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Annual European Union greenhouse gas inventory 1990–2017 and inventory report 2019

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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 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 present report is the official inventory submission of the European Union for 2019 under the UNFCCC and also under the Kyoto Protocol (KP).

The EU, its Member States and Iceland have agreed to fulfil their quantified emission limitation and reduction commitments under Article 3 of the Kyoto Protocol for the second commitment period to the Kyoto Protocol jointly, in accordance with the provisions of Article 4 thereof. The Union, its Member States 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' 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'.

This report, therefore, refers to the totals of the EU-28 plus Iceland. For reasons of clarity, please note that in some cases the terms '(EU-28) Member States' and 'EU-28'/'EU' may be used. As a general rule, these terms also refer to Iceland.

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

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[1].

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 Kyoto Protocol 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;

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

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 new Monitoring Mechanism Regulation has enhanced the reporting rules on GHG emissions to meet the requirements arising from international climate agreements, as well as the 2009 EU climate and energy package. Since in 2014, GHG inventory reporting has taken place under this new legal instrument, which 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 EU Member States making up the EU-28. 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 28 Member States plus Iceland, 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 Change Mitigation (ETC/ACM), Eurostat, and the Joint Research Centre (JRC).

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

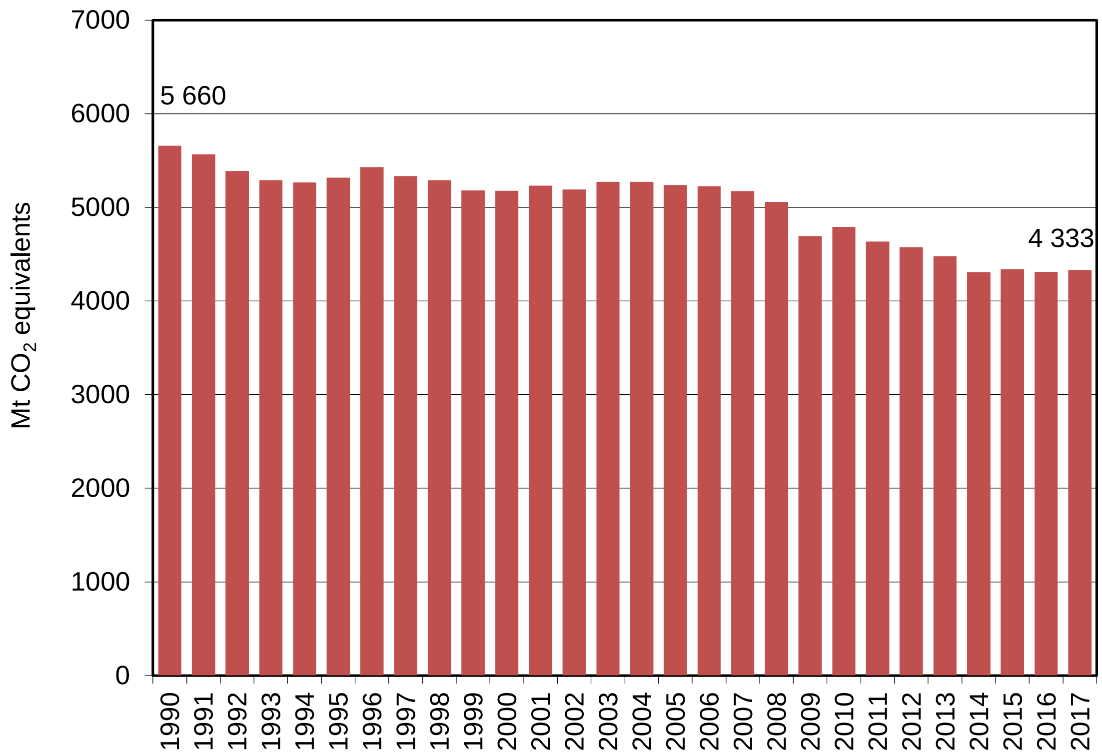
1. Member States submit their annual GHG inventories by 15 January each year to the European Commission (DG CLIMA), with a copy to the EEA.
2. The EEA and its ETC/ACM, Eurostat, and the JRC then perform initial checks on the data submitted. Specific findings from the initial quality assurance/quality 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/ACM 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.
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-28 plus Iceland amounted to 4 333 million tonnes CO_2 equivalent in 2017 (including indirect CO_2 emissions). All GHG emission totals provided in this report include indirect CO_2 emissions[2].

In 2017, total GHG emissions were 23.5% (1 327 million tonnes CO_2 equivalents) below 1990 levels. Emissions increased by 0.5 % (20 million tonnes CO_2 equivalent) between 2016 and 2017 (Figure ES. 1).

Figure ES. 1 EU-28 plus Iceland GHG emissions (excl. LULUCF)



Notes: GHG emissions data for the EU-28 plus Iceland as a whole refer to domestic emissions (i.e. within the 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] 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 them. The CRF tables include national totals, including and excluding indirect CO_2 emissions.

1.1 Main trends by source category, 1990-2017

Total GHG emissions (excluding LULUCF and excluding international aviation) decreased by 1327 million tonnes since 1990 (or 23.5 %) reaching their lowest level during this period in 2014 (4307 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 of about 58 % alongside a decrease in emissions of 23 % over the period.

The reduction in greenhouse gas emissions over the 27-year period was due to a variety of factors, including the growing share in the use of renewables, the use of less carbon intensive fuels and improvements in energy efficiency, as well as to structural changes in the economy and the economic recession. 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 2017, 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 and residential combustion.

A combination of factors explains lower emissions in industrial sectors, such as improved efficiency and 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. The economic recession that began in the second half of 2008 and continued through to 2009 also had an impact on emissions from industrial sectors. 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 2017, the use of solid and liquid fuels in thermal power stations decreased strongly whereas natural gas consumption more than doubled, resulting 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 as a whole over the past 27 years. The very strong increase in the use of biomass for energy purposes has also contributed to lower GHG emissions in the EU.

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 agricultural soils. A number of policies (both EU and country-specific) have also 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 about 50% of the total net reduction in the EU of the past 27 years.

Table ES. 1 shows those sources that made the largest contribution to the change in total GHG emissions in the EU plus Iceland between 1990 and 2017.

Table ES. 1 Overview of EU-28 plus Iceland source categories whose emissions increased or decreased by more than 20 million tonnes CO_2 equivalent in the period 1990–2017

Source category	Million tonnes (CO_2 equivalents)
Road Transportation (CO2 from 1.A.3.b)	170
Refrigeration and Air conditioning (HFCs from 2.F.1)	93
Aluminium Production (PFCs from 2.C.3)	-21
Agricultural Soils: Direct N2O Emissions From Managed Soils (N2O from 3.D.1)	-22
Cement Production (CO2 from 2.A.1)	-26
Fluorochemical Production (HFCs from 2.B.9)	-29
Fugitive emisisons from Natural Gas (CH4 from 1.B.2.b)	-37
Commercial/Institutional (CO2 from 1.A.4.a)	-38
Enteric Fermentation: Cattle (CH4 from 3.A.1)	-43
Nitric Acid Production (N2O from 2.B.2)	-46
Adipic Acid Production (N2O from 2.B.3)	-56
Manufacture of Solid Fuels and Other Energy Industries (CO2 from 1.A.1.c)	-60
Coal Mining and Handling (CH4 from 1.B.1.a)	-66
Managed Waste Disposal Sites (CH4 from 5.A.1)	-73
Residential: Fuels (CO2 from 1.A.4.b)	-115
Iron and steel production (CO2 from 1.A.2.a +2.C.1)	-116
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A.2.a)	-253
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-433
Total	**-1327**

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.

1.2 Main trends by source category, 2016–2017

Total GHG emissions (excluding LULUCF) increased in 2017 by 19.9 million tonnes, or 0.5 % compared to 2016, to reach 4333 Mt CO_2 equivalent in 2017. This increase in emissions came along with an increase in GDP of 2.5 %. Poland and Spain accounted for the largest increases in GHG emissions in absolute terms in the EU in 2017.

At EU level, there was increased economic activity and higher emissions in several industrial sectors during 2017. In addition, emissions from road transportation increased for the fourth consecutive year since 2013, both for freight and passenger vehicles. Most of the increase was accounted for by higher consumption of diesel by heavy duty trucks and light duty vehicles, but consumption also increased for passenger cars.

In terms of fuels, there was a significant increase in the use of natural gas and of liquid fossil fuels, which were partly offset by a decline in coal consumption. Based on Eurostat data, there was a decline in nuclear energy in 2017 and a strong increase in the use of renewable energy sources.

The overall 0.5% net increase in total GHG emissions in 2017 was partly offset by lower fossil-fuel consumption and emissions in the production of heat and electricity in power stations, with lower use of coal and higher use of natural gas and renewables. In addition, the energy and carbon intensity of the economy improved. These were largely driven by lower transformation losses and better energy efficiency, on the one hand, and by the higher share of renewables and of natural gas in the fuel mix compared to coal, on the other.

Table ES. 2 shows the source categories making the largest contribution to the change in GHG emissions in the EU-28 between 2016 and 2017.

Table ES. 2 Overview of EU-28 plus Iceland source categories whose emissions increased or decreased by more than 3 million tonnes CO_2 equivalent in the period 2016–2017

Source category	Million tonnes (CO_2 equivalents)
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A.2.a)	12
Road Transportation (CO2 from 1.A.3.b)	11
Agricultural Soils: Direct N2O Emissions From Managed Soils (N2O from 3.D.1)	3
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-17
Total	**20**

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 country grouping does not match the total change listed at the bottom of the table.

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

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

	1990 (million tonnes)	2017 (million tonnes)	2016 - 2017 (million tonnes)	Change 2016 - 2017 (%)	Change 1990-2017 (%)
Austria	78.7	82.3	2.7	3.3%	4.6%
Belgium	146.6	114.5	-1.2	-1.1%	-21.9%
Bulgaria	101.8	61.4	2.3	3.9%	-39.7%
Croatia	31.9	25.0	0.6	2.6%	-21.5%
Cyprus	5.7	8.9	0.2	2.3%	57.8%
Czechia	199.2	129.4	-1.1	-0.9%	-35.1%
Denmark	70.3	47.9	-2.3	-4.5%	-31.9%
Estonia	40.4	20.9	1.2	6.2%	-48.4%
Finland	71.3	55.4	-2.7	-4.7%	-22.3%
France	548.1	464.6	3.9	0.9%	-15.2%
Germany	1251.0	906.6	-4.4	-0.5%	-27.5%
Greece	103.1	95.4	3.7	4.1%	-7.4%
Hungary	93.7	63.8	2.6	4.3%	-31.9%
Ireland	55.4	60.7	-0.5	-0.9%	9.6%
Italy	517.7	427.7	-4.4	-1.0%	-17.4%
Latvia	26.3	11.3	0.0	0.3%	-56.9%
Lithuania	48.2	20.4	0.2	1.1%	-57.7%
Luxembourg	12.8	10.2	0.2	1.8%	-19.8%
Malta	2.1	2.2	0.3	13.5%	2.3%
Netherlands	221.7	193.7	-2.1	-1.1%	-12.6%
Poland	474.4	413.8	14.7	3.7%	-12.8%
Portugal	59.2	70.7	4.6	7.0%	19.5%
Romania	248.1	113.8	-0.5	-0.4%	-54.1%
Slovakia	73.4	43.3	1.2	2.8%	-41.0%
Slovenia	18.6	17.5	-0.2	-1.3%	-6.4%
Spain	288.5	340.2	13.8	4.2%	17.9%
Sweden	71.3	52.7	-0.3	-0.5%	-26.1%
United Kingdom	794.4	470.5	-12.8	-2.6%	-40.8%
EU-28	**5653.7**	**4324.9**	**19.8**	**0.5%**	**-23.5%**
Iceland	3.6	4.8	0.1	2.5%	32.1%
United Kingdom (KP	797.1	473.6	-12.7	-2.6%	-40.6%
EU-28 + ISL	**5660.1**	**4332.7**	**19.9**	**0.5%**	**-23.5%**

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

Table ES. 4 gives an overview of the main trends in the EU-28 plus Iceland GHG emissions and removals for the period 1990–2017. By far the most important GHG is CO_2, which accounted for 81 % of total EU-28 emissions in 2017, excluding LULUCF. In 2017, EU-28 CO_2 emissions excluding LULUCF were 3 523 million tonnes, which was 21 % below 1990 levels. Compared to 2016, CO_2 emissions increased by 0.5 %. Emissions of CH_4 and N_2O slightly decreased.

Table ES. 4 Overview of EU-28 plus Iceland GHG emissions and removals from 1990 to 2017 in million tonnes CO_2 equivalent

GREENHOUSE GAS EMISSIONS	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Net CO_2 emissions/removals	4 212	3 936	3 870	3 986	3 830	3 492	3 615	3 482	3 424	3 333	3 176	3 208	3 198	3 245
CO_2 emissions (without LULUCF)	4 478	4 225	4 189	4 315	4 171	3 833	3 949	3 804	3 746	3 658	3 489	3 522	3 505	3 523
CH_4	740	679	618	557	523	511	501	491	487	476	469	469	465	466
N_2O	401	360	323	303	283	267	257	253	250	250	254	250	254	256
HFCs	29	44	55	77	97	98	104	106	109	111	114	110	107	105
PFCs	26	17	12	7	5	3	4	4	4	4	3	4	4	3
Unspecified mix of HFCs and PFCs	6	6	3	1	1	2	1	1	1	1	1	1	1	2
SF_6	11	15	11	8	7	6	6	6	6	6	6	6	6	7
NF_3	0.02	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.05
Total (with net CO_2 emissions/removals)	**5 425**	**5 058**	**4 891**	**4 939**	**4 746**	**4 380**	**4 488**	**4 343**	**4 281**	**4 181**	**4 023**	**4 047**	**4 036**	**4 084**
Total (without CO2 from LULUCF)	**5 691**	**5 346**	**5 210**	**5 268**	**5 087**	**4 721**	**4 822**	**4 665**	**4 603**	**4 507**	**4 335**	**4 361**	**4 343**	**4 363**
Total (without LULUCF)	**5 660**	**5 318**	**5 179**	**5 238**	**5 058**	**4 692**	**4 794**	**4 636**	**4 573**	**4 479**	**4 307**	**4 337**	**4 313**	**4 333**

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-28 plus Iceland GHG emissions in the main source categories for the period 1990–2017. The most important sector by far is energy (i.e. combustion and fugitive emissions), which accounted for 78 % of total EU emissions in 2017. The second largest sector is agriculture (10 %), 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-28 GHG emissions (in million tonnes CO_2-equivalent) in the main source and sink categories for the period 1990 to 2017

GHG SOURCE AND SINK	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1. Energy	4 353	4 095	4 025	4 127	3 986	3 707	3 803	3 655	3 611	3 522	3 342	3 378	3 359	3 372
2. Industrial Processes	518	499	457	467	453	379	396	392	379	377	383	379	376	380
3. Agriculture	544	474	462	439	435	429	424	425	423	426	434	435	436	440
4. Land-Use, Land-Use Change and Forestry	-236	-261	-288	-299	-312	-312	-305	-294	-292	-297	-284	-290	-276	-249
5. Waste	241	248	232	202	182	176	168	163	158	152	146	144	141	139
6. Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
indirect CO_2 emissions	4.2	3.5	2.9	2.5	2.3	2.1	2.2	2.1	2.0	1.8	1.8	1.8	1.7	1.7
Total (with net CO_2 emissions/removals)	**5 425**	**5 058**	**4 891**	**4 939**	**4 746**	**4 380**	**4 488**	**4 343**	**4 281**	**4 181**	**4 023**	**4 047**	**4 036**	**4 084**
Total (without LULUCF)	**5 660**	**5 318**	**5 179**	**5 238**	**5 058**	**4 692**	**4 794**	**4 636**	**4 573**	**4 479**	**4 307**	**4 337**	**4 313**	**4 333**

Notes: CO_2 emissions include indirect CO_2

ES-5 SUMMARY OF EU MEMBER STATE EMISSION TRENDS

Table ES. 6 gives an overview of Member State contributions to EU GHG emissions for the period 1990–2017. Member States show large variations in GHG emissions trends.

Table ES. 6 Overview of EU-28 plus Iceland contributions to total GHG emissions, excluding LULUCF, from 1990 to 2017 in million tonnes CO_2-equivalent

Member State	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Austria	79	80	80	93	87	80	85	82	80	80	77	79	80	82
Belgium	147	155	150	145	139	126	133	122	119	119	114	117	116	115
Bulgaria	102	75	60	64	67	58	61	66	61	56	59	62	59	61
Croatia	32	23	26	30	31	28	28	28	26	25	24	24	24	25
Cyprus	5.7	7.1	8.4	9.3	10	9.8	9.5	9.1	8.6	7.8	8.2	8.3	8.7	8.9
Czechia	199	158	150	149	147	138	141	139	135	129	128	129	131	129
Denmark	70	78	71	66	66	63	63	58	53	55	51	48	50	48
Estonia	40	20	17	19	20	17	21	21	20	22	21	18	20	21
Finland	71	72	70	70	71	68	76	68	62	63	59	55	58	55
France	548	543	552	555	526	506	512	486	485	485	455	460	461	465
Germany	1251	1123	1045	993	976	908	943	920	925	942	903	907	911	907
Greece	103	109	126	136	132	125	118	115	112	103	99	95	92	95
Hungary	94	75	73	75	71	65	65	63	60	57	57	61	61	64
Ireland	55	59	68	69	67	62	61	57	58	57	57	59	61	61
Italy	518	532	554	581	548	496	506	492	473	443	426	434	432	428
Latvia	26	13	11	11	12	11	12	12	11	11	11	11	11	11
Lithuania	48	22	20	23	24	20	21	21	21	20	20	20	20	20
Luxembourg	13	10	10	13	12	12	12	12	12	11	11	10	10	10
Malta	2.1	2.7	2.8	2.9	3.1	2.9	2.9	3.0	3.2	2.9	2.9	2.2	1.9	2.2
Netherlands	222	232	220	215	208	202	214	200	196	195	188	196	196	194
Poland	474	445	395	403	411	393	412	411	404	400	387	390	399	414
Portugal	59	69	82	86	76	73	69	68	66	64	64	68	66	71
Romania	248	187	143	151	150	130	124	129	126	116	116	116	114	114
Slovakia	73	53	49	51	50	45	46	46	43	43	41	42	42	43
Slovenia	19	19	19	21	22	20	20	20	19	18	17	17	18	17
Spain	288	329	388	441	411	372	358	357	351	323	326	338	326	340
Sweden	71	73	68	67	63	58	64	60	57	55	54	53	53	53
United Kingdom	794	748	712	691	652	596	610	563	580	566	526	508	483	471
EU-28	**5654**	**5312**	**5172**	**5231**	**5049**	**4684**	**4786**	**4628**	**4565**	**4471**	**4299**	**4329**	**4305**	**4325**
Iceland	3.6	3.4	4.0	3.9	5.2	4.9	4.8	4.6	4.6	4.6	4.6	4.7	4.6	4.8
United Kingdom (KP)	797	750	715	694	655	599	613	566	583	569	529	511	486	474
EU-28 + ISL	**5660**	**5318**	**5179**	**5238**	**5058**	**4692**	**4794**	**4636**	**4573**	**4479**	**4307**	**4337**	**4313**	**4333**

The overall EU GHG emission trend is dominated by the three largest emitters, Germany (21 %), the United Kingdom (11 %) and France (11 %), accounting for over forty percent of total EU-28 GHG emissions in 2017. Germany and the United Kingdom, the two Member States with the highest absolute reductions, achieved total domestic GHG emission reductions of 668 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.

ES-6 OTHER INFORMATION

INTERNATIONAL AVIATION AND MARITIME TRANSPORTATION

GHG emissions from international aviation increased by 130 % between 1990 and 2017and GHG emissions from international shipping increased by 32 % during the same period. In 2017 international aviation accounted for 159 million tonnes CO_2 equivalent and international shipping for 146 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 Member States, 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' GHG inventories in 2019, total EU GHG emissions (excluding LULUCF) for 2016 were 0.3 % higher than those reported in the 2018 GHG inventories. Total EU emissions in 1990, reported in 2019 GHG inventories, were 0.1 % higher than the 1990 emissions reported in 2018 inventories.

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

PART 1: ANNUAL INVENTORY SUBMISSION (EU-28)

1 INTRODUCTION TO THE EU GREENHOUSE GAS INVENTORY

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 present report is the official inventory submission of the European Union for 2018 under the UNFCCC and the Kyoto Protocol (KP).

The EU, its Member States and Iceland have agreed to fulfil their quantified emission limitation and reduction commitments under Article 3 of the Kyoto Protocol for the second commitment period to the Kyoto Protocol jointly, in accordance with the provisions of Article 4 thereof. The Union, its Member States 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' 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'.

This report, therefore, refers to the totals of the EU-28 plus Iceland. For reasons of clarity, please note that in some cases the terms '(EU-28) Member States' and 'EU-28'/'EU' may be used. As a general rule, these terms also refer to Iceland.

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 2018 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[3] (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-28 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, Sweden and the United Kingdom. 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 28 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[4]. For this purpose, the Commission has to prepare a 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,

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

[4] 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).

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 moNO_xide (CO), sulphur dioxide (SO_2), nitrogen oxides (NO_x) 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[5]. 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.

1.2 A description of the institutional arrangements

1.2.1 Institutional, legal and procedural arrangements

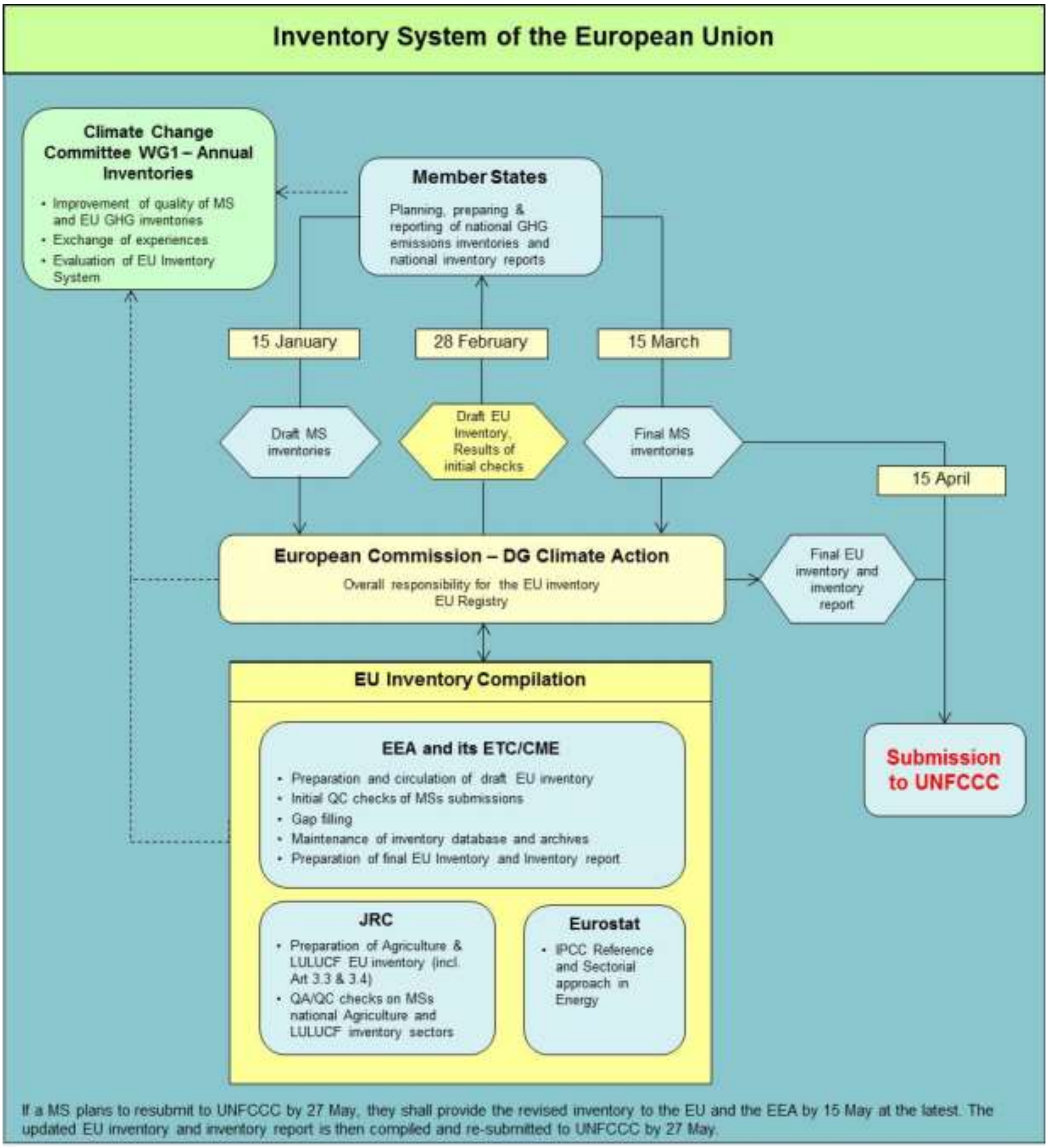
In accordance with the MMR Article 6(1), a Union Inventory system is established to ensure the timeliness, transparency, accuracy, consistency, comparability and completeness of national inventories with regard the Union greenhouse gas inventory. The Commission's Staff Working Document (SWD (2013) 308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

[5] 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).

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

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) [7].

Figure 1.1 Inventory system of the European Union



[7] 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.

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 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	Kristi Põlluveer Ministry of the Environment Adviser, Climate Department kristi.polluveer@envir.ee Cris-Tiina Türkson Estonian Environmental Research Centre Adviser 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	Michael Strogies Federal Environmental Agency michael.strogies@uba.de
Greece	Mr. Kyriakos Psychas Ministry of Environment and Energy
Hungary	Mr. Gábor KIS-KOVÁCS Hungarian Meteorological Service kiskovacs.g@met.hu
Ireland	Paul Duffy Environmental Protection Agency p.duffy@epa.ie
Italy	M. Contaldi, R. de Lauretis, D. Romano National Environment Protection Agency (ANPA)

Member State/EU institution	Contact address
	riccardo.delauretis@isprambiente.it, daniela.romano@isprambiente.it
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.nl
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	Milos Grajcar Ministry of the Environment of the Slovak Republic Climate Change Department (National Focal Point) and Janka Szemesova Department of Emissions, 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	Johan Kristensson The Ministry of the Environment and Energy Frida Löfström The Swedish Environmental Protection Agency frida.lofstrom@naturvardsverket.se
United Kingdom	Julia Sussams UK Greenhouse Gas Inventory GHG Statistics & Inventory Team julia.sussams@decc.gsi.gov.uk
European Commission	Olivier Juvyns European Commission, DG Climate Action Oliver.Juvyns@ec.europa.eu
European Environment Agency (EEA)	Ricardo Fernandez, Claire Qoul, Melanie Sporer 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	Nicole Mandl, Günther Schmidt, Elisabeth Rigler European Topic Centre on Air Pollution and Climate Change Mitigation

Member State/EU institution	Contact address
and Energy (ETC/CME)	Umweltbundesamt nicole.mandl@umweltbundesamt.at, günther.schmidt@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, Institute for Environment and Sustainability, Climate Change Unit 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 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[8] (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 the Belgium and EEA for the years 2019-2021, continuing the work of the previous ETC on continuing 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);

[8] 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

Element	Who	When	What
			to facilitate the use for the Union 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-28 and Iceland submissions in 2019 that were taken into account for the compilation EU GHG inventory.

Table 1.3 Date, mode and content of submission of EU-28 Member States and Iceland in 2019 that were taken into account for the compilation of EU GHG inventory

MS	date	Submission mode	XML	CRF	NIR
AUT	15.04.2019	CDR	AUT_2019_2_10042019_211858396556375199031164 6.xml	1990-2017	x
BEL	15.04.2019	CDR	BEL_2019_1_12042019_030741262282746089638228 4.xml	1990-2017	x

MS	date	Submission mode	XML	CRF	NIR
BGR	12.04.2019	CDR	BGR_2019_1_12042019_0007468489209121838502966.xml	1988-2017	x
CYP	28.04.2019	CDR			x
	07.05.2019	CDR	CYP_2019_5_07052019_1316527183273013162190112.xml	1990-2017	
CZE	12.04.2019	CDR	CZE_2019_1_04042019_1633058988853633950112718.xml	1990-2017	x
DEU	15.04.2019	CDR	DEU_2019_1_03042019_1348553281852248379932494.xml	1990-2017	x
DNM	15.04.2019	CDR	DNM_2019_1_11042019_1725003055298880573038786.xml	1990-2017	x
ESP	03.04.2019	CDR	ESP_2019_1_01042019_2150492491305319365421509.xml	1990-2017	x
EST	15.03.2019	CDR	EST_2019_1_14032019_0055391773727483281178681.xml	1990-2017	x
FIN	10.04.2019	CDR	FIN_2019_4_10042019_1123582457556681690788447.xml	1990-2017	x
FRK	18.03.2019	CDR	FRK_2019_2_10032019_2254028116817340568814365.xml	1990-2017	x
GBE	16.03.2019	CDR	GBE_2019_1_15032019_1926365691954683752113179.xml	1990-2017	x
GBK	16.03.2019	CDR	GBK_2019_2_16032019_014158130238187060115736.xml	1990-2017	x
GRC	15.03.2019	CDR	GRC_2019_1_25022019_1656473941737968585306860.xml	1990-2017	x
HRV	08.05.2019	CDR	HRV_2019_2_18042019_1046094887335755710039737.	1990-2017	x
HUN	16.03.2019	CDR	HUN_2019_2_15032019_2047031252030280512181599.xml	1985-2017	x
IRL	15.04.2019	CDR	IRL_2019_2_09042019_200126153576390599241470.xml	1990-2017	x
ITA	18.03.2019	CDR	ITA_2019_1_15032019_0048396106476930074154432.xml	1990-2017	
	24.03.2019	CDR			x
LTU	15.03.2019	CDR	LTU_2019_1_14032019_1956442892124684325091941.xml	1990-2017	x
LUX	15.03.2019	CDR	LUX_2019_1_13032019_1207072902692146976222305.xml	1990-2017	x
LVA	12.04.2019	CDR	LVA_2019_2_12042019_0731397850772921806684210.xml	1990-2017	x
MLT	08.05.2019	CDR	MLT_2019_4_17042019_0949125032701374848804953.xml	1990-2017	x
NLD	15.04.2019	CDR	NLD_2019_1_15042019_2145302882737856044490218.xml	1990-2017	x
POL	10.04.2019	CDR		1988-2017	x
	10.05.2019	CDR	POL_2019_2_10052019_1116321310086192232837460.xml	1988-2017	

MS	date	Submission mode	XML	CRF	NIR
PRT	07.05.2019	CDR	PRT_2019_2_26042019_1558034126418039201491521.xml	1990-2017	x
ROU	08.05.2019	CDR	ROU_2019_3_02052019_0204424529877355928983107.xml	1989-2017	x
SVK	11.03.2019	CDR	SVK_2019_4_06032019_1743325125142199039914229.xml	1990-2017	
	30.04.2019	CDR		1990-2017	x
SVN	15.04.2019	CDR	SVN_2019_3_10042019_1640362292736613116176681.xml	1986-2017	x
SWE	14.03.2019	CDR	SWE_2019_1_05032019_2031373748551322109971 43.xml	1990-2017	x
ISL	15.03.2019	CDR	ISL_2019_1_14032019_203652.xml	1990-1997, 1999-2001, 2003-2007, 2009-2017	x
	19.03.2019	CDR		1998, 2002, 2008	

Table 1.4 gives an overview on people involved in the compilation of the EU GHG inventory submission in 2018 and their individual responsibilities in this process.

Table 1.4 Responsibility list for the compilation of the EU GHG inventory submission in 2019

	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
Commission	Olivier JUVYNS (DG Clima) Olivier.JUVYNS@ec.europa.eu	X		Chapter 13 Changes national system	**QA NIR:** Executive summary, chapter 1	X			
	Francesca LANZA (DG Clima) Francesca.LANZA@ec.europa.eu			Chapter 12 Kyoto units, Chapter 14 Changes to registry, EU-SEF Tables					
	Adrian Leip (JRC) adrian.leip@ec.europa.eu			sector 3				sector 3	sector3
	Janka Szemesova (JRC) janka.szemesova@shmu.sk				**QA NIR:** sector 3			sector 3	
	Gema Carmona (JRC) gema.carmona-garcia@ec.europa.eu			sector 3				sector 3	
	Giacomo Grassi (JRC) giacomo.grassi@ec.europa.eu				**QA NIR:** sector 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			**QA NIR:** Executive summary, chapter 1, trend chapter, chapter 10	X			
	Claire Qoul (EEA) claire.qoul@eea.europa.eu	X				X			sector3
	Melanie Sporer (EEA) melanie.sporer@eea.europa.eu					X			
	Herdis Gudbrandsdottir (EEA) herdis.gudbrandsdottir@eea.europa.eu			Data checks					
	Michael Gager (ETC-CME; UBA-V) michael.gager@umweltbundesamt.at		Data manager						

	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
	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	sectors 1B, 1C	
	Eva Krtkova (ETC-CME;CHMI) eva.krtkova@chmi.cz			1A2, 1A4, 1A5				1A2, 1A4, 1A5	
	Beata Ondrusova (ETC-CME; CHMI) beata.ondrusova@chmi.cz			1A2, 1A4, 1A5				1A2, 1A4, 1A5	
	Céline GUEGUEN (ETC-CME; CITEPA) celine.gueguen@citepa.org			sector 5				sector 5	
	Coralie JEANNOT (ETC-CME; CITEPA) coralie.jeannot@citepa.org			EU ETS				EU ETS	
	Julien Vincent (ETC-CME; CITEPA) julien.vincent@citepa.org			1A1				1A1	1B, 1C, 1AB
	Laetitia Nicco (ETC-CME; CITEPA) laetitia.nicco@citepa.org			1A1					
	Giorgos Mellios (ETC-CME; Emisia) giorgos.m@emisia.com			1A3 + bunkers, comparison with Eurocontrol					sectors 1A3 + bunkers
	Matina Kastori (ETC-CME; Emisia) matina.k@emisia.com			1A3 + bunkers, comparison with Eurocontrol				sectors 1A3 + bunkers	
	Barbara Gschrey (ETC-CME; Oeko Recherche) b.gschrey@oekorecherche.de			F-gases 2E, 2F, 2G1-2				F-gases 2E, 2F, 2G1-2	
	Steffi Osterheld (ETC-CME; Oeko Recherche) steffi.osterheld@oekorecherche.de			F-gases 2E, 2F, 2G1-3				F-gases 2E, 2F, 2G1-3	
	Graham Anderson (ETC-CME; Oeko) g.anderson@oeko.de			sectors 2A, 2B				sectors 2A, 2B	
	Lorenz Moosmann (ETC-CME; Oeko) l.moosmann@oeko.de			sectors 2A, 2B, Chapter 15				sectors 2A, 2B	
	Bernd Gugele (ETC-CME, UBA-V) bernd.gugele@umweltbundesamt.at			1A Reference approach	**QA NIR:** sector 1			1A Reference approach	QA sector 1(1A1, 1A2, 1A4, 1A5)

	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
	Bradley Matthews (ETC-CME, UBA-V) bradley.matthews@umweltbundesamt.at			uncertainties,					
	Maria Purzner (ETC-CME; UBA-V) maria.purzner@umweltbundesamt.at			2C, 2D, 2G3-2G4, 2H				2C, 2D, 2G3-2G4, 2H	sector 2 f-gases only
	Ils Moorkens (ETC-CME; VITO) ils.moorkens@vito.be				**QA NIR:** sector 2				sector 2 (excl. f-gases)
	Kaat Jespers (ETC-CME; VITO) kaat.jespers@vito.be				**QA NIR:** sector 5				sector 5

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 plan 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[9]) 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'.

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

QUALITY CHECKS EU INVENTORY REPORT

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 Guidelinesare 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, six 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 will be used to check Member States' compliance with their annual ESD targets. There are two types of reviews: annual and comprehensive. Comprehensive reviews will be carried out in 2016, 2020 and 2022 – 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 participate in step 2 on a voluntary basis. Final review reports are not yet available as the review is still ongoing.

The 3rd comprehensive review will happen in 2020.

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 Guidelinesand/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 again 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.

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 May 2019 19 guidance documents are available: three for the Energy Sector; seven for the IPPU Sector; four for the Agriculture Sector; five 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 this context the experts:

- Provided support via e-mail for two MS related to non-energy use of fuels and for one MS related to category 5D Waste water treatment.
- Organized four 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.

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 GHG inventory related workshops and expert meetings organised by the EU national system

Workshop/expert meeting	**Date and venue**
JRC technical workshop on LULUCF reporting under the Kyoto Protocol	16-17 May 2018 Arona, Italy
Joint Workshop of the Europestat 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
JRC technical LULUCF workshop under the UNFCCC, the Kyoto Protocol (KP) and the EU LULUCF Decision No 529/2013	02-03 May 2016, Stresa, Italy
Capacity building workshop for MS GHG inventory experts	18 February 2016, European Commission, Brussels
Three webinars to support EU MS in the calculation of aviation emissions under UNFCCC and LRTAP reporting based on EUROCONTROL data	November 2017,
JRC technical workshop on LULUCF reporting under the Kyoto Protocol,	26-27 May 2015 Arona (NO) Italy.
Improving national GHG inventories for the agriculture sector	5 Nov 2014, Seventh International Symposium on Non-CO_2 GHG (NCGG7), Amsterdam
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.
Energy balances, ETS and CRF activity data	27-28 June 2013, Eurostat, Luxembourg
Improvement of Fluorinated-gas inventories	21 May 2013, EEA, Copenhagen
LULUCF and KP-LULUCF technical workshop	27 February – 01 March 2013, JRC, Ispra
ESD capacity building workshop 2015	18 February, Brussels
ESD capacity building webinars 2016	4 October (IPPU); 5 October (Energy); 7 October; 10 October (Waste)
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

Most of the workshop reports are available at the website of the EEA/ETC-ACM: http://acm.eionet.europa.eu/meetings/past_html

LULUCF workshops organized by Joint Research Center of the European Commission are all available at http://forest.jrc.ec.europa.eu/activities/lulucf/workshops/

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 Guidelinesfor 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-28 GHG inventory is compiled on the basis of the inventories of the 28 Member States. The emissions of each source category are the sum of the emissions of the respective source and sink categories of the 28 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-28 on the basis of Eurostat energy data (see Section 3.6) and the key category analysis (Section 1.5) is separately performed at EU-28 level[10].

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.

[10] 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.

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 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-28 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-28 and Iceland.

Table 1.7 Manual changes in the CRF Reporter

Year	Sector	Source category	Parameter	Manual changes / inclusion in the CRF Reporter
1990-2017	Energy	1 AB, 1AC, 1AD	All	Enter Reference Approach data from Eurostat
2013-2017	Energy	1.A.1, 1.A.2, 1.B.1, 1.B.2, 2.B.10, 2.C.1.f, 2.C.7	CO_2, CH_4, N_2O 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.
1990-2017	IPPU	2.B, 2.C, 2.E, 2.F, 2.G, 2.H	f gases	Enter country-specific f gases
1990-2017	IPPU	2.C.7, 2.G.4, 2.H	CO_2, CH_4, N_2O, NO_x, NMVOC, SO_2	Enter country-specific emissions and recovery data.
2017	IPPU	2.A.1, 2.A.2, 2.B.1	AD	Replace aggregated activity (‘AD’) data with gap-filled AD provided by sector experts
1990-2017	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
1990-2017	Agriculture	3	CH_4, N_2O, NMVOC	Enter aggregated data from JRC
1990-2017	Agriculture	3	AD	Correct additional information with aggregated data from JRC
1990-2017	LULUCF	4G	All	Enter aggregated data (approach B)
1990-2017	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 2019\1.3.1.1 EU 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 higher tiers used in the EU 28 and Iceland 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

Source category gas	Share of higher Tier
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	94%
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	95%
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	97%
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	97%
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	96%
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	98%
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	94%
1.A.1.b Petroleum Refining: Solid Fuels (CO_2)	93%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	91%
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%
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	98%
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	100%
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	93%
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	91%
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	98%
1.A.2.c Chemicals: Liquid Fuels (CO_2)	91%

Source category gas	Share of higher Tier
1.A.2.c Chemicals: Solid Fuels (CO_2)	99%
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	92%
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)	81%
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)	96%
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	95%
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	59%
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	93%
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	98%
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	97%
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	73%
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	99%
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	83%
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	83%
1.A.2.g Other Manufacturing Industries and Constructions: Other Fuels (CO_2)	83%
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)	83%
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	93%
1.A.3.b Road Transportation: Diesel Oil (CO_2)	87%
1.A.3.b Road Transportation: Diesel Oil (N_2O)	100%
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	90%
1.A.3.b Road Transportation: Gasoline (CH_4)	99%
1.A.3.b Road Transportation: Gasoline (CO_2)	90%
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	96%
1.A.3.c Railways: Liquid Fuels (CO_2)	74%
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	79%
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	50 %
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	65%
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	54%
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	97%
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	39%
1.A.4.b Residential: Biomass (CH_4)	29%
1.A.4.b Residential: Gaseous Fuels (CO_2)	68%
1.A.4.b Residential: Liquid Fuels (CO_2)	54%
1.A.4.b Residential: Solid Fuels (CH_4)	15%
1.A.4.b Residential: Solid Fuels (CO_2)	58%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	68%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	54%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	42%
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	99%
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	90%
1.B.1.a Coal Mining and Handling: Operation (CH_4)	71%
1.B.2.a Oil: Operation (CH_4)	50%
1.B.2.a Oil: Operation (CO_2)	90%
1.B.2.b Natural Gas: Operation (CH_4)	81%
1.B.2.c Venting and Flaring: Operation (CO_2)	86%

Source category gas	Share of higher Tier
2.A.1 Cement Production: no classification (CO_2)	100%
2.A.2 Lime Production: no classification (CO_2)	99.9%
2.A.4 Other Process Uses of Carbonates: no classification (CO_2)	99.9%
2.B.1 Ammonia Production: no classification (CO_2)	92%
2.B.10 Other chemical industry: no classification (CO_2)	100%
2.B.2 Nitric Acid Production: no classification (N_2O)	100%
2.B.3 Adipic Acid Production: no classification (N_2O)	88%
2.B.8 Petrochemical and Carbon Black Production: no classification (CO_2)	100%
2.B.9 Fluorochemical Production: no classification (HFCs)	100%
2.B.9 Fluorochemical Production: no classification (Unspecified mix of HFCs and PFCs)	92%
2.C.1 Iron and Steel Production: no classification (CO_2)	96%
2.C.3 Aluminium Production: no classification (PFCs)	100%
2.D.3 Other non energy products: no classification (CO_2)	66%
2.F.1 Refrigeration and Air conditioning: no classification (HFCs)	>90%
2.F.2 Foam Blowing Agents: no classification (HFCs)	>80%
2.F.3 Fire Protection: no classification (HFCs)	>80%
2.F.4 Aerosols: no classification (HFCs)	>80%
3.A.1 Enteric Fermentation: Dairy Cattle (CH_4)	100%
3.A.1 Enteric Fermentation: Non-Dairy Cattle (CH_4)	100%
3.A.2 Enteric Fermentation: Sheep (CH_4)	91%
3.A.4 Enteric Fermentation: Other livestock (CH_4)	52%
3.B.1 CH_4 Emissions: Manure management (CH_4)	95%
3.B.2 N_2O Emissions: Manure management (N_2O)	61%
3.D.1 Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O)	11%
3.D.2 Agricultural Soils: Indirect N_2O Emissions From Managed Soils (N_2O)	5%
5.A.1 Managed Waste Disposal Sites: Waste (CH_4)	96%
5.A.2 Unmanaged Waste Disposal Sites: Waste (CH_4)	100%
5.B.1 Waste Composting: Waste (CH_4)	30%
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	48%
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	23%
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	42%

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 2012a) and for monitoring and reporting were adopted (EU 2012b).

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 2012b) and in the accreditation and verification regulation (AVR) (EU 2012a), 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 2012a).

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 2017 the main activities, number of entities and verified emissions reported under the EU ETS are presented inTable 1.9.

Table 1.9 Activities and emissions covered by the EU ETS in 2017

Main activity	Activity code	Number of entities	Verified emissions (Mt CO_2-eq.)
Combustion of fuels	20	7,255	1.149
Refining of mineral oil	21	135	124
Production of coke	22	20	11
Metal ore roasting or sintering	23	9	3
Production of pig iron or steel	24	243	125
Production or processing of ferrous metals	25	234	10
Production of primary aluminium	26	23	5
Production of secondary aluminium	27	35	1
Production or processing of non-ferrous metals	28	83	7
Production of cement clinker	29	256	118
Production of lime, or calcination of dolomite/magnesite	30	297	32
Manufacture of glass	31	367	18
Manufacture of ceramics	32	1,048	15
Manufacture of mineral wool	33	48	2
Production or processing of gypsum or plasterboard	34	38	1
Production of pulp	35	165	5
Production of paper or cardboard	36	583	22
Production of carbon black	37	18	2
Production of nitric acid	38	37	5
Production of adipic acid	39	3	0
Production of glyoxal and glyoxylic acid	40	1	0
Production of ammonia	41	29	22
Production of bulk chemicals	42	320	37
Production of hydrogen and synthesis gas	43	42	9
Production of soda ash and sodium bicarbonate	44	14	3
Capture of greenhouse gases under Directive 2009/31/EC	45	0	1
Other activity opted-in under Art. 24	99	256	1
All stationary installations		11,559	1.727

Source: EEA, 2019

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 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 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 Guidelinesare 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	• 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
	1.A.1.c Manufacture of solid fuels and other energy industries	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 Guidelinesdo 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 2006 IPCC Guidelines. 2006 IPCC Guidelines also do not provide methods to estimate emissions from additives.
33 Manufacture of mineral wool insulation	2.A.3 Glass production 2.A.4 Other process uses of carbonates	• Emissions are included in EU ETS only for installations with a melting capacity exceeding 20 tonnes per day. Inventory methodology has no

EU ETS activity	CRF category	Comment
material using glass, rock or slag	2.A.5 Other 1.A.2.f Non-metallic minerals	threshold. • 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 card-board 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 Guidelinesfor 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 Guidelinesfor 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

EU ETS activity	CRF category	Comment
		Chemicals
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 Guidelinesfor 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 Guidelinesto 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

EU ETS activity	CRF category	Comment
		and synthesis gas production are recognised as part of integrated chemical production. Therefore MS 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 (currently no emissions reported under the EU ETS)
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 (currently no emissions reported under the EU ETS)
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. 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 2006 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 601/2012), 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 2019

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 2019 to the European Commission, all 28 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. All Member States used EU ETS data to improve country-specific emission factors. 27 Member States reported that they used activity data (e.g. fuel use) provided under the EU ETS in the national inventory.

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 2019 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.

EEA (European Environment Agency) 2019: 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).

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 sub-mitted by the 28 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 2018, in November 2017 Member States received fuel and emissions data for the years 2005 to 2016 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 2017 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 2018 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 2016, 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 2018 and eventually recalculate time series for the period 2005 to 2017 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 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 EU-28 level, every Member State provides a national key category analysis which is independent from the assessment at EU-28 level. The EU-28 key category analysis is not intended to replace the key category analysis by Member States. The key category analysis at EU-28 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 EU-28 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-28 and Iceland, 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 2017 The assessment was carried out for emissions excluding LULUCF and including LULUCF.
  The key category analysis excluding LULUCF resulted in the identification of 89 key categories for the EU-28 and Iceland and cover 96 % of total EU-28 GHG emissions in 2017 (see Annex I). The key category analysis including LULUCF resulted in 104 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-28 key category in terms of level and trend.

Table 1.12 Key categories for the EU-28 and Iceland (Gg CO_2 equivalents)

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2017		1990	2017
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	107487	231909	T	L	L
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	176244	29601	T	L	L
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	10785	41841	T	L	L
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	8508	7606	0	L	L
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	1127162	686081	T	L	L
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	5275	25001	T	0	L
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	112274	90903	T	L	L
1.A.1.b Petroleum Refining: Solid Fuels (CO_2)	3633	106	T	0	0
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	17326	20259	T	L	L
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)	91075	30623	T	L	L
1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)	30921	18989	T	L	L
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	8509	1391	T	L	0
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	143081	79619	T	L	L
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	3925	7363	T	0	L
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	8054	1176	T	0	0
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	54752	38056	T	L	L
1.A.2.c Chemicals: Liquid Fuels (CO_2)	38771	18997	T	L	L
1.A.2.c Chemicals: Solid Fuels (CO_2)	14908	8638	0	L	L
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	13216	18742	T	L	L
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)	11414	1690	T	L	0
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)	8368	3250	T	L	0
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	19335	30892	T	L	L
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	19811	4140	T	L	0
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	12491	4626	T	L	0
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	27353	30808	T	L	L
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	44632	25327	T	L	L
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	1422	13410	T	0	L
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	57693	16327	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	95250	91454	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	110040	51335	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Other Fuels (CO_2)	2527	4637	T	0	0
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)	93501	14603	T	L	L
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	13355	15931	T	L	L
1.A.3.b Road Transportation: Diesel Oil (CO_2)	302440	634592	T	L	L
1.A.3.b Road Transportation: Diesel Oil (N_2O)	1829	7510	T	0	L
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	505	3508	T	0	0
1.A.3.b Road Transportation: Gasoline (CH_4)	5862	835	T	0	0
1.A.3.b Road Transportation: Gasoline (CO_2)	406878	232690	T	L	L
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	7336	16091	T	0	L
1.A.3.c Railways: Liquid Fuels (CO_2)	12960	6281	T	L	L
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	17867	13709	0	L	L
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	10327	5466	0	L	0

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2017		1990	2017
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	66431	112004	T	L	L
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	83757	37938	T	L	L
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	781	6174	T	0	L
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	47293	4289	T	L	0
1.A.4.b Residential: Biomass (CH_4)	9220	10649	T	L	L
1.A.4.b Residential: Gaseous Fuels (CO_2)	183807	251753	T	L	L
1.A.4.b Residential: Liquid Fuels (CO_2)	181491	98793	T	L	L
1.A.4.b Residential: Solid Fuels (CH_4)	9212	2953	T	L	0
1.A.4.b Residential: Solid Fuels (CO_2)	135151	37829	T	L	L
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	12477	11450	0	L	L
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	72474	60411	T	L	L
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	9741	4008	T	L	0
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	5953	10	T	0	0
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	14217	4348	T	L	0
1.B.1.a Coal Mining and Handling: Operation (CH_4)	97062	31049	T	L	L
1.B.2.a Oil: Operation (CH_4)	6819	1233	T	0	0
1.B.2.a Oil: Operation (CO_2)	9104	11657	T	L	L
1.B.2.b Natural Gas: Operation (CH_4)	51231	22577	T	L	L
1.B.2.c Venting and Flaring: Operation (CO_2)	8718	6894	0	L	L
2.A.1 Cement Production: no classification (CO_2)	102687	76703	0	L	L
2.A.2 Lime Production: no classification (CO_2)	25336	19141	0	L	L
2.A.4 Other Process Uses of Carbonates: no classification (CO_2)	11734	10608	0	L	L
2.B.1 Ammonia Production: no classification (CO_2)	33360	25518	0	L	L
2.B.10 Other chemical industry: no classification (CO_2)	6422	11935	T	0	L
2.B.2 Nitric Acid Production: no classification (N_2O)	49553	3628	T	L	0
2.B.3 Adipic Acid Production: no classification (N_2O)	57555	1056	T	L	0
2.B.8 Petrochemical and Carbon Black Production: no classification (CO_2)	14617	15196	T	L	L
2.B.9 Fluorochemical Production: no classification (HFCs)	29033	432	T	L	0
2.B.9 Fluorochemical Production: no classification (Unspecified mix of HFCs and PFCs)	5567	65	T	0	0
2.C.1 Iron and Steel Production: no classification (CO_2)	95439	62992	T	L	L
2.C.3 Aluminium Production: no classification (PFCs)	21277	491	T	L	0
2.D.3 Other non energy products: no classification (CO_2)	8421	6205	0	L	L
2.F.1 Refrigeration and Air conditioning: no classification (HFCs)	69	93048	T	0	L
2.F.2 Foam Blowing Agents: no classification (HFCs)	0	3344	T	0	0
2.F.3 Fire Protection: no classification (HFCs)	0	2641	T	0	0
2.F.4 Aerosols: no classification (HFCs)	3	5315	T	0	0
3.A.1 Enteric Fermentation: Dairy Cattle (CH_4)	104462	75806	0	L	L
3.A.1 Enteric Fermentation: Non-Dairy Cattle (CH_4)	102662	88418	T	L	L
3.A.2 Enteric Fermentation: Sheep (CH_4)	28631	20224	0	L	L
3.A.4 Enteric Fermentation: Other livestock (CH_4)	6154	6178	0	0	L
3.B.1 CH_4 Emissions: Manure management (CH_4)	52537	42120	0	L	L
3.B.2 N_2O Emissions: Manure management (N_2O)	29952	22278	0	L	L
3.D.1 Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O)	156403	134209	T	L	L
3.D.2 Agricultural Soils: Indirect N_2O Emissions From Managed Soils (N_2O)	36989	30012	0	L	L

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2017		1990	2017
4.A.1 Forest Land: Land Use (CO_2)	-356186	-331368	T	L	L
4.A.2 Forest Land: Land Use (CO_2)	-38223	-42117	T	L	L
4.B.1 Cropland: Land Use (CO_2)	24526	18631	0	L	L
4.B.2 Cropland: Land Use (CO_2)	48709	40781	T	L	L
4.C.1 Grassland: Land Use (CO_2)	47667	34014	0	L	L
4.C.2 Grassland: Land Use (CO_2)	-17981	-22191	0	L	L
4.D.1 Wetlands: Land Use (CO_2)	7993	10728	T	0	L
4.D.2 Wetlands: Land Use (N_2O)	4094	109	T	0	0
4.E.2 Settlements: Land Use (CO_2)	34508	40831	T	L	L
4.G Harvested Wood Products: Wood product (CO_2)	-30835	-40597	0	L	L
5.A.1 Managed Waste Disposal Sites: Waste (CH_4)	160227	87422	T	L	L
5.A.2 Unmanaged Waste Disposal Sites: Waste (CH_4)	28118	12787	T	L	L
5.B.1 Waste Composting: Waste (CH_4)	378	2892	T	0	0
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	24495	11904	T	L	L
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	8268	6996	0	0	L
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	11286	7937	0	L	L

Note: EU totals for 2017 in sector Energy and IPPU may not include data for Sweden due to confidential reporting.

1.6 General uncertainty evaluation

The EU-28 uncertainty analysis was made on basis of the Tier 1 uncertainty estimates, which were submitted from the Member States under Article 7(1)(p) of Regulation (EU) 252/2013.

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 2006 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 2006 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 assumption on correlation between years has much larger effect on trend uncertainty than the assumption on correlation 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 simplicity, in 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:

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

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 (0.9 %), the highest estimates are for waste (51.5 %). Overall level uncertainty estimates including LULUCF of all EU-28 and Iceland GHG emissions is calculated with 5.9 % and excluding LULUCF slightly lower with 5.2 %.

With regard to trend uncertainty estimates the lowest uncertainty estimates are for fuel combustion activities (+/-0.3 percentage points), the highest estimates are for Waste (19.4percentage 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 uncertainty analysis for emissions reported for 2017 are very similar to the results of the previous year. The biggest change of level uncertainty can be identified in sector

Fugitive emissions. The uncertainty increase is due to an almost 6-fold increase in CH_4 emissions from sector 1B1a reported by Romania, which according to the Romanian submission are associated with a relative uncertainty of ca. 200%. Trend uncertainties changed substantially for the sectors Waste and LULUCF. The increased trend uncertainty for Waste emissions is driven by larger base year–latest year differences in the emissions reported for the inherently uncertain sectors 5.D (N_2O) and 5.B (N_2O and CH_4). The reduced trend uncertainty for LULUCF is caused by changes in emissions/uncertainties for the sectors 4F and 4G. Emissions of CO_2 from the sector 4F, which are significant in terms of LULUCF base year–latest year emission trends, are now associated with a reduced level and trend uncertainty compared with the 2018 submission. This is due a revised uncertainty estimate (from 1893 % to 60%) for Austria's emissions in this subsector. Emissions (removals) of CO_2 from the sector 4G, which in the 2018 submission demonstrated only a marginal base year–latest year emissions change, are now associated with a 21% change between the base year and 2017 and subsequently contribute significantly to the total LULUCF sector base year-2017 trend. The increase in the overall EU trend for 4G has been mainly driven by the substantially increased subsector trends of Croatia, Germany, and Sweden. These changes have led to a reduced LULUCF trend uncertainty due the relatively low trend uncertainty of this subsector compared with other LULUCF subsectors.. More detailed uncertainty estimates for the source categories are provided in Chapters 3-7.

Table 1.15 Tier 1 uncertainty estimates of EU-28 and Iceland GHG emissions (in CO_2 equivalents) for the main sectors

Source category	Gas	Emissions Base Year	Emissions 2017	Emission trends Base Year-2017	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A Fuel combustion activities	all	4 300 321	3 280 935	-23.7%	0.9%	0.3%
1.B Fugitive emissions	all	207 967	84 604	-59.3%	27.9%	8.2%
2. Industrial processes	all	534 187	350 274	-34.4%	11.8%	4.8%
3. Agriculture	all	550 243	438 304	-20.3%	47.0%	2.5%
5. Waste	all	240 327	138 497	-42.4%	51.5%	19.4%
4. LULUCF	all	-214 591	-243 019	13.2%	34.3%	13.9%
Total (incl LULUCF)	**all**	**5 618 454**	**4 049 595**	**-27.9%**	**5.9%**	**1.2%**
Total (excl LULUCF)	**all**	**5 833 044**	**4 292 614**	**-26.4%**	**5.2%**	**1.0%**

Note: Due to confidential values reported by Germany and Sweden, sectoral EU emissions and total EU emissions for 2016 in the following tables might not always be identical to the actual emission reported by MS in the sector chapters

Table 1.16 gives an overview of information provided by EU-28 Member States on uncertainty estimates in their national inventory reports 2019 and presents summarised results of these estimates.

Table 1.16 Overview of uncertainty estimates available from EU-28 Member States and Iceland

Member State	**Austria**		**Belgium**	**Bulgaria**		**Croatia**		**Cyprus**	**Czechia**		**Denmark**	
Citation	NIR April 2019, pp.61-67		NIR April 2019, pp.46-48	NIR April 2019, pp.56-58		NIR May 2019, p.51		NIR March 2019, p.44	NIR April 2019, pp.44		NIR April 2019, pp.60-66	
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: 2017; trends: 1990-2017; including LULUCF		emissions: 2017; trends: 1990-2017; including LULUCF	emissions: 2017; trends: 1988-2017; including LULUCF		emissions: 2017; trends: 1990-2017; including LULUCF		emissions: 2017; trends: 1990-2017*; excluding LULUCF	emissions: 2017; trends: 1990-2017; including LULUCF		emissions: 2017 trends: 1990-2017*; including LULUCF	
Uncertainty (%)	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 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2											4.60%	2.20%
CH_4											15.1%	
N_2O											37.0%	
F-gases			37%								41.6%	
Total	14.78%	4.68%	3.89%	56.84%	14.51%	-43.07% to 21.14%	-28.28% to -14.69%	5.43%	4.03%	3.70%	5.7%	5.1%
Uncertainty in trend (%)	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 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											11.20%	
N_2O											9.80%	
F-gases											61.2%	
Total	3.15%	2.37%	2.21%	8.38%	2.38%	-19.64%	-21.47%	2.20%	3.09%	2.34%	2.00%	1.80%

Member State	**Estonia**		**Finland**				**France**		**Germany**				**Greece**		**Hungary**	**Ireland**	
Citation	NIR March 2019, p.47		NIR April 2019, pp.45-47				NIR March 2019, pp.80-82		NIR April 2019, pp.124-127				NIR March 2019, pp.70-74		NIR March 2019, pp.26	NIR Apr. 2019, pp.25-27	
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.25-27)	
Years and sectors included	emissions: 2017; trends: 1990-2017; including LULUCF		emissions: 2017; trends: 1990-2017; including LULUCF				emissions: 2017; trends: 1990-2017; including LULUCF		emissions: 2017; trends: 1990-2017; including LULUCF				emissions: 2017; trends: 1990-2017; including LULUCF		emissions: 2017; trends: 1990-2017; excluding LULUCF	emissions: 2017; trends: 1990-2017; 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													2.9%	2.5%	2.5%	12.17%	1.24%
CH_4													32.9%	33.0%	26.7%	2.01%	2.07%
N_2O													105.4%	105.8%	144.9%	2.56%	2.78%
F-gases													273.0%	273.0%	12.9%	0.40%	0.45%
Total	9.03%	4.89%	±35%	±4%	-28% +35%	-3% +5%	12.2%	10,9%	4.47%	4.07%	-4.28% +4.53%	-2.69% +3.12%	13.1%	12.6%	11.3%	12.60%	3.71%
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																11.28%	1.77%
CH_4																1.19%	0.92%
N_2O																0.80%	0.76%
F-gases																0.60%	0.65%
Total	3.95%	2.11%	±31%	±5%	-21% +29%	-4% +4%	2.3%	2.1%	5.36%	4.65%	-28.57% +30.10%	-17.15% +18.13%	12.3%	12.0%	2.6%	11.39%	2.23%

Member State	Italy		Latvia		Lithuania		Luxembourg		Malta	Netherlands			Poland	
Citation	NIR March 2019, pp.46-48		NIR April 2019, pp.62-63		NIR March 2019, pp.40-41		NIR March 2019, pp.86-94		NIR May 2019, pp.45	NIR April 2019, pp.49-53			NIR April 2019, p.25	
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.86-94)		Yes (pp. 45)	Yes (Annex 2)			Yes (Annex 8)	
Years and sectors included	emissions: 2017; trends: 1990-2017; including LULUCF		emissions: 2017; trends: 1990-2017; including LULUCF		emissions: 2017; trends: 1990-2017; including LULUCF		emissions: 2017; trends: 1990-2017; including LULUCF		emissions: 2017; trends: 1990-2017; including LULUCF	emissions: 2017; trends: 1990-2017 *; including LULUCF			emissions: 2017; trends: 1988-2017; 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%	4.4%	1.8%
CH_4											13%	9%	22.3%	22.3%
N_2O											36%	26%	43.0%	48.8%
F-gases											41%	34%		
Total	3.9%	2.7%	31%	8%	31.8%	10.1%	5.25%	4.67%	5.00%	3%	3%	3%	5.3%	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%		1.36%	1.22%
CH_4											6%		2.76%	2.76%
N_2O											7%		2.34%	2.28%
F-gases											12%			
Total	3.1%	2.1%	12%	3%	7.6%	2.2%	6.09%	5.42%	5.62%	2%	2%		4.50%	4.30%

Member State	Portugal	Romania		Slovakia		Slovenia		Spain		Sweden		United Kingdom		Iceland	
Citation	NIR May 2019, pp."1-23"	NIR May 2018, pp.120-122		NIR April 2019, p.39		NIR April 2019, pp.31-32		NIR March 2019, pp.103 - 104		NIR March 2019, pp.68-70		NIR March 2019, p.96		NIR March 2019, p.12	
Method used	Tier 1	Tier 1		Tier 1		Tier 1		Tier 1 + Tier 2		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: 2017; trends: 1990-2017; including LULUCF **	emissions: 2017; trends: 1990-2017; including LULUCF		emissions: 2017; trends: 1990-2017; including LULUCF		emissions: 2017; trends: 1986-2017; including LULUCF		emissions: 2017; trends: 1990-2017 *; including LULUCF		emissions: 2017; trends: 1990-2017; including LULUCF		emissions: 2017; trends: 1990-2017 *; including LULUCF		emissions: 2017; trends: 1990-2017; including LULUCF	
Uncertainty (%)	Tier 1	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 (e. L.)	Tier 1	Tier 2	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2													2.9%		
CH_4													16.7%		
N_2O													15.0%		
F-gases															
Total	4.50%	26.8%	18.9%	10.74%	3.95%	7.30%	5.90%	19.2%	16.1%	89.46%	5.10%	3.00%	3.1%	40.0%	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 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 2	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2													-37.0%		
CH_4													-60.0%		
N_2O													-55.0%		
F-gases															
Total	9.01%	6.3%	2.3%	2.14%	1.84%	6.08%	2.64%	2.0%	1.4%	18.99%	2.12%	2.30%	-42.0%	19.0%	9.1%

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 2006 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 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 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.

1.7.1 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 the "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 6 mandatory categories have "NE" visible in the CRF tables for 2017.

Table 1.17 Overview of the number of NE visible in the EU CRF tables for 2017

Sector	Number of NE visible in the EU CRF for the year 2017 for mandatory categories (MS reporting NE)
Energy	0
IPPU	3 (PT)
Agriculture	0
Waste	1 (CZ)

1.7.2 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 2019 only two MS made use of this option; for the year 2017 Croatia reported CO_2, CH_4 and N_2O emission from 1D2 as confidential, while Sweden reported correct sector totals for all sectors but in the sectors Energy and IPPU on a less aggregated level the country reported 41 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 2019.

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 2017 no "C"s were shown in the comments of the relevant cells in the CRF tables.

1.7.3 Data gaps and gap-filling

1.7.3.1 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 2006 IPCC Guidelines[11].

1.7.3.2 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.

1.7.3.3 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.

1.7.3.4 Gap filling of activity data in GHG inventory submissions 2019

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

- Clinker Production 2A1
- Lime Production 2A2

1.7.4 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 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-28 inventory is the sum of the Member States' inventories, the EU-28 inventory covers the same geographical area as the inventories of the 28 Member States 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. And 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).

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

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
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-Barthelemy, 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-Barthelemy and 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

Member State	Geographical coverage	EU and MS Party coverage (Kyoto Protocol, second committment period)	EU-territory coverage (UNFCCC)	Party coverage (UNFCCC)	Country code
Slovakia	Slovakia	√	√	√	SVK
Slovenia	Slovenia	√	√	√	SVN
Spain	Spanish part of Iberian mainland, Canary Islands, Balearic Islands, Ceuta and Melilla	√	√	√	ESP
Sweden	Sweden	√	√	√	SWE
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	EU-28		√	√	EUA
Iceland	Iceland	√		√	
European Union and Iceland	EU-28, Iceland and the relevant UK's Overseas Territories and Crown Dependencies.	√			EUC

Notes: FRA includes emissions from Mayotte only since 2014

1.7.5 Completeness of the European Union submission

1.7.5.1 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

1.7.5.2 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.

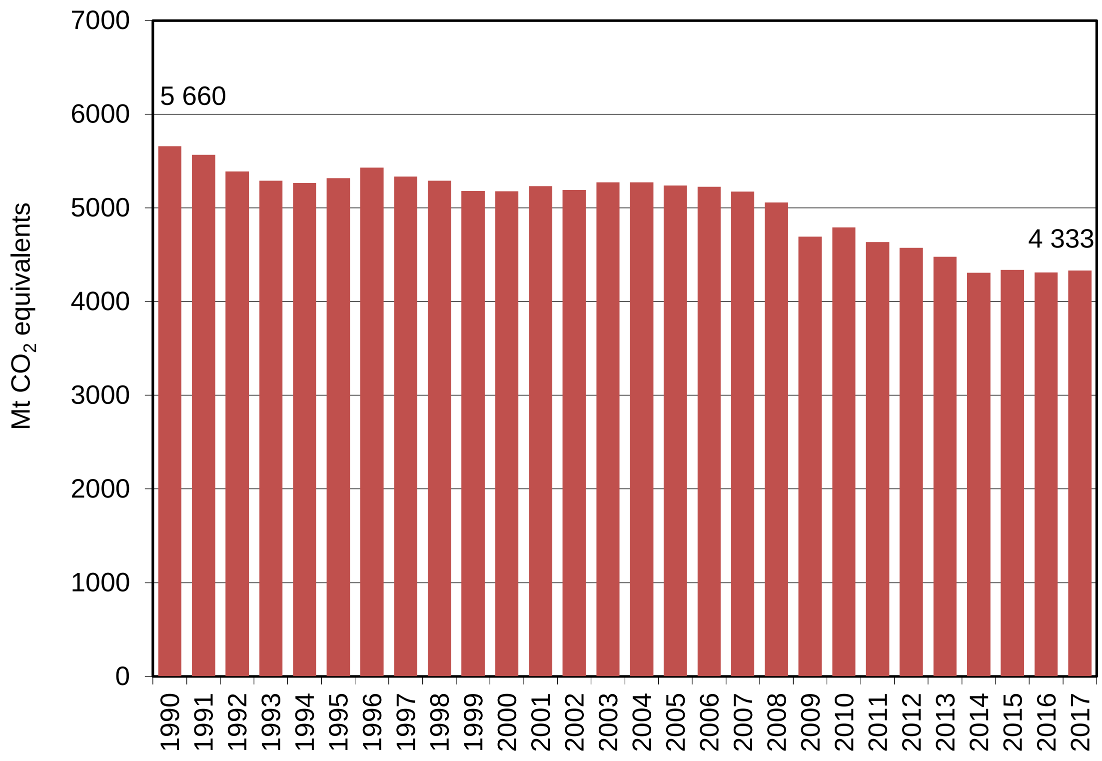
2 EU GREENHOUSE GAS EMISSION TRENDS

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

2.1 Aggregated greenhouse gas emissions

In 2017 total GHG emissions in the EU-28 and Iceland, without LULUCF, were 23.5 % (-1 327 million tonnes CO_2 equivalents) below 1990. Emissions increased by 0.5 % (20 million tonnes CO_2 equivalents) between 2016 and 2017 (Figure 2.1).

Figure 2.1 EU-28 and Iceland GHG emissions 1990–2017 (excl. LULUCF)



Notes: GHG emission data for the EU-28 and Iceland 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, 1990-2017

Total GHG emissions (excluding LULUCF) decreased by 1 327 million tonnes since 1990 (or 23.5 %) reaching their lowest level during this period in 2014 (4 307 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 of about 58 % alongside a decrease in emissions of 23 % over the period.

The reduction in greenhouse gas emissions over the 27-year period was due to a variety of factors, including the growing share in the use of renewables, the use of less carbon intensive fuels and improvements in energy efficiency, as well as to structural changes in the economy and the economic recession. 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 2017, 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 and residential combustion.

A combination of factors explains lower emissions in industrial sectors, such as improved efficiency and 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. The economic recession that began in the second half of 2008 and continued through to 2009 also had an impact on emissions from industrial sectors. 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 2017, the use of solid and liquid fuels in thermal power stations decreased strongly whereas natural gas consumption more than doubled, resulting 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 as a whole over the past 27 years. The very strong increase in the use of biomass for energy purposes has also contributed to lower GHG emissions in the EU.

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 agricultural soils. A number of policies (both EU and country-specific) have also 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 about 50% of the total net reduction in the EU of the past 27 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 2017.

Table 2.1 Overview of EU-28 plus Iceland source categories whose emissions increased or decreased by more than 20 Million tonnes CO_2 equivalent in the period 1990-2017

Source category	Million tonnes (CO_2 equivalents)
Road Transportation (CO2 from 1.A.3.b)	170
Refrigeration and Air conditioning (HFCs from 2.F.1)	93
Aluminium Production (PFCs from 2.C.3)	-21
Agricultural Soils: Direct N2O Emissions From Managed Soils (N2O from 3.D.1)	-22
Cement Production (CO2 from 2.A.1)	-26
Fluorochemical Production (HFCs from 2.B.9)	-29
Fugitive emisisons from Natural Gas (CH4 from 1.B.2.b)	-37
Commercial/Institutional (CO2 from 1.A.4.a)	-38
Enteric Fermentation: Cattle (CH4 from 3.A.1)	-43
Nitric Acid Production (N2O from 2.B.2)	-46
Adipic Acid Production (N2O from 2.B.3)	-56
Manufacture of Solid Fuels and Other Energy Industries (CO2 from 1.A.1.c)	-60
Coal Mining and Handling (CH4 from 1.B.1.a)	-66
Managed Waste Disposal Sites (CH4 from 5.A.1)	-73
Residential: Fuels (CO2 from 1.A.4.b)	-115
Iron and steel production (CO2 from 1.A.2.a +2.C.1)	-116
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A.2.a)	-253
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-433
Total	**-1327**

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, 2016-2017

Total GHG emissions (excluding LULUCF) increased in 2017 by 19.9 million tonnes, or 0.5 % compared to 2016, to reach 4333 Mt CO_2 equivalent in 2017. This increase in emissions came along with an increase in GDP of 2.42.5 %. Poland and Spain accounted for the largest increases in GHG emissions in absolute terms in the EU in 2017.

At EU level, there was increased economic activity and higher emissions in several industrial sectors during 2017. In addition, emissions from road transportation increased for the fourth consecutive year since 2013, both for freight and passenger vehicles. Most of the increase was accounted for by higher consumption of diesel by heavy duty trucks and light duty vehicles, but consumption also increased for passenger cars.

In terms of fuels, there was a significant increase in the use of natural gas and of liquid fossil fuels, which were partly offset by a decline in coal consumption. Based on Eurostat data, there was a decline in nuclear energy in 2017 and a strong increase in the use of renewable energy sources.

The overall 0.5% net increase in total GHG emissions in 2017 was partly offset by lower fossil-fuel consumption and emissions in the production of heat and electricity in power stations, with lower use of coal and higher use of natural gas and renewables. In addition, the energy and carbon intensity of the economy improved. These were largely driven by lower transformation losses and better energy efficiency, on the one hand, and by the higher share of renewables and of natural gas in the fuel mix compared to coal, on the other.

Table 2.2 shows the source categories making the largest contribution to the change in GHG emissions in the EU-28 between 2016 and 2017.

Table 2.2 Overview of EU-28 plus Iceland source categories whose emissions increased or decreased by more than 3 million tonnes CO_2 equivalent in the period 2016–2017

Source category	Million tonnes (CO_2 equivalents)
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A.2.a)	12
Road Transportation (CO2 from 1.A.3.b)	11
Agricultural Soils: Direct N2O Emissions From Managed Soils (N2O from 3.D.1)	3
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-17
Total	**19.9**

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 Member States, illustrating where main changes occurred.

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

	1990 (million tonnes)	2017 (million tonnes)	2016 - 2017 (million tonnes)	Change 2016 - 2017 (%)	Change 1990-2017 (%)
Austria	78.7	82.3	2.7	3.3%	4.6%
Belgium	146.6	114.5	-1.2	-1.1%	-21.9%
Bulgaria	101.8	61.4	2.3	3.9%	-39.7%
Croatia	31.9	25.0	0.6	2.6%	-21.5%
Cyprus	5.7	8.9	0.2	2.3%	57.8%
Czechia	199.2	129.4	-1.1	-0.9%	-35.1%
Denmark	70.3	47.9	-2.3	-4.5%	-31.9%
Estonia	40.4	20.9	1.2	6.2%	-48.4%
Finland	71.3	55.4	-2.7	-4.7%	-22.3%
France	548.1	464.6	3.9	0.9%	-15.2%
Germany	1251.0	906.6	-4.4	-0.5%	-27.5%
Greece	103.1	95.4	3.7	4.1%	-7.4%
Hungary	93.7	63.8	2.6	4.3%	-31.9%
Ireland	55.4	60.7	-0.5	-0.9%	9.6%
Italy	517.7	427.7	-4.4	-1.0%	-17.4%
Latvia	26.3	11.3	0.0	0.3%	-56.9%
Lithuania	48.2	20.4	0.2	1.1%	-57.7%
Luxembourg	12.8	10.2	0.2	1.8%	-19.8%
Malta	2.1	2.2	0.3	13.5%	2.3%
Netherlands	221.7	193.7	-2.1	-1.1%	-12.6%
Poland	474.4	413.8	14.7	3.7%	-12.8%
Portugal	59.2	70.7	4.6	7.0%	19.5%
Romania	248.1	113.8	-0.5	-0.4%	-54.1%
Slovakia	73.4	43.3	1.2	2.8%	-41.0%
Slovenia	18.6	17.5	-0.2	-1.3%	-6.4%
Spain	288.5	340.2	13.8	4.2%	17.9%
Sweden	71.3	52.7	-0.3	-0.5%	-26.1%
United Kingdom	794.4	470.5	-12.8	-2.6%	-40.8%
EU-28	**5653.7**	**4324.9**	**19.8**	**0.5%**	**-23.5%**
Iceland	3.6	4.8	0.1	2.5%	32.1%
United Kingdom (KP)	797.1	473.6	-12.7	-2.6%	-40.6%
EU-28 + ISL	**5660.1**	**4332.7**	**19.9**	**0.5%**	**-23.5%**

2.2 Emission trends by gas

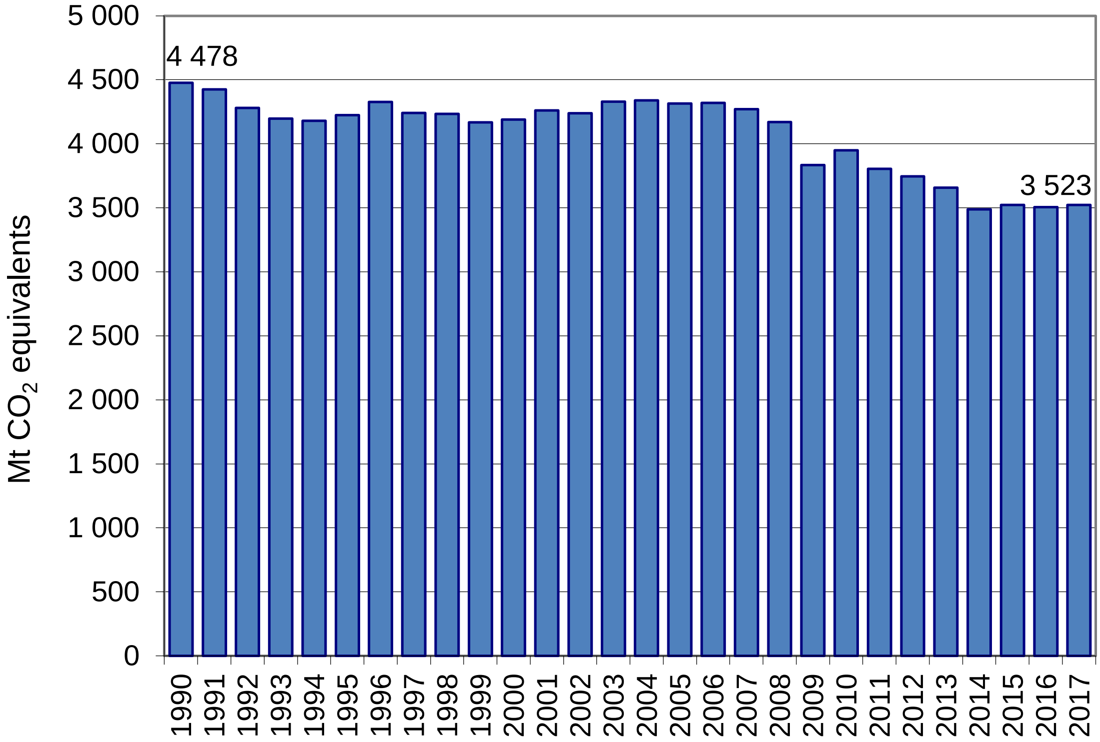
Table 2.4, Figure 2.2 and Figure 2.3 give an overview of the main trends in EU GHG emissions and removals for 1990–2017. In the EU the most important GHG is CO_2, accounting for 81 % of total EU emissions in 2017 excluding LULUCF. In 2017, EU CO_2 emissions excluding LULUCF were 3 523 Mt, which was 21 % below 1990 levels. Compared to 2016, CO_2 emissions increased by 0.5 % and N_2O emissions increased by 1 %. Emissions of CH_4 slightly increased.

Table 2.4 Overview of EU-28 and Iceland GHG emissions and removals from 1990 to 2017 in CO_2 equivalent

GREENHOUSE GAS EMISSIONS	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Net CO_2 emissions/removals	4 212	3 936	3 870	3 986	3 830	3 492	3 615	3 482	3 424	3 333	3 176	3 208	3 198	3 245
CO_2 emissions (without LULUCF)	4 478	4 225	4 189	4 315	4 171	3 833	3 949	3 804	3 746	3 658	3 489	3 522	3 505	3 523
CH_4	740	679	618	557	523	511	501	491	487	476	469	469	465	466
N_2O	401	360	323	303	283	267	257	253	250	250	254	250	254	256
HFCs	29	44	55	77	97	98	104	106	109	111	114	110	107	105
PFCs	26	17	12	7	5	3	4	4	4	4	3	4	4	3
Unspecified mix of HFCs and PFCs	6	6	3	1	1	2	1	1	1	1	1	1	1	2
SF_6	11	15	11	8	7	6	6	6	6	6	6	6	6	7
NF_3	0.02	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.05
Total (with net CO_2 emissions/removals)	**5 425**	**5 058**	**4 891**	**4 939**	**4 746**	**4 380**	**4 488**	**4 343**	**4 281**	**4 181**	**4 023**	**4 047**	**4 036**	**4 084**
Total (without CO2 from LULUCF)	**5 691**	**5 346**	**5 210**	**5 268**	**5 087**	**4 721**	**4 822**	**4 665**	**4 603**	**4 507**	**4 335**	**4 361**	**4 343**	**4 363**
Total (without LULUCF)	**5 660**	**5 318**	**5 179**	**5 238**	**5 058**	**4 692**	**4 794**	**4 636**	**4 573**	**4 479**	**4 307**	**4 337**	**4 313**	**4 333**

Notes: CO_2 emissions include indirect CO_2

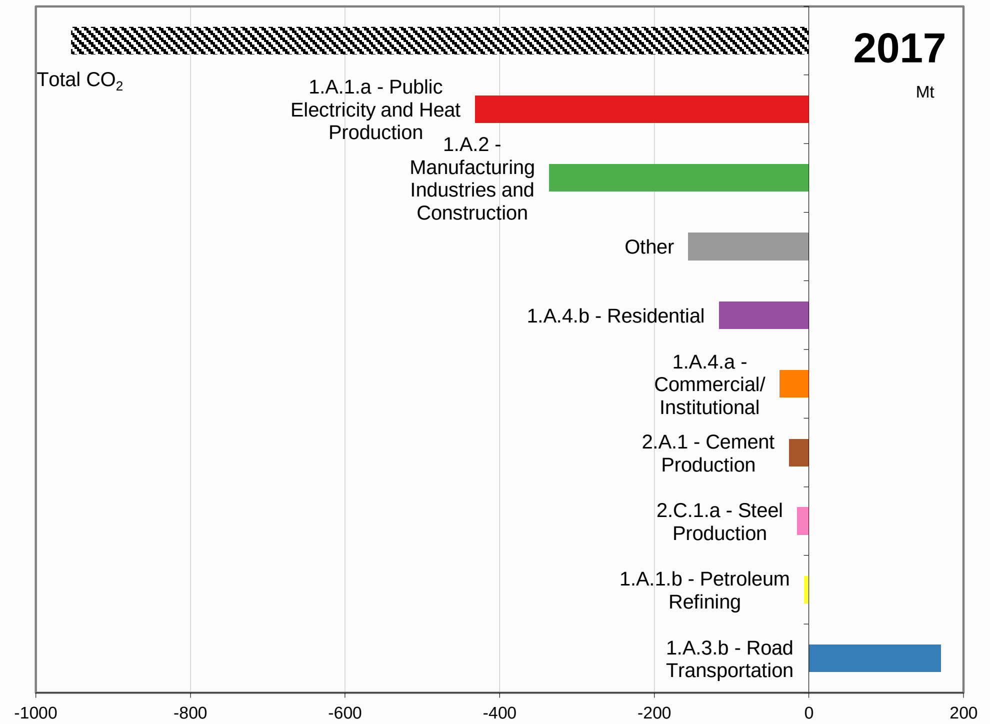
Figure 2.2 CO_2 emissions 1990 to 2017 (Mt)



Notes: CO_2 emissions include indirect CO_2

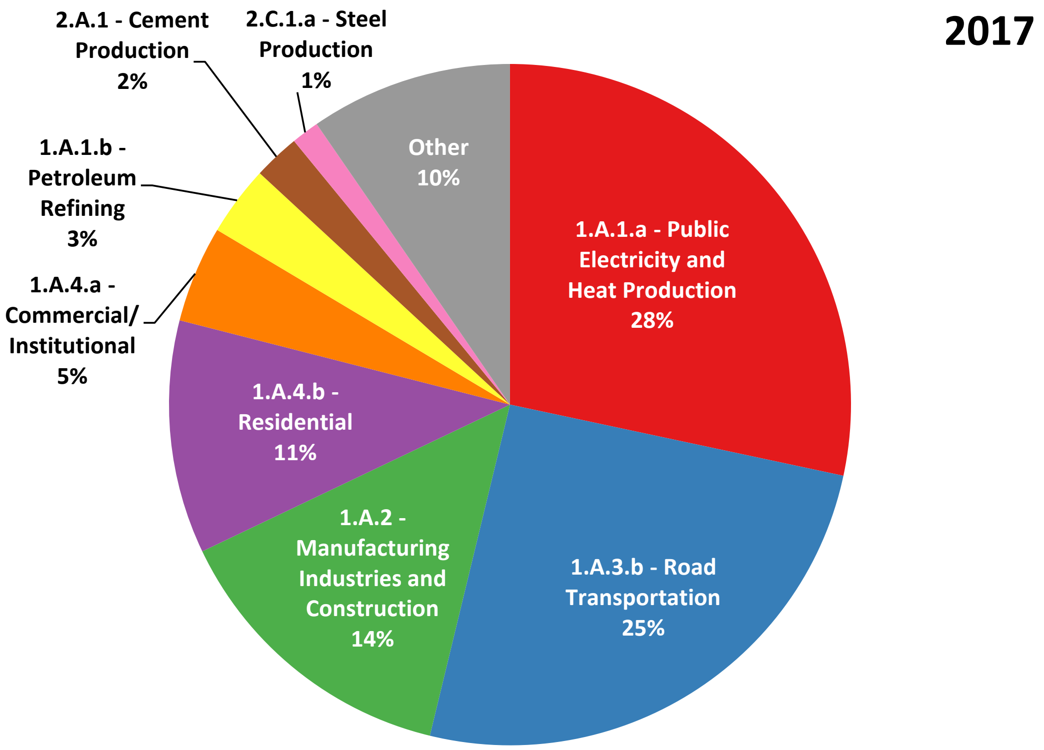
The largest key source categories for CO_2 emissions (Figure 2.3) have been reduced between 1990 and 2017 with the exception of 1.A.3.b Road transportation which accounts for 25 % of CO_2 emissions in 2017.

Figure 2.3 *Absolute change of CO_2 emissions by large key source categories 1990 to 2017 in CO_2 equivalents (Mt) for EU-28 and Iceland*



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 2017 for EU-28 and Iceland*



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 2017 and decreased by 37 % since 1990 to 466 Mt CO_2 equivalents in 2017 (Figure 2.5). The two largest key sources are enteric fermentation and anaerobic waste (Figure 2.7). They account for 54 % of CH_4 emissions in 2017.

Figure 2.5 CH_4 emissions 1990 to 2017 in CO_2 equivalents (Mt)

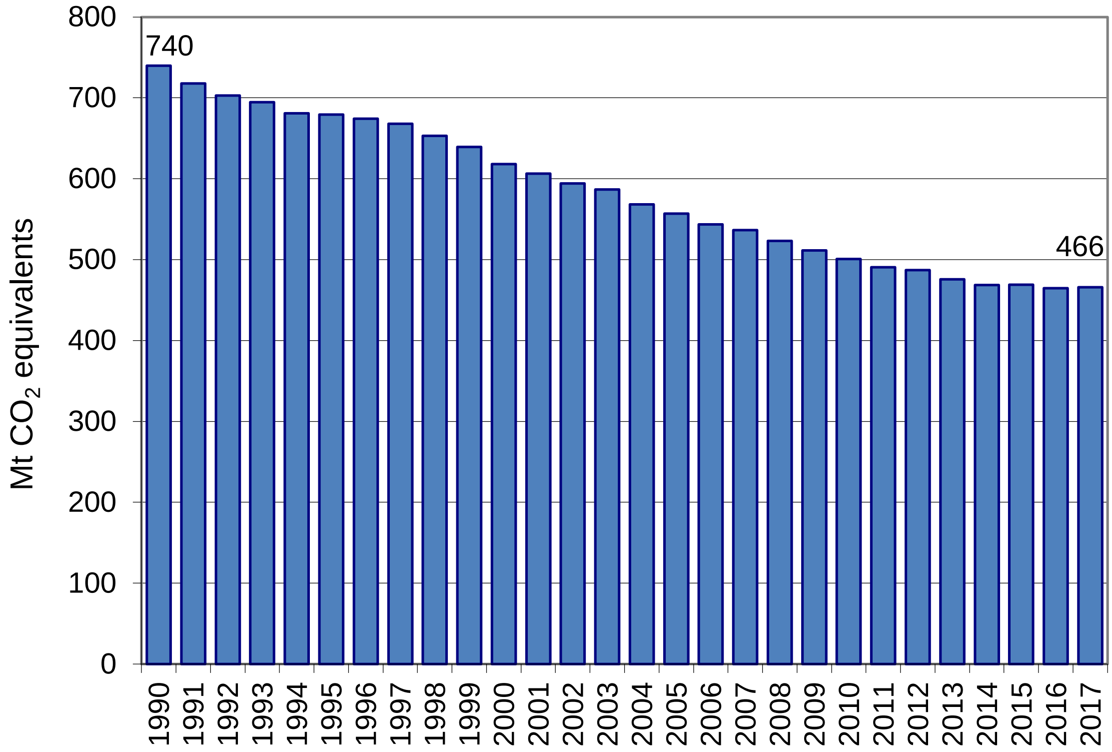
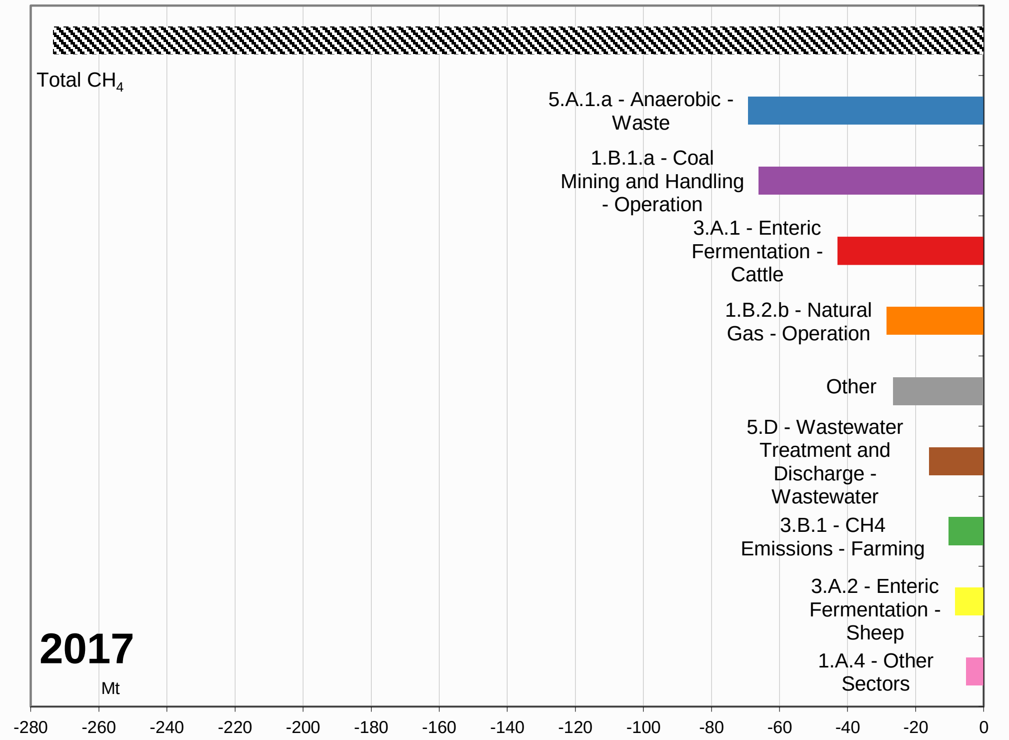


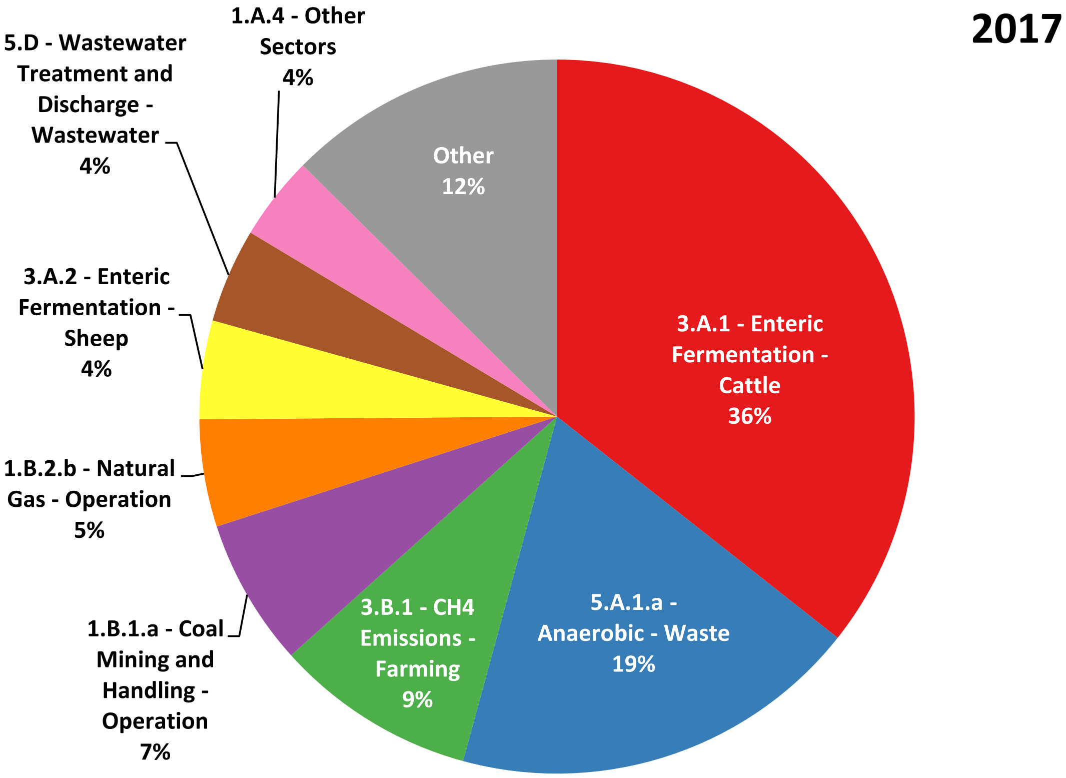
Figure 2.6 shows that the main reasons for declining CH_4 emissions were reductions in anaerobic waste and coal mining.

Figure 2.6 Absolute change of CH_4 emissions by large key source categories 1990 to 2017 in CO_2 equivalents (Mt) for EU-28 and Iceland



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 2017 for EU-28 and Iceland



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 36 % to 256 Mt CO_2 equivalents in 2017 (Figure 2.8). N_2O emissions derive mainly from the agriculture sector. The two largest key sources account for about 65 % of N_2O emissions in 2017 (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 20167 in CO_2 equivalents (Mt)

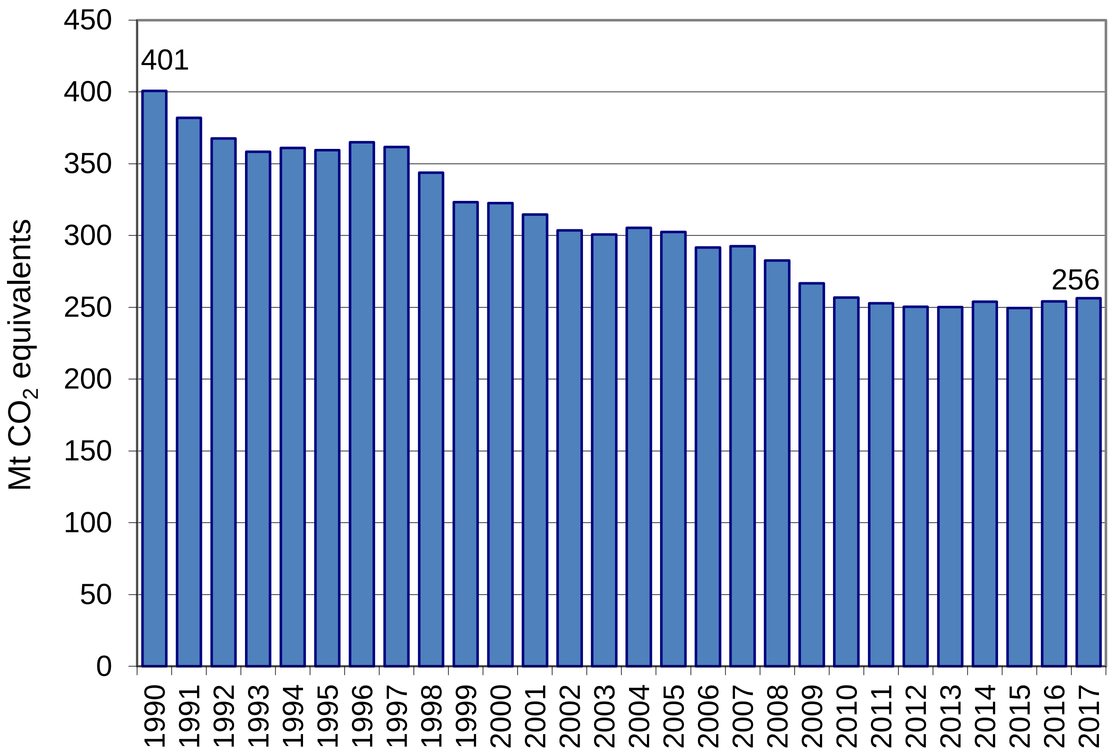
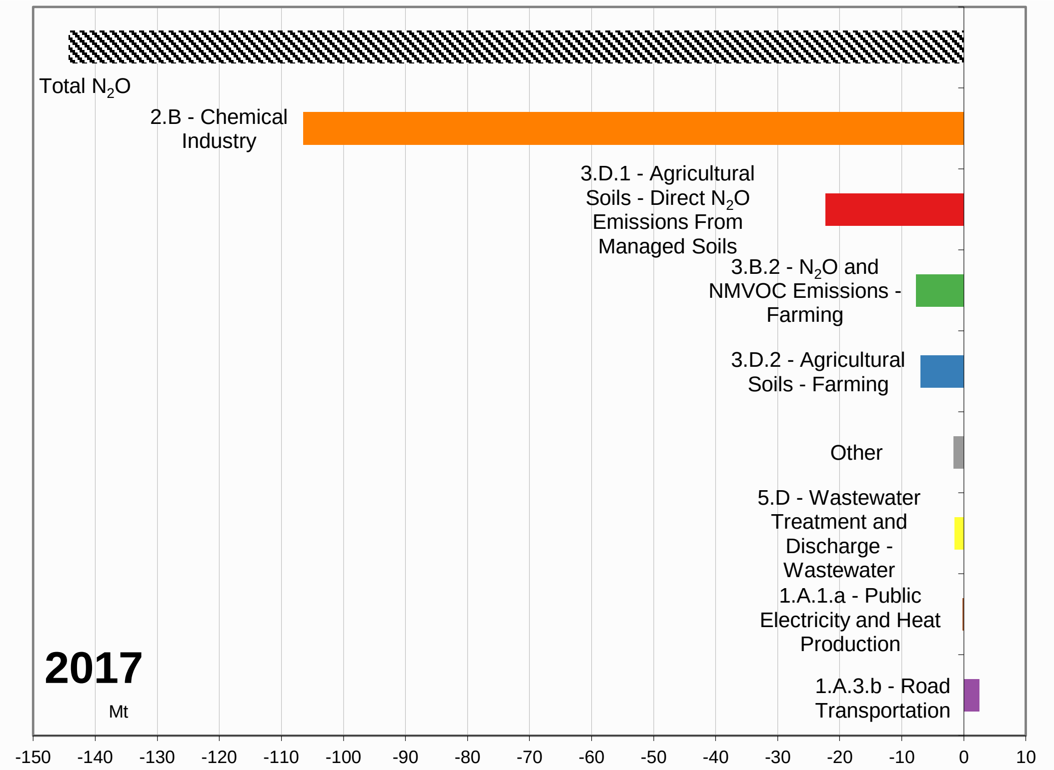
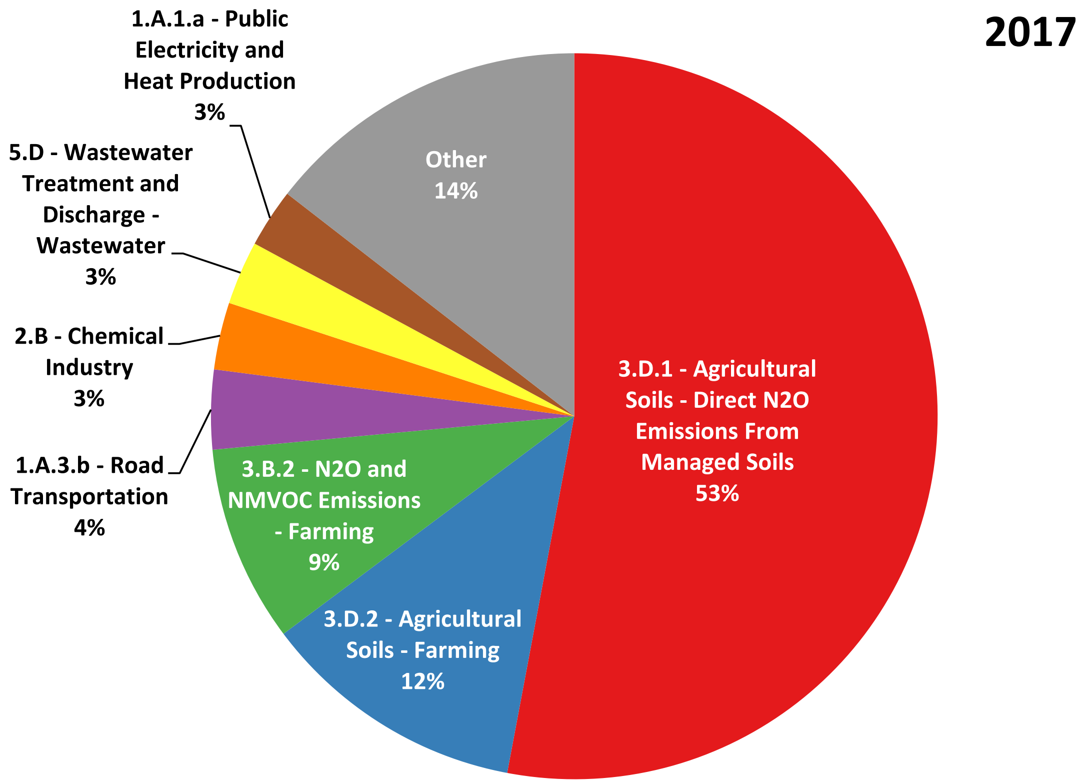


Figure 2.9 Absolute change of N_2O emissions by large key source categories 1990 to 2017 in CO_2 equivalents (Mt) for EU-28 and Iceland



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

Figure 2.10 N₂O emissions: Share of key source categories and all remaining categories in 2017 for EU-28 and Iceland



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%

Percentages are rounded and may lead to a sum higher or lower than 100%Fluorinated gas emissions account for 2.7 % of total EU GHG emissions. In 2017, emissions amounted to 117 Mt CO_2 equivalents, which was 62 % above 1990 levels (Figure 2.11). Refrigeration and air conditioning, the largest key category, accounts for 81 % of fluorinated gas emissions in 2017. Figure 2.12 reveals that HFCs from refrigeration and air conditioning showed large increases between 1990 and 2017. 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 2017 in CO_2 equivalents (Mt)

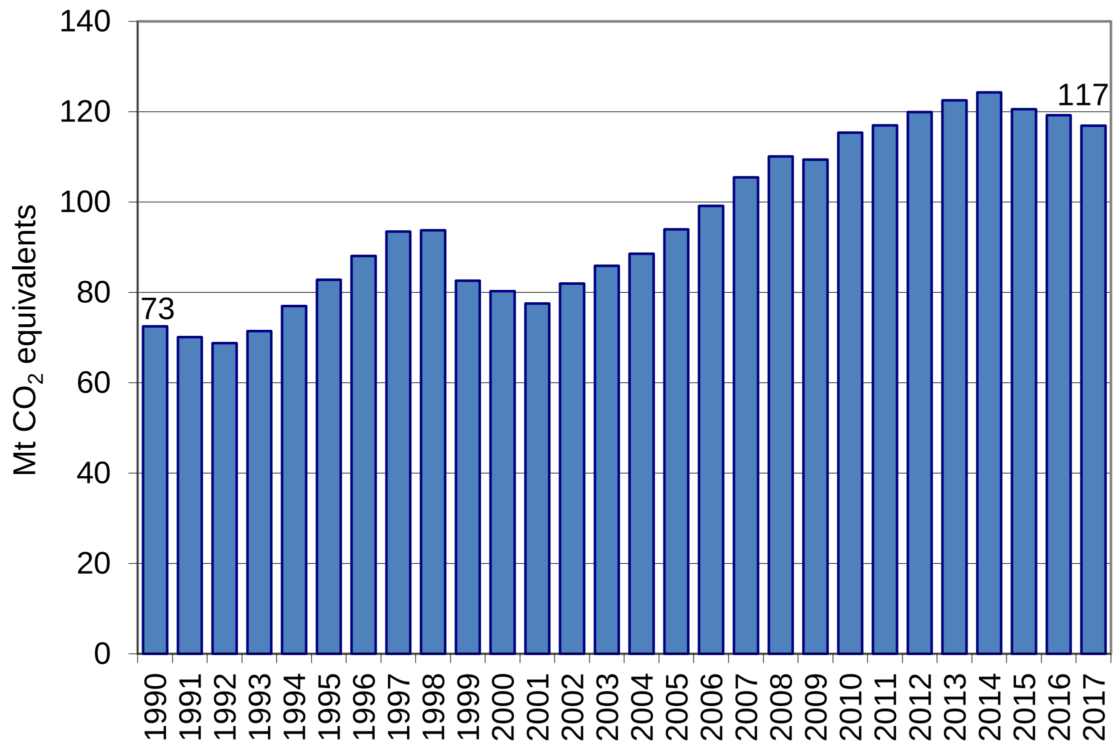
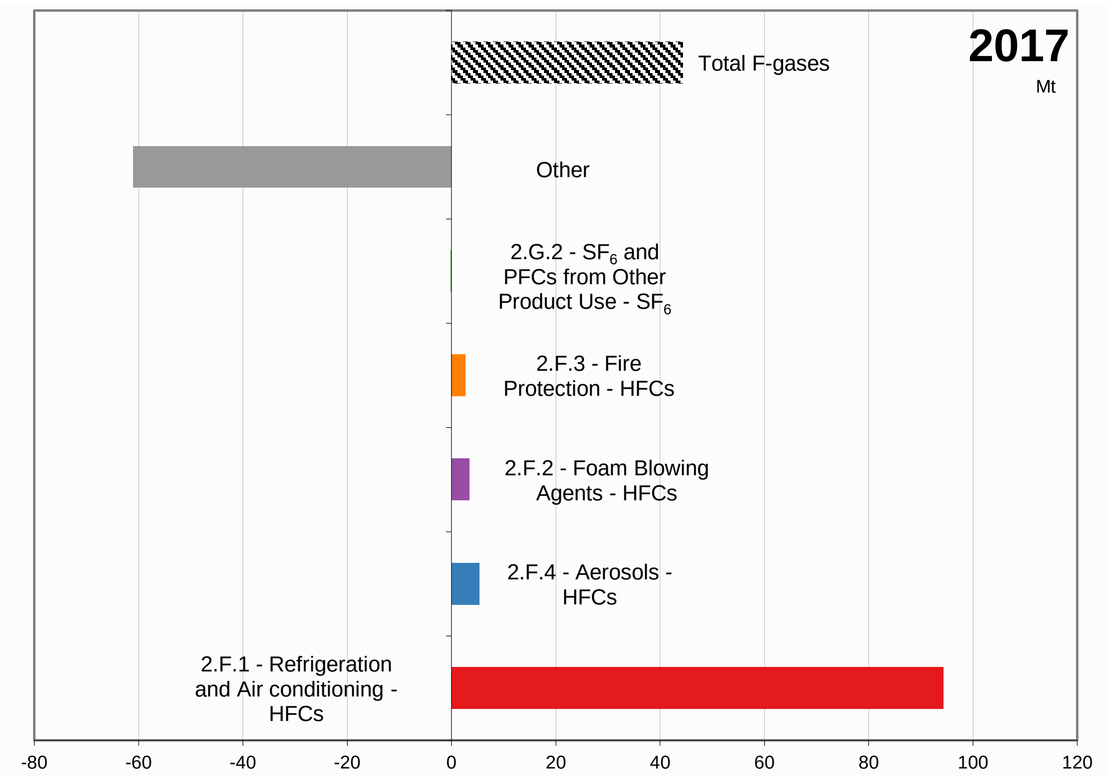
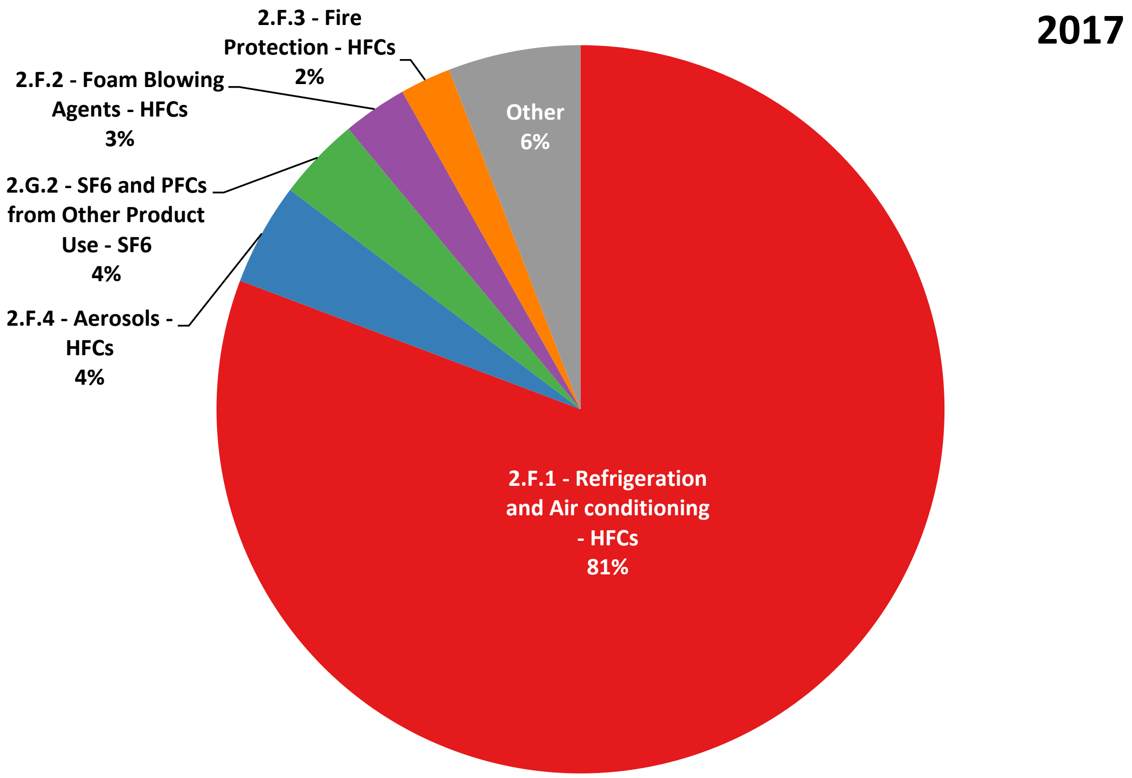


Figure 2.12 Absolute change of fluorinated gas emissions by large key source categories 1990 to 2017 in CO_2 equivalents (Mt) for EU-28 and Iceland



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 2017 for EU-28 and Iceland



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-28 and Iceland GHG emissions in the main source categories for 1990–2017. The most important sector by far is energy (i.e. combustion and fugitive emissions), which accounted for 78 % of total EU emissions in 2017. The second largest sector is agriculture (10 %), 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-28 and Iceland GHG emissions (in million tonnes CO_2 equivalent) in the main source and sink categories for the period 1990 to 2017

GHG SOURCE AND SINK	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1. Energy	4 353	4 095	4 025	4 127	3 986	3 707	3 803	3 655	3 611	3 522	3 342	3 378	3 359	3 372
2. Industrial Processes	518	499	457	467	453	379	396	392	379	377	383	379	376	380
3. Agriculture	544	474	462	439	435	429	424	425	423	426	434	435	436	440
4. Land-Use, Land-Use Change and Forestry	-236	-261	-288	-299	-312	-312	-305	-294	-292	-297	-284	-290	-276	-249
5. Waste	241	248	232	202	182	176	168	163	158	152	146	144	141	139
6. Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
indirect CO_2 emissions	4.2	3.5	2.9	2.5	2.3	2.1	2.2	2.1	2.0	1.8	1.8	1.8	1.7	1.7
Total (with net CO_2 emissions/removals)	**5 425**	**5 058**	**4 891**	**4 939**	**4 746**	**4 380**	**4 488**	**4 343**	**4 281**	**4 181**	**4 023**	**4 047**	**4 036**	**4 084**
Total (without LULUCF)	**5 660**	**5 318**	**5 179**	**5 238**	**5 058**	**4 692**	**4 794**	**4 636**	**4 573**	**4 479**	**4 307**	**4 337**	**4 313**	**4 333**

Notes: CO_2 emissions include indirect CO_2

2.4 Emission trends by Member State

Table 2.6 gives an overview of EU Member States contributions to the EU GHG emissions for 1990–2017. Member States show large variations in GHG emission trends.

Table 2.6 Overview of EU-28 plus Iceland contributions to total GHG emissions, excluding LULUCF, including indirect CO_2 emissions, from 1990 to 2017 in million tonnes CO_2-equivalent

Member State	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Austria	79	80	80	93	87	80	85	82	80	80	77	79	80	82
Belgium	147	155	150	145	139	126	133	122	119	119	114	117	116	115
Bulgaria	102	75	60	64	67	58	61	66	61	56	59	62	59	61
Croatia	32	23	26	30	31	28	28	28	26	25	24	24	24	25
Cyprus	5.7	7.1	8.4	9.3	10	9.8	9.5	9.1	8.6	7.8	8.2	8.3	8.7	8.9
Czechia	199	158	150	149	147	138	141	139	135	129	128	129	131	129
Denmark	70	78	71	66	66	63	63	58	53	55	51	48	50	48
Estonia	40	20	17	19	20	17	21	21	20	22	21	18	20	21
Finland	71	72	70	70	71	68	76	68	62	63	59	55	58	55
France	548	543	552	555	526	506	512	486	485	485	455	460	461	465
Germany	1251	1123	1045	993	976	908	943	920	925	942	903	907	911	907
Greece	103	109	126	136	132	125	118	115	112	103	99	95	92	95
Hungary	94	75	73	75	71	65	65	63	60	57	57	61	61	64
Ireland	55	59	68	69	67	62	61	57	58	57	57	59	61	61
Italy	518	532	554	581	548	496	506	492	473	443	426	434	432	428
Latvia	26	13	11	11	12	11	12	12	11	11	11	11	11	11
Lithuania	48	22	20	23	24	20	21	21	21	20	20	20	20	20
Luxembourg	13	10	10	13	12	12	12	12	12	11	11	10	10	10
Malta	2.1	2.7	2.8	2.9	3.1	2.9	2.9	3.0	3.2	2.9	2.9	2.2	1.9	2.2
Netherlands	222	232	220	215	208	202	214	200	196	195	188	196	196	194
Poland	474	445	395	403	411	393	412	411	404	400	387	390	399	414
Portugal	59	69	82	86	76	73	69	68	66	64	64	68	66	71
Romania	248	187	143	151	150	130	124	129	126	116	116	116	114	114
Slovakia	73	53	49	51	50	45	46	46	43	43	41	42	42	43
Slovenia	19	19	19	21	22	20	20	20	19	18	17	17	18	17
Spain	288	329	388	441	411	372	358	357	351	323	326	338	326	340
Sweden	71	73	68	67	63	58	64	60	57	55	54	53	53	53
United Kingdom	794	748	712	691	652	596	610	563	580	566	526	508	483	471
EU-28	**5654**	**5312**	**5172**	**5231**	**5049**	**4684**	**4786**	**4628**	**4565**	**4471**	**4299**	**4329**	**4305**	**4325**
Iceland	3.6	3.4	4.0	3.9	5.2	4.9	4.8	4.6	4.6	4.6	4.6	4.7	4.6	4.8
United Kingdom (KP)	797	750	715	694	655	599	613	566	583	569	529	511	486	474
EU-28 + ISL	**5660**	**5318**	**5179**	**5238**	**5058**	**4692**	**4794**	**4636**	**4573**	**4479**	**4307**	**4337**	**4313**	**4333**

The overall EU GHG emission trend is dominated by the three largest emitters Germany (21 %), the United Kingdom (11 %) and France (11 %), accounting for over forty percent of total EU GHG emissions in 2017. Germany and the United Kingdom, the two Member States with the highest absolute reductions, achieved total domestic GHG emission reductions of 668 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 15 % below 1990 levels in 2017. In France, large reductions were achieved in N_2O emissions from 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 2017. 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-28 with a share in total EU GHG emissions of 10 %, 10 % and 8 %, respectively.

Italy's GHG emissions were 17 % below 1990 levels in 2017However, 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 until 2014.

Poland's GHG emissions were 13 % below 1990 levels in 2017. 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 18 % between 1990 and 2017. 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 between 1990 and 2017. All emissions were reduced significantly from 1990 levels: the largest reduction was achieved in SO_2 (-90 %) followed by, CO (-67 %), NMVOC (-59 %). and NO_x (-57 %).

Table 2.7 Overview of EU-28 and Iceland indirect GHG and SO_2 emissions for 1990–2017(kt)

	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NO_X	17774	15440	13452	12309	10782	9921	9733	9343	9013	8598	8258	8094	7795	7599
CO	62707	51971	40217	31666	28551	25972	26583	24176	24273	23108	21292	21396	21017	20770
NMVOC	17204	13899	11421	9498	8589	8033	8016	7558	7422	7179	6967	6929	6888	6970
SO_2	24221	15708	9657	7401	5410	4613	4368	4237	3947	3514	3275	3166	2696	2319

Table 2.8 shows the NO_x emissions of the EU-28 Member States and Iceland between 1990 and 2017. The largest emitters, Germany, France, the United Kingdom, Spain, and Poland made up 60 % of total

EU NO_x emissions in 2017. All EU-28 Member States but Malta reduced their NO_x emissions between 1990 and 2017.

Table 2.9 shows the CO emissions of the EU-28 Member States and Iceland between 1990 and 2017. The largest emitters, France, Germany, Italy, Poland and Romania that made up 59 % of the total CO emissions in 2017, reduced their emissions from 1990 levels substantially. But also all other EU-28 Member States reduced emissions.

Table 2.6 shows the NMVOC emissions of the EU-28 Member States and Iceland between 1990 and 2017. The largest emitters France, Germany, Italy and Poland that made up 53 % of the total NMVOC emissions in 2017, reduced their emissions from 1990 levels, together with most other EU-28 Member States and Iceland.

Table 2.11 shows the SO_2 emissions of the EU-28 Member States and Iceland between 1990 and 2017. The largest emitters, Poland, Germany and Spain that made up 49 % of the total SO_2 emissions in 2017, reduced their emissions from 1990 levels substantially, together with all other EU-28 Member States.

Table 2.8 Overview of Member States' contributions to EU-28 and Iceland NO_x emissions for 1990–2017 (kt)

Member State	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Austria	218	198	213	236	197	182	181	172	166	167	158	155	149	143
Belgium	410	380	342	317	267	240	245	227	214	206	197	196	185	174
Bulgaria	94	190	161	153	167	160	167	175	154	134	135	135	129	61
Croatia	86	69	75	84	81	75	67	63	58	57	53	53	52	49
Cyprus	16	18	21	21	20	19	18	21	21	16	17	15	14	14
Czechia	729	370	280	276	253	239	232	220	207	191	184	176	167	164
Denmark	302	290	227	205	173	154	149	140	129	124	115	113	114	111
Estonia	96	50	44	41	42	38	45	44	41	38	40	39	39	41
Finland	299	267	236	201	189	172	181	165	156	152	144	133	129	125
France	2091	1918	1748	1553	1305	1222	1205	1146	1110	1101	1011	979	937	905
Germany	2892	2184	1947	1584	1429	1331	1355	1338	1305	1307	1271	1247	1221	1184
Greece	315	320	352	404	387	374	318	295	244	242	236	233	230	249
Hungary	241	188	185	176	158	147	144	134	127	124	122	124	116	119
Ireland	168	168	174	168	145	121	115	103	106	107	107	109	110	72
Italy	2066	1942	1493	1285	1075	990	973	935	876	822	804	778	754	712
Latvia	94	49	39	42	40	38	40	38	37	38	38	38	36	37
Lithuania	138	66	57	61	62	56	58	55	57	56	55	56	56	52
Luxembourg	29	26	35	49	33	28	28	27	25	23	21	17	15	12
Malta	7.4	8.9	9.5	8.4	8.7	7.8	7.6	7.9	8.8	8.5	8.9	7.9	6.5	12
Netherlands	586	486	399	349	317	293	287	271	261	252	239	241	230	223
Poland	1090	1053	852	869	863	856	888	872	836	796	747	725	742	804
Portugal	269	307	304	293	236	224	205	187	174	171	168	171	165	168
Romania	484	397	384	329	309	277	253	258	280	238	230	228	217	214
Slovakia	159	114	107	103	96	87	85	77	75	73	73	72	67	66
Slovenia	71	71	58	55	58	49	48	47	46	44	39	35	36	34
Spain	1421	1482	1474	1481	1217	1086	1010	993	954	829	836	846	815	824
Sweden	282	252	217	185	165	154	157	149	142	139	138	133	129	125
United Kingdom	3072	2521	1967	1732	1444	1256	1228	1141	1163	1105	1033	995	899	867
EU-28	**17725**	**15388**	**13400**	**12262**	**10734**	**9877**	**9690**	**9302**	**8972**	**8559**	**8217**	**8051**	**7759**	**7560**
Iceland	31	35	33	29	28	28	27	24	24	23	23	24	22	22
United Kingdom (KP)	3090	2538	1987	1750	1464	1271	1243	1157	1180	1121	1051	1014	913	884
EU-28 + ISL	**17774**	**15440**	**13452**	**12309**	**10782**	**9921**	**9733**	**9343**	**9013**	**8598**	**8258**	**8094**	**7795**	**7599**

Table 2.9 Overview of Member States' contributions to EU-28 and Iceland CO emissions for 1990–2017 (kt)

Member State	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Austria	1179	914	728	617	556	536	551	523	524	564	520	538	533	527
Belgium	1387	1108	926	753	654	427	497	394	344	519	319	372	360	292
Bulgaria	94	818	551	289	290	237	226	230	209	194	172	172	169	158
Croatia	536	434	440	418	323	315	299	272	254	231	202	216	202	202
Cyprus	43	38	30	26	22	20	18	17	15	14	14	14	14	14
Czechia	2066	1561	1075	934	886	903	927	897	883	883	843	825	820	820
Denmark	713	639	465	418	386	354	346	304	287	273	249	253	243	241
Estonia	239	179	163	132	133	127	128	112	115	110	113	111	118	116
Finland	708	616	545	466	415	395	406	369	365	351	345	329	335	326
France	10378	9050	6553	5255	4289	3824	4211	3543	3201	3262	2730	2692	2747	2706
Germany	12544	6482	4831	3753	3431	2981	3347	3259	2887	2859	2757	2864	2802	2829
Greece	1156	990	947	774	673	621	559	503	531	440	444	417	376	400
Hungary	1407	959	825	682	477	518	520	527	542	535	457	442	433	419
Ireland	346	289	246	216	177	156	142	131	124	116	109	105	99	48
Italy	7213	7261	4897	3510	3549	3155	3121	2478	2704	2535	2299	2343	2269	2330
Latvia	438	326	234	214	175	182	148	154	158	143	135	114	112	120
Lithuania	460	281	183	174	181	173	155	171	166	159	151	144	142	139
Luxembourg	88	54	39	31	24	22	22	21	20	19	18	15	15	8.4
Malta	20	20	14	11	11	8.9	8.3	7.8	7.1	6.8	6.6	6.4	5.8	9.3
Netherlands	1226	889	816	732	723	676	678	652	631	609	593	598	587	580
Poland	3641	4659	3356	3089	3009	2939	3077	2781	2787	2658	2387	2343	2456	2543
Portugal	809	850	704	533	437	414	412	384	371	353	337	345	334	352
Romania	2307	2332	3645	2502	2466	2380	2169	2103	2910	2095	2052	2157	1998	1756
Slovakia	1134	707	546	557	470	412	452	420	428	399	359	370	377	365
Slovenia	304	281	187	162	143	131	130	128	123	121	102	107	110	105
Spain	3779	3142	2385	1814	1538	1385	1450	1408	1341	1318	1329	1314	1308	1325
Sweden	1075	932	663	529	481	466	455	441	418	412	398	385	386	385
United Kingdom	7321	6073	4142	3004	2507	2088	2005	1828	1808	1809	1723	1681	1544	1528
EU-28	**62612**	**51886**	**40138**	**31593**	**28423**	**25845**	**26458**	**24055**	**24151**	**22985**	**21163**	**21273**	**20896**	**20645**
Iceland	70	64	64	61	118	119	117	114	115	117	124	118	117	121
United Kingdom (KP)	7346	6094	4157	3017	2517	2096	2013	1835	1815	1815	1729	1686	1548	1532
EU-28 + ISL	**62707**	**51971**	**40217**	**31666**	**28551**	**25972**	**26583**	**24176**	**24273**	**23108**	**21292**	**21396**	**21017**	**20770**

Table 2.10 Overview of Member States' contributions to EU-28 and Iceland NMVOC emissions for 1990–2017 (kt)

Member State	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Austria	324	237	179	156	149	136	137	131	128	133	120	124	122	120
Belgium	326	273	212	172	150	138	138	126	123	120	113	111	110	109
Bulgaria	179	171	120	103	96	96	87	85	86	82	81	85	79	80
Croatia	161	114	96	111	105	90	86	80	75	70	64	65	65	61
Cyprus	18	17	19	22	21	19	21	15	15	14	12	13	13	13
Czechia	509	356	287	252	243	243	241	230	224	221	214	212	207	207
Denmark	190	191	169	143	133	124	121	115	112	112	104	107	103	102
Estonia	49	33	30	26	27	23	23	22	22	22	24	25	25	26
Finland	242	213	187	157	135	126	128	117	115	110	108	102	103	101
France	2856	2465	2022	1540	1237	1155	1166	1092	1047	1034	1016	992	977	971
Germany	3439	2066	1638	1349	1242	1136	1257	1147	1146	1102	1068	1042	1043	1068
Greece	260	244	247	230	199	187	178	167	166	158	156	157	147	148
Hungary	301	212	197	171	149	150	146	150	152	151	141	144	142	141
Ireland	145	138	123	122	117	115	111	108	110	112	108	108	110	109
Italy	2001	2034	1602	1348	1266	1188	1124	1033	1024	996	931	915	899	935
Latvia	79	59	49	48	42	42	40	41	42	41	42	40	38	38
Lithuania	113	77	62	65	60	57	57	55	54	50	51	50	50	50
Luxembourg	22	18	15	15	13	12	11	11	12	12	11	11	11	11
Malta	1.5	1.7	1.5	1.9	1.8	1.5	1.9	1.6	2.5	2.6	2.6	3.1	3.1	3.9
Netherlands	569	394	292	227	215	208	218	214	211	206	201	199	192	193
Poland	706	825	732	721	747	748	712	694	676	633	631	641	672	686
Portugal	250	245	246	208	187	174	176	167	164	164	169	169	166	167
Romania	346	164	227	243	270	242	240	228	235	221	218	214	214	214
Slovakia	305	203	168	151	141	131	133	127	125	107	89	97	95	89
Slovenia	64	62	52	44	42	38	37	35	33	32	30	30	30	30
Spain	1034	979	974	826	718	656	647	621	597	577	581	601	616	632
Sweden	359	269	225	209	187	182	181	174	164	160	156	154	148	147
United Kingdom	2162	1821	1239	828	688	610	591	563	554	529	519	515	500	510
EU-28	**17015**	**13882**	**11410**	**9489**	**8581**	**8026**	**8009**	**7551**	**7415**	**7172**	**6960**	**6922**	**6881**	**6962**
Iceland	15	13	8.7	7.5	6.9	6.4	5.9	5.7	5.6	5.4	5.6	5.6	5.8	6.7
United Kingdom (KP)	2337	1825	1241	830	690	612	592	565	556	531	520	516	501	511
EU-28 + ISL	**17204**	**13899**	**11421**	**9498**	**8589**	**8033**	**8016**	**7558**	**7422**	**7179**	**6967**	**6929**	**6888**	**6970**

Table 2.11 Overview of Member States' contributions to EU-28 and Iceland SO_2 emissions for 1990–2017 (Gg)

Member State	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Austria	74	47	32	25	20	15	16	15	14	14	15	14	13	13
Belgium	365	258	172	142	96	74	60	53	47	43	40	41	39	37
Bulgaria	419	466	371	394	431	407	438	512	445	385	415	437	379	22
Croatia	134	64	51	58	53	56	35	29	25	17	14	16	14	12
Cyprus	31	39	48	38	22	18	22	21	16	14	17	13	16	16
Czechia	1756	1059	233	208	170	169	164	168	160	145	134	129	115	110
Denmark	178	146	32	26	21	15	15	14	13	13	10	10	10	10
Estonia	222	103	80	64	60	45	73	64	30	26	31	24	27	32
Finland	250	105	81	69	68	60	67	60	51	48	43	42	40	35
France	1302	987	653	486	379	315	295	273	258	232	192	181	162	161
Germany	5456	1747	646	472	451	395	409	395	375	366	346	343	319	315
Greece	518	528	575	601	465	415	233	171	143	130	114	112	108	106
Hungary	829	614	427	43	36	30	30	34	31	29	26	24	23	28
Ireland	183	163	144	73	45	32	26	25	23	23	17	15	14	13
Italy	1784	1323	756	410	290	237	218	196	178	147	132	125	117	115
Latvia	100	49	18	8.7	6.6	6.4	4.3	4.3	4.4	3.9	3.9	3.6	3.4	4.0
Lithuania	190	73	37	28	20	19	18	20	17	15	14	15	15	13
Luxembourg	2.5	2.5	1.8	1.2	0.6	0.6	0.5	0.4	0.5	0.5	0.4	0.5	0.1	0.0
Malta	10	11	10	12	12	8.2	7.8	8.0	8.6	3.8	3.3	2.1	1.4	0.7
Netherlands	187	126	71	62	50	37	33	33	34	30	29	30	28	27
Poland	2652	2141	1411	1171	947	811	874	836	803	768	724	711	591	583
Portugal	325	328	303	192	110	77	67	60	55	50	45	47	47	49
Romania	790	697	494	603	529	457	362	340	278	218	191	154	103	105
Slovakia	239	134	117	86	68	63	68	67	57	52	44	67	26	27
Slovenia	200	123	93	39	14	11	10	12	11	13	9.2	4.8	3.9	4.1
Spain	2116	1819	1421	1229	405	305	260	296	294	234	254	271	230	237
Sweden	104	69	43	36	28	27	29	26	25	22	20	18	18	18
United Kingdom	3763	2449	1286	772	529	432	449	415	459	396	321	249	175	172
EU-28	**24181**	**15671**	**9606**	**7351**	**5326**	**4536**	**4287**	**4150**	**3856**	**3439**	**3205**	**3101**	**2641**	**2265**
Iceland	24	22	39	43	78	73	77	84	86	72	66	61	52	50
United Kingdom (KP)	3778	2464	1298	780	535	437	454	418	463	400	325	254	178	176
EU-28 + ISL	**24221**	**15708**	**9657**	**7401**	**5410**	**4613**	**4368**	**4237**	**3947**	**3514**	**3275**	**3166**	**2696**	**2319**

3 ENERGY (CRF SECTOR 1)

This chapter starts with an overview on emission trends in CRF Sector 1 Energy. For each EU-28 + ISL key category as well as other important subsector specific categories overview tables are presented including the Member States' 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 78% to total GHG emissions and is the largest emitting sector in the EU-28 + ISL. Total GHG emissions from this sector decreased by 23% from 4353 Mt in 1990 to 3372 Mt in 2017 (Figure 3.1). In 2017, emissions increased by 0.4% compared to 2016.

The most important energy-related gas is CO_2 that makes up 75% of the total EU-28 + ISL greenhouse gas emissions in 2017. CH_4 of the energy sector is responsible for 2% and N_2O for 1% of the total GHG emissions.

Figure 3.1 CRF Sector 1 Energy: EU-28 + ISL GHG emissions in CO_2 equivalents (Mt) for 1990–2017

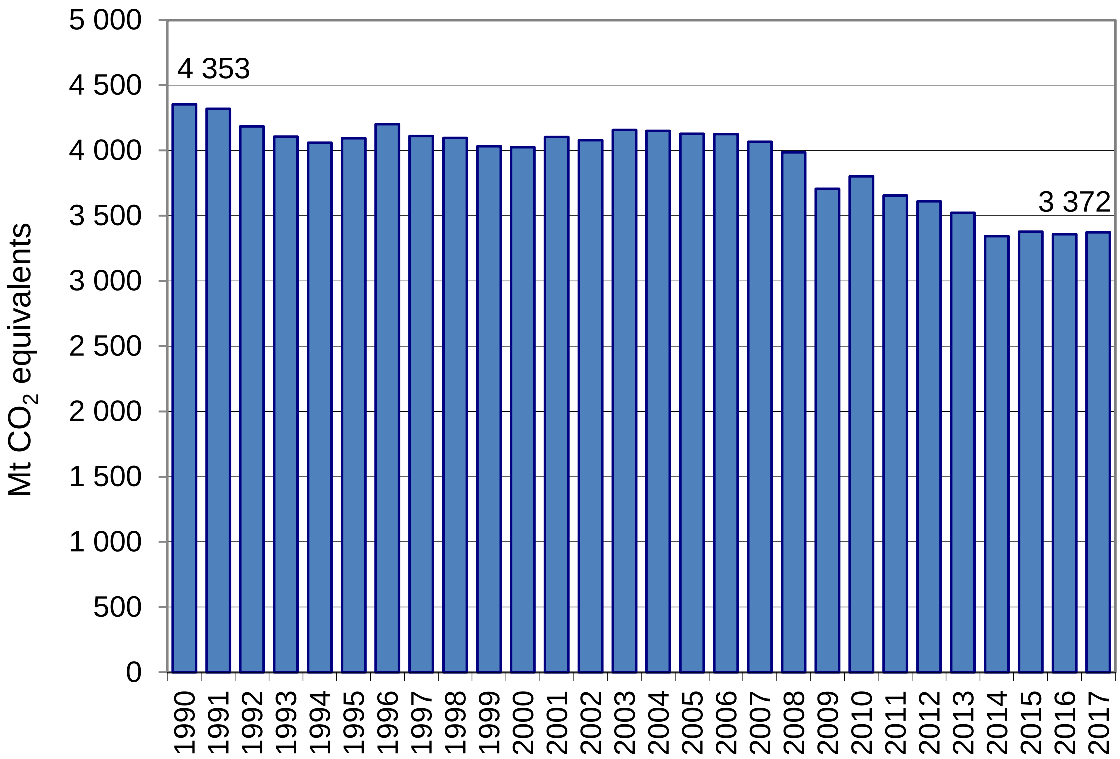
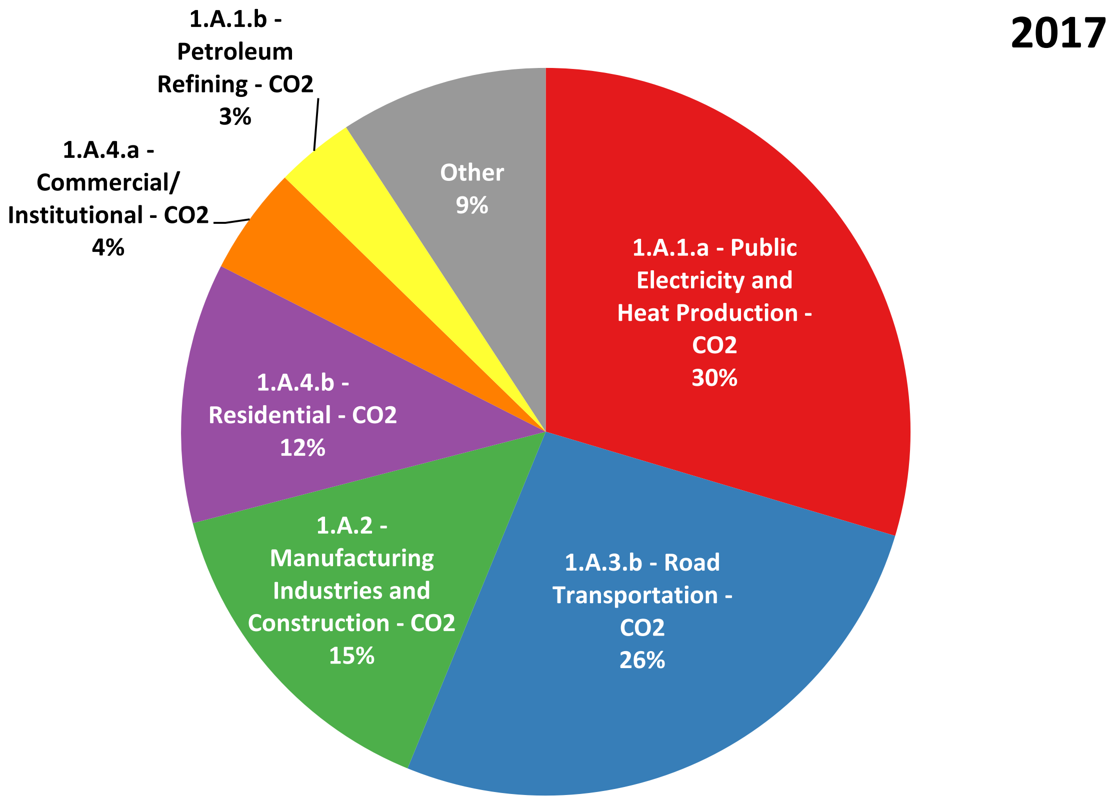


Figure 3.2 shows the share of the largest key categories in the sector Energy in 2017. The first chart illustrates that the three largest key categories account for 71 % and the largest six for 91 % of

emissions in the whole sector 1. The two largest categories of the energy sector alone are responsible for 44 % of the total EU-28 + ISL emissions in 2017.

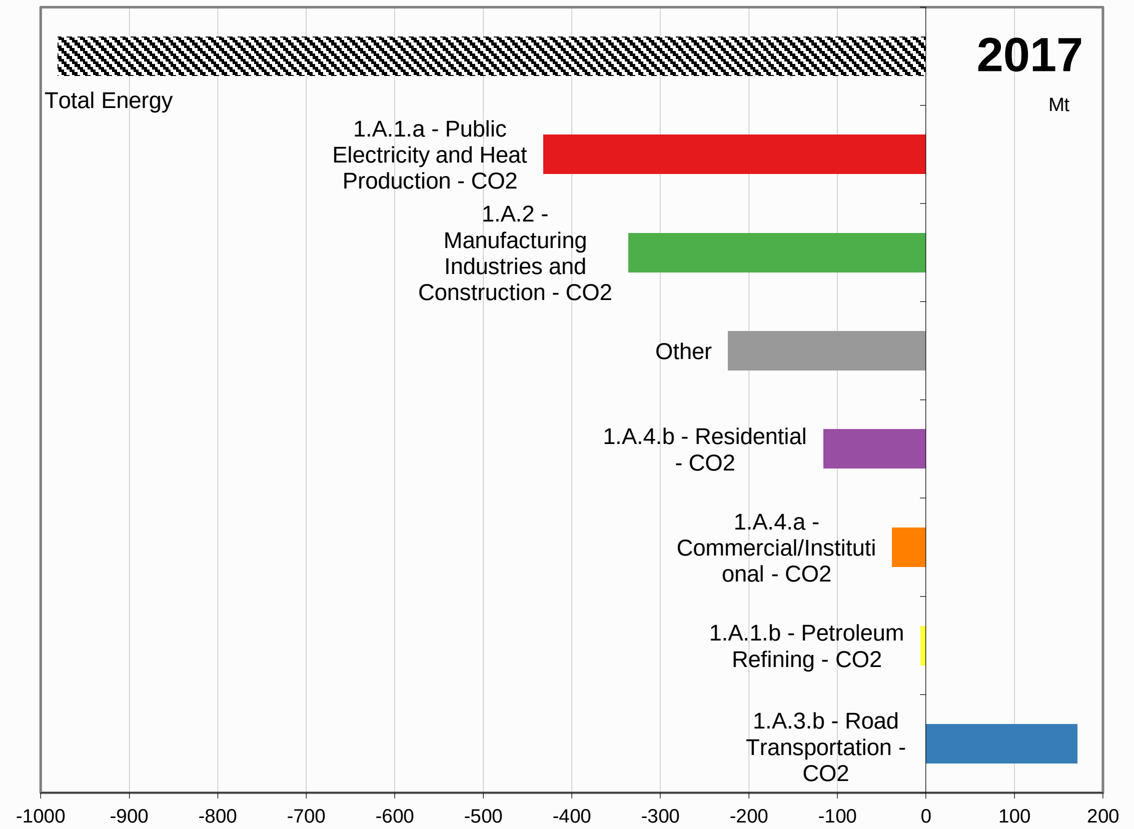
Figure 3.2 CRF Sector 1 Energy: Share of largest key source categories in 2017



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 (on the next page) shows the absolute change of GHG emissions of these large key categories for the years 1990-2017. 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 2017. The decreases in Public Electricity and Heat Production and Manufacturing Industries as well as the increases in Road Transportation occurred in almost all Member States. 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 1990-2017



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.b Petroleum Refining: Solid 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.2.g Other Manufacturing Industries and Constructions: Other 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.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 ten 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 Member States. 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 the Czech Republic 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

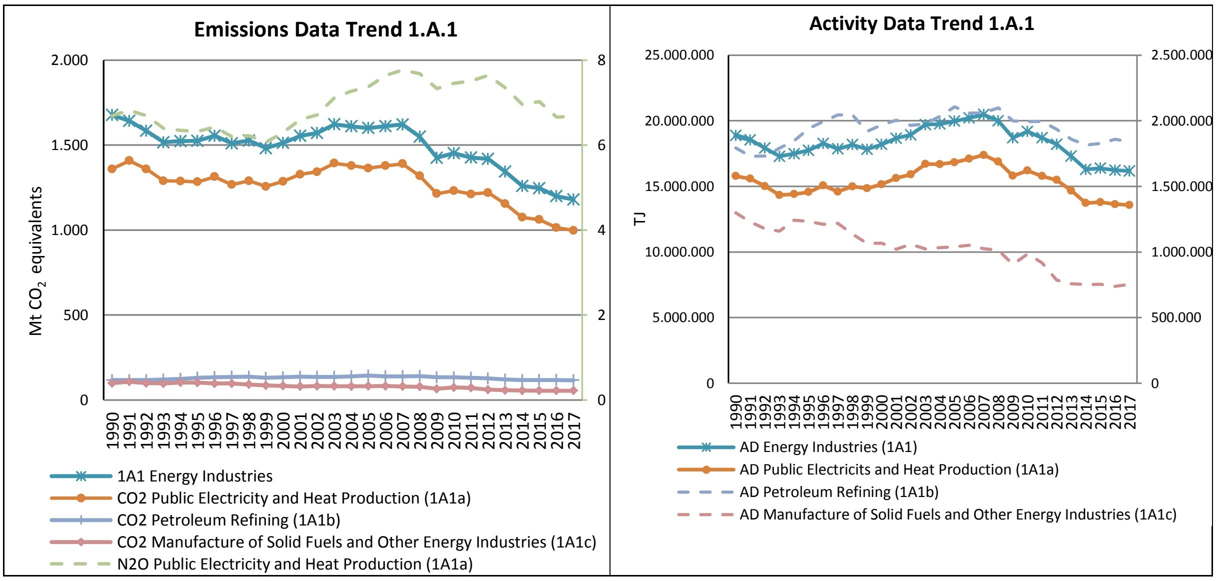
Source category gas	kt CO_2 eq.		Trend	Level		share of higher Tier
	1990	2017		1990	2017	
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	107487	231909	T	L	L	94%
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	176244	29601	T	L	L	95%
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	10785	41841	T	L	L	97%
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	8508	7606	0	L	L	97%
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	1127162	686081	T	L	L	96%
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	5275	25001	T	0	L	98%
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	112274	90903	T	L	L	94%
1.A.1.b Petroleum Refining: Solid Fuels (CO_2)	3633	106	T	0	0	93%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	17326	20259	T	L	L	91%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)	91075	30623	T	L	L	97%

Figure 3.4 shows the trends in emissions in Energy Industries for the EU-28 + ISL between 1990 and 2017, which was mainly dominated by CO_2 emissions from public electricity and heat production. Carbon dioxide from 1.A.1.a currently represents about 85% of greenhouse gas emissions in 1.A.1 (i.e. including methane and nitrous oxide).

Total greenhouse gas emissions from 1.A.1 decreased by 29.6%, between 1990 and 2017. This was mainly due to a decrease of CO_2eq emission from Public Electricity and Heat Production (- 430 Mt CO_2eq) followed by -60 Mt CO_2eq of the manufacturing of solid fuels and -5.4 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 Member State. Between 1990 and 2017, greenhouse gas emissions from energy industries increased in six Member States and fell in twenty-three. The highest absolute increase was accounted for by the Netherlands with 10 Mt CO_2e respectively 19%. The United Kingdom, Germany and Poland, followed by Romania and Italy account for the largest part of reductions (-398 Mt CO_2eq). The change in the EU-28 + ISL was a net decrease of about 496 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-28 + ISL 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 58% and the top six Member States account for 70% of the EU's greenhouse gas emissions from energy industries.

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

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2017 (kt CO2 equivalents)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2017 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2017 (kt CO2 equivalents)
Austria	14 100	11 195	42	103	8	26
Belgium	30 061	20 175	182	170	20	30
Bulgaria	36 540	27 672	124	109	13	8
Croatia	7 071	4 493	17	22	5	7
Cyprus	1 767	3 299	4	8	2	3
Czechia	56 855	51 765	245	243	17	34
Denmark	26 251	11 574	86	86	16	101
Estonia	29 281	14 706	18	41	8	20
Finland	18 969	17 554	116	250	10	29
France	66 373	49 585	318	305	66	40
Germany	427 353	313 447	3 167	2 527	280	3 041
Greece	43 253	39 941	145	109	14	15
Hungary	20 861	13 955	67	61	9	26
Ireland	11 223	11 647	71	140	7	9
Italy	137 158	104 769	485	425	227	129
Latvia	6 244	1 549	11	23	5	15
Lithuania	13 553	2 573	21	38	10	24
Luxembourg	36	244	1	4	1	3
Malta	1 367	727	5	2	1	1
Netherlands	53 368	63 465	148	287	72	106
Poland	236 171	164 864	1 022	736	82	93
Portugal	16 348	20 803	49	177	5	16
Romania	70 944	23 916	183	86	38	13
Slovakia	18 956	7 487	65	36	9	14
Slovenia	6 375	4 915	25	23	2	3
Spain	78 912	81 248	289	585	51	144
Sweden	9 928	9 170	120	246	17	46
United Kingdom	236 335	102 569	1 367	748	203	379
EU-28	**1 675 653**	**1 179 304**	**8 393**	**7 591**	**1 197**	**4 376**
Iceland	14	2	0.03	0.004	0.01	0.002
United Kingdom (KP)	237 026	103 202	1 369	750	204	380
EU-28 + ISL	**1 676 358**	**1 179 939**	**8 395**	**7 593**	**1 198**	**4 376**

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-28 + ISL greenhouse gas inventory. Differences in the intensity of greenhouse gas emissions of heat and electricity production between the Member States 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-28 + ISL level, 43% of the fuel used in energy industries comes from solid fuels. Its contribution has been declining in favour of the in comparison relatively cleaner natural gas, whose share amounted to about 30% in 2017 and biomass which has been constantly increasing with a share of 11.5% in 2017.

As can be seen in Figure 3.5 Germany, Poland, Italy and the United Kingdom contribute 58% of the total CO_2 emissions in sector 1.A.1 Energy industries in the year 2017. The relatively low share of greenhouse gas emissions from energy industries in France can be partly explained by the use of nuclear energy for power generation.

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

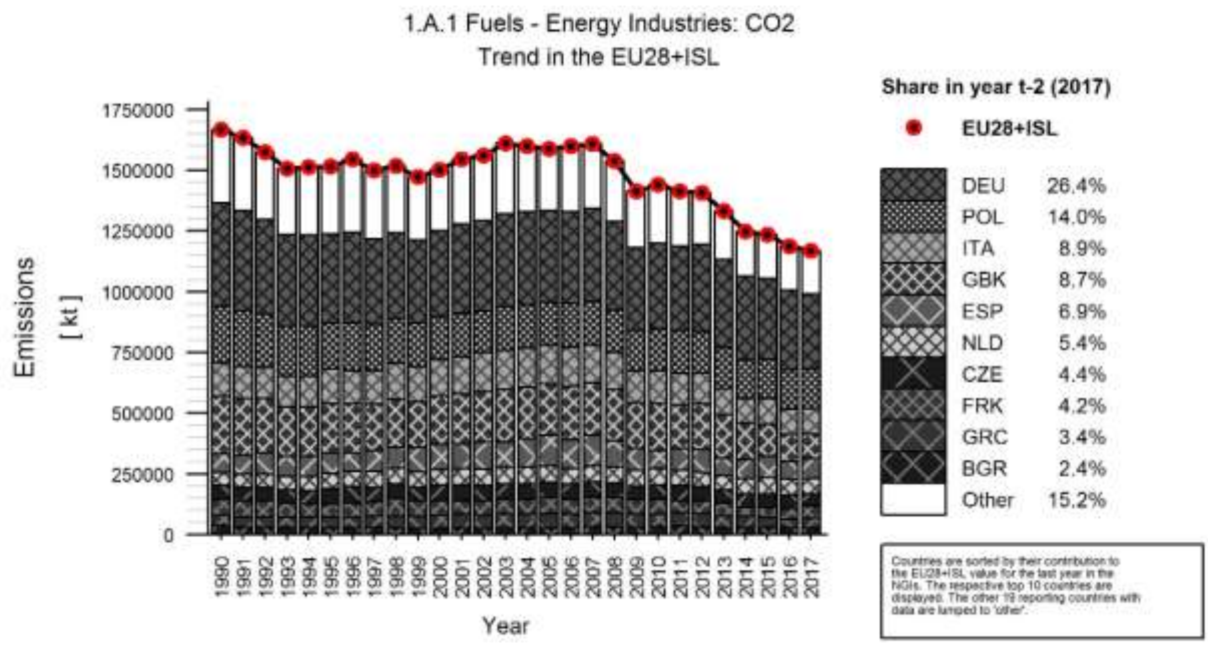


Table 3.3 provides information on the Member States' contribution to EU-28 + ISL recalculations in CO_2 from 1.A.1 Energy Industries for 1990 and 2016 as well as the main explanations for the largest recalculations in absolute terms.

Table 3.3 1.A.1 Energy Industries: Contribution of MS to EU-28 + ISL recalculations in CO_2 for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 and percent)

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	24	0.2	-17	-0.2	Revised energy balance
Belgium	-	-	24	0.1	Revised energy balance
Bulgaria	-2 128	-5.5	-739	-2.7	Change in solid fuel EF up to the year 2003
Croatia	-23	-0.3	-42	-0.9	Recalculation of all fuel consumptions using IPCC NCVs
Cyprus	-	-	-	-	
Czechia	-61	-0.1	6	0.01	Updated activity data
Denmark	-	-	5	0.03	Updated activity data
Estonia	-	-	0.02	0.0002	Minor errors in the data in the previous submission
Finland	-	-	28	0.2	Corrections in plant level fuel data
France	-19	-0.03	-38	-0.1	Small decrease of the consumption on the entire time series for district heating due to an update of the conversion factor from ktep to TJ (from 42 to 41.868)
Germany	-	-	759	0.2	Updated activity data
Greece	-	-	-	-	
Hungary	-5	-0.02	7	0.1	Recalculated fossil C in waste
Ireland	-	-	1	0.01	Updated activity data
Italy	-	-	-1	-0.001	Updated activity data
Latvia	-21	-0.3	-	-	Revision of CO_2 emissions from 1990 to 2015 due to the implementation of the research "Determination of Carbon Content and Calculation of Carbon Dioxide Emission Factors":
Lithuania	-	-	-	-	
Luxembourg	-	-	0.01	0.005	Energy balance revised
Malta	-	-	-3	-0.5	Energy balance revised
Netherlands	-	-	169	0.3	Energy balance revised
Poland	-	-	79	0.05	AD and emission from combustion of Other petroleum products were corrected
Portugal	-35	-0.2	-9	-0.1	Update of Tier 2 emission factor for Natural Gas QA/QC Compilation Error on Energy Consumption
Romania	-	-	1 137	4.4	Because the activity data from Energy Balance provided from National Institute of Statistics were updated for 1992-2016 period from the 1.A.1 Energy Industry sub-sector, the CO_2, CH_4 and N_2O emissions values for the 1992-2016 period were recalculated. ETS data were used as activity data in the 1A1a category for some specific fuels. Country specific CO_2 EFs for the corresponding fuels from 2016 EU ETS reports were used for all 1A1 categories. Net calorific values determined from the 2016 EU-ETS reports were used for the specific fuels in 1A1 categories.
Slovakia	-	-	-9	-0.1	Minor revision of residual fuel oil consumption in one plant.
Slovenia	-	-	-6	-0.1	Reallocation of emissions from NG.
Spain	8	0.01	-81	-0.1	Energy balance revised and correction of minor mistake
Sweden	-23	-0.2	21	0.2	Revision of NCV and EF for CO_2 Natural Gas, Revision of EF for CO_2 for Peat and Landfill Gas, Revision of plant specific EF for CO_2 incineration of other fossil fuels, Reallocation between IPPU and CRF1
United Kingdom	29	0.01	1 466	1.3	Revision to upstream oil and gas combustion estimates (new installation data added). Method change for Energy from Waste plant using revised UK energy statistics (fossil and biogenic split) and now applying IPCC default factors to those data.
EU28	-2 252	-0.1	2 757	0.2	
Iceland	-0	-0	-0	-0	
United Kingdom (KP)					
EU28+ISL	-2 281	-0.2	1 291	0.1	

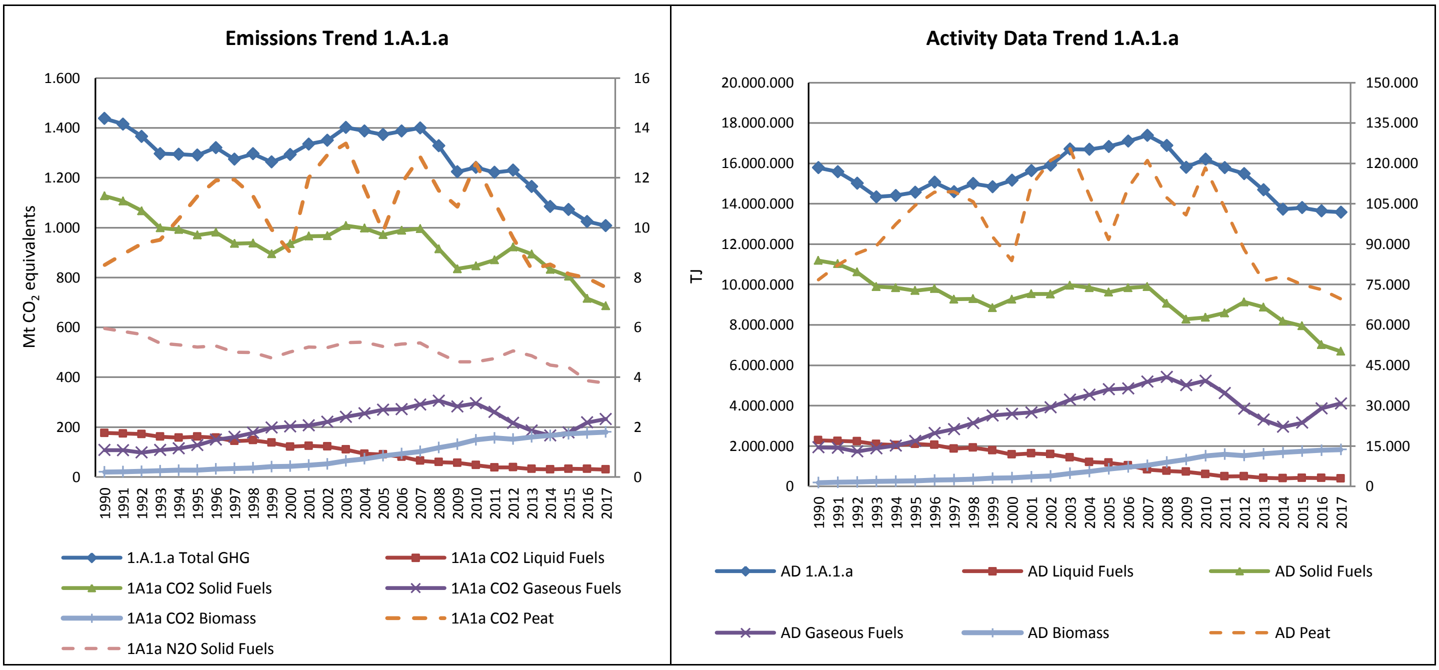
3.2.1.1 Public Electricity and Heat Production (1.A.1.a) (EU-28 + ISL)

According to the 2006 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-28 + ISL accounting for 23% of total greenhouse gas emissions in 2017 and for 85% of greenhouse gas emissions of the Energy Industries Sector. Between 1990 and 2017, CO_2 emissions from electricity and heat production decreased by 30% in the EU-28 + ISL.

Figure 3.6 shows the trends in emissions originating from the production of public electricity and heat by fuel in the EU-28 + ISL between 1990 and 2017 as well as the underlying activity data[12].

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



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

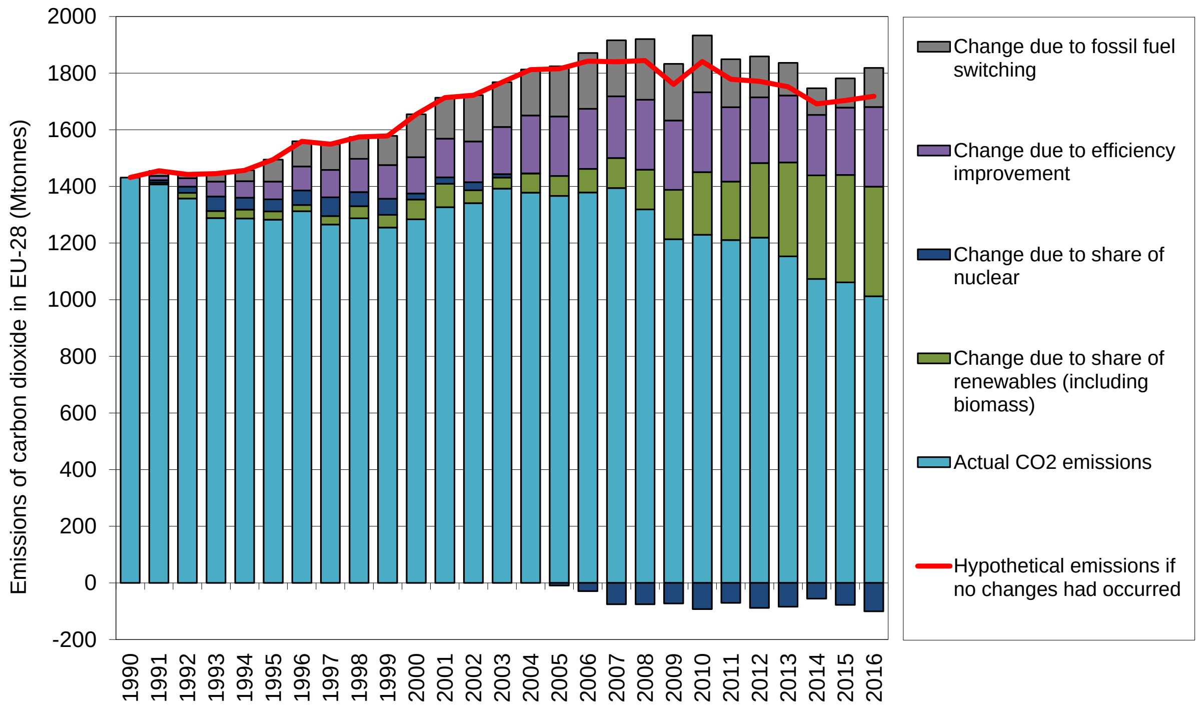
Fuel used for public electricity and heat production decreased by 13.9% in the EU-28 + ISL between 1990 and 2017. Solid fuels still represent 49.3% of the fuel used in public conventional thermal

[12] 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.

power plants, although its combustion has been declining by 40.2% between 1990 and 2017. 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 2017 its share amounts to 30.2% of all the fuels used for the production of heat and electricity in the EU-28 + ISL. Liquid fuels still account for some 3%, but its use has declined gradually during the past 20 years. The use of biomass has increased even more rapidly than the use of gas, but its share in the fuel mix is relatively small, at 13.4%.

Figure 3.7 below shows the estimated impact of different factors on the reduction of CO_2 emissions from public heat and electricity generation in the EU-28 between 1990 and 2016. The main explanatory factors at the EU-28 level during the past 26 years have been the increased share of renewable energy, improvements in energy efficiency and (fossil) fuel switching from coal to gas. This trend from coal to gas has reversed in recent years up until 2014, as a result of comparably high gas prices and lower coal prices. Since 2015, natural gas demand picked up again in the EU-28 + ISL, inter alia due to lower gas prices, higher coal prices, coal plant retirements, while world-wide coal demand dropped for a second year in a row in 2016[13][14].

Figure 3.7 Estimated impact of different factors on the reduction in emissions of CO_2 from public electricity and heat production in the EU-28 between 1990 and 2016



Note: The chart shows the estimated contributions of the various factors that have affected emissions from public electricity and heat production (including public thermal power stations, nuclear power stations, hydro power plants and wind plants). The red line represents the hypothetical development of emissions that would have occurred due to increasing public heat and electricity production between 1990 and 2016, if the structure of electricity and heat production had remained unchanged since 1990, i.e. if the shares of input fuels used to produce electricity and heat had remained constant, and if the efficiency of electricity and heat production also stayed the same. However, there were a number of changes that tended to reduce emissions. The contribution of each of these changes to reducing emissions is shown by each of the bars. The cumulative effect of all these

[13] IEA (2017): Market Report Series: Gas 2017. Analysis and Forecasts to 2022. Executive Summary. Available at: https://webstore.iea.org/download/summary/183?fileName=English-Gas-2017-ES.pdf (last accessed: 17.05.2018)

[14] IEA (2017): Market Report Series: Coal 2017. Analysis and Forecasts to 2022. Executive Summary. Available at: https://webstore.iea.org/download/summary/143?fileName=English-Coal-2017-ES.pdf (last accessed: 17.05.2018)

changes was that emissions from electricity and heat production actually followed the trend shown by the light blue bars. This is a frequently used approach for portraying the primary driving forces of emissions. It is based on the IPAT and Kaya identities. The explanatory factors should not be seen as fundamental factors in themselves nor should they be seen as independent from each other. The underpinning energy data is based on Eurostat's energy balances.

Based on the chart above, CO_2 emissions from public heat and electricity production decreased by 29% during 1990-2016 (light blue bar), but emissions would have risen by 19%, if the shares of input fuels used to produce electricity and heat as well as the efficiency remained constant and an increase due to the change in electricity consumption (20%), which was in line with the additional amount of electricity and heat produced took place. The relationship between the increase in electricity generation and the actual reduction in emissions during 1990-2016 can be explained by the following factors:

- An improvement in the thermal efficiency of electricity and heat production; during 1990-2016, there was a 17% reduction in the fossil-fuel input per unit of electricity produced from fossil fuels.
- Changes in the fossil fuel mix used to produce electricity, i.e. fuel switching from coal and lignite to natural gas. There was a 12% reduction in the CO_2 emissions per unit of fossil-fuel input during 1990-2016.
- The higher combined share of renewable energy (increasing share) and the share of nuclear (more or less constant share) for electricity and heat production in 2016 compared to 1990[15]. During 1990-2016, the share of electricity from fossil fuels in total electricity production decreased by 20%.

These three factors interact with each other in a multiplicative way: Actual CO_2 emissions change = 1.20 (increase in electricity and heat production) X 0.83 (efficiency improvement) X 0.88 (fossil fuel switching) X 0.80 (lower nuclear-renewable share) = 0.71. The combined effect was a decrease of 29% in CO_2 emissions in 2016 compared to the 1990 level.

Returning to the 2019 inventory, Table 3.4 shows emissions arising from the production of public heat and electricity by Member State. Carbon dioxide emissions amount to 98.9% of greenhouse gas emissions from public electricity and heat production. These emissions increased in six Countries and fell in 23 compared to 1990. Of the six countries where emissions were higher in 2017 than in 1990, almost 60% of the increase was accounted for by the Netherlands alone. Of the countries, where emissions fell, 69% of the total reduction was accounted for by the United Kingdom (29%),

[15] The specific nuclear effect can be separated from the renewable effect in an additive way. These two factors will then be additive to each other and the combined renewable and nuclear effect will remain multiplicative to the already-mentioned fuel-switching and efficiency factors. The reason for negative values of nuclear power is that - from 2004 onwards - the share of nuclear power in total electricity generation was below the share of 1990. During the period 1991-2003 the share of nuclear power was above the value of 1990 (29%) reaching a peak of 32% in 1997. Therefore during this period nuclear power contributed to lower GHG emissions compared to 1990. In the figure this is reflected in the (positive) *dark blue* bars. The positive value indicates that nuclear power had a positive effect with regard to GHG emission reductions between 1990 and 2003. From 2004 onwards the picture changed: the share of nuclear power was below the value of 1990 reaching 25% in 2016. In the figure this is reflected in the (negative) *dark blue* bars. The negative value indicates that nuclear power had a negative effect with regard to GHG emission reductions between 2004 and 2016. This is also reflected by the red line in the figure: the red line assumes that the share of nuclear power stays at 29% over the whole time series. Therefore from 2004 onwards the red line is below the bars.

Poland (16%), Romania (10%) and Germany (13%). The change in the EU-28 + ISL between 1990 and 2017 was a net decrease of 433 Mt CO_2 respectively of 30%.

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

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	11 145	7 376	8 046	0.8%	-3 099	-28%	670	9%
Belgium	23 537	15 040	15 131	1.5%	-8 405	-36%	91	1%
Bulgaria	35 179	25 423	26 678	2.7%	-8 501	-24%	1 255	5%
Croatia	3 729	3 347	2 896	0.3%	-833	-22%	-452	-13%
Cyprus	1 676	3 300	3 288	0.3%	1 612	96%	-12	0%
Czechia	54 585	47 399	45 066	4.5%	-9 519	-17%	-2 333	-5%
Denmark	24 697	11 670	9 091	0.9%	-15 606	-63%	-2 579	-22%
Estonia	29 170	12 441	13 272	1.3%	-15 898	-55%	831	7%
Finland	16 453	16 861	15 264	1.5%	-1 189	-7%	-1 597	-9%
France	49 315	34 739	39 429	4.0%	-9 886	-20%	4 690	14%
Germany	338 451	297 834	277 859	27.9%	-60 593	-18%	-19 975	-7%
Greece	40 617	31 311	34 876	3.5%	-5 741	-14%	3 564	11%
Hungary	17 892	11 750	12 055	1.2%	-5 837	-33%	304	3%
Ireland	10 876	11 930	11 057	1.1%	181	2%	-873	-7%
Italy	106 797	75 979	77 820	7.8%	-28 977	-27%	1 842	2%
Latvia	6 083	1 774	1 465	0.1%	-4 617	-76%	-309	-17%
Lithuania	12 003	1 403	1 077	0.1%	-10 926	-91%	-326	-23%
Luxembourg	33	247	237	0.02%	204	612%	-10	-4%
Malta	1 361	577	723	0.1%	-638	-47%	147	25%
Netherlands	40 027	54 998	51 387	5.2%	11 360	28%	-3 611	-7%
Poland	228 038	153 719	155 476	15.6%	-72 562	-32%	1 757	1%
Portugal	14 355	14 858	18 137	1.8%	3 783	26%	3 280	22%
Romania	66 280	22 732	19 421	1.9%	-46 859	-71%	-3 311	-15%
Slovakia	14 690	4 703	4 748	0.5%	-9 942	-68%	45	1%
Slovenia	6 096	4 903	4 889	0.5%	-1 207	-20%	-14	-0.3%
Spain	65 570	58 136	67 933	6.8%	2 364	4%	9 797	17%
Sweden	7 714	6 517	6 485	0.7%	-1 229	-16%	-32	-0.5%
United Kingdom	203 116	82 490	72 598	7.3%	-130 518	-64%	-9 892	-12%
EU-28	**1 429 483**	**1 013 458**	**996 406**	**100%**	**-433 078**	**-30%**	**-17 052**	**-2%**
Iceland	14	2	2	0.0002%	-12	-87%	-0.4	-19%
United Kingdom (KP)	203 804	83 163	73 229	7.3%	-130 576	-64%	-9 934	-12%
EU-28 + ISL	**1 430 186**	**1 014 133**	**997 038**	**100%**	**-433 148**	**-30%**	**-17 095**	**-2%**

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 2017, emissions decreased by 3% (Table 3.5). The largest decline in emissions from this source category was reported by the United Kingdom (-669 kt CO_2eq) and Poland (-281 kt CO_2eq). The biggest increase occurred in Spain (298 kt CO_2eq).

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

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	40	100	99	1.5%	59	150%	-1	-1%
Belgium	54	93	94	1.4%	40	75%	1	2%
Bulgaria	123	103	108	1.6%	-14	-12%	6	6%
Croatia	13	21	20	0.3%	7	50%	-1	-7%
Cyprus	4	8	8	0.1%	4	96%	0.04	1%
Czechia	242	233	224	3.3%	-18	-8%	-10	-4%
Denmark	79	80	78	1.2%	-1	-1%	-3	-3%
Estonia	18	35	39	0.6%	22	123%	5	13%
Finland	100	243	230	3.4%	129	129%	-13	-5%
France	289	278	299	4.5%	10	3%	21	8%
Germany	2 407	2 403	2 309	34.6%	-98	-4%	-93	-4%
Greece	142	93	104	1.6%	-37	-26%	11	12%
Hungary	63	61	59	0.9%	-3	-5%	-1	-2%
Ireland	71	139	140	2.1%	69	97%	1	1%
Italy	304	282	270	4.0%	-33	-11%	-12	-4%
Latvia	11	20	22	0.3%	12	107%	3	13%
Lithuania	19	34	37	0.6%	18	99%	3	9%
Luxembourg	1	3	4	0.06%	3	183%	1	25%
Malta	5	1	2	0.03%	-2	-53%	1	67%
Netherlands	133	288	265	4.0%	132	100%	-23	-8%
Poland	1 006	740	725	10.9%	-281	-28%	-14	-2%
Portugal	46	134	176	2.6%	130	285%	42	31%
Romania	179	95	82	1.2%	-96	-54%	-12	-13%
Slovakia	59	33	34	0.5%	-26	-43%	0.5	1%
Slovenia	25	23	23	0.3%	-2	-7%	0.3	1.2%
Spain	274	445	572	8.6%	298	109%	126	28%
Sweden	118	226	245	3.7%	127	107%	19	8.4%
United Kingdom	1 077	440	408	6.1%	-669	-62%	-32	-7%
EU-28	**6 900**	**6 653**	**6 678**	**100%**	**-222**	**-3%**	**25**	**0.4%**
Iceland	0.03	0.01	0.004	0.0001%	-0.03	-87%	-0.001	-20%
United Kingdom (KP)	1 079	442	410	6.1%	-669	-62%	-32	-7%
EU-28 + ISL	**6 902**	**6 655**	**6 680**	**100%**	**-223**	**-3%**	**25**	**0.4%**

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

Finally, CH_4 emissions currently represent 0.4% of greenhouse gas emissions from public electricity and heat production. Between 1990 and 2017, emissions increased by 464%. The biggest increase was reported by Germany (2673 kt CO_2eq), which is also responsible for 83.3% of the emissions EU-28 + ISL in 2017.

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

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	6	23	23	0.6%	17	280%	0	0%
Belgium	11	24	25	0.6%	13	118%	1	2%
Bulgaria	12	8	8	0.2%	-4	-35%	0	-4%
Croatia	3	5	6	0.2%	3	78%	1	32%
Cyprus	2	3	3	0.1%	2	93%	0.01	0%
Czechia	15	32	33	0.8%	17	111%	1	3%
Denmark	15	97	100	2.6%	85	571%	3	3%
Estonia	8	16	19	0.5%	11	150%	3	19%
Finland	9	27	28	0.7%	19	211%	1	3%
France	14	30	35	0.9%	22	159%	5	17%
Germany	172	2 776	2 846	73.0%	2 673	1553%	69	2%
Greece	13	11	12	0.3%	-1	-5%	1	13%
Hungary	7	24	25	0.6%	17	236%	1	3%
Ireland	6	7	9	0.2%	2	38%	2	22%
Italy	93	107	108	2.8%	15	16%	1	1%
Latvia	5	13	14	0.4%	10	205%	2	13%
Lithuania	9	21	23	0.6%	14	160%	2	9%
Luxembourg	1	2	3	0.07%	2	186%	1	25%
Malta	1	1	1	0.02%	0.04	4%	0.4	67%
Netherlands	42	91	86	2.2%	44	106%	-5	-5%
Poland	75	98	87	2.2%	12	16%	-11	-11%
Portugal	4	14	15	0.4%	11	273%	1	9%
Romania	36	11	11	0.3%	-25	-71%	-1	-8%
Slovakia	6	13	13	0.3%	7	108%	0.1	1%
Slovenia	2	3	3	0.1%	1	65%	0.2	9.0%
Spain	21	63	72	1.8%	51	246%	8	13%
Sweden	16	45	46	1.2%	30	190%	1	1.2%
United Kingdom	87	232	246	6.3%	159	184%	14	6%
EU-28	**690**	**3 797**	**3 898**	**100%**	**3 207**	**465%**	**100**	**3%**
Iceland	0.01	0.002	0.002	0.00005%	-0.01	-87%	-0.0004	-20%
United Kingdom (KP)	87	234	247	6.3%	160	182%	13	6%
EU-28 + ISL	**691**	**3 798**	**3 899**	**100%**	**3 207**	**464%**	**100**	**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-28 + ISL, emissions fell by 83% respectively by 147 Mt CO_2 between 1990 and 2017 (Table 3.7).

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

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	1 252	419	248	1%	-1 003	-80%	-170	-41%	T2	CS
Belgium	663	63	78	0.3%	-584	-88%	15	24%	T1, T3	D, PS
Bulgaria	3 245	837	498	2%	-2 747	-85%	-339	-40%	T1,T2	CS,D
Croatia	2 142	27	133	0.4%	-2 010	-94%	106	397%	T1	D
Cyprus	1 676	3 300	3 288	11%	1 612	96%	-12	0%	CS	CS
Czechia	1 174	113	128	0.4%	-1 045	-89%	15	13%	T1	D, CS
Denmark	953	160	161	1%	-792	-83%	1	0%	T1,T2,T3	CS,D,PS
Estonia	4 897	244	208	1%	-4 689	-96%	-36	-15%	T2	CS
Finland	1 234	832	705	2%	-529	-43%	-127	-15%	T3	CS/PS/D
France	8 220	4 074	4 182	14%	-4 038	-49%	109	3%	T2,T3	CS,PS
Germany	8 637	1 462	1 532	5%	-7 105	-82%	70	5%	CS	CS
Greece	5 416	3 643	4 029	14%	-1 387	-26%	386	11%	T2	CS, PS
Hungary	1 448	46	79	0.3%	-1 369	-95%	33	73%	T1, T2	D, CS
Ireland	1 087	206	105	0.4%	-981	-90%	-100	-49%	T1,T3	CS,D,PS
Italy	63 101	1 377	1 430	5%	-61 671	-98%	53	4%	T3	CS
Latvia	3 079	2	3	0.01%	-3 076	-100%	1	23%	T2	CS
Lithuania	6 021	131	86	0.3%	-5 935	-99%	-44	-34%	T1, T2, T3	CS, PS, D
Luxembourg	NO	3	2	0.01%	2	∞	-1	-24%	T1/T2	D/CS
Malta	742	577	171	1%	-571	-77%	-405	-70%	T1, T2	CS, D
Netherlands	233	754	591	2%	357	153%	-164	-22%	CS,T2	CS,D
Poland	5 160	448	493	2%	-4 668	-90%	44	10%	T1	D
Portugal	6 434	729	689	2%	-5 745	-89%	-40	-5%	T1	D
Romania	20 356	701	634	2%	-19 722	-97%	-66	-9%	T1,T2	CS,D
Slovakia	1 033	19	12	0.04%	-1 022	-99%	-7	-38%	T2	CS
Slovenia	272	21	25	0.1%	-247	-91%	4	21%	T1	D
Spain	6 087	9 722	8 586	29%	2 499	41%	-1 136	-12%	T2	CS/PS
Sweden	1 277	481	284	1%	-993	-78%	-197	-41%	T2	CS
United Kingdom	19 716	1 034	800	3%	-18 916	-96%	-234	-23%	T1, T2	CS, D
EU-28	**175 554**	**31 422**	**29 181**	**99%**	**-146 373**	**-83%**	**-2 241**	**-7%**		
Iceland	14	2	2	0.01%	-12	-87%	0	-19%	T1	D
United Kingdom (KP)	20 393	1 487	1 218	4%	-19 174	-94%	-269	-18%	T1, T2	CS, D
EU-28 + ISL	**176 244**	**31 877**	**29 601**	**100%**	**-146 644**	**-83%**	**-2 276**	**-7%**		

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

Table 3.7 also shows that about 95 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States 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 3.8 shows the contribution to the emission trend for liquid fuels by the main Member States. In 2017 Spain, France, Greece and Cyprus are responsible for about 68% 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 35.8% of the emissions in this category and now in 2017 only for 4.8%.

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

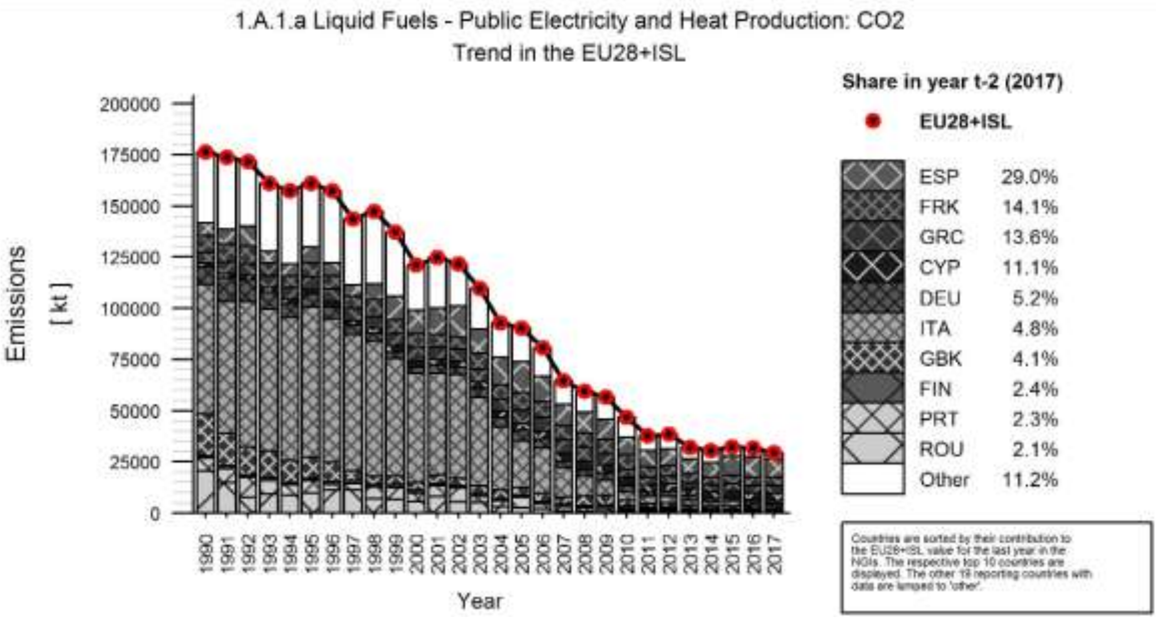
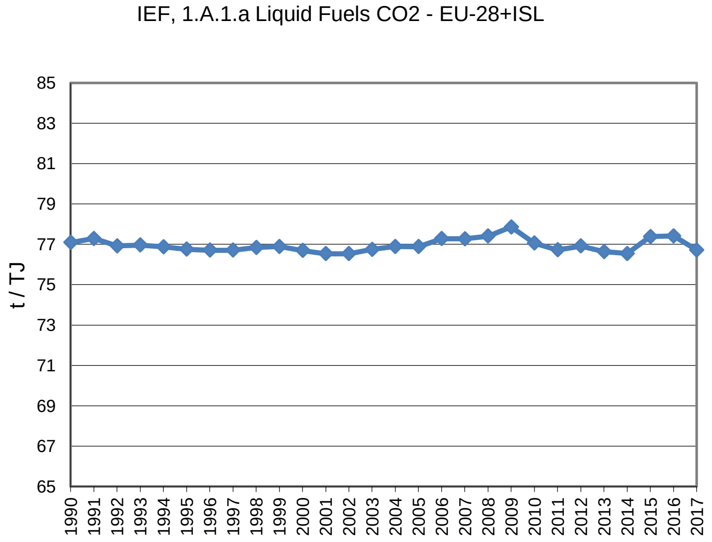
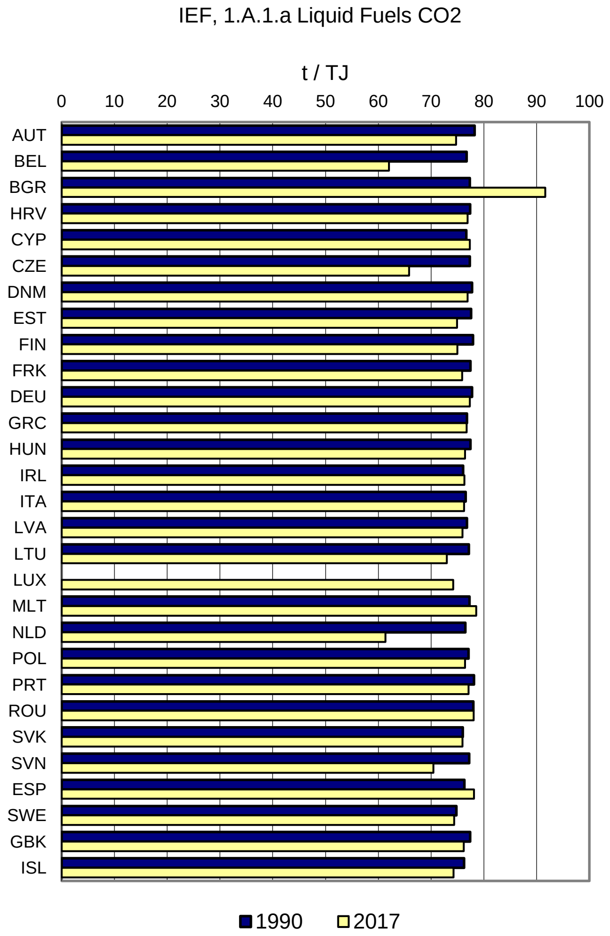


Figure 3.9 (on the next page) shows the implied emission factors for CO_2 emissions from liquid fuels used in public electricity and heat production. The IEFs in most countries range between 76 and 79 t/TJ on the entire time-series. The average IEF within the EU-28 + ISL is 76.7 t/TJ in 2017. Bulgaria has the highest IEF in 2017, which is explained by the relatively large share of petroleum coke used in main activity producer CHP plants. The CO_2 country-specific EF for petroleum coke varies in the range of 92-95 t/TJ, which is significantly higher than the average EF of liquid fuels. The IEF from Belgium is one of the lowest among the Member States in the year 2017. The low IEF and its fluctuation in the past years are caused by the varying mix of liquid fuels including gasoil and heavy fuel oil (with higher IEF) and on the other hand refinery gas (with lower IEF). The implied emission factor of the Netherlands is similarly low in 2017, it 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 Czech Republic which consumes a high share of Refinery gas (42% of liquid fuel consumption with an EF of 55.08 t CO_2/TJ).

Figure 3.9 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 68% of all greenhouse gas emissions from public electricity and heat production. Within the EU-28 + ISL, emissions fell by 39% between 1990 and 2017 (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 27 years United Kingdom, Germany and Poland account for 71.2 % of the decline in the EU-28 + ISL.

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

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	6 247	1 587	1 344	0.2%	-4 903	-78%	-243	-15%	T3	PS
Belgium	19 434	5 249	5 128	1%	-14 307	-74%	-121	-2%	T3	PS
Bulgaria	25 638	22 762	24 314	4%	-1 324	-5%	1 552	7%	T1,T2	CS,D
Croatia	595	2 269	1 215	0.2%	619	104%	-1 055	-46%	T2	CS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	52 368	44 262	42 001	6%	-10 367	-20%	-2 261	-5%	T1, T2	D, CS
Denmark	22 225	7 923	5 736	1%	-16 489	-74%	-2 187	-28%	T1,T2,T3	CS,D,PS
Estonia	22 109	11 303	12 194	2%	-9 915	-45%	892	8%	T2/T3	CS/PS
Finland	9 281	8 632	7 653	1%	-1 628	-18%	-979	-11%	T3	CS/PS/D
France	37 563	12 935	15 385	2%	-22 178	-59%	2 450	19%	T2,T3	CS,PS
Germany	307 246	249 532	227 866	33%	-79 380	-26%	-21 665	-9%	CS	CS
Greece	35 201	22 430	24 734	4%	-10 467	-30%	2 304	10%	T1,T2	D,PS
Hungary	12 266	7 305	7 057	1%	-5 209	-42%	-248	-3%	T1, T2, T3	D, CS, PS
Ireland	4 845	4 282	3 391	0.5%	-1 453	-30%	-890	-21%	T1,T3	CS,D,PS
Italy	27 755	31 326	28 279	4%	524	2%	-3 047	-10%	T3	CS
Latvia	197	16	11	0.002%	-186	-95%	-5	-31%	T2	CS
Lithuania	174	8	7	0.001%	-167	-96%	-1	-17%	T1, T2, T3	CS, PS, D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	619	NO	NO	-	-619	-100%	-	-	NA	NA
Netherlands	25 862	34 007	29 284	4%	3 422	13%	-4 723	-14%	CS,T2	CS,D
Poland	220 928	148 920	149 804	22%	-71 124	-32%	883	1%	T1/T2	D/CS
Portugal	7 921	10 498	11 574	2%	3 654	46%	1 077	10%	T3	PS
Romania	25 123	17 025	14 484	2%	-10 638	-42%	-2 541	-15%	T1,T2	CS,D
Slovakia	11 542	3 275	3 299	0.5%	-8 244	-71%	24	1%	T2, T3	CS
Slovenia	5 712	4 667	4 598	1%	-1 113	-19%	-68	-1%	T3	PS
Spain	58 931	35 744	44 179	6%	-14 753	-25%	8 434	24%	T2	PS
Sweden	4 231	2 492	2 956	0.4%	-1 275	-30%	464	19%	T2	CS
United Kingdom	183 150	27 157	19 589	3%	-163 561	-89%	-7 568	-28%	T2	CS
EU-28	**1 127 162**	**715 604**	**686 081**	**100%**	**-441 081**	**-39%**	**-29 523**	**-4%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	183 150	27 157	19 589	3%	-163 561	-89%	-7 568	-28%	T2	CS
EU-28 + ISL	**1 127 162**	**715 604**	**686 081**	**100%**	**-441 081**	**-39%**	**-29 523**	**-4%**		

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

Note: 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.

Table 3.8 also shows that about 96 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States 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 3.10 shows the trend of emissions for solid fuels for main contributing Member States. In 2017 Germany has the largest share of emissions from solid fuels in the EU-28 + ISL (33.2%), followed by Poland (21.8%) and then by a clear margin Spain (6.4%) and the Czech Republic (6.1%).

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

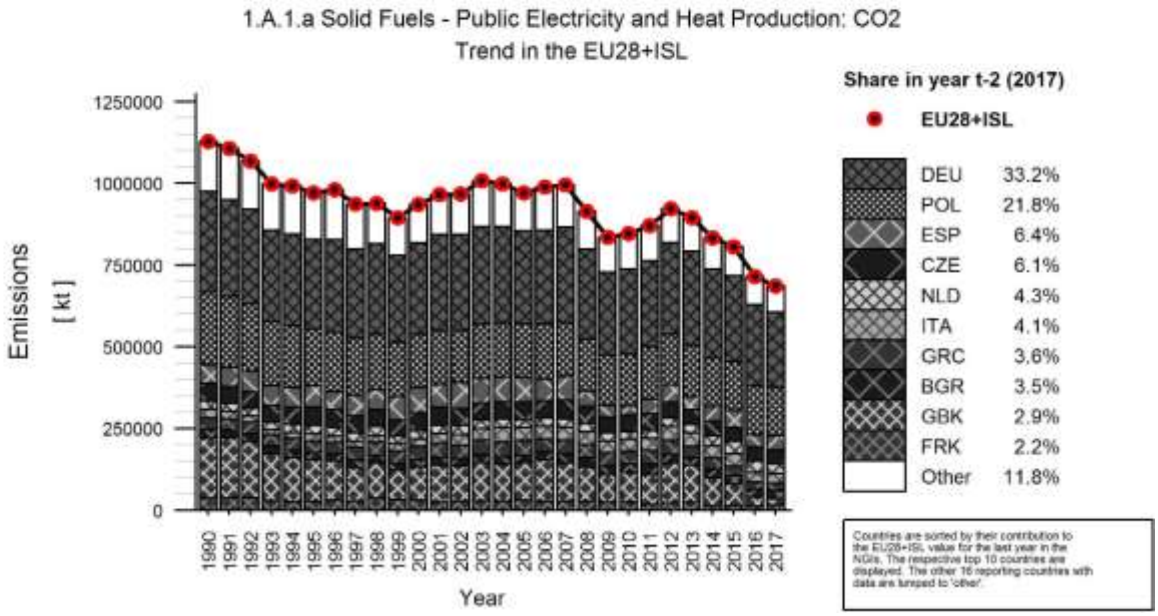
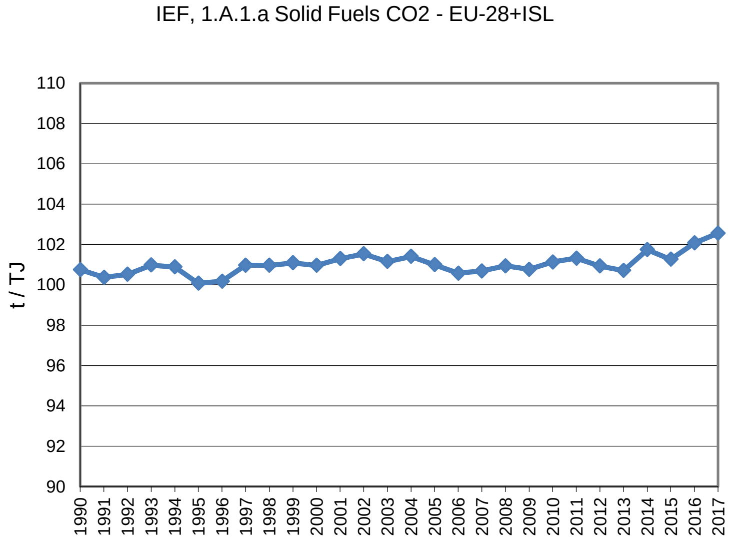
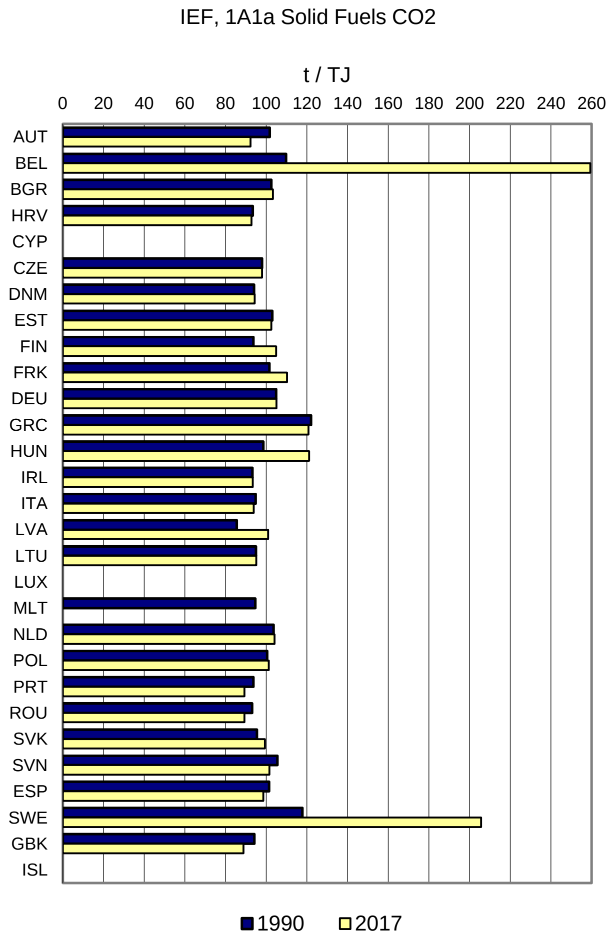


Figure 3.11 (on the next page) shows the relevant implied emission factors for solid fuels. The EU-28 + ISL implied emission factor has remained fairly stable between 100 t/TJ and 102 t/TJ on the entire time-series with a slight increase the last three years (102.5 t/TJ in 2017). The comparatively high IEF of Greece is due to the large importance of domestic lignite use for electricity production. The Greek IEF is based on verified EU-ETS reports, ranging from 33.74 to 35.37 tC/TJ. These values lie out of the range suggested by the 2006 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 and Sweden, 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 3.11 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 23 % of all greenhouse gas emissions from public electricity and heat generation in 2017. Emissions increased by 116 % in the EU-28 + ISL between 1990 and 2017 (Table 3.9). The United Kingdom and Italy together were responsible for about 64% of the increase in the last 27 years.

