger than 40 cm are measured only within a 15 m circle). Smaller trees, shrubs and other non woody are not counted. Aboveground biomass is defined as living biomass above stump height (1% of tree height).
Finland	Biomass of living trees with a height over 1.35 m, i.e., those trees that are measured in NFIs, including the stem wood, stem bark, living and dead branches, cones, needles/foliage. Understory is counted only to estimate the emission from forest fire.

Country	Description
France	Trees with DBH over 7.5 cm.
Germany	Trees with DBH over 7 cm.
Greece	Trees with DBH over 10 cm, but in cases of degraded forests (e.g., oak) and coppices (e.g., Castanea) the threshold is 4.6 cm. The trees in the sample area under the minimum diameter are not considered. Understory biomass is considered for GHG emissions from wildfires.
Hungary	The total biomass above the stump, including all branches and bark, of trees taller than two meters.
Lithuania	Above ground biomass refers to all living biomass above the soil including stem, stump, bark, branches, seeds and foliage.
Ireland	Modelled individual cycle of living biomass (but not the understory and annual/perennial non woody vegetation).
Italy	Trees with DBH over 3 cm.
Lithuania	Above ground biomass refers to all living biomass above the soil including stem, stump, bark, branches, seeds and foliage.
Luxemburg	Diameter of 4 cm at 3.5 m of the total height (average value)
Portugal	Living biomass above the soil, including stems, stumps, branches, bark and foliage, and forest understory (only for estimation of emissions from forest fires).
Slovakia	Merchantable volume, defined as tree stem and branch volume under bark with a minimum diameter threshold of 7 cm.
Slovenia	Volume over bark of all living trees more than 9.99 cm in diameter at breast height (1.3 m). Includes the stem from ground to a top diameter of 6.99 cm, and also branches to a minimum diameter of 6.99 cm.
Spain	Trees with DBH over 7.5 cm at the ground level are measured, while those under 7.5 cm are only counted.
Sweden	Biomass of living trees with a height over 1.3 m. Small trees, shrubs and other vegetation (i.e., herbs) are not counted. Aboveground biomass is defined as tree part above stump height (1% of tree height).
United Kingdom	Modelled living woody biomass (complete individual cycle of trees, it does not include understory and annual/perennial non woody vegetation).
Belowground biomass	
Austria	All living biomass of live roots with a diameter > 2 mm.
Ireland, United Kingdom	Fine roots pool is simulated within integrates models.
Belgium	Diameter of estimated roots > 5 mm.
Denmark	Stumps from harvested trees within a year from the measurement are measured.
France	Fine roots are included with the soil organic matter.
Finland	Stumps and roots down to a minimum diameter of 1cm.
Hungary	The total biomass of the above trees minus their above-ground biomass.
Czechia, Italy, Poland, Spain	Applies a country specific “root- to-shoot” factor.
Lithuania	Below-ground biomass refers to all living biomass of live roots.
Portugal	Living biomass of belowground biomass (the lower limit of root diameter, if any, is not explicitly defined).
Sweden	Biomass of living trees below stump height (1% of tree height) down to a root diameter of 2 mm.
Dead Organic Matter - Dead wood	
Austria	All non-living woody b biomass not contained in the litter or soil, standing on the ground, without roots, as they are already considered as part of the litter or soil.

Country	Description
Belgium	Dead wood as measured by NFI, namely standing dead trees and fallen logs and branches. A dead tree is considered as fallen when it tilts at a vertical angle equal or superior to 45°. Dead trees above 20 cm of circumference are measured, under 20 cm are estimated visually.
Denmark	Standing deadwood with a DBH larger than 4 cm. Lying dead wood with a diameter of more than 10 cm, whose length is recorded. The degree of decay is recorded on an ordinal scale.
Finland	Non-living biomass which is not contained in litter (described by model as coarse woody litter input, larger than 10 cm in diameter, from natural mortality of trees and harvesting residues).
France	Standing trees, dead for less than 5 years, plus 10% from the wood which is annually harvested.
Germany	Fallen dead wood with a thicker-end diameter of at least 20 cm; standing dead wood with a diameter of at least 20 cm at breast height and trunks with either a height of at least 50 cm or a cut surface diameter of at least 60 cm. NFI 2008 collected data on all dead-wood objects with a thicker-end diameter of at least 10 cm. Data collection was for both NFIs on 3 species groups and 4 decomposition class.
Ireland, United Kingdom	Pool is simulated by models.
Italy	The amount of carbon in dead wood is estimated from the aboveground carbon amount with an expansion factor.
Greece	Dead wood that remains on site after fire is assumed to fully decompose in 10 years.
Lithuania	Dead wood includes total standing and lying volume of dead tree stems.
Slovakia	The dead wood carbon pool contains dead trees from standing, stumps, coarse lying dead wood and small-sized lying dead wood not included in litter or soil carbon pools.
Slovenia	Dead wood content is all non-living woody biomass not contained in the litter, either standing, lying on the ground. According to definition from NFI 2007, dead wood in Slovenia includes: dead trees (DBH > 10 cm); stumps (D > 10 cm and H > 20 cm); snags (D > 10 cm and H > 50 cm); coarse woody debris (D > 10 cm and L > 50 cm).
Sweden	Dead wood is defined as fallen dead wood, snags or stumps including coarse and smaller roots down to a minimum "root diameter" of 2 mm. Dead wood of fallen dead wood or snags should have a minimum "stem diameter" of 100 mm and a length of at least 1.3 m.
Iceland	dead wood meeting the minimum criteria of 10 cm in diameter and 1 m in length
Dead Organic Matter – Litter	
Austria	All non-living biomass lying dead in various states of decomposition above the mineral or organic soil.
Austria, Ireland, United Kingdom	Litter is simulated by models.
Denmark	Non-living biomass, which is not included in other classes, under various status of decomposition on top of mineral or organic soil. It includes the litter, fumic and humic layers.
Finland	Non-living biomass with a diameter less than 10 cm in various status of decomposition (allocated by model in compartments: fine woody litter, coarse woody litter, extractives, celluloses and lignin-like compound). Biomass of ground vegetation (e.g., moss-, lichen-shrub-and twig vegetation) is not included in the living biomass, but it is included when the litter input to the soil is estimated.
France	Non-living dead wood lying on soil with maximum 7.5 cm diameter, dead leaves, humic and fumic layers, fine roots.
Germany	Dead organic cover with a fraction < 20 mm.
Italy	The amount of carbon in litter is estimated from the aboveground carbon amount with linear relations.
Portugal	Non-living biomass on top of mineral soil, in various stages of decomposition (include fumic, humic) (considered only in forest fires).
Slovakia	The litter pool definition used in the inventory includes all non-living biomass with a size less than the minimum diameter defined for dead wood (1 cm). The small-sized lying dead wood (diameter between 1 and 7 cm), in various states of decomposition above the mineral soil are

Country	Description
	not a part of litter, because they are included in dead wood. The litter includes the surface organic layer (L, F, H horizons) as usually defined in soil profile description and classification. Live fine roots above the mineral or organic soil (of less than the minimum diameter limit chosen for below-ground biomass) are included in litter.
Slovenia	The carbon stock in Ol, Of and Oh sub horizon. Volume of roots and coarse fragments (soil skeleton > 2 mm) is not included.
Sweden	Non-living biomass not classified in other classes, under various stages of decomposition, on top of mineral or organic soil: litter, fumic and humic layers. Litter includes, as well: a) live fine roots (<2 mm) from O horizon and b) coarse litter with “wood stem diameter” between 10-100 mm.
Soil Organic Carbon	
Austria	All organic matter in mineral and organic soils (including peat) to a soil depth of 50 cm (forests, LUC from and to forests) or to a soil depth of 30 cm (all other land uses and LUC).
Austria, Finland, United Kingdom Ireland	Pool is simulated by models (undefined depth or dimensions).
Belgium, France, Germany, Italy, Luxemburg, Portugal	Organic carbon in 0-30 cm topsoil.
Bulgaria	Organic carbon in 0-40 cm topsoil, also includes the C stock of the litter layer (humus layer).
Croatia	Organic carbon in 0-40 cm topsoil.
Czech Republic	Soil organic carbon in 0-30 cm, including the upper organic horizon.
Denmark	Organic carbon in the mineral soils below the litter, fumic and humic layers and all organic carbon in soils classified as Histosols. It is for 30 cm depth between top of the mineral soil or, alternatively, from the soil surface (if Histosols).
Hungary	The soil carbon stocks were determined from humus content (Hu) values (Filep, 1999) that were measured for the uppermost 30 cm of the soil.
Slovakia	Organic carbon in the mineral soils 0-20 cm.
Slovenia	Carbon stock in mineral part of soil (SOM) in 0–40 cm soil depth.
Spain	Organic carbon in the mineral soils down to 30 cm.
Estonia, Sweden	Organic carbon in the mineral soils below the litter, fumic and humic layers and all organic carbon in soils classified as Histosols, down to a depth of 50 cm.

When assessing inventory completeness, it should be noted that what is not reported under a pool, is reported under another one (e.g. fine roots are reported either as litter or as soil organic matter), so that no bias in the overall estimation is expected to occur.

Individual submissions of GHG inventories follow 2006 IPCC guidelines for estimating the carbon stock changes in forest carbon pools. For living biomass, methodologies are based either on the “stock difference” or “gain-loss” methods (

Table 6. 12).

Table 6. 12 Methodologies used for estimating carbon stock changes in forest aboveground biomass.

Country	Estimation method
Austria	Gain-loss

Country	Estimation method
Belgium	Stock-difference
Bulgaria	Stock-difference
Croatia	Gain-loss
Cyprus	Gain-loss
Czech Republic	Gain-loss
Denmark	Stock-difference
Estonia	Stock-difference
Finland	Gain-loss
France	Gain-loss
Germany	Stock-difference
Greece	Stock-difference
Hungary	Stock-difference
Ireland	Gain-loss
Italy	Gain-loss
Latvia	Gain-loss
Lithuania	Stock-difference
Luxemburg	Gain-loss
Malta	Gain-loss
Netherlands	Gain-loss
Poland	Gain-loss
Portugal	Gain-loss
Romania	Gain-loss
Slovakia	Gain-loss
Slovenia	Stock-difference
Spain	Stock-difference
Sweden	Stock-difference
UK	Gain-loss
Iceland	Gain-loss

Data sources for the estimation of carbon stock changes in living biomass also differ among countries, upon data availability. Nowadays, NFIs represent the primary source of information for most of MS, while others rely on other forestry statistics and yield tables. In addition, forest fire statistics complement both data sources. Data collection and data analysis programs are ongoing in most of the countries to further improve the completeness and accuracy of the estimates, primarily of carbon stock changes.

The implied carbon stock change factors reported for net carbon stock changes in living biomass for this inventory year range from -1.63 to 1.17 to T C ha^{-1} (Table 6. 13). Generally, low values of IEF are shown by countries with high harvesting rates or with less favorable climatic conditions (i.e., lower growth and also more losses by natural disturbances); while higher values are reported by countries where planting combined with relatively short forest rotation times is the main instrument to ensure forest regrowth.

Table 6. 13 **Implied carbon stock change factors for living biomass pool in 4A1 (t C ha-1 year-1) reported in individual GHGI 2021.**

Country	Net carbon stock change factor in living biomass t C/ha	
	1990	2019
AUT	0,76	0,30
BEL	0,74	0,69
BGR	1,24	0,46
HRV	0,79	0,65
CYP	0,06	0,23
CZE	0,56	-1,63
DNM	0,19	0,14
EST	0,37	0,13
FIN	0,31	0,27
FRK	0,46	0,56
DEU	0,21	1,04
GRC	0,10	0,18
HUN	0,47	0,55
IRL	2,55	1,17
ITA	0,55	1,01
LVA	1,54	0,32
LTU	0,96	0,73
LUX	-0,49	0,86
MLT	NA	NA
NLD	1,34	1,15
POL	1,04	0,33
PRT	0,40	0,59
ROU	1,11	0,96
SVK	0,96	0,61
SVN	1,18	-0,33
ESP	0,46	0,53
SWE	0,35	0,32
GBK	1,14	0,75
ISL	0,05	0,11

Changes of organic carbon stored in mineral soils and dead organic matter are mostly reported by applying Tier 1 method, which assumes for this land use subcategory that these carbon pools are in equilibrium, and therefore no net carbon stock changes occur. In these cases, notation keys are used in the corresponding CRF table 4.A (see also Table 6. 5 and Table 6. 6).

When they are estimated, countries mainly rely on data collected in the course of the national forest inventories. However, it should be noted that the widespread use of the Tier 1 assumption is due to the lack of appropriate data (and the high costs associated with systems that would allow a proper collection of data) or to the very high uncertainty of the existing data.

Nevertheless, an increasing number of countries document ongoing efforts to estimate emissions and removals from dead organic matter and mineral soils. This has resulted in more countries reporting for first time carbon stock changes in these pools using country-specific data.

When data on soil organic carbon content is available, they are either directly used for estimating carbon stock changes using stock difference approach, or as input in gain-loss methods. In few cases, data is also integrated in models. Moreover, depending on the availability of datasets in individual countries, carbon stock changes in dead organic matter are often disaggregated between dead wood (DW) and litter (LT) or some countries include their estimates within soil organic carbon pool (e.g. Finland).

Finally, a particularity is reported by France that reports carbon stock changes in dead organic matter only for part of the time-series. In line with the 2006 IPCC guidelines, France reports carbon stock changes in the pool starting in 1999 as a result of the significant carbon inputs that entered into the pool after a windstorm that affected dramatically the forest area in that year.

Table 6. 14 Implied carbon stock change factors in DOM carbon pool in 4A1 (t C ha-1 yr-1) reported in individual GHGI 2021.

Country	Net carbon stock change in dead wood per area (t C/ha)		Net carbon stock change in litter per area (t C/ha)	
	1990	2019	1990	2019
AUT	0,02	0,06	NE,IE	NE,IE
BEL	NA	NA	NA	NA
BGR	0,03	0,04	NA	NA
HRV	NA	NA	NA	NA
CYP	NO	NO	NO	NO
CZE	0,01	0,01	NO	NO
DNM	0,01	0,07	0,07	0,47
EST	0,02	0,01	NA	NA
FIN	IE	IE	IE	IE
FRK	NE	-0,02	NE	NE
DEU	0,04	0,09	-0,01	-0,01
GRC	NA,NO	NO,NA	NA,NO	NO,NA
HUN	0,03	0,08	NO,NA	NO,NA
IRL	IE	IE	0,11	-0,19
ITA	0,02	0,01	0,03	0,01

Country	Net carbon stock change in dead wood per area (t C/ha)		Net carbon stock change in litter per area (t C/ha)	
	1990	2019	1990	2019
LVA	0,05	0,17	NA	NA
LTU	0,07	0,05	NA	NA
LUX	0,09	0,11	NO	NO
MLT	NA	NA	NA	NA
NLD	0,08	0,07	NO	NO
POL	NA	NA	NA	NA
PRT	IE	IE	0,00	0,00
ROU	NO	NO	NO	NO
SVK	NA	NO	NA	NO
SVN	0,10	0,18	NA	NA
ESP	NA	NA	NA	NA
SWE	0,04	0,07	-0,09	-0,11
GBK	0,28	0,31	0,06	0,04
ISL	IE,NA	IE,NA	NA	NA

Carbon stock changes in mineral soils under forest land remaining forest land in this submission are quantitatively estimated generally as a small net sink of carbon. (Table 6. 15).

Most of the countries report absence or insignificant areas of organic soils under this land use subcategory. However, when organic soils are present, they are reported in most of the cases as resulting in a net source of emissions.

CO_2 emissions from organic soils are associated with managed forests (e.g. drainage of soils to establish plantations), and only UK reports a sink of carbon from organic soils in this sub-category.

Table 6. 15 Implied carbon stock change factors in mineral and organic soils in 4A1 (t C ha-1 yr-1) reported in individuals GHGI 2021.

Country	Net carbon stock change in mineral soils per area (t C/ha)		Net carbon stock change in organic soils per area (t C/ha)	
	1990	2019	1990	2019
AUT	-0,19	-0,18	NO	NO
BEL	NA	NA	NO	NO
BGR	NA	NA	NO	NO
HRV	NA	NA	NO	NO
CYP	NO	NO	NO	NO
CZE	NO	NO	NO	NO
DNM	NA	NA	-1,95	-1,30
EST	0,17	0,17	-0,18	-0,19
FIN	0,17	0,14	-0,55	-0,18

Country	Net carbon stock change in mineral soils per area (t C/ha)		Net carbon stock change in organic soils per area (t C/ha)	
	1990	2019	1990	2019
FRK	NE	NE	NO	NO
DEU	0,41	0,41	-2,57	-2,57
GRC	NA,NO	NO,NA	NA,NO	NO,NA
HUN	NO,NA	NO,NA	-2,60	-2,60
IRL	-0,05	-0,06	-0,55	-0,45
ITA	NO,NA	NO,NA	NO	NO
LVA	NA	NA	-0,52	-0,52
LTU	NE	NE	IE	IE
LUX	NO	NO	NO	NO
MLT	NA	NA	NO	NO
NLD	NA	NA	-1,03	-0,93
POL	0,05	0,10	-0,68	-0,68
PRT	0,02	0,00	NO	NO
ROU	NO	NO	-0,68	-0,68
SVK	NA	NO	NO	NO
SVN	NA	NA	NO	NO
ESP	NA	NA	NO	NO
SWE	0,17	0,15	-0,33	-0,31
GBK	0,23	0,40	-0,42	0,18
ISL	NA	NA	-0,37	-0,37

6.2.1.3 Land converted to Forest Land (CRF 4A2)

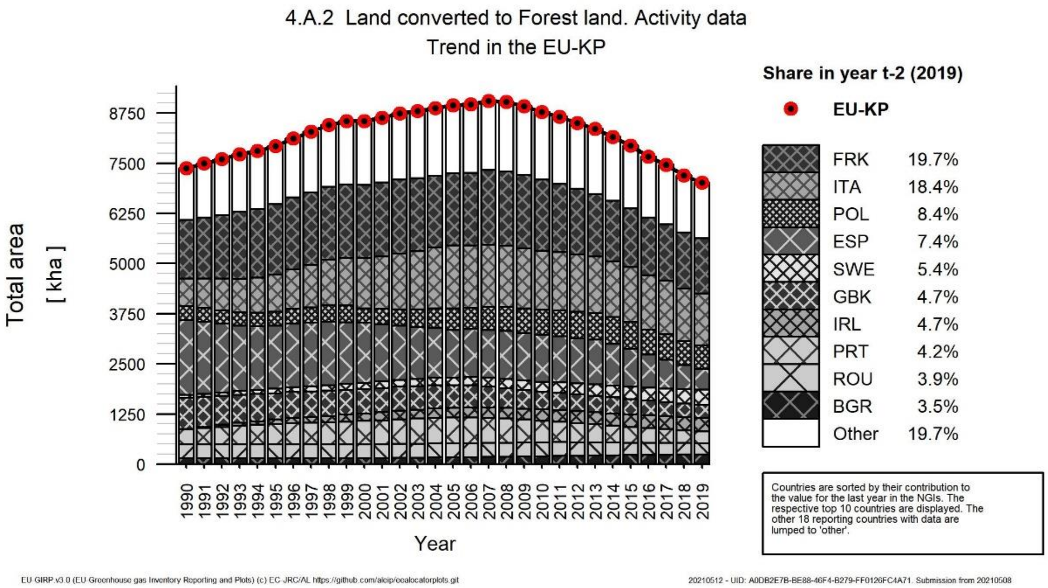
Overview of Land converted to Forest Land category

In this submission, the area reported under this subcategory represents 4% of the total Forest Land area. This subcategory has decreased by 2% as compared with 1990 (Figure 6. 5), from 7.381 kha in 1990 to 7.017 kha in 2019.

Most of the new forest lands are converted from former Grassland and Cropland areas, and although within the overall category they have a low share in terms of areas, they contribute by 10% to the total carbon sink of the European forest.

In term of areas, Italy, France, Poland and Spain together contribute with about 55% of the total areas being converted to forest land.

Figure 6. 5 Trend of activity data in subcategory 4A2 “Land converted to Forest Land” in EU-KP (kha)



This subcategory has been always reported as a net carbon sink. In this submission, it reaches -39.588 kt CO_2, which represents an increase of the sink by 1% as compared with 1990. This trend in removals is well associated with the trend on areas (Figure 6. 6; Table 6. 16).

Nevertheless, some MS (e.g., Finland and Sweden) have reported this subcategory as a net source of emissions for the first years of the time series or as a very small sink. This fact is explained by the emissions caused during the preparatory practices of soils that preceded the afforestation or reforestation activities. The absence of such emissions is often associated with natural expansion of forest areas.

Table 6. 16 4A2 Land converted to Forest Land: EU-KP contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	-3 043	-1 729	-1 723	4.4%	1 320	43%	6	0.4%
Belgium	-12	-154	-135	0.3%	-124	-1055%	19	12%
Bulgaria	-1 001	-1 588	-1 620	4.1%	-619	-62%	-32	-2%
Croatia	-29	-260	-261	0.7%	-232	-802%	-1	-0.3%
Cyprus	-13	-34	-30	0.1%	-17	-135%	4	12%
Czechia	-353	-547	-563	1.4%	-210	-59%	-16	-3%
Denmark	-1 015	-1 051	-1 373	3.5%	-358	-35%	-322	-31%
Estonia	-11	-171	-166	0.4%	-156	-1459%	5	3%
Finland	2	-219	-222	0.6%	-224	-11922%	-3	-1%
France	-7 256	-8 426	-8 245	20.8%	-989	-14%	181	2%
Germany	256	633	617	-1.6%	361	141%	-16	-2%
Greece	NO,NE	-127	-106	0.3%	-106	-∞	21	17%
Hungary	-313	-1 250	-1 197	3.0%	-883	-282%	54	4%
Ireland	-7	-3 693	-3 570	9.0%	-3 564	-52655%	123	3%
Italy	-2 849	-5 610	-6 103	15.4%	-3 254	-114%	-493	-9%
Latvia	-14	-209	-197	0.5%	-183	-1311%	11	5%
Lithuania	-783	-1 067	-1 100	2.8%	-317	-41%	-33	-3%
Luxembourg	-303	-57	-42	0.1%	262	86%	15	27%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	-516	-479	-473	1.2%	43	8%	6	1%
Poland	-1 460	-1 995	-1 919	4.8%	-459	-31%	76	4%
Portugal	-2 138	-2 399	-2 174	5.5%	-36	-2%	225	9%
Romania	-3 859	-3 145	-3 003	7.6%	856	22%	142	5%
Slovakia	-2 210	-362	-348	0.9%	1 862	84%	14	4%
Slovenia	-256	-519	-414	1.0%	-157	-61%	105	20%
Spain	-11 369	-4 345	-3 751	9.5%	7 618	67%	594	14%
Sweden	70	-811	-873	2.2%	-943	-1355%	-62	-8%
United Kingdom	-471	-200	-181	0.5%	290	61%	19	9%
EU-27+UK	**-38 955**	**-39 813**	**-39 171**	**99%**	**-217**	**-1%**	**642**	**2%**
Iceland	-28	-368	-413	1.0%	-385	-1382%	-45	-12%
United Kingdom (KP)	-502	-204	-185	0.5%	316	63%	18	9%
EU-KP	**-39 013**	**-40 185**	**-39 588**	**100%**	**-575**	**-1%**	**597**	**1%**

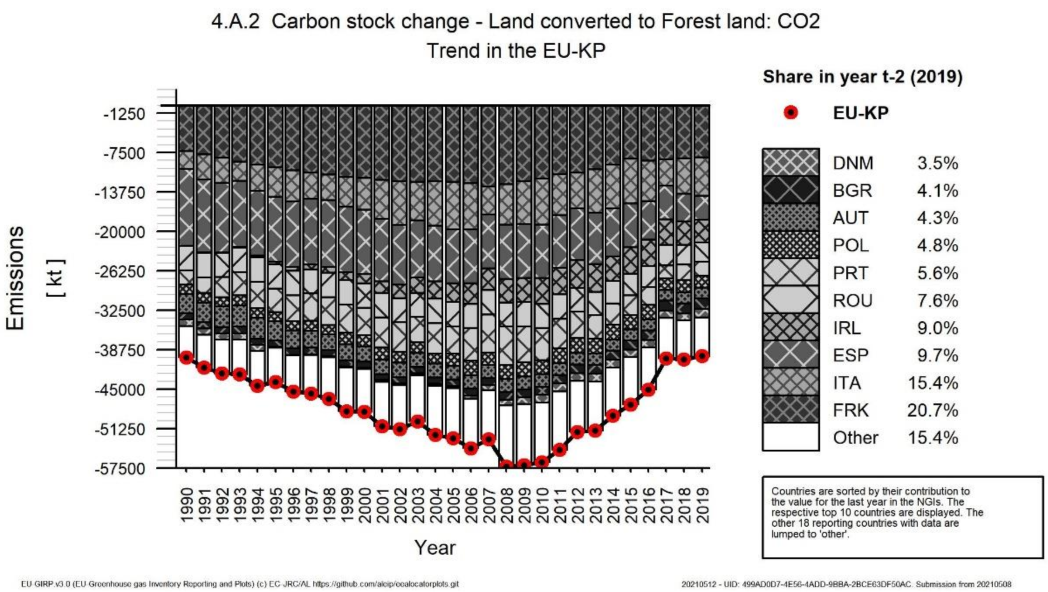
As shown in Table 6. 16, some MS reported significant changes in this subcategory as compared with 1990, for instance, Finland, Sweden, Ireland, and Spain.

In the case of Finland, this is given by the net result of summing up under the category 4A.2 emissions and removals from all lands converted to forest. While in 1990 emissions from drained organic soils in lands converted to forests counterbalanced the removals; much less drainage of organic soils occurs in the last years of the time series and therefore a larger sink was reported as a result of the carbon accumulation in living biomass.

In the case of Ireland, the increase on removals by the post-1990 forest is due to an increase in forest area, and their productivity as new established forests mature. The slight decrease in the slope of the change in removals from 2007 onward is due to thinning harvests in productive forests at age 17 years old and onwards.

Finally, the changes in the carbon sink reported by Sweden and Spain are driven by the trend of the area in this category. While Sweden reports a constant increase of land converted to forests, Spain reports a constant decrease that is well reflected in a lower the sink at the end of the time series as compared with the base year.

Figure 6. 6 Trend of emissions (+)/removals (-) in subcategory 4A2 "Land converted to Forest Land" in EU-KP (kt CO_2)



For this year, about 45% of total carbon sink reported in the subcategory 4A.2 was reported by France, Italy, and Germany while the 10 MS with the larger contribution represent about the 85% of the total sink of the new forest areas.

Methodological issues for Land converted to Forest Land category

Methods used to identify and represent the areas converted to forests, as well as to report the associated GHG emissions and CO_2 removals from these areas, are generally the same as the ones used for the subcategory 4A.1. Nevertheless, different parameters are involved under each subcategory due to differences in growth patterns, management practices, etc. of these forests.

In this sense and following past recommendations from the ERTs of the EU GHG inventory, in the last year, Italy was requested to prove that its method does not result in biased estimates for land converted to forest land. Italy has informed that the For-est model in its current version does not differentiate between forest land remaining forest land and land converted to forest land since all variables are calculated (current increment, mortality) or collected (harvest, burnt area) at the landscape level. The apportioning among forest land remaining forest land for the increment is made on the basis of the area proportion of this category over the entire forest area. Regarding losses, the harvest is all assigned to forest land remaining forest land, while the burnt area is divided between subcategories on the basis of the percentage of area of each subcategory in a yearly basis. Moreover, an analysis carried out by Italy across European forest reports showed that its approach does not cause any bias in the GHG estimates, so far as can be judged.

Most of the countries have developed land identification systems that are able to identify and track land use conversions to and from forest. Mainly, as already mentioned, these methods are based on information collected by the national forest inventories on systematic sampling plots, and that, in many cases, is complemented by auxiliary information on the form of satellites images or aerial photography, or national registries.

Estimates of GHG emissions and CO_2 removals from this subcategory are usually reported using tier 2 methods involving country-specific data collected during the national forest inventories. Under this subcategory, living biomass and dead organic matter carbon pools are in most of the cases reported as a net carbon sink. Mineral soils are reported either as a net source or a net sink of emissions depending on whether there is presence or absence of disturbed soils on new forest areas (i.e., natural regeneration or, management practices for soil preparation).

Concerning organic soils, all the countries, with the exception of UK that uses the CARBINE model, have reported this carbon pool as a net source of emissions whenever new forest areas were established in this type of soils.

Nevertheless, it should be noted that the heterogeneity in approaches used by the countries under 4A.2 suggests caution in interpreting differences in the implied carbon stock change factors among carbon pools. For instance, possible reasons of differences may include the length of the time series on activity data and their starting point, the use of time-averaged annual biomass growth, or the quantity of CO_2 emissions estimated from the land that is converted to forests, including lagged emissions.

6.2.2 **Cropland (CRF 4B)**

6.2.2.1 Overview of the Cropland category

Subject to intensive agriculture practices, Cropland category is an important contributor to the EU GHG budget. This category, which includes arable lands for annual crops, permanent crops, set aside lands and rice-fields, represents the largest source of emissions among the six land use categories.

Based on individual submissions reported this year, Cropland areas covered in 2019 a total of 124.741 kha, which represent 28% of the lands reported by EU MS, UK and Iceland. However, the category shows a steady decreasing trend. For this inventory year the area is about 8% less than in the year 1990.

6.2.2.2 Cropland remaining Cropland (CRF 4B1)

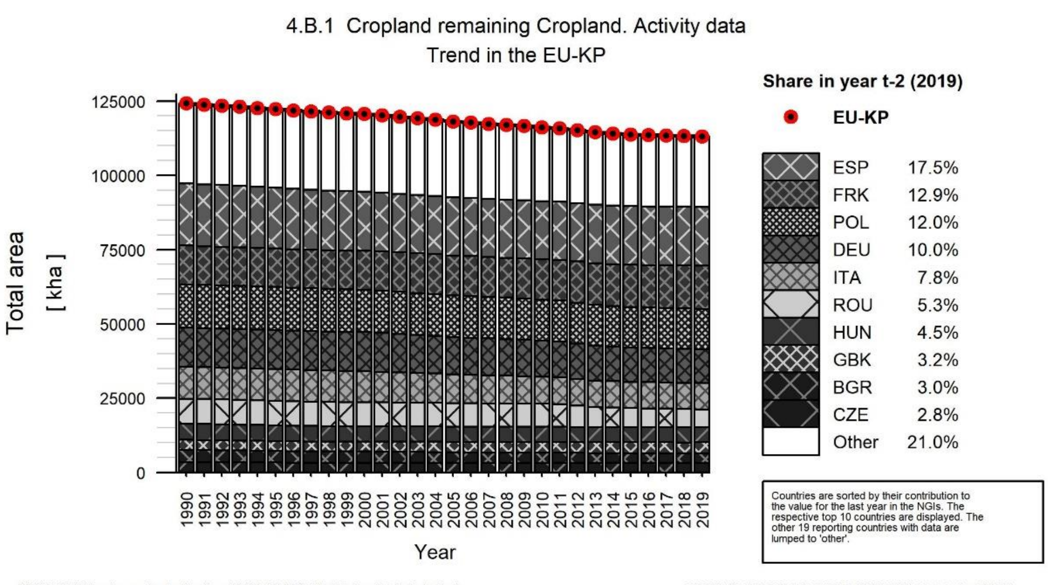
Overview of Cropland remaining Cropland category

In line with the overall category, this subcategory has constantly decreased since 1990 (Figure 6. 7) from 124.201 kha in 1990 to 113.087 kha in 2019. This represents a decrease of 9%.

With the exception of France, UK, Malta, Slovakia and Iceland, countries report a decrease of Cropland area as compared with 1990.

The overall trend of this subcategory is driven by 10 MS which together contribute to about 81% of the total area, and more specifically, Spain, France, Poland, and Germany which represent about half of the area reported under this subcategory.

Figure 6. 7 Trend of activity data in subcategory 4B1 "Cropland remaining Cropland" in EU-KP (kha)



In terms of emissions, at the EU level this subcategory has been always reported as a net source of GHG emissions.

For the year 2019, based on individual submissions, GHG emissions from Cropland remaining Cropland reached 14.490 kt CO_2 which represents a decrease of 55% as compared to 1990 (Table 6. 17).

This trend is mainly driven by Germany, UK and Finland that report the largest emissions from this subcategory (Figure 6. 8). In general, emissions are the result of the oxidation of organic matter in soils which are particularly important in those MS with presence of cultivated areas on organic soils.

Nevertheless, some MS report a considerable carbon sink in Cropland remaining Cropland. For instance, France, Romania, and Spain report a substantial net carbon sink in mineral soils and, in some cases, also in the living biomass carbon pool. This is generally justified by the implementation of IPCC methodologies (i.e. tier 1 and tier 2) that result in a net sink when current management practices of soils are less intensive than those implemented 20 years before. In addition, net carbon sink may occur in countries with significant areas of woody crops (i.e., orchards, vineyards, Christmas trees, fruits, bushes, and olive trees) that provide a net sink resulting from carbon accumulation in the living biomass pool.

A particular case is Romania, which reports a significant sink in this subcategory because, as explained in its NIR, Cropland areas include lands that are subject to Revegetation activities under the KP. Such areas are reported as tree plantations, but they are managed as part of the agricultural land, mainly arable. Tree plantations classified as revegetated areas “behave” as forest plantations with regard to change in each carbon pools, therefore resulting in a net carbon sink.

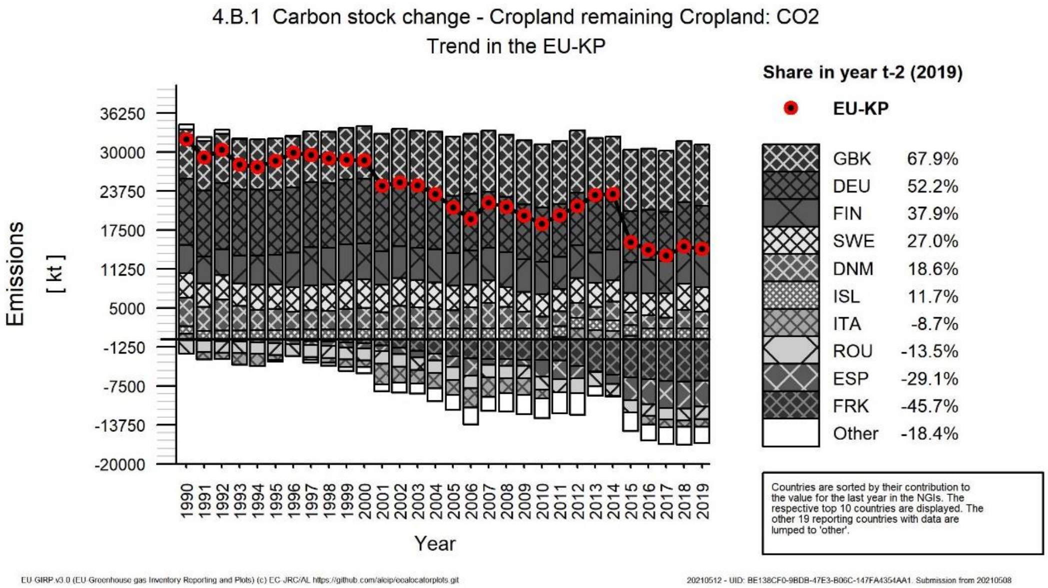
Table 6. 17 4B1 Cropland remaining Cropland: EU-KP contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	-18	-125	-108	-0.7%	-90	-504%	17	14%
Belgium	213	186	191	1.3%	-22	-10%	5	3%
Bulgaria	-911	-581	-540	-3.7%	372	41%	41	7%
Croatia	200	370	379	2.6%	180	90%	10	3%
Cyprus	-135	-132	-133	-0.9%	2	2%	-1	-0.5%
Czechia	91	53	54	0.4%	-37	-40%	1	3%
Denmark	4 617	3 034	2 699	18.6%	-1 919	-42%	-335	-11%
Estonia	664	198	254	1.8%	-409	-62%	56	28%
Finland	4 535	5 441	5 492	37.9%	957	21%	51	1%
France	77	-6 822	-6 619	-45.7%	-6 696	-8642%	203	3%
Germany	10 615	7 699	7 559	52.2%	-3 056	-29%	-140	-2%
Greece	-808	-405	-379	-2.6%	428	53%	26	6%
Hungary	25	-468	-397	-2.7%	-422	-1674%	71	15%
Ireland	20	-129	-110	-0.8%	-130	-644%	19	15%
Italy	774	-1 019	-1 247	-8.6%	-2 021	-261%	-227	-22%
Latvia	2 364	1 177	1 176	8.1%	-1 188	-50%	-1	-0.1%
Lithuania	78	-1 067	-1 066	-7.4%	-1 144	-1475%	1	0.1%
Luxembourg	-1	1	1	0.0%	2	171%	-0.2	-17%
Malta	0	-1	-1	0.0%	-1	-201%	-0.03	-4%
Netherlands	1 185	468	423	2.9%	-762	-64%	-45	-10%
Poland	-906	-1 102	-1 092	-7.5%	-186	-20%	10	1%
Portugal	21	-198	-182	-1.3%	-203	-968%	16	8%
Romania	-2 108	-1 927	-1 961	-13.5%	147	7%	-34	-2%
Slovakia	-1 391	-1 208	-1 212	-8.4%	179	13%	-4	-0.3%
Slovenia	63	87	83	0.6%	20	31%	-4	-4%
Spain	-203	-4 284	-4 212	-29.1%	-4 009	-1973%	71	2%
Sweden	3 890	4 135	3 910	27.0%	20	1%	-226	-5%
United Kingdom	7 940	9 780	9 825	67.8%	1 884	24%	45	0.5%
EU-27+UK	**30 890**	**13 160**	**12 788**	**88%**	**-18 102**	**-59%**	**-372**	**-3%**
Iceland	1 217	1 694	1 691	11.7%	475	39%	-2	-0.1%
United Kingdom (KP)	7 951	9 791	9 836	67.9%	1 885	24%	45	0.5%
EU-KP	**32 117**	**14 865**	**14 490**	**100%**	**-17 627**	**-55%**	**-375**	**-3%**

Information above shows that as compared with the year 1990, France and Spain have reported in this submission a significant increase of removals in Cropland remaining cropland. This results mainly from an increase in soil organic carbon in mineral soils which is driven by changes in management practices. However, larger sink in living biomass of woody crops at the end of the time series also contributes to the overall trend. By contrary, UK has reported a significant increase of emissions as compared with the base year, driven also by larger emissions from mineral soils due to management practices.

Germany reports a significant decrease of emissions from Cropland that is mainly driven by a constant decrease of cropland areas after 2000, and by agricultural practices that result in lower emissions, for instance lower area of cultivation of histosoils.

Figure 6. 8 Trend of emissions (+)/removals (-) in subcategory 4B1 "Cropland remaining Cropland" in EU-KP (kt CO_2)



Methodological issues for Cropland remaining Cropland category

Lands included under this category generally are in line with the IPCC definition (Table 6. 18). However, there could be national particularities (e.g., treatment of some woody crops) that result in small differences among countries.

In some cases, because of the absence of annual information on activity data coupled with the fact that management practices include crops-rotation cycles and fallow lands, some cropland areas may not be clearly separated from grassland areas. In these cases, countries have defined the number of years before a land is shifted from/to cropland and grassland.

Table 6. 18 Definitions of lands included under the category 4B: Cropland.

Country	*Definition*
Austria	Arable land, including annual and perennial crops (rotation period of up to thirty years), as well as forest arboretums, forest seed orchards, Christmas tree plantations and orchards (e.g., walnut or sweet chestnut) and rows of trees and areas with woody plants in parks and green areas, and house garden.

Country	*Definition*
Belgium	Tillage land and agro-forestry systems with vegetation falling below the thresholds for forests.
Bulgaria	Cropland consists of annual crops (cornfields and kitchen gardens) and perennials (vineyards, fruit and berry plantation and nurseries). Arable land is the land worked regularly, generally under a system of crop rotation - area with annual crops, set - aside area as well as area with seeds and seedlings. Perennial crops include fruit and berry plantation, vineyards and other permanent crops, nurseries for wine, fruits, ornamental plants, forest trees etc. The orchard is a uniformly kept plantation (by annual pruning and regular treatment for protection from diseases and insects) of fruit trees (pip-trees, stone-trees and nut-trees).
Croatia	Cropland category includes non-irrigated arable land, permanently irrigated arable land, vineyards, fruit trees and berry plantations, olive groves, annual crops associated with permanent crops (Complex cultivation patterns).
Cyprus	This category contains cropped land, including lands with woody vegetation (i.e., fruit trees) where the vegetation does not meet the definition of forest. In particular, this category includes land principally occupied by agriculture, including arable land, annual and permanent crops as well as vineyards, fruit trees and berry plantations, olive groves and other similar types of cultivation.
Czech Republic	Cropland is predominantly represented by arable land (92.6%), while the remaining area includes hop-fields, vineyards, gardens and orchards.
Denmark	Annual crops, wooden perennial crops, hedgerows and “other agricultural area” (i.e., small undefined areas lying inside the cropland area). It includes farmlands, commercial plantations with perennial crops (fruit trees, orchards and willow), house gardens, hedgerows (perennial trees/bushes not meeting the forest definition) in the agricultural landscape, as well as willow plantations on agricultural land for bioenergy purposes.
Estonia	Cropland is arable land, area where annual or perennial crops are growing (incl. fallow, orchards, short-term and long-term cultural grasslands and temporary greenhouses). It does not include built garden land under 0.3 ha (that is included in Settlements). Abandoned cropland is classified as cropland until it has not lost arable land features – changes in soil and vegetation have not taken place and the land is still usable as cropland without the implementation of specific treatments.
Finland	Arable crops, grass covered (for less than 5 years), set-aside, permanent horticultural crops, greenhouses and kitchen gardens.
France	Annual crops, temporary pastures (which last for maximum 6 annual harvests) and permanent crops (orchards, vineyards, olives, etc.).
Germany	Annual crops and cropland with perennial crops (long-lived crops: fruit crops, osiers, poplars, Christmas tree farms, nurseries) and lands for cultivation of vegetables, fruit and flowers.
Greece	Annual and perennial crops, temporary fallow land and perennial woody crops, i.e., tree crops and vineyards.
Hungary	Cropland contains arable lands, vegetable gardens, orchards and the vineyard areas, as well as set-aside croplands. Arable lands are any land area under regular cultivation irrespective of the rate or method of soil cultivation and whether the area is under crop production or not due to any reason, such as temporary inland waters or fallow. Areas under tree nurseries (including ornamental and orchard tree nurseries, vineyard nurseries, forest tree nurseries excluding those for the own requirements of forestry companies grown in the forest), permanent crops (e.g., alfalfa and strawberries), herbs and aromatic crops are included. Vegetable gardens are areas around residential houses where, in addition to meeting the owners’ demand may produce some surplus of low amount which is usually traded. Orchards are land under fruit trees and bushes that may include several fruit species (e.g.: apples, pears, cherries, etc.). Included are non-productive orchards and orchards of systematic layout in vegetable gardens if the area is 200 m^2 or above in case of berries and 400 m^2 or above in case of fruit trees. Vineyards are areas where grapes are planted in equal row width and planting space and include non-productive areas and vineyards in vegetable gardens (e.g., trellises) if grapes are planted in equal row width and planting space, and the size of the area is at least 200 m^2. Set-aside cropland is land that is abandoned but not converted to any other land use.
Ireland	Permanent crops and tillage land, including set-aside, as recorded by annual statistics.
Italy	Annual crops and perennial woody crops (e.g., woody plantations, that don’t meet national forest definition, olive groves or vineyards).

Country	*Definition*
Latvia	The cropland refers to the area of arable land, including orchards and extensively managed arable lands. Cropland also includes animal feeding glades, which according to national land use classification belong to forest land.
Lithuania	The area of cropland comprises of the area under arable crops as well as orchards and berry plantations. Arable land is continuously managed or temporary unmanaged land, used and suitable to use for cultivation of agricultural crops, also fallows, inspects, plastic cover greenhouses, strawberry and raspberry plantations, areas for production of flowers and decorative plants. Arable land set aside to rest for one or several years (<5 years) before being cultivated again as part of an annual crop-pasture rotation is still included under cropland. Orchards and berry plantations are areas planted with fruit trees and fruit bushes (apple-trees, pear-trees, plum-trees, cherry-trees, currants, gooseberry, quince and others).
Luxemburg	Agro-forestry systems where tree cover falls below the forest thresholds, respectively covered by permanent crops, annual crops, artificial meadows (not permanent) and lands temporarily set aside.
Malta	In Malta cropland can be split into three types: arable area which is cultivated under a system of crop rotation; kitchen gardens that include small plots of cultivated land, in which most of the products are intended for consumption by the farmer; land under permanent crops where the crop occupies the same land for a period of time, normally 5 years or more. For inventory purposes, local cropland was split into two: annual crops and perennial woody crops. The main perennial crops considered for this inventory are vines, being the most cultivated crop.
Netherlands	Arable and tillage land, including rice-fields, and agro-forestry systems where the vegetation structure falls below the thresholds for forest and nurseries (including tree nurseries).
Poland	Agricultural land considered as cropland consists of arable land includes land, which is cultivated, i.e., sowed and fallow land. Arable land should be maintained in good agricultural condition. Cultivated arable land is understood as land sowed or planted with agricultural or horticultural products, willow and hops plantations, area of greenhouses, area under cover and area of less than 1000 m^2, planted with fruit trees and bushes, as well as green manure, fallow land includes arable land which are not used for production purposes but are maintained in good agricultural condition; orchards include land with the area of at least 1000 m^2, planted with fruit trees and bushes.
Portugal	Rain-fed annual crops (without irrigation and fallow-land integrated into crop-rotations), irrigated annual crops (under irrigation, greenhouses), rice cultivation lands, wine yards, olives and other species of woody crops
Romania	Cropland includes agricultural lands, i.e., lands covered or temporary uncovered by agricultural crops (major crops and horticultural plants cultures). It includes 3 groups (non-woody crops, woody crops and other wooded land and trees outside forests (which do not meet the forest definition parameters, e.g., forest belts which are narrower than 20m) with 9 categories: orchard, vineyard, shrubs, cultivated land agricultural, temporary fallow land, deciduous tree, coniferous tree, deciduous and resinous trees and dead trees.
Slovakia	Cropland includes lands for growing cereals, root-crops, industrial crops, vegetables and other kinds of agricultural crops; perennial woody crops; lands temporary overgrown with grass or used for growing of fodder lasting several years; hotbeds and greenhouses if they are built up on the arable land; fallow land which is arable land left for regeneration for one growing season during which were not sow specific crops or just crops for green manure, eventually it is covered by spontaneous vegetation, which would be ploughed in.
Slovenia	Annual: arable land breeds more than 2 meters and grows the non-woody vegetation (cereals, potatoes, forage crops, vegetable crops, oilseed, ornamental plants, herbs, strawberries, hop fields) and agricultural fallow ground. Also, temporary meadows and greenhouses. Perennial: permanent crops on arable land such as vineyards, extensive and intensive orchards, olive groves, nursery (for grapevines, fruit and forest trees), forest plantations and forest trees on agricultural land.
Spain	Annual crops and fallow land, perennial crops (olive groves, wines and other woody crops) and mix of annual and permanent crops (except when they qualify as forest land, i.e., in “dehesa”).
Sweden	Regularly tilled agricultural land.
United Kingdom	Arable and horticultural land.
Iceland	All cultivated land not included under Settlements or Forest land and at least 0.5 ha in continuous area and minimum width 20 m. This category includes harvested hayfields with perennial grasses.

Country	*Definition*
	Two subcategories of Cropland are defined on the Land use map, “Cropland” and “Cropland on drained soils”.

Overall, following the IPCC approach, the living biomass carbon pool is assumed in balance for annual crops, while carbon stock changes are reported for conversions among annual and woody crops (e.g., Austria, Croatia, and Bulgaria). Concerning carbon stock changes in woody crops, countries often implement the IPCC approach, either by using country-specific data on biomass accumulation from growth and maturity cycles, or by using default data. However, what is not always transparently provided is how the lands in which woody crops have reached maturity are identified and excluded from those that are still accumulating carbon.

Carbon stock changes in dead organic matter are in most of the cases reported following the IPCC assumption that the dead organic matter stocks are not present in croplands or they are in equilibrium. In some cases, however, MS have reported this pool as a net sink (e.g., Sweden) or as a net source (e.g., Romania).

A particular case is given by Finland which reports the notation key IE since the net carbon stock change in dead organic matter is included in losses in living biomass, explaining that the number of dead branches of currants and apple trees in modern orchards is very low and they are usually chipped and left to decay in the orchards.

With regard to carbon stock change in soils, these have been reported under mineral soils as either a net source or a net sink of carbon. The final net result is typically associated with an increase or decrease of the intensity in the soil management practices along the time series. By contrary, as reported by all countries, for cultivated organic soils the net result of carbon stock changes is associated with a net source of CO_2 emissions. Methodologies for reporting this carbon pool follow, in most of the cases, IPCC tier 1 or tier 2 approaches, where carbon stock changes are estimated as the difference on the carbon stock in soils at two moments in time. In a few cases, carbon stock changes have been estimated by using models (e.g., C-tool by Denmark and ICBM by Sweden).

Applied Tier 2 methods consist of country-specific soil organic carbon reference values along with IPCC default values for relative change factors (i.e., for Fmg, Flu, Fi). In some cases, IPCC default relative change factors have been slightly modified to adapt them to national circumstances, but changes rely more on expert judgment than on a statistical analysis or systematic measurements. An exception is given by Austria, who derived own factors by close comparison with IPCC similar strata.

Parameters to estimate carbon stock change for living biomass of permanent crops vary depending on the types of crops and management practices across Europe, from North (i.e., bush-type currant crops) to South (i.e., olives trees and agroforestry systems).

Table 6. 19 Implied net carbon stock change factor for carbon pools in 4B1 (t C ha-1 yr-1) reported by individual submissions GHGI 2021.

Country	Net carbon stock change in living biomass per area (t C/ha)		Net carbon stock change in dead organic matter per area (t C/ha)		Net carbon stock change in mineral soils per area (t C/ha)		Net carbon stock change in organic soils per area (t C/ha)	
	1990	2019	1990	2019	1990	2019	1990	2019
AUT	0,003	0,000	NO	NO	0,000	0,022	NO	NO
BEL	NO	0,000	NO	NO	-0,041	-0,039	-10,000	-10,000
BGR	0,001	-0,009	NA	NA	0,058	0,052	NE	NE
HRV	-0,019	-0,042	NO	NO	0,000	-0,011	-10,000	-10,000
CYP	0,147	0,150	NO	NO	NO	NO	NO	NO
CZE	0,000	0,000	NO	NO	-0,008	-0,005	NO	NO
DNM	-0,007	-0,004	NO	NO	-0,057	-0,005	-8,076	-7,552
EST	0,000	NO	NE	NE	NO	0,095	-6,100	-6,100
FIN	0,000	0,000	IE	IE	0,005	-0,083	-6,468	-6,502
FRK	-0,002	-0,002	NE	NE	0,001	0,127	IE	IE
DEU	-0,001	0,001	NO	NO	-0,002	-0,001	-9,154	-9,337
GRC	0,073	0,056	NO	NO	NO	NO	-10,000	-10,000
HUN	-0,002	-0,005	NO	NO	0,001	0,026	NO	NO
IRL	-0,024	-0,003	NO	NO	0,016	0,043	NO	NO
ITA	-0,030	-0,023	NO	NO	0,031	0,086	-10,000	-10,000
LVA	0,001	0,001	0,000	0,000	NA	NA	-4,800	-4,800
LTU	-0,015	-0,015	NA	NA	NO	0,243	IE	IE
LUX	0,005	-0,005	NO	NO	0,001	0,000	NO	NO
MLT	0,016	0,024	NE,NA	NE,NA	-0,007	-0,001	NO	NO
NLD	NA	NA	NA	NA	NA	NA	-4,207	-3,548
POL	0,030	0,034	NO	NO	-0,002	0,000	-1,000	-1,000
PRT	-0,002	0,018	NA	NA	NA	0,005	NO	NO
ROU	0,018	0,052	-0,004	-0,005	0,060	0,051	-10,000	-10,000
SVK	0,245	0,205	NA	NA	0,009	0,015	NE	NE
SVN	0,013	-0,002	0,001	0,001	0,000	0,006	-10,000	-10,000
ESP	0,003	0,031	NA	NA	NO	0,027	NO	NO
SWE	0,002	0,026	0,002	0,001	-0,042	-0,121	-6,220	-6,220
GBR	-0,002	0,000	NO,NA	NO,NA	-0,173	-0,331	-8,184	-8,184
ISL	NA	NA	NA	NA	0,171	0,171	-7,900	-7,900

Whenever the Tier 1 assumption for carbon stock changes in living biomass of annual crops or dead organic matter was implemented, countries used the notation key NO, NE, or NA. Efforts have been devoted to follow the recommendation from the UN ERT on the use of NA when the assumption of equilibrium is applied. As result more MS are now using the notation key NA. Nevertheless, it should be noted a full harmonization on the use of the notation key NA across MS is not possible since some countries have received from their UN ERT a different recommendation on which notation key should be used.

6.2.2.3 Land converted to Cropland (CRF 4B2)

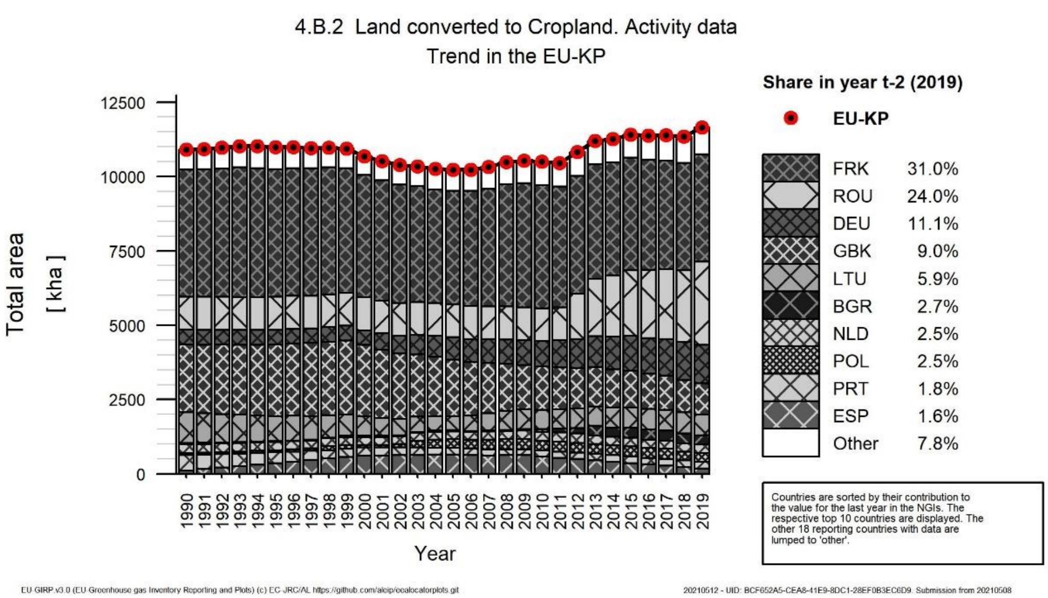
Overview of Land converted to Cropland category.

In terms of area, this subcategory represents 9% of the total cropland areas reported at the level of EU MS, UK, and Iceland. However, it accounts for 73% of the net CO_2 emissions that are reported in Cropland.

In overall, for this inventory year the area increased by 4% as compared with 1990, from 10.912 kha reported for the year 1990, to 11.655 Kha in 2019 (Figure 6. 9).

Main conversions of lands to Cropland take place from areas of Grassland and Forest land. The trend in this subcategory is mainly driven by France, Germany and Romania which report more than 60% of total area of new Croplands, often associated with rotation of crops and grasses on the same land.

Figure 6. 9 Trend of activity data in subcategory 4B2 "Land converted to Cropland" in EU-KP (kha)



In terms of emissions, this subcategory is reported as a net source of emissions that for the current inventory year reaches 35.726 Kt CO_2. This represents a decrease of 26% as compared to 1990 (**Error! Reference source not found.**). The largest emissions are reported by France, which reports about 51 % of the total emissions in this subcategory; followed by Germany and UK ().

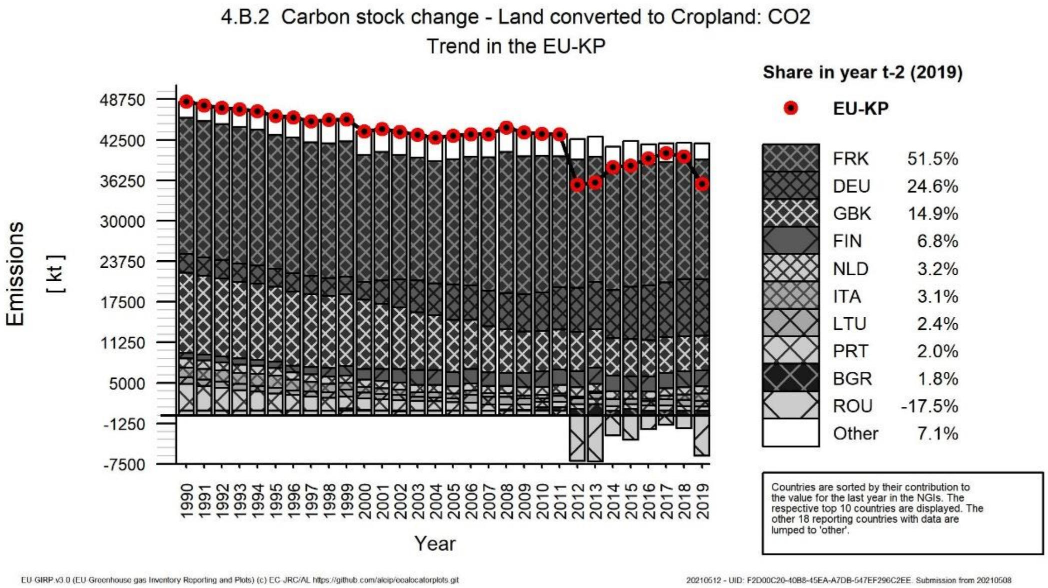
Nevertheless, some individual inventories report this subcategory as a carbon sink, as a result of removals from the living biomass carbon pool when lands are converted to Croplands with woody vegetation (e.g., Cyprus and Romania). With some few exceptions, all the other carbon pools are reported by the countries as a net source of emissions.

Table 6.1 4B2 Land converted to Cropland: EU-KP contributions to net CO_2 emissions (+)/ removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	195	231	233	0.7%	38	20%	2	1%
Belgium	33	598	620	1.7%	587	1782%	22	4%
Bulgaria	78	697	643	1.8%	565	723%	-54	-8%
Croatia	23	70	68	0.2%	44	192%	-2	-3%
Cyprus	-4	-21	-18	-0.1%	-15	-377%	3	14%
Czechia	116	40	46	0.1%	-70	-60%	6	15%
Denmark	89	50	6	0.02%	-83	-94%	-45	-89%
Estonia	NO,NE	138	97	0.3%	97	∞	-40	-29%
Finland	856	2 400	2 446	6.8%	1 590	186%	46	2%
France	20 999	18 348	18 398	51.5%	-2 602	-12%	50	0%
Germany	2 896	8 843	8 777	24.6%	5 881	203%	-66	-1%
Greece	52	15.9	16.0	0.0%	-36	-69%	0.1	1%
Hungary	120	246	289	0.8%	169	141%	42	17%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	1 519	861	1 107	3.1%	-412	-27%	246	29%
Latvia	7	252	255	0.7%	249	3635%	3	1%
Lithuania	1 062	906	853	2.4%	-209	-20%	-54	-6%
Luxembourg	72	31	31	0.1%	-41	-57%	-0.4	-1%
Malta	-1.2	-0.7	-0.7	-0.002%	0.5	39%	-0.03	-4%
Netherlands	1 380	1 130	1 151	3.2%	-228	-17%	21	2%
Poland	362	169	167	0.5%	-195	-54%	-2	-1%
Portugal	4 048	738	724	2.0%	-3 324	-82%	-14	-2%
Romania	661	-2 024	-6 251	-17.5%	-6 913	-1045%	-4 227	-209%
Slovakia	466	60	59	0.2%	-408	-87%	-2	-3%
Slovenia	189	88	89	0.3%	-100	-53%	2	2%
Spain	171	434	296	0.8%	126	74%	-137	-32%
Sweden	12	171	195	0.5%	183	1521%	24	14%
United Kingdom	12 358	5 397	5 317	14.9%	-7 041	-57%	-80	-1%
EU-27+UK	**47 758**	**39 868**	**35 613**	**100%**	**-12 145**	**-25%**	**-4 255**	**-11%**
Iceland	635	91	91	0.3%	-544	-86%	0	0%
United Kingdom (KP)	12 358	5 420	5 340	14.9%	-7 019	-57%	-80	-1%
EU-KP	**48 393**	**39 981**	**35 726**	**100%**	**-12 667**	**-26%**	**-4 255**	**-11%**

As in other land use subcategories that involve the conversion of areas, the trends in the time series of emissions from Land converted to Cropland have been driven by the activity data. As for instance, in the case of Belgium, Bulgaria and Netherlands that report an increase of the area converted to cropland under the subcategory 4B.2, which associate with a constant increase of the emissions in this subcategory. The opposite scenario is given by Portugal, France, and UK, which report significant reduction of emissions in this category driven by the trend in areas.

Figure 6. 10 Trend of emissions (+)/ removals (-) in subcategory 4B2 "Land converted to Cropland" in EU-KP (kt CO_2)



Methodological issues for Land converted to Cropland.

For estimating and reporting carbon stock changes in this subcategory, the countries generally use the IPCC default methodology. However, implementation of country-specific or default emissions factors depends on which type of lands is being converted to Cropland, and the estimated carbon pool. For instance, concerning the living biomass carbon pool, some countries consider the carbon stocks from one year of growth in Cropland following conversion, while others only consider the oxidation of the carbon stock in the land that is converted to cropland.

Usually, it is assumed that the carbon stored in living biomass and dead organic matter is lost in the year of the conversion, while for soil organic carbon in mineral soils, following IPCC methodology, countries often apply a 20 year transition period before the carbon stock of the soils converted to cropland reach an equilibrium.

In recent years, improvements have been implemented also in this subcategory, including the use of higher methods (as requested by the ERT), which have resulted in an overall increase of accuracy and completeness of the sector.

For instance, Latvia also used country-specific data and Biosoil Project's results to report carbon stock changes from DOM following the conversion from Forest land to Cropland. Also Poland improved the completeness of this category's reporting with the inclusion of carbon stock changes in living biomass following the conversion from Grassland to Cropland.

On the contrary, France reports the notation key NE for carbon stock changes in a very small area identified as Other Land converted to Cropland, also noting that as defined, Other land category are areas with none or insignificant carbon stock.

Portugal estimates emission or sequestration factors from soils following land use conversions based on data measurements from three data sets: (i) measurements made over the ICP Forests grid (1995 and 2005); (ii) Project Biosoil (1999); LUCAS soil assessment (2009). These factors were calculated for all possible land-use changes that led to significant changes in average carbon stocks. Since the conversion among cropland and grassland does not lead to significant carbon changes according to their significance test, the notation key NO was used in accordance.

6.2.3 Grassland (CRF 4C)

6.2.3.1 Overview of Grassland category (CRF 4C)

Under this category are included lands covered by natural and artificial meadows, range lands, moors and forage crops. They can be subject to economic activities (e.g., grazing lands), or be considered unmanaged lands. In several instances, Grassland areas cover also woody lands (i.e., trees and shrub lands) when they do not fall into the thresholds used to define forest lands.

In overall, these areas represent a net source of emissions that are below the emissions from Settlements (i.e., conversions of lands to Settlements), and far below the emissions reported under Cropland.

Based on individual submissions, for the current inventory year total Grassland covers 95.158 kha. This represents 21% of the total territory of EU MS, UK and ISL. However, as for Cropland, these areas have constantly decreased, and nowadays these ecosystems cover 4% less area than in the base year.

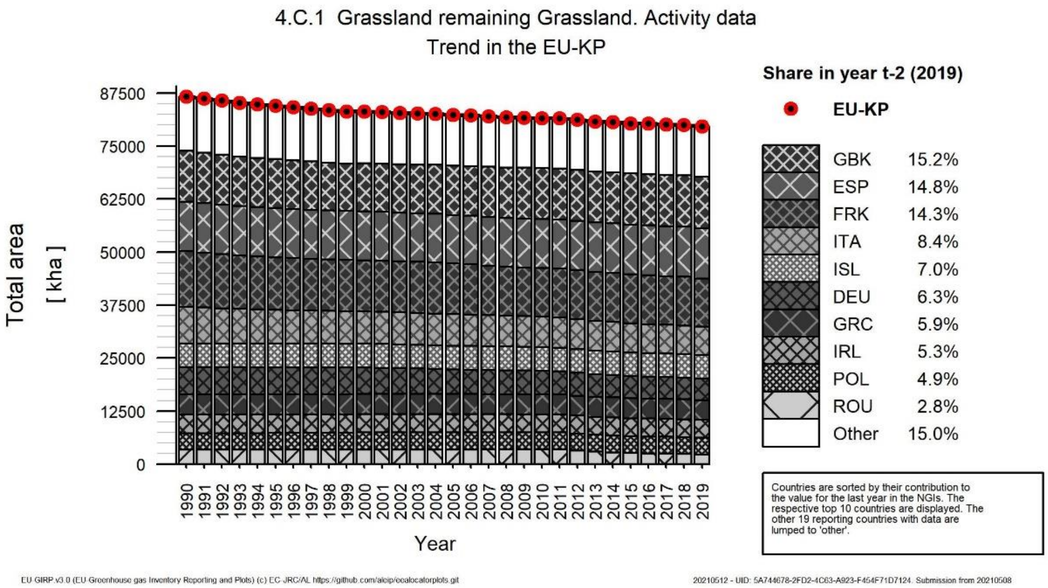
6.2.3.2 Grassland remaining Grassland (CRF 4C1)

Overview of Grassland remaining Grassland category

For the year 2019, total area reported under this subcategory reaches 79.662 kha. Following the general trend of these lands, this subcategory has also constantly decreased since 1990, and in 2019 it represents 8% less than in 1990 (Figure 6. 11).

UK, Spain, and France reported together about 45% of the total area of Grassland remaining Grassland, while the 10 MS with the larger contribution account for more than 85 % of the total area.

Figure 6. 11 Trend of activity data in subcategory 4C1 "Grassland remaining Grassland" in EU-KP (kha)



In terms of emissions, this subcategory has always resulted in a net source at the level of EU MS, UK and ISL. In the current inventory year, the reported emissions reached 36.208 kt CO_2, which represents a decrease of 34 % as compared with the year 1990 (Table 6. 20).

Nevertheless, individual inventories have reported this subcategory either as a net source or as a net sink of carbon.

As in the case of cropland areas, the net result of the carbon stock in grassland depends on the one hand on whether these areas are subject to agricultural activities, but also on the presence or absence of significant woody biomass and the intensity and variation of management practices over the years. Moreover, a very significant driver is whether there are management practices on organic soils or not.

Table 6. 20 4C1 Grassland remaining Grassland: EU-KP contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

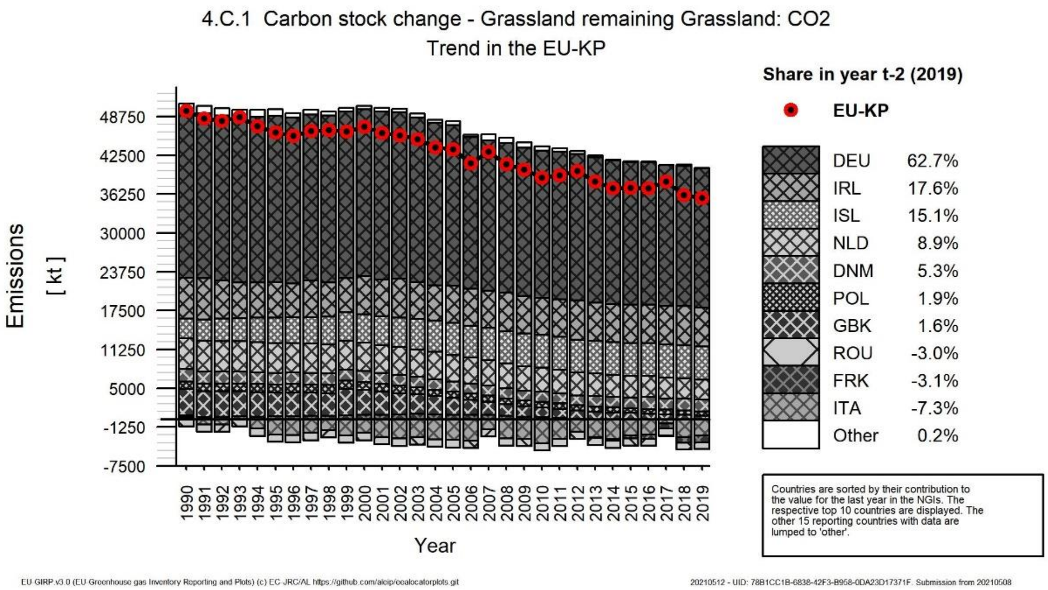
Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	294	297	297	0.8%	2	1%	0.1	0.04%
Belgium	-427	-368	-365	-1.0%	61	14%	3	1%
Bulgaria	151	52	48	0.1%	-102	-68%	-4	-7%
Croatia	2	2	2	0.01%	0	0%	0	0%
Cyprus	-134	-118	-118	-0.3%	16	12%	0.1	0.1%
Czechia	48	-79	-79	-0.2%	-127	-264%	0.3	0.4%
Denmark	1 982	1 973	1 908	5.3%	-74	-4%	-65	-3%
Estonia	43	43	44	0.1%	1	1%	1	3%
Finland	728	464	471	1.3%	-257	-35%	7	1%
France	301	-964	-1 092	-3.0%	-1 393	-463%	-128	-13%
Germany	26 512	22 562	22 379	61.8%	-4 134	-16%	-183	-1%
Greece	0.2	1	0.3	0.001%	0.1	47%	-0.2	-46%
Hungary	48	1	0	0%	-48	-100%	-1	-100%
Ireland	6 591	6 277	6 289	17.4%	-303	-5%	12	0.2%
Italy	5 358	-2 619	-2 124	-5.9%	-7 483	-140%	494	19%
Latvia	935	559	387	1.1%	-547	-59%	-172	-31%
Lithuania	O,NE,IE,NA	O,NE,IE,NA	O,NE,IE,NA	-	-	-	-	-
Luxembourg	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Malta	-10	-1	-0.3	-0.001%	9	97%	0.3	50%
Netherlands	5 002	3 253	3 171	8.8%	-1 831	-37%	-83	-3%
Poland	1 286	733	721	2.0%	-565	-44%	-12	-2%
Portugal	NO,NA	-375	-365	-1.0%	-365	-∞	10	3%
Romania	-1 184	-1 096	-1 080	-3.0%	104	9%	16	1%
Slovakia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Slovenia	184	-361	-348	-1.0%	-532	-289%	13	4%
Spain	NO,NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
Sweden	-286	105	106	0.3%	392	137%	1	1%
United Kingdom	4 278	689	585	1.6%	-3 693	-86%	-104	-15%
EU-27+UK	**51 703**	**31 029**	**30 836**	**85%**	**-20 867**	**-40%**	**-193**	**-1%**
Iceland	3 130	5 340	5 372	14.8%	2 241	72%	32	1%
United Kingdom (KP)	4 278	689	585	1.6%	-3 693	-86%	-104	-15%
EU-KP	**54 833**	**36 369**	**36 208**	**100%**	**-18 625**	**-34%**	**-161**	**0%**

The EU trend in emissions from this subcategory is largely affected by Germany, Ireland, Iceland and Netherlands (Figure 6. 12). While for some of these countries, the overall share in areas of grassland remaining grassland is not significant at EU level, all of them report important areas of grasslands managed on organic soils that generate significant emissions.

By contrary some other MS have reported this subcategory as a net carbon sink. Examples are Romania that reports a significant carbon sink from woody vegetation on grassland areas, and Italy that reports a net sink from living biomass in woody vegetation and from mineral soils in grazing areas.

In Mediterranean countries, inter-annual variability is driven by wildfires affecting woody biomass in grassland areas. These episodes, although at present occurring erratically, are expected to increase as a result of the climate change.

Figure 6. 12 Trend of emissions (+)/removals (-) in subcategory 4C1 "Grassland remaining Grassland" in EU-KP (kt CO_2)



Methodological issues for Grassland remaining Grassland category

Despite of different eco-regions and management approaches among the countries, Grassland definitions provided by countries show a good match with the IPCC land use definition (Table 6. 21). One of the most significant differences that should be considered when comparing implied emissions factor is the presence or absence of reported unmanaged grassland and the presence or absence of woody vegetation.

In general, there is a wide-spread use of the Tier 1 method for reporting carbon stock changes in living biomass and dead organic matter, which assumes no carbon stock changes for these pools. However, some countries have developed country-specific data and (or) methodologies to assess the changes in these pools (e.g. Italy, Latvia and Sweden). When this is the case, these pools are generally reported as a net sink that is associated with the presence of woody biomass on grassland areas.

Under mineral soils, a significant number of individual submissions have demonstrated that there are no changes over the time in the type of management practices that impact the carbon storage in the soils. In few cases also the absence of managed soils was argued (e.g., Spain, Lithuania). In these cases, quantitative estimates were not provided, and the notation keys were used instead. However, some other countries report this carbon pool by using IPCC methodology, with country-specific or default data.

For those countries that report presence of organic soils areas under managed grassland, this carbon pool is reported as a net source of emissions that result from the oxidation of the soil organic matter (Table 6. 22).

Table 6. 21 Definitions of lands included under the category 4C: Grasslands.

Country	*Definition*
Austria	Meadows cut once/twice/several times, cultivated pastures, litter meadows, rough pastures, alpine meadows and pastures and abandoned grassland.
Belgium	Rangelands and pastureland that is not considered under cropland. It also includes systems with vegetation that fall below the threshold of forest land category and are not expected to exceed it, without human intervention.
Bulgaria	Grassland includes the permanent grasslands – natural meadows, low productive grasslands, permanent lawns and grassland which are not used for production purposes.
Croatia	Grassland includes pastures, land principally occupied by agriculture, with significant areas of natural vegetation, natural grasslands, moors and heathland, sclerophyllous vegetation.
Cyprus	This category includes rangelands and pastureland that are not considered Cropland. It also includes systems with woody vegetation and other non-grass vegetation such as bushes and sclerophyllous vegetation that fall below the threshold values used in the Forest Land category. The category also includes all pastures, natural grassland and scarcely vegetated areas.
Czech Republic	Grassland as defined in this inventory is mostly used as pastures for cattle and meadows for growing feed. Additionally, the fraction of permanently unstocked cadastral FL is also included under Grassland. This is because it predominantly has the attributes of Grassland (such as land under power transmission lines).
Denmark	Land defined as grazing land under LPIS, heath land which may or may not be used for sheep grazing, as well as all other areas not meeting the definitions of forest land. The area of grassland is divided in “grazing land” and “other grassland”.
Estonia	Grassland includes rangelands and pasture, land that is not considered cropland nor forest land: land with perennial grasses that is proper for mow and pasture, smaller fallows and former cultural grasslands that have lost arable land features and grassland from wild lands (natural grassland). Overgrown wooded pasture with canopy cover between 30 and 50% is classified as grassland or forest, depending on the mainland-use purpose. The national land cover class ‘bushes’ (area covered with natural or wildered cultivated bush and shrub species where canopy cover is over 50%) is included into GL.
Finland	Grassland includes areas of extensive grass, ditches associated with agricultural land, areas of bioenergy plants and abandoned arable land. In this context, abandoned arable land refers to fields that are no longer used for agricultural production and where natural reforestation is possible or is already taking place.
France	Land covered by natural and seeded herbaceous for more than 5 years. Includes areas covered trees and bushes being under the forest definition or not included under land category.
Germany	Meadow and pasture areas that cannot be considered cropland. Includes land covered with trees and shrubs that does not fall within the definition of "forest", as well as natural grassland and recreational areas.
Greece	Rangeland and pasture with vegetation that falls below the threshold of national forest definition and are not expected to exceed that without human intervention. Pastures that have been fertilized or sown are considered as cropland.
Hungary	Grassland includes meadows, i.e., land under grass (artificial planting included) where the production is utilized by cutting, irrespective of whether it is used for grazing sometimes, and pasture, i.e., land under grass (artificial planting included) that is utilized for grazing irrespective of whether it is used for cutting sometimes. Grassland includes areas with trees which are utilized for grazing and unmanaged grasslands which are not in use for agricultural purposes.
Ireland	Improved grassland (pasture and areas used for the harvesting of hay and silage) and unimproved grassland (rough grazing) in use as recorded by annual statistics.

Country	***Definition***
Italy	Grazing lands, forage crops, permanent pastures, and set-aside lands since 1970, all shrub lands (data derived from NFI) and other woodlands that do not fulfil forest definition.
Latvia	The grassland category consists of lands used as pastures, as well as glades and bushland which do not fit to forest definition, vegetated areas on non-forest lands complying to forest definition where land use type can be easily switched back to grassland without legal requirement of transformation of the land use, but except grassland used in forage production and extensively managed cropland.
Lithuania	Grassland includes meadows and natural pastures planted with perennial grasses or naturally developed, on a regular basis used for moving and grazing. Grasslands cultivated for less than 5 years, in order to increase ground vegetation, still remain grasslands.
Luxemburg	All grasslands that are not considered as cropland including systems with vegetation or tree cover below forest threshold, natural grassland, recreational areas as well as agricultural systems. It includes one cut meadows; two and more cut meadows, cultivated pastures, litter meadows, rough pastures and pastures and abandoned grassland.
Malta	This category is split into other grassland and maquis. On the basis of expert judgement, it was decided that maquis will be included in this category. The data of this category was derived from the Corine Land Cover 1996, 2000, 2006 under the sclerophyllous vegetation and Grassland.
Netherlands	Under Grassland (non-TOF) any type of terrain which is predominantly covered by grass vegetation is reported. It also includes vegetation that falls below the threshold used in the forest land category and is not expected to exceed the threshold used in the forest land category. It is further stratified in: 'Grassland vegetation', 'Nature', 'Orchards'. Trees outside forests (TOF) are wooded areas that comply with the forest definition except for their surface area (< 0.5 ha or less than 30 m width). These represent fragmented forest plots as well as groups of trees in parks and nature terrains and most woody vegetation lining roads and fields.
Poland	Grassland consists of permanent meadow and pastures include land permanently covered with grass, but does not include arable land sown with grass as part of crop rotation; permanent meadow is understood as the land permanently covered with grass and mown in principle in mountain area; also, the area permanent pastures are understood as the land permanently covered with grass not mown but grazed in principle in mountain area; also the area of grazed pastures and meadows.
Portugal	Lands covered by permanent herbaceous cover.
Romania	Grassland includes land whose destination is grazing or mowing hay for livestock production, as well as other wooded land and trees outside forests (which do not meet forest definition parameters, e.g., forest belts which are narrower than 20m). It includes pastures, hayfields in hilly and mountainous areas and meadows in lowlands.
Slovakia	This category includes permanent grasslands and meadows used for the pasture or hay production, which is not considered as cropland.
Slovenia	Agricultural areas grown by grass and other herbs that are regularly cut or grazed. These areas are not in tillage or fallow ground. Included are areas covered with some of forest trees (less than 50 trees/ha) and the alpine pastures too. In this class there are swamp pastures and meadows on organic or mineral-organic soils, where the groundwater rises few times in the year. It includes also uncultivated agriculture land.
Spain	Pastureland, including grazing land not included in cropland. It includes also pastures and meadows in the dehesa (forested pasture) that do not comply with the definition of forest.
Sweden	Agricultural land that is not regularly tilled. This corresponds to natural grazing land. All grasslands are assumed managed.
United Kingdom	Area classified as following broad habitats: improved grassland, natural grassland, calcareous grassland, acid grassland, bracken, dwarf shrub heath, fen/marsh/swamp, bogs and mountains.
Iceland	All land where vascular plant cover is >20% and not included under the SL, FL, CL or WL categories. This category includes as subcategory land which is being revegetated and meeting the definition of the activity and does not fall into other categories. Drained wetlands not falling into other categories are included in this category. Grassland is represented by five subcategories on the Land use map, i.e. “Other grassland”, “Land re-vegetated before 1990”, “Land re-vegetated since 1990”, “Grassland on drained soils”, and “Natural birch shrubland”.

Table 6. 22 Implied net carbon stock change factors for carbon pools in 4C1 (t C ha-1 yr-1) reported by individual submissions in the GHGI 2021.

Country	Net carbon stock change in living biomass per area (t C/ha)		Net carbon stock change in dead organic matter per area (t C/ha)		Net carbon stock change in mineral soils per area (t C/ha)		Net carbon stock change in organic soils per area (t C/ha)	
	1990	2019	1990	2019	1990	2019	1990	2019
AUT	NA	NA	NO	NO	0,002	0,002	-6,402	#¿NOMBRE?
BEL	NO	NO	NO	NO	0,156	0,182	-1,521	-1,891
BGR	0,003	0,001	NE,NA	NE,NA	-0,024	-0,007	NE	NE
HRV	NO	NO	NO	NO	NO	NO	-2,500	-2,454
CYP	0,241	0,247	NO	NO	NO	NO	NO	NO
CZE	NO	NO	NO	NO	-0,017	0,024	NO	NO
DNM	-0,017	-0,192	NO	NO	IE	IE	-6,602	-6,418
EST	0,008	0,008	NO	NO	NA	NA	-0,279	-0,290
FIN	0,306	0,305	NE	NE	NA	NA	-3,500	-3,500
FRK	-0,007	0,026	NE	NE	0,001	0,000	IE	IE
DEU	-0,015	0,007	NO	NO	0,011	0,008	-7,412	-7,312
GRC	0,000	0,000	NO	NO	NO	NO	NO	NO
HUN	NA	NA	NA	NA	-0,011	0,000	NO	NA
IRL	NO	NO	NO	NO	-0,009	0,141	-4,671	-6,762
ITA	-0,011	0,076	0,004	0,004	-0,004	0,026	2,500	2,500
LVA	0,010	0,092	0,002	0,011	NA	NA	-4,400	-4,400
LTU	NA	NA	NA	NA	NE	NE	IE	IE
LUX	NA	NA	NO	NO	NA	NA	NO	NO
MLT	0,000	0,000	NE	NO,NE	0,307	0,009	NO	NO
NLD	0,008	0,009	NA	NA	0,001	0,003	-4,564	-4,085
POL	NO	NO	NO	NO	-0,042	-0,002	-0,250	-0,250
PRT	NA	NA	NA	NA	NA	0,219	NO	NO
ROU	0,098	0,136	NE	NE	NE	NE	-2,500	-2,500
SVK	NA	NO	NA	NO	NA	NA	NO	NO
SVN	-0,082	0,226	-0,018	0,061	-0,006	-0,011	NO	NO
ESP	NE	NE	NA	NA	NE	NE	NO	NO
SWE	0,161	0,186	0,139	0,185	0,012	-0,333	-1,364	-1,648
GBR	0,015	-0,001	NA	NA	0,048	0,154	-0,657	-0,597

Country	Net carbon stock change in living biomass per area (t C/ha)		Net carbon stock change in dead organic matter per area (t C/ha)		Net carbon stock change in mineral soils per area (t C/ha)		Net carbon stock change in organic soils per area (t C/ha)	
	1990	2019	1990	2019	1990	2019	1990	2019
ISL	0,000	0,000	0,000	0,000	0,000	0,000	-5,691	-5,690

6.2.3.3 Land converted to Grassland (CRF 4C2)

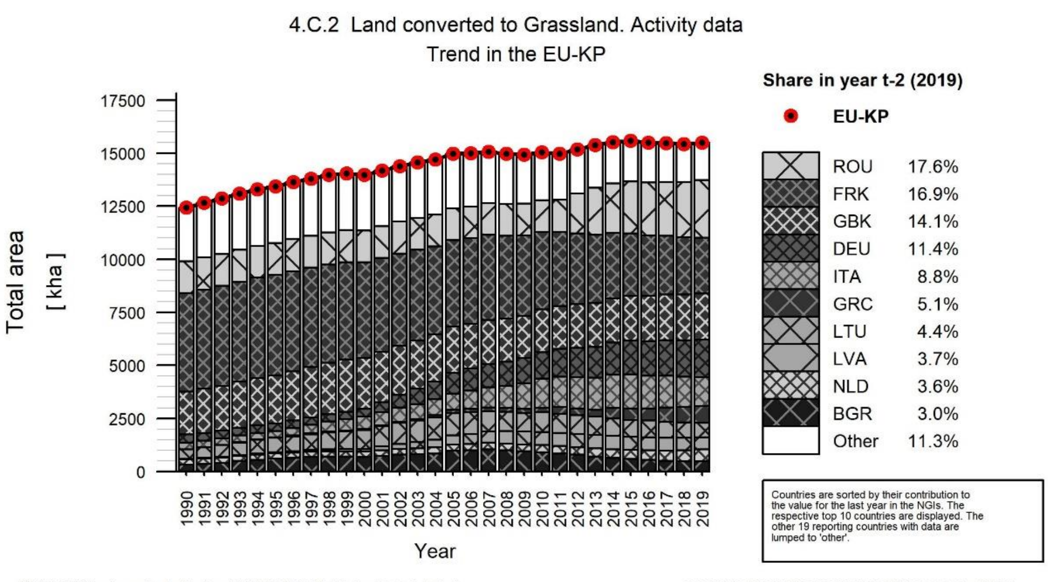
Overview of Land converted to Grassland category.

In terms of area, this subcategory represents 15% of the total grassland areas; however, the carbon sink reported offsets about 70% of the emissions resulting from grassland remaining grassland.

The area reported under this subcategory for this inventory year reaches 15.495 kha, which represents an increase of 24% as compared with 1990 (Figure 6. 13). Main conversions to grassland areas have origin in former croplands and, to a lesser extent, on forests land.

The main drivers of the EU trend on new grassland areas originate from the reporting of Romania, France, UK and Germany, which together report about 60% of the total area converted to Grassland.

Figure 6. 13 Trend of activity data in subcategory 4C2 "Land converted to Grassland" in EU-KP (kha)



In terms of emissions, lands converted to Grassland represent in the current inventory year a total net sink of -25.381 kt CO_2, which corresponds to an increase of about 22% compared to the year 1990 (Table 6. 23).

The trend in GHG emissions for this subcategory is driven by France, which together with Italy and UK report a significant carbon sink on mineral soils a result of the conversion of croplands areas to grassland. By contrary, final net emissions from this subcategory, as it has been reported for several countries (e.g., Romania and Sweden), are associated with emissions from the conversion of Forest land, and to a lesser extent, from woody crops to Grassland.

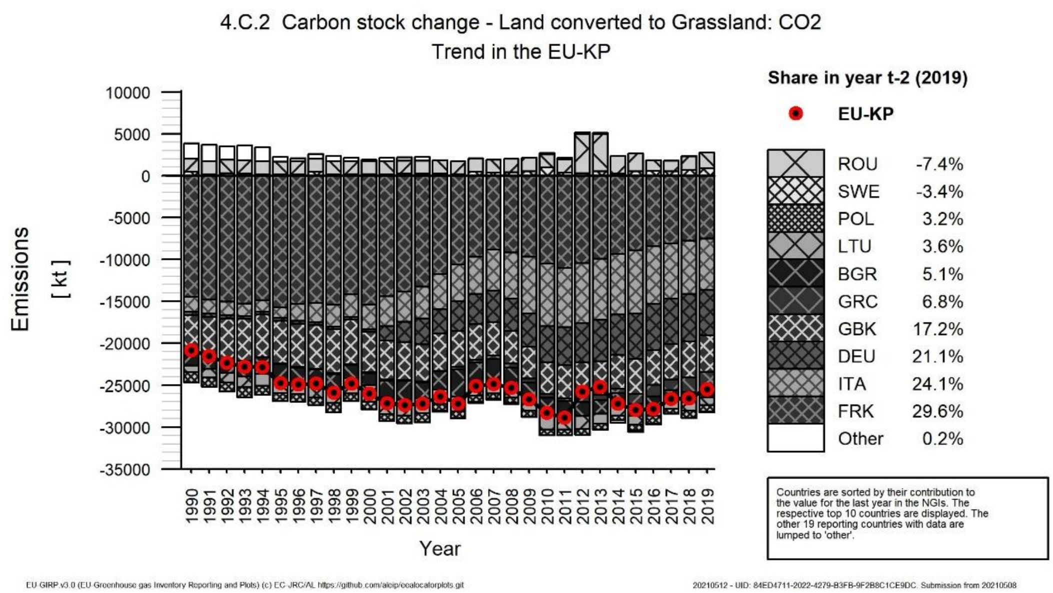
Table 6. 23 4C2 Land converted to Grassland: EU-KP contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	333	-6	-10	0.0%	-343	-103%	-4	-63%
Belgium	48	-336	-361	1.4%	-410	-846%	-25	-7%
Bulgaria	-1 248	-1 215	-1 303	5.1%	-55	-4%	-88	-7%
Croatia	-10	-322	-309	1.2%	-299	-3003%	13	4%
Cyprus	NO,NE	-7	-7	0.0%	-7	-∞	-0.2	-3%
Czechia	-158	-185	-196	0.8%	-38	-24%	-11	-6%
Denmark	56	65	45	-0.2%	-12	-21%	-20	-31%
Estonia	2	38	23	-0.1%	22	1319%	-15	-38%
Finland	170	228	230	-0.9%	60	35%	2	1%
France	-14 484	-7 751	-7 544	29.7%	6 940	48%	207	3%
Germany	-418	-5 640	-5 372	21.2%	-4 954	-1186%	269	5%
Greece	0.03	-1 712	-1 724	6.8%	-1 724	-6145974%	-12	-1%
Hungary	-33	24	-80	0.3%	-47	-142%	-103	-436%
Ireland	3	16	5	0.0%	2	71%	-12	-70%
Italy	-1 754	-6 392	-6 140	24.2%	-4 386	-250%	252	4%
Latvia	8	578	562	-2.2%	554	6742%	-15	-3%
Lithuania	-766	-1 016	-911	3.6%	-145	-19%	105	10%
Luxembourg	22	-41	-40	0.2%	-61	-285%	1	3%
Malta	11	1	0.3	-0.001%	-11	-97%	-0.3	-50%
Netherlands	-310	-220	-271	1.1%	40	13%	-51	-23%
Poland	-1 202	-870	-826	3.3%	376	31%	44	5%
Portugal	3 228	439	428	-1.7%	-2 800	-87%	-11	-2%
Romania	1 598	1 600	1 892	-7.5%	294	18%	293	18%
Slovakia	-206	-115	-119	0.5%	87	42%	-4	-3%
Slovenia	-390	-22	-17	0.1%	373	96%	5	23%
Spain	-2 696	40	169	-0.7%	2 865	106%	129	318%
Sweden	428	661	864	-3.4%	436	102%	203	31%
United Kingdom	-4 752	-4 130	-4 233	16.7%	519	11%	-103	-2%
EU-27+UK	**-22 521**	**-26 291**	**-25 243**	**99%**	**-2 722**	**-12%**	**1 049**	**4%**
Iceland	1 757	-87	-111	0.4%	-1 868	-106%	-24	-28%
United Kingdom (KP)	-4 760	-4 158	-4 260	16.8%	500	10%	-102	-2%
EU-KP	**-20 772**	**-26 406**	**-25 381**	**100%**	**-4 609**	**-22%**	**1 025**	**4%**

Major changes in the time series of emissions from Land converted to Grassland have been reported by Germany, France, Portugal, and Spain, mainly driven by the activity data.

New grassland areas are associated with the abandonment of cropland areas that result in a larger carbon sink reported in mineral soils at the end of the time series as compared with the base year. This is for instance reported by Germany. By contrary, some countries report a significant decrease of the carbon sink in these lands driven by the decrease of these areas but also when they are affected by wildfires in specific years.

Figure 6. 14 Trend of emissions (+)/removals (-) in subcategory 4C2 "Land converted to Grassland" in EU-KP (kt CO_2)



Methodological issues for Land converted to Grassland category.

For estimating and reporting carbon stocks changes in this subcategory, IPCC default methodology is generally used. The implementation of country-specific emission factors or default factors depends on which type of lands are being converted to Grassland, and on the estimated carbon pool. For instance, while some countries only consider a gross quantity of carbon loss from the conversion of forest lands to grassland, some others provide a net estimate on this carbon pool, by also considering one year of growth after the establishment of the grassland.

Usually, it is assumed that the carbon stored in living biomass and dead organic matter is lost in the year of the conversion, while for soil organic carbon in mineral soils, following IPCC methodology, countries often apply a 20 year transition period before the carbon stock of the soils converted to Grassland reach equilibrium.

6.2.4 Wetlands, Settlements and Other land (CRF Tables 4D, 4E, 4F)

6.2.4.1 Wetlands (CRF 4D)

In terms of area, total Wetlands represents 25.647 kha, which is 6% of the total area reported by EU MS, UK, and Iceland together. The category has shown a constant trend of slight increase, resulting in 2% more area in the reporting year, as compared to the base year.

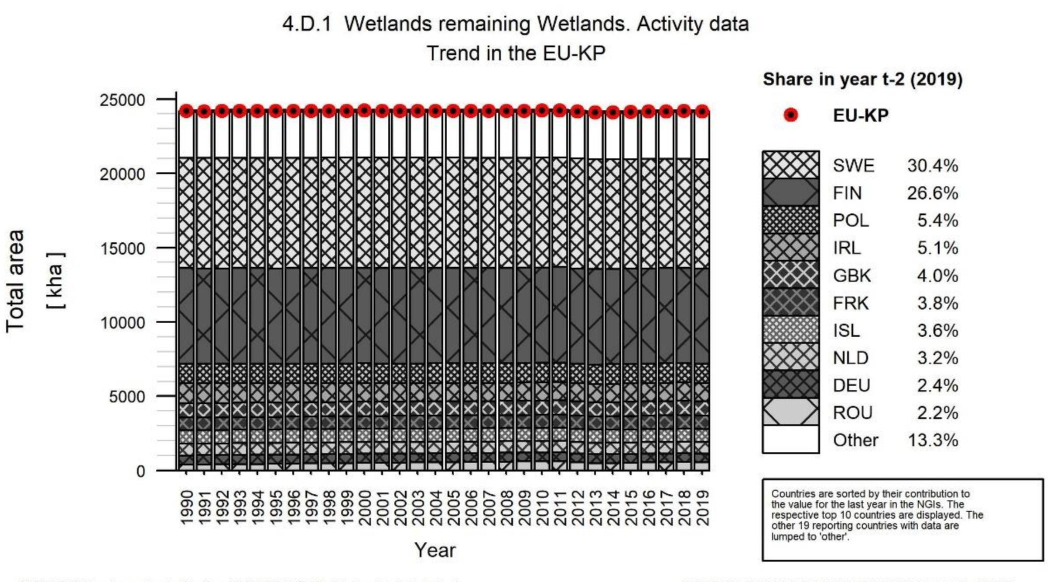
The trend in areas is strongly dominated by Sweden and Finland which, as the other individuals inventories, have reported rather constant values across the time series, and mainly for the dominant subcategory of Wetlands remaining Wetlands (Figure 6. 155).