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

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	3 294	3 983	5 117	2%	1 823	55%	1 134	28%	T2	CS
Belgium	2 766	7 628	7 812	3%	5 047	182%	184	2%	T1, T3	D, PS
Bulgaria	6 295	1 824	1 865	1%	-4 430	-70%	41	2%	T1,T2	CS,D
Croatia	991	1 051	1 548	1%	557	56%	497	47%	T2	CS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 019	2 775	2 685	1%	1 666	163%	-89	-3%	T1, T2	D, CS
Denmark	980	1 948	1 624	1%	644	66%	-324	-17%	T1,T2,T3	CS,D,PS
Estonia	1 977	614	584	0.3%	-1 393	-70%	-29	-5%	T2	CS
Finland	1 989	2 090	1 739	1%	-250	-13%	-351	-17%	T3	CS
France	974	11 868	13 474	6%	12 500	1283%	1 606	14%	T2,T3	CS,PS
Germany	18 447	31 706	33 092	14%	14 645	79%	1 386	4%	CS	CS
Greece	IE,NO	5 238	6 113	3%	6 113	∞	875	17%	T1,T2	D,PS
Hungary	4 148	4 157	4 681	2%	533	13%	524	13%	T1, T2	D, CS
Ireland	1 881	4 852	5 016	2%	3 135	167%	164	3%	T1,T3	CS,D,PS
Italy	15 798	43 068	47 910	21%	32 111	203%	4 842	11.24%	T3	CS
Latvia	2 658	1 757	1 452	1%	-1 206	-45%	-305	-17%	T2	CS
Lithuania	5 797	988	786	0.3%	-5 011	-86%	-202	-20%	T1, T2	CS, D
Luxembourg	NO	152	141	0.1%	141	∞	-11	-7%	T2	CS
Malta	NO	NO	552	0.2%	552	∞	552	∞	NA	NA
Netherlands	13 330	17 270	18 540	8%	5 209	39%	1 269	7%	CS,T2	CS,D
Poland	1 197	3 921	4 625	2%	3 428	286%	704	18%	T2	CS
Portugal	NO	3 155	5 376	2%	5 376	∞	2 221	70%	T3/T2	PS/D
Romania	20 801	5 006	4 302	2%	-16 499	-79%	-704	-14%	T1,T2	CS,D
Slovakia	2 089	1 387	1 412	1%	-677	-32%	25	2%	T2	CS
Slovenia	112	202	250	0.1%	138	123%	48	24%	T2	CS
Spain	441	11 135	13 502	6%	13 061	2960%	2 367	21%	T2	CS/PS
Sweden	486	671	286	0.1%	-199	-41%	-385	-57%	T2	CS
United Kingdom	16	49 675	47 250	20%	47 234	295997%	-2 425	-5%	T1, T2	CS, D
EU-28	**107 487**	**218 120**	**231 735**	**100%**	**124 248**	**116%**	**13 614**	**6%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	16	49 853	47 425	20%	47 409	297089%	-2 429	-5%	T1, T2	CS, D
EU-28 + ISL	**107 487**	**218 298**	**231 909**	**100%**	**124 422**	**116%**	**13 610**	**6%**		

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

Table 3.9 also shows that about 94 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States 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 eight EU-28 Member States the consumption of gaseous fuels was lower in 2017 than in 1990. Cyprus and Iceland are not utilising gaseous fuels for public electricity and heat production. Malta consumes natural gas since 2017. In the other 18 countries, gas consumption has increased of the last 27 years. From 1990 until 2008 the use of gaseous fuels saw 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 2017 compared to 2014. Figure 3.12 shows the trend of emissions from gaseous fuels by the main contributing Member States which are Italy (20.7%), the United Kingdom (20.4%) and Germany (14.3%). 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, but especially in the United Kingdom as well in Germany. Since 2015, natural gas demand picked up again in the EU-28 + ISL, inter alia due to lower gas prices, higher coal prices and coal plant retirements.

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

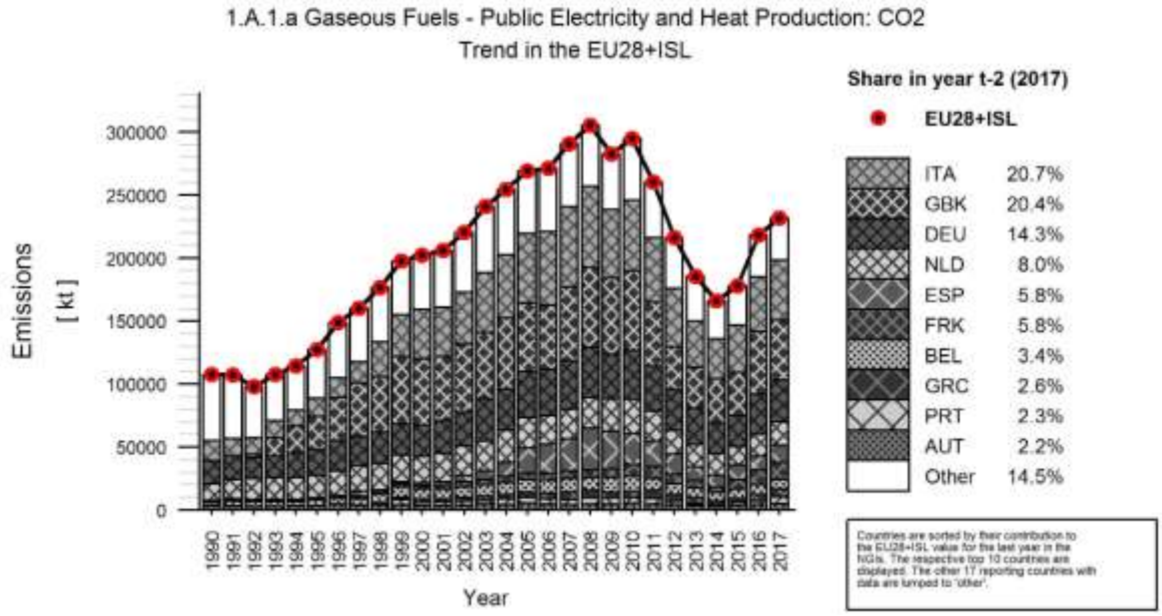
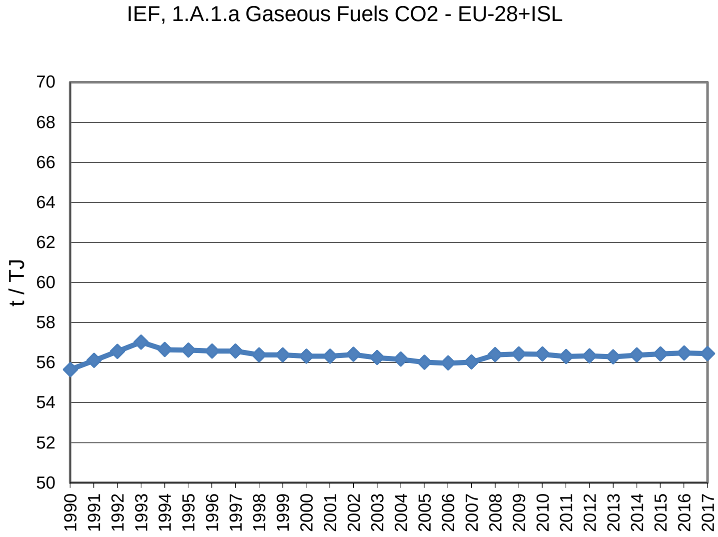
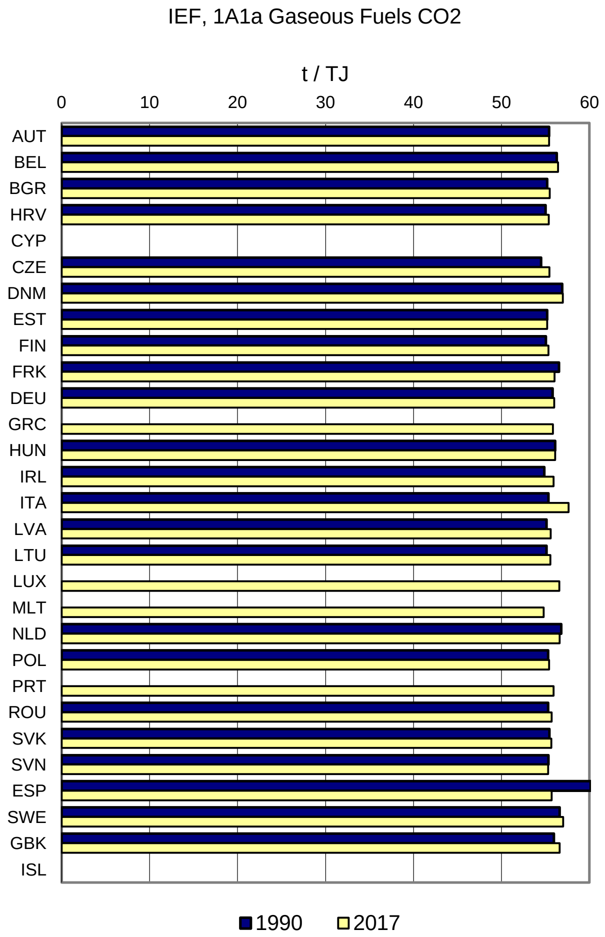


Figure 3.13 (on the next page) shows the implied emission factors from gaseous fuels for CO_2. The EU-28 + ISL implied emission factor has remained fairly stable (56.4 t/TJ in 2017) which is very close to the default emission factor of natural gas (56.1 t/TJ). The slight increase in the EU-28 + ISL factor observed in the early 1990s can be explained by the higher UK's gas share in the EU-28 + ISL and by an increase in the UK's implied emission factor. 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 3.13 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 2017, the share of CO_2 emissions from other fuels amounts to 4.2 % 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 (Table 3.10). Emissions increased by 288 % at EU-28 + ISL level between 1990 and 2017 and increased in all countries except for Poland, and Latvia. Germany alone is responsible for 36.2 % of the increase in the whole EU-28 + ISL over the last 27 years.

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

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	352	1 388	1 337	3%	985	280%	-51	-4%	T2	CS
Belgium	674	2 100	2 113	5%	1 439	213%	13	1%	T3	PS
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	24	250	251	1%	227	945%	2	1%	T1	D
Denmark	539	1 639	1 570	4%	1 031	191%	-70	-4%	T1,T2,T3	CS,D,PS
Estonia	NO	147	140	0.3%	140	∞	-7	-5%	T3	PS
Finland	1	507	578	1%	577	57660%	71	14%	T3	CS
France	2 558	5 862	6 388	15%	3 830	150%	525	9%	T2,T3	CS,PS
Germany	4 121	15 134	15 369	37%	11 248	273%	235	2%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	30	243	238	1%	208	695%	-4	-2%	T1, T2, T3	D, CS, PS
Ireland	NO	86	190	0.5%	190	∞	104	121%	T1,T3	CS,D,PS
Italy	143	208	202	0.5%	59	41%	-6	-3%	T3	CS
Latvia	3	NO	NO	-	-3	-100%	-	-	T2	CS
Lithuania	NO	266	162	0.4%	162	∞	-103	-39%	T1, T2	CS, D
Luxembourg	33	92	94	0.2%	61	183%	2	2%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	601	2 967	2 972	7%	2 371	394%	6	0.2%	CS,T2	CS,D
Poland	753	429	555	1%	-198	-26%	125	29%	T1	D
Portugal	NO	476	498	1%	498	∞	22	5%	T2	D/CS
Romania	NO	NO	NO	-	-	-	-	-	T1,T2	CS,D
Slovakia	25	23	26	0.1%	1	3%	3	13%	T2	CS
Slovenia	NO	14	15	0.04%	15	∞	2	11%	T1	D
Spain	110	1 535	1 667	4%	1 556	1414%	131	9%	T2	CS/PS
Sweden	570	2 340	2 479	6%	1 909	335%	139	6%	T2	CS
United Kingdom	234	4 624	4 958	12%	4 724	2021%	334	7%	T1, T2	CS, D
EU-28	**10 772**	**40 330**	**41 803**	**100%**	**31 030**	**288%**	**1 473**	**4%**		
Iceland	NO	NO	NO	-	-	-	-	-	T1	D
United Kingdom (KP)	246	4 666	4 997	12%	4 751	1930%	332	7%	T1, T2	CS, D
EU-28 + ISL	**10 785**	**40 372**	**41 841**	**100%**	**31 057**	**288%**	**1 470**	**4%**		

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

Table 3.10 also shows that 97 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States 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 3.14 illustrates clearly the strong increase of emissions caused by other fuels over the past 27 years. The largest emitters of other fuels in 2017 were Germany (36.7%), France (15.3%) and the

United Kingdom (11.9%). Together these three Member States accounted for 63.9% of the total EU-28 + ISL emissions in this category.

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

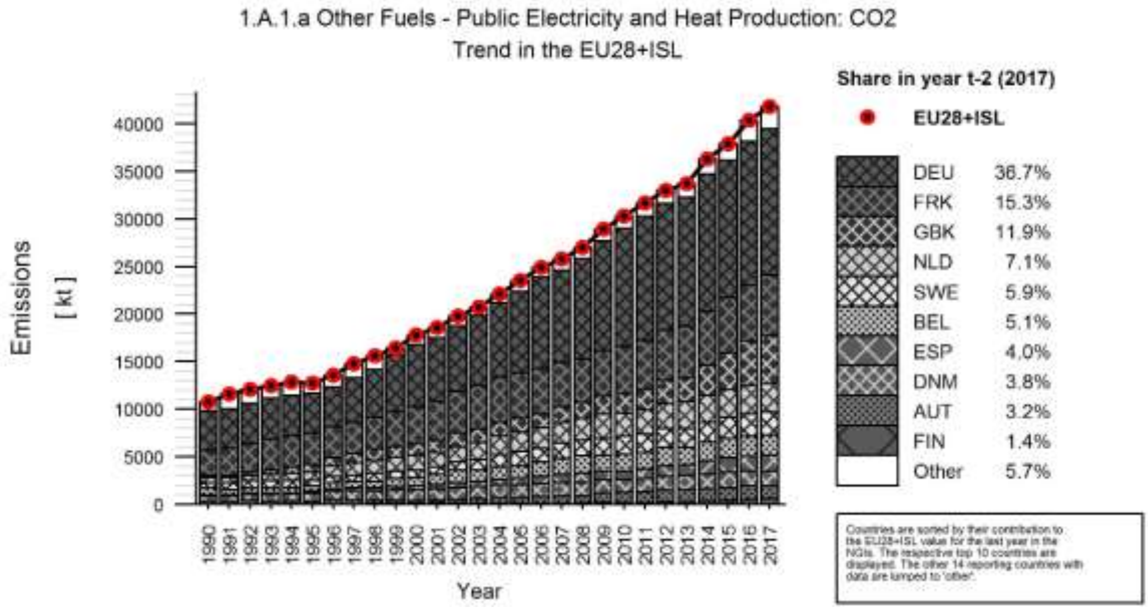
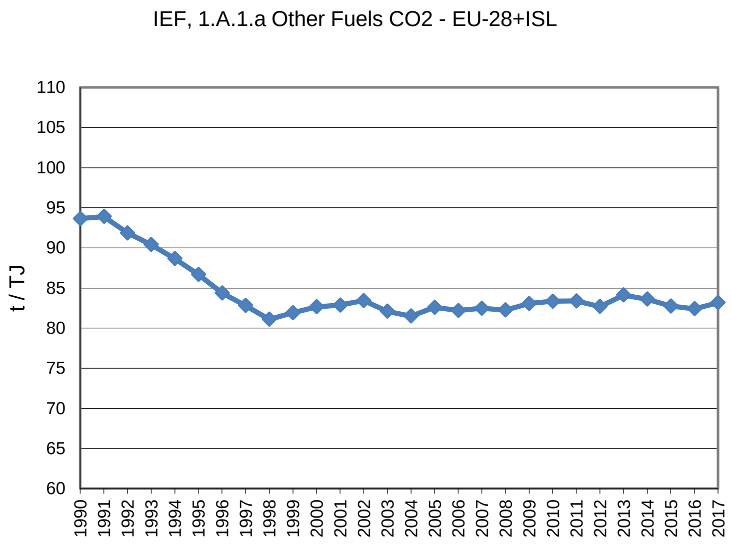
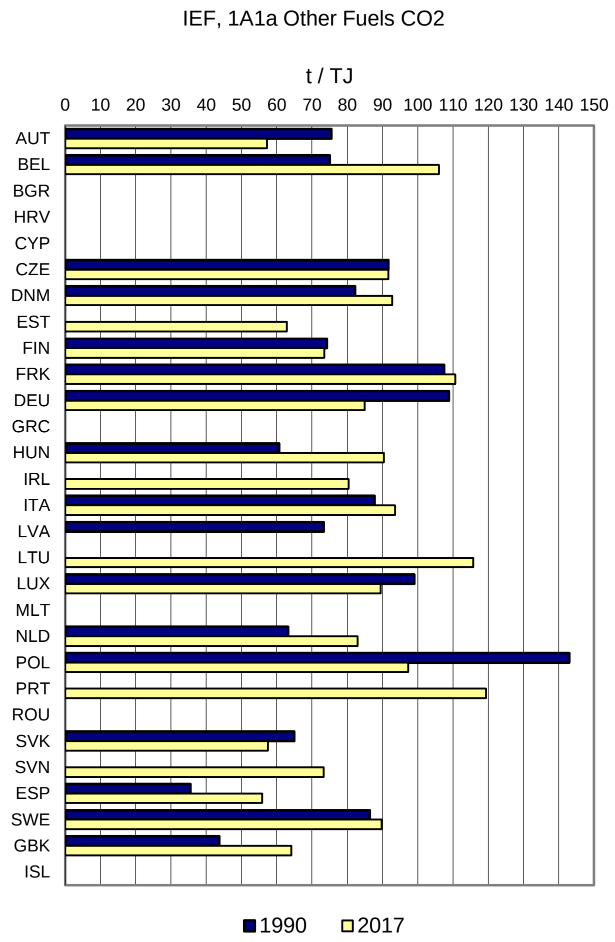


Figure 3.15 (on the next page) shows the implied emission factors of the category other fuels from CO_2. The EU-28 + ISL implied emission factor has gradually fallen until 1998, then levelled out between 80 and 85 t/TJ on the entire time-series. In Germany, the IEF declined continuously between 1990 and 2017 (from 109 to 85 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 Member States’ IEFs.

Figure 3.15 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 0.8% 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 Member States report emissions from peat combustion. Within the EU-28 + ISL, emissions declined by 11% respectively 0.9Mt CO_2 between 1990 and 2017 (Table 3.11).

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

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		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	187	134	146	2%	-41	-22%	12	9%	T1/T2	D/CS
Finland	3 950	4 799	4 590	60%	640	16%	-209	-4%	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	2 505	2 355	31%	-710	-23%	-150	-6%	T1,T3	CS,D,PS
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	146	NO	NO	-	-146	-100%	-	-	T2	CS
Lithuania	11	11	36	0.5%	25	224%	25	240%	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	533	480	6%	-670	-58%	-53	-10%	T2	CS
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28	**8 508**	**7 982**	**7 606**	**100%**	**-902**	**-11%**	**-376**	**-5%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28 + ISL	**8 508**	**7 982**	**7 606**	**100%**	**-902**	**-11%**	**-376**	**-5%**		

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 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States 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 3.16 illustrates the trend of peat emissions throughout the last 27 years, which is predominately influenced by the emission fluctuation over the years by Finland. In 2017, the two largest emitters, Finland and Ireland, are responsible for 91.3% of the total emissions in this category.

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

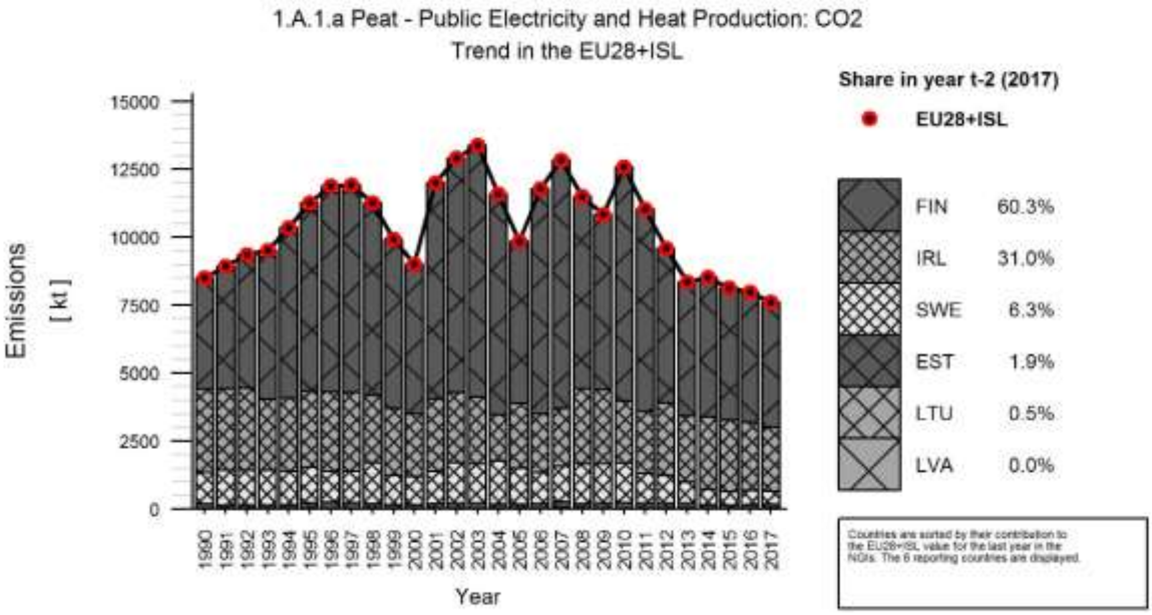
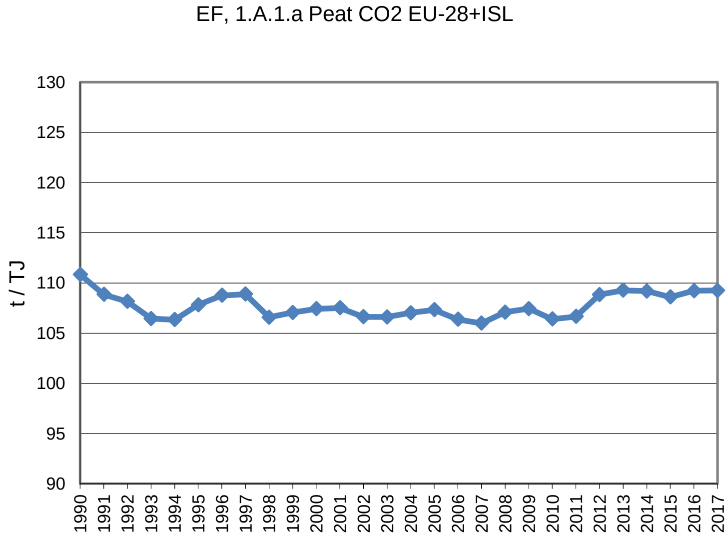
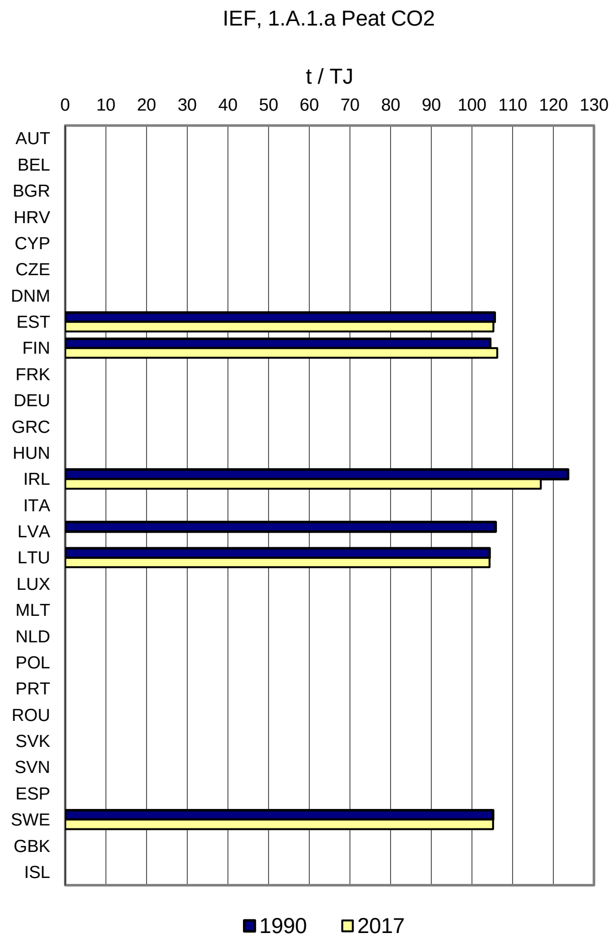


Figure 3.17 shows the implied emission factors of peat from CO_2. The EU-28 + ISL implied emission factor amounts to 109.3 t/TJ in 2017 and has been quite stable over the last 27 years. It is mainly influenced by the IEF of the two largest emitters (Finland and Ireland). The default emission factor for peat is 106 t/TJ according to the 2006 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 (117.273 t/TJ) for three milled peat power plants in use.

Figure 3.17 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-28 + ISL)

According to the 2006 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.

Carbon dioxide emissions from Petroleum Refining are accounting for 2.7% of total greenhouse gas emissions in year 2017. Between 1990 and 2017, EU-28 + ISL CO_2 emissions decreased by 4% (Table 3.12). Emissions in 2017 were above 1990 levels in 13 Member States, whereas they were decreasing in 11 and reported as not occurring for the whole time series in five countries. Italy, Poland and Greece had the largest emission increases together accounting for 74.2% of the whole increase between 1990 and 2017. In contrast France and the United Kingdom report the largest decreases together accounting for 53.2% of the whole decrease in emissions in this period.

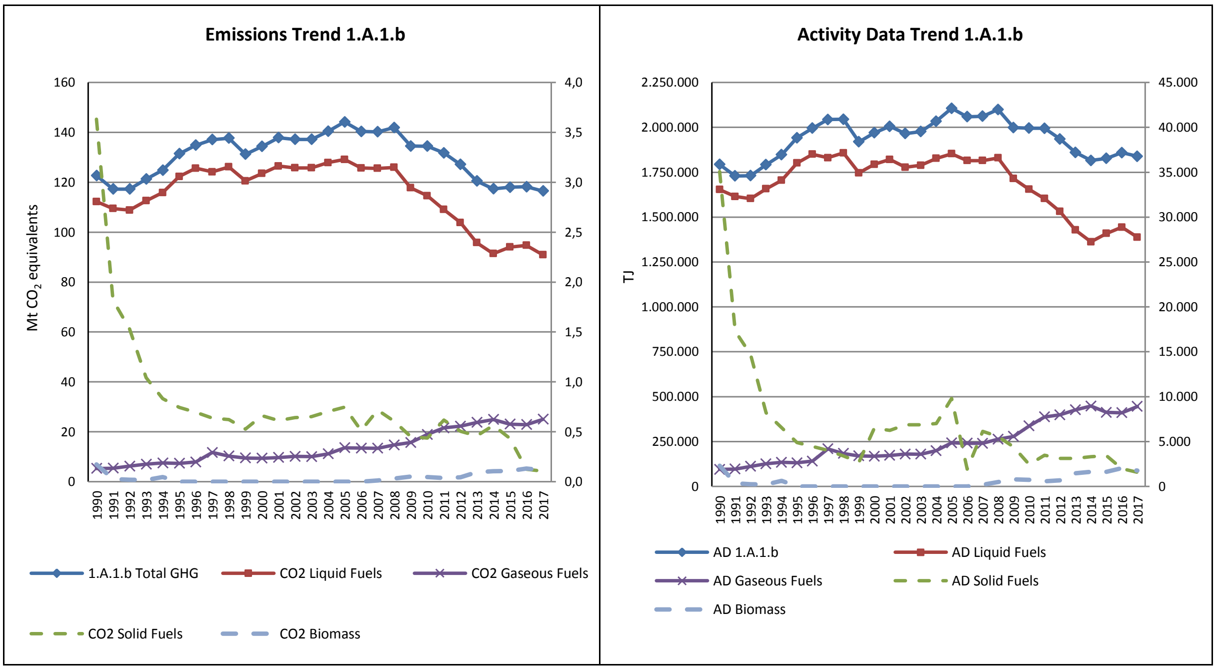
Table 3.12 1.A.1.b Petroleum Refining: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	2 394	2 784	2 739	2.4%	344	14%	-46	-2%
Belgium	4 299	4 621	4 693	4.0%	394	9%	72	2%
Bulgaria	861	849	873	0.8%	11	1%	24	3%
Croatia	2 446	1 299	1 351	1.2%	-1 096	-45%	52	4%
Cyprus	86	NO	NO	-	-86	-100%	-	-
Czechia	493	406	539	0.5%	46	9%	133	33%
Denmark	908	868	932	0.8%	24	3%	64	7%
Estonia	NO	NO	NO	-	-	-	-	-
Finland	2 042	1 662	1 685	1.5%	-357	-17%	23	1%
France	11 935	7 354	6 781	5.8%	-5 155	-43%	-573	-8%
Germany	20 166	19 654	20 301	17.5%	136	1%	647	3%
Greece	2 375	5 562	4 904	4.2%	2 529	107%	-658	-12%
Hungary	2 376	1 448	1 510	1.3%	-866	-36%	61	4%
Ireland	168	313	311	0.3%	142	85%	-2	-1%
Italy	17 201	21 030	20 618	17.8%	3 418	20%	-412	-2%
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	1 510	1 424	1 380	1.2%	-129	-9%	-43	-3%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	11 010	9 649	9 031	7.8%	-1 980	-18%	-618	-6%
Poland	2 163	5 490	5 474	4.7%	3 311	153%	-17	-0.3%
Portugal	1 861	2 389	2 472	2.1%	611	33%	84	4%
Romania	4 297	2 303	2 100	1.8%	-2 198	-51%	-203	-9%
Slovakia	2 873	1 483	1 469	1.3%	-1 404	-49%	-14.1	-1%
Slovenia	170	NO	NO	-	-170	-100%	-	-
Spain	10 858	11 569	11 348	9.8%	489	5%	-221	-2%
Sweden	1 778	2 010	2 000	1.7%	222	12%	-11	-0.5%
United Kingdom	17 831	13 594	13 560	11.7%	-4 271	-24%	-34	-0.3%
EU-28	**122 103**	**117 762**	**116 070**	**100%**	**-6 033**	**-5%**	**-1 692**	**-1%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	17 831	13 594	13 560	11.7%	-4 271	-24%	-34	-0.3%
EU-28 + ISL	**122 103**	**117 762**	**116 070**	**100%**	**-6 033**	**-5%**	**-1 692**	**-1%**

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

Figure 3.18 shows the trends in activity data and the associated emissions originating from the refining of petroleum by fuel in the EU-28 + ISL between the years 1990 and 2017. Fuel used for petroleum refining increased by 3.2% in the EU-28 + ISL between 1990 and 2017. In the year 2017, liquid fuels represent 75.2% of all fuel used in the refining of petroleum. Gaseous fuels almost fully account for the remaining part (24.6%) of the activity data. Gaseous fuels use is almost five times higher in 2017 compared to 1990. There remains a small amount of solid fuels used accounting for 0.1% in petroleum refining; in Germany (lignite and coke oven gas) and Poland (hard coal and lignite) as well as 0.06 % other fuels use.

Figure 3.18 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 77.7% of all greenhouse gas emissions from petroleum refining in 2017. Emissions decreased by 19% between 1990 and 2017 (Table 3.13). Greece, Poland and Germany had the largest emission increases together accounting for 82.7% of the whole increase between 1990 and 2017. In contrast the United Kingdom and France report the largest decreases together accounting for 46.1% of the whole decrease in emissions in this period.

Table 3.13 1.A.1.b Petroleum Refining, 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	1 958	2 440	2 342	2.6%	384	20%	-98	-4%	T2	CS
Belgium	4 285	3 552	3 528	3.9%	-758	-18%	-25	-1%	CS,T3	PS
Bulgaria	793	779	796	0.9%	3	0.4%	17	2%	T1	D
Croatia	2 432	909	934	1.0%	-1 499	-62%	25	3%	T1	D
Cyprus	86	NO	NO	-	-86	-100%	-	-	NA	NA
Czechia	176	226	322	0.4%	146	83%	96	43%	T1	CS,D
Denmark	908	868	932	1.0%	24	3%	64	7%	T1,T2,T3	CS,D,PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 383	1 436	1 496	1.6%	114	8%	60	4%	T3	CS,PS
France	11 413	5 915	5 225	5.7%	-6 189	-54%	-691	-12%	T2,T3	CS,PS
Germany	15 417	16 876	16 844	18.5%	1 427	9%	-33	0%	CS	CS
Greece	2 375	5 562	4 904	5.4%	2 529	107%	-658	-12%	T2	PS
Hungary	1 683	989	1 024	1.1%	-659	-39%	35	4%	T3	PS
Ireland	168	297	295	0.3%	127	75%	-2	-1%	T3	CS,PS
Italy	17 041	16 811	16 252	17.9%	-789	-5%	-559	-3%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 510	1 420	1 377	1.5%	-133	-9%	-44	-3%	T2,T3	CS,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	9 968	7 090	6 613	7.3%	-3 356	-34%	-478	-7%	T2	CS,D
Poland	1 319	3 980	2 972	3.3%	1 652	125%	-1 008	-25%	T1	D
Portugal	1 861	1 285	1 327	1.5%	-534	-29%	43	3%	T2	CR,D,PS
Romania	4 297	1 597	1 555	1.7%	-2 743	-64%	-43	-3%	T2	CS
Slovakia	2 786	1 249	1 236	1.4%	-1 549	-56%	-12.0	-1%	T3	PS
Slovenia	43	NO	NO	-	-43	-100%	-	-	NA	NA
Spain	10 812	8 215	7 945	8.7%	-2 867	-27%	-270	-3%	T2	PS
Sweden	1 778	1 926	1 863	2.0%	85	5%	-62	-3%	T2	CS
United Kingdom	17 782	11 304	11 122	12.2%	-6 661	-37%	-182	-2%	T2	CS
EU-28	**112 274**	**94 726**	**90 903**	**100%**	**-21 371**	**-19%**	**-3 823**	**-4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	17 782	11 304	11 122	12.2%	-6 661	-37%	-182	-2%	T2	CS
EU-28 + ISL	**112 274**	**94 726**	**90 903**	**100%**	**-21 371**	**-19%**	**-3 823**	**-4%**	**-**	**-**

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

Table 3.13 also shows that more than 94 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States 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 3.19 illustrates that Germany, Italy and the United Kingdom are the countries contributing most in terms of CO_2 emissions in 2017. It also can be seen that the trend for liquid fuels was continuously decreasing since the year 2008 and are rather stable since 2014.

Figure 3.19 1.A.1.b Petroleum Refining, Liquid Fuels: Emission trend and share for CO_2

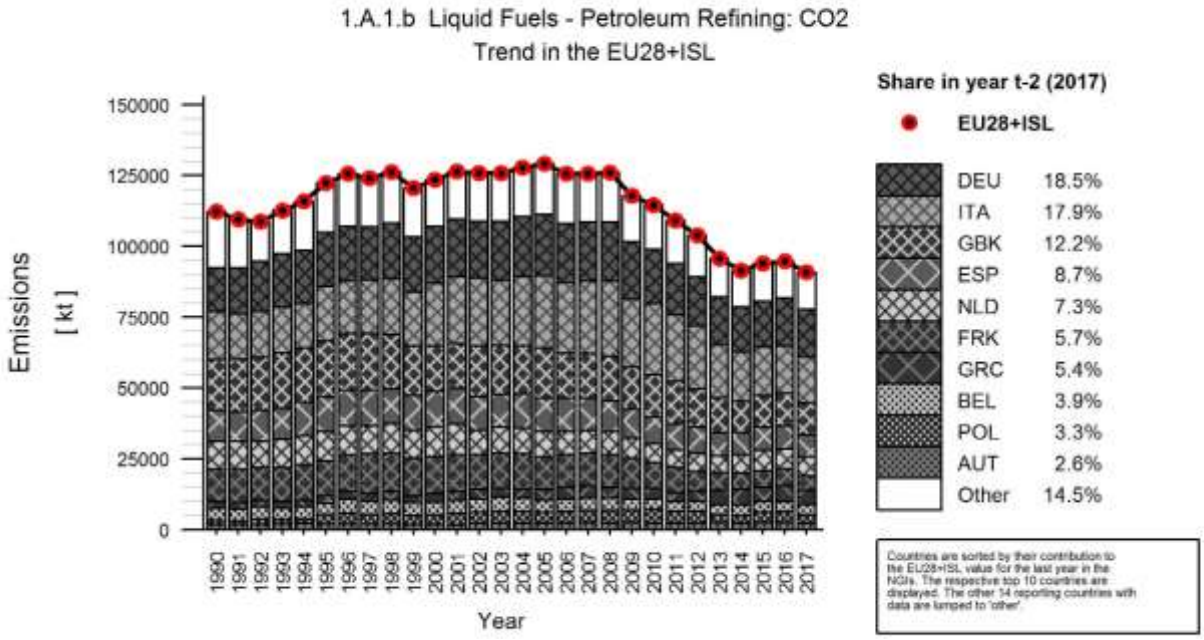
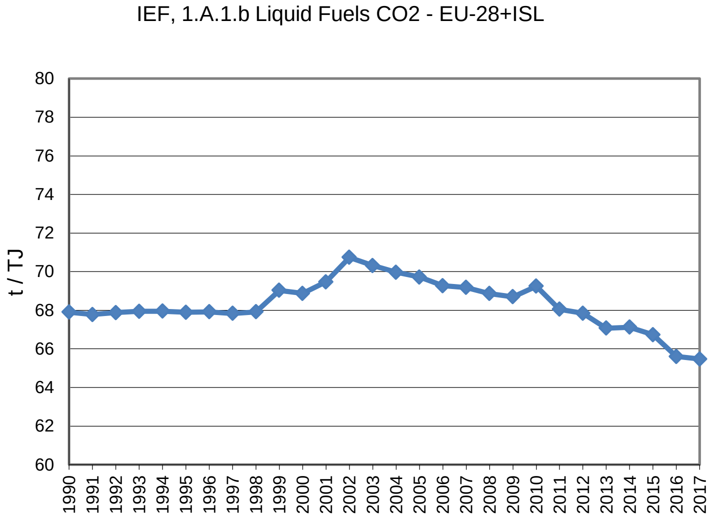
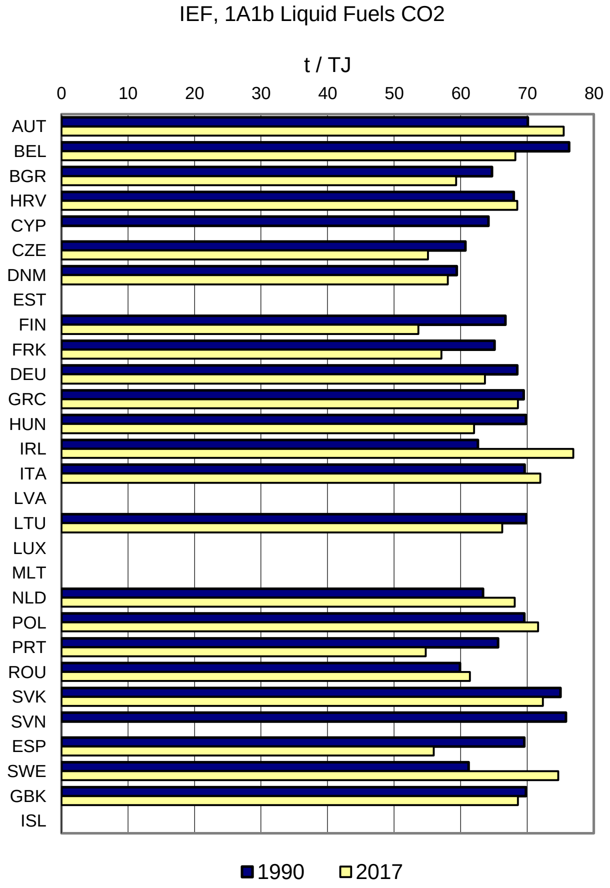


Figure 3.20 (on the next page) shows the emission factors for CO_2 emissions from liquid fuels. The EU-28 + ISL implied emission factor shows variations around 68 t/TJ over the time series and amounts 65.5 t/TJ in 2017. In general, the fluctuating IEF is due to the annual variations of fuel consumption with different carbon content.

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 second highest IEF in 2017 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. In this category in Sweden, CO_2 emissions are based on verified EU ETS data, while AD is not always certain and NCVs not always reported by operators causing a high IEF for the year 2017.

Figure 3.20 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 0.1% of all greenhouse gas emissions from 1.A.1.b in 2017. There are only two countries reporting emissions in the EU-28 + ISL in 2017 (Poland and Germany). Thereof only Poland reports increasing emissions between 1990 and 2017. France closed a refinery consuming blast furnace gas in 2016 which explains that no more emissions are reported from 2017 onwards. Poland is now responsible for the majority of emissions in 2017 in the EU-28 + ISL. 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: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		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	12	NO	-	-486	-100%	-12	-100%	NA	NA
Germany	3 131	35	33	31.2%	-3 098	-99%	-2	-6%	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	78	73	68.8%	68	1569%	-5	-6%	T1,T2	CS,D
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	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28	**3 633**	**125**	**106**	**100%**	**-3 527**	**-97%**	**-19**	**-15%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28 + ISL	**3 633**	**125**	**106**	**100%**	**-3 527**	**-97%**	**-19**	**-15%**	**-**	**-**

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

Table 3.14 also shows that 93 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States 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 3.21 illustrates the trend of emissions in 1.A.1.b for solid fuels for the past 27 years. The use of solid fuels in petroleum refining has declined drastically since 1990. Emissions are down by 97%. France contributed 67% to the total emissions in this sector in 2015 and is not represented any more. Germany is responsible for the strong declining trend in the 1990s and due to the recent overall trend, Poland is now responsible for 68.8% of the total emissions in the EU-28 + ISL for this category in 2017.

Figure 3.21 1.A.1.b Petroleum Refining, Solid Fuels: Emission trend and share for CO_2

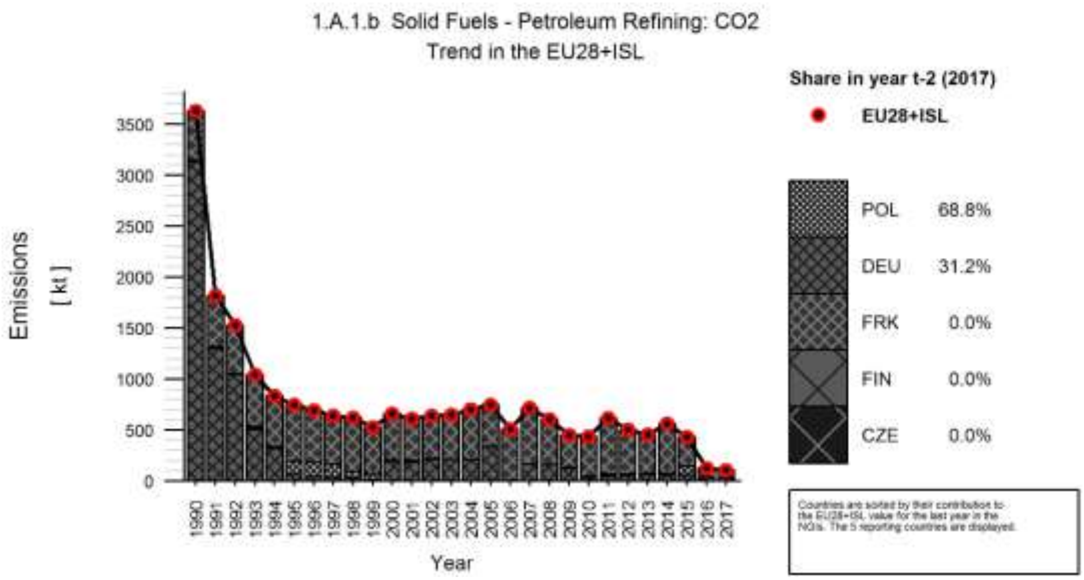
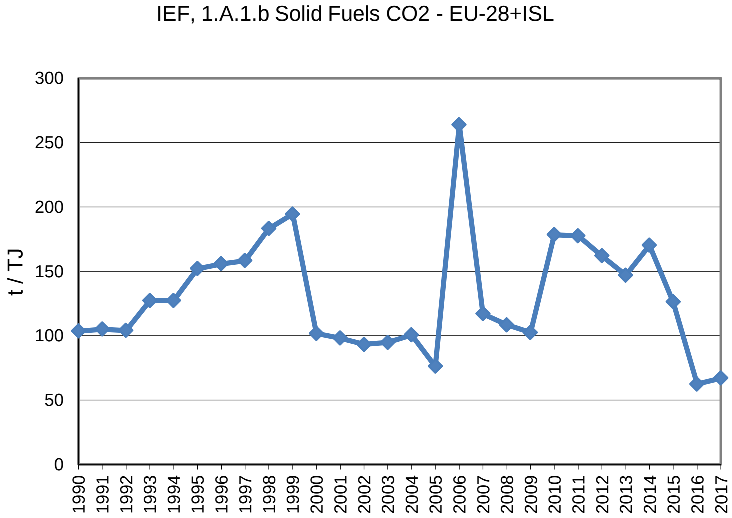
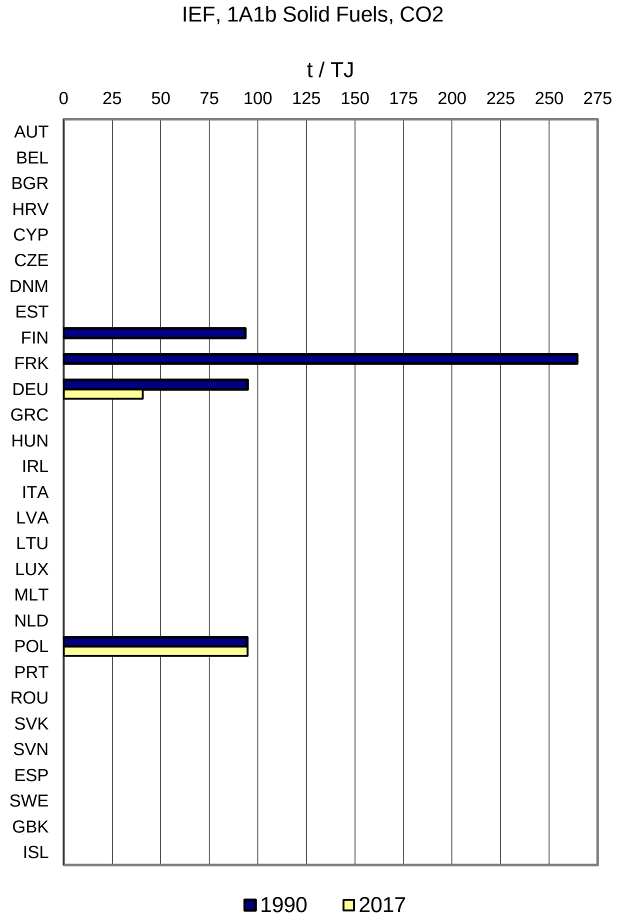


Figure 3.22 (on the next page) shows the relevant implied emission factors. The EU-28 + ISL implied emission factor showed strong fluctuations and amounts 67 t/TJ in 2017. One explanation for this is the low number of countries reporting this category. Apart from that, the variation in the EU-28 + ISL 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-28 + ISL 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-28 + ISL 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-28 + ISL level during these years. For 2006 Germany reports only negligible amounts of solid fuel use in petroleum refining. Therefore, the EU-28 + ISL IEF was almost entirely dominated by the high French IEF in this year. The drop in the implied emission factor from 2014 to 2015 can be explained by the increased weight of Poland with their lower IEF. Since there is no more solid fuel consumption in France in 2017, the average IEF is driven by Poland and Germany which have similar CO_2 EF.

Figure 3.22 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 2017, CO_2 emissions from the combustion of gaseous fuels used for petroleum refining accounted for about 21.7% of total greenhouse gas emissions from 1.A.1.b. Emissions in the EU-28 + ISL increased by 384% between 1990 and 2017 (Table 3.15). Only five of the EU-28 Member States reduced their emissions: Austria, Czech Republic, Finland, Hungary and Slovenia over the whole time series. Italy, Poland, Spain and the United Kingdom together account for 57.8% of the total increase between 1990 and 2017.

Table 3.15 1.A.1.b Petroleum Refining, Gaseous 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	437	344	397	1.6%	-40	-9%	52	15%	T2	CS
Belgium	14	1 069	1 165	4.7%	1 151	8289%	96	9%	CS,T3	PS
Bulgaria	69	70	77	0.3%	8	12.2%	7	11%	T2	CS
Croatia	14	390	417	1.7%	403	2893%	27	7%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	317	180	217	0.9%	-100	-32%	37	20%	T2	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	648	225	189	0.8%	-459	-71%	-37	-16%	T3	CS
France	36	1 427	1 556	6.2%	1 520	4199%	129	9%	T2,T3	CS,PS
Germany	1 444	2 743	3 425	13.7%	1 980	137%	682	25%	CS	CS
Greece	NO	IE	IE	-	-	-	-	-	NA	NA
Hungary	693	460	486	1.9%	-207	-30%	26	6%	T3	PS
Ireland	NO	16	16	0.1%	16	∞	-1	-4%	T3	CS,PS
Italy	159	4 219	4 366	17.5%	4 207	2641%	147	3%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	3	4	0.01%	4	∞	0.3	8%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 042	2 559	2 418	9.7%	1 376	132%	-140	-5%	T2	CS
Poland	92	1 433	2 429	9.7%	2 337	2528%	996	70%	T2	CS
Portugal	NO	1 104	1 145	4.6%	1 145	∞	41	4%	T2	CR,D,PS
Romania	NO	705	545	2.2%	545	∞	-160	-23%	T2	CS
Slovakia	88	235	233	0.9%	145	166%	-2.0	-1%	T3	PS
Slovenia	127	NO	NO	-	-127	-100%	-	-	NA	NA
Spain	46	3 330	3 342	13.4%	3 296	7168%	12	0.4%	T2	PS
Sweden	NO	85	137	0.5%	137	∞	52	61%	T2	CS
United Kingdom	49	2 290	2 439	9.8%	2 389	4844%	148	6%	T2	CS
EU-28	**5 275**	**22 887**	**25 001**	**100%**	**19 726**	**374%**	**2 114**	**9%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	49	2 290	2 439	9.8%	2 389	4844%	148	6%	T2	CS
EU-28 + ISL	**5 275**	**22 887**	**25 001**	**100%**	**19 726**	**374%**	**2 114**	**9%**	**-**	**-**

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

Table 3.15 also shows that about 98 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States 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 3.23 illustrates the trend of increasing emissions from gaseous fuels in category 1.A.1.b in the last 27 years. As can be seen the six largest contributors to CO_2 emissions in this sector account together for 72.2% of the total emissions in this category. Emissions have increased by 9% between 2016 and 2017 (combined +2 162 kt CO_2).

Figure 3.23 1.A.1.b Petroleum Refining, Gaseous Fuels: Emission trend and share for CO_2

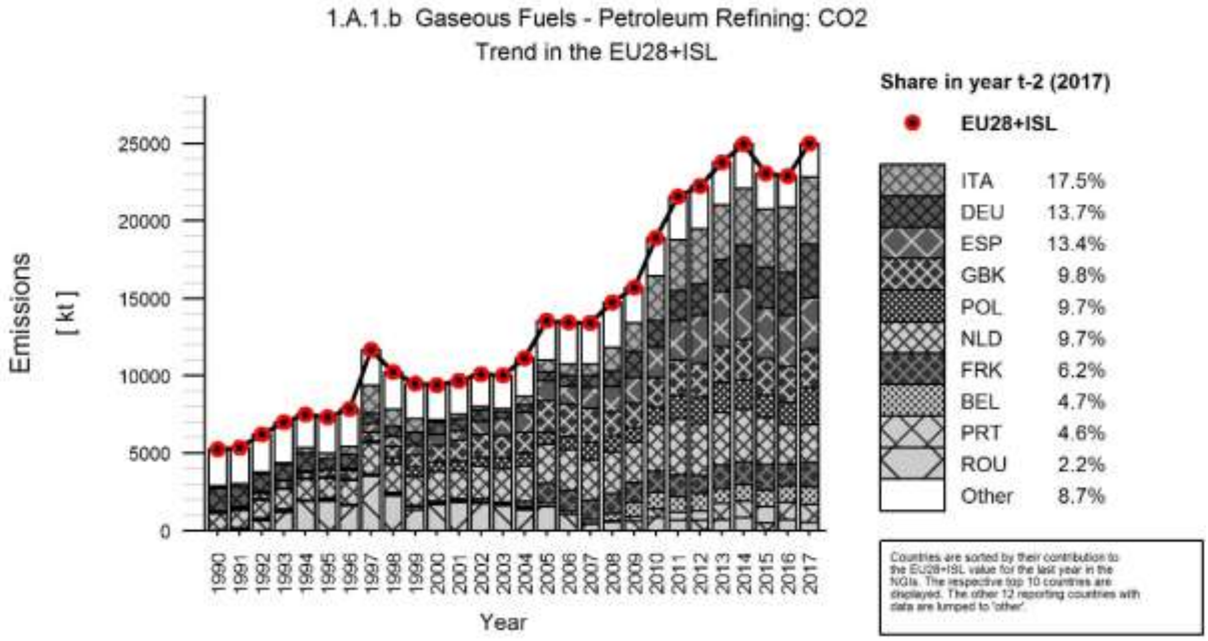
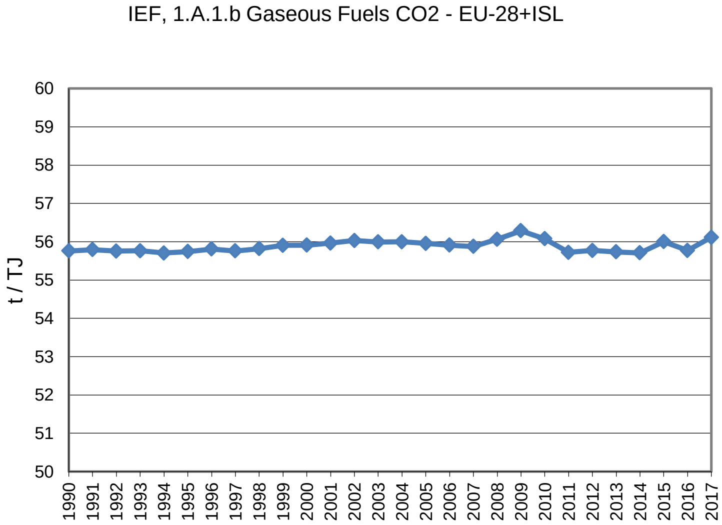
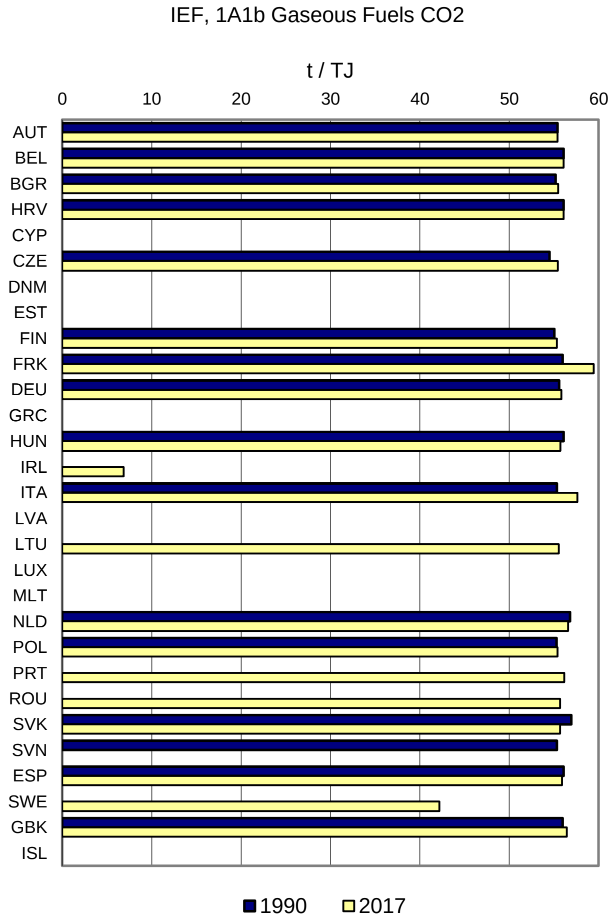


Figure 3.24 (on the next page) shows the implied emission factors for CO_2 emissions from gaseous fuels. The EU-28 + ISL implied emission factor has remained broadly stable around 56 t/TJ on the entire time-series. The very low IEF from Ireland is due to inconsistencies between CO_2 emissions originating 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. For Sweden which has the second lowest IEF in the EU-28 + ISL, it is due to a LNG-based plant which has lower EF than natural gas. CO_2 emissions are based on verified EU ETS data, while activity data and CO_2 emission allocations between stationary combustion and fugitive emissions are based on other information sources, causing the low IEF.

Figure 3.24 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-28 + ISL)

According to the 2006 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-28 + ISL greenhouse gas emissions in 2017. Between 1990 and 2017, CO_2 emissions fell by 52% in the EU-28 + ISL (Table 3.16). The United Kingdom, Germany, the Czech Republic and Italy together are responsible for 65.8% of the total EU-28 + ISL emissions in 2017. Germany is responsible for almost 79% of the whole decrease in this category between 1990 and 2017.

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

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	510	271	281	0.5%	-229	-45%	10	4%
Belgium	2 024	155	151	0.3%	-1 873	-93%	-4	-3%
Bulgaria	362	4	4	0.01%	-358	-98.9%	0.1	4%
Croatia	873	201	218	0.4%	-655	-75%	18	9%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	1 516	6 364	5 883	10.7%	4 366	288%	-481	-8%
Denmark	545	1 329	1 364	2.5%	819	150%	35	3%
Estonia	86	1 307	1 373	2.5%	1 287	1494%	66	5%
Finland	347	336	325	0.6%	-22	-6%	-10	-3%
France	4 738	2 742	3 030	5.5%	-1 709	-36%	288	11%
Germany	65 289	9 811	9 719	17.7%	-55 570	-85%	-92	-1%
Greece	102	36	37	0.1%	-65	-64%	1	3%
Hungary	517	299	305	0.6%	-212	-41%	6	2%
Ireland	100	126	129	0.2%	29	29%	3	2%
Italy	12 449	6 775	5 777	10.5%	-6 672	-54%	-999	-15%
Latvia	145	48	46	0.1%	-100	-68%	-3	-5%
Lithuania	9	72	53	0.10%	44	472%	-18.6	-26%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	2 110	2 794	2 654	4.8%	544	26%	-140	-5%
Poland	4 867	3 222	3 085	5.6%	-1 782	-37%	-138	-4%
Portugal	77	NO	NO	-	-77	-100%	-	-
Romania	146	1 808	2 296	4.2%	2 150	1472%	488	27%
Slovakia	1 319	1 303	1 218	2.2%	-100	-8%	-85.0	-7%
Slovenia	82	0.1	0.05	0.0001%	-82	-100%	-0.1	-67.9%
Spain	2 143	779	1 238	2.3%	-906	-42%	459	58.9%
Sweden	300	416	393	0.7%	93	31%	-23	-5%
United Kingdom	13 817	14 697	15 283	27.9%	1 466	11%	586	4%
EU-28	**114 476**	**54 896**	**54 862**	**100%**	**-59 614**	**-52%**	**-34**	**-0.1%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	13 817	14 697	15 283	27.9%	1 466	11%	586	4%
EU-28 + ISL	**114 476**	**54 896**	**54 862**	**100%**	**-59 614**	**-52%**	**-34**	**-0.1%**

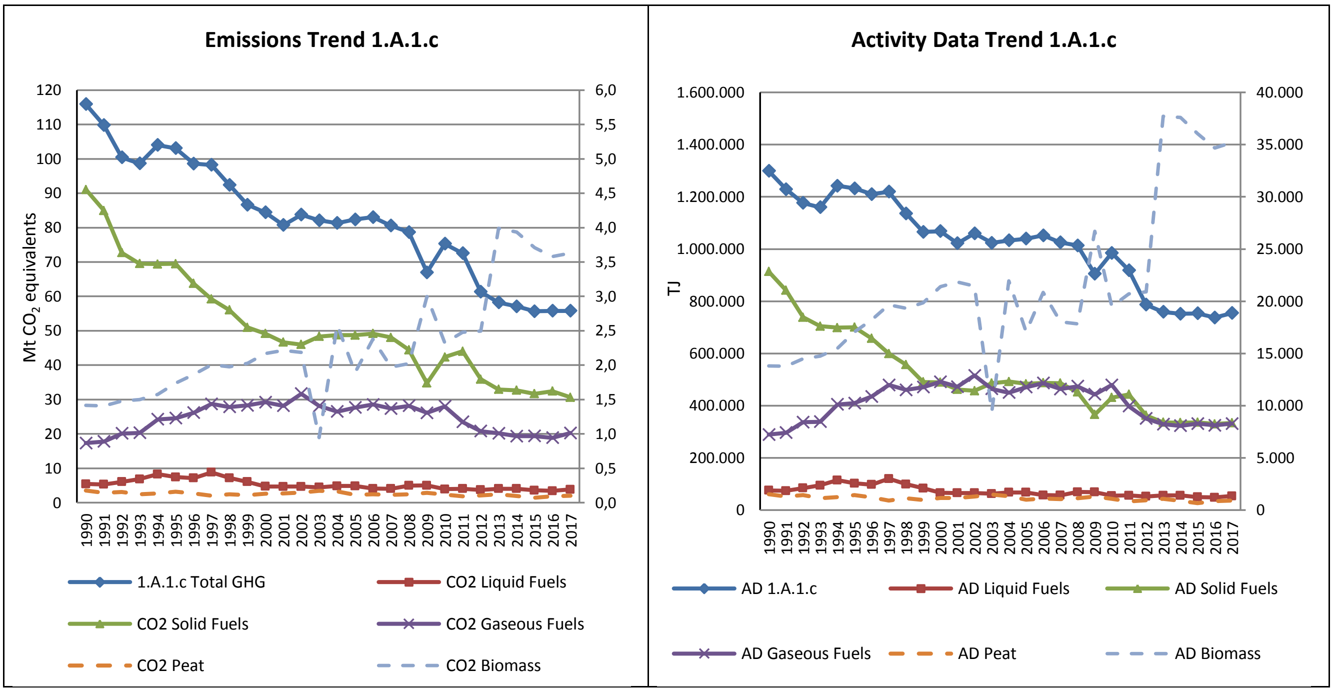
Abbreviations are explained in the Chapter 'Units and abbreviations'.

Note: 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.

Figure 3.25 shows the trends in emissions from this source category by fuel in the EU-28 + ISL between 1990 and 2017. 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% in the EU-28 + ISL between 1990 and 2017. The strongest decline was reported for solid fuels (-63.5%), followed by liquid fuels (-28.5%). On the other hand, gaseous fuels and biomass increased in the period 1990 to 2017. In the year 2017 solid fuels and gaseous fuels represented each 44% of all fuel used. Almost no other fossil fuels and peat are used in this category; together accounting for 0.12% of the total fuel used in 2017.

Figure 3.25 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 54.9% of total greenhouse gas emissions from 1.A.1.c in 2017. Emissions in the EU-28 + ISL declined by 66% since 1990. This was mainly driven by a strong decline in emissions in Germany (-51 937 kt CO_2), which amounts to about 86% of the total decline in this category.

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

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	IE	IE	IE	-	-	-	-	-	NA	NA
Belgium	1 969	155	151	0.5%	-1 818	-92%	-4	-3%	T3	PS
Bulgaria	274	2	2	0.01%	-272	-99%	0.1	6%	T1,T2	CS,D
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 352	6 307	5 859	19%	4 508	334%	-448.3	-7%	T1, T2	D, CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	86	1 307	1 373	4%	1 287	1494%	66	5%	T3	PS
Finland	347	336	325	1%	-22	-6%	-10	-3%	T3	CS
France	4 054	2 742	3 030	10%	-1 024	-25%	288	11%	T2	CS
Germany	61 101	9 332	9 164	30%	-51 937	-85%	-169	-2%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	164	182	180	1%	16	10%	-2.53	-1%	T1, T2, T3	D, CS, PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	10 891	5 973	4 802	16%	-6 089	-56%	-1 170.3	-19.59%	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	1 192	1 031	3%	114	12%	-161	-14%	T2	CS
Poland	4 030	2 131	2 090	7%	-1 940	-48%	-41	-2%	T1/T2	D/CS
Portugal	28	NO	NO	-	-28	-100%	-	-	T1	D
Romania	NO	1	1	0.002%	1	∞	-1	-47%	T1,T2	CS,D
Slovakia	1 319	1 254.5	1 174.5	4%	-144	-11%	-80.03	-6%	T2	CS
Slovenia	37.1	NO	NO	-	-37.1	-100%	-	-		
Spain	1 864	271	273	1%	-1 590	-85%	2	1%	T1/T2	D/CS/PS
Sweden	300	416	393	1%	93	31%	-23	-5%	T2	CS
United Kingdom	2 342	858	775	3%	-1 568	-67%	-83	-10%	T1, T2	CS, D
EU-28	**91 075**	**32 460**	**30 623**	**100%**	**-60 451**	**-66%**	**-1 837**	**-6%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 342	858	775	3%	-1 568	-67%	-83	-10%	T1, T2	CS, D
EU-28 + ISL	**91 075**	**32 460**	**30 623**	**100%**	**-60 451**	**-66%**	**-1 837**	**-6%**		

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 97 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States 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 3.26 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 2017 were Germany, the Czech Republic and Italy, jointly responsible for 64.7% of all EU-28 + ISL emissions in this category.

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

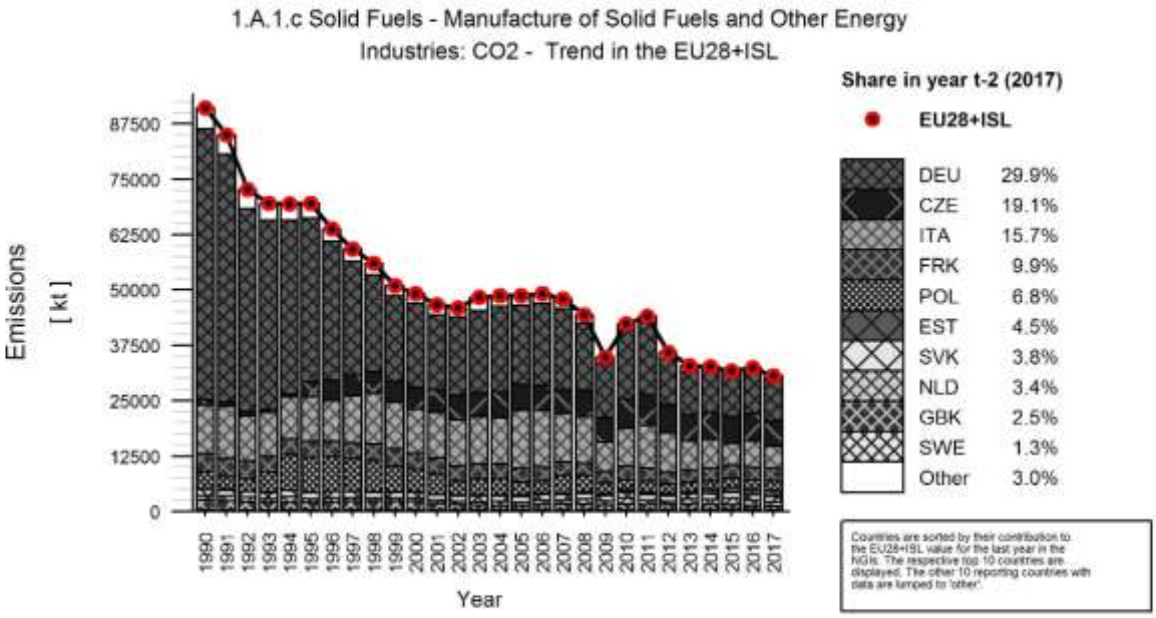
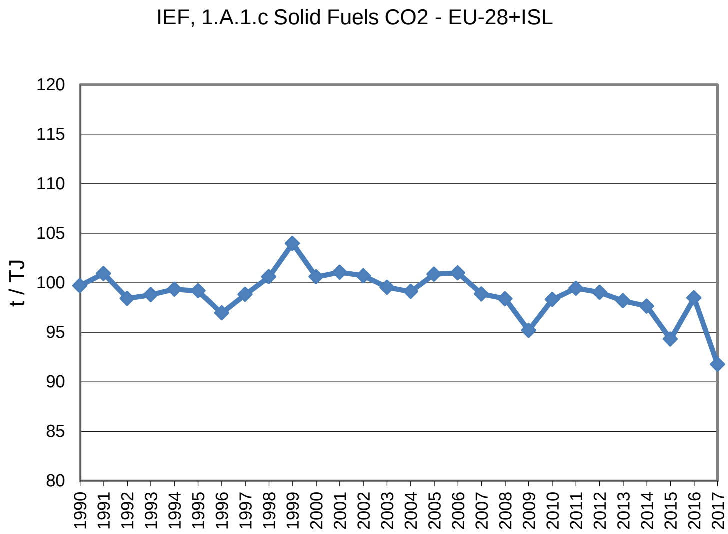
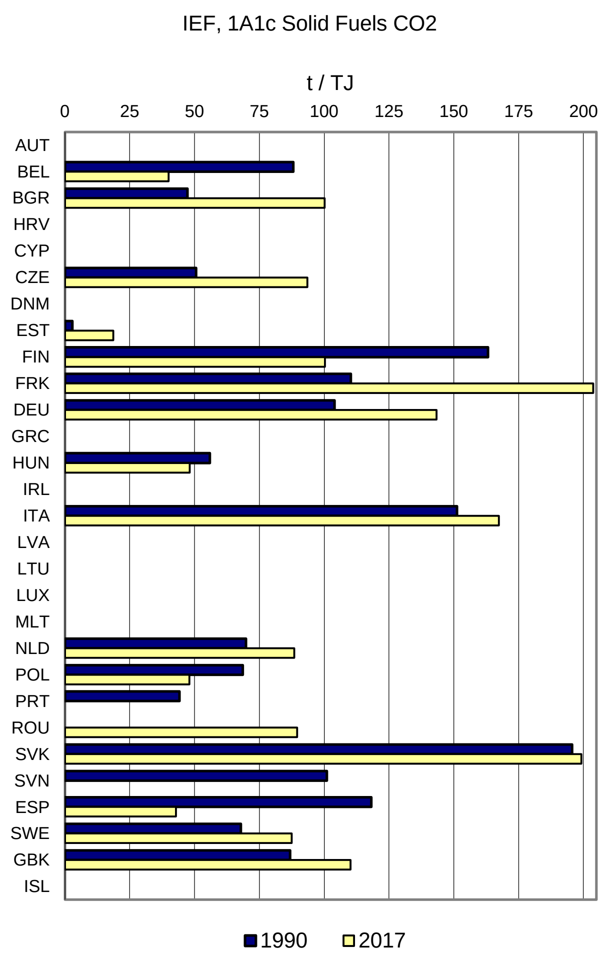


Figure 3.27 shows the relevant implied emission factors for solid fuels. The EU-28 + ISL implied emission factor amounted to 91.8 t/TJ in 2017: it is the lowest of the entire time-series. This drop can be partly explained by the decrease of 8% of IEF of Italy (third emitter with 15.7%) between 2016 and 2017.

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 3.27 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 36.3% of total greenhouse gas emissions from this category in 2017. Emissions in the EU-28 + ISL increased by 17% (Table 3.18 below) between the years 1990 and 2017. 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 57.3% of emissions in 2017 in the EU-28 + ISL. The top three Member States (United Kingdom, the Netherlands and Romania) together account for almost 73% of emissions in this category.

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

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	506	271	281	1%	-225	-44%	10	4%	T2	CS
Belgium	51	NO	NO	-	-51	-100%	-	-	NA	NA
Bulgaria	NO	2	1	0.01%	1	∞	-1	-30%	T1,T2	CS,D
Croatia	833	201	218	1%	-615	-74%	18	9%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	6	5	0.02%	5	∞	-1	-20%	T1, T2	D, CS
Denmark	545	1 329	1 364	7%	819	150%	35	3%	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	443	521	3%	-2 101	-80%	79	18%	CS	CS
Greece	102	36	37	0.2%	-65	-64%	1	3%	T2	PS
Hungary	313	117	125	1%	-189	-60%	8	7%	T1, T3	D, PS
Ireland	IE	29	30	0.1%	30	∞	1	5%	T3	CS
Italy	615	802	974	5%	359	58%	172	21%	T3	CS
Latvia	45	29	24	0.1%	-20	-46%	-4	-14%	T2	CS
Lithuania	NO	58	39	0.2%	39	∞	-19	-32%	T1, T2	CS, D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 184	1 602	1 623	8%	439	37%	21	1%	T2	CS
Poland	684	989	887	4%	202	30%	-102	-10%	T2	CS
Portugal	NO	NO	NO	-	-	-	-	-	T1	D
Romania	NO	1 503	1 548	8%	1 548	∞	45	3%	T1,T2	CS,D
Slovakia	NO	49	44	0.2%	44	∞	-5	-10%	T2	CS
Slovenia	42	0.1	0.05	0.0002%	-42	-100%	-0.1	-68%	T2	CS
Spain	89	460	923	5%	834	936%	463	100%	T2	CS
Sweden	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
United Kingdom	9 164	10 964	11 613	57%	2 449	27%	649	6%	T1, T2	CS, D
EU-28	**17 326**	**18 890**	**20 259**	**100%**	**2 932**	**17%**	**1 369**	**7%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	9 164	10 964	11 613	57%	2 449	27%	649	6%	T1, T2	CS, D
EU-28 + ISL	**17 326**	**18 890**	**20 259**	**100%**	**2 932**	**17%**	**1 369**	**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 91 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States 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 3.28 illustrates the emission trend for gaseous fuels split by Member States over the last 27 years. Although the emissions in the year 2017 compared to 1990 increased by 17% over the whole time series, there was a strong increase in the 1990s and a decline after 2009. The increase in EU-28 + ISL 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 57.3% of the total EU-28 + ISL emissions in this category in 2017.

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

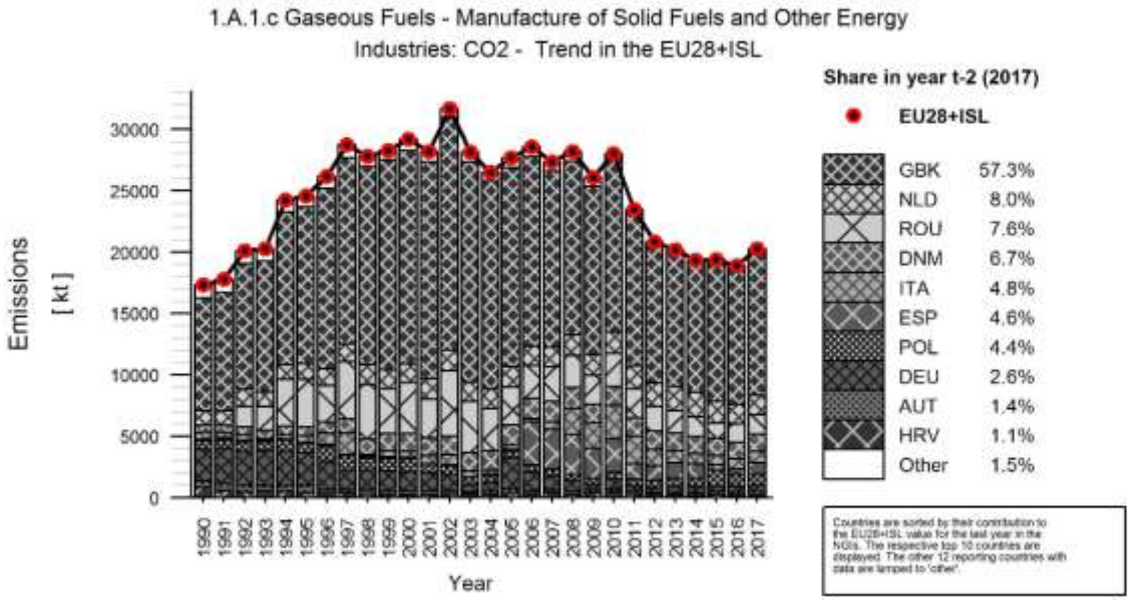
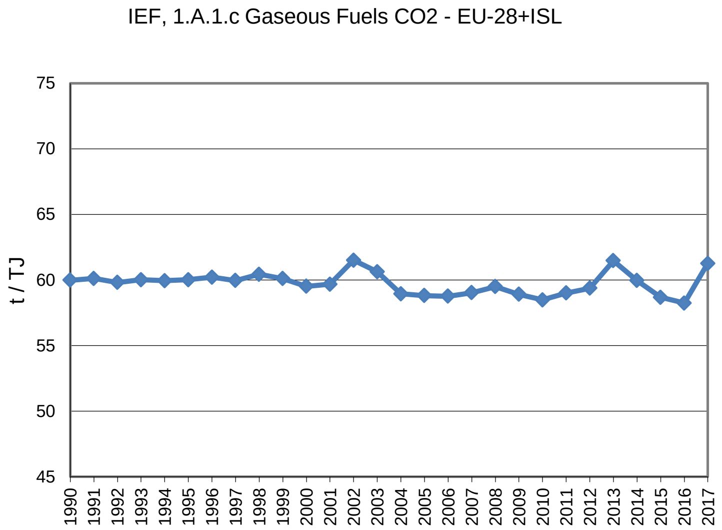
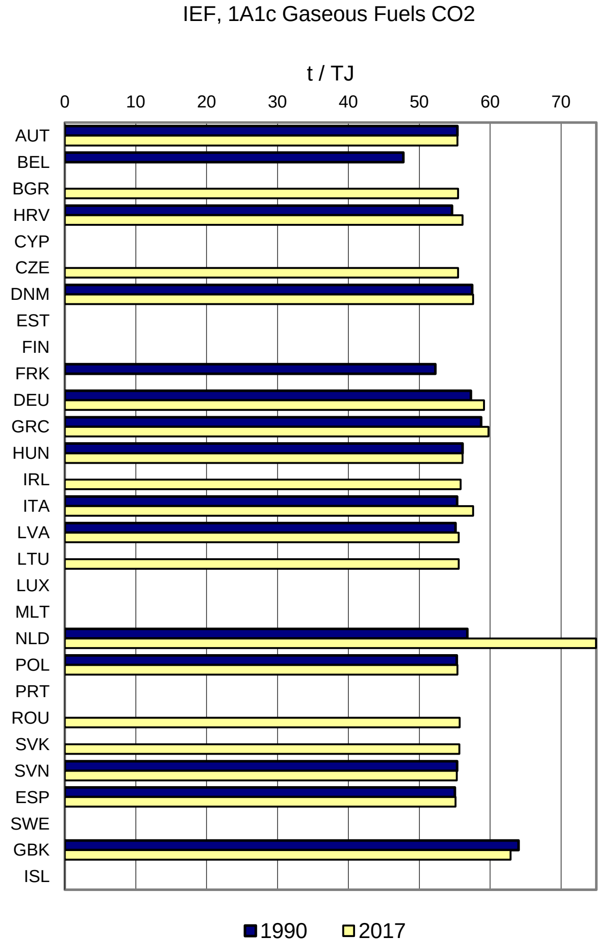


Figure 3.29 (on the next page) shows the implied emission factors for gaseous fuels. The EU-28 + ISL implied emission factor amounts 61.3 t/TJ in 2017 and remained fairly stable around 60 t/TJ over the last 27 years. The IPCC default values range between 54.3 t/TJ (lower) and 58.3 t/TJ (upper). The EU-28 + ISL IEF is dominated by the IEF of the United Kingdom and the Netherlands, which are comparatively high. The EU-28 + ISL IEF increase observed in 2017 is driven by the increase of the IEF of these two countries. 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 consumption in other sectors. The IEF of the Netherlands is comparatively high, which showed an increasing and fluctuating trend in recent years. The inter-annual variability in the EFs for CO_2 and CH_4 emissions from gas combustion (non-standard natural gas) is mainly due to the reported emissions in the AERs of individual companies. The comparatively

high IEF of Greece in 2017 is due to the fact, that the domestic natural gas is produced from reservoirs, which have different high carbon contents. The varied development of the IEF is caused by the interannual changes of the share of each reservoir in the total natural gas production.

Figure 3.29 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 1A2)

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 1A1c. Austria reports emissions from onsite coke ovens of integrated iron and steel plants under category 1A2a. Some MS report emissions of blast furnace and coke oven gas combustion under categories 1A1a public electricity and heat production or 1A4 other sectors and some MS are reporting emissions from refinery gas under 1A2. Emissions from category 1A2 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 1A3 Transport. Most MS report emissions arising from off-road and other mobile machinery used in industry (e.g. construction machinery) under category 1A2g. 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 sub categories 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 1A2 key source category emission estimates. It can be seen that most Member States use Tier 2 methodology for emission estimates.

Table 3.19: Share of Tier methods for 1A2 by type of reported method and method combinations.

Methods and method combinations	Share of emissions which are estimated by the specific Tier method'
CS	2%
T1	13%
T1,T2	14%
T1,T3	3%
T2	36%
T2,T3	2%
T3	5%
T1,T2,T3	1%
CS,T1,T3	22%

Information about methodology used by Member States for calculating emissions from category 1A2g is not included in submission files for specific fuels but only as overall methodology information and thus shares of higher Tiers in table below for 1A2g are the same for gaseous, liquid and other fuels.

Table 3.20: Key categories for sector 1A2 (Table excerpt)

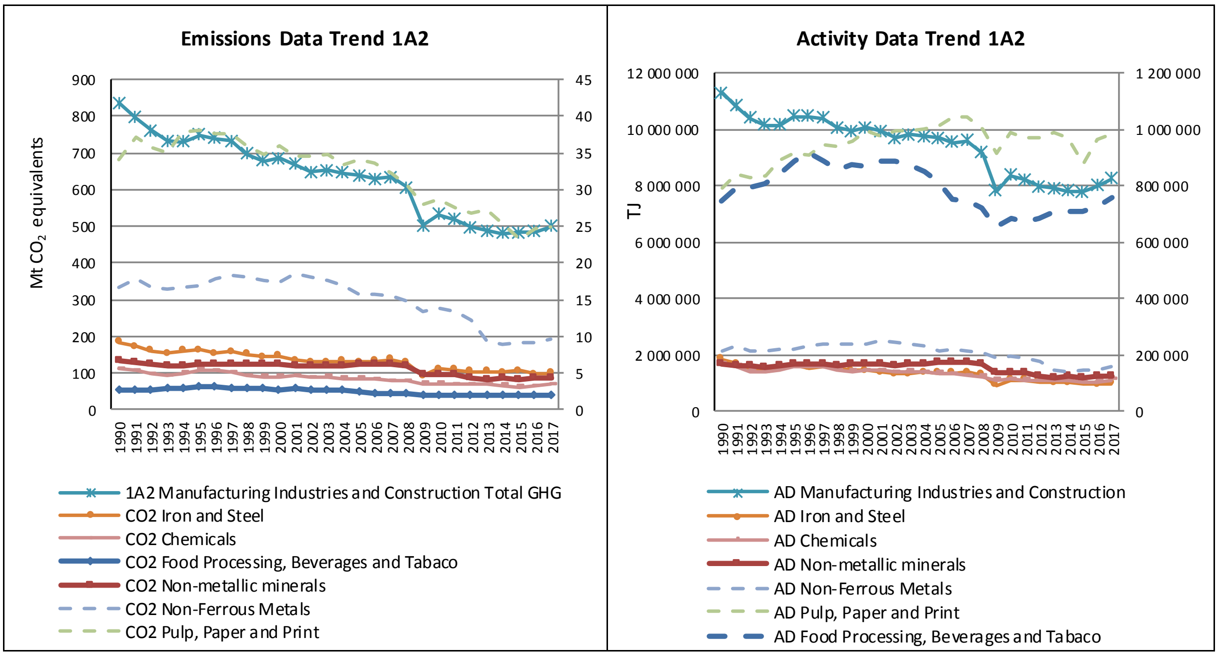
Source category gas	kt CO_2 equivalent		Trend	Level		Share of higher Tiers [%]
	1990	2017		1990	2017	
1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)	30921	18989	T	L	L	99
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	8509	1391	T	L	0	98
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	143081	79619	T	L	L	100
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	3925	7363	T	0	L	93
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	8054	1176	T	0	0	91
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	54752	38056	T	L	L	98
1.A.2.c Chemicals: Liquid Fuels (CO_2)	38771	18997	T	L	L	91
1.A.2.c Chemicals: Solid Fuels (CO_2)	14908	8638	0	L	L	99
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	13216	18742	T	L	L	92
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)	11414	1690	T	L	0	81
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)	8368	3250	T	L	0	96
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	19335	30892	T	L	L	95
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	19811	4140	T	L	0	59
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	12491	4626	T	L	0	93
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	27353	30808	T	L	L	98
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	44632	25327	T	L	L	97
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	1422	13410	T	0	L	73
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	57693	16327	T	L	L	99
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	95250	91454	T	L	L	83
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	110040	51335	T	L	L	83
1.A.2.g Other Manufacturing Industries and Constructions: Other Fuels (CO_2)	2527	4637	T	0	0	83

In 2017 category 1A2 contributed to 500 167 kt CO_2 equivalents of which 98.8% share belongs to CO_2 emissions, 0.8% to N_2O emissions and 0.4% to CH_4 emissions.

Figure 3.30 shows the emission trends within source category 1A2, which is dominated by CO_2 from category 1A2g Other which contributes to total kt CO_2 equivalents emissions by 33% followed by 1A2a Iron and steel contributing by 20%, 1A2f Non-metallic Minerals contributing by 17%, 1A2c Chemicals by 14%, 1A2e Food processing, beverages and tobacco by 8%, 1A2d Pulp, paper and print by 5% and 1A2b Non-ferrous metals by 2%. Some Member States do not allocate emissions to all sub-categories under 1A2, which is one reason for 1A2g being the largest sub-category within 1A2 source category.

Greece reports the rest of industrial sector emissions in category 1A2f instead of category 1A2g for whole time series. Germany reports some fuels of subcategories 1A2a-1A2e as included elsewhere (Notation key 'IE') and reports the specific emissions and activity data under 1A2g. For the years 2013 to 2017 Sweden makes excessive use of confidential reporting (Notation key 'C'), which implies that sub-categories include emissions without providing detailed fuel specific emissions (1A2a, 1A2b, 1A2c, 1A2d, 1A2e, 1A2f and 1A2g for 2013 and 1A2a, 1A2f and 1A2). However, all Swedish confidential emissions are included in the total emissions of 1A2 and have been included in 'other fossil fuels' of the EU inventory.

Figure 3.30: 1A2 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 Member State on GHG emissions and CO_2 emissions from 1A2 Manufacturing Industries and Construction in 1990 and 2017. The highest share on total kt CO_2 equivalent emissions (above the average share calculated for EU-28+ISL) has Germany (27%), France (10%), Italy (10%), United Kingdom (10%), Spain (9%), Netherland (6%) and Poland (6%). Together those countries contribute to 79% of total emissions from 1A2.

Table 3.21: 1A2 Manufacturing Industries and Construction: Member States' contributions to total GHG and CO_2 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2017 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)
Austria	9 900	11 052	9 817
Belgium	23 242	13 471	23 085
Bulgaria	17 765	3 604	17 666
Croatia	5 529	2 418	5 502
Cyprus	515	660	512
Czechia	47 113	10 423	46 824
Denmark	5 431	4 025	5 366
Estonia	2 507	631	2 498
Finland	13 663	6 853	13 478
France	78 443	51 433	77 735
Germany	186 709	135 562	185 108
Greece	9 405	5 787	9 338
Hungary	13 623	4 942	13 587
Ireland	3 962	4 665	3 943
Italy	93 235	51 129	91 713
Latvia	3 963	670	3 902
Lithuania	6 165	1 185	6 108
Luxembourg	6 266	1 141	6 250
Malta	53	34	53
Netherlands	34 561	29 107	34 457
Poland	43 053	31 172	42 770
Portugal	9 794	7 578	9 658
Romania	49 998	11 678	49 893
Slovakia	16 097	7 136	16 027
Slovenia	3 151	1 679	3 119
Spain	45 086	43 462	44 732
Sweden	10 851	6 942	10 690
United Kingdom	96 050	51 397	95 612
EU-28	**836 128**	**499 836**	**829 443**
Iceland	377	180	362
United Kingdom (KP)	96 158	51 547	95 720
EU-28 + ISL	**836 614**	**500 167**	**829 913**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The difference between EU-28 and EU-28 + ISL is not only Iceland but also the different geographical coverage of the UK included in the EU submission (GBE). The EU-28 numbers are the numbers submitted under the UNFCCC and include the EU territory for the UK. The EU-28 + ISL numbers are the numbers submitted under the Kyoto Protocol and include the Kyoto Protocol territory of the UK (GBK).

CO_2 emissions from 1A2 Manufacturing Industries and Construction is the fourth largest sector in the EU-28+ISL accounting for 15% of total GHG emissions from Energy sector in 2017. Between 1990 and 2017, CO_2 emissions from 1A2 Manufacturing Industries and Construction declined by 40%. Decrease of total emissions is caused by decrease of fossil fuel consumption in category 1A2 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 113% and an increase of other fossil fuels CO_2 emissions by 170% have been recorded in 2017 compared to 1990.

Between 1990 and 2017, CO_2 emissions were significantly reduced by Latvia (84%), Luxembourg (82%), Lithuania (81%), Bulgaria (80%), Czechia (78%), Romania (77%), Estonia (75%) followed by Hungary (64%) compared to the level of CO_2 emissions in 1990. Only Austria, Cyprus and Ireland 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 (78%) 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 (77%) were the transition to a market economy and the reduction of energy intensive activities. The main reason for the decline of emissions in Germany (27%) was the restructuring of the industry and efficiency improvements after German reunification.

Table 3.22 provides information on Member States recalculations in CO_2 from 1A2 Manufacturing Industries for 1990 and 2016 and main explanations for the largest recalculations in absolute terms. The largest recalculations in 1990 were reported by Czechia and Sweden. The largest recalculations in 2016 were reported by the Sweden and Italy. The reasons for year 2016 revisions are mostly changes in activity data/revised energy balances.

Table 3.22: 1A2 Manufacturing Industries and Construction: Recalculations in CO_2 for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 and percent)

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	10	0.1	-254	-2.4	Revised energy balance (6.5 kt CO_2 moved from 2.C.1)
Belgium	0.4	0.002	38	0.3	Revision of energy consumption data reported in energy balances
Bulgaria	-3	-0.02	-1	-0.03	Revision of 1A2a (the quantities of Coke Oven Coke, which were previously reported under energy use are now accounted as non-energy use and following the recommendation of the Technical review of GHG inventories under the EU Effort Sharing Decision (ESD) in 2012), 1A2b (reallocation of a significant part of previously reported emissions to subcategory 2C), 1A2c (Following the recommendation of the Technical review of GHG inventories under the EU Effort Sharing Decision (ESD) in 2012)
Croatia	-	-	-	-	-
Cyprus	-	-	-	-	-
Czechia	-4 107	-8.1	88	0.9	Updated activity data
Denmark	-5	-0.1	-29	-0.8	The consumption of gas oil and LPG allocated to stationary combustion has been revised based on improved fuel consumption data for mobile sources.This is reflected in the recalculations for liquid fuels in the sectors 1A2 and 1A4c.
Estonia	-	-	-	-	-
Finland	0.2	0.001	-162	-2.3	Updated economic index for construction machinery (2016), Revised data on liquid fuel properties (2013-2016)

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
France	367	0.5	2 136	4.4	Révision des consommations dans le bilan de l'énergie du SDES pour tous les combustibles
Germany	0.09	0.0	3 878	3.1	Revision of activity data, revision of the calculations, revision of emission factor (more detailed information could be find NIR 2019, chapters 3.2.9.1.5, 3.2.9.2.5, 3.2.9.4.5, 3.2.9.5.5, 3.2.9.6.5 and 3.2.9.7.5)
Greece	-	-	-	-	-
Hungary	-0.003	-0.0	-35	-0.7	Revised IEA Annual Questionnaires, separating fossil and biogenic industrial waste in cement and paper industry.
Ireland	-	-	-28	-0.6	Revised fuel consumption in national energy balance
Italy	-	-	4 212	9.0	Update of natural gas fuel consumption time series with data submitted to Eurostat
Latvia	-12	-0.3	-	-	-
Lithuania	-	-	-24	-2.1	Correction of activity data for natural gas in Chemicals industry (1.A.2.c) in 2016 based on information provided by Statistics Lithuania.
Luxembourg	0.4	0.01	16	1.4	Energy balance revised, revised EF for gasoil and gasoline
Malta	-0	-0.0	-1	-2.2	Inclusion of emissions from biomass
Netherlands	-	-	965	3.6	Improved energy statistics and error correction
Poland	-	-	-	-	-
Portugal	49	0.5	-79	-1.1	Update of Tier 2 emission factor for Natural Gas Update of 2016 Energy Balance in February 2019
Romania	-0	-0.0	36	0.3	In the 1.A.2 Manufacturing Industries and Construction sub-sector, the activity data provided from National Institute of Statistics was updated for the 1992, 1993, 1994, 1995, 1999, 2005, 2009, 2010, 2011, 2014 and 2016 years, the CO_2, CH_4 and N_2O emissions values for this years were recalculated. Country specific CO_2 EFs for the corresponding fuels from 2016 EU ETS reports were used for all 1A2 categories. Net calorific values determined from the 2016 EU-ETS reports were used for the specific fuels in 1A2 categories.
Slovakia	-	-	-	-	-
Slovenia	-	-	6	0.4	Reallocation of emissions from NG and correction of NCV
Spain	-0.05	-0.0001	-231	-0.6	Correction of EFs, revision of the methodology, update of activity data
Sweden	-493	-4.4	-768	-10.4	Revision of EF for Cement industry, Revision of NCV and EF for CO_2 Natural Gas, Revision of EF for CO_2 for Peat and Landfill Gas "New sales data for road rollers and counterbalanced trucks -> increased diesel Updated load factors and fuel consumption for Mining trucks and Wheel Loader > 560 kW -> Reduced diesel consumption for mining trucks and increased diesel consumption for wheel loaders. Reduced allocation of biodiesel to non-road mobile machinery -> increased fossil diesel. The changes in diesel equal pretty much out each other, but leave a small decrease in fossil diesel - > decreased emissions" Revision of AD in Energy Balances, Revision of NCV and EF for CO_2 Natural Gas, Revision of EF for CO_2 for Peat and Landfill Gas
United Kingdom	-4	-0.004	275	0.5	Revisions to natural gas use in energy statistics. Revision to UK off-road model for newer classes of machinery has also led to revisions in allocations of gas oil to mobile machinery in 1A2.
EU28	-4 197	-0.5	10 035	2.1	
Iceland	0.01	0.002	0.001	0.001	Emission factor for N_2O emissions from LPG was updated

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
United Kingdom (KP)					Revisions to natural gas use in energy statistics. Revision to UK off-road model for newer classes of machinery has also led to revisions in allocations of gas oil to mobile machinery in 1A2.
EU28+ISL	-4 193	-0.6	9 761	2.3	

Iron and Steel (1A2a)

This chapter provides information about European emission trend, Member States contribution to the overall emission trend, activity data and emission factors used for emission estimates by Member States and Island for category 1A2a Iron and Steel.

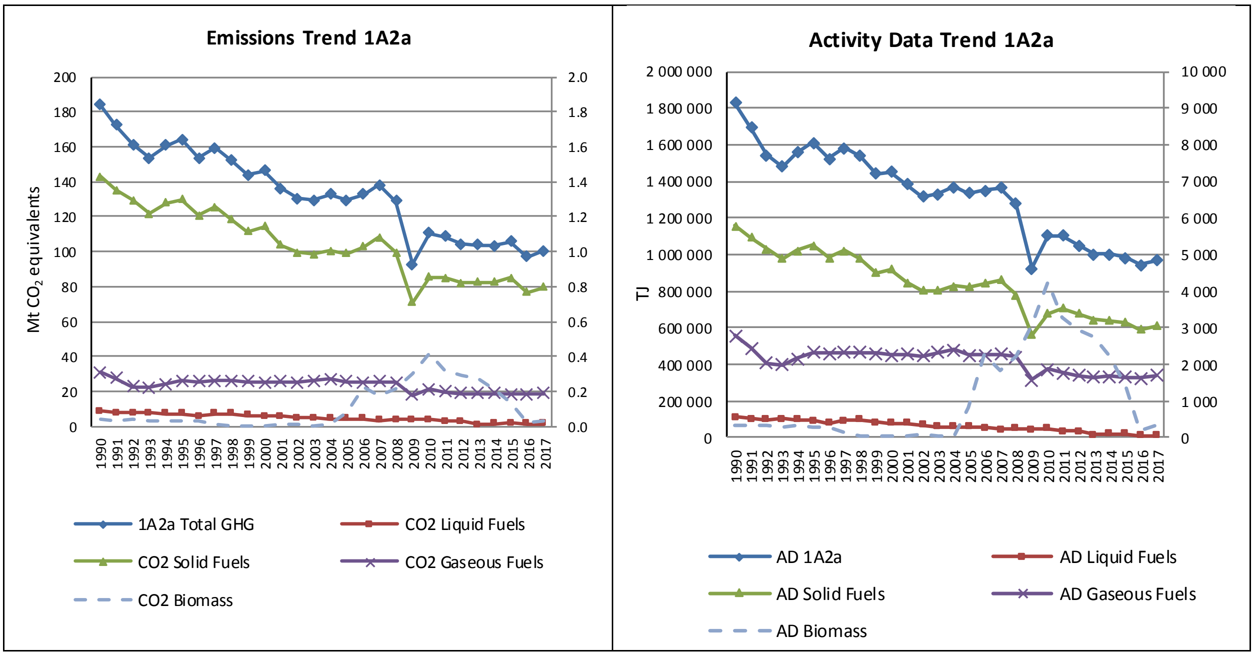
Category 1A2a (more specifically CO_2 emissions from use of gaseous, liquid and solid fuels) was identified as a key category by level and trend and thus next description is concerned only to CO_2 emissions. CO_2 emissions trend and activity data trends can be observed in *Figure 3.31*. Detailed data related to Member States CO_2 emissions and percentage differences is depicted in Table 3.23. CO_2 emissions have almost 100% share on total emissions from 1A2a. The strong increase of emissions (20%) observed between 2009 and 2010 correlates with crude steel production which was higher by 25% in 2010. Between 1990 and 2017 CO_2 emissions decreased by 45%. Small increase of CO_2 emissions (3%) is reported between 2016 and 2017.

Total CO_2 emissions from 1A2a amounted to 100 016 kt CO_2 eq. in 2017. The trend of total CO_2 emissions for 1990 to 2017 from category 1A2a is depicted in *Figure 3.31*. Total CO_2 emissions decreased by 45% 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 increased by 3% between 2016 and 2017. CO_2 emissions from 1A2a Iron and Steel accounted for 20% of 1A2 source category. The share of liquid fuels on CO_2 emissions from 1A2a decreased from 5% in 1990 to 1% in 2017. The share of solid fuels on CO_2 emissions from 1A2a increased from 78% in 1990 to 80% on 2017. The share of gaseous fuels on CO_2 emissions from 1A2a increased from 17% in 1990 to 19% in 2017.

Almost all Member States reported lower level of CO_2 emissions in 2017 compared to 1990 except of Germany, Slovakia and Iceland. Highest share on total EU-28+ISL emissions has Germany (38%) followed by France (13%) and Italy (9%). Most rapid decrease of emissions compared to 1990 can be observed for Ireland (99%), Bulgaria (96%), Luxembourg (95%), Hungary and Portugal (91%). Emissions are reported as 'NO' (not occurring) for Estonia and Lithuania. Emissions are reported by Latvia as 0 kt CO_2 eq. (starting from 2013 GHG emissions have not been occurring as no fuels have been used in category 1A2a in Estonia). Cyprus and Malta report emissions as 'NO, IE' (not occurring, included elsewhere). For Cyprus, consumption of fuels and emissions for 1A2a Iron and steel are included in 1A2b Non-ferrous metals category. Malta reports emissions related to category 1A2a Iron and steel in category 1A2g (more specifically 1A2gviii Other).

A main driver of category 1A2a CO_2 emissions is crude steel production which decreased from about 192 million tonnes in 1990 to 168 million tonnes in 2017 (www.worldsteel.org (Steel Statistical Yearbook)) as well as blast furnace iron production (BFI), which decreased from about 126 million tonnes to 91 million tonnes in 2016 (www.worldsteel.org).

Figure 3.31: 1A2a Iron and Steel: CO_2 emissions and activity data trends



Data displayed as dashed line refers to the secondary axis.

Table 3.23: 1A2a Iron and Steel: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	2 062	1 421	1 573	1.6%	-489	-24%	152	11%	T1,T2	CS,D
Belgium	5 662	1 174	1 213	1.2%	-4 449	-79%	39	3%	T1,T3	D,PS
Bulgaria	2 705	114	119	0.1%	-2 587	-96%	5	4%	T2	CS
Croatia	NO,IE	34	37	0.0%	37	∞	3	9%	T1	D
Cyprus	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Czech Republic	14 861	1 802	2 194	2.2%	-12 667	-85%	392	22%	T1,T2	CS,D
Denmark	128	108	112	0.1%	-16	-12%	5	5%	T1,T2,T3	CS,D
Estonia	3	3	NO	-	-3	-100%	-3	-100%	NA	NA
Finland	2 499	912	882	0.9%	-1 616	-65%	-29	-3%	T3	CS,PS
France	21 316	11 192	12 846	12.8%	-8 470	-40%	1 654	15%	T2,T3	CS,PS
Germany	35 269	37 422	38 438	38.4%	3 168	9%	1 016	3%	CS	CS
Greece	447	121	103	0.1%	-345	-77%	-18	-15%	T2	CS,PS
Hungary	2 341	169	199	0.2%	-2 141	-91%	30	18%	T1,T2	CS,D
Ireland	175	2	2	0.0%	-173	-99%	0	0%	T2	CS
Italy	24 389	11 097	9 329	9.3%	-15 060	-62%	-1 768	-16%	T2	CS
Latvia	389	3	0	0.0%	-389	-100%	-2	-86%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	5 404	269	269	0.3%	-5 136	-95%	0	0%	T1,T2	CS,D
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Netherlands	5 599	4 709	5 423	5.4%	-175	-3%	714	15%	T2	CS
Poland	16 189	5 043	5 919	5.9%	-10 269	-63%	876	17%	T1,T2	CS,D
Portugal	1 251	120	116	0.1%	-1 135	-91%	-4	-3%	T2	CR,D,PS
Romania	7 813	1 280	1 239	1.2%	-6 574	-84%	-41	-3%	T1,T2	CS,D
Slovakia	2 682	2 786	3 088	3.1%	406	15%	301	11%	T2	CS
Slovenia	421	202	215	0.2%	-206	-49%	14	7%	T1,T2	CS,D
Spain	8 323	5 586	6 001	6.0%	-2 322	-28%	415	7%	T1,T2	,D,OTH,PS
Sweden	1 705	1 228	1 377	1.4%	-328	-19%	149	12%	T2	CS
United Kingdom	21 534	9 959	9 319	9.3%	-12 215	-57%	-639	-6%	T2	CS
EU-28	**183 166**	**96 757**	**100 015**	**100%**	**-83 152**	**-45%**	**3 258**	**3%**	**-**	**-**
Iceland	0	1	1	0.0%	1	171%	-1	-36%	T1	D
United Kingdom (KP)	21 534	9 959	9 319	9.3%	-12 215	-57%	-639	-6%	T2	CS
EU-28 + ISL	**183 167**	**96 758**	**100 016**	**100%**	**-83 151**	**-45%**	**3 258**	**3%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g. Cyprus reports an 'IE' for liquid fuels (included in 1A2b) 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.

1A2a Iron and Steel - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1A2a amounted 1 391 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 84% and compared to 2016 by 7%. Category has 0.3% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption decreased by 90% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.24. Czechia, Estonia, Hungary, Ireland, Lithuania and Netherlands report emissions as 'NO' (not occurring). Three 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 98% of Member States emissions were calculated by using higher Tier methods or combination of methods in category 1A2a – Liquid Fuels (CO_2)). All Member States reported lower level of emissions in 2017 than in 1990 (except of Island, but it should be noted that the share of Island emissions on total EU-28+ISL emissions is only 0.1%).

Table 3.24: 1A2a Iron and Steel, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	76	43	10	0.7%	-67	-87%	-33	-78%	T2	CS
Belgium	885	14	16	1.2%	-868	-98%	2	15%	T1,T3	D,PS
Bulgaria	37	NO	1	0.1%	-37	-98%	1	∞	NA	NA
Croatia	IE	7	9	0.7%	9	∞	2	25%	T1	D
Cyprus	IE	IE	IE	-	-	-	-	-	NA	NA
Czech Republic	427	NO	NO	-	-427	-100%	-	-	NA	NA
Denmark	17	2	3	0.2%	-14	-83%	1	31%	T1,T2	CS,D
Estonia	NO	0	NO	-	-	-	0	-100%	NA	NA
Finland	305	284	304	21.8%	-1	0%	20	7%	T3	CS
France	1 065	167	136	9.8%	-929	-87%	-31	-19%	T2,T3	CS,PS
Germany	916	19	19	1.4%	-896	-98%	1	3%	CS	CS
Greece	447	34	37	2.7%	-410	-92%	4	11%	T2	PS
Hungary	392	NO	NO	-	-392	-100%	-	-	NA	NA
Ireland	16	NO	NO	-	-16	-100%	-	-	NA	NA
Italy	156	89	2	0.1%	-154	-99%	-87	-98%	T2	CS
Latvia	92	NO	0	0.0%	-92	-100%	0	∞	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	48	1	2	0.1%	-46	-96%	1	41%	T1,T2	CS,D
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	19	NO	NO	-	-19	-100%	-	-	NA	NA
Poland	864	16	19	1.3%	-846	-98%	3	19%	T1	D
Portugal	163	0	0	0.0%	-163	-100%	0	-64%	T2	CR,D,PS
Romania	NO	18	17	1.2%	17	∞	-2	-9%	T2	CS
Slovakia	164	1	2	0.2%	-162	-99%	1	49%	T2	CS
Slovenia	54	4	5	0.4%	-49	-91%	1	20%	T1	D
Spain	1 070	159	149	10.7%	-921	-86%	-10	-6%	T1,T2	CS,D,PS
Sweden	831	589	616	44.3%	-215	-26%	27	5%	T2	CS
United Kingdom	462	48	44	3.1%	-418	-91%	-4	-9%	T2	CS
EU-28	**8 508**	**1 497**	**1 390**	**100%**	**-7 118**	**-84%**	**-106**	**-7%**	**-**	**-**
Iceland	0	1	1	0.1%	1	171%	-1	-36%	T1	D
United Kingdom (KP)	462	48	44	3.1%	-418	-91%	-4	-9%	T2	CS
EU-28 + ISL	**8 509**	**1 498**	**1 391**	**100%**	**-7 118**	**-84%**	**-107**	**-7%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g. Cyprus reports an 'IE' for liquid fuels (included in 1A2b) 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.

Figure 3.32 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Sweden (44%), Finland (22%), Spain (11%) and France (10%) which together have 87% share on EU-28+ISL emissions.

Figure 3.32: 1A2a Iron and Steel, Liquid fuels: Emission trend and share for CO_2

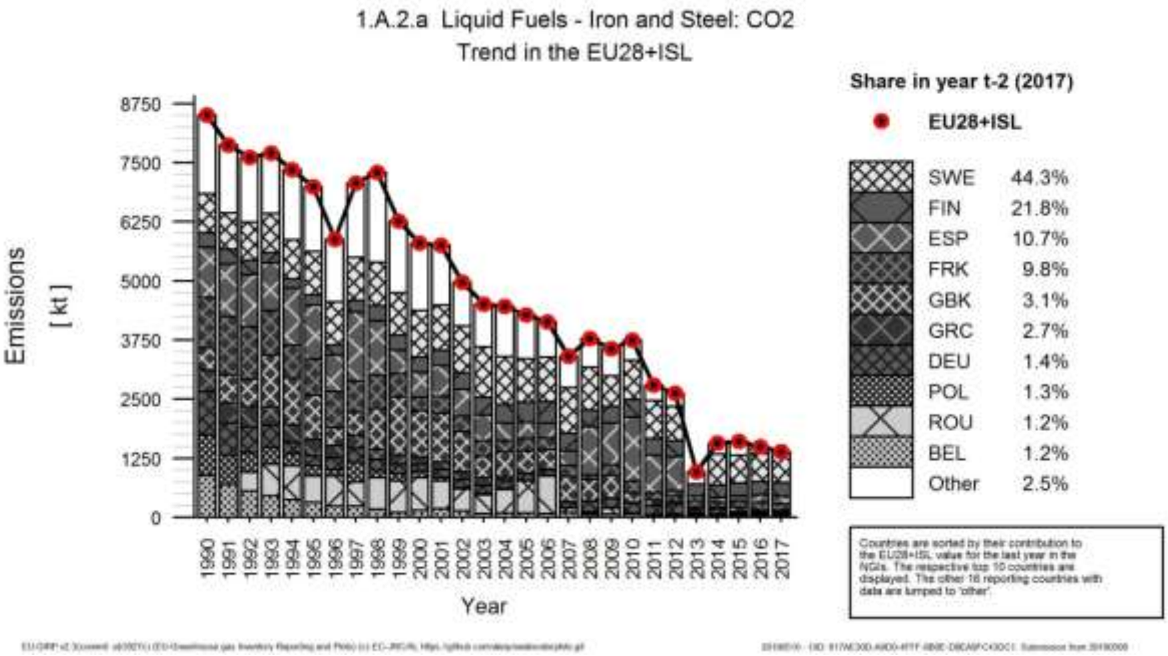
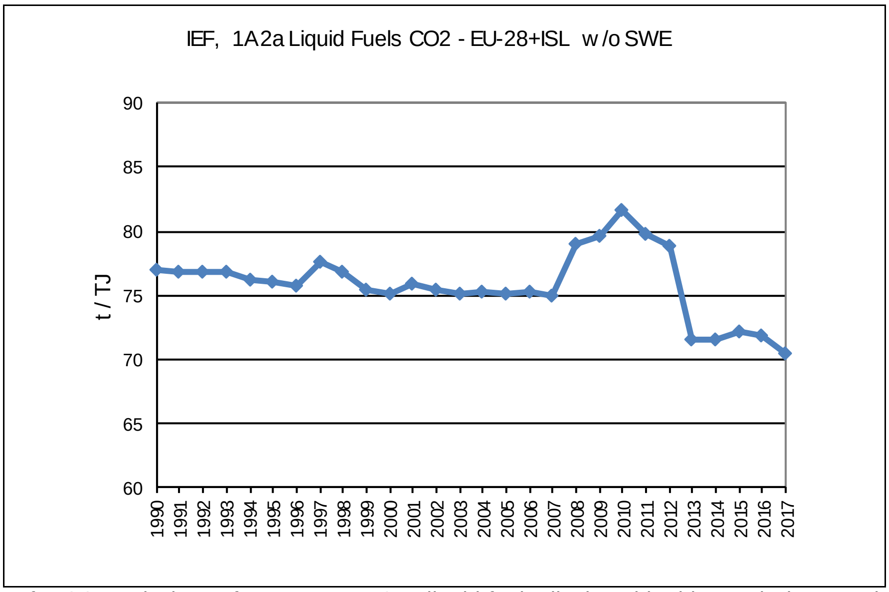


Figure 3.33 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. It can be seen, that for 2007-2012, CO_2 IEF increased more obvious compared to previous trend. Since 2013, CO_2 IEF is below the previous level for 1990-2012. CO_2 IEF equaled 70.5 t/TJ in 2017. The figure below does not include data from Sweden which reports activity data as 'C' (confidential) and thus difference between figure and CRF tables is occurring.

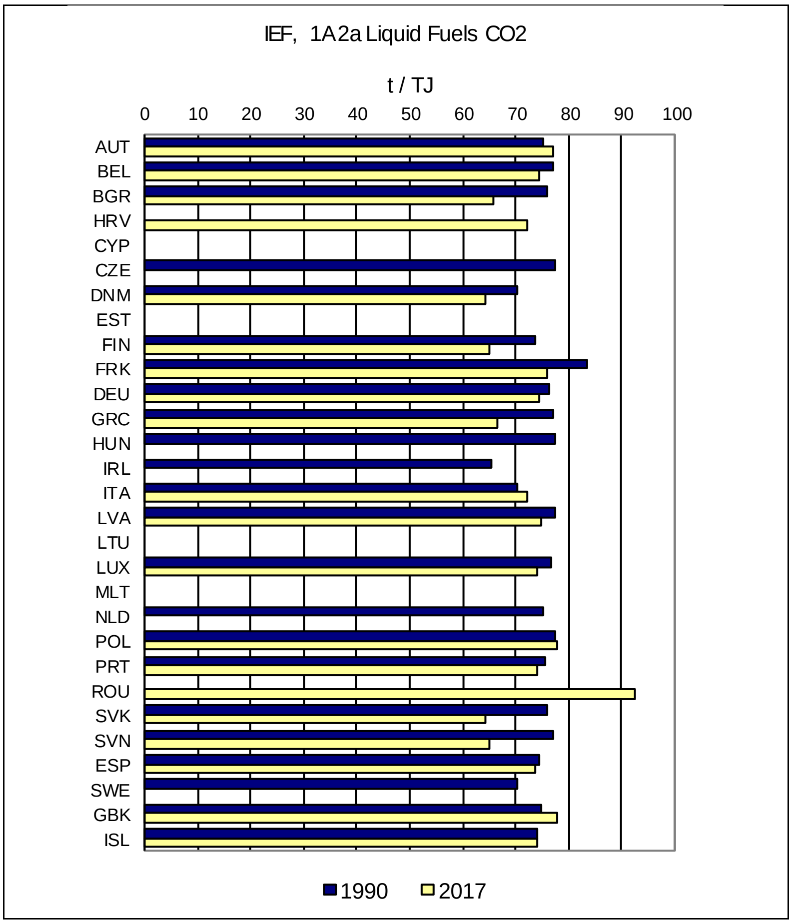
Figure 3.33: 1A2a Iron and Steel, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



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 3.34 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. Since 2015 Romania reports relatively high CO_2 IEF compared to other countries (CO_2 IEF is lower than IPCC upper default value). The comparatively high 2017 CO_2 IEF of Romania is caused by high share of petrol coke included in this category. For year 2017, Sweden reports activity data as C (‘confidential’) and thus CO_2 IEF is not depicted in Figure 3.34.

Figure 3.34: 1A2a Iron and Steel, Liquid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2a Iron and Steel - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1A2a amounted 79 619 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 44% and increased compared to 2016 by 4%. Category has 16% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption decreased by 47% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.25. Cyprus, Denmark, Estonia, Greece, Ireland, Latvia, Lithuania, Luxembourg, Malta and Island 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 100% of Member States emissions were calculated by using higher Tier methods or combination of methods in category 1A2a – Solid Fuels (CO_2)). All Member States reported lower level of emissions in 2017 than in 1990 (except of Germany with a 44% share on total EU-28+ISL emissions in 2017 and Slovakia with a 4% share on total EU-28+ISL emissions in 2017).

Table 3.25: 1A2a Iron and Steel, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	1 335	440	497	0.6%	-838	-63%	57	13%	T2	CS
Belgium	3 284	19	18	0.0%	-3 266	-99%	-1	-6%	T3	PS
Bulgaria	1 631	NO	0	0.0%	-1 631	-100%	0	∞	NA	NA
Croatia	IE	1	1	0.0%	1	∞	0	-23%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	13 709	1 289	1 566	2.0%	-12 143	-89%	278	22%	T2	CS,D
Denmark	5	NO	NO	-	-5	-100%	-	-	NA	NA
Estonia	3	2	NO	-	-3	-100%	-2	-100%	NA	NA
Finland	2 084	499	451	0.6%	-1 633	-78%	-48	-10%	T3	CS,PS
France	18 214	9 282	11 046	13.9%	-7 168	-39%	1 764	19%	T2,T3	CS,PS
Germany	29 912	34 167	34 940	43.9%	5 028	17%	773	2%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	625	61	86	0.1%	-539	-86%	25	42%	T1,T2	CS,D
Ireland	115	NO	NO	-	-115	-100%	-	-	NA	NA
Italy	19 955	6 858	5 434	6.8%	-14 521	-73%	-1 424	-21%	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	4 100	4 781	6.0%	-132	-3%	681	17%	T2	CS
Poland	11 817	3 947	4 586	5.8%	-7 231	-61%	639	16%	T1,T2	CS,D
Portugal	1 085	32	23	0.0%	-1 062	-98%	-9	-28%	T2	CR,D,PS
Romania	1 149	125	84	0.1%	-1 065	-93%	-41	-33%	T1,T2	CS,D
Slovakia	2 296	2 674	2 959	3.7%	663	29%	285	11%	T2	CS
Slovenia	57	25	28	0.0%	-29	-51%	3	13%	T1	D
Spain	6 475	3 877	4 108	5.2%	-2 367	-37%	231	6%	T1,T2	CS,PS
Sweden	849	462	581	0.7%	-268	-32%	118	26%	T2	CS
United Kingdom	18 610	9 022	8 429	10.6%	-10 180	-55%	-593	-7%	T2	CS
EU-28	**143 081**	**76 883**	**79 619**	**100%**	**-63 462**	**-44%**	**2 737**	**4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	18 610	9 022	8 429	10.6%	-10 180	-55%	-593	-7%	T2	CS
EU-28 + ISL	**143 081**	**76 883**	**79 619**	**100%**	**-63 462**	**-44%**	**2 737**	**4%**	**-**	**-**

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 3.35 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Germany (44%), France (14%), United Kingdom (11), Italy (7%), Netherland (6%) and Poland (6%) which together have 92% share on EU-28+ISL emissions.

Figure 3.35: 1A2a Iron and Steel, solid fuels: Emission trend and share for CO_2

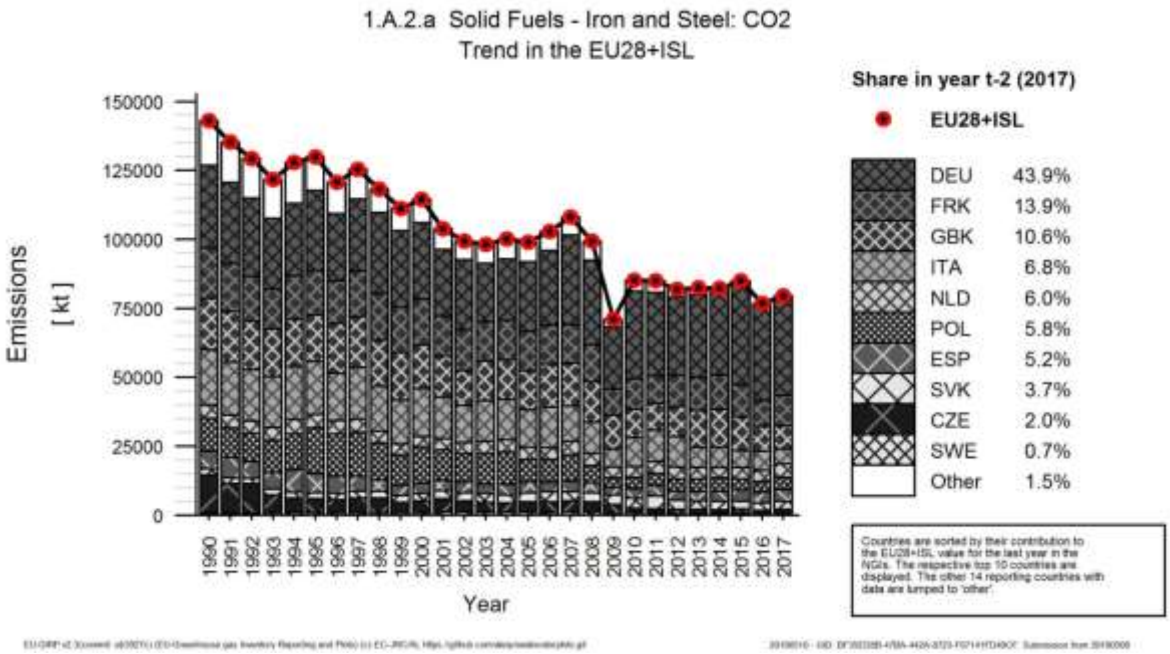


Figure 3.36 shows implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. It can be seen, that CO_2 IEF fluctuate during the whole time series. Lowest CO_2 IEF was calculated for year 2011 and since that CO_2 IEF has increasing but still fluctuating trend. CO_2 IEF equaled to 130.43 t/TJ in 2017.

Figure 3.36: 1A2a Iron and Steel, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

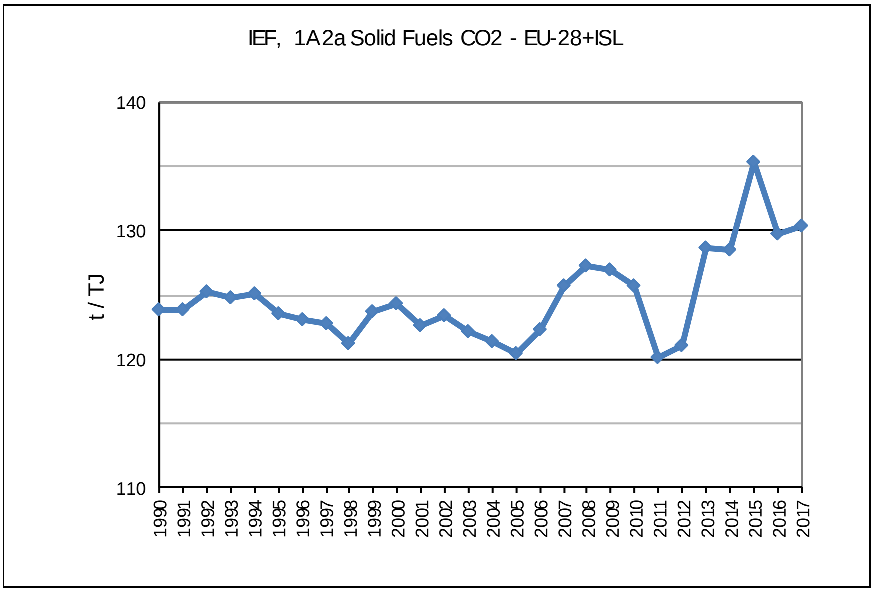
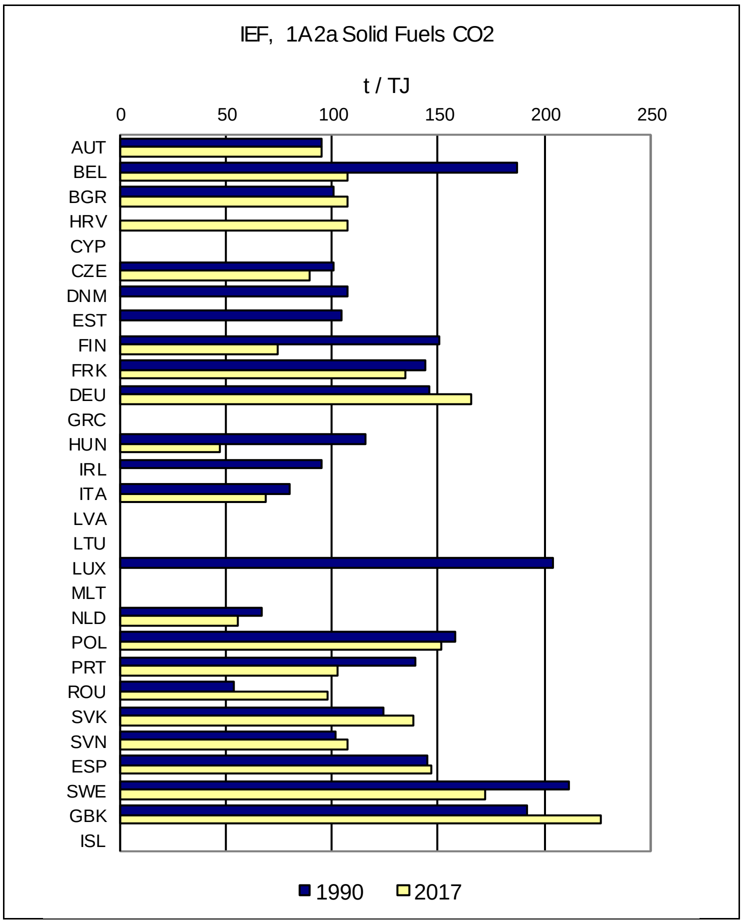


Figure 3.37 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. The high variation of the CO_2 IEFs across MS is due to usage of derived coal gases which have significant lower (coke oven gas) or higher carbon content (blast furnace gas) than coal.

Figure 3.37: 1A2a Iron and Steel, Solid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2a Iron and Steel - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1A2a amounted 18 989 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 39% and increased compared to 2016 by 4%. Category has 4% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption decreased by 39% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.26. Cyprus, Estonia, Lithuania, Malta and Island report emissions as 'NO' (not occurring). Two 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 99% of Member States emissions were calculated by using higher Tier methods or combination of methods in category 1A2a – Gaseous Fuels (CO_2)). Austria, Denmark, Finland, Spain and Sweden report higher level of emissions in 2017 than in 1990. Highest increase of emissions in comparing to the share of countries on EU-28+ISL emissions is calculated for Sweden.

Table 3.26: 1A2a Iron and Steel, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	650	938	1 066	5.6%	416	64%	129	14%	T2	CS
Belgium	1 493	1 135	1 174	6.2%	-319	-21%	38	3%	T1,T3	D,PS
Bulgaria	1 037	114	118	0.6%	-919	-89%	4	3%	T2	CS
Croatia	IE	25	27	0.1%	27	∞	1	6%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	724	514	628	3.3%	-96	-13%	114	22%	T2	CS
Denmark	107	105	110	0.6%	3	3%	4	4%	T3	CS
Estonia	NO	1	NO	-	-	-	-1	-100%	NA	NA
Finland	110	129	128	0.7%	18	16%	-1	-1%	T3	CS
France	2 028	1 720	1 656	8.7%	-373	-18%	-64	-4%	T2,T3	CS,PS
Germany	4 442	3 236	3 478	18.3%	-963	-22%	242	7%	CS	CS
Greece	NO	87	65	0.3%	65	∞	-22	-25%	T2	CS
Hungary	1 324	109	113	0.6%	-1 211	-91%	4	4%	T1	D
Ireland	44	2	2	0.0%	-41	-95%	0	0%	T2	CS
Italy	4 279	4 150	3 894	20.5%	-385	-9%	-257	-6%	T2	CS
Latvia	236	3	0	0.0%	-235	-100%	-2	-87%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	397	267	267	1.4%	-130	-33%	-1	0%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	667	609	642	3.4%	-25	-4%	33	5%	T2	CS
Poland	2 924	1 081	1 314	6.9%	-1 610	-55%	233	22%	T2	CS
Portugal	NO	88	93	0.5%	93	∞	5	6%	T2	CR,D,PS
Romania	6 665	1 134	1 135	6.0%	-5 530	-83%	1	0%	T2	CS
Slovakia	221	111	127	0.7%	-95	-43%	16	14%	T2	CS
Slovenia	310	173	182	1.0%	-127	-41%	9	5%	T2	CS
Spain	778	1 549	1 744	9.2%	966	124%	194	13%	T2	CS,PS
Sweden	25	177	181	1.0%	155	616%	4	2%	T2	CS
United Kingdom	2 463	889	847	4.5%	-1 616	-66%	-42	-5%	T2	CS
EU-28	**30 921**	**18 346**	**18 989**	**100%**	**-11 933**	**-39%**	**643**	**4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 463	889	847	4.5%	-1 616	-66%	-42	-5%	T2	CS
EU-28 + ISL	**30 921**	**18 346**	**18 989**	**100%**	**-11 933**	**-39%**	**643**	**4%**	**-**	**-**

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 3.38 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Italy (21%), Germany (18%), Spain (9%), France (9%), Poland (7%), Belgium (6%), Romania (6%), Austria (6%) and United Kingdom (4%) which together have 86% share on EU-28+ISL emissions.

Figure 3.38: 1A2a Iron and Steel, Gaseous fuels: Emission trend and share for CO_2

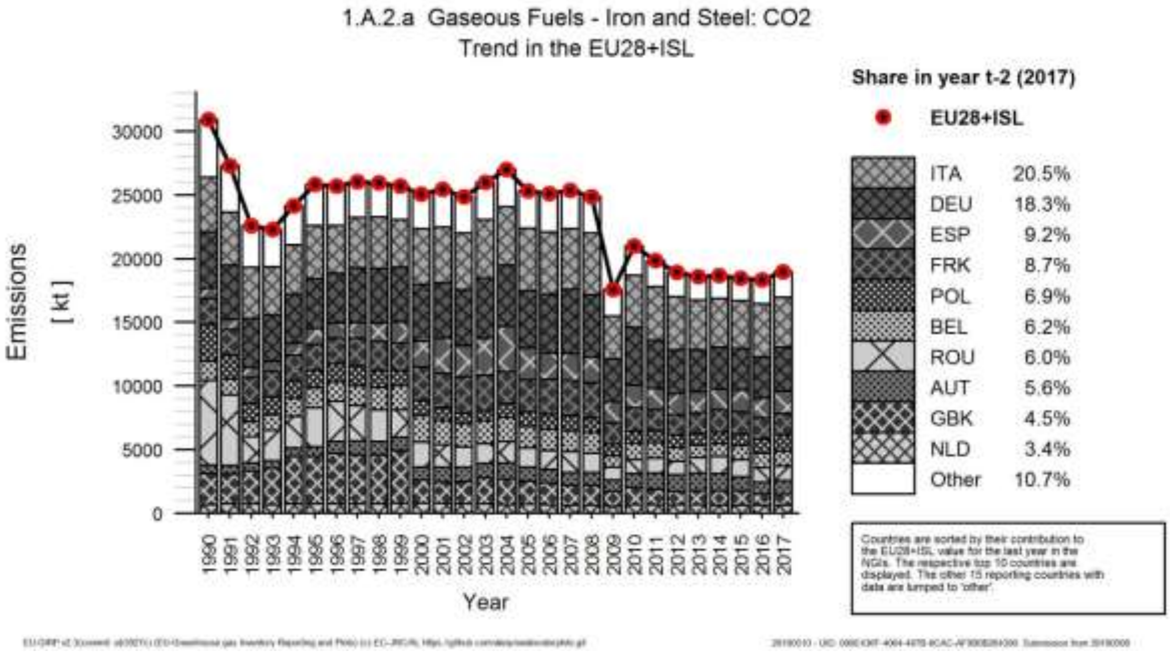


Figure 3.39 shows implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. It can be seen, that the CO_2 IEF is fluctuating but the fluctuation is not as noticeable as in the case of CO_2 IEF calculated for solid fuels. The increased CO_2 IEF factor from 2008 onwards was mainly caused due to NGL (Natural gas liquids) imports by Italy (e.g. from Oman) which has a significantly higher propane-butane content than natural gas which comes from pipeline systems. Since 2015, CO_2 IEF has again increasing trend. CO_2 IEF equaled to 56.20 t/TJ in 2017.

Figure 3.39: 1A2a Iron and Steel, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

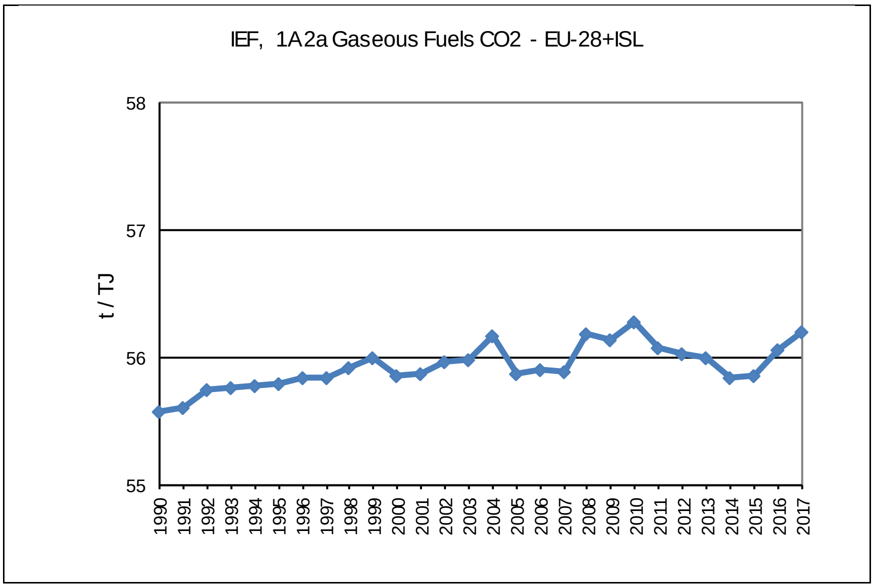
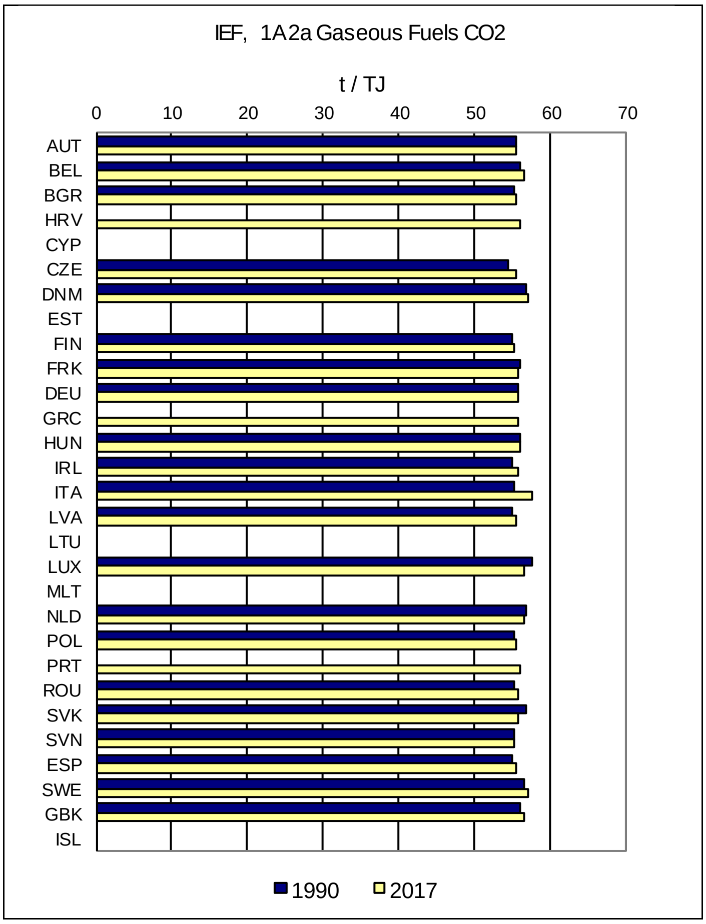


Figure ***3.40*** shows comparison of implied emission factors (CO_2 IEFs) used by Member States and Island for emission estimates in 1990 and 2017. No significant differences between CO_2 IEF used by

EU-28+ISL are not occurring as also no significant differences between CO_2 IEF used in 1990 and 2017 are occurring.

***Figure 3.40**: 1A2a Iron and Steel, Gaseous fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)*



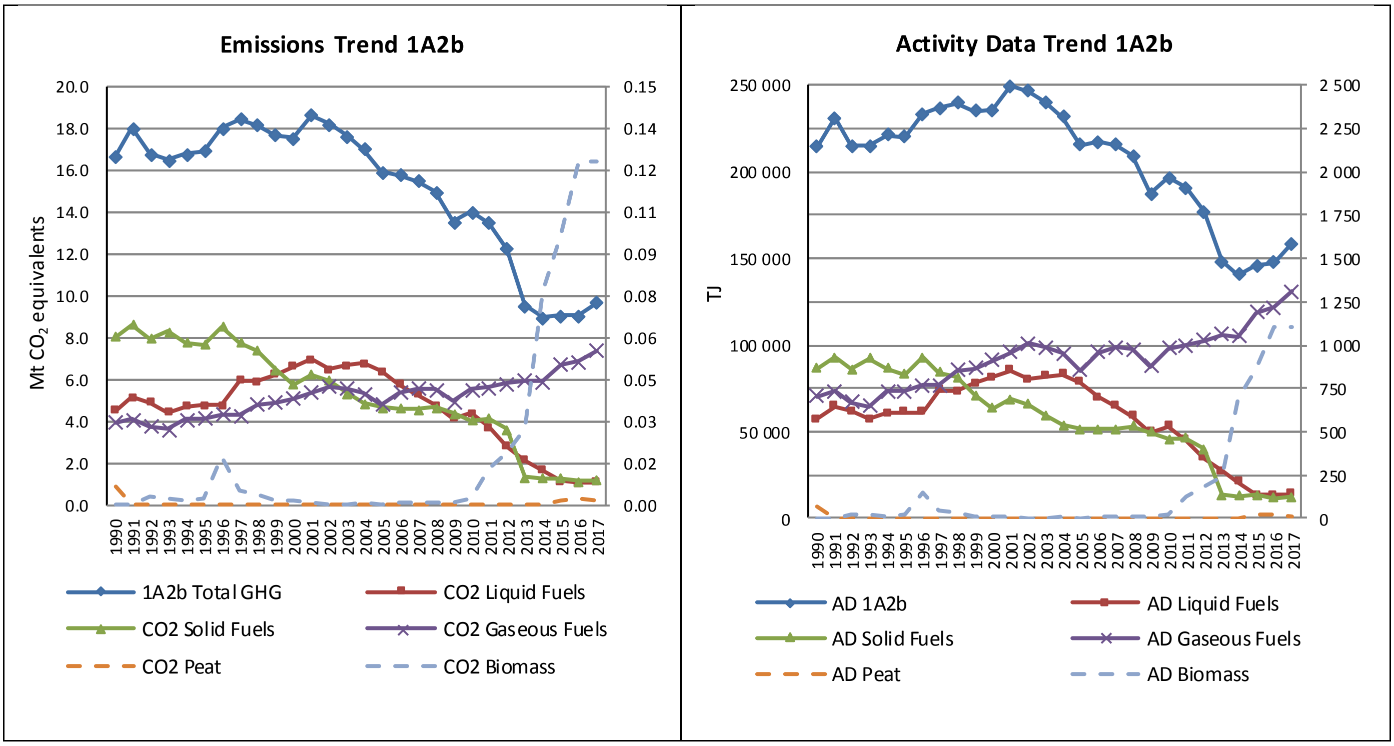
3.2.2.1 Non Ferrous Metals (1A2b)

This chapter provides information about European emission trend, Member States contribution to the overall emission trend, activity data and emission factors used for emission estimates by Member States and Island for category 1A2b Non Ferrous Metals.

Total CO_2 emissions from 1A2b amounted to 9 625 kt CO_2 eq. in 2017. The trend of total emissions for 1990 to 2017 from category 1A2b is depicted in Figure 3.41. Total CO_2 emissions decreased by 42% since 1990 and increased by 7% between 2016 and 2017. Total CO_2 emissions from 1A2b Non Ferrous Metals accounted for 2% of 1A2 source category.

Figure 12 shows the emission trend within the category 1A2b, which is dominated by CO_2 emissions from gaseous fuels in 2017. The share of liquid fuels on CO_2 emissions from 1A2b decreased from 27% in 1990 to 11% in 2017. The share of solid fuels on CO_2 emissions from 1A2b decreased from 49% in 1990 to 12% in 2017. The share of gaseous fuels on CO_2 emissions from 1A2b increased from 24% in 1990 to 76% in 2017.

Figure 3.41: 1A2b 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-28+ISL submissions are depicted in Table.3.27. Denmark, Lithuania, Malta, Portugal and Romania report emissions as ‘NO’ (not occurring) or ‘IE’ (included elsewhere). Seven 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 Austria.

Table.3.27: 1A2b Non-ferrous Metals: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	132	289	315	3.3%	183	139%	26	9%	T1,T2	CS,D
Belgium	629	446	479	5.0%	-150	-24%	33	7%	T1	D
Bulgaria	299	164	176	1.8%	-123	-41%	12	7%	T1,T2	CS,D
Croatia	NO,IE	11	21	0.2%	21	∞	10	94%	T1	D
Cyprus	5	6	2	0.0%	-3	-56%	-4	-65%	T1	D
Czech Republic	102	135	144	1.5%	42	41%	9	7%	T1,T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	3	4	0.0%	4	∞	1	50%	T2	CS
Finland	337	102	97	1.0%	-239	-71%	-4	-4%	T3	CS,D
France	2 450	992	893	9.3%	-1 557	-64%	-99	-10%	T2,T3	CS,PS
Germany	1 377	168	328	3.4%	-1 048	-76%	160	95%	CS	CS
Greece	582	562	759	7.9%	177	30%	197	35%	T2	CS,PS
Hungary	239	175	195	2.0%	-44	-19%	20	11%	T1	D
Ireland	809	1 390	1 402	14.6%	593	73%	12	1%	T1,T2	CS,D
Italy	728	1 054	1 073	11.2%	346	48%	19	2%	T2	CS
Latvia	NO	2	1	0.0%	1	∞	-1	-31%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	28	51	54	0.6%	25	90%	3	6%	T2	CS
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Netherlands	214	157	175	1.8%	-39	-18%	18	11%	T2	CS
Poland	1 085	1 099	1 139	11.8%	53	5%	40	4%	T1,T2	CS,D
Portugal	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Romania	73	NO,IE	NO,IE	-	-73	-100%	-	-	NA	NA
Slovakia	1 256	113	123	1.3%	-1 133	-90%	10	9%	T2	CS
Slovenia	439	103	127	1.3%	-312	-71%	24	23%	T1,T2	CS,D
Spain	1 323	1 192	1 276	13.3%	-46	-3%	84	7%	T1,T2	CS,D,PS
Sweden	128	101	101	1.0%	-27	-21%	0	0%	T2	CS
United Kingdom	4 332	712	732	7.6%	-3 600	-83%	21	3%	T2	CS
EU-28	**16 566**	**9 027**	**9 617**	**100%**	**-6 948**	**-42%**	**590**	**7%**	**-**	**-**
Iceland	14	6	8	0.1%	-6	-43%	2	34%	T1	D
United Kingdom (KP)	4 332	712	732	7.6%	-3 600	-83%	21	3%	T2	CS
EU-28 + ISL	**16 579**	**9 033**	**9 625**	**100%**	**-6 954**	**-42%**	**592**	**7%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g. Malta and Portugal include emissions under 1.A.2.g.*Romania includes emissions under 1.A.2.a.*

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

1A2b Non-Ferrous Metals - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1A2b amounted 1 084 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 76% and compared to 2016 increased by 3%. Category has 0.2% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption decreased by 76% 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-28+ISL submissions are depicted in *Table 3.28*. Czechia, Denmark, Estonia, Latvia, Lithuania, Luxemburg and Netherlands report emissions as 'NO' (not occurring). Malta, Portugal and Romania report emissions as 'IE' (included elsewhere). Seven Member States and Iceland use for emission estimates Tier 1 methodology (as it is calculated in chapter 3.2.1 approximately 84% of Member States were calculated by using higher Tier methods or combination of methods in category 1A2b – Liquid Fuels (CO_2)). All Member States reported lower level of emissions in 2017 than in 1990 (except of Germany and Italy).

Table 3.28: 1A2b Non-ferrous Metals, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	35	19	18	1.7%	-17	-48%	-1	-4%	T2	CS
Belgium	220	49	50	4.6%	-171	-78%	1	1%	T1	D
Bulgaria	199	40	36	3.4%	-163	-82%	-3	-8%	T1	D
Croatia	IE	5	2	0.2%	2	∞	-3	-51%	T1	D
Cyprus	5	6	2	0.2%	-3	-56%	-4	-65%	T1	D
Czech Republic	3	NO	NO	-	-3	-100%	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	0	NO	-	-	-	0	-100%	NA	NA
Finland	173	73	73	6.7%	-100	-58%	0	0%	T3	CS
France	698	135	64	5.9%	-635	-91%	-72	-53%	T2,T3	CS,PS
Germany	144	123	282	26.0%	138	96%	159	129%	CS	CS
Greece	582	12	23	2.1%	-559	-96%	11	95%	T2	PS
Hungary	143	NO	3	0.3%	-140	-98%	3	∞	T1	D
Ireland	766	24	23	2.1%	-743	-97%	-1	-3%	T1,T2	CS,D
Italy	18	111	42	3.9%	24	137%	-69	-62%	T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	15	NO	NO	-	-15	-100%	-	-	NA	NA
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	62	31	51	4.7%	-11	-17%	20	64%	T1	D
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	IE	IE	IE	-	-	-	-	-	NA	NA
Slovakia	23	8	6	0.6%	-17	-72%	-1	-17%	T2	CS
Slovenia	120	18	18	1.7%	-102	-85%	1	3%	T1	D
Spain	1 063	302	295	27.2%	-768	-72%	-7	-2%	T1,T2	CS,D,PS
Sweden	110	85	84	7.8%	-26	-23%	0	0%	T2	CS
United Kingdom	134	2	2	0.2%	-132	-99%	0	-3%	T2	CS
EU-28	**4 515**	**1 043**	**1 076**	**99%**	**-3 439**	**-76%**	**34**	**3%**	**-**	**-**
Iceland	14	6	8	0.7%	-6	-43%	2	34%	T1	D
United Kingdom (KP)	134	2	2	0.2%	-132	-99%	0	-3%	T2	CS
EU-28 + ISL	**4 529**	**1 048**	**1 084**	**100%**	**-3 445**	**-76%**	**35**	**3%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Portugal and Malta include emissions under 1A2g. Romania includes emissions under 1A2a.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.42 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Spain (27%), Germany (26%), Sweden (8%), Finland (7%) and France (6%) which together have 74% share on EU-28+ISL emissions.

Figure 3.42: 1A2b Non-ferrous Metals, liquid fuels: Emission trend and share for CO_2

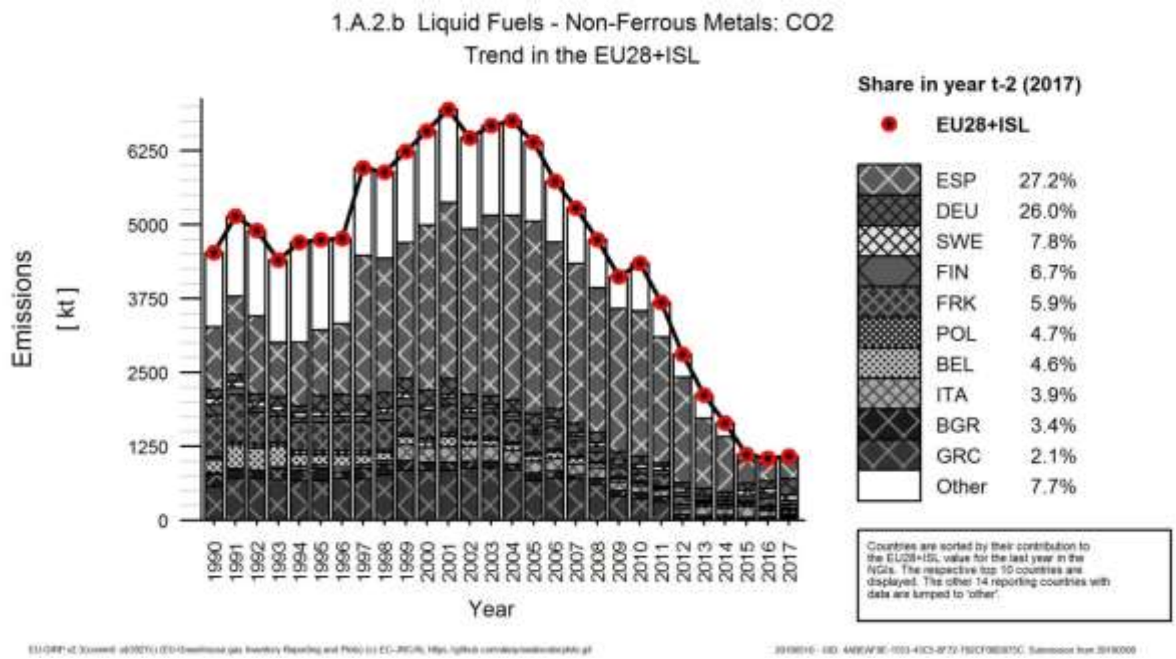


Figure 3.43 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. It can be seen, that CO_2 IEF fluctuated at the beginning of the time series and since 2013 shows major fluctuations. The peak in the 2015 implied emission factor, as presented in the figure below, occurs because Sweden reported activity data as confidential. CO_2 IEF equaled to 77.67 t/TJ in 2017.

Figure 3.43: 1A2b Non-ferrous Metals, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

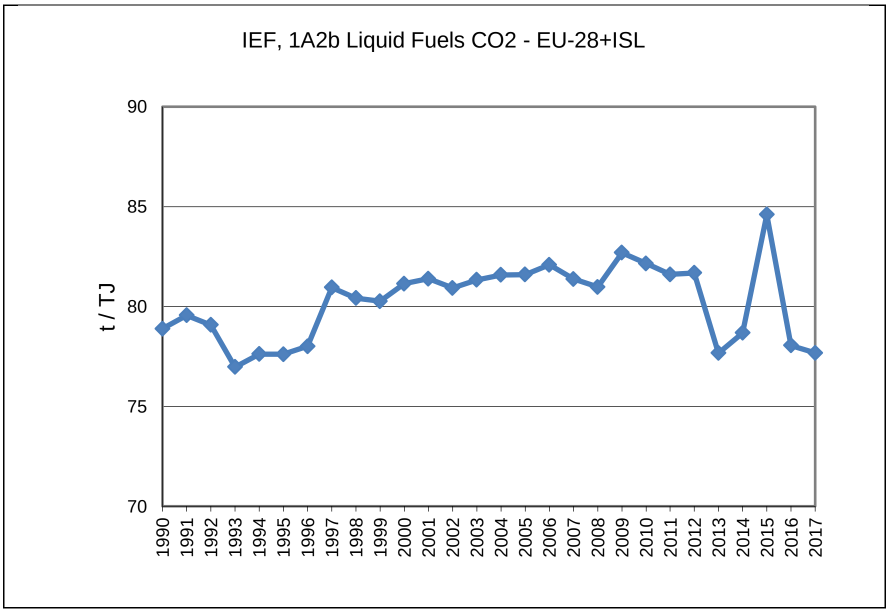
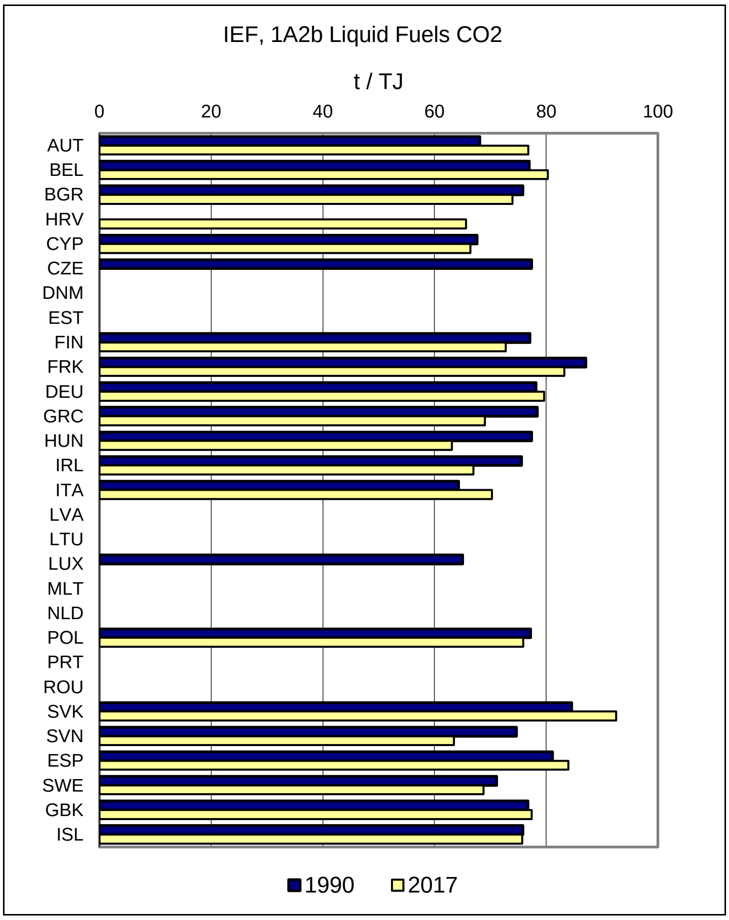


Figure 3.44 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. Particularly higher implied CO_2 emission factors are due to the use of petrol coke, which has significantly higher carbon content than liquid oil products.

Figure 3.44: 1A2b Non-ferrous Metals, liquid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2b Non-Ferrous Metals - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1A2b amounted 1 176 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 85% and compared to 2016 increased by 4%. Category has 0.2% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption decreased by 86% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.29. Twelve countries and Island 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 Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 91% of Member States were calculated by using higher Tier methods or combination of methods in category 1A2b – Solid Fuels (CO_2)). All Member States reported lower level of emissions in 2017 than in 1990.

Table 3.29: 1A2b Non-ferrous Metals, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	22	14	20	1.7%	-2	-10%	6	46%	T2	CS
Belgium	147	89	101	8.6%	-46	-31%	13	14%	T1	D
Bulgaria	76	50	49	4.1%	-28	-36%	-1	-2%	T1,T2	CS,D
Croatia	NO	1	NO	-	-	-	-1	-100%	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	46	12	16	1.3%	-30	-66%	4	29%	T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	3	0.2%	3	∞	3	∞	T2	CS
Finland	155	25	21	1.8%	-134	-87%	-4	-15%	T3	CS
France	904	2	2	0.1%	-903	-100%	-1	-25%	T2,T3	CS,PS
Germany	1 233	45	46	3.9%	-1 187	-96%	1	2%	CS	CS
Greece	IE	IE	IE	-	-	-	-	-	NA	NA
Hungary	9	NO	NO	-	-9	-100%	-	-	NA	NA
Ireland	4	NO	NO	-	-4	-100%	-	-	NA	NA
Italy	152	NO	NO	-	-152	-100%	-	-	NA	NA
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	0	NO	NO	-	0	-100%	-	-	NA	NA
Poland	706	666	669	56.9%	-37	-5%	3	0%	T1,T2	CS,D
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	73	IE	IE	-	-73	-100%	-	-	NA	NA
Slovakia	798	36	46	3.9%	-752	-94%	10	27%	T2	CS
Slovenia	154	5	6	0.5%	-149	-96%	1	16%	T1,T2	CS,D
Spain	188	69	72	6.2%	-115	-61%	3	5%	T1,T2	CS,D
Sweden	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom	3 379	118	126	10.7%	-3 253	-96%	9	7%	T2	CS
EU-28	**8 054**	**1 131**	**1 176**	**100%**	**-6 879**	**-85%**	**45**	**4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 379	118	126	10.7%	-3 253	-96%	9	7%	T2	CS
EU-28 + ISL	**8 054**	**1 131**	**1 176**	**100%**	**-6 879**	**-85%**	**45**	**4%**	**-**	**-**

Portugal includes emissions under 1A2g. Romania includes emissions under 1A2a.
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 3.45 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Poland (57%), United Kingdom (11%) and Belgium (9%) which together have 76% share on EU-28+ISL emissions.

Figure 3.45: 1A2b Non-ferrous Metals, solid fuels: Emission trend and share for CO_2

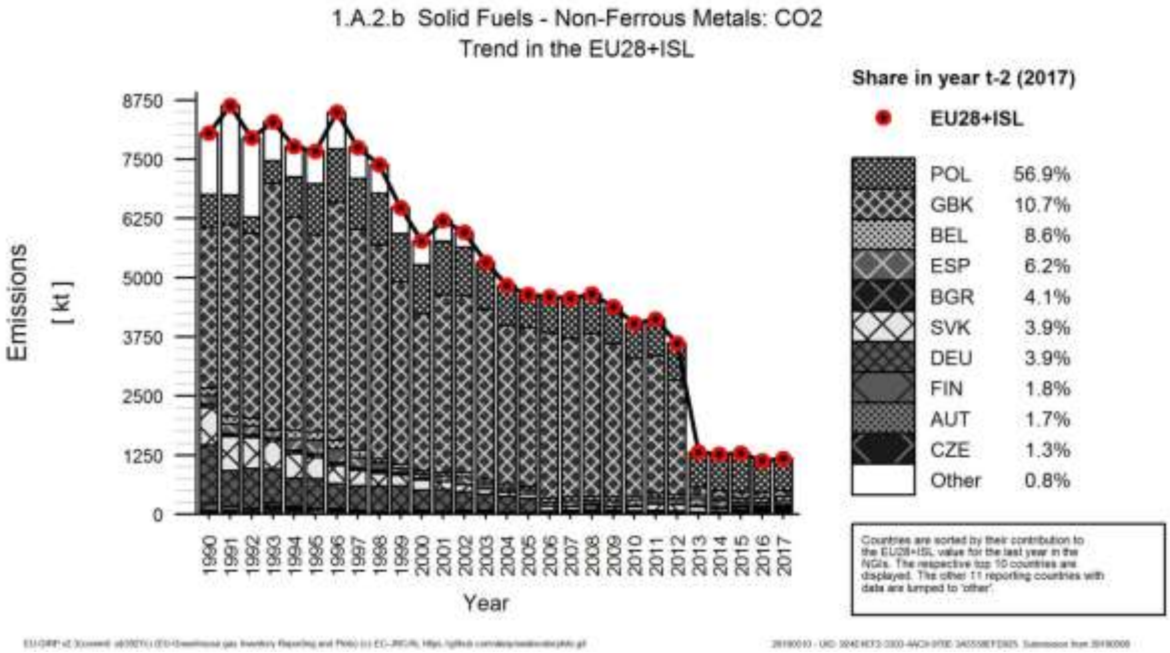


Figure 3.46 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. Since the beginning of the time series, the CO_2 IEF had relatively decreasing trend. In 2013 CO_2 IEF increased rapidly. The reason for the increase of the CO_2 IEF in 2013 is the reallocation of the UK power plant. The CO_2 IEF increased in 2014 compared to 2013 because of the growing weight in EU emissions and Poland having a higher IEF than the UK). CO_2 IEF equaled to 96.59 t/TJ in 2017.

Figure 3.46: 1A2b Non-ferrous Metals, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

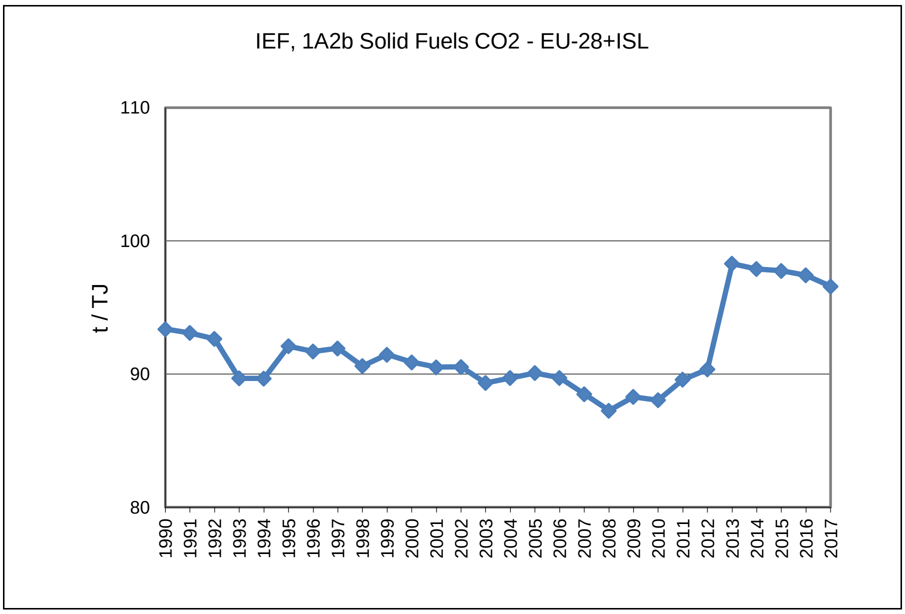
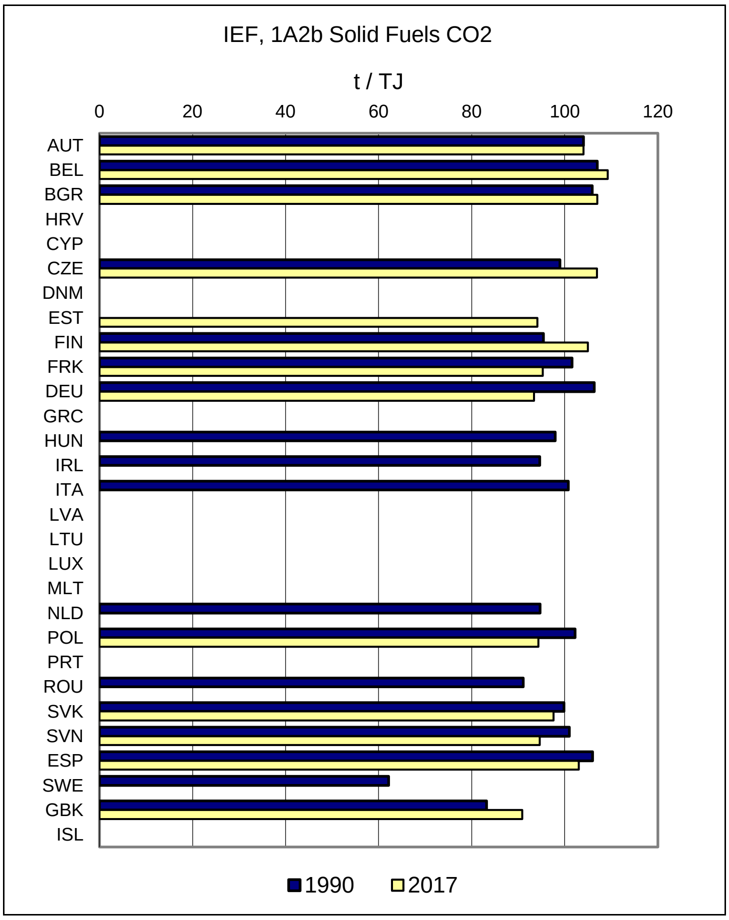


Figure 3.47 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017.

Figure 3.47: 1A2b Non-ferrous Metals, solid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2b Non-Ferrous Metals - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1A2b amounted 7 363 kt in 2017 for EU-28+ISL. CO_2 emissions increased compared to year 1990 by 88% and compared to 2016 by 7%. Category has 1% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption increased by 86% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.30. Cyprus, Denmark, Lithuania, Malta and Island report emissions as 'NO' (not occurring). Three 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 Member States were calculated by using higher Tier methods or combination of methods in category 1A2b – Gaseous Fuels (CO_2)). Five Member States reported lower level of emissions in 2017 than in 1990. Most rapid increase of emissions was reported by Ireland (3474%); Ireland has also the highest share on total CO_2 emissions from 1A2b – Gaseous Fuels (CO_2).

Table 3.30: 1A2b Non-ferrous Metals, Gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	75	256	276	3.7%	201	268%	20	8%	T2	CS
Belgium	261	307	328	4.5%	67	26%	20	7%	T1	D
Bulgaria	23	75	91	1.2%	68	290%	16	21%	T2	CS
Croatia	IE	5	18	0.2%	18	∞	13	260%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	53	123	129	1.7%	76	142%	5	4%	T2	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	3	2	0.0%	2	∞	-1	-26%	T2	CS
Finland	NO	3	3	0.0%	3	∞	0	1%	T3	CS
France	848	854	828	11.2%	-20	-2%	-27	-3%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	550	736	10.0%	736	∞	186	34%	T2	CS
Hungary	87	175	192	2.6%	105	120%	17	10%	T1	D
Ireland	39	1 366	1 378	18.7%	1 340	3474%	12	1%	T2	CS
Italy	558	943	1 031	14.0%	473	85%	88	9%	T2	CS
Latvia	NO	2	1	0.0%	1	∞	-1	-28%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	13	51	54	0.7%	40	302%	3	6%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	213	157	175	2.4%	-39	-18%	18	11%	T2	CS
Poland	254	401	419	5.7%	164	65%	17	4%	T2	CS
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	IE	IE	IE	-	-	-	-	-	NA	NA
Slovakia	435	68	70	1.0%	-364	-84%	2	3%	T2	CS
Slovenia	164	80	103	1.4%	-61	-37%	23	28%	T2	CS
Spain	72	821	909	12.3%	837	1169%	88	11%	T2	CS
Sweden	10	16	17	0.2%	6	59%	0	2%	T2	CS
United Kingdom	819	592	604	8.2%	-215	-26%	12	2%	T2	CS
EU-28	**3 925**	**6 850**	**7 363**	**100%**	**3 438**	**88%**	**513**	**7%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	819	592	604	8.2%	-215	-26%	12	2%	T2	CS
EU-28 + ISL	**3 925**	**6 850**	**7 363**	**100%**	**3 438**	**88%**	**513**	**7%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Portugal includes emissions under 1A2g Romania includes emissions under 1A2a. Germany reported emissions under 1A2g other (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 3.48 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Ireland (19%), Italy (14%), Spain (12%), France (11%), Greece (10%), United Kingdom (8%) and Poland (6%) which together have 80% share on EU-28+ISL emissions.

Figure 3.48: 1A2b Non-ferrous Metals, Gaseous fuels: Emission trend and share for CO_2

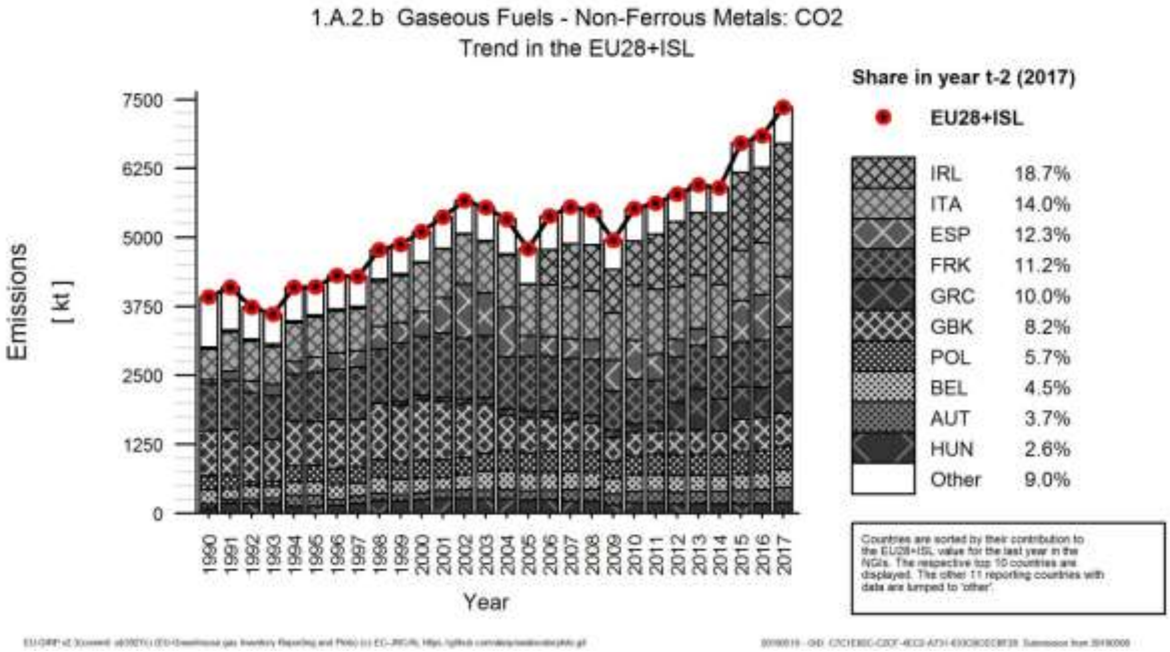


Figure 3.49 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. It can be seen that CO_2 IEF has stable trend for the whole time series. CO_2 IEF equaled to 56.21 t/TJ in 2017.

Figure 3.49: 1A2b Non-ferrous Metals, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

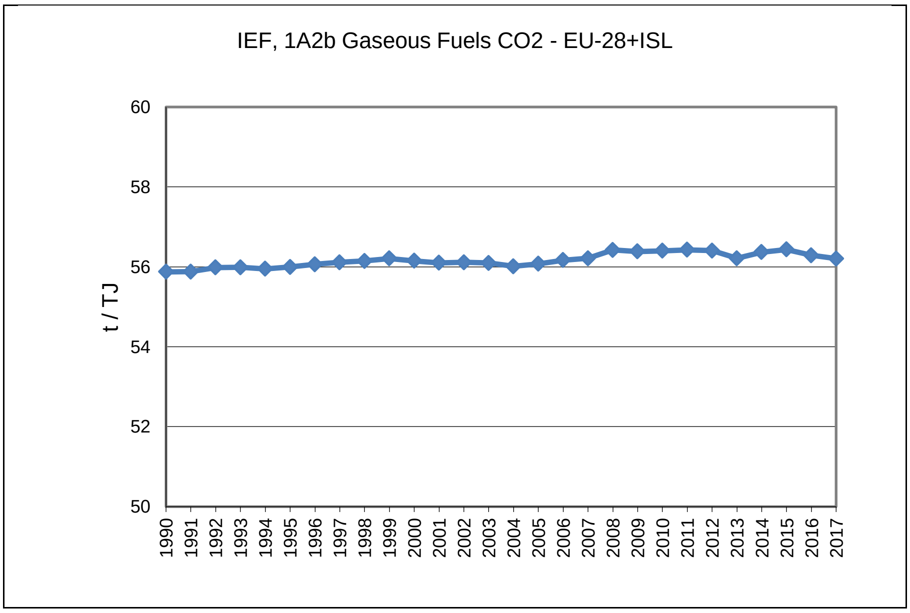
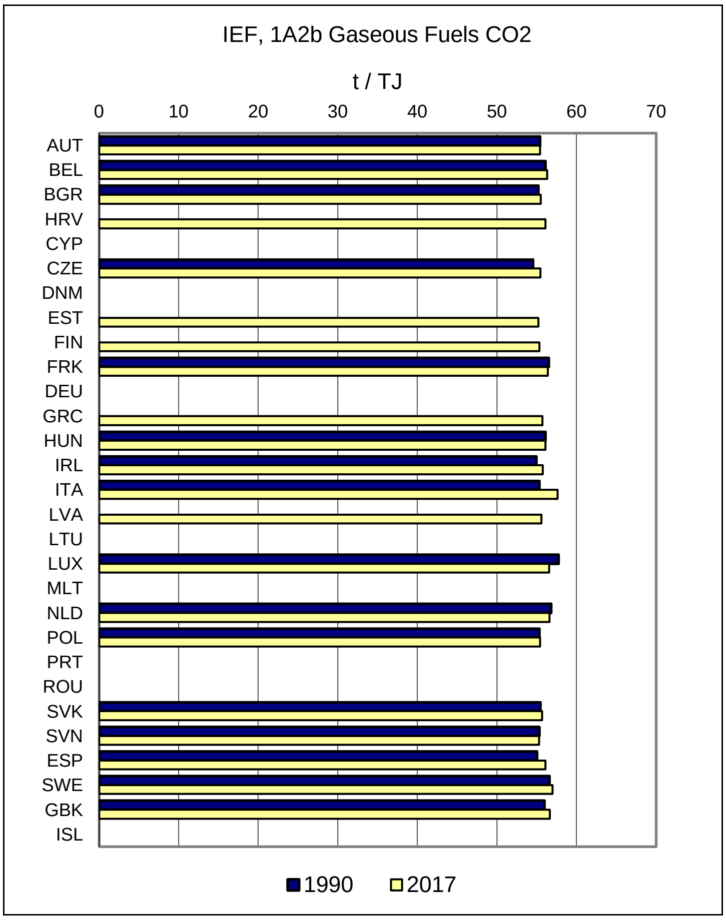


Figure 3.50 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. No significant differences between CO_2 IEF used by EU-28+ISL are not occurring as also no significant differences between CO_2 IEF used in 1990 and 2017 are occurring.

Figure 3.50: 1A2b Non-ferrous Metals, Gaseous fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



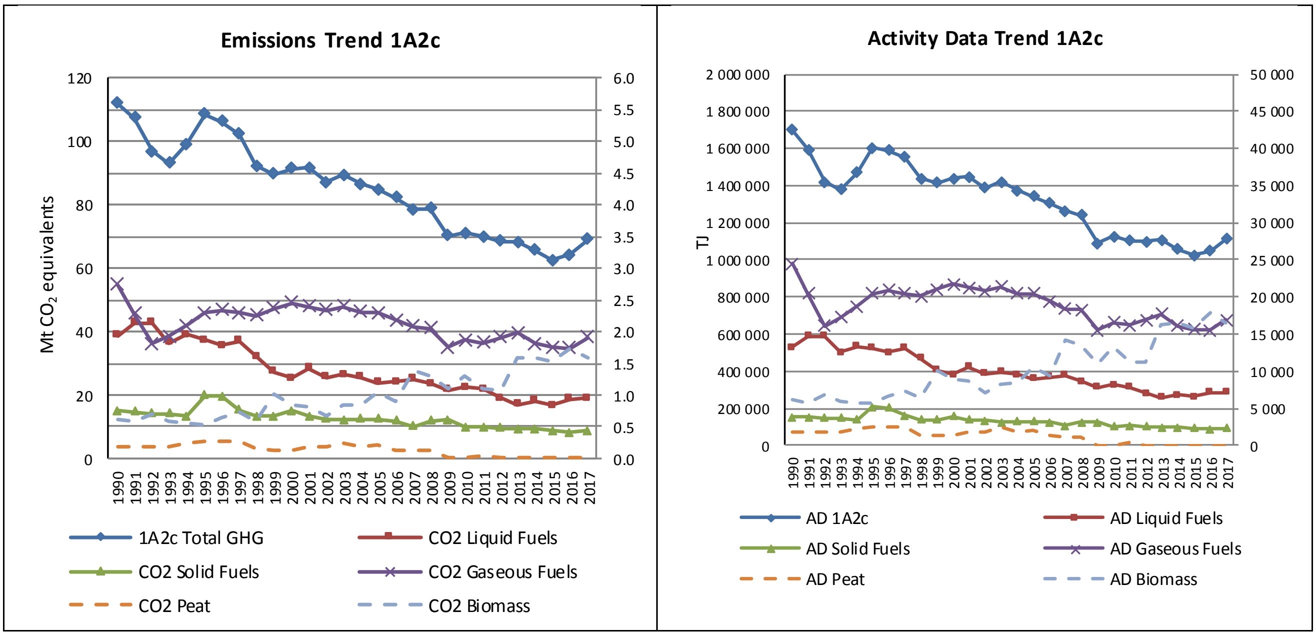
3.2.2.2 Chemicals (1A2c)

This chapter provides information about European emission trend, Member States contribution to the overall emission trend, activity data and emission factors used for emission estimates by Member States and Island for category 1A2c Chemicals.

Total CO_2 emissions from 1A2c amounted to 68 443 kt CO_2 eq. in 2017. The trend of total CO_2 emissions for 1990 to 2017 from category 1A2c is depicted in Figure 3.51. CO_2 emissions decreased by 39% since 1990 and increased by 7% between 2016 and 2017. CO_2 emissions from 1A2c Chemicals accounted for 14% of 1A2 source category.

Figure 12 shows the emission trend within the category 1A2c, which is dominated by CO_2 emissions from gaseous fuels in 2017. The share of liquid fuels on CO_2 emissions from 1A2c decreased from 35% in 1990 to 28% in 2017. The share of solid fuels on CO_2 emissions from 1A2c remains similar in 2017 as in 1990 (approximately 13%). The share of gaseous fuels on CO_2 emissions from 1A2c increased from 49% in 1990 to 56% in 2017.

Figure 3.51: 1A2c 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-28+ISL submissions are depicted in Table 3.31. Germany, Malta and Iceland report emissions as ‘NO’ (not occurring) or ‘IE’ (included elsewhere). 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-28+ISL emissions is minor compared to for example Poland, Sweden and Austria which reported significant increase of emissions and have also high share on total EU-28+ISL emissions).

Table 3.31: 1A2c Chemicals: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	896	1 578	1 711	2.5%	816	91%	133	8%	T1,T2	CS,D
Belgium	4 786	3 154	3 297	4.8%	-1 488	-31%	143	5%	T1,T3	D,PS
Bulgaria	967	381	1 013	1.5%	45	5%	632	166%	T1,T2	CS,D
Croatia	NO,IE	296	332	0.5%	332	∞	36	12%	T1	D
Cyprus	2	6	4	0.0%	2	102%	-2	-29%	T1	D
Czechia	2 996	1 362	1 901	2.8%	-1 095	-37%	539	40%	T1,T2	CS,D
Denmark	328	350	360	0.5%	32	10%	10	3%	T1,T2,T3	CS,D
Estonia	806	8	15	0.0%	-791	-98%	7	88%	T1,T2	CS,D
Finland	1 245	787	676	1.0%	-569	-46%	-111	-14%	T3	CS,D
France	15 228	10 801	10 658	15.6%	-4 570	-30%	-144	-1%	T2,T3	CS,PS
Germany	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Greece	808	92	266	0.4%	-542	-67%	174	189%	T2	CS
Hungary	1 540	389	409	0.6%	-1 131	-73%	20	5%	T1,T3	D,PS
Ireland	410	276	280	0.4%	-130	-32%	5	2%	T2	CS
Italy	19 424	8 917	9 512	13.9%	-9 912	-51%	595	7%	T2	CS
Latvia	294	30	34	0.0%	-259	-88%	4	15%	T1,T2	CS,D
Lithuania	399	268	274	0.4%	-126	-31%	6	2%	T2	CS
Luxembourg	170	147	144	0.2%	-26	-15%	-3	-2%	T1,T2	CS,D
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Netherlands	17 276	13 857	14 511	21.2%	-2 764	-16%	655	5%	T2	CS,D
Poland	4 016	5 969	6 268	9.2%	2 253	56%	300	5%	T1,T2	CS,D
Portugal	1 346	1 031	1 097	1.6%	-250	-19%	65	6%	T1,T3	D,PS
Romania	17 871	1 623	1 845	2.7%	-16 026	-90%	222	14%	T1,T2	CS,D
Slovakia	2 652	502	514	0.8%	-2 138	-81%	13	3%	T2	CS
Slovenia	209	71	68	0.1%	-142	-68%	-4	-5%	T1,T2	CS,D
Spain	5 322	6 329	7 492	10.9%	2 170	41%	1 162	18%	T1,T2	CS,D,PS
Sweden	629	569	451	0.7%	-177	-28%	-118	-21%	T2	CS
United Kingdom	12 077	4 918	5 310	7.8%	-6 768	-56%	392	8%	T2	CS
EU-28	**111 697**	**63 711**	**68 443**	**100%**	**-43 255**	**-39%**	**4 731**	**7%**	**-**	**-**
Iceland	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom (KP)	12 077	4 918	5 310	7.8%	-6 768	-56%	392	8%	T2	CS
EU-28 + ISL	**111 705**	**63 711**	**68 443**	**100%**	**-43 262**	**-39%**	**4 731**	**7%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany and Malta are included in 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A2c Chemicals - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1A2c amounted 18 997 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 51% and compared to 2016 increased by 2%. Category has 4% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption decreased by 46% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.32. Only Island reports emissions as 'NO' (not occurring). Eight 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 91% of Member States were calculated by using higher Tier methods or combination of methods in category 1A2c – Liquid Fuels (CO_2)). Cyprus, Netherland and Poland reported higher level of emissions in 2017 than in 1990.

Table 3.32: 1A2c Chemicals, Liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	97	42	44	0.2%	-53	-55%	2	5%	T2	CS
Belgium	1 852	158	171	0.9%	-1 681	-91%	12	8%	T1	D
Bulgaria	857	93	595	3.1%	-262	-31%	502	542%	T1	D
Croatia	IE	12	9	0.0%	9	∞	-3	-24%	T1	D
Cyprus	2	6	4	0.0%	2	102%	-2	-29%	T1	D
Czechia	175	42	117	0.6%	-58	-33%	75	180%	T1	D
Denmark	211	2	0	0.0%	-211	-100%	-2	-97%	T1,T2	CS,D
Estonia	13	6	6	0.0%	-7	-55%	0	0%	T1,T2	CS,D
Finland	731	701	560	2.9%	-171	-23%	-141	-20%	T3	CS
France	6 233	2 927	2 398	12.6%	-3 835	-62%	-529	-18%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	639	59	47	0.2%	-592	-93%	-12	-21%	T2	CS
Hungary	380	3	6	0.0%	-374	-98%	3	107%	T1	D
Ireland	131	83	87	0.5%	-44	-33%	4	5%	T2	CS
Italy	11 218	4 010	4 199	22.1%	-7 020	-63%	189	5%	T2	CS
Latvia	270	8	9	0.0%	-261	-97%	1	12%	T2	CS
Lithuania	69	2	3	0.0%	-66	-96%	1	80%	T2	CS
Luxembourg	112	0	0	0.0%	-112	-100%	0	41%	T1,T2	CS,D
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	6 493	7 824	7 795	41.0%	1 302	20%	-30	0%	T2	CS,D
Poland	306	622	792	4.2%	485	158%	170	27%	T1	D
Portugal	1 308	703	701	3.7%	-607	-46%	-2	0%	T1,T3	D,PS
Romania	NO	505	598	3.1%	598	∞	93	18%	T1,T2	D
Slovakia	51	7	5	0.0%	-47	-91%	-3	-36%	T2	CS
Slovenia	32	13	10	0.1%	-22	-68%	-3	-24%	T1	D
Spain	2 852	368	446	2.3%	-2 406	-84%	77	21%	T1,T2	CS,D
Sweden	341	424	305	1.6%	-36	-11%	-119	-28%	T2	CS
United Kingdom	4 392	86	93	0.5%	-4 299	-98%	7	8%	T2	CS
EU-28	**38 764**	**18 706**	**18 997**	**100%**	**-19 767**	**-51%**	**291**	**2%**	**-**	**-**
Iceland	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom (KP)	4 392	86	93	0.5%	-4 299	-98%	7	8%	T2	CS
EU-28 + ISL	**38 771**	**18 706**	**18 997**	**100%**	**-19 774**	**-51%**	**291**	**2%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany and Malta are included in 1A2g
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.52 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Netherland (41%), Italy (22%), France (13%) and Poland (4%) which together have 80% share on EU-28+ISL emissions.

Figure 3.52: 1A2c Chemicals, Liquid fuels: Emission trend and share for CO_2

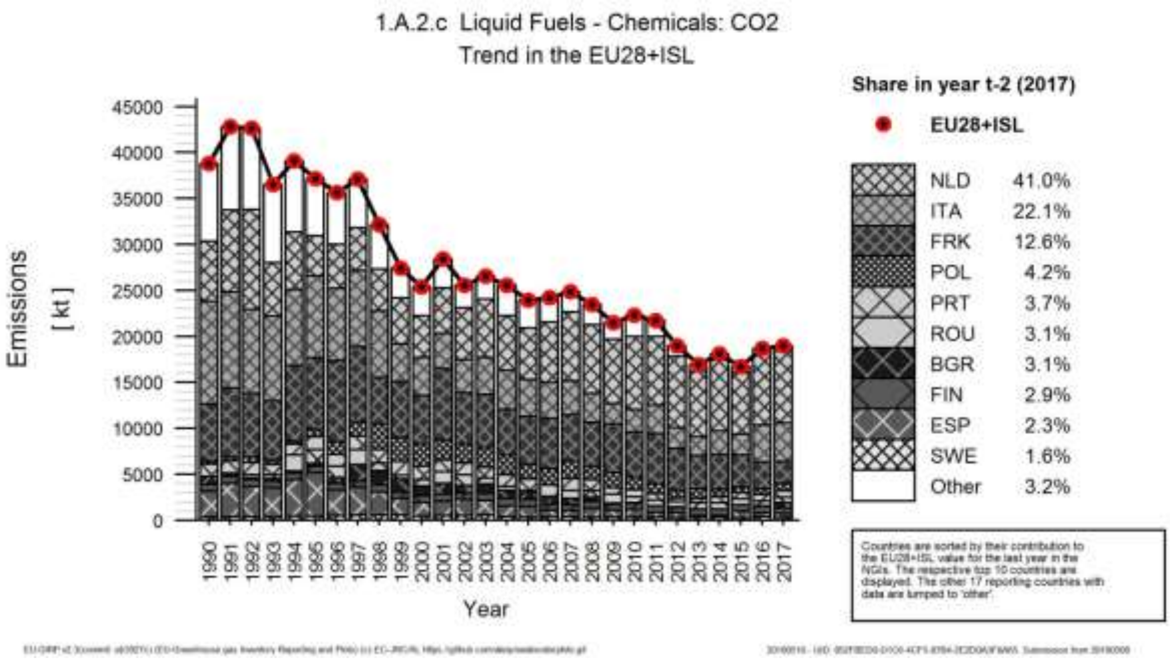


Figure 3.53 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. It can be seen, that CO_2 IEF fluctuates over the time period with decreasing trend. CO_2 IEF equaled to 66.28 t/TJ in 2017. The main reason for the declining trend of the IEF is the growing weight in EU emissions of the Netherlands (with a lower IEF) and the decreasing weight of Italy (with a higher IEF).

Figure 3.53: 1A2c Chemicals, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

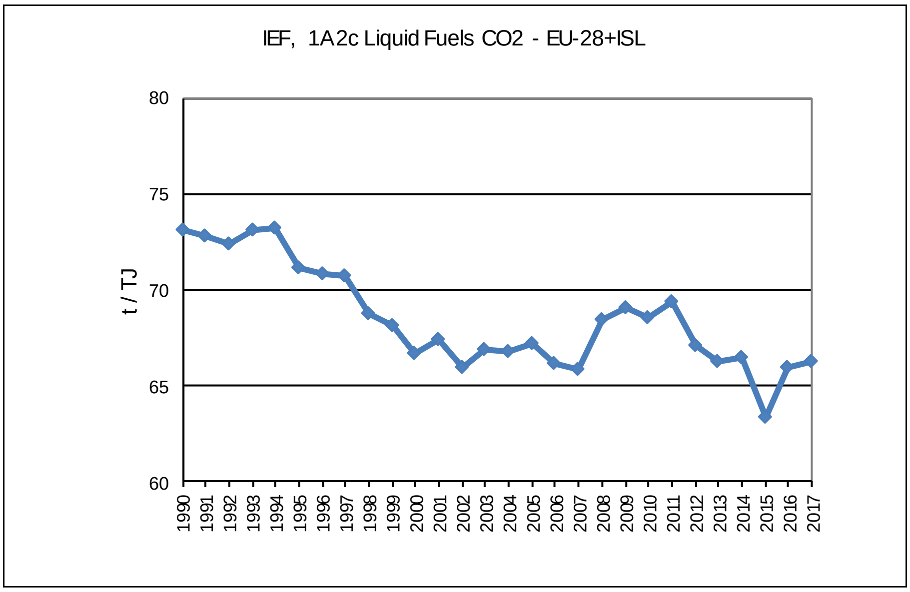
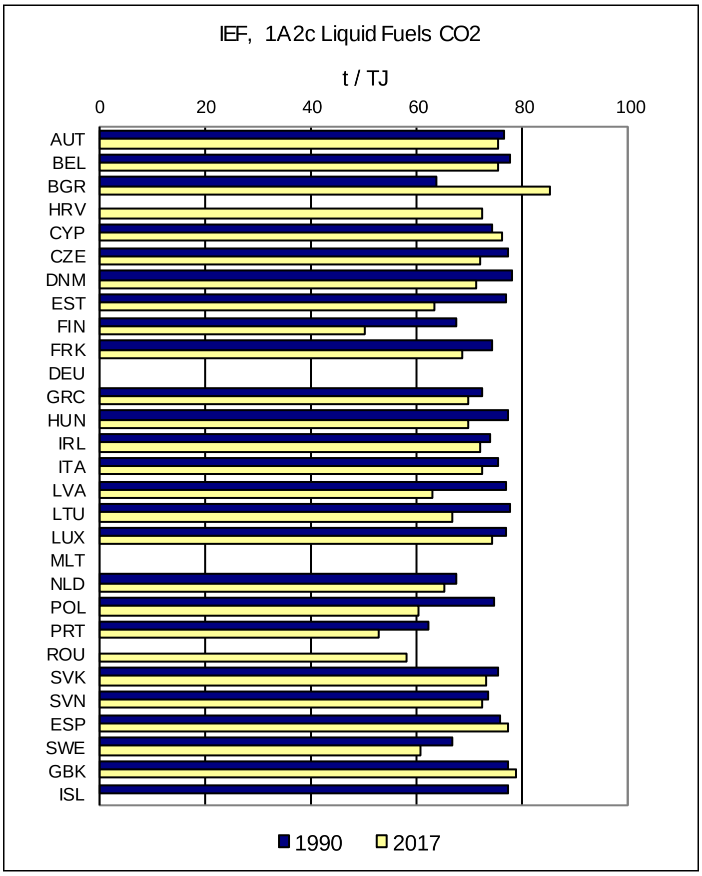


Figure 3.54 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. The main reason for the differences of IEFs across countries is differences in the fuel mix.