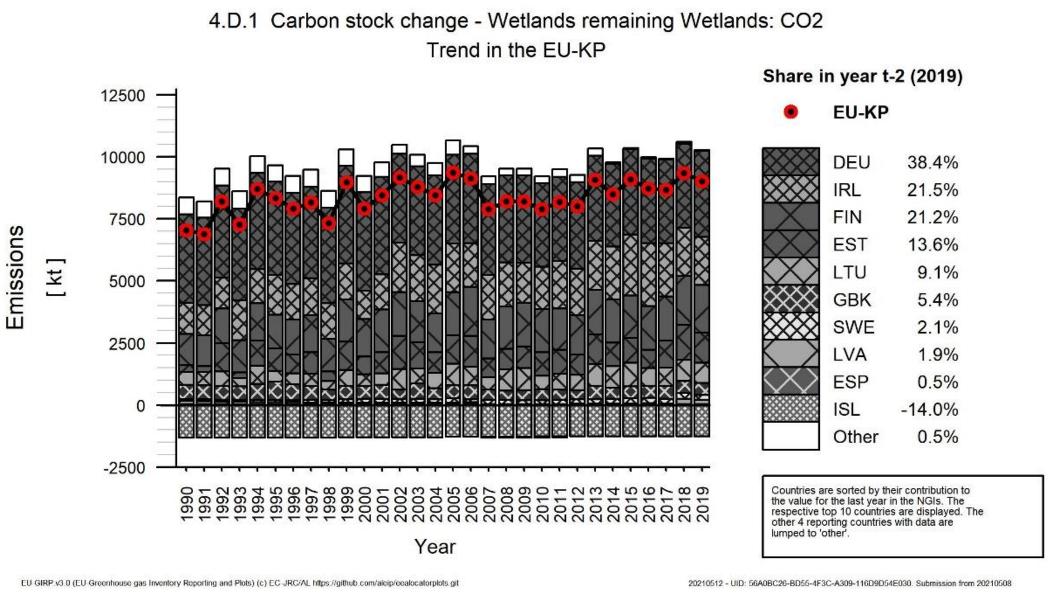
In terms of emissions, Wetlands remaining Wetlands reaches for this inventory year about 9.206 $ktCO_2$. Subcategories, 4D1 and 4D2, have been in overall reported as a net source of emissions, resulting mostly from countries reporting the management of peatland areas. On the other hand, in some countries these subcategories have been also reported as a net carbon sink.

The main driver of emissions is indeed peat extraction, which – even if affecting relatively small areas – has a big impact on the overall emissions. Within the EU, Germany, Ireland, Finland, and Estonia are the main contributors of the emissions from Wetlands remaining wetlands.

By contrary, an exception is represented by Iceland, which under 4D1 reports significant removals from intact mires.

Figure 6. 155 Trend of activity data and emissions (+)/removals (-) in subcategory 4D1 "Wetlands remaining Wetlands" in EU-KP (kha, Kt CO_2)





4.D.1 Carbon stock change - Wetlands remaining Wetlands: CO2
Trend in the EU-KP
Share in year t-2 (2019)
EU-KP
DEU 38.4%
IRL 21.5%
FIN 21.2%
EST 13.6%
LTU 9.1%
GBK 5.4%
SWE 2.1%
LVA 1.9%
ESP 0.5%
ISL -14.0%
Other 0.5%
Emissions
[kt]
Year
Countries are sorted by their contribution to the value for the last year in the NGIs. The respective top 10 countries are displayed. The other 4 reporting countries with data are lumped to 'other'.

Table 6. 24 CO_2 Emissions and removals from 4.D.1 wetlands remaining wetlands contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

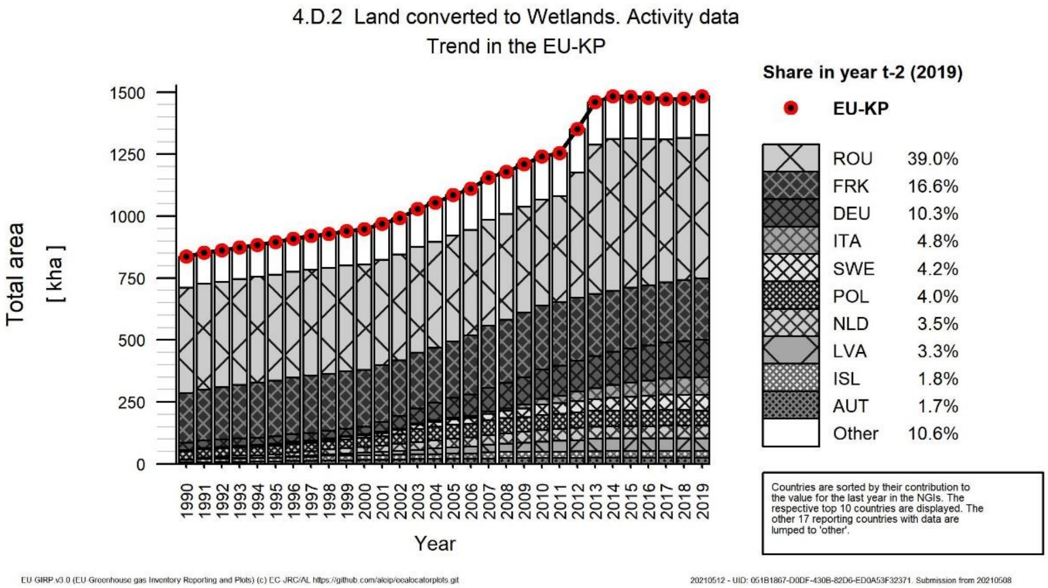
Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	NA	NA	NA	-	-	-	-	-
Denmark	100	53	30	0.3%	-70	-70%	-23	-44%
Estonia	272	1 409	1 229	13.3%	957	352%	-180	-13%
Finland	1 269	1 975	1 914	20.8%	645	51%	-60	-3%
France	NO,NE,IE	NO,NE,IE	NO,NE,IE	-	-	-	-	-
Germany	3 569	3 392	3 459	37.6%	-110	-3%	67	2%
Greece	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Hungary	10	0.1	0.2	0.002%	-10	-98%	0.1	38%
Ireland	1 648	2 221	2 124	23.1%	476	29%	-97	-4%
Italy	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Latvia	131	202	171	1.9%	41	31%	-31	-15%
Lithuania	517	855	817	8.9%	299	58%	-38	-4%
Luxembourg	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Malta	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Netherlands	NO,IE,NA	-2	-2	0.0%	-2	-∞	-0.02	-1%
Poland	578	14	14	0.2%	-564	-98%	-0.1	0%
Portugal	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO,NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
Spain	31	41	41	0.4%	10	34%	0	0%
Sweden	73	230	185	2.0%	112	152%	-46	-20%
United Kingdom	571	495	484	5.3%	-87	-15%	-11	-2%
EU-27+UK	**8 768**	**10 885**	**10 465**	**114%**	**1 697**	**19%**	**-419**	**-4%**
Iceland	-1 324	-1 257	-1 259	-13.7%	65	5%	-2	0%
United Kingdom (KP)	571	495	484	5.3%	-87	-15%	-11	-2%
EU-KP	**7 444**	**9 627**	**9 206**	**100%**	**1 762**	**24%**	**-421**	**-4%**

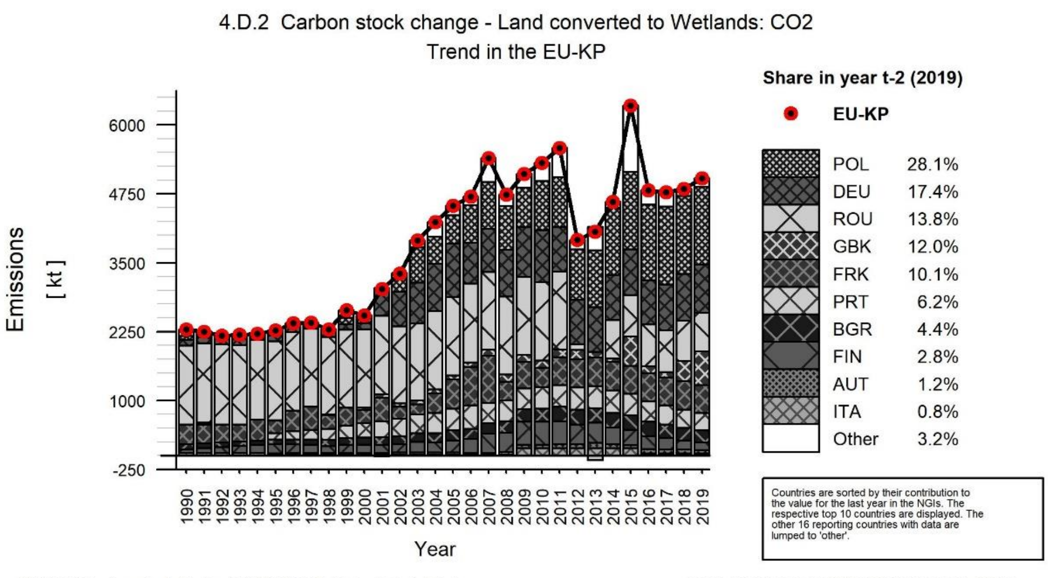
The other subcategory, Land converted to wetlands, represents only 6% of the wetlands area but results in about 37% of the final net emissions reported within the category. For the current inventory year, this subcategory category has reached respectively 1.483 kha, and 5.351 kt CO_2.

The area of land converted to wetlands is dominated by Romania and France. Overall, this area has increased by 72% as compared with 1990, mainly driven by new areas reported by Sweden, Poland, Germany and Italy in the second half of the time series (Figure 6.17).

Nevertheless, these new areas are not always linked to carbon stock changes, as in some cases new wetlans areas are the result of the conversion from Other lands (i.e. no carbon stocks are present in these areas) to Other wetlands (i.e. mires and areas saturated by fresh water).

Figure 6. 16 Trend of activity data and emissions (+) / removals (-) in subcategory 4D2 "Lands converted to Wetlands" in EU-KP (kha, Kt CO_2)





Emissions in this subcategory are mainly reported by Poland, Germany and Romania as a result of the loss of carbon from the living biomass existing in the lands that area converted to wetlands.

Table 6. 25 CO_2 Emissions and removals from 4.D.2 land converted to wetlands contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	42	66	60	1.1%	18	42%	-7	-10%
Belgium	11	-1	-1	0.0%	-12	-112%	-0.1	-6%
Bulgaria	96	233	221	4.1%	125	130%	-12	-5%
Croatia	83	12	12	0.2%	-71	-85%	0.3	2%
Cyprus	-1	-9	NO,NE	-	1	100%	9	100%
Czechia	22	20	22	0.4%	0	-1%	1	6%
Denmark	9	14	14	0.3%	5	55%	1	6%
Estonia	10	15	14	0.3%	4	44%	-1	-7%
Finland	65	166	140	2.6%	74	113%	-26	-16%
France	358	511	511	9.5%	152	43%	-0.2	-0.03%
Germany	100	851	875	16.4%	775	778%	24	3%
Greece	NO	0.21	0.25	0.005%	0.25	∞	0.041	20%
Hungary	3	-4	-4	-0.1%	-7	-236%	-0.4	-12%
Ireland	NO,IE	11	11	0.2%	11	∞	0.1	1%
Italy	NO	40	40	0.7%	40	∞	0	0%
Latvia	0.1	19	19	0.4%	19	15352%	0.3	2%
Lithuania	63	NO,NE	8	0.1%	-55	-87%	8	∞
Luxembourg	15	4	3	0.1%	-12	-78%	-1	-13%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	79	28	27	0.5%	-52	-66%	-1	-5%
Poland	68	1 410	1 413	26.4%	1 344	1974%	2	0.2%
Portugal	NO,IE,NA	332	311	5.8%	311	∞	-21	-6%
Romania	1 434	727	696	13.0%	-738	-51%	-31	-4%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	2.3	2.3	2.2	0.04%	-0.1	-5%	-0.1	-4%
Spain	-167	16	28	0.5%	195	117%	12	70%
Sweden	NO,NA	NO,NA	NO,NA	-	-	-	-	-
United Kingdom	1	556	924	17.3%	923	111216%	368	66%
EU-27+UK	**2 294**	**5 020**	**5 346**	**100%**	**3 051**	**133%**	**326**	**6%**
Iceland	0.5	5.9	5.5	0.1%	5	999%	-0.4	-8%
United Kingdom (KP)	1	556	924	17.3%	923	111216%	368	66%
EU-KP	**2 295**	**5 025**	**5 351**	**100%**	**3 056**	**133%**	**326**	**6%**

Under this category, countries include different lands that are not always subject to management activities. This explains why countries with the largest share on areas not always report the largest emissions. For instance, this happens when areas within wetlands include flooded lands, or other wetlands that are not subject to management activities. Carbon fluxes are not reported in all these areas, mainly due to lack of IPCC methods.

Table 6. 26 Definitions of lands included under the category 4D: Wetlands.

Country	*Definition*
Austria	Rivers, lakes, mires and peat areas (protected areas, in general) as classified by national statistical system.
Belgium	Land covered or saturated by water for all or part of the year (e.g., peatland) and that does not fall into the other land category. It includes reservoirs as a managed subdivision and natural rivers and lakes as unmanaged subdivisions.
Bulgaria	Wetlands category - wetlands surface water areas are included (wetlands) – covered with water or water saturated lands (throughout the year or partially in the year) which does not fall in the other categories. These are natural or artificial watercourses serving as water drainage channels, natural or artificial stretches of water, coastal lagoons, wetlands areas and peatbogs.
Croatia	Inland marshes, salt marshes, salines, intertidal flats, water courses, water bodies, coastal lagoons
Cyprus	This category contains areas of land that is covered or saturated by water for all or part of the year and that does not fall into the Forest Land, Cropland, Grassland or Settlements categories. In particular, it contains inland and salt marshes, water courses and water bodies.
Czech Republic	Category Wetlands includes riverbeds, and water reservoirs such as lakes and ponds, wetlands and swamps.
Denmark	Permanent wetlands, wetlands for peat extraction and re-established anthropogenic wetlands. Several subdivisions may be distinguished: unmanaged fully water covered wetlands (lakes and rivers); unmanaged partly water covered wetlands (fens and bogs); managed drained land for peat extraction; managed partly water covered wetlands (re-established wetlands on primarily former cropland and grassland).
Estonia	Land permanently saturated by water and/or areas where the peat layer is at least 30 cm, and the minimum potential tree height does not conform to the forest land definition. It does include smaller bog holes.
Finland	Inland waters (reservoirs, natural lakes and rivers), peat extraction areas and peatlands which do not fulfil the definition of other land uses.
Germany	Reporting in the wetlands category primarily covers emissions from organic soils that are released during peat extraction, covering: CO_2 losses from extraction areas, and during extraction and spreading of peat. Also, it includes (but they are not estimated) the few non-drained semi-natural bogs that have been largely free of anthropogenic impacts, flooded lands, water-storage facilities (dams, reservoirs, etc.) and settling basins that are used for energy production, irrigation, shipping and recreation, and that are flooded or drained, or that otherwise have large water-level fluctuations.
Greece	Land that is covered or saturated by water for all or the greatest part of the year (e.g., lakes, reservoirs, marshes), riverbed (including torrent beds) and that does not fall into the forest land, cropland, grassland or settlements categories.
France	Lands covered or saturated by water all year long or part of it.
Hungary	Wetland includes the wetlands and water bodies as defined by the CORINE land-cover databases and contain inland marshes (low-lying land usually flooded in winter, and more or less saturated by water all year round), peat bogs (peat land consisting mainly decomposed moss and vegetable matter), water courses (natural or artificial watercourses including those serving as water drainage) and water bodies (natural or artificial lakes, ponds etc.).
Ireland	Natural unexploited wetlands and areas commercially exploited for public and private extraction of peat and areas used for domestic harvesting of peat.
Italy	Lands covered or saturated by water, for all or part of the year, have been included in this category (MAMB, 1992). Reservoirs or water bodies regulated by human activities have not been considered.
Latvia	Wetlands category includes all inland water bodies (rivers, ponds, and lakes), swamps (constantly wet areas where height of trees cannot reach more than 5 m in height and ground vegetation consists mostly of sphagnum and different sword grasses), flood-lands (small areas) and alluvial lands (larger flood-lands).
Lithuania	Wetlands include peat extraction areas and peat lands which do not fulfil the definition of other categories. Water bodies and swamps (bogs) are also included under this category. Peat extraction areas are considered as managed land.

Country	*Definition*
Luxemburg	Land that is covered or saturated by water for all or part of the year (e.g., peat land, reservoirs) and that does not fall into other categories.
Malta	In the Maltese islands wetlands are mostly saline.
Netherlands	Land covered or saturated with water for all or part of the year and does not fall into the other land category. It includes reservoirs as a managed sub-division and natural lakes and rivers as unmanaged, including natural open water in rivers, but also man-made open water in channels, ditches and artificial lakes.
Poland	Wetland consists of marine internal; surface flowing waters, which covers land under waters flowing in rivers, mountain streams, channels, and other water courses, permanently or seasonally and their sources as well as land under lakes and artificial water reservoirs. from or to which the water course flow; land under surface lentic water which covers land under water in lakes and reservoirs other than those described above, land under ponds including water reservoirs (excluding lakes and dam reservoirs for water level adjustment) including ditches and areas adjacent and related to ponds; land under ditches including open ditches acting as land improvement facilities for land used.
Portugal	Inland wetlands, coastal wetlands, salt marshes, saline and intertidal flats.
Romania	Wetlands includes all lands covered by water (rivers, ponds, dams, swimming pools, etc.) and land affected by humidity (caused by water stagnation, marshy areas, etc.), with the exception of agricultural land. It contains two sections (waters and wetlands) and 11 categories (permanent streams, temporary streams, lakes, dams, floating vegetation, hydrophilic vegetation (stubble etc.), harbours, temporarily flooded areas, bogs, channels and piers.
Slovakia	The wetlands include artificial reservoirs and dam lakes, natural lakes, rivers and swamps.
Slovenia	Wetlands are defined as land that is temporarily or permanently saturated by water. Wetlands include lands such as fens, marshes, bogs and reeds and are not under agricultural use. Inland water bodies (major rivers, lakes and water reservoirs) are also part of Wetlands. Although there are small areas of raised bogs, all Wetlands are assumed managed.
Spain	Includes the lands covered or saturated by water all year long or part of it.
Sweden	Wetlands is assumed unmanaged (mires and areas saturated by fresh water) and managed (cca 10 000 ha used for peat extraction).
United Kingdom	Includes reservoirs and peat extraction sites currently registered for commercial extraction where extraction activity is visible on recent aerial/satellite photographs or by field visits. The areas of inland water exceeding 1km2 are included also in this category.
Iceland	All land that is covered or saturated by water for all or part of the year and does not fall into the SL, FL and CL categories. It includes intact mires and reservoirs as managed subdivisions and natural rivers and lakes as unmanaged subdivision. Wetland is in the land use map represented as three classes; “Lakes and rivers”, “Reservoirs”, and “Other Wetland”.

6.2.4.2 Settlements (CRF 4E)

In terms of area, this land use category represents 30.873 kha, which is 7% of the total reported area. For the year 2019, Settlements areas have resulted in an increase of 26 % as compared with 1990.

The expansion of these areas, which generally include urban areas, either paved or unpaved, transport infrastructures, and industrial and commercial units, has been mainly driven by the urban expansion on abandonment of agricultural lands.

In terms of emissions, this land use category is reported as a net source that reaches 45.656 kt CO_2 in 2019. Out of this, 91% are due to emissions resulting from Land converted to Settlement, which although in terms of area represents only 22% of the total category, results in significant emissions when forest, other woody lands, or high-carbon content soils are converted to urban areas.

Definitions of lands included under this category vary across individual inventories (Table 6. 27).

Table 6. 27 Definitions of lands included under the category 4E: Settlements.

Country	*Definition*
Austria	Includes buildings land: sealed, partly sealed and unsealed areas; parks and gardens; roads and railway tracks; excavation areas, and other not further differentiated settlement area.
Belgium	All developed land, including transportation infrastructure and human settlements of any size (i.e., including roadsides) unless they are already included under other categories.
Bulgaria	The Settlements refer to all classes of urban formation. These are areas that are functionally or administratively associated with public or private land in cities, villages or other settlement types.
Croatia	Continuous and discontinuous urban fabric area, industrial or commercial units, road and rail networks and associated land, port areas, airports, mineral extraction sites, dump sites, construction sites, green urban areas, sport and leisure facilities.
Cyprus	All developed land, including transportation infrastructure and human settlements of any size. In particular, it contains industrial and commercial units, urban areas, port areas, airports, construction, mineral extraction and waste dump sites.
Czechia	Settlements include two categories built-up areas and courtyards and other lands. Other lands include all types of land-use were included with the exception of "unproductive land", which corresponds to category 4.F Other Land. Hence, the Settlements category also includes all land used for infrastructure, as well as that of industrial zones and city parks.
Denmark	Urban cores, industrial areas, roads, high and low build-up areas. Low build-up areas are characterized as single-family houses surrounded by gardens, graveyards, sports facilities, etc. (estimates are reported only for low build-up areas).
Estonia	Built-up areas, with roads, streets and squares, traffic and power lines, urban parks, industrial and manufacturing land, sports facilities, airports, legal waste down points, construction sites and buildings with up to 0.3 ha of garden yard (including permanent greenhouses), and open cast areas (except peat extraction areas) are included into this land-use category
Finland	Combined area of NFI built-up land, traffic lines and power lines. Includes parks, yards, farm roads and barns.
France	Artificialized land (settlements, parks, roads and infrastructure, etc.).
Germany	Open settlement and transport areas.
Greece	Developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other land-use categories.
Hungary	Settlements comprises the urban areas, industrial, commercial and transport units, as well as mines, dump and construction sites and artificial non-agricultural vegetated areas.
Ireland	Urban areas, roads, airports and the footprint of industrial commercial/institutional and residential buildings.
Italy	Artificial surfaces, transportation infrastructures (urban and rural), power lines and human settlements of any size, comprising also parks.
Latvia	According to national definitions settlements include land under buildings including yards and gardens as well as land necessary to maintain and to access those buildings; land under roads including buffer zones; forest infrastructure excluding ditches and other wetlands, but including seed orchards, forest nurseries and firebreaks; other infrastructure – buffer zones of industrial networks, quarries etc.
Lithuania	All urban territories, power lines, traffic lines and roads are included under this category as well as orchards and berry plantations planted in small size household areas and only used for householders' meanings.
Luxemburg	Developed land, including transportation and any size of human settlement unless already included under other category.

Country	*Definition*
Malta	The land-use category Settlements includes all classes of urban tree formations, namely trees grown along roads and streets, in public and private gardens, and in cemeteries, airports, construction sites, dumpsites, industrial or commercial units, port areas and sport and leisure facilities.
Netherlands	Developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories.
Poland	Settlements consists of: residential areas include land not used for agricultural and forest production, put under dwelling buildings, devices functionally related to dwelling buildings (yards, drives, passages, playgrounds adjacent to houses), as well as gardens adjacent to houses; industrial areas include land put under buildings and devices serving the purpose of industrial production; other built-up areas include land put under buildings and devices related to administration; undeveloped urbanised areas include land that is not built over, allocated in spatial management plans to building development and excluded from agricultural and forest production; recreational and resting areas comprise the following types of land not put under buildings; areas of recreational centres,. children playgrounds, beaches, arranged parks, squares, lawns (outside street lanes); areas of historical significance: ruins of castles, strongholds, etc.; sport grounds: stadiums, football fields, ski-jumping take-offs, toboggan-run, sports rifle ranges, public baths etc.; area for entertainment purposes: amusement, grounds, funfairs etc.; zoological and botanical gardens; areas of non-arranged greenery, not listed under woodlands or land planted with trees or shrubbery; transport areas including land put under: roads; stopping yards next to railway stations, bus stations and airports, maritime and river ports and other ports, as well as universal accesses to unloading platforms and storage yards; railway grounds; other transport grounds.
Portugal	Includes all artificial territories, including cities and villages, industry, roads and railway, ports and airports.
Romania	Settlements has 3 groups (urban/rural, buildings and infrastructure) and includes: fenced and constructed areas, sealed lands (e.g., car parks, roundabouts, platforms), urban/rural lawns, playgrounds in green areas, beach lawn and other areas with lawn, dwellings, industrial and administration buildings (e.g., banks, churches, railway stations, restaurants), warehouses, huts, ruins, greenhouses, graveyards, dirt roads, trails, rail roads and roads (street, sidewalk, square), bridges and dams.
Slovakia	The settlements include all developed land, including transportation infrastructure and human settlements of any size.
Slovenia	Settlements are all piece of land where the buildings, roads, parking places, mines, stone pits and all other infrastructure are in human use.
Spain	All developed land, transport infrastructure and establishments of any size, unless they are included in other categories.
Sweden	Infrastructure such as roads and railways, power lines, municipality areas, gardens and gravel pits.
United Kingdom	Covers urban and rural settlements, farm buildings, caravan parks and other man-made built structures such as industrial estates, retail parks, waste and derelict ground, urban parkland and urban transport infrastructure. It also includes domestic gardens and allotments, linearly arranged landscape features such as hedgerows, walls, stone and earth banks, grass strips and dry ditches.

Country	*Definition*
Iceland	All areas included within map layers “Towns and villages” and “Airports” as defined in the IS geographical database. Also included as Settlement are roads classified with 15 m wide road zone, including primary and secondary roads. Roads within forest land are excluded as road zone does not reach 20 m. Settlement is in the land use map represented as two classes; “Settlements towns” and “Settlements other”.

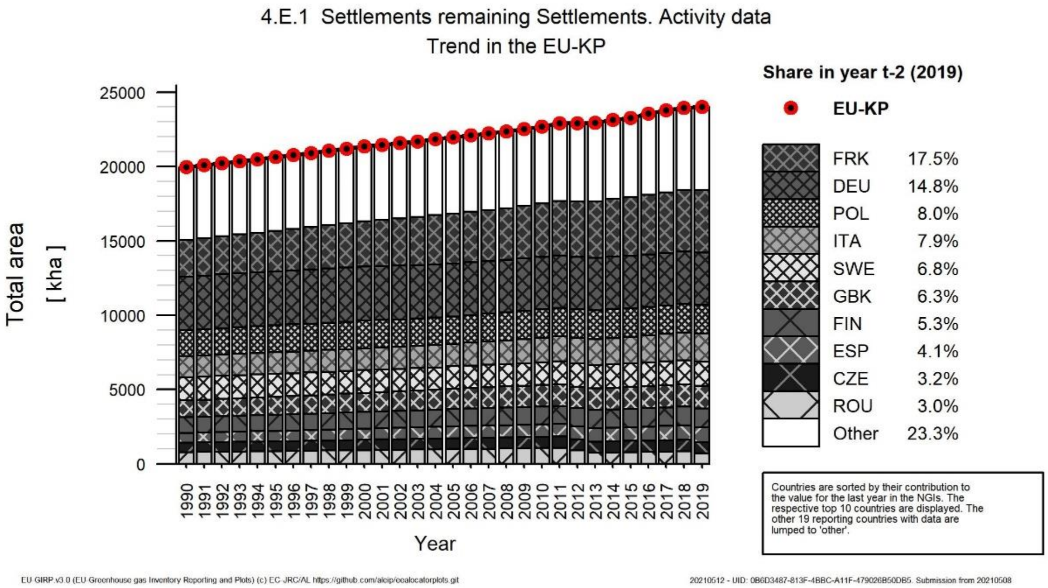
As regards the methods used for reporting carbon stock changes in these areas, often countries used the Tier 1 assumption of equilibrium under the subcategory 4E1, therefore no carbon stock changes are reported, and notation keys are accordingly included in the CRF tables.

Nevertheless, a few countries have reported this subcategory as a net source of GHG emissions. For instance, Germany, France, and Netherlands have reported emissions as a result of disturbed organic soils in these areas, while UK reports emissions from disturbed mineral soils.

By contrary, Latvia, Poland and Slovenia have reported the subcategory 4E1 as a net sink of carbon due to carbon accumulation from living biomass on green urban areas (Figure 6. 17; Figure 6. 18).

A particular case is Latvia that reports a remarkable increase in the sink of this category in 2012. It is explained because carbon stock changes in living biomass and dead organic matter for different land use categories are calculated using the most recent available national forest inventory data “floating NFI cycle” and then with average values used for different periods. The increase of carbon stock in living biomass in settlements reflects an increase of age and gross increment of trees growing on settlements, as well as increased area of settlements covered by woody vegetation. Reduction of increment in 2017 is a result of changes in age structure of woody vegetation, caused by more intensive extraction of trees in settlement areas such as roadsides, buffer zones of drainage ditches and other settlements. The losses due to extraction of wood in settlements are accounted using instant oxidation method due to lack of knowledge about further use of biomass.

Figure 6. 17 Trend of activity data and emissions (+)/removals (-) in subcategory 4E1 "Settlements remaining Settlements" in EU-KP (kha, kt CO_2)



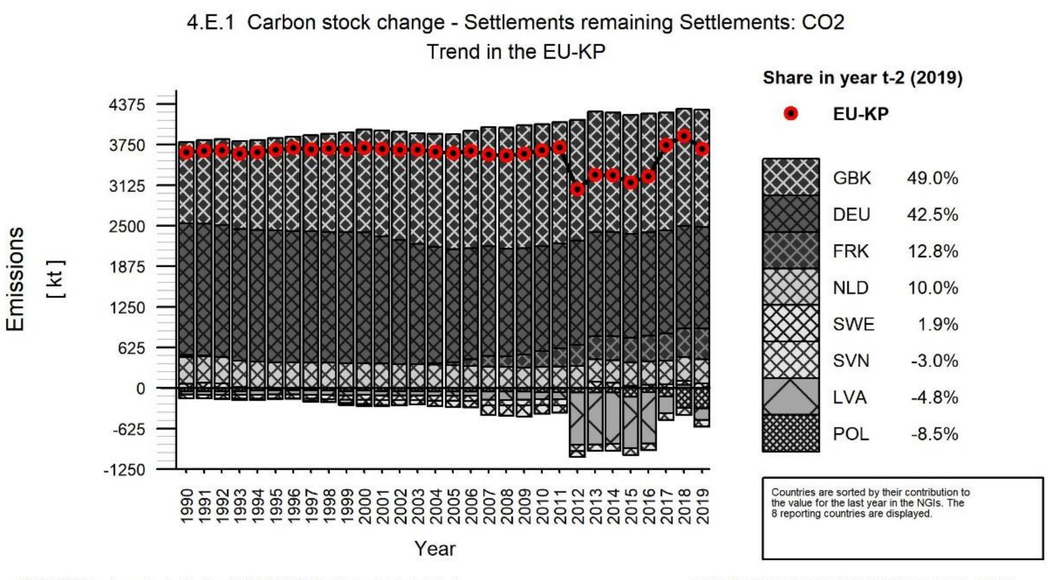
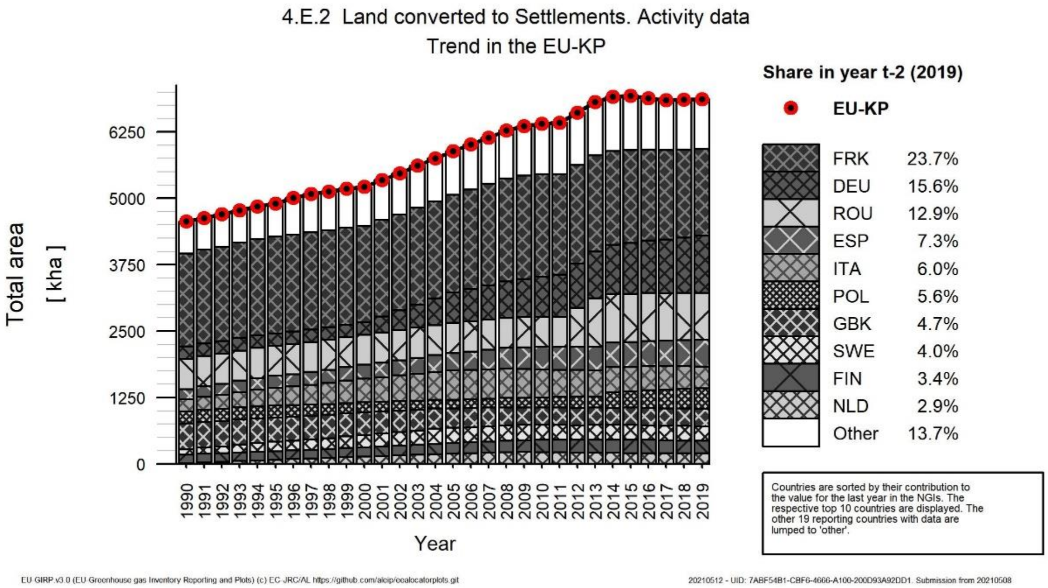
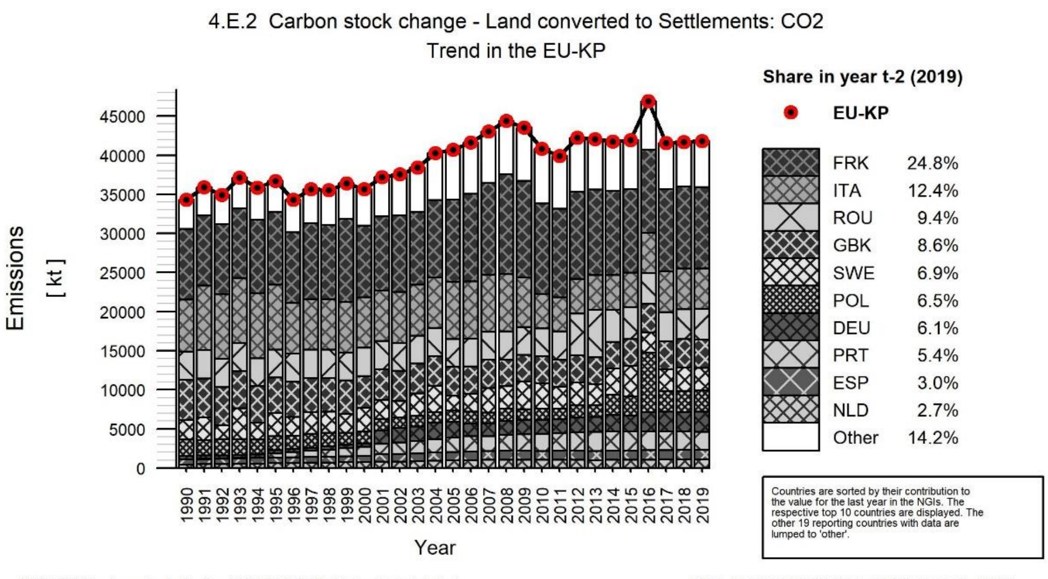


Figure 6. 18 Trend of activity data and emissions (+)/removals (-) in subcategory 4E2 "Land converted to Settlements" in EU-KP kha, kt CO_2)





As regards the subcategory 4E2, annual emissions from Land converted to Settlements have increased by 22% since 1990 (Table 6. 28). For the year 2019 this subcategory was reported as a net source of emissions, reaching 41.830 kt CO_2.

Emissions are mainly the result of disturbed mineral soils and loss of carbon from living biomass when forests are converted to urban areas (e.g., France, Italy, Romania and UK). In fact, the conversion of forests to Settlements is an important component of the total deforestation. It represents around 30% of total area reported as deforested; and 15% of the Land converted to

Settlements. While conversions to Wetland or Other land may be caused by natural effects, a conversion to Settlement is always, by definition, the result of human actions.

When a land is converted to Settlements, carbon pools are not uniformly disturbed over the whole area. For instance, usually only part of the converted area is paved, trees or upper soils layer is removed, and carbon stored in dead organic matter and soil organic matter diminish significantly. To address this issue, carbon stock changes associated with these deforestation events are reported using country-specific data and approaches.

Table 6. 28 4E2 Land converted to Settlements: EU-KP contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	392	292	307	0.7%	-85	-22%	15	5%
Belgium	143	540	520	1.2%	377	263%	-20	-4%
Bulgaria	428	587	737	1.8%	308	72%	149	25%
Croatia	251	675	679	1.6%	428	171%	4	1%
Cyprus	2	20	20	0.0%	18	1044%	0	0%
Czechia	271	122	134	0.3%	-137	-51%	12	10%
Denmark	428	212	206	0.5%	-222	-52%	-6	-3%
Estonia	NO	365	338	0.8%	338	∞	-27	-7%
Finland	848	782	662	1.6%	-186	-22%	-120	-15%
France	9 067	10 495	10 367	24.8%	1 300	14%	-129	-1%
Germany	392	2 478	2 554	6.1%	2 163	552%	76	3%
Greece	50	132	129	0.3%	79	159%	-3	-2%
Hungary	109	164	281	0.7%	172	158%	116	71%
Ireland	80	94	129	0.3%	49	61%	36	38%
Italy	6 640	5 187	5 195	12.4%	-1 445	-22%	8	0.1%
Latvia	81	720	751	1.8%	670	827%	30	4%
Lithuania	16	677	719	1.7%	703	4372%	43	6%
Luxembourg	142	55	52	0.1%	-90	-63%	-3	-6%
Malta	6	1.0	0.8	0.0%	-5	-87%	-0.2	-20%
Netherlands	431	1 093	1 109	2.7%	678	157%	16	1%
Poland	2 126	2 714	2 722	6.5%	596	28%	8	0%
Portugal	30	2 320	2 274	5.4%	2 244	7359%	-46	-2%
Romania	3 606	3 846	3 932	9.4%	326	9%	85	2%
Slovakia	96	81	83	0.2%	-13	-14%	2	2%
Slovenia	361	194	183	0.4%	-177	-49%	-11	-6%
Spain	657	1 235	1 249	3.0%	592	90%	14	1%
Sweden	2 497	3 021	2 886	6.9%	389	16%	-135	-4%
United Kingdom	5 040	3 532	3 541	8.5%	-1 498	-30%	10	0%
EU-27+UK	**34 189**	**41 636**	**41 760**	**100%**	**7 570**	**22%**	**123**	**0%**
Iceland	16	6	6	0.0%	-11	-64%	0	0%
United Kingdom (KP)	5 123	3 597	3 606	8.6%	-1 517	-30%	9	0.2%
EU-KP	**34 289**	**41 708**	**41 830**	**100%**	**7 541**	**22%**	**122**	**0%**

Major changes in the time series in Land converted to Settlements have been reported by Lithuania and Portugal, driven by the activity data. And, specifically for an increase in the conversion of areas that has associated large carbon stocks and therefore more carbon is lost from their conversions.

Noteworthy is also Poland, which reports for the year 2016 a significant increase of emissions from 4E.2 that is reflected in the overall trend of the LULUCF sector at EU level. Such increase results from significant conversion of forest lands used for expanding infrastructures required to support the growing population.

For reporting carbon stock changes in dead organic matter, it is generally assumed that all the carbon stock in the pool is instantaneously oxidized in the moment of conversion from Forest land to Settlements. It is also assumed that there is no dead wood and litter on Settlements. Emissions are estimated based on average carbon stock per area of these carbon pools, determined either at national or regional scale or specific to each deforestation site.

For reporting soil organic matter, different assumptions have been implemented by MS. These are generally based on expert judgment or, occasionally, on scientific studies. For instance, in Sweden the carbon stock in Settlements is estimated as the weighted average of carbon stocks in two strata: unpaved and paved. Unpaved area is usually considered to cover 40-60% of national settlements area (e.g. Austria, Luxembourg), going down to 2-3% in other cities (i.e. Bulgaria). Associated carbon stocks are derived from one of the following options (depending on MS):

- data from measurements in green area of the city (from scientific studies);
- same carbon stock as under 'GL remaining GL' (assuming that under national circumstances GL is the source of land for Settlement's expansion);
- lowest carbon stock value among the major land categories Forest land, Cropland and Grassland (assuming limited change of carbon stock in the soil under construction);
- applying a factor against carbon stock in previous land use (e.g., constant loss of 50%).

6.2.4.3 Other land (CRF 4F)

The land use category Other land reached in this reporting year 15.552 Kha, which represents about 3% of the total reported area. This land use category has been reported rather constant across the time series because of the balance among the decrease in the subcategory 4F1 and the increase in the subcategory 4F2 (Figure 6. 19).

The largest areas under the category 4F1 are reported by Sweden and Iceland, while new Other lands areas in the subcategory 4F2 are mainly reported by Portugal, France and Bulgaria, although without a common pattern on the origin of these lands.

In terms of emissions, inter-annual variations at EU level are due to Portugal, Bulgaria and Ireland.

In the case of Portugal, emissions/removals are dominated by the trend on activity data. Cropland and Grassland are the main categories being converted to Other Land. However, the Forest land category also plays an important role at the beginning of the time series. Consequently, this category is reported as a net source of emissions for the years 1990, 1991 and 1992 due to the loss of carbon in living biomass, and then as a net sink of carbon, which increases until 2009 and then decreases, following the trend in agricultural areas under conversion. The net sink is the result of abandonment of agricultural areas that resulted in net carbon accumulation in soils under Other Land.

Noteworthy is the case of Ireland, which reports for the year 2006 significant emissions from Forest land converted to Other land. This is due to a former area of peat extraction (pre-1990) that was abandoned and then (since 1990) classified as forest. Subsequently, a dump was built on the land, and the area was reclassified as Other land. Ireland has informed that a process is ongoing to improve the reporting of these areas.

Finally, Poland calculates the area in this category as the difference of the area of all land-use categories and the whole area of the country, thereby intending to avoid double accounting or omission of areas. Due to the land representation system, the year 2000 represents a change in the land use matrix. Starting from that year, Poland reports a leap on activity data of "Land converted to Other Land" that is reflected in the EU trend.

Definitions of Other land are close to each other among countries and overall match the IPCC general description (Table 6. 29). In most of the cases, following the IPCC approach, this category is used to ensure that the total area reported under LULUCF remains constant along the time series, and matches official country area. To this aim, this land category is on a lower level of hierarchy and includes all the areas that were not identified under any other land use category, and that are in all cases considered unmanaged. Following a recommendation from the ERT the definitions of the category have been updated to better reflect lands that are included in the category. Furthermore, following a recommendation of the previous ERT, Finland, UK and Portugal confirmed that all the areas included in this category are unmanaged.

As regards Finland, which includes under this category "mineral soils on poorly productive forest lands", it should be noted that such lands correspond with a national category definition of its national forest inventory that are unmanaged. Those areas do not fulfil the threshold values for Forest Land and do not meet the criteria for any other land use category; therefore these lands are included into the Other land category following the 2006 IPCC.

In the case of UK, this category is defined as areas that do not fall into the other land use categories. These areas contain unmanaged lands that include inland rock, standing water, and canals, rivers and streams broad habitat types that do not fall under Wetland category.

A particular case is given by Portugal that included shrubland areas under this category. This country-specific definition, although different to the one provided by IPCC, is consistently applied across the time series. Portugal provided in its NIR specific information on this land use category and on the methods used to estimate carbon stock changes in these areas. Although Portugal plans to move shrubland areas under the land use category Grassland in the next submission, as an interim solution this year the carbon stock changes from Other land remaining Other land were included in land converted to Other land in order to ensure the completeness of the inventory. Portugal has further informed that once the change is implemented, Grassland will contain 2 sub-categories: pastures and shrubland. For this submission, Portugal stated that new 2018 and 2015 land-use maps and revisions of the maps for 1995, 2007, 2010 from their National Cartography Authority (DGT) are ready and that a revision of the full time series of land-use changes will be carried out. As part of this task the relocation of shrubland from “Other land” to “Grassland” will be implemented in next submission.

Table 6. 29 Definitions of lands included under the category 4F: Other lands.

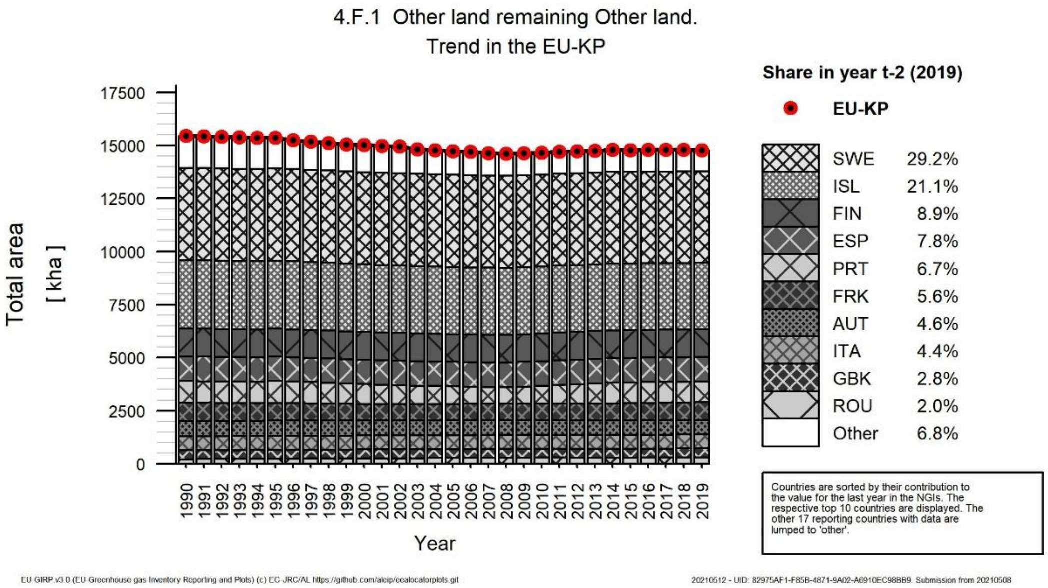
Country	Definition
Austria	Area with i) rocks and screes, ii) glaciers and iii) unmanaged alpine dwarf shrub heaths. It is calculated as the difference of total country area and all other land uses, showing max 2% difference by relevant cadastral data.
Belgium	Bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories.
Bulgaria	Other land category includes bare soil, rock and all area that do not fall into any of other five land-use categories.
Croatia	Other land category represents a difference between the total area of Croatia and sum of all other land use categories.
Cyprus	Bare soil, rock, beaches, dunes and sand plains and all land areas that do not fall into any of the other five categories.
Czech Republic	Other land is not represented by any land use category within the Czech conditions and the national system of land use representation and land use change identification.
Denmark	Unmanaged area like moors, fens, beaches, sand dunes and other areas without human interference.
Estonia	Land areas that do not fall into any of the other five land-use categories.
Finland	Mineral soils on poorly productive forest land, which do not fulfil the threshold values for forest, unproductive lands on mineral soils on rocky lands and treeless mountain areas.
France	All lands that do not correspond to any other land use categories (e.g., rock areas). Other lands (flush rocks, etc.) cover around 0.9 million hectares, and are the lowest source of emissions due to low soil disturbance. This is land with no significant carbon stock, neither in soils nor in biomass.
Germany	Waste and swaths/aisles, glacier areas, scree slopes and sand bars and other land which cannot be allocated under other land categories. "Other land" consists of areas that are neither influenced nor cultivated by people.
Greece	All land areas that do not fall into any of other land-use categories (e.g., rocky areas, bare soil, mine and quarry land).
Hungary	Other Land includes comprises any area not included in another categories.
Ireland	Residual lands that are determinate when all other land use areas have been determined.
Italy	Other Land includes comprises any area not included in another categories. It is included to match overall consistency of country land area.
Latvia	According to the national land use statistics other lands include unmanaged lands, wetlands and settlements (1 459.3 mill. ha in 2008). Instead of the official statistics since 2009 the NFI is used to estimate area of other lands. It is assumed that other lands are dunes not covered by woody vegetation.
Lithuania	All other land which is not assigned to any other category such as quarries, sand - dunes and rocky areas is defined as Other land.
Luxemburg	This category includes bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area.
Malta	This category includes bare soil, rock, and all unmanaged land areas that do not fall into any of the other five categories. Mineral extraction sites in Malta are included under this land-use category.
Netherlands	Surfaces of bare soil which are not included in any other category like: bare sands and the earliest stages of succession from sand in the coastal areas (beaches, dunes and sandy roads) or uncultivated land alongside rivers. It does not include bare areas that emerge from shrinking and expanding water surfaces (which are included in wetlands).

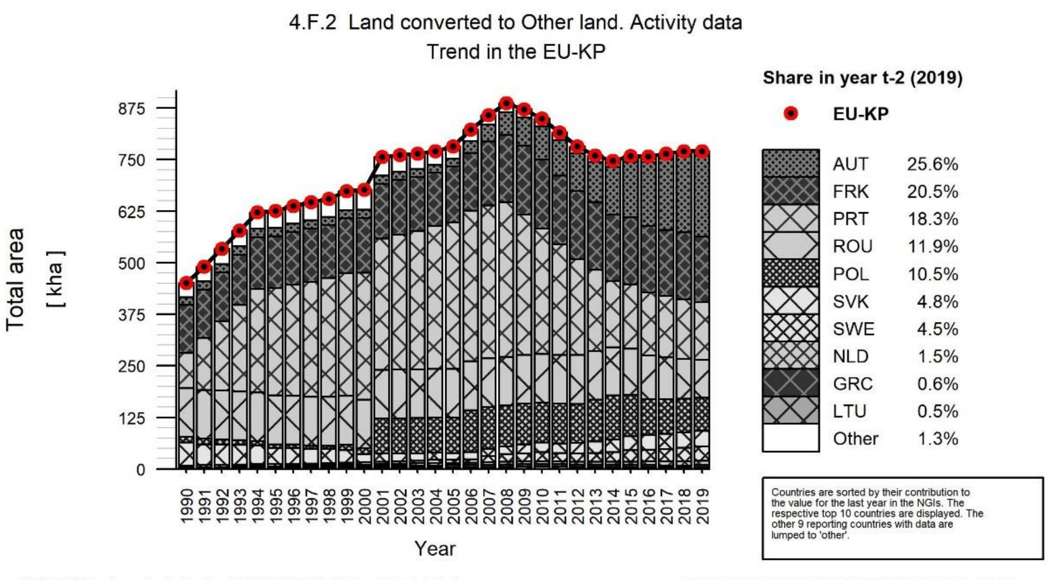
Country	Definition
Poland	Other Land includes comprises any area not included in another categories. It is included to match overall consistency of country land area.
Portugal	Shrubland - includes all lands covered in woody vegetation that do not meet the forest or permanent crop definitions and Other land - includes all lands that do not meet the previous definitions, such as lands covered in rocks, sand dunes, etc.
Romania	Other land includes following categories: rocky areas, excavations, stone quarries (active, closed), stony debris, gravel/sand/earth pits, drilling perimeters and locally degraded lands.
Slovakia	Other land represents bare soil, rock and all unmanaged land areas that do not fall into any of the other categories.
Slovenia	Other land includes non-forest land covered with vegetation lover than 2 m or covered less than 75%, which is not used in agriculture. There are inbuilt areas with little or no vegetation as rocks, sands, sand banks (bigger than 5000 m2), waste and other opened areas. This is all land that is not classified in other land use definitions.
Spain	Bare soil, rock areas, ice and other areas of land that do not fall into any of the other land category.
Sweden	Waste land and most of the mountain area in northwest Sweden. It is assumed unmanaged.
United Kingdom	For pre-1980 Other Land is the sum of the bare rock, sand/shingle, inland water and coastal water land. For Post-1980, Other Land contains the inland rock, standing water and canals and rivers and streams.
Iceland	Other Land is defined as areas that do not fall into the other land use categories. Other Land contains the inland rock, standing water and canals and rivers and streams broad habitat types in the Countryside Survey (Jackson, 2000). Areas of inland water exceeding 1km2 are included in 4D Wetlands, but water bodies below this threshold would still be included under Other Land.

In terms of emissions, Other land represents a net source resulting from the conversion from other categories to Other land. It reaches 486 kt CO_2 for the year 2019.

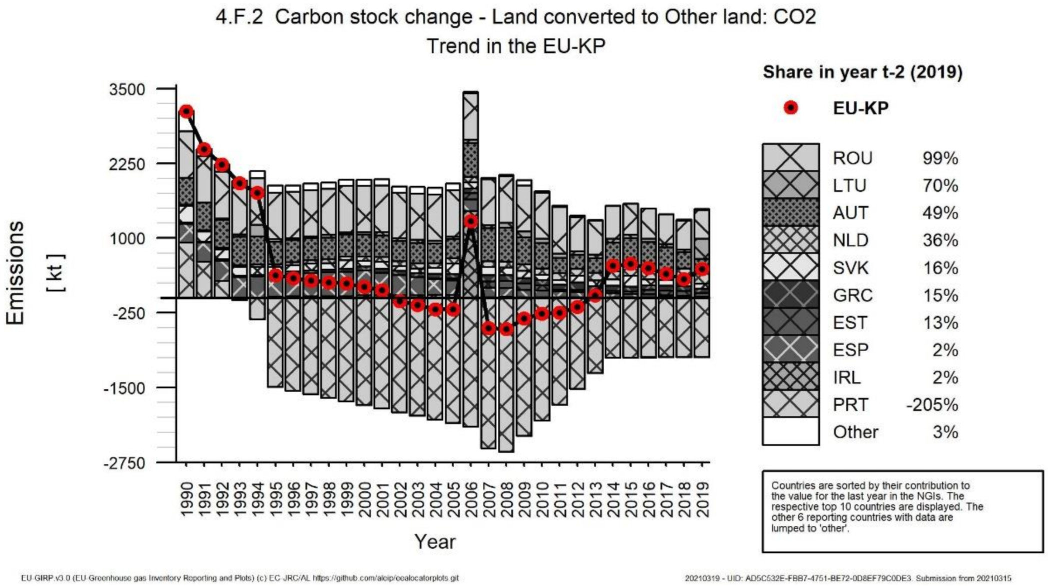
Countries generally report emissions as a result of carbon oxidation from living biomass and soils when lands are converted to Other land. However, some have also reported a net sink of carbon in mineral soils following such conversions. As explained above, this is the case of Portugal that reports all the carbon pools as being a net sink under 4F.2 due to the woody biomass that is presented in this category according with the country's own national definition.

Figure 6. 19 Trend of activity data in subcategories 4F1 and 4F2 “Other land remaining Other Land” and “Land converted to Other land” in EU-KP (kha, kt CO_2)





igure 6. 20 Trend of emissions (+)/removals (-) in subcategory 4F2, "Land converted to Other lands" in EU-KP (kt CO_2)



6.2.5 Harvest Wood Products (CRF 4G)

6.2.5.1 Overview of the Harvest Wood Products category

This carbon pool covers emissions and removals from carbon stock changes in harvested wood products (HWPs). The net contribution of this pool is the result of the annual carbon inflow to the pool (i.e., gains), and carbon outflow from the pool (i.e., losses).

According to the 2006 IPCC guidelines, HWPs includes all wood material (including bark) that leaves harvest sites, where this removal is initially counted as a loss of carbon from living biomass. Slash and other material left at harvest sites should be regarded as dead organic matter in the associated land use category and not as HWP. The inflow of biomass into the HWPs is counted as a gain in the HWPs category.

HWPs represent at the level of EU MS, UK, and Iceland a net carbon sink of -40.412 kt CO_2 in the current inventory year. Most of the countries reported this carbon pool as a net sink; however, Cyprus, Belgium, Netherlands, and Luxembourg estimated that HWPs resulted in a net source of emissions for the inventory year.

The main contributors to the carbon sink are Sweden, Poland, Germany, Romania and Finland.

Belgium, that in previous submissions reported only HWPs from 2000 onwards, has increased the accuracy and consistency of the reporting of this pool covering the whole time series as requested by the ERT.

The methods and data sources for estimating carbon stock changes in HWPs are consistent with methodologies provided by 2006 IPCC GL. Individual inventories implemented the IPCC

Approach B (i.e., production approach) to provide estimates on HWPs consistently with the reporting of the carbon pool under the KP reporting.

Countries reported carbon stock changes in HWPs considering individual estimates for the semi-finished wood products categories of (i) Solid wood, disaggregated into Sawn wood and wood panels, and (ii) Paper and paperboard. To this aim, the IPCC default half-life values have been used by all individual inventories.

A particular case is given by Malta that has stated that carbon stock changes in HWPs pool, as considered under the Approach B, do not exist, as commercial logging does not occur in its territory.

With regards to the activity data, most of the MS have based their estimates on the information provided by the FAOSTAT database, the TIMBER database of the United Nations Economic Commission for Europe (UNECE, 2011), national statistics when available, or, in specific cases, on information collected by surveying wood industries.

Table 6.29 4G Harvest Wood Products: contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2	%	kt CO2	%		
Austria	-3 122	-1 969	-1 481	3.7%	1 641	53%	488	25%	T3	CS,D
Belgium	-1 522	56	64	-0.2%	1 586	104%	8	15%	T2	D
Bulgaria	-583	-1 339	-1 339	3.3%	-755	-130%	0	0%	T2	D
Croatia	-302	-746	-722	1.8%	-421	-140%	24	3%	T2	D
Cyprus	3	24	24	-0.1%	21	628%	0	-1%	NA	NA
Czechia	-1 713	-1 473	-1 506	3.7%	207	12%	-33	-2%	T1,T2	D
Denmark	-2	-130	-335	0.8%	-332	-13942%	-205	-158%	-	-
Estonia	-156	-1 095	-1 015	2.5%	-858	-549%	80	7%	T2	CS,D
Finland	-2 952	-4 582	-3 373	8.3%	-422	-14%	1 208	26%	T2	CS,D
France	-5 100	-914	-768	1.9%	4 332	85%	146	16%	T3	CS
Germany	-1 330	-5 930	-4 151	10.3%	-2 820	-212%	1 780	30%	CS,T2	D
Greece	-349	-32	-31	0.1%	318	91%	1	4%	NA	NA
Hungary	-335	-331	-282	0.7%	53	16%	48	15%	T2	D
Ireland	-413	-826	-618	1.5%	-205	-50%	208	25%	T2	D
Italy	-388	156	-1 799	4.5%	-1 411	-364%	-1 955	-1252%	T2	CS
Latvia	-166	-2 036	-2 080	5.1%	-1 913	-1152%	-44	-2%	T2	CS
Lithuania	-253	-935	-808	2.0%	-556	-220%	126	14%	T1,T2	D
Luxembourg	2	7	6	0.0%	4	205%	-1	-11%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	-163	118	111	-0.3%	274	168%	-6	-5%	T1	D
Poland	-459	-4 789	-4 680	11.6%	-4 221	-919%	109	2%	T2	D
Portugal	-1 674	-44	-104	0.3%	1 570	94%	-60	-134%	D	D
Romania	-817	-4 038	-3 854	9.5%	-3 037	-372%	184	5%	T1	D
Slovakia	-470	-889	-645	1.6%	-174	-37%	244	27%	T2	CS,D
Slovenia	-67	-126	-253	0.6%	-186	-277%	-127	-101%	D,T1	D
Spain	-2 020	-2 748	-2 191	5.4%	-171	-8%	557	20%	T2	D
Sweden	-4 815	-5 936	-6 362	15.7%	-1 547	-32%	-426	-7%	T3	D
United Kingdom	-2 095	-2 195	-2 223	5.5%	-128	-6%	-27	-1%	CS,T3	CS
EU-27+UK	**-31 260**	**-42 742**	**-40 412**	**100%**	**-9 152**	**-29%**	**2 330**	**5%**	**-**	**-**
Iceland	NO,NA	0	0	0.0%	0	-∞	0	81%	D	D
United Kingdom (KP)	-2 095	-2 195	-2 223	5.5%	-128	-6%	-27	-1%	CS,T3	CS
EU-KP	**-31 260**	**-42 742**	**-40 412**	**100%**	**-9 152**	**-29%**	**2 330**	**5%**	**-**	**-**

6.2.6 LULUCF – non-key categories

In this section, a general overview of emissions and removals for non-key categories is provided.

Table 6. 30 Aggregated GHG emission from non-key categories in the LULUCF sector

EU-KP	Aggregated GHG emissions in kt CO_2 eq.			Share in sector 4. LULUCF in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 eq.	%	kt CO_2 eq.	%
4.A Forest Land: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	2 036.3	1 530.2	1 569.1	-0.62%	-467	-23%	39	3%
4.A Forest Land: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	353.5	479.0	493.6	-0.19%	140	40%	15	3%
4.A Forest Land: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	5 003.1	4 930.9	4 941.1	-1.94%	-62	-1%	10	0%
4.A.1 Forest Land: Land Use (CH_4)	1 754.8	983.6	1 123.4	-0.44%	-631	-36%	140	14%
4.A.1 Forest Land: Land Use (N_2O)	828.5	489.7	630.4	-0.25%	-198	-24%	141	29%
4.A.2 Forest Land: Land Use (CH_4)	113.1	26.6	27.6	-0.01%	-86	-76%	1	4%
4.A.2 Forest Land: Land Use (N_2O)	542.9	498.3	498.6	-0.20%	-44	-8%	0	0%
4.B Cropland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	1 090.9	920.1	918.2	-0.36%	-173	-16%	-2	0%
4.B Cropland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	4 001.7	3 575.1	3 567.9	-1.40%	-434	-11%	-7	0%
4.B.1 Cropland: Land Use (CH_4)	89.3	70.4	71.3	-0.03%	-18	-20%	1	1%
4.B.1 Cropland: Land Use (N_2O)	56.3	47.7	47.9	-0.02%	-8	-15%	0	1%
4.B.2 Cropland: Land Use (CH_4)	57.9	54.6	54.7	-0.02%	-3	-5%	0.1	0%
4.B.2 Cropland: Land Use (N_2O)	4 015.3	3 984.5	4 099.0	-1.61%	84	2%	114	3%

EU-KP	Aggregated GHG emissions in kt CO_2 eq.			Share in sector 4. LULUCF in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 eq.	%	kt CO_2 eq.	%
4.C Grassland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	4 475.4	4 580.9	4 586.0	-1.80%	111	2%	5	0%
4.C Grassland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	1 447.4	1 486.6	1 488.2	-0.58%	41	3%	2	0%
4.C Grassland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	57.6	29.5	28.2	-0.01%	-29	-51%	-1.2	-4%
4.C.1 Grassland: Land Use (CH_4)	851.1	160.6	243.4	-0.10%	-608	-71%	83	52%
4.C.1 Grassland: Land Use (N_2O)	424.9	223.4	251.6	-0.10%	-173	-41%	28	13%
4.C.2 Grassland: Land Use (CH_4)	44.4	40.7	38.7	-0.02%	-6	-13%	-2	-5%
4.C.2 Grassland: Land Use (N_2O)	280.8	211.1	204.1	-0.08%	-77	-27%	-7.1	-3.3%
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	5 490.4	5 658.6	5 671.6	-2.23%	181	3%	13	0.2%
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	1 922.3	1 926.4	1 629.1	-0.64%	-293	-15%	-297	-15%
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	155.3	188.6	187.5	-0.07%	32	21%	-1	-1%
4.D.1 Wetlands: Land Use (CH_4)	66.9	47.9	31.6	-0.01%	-35	-53%	-16	-34%
4.D.1 Wetlands: Land Use (N_2O)	20.1	14.4	9.5	0.00%	-11	-52%	-5	-34%
4.D.2 Wetlands: Land Use (CH_4)	6.9	23.2	33.2	-0.01%	26	382%	10.0	43%
4.D.2 Wetlands: Land Use (CO_2)	2 294.7	5 025.4	5 351.0	-2.10%	3 056	133%	326	6%
4.D.2 Wetlands: Land Use (N_2O)	65.7	99.3	103.1	-0.04%	37	57%	4	4%
4.E Settlements: Biomass Burning (CH_4)	52.6	163.1	70.9	-0.03%	18	35%	-92	-57%
4.E Settlements: Biomass Burning (CO_2)	46.4	684.1	140.8	-0.06%	94	203%	-543	-79%
4.E Settlements: Biomass Burning (N_2O)	2.9	8.2	8.3	0.00%	5	183%	0	1%

EU-KP	Aggregated GHG emissions in kt CO_2 eq.			Share in sector 4. LULUCF in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 eq.	%	kt CO_2 eq.	%
4.E.1 Settlements: Land Use (CH_4)	45.1	40.0	39.9	-0.02%	-5	-12%	-0.2	0%
4.E.1 Settlements: Land Use (CO_2)	3 631.8	3 886.5	3 684.8	-1.45%	53	1%	-202	-5%
4.E.1 Settlements: Land Use (N_2O)	106.3	160.2	160.3	-0.06%	54	51%	0.0	0%
4.E.2 Settlements: Land Use (CH_4)	2.8	27.6	29.7	-0.01%	27	945%	2	8%
4.E.2 Settlements: Land Use (N_2O)	3 849.5	4 484.2	4 481.1	-1.76%	632	16%	-3	0%
4.F.2 Other Land: Land Use (CO_2)	3 118.5	316.7	486.4	-0.19%	-2 632	-84%	170	54%
4.F.2 Other Land: Land Use (N_2O)	0.1	0.01	0.01	0.00%	-0.1	-93%	-0.004	-40%
4.F.3 Other Land: Direct N_2O Emissions from N Mineralization/Immobilization (N_2O)	614.0	1 168.9	1 183.0	-0.46%	569	93%	14	1%
4.F.4 Other Land: Biomass Burning (CH_4)	137.2	56.1	50.6	-0.02%	-87	-63%	-5	-10%
4.F.4 Other Land: Biomass Burning (N_2O)	22.5	9.2	8.3	0.00%	-14	-63%	-1	-10%
4.G Atmospheric Deposition: Land Use (N_2O)	-	-	-	-	-	-	-	-
4.G Nitrogen Leaching and Run-off: Land Use (N_2O)	-	-	-	-	-	-	-	-
4.H Other LULUCF: Land Use (CH_4)	12.9	231.6	231.5	-0.09%	219	1688%	0	-0.1%
4.H Other LULUCF: Land Use (CO_2)	0.0	52.4	45.7	-0.02%	46	100%	-7	-13%
4.H Other LULUCF: Land Use (N_2O)	249.9	248.8	249.1	-0.10%	-1	0%	0	0%

6.2.7 **Other sources of emissions: Tables 4(I)-4(V)**

6.2.7.1 Direct nitrous oxide (N_2O) emissions from nitrogen (N) inputs to managed soils (CRF Table 4(I))

Under CRF table 4(I) countries reports N_2O emissions resulting from the addition of organic and inorganic fertilizers to managed soils under land use categories other than Cropland and Grassland.

The majority of countries have stated that fertilization is not part of the management practices of forests, while, if any, emissions from the addition of nitrogen inputs in Wetlands, Settlements, or in a few cases also under forests, are reported under Agriculture sector when it is not possible to separate emissions from fertilization among the land use categories. Therefore, under the LULUCF almost all the countries have reported these emissions using the notation key NO or IE (Table 6. 31).

Exceptions are Finland, Sweden, UK that report N_2O emissions under this source category due to forest fertilization. Sweden reports emissions from nitrogen fertilization as a result of nitrogen inputs occasionally applied to increase the wood production in older forests stands. Finland reports also notable emissions in this category as a result of forest growth fertilization and, to a lesser extent, vitality fertilization.

UK reports low emissions in this source as a result of inorganic nitrogen fertilizers applied to forest e.g. during the first rotation on ‘poor’ soils, such as reclaimed slag heaps, impoverished brown field sites and upland organic soils. Iceland reports emissions from fertilization of cultivated forest at the planting stage.

In addition, Ireland reports N_2O emissions resulting from the addition of organic fertilizers in Settlements areas.

Activity data for reporting this source of emissions results from national or sectorial statistics (e.g. sales statistics), which provide the total amount and type of fertilizer. Then, the IPCC default value of 0.01 kg N_2O-N/kg N yr^{-1} is usually used to derive N_2O emissions from nitrogen inputs to managed soils.

For this inventory year, this source of emissions reaches 60 kt CO_2 equivalents, which is about 20% less than in 1990.

Table 6. 31 4 LULUCF Direct nitrous oxide (N_2O) emissions from nitrogen (N) inputs to managed soils (kt CO_2 eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Denmark	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Estonia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Finland	21	33	35	58.5%	15	71%	2	6%
France	NO	NO	NO	-	-	-	-	-
Germany	NO	NO	NO	-	-	-	-	-
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Ireland	NO,IE	6	6	9.2%	6	∞	0	0%
Italy	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Latvia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NA,NO	NO	NO	-	-	-	-	-
Netherlands	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Poland	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Portugal	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Romania	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	NO	NO	NO	-	-	-	-	-
Sweden	49	18	18	29.5%	-31	-64%	0	0%
United Kingdom	13	2	2	2.7%	-12	-88%	0	1%
EU-27+UK	**83**	**58**	**60**	**100%**	**-23**	**-28%**	**2**	**4%**
Iceland	NE,IE,NA	NE,IE,NA	NE,IE,NA	-	-	-	-	-
United Kingdom (KP)	13.39	1.62	1.64	2.7%	-11.75	-88%	0.02	1%
EU-KP	**83**	**58**	**60**	**100%**	**-23**	**-28%**	**2**	**4%**

6.2.7.2 Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CRF Table 4(II))

Under CRF table 4(II), CO_2, CH_4 and N_2O emissions and removals from drainage and rewetting and other management of organic and mineral soils areas are reported. However, part of these emissions is already covered under other sectors, so countries need to avoid double counting (e.g., nitrous oxide emissions from drained cropland and grassland soils are covered in the agriculture sector) or they may be reported under other tables within the LULUCF (e.g., CO_2 emissions or removals from drainage of wetlands areas are often already included in CRF tables 4.A to 4.F).

For this year, total emissions from this source reached 25.343 kt CO_2 equivalent (tables 6.34, 6.35 and 6.36) that occurred mostly in organic soils and that are mainly reported by UK, Finland, Sweden, Lithuania and Iceland.

Table 6. 32 4 LULUCF CO_2 Emissions and removals from drainage and rewetting and other management of organic and mineral soils (kt CO_2 eq.)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Belgium	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Bulgaria	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Denmark	180	141	141	2.0%	-39	-22%	0	0%
Estonia	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Finland	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
France	3 266	3 266	3 266	45.5%	0	0%	0	0%
Germany	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Greece	NO	NO	NO	-	-	-	-	-
Hungary	786	177	182	2.5%	-604	-77%	5	3%
Ireland	457	474	468	6.5%	11	2%	-6	-1%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	856	1 579	1 298	18.1%	442	52%	-282	-18%
Lithuania	1 848	1 494	1 488	20.7%	-360	-19%	-6	-0.4%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO,NE,IE	NO,NE,IE	NO,NE,IE	-	-	-	-	-
Poland	NA	NA	NA	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0.02	0.03	0.03	0.0004%	0.01	34%	0	0%
Sweden	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
United Kingdom	),NE,IE,NA	),NE,IE,NA	),NE,IE,NA	-	-	-	-	-
EU-27+UK	**7 393**	**7 131**	**6 842**	**95%**	**-551**	**-7%**	**-289**	**-4%**
Iceland	332	337	337	4.7%	5	2%	1	0.2%
United Kingdom (KP)	),NE,IE,NA	),NE,IE,NA	),NE,IE,NA	-	-	-	-	-
EU-KP	**7 725**	**7 467**	**7 179**	**100%**	**-546**	**-7%**	**-288**	**-4%**

Table 6. 33 4 LULUCF N_2O Emissions and removals from drainage and rewetting and other management of organic and mineral soils (kt CO_2 eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Denmark	27	21	21	0.4%	-6	-22%	0.03	0.2%
Estonia	267	272	272	5.0%	5	2%	-0.1	-0.03%
Finland	2 081	1 955	1 954	36.1%	-127	-6%	-1	-0.03%
France	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Germany	508	521	523	9.7%	15	3%	2	0.3%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	0.14	0.40	0.36	0.01%	0.21	150%	-0.05	-11%
Ireland	103	191	192	3.5%	89	86%	1	0.5%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	541	518	511	9.5%	-29	-5%	-7	-1%
Lithuania	35	36	36	0.7%	1	2%	-0.03	-0.1%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	1	1	1	0.02%	-0.1	-9%	-0.01	-1%
Poland	NA	NA	NA	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	1	1	1	0.01%	0	0%	0	0%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0.0003	0.0004	0.0004	0.00001%	0.0001	34%	0	0%
Sweden	1 121	1 078	1 096	20.3%	-25	-2%	18	2%
United Kingdom	781	803	798	14.8%	17	2%	-5	-1%
EU-27+UK	**5 466**	**5 397**	**5 405**	**100%**	**-61**	**-1%**	**8**	**0.2%**
Iceland	0.1	0.821	0.826	0.02%	1	655%	0.005	1%
United Kingdom (KP)	781	803	798	14.8%	17	2%	-5	-1%
EU-KP	**5 466**	**5 398**	**5 406**	**100%**	**-60**	**-1%**	**8**	**0.2%**

Table 6. 34 4 LULUCF CH_4 Emissions and removals from drainage and rewetting and other management of organic and mineral soils (kt CO_2 eq.)

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	24	24	24	0.2%	0	0%	0	0%
Belgium	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Bulgaria	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Denmark	262	238	239	1.9%	-23	-9%	1	0%
Estonia	66	68	68	0.5%	2	3%	-0.001	0%
Finland	1 529	765	765	6.0%	-764	-50%	0.5	0%
France	57	57	57	0.4%	0	0%	0	0%
Germany	1 605	1 794	1 792	14.0%	187	12%	-2	0%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Ireland	370	391	388	3.0%	18	5%	-3	-1%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	530	744	783	6.1%	253	48%	39	5%
Lithuania	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Poland	NA	NA	NA	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0.0003	0.0004	0.0004	0.000003%	0.0001	34%	0	0%
Sweden	466	442	442	3.5%	-24	-5%	-1	-0.1%
United Kingdom	4 726	4 799	4 813	37.7%	87	2%	14	0.3%
EU-27+UK	**9 634**	**9 321**	**9 371**	**73%**	**-263**	**-3%**	**50**	**1%**
Iceland	3 472	3 381	3 387	26.5%	-85	-2%	6	0.2%
United Kingdom (KP)	4 726	4 799	4 813	37.7%	87	2%	14	0.3%
EU-KP	**13 106**	**12 703**	**12 758**	**100%**	**-348**	**-3%**	**55**	**0.4%**

6.2.7.3 Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils (CRF Table 4(III))

Under CRF table 4(III), direct nitrous oxide emissions from nitrogen mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soils are reported by almost all countries. This indicates significant efforts devoted by countries to increase the completeness of reporting for this source of emissions during the last years.

For this year, net emissions from this source category reached 10.834 kt CO_2 equivalent, which represent an increase of 13% as compared to 1990. Significant emissions under this category are reported by France, Romania, Poland and UK (Table 6. 35) and in most of the cases they were estimated using IPCC methodologies and default emissions factors.

Table 6. 35 Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils (kt CO_2eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	115	114	115	1.1%	1	1%	1	1%
Belgium	5	91	93	0.9%	87	1607%	2	2%
Bulgaria	142	285	278	2.6%	136	96%	-7	-2%
Croatia	47	121	121	1.1%	74	156%	0	0%
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	9	2	2	0.0%	-7	-74%	0	2%
Denmark	44	22	21	0.2%	-23	-53%	-2	-8%
Estonia	0	23	24	0.2%	24	191577%	0.4	2%
Finland	27	31	29	0.3%	3	11%	-1.2	-4%
France	2 224	2 242	2 238	20.7%	13	1%	-4.2	0%
Germany	313	746	763	7.0%	450	144%	16	2%
Greece	1	14	14	0.1%	13	956%	0	-3%
Hungary	22	31	29	0.3%	7	34%	-2	-6%
Ireland	18	191	189	1.7%	171	936%	-1	-1%
Italy	635	426	447	4.1%	-187	-30%	21	5%
Latvia	2	101	110	1.0%	108	4836%	10	10%
Lithuania	74	106	124	1.1%	50	68%	18	17%
Luxembourg	17	9	8	0.1%	-9	-53%	-1	-7%
Malta	1	0	0	0.0%	-1	-55%	0	-5%
Netherlands	77	98	100	0.9%	24	31%	3	3%
Poland	1 869	1 965	1 952	18.0%	83	4%	-13	-1%
Portugal	507	307	298	2.8%	-209	-41%	-9	-3%
Romania	1 305	2 443	2 546	23.5%	1 242	95%	104	4%
Slovakia	75	18	22	0.2%	-52	-70%	4	23%
Slovenia	47	25	24	0.2%	-24	-50%	-1	-6%
Spain	83	128	116	1.1%	33	40%	-12	-10%
Sweden	48	172	171	1.6%	123	259%	-1	-1%
United Kingdom	1 776	999	991	9.1%	-784	-44%	-8	-1%
EU-27+UK	**9 481**	**10 712**	**10 827**	**100%**	**1 346**	**14%**	**116**	**1%**
Iceland	0.07	0.21	0.21	0.002%	0	178%	0	0%
United Kingdom (KP)	1 777	1 006	998	9.2%	-779	-44%	-8	-1%
EU-KP	**9 483**	**10 719**	**10 834**	**100%**	**1 351**	**14%**	**116**	**1%**

6.2.7.4 Indirect nitrous oxide (N_2O) emissions from managed soils (CRF Table 4(IV))

This category covers indirect N_2O emissions from managed soils. Under certain conditions and land use categories, these emissions can be reported under Agriculture sector. Examples of such cases are emissions associated with the addition on nitrogen inputs on Cropland and Grassland or with the mineralization of nitrogen associated with loss of soil organic matter resulting from change of land use or management on mineral soils in Cropland remaining Cropland. Moreover, if the sources of nitrogen cannot be separated in any other way than between cropland and grassland, these emissions were reported under the Agriculture sector.

Therefore, given that according to the CRF table 4 (I) most of the fertilizer are added in Cropland and Grassland areas, and that direct nitrogen emissions are mostly reported so far under Cropland remaining Cropland, an important number of countries have reported in the CRF table 4(IV) the notation key IE (i.e., included elsewhere).

Nevertheless, the completeness reporting of these emissions has also undergone a significant increase in the last year submission following recommendations provided during the EU QA/QC checks.

For this inventory year, indirect N_2O emissions reported under LULUCF reached 1.035 kt CO_2 equivalent (Table 6. 36). These emissions are mainly reported by France, UK and Germany. Others MS have provided for first time also minor quantities of indirect N_2O emissions.

Table 6. 36 Indirect nitrous oxide (N_2O) emissions from managed soils (kt CO_2 eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	13	13	13	1.3%	0.1	1%	0.1	1%
Belgium	1	20	21	2.0%	20	1597%	0.4	2%
Bulgaria	33	77	74	7.2%	41	124%	-2	-3%
Croatia	IE	IE	IE	-	-	-	-	-
Cyprus	NE	NE	NE	-	-	-	-	-
Czechia	2	1	1	0.1%	-1	-74%	0.01	2%
Denmark	IE	IE	IE	-	-	-	-	-
Estonia	0.003	5	5	0.5%	5	191577%	0.1	2%
Finland	2	2	2	0.2%	0	17%	-0.03	-2%
France	498	449	447	43.2%	-51	-10%	-2	0%
Germany	70	168	172	16.6%	101	144%	4	2%
Greece	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Hungary	3	5	4	0.4%	1	35%	-0.2	-5%
Ireland	IE	IE	IE	-	-	-	-	-
Italy	29	14	19	1.8%	-10	-34%	5	33%
Latvia	IE,NA	2	2	0.2%	2	∞	0.2	9%
Lithuania	17	21	22	2.1%	5	30%	0.1	0%
Luxembourg	4	2	2	0.2%	-2	-53%	-0.1	-7%
Malta	IE	IE	IE	-	-	-	-	-
Netherlands	IE	IE	IE	-	-	-	-	-
Poland	IE	IE	IE	-	-	-	-	-
Portugal	20	10	10	0.9%	-11	-53%	-0.2	-2%
Romania	IE	IE	IE	-	-	-	-	-
Slovakia	15	5	5	0.5%	-10	-67%	-0.1	-2%
Slovenia	11	6	5	0.5%	-5	-49%	-0.3	-6%
Spain	3	5	4	0.4%	1	40%	-0.5	-10%
Sweden	8	3	3	0.3%	-5	-63%	-0.001	0%
United Kingdom	404	225	224	21.6%	-180	-45%	-2	-1%
EU-27+UK	**1 133**	**1 033**	**1 034**	**100%**	**-99**	**-9%**	**2**	**0%**
Iceland	IE	IE	IE	-	-	-	-	-
United Kingdom (KP)	404	225	224	21.6%	-180	-45%	-2	-1%
EU-KP	**1 133**	**1 033**	**1 035**	**100%**	**-99**	**-9%**	**2**	**0%**

6.2.7.5 CO_2, CH_4 & N_2O emissions from Biomass Burning (CRF Table 4(V))

This source category covers CO_2, and non-CO_2 emissions from biomass burning because of wildfires and controlled burning, affecting all land use categories.

Following the IPCC approach, many countries that implement the stock-different method to estimate carbon stock changes in forest living biomass use the notation key IE in the CRF table 4(V), so avoiding double counting of CO_2 emissions. In addition, countries have also used the notation keys NO or NA when wildfires or controlled burning have not taken place under certain categories, or NE for those land use categories for which the IPCC does not provide methods. An example is the reporting of emissions from biomass burning in Settlement (e.g., Estonia).

In general, countries informed that controlled burning on managed lands is not a common practice. With few exceptions for confined areas that are reported by Finland, Sweden, and UK in forest lands and, Spain and UK in grasslands. In general, northern countries report generally low emissions from biomass burning (i.e., controlled burning and wildfires).

Methodologies used to report CO_2 emissions from fires are always based on Tier 2 methods by using information on activity data provided by national statistics and country-specific emission factors. By contrary, Tier 1 methodologies are used for estimation of CH_4 and N_2O emissions resulting from fires.

Overall, emissions from biomass burning decreased in 2019 compared to 1990, reaching in this inventory year 6.424 kt CO_2 equivalent (Table 6. 37, Table 6. 38 and Table 6. 39). There was also a considerable decrease in emissions compared with the previous year. The reason is the dramatic number of fires that affected Portugal and to a lesser extent Italy in 2017.

Overall, this source of emissions presents a very variable trend and interannual variability that is related to several factors, in many cases driven by climate conditions. It is well known that the countries that often report the larger quantities of emissions from biomass burning are Italy, France, Spain, and Greece. However, it is remarkable that during the last years more central and northern countries are also reporting significant number of emissions from this source (e.g., Ireland, Germany) as a result of the impact of wildfires in their territories.

Table 6. 37 **CO_2 emissions from Biomass Burning (in kt CO_2)**

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2	%	kt CO2	%
Austria	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Belgium	NO,NE,IE	NO	NO	-	-	-	-	-
Bulgaria	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Croatia	15	11	31	0.8%	16	109%	20	175%
Cyprus	0	7	5	0.1%	4	900%	-2	-29%
Czechia	16	59	62	1.6%	46	288%	4	6%
Denmark	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Estonia	NO,NE,IE	NO,NE,IE	NO,NE,IE	-	-	-	-	-
Finland	0	0	NE,IE,NA	-	0	-100%	0	-100%
France	1 861	168	635	16.4%	-1 226	-66%	467	278%
Germany	NO,IE,NA	545	NO,IE,NA	-	-	-	-545	-100%
Greece	146	12	591	15.2%	445	304%	579	4668%
Hungary	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Ireland	503	395	202	5.2%	-301	-60%	-193	-49%
Italy	5 072	222	509	13.1%	-4 563	-90%	286	129%
Latvia	24	402	117	3.0%	92	379%	-285	-71%
Lithuania	1	1	3	0.1%	2	114%	2	132%
Luxembourg	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Malta	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Netherlands	4	5	5	0.1%	1	27%	0	0%
Poland	107	26	41	1.0%	-66	-62%	15	57%
Portugal	1 723	400	483	12.4%	-1 240	-72%	83	21%
Romania	14	41	77	2.0%	63	462%	36	86%
Slovakia	43	67	125	3.2%	83	195%	58	87%
Slovenia	79	3	12	0.3%	-66	-85%	10	384%
Spain	843	26	105	2.7%	-739	-88%	79	308%
Sweden	NO,IE	NO,IE	NO,IE	-	-	-	-	-
United Kingdom	104	697	875	22.5%	771	744%	177	25%
EU-27+UK	**10 555**	**3 087**	**3 877**	**100%**	**-6 678**	**-63%**	**790**	**26%**
Iceland	IE,NA	IE,NA	IE,NA	-	-	-	-	-
United Kingdom (KP)	107	700	877	22.6%	770	718%	177	25%
EU-KP	**10 558**	**3 090**	**3 880**	**100%**	**-6 679**	**-63%**	**790**	**26%**

Table 6. 38 **CH_4 emissions from Biomass Burning (in kt CO_2 eq.)**

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	0	0	0	0.0%	0	-80%	0	-41%
Belgium	1	NO	NO	-	-1	-100%	-	-
Bulgaria	2	3	13	0.8%	11	451%	10	295%
Croatia	1	1	3	0.1%	1	113%	1	101%
Cyprus	0	1	1	0.0%	0	900%	0	-29%
Czechia	50	22	28	1.6%	-23	-45%	6	26%
Denmark	1	0	0	0.0%	-1	-96%	0	7%
Estonia	0	3	0	0.0%	0	-65%	-3	-96%
Finland	3	1	1	0.0%	-2	-75%	0	-35%
France	920	897	920	52.5%	0	0%	24	3%
Germany	7	104	13	0.8%	6	96%	-90	-87%
Greece	63	19	121	6.9%	59	94%	102	525%
Hungary	23	10	16	0.9%	-7	-29%	6	68%
Ireland	89	70	37	2.1%	-52	-58%	-33	-47%
Italy	1 286	153	181	10.3%	-1 105	-86%	28	19%
Latvia	25	47	19	1.1%	-6	-26%	-28	-60%
Lithuania	3	1	1	0.1%	-2	-63%	0	81%
Luxembourg	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Malta	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Netherlands	0	0	0	0.0%	0	33%	0	0%
Poland	49	18	25	1.4%	-24	-49%	7	38%
Portugal	300	98	98	5.6%	-201	-67%	0	0%
Romania	1	5	8	0.5%	7	462%	4	86%
Slovakia	10	21	25	1.4%	14	143%	4	17%
Slovenia	6	0	1	0.1%	-5	-85%	1	384%
Spain	314	40	152	8.7%	-162	-52%	112	280%
Sweden	2	52	3	0.2%	1	39%	-49	-94%
United Kingdom	17	65	84	4.8%	67	399%	19	29%
EU-27+UK	**3 174**	**1 629**	**1 751**	**100%**	**-1 424**	**-45%**	**121**	**7%**
Iceland	IE,NA	IE,NA	IE,NA	-	-	-	-	-
United Kingdom (KP)	18	66	85	4.8%	67	375%	19	29%
EU-KP	**3 175**	**1 630**	**1 751**	**100%**	**-1 424**	**-45%**	**121**	**7%**

Table 6. 39 **N_2O emissions from Biomass Burning (in kt CO_2 eq.)**

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	0	0	0	0.0%	0	-80%	0	-41%
Belgium	5	NO	NO	-	-5	-100%	-	-
Bulgaria	2	2	9	1.1%	7	451%	7	295%
Croatia	1	1	2	0.2%	1	115%	1	75%
Cyprus	0	0	0	0.0%	0	900%	0	-29%
Czechia	33	15	18	2.3%	-15	-45%	4	26%
Denmark	0	0	0	0.0%	0	-93%	0	7%
Estonia	0	0	0	0.0%	0	-63%	0	-96%
Finland	2	1	0	0.1%	-1	-75%	0	-35%
France	511	423	438	55.3%	-73	-14%	15	4%
Germany	4	7	9	1.1%	4	96%	1	17%
Greece	5	2	10	1.3%	5	94%	8	525%
Hungary	15	6	11	1.4%	-4	-24%	5	78%
Ireland	24	18	11	1.4%	-14	-55%	-7	-41%
Italy	261	12	26	3.3%	-235	-90%	15	124%
Latvia	3	6	2	0.3%	-1	-19%	-3	-57%
Lithuania	3	1	1	0.1%	-2	-68%	0	66%
Luxembourg	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Malta	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Netherlands	0	0	0	0.0%	0	29%	0	0%
Poland	32	12	16	2.1%	-16	-49%	5	38%
Portugal	49	16	16	2.0%	-33	-67%	0	0%
Romania	0	1	3	0.3%	2	462%	1	86%
Slovakia	7	14	16	2.0%	10	143%	2	17%
Slovenia	4	0	1	0.1%	-3	-85%	0	384%
Spain	285	35	141	17.8%	-144	-50%	106	299%
Sweden	0	4	0	0.0%	0	39%	-4	-94%
United Kingdom	15	46	60	7.5%	45	308%	14	31%
EU-27+UK	**1 263**	**623**	**792**	**100%**	**-471**	**-37%**	**169**	**27%**
Iceland	IE,NA	IE,NA	IE,NA	-	-	-	-	-
United Kingdom (KP)	15	46	61	7.6%	45	291%	14	31%
EU-KP	**1 264**	**624**	**793**	**100%**	**-471**	**-37%**	**169**	**27%**

6.2.8 Emissions from organic soils in the EU GHG inventory

Area of organic soils reported by EU MS, UK and ISL under the three main land use categories (i.e., Forest land, Cropland and Grassland) cover about 20.356 kha that are mainly located in northern countries.

Total CO_2 emissions linked to that area in in the inventory year reached 106.584 kt CO_2 (Table 6. 40), which correspond to an amount of about 37% of total EU net removals from LULUCF. Emissions from organic soils in these land categories decreased as compared with 1990. Finland and Sweden report together more than half of the total area of organic soil in these categories.

Organic soils are an important source of emissions when they are under management practices that disturb the organic matter stored in the soil. In general, emissions from these soils are reported using country-specific values when they represent an important source within the total budget of GHG emissions. In contrast, countries with small areas of organic soil often use default IPCC factors to report emissions from this carbon pool.

Overall, among Forest land, Cropland and Grassland, most of the organic soil area is reported under Forest land, although most of the emissions are due to managed organic soils in Grasslands and Croplands (Table 6. 40).

In Finland, organic soil areas are derived from national forest inventory database and a geo-referenced soil database across all land uses. In Sweden, data is also provided by national forest inventory, combined with Swedish Forest Soil Inventory. Emission factors are derived based on field measurements from systematic monitoring system.

Organic soils in Forest land show the lowest values of implied emission factors due to the fact that not the entire area of organic soils under forest land is drained. Positive values of implied emission factor (i.e., removals) under forest organic soils are used by UK that reports a net sink in this pool by using CARBINE model.

Table 6. 40 Area, CO_2 emissions and average implied C stock change factors in the EU MS, UK and Iceland reported for the year 2019 for organic soils.

Land use subcategory	Area (Kha)	ICECF (tC/ha)	Emissions from Org. Soils. (Kt CO_2)
4A1	12 540	[-2.60; 0.18]	13 312
4A2	435		1 636
4B1	1 320	[-10.01; -1.00]	29 680
4B2	273		6 126
4C1	5 434	[-7,30; 2,50]	49 705
4C2	353		6 126

6.3 Uncertainties

For the year 2019, LULUCF uncertainty was estimated in 27.7 % for the uncertainty of the level and 20.3 % for the uncertainty of the trend (0).

For more information on the uncertainty analysis please refer to chapter 1.6.

Table 6. 41 Level and trend uncertainty assessment of the annual EU-KP emission/removal on LULUCF land subcategories and GHG sources.

Source category	Gas	Emissions Base Year	Emissions 2019	Emission trends Base Year-2019	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
4.A Forest Land	CO2	-321 184	-333 585	3.9%	13.5%	0.1%
4.A Forest Land	CH4	1 965	1 696	-13.7%	101.9%	0.2%
4.A Forest Land	N2O	3 572	3 387	-5.2%	97.1%	0.04%
4.B Cropland	CO2	78 674	49 840	-36.7%	61.1%	0.1%
4.B Cropland	CH4	775	649	-16.2%	63.4%	0.1%
4.B Cropland	N2O	3 938	4 177	6.1%	90.3%	0.3%
4.C Grasland	CO2	27 196	4 657	-82.9%	353.8%	0.6%
4.C Grasland	CH4	4 563	4 048	-11.3%	115.4%	0.1%
4.C Grasland	N2O	861	537	-37.7%	81.3%	0.2%
4.D Wetlands	CO2	8 852	13 266	49.9%	59.2%	0.2%
4.D Wetlands	CH4	2 448	2 732	11.6%	55.5%	0.1%
4.D Wetlands	N2O	379	420	11.0%	56.3%	0.1%
4.E Settlements	CO2	36 776	44 108	19.9%	32.6%	0.1%
4.E Settlements	CH4	114	154	35.2%	60.6%	0.2%
4.E Settlements	N2O	3 891	4 336	11.4%	112.4%	0.1%
4.F Other Land	CO2	3 012	470	-84.4%	106.7%	0.1%
4.F Other Land	CH4	137	51	-63.1%	35.7%	0.2%
4.F Other Land	N2O	535	1 129	111.2%	31.8%	0.3%
4.G Harvested wood products	CO2	-31 996	-38 048	18.9%	42.5%	0.2%
4.G Harvested wood products	CH4	0	0		0.0%	
4.G Harvested wood products	N2O	0	0		0.0%	
4.H Other	CO2	0	46		30.4%	
4.H Other	CH4	0	218		100.0%	
4.H Other	N2O	507	490	-3.3%	93.4%	0.1%
4.I	CO2	0	0		0.0%	0.0%
4.I	CH4	0	0		0.0%	0.0%
4.I	N2O	21	35	71.0%	199.4%	1.4%
4.II	CO2	2 180	1 824	-16.3%	54.9%	0.1%
4.II	CH4	5 225	4 350	-16.7%	205.3%	0.2%
4.II	N2O	2 117	1 990	-6.0%	113.4%	0.1%
4.III	CO2	0	0		0.0%	0.0%
4.III	CH4	0	0		0.0%	0.0%
4.III	N2O	80	173	115.1%	652.6%	8.1%
4.IV	CO2	0	0		0.0%	0.0%
4.IV	CH4	0	0		0.0%	0.0%
4.IV	N2O	464	275	-40.6%	164.5%	0.7%
4.V	CO2	57	157	172.6%	116.6%	1.5%
4.V	CH4	15	28	92.8%	42.4%	0.4%
4.V	N2O	78	19	-76.1%	46.3%	0.1%
4 (where no subsector data were submitted	*all*	*248*	*-154*	-162.3%	*201.5%*	*67.9%*
Total - 4	**all**	**-164 503**	**-226 527**	**37.7%**	**27.7%**	**20.3%**

6.4 Sector-specific quality assurance and quality control and verification

6.4.1 Time series consistency

The EU greenhouse gas inventory is compiled rigorously by aggregation of national inventories; thus, its consistency strictly depends on the consistency of the individual inventories.

The time-series consistency is checked every year for each individual submission as part of the quality control procedures implemented under the EU GHG Monitoring Mechanism Regulation[52]. Consistency is checked, in terms of each land use subcategory, and the overall land representation system, across time and space. Ensuring for instance, that the sum of all land use areas is constant over time and matches the official country area. Moreover, there

[52] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0525

are no circumstances that can justify discontinuities of areas across years. Therefore, the area for each land use category, and KP activity, at the end of one year must be the same as the area at the beginning of the next year.

For the sake of consistency, all parameters used to estimate GHG fluxes are checked. In this sense, activity data, implied carbon stock change factors, and emissions or removals reported for each land use subcategory across the years of the time series are checked to discard errors, identify outliers and to ensure the plausibility of their trends.

Countries provide early submissions to the European Commission that is in charge of implementing a set of quality checks aimed to ensure the consistency and completeness, but also to increase the accuracy, transparency, and comparability. For each potential issue identified during this phase, a dialogue is established to discuss the best way to resolve the issue, if any.

One of the key features of the methodologies implemented by national systems is to ensure full consistency in definitions, parameters and datasets used for preparing the entire time series for the LULUCF sector. The main challenge is to ensure consistency when historical data are not fully adequate to fulfill reporting requirements or when data is not available on an annual basis.

Land use definitions are not identical among countries. As shown in the previous chapters, each country has its own definition according with its land representation and data collection systems. However, they all are in accordance with IPCC definitions. Differences are caused by small variations in the treatment of particular lands and are in many cases related to historical definitions and available datasets. Some examples are the different thresholds used to define forest; the categorization of hedges or bush areas under Cropland, Grassland or Forest land; or the inclusion of woody plantations either under Cropland or Forest land.

After all the years of implementing QA/QC procedures and undoubtedly because of the efforts devoted by countries to overcome with the issues, and to improve their inventories in line with the IPCC methods and UNFCCC reporting guidelines, it can be appreciated a substantial improvement on the consistency of the information.

Moreover, every year new projects are launched, and new data is involved to further improve the land representation system and the estimation of carbon stock changes and other GHG emissions that result in recalculations aiming to enhance the reported numbers.

6.4.2 Quality Assurance and Quality Control

Information submitted under the LULUCF sector by EU MS, UK and Iceland are under a double QA/QC system. One implemented at country level, and another one, carried out in the context of the EU GHG Monitoring Mechanism Regulation (MMR), which is performed for this sector by the Joint Research Centre (JRC) of the European Commission in collaboration with countries, the EEA, DG CLIMA and European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM)

Under the MMR, the checks focus on early versions of national GHG inventories that are submitted in January. The checks aim to assess and improve the completeness and consistency, but also the accuracy, transparency, and to the extent possible the comparability. A second round of submissions received in March is also checked in terms of the implementation status of issues previously identified and potential recalculations among the January and March submission.

Ultimately, the checks are intended to identify and resolve calculation errors, to provide suggestions to address completeness issues, to identify the need for further descriptions to amend a lack of transparency, and to spot outliers on time-series consistency and discrepancies among data included on the different sections of the submission. In all the cases, QA/QC procedures are implemented by interacting with national experts to get clarifications and to plan possible improvements.

During the analysis of this year submissions, around 140 findings (i.e. potential issues) were communicated to the countries. Examples of issues include the use and justifications of notations keys, potential inconsistencies in land representation, wrong interpretation of how to fill in the tables, inconsistent reporting of activity data among CRF tables and between CRF tables and NIR, outliers in IEFs values for different categories, and lack of transparency in specific national circumstances that affected the EU trend.

The following list aims to provide an overview of the checks that are implemented on the LULUCF and KP-LULUCF data submitted by countries, but it does not intend to represent an exhaustive description:

1. Completeness check: the use of any notation key “NE”, but also possible inappropriate use of “NA”, “NO”, “IE”, whenever IPCC methods are available, is monitored and followed up with the relevant countries. Furthermore, the check also aims to identify empty cells that should have been filled in with information.
2. Time-series check of activity data information:
    a. The sum of areas reported for each land use category is constant over time.
    b. The feasibility of the time series of area and land use changes occurring in a single year.
    c. The area at the end of the previous year (t-1) matches the area at the beginning of the current year (t).
    d. Check to ensure that only annual land use changes from one year to another are reported in the CRF table 4.1.
3. Time-series check of emissions/removals and implied carbon stock change factors (ICSCF):
    a. Check the feasibility of potential discontinuities in ICSCF and emissions or removals.
    b. Check for outliers in ICSCF and emissions or removals.
    c. Check the coherence of emissions and removals with activity data.
    d. Check the plausibility of constant values of emissions and removals across years.
4. Check the consistency of areas reported across different CRF tables:
    a. The sum of total area reported under the CRF table 4.1 matches the total area reported under the CRF table NIR-2 (using the cell “Other”).
    b. The area reported for each land use category in CRF table 4.1 matches the area reported under the sectorial background data tables (i.e. 4.A-4.F). (**To note**: Despite this check and the recommendation provided by the EU in the context of the QAQC procedures to ensure the consistency among tables, following a recommendation from the 2016 ERT, Estonia is not reporting unmanaged wetlands under “other wetlands” in the CRF table 4.D; however, those areas are included in CRF 4.1. This leads to an inconsistency among the information of these tables that is directly translated to the LULUCF sector of the EU GHG inventory.
    c. The area reported for each KP activity in CRF NIR-2 matches the area reported under the sectorial background data tables (i.e. 4(KP-I) A.1- 4(KP-I) B-5).

5. Check the consistency among LULUCF and Agriculture: Histosols areas reported in Agriculture are equal or less than organic soils areas reported in Cropland plus Grassland (N.B.: organic soils for unmanaged grassland are reported in LULUCF but not in Agriculture)
6. Additional checks implemented on LULUCF and KP-LULUCF information:
   a. Check that adequate information on recalculations is included in the NIR.
   b. Check that FMRL value matches the value inscribed in the appendix to the annex of decision 2/CMP.7.
   c. Check that information on key category analysis is provided. (**To note:** some MS have stated bugs in the CRF Reporter software that prevent the inclusion of this information on the CRF table NIR-3)
   d. Check that the Cap value is included in the Accounting table.
   e. Check that unresolved and partially resolved issues from previous year are addressed.
   f. Check that ERT team's recommendation that concern countries 'submissions are addressed.
   g. Check that HWP information on LULUCF is complete and properly allocated under the correct approach.
   h. Check the coherence among units and activity data used for reporting Biomass burning in CRF table 4(V)

In addition to the routine implementation of QA/QC checks, some additional activities have been implemented during the past years that were meant to improve the quality of both national, and EU GHG inventories, as follows:

- In 2012 an exercise was carried out involving LULUCF reviewers that participate in the UNFCCC review process to assess the reporting of dead organic matter and soils, and identify common issues and alternative solutions. Some decision trees were created and shared with inventory compilers. (E.g. is the "not a source" provision properly applied?)
- In 2014 and 2015 two assessments were carried out to verify data on burned areas reported by individual GHG inventories and those reported in EFFIS[53].
- The JRC have collaborated during the past years, and continues to do so, on several capacity building projects launched by DG CLIMA to support the LULUCF reporting on MS.

Furthermore, with the purpose of enhancing the LULUCF reporting, sharing experiences amongst countries, and the harmonization of methods for estimating GHG emissions and CO_2 removals in the sector, a series of technical workshops dedicated to UNFCCC reporting (including Kyoto Protocol), under the auspices of the Joint Research Center have been organized.

- JRC technical workshop on LULUCF reporting under the Kyoto Protocol 28-29 May 2019, Varese (VA), Italy.
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 16-17 May 2018 Arona (NO), Italy
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 26-27 April 2017 Stresa (NO), Italy
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 02-03 May 2016 Stresa (NO), Italy.
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 26-27 May 2015 Arona (NO), Italy.

[53] http://forest.jrc.ec.europa.eu/effis/

- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 05-07 May 2014, Arona (NO), Italy.
- II JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 04-06 November 2013, Arona (NO), Italy.
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 27 February-1 March 2013, Ispra (VA), Italy.
- "JRC technical workshop on LULUCF issues under the Kyoto Protocol", held in Brussels, November 21, 2011.
- "JRC technical workshop on LULUCF issues under the Kyoto Protocol", held in Brussels, November 9-10, 2010.
- Technical workshop on projections of GHG emissions and removals in the LULUCF sector, Ispra (VA), Italy. 27-28 January 2010.
- Technical workshop on LULUCF reporting issues under the Kyoto Protocol, Ispra (VA), Italy. November 13-14, 2008.
- "Technical meeting on specific forestry issues related to reporting and accounting under the Kyoto Protocol" Ispra (VA), Italy. 27-29 November 2006).
- "Improving the Quality of Community GHG Inventories and Projections for the LULUCF Sector". Ispra (VA), Italy. September 22-23, 2005.

For further information on these workshops and additional activities see: http://forest.jrc.ec.europa.eu/activities/lulucf/workshops/.

6.4.3 Verification

Relatively little information on verification is included in national GHG inventories. For forest land, the JRC has implemented the Carbon Budget Model (CBM), a forest growth model developed by the Canadian Forest Service and adapted to the EU conditions (Pilli et al. 2014[54], Pilli et al. 2016[55],[56]), to estimate carbon stock changes in all forest carbon pools for 26 MS (all EU countries except Malta and Cyprus, and the UK). Overall, at EU level, the results from CBM were very close to the sum of individual inventories (a difference of only 3% for the average sink 2000-2015 in the category "forest land remaining forest land"). However, for few MS the differences were larger and deserve further investigations. The results of this modeling have been offered to MS as a potential verification exercise (see Bulgaria's NIR); in some cases the comparison of model results with GHG inventories resulted in identifying errors in the GHG inventory. It is expected that more comparisons of national GHG inventories with CBM results will be carried out in coming years.

Besides that, a comprehensive analysis of individual submissions has been also carried out in 2015[57]. In this context, some inconsistencies were found that were communicated to concerned country during the 2016 QA/QC process. Finally, the JRC recommended to national LULUCF experts to verify, where available data allow, the gain-loss methodology applied for

[54] Pilli R., Grassi G., Kurz W.A., Smyth C.E. and Blujdea V. (2013). Application of the CBM-CFS model to estimate Italy's forest carbon budget, 1995 to 2020. Ecological modelling. 266, 144-171.

[55] Pilli, R., Grassi, G., Kurz, W., Abad Viñas, R., Guerrero Hue, N. (2016) Modelling forest carbon stock changes as affected by harvest and natural disturbances. I. Comparison with countries' estimates for forest management. Carbon Balance and Management vol. 11 no. 1 p. 5. doi: 10.1186/s13021-016-0047-8

[56] Pilli, R., Grassi, G., Kurz, W., Moris, J., Abad Viñas, R. (2016) Modelling forest carbon stock changes as affected by harvest and natural disturbances. II. EU-level analysis Carbon Balance and Management vol. 11 no. 1 p. 20. doi:10.1186/s13021-016-0059-4

[57] Viorel NB Blujdea, Raúl Abad Viñas, Sandro Federici & Giacomo Grassi (2016): The EU greenhouse gas inventory for the LULUCF sector: I. Overview and comparative analysis of methods used by EU member states, Carbon Management, DOI: 10.1080/17583004.2016.1151504

estimating their forest land with an alternative estimate prepared by applying the stock-difference method, and vice versa.

6.4.4 Improvement status and plan

Improvements and major changes from previous submissions

The following improvements were introduced in the GHGI 2021 to address the recommendations received from the UNFCCC's expert review team (ERT) to correct issues identified during our internal quality control process and/or the results of our internal peer review:

- A revision of the entire chapter has been carried out by a person not involved in its e compilation in order to identify areas for improvements. As a result, some change have been done to increase the readability and clarity of the information.
- More references have been introduced to the work carried out along with countries to address issues identified by the ERT issues. For instance, as requested by the ERT, we have provided explicit information on the reporting of the category of 4.B.2 by Portugal. (section 6.2.2.3) which explain the use of the notation key.
- New and better explanations, when necessary, on the reasons for changes in trends and inter-annual variability of the emissions and removals across the lands use categories have been added in specific sections dedicated to land use subcategories.
- Correction of identified typo errors that were found across the text.
- The use of the notation key NA by Member States for carbon pools considered in balance or equilibriums has been widened. Although it should be noted that some countries have received different recommendation from their own ERT therefore , following their UN ERT decided to do not use the notation key NA.
- Correction of further inconsistencies identified across the activity data reported in CRF tables 4.1 and 4.A-4.F. More improvements are expected on this regard in next submission.
- The improvement plan of Portugal for the reporting of the category 4.F has been tracked and information included in the land use category section.
- More transparent explanations of the planned improvements have been added.
- Romania has recalculated its inventory to avoid the inconsistency generated by the use of new data only for the year 2018.

Planned improvements.

The following improvements are foreseen for next submission:

- Follow up individual submissions to ensure that remaining inconsistencies on areas reported in CRF table 4.1 and 4.A - 4.F that were not resolved this year are addressed.
- Follow up the submission of Portugal to track the planned improvement to be implemented in the reporting of Grassland and Other land (see section 6.2.4.6).
- Follow up the submission of Malta to track the planned improvement to be implemented in the reporting of Forest land. (see section 6.2.1.2)

6.5 Sector-specific recalculations, including changes in response of to the review process and impact on emission trend.

Table 6. 42 to Table 6. 47 provide information on the contribution of EU MS, UK and ISL to the recalculations in sectors 4A, 4B, 4C, 4D, 4E and 4F (all GHGs) for 1990 and 2018 and main explanations for the largest recalculations in absolute terms.

Table 6. 42 4A Forest Land: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
Austria	-16	-0.1	-25	-0.6	Following a recommendation raised during the ESD Review 2020 (EEA 2020), the total forest area (previously rounded to kha) was slightly adjusted so that the net land use changes to/from Forest land (given in ha) exactly fits to the annual change of the Forest land area. Furthermore, an error in the calculation of the soil C losses from the expansion of forest roads was identified and corrected for in this submission. Both recalculations caused a change in the GHG emissions from mineral soil and litter of the remaining Forest land category and consequently led to increased annual net removals in the Forest land category that were about 15 to 26 kt CO_2e larger than those reported in the last submission in 2020.
Belgium	-183	-10.5	-648	-51.8	Flemish region: mainly update of the C-uptake factor during the 15/3 submission (big influence: increase of the sink of -597,79 kt CO_2). Wallonia : Increase of the sink by -50.03 kt CO_2 due to an update of the forest inventory data (central year 2001). Brussels region (-0,05 kt CO_2) due to update of soil carbon content parameter in forest land.
Bulgaria	383	2.2	-812	-10.7	Recalculations in relation to some updates of the information from the activity data. It is about perennial CL area and GL area since 2008. The area of FL-FL was corrected for 2018 due to a found error. Recalculations in estimates of the emissions/removals from dead wood in FL-FL due to refinement of the calculation model. Recalculations in CSC in living biomass pool for subcategory FL-FL.
Croatia	-26	-0.4	-194	-3.6	In this year submission, some recalculations have been done. Corrections in the emissions from biomass was done. On that basis new calculation was performed.
Cyprus	-	-	-0	-0.2	Change of BCEFI (biomass conversion and expansion factor for increment) from 0.645 tC/m3 to the default value 0.450 tC/m3 (Table 6.4.5, p. 4.51, value for Mediterranean, dry tropical and subtropical coniferous forest). Use of interpolated and extrapolated data provided in Table 6.6 to cover the entire period 1990 to the reported year instead of using an average (0.844 m3/ha/yr) for the entire period (coniferous forest). Use of corrected data for area of land remaining in Forest Land category and converted to Forest Land category. The correction reflects the implementation of the rule of 20-year transition period to Forest Land.
Czechia	-1 285	-28.9	-1 701	-23.4	Carbon stock estimate in living biomass was recalculated due to the rectified fraction of additional harvest (Fhl). This estimate of removals of solid wood and forest residues enter the estimation using a partitioning of 50% between the two woody components since this NIR submission. This represents a conservative estimate of extra harvest, which treats more adequately the unaccounted harvest loss, preventing double counting of forest residues associated with the reported harvest volumes from harvest statistics. The impact of this correction on carbon stock change in biomass is 17.4% for the period 1990-2018
Denmark	-709	-123.5	-2 567	-736.0	In this reporting numerous recalculations have been implemented, of which the main relates to the age for land use transition, which has been revised from 20 to 30 years for all sectors.
Estonia	-505	-14.0	829	28.0	Updated activity data and EF-s for soils in FL-FL category; implementation of country-specific BCEFs values

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
Finland	1 135	4.8	2 196	10.9	All carbon stock changes and non-CO_2 emissions for which activity data are areas and are computed from the NFI data were recalculated (4A-4E). New NFI data and new BCEFs were applied to estimate the gains in living biomass. Losses in living biomass were recalculated due to updated statistical data on natural mortality and waste wood and an update of allocation of harvesting between mineral and organic soils. Recalculations in the biomass stocks caused a recalculation to the litter input to soils. The amount of harvested energy wood was reallocated to harvesting years. Gains in living biomass on land converted to forest land were recalculated due to new methodology applied. Losses in living biomass on land converted to forest land were recalculated due to new NFI data.
France	76	0.2	-1 155	-2.3	- Update of the activity data of the database on forest fires in France (BDIFF) for the metropolis - For Guyana, elimination of on-site burning, implementation of a Gains-Losses method on the exploited forest. In mainland France, correction of the expansion factor (for forest biomass) and update of wood energy consumption over recent years.
Germany	49 239	69.1	9 206	13.7	Updated emissions factors for biomass and dead wood Modification of the method for surveying the areas of drainage trenches for organic oil Adaptation of the sample network to determine land use and Land use change
Greece	-	-	-85	-4.0	Activity areas were also updated for year 2018, due to errors in the CRF tables, which in some cases included the same values as 2017 by mistake. Moreover, values regarding HWP were also updated with more recent information from FAO for the years 2017 – 2019
Hungary	-59	-1.7	-0	-0.0	We have done a number of recalculations in the forestry sector to improve the accuracy of our estimates and to correct upload errors. These recalculations for FL-FL and L-FL as well as for the HWP pool, their reason and scale are detailed in Tables 6.5.15, 6.5.16. and 6.5.17., respectively. Note that the scale of difference expressed in percent may be misleading due to the reference which in the case of (gross or net) removals can be close to zero and does not necessarily represent a useful reference for the calculation of percentages.
Ireland	-1	-0.0	-405	-10.6	The area of forest fires was adjusted for the years 1990-2013 and for 2018 and 2019 based on new forest fire statistics. Recalculations for the forest category 4A.2 were due to: • The harvests from 2006-2018 was corrected in the CBM simulation, harvest was previously assigned to incorrect years (i.e. the 2007 harvest was scheduled in 2006 etc). The recalculation results in slightly different allocations of harvest from different species, or between clear fell and thinning, but no differences in the total harvest over the period. The effect of the altered harvest influences stock changes in all C pools, but overall differences in removal was small (a change in net emissions of 0.9 to 13.1%). • Forest fire statistics were revised and used to update forest fire data for the period 2007 to 2018.
Italy	-0	-0.0	649	1.9	Update of activity data (i.e., harvest data and burned areas). Slight recalculation occurs in the 2021 submission, comparing to the 2020 submission, for the forest land remaining forest land and land converted to forest land
Latvia	0	0.0	-607	-14.7	Improvement of activity data.

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
Lithuania	131	1.7	-2 481	-52.0	Extrapolated values for year 2017 were replaced with actual values. Calculation errors in carbon stock changes in living biomass of forest land remaining forest land were corrected as a resulted of additional internal QA/QC procedure. This includes error in growing stock volume changes calculation for year 2016 (which resulted in corrected stock change estimate for subsequent years) and corrected algorithm of total growing stock volume collection from NFI statistics.
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-314	-18.1	-12	-0.7	The data for national round wood harvest and input values for calculation of the Harvested Wood Products have been update. Additionally, the more general methodological change of adding pre 1990 land-use changes (i.e. including the 1970 land use map), has resulted in recalculations in the forest land category for the whole time series 1990-2018.
Poland	-55	-0.2	599	1.6	Update of soil AD for the year 2017-2018
Portugal	81	1.3	-416	-4.7	Recalculations have been made in the input variables: Burnt areas per land-use type 1990-2019, reflecting the latest information provided by ICNF (Institute for Nature Conservation and Forests) Harvest and HWP input data 2012-2019, reflecting the latest version of the UNECE/FAO Timber Products database.
Romania	-6 954	-29.3	-5 870	-28.8	1. Changes have been made in conversion areas, period 2012 - 2019 from forestland use to other land categories as well from other land categories to forestland. This activity affected also the FLFL areas in the time series. FL area was also recalculated, top to bottom to be in alignment with NFI (2012 and 2018) area. 2. Starting with three points in time a linear interpolation of the share of species group, age class, and yield class affected all the time series for the calculation of gain due to the growth of the biomass 3. Different wood density, root to shoot and carbon fraction values have been used for all-time series.
Slovakia	-0	-0.0	-	-	
Slovenia	-292	-6.5	472	66.0	There are two main reasons for the recalculations in the 2021 submission. First, the total forest area was carefully stratified into forest land remaining forest land and land converted to forest land. Sampling plots of the national forest inventory were assigned to each subcategory, and carbon stocks in the living biomass were recalculated accordingly. Based on the carbon stock changes for the 2007-2012 and 2012-201 inventory cycles, new emission factors were calculated for each subcategory. Second, following the recommendation of the ERT, the new BCEF factors were used to convert volume to biomass. The BCEF factors were calculated as the product of basic wood density (D) of each tree species and the biomass expansions factors (BEF) dependent on the growing stock using the equations proposed by Teobaldelli et al. (2009). Recalculations in this category were also made due to the inclusion of two carbon pools, litter and dead wood, in the mass of available fuel in relative to emissions from wildfires (biomass burning), as recommended by the ERT.
Spain	-	-	-106	-0.3	In this edition of the National Inventory, the statistical data (interim) of fires for the years 2016, 2017 and 2018 have been updated, with implications in the emissions and absolute absorptions of the FL category of the LULUCF sector
Sweden	-2 243	-5.9	5 276	11.8	Recalculation due to reassessment of inventory data after adding new sample data (areas, CSC).

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
United Kingdom	982	6.4	928	5.1	Changes to estimate of % area afforested on organic soils over time and areas deforested for rewetting and minor change to the estimate of quantity of deadwood and litter removed on deforested land. Minor changes to activity data based on the latest Forestry Statistics. Addition of estimates of carbon stock change from POC and DOC. Minor changes to wildfires due to conversion from fiscal to calendar year.
EU27+UK	39 386	9.9	3 072	0.8	
Iceland	-1	-1.6	-17	-4.4	As described above the emission/removal estimate for forest land has been slightly revised in comparison to previous submissions. Area dependent sources as removal to litter and soil and emission from drained organic soil have been changed in relation to changes in the area estimate for each category and each year. The C-stock changes in biomass in CF are based on direct stock measurements (Tier 3) as in last year's submission. They are recalculated for the years 2017 and 2018
United Kingdom (KP)	973	6.3	926	5.0	The changes were mainly seen in the carbon stock changes in the soil carbon pool under Forest Remaining Forest. The main cause of this change was the change in the estimated activity data for afforestation and deforestation on organic soils, based on work implementing the wetland drainage and rewetting provisions.
EU-KP	39 376	9.9	3 052	0.8	

Table 6. 43 4B Cropland: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
Austria	1	0.7	0	0.0	Following a recommendation raised during the ESD Review 2020 (EEA 2020), the total areas of Cropland, Grassland and Settlement as well as the land-use change areas between these categories were adjusted so that the net land use changes to/from these categories exactly fit to the annual change of the total area of these categories. For this purpose, smoothing operations of the trends of the total areas of these categories as well as different interpolations between the years were also carried out. In the case of Cropland, the adjustments made to the annual total Cropland areas impacted the areas of Cropland remaining Cropland and the land use change areas for conversions from Grassland to Cropland. These area changes had an impact on the emissions/removals of these categories.
Belgium	2	0.7	5	0.6	Flemish region: The implementation of the results of the full second forest inventory have resultated in a new carbon uptake factor and other cabon stocks . The C/N ratio of several LUC have been changed. In previous submissions the C/N of the new landuse was taken over, this has been changed to the C/N-ratio of the previous landuse. Brussels region: Matrix update: 2019 was added National level: The C/N ratio for wetlands has been changed from 10 to 15. The N_2O emissions have been split up in direct and indirect emissions
Bulgaria	-73	-9.6	-470	-80.2	Recalculations in relation to some updates of the information from the activity data. It is about perennial CL area and GL area since 2008. The area of FL-FL was corrected for 2018 due to a found error. Recalculations in estimates of the emissions/removals from dead wood in FL-FL due to refinement of the calculation model.
Croatia	-0	-0.0	-9	-2.1	For this reporting Croatia uses revisioned CLC change databases. Changes in Activity data (areas) can result with differences in emissions/removals.
Cyprus	-	-	-	-	
Czechia	1	0.3	-4	-4.4	Since the last submission, the emission estimates related to soil carbon stock changes were recalculated for both the categories 4.B.1 Cropland remaining Cropland and 4.B.2 Land converted to Cropland, due to the revised activity data on soil carbon and emission factors.
Denmark	-368	-7.1	-1 287	-29.0	In this reporting numerous recalculations have been implemented, of which the main relates to the age for land use transition, which has been revised from 20 to 30 years for all sectors.
Estonia	-14	-2.1	30	10.0	The entire time series of activity data is annually recalculated for all areas of land categories and land-use conversions,since new data about land-use transitions is collected every year and new estimates will be integrated into overall activity data.
Finland	-32	-0.6	-215	-2.7	New area estimates were calculated due to the update of the NFI data (see Section 6.2). This resulted in recalculation for the cropland areas since 2012 and all carbon stock changes were recalculated accordingly. Furthermore, for the first time the effect of cover crops on soil carbon emissions was included in the calculation procedure. Cover crops had an impact especially on the emissions since 2015, when the cultivated area of cover crops increased considerably.
France	0	0.0	-3 706	-21.0	Update of cultivation practices with a new 2017 survey (previous survey of 2011) resulting in an increase in the soil carbon sink (decline in plowing and progress in intermediate crops generate an increase in the soil carbon sink on crops remaining in cultivation)

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
Germany	997	8.0	804	5.1	Implementation of a new method for calculating emissions from organic soil as a function of the distance from the groundwater Modification of the method for surveying the areas of drainage ditches for organic soils Introduction of a new method for calculating mineral soil emission factors as a result of land use changes from / to settlements and the introduction of new emission factors associated with this Introduction of new emission factors for forest biomass Introduction of new emission factors for dead wood.
Greece	-	-	-716	-218.8	Recalculations were made for years 2017 and 2018, regarding Croplands due to the availability of more precise data. The annual report of ELSTAT is published in June each year. As a result, the values provided for croplands during the reporting period were not cross-checked with these statistics. Once the data became available they were incorporated in the calculations, leading to significant recalculation in the land use category 4.B.1 for the year 2018 as reported in the GHGI 2021 compared with the information provided in the GHGI 2020. These recalculations lead a shift in the category 4.B.1 from a net source of emissions reported in 2020 to a net sink reported in 2021.
Hungary	-	-	0	0.1	Recalculations due to minor corrections in formulas.
Ireland	-10	-32.4	31	19.4	The recalculations in 4.B Cropland relate to the refinement of LPIS data. This has led to recalculation of emissions and removals for all years in the reporting period.
Italy	0	0.0	-63	-65.5	The recalculation is due to the updated activity data (i.e., areas subject to different management practices) and consequent recalculation of related soils C stock changes. Activity data related to organic soils has been updated, resulting in a slight deviation from 2020 submission
Latvia	-1 536	-39.3	-908	-38.8	Implementation of new country-specific emission factor for drained organic soils.
Lithuania	-3	-0.1	-133	-13.0	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service. Database review was done (started in 2017) taking into account NFI field measurement data, National Paying Agency data of declared agricultural land and the initial data from studies (Study 1 and Study 2) conducted in 2012, in order to improve accuracy in land-use matrix preparation, which resulted in slighty different areas of mineral and organic soils of land converted to cropland, used to estimate carbon stock changes in mineral soils, CO_2 emissions from drainage and direct N_2O emissions due to the N mineralization/immobilization. National carbon stock value in dead wood was applied to estimate carbon stock changes in dead organic matter (dead wood) in grassland converted to cropland. In addition to the updated estimations, calculation error was corrected in carbon stock changes of organic soils in grassland converted to croplands subcategory for the year 2012 and incorrect application of areas in the estimation of carbon stock changes in mineral soils after settlements conversion to cropland
Luxembourg	-3	-3.8	0	0.7	In the 2020v1 calculations carbon losses of deadwood resulting from land use change from forestland to cropland a static value of dead wood carbon stock as used. In the 2021 version the dynamic value of the deadwood carbon stock, calculated in the forestland category, was used. This has led to minor changes
Malta	-4	-151.3	-4	-155.6	The following updates below indicate the improvements made throughout the years in the LULUCF chapter submission: Better reconstruction of the land use areas and land use changes/conversions to acquire an accurate representation of the land use matrix for the

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
					years starting 1970 to the present year minus 2, following the experts' recommendation during the in-country capacity building support visits. Improved estimations in the categories and sub-categories of the LULUCF sector. Update in the Forest Land category, following the provision of new information and data related to Malta's woodland reserves. Correction of notation keys in the CRF tables. Use of various emission factors from other countries having similar land conditions to Malta, with the assistance of the external experts and reviewers. Uncertainty is being reported, and QA/QC checks being performed, following the recommendations from the ERT. More detailed information on the reporting of estimates and information on the national land use categories to improve the NIR.
Netherlands	748	41.2	-21	-1.3	The correction of an error in the carbon stock losses resulting from loss of litter in the dead organic matter (DOM) pool resulted in recalculations of the category forest land converted to cropland for the years 2017 and 2018. Additionally, the more general methodological change of adding pre 1990 land-use changes (i.e. including the 1970 land use map), also has resulted in recalculations in the cropland category for the time series 1990-2010
Poland	616	53.1	-321	-52.4	It has been noted, the approach applied by Poland to calculate the percentage change as well as the net effect (in the CO_2 eq.) of changes in methodologies, changes in the manner in which EFs and AD, or the inclusion of new sources or sinks which have existed since the base year, allows to maintain TACCC principle in relatively simple way. Despite the fact that recalculations of reported data, driven mainly by the ERT recommendations are frequent and sometimes substantial (see Annex I) but as long as the whole time series of data is updated this is not an issue for time consistency. Since the recalculations always affects all reported time series, we consider the recalculated values consistent with the trends in the activity data, and thus more accurate and comparable than before. Main reasons leading to recalculations in the LULUCF sector for the whole time-series are as follows: comprehensive implementation of methods and factors provided in IPCC 2006 guidelines; LUC matrix revision and update since 1968. Factors related adjustment of carbon stocks calculation in category 4.A (update of emission factors for various types of burning); Factors related adjustment of carbon stocks calculation in category 4.C (update of emission factors for various types of burning).
Portugal	-	-	-	-	
Romania	710	32.9	-1 527	-63.0	In relation to the previous reporting, for the CL it can be observed an accentuated tendency to retain the emissions generated by its specific activities. The main drivers of the accentuation of the tendency to retain CO_2 emissions is due to the change of approach, respectively: 1. the use of AD (kha) coming from queries / intersections of explicit geospatial maps; 2. development of maps on AD (kha) organic soil surfaces, 1970-2019; 3. country specific parameters, SOCref. The approached time series, 2012-2019, coincides with IFN, 2012-2018.
Slovakia	-	-	-	-	
Slovenia	345	373.1	318	221.8	Recalculations in cropland remaining cropland were made due to improved stratification of perennial cropland and improved calculation of emission factors for perennial (woody) cropland types, such as vineyards, intensive and extensive orchards, olive groves and other perennial crops.

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
					Recalculations for land converted to cropland were made based on updated emission factors for litter in perennial cropland and new estimates of the country-specific carbon stock for annual cropland. In addition, figures have been recalculated separately for living biomass gains and losses using equations 2.15 and 2.16 in accordance with the 2006 Guidelines to increase transparency, as suggested by the ERT.
Spain	-49	-299.5	-137	-3.7	In this edition of the National Inventory, the results of new farms from the ESYRCE database have been incorporated, for the entire time series available and by province (instead of by CC. AA. As in previous editions), of the practices woody crop management; and of the transitions between crops in which at least one woody crop is involved.
Sweden	79	2.1	472	12.3	Recalculations can be divided into several categories of which the two first ones can be considered “ordinary” recalculations due to the applied methodology using random sampling. The first category is recalculations due to updated NFI-data which mainly affects the estimates for the previous four years as described in section 6.3.1.1. Small corrections of historical land-use changes may affect estimates for earlier years, especially for categories using area as activity data. The second category is recalculations related to extended datasets for litter and soil from the SFSI. Since the whole dataset is included using extrapolation and interpolation techniques this may generate updated data for the entire time series. The third category is when new activity data (not related to NFI or MI) or emission factors have become available (i.e. better sales statistics, information on biomass burning or emission factors related to land-use change). The fourth category is when the methods have been improved. The fifth category is when an obvious computational error has been detected in the calcualtions and needs to be corrected.
United Kingdom	5 701	39.1	4 131	37.4	Implementation of WDR including changes to the area of cropland on organic soils and new tier 2 EFs for cropland on drained organic soils. Minor changes to wildfires due to conversion from fiscal to calendar year.
EU27+UK	7 108	9.4	-3 729	-6.2	
Iceland	28	1.5	669	58.5	Recalculations are due to revised area estimation.
United Kingdom (KP)	5 701	39.0	4 130	37.3	Implementation of peatlands research. Work on implementing wetland drainage and rewetting has changed the relative areas of mineral and organic soils under Cropland (split between mineral and organic soils). The consequent revision of the LUC soils model to avoid double counting has changed the soil carbon stock changes of mineral soils. N_2O emissions from mineralization has also changed as a consequence. The new information also included deforestation on organic soils for the purposes of rewetting (revision of deforestation areas). New emission factors are used for organic soils and are described in Annex 3.4.6, including for the first time reporting of emissions of CH_4 on drained organic soils consistently with chapter 2 of the 2013 IPCC Wetlands Supplement. • There have been minor revisions to agricultural census data for Scotland and Northern Ireland. • Conversion from fiscal year to calendar year: Using data from the Fire and Rescue service Incident Response System (IRS), wildfire data has now been reformatted to calendar years to allow wildfire emissions to be calculated more accurately for the year in which the fires occurred. In the process of reformatting the data additional fires were included which had been omitted in previous inventories. This affects the emissions for biomass burning on forest land, cropland and grassland.

	1990		2018		Explanations for major changes in 2018
	kt CO_2	**%**	**kt CO_2**	**%**	
EU-KP	7 136	9.2	-3 061	-5.0	

Table 6. 44 4C Grassland: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
Austria	1	0.1	-0	-0.0	Following a recommendation raised during the ESD Review 2020 (EEA 2020), the total areas of Cropland, Grassland and Settlement as well as the land-use change areas between these cate-gories were adjusted so that the net land use changes to/from these categories exactly fit to the annual change of the total area of these categories. For this purpose, smoothing operations of the trends of the total areas of these categories as well as different interpolations between the years were also carried out. In the case of Grassland, the adjustments made to the annual total Grassland areas impacted the areas of Grassland remaining Grassland and the land use change areas for conversions from Cropland to Grassland. These area changes had an impact on the emissions/removals of these categories.
Belgium	5	1.4	113	13.8	Flemish region: The implementation of the results of the full second forest inventory have resultated in a new carbon uptake factor and other cabon stocks . The C/N ratio of several LUC have been changed. In previous submissions the C/N of the new landuse was taken over, this has been changed to the C/N-ratio of the previous landuse. Brussels region: Matrix update: 2019 was added National level: The C/N ratio for wetlands has been changed from 10 to 15. The N_2O emissions have been split up in direct and indirect emissions
Bulgaria	-35	-3.3	503	30.2	1) Recalculations due to identification of some calculations error in the calculation's sheets – for example, a wrong reference to cell in a formula or to activity data information. Such errors have been found in area calculations for CL and WL. Another error of this type was found in the estimation sheet for an average carbon stock in soils under Shrubs and grasslands subcategory, which resulted in recalculation of the average stock and its decrease from 100.95 tC/ha to 86.96 tC/ha. 2) Recalculations in LUC matrices due to changes in area of land-use changes before the base year. For all categories the land-use changes have been reported as an average of the LUC for the period 1988-1998, which was not the case in the previous submissions. The only difference applies for GL category, where a different approach was used.
Croatia	0	2.5	-97	-43.3	For this reporting Croatia uses revisioned CLC change databases. Changes in Activity data (areas) can result with differences in emissions/removals.
Cyprus	-	-	-0	-0.0	
Czechia	-0	-0.1	18	6.2	Since the last submission, the emission estimates related to soil carbon stock changes were recalculated for the 4.B.2 Land converted to Grassland , due to the revised activity data on soil carbon. These changes resulted in altered emissions for the entire category 4.C Grassland
Denmark	659	45.4	717	51.6	In this reporting numerous recalculations have been implemented, of which the main relates to the age for land use transition, which has been revised from 20 to 30 years for all sectors.
Estonia	-6	-12.4	42	110.0	The entire time series of activity data is annually recalculated for all areas of land categories and land-use conversions,since new data about land-use transitions is collected every year and new estimates will be integrated into overall activity data.

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
Finland	2	0.2	-36	-4.9	New area estimates were calculated due to the updating of NFI data (see Section 6.2). This resulted in recalculation of grassland time series since 2011 and all carbon stock changes were recalculated accordingly
France	-	-	-114	-1.5	The integration of the Cultural Practices survey of 2017 allowed a significant recalculation of carbon fluxes in mineral soils for grasslands remaining grasslands, leading to an increase in removals which allows this category to become a net sink over the recent period.
Germany	2 548	10.8	1 587	10.3	With this year's submission, source-specific back calculations for the entire reporting period from 1990 to 2019 are presented. The reasons for the recalculation of the emissions were new, improved data sources, method changes and error corrections in the context of improving the inventory.
Greece	-	-	-223	-15.0	Activity areas were also updated for year 2018, due to errors in the CRF tables, which in some cases included the same values as 2017 by mistake. Moreover, values regarding HWP were also updated with more recent information from FAO for the years 2017 – 2019
Hungary	-	-	0	1.7	Recalculations due to minor corrections in formulas.
Ireland	83	1.2	53	0.8	Recalculations to emissions and removals in the Grassland category in this submission are due to revised assessment of land area statistics with respect to grasslands
Italy	-41	-1.1	-615	-7.3	Updtate of activity data (i.e. areas subject to different management practices) and consequent recalculation of related soils C stock changes. Activity data related to organic soils has been updated.
Latvia	-374	-28.4	-426	-27.2	Recalculations are done due to continuous improvement of activity data and implementation of new country-specific emission factors (results of scientific studies)228 for drained organic soils in grassland.
Lithuania	-0	-0.0	14	1.4	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service. Database review was done (started in 2017) taking into account NFI field measurement data, National Paying Agency data of declared agricultural land and the initial data from studies (Study 1 and Study 2) conducted in 2012, in order to improve accuracy in land-use matrix preparation, which resulted in slighty different areas of mineral and organic soils of land converted to grassland, used to estimate carbon stock changes in mineral soils and CO_2 emissions from drainage. National carbon stock value in dead wood was applied to estimate carbon stock changes in dead organic matter (dead wood) in other land uses converted to grassland. Incorrect application of areas in the estimation of carbon stock changes in mineral soils after settlements conversion to grassland were corrected for this submission as well.
Luxembourg	-10	-31.7	1	1.7	In the 2020v1 calculations carbon losses of deadwood resulting from land use change from forestland to cropland a static value of dead wood carbon stock as used. In the 2021 version the dynamic value of the deadwood carbon stock, calculated in the forestland category, was used. This has led to minor changes
Malta	6	125.3	0	114.5	The following updates below indicate the improvements made throughout the years in the LULUCF chapter submission: Better reconstruction of the land use areas and land use changes/conversions to acquire an accurate representation of the land use matrix for the years starting 1970 to the present year minus 2, following the experts' recommendation during the in-country capacity building support visits. Improved estimations in the categories and sub-categories of the LULUCF sector. Update in the Forest Land category, following the provision of new information and data related to Malta's woodland reserves. Correction of notation keys in the CRF tables. Use of various emission factors from other countries having similar land

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
					conditions to Malta, with the assistance of the external experts and reviewers. Uncertainty is being reported, and QA/QC checks being performed, following the recommendations from the ERT. More detailed information on the reporting of estimates and information on the national land use categories to improve the NIR.
Netherlands	-846	-15.3	-161	-5.0	The area of fruit orchards after 2016 is updated using new and updated information. This has an effect on the emission factor for Grassland (non-TOF) which is partly determined by the fraction of orchards. This results in recalculations for the period 2016-2018. Additionally using new information on the age of fruit orchards in 2017 the carbon stocks in fruit orchards were recalculated and updated for the whole time series from 1990-2018 (see also section 6.1.3). The correction of an error in the carbon stock losses resulting from loss of litter in the dead organic matter (DOM) pool resulted in recalculations of the category forest land converted to grassland for the years 2017 and 2018. Additionally, the more general methodological change of adding pre 1990 land-use changes (i.e. including the 1970 land use map), has also resulted in recalculations in the grassland category for the time series 1990-2010
Poland	-92	-52.2	-67	-94.7	It has be noted, the approach applied by Poland to calculate the percentage change as well as the net effect (in the CO_2 eq.) of changes in methodologies, changes in the manner in which EFs and AD, or the inclusion of new sources or sinks which have existed since the base year, allows to maintain TACCC principle in relatively simple way. Despite the fact that recalculations of reported data, driven mainly by the ERT recommendations are frequent and sometimes substantial (see Annex I) but as long as the whole time series of data is updated this is not an issue for time consistency. Since the recalculations always affects all reported time series, we consider the recalculated values consistent with the trends in the activity data, and thus more accurate and comparable than before. Main reasons leading to recalculations in the LULUCF sector for the whole time-series are as follows: comprehensive implementation of methods and factors provided in IPCC 2006 guidelines; LUC matrix revision and update since 1968. Factors related adjustment of carbon stocks calculation in category 4.A (update of emission factors for various types of burning); Factors related adjustment of carbon stocks calculation in category 4.C (update of emission factors for various types of burning).
Portugal	-	-	-	-	
Romania	-39	-8.7	358	246.1	Deviations occur in the 2021 submission, comparing to the 2020 submission, for the whole time series, Table 6.34. This submission is characterized in two stages of recalculations, differing in terms of reasons and time periods, depending on the inputs. The time period 1989-2011 is characterized by the new data on mineral and organic soil areas due to the development of OSM - AD(kha) through a national scientific study.The second differing time period, 2012-2019, is characterized by the same set of data input as in the 1989-2011 time period plus the development of EGM - approach 3 methodology (LPIS+ LIDAR+CLC). Thus, recalculations were made to replace previously interpolated and extrapolated land use change AD(kha) with those estimated in the 2012-2019 by the EGM and OSM. The 2012-2019 values of the LUC areas between LC to CL were updated, which had an impact on the C stock changes and E(+)/R(-) estimates in all carbon pools due to land-use changes/dynamic in these years.
Slovakia	-	-	-	-	
Slovenia	-12	-6.3	15	3.7	No specific QA/QC and verification for grassland was used in the 2021 NIR submission. However, a general

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
					QA/QC was cerried out considering the verification of figures, correctness of calculation used, data sources etc. in the category as it was subject to source-specific recalculation.
Spain	-	-	-1	-3.3	In this edition of the National Inventory, the (interim) fire statistics for the years 2016, 2017 and 201852 have been updated, with implications for the absolute emissions and removals of the GL category of the LULUCF sector.
Sweden	-34	-19.2	892	710.1	Recalculations can be divided into several categories of which the two first ones can be considered “ordinary” recalculations due to the applied methodology using random sampling. The first category is recalculations due to updated NFI-data which mainly affects the estimates for the previous four years as described in section 6.3.1.1. Small corrections of historical land-use changes may affect estimates for earlier years, especially for categories using area as activity data. The second category is recalculations related to extended datasets for litter and soil from the SFSI. Since the whole dataset is included using extrapolation and interpolation techniques this may generate updated data for the entire time series. The third category is when new activity data (not related to NFI or MI) or emission factors have become available (i.e. better sales statistics, information on biomass burning or emission factors related to land-use change). The fourth category is when the methods have been improved. The fifth category is when an obvious computational error has been detected in the calcualtions and needs to be corrected.
United Kingdom	6 621	93.3	5 536	61.7	Changes to the area of grasslands on organic soils due to implementation of WDR. New tier 2 EFs applied to grasslands (improved and unimproved) on organic soils. Minor changes to wildfires due to conversion from fiscal to calendar year.
EU27+UK	8 435	38.2	8 109	403.6	
Iceland	-16	-0.3	-433	-7.5	Two new time series are created based on the time series "Other Grassland": "Grazing areas" and "Grassland without grazing". A new time series for the subcategory "Grazing areas on Other Land" (not classified as Grassland) is created based on time series for "Other Land" and added in Grassland remaining Grassland. Detailed information regarding the revisions made in "Grassland remaining Grassland" are described in the chapter 6.7.1. Category description. The emission is recalculated accordingly.
United Kingdom (KP)	6 621	93.2	5 536	61.5	Implementation of peatlands research.. Work on implementing wetland drainage and rewetting has changed the relative areas of mineral and organic soils under Cropland (split between mineral and organic soils). The consequent revision of the LUC soils model to avoid double counting has changed the soil carbon stock changes of mineral soils. N_2O emissions from mineralization has also changed as a consequence. The new information also included deforestation on organic soils for the purposes of rewetting (revision of deforestation areas). New emission factors are used for organic soils and are described in Annex 3.4.6, including for the first time reporting of emissions of CH_4 on drained organic soils consistently with chapter 2 of the 2013 IPCC Wetlands Supplement. Conversion from fiscal year to calendar year: Using data from the Fire and Rescue service Incident Response System (IRS), wildfire data has now been reformatted to calendar years to allow wildfire emissions to be calculated more accurately for the year in which the fires occurred. In the process of reformatting the data additional fires were included which had been omitted in previous inventories. This affects the emissions for biomass burning on forest land, cropland and grassland.
EU-KP	8 419	31.1	7 676	203.4	

Table 6. 45 4D Wetlands: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	1	6.6	5	81.6	Flemish region: The implementation of the results of the full second forest inventory have resultated in a new carbon uptake factor and other cabon stocks . The C/N ratio of several LUC have been changed. In previous submissions the C/N of the new landuse was taken over, this has been changed to the C/N-ratio of the previous landuse. Brussels region: Matrix update: 2019 was added National level: The C/N ratio for wetlands has been changed from 10 to 15. The N_2O emissions have been split up in direct and indirect emissions
Bulgaria	-13	-12.1	-33	-12.6	Recalculations in LUC matrices due to changes in area of land-use changes before the base year. For all categories the land-use changes have been reported as an average of the LUC for the period 1988-1998, which was not the case in the previous submissions.
Croatia	-0	-0.0	0	0.0	For this reporting Croatia uses revisioned CLC change databases. Changes in Activity data (areas) can result with differences in emissions/removals
Cyprus	-	-	-	-	
Czechia	-0	-0.1	0	0.2	The estimates of soil carbon stock change resulting from land converted to other land use categories that involve Settlements were revised due to the updated activity data on agricultural soil, which affect the soil carbon stock values for Settlement.
Denmark	11	10.7	14	25.7	Time for all land use transition has been revised to 30 years for all sectors also the land converted to forest. The recalculations related to afforestation/land converted to forest have been addressedIn this reporting numerous recalculations have been implemented, of which the main relates to the age for land use transition, which has been revised from 20 to 30 years for all sectors. In the following some key points are highlighted.
Estonia	-823	-74.5	357	33.5	The entire time series of activity data is annually recalculated for all areas of land categories and land-use conversions,since new data about land-use transitions is collected every year and new estimates will be integrated into overall activity data.
Finland	131	10.9	217	11.3	Area estimates were recalculated in 2007 to 2018 due to the updated data and corrections to it. Corrections were also made in the implementation of EFs for peat extraction sites related to emissions from stockpiles i.e. EF's for stockpile emissions were updated because there has been a change in practices, according to which a greater proportion of stockpiles are kept on the peat extraction sites over the winter than before the year 2015 and also the proportion of the peat extraction areas that are in active use and on which stockpiles can be found has now been used in the calculation for the stockpile emissions instead of the total area of peat extraction. An error in the amount of off-site emissions from horticultural peat was corrected. This resulted in recalculation of the time series and all carbon stock changes were recalculated accordingly
France	-	-	-	-	
Germany	143	4.0	-71	-1.7	With this year's submission, source-specific back calculations for the entire reporting period from 1990 to 2019 are presented. The reasons for the recalculation of the emissions were new, improved data sources, method changes and error corrections in the context of improving the inventory.
Greece	-	-	0	2 862.9	The annual report of ELSTAT is published in June each year. As a result the values provided for croplands during the reporting period were not cross-checked with these statistics. Once the data became available they

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
					were incorporated in the calculations, leading to significant recalculation in the land use category 4.B.1 for the year 2018 as reported in the GHGI 2021 compared with the information provided in the GHGI 2020
Hungary	-	-	-	-	
Ireland	126	7.9	806	53.4	The main source of recalculations in Wetlands is associated with the correction of a transcription error associated with the summation of offsite emissions from horticultural peat harvesting (Figure 6.38). Additionally, revised data on the areas of land on which biomass burning occurred national contributed to the recalculation. The average recalculation across the timeseries is 20.9 per cent increase in emissions with significant interannual variability.
Italy	-	-	-13	-25.0	An average recalculation of 13.2% occurs in the 2021 submission, comparing to the 2020 submission, for the 2016, 2017 and 2018 reporting years. The recalculation is due to an update of the activity data and the consequent smoothing process affecting the 2016-2018 period.
Latvia	-278	-22.0	82	5.0	Recalculations are done due to continuous improvement of activity data and implementation of new country-specific emission factors (results of scientific studies)236 for drained organic soils in wetlands (drained peat extraction areas). In the previous submission, forest land converted to other wetlands were not included in calculation of CO_2 emissions from organic soils under category Land Converted to Other Wetlands due to an error. In the previous submission, there was an error in activity data for calculation of off-site CO_2-C emissions associated to the horticultural use of peat for 2018.
Lithuania	-	-	-	-	
Luxembourg	-0	-2.0	0	0.3	In the 2020v1 calculations carbon losses of deadwood resulting from land use change from forestland to cropland a static value of dead wood carbon stock as used. In the 2021 version the dynamic value of the deadwood carbon stock, calculated in the forestland category, was used. This has led to minor changes
Malta	-	-	-	-	
Netherlands	-8	-9.2	-15	-35.5	There are no category-specific recalculations. The correction of an error in the carbon stock losses resulting from loss of litter in the dead organic matter (DOM) pool resulted in recalculations of the category forest land converted to wetlands for the years 2017 and 2018. Additionally, the more general methodological change of adding pre 1990 land-use changes (i.e. including the 1970 land use map), has resulted in recalculations in the forest land category for the time series 1990-2010.
Poland	-2	-0.2	-458	-24.3	It has be noted, the approach applied by Poland to calculate the percentage change as well as the net effect (in the CO_2 eq.) of changes in methodologies, changes in the manner in which EFs and AD, or the inclusion of new sources or sinks which have existed since the base year, allows to maintain TACCC principle in relatively simple way. Despite the fact that recalculations of reported data, driven mainly by the ERT recommendations are frequent and sometimes substantial (see Annex I) but as long as the whole time series of data is updated this is not an issue for time consistency. Since the recalculations always affects all reported time series, we consider the recalculated values consistent with the trends in the activity data, and thus more accurate and comparable than before. Main reasons leading to recalculations in the LULUCF sector for the whole time-series are as follows: comprehensive implementation of methods and factors provided in IPCC 2006 guidelines; LUC matrix revision and update

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
					since 1968. Factors related adjustment of carbon stocks calculation in category 4.A (update of emission factors for various types of burning); Factors related adjustment of carbon stocks calculation in category 4.C (update of emission factors for various types of burning).
Portugal	-	-	-	-	
Romania	-81	-5.4	-416	-36.4	Deviations occur in the 2021 submission, comparing to the 2020 submission, for the whole time series, Table 6.34. This submission is characterized in two stages of recalculations, differing in terms of reasons and time periods, depending on the inputs. The time period 1989-2011 is characterized by the new data on mineral and organic soil areas due to the development of OSM - AD(kha) through a national scientific study.
Slovakia	-	-	-	-	
Slovenia	-1	-20.5	-0	-2.7	Recalculations for land converted to wetlands were performed based on updated emission factors for living biomass and litter for transitions from forest land, perennial grassland and cropland to wetlands.
Spain	-	-	4	6.6	In this edition of the National Inventory, the value of peat production for the year 2018 has been updated, which replaces the replica of the value for the year 2017.
Sweden	-	-	-	-	
United Kingdom	85	17.5	716	213.9	Changes to the Wetlands area due to WDR including new estimates of CSC for peat extraction, rewetted fen, and near natural peatlands. Minor change to flooded lands due to revision of the biomass carbon stock value to use the UK specific value for shrubby grassland.
EU27+UK	-710	-5.3	1 195	7.3	
Iceland	94	7.7	94	8.1	The time series for the area of intact mires is revised according to the new IGLUD land use map categorizing much larger area as intact mire than in previous submission. The emissions based on the categories area are revised accordingly
United Kingdom (KP)	85	17.5	716	213.9	Category 4D is a much larger net source in the latest inventory year due to the revision in organic soils and emissions. The overall change is an increase in emissions between 2.1 and 3.0 Mt CO_2e (314-1071%) across the time series compared to the previous inventory
EU-KP	-616	-5.0	1 289	8.4	

Table 6. 46 4E Settlements: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
Austria	-178	-31.2	-82	-22.0	Following a recommendation raised during the ESD Review 2020 (EEA 2020), the total areas of Cropland, Grassland and Settlement as well as the land-use change areas between these categories were adjusted so that the net land use changes to/from these categories exactly fit to the annual change of the total area of these categories. For this purpose, smoothing operations of the trends of the total areas of these categories as well as different interpolations in between the years were also carried out. In the case of Settlements, the adjustments made to the these are-as impacted the the total Settlement area as well as areas of Settlements remaining Settlements and land use change areas for conversions to Settlements from Cropland and Grassland. These area changes had a substantial impact on the emissions from the category as a whole.
Belgium	9	7.1	79	17.2	soil C in ‘settlements remaining settlements’ was set equal to soil C in ‘cropland remaining cropland’ for the entire time series, in line with the assumption explained

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
					in section 6.3.8 above. Formerly, an average value was used in settlements, but this brought minor C stock changes as the soil C in cropland is evolving. update of areas in the three regions following last data available. Brussels region: Matrix update: 2019 was added
Bulgaria	-9	-2.0	-15	-2.4	In order to avoid double counting of lands the SM area pattern has been recalculated. The following has been applied: Adjustment of the total settlements area for 1996 to match with the known increase in settlements for the period 2001-2016. Interpolation between the adjusted settlements area for 1996 and 2015. Extrapolation of settlements area for the period 1988-1996 considering the available data on LUC to settlements
Croatia	0	0.0	-0	-0.0	For this reporting Croatia uses revisioned CLC change databases for the first time. Changes in Activity data (areas) results with significant differences in emissions/removals
Cyprus	-	-	-	-	
Czechia	-0	-0.1	-2	-1.7	The estimates of soil carbon stock change resulting from land converted to other land use categories that involve Settlements were revised due to the updated activity data on agricultural soil, which affect the soil carbon stock values for Settlement.
Denmark	410	2 207.8	32	18.1	Time for all land use transition has been revised to 30 years for all sectors also the land converted to forest. The recalculations related to afforestation/land converted to forest have been addressedIn this reporting numerous recalculations have been implemented, of which the main relates to the age for land use transition, which has been revised from 20 to 30 years for all sectors. In the following some key points are highlighted.
Estonia	-	-	90	33.0	The entire time series of activity data is annually recalculated for all areas of land categories and land-use conversions,since new data about land-use transitions is collected every year and new estimates will be integrated into overall activity data.
Finland	-17	-2.0	63	8.7	New area estimates were calculated for years 2011 to 2018 due to new data and updating of NFI data. This resulted in recalculations for the time series and all carbon stock changes were updated accordingly.
France	-	-	-	-	
Germany	-156	-6.0	-1 214	-20.9	Implementation of a new method for calculating emissions from organic soils as a function of the distance from the groundwater to the surface • Modification of the method for surveying the areas of drainage ditches for organic soils Introduction of a new method for calculating mineral soil emission factors as a result of land use changes from / to settlements and the introduction of new emission factors associated with this Introduction of new emission factors for forest biomass • Introduction of new emission factors for dead wood.
Greece	-	-	1	1.1	Activity areas were also updated for year 2018, due to errors in the CRF tables, which in some cases included the same values as 2017 by mistake. Moreover, values regarding HWP were also updated with more recent information from FAO for the years 2017 – 2019
Hungary	-	-	0	0.1	Recalculations due to minor corrections in formulas.
Ireland	-	-	-0	-0.2	Minor recalculations were undertaken for the years 2017 and 2018, on foot of updated statistics on sealed surface estimates
Italy	0	0.0	3	0.0	Slight recalculation (0.05% in 2018) occurs in 2021 submission compared to the 2020 one, due to the updated activity data.
Latvia	-0	-0.0	-0	-0.0	
Lithuania	-0	-2.4	-41	-5.7	Recalculations were done as a result of continued internal land use and land-use change database review

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
					in State Forest Service. Database review was done (started in 2017) taking into account NFI field measurement data, National Paying Agency data of declared agricultural land and the initial data from studies (Study 1 and Study 2) conducted in 2012, in order to improve accuracy in land-use matrix preparation, which resulted in slightly different areas of mineral and organic soils used to estimate carbon stock changes in mineral soils, CO_2 emissions from drainage and direct N_2O emissions from N mineralization/immobilization. National carbon stock value in dead wood was applied to estimate carbon stock changes in dead organic matter (dead wood) in grassland converted to settlements and corrected estimation of dead organic matter carbon stock changes in forest land converted to settlements, since only litter carbon stock changes should be included, while dead wood carbon stock changes due to deforestation are included under forest land.
Luxembourg	-3	-2.3	1	1.0	In the 2020v1 calculations carbon losses of deadwood resulting from land use change from forestland to cropland a static value of dead wood carbon stock as used. In the 2021 version the dynamic value of the deadwood carbon stock, calculated in the forestland category, was used. This has led to minor changes
Malta	2	40.8	0	30.4	The following updates below indicate the improvements made throughout the years in the LULUCF chapter submission: Better reconstruction of the land use areas and land use changes/conversions to acquire an accurate representation of the land use matrix for the years starting 1970 to the present year minus 2, following the experts' recommendation during the in-country capacity building support visits. Improved estimations in the categories and sub-categories of the LULUCF sector. Update in the Forest Land category, following the provision of new information and data related to Malta's woodland reserves. Correction of notation keys in the CRF tables. Use of various emission factors from other countries having similar land conditions to Malta, with the assistance of the external experts and reviewers. Uncertainty is being reported, and QA/QC checks being performed, following the recommendations from the ERT. More detailed information on the reporting of estimates and information on the national land use categories to improve the NIR.
Netherlands	-62	-6.9	-67	-4.4	There are no category-specific recalculations. The correction of an error in the carbon stock losses resulting from loss of litter in the dead organic matter (DOM) pool resulted in recalculations of the category forest land Convert d to settlements for the years 2017 and 2018. Additionally, the more general methodological change of adding pre 1990 land-use changes (i.e. including the 1970 land use map), has resulted in recalculations in the forest land category for the time series 1990-2010.
Poland	262	14.4	-722	-23.1	Update of EF (application of default TP in soil assessment) Update of EF for direct nitrous oxide emissions from nitrogen mineralization/immobilization associated with loss/gain of soil organic matter
Portugal	-	-	-	-	
Romania	-76	-2.1	730	23.4	In relation to the previous reporting, for the SL land can be observed a tendency to generate emissions caused by its specific activities. The main driver of CO_2 emissions for this land is represented by the change of approach, respectively, the use of AD (kha) from queries / intersections of explicit geospatial maps, 2012-2019.
Slovakia	-	-	-	-	
Slovenia	-100	-24.7	-73	-45.8	Recalculations for land converted to settlements were made based on updated emission factors for living

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
					biomass and litter for transitions from forest land, perennial grassland, and cropland to settlements
Spain	-	-	-	-	
Sweden	12	0.5	285	10.2	Recalculations can be divided into several categories of which the two first ones can be considered “ordinary” recalculations due to the applied methodology using random sampling. The first category is recalculations due to updated NFI-data which mainly affects the estimates for the previous four years as described in section 6.3.1.1. Small corrections of historical land-use changes may affect estimates for earlier years, especially for categories using area as activity data. The second category is recalculations related to extended datasets for litter and soil from the SFSI. Since the whole dataset is included using extrapolation and interpolation techniques this may generate updated data for the entire time series. The third category is when new activity data (not related to NFI or MI) or emission factors have become available (i.e. better sales statistics, information on biomass burning or emission factors related to land-use change). The fourth category is when the methods have been improved. The fifth category is when an obvious computational error has been detected in the calcualtions and needs to be corrected.
United Kingdom	-680	-9.7	-1 129	-17.2	Changes to Settlement areas on organic soils.
EU27+UK	-587	-1.5	-2 061	-4.3	
Iceland	-8	-33.0	-0	-6.3	As the total area is revised the time series for “All other Grassland converted to Settlement” is modified accordingly and emission recalculated
United Kingdom (KP)	-680	-9.6	-1 128	-16.9	Implementation of peatlands research. Work on implementing methodologies consistent with chapter 2 and 3 in the IPCC 2013 Wetlands Supplement for wetland drainage and rewetting has changed the relative areas of mineral and organic soils under Cropland (split between mineral and organic soils). The consequent revision of the LUC soils model to avoid double counting has changed the soil carbon stock changes of mineral soils. N_2O emissions from mineralization has also changed as a consequence. The new information also included deforestation on organic soils for the purposes of rewetting (revision of deforestation areas). New emission factors for organic soils from Evans et al. (2017) and further work include new source of CH_4 and N_2O on drained organic soils.
EU-KP	-595	-1.5	-2 061	-4.3	

Table 6. 47 4F Other land: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2018 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
Austria	-	-	110	69.1	Following a recommendation raised during the ESD Review 2020 (EEA 2020), the total areas of Cropland, Grassland and Settlement as well as the land-use change areas between these cate-gories were adjusted so that the net land use changes to/from these categories exactly fit to the annual change of the total area of these categories. For this purpose, smoothing operations of the trends of the total areas of these categories as well as different interpolations between the years were also carried out. In the case of Other land, these adjustments have impacted the areas of land use change from Grassland to Other land, which in previous submissions were considered to be not occurring. In this submission, this conversion has been estimated for the years from 2005 onwards due to limits to which the decrease in Grassland area can be explained by conversions to Settlements and/or conversions to Forest land due to land abandonment.

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
					After further examination of this issue, it is considered that part of the abandoned Grassland is indeed converted to areas of Other land. These areas of land use change are now estimated by the new adjustments to the land use and land use change areas ensuring interannual consistency in the land use change matrices.
Belgium	-	-	-	-	
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czechia	-	-	-	-	
Denmark	-	-	-	-	
Estonia	-	-	47	149.0	The entire time series of activity data is annually recalculated for all areas of land categories and land-use conversions,since new data about land-use transitions is collected every year and new estimates will be integrated into overall activity data.
Finland	-	-	-	-	
France	-	-	-	-	
Germany	-	-	-	-	
Greece	-	-	1	0.8	Activity areas were also updated for year 2018, due to errors in the CRF tables, which in some cases included the same values as 2017 by mistake. Moreover, values regarding HWP were also updated with more recent information from FAO for the years 2017 – 2019
Hungary	-	-	-	-	
Ireland	-	-	2	21.3	Estimates of emissions from Other Land are by default directly affected by changes in the areas and revisions to the areas associated with all the other land uses. Given the low level of emissions from this land use category for most years, the absolute values of recalculations are small
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-	-	0	0.8	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service. Database review was done (started in 2017) taking into account NFI field measurement data, National Paying Agency data of declared agricultural land and the initial data from studies (Study 1 and Study 2) conducted in 2012, in order to improve accuracy in land-use matrix preparation
Luxembourg	-0	-3.4	0	1.9	In the 2020v1 calculations carbon losses of deadwood resulting from land use change from forestland to cropland a static value of dead wood carbon stock as used. In the 2021 version the dynamic value of the deadwood carbon stock, calculated in the forestland category, was used. This has led to minor changes
Malta	0	17.7	0	17.7	The following updates below indicate the improvements made throughout the years in the LULUCF chapter submission: Better reconstruction of the land use areas and land use changes/conversions to acquire an accurate representation of the land use matrix for the years starting 1970 to the present year minus 2, following the experts' recommendation during the in-country capacity building support visits. Improved estimations in the categories and sub-categories of the LULUCF sector. Update in the Forest Land category, following the provision of new information and data

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
					related to Malta's woodland reserves. Correction of notation keys in the CRF tables. Use of various emission factors from other countries having similar land conditions to Malta, with the assistance of the external experts and reviewers. Uncertainty is being reported, and QA/QC checks being performed, following the recommendations from the ERT. More detailed information on the reporting of estimates and information on the national land use categories to improve the NIR.
Netherlands	-4	-15.5	-8	-4.4	There are no category-specific recalculations. The correction of an error in the carbon stock losses resulting from loss of litter in the dead organic matter (DOM) pool resulted in recalculations of the category forest land converted to other land for the years 2017 and 2018. Additionally, the more general methodological change of adding pre 1990 land-use changes (i.e. including the 1970 land use map), has resulted in recalculations in the forest land category for the time series 1990-2010
Poland	-	-	-	-	
Portugal	-	-	-	-	
Romania	-27	-3.4	-151	-23.5	Deviations occur in the 2021 submission, comparing to the 2020 submission, for the whole time series, Table 6.53. This submission is characterized in three stages of recalculation, distinct as reasons and as time period, depending on the input of data/information. The 1989-2011 time period is characterized by the new data on CS AD(kha), FL to OL. The second distinct time period, 2012-2019, is characterized by the same set of data input as in the 1989-2011 time period plus the development of EGM - approach 3 methodology (LPIS+ LIDAR+CLC).
Slovakia	-	-	-	-	
Slovenia	-1	-4.0	-	-	Recalculations for land converted to other land were made based on updated emission factors for living biomass and litter for transitions from forest land, perennial grasslands, and cropland to other land.
Spain	-	-	-	-	
Sweden	-0	-0.0	-28	-88.5	Recalculations can be divided into several categories of which the two first ones can be considered "ordinary" recalculations due to the applied methodology using random sampling. The first category is recalculations due to updated NFI-data which mainly affects the estimates for the previous four years as described in section 6.3.1.1. Small corrections of historical land-use changes may affect estimates for earlier years, especially for categories using area as activity data. The second category is recalculations related to extended datasets for litter and soil from the SFSI. Since the whole dataset is included using extrapolation and interpolation techniques this may generate updated data for the entire time series. The third category is when new activity data (not related to NFI or MI) or emission factors have become available (i.e. better sales statistics, information on biomass burning or emission factors related to land-use change). The fourth category is when the methods have been improved. The fifth category is when an obvious computational error has been detected in the calcualtions and needs to be corrected.
United Kingdom	-	-	-	-	
EU27+UK	-32	-1.0	-27	-7.8	
Iceland	-	-	-	-	
United Kingdom (KP)	-	-	-	-	

	1990		2018		Explanations for major changes in 2018
	kt CO_2	%	kt CO_2	%	
EU-KP	-32	-1.0	-27	-7.8	

7 WASTE (CRF SECTOR 5)

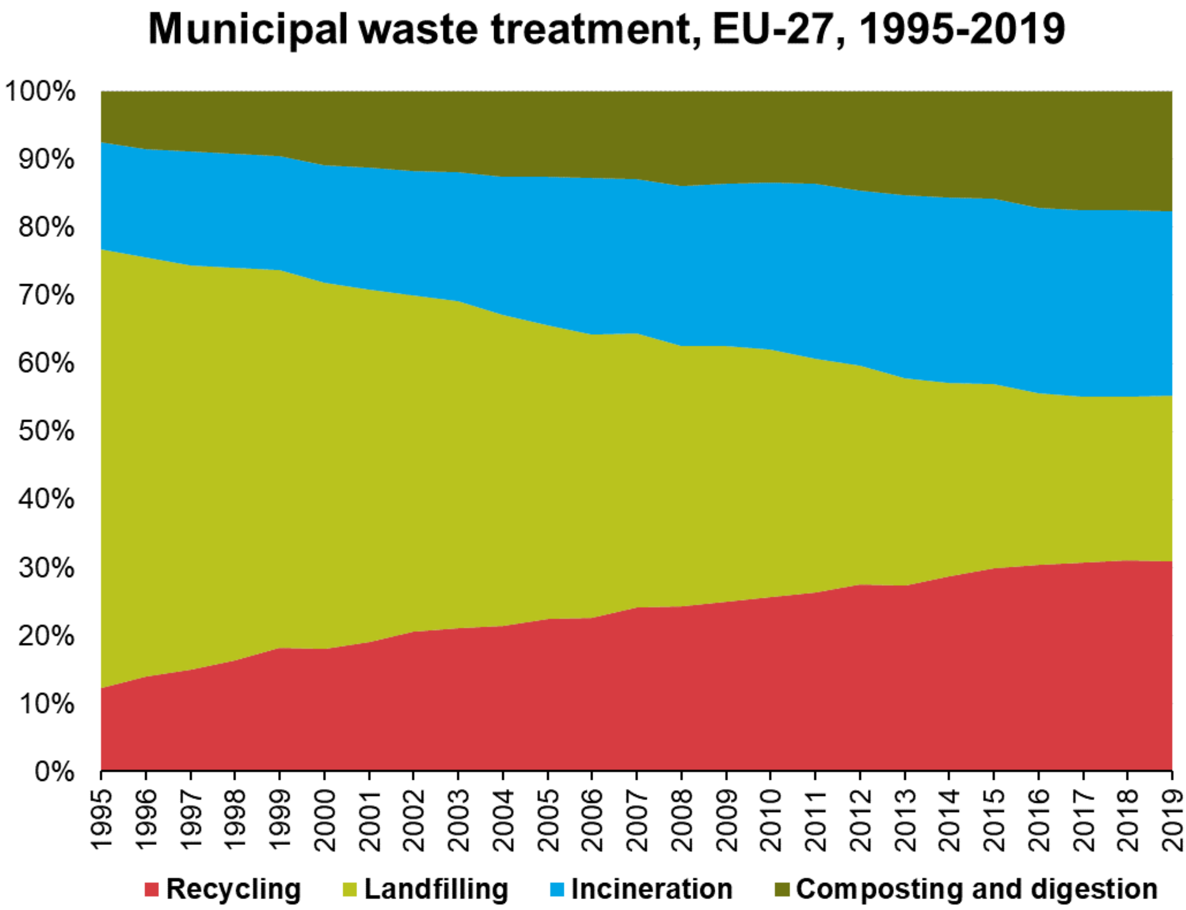
GHG emissions in the waste sector are generated from the treatment and disposal of liquid and solid waste. According to the IPCC 2006 Guidelines emission estimates in the waste sector need to be carried out for four subcategories:

- 5.A Solid waste disposal
- 5.B Biological treatment of solid waste
- 5.C Incineration and open burning of waste
- 5.D Wastewater treatment and discharge.

Of the above, the first three categories mainly refer to possible routes for treatment and disposal of solid waste. Solid waste can be recycled, landfilled, incinerated and biological treated. The decrease of total GHG emissions in the waste sector is mainly driven by the development of the different waste treatment routes. Figure 7.1 shows the share of the Municipal Solid Waste (MSW) treatments over the time series 1995 to 2019 based on activity data for municipal solid waste as published in 2021. The figure is based on Eurostat data as there is a common definition for the reporting of municipal waste to Eurostat and information on waste recycling is also included. On the basis of the Regulation on waste statistics (EC) No. 2150/2002, amended by Commission Regulation (EU) No. 849/2010, data on the generation and treatment of waste is collected from the Member States. The information on waste treatment reported to Eurostat is broken down to five treatment types (recovery, incineration with energy recovery, other incineration, disposal on land, biological treatment) and in waste categories. Eurostat data shown in the figures below include only information for municipal waste treatment, while in the GHG inventory also industrial waste, sludge and hazardous waste are reported by some countries under the categories solid waste disposal, biological treatment and waste incineration. However, the Eurostat data is used to show the overall trend of waste treatment in the European Union.

Between 1995 and 2019 the amount of municipal solid waste landfilled is continuously decreasing in the EU countries and Iceland and other waste treatment methods like recycling, biological treatment of waste and waste incineration with energy recovery are applied more. In 1995, 65 % of waste has been landfilled, 16 % was incinerated (with and without energy recovery), 12 % recycled and only 8 % of the municipal solid waste has been composted or digested. In 2019, the share of waste landfilled decreased to 24 % of total waste treated while incineration including energy recovery increased to 27%, recycling increased to 31 % and biological treatment of waste makes up 18 % of total municipal solid waste treated.

Figure 7.1 Sector 5 Waste: Development of municipal waste treatment in the EU-27



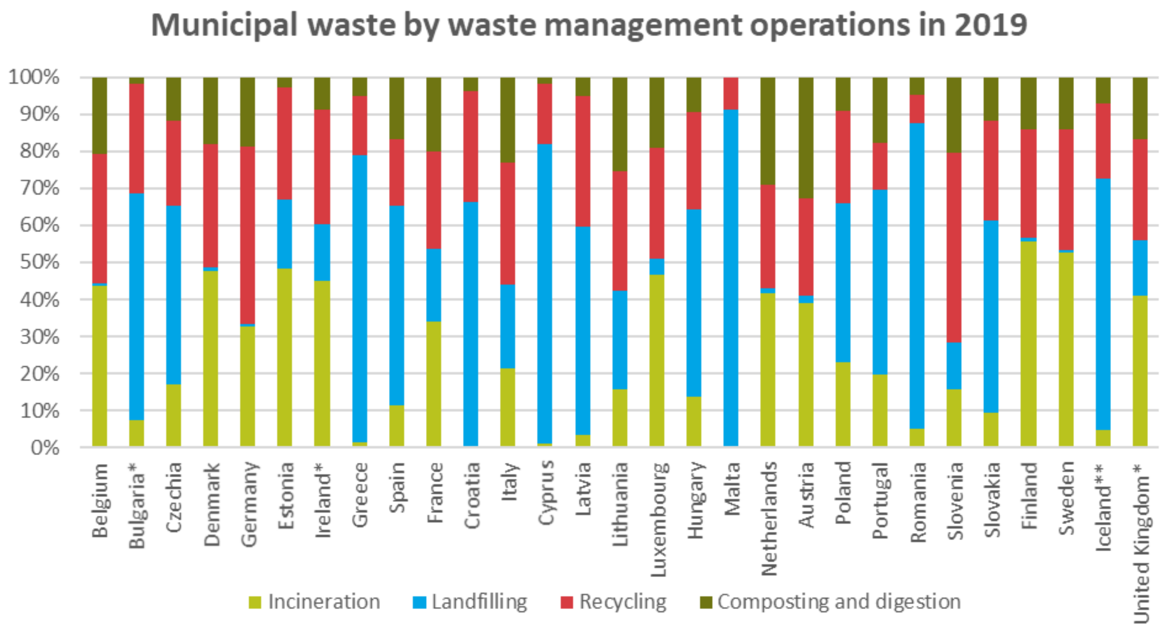
Note: estimated by Eurostat.

Source: Eurostat (online data code: env_wasmun)

Many countries experienced a reduction of waste landfilled and an increase of recycling, composting, landfill gas recovery and waste incineration with energy recovery. These trends have already started before the Landfill Directive 1999/31/EC and the Directive on packaging waste 94/62/EC and 2008/98/EC, but are further supported by these directives.

The share of the single municipal waste treatment routes differs significantly among countries in 2019 (comparison in Figure 7.2). Indeed, the waste management practices and policies which determine the fraction of municipal solid waste (MSW) disposed to solid waste disposal sites (SWDS), the fraction of waste incinerated and the fraction of waste recycled or with biological treatment differ significantly between the countries. For example, disposing municipal waste on SWDS is the predominant (>60%) municipal waste disposal route in Bulgaria, Greece, Croatia, Cyprus, Malta and Romania and Iceland with correspondingly fewer quantities of waste incinerated, recycled or biological treated. In Belgium, Denmark, Germany, Ireland, Luxembourg, the Netherlands, Austria, Slovenia, Finland, Sweden and the United Kingdom, it is the opposite (<20%). Since 2005, landfills in Germany remaining in operation may only store waste that conforms to strict categorization criteria. Landfills also must reduce landfill gas formation from such waste by more than 90 % compared to gas production from untreated waste. In the Netherlands (also in Belgium), waste policy also has the aim of reducing landfilling by introducing bans for the landfilling of certain categories of waste, e.g. by limiting the authorized organic fraction of landfilled waste and by raising the landfill tariff to shift waste streams to other treatment routes.

Figure 7.2 Waste management practices in the EU-KP (shares) in 2019



** Data 2018 **Data 2017*

Source: Eurostat (online data code: env_wasmun)

7.1 Overview of sector

CRF Sector 5 Waste is the fourth largest sector in the EU-KP, after energy, agriculture and industrial processes, contributing 3.3% to total GHG emissions without LULUCF in 2019. Total emissions from waste decreased by 43.8 % from 240 Mt in 1990 to 135 Mt in 2019 (Figure 7.3). In 2019, emissions decreased by 1.1 % compared to 2018.

The strong decrease of emissions from the waste sector is mainly influenced by a strong decline of emissions in the waste sector from the United Kingdom, Germany, the Netherlands and Poland. Reductions from category 5.A solid waste disposal on land make up 86 % of total emission reductions in the waste sector (between 1990 and 2019). Emissions from the waste sector show a continuously decreasing trend during the last years, but as many countries with large emissions from this sector already decreased emissions since 1990 by more than 70 % and most technical mitigation options are implemented in those big countries, the declining emission trend is slowing down.

Figure 7.3 Sector 5 Waste: EU-KP GHG emissions, 1990-2019

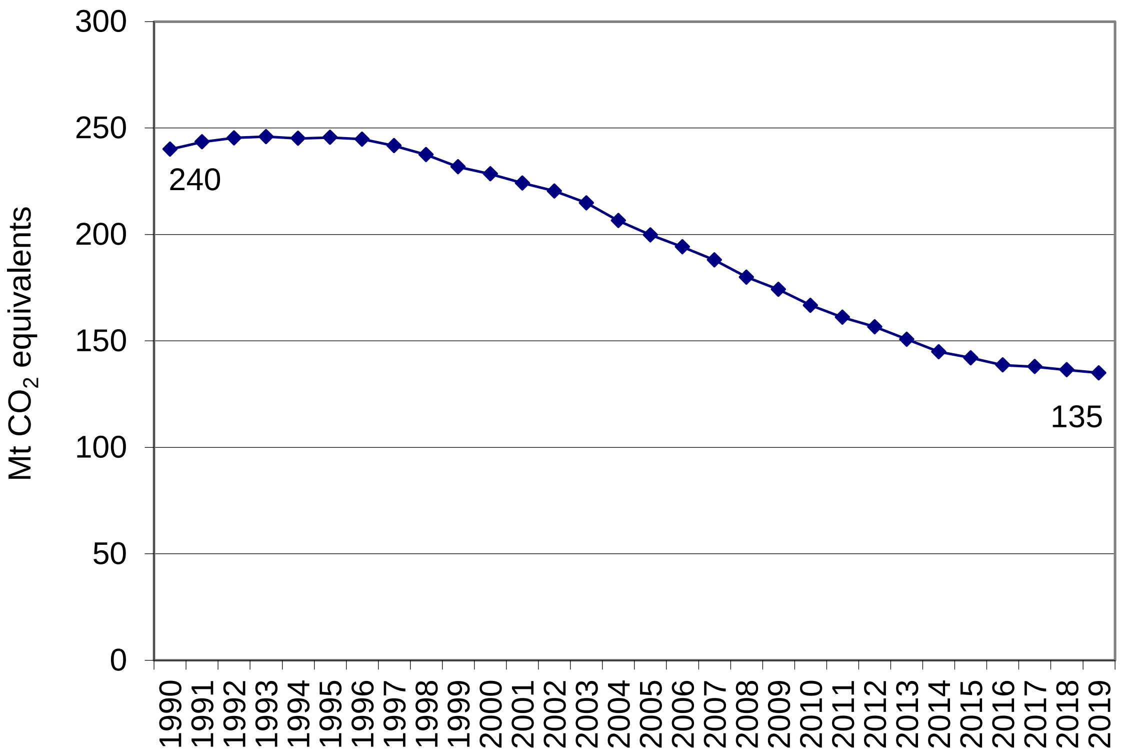
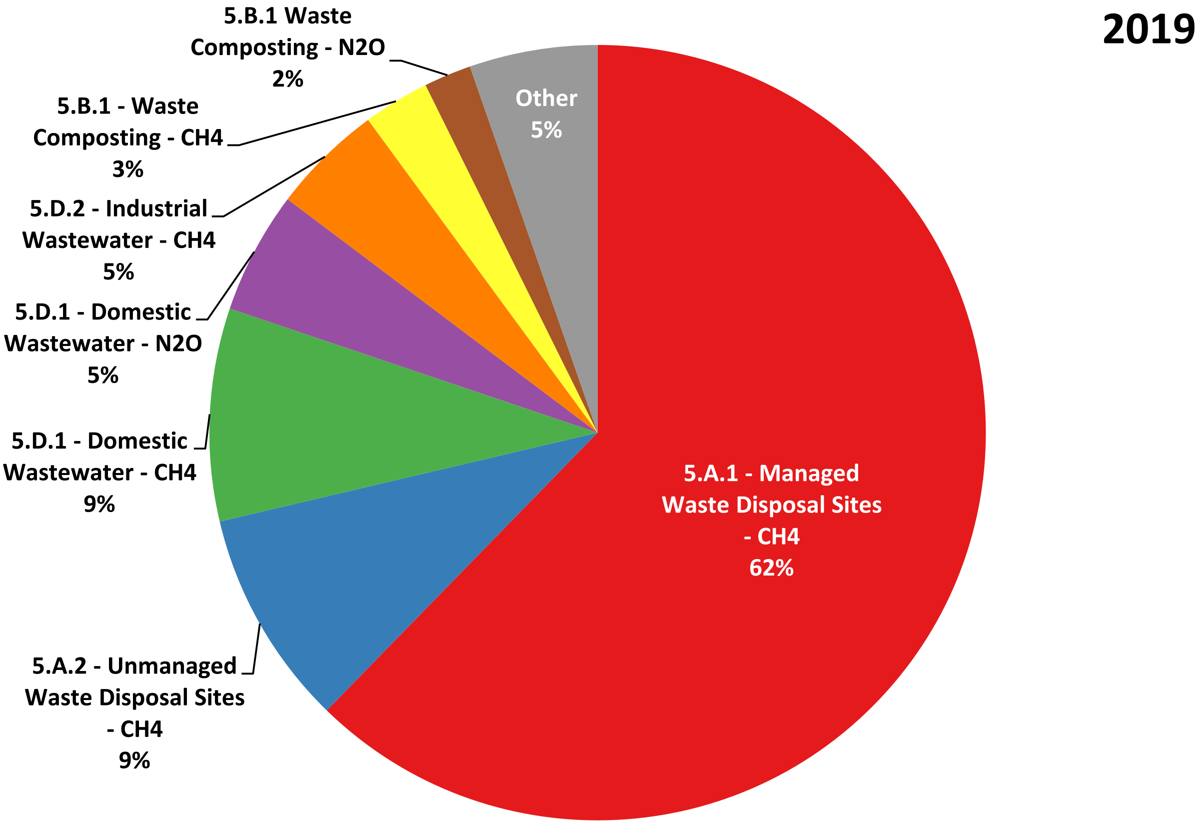


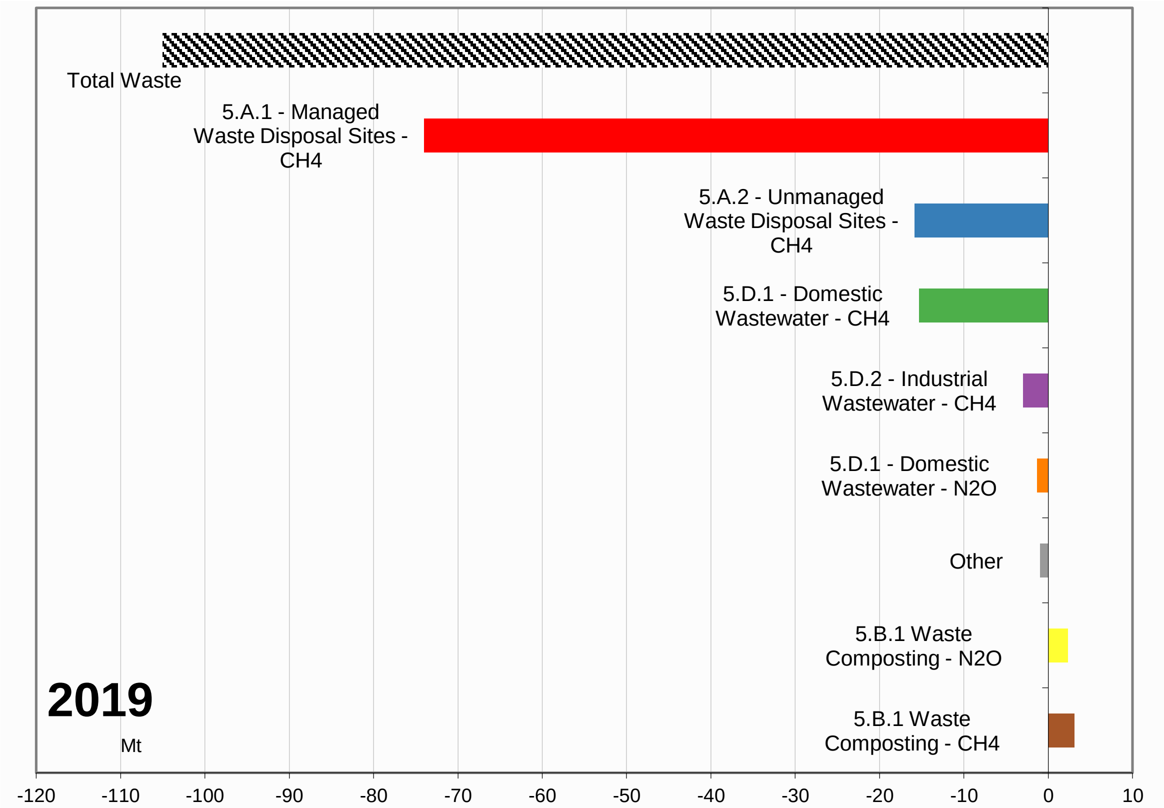
Figure 7.5 shows that CH_4 emissions from 5A1 Managed Waste Disposal on Land had the greatest decrease of all waste-related emissions, but still accounts for 62 % of waste-related GHG emissions in the EU-KP in 2019 as shown in Figure 7.4.

Figure 7.4 Sector 5 Waste: Share of key source categories and all remaining categories in 2019 for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 7.5 Sector 5 Waste: Absolute change between 1990 and 2019 of GHG emissions (in CO_2 equivalents) by large key source categories for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total

7.2 Source categories and methodological issues

This chapter includes information on emission levels and emission trends for all 28 countries (EU27 + UK) plus Iceland for the EU key source categories. Additionally, information for EU key source categories on national methods and circumstances, which are available in the countries' national inventory reports, are provided in the Annex III.

In this section we present information relevant for the EU-KP key source categories in the sector 5 Waste. Source categories considered in detail are:

Table 7.1 Key source categories for level and/or trend analyses and share of MS emissions using higher tier methods

Source category gas	kt CO_2 eq.		Trend	Level		share of higher Tier
	1990	2019		1990	2019	
5.A.1 Managed Waste Disposal Sites: Waste (CH_4)	158 092	84 074	T	L	L	95,0%
5.A.2 Unmanaged Waste Disposal Sites: Waste (CH_4)	28 037	12 190	T	L	L	94.2%
5.B.1 Waste Composting: Waste (CH_4)	611	3 721	T	0	0	42,0%
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	27 292	11 974	T	L	L	49.1%
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	8 208	6 879	0	0	L	20.6%
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	9 274	6 282	0	L	L	54.2%

The share of higher Tier corresponds to the share of EU emissions documented by countries reporting the method as an IPCC Tier 2 method (T2) or a country-specific method (CS), or countries reporting EF as country-specific (CS).

Almost all countries report CH_4 emissions from solid waste disposal on managed and unmanaged landfills 5.A using a Tier 2 methodology. In all other source categories in the waste sector the share of countries using a higher Tier method is much lower.

For CH_4 emissions from composting (5.B.1) France and Germany mainly influence the share of higher Tiers because they have one of the highest shares for this gas, respectively 26.6% and 8.3% in this category and are using a higher Tier. However, UK which has the highest share of CH_4 from composting (27,4%) is applying a Tier 1For CH_4 emissions from domestic wastewater treatment (5.D.1), Poland and France, which represents respectively 19% and 18% of the EU emissions from this category, mainly influence the share of higher Tiers.

For CH_4 emissions from industrial wastewater Italy contributes almost to 23,7% to the 52,4 % of CH_4 emissions that are reported in this sub-category using higher Tiers.

Other source categories in the waste sector are not contributing to a key source and only information on total emissions from these categories is provided for completeness reasons (see chapter 3.2.8). Further information on emission trends and methodological information on other source categories from the waste sector are not provided.

7.2.1 Solid waste disposal on land (CRF Source Category 5A)

Methane is produced from anaerobic microbial decomposition of organic matter in solid waste disposal sites. This source category includes two key categories: CH_4 from 5A1 Managed waste disposal on land and CH_4 from 5A2 Unmanaged waste disposal on land. In addition, source category 5A includes the category 5A3 CH_4 emissions from uncategorized landfills, but only Estonia (1990-1993) and Poland (1990-2019) report emissions from this category. As this is no EU key category no further information on 5A3 is included in the following chapters.

The source category 5A contributes 2.4 % to total GHG emissions without LULUCF in 2019.

The methane recovery that takes place in the managed or unmanaged solid waste landfills is also reported in CRF-table 5A but those amounts are not included in the reported CH_4-emissions, as prescribed by the IPCC guidelines. In the unmanaged solid waste landfills, mainly no CH_4-recovery is taken place. Only Ireland (1996-1998) and Latvia (2002-2017) report CH_4 recovery from unmanaged landfills for a few years in the time series.

Table 7.2 provides total greenhouse gas and CH_4 emissions by Member State from 5A Solid Waste Disposal on Land. CH_4 emissions from this category decreased by 48 % between 1990 and 2019 in the EU-KP. Fifteen EU-KP countries reduced their emissions from this source, while Croatia, Cyprus, the Czech Republic, France, Greece, Hungary, Italy, Latvia, Malta, Portugal, Romania, Slovakia, Spain and Iceland did not. In many of these countries waste disposal changed from unmanaged to managed landfills during the time period 1990 and 2019 which leads to increasing CH_4 emissions from managed landfills. In 2019, CH_4 emissions from landfills decreased by 1.1% compared to 2018.

Table 7.2 5A Solid Waste Disposal on Land: Countries contributions to total GHG emissions and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2019 (kt CO2 equivalents)
Austria	3 644	882	3 644	882
Belgium	2 967	648	2 967	648
Bulgaria	3 434	2 557	3 434	2 557
Croatia	326	1 203	326	1 203
Cyprus	264	499	264	499
Czechia	1 793	3 394	1 793	3 394
Denmark	1 536	534	1 536	534
Estonia	214	182	214	182
Finland	4 328	1 423	4 328	1 423
France	12 563	12 734	12 563	12 734
Germany	34 200	7 189	34 200	7 189
Greece	2 243	3 325	2 243	3 325
Hungary	2 533	2 927	2 533	2 927
Ireland	1 318	677	1 318	677
Italy	12 206	13 659	12 206	13 659
Latvia	315	412	315	412
Lithuania	1 029	573	1 029	573
Luxembourg	93	46	93	46
Malta	41	141	41	141
Netherlands	13 679	2 370	13 679	2 370
Poland	14 078	7 900	14 078	7 900
Portugal	2 821	3 569	2 821	3 569
Romania	1 372	3 818	1 372	3 818
Slovakia	698	1 122	698	1 122
Slovenia	373	225	373	225
Spain	5 474	9 860	5 474	9 860
Sweden	3 422	633	3 422	633
United Kingdom	60 203	14 206	60 203	14 206
EU-27+ISL	**187 166**	**96 708**	**187 166**	**96 708**
Iceland	150	163	150	163
United Kingdom (KP)	60 324	14 330	60 324	14 330
EU-KP	**187 436**	**96 996**	**187 436**	**96 996**

Note: The first two column show total emissions from 5A reported in kt CO_2 eq. The last two columns show CH_4 emissions in kt CO_2 eq.. As only CH_4 emissions are reported under 5.A the figures in the columns are identical Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.1.1 Managed waste disposal sites (CRF Source Category 5A1)

Table 7.3 provides information on emission trends of the key source CH_4 from 5A1 Managed Waste Disposal on Land by Member State. CH_4 emissions from this source account for 2.1 % of total EU-KP GHG emissions in 2019. Between 1990 and 2019, CH_4 emissions from managed landfills declined by 46.8 % in the EU-KP.