Figure 3.54: 1A2c Chemicals, Liquid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2c Chemicals - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1A2c amounted 8 638 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 42% and compared to 2016 increased by 5%. Category has 2% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption decreased by 41% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.33. Fifteen Member States and Island report emissions as 'NO' (not occurring). Two 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 99% of Member States were calculated by using higher Tier methods or combination of methods in category 1A2c – Solid Fuels (CO_2)). Four Member States reported higher level of emissions in 2017 than in 1990. Noticeable increase of emissions compared to year 1990 can be observed for the Austria, Bulgaria, Denmark and Poland. Poland has the highest share on total EU-28+ISL emissions. Rapid increase of emissions in Bulgaria is linked with increased consumption of solid fuels in this category.

Table 3.33: 1A2c Chemicals, Solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	106	105	207	2.4%	101	95%	102	96%	T2	CS
Belgium	402	2	3	0.0%	-398	-99%	1	34%	T1	D
Bulgaria	80	0	143	1.7%	63	78%	143	29586%	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	2 487	892	1 189	13.8%	-1 298	-52%	297	33%	T2	CS,D
Denmark	7	43	48	0.6%	41	637%	5	10%	T1	D
Estonia	626	NO	NO	-	-626	-100%	-	-	NA	NA
Finland	214	NO	NO	-	-214	-100%	-	-	NA	NA
France	2 057	1 514	1 489	17.2%	-568	-28%	-25	-2%	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	NO	NO	-	-640	-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	1 087	NO	NO	-	-1 087	-100%	-	-	NA	NA
Poland	1 027	4 583	4 542	52.6%	3 515	342%	-42	-1%	T1,T2	CS,D
Portugal	39	NO	NO	-	-39	-100%	-	-	NA	NA
Romania	581	105	128	1.5%	-453	-78%	23	22%	T1,T2	CS,D
Slovakia	1 584	72	70	0.8%	-1 514	-96%	-2	-3%	T2	CS
Slovenia	1	NO	NO	-	-1	-100%	-	-	NA	NA
Spain	691	641	626	7.2%	-64	-9%	-15	-2%	T1,T2	CS,D,PS
Sweden	127	33	28	0.3%	-99	-78%	-5	-15%	T2	CS
United Kingdom	2 815	209	164	1.9%	-2 651	-94%	-45	-21%	T2	CS
EU-28	**14 908**	**8 202**	**8 638**	**100%**	**-6 270**	**-42%**	**436**	**5%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 815	209	164	1.9%	-2 651	-94%	-45	-21%	T2	CS
EU-28 + ISL	**14 908**	**8 202**	**8 638**	**100%**	**-6 270**	**-42%**	**436**	**5%**	**-**	**-**

Emissions of Germany are included in 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.55 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Poland (53%), France (17%) and Czechia (14%) which together have 84% share on EU-28+ISL emissions.

Figure 3.55: 1A2c Chemicals, Solid fuels: Emission trend and share for CO_2

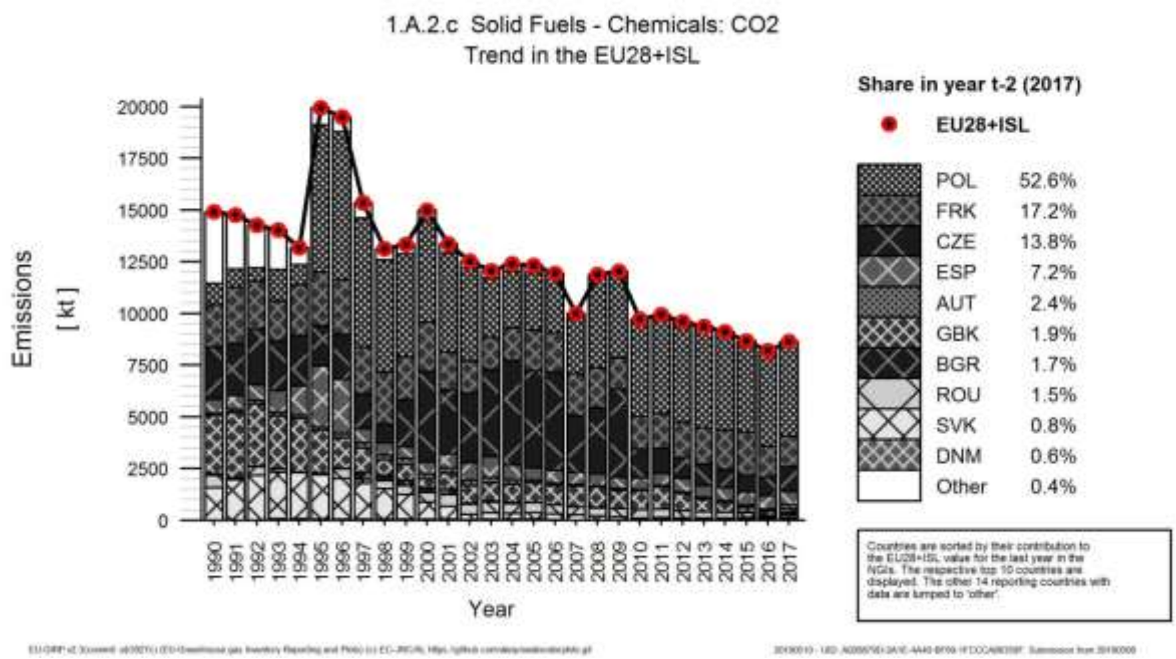


Figure 3.56 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. It can be seen, that since 2015 CO_2 IEF shows stable trend. CO_2 IEF equaled to 95.05 t/TJ in 2017.

Figure 3.56: 1A2c Chemicals, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

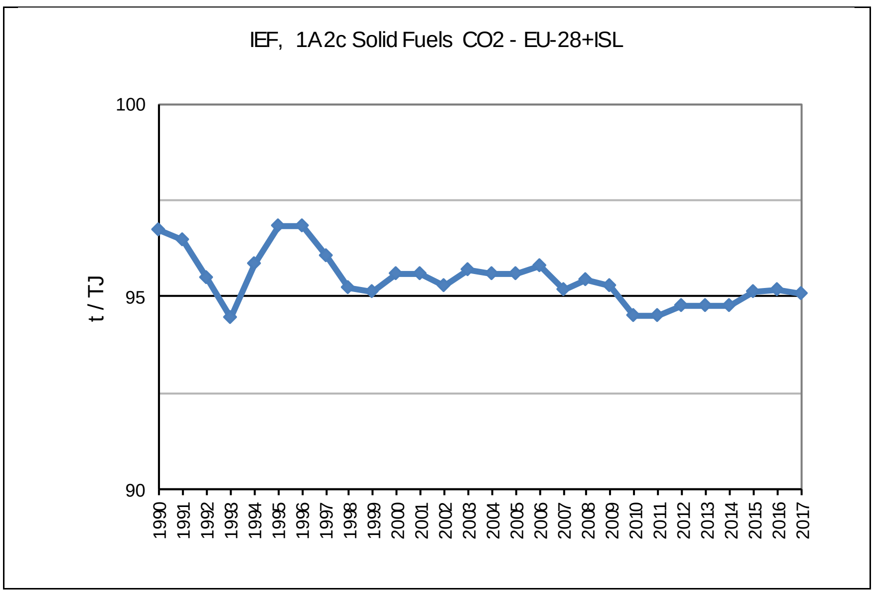
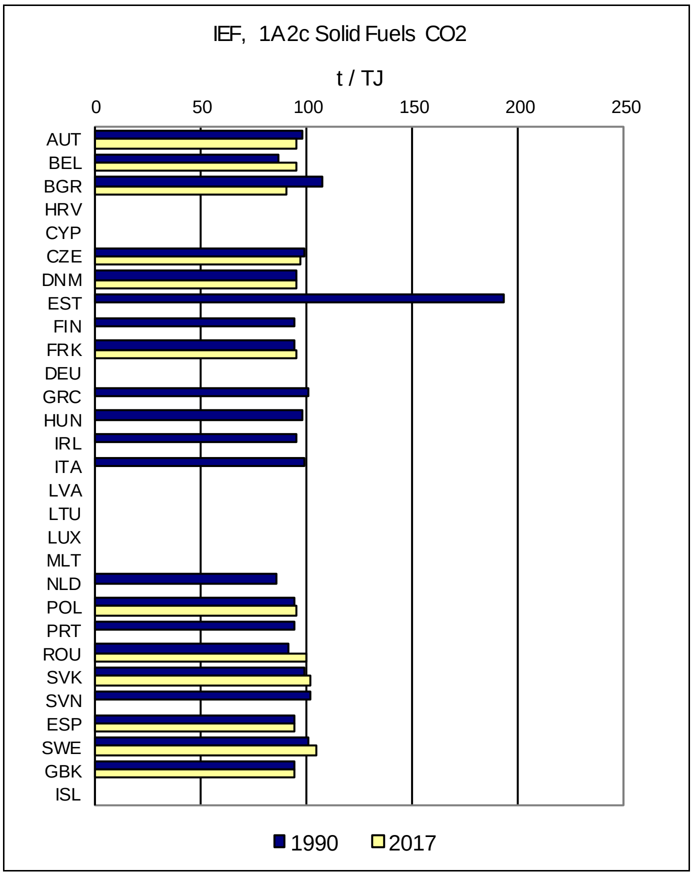


Figure 3.57 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. The high CO_2 IEF factor for Estonia is caused by the use of oil shale generator gas which has high carbon content.

Figure 3.57: 1A2c Chemicals, Solid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2c Chemicals – Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1A2c amounted 38 056 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 30% and compared to 2016 increased by 9%. Category has 8% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption decreased by 31% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.34. Cyprus, Malta and Island report emissions as 'NO' (not occurring). Two 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 98% of Member States were calculated by using higher Tier methods or combination of methods in category 1A2c –Gaseous Fuels (CO_2)). Eleven Member States reported higher level of emissions in 2017 than in 1990. Noticeable higher level of emissions in 2017 compared to 1990 was reported by Bulgaria, Spain and Luxembourg.

Table 3.34: 1A2c Chemicals, gaseous fuels: Member States' contributions to CO_2

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	519	1 106	1 134	3.0%	615	119%	28	3%	T2	CS
Belgium	2 532	2 979	3 109	8.2%	577	23%	130	4%	T1,T3	D,PS
Bulgaria	30	287	275	0.7%	245	809%	-13	-4%	T2	CS
Croatia	IE	285	324	0.9%	324	∞	39	14%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	334	428	595	1.6%	261	78%	167	39%	T2	CS
Denmark	111	304	312	0.8%	201	182%	8	3%	T3	CS
Estonia	167	2	9	0.0%	-158	-94%	7	310%	T2	CS
Finland	99	72	103	0.3%	5	5%	31	43%	T3	CS
France	6 463	4 953	4 719	12.4%	-1 744	-27%	-234	-5%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	33	219	0.6%	219	∞	187	570%	T2	CS
Hungary	1 064	385	402	1.1%	-663	-62%	16	4%	T1	D
Ireland	207	193	193	0.5%	-14	-7%	0	0%	T2	CS
Italy	7 566	4 907	5 313	14.0%	-2 253	-30%	406	8%	T2	CS
Latvia	24	22	25	0.1%	2	7%	3	16%	T2	CS
Lithuania	331	266	271	0.7%	-60	-18%	5	2%	T2	CS
Luxembourg	57	147	144	0.4%	86	150%	-4	-2%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	9 696	6 032	6 717	17.6%	-2 979	-31%	684	11%	T2	CS
Poland	293	670	722	1.9%	429	147%	51	8%	T2	CS
Portugal	NO	328	395	1.0%	395	∞	67	21%	T1,T3	D,PS
Romania	17 290	958	1 068	2.8%	-16 223	-94%	110	11%	T2	CS
Slovakia	989	406	420	1.1%	-570	-58%	13	3%	T2	CS
Slovenia	176	58	58	0.2%	-118	-67%	0	-1%	T2	CS
Spain	1 780	5 320	6 420	16.9%	4 640	261%	1 100	21%	T2	CS
Sweden	155	57	58	0.2%	-96	-62%	1	2%	T2	CS
United Kingdom	4 870	4 622	5 052	13.3%	182	4%	430	9%	T2	CS
EU-28	**54 752**	**34 823**	**38 056**	**100%**	**-16 696**	**-30%**	**3 233**	**9%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 870	4 622	5 052	13.3%	182	4%	430	9%	T2	CS
EU-28 + ISL	**54 752**	**34 823**	**38 056**	**100%**	**-16 696**	**-30%**	**3 233**	**9%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany are included in 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.58 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Netherland (18%), Spain (17%), Italy (14%), United Kingdom (13%), France (12%) and Belgium (8%) which together have 82% share on EU-28+ISL emissions.

Figure 3.58: 1A2c Chemicals, Gaseous fuels: Emission trend and share for CO_2

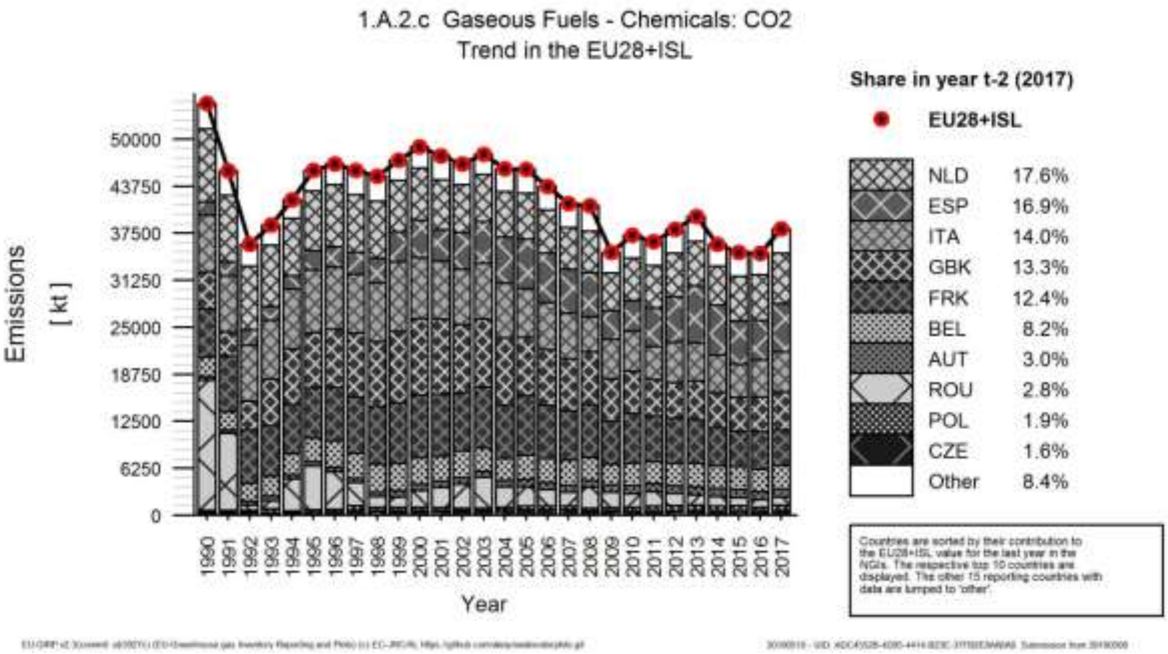


Figure 3.59 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. CO_2 IEF shows stable trend for the whole time series. CO_2 IEF equaled to 56.21 t/TJ in 2017.

Figure 3.59: 1A2c Chemicals, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

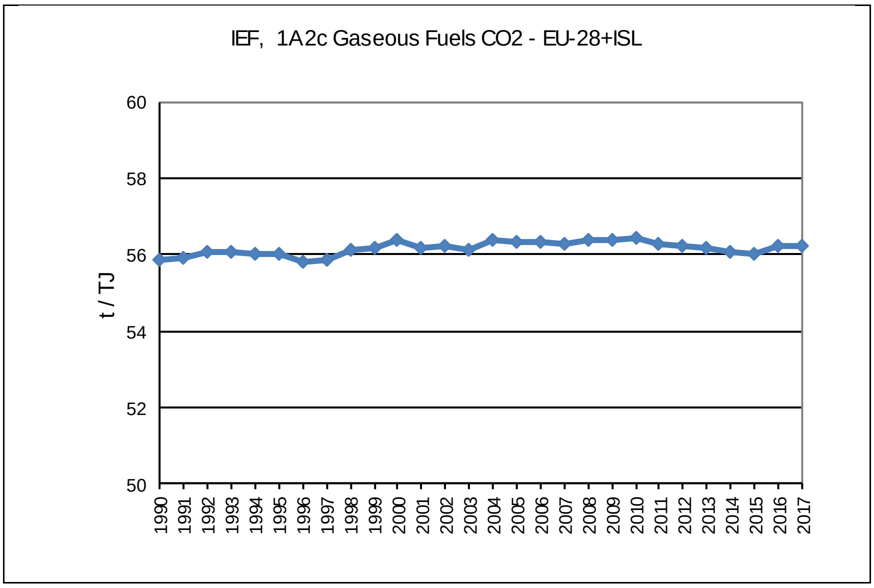
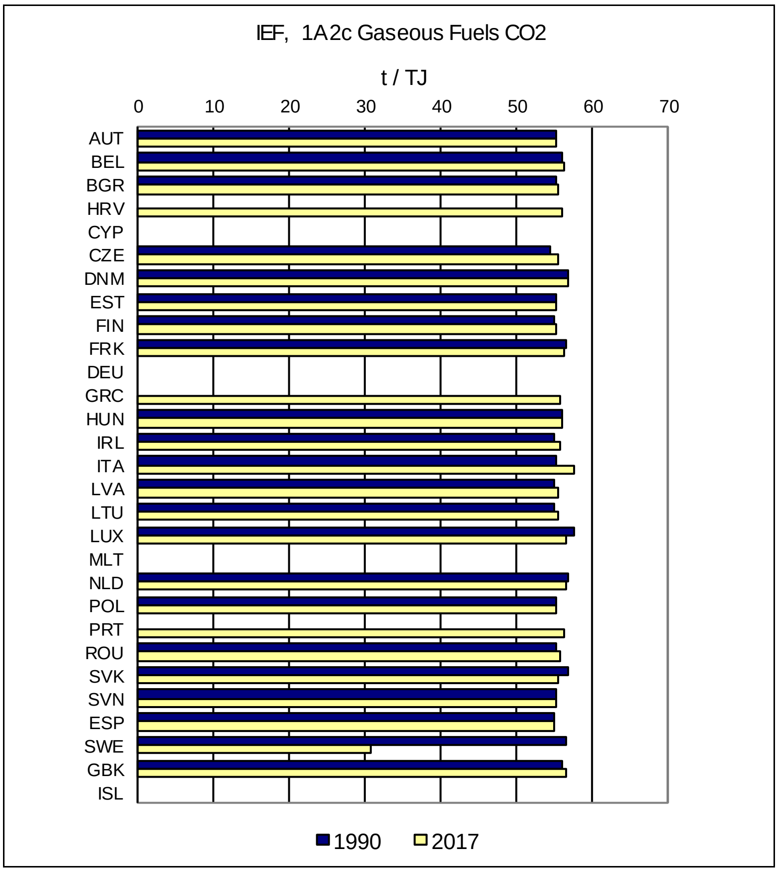


Figure 3.60 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. No significant differences between CO_2 IEF used by EU-28+ISL are not occurring as also no significant differences between CO_2 IEF used in 1990 and 2017 are occurring.

Figure 3.60: 1A2c Chemicals, Gaseous fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



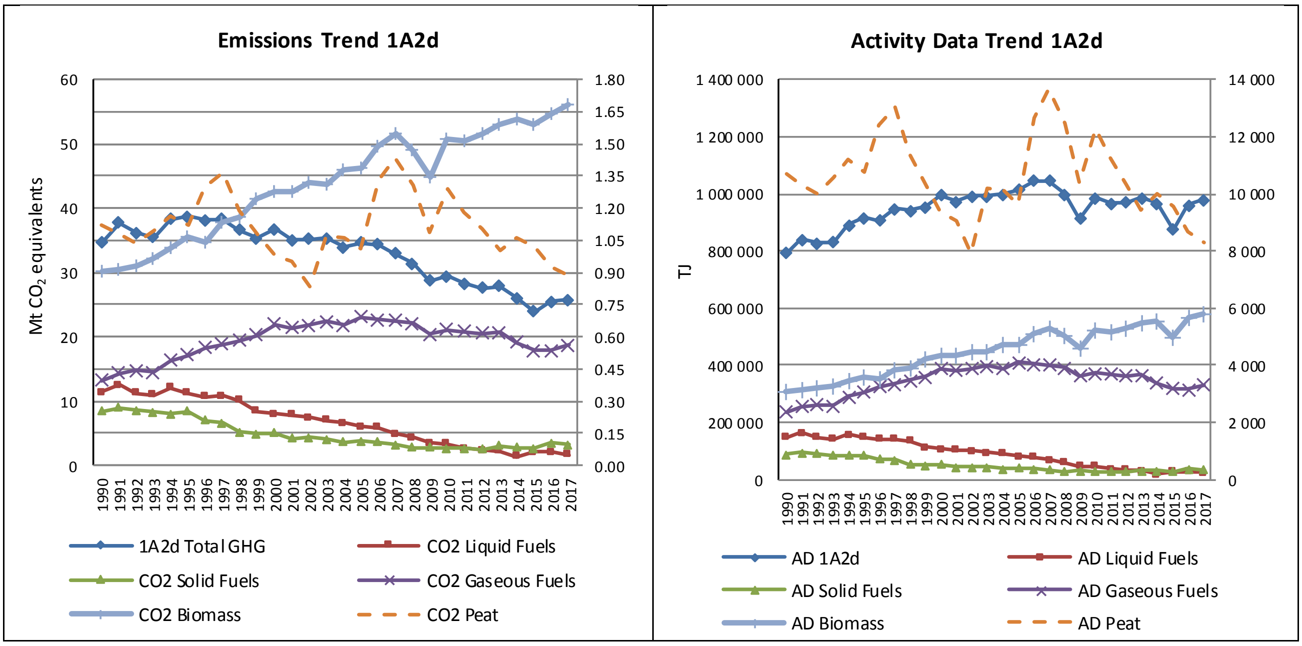
3.2.2.3 Pulp, Paper and Print (1A2d)

This chapter provides information about European emission trend, Member States contribution to the overall emission trend, activity data and emission factors used for emission estimates by Member States and Island for category 1A2d Pulp, Paper and Print.

Total CO_2 emissions from 1A2d amounted to 24 943 kt CO_2 eq. in 2017. The trend of total emissions for 1990 to 2017 from category 1A2d is depicted in Figure **3.61**. Total CO_2 emissions decreased by 27% since 1990 and increased by 1% between 2016 and 2017. CO_2 emissions from 1A2d Pulp, Paper and Print accounted for 5% of 1A2 source category.

Figure 12 shows the emission trend within the category 1A2d, which is dominated by CO_2 emissions from gaseous fuels in 2017. The share of liquid fuels on CO_2 emissions from 1A2d decreased from 33% in 1990 to 7% in 2017. The share of solid fuels on CO_2 emissions from 1A2d decreased from 24% in 1990 to 13% in 2017. The share of gaseous fuels on CO_2 emissions from 1A2d increased from 39% in 1990 to 75% in 2017. 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 3.61: 1A2d 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 hand side do not include CO_2 from biomass whereas total activity data in the figure on the right hand side includes AD biomass.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.35. Malta and Island report emissions as ‘NO’ (not occurring) or ‘IE’ (included elsewhere). Eight 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 Bulgaria, Hungary and Poland.

Table 3.35: 1A2d Pulp, Paper and Print: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	2 214	1 706	1 790	7.2%	-424	-19%	83	5%	T1,T2	CS,D
Belgium	644	609	659	2.6%	15	2%	50	8%	T1,T3	D,PS
Bulgaria	16	117	106	0.4%	90	579%	-11	-10%	T1,T2	CS,D
Croatia	NO,IE	105	97	0.4%	97	∞	-9	-8%	T1	D
Cyprus	5	3	2	0.0%	-3	-56%	-1	-33%	T1	D
Czech Republic	2 285	404	400	1.6%	-1 885	-82%	-4	-1%	T1,T2	CS,D
Denmark	337	36	45	0.2%	-291	-86%	10	27%	T1,T2,T3	CS,D
Estonia	NO	25	11	0.0%	11	∞	-14	-56%	T2	CS
Finland	5 330	2 647	2 487	10.0%	-2 843	-53%	-161	-6%	T3	CS,D
France	4 686	3 285	3 022	12.1%	-1 664	-36%	-263	-8%	T2	CS
Germany	4	4	4	0.0%	0	6%	-1	-12%	CS	CS
Greece	306	80	77	0.3%	-229	-75%	-3	-3%	T2	CS
Hungary	74	424	479	1.9%	405	545%	55	13%	T1,T3	D,PS
Ireland	28	16	17	0.1%	-12	-41%	1	5%	T2	CS
Italy	3 079	4 830	4 994	20.0%	1 915	62%	164	3%	T2	CS
Latvia	168	5	6	0.0%	-162	-96%	1	19%	T2	CS
Lithuania	255	29	33	0.1%	-222	-87%	4	15%	T2	CS
Luxembourg	NO,IE	5	5	0.0%	5	∞	0	0%	T2	CS
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Netherlands	1 669	872	900	3.6%	-768	-46%	28	3%	T2	CS
Poland	285	1 526	1 496	6.0%	1 211	425%	-29	-2%	T1,T2	CS,D
Portugal	754	1 113	1 125	4.5%	372	49%	13	1%	T1	D
Romania	NO	177	233	0.9%	233	∞	56	32%	T1,T2	CS,D
Slovakia	2 329	402	377	1.5%	-1 952	-84%	-25	-6%	T2	CS
Slovenia	380	306	306	1.2%	-74	-19%	0	0%	T1,T2,T3	CS,D,PS
Spain	2 577	3 844	4 112	16.5%	1 535	60%	267	7%	T1,T2	CS,D,PS
Sweden	2 189	719	736	3.0%	-1 453	-66%	17	2%	T2	CS
United Kingdom	4 599	1 468	1 414	5.7%	-3 185	-69%	-53	-4%	T2	CS
EU-28	**34 212**	**24 759**	**24 934**	**100%**	**-9 278**	**-27%**	**175**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 599	1 468	1 414	5.7%	-3 185	-69%	-53	-4%	T2	CS
EU-28 + ISL	**34 212**	**24 759**	**24 934**	**100%**	**-9 278**	**-27%**	**175**	**1%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Luxembourg, Croatia and Malta are included in 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A2d Pulp, Paper and Print – Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1A2d amounted 1 690 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 85% and compared to 2016 by 17%. Category has 0.3% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption decreased by 84% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.36. Estonia, Netherland and Island 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 81% of Member States were calculated by using higher Tier methods or combination of methods in category 1A2d – Liquid Fuels (CO_2)). All Member States reported lower level of emissions in 2017 than in 1990 (except of Poland, which has 8% share on total EU-28+ISL emissions in 2017).

Table 3.36: 1A2d Pulp, Paper and Print, Liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	853	15	31	1.8%	-822	-96%	16	112%	T2	CS
Belgium	235	55	21	1.3%	-213	-91%	-34	-61%	T1,T3	D,PS
Bulgaria	16	NO	3	0.2%	-13	-83%	3	∞	NA	NA
Croatia	IE	16	6	0.3%	6	∞	-11	-64%	T1	D
Cyprus	5	3	2	0.1%	-3	-56%	-1	-33%	T1	D
Czech Republic	461	3	7	0.4%	-454	-99%	3	101%	T1	CS,D
Denmark	87	3	4	0.3%	-82	-95%	1	37%	T1,T2	CS,D
Estonia	NO	1	NO	-	-	-	-1	-100%	NA	NA
Finland	1 138	354	336	19.9%	-802	-70%	-19	-5%	T3	CS
France	1 426	153	113	6.7%	-1 313	-92%	-40	-26%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	302	60	50	3.0%	-252	-83%	-10	-17%	T2	CS
Hungary	19	6	6	0.4%	-13	-68%	0	0%	T1	D
Ireland	28	8	9	0.5%	-20	-69%	0	5%	T2	CS
Italy	1 017	150	37	2.2%	-979	-96%	-112	-75%	T2	CS
Latvia	16	0	0	0.0%	-15	-98%	0	0%	T2	CS
Lithuania	69	0	1	0.0%	-68	-99%	0	32%	T2	CS
Luxembourg	IE	0	0	0.0%	0	∞	0	41%	T2	CS
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	2	NO	NO	-	-2	-100%	-	-	NA	NA
Poland	105	143	133	7.9%	28	26%	-10	-7%	T1	D
Portugal	754	237	159	9.4%	-595	-79%	-79	-33%	T1	D
Romania	NO	3	1	0.0%	1	∞	-3	-84%	T1,T2	CS,D
Slovakia	985	4	3	0.2%	-982	-100%	-1	-25%	T2	CS
Slovenia	98	4	2	0.1%	-96	-98%	-2	-57%	T1	D
Spain	1 247	222	167	9.9%	-1 080	-87%	-55	-25%	T1,T2	CS,D,PS
Sweden	1 786	578	596	35.3%	-1 189	-67%	18	3%	T2	CS
United Kingdom	769	5	5	0.3%	-764	-99%	0	-1%	T2	CS
EU-28	**11 414**	**2 027**	**1 690**	**100%**	**-9 724**	**-85%**	**-337**	**-17%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	769	5	5	0.3%	-764	-99%	0	-1%	T2	CS
EU-28 + ISL	**11 414**	**2 027**	**1 690**	**100%**	**-9 724**	**-85%**	**-337**	**-17%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany, Luxembourg and Malta are included in 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.62 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Sweden (35%), Finland (20%) Spain (10%), Portugal (9%), Poland (8%) and France (7%) which together have 89% share on EU-28+ISL emissions.

Figure 3.62: 1A2d Pulp, Paper and Print, Liquid fuels: Emission trend and share for CO_2

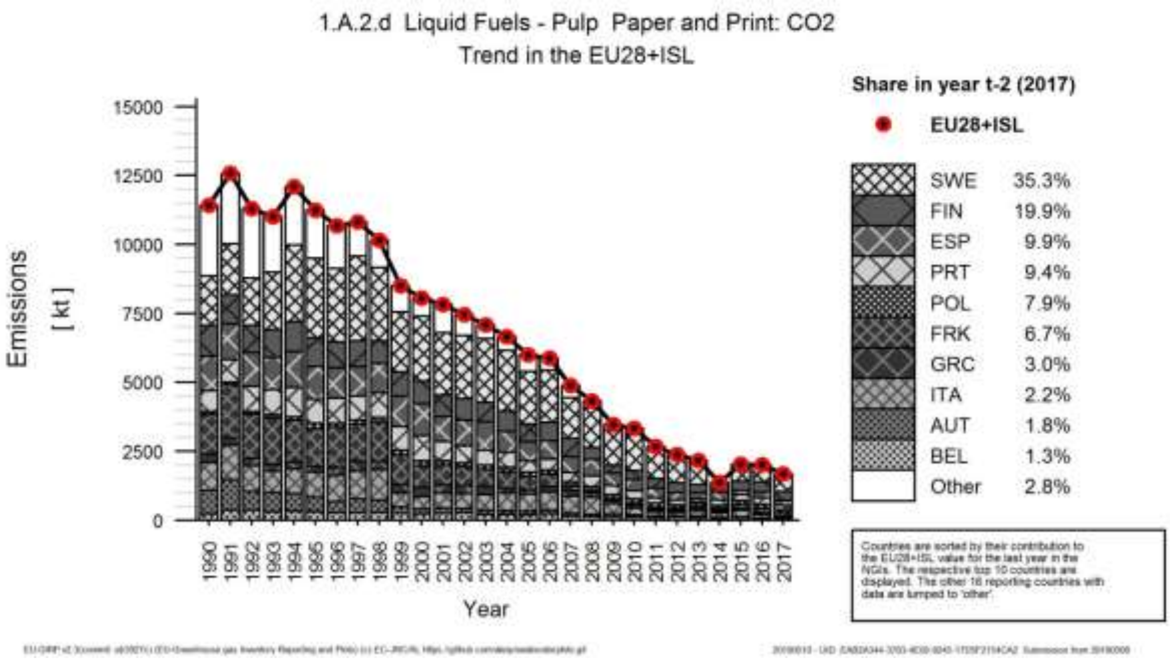
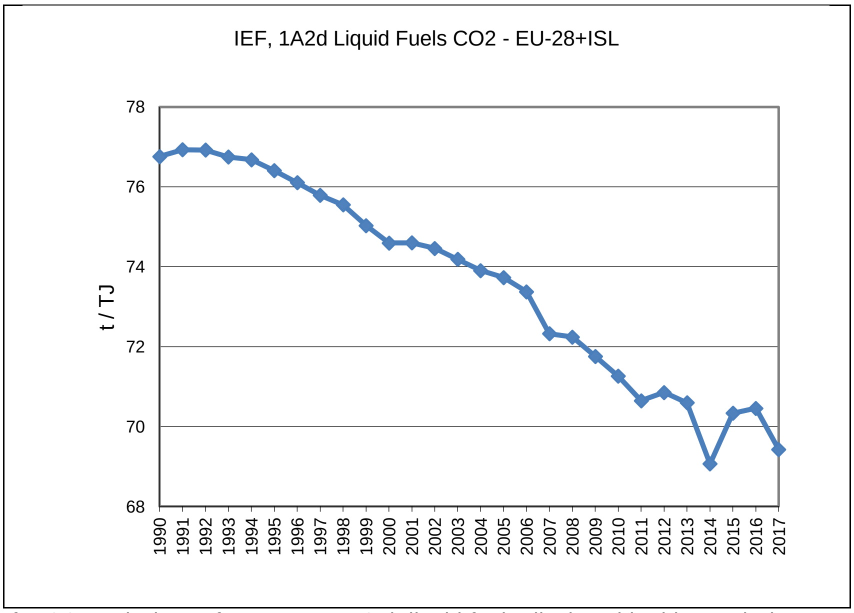


Figure.3.63 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. It can be seen that CO_2 IEF is decreasing during whole period, slight fluctuation occurred during few last years. CO_2 IEF equaled to 69.43 t/TJ in 2017. The figure below does not include data from Sweden which reports activity data as ‘C’ (confidential) and thus difference between figure and CRF tables is occurring.

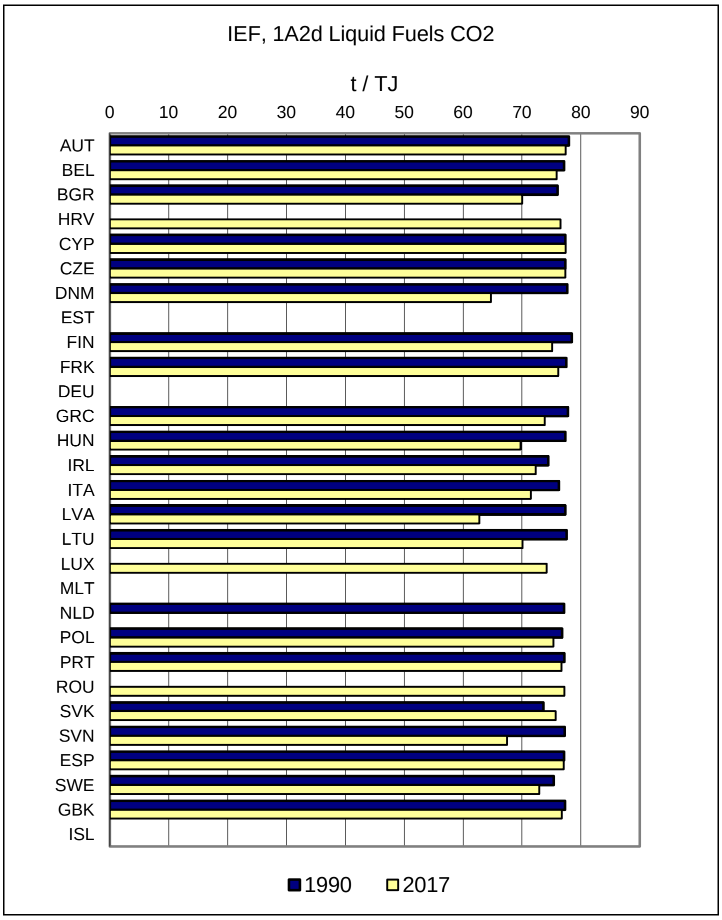
Figure.3.63: 1A2d Pulp, Paper and Print, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



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

Figure.3.64 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. No major differences between Member States CO_2 IEF occur.

Figure.3.64: 1A2d Pulp, Paper and Print, Liquid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2d Pulp, Paper and Print - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1A2d amounted 3 250 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 61% and compared to 2016 by 8%. Category has 0.7% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption decreased by 60% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table **3.37**. Thirteen Member States and Island 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 96% of Member States were calculated by using higher Tier methods or combination of methods in category 1A2d – Solid Fuels (CO_2)). All Member States reported lower level of emissions in 2017 than in 1990 (except of Hungary and Poland, which together has 36% share on EU-28+ISL emissions).

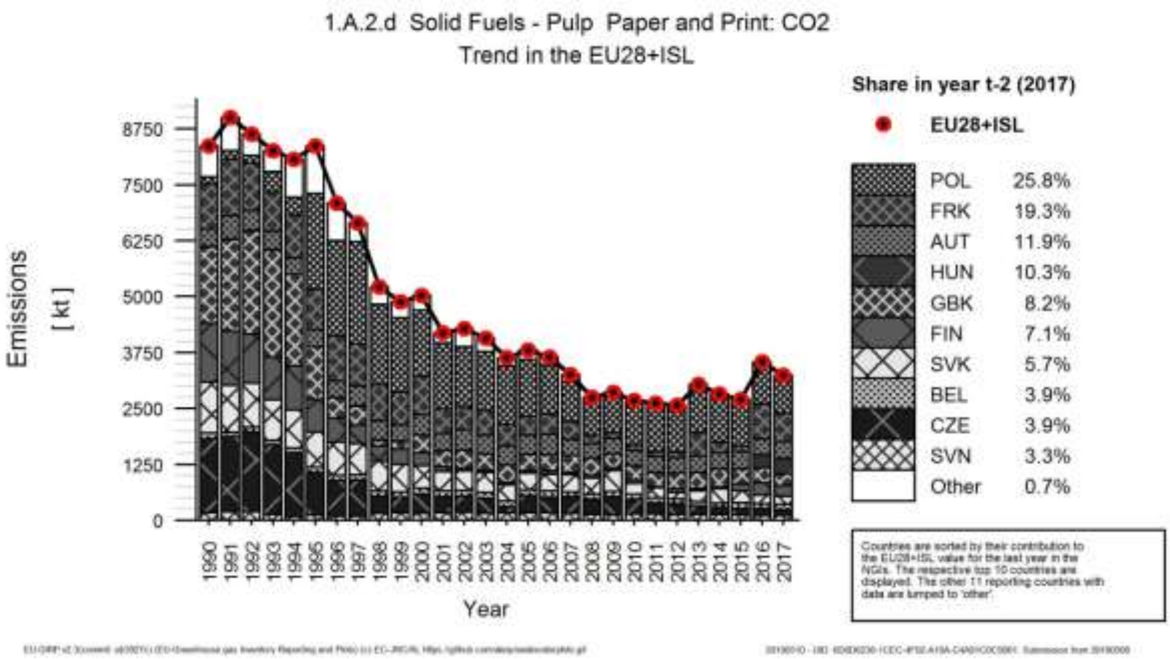
Table 3.37: 1A2d Pulp, Paper and Print, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	398	365	387	11.9%	-11	-3%	22	6%	T2	CS
Belgium	128	104	126	3.9%	-1	-1%	22	22%	T1	D
Bulgaria	NO	7	6	0.2%	6	∞	-1	-12%	T1,T2	CS,D
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	1 646	153	126	3.9%	-1 520	-92%	-27	-18%	T2	CS,D
Denmark	125	NO	NO	-	-125	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 318	279	230	7.1%	-1 087	-83%	-49	-18%	T3	CS
France	990	779	628	19.3%	-362	-37%	-151	-19%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	4	NO	NO	-	-4	-100%	-	-	NA	NA
Hungary	6	288	335	10.3%	330	5920%	47	16%	NA	NA
Ireland	NO	NO	0	0.0%	0	∞	0	∞	T2	CS
Italy	6	NO	NO	-	-6	-100%	-	-	NA	NA
Latvia	2	0	NO	-	-2	-100%	0	-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	174	912	839	25.8%	664	381%	-73	-8%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	1 142	195	184	5.7%	-958	-84%	-12	-6%	T2	CS
Slovenia	172	110	108	3.3%	-65	-38%	-2	-2%	T3	PS
Spain	277	NO	1	0.0%	-275	-100%	1	∞	NA	NA
Sweden	265	23	15	0.5%	-249	-94%	-8	-33%	T2	CS
United Kingdom	1 708	327	265	8.2%	-1 443	-84%	-62	-19%	T2	CS
EU-28	**8 368**	**3 541**	**3 250**	**100%**	**-5 118**	**-61%**	**-291**	**-8%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 708	327	265	8.2%	-1 443	-84%	-62	-19%	T2	CS
EU-28 + ISL	**8 368**	**3 541**	**3 250**	**100%**	**-5 118**	**-61%**	**-291**	**-8%**	**-**	**-**

Emissions of Germany are included in 1A2g. Sweden confidential data is included in other solid fuels within the EU
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.65 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Poland (26%), France (19%), Austria (12%), Hungary (10%) and United Kingdom (8%) which together have 76% share on EU-28+ISL emissions.

Figure 3.65: 1A2d Pulp, Paper and Print, Solid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.66 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. CO_2 IEF equaled to 93.88 t/TJ in 2017.

Figure 3.66: 1A2d Pulp, Paper and Print, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

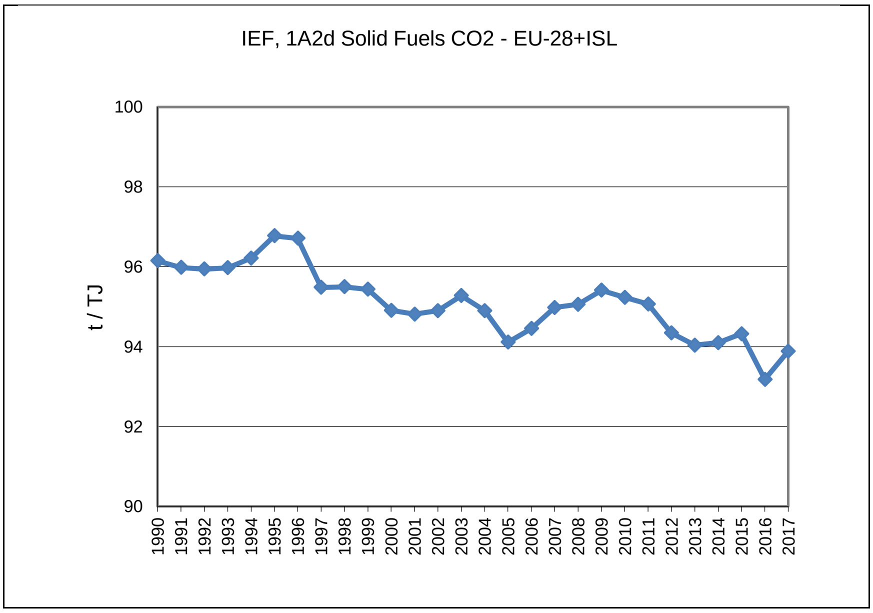
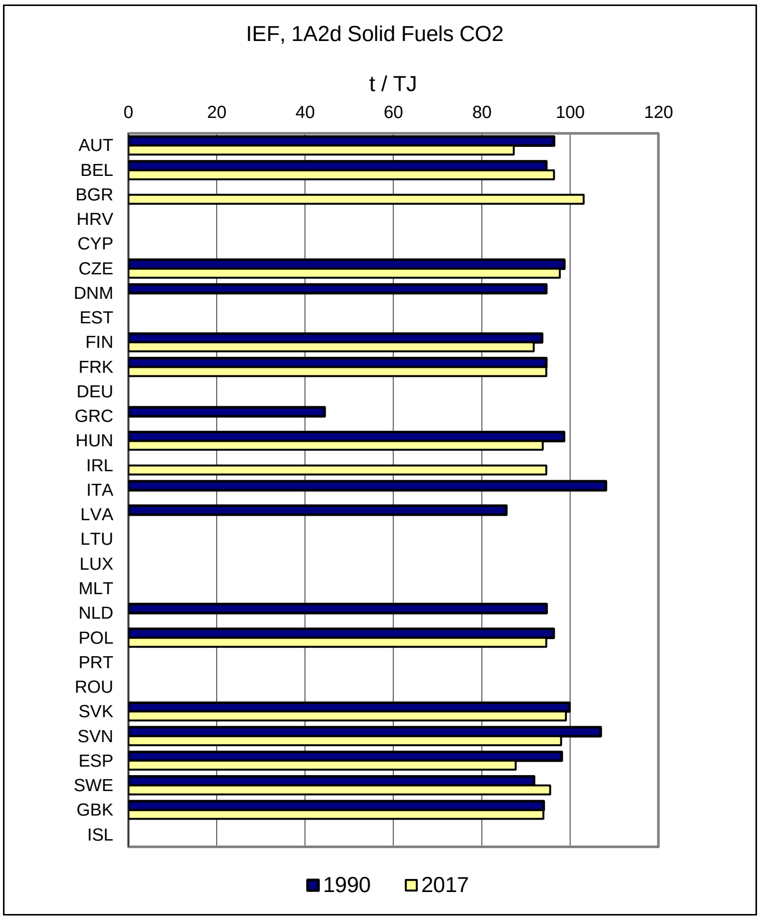


Figure 3.67 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017.

Figure 3.67: 1A2d Pulp, Paper and Print, Solid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2d Pulp, Paper and Print - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1A2d amounted 18 742 kt in 2017 for EU-28+ISL. CO_2 emissions increased compared to year 1990 by 42% and compared to 2016 by 5%. Category has 4% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption increased by 40% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.38. Cyprus, Malta and Island report emissions as 'NO' (not occurring). Four 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 92% of Member States were calculated by using higher Tier methods or combination of methods in category 1A2d – Gaseous Fuels (CO_2)). Nine Member States reported lower level of emissions in 2017 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 Ireland.

Table 3.38: 1A2d Pulp, Paper and Print, Gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	943	1 306	1 349	7.2%	406	43%	43	3%	T2	CS
Belgium	282	356	415	2.2%	133	47%	59	17%	T1	D
Bulgaria	NO	110	97	0.5%	97	∞	-13	-12%	T2	CS
Croatia	IE	89	91	0.5%	91	∞	2	2%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	179	248	268	1.4%	89	50%	20	8%	T2	CS
Denmark	125	33	41	0.2%	-84	-67%	9	26%	T3	CS
Estonia	NO	24	11	0.1%	11	∞	-13	-54%	T2	CS
Finland	1 757	1 023	963	5.1%	-793	-45%	-59	-6%	T3	CS
France	2 270	2 336	2 263	12.1%	-8	0%	-73	-3%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	20	27	0.1%	27	∞	7	37%	T2	CS
Hungary	50	98	108	0.6%	58	115%	9	10%	T1	D
Ireland	NO	8	8	0.0%	8	∞	0	2%	T2	CS
Italy	2 056	4 680	4 957	26.4%	2 900	141%	277	6%	T2	CS
Latvia	150	5	6	0.0%	-144	-96%	1	22%	T2	CS
Lithuania	187	28	33	0.2%	-154	-83%	4	15%	T2	CS
Luxembourg	IE	5	5	0.0%	5	∞	0	-1%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 659	872	900	4.8%	-758	-46%	28	3%	T2	CS
Poland	6	444	483	2.6%	477	8537%	39	9%	T2	CS
Portugal	NO	875	967	5.2%	967	∞	92	10%	T1	D
Romania	NO	172	226	1.2%	226	∞	54	32%	T2	CS
Slovakia	203	186	173	0.9%	-30	-15%	-13	-7%	T2	CS
Slovenia	110	192	197	1.0%	87	79%	4	2%	T2	CS
Spain	1 053	3 622	3 943	21.0%	2 890	274%	321	9%	T2	CS
Sweden	66	64	69	0.4%	3	4%	5	7%	T2	CS
United Kingdom	2 122	1 135	1 144	6.1%	-978	-46%	9	1%	T2	CS
EU-28	**13 216**	**17 932**	**18 742**	**100%**	**5 526**	**42%**	**810**	**5%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 122	1 135	1 144	6.1%	-978	-46%	9	1%	T2	CS
EU-28 + ISL	**13 216**	**17 932**	**18 742**	**100%**	**5 526**	**42%**	**810**	**5%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany are included in 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.68 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Italy (26%), Spain (21%), France (12%), Austria (7%), United Kingdom (6%), Portugal (5%), Finland (5%) and Netherland (5%) which together have 88% share on EU-28+ISL emissions.

Figure 3.68: 1A2d Pulp, Paper and Print, Gaseous fuels: Emission trend and share for CO_2

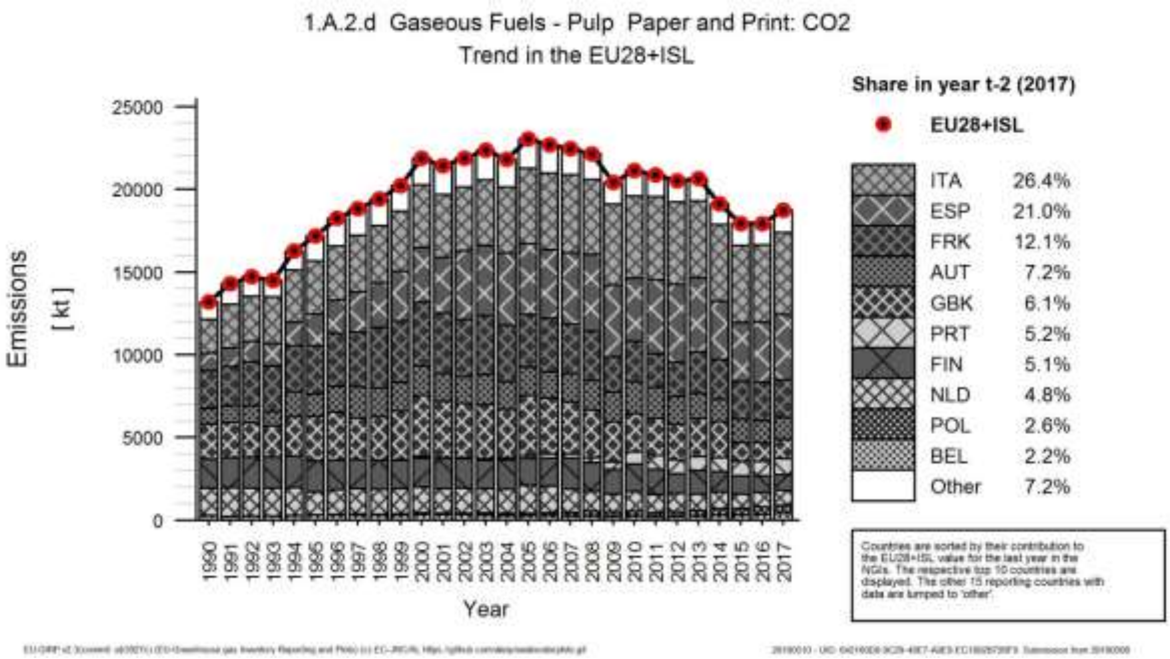


Figure 3.69 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. CO_2 IEF shows relatively stable trend without major fluctuations for whole time series with slightly increasing trend. The main reason for increasing trend of the CO_2 IEF is the growing weight in EU emissions of Italy and Spain; these countries had comparatively high CO_2 IEFs in 2017 and their I CO_2 IEFs grew since 1990. CO_2 IEF equaled to 56.65 t/TJ in 2017.

Figure 3.69: 1A2d Pulp, Paper and Print, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

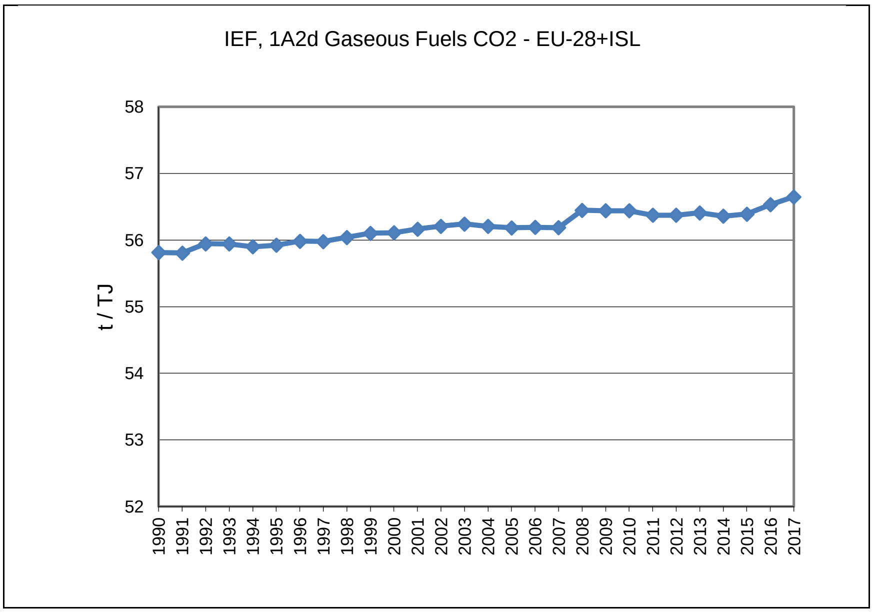
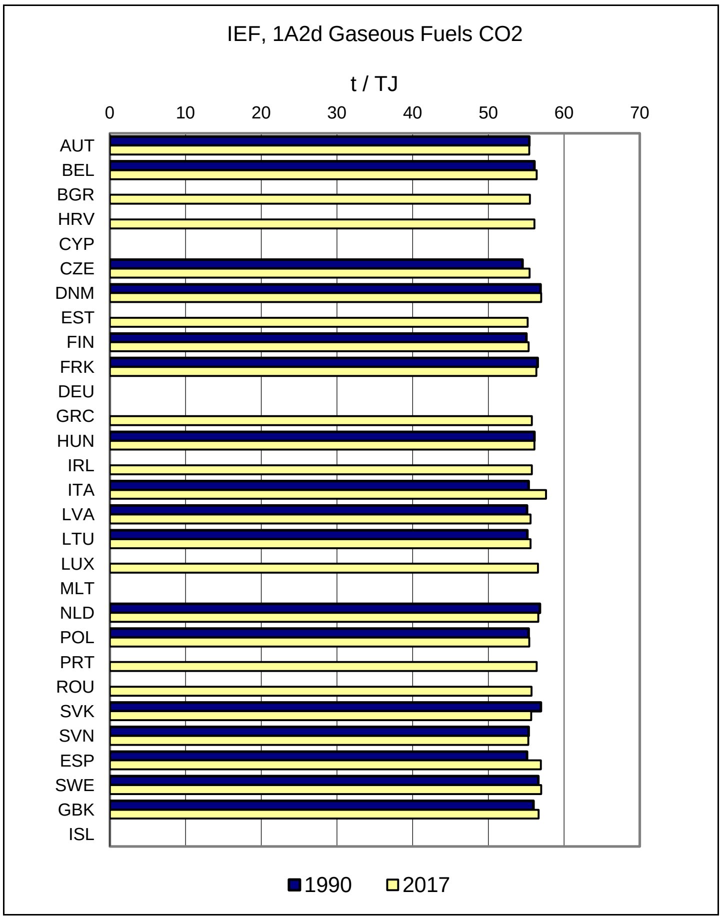


Figure 3.70 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. It can be seen that no major differences between CO_2 IEF used by Member States occur, also no major differences between CO_2 IEF calculated by Member States for 1990 and 2017 occur.

Figure 3.70: 1A2d Pulp, Paper and Print, Gaseous fuels: Implied Emission Factors for CO_2 by Member State and Iceland (in t/TJ)



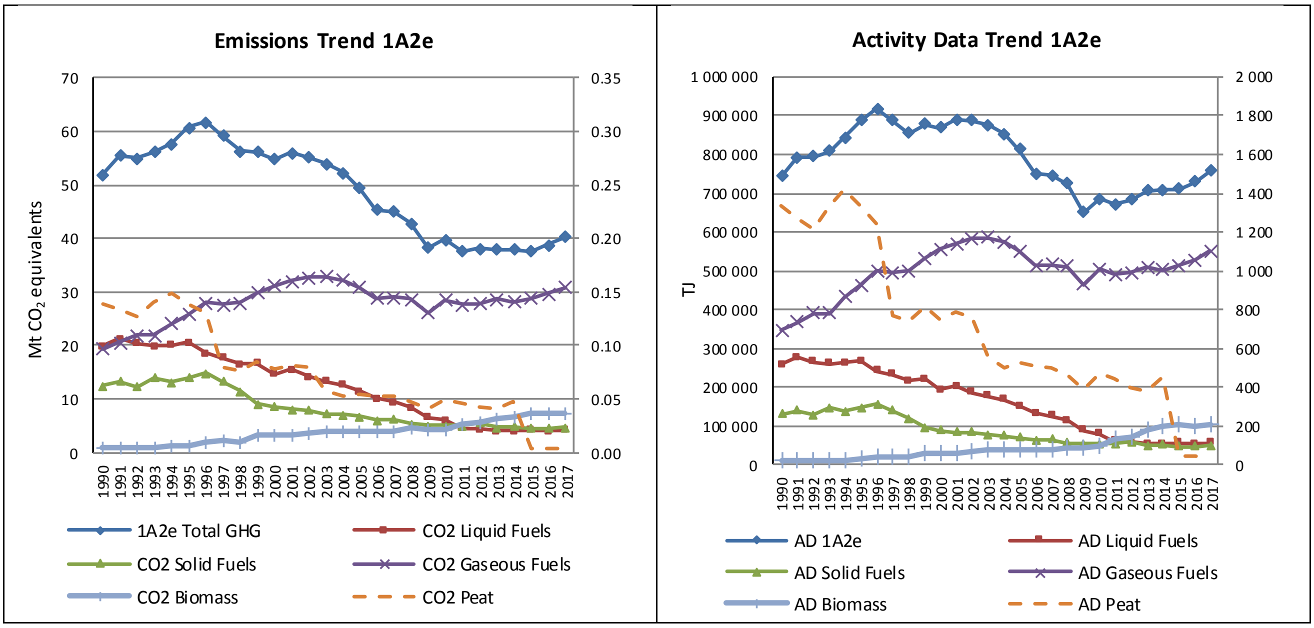
3.2.2.4 Food Processing, Beverages and Tobacco (1A2e)

This chapter provides information about European emission trend, Member States contribution to the overall emission trend, activity data and emission factors used for emission estimates by Member States and Island for category 1A2e Food Processing, Beverages and Tobacco.

Total CO_2 emissions from 1A2e amounted to 39 711 kt CO_2 eq. in 2017. The trend of total CO_2 emissions for 1990 to 2017 from category 1A2e is depicted in Figure 3.71. Total CO_2 emissions decreased by 23% since 1990 and increased by 4% between 2016 and 2017. CO_2 emissions from 1A2e Food Processing, Beverages and Tobacco accounted for 8% of 1A2 source category.

Figure 3.71 shows the emission trend within the category 1A2e, which is dominated by CO_2 emissions from gaseous fuels in 2017. The share of liquid fuels on CO_2 emissions from 1A2e decreased from 38% in 1990 to 10% in 2017. The share of solid fuels on CO_2 emissions from 1A2e decreased from 24% in 1990 to 12% in 2017. The share of gaseous fuels on CO_2 emissions from 1A2e increased from 37% in 1990 to 78% in 2017.

Figure 3.71: 1A2e 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-28+ISL submissions are depicted in Table 3.39. Malta reports emissions as 'NO' (not occurring) and 'IE' (included elsewhere). 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 has 2% share on total EU-28+ISL emissions.

Table 3.39: 1A2e Food Processing, Beverages and Tobacco: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	870	1 004	1 005	2.5%	135	15%	0	0%	T1,T2	CS,D
Belgium	3 023	2 282	2 271	5.7%	-753	-25%	-11	0%	T1,T3	D,PS
Bulgaria	454	240	240	0.6%	-213	-47%	0	0%	T1,T2	CS,D
Croatia	NO,IE	377	358	0.9%	358	∞	-18	-5%	T1	D
Cyprus	73	50	68	0.2%	-5	-7%	18	36%	T1	D
Czech Republic	2 988	1 021	1 031	2.6%	-1 958	-66%	9	1%	T1,T2	CS,D
Denmark	1 591	1 028	1 067	2.7%	-524	-33%	39	4%	T1,T2,T3	CS,D
Estonia	457	12	16	0.0%	-441	-97%	4	33%	T1,T2	CS,D
Finland	828	168	151	0.4%	-676	-82%	-16	-10%	T3	CS,D
France	8 582	7 588	7 351	18.5%	-1 231	-14%	-237	-3%	T2	CS
Germany	2 016	168	201	0.5%	-1 815	-90%	33	19%	CS	CS
Greece	917	630	637	1.6%	-280	-31%	6	1%	T1,T2	CS,D,PS
Hungary	1 888	676	721	1.8%	-1 167	-62%	44	7%	T1,T2	CS,D
Ireland	1 017	857	896	2.3%	-121	-12%	39	5%	T1,T2	CS,D
Italy	3 859	3 337	3 699	9.3%	-159	-4%	362	11%	T2	CS
Latvia	835	101	91	0.2%	-744	-89%	-10	-10%	T1,T2	CS,D
Lithuania	676	246	247	0.6%	-430	-64%	1	0%	T2	CS
Luxembourg	8	23	25	0.1%	17	203%	1	6%	T1,T2	CS,D
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Netherlands	4 009	3 628	3 731	9.4%	-278	-7%	104	3%	T2	CS
Poland	3 732	3 975	4 239	10.7%	506	14%	264	7%	T1,T2	CS,D
Portugal	830	797	782	2.0%	-48	-6%	-14	-2%	T1	CR,D
Romania	110	897	892	2.2%	782	712%	-5	-1%	T1,T2	CS,D
Slovakia	1 140	320	324	0.8%	-816	-72%	4	1%	T2	CS
Slovenia	221	87	88	0.2%	-133	-60%	0	0%	T1,T2	CS,D
Spain	2 990	4 262	5 119	12.9%	2 129	71%	857	20%	T1,T2	CS,D
Sweden	948	399	336	0.8%	-612	-65%	-62	-16%	T2	CS
United Kingdom	7 594	3 999	4 110	10.3%	-3 484	-46%	111	3%	T2	CS
EU-28	**51 657**	**38 171**	**39 694**	**100%**	**-11 963**	**-23%**	**1 522**	**4%**	**-**	**-**
Iceland	128	26	17	0.0%	-111	-87%	-9	-36%	T1	D
United Kingdom (KP)	7 594	3 999	4 110	10.3%	-3 484	-46%	111	3%	T2	CS
EU-28 + ISL	**51 785**	**38 197**	**39 711**	**100%**	**-12 074**	**-23%**	**1 513**	**4%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.Emissions of Malta are included in 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A2e Food Processing, Beverages and Tobacco - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1A2e amounted 4 140 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 79% and compared to 2016 increased by 3%. Category has 0.8% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption decreased by 78% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.40. Only Netherlands reports emissions as 'NO' (not occurring). Malta reports emissions as 'IE' (included elsewhere); emissions are included in category 1A2g. Ten 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 59% of Member States were calculated by using higher Tier methods or combination of methods in category 1A2e – Liquid Fuels (CO_2)). All Member States reported lower level of emissions in 2017 than in 1990 (except of Luxembourg and Poland).

Table 3.40: 1A2e Food Processing, Beverages and Tobacco, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	345	159	160	3.9%	-185	-54%	1	1%	T2	CS
Belgium	1 689	91	73	1.8%	-1 615	-96%	-18	-20%	T1	D
Bulgaria	409	33	30	0.7%	-379	-93%	-3	-10%	T1	D
Croatia	IE	61	50	1.2%	50	∞	-12	-19%	T1	D
Cyprus	73	50	68	1.6%	-5	-7%	18	36%	T1	D
Czech Republic	472	22	18	0.4%	-454	-96%	-4	-19%	T1	CS,D
Denmark	722	192	207	5.0%	-515	-71%	15	8%	T1,T2	CS,D
Estonia	437	3	6	0.2%	-431	-99%	4	141%	T1,T2	CS,D
Finland	365	72	71	1.7%	-293	-80%	0	-1%	T3	CS
France	3 025	280	238	5.8%	-2 787	-92%	-41	-15%	T2	CS
Germany	908	23	58	1.4%	-850	-94%	35	155%	CS	CS
Greece	863	476	491	11.9%	-371	-43%	15	3%	T2	CS
Hungary	463	23	23	0.6%	-440	-95%	0	0%	T1	D
Ireland	433	387	406	9.8%	-26	-6%	20	5%	T1,T2	CS,D
Italy	1 424	57	274	6.6%	-1 149	-81%	217	378%	T2	CS
Latvia	565	12	13	0.3%	-552	-98%	0	2%	T2	CS
Lithuania	174	40	42	1.0%	-132	-76%	3	6%	T2	CS
Luxembourg	4	7	8	0.2%	4	94%	2	22%	T1,T2	CS,D
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	165	NO	NO	-	-165	-100%	-	-	NA	NA
Poland	231	237	241	5.8%	10	4%	5	2%	T1	D
Portugal	829	235	216	5.2%	-614	-74%	-19	-8%	T1	CR,D
Romania	NO	150	145	3.5%	145	∞	-6	-4%	T1,T2	CS,D
Slovakia	359	0	1	0.0%	-358	-100%	1	158%	T2	CS
Slovenia	146	26	25	0.6%	-121	-83%	-2	-6%	T1	D
Spain	2 251	1 035	950	22.9%	-1 301	-58%	-85	-8%	T1	D
Sweden	596	158	135	3.3%	-461	-77%	-23	-15%	T2	CS
United Kingdom	2 735	170	173	4.2%	-2 563	-94%	3	2%	T2	CS
EU-28	**19 683**	**3 998**	**4 123**	**100%**	**-15 560**	**-79%**	**125**	**3%**	**-**	**-**
Iceland	128	26	17	0.4%	-111	-87%	-9	-36%	T1	D
United Kingdom (KP)	2 735	170	173	4.2%	-2 563	-94%	3	2%	T2	CS
EU-28 + ISL	**19 811**	**4 025**	**4 140**	**100%**	**-15 671**	**-79%**	**116**	**3%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Malta are included in 1A2g
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.72 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Spain (23%), Greece (12%), Ireland (10%), Italy (7%), Poland (6%), France (6%), Portugal (5%), Denmark (5%), United Kingdom (4%) and Austria (4%) which together have 81% share on EU-28+ISL emissions.

Figure 3.72: 1A2e Food Processing, Beverages and Tobacco, Liquid fuels: Emission trend and share for CO_2

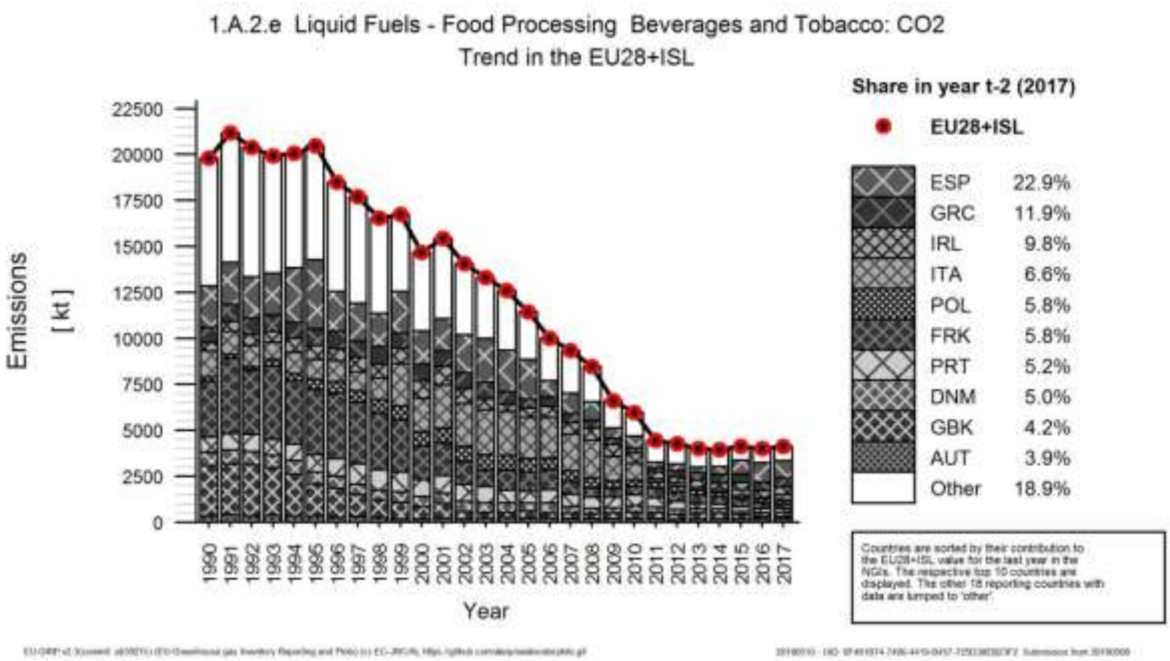


Figure 3.73 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. It can be seen, that CO_2 IEF decreased during 1990-2013, since 2013 is on relatively stable level. CO_2 IEF equaled to 74.05 t/TJ in 2017.

Figure 3.73: 1A2e Food Processing, Beverages and Tobacco, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

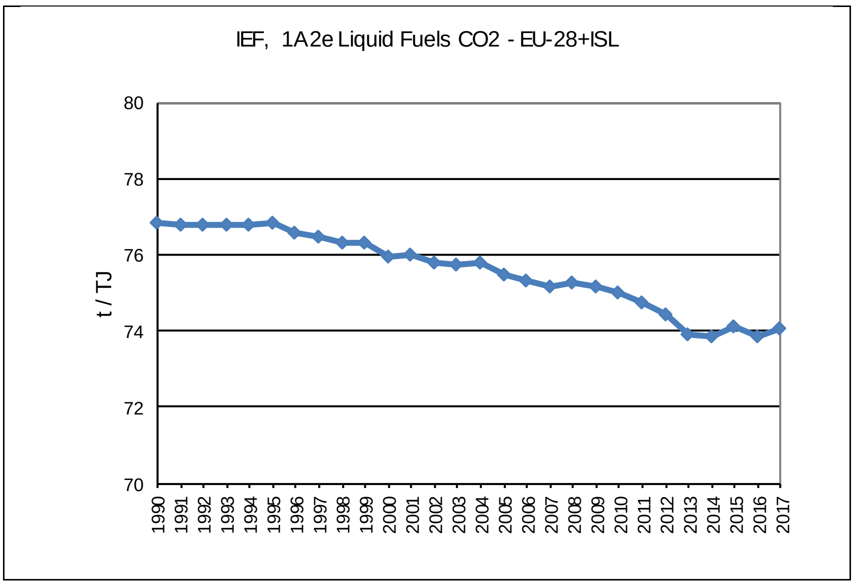
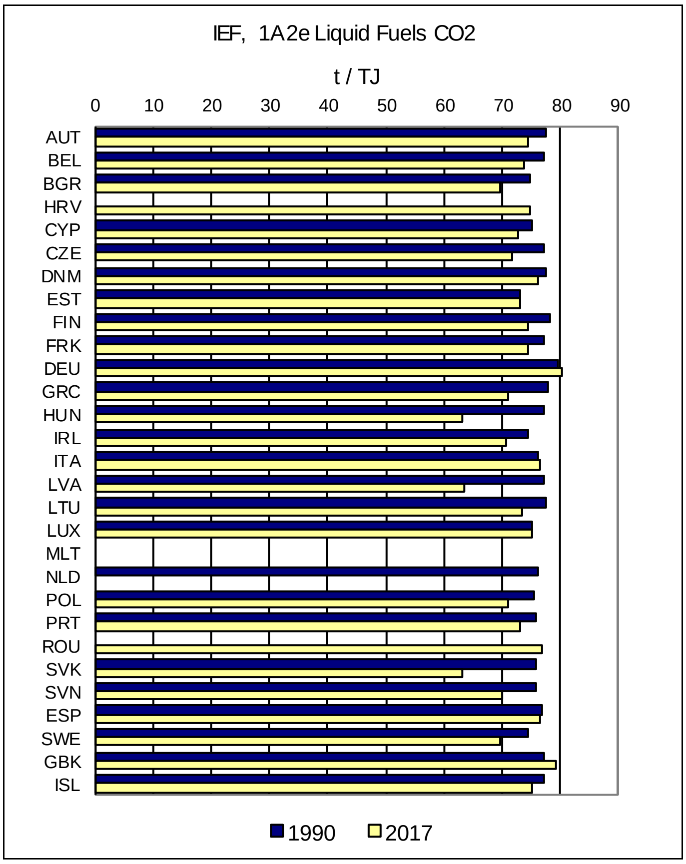


Figure 3.74 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. It can be seen that no major differences between CO_2 IEF used by Member States occur, also no major differences between CO_2 IEF calculated by Member States for 1990 and 2017 occur.

Figure 3.74: 1A2e Food Processing, Beverages and Tobacco, Liquid fuels: Implied Emissions for CO_2 by Member State and Iceland (in t/TJ)



1A2e Food Processing Beverages and Tobacco - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1A2e amounted 4 626 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 63% and compared to 2016 increased by 4%. Category has 0.9% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption decreased by 63% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.41. Cyprus, Estonia, Luxembourg, Malta, Portugal, Slovenia and Island report emissions as 'NO' (not occurring). Four 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 Member States were calculated by using higher Tier methods or combination of methods in category 1A2e – Solid Fuels (CO_2)). All Member States reported lower level of emissions in 2017 than in 1990.

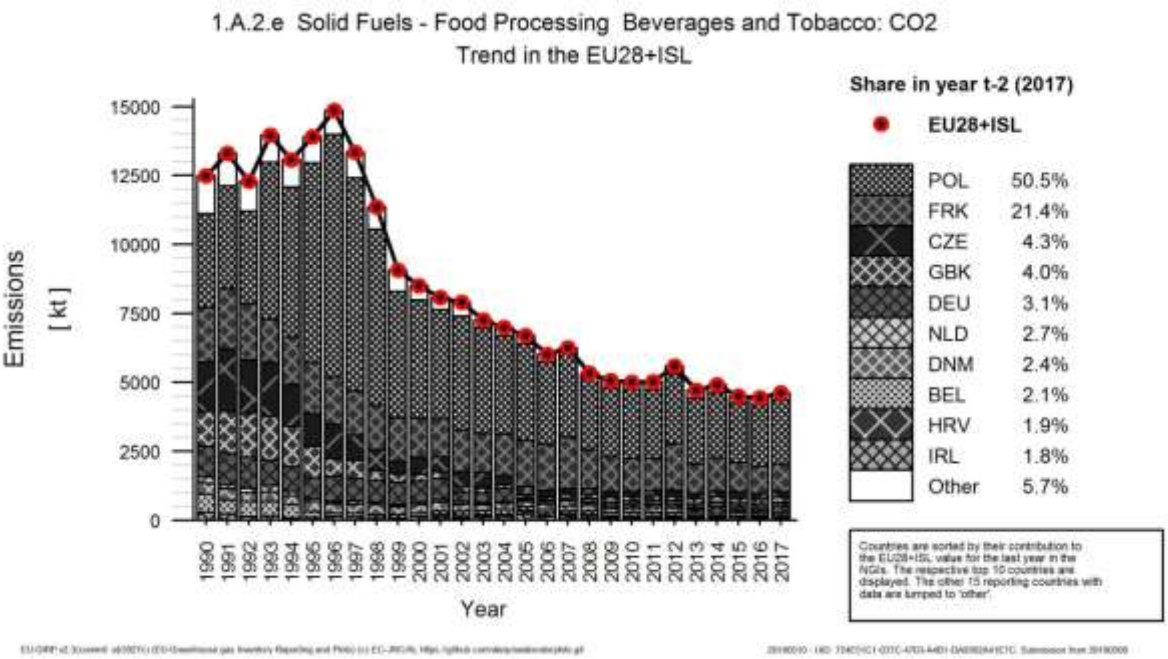
Table 3.41: 1A2e Food Processing, Beverages and Tobacco, Solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	18	16	18	0.4%	0	0%	2	10%	T2	CS
Belgium	651	95	98	2.1%	-552	-85%	3	4%	T1	D
Bulgaria	33	3	3	0.1%	-30	-90%	1	25%	T1,T2	CS,D
Croatia	IE	79	86	1.9%	86	∞	7	9%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	1 789	213	200	4.3%	-1 589	-89%	-14	-6%	T2	CS,D
Denmark	402	100	109	2.4%	-293	-73%	9	9%	T1	D
Estonia	5	0	NO	-	-5	-100%	0	-100%	NA	NA
Finland	257	79	67	1.5%	-189	-74%	-12	-15%	T3	CS
France	1 995	999	990	21.4%	-1 005	-50%	-9	-1%	T2	CS
Germany	1 108	145	142	3.1%	-965	-87%	-3	-2%	CS	CS
Greece	54	4	5	0.1%	-50	-92%	1	14%	T2	PS
Hungary	185	6	6	0.1%	-179	-97%	0	-1%	T1,T2	CS,D
Ireland	292	82	85	1.8%	-207	-71%	3	3%	T2	CS
Italy	87	12	17	0.4%	-70	-81%	5	37%	T2	CS
Latvia	95	5	4	0.1%	-91	-96%	-1	-14%	T2	CS
Lithuania	33	10	10	0.2%	-23	-69%	1	8%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	227	91	127	2.7%	-100	-44%	36	40%	T2	CS
Poland	3 392	2 206	2 338	50.5%	-1 054	-31%	132	6%	T1,T2	CS,D
Portugal	1	NO	NO	-	-1	-100%	-	-	NA	NA
Romania	110	45	35	0.8%	-74	-68%	-10	-21%	T1	D
Slovakia	312	40	47	1.0%	-264	-85%	8	20%	T2	CS
Slovenia	9	NO	NO	-	-9	-100%	-	-	NA	NA
Spain	94	37	41	0.9%	-53	-56%	4	12%	T1,T2	CS,D
Sweden	90	19	11	0.2%	-79	-88%	-8	-44%	T2	CS
United Kingdom	1 254	162	185	4.0%	-1 068	-85%	23	14%	T2	CS
EU-28	**12 491**	**4 449**	**4 626**	**100%**	**-7 866**	**-63%**	**177**	**4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 254	162	185	4.0%	-1 068	-85%	23	14%	T2	CS
EU-28 + ISL	**12 491**	**4 449**	**4 626**	**100%**	**-7 866**	**-63%**	**177**	**4%**	**-**	**-**

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 3.75 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Poland (51%) and France (21%) which together have 72% share on EU-28+ISL emissions.

Figure 3.75: 1A2e Food Processing, Beverages and Tobacco, solid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.76 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. It can be seen, that CO_2 IEF is relatively stable during whole time period. CO_2 IEF equaled to 95.00 t/TJ in 2017.

Figure 3.76: 1A2e Food Processing, Beverages and Tobacco, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

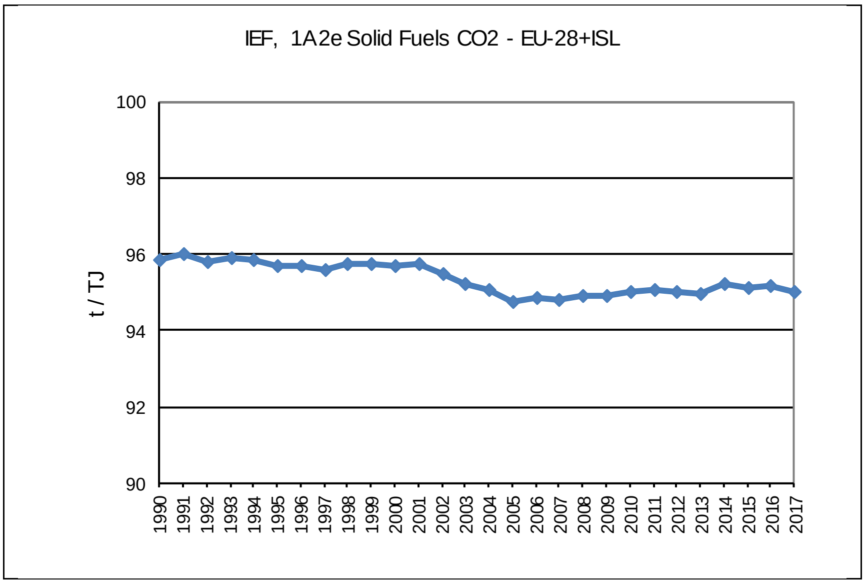
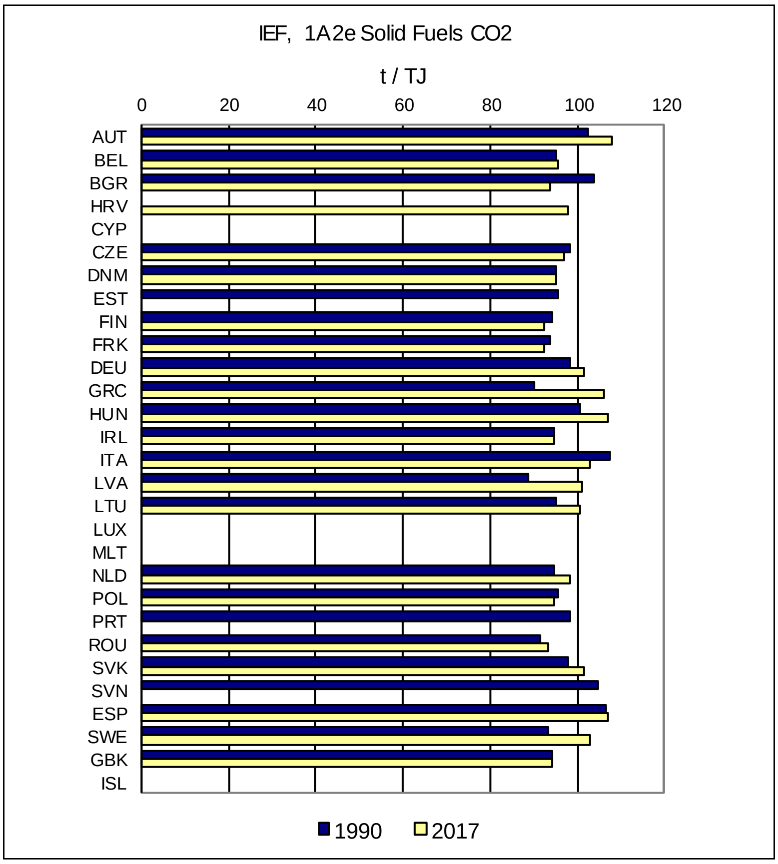


Figure 3.77 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. It can be seen that no major differences between CO_2 IEF used by Member States occur, also no major differences between CO_2 IEF calculated by Member States for 1990 and 2017 occur.

Figure 3.77: 1A2e Food Processing, Beverages and Tobacco, Solid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2e Food Processing Beverages and Tobacco - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1A2e amounted 30 892 kt in 2017 for EU-28+ISL. CO_2 emissions increased compared to year 1990 by 60% and compared to 2016 by 4%. Category has 6% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption increased by 59% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.42. Cyprus, Malta and Island report emissions as 'NO' (not occurring). For confidentiality reasons Germany reports emissions in 1A2g. Emissions of Malta are included in 1A2g. Three 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 95% of Member States were calculated by using higher Tier methods or combination of methods in category 1A2e – Gaseous Fuels (CO_2)). Nine Member States reported lower level of emissions in 2017 than in 1990, the rest of Member States reported increase of emissions.

Table 3.42: 1A2e Food Processing, Beverages and Tobacco, gaseous 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	507	829	826	2.7%	320	63%	-3	0%	T2	CS
Belgium	684	2 093	2 099	6.8%	1 415	207%	6	0%	T1,T3	D,PS
Bulgaria	11	204	207	0.7%	196	1711%	3	1%	T2	CS
Croatia	IE	236	223	0.7%	223	∞	-14	-6%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	727	786	813	2.6%	85	12%	27	3%	T2	CS
Denmark	468	736	751	2.4%	283	60%	15	2%	T3	CS
Estonia	15	9	9	0.0%	-6	-38%	0	5%	T2	CS
Finland	67	17	13	0.0%	-54	-81%	-4	-26%	T3	CS
France	3 562	6 309	6 112	19.8%	2 550	72%	-197	-3%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	150	141	0.5%	141	∞	-9	-6%	T2	CS
Hungary	1 239	647	691	2.2%	-548	-44%	44	7%	T1	D
Ireland	293	385	402	1.3%	109	37%	17	4%	T2	CS
Italy	2 348	3 268	3 408	11.0%	1 060	45%	141	4%	T2	CS
Latvia	175	82	72	0.2%	-103	-59%	-10	-12%	T2	CS
Lithuania	469	196	193	0.6%	-275	-59%	-3	-1%	T2	CS
Luxembourg	4	17	16	0.1%	13	329%	0	-1%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 617	3 537	3 604	11.7%	-13	0%	67	2%	T2	CS
Poland	109	1 532	1 659	5.4%	1 550	1422%	127	8%	T2	CS
Portugal	NO	562	567	1.8%	567	∞	5	1%	T1	D
Romania	NO	687	688	2.2%	688	∞	2	0%	T2	CS
Slovakia	470	280	276	0.9%	-194	-41%	-4	-1%	T2	CS
Slovenia	65	61	63	0.2%	-3	-4%	2	3%	T2	CS
Spain	646	3 191	4 128	13.4%	3 483	540%	938	29%	T2	CS
Sweden	254	214	178	0.6%	-76	-30%	-36	-17%	T2	CS
United Kingdom	3 605	3 667	3 752	12.1%	147	4%	85	2%	T2	CS
EU-28	**19 335**	**29 693**	**30 892**	**100%**	**11 557**	**60%**	**1 199**	**4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 605	3 667	3 752	12.1%	147	4%	85	2%	T2	CS
EU-28 + ISL	**19 335**	**29 693**	**30 892**	**100%**	**11 557**	**60%**	**1 199**	**4%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany included in 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.78 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has France (20%), Spain (13%), United Kingdom (12%), Netherland (12%), Italy (11%), Belgium (7%) and Poland (5%) which together have 80% share on EU-28+ISL emissions.

Figure 3.78: 1A2e Food Processing, Beverages and Tobacco, Gaseous fuels: Emission trend and share for CO_2

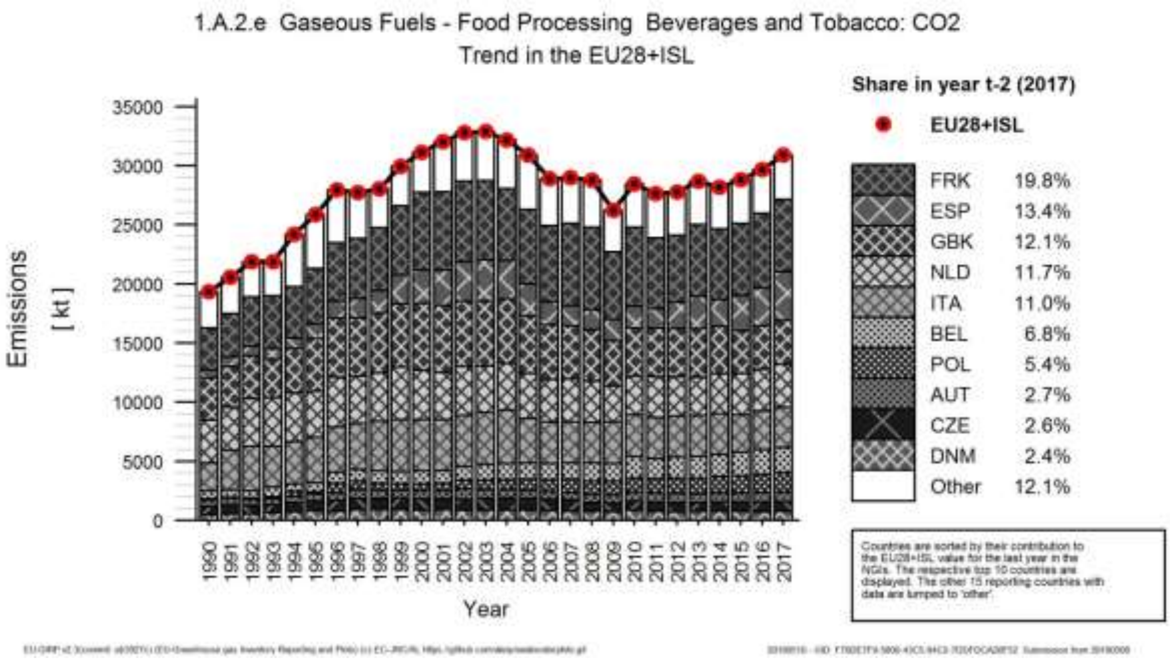


Figure 3.79 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. CO_2 IEF equaled to 56.25 t/TJ in 2017.

Figure 3.79: 1A2e Food Processing, Beverages and Tobacco, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

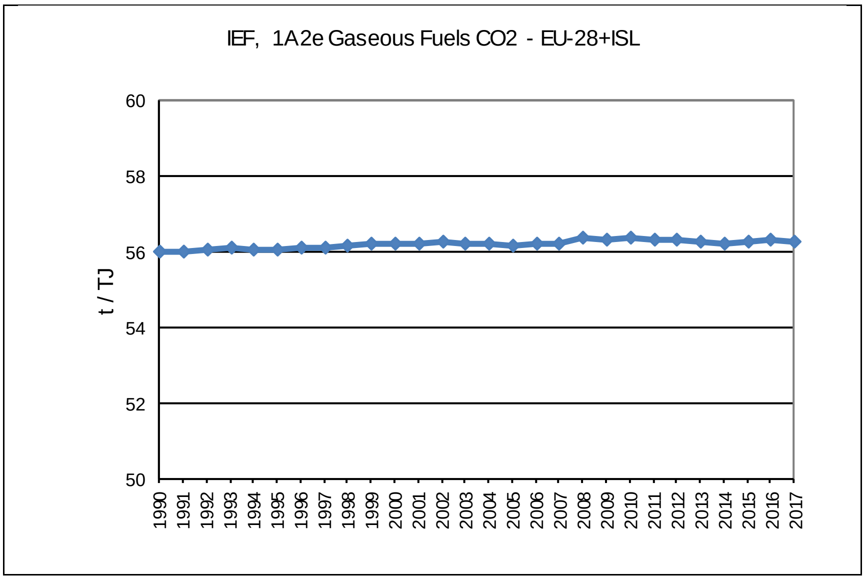
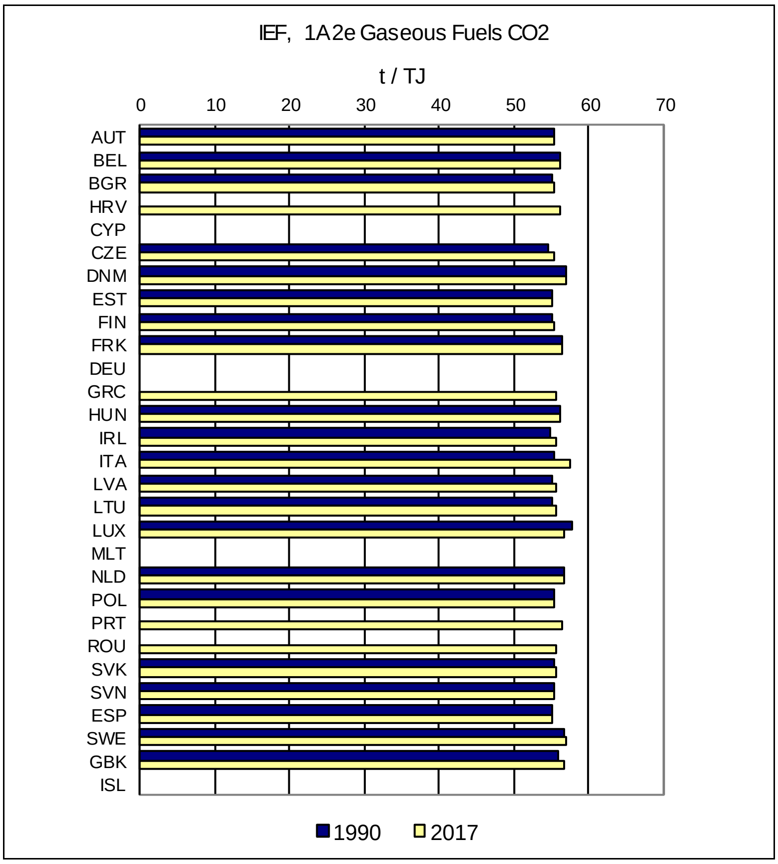


Figure 3.80 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. It can be seen that no major differences between CO_2 IEF used by Member States occur, also no major differences between CO_2 IEF calculated by Member States for 1990 and 2017 occur.

Figure 3.80: 1A2e Food Processing, Beverages and Tobacco, Gaseous fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



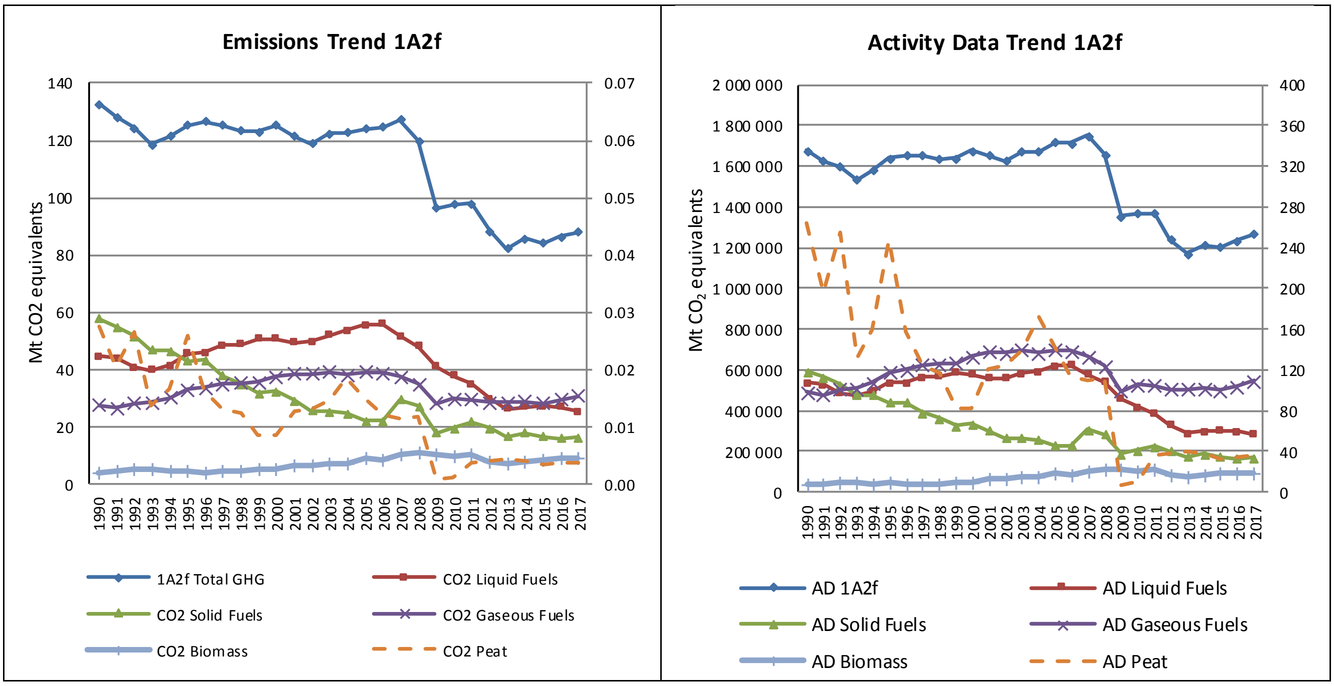
3.2.2.5 Non-metallic Minerals (1A2f)

This chapter provides information about European emission trend, Member States contribution to the overall emission trend, activity data and emission factors used for emission estimates by Member States and Island for category 1A2f Non-metallic Minerals.

Total CO_2 emissions from 1A2f amounted to 86 814 kt CO_2 eq. in 2017. The trend of total emissions for 1990 to 2017 from category 1A2f is depicted in Figure 3.81. Total CO_2 emissions decreased by 34% since 1990 and increased by 2% between 2016 and 2017. The sharp decline in 2009 is due to the economic crisis and sharp decline in building activity. CO_2 emissions from 1A2f Non-metallic Minerals accounted for 18% of 1A2 source category.

Figure 3.81 shows the emission trend within the category 1A2f, which is dominated by CO_2 emissions from gaseous fuels in 2017. The share of liquid fuels on CO_2 emissions from 1A2f decreased from 34% in 1990 to 29% in 2017. The share of solid fuels on CO_2 emissions from 1A2f decreased from 44% in 1990 to 19% in 2017. The share of gaseous fuels on CO_2 emissions from 1A2f increased from 21% in 1990 to 35% in 2017.

Figure 3.81: 1A2f 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-28+ISL submissions are depicted in Table.3.43. Malta reports emissions as 'NO' (not occurring) and 'IE' (included elsewhere). 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 (897%) which has 3% share on total EU-28+ISL emissions.

Table.3.43: 1A2f Non-metallic Minerals : Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	1 669	1 631	1 636	1.9%	-33	-2%	6	0%	T1,T2	CS,D
Belgium	5 525	3 463	3 352	3.9%	-2 173	-39%	-111	-3%	T1,T3	D,PS
Bulgaria	2 646	1 232	1 194	1.4%	-1 452	-55%	-38	-3%	T1,T2	CS,D
Croatia	NO,IE	110	105	0.1%	105	∞	-6	-5%	T1	D
Cyprus	380	480	508	0.6%	128	34%	28	6%	CS,T1	CS,D
Czech Republic	4 527	2 549	2 598	3.0%	-1 930	-43%	48	2%	T1,T2	CS,D
Denmark	1 311	1 362	1 432	1.6%	121	9%	70	5%	T1,T2,T3	CS,D,PS
Estonia	952	253	421	0.5%	-530	-56%	168	67%	T1,T2,T3	CS,D,PS
Finland	1 368	642	672	0.8%	-696	-51%	31	5%	T3	CS,D
France	14 260	8 735	8 092	9.3%	-6 168	-43%	-643	-7%	T2,T3	CS,PS
Germany	18 507	14 085	15 233	17.5%	-3 274	-18%	1 149	8%	CS	CS
Greece	6 278	3 807	3 875	4.5%	-2 404	-38%	68	2%	T1,T2	CS,D,PS
Hungary	2 326	1 120	1 130	1.3%	-1 196	-51%	10	1%	T1,T2,T3	CS,D,PS
Ireland	819	1 216	1 278	1.5%	459	56%	62	5%	T1,T2,T3	CS,D,PS
Italy	20 980	13 142	12 335	14.2%	-8 644	-41%	-807	-6%	T2	CS
Latvia	598	221	264	0.3%	-334	-56%	43	20%	T1,T2,T3	CS,D,PS
Lithuania	3 210	408	399	0.5%	-2 811	-88%	-10	-2%	T2	CS
Luxembourg	537	407	392	0.5%	-144	-27%	-15	-4%	T1,T2	CS,D,PS
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Netherlands	2 298	1 224	1 222	1.4%	-1 076	-47%	-3	0%	T2	CS
Poland	10 414	7 973	8 906	10.3%	-1 508	-14%	933	12%	T1,T2	CS,D
Portugal	3 288	2 593	2 732	3.1%	-556	-17%	139	5%	T1,T3	D,PS
Romania	265	2 554	2 638	3.0%	2 373	897%	84	3%	T1,T2	CS,D
Slovakia	3 408	1 349	1 311	1.5%	-2 097	-62%	-38	-3%	T2	CS
Slovenia	296	408	442	0.5%	145	49%	34	8%	T1,T2,T3	CS,D,PS
Spain	16 340	10 597	10 887	12.5%	-5 453	-33%	290	3%	T1,T2	CS,D,PS
Sweden	1 826	1 226	1 222	1.4%	-604	-33%	-4	0%	T1,T2	CS
United Kingdom	7 049	2 599	2 538	2.9%	-4 511	-64%	-61	-2%	T2	CS
EU-28	**131 077**	**85 387**	**86 814**	**100%**	**-44 263**	**-34%**	**1 427**	**2%**	**-**	**-**
Iceland	50	0	0	0.0%	-50	-99%	0	19%	T1	D
United Kingdom (KP)	7 049	2 599	2 538	2.9%	-4 511	-64%	-61	-2%	T2	CS
EU-28 + ISL	**131 127**	**85 387**	**86 814**	**100%**	**-44 312**	**-34%**	**1 427**	**2%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Malta includes emissions under 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A2f Non-metallic Minerals - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1A2f amounted 25 327 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 42% and compared to 2016 by 5%. Category has 5% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption decreased by 47% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table **3.44**. Sweden reports 2016 and 2017 emissions as 'C' (confidential). Malta reports emissions as 'IE' (included elsewhere); emissions are included in category 1A2g. Six 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 97% of member were calculated by using higher Tier methods or combination of methods in category 1A2f – Liquid Fuels (CO_2)). Seven Member States reported higher level of emissions in 2017 than in 1990.

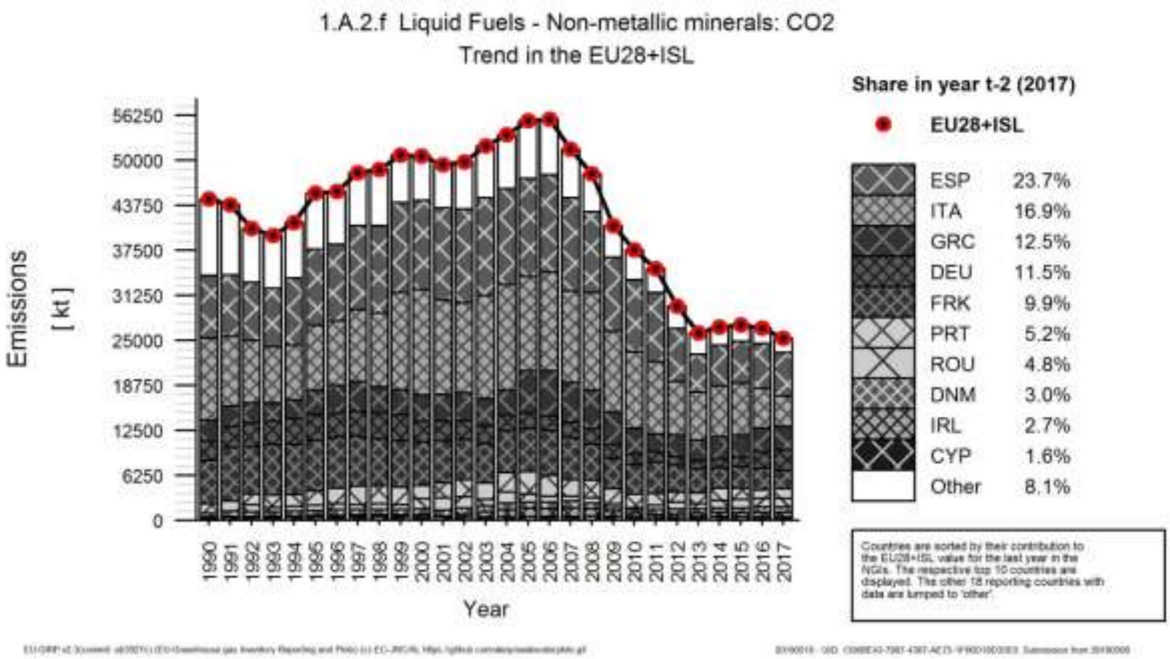
Table 3.44: 1A2f Non-metallic Minerals , liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt				Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	EF informa-tion
	1990	1995	2016	2017		kt CO2	%	kt CO2	%		
Austria	508	348	165	136	0.5%	-372	-73%	-29	-18%	T2	CS
Belgium	1 509	1 932	235	236	0.9%	-1 272	-84%	2	1%	T1,T3	D,PS
Bulgaria	666	446	370	339	1.3%	-328	-49%	-32	-9%	T1	D
Croatia	IE	IE	17	1	0.0%	1	∞	-16	-97%	T1	D
Cyprus	148	432	413	407	1.6%	259	175%	-5	-1%	CS	CS
Czech Republic	1 029	920	43	19	0.1%	-1 010	-98%	-24	-55%	T1	CS,D
Denmark	499	651	737	769	3.0%	270	54%	32	4%	T1,T2	CS,D
Estonia	140	66	2	3	0.0%	-137	-98%	1	83%	T1,T2	CS,D
Finland	437	253	248	250	1.0%	-187	-43%	2	1%	T3	CS
France	6 068	7 008	2 960	2 514	9.9%	-3 555	-59%	-447	-15%	T2,T3	CS,PS
Germany	2 663	3 591	2 300	2 906	11.5%	243	9%	606	26%	CS	CS
Greece	2 914	3 417	3 306	3 177	12.5%	264	9%	-129	-4%	T2	PS
Hungary	423	425	368	338	1.3%	-85	-20%	-30	-8%	T1,T2	CS,D
Ireland	312	226	676	675	2.7%	363	116%	-1	0%	T1,T2	CS,D
Italy	11 375	8 970	5 572	4 271	16.9%	-7 104	-62%	-1 301	-23%	T2	CS
Latvia	267	192	12	4	0.0%	-262	-98%	-8	-64%	T1,T2	CS,D
Lithuania	2 750	604	7	12	0.0%	-2 738	-100%	5	76%	T2	CS
Luxembourg	23	28	5	7	0.0%	-16	-69%	2	41%	T2	CS
Malta	IE	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	468	358	15	15	0.1%	-453	-97%	0	0%	T2	CS
Poland	392	578	222	281	1.1%	-111	-28%	60	27%	T1	D
Portugal	1 318	2 021	1 205	1 327	5.2%	9	1%	122	10%	T1,T3	D,PS
Romania	NO	755	1 230	1 224	4.8%	1 224	∞	-6	-1%	T1,T2	CS,D
Slovakia	1 219	376	226	204	0.8%	-1 015	-83%	-22	-10%	T2	CS
Slovenia	63	82	96	112	0.4%	48	76%	16	16%	T1	D
Spain	8 686	10 575	6 152	6 011	23.7%	-2 675	-31%	-141	-2%	T1,T2	CS,D
Sweden	625	727	C	C	-	-625	-100%	-	-	T1	CS
United Kingdom	127	474	143	89	0.4%	-38	-30%	-54	-38%	T2	CS
EU-28	**44 004**	**44 727**	**26 726**	**25 327**	**100%**	**-18 677**	**-42%**	**-1 399**	**-5%**	**-**	**-**
Iceland	2	15	0	0	0.0%	-2	-81%	0	19%	T1	D
United Kingdom (KP)	127	474	143	89	0.4%	-38	-30%	-54	-38%	T2	CS
EU-28 + ISL	**44 006**	**44 742**	**26 726**	**25 327**	**100%**	**-18 679**	**-42%**	**-1 399**	**-5%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Malta includes emissions under 1A2g.
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.3.82 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Spain (24%), Italy (17%), Greece (13%), Germany (11%), France (10%), Portugal (5%) and Romania (5%) which together have 85% share on EU-28+ISL emissions.

Figure.3.82: 1A2f Non-metallic Minerals, liquid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure.3.83 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. It can be seen, that CO_2 IEF increased more obvious 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. CO_2 IEF equaled to 89.58 t/TJ in 2017.

Figure.3.83: 1A2f Non-metallic Minerals, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

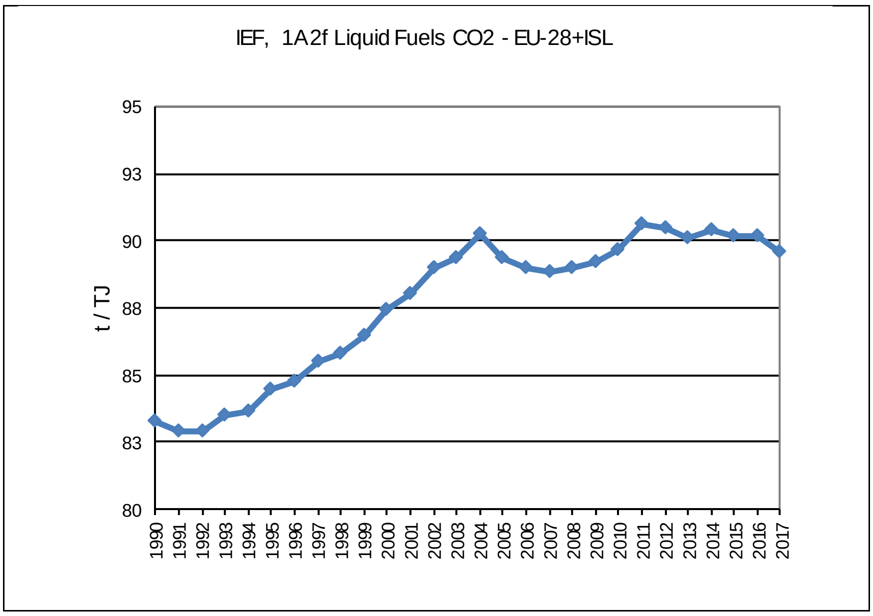
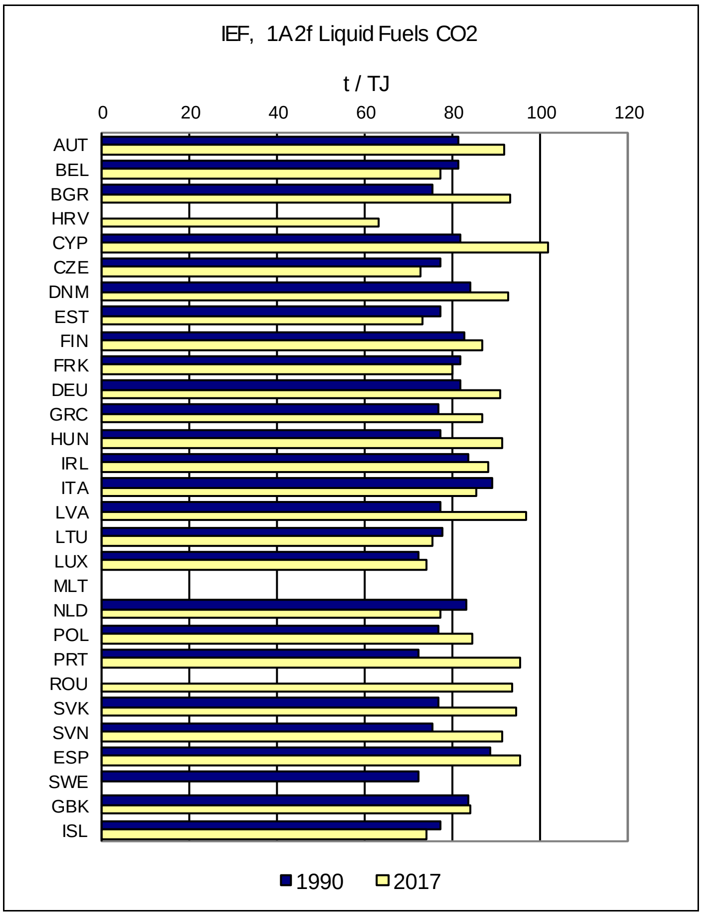


Figure 3.84 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. The CO_2 IEF is in many cases higher in 2017 than in 1990 which reflects reasons for relatively high CO_2 IEF mentioned above.

Figure 3.84: 1A2f Non-metallic Minerals, liquid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2f Non-metallic Minerals - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1A2f amounted 16 327 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 71% and compared to 2016 increased by 3%. Category has 3% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption decreased by 71% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.45. Croatia, Malta, Portugal and Island report emissions as 'NO' (not occurring). Sweden reports emissions as 'C' (confidential). Luxembourg 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 Member States were calculated by using higher Tier methods or combination of methods in category 1A2f – Solid Fuels (CO_2)). All Member States reported lower level of emissions in 2017 than in 1990 (except of Latvia and Lithuania, but it should be noted that the share of their emissions on total EU-28+ISL emissions is minor compared to for example Germany which has the highest share on EU-28+ISL emissions).

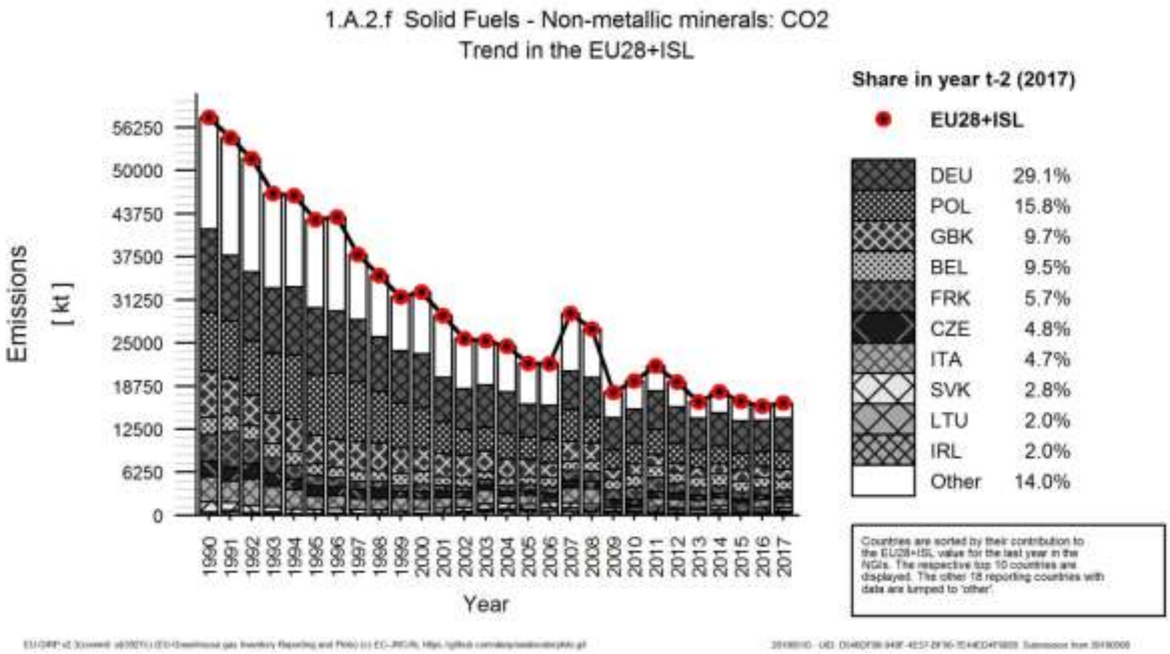
Table 3.45: 1A2f Non-metallic Minerals, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	EF informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	535	221	211	1.3%	-324	-61%	-10	-5%	T2	CS
Belgium	2 466	1 520	1 544	9.5%	-922	-37%	24	2%	T1,T3	D,PS
Bulgaria	295	240	209	1.3%	-86	-29%	-31	-13%	T1,T2	CS,D
Croatia	IE	NO	NO	-	-	-	-	-	NA	NA
Cyprus	232	2	12	0.1%	-220	-95%	10	499%	CS	CS
Czech Republic	2 209	673	788	4.8%	-1 421	-64%	115	17%	T2	CS,D
Denmark	574	206	224	1.4%	-350	-61%	19	9%	T1,T3	D,PS
Estonia	756	93	171	1.0%	-585	-77%	78	85%	T1,T2	CS,D
Finland	806	281	309	1.9%	-497	-62%	28	10%	T3	CS
France	3 906	1 004	936	5.7%	-2 970	-76%	-68	-7%	T2,T3	CS,PS
Germany	12 053	4 599	4 748	29.1%	-7 305	-61%	149	3%	CS	CS
Greece	3 364	128	154	0.9%	-3 211	-95%	25	20%	T2	PS
Hungary	230	116	135	0.8%	-95	-41%	19	16%	T1,T2	D,PS
Ireland	375	340	319	2.0%	-56	-15%	-21	-6%	T2	CS
Italy	3 690	1 124	767	4.7%	-2 923	-79%	-357	-32%	T2	CS
Latvia	15	67	91	0.6%	76	499%	24	36%	T2	CS
Lithuania	60	339	328	2.0%	269	451%	-11	-3%	T2	CS
Luxembourg	312	161	152	0.9%	-160	-51%	-9	-5%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	346	162	197	1.2%	-149	-43%	36	22%	T2	CS
Poland	8 653	2 092	2 573	15.8%	-6 079	-70%	481	23%	T1,T2	CS,D
Portugal	1 958	NO	NO	-	-1 958	-100%	-	-	NA	NA
Romania	265	240	229	1.4%	-36	-13%	-11	-5%	T1,T2	CS,D
Slovakia	1 474	451	451	2.8%	-1 023	-69%	1	0%	T2	CS
Slovenia	113	44	49	0.3%	-64	-57%	5	11%	T1,T3	D,PS
Spain	5 221	147	148	0.9%	-5 073	-97%	2	1%	T1,T2	CS,D
Sweden	1 135	C	C	-	-1 135	-100%	-	-	T2	CS
United Kingdom	6 601	1 608	1 580	9.7%	-5 022	-76%	-29	-2%	T2	CS
EU-28	**56 509**	**15 857**	**16 327**	**100%**	**-40 182**	**-71%**	**470**	**3%**	**-**	**-**
Iceland	48	NO	NO	-	-48	-100%	-	-	NA	NA
United Kingdom (KP)	6 601	1 608	1 580	9.7%	-5 022	-76%	-29	-2%	T2	CS
EU-28 + ISL	**56 557**	**15 857**	**16 327**	**100%**	**-40 230**	**-71%**	**470**	**3%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
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 3.85 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Germany (29%), Poland (16%), United Kingdom (10%), Belgium (9%), France (6%), Czechia (5%) and Italy (5%) which together have 79% share on EU-28+ISL emissions.

Figure 3.85: 1A2f Non-metallic Minerals, solid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.86 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. CO_2 IEF equaled to 95.85 t/TJ in 2017.

Figure 3.86: 1A2f Non-metallic Minerals, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

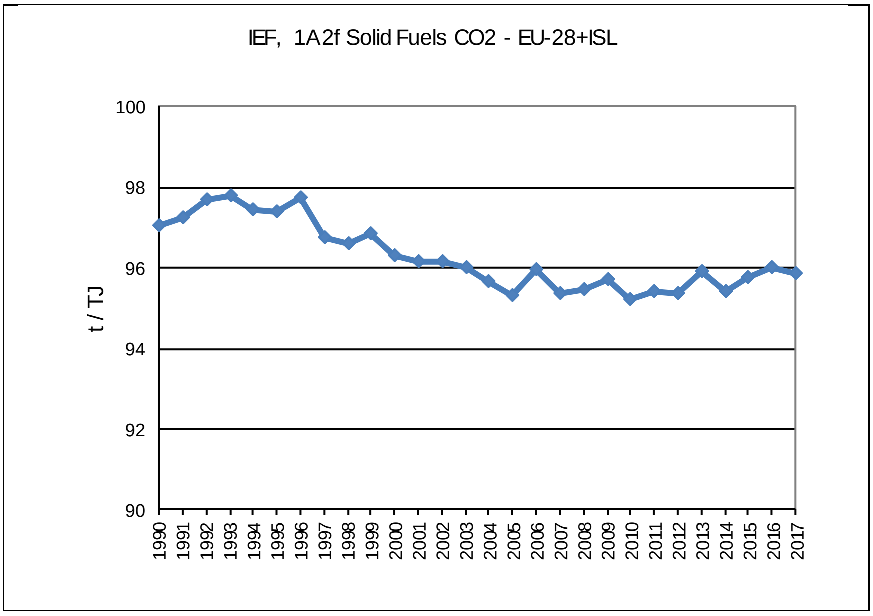
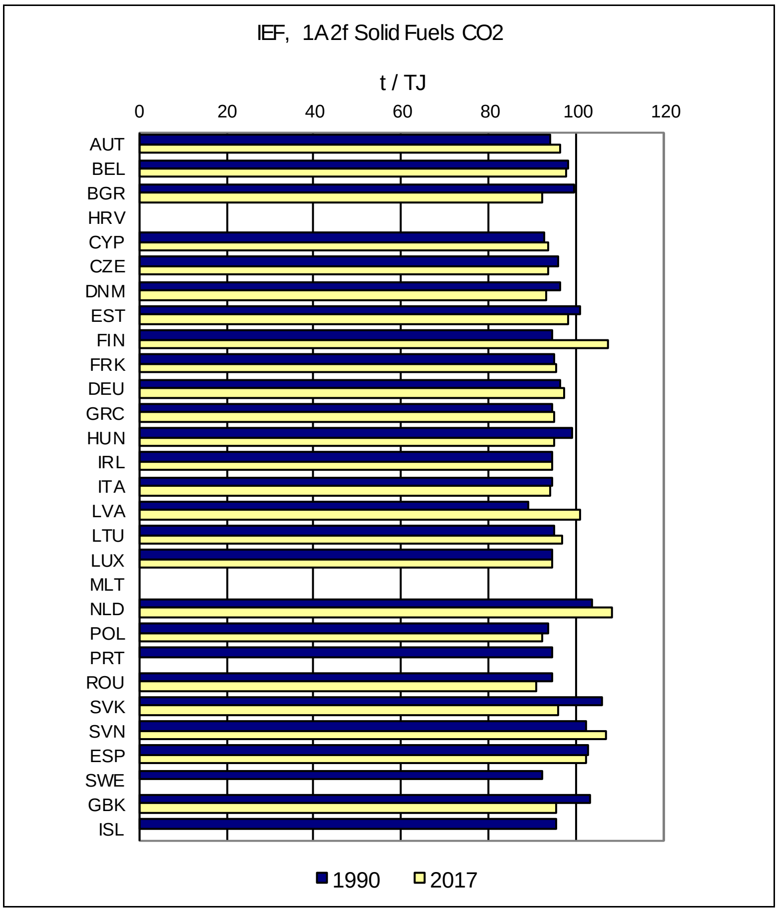


Figure 3.87 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. It can be seen that no major differences between CO_2 IEF used by Member States occur, also no major differences between CO_2 IEF calculated by Member States for 1990 and 2017 occur. The comparatively high implied emission factor of Finland for 2017 is due to the use of CO waste gas from a steel plant.

Figure 3.87: 1A2f Non-metallic Minerals, solid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2f Non-metallic Minerals - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1A2f amounted 30 808 kt in 2017 for EU-28+ISL. CO_2 emissions increased compared to year 1990 by 13% and compared to 2016 by 5%. Category has 6% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption increased by 11% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.46. Cyprus, Malta and Island report emissions as 'NO' (not occurring). Three 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 98% of Member States were calculated by using higher Tier methods or combination of methods in category 1A2f – Gaseous Fuels (CO_2)). Nine Member States reported higher level of emissions in 2017 than in 1990.

Table 3.46: 1A2f Non-metallic Minerals, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	559	645	667	2.2%	108	19%	22	3%	T2	CS
Belgium	1 364	1 284	1 249	4.1%	-116	-8%	-35	-3%	T1,T3	D,PS
Bulgaria	1 684	622	646	2.1%	-1 038	-62%	24	4%	T2	CS
Croatia	IE	93	104	0.3%	104	∞	11	11%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	1 289	1 380	1 388	4.5%	99	8%	8	1%	T2	CS
Denmark	238	274	285	0.9%	47	20%	12	4%	T3	CS
Estonia	46	32	30	0.1%	-17	-36%	-3	-8%	T2	CS
Finland	126	50	49	0.2%	-77	-61%	-1	-3%	T3	CS
France	3 962	3 491	3 397	11.0%	-565	-14%	-94	-3%	T2,T3	CS,PS
Germany	3 265	4 529	4 707	15.3%	1 442	44%	178	4%	CS	CS
Greece	NO	329	462	1.5%	462	∞	133	40%	T2	CS
Hungary	1 673	473	454	1.5%	-1 218	-73%	-19	-4%	T1	D
Ireland	132	39	39	0.1%	-93	-70%	1	2%	T2	CS
Italy	5 915	6 037	6 851	22.2%	936	16%	814	13%	T2	CS
Latvia	316	66	71	0.2%	-245	-77%	6	8%	T2	CS
Lithuania	382	59	55	0.2%	-328	-86%	-4	-7%	T2	CS
Luxembourg	201	169	158	0.5%	-43	-22%	-11	-6%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 484	1 047	1 009	3.3%	-475	-32%	-38	-4%	T2	CS
Poland	1 359	2 443	2 470	8.0%	1 111	82%	27	1%	T2	CS
Portugal	NO	1 108	1 107	3.6%	1 107	∞	-1	0%	T1,T3	D,PS
Romania	NO	610	629	2.0%	629	∞	19	3%	T2	CS
Slovakia	542	373	343	1.1%	-199	-37%	-29	-8%	T2	CS
Slovenia	115	174	180	0.6%	65	56%	6	3%	T2	CS
Spain	2 314	3 606	4 071	13.2%	1 757	76%	465	13%	T2	CS
Sweden	65	113	120	0.4%	54	83%	6	5%	T1	CS
United Kingdom	320	266	266	0.9%	-53	-17%	1	0%	T2	CS
EU-28	**27 353**	**29 313**	**30 808**	**100%**	**3 455**	**13%**	**1 494**	**5%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	320	266	266	0.9%	-53	-17%	1	0%	T2	CS
EU-28 + ISL	**27 353**	**29 313**	**30 808**	**100%**	**3 455**	**13%**	**1 494**	**5%**	**-**	**-**

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 3.88 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Italy (22%), Germany (15%), Spain (13%), France (11%), Poland (8%), Czechia (5%) and Belgium (4%) which together have 78% share on EU-28+ISL emissions.

Figure 3.88: 1A2f Non-metallic Minerals, gaseous fuels: Emission trend and share for CO_2

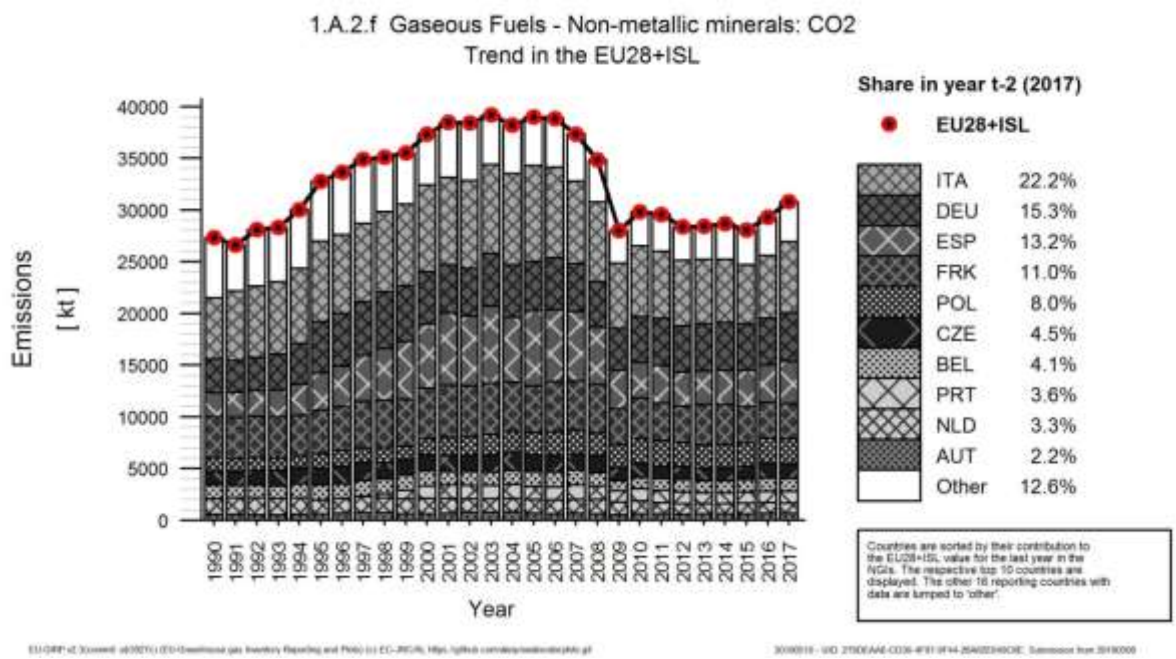


Figure 3.89 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. CO_2 IEF is slightly increasing during 1990-2017. CO_2 IEF equaled to 56.30 t/TJ in 2017.

Figure 3.89: 1A2f Non-metallic Minerals, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

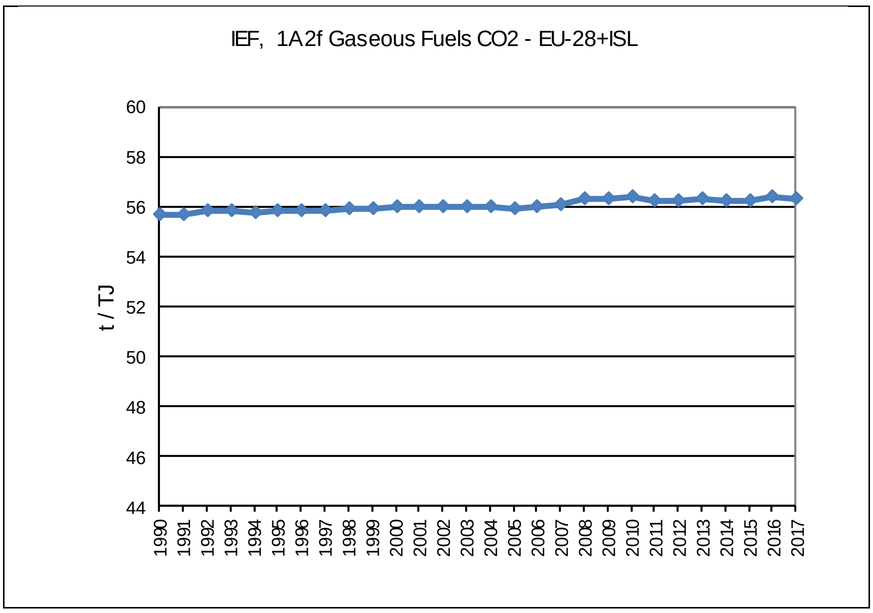
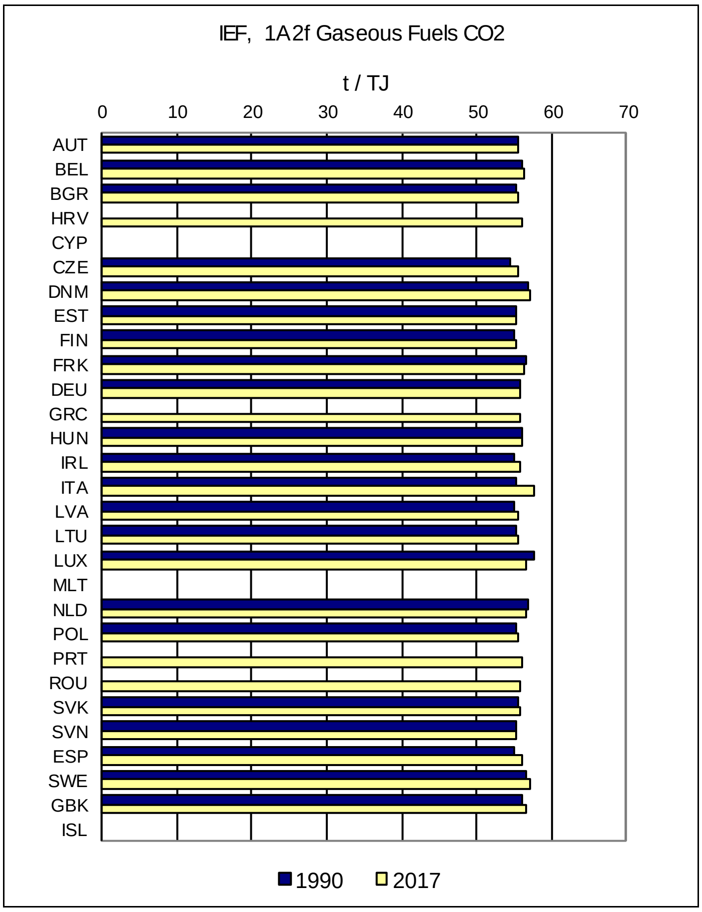


Figure 3.90 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. It can be seen that no major differences between CO_2 IEF used by Member States occur, also no major differences between CO_2 IEF calculated by Member States for 1990 and 2017 occur.

Figure 3.90: 1A2f Non-metallic Minerals, gaseous fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2f Non-metallic Minerals – Other Fossil Fuels (CO_2)

CO_2 emissions from the use of other fossil fuels in category 1A2f amounted 13 410 kt in 2017 for EU-28+ISL. CO_2 emissions increased compared to year 1990 by 843% and compared to 2016 by 7%. Category has 3% share on total CO_2 equivalent emissions from category 1A2. Fuel consumption increased by 927% compared to 1990.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.47. Bulgaria, Croatia, Lithuania, Malta, Netherlands and Iceland report emissions as 'NO' (not occurring). Two 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 73% of Member States were calculated by using higher Tier methods or combination of methods in category 1A2f – Other Fossil Fuels (CO_2)). All Member States reported higher level of emissions in 2017 than in 1990. Most Member States 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: 1A2f Non-metallic Minerals, other fossil fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	67	600	622	4.6%	555	825%	23	4%	T2	CS
Belgium	186	424	323	2.4%	137	73%	-102	-24%	T1,T3	D,PS
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	66	89	0.7%	89	∞	24	36%	T1	D
Czech Republic	NO	453	403	3.0%	403	∞	-50	-11%	T2	CS
Denmark	NO	145	154	1.1%	154	∞	8	6%	T2	CS
Estonia	NO	126	217	1.6%	217	∞	91	72%	T3	PS
Finland	NO	63	64	0.5%	64	∞	2	3%	T3	CS
France	323	1 279	1 245	9.3%	922	285%	-35	-3%	T2,T3	CS,PS
Germany	526	2 656	2 872	21.4%	2 347	446%	217	8%	CS	CS
Greece	NO	43	81	0.6%	81	∞	38	88%	T2	PS
Hungary	NO	162	202	1.5%	202	∞	40	25%	T3	PS
Ireland	NO	162	245	1.8%	245	∞	83	51%	T3	PS
Italy	NO	409	446	3.3%	446	∞	38	9%	NA	NA
Latvia	NO	76	98	0.7%	98	∞	22	28%	T3	PS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	73	75	0.6%	75	∞	2	3%	T1,T2	D,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	10	3 217	3 582	26.7%	3 572	36732%	365	11%	T1	D
Portugal	12	279	298	2.2%	286	2339%	19	7%	T1,T3	D,PS
Romania	NO	473	556	4.1%	556	∞	83	18%	T2	CS
Slovakia	173	300	312	2.3%	139	81%	13	4%	T2	CS
Slovenia	5	94	101	0.8%	96	2058%	7	8%	T1,T3	D,PS
Spain	120	693	658	4.9%	538	450%	-36	-5%	T2	CS,PS
Sweden	NO	202	163	1.2%	163	∞	-38	-19%	T2	CS
United Kingdom	1	582	603	4.5%	602	60118%	21	4%	T2	CS
EU-28	**1 422**	**12 577**	**13 410**	**100%**	**11 988**	**843%**	**833**	**7%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1	582	603	4.5%	602	60118%	21	4%	T2	CS
EU-28 + ISL	**1 422**	**12 577**	**13 410**	**100%**	**11 988**	**843%**	**833**	**7%**	**-**	**-**

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

Figure 3.91 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Poland (27%), Germany (21%), France (9%), Spain (5%), Austria (5%) and United Kingdom (4%) which together have 71% share on EU-28+ISL emissions.

Figure 3.91: 1A2f Non-metallic Minerals, other fossil fuels: Emission trend and share for CO_2

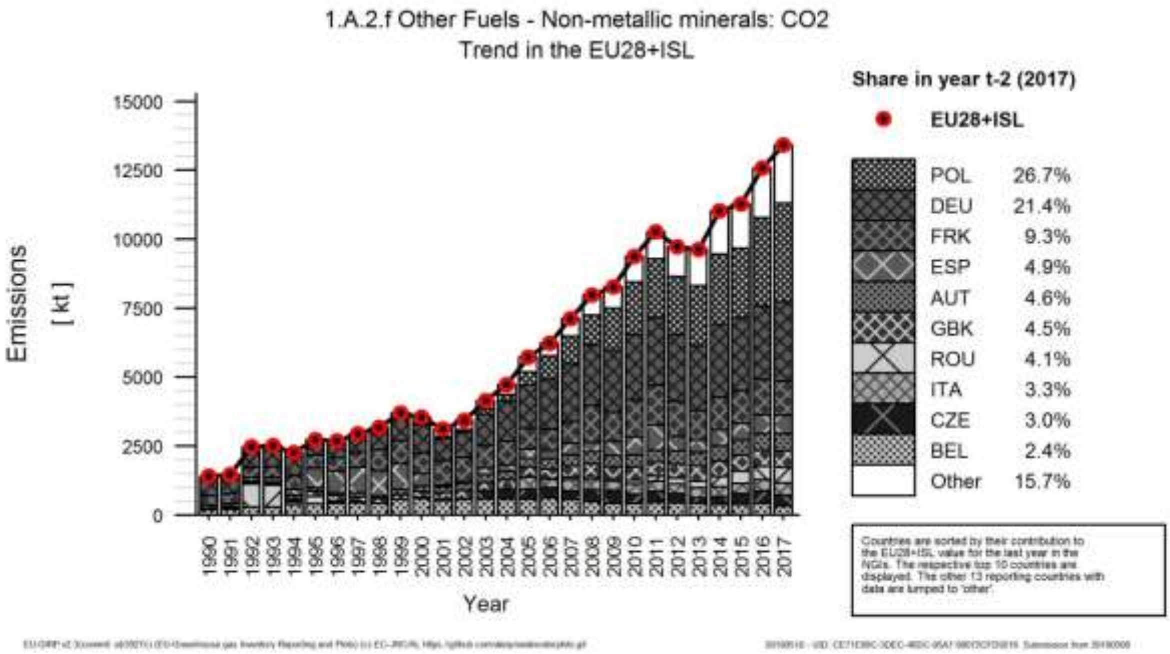


Figure 3.92 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. It can be seen, that CO_2 IEF is fluctuating during whole period, the lowest CO_2 IEF was calculated for 2002 and since then CO_2 IEF is increasing but still is lower than at the beginning of the time series. CO_2 IEF equaled to 81.63 t/TJ in 2017.

Figure 3.92: 1A2f Non-metallic Minerals, other fossil fuels: Implied Emission Factors for CO_2 (in t/TJ)

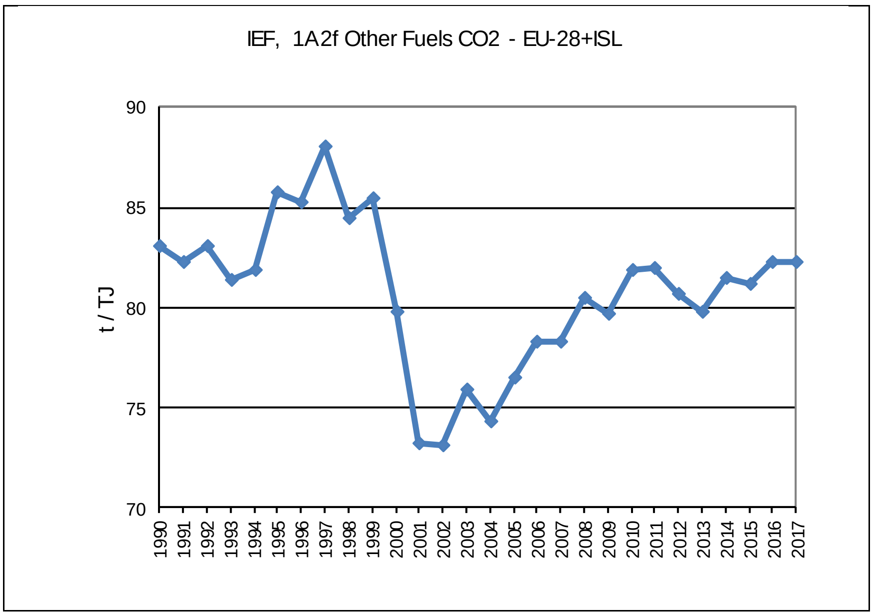
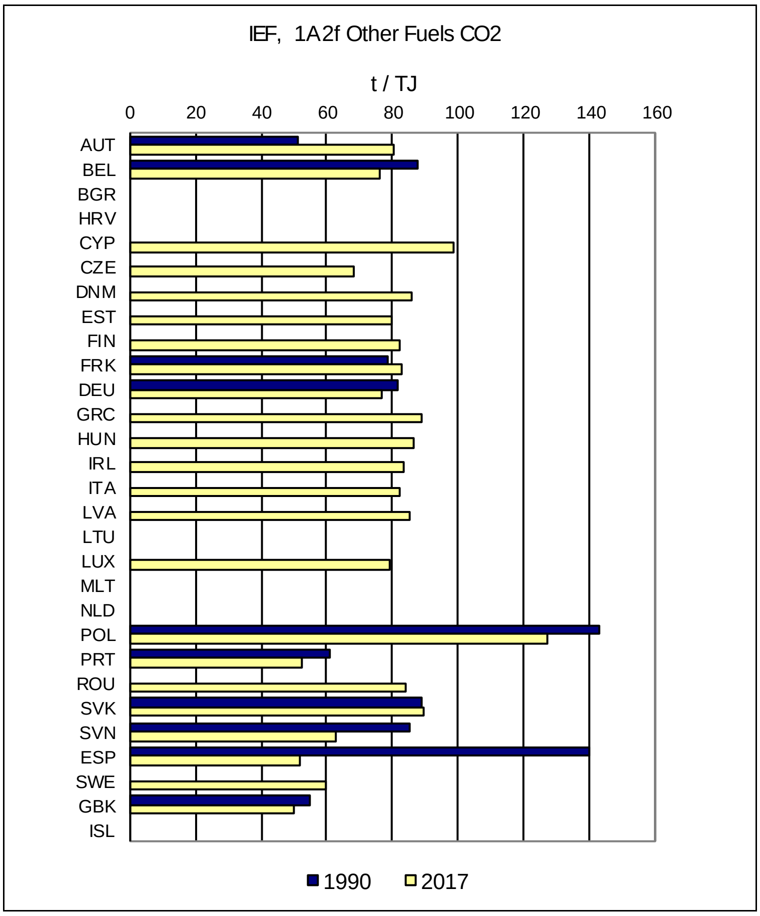


Figure 3.93 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. Poland applies the default IPCC CO_2 emission factor (or a factor which is close to it) which is significantly higher than the country specific values used by almost all other countries.

Figure 3.93: 1A2f Non-metallic Minerals, other fossil fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



3.2.2.6 Other (1A2g)

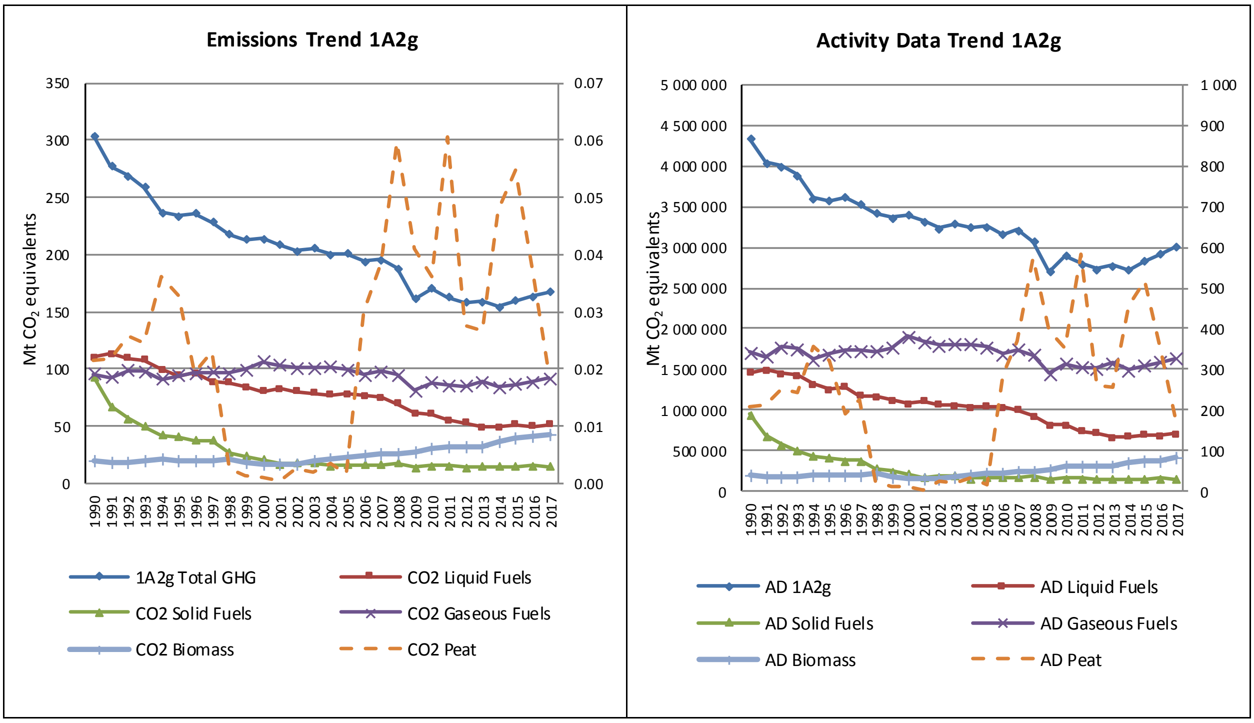
This chapter provides information about European emission trend, Member States contribution to the overall emission trend, activity data and emission factors used for emission estimates by Member States and Island for category 1A2g Other.

This category includes emissions from stationary combustion but also may include emissions from mobile sources (e.g. construction machinery). Some Member States use this category to report emissions which cannot be allocated to the categories 1A2a to 1A2f 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 1A2g amounted to 164 494 kt CO_2 eq. in 2017. The trend of total CO_2 emissions for 1990 to 2017 from category 1A2g is depicted in Figure 3.94. Total CO_2 emissions decreased by 45% since 1990 and increased by 2% between 2016 and 2017. CO_2 emissions from 1A2g Other accounted for 33% of 1A2 source category.

Figure 3.94 shows the emission trend within the category 1A2g, 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 3.94: 1A2g Other: Activity data and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-28+ISL 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 (133%) but it should be noted that Luxembourg has minor share (approximately 0.1%) on total EU-28+ISL emissions.

Table 3.48: 1A2g Other: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	1 976	2 778	2 870	1.7%	894	45%	92	3%	T1,T2,T3	CS,D
Belgium	2 816	2 105	2 075	1.3%	-741	-26%	-30	-1%	CS,T1,T3	D
Bulgaria	10 579	624	718	0.4%	-9 862	-93%	94	15%	T1,T2	CS,D
Croatia	5 502	1 274	1 459	0.9%	-4 043	-73%	185	14%	T1	D
Cyprus	48	54	70	0.0%	22	47%	17	31%	T1	D
Czechia	19 064	2 116	2 058	1.3%	-17 006	-89%	-58	-3%	T1,T2	CS,D
Denmark	1 670	970	946	0.6%	-724	-43%	-24	-2%	M,T1,T2,T3	CS,D
Estonia	280	213	152	0.1%	-128	-46%	-61	-29%	T1,T2	CS,D
Finland	1 872	1 592	1 712	1.0%	-160	-9%	120	8%	T3	CS,D
France	11 214	8 020	7 854	4.8%	-3 360	-30%	-166	-2%	T2	CS
Germany	127 935	77 338	80 149	48.7%	-47 786	-37%	2 810	4%	CS	CS,D
Greece	IE	IE	IE	-	-	-	-	-	NA	NA
Hungary	5 180	1 711	1 774	1.1%	-3 406	-66%	63	4%	T1,T2	CS,D
Ireland	684	745	764	0.5%	80	12%	19	3%	T1,T2	CS,D
Italy	19 255	8 790	9 177	5.6%	-10 077	-52%	388	4%	T2	CS
Latvia	1 618	220	226	0.1%	-1 392	-86%	6	3%	T1,T2	CS,D
Lithuania	1 567	193	216	0.1%	-1 351	-86%	23	12%	T1,T2,T3	CS,D,PS
Luxembourg	103	228	241	0.1%	138	133%	13	6%	T1,T2	CS,D
Malta	53	33	34	0.0%	-19	-36%	1	4%	T1	D
Netherlands	3 393	2 979	3 036	1.8%	-357	-11%	56	2%	T2	CS
Poland	7 049	2 649	2 871	1.7%	-4 178	-59%	223	8%	T1,T2	CS,D
Portugal	2 189	1 551	1 585	1.0%	-604	-28%	34	2%	T1	D
Romania	23 761	4 786	4 769	2.9%	-18 992	-80%	-18	0%	T1,T2	CS,D
Slovakia	2 560	1 189	1 346	0.8%	-1 214	-47%	157	13%	T2	CS
Slovenia	1 153	399	410	0.2%	-743	-64%	11	3%	T1,T2	CS,D
Spain	7 857	7 875	7 542	4.6%	-315	-4%	-333	-4%	T1,T2	CS,D,M,PS
Sweden	3 265	2 402	2 549	1.5%	-717	-22%	147	6%	T1,T2	CS
United Kingdom	38 426	27 548	27 601	16.8%	-10 825	-28%	52	0%	T1,T2,T3	CS,D
EU-28	**301 068**	**160 382**	**164 203**	**100%**	**-136 865**	**-45%**	**3 821**	**2%**	**-**	**-**
Iceland	162	152	141	0.1%	-21	-13%	-11	-7%	T1	D
United Kingdom (KP)	38 534	27 697	27 751	16.9%	-10 784	-28%	53	0%	T1,T2,T3	CS,D
EU-28 + ISL	**301 338**	**160 683**	**164 494**	**100%**	**-136 844**	**-45%**	**3 811**	**2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.
Greece includes emissions of 1A2g in category 1A2f

1A2g Other – Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1A2g amounted 51 335 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 53% and compared to 2016 increased by 4%. Category has 10% share on total CO_2 equivalent emissions from category 1A2.

Detailed data related to the EU-28+ISL submissions are depicted in Table.3.49. Sweden reports emissions as 'C' (confidential). Greece includes emissions of 1A2g in category 1A2f. All Member States reported lower level of emissions in 2017 than in 1990 (except of Austria, Cyprus and Luxembourg.

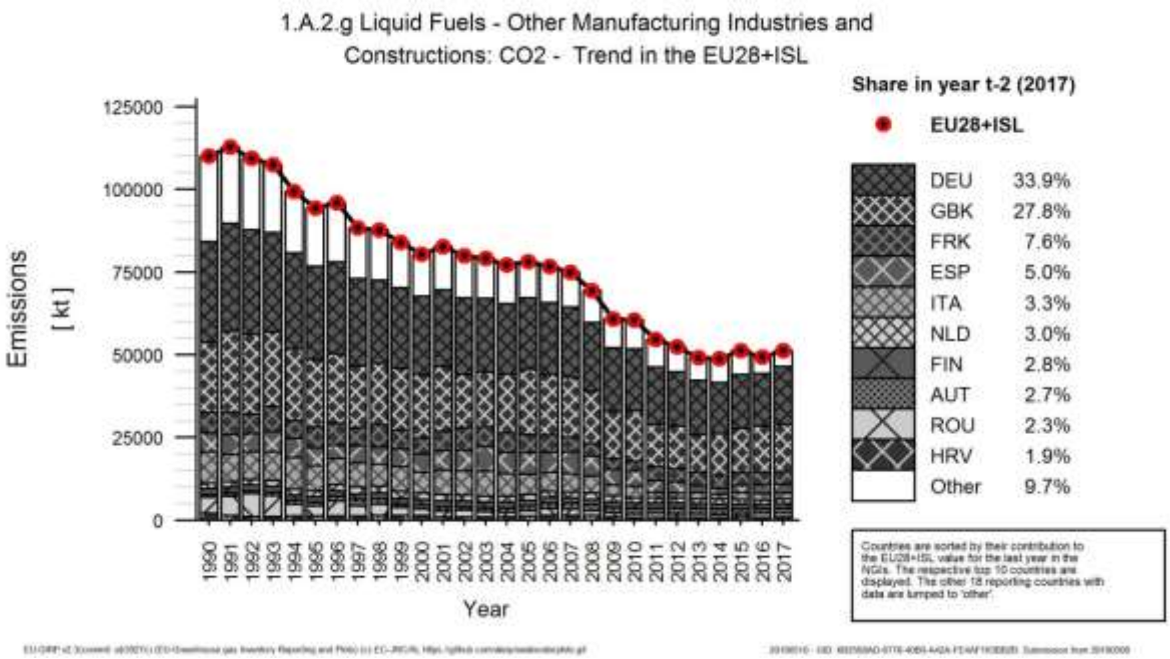
Table.3.49: 1A2g Other, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	866	1 311	1 381	2.7%	515	59%	70	5%
Belgium	1 579	912	856	1.7%	-723	-46%	-57	-6%
Bulgaria	8 632	144	216	0.4%	-8 416	-97%	73	50%
Croatia	2 158	857	960	1.9%	-1 198	-55%	104	12%
Cyprus	48	54	70	0.1%	22	47%	17	31%
Czechia	2 935	198	108	0.2%	-2 826	-96%	-90	-45%
Denmark	1 059	632	604	1.2%	-455	-43%	-28	-4%
Estonia	188	167	127	0.2%	-62	-33%	-41	-24%
Finland	1 713	1 301	1 422	2.8%	-292	-17%	120	9%
France	6 129	3 940	3 919	7.6%	-2 210	-36%	-21	-1%
Germany	30 317	15 832	17 405	33.9%	-12 911	-43%	1 573	10%
Greece	IE	IE	IE	-	-	-	-	-
Hungary	1 900	614	644	1.3%	-1 256	-66%	30	5%
Ireland	512	379	393	0.8%	-118	-23%	14	4%
Italy	9 470	1 996	1 718	3.3%	-7 752	-82%	-278	-14%
Latvia	1 066	128	139	0.3%	-927	-87%	11	8%
Lithuania	812	59	66	0.1%	-746	-92%	7	11%
Luxembourg	59	168	178	0.3%	118	199%	10	6%
Malta	53	33	34	0.1%	-19	-36%	1	4%
Netherlands	1 642	1 506	1 550	3.0%	-92	-6%	44	3%
Poland	1 026	617	641	1.2%	-385	-38%	24	4%
Portugal	2 139	576	591	1.2%	-1 548	-72%	15	3%
Romania	4 805	1 176	1 162	2.3%	-3 643	-76%	-14	-1%
Slovakia	66	12	17	0.0%	-49	-74%	5	38%
Slovenia	647	137	136	0.3%	-511	-79%	-1	-1%
Spain	5 788	2 522	2 587	5.0%	-3 201	-55%	65	3%
Sweden	3 058	C	C	-	-3 058	-100%	-	-
United Kingdom	21 100	13 760	14 120	27.5%	-6 981	-33%	360	3%
EU-28	**109 769**	**49 033**	**51 045**	**99%**	**-58 725**	**-53%**	**2 012**	**4%**
Iceland	162	152	141	0.3%	-21	-13%	-11	-7%
United Kingdom (KP)	21 209	13 909	14 270	27.8%	-6 939	-33%	361	3%
EU-28 + ISL	**110 040**	**49 333**	**51 335**	**100%**	**-58 704**	**-53%**	**2 002**	**4%**

Greece includes emissions of 1A2g in category 1A2f
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 3.95 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Germany (34%), United Kingdom (28%), France (8%) and Spain (5%) which together have 74% share on EU-28+ISL emissions.

Figure 3.95: 1A2g Other, liquid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.96 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. It can be seen, that CO_2 IEF has decreasing trend since 2008. CO_2 IEF equaled to 72.9 t/TJ in 2017.

Figure 3.96: 1A2g Other, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

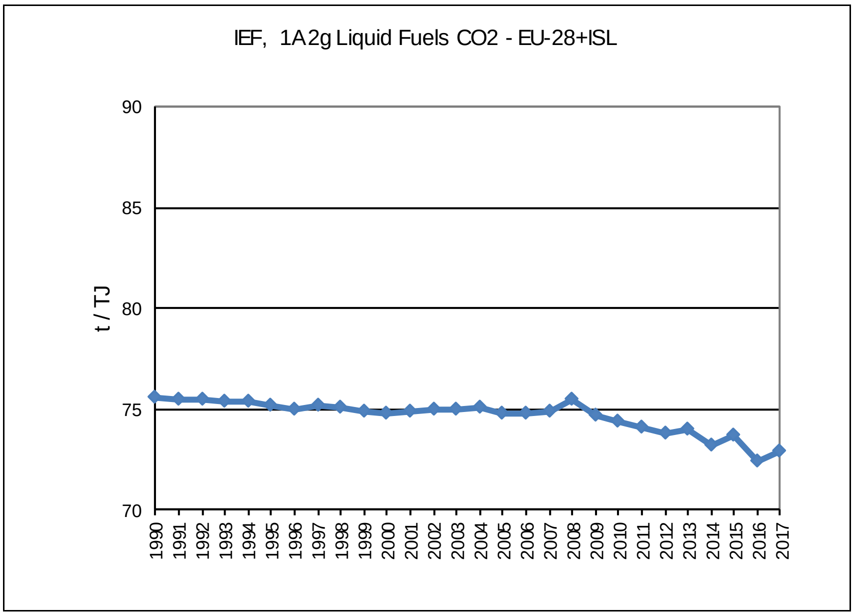
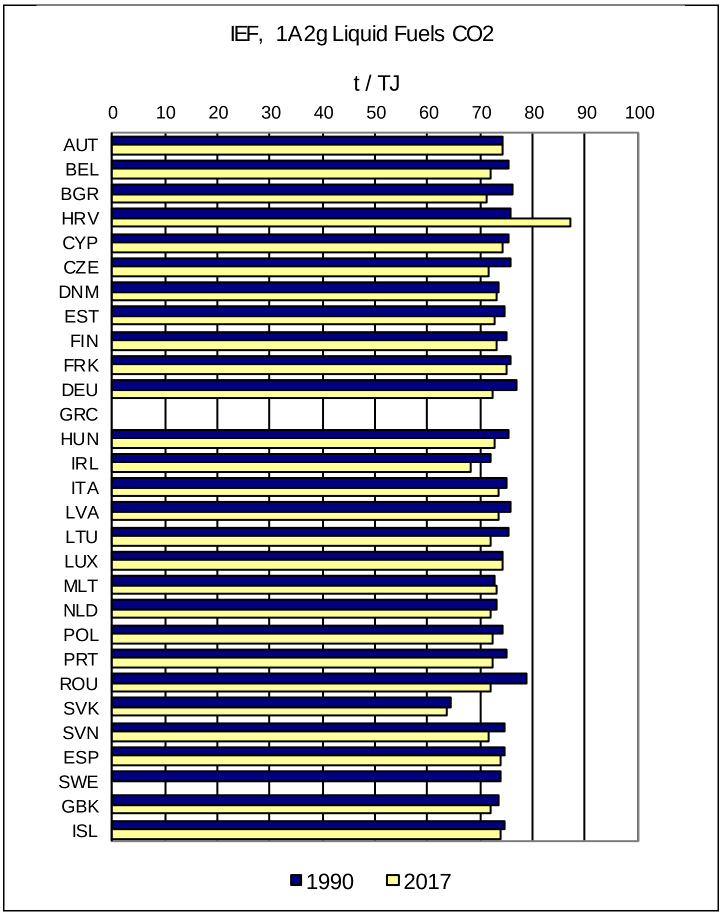


Figure 3.97 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017.

Figure 3.97: 1A2g Other, liquid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2g Other – Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1A2g amounted 14 603 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 84% and compared to 2016 by 6%. Category has 3% share on total CO_2 equivalent emissions from category 1A2.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.50. Cyprus, Estonia, Malta, Spain and Iceland report emissions as 'NO' (not occurring). Sweden reports emissions as 'C' (confidential). All Member States reported lower level of emissions in 2017 than in 1990 (except of Netherland, but it should be noted that the share of Netherland's emissions on total EU-28+ISL emissions is less than 1%).

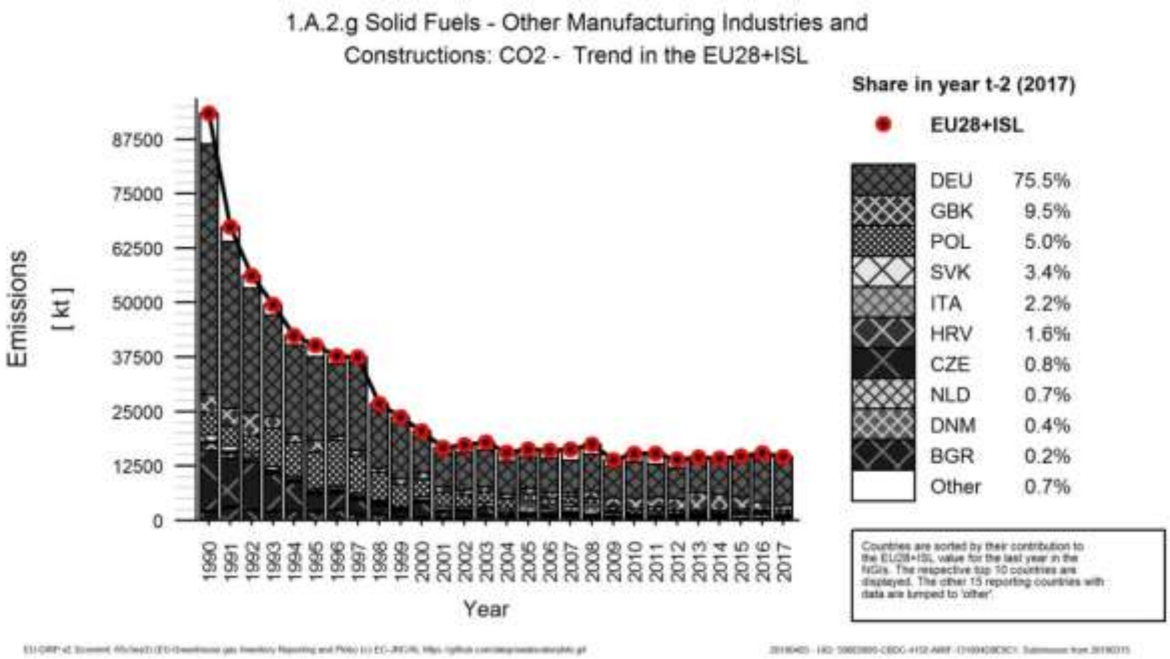
Table 3.50: 1A2g Other, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	91	0	2	0.0%	-89	-98%	2	592%
Belgium	33	14	18	0.1%	-15	-46%	4	25%
Bulgaria	1 858	13	24	0.2%	-1 834	-99%	11	84%
Croatia	1 703	200	236	1.6%	-1 467	-86%	35	18%
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	13 750	118	112	0.8%	-13 639	-99%	-6	-5%
Denmark	326	55	54	0.4%	-271	-83%	0	0%
Estonia	38	0	NO	-	-38	-100%	0	-100%
Finland	8	NO	0	0.0%	-8	-99%	0	∞
France	372	7	8	0.1%	-364	-98%	2	26%
Germany	57 580	11 042	11 032	75.5%	-46 549	-81%	-11	0%
Greece	IE	IE	IE	-	-	-	-	-
Hungary	677	30	15	0.1%	-662	-98%	-14	-48%
Ireland	14	NO	1	0.0%	-13	-91%	1	∞
Italy	397	808	325	2.2%	-72	-18%	-483	-60%
Latvia	25	3	4	0.0%	-22	-86%	1	19%
Lithuania	79	5	5	0.0%	-73	-93%	1	13%
Luxembourg	20	15	19	0.1%	-1	-5%	4	28%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	42	92	96	0.7%	54	130%	4	5%
Poland	5 154	667	733	5.0%	-4 421	-86%	67	10%
Portugal	49	25	23	0.2%	-27	-54%	-3	-10%
Romania	5 313	190	13	0.1%	-5 300	-100%	-177	-93%
Slovakia	1 422	428	497	3.4%	-925	-65%	69	16%
Slovenia	89	0	0	0.0%	-88	-100%	0	15%
Spain	248	NO	NO	-	-248	-100%	-	-
Sweden	94	C	C	-	-94	-100%	-	-
United Kingdom	4 118	1 765	1 384	9.5%	-2 734	-66%	-381	-22%
EU-28	**93 501**	**15 477**	**14 603**	**100%**	**-78 898**	**-84%**	**-874**	**-6%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	4 118	1 765	1 384	9.5%	-2 734	-66%	-381	-22%
EU-28 + ISL	**93 501**	**15 477**	**14 603**	**100%**	**-78 898**	**-84%**	**-874**	**-6%**

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'.
Greece includes emissions of 1A2g in category 1A2f

Figure.3.98 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Germany (76%), United Kingdom (9%) and Poland (5%) which together have 90% share on EU-28+ISL emissions.

Figure.3.98: 1A2g Other, solid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.99 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. CO_2 IEF equaled to 95.71 t/TJ in 2017.

Figure 3.99: 1A2g Other, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

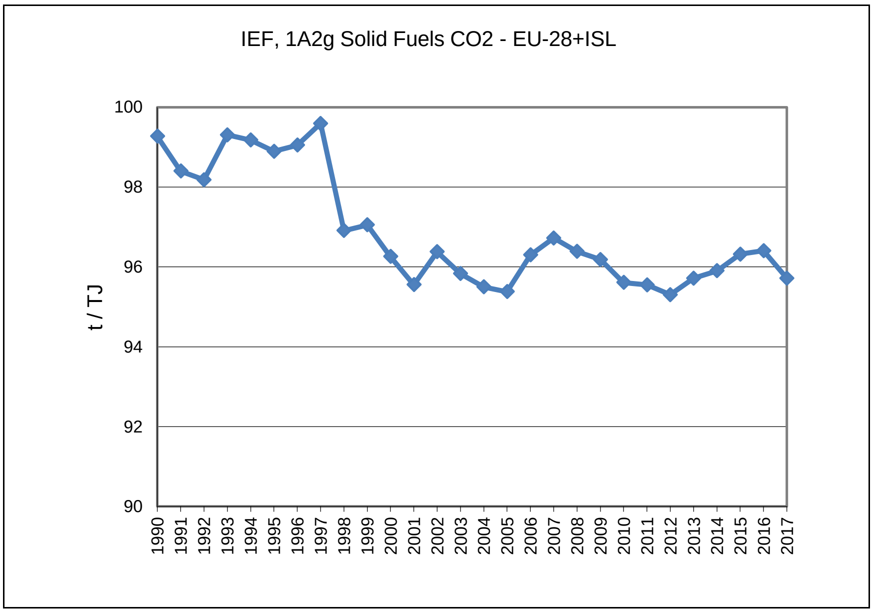
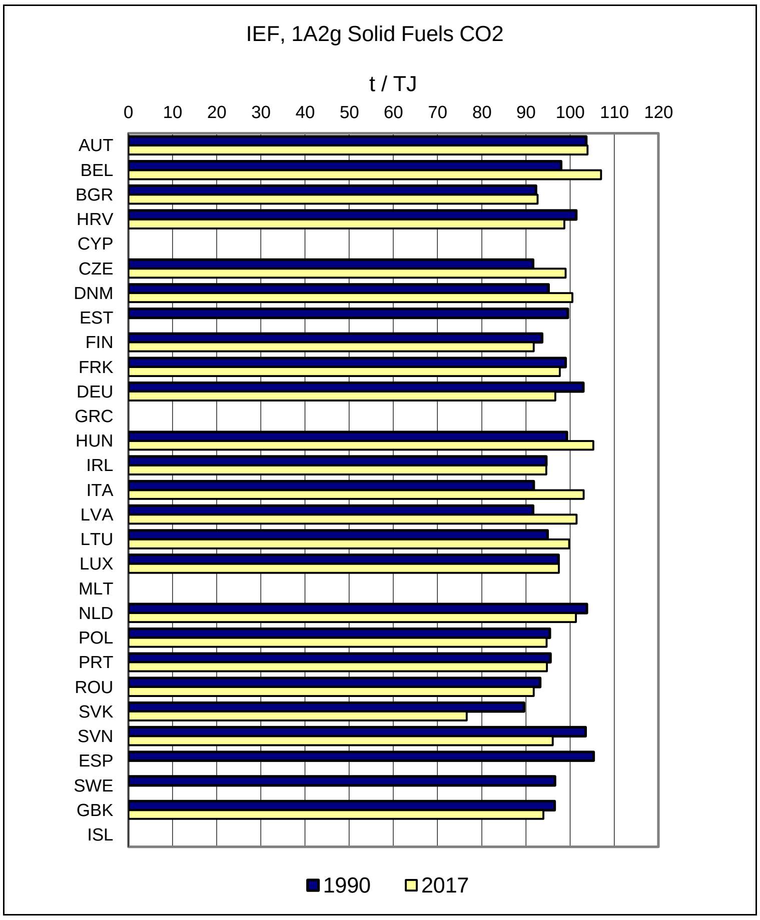


Figure 68 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017.

Figure 3.100: 1A2g Other, solid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2g Other – Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1A2g amounted 91 454 kt in 2017 for EU-28+ISL. CO_2 emissions decreased compared to year 1990 by 4% and compared to 2016 increased by 3%. Category has 19% share on total CO_2 equivalent emissions from category 1A2.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.51. Cyprus, Malta and Island report emissions as 'NO' (not occurring). Greece includes emissions of 1A2g in category 1A2f. Sixteen Member States reported lower level of emissions in 2017 than in 1990.

Table 3.51: 1A2g Other, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	1 014	1 433	1 454	1.6%	440	43%	20	1%
Belgium	1 204	1 141	1 163	1.3%	-40	-3%	23	2%
Bulgaria	89	365	358	0.4%	269	302%	-8	-2%
Croatia	1 641	158	193	0.2%	-1 448	-88%	36	23%
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	2 379	1 800	1 838	2.0%	-541	-23%	38	2%
Denmark	284	284	287	0.3%	3	1%	4	1%
Estonia	54	45	24	0.0%	-30	-55%	-21	-46%
Finland	41	34	31	0.0%	-10	-25%	-3	-9%
France	4 703	4 058	3 908	4.3%	-794	-17%	-150	-4%
Germany	37 693	46 445	47 691	52.1%	9 998	27%	1 245	3%
Greece	IE	IE	IE	-	-	-	-	-
Hungary	2 603	1 067	1 115	1.2%	-1 488	-57%	48	4%
Ireland	158	366	369	0.4%	211	134%	3	1%
Italy	9 388	5 985	7 134	7.8%	-2 253	-24%	1 149	19%
Latvia	527	85	84	0.1%	-443	-84%	-1	-2%
Lithuania	677	122	127	0.1%	-550	-81%	5	4%
Luxembourg	24	45	44	0.0%	20	84%	-1	-2%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	1 710	1 382	1 390	1.5%	-320	-19%	8	1%
Poland	865	1 360	1 482	1.6%	617	71%	122	9%
Portugal	NO,IE	944	967	1.1%	967	∞	22	2%
Romania	13 643	3 420	3 593	3.9%	-10 050	-74%	173	5%
Slovakia	1 071	749	831	0.9%	-240	-22%	83	11%
Slovenia	417	256	269	0.3%	-148	-36%	13	5%
Spain	1 821	5 353	4 955	5.4%	3 134	172%	-398	-7%
Sweden	113	97	88	0.1%	-25	-22%	-9	-9%
United Kingdom	13 132	11 991	12 058	13.2%	-1 074	-8%	67	1%
EU-28	**95 250**	**88 986**	**91 454**	**100%**	**-3 795**	**-4%**	**2 469**	**3%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	13 132	11 991	12 058	13.2%	-1 074	-8%	67	1%
EU-28 + ISL	**95 250**	**88 986**	**91 454**	**100%**	**-3 795**	**-4%**	**2 469**	**3%**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Greece includes emissions of 1A2g in category 1A2f
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

Figure 3.101 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 share on total CO_2 emissions (above the average share calculated for EU-28+ISL) has Germany (52%), United Kingdom (13%), Italy (8%), Spain (5%) and France (4%) which together have 83% share on EU-28+ISL emissions.

Figure 3.101: 1A2g Other, gaseous fuels: Emission trend and share for CO_2

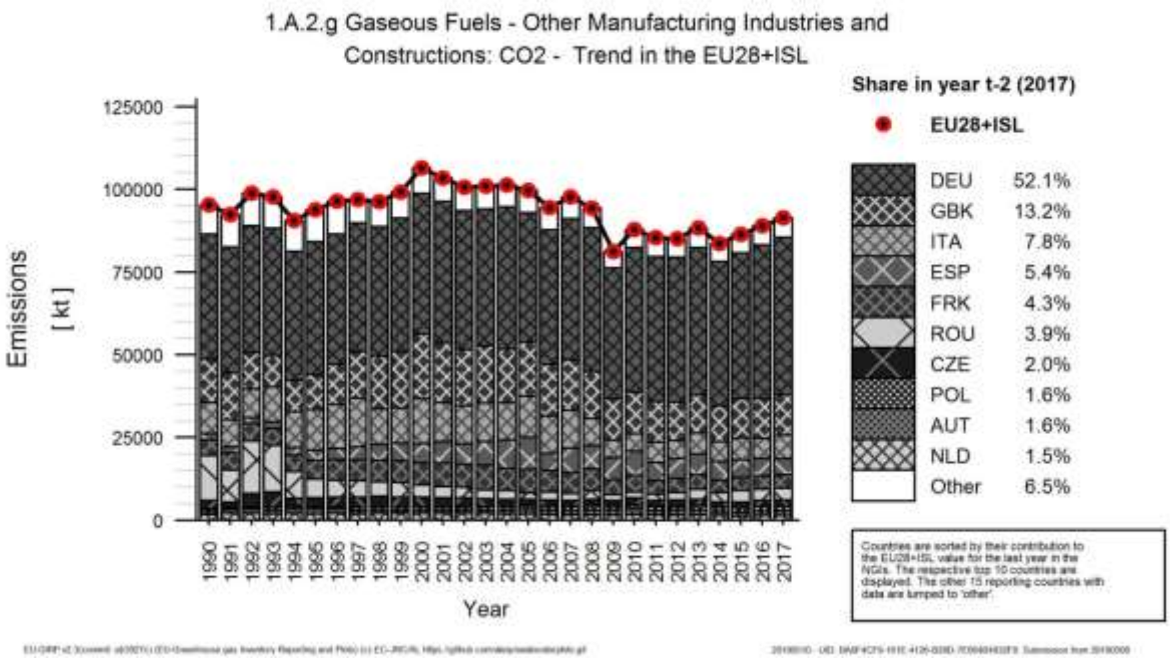


Figure 3.102 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. CO_2 IEF is relatively stable during reporting period and equaled to 56.07 t/TJ in 2017.

Figure 3.102: 1A2g Other, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

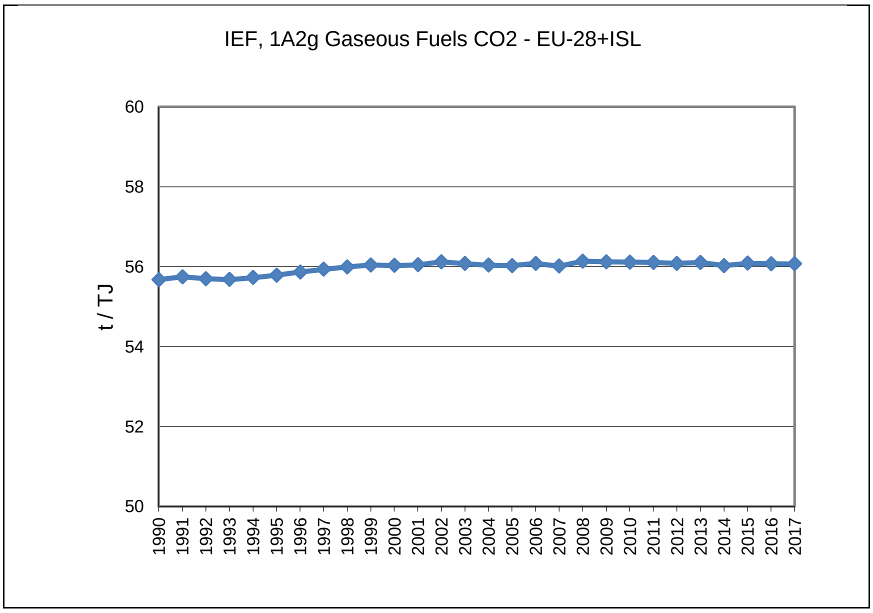
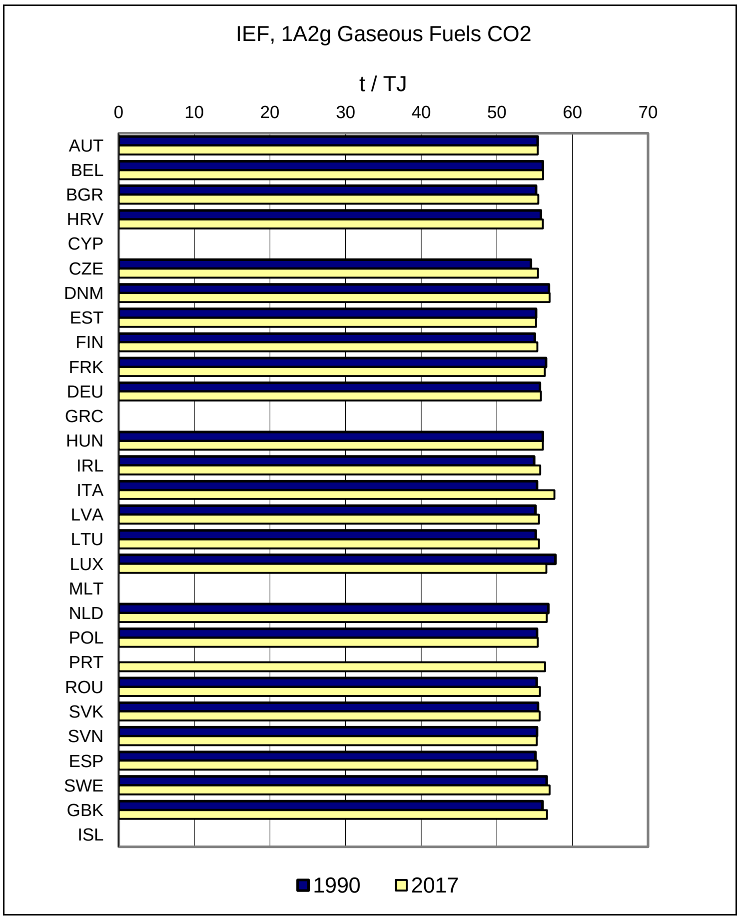


Figure 3.103 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. It can be seen that no major differences between CO_2 IEF used by Member States occur, also no major differences between CO_2 IEF calculated by Member States for 1990 and 2017 occur.

Figure 3.103: 1A2g Other, gaseous fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1A2g Other – Other fossil fuels (CO_2)

CO_2 emissions from the use of other fossil fuels in category 1A2g amounted 4 637 kt in 2017 for EU-28+ISL. CO_2 emissions increased compared to year 1990 by 84% and compared to 2016 by 2%. Category has 1% share on total CO_2 equivalent emissions from category 1A2.

Detailed data related to the EU-28+ISL submissions are depicted in Table 3.52. Twelve Member States and Island report emissions as 'NO' (not occurring). All Member States reported higher level of emissions in 2017 than in 1990 (except of United Kingdom and Denmark).

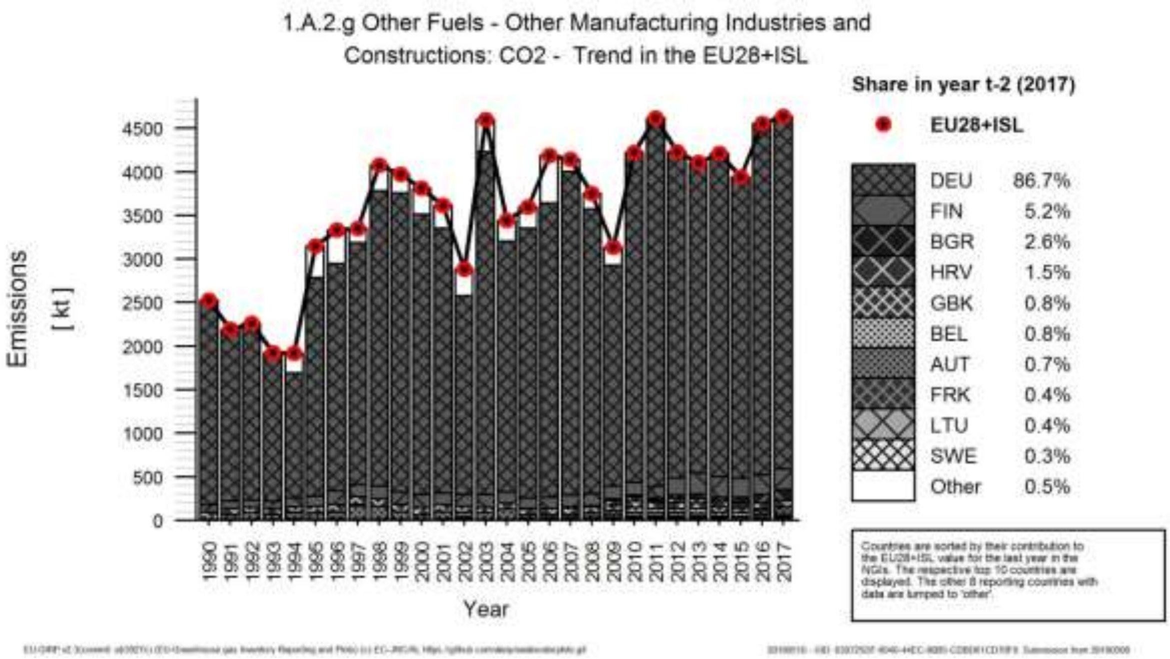
Table 3.52: 1A2g Other, other fossil fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	5	33	33	0.7%	28	587%	0	0%
Belgium	NO	38	38	0.8%	38	∞	0	1%
Bulgaria	0	102	120	2.6%	120	100%	18	18%
Croatia	NO	59	69	1.5%	69	∞	10	17%
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	NO	NO	NO	-	-	-	-	-
Denmark	1	NO	NO	-	-1	-100%	-	-
Estonia	NO	NO	NO	-	-	-	-	-
Finland	88	225	243	5.2%	155	177%	18	8%
France	10	15	18	0.4%	8	81%	3	20%
Germany	2 344	4 018	4 021	86.7%	1 676	72%	3	0%
Greece	-	-	-	-	-	-	-	-
Hungary	NO	NO	NO	-	-	-	-	-
Ireland	NO	NO	NO	-	-	-	-	-
Italy	NO	NO	NO	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	7	16	0.4%	16	∞	10	142%
Luxembourg	NO	0	1	0.0%	1	∞	0	38%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-
Poland	3	5	15	0.3%	12	376%	10	183%
Portugal	NO,IE	5	3	0.1%	3	∞	-1	-24%
Romania	NO	1	1	0.0%	1	∞	0	26%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	6	5	0.1%	5	∞	-1	-12%
Spain	NO	NO	NO	-	-	-	-	-
Sweden	NO	12	15	0.3%	15	∞	4	30%
United Kingdom	76	32	39	0.8%	-37	-49%	7	22%
EU-28	**2 527**	**4 556**	**4 637**	**100%**	**2 110**	**84%**	**80**	**2%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	76	32	39	0.8%	-37	-49%	7	22%
EU-28 + ISL	**2 527**	**4 556**	**4 637**	**100%**	**2 110**	**84%**	**80**	**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.
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.

Figure 3.32Figure 3.104 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 share on total CO_2 emissions has Germany (87%) for 2017.

Figure 3.104: 1A2g Other, other fossil fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.105 shows CO_2 implied emission factor (CO_2 IEF) calculated from Member State submissions for 1990-2017. CO_2 IEF equaled to 74.50 t/TJ in 2017.

Figure 3.105: 1A2g Other, other fossil fuels: Implied Emission Factors for CO_2 (in t/TJ)

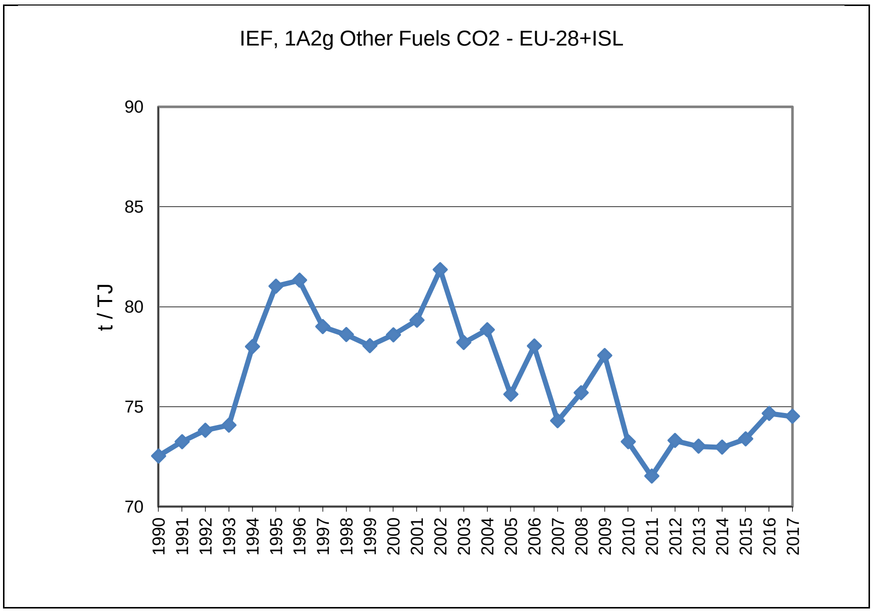
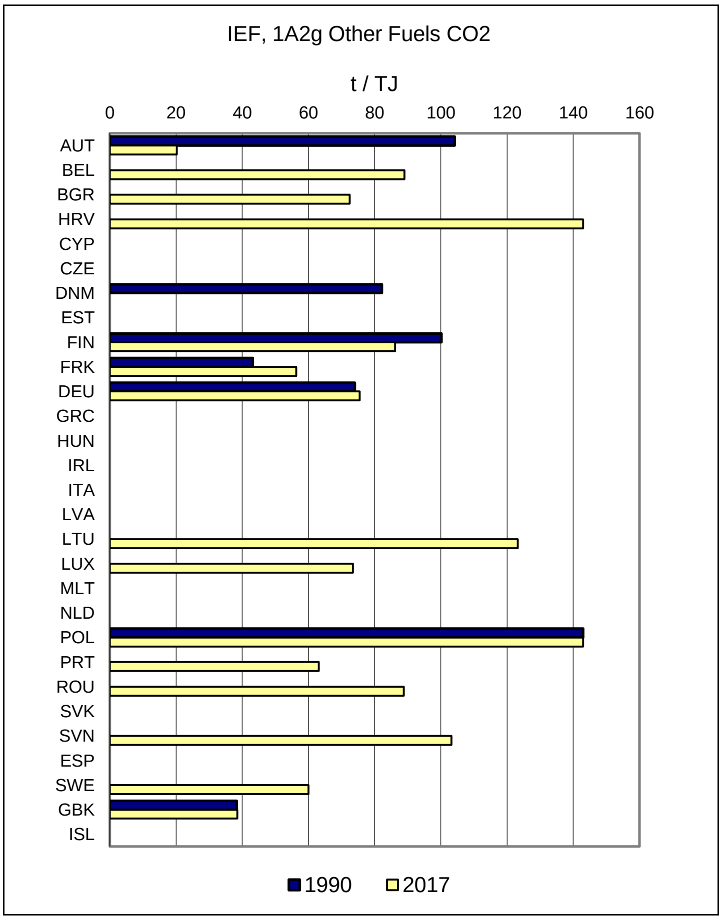


Figure 3.106 shows comparison of CO_2 IEF used by Member States and Island for emission estimates in 1990 and 2017. The comparatively low implied emission factor of Austria is mainly due to reporting of wood waste with high biomass content.

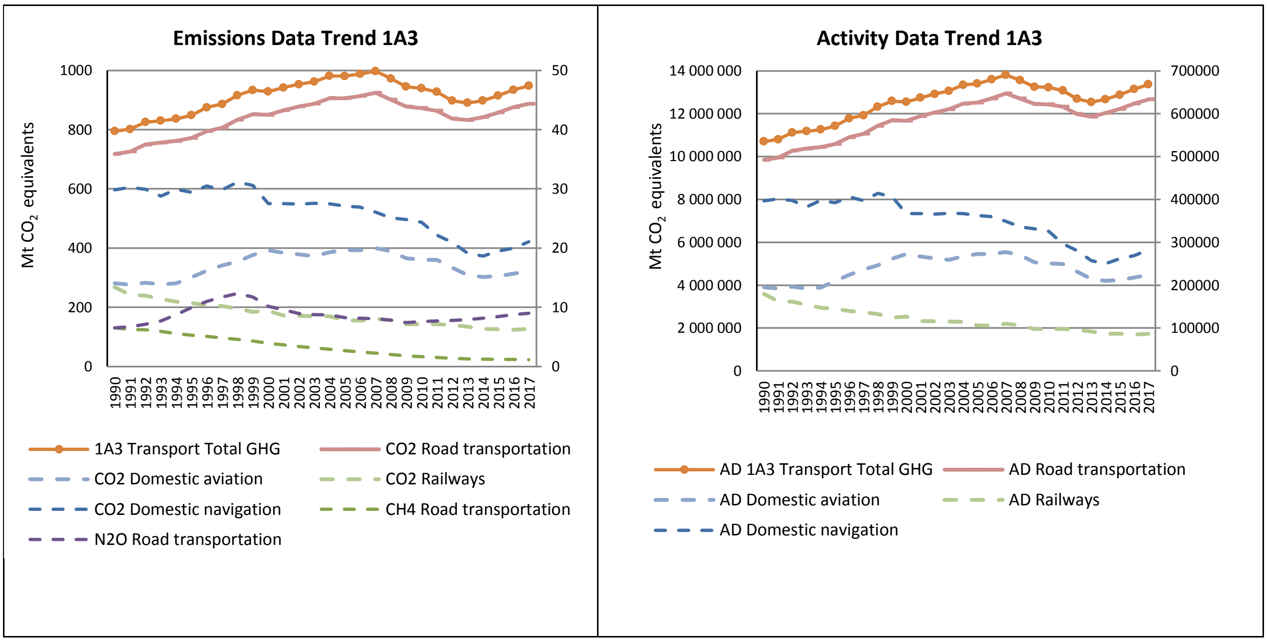
Figure 3.106: 1A2g Other, other fossil fuels: Implied Emission Factors for CO_2 by Member States and Iceland(in t/TJ)



3.2.3 Transport (CRF Source Category 1A3) (EU-28+ISL)

Greenhouse gas emissions from 1A3 Transport are shown in Figure 3.107. CO_2 emissions from this source category account for 21.6 %, CH_4 for 0.03 %, N_2O for 0.2 % of total GHG emissions (without LULUCF). Between 1990 and 2017, GHG from transport increased by 19 % in the EU-28+ISL.

Figure 3.107 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 MS 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 MS NIRs were reviewed so as to calculate the share of higher tiers. As presented, most MSs use higher tiers, whereas the lower percentage is observed for 1A3d Domestic navigation: residual fuel oil, where most MS 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 MS emissions using higher tier methods

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2017		1990	2017	
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	13355	15931	T	L	L	93 %
1.A.3.b Road Transportation: Diesel Oil (CO_2)	302440	634592	T	L	L	87 %
1.A.3.b Road Transportation: Diesel Oil (N_2O)	1829	7510	T	0	L	100 %
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	505	3508	T	0	0	90 %
1.A.3.b Road Transportation: Gasoline (CH_4)	5862	835	T	0	0	99 %
1.A.3.b Road Transportation: Gasoline (CO_2)	406878	232690	T	L	L	90 %
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	7336	16091	T	0	L	96 %
1.A.3.c Railways: Liquid Fuels (CO_2)	12960	6281	T	L	L	74 %
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	17867	13709	0	L	L	79 %
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	10327	5466	0	L	0	50 %

Table 3.54 shows total GHG, CO_2, CH_4 and N_2O emissions from 1A3 Transport.