Twelve EU-KP countries reduced their emissions from this source during that period while Croatia, the Czech Republic, France, Greece, Hungary, Italy, Portugal, Slovakia, Spain and Iceland did not. Bulgaria, Cyprus, Estonia, Ireland, Latvia, Malta, and Romania did not report CH_4 emissions from managed landfills in 1990. In 2019, CH_4 emissions from managed landfills decreased by 0.5% compared to 2018.

Table 7.3 5A1 Managed Waste Disposal on Land: Countries contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	3 644	939	882	1.0%	-2 761	-76%	-57	-6%	T2	CS,D
Belgium	2 967	701	648	0.8%	-2 320	-78%	-53	-8%	T2	D
Bulgaria	NO	1 232	1 232	1.5%	1 232	∞	0	0%	T2	CS,D
Croatia	16	1 152	1 128	1.3%	1 112	6879%	-24	-2%	T2	CS
Cyprus	NO	83	96	0.1%	96	∞	13	16%	T2	D
Czechia	1 793	3 366	3 394	4.0%	1 601	89%	28	1%	T1	D
Denmark	1 536	576	534	0.6%	-1 002	-65%	-42	-7%	CS,T2	CS,D
Estonia	NO	182	182	0.2%	182	∞	0	0%	T2	D
Finland	4 328	1 468	1 423	1.7%	-2 905	-67%	-45	-3%	T2	CS,D
France	12 563	12 463	12 734	15.1%	172	1%	271	2%	T2	CS,D
Germany	34 200	7 556	7 189	8.5%	-27 011	-79%	-366	-5%	T2	CS
Greece	80	1 857	1 926	2.3%	1 846	2307%	69	4%	T2	CS,D
Hungary	393	1 703	1 757	2.1%	1 364	347%	54	3%	T2	D
Ireland	NO	693	677	0.8%	677	∞	-16	-2%	T2	CS,D
Italy	6 386	11 677	11 658	13.9%	5 271	83%	-19	0%	T2	CS
Latvia	NO	254	283	0.3%	283	∞	28	11%	T2	D
Lithuania	684	454	437	0.5%	-247	-36%	-17	-4%	T2	D
Luxembourg	93	48	46	0.1%	-47	-50%	-2	-3%	T1	D
Malta	NO	131	134	0.2%	134	∞	3	2%	T2	M
Netherlands	13 679	2 486	2 370	2.8%	-11 309	-83%	-116	-5%	T2	CS
Poland	5 829	4 826	4 743	5.6%	-1 086	-19%	-83	-2%	T2	CS,D
Portugal	744	2 842	2 898	3.4%	2 153	289%	56	2%	T2	CS,D
Romania	NO	1 799	2 025	2.4%	2 025	∞	226	13%	T2	CS,D
Slovakia	698	1 125	1 122	1.3%	424	61%	-3	0%	T2	CS
Slovenia	373	234	225	0.3%	-148	-40%	-9	-4%	T2	CS,D
Spain	4 324	9 265	9 240	11.0%	4 916	114%	-25	0%	T2	CS,D,OTH
Sweden	3 422	738	633	0.8%	-2 788	-81%	-105	-14%	T2	CS,D
United Kingdom	60 203	14 389	14 206	16.9%	-45 998	-76%	-183	-1%	T2	CS
EU-27+UK	**157 955**	**84 238**	**83 822**	**100%**	**-74 133**	**-47%**	**-416**	**0%**	**-**	**-**
Iceland	17	169	140	0.2%	124	736%	-29	-17%	T2	CS,D
United Kingdom (KP)	60 324	14 512	14 330	17.0%	-45 993	-76%	-182	-1%	T2	CS
EU-KP	**158 092**	**84 530**	**84 087**	**100%**	**-74 005**	**-47%**	**-443**	**-1%**	**-**	**-**

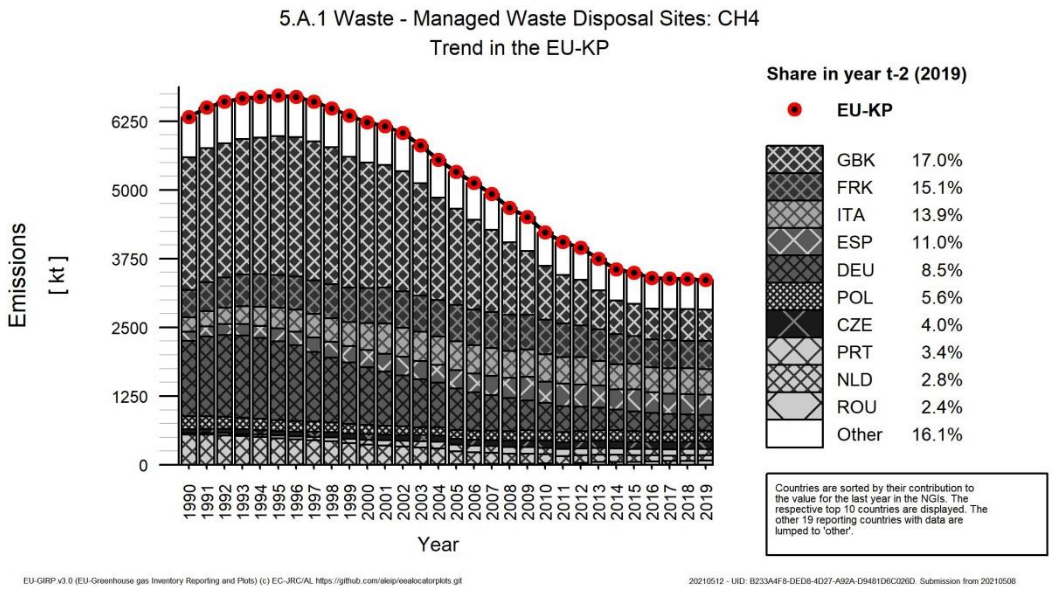
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data

CH_4 emissions from solid waste disposal on managed land decreased considerably between 1990 and 2019 by 47 %. *Figure 7.6* shows the trend of emissions indicating the countries contributing most to EU-KP total.

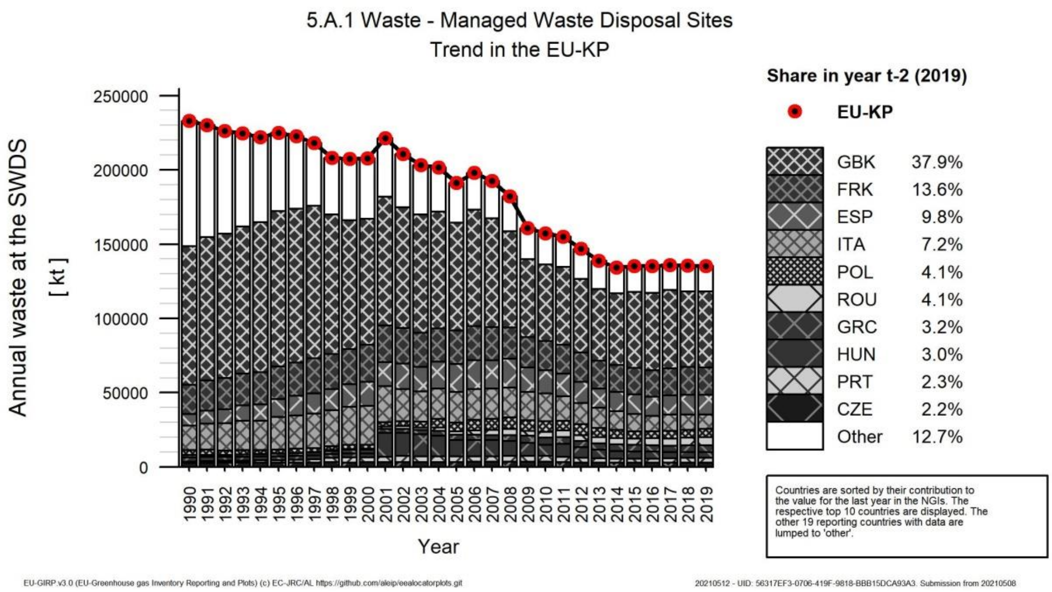
The countries with highest emissions from this source in 2019 were the United Kingdom, France, Italy, Spain and Germany. These MS account for 65.6% of EU-KP CH_4 emissions from 5A1 in 2019. The largest reductions in absolute terms between 1990 and 2019 were reported by the United Kingdom (–46 Mt CO_2 equiv.) and Germany (–27 Mt CO_2 equiv.). The emission reductions are partly due to the (early) implementation of the landfill waste directive or similar legislation in these countries. The landfill waste directive was adopted in 1999 and requires the Member States to reduce the amount of biodegradable waste disposed untreated to landfills and to install landfill gas recovery at all new sites.

Figure 7.6 5A1 Managed waste disposal on land: CH_4 emissions (Trend in relevant countries)



A main driving force of CH_4 emissions from managed waste disposal on land is the amount of waste, especially of biodegradable waste going to landfills. According to the CRF Tables submitted in 2021 the yearly total amount of waste disposal on managed landfills declined by 40 % between 1990 and 2019 (see *Figure 7.7*). In addition, CH_4 emissions from landfills are influenced by the amount of CH_4 recovered and utilized or flared. The share of CH_4 recovery has increased significantly in EU-KP since 1990 (see Figure 7.8).

Figure 7.7 5A1 Managed waste disposal on land: Waste disposal (Trend in relevant countries)



In the following description more information is provided for the countries that are contributing most to the trend of this key category on the level of the EU-KP.

The **United Kingdom (KP)** has a high share of CH_4 emissions from managed landfills among countries contributing 17 % to EU-KP emissions in 2019. From 1996 onwards CH_4 emission decreased continuously due to a reduction of the amount of waste landfilled and also due to very high amounts of CH_4 recovery. Since 2012 the amount of CH_4 recovery shows a declining trend, with a decrease of CH_4 emissions by 1.3 % between 2018 and 2019.

France, contributing with 15.1 % to EU-KP emissions in 2019, increased its emissions from managed solid waste disposal sites steadily until 2003; followed by a declining trend until 2015 and a steady trend thereafter. Emissions followed the increased amount of municipal waste going to landfills until 2000, which decreased until 2016. Between 2016 and 2018, the amount of municipal waste going to landfills increased temporary before decreasing again in 2019. This situation over recent years leads to an increase in CH_4 emissions by 2.2 % between 2018 and 2019. Small amounts of CH_4 have been flared and recovered already in 1990, while the steady amount of CH_4 recovery can be found since 2015.

Italy, contributing with 13.9 % to EU-KP emissions in 2019, featured an increasing trend of CH_4 emissions from landfills until 2001 and a decreasing trend thereafter. This is driven, inter alia, by the increasing amount of waste landfilled until 2000 and a decrease thereafter. Also, CH_4 recovery has increased throughout the time series up to 2013 and decrease onward. The key drivers for the fall in emissions are the national policy diverting solid waste from landfill to waste incineration plants and waste diversion measures. Composting and mechanical and biological treatment have shown a remarkable rise due to the enforcement of legislation. In 2019, CH_4 emissions from managed solid waste disposal decreased by 0.2 % compared to 2018.

CH_4 emissions in **Spain**, contributing with 11.0 % to EU-KP emissions in 2019, increased almost continuously between 1990 and 2009 due to a growth of the annual municipal solid waste going to solid waste disposal sites. Key drivers are a growing population and the shift of waste disposal from unmanaged to managed landfills. CH_4 emissions are decreasing since 2009 with fluctuations from 2008 to 2015 due to fluctuations in the amount of CH_4 recovery. CH_4 recovery and flaring of CH_4 has already been practiced in earlier years and increased significantly from 2002 to 2009. In 2019, CH_4 emissions from solid waste disposal decreased slightly by 0.3 % compared to 2018.

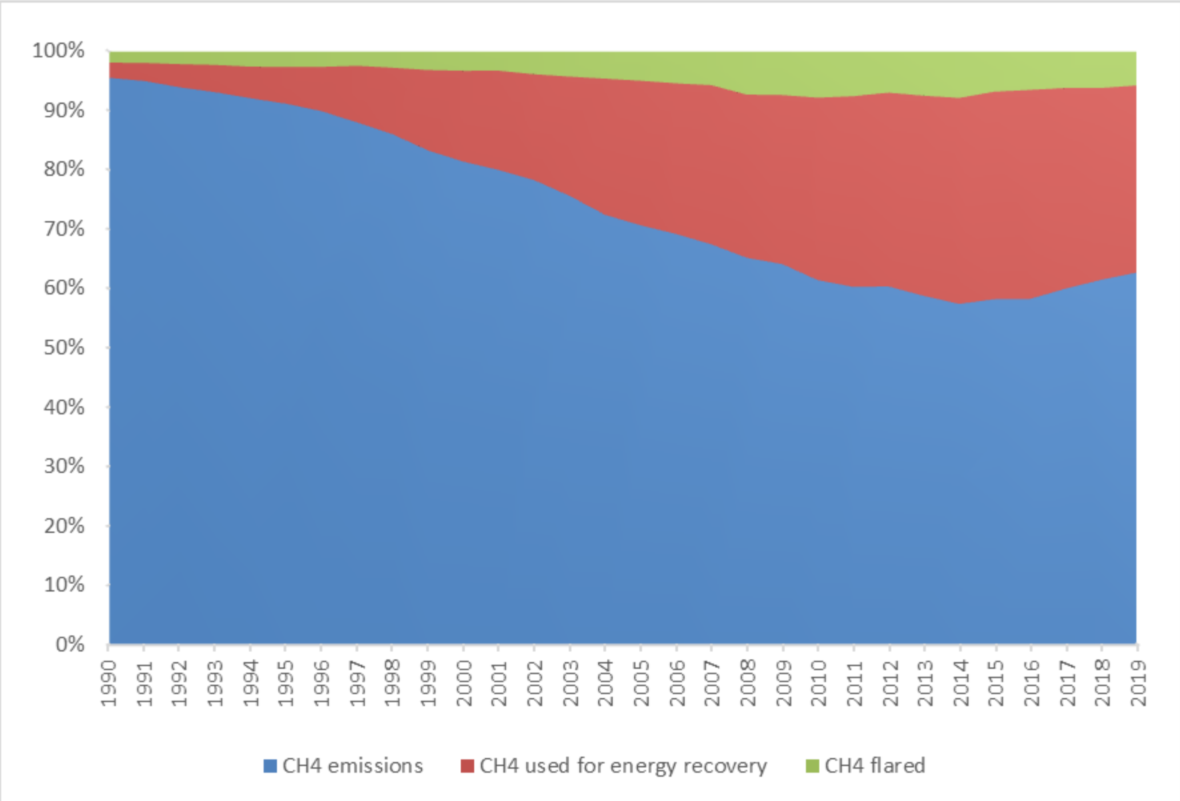
Germany, contributing with 8.5 % to EU-KP emissions in 2019, managed to reduce CH_4 emissions steadily until now from 1993 onwards. The amount of waste disposed on landfills shows a strong decrease from 1990 onwards, while in parallel CH_4 recovery increased. The highest share of CH_4 recovery could be found in 2002 and declined thereafter due to a strong decreasing amount of waste landfilled.

Methane recovery and flaring

Besides lower quantities of organic carbon deposited on landfills, the major determining factor for the decrease in net CH_4 emissions are increasing methane recovery rates from landfills and flaring of CH_4.

CH_4 recovery and flaring of CH_4 in EU-KP increased from 4.0 % of the total amount of CH_4 generated ("generated" = CH_4 emitted / (1-Ox) + CH_4 flared + CH_4 recovered where the oxidation factor Ox = 0.9) in managed landfills (only 5A1) in 1990 to 35 % in 2019 (Figure 7.8, Figure 1.9). Methane recovery is further promoted by the Landfill Directive, and monitoring programs are established. The recovery potential depends on the waste management strategies, e.g. diverting organic fractions to composting leaves more inert materials on landfills and reduces the potentials to recover and use CH_4. Compared to 2018, CH_4 recovery and CH_4 flaring decreased respectively by 4.9% and by 9.4 % in 2019 in managed landfills. This is caused by reduced amounts of waste landfilled and the ban of organic material in the landfilled waste.

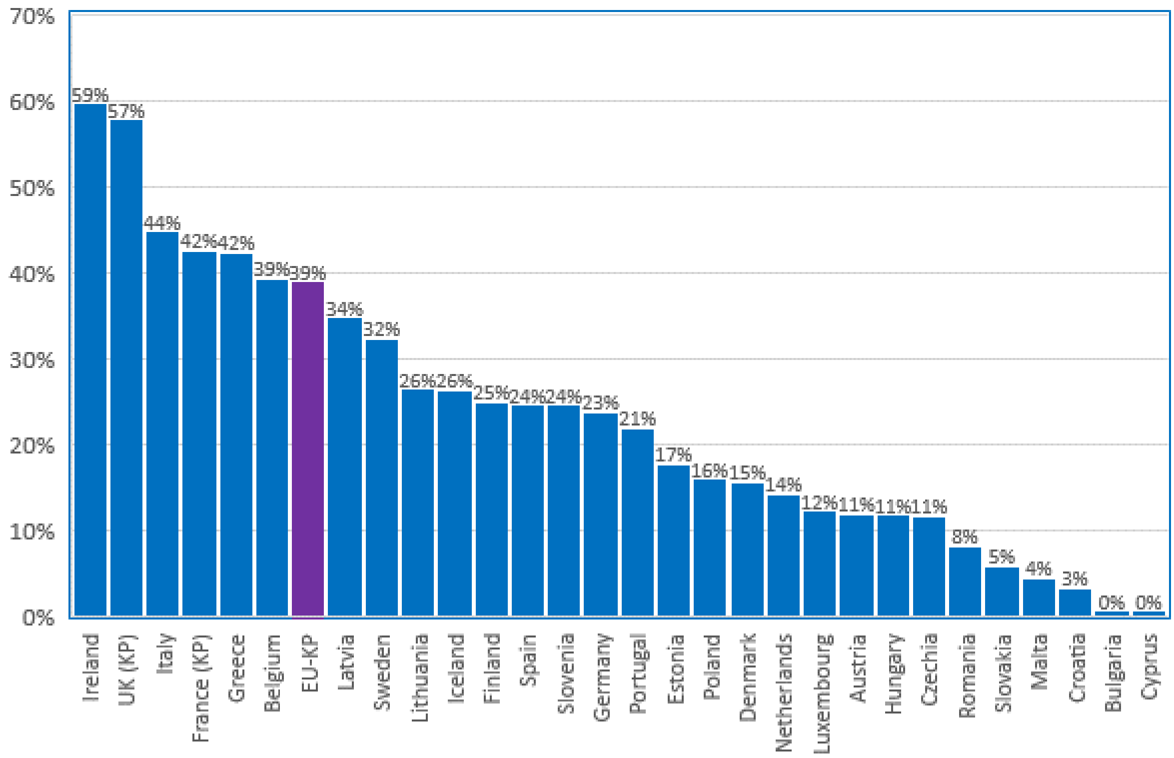
Figure 7.8 *5A1 Managed Solid Waste Disposal: Evolution of the share of methane used for energy recovery, methane flared and CH_4 emissions in managed landfills in the EU-KP*



Source: CRF 2021, Table 5A

The recovered CH_4 is the amount of CH_4 that is captured for energy use and is a country-specific value which has significant influence on the emission level. Additionally, the amount of CH_4 flared is considered. The percentage of CH_4 recovered and flared, in Figure 7.9, varies among the countries between 0 % in Cyprus and 60 % in Ireland and depends - amongst other - on the share of solid waste disposal sites where recovery installations exist. Cyprus does not report any data under 5.A CH_4 recovery and flaring in 2019. For 2011 - 2014 and 2017 Malta reported a small amount of CH_4 flared and in 2013 and 2014 a small amount for CH_4 recovery.

Figure 7.9 5A1 Managed Solid Waste Disposal: Methane recovery fraction (energy recovery and flaring) for 2019



CH_4 recovery and flaring in % = (CH_4 recovery in Gg + CH_4 flared in Gg)/ (CH_4 recovery in Gg + CH_4 flared in Gg + CH_4 emissions 5A1/0,9 in Gg)
CH_4 emissions from 5A2 unmanaged landfills are not included in this calculation
Source: CRF 2021 Table 5A

Methodological issues

For key sources in the source category 5A it is good practice to use the First Order Decay (FOD) method to calculate the emissions and to display emission trends over time. According to Table 7.3 the Czech Republic and Luxembourg apply a Tier 1 method to estimate CH_4 emissions from solid waste disposal on managed landfills. Giving the IPCC 2006 Guidelines for National Greenhouse Gas Inventories, the First Order Decay (FOD) method that accounts for the fact that the degradable organic components decay slowly over decades, has to be applied for all Tier levels. The Tier 1 method applies mainly default parameters and default activity data. The Tier 2 FOD method requires data on current as well as historic waste quantities, composition and disposal practices for several decades. Historical waste disposal data for 10 years or more should be based on country-specific statistics, surveys or other similar sources. In the following, a short overview of the most important parameters and methodological aspects of the FOD method is presented. The main factors influencing the quantity of CH_4 produced are the amount of waste disposed on land and the concentration of biodegradable carbon in that waste. Further methodological information for all EU countries and Iceland is provided in the Annex III of this submission.

Municipal Waste landfilled

The amount of waste disposed on SWDS depends on the total amount of waste generated and the share of waste disposed. The total amount of waste disposed can be calculated by using total population numbers, waste generation rate per capita and the share of waste disposed. The FOD method requires historic data on waste generation and the share of waste landfilled over decades but it is difficult to achieve consistent time series for the activity data over such long periods.

countries that do not have historic data on waste generation and waste disposal available use the default IPCC values for the waste generation rate per capita and the share of waste disposed and apply inter- or extrapolation methods to create a time series. Recent data on waste generation and waste disposal is available in most EU countries and Iceland and is not estimated based on the per capita waste generation rate and a share of waste landfilled, but on direct measurements.

The data sources used for generating time series of activity data by the countries and Iceland are summarized in the Annex III.

Industrial waste

Data on industrial waste may be difficult to obtain in many countries and there are only very few default values available. Only industrial waste that contains organic or fossil carbon fractions needs to be included in the inventory. Many countries do not provide any information on industrial waste landfilled, while other countries report that industrial waste is not reported separately and included under municipal solid waste. Further information on the reporting of industrial waste by the countries and Iceland is summarized in the Annex III.

Sludge

Some countries dispose of sludge from domestic and industrial wastewater plants in landfills. The amount of sludge from domestic wastewater might be included under municipal waste or sludge from industrial wastewater may be included under industrial waste. Double counting needs to be avoided by reporting a consistent amount of sludge that is disposed of on SWDS; only sludge that goes along with solid waste has to be accounted under this category. All other sludge that is composted, incinerated, treated in wastewater plants or applied to agricultural land should be accounted under other categories. There is no IPCC default activity data available. If no country-specific activity data is available on the amount of sludge that is disposed, composted, incinerated or spread on agricultural land, all emissions from sludge are included under wastewater treatment.

Waste composition

The amount of methane generated on SWDS depends strongly on the waste composition. Disposing waste with no or hardly degradable carbon (e.g. metal or plastics) does not contribute to CH_4 emissions, but the disposal of paper or food waste with large degradable organic carbon fractions leads to high CH_4 emissions. The composition of the waste landfilled is strongly influenced by waste management practices, such as recycling or composting. This leads also to varying waste compositions along the time series. Based on the information provided in the CRF tables and the NIR it is not possible to conduct a time series for waste composition in the EU-KP. Country specific information on waste composition is provided in the Annex III.

Landfill gas recovery

Countries use different methods to determine CH_4 recovery. Several countries combine different methods and sources to estimate the amounts of CH_4 recovered for flaring or for energy purposes, while other countries are using only one method. Data on landfill gas recovery can be based on measured plant specific data, questionnaires and surveys or can be taken from the energy statistics. Further information on CH_4 recovery in the country is provided in the Annex III of this submission.

Emission factors and parameters

Besides information on the amount of waste landfilled, the waste composition and the amounts of CH_4 recovered, other parameters are relevant for the calculation of CH_4 emissions from waste disposal. The fraction of degradable organic carbon (DOC) dissimilated in the individual waste fractions and the methane generation rate constant, which reflects the years necessary for the degradable organic carbon to decompose, are the most relevant parameters for calculating CH_4 emissions. Further parameters included in the calculation are the methane correction factor (MCF), the fraction of DOC that decomposes, the fraction of CH_4 in generated landfill gas and the oxidation factor.

Fraction of Degradable Organic Carbon (DOC): There are default IPCC values for DOC of the different waste fractions available (paper, food waste etc.). Some countries have conducted own chemical analysis to determine the DOC value of different waste fractions. The DOC content of total landfilled waste is based on the composition of waste and can be calculated from a weighted average of the carbon content of various components of the waste. Countries have MSW with widely differing waste compositions. If large amounts of organic waste is composted and waste is pretreated before disposed on landfills the average DOC is very low, even if still a high amount of waste is disposed. As waste composition varies over time and single DOC values are used for individual waste fractions the DOC-values also vary over time. A few examples: in the case of the United Kingdom, a detailed review of waste composition with regard to materials, moisture content and decomposable degradable organic carbon was carried out. For Austria composting became a more important waste treatment method. Consequently, considerable amounts of waste with high DOC are excluded from category 5A which results in a lower DOC for the remaining MSW. In addition the DOC reflects the considerable reductions achieved in diverting biodegradable waste to other waste management methods such as composting or mechanical-biological treatment. Within this submission a table in Annex III is provided containing detailed information on the DOC values extracted from the NIR.

Methane generation rate constant: CH_4 is emitted on SWDS over a long period of time rather than instantaneously. The FOD model can be used to model landfill gas generation rate curves for individual landfills over time. One important parameter is the methane generation rate constant (also referred to as k-value or half-life value). It is determined by a large number of factors associated with the composition of waste and the conditions at the site. The restructured CRF tables do not include information on the methane generation rate constant anymore. Within this submission a table in the Annex III is provided that contains corresponding detailed information on the methane generation rate constant extracted from the individual NIRs from the countries.

7.2.1.2 Unmanaged waste disposal sites (CRF Source Category 5A2)

CH_4 emissions from 5A2 Unmanaged Waste Disposal on Land account for 0.3 % of total EU-KP GHG emissions in 2019. Between 1990 and 2019, CH_4 emissions from this source decreased by 56.5 % (Table 7.4). In 2019, CH_4 emissions from unmanaged landfills decreased by 4.7 % compared to 2018. Almost all countries with unmanaged waste disposal feature a decreasing emission trend, due to a decreasing amount of municipal waste going to unmanaged waste disposal sites. Only Cyprus and Romania showed an increase of CH_4 emissions from unmanaged landfills between 1990 and 2019 (respectively +51% and +31 %). In Romania CH_4 emissions from unmanaged waste disposal sites increased until 2010, but showed a decreasing trend from 2010 onwards. Between 2010 and 2019 the CH_4 emissions decreased by 29 %. In Cyprus, CH_4 emissions from unmanaged waste disposal sites increased until 2010, and showed a steady trend from 2010 onwards.

Table 7.4 5A2 Unmanaged Waste Disposal on Land: Countries contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	3 434	1 325	1 325	10.9%	-2 109	-61%	0	0%	T2	CS,D
Croatia	310	93	76	0.6%	-235	-76%	-18	-19%	T2	CS
Cyprus	264	412	403	3.3%	139	53%	-9	-2%	T2	D
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	IE	NO	NO	-	-	-	-	-	NA	NA
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	NO	NO	NO	-	-	-	-	-	NA	NA
Greece	2 163	1 452	1 398	11.5%	-765	-35%	-54	-4%	T2	CS,D
Hungary	2 140	1 223	1 169	9.6%	-971	-45%	-54	-4%	T2	D
Ireland	1 318	IE	IE	-	-1 318	-100%	-	-	NA	NA
Italy	5 820	2 093	2 001	16.4%	-3 818	-66%	-91	-4%	T2	CS
Latvia	315	143	129	1.1%	-186	-59%	-14	-10%	T2	CS,D
Lithuania	345	145	135	1.1%	-209	-61%	-10	-7%	T2	D
Luxembourg	IE	IE	IE	-	-	-	-	-	NA	NA
Malta	41	8	8	0.1%	-34	-82%	0	-4%	M	M
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	7 156	2 615	2 438	20.0%	-4 718	-66%	-177	-7%	T2	CS,D
Portugal	2 076	720	672	5.5%	-1 405	-68%	-49	-7%	-	-
Romania	1 372	1 885	1 793	14.7%	421	31%	-92	-5%	T2	CS,D
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1 150	653	620	5.1%	-530	-46%	-32	-5%	T2	D
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-27+UK	**27 904**	**12 768**	**12 167**	**100%**	**-15 736**	**-56%**	**-601**	**-5%**	**-**	**-**
Iceland	133	24	22	0.2%	-111	-83%	-1	-6%	T2	CS,D
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**28 037**	**12 792**	**12 190**	**100%**	**-15 847**	**-57%**	**-602**	**-5%**	**-**	**-**

Note: According to the MS NIR Ireland, Portugal and Malta apply a Tier 2 method to calculate CH_4 emissions from waste disposal on unmanaged landfills.
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data

CH_4 emissions from unmanaged solid waste disposal sites decreased considerably between 1990 and 2019 by 57 %. *Figure 7.10* shows the trend of emissions indicating the countries contributing most to

EU-KP total. In comparison to the rather drastic decrease of the amount of waste disposed on unmanaged landfills (see *Figure 7.11*) CH_4 emissions from unmanaged landfills show only a moderate decrease during the time series.

Not all countries reported emissions from this source since all waste disposal sites in the countries are managed (Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Luxembourg, the Netherlands, Slovakia, Slovenia, Sweden and the United Kingdom) or they are included elsewhere (Ireland). Poland, Italy, Romania, Bulgaria and Greece, are responsible for about 74 % of the total EU-KP emissions from unmanaged waste disposal sites in 2019. Poland, Italy and Bulgaria show large absolute reductions between 1990 and 2019.

Figure 7.10 5A2 Waste disposal on unmanaged landfills: CH_4 emissions (Trend in relevant countries)

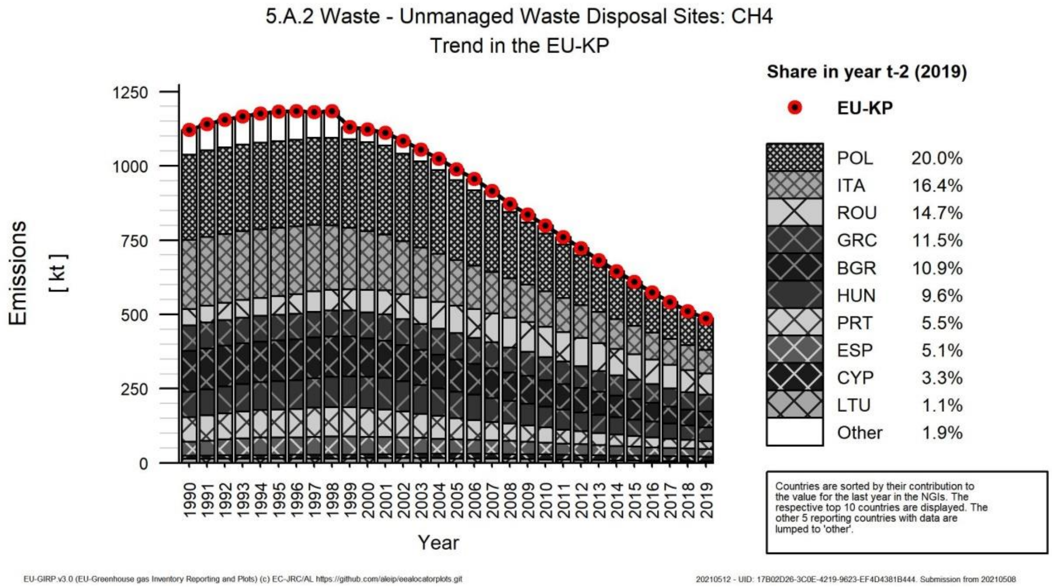
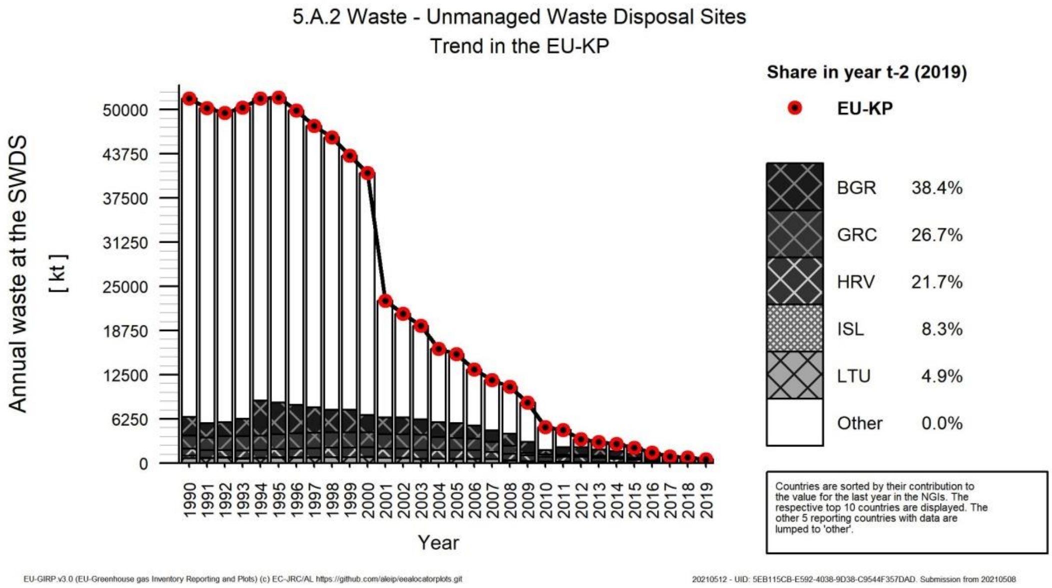


Figure 7.11 shows the relevant trends for the amount of waste disposed on unmanaged landfills. In the description below Figure 1.11 we focus on the countries with the highest CH_4 emissions from unmanaged SWDS in 2019. Note that, in some countries, waste disposal in unmanaged landfills was practiced but does not occur anymore. However, emissions are still produced from the waste disposed in the past. For the following countries, there are still emissions, but no more waste is disposed on the unmanaged landfills as from the year mentioned: Ireland since 1999, Italy since 2000, Hungary since 2001, Finland since 2002, Portugal and Malta since 2005, Slovakia since 2010, Poland since 2012, Latvia and Spain since 2013, Romania in 2018 and Cyprus since 2019.

For countries still using unmanaged landfills (Bulgaria, Croatia, Greece, Iceland, Lithuania), solid waste disposal on unmanaged landfillsites is still practiced, but the amount of waste disposed is considerably decreasing since 1992. The highest reductions in the amount of waste disposed between 1990 and 2019 are found for Lithuania, Bulgaria and Greece. In countries which still dispose waste in unmanaged landfills in 2019, the relative decrease of waste disposed is higher than 90% in comparison with 1990, except for in Iceland (-85%) and Croatia (-88%).

Figure 7.11 5A2 Waste disposal on unmanaged landfills: Total waste disposed on unmanaged landfills (Trend in relevant countries)



Poland's CH_4 emissions from the disposal of solid waste on unmanaged landfills contribute 20.0 % to EU-KP emissions from this source category in 2019. Since 2001 the emissions show a decreasing trend. Key drivers for this decrease are the implementation of the landfill directive 1999/31/EC and the introduction of new waste treatment technologies that reduce the amount of waste disposed on unmanaged landfills (zero disposal on unmanaged SWDS in Poland since 2012).

Italy, contributing with 16.4 % to EU-KP emissions in 2019, managed to reduce CH_4 emissions from solid waste disposal on unmanaged landfills already from 1991 onwards. The reduction of emissions from unmanaged waste disposal on land is caused by legal acts. The first legal provision concerning waste management was issued in 1982. In this decree, uncontrolled waste dumping as well as unmanaged landfilling is forbidden, but the enforcement of these measures was concluded only in 2000. Thus the share of waste disposed on uncontrolled landfills gradually decreased, and in the year 2000 it is assumed to be zero; nevertheless emissions still occur due to the waste disposed in the past years.

Romania is contributing with 14.7 % to EU-KP CH_4 emissions from unmanaged landfills in 2019. From 2010 CH_4 emissions are declining. The amount of waste disposed on unmanaged landfills is zero since 2018.

Bulgaria is contributing with 10.9 % to EU-KP CH_4 emissions from unmanaged landfills in 2019. CH_4 emissions are declining over the time series, due to a reduction of waste disposed on unmanaged landfills. In 2019, waste is still disposed on uncontrolled landfills in Bulgaria.

Methodological issues

CH_4 emissions from unmanaged solid waste disposal sites were reported in 13 EU countries (Bulgaria, Croatia, Cyprus, Greece, Hungary, Italy, Latvia, Lithuania, Malta, Poland, Portugal, Romania and Spain) and Iceland. Only four of these EU countries (Bulgaria, Croatia, Greece, and Lithuania) and Iceland still dispose MSW to unmanaged SWDS, although in small quantities, while in all other countries waste disposal from the past still cause emissions in 2019 (see Table 7.4). 100% of all EU-KP emissions from this category are calculated using higher tier methods.

CH_4 emissions from waste disposal on unmanaged landfills are calculated similar to CH_4 emissions from managed landfills, using the amount of waste disposed on unmanaged landfills. If no other data is available the same data on waste composition and the same parameters as used for managed landfills can be applied in the calculation. The Methane Correction Factor (MCF) is the relevant parameter that differentiates between managed and unmanaged landfills. The Methane Correction Factor reflects the way in which a SWDS is managed and the effect of management practices on CH_4 generation. According to the 2006 IPCC Guidelines, the MCF for unmanaged disposal of solid waste depends of the type of site – shallow or deep. The IPCC default MCF for deep unmanaged landfills is 0.8, while shallow unmanaged landfills have an MCF of only 0.4 as in shallow landfills more waste decomposes aerobically. Table 7.5 shows the different MCFs used by countries to estimate CH_4 emissions from waste disposal on unmanaged landfills in 2018. All countries use a MCF between 0.6 and 0.8, except for Iceland (MCF = 0.2). Iceland refers to two landfill gas studies that found out that unmanaged landfills in Iceland have reduced CH_4 production in comparison to the default IPCC MCF value.

Table 7.5 5A2 Waste disposal on unmanaged landfills: MCFs applied by countries in 2019

Member State	MCF
Bulgaria	0.8
Croatia	0.8
Greece	0.8
Iceland	0.2
Lithuania	0.56

Source: CRF Table 5.A 2019,

7.2.1.3 Recalculations (CRF Source Category 5A)

Table 7.6 provides information on the contribution of Countries to EU recalculations in CH_4 emissions from 5A Solid Waste Disposal on Land for 1990 and 2018 and main explanations (as available in the national inventory reports) for the largest recalculations in absolute terms. Countries contributing most to the recalculations in the year 2018 for the sector 5.A in absolute terms are Croatia and France.

Table 7.6: 5A Solid Waste Disposal on Land: Contribution of countries to EU recalculations in CH_4 emissions for 1990 and 2018 (difference between latest submission and previous submission)

	1990		2018		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-106	-10.1	Revised estimate (ESD Review 2020)

	1990		2018		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Belgium	-86	-2.8	-71	-9.2	Flemish region: recalculation as the result of corrections in emission estimates during the ESD-review 2020. Walloon region: recalculation as the result of same corrections of Flanders.
Bulgaria	-1 511	-30.6	-185	-6.7	*Not available in MMR-IRArticle8*
Croatia	-213	-39.4	-526	-29.7	usage of OX=0.1 for managed landfills and OX=0 for unmanaged landfills, usage of CS-value for DOC in industrial waste.
Cyprus	5	2.1	-8	-1.6	Revised data from Statistical Service of total MSW production
Czechia	-187	-9.4	-377	-10.1	updated IEF (F factor was changed from 0.55 to 2006 IPCC GL default 0.5 value to avoid overestimation)
Denmark	0	0.0	16	2.9	Minor changes (less than 3%) in the time trend and the year emissions in the period 2010-2018 for this year´s submission are due updated activity data obtained from the Danish EPA
Estonia	-	-	-18	-9.0	The recalculation is connected with the Oxidation Factor value 0 (OX) used for calculation CH_4 emissions until 2021 submission. The OX value should be 0.1 for managed landfills covered with CH_4 oxidising material. Considering that before 2009 there were no managed landfills a linear interpolation between 2009 and 2015 is applied. Since 2015 almost all waste is disposed in managed landfills. The OX applied takes into consideration that for some landfills, OX lower than 0.1 is applicable.
Finland	-	-	-	-	No recalculations
France	-32	-0.3	461	3.8	- Change in the quantities of biogas captured (correction of duplicates on certain sites) => leads to a decrease in the quantity of biogas captured and therefore an increase in CH_4 emissions. - Modification of the quantities of waste landfilled in 2016 and 2018 (taking into account the ITOM 2018 survey) -> increase in the quantities landfilled in 2018. - Addition of the quantities of sludge landfilled in 2015 (correction of an error)
Germany	-	-	-23	-0.3	Regular recalculations are necessary every year for the previous year, since the waste statistics of the Federal Statistical Office are published with a delay of one year for the data on the amount and compositions of waste deposited, and data on the quantities of landfill gas collected on landfill are collected at two-year intervals. So, the current reporting year must be estimated. The estimate is replaced in the following year by the current data. For the above reasons, a recalculation became necessary.
Greece	-	-	-18	-0.5	Updated activity data as far as the amounts MSW for the period 2015 – 2018 have been utilized.
Hungary	11	0.4	3	0.1	2018 :Correction of an interpolation error in AD (1970-75), revised OX factors from 2004 1990: Correction of an interpolation error in the backward time series
Ireland	-	-	0	0.0	Negligeable recalculation (< 0.05% of the national total)
Italy	-	-	65	0.5	Update of amount and composition of waste disposed in landfills
Latvia	32	11.2	16	4.1	Time series for CH_4 calculations from SWD were prolonged till 1950. That gives impact to total emissions in all years.
Lithuania	-	-	-62	-9.4	Waste disposal in new modern regional landfills started in 2008. In the same time remediation of old landfills and dumps started including covering with soil. Assuming that methane is oxidised during diffusion through any soil layer (daily and intermediate cover or final cap) methane emissions starting from 2008 were recalculated using methane oxidation factor OX = 0.1. In addition, composition of waste directed for disposal was recalculated assuming that about 50% of recyclable plastics, glass, and metals as well as part of biodegradables separated for biological treatment were removed from the original waste stream. In this submission also composition of landfilled MSW was recalculated by subtracting the amount of biodegradable components directed for composting from the total amount of MSW, which resulted in additional reduction of CH_4 emissions.
Luxembourg	1	0.9	0	0.2	Negligeable recalculation (< 0.05% of the national total)

	1990		2018		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Malta	-	-	-15	-9.6	The waste composition in the FOD managed model and the oxidation factor value, were updated as recommended during the ESD 2020 review.
Netherlands	-	-	6	0.2	Compared with the previous submission, minor errors in the data have been corrected in this submission.
Poland	-89	-0.6	-349	-4.1	Correction of methodology of estimating amount of methane in recovered biogas and division on unmanaged landfills between shallow and deep.
Portugal	-	-	-	-	No recalculation
Romania	-	-	46	1.3	The activity data are updated due to recalculation made by Waste Directorate, regarding the composition of municipal solid waste for 2011-2018 period.
Slovakia	52	8.0	-15	-1.3	Implementation of the ESD recommendation regarding the oxidation factor (10%). In addition, further revisions were implemented in the municipal and industrial SWDS.
Slovenia	-	-	-	-	No recalculation
Spain	-	-	-14	-0.1	As the focal point supplied the quantity of waste one year late, the quantity for 2018 has been updated.
Sweden	-	-	-43	-5.5	New emission estimates due to revised AD on landfilled waste: New estimates on DOC content of landfilled waste and new data on quantities of landfilled waste.
United Kingdom	-	-	-33	-0.2	
EU27+UK	-2 016	-1.1	-1 250	-1.3	
Iceland	-8	-5.1	-22	-10.0	Following the 2020 EU Comprehensive review, the oxidation factor for Managed SWDS was changed from 0 to 0.1 and the DOC for Industrial waste was updated as well leading to recalculations.
United Kingdom (KP)	-44	-0.1	-77	-0.5	- Data on waste landfilled for Wales for 2017 2018 was updated following a revision to EWC codes for inert material. - Revision of methane flaring data for Scotland for 2018.
EU-KP	-2 069	-1.1	-1 315	-1.3	

7.2.2 Biological treatment of solid waste (CRF Source Category 5B)

Source category 5B Biological treatment of solid waste includes the key source CH_4 from 5B1 Composting. Besides composting the source category 5B includes the subcategory 5B2 anaerobic digestion and also emissions from mechanical-biological treatment according to the IPCC 2006 Guidelines. The whole sector 5.B contributes only 0.20 % to EU-KP total GHG emissions without LULUCF in 2019. Decomposition of biomass during biological treatment is much faster than on landfills and the CH_4 emissions are estimated on an annual basis without the need for long time series as in the case of landfills. For composting the decomposition of the organic waste fraction takes place under aerobic conditions. In anaerobic digestion processes the decomposition takes place without oxygen. Further information on emission trends and methodologies is only provided for source category composting 5B1, as anaerobic digestion 5B2 is no EU key source.

Table 7.7 provides total GHG and CH_4 and N_2O emissions by Member State and Iceland from 5B Biological treatment of solid waste. Total emissions from this category increased considerably since 1990. Twelve countries (Bulgaria, Croatia, Cyprus, Czech Republic, Iceland, Ireland, Luxembourg, Malta, Lithania, Romania and Slovenia) did not practice this kind of waste treatment in 1990. Due to landfill regulations etc. this type of waste treatment increased considerably during the last years and all countries report emissions from this category since 2011.

Table 7.7 5B Biological treatment of solid waste: Countries contributions to total GHG emissions and CH_4 and N_2O emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2019 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2019 (kt CO2 equivalents)
Austria	36	183	23	99	13	83
Belgium	7	58	4	35	3	23
Bulgaria	NO	16	NO	7	NO	10
Croatia	NE,IE,NO	9	NO,NE,IE	4	NO,NE,IE	5
Cyprus	NO	10	NO	4	NO	6
Czechia	NE,IE	717	NE,IE	73	NE,IE	644
Denmark	55	482	22	74	32	407
Estonia	1	38	0	16	1	22
Finland	44	128	18	49	26	79
France	312	1 291	51	204	261	1 087
Germany	41	1 008	16	306	25	701
Greece	0	88	NO	20	0	68
Hungary	9	155	4	42	5	114
Ireland	NO	44	NO	18	NO	27
Italy	25	608	20	494	5	114
Latvia	29	60	12	18	17	42
Lithuania	0	86	0	25	0	61
Luxembourg	NA,IE,NO	25	NA,NO	6	NO,IE	19
Malta	NO	2	NO	NO,NA	NO	2
Netherlands	11	205	7	91	4	114
Poland	22	209	9	87	13	122
Portugal	9	39	4	14	5	25
Romania	NO	56	NO	23	NO	33
Slovakia	111	188	46	78	65	110
Slovenia	NO	19	NO	8	NO	11
Spain	204	583	85	233	119	350
Sweden	12	108	5	25	7	83
United Kingdom	31	1 960	13	729	18	1 231
EU-27+ISL	**959**	**8 376**	**340**	**2 782**	**620**	**5 594**
Iceland	NA,NO	4	NO,NA	2	NO,NA	2
United Kingdom (KP)	31	1 961	13	730	18	1 232
EU-KP	**959**	**8 382**	**340**	**2 785**	**620**	**5 597**

Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.2.1 Waste Composting (CRF Source Category 5B1)

Emission and Trends

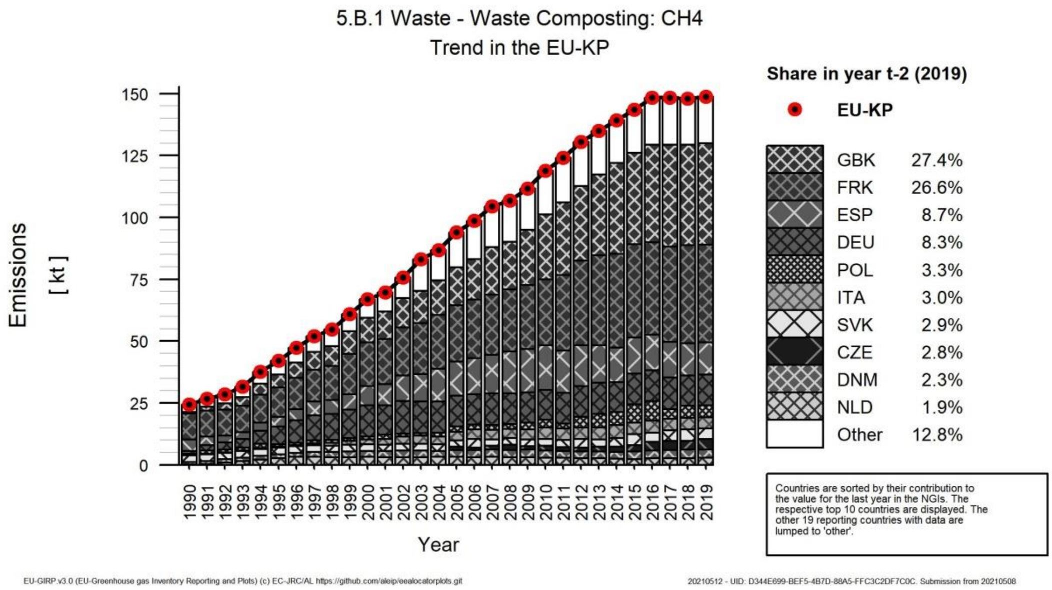
CH_4 emissions from 5B1 Composting account for 0.08 % of total EU-KP GHG emissions in 2019. Between 1990 and 2019, CH_4 emissions from this source increased considerably from 611 kt CO_2 equivalents to 3717 kt CO_2 equivalents in 2019 (Table 7.8). Malta reports emissions from composting only in the period 1993 - 2006. All countries that practice composting feature an increasing emission trend from 1990 onwards. Nevertheless between 2018 and 2019 nine countries experienced a decrease in CH_4 emissions from composting, among which five experienced a decrease higher than 5% (Latvia, Estonia, Lithuania, Portugal and Slovakia). Total CH_4 emissions from composting in EU-KP increased slightly by 0.6% between 2018 and 2019 with as most important increase in Czechia and United Kingdom (KP).

Table 7.8: 5B1 Waste Composting: Countries contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	13	60	61	1.6%	48	369%	1	2%	T2	CS
Belgium	3	20	23	0.6%	20	785%	3	15%	T1	CS
Bulgaria	NO	10	10	0.3%	10	∞	0	0%	T1	D
Croatia	IE,NE	5	5	0.1%	5	∞	0	4%	T1	D
Cyprus	NO	5	6	0.2%	6	∞	1	22%	T1	D
Czechia	NE	92	103	2.8%	103	∞	11	12%	T1	D
Denmark	27	83	86	2.3%	60	224%	3	4%	CS,T1	CS,OTH
Estonia	1	25	22	0.6%	22	3189%	-2	-9%	T1	D
Finland	26	58	69	1.9%	43	169%	11	19%	T1	D
France	259	990	989	26.6%	730	282%	-1	0%	T2	CS
Germany	25	308	308	8.3%	282	1114%	-1	0%	T2	CS
Greece	NO	28	28	0.8%	28	∞	0	0%	D	D
Hungary	5	56	58	1.6%	53	1063%	2	4%	T1	D
Ireland	NO	24	24	0.7%	24	∞	0	0%	T1	D
Italy	5	117	112	3.0%	108	2331%	-5	-4%	D	CS
Latvia	17	28	25	0.7%	8	48%	-3	-11%	D	D
Lithuania	0	38	35	0.9%	35	16954%	-3	-9%	T1	D
Luxembourg	NO	8	8	0.2%	8	∞	0	1%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	4	70	71	1.9%	66	1553%	1	1%	T1	CS
Poland	13	119	122	3.3%	109	860%	3	3%	T1	D
Portugal	5	21	19	0.5%	14	287%	-2	-7%	T1	D
Romania	NO	34	33	0.9%	33	∞	-1	-3%	T1	D
Slovakia	65	116	110	2.9%	45	69%	-6	-6%	T1	D
Slovenia	NO	11	11	0.3%	11	∞	0	3%	T1	D
Spain	119	325	325	8.7%	206	173%	0	0%	T1	D
Sweden	7	35	35	1.0%	28	400%	0	1%	T1	D
United Kingdom	18	1 010	1 019	27.4%	1 001	5521%	9	1%	T1	D
EU-27+UK	**611**	**3 694**	**3 717**	**100%**	**3 107**	**509%**	**24**	**1%**	**-**	**-**
Iceland	NO,NA	2	2	0.1%	2	∞	0	-1%	T2	CS,D
United Kingdom (KP)	18	1 011	1 020	27.4%	1 002	5527%	9	1%	T1	D
EU-KP	**611**	**3 698**	**3 721**	**100%**	**3 110**	**509%**	**23**	**1%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 7.12 5B1 Waste Composting: CH_4 emissions (Trend in relevant countries)



Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Emissions from 5.B.1 relate with composting of municipal (5.B.1.a) and composting of other waste (5.B.1.b). As stated in figure ***Figure 7.14 5B1b Waste Composting of other waste : CH4 emissions (Trend in relevant countries)***, only 11 countries (Denmark, Slovakia, the Netherlands, Czech Republic, Finland, Hungary, Estonia, Lithuania, Poland, Latvia and Luxembourg) report emissions from other waste composting. Other countries generally report emissions from composting of all types of waste (municipal, industrial, sludge…) in the category 5.B.1.a since statistal data concerning composting generally relate to total waste and do not make a distinction between the various types of waste.

Figure 7.13 5B1a Waste Composting of municipal waste: CH_4 emissions (Trend in relevant countries)

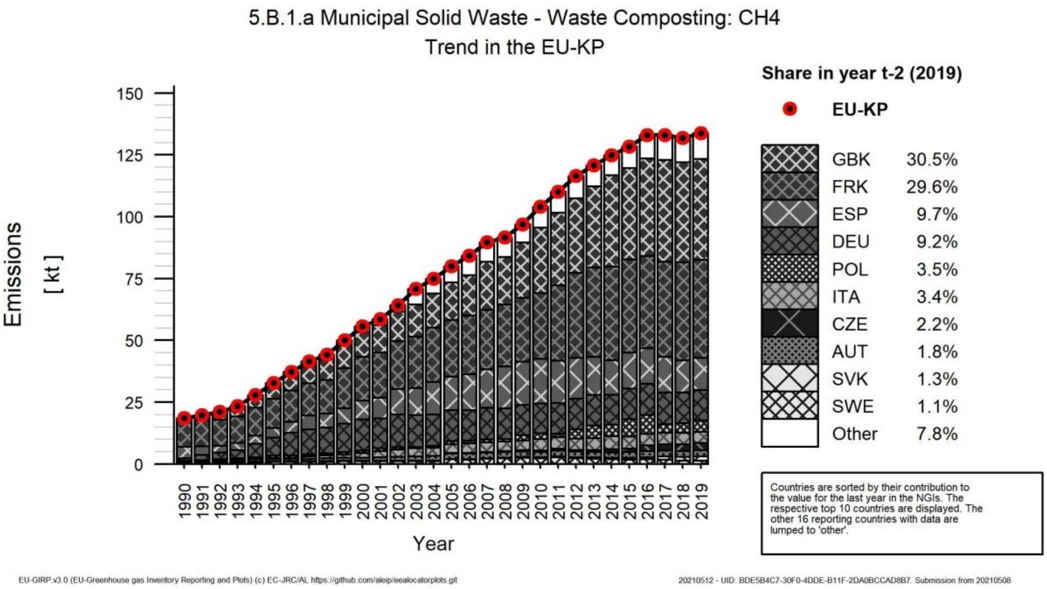
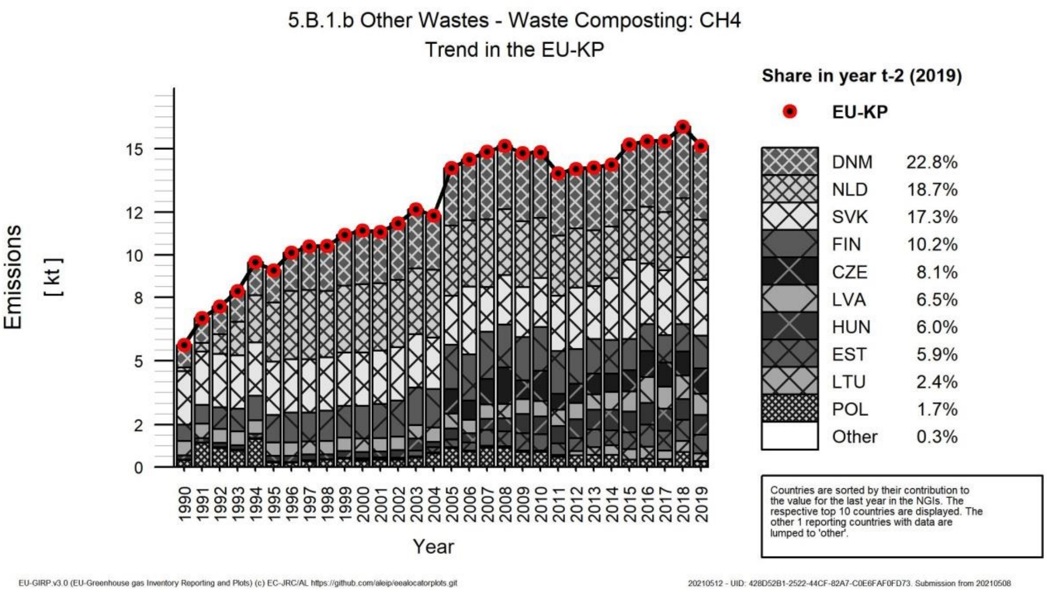


Figure 7.14 5B1b Waste Composting of other waste : CH_4 emissions (Trend in relevant countries)



Methodological information

According to the IPCC 2006 Guidelines CH_4 from composting is estimated by using the quantity of organic waste processed by composting and the respective emission factor. The application of a Tier 2 method requires the use of a country specific emission factor based on representative measurements. The IPCC default emission factor for CH_4 emissions from composting is 10 g CH_4/kg waste treated on a dry weight basis and 4 g CH_4/kg based on a wet weight basis. The range of this emission factor is very high and varies between 0.08 and 20 g CH_4/kg waste treated. Most countries apply the default EF for CH_4 emissions (see

Table 7.9). In all cases the EFs (wet vs. dry) applied by the countries are consistent with the unit of AD (wet vs. dry), even if few Member States (Cyprus and Czechia) reported on a wet basis in the CRF tables although dry basis should be reported. Only Austria, Belgium, Finland, France, Germany, Italy, the Netherlands, Poland and Sweden present IEFs different from the default one and these EFs are within the interval indicated in the 2006 IPCC guidelines. In most cases country specific EFs are much lower than the IPCC default EF.

Table 7.9 5B1 Composting: EFs applied by countries in 2019 in g CH_4/kg waste treated (dry basis)

Member State	CH4 IEF g/kg dry matter		Member State	CH4 IEF g/kg dry matter
Austria	1.8		Ireland	10.0
Belgium	0.75		Italy	1.62
Bulgaria	10.0		Latvia	10.0
Croatia	10.0		Lithuania	10.0
Cyprus	4.5		Luxembourg	10.0
Czech Republic	4		Malta	NO
Denmark	NO		Netherlands	0.87
Estonia	10.0		Poland	6.67
Finland	5.6		Portugal	10.0
France	8.3		Romania	10.0
Germany	1.4		Slovakia	10.0
Great Britain	10.0		Slovenia	10.0
Greece	10.0		Spain	10.0
Hungary	10.0		Sweden	11.4
Iceland	10.0		United Kingdom (new_KP)	10.0

Further methodological information for all countries is provided in the Annex of this submission

7.2.2.2 Recalculations (CRF Source Category 5B)

Table 7.10 provides information on the contribution of countries to EU recalculations in CH_4 from 5B Biological treatment of solid waste for 1990 and 2019 and main explanations (if available in countries' inventories) for the largest recalculations in absolute terms.

Table 7.10: 5B Biological treatment: Contribution of countries to EU recalculations in CH_4 for 1990 and 2018 (difference between latest submission and previous submission)

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	No recalculation
Belgium	-	-	4	22.4	In Wallonia and in Flanders, activity data (amount of waste composted) of 2018 have been updated during this submission.
Bulgaria	-	-	-	-	No recalculation
Croatia	-	-	-	-	No recalculation
Cyprus	-	-	2	50.5	Emissions from composting (5B1) were recalculated for the time series 2010-2018, due to revised data on composting provided by the Statistical Service.
Czechia	-	-	-	-	No recalculation
Denmark	-8	-19.8	-21	-5.9	Regarding 5B1, change in the time trend for this year´s submission are due to updating of the activity data on sludge and throughout the time series due to updating of the CH_4 (and N_2O) EF values for the waste types GPW, Sludge and Home composting. Regarding 5.B.2, changes in year 2018 is caused by updated activity data obtained from the Danish Energy Agency.
Estonia	-	-	3	13.2	The reason for the recalculation is that companies have started reporting composting activities under the recovery operation R12o (biological treatment prior to waste recovery) and as a result of further investigating waste data these amounts are included in this submission. Previously, activity data in recovery operation R3o (composting) and data only from sewage sludge companies reporting R12o was used in calculations.
Finland	-	-	-	-	No recalculation
France	0	0.0	61	5.9	Change in the amount of composted waste in 2018 due to the latest ITOM survey.
Germany	-	-	-21	-2.9	When the current inventory data are compiled, statistical data (Federal Statistical Office) are only available for the previous year. Indeed, data are only available for the previous reporting year as the waste statistics of the Federal Statistical Office are published two years in arrears. The current reporting year is therefore estimated by extrapolation of the basis of the trend of the activity data of the past three years This extrapolation is then updated in the following year by the data then collected statistically.
Greece	-	-	5	9.1	Updated activity data for 2018 have been utilized.
Hungary	-	-	-	-	No recalculation
Ireland	-	-	12	79.7	Activity Data for 5B1- Composting updated to include commercial waste composted. Anaerobic digestion data also added for the first time.
Italy	-	-	-	-	No recalculation
Latvia	-	-	19	69.5	CH_4 emissions are calculated from waste anaerobic digestion.
Lithuania	-	-	1	2.2	Data on waste biological treatment were reviewed and updated
Luxembourg	-	-	-0	-0.5	For the year 2018, the waste composition analysis was updated which led to a recalculation in category 5.B.1.b – MBA treated MSW. This was due to a slightly higher percentage of inert waste in MSW.
Malta	-	-	1	123.0	An update in the activity data as provided by the data provider.
Netherlands	-9	-68.8	-0	-0.3	Compared with the previous submission, minor errors in the data have been corrected in this submission. Additionally, CH_4 emissions from the digesting of manure (category 5B2) have been added from the starting year 2006
Poland	-	-	-	-	No recalculation
Portugal	-	-	-0	-0.3	Revision of activity data (reallocation of Composting to AD for one instalation).
Romania	-	-	-	-	No recalculation
Slovakia	-	-	-	-	No recalculation
Slovenia	-	-	-	-	No recalculation
Spain	-	-	-30	-8.0	Emissions for 2018 have been recalculated due to updated information for that year. This is due to the time lag between the reference year for the waste data and the latest year reported by the data and the last year reported by the National Inventory.

	1990		2018		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					In addition, information on six biomethanisation plants has been included for the period 2009-2018.
Sweden	-	-	-	-	No recalculation
United Kingdom	-	-	16	1.3	
EU27+UK	**-17**	**-2.7**	**51**	**0.9**	
Iceland	-	-	-	-	No recalculation
United Kingdom (KP)	-	-	16	1.3	The inputs to anaerobic digestion plants have been revised and the historic timeline updated. This resulted in an incre ase in the quantity of waste assumed to be processed at anaerobic igestion facilities, and associated methane.
EU-KP	**-17**	**-2.7**	**51**	**0.9**	

7.2.3 Incineration and open burning of waste (CRF Source Category 5.C)

This category includes incineration and open burning of waste. Emissions from waste incinerated for energy use are reported under 1A Fuel combustion activities. Emissions from on field burning of agricultural wastes should be reported under 3 Agriculture.

Incineration and open burning of waste is not a key category for the European Union. Some additional information can be found in the chapter 3.2.8 dedicated to waste- non key categories.

7.2.4 Wastewater treatment and discharge (CRF Source Category 5D)

Source category 5D includes the CH_4 and N_2O emissions from domestic and industrial and other wastewater treatment and discharge. Methane and nitrous oxide are produced from microbial processes (anaerobic decomposition of organic matter, nitrification) in sewage systems and facilities. N_2O is also indirectly released from disposal of wastewater effluents into aquatic environments[58]. According to the key category analysis CH_4 and N_2O emissions from 5D1 Domestic wastewater and CH_4 emissions from 5D2 Industrial wastewater are an EU key source and analysed in more detail in this chapter. N_2O emissions from industrial wastewater are not a EU key source and are therefore not further analysed in this chapter.

Domestic wastewater includes the handling of liquid wastes and sludges from housing and commercial sources through wastewater collection and treatment, open pits/latrines, ponds, or discharge into surface waters. Industrial wastewater can also be released into domestic sewer systems and resulting emissions are in that case included under domestic wastewater. On the other hand, industrial wastewater can be treated on the industrial site and then the resulting emissions will be accounted under the separate category 5D2 industrial wastewater.

Total emissions from 5D wastewater handling, including N_2O and CH_4 emissions account for 0.6 % of total EU-KP GHG emissions in 2019. Table 7.11 shows total GHG, CH_4 and N_2O emissions by Member State from 5D Wastewater Handling. Between 1990 and 2019, total emissions from wastewater

[58] In most countries, indirect N_2O emissions from disposal of wastewater effluents are the major source of N_2O emissions from wastewater handling, whereas direct N_2O emissions from wastewater treatment plants are small or not relevant.

handling decreased by 43.7 % in EU-KP. All countries except for France and Ireland decreased their emissions from wastewater treatment and discharge between 1990 and 2019. Due to the implementation of new wastewater treatment technologies CH_4 emission decreased considerably by 50.2 % between 1990 and 2019, while N_2O emissions decreased moderately by 16.8%.

Table 7.11 5D Wastewater handling: Countries' contributions to total GHG, CH_4 and N_2O emissions from 5D

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2019 (kt CO2 equivalents)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2019 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2019 (kt CO2 equivalents)
Austria	219	192	96	170	122	23
Belgium	1 068	341	138	102	930	239
Bulgaria	2 842	537	198	138	2 644	400
Croatia	656	542	67	91	589	451
Cyprus	128	63	12	17	116	46
Czechia	1 124	1 102	234	198	890	904
Denmark	280	196	239	144	41	52
Estonia	151	85	39	33	113	52
Finland	297	240	76	74	221	165
France	2 215	2 656	724	398	1 491	2 258
Germany	3 994	1 010	1 421	513	2 572	497
Greece	2 621	1 423	280	293	2 341	1 130
Hungary	1 050	324	148	86	902	238
Ireland	136	151	75	100	61	51
Italy	4 474	3 788	1 266	1 341	3 209	2 447
Latvia	388	109	53	32	335	76
Lithuania	490	163	67	42	423	120
Luxembourg	13	7	5	5	8	2
Malta	27	16	10	8	17	7
Netherlands	481	306	172	75	309	231
Poland	7 041	3 358	723	771	6 318	2 586
Portugal	1 717	914	200	180	1 517	735
Romania	3 714	2 068	397	431	3 317	1 637
Slovakia	596	333	130	49	466	284
Slovenia	324	171	39	38	285	133
Spain	6 043	2 579	863	813	5 180	1 766
Sweden	263	228	226	198	38	30
United Kingdom	3 075	2 646	925	996	2 150	1 650
EU-27+ISL	**45 428**	**25 546**	**8 824**	**7 334**	**36 605**	**18 211**
Iceland	55	48	5	6	50	42
United Kingdom (KP)	3 099	2 683	939	1 016	2 160	1 667
EU-KP	**45 507**	**25 631**	**8 843**	**7 361**	**36 664**	**18 270**

Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.4.1 Domestic wastewater (CRF Source Category 5D1)

CH_4 emissions

CH_4 emissions from 5D1 Domestic Wastewater account for 0.3 % of total EU-KP GHG emissions without LULUCF in 2019. Between 1990 and 2019, CH_4 emissions decreased by 56% (Table 7.12). Key drivers for the large emission reduction are the development of centralized wastewater treatment plants (especially implementing aerobic treatments) and an increase of CH_4 recovery and flaring on anaerobic systems (see ***Figure 7.16***). In 2019, CH_4 emissions decreased by 1.6 % in comparison to 2018.

Table 7.12 5D1 Domestic and commercial wastewater: Countries' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	121	19	19	0.2%	-102	-84%	0	0%	T2	CS,D
Belgium	930	245	239	2.0%	-691	-74%	-6	-2%	CR,T1	CR,D
Bulgaria	422	238	234	2.0%	-188	-45%	-4	-2%	T2	D
Croatia	492	337	334	2.8%	-159	-32%	-3	-1%	T1	D
Cyprus	92	18	15	0.1%	-77	-84%	-4	-20%	T1	D
Czechia	527	436	438	3.7%	-89	-17%	2	1%	T1	CS,D
Denmark	41	51	52	0.4%	11	27%	2	3%	CS	CS
Estonia	113	47	48	0.4%	-65	-58%	0	0%	T1	D
Finland	194	143	141	1.2%	-54	-28%	-2	-1%	CS,T2	CS,D
France	1 401	2 160	2 160	18.0%	759	54%	0	0%	T1	D
Germany	2 563	465	451	3.8%	-2 113	-82%	-14	-3%	CS,D	CS,D
Greece	1 520	154	154	1.3%	-1 366	-90%	0	0%	D	D
Hungary	767	224	213	1.8%	-554	-72%	-11	-5%	T1	D
Ireland	61	50	51	0.4%	-10	-16%	1	2%	T1,T2	CS,D
Italy	1 688	1 029	1 020	8.5%	-669	-40%	-9	-1%	T1	D
Latvia	198	84	74	0.6%	-124	-63%	-10	-12%	T2	CS
Lithuania	423	125	120	1.0%	-303	-72%	-4	-4%	T1	D
Luxembourg	8	3	2	0.0%	-5	-72%	-1	-20%	T1	CS
Malta	17	3	7	0.1%	-10	-57%	5	164%	D	CS
Netherlands	203	194	206	1.7%	3	1%	12	6%	T2	CS,D
Poland	5 692	2 273	2 315	19.3%	-3 377	-59%	41	2%	T1,T2	CS,D
Portugal	1 258	525	518	4.3%	-740	-59%	-7	-1%	T2	CS,D
Romania	2 939	1 469	1 424	11.9%	-1 515	-52%	-45	-3%	D	D
Slovakia	437	285	280	2.3%	-157	-36%	-5	-2%	T2	D
Slovenia	186	124	124	1.0%	-62	-33%	0	0%	T1	CS,D
Spain	3 461	675	555	4.6%	-2 906	-84%	-121	-18%	T1,T2	D
Sweden	31	24	24	0.2%	-7	-22%	0	1%	T2	CS
United Kingdom	1 476	723	714	6.0%	-763	-52%	-9	-1%	CS	CS
EU-27+UK	**27 264**	**12 124**	**11 933**	**100%**	**-15 332**	**-56%**	**-192**	**-2%**	**-**	**-**
Iceland	18	24	24	0.2%	7	38%	1	2%	T1	CS,D
United Kingdom (KP)	1 486	739	731	6.1%	-756	-51%	-8	-1%	CS	CS
EU-KP	**27 292**	**12 164**	**11 974**	**100%**	**-15 318**	**-56%**	**-190**	**-2%**	**-**	**-**

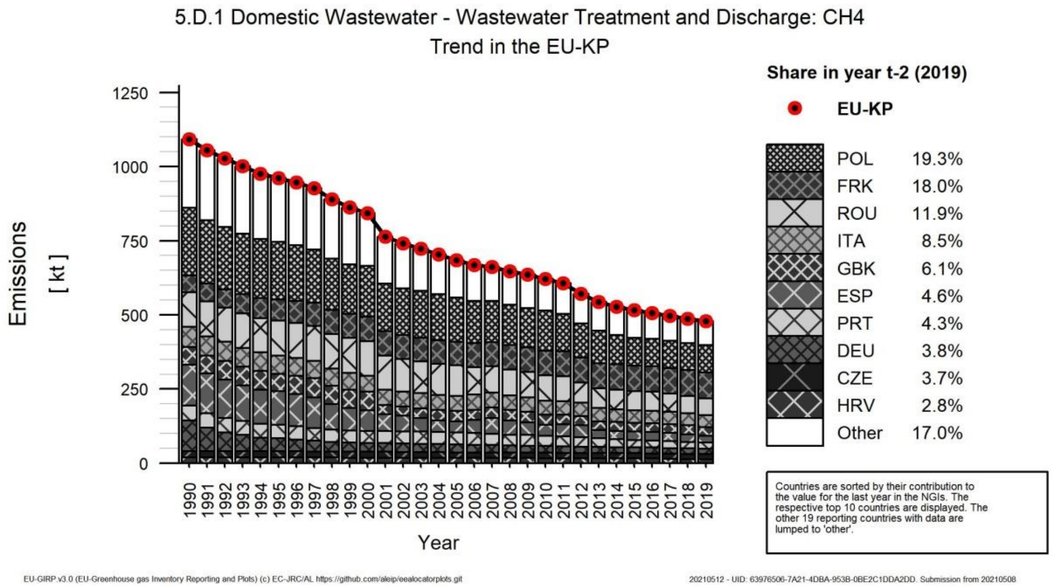
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data for CH_4 emissions from domestic wastewater

CH_4 emissions from domestic wastewater treatment and discharge decreased considerably between 1990 and 2019 by 56%. Figure 7.15 shows the trend of emissions indicating the countries contributing most to EU-KP total.

Large decreases in absolute terms between 1990 and 2019 are reported by Poland, Spain, Germany, Romania and Greece, contributing together to only 41 % of EU-KP emissions from source 5D1 in 2019. Whereas France shows significant emission increases (Table 7.12) between 1990 and 2019. France is responsible for 18 %, Poland for 19.3 %, Romania for 11.9 % and Italy for 8.5 % of EU-KP emissions from this source in 2019. Although France increased its emissions between 1990 and 2019 by 54 %, the trend of EU-KP emissions is dominated by the large emission reductions in Poland, Germany, Greece, and Romania. Also the United Kingdom, Portugal, Belgium, Italy, Spain and Hungary achieved significant reductions in emissions compared to 1990.

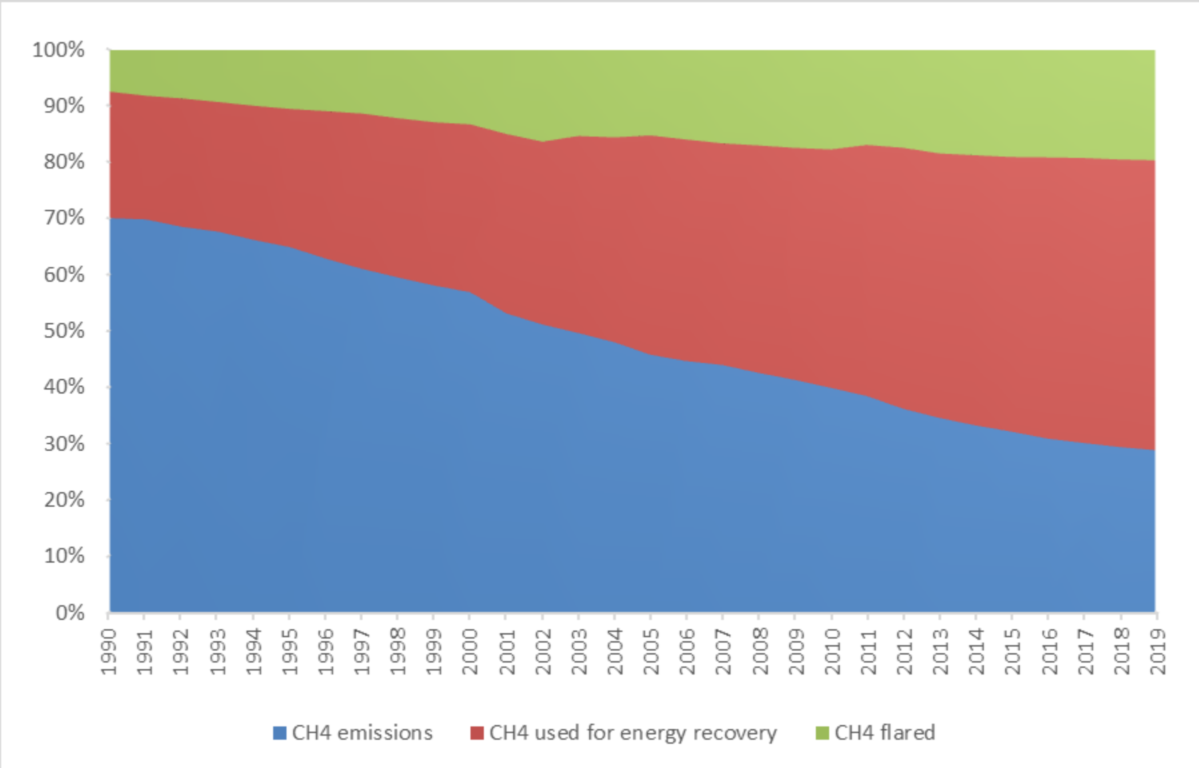
Figure 7.15 *5D1 Domestic wastewater: CH_4 emissions (Trend in relevant countries)*



The decreasing trend of CH_4 emissions from wastewater is not related to a decreasing quantity of wastewater and the amount of the total organic product in the wastewater. In fact the decrease is based on several reasons:

- Improvements of wastewater disposal routes with the development of centralized wastewater treatment plants, especially applying aerobic processes
- Amount of sludge removed
- Increased share of CH_4 flared or recovered (see *Figure 7.16*) on anaerobic wastewater and sludge treatment systems

Figure 7.16 5D1 Domestic wastewater: Share of CH_4 recovered or flared and CH_4 emissions on total CH_4 produced from domestic wastewater handling



Source: CRF 2021, Table 5D

In 2019, 19.6 % of the CH_4-emissions generated by Domestic Wastewater Handling were flared and 51.6 % was recovered for energy purposes.

An important driver for the total CH_4 emissions from 5D Wastewater Handling for the EU-KP are CH_4 emissions from 5D1 Domestic Wastewater in Germany, Greece, Poland and Romania. Therefore, more information about the development of CH_4 emissions from wastewater handling in these and other important countries is presented.

France's CH_4 emissions from domestic wastewater (5D1) show an increasing trend from 1990 to 2001 and remain at a rather constant level thereafter (with a slight increase since 2006). One driver influencing the trend is the share of population connected to different wastewater treatment systems. The share of the population connected to septic tanks increased from 1990 to 2000 (from 13 % in 1990 to 18 % in 2000), and remained almost constant thereafter (17 % average 2001-2019). In the same period, the share of the population with direct discharge of wastewater decreased from 8 % in 1990 to 2 % in 2005. Wastewater treatment in collective systems increased slightly from 79 % in 1990 to 81 % since 2005, but the share of anaerobic lagooning is rather high. According to the NIR 2021 the share of wastewater treated in the different treatment routes is constant from 2005 onwards. Furthermore France applies CH_4 recovery for generated CH_4 from wastewater since 1990.

CH_4 emissions from domestic wastewater are continuously decreasing from 1999 onwards in **Romania**. The amount of wastewater that underlies sufficient treatment increases over the years. About 65 % of the total wastewater has been treated appropriate, 9.5 % remained untreated and 25.5 % of total wastewater received only insufficient treatment in 2017. Between 2000 and 2019 public sewage systems have been expanded and modernized.

Germany's reduction in CH_4 emissions from domestic and commercial wastewater (5D1) occurred mainly between 1990 and 1998. The decrease of 95 % in that period was due to the legal requirement to connect households to decentralised wastewater treatment plants. The basis for legal requirements for the collection and treatment of domestic and commercial wastewater is the Council directive 91/271/EWG concerning urban wastewater treatment from 1991. Many wastewater plants had to be built in the former GDR after the German reunification, as most households were not connected to a sewage system, but used septic tanks.

The **Greek** CH_4 emissions from 5D1 decreased mainly between 1990 and 2007 (-89 %) due to the increased number of wastewater handling facilities with aerobic conditions. Domestic wastewater handling in aerobic treatment facilities shows a substantial increase since 1999.

Italian CH_4 emissions from domestic wastewater handling decreased slightly throughout the time series. In 1990, 57 % of population was served by sewer systems and only 52 % of the population was served by wastewater treatment plants. In 2019, more than 99 % of population was served by sewer systems and about 85 % of population is served by wastewater treatment plants.

CH_4 emissions from domestic wastewater handling in **Poland** decreased continuously throughout the time series. The share of rural population using autonomous treatments (septic tanks or latrines) for domestic wastewater decreased from 98 % in 1990 to 56% in 2019 and the share of urban populations using autonomous treatments decreased from 55 % to 5.2% in the same period. The treatment pathway using advanced wastewater treatment plants increased from 0 % to about 60 % between 1990 and 2019.

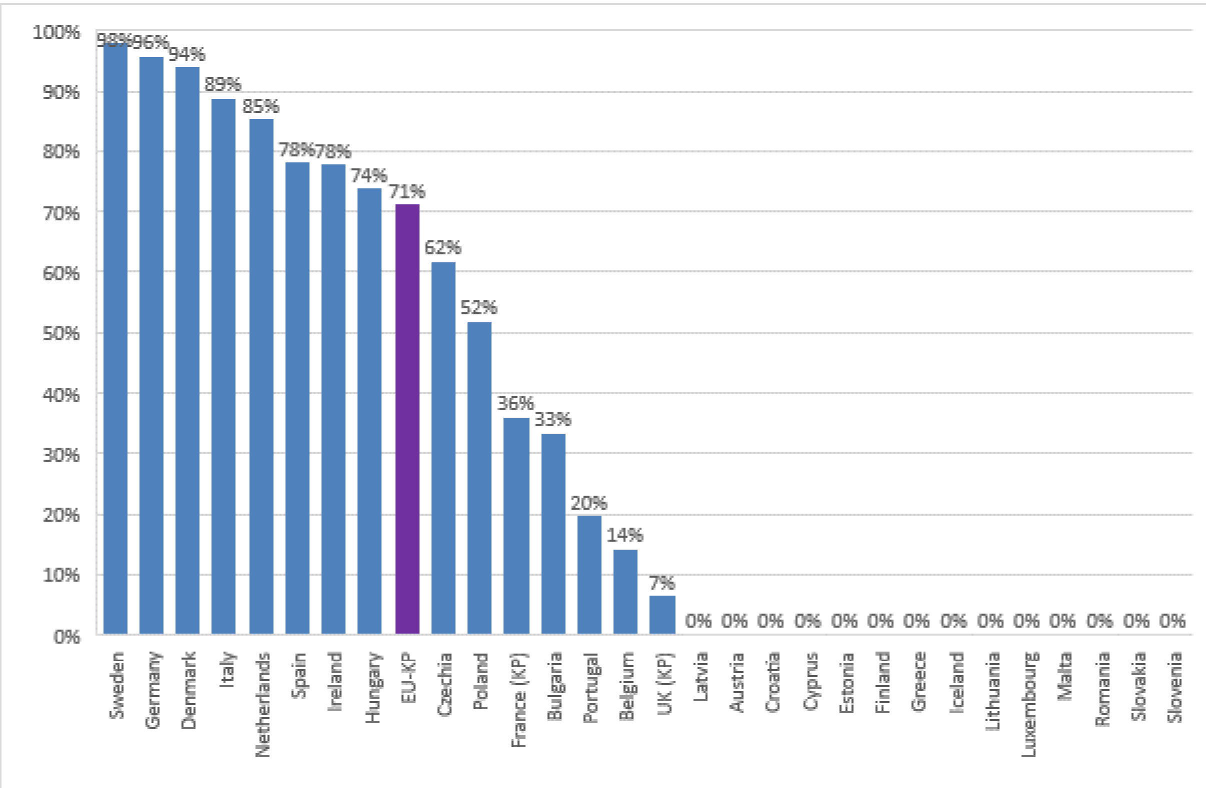
Methodological information for CH_4 emissions from domestic wastewater

All wastewater generated by households as well as any wastewater not disposed on-site in industrial installations is reported as domestic wastewater. CH_4 emissions from wastewater are formed by anaerobic conditions, these can originate during all stages: from wastewater generation to final disposal. CH_4 emissions from domestic wastewater handling (5D1) are a significant emission source in category 5D and key source in the EU. The IPCC 2006 Guidelines introduce three different Tier methods to calculate CH_4 emissions from waste water handling. Activity data needed to estimate CH_4 emissions from domestic wastewater handling is the amount of total degradable organic carbon (TOW) produced in a country. The TOW needs to be calculated based on the total population and the quantity of carbon discharged per person and day expressed in Biochemical Oxygen Demand (BOD). Many countries apply the default value for BOD (0.6 kg CH_4/kg BOD) to estimate the total degradable organic carbon. Furthermore, the country specific share of the different treatment pathways and systems of wastewater need to be identified. This is mainly done by analyzing wastewater statistics and determining the share of the population that is connected to the central sewage system and remaining wastewater that is treated in septic tanks or other wastewater treatment plants. The IPCC 2006 Guidelines provide default MCFs (methane correction factor) for each pathway, but also country specific MCFs can be applied. In the Annex III of this submission a table on countries specific methodology is provided.

If methane is recovered and burned (see *Figure 7.16*), the emissions from wastewater need to be adjusted accordingly. If sludge is removed from the wastewater, a corresponding quantity needs to be deducted from the Total Organically Degradable Content (TOW). Emissions from sludge decomposition are reported under solid waste disposal, biological treatment, burning or in the AFOLU sector depending on the disposal method.

An important remark in the interpretation of data on CH_4-recovery that are reported in the EU's CRF tables (and the countries CRF tables) for wastewater treatment (5D) is that, not all countries are reporting data related to CH_4 recovery, (for energy use of flaring) in CRF table 5D. The reported CH_4 recovery is generally recovered during sludge digestion for biogas production in a follow-up step of aerated wastewater treatment plants. On the opposite, CH_4 emissions relate mainly to anaerobic treatment systems (septic tanks and natural lagoons). Therefore, comparing CH_4 emissions to CH_4 recovery is meaningless. Three countries are reporting this information as included elsewhere (notation key IE), whereas others countries are reporting not occurring (NO), not applicable (NA) or not estimated (NE). Moreover, information related to the amount of CH_4 recovered on sludge digesters is not necessary to apply the 2006 IPCC Guidelines to estimate CH_4 emissions neither from wastewater treatment nor from sludge digestion. Therefore, not reporting any CH_4 recovered doesn't mean that sludge digestion is not occurring (NO) but that the information is not used for the CH_4 estimate from 5D1.

Figure 7.17 5D1 Managed Solid Waste Disposal: Methane recovery fraction (energy use and flaring) for 2019



Further methodological information for all countries is provided in the Annex III of this submission.

N_2O emissions

Table 7.13 5D1 Domestic and commercial wastewater: Countries' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	96	167	169	2.5%	73	76%	1	1%	CS	CS,D
Belgium	138	103	102	1.5%	-36	-26%	-1	-1%	D	D
Bulgaria	198	140	138	2.0%	-61	-31%	-2	-2%	T1	D
Croatia	67	90	91	1.3%	24	37%	1	1%	T1	D
Cyprus	12	17	17	0.2%	5	40%	0	1%	T1	D
Czechia	234	198	198	2.9%	-36	-15%	1	0%	T1	CS,D
Denmark	113	133	132	1.9%	19	17%	-1	-1%	CS	CS
Estonia	39	33	33	0.5%	-6	-15%	0	0%	T1	D
Finland	56	63	62	0.9%	7	12%	-1	-1%	CS,T1	D
France	681	363	363	5.3%	-318	-47%	1	0%	T1	D
Germany	1 390	479	486	7.1%	-904	-65%	6	1%	CS,D	CS,D
Greece	274	286	286	4.2%	11	4%	0	0%	D	CS
Hungary	148	80	86	1.2%	-62	-42%	6	7%	CS	D
Ireland	75	98	100	1.5%	25	33%	2	2%	T1	D
Italy	1 198	1 290	1 289	18.7%	90	8%	-2	0%	T1	D
Latvia	50	32	32	0.5%	-18	-36%	0	0%	D	D
Lithuania	67	43	42	0.6%	-25	-37%	0	0%	T1	D
Luxembourg	5	5	5	0.1%	0	-6%	0	-1%	T1	D
Malta	10	6	8	0.1%	-2	-20%	2	36%	D	D
Netherlands	23	25	25	0.4%	2	10%	0	-1%	T1	D
Poland	723	772	771	11.2%	48	7%	0	0%	T1	D
Portugal	200	180	180	2.6%	-20	-10%	0	0%	D	CS,D
Romania	397	430	431	6.3%	34	9%	1	0%	D	D
Slovakia	119	51	47	0.7%	-72	-60%	-4	-7%	T2	D
Slovenia	39	38	38	0.6%	-1	-4%	0	1%	T1	D
Spain	863	816	813	11.8%	-50	-6%	-4	0%	D	D
Sweden	208	190	190	2.8%	-18	-9%	0	0%	T1	CS,D
United Kingdom	765	709	720	10.5%	-45	-6%	11	2%	T1	D
EU-27+UK	**8 189**	**6 835**	**6 852**	**100%**	**-1 336**	**-16%**	**17**	**0%**	**-**	**-**
Iceland	5	6	6	0.1%	1	30%	0	3%	T1	D
United Kingdom (KP)	780	729	741	10.8%	-39	-5%	11	2%	T1	D
EU-KP	**8 208**	**6 861**	**6 879**	**100%**	**-1 329**	**-16%**	**18**	**0%**	**-**	**-**

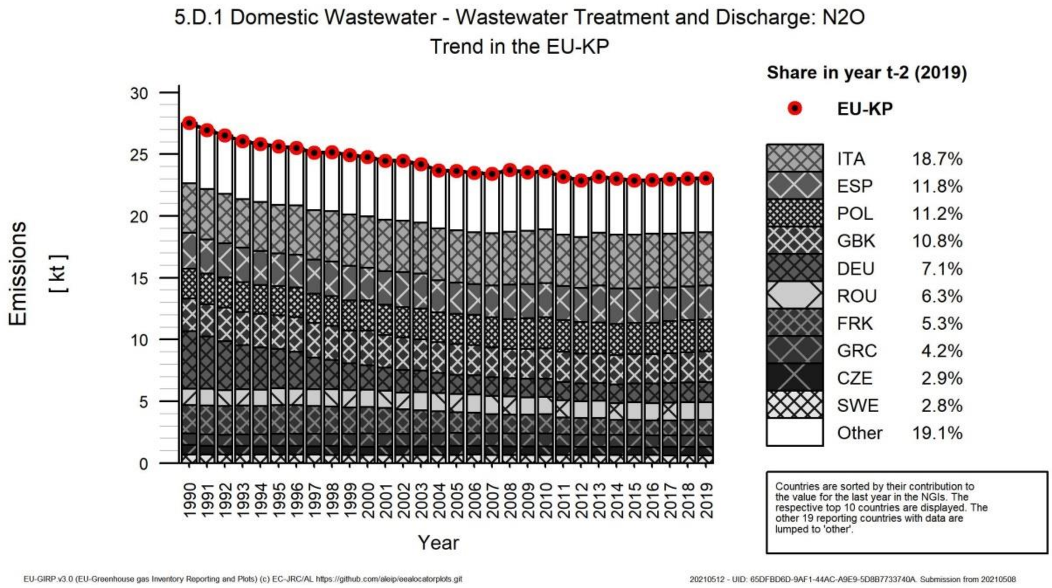
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data for N_2O emissions

N_2O emissions from 5D1 Domestic Wastewater account for 0.2 % of total EU-KP GHG emissions in 2019. N_2O emissions from domestic wastewater treatment and discharge decreased moderately between 1990 and 2019 by 16.2 % (Table 7.13). *Figure 7.18* shows the trend of emissions indicating the countries contributing most to EU-KP total. The countries contributing most to the observed decrease between 1990 and 2019 are Germany and France. Key drivers for the emission reduction are the development of centralized wastewater treatment plants with nitrogen abatement technologies. In 2019, N_2O emissions decreased by 0.4% in comparison to 2018.

Countries with large population have a high share of EU-KP N_2O emissions from this source in general. In 2019, Italy is responsible for 18.7 %, Spain for 11.8 %, Poland for 11.2 % of EU-KP N_2O emissions from domestic wastewater treatment (see Table 7.13). Large decreases in absolute terms are reported by Germany and France between 1990 and 2018, as the amount of wastewater treated in advanced centralized wastewater treatment plants with nitrogen abatement increased over the years.

Figure 7.18 5D1 Domestic wastewater: N_2O emissions (Trend in relevant countries)



Methodological information for N_2O emissions from domestic wastewater

Direct emissions of N_2O during processing only occur in countries with predominantly advanced centralized wastewater treatment plants with nitrification and denitrification steps. Indirect emissions come from wastewater treatment effluent discharged into aquatic environments. For direct emissions the quantity of wastewater treated in such facilities needs to be multiplied with a default emission factor. For indirect emissions, it is necessary to estimate the nitrogen in wastewater based on protein intake per person and correction factors to reflect non-consumed proteins and industrial/commercial co-discharged into the sewer system. If sludge is removed, a corresponding quantity of nitrogen needs to be deducted.

For the calculation of N_2O emissions from domestic wastewater no different tier levels are provided in the IPCC 2006 Guidelines and it is good practice to estimate N_2O emissions from domestic wastewater effluent by applying the methodology provided in the 2006 IPCC Guidelines. According to Table 7.13 only Austria, Denmark, Finland, Germany, Hungary apply a country specific methodology and/or emission factor, and Czechia, Portugal and Sweden apply a country specific emission factor.

Further methodological information for all countries is provided in the Annex III of this submission.

7.2.4.2 Industrial wastewater (CRF Source Category 5D2)

CH_4 emissions from 5D2 Industrial Wastewater account for 0.2 % of total EU-KP GHG emissions in 2019. Between 1990 and 2019, CH_4 emissions decreased by 32 %. Key drivers for the development of CH_4 emissions are primarily economic activities and the share of CH_4 flared or recovered. CH_4 emissions are related to production data in certain industries with high organic contents in the wastewater. Therefore, the trend in CH_4 emissions is fluctuating throughout the time series based on the economic situation in the countries. CH_4 emissions are almost constant in 2019 in comparison to 2018 (0.3%) (see Table 7.14).

Table 7.14 5D2 Industrial wastewater: Countries' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2019	Change 1990-2019		Change 2018-2019		Method	Emission factor Informa-tion
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1	3	3	0.1%	3	298%	0	0%	-	-
Belgium	IE,NE	IE,NE	IE,NE	-	-	-	-	-	NA	NA
Bulgaria	2 221	210	165	2.6%	-2 056	-93%	-44	-21%	T2	D
Croatia	97	109	117	1.9%	21	21%	8	7%	T1	D
Cyprus	24	31	31	0.5%	7	27%	0	0%	T1	D
Czechia	363	465	466	7.4%	103	28%	0	0%	CS,T1	CS,D
Denmark	IE	IE	IE	-	-	-	-	-	NA	NA
Estonia	NO	3	5	0.1%	5	∞	2	66%	T1	D
Finland	27	25	24	0.4%	-2	-8%	0	-2%	CS,T2	CS,D
France	90	98	98	1.6%	8	9%	0	0%	T1	D
Germany	9	46	46	0.7%	37	402%	1	2%	CS,T2	CS
Greece	821	958	976	15.5%	155	19%	18	2%	CS,D	CS,D
Hungary	135	25	25	0.4%	-110	-81%	0	1%	T1	D
Ireland	IE	IE	IE	-	-	-	-	-	NA	NA
Italy	1 520	1 429	1 428	22.7%	-92	-6%	-1	0%	T1	D
Latvia	137	2	2	0.0%	-135	-99%	0	9%	T1	PS
Lithuania	IE	IE	IE	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	7	10	10	0.2%	3	42%	0	-2%	T2	CS
Poland	627	275	272	4.3%	-355	-57%	-4	-1%	T1	CS,D
Portugal	259	231	217	3.5%	-42	-16%	-14	-6%	T2	CS,D
Romania	378	239	213	3.4%	-165	-44%	-27	-11%	D	D
Slovakia	29	4	5	0.1%	-25	-84%	0	4%	T1	D
Slovenia	99	8	8	0.1%	-90	-91%	0	3%	T1	CS,D
Spain	1 719	1 211	1 212	19.3%	-508	-30%	0	0%	T1	CS,D
Sweden	6	5	5	0.1%	-1	-14%	0	-1%	T2	CS
United Kingdom	673	907	936	14.9%	263	39%	29	3%	T1	D
EU-27+UK	**9 242**	**6 296**	**6 264**	**100%**	**-2 977**	**-32%**	**-31**	**0%**	**-**	**-**
Iceland	32	22	18	0.3%	-15	-46%	-4	-19%	NA	NA
United Kingdom (KP)	673	907	936	14.9%	263	39%	29	3%	T1	D
EU-KP	**9 274**	**6 317**	**6 282**	**100%**	**-2 992**	**-32%**	**-35**	**-1%**	**-**	**-**

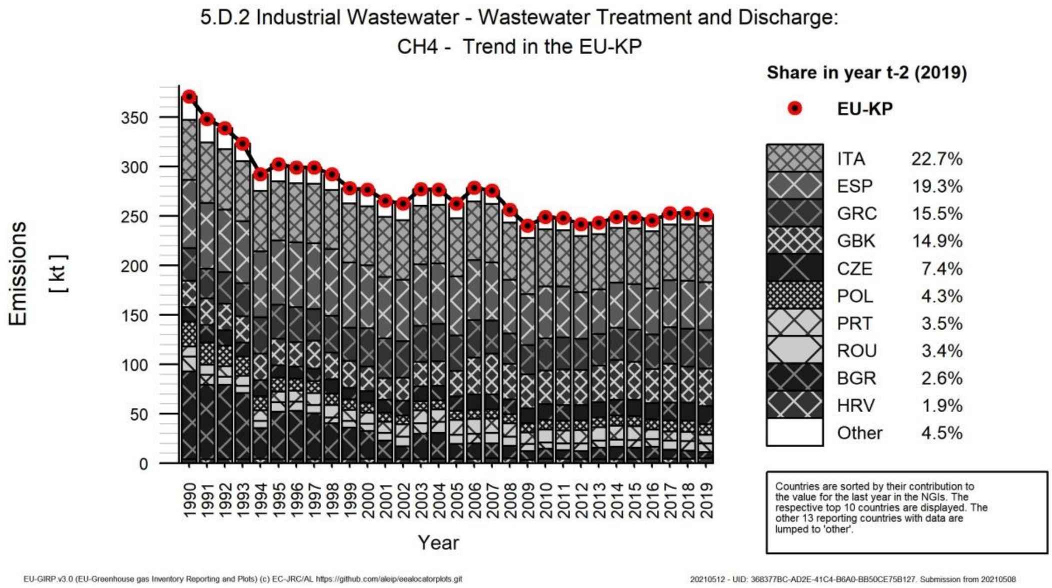
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data

CH_4 emissions from industrial wastewater treatment and discharge decreased between 1990 and 2019 by 32 %. *Figure 7.19* shows the trend of emissions indicating the countries contributing most to EU-KP total.

The largest decrease in absolute terms is reported by Bulgaria, followed far below by Spain and Poland contributing together 26.2 % of EU-KP emissions from source 5D2 in 2019, whereas Czech Republic, and Greece show the largest, but moderate, absolute emission increases between 1990 and 2019 (Table 7.14). Italy is responsible for 22.7% Spain for 19.3%, Greece for 15.5% and United Kingdom for 14.9 %, of EU-KP CH_4 emissions from this source in 2019. The emission trends in this sector are mainly influenced by the strong decrease in Bulgaria.

Figure 7.19 5D2 Industrial wastewater: CH_4 emissions (Trend in relevant countries)



Bulgaria decreased its CH_4 emissions from industrial wastewater until 2005 and remains rather constant in the following years with little annual variations. In 2003 and 2004 CH_4 emissions show a peak compared to the preceding years due to the discharge of industrial wastewater into several big tailing ponds by mining companies. The strong decrease of CH_4 emissions from industrial wastewater between 1990 and 2005 is caused by decreasing quantities of total industrial wastewater in the country, which decreased from 1,1 billion m^3 in 1990 to 0.10 billion m^3 in 2019 as well as by the decrease of organic load in industrial wastewater. Moreover, between 1990 and 2019 the fraction of industrial wastewater treated in not well managed in-situ wastewater treatment plants decreased from 46% to 39%, and the fraction discharged in stagnant sewer decreased from 8.2 to 0.7%. As a consequence, CH_4 emissions decreased by 93 % between 1990 and 2019.

In **Spain**, CH_4 emissions from industrial wastewater decreased by 30 % in 2019 in comparison to 1990. Industries with high organic loads that have on-site wastewater treatment are the oil refining industry and the pulp and paper production industry. Other industries with high organic loads are the food- and drink processing industry and the organic chemical industry. Due to changes in production levels CH_4 emissions from this source are also slightly fluctuating throughout the time series in Spain.

In **Italy,** CH_4 emissions from industrial wastewater decreased only slightly by 6.1% between 1990 and 2019. This is caused by a decreasing amount of wastewater from industries. Main reductions in industrial wastewater load can be found in the pulp and paper and in the textiles industry.

CH_4 emissions from industrial wastewater in **Poland** decreased by 57 % between 1990 and 2019, due to a reduction in wastewater production by industries. Main reduction of wastewater production took place in the mining and quarrying industry, the iron and steel industry and in the wood and paper industry.

In **Greece**, CH_4 emissions from industrial wastewater increased by 19 % between 1990 and 2019 due to the increase of the organic load from organic chemical industries and other industries despite the increase of the organic load removed as sludge.

CH_4 emissions from industrial wastewater in the **United Kingdom** increased by 39% throughout the time series 1990 and 2019 with two main quite steady period: 1990-2005 and 2006-2019. Lowest emissions during the economic break down from 2008 to 2010 are observed.

Methodological information

Emissions from industrial wastewater include all wastewater that is treated/disposed on-site and not sent to public sewers. The main sources for methane emissions from industrial wastewater are:

- pulp and paper manufacture;
- food and drink processing (e.g. meat and poultry processing, alcohol/starch production and dairy products); and
- Organic chemicals production.

Activity data is based on production output from the relevant industries and a Chemical Oxygen Demand per unit of output for each industry. Default IPCC values are provided and it is good practice to use them in the absence of national data.

CH_4 emissions from industrial wastewater handling are reported by 22 countries, while Belgium reports CH_4 emissions as Included Elsewhere/Not estimated (IE/NE) because the same methodology is not applied in its 3 regions, Luxembourg reports CH_4 emissions under 5D2 as not occurring (NO) and Denmark, Ireland, Lithuania and Malta report CH_4 emissions from industrial wastewater as included elsewhere (IE).

According to the IPCC 2006 Guidelines, the emission factor for determining CH_4 emissions from wastewater is composed of the maximum methane producing potential (B0) and the methane conversion factor (MCF). There is an IPCC default value available for the maximum methane producing potential which is applied in most of the countries. In contrast, the MCF has to be determined country specifically and varies strongly among the countries depending on wastewater treatment systems used.

7.2.4.3 Recalculations CH_4 and N_2O emissions (CRF Source Category 5D)

Table 7.15: 5D Waste water treatment: Contribution of EU-KP countries to recalculations in CH_4 for 1990 and 2018 (difference between latest submission and previous submission)

	1990		2018		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-3	-12.0	Recalculations were carried out due to availability of new data on the connection rate 2018 as well as revised data on waste water amounts and N-flows 2018,
Belgium	95	11.4	67	37.4	- In Wallonia and the Brussels-Capital region, the CH_4 emissions have been recalculated to include river discharge as recommended during the ESD review in June 2020. -
Bulgaria	-169	-6.0	-324	-41.9	Not documented
Croatia	144	32.3	276	162.6	The 2020 ESD review advised that the TOW for a septic tank should not be corrected for the total amount of sludge and the inclusion of indirect methane emissions by direct discharge of untreated wastewater.
Cyprus	-	-	-0	-0.0	Negligeable recalculation

	1990		2018		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Czechia	-	-	-	-	No recalculation
Denmark	-0	-0.0	-0	-0.1	Negligeable recalculation
Estonia	-	-	0	0.2	Negligeable recalculation
Finland	-	-	-	-	No recalculation
France	0	0.0	-1	-0.0	Negligeable recalculation
Germany	-66	-2.5	-37	-6.7	In the past, the EF for urban wastewater treatment, which is based on measurements, was wrongly used for the year 2014 and not for the year of the measurements (2011). measurements (2011). This error has been corrected with this year's reporting. For emissions from sewage treatment plants, this results in only minor changes in the overall time series.
Greece	-	-	61	5.8	Updated activity data for the period 2015-2018 have been utilized.
Hungary	-	-	2	0.7	Updated activity data (biogas production)
Ireland	-	-	-	-	No recalculation
Italy	-	-	15	0.6	Update of sludge activity data
Latvia	-2.5	-0.8	-1.0	-1.1	Recalculations were done due to slight changes in calculations and acitivty data
Lithuania	-48	-10.2	-3.9	-3.0	Following recommendations of the ESD review, mechanical, mechanical/chemical and chemical treatment facilities were categorised as primary treatment in this submission assuming MCF = 0.1 for wastewater discharged to open waters after primary treatment and about 40% of BOD removed as sludge.
Luxembourg	0	3.7	0	0.2	Recalculation over the entire time series (1990-2018) due to the revision of population numbers connected to septic tanks and mechanical WWTPs. No revision in the methodology was operated, and in particular, the country-specific MCF for mechanical WWTPs was kept identical to the country-specific MCF for septic tanks, as the systems are very similar (recommendation from theESD Review 2020)
Malta	-	-	0	15	- Emissions from “Not well managed” wastewater treatment plants, (97% of the organic load) using a MCF of 0,3. - BOD values consistent over the time series are now used
Netherlands	-	-	-2.7	-1.2	Due to final activity data on wastewater and sludge treatment, the CH_4 emissions from domestic wastewater treatment (5D1) decreased in 2018.
Poland	3.6	0.1	44	1.8	Correction of methodology of estimating amount of methane in recovered biogas.
Portugal	-	-	1	0.1	Revision of industrial wastewater treatment in order to ensure data consistency between domestic and industrial wastewater treated in municipal systems.
Romania	171	5.4	138	8.8	Recalculation have been performed for the whole time series at the level of MCF-centralised WWTP. The values derived from the UWWTD website (http://uwwtd.oieau.fr/) have been used.
Slovakia	-	-	-	-	No recalculation
Slovenia	2.2	0.8	1.6	1.2	Addition of waste waters from pharmaceutical industry.
Spain	2 661	106	433	29.8	Update of EF for 1990-2018 due to new data of CNV (Censo Nacional de Vertidos)
Sweden	-	-	-	-	No recalculation
United Kingdom	-2 047	-48.8	-1 779	-52.2	Improvements to the industrial wastewater model.
EU27+UK	**745**	**2.1**	**-1 111**	**-5.7**	
Iceland	-0	-0.0	0	0.0	Negligeable recalculation
United Kingdom (KP)	-2 047	-48.7	-1 779	-51.9	Improvements to the industrial wastewater model.
EU-KP	**745**	**2.1**	**-1 111**	**-5.7**	

Table 7.16: 5D Waste water treatment: Contribution of EU-KP countries to recalculations in N_2O for 1990 and 2018 (difference between latest submission and previous submission)

	1990		2018		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria		-	0	0.2	Recalculations were carried out due to availability of new data on the connection rate 2018 as well as revised data on waste water amounts and N-flows 2018,
Belgium	-0	-0.0	-1.1	-1.1	- In the Brussels-Capital region, the abatement of the wastewater treatment plants has been recalculated from 2007 on in order to better take into account the effluent effectively treated by each of the plants. - In the Flemish region the amounts of N effluent from inhabitants not connected to WWTP are revised for the years 2010, 2012 and from 2015.
Bulgaria	-	-	-	-	No recalculation
Croatia	-	-	1.4	1.5	New data on protein intake value for the period 2014 - 2017, were obtained by the FAOSTAT. Extrapolation method has been for 2018 and 2019.
Cyprus	-	-	0.0	0.0	Negligeable recalculation (<0.05% of the national total)
Czechia	-	-	-1.1	-0.5	Updated activity data due to information from FAOSTAT
Denmark	130	119	85	131	Recalculation for 5.D Wastewater and discharge is due to changes in activity data for indirect industrial N_2O emission in the period 1990-1994 and due to updating of the country specific EF for direct N_2O emissions.
Estonia	-	-	0	1.4	Due to changed statistics on human protein consumption in FAO statistics N_2O emissions have changed.
Finland	-	-	-	-	No recalculation
France	-	-	-0.9	-0.2	Negligeable recalculation (<0,05% of the national total)
Germany	-	-	10	2.0	In the past, the EF for urban wastewater treatment, which is based on measurements, was wrongly used for the year 2014 and not for the year of the measurements (2011). measurements (2011). This error has been corrected with this year's reporting. For emissions from sewage treatment plants, this results in only minor changes in the overall time series.
Greece	-	-	2.7	0.9	Updated activity data have been utilized for the estimation of CH_4 emissions from wastewater handling for the period 2017 - 2018.
Hungary	-	-	4.5	6.0	Protein consumption has been updated for 2018.
Ireland	-	-	-	-	No recalculation
Italy	-	-	-0.6	-0.0	Negligeable recalculation (<0,05% of the national total)
Latvia	-0	-0.2	0.8	2.5	Recalculations were done due to slight changes in calculations and acitivty data
Lithuania	-	-	-0	-0.0	Negligeable recalculation (<0,05% of the national total)
Luxembourg	-0	-7.1	0.8	20	Recalculations were operated over the entire time series, due to revisions in population numbers per WWT system, protein intake and N-removal efficiency (recommendation from theESD Review 2020)
Malta	0.5	5.4	-0.1	-1.6	Activity data of swine manure N going to sewers (from the Agriculture sector) was updated.
Netherlands	-	-	-0.1	-0.1	Due to final activity data on total N discharges, the indirect N_2O emissions from surface water as a result of the discharge of domestic and industrial effluents (5D3, Wastewater effluents) decreased in 2018.
Poland	-	-	12	1.5	Update of data on protein consumption in Faostat database.
Portugal	-	-	-	-	No recalculation
Romania	-108	-21	-102	-19	Recalculation have been performed for the entire time series by exchanging the Fnon-con from 1.4 to 1.1.
Slovakia	-	-	0.1	0.2	Protein consumption for the year 2018 was updated.
Slovenia	-	-	-	-	No recalculation
Spain	-	-	15	1.8	- Update of AD due to new data for 2011-2018. - Change in the value of kg proteins/person/year for 2000-2018.
Sweden	-	-	-1.6	-0.8	Recalculation due to the availability of new AD on discharges on discharges to water from municipal wastewater treatment plants.
United Kingdom	160	21	244	34	

	1990		2018		Main Explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
EU27+UK	181	2.1	269	3.8	
Iceland	-	-	-	-	No recalculation
United Kingdom (KP)	160	20	244	33	Improvements to the industrial wastewater model.
EU-KP	181	2.1	269	3.8	

7.2.5 Waste – non-key categories

Table 7.17 Aggregated GHG emission from non-key categories in the waste sector

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 5. Waste in 2019	Change 1990-2019		Change 2018-2019	
	1990	2018	2019		kt CO_2 equ.	%	kt CO_2 equ.	%
5.A.3 Uncategorized Waste Disposal Sites: Waste (CH4)	1 307.1	787.1	719.0	0.53%	-588	-45%	-68	-9%
5.B.1 Waste Composting: Waste (N2O)	339.5	2 660.4	2 664.7	1.97%	2 325	685%	4.4	0%
5.B.2 Anaerobic Digestion at Biogas Facilities: Waste (CH4)	8.8	1 807.5	1 876.4	1.39%	1 868	21200%	69	4%
5.B.2 Anaerobic Digestion at Biogas Facilities: Waste (N2O)	0.0	118.8	120.1	0.09%	120	100%	1.3	1%
5.C.1 Waste Incineration: Waste (CH4)	111.5	3.2	3.0	0.00%	-108	-97%	-0.2	-5%
5.C.1 Waste Incineration: Waste (CO2)	4 992.6	2 966.3	2 731.5	2.02%	-2 261	-45%	-235	-8%
5.C.1 Waste Incineration: Waste (N2O)	249.9	215.4	194.4	0.14%	-56	-22%	-21	-10%
5.C.2 Open Burning of Waste: Waste (CH4)	357.1	525.0	522.7	0.39%	166	46%	-2.2	0%
5.C.2 Open Burning of Waste: Waste (CO2)	104.7	44.6	45.8	0.03%	-59	-56%	1.2	3%
5.C.2 Open Burning of Waste: Waste (N2O)	243.8	430.7	429.8	0.32%	186	76%	-0.9	0%
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (N2O)	481.8	405.3	430.0	0.32%	-52	-11%	24.7	6%
5.D.3 Wastewater Treatment and Discharge: Other Wastewater (CH4)	98.2	14.1	14.2	0.01%	-84	-85%	0.1	1%
5.D.3 Wastewater Treatment and Discharge: Other Wastewater (N2O)	153.4	51.2	52.0	0.04%	-101	-66%	0.9	2%
5.E Other Disposal: Waste (CH4)	46.6	6.0	5.7	0.00%	-41	-88%	-0.3	-5%
5.E Other Disposal: Waste (CO2)	21.7	24.4	23.0	0.02%	1.3	6%	-1.5	-6%
5.E Other Disposal: Waste (N2O)	0.0	34.0	33.6	0.02%	34	100%	-0.5	-1%

7.3 EU-KP uncertainty estimates

Table 7.18 shows the total EU-27+UK and Iceland uncertainty estimates for the sector Waste and the uncertainty estimates for the relevant gases of each source category. The highest level uncertainty was estimated for N_2O from 5D and CO_2 and CH_4 from from 5E. Unexpectively CH_4 from 5A has one of the lower uncertainties. Regarding the uncertainty on trend, N_2O from 5D and N_2O from 5B show the highest uncertainty estimates, followed by CH_4 from 5B.. For a description of the Tier 1 uncertainty analysis carried out for the EU-KP see Chapter 1.6.

Table 7.18 Sector 5 -Waste: EU-KP uncertainty estimates

Source category	Gas	Emissions Base Year	Emissions 2019	Emission trends Base Year-2019	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
5.A Solid Waste Disposal	CO2	0	0		0.0%	
5.A Solid Waste Disposal	CH4	183 254	95 580	-47.8%	29.3%	0.1%
5.A Solid Waste Disposal	N2O	0	0		0.0%	
5.B Biological treatment of solid waste	CO2	0	0		0.0%	
5.B Biological treatment of solid waste	CH4	591	5 184	777.1%	82.3%	3.7%
5.B Biological treatment of solid waste	N2O	235	2 473	954.0%	86.0%	4.2%
5.C Waste Incineration	CO2	5 080	2 777	-45.3%	31.5%	0.6%
5.C Waste Incineration	CH4	213	89	-58.5%	28.8%	0.3%
5.C Waste Incineration	N2O	259	193	-25.5%	82.3%	0.4%
5.D Wastewater treatment and discharge	CO2	0	0		0.0%	
5.D Wastewater treatment and discharge	CH4	36 999	18 036	-51.3%	53.5%	0.1%
5.D Wastewater treatment and discharge	N2O	8 653	7 181	-17.0%	462.3%	4.2%
5.E Other	CO2	0	0		0.0%	
5.E Other	CH4	0	2		60.0%	
5.E Other	N2O	0	34		60.0%	
Total - 5	**all**	**235 284**	**131 548**	**-44.1%**	**34.0%**	**19.5%**

***Note**: Emissions are in Gg CO_2 equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions of the EU-NIR because uncertainty estimates are not available for all source categories in all countries;*

7.4 Sector-specific quality assurance and quality control

There are several activities for improving the quality of estimating and reporting GHG emissions from waste: Before and during the compilation of the EU GHG inventory, several checks are made of the countries data in particular for completeness, time series consistency of emissions and implied emission factors, comparisons of implied emission factors across countries and checks of internal consistency.

In the second half of the year, the EU internal review is carried out for selected source categories. In 2005, the EU internal review was carried out for the first time. In 2012 a comprehensive review was carried out for all sectors and all EU countries in order to Source category Gas Emissions fix the base year 2020 under the EU Effort Sharing Decision. (ESD review 2012). This review also covered the waste sector of the MS GHG inventories (peer review). In 2015, a few countries volunteered to be reviewed under step 2 of the ESD trial review for the sector waste. In 2016, again a comprehensive review was carried out for all sectors and all EU countries with a focus on the years 2005, 2008-2010, 2013 and 2014 in order to track progress of the EU countries under the EU Effort Sharing Decision. (ESD review 2016).

In March 2016, during the WG1-meeting, a note/paper on wastewater treatment and discharge was discussed with the countries. This note/paper reflects a number of concerns raised during the ESD 2015 trial review. In connection to the ESD review further capacity building activities between the ESD review team and EU sectoral experts have taken place via webinars and distribution of working papers on the main conclusions from the ESD reviews.

In September 2017 a capacity building webinar related to the waste sector was organized between the ESD review team and the countries. Several aspects on solid waste disposal, biological treatment and wastewater treatment were discussed. A second webinar took place in November 2017 in order to discuss in more detail the different interpretations when using equations 6.1-6.3 of the IPCC 2006 guidelines (Volume 5, chapter 6) for calculating emissions from wastewater treatment. An elaborated spreadsheet, along with a brief explanation of the spreadsheet was presented and explained during the webinar.

In the autumn of 2018 a capacity building webinar related to the waste sector was organized where the ESD review team informed the Countries on specific aspects that were handled and discussed during the ESD review round in 2018.

In the autumn of 2019 a capacity building webinar related to the waste sector was organized where the ESD review team informed the Countries on specific aspects that were handled and discussed during the ESD review round in 2019.

In the autumn of 2020 a capacity building webinar related to the waste sector was organized where the ESD review team informed the Countries on specific aspects that were handled and discussed during the ESD review round in 2020.

7.5 Sector-specific improvements

After the implementation of the new IPCC guidelines in 2015 and the subsequent changes to the sector, chapters had to be re-written in 2016, and certain methodological changes had to be applied, which have been reviewed in the 2016 ESD review.

In 2016, 2017, 2018, 2019, 2020 and 2021, additional quality checks of the EU NIR chapter waste were carried out in order to improve the consistency between the CRF tables and the EU NIR and consistency of tables and figures with text in the EU NIR.

8 OTHER

Sector Other is not an EU key category (see Annex 1.1) and does not include any emissions in 2019.

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9 INDIRECT CO_2 AND NITROUS OXIDE EMISSIONS

9.1 Description of sources of indirect emissions in the GHG inventory

The CO_2 resulting from the atmospheric oxidation of CH_4, CO and NMVOC is referred to as indirect CO_2. Indirect CO_2 resulting from the oxidation of CH_4, CO and NMVOCs produced by fossil fuel combustion are included in the general methodological approach which assumes that all the carbon in the fuel (minus the portion that remains as soot or ash) is oxidized to CO_2 whereas actually a fraction of this carbon is initially emitted as CH_4, CO or NMVOC.

Other sources of indirect CO_2 emissions are not yet captured by the general inventory methodologies. According to the 2006 IPCC Guidelines such sources include:

- Fugitive emissions from energy use, e.g. NMVOC emissions from oil refineries, storage of chemicals at refineries, road traffic evaporative emissions from cars, emissions from gasoline distribution network and refuelling of cars, ships and aircrafts, CH_4 emissions from natural gas transmission and distribution or coke production.
- Carbon from Non-energy products from fuels and solvent use in IPPU: The production and use of asphalt for road paving and roofing and the use of solvents derived from petroleum and coal are sometimes substantial sources of NMVOC and CO emissions, which oxidise to CO_2 in the atmosphere. The resulting CO_2 input can be estimated from the emissions of these non-CO_2 gases.
- AFOLU emissions where non-CO_2 gases have been explicitly deducted (Such NMVOC emissions are considered as biogenic in MS reporting and resulting indirect CO_2 emissions are not included in MS GHG inventories).

Indirect N_2O emissions in the agriculture sector address nitrous oxide (N_2O) emissions that result from the deposition of the nitrogen emitted as nitrogen oxides (NO_x) and ammonia (NH_3). N_2O is produced in soils through the biological processes of nitrification and denitrification. One of the main controlling factors in this reaction is the availability of inorganic nitrogen in the soil and therefore deposition of nitrogen resulting from NO_x and NH_3 will enhance emissions.

The Revised 1996 IPCC Guidelines only estimated indirect N_2O emissions from agricultural sources of nitrogen. The 2006 IPCC Guidelines include guidance for estimating N_2O emissions resulting from nitrogen deposition of all anthropogenic sources of NO_x and NH_3 (in particular from sources in the energy and IPPU sectors).The 2006 IPCC Guidelines, Volume 5, also address indirect N_2O emissions which occur from the release of wastewater effluents into waterways, lakes or the sea.

The EU national total includes indirect CO_2 if these emissions were reported by countries. Both national totals, including and excluding indirect CO_2, are reported in the CRF tables. This is to ensure consistency with the scope of reported greenhouse gas emissions during the first commitment period. Indirect N_2O emissions reported in Summary 1 are not included in national totals. This chapter refers to the indirect emissions that are reported in Table 6 of the EU CRF tables. Indirect emissions may also be included in other sectors, such as indirect CO_2 in IPPU (i.e. under '2D Non-energy products from fuels and solvents') and indirect N_2O in the agriculture and LULUCF sectors (i.e. in CRF tables 3.D and 3.B.b or table 4(IV)). These emissions are dealt with in the corresponding sectoral chapters.

9.2 Methodological issues

Table 9.1 summarizes indirect CO_2 and nitrous oxide emissions reported from the EU countries [not directly included with other sectors]. Eight countries provided values for indirect CO_2 emissions. The highest shares of the EU-KP total of indirect CO_2 emissions are held by Czechia (40 %) and the Netherlands (26 %). Nine countries reported indirect N_2O emissions in 2021, with Bulgaria, Romania, Italy and the UK accounting for 89% of the total EU-KP indirect N_2O emissions.

Indirect CO_2 is not an EU key category.

Table 9.1 Indirect CO_2 and N_2O emission for EU-KP in 2019

Countries	indirect CO_2 [kt CO_2 equ.]	Share in EU-KP [%]	indirect N_2O [kt CO_2 equ.]	Share in EU-KP [%]
Austria	NO,NE,IE,NA	-	13	0.2%
Belgium	NO,NE	-	NO,NE	-
Bulgaria	NO	-	1 057	16%
Croatia	NO,NA	-	NO,NA	-
Cyprus	8	0.5%	NO,NE	-
Czechia	659	40%	246	4%
Denmark	270	17%	281	4%
Estonia	NO,NE,IE	-	NO,NE	-
Finland	51	3%	160	2%
France	IE,NA	-	NO,NE	-
Germany	NO,NE,IE	-	NO,NE,IE	-
Greece	NO,NE	-	NO,NE	-
Hungary	NO,NE	-	NO,NE	-
Ireland	NO,NE,IE	-	NO,NE	-
Italy	NO	-	909	14%
Latvia	13	1%	NO,IE,NA	-
Lithuania	NO,NE,IE	-	NO,NE	-
Luxembourg	NO,NE	-	NO,NE	-
Malta	NO,NE,NA	-	5	0%
Netherlands	431	26%	NO,NE	-
Poland	NA	-	NA	-
Portugal	156	10%	NO,NE,NA	-
Romania	NO,NE	-	2 743	41%
Slovakia	45	3%	NO,NE	-
Slovenia	NO,NE	-	NO,NE	-
Spain	NE,IE	-	NE,NA	-
Sweden	NE	-	NE	-
United Kingdom	NO,NE	-	1 263	19%
EU-27+UK	**1 634**	**100%**	**6 678**	**100%**
United Kingdom (KP)	NO,NE	-	1 282	19%
Iceland	NE	-	NE	-
EU-KP	**1 634**	**100%**	**6 697**	**100%**

In general, the methodologies for the estimation of indirect emissions in EU countries are in line with the 2006 IPCC Guidelines.

For the estimation of indirect CO_2 emissions EU countries follow the basic principle proposed by the IPCC for calculating the CO_2 inputs from the atmospheric oxidation of CH_4, CO or NMVOC (2006 IPCC Guidelines, Volume 1, Chapter 7, p. 7.6):

From CH_4:	$Inputs_{CO2} = Emissions_{CH4} \bullet 44/16$
From CO:	$Inputs_{CO2} = Emissions_{CO} \bullet 44/28$
From NMVOC:	$Inputs_{CO2} = Emissions_{NMVOC} \bullet C \bullet 44/12$
Where C is the fraction carbon in NMVOC by mass (default = 0.6)	

Some countries (i.e. CZ, DK) explicitly mention that the precursor gases emissions (CO, NOx and NMVOC) used in the above equations are consistent with the precursor gases emissions reported under the United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP) and the CH_4 emissions reported to the UNFCCC.

In general, emissions reported in table 6 refer to indirect emissions from energy, IPPU and waste, while some countries report the indirect CO_2 emissions in other categories too (mainly in IPPU category 2.D.3).

9.3 Uncertainties and time-series consistency

Indirect CO_2 emissions have decreased since 1990 in all countries but Portugal (+78%) and Cyprus (+25%). The highest percentage decrease has been noted in Denmark (-78%), while in absolute terms Czechia had the biggest share in the EU reduction, decreasing its indirect CO_2 emissions by more than 1.2 Mt. The main reason for the decrease in indirect CO_2 emissions is the decrease of the precursor gases emissions. The uncertainty of the indirect emission estimates is also based on the calculation of emissions from these gases.

9.4 Category specific planned improvements

The separate reporting of indirect CO_2 and nitrous oxide emissions (from sources other than agriculture and LULUCF)[59] to the UNFCCC under CRF Table 6 has been performed for the first time in 2015 and is in line with paragraph 29 of the UNFCCC reporting guidelines (Decision 24/CP.19). Following this reporting the EU team analysed the ways that countries reported these emissions and presented the results in Working Group 1. The different approaches have been discussed and guidance was provided to Member States in order to improve the consistency in the reporting of these emissions.

[59] As explained in paragraph 9.1, methodologies for the indirect nitrous oxide emissions from agriculture and LULUCF were available in the 1996 IPCC Guidelines as well.

10 RECALCULATIONS AND IMPROVEMENTS

10.1 Explanations and justifications for recalculations

Table 10.1 to Table 10.2 provide an overview for the largest recalculations (>+/- 500 kt CO_2 equiv.) in the year 1990 and 2018 for the EU-27 Member States and the UK. For explanations of the recalculations (including recalculations >+/- 500 kt CO_2 equiv see the sectoral chapters of the EU NIR and the information provided in the Member States' submissions.

Recalculations presented are calculated from countries submissions used for the EU submission in May 2020 and MS submissions received until 8 May 2021.

Table 10.1 Main recalculations by source category for 1990 (>+/-500 kt CO_2 eq.)

Category	MS	1990	
		kt CO_2 equiv.	%
1A1_Energy Industries CO_2	Estonia	-834	-2.9
1A2_Manufacturing Industries and Construction CO_2	Estonia	1 710	68.5
1A2_Manufacturing Industries and Construction CO_2	France	-12 913	-16.5
1A2_Manufacturing Industries and Construction CO_2	Italy	1 075	1.2
1A2_Manufacturing Industries and Construction CO_2	Romania	18 946	38.6
1A3_Transport CO_2	France	-518	-0.4
1A4_Other sectors CO_2	France	-5 611	-5.8
1A5_Other CO_2	France	4 464	100.0
1B2_Oil and natural gas CH_4	Hungary	1 057	78.1
1B2_Oil and natural gas CH_4	Romania	-578	-2.4
2B_Chemical industries CO_2	Netherlands	-581	-12.3
2C_Metal industry CO_2	France	11 435	183.2
2C_Metal industry CO_2	Romania	1 840	16.2
2D_Non-energy products from fuels and solvent use CO_2	Romania	-675	-50.4
3A_Enteric fermentation CH_4	Belgium	-641	-11.8
3A_Enteric fermentation CH_4	Germany	-2 538	-7.2
3A_Enteric fermentation CH_4	Ireland	-891	-7.8
3A_Enteric fermentation CH_4	Poland	-1 904	-8.8
3A_Enteric fermentation CH_4	Romania	-4 517	-23.2
3A_Enteric fermentation CH_4	Spain	-1 570	-9.9
3A_Enteric fermentation CH_4	United Kingdom (KP)	-856	-3.4
3B_Manure management CH_4	Germany	-684	-8.4
3B_Manure management CH_4	Italy	895	22.7
3B_Manure management CH_4	Romania	-2 714	-59.5
3B_Manure management N_2O	Poland	1 075	35.8
3B_Manure management N_2O	Romania	779	64.7
3D_Agricultural soils N_2O	France	-927	-2.6
3D_Agricultural soils N_2O	Germany	708	2.5
3D_Agricultural soils N_2O	Latvia	-595	-23.6
3D_Agricultural soils N_2O	Netherlands	-545	-5.9
3D_Agricultural soils N_2O	Poland	1 645	8.6
3D_Agricultural soils N_2O	Romania	4 821	52.1
3D_Agricultural soils N_2O	United Kingdom (KP)	648	4.8
5A_Solid waste disposal on land CH_4	Bulgaria	-1 511	-30.6
5D_Waste water treatment and discharge CH_4	Spain	2 661	105.7
5D_Waste water treatment and discharge CH_4	United Kingdom (KP)	-2 047	-48.7
4A_Forest land CO_2	Czechia	-1 285	-28.9
4A_Forest land CO_2	Denmark	-709	-123.5
4A_Forest land CO_2	Estonia	-505	-14.0
4A_Forest land CO_2	Finland	1 135	4.8
4A_Forest land CO_2	Germany	49 239	69.1
4A_Forest land CO_2	Romania	-6 944	-29.3
4A_Forest land CO_2	Sweden	-2 243	-5.9
4A_Forest land CO_2	United Kingdom (KP)	973	6.3
4B_Cropland CO_2	Germany	997	8.0

Category	MS	1990	
		kt CO_2 equiv.	%
4B_Cropland CO_2	Latvia	-1 536	-39.3
4B_Cropland CO_2	Netherlands	748	41.2
4B_Cropland CO_2	Poland	616	53.1
4B_Cropland CO_2	Romania	710	32.9
4B_Cropland CO_2	United Kingdom (KP)	5 701	39.0
4C_Grassland CO_2	Denmark	659	45.4
4C_Grassland CO_2	Germany	2 548	10.8
4C_Grassland CO_2	Netherlands	-846	-15.3
4C_Grassland CO_2	United Kingdom (KP)	6 621	93.2
4D_Wetlands CO_2	Estonia	-823	-74.5
4E_Settlements CO_2	United Kingdom (KP)	-680	-9.6

Table 10.2 Main recalculations by source category for 2018

Category	MS	2018	
		kt CO_2 equiv.	%
1A1_Energy Industries CO_2	Czechia	1 875	3.7
1A1_Energy Industries CO_2	France	-1 173	-2.9
1A1_Energy Industries CO_2	Germany	4 042	1.4
1A1_Energy Industries CO_2	United Kingdom (KP)	-535	-0.6
1A2_Manufacturing Industries and Construction CO_2	France	-1 658	-3.3
1A2_Manufacturing Industries and Construction CO_2	Germany	-3 671	-2.8
1A2_Manufacturing Industries and Construction CO_2	Romania	3 570	29.5
1A2_Manufacturing Industries and Construction CO_2	United Kingdom (KP)	1 052	2.1
1A4_Other sectors CO_2	France	-7 303	-9.1
1A4_Other sectors CO_2	Germany	-572	-0.5
1A4_Other sectors CO_2	Poland	-965	-1.8
1A4_Other sectors CO_2	United Kingdom (KP)	1 046	1.1
1A5_Other CO_2	France	1 417	100.0
1B2_Oil and natural gas CH_4	Hungary	1 046	165.9
1B2_Oil and natural gas CH_4	Italy	595	13.3
1B2_Oil and natural gas CH_4	Romania	-1 101	-30.4
1B2_Oil and natural gas CH_4	Slovakia	-1 136	-84.7
2B_Chemical industries CO_2	Netherlands	-1 285	-22.8
2C_Metal industry CO_2	France	9 349	210.3
2C_Metal industry CO_2	Germany	-1 420	-6.7
2F_Product uses as substitute for ODS HFC	Hungary	675	49.7
3A_Enteric fermentation CH_4	Germany	-1 089	-4.3
3A_Enteric fermentation CH_4	Ireland	921	8.0
3A_Enteric fermentation CH_4	Italy	-945	-6.7
3A_Enteric fermentation CH_4	Romania	-3 426	-31.6
3A_Enteric fermentation CH_4	Spain	-1 634	-9.3
3B_Manure management CH_4	Italy	662	19.0
3B_Manure management CH_4	Romania	-734	-53.2
3B_Manure management N_2O	Poland	580	26.3
3D_Agricultural soils N_2O	France	-661	-2.1
3D_Agricultural soils N_2O	Germany	542	2.2
3D_Agricultural soils N_2O	Latvia	-511	-33.1
3D_Agricultural soils N_2O	Poland	622	4.0
3D_Agricultural soils N_2O	Romania	3 037	46.8
3D_Agricultural soils N_2O	United Kingdom (KP)	742	6.5
5A_Solid waste disposal on land CH_4	Croatia	-526	-29.7
5D_Waste water treatment and discharge CH_4	United Kingdom (KP)	-1 779	-51.9
4A_Forest land CO_2	Belgium	-648	-51.8
4A_Forest land CO_2	Bulgaria	-812	-10.7
4A_Forest land CO_2	Czechia	-1 701	-23.4
4A_Forest land CO_2	Denmark	-2 567	-736.0

Category	MS	2018	
		kt CO_2 equiv.	%
4A_Forest land CO_2	Estonia	829	28.0
4A_Forest land CO_2	Finland	2 196	10.9
4A_Forest land CO_2	France	-1 155	-2.3
4A_Forest land CO_2	Germany	9 206	13.7
4A_Forest land CO_2	Italy	649	1.9
4A_Forest land CO_2	Latvia	-607	-14.7
4A_Forest land CO_2	Lithuania	-2 481	-52.0
4A_Forest land CO_2	Poland	599	1.6
4A_Forest land CO_2	Romania	-5 840	-28.7
4A_Forest land CO_2	Sweden	5 276	11.8
4A_Forest land CO_2	United Kingdom (KP)	926	5.0
4B_Cropland CO_2	Denmark	-1 287	-29.0
4B_Cropland CO_2	France	-3 706	-21.0
4B_Cropland CO_2	Germany	804	5.1
4B_Cropland CO_2	Greece	-716	-218.8
4B_Cropland CO_2	Latvia	-908	-38.8
4B_Cropland CO_2	Romania	-1 527	-63.0
4B_Cropland CO_2	Iceland	669	58.5
4B_Cropland CO_2	United Kingdom (KP)	4 130	37.3
4C_Grassland CO_2	Bulgaria	503	30.2
4C_Grassland CO_2	Denmark	717	51.6
4C_Grassland CO_2	Germany	1 587	10.3
4C_Grassland CO_2	Italy	-615	-7.3
4C_Grassland CO_2	Sweden	892	710.1
4C_Grassland CO_2	United Kingdom (KP)	5 536	61.5
4D_Wetlands CO_2	Ireland	806	53.4
4D_Wetlands CO_2	United Kingdom (KP)	716	213.9
4E_Settlements CO_2	Germany	-1 214	-20.9
4E_Settlements CO_2	Poland	-722	-23.1
4E_Settlements CO_2	Romania	730	23.4
4E_Settlements CO_2	United Kingdom (KP)	-1 128	-16.9
4G_Harvested wood products CO_2	Germany	-2 691	-83.1
4G_Harvested wood products CO_2	Romania	4 508	52.8

10.2 Implications for emission levels

Table 10.3 provides the differences in total GHG emissions between the latest submission and the previous submission in absolute and relative terms for EU-27, United Kingdom and Iceland (EU-KP). The table shows that due to recalculations, total 1990 GHG emissions with indirect CO_2 excluding LULUCF have increased in the latest submission compared to the previous submission by 9 953 kt (0.2 %). EU-KP GHG emissions for 2018 increased by 1 309 kt (-0.0.03 %) due to recalculations.

Table 10.3 Overview of recalculations of EU-KP total GHG emissions (difference between latest submission and previous submission in kt CO_2 equivalents)

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total CO_2 equivalent emissions including LULUCF (absolute in kt)	71307	-11260	7478	22	-3325	1657	261	3541	10470	21547	8062
Total CO_2 equivalent emissions including LULUCF (percent)	1.3	-0.2	0.2	0.0	-0.1	0.0	0.0	0.1	0.2	0.4	0.2
Total CO_2 equivalent emissions excluding LULUCF (absolute in	9953	-10482	-11991	-10667	-11800	-12100	-13521	-13586	-11302	-13575	-15541
Total CO_2 equivalent emissions excluding LULUCF (percent)	0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3	-0.2	-0.3	-0.3

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total CO_2 equivalent emissions including LULUCF (absolute in kt)	-1659	8291	12663	11753	11084	7583	368	-961	5117	15104
Total CO_2 equivalent emissions including LULUCF (percent)	0.0	0.2	0.3	0.3	0.3	0.2	0.0	0.0	0.1	0.4
Total CO_2 equivalent emissions excluding LULUCF (absolute in	-16783	-17081	-9837	-6157	-5902	-7087	-10369	-5714	-5477	-1309
Total CO_2 equivalent emissions excluding LULUCF (percent)	-0.4	-0.4	-0.2	-0.1	-0.1	-0.2	-0.2	-0.1	-0.1	0.0

Table 10.4 provides an overview of recalculations for the key categories for 1990 and 2018 (see Section 1.5 for information on identification of key categories). The table shows that the largest recalculations in absolute terms were made in the key category CO_2 from '2C Metal Industry'. for 1990 and as well as in 2018, followed by CH_4 recalculations in the category '3A Enteric Fermentation'..

Table 10.5 and Table 10.6 give an overview of absolute and relative changes of Member States' emissions due to recalculations for 1990 and 2018. Recalculations of more than 2 million tonnes of CO_2 equivalents were made by France, Germany, Italy, Netherlands, Portugal, Romania and the United Kingdom. Recalculations in relative terms of more than 2 % were made in Bulgaria, Cyprus, Hungary, Ireland, Latvia, Malta, Romania, Slovakia and Slovenia.

Table 10.4 Recalculations for EU-KP key source categories 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and in percentage)

Greenhouse Gas Source Categories	Gas	Recalculations 1990		Recalculations 2018	
		(kt CO_2 equivalents)	(%)	(kt CO_2 equivalents)	(%)
1.A.1. Energy Industries	CO_2	-705	0.0%	4 499	0.4%
1.A.2. Manufacturing Industries	CO_2	8 468	1.0%	-731	-0.1%
1.A.3. Transport	CO_2	-131	0.0%	328	0.0%
1.A.3. Transport	CH_4	-180	-2.6%	-7	-0.5%
1.A.3. Transport	N_2O	-45	-0.5%	-137	-1.4%
1.A.4. Other Sectors	CO_2	-5 311	-0.7%	-6 022	-1.0%
1.A.4. Other Sectors	CH_4	-105	-0.5%	-41	-0.2%
1.A.5. Other	CO_2	4 507	19.4%	1 509	24.6%
1.B.1. Solid Fuels	CH_4	0	0.0%	3	0.0%
1.B.2. Oil and Natural Gas	CH_4	700	1.1%	-688	-2.6%
1.B.2. Oil and Natural Gas	CO2	-81	-0.4%	-120	-0.5%
2.A. Mineral Industry	CO_2	-10	0.0%	208	0.2%
2.B. Chemical Industry	CO_2	-417	-0.7%	-1 278	-2.4%
2.B. Chemical Industry	Unspecified mix of HFCs and PFCs	-	0.0%	-	0.0%
2.B. Chemical Industry	N_2O	23	0.0%	0	0.0%
2.B. Chemical Industry	HFCs	-	0.0%	-0	0.0%
2.C. Metal Industry	CO_2	13 245	12.1%	7 805	10.5%
2.C. Metal Industry	PFC	0	0.0%	-0	0.0%
2.D. Non-energy products from fuels and solvent us	CO_2	-1 081	-8.2%	-418	-4.3%
2.F. Product uses as substitute for ODS	HFC	-72	-82.3%	-410	-0.4%
3.A. Enteric Fermentation	CH_4	-12 765	-5.1%	-6 963	-3.6%
3.B. Manure Management	CH_4	-3 025	-5.7%	-502	-1.2%
3.B. Manure Management	N_2O	667	2.3%	329	1.5%
3.D. Agricultural Soils	N_2O	4 928	2.5%	2 677	1.6%
5.A. Solid Waste Disposal	CH_4	-2 069	-1.1%	-1 315	-1.3%
5.B. Biological Treatment of Solid Waste	CH_4	-17	-2.7%	51	0.9%
5.D. Waste Water treatment and discharge	CH_4	745	2.1%	-1 111	-5.7%
5.D. Waste Water treatment and discharge	N2O	181	2.1%	269	3.8%

Note: Many of these source categories are more aggregated than the EU-KP key source categories identified in Section 1.5.

Table 10.5 Contribution of countries to EU-KP recalculations of total GHG emissions with indirect CO_2 and without LULUCF for 1990–2018 (difference between latest submission and previous submission kt of CO_2 equivalents)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Austria	-72	-145	-133	-280	-294	-354	-308	-384	-276	-160	-96	-155	-107	-48	4	-161	-323
Belgium	-691	-879	-822	-690	-671	-718	-719	-727	-682	-648	-537	-506	-484	-458	-483	-581	-561
Bulgaria	-1 816	-1 706	-1 716	-1 403	-1 301	-1 248	-1 146	-990	-930	-924	-854	-773	-691	-582	-544	-534	-534
Croatia	-489	-252	-145	-190	-219	-241	-317	-317	-281	-278	-275	-133	-222	-213	-275	-295	-257
Cyprus	-113	-153	-145	-182	-137	-151	-86	-74	-71	-22	-11	5	5	-6	-8	-4	1
Czechia	-118	-184	-170	-148	-96	-110	-170	-359	-285	-280	-53	-280	-277	-322	-547	1 405	1 112
Denmark	93	106	-18	70	44	42	35	-19	14	11	0	0	-30	-6	-37	-35	-79
Estonia	768	165	249	245	303	184	211	142	199	228	148	172	120	30	169	143	232
Finland	10	6	17	14	20	30	13	-6	-28	-23	-17	-60	-41	1	-33	-107	-77
France	-4 289	-6 424	-4 295	-3 627	-1 942	-1 267	-792	-3 834	-3 570	234	1 198	1 116	962	108	1 339	-83	-233
Germany	-882	-815	-814	-669	-1 165	-70	-1 892	-572	-533	-2 161	-805	-1 151	-1 134	-2 058	-1 085	-2 221	-2 478
Greece	-19	-22	-22	-23	-22	-22	-21	-21	-22	-22	-21	-21	-19	-18	-18	15	87
Hungary	836	1 841	1 682	1 331	1 367	1 269	1 064	921	1 200	1 115	1 388	1 305	1 017	719	1 001	935	1 516
Ireland	-1 068	-423	144	562	795	550	641	620	672	637	1 032	981	737	1 016	984	1 110	1 591
Italy	2 669	2 569	2 992	2 542	1 912	3 320	3 017	2 615	2 717	2 357	1 856	2 106	1 439	1 005	1 608	1 389	1 020
Latvia	-420	-492	-451	-467	-473	-477	-453	-457	-442	-445	-445	-462	-457	-454	-454	-460	-455
Lithuania	-224	-131	-97	-102	-105	-112	-184	-166	-145	-124	-135	-144	-124	-117	-109	-99	-117
Luxembourg	-14	-8	-11	-4	-1	0	6	9	7	7	34	36	30	34	32	31	18
Malta	25	25	23	13	8	6	-2	-8	-16	-20	-26	-23	-28	-35	-42	-95	-145
Netherlands	-1 137	-1 298	-1 661	-1 673	-1 666	-1 783	-1 724	-1 660	-1 606	-1 848	-2 191	-1 491	-1 567	-2 710	-1 891	-2 309	-1 438
Poland	783	587	645	766	667	771	626	629	575	483	449	491	460	-858	153	140	-1 004
Portugal	225	41	140	201	138	144	129	9	-23	-37	-62	-69	-80	-112	-124	344	-149
Romania	18 377	196	-1 426	-2 254	-1 294	-6 409	-5 926	-4 301	-5 855	-2 563	-1 736	-1 004	-991	-68	-753	92	2 050
Slovakia	-131	-413	-622	-914	-901	-939	-1 037	-948	-1 042	-1 149	-877	-993	-929	-1 118	-1 205	-1 249	-1 189
Slovenia	-29	57	-456	-24	8	28	29	-152	58	-25	-87	-87	6	10	9	330	20
Spain	618	449	-565	-1 365	-1 140	-926	-892	-1 106	-983	-642	-641	-1 167	-1 206	-1 259	-1 425	-1 560	-1 005
Sweden	54	65	34	38	34	35	35	27	90	99	82	111	-13	259	286	296	391
United Kingdom	-2 897	-3 156	-4 260	-5 267	-5 076	-5 028	-5 582	-5 563	-5 712	-3 548	-3 406	-3 640	-3 401	-3 053	-2 213	-1 872	757
EU27+UK	**10 048**	**-10 395**	**-11 900**	**-13 499**	**-11 210**	**-13 477**	**-15 444**	**-16 690**	**-16 968**	**-9 751**	**-6 089**	**-5 834**	**-7 026**	**-10 314**	**-5 661**	**-5 434**	**-1 249**
Iceland	-50	-38	-44	-37	-42	-46	-43	-39	-63	-34	-26	-34	-36	-36	-38	-40	-35
United Kingdom (KP)	-2 943	-3 205	-4 307	-5 318	-5 127	-5 080	-5 636	-5 616	-5 762	-3 601	-3 449	-3 674	-3 426	-3 072	-2 228	-1 874	733

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU-KP	**9 953**	**-10 482**	**-11 991**	**-13 586**	**-11 302**	**-13 575**	**-15 541**	**-16 783**	**-17 081**	**-9 837**	**-6 157**	**-5 902**	**-7 087**	**-10 369**	**-5 714**	**-5 477**	**-1 309**

Table 10.6 Contribution of Member States to EU-KP recalculations of total GHG emissions with indirect CO_2 and without LULUCF for 1990–2018 (difference between latest submission and previous submission in percentage)

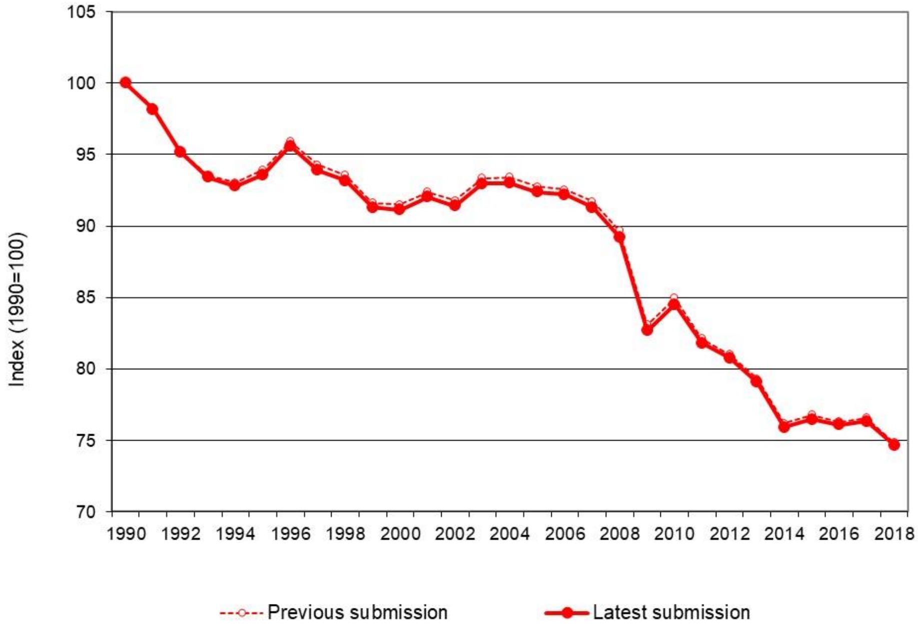
	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Austria	-0.09	-0.18	-0.17	-0.30	-0.33	-0.41	-0.35	-0.48	-0.33	-0.19	-0.12	-0.19	-0.14	-0.06	0.00	-0.20	-0.41
Belgium	-0.47	-0.57	-0.55	-0.47	-0.47	-0.51	-0.51	-0.57	-0.51	-0.52	-0.44	-0.42	-0.42	-0.38	-0.41	-0.49	-0.47
Bulgaria	-1.78	-2.29	-2.88	-2.19	-2.01	-1.82	-1.71	-1.70	-1.53	-1.40	-1.40	-1.39	-1.18	-0.94	-0.92	-0.87	-0.92
Croatia	-1.53	-1.11	-0.57	-0.63	-0.72	-0.76	-1.03	-1.11	-1.00	-1.00	-1.06	-0.54	-0.94	-0.88	-1.13	-1.18	-1.08
Cyprus	-1.99	-2.14	-1.71	-1.94	-1.43	-1.52	-0.85	-0.75	-0.74	-0.23	-0.13	0.07	0.07	-0.08	-0.09	-0.05	0.01
Czechia	-0.06	-0.12	-0.11	-0.10	-0.06	-0.07	-0.12	-0.26	-0.20	-0.20	-0.04	-0.22	-0.22	-0.25	-0.42	1.08	0.87
Denmark	0.13	0.13	-0.02	0.10	0.06	0.06	0.05	-0.03	0.02	0.02	0.00	0.00	-0.06	-0.01	-0.07	-0.07	-0.16
Estonia	1.91	0.82	1.45	1.29	1.66	0.83	1.06	0.86	0.95	1.08	0.74	0.79	0.57	0.16	0.86	0.68	1.16
Finland	0.01	0.01	0.02	0.02	0.02	0.04	0.02	-0.01	-0.04	-0.03	-0.03	-0.09	-0.07	0.00	-0.06	-0.19	-0.14
France	-0.78	-1.18	-0.78	-0.65	-0.36	-0.24	-0.15	-0.76	-0.70	0.05	0.25	0.23	0.21	0.02	0.29	-0.02	-0.05
Germany	-0.07	-0.07	-0.08	-0.07	-0.12	-0.01	-0.19	-0.06	-0.06	-0.24	-0.09	-0.12	-0.13	-0.23	-0.12	-0.25	-0.29
Greece	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	0.02	0.09
Hungary	0.89	2.44	2.30	1.77	1.84	1.75	1.51	1.43	1.85	1.76	2.33	2.30	1.77	1.18	1.63	1.47	2.40
Ireland	-1.93	-0.72	0.21	0.81	1.16	0.81	0.95	1.00	1.10	1.11	1.79	1.70	1.29	1.71	1.60	1.82	2.61
Italy	0.52	0.49	0.54	0.43	0.33	0.58	0.54	0.52	0.53	0.47	0.38	0.47	0.34	0.23	0.37	0.32	0.24
Latvia	-1.60	-3.79	-4.29	-4.09	-3.97	-3.86	-3.81	-4.08	-3.60	-3.88	-3.94	-4.11	-4.10	-4.06	-4.05	-4.09	-3.88
Lithuania	-0.47	-0.59	-0.50	-0.45	-0.46	-0.44	-0.75	-0.83	-0.70	-0.58	-0.63	-0.71	-0.62	-0.58	-0.53	-0.48	-0.58
Luxembourg	-0.11	-0.08	-0.11	-0.03	-0.01	0.00	0.05	0.08	0.06	0.05	0.29	0.32	0.28	0.33	0.32	0.31	0.17
Malta	0.98	0.93	0.84	0.43	0.26	0.20	-0.05	-0.27	-0.52	-0.68	-0.81	-0.78	-0.96	-1.56	-2.14	-4.42	-6.63
Netherlands	-0.51	-0.56	-0.76	-0.78	-0.80	-0.86	-0.83	-0.82	-0.75	-0.93	-1.12	-0.76	-0.84	-1.38	-0.97	-1.19	-0.76
Poland	0.16	0.13	0.16	0.19	0.16	0.18	0.15	0.16	0.14	0.12	0.11	0.12	0.12	-0.22	0.04	0.03	-0.24
Portugal	0.38	0.06	0.17	0.23	0.17	0.18	0.17	0.01	-0.03	-0.05	-0.09	-0.11	-0.13	-0.16	-0.19	0.49	-0.22
Romania	7.41	0.10	-1.00	-1.49	-0.85	-4.14	-3.95	-3.36	-4.71	-1.99	-1.38	-0.87	-0.85	-0.06	-0.66	0.08	1.77
Slovakia	-0.18	-0.78	-1.26	-1.78	-1.76	-1.90	-2.08	-2.08	-2.24	-2.51	-2.03	-2.32	-2.28	-2.67	-2.85	-2.87	-2.74
Slovenia	-0.16	0.30	-2.39	-0.12	0.04	0.14	0.13	-0.78	0.30	-0.13	-0.46	-0.47	0.04	0.06	0.05	1.90	0.11
Spain	0.21	0.14	-0.15	-0.31	-0.26	-0.21	-0.22	-0.30	-0.27	-0.18	-0.18	-0.36	-0.37	-0.37	-0.44	-0.46	-0.30
Sweden	0.08	0.09	0.05	0.06	0.05	0.05	0.06	0.05	0.14	0.16	0.14	0.20	-0.02	0.48	0.54	0.56	0.76
United Kingdom	-0.36	-0.42	-0.60	-0.76	-0.74	-0.75	-0.86	-0.93	-0.94	-0.63	-0.59	-0.64	-0.65	-0.60	-0.46	-0.40	0.16

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU27+UK	**0.18**	**-0.20**	**-0.23**	**-0.26**	**-0.21**	**-0.26**	**-0.30**	**-0.36**	**-0.35**	**-0.21**	**-0.13**	**-0.13**	**-0.16**	**-0.24**	**-0.13**	**-0.13**	**-0.03**
Iceland	-1.34	-1.07	-1.06	-0.90	-0.90	-0.93	-0.80	-0.79	-1.27	-0.72	-0.56	-0.73	-0.77	-0.75	-0.80	-0.83	-0.72
United Kingdom (KP)	-0.37	-0.43	-0.60	-0.77	-0.75	-0.75	-0.86	-0.94	-0.94	-0.64	-0.59	-0.65	-0.65	-0.60	-0.46	-0.40	0.16
EU-KP	**0.18**	**-0.20**	**-0.23**	**-0.26**	**-0.22**	**-0.26**	**-0.31**	**-0.36**	**-0.36**	**-0.21**	**-0.13**	**-0.13**	**-0.16**	**-0.24**	**-0.13**	**-0.13**	**-0.03**

10.3 Implications for emission trends, including time series consistency

Figure 10.1 shows that due to the fact that both 1990 and 2018 emissions have been recalculated in the same order of magnitude the emission trend in the EU-KP did hardly change, and the trends are therefore largerely overlapping. In the previous submission the trend of GHG with indirect CO_2 and excluding LULUCF between 1990 and 2018 was -25.2 %. In the latest submission the trend is - 25.3 %.

Figure 10.1: Comparison of EU-KP GHG emission trends 1990–2018 (with indirect CO_2, excl. LULUCF) of the latest and the previous submission



10.4 Recalculations, including in response to the review process, and planned improvements to the inventory

10.4.1 EU response to UNFCCC review

A list of recommendations and improvements is presented in Table 10.7

Table 10.7 Improvements made in response to UNFCCC review findings as indicated in Tables 3 of the ARR 2018

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
G.2	Transparency	Methods (G.3, 2016) (G.3, 2015) (14, 2014) Transparency	Work with member States in order to report consistent notation keys among member States for describing the completeness of the overall inventory.	Addressing. The EU has resolved the issue raised in the 2014 ARR regarding inconsistent use of notation keys for deforestation (see ID# KL.8 below). In addition, as part of its routine initial QA/QC checks on member State submissions the EU performs checks on notation keys to ensure their consistent use. Nevertheless, a couple of inconsistencies in the reporting of notation keys among member States remain from the 2014 ARR (see ID#s I.35 and KL.2 below).	The EU carries out QA/QC checks on Member States' use of notation keys as part of the regular initial checks. Due to this process, past and existing inconsistencies have been resolved; however new reporting from Member States may add further cases of inconsistencies in the use of notation keys. Countries, as own Parties to UNFCCC, also have their own reasons for reporting specific notation keys according to their national circumstances. Sometimes it can be about correctness (which we try to adress) but other times is about interpretation of the reporting guidelines. The EU tries to harmonise notation keys to the extent possible. We suggest that open-ending recommendations are avoided and that they are as specific as possible so that the EU can implement and resolve them effectively. We believe that we have implemented the recomendations, as we 'work with Member states to improve the reporting of notation keys'. If the ERT believes that something is not yet resolved we would suggest opening a new finding for the specific issue, while closing the more generic recommendation here as resolved.
E.1	Transparency	1. General (energy sector) (E.2, 2016) (E.2, 2015) (40, 2014) Transparency	Present methodological summaries that are consistent among member States and categories, at least for the key categories.	Addressing. The NIR includes tables with the methodology used and EF applied for subcategories 1.A.1.a (public electricity and heat production) and 1.A.1.c (manufacture of solid fuels and other energy industries), but not for the key categories 1.A.2.g (other (manufacturing industries and construction)), 1.A.3.b (road transportation) and 1.A.5.b (mobile (other)).	Information on methodology used and EFs applied for subcategories 1.A.2g, 1.A.3.b and 1.A.5.b are not provided in the XML of MS and cannot be provided automatically in these tables. The EU sets efforts to collect this information and will provide methodology used and EF applied in future submissions.
E.2	Accuracy	1. General (energy sector) – gaseous, solid and liquid fuels – CO_2, CH_4 and N_2O (E.9, 2016) (E.9, 2015) Accuracy	Work with member States to improve the methodology used to estimate emissions from key categories by using a methodological tier for each member State in accordance with the decision trees in the 2006 IPCC Guidelines, the key category analysis of the EU and the relative importance of the	Addressing. During the review, the EU explained that capacity-building activities to help member States improve the methodology used to estimate emissions for key categories have been carried out, and the EU foresees supporting countries in moving to higher-tier methods for key categories in the second half of 2018.	Every year in Autumn capacity-building activities are organized to help member States improve their methodology used to estimate emissions for key categories and support countries in moving to higher-tier methods for key categories. In this context capacity building webinars are organized and guidance documents have been prepared. The share of higher tier methods applied is continuously increasing. This information is also available to the ERT.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
E.3	Transparency	1. General (energy sector) – gaseous fuels – CO_2, CH_4 and N_2O (E.10, 2016) (E.10, 2015) Transparency	Provide information in the NIR on the fuel combustion categories under which the emissions from the combustion of CH_4 recovered are included.	Not resolved. Additional information on the reporting of the recovery of emissions from coal mining and oil and gas operations is not included in the NIR. During the review, the EU explained that when a member State reports CH_4 recovery as "IE" in the CRF tables, the NIR provides information regarding the fuel combustion categories under which the emissions from the combustion of CH_4 recovered are included.	Recovery of CH_4 emissions does only occur in subcategory 1B1 in 3 countries (UK, Romania, Slovakia). A description of the share and allocation of recovered CH_4 emissions for each reporting country is included in chapter 1B of the EU NIR.
E.12	Comparability	1.A.3.b Road transportation – liquid fuels – CO_2, CH_4 and N_2O (E.15, 2016) (E.15, 2015) Comparability	Provide summary information on how each member State has reported the emissions from use of lubricants under the transport (1.A.3) and/or lubricant use (2.D.1) categories and work with the member States to report emissions from lubricants combusted in two-stroke engines under the transport category in accordance with the 2006 IPCC Guidelines.	Not resolved. The required summary information on emissions from lubricant use is not included in the NIR. During the review, the EU explained that for member States that have provided information in their NIR on how they reported emissions from lubricant use, the recommendation is considered to have been implemented. In the case of member States for which no clear conclusion can be drawn from the information reported, additional actions are needed by the EU, which it will carry out for the next submission.	All countries provide relevant information on the NIR concerning lubricant use. In cases where lubricants are not reported separately in Transport category a justification is provided that no over/underestimation of emissions occurs.
I.2	Transparency	2. General (IPPU) (I.26, 2016) (I.26, 2015) Transparency	Provide consistent information on the methodologies used to estimate GHG emissions from the IPPU sector within the NIR, while also ensuring consistency with the NIRs of member States.	Addressing. Information on the methodologies used by member States is still inconsistent within the NIR (chapter 4 versus annex III). Although there were improvements in the consistency of information between the sections on Denmark in the EU NIR, inconsistencies in the sections on Greece, Lithuania and France were identified for cement production.	The information in the NIR (chapter 4.2.1.1) was updated accordingly. For France and Lithuania, consistent tiers are reported. For Greece, it is specified that a country-specific method was used (in line with the national submission). In addition, it is specified that the level of complexity of that method is Tier 3, which is consistent with the information provided in Annex III.
I.3	Transparency	2. General (IPPU) (I.27, 2016) (I.27, 2015) Transparency	Identify which tier method was used to estimate emissions under each key category of the IPPU sector, in accordance with the 2006 IPCC Guidelines, and provide the corresponding tier method when a country-specific method is used.	Addressing. The EU generally provides methodological information for key categories for all member States in annex III to the NIR. However, the previous review report specifically identified the issues listed in ID#s I.6 and I.8 below in this context, and these issues were not resolved in the NIR.	The information on the methodological tier for those countries that report country-specific methods was added in chapters 4.2.1.1 and 4.2.1.2 (cf. IDs 6 and 8, below).

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
I.6	Transparency	2.A.1 Cement production – CO_2 (I.29, 2016) (I.29, 2015) Transparency	Provide information in the NIR on the corresponding level of complexity (IPCC tier) of the country-specific methods used by Cyprus, Greece, Hungary, the Netherlands and Sweden to estimate emissions from cement production.	Addressing. Information on the tier used to estimate emissions from cement production has been updated in the NIR only for Hungary (in chapter 4 and annex III) and Sweden (in chapter 4 only). Tiers for Cyprus, Greece and the Netherlands are missing. During the review, the EU indicated that the missing information would be addressed in a future submission.	Information on the methodological tier is provided for all countries in chapter 4.2.1.1 of the NIR. Please note that the information provided in tabular format in this chapter is identical with the information submitted in the various national submissions. As Greece uses a country-specific method and reports "CS" in its national submission, the information on the methodological tier used by Greece (T3) is provided below the table.
I.8	Transparency	2.A.2 Lime production – CO_2 (I.30, 2016) (I.30, 2015) Transparency	Provide information in the NIR on the methods and EFs used by Austria, France and Malta and the level of complexity (IPCC tier) of the country-specific methods used by Greece, Hungary and Sweden to estimate CO_2 emissions from lime production.	Addressing. Information on the tier used to estimate emissions from lime production has been updated in the NIR for France and Hungary in both table 4.5 and annex III, and for Austria and Sweden in table 4.5 only (in annex III, the column for method and EF used is blank). No information is included for Greece, Malta or the Netherlands.	Information on the methodological tier is provided for all countries in chapter 4.2.1.2 of the NIR. Please note that the information provided in tabular format in this chapter is identical with the information submitted in the various national submissions. As Greece and the Netherlands use a country-specific method and report "CS" accordingly, the information on the methodological tier used (T3) is provided below the table.
I.9	Comparability	2.A.2 Lime production – CO_2 (I.30, 2016) (I.30, 2015) Transparency (I.31, 2016) (I.31, 2015) Comparability	Work with the Netherlands to report CO_2 emissions from lime production under the lime production category (2.A.2) in accordance with the 2006 IPCC Guidelines.	Addressing. The Netherlands now reports CO_2 emissions from lime production in the IPPU sector, but under the category food industries (2.D.2) rather than lime production (2.A.2).	CO_2 emissions from lime production are now reported under category 2.A.2, as recommended by the ERT (see chapter 4.2.1.2.
I.16	Accuracy	2.B.1 Ammonia production – CO_2 (I.36, 2016) (I.35, 2015) Accuracy	Work with Czechia to move from a tier 1 to a higher-tier method to estimate CO_2 emissions from ammonia production, which is a key category, in accordance with the 2006 IPCC Guidelines.	Not resolved. During the review, the EU informed the ERT that implementation of this recommendation is planned for a future submission.	Investigations which will allow the estimation of CO_2 emissions using plant-specific emission factors are ongoing, but have not been completed yet.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
I.20	Accuracy	2.B.4 Caprolactam, glyoxal and glyoxylic acid production – N_2O (I.40, 2016) (I.38, 2015) Accuracy	Work with Czechia to recalculate and report more accurate N_2O emissions from caprolactam production, taking into account the data collected under the EU ETS.	Not resolved. During the review, the EU informed the ERT that implementation of this recommendation is planned for a future submission. The ERT notes that Czechia reports annual emissions from caprolactam production of 0.25 kt N_2O (74.5 kt CO_2 eq) and that emissions have been measured since 2012, so any underestimation is below the level of significance given in decision 22/CMP.1 in conjunction with decision 4/CMP.11, annex, paragraph 80(b). In response to a draft version of this report, the EU stated that it continues to work with Czechia to report more accurate emissions from caprolactam production, taking into account the data collected under the EU ETS.	Emissions are estimated using a plant-specific emission factor, which was derived from a mass balance calculation. It is not possible to switch to a method using EU ETS data, because the facility reports several sources of emissions together and data are not available separately for the caprolactam production process.
I.23	Comparability	2.B.8 Petrochemical and carbon black production – CO_2 (I.42, 2016) (I.40, 2015) Comparability	Include in the NIR the reasons why CO_2 emissions from fuel consumption in ethylene production in France were allocated to the energy sector and work with the member State to allocate CO_2 emissions from fuel use in ethylene production to the IPPU sector, under petrochemical and carbon black production, in accordance with the 2006 IPCC Guidelines.	Not resolved. During the review, the EU informed the ERT that implementation of this recommendation is planned for a future submission.	All emissions from ethylene production (combustion and process) are now fully reported in category 2B10 and not in the energy sector. More information can be found in section 4.3.2.9 of the French NIR.
I.24	Comparability	2.B.9 Fluorochemical production – HFCs (I.43, 2016) (I.41, 2015) Comparability	Explain in the NIR how tetrafluoromethane emissions from the production of HCFC-22 occur and work with Italy to allocate these emissions under the subcategory fluorochemical production – by-product emissions (other) (2.B.9.a.2) instead of the subcategory fluorochemical production – by- product emissions (production of HCFC-22) (2.B.9.a.1).	Not resolved. The EU continues to report tetrafluoromethane emissions as by-product emissions from the production of HCFC-22, but an explanation for how these emissions occur is not included in the NIR.	IT-2B9-2020-0002: The origin of the CF4 emissions was not fully clarified but does not relate to the production of HCFC-22 for feedstock use as only HFC-23 is formed as by-product during that process. However, the answer says that CF4 is still measured AFTER treatment of the flue gases from different production lines. CF4 might be formed during the incineration process of hydrocarbons and fluorine. It is certain that it is formed during incineration of PTFE at temperatures of around 800°C. Therefore the emissions might either result from an incomplete abatement process or are formed in the course of the treatment process or come from other production processes. Due to these uncertainties and ongoing communication on the issue this has not been picked up in the NIR.

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I.29	Transparency	2.C.1 Iron and steel production – CO_2 (I.49, 2016) Transparency	Work with Hungary to estimate and report the CO_2 IEF, expressed in t CO_2 per t sinter produced.	Not resolved. The EU continues to report a comparatively high CO_2 IEF for Hungary of 5.28 t CO_2/t sinter for 1990 and 5.08 t CO_2/t sinter for 2016 (NIR, table 4.17). During the review, the EU informed the ERT that implementation of this recommendation is planned for a future submission.	Hungary provides in their NIR information as to why they report a relatively high IEF. The EU will undertake efforts to assess, if capacity building is necessary to address this problem, and what can be done by the EU to help Hungary allocate emissions from BOF and limestone and dolomite use to the respective subsectors.
I.31	Transparency	2.C.3 Aluminium production – CO_2 (I.50, 2016) (I.47, 2015) Transparency	Include in the NIR information on the method, assumptions, EFs and AD used to estimate CO_2 emissions from aluminium production.	Addressing. Some additional information on the methods used to estimate CO_2 emissions from aluminium is included in the NIR (p.488); however, EFs and AD were not provided (AD were reported for PFC emissions).	The scope of the EU NIR entails information on key categories only (please refer to the Introduction for additional information), this is why no information is included on CO_2 emissions from 2A3, Aluminium Production. Could the TERT please specify, if additional information on PFC emissions is necessary to increase transparency?
I.33	Transparency	2.D Non-energy products from fuels and solvents use – CO_2 (I.52, 2016) (I.49, 2015) Transparency	Provide in the NIR information on the methodologies, assumptions, EFs and AD used to estimate CO_2 emissions from non-energy products from fuel and solvent use, which is a key category.	Addressing. Information on methodologies and EFs is included only for other non-energy products from fuel and solvent use (2.D.3) (NIR, table 4.40).	The scope of the EU NIR entails information on key categories only (please refer to the Introduction for additional information), this is why no information is included on CO_2 emissions from 2D1 and 2D2. Could the TERT please specify, if additional information should be added on emissions from 2C3 to increase transparency?
I.34	Transparency	2.F Product uses as substitutes for ozone- depleting substances – HFCs (I.20, 2016) (I.20, 2015) (74, 2014) Transparency	Endeavour to provide in the NIR summary overviews of methodologies used to estimate emissions from the consumption of halocarbons and SF_6 for key categories based on the relevant methodological descriptions reported in the NIRs of member States.	Addressing. The two key categories are refrigeration and air conditioning, and aerosols. Information on the methodologies used to estimate HFC emissions from refrigeration and air conditioning for all member States is included in the NIR (table 4.45). Regarding aerosols, methodological information is reported for all member States, except Cyprus, in table 4.48.	Methodological information regarding aerosols is reported for Cyprus in the EU NIR.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
I.35	Transparency	2.F Product uses as substitutes for ozone- depleting substances – HFCs, PFCs and SF_6 (I.21, 2016) (I.21, 2015) (75, 2014) Transparency	Make the necessary corrections in the use of the notation keys to ensure the transparency of the reporting (specifically: “NE” reported by Denmark for the amount of gas remaining in products at decommissioning; “NO” reported by Finland for SF_6 emissions from aluminium and magnesium foundries; “IE” and “NA” reported by Ireland for AD and emission estimates for HFC emissions from refrigeration and air-conditioning equipment (except mobile air conditioning); “NO” reported by Luxembourg for potential emissions of PFCs from refrigeration and air-conditioning equipment; “NA” and “NA and NO” reported by the Netherlands for AD and IEFs of emissions from stocks in industrial refrigeration and mobile equipment, whereas the emissions are actually estimated; and empty cells in the CRF tables for Spain as a replacement of “NA” and “NE” notation keys for reporting emissions from semiconductor manufacturing).	Addressing. The only outstanding issue of the specific issues with notation keys listed in the annual review report of the 2014 submission is that Finland still reports “NO” for SF_6 emissions from aluminium and magnesium foundries.	SF_6 emissions from 2C4 occurred in Finland only in the years 1994 to 2009 and in 2012, but ceased since then. For these years "IE" is reported and emissions are included in 2H3. For all other years "NO" is reported as Mg die casting did not occur and therefore no emissions occurred.
I.37	Transparency	2.F.6 Other applications (product uses as substitutes for ozone-depleting substances) – HFCs, PFCs and SF_6 (I.25, 2016) (I.25, 2015) (77, 2014) Transparency	Include an explanation in the annual submission on the reporting of the emissions from the processes related to the use of HFCs and SF_6 in the Netherlands, and enhance the QC procedures to ensure that the information in the NIR of the EU accurately reflects the information in the NIRs of member States.	Addressing. The NIR does not include consumption data for aerosols, fire extinguishers, foams or solvents under category 2.F to address the transparency issue of the current reporting for the Netherlands. Table 4- 44 of the NIR reports “IE, NA” for category 2.F.2, blank cells for 2.F.3 and 2.F.5, and “NO” for category 2.F.4. No explanation for the reporting of “IE” and blank cells for the Netherlands has been provided. During the review, the EU confirmed that, as stated in the NIR (table 10.7), a new methodology for estimating emissions for this category is being developed by the Netherlands and will be implemented for the next submission.	Notation keys have not been corrected in the EU NIR, a note has been added that the Netherlands reports HFC emissions from 2.F.2, 2.F.3, 2.F.4 and 2.F.5 in 2.F.6.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
A.1	Transparency	3. General (agriculture) – CO_2 (A.8, 2016) (A.8, 2015) Transparency	Indicate in the NIR where in the inventory of the Netherlands indirect CO_2 emissions from the agriculture sector are included.	Not resolved. The EU has reported in the NIR (table 10.7) and confirmed during the review that the recommendation will be implemented in a future submission.	NDL NIR (15/04/2020), Chapter 9.1, page 271. The data is provided in the EU NIR, Table 9.1.
A.2	Transparency	3. General (agriculture) – CO_2 (A.8, 2016) (A.8 2015) Transparency	Work with Slovakia to use the appropriate notation key to report indirect CO_2 emissions from the agriculture sector or explain where in the inventory Slovakia has reported these emissions.	Not resolved. The EU has reported in the NIR (table 10.7) and confirmed during the review that the recommendation will be implemented in a future submission. that the recommendation will be implemented in a future submission.	The Notation Key for indirect emissions in agriculture of Slovakia is reported in the Table 6 and were corrected to "NE".
A.3	Transparency	3. General (agriculture) – CH_4 (A.9, 2016) (A.9, 2015) Transparency	Compile and report information on the methodology and CH_4 EFs used to estimate emissions from cattle, sheep and swine for all member States and Iceland.	Addressing. The EU has reported information on the methodology and CH_4 EFs used to estimate emissions from cattle, sheep and swine for all member States but not Iceland (NIR, tables 5.5, 5.6, 5.16 and 5.17). During the review, the EU indicated that Iceland used a tier 2 method to estimate CH_4 emissions from sheep. For Iceland's approach to estimating emissions from cattle, see ID# A.16 in table 5.	Information on Iceland IEFs, methodological tiers and emissions from cattle, sheep and swine were included in appropriate tables of the EU NIR 2020. Please see Chapter 5.3.1.
A.5	Transparency	3.A.1 Cattle – CH_4 (A.11, 2016) (A.11, 2015) Transparency	Work with the Netherlands to include the Party's milk yield for dairy cattle in the NIR of the EU, as is the case for all other member States.	Addressing. The EU reported that it has included the Netherlands' milk yield for dairy cattle in the EU NIR (table 10.7). The ERT notes, however, that the EU mentioned that, while the Netherlands does not report this milk yield in its CRF tables, the data are available in table 5.4 of the Netherlands' 2018 NIR (EU NIR, p.548). The milk yield for the Netherlands has therefore not actually been provided in the EU NIR, as acknowledged by the Party during the review.	Netherlands CRF Table 3.A2 doesn´t include information on milk yield. Table 5.10 of the EU NIR 2020 therefore does not include data on milk yield for NDL; a comment is provided: Netherlands does not report milk yield in their CRF, but such data are available in their NIR (see also Annex III).

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
A.6	Comparability	3.B Manure management – N_2O (A.12, 2016) (A.12, 2015) Comparability	Work with the Netherlands to investigate whether N_2O emissions from manure management can be estimated and reported separately for each livestock category.	Not resolved. The EU reported that the Netherlands reports the amount of manure managed in each animal system (EU NIR, table 10.7). Nevertheless, the EU uses the notation key “IE” to report N_2O emissions from manure management for cattle and swine for the Netherlands in tables 5.29 and 5.30 of the NIR. The ERT notes that in CRF table 3.B(b) the EU also uses the notation key “IE” to report N_2O emissions from manure management for sheep and swine for the Netherlands. For 2018 the Netherlands reported manure by MMS and livestock category, but emissions in category 3.B.b were still reported under other livestock. According to the Netherlands’ improvement plan, the disaggregation of emissions by livestock category is expected to be completed in time for the next submission.	Tables 5.29 and 5.30 of the EU NIR (15/04/2020) included information on cattle and swine.
A.11	Accuracy	3.B.3 Swine – CH_4 A.16, 2016) (A.16 2015) Accuracy	Work with Cyprus, Czechia, Greece and Slovakia to move to a higher-tier method to estimate CH_4 emissions from manure management for swine.	Addressing. The EU has reported that Cyprus is now using a tier 2 method to estimate CH_4 emissions from manure management for swine, while a tier 1 method is still being used by Czechia, Greece and Slovakia (NIR, table 5.17). During the review, the EU indicated that ongoing efforts are being made together with the member States concerned to move to a higher- tier method and that the issue is included in the member States’ respective improvement plans.	Slovakia: SVK NIR 15/04/2020, Chapter 5.8.1, pages 268-273, T2 for swine CH_4 emissions in 3.B.1 and CS EF Cyprus: CY NIR 15/04/2020 Chapter 5.3.2.1 page 156, swine CH_4 emissions estimated by T2 (2006 IPCC Guidelines, vol. 4, Annex 10A.2) and default EF CZ not yet resolved: will be implemented as regards the improvement plan in the future Greece not resolved
A.12	Comparability	3.D.b Indirect N_2O emissions from managed soils – N_2O (A.7 2016) (A.7, 2015) (92, 2014) Comparability	Work with member States to ensure more consistent reporting of the area of organic soils between the agriculture and LULUCF sectors.	Not resolved. The total area of organic cultivated soils reported in CRF table 3.D (86,174.66 kha for 2016) is more than 10 times higher than the sum of the areas reported in CRF tables 4.B and 4.C (6,084.71 kha for 2016). During the review, the EU explained that it checked if the sum of the areas reported in CRF tables 4.B and 4.C is at least as large as the area of cultivated histosols reported in CRF table 3.D. The EU found that the reporting was correct in the January 2018 submission (for all countries reporting both categories) but that there was an error in the Netherlands’ March submission to the EU in CRF table 3.D. The EU noted in its response that differences between the sum of areas reported in CRF tables 4.B and 4.C and the area reported in CRF table 3.D could be explained by non-cultivated or non- managed areas; for example, non-cultivated grassland, which needs to be reported in CRF table 4.C but not in CRF table 3.D, as CRF table 3.D includes emissions from cultivation and management of cropland and grassland (as noted in its footnote 2). The ERT asked the EU to provide	Check done during the initial ESD review 2020.

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				the area of non-cultivated grassland that is reported only under category 4.C and to explain whether this non-cultivated component of grassland is managed or not, but the EU did not provide that information. In this regard, keeping in mind the level of aggregation required in the CRF tables, during the initial QA/QC checks of member State submissions, the EU noted that the figures reported by member States are considered inconsistent only when the area under "cultivation of histosols" in CRF table 3.D is greater than the sum of the areas of organic soils reported under cropland (CRF table 4.B) and grassland (CRF table 4.C). The ERT disagrees with the assessment of the EU that the area under "cultivation of histosols" in CRF table 3.D should not be equal to the sum of the areas of cultivated organic soils reported under cropland (CRF table 4.B) and grassland (CRF table 4.C). In response to a draft version of this report, the Party indicated that it will work to better understand the reasons for the differences between category 3.D and the sum of categories 4.B and 4.C for the 2020 annual submission.	
L.1	Completeness	4. General (LULUCF) (L.1, 2016) (L.1, 2015) (13, 2014) (27, 2013) (12, 2012) Completeness	Continue efforts to improve the completeness of the reporting of emissions from all mandatory source categories in the LULUCF sector.	Addressing. The EU demonstrated that improvements have been made by some member States in providing estimates for mandatory categories in the LULUCF sector (see ID# L.10 below). However, some member States are still using the notation key "NE" for reporting these emissions (see ID# L.16 below). During the review, the EU indicated that further improvements are expected to be implemented in future submissions.	The EU has continued improving the completeness of the LULUCF sector in order to provide emissions from all the mandatory source categories. Specific information on this regard is provided in section 6.1.3 of the EU NIR where we have reflected the improvements implemented on completeness at country level. Among others improvements, Belgium reports now carbon stock changes from HWP for the whole time series (addressing ID# L.10), and the use of NE by France in land converted to Cropland has been now explained in the EU NIR in the relevant section (addressing ID# L.1)
L.2	Completeness	4. General (LULUCF) (L.2, 2016) (L.2, 2015) (95, 2014) (76, 2013) (86, 2012) Completeness	Work with member States with a view to reporting mandatory pools and categories that are currently not estimated in order to increase the completeness of the inventory.	Addressing. See ID# L.1 above.	See ID# L.1 above.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
L.3	Adherence to the UNFCCC Annex I inventory reporting guidelines	4. General (LULUCF) (L.13, 2016) (L.13, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines	Include in the NIR information on planned inventory improvements for the LULUCF sector and KP-LULUCF activities.	Addressing. In the NIR, the EU reports planned improvements (section 6.4.4) and implemented improvements (section 11.3.6). However, for two of the planned improvements listed in section 6.4.4, the information is not sufficient to allow the ERT to identify what type of improvements are being considered by the EU for future submissions. In particular, the EU indicates that a planned improvement is the implementation of additional sector-specific checks, without describing the planned checks. Similarly, the EU does not provide sufficient information on the required corrections it identified during the QA/QC checks, but which could not be implemented for the 2018 annual submission (p.767). During the review, the EU provided more details on the planned improvements that will be included in the next submission.	For the GHG 2019 the EU reformulated the information included in sections 6.4.4 and 11.3.6 of the EU NIR in order to better describes the planned improvements for the LULUCF and KP-LULUCF sectors. This has resulted in a more transparent and clear description of what is planned to continue improving these sectors of the EU NIR.
L.4	Adherence to the UNFCCC Annex I inventory reporting guidelines	4. General (LULUCF) (L.16, 2016) (L.15, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines	Correct the inconsistencies in the reported areas in CRF tables 4.1 and 4.A–4.F.	Not resolved. The inconsistencies in the reported areas in CRF tables 4.1 and 4.A–4.F remain.	This issue is subject to a specific QAQC check that is implemented every year. This has resulted in a less inconsistent reporting among the areas reported in CRF tables 4.1 and 4.A–4.F. However, despite of this check and the recommendation that was provided by the EU to its MS whenever this issue was identified in individual inventories, some discrepancies remain in 2020.
L.5	Comparability	4. General (LULUCF) – CO_2 (L.12, 2016) (L.12, 2015) Comparability	Use the notation key “NA” to report carbon stock changes from carbon pools where carbon stock changes are neutral (i.e. where net emissions are equal to net removals).	Addressing. The EU is continuing its inventory improvement efforts with regard to using the notation key “NA” where carbon stock changes are considered neutral (e.g. Latvia now reports “NA” for mineral soils for grassland remaining grassland). The ERT commends the EU for the fact that France provided a quantitative assessment of carbon stock changes in mineral soils for grassland remaining grassland instead of using a notation key. However, some member States continue to report “NO” for mandatory pools. For instance, Estonia, Greece, Lithuania, Luxembourg and Slovakia have reported “NO” for carbon stock changes in mineral soils for grassland remaining grassland. During the review, the EU indicated that it is working with member States to ensure use of the notation key “NA” where carbon stock changes are considered neutral. This issue was discussed with member States during the annual LULUCF workshop led by the JRC.	QA/QC checks on member State submissions on the correct use of notation keys to ensure are part of the annual routine initial checks carried out before submission of the EU inventory and NIR. This issue has been also discussed with MS during the annual LULUCF workshops organized by the JRC, as well as communicated to the MS during the meeting that are organized by the EC under the Climate Change Committee. MS has now used more the notation key NA to report carbon stock changes from carbon pools where carbon stock changes are neutral. However, some MS continue using the notation NO or NE because they have focused the efforts on improve the accuracy, consistency and completeness of the sector and to a lesser extend to change the notation key.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
L.6	Consistency	4.A.1 Forest land remaining forest land – CO_2 (L.17, 2016) (L.16, 2016) Consistency	Work with Luxembourg to improve the time-series consistency of net carbon stock changes in deadwood in forest land remaining forest land.	Addressing. Luxembourg has reported an inconsistent time series of net carbon stock changes in deadwood for forest land remaining forest land ("NO" is reported for 1990–2000, and net carbon stock changes for thereafter). During the review, the EU noted that it had already held discussions with Luxembourg on this issue specifically and that the issue was included in the planned improvements section of the NIR (p.767). The Party indicated that this issue will be addressed in the 2019 submission	For the GHG 2020, Luxembourg reports a complete time series of carbon stock changes in deadwood in forest land remaining forest land.
L.7	Transparency	4.A.2 Land converted to forest land – CO_2 (L.4, 2016) (L.4, 2015) (97, 2014) (80, 2013) Transparency	Improve the transparency of the reporting, including the provision of updated information from member States and internal QA/QC checks, in order to ensure that the aggregated reporting is complete and consistent among member States.	Addressing. The original recommendation from the 2013 ARR related to the reporting by Italy. The EU does not provide transparent information in the NIR (section 6.2.1.3) for Italy regarding its methodological approach to improving accuracy for all forest-related subcategories. It is not clear from the description what exactly was improved in Italy's methodology.	In order to address the recommendation of the ERT, the EU has requested Italy to provide specific information on the methodological approach that is using to report carbon stock changes from Land converted to Forest land. In section 6.2.1.3 of the GHG 2020 specific information on this issues is now included.
L.10	Completeness	4.B.2 Land converted to cropland – CO_2 (L.7, 2016) (L.7, 2015) (100, 2014) (81, 2013) (92, 2012) Completeness	Work with the member States to improve the completeness of their reporting and use higher-tier methods in order to enhance accuracy.	Addressing. Quantitative estimates of carbon stock changes in mineral soils for Cyprus were included in CRF table 4.B of the EU submission. However, some member States continue to use the notation key "NE" for reporting net carbon stock changes (e.g. France uses "NE" for carbon stock changes in all pools for other land converted to cropland). In addition, the EU has not reported information on methodological changes by member States or the efforts they have made to move to a higher- tier methodology in the designated section of the NIR (section 6.2.2.3).	The EU has included in section 6.2.2.3 information on the use by France of the notation key "NE" to report carbon stock changes for land converted to Cropland. And on improvements that have been implemented in this subcategory, including the use of higher methods (as requested by the ERT), which have resulted in an overall increase of accuracy and completeness of the sector.
L.11	Transparency	4.F Other land – CO_2 (L.20, 2016) (L.19, 2015) Transparency	Include in the NIR information on whether land areas reported under other land in Finland, Portugal and the United Kingdom of Great Britain and Northern Ireland are unmanaged, and if not, to work with these member States to report these areas and the associated CO_2 emissions and removals under the appropriate land-use categories.	Addressing. The EU does not provide transparent information on whether land areas reported under other land for Finland, Portugal and the United Kingdom are unmanaged. The EU has reported, however, that Portugal intends to reallocate its estimate of carbon stock changes for other land remaining other land for shrubland to grassland in the next submission (NIR, p.738).	The EU has included information on this regard in section 6.2.4.3. Moreover, as included in the improvement plan section 6.4.4, the EU is following the reporting of Portugal to track that the planned improvement the reporting of Grassland and Other land is implemented.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
L.16	Completeness	4.G HWP – CO_2 (L.22, 2016) (L.21, 2015) Completeness	Work with Belgium and Cyprus to ensure that the information on HWP in CRF table 4.G is complete for the whole time series.	Addressing. The EU has included in CRF table 4.G HWP estimates made by Cyprus in 2018 for the entire time series. Belgium is still working to provide HWP estimates for the entire time series.	Belgium reports in 2020 a complete time series of estimates for carbon stock changes in HWP.
KL.2	Transparency	General (KP-LULUCF) (KL.1, 2016) (KL.1, 2015) (121, 2014) Transparency	Work with and support member States to improve consistency in the use of notation keys and further improve the transparency of future submissions.	Addressing. The EU has worked with member States to improve consistency in the use of notation keys. Every year a presentation is given on this issue during the annual JRC LULUCF workshop and a Working Group 1 meeting. Although progress has been made (see ID# KL.8 below), some inconsistency and lack of transparency in the use of notation keys by member States persist. The ERT noted that “NE” is mainly used when the “not a net source” provision is applied (decision 2/CMP.8 annex II, paragraph 2(e)), and that “NO” is used by some member States for existing activities.	QA/QC checks on Member State submissions on the correct use of notation keys to ensure are part of the annual routine initial checks carried out before submission of the EU inventory and NIR. This issue has been also discussed with MS during the annual LULUCF workshops organized by the JRC, as well as communicated to the MS during the meeting that are organized by the EC under the Climate Change Committee. MS has now used more the notation key NA to report carbon stock changes from carbon pools where carbon stock changes are neutral. However, some MS continue using the notation NO or NE because they have focused the efforts on improve the accuracy, consistency and completeness of the sector and to a lesser extend to change the notation key.
KL.4	Adherence to the UNFCCC Annex I inventory reporting guidelines	General (KP-LULUCF) (KL.7, 2016) (KL.7, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines	Correct the error found in the aggregation process of member States’ inventories to ensure the consistency of information of the EU and its member States.	Addressing. The ERT commends the EU for the efforts it has made to ensure the consistency and transparency of its reporting in this area. Some inconsistencies have been resolved and the aggregation process has been improved (e.g. consistent information is provided in NIR tables 11.3 and 11.5 and CRF tables NIR-2 and 4(KP)). However, some inconsistencies remain in the data reported within CRF tables NIR-2 and 4(KP)A.1–4(KP)B.4, and additional transparent information on approaches used to identify HWP from deforestation events is needed.	This issue is subject to a specific QAQC check that is implemented every year. This has resulted in a less inconsistent reporting among the areas reported in CRF tables NIR-2 and 4(KP)A.1–4(KP)B.4. However, despite of this check and the recommendation that was provided by the EU to its MS whenever this issue was identified in individual inventories, some discrepancies remain in 2020.
KL.5	Transparency	General (KP-LULUCF) (KL.7, 2016) (KL.7, 2015) Transparency	Ensure that issues identified during the aggregation process, which affect the accuracy and completeness of the submission, are resolved.	Addressing. See ID# KL.4 above.	See ID# KL.4 above.