Table 3.54 1A3 Transport: Member States' contributions to CO_2 emissions, CH_4 and N_2O emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2015 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2015 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2015 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2015 (kt CO2 equivalents)
Austria	13 975	24 266	13 777	24 046	130	210	68	10
Belgium	20 893	25 824	20 554	25 530	218	277	121	16
Bulgaria	6 604	9 460	6 426	9 350	107	87	71	23
Croatia	3 881	6 645	3 787	6 570	53	64	41	11
Cyprus	1 242	2 094	1 212	2 077	24	13	7	4
Czechia	11 484	18 659	11 218	18 418	190	215	76	25
Denmark	10 752	13 209	10 573	13 058	99	140	79	11
Estonia	2 477	2 443	2 416	2 413	38	26	23	4
Finland	12 097	11 484	11 824	11 384	161	84	113	16
France	122 819	134 736	120 812	133 017	970	1 576	1 038	143
Germany	164 267	167 952	161 747	166 155	1 191	1 653	1 329	144
Greece	14 507	17 241	14 124	16 903	272	262	110	76
Hungary	8 870	13 143	8 677	12 979	123	140	69	24
Ireland	5 151	12 003	5 035	11 864	67	127	49	12
Italy	102 217	99 487	100 313	98 391	954	884	950	211
Latvia	3 040	3 325	2 941	3 273	81	48	19	4
Lithuania	5 838	5 755	5 706	5 689	80	47	53	19
Luxembourg	2 616	5 639	2 587	5 588	18	50	11	1
Malta	331	636	326	627	1	5	3	4
Netherlands	28 019	31 183	27 718	30 862	105	256	196	65
Poland	20 898	63 353	20 379	62 503	334	712	185	138
Portugal	10 217	17 148	10 023	16 967	98	157	96	24
Romania	12 439	17 976	12 059	17 719	285	221	94	35
Slovakia	6 824	7 660	6 693	7 563	100	89	30	8
Slovenia	2 728	5 541	2 666	5 470	36	66	26	5
Spain	58 655	88 784	57 748	87 764	524	931	383	89
Sweden	19 020	16 573	18 685	16 403	179	151	155	19
United Kingdom	121 337	123 653	118 648	122 348	1 441	1 203	1 248	102
EU-28	**793 200**	**945 872**	**778 676**	**934 932**	**7 882**	**9 694**	**6 642**	**1 246**
Iceland	620	1 030	600	988	16	39	4	3
United Kingdom (KP)	122 155	124 519	119 449	123 205	1 449	1 210	1 257	104
EU-28 + ISL	**794 638**	**947 768**	**780 077**	**936 778**	**7 905**	**9 740**	**6 655**	**1 250**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3.55 provides information on the contribution of Member States to EU-28+ISL recalculations in CO_2 from 1A3 Transport for 1990 and 2016 and main explanations for the largest recalculations in absolute terms.

Table 3.55 1A3 Transport: Contribution of MS to EU-28+ISL recalculations in CO_2 for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-0	-0.0	31	0.1	Revised energy balance
Belgium	1	0.01	7	0.03	More accurate figures became available for gasoline and gasoil in the most recent national petroleum balances in Belgium for the years from 2009 on. These values are used to calculate the fuel sold emissions. Revision of 1A3d AD values for the period 2014-2016.
Bulgaria	-	-	-28	-0.3	For the 2018 submission, a complete recalculation has been performed, introducing the new COPERT version 5.1.
Croatia	-	-	-	-	
Cyprus	16	1.4	46	2.3	In precious submission 2006 IPCC Tier 1 methodology was used, whereas in the current submission the emissions have been obtained from the application of COPERT, which is considered T2 methodology.

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
					Domestic water-borne navigation (1A3d ii) the recalculations have been caused by availability of new data from the Statistical Service for the year 2016.
Czechia	4 187	59.5	-103	-0.6	COPERT 5 used for the emission estimation for the first time
Denmark	-43	-0.4	28	0.2	Small changes in the list of aircraft types – representative aircraft types has been made in the model used for calculating civil aviation emissions. The bio ethanol fuel consumption for road transport has been somewhat changed, due to the inclusion of bio ethanol in the emission inventory for gasoline fuelled non-road machinery and recreational craft from 2006 onwards.
Estonia	-	-	-13	-0.6	Calculations were improved 2001 - 2016 in 1.A.3.a. 1.A.3.d energy balance was updated. Please see chapter 3.2.5.6
Finland	-4	-0.03	-535	-4.3	Revised activity data (in 2016) due to fuel tax changes Revised data on liquid fuel properties (density, NCV, carbon content) in 2013-2016 Revised jet fuel data from Eurocontrol 1990-2016: Minor changes the allocation of gasoline consumption are reflected here
France	2 099	1.8	1 496	1.1	Update of CO_2 emission factors gasoline and diesel (Measurements) Addition of diesel carts -> modifications% network all vehicles and energy balance.
Germany	-135	-0.1	-833	-0.5	Revised activity data and emission factors
Greece	-	-	-	-	-
Hungary	-8	-0.1	-5	-0.0	New version of COPERT (v5.2) with updated circulation data was used that affected also calculated fuel consumption; revised energy statistics (gasoil in road and navigation)
Ireland	13	0.3	2	0.0	New approach, Eurocontrol methodology for Domestic aviation
Italy	73	0.1	-1 377	-1.3	Update of natural gas fuel consumption time series with data submitted to Eurostat
Latvia	-0	-0.0	-27	-0.9	Recalculations have been done due to switch from COPERT 5.0 model version to COPERT 5.2 model version and corrected distribution of vehicles fleet by sub-classes
Lithuania	-	-	-10	-0.2	Emissions correction for road and railways transportation according updated activity data on diesel oil from 2012 due to split of biodiesel consumption between road and railways transport. Fossil carbon content of biodiesel (FAME) was also evaluated for road and railways transportation and CO_2 emissions with the fossil-origin carbon allocated separately from emissions of biogenic carbon from 2004. Recalculation was done in Pipeline transport as Statistics of Lithuania provided CNG consumption disaggregation between Pipeline and Road transport sectors, so a part of gas consumption was transferred to 1.A.3.b Road transport.
Luxembourg	31	1.2	53	1.0	revision of methodology: following UNFCCC ICR (2018), addition of fossil part from biofuels; revision of EF for diesel and gasoline based on revised EF from Belgium and Germany; revision of AD: energy balance revised
Malta	0	0.0	-33	-5.3	Harmonisation of national aviation emissions from 2005 onwards, using EUROCONTROL model.
Netherlands	-13	-0.0	-11	-0.0	Updated energy statistics.
Poland	394	2.0	1 265	2.4	AD data and the method of calculation from COPERT 4 to COPERT 5 was changed
Portugal	-23	-0.2	119	0.7	Road Transport (1A3b) - Revision of the 2016 Energy Balance data
Romania	-	-	-	-	NA
Slovakia	-	-	774	11.6	Recalculations in the category 1.A.3.b as a result of changes in the statistical fuel consumption.
Slovenia	-	-	-	-	
Spain	-539	-0.9	-24	-0.0	Correction of mistakes in the emission factors used. Review of the AD for the whole time period by the data provider. Recalculations due to activity data update from National Statistics. Uptate of CO_2 emissions estimates for 1A3b and 1A5b taking into account the fosil fraction of biodiesel.

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Sweden	-86	-0.5	149	0.9	Reallocation of aviation kerosene from military consumption to civil consumption. The amount of diesel and FAME was reallocated between road traffic and working machinery The amount of gasoline was adjusted As from 2005, the fuel consumption for leisure boats has been adjusted. This is due to adjusted information from a report about leisure boats in Sweden 2005 and new information from a similar report for leisure boats in 2010. The gasoline consumption and emissions have increased , while the diesel consumption and emissions have decreased for 2010-2016. This leads to a increased emissions for some years and decreased emissions for som years in between 2005-2016 in CRF 1A3d. Reallocation and consequently decreased consumption of diesel for working machinery in CRF 1A3eii, as a result from the conslusion in the PM "Utvecklingsaktiviteter hösten 2017 för att förbättra Sveriges inventering av utsläpp från arbetsmaskiner" (2017).
United Kingdom	39	0.0	181	0.1	Small recalculations in 1A3 transport sector occur due to a combination of changes in different transport sub-sectors; 1A3aii: Increase in CO_2 emissions is related to revised taxi-ing times, where more fuel and time is spent on the ground, and more specifically at lower thrust modes, than previously thought. 1A3b: Now containing fossil carbon content in biofuels.
EU28	6 001	0.8	1 154	0.1	-
Iceland	-0	-0.0	0	0.0	
United Kingdom (KP)					Small recalculations in 1A3 transport sector occur due to a combination of changes in different transport sub-sectors; 1A3aii: Increase in CO_2 emissions is related to revised taxi-ing times, where more fuel and time is spent on the ground, and more specifically at lower thrust modes, than previously thought. 1A3b: Now containing fossil carbon content in biofuels.
EU28+ISL	5 962	0.9	973	0.1	-

Table 3.57 provides information on the contribution of Member States to EU-28+ISL recalculations in CH_4 from 1A3 Transport for 1990 and 2016.

Table 3.56 1A3 Transport: Contribution of MS to EU-28+ISL recalculations in CH_4 for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	1	1.1	0.4	3.6	Revised energy balance
Belgium	-0	-0.0	-0.3	-1.8	More accurate figures became available for gasoline and gasoil in the most recent national petroleum balances in Belgium for the years from 2009 on. These values are used to calculate the fuel sold emissions. Revision of 1A3d AD values for the period 2014-2016.
Bulgaria	-0.1	-0.2	-1	-3.1	For the 2018 submission, a complete recalculation has been performed, introducing the new COPERT version 5.1.
Croatia	-	-	-	-	
Cyprus	1	27.5	-7	-61.5	In precious submission 2006 IPCC Tier 1 methodology was used, whereas in the current submission the emissions have been obtained from the application of COPERT, which is considered T2 methodology. Domestic water-borne navigation (1A3d ii) the recalculations have been caused by availability of new data from the Statistical Service for the year 2016.
Czechia	37	96.3	-1	-3.8	COPERT 5 used for the emission estimation for the first time.
Denmark	22	37.8	1	5.0	Emission factors for CH_4 has been updated for pre-cat gasoline cars and vans based on emission data in the COPERT 5 emission model. Small emission changes are noted for CH_4 and N_2O due to changes in the activity data for road transport based on data from the Danish car register kept by Statistics Denmark.

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Estonia	-	-	-0.04	-1.0	Calculations were improved in 1.A.3.a and 1.A.3.d. Please see chapter 3.2.5.6
Finland	-0	-0.1	-3	-15.5	Revised activity data (in 2016) due to fuel tax changes Revised data on liquid fuel properties (density, NCV, carbon content) in 2013-2016 Revised jet fuel data from Eurocontrol 1990-2016: Minor changes the allocation of gasoline consumption are reflected here
France	34	3.4	-2	-1.2	Update of CO_2 emission factors gasoline and diesel (Measurements) Addition of diesel carts -> modifications% network all vehicles and energy balance.
Germany	-0	-0.0	-1	-0.6	Changes to the specific Tier 3 emission factors (depending on the type of vehicle and the type of road).
Greece	-	-	-0.1	-0.1	Updated data
Hungary	5	8.6	-0	-1.9	New version of COPERT (v5.2) with updated circulation data was used that affected also calculated fuel consumption; revised energy statistics (gasoil in road and navigation)
Ireland	0	0.2	-0	-2.9	New approach, Eurocontrol methodology for Domestic aviation
Italy	43	4.8	7	3.3	Update of the road transport model COPERT 5.2.2
Latvia	-1	-3.2	0	9.7	Recalculations have been done due to switch from COPERT 5.0 model version to COPERT 5.2 model version and corrected distribution of vehicles fleet by sub-classes
Lithuania	1	2.0	7	55.9	Emissions correction for jet kerosene from Civil aviation according change of Tier 2 to Tier 1 due to high level of assumptions for Tier 2 and minimal impact to values in 2006-2016. Emissions correction for CNG from road transportation according updated CH_4 and N_2O emissions values in 2009-2016 and LPG CH_4 and N_2O emissions shift from Tier 3 to Tier 1 due to insufficient quality of engine type input data in 1990-2017. Emissions correction for road and railways transportation according updated activity data on diesel oil from 2012 due to split of biodiesel consumption between road and railways transport. Recalculation was done in Pipeline transport as Statistics of Lithuania provided CNG consumption disaggregation between Pipeline and Road transport sectors, so a part of gas consumption was transferred to 1.A.3.b Road transport.
Luxembourg	0.4	4.0	0.05	4.8	Revision of methodology: following UNFCCC ICR (2018), addition of fossil part from biofuels; revision of AD: energy balance revised, error correction; offroad EFs revised
Malta	0.0001	0.004	-0.05	-2.4	Harmonisation of national aviation emissions from 2005 onwards, using EUROCONTROL model.
Netherlands	-0.1	-0.04	3	4.2	Updated energy statistics. CH_4 emissions for mopeds and motorcycles were adjusted upwards from 2002.
Poland	5	2.6	12	10.7	AD data and the method of calculation from COPERT 4 to COPERT 5 was changed
Portugal	11	13.5	-0	-0.1	Road Transport (1A3b) - Update of the stock, mean activity, lifetime cumulative activity data and the assumed mileage percentage driven by each driving mode.
Romania	-	-	-0.01	-0.01	NA
Slovakia	-	-	-0	-1.1	Recalculations in the category 1.A.3.b as a result of changes in the statistical fuel consumption.
Slovenia	-	-	-	-	
Spain	-1	-0.2	-2	-2.6	Correction of mistakes in the emission factors used. Review of the AD for the whole time period by the data provider. Recalculations due to activity data update from National Statistics.
Sweden	-0	-0.0	1	6.4	Added working machine (pistmaskin) in model, which increase consumption of diesel and emissions for all years. The distribution of engine types (2-stroke / 4-stroke) and number of snowmobiles and 4-wheelers have been updated → increased emissions for 1990-1993 and decreased emissions for 1994-2016. Revision of EF and AD for wood fuels, Revision of AD in Energy Balances, Revision of NCV and EF for CO_2 Natural Gas, "The distribution of engine types (2-stroke / 4-stroke) and number of snowmobiles and 4-wheelers have been updated → reduced gasoline consumption and emissions for the agricultural sector. The redistribution of FAME between road traffic and working machineries in 2009-2016

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
United Kingdom	2	0.1	-1	-0.6	Small recalculations due to a combination of changes in different transport sub-sectors; 1A3aii: Increase in CH_4 emissions is related to revised taxi-ing times, where more fuel and time is spent on the ground, and more specifically at lower thrust modes, than previously thought. This increase is offset by the small reduction in 1A3b sector. 1A3b: Small reduction in CH_4 emissions due to significantly lower EFs for Euro 5 and 6 diesel passenger cars and small diesel LGVs; change in gamma factor to reflect latest EMEP/EEA Guidebook revision.
EU28	161	2.5	13	1.0	-
Iceland	0.000001	0.00002	-0.2	-7.9	Updated emission factors from EMEP/EEA 2016 guidebook.
United Kingdom (KP)					Small recalculations due to a combination of changes in different transport sub-sectors; 1A3aii: Increase in CH_4 emissions is related to revised taxi-ing times, where more fuel and time is spent on the ground, and more specifically at lower thrust modes, than previously thought. This increase is offset by the small reduction in 1A3b sector. 1A3b: Small reduction in CH_4 emissions due to significantly lower EFs for Euro 5 and 6 diesel passenger cars and small diesel LGVs; change in gamma factor to reflect latest EMEP/EEA Guidebook revision.
EU28+ISL	160	3.0	13	1.1	-

Table 3.57 provides information on the contribution of Member States to EU-28+ISL recalculations in N_2O from 1A3 Transport for 1990 and 2016.

Table 3.57 1A3 Transport: Contribution of MS to EU-28+ISL recalculations in N_2O for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	1	0.9	-1	-0.3	Revised energy balance
Belgium	0.001	0.0	2	0.7	More accurate figures became available for gasoline and gasoil in the most recent national petroleum balances in Belgium for the years from 2009 on. These values are used to calculate the fuel sold emissions. Revision of 1A3d AD values for the period 2014-2016.
Bulgaria	-0.002	-0.0	-0.1	-0.1	For the 2018 submission, a complete recalculation has been performed, introducing the new COPERT version 5.1.
Croatia	-	-	-	-	
Cyprus	-4	-14.6	-39	-76.0	In precious submission 2006 IPCC Tier 1 methodology was used, whereas in the current submission the emissions have been obtained from the application of COPERT, which is considered T2 methodology. Domestic water-borne navigation (1A3d ii) the recalculations have been caused by availability of new data from the Statistical Service for the year 2016.
Czech Republic	-24	-11.1	-184	-46.7	COPERT 5 used for the emission estimation for the first time.
Denmark	-2	-1.8	-3	-2.5	Small emission changes are noted for CH_4 and N_2O due to the changes in the activity data for road transport based on data from the Danish car register kept by Statistics Denmark. For railways, for the years 2014-2016, an error in the emission factor for N_2O has been corrected.
Estonia	-	-	-0.1	-0.4	Calculations were improved in 1.A.3.a and 1.A.3.d. Please see chapter 3.2.5.6
Finland	-0.01	-0.01	4	4.4	Revised activity data (in 2016) due to fuel tax changes Revised data on liquid fuel properties (density, NCV, carbon content) in 2013-2016 Revised jet fuel data from Eurocontrol 1990-2016: Minor changes the allocation of gasoline consumption are reflected here
France	21	2.3	1	0.1	Update of CO_2 emission factors gasoline and diesel (Measurements)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					Addition of diesel carts -> modifications% network all vehicles and energy balance.
Germany	-1	-0.1	-7	-0.4	Changes to the specific Tier 3 emission factors (depending on the type of vehicle and the type of road).
Greece	-	-	-	-	updated data
Hungary	-4	-3.1	-1	-0.4	New version of COPERT (v5.2) with updated circulation data was used that affected also calculated fuel consumption; revised energy statistics (gasoil in road and navigation)
Ireland	1	1.4	-1	-0.7	New approach, Eurocontrol methodology for Domestic aviation
Italy	0.3	0.03	2	0.3	update of the road transport model COPERT 5.2.2
Latvia	-1	-0.8	0.4	0.8	Recalculations have been done due to switch from COPERT 5.0 model version to COPERT 5.2 model version and corrected distribution of vehicles fleet by sub-classes
Lithuania	-1	-0.8	-4	-7.4	Emissions correction for jet kerosene from Civil aviation according change of Tier 2 to Tier 1 due to high level of assumptions for Tier 2 and minimal impact to values in 2006-2016. Emissions correction for CNG from road transportation according updated CH_4 and N_2O emissions values in 2009-2016 and LPG CH_4 and N_2O emissions shift from Tier 3 to Tier 1 due to insufficient quality of engine type input data in 1990-2017. Emissions correction for road and railways transportation according updated activity data on diesel oil from 2012 due to split of biodiesel consumption between road and railways transport. Recalculation was done in Pipeline transport as Statistics of Lithuania provided CNG consumption disaggregation between Pipeline and Road transport sectors, so a part of gas consumption was transferred to 1.A.3.b Road transport.
Luxembourg	1	2.8	0.1	0.3	revision of methodology: following UNFCCC ICR (2018), addition of fossil part from biofuels; revision of AD: energy balance revised, error correction; offroad EFs revised
Malta	0.0004	0.03	-0.2	-5.0	Harmonisation of national aviation emissions from 2005 onwards, using EUROCONTROL model.
Netherlands	0	0.3	1	0.3	Updated energy statistics.
Poland	4	1.1	87	16.5	AD data and the method of calculation from COPERT 4 to COPERT 5 was changed
Portugal	0	0.0	-8	-5.2	Road Transport (1A3b) - Update of the assumed mileage percentage driven by each driving mode.
Romania	-	-	-0.01	-0.004	NA
Slovakia	-	-	15	20.7	Recalculations in the category 1.A.3.b as a result of changes in the statistical fuel consumption.
Slovenia	-	-	-	-	
Spain	-3	-0.6	-2	-0.2	Correction of mistakes in the emission factors used. Review of the AD for the whole time period by the data provider. Recalculations due to activity data update from National Statistics.
Sweden	-0	-0.3	1	0.5	Added working machine (pistmaskin) in model, which increase consumption of diesel and emissions for all years. The distribution of engine types (2-stroke / 4-stroke) and number of snowmobiles and 4-wheelers have been updated → increased emissions for 1990-1993 and decreased emissions for 1994-2016. Revision of EF and AD for wood fuels, Revision of AD in Energy Balances, Revision of NCV and EF for CO_2 Natural Gas, "The distribution of engine types (2-stroke / 4-stroke) and number of snowmobiles and 4-wheelers have been updated → reduced gasoline consumption and emissions for the agricultural sector. The redistribution of FAME between road traffic and working machineries in 2009-2016
United Kingdom	-23	-1.6	-54	-4.4	1A3aii: Increase in N_2O emissions is related to revised taxi-ing times, where more fuel and time is spent on the ground, and more specifically at lower thrust modes, than previously thought. This increase is offset by the significant decrease in

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					1A3eii sector. 1A3eii: Revised N_2O EF for all (d) machinery types from 0.35 to 0.035 g/kWh to be more in line with other transport sources.
EU28	-35	-0.4	-193	-2.0	-
Iceland	0.00002	0.0001	2	4.6	Updated emission factors from EMEP/EEA 2016 guidebook.
United Kingdom (KP)					1A3aii: Increase in N_2O emissions is related to revised taxi-ing times, where more fuel and time is spent on the ground, and more specifically at lower thrust modes, than previously thought. This increase is offset by the significant decrease in 1A3eii sector. 1A3eii: Revised N_2O EF for all (d) machinery types from 0.35 to 0.035 g/kWh to be more in line with other transport sources.
EU28+ISL	-12	-0.2	-137	-1.6	-

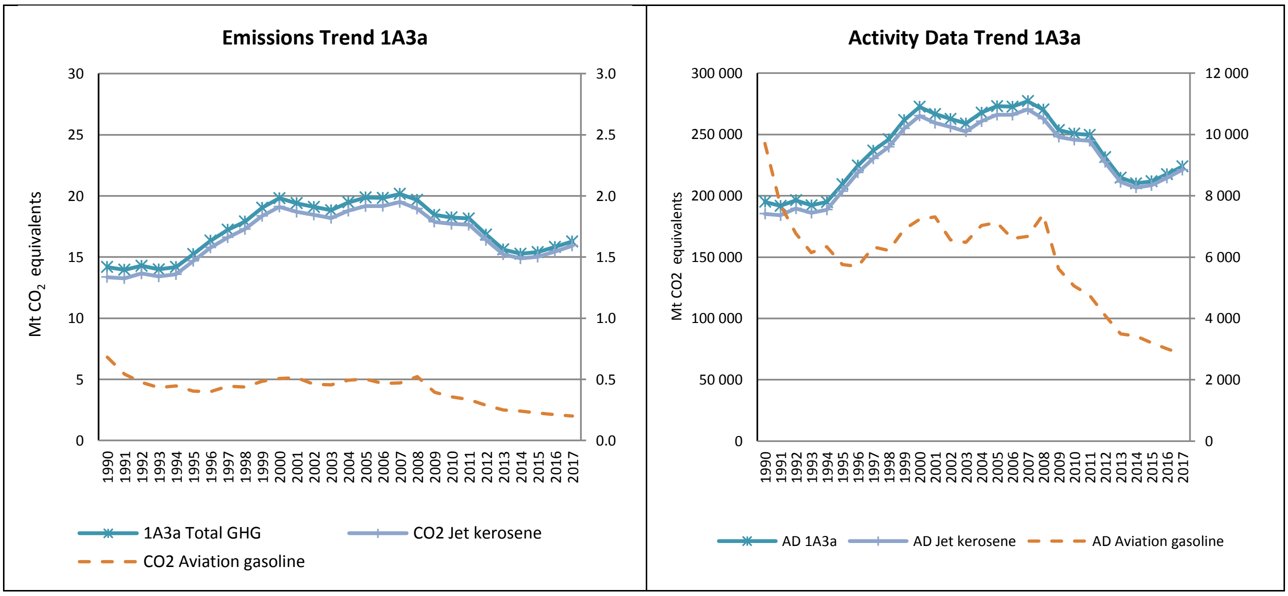
3.2.3.1 Domestic Aviation (1A3a) (EU-28+ISL)

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 Member States. Croatia and Ireland have stated in their NIR that emissions from military aviation are reported under category 1A3a, since it is not possible to split the fuel use between these two sub-categories (but the fuel used for military purposes is small compared to the fuel used for civil domestic aviation).Bulgaria and Iceland do not report emissions under category 1A5b in the CRF file and relevant information is not included in the NIR. Thus, this issue will be examined next year.

CO_2 emissions from 1A3a Domestic Aviation account for 2 % of total transport-related GHG emissions in 2017. Between 1990 and 2017, CO_2 emissions from domestic aviation increased by 15 % in the EU-28+ISL (Table 3.58, Figure 3.108).

CO_2 emissions from Jet Kerosene account for 99 % of total CO_2 emissions from 1A3a Domestic Aviation. Between 2016 and 2017, CO_2 emissions from domestic aviation increased by 3 % in the EU-28+ISL (Table 3.58, Figure 3.108).

Figure 3.108 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 Member States France, Germany, Italy and Spain alone contributed 75 % to the emissions from this source. Thirteen Member States in total increased emissions from civil aviation between 1990 and 2017 (Table 3.58). Based on the following table the Member States Germany, Italy and Spain 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%.

Table 3.58 1A3a Civil Aviation: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	32	47	42	0.3%	10	33%	-5	-11%	T2,T3	CS
Belgium	15	11	11	0.1%	-3	-22%	1	6%	T1	D
Bulgaria	135	61	62	0.4%	-73	-54%	1	1%	T1,T2	D
Croatia	7	31	31	0.2%	25	376%	0	1%	T1	D
Cyprus	26	1	1	0.0%	-25	-97%	0	46%	T1	D
Czech Republic	139	10	10	0.1%	-130	-93%	0	-2%	T1	D
Denmark	205	135	137	0.9%	-68	-33%	2	1%	CR,M,T2	CS
Estonia	6	3	4	0.0%	-2	-36%	0	6%	T2	D
Finland	385	186	194	1.2%	-191	-50%	8	4%	T1	CS
France	4 446	4 765	4 935	30.6%	489	11%	170	4%	T3	M
Germany	2 239	2 152	2 056	12.7%	-182	-8%	-96	-4%	CS,T1,T2	CS,D,M
Greece	323	410	404	2.5%	80	25%	-7	-2%	T2,T3	D
Hungary	4	4	4	0.0%	0	-2%	0	-10%	T1	D
Ireland	52	17	17	0.1%	-35	-67%	1	4%	T3	CS
Italy	1 493	2 155	2 221	13.8%	728	49%	66	3%	T1,T2	CS
Latvia	0	2	4	0.0%	4	6735%	3	131%	T1	D
Lithuania	8	1	1	0.0%	-7	-82%	0	5%	T1	CS
Luxembourg	0	1	1	0.0%	0	170%	0	-5%	T1	D
Malta	1	1	0	0.0%	-1	-64%	0	-45%	T1,T3	M
Netherlands	85	30	32	0.2%	-53	-62%	2	7%	T1	CS,D
Poland	64	116	133	0.8%	69	108%	17	14%	T1	D
Portugal	178	447	502	3.1%	324	182%	55	12%	T1,T3	D
Romania	25	84	148	0.9%	123	493%	64	76%	T1,T2	D,OTH
Slovakia	4	4	3	0.0%	0	-9%	0	-4%	T3	D
Slovenia	1	2	2	0.0%	1	59%	0	-15%	T1	D
Spain	1 664	2 675	2 805	17.4%	1 140	69%	130	5%	T3	D
Sweden	673	545	545	3.4%	-128	-19%	0	0%	T1	D
United Kingdom	1 540	1 571	1 611	10.0%	71	5%	39	2%	T3	CS
EU-28	**13 749**	**15 468**	**15 915**	**99%**	**2 166**	**16%**	**448**	**3%**	**-**	**-**
Iceland	32	23	23	0.1%	-9	-28%	0	2%	T1	D
United Kingdom (KP)	1 795	1 759	1 803	11.2%	8	0%	44	2%	T3	CS
EU-28 + ISL	**14 036**	**15 678**	**16 131**	**100%**	**2 095**	**15%**	**453**	**3%**	**-**	**-**

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 2017 CO_2 emissions resulting from jet kerosene within the category 1A3a were responsible for 99 % of CO_2 emissions in 1A3a. Within the EU-28+ISL the emissions increased between 1990 and 2017 by 19 % (Table 3.59). By far the largest absolute increase occurred in Spain. Between 2016 and 2017, EU-28+ISL emissions increased by 3 %.

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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	24	37	35	0.2%	11	45%	-2	-6%	T3	CS
Belgium	12	8	9	0.1%	-3	-24%	1	9%	T1	D
Bulgaria	114	59	60	0.4%	-53	-47%	2	3%	T2	D
Croatia	6	30	30	0.2%	24	380%	0	1%	T1	D
Cyprus	26	1	1	0.0%	-25	-97%	0	46%	T1	D
Czech Republic	1	1	1	0.0%	-1	-53%	0	-20%	T1	D
Denmark	197	132	135	0.8%	-62	-31%	3	2%	CR,M,T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	377	185	193	1.2%	-185	-49%	8	4%	T1	CS
France	4 340	4 709	4 881	30.6%	540	12%	172	4%	T3	M
Germany	2 068	2 123	2 028	12.7%	-40	-2%	-95	-4%	CS,T2	CS,M
Greece	311	404	397	2.5%	85	27%	-8	-2%	T3	D
Hungary	1	1	1	0.0%	0	-8%	0	-27%	T1	D
Ireland	49	14	16	0.1%	-33	-68%	2	13%	T3	CS
Italy	1 459	2 148	2 213	13.9%	754	52%	65	3%	T1,T2	CS
Latvia	0	1	4	0.0%	4	7341%	3	180%	T1	D
Lithuania	7	0	0	0.0%	-7	-98%	0	-50%	T1	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	1	1	0	0.0%	-1	-66%	0	-49%	T1,T3	M
Netherlands	73	27	29	0.2%	-44	-60%	2	8%	T1	D
Poland	39	104	122	0.8%	83	212%	19	18%	T1	D
Portugal	176	446	501	3.1%	325	184%	55	12%	T3	D
Romania	25	81	145	0.9%	120	483%	64	80%	T2	OTH
Slovakia	4	3	3	0.0%	0	-6%	0	-5%	T3	D
Slovenia	NO	1	1	0.0%	1	∞	0	4%	T1	D
Spain	1 638	2 666	2 795	17.5%	1 157	71%	129	5%	T3	D
Sweden	658	541	541	3.4%	-117	-18%	0	0%	T1	D
United Kingdom	1 477	1 538	1 580	9.9%	103	7%	41	3%	T3	CS
EU-28	**13 085**	**15 261**	**15 720**	**99%**	**2 635**	**20%**	**459**	**3%**	**-**	**-**
Iceland	27	21	22	0.1%	-5	-18%	1	3%	T1	D
United Kingdom (KP)	1 721	1 722	1 770	11.1%	49	3%	48	3%	T3	CS
EU-28 + ISL	**13 355**	**15 466**	**15 931**	**100%**	**2 577**	**19%**	**466**	**3%**	**-**	**-**

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 85 % of CO_2 emissions from jet kerosene in 2017 (Figure 3.110). Table **3.59** shows that the majority of emissions from Domestic Aviation jet kerosene were calculated using a higher tier method (93%) as presented in Table 6.1. It should be mentioned that Italy, one of the main contributors, is using T1 method for calculating emissions for N_2O. Thus, it was included in the share of the high tier methods calculation for CO_2 emissions. In Figure 3.109 the IEF is depicted, showing a mean value of around 72 t/TJ.

Figure 3.110 1A3a Civil Aviation, Jet Kerosene: Emission trend and share for CO_2

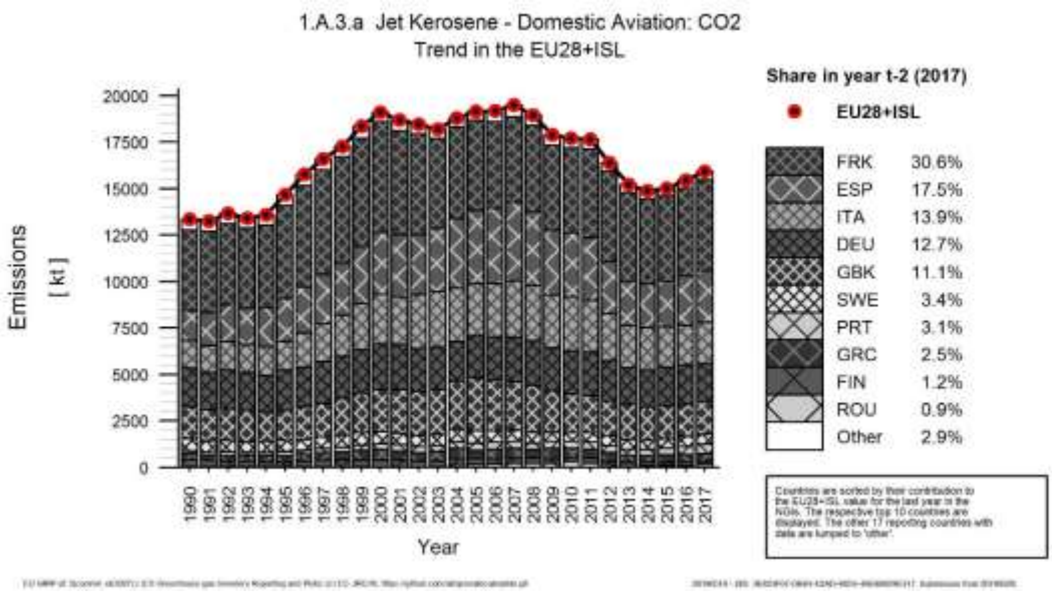
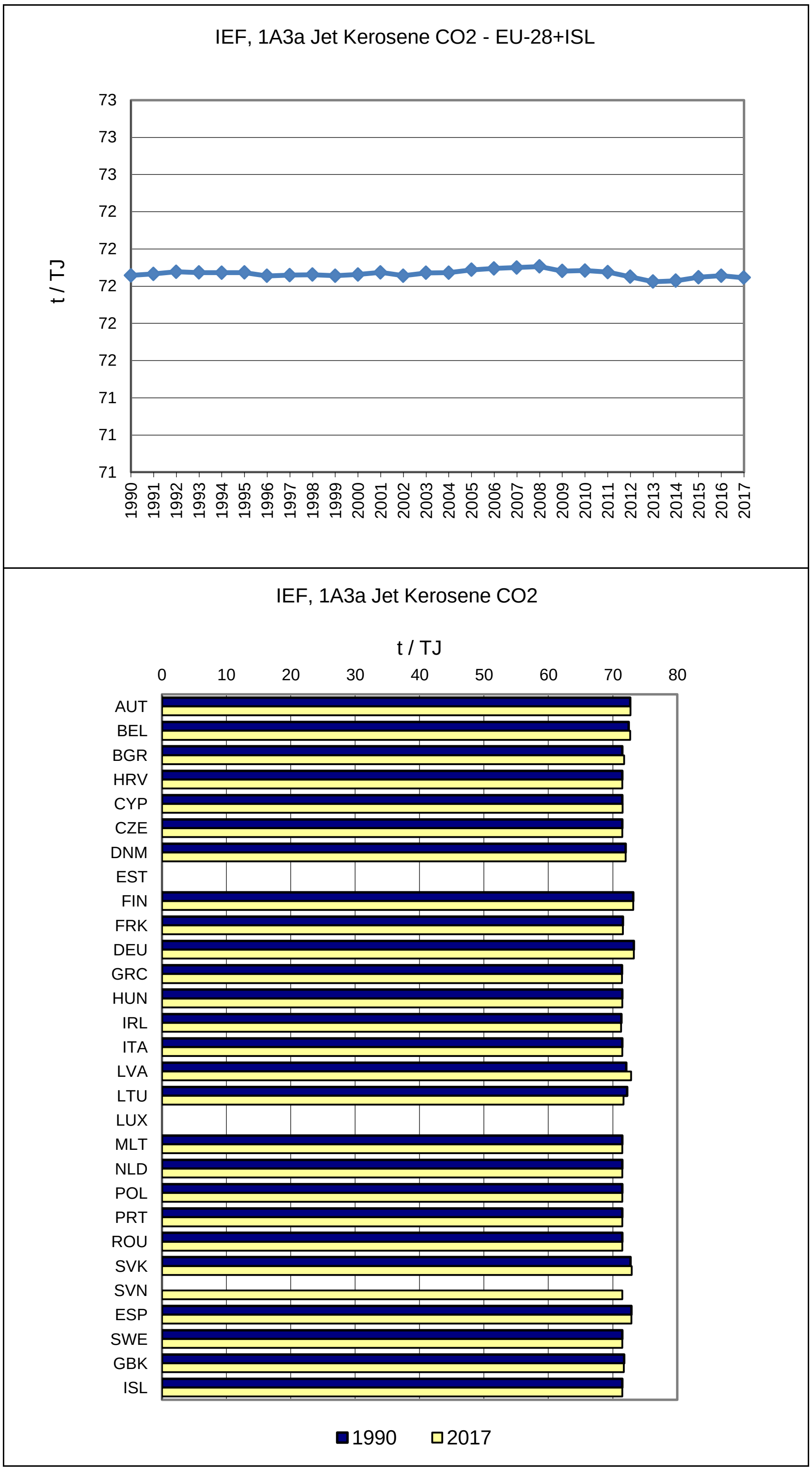


Figure 3.111   1A3a Civil Aviation, Jet Kerosene: Implied Emission Factors for CO_2 (in t/TJ)



3.2.3.2 Road Transportation (1A3b) (EU-28+ISL)

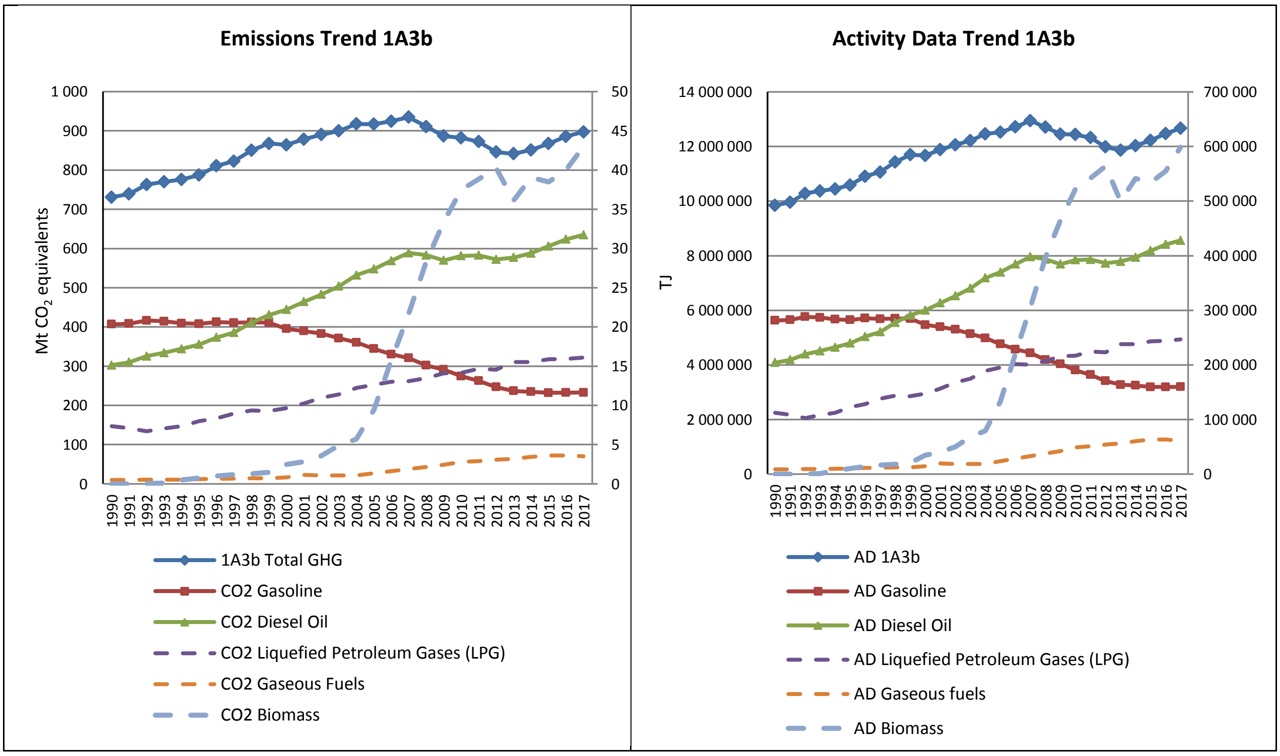
CO_2 emissions from 1A3b Road Transportation

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-28+ISL accounting for 20.5 % of total GHG emissions in 2017. Between 1990 and 2017, CO_2 emissions from road transportation increased by 24 % in the EU-28+ISL (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. The emissions from this key source are due to fossil fuel consumption in road transport, which increased by 24 % between 1990 and 2017.

Figure 3.112 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 strong increase of diesel show the gradual switch from gasoline to diesel passenger cars in several EU-28+ISL Member States.

Figure 3.112 1A3b Road Transport: CO_2 Emission Trend and Activity Data



Data displayed as dashed line refers to the secondary axis.

The Member States Germany, France, Italy, Spain and the United Kingdom contributed most to the CO_2 emissions from this source (65 %). All Member States, except Finland (-1%), Italy (-1%) and Sweden (-10%), show increased emissions from road transportation between 1990 and 2017. 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 Member States with the highest increases in absolute terms were Poland, Spain, France and Austria. The countries with the lowest increase in relative terms were Estonia and Lithuania (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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	13 328	22 581	23 243	2.6%	9 915	74%	662	3%	T1,T2	CS,D
Belgium	19 729	25 464	24 872	2.8%	5 143	26%	-592	-2%	M,T1,T3	OTH
Bulgaria	5 780	8 768	8 842	1.0%	3 062	53%	75	1%	T2	CR
Croatia	3 506	5 880	6 343	0.7%	2 837	81%	462	8%	T1	D
Cyprus	1 184	2 003	2 075	0.2%	891	75%	72	4%	T2	M
Czechia	10 252	17 615	18 082	2.0%	7 830	76%	467	3%	T2	M
Denmark	9 357	11 834	12 009	1.4%	2 653	28%	175	1%	CR,M,T2	CS
Estonia	2 235	2 239	2 326	0.3%	91	4%	87	4%	T1,T2	CS,D
Finland	10 804	11 317	10 694	1.2%	-110	-1%	-623	-6%	T2	CS
France	114 060	125 776	126 037	14.2%	11 976	10%	261	0%	T3	M
Germany	151 881	157 992	160 083	18.0%	8 202	5%	2 091	1%	CS,M,T2,T3	CS,D
Greece	11 793	14 788	14 534	1.6%	2 741	23%	-254	-2%	T1,T2,T3	CS,D
Hungary	7 827	12 072	12 695	1.4%	4 868	62%	622	5%	T1,T2	CS,D
Ireland	4 690	11 624	11 371	1.3%	6 681	142%	-252	-2%	T2,T3	CS,M
Italy	92 330	95 244	91 395	10.3%	-935	-1%	-3 850	-4%	T1,T2	CS,D
Latvia	2 403	2 930	3 090	0.3%	687	29%	160	5%	T1,T2	CS,D,OTH
Lithuania	5 247	5 199	5 445	0.6%	198	4%	245	5%	T1,T2	CS,D
Luxembourg	2 561	5 476	5 578	0.6%	3 017	118%	101	2%	T1,T2	CS,D
Malta	300	514	558	0.1%	258	86%	44	9%	T1,T3	M
Netherlands	26 457	28 971	29 667	3.3%	3 210	12%	697	2%	T2	CS
Poland	18 544	52 780	61 146	6.9%	42 601	230%	8 366	16%	T2	D
Portugal	9 406	15 874	16 168	1.8%	6 762	72%	294	2%	T2	OTH
Romania	10 366	16 014	17 066	1.9%	6 701	65%	1 052	7%	T1,T3	D,OTH
Slovakia	4 503	7 046	7 151	0.8%	2 648	59%	105	1%	T2	CS,D
Slovenia	2 600	5 628	5 435	0.6%	2 835	109%	-193	-3%	M	M
Spain	50 429	80 192	81 551	9.2%	31 122	62%	1 359	2%	T1	D,M
Sweden	17 130	15 784	15 345	1.7%	-1 785	-10%	-439	-3%	T2	CS
United Kingdom	107 893	112 843	112 884	12.7%	4 992	5%	41	0%	T1,T3	CS,OTH
EU-28	**716 592**	**874 446**	**885 683**	**100%**	**169 091**	**24%**	**11 237**	**1%**	**-**	**-**
Iceland	509	884	934	0.1%	425	84%	50	6%	T1	D
United Kingdom (KP)	108 366	113 377	113 416	12.8%	5 050	5%	40	0%	OTH,T1,T3	CS,OTH
EU-28 + ISL	**717 574**	**875 864**	**887 150**	**100%**	**169 575**	**24%**	**11 285**	**1%**	**-**	**-**

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

In Table 3.61the fuel share is presented per Member State. It is clear that diesel oil accounts for 68 % for EU-28+ISL and gasoline for 25 %. The highest LPG consumption is observed in Bulgaria (16 %) and Poland (10 %). The share of biomass is around 5 % for EU-28+ISL with Sweden having the highest percentage (21 %).

Table 3.61: 1A3b Road Transport: Member States' share of different fuel in the total consumption

Member State	Gasoline (%)	Diesel oil (%)	LPG (%)	Gaseous fuels (%)	Biomass (%)
Austria	18.9%	75.8%	0.1%	0.2%	4.9%
Belgium	16.8%	76.9%	0.7%	0.1%	5.5%
Bulgaria	16.4%	60.2%	15.5%	2.4%	5.5%
Croatia	25.6%	70.4%	3.8%	0.2%	0.0%
Cyprus	54.1%	44.7%	NO	NO	1.2%
Czech Republic	25.1%	67.4%	1.7%	0.9%	5.0%

Member State	Gasoline (%)	Diesel oil (%)	LPG (%)	Gaseous fuels (%)	Biomass (%)
Denmark	31.3%	63.2%	0.0004%	0.2%	5.2%
Estonia	34.3%	64.6%	1.0%	NO	0.1%
Finland	32.5%	57.4%	NA,NO	0.06%	10.0%
France	16.8%	76.1%	0.2%	0.2%	6.8%
Germany	31.5%	62.9%	0.6%	0.2%	4.7%
Greece	48.0%	42.8%	5.1%	0.3%	3.8%
Hungary	31.5%	64.2%	0.6%	0.2%	3.4%
Ireland	23.1%	72.7%	0.03%	NO	4.1%
Italy	23.2%	64.1%	5.8%	2.7%	4.2%
Latvia	18.9%	74.3%	5.7%	NO	0.8%
Lithuania	11.5%	78.8%	6.3%	0.4%	3.0%
Luxembourg	15.7%	78.6%	0.04%	NO	5.7%
Malta	37.9%	59.3%	0.3%	NO	2.5%
Netherlands	39.6%	55.8%	1.2%	0.4%	3.0%
Poland	20.4%	66.8%	9.7%	0.1%	2.9%
Portugal	19.8%	75.1%	0.7%	0.3%	4.1%
Romania	24.5%	68.4%	1.7%	NO	5.5%
Slovakia	21.2%	70.6%	1.9%	0.2%	6.1%
Slovenia	23.5%	73.1%	0.8%	0.2%	2.4%
Spain	17.1%	77.4%	0.2%	0.5%	4.8%
Sweden	33.3%	45.8%	0.01%	0.3%	20.6%
United Kingdom	31.9%	66.4%	0.2%	IE	1.5%
EU-28	**25%**	**68%**	**2%**	**0.5%**	**4.7%**
Iceland	43.1%	51.3%	NO	NO	5.6%
EU-28 + ISL	**25%**	**68%**	**2%**	**0.5%**	**4.7%**

1A3b Road Transportation – Gaseous Fuels (CO_2)

CO_2 emissions from Gaseous fuels account for 0,4 % of CO_2 emissions from 1A3b Road Transport in 2017 (Figure 3.112). Between 2016 and 2017 CO_2 emissions from Gaseous fuels have decreased by 3 %, between 1990 and 2017 emissions show an increase of 595% in EU-28+ISL. Most Member States showed increased emissions, whereas 9 Member States reported emissions as “Not occurring” or “Included elsewhere” United Kingdom includes the small amount of natural gas used for road transport with LPG consumption.

Table 3.62: 1A3b Road Transport, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	NO	40	39	1.1%	39	∞	0	-1%
Belgium	NO	17	28	0.8%	28	∞	11	64%
Bulgaria	NO	174	176	5.0%	176	∞	2	1%
Croatia	NO	9	10	0.3%	10	∞	1	16%
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	NO	116	130	3.7%	130	∞	14	12%
Denmark	0	11	21	0.6%	21	105657%	10	86%
Estonia	NO	NO	NO	-	-	-	-	-
Finland	NO,NA	5	5	0.1%	5	∞	0	-5%
France	0	149	170	4.8%	170	47616%	21	14%
Germany	NA	327	290	8.3%	290	∞	-36	-11%
Greece	NO	36	33	0.9%	33	∞	-3	-8%
Hungary	0	19	21	0.6%	20	6683%	2	8%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	483	2 157	2 042	58.2%	1 559	322%	-115	-5%
Latvia	18	NO,NA	NO,NA	-	-18	-100%	-	-
Lithuania	NO	18	18	0.5%	18	∞	0	0%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	102	98	2.8%	98	∞	-3	-3%
Poland	NO	35	27	0.8%	27	∞	-8	-24%
Portugal	NO	33	35	1.0%	35	∞	2	6%
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	NO	13	13	0.4%	13	∞	0	-3%
Slovenia	NO	6	8	0.2%	8	∞	1	16%
Spain	NO	256	300	8.5%	300	∞	43	17%
Sweden	3	87	43	1.2%	41	1402%	-44	-50%
United Kingdom	IE	IE	IE	-	-	-	-	-
EU-28	**505**	**3 611**	**3 508**	**100%**	**3 003**	**595%**	**-104**	**-3%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	IE	IE	IE	-	-	-	-	-
EU-28 + ISL	**505**	**3 611**	**3 508**	**100%**	**3 003**	**595%**	**-104**	**-3%**

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 Member States Germany, France, Italy and Spain contributed most to the CO_2 emissions from this source (80 %). All Member States, except for Latvia, show increased emissions from road transportation between 1990 and 2017. The Member States with the highest increases in absolute terms were Italy, Germany and Spain. (Table 3.60).

In Figure **3**.7 it is depicted that the share of gaseous fuels is constantly increasing from 1990 to 2017. The reason for this increase is the increasing activity data and corresponing emissions of Italy, which is a high contributor to this source category. A small decrese is observed from last year's submission. In Figure **3**.10 the IEF is depicted and the mean value is around 56 t/TJ. 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 2017.

Figure 3.113: 1A3b Road Transport, gaseous fuels: Emission trend and share for CO_2

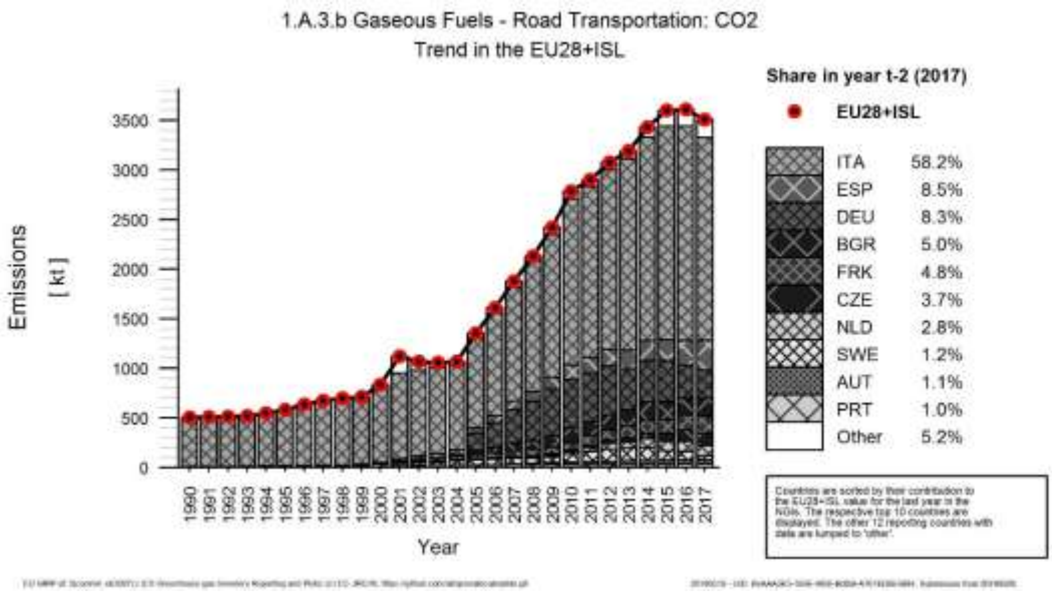
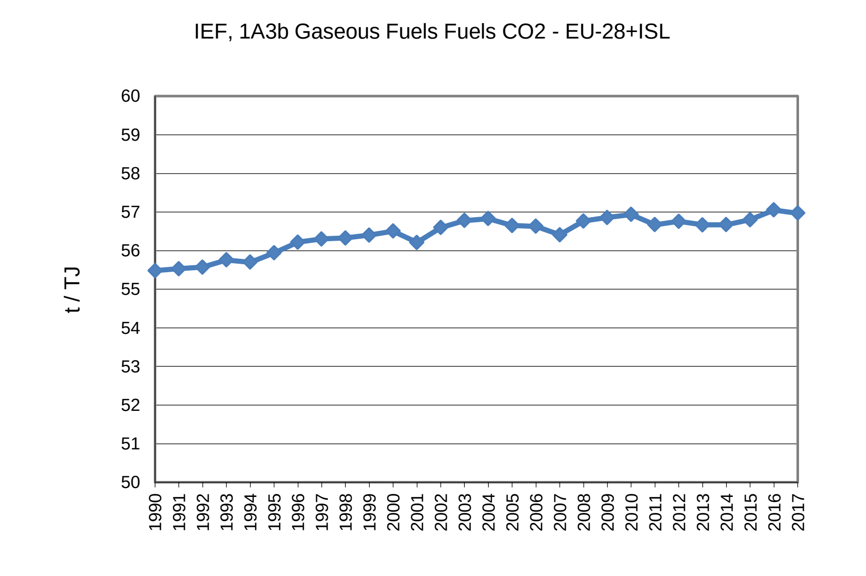
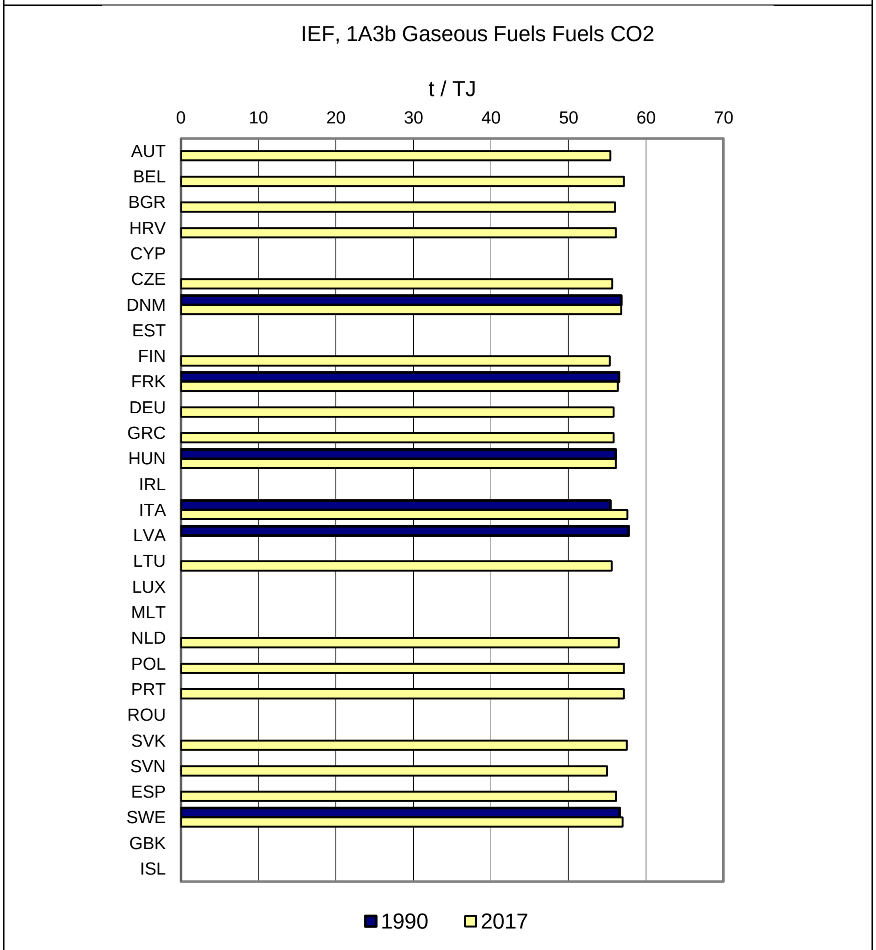


Figure 3.114 1A3b Road Transport, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A3b Road Transportation – Diesel Oil (CO_2)

CO_2 emissions from Diesel oil account for 68 % of CO_2 emissions from 1A3b Road Transport in 2017 (Figure 3.112). All Member States show increased emissions from Diesel oil between 1990 and 2017 (Table 3.). Member States with the highest increase in per cent were Slovenia, 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: Member States' contributions to CO_2 emissions*

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	5 378	17 663	18 386	2.9%	13 008	242%	723	4%
Belgium	11 027	20 946	20 355	3.2%	9 328	85%	-591	-3%
Bulgaria	1 539	5 754	5 831	0.9%	4 292	279%	77	1%
Croatia	1 159	4 050	4 572	0.7%	3 413	295%	523	13%
Cyprus	668	871	953	0.2%	285	43%	82	9%
Czechia	6 655	12 467	13 004	2.0%	6 350	95%	538	4%
Denmark	4 436	7 889	8 032	1.3%	3 596	81%	143	2%
Estonia	697	1 475	1 510	0.2%	813	117%	34	2%
Finland	4 923	7 355	6 887	1.1%	1 964	40%	-468	-6%
France	54 621	104 303	103 725	16.3%	49 104	90%	-578	-1%
Germany	54 478	103 155	105 308	16.6%	50 830	93%	2 153	2%
Greece	4 264	6 534	6 514	1.0%	2 250	53%	-20	0%
Hungary	2 388	7 855	8 544	1.3%	6 156	258%	690	9%
Ireland	1 914	8 682	8 720	1.4%	6 806	356%	39	0%
Italy	47 806	65 340	62 058	9.8%	14 252	30%	-3 282	-5%
Latvia	623	2 167	2 360	0.4%	1 737	279%	193	9%
Lithuania	2 134	4 169	4 464	0.7%	2 330	109%	295	7%
Luxembourg	1 270	4 595	4 642	0.7%	3 371	265%	46	1%
Malta	120	277	343	0.1%	223	187%	66	24%
Netherlands	13 012	16 706	17 048	2.7%	4 037	31%	342	2%
Poland	8 748	35 950	42 913	6.8%	34 165	391%	6 964	19%
Portugal	5 072	12 463	12 762	2.0%	7 691	152%	299	2%
Romania	3 648	11 855	12 847	2.0%	9 199	252%	992	8%
Slovakia	3 123	5 357	5 464	0.9%	2 341	75%	107	2%
Slovenia	904	4 297	4 149	0.7%	3 244	359%	-148	-3%
Spain	24 420	65 326	66 304	10.4%	41 884	172%	979	1%
Sweden	4 381	8 937	8 866	1.4%	4 486	102%	-71	-1%
United Kingdom	32 772	76 529	77 283	12.2%	44 511	136%	754	1%
EU-28	**302 179**	**622 966**	**633 846**	**100%**	**331 666**	**110%**	**10 880**	**2%**
Iceland	117	465	523	0.1%	407	349%	58	12%
United Kingdom (KP)	32 916	76 751	77 506	12.2%	44 589	135%	755	1%
EU-28 + ISL	**302 440**	**623 653**	**634 592**	**100%**	**332 152**	**110%**	**10 938**	**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.

France, Germany, Italy, Spain and the UK account for 65 % of CO_2 emissions from diesel oil in 2017 (In Figure 3.115 the IEF is depicted and the mean value is around 74 t/TJ. For some Member States 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). Investigations are still on-going.

Figure 3.116 1A3b Road Transport, Diesel Oil: Emission trend and share for CO_2

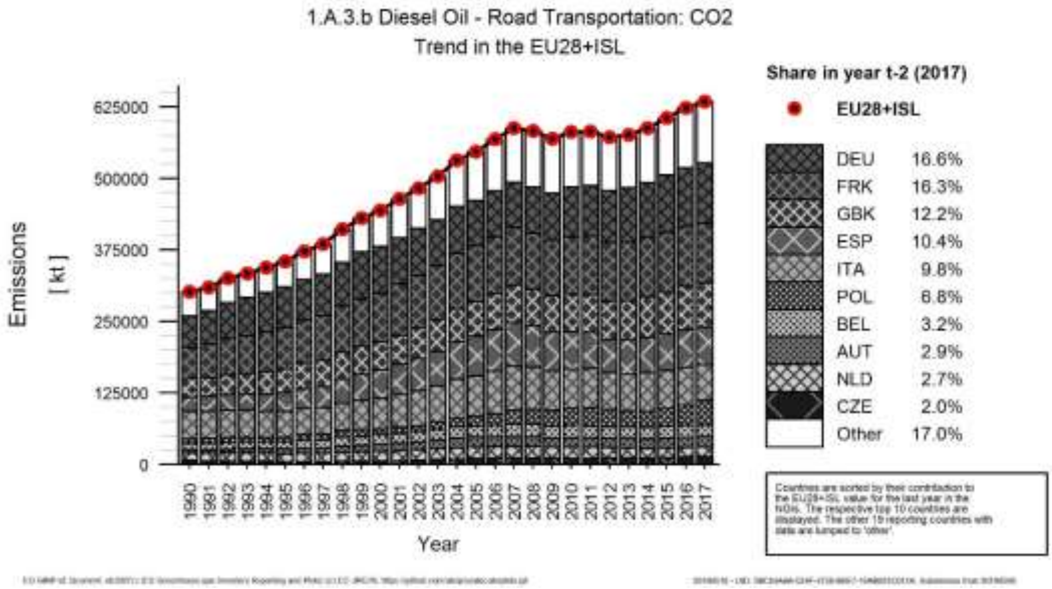
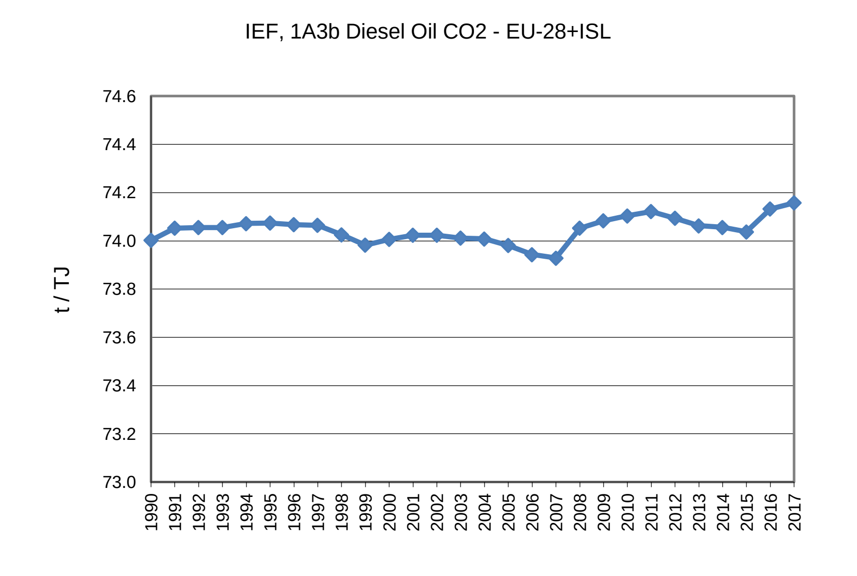
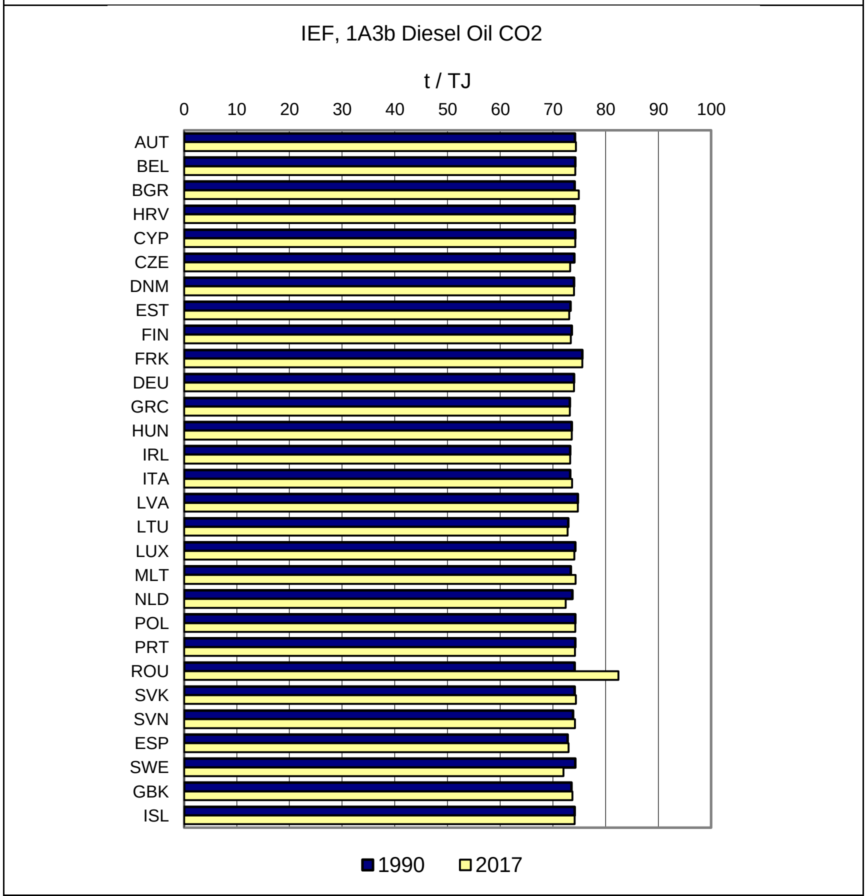


Figure 3.117 1A3b Road Transport, Diesel Oil: Implied Emission Factors for CO_2 (in t/TJ)





1A3b Road Transportation – Gasoline (CO_2)

Between 1990 and 2017, CO_2 emissions from gasoline decreased by 43 % in the EU-28+ISL (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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	7 924	4 779	4 723	2.0%	-3 201	-40%	-56	-1%
Belgium	8 532	4 322	4 327	1.9%	-4 205	-49%	5	0%
Bulgaria	4 241	1 476	1 517	0.7%	-2 724	-64%	41	3%
Croatia	2 347	1 613	1 551	0.7%	-796	-34%	-61	-4%
Cyprus	515	1 132	1 122	0.5%	606	118%	-10	-1%
Czech Republic	3 597	4 733	4 658	2.0%	1 060	29%	-75	-2%
Denmark	4 911	3 904	3 927	1.7%	-984	-20%	23	1%
Estonia	1 529	749	796	0.3%	-733	-48%	48	6%
Finland	5 880	3 956	3 802	1.6%	-2 078	-35%	-154	-4%
France	59 278	21 097	21 940	9.4%	-37 337	-63%	843	4%
Germany	97 217	53 390	53 578	23.0%	-43 638	-45%	188	0%
Greece	7 438	7 498	7 310	3.1%	-128	-2%	-188	-3%
Hungary	5 404	4 124	4 059	1.7%	-1 346	-25%	-66	-2%
Ireland	2 758	2 935	2 647	1.1%	-110	-4%	-287	-10%
Italy	39 964	22 874	22 216	9.5%	-17 748	-44%	-658	-3%
Latvia	1 722	595	572	0.2%	-1 151	-67%	-24	-4%
Lithuania	3 053	657	628	0.3%	-2 426	-79%	-30	-5%
Luxembourg	1 279	866	917	0.4%	-362	-28%	51	6%
Malta	180	235	213	0.1%	33	18%	-22	-9%
Netherlands	10 805	11 776	12 175	5.2%	1 369	13%	399	3%
Poland	9 796	11 640	12 733	5.5%	2 938	30%	1 093	9%
Portugal	4 329	3 264	3 258	1.4%	-1 070	-25%	-5	0%
Romania	6 591	3 963	3 982	1.7%	-2 608	-40%	20	0%
Slovakia	1 380	1 561	1 547	0.7%	167	12%	-14	-1%
Slovenia	1 695	1 283	1 237	0.5%	-458	-27%	-46	-4%
Spain	25 925	14 466	14 791	6.4%	-11 134	-43%	325	2%
Sweden	12 746	6 757	6 433	2.8%	-6 313	-50%	-324	-5%
United Kingdom	75 119	36 005	35 309	15.2%	-39 809	-53%	-696	-2%
EU-28	**406 156**	**231 649**	**231 970**	**100%**	**-174 186**	**-43%**	**321**	**0%**
Iceland	392	419	411	0.2%	18	5%	-8	-2%
United Kingdom (KP)	75 448	36 317	35 619	15.3%	-39 829	-53%	-698	-2%
EU-28 + ISL	**406 878**	**232 380**	**232 690**	**100%**	**-174 188**	**-43%**	**310**	**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.

France, Germany, Italy, Spain and the United Kingdom account for 64 % for CO_2 emissions from gasoline in 2017). In Figure 3.118 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 23% of emissions in this sector. For some Member States 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 3.119 1A3b Road Transport, Gasoline: Emission trend and share for CO_2

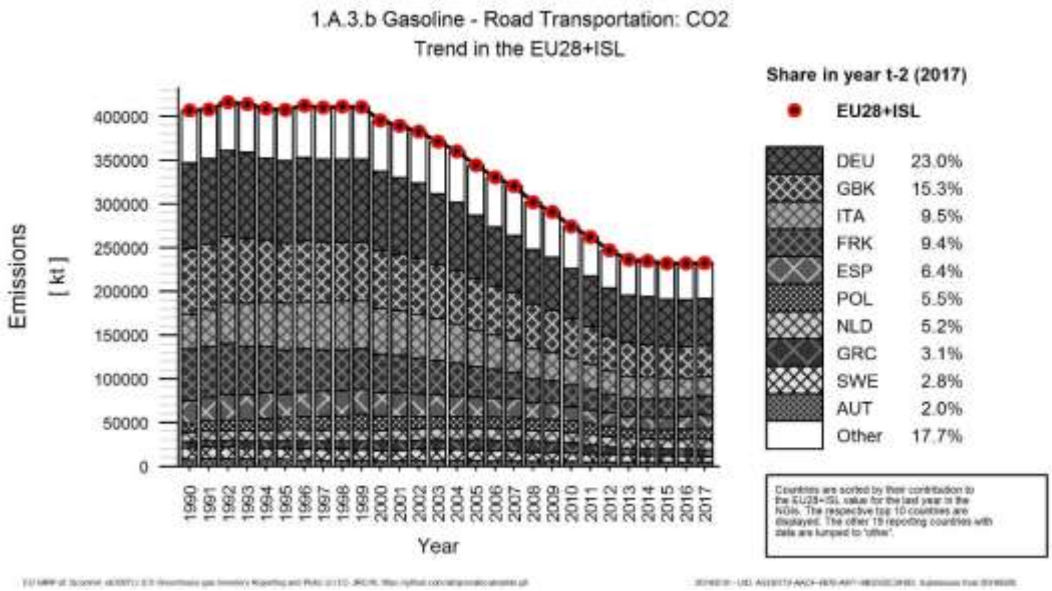
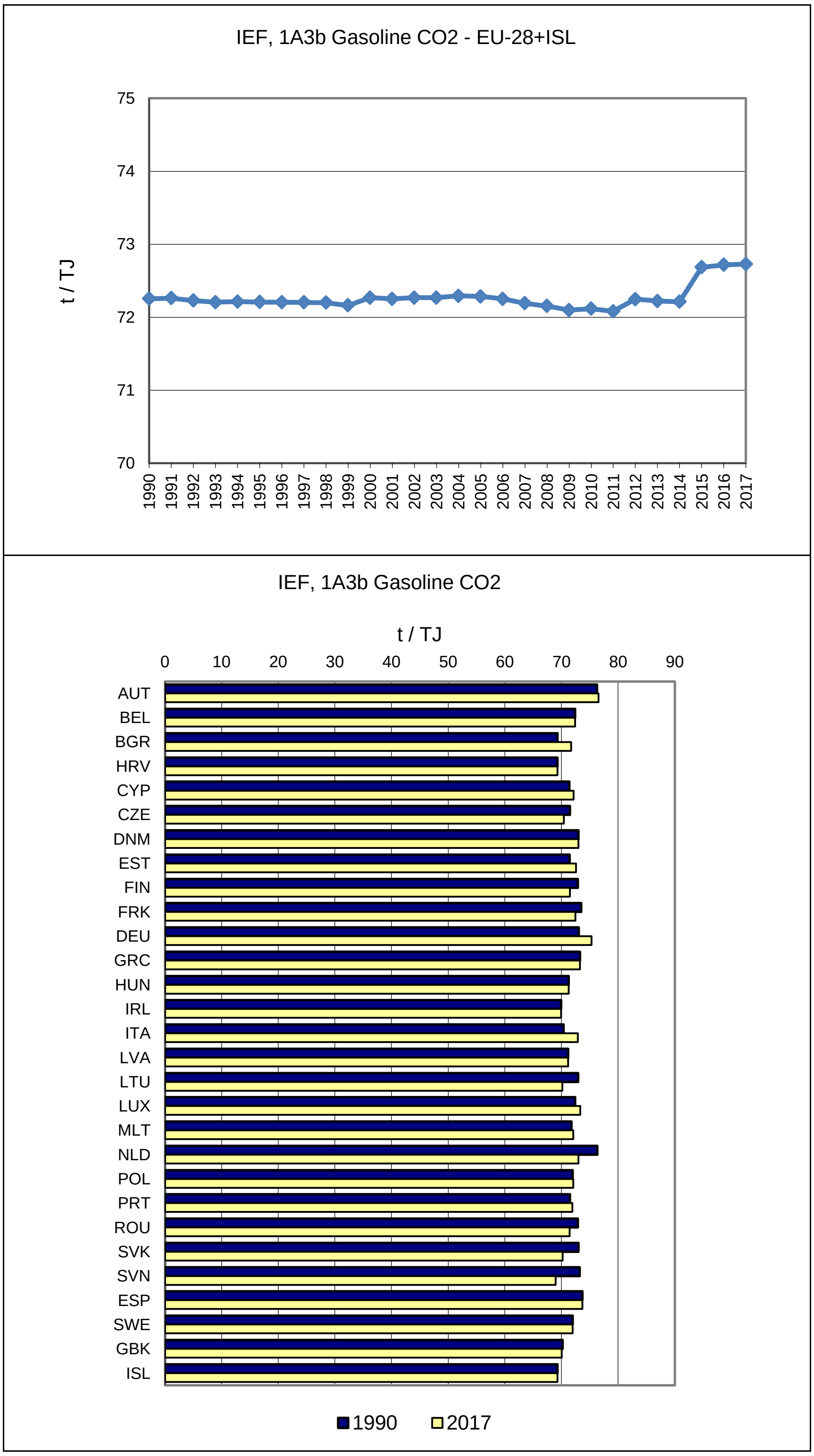


Figure 3.120 1A3b Road Transport, Gasoline: Implied Emission Factors for CO_2 (in t/TJ)



1A3b Road Transportation – LPG (CO_2)

Between 1990 and 2017, CO_2 emissions from LPG increased by 119 % in the EU-28+ISL. Three Member States report emissions as ‘Not occurring’. Between 2016 and 2017 EU-28+ISL emissions increased by 1 % (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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	26	31	31	0.2%	5	17%	1	2%
Belgium	169	178	162	1.0%	-8	-4%	-17	-9%
Bulgaria	NO	1 364	1 318	8.2%	1 318	∞	-46	-3%
Croatia	NO	209	209	1.3%	209	∞	0	0%
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	NO	299	290	1.8%	290	∞	-9	-3%
Denmark	9	0	0	0.0%	-9	-100%	0	-24%
Estonia	9	15	20	0.1%	11	123%	5	33%
Finland	NO,NA	NO,NA	NO,NA	-	-	-	-	-
France	150	219	193	1.2%	43	28%	-26	-12%
Germany	9	1 114	900	5.6%	891	9850%	-214	-19%
Greece	91	720	677	4.2%	586	646%	-43	-6%
Hungary	NO	73	70	0.4%	70	∞	-3	-4%
Ireland	19	7	4	0.0%	-15	-80%	-3	-47%
Italy	4 026	4 836	5 046	31.4%	1 020	25%	210	4%
Latvia	37	163	153	1.0%	116	312%	-9	-6%
Lithuania	60	347	326	2.0%	266	441%	-21	-6%
Luxembourg	11	2	2	0.0%	-9	-83%	0	-13%
Malta	NO	2	2	0.0%	2	∞	0	0%
Netherlands	2 640	387	346	2.2%	-2 294	-87%	-41	-11%
Poland	NO,IE	5 155	5 472	34.0%	5 472	∞	317	6%
Portugal	0	112	110	0.7%	110	174188%	-1	-1%
Romania	NO	197	237	1.5%	237	∞	40	21%
Slovakia	NO	115	127	0.8%	127	∞	12	10%
Slovenia	NO	42	42	0.3%	42	∞	0	-1%
Spain	78	142	154	1.0%	75	96%	12	9%
Sweden	0	2	2	0.0%	2	634%	0	-6%
United Kingdom	NO	208	198	1.2%	198	∞	-10	-5%
EU-28	**7 336**	**15 939**	**16 091**	**100%**	**8 755**	**119%**	**152**	**1%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	NO	208	198	1.2%	198	∞	-10	-5%
EU-28 + ISL	**7 336**	**15 939**	**16 091**	**100%**	**8 755**	**119%**	**152**	**1%**

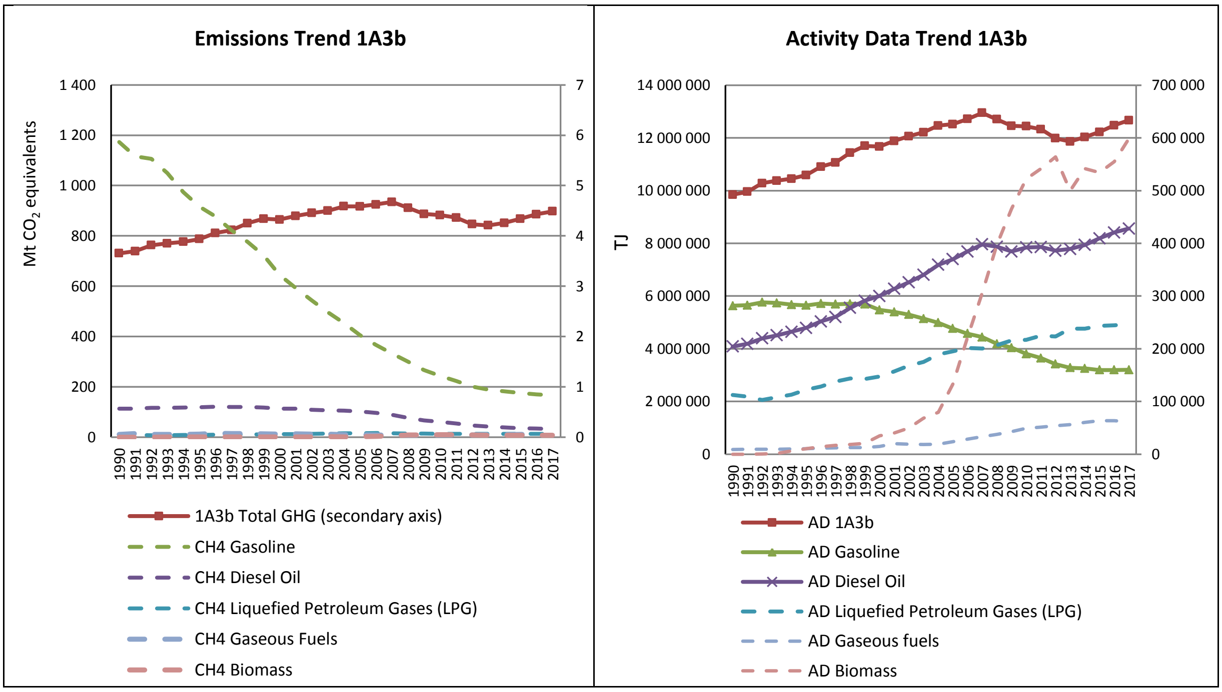
Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

Italy accounts for 31 % and Poland for 34 % of CO_2 emissions from LPG in 2017 whereas France, Germany, Spain and the United Kingdom account for only 9 % of CO_2 emissions (Table 3.).

CH_4 emissions from 1A3b Road Transportation

CH_4 emissions from 1A3b Road Transportation account for 0.03 % of total EU-28+ISL GHG emissions in 2017 Figure 3.124 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 3.121 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 2017 by 82 % (Table 3.66). All Member States, except for Malta (increase by 25 %) showed a decrease in CH_4 emissions from 1990 to 2017. Between 2016 and 2017, CH_4 emissions decreased by 2 % in EU-28+ISL. In the same time period the largest decrease in relative terms was reported by Ireland, Slovenia and Bulgaria.

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-28+ISL	Change 1990-2017		Change 2016-2017		Method	Emission factor
	1990	2016	2017	Emissions in 2017	kt CO2 equiv.	%	kt CO2 equiv.	%		Informa-tion
Austria	68	10	10	0.9%	-58	-85%	0	-4%	T3	CS
Belgium	120	16	16	1.4%	-105	-87%	-1	-4%	M,T3	CS,OTH
Bulgaria	70	25	23	2.0%	-47	-67%	-2	-9%	T2	CR
Croatia	41	11	11	1.0%	-30	-73%	0	-3%	T1,T3	CR,D
Cyprus	7	4	4	0.4%	-3	-41%	0	-4%	T2	M
Czech Republic	75	26	25	2.1%	-50	-67%	-1	-5%	T3	M
Denmark	79	10	10	0.8%	-69	-88%	-1	-5%	CR,M,T3	CR
Estonia	23	4	3	0.3%	-19	-85%	0	-5%	T1,T3	CS,D
Finland	107	13	12	1.1%	-95	-89%	-1	-7%	T3	CR
France	1 016	121	119	10.3%	-897	-88%	-3	-2%	T3	M
Germany	1 317	136	135	11.7%	-1 182	-90%	-1	0%	CS,M,T2,T3	CS,M
Greece	107	70	72	6.3%	-35	-32%	3	4%	M,T1	D,M
Hungary	67	25	23	2.0%	-44	-65%	-1	-6%	T1,T3	D,M
Ireland	48	13	11	1.0%	-37	-77%	-2	-15%	T3	M
Italy	913	206	192	16.6%	-721	-79%	-14	-7%	T3	M
Latvia	18	4	4	0.3%	-14	-79%	0	0%	T1,T2	CR,OTH
Lithuania	52	20	19	1.6%	-33	-64%	-2	-8%	T1,T3	CR,D
Luxembourg	11	1	1	0.1%	-10	-91%	0	-2%	T3	M
Malta	3	2	4	0.3%	1	25%	2	154%	T1,T3	M
Netherlands	193	60	61	5.3%	-132	-68%	2	3%	T3	CS
Poland	182	123	137	11.9%	-45	-25%	15	12%	T3	D
Portugal	94	24	23	2.0%	-71	-76%	-1	-5%	T3	OTH
Romania	90	35	34	3.0%	-56	-62%	0	-1%	T1,T3	D,OTH
Slovakia	29	8	8	0.7%	-21	-73%	-1	-6%	T3	D
Slovenia	26	6	5	0.5%	-20	-79%	-1	-9%	M	M
Spain	370	81	81	7.0%	-289	-78%	0	0%	T3	M
Sweden	152	16	15	1.3%	-137	-90%	-1	-8%	M,T1,T2	CS,D
United Kingdom	1 237	99	92	7.9%	-1 145	-93%	-7	-7%	T3	CS
EU-28	**6 513**	**1 169**	**1 150**	**100%**	**-5 363**	**-82%**	**-19**	**-2%**	**-**	**-**
Iceland	4	3	3	0.2%	-1	-29%	0	-3%	T1	D
United Kingdom (KP)	1 244	100	93	8.1%	-1 151	-93%	-7	-7%	T3	CS
EU-28 + ISL	**6 524**	**1 173**	**1 154**	**100%**	**-5 370**	**-82%**	**-19**	**-2%**	**-**	**-**

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 2017, CH_4 emissions from gasoline decreased by 86 % in the EU-28+ISL. All Member States reported decreasing emissions, apart from Malta (increase by 29 %). Between 2016 and 2017 EU-28+ISL emissions decreased by 2 % (Table 3.). The largest decreases in per cent were reported by Ireland (-16 %) and Slovenia (-10 %).

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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	65	9	9	1.0%	-56	-87%	0	-4%
Belgium	97	12	11	1.3%	-86	-89%	-1	-7%
Bulgaria	66	8	7	0.9%	-59	-89%	0	-5%
Croatia	38	8	7	0.9%	-30	-80%	0	-6%
Cyprus	5	3	3	0.4%	-2	-41%	0	-2%
Czech Republic	57	19	18	2.1%	-39	-69%	-1	-5%
Denmark	69	8	8	0.9%	-61	-89%	0	-5%
Estonia	21	3	3	0.3%	-18	-87%	0	-2%
Finland	93	10	9	1.1%	-84	-90%	-1	-6%
France	899	90	89	10.7%	-810	-90%	-1	-1%
Germany	1 289	121	121	14.5%	-1 168	-91%	0	0%
Greece	97	54	56	6.7%	-42	-43%	1	3%
Hungary	61	17	16	1.9%	-45	-74%	-1	-6%
Ireland	44	11	9	1.1%	-35	-80%	-2	-16%
Italy	737	137	128	15.3%	-610	-83%	-9	-7%
Latvia	16	2	2	0.2%	-14	-88%	0	-7%
Lithuania	44	6	6	0.7%	-38	-87%	0	-6%
Luxembourg	11	1	1	0.1%	-10	-92%	0	-1%
Malta	3	1	4	0.4%	1	29%	3	224%
Netherlands	156	51	52	6.3%	-104	-67%	2	3%
Poland	159	66	72	8.6%	-87	-55%	6	10%
Portugal	82	16	16	1.9%	-66	-81%	0	-2%
Romania	81	23	22	2.7%	-59	-73%	-1	-3%
Slovakia	21	5	5	0.5%	-16	-78%	0	-5%
Slovenia	24	5	4	0.5%	-20	-83%	0	-10%
Spain	321	59	60	7.2%	-261	-81%	1	1%
Sweden	149	13	12	1.5%	-136	-92%	-1	-6%
United Kingdom	1 149	89	84	10.0%	-1 065	-93%	-5	-6%
EU-28	**5 852**	**846**	**832**	**100%**	**-5 020**	**-86%**	**-14**	**-2%**
Iceland	4	2	2	0.2%	-2	-53%	0	-9%
United Kingdom (KP)	1 155	90	85	10.2%	-1 070	-93%	-5	-6%
EU-28 + ISL	**5 862**	**849**	**835**	**100%**	**-5 027**	**-86%**	**-14**	**-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.

France, Germany, Italy, Spain and the United Kingdom account for 58 % of CH_4 emissions from gasoline in 2017 (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 2017. All MSs show a similar trend in both the IEF and emission values, which is also linked to the decreasing trend of the corresponding activity data. The increased IEF of Malta for 2017 will be corrected in the next submission. Malta provided a revised estimate.

Figure 3.122 1A3b Road Transport, gasoline: Emission trend and share for CH_4 emission

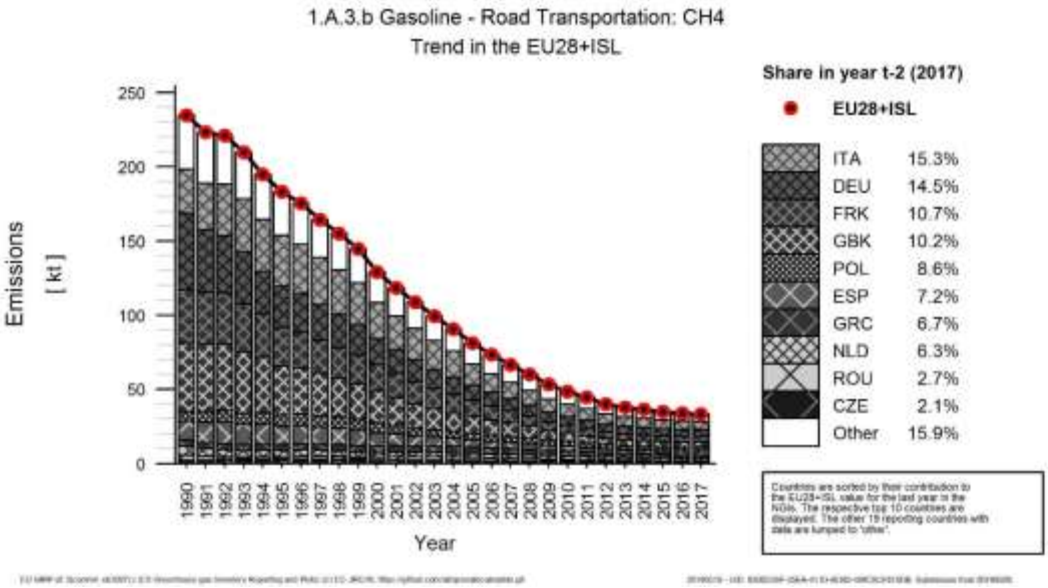
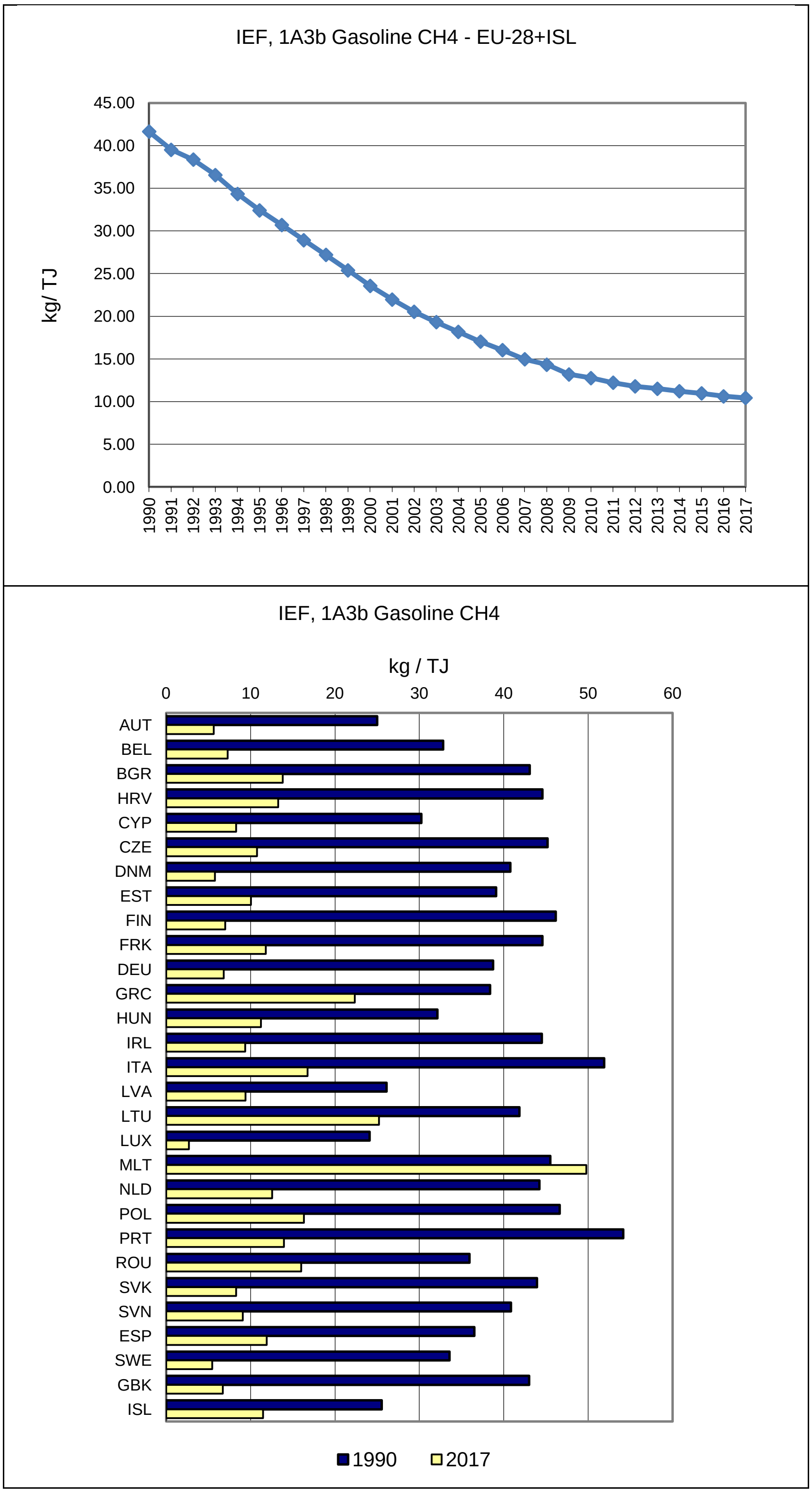


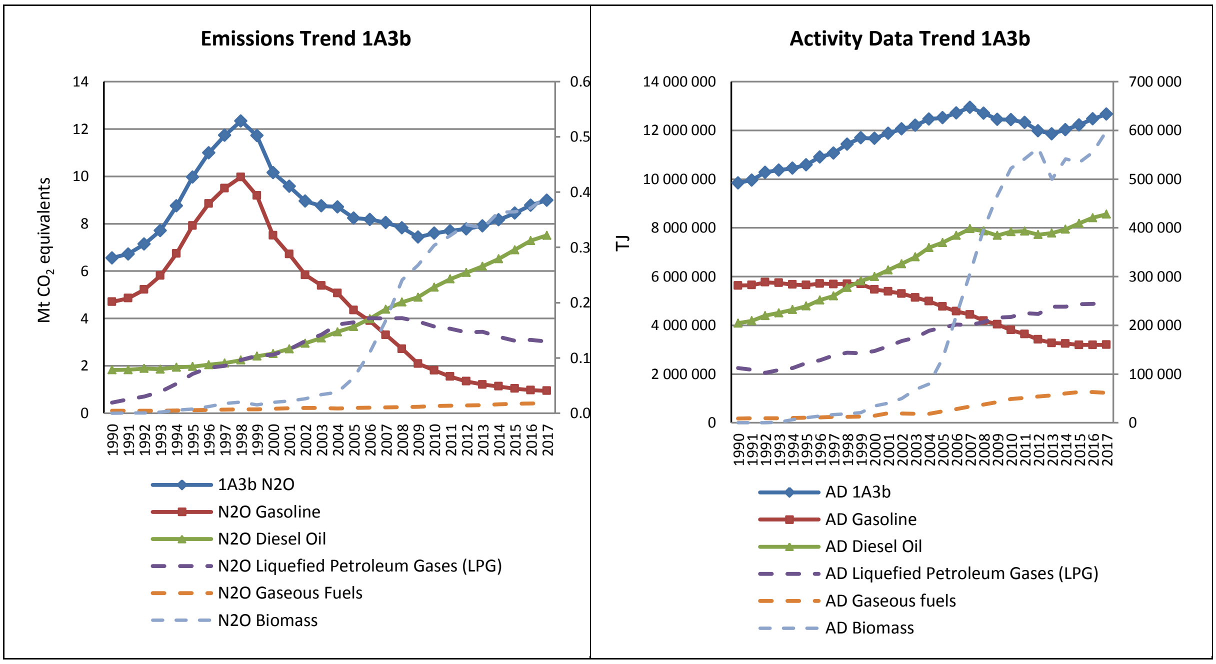
Figure 3.123 1A3b Road Transport, Gasoline: Implied Emission Factors for CH_4 (in kg/TJ)



N_2O emissions from 1A3b Road Transportation

N_2O emissions from 1A3b Road Transportation account for 0.2 % of total EU-28+ISL GHG emissions in 2017. Figure 3.124 gives an overview of the N_2O trend caused by different fuels. The trend is mainly dominated by emissions resulting from gasoline, diesel oil and biomass in the recent years.

Figure 3.124 1A3b Road Transport: N_2O Emissions Trend



Data displayed as dashed line refers to the secondary axis.

N_2O emissions increased between 1990 and 2017 by 37 % (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-28+ISL 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 sulfur.	
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	

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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	110	194	201	2.2%	90	82%	7	4%	T3	CS
Belgium	196	272	268	3.0%	72	37%	-4	-2%	M,T3	CS,OTH
Bulgaria	54	80	81	0.9%	28	51%	1	2%	T2	CR
Croatia	39	52	56	0.6%	17	45%	4	8%	T1,T3	CR,D
Cyprus	24	12	13	0.1%	-11	-45%	1	5%	T2	M
Czech Republic	100	179	183	2.0%	83	83%	4	2%	T3	M
Denmark	88	128	130	1.4%	42	48%	2	2%	CR,M,T3	CR
Estonia	22	20	20	0.2%	-2	-8%	0	0%	T1,T3	CS,D
Finland	154	79	79	0.9%	-75	-49%	1	1%	T3	CR
France	914	1 526	1 520	16.9%	605	66%	-6	0%	T3	M
Germany	1 113	1 564	1 601	17.8%	488	44%	37	2%	CS,M,T2,T3	CS,M
Greece	117	116	143	1.6%	26	22%	27	23%	M,T1	D,M
Hungary	60	121	125	1.4%	64	107%	3	3%	T1,T3	D,M
Ireland	51	115	111	1.2%	61	120%	-3	-3%	T3	M
Italy	824	849	814	9.0%	-11	-1%	-35	-4%	T3	M
Latvia	19	26	28	0.3%	9	45%	2	8%	T1,T2	CR,OTH
Lithuania	38	29	28	0.3%	-11	-27%	-1	-3%	T1,T3	CR,D
Luxembourg	16	48	49	0.5%	34	215%	2	3%	T3	M
Malta	1	3	5	0.1%	3	235%	2	64%	T1,T3	M
Netherlands	98	239	247	2.8%	149	152%	9	4%	T2	CS
Poland	180	581	671	7.5%	491	274%	90	16%	T3	D
Portugal	75	143	147	1.6%	73	97%	4	3%	OTH,T3	OTH
Romania	227	166	180	2.0%	-47	-21%	14	8%	T1,T3	D,OTH
Slovakia	56	77	78	0.9%	22	38%	1	1%	T3	D
Slovenia	29	61	62	0.7%	34	119%	1	2%	M	M
Spain	468	857	884	9.8%	416	89%	27	3%	T3	M
Sweden	154	137	137	1.5%	-17	-11%	0	0%	M,T1,T2	CS,D
United Kingdom	1 306	1 067	1 092	12.1%	-214	-16%	25	2%	T3	CR,CS
EU-28	**6 533**	**8 739**	**8 954**	**100%**	**2 421**	**37%**	**215**	**2%**	**-**	**-**
Iceland	15	38	38	0.4%	24	160%	1	2%	T1	D
United Kingdom (KP)	1 311	1 071	1 095	12.2%	-216	-16%	25	2%	T3	CR,CS
EU-28 + ISL	**6 552**	**8 780**	**8 996**	**100%**	**2 443**	**37%**	**216**	**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 83 % of N_2O emissions from 1A3b “Road Transportation” in 2017. Between 1990 and 2017 N_2O emissions from Diesel oil increased in all Member States, except for Finland (decrease by 13 %) and Cyprus (decrease by 43 %); within the EU-28+ISL the emission increased by 311 %. The largest increase in absolute terms was reported by France and Germany. Between 2016 and 2017, EU-28+ISL emissions rose by 3 % (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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	13	165	176	2.3%	163	1269%	10	6%
Belgium	59	244	240	3.2%	181	304%	-3	-1%
Bulgaria	13	46	50	0.7%	37	296%	4	8%
Croatia	10	38	43	0.6%	33	328%	5	13%
Cyprus	13	7	7	0.1%	-6	-43%	1	15%
Czech Republic	61	145	151	2.0%	90	149%	5	4%
Denmark	32	105	109	1.5%	78	246%	4	4%
Estonia	7	16	16	0.2%	9	128%	1	5%
Finland	65	60	57	0.8%	-8	-13%	-3	-5%
France	256	1 293	1 290	17.2%	1 034	404%	-3	0%
Germany	119	1 354	1 396	18.6%	1 277	1070%	42	3%
Greece	39	54	59	0.8%	20	51%	5	10%
Hungary	21	87	94	1.3%	73	346%	7	8%
Ireland	15	97	96	1.3%	81	533%	-1	-1%
Italy	339	663	637	8.5%	297	88%	-27	-4%
Latvia	7	21	23	0.3%	16	241%	2	12%
Lithuania	19	23	21	0.3%	2	10%	-1	-5%
Luxembourg	3	44	44	0.6%	42	1581%	1	2%
Malta	0	1	3	0.0%	3	1443%	2	127%
Netherlands	23	185	189	2.5%	166	709%	4	2%
Poland	74	407	486	6.5%	412	557%	79	19%
Portugal	26	107	113	1.5%	87	329%	6	6%
Romania	31	122	134	1.8%	104	336%	12	10%
Slovakia	41	63	65	0.9%	23	56%	1	2%
Slovenia	9	55	57	0.8%	48	547%	2	4%
Spain	195	789	822	10.9%	627	322%	33	4%
Sweden	14	119	122	1.6%	108	796%	3	3%
United Kingdom	321	965	998	13.3%	677	211%	33	3%
EU-28	**1 826**	**7 273**	**7 499**	**100%**	**5 673**	**311%**	**226**	**3%**
Iceland	2	7	8	0.1%	6	349%	1	12%
United Kingdom (KP)	323	967	1 000	13.3%	678	210%	33	3%
EU-28 + ISL	**1 829**	**7 283**	**7 510**	**100%**	**5 681**	**311%**	**227**	**3%**

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.

France, Germany, Italy, Spain and the United Kingdom account for 69 % of N_2O emissions from diesel oil in 2017 (Figure 3.126). In Figure 3.125 the IEF is depicted and the EU IEF increased from 1.5 Kg/TJ in 1990 to about 3 kg/TJ in 2017. A similar situation, increase in the values of the IEF, is observed for almost all MSs.In most cases the IEF is country specific, with the exception of Iceland where the default emission factor was used (3.9 kg/TJ), 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. Thus, they can also lead to increased emission factors over the years.

Figure 3.126 1A3b Road Transport, diesel oil: Emission trend and share for N_2O emission

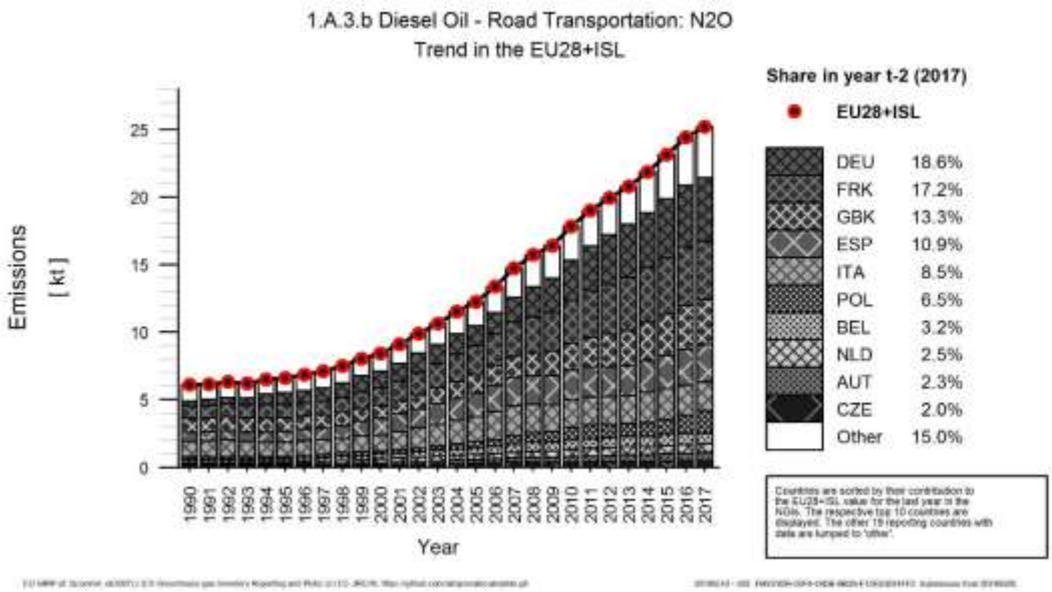
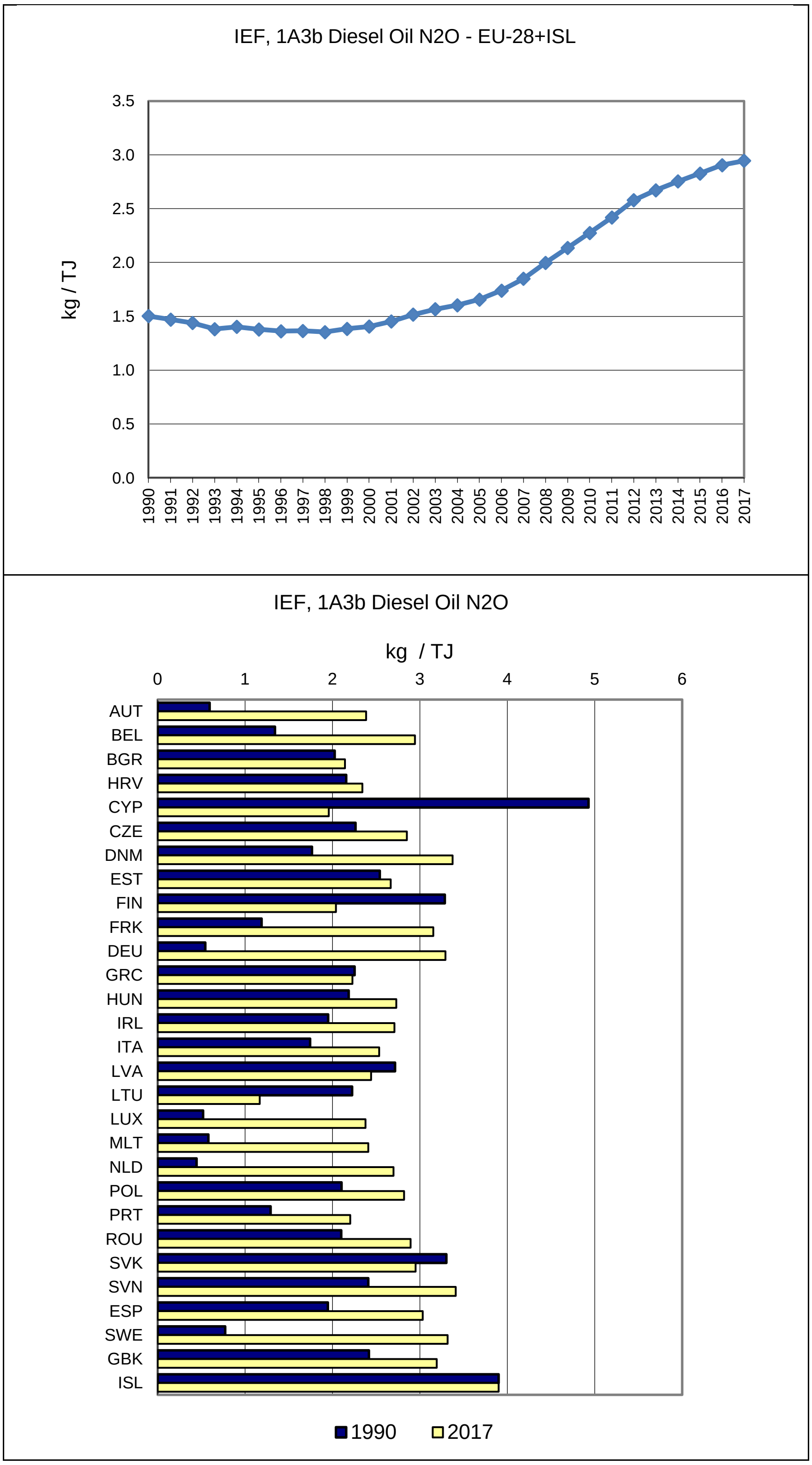


Figure 3.127 1A3b Road Transport, Diesel Oil: Implied Emission Factors for N_2O (in kg/TJ)



1A3b Road Transportation – Gasoline (N_2O)

N_2O emissions from Gasoline account for 11 % of N_2O emissions from 1A3b Road Transportation in 2017. Between 1990 and 2017, N_2O emissions from gasoline decreased by 80 % in the EU-28+ISL 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 2016 and 2017, most Member States, (25 in total), showed a decreasing trend. The EU-28+ISL total N_2O emissions dropped by 3 % (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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	97	11	11	1.1%	-87	-89%	-1	-6%
Belgium	135	11	10	1.0%	-125	-93%	-1	-9%
Bulgaria	41	13	11	1.2%	-30	-72%	-1	-10%
Croatia	29	12	11	1.1%	-18	-63%	-1	-9%
Cyprus	10	6	5	0.6%	-5	-49%	0	-7%
Czech Republic	39	20	19	2.0%	-21	-53%	-1	-6%
Denmark	57	14	13	1.4%	-44	-77%	-2	-11%
Estonia	14	4	3	0.4%	-11	-76%	-1	-17%
Finland	88	15	13	1.4%	-75	-85%	-2	-11%
France	658	119	110	11.7%	-548	-83%	-9	-7%
Germany	994	125	119	12.6%	-875	-88%	-6	-5%
Greece	78	52	74	7.8%	-4	-5%	22	41%
Hungary	39	27	24	2.6%	-15	-38%	-2	-8%
Ireland	35	14	11	1.1%	-25	-70%	-3	-25%
Italy	481	109	102	10.7%	-380	-79%	-7	-7%
Latvia	12	3	2	0.3%	-9	-79%	0	-12%
Lithuania	19	5	6	0.6%	-13	-71%	0	4%
Luxembourg	13	2	2	0.2%	-11	-88%	0	-1%
Malta	1	1	1	0.1%	0	11%	0	-2%
Netherlands	58	45	48	5.1%	-10	-17%	3	6%
Poland	106	92	98	10.4%	-8	-7%	6	6%
Portugal	48	28	26	2.8%	-22	-45%	-1	-5%
Romania	196	30	29	3.0%	-167	-85%	-1	-4%
Slovakia	15	7	7	0.7%	-8	-55%	-1	-9%
Slovenia	20	4	1	0.1%	-18	-93%	-3	-71%
Spain	273	61	55	5.8%	-219	-80%	-7	-11%
Sweden	140	13	11	1.2%	-129	-92%	-2	-14%
United Kingdom	985	102	94	9.9%	-891	-90%	-8	-8%
EU-28	**4 683**	**945**	**915**	**97%**	**-3 768**	**-80%**	**-30**	**-3%**
Iceland	13	29	29	3.0%	16	120%	0	-1%
United Kingdom (KP)	988	103	94	10.0%	-894	-90%	-8	-8%
EU-28 + ISL	**4 699**	**975**	**945**	**100%**	**-3 755**	**-80%**	**-30**	**-3%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

France, Germany, Italy, Spain and the United Kingdom accounted for 51 % of N_2O emissions (Figure **3.129**). In Figure 3.128 the IEF is depicted and it is clear that high variability exists for all Member States through the whole time series.

Figure 3.129 1A3b Road Transport, Gasoline: Emission trend and share for N_2O emissions

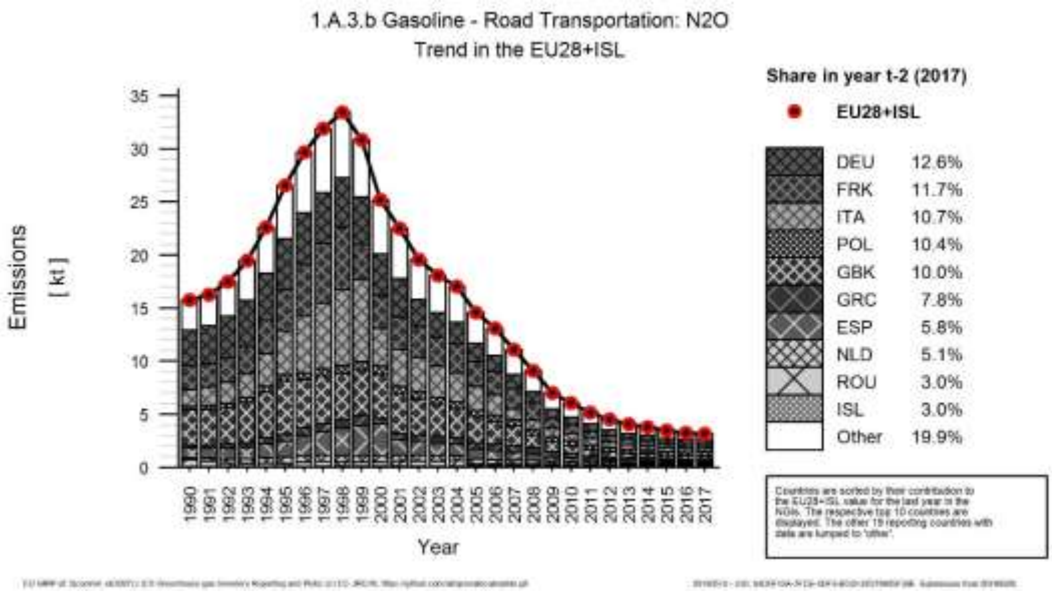
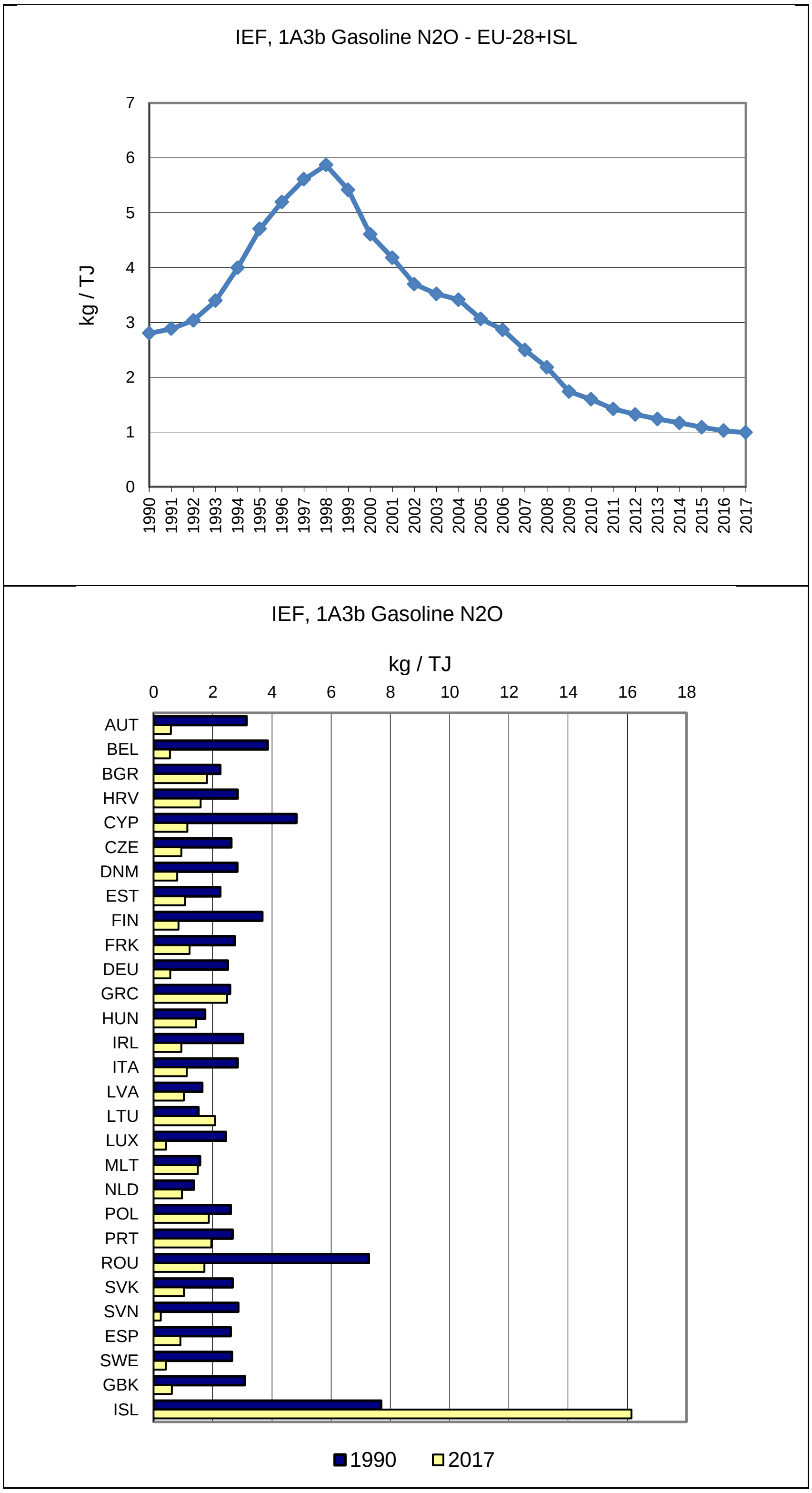


Figure 3.130 1A3b Road Transport, Gasoline: Implied Emission Factors for N_2O (in kg/TJ)

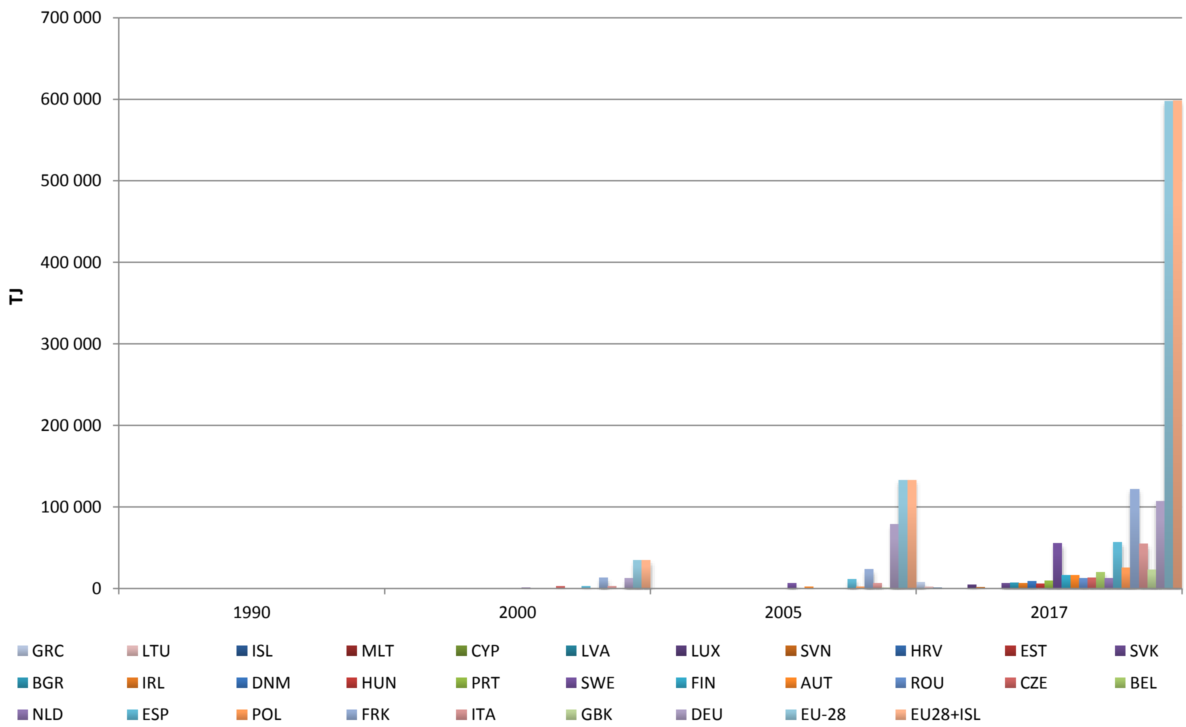


1A3b Road Transportation – Activity Data Biofuels

According to the European Directive on the promotion of the use of biofuels or other renewable fuels for transport (2003/30/EG), Member States 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. Member States 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.

Between 1990 and 2017, combustion of biofuels increased from 41 TJ to 597 646 TJ in the EU-28+ISL (Figure 3.131). France reports most of total amount of biofuels (20.4 % of total EU-28+ISL activity in 2017), followed by Germany (17.9 %). All Member States report biofuels activity under 1A3b for 2017.

Figure 3.131 1A3b Road Transport, Biofuels: Trend of Activity data of Biofuels



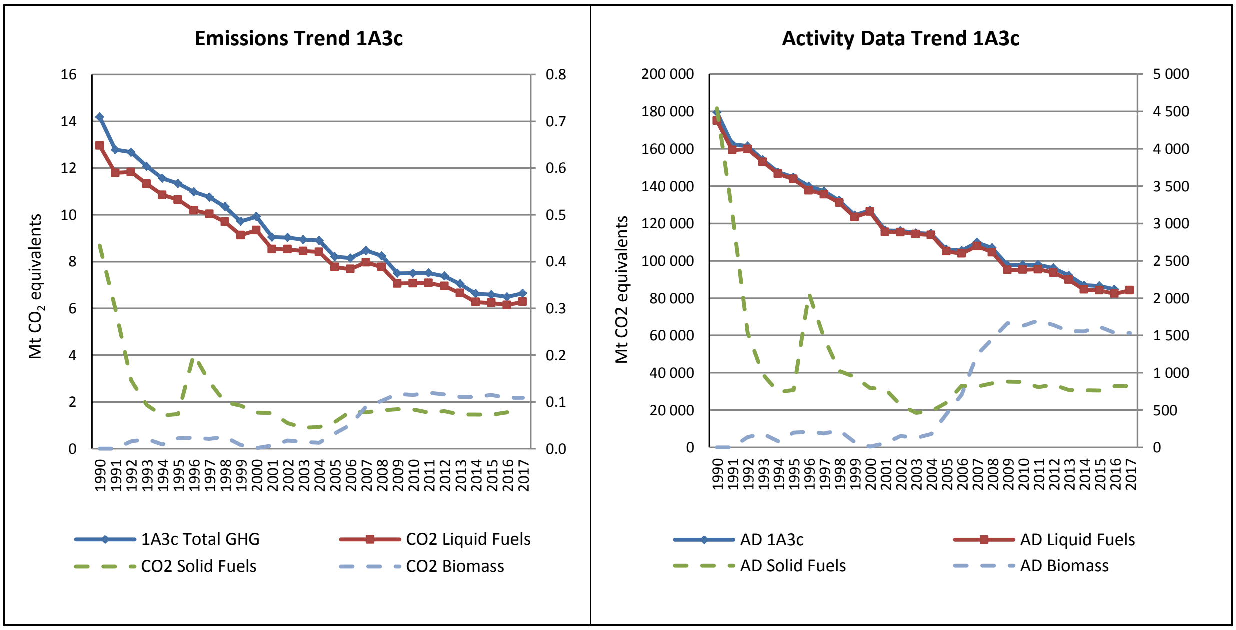
3.2.3.3 Railways (1A3c) (EU-28+ISL)

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 0.15 % of total EU-28+ISL GHG emissions in 2017. Between 1990 and 2017, CO_2 emissions from rail transportation decreased by 53 % in the EU-28+ISL.

The total trend is dominated by CO_2 emissions from liquid fuels (Figure 3.132). The emissions from this key category are due to fossil fuel consumption in rail transport, which decreased by 53 % between 1990 and 2017.

Figure 3.132 1A3c Railways: CO_2 Emission Trend and Activity Data



Data displayed as dashed line refers to the secondary axis.

The Member States France, Germany and the United Kingdom contributed most to the emissions from this source (54 %). Between 1990 and 2017, Germany had by far the highest decreases in absolute terms (Table 3.69).

Table 3.69 1A3c Railways: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	178	111	116	1.8%	-62	-35%	5	5%	T1,T2	CS,D
Belgium	222	66	66	1.0%	-156	-70%	0	0%	T3	CS,D
Bulgaria	323	40	42	0.7%	-281	-87%	1	3%	T1	D
Croatia	140	58	56	0.9%	-84	-60%	-2	-4%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	768	275	281	4.4%	-487	-63%	6	2%	T1	D
Denmark	297	253	244	3.8%	-53	-18%	-10	-4%	CR,T2	CS
Estonia	154	47	49	0.8%	-104	-68%	2	5%	T2	CS
Finland	191	63	63	1.0%	-128	-67%	0	0%	T2	CS
France	1 070	387	385	6.1%	-685	-64%	-2	0%	T1	OTH
Germany	2 901	1 052	1 045	16.4%	-1 855	-64%	-6	-1%	CS,M	CS,D,M
Greece	199	125	122	1.9%	-77	-39%	-3	-2%	T1,T2	CS
Hungary	537	127	134	2.1%	-403	-75%	6	5%	T1	D
Ireland	133	112	116	1.8%	-18	-13%	4	3%	T2	CS
Italy	613	47	104	1.6%	-510	-83%	57	120%	T2	CS
Latvia	537	175	164	2.6%	-373	-69%	-11	-6%	T1,T2	CS,D
Lithuania	350	154	165	2.6%	-185	-53%	11	7%	T1,T2	CS,D
Luxembourg	25	6	8	0.1%	-17	-66%	2	37%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	91	88	81	1.3%	-9	-10%	-6	-7%	T2	CS
Poland	1 621	261	339	5.3%	-1 281	-79%	78	30%	T1	D
Portugal	177	28	29	0.5%	-148	-83%	2	7%	T1	D
Romania	452	353	371	5.8%	-81	-18%	17	5%	T1,T2	CS,D
Slovakia	372	87	84	1.3%	-288	-77%	-2	-3%	T1	D
Slovenia	65	31	29	0.5%	-36	-56%	-2	-7%	T1	D
Spain	422	234	244	3.8%	-178	-42%	10	4%	T1	D
Sweden	101	44	41	0.6%	-60	-59%	-3	-6%	T2	CS
United Kingdom	1 455	2 000	1 980	31.1%	525	36%	-19	-1%	T1,T2	CS
EU-28	**13 394**	**6 223**	**6 360**	**100%**	**-7 034**	**-53%**	**137**	**2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 455	2 000	1 980	31.1%	525	36%	-19	-1%	T1,T2	CS
EU-28 + ISL	**13 394**	**6 223**	**6 360**	**100%**	**-7 034**	**-53%**	**137**	**2%**	**-**	**-**

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 2017, CO_2 emissions from liquid fuels decreased by 52 % in the EU-28+ISL. Between 2016 and 2017, EU-28+ISL emissions decreased by 2 % (Table 3.70).

Table 3.70 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	171	110	115	1.8%	-56	-33%	5	5%	T2	CS
Belgium	222	66	66	1.1%	-156	-70%	0	0%	T3	CS,D
Bulgaria	323	40	42	0.7%	-281	-87%	1	3%	T1	D
Croatia	119	58	56	0.9%	-63	-53%	-2	-4%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	768	271	277	4.4%	-491	-64%	6	2%	T1	D
Denmark	297	253	244	3.9%	-53	-18%	-10	-4%	CR,T2	CS
Estonia	143	47	49	0.8%	-93	-65%	2	5%	T2	CS
Finland	191	63	63	1.0%	-128	-67%	0	0%	T2	CS
France	1 070	387	385	6.1%	-685	-64%	-2	0%	T1	OTH
Germany	2 847	1 020	1 013	16.1%	-1 833	-64%	-6	-1%	CS,M	CS,M
Greece	199	125	122	1.9%	-77	-39%	-3	-2%	T2	CS
Hungary	532	127	134	2.1%	-398	-75%	6	5%	T1	D
Ireland	133	112	116	1.8%	-18	-13%	4	3%	T2	CS
Italy	613	47	104	1.7%	-510	-83%	57	120%	T2	CS
Latvia	537	175	164	2.6%	-373	-69%	-11	-6%	T2	CS
Lithuania	350	153	165	2.6%	-185	-53%	11	7%	T2	CS
Luxembourg	25	6	8	0.1%	-17	-67%	2	37%	-	-
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	91	88	81	1.3%	-9	-10%	-6	-7%	T2	CS
Poland	1 316	261	339	5.4%	-977	-74%	78	30%	T1	D
Portugal	177	28	29	0.5%	-148	-83%	2	7%	T1	D
Romania	420	353	371	5.9%	-49	-12%	17	5%	T1,T2	CS,D
Slovakia	372	87	84	1.3%	-288	-77%	-2	-3%	T1	D
Slovenia	65	31	28	0.5%	-37	-56%	-2	-7%	T1	D
Spain	422	234	244	3.9%	-178	-42%	10	4%	T1	D
Sweden	101	44	41	0.7%	-60	-59%	-3	-6%	T2	CS
United Kingdom	1 455	1 958	1 939	30.9%	484	33%	-19	-1%	T2	CS
EU-28	**12 960**	**6 144**	**6 281**	**100%**	**-6 679**	**-52%**	**137**	**2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 455	1 958	1 939	30.9%	484	33%	-19	-1%	T2	CS
EU-28 + ISL	**12 960**	**6 144**	**6 281**	**100%**	**-6 679**	**-52%**	**137**	**2%**	**-**	**-**

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 64 % of CO_2 emissions from liquid fuels in 2017 (Figure 3.134).

Table 3.70 shows that the majority of CO_2 emissions from the combustion of liquid fuels in railways were calculated using a higher tier method (74.2%). From the calculation of the higher tier methods, MS 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 3.133 the IEF is depicted where the mean value is around 74 t/TJ. In 2016 the IEF showed a slight increase, mainly due to the increased value of the IEF of Romania. The high IEF of Romania, is due to the fact that country specific EFs for CO_2 emissions have been determined.

Figure 3.134 1A3c Railways, Liquid Fuels: Emission trend and share for CO_2

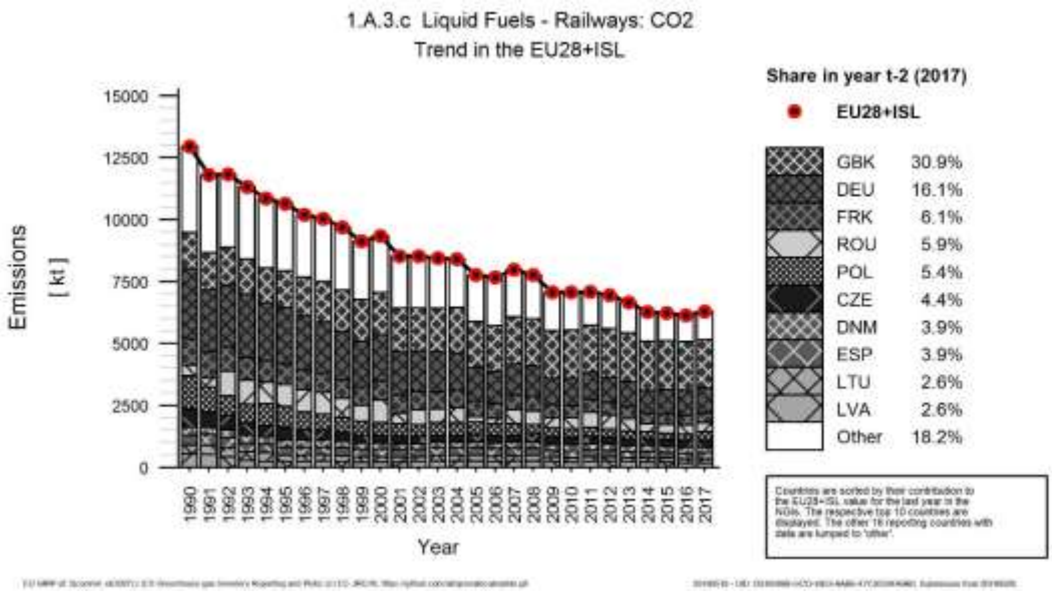
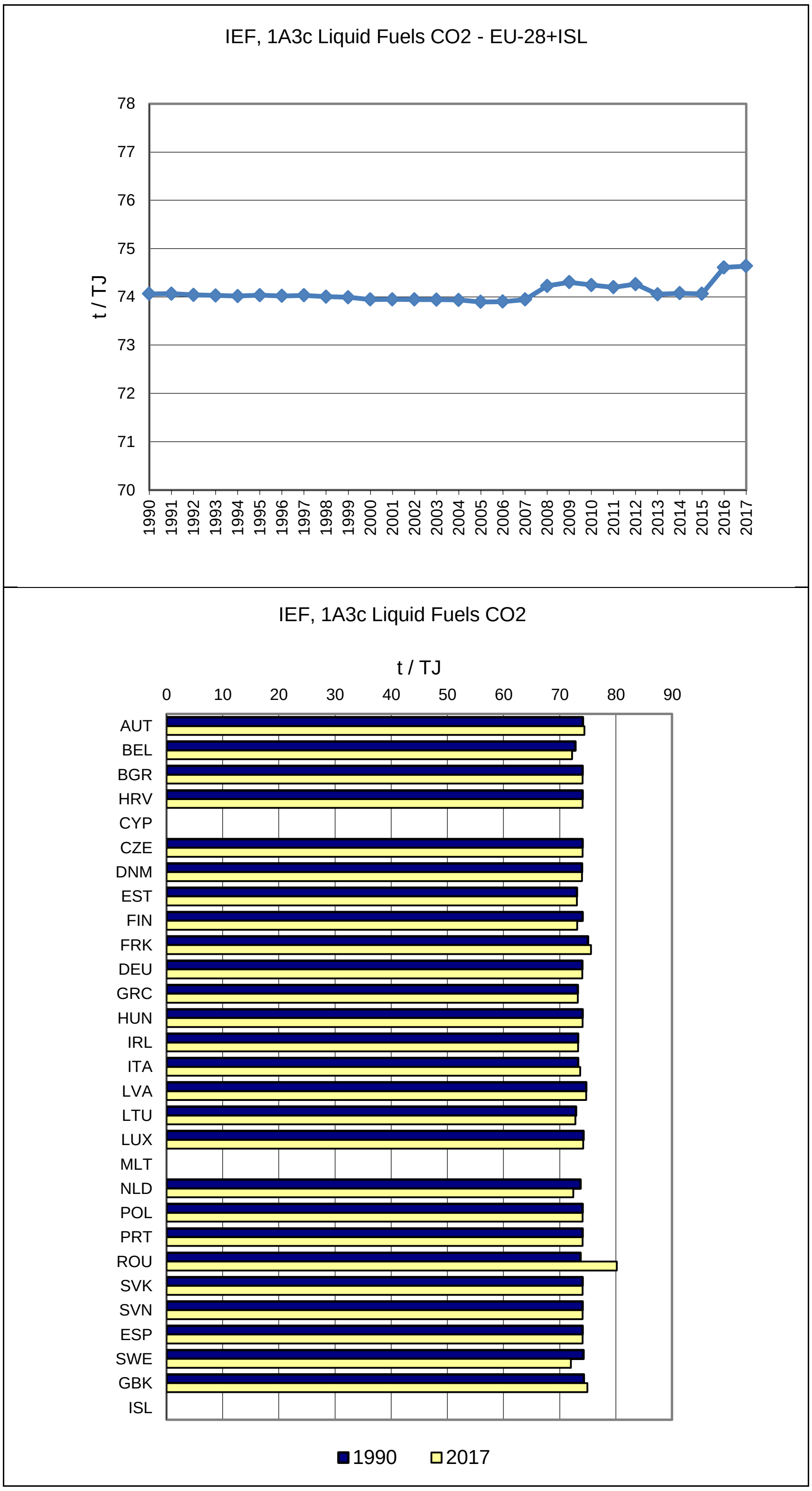


Figure 3.135 1A3c Railways, Liquid Fuels: Implied Emission Factors for CO_2 (in t/TJ)

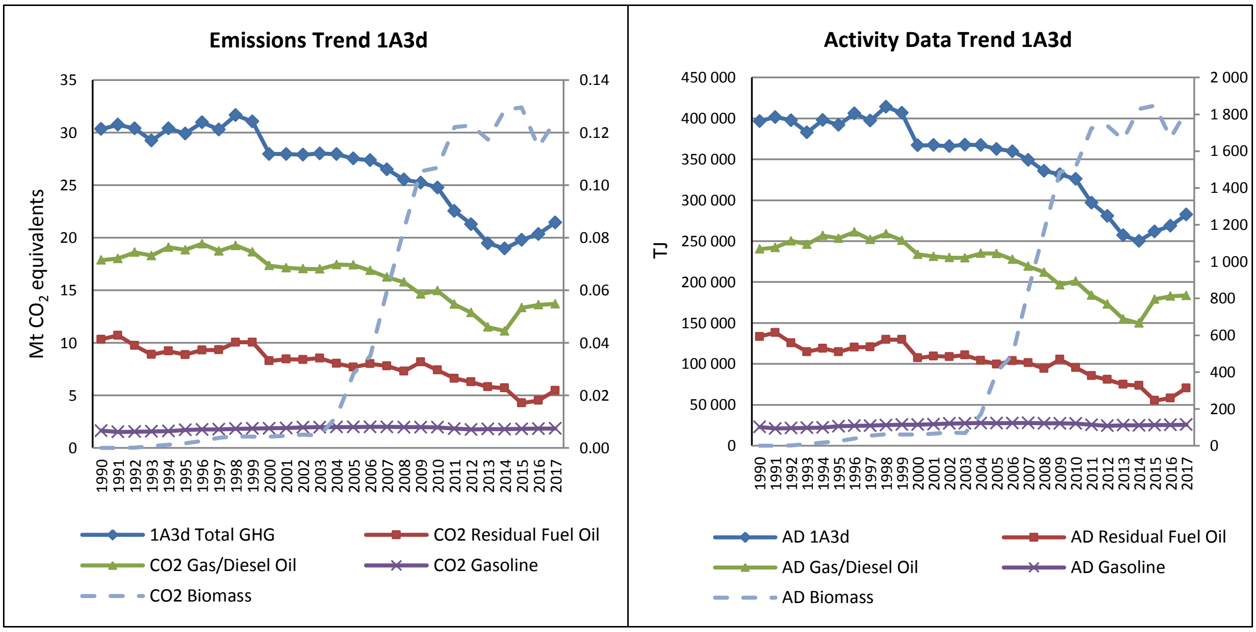


3.2.3.4 Domestic Navigation (1A3d) (EU-28+ISL)

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 0.5 % of total EU-28+ISL GHG emissions in 2017. Between 1990 and 2017, CO_2 emissions from navigation decreased by 29 % in the EU-28+ISL (Table 3.71). 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 3.136).

Figure 3.136 1A3d Domestic Navigation: CO_2 Emission Trend and Activity Data



Data displayed as dashed line refers to the secondary axis.

Five Member States (Germany, Greece, Italy, Spain and the United Kingdom) contributed the most to the emissions from this source (75 %). Most Member States (16 in total) had decreasing emissions from navigation between 1990 and 2017. The Member States with the highest decreases in absolute terms were Germany, United Kingdom and Spain (Table 3.71).

Table 3.71 1A3d Domestic Navigation: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	15	10	10	0.0%	-5	-34%	-1	-7%	T1,T2	CS,D
Belgium	362	412	439	2.1%	77	21%	27	7%	T1,T3	CS,D
Bulgaria	56	7	7	0.0%	-49	-87%	0	0%	T1	D
Croatia	134	132	140	0.7%	6	4%	8	6%	T1	D
Cyprus	2	2	2	0.0%	-1	-25%	0	9%	T1	D
Czech Republic	54	13	13	0.1%	-41	-76%	0	0%	T1	D
Denmark	715	641	668	3.2%	-47	-7%	27	4%	CR,M,T2	CS
Estonia	22	44	34	0.2%	12	56%	-10	-23%	T2	CS
Finland	441	402	429	2.0%	-12	-3%	28	7%	T2	CS
France	1 024	1 300	1 293	6.1%	269	26%	-7	-1%	T1	CS
Germany	3 645	1 790	1 721	8.2%	-1 923	-53%	-68	-4%	CS	CS,D,M
Greece	1 809	1 801	1 844	8.7%	35	2%	43	2%	T1	CS
Hungary	209	16	13	0.1%	-197	-94%	-3	-20%	T1	D
Ireland	85	264	233	1.1%	148	174%	-31	-12%	T2	CS
Italy	5 470	3 887	3 915	18.6%	-1 555	-28%	29	1%	T1,T2	CS
Latvia	1	14	14	0.1%	13	1312%	1	6%	T1,T2	CS,D
Lithuania	15	13	17	0.1%	1	9%	4	28%	T1	CS
Luxembourg	1	1	1	0.0%	0	-12%	0	7%	T1,T2	CS,D
Malta	25	80	69	0.3%	44	177%	-11	-14%	T1,T3	CS,D
Netherlands	743	1 010	986	4.7%	243	33%	-24	-2%	T2	CS
Poland	151	22	22	0.1%	-129	-86%	0	-1%	T1	D
Portugal	263	262	268	1.3%	6	2%	6	2%	T2	D
Romania	1 151	131	131	0.6%	-1 020	-89%	1	1%	T2	CS
Slovakia	0	5	5	0.0%	5	20759%	0	-1%	T1	D
Slovenia	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Spain	5 214	1 904	3 035	14.4%	-2 179	-42%	1 130	59%	T1	D
Sweden	575	334	305	1.4%	-270	-47%	-29	-9%	T2	CS
United Kingdom	7 536	5 405	5 308	25.2%	-2 228	-30%	-97	-2%	T2	CS
EU-28	**29 718**	**19 899**	**20 920**	**99%**	**-8 798**	**-30%**	**1 021**	**5%**	**-**	**-**
Iceland	60	28	32	0.1%	-28	-47%	4	14%	T1	D
United Kingdom (KP)	7 608	5 492	5 440	25.8%	-2 168	-28%	-51	-1%	T2	CS
EU-28 + ISL	**29 850**	**20 014**	**21 085**	**100%**	**-8 765**	**-29%**	**1 071**	**5%**	**-**	**-**

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 26 % of CO_2 emissions from 1A3d Navigation in 2017. Between 1990 and 2017, CO_2 emissions from residual fuel oil decreased by 47 % in the EU-28+ISL. The countries with the highest decrease in absolute terms were Romania, United Kingdom and Germany. 18 Member States reported emissions as 'Not Occurring' (Table 3.72) for 2017, 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 3.72 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		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
Czech Republic	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	357	123	149	2.7%	-208	-58%	26	21%	CR,T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	123	32	34	0.6%	-90	-73%	2	5%	T2	CS
France	159	44	51	0.9%	-108	-68%	8	18%	T1	CS
Germany	935	1	1	0.0%	-934	-100%	0	-2%	CS	CS,M
Greece	746	1 022	1 045	19.1%	299	40%	22	2%	T1	CS
Hungary	3	NO	NO	-	-3	-100%	-	-	NA	NA
Ireland	63	NO	NO	-	-63	-100%	-	-	NA	NA
Italy	2 576	1 729	1 741	31.8%	-835	-32%	11	1%	T1,T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	5	12	NO	-	-5	-100%	-12	-100%	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	70	NO	NO	-	-70	-100%	-	-	NA	NA
Portugal	190	189	194	3.5%	4	2%	4	2%	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	730	1 596	29.2%	342	27%	865	118%	T1	D
Sweden	194	13	12	0.2%	-182	-94%	-1	-6%	T2	CS
United Kingdom	2 581	588	565	10.3%	-2 016	-78%	-23	-4%	T2	CS
EU-28	**10 286**	**4 483**	**5 386**	**99%**	**-4 900**	**-48%**	**903**	**20%**	**-**	**-**
Iceland	22	1	NO	-	-22	-100%	-1	-100%	NA	NA
United Kingdom (KP)	2 599	622	645	11.8%	-1 954	-75%	22	4%	T2	CS
EU-28 + ISL	**10 327**	**4 518**	**5 466**	**100%**	**-4 861**	**-47%**	**948**	**21%**	**-**	**-**

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 80 % of CO_2 emissions from residual fuel oil in 2017 (Figure 3.138).

Table **3.72** shows that the majority of CO_2 emissions from the combustion of residual fuel oil in navigation were calculated using a higher tier method (50%). Greece and Spain were not included in this calculation, since they use T1 to calculate these emissions. On the other hand, Italy stated that country specific IEF were used, thus they were considered in the calculation. In Figure 3.137 the IEF is depicted where the mean value is around 78 t/TJ.

Figure 3.138 1A3d Navigation, Residual Fuel Oil: Emission trend and share for CO_2

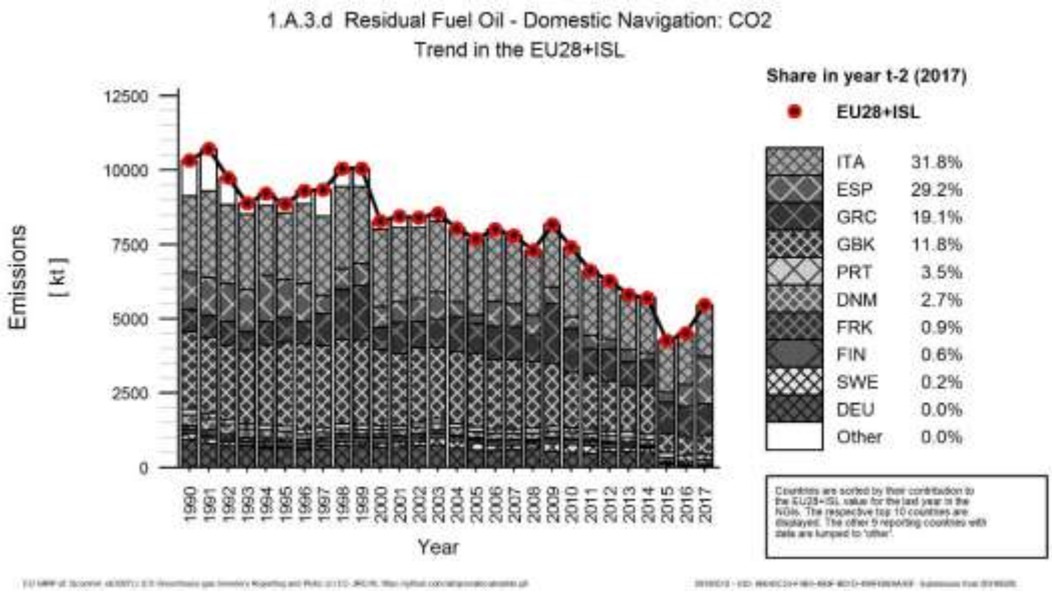
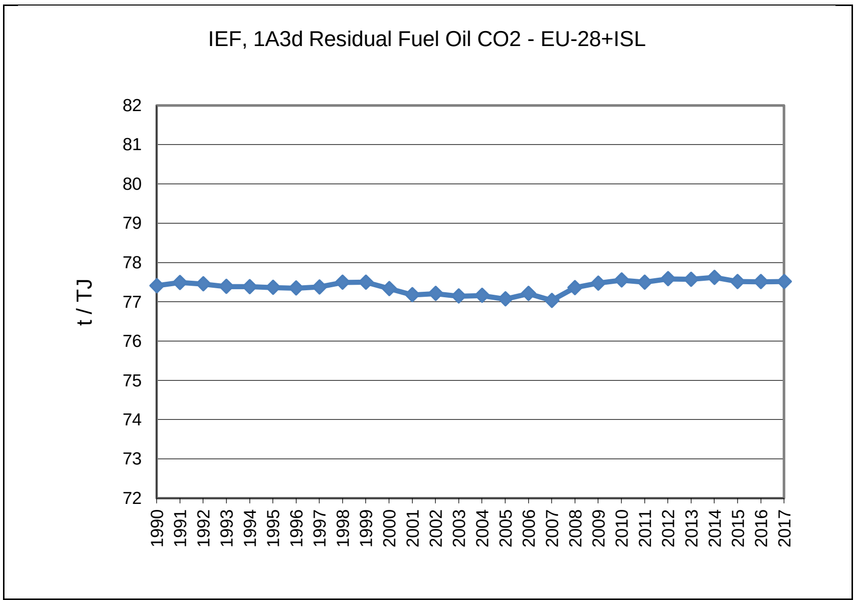
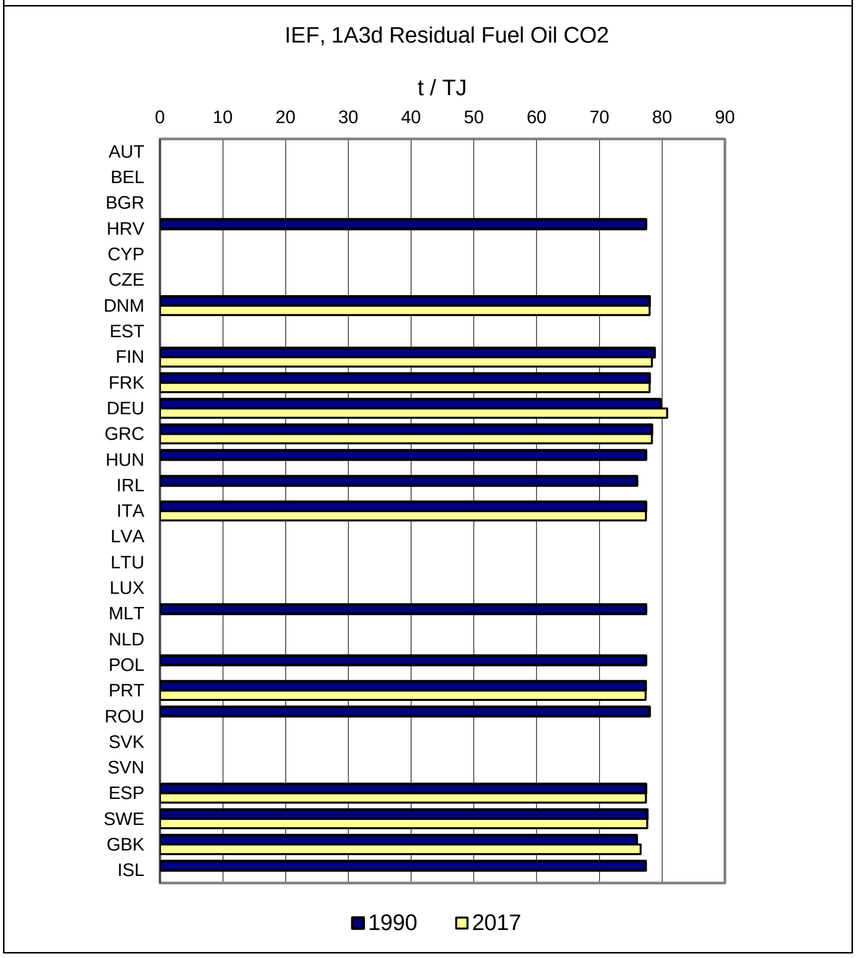


Figure 3.139 1A3d Navigation, Residual Fuel Implied Emission Factors for CO_2 (in t/TJ)





1A3d Navigation – Gas/Diesel Oil (CO_2)

CO_2 emissions from Gas/Diesel oil account for 65 % of CO_2 emissions from 1A3d Navigation in 2017 (Table 3.73). The CO_2 emissions from Gas/Diesel oil decreased by 23 % between 1990 and 2017.

Table 3.73 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	5	4	3	0.0%	-3	-46%	-1	-18%	T2	CS
Belgium	362	412	439	3.2%	77	21%	27	7%	T1,T3	CS,D
Bulgaria	56	7	7	0.1%	-49	-87%	0	0%	T1	D
Croatia	128	132	140	1.0%	13	10%	8	6%	T1	D
Cyprus	2	2	2	0.0%	-1	-25%	0	9%	T1	D
Czech Republic	54	13	13	0.1%	-41	-76%	0	0%	T1	D
Denmark	358	513	514	3.8%	156	43%	1	0%	CR,M,T2	CS
Estonia	22	44	34	0.2%	12	56%	-10	-23%	T2	CS
Finland	186	243	259	1.9%	72	39%	15	6%	T2	CS
France	324	374	357	2.6%	34	10%	-16	-4%	T1	CS
Germany	2 710	1 789	1 721	12.6%	-989	-36%	-68	-4%	CS	CS,M
Greece	1 063	778	799	5.8%	-264	-25%	21	3%	T1	CS
Hungary	29	16	13	0.1%	-16	-56%	-3	-20%	T1	D
Ireland	22	264	233	1.7%	211	948%	-31	-12%	T2	CS
Italy	2 326	1 838	1 855	13.5%	-471	-20%	17	1%	T1,T2	CS
Latvia	1	13	14	0.1%	13	1561%	1	6%	T2	CS
Lithuania	15	13	17	0.1%	1	9%	4	28%	T1	CS
Luxembourg	1	1	1	0.0%	0	3%	0	8%	T2	CS
Malta	19	67	69	0.5%	49	256%	1	2%	T1,T3	CS,D
Netherlands	697	944	920	6.7%	223	32%	-24	-3%	T2	CS
Poland	81	22	22	0.2%	-59	-73%	0	-1%	T1	D
Portugal	73	73	75	0.5%	2	2%	2	2%	T2	D
Romania	125	130	130	0.9%	5	4%	0	0%	T2	CS
Slovakia	0	5	5	0.0%	5	20741%	0	-1%	T1	D
Slovenia	IE	IE	IE	-	-	-	-	-	NA	NA
Spain	3 960	1 174	1 439	10.5%	-2 521	-64%	265	23%	T1	D
Sweden	304	187	158	1.2%	-146	-48%	-29	-15%	T2	CS
United Kingdom	4 851	4 476	4 387	32.0%	-465	-10%	-90	-2%	T2	CS
EU-28	**17 775**	**13 534**	**13 624**	**99%**	**-4 151**	**-23%**	**90**	**1%**	**-**	**-**
Iceland	37	27	32	0.2%	-6	-16%	4	16%	T1	D
United Kingdom (KP)	4 905	4 529	4 440	32.4%	-466	-9%	-90	-2%	T2	CS
EU-28 + ISL	**17 867**	**13 614**	**13 709**	**100%**	**-4 158**	**-23%**	**95**	**1%**	**-**	**-**

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

Germany, Italy, Netherlands, Spain and the United Kingdom account for 76 % of the CO_2 emissions from gas/diesel oil in 2017 (Figure 3.141).

Table 3.73 shows that the majority of CO_2 emissions from the combustion of gas/diesel oil in navigation were calculated using a higher tier method (78.8%). Greece and Spain were not taken into account for this calculation, since they are using only T1 method. Whereas Italy, using country specific emission factors, was included in the calculation of higher tier methods. In Figure 3.140 the IEF is depicted where the mean value is around 74 t/TJ. The high IEF of Romania, is due to the fact that country specific EFs for CO_2 emissions have been determined. It should be noted that Slovenia reported emission as "Included elsewere" and more specifically under Road transport, since no separate data are available.

Figure 3.141 1A3d Navigation, Gas/Diesel Oil: Emission trend and share for CO_2

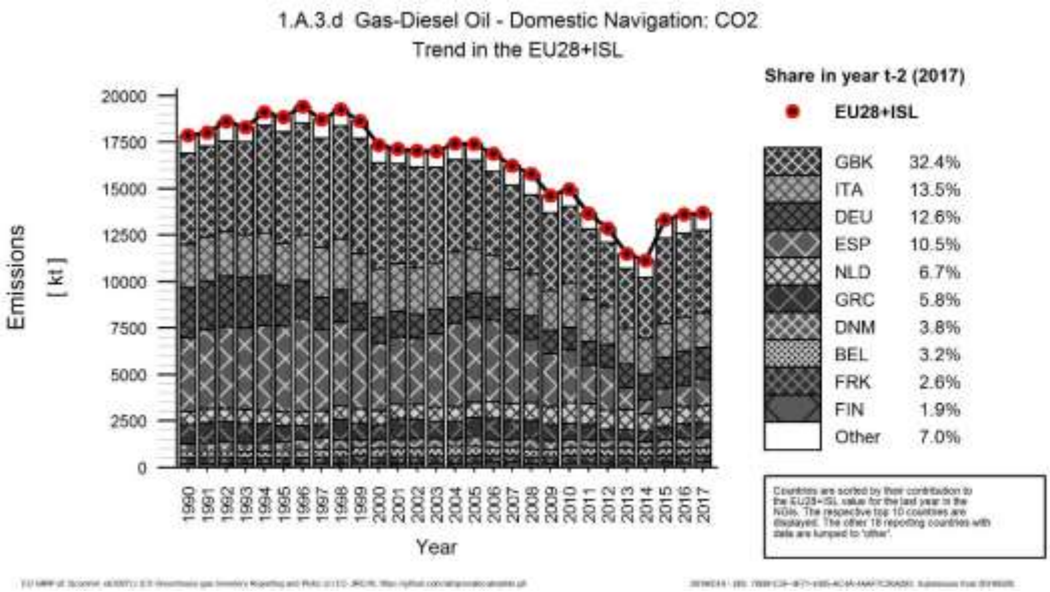
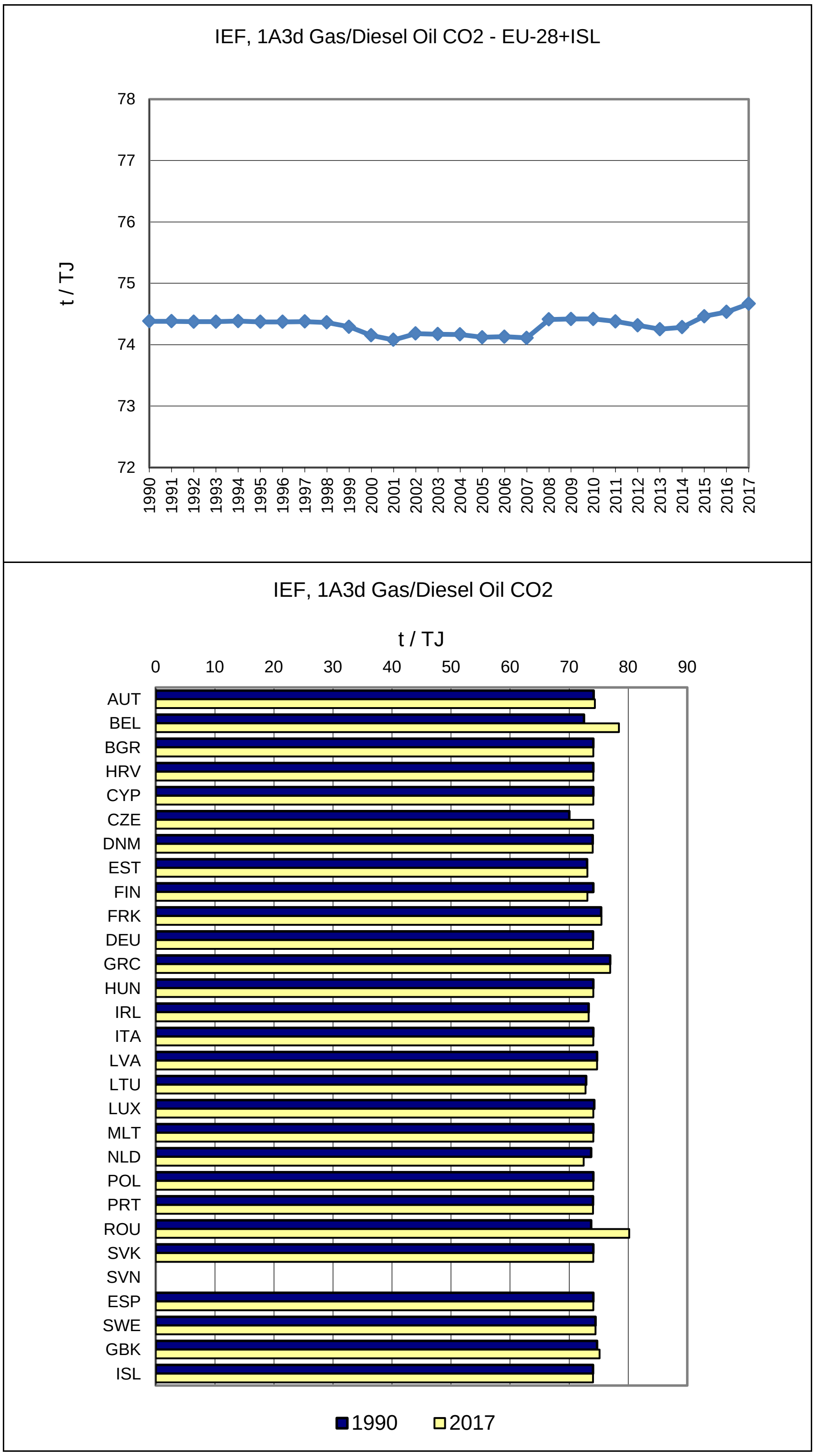


Figure 3.142 1A3d Navigation, Gas/Diesel Oil: Implied Emission Factors for CO_2 (in t/TJ)



3.2.3.5 Other (1A3e) (EU-28+ISL)

CO_2 emissions from 1A3e Other account for only 0.1 % of total EU-28+ISL GHG emissions in 2017. 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 16 % between 1990 and 2017.

Germany contributed 21 % and Poland 14 % to the EU-28+ISL emissions from this source in 2017 (Table 3.74). Between 1990 and 2017 the EU-28+ISL emissions increased by 16 %. Seven Member States report emissions as 'Not occurring'. Latvia reports emissions as "Included elsewhere" and more specifically, emissions from pipeline transport are included under 1.A.4.a.i Commercial/Institutional. Iceland also 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 this sectors in the Energy Balance.

Table 3.74 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	224	556	634	10.5%	410	183%	79	14%	T2	CS
Belgium	226	148	142	2.3%	-84	-37%	-6	-4%	CS,T3	D
Bulgaria	132	335	397	6.6%	265	202%	63	19%	T2	CS
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	5	13	33	0.5%	28	508%	20	158%	T2	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	2	9	3	0.0%	1	25%	-6	-70%	T1	CS
France	212	389	368	6.1%	156	74%	-21	-5%	T2	CS
Germany	1 083	1 228	1 249	20.6%	166	15%	21	2%	CS	CS
Greece	NO	8	NO,IE	-	-	-	-8	-100%	NA	NA
Hungary	100	94	135	2.2%	34	34%	41	44%	T1	D
Ireland	74	135	127	2.1%	53	71%	-8	-6%	T2	CS
Italy	407	669	757	12.5%	350	86%	88	13%	T2	CS
Latvia	IE,NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Lithuania	85	55	60	1.0%	-25	-29%	6	11%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	342	92	96	1.6%	-247	-72%	4	4%	T2	CS
Poland	NO	863	864	14.3%	864	∞	1	0%	T1	D
Portugal	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Romania	66	6	3	0.1%	-62	-95%	-3	-45%	T1,T2	CS,D
Slovakia	1 814	298	319	5.3%	-1 495	-82%	21	7%	T2	CS
Slovenia	NO	3	5	0.1%	5	∞	2	66%	T2	CS
Spain	19	117	129	2.1%	110	575%	12	10%	T1	CS,D
Sweden	206	163	167	2.8%	-39	-19%	3	2%	T2	CS
United Kingdom	225	547	566	9.3%	341	152%	18	3%	T3	CS
EU-28	**5 223**	**5 728**	**6 053**	**100%**	**830**	**16%**	**325**	**6%**	**-**	**-**
Iceland	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
United Kingdom (KP)	225	547	566	9.3%	341	152%	18	3%	T3	CS
EU-28 + ISL	**5 223**	**5 728**	**6 053**	**100%**	**830**	**16%**	**325**	**6%**	**-**	**-**

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 1A4)

Category 1A4 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 1A4c includes emissions from domestic inland, coastal, deep sea and international fishing. Emissions from transportation of agricultural goods are reported under category 1A3 Transport. The emissions reported under 1A4 can be generally defined as heat production processes for internal consumption.

The main driving force for CO_2 emissions in the 1A4 is energy consumption for purposes of space heating. The fluctuations in consumption the 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 1A4 sub categories 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 2017 category 1A4 contributed to 649 812 kt CO_2 equivalents of which 96.1% CO_2, 2.7% CH_4 and 1.2% N_2O.

Almost all countries report increases for 1A4b fuel consumption in 2017. The main reason might be the lower temperatures in the heating period within most European countries. The following Table **3.75** presents the (15°/18°) heating degree days in 2016 and 2017 for EU-28 Member States and the energy consumption-weighted calculated values for EU-28 as well as the trend in 1A4b total fuel consumption.

Table 3.75: EU-28 heating degree days 2016 and 2017 and 1A4b trend in total fuel consumption.

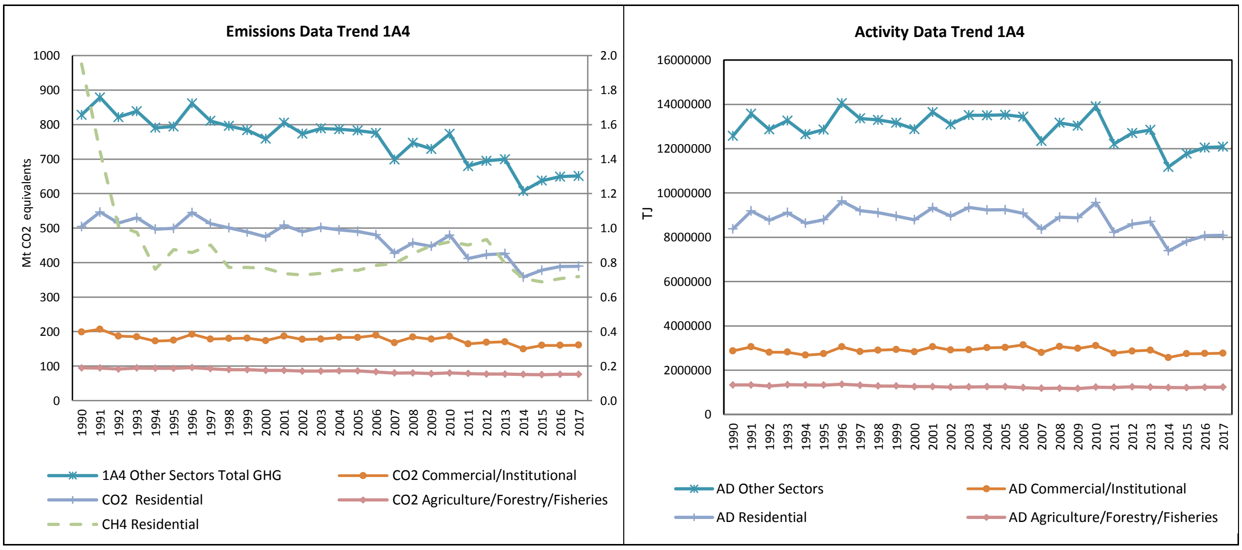
	2016	2017	Trend 2016 – 2017	Trend fuel consumption 1A4b
Austria	3 322	3 419	3%	3%
Belgium	2 630	2 689	2%	7%
Bulgaria	2 377	2 427	2%	5%
Croatia	2 250	2 273	1%	0%
Cyprus	740	680	-8%	-1%
Czech Rep	3 092	3 247	5%	4%
Denmark	3 113	3 136	1%	4%
Estonia	3 791	4 208	11%	3%
Finland	5 032	5 338	6%	5%
France	2 258	2 398	6%	4%
Germany	2 909	3 005	3%	6%
Greece	1 578	1 464	-7%	-8%

	2016	2017	Trend 2016 – 2017	Trend fuel consumption 1A4b
Hungary	2 593	2 707	4%	3%
Ireland	2 913	2 746	-6%	2%
Italy	1 810	1 762	-3%	0%
Latvia	3 695	4 003	8%	0%
Lithuania	3 523	3 827	9%	5%
Luxembourg	2 849	2 967	4%	5%
Malta	542	322	-41%	-1%
Netherlands	2 624	2 680	2%	2%
Poland	3 113	3 286	6%	7%
Portugal	1 076	1 237	15%	-1%
Romania	2 786	2 919	5%	1%
Slovakia	3 056	3 172	4%	-1%
Slovenia	2 700	2 757	2%	5%
Spain	1 640	1 729	5%	4%
Sweden	4 911	5 125	4%	0%
United Kingdom	3 015	2 976	-1%	4%
EU-28 (weighted)	2 607	2 683	3%	3%

Source: EEA 2019

Figure **3.143** shows the trend of total GHG emissions within source category 1A4 and the dominating sources which are CO_2 emissions from 1A4b Residential and from 1A4a Commercial/Residential. The emission trends of the large key sources show larger fluctuations between 1990 and 2017. Between 1990 and 2017 emissions from 1A4 decreased by 21%. From 2016 to 2017 emissions increased by 0.3% (+1.9 Mt CO_2 equivalents) which is mainly due to an increase of category 1A4b CO_2 emissions which increased by 0.2% and category 1A4a CO_2 emissions which increased by 0.3%. The increase of 1A4b CO_2 emissions in the year 2017 is mostly influenced by Germany (+3.5 Mt CO_2), and the United Kingdom (+2.8 Mt CO_2). The trend of 1A4a CO_2 emissions in the year 2017 is mostly influenced by Germany (+3.3 Mt CO_2), and Poland (+1.2 Mt CO_2).

Figure 3.143 1A4 Other Sectors: Total, CO_2 and CH_4 emission trends



Data displayed as dashed line refers to the secondary axis.

In 2017 GHG emissions from source category 1A4 accounted for 15 % of total GHG emissions. This source category includes twelve key sources which contributed to 98% of total 1A4 GHG emissions in 2017. The following list shows the key sources and their contribution to total 1A4 GHG emissions for the year 2017:

1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2) - 17.2%

1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)- 5.8%

1.A.4.a Commercial/Institutional: Other Fuels (CO_2) - 0.9%

1.A.4.a Commercial/Institutional: Solid Fuels (CO_2) - 0.6%

1.A.4.b Residential: Biomass (CH_4) - 1.6%

1.A.4.b Residential: Gaseous Fuels (CO_2) -38.6%

1.A.4.b Residential: Liquid Fuels (CO_2) - 15.1%

1.A.4.b Residential: Solid Fuels (CH_4) - 0.5%

1.A.4.b Residential: Solid Fuels (CO_2) -5.8%

1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2) - 1.7%

1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2) - 9.2%

1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2) - 0.6%

The following table shows the share of higher tier methods used for each key source of category 1A4. It comprises all methods and method combinations as reported by member states for any of the 1A4 key sources. Table 3.76: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 1A4 (Table excerpt)

Source category gas	kt CO_2 equ.	Trend	Level	

	1990	2017		1990	2017	share of higher Tier
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	66431	112004	T	L	L	65
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	83757	37938	T	L	L	54
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	781	6174	T	0	L	97
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	47293	4289	T	L	0	39
1.A.4.b Residential: Biomass (CH_4)	9220	10649	T	L	L	29
1.A.4.b Residential: Gaseous Fuels (CO_2)	183807	251753	T	L	L	68
1.A.4.b Residential: Liquid Fuels (CO_2)	181491	98793	T	L	L	54
1.A.4.b Residential: Solid Fuels (CH_4)	9212	2953	T	L	0	15
1.A.4.b Residential: Solid Fuels (CO_2)	135151	37829	T	L	L	58
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	12477	11450	0	L	L	68
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	72474	60411	T	L	L	54
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	9741	4008	T	L	0	42

The following table shows the assumptions made when estimating the share of higher tiers in a category.

Table 3.77: Assumptions made when estimating the share of higher Tier methods for 1A4.

Methods and method of EF combinations	Share of emissions which are estimated with a 'higher Tier method'
CS	82%
T1	0%
T1,T2	43%
T1,T3	43%
T2	93%
T2,T3	93%
T3	100%
No information	0%

Table 3.78 shows total GHG, CO_2 and CH_4 emissions from 1A4 Other sectors. Between 1990 and 2017 CO_2 emissions from 1A4 Other Sectors decreased by 21%, CH_4 decreased by 21% and N_2O emissions decreased by 0.16%.

Table 3.78 1A4 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 2017 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2017 (kt)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2017 (kt CO2 equivalents)
Austria	14 234	9 281	13 548	8 861	494	277
Belgium	28 136	23 030	27 790	22 515	256	405
Bulgaria	8 133	2 006	7 654	1 608	286	313
Croatia	4 218	3 297	3 719	2 821	358	352
Cyprus	434	543	430	536	2	5
Czechia	33 807	13 990	31 954	12 938	1 676	915
Denmark	9 266	4 333	9 043	4 103	160	143
Estonia	2 038	680	1 881	508	103	127
Finland	7 561	3 841	7 254	3 591	223	187
France	102 667	87 449	96 403	84 745	4 780	1 350
Germany	208 173	137 948	203 012	136 275	4 185	1 196
Greece	8 496	6 043	8 066	5 865	104	119
Hungary	22 169	13 090	21 211	12 390	858	594
Ireland	10 586	8 351	10 031	8 138	451	140
Italy	78 603	83 034	75 721	78 032	1 141	2 495
Latvia	5 794	1 515	5 418	1 296	219	139
Lithuania	7 300	1 495	6 903	1 292	210	161
Luxembourg	1 361	1 723	1 344	1 705	11	13
Malta	197	218	195	216	1	1
Netherlands	39 509	34 594	38 887	33 086	572	1 456
Poland	57 097	58 407	53 611	53 901	2 811	3 439
Portugal	4 683	4 371	4 063	3 977	414	247
Romania	9 897	11 188	9 540	9 936	316	998
Slovakia	11 502	5 357	11 067	5 075	389	213
Slovenia	1 851	1 452	1 646	1 257	148	147
Spain	26 352	40 308	25 313	38 991	828	1 028
Sweden	11 250	2 897	10 969	2 678	116	117
United Kingdom	111 602	89 371	109 648	88 163	1 565	969
EU-28	**826 915**	**649 812**	**796 319**	**624 499**	**22 679**	**17 547**
Iceland	794	546	785	540	3	1
United Kingdom (KP)	112 172	90 188	110 210	88 973	1 569	970
EU-28 + ISL	**828 279**	**651 175**	**797 666**	**625 849**	**22 686**	**17 550**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3.79 provides information on the contribution of Member States to EU-28+ISL recalculations in CO_2 from 1A4 Other sectors for 1990 and 2017 and main explanations for the largest recalculations in absolute terms.

Table 3.79 1A4 Other Sectors: Contribution of MS to EU-28 recalculations in CO_2 for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-4	-0.0	218	2.5	revised energy balance
Belgium	0	0.0	-1 900	-7.6	Each year x the activity data - energy consumption data - reported in the regional energy balances of the year x-2 are provisional data and the activity data of the year x-3 are made definitive. Consequently the emissions of the year 2016 are revised in the submission of January 2019. Flanders: correction of +64.51 kt (0.88%) due to optimization of EB Wallonia: correction of -1.69 kt (-0.03%) due to optimization of EB Brussels: correction of -25.13 kt (-25.57%) due partlly to optimization of EB. In the case of the Brussels-Capital Region, the revision of the activity

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
					data for the year 2016 appears to be more significant than usual because of some changes in the allocation of the total natural gas consumption to some sectors previously ignored or included elsewhere. This resulted in a drop of gas consumption by the industrial sector.
Bulgaria	-1 396	-18.3	50	3.2	
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czech Republic	-235	-0.7	49	0.4	Updated activity data
Denmark	5	0.1	-100	-2.3	The consumption of gas oil and LPG allocated to stationary combustion has been revised based on improved fuel consumption data for mobile sources. This is reflected in the recalculations for liquid fuels in the sectors 1A2 and1A4c. The fuel consumption for gas oil applied in 1A4b was not correct in the 2018 reporting. This has been rectified.
Estonia	-	-	-	-	
Finland	-4	-0.1	64	1.7	Updates of preliminary data; properties of liquid fuels
France	-268	-0.3	-1 144	-1.3	Révision des consommations dans le bilan de l'énergie du SDES pour combustibles liquides et solides
Germany	-	-	-4 702	-3.5	see NIR 2019, chapters 3.2.11.5 and 3.2.12.5
Greece	-	-	-	-	
Hungary	-0	-0.0	-115	-0.9	Updated activity data (IEA AQ)
Ireland	-	-	-13	-0.2	Revised natural gas fuel consumption in national energy balance
Italy	-380	-0.5	321	0.4	Update of activity data of agriculture off-road and Carbon content in municipal waste
Latvia	-203	-3.6	-	-	
Lithuania	-	-	-	-	
Luxembourg	5	0.4	5	0.3	energy balance revised, revised EF for gasoil and gasoline
Malta	0	0.0	23	13.3	
Netherlands	-0	-0.0	-517	-1.5	improved energy statistics
Poland	-	-	-	-	
Portugal	-	-	24	0.6	Update of Tier 2 emission factor for Natural Gas Update of 2016 Energy Balance in February 2019
Romania	-1 307	-12.1	30	0.3	The CO_2, CH_4 and N_2O emissions values for the 1990, 1991, 1992, 1995 and 2005 years were recalculated because the activity data from Energy Balance provided from National Institute of Statistics from the 1.A.4 Other sub-sector were updated. Country specific CO_2 EFs for the corresponding fuels from 2016 EU ETS reports were used for all 1A4 categories. Net calorific values determined from the 2016 EU-ETS reports were used for the specific fuels in 1A4 categories.
Slovakia	-389	-3.4	92	2.0	Improvement in biomass and solid fuels consumption in households. In addition, recalculations in the category [1. Energy][1.AA Fuel Combustion - Sectoral approach][1.A.4 Other Sectors][1.A.4.c Agriculture/Forestry/Fishing][1.A.4.c.ii Off-road vehicles and other machinery] as a result of changes in the statistical fuel consumption.
Slovenia	-	-	-	-	
Spain	-0	-0.0	-12	-0.0	35, 39, 43, 229
Sweden	61	0.6	-61	-2.2	Added working machine (pistmaskin) in model, which increase consumption of diesel and emissions for all years. Revision of AD in Energy Balances, Revision of NCV and EF for CO_2 Natural Gas, Revision of EF for CO_2 for Peat and Landfill Gas The distribution of engine types (2-stroke / 4-stroke) and number of snowmobiles and 4-wheelers have been updated → increased emissions for 1990-1993 and decreased emissions for 1994-2016. Revision of EF and AD for wood fuels, Revision of AD in Energy Balances, Revision of NCV and EF for CO_2 Natural Gas, Revision of EF for CO_2 for Peat and Landfill Gas "The distribution of engine types (2-stroke / 4-stroke) and number of

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
					snowmobiles and 4-wheelers have been updated → reduced gasoline consumption and emissions for the agricultural sector. Counterbalanced trucks were reallocated from agriculture (1A4c) to industry (1A2g) → reduced gasoline consumption agricultural sector. Increased number of chainsaws in implemented sales statistics for 2005-2016 → increased gasoline consumption in the forest sector 2005-2009. The redistribution of FAME between road traffic and woring machineries in 2009-2016 → lower proportion of FAME to working machineries → slight increase of fossil diesel for agriculture / forestry. IN TOTAL → decreased emissions for most years." Revision of NCV and EF for CO_2 Natural Gas, Revision of EF for CO_2 for Peat and Landfill Gas
United Kingdom	-116	-0.1	19	0.0	No significant recalculations. Minor changes to energy statistics.
EU28	-4 232	-0.5	-7 670	-1.2	
Iceland	-0	-0.0	-0	-0.0	
United Kingdom (KP)					No significant recalculations. Minor changes to energy statistics.
EU28+ISL	-4 116	-0.6	-7 689	-1.4	

Table 3.80 provides information on the contribution of Member States to EU-28+ISL recalculations in CH_4 from 1A4 Other sectors for 1990 and 2016.

Table 3.80 1A4 Other Sectors: Contribution of MS to EU-28 recalculations in CH_4 for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-0	-0.0	-24	-8.1	revised energy balance
Belgium	1	0.4	-3	-0.7	Each year x the activity data - energy consumption data - reported in the regional energy balances of the year x-2 are provisional data and the activity data of the year x-3 are made definitive. Consequently the emissions of the year 2016 are revised in the submission of January 2019. Flanders: correction of +64.51 kt (0.88%) due to optimization of EB Wallonia: correction of -1.69 kt (-0.03%) due to optimization of EB Brussels: correction of -25.13 kt (-25.57%) due partlly to optimization of EB. In the case of the Brussels-Capital Region, the revision of the activity data for the year 2016 appears to be more significant than usual because of some changes in the allocation of the total natural gas consumption to some sectors previously ignored or included elsewhere. This resulted in a drop of gas consumption by the industrial sector.
Bulgaria	-2	-0.7	0	0.1	
Croatia	-	-	-	-	
Cyprus	-	-	0	0.6	section 3.2.6.5, pg 87 of the report
Czech Republic	-1	-0.0	0	0.0	
Denmark	0	0.0	-1	-0.7	The consumption of gas oil and LPG allocated to stationary combustion has been revised based on improved fuel consumption data for mobile sources. This is reflected in the recalculations for liquid fuels in the sectors 1A2 and1A4c. The fuel consumption for gas oil applied in 1A4b was not correct in the 2018 reporting. This has been rectified
Estonia	-	-	-	-	
Finland	-0	-0.0	2	0.8	Updates of preliminary data; properties of liquid fuels
France	-2	-0.0	4	0.3	Révision des consommations dans le bilan de l'énergie du SDES pour combustibles liquides et solides
Germany	0	0.0	-38	-3.0	see NIR 2019, chapters 3.2.11.5 and 3.2.12.5
Greece	-	-	-	-	
Hungary	-0	-0.0	-5	-0.9	Updated activity data (IEA AQ)

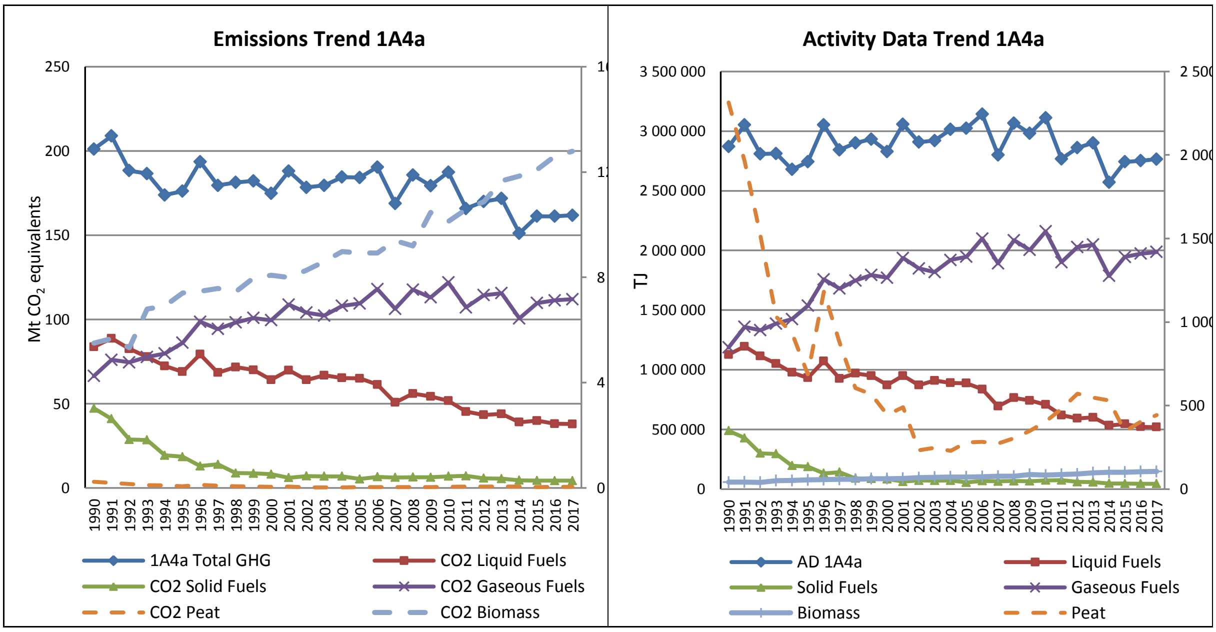
	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Ireland	-	-	-0	-0.3	Revised natural gas fuel consumption in national energy balance
Italy	-1	-0.1	-1	-0.0	Update of activity data of agriculture off-road and Carbon content in municipal waste
Latvia	-1	-0.7	-0	-0.3	Diesel oil relocation from complete stationary combustion to split between stationary combustion and combustion in off-roads.
Lithuania	-	-	-	-	
Luxembourg	0	3.8	0	1.2	energy balance revised; offroad EFs revised
Malta	1	107.4	1	188.9	Recalculations were performed for emissions of direct greenhouse gases in the category Other Sectors due to the addition of emissions from biomass.
Netherlands	-0	-0.0	-20	-1.4	reallocation see1.A.1
Poland	-	-	-	-	
Portugal	-	-	0	0.0	Update of 2016 Energy Balance in February 2019
Romania	-101	-24.1	-	-	The CH_4 emissions values for the 1990, 1991, 1992, 1995 and 2005 years were recalculated because the activity data from Energy Balance provided from National Institute of Statistics from the 1.A.4 Other sub-sector were updated.
Slovakia	-74	-16.0	51	28.1	Improvement in biomass and solid fuels consumption in households. In addition, recalculations in the category [1. Energy][1.AA Fuel Combustion - Sectoral approach][1.A.4 Other Sectors][1.A.4.c Agriculture/Forestry/Fishing][1.A.4.c.ii Off-road vehicles and other machinery] as a result of changes in the statistical fuel consumption.
Slovenia	-	-	-	-	
Spain	-	-	7	0.7	35, 39, 43, 229
Sweden	-180	-60.8	-188	-62.3	
United Kingdom	-26	-1.7	11	1.1	Revisions to biomass AD time series - most of straw previously in 1A4c re-allocated to 1A2, revisions to UK Sea Fisheries annual statistics.
EU28	-385	-1.7	-205	-1.2	
Iceland	-0	-0.0	0	0.0	
United Kingdom (KP)					Revisions to biomass AD time series - most of straw previously in 1A4c re-allocated to 1A2, revisions to UK Sea Fisheries annual statistics.
EU28+ISL	-359	-1.7	-215	-1.3	

3.2.4.1 Commercial/Institutional (1A4a)

CO_2 emissions from 1A4a Commercial/Institutional accounted for 5% of total GHG emissions from 1A Fuel Combustion in 2017. 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 3.144 shows the emission trend within the category 1A4a, which is mainly dominated by CO_2 emissions from liquid and gaseous fuels. Between 1990 and 2017 CO_2 emissions decreased by 19% (see also the Table 3-70), mainly due to decreases in CO_2 emissions from solid (-91%) and liquid (-54%) fuels while CO_2 emissions from gaseous fuels increased by 69% and showed a continuous uptrend for the whole time series until 2010. Between 2016 and 2017 the GHG emissions increased by 0.4%, mainly driven by an increase in gaseous fuel consumption.

Figure 3.144 1A4a 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. Fossil fuel consumption in 1A4a decreased by 4% between 1990 and 2017 and biomass consumption increased by 200%.

France, Germany, Italy and the United Kingdom contributed the most to the CO_2 emissions from this source (68%). The Member States with the highest increases in absolute terms were Spain, Italy, Romania and Estonia. The Member States with the highest reduction in absolute terms were Germany, the Czech Republic, France and the United Kingdom (Table 3.81).

Table 3.81 1A4a 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	2 333	1 162	1 176	0.7%	-1 157	-50%	15	1%	T1,T2	CS,D
Belgium	4 286	5 492	5 474	3.4%	1 188	28%	-18	0%	T1	D
Bulgaria	3 117	353	341	0.2%	-2 776	-89%	-12	-3%	T1,T2	CS,D
Croatia	855	608	627	0.4%	-228	-27%	19	3%	T1	D
Cyprus	75	81	92	0.1%	16	22%	11	14%	T1	D
Czechia	9 907	2 892	2 966	1.8%	-6 941	-70%	74	3%	T1,T2	CS,D
Denmark	1 460	722	719	0.4%	-741	-51%	-3	0%	M,T1,T2,T3	CS,D
Estonia	48	104	96	0.1%	49	103%	-8	-8%	T1,T2	CS,D
Finland	2 243	1 029	1 016	0.6%	-1 227	-55%	-13	-1%	T1,T2,T3	CS,D
France	30 397	29 449	28 593	17.8%	-1 804	-6%	-855	-3%	T1,T2	CS,D
Germany	64 106	34 734	38 111	23.8%	-25 995	-41%	3 377	10%	CS,T2,T3	CS,D
Greece	519	695	711	0.4%	192	37%	16	2%	T1,T2	CS,D
Hungary	2 757	3 202	3 068	1.9%	311	11%	-133	-4%	T1,T2	CS,D
Ireland	2 232	1 838	1 963	1.2%	-269	-12%	125	7%	T2	CS
Italy	11 815	23 124	23 244	14.5%	11 429	97%	121	1%	T2	CS
Latvia	2 696	398	394	0.2%	-2 302	-85%	-4	-1%	T1,T2	CS,D
Lithuania	3 059	314	331	0.2%	-2 728	-89%	17	5%	T2	CS
Luxembourg	639	509	581	0.4%	-59	-9%	71	14%	T1,T2	CS,D
Malta	165	144	160	0.1%	-5	-3%	15	11%	T1	D
Netherlands	8 310	7 415	7 624	4.8%	-686	-8%	209	3%	T2	CS,D
Poland	9 826	8 494	7 328	4.6%	-2 498	-25%	-1 166	-14%	T1,T2	CS,D
Portugal	745	1 146	1 156	0.7%	411	55%	10	1%	T1	D
Romania	NO	2 058	2 166	1.3%	2 166	∞	107	5%	T1,T2	CS
Slovakia	4 148	1 439	1 596	1.0%	-2 551	-62%	157	11%	T2	CS
Slovenia	503	462	363	0.2%	-140	-28%	-100	-22%	T1,T2	CS,D
Spain	3 827	11 318	10 565	6.6%	6 738	176%	-753	-7%	T2	CS,D,OTH
Sweden	2 888	800	746	0.5%	-2 142	-74%	-54	-7%	T1,T2	CS
United Kingdom	25 442	19 864	19 212	12.0%	-6 230	-24%	-652	-3%	T2	CS
EU-28	**198 396**	**159 844**	**160 416**	**100%**	**-37 980**	**-19%**	**573**	**0%**	**-**	**-**
Iceland	16	2	1	0.0%	-15	-95%	-1	-51%	T1	D
United Kingdom (KP)	25 524	19 899	19 247	12.0%	-6 278	-25%	-652	-3%	T2	CS
EU-28 + ISL	**198 495**	**159 880**	**160 452**	**100%**	**-38 043**	**-19%**	**572**	**0%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1A4 a Commercial/Institutional – Liquid Fuels (CO_2)

In 2017 CO_2 emissions from liquid fuels had a share of 24% within source category 1A4a (compared to 42% in 1990). Between 1990 and 2017, CO_2 emissions decreased by 55% (Table 3.82). However, five Member States increased the use of fossil fuels in the time series, the highest absolute increases are noted for Poland and Romania. It is important to note, however, that Poland and Romania, haven't been using the liquid fuels at the beginning of 90's. The highest absolute decreases were achieved in Bulgaria, Czech Republic, United Kingdom, Iceland and Lithuania. 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 2016 and 2017 EU-28+ISL CO_2 emissions decreased by 0.5%. According to the methodology as described in chapter 3.2.4 about 54% of EU-28 emissions are calculated by using higher tier methods in 2017.

Table 3.82 1A4a Commercial/Institutional, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	1 420	407	414	1.1%	-1 005	-71%	7	2%	T2	CS
Belgium	2 315	1 091	1 042	2.7%	-1 273	-55%	-49	-4%	T1	D
Bulgaria	2 986	120	105	0.3%	-2 880	-96%	-15	-12%	T1	D
Croatia	526	182	176	0.5%	-350	-67%	-6	-3%	T1	D
Cyprus	75	81	92	0.2%	16	22%	11	14%	T1	D
Czechia	2 000	58	58	0.2%	-1 942	-97%	0	0%	T1	CS,D
Denmark	1 055	273	257	0.7%	-798	-76%	-16	-6%	T1,T2	CS,D
Estonia	19	17	12	0.0%	-7	-37%	-5	-29%	-	-
Finland	2 190	940	931	2.5%	-1 259	-58%	-9	-1%	T2	CS
France	20 973	11 575	10 712	28.2%	-10 261	-49%	-862	-7%	-	-
Germany	28 133	13 207	13 402	35.3%	-14 731	-52%	195	1%	CS	CS
Greece	499	348	358	0.9%	-141	-28%	10	3%	T2	CS
Hungary	1 124	108	102	0.3%	-1 022	-91%	-6	-5%	T1	D
Ireland	1 870	729	787	2.1%	-1 083	-58%	57	8%	T2	CS
Italy	1 530	1 577	1 531	4.0%	0	0%	-46	-3%	-	-
Latvia	1 017	117	114	0.3%	-903	-89%	-3	-2%	T2	CS
Lithuania	1 166	8	9	0.0%	-1 157	-99%	1	19%	T2	CS
Luxembourg	470	235	316	0.8%	-154	-33%	81	35%	T2	CS
Malta	165	144	160	0.4%	-5	-3%	15	11%	T1	D
Netherlands	450	396	399	1.1%	-51	-11%	3	1%	T2	CS,D
Poland	IE,NO	1 280	1 328	3.5%	1 328	∞	47	4%	T1	D
Portugal	745	378	371	1.0%	-375	-50%	-7	-2%	-	-
Romania	NO	257	258	0.7%	258	∞	1	0%	T1,T2	CS
Slovakia	384	31	29	0.1%	-355	-92%	-2	-6%	T2	CS
Slovenia	270	314	254	0.7%	-16	-6%	-60	-19%	T1	D
Spain	3 284	3 135	3 620	9.5%	336	10%	485	15%	T2	D
Sweden	2 802	556	562	1.5%	-2 241	-80%	5	1%	T1	CS
United Kingdom	6 191	523	506	1.3%	-5 685	-92%	-17	-3%	T2	CS
EU-28	**83 659**	**38 087**	**37 904**	**100%**	**-45 755**	**-55%**	**-183**	**0%**		
Iceland	16	2	1	0.0%	-15	-95%	-1	-51%	T1	D
United Kingdom	6 272	557	540	1.4%	-5 733	-91%	-17	-3%	T2	CS
EU-28 + ISL	**83 757**	**38 122**	**37 938**	**100%**	**-45 818**	**-55%**	**-184**	**0%**		

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 3.145 and Figure **3.146** show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by France, Germany and Spain; together they cause 73% of the CO_2 emissions from liquid fuels in 1A4a. Fuel consumption decreased by 54% between 1990 and 2017. The CO_2 implied emission factor for liquid fuels was 72.98 t/TJ in 2017.

Figure 3.145 1A4a Commercial/Institutional, liquid fuels: Emission trend and share for CO_2

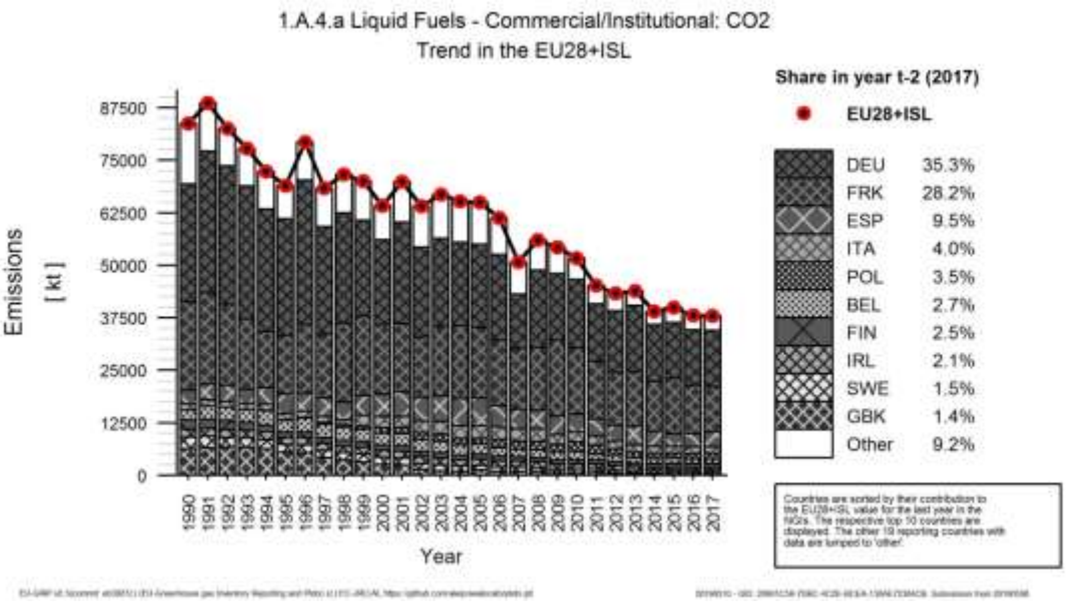
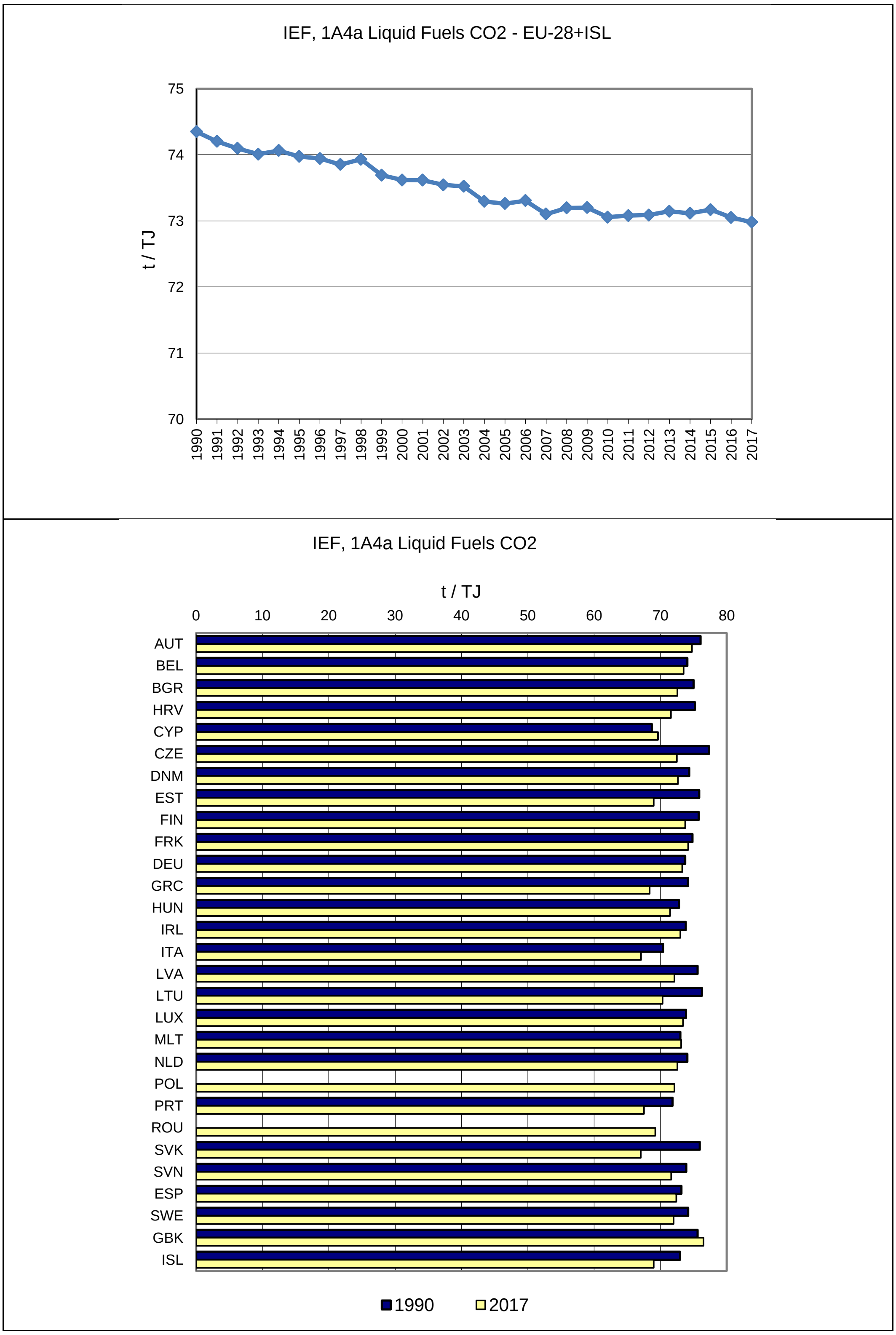


Figure 3.146 1A4a Commercial/Institutional, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1A4a Commercial/Institutional – Solid Fuels (CO_2)

In 2017, CO_2 from solid fuels had a share of 3% within source category 1A4a (compared to 24% in 1990). Between 1990 and 2017 CO_2 emissions decreased by 91% (Table 3.83). Fourteen Member States and Island report emissions as 'Not occurring' in 2017; all other Member States reduced emissions between 1990 and 2017 except Spain and France. Between 2016 and 2017 CO_2 emissions decreased by 0.2%. According to the methodology as described in chapter about 39% of EU-28 emissions are calculated by using higher tier methods in 2017.

Table 3.83 1A4a Commercial/Institutional, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	91	NO	NO	-	-91	-100%	-	-	NA	NA
Belgium	9	0	0	0.0%	-9	-100%	0	-4%	T1	D
Bulgaria	89	24	16	0.4%	-73	-82%	-8	-34%	T1,T2	CS,D
Croatia	88	0	0	0.0%	-88	-100%	0	161%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	6 237	134	131	3.1%	-6 106	-98%	-3	-2%	T2	CS,D
Denmark	8	NO	NO	-	-8	-100%	-	-	NA	NA
Estonia	5	NO	1	0.0%	-4	-80%	1	∞	-	-
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	684	686	740	17.3%	56	8%	54	8%	-	-
Germany	22 426	90	89	2.1%	-22 337	-100%	-1	-2%	CS	CS
Greece	20	NO,IE	NO,IE	-	-20	-100%	-	-	NA	NA
Hungary	475	12	6	0.1%	-469	-99%	-5	-45%	T1,T2	CS,D
Ireland	3	NO	NO	-	-3	-100%	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	-	-
Latvia	1 276	30	20	0.5%	-1 256	-98%	-10	-33%	T1,T2	CS,D
Lithuania	1 173	126	132	3.1%	-1 041	-89%	5	4%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	101	8	9	0.2%	-93	-92%	1	6%	T2	CS,D
Poland	8 992	2 687	2 590	60.4%	-6 402	-71%	-97	-4%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	-	-
Romania	NO	3	NO	-	-	-	-3	-100%	NA	NA
Slovakia	1 729	226	270	6.3%	-1 459	-84%	44	19%	T2	CS
Slovenia	203	NO	NO	-	-203	-100%	-	-	NA	NA
Spain	147	155	186	4.3%	39	27%	31	20%	T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	3 535	114	99	2.3%	-3 437	-97%	-16	-14%	T2	CS
EU-28	**47 292**	**4 296**	**4 288**	**100%**	**-43 004**	**-91%**	**-8**	**0%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	3 536	115	99	2.3%	-3 437	-97%	-16	-13%	T2	CS
EU-28 + ISL	**47 293**	**4 297**	**4 289**	**100%**	**-43 004**	**-91%**	**-8**	**0%**		

Greece reports emissions from stationary combustion as 'NO' and emissions from mobile sources as 'IE'
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.147 and Figure 3.148 shows CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Poland and France in 2017; together they cause 78% of the CO_2 emissions from solid fuels in 1A4a. Fuel consumption in the EU-28 decreased by 91% between 1990 and 2017. The CO_2 implied emission factor for solid fuels was 95.3 t/TJ in 2017. 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 3.147 1A4a Commercial/Institutional, solid fuels: Emission trend and share for CO_2

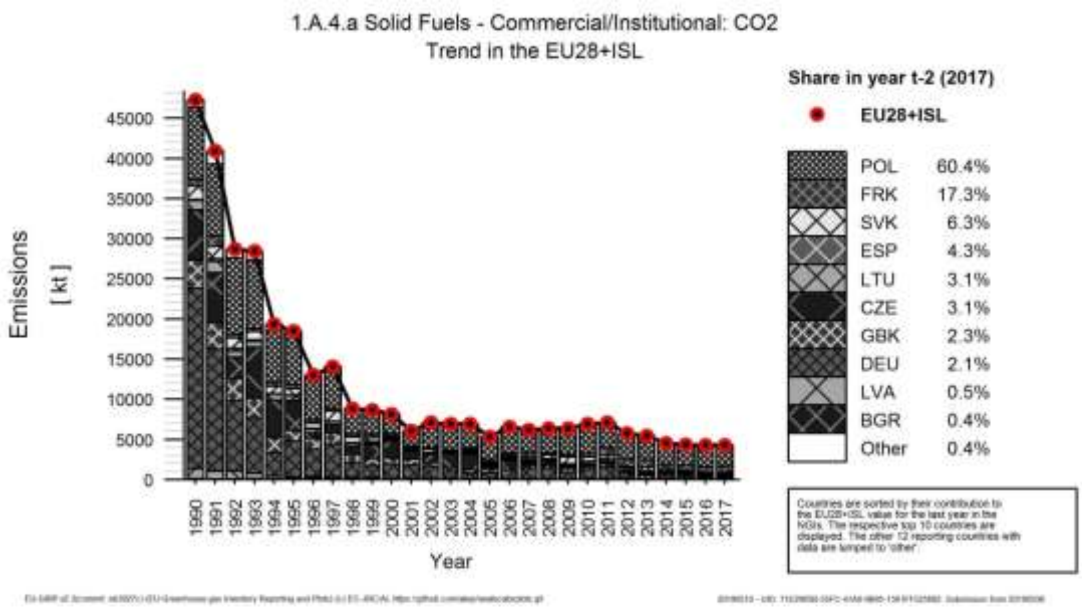
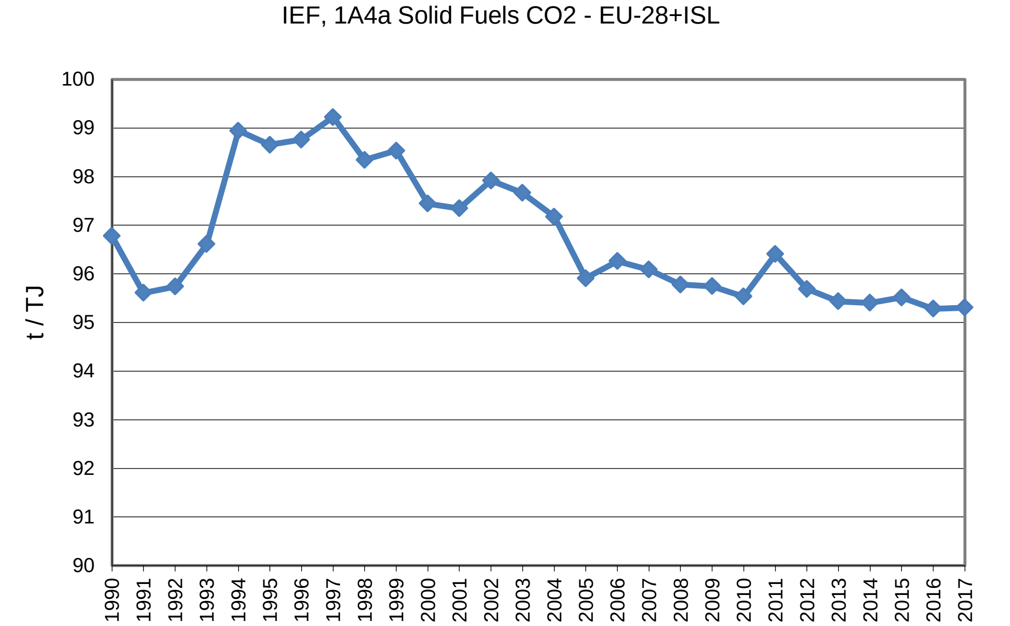
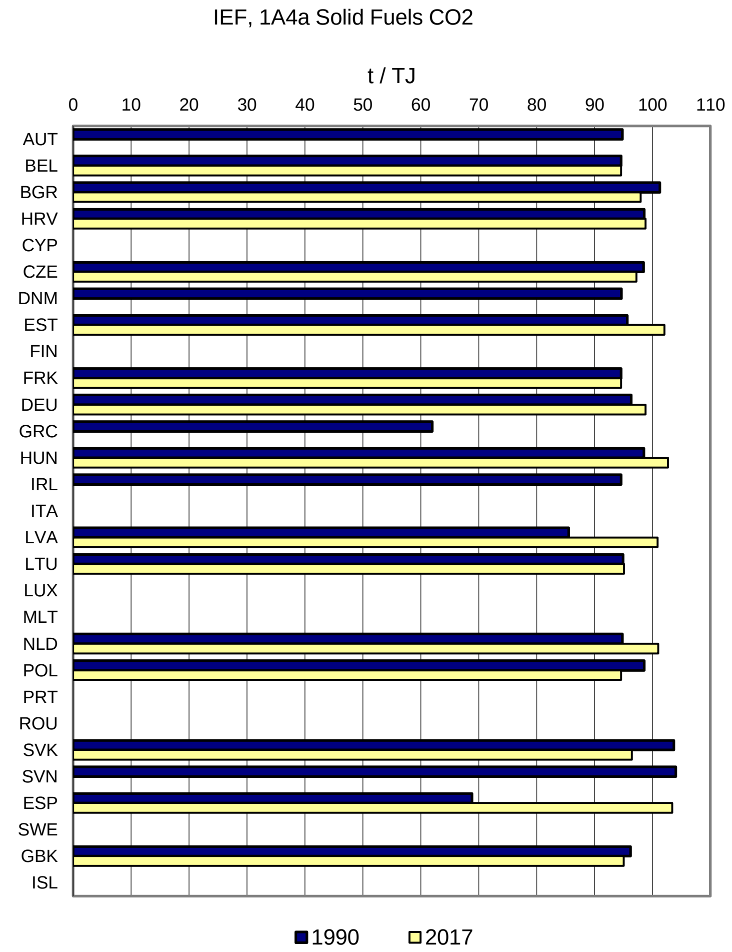


Figure 3.148 1A4a Commercial/Institutional, solid fuels: of Implied Emission Factors for CO_2 (in t/TJ)





1A4a Commercial/Institutional – Gaseous Fuels (CO_2)

In 2017 CO_2 from gaseous fuels had a share of 70% within source category 1A4a (compared to 33% in 1990). Between 1990 and 2017, the emissions increased by 69% (Table 3.84). All Member States except of Latvia, Lithuania, the Netherlands and Slovakia reported increasing emissions. The highest absolute increases occurred in Bulgaria, Estonia, Ireland, Poland, Spain and Slovenia. Between 2016 and 2017 CO_2 emissions increased by 1%. According to the methodology as described in chapter 3.2.4 about 65% of EU-28 emissions are calculated by using higher tier methods in 2017.

Table 3.84 1A4a Commercial/Institutional, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	707	748	756	0.7%	50	7%	8	1%	T2	CS
Belgium	1 933	4 286	4 298	3.8%	2 365	122%	12	0%	T1	D
Bulgaria	42	209	220	0.2%	178	423%	11	5%	T2	CS
Croatia	241	425	450	0.4%	210	87%	25	6%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 670	2 700	2 777	2.5%	1 106	66%	76	3%	T2	CS
Denmark	363	439	453	0.4%	90	25%	14	3%	T3	CS
Estonia	20	87	83	0.1%	63	309%	-4	-4%	-	-
Finland	37	75	71	0.1%	33	88%	-4	-5%	T2	CS
France	8 740	17 188	17 141	15.3%	8 401	96%	-47	0%	-	-
Germany	13 547	21 436	24 620	22.0%	11 073	82%	3 183	15%	CS	CS
Greece	IE,NO	346	353	0.3%	353	∞	6	2%	T2	CS
Hungary	1 158	2 920	2 788	2.5%	1 630	141%	-132	-5%	T1	D
Ireland	223	1 109	1 176	1.0%	952	426%	67	6%	T2	CS
Italy	9 755	15 804	15 920	14.2%	6 165	63%	116	1%	-	-
Latvia	336	251	259	0.2%	-77	-23%	8	3%	T2	CS
Lithuania	708	153	160	0.1%	-547	-77%	7	5%	T2	CS
Luxembourg	170	274	265	0.2%	95	56%	-10	-4%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	7 758	7 011	7 216	6.4%	-542	-7%	205	3%	T2	CS
Poland	762	4 488	3 364	3.0%	2 603	342%	-1 124	-25%	T2	CS
Portugal	NO	769	785	0.7%	785	∞	17	2%	-	-
Romania	NO	1 779	1 894	1.7%	1 894	∞	115	6%	T2	CS
Slovakia	2 035	1 182	1 297	1.2%	-738	-36%	115	10%	T2	CS
Slovenia	29	148	109	0.1%	79	273%	-39	-27%	T2	CS
Spain	396	8 027	6 759	6.0%	6 363	1608%	-1 269	-16%	T2	CS,D
Sweden	86	234	184	0.2%	98	114%	-50	-21%	-	CS
United Kingdom	15 716	19 227	18 608	16.6%	2 892	18%	-619	-3%	T2	CS
EU-28	**66 431**	**111 317**	**112 004**	**100%**	**45 573**	**69%**	**687**	**1%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	15 716	19 227	18 608	16.6%	2 892	18%	-619	-3%	T2	CS
EU-28 + ISL	**66 431**	**111 317**	**112 004**	**100%**	**45 573**	**69%**	**687**	**1%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.149 and Figure 3.150 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Germany, United Kingdom, France and Italy; together they cause 68% of the CO_2 emissions from gaseous fuels in 1A4a. Fuel combustion rose by 67% between 1990 and 2017. The CO_2 implied emission factor for gaseous fuels was 56.4 t/TJ in 2017.

Figure 3.149 1A4a Commercial/Institutional, gaseous fuels: Emission trend and share for CO_2

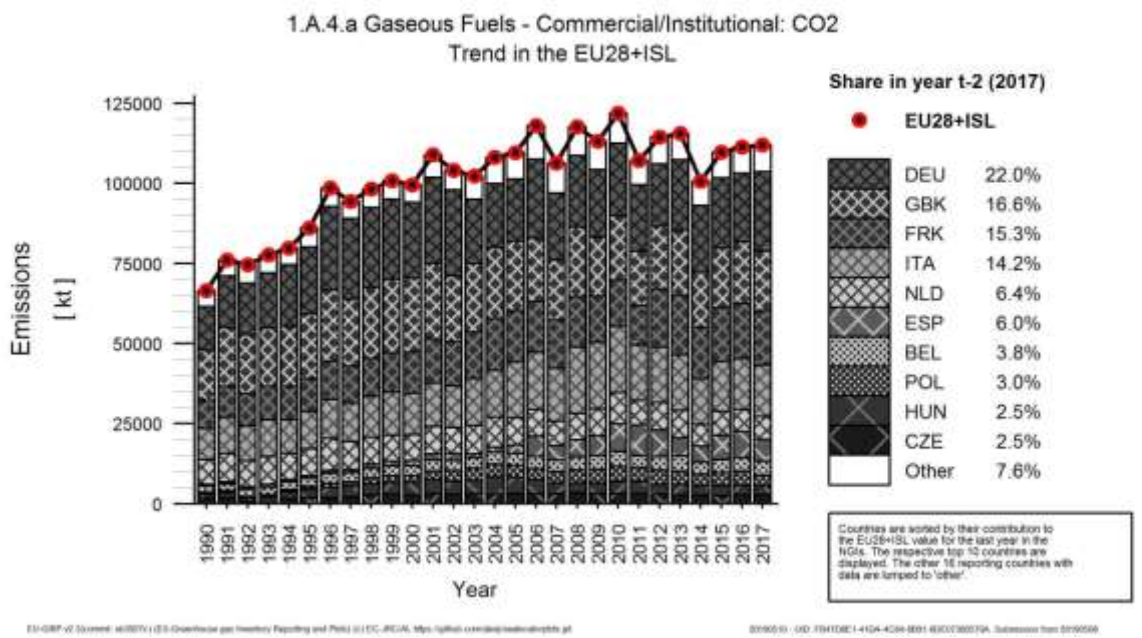
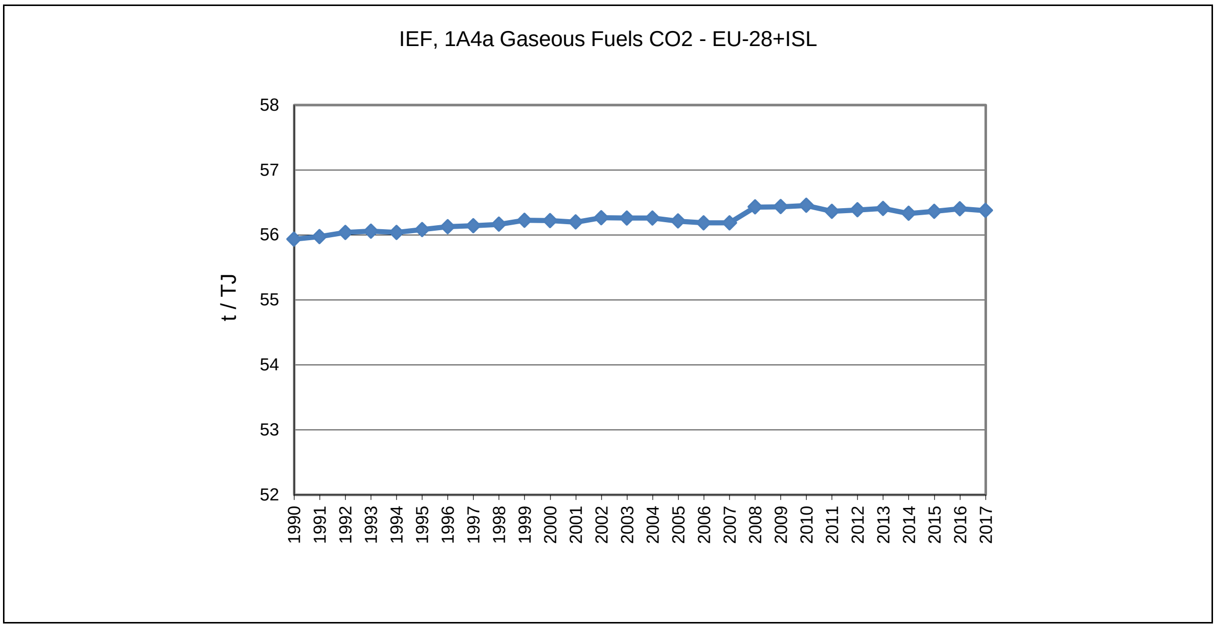


Figure 3.150 1A4a Commercial/Institutional, gaseous fuels: Overview of outliers of Implied Emission Factors for CO_2 (in t/TJ)



Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emissior factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	116	6	6	0.1%	-110	-95%	-1	-11%	T2	C
Belgium	29	115	134	2.2%	105	360%	19	17%	T1	
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	N
Croatia	NO	NO	NO	-	-	-	-	-	NA	N
Cyprus	NO	NO	NO	-	-	-	-	-	NA	N
Czechia	NO	NO	NO	-	-	-	-	-	NA	N
Denmark	34	10	10	0.2%	-24	-71%	0	0%	T2	C
Estonia	NO	NO	NO	-	-	-	-	-	-	
Finland	0	NO	NO	-	0	-100%	-	-	NA	N
France	NO	NO	NO	-	-	-	-	-	-	
Germany	NO	NO	NO	-	-	-	-	-	NA	N
Greece	IE,NO	NO,IE	NO,IE	-	-	-	-	-	NA	N
Hungary	NO	162	172	2.8%	172	∞	10	6%	T2	C
Ireland	NO	NO	NO	-	-	-	-	-	NA	N
Italy	530	5 743	5 793	93.8%	5 263	993%	50	1%	-	
Latvia	NO	0	0	0.0%	0	∞	0	50%	T1	
Lithuania	NO	NO	NO	-	-	-	-	-	NA	N
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	N
Malta	NO	NO	NO	-	-	-	-	-	NA	N
Netherlands	NO	NO	NO	-	-	-	-	-	NA	N
Poland	72	39	46	0.7%	-26	-36%	8	20%	T1	
Portugal	NO	NO	NO	-	-	-	-	-	-	
Romania	NO	19	14	0.2%	14	∞	-5	-27%	T2	C
Slovakia	NO	NO	NO	-	-	-	-	-	NA	N
Slovenia	NO	NO	NO	-	-	-	-	-	NA	N
Spain	NO	NO	NO	-	-	-	-	-	NA	N
Sweden	NO	9	NO	-	-	-	-9	-100%	NA	
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	N
EU-28	**781**	**6 102**	**6 174**	**100%**	**5 394**	**691%**	**72**	**1%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	N
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	N
EU-28 + ISL	**781**	**6 102**	**6 174**	**100%**	**5 394**	**691%**	**72**	**1%**		

1A4a 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 2017, CO_2 from other fossil fuels had a share of 4% within category 1A4a. Between 1990 and 2017 CO_2 increased by 691% (Table 3.85). 21 Member States and Island report emissions as 'Not occurring' in 2017; between 2016 and 2017 CO_2 increased by 1%. Level of emissions are 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 97% of EU-28 emissions are calculated by using higher tier methods in 2017.

Table 3.85: 1A4a Commercial/Institutional, other fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	116	6	6	0.1%	-110	-95%	-1	-11%	T2	CS
Belgium	29	115	134	2.2%	105	360%	19	17%	T1	D
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	10	10	0.2%	-24	-71%	0	0%	T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	-	-
Finland	0	NO	NO	-	0	-100%	-	-	NA	NA
France	NO	NO	NO	-	-	-	-	-	-	-
Germany	NO	NO	NO	-	-	-	-	-	NA	NA
Greece	IE,NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Hungary	NO	162	172	2.8%	172	∞	10	6%	T2	CS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	530	5 743	5 793	93.8%	5 263	993%	50	1%	-	-
Latvia	NO	0	0	0.0%	0	∞	0	50%	T1	D
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	72	39	46	0.7%	-26	-36%	8	20%	T1	D
Portugal	NO	NO	NO	-	-	-	-	-	-	-
Romania	NO	19	14	0.2%	14	∞	-5	-27%	T2	CS
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	NO	9	NO	-	-	-	-9	-100%	NA	-
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28	**781**	**6 102**	**6 174**	**100%**	**5 394**	**691%**	**72**	**1%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28 + ISL	**781**	**6 102**	**6 174**	**100%**	**5 394**	**691%**	**72**	**1%**		

Greece reports emissions from stationary combustion as 'NO' and emissions from mobile sources as 'IE'

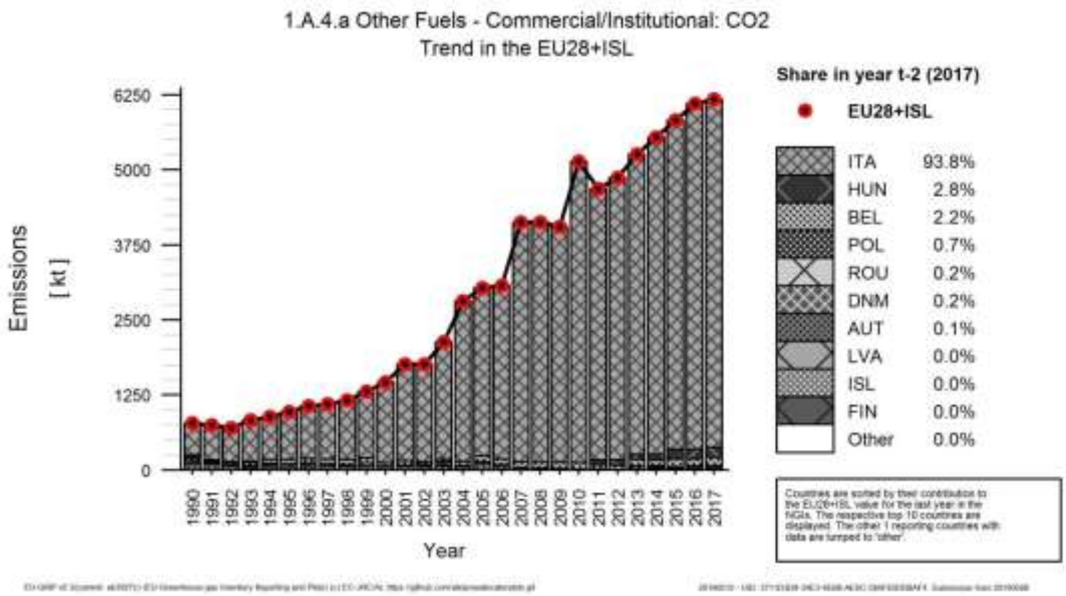


Figure 3.152 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Italy; it causes 94% of the CO_2 emissions from other fuels in 1A4a. The CO_2 implied emission factor for other

fossil fuels was 115.6 t/TJ in 2017. The comparatively high implied emission factor is a calculated value from a mass balance calculation method and data from energy statistics.

Figure 3.151 1A4a Commercial/Institutional, other fuels: Emission trend and share for CO_2

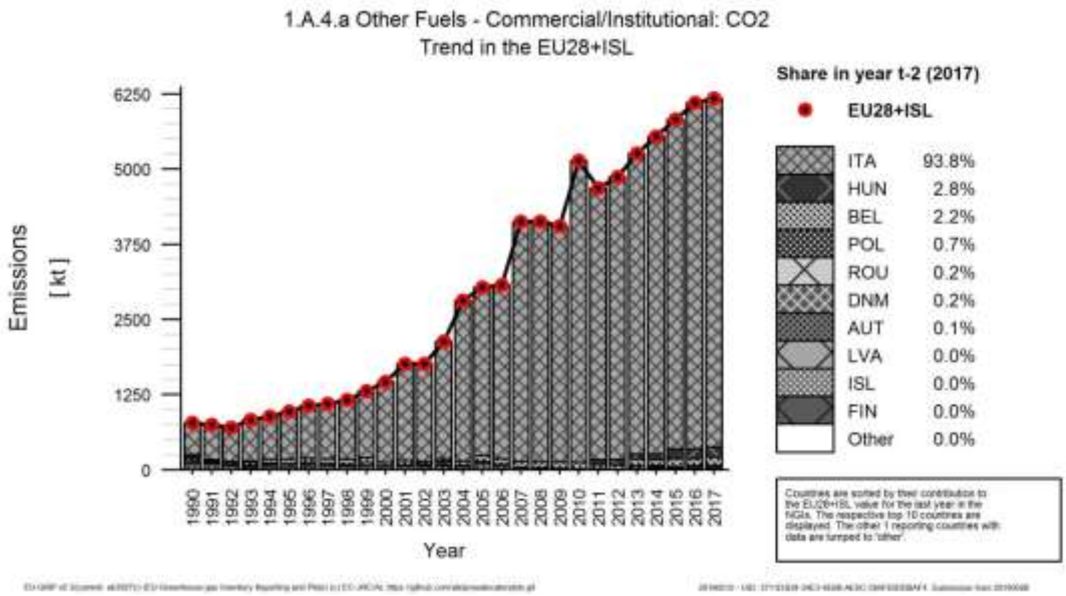
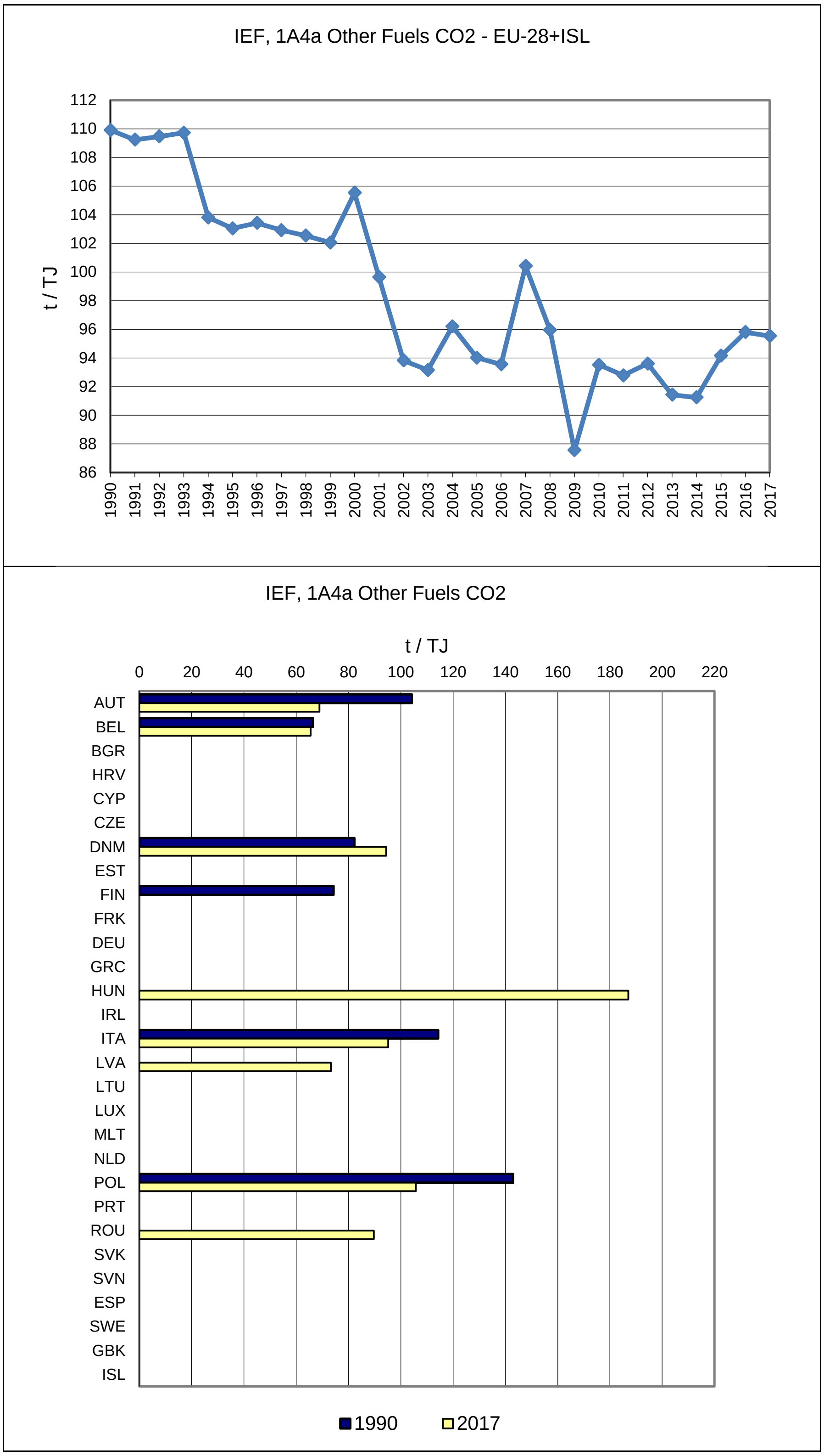


Figure 3.152 1A4a Commercial/Institutional, other fuels: Overview of outliers of Implied Emission Factors for CO_2 (in t/TJ)

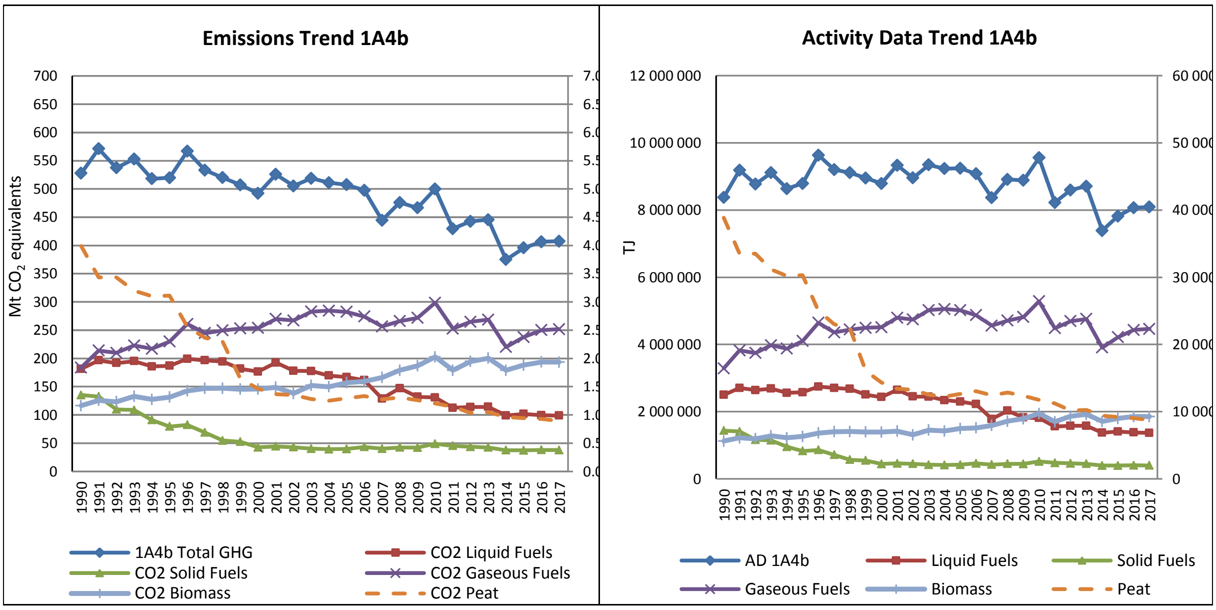


3.2.4.2 Residential (1A4b)

CO_2 emissions from 1A4b Residential account for 12% of total GHG emissions from 1A Fuels Combustion in 2017.

Figure 3.153 shows the emission trend within the category 1A4b, which is mainly dominated by CO_2 emissions from liquid and gaseous fuels. Total GHG emissions decreased by 23% since 1990, although CO_2 emissions from gaseous fuels increased strongly (+37%) which was counterbalanced by decreasing emissions from liquid and solid fuels. From 2016 to 2017 CO_2 emissions increased by 0.2% and energy consumption increased by 3.5% which is correlating with the trend in EU-28 heating degree days (+3%). Biomass consumption reached a share of 15% in the year 2017 (in whole 1A4) while the share of solid fuels consumption dropped to 3%.

Figure 3.153 1A4b 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 1A4b Residential

Between 1990 and 2017, CO_2 emissions from households decreased by 23% in the EU-28+ISL (Table 3.86). 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. Fossil fuel consumption of households decreased by 13% between 1990 and 2017, with a fuel shift from coal and oil to natural gas and biomass.

Between 1990 and 2017, the largest CO_2 reduction in absolute terms was reported by Estonia and Sweden. Only seven Member States show increases in their emissions. One reason for the performance of the Nordic countries and Austria 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 2016 and 2017 the largest increase in the emissions is reported by Lithuania and Slovakia.

Table 3.86 1A4b 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	9 963	6 722	6 849	1.8%	-3 114	-31%	128	2%	T1,T2	CS,D
Belgium	20 471	15 409	14 932	3.8%	-5 539	-27%	-477	-3%	CS,T1,T3	D
Bulgaria	2 887	808	833	0.2%	-2 054	-71%	26	3%	T1,T2	CS,D
Croatia	2 029	1 544	1 566	0.4%	-463	-23%	21	1%	T1	D
Cyprus	300	356	360	0.1%	61	20%	5	1%	T1	D
Czech Republic	18 375	8 468	8 762	2.3%	-9 613	-52%	294	3%	T1,T2	CS,D
Denmark	4 988	2 030	1 887	0.5%	-3 101	-62%	-143	-7%	M,T1,T2,T3	CS,D
Estonia	1 338	182	178	0.0%	-1 160	-87%	-5	-3%	T1,T2	CS,D
Finland	3 148	1 287	1 205	0.3%	-1 943	-62%	-82	-6%	T1,T2,T3	CS,D
France	54 652	46 036	46 432	11.9%	-8 220	-15%	396	1%	T1,T2	CS,D
Germany	128 636	88 248	91 808	23.6%	-36 828	-29%	3 560	4%	CS,T2	CS
Greece	4 654	4 687	4 696	1.2%	42	1%	8	0%	T1,T2	CS,D
Hungary	15 798	7 411	7 937	2.0%	-7 861	-50%	526	7%	T1,T2	CS,D
Ireland	7 052	5 889	5 599	1.4%	-1 453	-21%	-290	-5%	T2	CS
Italy	55 554	47 998	47 758	12.3%	-7 796	-14%	-240	0%	T2	CS
Latvia	1 143	452	464	0.1%	-680	-59%	12	3%	T1,T2	CS,D
Lithuania	2 361	684	751	0.2%	-1 610	-68%	67	10%	T2	CS
Luxembourg	670	1 104	1 101	0.3%	431	64%	-3	0%	T1,T2	CS,D
Malta	27	42	44	0.0%	17	64%	2	4%	T1	D
Netherlands	20 731	16 974	16 495	4.2%	-4 235	-20%	-478	-3%	T1,T2	CS,D
Poland	35 278	35 659	35 691	9.2%	414	1%	32	0%	T1,T2	CS,D
Portugal	1 639	1 762	1 727	0.4%	88	5%	-35	-2%	-	D
Romania	7 546	6 224	6 529	1.7%	-1 017	-13%	305	5%	T1,T2	CS,D
Slovakia	6 773	2 782	3 092	0.8%	-3 681	-54%	310	11%	T2	CS
Slovenia	809	696	677	0.2%	-132	-16%	-19	-3%	T1,T2	CS,D
Spain	12 808	16 999	16 772	4.3%	3 964	31%	-227	-1%	T2	CS,D,OTH
Sweden	6 320	605	616	0.2%	-5 703	-90%	12	2%	T1,T2	CS
United Kingdom	78 228	66 913	64 083	16.5%	-14 145	-18%	-2 830	-4%	T1,T2,T3	CS,D
EU-28	**504 177**	**387 970**	**388 845**	**100%**	**-115 333**	**-23%**	**875**	**0%**	**-**	**-**
Iceland	31	6	12	0.0%	-19	-62%	6	94%	T1,T2	D
United Kingdom (KP)	78 456	67 321	64 497	16.6%	-13 959	-18%	-2 824	-4%	T1,T2,T3	CS,D
EU-28 + ISL	**504 436**	**388 384**	**389 271**	**100%**	**-115 166**	**-23%**	**887**	**0%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1A4b Residential – Liquid Fuels (CO_2)

In 2017 CO_2 from liquid fuels had a share of 25% within source category 1A4b (compared to 36% in 1990). Between 1990 and 2016 emissions decreased by 46% (Table 3.87). Sweden, Hungary and Estonia show the highest absolute decreases. Only six Member States reported increasing emissions since 1990. Between 2016 and 2017 EU-28+ISL CO_2 emissions decreased by 1%. 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 54% of EU-28 emissions are calculated by using higher tier methods in 2017.

Table 3.87 1A4b Residential, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	5 605	3 310	3 415	3.5%	-2 190	-39%	105	3%	T2	CS
Belgium	12 800	7 256	6 950	7.0%	-5 851	-46%	-306	-4%	T1	D
Bulgaria	158	73	66	0.1%	-91	-58%	-6	-9%	T1	D
Croatia	1 137	441	428	0.4%	-708	-62%	-12	-3%	T1	D
Cyprus	300	356	360	0.4%	61	20%	5	1%	-	-
Czechia	239	130	130	0.1%	-109	-46%	0	0%	T1	CS,D
Denmark	3 928	543	482	0.5%	-3 446	-88%	-60	-11%	T1,T2	CS,D
Estonia	544	44	43	0.0%	-501	-92%	0	-1%	-	-
Finland	3 024	1 209	1 129	1.1%	-1 895	-63%	-80	-7%	T2	CS
France	31 001	15 358	15 782	16.0%	-15 219	-49%	424	3%	-	-
Germany	56 382	35 211	36 156	36.6%	-20 225	-36%	945	3%	CS	CS
Greece	4 565	3 900	3 836	3.9%	-729	-16%	-64	-2%	T2	CS
Hungary	3 540	176	217	0.2%	-3 323	-94%	41	23%	T1	D
Ireland	1 175	3 009	2 894	2.9%	1 719	146%	-114	-4%	T2	CS
Italy	28 444	6 694	6 060	6.1%	-22 384	-79%	-634	-9%	T2	CS
Latvia	332	150	163	0.2%	-170	-51%	13	8%	T2	CS
Lithuania	397	138	159	0.2%	-238	-60%	21	15%	T2	CS
Luxembourg	474	549	535	0.5%	60	13%	-14	-3%	T2	CS
Malta	27	42	44	0.0%	17	64%	2	4%	T1	D
Netherlands	774	176	175	0.2%	-599	-77%	-1	-1%	T2	CS,D
Poland	107	1 587	1 617	1.6%	1 509	1405%	29	2%	T1	D
Portugal	1 639	1 183	1 132	1.1%	-507	-31%	-51	-4%	-	-
Romania	922	671	754	0.8%	-168	-18%	83	12%	T1,T2	CS,D
Slovakia	93	23	23	0.0%	-70	-75%	0	0%	T2	CS
Slovenia	439	429	401	0.4%	-38	-9%	-28	-7%	T1	D
Spain	9 855	8 397	7 568	7.7%	-2 287	-23%	-828	-10%	T2	D
Sweden	6 234	526	524	0.5%	-5 709	-92%	-2	0%	T1	CS
United Kingdom	7 126	7 532	7 372	7.5%	246	3%	-159	-2%	T2	CS
EU-28	**181 262**	**99 112**	**98 418**	**100%**	**-82 844**	**-46%**	**-694**	**-1%**		
Iceland	31	6	12	0.0%	-19	-62%	6	94%	T1,T2	D
United Kingdom	7 325	7 890	7 736	7.8%	411	6%	-154	-2%	T2	CS
EU-28 + ISL	**181 491**	**99 476**	**98 793**	**100%**	**-82 698**	**-46%**	**-684**	**-1%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.154 and Figure 3.155 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by France and Germany; together they cause 53% of the CO_2 emissions from liquid fuels in 1A4b. Fuel consumption in the EU-28+ISL decreased by 46% between 1990 and 2017. The CO_2 implied emission factor for liquid fuels was 72.2 t/TJ in 2017. 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 3.154 1A4b Residential, liquid fuels: Emission trend and share for CO_2

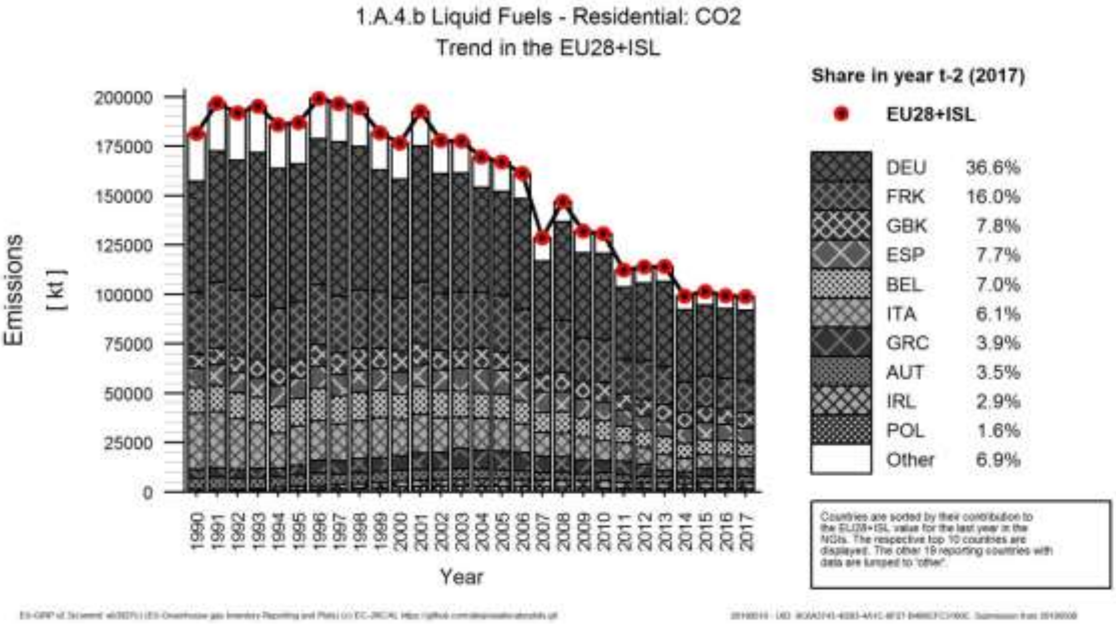
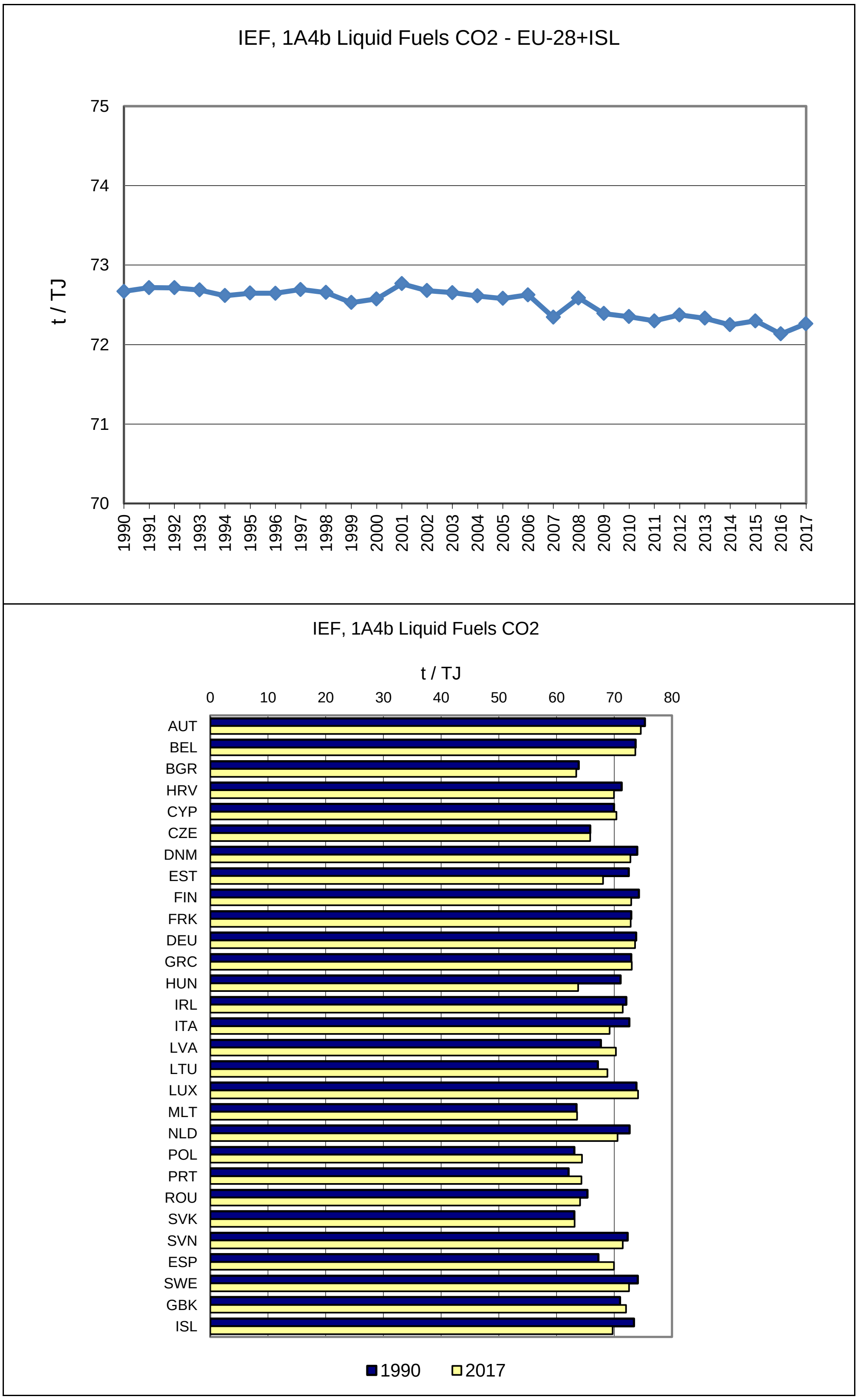


Figure 3.155 1A4b Residential, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1A4b Residential –Solid Fuels (CO_2)

In 2017 CO_2 from solid fuels had a share of 10% within source category 1A4b (compared to 27% in 1990). Between 1990 and 2017 CO_2 emissions decreased by 72% (Table 3.88). All Member States reported decreasing emissions with the highest reductions in absolute terms in Germany, the United Kingdom, the Czech Republic, Hungary and Slovakia. Between 2016 and 2017 CO_2 emissions decreased by 0.2%. Iceland, Cyprus, Malta, Sweden, Italy, Denmark and Portugal report emissions as 'Not occurring' in 2017. According to the methodology as described in chapter 3.2.4 about 58% of EU-28 emissions are calculated by using higher tier methods in 2017.

Table 3.88 1A4b Residential, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	2 511	73	73	0.2%	-2 437	-97%	0	1%	T2	CS
Belgium	1 796	140	137	0.4%	-1 659	-92%	-3	-2%	T1	D
Bulgaria	2 730	598	609	1.6%	-2 121	-78%	11	2%	T1,T2	CS,D
Croatia	436	10	12	0.0%	-424	-97%	2	24%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czechia	16 038	3 694	3 966	10.5%	-12 071	-75%	273	7%	T2	CS,D
Denmark	72	0	NO	-	-72	-100%	0	-100%	NA	NA
Estonia	338	8	10	0.0%	-327	-97%	2	25%	-	-
Finland	33	1	1	0.0%	-32	-98%	0	-10%	T2	CS
France	3 283	686	740	2.0%	-2 543	-77%	54	8%	-	-
Germany	40 661	2 149	2 150	5.7%	-38 511	-95%	1	0%	CS	CS
Greece	89	18	18	0.0%	-70	-79%	0	1%	T2	CS
Hungary	8 107	515	614	1.6%	-7 493	-92%	99	19%	T1,T2	CS,D
Ireland	2 483	721	602	1.6%	-1 882	-76%	-120	-17%	T2	CS
Italy	899	NO	NO	-	-899	-100%	-	-	NA	NA
Latvia	548	51	41	0.1%	-506	-92%	-10	-19%	T2	CS
Lithuania	1 440	144	166	0.4%	-1 274	-88%	22	15%	T2	CS
Luxembourg	26	2	2	0.0%	-25	-94%	-1	-35%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	61	5	5	0.0%	-57	-92%	0	5%	T2	CS,D
Poland	28 420	26 026	25 667	67.8%	-2 754	-10%	-360	-1%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	-	-
Romania	1 396	214	127	0.3%	-1 269	-91%	-86	-40%	T1,T2	CS,D
Slovakia	5 122	267	322	0.9%	-4 800	-94%	55	21%	T2	CS
Slovenia	345	1	0	0.0%	-344	-100%	0	-33%	T1	D
Spain	2 035	390	390	1.0%	-1 645	-81%	0	0%	T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	16 254	2 202	2 177	5.8%	-14 076	-87%	-24	-1%	T2	CS
EU-28	**135 121**	**37 913**	**37 829**	**100%**	**-97 292**	**-72%**	**-84**	**0%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	16 283	2 202	2 177	5.8%	-14 106	-87%	-24	-1%	T2	CS
EU-28 + ISL	**135 151**	**37 913**	**37 829**	**100%**	**-97 321**	**-72%**	**-84**	**0%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.156 and Figure 3.157 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Poland, and the Czech Republic; together they cause 78% of the CO_2 emissions from solid fuels in 1A4b. Fuel consumption in the EU-28 decreased by 72% between 1990 and 2017. The CO_2 implied emission factor for solid fuels was 94.9 t/TJ in 2017. 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 3.156 1A4b Residential, solid fuels: Emission trend and share for CO_2

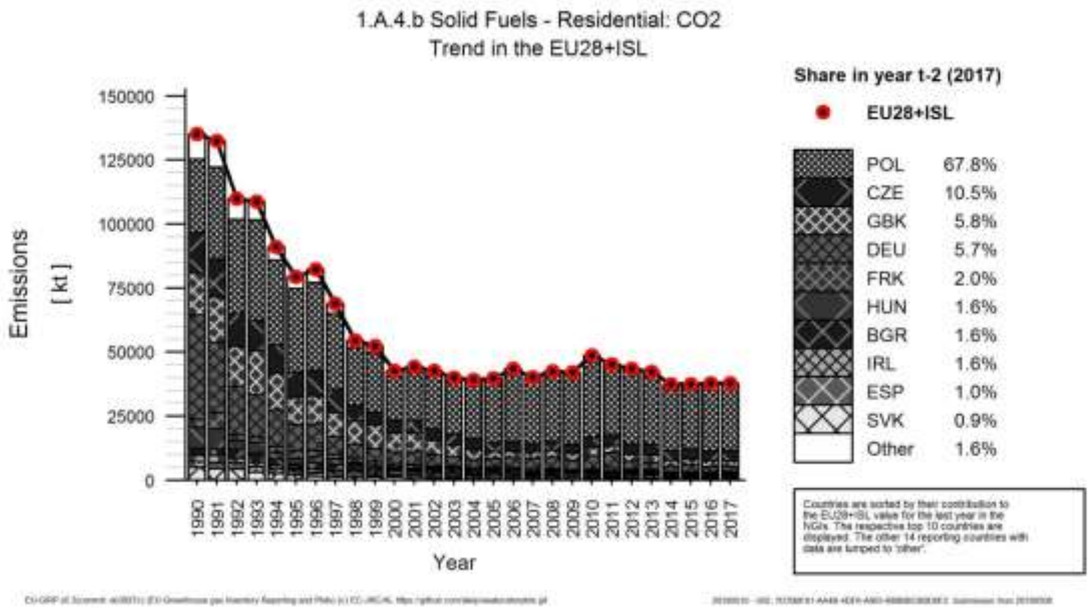
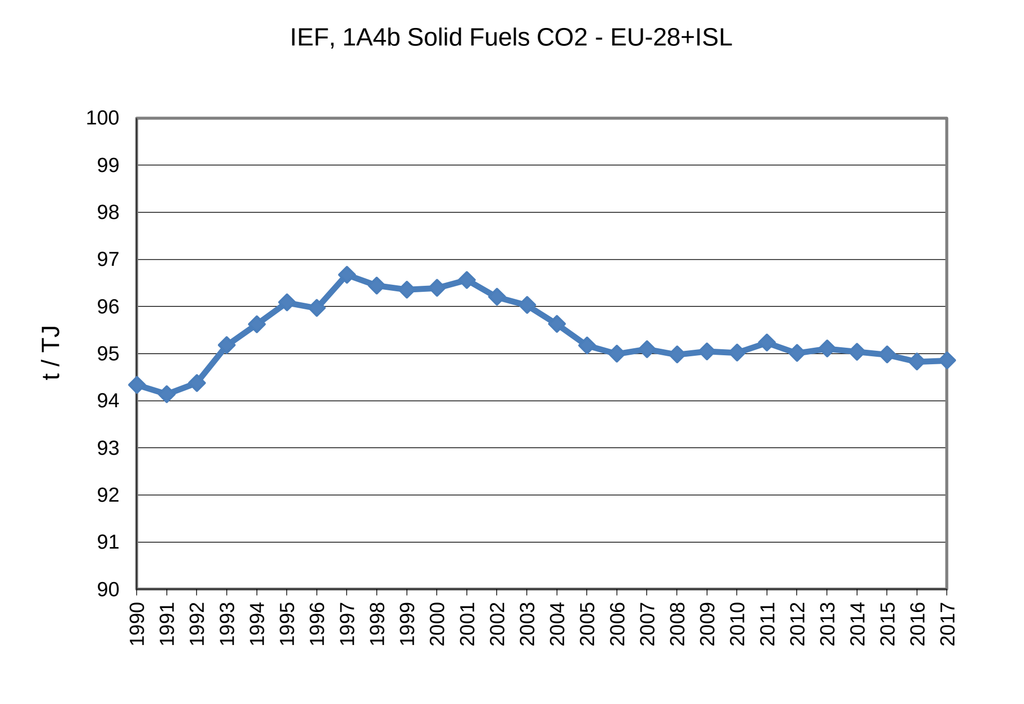
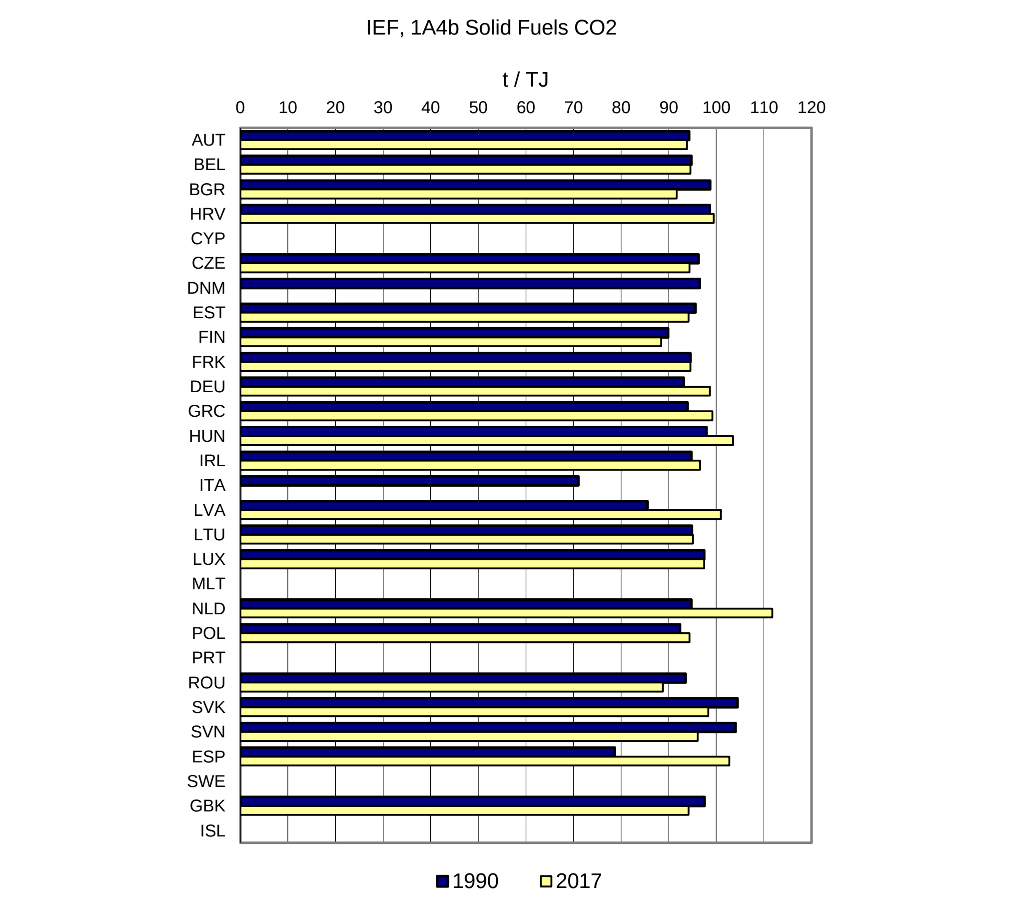


Figure 3.157 1A4b Residential, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A4b Residential – Gaseous Fuels (CO_2)

In 2017, CO_2 from gaseous fuels had a share of 65% within source category 1A4b (compared to 36% in 1990). Between 1990 and 2017, the emissions increased by 36% (Table 3.89). All Member States except Lithuania and the Netherlands reported increasing emissions from the gaseous fuels combustion. The highest absolute increase occurred in Slovenia and Spain. Between 2016 and 2017 EU-28+ISL emissions increased by 1%. According to the methodology as described in chapter 3.2.4 about 68% of EU-28 emissions are calculated by using higher tier methods in 2017.

Table 3.89 1A4b Residential, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	1 847	3 339	3 361	1.3%	1 514	82%	22	1%	T2	CS
Belgium	5 874	8 014	7 845	3.1%	1 971	34%	-168	-2%	T1	D
Bulgaria	NO	137	158	0.1%	158	∞	21	15%	T2	CS
Croatia	456	1 094	1 125	0.4%	670	147%	31	3%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czechia	2 098	4 644	4 665	1.9%	2 567	122%	21	0%	T2	CS
Denmark	988	1 487	1 405	0.6%	417	42%	-82	-6%	T3	CS
Estonia	117	131	124	0.0%	8	6%	-6	-5%	-	-
Finland	25	61	60	0.0%	34	135%	-1	-2%	T2	CS
France	20 368	29 992	29 909	11.9%	9 542	47%	-83	0%	-	-
Germany	31 564	50 887	53 502	21.3%	21 937	70%	2 614	5%	CS	CS
Greece	IE,NO	769	842	0.3%	842	∞	73	9%	T2	CS
Hungary	4 152	6 719	7 106	2.8%	2 955	71%	387	6%	T1	D
Ireland	270	1 316	1 296	0.5%	1 027	381%	-20	-2%	T2	CS
Italy	26 211	41 304	41 698	16.6%	15 487	59%	394	1%	T2	CS
Latvia	221	251	260	0.1%	39	18%	9	4%	T2	CS
Lithuania	509	339	358	0.1%	-152	-30%	18	5%	T2	CS
Luxembourg	170	553	565	0.2%	396	233%	12	2%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	19 896	16 793	16 316	6.5%	-3 580	-18%	-477	-3%	T2	CS
Poland	6 750	8 045	8 408	3.3%	1 658	25%	363	5%	T2	CS
Portugal	NO	578	595	0.2%	595	∞	16	3%	-	-
Romania	5 228	5 339	5 647	2.2%	419	8%	308	6%	T2	CS
Slovakia	1 559	2 493	2 747	1.1%	1 189	76%	255	10%	T2	CS
Slovenia	25	266	276	0.1%	250	998%	9	4%	T2	CS
Spain	918	8 213	8 814	3.5%	7 895	860%	601	7%	T2	CS,D
Sweden	86	79	92	0.0%	6	7%	13	17%	T1	CS
United Kingdom	54 476	57 175	54 529	21.7%	53	0%	-2 647	-5%	T2	CS
EU-28	**183 807**	**250 018**	**251 702**	**100%**	**67 895**	**37%**	**1 684**	**1%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	54 476	57 225	54 579	21.7%	104	0%	-2 646	-5%	T2	CS
EU-28 + ISL	**183 807**	**250 068**	**251 753**	**100%**	**67 946**	**37%**	**1 685**	**1%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.158 show CO_2 emissions for EU-28 and the Member States as well as the share of the Member States with the highest contributions. The largest emissions are reported by the United Kingdom, Germany, Italy and France; together they cause 72% of the CO_2 emissions from gaseous fuels in 1A4b. Fuel consumption in the EU-28+ISL rose 39% between 1990 and 2017. The CO_2 implied emission factor for gaseous fuels was 56.5 t/TJ in 2017.

Figure 3.158 1A4b Residential, gaseous fuels: Emission trend and share for CO_2

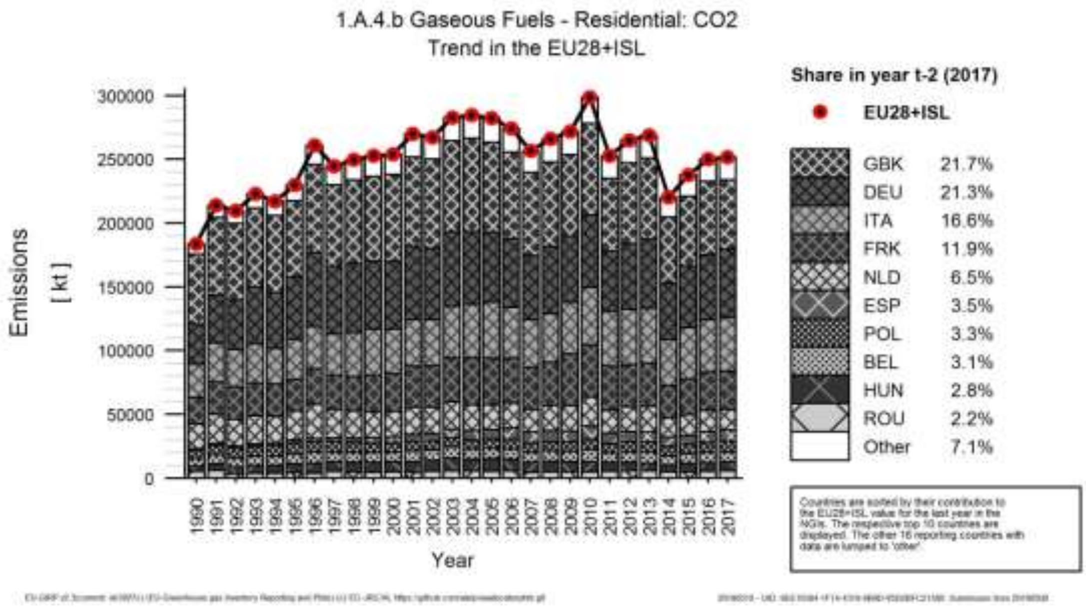
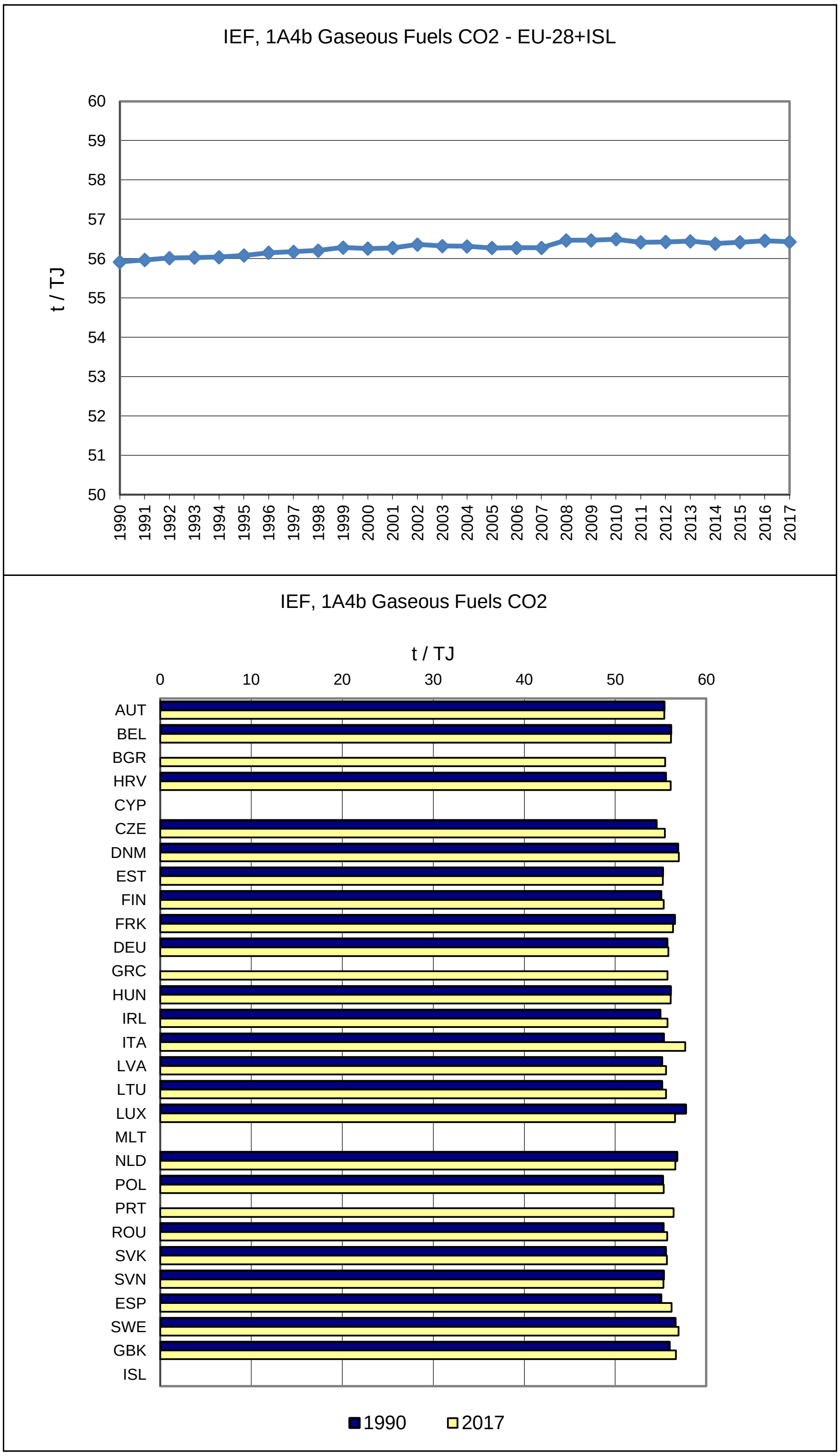


Figure 3.159 1A4b Residential, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



CH_4 emissions from 1A4b Residential

CH_4 emissions mainly occur from incomplete biomass and coal combustion. CH_4 emissions from 1A4b Residential accounted for 57% of total GHG emissions in 1A in 2017. Between 1990 and 2017, CH_4 emissions from households decreased by 26% in the EU-28 (Table 3.90). France, Germany, and

Austria reported the highest decrease in emissions while Italy and Romania reported the highest increase in emissions. Between 2016 and 2017 CH_4 emissions neither increased nor decreased.

Table 3.90 1A4b 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	442	220	223	1.5%	-220	-50%	3	1%	T1,T2,T3	CS,D
Belgium	234	279	261	1.8%	27	11%	-18	-6%	CS,T1,T3	CR,D
Bulgaria	262	286	289	2.0%	27	10%	3	1%	T1	D
Croatia	354	359	347	2.4%	-7	-2%	-11	-3%	T1	D
Cyprus	2	3	4	0.0%	2	88%	0	11%	T1	D
Czechia	1 515	865	897	6.2%	-619	-41%	32	4%	T1	D
Denmark	122	110	106	0.7%	-17	-14%	-4	-4%	M,T1,T2,T3	CS,D,OTH
Estonia	95	122	124	0.9%	29	31%	2	2%	T1	D
Finland	198	167	163	1.1%	-35	-18%	-4	-2%	T1,T2,T3	CR,CS,D
France	4 665	1 316	1 255	8.6%	-3 410	-73%	-61	-5%	T1,T2	CS,D
Germany	2 484	802	777	5.3%	-1 707	-69%	-25	-3%	T2,T3	CS,M
Greece	94	96	108	0.7%	14	15%	11	12%	T1	D
Hungary	829	594	572	3.9%	-257	-31%	-22	-4%	T1	D
Ireland	443	141	127	0.9%	-315	-71%	-14	-10%	T1	D
Italy	1 095	2 122	2 317	15.9%	1 222	112%	194	9%	T2	CR
Latvia	149	86	95	0.7%	-53	-36%	9	11%	T1,T2	CS,D
Lithuania	175	149	147	1.0%	-28	-16%	-1	-1%	T1,T2	CS,D
Luxembourg	9	11	11	0.1%	2	25%	0	2%	T1,T3	D,M
Malta	1	1	1	0.0%	0	61%	0	12%	T1	D
Netherlands	457	446	440	3.0%	-17	-4%	-6	-1%	T1,T2	CS,D
Poland	2 445	2 926	2 885	19.8%	439	18%	-41	-1%	T1	D
Portugal	410	243	243	1.7%	-167	-41%	0	0%	-	D
Romania	307	965	983	6.8%	676	220%	18	2%	T1	D
Slovakia	378	215	199	1.4%	-179	-47%	-15	-7%	T1	D
Slovenia	128	154	145	1.0%	17	14%	-8	-5%	T1	D
Spain	794	862	863	5.9%	69	9%	1	0%	T2	D
Sweden	103	64	63	0.4%	-41	-39%	-1	-2%	M,T1	CS
United Kingdom	1 488	921	911	6.3%	-577	-39%	-10	-1%	T1,T2,T3	CS,D
EU-28	**19 679**	**14 526**	**14 556**	**100%**	**-5 123**	**-26%**	**31**	**0%**	**-**	**-**
Iceland	0	0	0	0.0%	0	-67%	0	107%	T1,T2	D
United Kingdom (KP)	1 491	922	912	6.3%	-579	-39%	-10	-1%	T1,T2,T3	CS,D
EU-28 + ISL	**19 682**	**14 527**	**14 558**	**100%**	**-5 124**	**-26%**	**31**	**0%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1A4b Residential – Biomass (CH_4)

In 2017 CH_4 from biomass had a share of 1.6% within source category on the total emissions from 1A4b (compared to 1.7% in 1990). Between 1990 and 2017 CH_4 emissions increased by 15% (Table 3.91). France reported the highest absolute decrease, while CH_4 emissions of United Kingdom increased significantly. Between 2016 and 2017, CH_4 emissions increased by 1%. According to the methodology as described in chapter 3.2.4 about 29% of EU-28 emissions are calculated by using higher tier methods in 2017.

Table 3.91 1A4b Residential, biomass: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	228	203	205	1.9%	-23	-10%	2	1%	T1,T2	CS,D
Belgium	98	249	231	2.2%	133	136%	-17	-7%	T1	D
Bulgaria	54	238	239	2.2%	184	340%	0	0%	T1	D
Croatia	316	354	343	3.2%	26	8%	-12	-3%	T1	D
Cyprus	1	2	2	0.0%	1	145%	0	16%	-	-
Czechia	324	560	571	5.4%	246	76%	11	2%	T1	D
Denmark	113	108	104	1.0%	-10	-9%	-4	-4%	T1,T3	CS,D
Estonia	40	121	123	1.2%	83	206%	2	2%	-	-
Finland	181	158	155	1.5%	-27	-15%	-3	-2%	T2	CS
France	4 252	1 138	1 071	10.1%	-3 181	-75%	-67	-6%	-	-
Germany	280	592	566	5.3%	287	102%	-26	-4%	T2	CS
Greece	85	94	105	1.0%	20	23%	11	12%	T1	D
Hungary	186	540	510	4.8%	323	174%	-30	-6%	T1	D
Ireland	14	10	9	0.1%	-6	-39%	-2	-15%	T1	D
Italy	996	2 068	2 263	21.3%	1 267	127%	196	9%	T2	CR
Latvia	96	81	91	0.9%	-6	-6%	10	12%	T2	CS
Lithuania	58	132	128	1.2%	69	119%	-4	-3%	T2	CS
Luxembourg	5	8	8	0.1%	3	70%	0	4%	T1	D
Malta	1	1	1	0.0%	0	52%	0	13%	T1	D
Netherlands	98	142	145	1.4%	47	48%	3	2%	T1	D
Poland	258	836	823	7.7%	565	220%	-13	-2%	T1	D
Portugal	407	241	241	2.3%	-166	-41%	0	0%	-	-
Romania	181	934	958	9.0%	777	430%	24	3%	T1	D
Slovakia	36	190	170	1.6%	134	374%	-20	-11%	T1	D
Slovenia	102	152	144	1.3%	42	41%	-8	-5%	T1	D
Spain	651	792	793	7.4%	142	22%	1	0%	T2	D
Sweden	96	60	59	0.6%	-37	-39%	-1	-2%	T1	CS
United Kingdom	62	594	593	5.6%	531	859%	-2	0%	T1	D
EU-28	**9 220**	**10 596**	**10 649**	**100%**	**1 429**	**15%**	**53**	**1%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	62	594	593	5.6%	531	859%	-2	0%	T1	D
EU-28 + ISL	**9 220**	**10 596**	**10 649**	**100%**	**1 429**	**15%**	**53**	**1%**		

Abbreviations explained in the Chapter 'Units and abbreviation'.

Figure 3.160 and

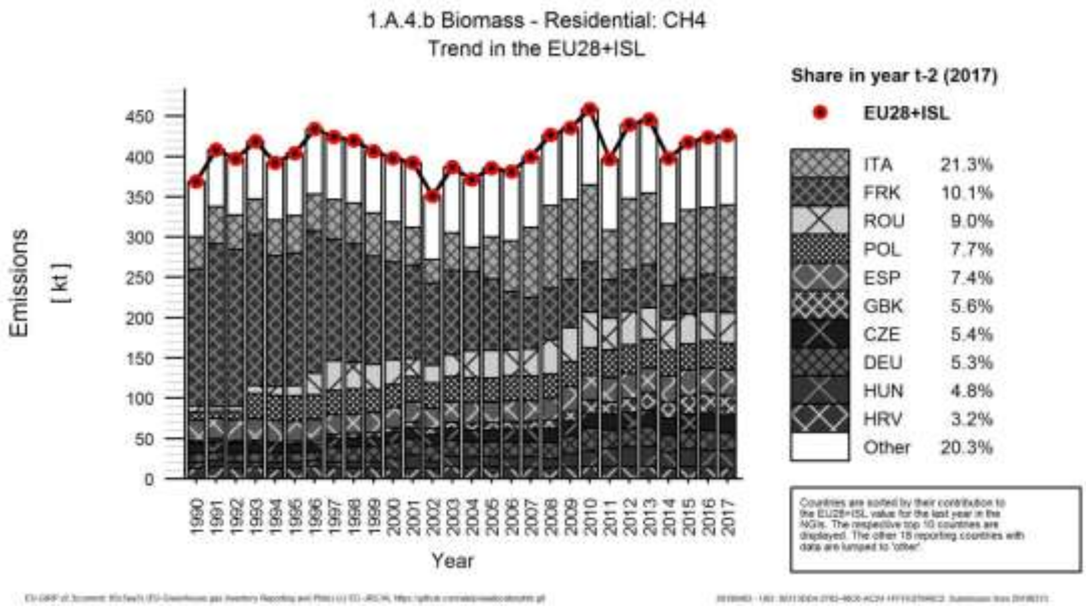


Figure 3.161 show CH_4 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Italy, France and Romania; together they cause 40% of the CH_4 emissions from biomass fuels in 1A4b.

Biomass fuel consumption in the EU-28 rose by 65% between 1990 and 2017. The CH_4 implied emission factor for biomass fuels was 230.1 kg/TJ in 2017.

The implied emission factors are decreasing because old biomass boilers and stoves 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 3.160 1A4b Residential, biomass: Emission trend and share for CH_4

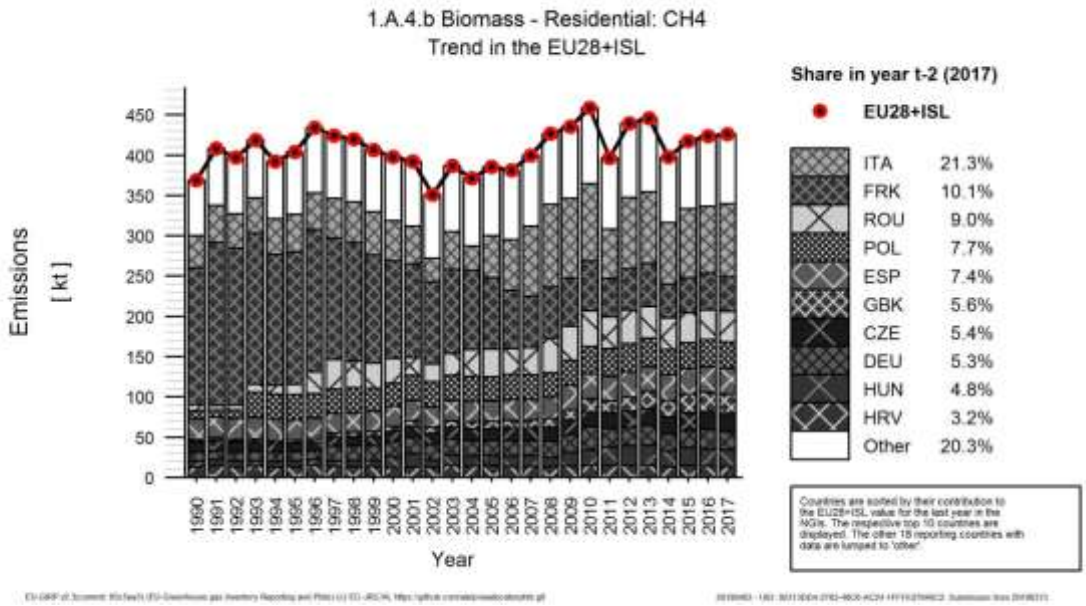
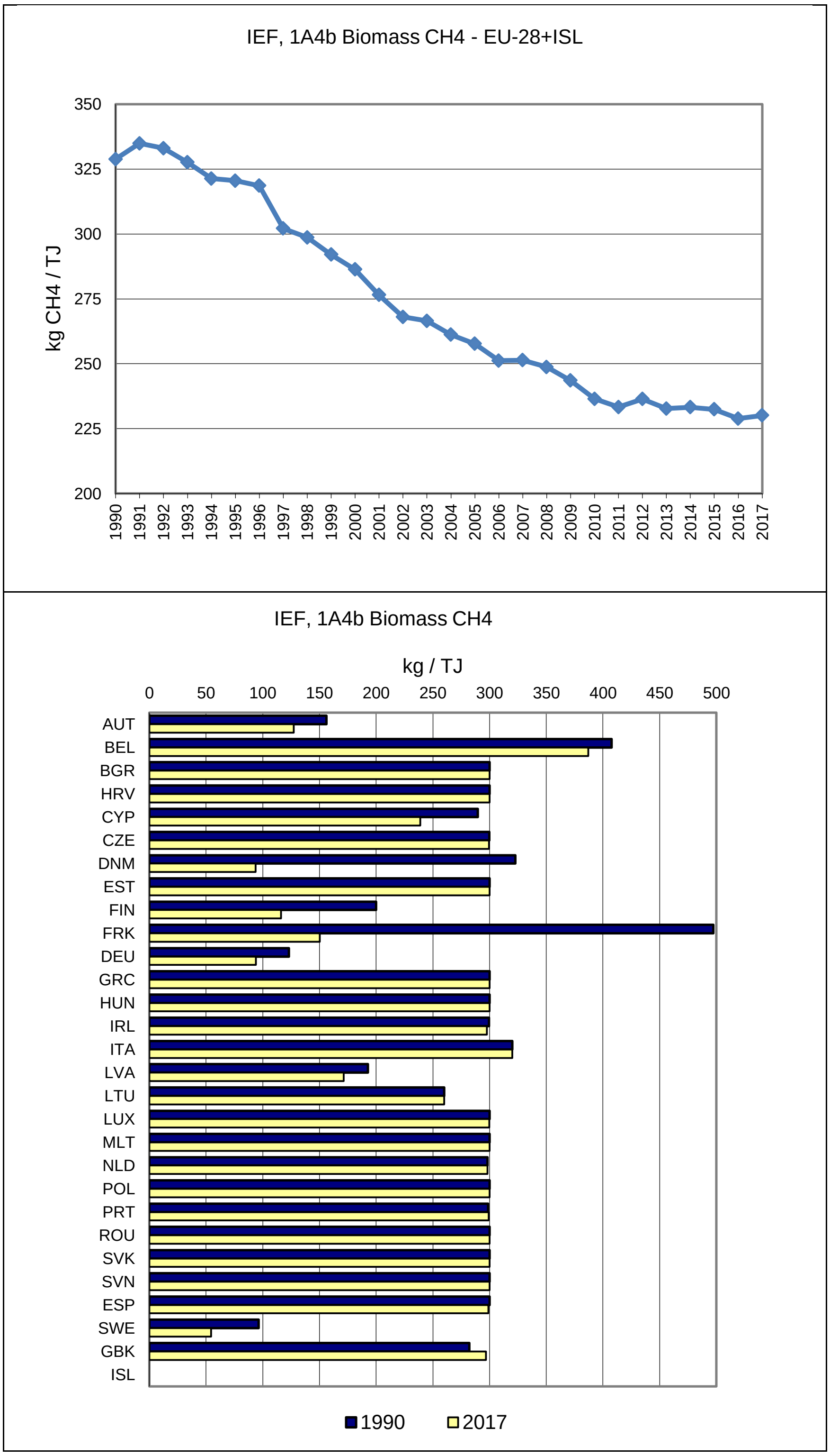


Figure 3.161 1A4b Residential, biomass: Implied Emission Factors for CH_4 (in kg/TJ)



1A4b Residential – Solid Fuels (CH_4)

In 2017 CH_4 from solid fuels had a share of 0.5% within source category 1A4b (compared to 1.7% in 1990). Between 1990 and 2017 CH_4 emissions decreased by 68% (Table 3.91). All Member States reported decreasing emissions since 1990 with Germany, Croatia, Austria and Estonia showing the largest absolute decreases. Between 2016 and 2017 CH_4 emissions neither increased nor decreased.

According to the methodology as described in chapter 3.2.4 about 15% of EU-28 emissions are calculated by using higher tier methods in 2017.

Table 3.92: 1A4b Residential, solid fuels: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	200	6	6	0.2%	-194	-97%	0	1%	T1	D
Belgium	110	9	9	0.3%	-101	-92%	0	-1%	T1	D
Bulgaria	207	47	50	1.7%	-158	-76%	3	5%	T1	D
Croatia	33	1	1	0.0%	-32	-97%	0	23%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czechia	1 186	294	315	10.7%	-871	-73%	21	7%	T1	D
Denmark	6	0	NO	-	-6	-100%	0	-100%	NA	NA
Estonia	26	1	1	0.0%	-26	-97%	0	25%	-	-
Finland	3	0	0	0.0%	-3	-98%	0	-10%	T1	D
France	260	54	59	2.0%	-202	-77%	4	8%	-	-
Germany	2 168	132	130	4.4%	-2 039	-94%	-2	-2%	T2	CS
Greece	7	1	1	0.0%	-6	-80%	0	1%	T1	D
Hungary	621	38	44	1.5%	-576	-93%	7	17%	T1	D
Ireland	197	56	47	1.6%	-150	-76%	-9	-17%	T1	D
Italy	10	NO	NO	-	-10	-100%	-	-	NA	NA
Latvia	48	4	3	0.1%	-45	-94%	-1	-18%	T1	D
Lithuania	114	11	13	0.4%	-101	-88%	2	15%	T1	D
Luxembourg	2	0	0	0.0%	-2	-94%	0	-35%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	0	0	0	0.0%	0	-40%	0	6%	T2	CS
Poland	2 172	2 069	2 039	69.0%	-133	-6%	-30	-1%	T1	D
Portugal	NO	NO	NO	-	-	-	-	-	-	-
Romania	112	18	11	0.4%	-101	-90%	-7	-39%	T1	D
Slovakia	339	19	23	0.8%	-316	-93%	4	24%	T1	D
Slovenia	25	0	0	0.0%	-25	-100%	0	-33%	T1	D
Spain	116	28	28	1.0%	-87	-75%	0	0%	T2	D
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	1 249	175	173	5.9%	-1 076	-86%	-2	-1%	T1,T2	CS,D
EU-28	**9 210**	**2 963**	**2 953**	**100%**	**-6 257**	**-68%**	**-9**	**0%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	1 252	175	173	5.9%	-1 079	-86%	-2	-1%	T1,T2	CS,D
EU-28 + ISL	**9 212**	**2 963**	**2 953**	**100%**	**-6 259**	**-68%**	**-9**	**0%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.160 and Table 3.93 show CH_4 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Poland with a share of 69% of total CH_4 emissions from solid fuels in 1A4b. Solid fuel consumption in the EU-28 decreased by 73% between 1990 and 2017. The CH_4 implied emission factor for solid fuels was 293.8 kg/TJ in 2017.

Figure 3.162: 1A4b Residential, solid fuels: Emission trend and share for CH_4

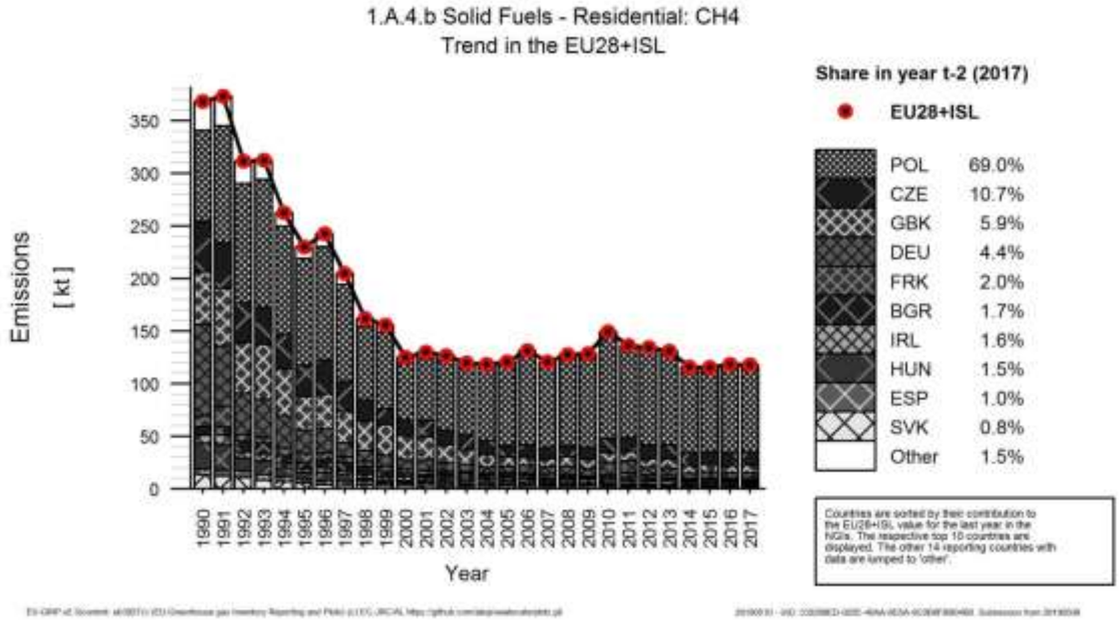
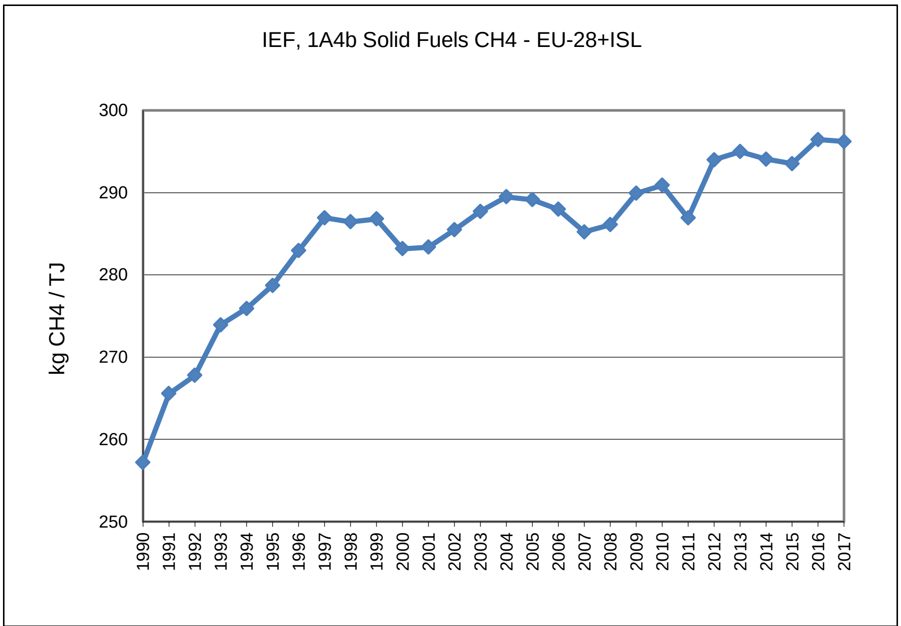
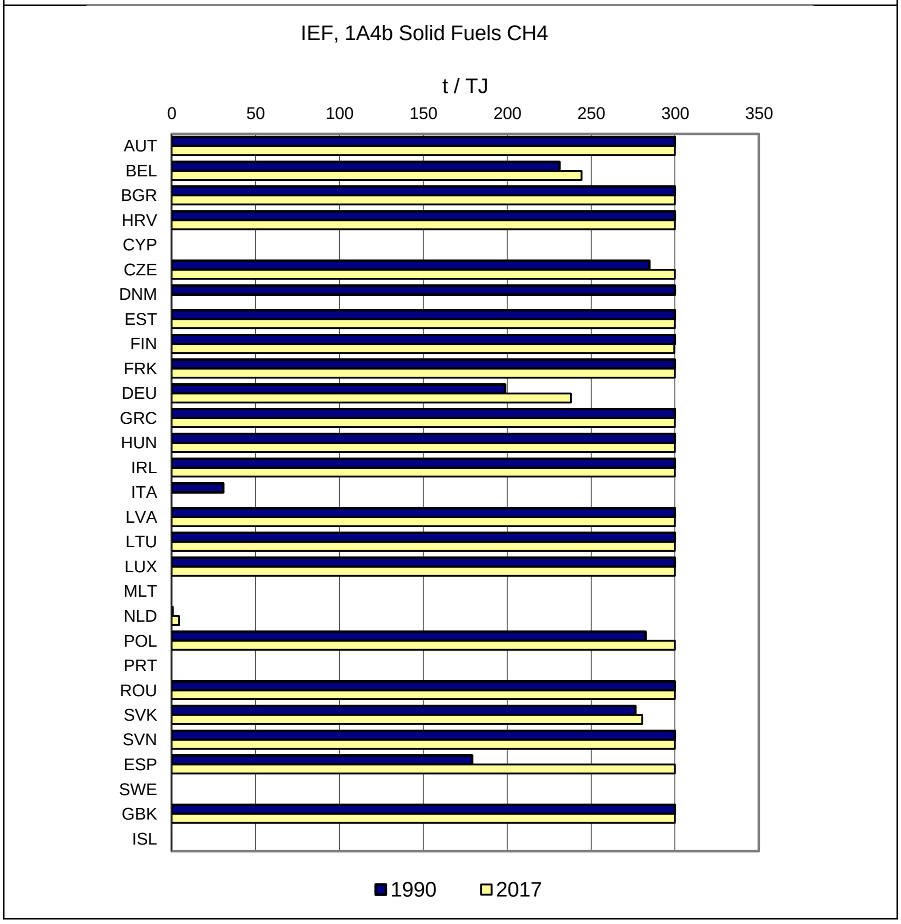


Table 3.93: 1A4b Residential, solid fuels: Implied Emission Factors for CH_4 (in kg/TJ)



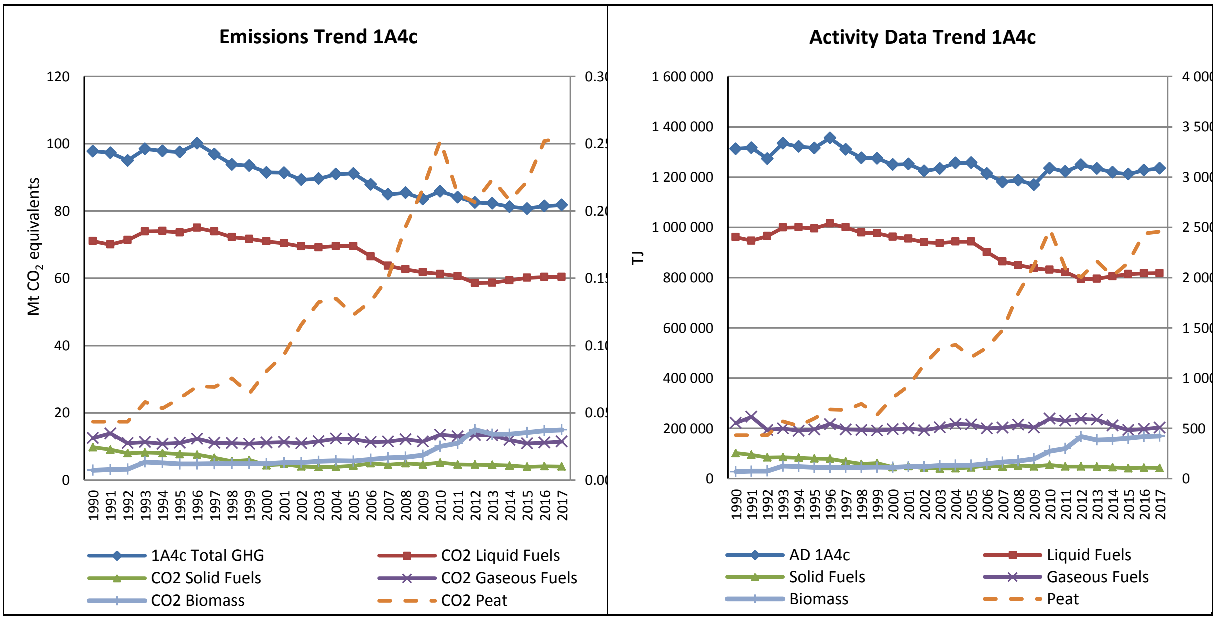


3.2.4.3 Agriculture/Forestry/Fisheries (1A4c)

In this chapter information about emission trends, Member States' contribution and activity data is provided for category 1A4c by fuels. CO_2 emissions from 1A4c Agriculture/Forestry/Fisheries accounted for 2.4% of total EU-28+ISL GHG emissions in 1A Fuel Combustion in 2017. Between 1990 and 2017, CO_2 emissions from 1A4c Agriculture/Forestry/Fisheries decreased by 20% in the EU-28+ISL (Table 3.94).

Figure 3.163 shows the emission trend within source category 1A4c, which is mainly dominated by CO_2 emissions from liquid fuels. Total GHG emissions decreased by 18%, mainly due to decreases in CO_2 emissions from liquid fuels (-17%).

Figure 3.163 1A4c Agriculture/Forestry/Fisheries: Total and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

The five Member States, France, Poland, Italy, the Netherlands and Spain together contributed 64% to the emissions from this source in 2017. Spain and Poland were the Member States with the highest increase in absolute terms between 1990 and 2017, while the highest decreases were achieved in the Czech Republic, Germany and Greece.

Table 3.94 1A4c 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	1 252	891	836	1.1%	-416	-33%	-55	-6%	IO,T1,T2,T3	CS,D,NO
Belgium	3 033	2 091	2 110	2.8%	-924	-30%	19	1%	CS,T1,T3	D
Bulgaria	1 649	429	433	0.6%	-1 216	-74%	4	1%	T1,T2	CS,D
Croatia	835	638	629	0.8%	-206	-25%	-9	-1%	T1	D
Cyprus	55	79	84	0.1%	29	51%	5	6%	T1	D
Czechia	3 672	1 217	1 211	1.6%	-2 461	-67%	-6	-1%	T1,T2	CS,D
Denmark	2 595	1 575	1 497	2.0%	-1 099	-42%	-78	-5%	M,T1,T2,T3	CS,D
Estonia	495	272	234	0.3%	-262	-53%	-38	-14%	T1,T2	CS,D
Finland	1 863	1 411	1 370	1.8%	-493	-26%	-41	-3%	T1,T2,T3	CS,D
France	11 353	10 976	9 720	12.8%	-1 633	-14%	-1 256	-11%	T1,T2	CS,D
Germany	10 270	6 107	6 356	8.3%	-3 914	-38%	250	4%	CS,T1,T2,T3	CS,D
Greece	2 893	431	458	0.6%	-2 435	-84%	27	6%	T1,T2	CS,D,NO
Hungary	2 655	1 490	1 385	1.8%	-1 270	-48%	-105	-7%	T1,T2	CS,D
Ireland	747	548	576	0.8%	-171	-23%	29	5%	T1,T2	CS,D
Italy	8 352	7 008	7 029	9.2%	-1 322	-16%	21	0%	T2	CS
Latvia	1 579	415	438	0.6%	-1 140	-72%	24	6%	T1,T2	CS,D
Lithuania	1 483	204	210	0.3%	-1 273	-86%	7	3%	T2	CS
Luxembourg	34	23	23	0.0%	-11	-34%	0	-1%	T1,T2	CS,D
Malta	4	12	12	0.0%	8	213%	1	6%	T1	D
Netherlands	9 846	8 968	8 967	11.8%	-880	-9%	-2	0%	T1,T2	CS,D
Poland	8 507	9 875	10 882	14.3%	2 375	28%	1 007	10%	T1,T2	CS,D
Portugal	1 679	1 070	1 094	1.4%	-585	-35%	24	2%	T1	D
Romania	1 994	1 132	1 242	1.6%	-752	-38%	110	10%	T1,T2	CS,D
Slovakia	146	417	387	0.5%	241	164%	-30	-7%	T1,T2	CS,D
Slovenia	334	217	217	0.3%	-117	-35%	0	0%	T1	D
Spain	8 678	11 394	11 654	15.3%	2 976	34%	260	2%	T1,T2,T3	S,D,M,OTH
Sweden	1 761	1 331	1 316	1.7%	-445	-25%	-15	-1%	T1,T2	CS
United Kingdom	5 978	4 835	4 868	6.4%	-1 109	-19%	34	1%	T1,T2,T3	CS,D
EU-28	**93 745**	**75 052**	**75 238**	**99%**	**-18 507**	**-20%**	**186**	**0%**	**-**	**-**
Iceland	738	516	528	0.7%	-211	-29%	11	2%	T1	D
United Kingdom (KP)	6 229	5 141	5 229	6.9%	-1 000	-16%	87	2%	T1,T2,T3	CS,D
EU-28 + ISL	**94 735**	**75 875**	**76 126**	**100%**	**-18 609**	**-20%**	**251**	**0%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1A4c Agriculture/Forestry/Fisheries – Liquid Fuels (CO_2)

In 2017 CO_2 from liquid fuels had a share of 79% within source category 1A4c (compared to 76% in 1990). Between 1990 and 2017 CO_2 decreased by 17% (Table 3.95Seven Member States reported increasing emissions with the highest increases in absolute terms in Romania. Between 2016 and 2017 EU-28+ISL emissions neither increased nor decreased. According to the methodology as described in chapter 3.2.4 54% of EU-28 emissions are calculated by using higher tier methods in 2017.

Table 3.95 1A4c Agriculture/Forestry/Fisheries, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	1 181	852	782	1.3%	-399	-34%	-70	-8%	T2	CS
Belgium	2 754	1 098	1 031	1.7%	-1 723	-63%	-67	-6%	T1	D
Bulgaria	1 498	364	359	0.6%	-1 139	-76%	-5	-1%	T1	D
Croatia	788	584	582	1.0%	-205	-26%	-1	0%	T1	D
Cyprus	55	79	84	0.1%	29	51%	5	6%	T1	D
Czechia	1 536	1 041	1 033	1.7%	-503	-33%	-8	-1%	T1	CS,D
Denmark	2 230	1 408	1 343	2.2%	-887	-40%	-65	-5%	T1,T2	CS,D
Estonia	476	256	228	0.4%	-247	-52%	-28	-11%	T1,T2	CS,D
Finland	1 778	1 191	1 160	1.9%	-617	-35%	-31	-3%	T1	CS
France	11 031	10 484	9 228	15.3%	-1 803	-16%	-1 256	-12%	T1,T2	CS,D
Germany	6 926	5 426	5 577	9.2%	-1 350	-19%	151	3%	CS	CS
Greece	2 882	429	455	0.8%	-2 427	-84%	26	6%	T2	CS
Hungary	2 085	1 141	1 096	1.8%	-989	-47%	-45	-4%	T1	D
Ireland	747	548	576	1.0%	-171	-23%	29	5%	T1,T2	CS,D
Italy	8 300	6 694	6 701	11.1%	-1 599	-19%	7	0%	T2	CS
Latvia	701	365	403	0.7%	-297	-42%	38	10%	T2	CS
Lithuania	1 173	143	149	0.2%	-1 024	-87%	6	4%	T2	CS
Luxembourg	34	23	23	0.0%	-12	-34%	0	-1%	NA	NA
Malta	4	12	12	0.0%	8	213%	1	6%	T1	D
Netherlands	2 517	1 841	1 751	2.9%	-766	-30%	-90	-5%	T1,T2	CS,D
Poland	4 709	5 928	6 997	11.6%	2 287	49%	1 068	18%	T1	D
Portugal	1 679	1 046	1 069	1.8%	-610	-36%	23	2%	T1	D
Romania	9	930	943	1.6%	933	9970%	13	1%	T1,T2	CS,D
Slovakia	104	328	313	0.5%	209	200%	-15	-5%	T2	CS
Slovenia	334	217	217	0.4%	-117	-35%	0	0%	NA	NA
Spain	8 635	11 196	11 475	19.0%	2 840	33%	279	2%	T2,T3	D
Sweden	1 572	1 311	1 302	2.2%	-270	-17%	-9	-1%	T1	CS
United Kingdom	5 747	4 624	4 634	7.7%	-1 113	-19%	9	0%	T2	CS
EU-28	**71 484**	**59 560**	**59 524**	**99%**	**-11 961**	**-17%**	**-36**	**0%**		
Iceland	738	516	528	0.9%	-211	-29%	11	2%	NA	NA
United Kingdom	5 998	4 931	4 994	8.3%	-1 004	-17%	63	1%	T2	CS
EU-28 + ISL	**72 474**	**60 383**	**60 411**	**100%**	**-12 062**	**-17%**	**29**	**0%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.164 and Figure 3.165 1A4c Agriculture/Forestry/Fisheries, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ) show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Spain and France; together they cause 34% of the CO_2 emissions from liquid fuels in 1A4c. Fuel consumption in the EU-28+ISL decreased by 18% between 1990 and 2017. The CO_2 implied emission factor for liquid fuels was 73.8 t/TJ in 2017.

Figure 3.164 1A4c Agriculture/Forestry/Fisheries, liquid fuels: Emission trend and share for CO_2

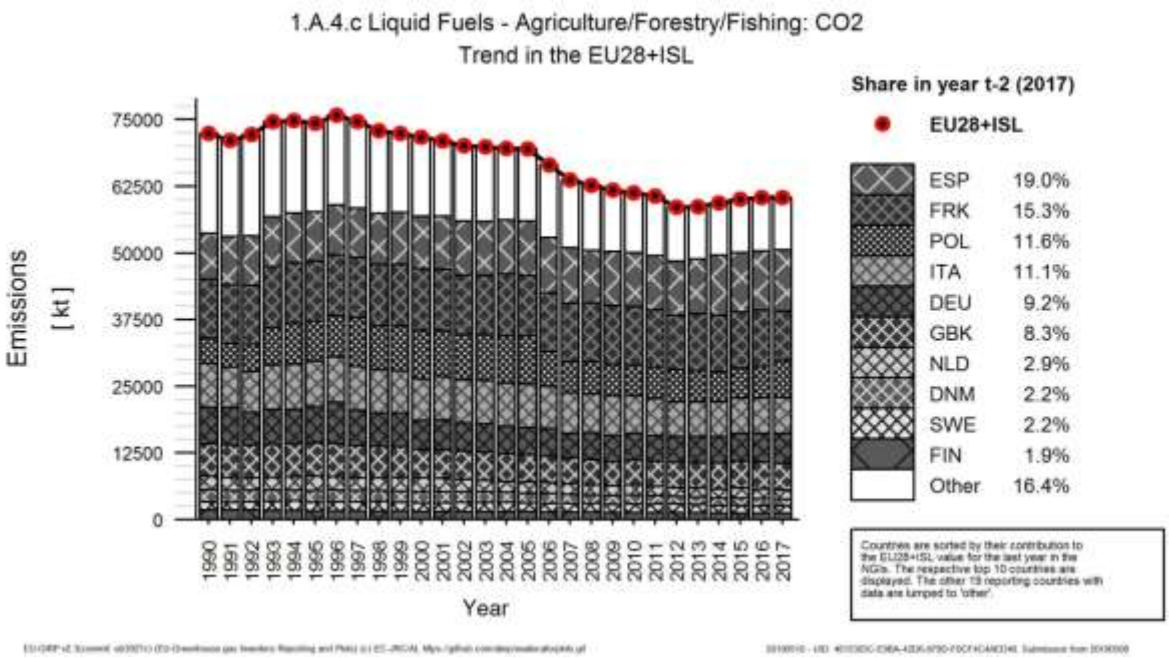
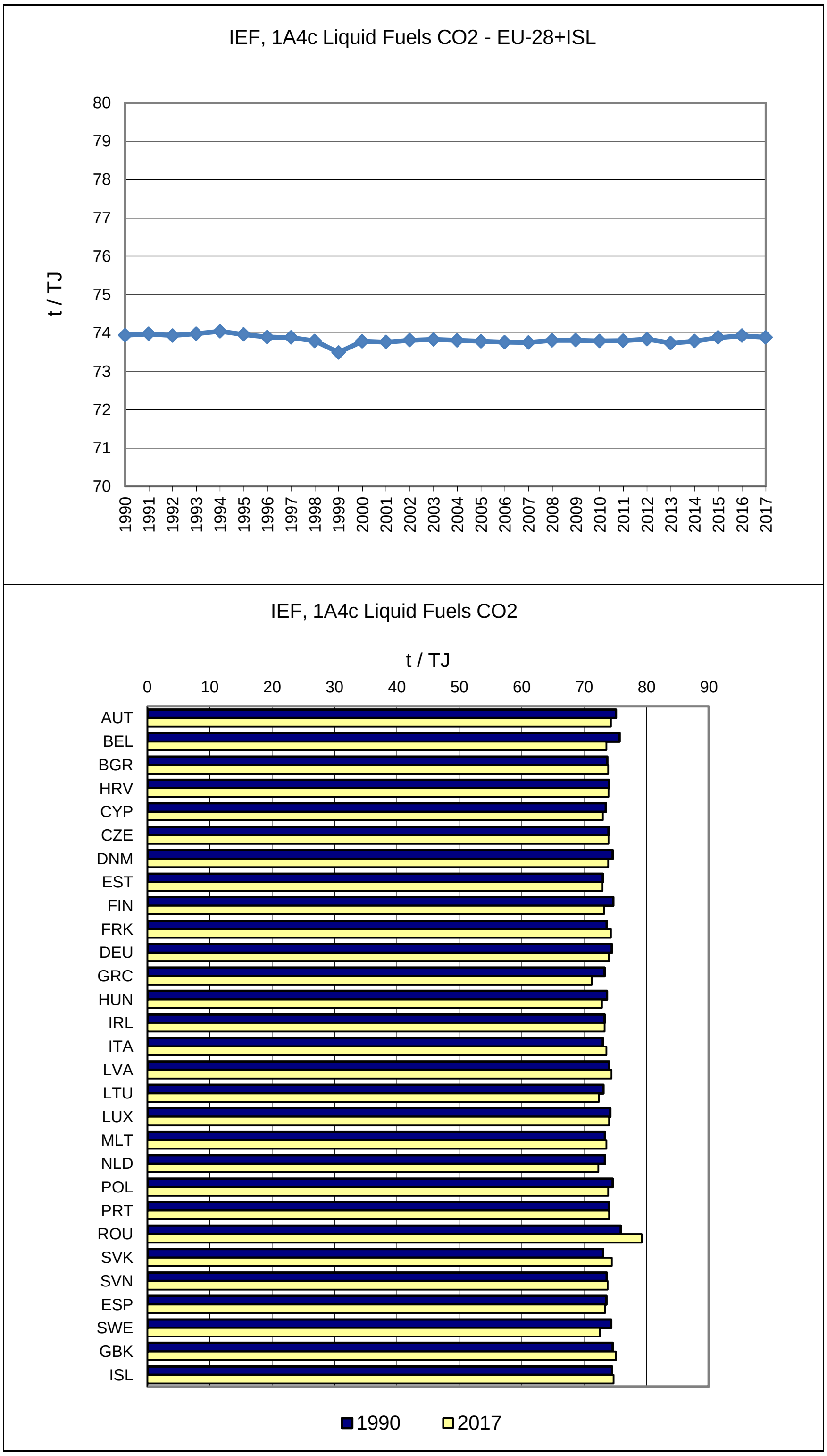


Figure 3.165 1A4c Agriculture/Forestry/Fisheries, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



Different IEF for Romania is caused by the specific methodology of the MS. Default emission factors for the fuels which are not reported under EU-ETS, are used. For the fuels reported in this activity category having determined Country Specific Emission Factors on EU-ETS analysis, Tier 2 methodology is used. The activity data are provided on Romanian Energy Balance sent by NIS to IEA/ EUROSTAT. The NCVs used are those provided in correspondence with this activity in the Energy

Balance, and for the concerned fuels, the national weighted averages values derived from the EU-ETS reports, are used

1A4c Agriculture/Forestry/Fisheries – Solid Fuels (CO_2)

In 2017 CO_2 from solid fuels had a share of 5% within source category 1A4c (compared to 10% in 1990). Between 1990 and 2017 CO_2 decreased by 59% (Table 3.96). Fourteen member states and Iceland reported CO_2 emissions from this source category as 'Not occurring' in 2017. All Member States except for Slovakia and Poland reported decreasing emissions between 1990 and 2017. Between 2016 and 2017 EU-28+ISL emissions decreased by 2%, mainly due to decrease reported by Latvia. The strong decrease in 1990 to 1992 emissions is due to the reporting of Germany. According to the methodology as described in chapter 3.2.4 42% of EU-28 emissions are calculated by using higher tier methods in 2017.

Table 3.96 1A4c Agriculture/Forestry/Fisheries, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	51	2	2	0.0%	-49	-97%	0	1%	T2	CS
Belgium	212	63	63	1.6%	-149	-70%	0	0%	T1	D
Bulgaria	151	31	39	1.0%	-112	-74%	8	25%	T1,T2	CS,D
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 730	33	26	0.6%	-1 705	-99%	-8	-23%	T2	CS,D
Denmark	238	55	38	1.0%	-200	-84%	-16	-30%	T1	D
Estonia	16	12	3	0.1%	-13	-78%	-8	-70%	T1,T2	CS,D
Finland	13	8	7	0.2%	-6	-48%	-2	-19%	T3	CS
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	2 861	13	13	0.3%	-2 848	-100%	0	-1%	CS	CS
Greece	11	2	3	0.1%	-8	-69%	1	71%	T2	CS
Hungary	134	2	1	0.0%	-133	-99%	0	-23%	T1,T2	CS,D
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	92	1	0	0.0%	-92	-100%	-1	-89%	T2	CS
Lithuania	148	9	9	0.2%	-139	-94%	0	-4%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	3 773	3 874	3 801	94.9%	28	1%	-73	-2%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	65	NO	0	0.0%	-64	-100%	0	∞	NA	NA
Slovakia	1	3	2	0.1%	1	61%	0	-14%	T2	CS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	37	NO	NO	-	-37	-100%	-	-	NA	NA
Sweden	157	NO	NO	-	-157	-100%	-	-	NA	NA
United Kingdom	50	NO	NO	-	-50	-100%	-	-	NA	NA
EU-28	**9 741**	**4 107**	**4 008**	**100%**	**-5 733**	**-59%**	**-100**	**-2%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	50	NO	NO	-	-50	-100%	-	-	NA	NA
EU-28 + ISL	**9 741**	**4 107**	**4 008**	**100%**	**-5 733**	**-59%**	**-100**	**-2%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.166 and

Figure **3.167** show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. Poland contributes to 95% of emissions in 2017.

Fuel consumption in the EU-28+ISL decreased by 59% between 1990 and 2017. The CO_2 implied emission factor for solid fuels was 94.6 t/TJ in 2017.

Figure 3.166 1A4c Agriculture/Forestry/Fisheries, solid fuels: Emission trend and share for CO_2

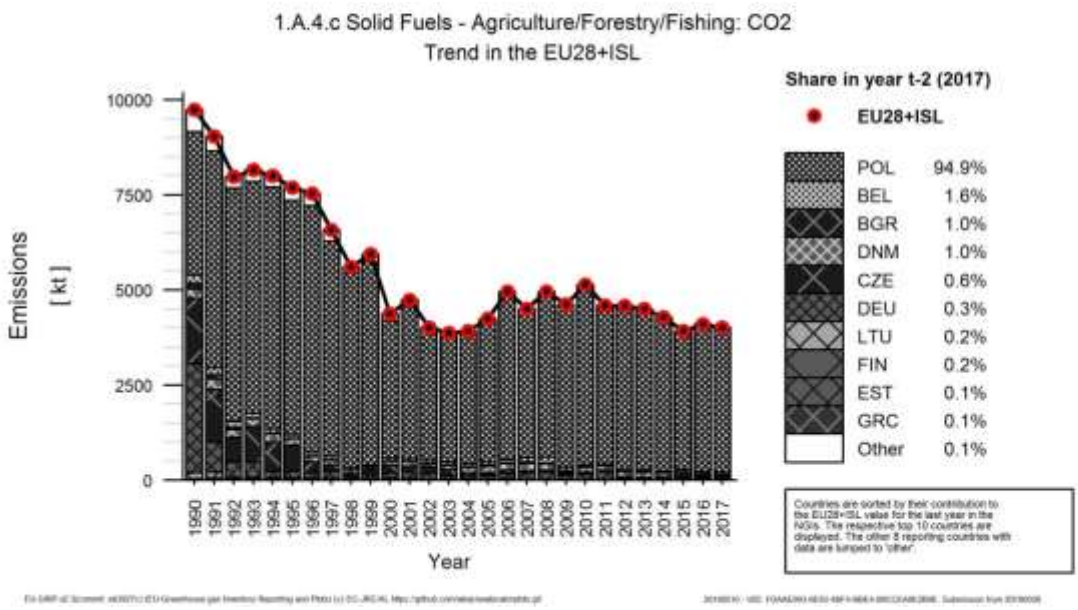
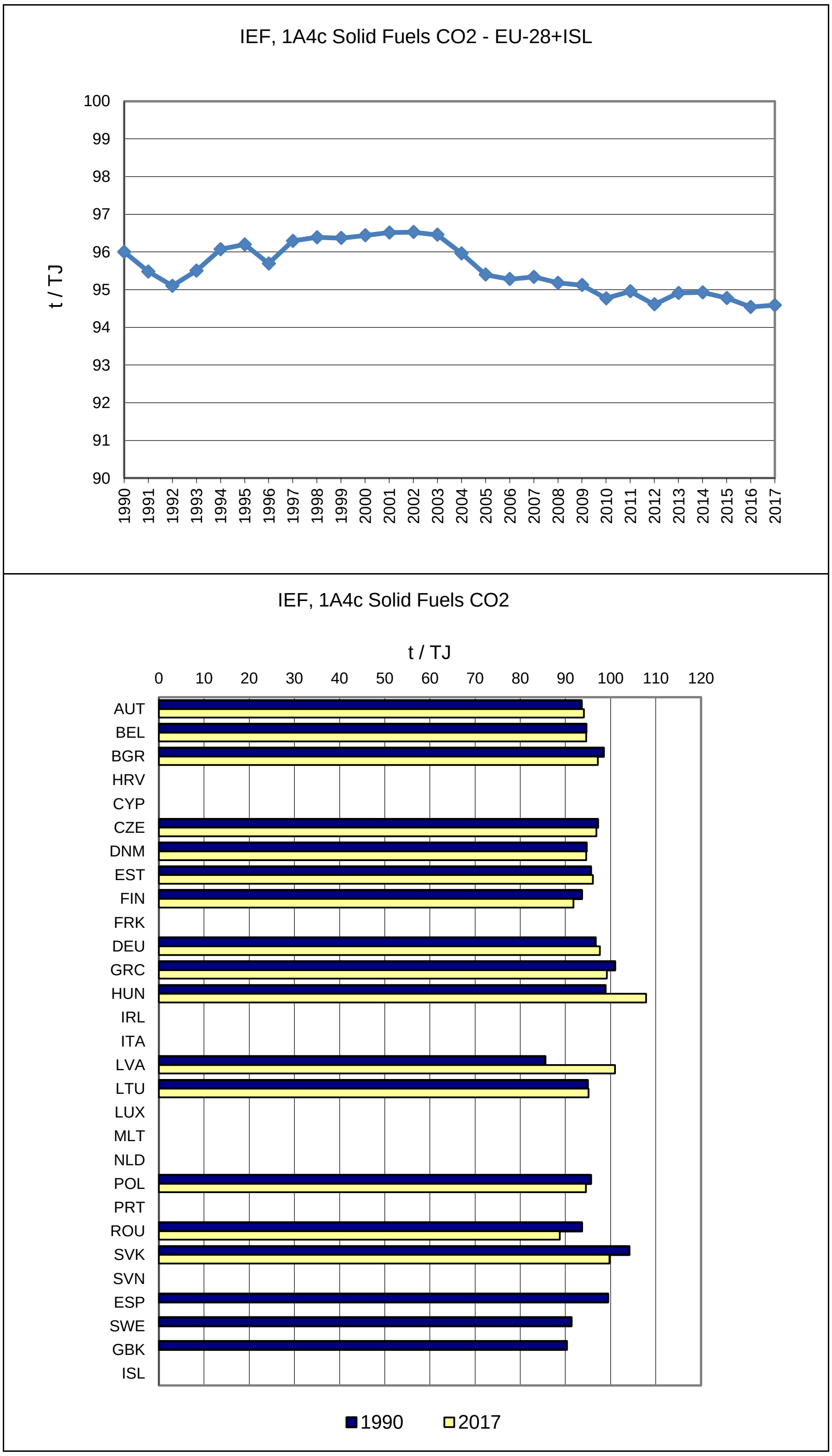


Figure 3.167 1A4c Agriculture/Forestry/Fisheries, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1A4c Agriculture/Forestry/Fisheries –Gaseous Fuels (CO_2)

In 2017, CO_2 from gaseous fuels had a share of 15% within source category 1A4c (compared to 13% in 1990). Between 1990 and 2017 CO_2 emissions decreased by 8% (Table 3.97). The highest increase occurred in Bulgaria (+17597%). Between 2016 and 2017 EU-28+ISL emissions increased by 3%. This source of emissions is dominated by the Netherlands were natural gas is used for greenhouse horticulture. According to the methodology as described in chapter 3.2.4 about 68% of EU-28 emissions are calculated by using higher tier methods in 2017.

Table 3.97 1A4c Agriculture/Forestry/Fisheries, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	20	34	49	0.4%	29	144%	15	44%	T2	CS
Belgium	67	930	1 016	8.9%	948	1407%	86	9%	T1	D
Bulgaria	0	34	35	0.3%	35	17597%	1	4%	T2	CS
Croatia	48	54	47	0.4%	-1	-2%	-8	-14%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	405	143	152	1.3%	-253	-62%	10	7%	T2	CS
Denmark	126	112	115	1.0%	-11	-9%	3	3%	T3	CS
Estonia	4	4	2	0.0%	-2	-49%	-3	-58%	T2	CS
Finland	32	2	2	0.0%	-30	-93%	0	0%	T2	CS
France	322	492	492	4.3%	170	53%	0	0%	T1,T2	CS,D
Germany	483	668	767	6.7%	284	59%	99	15%	CS	CS
Greece	IE,NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Hungary	437	347	288	2.5%	-149	-34%	-59	-17%	T1	D
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	52	314	328	2.9%	277	537%	15	5%	T2	CS
Latvia	782	48	35	0.3%	-748	-96%	-13	-28%	T2	CS
Lithuania	162	50	51	0.4%	-112	-69%	1	1%	T2	CS
Luxembourg	NO	0	0	0.0%	0	∞	0	-4%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	7 329	7 127	7 215	63.0%	-114	-2%	88	1%	T1,T2	CS,D
Poland	25	72	84	0.7%	59	240%	12	16%	T2	CS
Portugal	NO	24	25	0.2%	25	∞	1	4%	T1	D
Romania	1 920	160	247	2.2%	-1 674	-87%	87	54%	T2	CS
Slovakia	41	86	72	0.6%	31	76%	-14	-17%	T2	CS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	6	198	179	1.6%	173	2803%	-19	-10%	T2	CS,D
Sweden	33	20	14	0.1%	-19	-57%	-5	-27%	-	CS
United Kingdom	182	210	235	2.0%	53	29%	24	12%	T2	CS
EU-28	**12 477**	**11 130**	**11 450**	**100%**	**-1 027**	**-8%**	**320**	**3%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	182	210	235	2.0%	53	29%	24	12%	T2	CS
EU-28 + ISL	**12 477**	**11 130**	**11 450**	**100%**	**-1 027**	**-8%**	**320**	**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 3.168 and Figure 3.169 1A4c Agriculture/Forestry/Fisheries, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ) show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by the Netherlands, accounting for 63% of the CO_2 emissions from gaseous fuels in 1A4c. Fuel consumption in the EU-28+ISL decreased by 10% between 1990 and 2017. The CO_2 implied emission factor for gaseous fuels was 56.4 t/TJ in 2017.

Figure 3.168 1A4c Agriculture/Forestry/Fisheries, gaseous fuels: Emission trend and share for CO_2

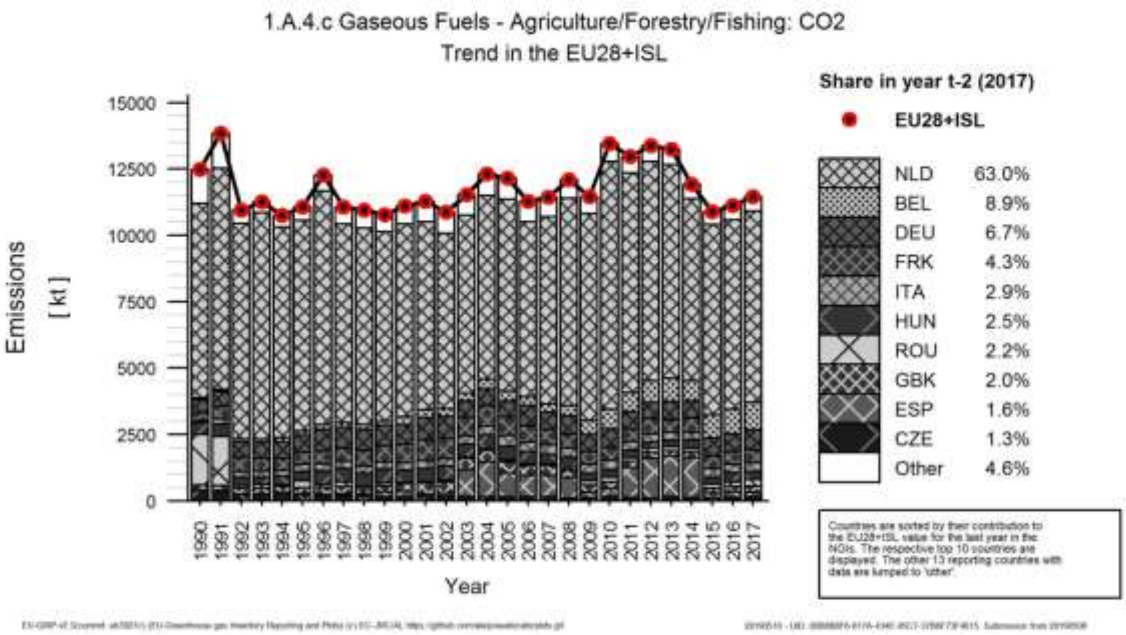
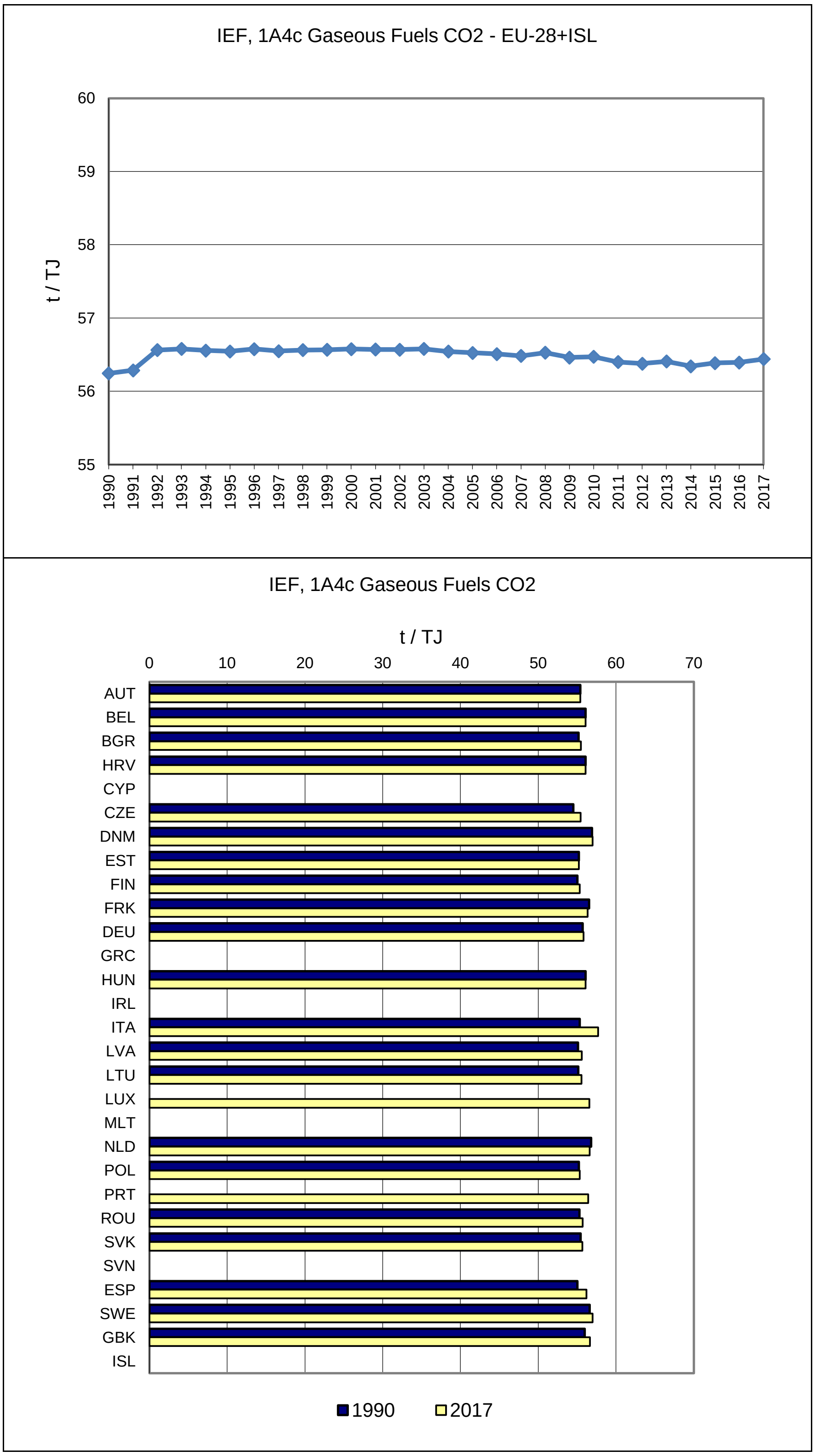


Figure 3.169 1A4c Agriculture/Forestry/Fisheries, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



3.2.5 Other (CRF Source Category 1A5)

Source category 1A5 Other includes emissions from stationary and mobile military fuel use including air craft. In 2017 category 1A5 contributed to 6 6643 kt CO_2 equivalents of which 98.2% CO_2, 0.6% CH_4 and 1.2% N_2O.

Table 3.98: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 1A5 (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2017		1990	2017	
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	5953	10	T	0	0	99
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	14217	4348	T	L	0	90

Table 3.99 provides an overview of Member States' source allocation to Source Category 1A5 Other as reported in CRF Table1.A(a)s4.

Table 3.99 1A5 Other: Member States' allocation of sources

Member State	Source allocation to 1A5 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: Emissions are 'Not occurring'
Croatia	Emissions are 'Not occurring' or 'Included elsewhere', Data on disaggregated level are not available
Cyprus	Stationary: Emissions reported from Liquid Fuels Mobile: aviation component
Czech Republic	Mobile; Other mobile sources not included elsewhere (not included under 1A4cii). Agriculture and Forestry and Fishing, includes 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
Estonia	Mobile reported, however no detailed information provided
Denmark	Mobile: Military use
Finland	Stationary: Other non-specified, emissions from fuel combustion in stationary sources that are not specified elsewhere Mobile: other non-specified: Emissions are ‚Included elsewhere', CO_2, CH_4 and N_2O emissions and fuel consumptions of all fuels from category 1A5b is reported in 1A5a due to confidentiality
France	Emissions are 'Not occurring'
Germany	stationary_ Military use mobile: Military use
Greece	Mobile: Military use
Hungary	Mobile: Military use
Ireland	Emissions are 'Included elsewhere' (under 1A4c)
Iceland	Emissions are 'Not occurring'
Italy	Stationary: Emissions are 'Not occurring' Mobile Other mobile sources not included elsewhere (not included under 1A4cii).
Latvia	Mobile Other mobile sources not included elsewhere (not included under 1A4cii).
Lithuania	Mobile: Military use
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	Mobile: Military use of fuels
Netherlands	Stationary: Emissions are 'Not occurring' Mobile: military use
Poland	Stationary: Emissions are 'Included elsewhere' (under 1A4c) Mobile: Emissions are 'Not occurring'

Member State	Source allocation to 1A5 Other
Portugal	Stationary (no further specification): Emissions are reported for 1990-1994 and 'Not occurring' from 1995 on. Mobile: Military aviation
Romania	Stationary Other non-specified, emissions from fuel combustion in stationary sources that are not specified elsewhere Mobile: Emissions are 'Not occurring'
Slovakia	Stationary: Other non-specified, emissions from fuel combustion in stationary sources that are not specified elsewhere Mobile: Military use Jet Kerosene
Slovenia	Stationary: Emissions are 'Not occurring' Mobile: Military use of fuels
Spain	Mobile: Military use of fuels
Sweden	Stationary: Emissions are 'Not occurring' Mobile: Military use
United Kingdom	Stationary: Emissions are 'Included elsewhere' (under 1A4c) Mobile: Military aviation and naval shipping

Figure 3.170 shows the total trend within source category 1A5 and the dominating emission sources: CO_2 emissions from 1A5b Mobile and from 1A5a Stationary. Total GHG emissions of source category 1A5 decreased by 71% between 1990 and 2017. Germany has the most influence to the overall trend, it reports minus 93% CO_2 emissions since 1990 and contributes to 51% in 1990. The German NIR states that only military sources (incl. aircraft) are included in its inventory. Since 2001 the United Kingdom has a main share and contributes 23% to CO_2 emissions in 2017. The United Kingdom reports military aircraft and naval vessels within this category.

Figure 3.170 1A5 Other: Total and CO_2 emission and activity trends

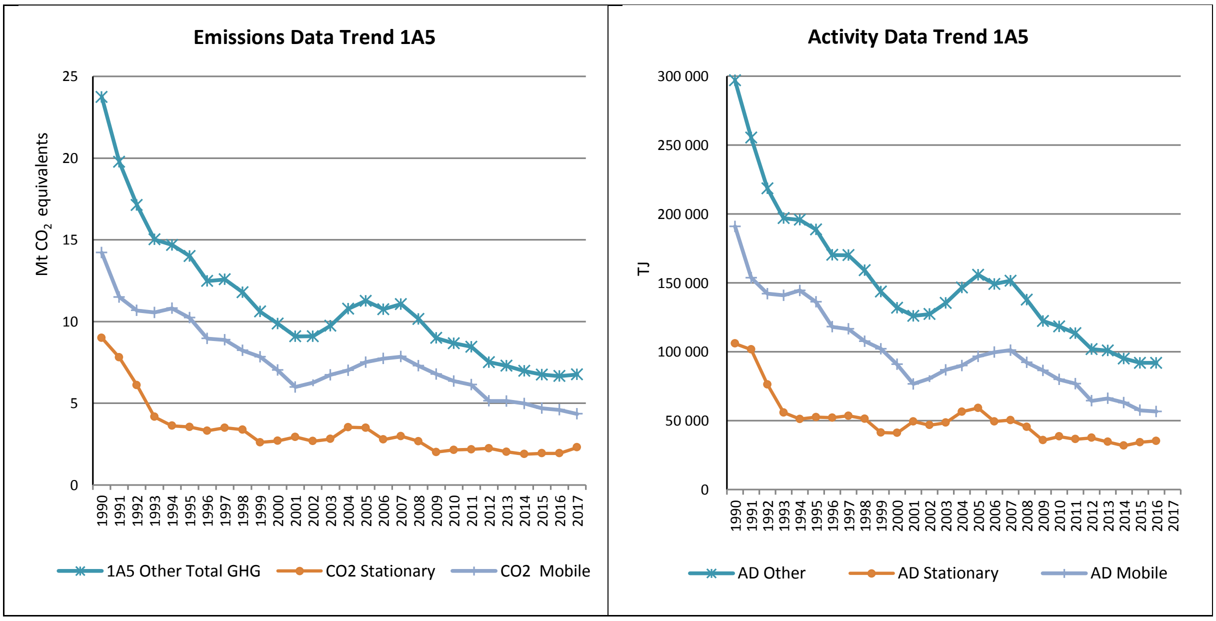


Table 3.100 shows total GHG and CO_2 emissions by Member State from 1A5. CO_2 emissions from 1A5 Other accounted for 0.18% of total EU-28+ISL GHG emissions in 2017. Between 1990 and 2017, CO_2 emissions from this source decreased by 71% in the EU-28+ISL. Between 1990 and 2017 the largest reduction in absolute terms was reported by Germany, which was partly due to reduced military operations after German reunification.

Table 3.100 1A5 Other: Member States' contributions to CO_2 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2017 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2017 (kt)
Austria	36	51	35	50
Belgium	173	108	172	106
Bulgaria	NO	NO	NO	NO
Croatia	IE,NO	IE,NO	NO,IE	NO,IE
Cyprus	11	23	11	23
Czechia	194	465	192	449
Denmark	170	306	167	302
Estonia	44	57	43	56
Finland	1 144	1 112	1 132	1 102
France	NO	NO	NO	NO
Germany	12 138	853	11 797	848
Greece	IE,NO	184	NO,IE	182
Hungary	14	25	14	25
Ireland	IE	IE	IE	IE
Italy	1 143	340	1 071	326
Latvia	NE,NO	13	NO,NE	13
Lithuania	0	26	0	26
Luxembourg	3	0	3	0
Malta	3	4	3	4
Netherlands	320	151	314	148
Poland	IE,NO	IE,NO	NO,IE	NO,IE
Portugal	105	44	105	44
Romania	1 220	686	1 212	646
Slovakia	479	66	476	65
Slovenia	32	4	32	4
Spain	301	486	298	482
Sweden	863	187	846	184
United Kingdom	5 353	1 576	5 293	1 558
EU-28	**23 749**	**6 765**	**23 216**	**6 643**
Iceland	NO	NO	NO	NO
United Kingdom (KP)	5 353	1 576	5 293	1 558
EU-28 + ISL	**23 749**	**6 765**	**23 216**	**6 643**

Croatia reports that 'Military water-borne component is included in 1A3d and 'Military aviation component is included in 1A3a
Poland reports emissions from stationary combustion as 'IE' without specification of the allocation.
Ireland reports that emissions of military use stationary combustion are included in 1A4a and that emissions from 1.A.5.b military are included in 1.A.3
Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3.101 provides information on the contribution of Member States to EU-28 recalculations in CO_2 from 1A5 Other for 1990 and 2016 and main explanations for the largest recalculations in absolute terms.

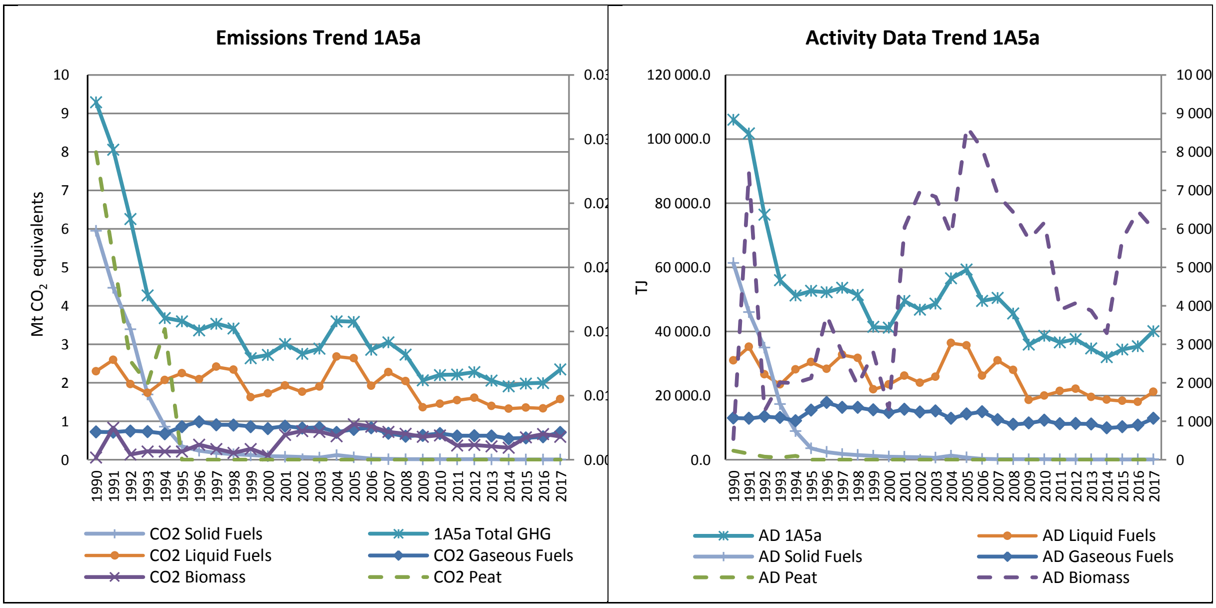
Table 3.1011A5 Other: Contribution of MS to EU-28 recalculations in CO_2 for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1 990		2 016		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	0	0.0	
Belgium	0	0.0	-0	-0.0	
Bulgaria	-30	-100.0	-50	-100.0	
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czech Republic	192	100.0	-1	-0.2	Updated activity data
Denmark	-0	-0.0	-1	-0.4	
Estonia	-	-	-	-	
Finland	8	0.7	-104	-9.4	Updates in other categories are reflected here
France	-	-	-	-	
Germany	-	-	0	0.0	see NIR 2019, chapters 3.2.13.5 and 3.2.14.5
Greece	-	-	-	-	
Hungary	-	-	-	-	
Ireland	-	-	-	-	
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Luxembourg	0	0.0	0	0.7	revised EF for gasoil and gasoline
Malta	-	-	-	-	
Netherlands	-	-	-0	-0.0	
Poland	-	-	-	-	
Portugal	-	-	-	-	
Romania	-	-	2	0.5	The activity data from the 1.A.5 Other sub-sector for the 2005 year were updated and the CO_2, CH_4 and N_2O emissions values for this year were recalculated.Country specific CO_2 EFs for the corresponding fuels from 2016 EU ETS reports were used for 1A5 category. Net calorific values determined from the 2016 EU-ETS reports were used for the specific fuels in 1A5 categories.
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-	-	-	-	
Sweden	-	-	-	-	
United Kingdom	-	-	-	-	No notable recalculations.
EU28	171	0.7	-153	-2.3	
Iceland	-	-	-	-	
United Kingdom (KP)					No notable recalculations.
EU28+ISL	171	1.0	-153	-3.0	

3.2.5.1 Stationary (1A5a)

In this chapter information about emission trends, Member States' contribution, activity data, and emission factors is provided for category 1A5a by fuels. CO_2 emissions from 1A5a Stationary accounted for 0.2% of total GHG emissions in 1A in 2017. Figure 3.171 shows the emission trend within the categories 1A5a, which is mainly dominated by CO_2 emissions from solid and liquid fuels for 1990 to 1993 and dominated by liquid and gaseous fuels after from 1994 on. The reduction in the early 1990s was driven by CO_2 from solid fuels. Total emissions decreased by 74%, mainly due to decreases in emissions from solid fuels (-100%) and liquid fuels (-37%).

Figure 3.171 1A5a Stationary: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Only five Member States (Cyprus, Germany, Finland, Romania and Slovakia) reported emissions from this key source in 2017 (Table 3.102). Between 1990 and 2017 Germany reported the highest absolute decrease. Portugal reports emissions from 1990 to 1994 only. Luxembourg reports emissions 1990 to 2003 only. This led to an EU-28+ISL decrease of 74% in GHG emissions. Between 2016 and 2017 CO_2 emissions increased by 18%.

Table 3.102 1A5a 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		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	19	18	0.8%	7	60%	-1	-8%	T1	D
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 132	1 004	1 102	48.0%	-30	-3%	98	10%	T2	CS
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	6 227	439	475	20.7%	-5 753	-92%	36	8%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	IE	IE	IE	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	-	-	-	-	-	-	-	-
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	8	NO	NO	-	-8	-100%	-	-	NA	NA
Romania	1 212	428	646	28.1%	-566	-47%	218	51%	T1,T2	CS,D
Slovakia	406	49	55	2.4%	-351	-86%	6	13%	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-28	**8 999**	**1 938**	**2 295**	**100%**	**-6 704**	**-74%**	**357**	**18%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	IE	IE	IE	-	-	-	-	-	NA	NA
EU-28 + ISL	**8 999**	**1 938**	**2 295**	**100%**	**-6 704**	**-74%**	**357**	**18%**	**-**	**-**

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 1A4ai 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 1A4a.
Ireland reports that emissions of military use stationary combustion are included in 1A4a.

1A5a Stationary – Solid Fuels (CO_2)

In 2017 CO_2 from solid fuels had a share of 0.4% within source category 1A5a (compared to 64% in 1990). Between 1990 and 2017, CO_2 decreased by nearly 100% (Table 3.103). In 2017 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.

Spain reports, that military reference activity data are not separated from civil data and that those emissions are estimated together in 1A4ai 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 1A4a.

Ireland reports that emissions of military use stationary combustion are included in 1A4a.

According to the methodology as described in chapter 3.2.1 about 99% of EU-28 emissions are calculated by using higher tier methods in 2017.

Table 3.103 1A5a Stationary, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		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	7	75.4%	-4 546	-100%	1	11%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NO	NO	NO	-	-	-	-	-
Ireland	IE	IE	IE	-	-	-	-	-
Italy	NO	NO	NO	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	NO	-	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-
Poland	IE	IE	IE	-	-	-	-	-
Portugal	8	NO	NO	-	-8	-100%	-	-
Romania	1 174	NO	NO	-	-1 174	-100%	-	-
Slovakia	216	3	2	24.6%	-214	-99%	0	-13%
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	IE	IE	IE	-	-	-	-	-
Sweden	NO	NO	NO	-	-	-	-	-
United Kingdom	IE	IE	IE	-	-	-	-	-
EU-28	**5 953**	**9**	**10**	**100%**	**-5 943**	**-100%**	**0**	**4%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	IE	IE	IE	-	-	-	-	-
EU-28 + ISL	**5 953**	**9**	**10**	**100%**	**-5 943**	**-100%**	**0**	**4%**

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 3.172 shows CO_2 emissions for EU-28 and the Member States. Germany accounts for 75% of EU-28 CO_2 emissions from this source category. Fuel combustion in the EU-28+ISL decreased by 99.8% between 1990 and 2017. The CO_2 implied emission factor for solid fuels was 100.0 t/TJ in 2017.

Figure 3.172 1A5a Stationary, solid fuels: Emission trend and share for CO_2

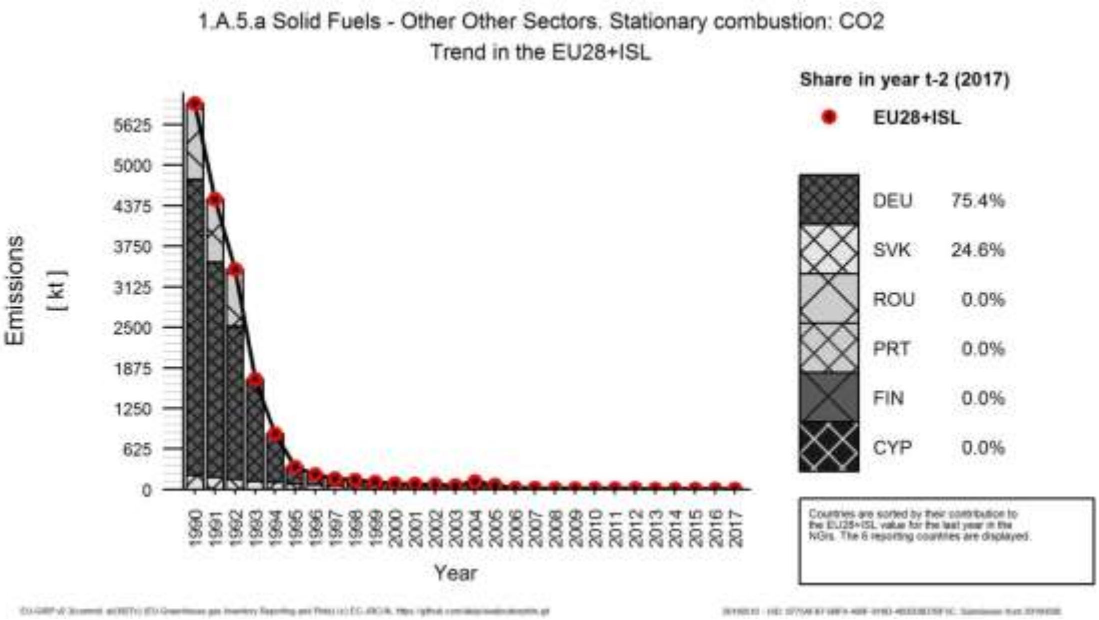
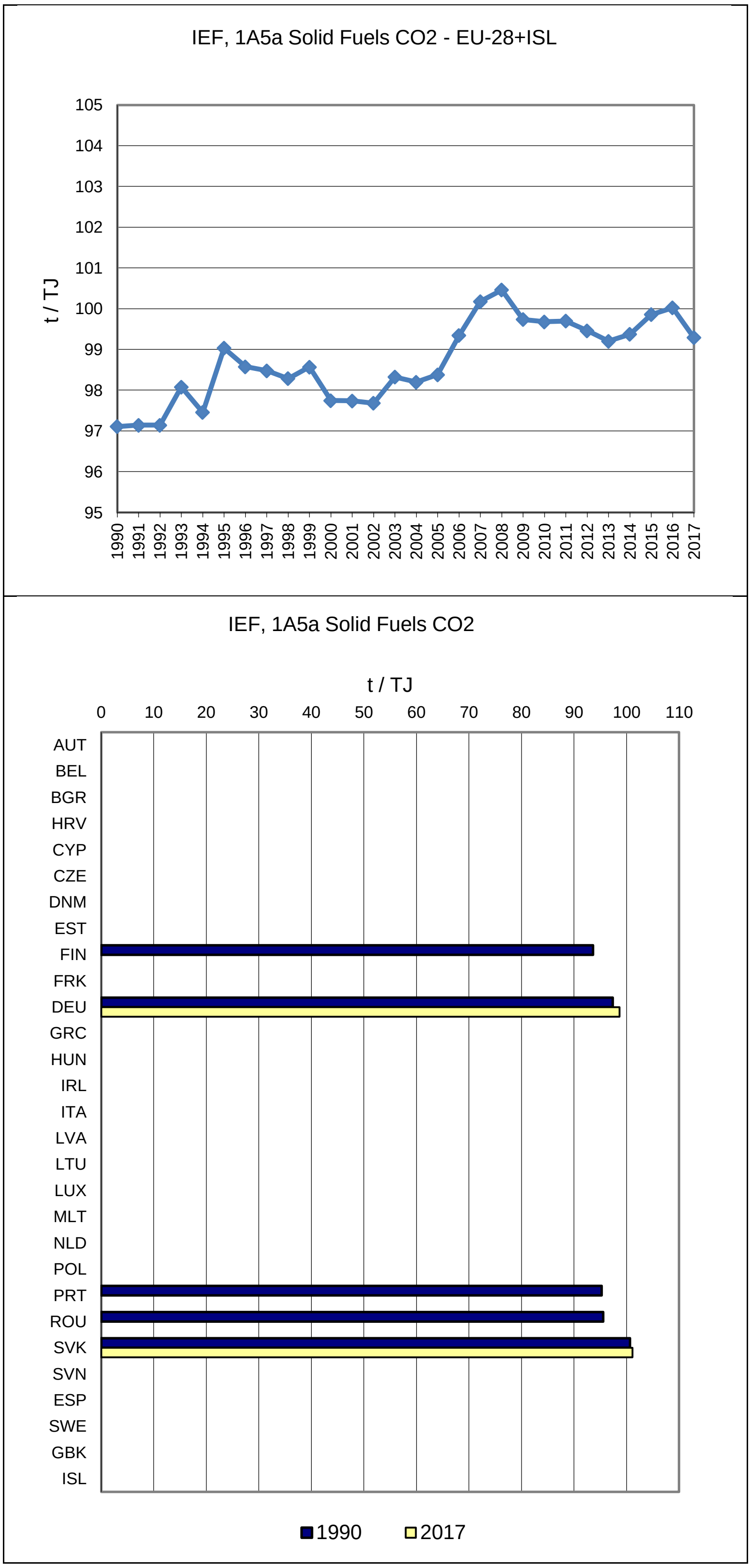


Figure 3.173 1A5a Stationary, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

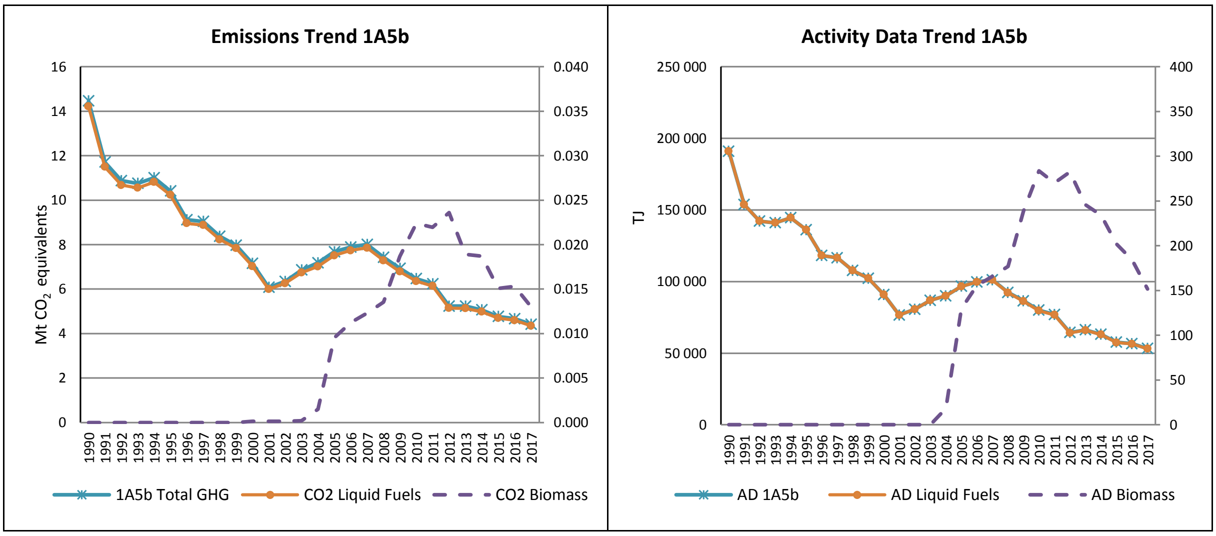


3.2.5.2 Mobile (1A5b)

In this chapter information about emission trends, Member States' contribution and activity data is provided for category 1A5b by fuels. CO_2 emissions from 1A5b Mobile accounted for 0.1% of total

EU-28+ISL GHG emissions in 2017. Figure 3.174 shows the emission trend within the category 1A5b, which is dominated by CO_2 emissions from liquid fuels. Total CO_2 emissions decreased by 74%.

Figure 3.174 1A5b Mobile: Total and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Eight Member States and Iceland reported emissions as ‘Not occurring’ or ’Included elsewhere‘. The United Kingdom had the highest emissions in 2017 and – together with Germany - decreased the most in absolute terms between 1990 and 2017. Between 2016 and 2017 the United Kingdom had the highest absolute decrease. The EU-28+ISL emissions decreased by 5% between 2016 and 2017 ().

Croatia reports emissions from military aviation in category 1A3a and emissions from military naval vessels under category 1A3d.

Ireland reports that emissions from mobile military sources are included in 1A3.

Table 3.104 1A5b Mobile: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	35	50	50	1.2%	15	43%	1	1%	T1,T2	CS,D
Belgium	172	109	106	2.4%	-65	-38%	-2	-2%	T1	D
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Cyprus	NO	3	5	0.1%	5	∞	2	69%	T1	D
Czechia	192	394	449	10.3%	257	134%	56	14%	T1	D
Denmark	167	205	302	6.9%	135	81%	96	47%	CR,M,T2	CS
Estonia	43	48	56	1.3%	12	28%	8	17%	T2	CS
Finland	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	5 570	578	374	8.6%	-5 197	-93%	-204	-35%	CS,D,M	CS,D,M
Greece	NO,IE	199	182	4.2%	182	∞	-17	-8%	T1	D
Hungary	14	22	25	0.6%	11	74%	3	14%	T1	D
Ireland	IE	IE	IE	-	-	-	-	-	NA	NA
Italy	1 071	515	326	7.5%	-745	-70%	-189	-37%	T2	CS
Latvia	NO,NE	11	13	0.3%	13	∞	2	16%	T1	D
Lithuania	0	25	26	0.6%	25	7004%	1	3%	T2	CS
Luxembourg	0	0	0	0.0%	0	-11%	0	-2%	T1,T2	CS,D
Malta	3	3	4	0.1%	1	45%	0	5%	T1,T3	CS,D
Netherlands	314	162	148	3.4%	-166	-53%	-14	-9%	T2	CS
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	96	44	44	1.0%	-52	-54%	0	0%	T1	D
Romania	IE	IE	IE	-	-	-	-	-	NA	NA
Slovakia	70	16	10	0.2%	-60	-86%	-6	-37%	T1,T2	D
Slovenia	32	4	4	0.1%	-28	-87%	0	14%	T1	D
Spain	298	486	482	11.1%	184	62%	-4	-1%	T1	D,M
Sweden	846	176	184	4.2%	-662	-78%	8	4%	NA	NA
United Kingdom	5 293	1 547	1 558	35.8%	-3 735	-71%	11	1%	T1	CS
EU-28	**14 217**	**4 597**	**4 348**	**100%**	**-9 869**	**-69%**	**-248**	**-5%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	5 293	1 547	1 558	35.8%	-3 735	-71%	11	1%	T1	CS
EU-28 + ISL	**14 217**	**4 597**	**4 348**	**100%**	**-9 869**	**-69%**	**-248**	**-5%**	**-**	**-**

Finland reports emissions from military activities in category 1A5a for reasons of confidentiality.
Ireland reports emission from military activities in category 1A3.
Croatia reports emissions from military aviation in category 1A3a and emissions from military naval vessels under category 1A3d.
Abbreviations explained in the Chapter 'Units and abbreviations'.

1A5b Mobile – Liquid Fuels (CO_2)

In 2017, CO_2 from liquid fuels had a share of 98% within source category 1A5b (compared to 98% in 1990). Between 1990 and 2017 CO_2 decreased by 69% (Table 3.105). Twenty one Member States reported emissions in 2017 while other Member States report emissions as 'Not occurring' or 'Included Elsewhere'. The highest decrease in absolute terms was achieved in Germany (-93%) and the United Kingdom (-71%), while the Czech Republic and Lithuania had the largest increases.

According to the methodology as described in chapter 3.2.1 about 90% of EU-28 emissions are calculated by using higher tier methods in 2017.

Table 3.105 1A5b Mobile, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	35	50	50	1.2%	15	43%	1	1%
Belgium	172	109	106	2.4%	-65	-38%	-2	-2%
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	IE	IE	IE	-	-	-	-	-
Cyprus	NO	3	5	0.1%	5	∞	2	69%
Czechia	192	394	449	10.3%	257	134%	56	14%
Denmark	167	205	302	6.9%	135	81%	96	47%
Estonia	43	48	56	1.3%	12	28%	8	17%
Finland	IE	IE	IE	-	-	-	-	-
France	NO	NO	NO	-	-	-	-	-
Germany	5 570	578	374	8.6%	-5 197	-93%	-204	-35%
Greece	IE	199	182	4.2%	182	∞	-17	-8%
Hungary	14	22	25	0.6%	11	74%	3	14%
Ireland	IE	IE	IE	-	-	-	-	-
Italy	1 071	515	326	7.5%	-745	-70%	-189	-37%
Latvia	NE	11	13	0.3%	13	∞	2	16%
Lithuania	0	25	26	0.6%	25	7004%	1	3%
Luxembourg	0	0	0	0.0%	0	-11%	0	-2%
Malta	3	3	4	0.1%	1	45%	0	5%
Netherlands	314	162	148	3.4%	-166	-53%	-14	-9%
Poland	NO	NO	NO	-	-	-	-	-
Portugal	96	44	44	1.0%	-52	-54%	0	0%
Romania	IE	IE	IE	-	-	-	-	-
Slovakia	70	16	10	0.2%	-60	-86%	-6	-37%
Slovenia	32	4	4	0.1%	-28	-87%	0	14%
Spain	298	486	482	11.1%	184	62%	-4	-1%
Sweden	846	176	184	4.2%	-662	-78%	8	4%
United Kingdom	5 293	1 547	1 558	35.8%	-3 735	-71%	11	1%
EU-28	**14 217**	**4 597**	**4 348**	**100%**	**-9 869**	**-69%**	**-248**	**-5%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	5 293	1 547	1 558	35.8%	-3 735	-71%	11	1%
EU-28 + ISL	**14 217**	**4 597**	**4 348**	**100%**	**-9 869**	**-69%**	**-248**	**-5%**

Finland reports emissions from military activities in category 1A5a for reasons of confidentiality.
Ireland reports emission from military activities in category 1A3.
Croatia reports emissions from military aviation in category 1A3a and emissions from military naval vessels under category 1A3d.
*Information on methods and emission factors are identical with those described in Table **3.104** as emissions from this source only occur in liquid fuels*
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.175 shows CO_2 emissions for EU-28 and the Member States. The largest emissions are reported by United Kingdom, Spain and the Czech Republic; together they cause 57% of the CO_2 emissions from liquid fuels in 1A5b. Fuel consumption in the EU-28+ISL decreased by 73% between 1990 and 2017. The CO_2 implied emission factor for liquid fuels was 81.3 t/TJ in 2017. 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 11 % in 2017.

Figure 3.175 1A5b Mobile, liquid fuels: Emission trend and share for CO_2

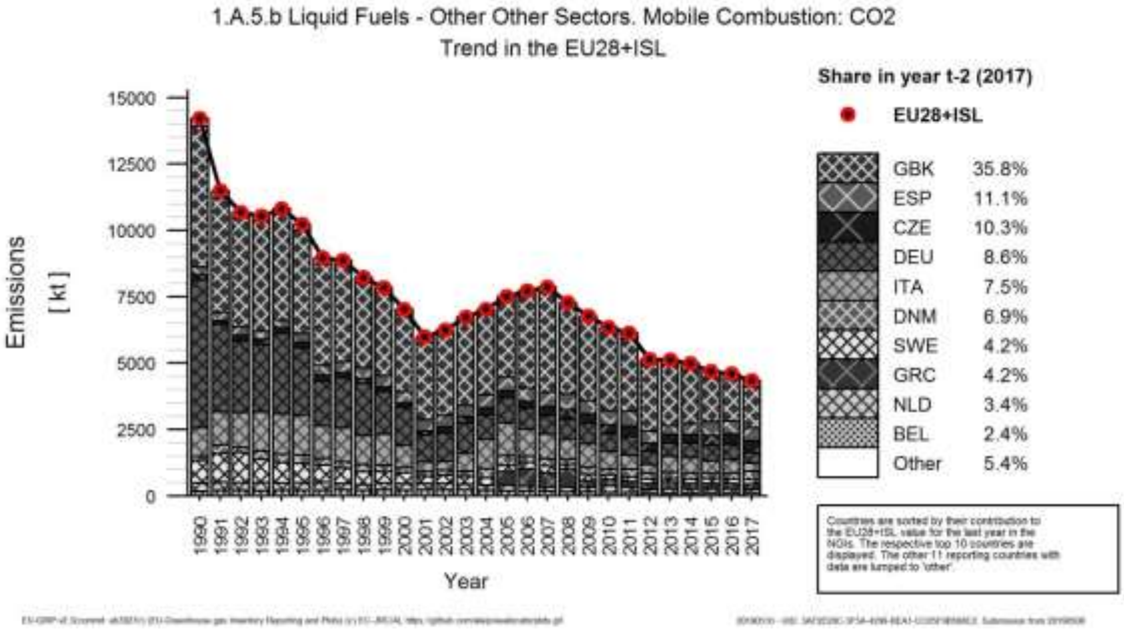
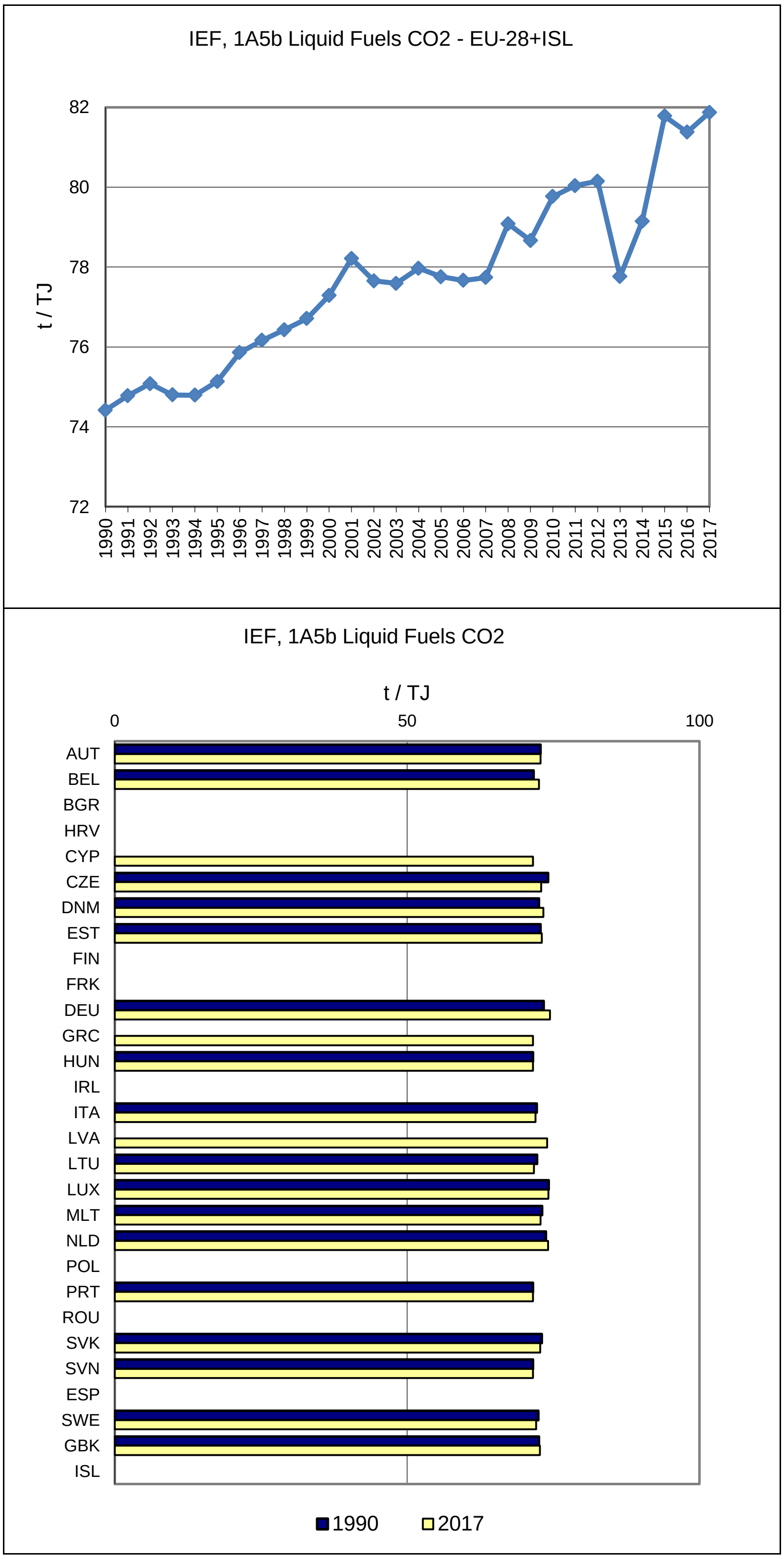


Figure 3.176 1A5b Mobile, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

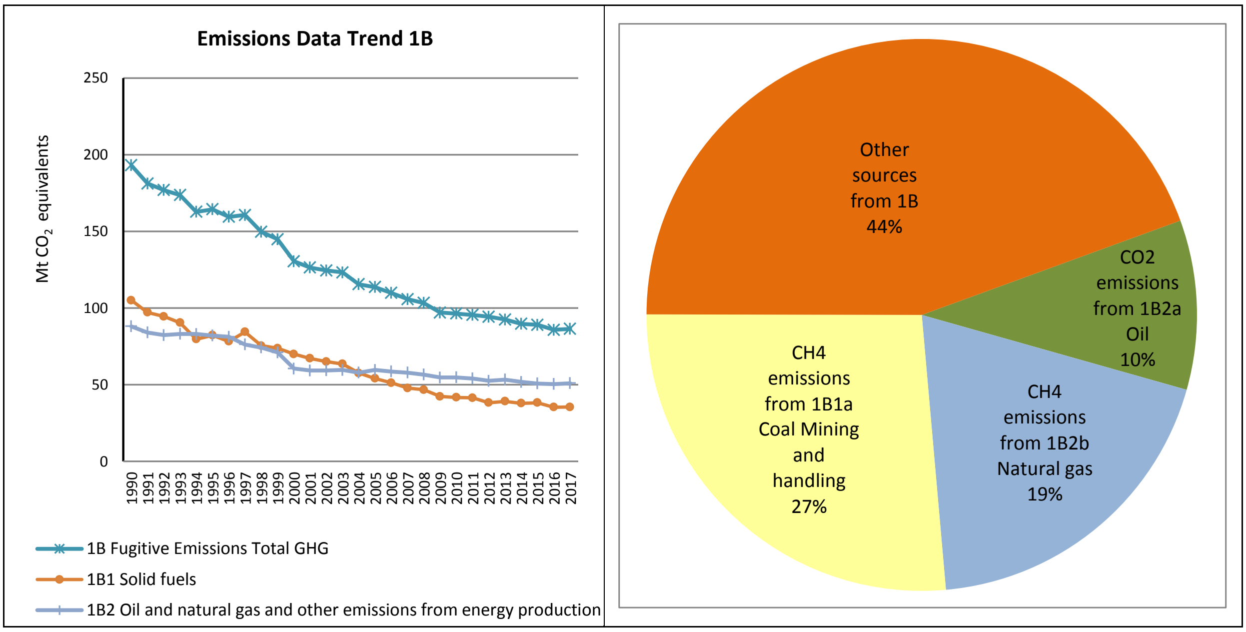


3.2.6 Fugitive emissions from fuels (CRF Source Category 1.B)

This chapter describes gaseous or volatile emissions which occur during extraction, handling and consumption of fossil fuels. In the 2006 IPCC Guidelinesfugitive 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 2006 IPCC Guidelines).

In 2017, in terms of CO_2 equivalents, about 69% of emissions from source category 1.B were fugitive CH_4 emissions while 31% were fugitive CO_2 emissions. Together, they represent 2 % of total GHG emissions in the EU-28+ISL. Fugitive GHG emissions have been steadily declining (Figure 3.177). Between 1990 and 2017, the total fugitive GHG emissions decreased by 55 %. This was mainly due to the decrease in underground mining activities: CH_4 emissions from underground mining activities have decreased by 71 % since 1990 (Figure 3.180) and decreases in CH_4 emissions from category 1B1a i underground mines are responsible for 60 % of the total decrease of fugitive emissions. Between 1990 and 2017, GHG emissions from 1.B.1 Solid Fuels decreased by 66 % Figure 3.178), while emissions from 1.B.2 Oil and Natural Gas decreased only by 42 % (Figure 3.178). While emissions from 1.B.1 Solid Fuels and 1.B.2 Oil and Natural Gas each were responsible for roughly 54 % (1.B.1) and 46% (1.B.2) of total fugitive emissions in 1990, fugitive emissions from 1.B.1 Solid Fuels represented only 41 % of total fugitive emissions in 2017 (Figure 3.177).

Figure 3.177 1.B Fugitive Emission from Fuel: GHG Emissions trend and proportion of fugitive emissions within source category



Fugitive emissions includes five key sources:

Table 3.106: Key source categories for level and trend analyses and share of MS 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	2017		1990	2017	
1.B.1.a Coal Mining and Handling: Operation (CH_4)	97062	31049	T	L	L	71%
1.B.2.a Oil: Operation (CH_4)	6819	1233	T	0	0	50%
1.B.2.a Oil: Operation (CO_2)	9104	11657	T	L	L	90%
1.B.2.b Natural Gas: Operation (CH_4)	51231	22577	T	L	L	81%
1.B.2.c Venting and Flaring: Operation (CO_2)	8718	6894	0	L	L	86%

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 62 % of total fugitive GHG emissions (Figure 3.177).

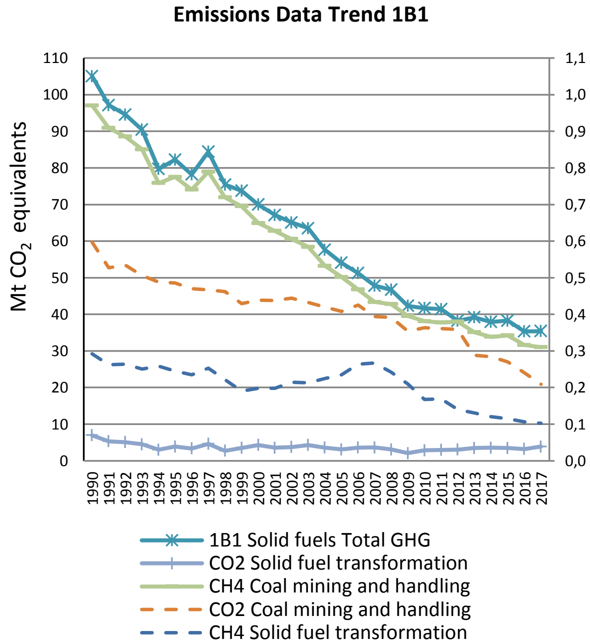
3.2.6.1 Fugitive emissions from Solid Fuels (1.B.1)

In the 2006 IPCC Guidelinesfugitive 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 member States (Denmark, Estonia, Finland, Latvia and Lithuania) have peat extraction but no coal mining.

In 2017 fugitive emissions from solid fuels accounted for 0.8 % of the total GHG emissions in the EU-28+ISL and 41 % of total fugitive emissions:

- 88 % 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.
- 11 % 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 3.178 1.B.1 Fugitive Emissions from Solid Fuels: Trend



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

In 2017 four countries, Poland, Germany Czech Republic and Romania represented 90 % of total fugitive GHG emissions from solid fuels (Table 3.107).

Table 3.107 1.B.1 Fugitive Emissions from Solid Fuels: Member States Contribution

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2017 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2017 (kt)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2017 (kt CO2 equivalents)
Austria	333	NA,IE,NO	NO,IE,NA	NO,IE,NA	333	NO,IE,NA
Belgium	433	42	0.3	NO	432	42
Bulgaria	2 047	844	NO	NO	2 047	844
Croatia	60	NA,NO	NO	NO	60	NO
Cyprus	NO	NO	NO	NO	NO	NO
Czechia	10 779	3 023	456	122	10 323	2 901
Denmark	NO	NO	NO	NO	NO	NO
Estonia	NO	NO	NO	NO	NO	NO
Finland	NO	NO	NO	NO	NO	NO
France	4 810	17	NO,NA	NO,NA	4 810	17
Germany	27 386	3 178	1 833	693	25 553	2 484
Greece	1 130	822	NO	NO	1 130	822
Hungary	896	53	7	NO,IE,NA	889	53
Ireland	56	19	NO	NO	56	19
Italy	132	37	0.4	NO,NA	132	37
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	24 471	19 730	3 303	2 740	21 167	16 989
Portugal	203	17	35	NO	169	17
Romania	5 867	5 957	NA,NO	NO,NA	5 867	5 957
Slovakia	699	297	19	21	680	275
Slovenia	461	369	101	139	361	230
Spain	1 638	83	18	11	1 620	72
Sweden	5	5	5	5	0.003	0.003
United Kingdom	23 525	847	1 699	360	21 827	488
EU-28	**105 053**	**35 416**	**7 586**	**4 166**	**97 467**	**31 250**
Iceland	NO	NO	NO	NO	NO	NO
United Kingdom (KP)	23 526	847	1 699	360	21 827	488
EU-28 + ISL	**105 053**	**35 416**	**7 586**	**4 166**	**97 467**	**31 250**

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.

Between 1990 and 2017 fugitive CH_4 emissions from solid fuels decreased by 68% (Table 3.108). Large reductions (in absolute terms) were observed in Czech Republic, Germany, and in the United Kingdom (Table 3.107).

CH_4 recovery from coal mining

The UK, which has a share of 99% of all reported CH_4 recovery in 2017 in category 1.B.1.a.1 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 1% of all reported CH_4 recovery in category 1.B.1.a.1 in the EU in 2017. The recovered CH_4 from Lupeni mines and Vulcan mine 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 0.7 % of total GHG emissions in 2017 and for 36 % of all fugitive emissions in the EU-28+ISL. CH_4 emissions from this source decreased by 68 % in the EU-28+ISL between 1990 and 2017 and also a decrease by -2 % between 2016 and 2017 due to decreases in Germany, the Czech Republic, Poland and Romania (Table 3.108). In 2017 Poland, Romania, Germany and the Czech Republic accounted together for 90 % of CH_4 emissions from 1.B.1.a. They had substantially reduced their emissions between 1990 and 2017 due to the decline of coal mining (Figure 3.90).

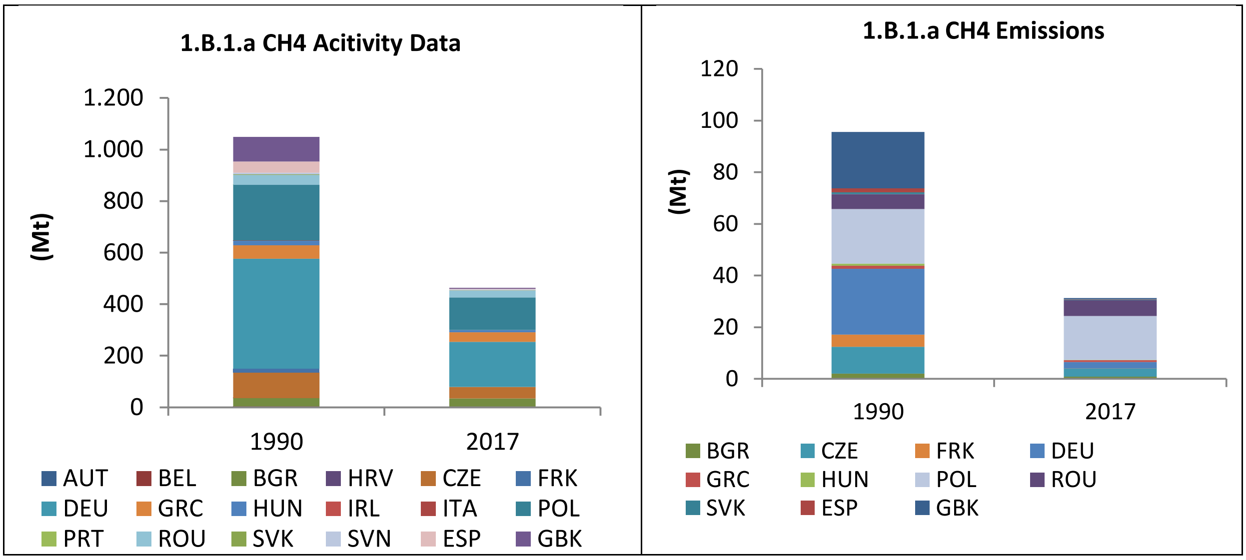
Table **3.108** shows that 71 % of EU-28 emissions are calculated using higher tier methods. In cases where member states report a mix of Tier 1 and higher Tier methods (CZE, HUN, POL) only emissions from subcategories of sector 1.B.1.a were taken into account, where the member states actually apply a higher tier method, according to the IPCC 2006 Guidelines.

Table 3.108 1.B.1.a Coal Mining: Member States contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	333	NO,NA	NO,NA	-	-333	-100%	-	-	NA	NA
Belgium	396	42	42	0.1%	-354	-89%	0	0%	D	D
Bulgaria	2 031	820	843	2.7%	-1 188	-59%	23	3%	OTH,T1	D,OTH
Croatia	60	NO	NO	-	-60	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	10 322	3 260	2 896	9.3%	-7 426	-72%	-364	-11%	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	0.03%	-4 770	-100%	0	0%	T2,T3	CS,PS
Germany	25 494	2 426	2 434	7.8%	-23 061	-90%	8	0.3%	T2,T3	CS
Greece	1 130	711	822	2.6%	-308	-27%	111	16%	T1	D
Hungary	889	54	53	0.2%	-836	-94%	-1	-2%	T1,T2	CS,D
Ireland	56	19	19	0.1%	-37	-66%	-0.3	-2%	T1	D
Italy	53	24	13	0.04%	-40	-76%	-12	-48%	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	17 093	16 891	54.4%	-4 164	-20%	-202	-1%	T1,T2	D
Portugal	168	17	17	0.1%	-151	-90%	0	0%	NO	NO
Romania	5 825	6 034	5 957	19.2%	132	2%	-77	-1%	T1,T2	D
Slovakia	680	310	272	0.9%	-408	-60%	-38	-12%	T2	CS
Slovenia	361	230	230	0.7%	-131	-36%	-0.03	-0.01%	T2,T3	CS,D,PS
Spain	1 620	84	72	0.2%	-1 549	-96%	-12	-14%	CS,T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	21 809	500	481	1.5%	-21 328	-98%	-19	-4%	T2,T3	CS
EU-28	**97 062**	**31 632**	**31 049**	**100%**	**-66 013**	**-68%**	**-583**	**-2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	21 809	500	481	1.5%	-21 328	-98%	-19	-4%	T2,T3	CS
EU-28 + ISL	**97 062**	**31 632**	**31 049**	**100%**	**-66 013**	**-68%**	**-583**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.
According to the MS NIR Poland calculates emissions from this source with a Tier3 approach

Figure 3.179 1.B.1.a Coal Mining and Handling: Contribution of MS to CH_4 Emission and Activity Data



CH_4 from Underground mines (1.B.1.a.1)

In 2017 84% of fugitive emissions from coal mines were due to underground mines. Within the EU-28+ISL coal mining in underground mines decreased substantially between 1990 and 2017 (-71 %) (Figure 3.180). Largest decreases of CH_4 emissions in absolute terms were observed in Germany (-91 %) 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 2019). 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 2019).

Poland and Germany, which are contributing 60%, and 9% of methane emissions to this source, respectively, apply a Tier 3 method based on direct measurements and calculations. (POL NIR 2019; DEU NIR 2019). Romania has a share of 21% of CH_4 emissions from this source, applying a Tier 2 methodology of the 2006 IPCC Guidelines(ROU NIR 2019). A Tier 2 method including country specific emission factors is applied by the Czechia , which is contributing almost 6% of methane emissions to this source (CZE NIR 2019) (Table **3.109**). For detailed information on Member States methodologies please see Annex III.