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
KL.10	Completeness	Article 3.4 activities – CO_2 (KL.11, 2016) (KL.11, 2015) Completeness	Work with the United Kingdom to estimate the net carbon stock changes in the litter and deadwood pools under CM and GM and CO_2 emissions/removals from WDR.	Addressing. The United Kingdom has reported "NE" for carbon stock changes in the litter and deadwood pools under CM and GM and for CO_2 emissions/removals from WDR. The EU provides information on the research and methodological development programme of the United Kingdom that aims to provide full estimates for these activities (NIR, p.893).	The EU has requested information to UK in order to know reporting status of WDR by the UK. During the last LULUCF workshops organized by the JRC, UK provided information on its research and methodological development programme that is ongoing to allow the reporting of carbon stock changes for this KP activity. United Kingdom has informed that they are not yet in the position of reporting emissions/removals from this activity, but a full reporting is expected, at the latest, by the end of the commitment period as a result of an ongoing research program and efforts on methodological development.
KL.13	Transparency	FM – CO_2 (KL.14, 2016) (KL.14, 2015) Transparency	Work with Cyprus and Malta to estimate net CO_2 emissions/removals from FM activities.	Addressing. Cyprus has reported estimates for FM in the 2018 submission. Malta has reported "NE" for all pools except organic soils, where "NO" was used. The EU includes in the NIR (p.888) information on the reasoning for the use of "NE" by Malta (e.g. as a result of discussions with a previous ERT during Malta's in-country review, related to ID# KL.6 in document FCCC/ARR/2015/MLT), but does not include the explanation in table 11.17 of the NIR. The EU also has not provided transparent and verifiable information on the use of "NE" for "not a net source" for Malta, in accordance with decision 2/CMP.8, annex II, paragraph 2(e). Such information should demonstrate that the area is not changing, or that no harvesting or fires occur.	Information for Malta has now been included in table 11.17. and more information on the use of NE by Malta to estimate net CO_2 emissions/removals from FM activities is now included in section 11.3.2. Under request by the JRC, Malta has informed that new information to report and update Forest Management activity has been gathered and will be used to report estimates in this category. For the time being, Malta has also stated that no controlled burning is allowed in those reserved forest, and moreover, no wildfires have occurred in those areas, from which emissions could have been omitted.
KL.14	Transparency	FM – CO_2 (KL.15, 2016) (KL.15, 2015) Transparency	Provide in the NIR and in CRF table 4(KP-1)B.1.1, as appropriate, accurate information on the value of the FMRL inscribed in decision 2/CMP.7 and the value of the technical correction for the EU as a whole and for each of the member States plus Iceland, in accordance with the requirements of decision 2/CMP.8, annex II, paragraph 5(f), and taking into consideration the changes made in the coverage of the FMRL.	Addressing. The EU has not provided in CRF table 4(KP-I)B.1.1, as appropriate, accurate information on the FMRL inscribed in decision 2/CMP.7, as was recommended by the ERT. It provided this value only in the documentation box to CRF table 4(KP-I)B.1.1 and for information purposes in the NIR (pp.905–906). The value reported in CRF table 4(KP-1)B.1.1 is –315,476.50 kt CO_2 eq, whereas the value inscribed in decision 2/CMP.7 is –306,736 kt CO_2 eq for the EU (27), applying the first-order decay function for HWP, and–154 kt CO_2 eq for Iceland, assuming instantaneous oxidation. The difference between the FMRL provided for the EU in decision 2/CMP.7 and the one reported by the EU should be reflected as a technical correction and described in the NIR. The EU also has not provided the value of the technical correction for the EU as a whole, in accordance with the requirements of decision 2/CMP.8, annex II, paragraph 5(f). The EU has reported a	The EU will provide a technical correction for each of the MS at the latest at the end of this commitment period when the real accounting quantities will be derived. Moreover, the EU considers that it is important to bear in mind that the accounting quantities for the KP activity FM as reported in the CRF table Accounting of the EU GHG inventory depends on the FMRL values and their technical corrections (TC) reported by countries in such CRF table. Thus, in order to ensure the consistency among the EU GHG inventory (i.e. as a sum of individual GHG inventories) and the individual inventories, the EU GHG inventory must use in the CRF table, not the value inscribed in the appendix of the Decision, but the sum of values for FMRL and TC as reported by current EU MS plus, UK plus Iceland. Doing it in this way, the sum of accounting quantities for FM submitted by individual inventories matches the accounting quantity that is reflected in the EU

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
				technical correction in the CRF accounting table (16,020.40 kt CO_2 eq). However, this value does not include all member States. For instance, the EU reports that some member States (e.g. the Netherlands and Spain) were not able to implement a technical correction owing to constraints in time and/or resources during this inventory year (NIR, p.906). The EU thus provides the technical corrections for some member States (NIR, table 11.22), while notation keys ("NA", "NO" or "NE") are used for others, but the reasoning for their use is not provided in the NIR.	CRF table 'Accounting" Furthermore, if the difference between the FMRL provided for the EU in decision 2/CMP.7 and the one reported by the EU (which consider the current composition of the Union) is reflected as a technical correction, the sum of the TC of its MS would not match the TC of the EU.
KL.15	Transparency	FM – CO_2 (KL.16, 2016) (KL.16, 2015) Transparency	Provide transparent information on the background level of emissions associated with natural disturbances included in the FMRL of the EU and work with member States, in particular those that apply the JRC approach, in order to improve consistency between the FMRL and the reporting of FM in relation to the treatment of natural disturbances, and to calculate a technical correction where required.	Addressing. The EU has reported information on the background level of emissions and the margin associated with natural disturbances for more member States than in the 2016 submission (e.g. for France and Portugal) (NIR, section 11.4.4 and table 11.21). This demonstrates that the EU has made an effort to improve its reporting in this regard. However, the EU has not provided the background level of emissions associated with natural disturbances of its FMRL. During the review, the EU explained that it is of the view that, while the information provided on the background level at the time of FMRL setting (in accordance with decision 2/CMP.7) may appear to be imprecise, the future final background level determined by the Party, as well as methodological consistency of the value with any technically corrected final FMRL, is what will ensure the accuracy of the final accounting.	The EU has included in section 11.5.2.2 information on the background level of emissions associated with natural disturbances included in the FMRL of the EU and has worked bilaterally with some MS to support the calculation of the technical corrections
KL.18	Completeness	HWP – CO_2 (KL.19, 2016) (KL.19, 2015) Completeness	Work with Belgium to estimate net CO_2 emissions/removals from HWP.	Addressing. Belgium has reported "NO" for net CO_2 emissions and removals from HWP. The EU has provided information on its ongoing work with Belgium under the planned improvements in chapter 11.3.6 of the NIR. During the review, the EU informed the ERT that Belgium intends to report net CO_2 emissions and removals from HWP for the entire time series in the next submission.	Belgium reports in 2020 a complete time series of estimates for carbon stock changes in HWP

Sector	TACCC	Category	Recommendation	ERT assessment and rationale	Status of Implementation
KL.19	Accuracy	HWP – CO_2 (KL.20, 2016) (KL.20, 2015) Accuracy	Work with member States to ensure that HWP from deforestation events are accounted for on the basis of instantaneous oxidation and report explicit information regarding HWP from deforestation events in CRF table 4(KP-I)C, in accordance with good practice requirements in the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (p.2.119).	Not resolved. The EU has reported quantitative carbon stock changes in HWP for land subject to deforestation for Denmark, Hungary, Latvia and Romania. However, information on how these member States distinguish HWP from regrowth on deforested land and from deforestation events is not included in the NIR.	The EU has requested information of these MS to ensure that HWP from deforestation events are accounted for on the basis of instantaneous oxidation. On this regard, information has been included in Section 11.4.5 which explains how and why these countries reported HWP under deforestation.

Table 10.8 Improvements made in response to UNFCCC review findings as indicated in Tables 4 of the ARR 2018

ID#	Previous recommendation for the issue identified	Number of successive reviews issue not addresseda	Status of Implementation
E.1	Present methodological summaries that are consistent among member States and categories, at least for the key categories 3 (2014–2018)	3 (2014–2018)	Annex III of the EU NIR shows updated methodological information on Member States level.
I.34	Endeavour to provide in the NIR summary overviews of methodologies used to estimate emissions from the consumption of halocarbons and SF_6 for key categories based on the relevant methodological descriptions reported in the NIRs of member States	3 (2014–2018)	Overview of methodologies used to estimate emissions from the consumption of halocarbons and SF_6 for key categories has been added.
I.35	Make the necessary corrections in the use of the notation keys to ensure the transparency of the reporting (specifically: “NE” reported by Denmark for the amount of gas remaining in products at decommissioning; “NO” reported by Finland for SF_6 emissions from aluminium and magnesium foundries; “IE” and “NA” reported by Ireland for AD and emission estimates for HFC emissions from refrigeration and air-conditioning equipment (except mobile air conditioning); “NO” reported by Luxembourg for potential emissions of PFCs from refrigeration and air-conditioning equipment; “NA” and “NA and NO” reported by the Netherlands for AD and IEFs of emissions from stocks in industrial refrigeration	3 (2014–2018)	SF_6 emissions from 2C4 occurred in Finland only in the years 1994 to 2009 and in 2012 but ceased since then. For these years "IE" is reported and emissions are included in 2H3. For all other years "NO" is reported as Mg die casting did not occur and therefore no emissions occurred.

ID#	Previous recommendation for the issue identified	Number of successive reviews issue not addresseda	Status of Implementation
	and mobile equipment, whereas the emissions are actually estimated; and empty cells in the CRF tables for Spain as a replacement of "NA" and "NE" notation keys for reporting emissions from semiconductor manufacturing)		
A.12	Work with member States to ensure more consistent reporting of the area of organic soils between the agriculture and LULUCF sectors	3 (2014–2018)	Check done during the initial ESD review 2020.
L.1	Continue efforts to improve the completeness of the reporting of emissions from all mandatory source categories in the LULUCF sector	5 (2012–2018)	The EU has continued to improve the completeness of the LULUCF sector in order to provide emissions from all the mandatory source categories. Specific information on this regard is provided in section 6.1.3 of the EU NIR where we have reflected the improvements implemented on completeness at country level. Among others improvements, Belgium reports now carbon stock changes from HWP for the whole time series (addressing ID# L.10), and the use of NE by France in land converted to Cropland has been now explained in the EU NIR in the relevant section (addressing ID# L.1).
L.2	Work with member States with a view to reporting mandatory pools and categories that are currently not estimated in order to increase the completeness of the inventory	5 (2012–2018)	The EU has worked with MS with a view to reporting mandatory pools and categories that were not estimated. This has resulted in a more complete inventory submitted in 2020. A description of the resulting improvements on completeness has been included in section 6.1.3.
L.7	Improve the transparency of the reporting, including the provision of updated information from member States and internal QA/QC checks, in order to ensure that the aggregated reporting is complete and consistent among member States	4 (2013–2018)	The EU has improved the transparency of the reporting with the inclusion of updated information from MS and on its internal QA/QC checks with the aim of ensuring that the aggregated reporting is complete and consistent. Among others examples, section 6.4.2 has been reformulated in order to better describe the specific QA/QC checks implemented in the LULUCF sector. And section 6.2.4.3 now includes updated information from MS on how the category other lands is defined by MS.
L.10	Work with the member States to improve the completeness of their reporting and use higher-tier methods in order to enhance accuracy	5 (2012–2018)	The EU has worked with MS to improve the completeness of the reporting and towards the use of higher tier methods. Among others an annual LULUCF workshop is held every year in order to support MS on addressing specific issues on the LULUCF reporting and to discuss the use of higher tier methods. This, along with huge efforts implemented at country level, has resulted in a more widespread use of higher tier methods nowadays and the associated improvement on completeness. See section 6.1.3.

Table 10.9 Improvements made in response to UNFCCC review findings as indicated in Table 5 of the ARR 2018

Sector	TACCC	Category	Recommendation	Status of Implementation
G.6	Adherence to the UNFCCC Annex I inventory reporting guidelines	Key category analysis	The ERT noted discrepancies in the total figures used for the calculation of the key categories and the totals reported in the CRF tables. In the Excel file of the key category analysis provided by the EU during the review, for instance, the value reported for total emissions for 1990, excluding LULUCF and indirect CO_2 emissions, used in the key category analysis is 5,653,399.40 CO_2 eq, whereas the value reported in the CRF table Summary2 is 5,652,249.73 CO_2 eq. Discrepancies were also observed in the total emissions (excluding indirect CO_2 emissions) reported for 2016, which are 4,295,862.27 CO_2 eq in the key category analysis and 4,298,569.36 CO_2 eq in CRF table Summary2 excluding LULUCF, and 4,003,573.43 CO_2 eq in the key category analysis and 4,007,313.10 CO_2 eq in CRF table Summary 2 including LULUCF. There is no transparent reason given for these differences. A note under the table reporting the key category analysis results (NIR, table 1.12) explains that the totals may not include data for Sweden owing to confidentiality concerns. During the review, the EU explained that data from all member States, including Sweden, are considered in the analysis. Nevertheless, the ERT found that the overall figures used for the key category analysis and those reported in the corresponding CRF tables do not match. The ERT recommends that the EU conduct QA/QC checks on the database used for the calculation of key categories, and ensure that all key category analyses are carried out using the same set of data. The ERT also recommends that the EU include in the NIR transparent information on the use of confidential data, including from which key category analysis such data have been excluded.	We can ensure that all key category analysis are carried out using the same set of data. Information on the reporting of confidential data is given in the EU NIR in section 1.7.2.
G.7	Adherence to the UNFCCC Annex I inventory reporting guidelines	Uncertainty analysis	The tier 1 uncertainty analysis of the EU is performed on the basis of the information on uncertainties and corresponding emissions provided by member States. Because not all member States report their emissions and uncertainties at the category level owing to confidentiality concerns, the emission estimates do not match those reported in the CRF tables, neither by sector nor in total. This situation is clearly explained in the NIR (section 1.6). However, for consistency and to ensure completeness and accuracy, the uncertainty analysis should be carried out on the same data as those reported in the CRF tables. The ERT recommends that the EU attribute the uncertainty values and category groupings derived from its analyses of data reported by member States to the same level of emissions reported at the category level in the CRF tables.	Given the limitations which even the ERT mentions in the finding (i.e. confidential sector estimates) implementing a full solution will likely be impossible. Merging the final reported emissions from the CRF Tables with the uncertainty estimates at different sector resolutions will require substantial programming effort. Nonetheless, we will explore options with which we can best address the issue and update procedures for the next submission.
G.8	Transparency	Methods	The ERT welcomed the annex on methodologies (annex III to the NIR). During the review, the ERT found that the sectoral Excel files in the annex had not been updated with the latest information available at the member State level (e.g. for categories 2.A.2 and 5.A). In response, the EU provided the ERT with an updated version of annex III. The ERT recommends that the EU ensure that annex III to the NIR, which includes summaries of the descriptions of the methodologies used by member States for the estimation of EU key categories, reflects the latest submissions of member States and is coherent with the information in the NIR and CRF tables.	The Annex III is updated by Member States every year according to a schedule.

Sector	TACCC	Category	Recommendation	Status of Implementation
E.13	Transparency	1.A.1.a Public electricity and heat production – peat – CO_2	The ERT noted that CO_2 emissions from peat consumption in public electricity and heat production show some relatively large inter-annual fluctuations; for example, a 13.3 per cent decline between 2003 (13,403.65 kt CO_2) and 2004 (11,618.63 kt CO_2), and a 16.1 per cent increase between 2009 (10,865.03 kt CO_2) and 2010 (12,615 kt CO_2). During the review, the EU explained that the trend is dominated by Finland's emissions and that there might be several reasons for the fluctuations, such as price competition with other fuels (some of the peat plants also use wood biomass or natural gas) or environmental issues related to peat collection. The ERT recommends that the EU include in the NIR clear reasons for the inter-annual fluctuation in CO_2 emissions from peat consumption in public electricity and heat production.	The following was added in paragraph 1.A.1.a Electricity and Heat Production - Peat (CO_2) of the NIR: "Several parameters such as weather conditions greatly influence the peat consumption: in Finland, peat represents 5% of electricity production and is the third most important energy source in district heat production. In 2018, the growth in peat use was affected by the exceptional weather conditions during the heating season at the start of the year and the resulting growth in demand."
E.14	Transparency	1.A.1.a Public electricity and heat production – other fossil fuels – CO_2	The ERT noted that other fossil fuels are not included in figure 3.6 of the NIR, which presents the emission trends and AD for public electricity and heat production. During the review, the EU provided the ERT with a revised figure 3.6 that includes the emission trends and AD for other fossil fuels. The ERT recommends that the EU include in the NIR an updated version of figure 3.6 that includes the emission trends and AD for other fossil fuels.	Other fossil fuels has been included in Figure 3.6 of the NIR.
E.15	Transparency	1.A.1.a Public electricity and heat production – liquid, solid and gaseous fuels – CO_2, CH_4 and N_2O	Under NIR tables 3.7, 3.8 and 3.9 for liquid fuels, solid fuels and gaseous fuels, respectively, there is a note stating that the total figures do not include data from Sweden owing to confidentiality concerns. This explains why the data reported in these tables do not match those reported in the CRF tables. The ERT noted that the total figures for 2015, for which emissions from Sweden are reported as "C", are the same values as those in CRF table 1.A(a) (e.g. 803,105.58 kt CO_2 for solid fuels), but the total figures for 2016, for which emissions from Sweden are reported in the tables, are different from those in CRF table 1.A(a) (e.g. for solid fuels, the value reported in NIR table 3.8 is 713,314 kt CO_2, whereas the value reported in CRF table 1.A(a) is 715,805.59 kt CO_2). During the review, the EU explained that the confidential emission data from Sweden for 2015 for liquid, solid and gaseous fuels consumed in public electricity and heat production (1.A.1.a) and all fuels consumed in petroleum refining (1.A.1.b) and manufacture of solid fuels and other energy industries (1.A.1.c) are included under other fossil fuels in subcategory 1.A.1.a. Owing to the inclusion of confidential data from Sweden, the value in CRF table 1.A(a)s1 for other fossil fuels for 2015 (43,485.64 kt CO_2) is higher than the value in NIR table 3.10 (37,621 kt CO_2). The ERT recommends that the EU clarify whether confidential emission data from Sweden have been included in NIR tables 3.7–3.10.	There is no more confidential issues of energy consumption concerning Sweden.
E.16	Transparency	1.A.1.a Public electricity and heat production – other fossil fuels – CO_2, CH_4 and N_2O	According to the NIR (p.127), other fossil fuels covers mainly the fossil fuel component of MSW incineration, including plastics, where there is energy recovery. During the review, in response to a question from the ERT about additional types of fuel, the EU clarified that incinerated waste may include hazardous waste, bulky waste and waste sludge. The ERT recommends that the EU include in the NIR all types of fuel consumed in MSW incineration, including hazardous waste, bulky waste and waste sludge.	Explanation was added in paragraph "1.A.1.a Electricity and Heat Production - Other Fuels (CO_2)" of the NIR.

Sector	TACCC	Category	Recommendation	Status of Implementation
E.17	Transparency	1.A.1.c Manufacture of solid fuels and other energy industries – solid fuels – CO_2	The EU states in the notes under NIR tables 3.16 and 3.17 that the figures in those tables do not include confidential emission data from Sweden. The ERT noted that the total emissions for 2016 reported in NIR table 3.17 (manufacture of solid fuels and other energy industries – solid fuels (1.A.1.c)) (31,227 kt CO_2 eq), in which the emissions from Sweden are reported, are different from the total emissions reported in CRF table 1.A(a) (31,802.82 kt CO_2 eq). However, for 2015, NIR table 3.16 (manufacture of solid fuels and other energy industries – all fuels (1.A.1.c)) has the same value for total emissions as CRF table 1.A(a) (53,610.55 kt CO_2), although the same note appears under both NIR tables 3.16 and 3.17. During the review, the EU explained that Sweden frequently uses the notation key "C" for 2015 in subcategories of energy industries (1.A.1). The EU noted that confidential emission data from Sweden for 2015 for liquid, solid and gaseous fuels consumed in public electricity and heat production (1.A.1.a) and all fuels consumed in petroleum refining (1.A.1.b) and manufacture of solid fuels and other energy industries (1.A.1.c) are included under other fossil fuels in subcategory 1.A.1.a. The ERT recommends that the EU remove from the NIR the note under table 3.16 referring to confidential emission data from Sweden being excluded from the table.	There is no more confidential issues of energy consumption concerning Sweden.
E.18	Transparency	1.A.1.c Manufacture of solid fuels and other energy industries – biomass – CO_2	The ERT noted significant inter-annual fluctuations in the consumption of biomass, in particular between 2012 (20,344.54 TJ) and 2013 (37,625.43 TJ) an increase of 84.9 per cent. During the review, the EU informed the ERT that the main cause for this trend is the data from Germany, which reported emissions from biomass of about 1.1 Mt for 2012 and about 2.7 Mt CO_2 for 2013 and an increase in AD from 8 PJ in 2012 to 25.6 PJ in 2013. The EU also explained that the energy balance of Germany indicates that its biomass mainly consists of biogas that is used in gasification plants. The ERT recommends that the EU include in the NIR information on the types of biomass consumed and any particular impact they have on the overall trend.	This issue is still under investigation.

Sector	TACCC	Category	Recommendation	Status of Implementation
E.19	Transparency	1.A.2.a Iron and steel – liquid fuels – CO_2	The ERT noted that the CO_2 IEFs for liquid fuels reported for 2008–2012, which range from 76.21 to 78.71 t CO_2/TJ, are higher than those reported for 1990–2007, which ranged from 73.46 to 76.50 t CO_2/TJ. The ERT noted increases between 2007 (73.46 t CO_2/TJ) and 2008 (76.58 t CO_2/TJ), and between 2015 (70.51 t CO_2/TJ) and 2016 (124.54 t CO_2/TJ), the latter constituting an increase of 76.6 per cent. During the review, the EU explained that the large increase between 2015 and 2016 is due to the confidential data of Sweden – emissions were reported under this category but AD were aggregated elsewhere, increasing the CO_2 IEF given in the NIR. The EU further explained that the high CO_2 IEF reported for 2008–2012 is mainly due to the contribution of Spain's CO_2 emissions to the EU total (up to 36 per cent, in 2010) and its high CO_2 IEF (ranging from 92.4 to 96.1 t CO_2/TJ) for those years, which is attributable to the consumption of petroleum coke in those years (from a low of 8 PJ to a high of 12 PJ, in 2010). Petroleum coke has a much higher carbon content (97.5 t CO_2/TJ) than the usual liquid fuels reported under this category. In contrast, from 2005 to 2007 and 2013 to 2016, Spain's CO_2 IEF ranged from 74.1 to 75.6 t CO_2/TJ and its contribution of CO_2 emissions to the EU total was only 7–12 per cent. The ERT recommends that the EU include in the NIR the reasons for the high CO_2 IEF for liquid fuels for 2008– 2012 and for the large increase in the IEF observed between 2015 and 2016.	Explanation implemented in the paragraph '1.A.2.a Iron and Steel - Liquid Fuels (CO_2)' in the chapter 3.2.2.1 of the NIR.
E.20	Transparency	1.A.2.a Iron and steel – solid fuels – CO_2	The ERT noted that the CO_2 IEF for solid fuels increased from 120.06 t CO_2/TJ in 2011 to 130.50 t CO_2/TJ in 2016. During the review, the EU explained that the reason for the increasing CO_2 IEF is the high variability in member State IEFs and iron production (and consequent CO_2 emission) trends. The main reason for the increase in the CO_2 IEF from 2012 (121.16 t CO_2/TJ) to 2013 (128.55 t CO_2/TJ) is Italy's decrease in CO_2 emissions. For these years, the share of Germany's CO_2 emissions in the EU total increased from 27 to 29 per cent, and Germany's CO_2 IEF was one of the highest reported, increasing from 155.17 t CO_2/TJ in 2012 to 158.47 t CO_2/TJ in 2013. The ERT recommends that the EU include in the NIR an explanation for the trend in the CO_2 IEF for solid fuels, particularly for 2011 onward.	Explanation implemented in the paragraph '1.A.2.a Iron and Steel - Solid Fuels (CO_2)' in the chapter 3.2.2.1 of the NIR.
E.22	Transparency	1.A.2.f Non- metallic minerals – liquid fuels – CO_2	The footnote below NIR table 3.45 states: "EU trends in this table do not include Sweden for confidentiality reasons and to preserve time-series consistency for the EU. The EU explains the differences between the numbers in this table and the CRF". According to the EU (see ID# E.15 above), confidential data from Sweden have been included in other fossil fuels in the subcategory public electricity and heat production (1.A.1.a). Sweden states in its NIR 2018 (p.70) that "several data sources that are used for producing emissions estimates for the inventory are confidential at a micro level (e.g. company or plant level)". The ERT recommends that the EU include in the NIR the reason for the emissions from liquid fuels in Sweden being reported as confidential and how time-series consistency at the EU level has been preserved.	Explanation of the reason for the emissions from liquid fuels in Sweden being reported as confidential implemented in the paragraph '1.A.2.f Non-metallic Minerals - Liquid Fuels (CO_2)' in the chapter 3.2.2.6 of the NIR.

Sector	TACCC	Category	Recommendation	Status of Implementation
E.23	Transparency	1.A.2.f Non- metallic minerals – other fossil fuels – CO_2	The ERT noted that Poland reported a CO_2 IEF of 126.50 t CO_2/TJ in 2016, which is within the IPCC default values for industrial waste. However, the CO_2 IEFs of the other member States (NIR, figure 3.75) are lower than the IPCC default values (110–183 t t CO_2/TJ). During the review, the EU explained that the member States included CO_2 emissions from cement kilns, whose operators have had to report under the EU ETS since 2005. The lower end of the IPCC default EF range (110 t CO_2/TJ) is much higher than the typical values for the waste fractions of waste oil, waste tyres and plastics incinerated in cement kilns, which are typically around 80 t fossil CO_2/TJ fossil energy (according to EU ETS data from Austria). The ERT recommends that the EU include in the NIR information on the main components incinerated in cement kilns by member States to support the low CO_2 IEFs reported for other fossil fuels.	Information on the main components incinerated in cement kilns included in the paragraph '1.A.2.f Non-metallic Minerals – Other Fossil Fuels (CO_2)' in the chapter 3.2.2.6 of the NIR. 'Sweden reports emissions as 'C' (confidential) since 2016 in order to comply with the Public Access to Information and Secrecy Act of the Swedish law. This decision was made based on the results of the internal review.'
E.24	Transparency	1.A.2.g Other (manufacturing industries and construction) – liquid fuels – CO_2, CH_4 and N_2O	Member States have variously reported emissions from liquid fuels for off-road vehicles in the subcategories other (manufacturing industries and construction) (1.A.2.g), other transportation (1.A.3.e) or off-road vehicles and other machinery (1.A.4.c ii). The ERT noted that Greece, Ireland, Portugal and Slovakia have reported these emissions as "IE", while Cyprus, Czechia, Estonia, France, Italy, Malta, Poland, Romania and Spain have left the relevant table cells blank (NIR, table 3.49). During the review, the EU provided detailed information on off-road machinery for the member States for which the relevant NIR table 3.49 cells are blank. The ERT recommends that the EU include in NIR table 3.49 a note explaining why cells for CO_2, CH_4 and N_2O emissions from liquid fuels for off-road vehicles are left blank (i.e. for Cyprus, Czechia, Estonia, France, Italy, Malta, Poland, Romania and Spain).	In the table 3.49 in the NIR, "IE" is reported only by Greece emissions are included in 1.A.2.f), other mentioned Member States reported emissions in this category. Therefore explanation on blank cells are no longer needed.
E.25	Transparency	1.A.4.b Residential – biomass – CH_4	The ERT noted that the CH_4 IEF for biomass in this subcategory decreased from 335.26 kg CH_4/TJ in 1990 to 232.50 kg CH_4/TJ in 2016, a decrease of 30.7 per cent. The ERT further noted that, according to the NIR, boilers and stoves have been replaced by modern technologies (p.317). During the review, the EU explained that it has not yet gathered information from member States on the biomass combustion technologies considered in their inventories. However, modern boilers are mostly automated, allowing their continuous operation and thus avoiding the high emissions of carbon monoxide, volatile organic compounds and particulate matter generated from incomplete combustion during the ignition and cooling phases of their operation (in contrast, for example, to wood stoves). It is generally assumed that lower carbon monoxide and volatile organic compound emissions correlate with lower CH_4 emissions, which arise mainly due to incomplete combustion in manually operated boilers and stoves and as a result of low fuel quality (e.g. high water content of fuelwood). The ERT recommends that the EU include in the NIR information on the characteristics of modern biomass boilers and stoves, which would explain the decrease in the CH_4 IEF for biomass in this subcategory for the period 1990– 2016.	Explanation of the boilers added in the NIR in 1.A.4.b Residential – Biomass (CH_4). Modern boilers are mostly automated, allowing their continuous operation and thus avoiding the high emissions of carbon monoxide, volatile organic compounds and particulate matter generated from incomplete combustion during the ignition and cooling phases of their operation (in contrast, for example, to wood stoves). It is generally assumed that lower carbon monoxide and volatile organic compound emissions correlate with lower CH_4 emissions, which arise mainly due to incomplete combustion in manually operated boilers and stoves and as a result of low fuel quality (e.g. high water content of fuelwood). The stoves have to fulfil the European standard 303-5:2013, plus eventually are also certified based in the EU Regulation No. 2015/1189.

Sector	TACCC	Category	Recommendation	Status of Implementation
E.26	Accuracy	1.A.5.a Stationary – solid fuels – CO_2, CH_4 and N_2O	In CRF table 1.A(a)s4 and in the NIR (p.333) the EU reports "IE" for Poland's emissions for this subcategory. The ERT noted that there is no explanation, either in the NIR or in CRF table 9, as to where these emissions are reported. During the review, the EU explained that it could not find any explanation in the CRF tables or the NIR of Poland's submission as to where these emissions are included, and indicated that it will include this information in the next NIR. The ERT recommends that the EU ensure that Poland's CO_2, CH_4 and N_2O emissions for this category are included in the EU inventory, and that it include in the NIR a description of where these emissions are included.	In the CRF tables from Poland, the solid fuels are not distinguished (no types of fuels are distinguished). Most likely the data is reported under the 1.A.4.c.i Agriculture/forestry/fishing – Stationary, however PL NIR does not contain any information about 1.A.5 at all.
E.27	Transparency	1.B.1.a Coal mining and handling – solid fuels – CH_4	The ERT noted that CH_4 emissions from underground coal mining decreased between 1990 (3,526.48 kt CH_4) and 1993 (3031.76 kt CH_4) by 14.0 per cent. In the same period, the CH_4 IEF exhibited a steep increase (287.0 per cent): from 2.54 kg/t in 1990 to 9.84 kg/t in 1993. According to the NIR, the increase in the CH_4 IEF was due to a strong decrease in CH_4 emissions in Belgium, which was responsible for 73 per cent of CH_4 emissions in 1990 (p.353). The ERT found that, according to figure 3.158 of the NIR, Belgium was responsible for less than 73 per cent of EU CH_4 emissions in 1990. During the review, the Party clarified that Belgium was responsible for 73 per cent of the AD for the EU in 1990, but only 0.44 per cent of its CH_4 emissions. In response to the question from the ERT, the EU contacted Belgium regarding the low CH_4 IEF. Belgium clarified that the AD in CRF table 1.B.1 of the EU submission were erroneously reported in kt instead of Mt; therefore, the AD need to be corrected by a factor of 1,000 (e.g. for 1990 the correct AD are 1.036 Mt, not 1,036 Mt). The EU indicated that corrected values will be reported in the next submission and that the explanation on page 353 of the NIR will also be corrected. The ERT recommends that the EU work with Belgium to ensure the correct reporting of AD for underground coal mining in CRF table 1.B.1, and that it correct the explanation of the trend for this subcategory in the NIR (i.e. that Belgium was responsible for 73 per cent of AD, not CH_4 emissions, in 1990).	Belgium provided corrected AD for underground mining. The EU trend was corrected and the corresponding text in the NIR was updated.
E.28	Transparency	1.C CO_2 transport and storage gaseous fuels – CO_2, CH_4 and N_2O	The EU reports an amount of 133.85 kt CO_2 captured for storage in 2016. The ERT noted, however, that the transport of CO_2 is reported as "NO" and injection and storage of CO_2 are reported as "IE, NO". During the review, the EU explained that only Finland reported the amount of CO_2 captured and that France reported fugitive emissions from CCS as "IE". The ERT noted that fugitive emissions from CCS are reported by the EU as "NO", although Finland reported captured CO_2. The EU explained that Finland reported fugitive emissions from CCS as "NA" in its submission, but, owing to an error in the software used by the EU to aggregate member State data, the correct notation key has not been reported in CRF table 1.C. The EU indicated that "NA" will be used in the next submission, but that the total amount of CO_2 captured (e.g. 133.85 kt in 2016) is less than 0.05 per cent of the EU's national total, and therefore any fugitive emissions from CCS must be less than the threshold of significance. The ERT recommends that the EU use in CRF table 1.C the notation key for fugitive emissions from CCS reported by Finland (i.e. "NA") and explain in the NIR why its use is appropriate.	The correct notation key is included in the EU CRF Table 1.C.

Sector	TACCC	Category	Recommendation	Status of Implementation
I.38	Transparency	2. General (IPPU) – CO_2	The EU described the gap-filling procedure for AD for the categories lime production (2.A.2), glass production (2.A.3) and ammonia production (2.B.1) (NIR, p.521). The procedure includes three steps: (1) aggregation of the emissions of those member States using the same type of AD; (2) calculation by the EU of the IEF for the member States included in step 1; and (3) multiplication of the IEF by the emissions of the 28 member States in order to derive a gap-filled estimate for AD for the EU. The ERT assumes that multiplying the IEF by emissions is an error, and that instead, in step 3 of the procedure, the EU should estimate its AD by dividing the total CO_2 emissions by the IEF estimated in step 2.	The error was corrected in chapter 4.3.1, as recommended by the ERT.
I.39	Transparency	2.B.1 Ammonia production – CO_2	The EU has reported the total AD (17,216 kt ammonia) and the estimated CO_2 emissions (23,935 kt CO_2) for ammonia production in NIR table 4.15. The CO_2 IEF (1.39 t CO_2/t ammonia) is calculated as the ratio of CO_2 emissions to AD. The EU describes the AD gap-filling procedure for this category (NIR, p.521). The ERT noted that Germany and France, which contribute significantly (22.4 per cent combined) to the total CO_2 emissions reported by the EU under this category, report CO_2 emissions from ammonia production in both the energy and the IPPU sector (NIR, p.450). In its estimation of the CO_2 IEF, however, the EU includes only CO_2 emissions reported under ammonia production. Not including CO_2 emissions reported in the energy sector by Germany and France results in a lower IEF, affecting comparability with other reporting Parties and also affecting the results of the estimation of AD by the gap-filling procedure. During the review, the EU informed the ERT that it was not possible to obtain detailed data from the published national energy balances of France and Germany to estimate CO_2 emissions from ammonia production reported in the energy sector, and that the EU could not change member States' reported estimates. The EU noted that EU ETS verified CO_2 emissions from ammonia production for 2016 (21,167 kt) are reasonably close to, but less than, the amount in the EU's GHG inventory (23,935 kt). The ERT acknowledged the EU's clarifications. In response to a draft version of the ARR, the EU stated that it will include a table in the NIR that includes the ammonia production combustion-related EU ETS emission values for France and Germany rather than only the process-related emissions reported for ammonia production. The ERT recommends that the EU improve the comparability of its CO_2 IEF estimates with those of other Parties by including in the NIR a table that includes the combustion-related EU ETS emission values for France and Germany rather than only the process-related emissions reported for ammonia production. The ERT notes that a similar table for iron and steel production (table 4.34) is already included in the EU NIR.	In chapter 4.2.2.1 of the NIR, a table, including discussion, was included, as recommended by the ERT.

Sector	TACCC	Category	Recommendation	Status of Implementation
I.40	Transparency	2.F.1 Refrigeration and air conditioning – HFCs and PFCs	In CRF table 2(II)B-Hs2, the EU has reported emissions from an unspecified mix of HFCs and PFCs for the subcategories commercial refrigeration (2.F.1.a) and industrial refrigeration (2.F.1.c). For 2016, the reported product manufacturing factor is 594 per cent and the product life factor is 99,000 per cent. According to information provided in table 7.9 of the 2006 IPCC Guidelines, the potential release of F-gases should not exceed 100 per cent. During the review, the ERT requested clarification from the EU on the reported EFs. The EU informed the ERT that in its technical opinion, for commercial refrigeration, the product life factor of a particular system can exceed 100 per cent if leakage occurs, no repairs are performed and the refrigerant is refilled several times per year. Product life factors of several hundred per cent have been observed for developing countries and ships, where low-quality servicing is available and refilling keeps refrigeration systems running. Furthermore, a system within the EU that is subject to total refrigerant loss (e.g. because of an accident) but which is refilled and begins leaking again would have an operational EF of more than 100 per cent in a given year. The EU acknowledged, however, that it is unlikely that such high operational EFs would relate to the entire stock of a country. Further, the EU explained that "unspecified mix of HFCs and PFCs" and "unspecified mix of HFCs" are reported for refrigeration and air conditioning (2.F.1) by several member States. A high amount of "unspecified mix of HFCs" in operating systems is, for example, reported by Denmark. A possible explanation for the high EFs reported is that some member States report "unspecified mix of HFCs and PFCs" from disposal in manufacturing or operating stocks because the refrigerants are not separated during end-of-life treatment and hence disposal emissions cannot be reported by substance. In some cases, "unspecified mix of HFCs" and "unspecified mix of HFCs and PFCs" are reported in a particular subcategory for confidentiality reasons. The EU indicated that it would need to follow up with member States to obtain more information on these matters and possibly the data on both "unspecified mix of HFCs" and "unspecified mix of HFCs and PFCs" in order to further analyse the F-gases reported. While the ERT recognizes that some types of equipment can be filled more than once a year, it notes that, to reach a 99,000 per cent product life factor the equipment would need to be refilled more than twice a day, which is not a realistic scenario, especially for large commercial and industrial applications. The ERT considers that if equipment is filled more than once a year, it should be reflected in increased AD, such as the amount of HFCs and PFCs used in operating stock, and not in the product life EF. The ERT recommends that the EU further analyse the F-gases reported as "unspecified mix of HFCs and PFCs" for commercial and industrial refrigeration applications, focusing on the practices related to refilling, and reflecting these refilling practices in the AD and not in the EFs (i.e. if equipment is filled more than once a year, it should be reflected in increased AD, such as the amount of HFCs and PFCs used in operating stock, and not in the product life EF).	Being followed up in step 2.

Sector	TACCC	Category	Recommendation	Status of Implementation
I.41	Transparency	2.F.1 Refrigeration and air conditioning – HFCs	The EU reported HFC-134a emissions from disposal in the subcategory mobile air conditioning (2.F.1.e) in CRF table 2(II)B-Hs2. The ERT noted that in 1995 the disposal loss factor was 100 per cent. This value is high compared with the values for 1996–2016, which range from 36.3 per cent (1997) to 51.1 per cent (2008). During the review, in response to the request of the ERT for more information on the 1995 disposal loss factor, the EU provided information showing that HFC-134a was introduced in the early 1990s, and 1995 was the first year in which it was used on a large scale for mobile air conditioning in passenger cars. The reported (very small) disposal emissions in 1995 relate to particularities of the inventories of France and Latvia: both of these member States run models of the vehicle stock that assume end of life of a certain share of vehicles each year, in line with a Gaussian normal distribution. Thus, some cars reached their end of life in the first year of widespread use of HFC-134a in mobile air conditioning. Because at that time no measures were in place in these countries to recover the refrigerant during end-of-life treatment, a disposal loss factor of 100 per cent was applied. The ERT considers realistic the assumption that not every car reaches an average lifespan and that some are disposed of earlier (e.g. owing to damage in an accident). The ERT also considers acceptable the assumption that in the first year when disposal emissions occurred there was no recovery of emissions. The ERT recommends that the EU include information in the NIR to explain the rationale for its reporting of a 100 per cent disposal loss factor in 1995 for the subcategory mobile air conditioning (2.F.1.e).	Very minor amount of emissions in one subsector, but will be included in the NIR.
I.44	Comparability	2.F.4 Aerosols – HFCs	The EU reported that HFC emissions from aerosols (2.F.4) (which mainly concerns the use of metered-dose inhalers) occur in all member States except the Netherlands (i.e. the Netherlands reported the emissions as "NO") (NIR, table 4.44). Taking into account the EU open market, the ERT would expect some emissions to occur in the Netherlands. During the review, the ERT requested clarification as to whether the reporting of "NO" by the Netherlands had been verified by the EU. In response, the EU informed the ERT that emissions from aerosols do occur in all member States and the Dutch NIR states (p.163) that emissions from this category (2.F.4) are included in the category other applications (2.F.6). The EU acknowledged that use of the notation key "NO" for theNetherlands was an error and "IE" should be used. The ERT recommends that the EU use the correct notation key to report HFC emissions from aerosols for the Netherlands in NIR table 4.44 and CRF table2(II)B-Hs2, that is to use "IE" rather than "NO", and include information in the NIR as to where these emissions have been allocated.	Notation key has not been corrected in the EU NIR, a note has been added that the Netherlands report HFC emissions from 2.F.4 in 2.F.6.

Sector	TACCC	Category	Recommendation	Status of Implementation
A.14	Adherence to the UNFCCC Annex I inventory reporting guidelines	3. General (agriculture) – CO_2	The previous ERT (which conducted the review of the 2015 and 2016 submissions) noted that the EU used the notation key "IE" to report indirect CO_2 emissions from the agriculture sector in CRF table 6 for Slovakia. As the previous ERT did not find any indication in the NIR of Slovakia that indirect CO_2 emissions had been estimated, it concluded that the correct notation key for reporting indirect CO_2 emissions from the agriculture sector would be "NE" (see ID# A.2 in table 3). During the current review, the EU indicated that Slovakia had explained that indirect CO_2 emissions are reported in the documentation box of its CRF table 3s2, so the EU could report this as a resolved issue in its next submission. The ERT noted, however, that indirect CO_2 emissions are reported by Slovakia in CRF table 3s2 and CRF table 3.G-I, and that the information in the documentation box of CRF table 3s2 is not linked to the issue. The ERT recommends that the EU work with Slovakia to clarify where indirect CO_2 emissions from the agriculture sector are reported and to ensure those emissions are included in the EU NIR.	Notation key provided for indirect emissions in agriculture of Slovakia, reported in the Table 6, were corrected to "NE".

Sector	TACCC	Category	Recommendation	Status of Implementation
A.15	Transparency	3.A.1 Cattle – CH_4	The CH_4 IEF reported by the EU for dairy cattle in 2015 (128.82 kg CH_4/head/year) and 2016 (129.22 kg CH_4/head/year) is higher than the IPCC default value (99 kg CH_4/head/year for Eastern Europe, 117 kg CH_4/head/year for Western Europe and 128 kg CH_4/head/year for North America). The comparatively high average appears to be driven by several member States. During the review, the EU confirmed that the high average CH_4 IEF for dairy cattle is driven by several member States but mostly by Denmark and Sweden. These countries use a national methodology for estimating the IEF that assumes the cattle are fed sugar beet and employs the gross energy feed per unit estimated by the Danish Centre for Food and Agriculture (the Danish Normative System). Use of this method leads to a very high milk yield (26 l/day in Denmark and similar in Sweden) and accordingly a high CH_4 IEF. The ERT noted that the contributions of Denmark and Sweden to the EU dairy cattle population and CH_4 emissions are too low to drive the average CH_4 IEF for dairy cattle of the EU – the cattle population of Denmark comprises 2.4 per cent of the EU cattle population, and Denmark's CH_4 emissions represent just 2.9 per cent of the EU total for 2016, while Sweden is not among the 10 countries with the highest population of cattle or CH_4 emissions. In response to a question from the ERT on how the EU determines that these two countries drive the high average CH_4 IEF for dairy cattle, the EU explained that all member States report a higher IEF than the default value for Eastern European countries and 15 member States report a higher IEF than the default value for Western European countries. The CH_4 IEF of the EU is influenced most by those countries with a high cattle population, and those with the highest deviation from the average IEF. Germany, Italy and the Netherlands have a great influence as they have high CH_4 IEFs and shares of CH_4 emissions of 18.9, 8.6 and 7.4 per cent, respectively. The highest IEFs are reported by Denmark (156 kg CH_4/head/year) and Finland (151 kg CH_4/head/year) and they contribute shares of 2.9 and 1.4 per cent, respectively, to the total EU CH_4 emissions. As requested, the EU provided the ERT with the member States' contributions to the EU dairy cattle population andCH_4 emissions and their CH_4 IEFs. On the basis of the clarifications and the documentation provided, the ERT acknowledges that the high average CH_4 IEF for dairy cattle is driven by several member States, but disagrees that Denmark and Sweden are the predominant drivers. The ERT recommends that the EU consider the share of each member State's contribution to the EU's total dairy cattle population and the CH_4 IEF of each member State to determine the factors driving the average CH_4 IEF for dairy cattle of the EU, and report on those factors in the NIR.	Explanation on IEFs for dairy cattle among the EU MSs is provided in the EU NIR, Table 5.8, Figure 5.1.

Sector	TACCC	Category	Recommendation	Status of Implementation
A.16	Transparency	3.A.1 Cattle – CH_4	In NIR table 5.5 the EU reports that Iceland used a tier 2 method to estimate CH_4 emissions from cattle but did not provide any information on the EF (see ID# A.3 in table 3). During the review, the EU explained that Iceland used livestock population characterization to calculate GE of cattle (Iceland NIR 2018, pp.102–103). The values for GE were used to calculate the CH_4 EFs for enteric fermentation (using equation 10.21 from the IPCC good practice guidance). The CH_4 conversion rate depends on several interacting feed and animal factors. The ERT concluded that Iceland used a country-specific CH_4 EF for cattle, but this information is missing from Iceland's NIR and CRF tables. See ID# A.3 in table 3 for the outstanding recommendation from the previous review report on this issue.	Information on Iceland IEFs, methodological tiers and emissions from cattle, sheep and swine was included in appropriate tables of the EU NIR 2020. Please see Chapter 5.3.1.
A.17	Transparency	3.A.2 Sheep – CH_4	In NIR table 5.6 the EU reports that Denmark used a tier 2 method to estimate CH_4 emissions from sheep with default EFs. The ERT noted that the use of a tier 2 method suggests the use of a country-specific EF. During the review, in response to a question from the ERT on how Denmark used a tier 2 method with a default EF, the EU explained that Denmark used a tier 2/country-specific method for enteric fermentation, which is different from the IPCC tier 2 method in the calculation of GE (Denmark NIR 2018, pp.367–370). GE is estimated as gross energy per feed unit. The feed unit is based on the composition of feed intake and the energy content in proteins, fats and carbohydrates, and the actual efficacy of feeding controls or actual feeding plans at the farm level, data on which are collected by the Danish Agricultural Advisory Service or the Danish Centre for Food and Agriculture. For horses, heifers, suckling cattle, sheep and goats, an average winter feed plan is provided on the basis of information from the Danish Centre for Food and Agriculture and SEGES, on which the calculation of GE is based. The ERT concluded that Denmark used a country-specific EF to estimate CH_4 emissions from sheep and not a default EF. The ERT recommends that the EU report accurately in the NIR the method and CH_4 EF used by Denmark to estimate CH_4 emissions from sheep.	Please see Table 5.6 of the EU NIR.

Sector	TACCC	Category	Recommendation	Status of Implementation
A.18	Transparency	3.B Manure management – N_2O	The EU used the notation key "IE" to report N_2O emissions from manure management for cattle and swine for the Netherlands in NIR tables 5.29 and 5.30. In CRF table 3.B(b), the EU used the notation key "IE" to report N_2O emissions from manure management for sheep and swine for the Netherlands. The ERT noted that no explanation is provided, either in the documentation box of CRF table 3.B(b) or in the NIR, as to where in the inventory the emissions have been included. During the review, the EU explained that the Netherlands reported manure in CRF table 3.B(b) in the different MMS without distinguishing among livestock categories until the last inventory year, and the EU had no data for individual animal types; it therefore assigned all manure to the category other. The EU has been working with the Netherlands on this issue for a few years, and the Netherlands is now advancing in the recommended calculations. For 2018 the Netherlands reported manure by MMS and livestock category (see ID#s A.6 and A.7 in table 3), but emissions for category 3.B.b were still reported under other livestock. According to the Netherlands' improvement plan, the disaggregation of emissions by livestock category is expected to be finished in time for the next submission. See ID# A.6 in table 3 for the outstanding recommendation from the previous review report on this issue.	Tables 5.29 and 5.30 of the EU NIR included information on cattle and swine.
A.19	Transparency	3.B Manure management – N_2O	In CRF table 3.B(b), the EU used the notation key "NA" to report direct N_2O emissions from manure management for liquid systems for Bulgaria and for daily spread for Bulgaria, Czechia and Poland. The ERT noted that no explanation is provided in the NIR as to why this notation key is used. During the review, the EU explained that Bulgaria reported manure managed in liquid systems for swine and buffalo, but used an EF of zero for this MMS; Czechia reported manure in the daily spread system for cattle, but used an EF of zero; and Bulgaria and Poland did not report manure managed in the daily spread system. The ERT recommends that the EU work with Bulgaria and Poland to clarify why they use "NA" to report N_2O emissions from MMS when manure is not reported in those MMS in their NIR.	Partly resolved: BG reported in the CRF Table 3.B(b) "NA" for "their livestock" only, Poland has not reported "NA" in the CRF Table 3.B(b).
A.20	Transparency	3.B Manure management – N_2O	In CRF table 3.B(b) the EU uses the notation key "NA" to report direct N_2O emissions from manure management for composting systems for Croatia, Poland and Slovenia. The ERT noted that no explanation is provided in the NIR as to why this notation key is used. The ERT also noted that composting is practiced in these countries, as shown in figure 7.2 of the NIR. During the review, the EU explained that Croatia, Poland and Slovenia reported in their NIRs that only urban waste is composted; composting of manure waste is not mentioned. The ERT recommends that the EU work with Croatia, Poland and Slovenia to clarify in their NIRs the use of the notation key "NA" to report direct N_2O emissions from manure management for composting systems.	PL: no "NA" used in the CRF Table 3.B(b) HR: no "NA" used in the CRF Table 3.B(b) SI: no "NA" used in the CRF Table 3.B(b)

Sector	TACCC	Category	Recommendation	Status of Implementation
A.21	Transparency	3.B Manure management – N_2O	In CRF table 3.B(b), the EU used the notation key “NE” to report direct N_2O emissions from manure management for composting systems for Finland and the United Kingdom. The ERT noted that no explanation is provided in CRF table 9 or in the NIR as to why this notation key is used. During the review, the EU explained that in Finland emissions from manure composting are negligible (Finland 2018 NIR, table 5.3.1). In chapter 7 of its 2018 NIR the United Kingdom reports household and non-household waste as composting sources, but does not mention manure. The ERT considers it incorrect to use the notation key “NE” to report direct N_2O emissions from manure management for composting systems for the United Kingdom. The ERT recommends that the EU work with the United Kingdom to clarify the use of the notation key “NE” to report direct N_2O emissions from manure management for composting systems, or replace “NE” with “NO” if these emissions do not occur, always reporting in the NIR the rationale for using this notation key.	Not yet resolved for UK: used "NE" for composting and digester, explanation in the Table 9 not provided. Explanation in the UK NIR Table page 510: Addressing. Emissions of CH_4 and N_2O emissions from the anaerobic digestion of livestock manures and from the application of digestates (from anaerobic digestion of manures, crop-based AD and food waste-based AD) are currently being incorporated in the UK model and will be fully reported in the 2021submission. Activity data on composting and the application of composts to land are being reviewed.
A.22	Transparency	3.B.3 Swine – CH_4	In NIR table 5.17 the EU reports that Cyprus and the United Kingdom used a tier 2 method to estimate CH_4 emissions from manure management for swine. The EU also reports that these member States used default information for the CH_4 EF. As the use of a tier 2 method for CH_4 emissions from manure management implies the use of a country-specific EF estimated using country-specific data, the ERT asked the EU to explain how Cyprus and the United Kingdom used default information for the CH_4 EF for manure management when applying a tier 2 method. During the review, the EU explained that Cyprus and the United Kingdom estimated the CH_4 EF from manure management for swine on the basis of the IPCC tier 2 method using country-specific values for the manure managed in each MMS and that the EU had incorrectly interpreted these member States’ explanations of how they calculate the EFs. The ERT recommends that the EU report accurately in the NIR the method and CH_4 EF used by Cyprus and the United Kingdom to estimate CH_4 emissions from manure management for swine.	CY (see answer A.11). UK (NIR 2020 page 329): The emission factors for manure management are calculated following IPCC Tier 2 methodology for cattle, sheep, pigs and poultry, according to IPCC (2006) Equation 10.23.

Sector	TACCC	Category	Recommendation	Status of Implementation
A.23	Completeness	3.D.a.2 Organic nitrogen fertilizers – N_2O	In CRF table 3.D the EU uses the notation key "NE" to report direct N_2O emissions from other organic fertilizers applied to soils for Croatia and Finland, and did not report on these emissions for Iceland. The ERT noted that no explanation is provided in CRF table 9 or in the NIR as to why this notation key is used. During the review, the EU explained that, in the case of Croatia, the Party reported "NA" for these emissions in CRF table 3.D, although it also referred to composting activities in the waste sector. The EU raised the issue with the Party and suggested that Croatia make efforts to find data related to other organic fertilizers applied to soils for CRF table 3.D, and in the meantime use the notation key "NE" rather than "NA" to report these emissions. The EU noted that Croatia has included this issue in its improvement plan and might be in a position to report those emissions soon. Regarding Finland, the EU explained that the Party stated in its NIR (p.252) that it did not report N_2O emissions from "other organic fertilizers applied to fields (for example, composted household waste and industrial waste) under the agriculture sector as there is no register from which to obtain the data and the amounts applied to fields are considered insignificant (most is used in landscaping and not in fields) and that the emissions of the composted waste types are reported in the waste sector (5.B.1)". Finally, the ERT noted that the EU did not report direct N_2O emissions from other organic fertilizers applied to soils for Iceland, which used the notation key "NE" in CRF table 3.D. The ERT concluded that Croatia partially estimated N_2O emissions from other organic fertilizers applied to soils (only for composted household waste and industrial waste) and reported them under the waste sector. Therefore, the appropriate notation key to be used for this Party is "IE, NE". The ERT recommends that the EU work with Croatia and Iceland to estimate and report direct N_2O emissions from other organic fertilizers applied to soils under the agriculture sector (organic nitrogen fertilizers (3.(II).D.A.2)). If N_2O emissions are determined to be insignificant, the ERT recommends that the EU work with the countries so that they can explain the use of the notation key "NE" to report these emissions in their NIRs, in accordance with paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.	This issue has been considered under the initial checks 2020; but could not be resloved for all MS within this year. FI: explained in the NIR, that emissions are under the threshold (0.05%) IS: not yet resolved HR: explanation provided during ESD 1st step review

Sector	TACCC	Category	Recommendation	Status of Implementation
A.24	Transparency	3.D.a.5 Mineralization/immobilization associated with loss/gain of soil organic matter – N_2O	In CRF table 3.D the EU used the notation key "NA" to report direct N_2O emissions from mineralization/ immobilization associated with loss/gain of soil organic matter for Finland, Germany and Spain, and "NE" for Iceland. The ERT noted that no explanation is provided in the NIR, or in the case of Iceland in CRF table 9, as to why these notation keys are used. During the review, in response to a question raised by the ERT on the reason for not using the notation key "NE" for Finland, Germany and Spain, the EU explained that for Finland numerical values were reported for direct N_2O emissions in this category for some years (those in which loss of organic carbon takes place), and "NA" was used when no loss of organic carbon took place (Finland NIR, table 5.4-2). Regarding Germany, the EU explained that the soils pool was not a source of emissions given that there have been no changes in management practices in the country since 1990, as reported in the documentation box of Germany's CRF table 3.D. Finally, the EU noted that Spain indicated in CRF table 3.D that the net carbon stock change in mineral soils in cropland remaining cropland was positive (a gain) for the entire time series, and therefore equation 11.8 from the 2006 IPCC Guidelines is not applicable. The ERT concluded that reporting for Finland, Germany and Spain is consistent with the UNFCCC Annex I inventory reporting guidelines, but reporting for Iceland is not because the rationale for the use of "NE" is not transparent. The ERT recommends that the EU, in reporting direct N_2O emissions from mineralization/immobilization associated with loss/gain of soil organic matter in CRF table 3.D, work with Iceland to include in its NIR and CRF table 3.D the justification for the use of "NE" for reporting direct N_2O emissions from mineralization/immobilization associated with loss/gain of soil organic matter.	Iceland used notation key "NO"
A.25	Adherence to the UNFCCC Annex I inventory reporting guidelines	3.D.b Indirect N_2O emissions from managed soils – N_2O	When responding to the ERT regarding a previous recommendation (see ID# A.12 in table 3), the EU indicated that the Netherlands reported a different (higher) value in its March submission to the EU for the area of cultivated histosols in the subcategory indirect N_2O emissions from managed soils (3.D.b) from its January submission, which, according to the EU, was probably due to a reporting error. The EU explained that it would address the issue with the Netherlands in the next reporting period. It also indicated it would continue with consistency checks between the agriculture and LULUCF sectors for organic soils. The ERT recommends that the EU work with the Netherlands to correct the error made in reporting the area of cultivated histosols in CRF table 3.D and report the correct value in the EU CRF table 3.D.	This issue has been considered under the initial checks 2020 and could be resolved.

Sector	TACCC	Category	Recommendation	Status of Implementation
KL.20	Completeness	CM – CO_2	The ERT noted that for Italy the EU has reported net carbon stock changes in mineral soils in CRF table 4(KP-I)B.2 using the notation key "NE", while reporting an area of mineral soils (8,994.9 kha) for 2016. During the review, the EU explained that the notation key "NE" was used for carbon stock changes in mineral soils following a recommendation in the 2016 annual review report of Italy (see ID# KL.2 in document FCCC/ARR/2016/ITA).While the ERT acknowledges the Party's reporting of "NE", it notes that transparent and verifiable information indicating that this pool is not a net source of emissions is not provided in the NIR as required by paragraph 2(e) of annex II to decision 2/CMP.8. The ERT recommends that the EU provide transparent and verifiable information on the use of notation key "NE" to report CM for Italy in order to increase transparency.	Addressing the recommendation of the ERT, in the GHG inventory 2020 Italy has reported carbon stock changes from mineral soils in Cropland Management.
W.3	Comparability	5.B.1 Composting – CH_4 and N_2O	In CRF table 5.B the EU reported two types of waste treated by composting: MSW and other waste. However, the ERT noted that in the NIR (section 7.2.2.1) the EU reported information only on MSW. No information regarding the type of waste contained in other waste is included in the NIR. During the review, the EU explained that in 2016 10 member States reported CH_4 and N_2O emissions for the subcategory other (5.B.1.b). Many member States apply the same EFs for category 5.B.1.b as for MSW (5.B.1.a) (IPCC defaults: 4 g CH_4/kg wet waste and 0.24 g N_2O/kg wet waste). Other member States report emissions from composting only under subcategory 5.B.1.b. Still others use IPCC default EFs but report different waste categories under category 5.B.1.b and differentiate between dry and wet waste. Some member States report industrial solid waste and construction waste as well as municipal sludge and industrial sludge under category 5.B.1.b using IPCC default EFs. The ERT considers that the explanation provided by the EU highlights the potential issue related to the comparability of data among member States; it is clear they are not reporting each type of waste under the correct subcategories (5.B.1.a and 5.B.1.b). According to the specifications provided in CRF table 5.B, subcategory 5.B.1.a should include emissions from MSW and subcategory 5.B.1.b should include emissions from all organic waste sources not covered by MSW. The ERT recommends that the EU report the CH_4 and N_2O emissions of each type of composting waste in the correct subcategory: 5.B.1.a (for MSW) or 5.B.1.b (for other organic waste). The ERT also recommends that the EU improve the transparency of the NIR by including more information on both types of waste composted, including AD, EFs and the type of waste included under other (5.B.1.b).	In 2020, a huge effort has been made among MS to report consistent AD as asked in their CRF tables (dry basis as required in the CRF tables). Anyway, reporting AD in a dry basis unit as required in the CRF tables seems inappropriate because data are usually available in a wet basis.

Sector	TACCC	Category	Recommendation	Status of Implementation
W.4	Comparability	5.B.2 Anaerobic digestion at biogas facilities – CH_4 and N_2O	In CRF table 5.B the EU has reported the AD for waste treated by anaerobic digestion at biogas facilities (category 5.B.2) as "NE" for the entire time series. However, CH_4 emissions have been estimated and reported for all years. No information regarding category 5.B.2 is included in the NIR. During the review, the EU explained that the reporting of AD and emissions for this category varies among member States. While some report AD as well as CH_4 and N_2O emissions, others report emissions but not AD. This would lead to unreliable CH_4 and N_2O IEFs in CRF table 5.B. The EU noted that in the CRF Reporter software it is not possible to report "NE" for the IEFs; therefore AD have been reported as "NE" in order to avoid the reporting of unreliable IEFs for this category. The Party also noted that because information on AD for each member State is included in the commenting field of the CRF table cell, information is not lost. The ERT considers that the explanation provided by the EU highlights the potential issue related to comparability of data among member States; it is clear they are not reporting all of the information required in the CRF tables. The ERT recommends that the EU improve the comparability of the inventory by working with member States to ensure that AD on the annual amount of waste treated through anaerobic digestion at biogas facilities (category 5.B.2) are reported for all Parties, thereby allowing the correct calculation and reporting of the CH_4 and N_2O IEFs for this category. The ERT also recommends that the EU improve the transparency of the NIR by including information on the AD and EFs used, as well as the calculation methodology followed, for the estimation of CH_4 and N_2O emissions for this category.	In 2020, a huge effort has been made among MS to report consistent AD as asked in their CRF tables (dry basis as required in the CRF tables). Anyway, reporting AD in a dry basis unit as required in the CRF tables seems inappropriate because data are usually available in a wet basis.
W.5	Adherence to the UNFCCC Annex I inventory reporting guidelines	5.C Incineration and open burning of waste – CO_2, CH_4 and N_2O	The ERT noted that a section for the category incineration and open burning of waste (5.C) is not included in the NIR. During the review, the EU explained that the chapter for category 5.C was mistakenly deleted from the May submission of the 2018 NIR, but had been included in the April 2018 submission and was therefore available for the ERT to review. The ERT recommends that the EU ensure that the section for the category incineration and open burning of waste (5.C) is included in the NIR and that the EU conduct a quality check of the NIR before submission.	The paragraph is presented in the 2020 NIR, but 5C is not a key category for the EU in 2020, therefore no detailed information is presented.

Sector	TACCC	Category	Recommendation	Status of Implementation
W.6	Transparency	5.D.1 Domestic wastewater – CH_4	The ERT noted that figure 7.15 in the NIR shows only the total fractions of CH_4 emissions, CH_4 recovered and CH_4 flared from domestic wastewater treatment facilities at the EU level. The ERT also noted that the amounts of CH_4 recovered and CH_4 flared are more than double the CH_4 emissions in recent years. Given this situation, the ERT considers that the technologies and practices related to CH_4 recovery and CH_4 flaring in individual member States need to be more clearly explained in the NIR. The ERT recommends that the EU include in the NIR a table reporting the amount of CH_4 emissions, CH_4 recovered and CH_4 flared by member State, and provide the results of an analysis of major trends related to CH_4 recovery and flaring practices.	As indicated in the NIR, the CH_4 recovery is generally recovered during sludge digestion for biogas production in a follow-up step of aerated wastewater treatment plants. On the opposite, CH_4 emissions relate mainly to anaerobic treatment systems (septic tanks and natural lagoons). Therefore comparing CH_4 emissions to CH_4 recovery is meaningless. Moreover, information related to the split between flaring and energy use of CH_4 recovered on sludge digesters is not necessary to apply the 2006 IPCC Guidelines and to estimate CH_4 emissions from waste water treatment and sludge digestion. Therefore, the text has been completed, but the split is still not presented.

10.4.2 Improvements planned at EU level

The following activities are planned at EU level with a view to improving the EU GHG inventory:

- Include new key categories in the NIR giving detailed information like for other key categories
- Further implement the recommendations from the past reviews;
- Continue sector-specific QA/QC activities within the EU internal review (ESD review);

11 KP-LULUCF

For each Article 3(3), and Article 3(4) activities, estimates reported in the EU GHG inventory result from summing up all GHG emissions and CO_2 removals reported by individual EU Member States (MS), UK and Iceland. For the voluntary activities under the Article 3(4), information is included only for those countries that elected to account for these activities during the second commitment period (CP2) of the Kyoto Protocol (KP).

It is important to note that each country will account for net emissions and removals for each activity under Article 3(3), and 3(4) if elected, by issuing removals units (RMUs) or cancelling KP units based on their own reported emissions and removals from their activities, and the specific accounting rules. The EU will neither issue, nor cancel units based on the reported emissions and removals from activities under Article 3(3) and (4).

This chapter provides an overview of relevant supplementary information for KP-LULUCF activities, as reported by EU MS, UK and Iceland.

In the absence of an official annotated outline for the provision of supplementary information under the CP2 of the KP, the JRC[60] provided to the countries a proposal on the outline for reporting KP-LULUCF supplementary information within the national inventory reports (NIRs). Nevertheless, the type and amount of information reported by individual inventories slightly differs among them. Therefore, note that this chapter does not aim to provide an exhaustive compilation of all supplementary information reported by EU MS, UK and Iceland, but an overview of the most important elements on KP-LULUCF as included in the individual inventories. For more detailed information, we encourage readers to refer to information included in the NIR of the countries.

In particular, this chapter includes:

- General information concerning KP-LULUCF activities, (i.e., elected activities under Article 3(4), completeness of reporting of carbon pools and other sources of GHG emissions, areas reported under each activity, accounting quantities, key category analysis, definition of forest used by EU MS, UK and Iceland).
- Information related to the land representation approach for KP-LULUCF activities.
- Activity-specific information, (i.e., methodologies for estimating carbon stock changes and other sources of GHG emissions, justification for omitting carbon pools, information on whether indirect and natural CO_2 removals have been factored out, information on the year of the onset of the activity, and information on other methodological issues).
- A synthesis of supplementary information required for Article 3(3) and 3(4) activities (i.e. information on natural disturbances, information on HWP, methods for constructing the FMRLs, whether EU MS, UK and Iceland have implemented technical corrections, and information about conversion from natural to planted forests).

The main postulation when reporting under the KP is that the consistency of the information reported in the EU GHG inventory with the IPCC good practices is ensured when individual GHG inventories are consistent with those good practices. To achieve and ensure such assumption, the consistency of the EU MS, UK and Iceland GHG inventories with the IPCC good practices is checked twice every year before national GHG inventories are officially submitted to the UNFCCC. A first check is carried out at country

[60] Joint Research Centre of the European Commission. https://ec.europa.eu/jrc/en

level as part of the own QA/QC procedures, and a second one in the context of the EU's QA/QC procedures as implemented by the JRC experts pursuant the Regulation 525/2013 (see section 6.4 on QAQC procedures implemented for LULUCF and KP-LULUCF)

11.1 General information

11.1.1 Elected activities under Article 3(4) of the Kyoto Protocol

As shown in Table 11.1, with regard to voluntary activities under the Article 3(4) during the CP2; 6 EU MS and UK have elected to account for Cropland Management, 5 EU MS and UK for Grazing Land Management, 1 EU MS and Iceland for Revegetation, and only UK for Wetland Drainage and Rewetting. Concerning the accounting frequency, with the exception of 2 EU MS, all other have elected to account at the end of the commitment period.

Table 11.1 Activities elected under Art. 3(4), and accounting frequency. FM: forest management, CM: cropland management, GM: grazing land management, RV: revegetation, WDR: wetlands drainage and rewetting.

Country	Art 3.4 elected activities [1]	Accounting frequency
Austria	---	end of CP
Belgium	---	end of CP
Bulgaria	---	end of CP
Croatia	---	end of CP
Cyprus	---	end of CP
Czech Republic	---	end of CP
Denmark	CM, GM	annual
Estonia	---	end of CP
Finland	---	end of CP
France	---	end of CP
Germany	CM, GM	end of CP
Greece	---	end of CP
Hungary	---	annual
Ireland	CM, GM	end of CP
Italy	CM, GM	end of CP
Latvia	---	end of CP
Lithuania	---	end of CP
Luxembourg	---	end of CP
Malta	---	end of CP
Netherlands	---	end of CP
Poland	---	end of CP
Portugal	CM, GM	end of CP
Romania	RV	end of CP
Slovakia	---	end of CP
Slovenia	---	end of CP
Spain	CM	end of CP
Sweden	---	end of CP
United Kingdom	CM, GM, WDR	end of CP
Iceland	RV	end of CP

[1]*FM activity has become mandatory reporting activity for the KP- CP2.*

11.1.2 Activity coverage under Article 3(3) and Article 3(4) (CRF table NIR-1)

Table 11.2 presents an assessment of completeness of carbon pools and GHG emissions reported by EU MS, UK and Iceland for each mandatory and elected activity.

Carbon stock changes are estimated in all cases for living biomass pool. For dead organic matter and soil organic carbon pools notation keys are also used. “NE”, “NO” “NA” are used mainly when the “not a source” provision is applied, while “IE” is mainly used for belowground biomass being included under aboveground biomass, or for “gain” or “losses” in living biomass when the stock-difference method is applied, and therefore, only a net gain, or net loss, is reported.

In addition, “IE” is also used when carbon stock changes in litter and dead wood are reported together, or when dead organic matter and soil organic carbon pools are estimated by using models not capable to apportion net carbon stock changes among these pools.

Despite of the continuous improvements implemented by EU MS, UK and Iceland in their GHG inventories, when implementing the “not a source” provision, both the EU QA/QC procedures and the UNFCCC expert review teams highlighted the need of providing more transparent information to demonstrate that omitted carbon pools are not a net source of emissions. After such recommendations more detailed information has been provided in individual inventories during the recent years, and a synthesis of such information is presented in Table 11.17.

Concerning other sources of GHG emissions, individual inventories have also introduced significant improvements, especially with regard to N_2O emissions from management of soils. But notation keys are also used when a specific source of GHG emissions does not occur within the national territories (e.g., fertilization of natural forests does not occur) or when such emissions are already reported under the agriculture sector. An example is given, following IPCC methods, when the source of information does not allow to separate between LULUCF and Agriculture the final destination of nitrogen fertilizers.

Table 11.2 Synthesis of carbon pools and other sources of GHG emissions reported for KP-LULUCF activities in EU MS, UK and Iceland, based on table NIR-1 and sectorial tables for the current inventor year.

Country	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	AGB	BGB	Litter	Dead wood	Soil		HWP	Fertilization	Drained, rewetted and other soils		Nitrogen mineralization in mineral soils	Indirect N_2O emissions from managed soil	Biomass burning		
					Min	Org		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
Afforestation/Reforestation															
Austria	R	R	R	R	R	NO	R	NO	NO	NO	R	IE	NO	NO	NO
Belgium	R	R	R	R	R	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Bulgaria	R	IE	R	NO	R	NO	R	NO	NO	NO	NO	NO	IE	R	R
Croatia	R	R	R	R	R	NO	NO	NO	NO	NO	NO	NO	R	R	R
Cyprus	R	R	R	NO	NR	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Czech Republic	R	R	R	R	R	R	R	NO	NO	NO	NO	NO	NO	NO	NO
Denmark	R	R	R	R	R	R	R	IE	R	R	NO	R	NO	NO	NO
Estonia	R	R	R	R	R	R	R	NO	R	R	NO	NO	IE	R	R
Finland	R	R	IE	IE	R	R	R	R	R	R	R	R	R	R	R
France	R	R	R	R	R	NO	NO	NO	NO	NO	R	NE	R	R	R

Country	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	AGB	BGB	Litter	Dead wood	Soil		HWP	Fertilization	Drained, rewetted and other soils		Nitrogen mineralization in mineral soils	Indirect N_2O emissions from managed soil	Biomass burning		
					Min	Org		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
Germany	R	R	R	R	R	R	IE	NO	NO, R	NO, R	R	R	IE,NO	IE,NO	IE,NO
Greece	R	R	NR	NR	NR	NO	NO	NO	NO	NO	NO	NO	R	R	R
Hungary	R	R	NR	NR	NR	NO	IE	IE	NO	NO	NO	NO	IE	R	R
Ireland	R	R	R	R	R	R	R	IE	R	R	NO	IE	R	R	R
Italy	R	R	R	R	R	NO	R	NO	NO	NO	R	R	R	R	R
Latvia	R	R	R	R	NO	R	NO	NO	R	R	NO	NO	NO	NO	NO
Lithuania	R	R	R	NO	R	R	IE	NO	R	R	NO	NO	R	R	R
Luxembourg	R	R	R	R	R	NO	IO	NO	NO	NO	NO	NO	NO	NO	NO
Malta	NR	NR	NR	NR	NR	NR	NR	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	R	R	NR	R	R	R	IE	NO	NE	R	R	NO	R	R	R
Poland	R	R	NR	NR	R	R	NO	NO	NO	NO	NO	NO	R	R	R
Portugal	R	R	R	IE	R	NO	R	IE	NO	NO	R	IE	R	R	R
Romania	R	R	R	NO	R	NR	R	IE	NO	NO	R	R	R	R	R
Slovakia	R	R	R	NO,NR	R	NO,NR	NR	NO	NO	NO	NO	NO	R	R	R
Slovenia	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Spain	R	IE	NR,R	NR,R	NR,R	NO	NR	NO	NO	NO	NE,R	IE,NE	IE,NO, R	NO,R	NO,R
Sweden	R	R	R	R	R	R	R	NO	R	R	R	R	NO	NO	NO
United Kingdom	R	R	R	R	R	R	R	R	R	R	R	NE	R	R	R
Iceland	R	R	R	NO	R	R	NO	R	R	R	NO	NO	NO	NO	NO
Deforestation															
Austria	R	R	R	R	R	NO	IO	NO	NO	NO	R	IE	NO	NO	NO
Belgium	R	R	R	R	R	NO	R	IE	NO	NO	R	NO	NO	NO	NO
Bulgaria	R	IE	R	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO
Croatia	R	R	R	R	R	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Cyprus	R	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Czech Republic	R	R	R	R	R	R	R	NO	NO	NO	R	NO	NO	NO	NO
Denmark	R	R	R	R	R	R	R	R	R	R	R	IE	NO	NO	NO
Estonia	R	R	R	R	R	R	R	NO	NE	NE	R	NO	NO	NO	NO
Finland	R	R	IE	IE,R	R	R	IO	IE	R	R	R	IE	R	R	R
France	R	R	R	R	R	NO	IO	NO	NO	NO	R	NE	R	R	R
Germany	R	R	R	R	R	R	NO	NO	NO, R	NO, R	R	R	NO	NO	NO
Greece	R	R	R	R	R	NO	NO	NO	NO	NO	R	NO	NO	NO	NO
Hungary	R	R	R	R	R	NO	IO	IE	NO	NO	R	R	IE	R	R
Ireland	R	R	R	R	R	R	IO	IE	R	R	R	IE	NO	NO	NO
Italy	R	R	R	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO
Latvia	R	R	R	R	R	R	R	IE	R	R	R	R	NO	NO	NO
Lithuania	R	R	R	R	R	R	IO	NO	NO	NO	R	NO	NO	NO	NO
Luxembourg	R	R	R	R	R	NO	IO	NO	NO	NO	R	NO	NO	NO	NO
Malta	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	R	R	R	R	R	R	IO	IE	NE	IE	R	IE	R	R	R
Poland	R	R	R	R	R	R	NO	NO	NO	NO	NO	NO	NO	NO	NO
Portugal	R	R	R	IE	R	NO	R	IE	NO	NO	R	IE	R	R	R

Country	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	AGB	BGB	Litter	Dead wood	Soil		HWP	Fertilization	Drained, rewetted and other soils		Nitrogen mineralization in mineral soils	Indirect N_2O emissions from managed soil	Biomass burning		
					Min	Org		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
Romania	R	R	R	NO	R	NR	R	NE	NO	NO	R	R	R	R	R
Slovakia	R	R	R	R	R	NO,NR	NR	NO	NO	NO	NO	NO	NO	NO	NO
Slovenia	R	R	R	R	R	NO	IO	NO	NO	NO	R	NO	NO	NO	NO
Spain	NR,R	IE,NR	NR,R	NR,R	NR,R	NO	NR	NO	NO	NO	NE,R	IE,NE	NO,R	IE,NO,R	IE,NO,R
Sweden	R	R	R	R	R	R	IO	NO	R	R	R	R	NO	NO	NO
United Kingdom	R	IE	R	IE	R	R	IO	NO	R	R	R	NO	R	R	R
Iceland	R	NO	NO	NO	R	R	NO	NO	R	R	NE	NO	NO	NO	NO
Forest Management															
Austria	R	R	IE	R	R	NO	R	NO	NO	NO	NO	NO	IE	R	R
Belgium	R	R	NO	NO	NR	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Bulgaria	R	IE	NA	R	NA	NO	R	NO	NO	NO	NO	NO	IE	R	R
Croatia	R	R	NO	NO	NO	NO	R	NO	NO	NO	NO	NO	R	R	R
Cyprus	R	R	NO	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO
Czech Republic	R	R	IE	R	NR	R	R	NO	NO	NO	NO	NO	R	R	R
Denmark	R	R	R	R	R	R	R	R	R	R	NO	R	NO	NO	NO
Estonia	R	R	R	R	R	R	R	NO	R	R	NO	NO	IE	R	R
Finland	R	R	IE	IE	R	R	R	R	R	R	R	R	R	R	R
France	R	R	R	R	R	NO	R	NO	NO	NO	R	NE	R	R	R
Germany	R	R	R	R	R	R	R	NO	R	R	R	R	IE,NO	NO,R	NO,R
Greece	R	R	NR	NR	NR	NO	R	NO	NO	NO	NO	NO	R	R	R
Hungary	R	R	NR	NR	NR	R	R	IE	NO	NO	NO	NO	IE	R	R
Ireland	R	R	R	R	R	R	R	IE	R	R	NO	IE	R	R	R
Italy	R	R	R	R	NR	NR	R	NO	NO	NO	NO	NO	R	R	R
Latvia	R	R	R	R	NO	R	R	NO	R	R	NO	NO	R	R	R
Lithuania	R	R	R	R	NO	R	R	NO	R	R	NO	NO	R	R	R
Luxembourg	R	R	R	R	R	NO	IO	NO	NO	NO	NO	NO	NE	NE	NE
Malta	NR	NR	NR	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA
Netherlands	R	R	NR	R	R	R	R	NO	NE	R	R	NO	R	R	R
Poland	R	R	NR	NR	R	R	R	NO	NO	NO	NO	NO	R	R	R
Portugal	R	R	R	IE	R	NO	R	IE	NO	NO	R	IE	R	R	R
Romania	R	R	R	NO	R	NR	R	IE	NO	NO	R	R	R	R	R
Slovakia	R	R	NO,NR	NO,NR	NO,NR	NO,NR	R	NO	NO	NO	NO	NO	R	R	R
Slovenia	R	R	NR	R	NR	NO	R	NO	NO	NO	NO	NO	R	R	R
Spain	R	IE	NR	NR	NR	NO	R	NO	NO	NO	NE	NE	IE	R	R
Sweden	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
United Kingdom	R	R	R	R	R	R	R	NO	R	R	R	NO	R	R	R
Iceland	R	R	R	NR	R	R	R	NO	R	R	NE	NE	NO	NO	NO
Cropland Management															
Denmark	R	R	NO	NO	R	R			R		R		NO	NO	NO
Germany	R	R	IE	IE	R	R			R		R		NO	NO	NO
Ireland	R	IE	NO	NO	R	NO			NO		IE		NO	R	R
Italy	R	R	NO	NO	R	R			NO		R		R	R	R

Country	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	AGB	BGB	Litter	Dead wood	Soil		HWP	Fertilization	Drained, rewetted and other soils		Nitrogen mineralization in mineral soils	Indirect N_2O emissions from managed soil	Biomass burning		
					Min	Org		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
Portugal	R	R	R	NO	R	NO			NO		R		R	R	R
Spain	R	IE	NR,R	NR	R	NO			NO		NE,R		NO,R	IE,NO, R	IE,NO, R
United Kingdom	R	IE	NR	NR	R	R			R		R		NE,NO	R	R
Grassland Management															
Denmark	R	R	NO	NO	R	R			R		R		NO	NO	NO
Germany	R	R	IE	IE	R	R			R		R		NO	NO	NO
Ireland	R	IE	NO	NO	R	NO			NO		IE		NO	R	R
Italy	R	R	NO	NO	R	R			NO		R		R	R	R
Portugal	R	R	R	NO	R	NO			NO		R		R	R	R
United Kingdom	R	IE	NR	NR	R	R			R		R		NE,NO	R	R
Revegetation Management															
Romania	R	R	R	R	R	NO		R	NO	NO	R	R	R	R	R
Iceland	R	IE	IE	NO	R	NO		R	NO	NO	IE	IE	NE	R	R
Wetlands Drainage and Rewetting															
United Kingdom	NR	NR	NR	NR		R		NE	R	R		NE	NE	NE	NE

Notation keys: R – carbon stock changes or GHG emissions from other sources are reported; NR – the pool is not reported (mainly under assumption of "not a source"); NE – removals/emissions are not estimated; IE – included elsewhere; NO –not occurring; NA – not applicable.

11.1.3 Areas reported under the KP-LULUCF activities (KP CRF table NIR-2)

Total land area reported under KP-LULUCF activities by EU MS, UK and Iceland is about 252.000 kha, which is approximately 55% of the total area reported under the Convention (Table 11.3).

The activity that covers the largest area is Forest Management (61%), followed by Cropland Management (21%), Grazing land Management (12%), Afforestation/Reforestation (4%) and Deforestation (1%), while Revegetation and Wetlands Drainage and Rewetting together cover less than 1% of the area reported under the KP.

With the exception of Belgium, Finland, Netherlands, Romania, and Sweden all individual GHG inventories report larger areas under Afforestation/Reforestation than under Deforestation. Consequently, forest area reported under KP increases over time.

Regardless of specific activities, most of the area under the KP accounting is reported by Spain, Germany, Sweden, Italy, France, UK. The largest area under AR, and D is reported by France, and the largest under FM is reported by Sweden. For CM and GM, respectively Spain and UK report the largest area.

Table 11.3 Synthesis of total area (kha) reported under KP-LULUCF activities by EU MS, UK, and Iceland in the CRF table NIR-2. Grey cells indicate that the activity has not been elected.

Country	Art. 3.3 activities		Art. 3.4 activities					TOTAL
	AR	D	FM	CM	GM	RV	WDR	
Austria	247,00	80,65	3.805,29					4.132,94
Belgium	24,53	26,04	678,97					729,54

Country	Art. 3.3 activities		Art. 3.4 activities					TOTAL
	AR	D	FM	CM	GM	RV	WDR	
Bulgaria	313,61	6,23	3.621,10					3.940,94
Croatia	63,86	4,75	2.320,30					2.388,91
Cyprus	9,69	1,10	142,77					153,55
Czech Republic	67,39	19,19	2.608,28					2.694,86
Denmark	109,32	13,74	530,80	2.859,34	182,98			3.696,17
Estonia	55,81	31,63	2.394,33					2.481,77
Finland	205,50	459,06	21.616,53					22.281,08
France	2.337,71	1.118,18	20.625,22					24.081,12
Germany	315,59	135,31	10.692,70	13.532,17	7.200,11			31.875,88
Greece	34,25	5,81	1.247,69					1.287,74
Hungary	175,92	43,76	1.878,37					2.098,04
Ireland	330,60	20,65	446,05	740,00	4.222,55			5.759,85
Italy	2.078,28	66,25	7.445,59	8.999,81	3.554,25			22.144,18
Latvia	118,52	97,86	3.125,08					3.341,46
Lithuania	54,78	5,40	2.160,75					2.220,93
Luxembourg	9,05	5,98	87,15					102,18
Malta	NO,NA	NO,NA	0,07					0,07
Netherlands	47,47	81,36	304,70					433,54
Poland	793,24	29,44	8.645,89					9.468,56
Portugal	635,88	385,62	3.733,69	2.344,18	589,50			7.688,87
Romania	32,97	378,07	6.953,81			102,07		7.466,92
Slovakia	50,09	9,02	1.977,01					2.036,12
Slovenia	NO,NA	26,96	1.148,20					1.175,16
Spain	1.262,80	127,79	14.421,94	20.186,22				35.998,74
Sweden	338,65	341,74	27.865,35					28.545,74
EU	**9.712,53**	**3.521,58**	**150.477,60**	**48.661,71**	**15.749,39**	**102,07**		**228.224,87**
United Kingdom	598,59	80,87	2.969,37	4.773,71	14.616,25		30,21	23.069,01
Iceland	48,52	0,06	93,90			322,07		464,56
EU +UK+ Iceland	**10.359,64**	**3.602,52**	**153.540,87**	**53.435,43**	**30.365,64**	**424,14**	30,21	**251.758,44**

11.1.4 Summary overview of key categories for KP-LULUCF activities (KP CRF table NIR-3)

Information included in Table 11.4 relies on the information reported by EU MS, UK and Iceland in CRF table NIR-3. However, in some cases the information was taken from the NIR because, as explained by some countries during the EU QA/QC procedures, remaining open issues in the CRF Reporter prevented the provision of this information in table NIR-3.

Table 11.4 Synthesis of KP-LULUCF activities being key category as reported by EU MS, UK and Iceland (from table NIR-3). “KC” indicates a key category.

Country	Art. 3.3 activities		Art. 3.4 activities				
	AR	D	FM	CM	GM	RV	WDR
Austria	KC	KC	KC				
Belgium	KC	KC	KC				

Country	Art. 3.3 activities		Art. 3.4 activities				
	AR	D	FM	CM	GM	RV	WDR
Bulgaria	KC	KC	KC				
Croatia	KC	KC	KC				
Cyprus	KC	KC	KC				
Czech Republic			KC				
Denmark			KC	KC	KC		
Estonia	KC	KC	KC				
Finland	KC	KC	KC				
France	KC	KC	KC				
Germany	KC	KC	KC	KC	KC		
Greece			KC				
Hungary	KC	KC	KC				
Ireland	KC		KC		KC		
Italy	KC	KC	KC	KC	KC		
Latvia	KC	KC	KC				
Lithuania	KC	KC	KC				
Luxembourg	KC	KC	KC				
Malta	----	----	----				
Netherlands	KC	KC	KC				
Poland			KC				
Portugal	KC	KC	KC	KC	KC		
Romania	KC		KC			KC	
Slovakia	KC		KC				
Slovenia		KC	KC				
Spain	KC	KC	KC	KC			
Sweden	KC	KC	KC				
UK	KC	KC	KC	KC	KC		KC
Iceland	KC		KC			KC	

11.1.5 Summary of net emissions and removals (kt CO_2 eq.), and accounting quantities for KP-LULUCF activities (KP CRF table "Accounting")

Tables 11.5 and Table 11.6 show respectively: (i) reported net emissions and removals, and (ii) accounted quantities, for individual EU MS, UK and Iceland for each of the KP activities; and the sum for total EU and total EU plus UK plus Iceland, when relevant.

The total net accounted amount at EU level, as reported so far for the KP CP2 by EU MS in the accounting tables is: -975.809,52 CO_2eq. With the addition of UK and Iceland the total net accounting results in a net sink of -1.015.932,81 CO_2eq. These values should be considered with caution, because a number of technical corrections to FMRLs still need to be implemented. Moreover, the cap value could be implemented in some countries.