Table 3.109 1.B.1.a.1 Coal Mining – underground mining: Member States contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	299	NO,NA	NO,NA	-	-299	-100%	-	-	NA	NA
Belgium	396	42	42	0.2%	-354	-89%	0	0%	D	D
Bulgaria	1 425	146	99	0.4%	-1 326	-93%	-47	-32%	OTH,T1	D,OTH
Croatia	60	NO	NO	-	-60	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	7 544	1 904	1 513	5.8%	-6 031	-80%	-391	-21%	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	0.04%	-4 724	-100%	0	0%	T2,T3	CS,PS
Germany	25 396	2 379	2 387	9.1%	-23 010	-91%	8	0.3%	T3	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	889	54	53	0.2%	-836	-94%	-1	-2%	T1,T2	CS,D
Ireland	56	19	19	0.1%	-37	-66%	-0.3	-2%	T1	D
Italy	20	24	13	0.05%	-7	-36%	-12	-48%	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	15 781	15 559	59.5%	-4 024	-21%	-222	-1%	T1,T2	D
Portugal	168	17	17	0.1%	-151	-90%	0	0%	NO	NO
Romania	5 282	5 556	5 412	20.7%	131	2%	-144	-3%	T1,T2	D
Slovakia	680	310	272	1.0%	-408	-60%	-38	-12%	T2	CS
Slovenia	361	230	230	0.9%	-131	-36%	-0.03	-0.01%	T2,T3	CS,D,PS
Spain	1 620	84	72	0.3%	-1 548	-96%	-12	-14%	CS,T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	21 616	455	449	1.7%	-21 168	-98%	-7	-1%	T2,T3	CS
EU-28	**90 127**	**27 010**	**26 146**	**100%**	**-63 981**	**-71%**	**-864**	**-3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	21 616	455	449	1.7%	-21 168	-98%	-7	-1%	T2,T3	CS
EU-28 + ISL	**90 127**	**27 010**	**26 146**	**100%**	**-63 981**	**-71%**	**-864**	**-3%**	**-**	**-**

Note: According to the MS NIR Poland calculates emissions from this source with a Tier3 approach

Figure 3.180   1.B.1.a.1.i Mining activities - Underground Mines: Emission trend and share for EU-28 and the emitting countries of CH_4

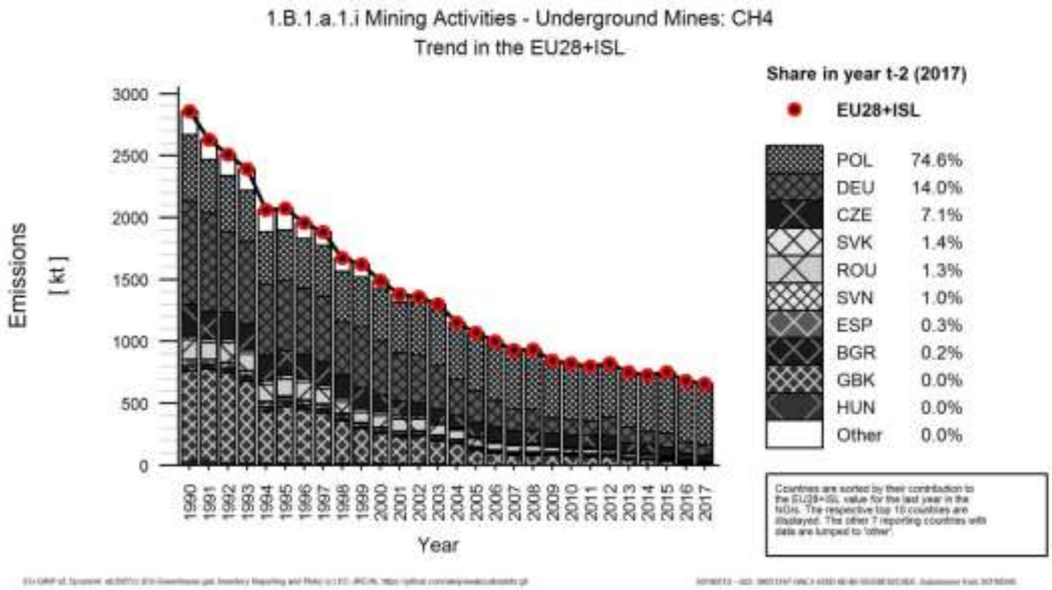
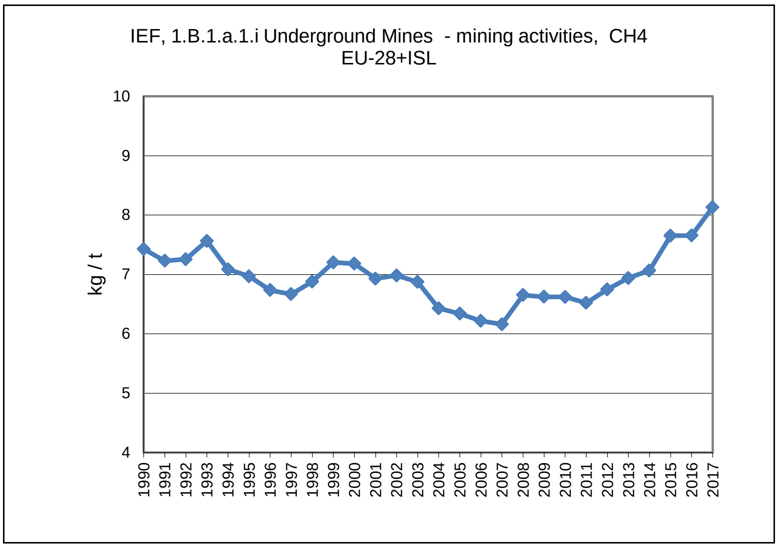
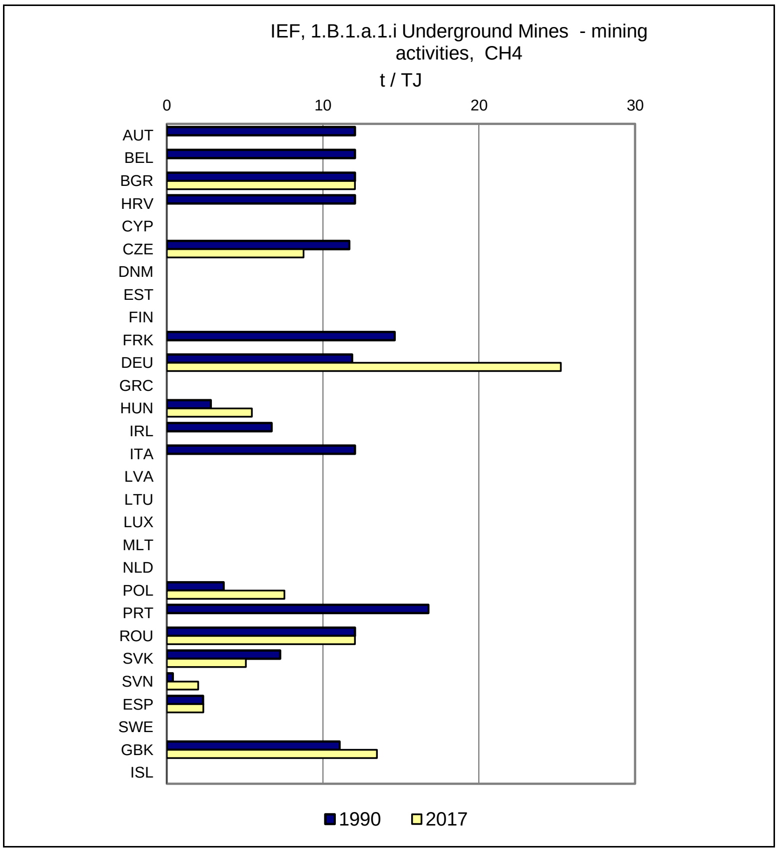


Figure 3.181 shows the implied emission factor of EU28+ISL and also the implied emission factor for each Member State for CH_4 emissions in 1B1a1i – underground mines, mining activities, which are responsible for 63 % of total GHG emissions from 1.B.1.a.1. Germany is calculating emissions from this source applying a Tier 3 methodology, which results in a higher emission factor, compared to the IEF of other member states (see DEU NIR 2019).

Figure 3.181: 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 2017, only 16% of emissions from coal mining originate from surface mining. Overall, the coal production from surface mines decreased by 29 % between 1990 and 2017 (Figure 3.182).

Czech Republic shows largest decreases of methane emissions in absolute terms between 1990 and 2017 (-1 396 kt CO_2 equ.), which is caused by the closure of mines (CZE NIR 2019).

Together, Czech Republic and Poland account for 55% 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 Czech Republic is 48%. For detailed information on Member States methodologies please see Annex III. (Table **3.110**).

Table 3.110 1.B.1.a.2 Coal Mining – surface mining: Member States contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	34	NO	NO	-	-34	-100%	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	606	674	743	15.2%	138	23%	69	10%	T1	D
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	2 778	1 355	1 383	28.2%	-1 396	-50%	27	2%	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	47	47	1.0%	-51	-52%	-0.1	-0.2%	T2	CS
Greece	1 130	711	822	16.8%	-308	-27%	111	16%	T1	D
Hungary	NO	IE	IE	-	-	-	-	-	NA	NA
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	1 312	1 332	27.2%	-140	-10%	20	2%	T1	D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	544	478	544	11.1%	1	0.1%	66	14%	T1	D
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1	NA	NA	-	-1	-100%	-	-	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	193	44	32	0.7%	-160	-83%	-12	-27%	T2	CS
EU-28	**6 935**	**4 621**	**4 903**	**100%**	**-2 032**	**-29%**	**282**	**6%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	193	44	32	0.7%	-160	-83%	-12	-27%	T2	CS
EU-28 + ISL	**6 935**	**4 621**	**4 903**	**100%**	**-2 032**	**-29%**	**282**	**6%**	**-**	**-**

Figure 3.182 1.B.1.a.2.i Mining activities - Surface Mines: Emission trend and share for the emitting countries of CH_4

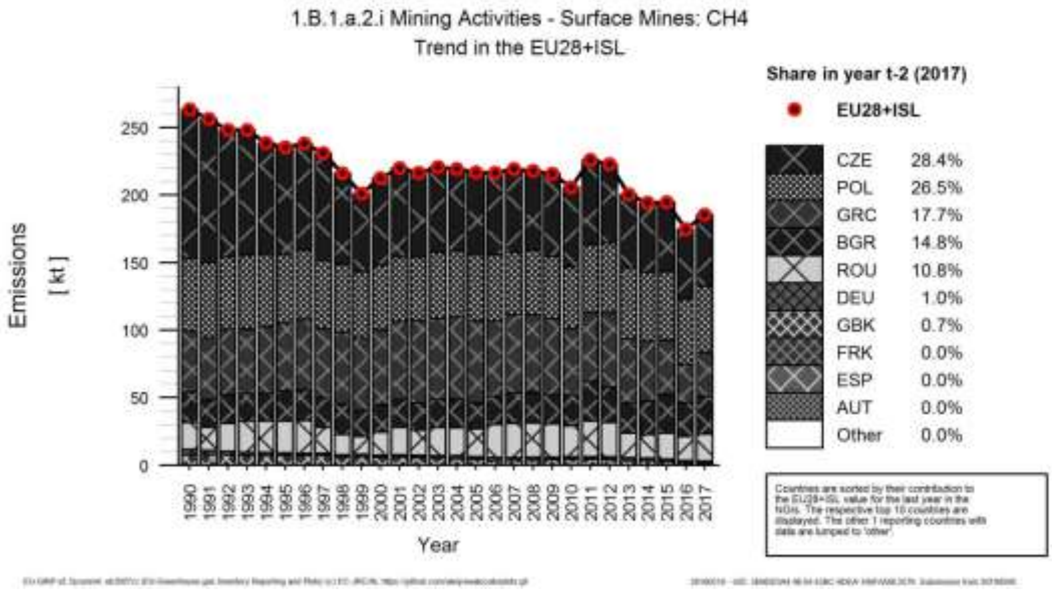
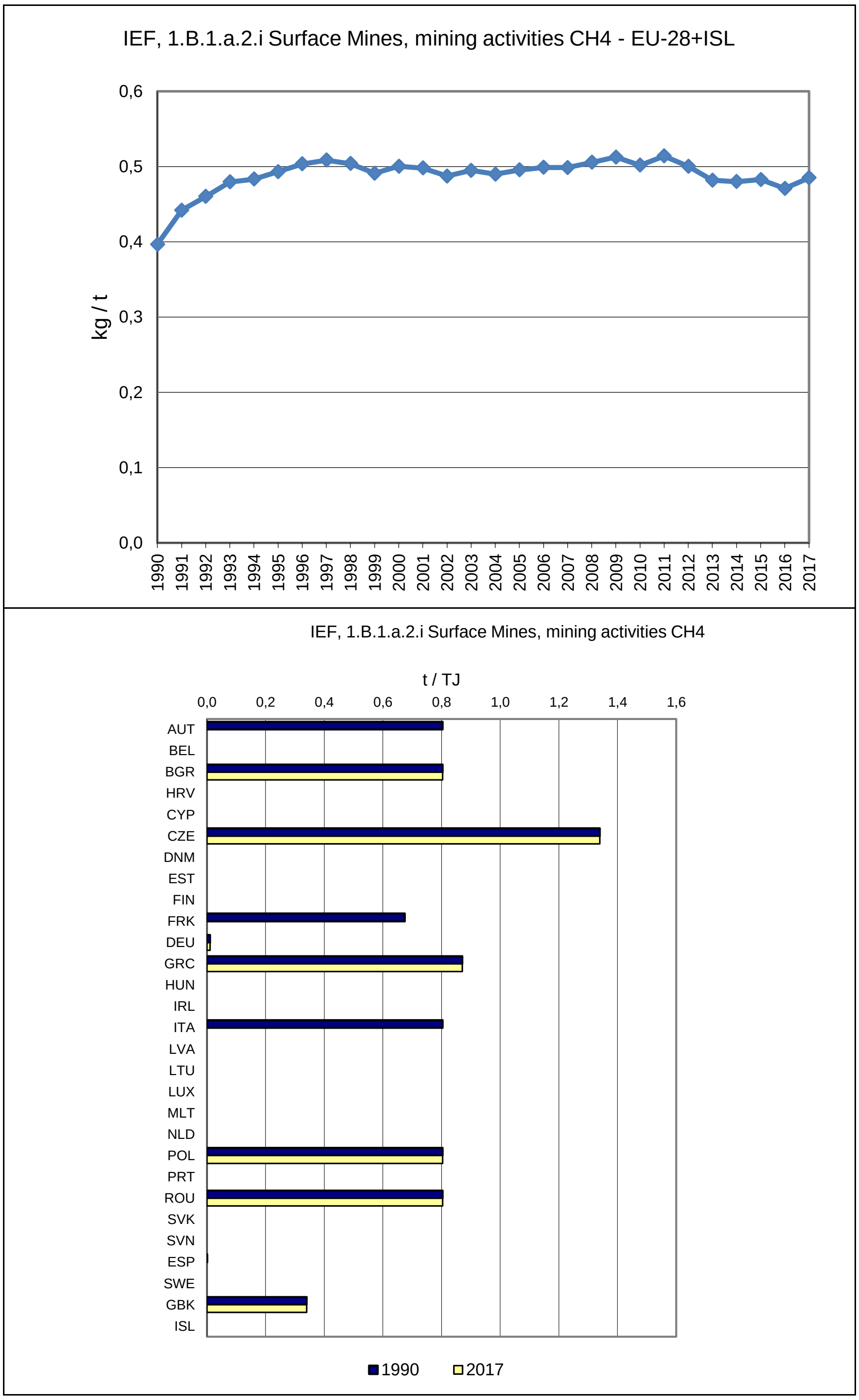


Figure **3.177** shows the Implied Emission factor of EU28+ISL and also the implied Emission factor for each Member State for CH_4 emissions in 1.B.1.a.2.i – mining activities from surface mines, which are responsible for 95 % of total GHG emissions from 1.B.1.a.2.

CZE applies the high default emission factor from the IPCC 2006 Guidelines which explains the outlier in Figure 3.183 (lower figure). Germanys 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 DEU 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 DEU NIR, 2019).

Figure 3.183: 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... The description of the subcategories are presented in Table 3.111.

Table 3.111 Description of subcategories in sector 1.B.1c for CO_2- and CH_4-emissions for reporting Member States

Member state	Emission	Subcategory
Poland	CO_2, CH_4	emissions from Coke Oven Gas Subsystem
Sweden	CO_2, CH_4, N_2O	Flaring of gas

Table 3.112 provides information on the contribution of Member States to EU-28+ISL recalculations in CH_4 from 1.B.1 Solid fuels for 1990 and 2016.

Table 3.1121.B.1 Fugitive Emissions from Solid Fuels: Contribution of MS to EU-28+ISL recalculations in CH_4 for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	-	-	
Bulgaria	-	-	-1	-0.1	For category 1.B.1.a.2.1 Fugitive emissions from surface mines, the previous emission factor of 1.2 m3/t was changed to 1.5 m3/t (IPCC GPG 2000, p.2.75), following a recommendation of the ERT during the Centralized review in 2012. For the 2014 submission the EF was changed back to 1.2 m3/t following the adoption of the 2006 2006 IPCC Guidelines.
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czechia	-	-	-	-	
Denmark	-	-	-	-	
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	-	-	-	-	
Germany	-0	-0.0	-	-	
Greece	-	-	-	-	
Hungary	-	-	-	-	
Ireland	-	-	-	-	
Italy	-	-	7	17.2	Update of coal production for 2015 resulting in change of 2016 emissions post mine
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-	-	-	-	
Poland	-162	-0.8	163	1.0	Update of the activity data concering hard and brown coal extraction according to Eurostat database.
Portugal	78	85.4	8	95.1	
Romania	1 968	50.5	5 127	565.6	Recalculations have been made for the entire period 1989-2016 due to an improvement in activity data and Tier 2 approach of Abandoned undeground mines category. (CRF 1.B.1.a.iii); Recalculations have been made for Coal mining and handling (1.B.1.a.1 and 1.B.1.a.2) category: the activity data values for 1989 -1999 period have been updated because the ratio afferent to underground and surface mines from 15/85 % to 26/74% have been changed and the activity data values for

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					2007 – 2016 period have been updated because activity data of lignite production in related to underground and surface mines from IEA/Eurostat Questionnaire 2017 have been updated.
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-	-	-	-	
Sweden	-	-	-	-	
United Kingdom	0	0.0	-0	-0.0	No significant recalculations.
EU28	1 883	2.0	5 305	20.0	
Iceland	-	-	-	-	
United Kingdom (KP)	0	0.0	-0	-0.0	
EU28+ISL	1 883	2.6	5 305	20.4	

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 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 2017 and for 58 % (Figure 3.184) of all fugitive emissions in the EU-28+ISL.

Of all fugitive emissions from oil and natural gas, in 2017:

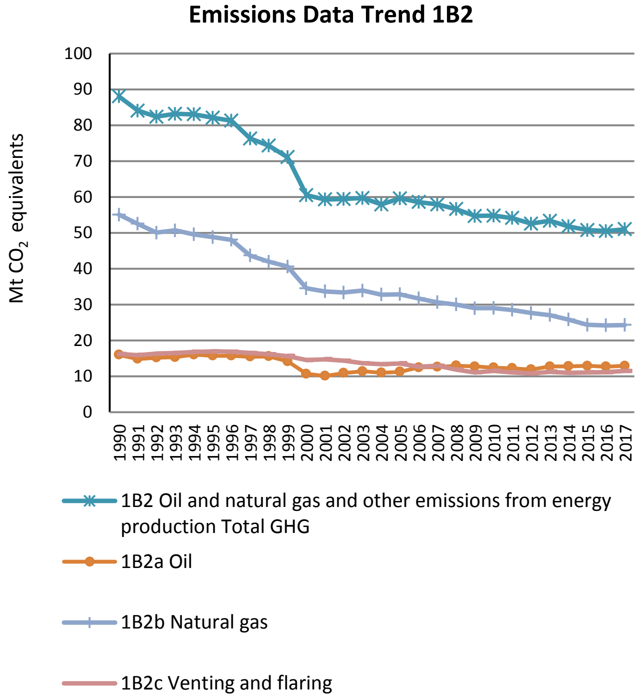
- 44 % were CH_4 emissions from natural gas (exploration, production, processing, transport and distribution)
- 23 % were CO_2 emissions from oil (exploration, production, transport, refining and storage and distribution)
- 5 % were CH_4 emissions due to Other emissions

This source category includes four key categories:

Table 3.113: Key source categories for level and trend analyses and share of MS 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	2017		1990	2017	
1.B.2.a Oil: Operation (CH_4)	6819	1233	T	0	0	71%
1.B.2.a Oil: Operation (CO_2)	9104	11657	T	L	L	90%
1.B.2.b Natural Gas: Operation (CH_4)	51231	22577	T	L	L	81%
1.B.2.c Venting and Flaring: Operation (CO_2)	8718	6894	0	L	L	86%

Figure 3.184 1.B.2-Fugitive Emissions Oil and Natural Gas: Trend



Fugitive emissions from oil and natural gas occur in all Member States but Malta (Table 3.114). Total greenhouse gas emissions from 1.B.2 decreased by 42 % between 1990 and 2017 (Figure **3.184**). This trend was mainly due to the reduction of fugitive CH_4 emissions from natural gas activities, which decreased by 56 % over that period.

In 2017, 54% of all fugitive GHG emissions from oil and natural gas were emitted by four countries: Germany, Italy, Poland and the United Kingdom (Table 3.114). The largest reductions (in absolute terms) were observed in the Romania and in the United Kingdom (both mainly CH_4 emissions), while emissions increased most in Poland (mainly CH_4 emissions) (Table 3.114).

Table 3.114 1.B.2 Fugitive emissions from oil and natural gas: Member States' contributions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2017 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2017 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2017 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2017 (kt CO2 equivalents)
Austria	369	427	102	138	NA,NO,IE	NO,IE,NA	266	289
Belgium	805	614	85	99	NO,IE,NA	NO,IE,NA	720	515
Bulgaria	274	1 024	4	804	0.01	1	270	219
Croatia	971	496	601	296	1	0.2	369	200
Cyprus	0.2	0.2	0.0	0.1	NE,NO	NO	0.2	0.2
Czechia	1 082	612	2	5	0.01	0.02	1 080	608
Denmark	517	383	341	240	53	43	123	99
Estonia	50	16	0.1	0.03	NO	NO	50	16
Finland	123	178	111	147	1	2	11	30
France	6 181	4 031	4 362	2 901	26	13	1 793	1 118
Germany	10 581	6 721	2 234	1 711	1	0.1	8 346	5 011
Greece	79	136	43	8	0.2	0.03	36	128
Hungary	1 750	942	478	130	1	0.3	1 271	811
Ireland	49	78	0.03	5	NO	0.003	49	73
Italy	12 745	7 057	4 013	2 351	12	10	8 720	4 696
Latvia	248	153	0.01	0.02	NO	NO	248	153
Lithuania	266	304	1	3	0.003	0.01	265	301
Luxembourg	19	31	0.03	0.04	NO	NO	19	31
Malta	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	2 707	1 583	775	1 045	NO,IE,NA	NO,IE,NA	1 932	538
Poland	1 130	4 563	46	1 915	0.3	1	1 084	2 648
Portugal	124	1 240	119	1 182	2	3	2	54
Romania	25 366	4 144	1 177	525	3	1	24 186	3 618
Slovakia	1 714	1 440	5	1	0.02	0.003	1 708	1 439
Slovenia	50	40	0.2	0.1	0.001	0.0001	50	40
Spain	2 229	4 543	1 749	3 829	0.2	0.04	480	713
Sweden	375	856	282	795	1	1	92	60
United Kingdom	18 164	9 205	5 778	4 231	41	39	12 345	4 935
EU-28	**87 967**	**50 819**	**22 307**	**22 362**	**143**	**114**	**65 517**	**28 343**
Iceland	62	150	61	146	NA,NO	NO,NA	1	3
United Kingdom (KP)	18 164	9 205	5 778	4 231	41	39	12 345	4 935
EU-28 + ISL	**88 029**	**50 969**	**22 368**	**22 508**	**143**	**114**	**65 517**	**28 347**

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)

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 2006 IPCC Guidelines).

CO_2 emissions from 1.B.2.a 'Fugitive emissions from oil' account for 0.3 % of total EU-28+ISL GHG emissions in 2017 and for 13 % of all fugitive emissions. Between 1990 and 2017, CO_2 emissions from this source increased by 28 % in the EU-28+ISL (Table 3.115). By contrast, during the same period 1990-2017, CH_4 emissions of this source category were reduced by 82 %.

Together France, Italy and Spain accounted for 66 % of the EU-28+ISL total CO_2 emissions of 1.B.2.a 'Fugitive CO_2 emissions from oil' (Table 3.115, Figure 3.185). 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 2019). For detailed information on Member States methodologies please see Annex III. Table **3.115** shows that 90 % of EU-28 CO_2 emissions from this source are calculated using higher tier methods. In cases where member states report a mix of Tier 1 and higher Tier methods (FRK, ITA, ROU, ESP) only emissions from subcategories of sector 1.B.2.a were taken into account for the calculation, where the member states actually apply a higher tier method. Countries that report a Tier 1 method but a country specific or plant specific emission factor (HUN, SVK) were calculated as a Tier 2 method, according to the IPCC 2006 Guidelines.

During the period 1990-2017, the largest decreases in CO_2 emissions (in absolute terms) were observed in Italy, Romania and the United Kingdom. (Table 3.115). Decreasing CO_2 emissions in Italy are mainly driven by the reduction in crude oil losses in refineries (ITA NIR 2019). In the UK, CO_2 emissions from this source decline mainly due to a decrease of 88% of CO_2 emissions in oil exploration (1.B.2.a.1).

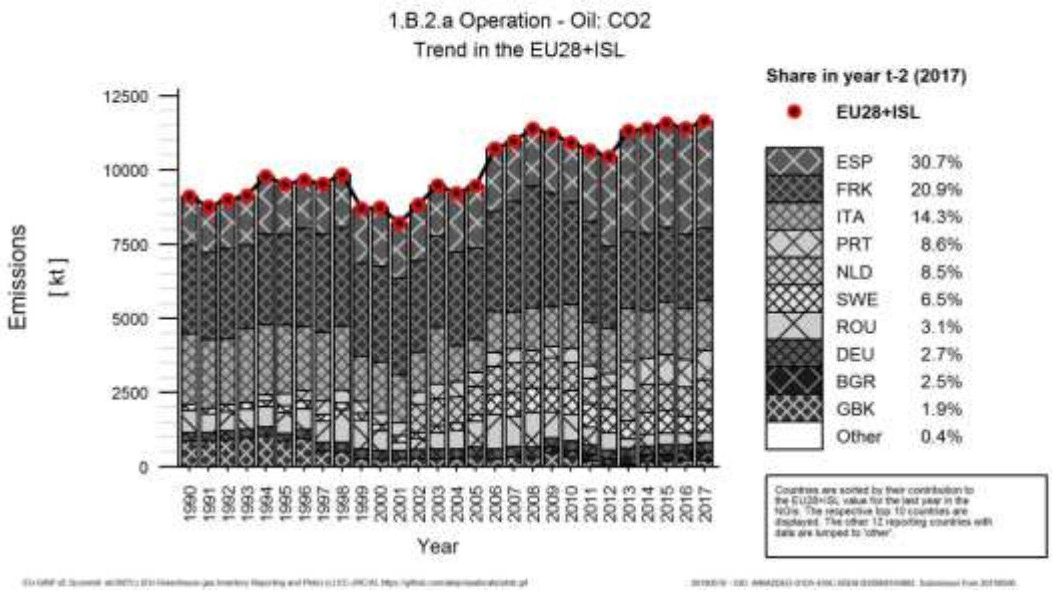
Largest increases between 1990-2017 are reported in the Netherlands, Portugal and Spain (Table 3.115). In all three countries, increases are mainly driven by increases in CO_2 emissions from subcategory 1.B.2.a.4 (Oil – Refining/Storage).

Table 3.115 1.B.2.a Fugitive CO_2 emissions from oil: Member States' contributions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Information
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	0.004	0.004	0.004	0.00004%	0.000	13%	0.00005	1%	T1	D
Belgium	0.01	0.02	0.02	0.0002%	0.01	36%	0.001	7%	T1	D
Bulgaria	1	278	290	2%	289	44016%	12	4%	T1	D
Croatia	158	43	44	0.4%	-114	-72%	0.4	1%	T1	D
Cyprus	NO,NE	NO,NE	NO,NE	-	-	-	-	-	NA	NA
Czechia	0.02	0.04	0.04	0.0003%	0.02	97%	-0.002	-4%	T1	D
Denmark	5	0.004	0.004	0.00003%	-5	-100%	-0.0001	-2%	T3	D,PS
Estonia	NO,NE	NO,NE	NO,NE	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	2 983	2 508	2 437	21%	-546	-18%	-71	-3%	T1,T2,T3	CS,D,PS
Germany	283	249	310	3%	27	10%	60	24%	T2	CS
Greece	0.00004	0.00001	0.00001	0.0000001%	-0.00003	-82%	-0.000002	-20%	T1	D
Hungary	5	0.5	1	0.005%	-5	-90%	0.04	8%	T1	CS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	2 368	1 706	1 671	14%	-697	-29%	-35	-2%	T1,T2	CS,D
Latvia	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Lithuania	0.1	1	1	0.01%	0.5	324%	-0.1	-13%	T1	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	0.02	975	991	9%	991	5506792%	16	2%	CS,T1	D,PS
Poland	0.1	0.2	0.2	0.00%	0.2	345%	0.01	3%	T1	CS,D
Portugal	0.5	931	999	9%	999	206299%	68	7%	D	D
Romania	746	383	359	3%	-388	-52%	-24	-6%	T1,T2	CS,D
Slovakia	0.03	0.01	0.01	0.00%	-0.02	-74%	-0.0003	-4%	T1	CS
Slovenia	0.01	0.02	0.02	0.00%	0.01	154%	0.001	7%	T1	D
Spain	1 477	3 538	3 583	31%	2 107	143%	45	1%	T1,T2	D,PS
Sweden	219	580	756	6%	537	245%	177	31%	T3	PS
United Kingdom	859	216	217	2%	-642	-75%	1	1%	T2	CS,PS
EU-28	**9 104**	**11 408**	**11 657**	**100%**	**2 554**	**28%**	**250**	**2%**	**-**	**-**
Iceland	0.003	0.005	0.005	0.00004%	0.002	62%	0.00004	1%	T1	D
United Kingdom (KP)	859	216	217	2%	-642	-75%	1	1%	T2	CS,PS
EU-28 + ISL	**9 104**	**11 408**	**11 657**	**100%**	**2 554**	**28%**	**250**	**2%**	**-**	**-**

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 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-28+ISL GHG emissions in 2017 and for 1.4 % of all fugitive emissions. Between 1990 and 2017, CH_4 emissions from this source decreased by 82 % in the EU-28+ISL (Table 3.115).

Together Romania, Italy and Germany accounted for 58 % of the EU-28+ISL total CH_4 emissions of 1.B.2.a 'Fugitive CH_4 emissions from oil' (Table 3.116). 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 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 2019). This also explains the outlier in ***Figure 3.186***. 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 Member States methodologies please see Annex III.

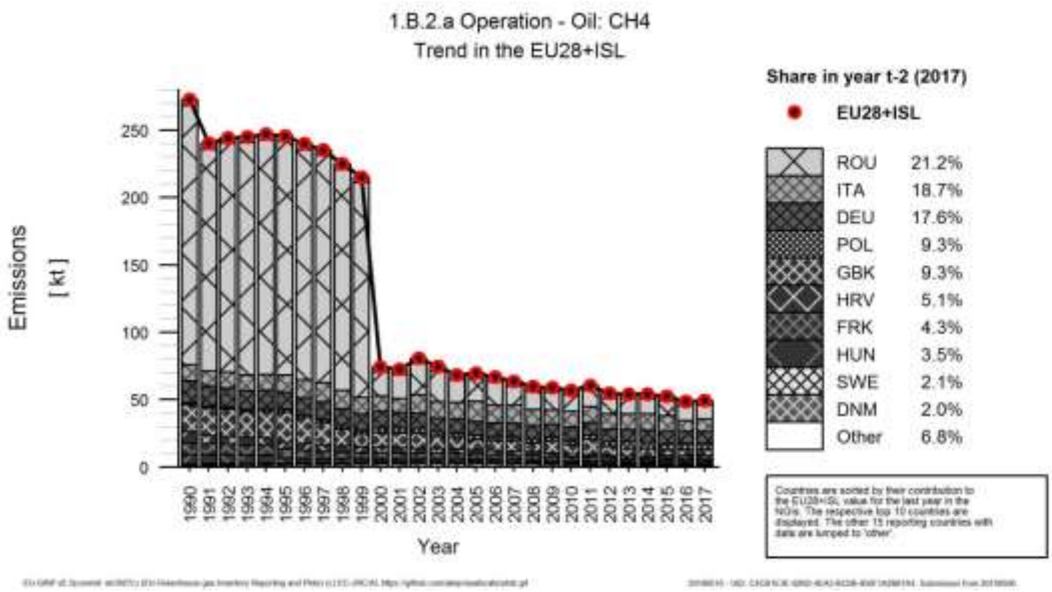
During the period 1990-2017, the largest decreases in CH_4 emissions (in absolute terms) were observed in the United Kingdom and Romania, caused by significant decreases in oil production (-95% in Romania, -75% in the UK). In the same period of time emissions increased most in Poland due to an increase of 384% in oil production (Table 3.116).

Table 3.116 1.B.2.a Fugitive CH_4 emissions from oil: Member States' contributions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	7	8	8	1%	0.2	3%	-0.1	-1%	T1	D
Belgium	11	7	8	1%	-4	-34%	1	8%	CS,D	CS,D
Bulgaria	9	6	6	1%	-3	-34%	0.3	6%	T1	D
Croatia	221	62	62	5%	-158	-72%	1	1%	T1	D
Cyprus	0.1	NO,NE	NO,NE	-	-0.1	-100%	-	-	NA	NA
Czechia	23	5	7	1%	-16	-71%	2	39%	T1,T2	CS,D
Denmark	31	26	25	2%	-6	-21%	-1	-4%	T2,T3	,D,OTH,PS
Estonia	NO,NE	NO,NE	NO,NE	-	-	-	-	-	NA	NA
Finland	6	9	9	1%	3	45%	0.2	2%	T1	D
France	206	57	53	4%	-153	-74%	-4	-7%	T1,T2,T3	CS,D,PS
Germany	404	218	217	18%	-187	-46%	-1	-0.3%	T2	CS
Greece	10	15	15	1%	6	59%	1	3%	T1	D
Hungary	179	43	43	3%	-136	-76%	-0.3	-1%	T1	CS
Ireland	0.2	0.4	0.4	0.03%	0.2	76%	-0.002	-1%	T1	D
Italy	295	211	231	19%	-64	-22%	20	9%	T1,T2	CS,D
Latvia	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Lithuania	4	3	3	0.3%	-1	-26%	0.03	1%	T1	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	20	14	14	1%	-6	-30%	1	5%	T1,T1b	D
Poland	34	113	115	9%	81	237%	2	1%	T1	CS,D
Portugal	2	2	2	0.2%	1	34%	-0.04	-2%	CR,OTH	CR,OTH
Romania	4 811	274	261	21%	-4 550	-95%	-12	-5%	T1	D
Slovakia	15	8	8	1%	-7	-48%	-0.3	-4%	T1	CS
Slovenia	0.3	NO,NA	NO,NA	-	-0.3	-100%	-	-	NA	NA
Spain	4	3	3	0.3%	-1	-17%	0.05	1%	T1	D
Sweden	25	25	26	2%	2	6%	1	4%	T1,T2	CS,D,PS
United Kingdom	500	111	114	9%	-385	-77%	4	3%	T2	CS,PS
EU-28	**6 818**	**1 220**	**1 232**	**100%**	**-5 586**	**-82%**	**12**	**1%**	**-**	**-**
Iceland	0.5	1	1	0%	0.2	45%	0.02	4%	T1	D
United Kingdom (KP)	500	111	114	9%	-385	-77%	4	3%	T2	CS,PS
EU-28 + ISL	**6 819**	**1 221**	**1 233**	**100%**	**-5 586**	**-82%**	**12**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.186: 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 2006 IPCC Guidelines).

CH_4 emissions from 1.B.2.b 'Fugitive emissions from natural gas' account for 0.5 % of total EU-28+ISL GHG emissions in 2017 and for 26 % of all fugitive emissions in the EU-28+ISL. Between 1990 and 2017, CH_4 emissions from this source decreased by 56 % (Table 3.117).

In 2017, 68% of the EU-28+ISL CH_4 emissions from 1.B.2.b were emitted by four Member States: Germany, Italy, Romania and the United Kingdom (Table 3.117, Figure 3.187). 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 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 2019). This also explains the outlier in Figure **3.187**For detailed information on Member States methodologies please see Annex III. Table **3.117** shows that 81 % of EU-28 emissions are calculated using higher tier methods. In cases where member states report a mix of Tier 1 and higher Tier methods (AUT, HRV, FIN, PRT, ESP) only emissions from subcategories of sector 1.B.2.b were taken into account for the calculation, where the member states actually apply a higher tier method. Countries that report a Tier 1 method but a country specific or plant specific emission factor (HUN, SVK) were calculated as a Tier 2 method, according to the IPCC 2006 Guidelines.

The emission decreases between 1990 and 2017 observed in Romania (-86 %), the United Kingdom (-63 %), Germany (-40 %) and in Italy (-47 %) contributed most significantly to the overall reduction in the EU-28+ISL between 1990 and 2017. 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 3.117 1.B.2.b Fugitive CH_4 emissions from natural gas: Member States' contributions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	259	253	281	1%	22	9%	28	11%	T1,T2	CS,D
Belgium	709	515	507	2%	-202	-28%	-9	-2%	CS	CS
Bulgaria	246	192	206	1%	-40	-16%	14	7%	T1	D
Croatia	148	141	138	1%	-10	-7%	-3	-2%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 045	571	574	3%	-471	-45%	3	1%	T1,T2	CS
Denmark	61	47	49	0.2%	-12	-20%	2	4%	T2,T3	CS,D
Estonia	50	17	16	0.1%	-34	-68%	-1	-5%	T1	D
Finland	4	24	21	0.1%	17	394%	-3	-12%	T1,T2	CS,D,PS
France	1 512	1 136	1 042	5%	-470	-31%	-94	-8%	T2,T3	CS,PS
Germany	7 940	4 789	4 791	21%	-3 149	-40%	2	0.04%	T2,T3	CS
Greece	9	69	87	0.4%	78	842%	18	25%	T1	D
Hungary	735	479	604	3%	-131	-18%	125	26%	T1	CS
Ireland	49	71	73	0.3%	24	49%	2	3%	T1,T2	CS,D
Italy	8 235	4 417	4 403	20%	-3 832	-47%	-14	-0.3%	T2	CS
Latvia	177	101	140	1%	-38	-21%	39	39%	T3	CS
Lithuania	261	300	297	1%	36	14%	-3	-1%	T2	CS
Luxembourg	19	32	31	0.1%	12	62%	-0.5	-2%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	421	314	256	1%	-165	-39%	-58	-18%	T3	CS
Poland	753	1 155	1 189	5%	436	58%	34	3%	T1	D
Portugal	NO	48	51	0.2%	51	∞	3	7%	CR,NO,OTH	CR,NO,OTH
Romania	16 762	2 252	2 388	11%	-14 373	-86%	137	6%	T1	D
Slovakia	1 103	865	917	4%	-186	-17%	52	6%	T1	CS
Slovenia	42	32	34	0.2%	-8	-20%	2	5%	T1	D
Spain	454	701	685	3%	231	51%	-16	-2%	CS,T1	CS,D
Sweden	67	37	34	0.1%	-34	-50%	-3	-9%	T2,T3	CS,PS
United Kingdom	10 168	3 838	3 765	17%	-6 404	-63%	-73	-2%	T2,T3	CS,PS
EU-28	**51 231**	**22 394**	**22 577**	**100%**	**-28 653**	**-56%**	**184**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	10 168	3 838	3 765	17%	-6 404	-63%	-73	-2%	T2,T3	CS,PS
EU-28 + ISL	**51 231**	**22 394**	**22 577**	**100%**	**-28 653**	**-56%**	**184**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.187 1.B.2.b Natural Gas: Emission trend and share for the emitting countries of CH_4

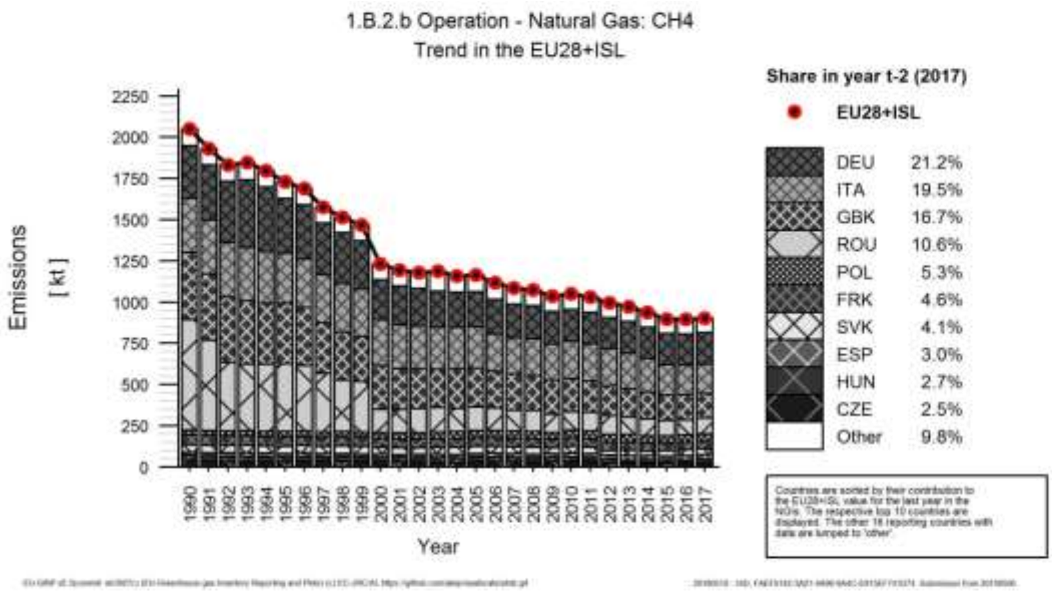


Table 3.118 and Table 3.119 provide an overview on activity data description and emission factors for all member states for sector 1.B.2.a and 1.B.2.b. CRF Tables do not include activity data for sector 1.B.2 because member states use different types of activity data which cannot be aggregated.

Table 3.118: 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**							**2017**						
Member State		**GHG source category**	**Activity data**			**CO_2 IEF (kg/unit)**	**CH_4 IEF (kg/unit)**	**CO_2 EM (kt)**	**CH_4 EM (kt)**	**Activity data**			**CO_2 IEF (kg/unit)**	**CH_4 IEF (kg/unit)**	**CO_2 EM (kt)**	**CH_4 EM (kt)**
			Description	**Unit**	**Value**					**Description**	**Unit**	**Value**				
AUT	**Austria**	**Oil**						**0**	**0.29**						**0**	**0.30**
		1. Exploration	Mt crude oil	Mt	1	NO,IE	IE	IE	IE	Mt crude oil	Mt	0.73	NO,IE	IE	IE	IE
		2. Production	Mt crude oil	Mt	1	NO,IE	IE	IE	IE	Mt crude oil	Mt	0.73	NO,IE	IE	IE	IE
		3. Transport	1000 m3 crude oil	Mt	7 993	0.5	5	0.004	0.04	1000 m3 crude oil	Mt	9 000	0.49	5	0	0.05
		4. Refining and storage	Mt crude oil Input	Mt	8	NA,NO	31 663	NA	0.25	Mt crude oil Input	Mt	8	NO,NA	31663	NA	0.26
		5. Distribution of oil products	Mt gasoline	Mt	3	NA,NO	NA	NA	NA	Mt gasoline	Mt	2	NO,NA	NA	NA	NA
		6. Other		Mt	NO	NO	NO	NO	NO		Mt	NO	NO	NO	NO	NO
BEL	**Belgium**	**Oil**						**0**	**0.46**						**0.02**	**0.30**
		1. Exploration		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
		2. Production		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
		3. Transport		PJ	1 051	14	150	0.01	0.16		PJ	1 428	14	150	0.02	0.21
		4. Refining and storage		PJ	1 251	NA,NO	238	NA	0.30		PJ	1 501	NO,NA	57	NA	0.09
		5. Distribution of oil products		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
		6. Other		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
B	**Bu**	**Oil**						**1**	**0.38**						**0**	**0.24**

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			**1990**							**2017**						
Member State		**GHG source category**	**Activity data**			**CO_2 IEF (kg/unit)**	**CH_4 IEF (kg/unit)**	**CO_2 EM (kt)**	**CH_4 EM (kt)**	**Activity data**			**CO_2 IEF (kg/unit)**	**CH_4 IEF (kg/unit)**	**CO_2 EM (kt)**	**CH_4 EM (kt)**
			Description	**Unit**	**Value**					**Description**	**Unit**	**Value**				
		1. Exploration	Indigenous production	10^3m^3	70	9 102	194	1	0.01	Indigenous production	10^3m^3	28	9102	194	0	0.01
		2. Production	Indigenous production	10^3m^3	70	280	2 200	0.02	0.15	Indigenous production	10^3m^3	28	280	2200	0	0.06
		3. Transport	Indigenous production	10^3m^3	70	2	25	0.0002	0.002	Indigenous production	10^3m^3	28	2	25	0	0.00
		4. Refining and storage	Refinery intake	10^3m^3	9 667	NO	22	NO	0.21	Refinery intake	10^3m^3	7 907	NO	22	NO	0.17
		5. Distribution of oil products		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
CYP	**Cypress**	**Oil**						**NO,NE**	**0.00**						**NO,NE**	**NO,NE**
		1. Exploration		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		2. Production		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		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	NE,NO	3	NE	0.00	Crude Oil refined (10^3 m3)	NO	NO	NO	NO	NO	NO
		5. Distribution of oil products		NE	NE	NO,NE	NE	NE	NE		NE	NE	NO,NE	NE	NE	NE
		6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
CZE	**Czech Republic**	**Oil**						**0.02**	**0.91**						**0.04**	**0.27**
		1. Exploration	(e.g. number of wells drilled)	PJ	NE	NE	NE	NE	NE	(e.g. number of wells drilled)	PJ	NE	NE	NE	NE	NE
		2. Production	(e.g. PJ of oil produced)	PJ	2	7 473	5 897	0.02	0.01	(e.g. PJ of oil produced)	PJ	5	7576	4746	0.03	0.02

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2017						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)
			Description	Unit	Value					Description	Unit	Value				
		3. Transport	(e.g. PJ oil loaded in tankers)	PJ	306	13	145	0.004	0.04	(e.g. PJ oil loaded in tankers)	PJ	333	13	146	0.004	0.05
		4. Refining and storage	(e.g. PJ oil refined)	PJ	306	NE,NO	2 779	NE	0.85	(e.g. PJ oil refined)	PJ	333	NO,NE	585	NE	0.19
		5. Distribution of oil products	(e.g. PJ oil refined)	PJ	306	NE,NO	NE	NE	NE	(e.g. PJ oil refined)	PJ	333	NO,NE	NE	NE	NE
		6. Other	(NO)	PJ	NO	NO	NO	NO	NO	(NO)	PJ	NO	NO	NO	NO	NO
DEU	Germany	**Oil**						**283**	**16.17**						**310**	**8.70**
		1. Exploration	Number of wells drilled	number	12	0.5	64	0.00001	0.00	Number of wells drilled	number	30	0.48	64	0.00001	0.00
		2. Production	oil produced	t	3 605 667	0.1	0.3	0.5	1.08	oil produced	t	2 217 274	0.11	0.01	0.25	0.03
		3. Transport	oil transported	t	87 702 887	NO,NA	0.01	NA	0.59	oil transported	t	104 500 000	NO,NA	0.01	NA	0.61
		4. Refining and storage	oil refined	t	214 116 000	1	0.1	282	14.50	oil refined	t	93 104 000	3	0.09	310	8.05
		5. Distribution of oil products	oil products distributed	t	89 461 000	NO,NA	NA	NA	NA	oil products distributed	t	82 812 827	NO,NA	NA	NA	NA
		6. Other			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
DNM	Denmark	**Oil**						**5**	**1.26**						**0.004**	**1.00**
		1. Exploration	Oil explored	m3	1 930	2 433	0	5	0.00	Oil explored	m3	NO	NO	NO	NO	NO
		2. Production	Oil produced	10^3 m3	6 999	0	1	0	0.00	Oil produced	10^3 m3	7 937	0.04	1	0.0003	0.00
		3. Transport	Oil loaded	Mg	3 390 120	NO,NA	0	NA	0.03	Oil loaded	Mg	3 959 000	NO,NA	0	NA	0.07
		4. Refining and storage	Oil refined	Mg	7 263 000	0	0	0	1.22	Oil refined	Mg	7 490 000	0.0005	0.12	0.003	0.92
		5. Distribution of oil products	Gasoline distribution	Mg	1 734 295	NA	NA	NA	NA	Gasoline distribution	Mg	1 313 933	NA	NA	NA	NA

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2017						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)
			Description	Unit	Value					Description	Unit	Value				
		6. Other	Other	m3	NO	NO	NO	NO	NO	Other	m3	NO	NO	NO	NO	NO
ESP	Spain	**Oil**						**1477**	**0.16**						**3583**	**0.13**
		1. Exploration	Crude oil produced	Tg	NA	NO,NA	NA	NA	NA	Crude oil produced	Tg	NA	NO,NA	NA	NA	NA
		2. Production	Crude oil produced	Tg	1	58	705	0.00005	0.00	Crude oil produced	Tg	0	58.28	676	0.00001	0.00
		3. Transport	Transport of crude oil	Tg	57	66	729	0.004	0.04	Transport of crude oil	Tg	73	50.32	555	0.004	0.04
		4. Refining and storage	Oil refined	Tg	54	27 571 240	2 107	1477	0.11	Oil refined	Tg	69	51847235	1293	3583	0.09
		5. Distribution of oil products	Oil products	Tg	NA	NO,NA	NA	NA	NA	Oil products	Tg	NA	NO,NA	NA	NA	NA
		6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
EST	Estonia	**Oil**						**NO,NE**	**NO,NE**						**NO,NE**	**NO,NE**
		1. Exploration	Exploration	NA	NO	NO	NO	NO	NO	Exploration	NA	NO	NO	NO	NO	NO
		2. Production	Production	NA	NO	NO	NO	NO	NO	Production	NA	NO	NO	NO	NO	NO
		3. Transport	Transport	NA	NO	NO	NO	NO	NO	Transport	NA	NO	NO	NO	NO	NO
		4. Refining and storage	Refining/Storage	NA	NO	NO	NO	NO	NO	Refining/Storag e	NA	NO	NO	NO	NO	NO
		5. Distribution of oil products	Distribution of oil products	kt	NE	NE	NE	NE	NE	Distribution of oil products	kt	NE	NE	NE	NE	NE
		6. Other	Other	NA	NO	NO	NO	NO	NO	Other	NA	NO	NO	NO	NO	NO
FIN	Finland	**Oil**						**NO**	**0.25**						**NO**	**0.36**
		1. Exploration		NA	NO	NO	NO	NO	NO		NA	NO	NO	NO	NO	NO
		2. Production		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		3. Transport		NO	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							2017						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)
			Description	Unit	Value					Description	Unit	Value				
		4. Refining and storage	kt oil refined	kt	9 884	NO	25	NO	0.25	kt oil refined	kt	14 285	NO	25	NO	0.36
		5. Distribution of oil products		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
FRK	France	**Oil**						**2983**	**8.23**						**2437**	**2.12**
FRK	France	1. Exploration	Oil produced	PJ	127	252 097	5 373	32	0.68	Oil produced	PJ	32	252097	5373	8	0.17
FRK	France	2. Production	Oil produced	PJ	127	7 201	54 578	1	6.93	Oil produced	PJ	32	7201	54578	0.23	1.74
FRK	France	3. Transport	Oil loaded	PJ	5 189	7	73	0.03	0.38	Oil loaded	PJ	3 155	6	63	0.02	0.20
FRK	France	4. Refining and storage	Oil refined	PJ	3 194	923 744	75	2950	0.24	Oil refined	PJ	2 420	1003432	6	2428	0.01
FRK	France	5. Distribution of oil products	Oil refined	PJ	3 785	NA	NA	NA	NA	Oil refined	PJ	3 637	NA	NA	NA	NA
FRK	France	6. Other	NO	PJ	NO	NO	NO	NO	NO	NO	PJ	NO	NO	NO	NO	NO
GBK	United Kingdom	**Oil**						**859**	**19.99**						**217**	**4.58**
GBK	United Kingdom	1. Exploration	Exploration drilling: fuel use	t	234 422	3 185	16	747	3.67	Exploration drilling: fuel use	t	27 358	3200	25	88	0.68
GBK	United Kingdom	2. Production	Oil produced	PJ	3 981	28 256	3 209	112	12.78	Oil produced	PJ	2 055	62943	1551	129	3.19
GBK	United Kingdom	3. Transport	Oil loading	t	222 791 650	NO	0.02	NO	3.40	Oil loading	t	57 078 967	NO	0	NO	0.70
GBK	United Kingdom	4. Refining and storage	Refinery throughput	PJ	3 862	NO	37	NO	0.14	Refinery throughput	PJ	2 627	NO	2	NO	0.01
GBK	United Kingdom	5. Distribution of oil products		NA	NO	NO	NO	NO	NO		NA				NO	NO
GBK	United Kingdom	6. Other		NA	NO	NO	NO	NO	NO		NA	NO	NO	NO	NO	NO
G	Gre	**Oil**						**0.00004**	**0.39**						**0.00001**	**0.62**

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2017						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)
			Description	Unit	Value					Description	Unit	Value				
		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		kt	142	0.05	1	0.00001	0.00
		3. Transport		kt	773	NO,NE	27	NE	0.02		kt	142	NO,NE	27	NE	0.00
		4. Refining and storage		kt	14 411	IE,NO	26	IE	0.37		kt	24 030	NO,IE	26	IE	0.61
		5. Distribution of oil products		kt	2 450	NA,NO	NA	NA	NA		kt	2 351	NO,NA	NA	NA	NA
		6. Other			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
HRV	Croatia	**Oil**						**158**	**8.82**						**44**	**2.49**
		1. Exploration	total oil production	1000 m3	3 135	9 102	194	29	0.61	total oil production	1000 m3	866	9102	194	8	0.17
		2. Production	total oil production	1000 m3	3 135	41 225	2 546	129	7.98	total oil production	1000 m3	866	41225	2546	36	2.20
		3. Transport	total oil transported by pipelines	1000 m3	11 230	0.49	5	0.01	0.06	total oil transported by pipelines	1000 m3	6 391	0.49	5	0.003	0.03
		4. Refining and storage	oil refined	1000 m3	7 978	NO,NA	22	NA	0.17	oil refined	1000 m3	4 050	NO,NA	22	NA	0.09
		5. Distribution of oil products	product transported	NA	NA	NO,NA	NA	NA	NA	product transported	NA	NA	NO,NA	NA	NA	NA
		6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
HUN	Hungary	**Oil**						**5**	**7.14**						**1**	**1.71**
		1. Exploration		NA	IE	IE,NO	IE	IE	IE		NA	IE	NO,IE	IE	IE	IE
		2. Production	conventional oil production (thousand m3)	1000 m3	2 269	2 150	3 000	5	6.81	conventional oil production (thousand m3)	1000 m3	810	130	1808	0.1	1.46

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2017						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)
			Description	Unit	Value					Description	Unit	Value				
		3. Transport	Oil transported by pipeline (thousand m3)	1000 m3	10 432	25	13	0.3	0.13	Oil transported by pipeline (thousand m3)	1000 m3	8 430	51	10	0.4	0.08
		4. Refining and storage	Oil refined (thousand m3)	1000 m3	9 364	NA,NO	22	NA	0.20	Oil refined (thousand m3)	1000 m3	7 701	NO,NA	22	NA	0.17
		5. Distribution of oil products		NA	NA	NA,NO	NA	NA	NA		NA	NA	NO,NA	NA	NA	NA
		6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
IRL	Ireland	**Oil**						**NO**	**0.01**						**NO**	**0.01**
		1. Exploration		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
		2. Production		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
		3. Transport		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
		4. Refining and storage		PJ	77	NO	110	NO	0.01		PJ	136	NO	110	NO	0.01
		5. Distribution of oil products		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
		6. Other		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
ISL	Iceland	**Oil**						**0.003**	**0.02**						**0**	**0.03**
		1. Exploration			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
		2. Production			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
		3. Transport			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
		4. Refining and storage			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
		5. Distribution of oil products	oil distributed	TJ	27 981	0.1	1	0.003	0.02	oil distributed	TJ	40 446	0.11	1	0.005	0.03

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2017						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)
			Description	Unit	Value					Description	Unit	Value				
		6. Other			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
ITA	Italy	**Oil**						**2368**	**11.81**						**1671**	**9.24**
ITA	Italy	1. Exploration	Wells drilled	Number	6	1 900	112	0.01	0.00	Wells drilled	Number	NO	NO	NO	NO	NO
ITA	Italy	2. Production	Oil produced	Gg	4 668	320	2 049	1	9.56	Oil produced	Gg	4 148	321	1872	1	7.76
ITA	Italy	3. Transport	Oil transported	Gg	94 600	1	6	0.1	0.58	Oil transported	Gg	115 481	0.56	6	0.06	0.71
ITA	Italy	4. Refining and storage	Oil refined	Gg	93 711	25 251	18	2366	1.66	Oil refined	Gg	80 132	20834	9	1669	0.76
ITA	Italy	5. Distribution of oil products	Oil distributed	NA	NA	NA	NA	NA	NA	Oil distributed	NA	NA	NA	NA	NA	NA
ITA	Italy	6. Other	Other	NA	NO	NO	NO	NO	NO	Other	NA	NO	NO	NO	NO	NO
LTU	Lithuania	**Oil**						**0.1**	**0.17**						**1**	**0.13**
LTU	Lithuania	1. Exploration	Wells drilled, number	thous.m3	14	9 100	194	0.1	0.00	Wells drilled, number	thous.m3	65	9100.00	194	1	0.01
LTU	Lithuania	2. Production	Oil produced, thous.m3	thous.m3	14	0.1	2	0.000002	0.00	Oil produced, thous.m3	thous.m3	65	0.11	1	0.00001	0.00
LTU	Lithuania	3. Transport	Oil transported, thous.m3	thous.m3	25 577	0.5	5	0.01	0.14	Oil transported, thous.m3	thous.m3	15 485	0.49	5	0.01	0.08
LTU	Lithuania	4. Refining and storage	Oil refining, PJ	thous.m3	11 181	NO	3	NO	0.03	Oil refining, PJ	thous.m3	11 512	NO	3	NO	0.03
LTU	Lithuania	5. Distribution of oil products		NA	NA	NO,NA	NA	NA	NA		NA	NA	NO,NA	NA	NA	NA
LTU	Lithuania	6. Other	Producing and capable wells, number	NO	NO	NO	NO	NO	NO	Producing and capable wells, number	NO	NO	NO	NO	NO	NO
LUX	Luxembourg	**Oil**						**NO**	**NO**						**NO**	**NO**
LUX	Luxembourg	1. Exploration	number of wells drilled	NA	NO	NO	NO	NO	NO	number of wells drilled	NA	NO	NO	NO	NO	NO
LUX	Luxembourg	2. Production	oil produced	NA	NO	NO	NO	NO	NO	oil produced	NA	NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990								2017							
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)
			Description	Unit	Value					Description	Unit	Value				
		3. Transport	oil loaded in tankers	NA	NO	NO	NO	NO	NO	oil loaded in tankers	NA	NO	NO	NO	NO	NO
		4. Refining and storage	oil refined	NA	NO	NO	NO	NO	NO	oil refined	NA	NO	NO	NO	NO	NO
		5. Distribution of oil products	oil refined	ktoe	1 577	NO	NO	NO	NO	oil refined	ktoe	2 627	NO	NO	NO	NO
		6. Other	other n.i.e.	NA	NO	NO	NO	NO	NO	other n.i.e.	NA	NO	NO	NO	NO	NO
LVA	Latvia	**Oil**						**NO,NA**	**NO,NA**						**NO,NA**	**NO,NA**
		1. Exploration	Exploration	kt	NO	NO	NO	NO	NO	Exploration	kt	NO	NO	NO	NO	NO
		2. Production	Production	kt	NO	NO	NO	NO	NO	Production	kt	NO	NO	NO	NO	NO
		3. Transport	Transport	kt	NO	NO	NO	NO	NO	Transport	kt	NO	NO	NO	NO	NO
		4. Refining and storage	Refining/Storage	kt	NO	NO	NO	NO	NO	Refining/Storage	kt	NO	NO	NO	NO	NO
		5. Distribution of oil products	Distribution of Oil Products	kt	609	NO,NA	NA	NA	NA	Distribution of Oil Products	kt	190	NO,NA	NA	NA	NA
		6. Other	Other	kt	NO	NO	NO	NO	NO	Other	kt	NO	NO	NO	NO	NO
MLT	Malta	**Oil**						**NO**	**NO**						**NO**	**NO**
		1. Exploration	number of wells drilled	NO	NO	NO	NO	NO	NO	number of wells drilled	NO	NO	NO	NO	NO	NO
		2. Production	oil produced	NO	NO	NO	NO	NO	NO	oil produced	NO	NO	NO	NO	NO	NO
		3. Transport	oil loaded in tankers	NO	NO	NO	NO	NO	NO	oil loaded in tankers	NO	NO	NO	NO	NO	NO
		4. Refining and storage	oil refined	NO	NO	NO	NO	NO	NO	oil refined	NO	NO	NO	NO	NO	NO
		5. Distribution of oil products	Gasoline	NO	NO	NO	NO	NO	NO	Gasoline	NO	NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2017						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)
			Description	Unit	Value					Description	Unit	Value				
		6. Other	Other Petroleum Product	NO	NO	NO	NO	NO	NO	Other Petroleum Product	NO	NO	NO	NO	NO	NO
NLD	Netherlands	**Oil**						**0.02**	**0.81**						**991**	**0.57**
		1. Exploration		PJ	IE	NO,IE	IE	IE	IE		PJ	IE	NO,IE	IE	IE	IE
		2. Production		PJ	IE	NO,IE	IE	IE	IE		PJ	IE	NO,IE	IE	IE	IE
		3. Transport		Mg	33 912	1	6	0.02	0.20		Mg	45 054	0.53	6	0.02	0.26
		4. Refining and storage		PJ	2 077	NO,NA	296	NA	0.61		PJ	2 441	405986	126	991	0.31
		5. Distribution of oil products		PJ	NA	NA	NA	NA	NA		PJ	NE	NO,NA	NE	NA	NE
		6. Other		PJ	NE	NO	NO	NO	NO		PJ	NE	NO	NO	NO	NO
POL	Poland	**Oil**						**0**	**1.36**						**0.25**	**4.60**
		1. Exploration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		2. Production	Production	PJ	7	7 336	101 578	0	0.67	Production	PJ	42	5580	77257	0.23	3.24
		3. Transport	oil ltransported by pipeline	Gg	13 286	1	6	0	0.08	oil ltransported by pipeline	Gg	26 014	0.57	6	0.01	0.16
		4. Refining and storage	oil refined	PJ	529	NA	1 157	NA	0.61	oil refined	PJ	1 068	NA	1121	NA	1.20
		5. Distribution of oil products	NA	NA	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	NA	NA
PRT	Portugal	**Oil**						**0.5**	**0.07**						**999**	**0.09**
		1. Exploration		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		2. Production		NO	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							2017						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)
			Description	Unit	Value					Description	Unit	Value				
		3. Transport		Mt	0.01	490	5 400 000	0.00001	0.07		Mt	0	490	5400000	0.00001	0.09
		4. Refining and storage		Mt	0.04	10 891 516	6	0.5	0.00		Mt	0	14535566534	5	999	0.00
		5. Distribution of oil products		Mt	0.001	NO	NO	NO	NO		Mt	0	NO	NO	NO	NO
		6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
ROU	Romania	**Oil**						**746**	**192.45**						**359**	**10.46**
		1. Exploration	oil produced	PJ	322	2 245 932	47 534	724	15.32	oil produced	PJ	149	258473	5509	38	0.82
		2. Production	oil produced	PJ	322	69 542	547 400	22	176.40	oil produced	PJ	149	7588	62475	1	9.28
		3. Transport	oil refined	PJ	975	14	151	0.01	0.15	oil refined	PJ	476	14	149	0.01	0.07
		4. Refining and storage	oil refined	PJ	962	IE,NO	609	IE	0.59	oil refined	PJ	471	NO,IE	613	IE	0.29
		5. Distribution of oil products	oil refined	PJ	NO	NO	NO	NO	NO	oil refined	PJ	NO	NO	NO	NO	NO
		6. Other	oil refined	kt	NO	NO	IE	NO	IE	oil refined	kt	106	2998533	IE	319	IE
SVK	Slovakia	**Oil**						**0.03**	**0.59**						**0.01**	**0.31**
		1. Exploration		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
		2. Production	Production	kt	73	260	3 600	0.02	0.26	Production	kt	8	260	3600	0.002	0.03
		3. Transport	Transfer	kt	13 581	0.5	5	0.01	0.07	Transfer	kt	9 582	0.49	5	0.005	0.05
		4. Refining and storage	Refining/Storage	kt	6 221	NE	41	NE	0.26	Refining/Storag e	kt	5 557	NE	41	NE	0.23
		5. Distribution of oil products		NA	NO	NO	NO	NO	NO		NA	NO	NO	NO	NO	NO
		6. Other		NA	NO	NO	NO	NO	NO		NA	NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil			1990							2017						
Member State		GHG source category	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)	Activity data			CO_2 IEF (kg/unit)	CH_4 IEF (kg/unit)	CO_2 EM (kt)	CH_4 EM (kt)
			Description	Unit	Value					Description	Unit	Value				
SVN	Slovenia	**Oil**						**0.01**	**0.01**						**0**	**NO,NA**
SVN	Slovenia	1. Exploration	NA	1000 m3	NO	NO	NO	NO	NO	NA	1000 m3	NO	NO	NO	NO	NO
SVN	Slovenia	2. Production	Conventional oil produced	1000 m3	3	0.04	1	0.0000001	0.00	Conventional oil produced	1000 m3	NO	NO	NO	NO	NO
SVN	Slovenia	3. Transport	Consumption of LPG	1000 m3	20	430	NA	0.01	NA	Consumption of LPG	1000 m3	50	430	NA	0.02	NA
SVN	Slovenia	4. Refining and storage	Oil refined	1000 m3	626	NO,NA	22	NA	0.01	Oil refined	1000 m3	NO	NO,NA	NO	NA	NO
SVN	Slovenia	5. Distribution of oil products	NA	1000 m3	NO	NO	NO	NO	NO	NA	1000 m3	NO	NO	NO	NO	NO
SVN	Slovenia	6. Other	NA	1000 m3	NO	NO	NO	NO	NO	NA	1000 m3	NO	NO	NO	NO	NO
SWE	Sweden	**Oil**						**219**	**0.99**						**756**	**1.05**
SWE	Sweden	1. Exploration	Consumption of feedstock	TJ	NO	NO	NO	NO	NO	Consumption of feedstock	TJ	NA	C,NA	C	C	C
SWE	Sweden	2. Production	Oil production		NO	NO	NO	NO	NO	Oil production		NO	NO	NO	NO	NO
SWE	Sweden	3. Transport	Transported amount of oil	PJ	725	NE	745	NE	0.54	Transported amount of oil	PJ	830	NE	745	NE	0.62
SWE	Sweden	4. Refining and storage	Consumption of crude oil	Mt	17	12 645 071	25 906	219	0.45	Consumption of crude oil	Mt	C	C,NA	C	C	C
SWE	Sweden	5. Distribution of oil products	Distribution of oil products		NE	NA	NA	NA	NA	Distribution of oil products		NE	NA	NA	NA	NA
SWE	Sweden	6. Other			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO

Table 3.119 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					2017					
Member State		GHG source category	Activity data: Description	Unit	Value	Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data: Description	Unit	Value	Implied emission factor (kg/unit)	CH_4 emissions (kt)
AUT	Austria	Natural Gas					10.36					11.25
		1. Exploration	Mm3 natural gas	Mm3	248.09	IE	IE	Mm3 natural gas	Mm3	252.84	IE	IE
		2. Production	Mm3 natural gas	Mm3	1288.00	4478.94	5.77	Mm3 natural gas	Mm3	1742.00	3178.18	5.54
		3. Processing	Mm3 natural gas	Mm3	1288.00	NA	NA	Mm3 natural gas	Mm3	1742.00	NA	NA
		4. Transmission and storage	km pipeline length	km	3628.00	718.43	2.61	km pipeline length	km	7249.54	578.54	4.19
		5. Distribution	km distribution network length	km	11672.00	170.22	1.99	km distribution network length	km	30507.27	49.78	1.52
		6. Other	Mm3 natural gas stored	Mm3	1500.00	NO	NO	Mm3 natural gas stored	Mm3	6745.17	NO	NO
BEL	Belgium	Natural Gas					28.35					20.27
		1. Exploration		PJ	NO	NO	NO		PJ	NO	NO	NO
		2. Production		PJ	NO	NO	NO		PJ	NO	NO	NO
		3. Processing		PJ	NO	NO	NO		PJ	NO	NO	NO
		4. Transmission and storage		PJ	342.62	16575.78	5.68		PJ	591.56	9832.33	5.82
		5. Distribution		PJ	342.62	66163.74	22.67		PJ	591.56	24437.24	14.46
		6. Other		PJ	NO	NO	NO		PJ	NO	NO	NO
BGR	Bulgaria	**Natural Gas**					**9.82**					**8.24**
		2. Exploration		NA	IE	IE	IE		NA	IE	IE	IE
		3. Production	Indigenous production	106m3	14.00	1340.00	0.02	Indigenous production	106m3	80.09	1340.00	0.11
		4. Processing	Indigenous production	106m3	14.00	590.00	0.01	Indigenous production	106m3	80.09	590.00	0.05
		5. Transmission and storage	Transmission and storage	106m3	8789.55	273.62	2.41	Transmission and storage	106m3	16387.43	273.50	4.48
		6. Distribution	Inland consumption	106m3	6717.00	1100.00	7.39	Inland consumption	106m3	3272.66	1100.00	3.60

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2017				
Member State		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			Description	Unit	Value		
		7. Other		NO	NO	NO	NO		NO	NO	NO	NO
CYP	Cypress	**Natural Gas**					**NO**					**NO**
		2. Exploration		NO	NO	NO	NO		NO	NO	NO	NO
		3. Production		NO	NO	NO	NO		NO	NO	NO	NO
		4. Processing		NO	NO	NO	NO		NO	NO	NO	NO
		5. Transmission and storage		NO	NO	NO	NO		NO	NO	NO	NO
		6. Distribution		NO	NO	NO	NO		NO	NO	NO	NO
		7. Other		NO	NO	NO	NO		NO	NO	NO	NO
CZE	Czech Republic	**Natural Gas**					**41.80**					**22.97**
		2. Exploration		PJ	NE	NE	NE		PJ	NE	NE	NE
		3. Production	(e.g. PJ gas produced)	PJ	7.84	39365.45	0.31	(e.g. PJ gas produced)	PJ	7.80	38649.05	0.30
		4. Processing		PJ	NO	NA	NA		PJ	NO	NA	NA
		5. Transmission and storage	(e.g. PJ gas consumed)	PJ	1357.98	9296.21	12.62	(e.g. PJ gas consumed)	PJ	1192.06	5370.45	6.40
		6. Distribution	(e.g. PJ gas consumed)	PJ	55.77	517563.35	28.86	(e.g. PJ gas consumed)	PJ	136.61	119047.37	16.26
		7. Other	(e.g. PJ gas consumed)	PJ	29.68	IE	IE	(e.g. PJ gas consumed)	PJ	176.79	IE	IE
DEU	Germany	**Natural Gas**					**317.60**					**191.62**
		3. Exploration	number of wells drilled	number	IE	IE	IE	number of wells drilled	number	IE	IE	IE
		4. Production	gas produced	1000 m³	15262000.00	0.38	5.80	gas produced	1000 m³	7252377.91	0.07	0.54
		5. Processing	gas produced	1000 m³	15262000.00	0.35	5.34	gas produced	1000 m³	7252377.91	0.02	0.12
		6. Transmission and storage	lenght of transmission pipelines	km	22696.00	1957.42	44.43	lenght of transmission pipelines	km	34981.00	2153.71	75.34
		7. Distribution	lenght of distribution pipelines	km	282612.00	824.05	232.89	lenght of distribution pipelines	km	486140.00	176.30	85.70

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2017				
Member State		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			Description	Unit	Value		
		8. Other	gas consumed	TJ	893519.00	32.62	29.15	gas consumed	TJ	1419656.00	21.08	29.92
DNM	Denmark	**Natural Gas**					**2.43**					**1.95**
		3. Exploration	Gas explored	m3	2892052.00	0.01	0.03	Gas explored	m3	NO	NO	NO
		4. Production	Gas produced	10^6 m3	5137.00	380.00	1.95	Gas produced	10^6 m3	4723.00	380.00	1.79
		5. Processing	Gas produced	10^6 m3	5137.00	NA	NA	Gas produced	10^6 m3	4723.00	NA	NA
		6. Transmission and storage	Gas transmission	10^6 m3	2739.00	69.45	0.19	Gas transmission	10^6 m3	4152.00	5.67	0.02
		7. Distribution	Gas distributed	10^6 m3	1749.06	145.93	0.26	Gas distributed	10^6 m3	2349.00	56.84	0.13
		8. Other	Incl. In transmission	m3	NO	NO	NO	Incl. In transmission	m3	NO	NO	NO
ESP	Spain	**Natural Gas**					**18.18**					**27.41**
		3. Exploration	Mm3 gas produced	Mm3	NO	NO	NO	Mm3 gas produced	Mm3	NO	NO	NO
		4. Production	Mm3 gas produced	Mm3	1314.69	461.95	0.61	Mm3 gas produced	Mm3	28.95	2049.77	0.06
		5. Processing	Mm3 gas produced	Mm3	1314.69	150.00	0.20	Mm3 gas produced	Mm3	28.95	150.00	0.00
		6. Transmission and storage	PJ gas (NCV)	PJ	198.23	5893.00	1.17	PJ gas (NCV)	PJ	1137.82	1676.08	1.91
		7. Distribution	PJ of gaseous fuels (natural gas, LPG, gas work gas or propanized air) distributed by networks	PJ	205.63	78806.68	16.21	PJ of gaseous fuels (natural gas, LPG, gas work gas or propanized air) distributed by networks	PJ	1154.32	22042.55	25.44
		8. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
EST	Estonia	**Natural Gas**					**2.01**					**0.65**
		4. Exploration	Exploration	NA	NO	NO	NO	Exploration	NA	NO	NO	NO
		5. Production	Production	NA	NO	NO	NO	Production	NA	NO	NO	NO
		6. Processing	Processing	NA	NO	NO	NO	Processing	NA	NO	NO	NO
		7. Transmission and storage	Amount of the transmission of Natural Gas	PJ	51.23	2217.60	0.11	Amount of the transmission of Natural Gas	PJ	16.53	2217.60	0.04
		8. Distribution	Amount of natural gas distributed	PJ	51.23	36960.00	1.89	Amount of natural gas distributed	PJ	16.53	36960.00	0.61

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2017				
Member State		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			Description	Unit	Value		
		9. Other	Other	NA	NO	NO	NO	Other	NA	NO	NO	NO
FIN	Finland	**Natural Gas**					**0.17**					**0.84**
		4. Exploration		NO	NO	NO	NO		NO	NO	NO	NO
		5. Production		NO	NO	NO	NO		NO	NO	NO	NO
		6. Processing		NA	NO	NO	NO		NA	NA	NA	0.00
		7. Transmission and storage	PJ gas consumed	PJ	91.58	1856.22	0.17	PJ gas consumed	PJ	81.04	3318.28	0.27
		8. Distribution	PJ gas distributed	NO	NO	NO	NO	PJ gas distributed	NO	6.34	89962.12	0.57
		9. Other		NO	NO	NO	NO		NO	NO	NO	NO
FRK	France	**Natural Gas**					**60.47**					**41.67**
		4. Exploration	NO	PJ	NO	NO	NO	NO	PJ	NO	NO	NO
		5. Production	NO	PJ	IE	IE	IE	NO	PJ	IE	IE	IE
		6. Processing	Gas processed	PJ	309.00	2376.20	0.73	Gas processed	PJ	6.44	303.96	0.00
		7. Transmission and storage	Gas consumed	PJ	1089.91	24450.02	26.65	Gas consumed	PJ	1612.88	12968.89	20.92
		8. Distribution	Gas consumed	PJ	1089.91	30361.79	33.09	Gas consumed	PJ	1612.88	12867.73	20.75
		9. Other	NO	PJ	NO	NO	NO	NO	PJ	NO	NO	NO
GBK	United Kingdom	**Natural Gas**					**406.73**					**150.59**
		5. Exploration	Exploration drilling: fuel use	t	225517.62	15.66	3.53	Exploration drilling: fuel use	t	48292.63	45.00	2.17
		6. Production	Gas produced	PJ	1709.37	IE	IE	Gas produced	PJ	1506.37	IE	IE
		7. Processing	Gas produced	PJ	1709.37	12756.73	21.81	Gas produced	PJ	1506.37	1393.37	2.10
		8. Transmission and storage	Natural gas supply	GWh	387730.56	23.58	9.14	Natural gas supply	GWh	495421.85	8.48	4.20
		9. Distribution	Natural gas supply	GWh	387730.56	960.08	372.25	Natural gas supply	GWh	495421.85	286.85	142.11
		10. Other		NA	NO	NO	NO		NA	NO	NO	NO

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2017				
Member State		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			Description	Unit	Value		
GRC	Greece	**Natural Gas**					**0.37**					**3.47**
		5. Exploration			NE	NE	NE			NE	NE	NE
		6. Production		mil_m3	123.00	1930.00	0.24		mil_m3	8.25	1930.00	0.02
		7. Processing		mil_m3	123.00	IE	IE		mil_m3	8.25	IE	IE
		8. Transmission and storage		mil m3	123.00	298.00	0.04		mil m3	4923.97	298.00	1.47
		9. Distribution		mil m3	86.24	1100.00	0.09		mil m3	1809.32	1100.00	1.99
		10. Other			IE	IE	IE			IE	IE	IE
HRV	Croatia	**Natural Gas**					**5.92**					**5.52**
		5. Exploration	Natural gas production	1000000 m3	1982.30	194.00	0.38	Natural gas production	1000000 m3	1483.50	194.00	0.29
		6. Production	gas produced	1000000 m3	1982.30	1340.76	2.66	gas produced	1000000 m3	1483.50	1340.76	1.99
		7. Processing	gas produced	1000000 m3	1982.30	592.00	1.17	gas produced	1000000 m3	1483.50	592.00	0.88
		8. Transmission and storage	marketable gas	1000000 m3	2686.60	480.00	1.29	marketable gas	1000000 m3	3008.30	480.00	1.44
		9. Distribution	utility sales	1000000 m3	379.30	1100.00	0.42	utility sales	1000000 m3	833.40	1100.00	0.92
		10. Other		NO	NO	NO	NO		NO	NO	NO	NO
HUN	Hungary	**Natural Gas**					**29.39**					**24.14**
		6. Exploration		NA	IE	IE	IE		NA	IE	IE	IE
		7. Production	Gas production (million m3)	million m3	4874.00	1340.00	6.53	Gas production (million m3)	million m3	1818.00	1340.00	2.44
		8. Processing	Sweet gas plants-raw gas feed (million m3)	million m3	1593.00	940.86	1.50	Sweet gas plants-raw gas feed (million m3)	million m3	655.59	913.23	0.60
		9. Transmission and storage	Marketable gas (million m3)	million m3	11278.00	674.50	7.61	Marketable gas (million m3)	million m3	17444.00	298.00	5.20

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2017				
Member State		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			Description	Unit	Value		
		10. Distribution	Utility sales (million m3)	million m3	12507.10	1100.00	13.76	Utility sales (million m3)	million m3	14465.10	1100.00	15.91
		11. Other		NO	NO	NO	NO		NO	NO	NO	NO
IRL	Ireland	**Natural Gas**					**1.97**					**2.92**
		6. Exploration	Natural gas exploration	PJ	IE	IE	IE	Natural gas exploration	PJ	IE	IE	IE
		7. Production		PJ	78.58	14330.75	1.13		PJ	119.49	3174.04	0.38
		8. Processing		PJ	IE	IE	IE		PJ	IE	IE	IE
		9. Transmission and storage		PJ	77.19	1768.05	0.14		PJ	178.60	1768.05	0.32
		10. Distribution		PJ	23.85	29467.53	0.70		PJ	75.50	29467.53	2.22
		11. Other		PJ	NO	NO	NO		PJ	NO	NO	NO
ISL	Iceland	**Natural Gas**					**NO**					**NO**
		6. Exploration	Natural gas exploration	PJ	NO	NO	NO	Natural gas exploration	PJ	NO	NO	NO
		7. Production		PJ	NO	NO	NO		PJ	NO	NO	NO
		8. Processing		PJ	NO	NO	NO		PJ	NO	NO	NO
		9. Transmission and storage		PJ	NO	NO	NO		PJ	NO	NO	NO
		10. Distribution		PJ	NO	NO	NO		PJ	NO	NO	NO
		11. Other		PJ	NO	NO	NO		PJ	NO	NO	NO
ITA	Italy	**Natural Gas**					**329.40**					**176.12**
		6. Exploration	Wells explored	Number	36.00	158.15	0.01	Wells explored	Number	3.00	111.76	0.00
		7. Production	Gas produced	Mm3	17296.39	1726.36	29.86	Gas produced	Mm3	5656.85	905.99	5.13
		8. Processing	Gas produced	Mm3	17296.39	773.26	13.37	Gas produced	Mm3	5656.85	405.75	2.30
		9. Transmission and storage	Gas transported	Mm3	45683.58	822.12	37.56	Gas transported	Mm3	74590.00	397.18	29.63

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2017				
Member State		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			Description	Unit	Value		
		10. Distribution	Gas distributed	Mm3	20632.00	12049.57	248.61	Gas distributed	Mm3	33498.67	4151.76	139.08
		11. Other	other	NA	NO	NO	NO	other	NA	NO	NO	NO
LTU	Lithuania	**Natural Gas**					**10.42**					**11.87**
		7. Exploration		NO	NO	NO	NO		NO	NO	NO	NO
		8. Production		NO	NO	NO	NO		NO	NO	NO	NO
		9. Processing		NO	NO	NO	NO		NO	NO	NO	NO
		10. Transmission and storage	Natural gas leakages	kt	2.01	977699.00	1.97	Natural gas leakages	kt	4.51	950519.00	4.28
		11. Distribution	Natural gas leakages	kt	8.65	977699.00	8.46	Natural gas leakages	kt	7.93	950519.00	7.54
		12. Other	Natural gas leakages	NO	NO	NO	NO	Natural gas leakages	NO	0.04	950519.00	0.04
LUX	Luxembourg	**Natural Gas**					**0.77**					**1.25**
		7. Exploration	gas exploration	NA	NO	NO	NO	gas exploration	NA	NO	NO	NO
		8. Production	gas produced	NA	NO	NO	NO	gas produced	NA	NO	NO	NO
		9. Processing	NO	NA	NO	NO	NO	NO	NA	NO	NO	NO
		10. Transmission and storage	gas consumed	TJ	17933.32	13.12	0.24	gas consumed	TJ	29283.80	12.98	0.38
		11. Distribution	gas consumed	TJ	17933.32	30.07	0.54	gas consumed	TJ	29283.80	29.74	0.87
		12. Other	NO	NA	NO	NO	NO	NO	NA	NO	NO	NO
LVA	Latvia	**Natural Gas**					**7.09**					**5.58**
		7. Exploration	Exploration	m3	NO	NO	NO	Exploration	m3	NO	NO	NO
		8. Production	Production	m3	NO	NO	NO	Production	m3	NO	NO	NO
		9. Processing	Processing	m3	NO	NO	NO	Processing	m3	NO	NO	NO
		10. Transmission and storage	Transmission and storage	m3	125172.00	0.69	0.09	Transmission and storage	m3	12237.00	0.63	0.01

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2017				
Member State		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			Description	Unit	Value		
		11. Distribution	Distribution	m3	694188.00	0.69	0.48	Distribution	m3	731977.00	0.65	0.48
		12. Other	Other	m3	12435406.00	0.52	6.53	Other	m3	7816723.00	0.65	5.10
MLT	Malta	**Natural Gas**					**NO**					**NO**
		8. Exploration	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
		9. Production	gas produced	NO	NO	NO	NO	gas produced	NO	NO	NO	NO
		10. Processing	gas processed	no	NO	NO	NO	gas processed	no	NO	NO	NO
		11. Transmission and storage	gas consumed	NO	NO	NO	NO	gas consumed	NO	NO	NO	NO
		12. Distribution	gas consumed	NO	NO	NO	NO	gas consumed	NO	NO	NO	NO
		13. Other	gas consumed	NO	NO	NO	NO	gas consumed	NO	NO	NO	NO
NLD	Netherlands	**Natural Gas**					**16.84**					**10.23**
		8. Exploration		number	NA	IE	IE		number	NA	IE	IE
		9. Production		mln m3	72131.00	IE	IE		mln m3	43915.00	IE	IE
		10. Processing		PJ	IE	IE	IE		PJ	IE	IE	IE
		11. Transmission and storage		PJ	2648.08	4121.34	10.91		PJ	3108.00	1486.16	4.62
		12. Distribution		10^3 km	99.98	59294.88	5.93		10^3 km	125.13	44860.86	5.61
		13. Other		PJ	NA	NO	NO		PJ	IE	NO	NO
POL	Poland	**Natural Gas**					**30.13**					**47.57**
		8. Exploration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		9. Production	Production	PJ	99.56	74346.49	7.40	Production	PJ	147.04	71634.78	10.53
		10. Processing		PJ	99.56	33294.30	3.31		PJ	147.04	32079.92	4.72
		11. Transmission and storage	gas consumed	PJ	374.21	15515.79	5.81	gas consumed	PJ	646.64	14949.87	9.67

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2017				
Member State		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			Description	Unit	Value		
		12. Distribution	gas consumed	PJ	374.21	35557.02	13.31	gas consumed	PJ	646.64	34260.11	22.15
		13. Other	NA	PJ	374.21	808.11	0.30	NA	PJ	646.64	778.64	0.50
PRT	Portugal	**Natural Gas**					**NO**					**2.03**
		9. Exploration		NO	NO	NO	NO		NO	NO	NO	NO
		10. Production		NO	NO	NO	NO		NO	NO	NO	NO
		11. Processing		NO	NO	NO	NO		NO	NO	NO	NO
		12. Transmission and storage		toe NG Transmitted	NO	NO	NO		toe NG Transmitted	5389.38	10.90	0.06
		13. Distribution		toe NG Distributed	NO	NO	NO		toe NG Distributed	1728.64	1138.83	1.97
		14. Other		NO	NO	NO	NO		NO	NO	NO	NO
ROU	Romania	**Natural Gas**					**670.47**					**95.53**
		9. Exploration	gas produced		IE	IE	IE	gas produced		IE	IE	IE
		10. Production	gas produced	106m3	28336.00	12190.00	345.42	gas produced	106m3	10581.90	1340.00	14.18
		11. Processing	gas produced and processed	106m3	28336.00	250.00	7.08	gas produced and processed	106m3	10581.90	590.00	6.24
		12. Transmission and storage	gas produced	106m3	35667.00	633.00	22.58	gas produced	106m3	13391.15	243.12	3.26
		13. Distribution	gas supplied	106m3	35667.00	1800.00	64.20	gas supplied	106m3	11777.60	1100.00	12.96
		14. Other	gas consumed	PJ	899.10	257135.36	231.19	gas consumed	PJ	288.54	204133.18	58.90
SVK	Slovakia	**Natural Gas**					**44.14**					**36.68**
		9. Exploration		NA	NO	NO	NO		NA	NO	NO	NO
		10. Production	Production/Processing	mil m3	444.00	2300.00	1.02	Production/Processing	mil m3	140.00	2300.00	0.32

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2017				
Member State		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			Description	Unit	Value		
		11. Processing		mil m3	444.00	1030.00	0.46		mil m3	140.00	1030.00	0.14
		12. Transmission and storage	Transfer	mil m3	73600.00	480.00	35.33	Transfer	mil m3	64200.00	480.00	30.82
		13. Distribution	Distribution	mil m3	6666.00	1100.00	7.33	Distribution	mil m3	4901.25	1100.00	5.39
		14. Other	Storage	mil m3	1.00	25.00	0.00	Storage	mil m3	418.00	25.00	0.01
SVN	Slovenia	**Natural Gas**					**1.70**					**1.36**
		10. Exploration	NA	1000 m3	NO	NO	NO	NA	1000 m3	NO	NO	NO
		11. Production	Gas production	1000 m3	23631.00	12.19	0.29	Gas production	1000 m3	8393.00	1.34	0.01
		12. Processing	NA	1000 m3	NO	NO	NO	NA	1000 m3	NO	NO	NO
		13. Transmission and storage	Marketable gas	1000 m3	892000.60	0.48	0.43	Marketable gas	1000 m3	910893.00	0.38	0.35
		14. Distribution	Utility sale	1000 m3	892000.60	1.10	0.98	Utility sale	1000 m3	907294.00	1.10	1.00
		15. Other	NA	1000 m3	NO	NO	NO	NA	1000 m3	NO	NO	NO
SWE	Sweden	**Natural Gas**					**2.69**					**1.35**
		10. Exploration	Gas produced		NO	NO	NO	Gas produced		NO	NO	NO
		11. Production	Gas produced		NO	NO	NO	Gas produced		NO	NO	NO
		12. Processing	Gas produced		NO	NO	NO	Gas produced		NO	NO	NO
		13. Transmission and storage	Length of transmission pipelines	km	NA	NA	0.05	Length of transmission pipelines	km	NA	NA	0.08
		14. Distribution	Length of distribution pipelines	km	NA	NA	2.65	Length of distribution pipelines	km	NA	NA	1.27
		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-28+ISL GHG emissions in 2017 and for 8 % of all fugitive emissions in the EU28+ISL. Between 1990 and 2017 CO_2 emissions from this source decreased by 21%.

All but four Member states (Austria, Estonia, Luxembourg, Malta) - are reporting CO_2 emissions in this category.

In 2017, 55% of the EU-28+ISL CO_2 emissions from 1.B.2.c were emitted by the UK (Table 3.120, Figure 3.188) 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 3.120 shows that 86 % of EU-28 emissions are calculated using higher tier methods. In cases where member states report a mix of Tier 1 and higher Tier methods (FRK, ESP) only emissions from subcategories of sector 1.B.2.b were taken into account for the calculation, where the member states actually apply a higher tier method. Countries that report a Tier 1 method but a country specific or plant specific emission factor (HUN, SVK) were calculated as a Tier 2 method, according to the IPCC 2006 Guidelines.

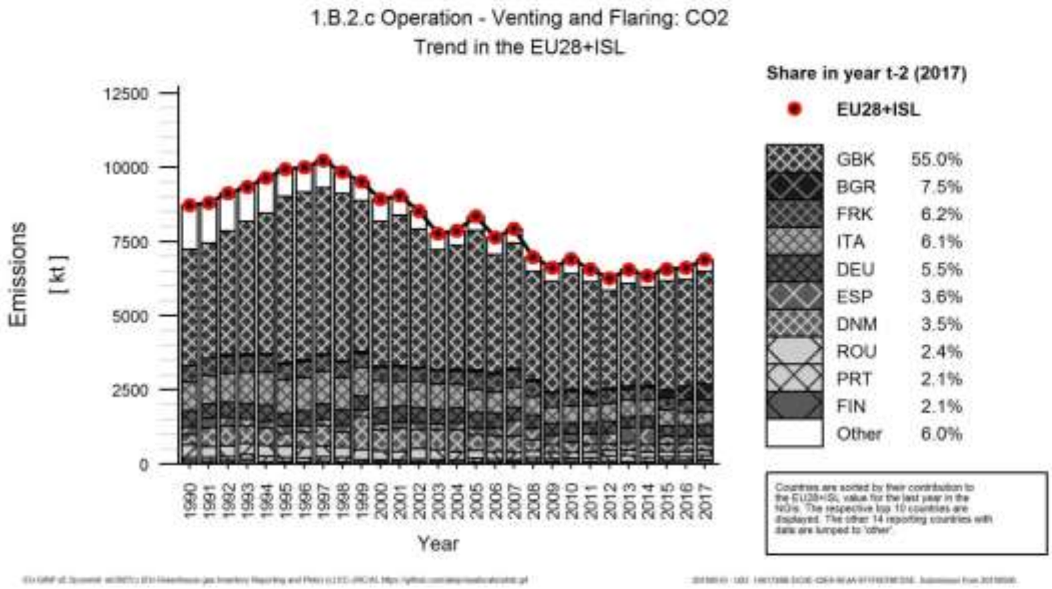
The emission decreases between 1990 and 2017 observed in the Netherlands (-93%), Italy (-56%), the UK (-3%), Hungary (-73%) and Romania (-61 %) contributed most significantly to the overall reduction in the EU-28+ISL between 1990 and 2017.

Table 3.120: 1.B.2.c Fugitive CO_2 emissions from Other emissions: Member States' contributions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	IE	IE	IE	-	-	-	-	-	NA	NA
Belgium	84	78	98	1%	15	17%	21	27%	T3	PS
Bulgaria	3	467	514	7%	511	16378%	48	10%	T1	D
Croatia	0.002	0.0002	0.0001	0.000002%	-0.002	-94%	-0.0001	-40%	T1	D
Cyprus	0.04	0.1	0.1	0.001%	0.02	66%	0.002	4%	T1	D
Czechia	2	5	4	0.1%	2	120%	-0.4	-8%	T1	D
Denmark	328	273	240	3%	-88	-27%	-33	-12%	T3	PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	111	104	147	2%	36	32%	42	41%	CS	CS
France	560	414	429	6%	-131	-23%	15	4%	T1,T2,T3	CS,D,PS
Germany	544	387	381	6%	-163	-30%	-6	-1.52%	T2	CS
Greece	43	9	7	0.1%	-35	-83%	-2	-19%	T1	D
Hungary	471	132	129	2%	-343	-73%	-4	-3%	T1,T3	CS
Ireland	NO	1	5	0.1%	5	∞	3	252%	CS,T3	CS,PS
Italy	956	420	420	6%	-536	-56%	-0.2	-0.04%	T1	D
Latvia	0.003	0.002	0.002	0.00003%	-0.001	-34%	0.0002	15%	T3	CS
Lithuania	1	3	3	0.04%	2	360%	-0.4	-13%	T1	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	774	52	54	1%	-721	-93%	2	4%	T2	PS
Poland	44	69	73	1%	29	67%	4	5%	T1	D
Portugal	118	143	147	2%	29	24%	3	2%	NO	NO
Romania	424	170	164	2%	-260	-61%	-7	-4%	T1	D
Slovakia	5	1	1	0.01%	-4	-79%	0.1	8%	T1	CS
Slovenia	0.2	0.01	0.01	0.0002%	-0.2	-93%	0.004	52%	T1	D
Spain	272	238	246	4%	-26	-10%	8	3%	CS,T1,T2	CS,D,PS
Sweden	61	50	39	1%	-22	-36%	-11	-23%	T2,T3	CS,PS
United Kingdom	3920	3600	3794	55%	-126	-3%	194	5%	T2	CS,PS
EU-28	**8718**	**6617**	**6894**	**100%**	**-1 825**	**-21%**	**277**	**4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3920	3600	3794	55%	-126	-3%	194	5%	T2	CS,PS
EU-28 + ISL	**8718**	**6617**	**6894**	**100%**	**-1 825**	**-21%**	**277**	**4%**	**-**	**-**

Note: Austria includes CO_2 emissions from venting and flaring in 1.A.1b Petroleum refining

Figure 3.188: 1.B.2.c Venting and Flaring: Emission trend and share for the emitting countries of CO_2



3.2.6.4 CH_4 Emissions from Other (1.B.2.d)

Fugitive emissions from other correspond to emissions from geo thermal 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, three countries also report N_2O emissions. The description of the subcategories is presented in Table 3.121.

Table 3.121 Description of subcategories in sector 1.B.2.d for CO_2-, N_2O- and CH_4-emissions for reporting Member States

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	No information on subcategory available
Portugal	CO_2	Geothermal
United Kingdom	N_2O	Natural gas exploration: N_2O emissions

Table 3.122 and Table 3.123 provide information on the contribution of countries to EU-28+ISL recalculations in CO_2 and CH_4 from 1.B.2 'Oil and natural gas' for 1990 and 2016 and main explanations for the largest recalculations in absolute terms.

Table 3.1221.B.2 Fugitive CO_2 emissions from Oil and natural gas: Contribution of MS to EU recalculations in CO_2 for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	-	-	-0	-0.0	
Bulgaria	-	-	739	13 297.2	
Croatia	-79	-11.7	-66	-22.8	double counted emissions from scrubbing process
Cyprus	-	-	-	-	
Czechia	-	-	-	-	
Denmark	-	-	0	0.0	Activity data for the gas treatment plant have been updated for the time series. The largest change is made for 2013 with an increase of 38 % (10447 GJ). CO_2 from flaring in gas storage and treatment plants have been updated (minor corrections) according to annual gas quality data from Energinet.dk.
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	-	-	1	0.0	Update of the distribution of natural gas distributors in France
Germany	0	0.0	5	0.3	Update of activity data (transport of natural gas, distribution of oil products)
Greece	-	-	-	-	

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Hungary	-	-	-	-	
Ireland	0	16.0	-0	-10.1	Estimation of CO_2- and CH_4 emissions in category 1B2b5
Italy	-0	-0.0	-0	-0.0	
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-	-	-0	-0.0	
Poland	5	11.1	157	8.5	The calorific value for natural gas and CO_2 process emission from refineries was updated.
Portugal	-	-	0	0.0	Update of 2016 Activity Data
Romania	-	-	-357	-39.1	CO_2 emissions were recalculated for 2000 - 2016 period taking into account the EFs updated; thus, for this period EF values from table 4.2.4, page 4.48 were used, while for the 1989-1999 period EFs from table 4.2.5., page 4.55 continued to be used; Transmission and storage (1.B.2.b.4) category: the emission values for 2016 has been updated because activity data related to storage of natural gas for 2016 has been updated.
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	0	0.0	-0	-0.0	Correction of mistakes in the emission factors used Recalculations due to a methodological up-grading
Sweden	-9	-3.1	-37	-5.5	Re-allocations and EF corrections flaring
United Kingdom	-	-	58	1.4	Revision to upstream oil and gas fugitive estimates (new installation data added).
EU28	-84	-0.4	499	2.3	
Iceland	0	0.0	0	0.0	
United Kingdom (KP)					Revision to upstream oil and gas fugitive estimates (new installation data added).
EU28+ISL	-84	-0.5	441	2.5	

Table 3.1231.B.2 Fugitive CH_4 emissions from Oil and natural gas: Contribution of MS to EU-28+ISL recalculations in CH_4 for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-0.0004	-0.0	Update of Activity Data
Belgium	-	-	-0.0003	-0.0	
Bulgaria	-	-	0.04	0.0	For category 1.B.2.b.4 Fugitive emissions from gas transmission, the previous emission factor of 1340 kgCH_4/km was changed to 2500 kgCH_4/km (IPCC GPG 2000, Table 2.16, p.2.86), following a recommendation of the ERT during the Centralized review in 2012. For the latest submission the calculation approach was changed to rely on transited gas quantities following the adoption of the 2006 2006 IPCC Guidelines.
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czechia	-	-	-	-	

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Denmark	-	-	0.1	0.1	Activity data for the gas treatment plant have been updated for the time series. The largest change is made for 2013 with an increase of 38 % (10447 GJ).
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	0.02	0.001	3	0.3	Update of the distribution of natural gas distributors in France
Germany	-0	-0.0	-57	-1.1	Update of activity data (transport of natural gas, distribution of oil products).
Greece	-	-	-	-	
Hungary	-	-	-	-	
Ireland	-107	-68.4	51	248.9	Estimation of CO_2- and CH_4 emissions in category 1B2b5.
Italy	-0.2	-0.002	-0.01	-0.0003	
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-	-	-	-	
Poland	85	8.5	90	3.5	Recalculation for the years 1988-2016 was made. Recalculation for this years was made as the result of: - updated activity data according to Eurostat database; - updated the net calorific value of natural gas; - update of clasification of instalations related to calculation of CO_2 process emission from refineries.
Portugal	2	309.4	-3	-6.0	Review of molar mass composition of Natural Gas
Romania	-171	-0.7	-5 276	-59.9	CH_4 emissions were recalculated for 2000 - 2016 period taking into account the EFs updated; thus, for this period EF values from table 4.2.4, page 4.48 were used, while for the 1989-1999 period EFs from table 4.2.5., page 4.55 continued to be used; Transmission and storage (1.B.2.b.4) category: the emission values for 2016 has been updated because activity data related to storage of natural gas for 2016 has been updated.
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	29	6.5	98	15.5	Correction of a mistake in the activity data used Correction of mistakes in the emission factors used
Sweden	-0	-0.1	-1	-1.4	
United Kingdom	0.03	0.0003	61	1.2	Updated emission estimates from fugitives and venting in the natural gas National Transmission System.
EU28	-162	-0.2	-5 034	-15.2	
Iceland	-0	-0.0	-0	-0.0	
United Kingdom (KP)					Updated emission estimates from fugitives and venting in the natural gas National Transmission System.
EU28+ISL	-162	-0.3	-5 094	-18.0	

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 CO_2 emissions in this category for the years 1993 to 2017.

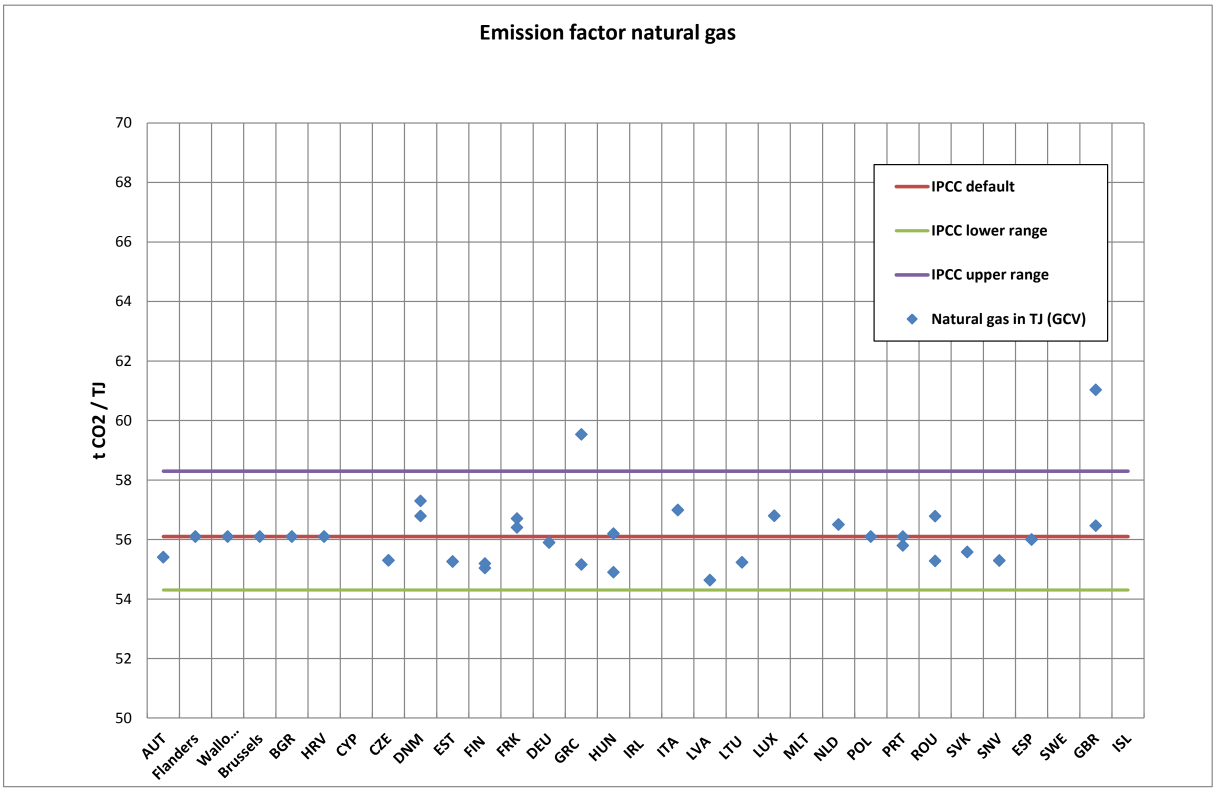
The amount of CO_2 captured reflects the CO_2 captured in pulp and paper mills in Finland, where precipitated calcium carbonate (PCC) is formed and then used in the paper and paperboard industry. The final use of the CO_2 captured is considered as long-term storage except if the products are combusted. 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.

CO_2 emissions from 1C 'CO_2 capture and storage' account for 0.003 % of total EU-28+ISL GHG emissions in 2017. The emissions increased between 1993 and 2017 by 14 715%.

3.3 Methodological issues and uncertainties (EU-28)

The previous section presented for each EU-28 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 in 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.

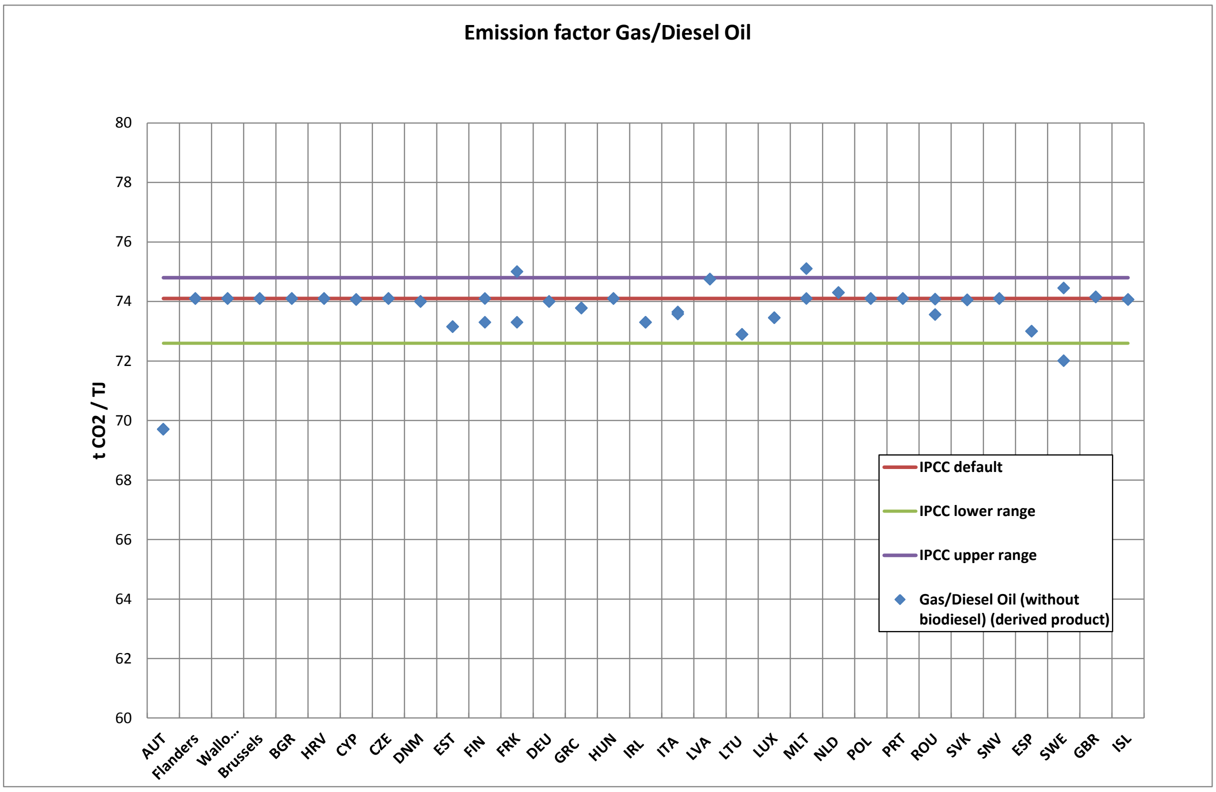
Figure 3.189 Emission factors used by Member States for natural gas



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 3.190 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 3.191 Emission factors used by Member States for LPG

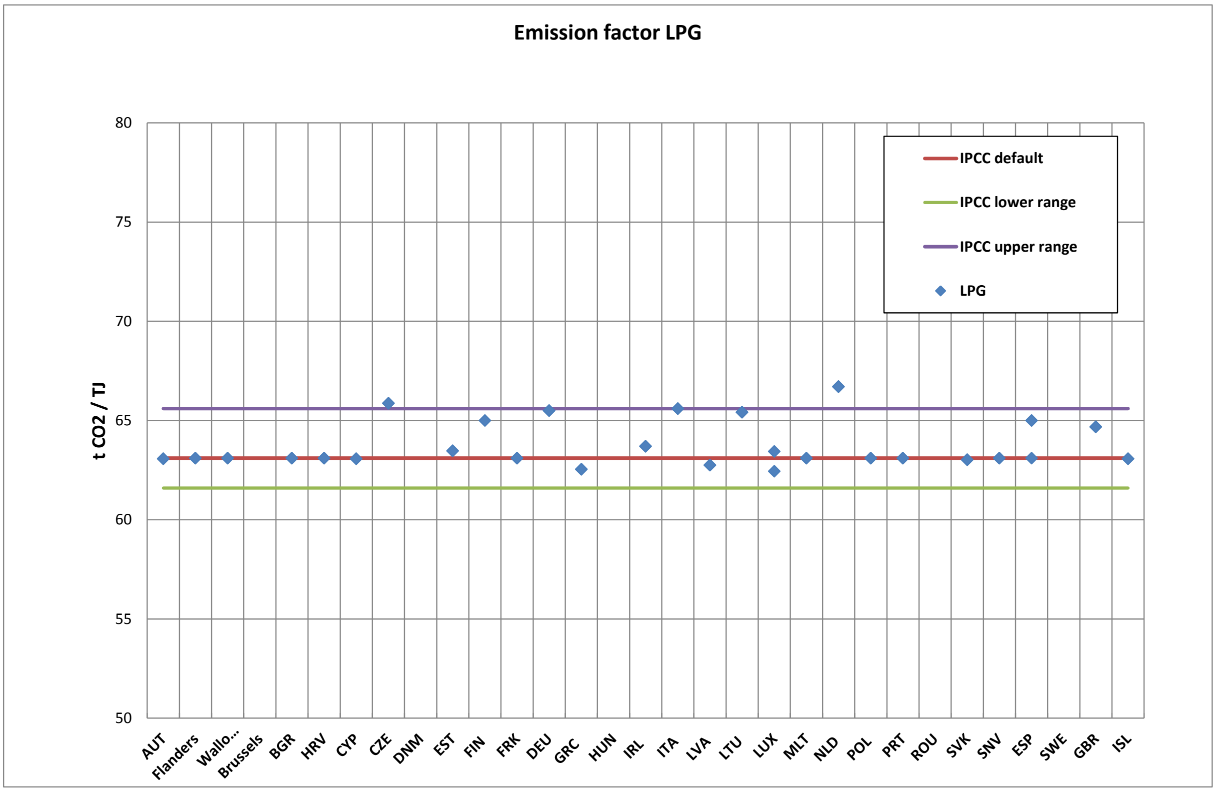
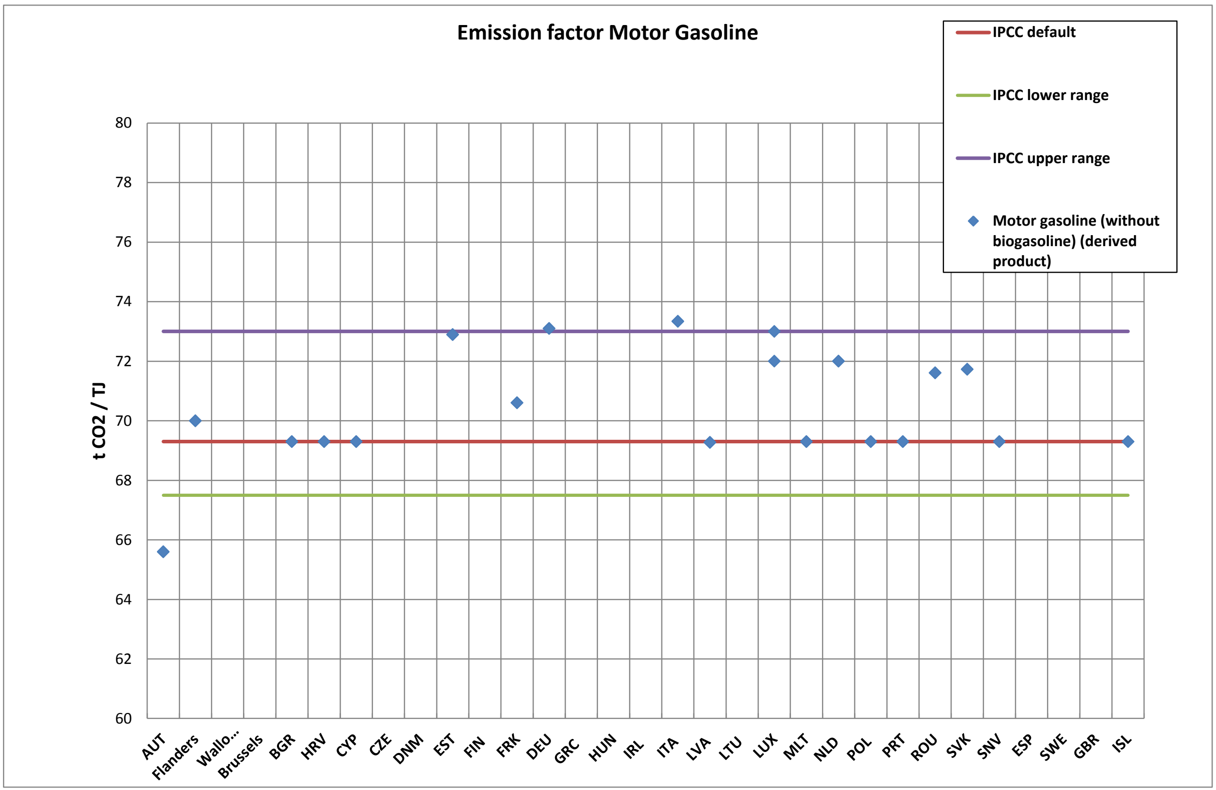


Figure 3.192 Emission factors used by Member States for natural gasoline



AUT: This factor is used in the reference approach and reflects increasing share of biofuels in blend.

Figure 3.193 Emission factors used by Member States for jet kerosene

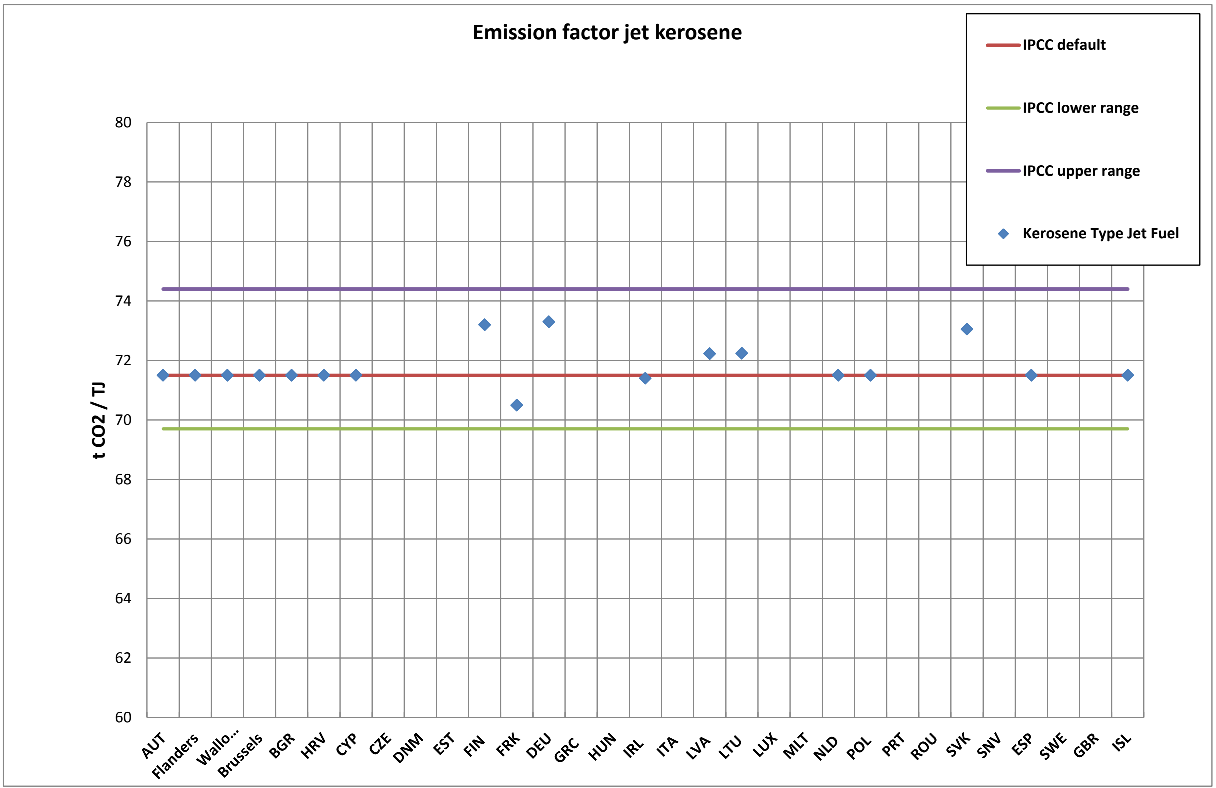
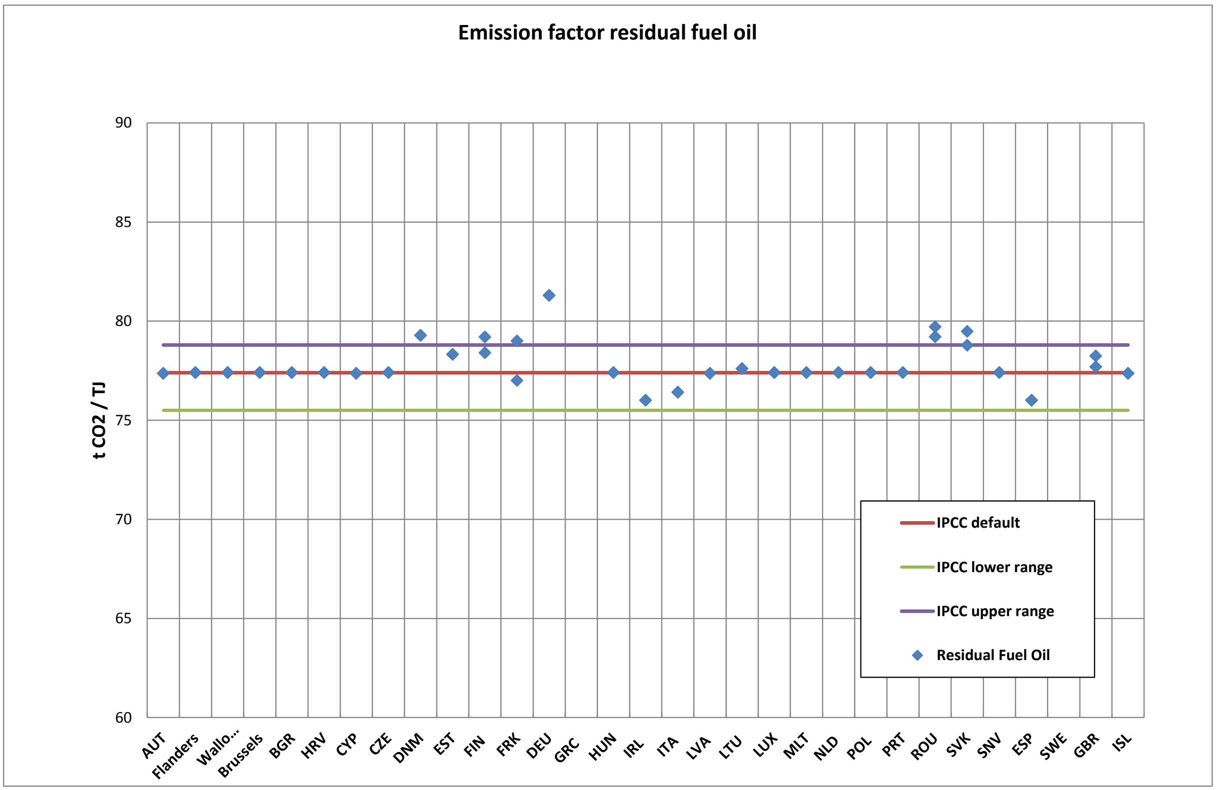


Figure 3.194 Emission factors used by Member States for residual fuel oil



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 in methodology. Primarily, a number of 36 EU-ETS operators were considered.

Figure 3.195 Emission factors used by Member States for petroleum coke

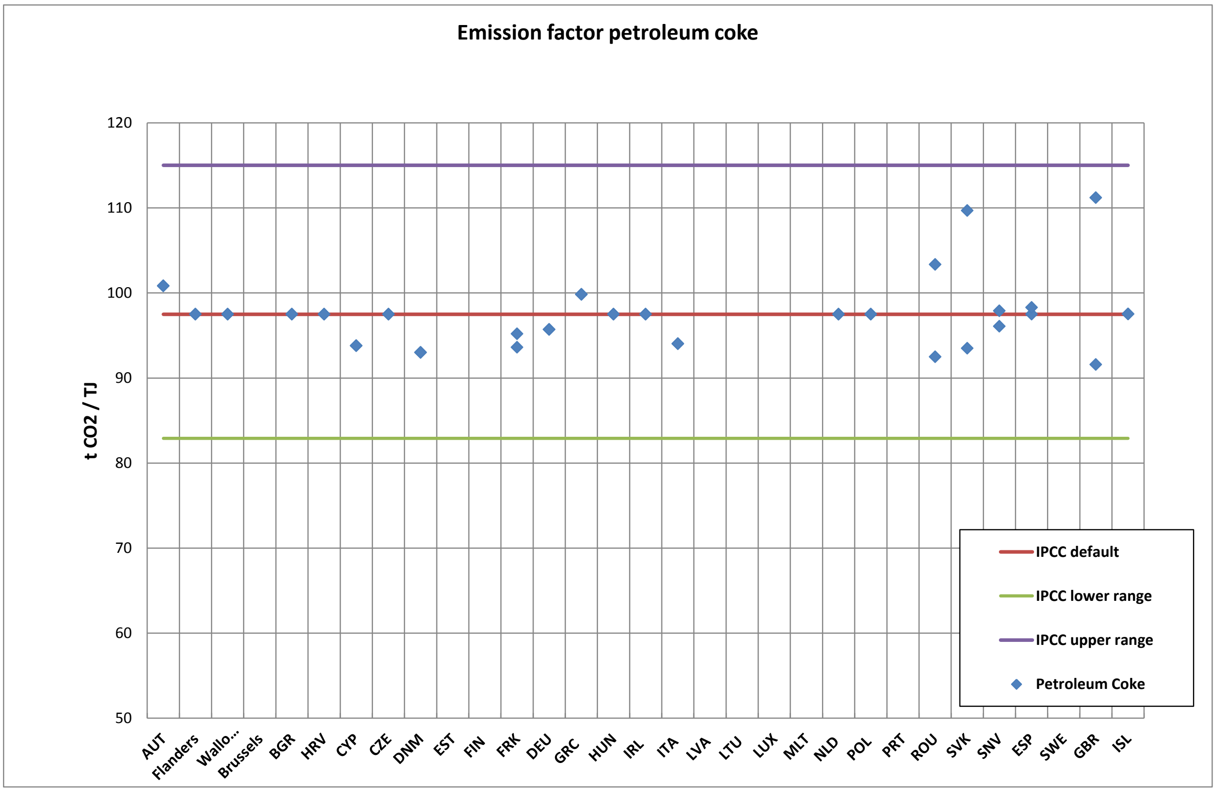


Figure 3.196 Emission factors used by Member States for refinery gas

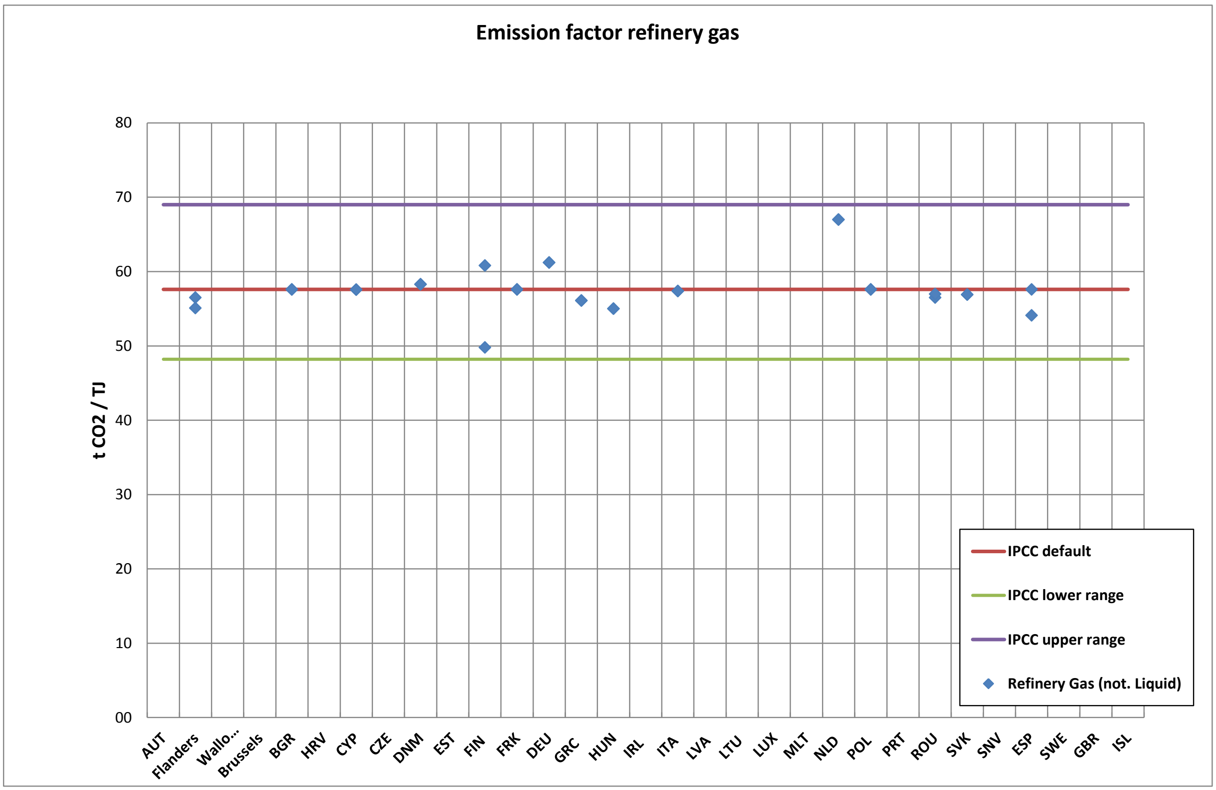


Figure 3.197 Emission factors used by Member States for bituminous coal

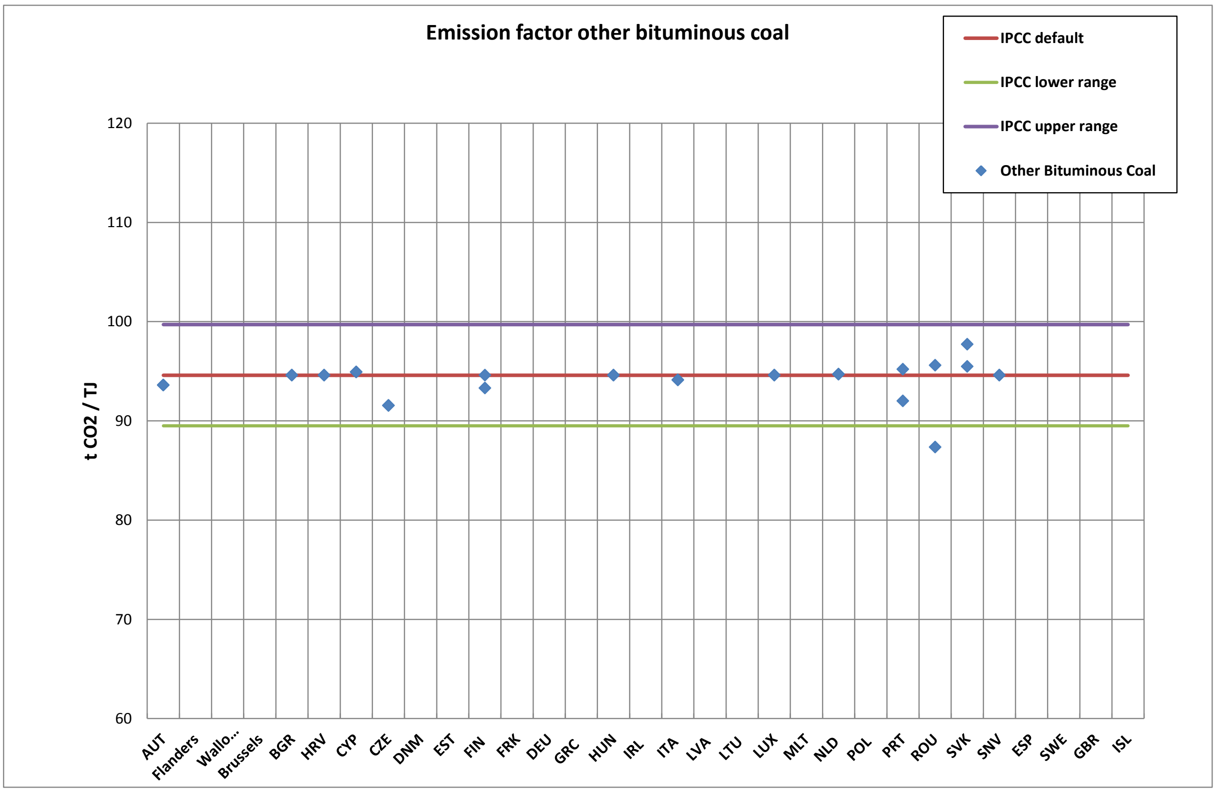
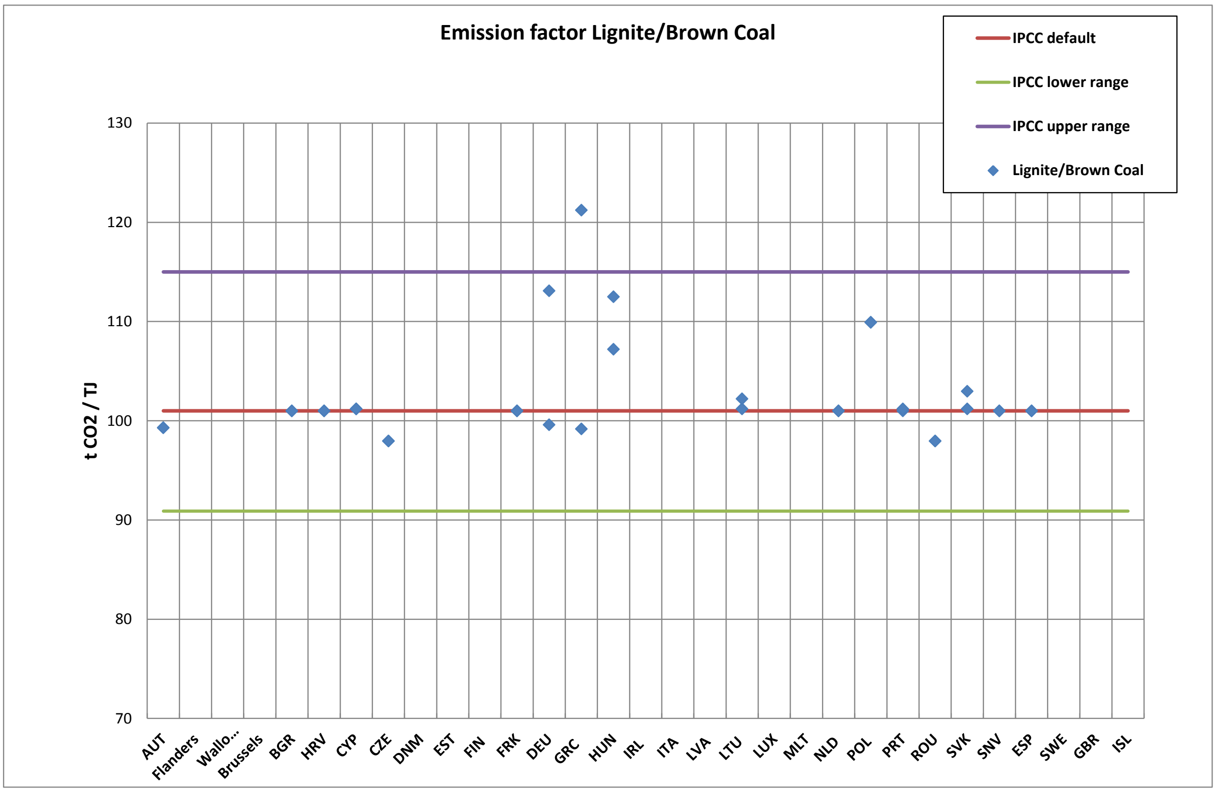


Figure 3.198 Emission factors used by Member States for lignite



<u>GRC:</u> 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 2006-2016 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 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 3.199 Emission factors used by Member States for coking coal

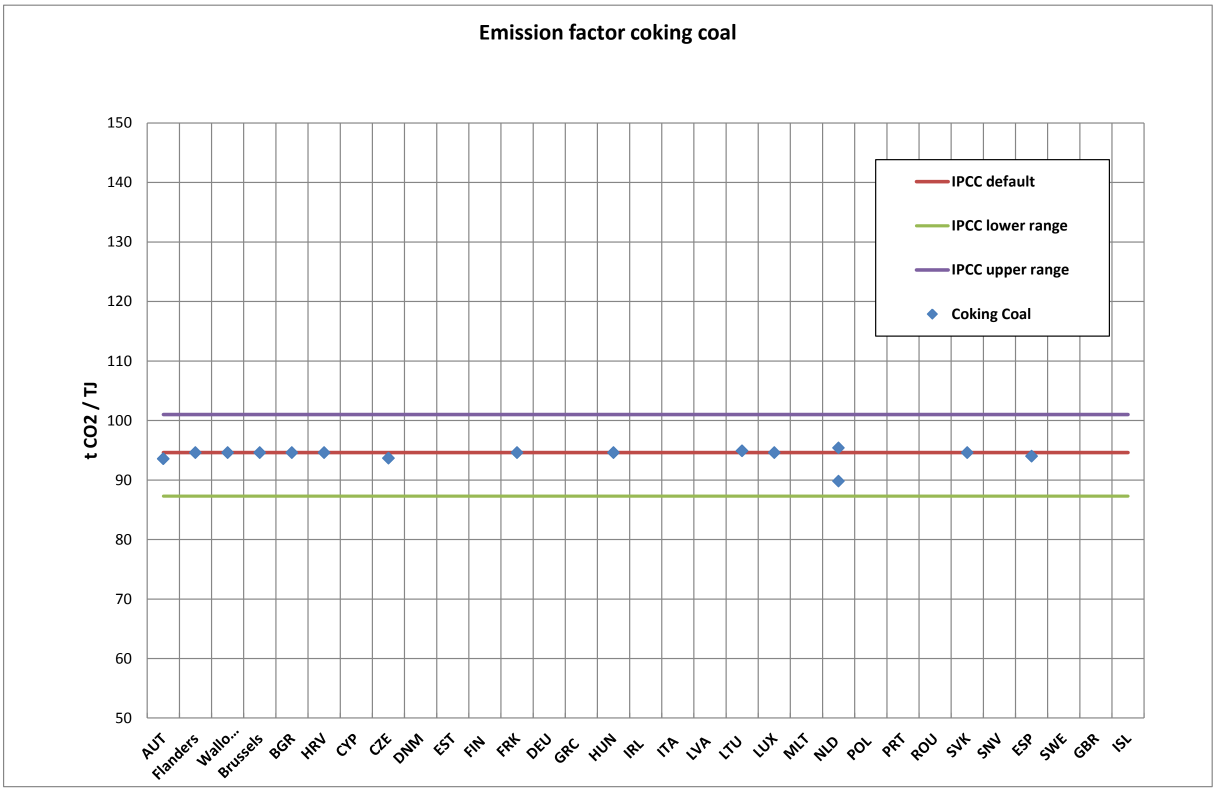


Figure 3.200 Emission factors used by Member States for coke oven coke

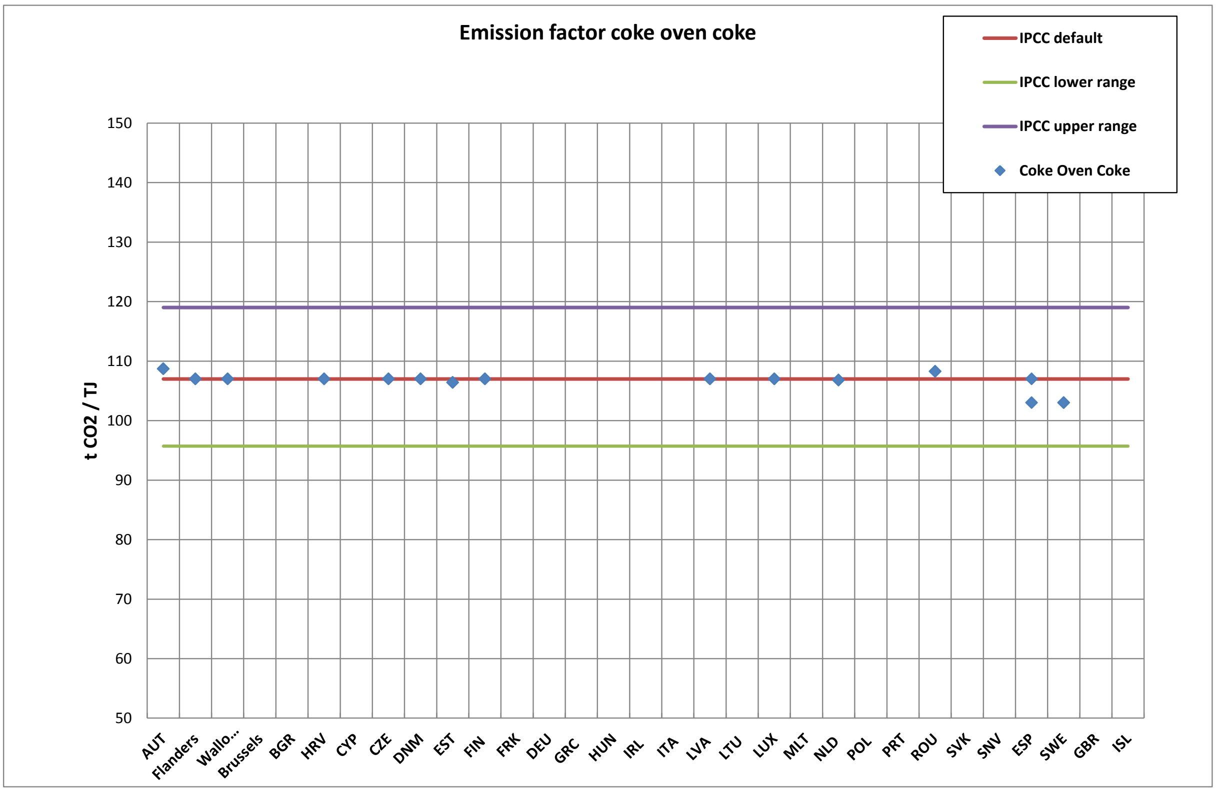
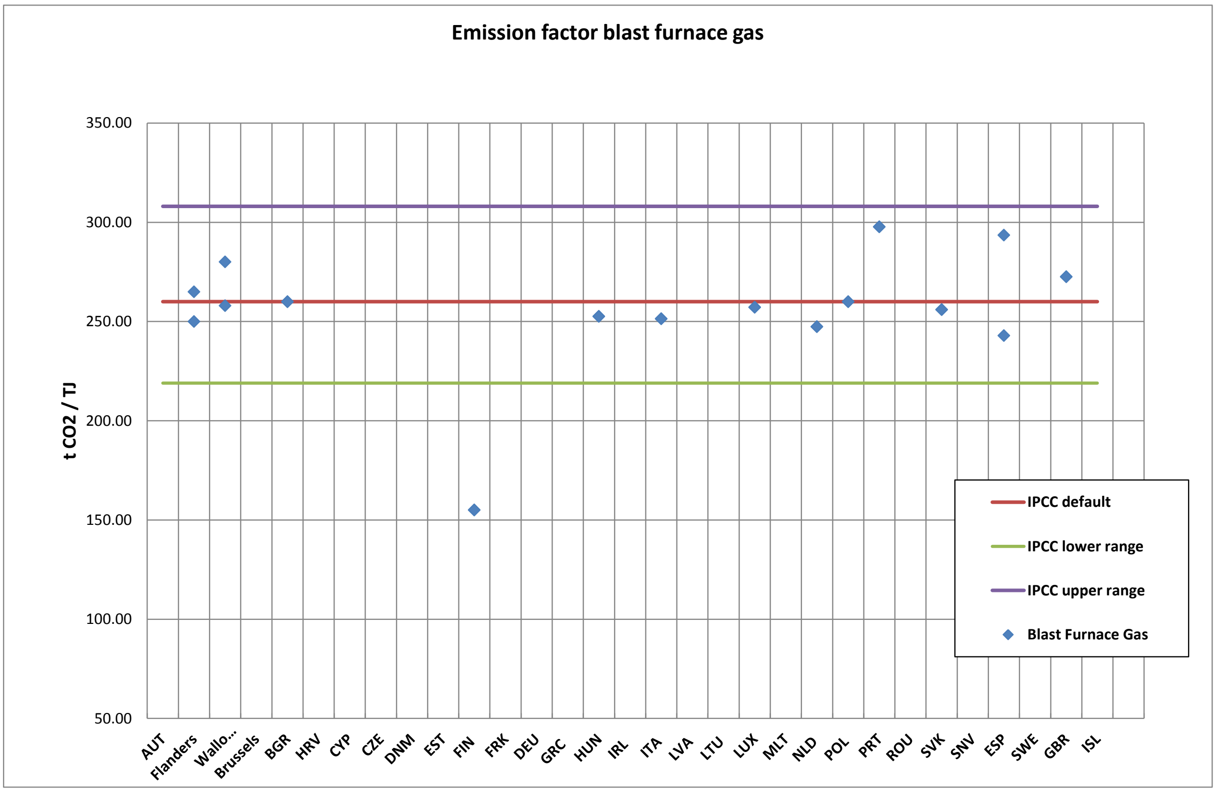
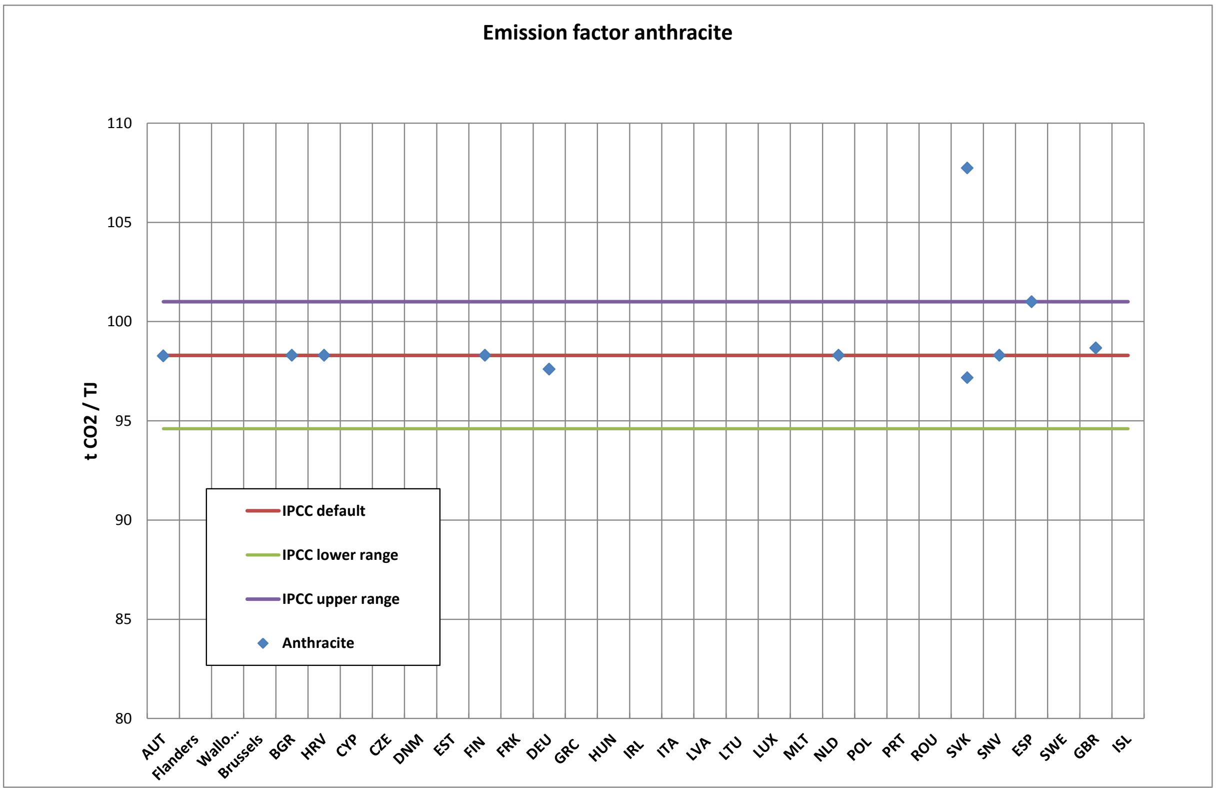


Figure 3.201 Emission factors used by Member States for blast furnace gas



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 3.202 Emission factors used by Member States for anthracite



SVK: The higher value is used for 1A2a, the lower value for 1A1a.

Figure 3.203 Emission factors used by Member States for coke oven gas

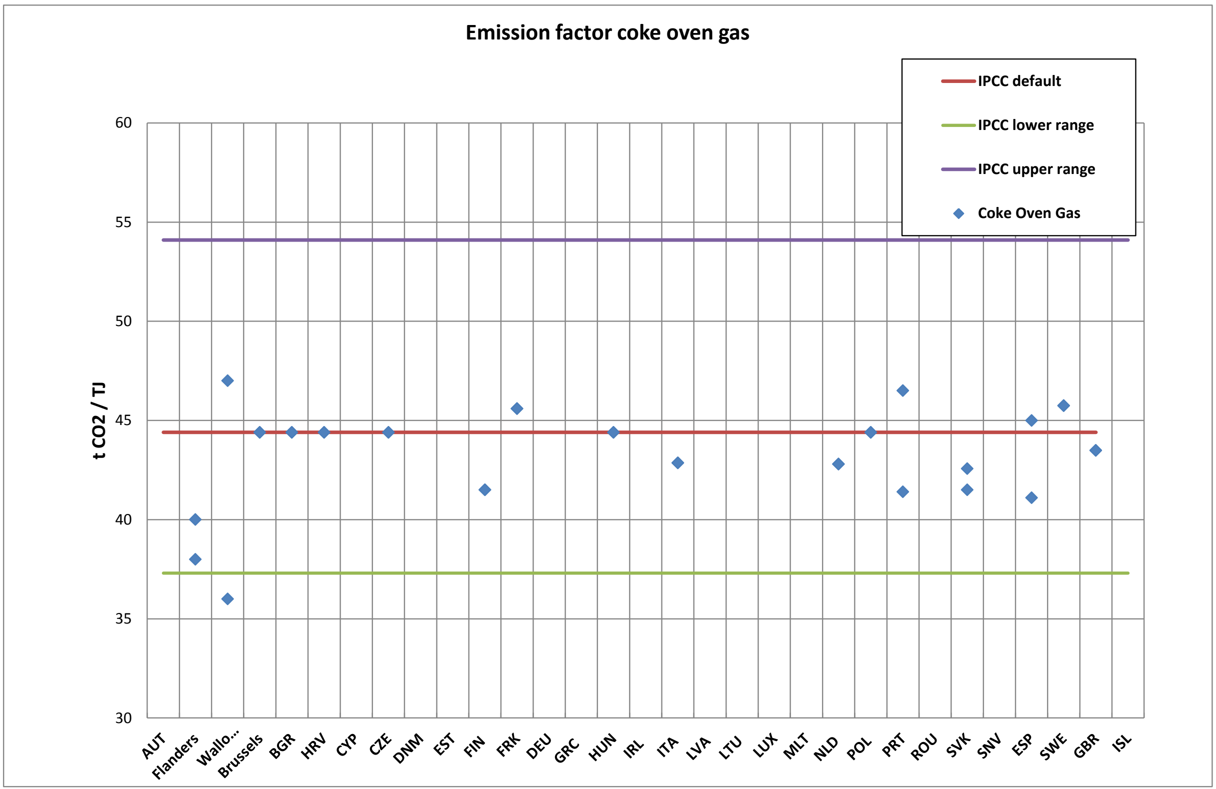


Table 3.124 shows the total EU-28 uncertainty estimates for the sector 'Energy' excluding 1A3 'Transport' and the uncertainty estimates for the relevant gases for each source category. For those emissions for which no split by source category was available, uncertainty estimates were made for stationary combustion as a whole. The highest level uncertainty was estimated for N_2O from 1A2c and the lowest for CO_2 from 1A2e. With regard to trend CH_4 from 1A1a shows the highest uncertainty estimates, CO_2 from 1A1a the lowest. The results of this year's uncertainty analysis are very similar to the results in 2017. For a description of the Tier 1 uncertainty analysis carried out for the EU-28 see Chapter 1.6.

Table 3.124 Sector 1 Energy (excl. 1A3b and 1B): Uncertainty estimates for EU-28

Source category	Gas	Emissions Base Year	Emissions 2017	Emission trends Base Year-2017	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	587 349	456 966	-22.2%	2.6%	0.0%
1.A.1.a Public electricity and heat production	CH_4	245	2 961	1109.7%	68.4%	7.7%
1.A.1.a Public electricity and heat production	N_2O	2 842	2 795	-1.7%	32.1%	0.1%
1.A.1.b Petroleum refining	CO_2	53 513	50 307	-6.0%	4.2%	0.0%
1.A.1.b Petroleum refining	CH_4	19	17	-13.3%	18.3%	0.0%
1.A.1.b Petroleum refining	N_2O	230	142	-38.2%	30.9%	0.1%
1.A.1.c Manufacture of solid fuels and other energy industries	CO_2	74 414	19 184	-74.2%	4.6%	0.0%
1.A.1.c Manufacture of solid fuels and other energy industries	CH_4	102	189	85.6%	135.8%	1.2%
1.A.1.c Manufacture of solid fuels and other energy industries	N_2O	670	158	-76.4%	22.8%	0.2%
1.A.2.a Iron and Steel	CO_2	51 557	42 268	-18.0%	5.7%	0.0%
1.A.2.a Iron and Steel	CH_4	73	61	-15.4%	26.5%	0.0%
1.A.2.a Iron and Steel	N_2O	228	115	-49.5%	34.6%	1.2%
1.A.2.b Non-ferrous Metals	CO_2	2 615	2 414	-7.7%	7.9%	0.0%
1.A.2.b Non-ferrous Metals	CH_4	3	3	-9.8%	58.5%	0.2%
1.A.2.b Non-ferrous Metals	N_2O	20	11	-42.8%	70.6%	0.2%
1.A.2.c Chemicals	CO_2	29 660	5 647	-81.0%	1.8%	0.0%
1.A.2.c Chemicals	CH_4	19	16	-17.1%	70.8%	0.4%
1.A.2.c Chemicals	N_2O	31	27	-12.7%	403.4%	1.8%
1.A.2.d Pulp, Paper and Print	CO_2	3 010	1 652	-45.1%	3.8%	0.0%
1.A.2.d Pulp, Paper and Print	CH_4	15	20	30.6%	37.3%	0.1%
1.A.2.d Pulp, Paper and Print	N_2O	77	99	29.0%	71.4%	0.2%
1.A.2.e Food Processing, Beverages and Tobacco	CO_2	7 766	3 931	-49.4%	1.6%	0.0%
1.A.2.e Food Processing, Beverages and Tobacco	CH_4	11	12	2.1%	66.8%	0.5%
1.A.2.e Food Processing, Beverages and Tobacco	N_2O	40	13	-67.2%	209.2%	0.7%
1.A.2.f Non-metallic minerals	CO2	28 352	22 701	-19.9%	2.6%	0.0%
1.A.2.f Non-metallic minerals	CH4	67	38	-43.1%	30.6%	0.1%
1.A.2.f Non-metallic minerals	N2O	237	196	-17.3%	51.2%	0.3%
1.A.2.g Other	CO_2	170 229	87 980	-48.3%	3.3%	0.0%
1.A.2.g Other	CH_4	194	251	29.5%	29.0%	0.1%
1.A.2.g Other	N_2O	1 164	768	-34.0%	31.5%	0.1%
1.A.4.a Commercial/Institutional	CO_2	82 082	54 537	-33.6%	6.2%	0.0%
1.A.4.a Commercial/Institutional	CH_4	1 575	164	-89.6%	54.5%	1.5%
1.A.4.a Commercial/Institutional	N_2O	272	134	-50.6%	130.7%	0.3%
1.A.4.b Residential	CO_2	186 666	131 282	-29.7%	6.5%	0.0%
1.A.4.b Residential	CH_4	4 017	2 826	-29.7%	68.9%	0.6%
1.A.4.b Residential	N_2O	1 018	672	-34.0%	118.7%	0.4%
1.A.4.c Agriculture/forestry/fishing	CO_2	35 400	22 619	-36.1%	5.9%	0.0%
1.A.4.c Agriculture/forestry/fishing	CH_4	456	1 573	245.2%	40.5%	1.0%
1.A.4.c Agriculture/forestry/fishing	N_2O	664	337	-49.2%	127.2%	0.3%
1.A.5 Other	CO_2	23 715	4 222	-82.2%	18.3%	0.1%
1.A.5 Other	CH_4	301	41	-86.4%	138.1%	5.0%
1.A.5 Other	N_2O	184	51	-72.4%	389.2%	2.0%
1.A (where no subsector data were submitted)	*all*	607 779	*365 139*	-39.9%	*1.4%*	*1.2%*
1.A.1 (where no subsector data were submitted)	*all*	*680 451*	*484 083*	*-28.9%*	*1.4%*	*0.6%*
1.A.2 (where no subsector data were submitted)	*all*	*447 145*	*255 594*	*-42.8%*	*1.9%*	*0.8%*
1.A.3 (where no subsector data were submitted)	*all*	*251 352*	*300 214*	*19.4%*	*3.0%*	*0.9%*
1.A.4 (where no subsector data were submitted)	*all*	*432 539*	*327 360*	*-24.3%*	*2.9%*	*1.4%*
Total - 1.A (where no subsector data were submitted)	**all**	**607 779**	**365 139**	**-39.9%**	**1.4%**	**1.2%**
Total - 1.A.1	**all**	**1 399 837**	**1 016 802**	**-27.4%**	**1.4%**	**0.5%**
Total - 1.A.2	**all**	**742 512**	**423 817**	**-42.9%**	**1.4%**	**0.6%**
Total - 1.A.3	**all**	**781 303**	**929 360**	**19.0%**	**2.1%**	**0.6%**
Total - 1.A.4	**all**	**744 690**	**541 504**	**-27.3%**	**2.5%**	**1.1%**
Total - 1.A.5	**all**	**24 200**	**4 314**	**-82.2%**	**4.9%**	**3.3%**
Total - 1.A	**all**	**4 300 321**	**3 280 935**	**-23.7%**	**0.9%**	**0.3%**

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 3.125 shows the total EU-28 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 CH_4 from 1B1, the lowest for CO_2 from 1B1. The results of this year's uncertainty analysis differ to some extent from the results in 2017; further analysis is needed on this.

Table 3.125 1B Fugitive Emissions: Uncertainty estimates for EU-28

Source category	Gas	Emissions Base Year	Emissions 2017	Emission trends Base Year-2017	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.B.1 Solid Fuels	CO_2	8 276	4 155	-49.8%	11.8%	0.1%
1.B.1 Solid Fuels	CH_4	102 763	30 379	-70.4%	72.9%	0.1%
1.B.1 Solid Fuels	N_2O	0.1	0.0	-77.7%	107.5%	0.9%
1.B.2. Oil and Natural Gas and other emissions from energy pr	CO_2	18 378	19 110	4.0%	12.5%	0.1%
1.B.2. Oil and Natural Gas and other emissions from energy pr	CH_4	64 410	22 940	-64.4%	29.5%	0.2%
1.B.2. Oil and Natural Gas and other emissions from energy pr	N_2O	131	104	-21.2%	448.3%	0.6%
1.B (werhe no subsector data were submitted)	*all*	*14 008*	*7 917*	*-43.5%*	*52.0%*	*15.4%*
Total - 1.B	**all**	**207 967**	**84 604**	**-59.3%**	**27.9%**	**8.2%**

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 3.126 shows the total EU-28 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 1A3e. With regard to trend N_2O from 1A3c 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 2017.

Table 3.126 1A3 Transport: Uncertainty estimates for EU-28

Source category	Gas	Emissions Base Year	Emissions 2017	Emission trends Base Year-2017	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A.3.a Domestic aviation	CO_2	7 871	8 534	8.4%	12.5%	0.0%
1.A.3.a Domestic aviation	CH_4	11	4	-58.6%	69.6%	0.3%
1.A.3.a Domestic aviation	N_2O	72	63	-12.8%	151.6%	0.3%
1.A.3.b Road transport	CO_2	479 024	593 536	23.9%	2.9%	0.0%
1.A.3.b Road transport	CH_4	4 004	841	-79.0%	32.9%	0.2%
1.A.3.b Road transport	N_2O	4 098	5 095	24.3%	41.9%	0.3%
1.A.3.c Railways	CO_2	7 855	3 227	-58.9%	4.7%	0.0%
1.A.3.c Railways	CH_4	10	4	-58.1%	76.9%	0.3%
1.A.3.c Railways	N_2O	503	203	-59.7%	122.0%	0.5%
1.A.3.d Domestic navigation	CO_2	21 907	14 015	-36.0%	19.9%	0.1%
1.A.3.d Domestic navigation	CH_4	24	22	-9.4%	88.1%	0.2%
1.A.3.d Domestic navigation	N_2O	309	215	-30.5%	216.9%	0.3%
1.A.3.e Other transportation	CO_2	4 234	3 365	-20.5%	2.1%	0.0%
1.A.3.e Other transportation	CH_4	7	7	-0.3%	61.8%	0.1%
1.A.3.e Other transportation	N_2O	23	16	-28.4%	70.0%	0.5%
Total - 1.A.3	**all**	**781 303**	**929 360**	**19.0%**	**2.1%**	**0.6%**
Total - 1.A	**all**	**4 300 321**	**3 280 935**	**-23.7%**	**0.9%**	**0.3%**

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 3.127 summarizes the main checks carried out on Member States' submissions.

Table 3.127 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 2017 (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 2017 (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 2017 (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 2017 (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 2016 Focus on EU key categories
Follow-up from 2017	Check if issues that were classified as "Unresolved" or "Partly resolved" in 2018 have been resolved by Member States in 2019.
Implementation of UNFCCC and ESD review recommendations	Check if recommendations from 2016 and 2017 UNFCCC review reports have been implemented by Member States. Check if recommendations from ESD review 2018 have been implemented by Member States.

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 2020 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 and 2018, annual reviews were carried out for all significant issues identified the initial checks phase with a focus on the years 2015 and 2016 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 2018 the energy-related webinar had 51 participants from 20 EU Member States. Main issues discussed at the webinar were:

- Main findings from ESD review 2018:
- Overview of energy sector conclusions
- Status of the 1A3d Maritime transport issue
- Presentation and discussion of note: Reference approach non-energy use of fuels
- Presentation and discussion of note: Country-specific CO_2 emissions from transport

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 2012, 2015, 2016, 2017, 2018 and 2019 and during the initial checks 2015, 2016, 2017, 2018 and 2019 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:

[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.

'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.

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 28 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 November 2018 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 2017 by EU Member States and other EEA member countries (Iceland, Liechtenstein, Switzerland, Norway and Turkey). Recalculations took place to reflect i.a. 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 2017 has been prepared by the European Environment Agency and its ETC/ACM in February 2019. 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-28 kerosene consumption in 2017 resulting from EUROCONTROL calculations is 4 % lower for both domestic and 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-28 is identical between EU inventory and EUROCONTROL results. For domestic aviation the difference in CO_2 emissions is 0.5 Mt CO_2 in 2017. With this, the actual difference is considerably lower than the one which has been calculated in the very first exercise to compare EUROCONTROL results with MS data in 2007 (see EU NIR 2014). 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 2017 for EU-28 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, either for checking purposes but also by using the numbers directly in inventory calculations. In the course of 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. Some of the outcomes could on the one hand 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 3.128 an overview is given, how Eurocontrol data has been used by Member States, as it has been mentioned in their NIR 2019.

Table 3.128 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			Airport related data for distribution in regions	In Flamish region for international flights. In Wallonia, for N_2O and CH_4	NA
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					
Germany	yes				

	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?
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 (2005-2017).
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					
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 Eirocontrol 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	yes, comparison in NIR				
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 (2008-2017)				
Malta				For domestic aviation (from 2005 until 2017)	Recalculations would have been implemented for the whole timeseries, from 1990 until 2017, if possible but the EUROCONTROL model data started from 2005.
Netherlands					

	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?
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					
Slovakia				For domestic and international flights	For the years 1990-2004 summary information from the Eurocontrol database was used (emission factors and domestic share).
Slovenia				For domestic flights	Only a small amount of domestic flights has been recorded by Eurocontrol. No adaptation took place for the years 1990-2004
Sweden					

Four Member States report a comparison or a verification of their results with EUROCONTROL data and one Member State mention possible improvements in future submissions using this data. Four Member States mention the indirect use of this data, using emissions factors or LTO information. Eleven 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 2018 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 3.129 shows that in the energy sector the largest recalculations in absolute terms in 1990 and in 2016 were made for CO_2. In relative terms, the largest recalculations in 1990 were made for CH_4 (0.4 %) and in 2016 for N_2O (+1.2 %).

Table 3.129 Sector 1 Energy: Recalculations of total GHG emissions and recalculations of GHG emissions for the years 1990 and 2015 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	1 749	0.0%	10 312	1.7%	5 236	1.5%	14	0.1%	-163	-0.7%	-1	0.0%	229	3.9%	-7	-29.5%
Energy	-2 337	-0.1%	1 519	1.0%	90	0.3%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2016																
Total emissions and removals	8 972	0.3%	8 257	2.0%	7 120	3.1%	-2 690	-2.8%	-178	-4.6%	-305	-4.8%	542	73.0%	-5	-9.1%
Energy	5 162	0.2%	-64	-0.1%	367	1.4%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

NO: not occurring

Table 3.130 provides an overview of Member States' contributions to EU-28 and Iceland recalculations. In absolute terms, Italy had the most influence on CO_2 recalculations in the EU-28 + ISL for 2016. Explanations for recalculations by Member State are provided in Chapters 3.2 and 10.1.

Table 3.130 Sector 1 Energy: Contribution of Member States to EU-28 and Iceland recalculations for 1990 and 2015 by gas (difference between latest submission and previous submission kt of CO_2 equivalents)

	1990								2016							
	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	30	1	1	NO	NO	NO	NO	NO	-22	-25	-11	NO	NO	NO	NO	NO
Belgium	1.5	1.1	1.6	NO	NO	NO	NO	NO	-1 831	-3	1	NO	NO	NO	NO	NO
Bulgaria	-2 131.2	-0.6	-9.0	NO	NO	NO	NO	NO	-29	-2	0	NO	NO	NO	NO	NO
Croatia	-102.1	0.0	0.0	NO	NO	NO	NO	NO	-108	0	0	NO	NO	NO	NO	NO
Cyprus	16.2	1.5	-4.1	NO	NO	NO	NO	NO	46	-7	-39	NO	NO	NO	NO	NO
Czechia	-23.8	32.7	-33.3	NO	NO	NO	NO	NO	39	-1	-185	NO	NO	NO	NO	NO
Denmark	-43.3	21.8	-1.9	NO	NO	NO	NO	NO	-98	0	-3	NO	NO	NO	NO	NO
Estonia	0.0	0.0	0.0	NO	NO	NO	NO	NO	-13	-25	0	NO	NO	NO	NO	NO
Finland	0.0	-0.1	0.0	NO	NO	NO	NO	NO	-709	-2	3	NO	NO	NO	NO	NO
France	2 178.4	33.7	22.2	NO	NO	NO	NO	NO	2 451	3	104	NO	NO	NO	NO	NO
Germany	-134.9	1.3	5.5	NO	NO	NO	NO	NO	-892	-157	61	NO	NO	NO	NO	NO
Greece	0.0	0.0	0.0	NO	NO	NO	NO	NO	0	0	0	NO	NO	NO	NO	NO
Hungary	-12.9	5.4	-3.8	NO	NO	NO	NO	NO	-147	-6	0	NO	NO	NO	NO	NO
Ireland	13.2	-106.8	0.9	NO	NO	NO	NO	NO	-39	50	-1	NO	NO	NO	NO	NO
Italy	-306.7	42.4	-1.9	NO	NO	NO	NO	NO	3 154	16	34	NO	NO	NO	NO	NO
Latvia	-235.2	-1.9	128.5	NO	NO	NO	NO	NO	-27	0	33	NO	NO	NO	NO	NO
Lithuania	0.0	1.0	-0.7	NO	NO	NO	NO	NO	-34	7	-4	NO	NO	NO	NO	NO
Luxembourg	36.0	0.8	0.5	NO	NO	NO	NO	NO	75	0	1	NO	NO	NO	NO	NO
Malta	0.1	0.6	0.1	NO	NO	NO	NO	NO	-14	1	0	NO	NO	NO	NO	NO
Netherlands	-12.6	-0.2	0.4	NO	NO	NO	NO	NO	606	9	1	NO	NO	NO	NO	NO
Poland	1 140.6	-72.3	3.6	NO	NO	NO	NO	NO	2 038	275	105	NO	NO	NO	NO	NO
Portugal	26.0	90.1	0.0	NO	NO	NO	NO	NO	54	5	-8	NO	NO	NO	NO	NO
Romania	-1 307.3	1 695.8	-6.0	NO	NO	NO	NO	NO	849	-148	272	NO	NO	NO	NO	NO
Slovakia	-389.3	-73.8	-2.3	NO	NO	NO	NO	NO	857	51	32	NO	NO	NO	NO	NO
Slovenia	2.2	0.1	1.1	NO	NO	NO	NO	NO	1	0	0	NO	NO	NO	NO	NO
Spain	-531.4	26.5	-13.9	NO	NO	NO	NO	NO	-349	86	-24	NO	NO	NO	NO	NO
Sweden	-550.6	-180.5	1.1	NO	NO	NO	NO	NO	-696	-189	-5	NO	NO	NO	NO	NO
United Kingdom	-52.7	-16.7	-1 301.1	NO	NO	NO	NO	NO	1 999	71	-1 084	NO	NO	NO	NO	NO
EU28	-2 389.4	1 502.7	-1 211.3	NO	NO	NO	NO	NO	7 162	7	-718	NO	NO	NO	NO	NO
Iceland	0.0	0.0	0.0	NO	NO	NO	NO	NO	0	0	2	NO	NO	NO	NO	NO
United Kingdom (KP)				NO	NO	NO	NO	NO				NO	NO	NO	NO	NO
EU28+ISL	-2 336.7	1 519.4	89.8	NO	NO	NO	NO	NO	5 162	-64	367	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-28 + ISL)

The IPCC reference approach for CO_2 from fossil fuels for the EU-28 + ISL is based on Eurostat energy data (Eurostat database, February 2019) 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 2006 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-28 + ISL as a whole.

The Eurostat data for the EU-28 + ISL 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-28 + ISL 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 28 Member States and Iceland, 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 + ISL 2017 inventory submission, and reported in table 1.A(b), corresponds to the sum of its 28 MS and Iceland.
- 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 2019.
- 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 2006 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-28 + ISL CO_2 emissions calculated with the IPCC reference approach and the sectoral approach (Table 3.131). The percentage differences for both energy consumption and CO_2 emissions are very similar to previous submissions.

Table 3.131 Comparison of reference approach and sectoral approach for EU-28 and Iceland

[1. Energy][1.AC Comparison of CO2 Emissions from Fuel Combustion]	Unit	1990	1995	2000	2005	2010	2015	2016	2017
Fuel consumption									
Sectoral approach	PJ	51 788	50 376	51 138	53 261	49 587	43 455	43 792	44 119
Apparent energy consumption (excluding non-energy use, reductants and feedstocks)	PJ	51 603	50 106	50 548	52 884	49 335	43 062	43 479	43 890
Difference	%	-0.4	-0.5	-1.2	-0.7	-0.5	-0.9	-0.7	-0.5
CO2 emissions									
Reference approach	kt	4 009 158	3 789 968	3 739 438	3 880 977	3 585 977	3 173 357	3 166 946	3 181 001
Sectoral approach	kt	4 097 638	3 870 899	3 840 166	3 960 016	3 650 142	3 235 644	3 219 501	3 231 276
Difference	%	-2.2	-2.1	-2.6	-2.0	-1.8	-1.9	-1.6	-1.6

Table 3.132 provides an overview for EU-28 Member States and Iceland on differences between the Eurostat and national reference approach for apparent consumption in TJ for 2017. For EU-28 + ISL 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).

For Iceland the Eurostat database did not include data for the reference approach.

Table 3.132 Comparison between Eurostat and national reference approach for apparent consumption for EU-28 for 2017 (CRF 1.A) [17]

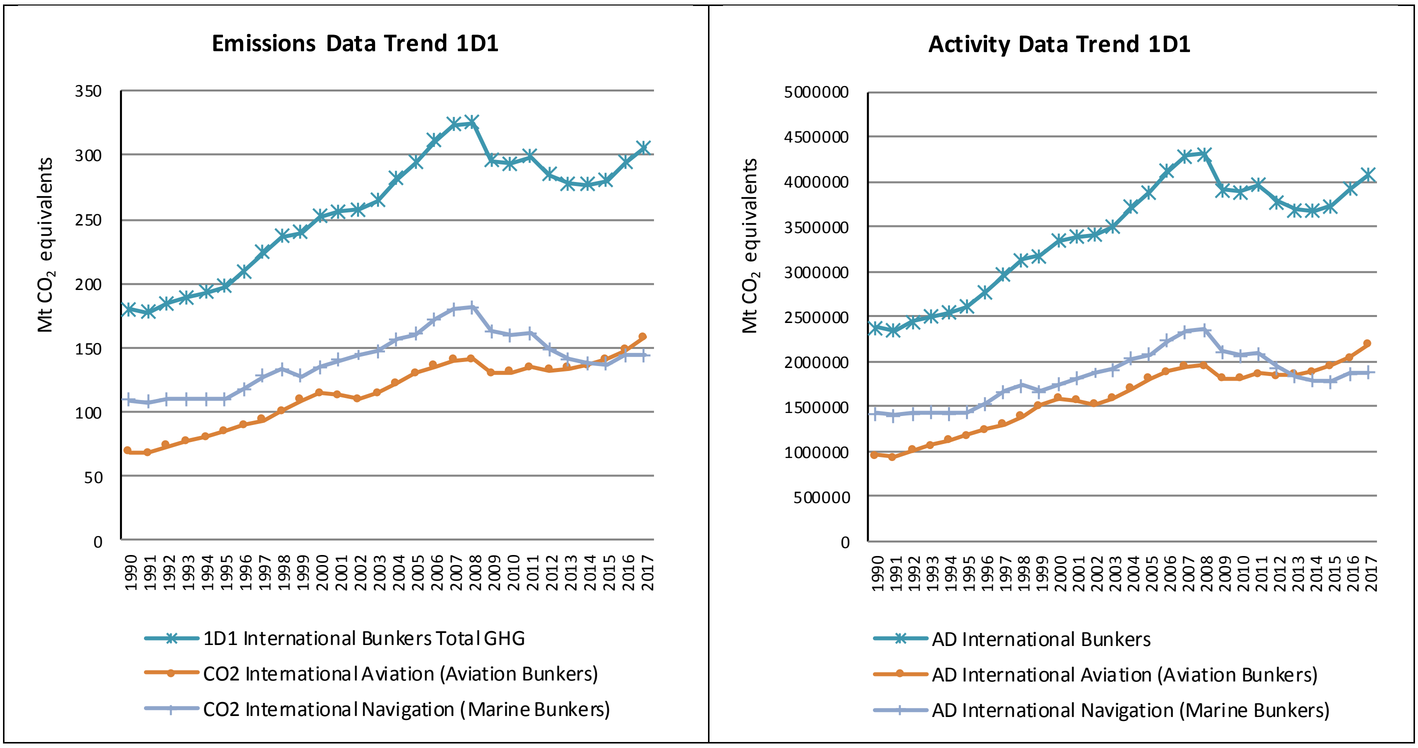
	Total liquid			Total solid			Total gaseous		
	Eurostat TJ	**Crf TJ**	**Difference %**	**Eurostat TJ**	**Crf TJ**	**Difference %**	**Eurostat TJ**	**Crf TJ**	**Difference %**
AT	484 579	493 156	2%	128 951	130 349	1%	325 584	325 584	0%
BE	888 260	888 260	0%	128 552	130 056	1%	606 500	606 500	0%
BG	180 252	181 260	1%	255 124	253 875	0%	115 650	115 650	0%
CY	85 813	86 875	1%	125	125	0%	- -	- -	0%
CZ	389 249	381 445	-2%	646 600	648 587	0%	301 491	302 188	0%
DE	4 319 135	4 315 994	0%	2 985 544	2 994 949	0%	3 154 364	3 241 764	3%
DK	256 700	258 614	1%	64 835	64 835	0%	115 024	115 024	0%
EE	6 271	6 147	-2%	176 436	176 327	0%	16 997	16 556	-3%
ES	2 231 368	2 134 677	-4%	533 702	506 410	-5%	1 141 590	1 144 127	0%
FI	333 085	331 626	0%	118 931	115 494	-3%	80 896	79 962	-1%
FR	3 038 302	3 128 236	3%	414 952	435 139	5%	1 611 565	1 612 881	0%
GR	450 563	474 019	5%	201 663	214 596	6%	175 999	175 999	0%
HR	139 382	143 179	3%	16 426	16 492	0%	104 388	104 388	0%
HU	308 650	307 144	0%	93 563	93 745	0%	357 629	357 629	0%
IE	258 137	258 180	0%	46 007	46 016	0%	180 559	180 680	0%
IS	- -	23 958	0%	- -	4 013	0%	- -	0	0%
IT	2 177 159	2 230 341	2%	391 122	391 008	0%	2 576 934	2 577 241	0%
LT	117 179	117 866	1%	6 833	6 836	0%	80 447	80 447	0%
LU	91 361	91 315	0%	1 898	1 896	0%	29 020	29 020	0%
LV	58 977	58 115	-1%	1 691	1 689	0%	41 573	41 670	0%
MT	13 972	13 281	-5%	- -	- -	0%	10 120	10 120	0%
NL	1 153 434	1 142 708	-1%	382 990	382 900	0%	1 294 153	1 294 200	0%
PL	1 217 731	1 225 738	1%	2 066 671	2 069 795	0%	646 642	646 642	0%
PT	387 998	378 530	-2%	135 114	135 971	1%	226 732	228 339	1%
RO	389 248	403 752	4%	225 613	225 572	0%	402 771	402 771	0%
SE	424 504	434 707	2%	79 975	76 293	-5%	38 501	40 068	4%
SI	96 357	96 575	0%	47 747	47 757	0%	30 925	30 925	0%
SK	152 829	154 010	1%	141 379	140 452	-1%	173 195	173 573	0%
UK	2 536 946	2 553 096	1%	414 387	408 618	-1%	2 840 300	2 838 442	0%
EU-28 + IS	22 187 441	22 312 804	1%	9 706 832	9 719 796	0%	16 679 546	16 772 389	1%

[17] Minus means that Member State-based estimates are lower than the Eurostat-based estimates.

3.8 International bunker fuels (EU-28+ISL)

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 Member States[18]. Between 1990 and 2017, greenhouse gas emissions from international bunker fuels increased by 70 % in the EU-28+ISL. CO_2 emissions from "Marine bunkers" account for 48 % of total greenhouse gas emissions from international bunkers in 2017, CO_2 from "Aviation bunkers" accounts for 52 % (Figure 3.204).

Figure 3.204 1D1 International bunker fuels: GHG emission trend and activity data



3.8.1 Aviation bunkers (EU-28+ISL)

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 2017 but are not included in the national total of GHG emissions (Table 3.133).

[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 Member States 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.

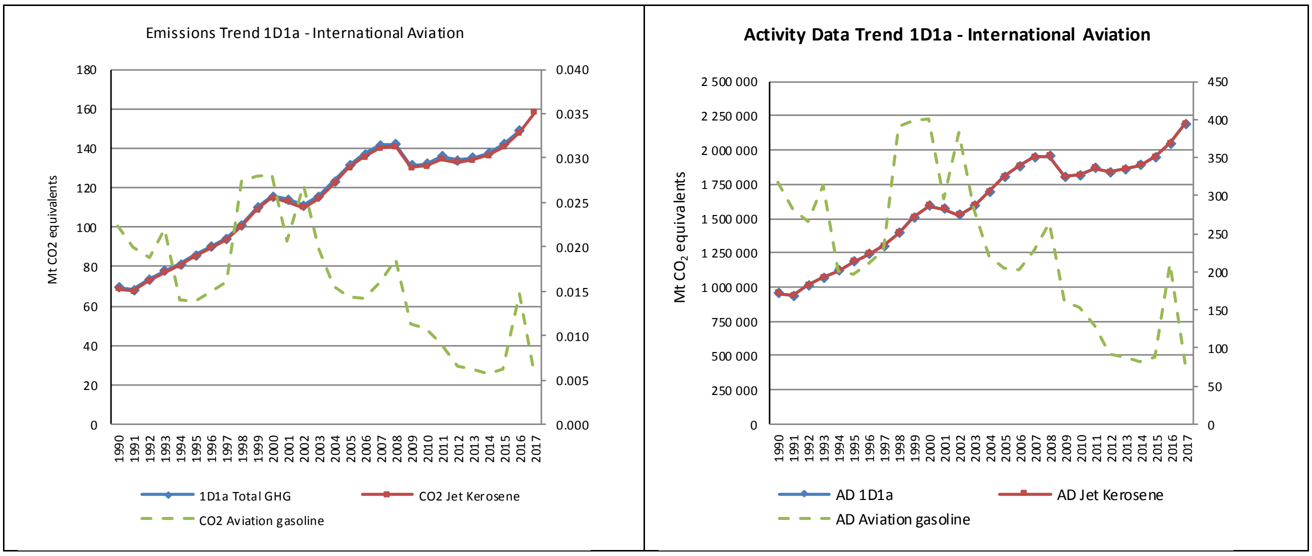
The Member States France, Germany, Spain and the United Kingdom contributed more than 60 % to the EU-28+ISL emissions from this source. Most Member States (26 in total) increased emissions from Aviation bunkers between 1990 and 2017.

Table 3.133 Aviation bunkers: Member States' contributions to CO_2

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	886	2 325	2 246	1.4%	1 360	154%	-79	-3%
Belgium	3 126	4 392	4 803	3.0%	1 677	54%	411	9%
Bulgaria	713	636	712	0.5%	-1	0%	76	12%
Croatia	497	376	449	0.3%	-48	-10%	73	20%
Cyprus	718	877	998	0.6%	280	39%	121	14%
Czechia	524	947	1 074	0.7%	550	105%	126	13%
Denmark	1 774	2 822	2 906	1.8%	1 132	64%	84	3%
Estonia	107	138	179	0.1%	73	68%	41	30%
Finland	1 008	1 968	2 097	1.3%	1 090	108%	130	7%
France	8 463	17 003	17 247	10.9%	8 784	104%	243	1%
Germany	12 095	26 375	29 116	18.4%	17 021	141%	2 741	10%
Greece	2 475	3 079	3 435	2.2%	960	39%	355	12%
Hungary	497	599	695	0.4%	199	40%	96	16%
Ireland	1 068	2 582	3 037	1.9%	1 968	184%	455	18%
Italy	4 285	10 301	11 166	7.1%	6 881	161%	865	8%
Latvia	221	372	426	0.3%	205	92%	54	15%
Lithuania	399	287	318	0.2%	-81	-20%	31	11%
Luxembourg	386	1 488	1 682	1.1%	1 296	336%	194	13%
Malta	197	375	428	0.3%	231	117%	53	14%
Netherlands	4 604	11 676	12 014	7.6%	7 410	161%	339	3%
Poland	622	2 002	2 496	1.6%	1 874	301%	494	25%
Portugal	1 533	3 367	3 836	2.4%	2 303	150%	469	14%
Romania	790	870	1 006	0.6%	216	27%	136	16%
Slovakia	67	154	165	0.1%	98	146%	11	7%
Slovenia	49	61	74	0.0%	25	51%	13	22%
Spain	4 731	15 709	16 926	10.7%	12 195	258%	1 217	8%
Sweden	1 335	2 528	2 753	1.7%	1 418	106%	225	9%
United Kingdom	15 337	33 384	34 581	21.9%	19 245	125%	1 198	4%
EU-28	**68 505**	**146 691**	**156 865**	**99%**	**88 360**	**129%**	**10 174**	**7%**
Iceland	219	917	1 147	0.7%	927	423%	230	25%
United Kingdom (KP)	15 270	33 399	34 600	21.9%	19 330	127%	1 201	4%
EU-28 + ISL	**68 658**	**147 623**	**158 030**	**100%**	**89 372**	**130%**	**10 406**	**7%**

CO_2 emissions from jet kerosene account for 99 % of total emissions from "Aviation bunkers" in 2017 (Figure 3.205). All Member States but Bulgaria, Croatia and Lithuania increased emissions from jet kerosene between 1990 and 2017. Member States with the highest increase between 1990 and 2017 in percent were Iceland, Luxembourg, Spain and Poland.

Figure 3.205 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-28+ISL and those Member States contributing most to EU-28+ISL emissions. The United Kingdom, Germany, France and Spain are the Member States that contributed more to the EU-28+ISL emissions. Fuel combustion of EU-28+ISL increased by 130 % between 1990 and 2017.

In Figure 3. the IEF is depicted, showing a mean value of around 72 t/TJ for 2017.

*Figure **3**.3 Aviation bunkers, Jet kerosene: Emission trend and share for CO_2*

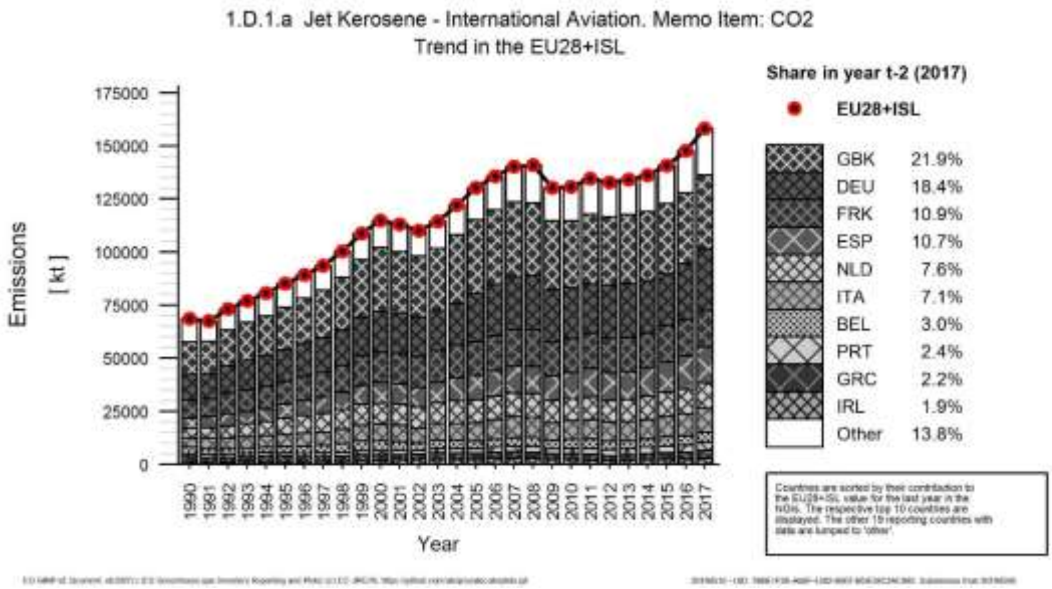
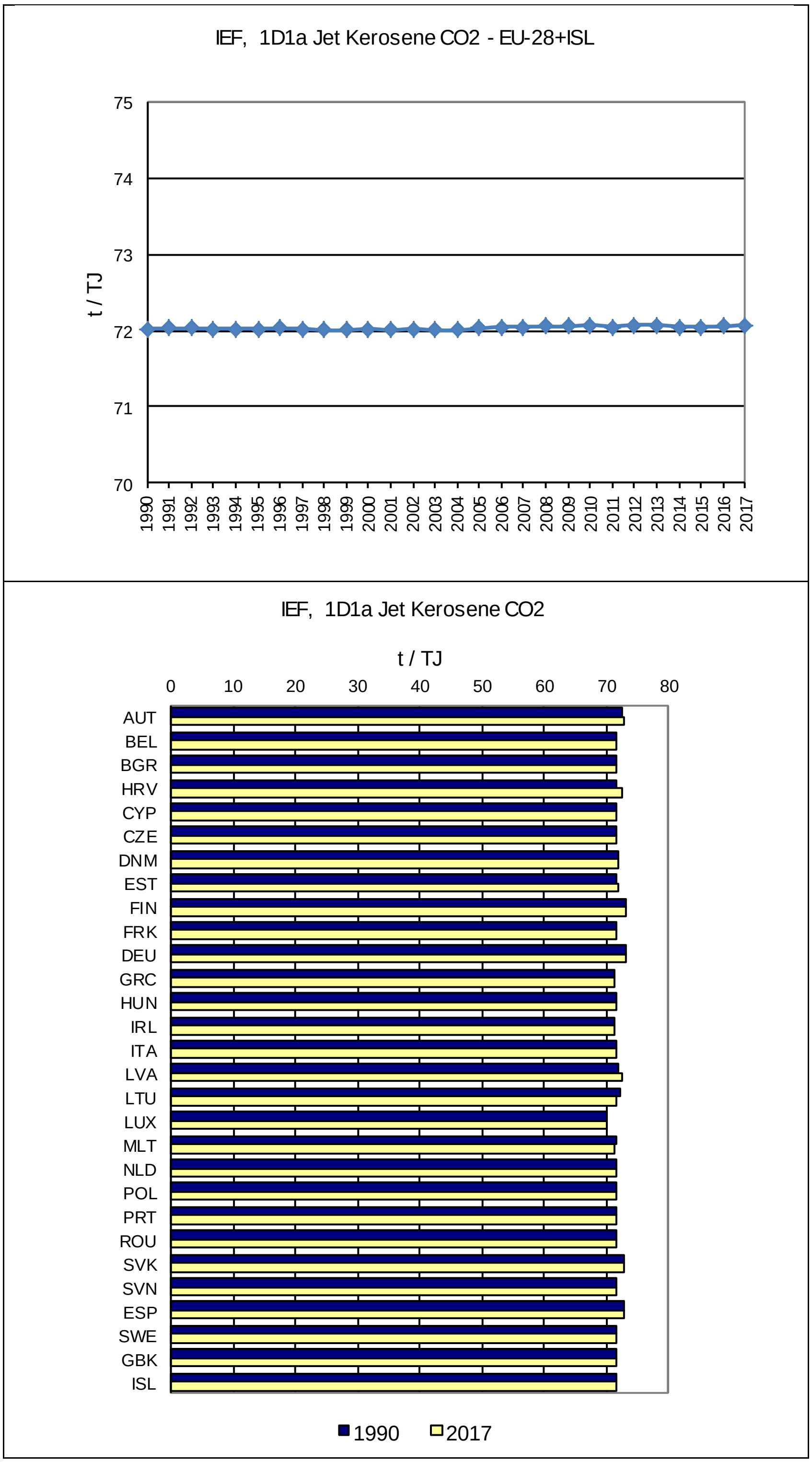


Figure 3.4: 1D1a Aviation bunkers – Jet kerosene: Implied Emission Factors for CO_2 (in t/TJ)



3.8.2 Marine bunkers (EU-28+ISL)

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 3 % of total GHG emissions in 2017 and are also not included in the national total of GHG emissions. Between 1990 and 2017, CO_2 emissions from Marine bunkers increased by 32 % in the EU-28+ISL (Table 3.134).

The Member States the Netherlands, Spain and Belgium contributed most to the emissions from this source (57 %) in 2017. Between 1990 and 2017, most Member States (19 in total) increased emissions from Marine bunkers. The Member States 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.

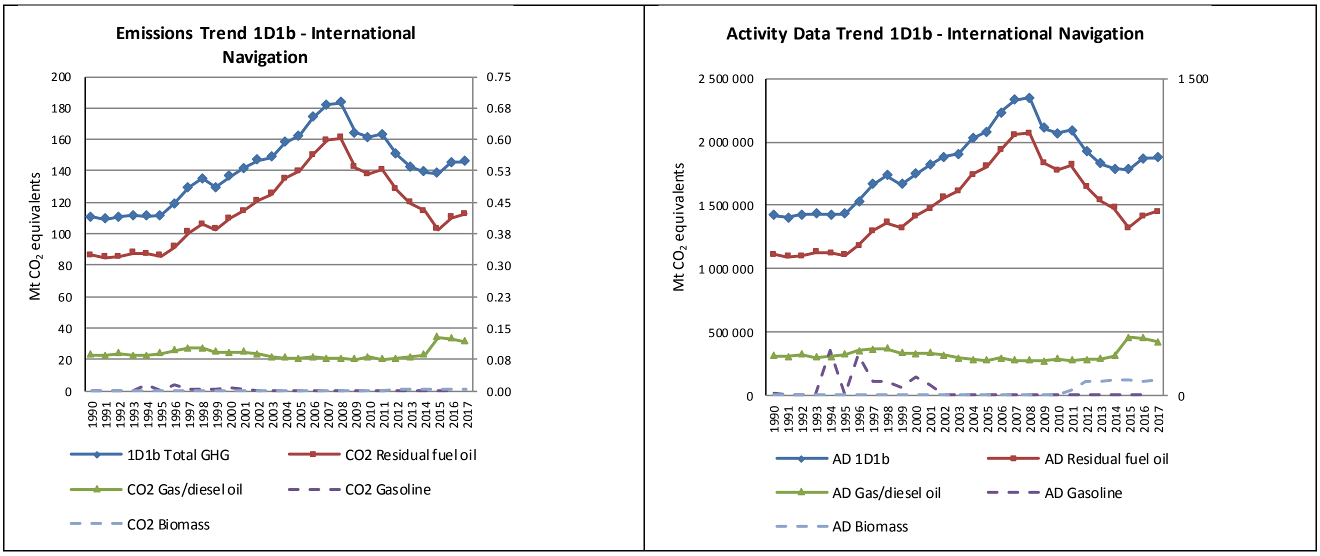
Table 3.134 Marine bunkers: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	49	58	60	0.0%	11	22%	2	4%
Belgium	13 313	21 714	23 558	16.3%	10 246	77%	1 844	8%
Bulgaria	183	242	250	0.2%	68	37%	8	3%
Croatia	147	13	20	0.0%	-127	-86%	7	52%
Cyprus	183	906	805	0.6%	622	340%	-102	-11%
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	3 012	1 957	1 470	1.0%	-1 543	-51%	-488	-25%
Estonia	552	831	954	0.7%	401	73%	123	15%
Finland	1 832	887	1 097	0.8%	-735	-40%	210	24%
France	7 954	5 267	5 580	3.9%	-2 374	-30%	313	6%
Germany	6 405	8 188	6 466	4.5%	61	1%	-1 722	-21%
Greece	8 106	5 586	6 967	4.8%	-1 139	-14%	1 381	25%
Hungary	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Ireland	57	491	480	0.3%	423	745%	-12	-2%
Italy	4 454	6 690	7 113	4.9%	2 659	60%	423	6%
Latvia	1 515	1 003	828	0.6%	-688	-45%	-175	-17%
Lithuania	302	512	554	0.4%	252	83%	42	8%
Luxembourg	0	0	0	0.0%	0	98%	0	25%
Malta	895	5 458	6 924	4.8%	6 030	674%	1 466	27%
Netherlands	34 906	38 048	37 321	25.9%	2 415	7%	-727	-2%
Poland	1 256	575	836	0.6%	-421	-33%	260	45%
Portugal	1 400	2 373	2 491	1.7%	1 091	78%	118	5%
Romania	NO	100	90	0.1%	90	∞	-11	-11%
Slovakia	65	19	18	0.0%	-46	-71%	0	-1%
Slovenia	NO,NA	396	500	0.3%	500	∞	103	26%
Spain	11 659	24 158	21 465	14.9%	9 806	84%	-2 693	-11%
Sweden	2 228	6 725	7 715	5.3%	5 487	246%	989	15%
United Kingdom	8 915	11 312	10 589	7.3%	1 675	19%	-723	-6%
EU-28	**109 387**	**143 513**	**144 151**	**100%**	**34 764**	**32%**	**638**	**0%**
Iceland	19	185	193	0.1%	174	899%	8	4%
United Kingdom (KP)	8 886	11 281	10 553	7.3%	1 667	19%	-727	-6%
EU-28 + ISL	**109 378**	**143 667**	**144 308**	**100%**	**34 930**	**32%**	**641**	**0%**

CO_2 emissions from residual fuel oil account for 77 % of total emissions from “Marine bunkers” in 2017 (**Error! Reference source not found.**). Between 1990 and 2017, CO_2 emissions from residual fuel oil increased by 31 % in the EU-28+ISL. Croatia, Denmark, Finland, France, Greece, Latvia, Poland and Slovakia decreased their emissions. Czech Republic, Hungary, Romania and Slovenia reported in 1990 and/or 2017 notation keys. All other Member states reported increased emissions from residual oil between 1990 and 2017. Member States with the highest increase in percent were Iceland, Ireland, Malta, Cyprus and Sweden.

CO_2 emissions from gas/diesel oil account for 21 % of total emissions from “Marine bunkers” in 2017. Between 1990 and 2017, CO_2 emissions from gas/diesel oil increased by 37 % in the EU-28+ISL.

Figure 3.206: 1D1b Marine bunkers: Trend of CO_2 Emissions and Activity Data



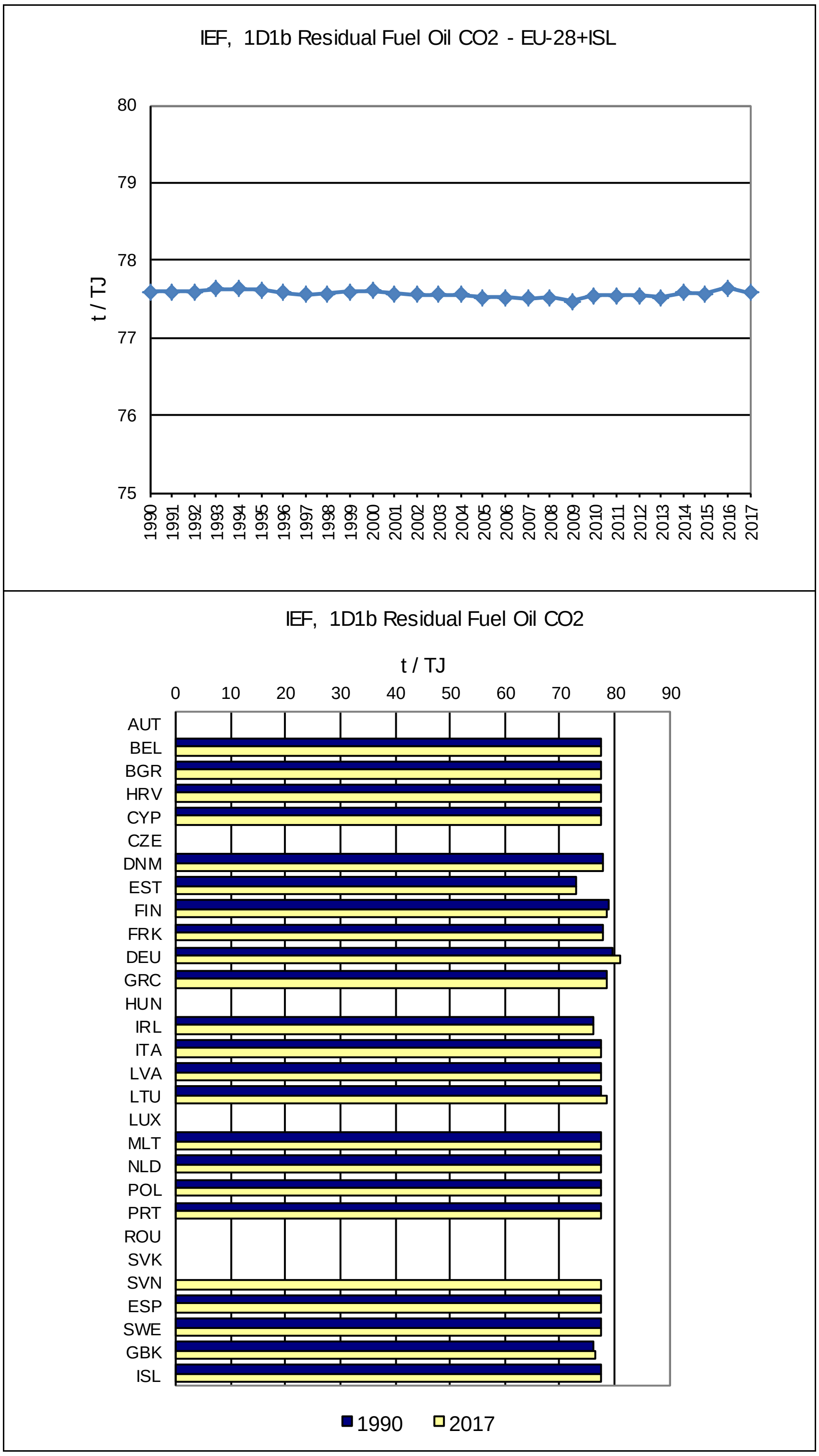
Data displayed as dashed line refers to the secondary axis.

Table 3.134 and Figure 3.206 provide an overview of emissions for residual oil and gas/diesel oil for EU-28 and those Member States contributing most to EU-28 emissions.

3.8.2.1 Marine Bunkers – Residual Oil (CO_2)

Combustion of residual oil in the EU-28+ISL increased by 31 % between 1990 and 2017. In Figure 3. the IEF is depicted, with a mean value of 77.6 t/TJ.

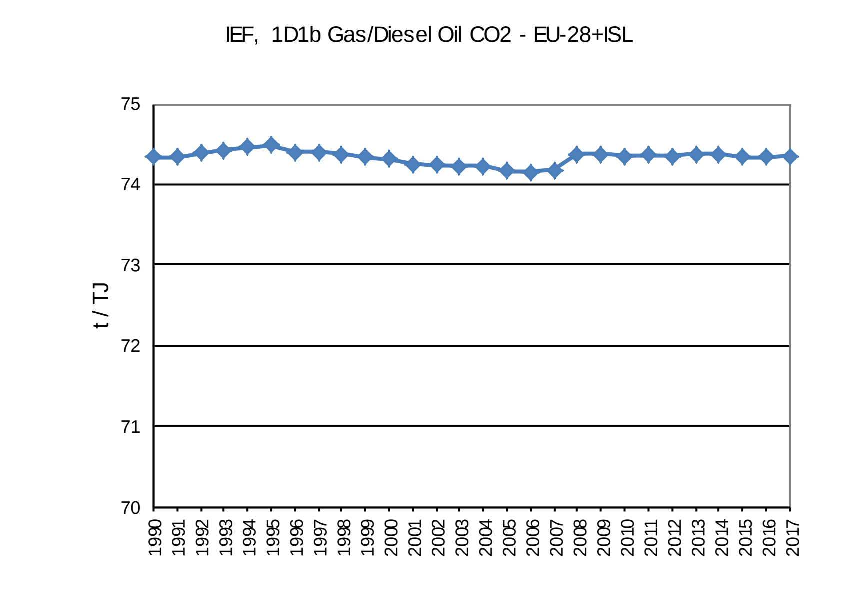
Figure 3.7: 1D1b Marine bunkers – Residual Oil: Implied Emission Factors for CO_2 (in t/TJ)

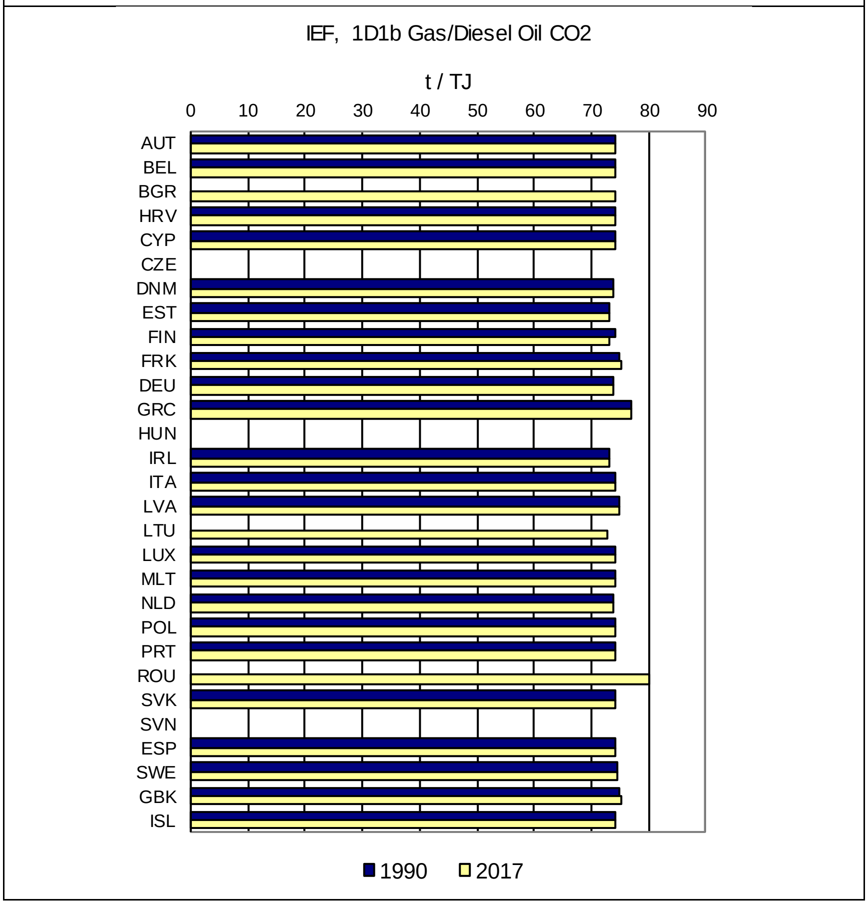


3.8.2.2 Marine Bunkers – Gas/Diesel Oil (CO_2)

Combustion of gas/diesel oil in the EU-28 increased by 37 % between 1990 and 2017. 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 Guidelinesnon 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.

Up to the GHG inventory submission 2017 the EU used Eurostat data for non-energy use of fuels. The reason for using Eurostat data was that 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 2006 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.

Table 3.135 shows the fuels that were used for the purpose of non-energy use in the EU in 2017. It shows that 73 % of non-energy use of fuels are liquid fuels with naphta, bitumen and LPG showing the largest contribution to NEU of liquid fuels. Naphta is reported by 17 Member States and is mainly used as feedstock in the petrochemical industry. Bitumen is reported by 28 Member States and is mainly used in the construction industry. LPG is reported by 12 Member States and is mainly used as feedstock in the petrochemical industry. Natural gas accounts for 14 % of non-energy use of fuels and is mainly used for feedstock in ammonia production. Coke oven / gas coke accounts for 8 % of NEU of fuels and is manily used as reductant in the metal industry.

Table 3.135 Fuel quantity for non-energy use in TJ and % for the EU-28 and Iceland

Fuel			TJ	%
Liquid fossil	Primary fuels	Crude oil	932	0%
		Natural gas liquids	90.100	2%
		Gasoline	300	0%
		Jet kerosene	1	0%
		Other kerosene	2.327	0%
		Gas/diesel oil	140.253	3%
		Residual fuel oil	84.670	2%
		Liquefied petroleum gases (LPG)	522.887	10%
		Ethane	59.813	1%
		Naphtha	1.760.410	33%
		Bitumen	578.327	11%
		Lubricants	217.823	4%
		Petroleum coke	70.625	1%
		Refinery feedstocks	13.014	0%
		Other oil	298.943	6%
Other liquid fossil			4.800	0%
Liquid fossil totals			**3.845.225**	**73%**
Solid fossil	Primary fuels	Anthracite	47.727	1%
		Coking coal	137.644	3%
		Other bituminous coal	99.059	2%
		Lignite	378	0%
		Oil shale and tar sand	5.595	0%
		Coke oven/gas coke	407.594	8%
		Coal tar	26.699	1%
Solid fossil totals			**724.696**	**14%**
Gaseous fossil		Natural gas (dry)	729.423	14%
Gaseous fossil totals			**729.423**	**14%**
Waste (non-biomass fraction)			482	0%
Total			**5.299.343**	**100%**

Table 3.136shows the associated CO_2 emissions from the NEU reported in the inventory for the year 2017. It shows that 45 % of the CO_2 emissions stem from solid fuels, 26% from liquid fuels and 30 % from natural gas. It has to be noted that the reporting in CRF table 1A(d) is still patchy and work is ongoing between the EU and its Member States in order to improve the reporting in this table.

Table 3.136 CO_2 emissions from the NEU reported in the inventory kt CO_2 and % for the EU-28 and Iceland

Fuel			kt	%
Liquid fossil	Primary fuels	Crude oil	13	0%
		Natural gas liquids	799	1%
		Other kerosene	0,3	0%
		Gas/diesel oil	4	0%
		Residual fuel oil	134	0%
		Liquefied petroleum gases (LPG)	1.555	1%
		Naphtha	14.037	13%
		Bitumen	3.222	3%
		Lubricants	2.899	3%
		Petroleum coke	4.149	4%
		Other oil	2.056	2%
Other liquid fossil			317	0%
Liquid fossil totals			**28.385**	**26%**
Solid fossil	Primary fuels	Anthracite	3.698	3%
		Coking coal	12.626	11%
		Other bituminous coal	8.906	8%
		Lignite	12	0%
		Coke oven/gas coke	24.074	22%
		Coal tar	10	0%
Solid fossil totals			**49.325**	**45%**
Gaseous fossil		Natural gas (dry)	32.744	30%
Gaseous fossil totals			**32.744**	**30%**
Waste (non-biomass fraction)			104	0%
Total			**110.455**	**100%**

Table 3.137 shows the recalculations of non-energy use of fuels for the year 2016. A major recalculation can be seen for non-energy use of liquid fuels which needs to be further analysed. Across all fuels recalculations were at -3%. Most recalculations at fuel level were due to revisions in the energy balance.

Table 3.137 Recalculations of fuel quantity for non-energy use of fuels for the inventory year 2016

FUEL TYPE			ACTIVITY DATA AND RELATED INFORMATION			
			Fuel quantity for NEU (TJ)		Difference in TJ	Difference in %
			2018	2019		
Liquid fossil fossil	Primary fuels	Crude oil	507	251	-256	-51%
		Orimulsion	IE,NO	IE,NO	0	-
		Natural gas liquids	102.100	95.700	-6.400	-6%
	Secondary fuels	Gasoline	IE,NO	IE,NO	0	-
		Jet kerosene	NO	NO	0	-
		Other kerosene	3.109	2.022	-1.087	-35%
		Shale oil	NO	NO	0	-
		Gas/diesel oil	108.347	131.381	23.034	21%
		Residual fuel oil	160.839	86.502	-74.337	-46%
		Liquefied petroleum gases (LPG)	570.673	466.568	-104.105	-18%
		Ethane	48.100	58.446	10.346	22%
		Naphtha	1.709.343	1.683.089	-26.253	-2%
		Bitumen	612.529	577.959	-34.570	-6%
		Lubricants	189.335	209.413	20.079	11%
		Petroleum coke	50.955	68.615	17.660	35%
		Refinery feedstocks	12.024	16.860	4.836	40%
		Other oil	306.904	291.344	-15.561	-5%
Other liquid fossil			4.808	5.395	588	12%
Liquid fossil totals			**3.879.573**	**3.693.546**	**-186.026**	**-5%**
Solid fossil	Primary fuels	Anthracite	43.778	47.068	3.290	8%
		Coking coal	189.235	139.091	-50.143	-26%
		Other bituminous coal	79.985	96.037	16.053	20%
		Sub-bituminous Coal	IE,NO	IE,NO	0	-
		Lignite	1.406	350	-1.056	-75%
		Oil shale and tar sand	5.214	3.033	-2.182	-42%
	Secondary fuels	BKB and patent fuel	NO	NA,NO	0	-
		Coke oven/gas coke	384.664	404.235	19.570	5%
		Coal tar[7]	24.772	29.339	4.567	18%
Other solid fossil					0	-
		Other			0	-
Solid fossil totals			**729.054**	**719.154**	**-9.900**	**-1%**
Gaseous fossil		Natural gas (dry)	658.100	673.597	15.497	2%
Other gaseous fossil			NO	NA,NO	0	-
Gaseous fossil totals			**658.100**	**673.597**	**15.497**	**2%**
Waste (non-biomass fraction)			561	536	-25	-4%
Other fossil fuels			NO	NA,NO	0	-
Other fossil fuels totals			NO	NA,NO	0	-
Total fossil fuels			**5.266.727**	**5.086.298**	**-180.429**	**-3%**

Table 3.138 provides information on feedstocks and non-energy use of fuels from Member States' NIRs.

Table 3.138 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 2006 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	National Inventory Report, Chapter 3.2.3

	in the petrochemical industry (approx. 2/3) and other recovered fuels from the chemical industry (approx. 1/3). These 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 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 2006 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 Guidelineswere 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	National Inventory Report, Chapter 3.2.3

	data for non-energy use for 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 GuidelinesVolume 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

Slovenia	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 2006 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, 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.	National Inventory Report, Chapter 3.2.3
Spain	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.	National Inventory Report, Chapter 3.1.4 translation
Sweden	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 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.	National Inventory Report, Chapter 3.2.3

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 EU-28 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-28 GHG (without LULUCF) emissions in 2017. 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 27 % from 518 Mt in 1990 to 380 Mt in 2017 (Figure 4.1). In 2017, the emissions increased by 1 % compared to 2016. 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.2 Foam Blowing Agents (HFCs)
- 2.F.3 Fire Protection (HFCs)
- 2.F.4 Aerosols/ Metered Dose Inhalers (HFCs)

Figure 4.1: CRF Sector 2 Industrial Processes and Product Use: EU-28 and Iceland GHG emissions for 1990–2017in CO_2 equivalents (Mt)

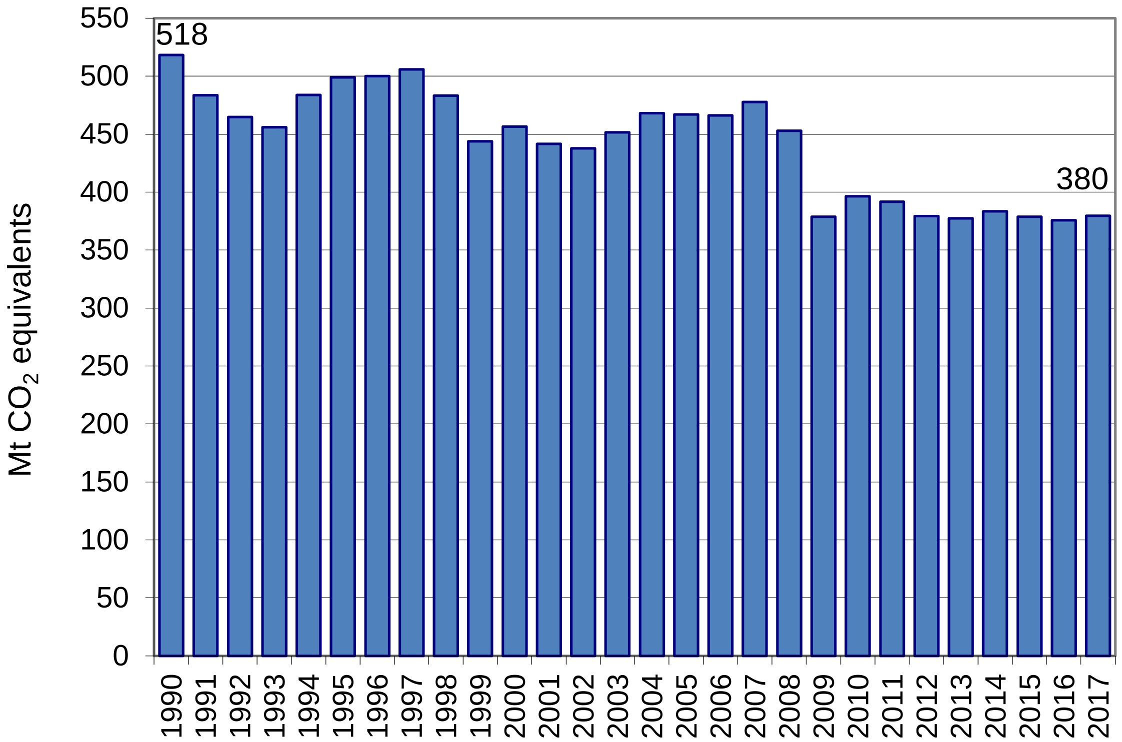
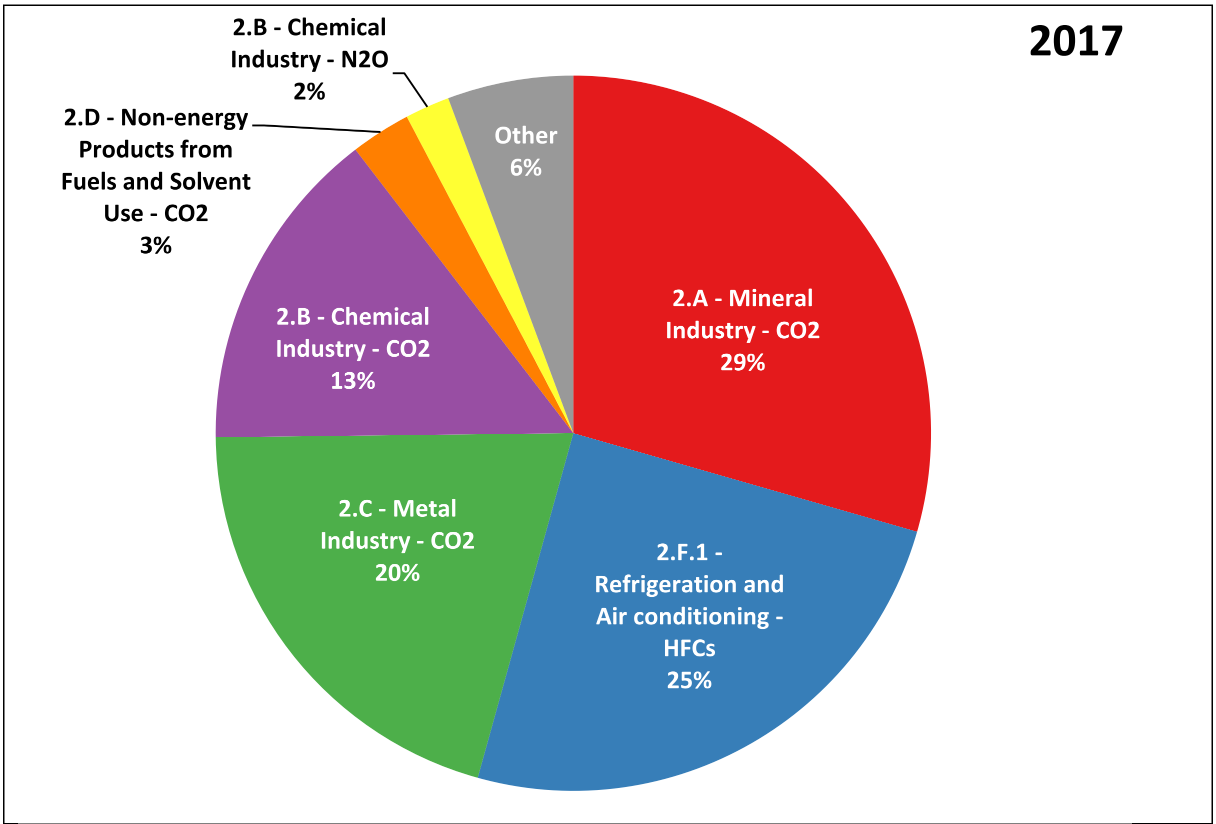
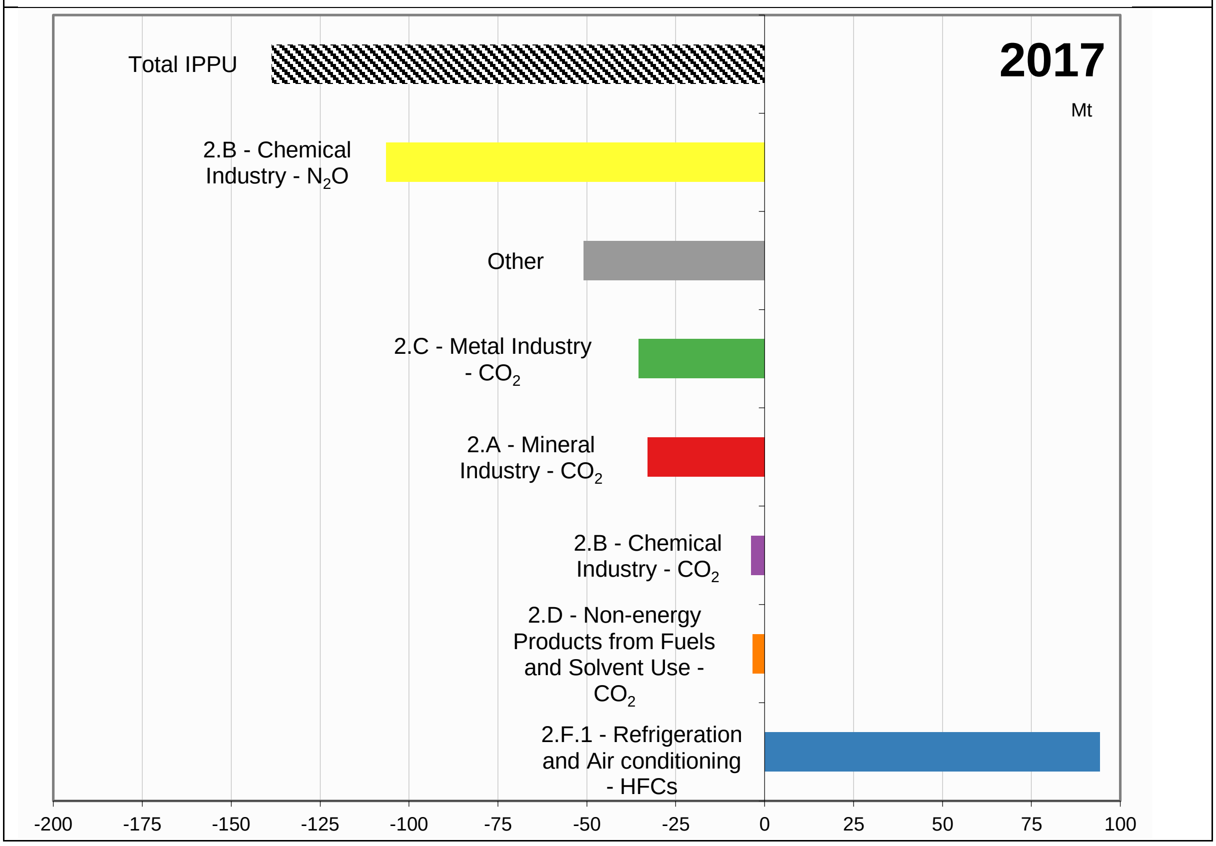


Figure 4.2: CRF Sector 2 Industrial processes and Product Use: Share of largest key categories in 2017 and absolute change of GHG emissions by large key categories 1990–2017 in CO_2 equivalents (Mt)





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	2017		1990	2017	
2.A.1 Cement Production (CO_2)	102687	76703	0	L	L	100%
2.A.2 Lime Production (CO_2)	25336	19141	0	L	L	99.9%
2.A.4 Other Process Uses of Carbonates (CO_2)	11734	10608	0	L	L	99.9%

This sector is dominated by cement production which contributes nearly 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 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 10% of the sector and is composed of several sources with independent estimation methods. The remaining 4% of emissions is from 2A3 Glass production. The share of higher tiers used is complete or almost complete for each of the three key categories.

While mineral sector emissions decreased since the 2009 economic crisis they increased again by nearly 3% between 2016 and 2017 after a similar increase between 2013 and 2014. Nevertheless, mineral industry emissions have fallen by 23% since 1990. (Figure **4.3**). Only seven countries (HR, CY, DK, IE, NL, PL, SE), have higher Mineral industry CO_2 emissions in 2017 compared to 1990 (Table 4.2).

Figure 4.3 2A Mineral industry CO_2 emissions

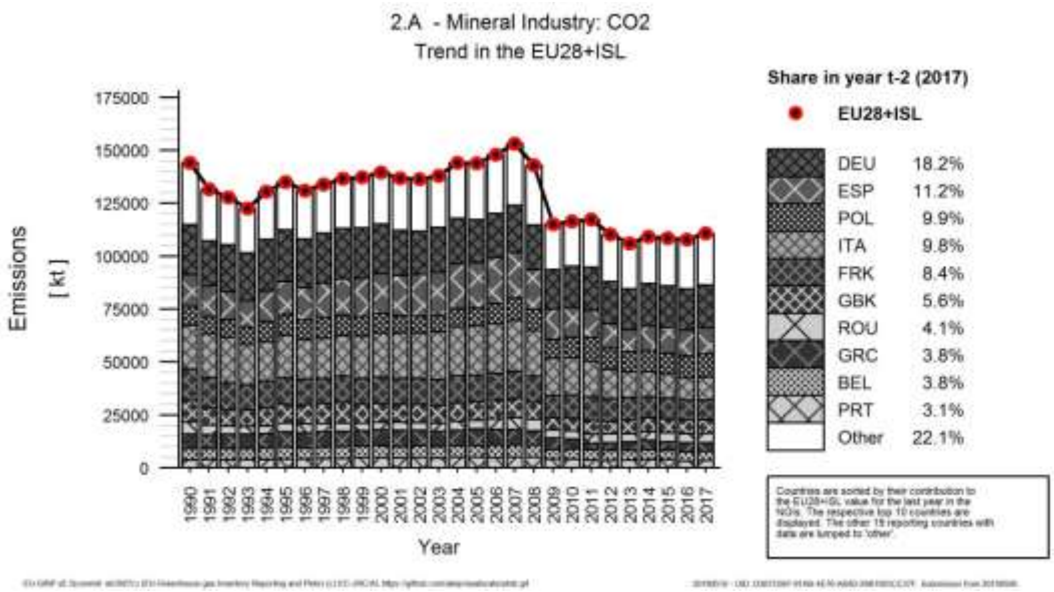


Table 4.2 2A Mineral industry: Member States total GHG and CO_2 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2017 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2017 (kt)
Austria	3 092	2 800	3 092	2 800
Belgium	5 319	4 223	5 319	4 223
Bulgaria	3 236	2 520	3 236	2 520
Croatia	1 310	1 439	1 310	1 439
Cyprus	717	935	717	935
Czechia	4 082	2 856	4 082	2 856
Denmark	1 082	1 333	1 082	1 333
Estonia	614	375	614	375
Finland	1 218	1 134	1 218	1 134
France	14 973	9 328	14 973	9 328
Germany	23 522	20 201	23 522	20 201
Greece	6 775	4 239	6 775	4 239
Hungary	2 890	1 256	2 890	1 256
Ireland	1 117	2 040	1 117	2 040
Italy	20 720	10 816	20 720	10 816
Latvia	537	447	537	447
Lithuania	2 142	493	2 142	493
Luxembourg	623	436	623	436
Malta	1	0	1	0
Netherlands	1 411	1 630	1 411	1 630
Poland	8 855	10 933	8 855	10 933
Portugal	3 686	3 389	3 686	3 389
Romania	6 037	4 527	6 037	4 527
Slovakia	2 714	2 277	2 714	2 277
Slovenia	694	497	694	497
Spain	15 119	12 394	15 119	12 394
Sweden	1 672	1 984	1 672	1 984
United Kingdom	9 804	6 249	9 804	6 249
EU-28	**143 965**	**110 751**	**143 965**	**110 751**
Iceland	52	1	52	1
United Kingdom (KP)	9 804	6 249	9 804	6 249
EU-28 + ISL	**144 018**	**110 752**	**144 018**	**110 752**

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 Member States' contribution to EU-28+ISL recalculations in CO_2 from 2A Mineral industry for 1990 and 2016 as well as some explanations for the larger recalculations provided by Member States.

Table 4.3 2A Mineral industry: Contribution of MS to EU-28+ISL recalculations in CO_2 for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

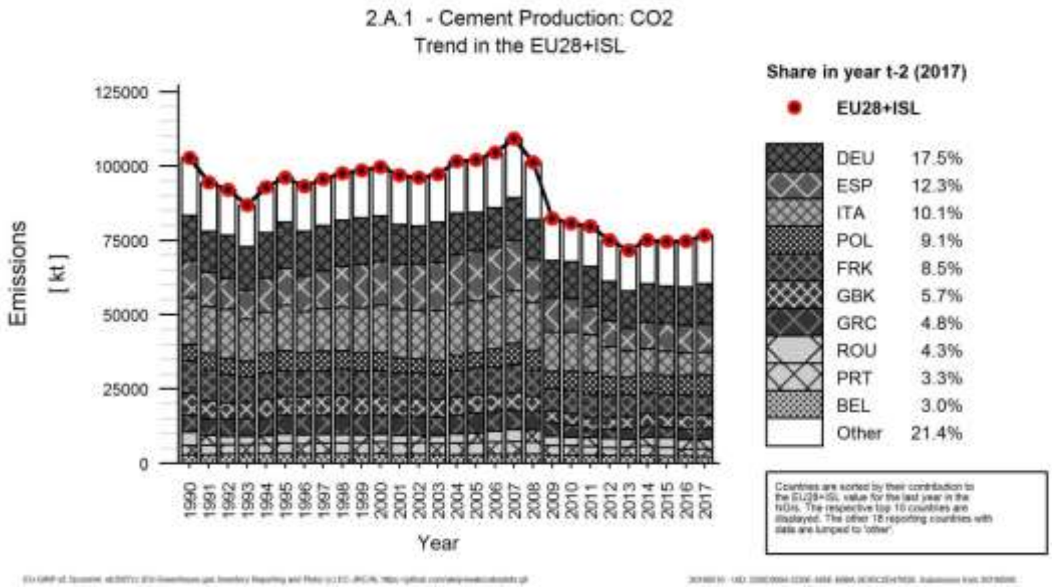
	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	-4	-0.1	-	-	
Bulgaria	-	-	-	-	
Croatia	30	2.3	-23	-1.8	Technical corrections (corrected data input errors; new methodology used for emissions from lime production in sugar factories)
Cyprus	-	-	-	-	
Czech Republic	-	-	18	0.6	Updated activity data in 2.A.4.d
Denmark	-	-	-0.03	-0.003	
Estonia	-0.3	-0.05	0.2	0.1	Emissions from category 2.A.4.b are included into category 2.C.5. Emissions from two production plants under category 2.A.4.d are now calculated with the same method.
Finland	4	0.4	3	0.3	The total time series of emissions of clay included in ceramics production
France	-	-	-2	-0.0	
Germany	-	-	-83	-0.4	Changes in activity data for lime kiln dust (LKD) in the lime industry, 2015 & 2016 (2.A.2) see NIR 4.2.2.5. Minimal update of activity data for the glass industry, 2016 (2.A.3) see NIR 4.2.3.5. Correction of a calculation on soda-ash use, 2016 (2.A.4.b) see NIR 4.2.4.2.5
Greece	-	-	-	-	
Hungary	-5	-0.2	-4	-0.3	Inclusion of non-ETS plants and exclusion of +10% CO_2 emission in subsector Glass; small error was detected in 2A4di
Ireland	-	-	-	-	
Italy	-	-	6	0.1	
Latvia	-58	-9.8	-	-	
Lithuania	-	-	-	-	
Luxembourg	-	-	-	-	
Malta	-	-	1.1	1 962	Recalculation for Sodium Bicarbonate for Desulphurisation (2.a.4.d Other): In previous inventories, the emissions from imported sodium bicarbonate used in desulphurisation were accounted for under the specific sectors. For the years 2015 and 2016, the activity data showing the amount of sodium bicarbonate consumed annually in the desulphurisation process in waste incineration was revised by the operator as follows: from 256.3tons to 227.7tons, for the year 2015 and, for the year 2016, from 256.3tons to 316.8tons
Netherlands	-	-	-	-	
Poland	-	-	1	0.01	AD and emission correction in ceramic production and 2.A.4.d category (limestone use in desulfurization process)
Portugal	-4	-0.1	3	0.1	Update on AD in 2A4a and 2A4d; correction on ETS data in 2A2
Romania	-494	-7.6	-76	-1.7	Recalculations have been made for the entire period 1989-2016 due to an improvement in activity data, stoichiometric report and CaO content for the calcium lime production. (CRF Category 2.A.2); Recalculations have been made for the 2014-2016 period due to an improvement of the percentage of glass pieces reintroduced into the process (cullet ratio) value. (CRF Category 2.A.3); Recalculations have been made for the 2015-2016 period due to the changes in activity data for these years (a new operator has sent data on soda ash consumption). (CRF Category 2.A.4 b)
Slovakia	-	-	-	-	
Slovenia	-0	-0.0	-	-	
Spain	-38	-0.3	8	0.1	2A2 recalculations have been made for the entire series as a new methodology is implemented. In parallel, this has led to the revision of the complete series of the activity variable and the correction of some recording errors NIR 4.3.5.
Sweden	-0	-0.0	16	0.8	Earlier missing emissions from CKD i Slite Reallocation of a facility to 2H1
United Kingdom	-0	-0.0	-0	-0.0	Minor re-allocation of some EUETS data, which was previously assumed to be 2A3.
EU28	-570	-0.4	-132	-0.1	
Iceland	0	0.0	-0	-0.0	
United Kingdom (KP)					
EU28+ISL	-570	-0.4	-132	-0.1	

(*) 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 1.8% of total EU 28+ISL (without LULUCF) emissions in 2017. In 2017, CO_2 emissions from Cement production were 25% 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-28+ISL CO_2 emissions



Germany, Spain and Italy were the largest emitters accounting for 17.5%, 12.3% and 10.1% respectively of cement related emissions. (Figure 4.4, Table 4.4). Cement production saw 2.7% increase in overall emissions in 2017 compared to 2016, with increases outweighing decreases. The three countries with the largest absolute growth (2016-2017) were Germany, Poland and Portugal. The three countries with the largest absolute reductions were Belgium, France and the United Kingdom.

Table 4.4 2A1 Cement production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	2 033	1 729	1 710	2.2%	-323	-16%	-19	-1%	T3	PS
Belgium	2 824	2 436	2 291	3.0%	-532	-19%	-144	-6%	T3	PS
Bulgaria	2 100	1 200	1 238	1.6%	-863	-41%	38	3%	T2	PS
Croatia	1 093	1 077	1 287	1.7%	194	18%	211	20%	T2,T3	PS
Cyprus	668	883	919	1.2%	251	38%	36	4%	CS	CS
Czech Republic	2 489	1 698	1 728	2.3%	-761	-31%	31	2%	T3	PS
Denmark	882	1 095	1 194	1.6%	311	35%	98	9%	T3	PS
Estonia	483	185	307	0.4%	-176	-36%	122	66%	T2	PS
Finland	729	553	604	0.8%	-126	-17%	50	9%	T3	PS
France	10 937	6 639	6 483	8.5%	-4 454	-41%	-156	-2%	T2,T3	CS,PS
Germany	15 297	12 663	13 408	17.5%	-1 889	-12%	745	6%	T2	CS
Greece	5 762	3 772	3 685	4.8%	-2 076	-36%	-87	-2%	CS	PS
Hungary	1 751	705	783	1.0%	-968	-55%	78	11%	T3	PS
Ireland	884	1 794	1 840	2.4%	956	108%	46	3%	T3	PS
Italy	15 846	7 680	7 711	10.1%	-8 134	-51%	31	0%	T2	CS,PS
Latvia	346	346	437	0.6%	91	26%	91	26%	T2	PS
Lithuania	1 668	452	450	0.6%	-1 218	-73%	-2	0%	T2	PS
Luxembourg	570	355	373	0.5%	-197	-35%	18	5%	T2	CS,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	416	239	298	0.4%	-118	-28%	59	25%	CS	PS
Poland	5 453	6 530	6 996	9.1%	1 543	28%	467	7%	T2	CS
Portugal	3 176	2 297	2 531	3.3%	-646	-20%	234	10%	T3	OTH
Romania	4 445	3 181	3 309	4.3%	-1 137	-26%	128	4%	CS,T2	PS
Slovakia	1 464	1 341	1 367	1.8%	-97	-7%	26	2%	T2	PS
Slovenia	470	344	410	0.5%	-60	-13%	67	19%	T2	CS
Spain	12 279	9 414	9 449	12.3%	-2 830	-23%	35	0%	T2	CS
Sweden	1 272	1 554	1 484	1.9%	212	17%	-69	-4%	T3	PS
United Kingdom	7 295	4 553	4 410	5.7%	-2 885	-40%	-144	-3%	T3	CS
EU-28	**102 635**	**74 715**	**76 703**	**100%**	**-25 933**	**-25%**	**1 988**	**3%**	**-**	**-**
Iceland	52	NO	NO	-	-52	-100%	-	-	NA	NA
United Kingdom (KP)	7 295	4 553	4 410	5.7%	-2 885	-40%	-144	-3%	T3	CS
EU-28 + ISL	**102 687**	**74 715**	**76 703**	**100%**	**-25 984**	**-25%**	**1 988**	**3%**	**-**	**-**

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

Table 4.5 shows information on methods, activity data, and emission factors for CO_2 emissions from 2A1 Cement production for 1990 and 2017. All cement production emissions are estimated with higher Tier methods and most Member States use plant-specific emission factors.

The implied emission factors per tonne of clinker produced in 2017 range from 0.49 t CO_2/t of clinker produced for 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 2017 the EU-28+ISL IEF remained at 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				2017				Method	Emission Factor Information
	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	Clinker production	3 694	1	2 033	Clinker production	3 313	0.52	1 710	T3	PS
Belgium	Clinker production	5 292	1	2 824	Clinker production	4 238	0.54	2 348	T3	PS
Bulgaria	Clinker production	3 987	1	2 100	Clinker production	2 327	0.53	1 105	T2	PS
Croatia	Clinker production	2 062	1	1 093	Clinker production	2 411	0.53	1 169	T2,T3	PS
Cyprus	Clinker production	1 249	1	668	Clinker production	1 717	0.54	877	CS	CS
Czech Republi	Clinker production	4 726	1	2 489	Clinker production	3 236	0.53	1 558	T3	PS
Denmark	Clinker production	1 406	1	882	Clinker production	2 170	0.55	932	T3	PS
Estonia	Clinker production	790	1	483	Clinker production	518	0.59	206	T2	PS
Finland	Clinker production	1 470	0	729	Clinker production	1 181	0.51	462	T3	PS
France	Clinker production	20 854	1	10 937	Clinker production	11 312	0.57	6 606	T2,T3	CS,PS
Germany	Clinker production	28 863	1	15 297	Clinker production	25 298	0.53	12 626	T2	CS
Greece	Clinker production	10 645	1	5 762	Clinker production	7 088	0.52	3 467	CS	PS
Hungary	Clinker production	3 210	1	1 751	Clinker production	C	C	676	T3	PS
Ireland	Clinker production	1 610	1	884	Clinker production	3 345	0.55	1 652	T3	PS
Italy	Clinker production	29 786	1	15 846	Clinker production	14 822	0.52	8 196	T2	CS,PS
Latvia	Clinker production	669	1	346	Clinker production	854	0.51	470	T2	PS
Lithuania	Clinker production	3 058	1	1 668	Clinker production	839	0.54	518	T2	PS
Luxembourg	Clinker production	1 048	1	570	Clinker production	761	0.49	329	T2	CS,PS
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	Clinker production	770	1	416	Clinker production	588	0.51	249	CS	PS
Poland	Clinker production	10 309	1	5 453	Clinker production	12 997	0.54	6 342	T2	CS
Portugal	Clinker production	6 128	1	3 176	Clinker production	4 854	0.52	2 921	T3	OTH
Romania	Clinker production	8 379	1	4 445	Clinker production	6 323	0.52	3 337	CS,T2	PS
Slovakia	Clinker production	2 836	1	1 464	Clinker production	2 699	0.51	1 309	T2	PS
Slovenia	Clinker production	891	1	470	Clinker production	797	0.51	367	T2	CS
Spain	Clinker production	23 212	1	12 279	Clinker production	17 936	0.53	9 216	T2	CS
Sweden	Clinker production	2 348	1	1 272	Clinker production	2 768	0.54	1 537	T3	PS
United Kingdo	Clinker production	13 199	1	7 295	Clinker production	7 824	0.56	4 451	T3	CS
EU-28	**NE**	**NE**	**1**	**102 635**	**Clinker production**	**143 683**	**0.5**	**76 703**	**-**	**-**
Iceland	Clinker production	97	1	52	Clinker production	NO	NO	NO	NA	NA
United Kingdo	Clinker production	13 199	1	7 295	Clinker production	7 824	0.6	4 451	T3	CS
EU-28+ISL	**NE**	**NE**	**1**	**102 687**	**Clinker production**	**142 216**	**0.5**	**75 920**	**-**	**-**

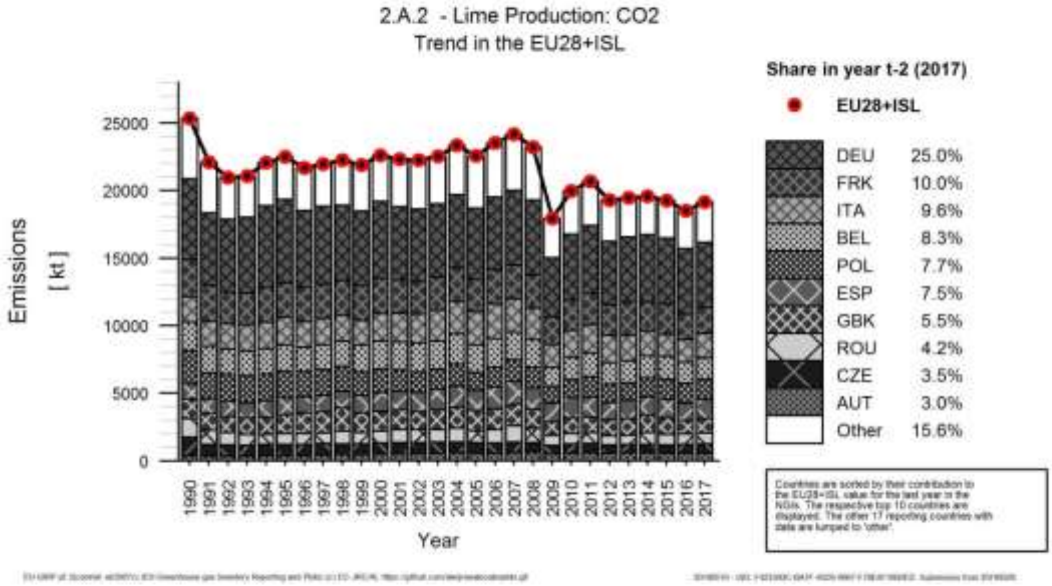
Abbreviations are explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Not all countries show production as the activity data for this emissions category. Gap-filled values are shown against clinker production for 2017 EU activity and the 2017 EU IEF.

4.2.1.2 2A2 Lime production

CO_2 emissions from 2A2 Lime production account for only 0.4% of total EU 28+ISL (without LULUCF) emissions. Between 1990 and 2017, CO_2 emissions from this source decreased by 24%.

Lime production CO_2 emissions saw a 3.5% increase in overall emissions in 2017 with increases outweighing decreases. The largest increases were 168kt in Spain and 165kt in Italy. Small decreases occurred in Belgium, Denmark, Germany, Lithuania, Slovakia and Slovenia (Figure 4.5).

Figure 4.5 2A2 Lime production: EU-28+ISL CO_2 emissions



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Emissions from lime production have been fairly stable since the recovery from the 2009 economic crisis. Germany, France and Italy are the largest emitters contributing 25%, 10% and 9.6% of the sector respectively (Table 4.6).

Table 4.6 2A2 Lime production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	396	582	583	3.0%	187	47%	1	0%	T3	PS
Belgium	2 097	1 589	1 579	8.3%	-518	-25%	-10	-1%	T3	PS
Bulgaria	390	217	224	1.2%	-167	-43%	7	3%	T2	D
Croatia	157	70	88	0.5%	-69	-44%	18	26%	T2,T3	PS
Cyprus	5	2	3	0.0%	-2	-40%	1	33%	T1	D
Czechia	1 337	640	674	3.5%	-663	-50%	34	5%	T3	PS
Denmark	105	55	51	0.3%	-55	-52%	-5	-9%	T3	CS
Estonia	130	39	55	0.3%	-74	-57%	16	41%	T2	PS
Finland	401	386	397	2.1%	-4	-1%	10	3%	T3	CS
France	2 751	1 889	1 923	10.0%	-828	-30%	34	2%	T2,T3	CS,PS
Germany	5 987	4 838	4 777	25.0%	-1 209	-20%	-61	-1%	T2	D
Greece	404	174	174	0.9%	-230	-57%	0	0%	CS	PS
Hungary	614	126	171	0.9%	-443	-72%	44	35%	T3	PS
Ireland	214	174	199	1.0%	-15	-7%	25	14%	T3	PS
Italy	1 877	1 667	1 832	9.6%	-46	-2%	165	10%	T2	CS,PS
Latvia	122	NO	NO	-	-122	-100%	-	-	NA	NA
Lithuania	223	37	21	0.1%	-202	-91%	-16	-44%	T2	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	1	NO	NO	-	-1	-100%	-	-	NA	NA
Netherlands	163	166	226	1.2%	63	39%	60	36%	CS	D
Poland	2 461	1 448	1 480	7.7%	-981	-40%	32	2%	T2	CS
Portugal	201	340	353	1.8%	152	76%	13	4%	T3	OTH
Romania	1 404	756	806	4.2%	-597	-43%	51	7%	T2	CS,D
Slovakia	795	522	508	2.7%	-287	-36%	-14	-3%	T2	PS
Slovenia	200	61	58	0.3%	-142	-71%	-2	-4%	T3	CS
Spain	1 108	1 277	1 445	7.5%	337	30%	168	13%	T3	PS
Sweden	331	428	465	2.4%	133	40%	37	9%	T3	D
United Kingdom	1 462	1 021	1 052	5.5%	-410	-28%	31	3%	T3	CS
EU-28	**25 336**	**18 502**	**19 141**	**100%**	**-6 194**	**-24%**	**639**	**3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 462	1 021	1 052	5.5%	-410	-28%	31	3%	T3	CS
EU-28 + ISL	**25 336**	**18 502**	**19 141**	**100%**	**-6 194**	**-24%**	**639**	**3%**	**-**	**-**

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

Table 4.7 shows information on the methods and emission factors for CO_2 emissions from 2A2 Lime production for 1990 and 2017. 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 2017 is 0.74 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 2017 range from 0.60 for Croatia to 0.80 for Finland. The IEFs for three Member States (Netherlands, Portugal and the United Kingdom) stand out because they report activity as Limestone used and Carbonate used. Of the twenty-five countries which report lime production emissions, all but one use higher tier methodologies (country or plant specific emission factors or 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

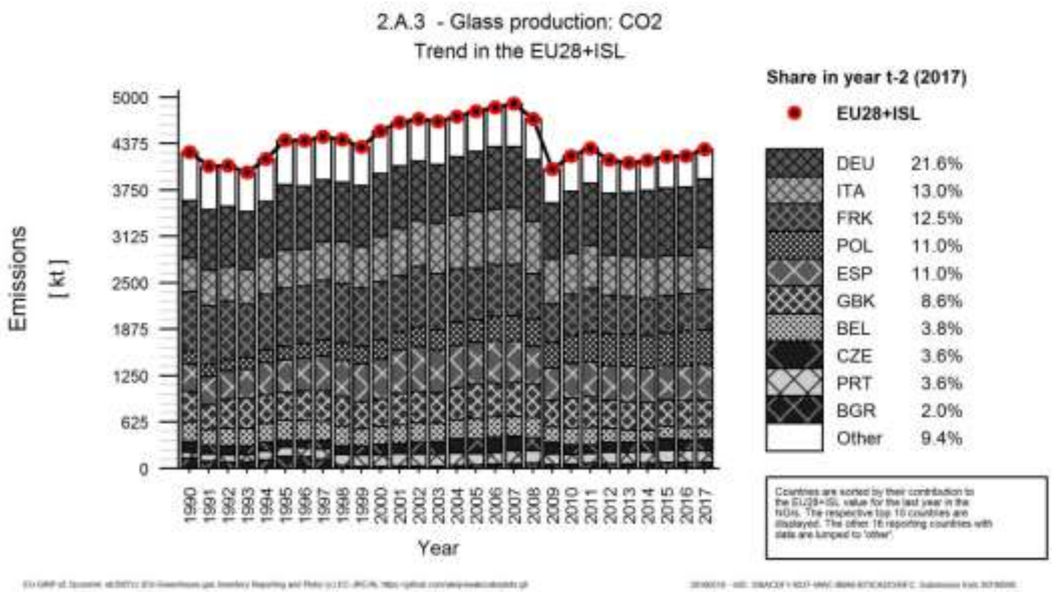
Member State	1990				2017				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Lime Production	513	0.77	396	Lime Production	775	0.75	583	T3	PS
Belgium	Lime Production	2 660	0.79	2 097	Lime Production	1 997	0.79	1 665	T3	PS
Bulgaria	Lime Production	490	0.80	390	Lime Production	287	0.78	204	T2	D
Croatia	Lime Production	219	0.72	157	Lime Production	146	0.60	79	T2,T3	PS
Cyprus	Lime Production	7	0.73	5	Lime Production	4	0.73	2	T1	D
Czech Republic	Lime Production	1 823	0.73	1 337	Lime Production	888	0.76	612	T3	PS
Denmark	Lime Production	134	0.79	105	Lime Production	64	0.79	51	T3	CS
Estonia	Lime Production	185	0.70	130	Lime Production	78	0.71	39	T2	PS
Finland	Lime Production	488	0.82	401	Lime Production	495	0.80	359	T3	CS
France	Lime Production	3 589	0.77	2 751	Lime Production	3 013	0.64	2 249	T2,T3	CS,PS
Germany	Lime Production	7 927	0.76	5 987	Lime Production	6 365	0.75	4 878	T2	D
Greece	Lime Production	491	0.82	404	Lime Production	225	0.77	163	CS	PS
Hungary	Lime Production	831	0.74	614	Lime Production	C	C	151	T3	PS
Ireland	Lime Production	255	0.84	214	Lime Production	264	0.75	177	T3	PS
Italy	Lime Production	2 583	0.73	1 877	Lime Production	2 510	0.73	1 659	T2	CS,PS
Latvia	Lime Production	225	0.54	122	Lime Production	NO	NO,NA	0	NA	NA
Lithuania	Lime Production	288	0.77	223	Lime Production	27	0.77	39	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	516	0.44	129	CS	D
Poland	Lime Production	3 464	0.71	2 461	Lime Production	2 011	0.74	1 495	T2	CS
Portugal	Carbonate used	492	0.41	201	Carbonate used	858	0.41	351	T3	OTH
Romania	Lime Production	2 025	0.69	1 404	Lime Production	1 125	0.72	758	T2	CS,D
Slovakia	Lime Production	1 076	0.74	795	Lime Production	640	0.79	534	T2	PS
Slovenia	Lime Production	275	0.73	200	Lime Production	78	0.75	60	T3	CS
Spain	Lime Production	1 601	0.69	1 108	Lime Production	2 146	0.67	1 380	T3	PS
Sweden	Lime Production	439	0.75	331	Lime Production	623	0.75	420	T3	D
United Kingdom	Carbonate used	3 282	0.45	1 462	Carbonate used	2 362	0.45	1 220	T3	CS
EU-28	**NE**	**NE**	**0.71**	**25 336**	**Lime Production**	**26 061**	**0.74**	**19 257**	-	-
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Carbonate used	3 282	0.4	1 462	Carbonate used	2 362	0.45	1 220	T3	CS
EU-28+ISL	**NE**	**NE**	**0.71**	**25 336**	**Lime Production**	**26 061**	**0.74**	**19 257**	-	-

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'. Not all Member States show 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 2017.

4.2.1.3 2A3 Glass production

CO_2 emissions from 2A3 Glass production contributed to only 0.1% of total EU 28+ISL (without LULUCF) emissions in 2017. As can be seen in Figure 4.6, emissions in 2017 were very similar to 1990 levels (just 1% higher). CO_2 emissions from glass production in 2017 increased by 2% on 2016 levels.

Figure 4.6 2A3 Glass production: EU-28+ISL CO_2 emissions



In 2017, Germany was responsible for 21.6%, Italy for 13% and France for 12.5% of the emissions from this source. The largest absolute reduction in annual emissions compared to 1990 has been seen in France (-261kt or 33%).

Table 4.8 2A3 Glass production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	39	38	38	0.9%	0	0%	0	0%	T3	PS
Belgium	263	170	164	3.8%	-98	-37%	-6	-3%	T3	CS,PS
Bulgaria	138	84	86	2.0%	-52	-38%	2	2%	T1	CS
Croatia	43	33	32	0.7%	-11	-26%	-1	-2%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	143	138	155	3.6%	12	9%	17	12%	T3	PS
Denmark	16	9	9	0.2%	-8	-47%	0	-4%	T3	PS
Estonia	1	9	10	0.2%	9	696%	0	4%	T3	PS
Finland	21	2	3	0.1%	-18	-88%	0	21%	T3	CS
France	797	494	536	12.5%	-261	-33%	42	8%	T2,T3	CS,PS
Germany	780	923	927	21.6%	146	19%	3	0%	T2	CS
Greece	20	17	18	0.4%	-3	-13%	1	5%	CS	CS
Hungary	77	51	48	1.1%	-29	-37%	-3	-6%	T3	CS,PS
Ireland	13	NO	NO	-	-13	-100%	-	-	NA	NA
Italy	453	512	561	13.0%	107	24%	49	9%	T2	CS,PS
Latvia	0	1	1	0.0%	0	105%	0	19%	T3	D,PS
Lithuania	12	7	6	0.1%	-6	-52%	-1	-19%	T2	D
Luxembourg	54	65	64	1.5%	10	19%	-1	-2%	CS	PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	142	96	80	1.9%	-63	-44%	-16	-17%	CS	CS
Poland	169	471	474	11.0%	305	180%	3	1%	T2	D
Portugal	84	159	154	3.6%	71	84%	-5	-3%	T3	OTH
Romania	150	57	53	1.2%	-97	-64%	-3	-6%	T2	CS,D
Slovakia	8	15	15	0.4%	7	93%	0	2%	T3	PS
Slovenia	3	11	11	0.2%	7	225%	0	-2%	T3	D
Spain	374	471	472	11.0%	97	26%	1	0%	T3	CS,D,PS
Sweden	54	16	17	0.4%	-36	-68%	1	9%	T3	CS,D
United Kingdom	406	361	368	8.6%	-38	-9%	7	2%	T3	CS
EU-28	**4 261**	**4 209**	**4 300**	**100%**	**39**	**1%**	**91**	**2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	406	361	368	8.6%	-38	-9%	7	2%	T3	CS
EU-28 + ISL	**4 261**	**4 209**	**4 300**	**100%**	**39**	**1%**	**91**	**2%**	**-**	**-**

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

Table 4.9 shows information on the methods applied, activity data, and the emissions factors for CO_2 emissions from 2A3 Glass production for 1990 and 2017. The use of plant-specific data reported and verified under the EU ETS by Member States can be considered as equivalent to a Tier 2 or Tier 3 method which means that all emissions from this category are calculated using higher Tier methods.

The table below shows that while most countries report glass production as activity data for glass production some report inputs (carbonate use). A gap-filled IEF was not calculated for EU glass production because the standard deviation of the Member States' IEF for glass production was above 50%.

Table 4.9 2A3 Glass production: Information on methods applied, activity data, emission factors for CO_2 emissions

Member State	1990				2017				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	502	0.08	38	T3	PS
Belgium	Glass Production	1 993	0.13	263	Glass Production	1 594	0.10	164	T3	CS,PS
Bulgaria	-	818	0.17	138	-	576	0.15	86	T1	CS
Croatia	Glass Production	99	0.44	43	Glass Production	74	0.43	32	T3	PS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czechia	Glass Production	1 237	0.12	143	Glass Production	1 194	0.13	155	T3	PS
Denmark	Glass Production	200	0.08	16	Glass Production	188	0.05	9	T3	PS
Estonia	Glass Production	12	0.10	1	Glass Production	85	0.12	10	T3	PS
Finland	Used Carbonates	48	0.44	21	Used Carbonates	6	0.41	3	T3	CS
France	Glass Production	4 307	0.19	797	Glass Production	3 254	0.16	536	T2,T3	CS,PS
Germany	Glass Production	6 562	0.12	780	Glass Production	7 552	0.12	927	T2	CS
Greece	Glass Production	135	0.15	20	Glass Production	99	0.18	18	CS	CS
Hungary	Glass Production	418	0.18	77	Glass Production	384	0.13	48	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	5 539	0.10	561	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	41	0.14	6	T2	D
Luxembourg	Glass Production	377	0.14	54	Glass Production	433	0.15	64	CS	PS
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	-	1 095	0.13	142	-	1 494	0.05	80	CS	CS
Poland	Glass Production	1 058	0.16	169	Glass Production	2 963	0.16	474	T2	D
Portugal	-	615	0.14	84	-	1 737	0.09	154	T3	OTH
Romania	Glass Production	926	0.16	150	Glass Production	402	0.13	53	T2	CS,D
Slovakia	Used Carbonates	18	0.44	8	Used Carbonates	36	0.42	15	T3	PS
Slovenia	Glass Production	25	0.13	3	Glass Production	79	0.13	11	T3	D
Spain	Glass Production	2 866	0.13	374	Glass Production	4 620	0.10	472	T3	CS,D,PS
Sweden	-	NE	NE	54	-	NE	NE	17	T3	CS,D
United Kingdom	Glass Production	1 942	0.21	406	Glass Production	2 033	0.18	368	T3	CS
EU-28	**-**	**NE**	**NE**	**4 261**	**-**	**34 885**	**0.12**	**4 300**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Glass Production	1 942	0.21	406	Glass Production	2 033	0.18	368	T3	CS
EU-28+ISL	**-**	**NE**	**NE**	**4 261**	**-**	**34 885**	**0.12**	**4300**	**-**	**-**

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 Member States was above 50%.

4.2.1.4 2A4 Other process uses of carbonates

CO_2 emissions from 2A4 Other process uses of carbonates contributed only 0.2% of total EU 28+ISL (without LULUCF) emissions in 2017. Emissions from this sector in 2017 were 10% lower than 1990 levels. While emissions have been reasonably stable since 2014 CO_2 emissions from Other process uses of carbonates in 2017 increased by 2% on 2016 levels. 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 4.10 2A4 Other process uses of carbonates: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	624	439	468	4.4%	-156	-25%	29	7%	T1,T3	D,PS
Belgium	136	182	188	1.8%	52	38%	5	3%	T3	CS,PS
Bulgaria	607	951	973	9.2%	366	60%	22	2%	T1,T2	D,PS
Croatia	17	36	31	0.3%	15	86%	-5	-14%	T2,T3	D,PS
Cyprus	44	11	13	0.1%	-31	-71%	2	19%	CS,T1	CS,D
Czechia	114	359	299	2.8%	185	162%	-60	-17%	T1,T3	D,PS
Denmark	77	71	80	0.7%	2	3%	9	12%	CS,T2,T3	CS,D
Estonia	NO,IE,NA	3	3	0.0%	3	∞	-1	-20%	T1,T2	D,PS
Finland	67	142	132	1.2%	64	95%	-10	-7%	T1,T3	CS,D
France	488	375	386	3.6%	-102	-21%	11	3%	T1,T2,T3	CS,D,PS
Germany	1 458	1 102	1 088	10.3%	-369	-25%	-14	-1%	T1,T2	CS,D
Greece	590	309	362	3.4%	-228	-39%	53	17%	CS,T1	CS,D
Hungary	449	277	254	2.4%	-194	-43%	-22	-8%	T2,T3	CS,D,PS
Ireland	5	1	1	0.0%	-4	-75%	0	33%	T3	PS
Italy	2 544	753	712	6.7%	-1 831	-72%	-41	-5%	T2	CS,PS
Latvia	69	9	9	0.1%	-60	-86%	0	3%	T1,T2	D,PS
Lithuania	240	18	16	0.2%	-223	-93%	-1	-8%	T1,T2	CS,D,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	0	1	0	0.0%	0	60%	-1	-74%	T1	D
Netherlands	690	1 001	1 027	9.7%	337	49%	26	3%	CS,T1,T3	D
Poland	771	1 945	1 983	18.7%	1 211	157%	37	2%	T1,T2	CS,D
Portugal	225	332	351	3.3%	127	56%	19	6%	T1,T3	OTH
Romania	38	329	358	3.4%	320	836%	30	9%	OTH,T2,T3	D,PS
Slovakia	447	306	387	3.6%	-60	-13%	81	26%	T3	PS
Slovenia	20	17	18	0.2%	-3	-12%	1	7%	T2	D
Spain	1 358	998	1 029	9.7%	-329	-24%	30	3%	T1,T2,T3	CS,D,PS
Sweden	15	15	18	0.2%	2	15%	3	21%	T3	D
United Kingdom	641	391	420	4.0%	-221	-35%	28	7%	T3	CS
EU-28	**11 733**	**10 375**	**10 607**	**100%**	**-1 126**	**-10%**	**233**	**2%**	**-**	**-**
Iceland	1	1	1	0.0%	0	30%	0	17%	T3	PS
United Kingdom (KP)	641	391	420	4.0%	-221	-35%	28	7%	T3	CS
EU-28 + ISL	**11 734**	**10 375**	**10 608**	**100%**	**-1 126**	**-10%**	**233**	**2%**	**-**	**-**

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

4.2.2 Chemical industry (CRF Source Category 2B)

The key categories in the chemical industry include:

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	2017		1990	2017	
2.B.1 Ammonia Production (CO_2)	33360	25518	0	L	L	100%
2.B.2 Nitric Acid Production (N_2O)	49553	3628	T	L	0	100%
2.B.3 Adipic Acid Production (N_2O)	57555	1056	T	L	0	100%
2.B.8 Petrochemical and Carbon Black Production (CO_2)	14617	15196	T	L	L	88%
2.B.9 Fluorochemical Production (HFCs)	29033	432	T	L	0	100%
2.B.9 Fluorochemical Production (Unspecified mix of HFCs and PFCs)	5567	65	T	0	0	100%
2.B.10 Other chemical industry (CO_2)	6422	11935	T	0	L	92%

The key category 2B1 Ammonia production accounts for the CO_2 emissions that occur during the production of ammonia, which is used in both its pure form and as a feedstock for the production of a wide variety of other chemicals. The key category 2B2 Nitric acid production accounts for N_2O that is emitted as a by-product of the high temperature catalytic oxidation of ammonia (NH_3) in the production of nitric acid. The key category 2B3 Adipic acid production accounts for the N_2O emitted as a by-product when a cyclohexanone/cyclohexanol mixture is oxidized by nitric acid. The key category Petrochemical and Carbon Black Production (2B8) includes the CO_2 emissions associated with a wide range of petrochemicals including methanol and ethylene and carbon black manufacture.

Figure 4.7 shows chemical industry CO_2 emissions while Table 4.12 presents a summary of emissions as CO_2, N_2O, CH_4 and total emissions as CO_2 equivalents. Ammonia production accounts for more than half of the chemical industry's CO_2 emissions.

Figure 4.7 2B Chemical industry CO_2 emissions

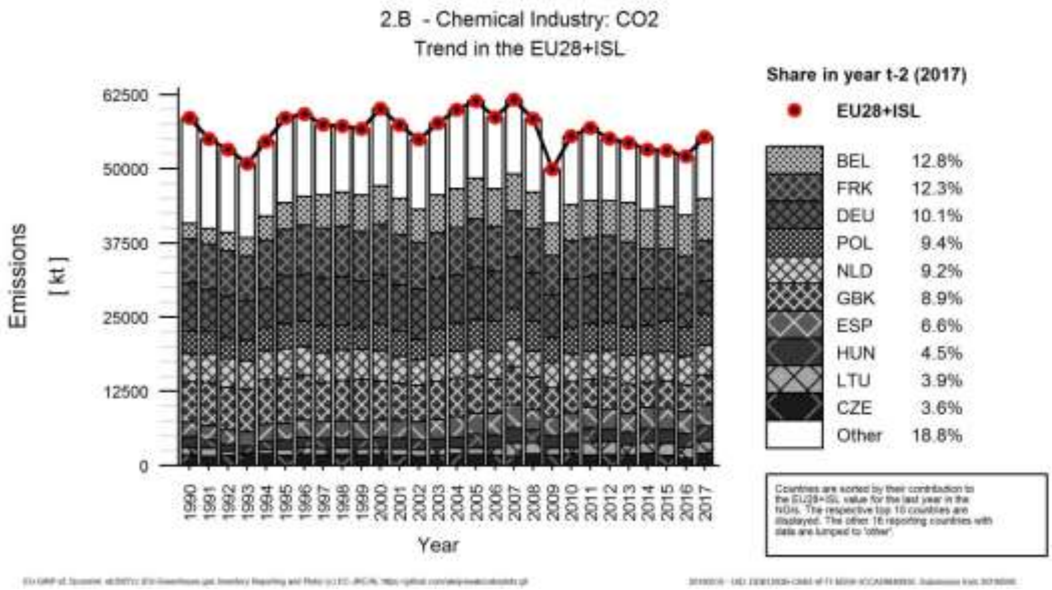


Table 4.12 shows chemical industry CO_2, CH_4, N_2O and total GHG emissions (which includes F-gases) as CO_2e. Between 1990 and 2017 GHG emissions from the chemical industry sector have decreased markedly largely due to the significant reduction in N_2O emissions which have decreased by 93%. The greatest absolute decreases in N_2O emissions over the period have been in France, Germany and the UK.

Table 4.12 2B Chemical industry: EU-28+ISL 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 2017 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2017 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2017 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2017 (kt CO2 equivalents)
Austria	1 555	746	644	661	877	39	35	47
Belgium	10 076	8 231	2 590	7 068	3 807	999	0	9
Bulgaria	4 943	1 746	3 283	1 653	1 647	93	13	NO,NA
Croatia	1 511	665	751	567	754	99	5	NO,NE,IE
Cyprus	NO	NO	NO	NO	NO	NO	NO	NO
Czechia	2 944	2 236	1 783	1 981	1 125	204	36	51
Denmark	1 003	1	1	1	1 003	NO,NA	NO,NA	NO,NA
Estonia	308	NO	308	NO	NO	NO	NO	NO
Finland	1 862	1 382	270	1 151	1 592	231	NO,NA	NO,NA
France	36 909	8 664	7 478	6 794	23 656	1 523	81	44
Germany	35 459	6 917	8 109	5 578	21 335	694	334	502
Greece	2 931	825	681	805	1 066	20	1	NO,NA
Hungary	4 867	2 596	1 759	2 504	3 090	48	18	45
Ireland	1 986	NO	990	NO	995	NO	NO	NO
Italy	10 546	2 809	2 577	1 473	6 418	138	61	4
Latvia	NA,NO	NA,NO	NO	NO	NO	NO	NO	NO
Lithuania	2 176	2 365	1 278	2 137	893	228	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	17 657	7 047	4 713	5 109	7 069	1 489	269	300
Poland	7 378	5 933	3 802	5 176	3 536	707	40	51
Portugal	1 735	747	1 211	682	498	37	26	27
Romania	9 748	1 342	5 563	1 086	4 135	250	50	5
Slovakia	2 020	1 535	878	1 428	1 142	106	0	1
Slovenia	88	65	83	65	NO	NO	4	NO,NA
Spain	8 457	4 207	2 456	3 649	2 829	394	131	164
Sweden	1 413	885	610	837	803	48	1	NO,IE,C,NA
United Kingdom	45 177	5 208	6 770	4 932	23 797	39	205	61
EU-28	**212 748**	**66 152**	**58 588**	**55 336**	**112 066**	**7 385**	**1 316**	**1 310**
Iceland	47	NO	0	NO	46	NO	NO,NA	NO
United Kingdom (KP)	45 177	5 208	6 770	4 932	23 797	39	205	61
EU-28 + ISL	**212 795**	**66 152**	**58 588**	**55 336**	**112 112**	**7 385**	**1 316**	**1 310**

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 lists information on recalculations in 2B Chemical industry for 1990 and 2016 showing explanations for large recalculations.

Table 4.13 2B Chemical Industry: Contribution of MS to EU recalculated emissions for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	0.04	0.006	1	0.2	
Belgium	-	-	0.0002	0.0	
Bulgaria	-	-	-	-	
Croatia	-27	-3.5	-0.001	-0.0002	
Cyprus	-	-	-	-	
Czech Republic	-	-	-	-	
Denmark	-	-	-	-	
Estonia	-	-	-	-	
Finland	-	-	-0.0	-0.0	
France	-1	-0.02	1	0.02	
Germany	-	-	11	0.2	2.B.3 N_2O emissions changed for 2016, because one producer corrected reported nitrous oxide emissions data for that year. see NIR 2019, chapter 4.3.3.5 Correction of an erroneous emission calculation relative to carbon black, 2005 through 2015 (2.B.8) see NIR 2019, chapter 4.3.8.2.5
Greece	-	-	-	-	
Hungary	-	-	-	-	

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Ireland	-	-	-	-	
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-	-	-1	-0.1	Recalculation in urea use in Agriculture sector.
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-0	-0.0	284	6.3	Improved AD
Poland	-	-	-	-	
Portugal	-	-	0.1	0.02	
Romania	-	-	-	-	
Slovakia	-	-	-	-	
Slovenia	17	26.5	13	25.6	Improved AD and EF on natural gas used as a feedstock for a hydrogen production.
Spain	-317	-11.4	-470	-11.4	Update to Tier 3 for CO_2 emissions estimation, attending to recommendation from the ERT. EFI calculated based on EU ETS data for 2016 and 2017.
Sweden	498	447.0	706	481.2	Re-allocations for several plants between CRF 1 and 2.
United Kingdom	2	0.03	15	0.3	Revision to EUETS-based estimates: we now include some further emissions reported in EUETS within our estimate for 2B8g (petrochemical sector use of process off-gases).
EU28	172	0.3	560	1.1	
Iceland	-	-	-	-	
United Kingdom (KP)	-	-	-	-	
EU28+ISL	170	0.3	545	1.2	

(*) contribution of the recalculation as percentage of the total emissions of category 2B for the respective year and MS

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 0.6 % of total EU-28+ISL emissions in 2017. While missions have decreased by 24% since 1990, 2017 saw a significant 7% increase.

Figure 4.8 2B1 Ammonia production: CO_2 emissions

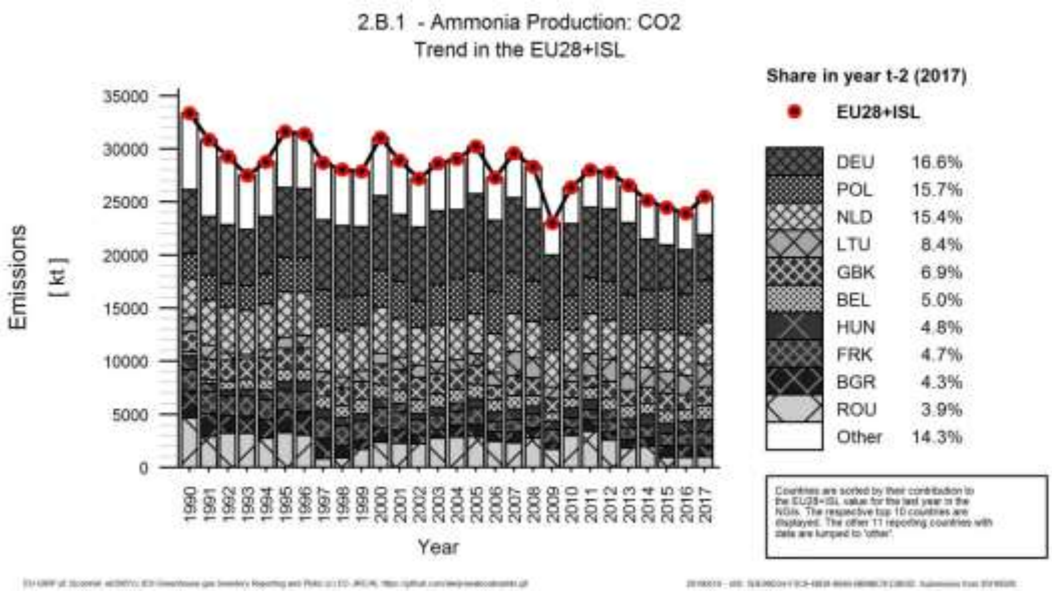


Figure 4.8 and Table 4.16 show that in 2017 Germany was responsible for 16.6% of this category's emissions. The next largest contributors are Poland and Netherlands which contribute 15.7% and 15.4% respectively.

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 emissions between 1990 and 2017 were in Belgium, Lithuania, the Netherlands, Poland and Slovakia.

Table 4.14 2B1 Ammonia production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	467	528	473	1.9%	5	1%	-56	-11%	T2	PS
Belgium	423	1 066	1 285	5.0%	862	204%	219	21%	T3	D,PS
Bulgaria	2 508	1 138	1 086	4.3%	-1 421	-57%	-51	-4%	T2	PS
Croatia	559	548	567	2.2%	8	1%	19	3%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	991	686	744	2.9%	-247	-25%	58	8%	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	1 183	1 194	4.7%	-825	-41%	11	1%	T1,T2,T3	CS,D,PS
Germany	6 025	4 182	4 228	16.6%	-1 797	-30%	46	1%	T3	PS
Greece	652	152	268	1.0%	-384	-59%	116	76%	T1a	CS
Hungary	1 255	1 078	1 217	4.8%	-38	-3%	139	13%	T3	D
Ireland	990	NO	NO	-	-990	-100%	-	-	NA	NA
Italy	1 892	643	642	2.5%	-1 249	-66%	0	0%	T2	PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 254	1 826	2 137	8.4%	884	70%	311	17%	T3	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 730	3 815	3 942	15.4%	212	6%	127	3%	T3	-
Poland	2 344	3 814	4 008	15.7%	1 664	71%	194	5%	T2	CS
Portugal	540	NO	NO	-	-540	-100%	-	-	NA	NA
Romania	4 678	937	1 006	3.9%	-3 672	-78%	69	7%	T3	PS
Slovakia	332	564	633	2.5%	301	91%	69	12%	T3	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	407	333	325	1.3%	-82	-20%	-9	-3%	T3	PS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	1 895	1 442	1 764	6.9%	-131	-7%	322	22%	T3	CS
EU-28	**33 360**	**23 935**	**25 518**	**100%**	**-7 842**	**-24%**	**1 583**	**7%**	**-**	**-**
Iceland	NA	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 895	1 442	1 764	6.9%	-131	-7%	322	22%	T3	CS
EU-28 + ISL	**33 360**	**23 935**	**25 518**	**100%**	**-7 842**	**-24%**	**1 583**	**7%**	**-**	**-**

The method and emission factor information shown here only refers to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

In line with the 2006 IPCC Guidelines all emissions (energy and non-energy use of feedstocks/fuels) from ammonia production should be reported in 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 4.15 aligns 2B1. Ammonia production against EU ETS reported emissions for Production of ammonia (EU ETS activity sector code 41). Of the seventeen Member States which report emissions under 2B1 Ammonia production only thirteen also report against EU ETS 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 difference between IPPU 2B1 and ETS reported emissions from production of ammonia where the ETS figure is greater.

Table 4.15 2B1 Ammonia production: inventory and relevant EU ETS reported CO_2 emissions for 2017

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	473	881	408	-
Belgium	1 285	-	-	689
Bulgaria	1 086	726	-	-
Croatia	567	1 336	769	-
Cyprus	NO	-	-	-
Czech Republic	744	-	-	-
Denmark	NO	-	-	-
Estonia	NO	-	-	-
Finland	NO	-	-	-
France	1 194	1 560	366	555
Germany	4 228	4 455	227	3 184
Greece	268	288	20	-
Hungary	1 217	1 003	-	132
Ireland	NO	-	-	-
Italy	642	-	-	557
Latvia	NO	-	-	-
Lithuania	2 137	2 834	697	-
Luxembourg	NO	-	-	-
Malta	NO	-	-	-
Netherlands	3 942	3 828	-	1 922
Poland	4 008	1 825	-	-
Portugal	NO	-	-	68
Romania	1 006	-	-	62
Slovakia	633	1 054	421	-
Slovenia	NO	-	-	-
Spain	325	617	293	892
Sweden	NO	-	-	-
United Kingdom	1 764	1 790	26	585
EU28	**25 518**	**22 198**	**3 227**	**8 647**
Iceland	NO	-	-	-
United Kingdom (KP)	1 764	1 790	26	585
EU-28 + ISL	**25 518**	**22 198**	**3 227**	**8 647**

[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 4.15. 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) 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 4.16 shows information on methods applied, activity data, emission factors for CO_2 emissions from 2B1 Ammonia production for 1990 to 2017. Not all countries show ammonia production as activity data for this emissions category but gap-filled values for the EU IEF have been not been calculated because the data distribution does not appear to be normal (the standard deviation divided by mean is greater than 50%). In 2017, emissions from all seventeen countries which report ammonia production emissions, are estimated with higher Tier methods (country or plant specific emission factors and/or Tier 2 or Tier 3).

Table 4.16 2B1 Ammonia production: Information on methods applied, activity data, emission factors for CO_2 emissions

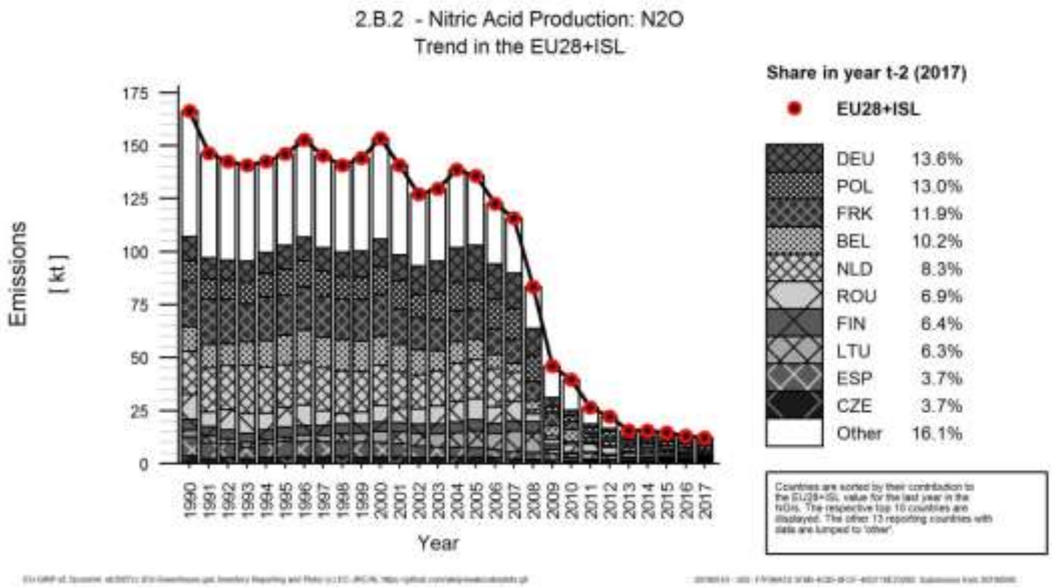
Member State	1990				2017				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Ammonia Production	461	1.22	467	Ammonia Production	508	1.21	473	T2	PS
Belgium	Ammonia Production	360	1.17	423	Ammonia Production	1 117	1.15	1 285	T3	D,PS
Bulgaria	-	C	C	2 508	-	C	C	1 086	T2	PS
Croatia	Ammonia Production	345	2.24	559	Ammonia Production	469	1.97	567	T3	PS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czechia	Ammonia Production	336	3.27	991	Ammonia Production	227	3.27	744	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	1 928	1.05	2 019	Ammonia Production	911	1.31	1 194	T1,T2,T3	CS,D,PS
Germany	Ammonia Production	2 705	2.41	6 025	Ammonia Production	3 027	1.77	4 228	T3	PS
Greece	Ammonia Production	313	2.08	652	Ammonia Production	162	1.65	268	T1a	CS
Hungary	Natural Gas Consumption	25 334	0.06	1 255	Natural Gas Consumption	23 015	0.06	1 217	T3	D
Ireland	Natural Gas Feedstocks	430	2.30	990	Natural Gas Feedstocks	NO	NO	NO	NA	NA
Italy	Ammonia Production	1 455	1.94	1 892	Ammonia Production	587	1.82	642	T2	PS
Latvia	Ammonia Production	NO	NO	NO	Ammonia Production	NO	NO	NO	NA	NA
Lithuania	Ammonia Production	568	2.27	1 254	Ammonia Production	1 126	2.06	2 137	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	3 730	-	C	C	3 942	T3	-
Poland	Ammonia Production	1 532	1.53	2 344	Ammonia Production	2 783	1.44	4 008	T2	CS
Portugal	-	C	C	540	-	C	NO	NO	NA	NA
Romania	Natural Gas Consumption	2 101	2.28	4 678	Natural Gas Consumption	511	2.29	1 006	T3	PS
Slovakia	Ammonia Production	360	1.71	332	Ammonia Production	459	1.90	633	T3	PS
Slovenia	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Spain	Ammonia Production	573	1.24	407	Ammonia Production	489	1.21	325	T3	PS
Sweden	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom	Ammonia Production	1 328	1.43	1 895	Ammonia Production	1 129	1.56	1 764	T3	CS
EU-28	**-**	**40 452**	**0.82**	**33 360**	**-**	**NE**	**NE**	**25 518**	**-**	**-**
Iceland	-	IE	NA,NO	NA	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Ammonia Production	1 328	1.43	1 895	Ammonia Production	1 129	1.56	1 764	T3	CS
EU-28+ISL	**-**	**40 452**	**0.82**	**33 360**	**-**	**NE**	**NE**	**25518**	**-**	**-**

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.

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 8% in 2017 and by 93% 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. N_2O emissions from nitric acid production contributed less than 0.1% of total EU 28+ISL (without LULUCF) emissions in 2017. (Figure **4.9** and Table 4.17). 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 (middle of 2004) and ceased in Ireland in 2002 due to the insolvency of Irish fertiliser industries.

Figure 4.9 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 trend in emissions. This trend of declining N_2O emissions has slowed in recent years with emissions decreasing by 8% between 2016 and 2017. Twenty countries reported these emissions in 2017, eleven of which reported slight emissions increases in this period.

Table 4.17 2B2 Nitric acid production: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	877	36	39	1.1%	-838	-96%	3	8%	T3	PS
Belgium	3 422	297	371	10.2%	-3 050	-89%	75	25%	T3	PS
Bulgaria	1 647	113	93	2.6%	-1 554	-94%	-20	-18%	T3	PS
Croatia	754	109	99	2.7%	-656	-87%	-11	-10%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 050	216	134	3.7%	-916	-87%	-82	-38%	T3	PS
Denmark	1 003	NO	NO	-	-1 003	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 592	218	231	6.4%	-1 361	-86%	12	6%	T3	PS
France	6 316	544	433	11.9%	-5 883	-93%	-111	-20%	T2,T3	CS,D,PS
Germany	3 258	477	493	13.6%	-2 766	-85%	16	3%	T3	PS
Greece	1 066	15	20	0.6%	-1 046	-98%	5	29%	CS	CS
Hungary	3 090	27	48	1.3%	-3 042	-98%	21	76%	T3	PS
Ireland	995	NO	NO	-	-995	-100%	-	-	NA	NA
Italy	2 005	50	64	1.8%	-1 941	-97%	14	28%	T2	D,PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	893	210	228	6.3%	-665	-75%	18	9%	T3	PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	6 085	270	299	8.3%	-5 785	-95%	30	11%	T2	PS
Poland	3 041	607	471	13.0%	-2 570	-85%	-136	-22%	T1	CS
Portugal	498	25	37	1.0%	-461	-93%	13	52%	D	PS
Romania	3 473	342	250	6.9%	-3 223	-93%	-92	-27%	T2,T3	D,PS
Slovakia	1 142	121	105	2.9%	-1 037	-91%	-16	-13%	T3	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	2 704	170	135	3.7%	-2 569	-95%	-35	-21%	T3	PS
Sweden	782	52	42	1.1%	-741	-95%	-10	-19%	T2	PS
United Kingdom	3 860	25	37	1.0%	-3 823	-99%	13	51%	T3	CS
EU-28	**49 553**	**3 924**	**3 628**	**100%**	**-45 925**	**-93%**	**-296**	**-8%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 860	25	37	1.0%	-3 823	-99%	13	51%	T3	CS
EU-28 + ISL	**49 553**	**3 924**	**3 628**	**100%**	**-45 925**	**-93%**	**-296**	**-8%**	**-**	**-**

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

Table 4.18 shows information on methods applied, activity data, emission factors for N_2O emissions from 2B2 Nitric acid production for 1990 to 2017. 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 as recommended by the ERT. 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 different MS and the closure of some older plants. The table also shows that all emissions are estimated with higher tier methods (country or plant specific emission factors and/or Tier 2 or Tier 3).

Table 4.18 2B2 Nitric acid production: Information on methods applied, activity data, emission factors for N_2O emissions

Member State	1990				2017				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (kg/t)	N2O 'Emissions' (kt CO2 equiv.)	Activity Data		Implied Emission Factor (kg/t)	N2O 'Emissions' (kt CO2 equiv.)		
	Description	(kt)			Description	(kt)				
Austria	Nitric Acid Production	530	5.6	877	Nitric Acid Production	501	0.3	39	T3	PS
Belgium	Nitric Acid Production	1436	8.0	3422	Nitric Acid Production	2135	0.6	371	T3	PS
Bulgaria	-	C	C	1647	-	C	C	93	T3	PS
Croatia	Nitric Acid Production	332	7.6	754	Nitric Acid Production	322	1.0	99	T3	PS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czech Repub	Nitric Acid Production	530	6.6	1050	Nitric Acid Production	544	0.8	134	T3	PS
Denmark	-	450	7.5	1003	-	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	9.7	1592	Nitric Acid Production	667	1.2	231	T3	PS
France	Nitric Acid Production	3200	6.6	6316	Nitric Acid Production	2014	0.7	433	T2,T3	CS,D,PS
Germany	Nitric Acid Production	1698	6.4	3258	Nitric Acid Production	2711	0.6	493	T3	PS
Greece	Nitric Acid Production	511	7.0	1066	Nitric Acid Production	190	0.4	20	CS	CS
Hungary	-	732	14.2	3090	-	865	0.2	48	T3	PS
Ireland	Nitric Acid Production	339	9.9	995	Nitric Acid Production	NO	NO	NO	NA	NA
Italy	Nitric Acid Production	1037	6.5	2005	Nitric Acid Production	437	0.5	64	T2	D,PS
Latvia	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Lithuania	Nitric Acid Production	355	8.4	893	Nitric Acid Production	1251	0.6	228	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	6085	-	C	C	299	T2	PS
Poland	Nitric Acid Production	1577	6.5	3041	Nitric Acid Production	2404	0.7	471	T2	CS
Portugal	-	C	C	498	-	C	C	37	D	PS
Romania	Nitric Acid Production	1261	9.2	3473	Nitric Acid Production	638	1.3	250	T2,T3	D,PS
Slovakia	Nitric Acid Production	401	9.6	1142	Nitric Acid Production	646	0.5	105	T3	PS
Slovenia	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Spain	Nitric Acid Production	1329	6.8	2704	Nitric Acid Production	723	0.6	135	T3	PS
Sweden	Nitric Acid Production	374	7.0	782	Nitric Acid Production	267	0.5	42	T2	PS
United Kingd	Nitric Acid Production	2408	5.4	3860	Nitric Acid Production	1219	0.1	37	T3	CS
EU-28	**-**	**NE**	**NE**	**49553**	**-**	**17533**	**207**	**3628**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingd	Nitric Acid Production	2408	5.4	3860	Nitric Acid Production	1219	0.1	37	T3	CS
EU-28+ISL	**-**	**NE**	**NE**	**49553**	**-**	**17533**	**207**	**3628**	**-**	**-**

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

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 0.02% of total EU 28+ISL (without LULUCF) emissions. Between 1990 and 2017, N_2O emissions from this source decreased by 98% (Figure 4.10 and Table 4.19). Only France, Germany and Italy continue to produce adipic acid and emissions increased by 2.4kt in 2017.

Figure 4.10 2B3 Adipic acid production N_2O emissions

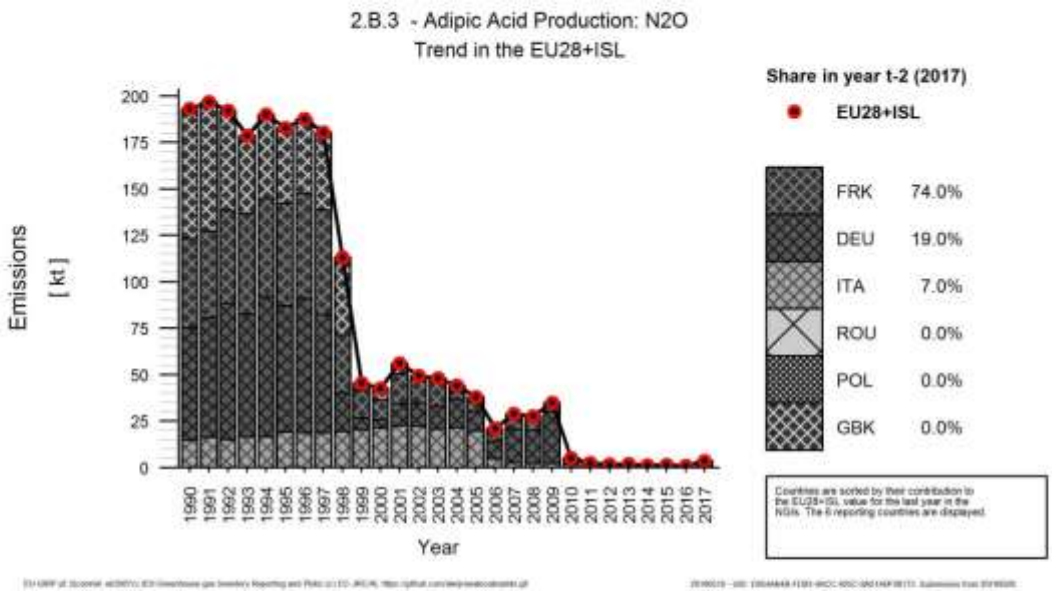


Table 4.19 2B3 Adipic acid production: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
France	14 232	73	781	74.0%	-13 451	-95%	708	972%	T2,T3	CS,D,PS
Germany	18 077	194	201	19.0%	-17 876	-99%	7	4%	T3	PS
Italy	4 402	66	74	7.0%	-4 328	-98%	8	12%	T2	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-28	**57 555**	**333**	**1 056**	**100%**	**-56 499**	**-98%**	**724**	**218%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	19 935	NO	NO	-	-19 935	-100%	-	-	NA	NA
EU-28 + ISL	**57 555**	**333**	**1 056**	**100%**	**-56 499**	**-98%**	**724**	**218%**	**-**	**-**

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

Table 4.20 shows information on methods applied, activity data, emission factors for N_2O emissions from 2B3 Adipic acid production for 1990 to 2017. 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 2017. In 2017 all emissions are estimated with higher Tier methods.

Table 4.20 2B3 Adipic acid production: methods, activity data, emission factors for N_2O emissions

Member State	1990				2017				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	N2O 'Emissions' (kt CO2 equiv.)	Activity Data		Implied Emission Factor (t/t)	N2O 'Emissions' (kt CO2 equiv.)		
	Description	(kt)			Description	(kt)				
Austria	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Czech Republic	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Estonia	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
France	Adipic Acid Production	C	C	14 232	Adipic Acid Production	C	C	781	T2,T3	CS,D,PS
Germany	Adipic Acid Production	C	C	18 077	Adipic Acid Production	C	C	201	T3	PS
Italy	Adipic Acid Production	49	0.3	4 402	Adipic Acid Production	87	0.003	74	T2	D,PS
Latvia	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Luxembourg	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Poland	Adipic Acid Production	4	0.3	358	Adipic Acid Production	NO	NO,NA	NO	NA	NA
Romania	Adipic Acid Production	6	0.3	552	Adipic Acid Production	NO	NO	NO	NA	NA
Spain	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
United Kingdom	Adipic Acid Production	C	C	19 935	Adipic Acid Production	NO	NO	NO	NA	NA
EU-28	**-**	**NE**	**NE**	**57 555**	**-**	**NE**	**NE**	**1 056**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdo	Adipic Acid Production	C	C	19 935	Adipic Acid Production	NO	NO	NO	NA	NA
EU-28+ISL	**-**	**NE**	**NE**	**57 555**	**-**	**NE**	**NE**	**1 056**	**-**	**-**

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

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 2006 IPCC Guidelines. Eighteen countries report CO_2 emissions from this category for at least part of the period 1990-2017 with this source being a key category of CO_2 emissions in terms of emissions level and trend for EU 28+ISL.

CO_2 emissions from 2B8 Petrochemical and carbon black production increased by 5% in 2017 compared to 2016 and contributed 0.35% of total EU 28+ISL (without LULUCF) emissions in 2017. Belgium, Spain, Hungary and Poland contribute the largest share of emissions, respectively 30.2 %, 16.8 %, 10.4 % and 9.5 %. In Belgium emissions have almost doubled since 1990.

Figure 4.11 2B8 Petrochemical and carbon black production: EU-28+ISL CO_2 emissions

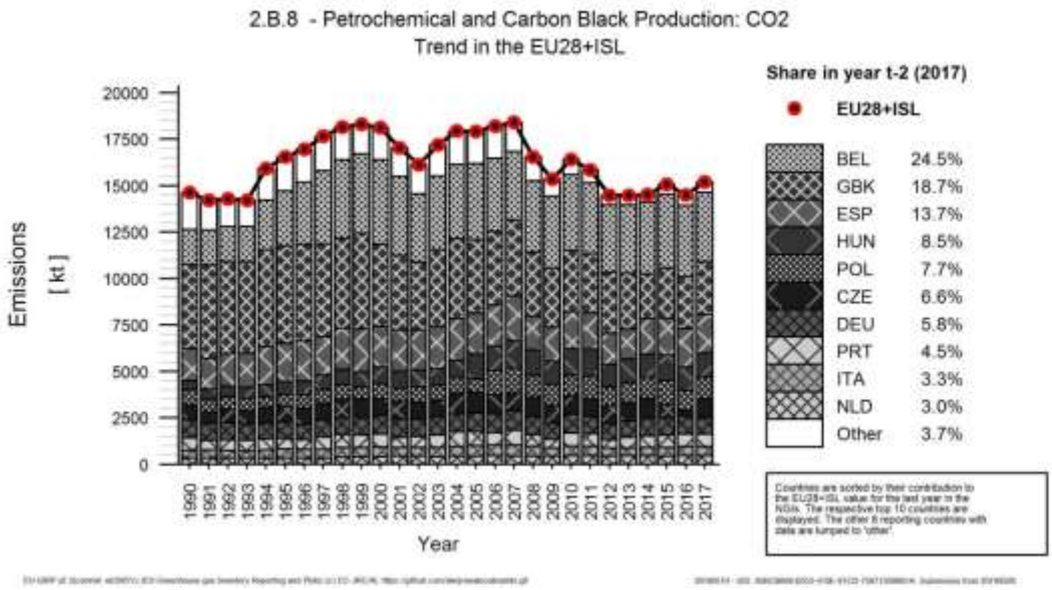


Table 4.21: 2B8 Petrochemical and carbon black production CO_2

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Belgium	1 882	3 832	3 726	24.5%	1 843	98%	-107	-3%	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
Czech Republic	792	303	1 007	6.6%	215	27%	705	233%	T1	D,PS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
France	376	231	204	1.3%	-172	-46%	-27	-12%	T1,T2,T3	CS,D,PS
Germany	974	972	885	5.8%	-89	-9%	-86	-9%	T1,T2	CS,D
Greece	29	NO,NA	NO,NA	-	-29	-100%	-	-	NA	NA
Hungary	504	1 243	1 287	8.5%	783	155%	44	4%	T3	PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	422	497	495	3.3%	73	17%	-2	0%	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	455	459	3.0%	123	37%	4	1%	CS	CS
Poland	806	1 089	1 168	7.7%	362	45%	79	7%	T1	D
Portugal	672	672	682	4.5%	10	2%	10	1%	NO	NO
Romania	574	NO	NO	-	-574	-100%	-	-	NA	NA
Slovakia	429	338	358	2.4%	-71	-17%	20	6%	T2	CS,PS
Slovenia	16	NO	NO	-	-16	-100%	-	-	NA	NA
Spain	1 703	2 080	2 079	13.7%	376	22%	-1	0%	T1,T3	D,PS
Sweden	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-	NA	NA
United Kingdom	4 539	2 782	2 847	18.7%	-1 692	-37%	65	2%	CS,T1	CS,D
EU-28	**14 617**	**14 493**	**15 196**	**100%**	**579**	**4%**	**702**	**5%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 539	2 782	2 847	18.7%	-1 692	-37%	65	2%	CS,T1	CS,D
EU-28 + ISL	**14 617**	**14 493**	**15 196**	**100%**	**579**	**4%**	**702**	**5%**	**-**	**-**

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

4.2.2.5 Chemical industry – Fluorochemical production (CRF Source Category 2.B.9)

Table 4.22 Key categories for sector 2B9 (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2017		1990	2017	
2.B.9 Fluorochemical Production: no classification (HFCs)	29033	432	T	L	0	100%
2.B.9 Fluorochemical Production: no classification (Unspecified mix of HFCs and PFCs)	5567	65	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, CHCl3or R20). Since chloroform is a feedstock for chlorodifluoromethane (HCFC-22 or R22), HFC-23 is a by-product during the manufacture of this widely used substance. 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 included in a number of frequently used refrigerant blends such as the R407series (10-30% R32) and R410A (50% R32). 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 a number of HCFC production plants and the installation of abatement systems in the remaining facilities, HFC-23 emissions were largely 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. 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.

[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.

Table 4.23: 2B9 Fluorochemical production – HFCs: 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	1995	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	-	-	-	-	-	-	-	-	-	-	-
Belgium	NO	NO	1	0	0.0%	0	∞	-1	-98%	NA	NA
Bulgaria	NA	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	-	NA	NA
Czech Republic	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	NO	-	-	-	-	-	NA	NA
France	4 374	666	288	300	69.5%	-4 073	-93%	12	4%	T3	PS
Germany	IE	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	1 183	4 115	NO	NO	-	-1 183	-100%	-	-	NA	NA
Hungary	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	444	549	1	1	0.3%	-443	-100%	0	4%	CS	PS
Latvia	NA	NA	NA	NA	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO,NA	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Netherlands	5 606	7 298	178	128	29.6%	-5 478	-98%	-50	-28%	NA	NA
Poland	NO	NO	NO	NO	-	-	-	-	-	NO	NO
Portugal	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	3 040	5 867	NO	NO	-	-3 040	-100%	-	-	NA	NA
Sweden	-	-	-	-	-	-	-	-	-	-	-
United Kingdom	14 387	17 671	3	3	0.6%	-14 384	-100%	0	0%	T2	PS
EU-28	**29 033**	**36 165**	**471**	**432**	**100%**	**-28 601**	**-99%**	**-39**	**-8%**	**-**	**-**
Iceland	NO	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	14 387	17 671	3	3	0.6%	-14 384	-100%	0	0%	T2	PS
EU-28 + ISL	**29 033**	**36 165**	**471**	**432**	**100%**	**-28 601**	**-99%**	**-39**	**-8%**	**-**	**-**

Table 4.24: 2B9 Fluorochemical production: Member States' 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	1995	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	-	-	-	-	-	-	-	-	-	-	-
Belgium	-	-	-	-	-	-	-	-	-	NA	NA
Bulgaria	NA	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	-	-	-
Czech Republic	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	NO	-	-	-	-	-	NA	NA
France	NO,NA	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Germany	5 567	5 335	62	65	100.0%	-5 502	-99%	3	6%	T3	PS
Greece	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	-	-	-	-	-	-	-	-	-	-	-
Latvia	NA	NA	NA	NA	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NA	NA	NA	NA	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	NO	NO	NO	NO	-	-	-	-	-	NO	NO
Portugal	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	-	-	-	-	-	-	-	-	-	-	-
United Kingdom	NO	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28	**5 567**	**5 335**	**62**	**65**	**100%**	**-5 502**	**-99%**	**3**	**6%**	**-**	**-**
Iceland	NO	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28 + ISL	**5 567**	**5 335**	**62**	**65**	**100%**	**-5 502**	**-99%**	**3**	**6%**	**-**	**-**

Table 4.25: 2B Chemical production: Contribution of MS to EU recalculations in HFCs for 1990 and 2016(difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	1.0	100.0	Recalculations relate to changes mainly in 2.F.1 (NIR CH. 4.7.5) including: 2F1a Commercial refrigeration: figures were adapted from 1995 to 2016; the largest change is reached for 2016 (impact: -345.5 kt CO_2-eq): This is because stationary air conditioning, which used to be included in 'Commercial refrigeration' is now calculated and reported separately, under 2F1f 2F1b Domestic refrigeration: figures were adapted from 1996 to 2016; the largest change is +1.6 kt CO_2-eq, in 2015. This change is because hermetic commercial refrigerators (previously not in the inventory) are now also accounted for in this category 2F1e Mobile air-conditioning: figures were adapted from 1995 to 2016; the largest change is reached for 2016 (impact: -106.3 kt CO_2-eq): This is because of a revision of the emissions at car refilling 2F1f Stationary air conditioning: figures were adapted from 1995 to 2016; the largest change is reached for 2016 (impact: +351.2 kt CO_2-eq): This emission source was previously included in 'Commercial refrigeration'.
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
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	-0.4	-0.002	-5.0	-66.1	Minor changes to estimates are primarily due to access to revised AD, for example due to the EEA F-gas reports for 2016 and 2017 being available in enough time for the 2019 submission.
EU28	-0.4	-0.001	-4.0	-0.8	
Iceland	-	-	-	-	
United Kingdom (KP)	-0.4	-0.002	-5.0	-66.1	Minor changes to estimates are primarily due to access to revised AD, for example due to the EEA F-gas reports for 2016 and 2017 being available in enough time for the 2019 submission.
EU28+ISL	-	-	1.0	0.2	

4.2.2.6 2B10 Other chemical industry

Fifteen countries reported CO_2, CH_4 or N_2O emissions in this category in 2017 which contributed 12.6 Mt of CO_2e or 0.3% of total EU 28+ISL (without LULUCF) emissions.

Figure 4.12 2B8 Petrochemical and carbon black production: EU-28+ISL CO_2 emissions

Between 1990 and 2017, CO_2 emissions from this source nearly doubled (Table 4.27) while CH_4 and N_2O emissions both decreased by about 58% and 41% respectively. This category contains a wide range of emissions and sources as shown in the tables below.

Table 4.26 2B10 Other: CO_2, CH_4 and N_2O emissions for 1990 and 2017

Member State	2.B.10 Other	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]
		1990	**1990**	**1990**	**1990**	**2017**	**2017**	**2017**	**2017**
AUT	10. Other (please specify)	138.56	7.30	NA	145.86	144.87	6.74	NA	151.60
	CO_2 from Nitric Acid Production	0.41	NA	NA	0.41	0.36	NA	NA	0.36
	Other chemical bulk production	138.15	7.30	NA	145.44	144.50	6.74	NA	151.24
BEL	10. Other (please specify)	285.15	NA	27.42	312.56	2057.50	8.96	53.17	2119.63
	Other non-specified	285.15	NA	27.42	312.56	2057.50	8.96	53.17	2119.63
BGR	10. Other (please specify)	IE	NA	NA		NA	NA	NA	
CYP	10. Other (please specify)	NO	NO	NO					
CZE	10. Other (please specify)	IE	NO	NO		229.49	NO	NO	229.49
	Other non-energy use in chemical industry	IE	NO	NO		212.09	NO	NO	212.09
	Non selective catalytic reduction	IE	NO	NO		17.40	NO	NO	17.40
DEU	10. Other (please specify)	NA	NA	IE		NA	NA	IE	
	Other	NA	NA	IE		NA	NA	IE	
DNM	10. Other (please specify)	0.57	NA	NA	0.57	1.37	NA	NA	1.37
	Production of catalysts	0.57	NA	NA	0.57	1.37	NA	NA	1.37
ESP	10. Other (please specify)	NO,NA	NA	NA		871.65	NA	NA	871.65
	Other No-Specify	NO	NA	NA		871.65	NA	NA	871.65
EST	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
FIN	10. Other (please specify)	177.28	NO	NO	177.28	1150.84	NO	NO	1150.84
	Phosphoric Acid Production	24.54	NO	NO	24.54	33.25	NO	NO	33.25
	Hydrogen Production	116.22	NO	NO	116.22	1036.06	NO	NO	1036.06

Member State	2.B.10 Other	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]
		1990	1990	1990	1990	2017	2017	2017	2017
	Limestone and Dolomite Use	36.52	NO	NO	36.52	81.53	NO	NO	81.53
	Chemicals Production	NO	NO	NO		NO	NO	NO	
FRK	10. Other (please specify)	4504.93	76.81	534.27	5116.01	5012.66	43.20	64.82	5120.69
GBE	10. Other (please specify)	NO	174.65	2.10	176.75	NO	48.97	1.51	50.48
	Chemical industry - other	NO	174.65	2.10	176.75	NO	48.97	1.51	50.48
GRC	10. Other (please specify)	NA,NO	NA	NA		536.90	NA	NA	536.90
	Sulfuric acid	NA	NA	NA		NA	NA	NA	
	Hydrogen production	NO	NA	NA		536.90	NA	NA	536.90
HRV	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
HUN	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
IRL	10. Other (please specify)								
ITA	10. Other (please specify)	NA	NA	NA		NA	NA	NA	
	other (indirect emissions)	NA	NA	NA		NA	NA	NA	
	Soda Ash (CO emissions only)	NA	NA	NA		NA	NA	NA	
LTU	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
	Sulfuric acid production	NO	NO	NO		NO	NO	NO	
LUX	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
LVA	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
MLT	10. Other (please specify)	0.17	NA	NA	0.17	0.04	NA	NA	0.04
	Carbide use	0.17	NA	NA	0.17	0.04	NA	NA	0.04
NLD	10. Other (please specify)	583.27	NO	244.19	827.46	708.65	NO	387.40	1096.05
	Other process emissions	583.27	NO	244.19	827.46	708.65	NO	387.40	1096.05
POL	10. Other (please specify)	NO	NO	NO		NO	NO	NO	

Member State	2.B.10 Other	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]
		1990	1990	1990	1990	2017	2017	2017	2017
PRT	10. Other (please specify)	1.41	NO		1.41	2.53	NO		2.53
	2.B.10.b Ammonium Sulphate	NO,NA	NO,NA	NO,NA		NO,NA	NO,NA	NO,NA	
	2.B.10.c Explosives	NA	NA	NA		NA	NA	NA	
	2.B.10.d Solvent use in plastic products manufacturing	NO	NO	NO		NO	NO	NO	
	2.B.10.a Sulphuric Acid	NA	NA	NA		NA	NA	NA	
ROU	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
	Other - non-specified	NO	NO	NO		NO	NO	NO	
SVK	10. Other (please specify)	116.99	0.05	0.06	117.10	378.24	0.17	0.20	378.61
	Hydrogen Production	116.99	0.05	0.06	117.10	378.24	0.17	0.20	378.61
SVN	10. Other (please specify)	17.43	NO	NO	17.43	12.53	NO	NO	12.53
SWE	10. Other (please specify)	597.74	0.71	20.72	619.17	829.78	C	6.39	836.16
	Pharmaceutical industry	NA	NE	14.90	14.90	NA	NE	5.36	5.36
	Other non-specified	NE	NE	NE		NE	NE	NE	
	Other organic chemical products	520.07	0.63	0.01	520.70	737.62	C	C	737.62
	Base chemicals for plastic industry	36.80	0.00	3.55	40.35	25.00	C	C	25.00
	Other inorganic chemical products	40.87	0.07	2.27	43.21	67.16	0.08	1.01	68.25
	Sulphuric acid production	NE	NA	NA		NE	NA	NA	
EU 28		**6423**	**260**	**829**	**7512**	**11937**	**108**	**513**	**12559**
ISL	10. Other (please specify)	0.36	NA	46.49	46.85	NO	NO	NO	
	Silicium production	0.36	NA	NA	0.36	NO	NO	NO	
	Fertilizer production	NA	NA	46.49	46.49	NO	NO	NO	

Member State	2.B.10 Other	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]
		1990	**1990**	**1990**	**1990**	**2017**	**2017**	**2017**	**2017**
GBK	10. Other (please specify)	NO	174.65	2.10	176.75	NO	48.97	1.51	50.48
	Chemical industry - other	NO	174.65	2.10	176.75	NO	48.97	1.51	50.48
EU 28+ISL		**6424**	**260**	**875**	**7559**	**11937**	**108**	**513**	**12559**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table **4.27** provides an overview of change between 1990 and 2017 at an aggregated level. Due to the heterogeneity of emission sources in this category, it is not possible to interpret aggregate trends in a meaningful way.

Table 4.27 2B10 Other: CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2	%	kt CO2	%		
Austria	139	148	145	1.2%	6	5%	-3	-2%	T3	PS
Belgium	285	1 963	2 057	17.2%	1 772	622%	95	5%	T3	PS
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	-	-	-	-	-	-	-	-
Czech Republic	IE	234	229	1.9%	229	∞	-4	-2%	T1	CS
Denmark	1	1	1	0.0%	1	140%	0	-2%	T2	PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	177	1 053	1 151	9.6%	974	549%	98	9%	CS,T2,T3	CS,PS
France	4 505	4 665	5 013	42.0%	508	11%	348	7%	T1,T2,T3	CS,D,PS
Germany	NA	NA	NA	-	-	-	-	-	NA	NA
Greece	NA,NO	310	537	4.5%	537	∞	227	73%	T1	CS
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	-	-	-	-	-	-	-	-	-	-
Italy	NA	NA	NA	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	0	0	0	0.0%	0	-79%	0	2%	T1	D
Netherlands	583	492	709	5.9%	125	21%	217	44%	T1	D
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	117	383	378	3.2%	261	223%	-5	-1%	T3	CS
Slovenia	17	13	13	0.1%	-5	-28%	0	-1%	D	CS
Spain	NO,NA	853	872	7.3%	872	∞	19	2%	T3	PS
Sweden	598	844	830	7.0%	232	39%	-14	-2%	T3	PS
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28	**6 422**	**10 958**	**11 935**	**100%**	**5 512**	**86%**	**977**	**9%**	**-**	**-**
Iceland	0	NO	NO	-	0	-100%	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28 + ISL	**6 422**	**10 958**	**11 935**	**100%**	**5 512**	**86%**	**977**	**9%**	**-**	**-**

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

Table 4.28 2B10 Other: N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NA	NA	NA	-	-	-	-	-	NA	NA
Belgium	27	48	53	10.4%	26	94%	6	12%	T3	PS
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	-	-	-	-	-	-	-	-
Czech Republic	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NA	NA	NA	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	534	151	65	12.6%	-469	-88%	-86	-57%	T2,T3	CS,D,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NA	NA	NA	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	-	-	-	-	-	-	-	-	-	-
Italy	NA	NA	NA	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NA	NA	NA	-	-	-	-	-	NA	NA
Netherlands	244	380	387	75.4%	143	59%	7	2%	T1	CS
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	0	0	0	0.0%	0	231%	0	-1%	T3	D
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NA	NA	NA	-	-	-	-	-	NA	NA
Sweden	21	7	6	1.2%	-14	-69%	0	-3%	T3	PS
United Kingdom	2	1	2	0.3%	-1	-28%	0	2%	T3	CS
EU-28	**829**	**586**	**513**	**100%**	**-315**	**-38%**	**-73**	**-12%**	**-**	**-**
Iceland	46	NO	NO	-	-46	-100%	-	-	NA	NA
United Kingdom (KP)	2	1	2	0.3%	-1	-28%	0	2%	T3	CS
EU-28 + ISL	**875**	**586**	**513**	**100%**	**-362**	**-41%**	**-73**	**-12%**	**-**	**-**

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

Table 4.29: 2B10 Other: CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	7	7	7	6.2%	-1	-8%	-1	-8%	T3	PS
Belgium	NA	6	9	8.3%	9	∞	3	42%	T3	PS
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	-	-	-	-	-	-	-	-
Czech Republic	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NA	NA	NA	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	77	45	43	40.0%	-34	-44%	-2	-4%	T2,T3	CS,D,PS
Germany	NA	NA	NA	-	-	-	-	-	NA	NA
Greece	NA	NA	NA	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	-	-	-	-	-	-	-	-	-	-
Italy	NA	NA	NA	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	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	-	-	-	-	-	NA	NA
Portugal	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	0	0	0	0.2%	0	231%	0	-1%	T3	D
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NA	NA	NA	-	-	-	-	-	NA	NA
Sweden	1	1	C	-	-1	-100%	-1	-100%	T1,T3	D,PS
United Kingdom	175	61	49	45.3%	-126	-72%	-12	-20%	CS	CS
EU-28	**260**	**121**	**108**	**100%**	**-151**	**-58%**	**-13**	**-11%**	**-**	**-**
Iceland	NA	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	175	61	49	45.3%	-126	-72%	-12	-20%	CS	CS
EU-28 + ISL	**260**	**121**	**108**	**100%**	**-151**	**-58%**	**-13**	**-11%**	**-**	**-**

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

Table 4.30 provides an overview of all sources reported under 2B10 Other Chemical Industry for all gases for the year 2017. The largest contributors to the total emissions are France, Belgium and Finland.

Table 4.30 2B10 Other: Overview of sources reported under this source category for 2017

Member State	2.B.10 Other Chemical Industry	CO2 emissions [kt]	CH4 emissions [kt]	N2O emissions [kt]	Total emissions [kt CO2 equivalents	Share in EU-28 Total
		2017	2017	2017	2017	2017
Austria	10. Other (please specify), CO2 from Nitric Acid Production, Other chemical bulk production	145	0	NA	152	1%
Belgium	10. Other (please specify), Other non-specified	2057	0	0	2120	17%
Bulgaria	10. Other (please specify)	NA	NA	NA	-	-
Croatia	10. Other (please specify)	NO	NO	NO	-	-
Cyprus	10. Other (please specify)				-	-
Czech Republic	10. Other (please specify), Other non energy use in chemical industry, Non selective catalytic reduction	229	NO	NO	229	2%
Denmark	10. Other (please specify), Production of catalysts	1	NA	NA	1	0.01%
Estonia	10. Other (please specify)	NO	NO	NO	-	-
Finland	10. Other (please specify), Phosphoric Acid Production, Hydrogen Production, Limestone and Dolomite Use, Chemicals Production	1151	NO	NO	1151	9%
France	10. Other (please specify)	5013	2	0	5121	41%
Germany	10. Other (please specify), Other	NA	NA	IE	-	-
Greece	10. Other (please specify), Sulfuric acid, Hydrogen production	537	NA	NA	537	4%
Hungary	10. Other (please specify)	NO	NO	NO	-	-
Ireland	10. Other (please specify)				-	-
Italy	10. Other (please specify), other (indirect emissions), Soda Ash (CO emissions only)	NA	NA	NA	-	-
Latvia	10. Other (please specify)	NO	NO	NO	-	-
Lithuania	10. Other (please specify), Sulfuric acid production	NO	NO	NO	-	-
Luxembourg	10. Other (please specify)	NO	NO	NO	-	-
Malta	10. Other (please specify)	0	NA	NA	0	0%
Netherlands	10. Other (please specify), Other process emissions	709	NO	1	1096	9%
Poland	10. Other (please specify)	NO	NO	NO	-	-
Portugal	10. Other (please specify), 2.B.10.b Ammonium Sulphate, 2.B.10.c Explosives, 2.B.10.d Solvent use in plastic products manufacturing, 2.B.10.a Sulphuric Acid	3	NO		3	0.0%
Romania	10. Other (please specify), Other - non-specified	NO	NO	NO	-	-
Slovakia	10. Other (please specify), Hydrogen Production	378	0	0	379	3%
Slovenia	10. Other (please specify)	13	NO	NO	13	0%
Spain	10. Other (please specify), Other No-Specify	872	NA	NA	872	7%
Sweden	10. Other (please specify), Pharmaceutical industry, Other non-specified, Other organic chemical products, Base chemicals for plastic industry, Other inorganic chemical products, Sulphuric acid production	830	C	0	836	7%
United Kingdom	10. Other (please specify), Chemical industry - other	NO	2	0	50	0%
EU 28 - Total		**11937**	**4**	**2**	**12559**	**100%**
Island	10. Other (please specify), Silicium production, Fertilizer production	NO	NO	NO	-	-
Great Britain	10. Other (please specify), Chemical industry - other	NO	2	0	50	0%
EU 28+ISL - Total		**11937**	**4**	**2**	**12559**	**100%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2.7 Non-key sources

Non key sources in the chemical sector include: 2B4 Caprolactam, glyoxal and glyoxylic acid production; 2B5 Carbide production; 2B6 Titanium dioxide production and 2B7 Soda ash production are grouped here for comparison. In 2017 sixteen countries reported emissions from these categories which contributed 4.9 Mt of CO_2 equivalent or 0.1% of total EU 28+ISL (without LULUCF) emissions.

4.2.3 Electronics Industry (CRF Source Category 2.E)

2.E Electronics Industry comprises mainly emissions which were formerly reported under 2.F.7 Semiconductor Manufacture and 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.

4.2.4 Product uses as substitutes for ODS (CRF Source Category 2.F)

This category is similar to the former category 2.F Consumption of Halocarbons and SF_6, except that the former subcategory 2.F.7 Electronics Industry is now reported under 2.E and the former subcategories 2.F.8 Electrical Equipment and 2.F.9 Other sources of SF_6 are now reported under 2.G. Emissions related to the Consumption of Halocarbons (HFCs, PFCs) are reported under this source category.

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 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 but mainly in semiconductor manufacture (2.E.1).

The source category 2.F Product uses as substitutes for ODS includes four key categories which occur in all Member States:

Table 4.31: Key categories for sector 2F (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2017		1990	2017	
2.F.1 Refrigeration and Air conditioning: no classification (HFCs)	69	93048	T	0	L	>90%
2.F.2 Foam Blowing Agents: no classification (HFCs)	0	3344	T	0	0	>80%
2.F.3 Fire Protection: no classification (HFCs)	0	2641	T	0	0	>80%
2.F.4 Aerosols: no classification (HFCs)	3	5315	T	0	0	>80%

Table.**4.32** provides information on the contribution of Member States to EU-28+ISL recalculations in HFC from 2F Product uses as substitutes for ODS for 1990 and 2016 and main explanations for the largest recalculations in absolute terms.

Table.4.32 2F Product uses as substitutes for ODS: Contribution of MS to EU recalculations in HFC for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-8	-0.5	
Belgium	-	-	-102	-3.5	For car air conditioning, adaptation of the quantity and the emission factor of refrigerant refilling Adaptation of the consumption of installations as a result of the lower R134a consumption for car airconditioning Evaluation of the emissions from chillers separately from the 'installations', taking into account the fact that they are to a significant extent pre-charged and other recommendations made in the study of Departement Omgeving. For commercial refrigeration, evaluation of the emissions of F-gases imported in hermetic products.
Bulgaria	-	-	-0	-0.0	-
Croatia	-	-	64	15.2	Correction of activity data and emission factors based on recent studies and expert judgements for the period 2013-2016 in 2F1.
Cyprus	37	100.0	-108	-38.6	Emissions for the whole period have been recalculated for the category 2F1 due to the revision of the methodology applied.
Czech Republic	-	-	341	10.9	New source of activity data for emission estimates from subcategory 2.F.1.e - data are obtained from COPERT
Denmark	-	-	-107	-17.5	Most recalculations relate to 2F1 where certain activity data and emission factors were adapted.
Estonia	-	-	0.4	0.2	Stock and disposal emissions were corrected for Mobile AC. Please see NIR chapter 4.6.1.5.1 Stock and disposed equipment in category 2.F.1.b Domestic refrigeration were corrected. Please see NIR chapter 4.6.1.2.5
Finland	-	-	-32	-2.3	Correction of calculation model and addition of domestic charge emissions from commercial stand-alone equipment. Addition of domestic charge emissions. Correction of parameters and activity data. Addition of new activity data. Correction of calculation model and addition of domestic charge emissions from commercial stand-alone equipment. Addition of domestic charge emissions. Correction of parameters and activity data. Addition of new activity data.
France	-	-	-25	-0.1	Ajout de nouveaux secteurs dans le froid domestique dont la production en France existe depuis le début des années 2000 (cave à vin) et 2013 (sèche-linge PAC). Ce secteur du froid domestique est donc étendu aux applications domestiques. Modifications des ventes en France de HFC utilisés comme solvant à l'aide de données récentes d'un producteur de HFC
Germany	-	-	350	3.2	Corrections of activity data on the basis of statistics which become available only in later in the year for the previous years. Addition of new activity data regarding the use of F-gas free alternatives and new sub-applications of 2F1. Activity data on F-gas consumption in 2F2 were revised on the basis of new findings and new statistical data. Corrections of activity data for 2F4 on general purpose aerosols.
Greece	-	-	108	1.8	Updated activity data led to recalculations

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Hungary	-	-	-94	-5.4	Revised amount of automobiles; buses and trains are taken into account; revised values for used for filling to new systems and used for servicing Revision of the AD (HCSO statistics)
Ireland	-	-	-77	-6.4	Revised AD from data supplier and improvement in calculation methodology
Italy	-	-	365	2.5	Update of methodology to estimate emissions from stationary air conditioning
Latvia	-	-	-	-	-
Lithuania	-	-	78	11.9	Recalculations have been done due to correction of mistakes in activity data in Domestic Refrigeration, Transport Refrigeration, Mobile AC and Stationary AC sub-categories and due to updated activity data for Commercial, Industrial, Transport refrigeration and Stationary Air-Conditioning. Emissions from Foam blowing category were recalculated due to updated data for 2014-2016 provided by the Statistics Lithuania. Emissions from Metered Dose Inhalers were recalculated due to mistake in calculations based on omitted data for 2015-2016.
Luxembourg	-	-	-0	-0.2	Error correction (2016) Revision of method following UNFCCC ICR (2018) Recommendation: interpolation now based on values from Belgium, France and Germany, previously, interpolation only based on values from Belgium Updated activity data (2016)
Malta	-	-	0.04	0.02	Recalculation for Stationary Air Conditioning - HFC-32 - Emissions (2.F.1.f): It was determined that HFC-32 is found on the local market as a refrigerant and not only as an ingredient in a blend. The data available indicated that the first imports to the local market of this substance as a refrigerant, rather than as an ingredient in a blend, occurred in the year 2016 and have increased in the year 2017. This has, inevitably, led to this recalculation.
Netherlands	-	-	-541	-24.2	New calculation method has been introduced
Poland	-	-	-2 227	-24.9	Revised product life factors and disposal loss factors for refrigeration and air conditioning.
Portugal	-	-	-1	-0.03	Update on AD in several sub-categories; update on the fleet of Road Transports with AC for the whole time series in 2F1e Update on AD (Gross Domestic Product)
Romania	-	-	-0.3	-0.01	Recalculations of the HFC emissions have been made for the 2015-2016 period due to an improvement in activity data for these years. (2.F.1.a); Recalculations of the HFC emissions have been made for the 2016 year as a result of due to the changes in the "% new cars with AC units" value for 2016 year due to the use of HFC-1234yf in air conditioning units installed on new vehicle models. (2.F.1.e) Recalculations of the HFC emissions have been made for the 2004-2016 period due to the changes in activity data for these years. (2.F.3) Recalculations of the HFC emissions have been made for the 2016 year due to the changes in activity data for this year (a new operator has sent data for the 2016 year; 2.F.4)
Slovakia	-	-	-	-	-
Slovenia	-	-	-1	-0.4	Modification of the methodology for MAC, addition of disposal emissions from stationary AC. Improved AD
Spain	-	-	-955	-10.4	
Sweden	1	10.4	266	30.2	Addition of amounts of HFC-125 in imported products (Transport refigeration and Stand-alone Applications within 2.F.1.a). Addition of amounts of HFC-134a in imported products (MAC,

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					Transport refigeration) and addition of emissions from working machineries. Emission factor changed for light trucks. Addition of amounts of HFC-143a in imported products (Transport refrigeration and Stand-alone Applications within 2.F.1.a). Minor corrections of emissions from manufacturing and stock in 2.F.1.a Update of emissions of HFC-23 from stock and disposal in 2.F.1.c Update of emissions of HFC-32 from manufacturing, stock and disposal in 2.F.1.a, 2.F.1.c and 2.F.1.f HFO-1234yf added in submission 2019 Activity data (import in bulk) updated Technical correction in calculations
United Kingdom	0	100.0	-62	-0.4	Update to proxy data used to scale UK emissions for estimating Gibraltar emissions Update to proxy data used to scale UK emissions for estimating Gibraltar emissions Now using the latest EEA F-gas data for 2016 Update to proxy data used to scale UK emissions for estimating Gibraltar emissions Review of solvents estimates to be based on EU data on HFC-43-10mee, which is believed to be the only solvent used in the UK instead of the much higher estimates of F-gases allocated to the solvents sector HFC emissions associated with F-gas handling (rather than HFC or HCFC manufacture) reported by a UK manufacturer have beeen separated and reallocated from 2.B.9.
EU28	38	569.6	-2 768	-2.5	
Iceland	0	0.0	-0.01	-0.003	
United Kingdom (KP)					Update to proxy data used to scale UK emissions for estimating Gibraltar emissions Update to proxy data used to scale UK emissions for estimating Gibraltar emissions Now using the latest EEA F-gas data for 2016 Update to proxy data used to scale UK emissions for estimating Gibraltar emissions Review of solvents estimates to be based on EU data on HFC-43-10mee, which is believed to be the only solvent used in the UK instead of the much higher estimates of F-gases allocated to the solvents sector HFC emissions associated with F-gas handling (rather than HFC or HCFC manufacture) reported by a UK manufacturer have beeen separated and reallocated from 2.B.9.
EU28+ISL	38	511.6	-2 706	-2.9	

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.4.33 2F Product uses as substitutes for ODS in 1990 and 2016: Member States' and EU-28+ISL total 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 2017 (kt CO2 equivalents)	HFC emissions in 1990 (kt CO2 equivalents)	HFC emissions in 2017 (kt CO2 equivalents)	PFC emissions in 1990 (kt CO2 equivalents)	PFC emissions in 2017 (kt CO2 equivalents)
Austria	NO	1 720	NO	1 720	NO	NO,IE
Belgium	NO	2 806	NO	2 804	NO	2
Bulgaria	NO	1 818	NO	1 818	NO	0
Croatia	NO	489	NO	489	NO	NO
Cyprus	64	250	64	250	NO	NO
Czechia	NO	3 642	NO	3 641	NO	1
Denmark	NO	405	NO	405	NO	0
Estonia	NO	236	NO	236	NO	-
Finland	0	1 278	0	1 277	NO	1
France	IE,NO	18 403	NO,IE	18 403	-	-
Germany	NA,IE,NO	10 991	NO,IE,NA	10 985	IE,NA	6
Greece	NO	6 223	NO	6 179	NO	44
Hungary	NO	1 802	NO	1 801	NO	1
Ireland	1	1 141	1	1 141	NO	NO
Italy	NO	15 274	NO	15 274	NO	NO
Latvia	NE,NO	235	NO,NE	235	NO	NO
Lithuania	NO	711	NO	711	NO	NO
Luxembourg	0	67	0	67	-	-
Malta	NE,IE,NO	311	NO,NE,IE	311	NO	NO
Netherlands	NO	1 698	NO	1 698	NO	NO
Poland	NO	6 905	NO	6 893	NO	12
Portugal	NA	3 274	NA	3 257	NA	17
Romania	0	2 178	0	2 178	NO	NO
Slovakia	NO	739	NO	739	NO	NO
Slovenia	NO	357	NO	357	NO	NO
Spain	NO	7 167	NO	6 309	NO	8
Sweden	6	1 139	6	1 138	NO	1
United Kingdom	0	14 059	0	14 059	NO	NO
EU-28	**72**	**105 317**	**72**	**104 376**	**NA,IE,NO**	**91**
Iceland	1	205	1	205	NO	0
United Kingdom (KP)	0	14 148	0	14 148	NO	NO
EU-28 + ISL	**72**	**105 610**	**72**	**104 669**	**NA,IE,NO**	**91**

Abbreviations explained in the Chapter 'Units and abbreviations'.

F-gas emissions from 2.F Product uses as substitutes for ODS account for 2.5% of total EU-28+ISL GHG emissions (without LULUCF) in 2017. HFC emissions in 2017 were about 2300 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.**4.33** shows the sub-categories of HFC-gas emissions from 2.F Product uses as substitutes for ODS by Member States. It highlights that 2.F.1 Refrigeration and Air Conditioning is by far the largest sub-category accounting for 89% of HFC-gas 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 5% and 2.F.2 Foam blowing agents approximately 3%. Emissions from fire protection relate to 2.5% of HFC emissions from 2.F.1 in 2017.

Table.4.34 2F Product uses as substitutes for ODS: Member States' sub-categories of HFC emissions for 2017 (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	**1 720**	1 663	17	13	28	NO	-
Belgium	**2 804**	2 616	87	13	89	-	NO
Bulgaria	**1 818**	1 774	23	7	13		-
Croatia	**489**	475	NO	5	9	-	-
Cyprus	**250**	241	1	4	3	-	-
Czech Republic	**3 641**	3 601	13	25	NO	2	-
Denmark	**405**	388	1	NO	16	NO	NO
Estonia	**236**	227	2	3	4		0
Finland	**1 277**	1 230	5	NO,IE,NA	42	0	0
France	**18 403**	16 049	299	88	1 903	64	NO,IE
Germany	**10 985**	9 388	982	42	573	IE	-
Greece	**6 179**	5 783	195	156	45	-	-
Hungary	**1 801**	1 632	128	6	34	NO	NO
Ireland	**1 141**	974	NO	32	135	NO	NO
Italy	**15 274**	12 821	635	1 610	207		-
Latvia	**235**	230	0	0	5	-	-
Lithuania	**711**	668	32	3	8	NO	0
Luxembourg	**67**	62	1	-	3	-	-
Malta	**311**	305	3	2	1	NO	NO
Netherlands	**1 698**	1 523	NO	-	NO	-	175
Poland	**6 893**	6 365	305	96	126	1	-
Portugal	**3 257**	3 144	45	51	17		-
Romania	**2 178**	2 132	3	5	39	NO	NO
Slovakia	**739**	706	2	22	9	NO	-
Slovenia	**357**	350	2	1	5	-	-
Spain	**6 309**	5 792	82	130	305	NO	NO
Sweden	**1 138**	1 068	30	3	37	-	-
United Kingdom	**14 059**	11 560	449	322	1 648	19	62
EU-28	**104 376**	**92 768**	**3 342**	**2 639**	**5 306**	**84**	**237**
United Kingdom (KP)	**14 148**	11 637	450	324	1 656	19	62
Iceland	**205**	204	-		1		-
EU-28 + ISL	**104 669**	**93 048**	**3 344**	**2 641**	**5 315**	**84**	**237**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table **4.35** to Table.**4.38** shows the contribution of each MS to EU-28+ISL HFC emissions from 2.F by subcategories (2F1, 2F2, 2F3 2F4, 2F5, 2F6). It is evident that 2.F.1 represents the major source of HFC emissions in all Member States.

Table 4.35 *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-28+ISL Emissions in 2017	Change 1990-2017		Change 1995-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	1995	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	38	1 573	1 663	1.8%	1 663	∞	1 626	4323%	90	6%	T2	D
Belgium	NO	91	2 639	2 616	2.8%	2 616	∞	2 524	2760%	-23	-1%	T2	CS,D,PS
Bulgaria	NO	3	1 356	1 774	1.9%	1 774	∞	1 771	53205%	418	31%	NO,T2	D,NO
Croatia	NO	29	470	475	0.5%	475	∞	446	1528%	5	1%	T2	D
Cyprus	64	92	236	241	0.3%	177	276%	149	162%	4	2%	T2	D
Czechia	NO	27	3 427	3 601	3.9%	3 601	∞	3 574	13177%	174	5%	T2	CS
Denmark	NO	48	482	388	0.4%	388	∞	341	716%	-93	-19%	T2	D
Estonia	NO	10	228	227	0.2%	227	∞	217	2180%	-1	0%	T2	CS
Finland	0	147	1 300	1 230	1.3%	1 230	11647129%	1 082	735%	-70	-5%	T2	D
France	NO	544	16 628	16 049	17.2%	16 049	∞	15 505	2849%	-579	-3%	T2	CS
Germany	NO,NA	589	9 646	9 388	10.1%	9 388	∞	8 799	1493%	-258	-3%	T2	CS,D
Greece	NO	42	5 836	5 783	6.2%	5 783	∞	5 741	13555%	-53	-1%	IE,T2	D,IE
Hungary	NO	25	1 480	1 632	1.8%	1 632	∞	1 607	6308%	153	10%	T2	CS,D
Ireland	NO	77	945	974	1.0%	974	∞	897	1170%	29	3%	T2,T3	CS
Italy	NO	356	12 617	12 821	13.8%	12 821	∞	12 465	3499%	204	2%	T2	CS
Latvia	NE	2	234	230	0.2%	230	∞	228	10845%	-4	-2%	T2	CS,D,OTH
Lithuania	NO	5	694	668	0.7%	668	∞	663	12435%	-26	-4%	T2	CS,D,PS
Luxembourg	0	3	59	62	0.1%	62	87109099%	59	1798%	3	5%	T2	CS,M,PS
Malta	NO,IE	0	252	305	0.3%	305	∞	305	16179976%	53	21%	T2	CS
Netherlands	NO	72	1 523	1 523	1.6%	1 523	∞	1 452	2021%	0	0%	T2	CS
Poland	NO	147	6 223	6 365	6.8%	6 365	∞	6 219	4236%	142	2%	T2	D
Portugal	NA	78	2 963	3 144	3.4%	3 144	∞	3 066	3924%	180	6%	NO,T2	D,NO
Romania	NO	2	1 852	2 132	2.3%	2 132	∞	2 130	117966%	279	15%	T2	D
Slovakia	NO	11	639	706	0.8%	706	∞	695	6191%	67	10%	-	-
Slovenia	NO	3	345	350	0.4%	350	∞	347	11777%	5	2%	T1,T2	CS,D
Spain	NO	NO	7 683	5 792	6.2%	5 792	∞	5 792	∞	-1 891	-25%	T2	CS
Sweden	5	128	1 082	1 068	1.1%	1 063	21018%	940	734%	-14	-1%	T2	CS,D
United Kingdom	NO	528	12 544	11 560	12.4%	11 560	∞	11 032	2089%	-983	-8%	T2	CS
EU-28	**69**	**3 099**	**94 956**	**92 768**	**100%**	**92 699**	**134438%**	**89 668**	**2893%**	**-2 188**	**-2%**	**-**	**-**
Iceland	NO	10	191	204	0.2%	204	∞	194	2047%	13	7%	T2	D
United Kingdom (KP)	NO	531	12 620	11 637	12.5%	11 637	∞	11 106	2093%	-983	-8%	T2	CS
EU-28 + ISL	**69**	**3 111**	**95 223**	**93 048**	**100%**	**92 979**	**134845%**	**89 936**	**2891%**	**-2 175**	**-2%**	**-**	**-**

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

In 2017, HFC emissions from 2F1 were more than 30 times higher than in 1995 (Table **4.35** and ***Figure 4.13*** to Figure 4.16).

France, Germany, Italy and the UK were responsible for 54% of total EU-28+ISL emissions from this source in 2017. Compared to 2016, emissions decreased slightly by 2% in EU-28+ISL.

Figure 4.13: 2F1 Refrigeration and Air conditioning: EU-28+ISL HFC emissions

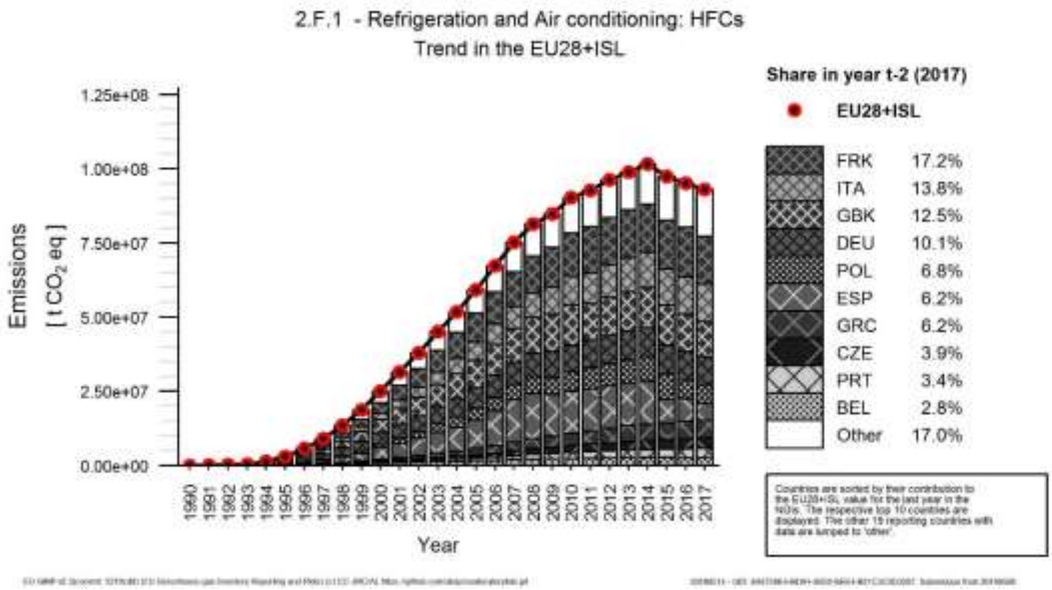


Figure 4.13 shows that emissions in sector 2.F.1 decreased slightly in 2017.

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.1a Commercial refrigeration, 2.F.1e Mobile air conditioning and 2.F.1f Stationary air conditioning.

Emission plots for these three prominent subcategories are provided in the following graphs. Please note that 2.F.1a 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, 2016 and 2017. This is in line with the policies and measures of the EU F-gas Regulation No. 517/2014.

Figure 4.14: 2F1a Commercial refrigeration: EU-28+ISL HFC emissions

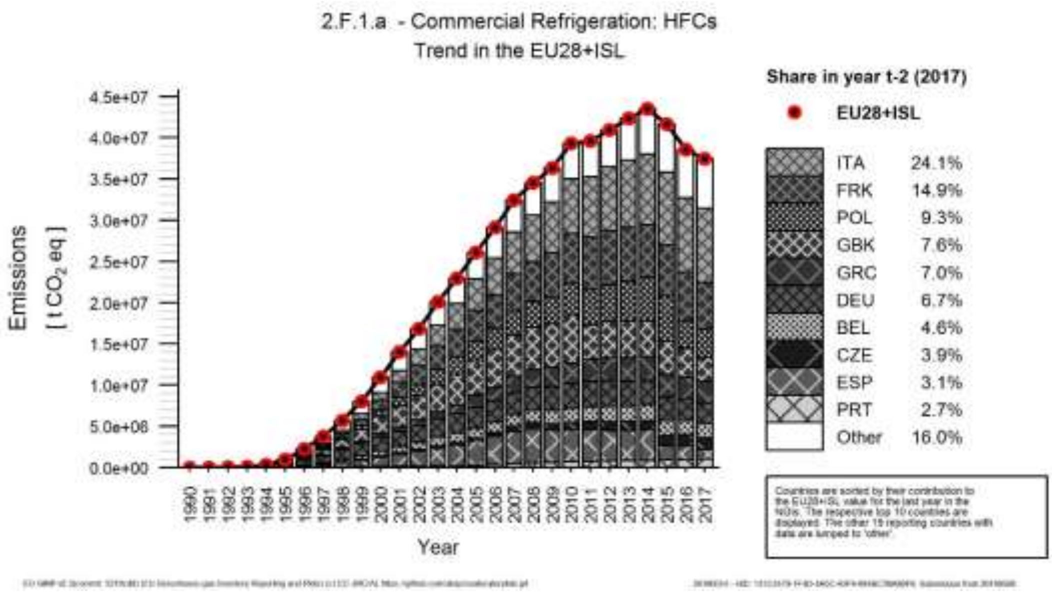


Figure 4.15: 2F1e Mobile air conditioning: EU-28+ISL HFC emissions

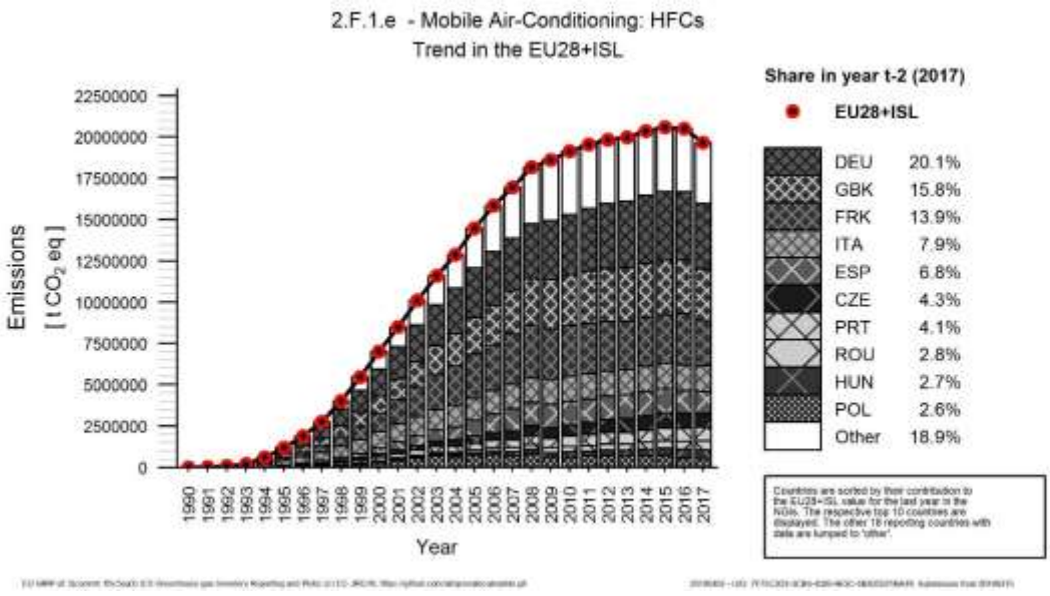


Figure 4.15 illustrates that emissions from mobile air-conditioning decreased in 2017. This relates to the introduction of the low-GWP refrigerant R1234yf in air-conditioning systems of new passenger cars. Germany accounts for more than 20% of emissions from 2F1e followed by the UK (15.8%) and France (13.9%).

Figure 4.16: 2F1f Stationary air conditioning: EU-28+ISL HFC emissions

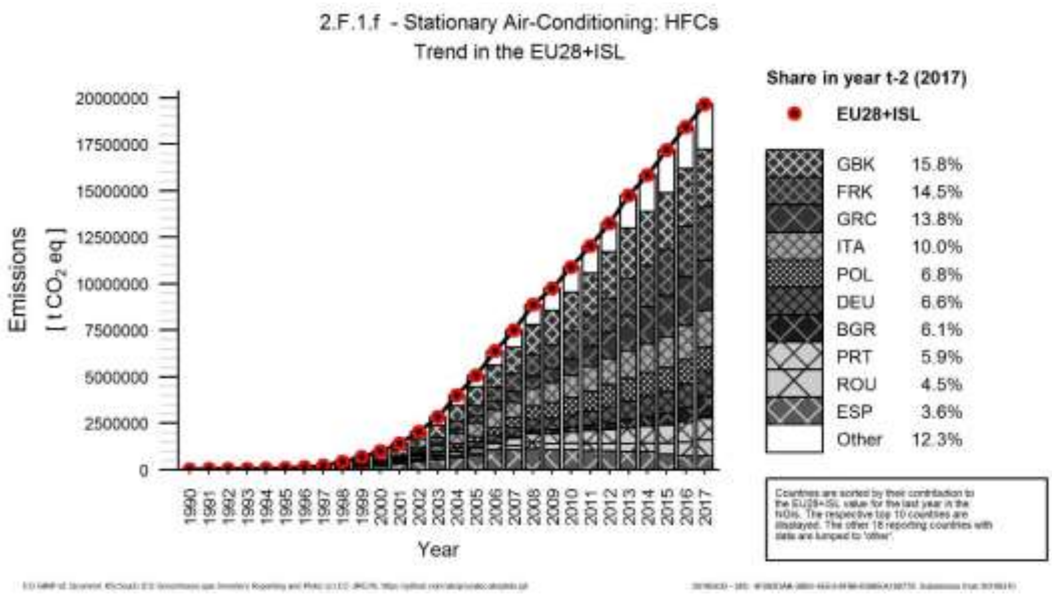


Figure 4.16 shows a consistent trend for sector 2.F.1.f with increasing emissions. This development reflects the growing use of air conditioning equipment, in particular in Southern Europe, and the so far rather slow uptake of alternatives to HFCs in this sub-category. It should also be noted that some Member States allocate emissions from 2.F.1.f under the 2.F.1.a subcategory.

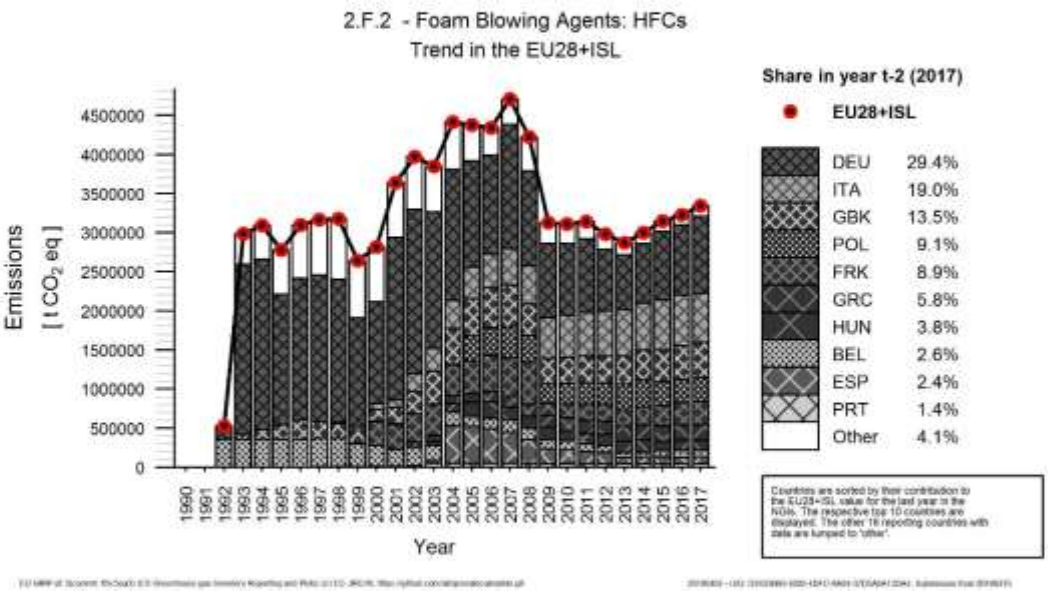
Table 4.36 2F2 Foam Blowing: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 1995-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	1995	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	301	17	17	0.5%	17	∞	-284	-95%	0	-1%	T2	D
Belgium	NO	357	92	87	2.6%	87	∞	-270	-76%	-5	-5%	T2	CS,D,PS
Bulgaria	NO	NO	22	23	0.7%	23	∞	23	∞	1	5%	NO,T2	D,NO
Croatia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Cyprus	NE,NO	NO,NE	1	1	0.0%	1	∞	1	∞	0	0%	NA	NA
Czech Republic	NO	0	6	13	0.4%	13	∞	13	92268%	7	109%	NO,T1	D
Denmark	NO	210	5	1	0.0%	1	∞	-209	-100%	-4	-84%	T2	D
Estonia	NO	18	2	2	0.1%	2	∞	-16	-87%	0	4%	T2	CS
Finland	NO	1	6	5	0.2%	5	∞	5	923%	0	-5%	T2	D
France	NO	NO	288	299	8.9%	299	∞	299	∞	11	4%	T2	CS,D
Germany	IE,NA	1 666	899	982	29.4%	982	∞	-684	-41%	82	9%	T2	CS
Greece	NO	NO	193	195	5.8%	195	∞	195	∞	2	1%	T2	D
Hungary	NO	NO	128	128	3.8%	128	∞	128	∞	1	1%	T2	CS
Ireland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Italy	NO	NO	650	635	19.0%	635	∞	635	∞	-15	-2%	NA	NA
Latvia	NO	0	2	0	0.0%	0	∞	0	-63%	-2	-94%	T1a	D,OTH
Lithuania	NO	NO	27	32	1.0%	32	∞	32	∞	5	18%	T2	D
Luxembourg	NO	10	2	1	0.0%	1	∞	-9	-85%	0	-1%	T1	CS
Malta	NO	NO	2	3	0.1%	3	∞	3	∞	1	29%	T1	D
Netherlands	NO	NO	NO	NO	-	-	-	-	-	-	-	T2	CS
Poland	NO	NO	298	305	9.1%	305	∞	305	∞	7	2%	T2	D
Portugal	NA	1	45	45	1.4%	45	∞	44	5908%	1	1%	T2	D
Romania	NO	NO	0	3	0.1%	3	∞	3	∞	3	5348%	T2	D
Slovakia	NO	NO	2	2	0.1%	2	∞	2	∞	0	-1%	-	-
Slovenia	NO	30	2	2	0.0%	2	∞	-28	-95%	0	-5%	T2	CS,D
Spain	NO	NO	81	82	2.4%	82	∞	82	∞	1	1%	T2	D
Sweden	NO	NO	31	30	0.9%	30	∞	30	∞	-1	-3%	T2	PS
United Kingdom	NO	184	424	449	13.4%	449	∞	265	144%	25	6%	T2	CS
EU-28	**NE,NA,IE,NO**	**2 777**	**3 225**	**3 342**	**100%**	**3 342**	**∞**	**565**	**20%**	**117**	**4%**	**-**	**-**
Iceland	-	-	-	-	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	184	425	450	13.5%	450	∞	266	144%	25	6%	T2	CS
EU-28 + ISL	**NE,NA,IE,NO**	**2 778**	**3 226**	**3 344**	**100%**	**3 344**	**∞**	**566**	**20%**	**117**	**4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Note: CY does not indicate method and EF since their emission estimates are based on a methodology currently under revision.

In 2017 HFC emissions from 2.F.2 (Table **4.36** and ***Figure 4.17***) increased 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 Germany (29.4%), Italy (19%), UK (13.5%) and Poland (9.1%) and those four countries account for 71% of the share in EU-28+ISL emissions in this sector.

Figure 4.17: 2F2 Foam Blowing Agents: EU-28+ISL HFC emissions



This ***Figure 4.17*** 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.

Table4.37 2F3 Fire protection: 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-28+ISL	Change 1990-2017		Change 1995-2017		Change 2016-2017		Method	Emission factor
	1990	1995	2016	2017	Emissions in 2017	kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		Informa-tion
Austria	NO	NO	13	13	0.5%	13	∞	13	∞	0	0%	T2	D
Belgium	NO	1	13	13	0.5%	13	∞	12	2054%	0	0%	T2	CS
Bulgaria	NO	NO	7	7	0.3%	7	∞	7	∞	0	6%	T2	D
Croatia	NO	0	5	5	0.2%	5	∞	5	3560%	0	0%	T2	D
Cyprus	NE,NO	0	4	4	0.2%	4	∞	4	57479%	0	0%	-	-
Czech Republic	NO	NO	24	25	0.9%	25	∞	25	∞	1	5%	D	D
Denmark	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Estonia	NO	NO	3	3	0.1%	3	∞	3	∞	0	0%	T2	CS
Finland	NO	NO	NO,IE,NA	NO,IE,NA	-	-	-	-	-	-	-	NA	NA
France	NO	5	98	88	3.3%	88	∞	83	1816%	-10	-10%	T1	CS
Germany	NA	NA	50	42	1.6%	42	∞	42	∞	-8	-16%	CS	CS,D
Greece	NO	NO	148	156	5.9%	156	∞	156	∞	8	5%	CS	D
Hungary	NO	NO	7	6	0.2%	6	∞	6	∞	-1	-10%	T1	D
Ireland	NO	NO	32	32	1.2%	32	∞	32	∞	0	0%	T2	CS
Italy	NO	16	1 593	1 610	60.9%	1 610	∞	1 594	10203%	16	1%	-	-
Latvia	NE	NE	0	0	0.0%	0	∞	0	∞	0	0%	T2	D
Lithuania	NO	NO	3	3	0.1%	3	∞	3	∞	0	3%	T1b	D
Luxembourg	-	-	-	-	-	-	-	-	-	-	-	-	-
Malta	NO	NO	1	2	0.1%	2	∞	2	∞	1	70%	CS	-
Netherlands	-	-	-	-	-	-	-	-	-	-	-	T2	CS
Poland	NO	NO	83	96	3.6%	96	∞	96	∞	14	16%	T2	D
Portugal	NA	NO	34	51	1.9%	51	∞	51	∞	17	50%	T2	D
Romania	NO	NO	5	5	0.2%	5	∞	5	∞	0	0%	T2	D
Slovakia	NO	2	22	22	0.8%	22	∞	20	946%	0	-2%	-	-
Slovenia	NO	NO	1	1	0.0%	1	∞	1	∞	0	0%	T2	CS,D
Spain	NO	1	144	130	4.9%	130	∞	129	14111%	-13	-9%	T1a	CS,D
Sweden	NO	NO	1	3	0.1%	3	∞	3	∞	3	315%	T1	CS
United Kingdom	NO	1	322	322	12.2%	322	∞	321	33208%	0	0%	T2	CS
EU-28	**NE,NA,NO**	**25**	**2 611**	**2 639**	**100%**	**2 639**	**∞**	**2 614**	**10491%**	**27**	**1%**	**-**	**-**
Iceland	-	-	-	-	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	1	324	324	12.3%	324	∞	323	33310%	0	0%	T2	CS
EU-28 + ISL	**NE,NA,NO**	**25**	**2 614**	**2 641**	**100%**	**2 641**	**∞**	**2 616**	**10499%**	**27**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Note: CY does not indicate method and EF since their emission estimates are based on a methodology currently under revision.

In 2017, HFC emissions from 2.F.3 (Table4.37) did hardly change compared to 2015 and 2016 – 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 2F6 subcategory.

The biggest contributors to this sector are Italy (60.9%), UK (12.3%) and Greece (5.9%), those three countries account for 79% of the share in EU-28+ISL emissions in this sector. Relevant increases of emissions from this subcategory compared to 2016 have been reported by Sweden (+315%), Malta (+70%), Portugal (+50%), while certain decreases were reported by Germany (-16%), Hungary (-10%), France (-10%) and Spain (-9%).

Figure 4.18: 2F3 Fire Protection, EU28+ISL: HFC emissions

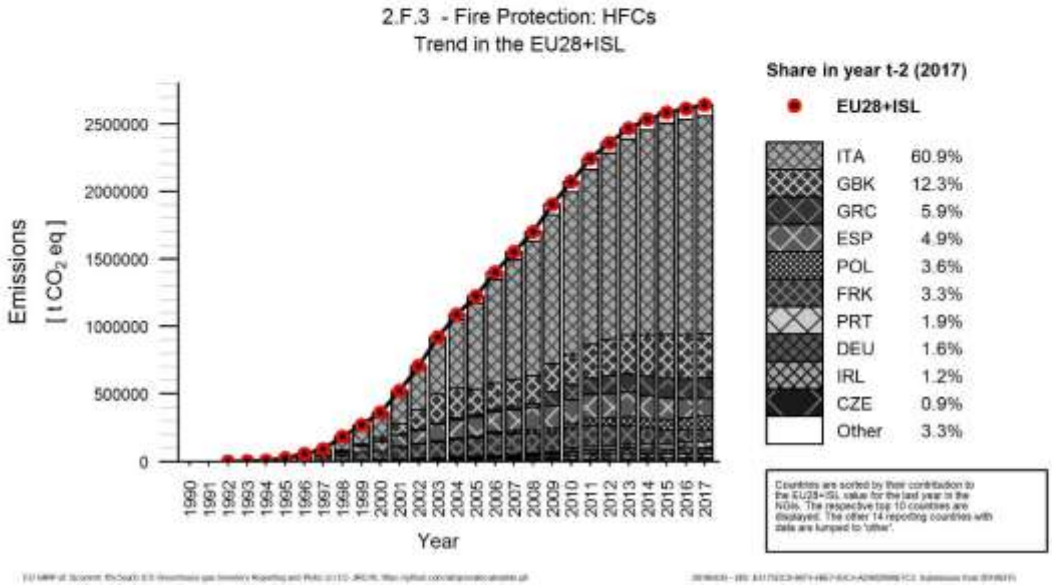


Figure 4.18 illustrates that the growth of emissions from fire protection is considerably slowing down since 2013.

Table.4.38 2F4 Aerosols/ Metered Dose Inhalers: 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-28+ISL	Change 1990-2017		Change 1995-2017		Change 2016-2017		Method	Emission factor
	1990	1995	2016	2017	Emissions in 2017	kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		Informa-tion
Austria	NO	4	27	28	0.5%	28	∞	23	512%	0	0%	T2	D
Belgium	NO	41	90	89	1.7%	89	∞	47	114%	-1	-1%	T2	CS,D,PS
Bulgaria	NO	NO	15	13	0.2%	13	∞	13	∞	-1	-9%	T2	D
Croatia	NO	NO	9	9	0.2%	9	∞	9	∞	0	0%	T2	D
Cyprus	NO	0	3	3	0.1%	3	∞	3	25651%	0	0%	NA	NA
Czech Republic	NO	NO	4	NO	-	-	-	-	-	-4	-100%	NA	NA
Denmark	NO	NO	17	16	0.3%	16	∞	16	∞	-1	-3%	-	-
Estonia	NO	0	3	4	0.1%	4	∞	4	8779%	1	51%	T2	CS
Finland	NO	2	51	42	0.8%	42	∞	40	1966%	-9	-18%	T2	D
France	NO	623	1 912	1 903	35.8%	1 903	∞	1 281	206%	-8	0%	T2	CS,PS
Germany	NO,IE,NA	342	633	573	10.8%	573	∞	231	68%	-60	-9%	T2	CS
Greece	NO	0	46	45	0.9%	45	∞	45	141544%	0	-1%	T2	D
Hungary	NO	12	33	34	0.6%	34	∞	22	191%	1	2%	T2	CS,D
Ireland	1	25	134	135	2.5%	134	20854%	109	431%	0	0%	T1,T2	CS
Italy	NO	NO	164	207	3.9%	207	∞	207	∞	43	26%	NA	NA
Latvia	NO,NE	NO,NE	5	5	0.1%	5	∞	5	∞	0	5%	T1a	D
Lithuania	NO	1	8	8	0.1%	8	∞	7	791%	0	-1%	T1a	NA
Luxembourg	NO	2	3	3	0.1%	3	∞	1	81%	0	8%	T1,T2	CS
Malta	NO,NE	NO,NE	1	1	0.0%	1	∞	1	∞	0	21%	T1	CS
Netherlands	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Poland	NO	18	127	126	2.4%	126	∞	109	622%	-1	-1%	a,T1b,T2	D
Portugal	NA	27	17	17	0.3%	17	∞	-9	-35%	0	1%	T2	D
Romania	0	1	37	39	0.7%	39	21278%	38	5276%	2	6%	T2	D
Slovakia	NO	NO	10	9	0.2%	9	∞	9	∞	-1	-10%	NA	NA
Slovenia	NO	NO	5	5	0.1%	5	∞	5	∞	0	0%	T1	D
Spain	NO	NO,NA	294	305	5.7%	305	∞	305	∞	11	4%	T2	CS
Sweden	1	7	35	37	0.7%	35	2481%	30	406%	2	5%	T2	D
United Kingdom	IE,NO	660	1 716	1 648	31.0%	1 648	∞	989	150%	-68	-4%	T2	CS
EU-28	**2**	**1 764**	**5 398**	**5 306**	**100%**	**5 304**	**235372%**	**3 542**	**201%**	**-92**	**-2%**	**-**	**-**
Iceland	1	1	1	1	0.0%	0	36%	0	30%	0	-3%	T1a	D
United Kingdom (KP)	NO,IE	662	1 724	1 656	31.2%	1 656	∞	994	150%	-68	-4%	T2	CS
EU-28 + ISL	**3**	**1 768**	**5 407**	**5 315**	**100%**	**5 312**	**180485%**	**3 548**	**201%**	**-92**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Note: CY does not indicate method and EF since their emission estimates are based on a methodology currently under revision.

In 2017, HFC emissions from 2F4 more than tripled compared to emissions from this subcategory in 1995 (Table.**4.38** and ***Figure 4.18***). 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 2F4 are HFC-134a (medical and technical aerosols), HFC-227ea (medical aerosols only) and HFC-152a (technical aerosols).

France (35.8%), UK (31.2%) and Germany (10.8%) accounted for 78% of total EU-28+ISL emissions from this source. EU-28+ISL emissions decreased slightly in 2017 (-2% compared to 2016) but a relatively stable level could be observed since 2013. A significant relative decrease between 2016 and 2017 was reported by Czech Republic (-100%) and Finland (-18%); the biggest increase was reported by Estonia (+51%), Italy (+26%) and Malta (+21%) (Table.**4.38**). It should be noted that emissions from this subcategory have been relatively stable since 2012/2013 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-28+ISL HFC emissions

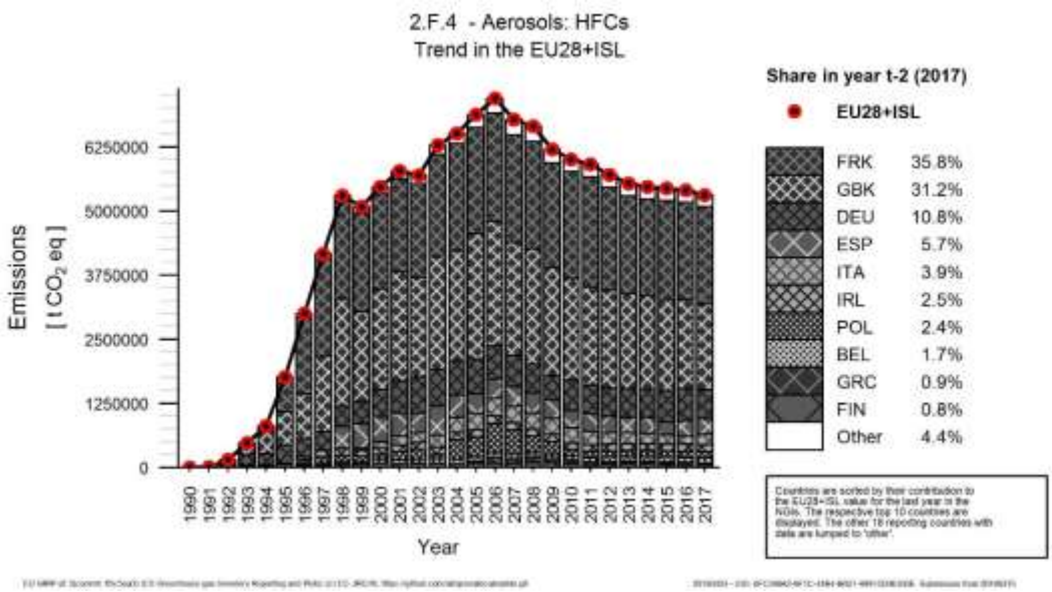


Figure 4.18 underlines the development of previous years. Emissions from sector 2.F.4 are decreasing since their peak in 2006.

The subcategories 2F5 Solvents and 2F6 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.

4.2.5 Other product manufacture and use (CRF Source Category 2G)

The former subcategories 2.F.8 Electrical Equipment and 2.F.9 Other sources of SF_6 are now reported under 2.G Other product manufacture and use. SF_6 is used 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. PFCs and SF_6 have been used for certain applications under this category for many decades.

Table 8 shows that all Member States report GHG emissions in 2.G Other product manufacture and use for the year 2017. 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.4.39 2G Other: Overview of sources reported under this source category for 2017

Member State	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-28 + ISL Total
AUT	Electrical equipment (SF_6); Soundproof windows (SF_6); Other (SF_6)	NO	NO	352			352	5.1%
BEL	Electrical equipment (SF_6); Soundproof windows (SF_6); Other (C6F14)	NO	NO	86	NO	NO	86	1.3%
BGR	Electrical equipment (SF_6)		NO	18			18	0.3%
HRV	Electrical equipment (SF_6)	NO	NO	6	NO	NO	6	0.1%
CYP	Electrical equipment (SF_6)		NO	0			0.2	0.0%
CZE	Electrical equipment (SF_6); Accelerators (SF_6); Soundproof windows (SF_6); Other (SF_6)			71			71	1.0%
DNM	Electrical equipment (SF_6); Soundproof windows (SF_6); Other (SF_6)	NO,NA	NO,NA	75	NO,NA	NO,NA	75	1.1%
EST	Electrical equipment (SF_6); Accelerators (SF_6)	NO	NO	2	NO	NO	2	0.0%
FIN	Electrical equipment (SF_6)	NO	NO,IE	12	NO	NO	12	0.2%
FRK	Electrical equipment (SF_6); Accelerators (SF_6); Other (SF_6, Unspecified mix of PFCs)	1	552	403	NA	NA	955	13.8%
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)	0	NO,IE,NA	3637	NO	NO	3637	52.7%
GRC	Electrical equipment (SF_6)		NO	5			5	0.1%
HUN	Electrical equipment (SF_6); Other (SF_6)	NO	NO	114	NO	NO	114	1.6%

Member State	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-28 + ISL Total
IRL	Electrical equipment (SF_6); Soundproof windows (SF_6); Adiabatic properties: shoes and tyres (SF_6); Other (SF_6)	NO	NO	23	NO	NO	23	0.3%
ITA	Electrical equipment (SF_6); Accelerators (SF_6)	NO	NO	352	NO	NO	352	5.1%
LVA	Electrical equipment (SF_6)	NO	NO	10	NO	NO	10	0.1%
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)	5		9			14	0.2%
MLT	Electrical equipment (SF_6), Other (SF_6, C3F8)		0.00	0.90			0.90	0.013%
NLD	Other (SF_6)	NO	NO	126			126	1.8%
POL	Electrical equipment (SF_6)	NA	NA	78	NA	NA	78	1.1%
PRT	Electrical equipment (SF_6)	NO	NO	25	NO	NO	25	0.4%
ROU	Electrical equipment (SF_6)	NO	NO	54	NO	NO	54	0.8%
SVK	Electrical equipment (SF_6)	NO	NO	7	NO	NO	7	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,NA	NO,NA	226	NO,NA	NO,NA	226	3.3%
SWE	Electrical equipment (SF_6); Soundproof windows (SF_6)		NO	34			34	0.5%
GBE	Electrical equipment (SF_6); Military applications (SF_6); Accelerators (SF_6); Other (CF4, C2F6, C3F8, c-C4F8, SF_6)		184	416			599	9%
EU-28	**TOTAL**	6	735	6161	0	0	6901	

Member State	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-28 + ISL Total
GBK	Electrical equipment (SF_6); Military applications (SF_6); Accelerators (SF_6); Other (CF4, C2F6, C3F8, c-C4F8, SF_6)		184	416			599	8.7%
ISL	Electrical equipment (SF_6)		NO	2			2	0.03%
EU-28+ISL	**TOTAL**	6	735	6163	0	0	6904	**100%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 4.19 and Table 4.40 summarize information by Member State on emissions for the key source SF_6 from 2G Other sources of SF_6. 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 (58.8% of SF_6 emissions from EU-28+ISL in 2017), where the disposal of sound proof windows containing SF_6 represents a particularly high emission source.

Table 4.40: Member States' contributions to SF_6 emissions

Member State	SF6 Emissions in kt CO2 equiv.				Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 1995-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	1995	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	132	268	357	352	5.7%	221	168%	84	31%	-5	-1%	T2	D
Belgium	134	134	88	86	1.4%	-48	-36%	-48	-36%	-2	-2%	T1,T2	D
Bulgaria	4	5	19	18	0.3%	14	374%	13	258%	-1	-7%	NO,T2	D,NO
Croatia	10	11	6	6	0.1%	-4	-39%	-5	-43%	0	0%	T2	CS
Cyprus	0	0	0	0	0.0%	0	542%	0	184%	0	0%	NA	NA
Czechia	84	89	75	71	1.1%	-13	-16%	-18	-20%	-4	-5%	D,T1	D
Denmark	13	70	104	75	1.2%	63	491%	6	8%	-29	-28%	T2,T3	D
Estonia	NO	3	3	2	0.0%	2	∞	-1	-21%	0	-3%	T3	CS
Finland	45	27	11	12	0.2%	-33	-73%	-14	-53%	1	8%	T2	CS
France	1 249	1 479	444	403	6.5%	-846	-68%	-1 076	-73%	-42	-9%	T1,T2	CS,D
Germany	4 050	6 072	3 386	3 637	59.0%	-413	-10%	-2 435	-40%	251	7%	CS,D,T3	CS,D
Greece	3	3	5	5	0.1%	2	71%	2	47%	0	-4%	CS	CS
Hungary	11	52	126	114	1.8%	103	945%	62	119%	-12	-10%	T1	D
Ireland	33	38	22	23	0.4%	-10	-31%	-15	-39%	1	4%	T1	NA
Italy	294	551	347	352	5.7%	57	19%	-199	-36%	5	1%	CS,T2	CS,PS
Latvia	NO	0	10	10	0.2%	10	∞	10	5854%	0	4%	T1	D
Lithuania	NO	0	1	1	0.0%	1	∞	1	1255%	0	1%	T3	CS
Luxembourg	1	1	9	9	0.2%	9	974%	8	577%	0	2%	D,T3	CS,M,PS
Malta	0	1	0	1	0.0%	1	8343%	-1	-38%	1	1826%	CS	CS,PS
Netherlands	207	261	134	126	2.1%	-80	-39%	-135	-52%	-8	-6%	T1,T3	CS
Poland	NA,NO	13	74	78	1.3%	78	∞	66	524%	4	5%	T1	D
Portugal	NO,NA	14	23	25	0.4%	25	∞	11	81%	2	7%	T1	D
Romania	0	1	50	54	0.9%	54	11310%	53	5451%	4	9%	T2	D
Slovakia	0	10	6	7	0.1%	7	12035%	-3	-30%	1	22%	NA	NA
Slovenia	10	12	17	16	0.3%	6	61%	4	30%	-2	-9%	T2	CS
Spain	64	100	230	226	3.7%	162	253%	126	126%	-4	-2%	T2,T3	CS,D
Sweden	79	108	38	34	0.6%	-45	-57%	-73	-68%	-3	-9%	T2,T3	CS,PS
United Kingdom	918	913	415	416	6.7%	-502	-55%	-497	-54%	0	0%	TH,T1,T2,T3	CS,D
EU-28	**7 341**	**10 236**	**6 001**	**6 161**	**100%**	**-1 180**	**-16%**	**-4 076**	**-40%**	**159**	**3%**	**-**	**-**
Iceland	1	1	1	2	0.0%	1	110%	1	85%	1	81%	T2	CS
United Kingdom (KP)	918	913	415	416	6.7%	-502	-55%	-497	-54%	0	0%	TH,T1,T2,T3	CS,D
EU-28 + ISL	**7 342**	**10 237**	**6 003**	**6 163**	**100%**	**-1 179**	**-16%**	**-4 074**	**-40%**	**160**	**3%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Note: CY does not indicate method and EF since their emission estimates are based on a methodology currently under revision.

Figure 4.19: 2G - Other Product Manufacture and Use: SF_6 Trend in the EU28+ISL

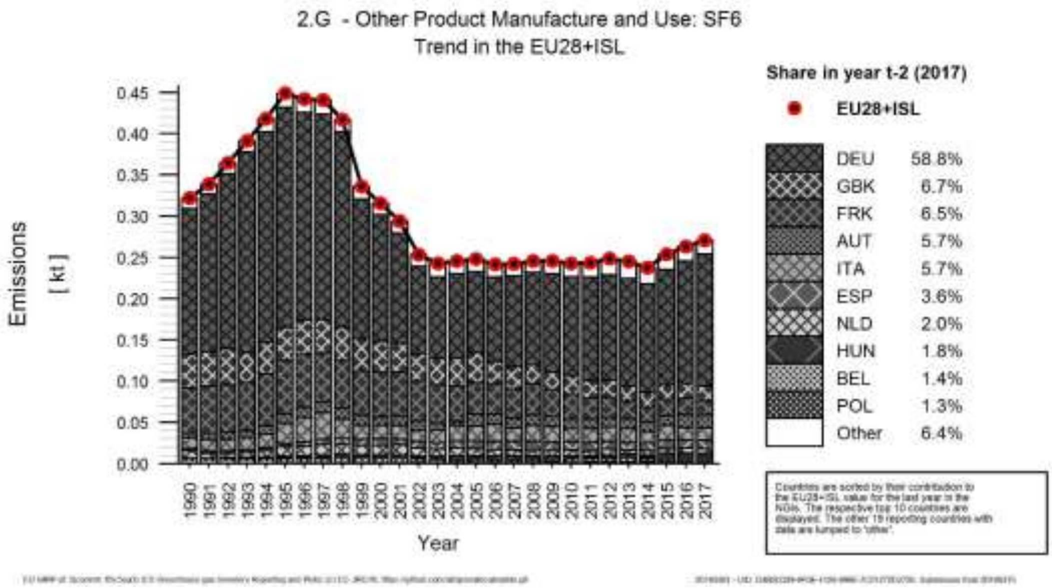


Figure 4.19 shows a stable trend for emissions from SF_6 in sector 2.G in the period 2002-2014, after a considerable decrease since 1995. Since 2014 smaller but steady increases took place (+3% in 2017 compared to 2016).

4.2.6 IPPU – non key categories

Table 4.41: Aggregeted GHG emission from non-key categories in the industrial processes and product use (IPPU) sector

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO_2 equ.	%	kt CO_2 equ.	%
2.A.3 Glass production: no classification (CO_2)	4 260.8	4 208.9	4 299.7	1.13%	39	1%	91	2%
2.B.1 Ammonia Production: no classification (CH_4)	2.1	2.3	3.0	0.00%	1	41%	1	28%
2.B.1 Ammonia Production: no classification (N_2O)	0.6	0.7	0.8	0.00%	0	28%	0	15%
2.B.10 Other chemical industry: no classification (CH_4)	259.5	120.9	108.0	0.03%	-151	-58%	-13	-11%
2.B.10 Other chemical industry: no classification (HFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.B.10 Other chemical industry: no classification (N_2O)	875.2	586.5	513.5	0.14%	-362	-41%	-73	-12%
2.B.10 Other chemical industry: no classification (NF_3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.B.10 Other chemical industry: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO_2 equ.	%	kt CO_2 equ.	%
2.B.10 Other chemical industry: no classification (SF_6)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.B.10 Other chemical industry: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.B.3 Adipic Acid Production: no classification (CO_2)	17.7	20.2	17.0	0.00%	-1	-4%	-3	-16%
2.B.4 Caprolactam, Glyoxal and Glyoxylic Acid Production: no classification (CO_2)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.B.4 Caprolactam, Glyoxal and Glyoxylic Acid Production: no classification (N_2O)	4 128.3	2 101.5	2 186.6	0.58%	-1 942	-47%	85	4%
2.B.5 Carbide Production: no classification (CH_4)	5.6	11.7	9.4	0.00%	4	69%	-2	-20%
2.B.5 Carbide Production: no classification (CO_2)	1 742.5	226.0	211.2	0.06%	-1 531	-88%	-15	-7%
2.B.6 Titanium Dioxide Production: no classification (CO_2)	179.0	261.0	277.8	0.07%	99	55%	17	6%
2.B.7 Soda Ash Production: no classification (CO_2)	2 249.3	2 193.3	2 181.9	0.57%	-67	-3%	-11	-1%
2.B.8 Petrochemical and Carbon Black Production: no classification (CH_4)	1 049.3	1 128.0	1 189.2	0.31%	140	13%	61	5%
2.B.9 Fluorochemical Production: no classification (NF_3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.B.9 Fluorochemical Production: no classification (PFCs)	4 331.8	2 357.7	1 545.0	0.41%	-2 787	-64%	-813	-34%
2.B.9 Fluorochemical Production: no classification (SF_6)	1 845.5	87.5	78.8	0.02%	-1 767	-96%	-9	-10%
2.C.1 Iron and Steel Production: no classification (CH_4)	290.3	170.9	160.8	0.04%	-130	-45%	-10	-6%
2.C.2 Ferroalloys Production: no classification (CH_4)	27.2	22.1	21.9	0.01%	-5	-19%	0	-1%
2.C.2 Ferroalloys Production: no classification (CO_2)	4 868.5	3 393.5	3 510.9	0.92%	-1 358	-28%	117	3%
2.C.3 Aluminium Production: no classification (CO_2)	4 906.1	4 654.0	4 695.4	1.24%	-211	-4%	41	1%
2.C.3 Aluminium Production: no classification (SF_6)	25.1	13.5	10.8	0.00%	-14	-57%	-3	-20%
2.C.4 Magnesium Production: no classification (CO_2)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.C.4 Magnesium Production: no classification (HFCs)	0.0	43.1	38.4	0.01%	38	100%	-5	-11%
2.C.4 Magnesium Production: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO_2 equ.	%	kt CO_2 equ.	%
2.C.5 Lead Production: no classification (CO_2)	391.0	249.2	214.5	0.06%	-177	-45%	-35	-14%
2.C.6 Zinc Production: no classification (CO_2)	2 961.4	1 037.1	1 087.2	0.29%	-1 874	-63%	50	5%
2.C.7 Other Metal Industry: no classification (CH_4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.C.7 Other Metal Industry: no classification (CO_2)	486.8	249.6	228.0	0.06%	-259	-53%	-22	-9%
2.C.7 Other Metal Industry: no classification (HFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.C.7 Other Metal Industry: no classification (N_2O)	44.3	21.2	21.7	0.01%	-23	-51%	1	3%
2.C.7 Other Metal Industry: no classification (NF_3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.C.7 Other Metal Industry: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.C.7 Other Metal Industry: no classification (SF_6)	781.0	60.2	53.8	0.01%	-727	-93%	-6	-11%
2.C.7 Other Metal Industry: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.D.1 Lubricant Use: no classification (CH_4)	3.4	0.4	0.3	0.00%	-3	-90%	0	-7%
2.D.1 Lubricant Use: no classification (CO_2)	4 320.5	2 665.7	2 702.5	0.71%	-1 618	-37%	37	1%
2.D.1 Lubricant Use: no classification (N_2O)	4.6	3.6	3.5	0.00%	-1	-24%	0	-2%
2.D.2 Paraffin Wax Use: no classification (CH_4)	0.2	0.4	0.4	0.00%	0	122%	0	3%
2.D.2 Paraffin Wax Use: no classification (CO_2)	632.7	1 197.0	1 207.3	0.32%	575	91%	10	1%
2.D.2 Paraffin Wax Use: no classification (N_2O)	0.7	1.6	1.6	0.00%	1	137%	0	-1%
2.D.3 Other non energy products: no classification (CH_4)	1.2	1.4	1.5	0.00%	0	31%	0	13%
2.D.3 Other non energy products: no classification (N_2O)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.1 Integrated Circuit or Semiconductor: no classification (HFCs)	35.9	36.3	46.4	0.01%	10	29%	10	28%
2.E.1 Integrated Circuit or Semiconductor: no classification (PFCs)	261.9	410.2	378.4	0.10%	117	45%	-32	-8%
2.E.2 TFT Flat Panel Display: no classification (HFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.2 TFT Flat Panel Display: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.3 Photovoltaics: no classification (HFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.3 Photovoltaics: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.4 Heat Transfer Fluid: no classification (HFCs)	0.0	0.0	0.0	0.00%	0	100%	0	100%
2.E.4 Heat Transfer Fluid: no classification (PFCs)	8.6	0.0	0.0	0.00%	-9	-100%	0	0%

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO_2 equ.	%	kt CO_2 equ.	%
2.E.5 Other electronics industry: no classification (HFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.5 Other electronics industry: no classification (NF_3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.5 Other electronics industry: no classification (PFCs)	0.0	0.0	1.1	0.00%	1	100%	1	100%
2.E.5 Other electronics industry: no classification (SF_6)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.5 Other electronics industry: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.1 Refrigeration and Air conditioning: no classification (NF_3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.1 Refrigeration and Air conditioning: no classification (PFCs)	0.0	80.7	79.4	0.02%	79	100%	-1	-2%
2.F.1 Refrigeration and Air conditioning: no classification (SF_6)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.1 Refrigeration and Air conditioning: no classification (Unspecified mix of HFCs and PFCs)	0.0	556.7	849.9	0.22%	850	100%	293	53%
2.F.2 Foam Blowing Agents: no classification (NF_3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.2 Foam Blowing Agents: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.2 Foam Blowing Agents: no classification (SF_6)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.2 Foam Blowing Agents: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.3 Fire Protection: no classification (PFCs)	0.0	12.6	12.0	0.00%	12	100%	-1	-5%
2.F.4 Aerosols: no classification (NF_3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.4 Aerosols: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.4 Aerosols: no classification (SF_6)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.4 Aerosols: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.5 Solvents: no classification (HFCs)	0.0	87.1	84.4	0.02%	84	100%	-3	-3%
2.F.5 Solvents: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.6 Other Applications: no classification (HFCs)	0.4	233.8	236.8	0.06%	236	65907 %	3	1%

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO_2 equ.	%	kt CO_2 equ.	%
2.F.6 Other Applications: no classification (NF_3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.6 Other Applications: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.6 Other Applications: no classification (SF_6)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.6 Other Applications: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.G.1 Electrical Equipment: no classification (HFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.G.1 Electrical Equipment: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.G.2 SF_6 and PFCs from Other Product Use: no classification (PFCs)	322.1	625.4	735.1	0.19%	413	128%	110	18%
2.G.2 SF_6 and PFCs from Other Product Use: no classification (SF_6)	4 492.5	4 097.4	4 296.7	1.13%	-196	-4%	199	5%
2.G.3 N_2O from Product Uses: no classification (N_2O)	5 696.8	3 387.3	3 360.7	0.89%	-2 336	-41%	-27	-1%
2.G.4 Other unspecifed product manufacture and use: no classification (CH_4)	56.8	76.8	78.6	0.02%	22	38%	2	2%
2.G.4 Other unspecifed product manufacture and use: no classification (CO_2)	789.8	553.7	581.8	0.15%	-208	-26%	28	5%
2.G.4 Other unspecifed product manufacture and use: no classification (HFCs)	0.0	2.8	5.8	0.00%	6	100%	3	108%
2.G.4 Other unspecifed product manufacture and use: no classification (N_2O)	45.4	200.0	213.4	0.06%	168	370%	13	7%
2.G.4 Other unspecifed product manufacture and use: no classification (NF_3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.G.4 Other unspecifed product manufacture and use: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.G.4 Other unspecifed product manufacture and use: no classification (SF_6)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.G.4 Other unspecifed product manufacture and use: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.H Other Industrial Process and Product Use: no classification (CH_4)	37.2	13.9	14.0	0.00%	-23	-62%	0	1%
2.H Other Industrial Process and Product Use: no classification (CO_2)	118.1	105.0	120.2	0.03%	2	2%	15	14%
2.H Other Industrial Process and Product Use: no classification (HFCs)	0.0	2.8	2.0	0.00%	2	18709 %	-1	-31%

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO_2 equ.	%	kt CO_2 equ.	%
2.H Other Industrial Process and Product Use: no classification (N_2O)	63.8	82.2	84.1	0.02%	20	32%	2	2%
2.H Other Industrial Process and Product Use: no classification (NF_3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.H Other Industrial Process and Product Use: no classification (PFCs)	0.2	3.5	4.9	0.00%	5	2287%	1	40%
2.H Other Industrial Process and Product Use: no classification (SF_6)	7.5	36.6	37.9	0.01%	30	407%	1	3%
2.H Other Industrial Process and Product Use: no classification (Unspecified mix of HFCs and PFCs)	502.4	645.1	731.7	0.19%	229	46%	87	13%
2.A.3 Glass production: no classification (CO_2)	4 260.8	4 208.9	4 299.7	1.13%	39	1%	91	2%
2.B.1 Ammonia Production: no classification (CH_4)	2.1	2.3	3.0	0.00%	1	41%	1	28%
2.B.1 Ammonia Production: no classification (N_2O)	0.6	0.7	0.8	0.00%	0	28%	0	15%
2.B.10 Other chemical industry: no classification (CH_4)	259.5	120.9	108.0	0.03%	-151	-58%	-13	-11%

4.3 Methodological issues and uncertainties

The previous section presented for each EU-28 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 Member States and the corresponding IEFs. Some of these tables do include a calculation of EU-level implied emission factors based on a number of Member States. 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 Member States 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 2017 and only for the EU key categories where the criteria above apply. In 2019 the following categories have been gap-filled:

- Cement Production 2.A.1
- Lime production in 2.A.2

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-28.
2. These emissions have been divided by the aggregated activity data of those MS in order to derive an IEF for those MS.
3. This IEF has been multiplied by the emissions of the EU-28 in order to derive a gap-filled estimate for activity data for EU-28.

Table **4.42** 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 4.42 Documentation of gap filling of activity data

Category	Geographical coverage	2017			
		Activity data Description	(kt)	IEF (t/t)	Emissions (kt)
2.A.1	EU-28	Clinker production	143 516	0.52	74 638
	EU-28 excl HUN	Clinker production	142 216	0.52	73 962
2.A.2	EU-28	Lime Production	26 061	0.74	19 257
	EU-28 excl. NLD, PRT & GBK	Lime Production	23 760	0.74	17 557

4.3.2 Uncertainty estimates

Table 4.43 shows the total EU-28 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 (154.6 %) 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-28 see Chapter 1.6.