Emissions from Deforestation offset about 70% of the removals accounted in Afforestation/Reforestation. By far, the largest contributors to emissions from deforestation are France and Romania that are responsible of about 50% of total GHG emissions from this activity in (see table 11.6)

Tables 11.5 Net emissions and removals (kt CO_2eq.) from KP-LULUCF activities for the period 2013-2019, as reported by EU MS, UK and Iceland. Based on MS CRF accounting tables

Country	Net emissions (+) and removals (-), kt CO_2eq.													
	Art 3.3 activities													
	A.1 AR							**A.2 D**						
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
AUT	-2.017,55	-2.031,47	-2.065,27	-2.098,48	-2.142,54	-2.181,59	-2.208,35	536,48	524,77	518,33	511,89	505,45	499,01	492,56
BEL	-193,38	-188,34	-183,30	-183,28	-175,54	-167,80	-152,15	239,10	238,43	237,76	537,84	543,92	550,02	531,49
BGR	-1.812,12	-1.978,16	-2.131,07	-2.295,26	-2.457,34	-2.625,30	-2.779,95	161,13	74,70	210,58	177,67	189,35	86,59	243,29
HRV	-88,52	-97,35	-136,05	-235,24	-186,69	-276,66	-279,30	43,57	25,27	55,78	26,14	20,27	19,18	55,26
CYP	-37,75	-42,98	-41,64	-36,77	-37,55	-35,29	-33,64	0,82	0,70	0,58	0,47	0,37	0,26	0,15
CZE	-494,66	-527,48	-543,96	-550,21	-562,31	-537,31	-504,64	252,97	250,44	197,28	237,74	263,32	149,81	177,56
DNM	-121,17	-240,01	-309,59	-306,94	-368,95	-520,43	-643,36	181,03	292,45	793,91	700,65	178,21	558,74	365,36
EST	-284,32	-283,74	-278,14	-291,73	-301,48	-286,58	-297,07	557,07	582,57	591,50	620,19	582,24	521,15	425,77
FIN	-693,55	-784,50	-781,59	-770,57	-507,55	-688,18	-898,15	4.236,13	4.090,96	3.828,52	3.631,42	3.466,87	3.443,84	3.434,85
FRA	-13.875,80	-13.979,30	-13.396,03	-14.787,91	-15.161,24	-15.725,30	-16.028,61	11.686,86	11.787,51	11.888,19	11.988,90	12.089,65	12.190,43	12.291,24
DEU	-795,27	-878,19	-962,35	-206,71	-333,07	-458,97	-582,45	1.121,53	1.125,48	1.131,43	1.612,64	1.623,33	1.634,01	1.643,14
GRC	-135,85	-146,89	-124,41	-138,41	-80,13	-126,17	-121,46	47,33	47,28	44,90	56,17	52,39	52,39	45,65
HUN	-1.275,55	-1.142,10	-1.218,76	-1.212,81	-1.302,10	-1.241,58	-1.108,06	164,25	197,55	261,10	329,06	363,72	424,77	425,75
IRL	-4.375,35	-4.090,23	-4.263,03	-4.336,30	-4.090,41	-3.963,89	-3.875,22	1.065,06	261,00	1.346,10	361,97	283,02	275,87	266,54
ITA	-7.989,34	-8.402,02	-8.862,63	-8.421,57	-5.213,09	-7.876,56	-9.018,10	1.942,32	1.953,16	1.963,94	1.973,97	1.975,96	1.984,30	1.994,32
LVA	-179,72	-194,04	-208,47	-222,67	-240,60	-254,47	-272,98	1.057,97	811,63	841,85	872,01	902,28	932,20	961,86
LTU	-215,60	-236,40	-271,41	-334,37	-291,31	-420,30	-408,15	206,31	271,58	27,39	165,62	85,27	1.354,05	557,32

Country	Net emissions (+) and removals (-), kt CO_2eq.													
	Art 3.3 activities													
	A.1 AR							**A.2 D**						
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
LUX	-179,71	-176,68	-173,63	-170,55	-167,45	-164,33	-161,18	46,94	44,74	42,53	40,33	38,13	35,92	33,72
MLT	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NLD	-602,28	-602,92	-603,02	-602,68	-605,33	-613,22	-620,87	1.086,74	1.126,51	1.167,57	1.209,71	1.250,67	1.291,88	1.333,29
POL	-2.206,59	-2.183,41	-2.250,99	-2.510,13	-1.545,39	-2.362,47	-2.451,45	946,87	936,68	1.027,77	5.571,86	1.876,48	1.892,64	1.911,60
PRT	-3.345,99	-3.585,76	-3.446,93	-2.866,49	-581,41	-3.177,70	-3.318,61	2.123,71	2.100,48	2.079,17	2.064,35	2.074,64	1.988,40	1.959,41
ROU	-497,66	-498,57	-492,44	-490,34	-481,79	-482,05	-476,71	4.567,35	4.520,55	4.492,32	4.443,06	4.394,00	4.335,31	4.279,70
SVK	-443,28	-462,92	-497,16	-523,25	-543,92	-565,20	-576,43	42,22	61,37	59,33	27,89	55,67	109,33	39,34
SVN	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	231,83	232,12	232,80	234,02	235,72	236,61	238,16
ESP	-8.211,82	-7.909,25	-7.289,35	-6.793,93	-6.095,10	-5.639,39	-5.163,58	640,43	637,77	634,17	632,95	632,31	631,57	631,70
SWE	-1.176,00	-1.125,15	-1.001,43	-1.054,45	-1.084,17	-1.076,08	-1.104,60	2.961,57	3.189,86	4.321,76	2.756,37	2.940,00	3.301,16	3.293,81
EU	**-51.248,84**	**-51.787,88**	**-51.532,66**	**-51.441,04**	**-44.556,47**	**-51.466,80**	**-53.085,06**	**36.147,60**	**35.385,56**	**37.996,55**	**40.784,89**	**36.623,23**	**38.499,45**	**37.632,85**
UK	-994,23	-1.332,96	-1.644,70	-1.986,58	-2.312,44	-2.565,05	-2.836,43	1.407,98	1.422,75	2.017,35	1.803,17	1.465,09	1.904,58	2.224,20
ISL	-184,01	-204,41	-224,86	-244,46	-281,30	-309,73	-356,10	0,16	0,11	0,65	0,25	0,47	0,46	0,46
EU+UK+ISL	**-52.427,07**	**-53.325,25**	**-53.402,22**	**-53.672,07**	**-47.150,20**	**-54.341,59**	**-56.277,59**	**37.555,74**	**36.808,42**	**40.014,54**	**42.588,31**	**38.088,78**	**40.404,49**	**39.857,51**

Country	Net emissions (+) and removals (-), kt CO_2eq.						
	Art. 3.3 activities						
	A2 FM						
	2013	2014	2015	2016	2017	2018	2019
AUT	-3.502,32	-3.694,11	-3.540,10	-3.388,43	-3.917,74	-4.123,36	-3.610,36
BEL	-2.014,29	-1.993,03	-2.046,45	-2.019,95	-1.958,82	-1.686,38	-1.677,97
BGR	-8.031,45	-8.086,47	-8.249,31	-7.825,21	-8.029,27	-8.013,43	-7.953,02
HRV	-7.095,25	-6.994,27	-6.334,54	-6.312,20	-5.531,39	-6.066,02	-6.251,14
CYP	-140,71	-141,29	-139,69	96,51	-143,78	-135,30	-151,83
CZE	-7.703,15	-7.595,95	-6.809,66	-5.700,67	-3.429,89	4.663,38	14.060,97
DNM	-3.373,57	-3.829,93	-3.857,83	-2.992,49	-2.405,21	-1.805,34	-1.949,08
EST	-5.425,57	-3.608,51	-4.636,40	-4.686,46	-4.006,99	-2.853,74	-2.783,14
FIN	-46.368,63	-45.164,93	-40.245,37	-37.700,82	-35.039,64	-26.708,62	-32.181,49
FRA	-53.391,21	-46.882,66	-43.139,86	-43.810,31	-41.232,81	-38.934,22	-38.684,96
DEU	-61.712,37	-65.186,63	-63.399,42	-65.276,33	-65.554,30	-63.715,44	-61.245,62
GRC	-1.964,66	-1.964,66	-1.953,56	-1.922,38	-1.972,54	-1.999,72	-1.900,30
HUN	-1.457,09	-3.029,36	-3.622,70	-2.769,43	-3.316,26	-2.787,05	-3.517,41
IRL	-1.455,28	-782,56	-1.137,40	-702,66	-415,72	-861,95	-1.212,73
ITA	-30.321,65	-31.346,82	-32.564,96	-29.527,89	-13.759,68	-24.878,84	-31.081,26
LVA	-6.630,87	-945,38	-2.729,87	-1.869,39	-3.105,95	-2.337,11	-2.867,62
LTU	-9.126,88	-8.102,16	-7.137,03	-5.986,49	-5.849,73	-5.788,46	-5.458,71
LUX	-433,83	-352,82	-296,86	-386,94	-277,37	-94,94	-215,25
MLT	NO	NO	NO	NO	NO	NO	NO
NLD	-1.233,46	-1.202,21	-1.140,50	-1.140,35	-1.093,67	-1.048,19	-1.024,25
POL	-42.608,87	-35.363,05	-31.478,23	-37.864,30	-37.922,50	-37.953,85	-17.653,84
PRT	-6.979,64	-8.879,91	-8.137,03	-4.505,12	7.632,77	-6.104,17	-7.075,59
ROU	-35.582,61	-36.534,60	-35.759,18	-36.629,96	-34.935,54	-32.357,04	-32.599,28
SVK	-7.036,28	-5.094,34	-5.648,42	-5.468,23	-5.385,22	-4.566,14	-5.157,62
SVN	-4.436,63	1.495,92	1.510,34	1.596,79	1.625,62	1.579,58	395,73
ESP	-28.050,35	-28.890,58	-29.678,00	-29.682,94	-30.286,18	-30.794,51	-30.033,38
SWE	-44.017,51	-43.194,96	-42.410,19	-45.631,49	-44.053,32	-42.802,51	-42.949,84
EU	**-420.094,13**	**-397.365,26**	**-384.582,21**	**-382.107,17**	**-344.365,14**	**-342.173,38**	**-324.778,99**
UK	-18.474,10	-18.110,24	-17.619,59	-17.272,86	-16.797,63	-16.036,88	-15.454,60
ISL	-81,26	-84,58	-88,30	-92,02	-93,73	-94,03	-90,63
EU+UK+ISL	**-438.649,50**	**-415.560,08**	**-402.290,10**	**-399.472,05**	**-361.256,50**	**-358.304,28**	**-340.324,21**

Country	Net emissions (+) and removals (-), kt CO_2eq.							
	Art. 3.4 activities							
	B.3 CM							
	1990	2013	2014	2015	2016	2017	2018	2019
DNM	5.196,33	2.158,10	3.220,22	2.186,46	2.335,04	1.933,61	3.171,76	2.827,46
DEU	13.682,29	15.862,12	15.706,99	16.529,98	17.183,20	17.069,15	17.565,62	17.271,51
IRL	23,69	42,36	4,51	-5,82	-38,95	-39,11	-125,18	-104,37
ITA	863,76	-2.283,25	-2.578,34	-3.503,61	-5.367,09	-5.126,76	-4.879,14	-5.009,57
PRT	3.352,83	349,36	357,85	356,54	357,55	401,23	357,45	373,35
ESP	-144,01	1.595,87	66,10	-2.315,29	-2.779,03	-3.202,28	-3.300,30	-3.350,12
EU	**22.974,89**	**17.724,58**	**16.777,34**	**13.248,25**	**11.690,71**	**11.035,83**	**12.790,21**	**12.008,26**

Country	Net emissions (+) and removals (-), kt CO_2eq.							
	Art. 3.4 activities							
	B.3 CM							
	1990	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
UK	22.274,22	17.411,71	17.219,91	17.126,05	17.010,91	16.943,92	16.811,75	16.793,24
EU+UK	**45.249,12**	**35.136,29**	**33.997,24**	**30.374,30**	**28.701,63**	**27.979,75**	**29.601,95**	**28.801,50**

Country	Net emissions (+) and removals (-), kt CO_2eq							
	Art. 3.4 activities							
	B.3 GM							
	1990	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
DNM	2.371,07	1.810,94	1.953,75	1.992,16	2.117,88	2.058,79	2.186,44	2.152,21
DEU	26.915,56	19.695,12	19.490,23	18.505,71	19.085,79	18.922,97	18.208,74	18.166,03
IRL	6.985,27	6.535,75	6.723,92	6.522,13	6.517,05	6.722,61	6.655,73	6.653,46
ITA	115,77	-769,26	-1.183,49	-845,01	-933,11	-542,41	-573,89	-639,91
PRT	1.442,75	42,07	22,47	-40,04	-100,13	-148,56	-132,21	-149,53
EU	**37.830,41**	**27.314,62**	**27.006,87**	**26.134,95**	**26.687,49**	**27.013,40**	**26.344,80**	**26.182,27**
UK	1.162,78	1.900,74	1.907,86	1.896,18	1.890,88	1.883,32	1.869,00	1.857,98
EU+UK	**38.993,19**	**29.215,36**	**28.914,73**	**28.031,13**	**28.578,36**	**28.896,72**	**28.213,80**	**28.040,24**

Country	Net emissions (+) and removals (-), kt CO_2eq.							
	Art. 3.4 activities							
	B.3 RV							
	1990	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
ROU	-1.698,59	-1.195,48	-1.197,79	-1.219,07	-1.249,45	-1.269,68	-1.280,80	-1.278,64
ISL	-386,76	-608,60	-615,04	-622,37	-595,87	-598,64	-615,50	-603,13
EU+ISL	**-2.085,35**	**-1.804,08**	**-1.812,83**	**-1.841,44**	**-1.845,32**	**-1.868,32**	**-1.896,31**	**-1.881,77**

Country	Net emissions (+) and removals (-), kt CO_2eq.							
	Art. 3.4 activities							
	B.3 WDR							
	1990	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
UK	345,15	284,29	284,09	284,09	282,91	282,73	271,02	270,68

NE – removals/emissions are not estimated; IE – removals/emissions are included elsewhere; NO – removals/emissions are not occurring; NA – MS does not account for the activity.

Table 11.6 Cumulated accounting quantities for 2013-2019 of KP-LULUCF activities as reported by EU MS, UK and Iceland (Kt CO_2eq), based on CRF accounting tables.*

Country	**Accounting quantity**							
	Article 3.3		**Article 3.4**					**Accounting amount on LULUCF activities (RMUs)**
	AR	**D**	**FM**	**CM**	**GM**	**RV**	**WDR**	
Austria	-14.745,26	3.588,49	-20.925,42					-32.082,19
Belgium	-1.243,77	2.878,55	-5.913,89					-4.279,11
Bulgaria	-16.079,20	1.143,32	-538,17					-15.474,05
Croatia	-1.299,81	245,47	-6.895,64					-7.949,97

Cyprus*	-265,62	3,35	-756,09					-1.018,36
Czech Republic	-3.720,56	1.529,12	20.287,04					18.095,60
Denmark	-2.510,45	3.070,36	-22.498,13	-18.541,65	-2.325,33			-42.805,20
Estonia	-2.023,07	3.880,49	-8.813,81					-6.956,38
Finland	-5.124,09	26.132,58	-43.581,51					-22.573,03
France	-102.954,19	83.922,78	13.228,97					-5.802,44
Germany	-4.217,02	9.891,57	-326.040,10	21.412,55	-56.334,31			-355.287,32
Greece	-873,32	346,11	-2.340,63					-2.867,83
Hungary	-8.500,96	2.166,21	-12.318,02					-18.652,78
Ireland	-28.994,43	3.859,55	960,84	-432,41	-2.566,22			-27.172,67
Italy	-55.783,31	13.787,97	-26.558,68	-34.794,07	-6.297,46			-109.645,55
Latvia	-1.572,93	6.379,80	11.704,06					16.510,93
Lithuania	-2.177,54	2.667,55	-9.131,45					-8.641,45
Luxembourg	-1.193,54	282,31	-403,78					-1.315,00
Malta	NO	NO	0,00					0,00
Netherlands	-4.250,34	8.466,38	-427,63					3.788,42
Poland	-15.510,43	14.163,89	-50.913,64					-52.260,17
Portugal	-20.322,89	14.390,16	-9.822,69	-20.916,50	-10.605,16			-47.277,08
Romania	-3.419,57	31.032,28	-133.847,22			3.199,22		-103.035,29
Slovakia	-3.612,16	395,15	-12.526,26					-15.743,27
Slovenia	NO,NA	1.641,26	25.964,34					27.605,60
Spain	-47.102,42	4.440,89	-45.715,94	-12.277,00				-100.654,46
Sweden	-7.621,88	22.764,54	-75.459,11					-60.316,46
EU	**-355.118,75**	**263.070,13**	**-743.282,56**	**-65.549,07**	**-78.128,48**	**3.199,22**		**-975.809,52**
United Kingdom	-13.672,38	12.245,11	-3.264,89	-36.602,08	5.066,49		-456,22	-36.683,96
Iceland	-1.804,86	2,55	-85,20			-1.551,81		-3.439,33
EU +UK+ Iceland	**-370.596,00**	**275.317,79**	**-746.632,65***	**-102.151,16**	**-73.061,99**	**1.647,41****	**-456,22**	**-1.015.932,81**

Information on EU-KP-LULUCF activities presented here is shown for information purpose. It is important to note that each country will account for net emissions/removals for each activity under Article 3(3), and 3(4) if elected, by issuing removals units (RMUs) or cancelling KP units based on own reported quantities. The EU will neither issue, nor cancel units based on the reported emissions and removals from KP activities.

**Cyprus did not included information on FMRL and TC for the year 2019 in its CRF tables. The lack of this information distorts the final accounting quantities of the FM activity for Cyprus and subsequently for the EU. During the QAQC procedure implemented by the EU Cyprus informed that this information will be added next year. Until this information is provided any assessment on accounting quantities for FM added in the EU GHG inventory should bear in mind this issue. It should be noted that because the EU CRF tables must be compiled by direct aggregation of the CRF tables provided by the countries the tables of the EU include in this document unavoidably this issue. This will be corrected in the next year submission.*

*** The accounting quantity for Revegetation should consider information from 1989 as the base year used by Romania. However, the CRF Reporter Software does not allow the EU to work with two different base years (i.e., Iceland 1990 and Romania 1989). As a result, although the table above shows the real sum of the two countries for RV, the CRF table accounting of the EU does not display correct information on the accounting quantity.*

11.1.6 Definition of forest and any other criteria

The threshold values applied to define a land as forest under the KP by EU MS, UK and Iceland are summarized in Table 11.7.

With an exception, threshold values and definitions applied for reporting forest areas under the KP are identical to those used to report forest area under the Convention. Finland applies 0.5 ha. as minimum forest area under KP, whereas two different values are used for reporting forest land under the Convention i.e., 0.25 ha in Southern and 0.5 ha in Northern Finland.

Table 11.7 Threshold values applied to define "forest" under the Kyoto Protocol.

Country	Minimum crown cover (%)	Minimum height (m)	Minimum area (ha)	Minimum width (m)
Austria	30	2	0.05	10
Belgium	20	5	0.5	--
Bulgaria	10	5	0.1	10
Croatia	10	2	0.1	20
Cyprus	10	5	0.3	--
Czech Republic	30	2	0.05	20
Denmark	10	5	0.5	20
Estonia	30	2	0.5	--
Finland	10	5	0.5	20
France	10	5	0.5	20
Germany	10	5	0.1	--
Greece	25	2	0.3	--
Hungary	30	5	0.5	10
Ireland	20	5	0.1	20
Italy	10	5	0.5	--
Latvia	20	5	0.1	--
Lithuania	30	5	0.1	--
Luxembourg	10	5	0.5	--
Malta	30	5	1.0	--
Netherlands	20	5	0.5	30
Poland	10	2	0.1	10
Portugal	10	5	1.0	20
Romania	10	5	0.25	20
Slovakia	20	5	0.3	20
Slovenia	30	2	0.25	--
Spain	20	3	1.0	25
Sweden	10	5	0.5	10
United Kingdom	20	2	0.1	20
Iceland	10	2	0.5	20

Only few countries provided explicit definitions on what is considered a natural forest. The vast majority of countries reported that conversions of natural to planted forests do not take place in their territories, based on the fact that (i) any natural forest is under strict protection (e.g., Czech Republic), or mainly, because (ii) there are no natural forests within the national territories.

When definitions are provided, natural forests are considered as those matching the definition of primary forests used by FAO (e.g., Finland), or forest lands with specific silvicultural features related to age, stand structure, species compositions, etc., (e.g., Estonia). In some case, natural forests are defined by exclusion from what is defined as planted forest (e.g., Hungary).

11.1.7 Information on how definitions of each activity under Article 3(3), and each mandatory and elected activity under Article 3(4) have been implemented and applied consistently over time.

Lands subject to KP activities have been generally identified considering that since the entire national territory is subject to direct anthropogenic influence, all lands under a specific land use category have to be reported in the corresponding direct human-induced activities. For instance, some countries considered "human-induced" AR any expansion of forest areas since 1990 (see following chapters for more details). Most of the countries considered all national pre-1990 forest area to be subject to management and, therefore, associated to FM activity. Only in few cases, countries do not include the entire forest area under KP LULUCF activities, e.g. Greece reports under FM and AR only one third of its forest land area.

Consistency of the land representation systems (i.e., identification and tracking of lands) is ensured with the use of the same activity definitions along the time series and data sources. Some countries have also performed comparison and internal verification exercises of activity data with other national datasets, to ensure the consistency (e.g., Finland compared AR and D data generated from NFI with statistics from the forest authority).

In addition, identification and tracking of lands also contributed to the consistency of the KP reporting with the reporting of the land use categories under the Convention and with the KP reporting under the first commitment period (CP1). Both, countries that elected to account for voluntary activities under the CP1, and those that did not elect to account for any voluntary activity under the CP1 and or CP2, started the reporting of the current CP looking into the activity data and the land use matrix underlying the already stablished reporting of lands under the Convention and under the CP1. In terms of reporting, the CP2 did not lead to a start from scratch, countries faced the new reporting requirements of the CP2, but they continued looking backward to the areas reported during the CP1 and implementing the same approaches to assign the unit of lands and their changes so that ensuring the consistency and that a unit of land that was accounted for during the CP1 continues being accounted for during the CP2.

The implementation of checks during the first years of the CP2 to detect discontinuities, along with the checks implemented currently to ensure the consistency of the time series, also contributed to address the requirement of ensuring that a unit of land that is accounted for during the CP1 is also accounted during the CP2. Emphasis was also given to ensure that a land "once Kyoto, always Kyoto".

11.1.8 Description of precedence conditions and/or hierarchy among elected Article 3(4) activities, and how they have been consistently applied in determining how each land has been classified.

According with the good practices, countries that have elected voluntary activities under Article 3(4) (see Table 11.1) have established a hierarchy among activities, in some cases driven by intensity of the human intervention, which ensures that there is not double accounting of lands. In general, the highest hierarchy is assigned to CM followed by GM and RV. The activity WDR is by definition at the lowest level.

All national systems ensure that once a unit of land has been accounted for under any KP activity, it has consistently tracked and accounted for in subsequent years. To this purpose, countries implement methods to avoid double counting (or omission) of lands under different activities (i.e., based on repeated field assessments and remote sensing products). In addition, also the implementation of a hierarchy among mandatory and elected activities ensures a consistent classification of lands.

The CRF table NIR-2 implicitly fulfills the obligation to demonstrate that emissions by sources and removals by sinks resulting from activities elected under Article 3(4) are not accounted for under Article 3(3) activities. To this regard, the consistency in the time series is checked every year during the QA/QC procedures, to ensure that: (i) the total area reported in NIR-2 table is constant over time and matches the official country area; and (ii) the total area for each activity “at the end of the current inventory year”, as reported for the year X-1, is the same to “total area at the end of the previous inventory year” reported for the year X.

11.2 Land-related information

11.2.1 Spatial assessment unit used for the determining the area of the units of land under Article 3(3)

For each national submission, the spatial assessment unit applied for identifying and tracking lands under Afforestation/Reforestation and Deforestation, as well as for Forest management, is in line with the thresholds value of minimum area, and minimum width (if applicable), used to define forest. This ensures that no land, defined as forest, and subject to direct human-induced activities, is left aside from the accounting.

11.2.2 Methodology used to develop the land transition matrix.

Areas of KP-LULUCF activities have to be consistent with areas of correspondent land categories reported under the Convention. This is an issue subject to annual QA/QC checks implemented by the JRC before the final version of the EU inventory is compiled.

The land transition matrix reported under the Convention (CRF table 4.1) and the one reported under KP (CRF table NIR-2) allow checking the consistency of the reported areas for land categories and KP activities across the time series.

Annual areas for KP activities are estimated by EU MS, UK and Iceland either based on extrapolation or interpolation of available datasets at different times (e.g., remote sensing products), or based on annual estimates provided by specific land surveys (i.e., sampling grids, subsidies records, land registries/cadaster). Sometimes, inventory compilers also combine several data sources involving expert judgment (e.g., Italy’s assumption that conversions to forest can only occur from grasslands).

A synthesis of the methodologies for land identification and tracking of lands is provided in Table 11.8. For more detailed information on data sources and methods applied by the countries, their individual national GHG inventories should be consulted.

Table 11.8 Methodologies for land identification and tracking of lands subject to KP- LULUCF activities by the EU MS, UK and Iceland

Country	Methods			Land identification and tracking features for the "lands" or "units of lands"
	NFI	Mapping by Earth Observations methods	Land registry systems, including surveys	
Austria	X			Statistical methods
Belgium	X	X		Statistical methods
Bulgaria	X			maps and forest management plans
Croatia	X	X		Statistical methods
Cyprus		X		CORINE Land Cover Maps
Czech Republic			X	Wall-to-wall mapping approach
Denmark	X	X		Statistical methods
Estonia	X			Statistical methods
Finland	X	X		Statistical methods
France			X	Statistical methods
Germany	X	X		Wall-to-wall mapping approach
Greece			X	Afforestation registry and Land Use Change Database
Hungary			X	Statistical methods
Ireland	X			Statistical methods, Land Parcel Information System and Central Statistics Office analysis of Utilized Agricultural Area (CL and GM)
Italy	X		X	Statistical methods
Latvia	X			Statistical methods
Lithuania	X	X		Wall-to-wall mapping approach (ARD) and statistical methods (FM)
Luxembourg		X		Geoprocessing based on successive land use maps
Malta		X		Malta use mainly CLC product to assess areas subject to KP
Netherlands	X			Wall-to-wall approach
Poland	X		X	Statistical methods
Portugal	X	X		Wall-to-wall maps
Romania	X		X	Statistical methods
Slovakia			X	Statistical methods
Slovenia	X			Statistical methods
Spain		X	X	Wall-to-wall approach
Sweden	X			Statistical methods
United Kingdom			X	National planting statistics (AR) multiple sources (D), agricultural census data and countryside survey data (CM,GM), and research program (WDR)
Iceland	X	X		Statistical methods

11.2.3 Maps and/or databases to identify the geographical locations, and the system of identification codes for the geographical locations.

The majority of inventories reported a single geographical boundary at country level (Table 11.9), although in some cases, underlying data might provide information at higher spatial disaggregation. On the other hand, some inventories report two (e.g., Finland) or more geographical boundaries (e.g., Italy, and UK) that often correspond to administrative regions and that are summed up in CRF tables to provide a total national value.

According to the availability of data and resources (Table 11.8), the individual inventories rely on various methods and approaches to identify and track lands under Article 3(3) and Article 3(4) of the KP. Generally, the data sources used for the identification of KP-LULUCF activities are the same, or in line with those, used under the Convention; nevertheless, because of specific requirements existing under the KP, in some instances, countries have implemented dedicated projects aimed to collect additional information that allow to comply with KP reporting requirements.

Reporting method 1 is based on the use of grid-based assessments, usually with Approach 3 or sometimes Approach 2 with supplementary information. Most of the national systems rely on the grid of their National Forest Inventories to identify and track lands under AR, D and FM, very often complemented by remote sensing datasets (specially to derive 1990), so most of the countries apply reporting Method 1 and Approach 3 (being this approach the only one that allow tracking lands across time) or approach 2 plus additional information to allow tracking lands.

National systems using Approach 3 may rely also on land parcel identification system (e.g., as used for subsidy payments or licensing), which allow recording and tracking individual parcels in time and space since the onset of the subsidized activity and for which the information is, in some cases, in digital format (e.g., in Ireland). Such systems are supported by adequate verification procedures at the country level as they are under public funding. Additional information when Approach 2 is used is taken from license database, payment scheme database, forest management planning related databases, or expert judgment.

Reporting Method 2 is used in only few cases, when, each single area subject to a KP activity is identified and tracked, usually, based on a geographical information system with wall-to-wall datasets derived from remotely sensed data.

Table 11.9 Information on reporting methods and approaches used for reporting KP activities (based on the information available in NIRs)

Country	Reporting Method used for identifying geographical locations of lands
Austria	1
Belgium	1
Bulgaria	1
Croatia	1
Cyprus	1
Czech Republic	1
Denmark	1
Estonia	1
Finland	1
France	1
Germany	2
Greece	1
Hungary	1
Ireland	2
Italy	1
Latvia	1
Lithuania	2
Luxembourg	1
Malta	1
Netherlands	2
Poland	1
Portugal	1
Romania	1 (FM,D) / 2 (AR)
Slovakia	1
Slovenia	1
Spain	1
Sweden	1
United Kingdom	1
Iceland	1

11.3 Activity-specific information

11.3.1 Methods for carbon stock change and GHG emissions and CO_2 removal estimates

Methods used for estimating emissions and removals related to Article 3(3) and Article 3(4) activities are consistent with those used for reporting carbon stock changes and non-CO_2 emissions in the corresponding land use categories under the Convention. In Chapter 6, methods and datasets used are described for each of the relevant land use categories and country. In addition, more detailed information on such methodologies can be found as an annex to this report (Annex III) and in the individual GHG inventories.

11.3.2 Description of the methodologies and the underlying assumptions used.

Information used to estimate carbon stock changes under ARD & FM.

The main data source used for reporting carbon stock changes in ARD and FM activities are the national forest inventories carried out by the countries. In few cases, annual net CO_2 emissions and removals are modeled based on non-NFI data (i.e., modeling based on yield tables and age-classes distribution from plantation plans and other available national statistics). Carbon stock changes from mineral soils associated with any conversion to and from forest lands are estimated by modeling or by using the IPCC default methodology together with country-specific reference carbon stocks values. When these activities occur in organic soils, the resulting GHG emissions are estimated using country-specific factors or in very few cases with IPCC default factors.

The reporting of carbon stock changes in litter, dead wood, and mineral soils carbon pools was improved considerably in the last years, as proven by the reduced number of countries using notation keys for these carbon pools in the current inventory.

The range of the implied carbon stock change factors reported for AR (Table 11.10) is similar to the one reported in the Convention tables for land converted to forest land. Among inventories, there are notable differences on the net biomass increment that are due to the type of species, climatic conditions, and other specific silvicultural characteristics (e.g., non-uniform rate of harvesting, different management practices). One additional reason for large differences is the use of either time averaged or actual annual growth data, depending on the methodology applied by the inventory compilers.

Slovenia reports that there is not AR in its territory, and Malta neither AR nor D. Some other countries reported the notation key (NE, NO or NA) for carbon pools for which it was demonstrated the absence of net emissions under the “not a source” provision (Table 11.17), or when AR (or any other activity) does not occur under organic soils.

The EU has devoted, and is still devoting, efforts to enhance the harmonization of the use of notation keys among countries, however some differences on which notation key have to be used when the “not a source” provision is implemented, still remain across submission. Partly due to different recommendations on the correct notation key to be used that have been received by the EU MS from the UN ERTs.

Table 11.10 Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under AR activity by EU MS, UK and Iceland (for the year 2019), based on KP CRF tables.

AR						
Country	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Austria	0,98	0,27	0,74	0,02	0,43	NO,NA
Belgium	1,00	0,20	NO,NA	NO,NA	0,49	NO,NA
Bulgaria	2,71	NO,IE	0,40	NO,NA	-0,61	NO
Croatia	0,86	0,38	0,22	0,02	-0,24	NO,NA
Cyprus	0,55	0,16	0,25	NO	0,01	NO
Czech Republic	1,15	0,22	0,43	0,02	0,22	NO
Denmark	0,18	0,23	0,41	0,02	0,18	-1,30
Estonia	0,79	0,31	0,30	0,01	0,17	-0,34

AR						
Country	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Finland	1,27	0,35	IE,NA	IE,NA	0,10	-1,01
France	1,18	0,48	0,16	0,02	0,04	NO,IE
Germany	0,16	-0,06	0,47	0,00	0,19	-2,57
Greece	0,82	0,15	NE,NA	NE,NA	NE,NA	NA
Hungary	1,31	0,34	NE,NA	0,07	NE,NA	NO,NA
Ireland	1,91	0,42	0,47	0,51	0,10	-0,75
Italy	0,88	0,18	0,01	0,01	0,11	NO,NA
Latvia	0,39	0,10	0,08	0,09	NO,NA	-0,52
Lithuania	1,40	0,27	0,09	NO	0,46	-0,74
Luxembourg	3,56	0,72	0,22	0,07	0,29	NO
Malta	NO	NO	NO	NO	NO	NO
Netherlands	3,15	0,45	NO,NE	0,10	0,01	-1,01
Poland	0,75	0,22	NO,NA	NO,NA	-0,09	-0,68
Portugal	1,09	0,10	0,04	NO,IE	0,17	NO
Romania	2,86	NO,IE	0,04	NO,IE	1,13	NO,IE
Slovakia	1,25	0,28	0,42	NO,NA	1,20	NO,NA
Slovenia	NA	NA	NA	NA	NA	NA
Spain	0,85	IE,NA	0,05	0,02	0,22	NO,NA
Sweden	0,65	0,22	0,21	0,03	-0,07	-2,31
United Kingdom	1,38	0,46	0,07	0,15	-0,62	-1,27
Iceland	1,21	0,30	0,14	NO,NA	0,41	-0,37

Notation keys for all tables below: IE – included elsewhere i.e., included in other pools. NO – not occurring e. NA- not applicable, NE-not estimated (the MS using NE, NA, NO justify these pools as being "not a net source" or negligible; or that the activity does not take place in organic soils).

The use of several notation keys under a single carbon pool is due to the aggregation system of the CRF tables. See CRF table of the concerned country for more clarification.

Under Deforestation, there is a rather full reporting of carbon pools (Table 11.11) where estimations are based on country-specific data. A particular case is Malta that did not report areas of Deforestation.

Moreover, some countries also used notation keys under Deforestation. For instance, when carbon stock changes for a certain pool have been already included in the estimation of other carbon pool due to the methodology used to derive carbon stock changes (e.g., below-ground biomass include as part of above-ground biomass, or litter estimated along with SOC), as it is the case for the use of "IE" by Finland, Spain, UK, and Romania.

Furthermore, also notation keys are also used when Deforestation does not take place in organic soils.

Finally, the notation key NA, as a second notation key in the cell, is a matter of the aggregation implemented by the CRF Reporter that adds to the summed-up value also the notation key "NA" when this refers to "*Deforested land previously reported under afforestation/reforestation and forest management and subject to natural disturbances".* This applies to other similar tables.

Table 11.11 Implied carbon stock change factors (tC ha-1yr-1) by pool reported under D activity in EU MS, UK and Iceland (for the year 2019), based on KP CRF tables.

D						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Austria	-0,61	-0,15	-0,48	0,00	-0,37	NO,NA
Belgium	-3,46	-0,67	-0,19	-0,05	-1,11	NO,NA
Bulgaria	-6,85	NO,IE	-1,07	-0,47	-2,09	NO
Croatia	0,43	-0,07	-0,03	-1,77	-1,56	NO,NA
Cyprus*	0,14	0,04	-0,16	NO	-0,12	NO
Czech Republic	-1,72	-0,37	-0,22	-0,07	-0,13	NO,NA
Denmark	-0,21	-0,51	-0,57	-0,05	-0,39	-8,40
Estonia	-1,48	-0,35	-0,59	-0,07	-1,03	-1,55
Finland	-0,52	-0,15	IE,NA	-0,01	-0,28	-4,72
France	-1,53	-0,42	-0,20	-0,03	-0,71	NO,IE
Germany	-1,34	-0,07	-0,92	-0,10	-0,35	-5,08
Greece	-0,14	-0,05	-0,09	-0,01	-1,71	NO,NA
Hungary	-1,15	-0,28	-0,46	-0,14	-0,55	NO
Ireland	-0,23	-0,04	-0,02	-0,01	-0,26	-0,96
Italy	-2,67	-0,56	-0,16	-0,08	-4,63	NO,NA
Latvia	-0,29	-0,15	-0,36	-0,50	-0,21	-4,17
Lithuania	-9,29	-2,20	-1,11	-0,49	-12,43	-25,10
Luxembourg	-0,63	-0,15	-0,13	-0,04	-0,52	NO,NA
Malta	NO	NO	NO	NO	NO	NO
Netherlands	-2,81	-0,38	-1,05	-0,08	0,09	-2,36
Poland	-1,14	-0,26	-0,30	-0,03	-1,87	-1,00
Portugal	-0,28	-0,04	-0,04	IE	-0,94	NO
Romania	-1,69	IE,NA	-0,15	IE,NA	-1,23	NO,NA
Slovakia	-0,85	-0,19	-0,08	-0,05	-0,01	NO,NA
Slovenia	-0,81	-0,12	-0,11	-0,07	-1,09	NA
Spain	-1,01	IE,NA	-0,07	-0,03	-0,21	NO,NA
Sweden	-1,10	-0,37	-0,40	0,00	-0,64	-2,06
United Kingdom	-2,60	IE,NA	-0,87	IE,NA	-1,63	-0,95
Iceland	NO,IE,NA	NO,IE,NA	NO,IE,NA	NO,IE,NA	-0,62	-7,87

* *The values of IEF reported by Cyprus are not correct. Cyprus must report in its CRF table 4(KP-I)A.2 values for "losses" which are currently nor reported. . This issue has been identified during the QAQC checks implemented at Union level and communicated to Cyprus who has informed to be working on the solution of this issue. However, it should be noted that because the EU CRF tables must be compiled by direct aggregation of the CRF tables provided by the countries the accounting value provided by the EU in its submission includes for the moment the value provided there by Cyprus.*

With regard to FM (Table 11.12), notation keys are more widely used for reporting carbon pools, than under AR and D. Mineral soils, litter and dead wood carbon pools when reported are mainly estimated to be a net sink of carbon under FM. Organic soils are always reported as a net source whenever drainage took place in such areas. UK report this pool as a carbon sink estimated using a model.

In addition, as reported in Malta's NIR, removals and emissions from FM were not estimated following a recommendation of its UN Expert Review Team during their in-country review. In view of this, since Malta is limited to two forest reserves, where the forest cover is almost at maturity and where therefore carbon stock losses are offset by carbon stock gains, so that, without considering the indirect impacts as the fertilization effect due to nitrogen deposition and the increasing CO_2 concentration in the atmosphere, their long-term carbon stock balance can be assumed at equilibrium.

However, Malta has informed that new information to report and update Forest Management activity has been gathered and will be used to report estimates in this category. For the time being, Malta has also stated that no controlled burning is allowed in those reserved forest, and moreover, no wildfires have occurred in those areas, from which emissions could have been omitted.

Concerning the reporting of carbon pools for agricultural activities (Table 11.13, Table 11.14), biomass is reported mainly as a net source of emissions under GM and as a net sink under CM. By contrary, mineral soils are mainly reported as a net sink under GM and as a net source under CM.

Italy uses the not a source provision for reporting DOM under CM and GM explaining that the pools are not estimated on the basis that either DOM stocks are insignificant (annual crops) and consequently any change is insignificant too or that DOM stocks are at equilibrium (perennial crops) and therefore that carbon stock changes are insignificant. Furthermore, considering that agricultural practices following European Union policies are increasingly more sustainable and climate change oriented, and that the area of annual and perennial crops is decreasing across time any comparison among GHG fluxes in the base year and in the CP´s years results in a net sink so that the DOM pools cannot be a net source.

With regards to WDR, the UK has reported for first time information on carbon stock change in this activity.

Table 11.12. Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under FM activity in EU MS, UK and Iceland (for the year 2019), based on MS CRF tables.

FM						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Austria	0,252	0,029	NO,NE,IE,NA	0,060	-0,183	NO,NA
Belgium	0,632	0,068	NO,NA	NO,NA	NO,NA	NO,NA
Bulgaria	0,463	NO,IE	NO,NA	0,039	NO,NA	NO
Croatia	0,527	0,125	NE,NA	NE,NA	NE,NA	NO,NA
Cyprus	0,232	0,065	NO	0,003	NO	NO
Czech Republic	-1,338	-0,290	NO,IE	0,012	NO,NE	NO
Denmark	0,431	0,091	0,453	0,068	NO,NA	-1,302
Estonia	0,102	0,024	NA	0,011	0,188	-0,176
Finland	0,230	0,026	IE,NA	IE,NA	0,136	-0,178
France	0,350	0,153	0,001	-0,021	0,001	IE
Germany	0,886	0,158	-0,013	0,095	0,410	-2,570
Greece	0,332	0,118	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NA
Hungary	0,376	0,094	NO,NA	NO,NA	NO,NA	-2,600
Ireland	1,005	0,167	0,012	-0,203	-0,055	-0,448
Italy	0,893	0,180	0,003	0,002	NO,NE,NA	NO,NA
Latvia	0,309	0,077	0,002	0,040	NO,NA	-0,518
Lithuania	0,619	0,147	0,004	0,039	NO,NE,NA	-1,476
Luxembourg	0,458	0,101	0,000	0,115	0,000	NO
Malta	NO	NO	NO	NO	NO	NO

FM						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Netherlands	0,851	0,153	NO	0,056	NO	-0,921
Poland	0,769	0,018	NO,NA	NO,NA	0,100	-0,680
Portugal	0,399	0,163	-0,002	NO,IE	-0,006	NO
Romania	1,061	NO,IE,NA	0,003	NO,NA	0,067	-0,680
Slovakia	0,467	0,161	NO,NA	NO,NA	NO,NA	NO,NA
Slovenia	-0,067	-0,268	NO,NA	0,184	NO,NA	NO,NA
Spain	0,533	NO,IE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NA
Sweden	0,242	0,079	-0,103	0,072	0,155	-0,342
United Kingdom	0,428	0,129	0,027	0,308	0,462	0,296
Iceland	0,194	0,050	0,006	NO,IE,NA	0,015	-0,370

Table 11.13 Implied carbon stock change factors (tC ha^{-1}yr^{-1}) by pool reported under CM activity in EU MS and UK (for the year 2019), based on MS CRF tables.

CM						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Denmark	0,002	-0,005	NO	NO	-0,003	-6,408
Germany	-0,007	0,001	NO,IE	NO,IE	-0,108	-8,634
Ireland	-0,003	IE	NO	NO	0,042	NO
Italy	-0,016	-0,007	NE	NE	0,201	-9,985
Portugal	0,015	-0,003	-0,001	IE	-0,046	NO
Spain	0,028	IE	0,000	NO	0,019	NO
United Kingdom	0,014	IE,NA	NA	NA	-0,615	-7,966

Table 11.14 Implied carbon stock change factors (tC ha^{-1}yr^{-1}) by pool reported under GM activity in EU MS and UK (for the year 2019), based on MS CRF tables.

GM						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Denmark	-0,1432	-0,0033	NO	NO	0,1278	-6,6471
Germany	-0,0930	0,0041	NO,IE	NO,IE	0,5054	-6,9797
Ireland	-0,0005	NO,IE	NO	NO	0,1356	-6,7616
Italy	NO	NO	NE	NE	0,0491	NO
Portugal	-0,0060	-0,0058	0,0008	IE	0,1005	NO
United Kingdom	-0,0112	IE,NA	NA	NA	0,1834	-0,7308

Table 11.15 Implied carbon stock change factors (tC ha^{-1}yr^{-1}) by pool reported under RV activity in EU MS and Iceland (for the year 2019), based on MS CRF tables.

RV						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Romania	3,24	IE	0,00	NO	0,17	NO
Iceland	0,06	IE	IE	NO	0,51	NA

Table 11.16 Implied carbon stock change factors (tC ha^{-1}yr^{-1}) by pool reported under WDR activity in UK (for the year 2019), based on its CRF tables.

WDR						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
United Kingdom	NO,NA	NO,NA	NO,NA	NO,NA	-3,37	-1,11

Information used to estimate direct and indirect N_2O emissions from N fertilization (4(KP-II)1)

Only few countries report fertilization of mature forests (e.g., Sweden) or young plantations (e.g. UK). For the majority of them, fertilization of forests is not a common practice, or if any, N_2O emissions are expected to be extremely low, and are in any case captured and reported under the Agriculture sector. For instance, the last occurs in cases when a country is not able to separate fertilizers applied to forest lands from those applied in agriculture (e.g., a unique total national value is available from national statistics).

Information used to estimate CH_4 and N_2O emissions from drained and rewetted organic soils (4(KP-II)2)

Total EU area of drained organic soils on forest related activities for which emissions are reported is about 8,000 kha, which occurs mainly in Finland and Germany. Emissions are estimated based on IPCC default factors or country-specific factors, but in any case, estimation methods are consistent with those used to report under Convention.

In general, most of the drainage area is associated with agricultural activities. Therefore, in the CRF table 4(KP-II) 2, most of the reported values refer to countries that elected to account for CM or GM and that report estimates of CH_4 emissions. Moreover, their associated CO_2 emissions are reported in the background activity table together with carbon stock changes in other carbon pools, and N_2O emissions are reported under agriculture.

N_2O emissions from N mineralization/immobilization due to carbon loss/gain associated with land-use conversions and management change in mineral soils (4(KP-II)3)

N_2O emissions, from N mineralization, are expected to be reported for those counties for which a loss of soil carbon stock is reported under the KP activities. These emissions are mainly reported for Deforestation.

In some instances, acknowledging the need to report this source of emissions, some individual inventories have used the notation key NE in the CRF table 4(KP-II)3, along with an explanation provided in the NIR on the efforts that are ongoing to report this source of emissions in the coming years.

Information used to estimate GHG emissions from biomass burning (4(KP-II)4)

Estimation methods are consistent with those used to report emissions from biomass burning under the Convention. In general, monitoring systems on burned areas are not able to discriminate whether the fire occurred on AR lands or on lands subject to FM so that burnt areas are apportioned on the basis of their share on total forest areas.

In Europe, usually burned areas are protected by law, so that there is not the possibility of a land use change after a fire event. Accordingly, just in few cases GHG emissions from biomass burning are reported under Deforestation. Besides that, there are some emissions from biomass burning reported under this activity that relate to “controlled burning” as a management practice of forest residues.

A small share of total emissions from biomass burning under non-forest related activities is also reported in the CRF table 4(KP-II) 4.

11.3.3 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article (3.3) and elected and mandatory activities under Article (3.4)

A decision tree guiding the use of the “not a source” provision was elaborated by the JRC, and countries were encouraged to follow it whenever such provision is applied, in order to ensure that no underestimation of emissions occur. (http://forest.jrc.ec.europa.eu/activities/lulucf/workshops/).

Accordingly, during the EU QA/QC process, countries have been encouraged to use the notation key “NR” in CRF table NIR-1 for pools reported under the “not a source”. Further, it was requested to provide information, on the reasons for omitting carbon pools, in the CRF documentation box and in the NIR of the countries concerned. Table 11.17 summarized the demonstrations provided by the individual inventories for omitted carbon pools.

Table 11.17 Overview of information provided by EU MS, UK and Iceland to demonstrate that omitted carbon pools are not a net source of emissions.

Country	Activity	Reasoning
Belgium	AR (LT, DW) FM (LT, DW, SOCmin)	Consistent with tier 1 presented in IPCC 2006 Guidelines, section 2.3.2.2, it is assumed that afforestation results in buildup of litter and dead wood carbon pools, starting from zero carbon in those pools. DOM carbon gains on land converted to forest occur linearly, starting from zero, over a default transition period of 20 years. The litter and deadwood C stock is assumed stable in the case of forest management, with respectively 1,9 t /ha and 7,56 t C/ha. Consequently, no variation of the C stock for the DOM category is calculated for forest management. The UNFCCC review drew the attention to the fact that the carbon stock change applied for SOC appeared to be an outlier compared to other Parties. The SOC stock change reported by Belgium in the former submissions was the highest of all member states: 18 member States report no change in carbon stocks and the other present an extremely limited sink (or source for 2 MS). Only one Member State currently reports an annual change of the same order of magnitude. As a consequence, and considering that no recent information confirms that the drivers of the SOC change between 1960 and 2000 are applicable to the present forest, Belgium is revising its estimates for Soil carbon in this submission. In the absence of complete updated values from the regional forest inventories, it is deemed that the currently available data and studies do not allow the application of the average carbon stock change factor from 1960-2000 to the recent years, as it appears likely to overestimate the actual carbon stock change.
Bulgaria	AR (DW) FM (LT, SOCmin)	Deadwood is assumed not to occur on AR areas. Due to the young age of the forests at AR areas (since 1990) and the assumed lack of dead wood at areas of all other land uses it is assumed that a stock change of dead wood does not occur at AR areas. If there was any in the young forests of AR areas, it would represent a C stock increase due to the lack of dead wood in the previous land uses. So, the assumption is conservative. Bulgaria reports CSC in litter and SOC under Tier 1 (2006 IPCC Guidelines), where litter inputs and outputs are assumed to balance, and the pools therefore taken to be stable.

Country	Activity	Reasoning
Croatia	FM (LT, DW, SOCmin)	Data on wood removal from FRA reports (for 1990 FRA 2005 and for 2000 and 2005 FRA 2010) were compared to NIR data on fellings. The comparison indicated that not all wood was removed from the forest and that certain percentage (about 10-15%) was left in the forest; thus, contributing to a C input in other carbon pools. Reporting on wood removals under the FRA fits adequately to the wood removals practices conducted in Croatia that is performed in a way that harvest residues and wood less than 7 cm in diameter are left in the forest. Within the KP Forest management reporting, total gross fellings (i.e., including branches and bark) are reported. Considering latter, there are no underestimations in regard to dead wood. Furthermore, based on the available data on growing stocks and harvest which prove steadily increase in the standing stocks in Croatia (Table 11.3-5) while the forest management methods remain the same. Under such circumstances and due to the fact that mortality is correlated with stand density, also an increase in dead wood stocks is very likely, as indicated by the FRA results. Within the reporting period, there was no change in the forest management. At this moment in Croatia there is no expert and scientific literature or investigation the hypothesis soil pool under the Forest management is not a source of emissions. However, based on the data and information provided above that prove carbon stock increases in biomass, dead wood and litter pool, an increase in these pools is correlated with an increase of the C input to the mineral soil and consequently with an increase of carbon stock in soil. Consequently, it can be also assumed this pool is not a source of emission.
Czech Republic	FM (SOCmin)	It is assumed that, under the conditions of current forestry practices in the country and at the country-level scale, forest soils do not represent a net source of CO_2 emissions. Justification for this approach is based on the targeted peer-reviewed modelling analysis performed for the actual circumstances of FM in the country (Cienciala et al., 2008b). It uses the well-established YASSO soil model (Liski et al., 2003, 2005) in combination with the similarly well-known and established EFISCEN forest scenario model (e.g., Karjalainen et al., 2002) and the actual data for forest biomass, growth performance and growing conditions in the country. The analysis shows that, under the adopted sustainable forest management practices implemented in the Czech Republic, the forest soil carbon pool (including litter) does not decrease, i.e., it is not a net source of emissions. The study contains further details on the country-specific model application, definition of scenarios and results related to both biomass and soil carbon pools, including the probable effect of changing climatic conditions. It also contains a discussion that elucidates the aspect of the YASSO model concept of litter input and aggregated output for litter/organic and mineral soil layers and its justification, as well as the reasoning with respect to the Kyoto protocol LULUCF reporting requirements. There is a wealth of literature on YASSO model applications that can be further consulted (www.environment.fi/syke/yasso). To conclude, the forest soil carbon pool and inherently the litter carbon pool under current forest management practices and growth trends can be assumed not to be a source of emissions. The underlying assumptions will be further verified.
Denmark	FM (SOCmin) CM (LT, DW) GM (LT, DW)	Aboveground and belowground living biomass, litter and dead organic are only reported for perennial woody crops, in accordance with IPCC Supplementary GPG 2014. No litter and dead organic matter are reported under CM, as this is seen as not occurring, or as very insignificant because it only related to a small area with fruit plantations and hedges. Therefore, only above- and belowground living biomasses for perennial fruit plantations, edgerows and willow plantations for bioenergy purposes on agricultural land, are reported under CM. CL converted to other land uses, such as WE and SE, is assumed not to store litter and other dead organic matter. Christmas trees are reported under Forest Management
Estonia	FM (LT)	For FM Estonia does not have sufficient data regarding litter stocks, thus the Tier 1 method was implemented, assuming that carbon stocks are in equilibrium, therefore the changes in the litter pool are assumed to be zero. In ARR 2016 ERT recommended to obtain necessary data for litter pool. Estonia has an ongoing project to obtain litter stock data and more thorough explanation is added in Chapter 6.2.2.

Country	Activity	Reasoning
Greece	AR (LT, DW, SOCmin) FM (LT, DW, SOCmin)	Based on several studies SOC and DOM increase in AR. For FM, selvicultural practices promotes the carbon accumulation in both those carbon pools, which is even more justified by the fact that the living biomass pool in forest under management acts as a net sink. Consequently, the dead organic matter pool and mineral soils in soil organic matter pools in Greece cannot be a net source of carbon. Quantitative demonstration is also provided in the NIR.
Hungary	AR (LT, SOCmin) FM (LT, DW, SOCmin)	For FM and AR, Hungary does not explicitly quantify emissions and removals for three forest carbon pools, i.e. soil, deadwood and litter, but demonstrates that these pools are not a source. To demonstrate that soils are not a source, a conservative approach is taken based on the IPCC 2006GL methodology using country-specific and other data. The demonstration for DW and LI is based on expert judgment which is a practicable method in our situation. Further demonstration is included separately for FM and R in the NIR
Ireland	CM (DW, LT) GM /DW, LT)	Based on the decision tree in Section 2.9.4.1 of the 2013 KP Supplement to the 2006 IPCC Guidelines, and Section 5.2.2.4, Vol 4 of the 2006 Guidelines, changes in Litter and Dead Matter carbon pools are assumed to be stable. Changes in biomass associated with transitions between grassland and croplands within the CM cohort are estimated. Changes in the biomass of hedgerows, and other non-forest wood features, have not been estimated. Biomass changes due to changes in the area of perennial woody crops are based on the analysis of the dominant crops, apple orchards and Christmas trees. It the case of Christmas trees, there is evidence that the market for trees is stable or increasing over time, and as such the biomass associated with this crop is stable or increasing, See section 6.4.7. The area of apple orchard decreased in the early 1990s but has been in near equilibrium in recent years as shown in Figure 6.21. Hedgerows are an integral part of the CM landscape. However, there is very limited long-term monitoring data as to conditions and extent of these features. The EPA has funded a research project to pilot an analysis of historic and contemporary remote sensing data to establish a robust time series of changes in these landscapes.
Italy	FM (SOCmin) CM (DW, LT) GM (DW, LT)	In relation to CM and GM, Tier1 is applied for litter and deadwood pools: those pools are not estimated on the basis that either DOM stocks are insignificant (annual crops) and consequently any change is insignificant too or that DOM stocks are at equilibrium (perennial crops) and therefore that C stock changes are insignificant. Furthermore, considering that agricultural practices within the European Union policies are increasingly sustainable and climate-friendly (see figure 9.2) and that the area of annual and perennial crops is decreasing across time any comparison among GHG fluxes in the base year and in the CP-year's results in a net sink so that the DOM pools cannot be under any circumstances a net source. Following the main finding of 2011 review process, Italy has decided not to account for the SOC changes in mineral soils from activities under forest management, providing transparent and verifiable information to demonstrate that SOM in mineral soils is not a source, as required by par. 21 of the annex to decision 16/CMP.1.
Latvia	AR (SOCmin) FM (SOCmin)	According to the NFI conversions to forestland that can be classified as afforestation/reforestation take place only on grasslands. The soil monitoring study initiated in 2012 by the Joint stock company "Latvia state forests" and Ministry of Agriculture demonstrates no statistically significant difference in carbon stock in mineral soil in grassland, forest land remaining forest in fertile stand types and in afforested lands, i.e. no changes appear in soil organic matter (SOM) due to afforestation.
Lithuania	AR (DW) FM (SOCmin)	Based on NFI 1998-2011 data changes of dead wood are not significant in the afforested and reforested lands, as any dead wood in young forest stands usually are fine (trees from natural losses or thinning residues) and decay in one year. For estimation of carbon stock change of dead wood, it was assumed to be zero and reported as 'NO'. Not having proof of significant increase in mineral soils in forest land and having information that this pool is not a source, Lithuania has decided to be conservative and consequently not to account for this pool under FM
Malta	FM (LB, DW, LT SOCmin)	Considered in equilibrium following a recommendation of ERT during the in-country review.

Country	Activity	Reasoning
Netherlands	AR (LT) FM (LT, SOCmin)	The NIF provides an estimate for the average amount of litter (in plots on sandy soils only) and the amount of dead wood (all plots) for plots in permanent forests. The data provide the age of the trees and assume that the plots are no older than the trees. However, it is possible that several cycles of forest have been grown and harvested on the same spot. The age of the plot does not consider this history or any effect it may have on litter accumulation from previous forests in the same location. Therefore, the age of the trees does not necessarily represent the time since AR. This is reflected in a very weak relation between tree age and carbon in litter and a large variation in dead wood, even for plots with young trees. Apart from Forest land, no land use class has a similar carbon stock in litter (in Dutch Grassland, management prevents the built-up of a significant litter layer). The conversion of non-forest to forest, therefore, always involves a build-up of carbon in litter. But because good data are lacking to quantify this sink, we report the accumulation of carbon in litter for AR conservatively as zero.
Poland	AR (LT DW) FM (LT, DW)	When an area is afforested, first it is cleared of all above-ground biomass in case there was any, however, no DW and LI are usually present on these lands prior to afforestation. After afforestation, dead woody debris, litter as well as dead trees start to accumulate. In lack of representative measurements, the rate and timing of accumulation is not known, however, standard forestry experience suggests that they depend on species, site and silvicultural regime, and quickly accumulate over time. Fast growing species are usually planted so that no large amount of deadwood is produced, or thinned so that self-thinning does not ensue, but litter is continuously produced even in these stands. On the other hand, slow-growing species tend to produce dead wood and litter even at an early stage. Overall for all AR land, also considering that AR activity has been continuous since 1990 and stands on AR land are usually younger for deadwood and litter accumulation to saturate, it can safely be concluded that the carbon in the deadwood and litter pools in AR lands was increasing between 2008-2010, i.e. these pools are not a source. The above demonstration is based upon well-established principles of forest science, the every-day experiences of forestry practice, the experience and data of forest surveys, as well as sound reasoning.
Romania	FM (DW) RV (DW)	DW in Afforestation/Reforestation and Revegetation is reported as NR (as not occurring or it is considered as a very small sink since initial mass is null, then it could only increase in time, or in any case it cannot decrease). Litter becomes a measurable pool in AR lands in some 4 years since planting (sampled data is available from Romanian JI and national FORLUC project mentioned under AFOLU sector chapter), thus C stock change is estimated and reported. Instead, DW cannot be defined as a standing alone pool, also recalling that dead wood is considered under same definition and dimensional thresholds as in NFI. Nevertheless, by the age of 20 years old of stands, the dead trees barely occur caused by natural mortality and especially by competition. This should lead to a continually increasing number of dead trees, thus expected that inputs are larger than decomposition. With such argumentation, we can safely and conservatively assume that DW is not a net source of emissions on AR lands.
Slovakia	AR (DW) FM (LT, DW, SOCmin)	It can be demonstrating that DW carbon pool is not a source of CO_2 emissions. The evidence is based on increasing growing stock in Slovak forests published in the latest Slovak Green Report 2017 http://www.mpsr.sk/en/index.php?navID=17&id=67. The growing stock in forests is gradually increasing as indicated by trends and actual age structure of forests. On large temporal and spatial scales, the amount of deadwood is roughly proportional to the growing stock. The statistically representative empirical data from the second Slovak NFI, which will confirm this assumption, are under the evaluation. Slovakia has assumed that, under the conditions of current forestry practices at the country level, forest soils and litter do not represent a net source of CO_2 emissions. This assumption was confirmed by soil data analysis (Slovak ICP forests data) in 1993 and 2006 (Table 11.11). The results of statistical analysis have not confirmed the changes of soil C stocks in FM areas. A similar conclusion was obtained from comparison of carbon stocks

Country	Activity	Reasoning
		in litter. The litter C stock in 2006 were even found slightly higher compared the first evaluation (1993).
Slovenia	FM (LT, SOCmin)	For calculations of carbon stock changes in litter and soils “a pool is not a source” approach was used. According to this approach the net emissions/removals from litter and soils is balanced and therefore equal to zero. Results of our preliminary expertise for period 1996 – 2006 (Kobal and Simoncic 2011), show relative stable carbon stocks in litter in forest land remaining forest land. Estimates under FM for carbon stock changes in litter and soils were therefore not reported.
Spain	FM (LT, DW, SOCmin) CM (DW)	Regarding the forest's DW and LT deposits, at least in the inventoried period (1990-2018), the set of both deposits it has not been a source, but rather a sink. However, accurate quantification of the net fixation of C by the set of these two arrangements is not presented in this edition of the National Inventory, since the process of modifications is still in progress development.
United Kingdom	CM (DW,LT) GM (DW, LT)	Carbon stock changes on CM and GM are calculated using Tier 1 methodologies, therefore carbon stock changes in below-ground biomass, litter and dead wood are reported as Not Estimated (no guidance).
Iceland	AR (DW) RV (DW)	Change in the carbon stock of other vegetation than trees are omitted in this year’s submission. A research project where carbon stock in other vegetation than trees was measured on afforestation sites of different ages of larch plantations did show very low increase C-stock 50 years after afforestation although the variation inside this period where considerable (Sigurðsson, et al., 2005). Losses in Revegetation are not specifically detected. The losses are assumed to be reflected as changes in the C-pool estimates of NIRA. Potential losses include losses in revegetated area, due to changes in land use. Losses in C-pools through grazing, biomass burning, and erosion are also recognized as potential. These losses are expected to be detected in the current NIRA upgrade and will be reported in future submissions.

For a consistent demonstration of ‘not a source’, EU MS, UK and Iceland have been encouraged to avoid simple assumption of “equilibrium” following IPCC Tier 1 methods, but to demonstrate, based on qualitative information, reasoning and, to the extent possible, quantitative estimates from any available documentation (i.e., scientific papers, reports, etc.) that the omitted pool does not result in a net source of emissions.

11.3.4 Information on whether or not indirect and natural CO_2 removals have been factored out.

Because of the use of the “managed land” approach, which so far is the stipulated approach used for estimating emissions and removals from anthropogenic activities, individual inventories have not factored out from the reported estimates indirect and natural CO_2 removals. In most cases, they argued the lack of methods to do so, or that, due to the length of the reporting period, the magnitude of these removals is insignificant.

For FM, it is recognized that the issue of factoring out indirect removals from elevated carbon dioxide concentrations above pre-industrial levels, indirect nitrogen deposition, and the dynamic effects of age structure resulting from KP activities prior to 1 January 1990 is addressed in the accounting through the

FMRL. Indeed, it is expected that the effects of such processes on the emissions and removals occurring during the commitment period approximately cancel out in the accounting when the projected FMRL is compared to the reported FM estimates.

11.3.5 Changes in data and methods since the previous submission (recalculations)

An overview of the reasons for recalculation of inventory estimates is provided in table 11.18.

Table 11.18 Summary of information on changes and methods since the previous submissions (recalculations)

Country	Overview of reasons for recalculations
Austria	The HWP production figures for the years 2017 and 2018 were updated in the most recent FAO statistics. Consequently, the HWP removal figures for afforestation and forest management for the years 2017 and 2018 had to be updated accordingly and led to differences in annual HWP removals for Forest management of 2.25 and 30.58 kt CO_2e for these two years compared to the last submission in 2020. Furthermore, a correction made to the calculation of soil carbon losses due to increasing extent of forest roads (see chapter 6.2.4.2.3) increased net removals between 2013 and 2018 by a further 23 to 25 kt CO_2e as compared to the last submission in 2020. This increase is on top of the ca. 0.9 kt CO_2e increase in removals by Forest Manage-ment caused by the adjustments to total forest area described in chapter 6.2.2 that impact FM areas and the subsequent changes in the soil and litter carbon pools of FM.
Belgium	The HWP production figures for the years 2017 and 2018 were updated in the most recent FAO statistics. Consequently, the HWP removal figures for afforestation and forest management for the years 2017 and 2018 had to be updated accordingly and led to differences in annual HWP removals for Forest management of 2.25 and 30.58 kt CO_2e for these two years compared to the last submission in 2020. Furthermore, a correction made to the calculation of soil carbon losses due to increasing extent of forest roads (see chapter 6.2.4.2.3) increased net removals between 2013 and 2018 by a further 23 to 25 kt CO_2e as compared to the last submission in 2020. This increase is on top of the ca. 0.9 kt CO_2e increase in removals by Forest Manage-ment caused by the adjustments to total forest area described in chapter 6.2.2 that impact FM areas and the subsequent changes in the soil and litter carbon pools of FM.
Bulgaria	The HWP production figures for the years 2017 and 2018 were updated in the most recent FAO statistics. Consequently, the HWP removal figures for afforestation and forest management for the years 2017 and 2018 had to be updated accordingly and led to differences in annual HWP removals for Forest management of 2.25 and 30.58 kt CO_2e for these two years compared to the last submission in 2020. Furthermore, a correction made to the calculation of soil carbon losses due to increasing extent of forest roads (see chapter 6.2.4.2.3) increased net removals between 2013 and 2018 by a further 23 to 25 kt CO_2e as compared to the last submission in 2020. This increase is on top of the ca. 0.9 kt CO_2e increase in removals by Forest Manage-ment caused by the adjustments to total forest area described in chapter 6.2.2 that impact FM areas and the subsequent changes in the soil and litter carbon pools of FM.
Croatia	Since NIR 2020 following changes are made in Croatian KP Chapter: 1) Since the NIR 2014 and start of applying the Approach 3 in identification of ARD areas and determining the FM areas, some of the management plans and programs ceased to be valid and new plans/programs were developed. When developing new plans/programmes a due attention is given to the identification and traceability of forests that are result of human induced afforestation before 1990. When these areas are identified, changes in forest areas occur and these areas are registered and reported under the 1990 forest areas in corresponding NIR. The change in forest areas that comes from the forest areas defined under the two consecutive plans/programs led to the difference between areas reported under the FM areas in NIR 2020 and NIR 2021 too. For this year reporting, 8,176.42 ha of areas were identified as a result of human induced afforestation before 1990 and now this area was reported under the 1990 FM area. In addition, Croatia corrected mistake in adding the areas identified as human induced afforestation before 1990 in year 2018 (1,146.65 ha) in NIR 2020 by reporting this area now under the 1990 FM areas.
Cyprus	This is the first submission hence no recalculations are reported.

Country	Overview of reasons for recalculations
Czech Republic	Carbon stock estimate in living biomass was recalculated due to the rectified fraction of additional harvest residues (Fhl). This estimate of removals of solid wood and forest residues enter the estimation using a partitioning of 50% between the two woody components since this NIR submission. This represents a conservative estimate of extra harvest, which treats more adequately the unaccounted harvest loss, preventing double counting of forest residues associated with the reported harvest volumes from harvest statistics. The impact of this correction on carbon stock change in living biomass is 14% for the period 1990-2018 when data can be compared. Carbon stock change estimates for DOM: Data of the available statistical programs, i.e., NFI1 (2001-2004), NFI2 (2011-2015) were used to construct a revised trend line and estimate carbon stock change also for the previously missing years of the reporting period. This applies both for standing and lying deadwood components. Hence, this revision resulted in a complete data series for this subcategory. The updated estimates marginally changed emissions in this category, extending the estimates prior 2003 and beyond 2015 using the observed trend.
Denmark	A recalculation has been made for HWP for the whole timeseries because of a displacement in the timeseries. The estimation of annual change for the forest sector have been recalculated to ensure independent data in the estimation. This influences all parts of forest areas (afforestation, reforestation, deforestation and forest remaining forest). More detailes are given in Chapter 6.2.2.
Estonia	Areas subject to Afforestation/Reforestation, Deforestation and Forest management are updated annually by NFI, new data is integrated into the overall activity data. New method was applied for estimating carbon stock changes in biomass under the AR category; previously it was calculated on the basis of differences in the aggregate average growing stocks for the total AR area, but in the current submission C stock changes in the subcategories (CLtoFL, WLtoF, SLtoFL) are summed to obtain aggregate emissions. Also miscalculation errors were corrected, resulting in recalculations for dead wood and soil C pools in AR and D categories.
Finland	The areas of Article 3.3 activities and Forest Management were recalculated. The areas were recalculated because new NFI data were available, also new remote sensing data for updating. The new AD estimates induced the recalculations of time series for gains and losses in living tree biomass as well as carbon stock changes in DOM and SOM pools. For the tree growth under the forest management, a recalculation was applied due to the new NFI data, also new BCEFs were applied to estimate the gains in living biomass. Due to the recalculation of activity data and biomass stocks to calculate litter input, also time series in carbon stock changes of mineral and organic soils were recalculated. For losses in living biomass, a recalculation was applied due to an update in the statistics of natural mortality and wastewood and an update of allocation of harvesting between mineral and organic soils based on the NFI data. The amount of collected energy wood based on the energy wood use statistics was reallocated to better coincide with the actual harvesting year, which affected the litter input to mineral soils. For more information about recalculations related to forest land see Section 6.4.5 and Appendix_6c.
France	The changes made to the results for the UNFCCC logically and directly impact the results in the Kyoto format. As a reminder, the main improvements relating to the forest are as follows: • The last campaign of the National Forest Inventory was not available in time for the update of the inventory, which explains why the values concerning growth and mortality in the forest could not be updated for the years. recent. Timber harvests, on the other hand, were able to be updated. • Wood energy consumption has been updated to be in line with the Energy Balance. • The forest balance in Guyana is now calculated by quantifying the losses linked to harvesting and the gains linked to post-harvest growth in the logging areas. Thus the principle, documented, of a reconstitution of stocks after withdrawals is maintained, but the calculation of gains and losses is made instead of an assumption of neutrality. For non-exploited areas, on the other hand, this hypothesis of neutrality is maintained. The total impact is therefore minimal. The burning of crop residues has been abolished in Guyana because it is considered inconsistent with local harvesting practices.
Germany	Significant inventory improvement measures that led to recalculations are: • Adaptation of the sample network to determine land use and Land use change (see Chapter 6.3.1ff) • Changed carbon emission factors for forest biomass and deadwood due to the update of the results of the 2017 carbon inventory. Method adjustments and data corrections were also made for previous Inventory periods adjusted to the EF. For the remaining forest, annual EFs were introduced for the biomass (see also Chapter 6.4.2.2 and Chapter 6.4.2.3). • Implementation of a new method for calculating emissions from organic soils as a function of the distance from the groundwater level (Chapter 0ff) • Modification of the method for surveying the areas of drainage trenches for organic soils (Chapter 6.1.2.2.1) • Introduction of a new method for calculating mineral soil emission factors as a result of changes in land use from / to settlements and the associated introduction of new emission factors (see Chapter 6.1.2.1.6)
Greece	In the current submission no specific changes have been made with regard to methodologies applied in comparison to the previous submission. The only recalculations performed in comparison to the previous submission refer to the 3.3 Afforestation/reforestation activity in 2016 as a result of the update (latest

Country	Overview of reasons for recalculations
	available EF) of the IEF used, and to 3.4 Forest Management activity for all years in the commitment period as a result to the update of the activity data in the FAO statistics database.
Hungary	Recalculations were made for all categories under the KP this year (Table 11.13). The reasons for this are the same or similar as those for the UNFCCC reporting. For other details, see Chapter 6.1.4. Partly due to these recalculations, a technical correction was made for the FM category
Ireland	Recalculations for the Article 3.3. ARD and 3.4 FM (CRF 4(KP) Recalculations also see sections 6.3.4.9, 6.3.5.9, 6.3.6.5, 6.3.7.3) are due to: Correction to levels of harvest in AR land since 2006 (see section 6.3.5.9 Chapter 6); New forest fire statistics (see section 6.3.7.3 Chapter 6). Other Recalculations for the 2019 submission are Cropland Management: - Refinement of the analysis of the LPIS spatial dataset; Further information on these recalculations is presented in section 6.4.11. Grazing land Management: - Revised assessment of land area statistics and management practices. Revised area of organic soils. Further information on these recalculations is presented in section 6.5.7
Italy	A comprehensive comparison of 2021 and 2020 submissions has been carried out; in table 9.9 a summary related to the ARD and FM activities is reported, while in table 9.10 the recalculation are shown for each carbon pool, with reference to the 2018 reporting year. The 2021 submission results, for AR activities, in a slight deviation for the Afforestation/Reforestation activities in 2018, due to the update of activity data harvest volume for some regions; no deviations for Deforestation activities, respect the previous estimates. A decrease of 4.0% results by the comparison of the last two submissions for FM activities, FOR 2018, mainly due to the revision of FAOSTAT time series for wood-based panels, industrial roundwood, sawnwood, paper and paperboard, production, import and export) used to estimate HWP emissions and removals.
Latvia	IImplementation of changes due to improvement of activity data by the NFI team, which leads to minor changes in the whole time series. The most significant changes in activity data are associated with transfer of lands converted to forest lands with signs of human induced afforestation (as soon as these signs, like tending, thinning, supplementary planting or legal conversion of land use in forest register, are identified by the NFI teams) from the forest management activity to afforestation activity. Recalculations are done for the whole time series starting from the year of afforestation.
Lithuania	Difference in total GHG removals from forest land resulted in adjustment of living biomass carbon stock change in forest land remaining forest land due to the newest growing stock volume data applied – extrapolated values in two latest years (for 2016 and 2017) were replaced with actual values. In addition to this adjustment, share of organic soils was updated using the most recent NFI (NFI 2014-2018) data, which resulted both in change of GHG emissions from drained organic soils and carbon stock changes in mineral soil of land converted to Forest land. In addition to this, correct value of litter carbon stock in Grassland previous to the conversion to Forest land was applied to estimate carbon stock change in dead organic matter of Land converted to forest land.
Luxembourg	No recalculations have occurred in the KP-LULUCF inventory since submission 2020.
Malta	No recalculations have occurred in the KP-LULUCF inventory since submission 2020.
Netherlands	New NFI statistics became available covering the period 2003–2012, and in the NIR 2021 a land-use map for 1970 was introduced, all resulting in recalculated historical data. Moreover, also new methodologies on calculating the carbon stock changes in forest land have been introduced since the adoption of the FMRL and new information on land-use change from using additional maps for the years 2013 and 2017 is used resulting in inconsistencies between the reported emissions and removals in FM and those included in the FMRL
Poland	All changes are caused by the change in activity data, for forest and forest management activity. In this submission, we have implemented a number of recalculations. The main reason for the recalculations is that we identified some minor calculation updates in the area of some categories. A few other recalculations were made due to some minor category-specific issues that are reported in the relevant sections.
Portugal	Recalculations have been made in the input variables: ▯ Burnt areas per land-use type 1990-2018, reflecting the latest information provided by ICNF (Institute for Nature Conservation and Forests) ▯ Harvest and HWP input data 2012-2018, reflecting the latest version of the UNECE/FAO Timber Products database.
Romania	The Forest land (FL) category area was recalculated for the entire time series due to a change of land use assessment system and by using the NFI forest area estimates. These changes are expected to generate recalculation in the next year also as the land identification system improves. The CO_2 removals, especially in the 4.A.1 category, increased due to the new emission factor applied for the whole period. For the net annual increment, wood density, and the ratio of BGB to AGB, the values were available for each group of species, age class, and yield class. As for the carbon fraction, new values from IPCC 2006 Volume 4, Chapter 4, Table 4.3 for broadleaves and conifers were applied.
Slovakia	The emissions/removals for FM activities were recalculated in 2021 submission. The whole time series were recalculated. The main reason for recalculation in FM was the correction of activity data - tree species composition value, in the case of other conifers on 1.10% in 2014 and on 1.06% in 2017.

Country	Overview of reasons for recalculations
	Recalculated CO_2 emissions/removals differ from the previous submission by -0.1% in 2014, 0.1% in 2017 in the Forest Management.
Slovenia	Considering ERT revision report and recommendations data and methodologies were internally revised, and recalculations were made.
Spain	The emissions / removals for the period 1990-2018 of this edition of the National Inventory of the LULUCF sector differ from those collected in the previous edition, due to changes in the available background information. See table 11.3.5
Sweden	The forest management reference level (with HWP) was recalculated to -32.8 Mt CO_2-eq. and the technical correction applied to the original value was estimated to 8.5 Mt CO_2-eq. Table 11.11 illustrates the differences in the different components included in the reference level.
UK	The net LULUCF emissions from the OTs and CDs changed compared to the previous inventory, with a reduction of 0.2 Mt CO_2e in the net source across the time series. This change is predominantly due to a correction in the emission factor used for calculating N_2O emissions from grassland wildfires, as previously the carbon monoxide factor was used in error. A small change in the carbon stock changes from Forest Land resulted from the move to a Tier 1 methodology for all territories and new activity data for land use and land use change in Guernsey. Harvested Wood Products are no longer reported for the OTs and CDs due to the move to Tier 1 reporting for Forestry which does not account for products. In previous inventories Harvested Wood Products had been modelled and reported for Isle of Man only. There is no publicly available data on the production of HWP in the Isle of Man.
Iceland	As explained in Chapter 6.5 and above in Chapter 10 are data on area in CF slightly revised. This will lead to revision on area dependent stock changes. Emission/removal factors used are unchanged Biomass carbon stock change estimates in Cultivated Forest for 2017 and 2018 have also been slightly revised on basis of new annual NFI data from 2019 and 2020. See further explanations in Chapter 6.5. above.

11.3.6 Improvement status and plan

The following improvements have been performed in order to correct errors and inconsistencies flagged during the internal QA/QC checks, or in order to address recommendations provided during the UNFCCC expert review:

- The table 11.2 and 11.17 and 11.23 were updated to reflect improvements introduced in the reporting of individual inventories.
- The text in sections 11.4.5 and 11.5.2.1 has been updated in line with current reporting by individual inventories.
- The completeness of the inventory has increase with the reporting by Romania of carbon stock changes from mineral soils under AR and FM.
- The completeness of the inventory has increase with the reporting by Poland of carbon stock changes from organic soils under Deforestation.
- The completeness of the inventory has increase with the reporting by UK of carbon stock changes in WDR.
- In this inventory the discrepancies among the information included in the CRF tables NIR-2 and background KP activity tables have been reduced as a result of the work done by the EU with its MS.
- In this inventory more individual inventories use the notation key ”NA” for pools where carbon stock changes are considered in equilibrium. However, others continue using in these cases the notation key NO or NA to follow the recommendation that they received from their UN, ERT.
- Table 11.6 includes information that explain why the accounting quantity in the EU CRF table accounting does not match the sum of the accounting quantities of Romania and Iceland.
- The FMRL value has been changed to match the value inscribed in the annex to the decision 2.Cmp/7. And accordingly, the text in section 11.5.2.2 has been changed.

Furthermore, the EU plans to continue devoting efforts to enhance the overall TACCC of the KP information with some further improvements and the correction of some identified issues for which a correction was not possible in this submission. In particular, the focus will be on:

- To continue tracking the consistency among the data reported within CRF tables NIR-2 and background KP activity tables to resolve some remaining inconsistencies reported by individual inventories that were not corrected on time for the submission of this inventory.
- To continue working with Malta for the mandatory KP activities.
- To continue supporting countries in the estimation and provision of information on Technical Corrections, and to ensure the consistency between the FMRL and the reporting of the activity FM.
- To continue working with Cyprus to ensure tat the information on FMRL and it TC is included in the corresponding CRF tables.
- To continue working with Cyprus to ensure that the reporting of carbon stock changes in Living biomass under Deforestation in CRF table (KP-I) A.2 includes "losses."

11.3.7 Uncertainty estimates

For information on uncertainties please refer to chapter 1.6

11.3.8 Information on other methodological issues

During the EU QA/QC process an important number of checks are implemented every year to ensure the accuracy, transparency, completeness, and consistency of the KP information included in the individual inventories. Focus is also placed on increase the comparability, and on improving the overall quality of the EU GHG inventory.

For instance, among many others, the consistency among the information submitted under the KP and the Convention is assessed every year in terms of methods, emission factors and activity data to ensure its consistency and discard potential issues. Also, many other checks are implemented to ensure that estimates are prepared by applying methodologies that are consistent with IPCC methods and adequate to the significance of the category or carbon pool that is being estimated. Detailed information on these QAQC procedures can be found in chapter 6.

11.3.9 The year of the onset of an activity, if after 2013

This information is implicitly achieved by each individual inventory, and consequently by the EU GHG inventory, through the provision of the estimates in the NIR-2 table. The onset of any activity on any land is reported according to the year when the land is reported as subject to the activity for the first time. Checks are also devoted to ensuring that once a unit of land is reported in such table, it continues to be reported in subsequent submissions.

11.4 Article 3(3)

11.4.1 Information that demonstrates that activities under Article 3(3) began on or after 1 January 1990 and before 31 December of the last year of the commitment period and are direct human induced.

Land representation systems implemented at national level are able to determine the onset for any KP activity along time series and starting from 1990 onwards.

For example, planting year is mentioned as the information used to assess the onset of AR activity (e.g., DNK, UK, GRC, IRL), or, the year when the encroaching woody vegetation meets the definition of forest, for instance in the case of natural-assisted afforestation, as detected by national forest inventories or remotely sensed products, that because are not often annually available are supported by interpolation/extrapolation techniques.

For D, information comes from annual direct assessments, for instance, when national statistics based on license for clear-felling are available; or datasets on land cover and land use compiled by sampling or wall-to-wall techniques with ground data and, or remotely sensed data. In the latter cases, as mentioned above, because data are not often annually available, interpolation/extrapolation techniques have to be involved. According to the IPCC, it is good practice to provide documentation to prove that all land reported under afforestation and reforestation are subject to direct human-induced activities. In this sense, relevant documentation provided in the individual inventories often includes forest management records or other documentation that demonstrates that a decision had been taken to replant or to allow forest regeneration by other means. Table 11.19 shows a synthesis of current information reported by EU MS and Iceland on the direct-human induced origin of reported AR lands.

Table 11.19 Summary of current information reported by EU MS, UK and Iceland aimed at demonstrating that Afforestation/Reforestation activities are direct human induced.

Country	Type of information/justification provided				
	Areas converted, either subject to subsidies or not, have been reported in registries either for authorization or compilation of land use changes	Whole national territory covered by legal instruments for Land planning and/or management, therefore any change in land use is directly human induced	Where a conversion results in a land use subject to management practice, the conversion is considered directly human-induced	As all land area is under management (i.e. subject to some kind of human interactions), all changes are considered as directly human-induced	A decision to change the use of a land or a decision not to continue the previous management practices has been made, which allow for conversion
Austria		X			
Belgium				X	
Bulgaria		X		X	
Croatia	X	X			
Cyprus				X	
Czech Republic	X	X			
Denmark				X	
Estonia				X	X
Finland	X			X	X
France			X		
Germany		X			
Greece	X				
Hungary	X				
Ireland	X	X		X	
Italy			X		
Latvia	X				
Lithuania		X			
Luxembourg			X	X	
Malta	--	--	--	--	--
Netherlands					X
Poland	X				
Portugal				X	
Romania	X				
Slovakia	X				
Slovenia		X		X	
Spain	X				
Sweden			X	X	
United Kingdom	X			X	
Iceland			X		

In general, a rather “broad” interpretation of “direct human-induced” AR is applied by most countries, so that around 90% of the total area reported under conversion to forest land is assumed as directly human-induced AR. However, some countries adopt some more stringent criteria. For instance, UK does not report under AR the areas of planting that are not state-owned or grant aided. If not included under AR, natural forest expansion has been reported by individual inventories under FM.

11.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation.

Although the loss of forest cover is often readily identified by the land monitoring systems, the classification of an area as deforested once the tree coverage has been removed, is more challenging. Individual inventories provided information on the criteria by which temporary removal or loss of tree cover can be distinguished from deforestation and how these criteria are consistently applied, see Table 11.20.

The simple combination of NFI data with remotely sensed data may not be fully adequate to assess the areas which can be classified as deforested, and thus these data are often complemented by other type of information. For instance, information on license that is typically required when a land use change occurs. Or in the absence of detailed information on the future use of the land, some countries defined an expected time period in years within which the removal of tree cover has to be followed by natural regeneration or planting, once such time period is passed and trees are not yet growing again on the land, the land is considered deforested.

On the other hand, most of the countries reported that there are legal obligations to restore the forest on harvested areas, or following wildfires, so that such kind of forest cover loss are never identified as deforestation.

Table 11.20 Information on differentiation between temporary forest cover loss and deforestation provided by EU MS and Iceland in their GHG inventories.

Country	Short description
Austria	In Austria temporarily unstocked areas (e.g., harvested area, disturbances) remain forests and are not accounted as deforestation. NFI teams are trained to distinguish between the results of forest management operations and Land Use Changes.
Belgium	It is assumed that forest has been planted and can be recognized on all areas that have been harvested or have been subject to other human disturbance but for which it was expected that a forest would be replanted. In this view no plantation is expected on areas identified as deforested. About one third of the deforested areas were replaced by settlements, for which no re-establishment of forest will occur. Each point identified by the geoprocessing tool as being subject to LUC is verified through photointerpretation to confirm the interpretation.
Bulgaria	Deforestation areas that followed all administrative steps needed to get the permission for deforestation. Only such areas are accounted as D areas in Bulgaria.
Croatia	The main criteria for distinguishing the harvesting or forest disturbance followed by the re-establishment of forest from deforestation is whether or not the land use has changed, which is strictly regulated by the legal framework.
Cyprus	This information is not yet available. The Forest Department is conducting a full inventory of forested areas which should be complete by 2020. This should give us the additional information needed to distinguish between forest disturbance and deforestation. Harvesting is not taking place extensively in Cyprus and no areas are clear-cut of forest as the common practice is the thinning of trees.
Czech Republic	The main criteria for distinguishing the harvesting or forest disturbance followed by the re-establishment of forest from deforestation is whether or not the land use has changed, which is strictly regulated by the legal framework.
Denmark	Deforestation is detected by analysis of satellite images. Furthermore, deforestation of larger areas is confirmed by e.g., projects on nature restoration. Temporarily unstocked areas are typically located within larger forest areas and will in most cases be reforested within a period of 10 years as according to the Forest Act of Denmark, which applies to all Legal Forest Reserves (Fredsskov) and equals approximately 70 % of the total forest area. Clear-cuts outside forests - e.g., small plantations of conifers on former cropland - is considered deforestation.
Estonia	According to Estonian legislation, the land category change by humans is allowed only with orders from local authorities and/or the Minister of the Environment. This must be preceded by the reassignment of the land (e.g. commercial, residential or transport land), which is reflected both in the Land Cadaster and Land Registry. When an NFI sample plot is located in a clear-cut area, the surveyor assesses whether the cutting has been done for regeneration purpose or for land-use change. Clear signs of a land-use change can be seen in the surrounding and location of the area; also, the data from Land Cadaster and Land Registry is checked. According to the Forest Act, the forest owner is obliged to implement reforestation techniques to the extent that within five years after logging or forest death a renewed forest is ensured. Re-establishment of a forest usually starts within 2 years after harvesting.
Finland	When a clear-cut area is located in an NFI sample plot, the surveyor assesses whether the cutting has been done for regeneration purpose or for land-use change. The distinction between these two cases can generally be made on a reliable basis. The distinction between these two cases can generally be made on a reliable basis.

Country	Short description
	Clear signs of a land-use change can be seen in the surroundings and location of the area: construction projects, stacked cutting residuals or if the area is under a regional or town plan. The re-establishment of a forest usually starts within two years after the harvesting. The Forest Act lays down provisions that a new forest must be established within three years after the regeneration cutting. In the case the land-use change occurs after a clear-cut, this can be considered by classifying the sample plot as non-forest.
France	The method used to monitor lands, works over two features, land use and land cover, therefore it is able to differentiate forest cover loss from deforestation.
Germany	Länder laws are to be enacted that set forth obligations for all forest owners whereby clear-cut or degraded forest areas are to be reforested, or replenished, in cases in which natural regrowth remains incomplete, within a reasonable period of time, unless conversion to another type of use has been approved or is otherwise permitted. In general, reforestation is called for on all forest areas that are to remain in use as forest land. That is a legal requirement, and it is the customary practice in the German forestry sector. Forest land that is temporarily unstocked thus continues to fall within the scope of required reporting on forest management pursuant to Art. 3.4 KP. The situation is different in cases in which forest land becomes unstocked and planning calls for subsequent use of the land to fall within the category "non-forest land". Such land is to be considered deforested land, with the relevant deforestation directly human-induced, regardless of whether the deforestation was caused by harvesting or by natural disturbances.
Greece	According to the national legislative framework the forest land use after any disturbance cannot be changed. More specifically in the cases of wildfire events, the areas affected, are instantly declared to be reforested by the responsible authority, which is the Forest Service, with this decision being published in the Official Government Gazette. Harvesting, either in public or private forests, is regulated through national laws (Presidential Degree No 126/1986) and regulations, according to which, specific, and discrete procedures have to be followed only after the authorization of the Forest Service.
Hungary	In Hungary, all forests must be regenerated after clearing mature stands by law. All AR and D areas, as well as those under regeneration are identified by categorizing forest compartments. These compartments have been surveyed since 1 Jan 2008 for all information that is relevant for assigning them to the respective Kyoto forest categories (AR or D and, in case of regenerations, FM), as well as their location within each geographical area. It is also possible to identify each compartment in both the underlying database of this report (which is part of the documentation) and on the forest management maps since 2008.
Ireland	NFI identifies if the lands are unstocked or deforested (5 years periodicity)
Italy	Extensive forest disturbances have been rare in Italy, except for wildfires. Land-use changes after damage do not occur; concerning wildfires, national legislation does not allow any land use change after a fire event for 15 years. Harvesting is regulated through regional rules, which establish procedures to follow in case of harvesting. Although different rules exist at regional level, a common denominator is the requirement of an explicit written communication with the localization and the extent of area to be harvested, existing forest typologies and forestry treatment. Deforestation is allowed only in very limited circumstances (i.e., in construction of railways the last years) and has to follow several administrative steps before being legally permitted. In addition, clear-cutting is a not allowed practice.
Latvia	In Latvia temporarily unstocked areas (e.g., harvested area) remain forests and are not accounted as deforestation if no other activities prohibiting forest regeneration are implemented. The NFI teams are trained to distinguish between forest management and land use changes.
Lithuania	According to Lithuanian Forest Law the clear-cut areas should be reforested for 3 years and are under strict control of forest management and State inspection. Temporarily unstocked areas after harvesting remain forests and are not accounted as deforestation. Every deforestation case must be reported to LSFC and is very rare. Any deforested area must follow the afforestation of three-time larger area than the one was deforested.
Luxembourg	Art 13 of the National Nature Conservation Act states that 3 years after a clear cut on forestland, the owner is pledged to reconstruct the forestland. This means that areas of forestland, where a clear-cut has occurred, has to be considered as forestland, as no other use of forestland after a clear-cut is permitted. In addition, after a period of three years, the owner is forced to take measures to restore forestland if it hasn't occurred already. So, no deforestation can occur by law, except if permitted by a ministerial act. If this is the case, this is documented by the Ministry.
Malta	No Deforestation is reported.
Netherlands	Following the Forest definition and the mapping practice applied in the Netherlands, areas subject to harvesting or forest disturbance are still classified as Forest and as such will not result in a change in land use in the overlay of the land-use maps (Kramer et al., 2009; Arets et al., 2016).
Poland	Since no remote sensing technology is directly involved in the KP LULUCF emission inventory, there is no issue related to distinguishing harvesting or forest disturbance from deforestation. Harvesting and forest disturbance always occur on forest land, while deforestation is a cadastral change of land use from forest land to other land use categories
Portugal	Some losses of forest cover are obvious deforestation events and are classified as deforestation as soon as they are detected (e.g. conversions to settlements, flooding by a recently constructed water reservoir, conversion to irrigated farmland). In other situations, the land use following forest cover loss is less obvious. In those situations, and consistent with the KP forest definition, land is considered as "temporarily unstocked" for a period of up to 5 years. After such period the land should be confirmed as forest land (i.e., no deforestation has occurred) or non-forest land. In the latter case the land is considered deforested and the time series for area of FM is recalculated since the year when the event was first detected.
Romania	The forest disturbance alone cannot trigger land conversions from forestland. Thus distinction between harvested and disturbance affected areas, on the one hand, and deforestation, on the other, is made as follows: for the former, there is legal obligation for the forest owner/administrator to maintain the land under forests

Country	Short description
	category and forestry regime (including tree harvest based on permit), to apply the forest management plans specifications and regenerate it within a given timeframe (maximum 2 years); for the latter, following legal procedure with the issuance of the approval, a new land use category is assigned to that land, and the forestry regime is no longer applicable.
Slovakia	The temporarily (no more than 2 years) unstocked areas (e.g., harvested area, disturbances) are still considered as forest area and are not accounted as deforestation. According to the cadastral law deforestation means that the category of forest land was definitely and permanently changed to another land use category.
Slovenia	Extensive forest disturbances have been rare in Slovenia. If a large forest area is mainly or totally damaged, the legislation on prevention of insect and fungus disturbances binds owners to remove the rest of the damaged trees. After that, the reestablishment work should be started immediately if possible. That areas remain registry as forest land in forestry spatial information system database.
Spain	After a disturbance, the land does not change its use. By other hand all deforested land is assessed on the basis of cartography where unless a change of the land use is detected, the land would continue to be considered as forest land.
Sweden	Final felling is a natural step in the rotation cycle of forestry. Also, storms may result in large areas of felled trees (wind-throws). If final felling or disturbances as storms have been identified between two consecutive inventories this is not enough to classify the plot as D. However, if for instance a new road, a power line or other land use preceding the definition of forest is located on the former Forest land, then the plot is considered D. The emission from "loss of biomass" is matched to the conversion year. If final felling has occurred on a plot between two consecutive inventories with no sign of D, but D is confirmed at the next re-inventory, then the year of D is "re-calculated" to match the "loss of biomass" to the conversion year.
UK	The data sources used for estimating Deforestation do not confuse between harvesting or forest disturbance and deforestation. This is because the unconditional felling licenses used for the estimation of rural deforestation are only given when no restocking will occur, and the survey of land converted to developed use describes the conversion of forest land to the settlement category, which precludes re-establishment. The Countryside Survey data (used for gap filling) are adjusted in order that deforestation is not over-estimated. New data sources (post-2000) have been used that clearly identify the post-deforestation land use.
Iceland	Deforestation is estimated by special inventory where the change in the area of forest where deforestation has been reported is estimated by GPS delineation of a new border between forest and the new land use which is dominantly settlements (new power lines, roads, or buildings). Major forest disturbances will be detected in the NFI but local forest disturbances (wildfires etc.) will be handled with special inventory as done for deforestation

11.4.3 Information on the size and geographical location of forest areas that have lost forest cover, but which are not yet classified as deforested.

The methodologies adopted by individual inventories ensure consistent reporting in time and space of KP lands declared as temporary un-stocked areas. Such post-disturbed areas correspond to all lands reported as harvested under clear-felling and all those areas where natural disturbances caused a complete loss of forest cover, e.g., windfall, destructive fires, and that are thus kept under AR or FM reporting.

In general, the distinction between deforested areas and temporarily un-stocked areas is achieved by national methodologies, through the implementation of multiple assessment criteria and hierarchical phases, field checks or plot data processing. Supplementary arguments for a correct classification of the lands are given by enforcement of law requirements.

11.4.4 Information related to the natural disturbances provision under Article 3(3)

In accordance with decision 2/CMP.7; 13 MS, UK and Iceland originally stated in their "Initial Reports" the intention of excluding emissions resulting from natural disturbances that affect AR lands during the CP2. However, during the review of that submission, Malta indicated that it would not exclude emissions from natural disturbances for any KP-LULUCF activity irrespective of the information in its Initial Report. (Table 11.21).

In general, countries argued that the effects of natural disturbances are always understood as "beyond the control" since those areas are considered direct human-induced and subject to management plans that implement prevention measurements to avoid such damages. In addition, it is also argued that according to current laws it is not allowed to change the use of a disturbed land, but just to implement measures to rehabilitate such forest areas.

The types of disturbance for which countries intends to exclude emissions from the accounting of AR activities vary among individual submissions. This also explains why a value on background level and margin for the EU was not provided. Among other factors, the heterogeneity on the type of disturbances considered by countries makes the information on background level and margin meaningless at EU level, either under AR or FM.

In general, wildfires seem to be the most important disturbance affecting AR areas. However, several countries intend to exclude emissions only from areas affected by windstorms, while some others considered all disturbance types as a safeguard measured in case some of these events occur in the future.

Overall, countries have developed a consistent time series of emissions from natural disturbances that cover different time spans depending on data availability. Annual emissions included in the time series were based on country-specific activity data, collected by national authorities, and emissions that are calculated in line with the methods used for reporting the forest land category reported to Convention.

Regarding the estimation of the background level and the margin, the vast majority of countries have used the default method as described in the 2013 KP Supplement. In the case of Luxembourg and Sweden, the background levels have been set as zero due to the low incidence of natural disturbances that emerged from the analysis of past disturbances.

Countries have also provided information to demonstrate the no expectation of net credits by implementing the default method (i.e., ensuring that annual emissions in the background group used to calculate the background level are always lower or equal to the background level plus the margin). In some instance, countries have also stated that:

- No trend was observed in natural disturbance emissions during the calibration period or is expected during the commitment period.
- The background level of emissions for FM included in the FMRL after technical correction is equal to the average of annual emissions from natural disturbances during the calibration period which are in the background group.

Besides that, in line with requirements for the exclusion of emissions from natural disturbances, in some cases, it has been also argued that salvage logging does not occur in lands subjected to forest fires, as all biomass and dead organic matter is immediately oxidized when affected by wildfires. In contrast, some other countries that intend to exclude emissions from windstorms applied a percentage value of the wood stock that is not subject to salvage logging (e.g., Netherlands and Romania) and for which emissions can be excluded.

Table 11.21 Synthesis of Information from EU MS, UK and Iceland that intend to apply the natural disturbance provision under AR activity during CP2, as reported in individual NIR

Country	Approach used for developing the BL and the Margin	BL	Margin	Type of disturbance
		Kt CO_2 eq		
Bulgaria	Default method	4.000	2.190	wildfires, extreme weather events – windstorms, wet snowfall, ice, others
Croatia	Default method	0.000	0.000	Wildfires

Country	Approach used for developing the BL and the Margin	BL	Margin	Type of disturbance
		Kt CO_2 eq		
France	Default method	5790.000	1581.000	Wildfires, storms, droughts
Greece	Default method	1.351	2.385	Wildfires
Ireland	Default method	23.950	46.666	Wildfires
Italy	Default method	0.451	0.708	Wildfires
Luxembourg	Minimum level of historical time series	0.000	0.000	Extreme weather events (storms)
Netherlands	Default method	0.007	0.006	Wildfires
Portugal	Default method	29.870	9.540	---
Romania	Default method	0.200	0.220	Wildfires
Spain	Default method	[0.287t CO_2eq/ha.]	[0.209t CO_2eq/ha.]	All considered in the 2013 KP supplement
Sweden	Default method	0.000	300.000	Wildfires, insect attacks and disease infestations, extreme weather events and geological disturbances
United Kingdom	Default method	34.900	18.800	Wildfires, insect attacks and disease infestations, extreme weather events and geological disturbances
Iceland	---	---	---	Only ND of catastrophic size that heavily will affect the normal emission/removal account

So far, emissions from natural disturbances have not been excluded from the accounting of AR activities. Some countries have stated that although emissions from natural disturbances, in some of the reporting years, have exceeded the calculated background level plus the margin, the method used to track the disturbance events does not allow to know the georeferenced location of the affected areas as it is required under the decision 2/CMP.8., (e.g., Ireland). Some other countries informed that irrespective to their intention to implement the natural disturbances provision, it seems unlike that emissions will be excluded pursuant this provision due to the low incidence of disturbances or because most emissions are associated to salvage logging that follows disturbance (e.g., Luxembourg).

11.4.5 Information on Harvested Wood Products under Article 3(3)

All countries used the “Production approach” to estimate net emissions and removals from this carbon pool. The methodology corresponds to the IPCC Tier 2 method, where first-order decay functions with default half-life values are used, along with activity data that are often collected from international data sources (i.e., FAO, UNECE, etc.). More details can be found in section 6.2.6 of this document and in the individual GHG inventories.

Some countries have stated that it is not possible to separate HWP originated from AR lands from those originated from FM lands. Therefore, when this is the case, following a conservative approach, all the emissions and removals from this carbon pool have been assigned to FM lands (in line with IPCC guidance). Additionally, some other countries have also stated that HWP are never originated from AR lands as the age of the trees does not allow harvesting practices (e.g., Croatia, Latvia). Finally, when carbon stock changes from HWP are separately reported between AR and FM, the default IPCC method (equation 2.8.3 of the 2013 KP Supplement) has been used for this purpose.

Concerning HWP originated from deforestation events, following reporting rules, these have been reported on the basis of instantaneous oxidation. Following an issue discussed during the 2016 annual review process, countries are currently providing information, when it is relevant, on *“harvest originating from deforestation events*” in table 4(KP-I)C for information purposes, which allow checking transparently the quantities considered as instantaneous oxidation.

Moreover, countries have also progressively enhanced the transparency of the information included in the NIR by providing more detailed descriptions on the origin of HWP reported under deforested lands. In some instances, the share of HWP originating from D within the total budget of the country is estimated on an area-basis share of lands under D and FM for individual reporting years (e.g., Czech Republic).

Beside this, some countries report, and account, for emissions and removals from HWP originated from trees growing in lands subject to deforestation. While some countries justified that by law HWP cannot be linked to Deforestation (e.g., Greece). Instantaneous oxidation approach has been also used to estimate carbon stock changes from wood products in solid waste disposal sites and harvested wood used for energy purposes as stated in individual GHG inventories.

Emissions and removals that are reported from HWP originating from Deforestation lands are in overall insignificant. For this year submission, Denmark reports 3.86 kt CO_2. Denmark explained that despite of that small quantity, in general there are no HWP resulting from trees growing in previously deforested lands because Deforestation in the period since 1990 have been reported for land use changes from forestry to other land uses, mainly cropland, grassland and settlement. The very few areas having truly changed from forestry – another land use – forestry within the reporting period, will in no circumstances have reached a size (height/diameter) that can provide HWP products. This deforestation will have been in effect for at least 1-2 years before any reforestation could occur. The land use matrix is based on wall-to-wall mapping in 1990, 2005 and 2011 and subsequently annual updates based on cadastral data and the Land Parcel Information System which is able to track and capture that land.

11.5 Article 3(4)

11.5.1 Information that demonstrates that activities under Article 3(4) have occurred since 1 January 1990 and are human induced.

Land representation systems that are used at national level to track the lands are able to determine the onset of the activities along the time series. Table NIR-2 allows to check when a unit of land enters in the accounting and to track that such unit of land continues to be accounted for during the subsequent years of the time series.

Since FM, CM, GM, WDR, and RV are management activities, they always qualify as direct human induced. In most of the cases, countries implemented the broad approach, described in the 2013 IPCC KP Supplement, to define what management refers to.

11.5.2 Information relating to Forest Management

Forest management is understood as the set of forest practices and operations, which occur at the stand-level as harvesting, natural and human-induced regeneration, site, and soil preparation (including drainage, burning of slash), seeding, thinning, pruning, fertilization and liming, conservation of habitats, and fire prevention.

Sustainable forestry has a long tradition in Europe, indeed, there are management plans dating from hundreds of years ago. Currently, each country has in force its own legislation on forest lands, as well as other laws supporting a sustainable management and protection of forest areas. At the EU level, forestry is not regulated directly by specific laws, but there are strong requirements for sustainable management of forests via European regulations on environmental obligations (on nature protection, biodiversity protection etc.), sustainable rural development, and renewable energy policies. Some countries report forest certification as an additional tool to highlight the sustainability of the whole chain of forestry and associated products.

Data reported under different international processes (e.g., FAO, MCFPE, CBD) may be different due to different reference time and definitions underlying each of the reporting obligations. Thus, any comparison among data sources has to be done cautiously.

A particular case that was subject to a question from the EU ERT is the case of France. In the past, new forest areas that are considered managed but that are not considered direct human-induced, and therefore not qualify as AR, were not included in the accounting under FM. France has now clarify that this issue is now solved and that all the managed areas of forest are entered in the KP accounting.

Finally, as previously mentioned, Malta does not report removals and emissions from FM following a recommendation of the LULUCF Expert Review Team during their in-country review. In view of this, since Malta is limited to two forest reserves, where the forest cover is almost at maturity and where therefore carbon stock losses are offset by carbon stock gains, so that, without considering the indirect impacts as the fertilization effect due to nitrogen deposition and the increasing CO_2 concentration in the atmosphere, their long-term carbon stock balance can be assumed at equilibrium.

11.5.2.1 Conversion of natural forest to planted forest.

The vast majority of countries have reported that these conversions do not take place in their territories. The main reasons are, either that these forests do not exist (i.e., as all the forests are under more or less intensive management plans), or because natural forests are under strict conservation and protection regimes (e.g., Czech Republic) that prevent such conversions.

11.5.2.2 Forest Management Reference Level (FMRL)

For the construction of the FMRL, EU MS, UK and Iceland implemented different approaches, although all of them were based on projections under a “business-as-usual” scenario (Table 11.22). This section provides a synthesis of information on those values and approaches, but for more detailed information, it is suggested to refer to individual submissions of information on FMRL, as submitted by individual countries and the EU before the beginning of the CP2; or to the individual GHG inventories.

As regards with approaches used in the construction of the FMRL; 10 MS, UK and Iceland prepared model-based projections using country-specific methodologies. In these cases, national forest inventory data, remotely sensed information, and other available national statistics were the main data sources used. Moreover, 14 MS prepared model-based projections using a common approach coordinated by the JRC in collaboration with the International Institute for Applied System Analysis (IIASA) and the European Forest Institute (EFI). To this purpose, the G4M and EFISCEN models were implemented on the basis of information on forest features (from country sources) and on wood production and prices of land and timber, derived from the GLOBIOM model. Finally, three MS used historical data projections based on the elaboration of historical data, assumed as proxy for a "business-as-usual" scenario. Specifically, Greece used the historical average of net removals from forests for the period 1990-2009, while Cyprus and Malta based their FMRL on the linear extrapolation of historical net emissions from forest for the period 1990-2008.

Table 11.22 Synthesis of information related to the construction of the FMRL values as reported by EU MS, UK and Iceland in this inventory year.

Country	Value inscribed in the Appendix to the annex to decision 2/CMP.7 (kt CO_2 eq/yr.)	Technical correction	FMRL based on projections under a "Business-as-usual" scenario		
			Model-based projections using country-specific methodology	Model-based projections using JRC approach	Projections based on historical data assumed as proxy for a "business-as-usual"
Austria	-6516	5823	X		
Belgium	-2499	1430		X	
Bulgaria	-7950	NA		X	
Croatia	-6289	905	X		
Cyprus	-157	NA			X
Czech Republic	-4686	NA		X	
Denmark	409	-83	X		
Estonia	-2741	NE		X	
Finland	-20466	-10938	X		
France	-67410	21795		X	
Germany	-22418	5268	X		
Greece	-1830	210			X
Hungary	-1000	-169		X	
Ireland	-142	-934	X		
Italy	-22166	-1680		X	
Latvia	-16302	11703		X	
Lithuania	-4552	-922		X	
Luxembourg	-418	182		X	
Malta	-49	49			X
Netherlands	-1425	360		X	
Poland	-27133	NA	X		
Portugal	-6830	3369	X		
Romania	-15793	NE		X	
Slovakia	-1084	-2606		X	
Slovenia	-3171	NE	X		
Spain	-23100	NO		X	
Sweden	-41336	8536	X		
UK	-8268	-8375	X		
Iceland	-154	77	X		
EU	**-306736**	**25261,45**	**----**	**----**	**----**

It should be noted that the FMRL value inscribed in the decision 2/CMP.7 for the EU corresponds to the coverage of the MS that were part of the Union at that moment. Such values as inscribed in the appendix of the decision are:

I. -253 336 kt CO_2 eq/yr, applying instantaneous oxidation,
II. -306 736 kt CO_2 eq/yr, applying first-order decay function for HWP.

Nevertheless, the current GHG inventory refers to a different coverage that the one represented by the value in decision 2/CMP.7. Noting that the FM accounting quantity of the EU GHG inventory depends on the FMRL values and their technical corrections (TC) as reported by countries in the CRF table "accounting"; in order to ensure the consistency among the EU GHG inventory (i.e., as a sum of individual GHG inventories) and the individual inventories this FMRL in the decision was technically corrected.

Following a reiterated recommendation from the UN ERT, the current inventory address the issue represented by the different coverages by applying a TC that is the sum of the TC applied by the countries plus the difference between the FMRL value inscribed in the decision and the one that would result from the current coverage[61] (-315 476.5 kt CO_2 eq/yr). Doing it so, the sum of accounting quantities for FM submitted by individual inventories matches the accounting quantity that is reflected in the EU CRF table 'Accounting".

In addition, with respect to the background level of emissions associated with natural disturbances that have been included in the FMRL of the EU, it should be noted that no emissions from natural disturbance were explicitly excluded. In fact, emissions were automatically captured as part of the historical records used. For MS that used the JRC approach, the calibration procedure automatically incorporated into the projections the average rate (for the period 2000-2008) of the GHG impact of past natural disturbances, which are not explicitly estimated by the models. At that moment, it was assumed, and it is still valid, that forest fires represent the major natural disturbance type for most of the countries and their averaged emissions for the years 2000-2008 reached 0.3% of the total 1990 GHG emissions for the same countries.

11.5.2.3 Technical Corrections of FMRL

In line with requirements of the Decision 2/CMP.7, countries have already assessed the consistency between the FMRL and the reporting of FM activity in terms of methodological elements (e.g., pools and gases included, area considered, natural disturbances, etc.). As a result, 19 EU MS, UK and Iceland implemented technical corrections to the FMRL (Table 11.22) in order to ensure such consistency.

Reasons for these inconsistencies and the associated technical corrections vary among inventories (Table 11.23). Overall, they mostly relate to the inclusion of emissions and removals from previously unaccounted carbon pools, the use of the new methodological guidance, especially on HWP and BL of natural disturbances, and the availability of updated data for FM reporting as compared with the data used for the construction of the FMRL.

However, noting the selection of accounting frequency for KP activities at the end of CP2, some countries have informed that, regardless of some inconsistencies that were found among the methodological elements, this year it was not possible to implement a technical correction, due to constrains on time and/or resources. In some case, it is explicitly indicated that a technical correction is expected to be implemented in the coming years (e.g., Spain).

[61] The FMRL for EU+UK+ISL is calculated as the value inscribed in the Appendix to the annex to decision 2/CMP/7 for EU-27 (this includes UK), plus the values applying instantaneous oxidation inscribed for Croatia and Iceland.

To this regard, the JRC has always encouraged countries to provide information on methodological consistency of FMRL in the annual GHG inventories, and, to the extent possible, to provide preliminarily quantitative information on the expected magnitude of any possible technical correction, as already done for some EU MS. The JRC is in contact with MS, and in particular those that used the JRC approach in the construction of their FMRL, providing them support on this matter. It is expected that all countries will implement a TC correction, as a minimum, at the time of the accounting which will ensure the consistency between the FMRL and the reporting of FM.

Table 11.23 **Information on inconsistencies among the FMRL and the reporting of FM activity that have triggered the need of TC.**

Country	Information on the need for applying Technical Correction to the FMRL
Austria	Improvements and updates in the forest land remaining forest land category have impacts on accounting for Forest Management in the second commitment period which require the following adjustments: 1) Inclusion of the litter and soil pools. 2) Updated expansion ratios: 3) Updated data on ‘drain’: 4) Updated dead wood pool: 5) Corrections in the calculations of the ‘increment’ 6) Update of harvested wood products:
Belgium	Updated historical data became available since the submission of the FMRL in 2011 and recent improvements were performed in the inventory. The most important recalculation in 2019 is Soil organic carbon, with a difference around 1350 kt CO_2-eq. The second one are the revisions in Wallonia (forest inventory data and BEF), which reduces the sink by 350 kt CO_2 from 2002 to present. Considering the magnitude of the changes, a technical correction of the reference level is proposed, in order to ensure methodological consistency between the FMRL and the current reporting for forest management.
Croatia	Since the submission of FMRL Croatia implemented several methodological improvement steps in estimating its emissions/removals of FM. Due to these methodological improvements, changes in the FM input data, FM estimates and FM figures of historic years occur. As a consequence of all these methodological changes the FMRL changes from -6,289 kt CO_2 net removals to FMRLcorr. – 4,906.20178 kt CO_2 net removals without HWP instantaneous oxidation) and to FMRLcorr. – 5,384.16933 kt CO_2 net removals with the HWP
Denmark	For the accounting of emissions, a FMRL is constructed specifying the expected average annual net emissions from the HWP pool for the second commitment period. Due to the data corrections it was decided to correct the original FMRL reported in 2011 (Johansen et al. 2011). This correction also entailed a change in the reference period used to project the inflow to the HWP pool – from 2005-2009 to 2008-2012 – in order to provide a more accurate reference level using the most recently collected data. Had the reference period not been changed, the FMRL would have significantly underestimated the inflow for 2013 and thus caused a significant gap between the report-ed net emissions and the projected net emissions by the FMRL. This means that the HWP pool would actually have been projected to decrease as op-posed to the expected increase in the pool during the second commitment period.
France	here are no plans to completely recalculate the FMRL based on new modeling. The modification of the calculation parameters is therefore not intended to improve the consistency between the FM activity and the FMRL, in particular with regard to the age class structure and the areas. However, the FMRL modeling is brought back into overall coherence with the inventory using a technical correction.
Germany	With regard to carbon stocks in living biomass, the previous FMRL, which was reported to the UNFCCC Secretariat and the EU in 2011, is based on data of the 2008 Inventory Study and, for the projection, on the forest management scenario of the WEHAM forest development and wood-production model. For the pools dead biomass (litter, dead wood) and soils, and for emissions from fertilization, drainage and combustion of biomass (forest fires), country-specific emission factors either were not available or were not recorded. Carbon in harvested wood products (HWP) was not accounted for in a manner consistent with decision 2/CMP.7 and the KP Supplement adopted following the submission of the FMRL. The reference level used to date does not contain all categories and other emissions that are reported relative to KP 3.4, pursuant to the current rules for GHG reporting, and thus are part of the pertinent accounting (cf. Table 510). Additional recommendations relative to corrections are provided in the "Report of the technical assessment of the FMRL submission of Germany submitted in 2011" (FCCC/TAR/2011/DEU). For this reason, Germany has carried out a technical correction of the FMRL.
Finland	The FMRL was constructed in 2011 and since then, several changes have been done to the applied data and methods. New NFI data are used to estimate FM and D areas for 1990-2009. Recalculated CO_2 emissions from drained organic soils. Emissions from wildfires were estimated according to 2006 IPCC Guidelines. Correction to the emission factor of N_2O emissions from drained organic forest soils. The MELA model was adjusted to more accurately produce the historical results. Fuelwood consumption in small-scale housing (5.5 million m3 per year) was included, it was previously not included in the reference scenario used for the FMRL which was based on the Finland’s National Forest Program 2015 (Ministry of Agriculture and Forestry 2008).

Country	Information on the need for applying Technical Correction to the FMRL
Greece	The changes that have occurred in relation to methodological elements, which are triggering a technical correction are: 1 The update of the Forest Management Plans database. The new data incorporated in the database have resulted in the recalculation of the whole time series for the 4.A.1 "Forest land remaining Forest land/managed" category which is equivalent to the Forest Management activity. 2 The area of forest land remaining forest land/managed that equals to Forest Management area has changed. 3 In the current submission, CO_2 and non-CO_2 emissions from dead wood and litter subject to wildfires in lands under 3.4 have been reported for the first time. 4 There has been a recalculation of the whole time series of emissions from wildfires. 5 The period 1990-2014 has been considered for the technical correction of the FMRL, while the FMRL value inscribed in the appendix of 2/CMP.7 is based on the average of emissions/removals of the period 1990-2009. 6 In the estimation of emissions/removals from Forest land remaining forest land, the updated emission and conversion factors from 2006 GL AFOLU and KP Supplement have been used. In addition, the new global warming potential values for CH_4 and N_2O from the 4th AR IPCC have been used. 7 In the current submission, both a FMRL assuming instantaneous oxidation and applying the FOD function for HWP is submitted. It should be noted that a forest management reference level applying first-order decay function for HWP was not included in the appendix of 2/CMP.7,
Hungary	A technical correction was necessary for the FMRL because there are several methodological changes that have been implemented in the estimation of emissions and removals from FM, including the HWP pool.
Ireland	Ireland has performed recalculations for the historic time series and 2013 and will apply a technical correction when accounting for the second commitment period. The requirement to apply a recalculation is based on conditions as outlined in the IPCC 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (IPCC 2013 GPG KP-LULUCF): 1 Use of new models to derive the reported carbon stock (CSC) changes in the inventory 2013. 2 There have been a range of methodological changes for estimation CO_2, N_2O and CH_4 emissions from organic and mineral soils. 3 Ireland has obtained new historical data for several elements included in the construction of the FMRL
Italy	The following changes have been done since the submission of the MFRL which trigger the need for TC: The FMRL has been calculated with the EU models G4M (IIASA) and EFISCEN (EFI). Estimates of emissions and removals under FM activities have been carried out with the growth model For-est, used to estimate the net change of carbon in the five reporting pools. Availability of new data resulting from the ongoing NFI and consequent recalculations of the reported data under FM and Forest Land Remaining Forest Land used to establish the reference level. The estimates have been carried out on the basis of the 2013 KP Supplement (IPCC 2014) methodology
Latvia	The need for Technical Correction is determined by following reasons: 1.- The method used for GHG reporting changed after the adoption of FMRL as part of improving inventory quality and due to conversion of calculations from the IPCC GPG LULUCF 2003 to 2006 IPCC Guidelines and IPCC Wetlands Supplement. 2.- New non-CO_2 GHG sources are included in reporting for FM in the second commitment period. 3.- Recalculated historical data was done for the most important parameters. 4.- The accounting of HWP has been also improved since estimation of the FMRL which was submitted before Decision 2/CMP.7. Technical Correction was calculated based on a model re-calibration. A full re-run of the model will be carried in the future to allow Latvia to implement a complete Technical Correction.
Lithuania	Lithuania has already applied technical correction to the forest management reference level which is equal to -922.0 kt CO_2 eq. G4M and EFISCEN models, used for FMRL estimation, were updated with more recent NFI data to calculate technical correction. The main changes were larger forest area for both models and a larger increment rate and growing stock and a higher share of wood coming from thinning in total wood removals for EFISCEN as compared to data used originally for the FMRL calculations. With the updated input data G4M and EFISCEN project a CO_2 sink in the range of 5.4-9.0 $MtCO_2$/year in 2020. Both models agree on the declining trend of the biomass forest management emissions. For the FMRL projection in 2011 EFISCEN model was initialized with the National Forest Inventory (NFI) data referring to the year 2000 and respective age structure while G4M was initialized with age structure projected by EFISCEN for 2010. For the technical correction projection EFISCEN model was initialized with data from the 2010-2012 (2010 midpoint) NFI measurements while G4M used the same initial age structure as for the FMRL.
Luxembourg	The IPCC KP Supplements require a technical correction of the FMRL if methodological changes result in calculation of the time series, if new historical data become available or if pools are included in current reporting that have not been taken into account in the FMRL. Those conditions are fulfilled as the current FMRL does not use the methodological approach employed in Luxembourg and hence a technical correction of the FMRL was carried out.
Malta	Since the national greenhouse gas inventory submission of 2011, Malta has changed the methodology for estimating emissions and removals for the sector LULUCF. During those previous submissions the category 'Forestland remaining forestland' was taken to include coniferous forest, mixed forest and shrubland (maquis). Malta has now a national definition which states that a forest is defined as an area of minimum 1 hectare with a tree crown cover of more than 30% and minimum tree height of 5 meters. This has resulted in shrubland no longer being considered as part of the category 'Forestland', now being classified as part of the category 'Grassland'. In view of this, Malta is seeking a correction of the FMRL currently inscribed under the Kyoto Protocol. This methodological change leads to the sink value of -49Gg CO_2 equivalent as reported when using the previous methodology being reduced to a net removal for the category 'Forestland remaining forestland' of 0Gg CO_2 equivalent.

Country	Information on the need for applying Technical Correction to the FMRL
Netherlands	A number of changes in the Netherlands' inventory caused methodological inconsistencies between the inventory and the FMRLs. This was partly because the accounting of HWP as agreed in decision 2/CMP.7 was not yet available at the time the FMRLs were submitted: natural disturbances were not yet included at the time of submission of the FMRLs. Additionally, new NFI statistics became available covering the period 2003–2012, and in the NIR 2021 a land-use map for 1970 was introduced, all resulting in recalculated historical data. Moreover, also new methodologies on calculating the carbon stock changes in forest land have been introduced since the adoption of the FMRL and new information on land-use change from using additional maps for the years 2013 and 2017 is used resulting in inconsistencies between the reported emissions and removals in FM and those included in the FMRL.
Portugal	All spreadsheets for estimating emissions and removals from KP LULUCF have been adapted so that they recalculate automatically the FMRL if and when the base information changes. Following the specifications of Decision 2/CMP.7, the assumptions used in FMRL construction are kept constant. All changes to the FMRL value are therefore due to changes in the base information (historical time series) or changes in methodologies in use, which then apply both to the historic time series and to reporting in the commitment period. Since the communication of the FMRL by Portugal in 2011, several changes have been introduced in the reporting by Portugal.
Romania	A technical correction is planned in the light of new data available from NFI (for 2008-on).
Slovakia	Technical corrections were (TC) calculated for the first time in submission 2018. The actual value of technical correction is -1 164.0 kt CO_2 eq. the TC values recalculated for 2019 submission. Methodology for reporting of Forest Management evolved significantly during CP2, leading to relatively high value of TC.
Sweden	Sweden has performed a technical correction for the forest management reference level due to the following reasons: - The historical dataset for Living biomass representing the period 2005-2009 has been updated using new inventory data from the NFI. - The historical dataset for Litter representing the period 2000-2009 has been updated using new inventory data from the soil inventory. - The historical dataset for Soil organic carbon representing the period 2000-2009 has been updated using new inventory data from the soil inventory. The method to calculate emissions/removals from the harvested products pool was slightly revised in Submission 2015. T - New sources of greenhouse gases was amended in the reporting in Submission 2015. - The emission factor for drained organic forest soils and nitrogen fertilization was changed in Submission 2015. - Biomass burning now includes only emissions of N_2O and CH_4. - The GWPs for CH_4 and N_2O have been changed according to decision 4/CMP.7 and affects all estimates of emissions of CH_4 and N_2O.
UK	The UK has calculated a technical correction (TC) to the FMRL for the 2016 inventory. The FMRL submitted by the UK in 2011 was based on the 1990-2008 UK greenhouse gas inventory, since which, the following data and assumptions have changed that necessitate a technical correction: 1.- A switch in the model used from CFlow to CARBINE; 2.- Inclusion of pre-1921 forest area; 3.- Change in tree growth assumptions; 4.- Change in the assumptions about harvesting rates; 5.- Updated information on the rate of deforestation; 6.- Updated approach to estimating the incidence of emissions from wildfires;
ISL	Iceland did estimate Forest Management Reverence level (FMRL) for current commitment period in February 2011 (Snorrason, 2011). It was clear in the beginning that the estimates were uncertain. Especially was the estimate for the natural birch forest (NBF) critical as the ERT did point out (see page 19 paragraph h) in Synthesis report of the technical assessments of the forest management reference level submissions. Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol Sixteenth session, part four Durban, 29 November 2011. FCCC/KP/AWG/2011/INF.2) New approach to estimate the change in the carbon stock of natural birch forest was conducted soon after the reference level was accepted.

11.5.2.4 Carbon equivalent Forest Conversion

This provision is not relevant for EU MS, or for UK, or Iceland.

11.5.3 Information related to the natural disturbances provision under article 3(4)

In accordance with decision 2/CMP.7; 18 MS, UK and Iceland originally stated their intention of excluding emissions resulting from natural disturbances that affect areas subject to FM during CP2, (Table 11.24). However, during the review of that submission, Malta indicated that it would not exclude emissions from natural disturbances for any KP-LULUCF activity irrespective of the information in its Initial Report.

Most detailed information on the approach used for the calculation of the background level and the margin, as well as, on other requirements for Parties that intend to apply this provision can be found in section 11.4.4 of this report. In addition, further and specifically related information to MS and Iceland can be found in individual GHG inventories.

As with the KP activity AR, so far, emissions from natural disturbances have not been excluded from the accounting of FM activities.

Table 11.24 Synthesis of Information from EU MS, UK and Iceland that intends to apply the natural disturbance provision under FM activities during CP2.

Country	Approach used for developing the BL and the Margin	BL	Margin	Type of disturbance
		Kt CO_2 eq		
Austria	Default method	[0.147t CO_2eq/ha.]	[0.171 t CO_2eq/ha.]	All considered in the 2013 KP supplement
Belgium	Default method	3.540	7.800	Wildfires
Bulgaria	Default method	848.012	531.646	Wildfires, extreme weather events – windstorms, wet snowfall, ice, others
Cyprus	Default method	14.910	23.030	Wildfires, extreme weather events – windbreaks, snow breaks and ice breaks
Croatia	Default method	59.480	114.070	Wildfires
Estonia	Default method	181.731	112.544	Biotic or abiotic damages being the most critical Extreme weather events (storms)
Finland	Default method	532.000	314.000	Windstorms, insect attacks and wildfires
France	Default method	13588.000	1744.000	Wildfires, storm, droughts
Greece	Default method	82.078	144.937	Wildfires
Ireland	Default method	69.363	66.782	Wildfires
Italy	Default method	1689.239	1374.197	Wildfires
Luxembourg	Minimum level of historical time series	0.000	0.000	Extreme weather events
Netherlands	Default method	2.380	2.000	Wildfires and wind storms
Portugal	Default method	1080.880	1197.120	Wildfires
Romania	Default method	66.000	61.000	Wildfires and windfalls
Spain	Default method	4166.460	3033.170	All considered in the 2013 KP supplement
Sweden	Default method	14.120	3000.000	Wildfires, insect attacks and disease infestations, windstorms and geological disturbances
United Kingdom	Default method	270.000	112.000	Wildfires, insect attacks and disease infestations, windstorms and geological disturbances
Iceland	---	---	---	Only ND of catastrophic size that heavily will affect the normal emission/removal account

11.5.4 Information on Harvested Wood Products under Article 3(4)

All counties used the “Production approach” to estimate net emissions and removals from this carbon pool, in line with the 2013 KP Supplement. The default IPCC method (equation 2.8.3 of the 2013 KP Supplement) was mainly used to allocate the carbon stock changes to specific forest related activities under Article 3(3), and Article 3(4).

As regards with harvest from lands not included under forest management or under Article 3(3) activities, five countries have reported quantitative information on CRF table 4(KP-I) C. All the other have explained that HWP are not originating from lands subject to any other activity than ARD, or FM.

11.5.5 Information relating to Cropland Management, Grazing Land Management and Revegetation, Wetland Drainage and Rewetting if elected, for the base year.

For CP2, emissions and removals from CM are reported and accounted for by Denmark, Germany, Ireland, Italy, Portugal, Spain and UK. With the exception of Spain, these countries also elected to account for emissions and removals from the activity GM. Moreover, RV activity has been elected only by Romania and Iceland, whereas only United Kingdom account for emissions and removals from the activity WDR.

Definitions implemented by the countries are consistent with those contained in decision 16/CMP.1. Cropland and Grazing land management activities consist in the implementation of specific practices and operations, which differ substantially from country to country. CM is dedicated to agricultural crops, perennial and annual, woody and non-woody crops, including lands temporary under reserve or out of the productive cycle (fallow lands). GM is the system of practices consisting in manipulating site features and the amount of vegetation on lands for livestock production (include e.g., drainage of organic soils, vegetation improvement).

As regard of the activity RV, as stated in individual GHG inventories, Iceland includes the activity of increasing carbon stocks on eroding or eroded/desertified sites through the establishment of vegetation or the restoration of existing vegetation that covers a minimum area of 0.5 hectares and does not meet the definitions of afforestation or reforestation. It includes also, activities related to emissions of GHG and/or decreases in carbon stocks on sites which have been categorized as revegetation areas and do not meet the definition of deforestation. For Romania this activity corresponds with plantation of trees on non-forest lands and can be associated with forest belts.

The area under CM corresponds, in overall, to the area reported under Cropland minus the cropland area originated from forest conversion since 1990, while GM areas may likely not correspond to Grassland since usually not the entire area of grassland within a country is managed for grazing.

Activity data for CM and GM in the base year, and all the years of the CP, are compiled from remotely sensed products, or NFIs grids, coupled with any available ancillary data. Agriculture census, national statistics, cadaster data, result-based payments information, and some European initiatives (e.g. LPIS) have also a significant role on data acquisition.

Concerning RV, Iceland uses national registry to collect the area subject to this activity, while in Romania activity data is available either as number of planted trees or km of tree lines or ha as recorded in statistical reports.

Wetland Drainage and Rewetting as covered in this inventory is only reported by UK. The areas under this activity are confined to areas of active peat extraction, areas of rewetted former peat extraction and areas that were known to have been rewetted by 1990. The total area remains constant at 30.2 kha across the time series, also UK informed that drained and rewetted organic soils also occur under the other KP-LULUCF categories following the KP activity hierarchy.

11.6 Other information

11.6.1 Key category analysis for Article 3(3) activities and any elected Article 3(4) activity

Countries apply mainly quantitative criteria for the assessment of key categories among KP-LULUCF activities (see Table 11.4), based on the correspondence between KP activities and land categories in the Convention. When elected, FM, CM and GM, as well as ARD are key categories in most of the cases. Further information regarding KC analysis can be found in section 11.1.4.

11.6.2 Information related to Article 6

With the exception of Romania, all other countries do not report information on JI projects.

In the case of Romania, a JI AR project is being carried out, which lasted from 2012-2017. Estimates of GHG emissions and removals are calculated for the commitment period and reported as a separate division in CRF Table 4(KP-I) A1.1

12 INFORMATION ON ACCOUNTING OF KYOTO UNITS

12.1 Background information

The standard electronic format (SEF) for providing information on ERUs, CERs, tCERs, lCERs, AAUs and RMUs for the year 2020 for the EU[62] registry is submitted together with this report (Annex 1.13). The data in the EU registry reflect only the transactions to and from the EU registry, but not the sum of all Member States' transactions. Member States separately submit information on Kyoto units in SEF tables to the UNFCCC.

12.2 Summary of information reported in the SEF tables for the EU registry

The standard electronic format tables for the EU are included in the submission. The SEF reporting software has been used for this purpose. The tables include information on the AAU, ERU, CER, t-CER, l-CER and RMU in the Union registry at 31.12.2020 as well as information on transfers of the units in 2020 to and from other Parties of the Kyoto Protocol.

The United Kingdom has left the EU on 1 February 2020, but continues to implement the Kyoto Protocol and relevant EU law in accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community[63].

The joint assigned amount of the EU, its Member States, United Kingdom, and Iceland for the second commitment period of the Kyoto Protocol is equal to the percentage inscribed for the Union, its Member States, United Kingdom and Iceland in the third column of Annex B to the Kyoto Protocol as replaced by the Doha Amendment (80 %) of its base year emissions multiplied by eight. Council Decision (EU) 2015/1339 sets out the terms of the joint fulfilment agreement as well as the respective emission levels of each Party to that agreement. The Agreement between the EU, its Member States and Iceland, concerning Iceland's participation in the joint fulfilment of commitments by the EU, its Member States and Iceland for the second commitment period of the Kyoto Protocol sets out the terms governing Iceland's participation.[64] The emission levels define the Member States', the United Kingdom's and Iceland's assigned amounts for the second commitment period. These emission levels have been determined on the basis of the existing Union legislation for the period 2013-2020 under the 'Climate and Energy package'[65]. This assigned amount of the EU is determined in line with the terms of the joint fulfilment agreement, as described in the EU's initial report[66] and was established

[62] The Community registry was replaced by the Union registry in 2012

[63] Adopted by Council Decision (2019/C 384 I/01) (OJ C 384, 12.11.2019, p. 1), Art 96 (5): "Article 5 of Commission Regulation (EU) No 389/2013 shall apply to the United Kingdom until the closure of the second commitment period of the Kyoto Protocol."

[64] OJ L 207, 4.8.2015, p. 17

[65] Directive 2009/29/EC of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community and Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020, OJ L 140, 5.6. 2009.

[66] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52016SC0316&from=en

upon the completion of the initial review[67]. The joint assigned amount as established upon completion of the initial review is 37 604 433 280 t CO_2 eq; the EU assigned amount is 15 813 089 338 t CO_2 eq.

12.3 Summary of information reported in the CP2 SEF tables of the EU registry.

SEF tables for the EU registry are provided in Annex 1.13. Table 12.1 provides an overview of transactions included in Table 2(b) in the EU registry.

Table 12.1 Transactions included in Table 2(b) in the EU registry.

		Additions						Subtractions					
		Unit type						Unit type					
		AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
	Total transfers and acquisitions												
1	AU	NO	NO	NO	3.415.163	NO	NO	NO	NO	NO	2.503.778	NO	NO
2	BE	NO	NO	NO	4.987	NO	NO	NO	NO	NO	987.314	NO	NO
3	CDM	NO	NO	NO	1.202.550	NO	NO	NO	NO	NO	NO	NO	NO
4	CH	NO	NO	NO	9.397.725	NO	NO	NO	NO	NO	8.568.746	NO	NO
5	CZ	NO	NO	NO	2.902	NO	NO	NO	NO	NO	NO	NO	NO
6	DE	NO	NO	NO	12.337.359	NO	NO	NO	NO	NO	352.177	NO	NO
7	DK	NO	NO	NO	3.575.000	NO	NO	NO	NO	NO	500.000	NO	NO
8	ES	NO	NO	NO	24.795	NO	NO	NO	NO	NO	143.274	NO	NO
9	FI	NO	NO	NO	814.579	NO	NO	NO	NO	NO	87.857	NO	NO
10	FR	NO	NO	NO	292	NO	NO	NO	NO	NO	1.007.298	NO	NO
11	GB	NO	NO	NO	2.380.163	NO	NO	NO	NO	NO	3.365.531	NO	NO
12	HU	NO	NO	NO	14.000	NO	NO	NO	NO	NO	14.000	NO	NO
13	IT	NO	NO	NO	223.431	NO	NO	NO	NO	NO	40.665	NO	NO
14	NL	NO	NO	NO	17.187.347	NO	NO	NO	NO	NO	1.277.395	NO	NO
15	NO	NO	NO	NO	99.233	NO	NO	NO	NO	NO	180.219	NO	NO
16	SE	NO	NO	NO	292.369	NO	NO	NO	NO	NO	50.078	NO	NO
17	IE	NO	NO	NO	NO	NO	NO	NO	NO	NO	1.117.466	NO	NO
	Sub-total	NO	NO	NO	50.971.895	NO	NO	NO	NO	NO	20.195.798	NO	NO

12.4 Discrepancies and notifications

With respect to the respective paragraphs of decision 15/CMP.1 the following information is provided for the EU registry:

- **Paragraph 12:** No discrepancies identified by the transaction log.
- **Paragraph 13**: No notifications directed to the Party to replace lCERs in accordance with Paragraph 49 of the annex to decision 5/CMP.1.
- **Paragraph 14:** No notifications directed to the Party to replace lCERs in accordance with para 50 of the annex to decision 5/CMP.1.
- **Paragraph 15:** No issue of non-replacement.
- **Paragraph 16**: No KP Units that are not valid.
- **Paragraph 17:** No actions were necessary to correct any problem causing a discrepancy.

12.5 Publicly accessible information

The information based on the requirements in the annex to decision 13/CMP is publicly available on the European Commission website:

[67] Report on the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of the European Union - FCCC/IRR/2016/EU - GE.18-07661(E)

https://ets-registry.webgate.ec.europa.eu/euregistry/EU/public/reports/publicReports.xhtml

Article 6 project information

No ERUs have been issued in the EU Registry in 2013
No ERUs have been issued in the EU Registry in 2014
No ERUs have been issued in the EU Registry in 2015
No ERUs have been issued in the EU Registry in 2016
No ERUs have been issued in the EU Registry in 2017
No ERUs have been issued in the EU Registry in 2018
No ERUs have been issued in the EU Registry in 2019
No ERUs have been issued in the EU Registry in 2020

The total quantity of ERUs, CERs, AAUs and RMUs in each account at the beginning of the year

This information is confidential.

The total quantity of AAUs issued on the basis of the assigned amount pursuant to Article 3, paragraphs 7 and 8

No AAUs have been issued in the EU Registry in 2013
No AAUs have been issued in the EU Registry in 2014
No AAUs have been issued in the EU Registry in 2015
No AAUs have been issued in the EU Registry in 2016
No AAUs have been issued in the EU Registry in 2017
No AAUs have been issued in the EU Registry in 2018
No AAUs have been issued in the EU Registry in 2019
No AAUs have been issued in the EU Registry in 2020

The total quantity of ERUs issued on the basis of Article 6 projects

No ERUs have been issued in the EU Registry in 2013

No ERUs have been issued in the EU Registry in 2014

No ERUs have been issued in the EU Registry in 2015

No ERUs have been issued in the EU Registry in 2016

No ERUs have been issued in the EU Registry in 2017

No ERUs have been issued in the EU Registry in 2018

No ERUs have been issued in the EU Registry in 2019

No ERUs have been issued in the EU Registry in 2020

The total quantity of ERUs, CERs, AAUs and RMUs acquired from other registries.

YEAR	Registry	AAU	ERU	RMU	CER
2013	GB	0	0	0	29.448
2013	CH	0	0	0	172.337
2014	AT	0	0	0	1
2014	FR	0	0	0	165.465
2014	DK	0	0	0	3.142
2014	DE	0	0	0	39.320
2014	SE	0	0	0	122.180
2014	GB	0	0	0	2.256.786
2014	AU	0	0	0	120.870
2014	NO	0	0	0	167.074
2014	CH	0	0	0	1.790.323
2014	NL	0	0	0	575.673
2014	IT	0	0	0	168.671
2014	ES	0	0	0	60.966
2014	CDM	0	0	0	14.921
2015	CDM	0	0	0	136.554
2015	FR	0	0	0	1.071.564
2015	SE	0	0	0	2.091.044
2015	DK	0	0	0	45.156
2015	NO	0	0	0	753.110
2015	DE	0	0	0	5.336.978
2015	GB	0	0	0	12.377.526
2015	NL	0	0	0	9.557.045
2015	AU	0	0	0	1.799.631
2015	ES	0	0	0	997.749
2015	BE	0	0	0	130.368
2015	CH	0	0	0	9.203.722
2015	PT	0	0	0	935.000

2015	IT	0	0	0	1.836.849
2015	FI	0	0	0	52.378
2016	AT	0	0	0	75.396
2016	AU	0	0	0	386.987
2016	BE	0	0	0	239.290
2016	CDM	0	0	0	6.620
2016	CH	0	0	0	6.066.604
2016	DE	0	0	0	1.402.960
2016	DK	0	0	0	634.856
2016	ES	0	0	0	229.375
2016	FI	0	0	0	294.692
2016	FR	0	0	0	1.314.645
2016	GB	0	0	0	13.163.692
2016	IT	0	0	0	154.464
2016	NL	0	0	0	9.551.267
2016	NO	0	0	0	11.392
2016	PT	0	0	0	3.403.623
2016	SE	0	0	0	5.101.906
2017	AT	0	0	0	458.832
2017	SE	0	0	0	1.638.914
2017	DK	0	0	0	16.155
2017	DE	0	0	0	953.892
2017	GB	0	0	0	4.014.277
2017	NO	0	0	0	12.166
2017	ES	0	0	0	241.452
2017	AU	0	0	0	943.312
2017	HU	0	0	0	9.647
2017	PT	0	0	0	167
2017	CH	0	0	0	10.435.307
2017	BE	0	0	0	217.165
2017	IE	0	0	0	115.965
2017	LU	0	0	0	314.417
2017	NL	0	0	0	17.607.672
2017	CDM	0	0	0	4.991
2017	IT	0	0	0	323.106
2017	FI	0	0	0	346.506
2018	ES	0	0	0	22.316
2018	GB	0	0	0	5.775.293
2018	DE	0	0	0	3.805.830
2018	CH	0	0	0	8.469.849
2018	SE	0	0	0	2.465.927
2018	NL	0	0	0	8.531.061
2018	NO	0	0	0	121.637
2018	FI	0	0	0	58.031

2018	IT	0	0	0	4.789
2018	AU	0	0	0	975.901
2018	DK	0	0	0	2.559
2018	BE	0	0	0	107.616
2019	AT	0	0	0	531
2019	AU	0	0	0	722.419
2019	BE	0	0	0	1.523
2019	CDM	0	0	0	515
2019	CH	0	0	0	3.768.871
2019	DE	0	0	0	4.899.665
2019	DK	0	0	0	1.199
2019	ES	0	0	0	365.442
2019	FI	0	0	0	334.701
2019	GB	0	0	0	437.845
2019	IT	0	0	0	12.401
2019	NL	0	0	0	12.730.228
2019	NO	0	0	0	277.593
2019	SE	0	0	0	1.420.654
2020	AU	0	0	0	3.415.163
2020	BE	0	0	0	4.987
2020	CDM	0	0	0	1.202.550
2020	CH	0	0	0	9.397.725
2020	CZ	0	0	0	2.902
2020	DE	0	0	0	12.337.359
2020	DK	0	0	0	3.575.000
2020	ES	0	0	0	24.795
2020	FI	0	0	0	814.579
2020	FR	0	0	0	292
2020	GB	0	0	0	2.380.163
2020	HU	0	0	0	14.000
2020	IT	0	0	0	223.431
2020	NL	0	0	0	17.187.347
2020	NO	0	0	0	99.233
2020	SE	0	0	0	292.369
TOTAL		**0**	**0**	**0**	**237.989.854**

The total quantity of RMUs issued on the basis of each activity under Article 3, paragraphs 3 and 4

No RMUs have been issued in the Union registry in 2013

No RMUs have been issued in the Union registry in 2014

No RMUs have been issued in the Union registry in 2015

No RMUs have been issued in the Union registry in 2016

No RMUs have been issued in the Union registry in 2017

No RMUs have been issued in the Union registry in 2018

No RMUs have been issued in the Union registry in 2019

No RMUs have been issued in the Union registry in 2020

The total quantity of ERUs, CERs, AAUs and RMUs transferred to other registries.

YEAR	Registry	AAU	ERU	RMU	CER
2014	GB	0	0	0	135.000
2014	CH	0	0	0	1.397.541
2015	FR	0	0	0	106.092
2015	SE	0	0	0	12.246
2015	DK	0	0	0	548.202
2015	NO	0	0	0	40.385
2015	DE	0	0	0	514.092
2015	GB	0	0	0	675.749
2015	NL	0	0	0	261.062
2015	AU	0	0	0	1.394.059
2015	ES	0	0	0	1.350
2015	BE	0	0	0	5.465
2015	CH	0	0	0	5.696.488
2015	IT	0	0	0	1
2015	FI	0	0	0	31.924
2016	AT	0	0	0	37.698
2016	AU	0	0	0	3.573.312
2016	BE	0	0	0	7.554
2016	CH	0	0	0	9.703.077
2016	DE	0	0	0	218.209
2016	ES	0	0	0	20.000
2016	FR	0	0	0	300
2016	GB	0	0	0	2.061.256
2016	NL	0	0	0	648.580
2016	NO	0	0	0	49.879
2016	PT	0	0	0	510
2016	SE	0	0	0	3.992
2017	AT	0	0	0	11.139
2017	SE	0	0	0	113.284
2017	DK	0	0	0	1.092
2017	LI	0	0	0	14.775
2017	DE	0	0	0	554.336

2017	GB	0	0	0	683.071
2017	NO	0	0	0	94.570
2017	ES	0	0	0	104.878
2017	AU	0	0	0	5.070.826
2017	HU	0	0	0	9.647
2017	CH	0	0	0	7.382.252
2017	IE	0	0	0	115.965
2017	LU	0	0	0	314.417
2017	NL	0	0	0	408.076
2017	FR	0	0	0	127.000
2017	FI	0	0	0	81.549
2018	ES	0	0	0	174.349
2018	GB	0	0	0	405.983
2018	DE	0	0	0	283.839
2018	LI	0	0	0	28.938
2018	CH	0	0	0	4.113.163
2018	SE	0	0	0	162.030
2018	NL	0	0	0	256.230
2018	NO	0	0	0	109.909
2018	FI	0	0	0	90.271
2018	IT	0	0	0	105.000
2018	AU	0	0	0	1.458.014
2018	DK	0	0	0	952
2018	FR	0	0	0	336.000
2019	AU	0	0	0	1.092.080
2019	CH	0	0	0	3.696.943
2019	DE	0	0	0	386.230
2019	DK	0	0	0	299
2019	ES	0	0	0	136.345
2019	FI	0	0	0	111.721
2019	GB	0	0	0	700.153
2019	IT	0	0	0	95.000
2019	NL	0	0	0	296.710
2019	NO	0	0	0	261.018
2019	SE	0	0	0	101.145
2019	FR	0	0	0	111.895
2019	IE	0	0	0	400.576
2019	LI	0	0	0	53.463
2020	AU	0	0	0	2.503.778
2020	BE	0	0	0	987.314
2020	CH	0	0	0	8.568.746
2020	DE	0	0	0	352.177
2020	DK	0	0	0	500.000
2020	ES	0	0	0	143.274

2020	FI	0	0	0	87.857
2020	FR	0	0	0	1.007.298
2020	GB	0	0	0	3.365.531
2020	HU	0	0	0	14.000
2020	IT	0	0	0	40.665
2020	NL	0	0	0	1.277.395
2020	NO	0	0	0	180.219
2020	SE	0	0	0	50.078
2020	IE	0	0	0	1.117.466
TOTAL		**0**	**0**	**0**	**77.394.954**

The total quantity of ERUs, CERs, AAUs and RMUs cancelled on the basis of activities under Article 3, paragraphs 3 and 4

YEAR	AAU	ERU	RMU	CER
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0
2020	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**

The total quantity of ERUs, CERs, AAUs and RMUs cancelled following determination by the Compliance Committee that the Party is not in compliance with its commitment under Article 3, paragraph 1

YEAR	AAU	ERU	RMU	CER
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0
2020	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**

The total quantity of other ERUs, CERs, AAUs and RMUs cancelled

YEAR	AAU	ERU	RMU	CER

2013	0	0	0	0
2014	0	0	0	1.892
2015	0	0	0	487.961
2016	0	0	0	877.355
2017	0	0	0	3.433.767
2018	0	0	0	4.115.756
2019	0	0	0	4.520.677
2020	0	0	0	5.409.430
TOTAL	**0**	**0**	**0**	**18.846.838**

The total quantity of ERUs, CERs, AAUs and RMUs retired

YEAR	AAU	ERU	RMU	CER
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0
2020	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**

12.6 Calculation of commitment period reserve (CPR)

For the purposes of the joint fulfilment, the commitment period reserve applies to the EU, its Member States and Iceland individually. The EU commitment period reserve, established upon the completion of the initial review[68], is 14 231 780 406 t CO_2 eq.

12.7 KP-LULUCF accounting

Each EU Member State and Iceland apply Article 3(3) and (4) of the Kyoto Protocol and decisions agreed thereunder individually. Member States account individually for emissions by sources and removals by sinks from Kyoto LULUCF activities and individually decide on accounting modalities and elections where foreseen under the Kyoto Protocol. Any issuance of removal units (RMUs) or cancellation of units resulting from the accounting under Articles 3(3) and (4) would be made to the Member States' and Iceland's Kyoto registries. The EU will report the sum of Member States' cumulative accounting quantities for these activities at the end of the commitment period, representing the Member States' cumulative additions to or subtractions from their assigned amount at the end of the commitment period.

The United Kingdom has left the EU on 1 February 2020, but continues to implement the Kyoto Protocol and relevant EU law in accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community[69].

[68] Report on the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of the European Union - FCCC/IRR/2016/EU - GE.18-07661(E)

[69] Adopted by Council Decision (2019/C 384 I/01) (OJ C 384, 12.11.2019, p. 1), Art 96 (5): "Article 5 of Commission Regulation (EU) No 389/2013 shall apply to the United Kingdom until the closure of the second commitment period of the Kyoto Protocol."

13 INFORMATION ON CHANGES IN NATIONAL SYSTEM

The European Union (EU) already had a quantified emission limitation and reduction target in the first commitment period and provided a description of its national system in the report to calculate the assigned amount of the first commitment period. Subsequently, any changes that occurred to the EU national system were reported as part of the annual supplementary information under Article 7 of the Kyoto Protocol and included in the national inventory report.

There are no changes compared to the 2020 inventory submission related to the national system, as the United Kingdom, which left the EU on 1 February 2020, continues to implement the Kyoto Protocol and relevant EU law in accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community[70].

As mentioned in the 2018 inventory submission of the EU under the Kyoto Protocol, the Kyoto greenhouse inventory for the second commitment period follows the terms of the joint fulfilment agreement for the second commitment period. This included, until 31 January 2020, 28 Member States[71] and Iceland, and includes 27 Member States and United Kingdom and Iceland thereafter.

The institutions, which were part of the EU inventory system and responsible for the EU inventory preparation during the first commitment period, remain the same in the second commitment period. The Directorate-General (DG) for Climate Action of the European Commission has overall responsibility for the inventory of the EU while each Member State is responsible for the preparation of its own inventory which is the basic input for the inventory of the EU. DG Climate Action is supported in the establishment of the inventory by the following main institutions: the European Environment Agency (EEA) and its European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/CME) as well as other DGs of the European Commission: Eurostat, and the Joint Research Centre (JRC).

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70 Adopted by Council Decision (2019/C 384 I/01) (OJ C 384, 12.11.2019, p. 1), Art 96 (5): "Article 5 of Commission Regulation (EU) No 389/2013 shall apply to the United Kingdom until the closure of the second commitment period of the Kyoto Protocol."

71 Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom

14 INFORMATION ON CHANGES IN NATIONAL REGISTRY

The following changes to the national registry of EU have occurred in 2020. Note that the 2020 SIAR confirms that previous recommendations have been implemented and included in the annual report.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	None
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	There has been a new EUCR release (version 11.5) after version 8.2.2 (the production version at the time of the last Chapter 14 submission). Due to the new release, some changes were applied to the database. The updated database model is provided in Annex A. No change was required to the application backup plan or to the disaster recovery plan. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	The changes that have been introduced with version 11.5 compared with version 8.2.2 of the national registry are presented in Annex B. It is to be noted that each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and are carried out prior to the relevant major release of the version to Production (see Annex B). No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	The use of soft tokens for authentication and signature was introduced for the registry end users.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change to the registry internet address during the reported period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	No change during the reported period.

15 INFORMATION ON MINIMIZING ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

15.1 Information on how the EU is striving, under Article 3, paragraph 14, of the Kyoto Protocol, to implement the commitments mentioned in Article 3, paragraph 1, of the Kyoto Protocol in such a way as to minimize adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention

Editorial comment: The EU is only required to report changes related to the information on minimizing adverse impacts in accordance with Article 3, paragraph 14. However, for an improved understanding, most of the text from the last year's inventory report was included and additional or new information is marked in bold.

In this section the EU provides information on how it is implementing its commitment under Article 3, paragraph 14 of the Kyoto Protocol, i.e. how it is striving to implement its emission reduction commitment under Article 3, paragraph 1 of the Kyoto Protocol in such a way as to minimize potential adverse social, environmental and economic impacts on developing countries. In order to strive for such a minimization, an assessment of potential positive and negative impacts – both of direct and indirect nature – is necessary with a double objective to maximize positive impacts and to minimize adverse impacts. The EU is well aware of the need to assess impacts and has built up thorough procedures in line with our obligations. This includes bilateral dialogues and different platforms in which we interact with third countries, explain new policy initiatives and receive comments from third countries.

Impacts on third countries are mostly indirect and can frequently neither be directly attributed to a specific EU policy, nor directly measured by the EU in developing countries. Therefore, the reported information covers potential adverse social, environmental and economic impacts that result from complex assessments of effects and that are based on accessible data sources in developing countries.

Impact assessment of EU policies

In the EU a wide-ranging impact assessment system accompanying all new policy initiatives has been established. This regulatory impact assessment is a key element in the development of the European Commission's legislative proposals. The Commission is required to take the impact assessment reports into account when taking its decisions, while the impact assessments are also presented and discussed during the scrutiny of legislative proposals by the Council and the Parliament. This approach ensures that potential adverse social, environmental and economic impacts are identified and minimized within the legislative process. In general, impact assessments are required for all legislative proposals, but also for other important Commission initiatives which are likely to have far-reaching impacts. Below the impact assessment process implemented in the EU policy making is explained in more detail in order to better demonstrate how the EU is striving for all strategies and policies to minimize their adverse impacts. This process is governed by the so-called "Better Regulation Guidelines"[72].

Assessing systematically the likely effects of different policy initiatives on developing countries is a requirement based on Article 208(1) TFEU (Treaty on the Functioning of the European Union), which stipulates that the EU "shall take account of the objectives of development co-operation in the policies that it implements which are likely to affect developing countries". This constitutes the legal basis of a concept generally known as "Policy Coherence for Development" (PCD). Practically, the application of the PCD principle means recognizing that some EU policy measures can have a significant impact outside of the EU which may contribute to or undermine the Union's policy objectives concerning development. Through PCD, the EU seeks to take account of development objectives in all of its policies that are likely to affect developing countries, by minimising contradictions and building synergies between different EU policies to benefit developing countries and by increasing the effectiveness of development cooperation. Measures regarding climate change mitigation and affecting adaptation needs in developing countries have been identified as "measures known to have impacts on developing countries". The assessment of impacts on developing countries includes economic, social and environmental impacts.

Related to economic impacts the following guiding questions have to be assessed[73]:

- Who are the developing countries producing (and exporting to the EU) the goods/services affected? Are these least developed countries?
- What is the impact on proportion (especially in value) of the trade between these developing countries and the EU, in particular regarding the trade balance of developing countries?
- What is the likely impact on price volatility?
- What are the impacts on proportion between the purchase of raw materials and finished products from developing countries?
- What is the impact on the competitiveness of exporters in developing countries in terms of intended or unintended trade barriers?
- What are the impacts of the initiative on intellectual property rights, standards, and technology and business skills in developing countries and on their capacity to trade their goods (towards the EU or between themselves)?
- What is the impact on food security for local population (e.g. by impacting on price of commodities or food on world and regional/local markets or by limiting access to land, water or other assets)?
- What is the impact on different population groups (urban vs. rural, small vs. large scale farmers)?
- What are the impacts on international and domestic investment flows (outflows and inflows including foreign direct investment) in the developing countries?
- What are the impacts on the private sector in developing countries (including competitiveness, access to finance, access to market)?

Related to social impacts the following guiding questions have to be assessed:

- What are the impacts on labour market (e.g. creation of job or decrease in employment level, impacts on different groups of the workforce – low-skilled vs. high skilled workforce, wages level, working conditions)?
- What are the impacts on main stakeholders and institutions affected by the proposal?

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[72] http://ec.europa.eu/smart-regulation/guidelines/toc_guide_en.htm

[73] Better regulation toolbox (page 266), http://ec.europa.eu/smart-regulation/guidelines/docs/br_toolbox_en.pdf

- What is the impact on poverty levels and inequality in developing countries?
- What are the impacts on gender equality and on the most vulnerable groups of society?
- What is the impact on human rights in the development countries?
- What is the impact on migration in developing countries (rural-urban or international)?
- What is the impact on food security for the local population (e.g. by impacting on price of commodities or food on world and regional/local markets or by limiting access to land, water or other assets)?
- What is the impact on different population groups (urban vs. rural, small vs. large scale farmers)?

Related to environmental impacts the following guiding questions have to be assessed:

- How does it impact ecosystems?
- What is the impact on emission targets in developing countries?
- What is the impact on chemicals authorisation as well as on use and waste management?
- What is the impact on green economy development, both globally and in partner countries?
- What is the impact on low carbon technology transfer and its availability in developing countries?
- What is the impact on biodiversity (mono-cropping, deforestation) and global or local food security?
- What is the impact on the management and use of natural resources, e.g. minerals, timber, water, land, etc.?
- Are these options consistent with our support (under development cooperation policy) to responsible approaches to natural resources management such as the Action plan on Forest Law enforcement, Governance and Trade (FLEGT)[74], the Extractive Industries Transparency Initiative (EITI)[75] or the Kimberley agreement[76]?

Depending on the case, a comprehensive literature review is conducted, while in some cases a detailed, substantial and quantified analysis including detailed quantitative data to establish the causal link between the policy option and its impacts is carried out. A range of analytical approaches can be used for this purpose, such as econometric analysis or computable general equilibrium (CGE) models.

Consulting interested parties is an obligation for every impact assessment and all affected stakeholders should be engaged. Each consultation includes a 12-week internet-based public consultation and can be complemented by other approaches and tools. Existing international policy dialogues are also used to keep third countries fully informed of forthcoming initiatives, and as a means of exchanging information, data and results of preparatory studies with partner countries and other external stakeholders.

The EU's Fourth Biennial Report[77] provides a detailed overview of the European policies and measures to mitigate GHG emissions in all sectors. All key strategies and climate policies have been subject to impact assessments as described above. All impact assessments and all opinions of the Impact Assessment Board are published online[78]. In addition to the general approach described above to

[74] The Action Plan on Forest Law Enforcement, Governance and Trade (FLEGT) is the European Union response to illegal logging that was adopted in 2003. http://ec.europa.eu/environment/forests/illegal_logging.htm

[75] The Extractive Industries Transparency Initiative (EITI) provides a global standard to promote the open and accountable management of oil, gas and mineral resources. https://eiti.org/who-we-are

[76] The Kimberley Process (KP) is a joint government, industry and civil society initiative to stem the flow of conflict diamonds – rough diamonds used by rebel movements to finance wars against legitimate governments. http://www.kimberleyprocess.com/

[77] https://unfccc.int/documents/228427

[78] http://ec.europa.eu/transparency/regdoc/?language=en

address adverse social, environmental and economic impacts, more specific ways to minimize impacts depend on the respective policies and measures implemented. As the reporting obligation related to Article 3, paragraph 14 in the UNFCCC reporting guidelines for GHG inventories does not include an obligation to report on each specific mitigation policy, the EU chooses the approach to provide some specific examples to illustrate how the EU is striving to minimize adverse impacts.

Major EU policies such as the directives on the promotion of the use of energy from renewable sources are presented in more detail as examples in this chapter, because the related impact assessments identified potential impacts on third countries.

Directives on the promotion of the use of renewable energy

The Directive 2009/28/EC on the promotion of the use of energy from renewable sources (the "Renewable Energy Directive") set ambitious targets for all Member States, such that the EU will reach a 20% share of energy from renewable sources in the overall energy consumption by 2020 (with individual targets for each Member State) and a 10% share of renewable energy specifically in the transport sector, which includes liquid biofuels, biogas, hydrogen and electricity from renewables. The impact assessments related to enhanced biofuel and biomass use in the EU showed that the cultivation of energy crops have both potential positive and negative impacts. To address the risk of potentially negative impacts, Article 17 of the Renewable Energy Directive created pioneering "sustainability criteria", applicable to all biofuels (biomass used in the transport sector) and bioliquids. These sustainability criteria included:

- Establishment of a threshold for GHG emission reductions that have to be achieved from the use of biofuels;
- exclusion of the use of biofuels from land with high biodiversity value (primary forest and wooded land, protected areas or highly biodiverse grasslands),
- exclusion of the use of biofuels from land with high carbon stocks, such as wetlands, peatlands or continuously forested areas.

Developing country representatives as well as other stakeholder were extensively consulted during the development of the sustainability criteria and preparation of the directive and the extensive consultation process has been documented.

A directive amending the legislation on biofuels through the Renewable Energy and the Fuel Quality Directives was adopted in 2015 (Directive (EU) 2015/1513) with the objectives:

- To increase the minimum greenhouse gas saving threshold for new installations to 60% in order to improve the efficiency of biofuel production processes as well as discouraging further investments in installations with low greenhouse gas performance.
- To include indirect land use change (ILUC) factors in the reporting by fuel suppliers and Member States of greenhouse gas savings of biofuels and bioliquids;
- To limit the amount of food crop-based biofuels and bioliquids that can be counted towards the EU's 10% target for renewable energy in the transport sector by 2020, to the current consumption level, 5% up to 2020, while keeping the overall renewable energy and carbon intensity reduction targets;
- To provide additional market incentives to the existing ones for biofuels with no or low indirect land use change emissions, and in particular the 2nd and 3rd generation biofuels produced from feedstock that do not create an additional demand for land, including algae, straw, and various types of waste, as they will contribute more towards the 10% renewable energy in transport target of the Renewable Energy Directive.

With these measures, the EU wants to promote biofuels that help achieving substantial emission cuts, do not directly compete with food and are more sustainable at the same time. While the directive does not affect the possibility for Member States to provide financial incentives for biofuels, the Commission considers that in the period after 2020 biofuels should only receive financial support if they lead to substantial greenhouse gas savings and are not produced from crops used for food and feed. The impact assessment of the directive analysed social, economic and environmental impacts on third countries in detail[79]. The directive also ensures that the Commission reports every two years, in respect to both third countries and Member States which constitute a significant source of biofuels or of raw material for biofuels consumed within the Union, on national measures taken to respect the sustainability criteria for soil, water and air protection.

In December 2018, the revised Renewable Energy Directive (EU) 2018/2001 was adopted, which set a new target, namely to achieve a share of at least 32% of energy from renewable energy sources in the EU's gross final energy consumption by 2030. In addition to biofuels and bioliquids, the directive now also covers solid biomass and biogas for heat and power. More specifically, it includes the following requirements that have to be applied to all biofuels, to biogas used in installations with a total rated thermal input equal to or exceeding 2 MW and to solid biomass with a total rated thermal input equal to or exceeding 20 MW:

- Requirements for minimum greenhouse gas emissions savings have been strengthened.
- Agriculture production within the EU is no longer interlinked with sustainability requirements under the Common Agriculture Policy, but globally applicable criteria to mitigate risks for soil quality and carbon have been added for agricultural biomass.
- A new sustainability criterion on forest biomass has been introduced, focusing on legality of harvest, forest regeneration, maintaining or improving long term productivity, protected areas, minimizing negative impacts on soil quality and biodiversity during harvest as well as LULUCF requirements

Furthermore, high indirect land use change risks biofuels like biofuels from palm oil shall not exceed the level of consumption in 2019 and shall gradually decrease to 0% (31 December 2023 until 31 December 2030).

In October 2020, the European Commission published its biennial Renewable Energy Progress Report[80] under the framework of the 2009 Renewable Energy Directive. The report includes information on the assessment of sustainability of EU biofuels. Biodiesel is the most common biofuel in the EU, and approx. 59% of the feedstock used for biodiesel consumed in the EU in 2018 was imported or produced from imported feedstock. It is estimated that 7.4 Mha of land was required for the production of crops for EU biofuel consumption in 2018. Of that amount, 3.4 Mha are located within the EU and 3.8 Mha are located in third countries. For most of the non-EU countries, it is estimated that less than 1% of their total cropland was used for the extraction of feedstock to be used in the production of biofuels produced or consumed in the EU.

The report found that in recent years, no correlation has been observed between food prices and biofuel demand. It must be noted, however, that between 2008 and 2016, growing global demand for food and feed crops was requiring the agricultural sector to constantly increase production, which was achieved by both increasing yields and by an expanding agricultural area. The report also

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[79] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0296&from=EN

[80] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0952

addresses environmental impacts, including eutrophication of water bodies, water scarcity, soil erosion, soil compaction, air pollution, habitat loss and biodiversity loss. The sustainability criteria for biofuels used in the EU prevent impacts such as the conversion of land with high carbon stock and land of high biodiversity value.

The Communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme[81] sets up a system for certifying sustainable biofuels, including those imported into the EU. It lays down rules that such schemes must adhere to if they are to be recognized by the Commission. This will ensure that the EU's requirements that biofuels deliver substantial reductions in greenhouse gas emissions and that biofuels do not result from forests, wetlands and nature protection areas are implemented.

The European Commission has so far (April 2021) recognised 14 voluntary schemes: International Sustainability and Carbon Certification (ISCC), Bonsucro EU, Round Table on Responsible Soy (RTRS EU RED), Roundtable of Sustainable Biofuels (RSB EU RED), Biomass Biofuels voluntary scheme (2BSvs), Red Tractor Farm Assurance Combinable Crops & Sugar Beet Scheme, SQC (Scottish Quality Farm Assured Combinable Crops (SQC) scheme), Red Cert, Better Biomass NTA 8080, RSPO RED (Roundtable on Sustainable Palm Oil RED), , KZR INIG System, Trade Assurance Scheme for Combinable Crops**, Universal Feed Assurance Scheme and U.S. Soybean Sustainability Assurance Protocol (SSAP)**[82].

Regulation for energy efficiency labelling

In 2017, Regulation (EU) 2017/1369 setting a framework for energy efficiency labelling was adopted. It aims at further exploiting the potential of energy efficiency especially with regard to the EU target of substantially improving energy efficiency by 2030 compared to 2005. Its implementation will contribute to a moderation of energy demand and a reduction of the energy dependency of the European Union. Based on common energy labelling within the EU customers can obtain accurate, relevant and comparable information on the energy efficiency and consumption of energy-related products wherever they are in the Union.

The Commission carried out an ex-post evaluation of the previous Energy Labelling Directive and of specific aspects of the Ecodesign Directive. Furthermore, it carried out an impact assessment accompanying the proposal for the Regulation for energy efficiency labelling[83]. The final option chosen was to improve the existing regulatory framework on energy labelling, to require labelled products to be registered in a new database, improve the legal structure by changing the current Energy Labelling Directive to a Regulation, to align it with the market surveillance regulation, and to fund EU joint market surveillance actions.

Third countries are affected, because the use of energy efficiency classes from A to G has been followed as a model in many different countries around the world and some countries have also implemented EU Ecodesign regulations[84]. They are also affected through the Agreement on Technical Barriers to Trade which is to ensure that regulations, standards, testing and certification procedures do not create

[81] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52010XC0619%2801%29

[82] https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/voluntary-schemes

[83] http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2015/swd_2015_0139_en.pdf

[84] https://ec.europa.eu/energy/sites/ener/files/documents/201404_ieel_third_jurisdictions.pdf

unnecessary obstacles, while also providing the right to implement measures to achieve legitimate policy objectives.

The EU's Nationally Determined Contribution and the assessment of its impacts

On 17 December 2020, the EU and its Member States communicated their updated NDC. The EU and its Member States, acting jointly, are committed to a binding target of a net domestic reduction of at least 55% in greenhouse gas emissions by 2030 compared to 1990. As part of the preparation of this NDC, an impact assessment[85] was carried out, which addresses the various impacts of increasing GHG ambition in the range of 50% to 55% reductions by 2030. It found that the reduction of GHG emissions in various decarbonisation scenarios has positive impacts on air pollution and human health. The impact assessment also addressed the synergies and trade-offs of bio-energy use and land management with biodiversity, social impacts and aspects of a just transition. The EU's 2030 climate and energy framework is currently under revision, and subsequent policies will be adopted to achieve the EU's updated NDC.

15.2 Information on how the EU gives priority, in implementing the commitments under Article 3, paragraph 14, to specific actions

The EU reports activities that are related to the actions specified in the subparagraphs (a) to (f) of paragraph 24 of the reporting requirements in the Annex to decision 15/CMP.1. However, no decision was agreed that these actions form part of the commitment under Article 3, paragraph 14. For some of the actions specified in the reporting requirements, it seems rather unclear how they relate to the minimization of adverse social, environmental and economic impacts resulting from policies and measures to mitigate GHG emissions. As an example, the cooperation activities specified in subparagraph (d) help both developing and developed countries in reducing emissions from fossil fuel technologies, but they do not directly address the minimization of potential adverse impacts in developing country Parties.

For the purposes of completeness in reporting, the EU addresses all subparagraphs specified in the reporting requirements, however the main ways how the EU is striving to minimize adverse impacts are described in the previous section.

a) The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities

The actions addressed in subparagraph a) also form part of the commitment to implement policies and measures requested under Article 2, paragraph 1(a) (v) of the Kyoto Protocol, however Article 2 specifies that Annex I Parties shall "implement and/or further elaborate policies and measures in accordance with national circumstances, such as progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and application of market instruments."

85 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020SC0176

Subparagraph a) in the reporting requirements lacks such objective and therefore seems somewhat inconsistent with the commitment under Article 2. The promotion of research, demonstration projects, fiscal incentives or carbon taxes is an important instrument to advance the objectives of the Convention, e.g. the use of renewable energies. A progressive reduction of all fiscal incentives or subsidies in all GHG emitting sectors would run counter the objective of the Convention and counter the ability of the EU to meet its commitment under Article 3, paragraph 1 of the Kyoto Protocol. Therefore the EU interprets this reporting requirement in a way consistent with Article 2 paragraph 1(a)(v) that the EU should focus on the progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies that run counter the objectives of the Convention and application of market instruments.

The 2009 Review of the EU Sustainable Development Strategy assesses that *"the Commission has been mainstreaming the progressive reform of environmentally harmful subsidies into its sectoral policies"*. For instance, environmental concerns have been gradually incorporated into the EU Common Agricultural Policy, including "decoupled" direct payments which have replaced price support; environmental cross compliance; a substantial increase in budget for rural development. As part of the 2008 Common Agriculture Policy Health Check, additional part of direct aid has been shifted to climate change, renewable energy, water management, biodiversity, innovation; transparency of agricultural subsidies has improved. It is important to note that in the other areas most subsidies are within the competence of the Member States and not of the EU, within the limits established by EU state aid rules.

EU policies aim to address market imperfections and to reflect externalities. For example, the EU has made significant efforts to liberalise the internal energy market and to create a genuine internal market for energy as one of its priority objectives. The existence of a competitive internal energy market is a strategic instrument both in terms of giving European consumers a choice between different companies supplying gas and electricity at reasonable prices, but also in terms of making the market accessible for all suppliers, especially the smallest and those investing in renewable forms of energy.

With the EU Emissions Trading System, the EU uses a market instrument to implement the objective of the Convention and its commitment under Article 3, paragraph 1 of the Kyoto Protocol which aims at creating the right incentives for forward looking low carbon investment decisions by reinforcing a clear, undistorted and long-term carbon price signal.

With respect to financial support provided by the Member States to undertakings, the EU Treaty pronounces a general prohibition of "State aid". This concept encompasses a broad range of financial support measures adopted at national or sub-national level (i.e. not at EU level), and which can take various forms (subsidies, tax relieves, soft loans…). The Treaty provides for exceptions to this general prohibition. When State aid measures can contribute in an appropriate manner to the furtherance of objectives of common interest for the EU, and provided that they comply with certain strict conditions, they may be authorised by the Commission. By complementing the fundamental rules through a series of legislative acts and guidelines, the EU has established a unique system of rules under which State aid is monitored and assessed in the European Union. This legal framework is regularly reviewed to improve its efficiency. EU State aid control is an essential component of competition policy and a necessary safeguard for effective competition and free trade.

State aid reform in the EU aims to redirect aid to objectives of common interest which are related to the EU Lisbon Treaty, such as research, development and innovation, risk capital measures, training, and environmental protection. Environmental protection, and in particular, the promotion of renewable energy and the fight against climate change, is considered one of the objectives of common interest for the EU which may, under certain circumstances, justify the granting of State aid.

Specific "Community Guidelines on State aid for Environmental Protection"[86] have been established. The Guidelines foresee in particular the possibility to authorise State aid for particular environmental purposes, such as for renewable energy sources or energy saving. The European Commission published in 2014 the "Guidelines on State aid for environmental protection and energy 2014-2020" The Guidelines set out the conditions under which state aid measures for environmental protection or energy objectives may be declared compatible with the internal market. This proposal includes a list of environmental and energy measures for which state aid under certain conditions may be compatible with the EU Treaty, covering the following areas:

- Aid to energy from renewable sources
- Energy efficiency measures, including cogeneration and district heating and district cooling
- Aid for resource efficiency and in particular aid to waste management
- Aid to Carbon Capture and Storage (CCS)
- Aid in the form of reductions in or exemptions from environmental taxes and in the form of reductions in funding support for electricity from renewable sources
- Aid to energy infrastructure
- Aid for generation adequacy
- Aid in the form of tradable permit schemes
- Aid for the relocation of undertakings

In 2012, the Commission adopted guidelines on certain state aid measures in the context of the EU Emissions Trading System (EU ETS). The guidelines provide a framework under which Member States may compensate some electro-intensive industries, such as steel and aluminium producers, for part of the higher electricity costs expected to result from the application of the harmonised allocation rules to be applied in the EU ETS as from 2013. The rules, subject to state aid scrutiny, ensure that national support measures are designed in a way that preserves the EU objective of decarbonising the European economy and maintains a level playing field among competitors in the internal market. The sectors deemed eligible for compensation include producers of aluminium, copper, fertilisers, steel, paper, cotton, chemicals and some plastics. The Guidelines give a right, not an obligation, to provide subsidies to energy intensive industries.

Carbon leakage means that global greenhouse gas emissions increase when companies in the EU shift production outside the EU because they cannot pass on the cost increases induced by the ETS to their customers without a significant loss of market share to third country competitors. The ETS Directive (2003/87/EC as amended) required the European Commission to compile a list of sectors and sub-

[86] Official Journal No C 82, 1.4.2008, p.1

sectors deemed exposed to significant risk of carbon leakage. Sectors on the list receive a higher share of free allowances. The criteria and thresholds to determine whether a sector is deemed exposed to carbon leakage or not are defined in Article 10a(13-18) of the ETS Directive and focus on additional costs incurred by the ETS Directive and trade intensity. The calculations are based on official Eurostat data and data collected from Member States. According to the ETS Directive, it is possible to add further sectors to the list if they comply with the criteria stated in the Directive, but it will not be possible to remove sectors from the list until its expiration.

The revised ETS Directive 2003/87/EC (as amended in 2018) builds on the positive experience with the harmonised rules implemented since 2013, by further developing predictable, robust and fair rules for free allocation of allowances to industry during the fourth trading period (2021-2030) to address the potential risk of carbon leakage in an adequate manner. This includes:

- Revising the system of free allocation to focus on sectors at highest risk of relocating their production outside the EU.
- A considerable number of free allowances set aside for new and growing installations.
- More flexible rules to better align the amount of free allowances with production figures.
- Update of benchmarks to reflect technological advances since 2008.

Under the revised ETS Directive, several support mechanisms are established to help the industry and the power sectors meet the innovation and investment challenges of the transition to a low-carbon economy. These include two new funds:

- Innovation Fund – extending existing support for the demonstration of innovative technologies to breakthrough innovation in industry.
- Modernisation Fund – facilitating investments in modernising the power sector and wider energy systems and boosting energy efficiency in 10 lower-income Member States.

The revised ETS Directive also contains a number of new provisions to protect industry against the risk of carbon leakage and the risk of application of a cross-sectoral correction factor:

- The share of allowances to be auctioned will be 57%, with a conditional lowering of the auction share by 3% if the cross-sectoral correction factor is applied. If triggered, it will be applied consistently across the sectors.
- Revised free allocation rules will enable better alignment with the actual production levels of companies, and the benchmark values used to determine free allocation will be updated.
- The sectors at highest risk of relocating their production outside the EU will receive full free allocation. The free allocation rate for sectors less exposed to carbon leakage will amount to 30%. A gradual phase-out of that free allocation for the less exposed sectors will start after 2026, with the exception of the district heating sector.
- The new entrants' reserve will initially contain unused allowances from the current 2013-2020 period and 200 million allowances from the market stability reserve. Up to 200 million allowances will be returned to the market stability reserve if not used during the period 2021-2030.

b) Removing subsidies associated with the use of environmentally unsound and unsafe technologies

There is no clear definition of environmentally unsound and unsafe technologies. Therefore, the EU interprets this provision in the context of the Kyoto Protocol that unsound and unsafe technologies would be those increasing GHG emissions.

The phase-out of subsidies to fossil fuel production and consumption by 2010 was one of the objectives in the Communication from the Commission “A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development (European Commission 2001)”.

Council Decision 2010/787/EU on State aid to facilitate the closure of uncompetitive coal mines adopted a new coal regulation enabling Member States to grant State aid to facilitate the closure of uncompetitive mines until 2018, following the expiry of the current Coal Regulation (Council Regulation (EC) N° 1407/2002). The decision includes the following main elements:

- the possibility of continuing to grant, under certain conditions, public aid to the coal industry with a view to facilitating the closure of uncompetitive hard coal mines until December 2018;
- the modalities for the phasing-out of the aid, under which the overall amount of aid granted by a Member State must follow a downward trend, in order to prevent undesirable effects of distortion of competition in the internal market. Subsidies will have to be lowered by at least 25% until 2013, by 40% until 2015, by 60% by 2016 and by 75% by 2017;
- the obligation for Member States granting aid to provide a plan on intended measures to mitigate the environmental impact of the production of coal; and
- the possibility of allowing subsidies, until December 2027, in order to cover exceptional expenditure in connection with the closure of mines that are not related to production, such as social welfare benefits and rehabilitation of sites.

In March 2015 the European Commission’s Directorate-General for Economic and Financial Affairs published an article called “Measuring Fossil Fuel Subsidies”[87] in its Economic Brief which aims to shed some light on the true magnitude and allocation of fossil fuel subsidies so as to enable comparisons between countries and regions to provide background to policy discussions.

c) Cooperating in the technological development of non-energy uses of fossil fuels, and supporting developing country Parties to this end;

The technological development of non-energy uses of fossil fuels is not a current research priority in the EU, nor a priority of cooperation with developing countries because the EU is not a major producer of oil and gas. Given the long-term depletion of fossil fuel resources and the decline in coal production, the EU’s priority in general is the replacement of the use of fossil fuels by renewable resources and the more efficient use of resources.

d) Cooperating in the development, diffusion, and transfer of less-greenhouse-gas-emitting advanced fossil-fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort;

The EU is cooperating with other developing and developed country Parties (Australia, Brazil, Canada, China, Czech Republic, France, Germany, Greece, India, Italy, Japan, Republic of Korea, Mexico,

[87] http://ec.europa.eu/economy_finance/publications/economic_briefs/2015/pdf/eb40_en.pdf

Netherlands, New Zealand, Norway, Poland, Romania, Russian Federation, Saudi Arabia, Serbia, South Africa, United Arab Emirates, United Kingdom and USA) in the Carbon Sequestration Leadership Forum (CSLF)[88]. The CSLF is a Ministerial-level international climate change initiative that is focused on the development of improved cost-effective technologies for the separation and capture of carbon dioxide (CO_2) for its transport and long-term safe storage. The mission of the CSLF is to facilitate the development and deployment of such technologies via collaborative efforts that address key technical, economic, and environmental obstacles. The CSLF also aims at promoting awareness and championing legal, regulatory, financial, and institutional environments conducive to such technologies. In 2017 a Technology Roadmap was released by the Carbon Sequestration Leadership Forum. This road map indicates that CCS has been proven to work and has been implemented in the power and industrial sectors, but that a number of important challenges remain that must be addressed to achieve widespread commercial deployment of CCS. A number of meetings and workshops are held each year. At the most recent physical meeting, the 2019 technical group annual meeting of the CSLF in Chatou, France, the focus was on carbon capture, utilization, and storage (CCUS). Workshops were held on hydrogen production with CCUS and on CCUS with energy intensive industries.

e) Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities

In the oil and gas industry the upstream sector is a term commonly used to refer to the exploration, drilling, recovery and production of crude oil and natural gas. The downstream sector includes the activities of refining, distillation, cracking, reforming, blending storage, mixing and shipping and distribution.

The EU contributes to strengthening of the capacities of fossil fuel exporting countries in the areas of energy efficiency via the work of the Energy Expert Group of the Gulf Cooperation Council (GCC)[89], in particular in the working sub-group on energy efficiency. As part of the EU's research programme, the "EUROGULF" project analysed EU-GCC relations with respect to oil and gas issues and proposing new policy initiatives and approaches to enhance cooperation between the two regional groupings.

The European Commission has started a project with the specific objective to create and facilitate the operation of an EU-GCC Clean Energy Technology Network. The network is to be set up to act as a catalyst and element of coordination for development of cooperation on clean energy. On the network's website[90] further information on its recent activities can be found. The Masdar Institute of Science and Technology in Abu Dhabi has been selected as the lead research institution to represent the Gulf Cooperation Council (GCC) in the European Union-GCC Clean Energy Network. A number of discussion groups and training seminars have taken place each year from 2013 onwards. As an

[88] https://www.cslforum.org/cslf/

[89] The Gulf Cooperation Council covers Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

[90] http://www.eugcc-cleanergy.net

essential element of the project, five Working Groups focus on areas of common interest for the stakeholders of the two regions (EU, GCC):

- Renewable Energy Sources
- Energy Demand Side Management and Energy Efficiency
- Clean Natural Gas and Related Technologies
- Electricity Interconnections and Market Integration
- Carbon Capture and Storage

Energy efficiency activities in the upstream or downstream sector are also candidates for Clean Development Mechanism (CDM) projects. Thus, the development of the CDM under the Kyoto Protocol and the demand of CERs by Annex I Parties under the Kyoto Protocol as well as by operators under the EU ETS have fostered such activities performed by the private sector. Related CDM projects are for example:

- Rang Dong Oil Field Associated Gas Recovery and Utilization Project in Vietnam: The purpose of this project activity is the recovery and utilization of gases produced as a by-product of oil production activities at the Rang Dong oil field in Vietnam with the involvement of ConocoPhillips (UK).
- Recovery of associated gas that would otherwise be flared at Kwale oil-gas processing plant in Nigeria involves the capture and utilisation of the majority of associated gas previously sent to flaring at Kwale OGPP plant. The Kwale OGPP plant receives oil with associated gas from oil fields operated by Eni Nigeria Agip Oil Company.
- Recovery and utilization of associated gas produced as by-product of oil recovery activities at the Al-Shaheen oil field in Qatar.
- Flare gas recovery and utilisation project at Uran oil and gas processing plant in India which is handling the oil and gas produced in the Mumbai High offshore oil field.
- Flare gas recovery and utilisation project at Hazira gas and condensate processing plant in India.
- Flare gas recovery and utilisation project from Kumchai oil field in India.
- Flare gas recovery and utilisation project at the Ovade-Ogharefe oil field operated by Pan Ocean Oil Corporation in Nigeria.
- Flare gas recovery and utilisation project at Soroosh and Nowrooz offshore oil fields in Iran.
- Leak reduction in aboveground gas distribution equipment in the KazTransgaz-Tbilisi gas distribution system in Georgia where leakages at gate stations, pressure regulator stations, valves, fittings as well at connection points with consumers are reduced.
- There are currently 21 Coal Mine Methane Utilization Project in China which use coalmine methane previously released to the atmosphere.

Improved energy efficiency in the energy and the transport sector in a more general way is one of the priorities in the EU's development assistance as well as for the EIB (European Investment Bank) and the EBRD (European Bank for Reconstruction and Development). The EIB has also developed other means of financing, such as equity and carbon funds, to further support renewable energy and energy-efficiency projects.

f) Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.

The EU actively undertakes a large number of activities aiming at reducing dependence on the consumption of fossil fuels, in particular the EU supports activities for the promotion of renewable energies and energy efficiency in developing countries, which contribute to the reduction of dependence on fossil fuels, to meeting rural electricity needs, and to the improvement of air quality. The EU support programmes include:

Africa, Caribbean and the Pacific Energy Facility

The ACP-EU Energy Facility (EF) was established in 2005 to co-finance projects on increasing access to modern and sustainable energy services for the poor in African, Caribbean and Pacific (ACP) countries, especially in rural and peri-urban areas.

Following the successful implementation of the first Energy Facility, it was decided to create a second Energy Facility, which has later been extended to include more projects than originally foreseen.

Therefore, a total of four Calls for Proposals (CfP) have been made under the EF: under the first EF (9th EDF) only one CfP was launched committing EUR 196 million to supporting projects; under the second EF (10th EDF), EUR 100 million was allocated to the first CfP, EUR 132 million to the second (targeting rural electrification) and EUR 15 million to the third call (targeting fragile states).

- A total of 173 projects were selected to receive support to increase access to energy in Africa, the Caribbean and the Pacific, and a total project budget of approximately EUR 800 million has been provided by the EU and other donors. Most projects of the first EF have now ended or are about to be finalized. In addition, many of the projects from the first CfP under the second EF have ended or been extended. Subsequent projects are either about to start or are being implemented.

- *Latin America Investment Facility (LAIF)*

The European Commission also established the Latin America Investment Facility (LAIF) in 2010. The primary objective of LAIF is to finance key infrastructure projects in transport, energy, social and environmental sectors as well as to support private sector development in the Latin American region, in particular small- and medium-sized enterprises (SMEs). The main purpose of the LAIF is to mobilise additional financing to support investment in Latin America, encouraging beneficiary governments and public institutions to carry out essential investment in projects and programmes that could not be otherwise financed either by the market or by development Finance Institutions alone.

As part of its efforts to achieve this objective, LAIF pursues three strategic objectives:

- Improving interconnectivity between and within Latin American countries, in particular establishing better energy and transport infrastructure, including energy efficiency, renewable energy systems and the sustainability of transport and communication networks.
- Increasing the protection of the environment and supporting climate change adaptation and mitigation actions.
- Promoting equitable and sustainable socio-economic development through the improvement of social services infrastructure and support for small- and medium-sized enterprises (SMEs).

Since 2010, 43 projects (28 bilateral and 15 multi-country) have been launched, representing a total investment cost of approximately EUR 9 billion with an EU LAIF contribution of over EUR 377 million.

Caribbean Investment Facility

Like LAIF, CIF is one of the EU's regional blending facilities, which combine EU grants with other public and private sector resources to leverage additional non-grant financing to support investments in infrastructure and to support the private sector. The main purpose of CIF is to support investments in strategic economic infrastructure and private sector development, with a focus on small and medium-sized enterprises (SMEs), as well as to contribute to measures that help Caribbean countries to adapt to and mitigate the impacts of climate change.

The main strategic objectives of CIF are:

- Strengthening investments in strategic economic infrastructure, such as renewable energy, transport, information and communication technologies, and interconnectivity.
- Increasing investments in water and sanitation, climate adaptation and sustainable social infrastructure.
- Supporting investments in SME-development, including SMEs which contribute to the green economy.

CIF resources are made available under the European Development Fund (EDF), the EU's multiannual funding instrument to support countries in the African-Caribbean-Pacific (ACP) group.

Global Energy Efficiency and Renewable Energy Fund (GEEREF)

The Global Energy Efficiency and Renewable Energy Fund (GEEREF)[91], launched in 2008, aims to accelerate the transfer, development, use and enforcement of environmentally sound technologies for the world's poorer regions, helping to bring secure, clean and affordable energy to local people. GEEREF invests in regionally-oriented investment schemes and prioritises small investments below €10 million. It particularly focuses on serving the needs of the ACP, which is a group of 79 African, Caribbean and Pacific developing countries. It also invests in Latin America, Asia and neighbouring states of the EU (except for Candidate Countries). Priority is given to investment in countries with policies and regulatory frameworks on energy efficiency and renewable energy.

Economic Partnership Agreements

The EU through the Directorate General Development and Cooperation – EuropeAid also supports African, Caribbean and Pacific countries in diversifying their economies. These activities are not limited to fossil fuel exporting countries, but are open to ACP countries based on Economic Partnership Agreements (EPAs) [92]. EPAs help ACP countries integrate into the global economy and improve the business environment, build up regional markets and promote good economic governance through reinforced regional cooperation in trade related issues. The majority of ACP countries are either implementing an EPA or have concluded EPA negotiations with the EU.

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[91] https://geeref.com/

[92] https://ec.europa.eu/trade/policy/countries-and-regions/development/economic-partnerships/

15.3 European Neighbourhood Policy

Through its European Neighbourhood Policy (ENP), the EU works with its southern and eastern neighbours to achieve the closest possible political association and the greatest possible degree of economic integration. Energy policy and diplomacy also plays an important role in ENP especially in relation to the newly established Energy Union.

The Energy Union Communication[93] and the related European Council Conclusions of March 2015 recognised the importance of the external dimension of the Energy Union and asked for greater engagement on energy and climate diplomacy. In particular, Action Point 15 of the Energy Union Communication states:

- The EU will use all external policy instruments to ensure that a strong, united EU engages constructively with its partners and speaks with one voice on energy and climate.
- The Commission and the Member States will revitalise the EU's energy and climate diplomacy.
- The Commission will develop an active agenda to strengthen EU energy cooperation with third countries, including on renewable energy and energy efficiency.
- The Commission will make full use of the EU's external trade policy to promote access to energy resources and to foreign markets for European energy technology and services.

In July 2015, the Foreign Affairs Council adopted Council Conclusions on EU Energy Diplomacy, which included an EU Energy Diplomacy Action Plan[94]. The Action Plan has four pillars:

1. Strengthen strategic guidance through high-level engagement.
2. Establish and further develop energy cooperation and dialogues, particularly in support of diversification of sources, suppliers and routes.
3. Support efforts to enhance the global energy architecture and multilateral initiatives.
4. Strengthen common messages and energy diplomacy capacities.

The EEAS (European External Action Service) works closely with the Commission and the EU Member States to ensure the follow-up of the EU Energy Diplomacy Action Plan.

The 2015 review of the EU neighbourhood policy emphasised strong support to give energy cooperation a greater place in the ENP, both as a security measure (energy sovereignty) and as a means to sustainable economic development and to support greater energy independence through support to diversification of energy sources, better cooperation on energy efficiency, and transition to the low carbon economy[95].

The International Renewable Energy Agency IRENA) supports countries in their transition to a sustainable energy future, and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA, founded in 2009, promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic

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[93] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0080

[94] http://data.consilium.europa.eu/doc/document/ST-10995-2015-INIT/en/pdf

[95] https://ec.europa.eu/neighbourhood-enlargement/sites/near/files/neighbourhood/pdf/key-documents/151118_joint-communication_review-of-the-enp_en.pdf

growth and prosperity. 145 countries of the world (including the EU) are members of IRENA, 31 more are states in accession. The permanent headquarter is located in Masdar City, Abu Dhabi.

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17 UNITS AND ABBREVIATIONS

t	1 tonne (metric) = 1 megagram (Mg) = 10^6 g
Mg	1 megagram = 10^6 g = 1 tonne (t)
Gg	1 gigagram = 10^9 g = 1 kilotonne (kt)
Tg	1 teragram = 10^{12} g = 1 megatonne (Mt)
TJ	1 terajoule

AWMS	animal waste management systems
AD	activity data
BEF	biomass expansion factor
BKB	lignite briquettes
C	confidential
CAPRI	Common Agricultural Policy Regional Impact Assessment model (http://www.capri-model.org/)
CCC	Climate Change Committee (established under Council Decision No 280/2004/EC)
CH_4	methane
CO_2	carbon dioxide
COP	conference of the parties
CRF	common reporting format
CV	calorific value
EC	European Community
EEA	European Environment Agency
EF	emission factor
Eionet	European environmental information and observation network
EMAS	Ecomanagement and Audit Scheme
ETC/CME	European Topic Centre on Climate Change Mitigation and Energy
ETS	European Emissions Trading System
EU	European Union

FAO	Food and Agriculture Organisation of the United Nations
GHG	greenhouse gas
GPG	good practice guidance and uncertainty management in national greenhouse gas inventories (IPCC, 2000)
GWP	global warming potential
HFCs	hydrofluorocarbons
JRC	Joint Research Centre
F-gases	fluorinated gases (HFCs, PFCs, SF_6)
IE	included elsewhere
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
KP	Kyoto Protocol
LULUCF	land-use, land-use change and forestry
MNP	Milieu-en Natuurplanbureau
MS	Member State
MRG	monitoring and reporting guidelines
N	nitrogen
NH_3	ammonia
N_2O	nitrous oxide
NA	not applicable
NE	not estimated
NFI	national forest inventory
NIR	national inventory report
NO	not occurring
NUTS	Nomenclature of Territorial Units for Statistics
PFCs	perfluorocarbons
QA	quality assurance
QA/QC	quality assurance/quality control
QM	quality management

QMS	quality management system
RIVM	National Institute of Public Health and the Environment (The Netherlands)
SF_6	sulphur hexafluoride
SNE	Single National Entity
UNFCCC	United Nations Framework Convention on Climate Change
VOCs	Volatile Organic Compounds

Abbreviations in the source category tables in Chapters 3 to 9 and 18-24

Methods applied	EF: methods applied for determining the emission factor	AD: methods applied for determining the activity data	Estimate: assessment of completeness	Quality: assessment of the uncertainty of the estimates
CR — Corinair	CR — Corinair	AS — associations, business organizations	All — full	H — high
CS — country-specific	CS — country-specific	IS — international statistics	F — full	M — medium
COPERT X — Copert Model X = version	D — default	NS — national statistics	Full — full	L — low
D — default	M — model	PS — plant specific data	IE — included elsewhere	
M — model	MB — mass balance	Q — specific questionnaires, surveys	NE — not estimated	
NA — not applicable	PS — plant-specific	RS — regional statistics	NO — not occurring	
OTH - other				
RA — reference approach			P — partial	
T1 — IPCC Tier 1			Part — partial	

Methods applied	EF: methods applied for determining the emission factor	AD: methods applied for determining the activity data	Estimate: assessment of completeness	Quality: assessment of the uncertainty of the estimates
T1a — IPCC Tier 1a				
T1b — IPCC Tier 1b				
T1c — IPCC Tier 1c				
T2 — IPCC Tier 2				
T3 — IPCC Tier 3				