Table 4.43 Sector 2 Industrial processes: Uncertainty estimates for the EU-28

Source category	Gas	Emissions Base Year	Emissions 2017	Emission trends Base Year-2017	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.A Mineral Industry	CO_2	148 362	110 062	-25.8%	3.1%	0.01%
2.A Mineral Industry	CH_4	31	6	-81.1%	100.0%	0.8%

Source category	Gas	Emissions Base Year	Emissions 2017	Emission trends Base Year-2017	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.A Mineral Industry	N_2O	0	0			
2.B Chemical Industry	CO_2	61 613	54 178	-12.1%	5.0%	0.01%
2.B Chemical Industry	CH_4	1 157	1 142	-1.4%	29.7%	0.1%
2.B Chemical Industry	N_2O	116 745	6 744	-94.2%	7.4%	0.2%
2.B Chemical Industry	HFC	35 144	432	-98.8%	13.9%	0.1%
2.B Chemical Industry	PFC	4 428	1 545	-65.1%	46.9%	0.1%
2.B Chemical Industry	Unspecified mix of HFCs and PFCs	0	0			
2.B Chemical Industry	SF_6	1 891	79	-95.8%	3.0%	0.2%
2.B Chemical Industry	NF_3	0	0			
2.C Metal Industry	CO_2	118 090	71 263	-39.7%	3.2%	0.01%
2.C Metal Industry	CH_4	284	139	-51.2%	14.8%	0.1%
2.C Metal Industry	N_2O	44	22	-50.9%	79.2%	0.3%
2.C Metal Industry	HFC	4 446	44	-99.0%	32.3%	0.5%
2.C Metal Industry	PFC	15 931	485	-97.0%	10.1%	0.1%
2.C Metal Industry	Unspecified mix of HFCs and PFCs	0	0			
2.C Metal Industry	SF_6	1 655	289	-82.6%	19.6%	0.1%
2.C Metal Industry	NF_3	0	0			
2.D Non-energy products from fuels and solvent use	CO_2	13 975	9 352	-33.1%	44.2%	0.2%
2.D Non-energy products from fuels and solvent use	CH_4	5	2	-52.3%	88.4%	0.6%
2.D Non-energy products from fuels and solvent use	N_2O	5	5	-4.0%	73.8%	0.1%
2.E Electronics industry	CO_2	0	0			
2.E Electronics industry	CH_4	0	0			
2.E Electronics industry	N_2O	0	0			
2.E Electronics industry	HFC	42	1 271	2960.5%	23.2%	6.5%
2.E Electronics industry	PFC	262	332	26.7%	26.4%	0.1%
2.E Electronics industry	Unspecified mix of HFCs and PFCs	0	0			
2.E Electronics industry	SF_6	200	139	-30.4%	16.6%	0.8%
2.E Electronics industry	NF_3	94	44	-53.5%	17.2%	0.1%
2.F Product uses as substitutes for ODS	CO_2	0	1 815		51.0%	
2.F Product uses as substitutes for ODS	CH_4	0	0			
2.F Product uses as substitutes for ODS	N_2O	0	0			
2.F Product uses as substitutes for ODS	HFC	1 734	84 207	4755.5%	48.6%	8.5%
2.F Product uses as substitutes for ODS	PFC	21	53	152.8%	154.6%	3.8%
2.F Product uses as substitutes for ODS	Unspecified mix of HFCs and PFCs	0	0			
2.F Product uses as substitutes for ODS	SF_6	0	0			
2.F Product uses as substitutes for ODS	NF_3	0	0			

Source category	Gas	Emissions Base Year	Emissions 2017	Emission trends Base Year-2017	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.G Other product manufacture and use	CO_2	805	600	-25.5%	11.3%	0.0%
2.G Other product manufacture and use	CH_4	57	79	38.3%	30.4%	0.2%
2.G Other product manufacture and use	N_2O	3 326	2 790	-16.1%	48.4%	0.1%
2.G Other product manufacture and use	HFC	46	143	213.4%	91.3%	2.1%
2.G Other product manufacture and use	PFC	401	773	92.6%	29.9%	0.2%
2.G Other product manufacture and use	Unspecified mix of HFCs and PFCs	0	0			
2.G Other product manufacture and use	SF_6	3 215	2 042	-36.5%	26.1%	0.1%
2.G Other product manufacture and use	NF_3	0	0			
2.H Other	CO_2	98	62	-37.2%	11.9%	0.1%
2.H Other	CH_4	6	8	33.0%	21.0%	0.1%
2.H Other	N_2O	64	84	32.1%	20.8%	0.1%
2.H Other	HFC	0	2	18365.4%	30.0%	55.2%
2.H Other	PFC	0	5	2287.1%	48.2%	11.0%
2.H Other	Unspecified mix of HFCs and PFCs	0	0			
2.H Other	SF_6	7	38	406.6%	63.6%	2.6%
2.H Other	NF_3	0	0			
2 (where no subsector data were submitted)	*all*	0	0			
Total - 2	**all**	**534 187**	**350 274**	-34.4%	**11.8%**	**4.8%**

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 Member States and checks of internal consistency. Table 3.127, 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 Member States 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 Member States experts for all source categories in Industrial Processes. In 2012 a comprehensive review was carried out for all sectors and all EU Member States in order to fix the base year 2020 under the EU Effort Sharing Decision. (ESD review 2012). For the inventory 2005 plant-specific data was available from the EU Emission Trading Scheme (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 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. Both workshops were very well attended.

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.

After the implementation of the new 2006 IPCC Guidelines in 2015 and the subsequent changes to the sector (it now comprises 2D, Non-Energy Products from Fuels and Solvent Use, 2E, Electronics Industry, 2F Product Uses as Substitutes for Ozone Depleting Substances, and 2G Other Product Manufacture and Use), chapters had to be re-written, and certain methodological changes had to be applied. NF_3 as a new gas had to be included, and new GWPs for most fluorinated gases had to be applied. In 2016 a comprehensive ESD review was performed followed by annual ESD reviews in 2017 and 2018. 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 4.44 shows that in the industrial processes sector the largest recalculations in absolute terms were made for N_2O and HFCs in 1990 and 2016.

Table 4.44 Recalculations of total GHG emissions and recalculations from industrial processes and product use for 1990 and 2016 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	1 749	0.0%	10 312	1.7%	5 236	1.5%	14	0.1%	-163	-0.7%	-1	0.0%	229	3.9%	-7	-29.5%
Industrial Processes and Product Use	-527	-0.2%	-83	-5.4%	253	0.3%	14	0.1%	-163	-0.7%	-1	0.0%	229	3.9%	-7	-29.5%
2016																
Total emissions and removals	8 972	0.3%	8 257	2.0%	7 120	3.1%	-2 690	-2.8%	-178	-4.6%	-305	-4.8%	542	73.0%	-5	-9.1%
Industrial Processes and Product Use	1 421	0.6%	-119	-7.5%	477	5.1%	-2 690	-2.8%	-178	-4.6%	-305	-4.8%	542	73.0%	-5	-9.1%

Table 4.45 provides an overview of Member States' contributions to EU-28+ISL recalculations.

Table 4.45 Sector 2 Industrial processes: Contribution of Member States to EU-28+ISL recalculations for 1990 and 2016 by gas (difference between latest submission and previous submission kt of CO_2 equivalents)

	1990								2016							
	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	0	0	0	0	0	0	-65	0	0	-8	0	0	0	0
Belgium	-4	0	3	0	0	0	0	0	4	0	2	-103	0	0	0	0
Bulgaria	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
Croatia	-3	0	0	0	0	0	0	0	-30	0	0	64	0	0	0	0
Cyprus	5	0	0	64	0	0	0	0	9	0	0	-33	0	0	0	0
Czechia	0	0	0	0	0	0	0	0	11	0	0	341	0	0	0	0
Denmark	0	0	0	0	0	0	0	0	0	0	0	-107	-4	12	0	0
Estonia	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	5	0	0	0	0	0	0	0	24	0	0	-32	0	0	0	0
France	174	0	2	0	0	0	0	0	79	1	0	-25	0	0	0	0
Germany	-342	0	24	-50	-163	0	229	-7	794	0	1	295	-157	-337	522	-11
Greece	0	0	0	0	0	0	0	0	0	0	0	108	0	0	0	0
Hungary	-4	0	-21	0	0	0	0	0	1	0	58	-94	0	-1	0	0
Ireland	0	0	0	0	0	0	0	0	-2	0	0	-77	0	0	0	0
Italy	0	0	0	0	0	-1	0	0	7	0	55	364	-15	22	19	6
Latvia	-66	0	0	0	0	0	0	0	-4	0	0	0	0	0	0	0
Lithuania	0	0	0	0	0	0	0	0	-1	0	0	78	0	0	0	0
Luxembourg	0	0	0	0	0	0	0	0	-2	0	1	0	0	0	0	0
Malta	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0
Netherlands	0	-111	244	0	0	0	0	0	287	-141	380	-541	0	0	0	0
Poland	8	0	0	0	0	0	0	0	-24	0	0	-2 227	0	0	0	0
Portugal	19	0	0	0	0	0	0	0	21	0	-8	-1	0	0	0	0
Romania	-494	0	0	0	0	0	0	0	-106	0	0	0	0	0	0	0
Slovakia	-29	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0
Slovenia	17	0	0	0	0	0	0	0	13	0	0	-1	0	0	0	0
Spain	-302	28	0	0	0	0	0	0	-348	20	0	-955	-1	0	0	0
Sweden	490	0	0	1	0	0			707	0	-12	266	0	-2		
United Kingdom	2	-9	0	0	0	26	0	0	184	-1	-2	-67	0	-16	0	0
EU28	-525	-92	253	14	-163	25	229	-7	1 605	-120	476	-2 757	-178	-321	542	-5
Iceland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
United Kingdom (KP)																
EU28+ISL	-527	-83	253	14	-163	-1	229	-7	1 421	-119	477	-2 690	-178	-305	542	-5

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

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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 Member State for the total emissions in 2010 of the four pollutants responsible for

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

acidification, 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 2017, CH_4, N_2O and CO_2 emissions from CRF sector 3 Agriculture were 47.4%, 72.1%, and 0.26% of total CH_4, N_2O and CO_2 EU28+ISL emissions, respectively. Total emissions from agriculture were 440 Mt CO_2-eq with contributions from CH_4, N_2O, and CO_2 of 242 Mt CO_2-eq, 187 Mt CO_2-eq and 10.4 Mt CO_2-eq, respectively. Thus, CH_4, N_2O, and CO_2 contributed with 5%, 3.9% and 0.21% to total EU28+ISL GHG emissions. They make 55.1%, 42.6% and 2.4% of total agricultural emissions.

Figure 5.1 shows the development of total GHG emissions from agriculture from 544 Mt CO_2-eq in 1990 to 440 Mt CO_2-eq in 2017 and the considerably decrease in EU28+ISL. The reduction of emissions was most pronounced for CO_2 with a decrease of 29.7%, followed by CH_4 with a decrease of 20.7% and N_2O with a decrease of 16.5%. The cut was most pronounced in the first decade with a total reduction of 15.1% between 1990 and 2000, a further decrease by between 2000 and 2005, while remaining constant since 2005 (change 0.23%).

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 Member States. Figure 5.3 shows the distribution of agricultural GHG emissions among the different source categories for the year 2017.

Figure 5.1: EU-28 GHG emissions for 1990-2017 from CRF Sector 3: 'Agriculture' in CO_2 equivalents (Mt)

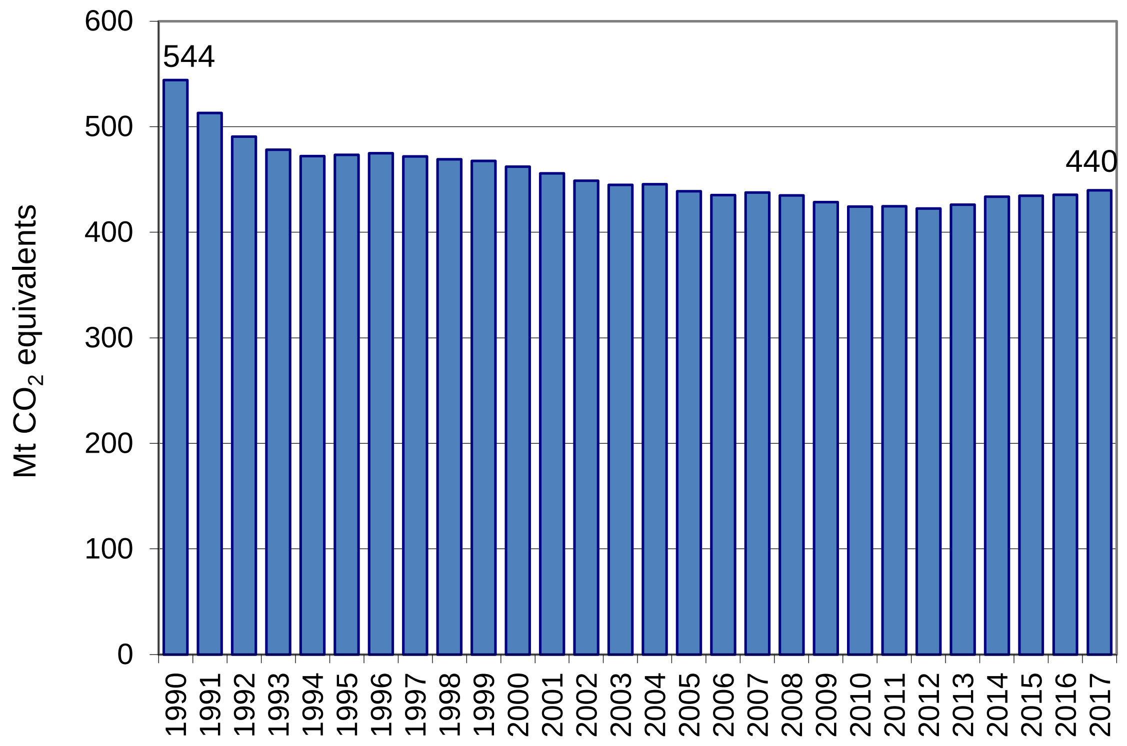


Figure 5.2: Absolute change of GHG emissions by large key source categories 1990-2017 in CO_2 equivalents (Mt) in CRF Sector 3: 'Agriculture'

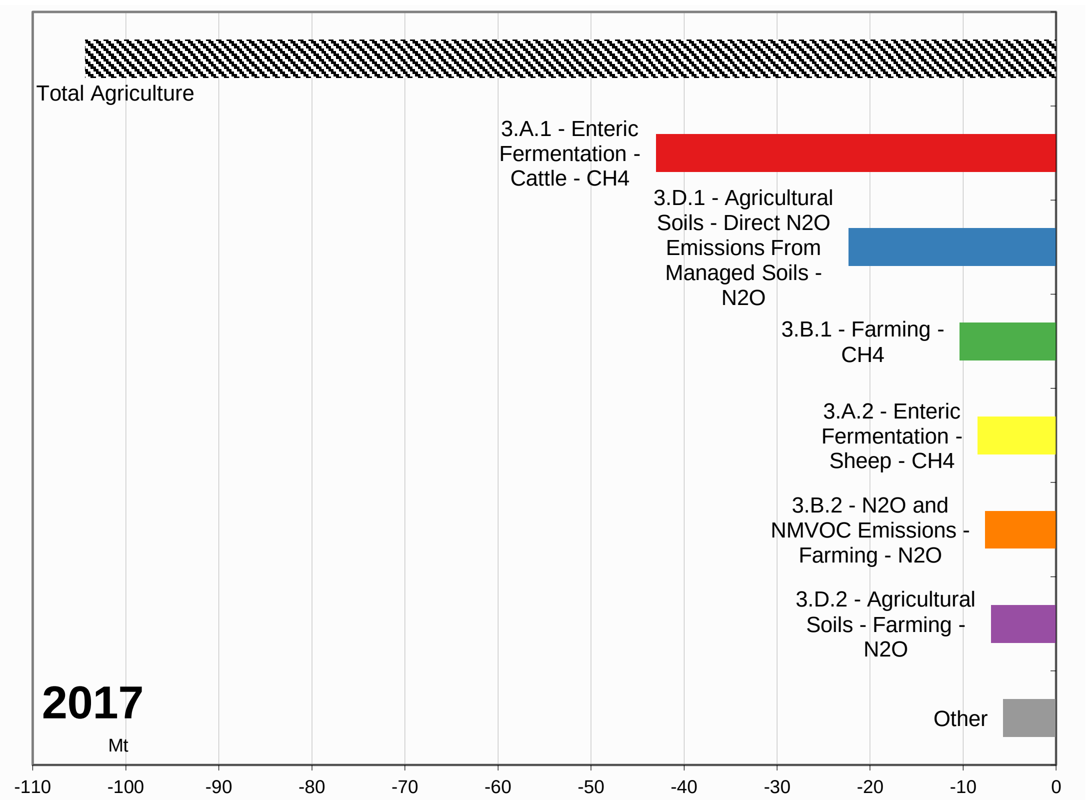
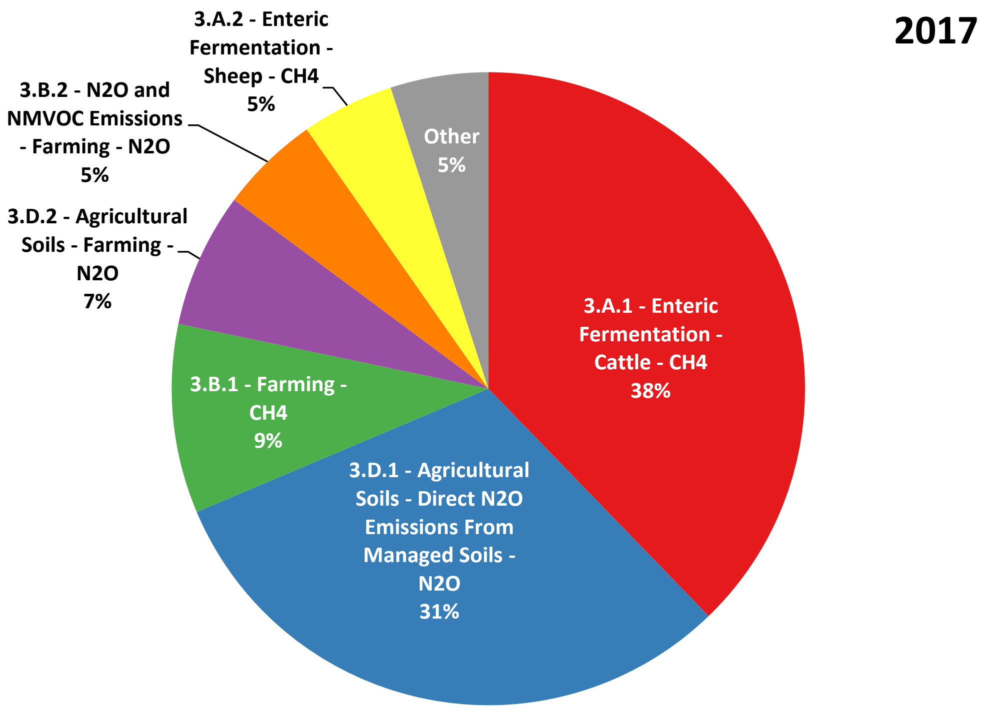


Figure 5.3: Distribution of agricultural GHG emissions among the different source categories for the year 2017



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 1990-2017 and 2016-2017. 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 19.5% compared to 1990, and 50% 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 21% of the total decrease in agricultural emissions, followed by 3.B.1 (10%), while all the other categories contribute less. The decrease in emissions is due to the decrease in the cattle population (26% between 1990 and 2017) and the decrease in the quantities applied of fertilisers, both synthetic and organic (21.6% and 12.1% decrease, respectively). Only emissions from 3.H follow the opposite trend, contributing to compensate the emission decrease but with a very low impact (-1% of agriculture total trend). Looking at the data by country in Table 5.1, we can see that the shares of the trend 1990-2017 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 half 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 2016 and 2017 (1% of total emissions), with key categories increasing emissions (3.A, 3.B.1, 3.D.1, 3.D.2, 3.I) and some less relevant categories decreasing (3.B.2, 3.C, 3.F, 3.G, 3.H), resulting in an increase of emissions for the whole sector. The greatest relative changes took place in category 3.F, with a 19.6% decrease of emissions, being the total impact in the general trend, however, only of -3% given the low share of these emissions in the total emissions of the sector. The main contributor to the total increase in agricultural emissions from last year is category 3.D.1 (81% of the total trend), followed by 3.D.2 and 3.A (16 and 10%, respectively). The contribution of the other categories is less than 10% of total change.

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 (2017)	Share of trend 1990-2017	Share of trend 2016-2017
3.A	CH_4	0.45	0.50	0.10
3.B.1	CH_4	0.10	0.10	0.06
3.B.2	N_2O	0.05	0.07	-0.01
3.C	CH_4	0.01	0.00	-0.02
3.D.1	N_2O	0.31	0.21	0.81
3.D.2	N_2O	0.07	0.07	0.16
3.F	CH_4	0.00	0.01	-0.02
3.F	N_2O	0.00	0.00	-0.01
3.G	CO_2	0.01	0.05	-0.06
3.H	CO_2	0.01	-0.01	-0.01
3.I	CO_2	0.00	0.00	0.00

The contribution of individual countries to the key categories will be addressed in the corresponding sections, but as a summary we can say that 2016-2017 changes in category 3.A are mainly motivated by Poland and Ireland, with France and Germany pushing to decrease emissions. In 3.B.1, Spain is the main responsible for the increasing trend, accounting for 6.7% of the EU trend. If we look at the main countries driving the EU trend in the different emission categories, we find that France, Poland, Spain and Romania are the most recurrent countries. These are also among the main contributors to total agricultural emissions, but also are Germany and UK, which are not as important contributors to the trend, especially the UK, which does not appear among the first 4 contributors in any of the emission categories.

Table 5.2 shows the contribution of the different emission categories in the individual countries to the overall emission trend of EU agriculture (2016-2017). The greatest contributions are those of category 3.D.1 from France and Poland. Although the trend of emissions in category 3.D.1 for the whole EU is nearly stable, the variability in the different member states is high, ranging from -75 to +476 CO_2-eq in 2017 compared to 2016. Other important contributors to the total trend are 3.D.1 from Spain and Romania and 3.A from Germany and Ireland. These countries are 7 of the top 8 contributors to total EU emissions, therefore it is expectable that they highly influence the EU trends. It is also expectable that 3.D.1 and 3.A are driving overall emission trends, as they represent together 76% of total agricultural emissions in 2017. In particular, the increasing trend in emissions from 3.D.1, which explains 80% of the increasing trend in total emissions, was due to an increase in activity data.

Table 5.2 Contribution to EU emission trends (2016-2017) per Member State 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 2017 (%)
FRK	-9.88	0.45	-1.13	17.81	4.41	-3.48	1.77	17.40
DEU	-5.70	-0.43	-0.58	-2.58	-1.23	4.96	-1.25	14.76
GBK	1.75	0.64	-0.17	5.57	1.08	0.25	-0.51	9.42

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 2017 (%)
ESP	5.23	6.66	0.70	11.50	1.75	0.03	2.41	9.02
POL	12.49	0.95	2.34	16.81	5.30	-3.84	0.94	7.25
ITA	4.66	0.08	-0.44	-4.09	-1.28	0.13	-2.62	7.03
IRL	7.97	0.65	0.18	6.09	0.51	-2.43	-0.02	4.47
ROU	-3.39	-2.12	-0.64	8.95	2.28	0.12	0.16	4.40
NLD	-3.61	0.53	0.15	3.15	0.54	0.15	NA	4.32
DNM	0.34	-0.80	-0.23	1.83	0.42	0.06	0.00	2.43
BEL	-0.79	-0.13	-0.09	5.11	1.09	-0.03	-0.03	2.31
CZE	1.24	-0.19	-0.25	0.33	-0.02	-0.22	-2.09	1.93
GRC	-0.33	-0.09	-0.09	0.09	0.01	NA	0.19	1.79
AUT	0.24	0.32	0.10	-1.81	-0.19	-0.01	-0.03	1.67
SWE	0.72	0.02	0.00	6.93	-0.03	0.00	-0.01	1.64
HUN	0.51	-0.27	-0.15	3.19	0.38	-0.05	0.40	1.61
PRT	2.22	0.23	0.09	0.16	-0.01	0.00	-0.02	1.57
BGR	-0.23	0.02	-0.08	0.13	-0.09	NA	-0.06	1.50
FIN	-0.22	-0.14	-0.09	0.68	0.10	-1.66	-0.02	1.48
LTU	-1.04	-0.25	-0.17	-0.24	-0.10	-0.04	-0.01	1.01
HRV	-1.73	-0.46	-0.26	2.22	0.78	-0.01	0.13	0.65
LVA	0.17	0.01	-0.04	0.12	0.04	0.04	0.04	0.64
SVK	-0.25	0.11	0.07	-1.58	-0.38	-0.21	0.01	0.58
SVN	-0.47	-0.09	-0.02	-0.17	-0.05	0.00	-0.03	0.39
EST	0.17	0.09	0.01	0.56	0.13	0.04	0.00	0.31
LUX	0.13	0.03	0.01	-0.02	0.00	0.03	NA	0.16
ISL	-0.11	0.00	-0.01	0.21	0.08	0.00	0.00	0.13
CYP	0.29	-0.06	0.03	0.05	0.01	NA	0.00	0.11
MLT	-0.03	0.00	0.00	0.00	0.00	NA	NA	0.01
TOTAL	**10**	**6**	**-1**	**81**	**16**	**-6**	**-1**	

5.3 Source categories and methodological issues

In this section, we present the information relevant for EU28+ISL key source categories in the sector 3 Agriculture.

Key source categories identified are:

- CH_4 emissions from source category 3.A.1 - Dairy cattle.
- CH_4 emissions from source category 3.A.1 - Non-dairy cattle.
- CH_4 emissions from source category 3.B.1.1 - Cattle
- CH_4 emissions from source category 3.A.2 - Sheep.

- CH_4 emissions from source category 3.A.4 - Other livestock.
- CH_4 emissions from source category 3.B.1 - Manure management.
- N_2O emissions from source category 3.B.2 - Manure management.
- N_2O emissions from source category 3.D.1 - Direct N_2O emissions from managed soils.
- 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 a Tier 2 or Tier 3 method. CH_4 emissions from enteric fermentation from cattle are calculated with very sophisticated methods, with only Cyprus using partially T1. For the 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)

Source category gas	kt CO_2 eq.		Trend	Level		Share of higher Tier
	1990	2017		1990	2017	
3.A.1 Enteric Fermentation: Dairy Cattle (CH_4)	104462	75806	0	L	L	1.00
3.A.1 Enteric Fermentation: Non-Dairy Cattle (CH_4)	102662	88418	T	L	L	1.00
3.A.2 Enteric Fermentation: Sheep (CH_4)	28631	20224	0	L	L	0.91
3.A.4 Enteric Fermentation: Other livestock (CH_4)	6154	6178	0	0	L	0.52
3.B.1 CH_4 Emissions: Manure management (CH_4)	52537	42120	0	L	L	0.95
3.B.2 N_2O Emissions: Manure management (N_2O)	29952	22278	0	L	L	0.61
3.D.1 Direct N_2O Emissions From Managed Soils (N_2O)	156403	134209	T	L	L	0.11
3.D.2 Indirect N_2O Emissions From Managed Soils (N_2O)	36989	30012	0	L	L	0.05

Other source categories are not identified as key source in the analysis at EU28+ISL level and are therefore not further discussed here. Emissions from source category 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 EU28+ISL emissions and to EU28+ISL emissions trend 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)

CH_4 emissions in source category *3.A - Enteric Fermentation* are 4% of total EU28+ISL GHG emissions and 38% of total EU28+ISL CH_4 emissions. They make 44.4% of total agricultural emissions and 81% 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 Member States, Figure 5.5 shows the distribution of CH_4 emissions from enteric fermentation by livestock category in all Member States and in the EU28+ISL. 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 EU28+ISL agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2017.

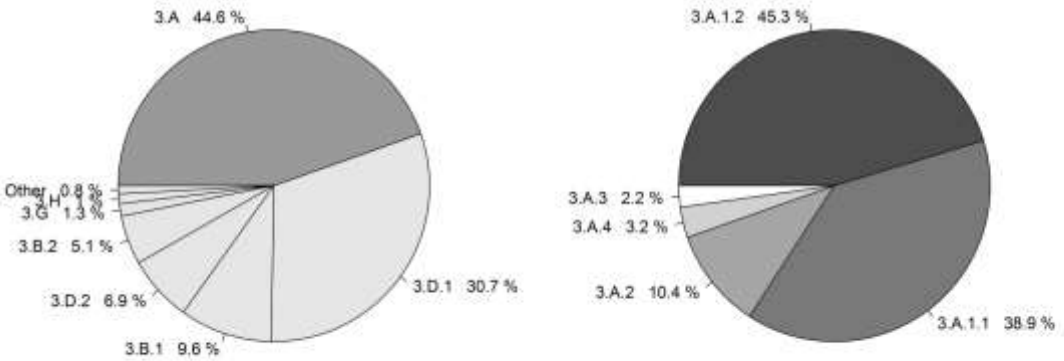
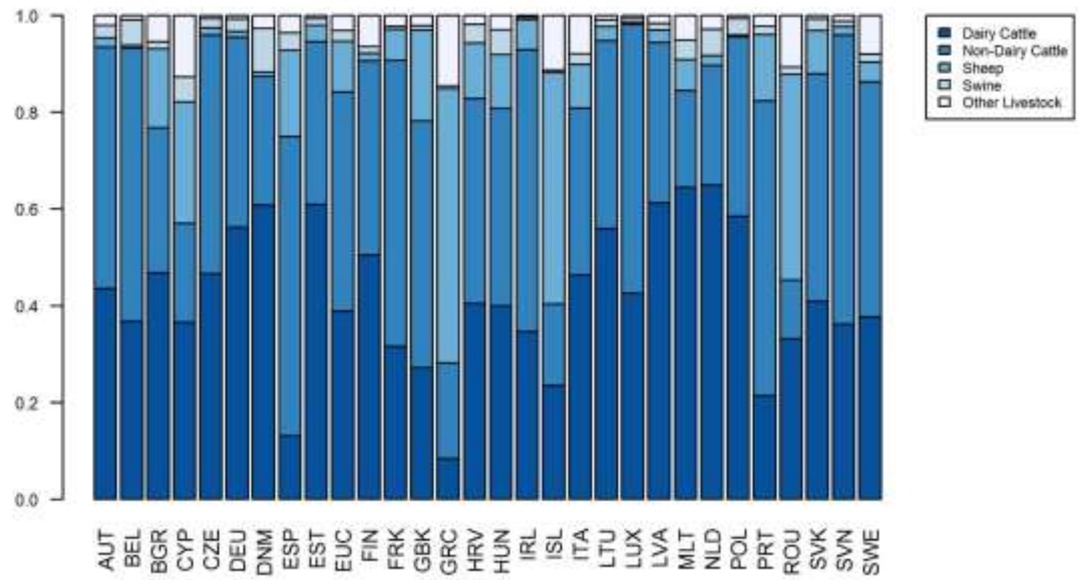


Figure 5.5: Decomposition of emissions in source category 3.A - Enteric Fermentation into its sub-categories by Member State in the year 2017.



Total GHG and CH_4 emissions by Member State from 3.A *Enteric Fermentation* are shown in Table 5.4 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2017). 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 2017, CH_4 emission in this source category decreased by 21% or 52.6 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (69%) and in Germany in absolute terms (9.8 Mt CO_2-eq). From 2016 to 2017 emissions in the current category increased by 0.2%.

Table 5.4 3.A - Enteric Fermentation: Member States' contributions to total EU-GHG and CH_4 emissions

Member States	GHG emissions in 1990 (kt CO_2-eq)	GHG emissions in 2016 (kt CO_2-eq)	GHG emissions in 2017 (kt CO_2-eq)	CH_4 emissions in 1990 (kt CO_2-eq)	CH_4 emissions in 2016 (kt CO_2-eq)	CH_4 emissions in 2017 (kt CO_2-eq)
Austria	4,821	4,147	4,156	4,821	4,147	4,156
Belgium	5,410	4,621	4,588	5,410	4,621	4,588
Bulgaria	4,805	1,522	1,512	4,805	1,522	1,512
Croatia	2,172	1,178	1,107	2,172	1,178	1,107
Cyprus	197	244	255	197	244	255
Czech Republic	5,601	2,888	2,939	5,601	2,888	2,939
Denmark	4,039	3,717	3,731	4,039	3,717	3,731
Estonia	1,230	532	539	1,230	532	539
Finland	2,423	2,105	2,095	2,423	2,105	2,095
France	38,630	35,137	34,728	38,630	35,137	34,728
Germany	35,353	25,772	25,536	35,353	25,772	25,536
Greece	4,024	3,643	3,629	4,024	3,643	3,629
Hungary	3,754	2,066	2,088	3,754	2,066	2,088
Ireland	11,357	11,212	11,542	11,357	11,212	11,542
Italy	15,497	14,039	14,232	15,497	14,039	14,232
Latvia	2,222	860	867	2,222	860	867
Lithuania	4,291	1,585	1,542	4,291	1,585	1,542
Luxembourg	388	402	407	388	402	407
Malta	36	33	32	36	33	32
Netherlands	9,231	8,812	8,662	9,231	8,812	8,662
Poland	21,554	12,277	12,794	21,554	12,277	12,794
Portugal	3,521	3,572	3,663	3,521	3,572	3,663
Romania	19,492	10,983	10,843	19,492	10,983	10,843
Slovakia	2,584	976	966	2,584	976	966
Slovenia	935	951	932	935	951	932
Spain	15,292	16,846	17,063	15,292	16,846	17,063
Sweden	3,278	2,991	3,021	3,278	2,991	3,021
United Kingdom	25,392	21,386	21,458	25,392	21,386	21,458
EU-28	**247,527**	**194,495**	**194,929**	**247,527**	**194,495**	**194,929**
Iceland	314	307	302	314	307	302
United Kingdom (KP)	25,392	21,386	21,458	25,392	21,386	21,458
EU-28 + ISL	**247,841**	**194,802**	**195,231**	**247,841**	**194,802**	**195,231**

Total GHG and CH_4 emissions by Member State from *3.A.1 - Cattle Enteric Fermentation* are shown in Table 5.5 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2017). Values are given in kt CO_2-eq. Between 1990 and 2017, CH_4 emission in this source category decreased by 21% or 42.9 Mt CO_2-eq. The decrease was largest in Lithuania in relative terms (65%) and in Germany in absolute terms (9.6 Mt CO_2-eq). From 2016 to 2017 emissions in the current category increased by 0.2%.

Table 5.5 3.A.1 - Cattle: Member States' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	4 579	3 886	3 885	2.4%	-695	-15%	-1	0%	T2	CS
Belgium	5 110	4 313	4 281	2.6%	-829	-16%	-32	-1%	T2	CS
Bulgaria	2 958	1 167	1 161	0.7%	-1 797	-61%	-6	-1%	T2	CS
Croatia	1 995	990	917	0.6%	-1 078	-54%	-73	-7%	T2	CS
Cyprus	101	138	146	0.1%	44	44%	7	5%	T1,T2	CS,D
Czechia	5 318	2 766	2 821	1.7%	-2 497	-47%	55	2%	T2	CS
Denmark	3 662	3 247	3 261	2.0%	-401	-11%	14	0%	T2	CS,D
Estonia	1 172	503	510	0.3%	-663	-57%	7	1%	T2	CS,D
Finland	2 226	1 907	1 899	1.2%	-327	-15%	-8	0%	T2	CS
France	34 130	31 857	31 482	19.2%	-2 648	-8%	-375	-1%	T2,T3	CS
Germany	33 941	24 624	24 380	14.8%	-9 561	-28%	-244	-1%	T2,T3	CS,D
Greece	1 184	1 034	1 022	0.6%	-163	-14%	-13	-1%	T2	CS,D
Hungary	2 962	1 651	1 686	1.0%	-1 276	-43%	35	2%	T2	CS
Ireland	10 101	10 429	10 720	6.5%	619	6%	291	3%	CS,T2	CS
Italy	13 164	11 346	11 510	7.0%	-1 655	-13%	164	1%	T2	CS
Latvia	2 118	813	818	0.5%	-1 300	-61%	6	1%	T2	CS
Lithuania	4 146	1 503	1 461	0.9%	-2 685	-65%	-42	-3%	T2	CS
Luxembourg	384	395	400	0.2%	16	4%	5	1%	T2	CS
Malta	28	28	27	0.0%	-1	-5%	-1	-4%	T2	CS
Netherlands	8 195	7 920	7 768	4.7%	-427	-5%	-152	-2%	T2,T3	CS
Poland	19 547	11 733	12 228	7.4%	-7 319	-37%	495	4%	T2	CS
Portugal	2 460	2 942	3 016	1.8%	556	23%	73	2%	T2	CS
Romania	11 213	5 066	4 916	3.0%	-6 297	-56%	-150	-3%	T2	CS
Slovakia	2 328	861	850	0.5%	-1 478	-64%	-11	-1%	T2	CS
Slovenia	904	912	894	0.5%	-10	-1%	-18	-2%	T2	CS
Spain	10 432	12 554	12 789	7.8%	2 357	23%	235	2%	CS,T2	CS
Sweden	2 885	2 586	2 608	1.6%	-277	-10%	22	1%	CS	CS
United Kingdom	19 881	16 806	16 771	10.2%	-3 110	-16%	-35	0%	T3	CS
EU-28	**207 125**	**163 976**	**164 224**	**100%**	**-42 901**	**-21%**	**247**	**0%**	**-**	**-**
Iceland	106	120	122	0.1%	16	15%	1	1%	T2	CS
United Kingdom (KP)	19 881	16 806	16 771	10.2%	-3 110	-16%	-35	0%	T3	CS
EU-28 + ISL	**207 231**	**164 097**	**164 345**	**100%**	**-42 885**	**-21%**	**249**	**0%**	**-**	**-**

Total GHG and CH_4 emissions by Member State from *3.A.2 - Sheep Enteric Fermentation* are shown in Table 5.6 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2017). Values are given in kt CO_2-eq. Between 1990 and 2017, CH_4 emission in this source category decreased by 29% or 8.4 Mt CO_2-eq. The decrease was largest in Poland in relative terms (94%) and in Romania in absolute terms (2 Mt CO_2-eq). From 2016 to 2017 emissions in the current category increased by 0.9%.

Table 5.6 3.A.2 - Sheep: Member States' contributions to total EU-GHG and CH_4 emissions

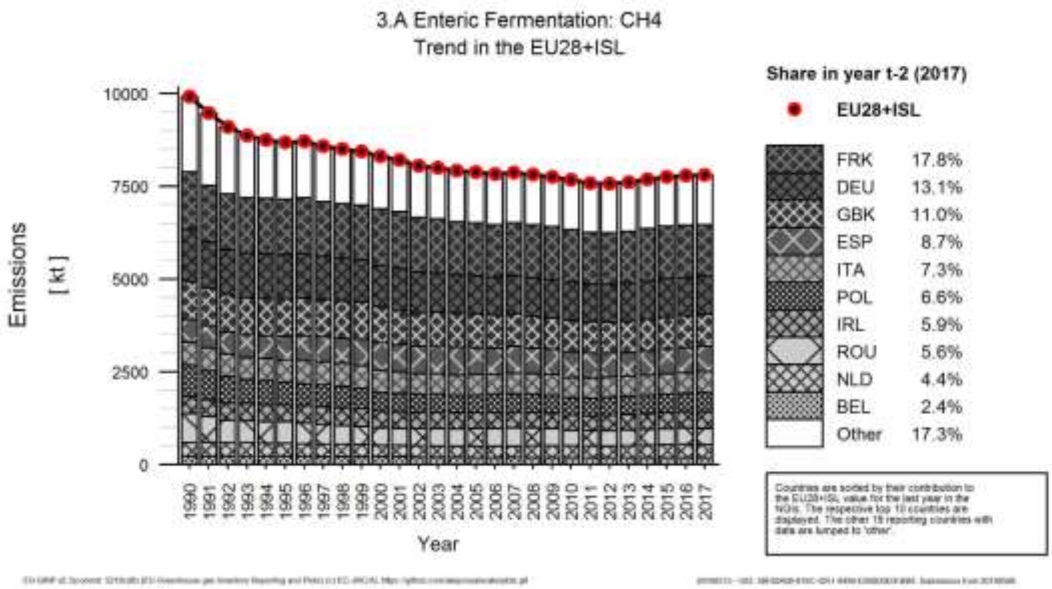
Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	62	76	80	0.4%	18	30%	5	6%	T1	D
Belgium	38	24	26	0.1%	-13	-33%	1	5%	T1	D
Bulgaria	1 454	248	247	1.2%	-1 207	-83%	-1	-1%	T2	CS
Croatia	94	124	127	0.6%	33	36%	4	3%	T2	CS
Cyprus	58	61	64	0.3%	6	11%	3	6%	-	-
Czech Republic	86	44	43	0.2%	-43	-49%	0	-1%	T1	D
Denmark	39	35	34	0.2%	-4	-11%	0	-1%	T2	D
Estonia	32	18	18	0.1%	-14	-43%	0	-1%	D,T1	D
Finland	18	33	33	0.2%	15	86%	0	0%	CS	CS
France	3 533	2 270	2 238	11.0%	-1 295	-37%	-32	-1%	T2,T3	CS
Germany	518	294	296	1.5%	-222	-43%	2	1%	T1	CS,D
Greece	2 054	2 054	2 055	10.1%	1	0%	1	0%	T2	CS,D
Hungary	392	238	232	1.1%	-160	-41%	-6	-2%	T1	D
Ireland	1 176	685	726	3.6%	-450	-38%	41	6%	T1	D
Italy	1 504	1 285	1 278	6.3%	-226	-15%	-7	-1%	T2	CS
Latvia	33	21	22	0.1%	-10	-32%	1	5%	T1	D
Lithuania	18	44	45	0.2%	27	147%	1	3%	T2	CS
Luxembourg	1	2	1	0.0%	0	29%	0	-4%	T2	CS
Malta	2	2	2	0.0%	0	-19%	0	2%	T2	CS
Netherlands	340	178	179	0.9%	-162	-48%	0	0%	T1	D
Poland	832	48	52	0.3%	-780	-94%	4	9%	T1	D
Portugal	794	483	504	2.5%	-291	-37%	21	4%	T2	CS
Romania	6 587	4 555	4 605	22.6%	-1 982	-30%	50	1%	T2	CS
Slovakia	154	86	86	0.4%	-68	-44%	0	0%	T2	CS
Slovenia	3	18	17	0.1%	14	483%	-1	-6%	T1	D
Spain	3 791	3 051	3 049	15.0%	-742	-20%	-2	0%	CS,T2	CS
Sweden	81	116	121	0.6%	40	49%	6	5%	T1	D
United Kingdom	4 936	3 936	4 043	19.8%	-893	-18%	107	3%	T3	CS
EU-28	**28 631**	**20 028**	**20 224**	**99%**	**-8 406**	**-29%**	**197**	**1%**	**-**	**-**
Iceland	173	150	145	0.7%	-29	-16%	-5	-4%	T2	CS
United Kingdom (KP)	4 936	3 936	4 043	19.8%	-893	-18%	107	3%	T3	CS
EU-28 + ISL	**28 804**	**20 178**	**20 369**	**100%**	**-8 435**	**-29%**	**191**	**1%**	**-**	**-**

5.3.1.1 Trends in Emissions and Activity Data

3.A - Enteric Fermentation - Emissions

Emissions in source category *3.A - Enteric Fermentation* decreased considerably in EU28+ISL by 21% or 52.6 Mt CO_2-eq in the period 1990 to 2017. Figure 5.6 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 82.7% of the total. Emissions decreased in 24 countries and increased in five countries. The three countries with the largest decreases were Germany, Poland and Romania with a total absolute decrease of 27.2 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 1.8 Mt CO_2-eq.

Figure 5.6: *3.A: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017*



3.A.1 - Cattle - Emissions

Emissions in source category *3.A.1 - Cattle* decreased considerably in EU28+ISL by 21% or 42.9 Mt CO_2-eq in the period 1990 to 2017. The ten countries with the highest emissions accounted together for 83.3% of the total. Emissions decreased in 23 countries and increased in six countries. The three countries with the largest decreases were Germany, Poland and Romania with a total absolute decrease of 23.2 Mt CO_2-eq. The three countries with the largest increases were Portugal, Ireland and Spain, with a total absolute increase of 3.5 Mt CO_2-eq.

Emissions in source category *3.A.1 - Dairy Cattle* decreased strongly in EU28+ISL by 27% or 28.7 Mt CO_2-eq in the period 1990 to 2017. Figure 5.7 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different Member States along the inventory period. Each bar shows the emissions in kt accumulated by the different Member States in a specific year. Every Member State is represented by a different pattern. Only the first ten Member States with the highest emission shares are shown separately, while the emissions corresponding to the remaining countries are represented under ‘other’ label. In red points, we see the total emissions of the category for the EU28+ISL. The legend on the right shows the Member States corresponding to each pattern and the share of their emissions over the EU-28 total. The ten countries with the highest emissions accounted together for 82.9% of the total. Emissions decreased in 23 countries and increased in six countries. The three countries with the largest decreases were Poland, Germany and Romania with a total absolute decrease of 14.4 Mt CO_2-eq. The largest increases occurred in the Netherlands and Ireland, with a total absolute increase of 1 Mt CO_2-eq.

Emissions in source category *3.A.1 - Non-Dairy Cattle* decreased clearly in EU28+ISL by 14% or 14.2 Mt CO_2-eq in the period 1990 to 2017. Figure 5.8 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 85.2% of the total. Emissions decreased in twenty countries and increased in nine countries. The three countries with the largest decreases were Germany, Romania and the United Kingdom with a total absolute decrease of 9.2 Mt CO_2-eq. The largest increases occurred in Portugal and Spain, with a total absolute increase of 4.6 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 EU28+ISL by 26% or 31.5 million heads in the period 1990 to 2017. The ten countries with the highest population accounted together for 84.3% of the total. Population decreased in 25 countries and increased in four countries. The largest decreases occurred in Germany and Poland with a total absolute decrease of 11.1 million heads. The three countries with the largest increases were Portugal, Ireland and Spain, with a total absolute increase of 2.1 million heads.

Figure 5.7: 3.A.1 Dairy Cattle: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017

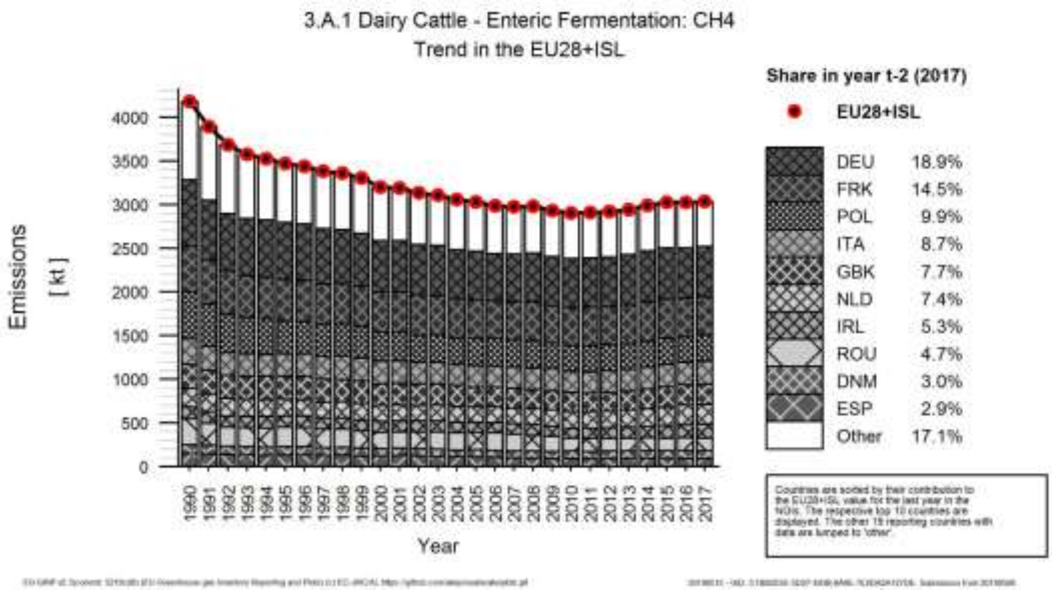


Figure 5.8: 3.A.1 Non-Dairy Cattle: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017

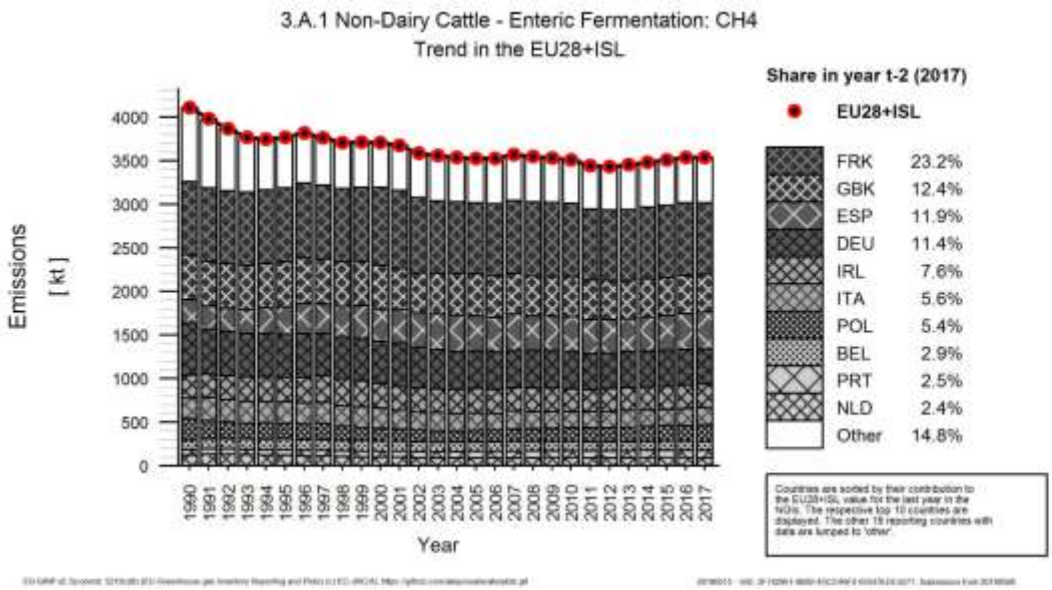


Figure 5.9: 3.A.1 Dairy Cattle: Trend in cattle population in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017

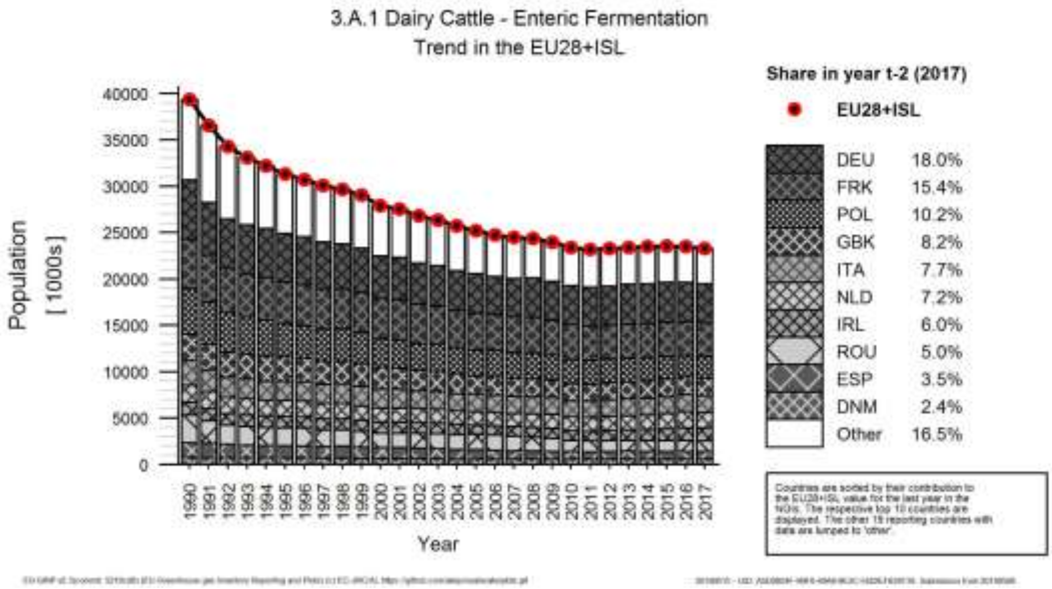
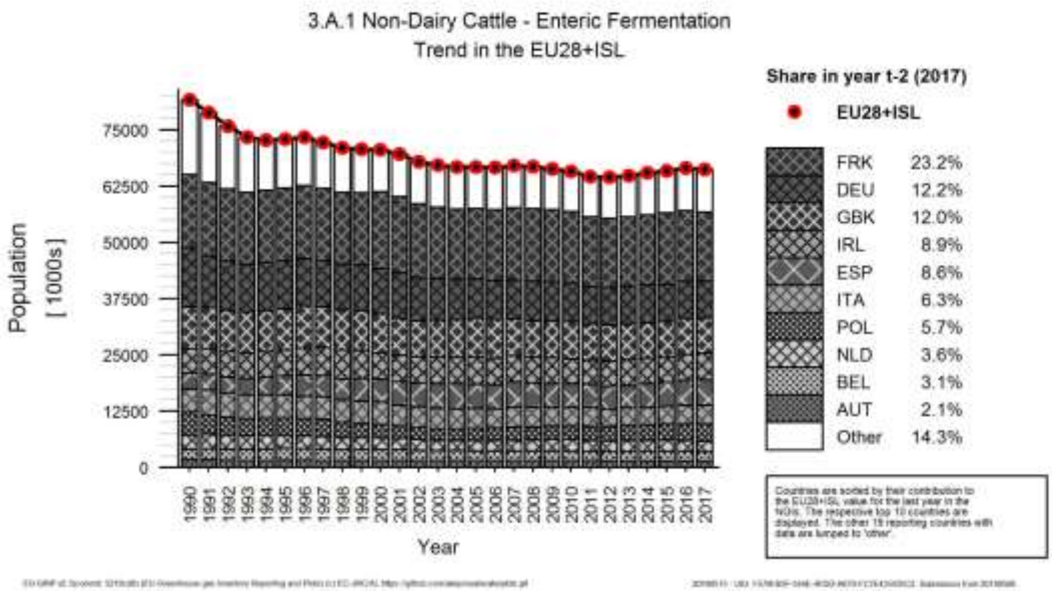


Figure 5.10: 3.A.1 Non-Dairy Cattle: Trend in cattle population in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



3.A.2 - Sheep - Emissions

Emissions in source category *3.A.2 - Sheep* decreased strongly in EU28+ISL by 29% or 8.4 Mt CO_2-eq in the period 1990 to 2017. Figure 5.11 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 93.5% of the total. Emissions decreased in twenty countries and increased in nine countries. The four countries with the largest decreases were Romania, France, Bulgaria and the United Kingdom with a total absolute decrease of 5.4 Mt CO_2-eq. The four countries with the largest increases were Austria, Lithuania, Croatia and Sweden, with a total absolute increase of 119 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 EU28+ISL by 31% or 46.2 million heads in the period 1990 to 2017. Figure 5.12 shows the trend of sheep population indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 population for the different Member States along the inventory period. The ten countries with the highest population accounted together for 93.5% of the total. 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 24.9 million heads. The four countries with the largest increases were Slovenia, Austria, Lithuania and Sweden, with a total absolute increase of 467 thousand heads.

Figure 5.11: 3.A.2: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017

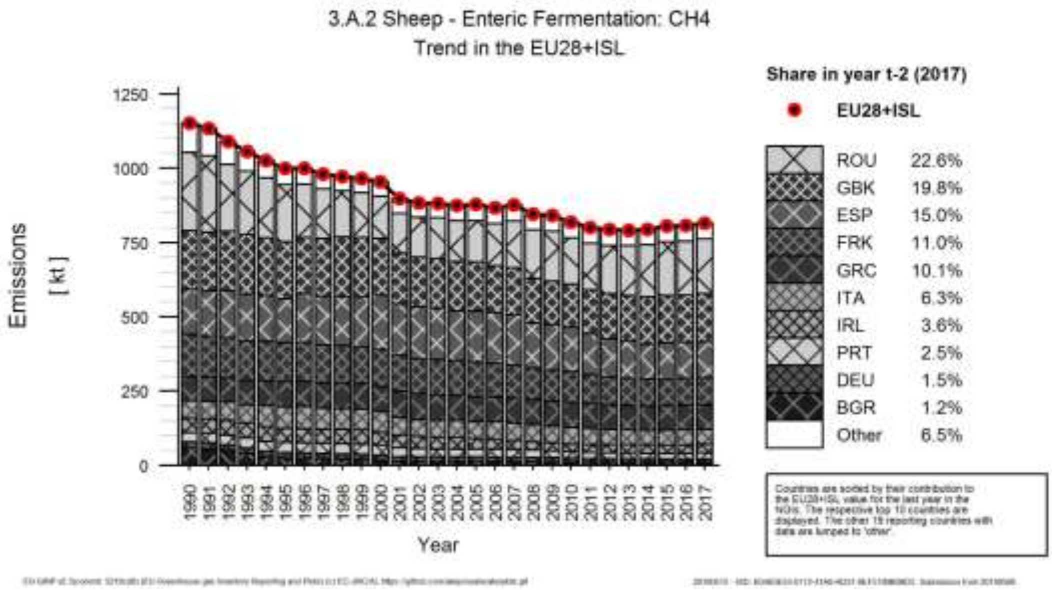
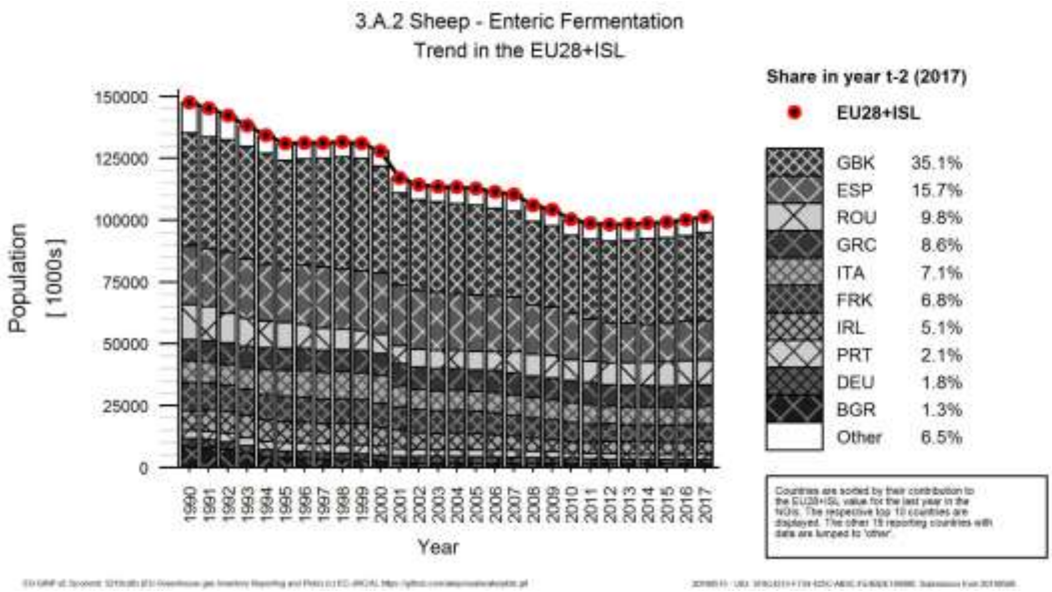


Figure 5.12: 3.A.2: Trend in sheep population in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



5.3.1.2 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 EU28+ISL 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 EU28+ISL moderately between 1990 and 2017 by 7% or 4.83 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 2017 for all Member States and EU28+ISL. The implied emission factor decreased in three countries and increased in 24 countries. Decreases occurred in Croatia, Spain and Ireland with a mean absolute value of 6 kg/head/year. The four countries with the largest increases were Malta, Latvia, Estonia and the Czech Republic with a mean absolute value of 20 kg/head/year.

Table 5.7 3.A.1 - Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2017	Member State	1990	2017
Austria	71	80	Ireland	59	59
Belgium	63	68	Iceland	57	68
Bulgaria	74	85	Italy	68	77
Cyprus	74	87	Lithuania	70	83
Czech Republic	61	79	Luxembourg	71	79
Germany	70	79	Latvia	59	81
Denmark	65	84	Malta	54	75
Spain	81	78	Netherlands	67	77
Estonia	62	81	Poland	82	83
Finland	65	85	Portugal	72	74
France	63	67	Romania	84	99
United Kingdom	66	68	Slovakia	60	77
United Kingdom (KP)	66	68	Slovenia	68	75
Greece	68	74	Sweden	67	69
Croatia	94	78	**EU28+ISL**	**69**	**74**

Hungary	73	78	

3.A.1 - Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1 - Dairy Cattle* increased in EU28+ISL considerably between 1990 and 2017 by 22.5% or 23.9 kg/head/year. Figure 5.13 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.8 shows the implied emission factor for CH_4 emissions in source category *3.A.1 - Dairy Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. The implied emission factor decreased in one country and increased in 28 countries. A decrease occurred in Croatia with an absolute value of 1 kg/head/year. The four countries with the largest increases were Malta, the Czech Republic, Slovakia and Estonia with a mean absolute value of 50 kg/head/year.

Figure 5.13: 3.A.1 - Dairy Cattle: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

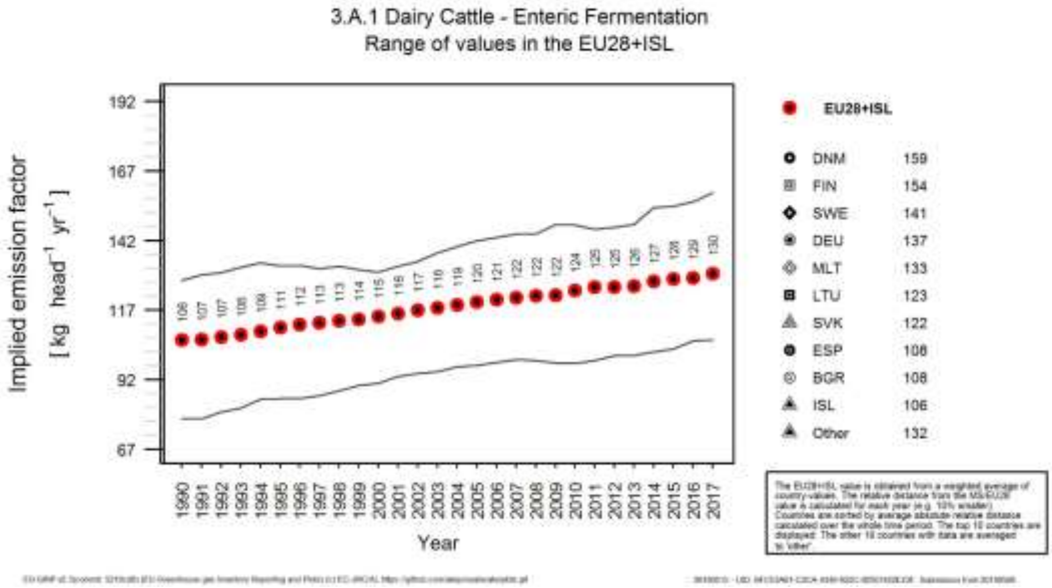


Table 5.8 3.A.1 - Dairy Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2017		Member State	1990	2017
Austria	105	133		Ireland	101	115
Belgium	112	147		Iceland	85	106
Bulgaria	105	108		Italy	111	147
Cyprus	99	124		Lithuania	100	123
Czech Republic	97	148		Luxembourg	112	145
Germany	120	137		Latvia	103	141
Denmark	128	159		Malta	78	133
Spain	95	108		Netherlands	110	135
Estonia	101	152		Poland	108	126
Finland	112	154		Portugal	97	130
France	99	122		Romania	100	124
United Kingdom	98	123		Slovakia	80	122

Member State	1990	2017	Member State	1990	2017
United Kingdom (KP)	98	123	Slovenia	92	124
Greece	93	125	Sweden	112	141
Croatia	113	112	**EU28+ISL**	**106**	**130**
Hungary	111	136			

3.A.1 - Dairy Cattle - Gross energy

The gross energy, a parameter used for calculating CH_4 emissions in source category *3.A.1 - Dairy Cattle*, increased in EU28+ISL strongly between 1990 and 2017 by 27.8% or 68.2 MJ/day. Figure 5.14 shows the trend of the gross energy in EU28+ISL indicating also the range of values used by the countries. Table 5.9 shows the gross energy in source category *3.A.1 - Dairy Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. The reported gross energy increased in all reporting 25 countries. The four countries with the largest increases were Malta, Slovakia, Estonia and Spain with a mean absolute value of 110 MJ/day.

Figure 5.14: 3.A.1 - Dairy Cattle: Trend in gross energy in the EU28+ISL and range of values reported by countries

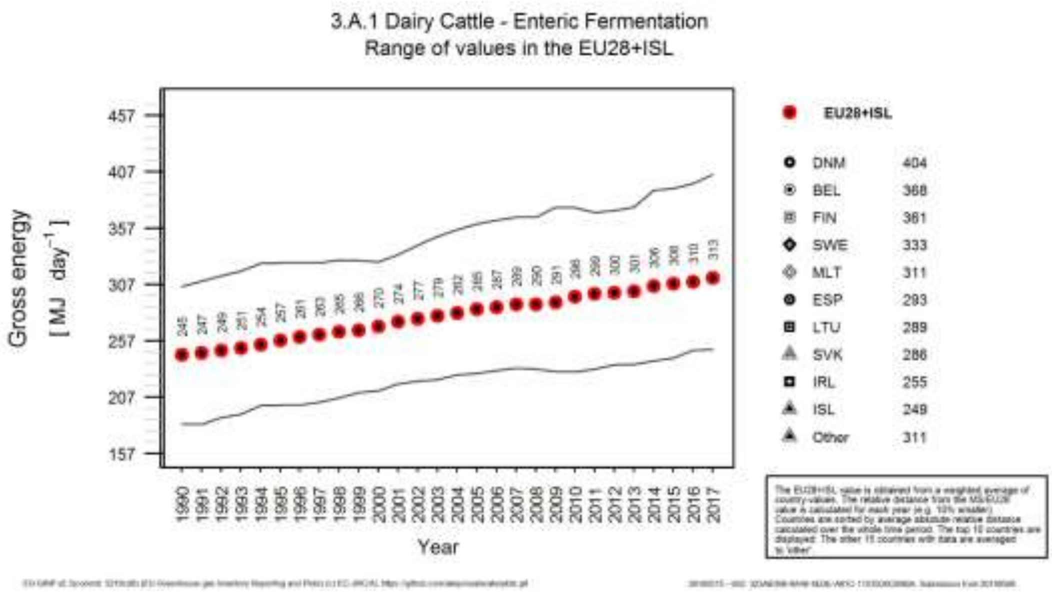


Table 5.9 3.A.1 - Dairy Cattle: Member States' and EU28+ISL gross energy (MJ/day)

Member State	1990	2017	Member State	1990	2017
Austria	247	313	Iceland	200	249
Belgium	279	368	Italy	261	345
Cyprus	232	291	Lithuania	234	289
Germany	259	331	Luxembourg	263	340
Denmark	305	404	Latvia	242	331
Spain	201	293	Malta	183	311
Estonia	237	356	Poland	254	296
Finland	264	361	Portugal	227	306
United Kingdom	212	289	Romania	233	291
United Kingdom (KP)	212	289	Slovakia	187	286

Member State	1990	2017		Member State	1990	2017
Greece	217	294	|	Slovenia	215	290
Croatia	256	275	|	Sweden	271	333
Hungary	255	314	|	**EU28+ISL**	**245**	**313**
Ireland	222	255	|			

3.A.1 - Dairy Cattle - Milk yield

The milk yield, a parameter used for calculating CH_4 emissions in source category *3.A.1 - Dairy Cattle*, increased in EU28+ISL very strongly between 1990 and 2017 by 73.5% or 8.23 kg/head/day. Figure 5.15 shows the trend of the milk yield in EU28+ISL indicating also the range of values used by the countries. Table 5.10 shows the milk yield in source category *3.A.1 - Dairy Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. The reported milk yield increased in all reporting 27 countries. The four countries with the largest increases were Slovakia, Romania, Spain and Greece with a mean absolute value of 10 kg/head/day.

Figure 5.15: 3.A.1 - Dairy Cattle: Trend in milk yield in the EU28+ISL and range of values reported by countries

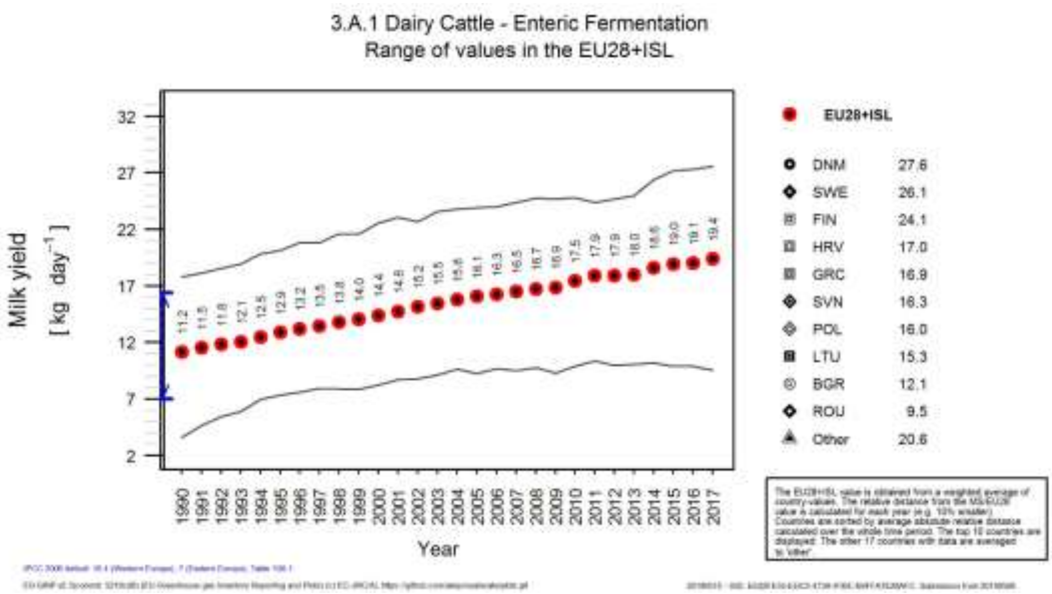


Table 5.10 3.A.1 - Dairy Cattle: Member States' and EU28+ISL milk yield (kg/head/day) [37] [38]

Member State	1990	2017		Member State	1990	2017
Austria	10.4	18.8	|	Hungary	13.8	22.0
Belgium	11.2	22.6	|	Ireland	11.5	15.5
Bulgaria	11.1	12.1	|	Iceland	11.3	16.9
Cyprus	12.2	19.7	|	Italy	11.5	20.7
Czech Republic	10.7	22.5	|	Lithuania	10.2	15.3

[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.

Germany	12.9	21.3	|	Latvia	11.3	21.4
Denmark	17.7	27.6	|	Malta	10.0	18.3
Spain	9.7	23.3	|	Poland	8.9	16.0
Estonia	11.4	25.1	|	Portugal	12.2	22.0
Finland	15.7	24.1	|	Romania	3.6	9.5
France	13.1	19.1	|	Slovakia	7.0	19.6
United Kingdom	14.1	21.6	|	Slovenia	7.6	16.3
United Kingdom (KP)	14.1	21.6	|	Sweden	17.8	26.1
Greece	7.6	16.9	|	**EU28+ISL**	**11.2**	**19.4**
Croatia	7.8	17.0	|			

3.A.1 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1 - Non-Dairy Cattle* increased in EU28+ISL moderately between 1990 and 2017 by 5.8% or 2.94 kg/head/year. Figure 5.16 shows the trend of the implied emission factor in EU28+ISL 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 - Non-Dairy Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. The implied emission factor decreased in eight countries and increased in nineteen countries. The three countries with the largest decreases were Croatia, Malta and the Netherlands with a mean absolute value of 5 kg/head/year. The three countries with the largest increases were Finland, Latvia and the Czech Republic with a mean absolute value of 14 kg/head/year.

Figure 5.16: 3.A.1 - Non-Dairy Cattle: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

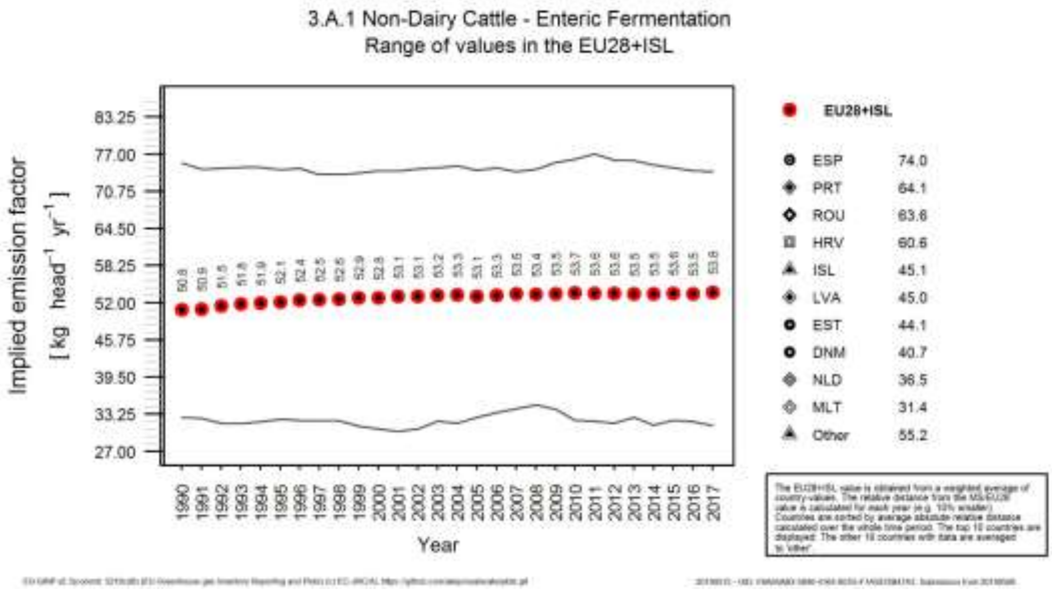


Table 5.11 3.A.1 - Non-Dairy Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2017		Member State	1990	2017
Austria	52	59	|	Ireland	49	46
Belgium	46	50	|	Iceland	35	45
Bulgaria	55	63	|	Italy	46	47

Cyprus	57	57	Lithuania	53	56
Czech Republic	42	55	Luxembourg	55	59
Germany	45	50	Latvia	33	45
Denmark	34	41	Malta	34	31
Spain	75	74	Netherlands	40	36
Estonia	39	44	Poland	57	56
Finland	39	54	Portugal	62	64
France	52	53	Romania	65	64
United Kingdom	56	55	Slovakia	53	59
United Kingdom (KP)	56	55	Slovenia	50	60
Greece	57	63	Sweden	44	50
Croatia	69	61	**EU28+ISL**	**51**	**54**
Hungary	53	55			

3.A.1 - 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 - Non-Dairy Cattle*, increased in EU28+ISL slightly between 1990 and 2017 by 3.4% or 4.22 MJ/head/day. Figure 5.17 shows the trend of the average gross energy intake in EU28+ISL 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 - Non-Dairy Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. Average gross energy intake decreased in seven countries and increased in eighteen countries. It was in 2017 at the level of 1990 in one country. No data were available for Cyprus. The largest decrease occurred in the Netherlands with an absolute value of 26 MJ/head/day. The largest increases occurred in Finland and Latvia with a mean absolute value of 31 MJ/head/day.

Figure 5.17: 3.A.1 - Non-Dairy Cattle: Trend in average gross energy intake in the EU28+ISL and range of values reported by countries

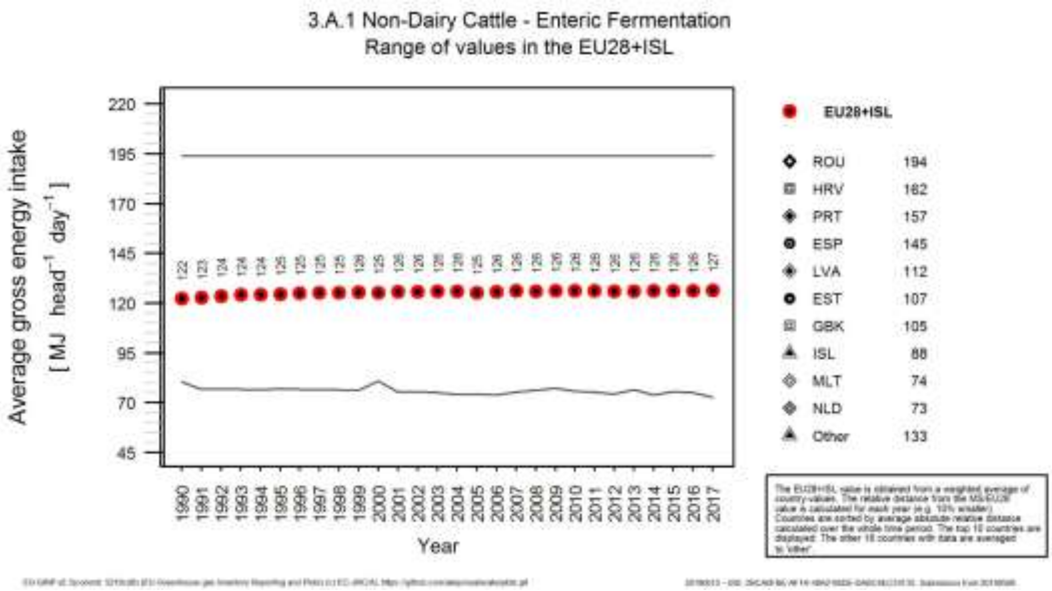


Table 5.12 3.A.1 - Non-Dairy Cattle: Member States' and EU28+ISL average gross energy intake (MJ/head/day)

Member State	1990	2017		Member State	1990	2017
Austria	123	139	|	Ireland	132	126
Belgium	119	131	|	Iceland	82	88
Bulgaria	129	148	|	Italy	141	142
Czech Republic	116	142	|	Lithuania	125	130
Germany	108	119	|	Luxembourg	102	111
Denmark	107	130	|	Latvia	86	112
Spain	148	145	|	Malta	80	74
Estonia	97	107	|	Netherlands	98	73
Finland	92	128	|	Poland	133	131
France	122	126	|	Portugal	151	157
United Kingdom	106	105	|	Romania	194	194
United Kingdom (KP)	106	105	|	Slovakia	125	140
Greece	135	147	|	Slovenia	111	134
Croatia	163	162	|	Sweden	129	139
Hungary	134	138	|	**EU28+ISL**	**122**	**127**

3.A.2 - Sheep - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.2 - Sheep* increased in EU28+ISL slightly between 1990 and 2017 by 2.9% or 0.226 kg/head/year. Figure 5.18 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.13 shows the implied emission factor for CH_4 emissions in source category *3.A.2 - Sheep* for the years 1990 and 2017 for all Member States and EU28+ISL. The implied emission factor decreased in seven countries and increased in thirteen countries. It was in 2017 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 largest increase occurred in Croatia with an absolute value of 3 kg/head/year.

Figure 5.18: 3.A.2 - Sheep: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

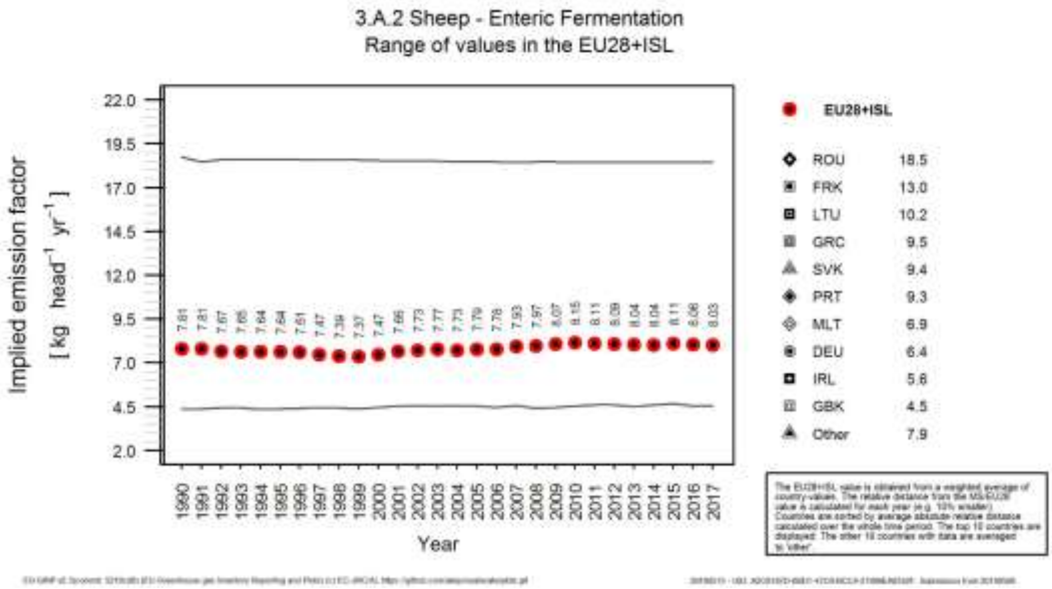


Table 5.13 3.A.2 - Sheep: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2017		Member State	1990	2017
Austria	8.0	8.0	|	Ireland	5.9	5.6
Belgium	8.0	8.0	|	Iceland	8.1	8.1
Bulgaria	6.9	7.4	|	Italy	6.9	7.1
Cyprus	8.0	8.0	|	Lithuania	10.2	10.2
Czech Republic	8.0	8.0	|	Luxembourg	7.7	8.2
Germany	6.3	6.4	|	Latvia	8.0	8.0
Denmark	6.7	6.7	|	Malta	6.2	6.9
Spain	6.3	7.6	|	Netherlands	8.0	8.0
Estonia	8.0	8.0	|	Poland	8.0	8.0
Finland	6.8	8.4	|	Portugal	9.7	9.3
France	12.4	13.0	|	Romania	18.7	18.5
United Kingdom	4.4	4.5	|	Slovakia	10.3	9.4
United Kingdom (KP)	4.4	4.5	|	Slovenia	8.0	8.0
Greece	9.5	9.5	|	Sweden	8.0	8.0
Croatia	5.0	8.0	|	**EU28+ISL**	**7.8**	**8.0**
Hungary	8.0	8.0	|			

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 EU28+ISL slightly between 1990 and 2017 by 4.8% or 0.954 MJ/head/day. Figure 5.19 shows the trend of the average gross energy intake in EU28+ISL indicating also the range of values used by the countries. Table 5.14 shows the average gross energy intake in source category *3.A.2 - Sheep* for the years 1990 and 2017 for all Member States and EU28+ISL. Average gross energy intake decreased in six countries and increased in six countries. It was in 2017 at the level of 1990 in four countries. No data were available for thirteen countries (Austria, Belgium, Cyprus, the Czech Republic, Estonia, Finland, France, Croatia, Hungary, Latvia, the Netherlands, Poland and Slovenia). The three countries with the largest decreases were Slovakia, Portugal and Greece with a mean absolute value of 1 MJ/head/day. The three countries with the largest increases were Spain, the United Kingdom and Bulgaria 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 EU28+ISL and range of values reported by countries

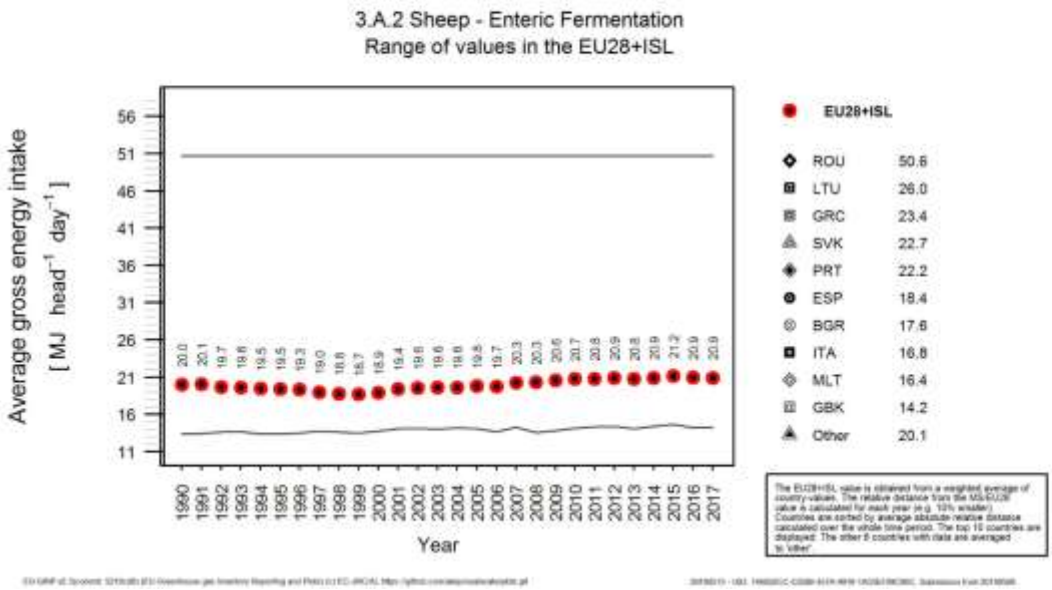


*Table 5.14 3.A.2 - Sheep: Member States' and EU28+ISL average gross energy intake (MJ/head/day) **

Member State	1990	2017	Member State	1990	2017
Bulgaria	17	18	Italy	16	17
Germany	20	20	Lithuania	26	26
Denmark	20	20	Luxembourg	19	20
Spain	15	18	Malta	16	16
United Kingdom	13	14	Portugal	23	22
United Kingdom (KP)	13	14	Romania	51	51
Greece	23	23	Slovakia	25	23
Ireland	20	20	Sweden	20	20
Iceland	20	20	**EU28+ISL**	**20**	**21**

not reported by 13 MS

5.3.2 Manure Management - CH_4 (CRF Source Category 3B1)

CH_4 emissions in source category *3.B.1 - Manure Management* are 0.87% of total EU28+ISL GHG emissions and 8.3% of total EU28+ISL CH_4 emissions. They make 9.6% of total agricultural emissions and 17% 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 Member States, Figure 5.21 shows the distribution of CH_4 emissions from manure management by livestock category in all Member States and in the EU28+ISL. Each bar represents the total emissions of a country in the current emission category, where different shades of grey correspond to the emitting animal types.

Figure 5.20: Share of source category 3.B.1 on total EU28+ISL agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2017.

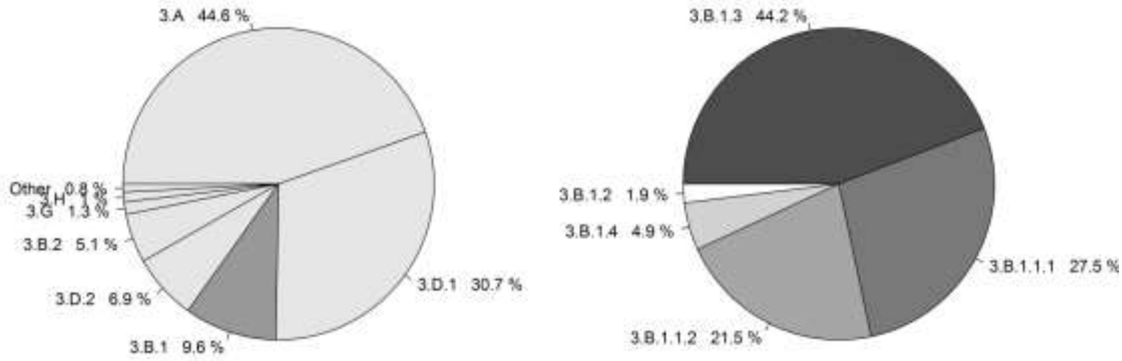
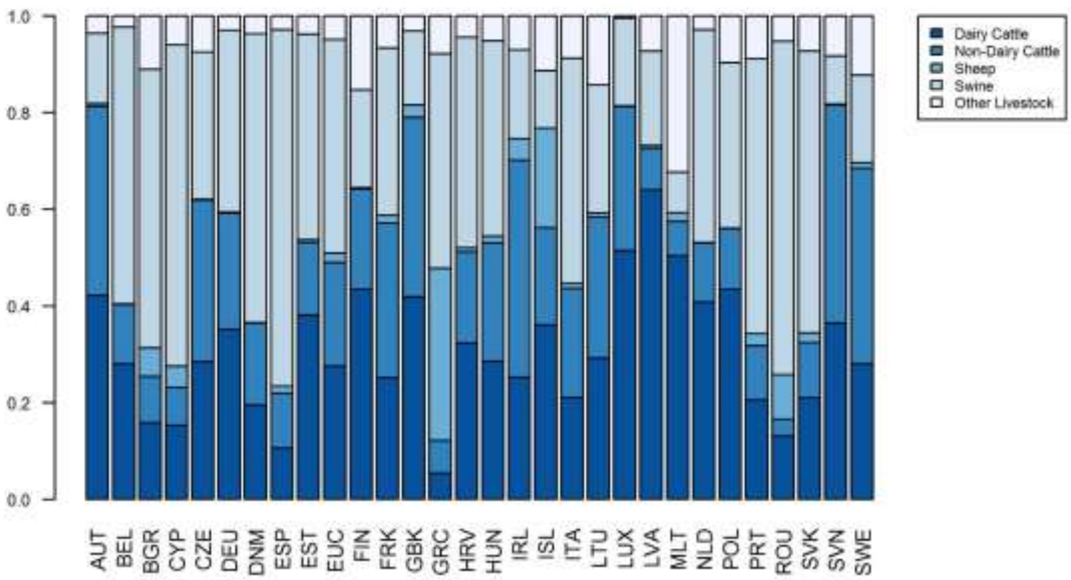


Figure 5.21: Decomposition of emissions in source category 3.B.1 - Manure Management into its sub-categories by Member State in the year 2017.



Total GHG and CH_4 emissions by Member State from 3.B.1 *Manure Management* are shown in Table 5.15 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2017). Values are given in kt CO_2-eq. Between 1990 and 2017, CH_4 emission in this source category decreased by 20% or 10.4 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (83%) and in Romania in absolute terms (3.1 Mt CO_2-eq). From 2016 to 2017 emissions in the current category increased by 0.6%.

Table 5.15 3.B.1 - Manure Management: Member States' contributions to total EU-GHG and CH_4 emissions

Member States	GHG emissions in 1990 (kt CO_2-eq)	GHG emissions in 2016 (kt CO_2-eq)	GHG emissions in 2017 (kt CO_2-eq)	CH_4 emissions in 1990 (kt CO_2-eq)	CH_4 emissions in 2016 (kt CO_2-eq)	CH_4 emissions in 2017 (kt CO_2-eq)

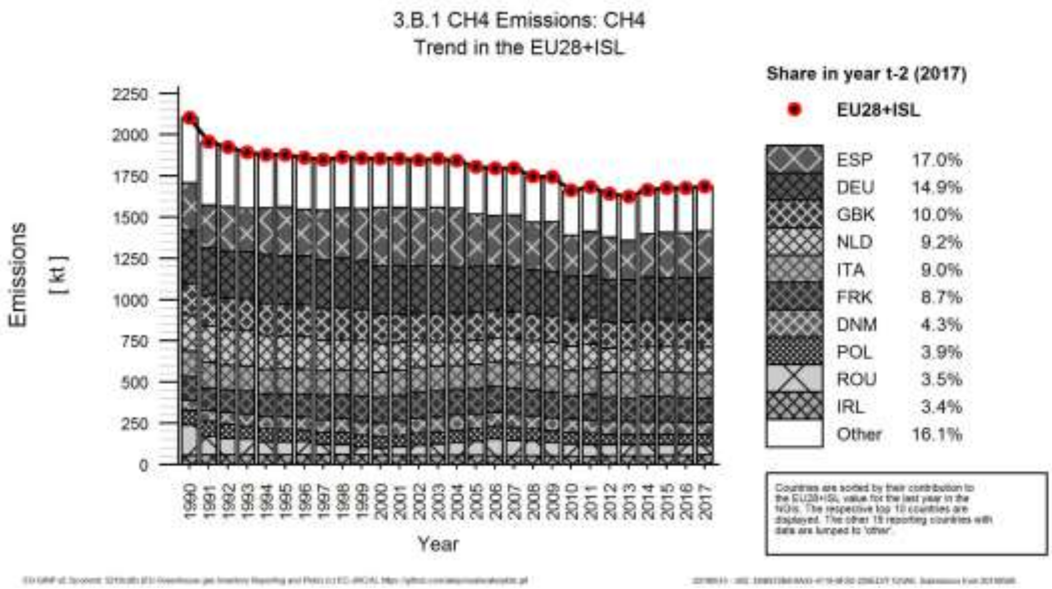
Austria	544	538	551	544	538	551
Belgium	1,299	1,255	1,250	1,299	1,255	1,250
Bulgaria	715	120	120	715	120	120
Croatia	416	443	424	416	443	424
Cyprus	69	53	51	69	53	51
Czech Republic	1,696	741	734	1,696	741	734
Denmark	1,544	1,845	1,812	1,544	1,845	1,812
Estonia	149	73	77	149	73	77
Finland	370	461	455	370	461	455
France	3,463	3,667	3,686	3,463	3,667	3,686
Germany	8,100	6,309	6,291	8,100	6,309	6,291
Greece	774	629	626	774	629	626
Hungary	1,161	656	645	1,161	656	645
Ireland	1,406	1,397	1,425	1,406	1,397	1,425
Italy	3,933	3,799	3,802	3,933	3,799	3,802
Latvia	190	101	102	190	101	102
Lithuania	666	245	235	666	245	235
Luxembourg	46	60	62	46	60	62
Malta	5	5	5	5	5	5
Netherlands	5,442	3,854	3,876	5,442	3,854	3,876
Poland	2,278	1,604	1,643	2,278	1,604	1,643
Portugal	814	733	742	814	733	742
Romania	4,561	1,580	1,492	4,561	1,580	1,492
Slovakia	388	116	120	388	116	120
Slovenia	342	258	255	342	258	255
Spain	7,188	6,876	7,152	7,188	6,876	7,152
Sweden	245	262	262	245	262	262
United Kingdom	4,733	4,200	4,227	4,733	4,200	4,227
EU-28	**52,537**	**41,882**	**42,120**	**52,537**	**41,882**	**42,120**
Iceland	53	55	55	53	55	55
United Kingdom (KP)	4,733	4,200	4,227	4,733	4,200	4,227
EU-28 + ISL	**52,590**	**41,936**	**42,175**	**52,590**	**41,936**	**42,175**

5.3.2.1 Trends in Emissions and Activity Data

3.B.1 - Manure Management - Emissions

Emissions in source category *3.B.1 - Manure Management* decreased considerably in EU28+ISL by 20% or 10.4 Mt CO_2-eq in the period 1990 to 2017. Figure 5.22 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 emissions from manure management for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 83.9% of the total. Emissions decreased in twenty countries and increased in nine countries. The three countries with the largest decreases were Romania, Germany and the Netherlands with a total absolute decrease of 6.4 Mt CO_2-eq. The three countries with the largest increases were Finland, France and Denmark, with a total absolute increase of 577 kt CO_2-eq.

Figure 5.22: 3.B.1: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



3.B.1.1 - Cattle - Emissions

CH_4 emissions in source category *3.B.1.1 - Cattle* are 0.43% of total EU28+ISL GHG emissions and 4% of total EU28+ISL CH_4 emissions. They make 4.7% of total agricultural emissions and 8.5% 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 EU28+ISL.

Total GHG and CH_4 emissions by Member State from 3.B.1.1 *Manure Management* are shown in Table 5.16 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2017). Values are given in kt CO_2-eq. Between 1990 and 2017, CH_4 emission in this source category decreased by 13% or 3 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (65%) and in Germany in absolute terms (1.5 Mt CO_2-eq). From 2016 to 2017 emissions in the current category increased by 0.1%. The ten countries with the highest emissions accounted together for 84.9% of the total. Emissions decreased in fifteen countries and increased in fourteen countries. The three countries with the largest decreases were Germany, the Czech Republic and Romania with a total absolute decrease of 2.4 Mt CO_2-eq. The largest increases occurred in Denmark and the Netherlands, with a total absolute increase of 527 kt CO_2-eq.

Table 5.16 3.B.1.1 - Cattle: Member States' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	400	436	448	2.2%	48	12%	12	3%	T2	CS
Belgium	489	500	504	2.4%	15	3%	4	1%	T2	CS
Bulgaria	87	31	31	0.1%	-57	-65%	-1	-2%	T2	CS
Croatia	209	223	217	1.1%	7	4%	-6	-3%	T2	CS
Cyprus	10	11	12	0.1%	2	23%	0	4%	T2	D
Czech Republic	872	447	454	2.2%	-418	-48%	7	2%	T1,T2	CS
Denmark	579	670	661	3.2%	81	14%	-10	-1%	CS,T2	CS,D
Estonia	43	41	41	0.2%	-2	-5%	1	1%	T2	CS,D
Finland	234	290	292	1.4%	58	25%	2	1%	T2	CS
France	2 104	2 088	2 109	10.2%	4	0%	20	1%	T2	CS
Germany	5 264	3 777	3 724	18.0%	-1 540	-29%	-53	-1%	T2	CS
Greece	95	78	76	0.4%	-19	-20%	-2	-3%	T2	CS,D
Hungary	566	336	342	1.7%	-224	-40%	7	2%	T2	CS
Ireland	1 039	981	999	4.8%	-40	-4%	18	2%	T2	CS
Italy	1 947	1 662	1 659	8.0%	-288	-15%	-3	0%	T2	CS
Latvia	111	72	74	0.4%	-37	-33%	2	2%	T2	CS
Lithuania	252	138	137	0.7%	-114	-45%	-1	-1%	T2	CS
Luxembourg	37	49	50	0.2%	13	35%	1	2%	T2	CS
Malta	2	3	3	0.0%	1	26%	0	-4%	T2	CS,D
Netherlands	1 608	2 117	2 054	9.9%	446	28%	-62	-3%	T2	CS
Poland	1 149	911	920	4.5%	-230	-20%	8	1%	T2	CS
Portugal	199	231	236	1.1%	37	19%	4	2%	T2	CS
Romania	651	255	247	1.2%	-404	-62%	-8	-3%	T2	CS
Slovakia	99	40	39	0.2%	-60	-61%	-1	-3%	T2	CS
Slovenia	176	211	208	1.0%	32	18%	-3	-2%	T2	CS
Spain	1 799	1 491	1 565	7.6%	-234	-13%	74	5%	T2	CS,D
Sweden	156	179	180	0.9%	24	15%	1	0%	T2	CS
United Kingdom	3 397	3 333	3 338	16.2%	-59	-2%	5	0%	T3	CS,D
EU-28	**23 574**	**20 603**	**20 617**	**100%**	**-2 957**	**-13%**	**15**	**0%**	**-**	**-**
Iceland	28	30	31	0.1%	2	8%	0	1%	-	-
United Kingdom (KP)	3 397	3 333	3 338	16.2%	-59	-2%	5	0%	T3	CS,D
EU-28 + ISL	**23 602**	**20 633**	**20 648**	**100%**	**-2 954**	**-13%**	**15**	**0%**	**-**	**-**

Figure 5.23: 3.B.1.1: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017

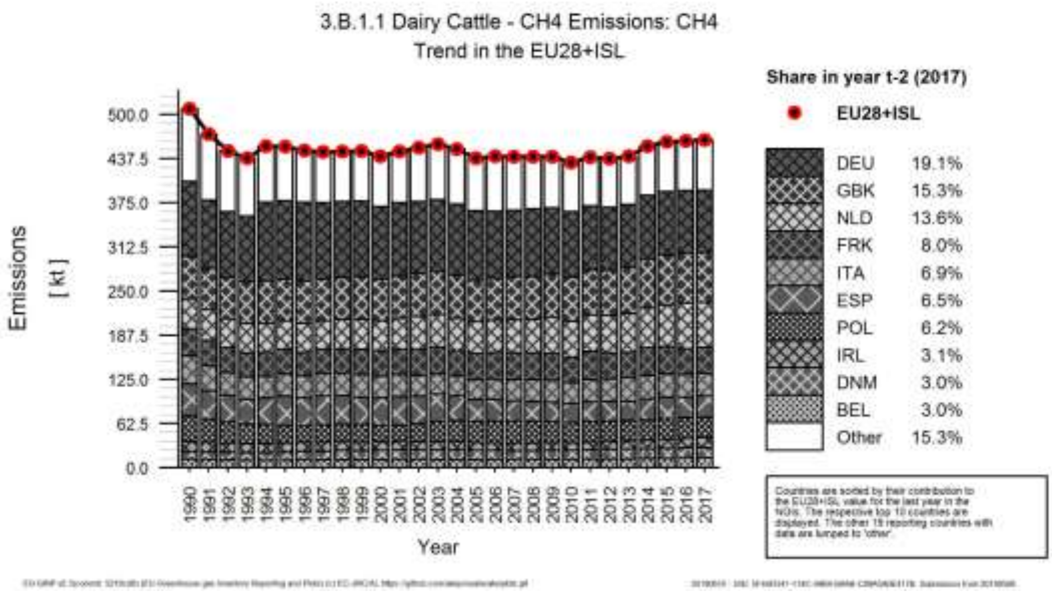
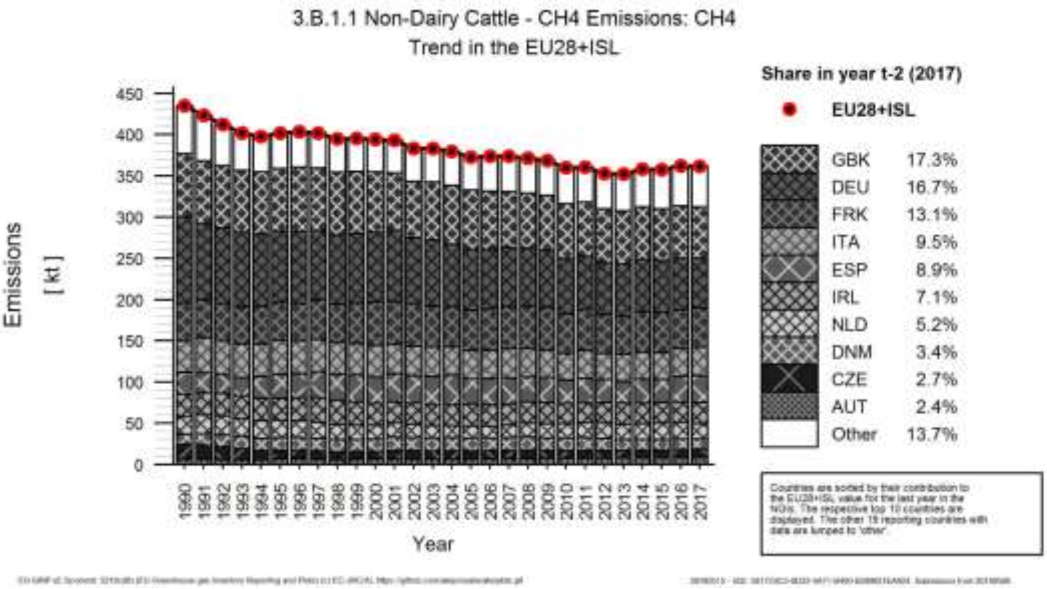


Figure 5.24: 3.B.1.1: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



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

CH_4 emissions in source category *3.B.1.3 - Swine* are 0.38% of total EU28+ISL GHG emissions and 3.6% of total EU28+ISL CH_4 emissions. They make 4.2% of total agricultural emissions and 7.7% of total agricultural CH_4 emissions.

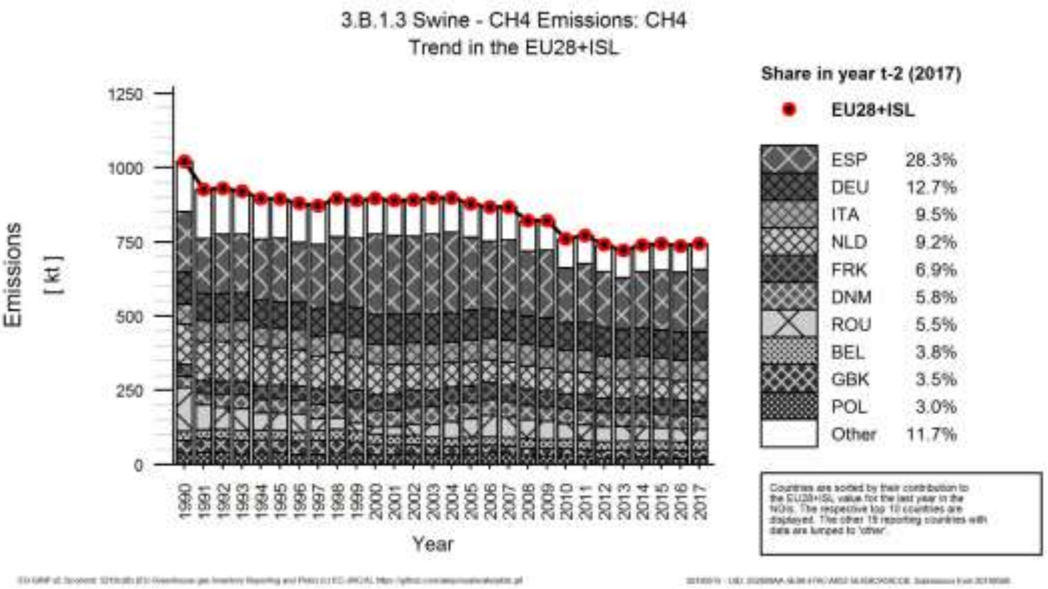
Total GHG and CH_4 emissions by Member State from 3.B.1.3 *Manure Management* are shown in Table 5.17 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2017). Values are given in kt CO_2-eq. Between 1990 and 2017, CH_4 emission in this source category decreased by 27% or 6.9 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (87%) and in Romania in absolute terms (2.6 Mt CO_2-eq). From 2016 to 2017 emissions in the current category increased by 1.1%. Figure 5.25 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 emissions for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 88.3% of the total. Emissions decreased in twenty countries and increased in nine countries. The largest decreases occurred in Romania and the Netherlands with a total absolute decrease of 4.3 Mt CO_2-eq. The three countries with the largest increases were Denmark, Spain and France, with a total absolute increase of 582 kt CO_2-eq.

Table 5.17 3.B.1.3 - Swine: Member States' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	129	80	80	0.4%	-49	-38%	1	1%	T1	D
Belgium	793	726	716	3.8%	-77	-10%	-10	-1%	T2	CS
Bulgaria	543	68	69	0.4%	-474	-87%	1	2%	T2	CS
Croatia	170	199	185	1.0%	15	9%	-14	-7%	T2	CS
Cyprus	55	37	34	0.2%	-21	-38%	-3	-9%	T2	D
Czechia	719	242	224	1.2%	-495	-69%	-18	-7%	T1	D
Denmark	920	1 109	1 084	5.8%	164	18%	-25	-2%	CS,T2	CS,D
Estonia	97	30	33	0.2%	-64	-66%	3	10%	T2	CS,D
Finland	68	100	92	0.5%	25	37%	-8	-8%	T2	CS
France	1 042	1 277	1 279	6.9%	236	23%	2	0%	T2	CS
Germany	2 685	2 335	2 370	12.7%	-314	-12%	35	2%	T2	CS
Greece	398	279	278	1.5%	-121	-30%	-1	-1%	T1	D
Hungary	500	276	261	1.4%	-239	-48%	-16	-6%	T2	CS
Ireland	206	260	261	1.4%	55	27%	2	1%	T2	CS,D
Italy	1 703	1 759	1 773	9.5%	70	4%	15	1%	T2	CS
Latvia	66	22	20	0.1%	-46	-70%	-2	-9%	T2	CS
Lithuania	329	70	62	0.3%	-267	-81%	-8	-11%	T2	CS
Luxembourg	9	11	11	0.1%	2	26%	0	3%	T2	CS
Malta	1	0	0	0.0%	-1	-63%	0	-16%	T2	CS,D
Netherlands	3 369	1 622	1 707	9.2%	-1 661	-49%	85	5%	T2	CS
Poland	913	539	564	3.0%	-349	-38%	24	4%	T1	CS
Portugal	506	420	422	2.3%	-84	-17%	2	1%	T2	CS
Romania	3 670	1 108	1 030	5.5%	-2 640	-72%	-78	-7%	T2	CS
Slovakia	272	65	70	0.4%	-202	-74%	5	8%	T2	CS
Slovenia	132	26	25	0.1%	-107	-81%	-1	-3%	T1	D
Spain	5 094	5 069	5 275	28.3%	181	4%	206	4%	CS,T2	CS,D
Sweden	59	47	48	0.3%	-12	-20%	0	0%	T2	CS
United Kingdom	1 090	632	646	3.5%	-445	-41%	13	2%	T2	D
EU-28	**25 536**	**18 409**	**18 619**	**100%**	**-6 917**	**-27%**	**210**	**1%**	**-**	**-**
Iceland	4	6	6	0.0%	2	45%	0	2%	-	-
United Kingdom (KP)	1 090	632	646	3.5%	-445	-41%	13	2%	T2	D
EU-28 + ISL	**25 540**	**18 415**	**18 625**	**100%**	**-6 915**	**-27%**	**210**	**1%**	**-**	**-**

Note that some member states 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 member states. For those countries using Tier 1, source category 3.B.1.3 is not a key category.

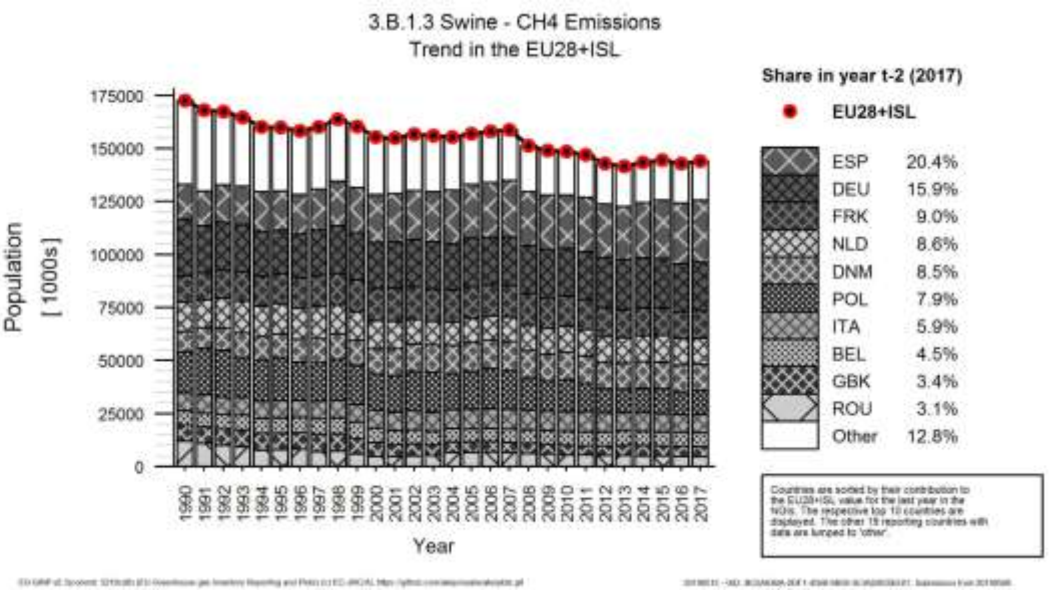
Figure 5.25: *3.B.1.3: Trend in swine emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017*



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 EU28+ISL by 17% or 28.6 million heads in the period 1990 to 2017. Figure 5.26 shows the trend of swine population indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 population for the different Member States along the inventory period. The ten countries with the highest population accounted together for 87.2% of the total. Population decreased in 21 countries and increased in eight countries. The three countries with the largest decreases were Poland, Romania and Hungary with a total absolute decrease of 21.6 million heads. The largest increases occurred in Denmark and Spain, with a total absolute increase of 15.7 million heads.

Figure 5.26: *3.B.1.3: Trend in swine population in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017*



5.3.2.2 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 EU28+ISL considerably between 1990 and 2017 by 18.1% or 1.4 kg/head/year. Table 5.18 shows the implied emission factor for CH_4 emissions in source category *3.B.1.1 - Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. The implied emission factor decreased in three countries and increased in 24 countries. The largest decrease occurred in Spain with an absolute value of 4 kg/head/year. The four countries with the largest increases were Estonia, Latvia, Finland and Malta with a mean absolute value of 5 kg/head/year.

Table 5.18 3.B.1.1 - Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2017	Member State	1990	2017
Austria	6.2	9.2	Ireland	6.1	5.5
Belgium	6.0	8.0	Iceland	15.2	17.2
Bulgaria	2.2	2.2	Italy	10.0	11.2
Cyprus	7.0	7.1	Lithuania	4.2	7.8
Czech Republic	9.9	12.8	Luxembourg	6.8	9.9
Germany	10.8	12.1	Latvia	3.1	7.3
Denmark	10.4	17.1	Malta	3.9	7.4
Spain	14.0	9.6	Netherlands	13.1	20.4
Estonia	2.3	6.5	Poland	4.6	6.0
Finland	6.9	13.1	Portugal	5.8	5.8
France	3.9	4.5	Romania	4.9	5.0
United Kingdom	11.2	13.6	Slovakia	2.5	3.5
United Kingdom (KP)	11.2	13.6	Slovenia	13.2	17.3
Greece	5.5	5.5	Sweden	3.6	4.8
Croatia	9.8	18.5	**EU28+ISL**	**7.8**	**9.2**
Hungary	14.0	15.9			

3.B.1.1 - Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.1 - Dairy Cattle* increased in EU28+ISL very strongly between 1990 and 2017 by 53.9% or 6.97 kg/head/year. Figure 5.27 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.19 shows the implied emission factor for CH_4 emissions in source category *3.B.1.1 - Dairy Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. The implied emission factor decreased in three countries and increased in 26 countries. Decreases occurred in Bulgaria, Cyprus and Ireland with a mean absolute value of 0.2 kg/head/year. The four countries with the largest increases were Estonia, Croatia, Latvia and Finland with a mean absolute value of 15 kg/head/year.

Figure 5.27: 3.B.1.1 - Dairy Cattle: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

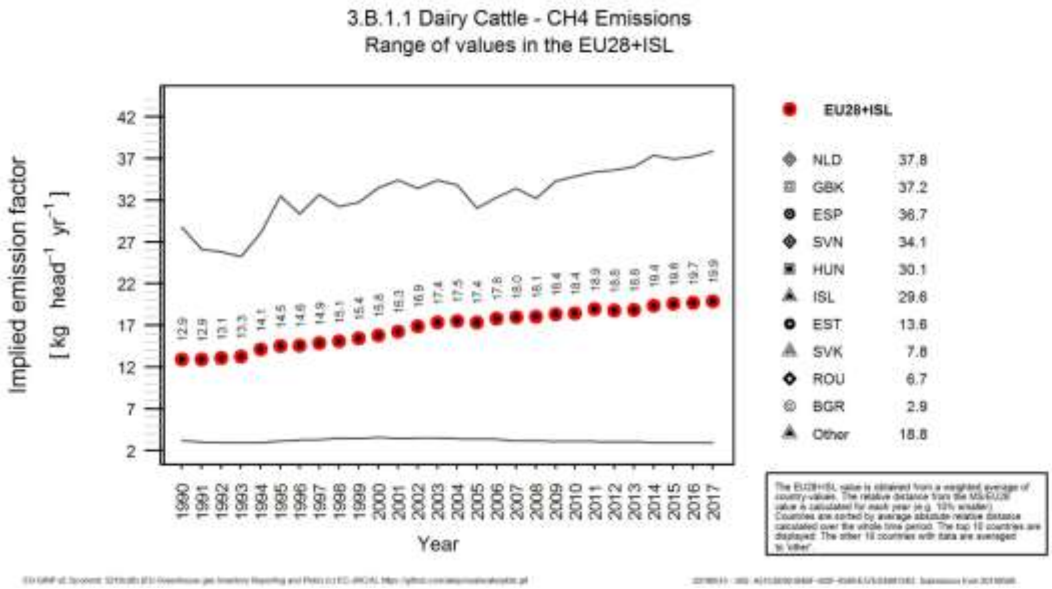


Table 5.19 3.B.1.1 - Dairy Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2017	Member State	1990	2017
Austria	10.8	17.1	Ireland	10.6	10.4
Belgium	14.1	30.6	Iceland	24.6	29.6
Bulgaria	3.2	2.9	Italy	15.0	17.9
Cyprus	10.6	10.3	Lithuania	6.0	9.8
Czech Republic	13.9	22.5	Luxembourg	13.6	26.5
Germany	16.6	21.1	Latvia	6.4	17.3
Denmark	14.0	24.8	Malta	6.6	15.0
Spain	28.8	36.7	Netherlands	23.1	37.8
Estonia	4.0	13.6	Poland	7.3	12.0
Finland	12.5	28.7	Portugal	14.6	25.3
France	7.2	10.3	Romania	6.5	6.7
United Kingdom	21.0	37.2	Slovakia	4.8	7.8
United Kingdom (KP)	21.0	37.2	Slovenia	21.0	34.1
Greece	10.4	14.0	Sweden	6.6	9.1
Croatia	12.2	34.1	**EU28+ISL**	**12.9**	**19.9**
Hungary	24.6	30.1			

3.B.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 - Dairy Cattle*, increased in EU28+ISL slightly between 1990 and 2017 by 3.6% or 21.5 kg. Figure 5.28 shows the trend of the typical animal mass in EU28+ISL indicating also the range of values used by the countries. Table 5.20 shows the typical animal mass in source category *3.B.1.1 - Dairy Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. Typical animal mass decreased in three countries and increased in twelve countries. It was in 2017 at the level of 1990 in thirteen countries. No data were available for the Netherlands. Decreases occurred in France, Slovakia and Iceland with a mean absolute value of 3 kg. The largest increase occurred in Finland with an absolute value of 144 kg.

Figure 5.28: 3.B.1.1 - Dairy Cattle: Trend in typical animal mass in the EU28+ISL and range of values reported by countries

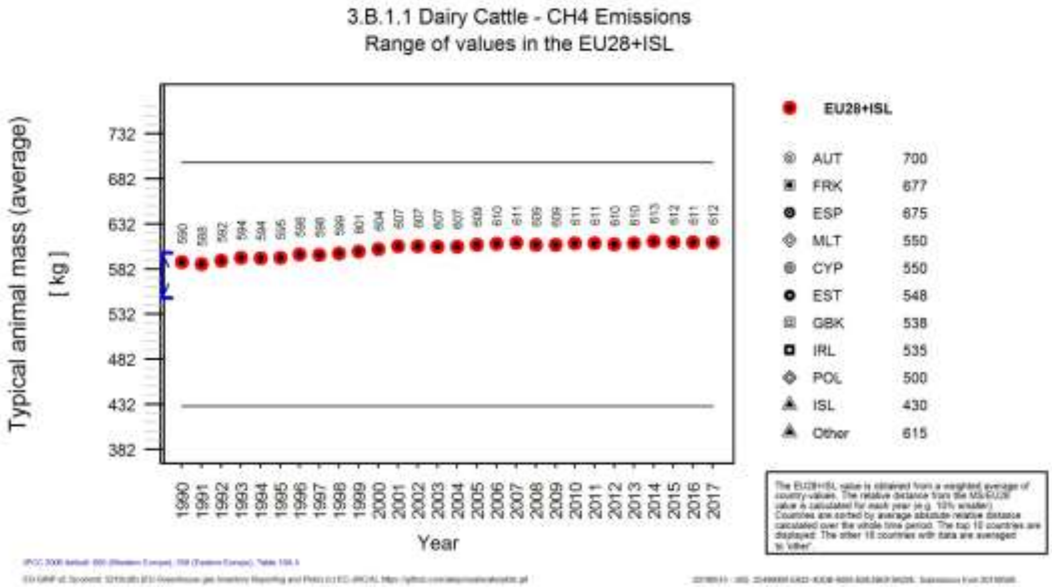


*Table 5.20 3.B.1.1 - Dairy Cattle: Member States' and EU28+ISL typical animal mass (kg)**

Member State	1990	2017		Member State	1990	2017
Austria	700	700	|	Hungary	633	643
Belgium	600	600	|	Ireland	535	535
Bulgaria	588	588	|	Iceland	430	430
Cyprus	550	550	|	Italy	603	603
Czech Republic	520	620	|	Lithuania	575	626
Germany	608	651	|	Luxembourg	650	650
Denmark	550	580	|	Latvia	550	565
Spain	652	675	|	Malta	550	550
Estonia	545	548	|	Poland	500	500
Finland	520	663	|	Portugal	600	600
France	685	677	|	Romania	650	650
United Kingdom	466	538	|	Slovakia	598	598
United Kingdom (KP)	466	538	|	Slovenia	510	615
Greece	600	600	|	Sweden	650	650
Croatia	563	563	|	**EU28+ISL**	**590**	**612**

not reported by 1 MS (NL)

3.B.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 - Dairy Cattle*, increased in EU28+ISL considerably between 1990 and 2017 by 15.5% or 0.672 kg dm/head/day. Figure 5.29 shows the trend of the VS daily excretion in EU28+ISL indicating also the range of values used by the countries. Table 5.21 shows the VS daily excretion in source category

3.B.1.1 - Dairy Cattle for the years 1990 and 2017 for all Member States and EU28+ISL. The reported vs daily excretion in 2017 was at the level of 1990 in two countries and increased in all reporting other 27 countries. The four countries with the largest increases were Malta, the Czech Republic, Estonia and Slovakia with a mean absolute value of 2 kg dm/head/day.

Figure 5.29: 3.B.1.1 - Dairy Cattle: Trend in VS daily excretion in the EU28+ISL and range of values reported by countries

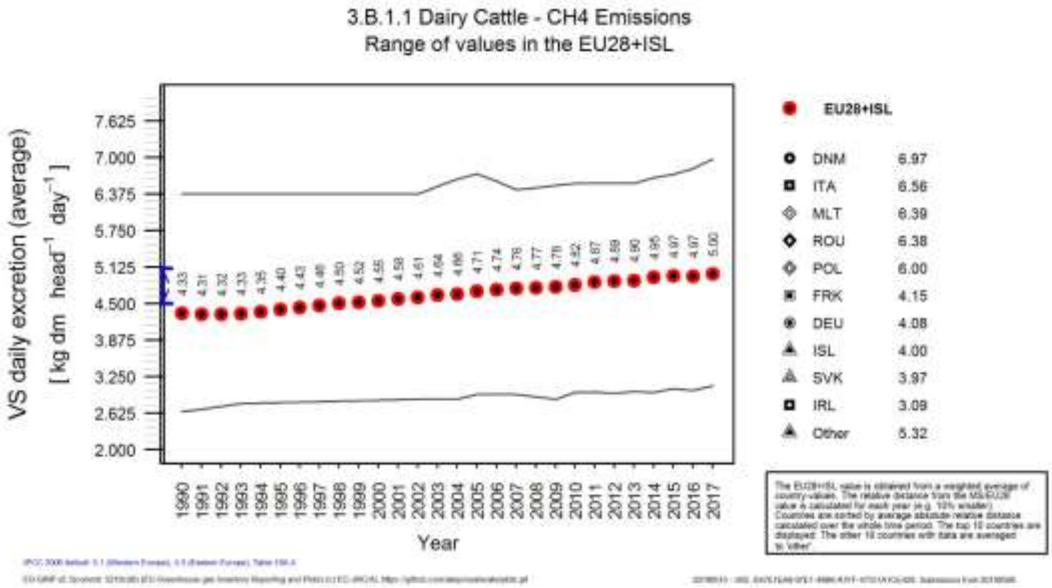


Table 5.21 3.B.1.1 - Dairy Cattle: Member States' and EU28+ISL VS daily excretion (kg dm/head/day)

Member State	1990	2017	Member State	1990	2017
Austria	4.5	5.0	Ireland	2.8	3.1
Belgium	4.0	5.3	Iceland	3.2	4.0
Bulgaria	4.0	4.2	Italy	6.4	6.6
Cyprus	4.5	4.5	Lithuania	4.5	5.6
Czech Republic	4.2	6.4	Luxembourg	4.5	5.8
Germany	3.5	4.1	Latvia	4.7	6.1
Denmark	5.7	7.0	Malta	2.8	6.4
Spain	3.9	5.2	Netherlands	3.8	4.7
Estonia	4.4	6.6	Poland	5.7	6.0
Finland	4.5	6.1	Portugal	3.5	4.7
France	3.5	4.1	Romania	5.1	6.4
United Kingdom	4.0	5.5	Slovakia	2.6	4.0
United Kingdom (KP)	4.0	5.5	Slovenia	4.5	5.3
Greece	3.7	5.0	Sweden	5.1	5.4
Croatia	4.5	4.5	**EU28+ISL**	**4.3**	**5.0**
Hungary	4.4	5.3			

3.B.1.1 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.1 - Non-Dairy Cattle* increased in EU28+ISL slightly between 1990 and 2017 by 2% or 0.105 kg/head/year. Figure 5.30 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries.

Table 5.22 shows the implied emission factor for CH_4 emissions in source category *3.B.1.1 - Non-Dairy Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. The implied emission factor decreased in nine countries and increased in eighteen countries. The three countries with the largest decreases were Spain, Romania and Ireland with a mean absolute value of 1 kg/head/year. The four countries with the largest increases were Estonia, Lithuania, Sweden and Austria with a mean absolute value of 2 kg/head/year.

Figure 5.30: 3.B.1.1 - Non-Dairy Cattle: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

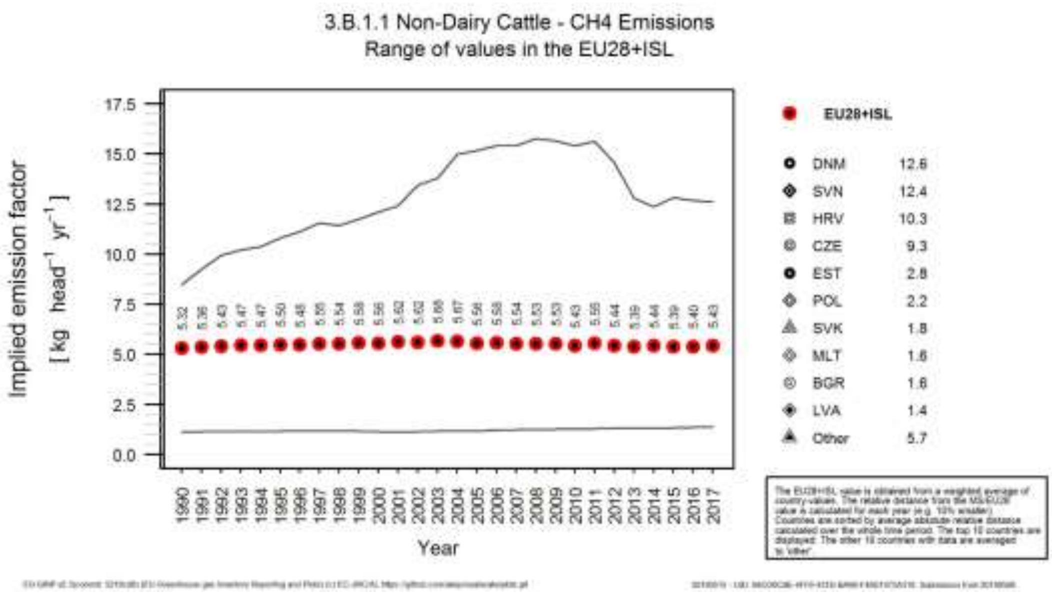


Table 5.22 3.B.1.1 - Non-Dairy Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2017		Member State	1990	2017
Austria	3.7	6.2	|	Ireland	5.0	4.3
Belgium	3.2	3.0	|	Iceland	8.1	9.8
Bulgaria	1.6	1.6	|	Italy	7.5	8.2
Cyprus	4.5	4.4	|	Lithuania	3.3	6.5
Czech Republic	7.9	9.3	|	Luxembourg	4.3	4.8
Germany	8.0	7.5	|	Latvia	1.1	1.4
Denmark	8.5	12.6	|	Malta	1.8	1.6
Spain	7.4	5.7	|	Netherlands	6.9	8.0
Estonia	1.3	2.8	|	Poland	2.0	2.2
Finland	3.7	6.1	|	Portugal	2.2	2.4
France	2.8	3.1	|	Romania	2.9	2.5
United Kingdom	8.2	7.9	|	Slovakia	1.8	1.8
United Kingdom (KP)	8.2	7.9	|	Slovenia	7.4	12.4
Greece	3.3	3.6	|	Sweden	2.1	3.6
Croatia	6.7	10.3	|	**EU28+ISL**	**5.3**	**5.4**
Hungary	8.3	10.2	|			

3.B.1.1 - 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 - Non-Dairy Cattle*, increased in EU28+ISL moderately between 1990 and 2017 by 6.2% or 23.5 kg. Figure 5.31 shows the trend of the typical animal mass in EU28+ISL indicating also the range of values used by the countries. Table 5.23 shows the typical animal mass in source category *3.B.1.1 - Non-Dairy Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. Typical animal mass decreased in two countries and increased in 21 countries. It was in 2017 at the level of 1990 in two countries. No data were available for the Netherlands and Sweden. Decreases occurred in Malta and Ireland with a mean absolute value of 17 kg. The three countries with the largest increases were Finland, Bulgaria and Estonia with a mean absolute value of 100 kg.

Figure 5.31: 3.B.1.1 - Non-Dairy Cattle: Trend in typical animal mass in the EU28+ISL and range of values reported by countries

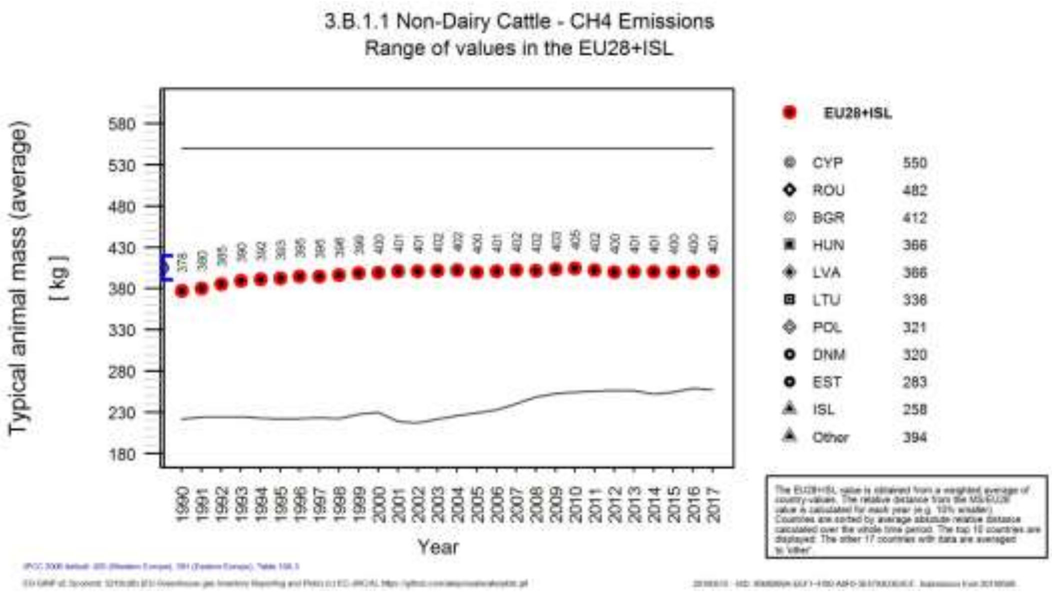


Table 5.23 3.B.1.1 - Non-Dairy Cattle: Member States' and EU28+ISL typical animal mass (kg)

Member State	1990	2017		Member State	1990	2017
Austria	364	414	|	Hungary	327	366
Belgium	381	407	|	Ireland	362	352
Bulgaria	298	412	|	Iceland	237	258
Cyprus	550	550	|	Italy	376	383
Czech Republic	326	396	|	Lithuania	327	336
Germany	339	371	|	Luxembourg	422	442
Denmark	290	320	|	Latvia	298	366
Spain	413	419	|	Malta	374	350
Estonia	222	283	|	Poland	311	321
Finland	278	402	|	Portugal	399	418
France	431	443	|	Romania	482	482
United Kingdom	426	426	|	Slovakia	331	366
United Kingdom (KP)	426	426	|	Slovenia	289	348
Greece	375	425	|	**EU28+ISL**	**378**	**401**
Croatia	331	341	|			

3.B.1.1 - 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 - Non-Dairy Cattle*, increased in EU28+ISL slightly between 1990 and 2017 by 2.3% or 0.0467 kg dm/head/day. Figure 5.32 shows the trend of the VS daily excretion in EU28+ISL indicating also the range of values used by the countries. Table 5.24 shows the VS daily excretion in source category *3.B.1.1 - Non-Dairy Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. VS daily excretion decreased in six countries and increased in eighteen countries. It was in 2017 at the level of 1990 in three countries. The three countries with the largest decreases were Malta, Ireland and Spain with a mean absolute value of 0.2 kg dm/head/day. The four countries with the largest increases were Finland, Denmark, Latvia and the Czech Republic with a mean absolute value of 1 kg dm/head/day.

Figure 5.32: 3.B.1.1 - Non-Dairy Cattle: Trend in VS daily excretion in the EU28+ISL and range of values reported by countries

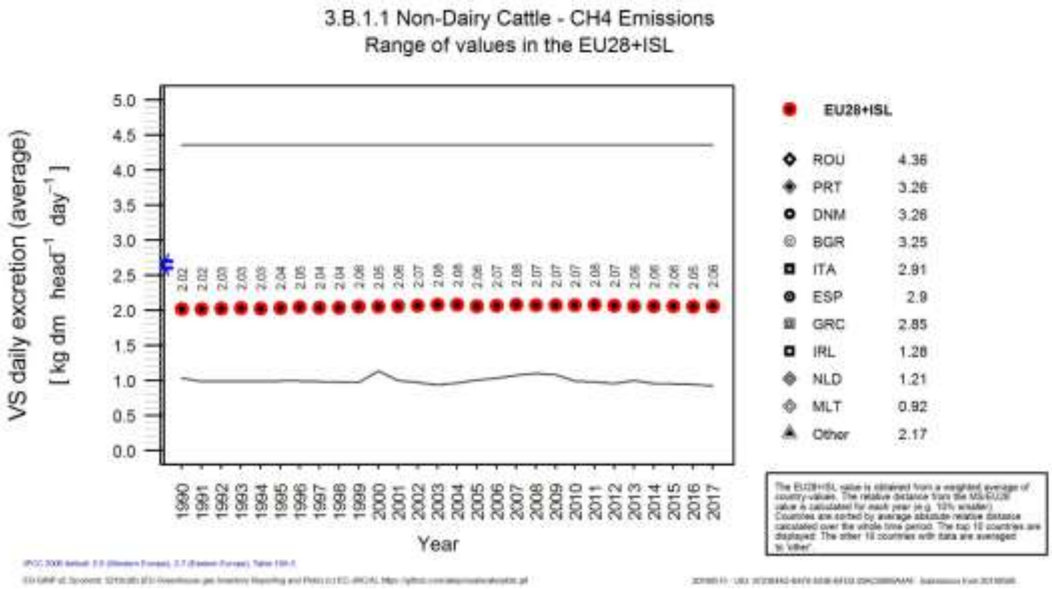


Table 5.24 3.B.1.1 - Non-Dairy Cattle: Member States' and EU28+ISL VS daily excretion (kg dm/head/day)

Member State	1990	2017	Member State	1990	2017
Austria	1.8	2.14	Ireland	1.4	1.28
Belgium	1.5	1.62	Iceland	1.3	1.41
Bulgaria	2.8	3.25	Italy	2.8	2.91
Cyprus	2.7	2.70	Lithuania	2.4	2.52
Czech Republic	2.3	2.84	Luxembourg	2.2	2.34
Germany	1.4	1.53	Latvia	1.7	2.19
Denmark	2.4	3.26	Malta	1.0	0.92
Spain	3.2	2.90	Netherlands	1.3	1.21
Estonia	2.0	2.21	Poland	2.0	1.92
Finland	1.5	2.20	Portugal	3.2	3.26
France	1.9	1.92	Romania	4.4	4.36
United Kingdom	2.0	1.98	Slovakia	1.9	2.19
United Kingdom (KP)	2.0	1.98	Slovenia	2.1	2.55
Greece	2.6	2.85	Sweden	1.6	1.75
Croatia	2.7	2.70	**EU28+ISL**	**2.0**	**2.06**

Hungary	2.5	2.63				

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 EU28+ISL clearly between 1990 and 2017 by 12.6% or 0.747 kg/head/year. Figure 5.33 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.25 shows the implied emission factor for CH_4 emissions in source category *3.B.1.3 - Swine* for the years 1990 and 2017 for all Member States and EU28+ISL. The implied emission factor decreased in fifteen countries and increased in thirteen countries. It was in 2017 at the level of 1990 in one country. The four countries with the largest decreases were Slovenia, Cyprus, the Netherlands and Spain with a mean absolute value of 5 kg/head/year. The four countries with the largest increases were Finland, Hungary, Croatia 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 EU28+ISL and range of values reported by countries

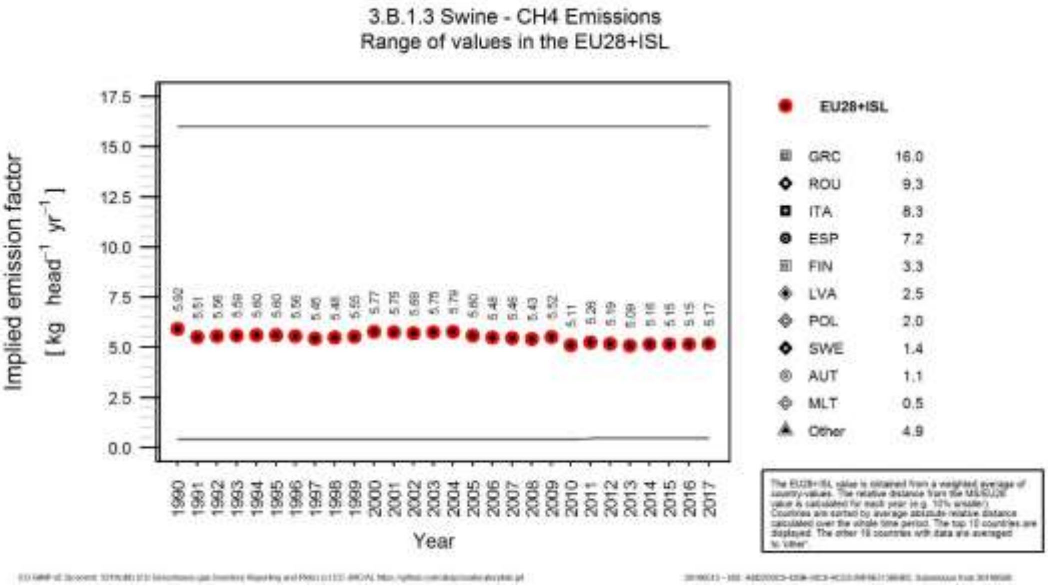


Table 5.25 3.B.1.3 - Swine: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2017	Member State	1990	2017
Austria	1.40	1.14	Ireland	6.76	6.59
Belgium	4.73	4.46	Iceland	6.00	6.00
Bulgaria	5.15	4.59	Italy	8.10	8.27
Cyprus	7.85	3.86	Lithuania	5.11	3.91
Czech Republic	6.00	6.00	Luxembourg	5.78	5.21
Germany	4.05	4.14	Latvia	1.87	2.47
Denmark	3.87	3.52	Malta	0.41	0.45
Spain	12.43	7.19	Netherlands	9.68	5.51
Estonia	4.51	4.54	Poland	1.88	1.99
Finland	2.02	3.33	Portugal	7.98	7.72
France	3.35	3.96	Romania	12.23	9.35
United Kingdom	5.78	5.20	Slovakia	4.32	4.56

Member State	1990	2017		Member State	1990	2017
United Kingdom (KP)	5.78	5.20	|	Slovenia	9.00	3.94
Greece	16.00	16.00	|	Sweden	1.05	1.40
Croatia	4.32	6.58	|	**EU28+ISL**	**5.92**	**5.17**
Hungary	2.29	3.66	|			

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 EU28+ISL slightly between 1990 and 2017 by 3.6% or 2.7 kg. Figure 5.34 shows the trend of the typical animal mass in EU28+ISL indicating also the range of values used by the countries. Table 5.26 shows the typical animal mass in source category *3.B.1.3 - Swine* for the years 1990 and 2017 for all Member States and EU28+ISL. Typical animal mass decreased in twelve countries and increased in six countries. It was in 2017 at the level of 1990 in two countries. No data were available for nine countries (Austria, Cyprus, Finland, the United Kingdom, the Netherlands, Poland, Slovakia, Slovenia and Sweden). The three countries with the largest decreases were Luxembourg, Latvia and Ireland with a mean absolute value of 14 kg. The three countries with the largest increases were Denmark, Estonia and Hungary with a mean absolute value of 7 kg.

Figure 5.34: 3.B.1.3 - Swine: Trend in typical animal mass in the EU28+ISL and range of values reported by countries

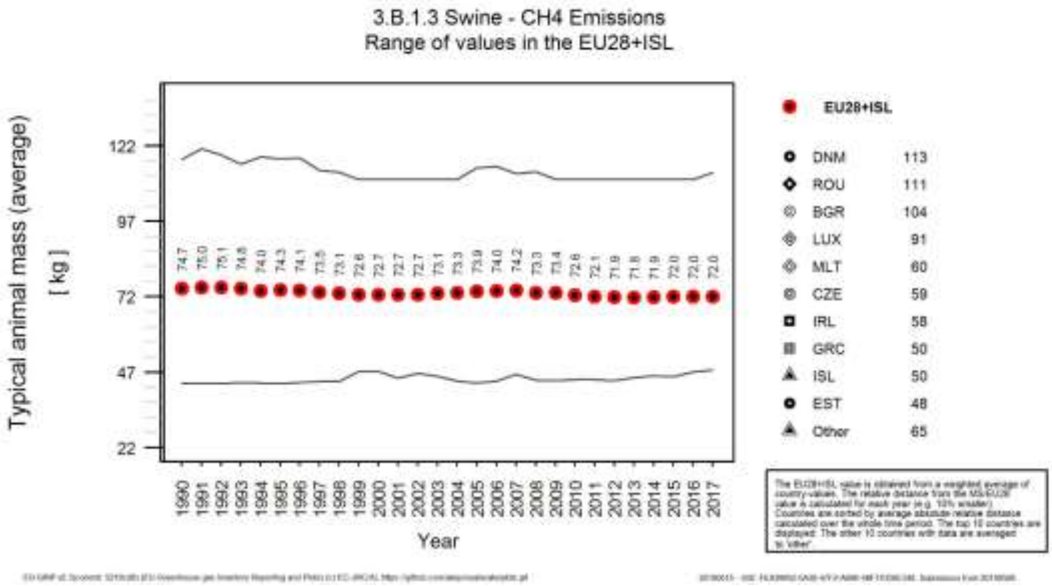


*Table 5.26 3.B.1.3 - Swine: Member States' and EU28+ISL typical animal mass (kg)**

Member State	1990	2017		Member State	1990	2017
Belgium	69	64	|	Ireland	63	58
Bulgaria	109	104	|	Iceland	52	50
Czech Republic	62	59	|	Italy	79	81
Germany	67	63	|	Lithuania	65	62
Denmark	98	113	|	Luxembourg	118	91

Spain	64	62	Latvia	75	64
Estonia	43	48	Malta	59	60
France	64	64	Portugal	62	57
Greece	50	50	Romania	111	111
Croatia	69	65	**EU28+ISL**	**75**	**72**
Hungary	63	65			

**not reported by 19 MS*

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 EU28+ISL moderately between 1990 and 2017 by 6% or 0.0193 kg dm/head/day. Figure 5.35 shows the trend of the VS daily excretion in EU28+ISL indicating also the range of values used by the countries. Table 5.27 shows the VS daily excretion in source category *3.B.1.3 - Swine* for the years 1990 and 2017 for all Member States and EU28+ISL. VS daily excretion decreased in seventeen countries and increased in four countries. It was in 2017 at the level of 1990 in four countries. No data were available for four countries (the Czech Republic, Greece, Iceland and Slovakia). The largest decreases occurred in 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, Estonia and France with a mean absolute value of 0.031 kg dm/head/day.

Figure 5.35: 3.B.1.3 - Swine: Trend in VS daily excretion in the EU28+ISL and range of values reported by countries

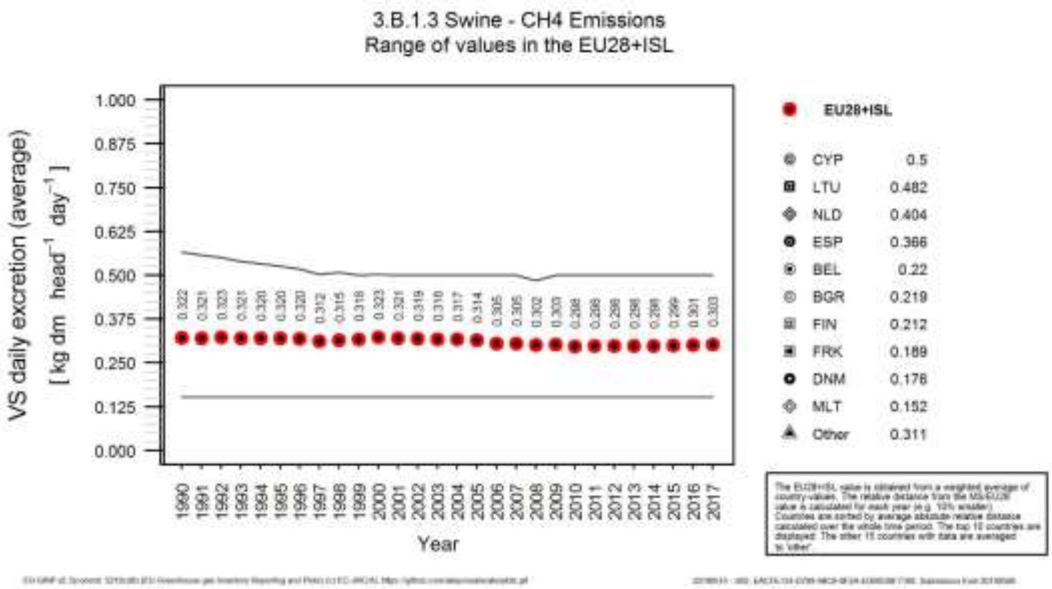


Table 5.27 3.B.1.3 - Swine: Member States' and EU28+ISL VS daily excretion (kg DM/head/day)

Member State	1990	2017	Member State	1990	2017
Austria	0.30	0.30	Ireland	0.36	0.35
Belgium	0.23	0.22	Italy	0.37	0.34
Bulgaria	0.25	0.22	Lithuania	0.50	0.48
Cyprus	0.50	0.50	Luxembourg	0.33	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	0.37	Netherlands	0.57	0.40
Estonia	0.26	0.30	Poland	0.32	0.32
Finland	0.22	0.21	Portugal	0.28	0.26
France	0.17	0.19	Romania	0.28	0.28
United Kingdom	0.32	0.32	Slovenia	0.32	0.31
United Kingdom (KP)	0.32	0.32	Sweden	0.29	0.31
Croatia	0.33	0.32	**EU28+ISL**	**0.32**	**0.30**
Hungary	0.30	0.30			

5.3.3 Manure Management - N_2O (CRF Source Category 3B2)

N_2O the emissions in source category *3.B.2 - Manure Management* are 0.46% of total EU28+ISL GHG emissions and 8.6% of total EU28+ISL 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 Member States, Figure 5.37 shows the distribution of N_2O emissions from manure management by livestock category in all Member States and in the EU28+ISL. Each bar represents the total emissions of a country in the current emission category, where different shades of grey correspond to the emitting animal types.

Regarding the handling of manure in the different Member States, Figure 5.38 shows the distribution of total manure nitrogen by manure system in all Member States and in the EU28. Each bar represents the total manure nitrogen handled in the current system for the country, where different shades of grey correspond to the emitting manure systems.

Figure 5.36: Share of source category 3.B.2 on total EU28+ISL agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2017.3.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.

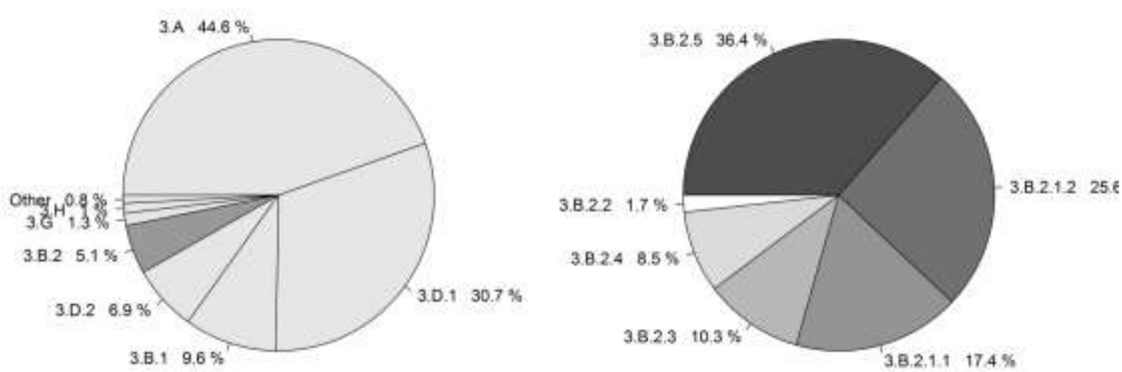


Figure 5.37: Decomposition of emissions in source category 3.B.2 - Manure Management into its sub-categories by Member State in the year 2017.

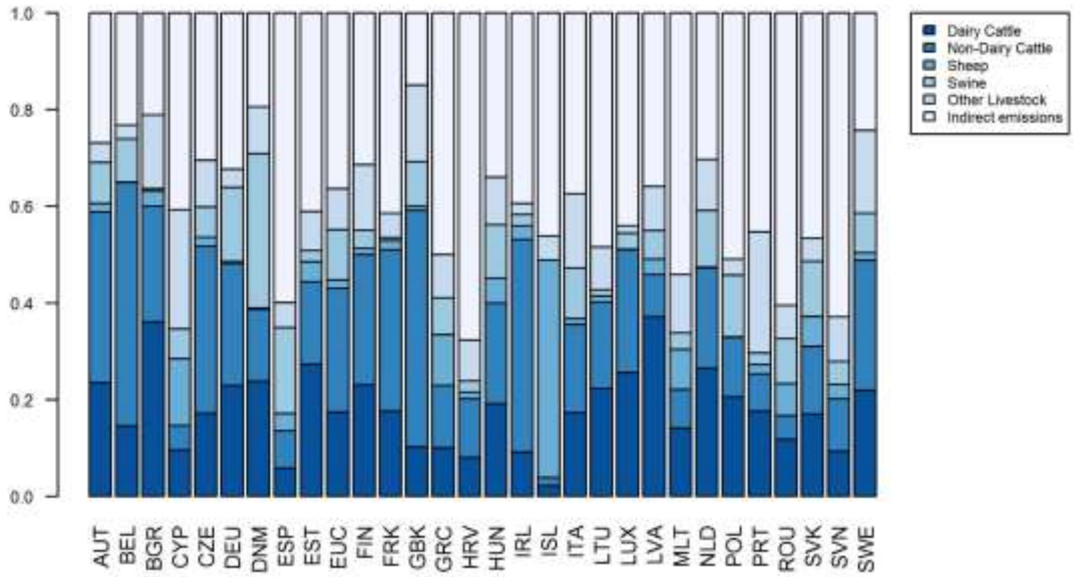
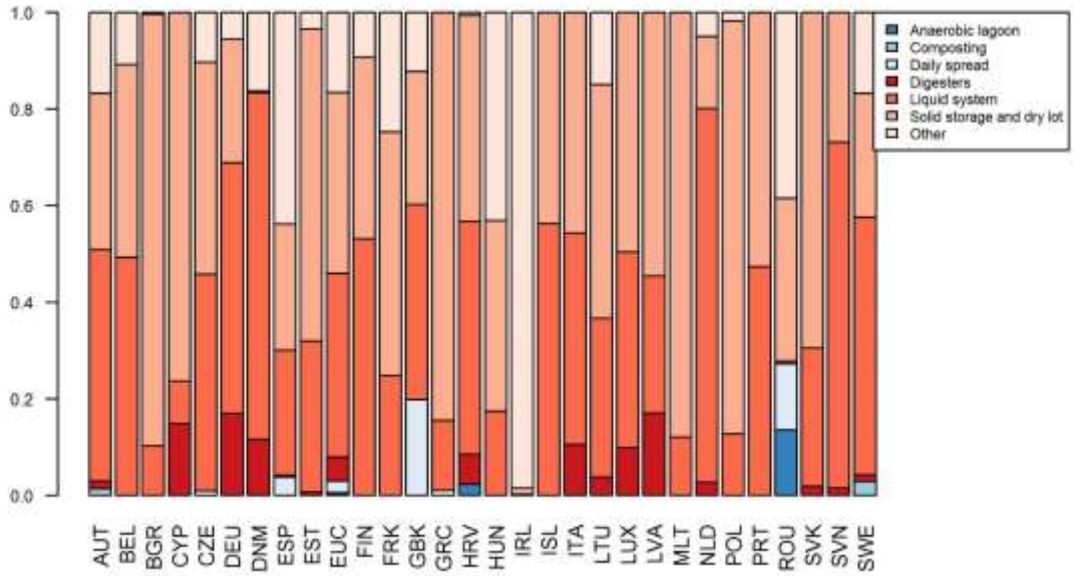


Figure 5.38: Decomposition of manure nitrogen handled in source category 3.B.2 - Manure Management into the different manure management systems by Member State in the year 2017.



Total GHG and N_2O emissions by Member State from 3.B.2 *Manure Management* are shown in Table 5.28 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2017). Values are given in kt CO_2-eq. Between 1990 and 2017, N_2O emission in this source category decreased by 26% or 7.7 Mt CO_2-eq. The decrease was largest in Lithuania in relative terms (74%) and in Poland in absolute terms (947 kt CO_2-eq). From 2016 to 2017 emissions in the current category decreased by 0.1%.

Table 5.28 3.B.2 - Manure Management: Member States' contributions to total EU-GHG and N_2O emissions

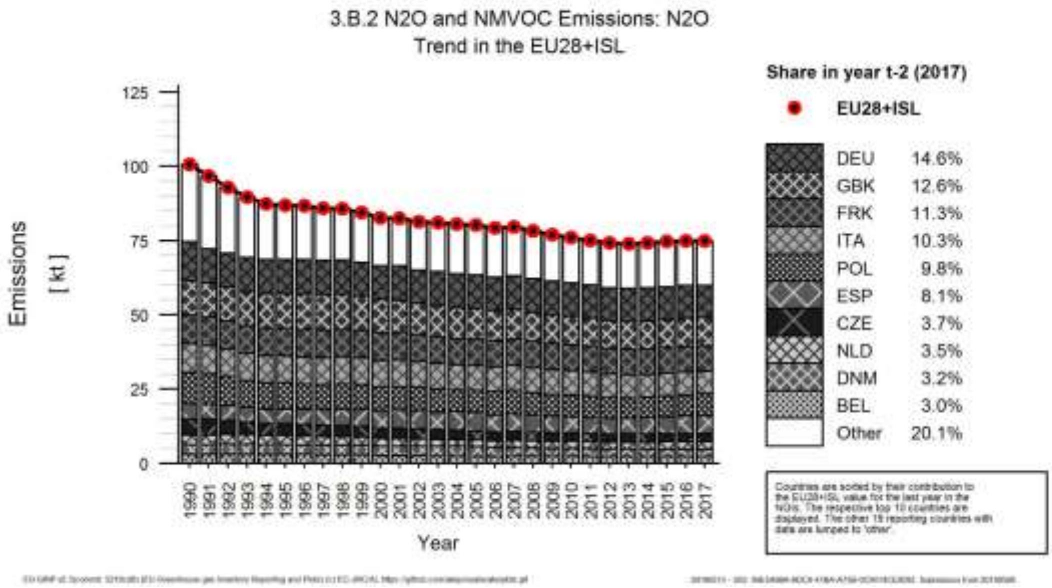
Member States	GHG emissions in 1990 (kt CO_2-eq)	GHG emissions in 2016 (kt CO_2-eq)	GHG emissions in 2017 (kt CO_2-eq)	N_2O emissions in 1990 (kt CO_2-eq)	N_2O emissions in 2016 (kt CO_2-eq)	N_2O emissions in 2017 (kt CO_2-eq)
Austria	442	446	450	442	446	450
Belgium	910	675	671	910	675	671
Bulgaria	1,260	485	481	1,260	485	481
Croatia	362	164	154	362	164	154
Cyprus	66	66	68	66	66	68
Czech Republic	1,620	839	829	1,620	839	829
Denmark	979	725	716	979	725	716
Estonia	126	54	55	126	54	55
Finland	285	285	281	285	285	281
France	2,871	2,559	2,512	2,871	2,559	2,512
Germany	3,903	3,273	3,250	3,903	3,273	3,250
Greece	333	293	289	333	293	289
Hungary	908	477	470	908	477	470
Ireland	498	539	547	498	539	547
Italy	2,896	2,307	2,289	2,896	2,307	2,289
Latvia	295	88	87	295	88	87
Lithuania	730	195	188	730	195	188
Luxembourg	40	35	35	40	35	35
Malta	13	10	10	13	10	10
Netherlands	940	768	774	940	768	774
Poland	3,135	2,091	2,188	3,135	2,091	2,188
Portugal	276	180	184	276	180	184
Romania	1,204	643	616	1,204	643	616
Slovakia	492	162	165	492	162	165
Slovenia	67	47	46	67	47	46
Spain	1,514	1,768	1,797	1,514	1,768	1,797
Sweden	369	333	333	369	333	333
United Kingdom	3,443	2,822	2,815	3,443	2,822	2,815
EU-28	**29,979**	**22,328**	**22,297**	**29,979**	**22,328**	**22,297**
Iceland	23	21	20	23	21	20
United Kingdom (KP)	3,443	2,822	2,815	3,443	2,822	2,815
EU-28 + ISL	**30,002**	**22,349**	**22,318**	**30,002**	**22,349**	**22,318**

5.3.3.1 Trends in Emissions and Activity Data

3.B.2 - Manure Management - Emissions

Emissions in source category *3.B.2 - Manure Management* decreased strongly in EU28+ISL by 26% or 7.7 Mt CO_2-eq in the period 1990 to 2017. Figure 5.39 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from manure management for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 79.9% of the total. Emissions decreased in 25 countries and increased in four countries. The largest decreases occurred in Poland with a total absolute decrease of 947 kt CO_2-eq. The largest increases occurred in Ireland and Spain, with a total absolute increase of 331 kt CO_2-eq.

Figure 5.39: 3.B.2 Manure Management: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



3.B.2.1 - Cattle - Emissions

N_2O emissions in source category *3.B.2.1 - Cattle* are 0.2% of total EU28+ISL GHG emissions and 3.7% of total EU28+ISL N_2O emissions. They make 2.2% of total agricultural emissions and 5.1% 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 EU28+ISL total. The figures represent the trend in N_2O emissions from manure management for the different Member States along the inventory period.

Total GHG and N_2O emissions by Member State from 3.B.2.1 *Manure Management* are shown in Table 5.29 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2017). Values are given in kt CO_2-eq. Between 1990 and 2017, N_2O emission in this source category decreased by 25% or 3.2 Mt CO_2-eq. The decrease was largest in Slovakia in relative terms (72%) and in Germany in absolute terms (578 kt CO_2-eq). From 2016 to 2017 emissions in the current category decreased by 0.7%. The ten countries with the highest emissions accounted together for 81.7% of the total. Emissions decreased in 23 countries and increased in six countries. The three countries with the largest decreases were Germany, Italy and the United Kingdom with a total absolute decrease of 1.5 Mt CO_2-eq. The three countries with the largest increases were Finland, the Netherlands and Ireland, with a total absolute increase of 62 kt CO_2-eq.

Table 5.29 3.B.2.1 - Cattle: Member States' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	258	264	265	2.8%	7	3%	0	0%	T2	CS
Belgium	622	439	436	4.5%	-186	-30%	-3	-1%	T2	D
Bulgaria	585	287	289	3.0%	-296	-51%	1	0%	T2	D
Croatia	92	33	31	0.3%	-61	-66%	-2	-6%	T2	CS,D
Cyprus	8	9	10	0.1%	2	20%	0	4%	T1	D
Czech Republic	710	431	429	4.5%	-282	-40%	-2	-1%	T2	CS
Denmark	326	286	277	2.9%	-49	-15%	-9	-3%	T2	D
Estonia	51	24	24	0.3%	-27	-52%	0	0%	T2	CS,D
Finland	128	141	140	1.5%	12	9%	-1	-1%	T2	D
France	1 429	1 309	1 280	13.3%	-148	-10%	-29	-2%	T2	CS,D
Germany	2 142	1 588	1 565	16.3%	-578	-27%	-24	-2%	T2	CS,D
Greece	84	68	66	0.7%	-18	-21%	-2	-3%	D	D
Hungary	281	182	188	2.0%	-93	-33%	6	3%	T2	CS
Ireland	264	288	290	3.0%	27	10%	2	1%	T2	CS,D
Italy	1 267	817	814	8.5%	-453	-36%	-3	0%	T2	CS,D
Latvia	121	40	40	0.4%	-81	-67%	0	-1%	T2	D
Lithuania	206	77	76	0.8%	-130	-63%	-2	-2%	T2	D
Luxembourg	22	18	18	0.2%	-4	-17%	0	1%	T2	CS
Malta	3	2	2	0.0%	-1	-34%	0	-4%	T1	D
Netherlands	342	361	366	3.8%	24	7%	5	1%	NA	NA
Poland	918	693	718	7.5%	-200	-22%	25	4%	T2	CS
Portugal	78	46	47	0.5%	-32	-40%	1	1%	T2	CS,D
Romania	214	106	103	1.1%	-111	-52%	-3	-3%	T2	D
Slovakia	181	51	51	0.5%	-130	-72%	0	0%	T1	CS
Slovenia	13	9	9	0.1%	-4	-29%	0	-2%	T1,T2	CS,D
Spain	243	240	243	2.5%	0	0%	3	1%	T2	D
Sweden	176	162	163	1.7%	-13	-8%	0	0%	CS,T2	CS,D
United Kingdom	2 088	1 692	1 664	17.3%	-423	-20%	-28	-2%	T2	CS,D
EU-28	**12 850**	**9 665**	**9 602**	**100%**	**-3 248**	**-25%**	**-63**	**-1%**	**-**	**-**
Iceland	1	1	1	0.0%	0	13%	0	1%	-	-
United Kingdom (KP)	2 088	1 692	1 664	17.3%	-423	-20%	-28	-2%	T2	CS,D
EU-28 + ISL	**12 851**	**9 666**	**9 603**	**100%**	**-3 248**	**-25%**	**-63**	**-1%**	**-**	**-**

Figure 5.40: 3.B.2.1 - Dairy cattle: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017

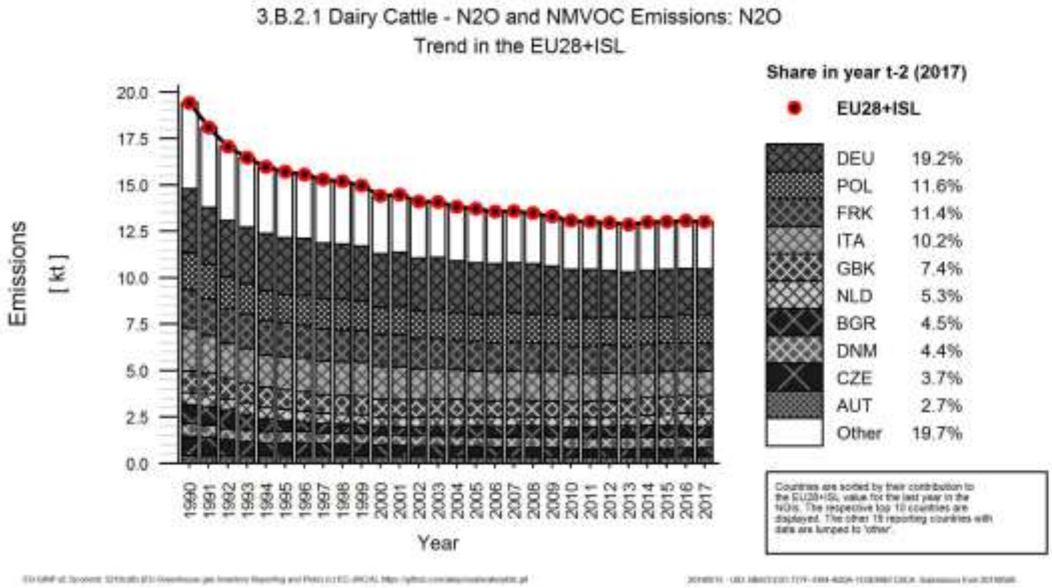
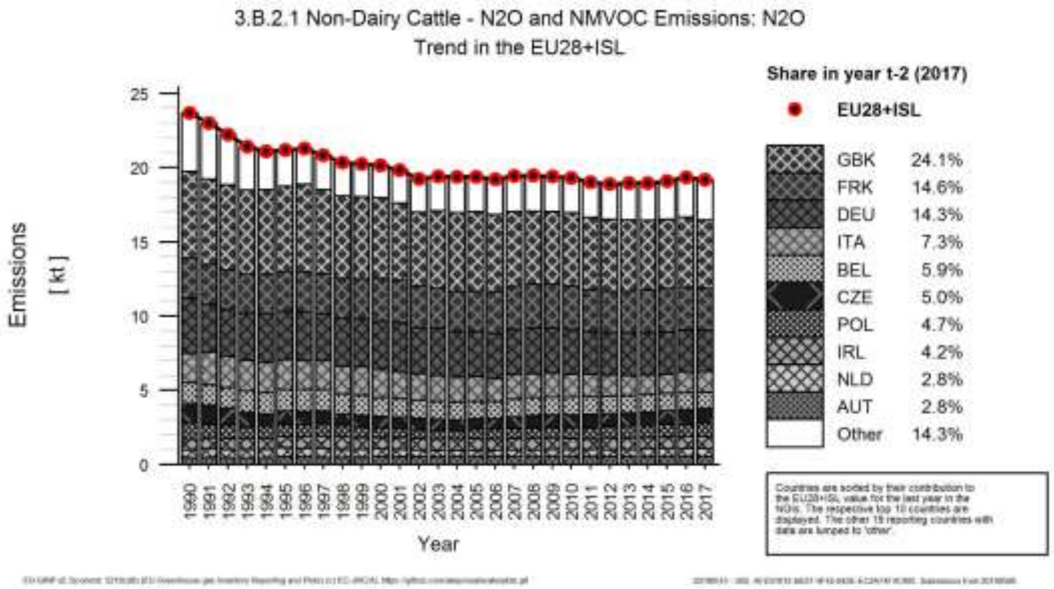


Figure 5.41: 3.B.2.1 - Non-dairy cattle: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



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

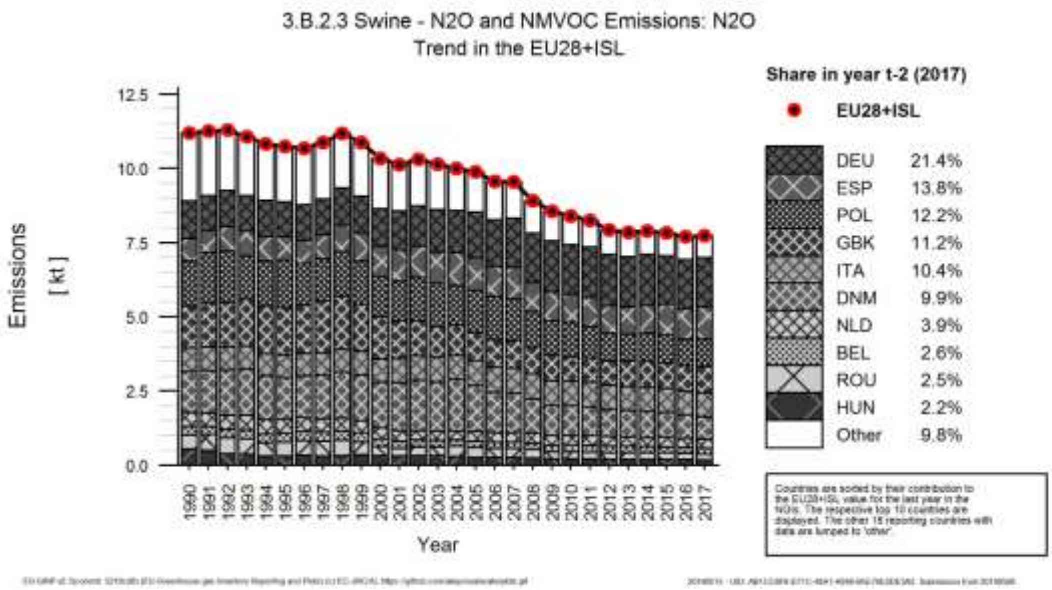
N_2O emissions in source category *3.B.2.3 - Swine* are 0.048% of total EU28+ISL GHG emissions and 0.89% of total EU28+ISL N_2O emissions. They make 0.52% of total agricultural emissions and 1.2% of total agricultural N_2O emissions. Figure 5.43 shows the trend of emissions indicating the countries contributing most to the EU28+ISL total. The figure represents the trend in N_2O emissions from manure management for the different Member States along the inventory period.

Total GHG and N_2O emissions by Member State from 3.B.2.3 *Manure Management* are shown in Table 5.30 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2017). Values are given in kt CO_2-eq. Between 1990 and 2017, N_2O emission in this source category decreased by 31% or 1 Mt CO_2-eq. The decrease was largest in Lithuania in relative terms (98%) and in Denmark in absolute terms (178 kt CO_2-eq). From 2016 to 2017 emissions in the current category increased by 0.5%. The ten countries with the highest emissions accounted together for 90.2% of the total. Emissions decreased in 23 countries and increased in five countries. The three countries with the largest decreases were Denmark, Poland and the United Kingdom with a total absolute decrease of 514 kt CO_2-eq. The largest increases occurred in Spain and Germany, with a total absolute increase of 208 kt CO_2-eq.

Table 5.30 3.B.2.3 - Swine: Member States' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	61	38	38	1.6%	-23	-38%	0	1%	T2	CS
Belgium	85	60	60	2.6%	-25	-30%	0	0%	T2	D
Bulgaria	10	3	2	0.1%	-8	-80%	-1	-33%	T2	D
Croatia	26	4	4	0.2%	-22	-86%	-1	-14%	T2	CS
Cyprus	8	5	4	0.2%	-4	-46%	0	-10%	T1	D
Czechia	174	56	52	2.2%	-123	-70%	-4	-7%	T2	CS
Denmark	407	236	229	9.9%	-178	-44%	-7	-3%	T2	D
Estonia	2	1	1	0.1%	-1	-43%	0	7%	T2	CS,D
Finland	26	11	11	0.5%	-15	-59%	-1	-6%	T2	D
France	46	18	18	0.8%	-28	-62%	0	-2%	T2	CS,D
Germany	376	489	494	21.4%	118	31%	6	1%	T2	CS,D
Greece	31	22	22	1.0%	-10	-30%	0	-1%	D	D
Hungary	162	55	52	2.2%	-110	-68%	-3	-6%	T2	CS
Ireland	10	12	13	0.5%	2	24%	0	2%	T2	CS,D
Italy	236	239	241	10.4%	4	2%	2	1%	T2	CS,D
Latvia	40	6	5	0.2%	-35	-87%	-1	-11%	T2	D
Lithuania	110	3	2	0.1%	-108	-98%	0	-9%	T1	D
Luxembourg	1	1	1	0.1%	0	20%	0	2%	T2	CS
Malta	1	0	0	0.0%	-1	-66%	0	-16%	T1	D
Netherlands	140	93	90	3.9%	-50	-36%	-3	-3%	NA	NA
Poland	455	263	280	12.2%	-174	-38%	17	7%	T2	CS
Portugal	11	4	4	0.2%	-7	-61%	0	0%	T2	CS,D
Romania	144	63	58	2.5%	-86	-60%	-5	-8%	T2	D
Slovakia	78	18	19	0.8%	-59	-76%	1	4%	T2	CS
Slovenia	7	2	2	0.1%	-5	-67%	0	-3%	T1	D
Spain	229	311	319	13.8%	90	39%	8	3%	CS,T2	D
Sweden	42	28	28	1.2%	-15	-35%	0	0%	CS,NA,T2	CS,D,NA
United Kingdom	420	255	259	11.2%	-161	-38%	4	1%	T2	CS,D
EU-28	**3 339**	**2 295**	**2 307**	**100%**	**-1 032**	**-31%**	**12**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	420	255	259	11.2%	-161	-38%	4	1%	T2	CS,D
EU-28 + ISL	**3 339**	**2 295**	**2 307**	**100%**	**-1 032**	**-31%**	**12**	**1%**	**-**	**-**

Figure 5.42: 3.B.2.3 - Swine: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



3.B.2.4 - Other Livestock - Emissions

N_2O emissions in source category *3.B.2.4 - Other Livestock* are 0.039% of total EU28+ISL GHG emissions and 0.73% of total EU28+ISL N_2O emissions. They make 0.43% of total agricultural emissions and 1% of total agricultural N_2O emissions.

Total GHG and N_2O emissions by Member State from 3.B.2.4 *Manure Management* are shown in Table 5.31 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2017). Values are given in kt CO_2-eq. Between 1990 and 2017, N_2O emission in this source category decreased by 5% or 106 kt CO_2-eq. The decrease was largest in Estonia in relative terms (65%) and in Bulgaria in absolute terms (128 kt CO_2-eq). From 2016 to 2017 emissions in the current category no changed by 0%. Figure 5.44 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from manure management for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 80% of the total. Emissions decreased in fourteen countries and increased in fifteen countries. The largest decreases occurred in Bulgaria and Poland with a total absolute decrease of 218 kt CO_2-eq. The largest increases occurred in Italy and the United Kingdom, with a total absolute increase of 122 kt CO_2-eq.

Table 5.31 3.B.2.4 - Other Livestock: Member States' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	9	17	18	1.0%	9	93%	1	7%	T2	CS
Belgium	10	18	19	1.0%	9	88%	1	4%	T2	D
Bulgaria	201	77	74	3.9%	-128	-63%	-3	-4%	T1,T2	D
Croatia	25	13	13	0.7%	-12	-49%	0	2%	T2	CS
Cyprus	17	16	17	0.9%	-1	-3%	0	1%	T1	D
Czechia	113	80	81	4.2%	-32	-28%	1	1%	T2	CS,D
Denmark	46	65	69	3.6%	23	51%	4	6%	T2	D
Estonia	13	4	4	0.2%	-8	-65%	0	4%	T1	D
Finland	29	39	38	2.0%	9	32%	-1	-2%	T2	D
France	123	128	128	6.7%	5	4%	-1	-1%	T2	CS,D
Germany	99	123	123	6.5%	24	24%	0	0%	T2	CS,D
Greece	30	26	26	1.4%	-4	-12%	0	0%	D	D
Hungary	83	51	46	2.4%	-36	-44%	-4	-8%	T1,T2	CS,D
Ireland	11	13	13	0.7%	2	15%	0	-2%	T2	CS,D
Italy	292	364	352	18.6%	60	20%	-12	-3%	T2	CS,D
Latvia	20	8	8	0.4%	-12	-61%	0	-5%	T1,T2	D
Lithuania	16	17	17	0.9%	0	3%	0	-1%	T1	D
Luxembourg	0	1	1	0.0%	0	178%	0	4%	T2	CS
Malta	1	1	1	0.1%	0	-6%	0	4%	T1,T2	CS,D
Netherlands	62	82	82	4.3%	21	33%	0	0%	NA	NA
Poland	163	70	72	3.8%	-91	-56%	2	3%	T1,T2	CS,D
Portugal	60	45	46	2.4%	-14	-23%	1	3%	T2	CS,D
Romania	67	44	42	2.2%	-25	-37%	-1	-3%	T2	D
Slovakia	10	8	8	0.4%	-2	-23%	0	6%	T1	CS
Slovenia	4	4	4	0.2%	0	11%	0	4%	T1	D
Spain	70	94	93	4.9%	23	34%	-1	-1%	T1,T2	D
Sweden	46	58	57	3.0%	11	25%	-1	-2%	CS,T2	CS,D
United Kingdom	382	432	445	23.5%	63	16%	13	3%	T2	CS,D
EU-28	**2 002**	**1 896**	**1 896**	**100%**	**-106**	**-5%**	**0**	**0%**	**-**	**-**
Iceland	1	1	1	0.1%	0	-12%	0	-3%	-	-
United Kingdom (KP)	382	432	445	23.5%	63	16%	13	3%	T2	CS,D
EU-28 + ISL	**2 004**	**1 897**	**1 897**	**100%**	**-106**	**-5%**	**0**	**0%**	**-**	**-**

3.B.2.4.7 - Poultry - Emissions

Largest contribution to other livestock emissions comes from sub-category poultry with 54% of total N_2O emissions. Other animal types with high emissions are horses with a share of 22% and Other Other Livestock with a share of 13%. Here only the most important animal type Poultry is discussed.

Emissions in source category *3.B.2.4.7 - Poultry* decreased clearly in EU28+ISL by 14% or 169 kt CO_2-eq in the period 1990 to 2017. Figure 5.45 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from manure management for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 88% of the total. Emissions decreased in nineteen countries and increased in nine countries. The largest decreases occurred in Bulgaria and the Czech Republic with a total absolute decrease of 150 kt CO_2-eq. The largest increases occurred in Sweden and Germany, with a total absolute increase of 39 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 EU28+ISL by 4.8% or 78.7 million heads in the period 1990 to 2017. Figure 5.46 shows the trend of poultry population indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 population for the different Member States along the inventory period. The ten countries with the highest population accounted together for 85.3% of the total. Population decreased in thirteen countries and increased in sixteen countries. The four countries with the largest decreases were Romania, Poland, Hungary and Bulgaria with a total absolute decrease of 127 million heads. The four countries with the largest increases were Italy, France, the United Kingdom and Germany, with a total absolute increase of 167 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 EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017

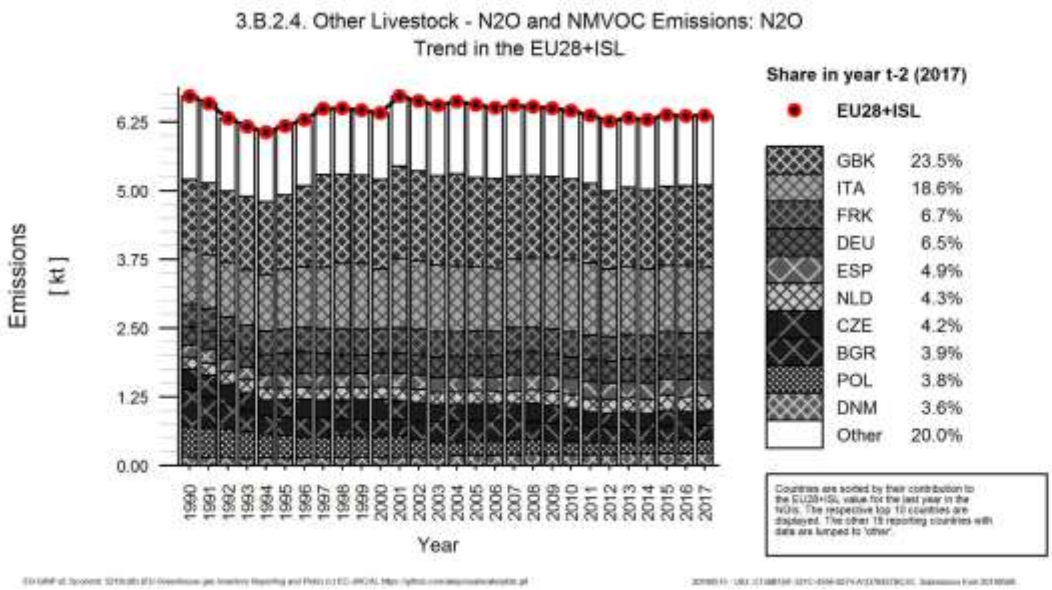


Figure 5.45: 3.B.2.4.7 - Poultry: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017

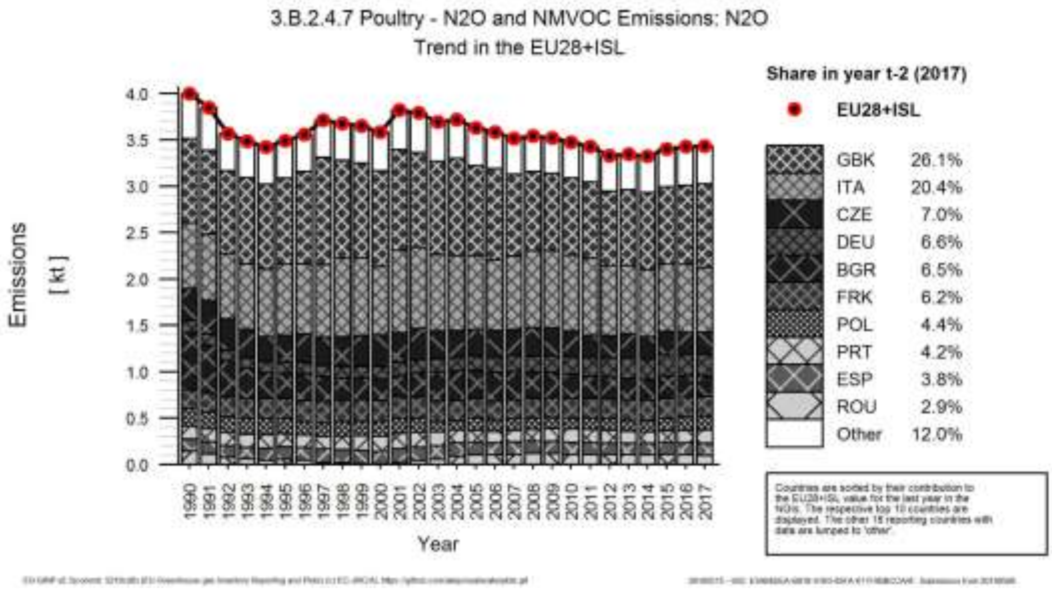
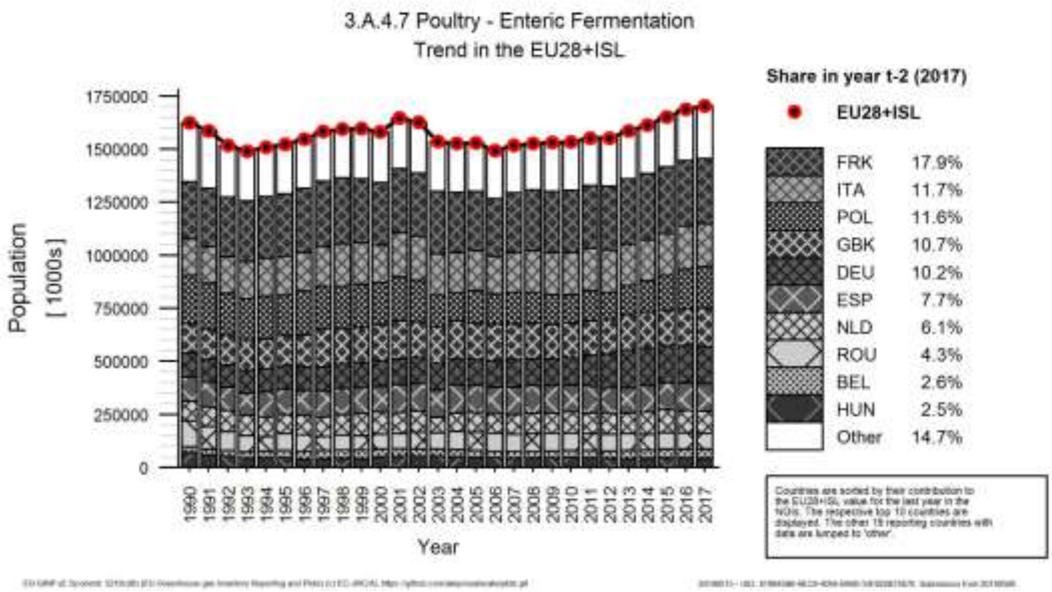


Figure 5.46: 3.A.4.7 - Poultry: Trend in population in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



5.3.3.2 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.2.5 - Manure Management - Indirect Emissions - Emissions

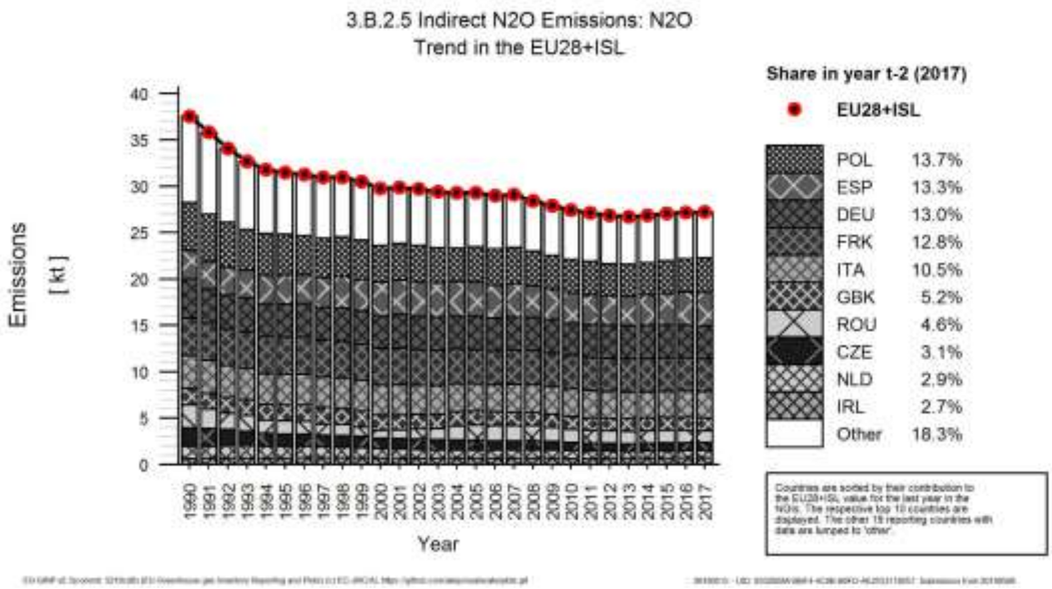
N_2O emissions in source category *3.B.2.5 - Manure Management - Indirect Emissions - Indirect N_2O emissions* are 0.17% of total EU28+ISL GHG emissions and 3.1% of total EU28+ISL N_2O emissions. They make 1.8% of total agricultural emissions and 4.3% of total agricultural N_2O emissions.

Total GHG and N_2O emissions by Member State from 3.B.2.5 *Manure Management - Indirect Emissions* are shown in Table 5.32 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2017). Values are given in kt CO_2-eq. Between 1990 and 2017, N_2O emission in this source category decreased by 27% or 3.1 Mt CO_2-eq. The decrease was largest in Lithuania in relative terms (77%) and in Poland in absolute terms (431 kt CO_2-eq). From 2016 to 2017 emissions in the current category increased by 0.2%. Figure 5.47 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from manure management - indirect emissions for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 81.7% of the total. 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 1.1 Mt CO_2-eq. The largest increases occurred in Ireland and Spain, with a total absolute increase of 201 kt CO_2-eq.

Table 5.32 3.B.2.5 - Manure Management - Indirect Emissions: Member States' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	108	119	121	1.5%	14	13%	2	2%
Belgium	192	157	156	1.9%	-36	-19%	-1	-1%
Bulgaria	367	102	101	1.2%	-266	-72%	-1	-1%
Croatia	216	112	104	1.3%	-113	-52%	-8	-7%
Cyprus	24	27	28	0.3%	3	13%	1	3%
Czechia	592	257	252	3.1%	-339	-57%	-5	-2%
Denmark	198	137	139	1.7%	-59	-30%	2	1%
Estonia	56	23	23	0.3%	-34	-60%	0	0%
Finland	99	90	88	1.1%	-11	-11%	-2	-2%
France	1 199	1 057	1 040	12.8%	-158	-13%	-17	-2%
Germany	1 257	1 057	1 052	13.0%	-205	-16%	-5	-1%
Greece	157	146	145	1.8%	-13	-8%	-2	-1%
Hungary	350	164	160	2.0%	-191	-54%	-4	-3%
Ireland	191	211	215	2.7%	25	13%	4	2%
Italy	1 068	859	855	10.5%	-213	-20%	-5	-1%
Latvia	109	31	31	0.4%	-78	-72%	0	0%
Lithuania	397	96	91	1.1%	-306	-77%	-5	-5%
Luxembourg	18	15	15	0.2%	-2	-12%	0	1%
Malta	7	5	5	0.1%	-1	-22%	0	-2%
Netherlands	390	231	235	2.9%	-155	-40%	4	2%
Poland	1 545	1 062	1 114	13.7%	-431	-28%	52	5%
Portugal	115	82	83	1.0%	-32	-28%	1	2%
Romania	746	391	373	4.6%	-373	-50%	-18	-5%
Slovakia	206	75	77	0.9%	-129	-63%	2	3%
Slovenia	43	29	29	0.4%	-14	-32%	0	-2%
Spain	901	1 060	1 078	13.3%	177	20%	18	2%
Sweden	103	81	81	1.0%	-22	-21%	0	0%
United Kingdom	520	417	420	5.2%	-99	-19%	4	1%
EU-28	**11 173**	**8 094**	**8 111**	**100%**	**-3 062**	**-27%**	**17**	**0%**
Iceland	10	10	9	0.1%	-1	-9%	0	-2%
United Kingdom (KP)	520	417	420	5.2%	-99	-19%	4	1%
EU-28 + ISL	**11 183**	**8 104**	**8 121**	**100%**	**-3 063**	**-27%**	**17**	**0%**

Figure 5.47: 3.B.2.5 - Manure Management - Indirect Emissions: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



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 EU28+ISL slightly between 1990 and 2017 by 1.2% or 0.00412 kg/head/year. 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 2017 for all Member States and EU28+ISL. The implied emission factor decreased in ten countries and increased in seventeen countries. The largest decreases occurred in Portugal and Croatia with a mean absolute value of 0.1 kg/head/year. The four countries with the largest increases were Finland, the Czech Republic, Estonia and Bulgaria with a mean absolute value of 0.3 kg/head/year.

Table 5.33 3.B.2.1 - Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2017		Member State	1990	2017
Austria	0.34	0.457	|	Ireland	0.13	0.134
Belgium	0.64	0.580	|	Iceland	0.03	0.036
Bulgaria	1.23	1.765	|	Italy	0.55	0.459
Cyprus	0.51	0.497	|	Lithuania	0.29	0.360
Czech Republic	0.68	1.012	|	Luxembourg	0.34	0.298
Germany	0.37	0.428	|	Latvia	0.28	0.328
Denmark	0.49	0.601	|	Malta	0.53	0.515
Spain	0.16	0.125	|	Netherlands	0.23	0.305
Estonia	0.23	0.325	|	Poland	0.31	0.392
Finland	0.32	0.527	|	Portugal	0.19	0.096
France	0.22	0.227	|	Romania	0.14	0.173
United Kingdom	0.58	0.568	|	Slovakia	0.39	0.389
United Kingdom (KP)	0.58	0.568	|	Slovenia	0.08	0.065
Greece	0.40	0.401	|	Sweden	0.34	0.363
Croatia	0.36	0.221	|	**EU28+ISL**	**0.36**	**0.362**
Hungary	0.58	0.731	|			

3.B.2.1 - Dairy Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.1 - Dairy Cattle* increased in EU28+ISL clearly between 1990 and 2017 by 13.1% or 0.0648 kg/head/year. Figure 5.48 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.34 shows the implied emission factor for N_2O emissions in source category *3.B.2.1 - Dairy Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. The implied emission factor decreased in nine countries and increased in twenty countries. The largest decrease occurred in Croatia with an absolute value of 0.1 kg/head/year. The four countries with the largest increases were Finland, Poland, Estonia and the Czech Republic with a mean absolute value of 0.3 kg/head/year.

Figure 5.48: 3.B.2.1 - Dairy Cattle: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

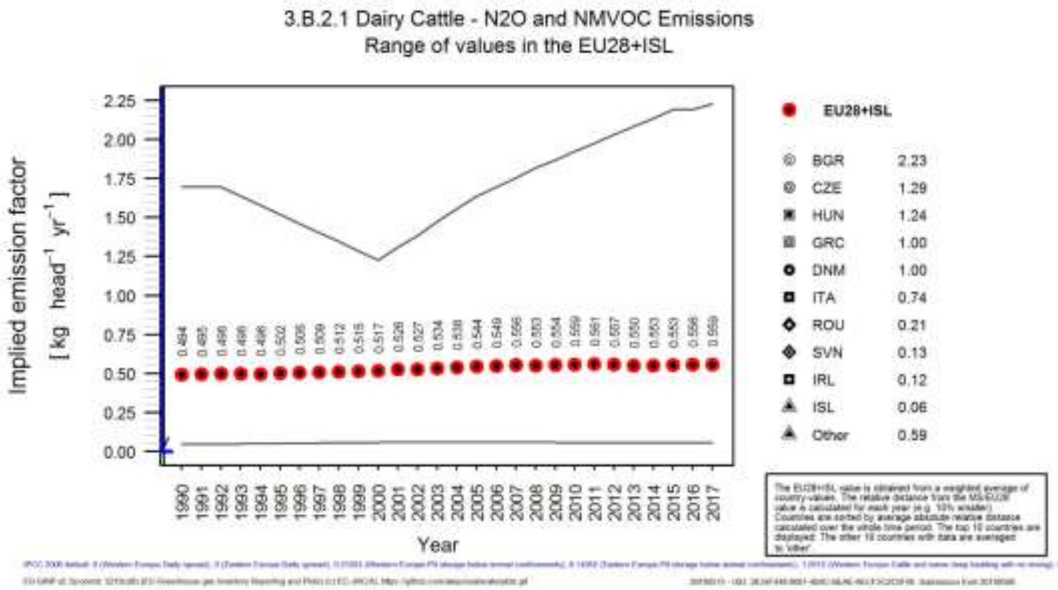


Table 5.34 3.B.2.1 - Dairy Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2017	Member State	1990	2017
Austria	0.444	0.653	Ireland	0.128	0.121
Belgium	0.845	0.716	Iceland	0.044	0.056
Bulgaria	1.696	2.228	Italy	0.866	0.742
Cyprus	0.759	0.720	Lithuania	0.375	0.503
Czech Republic	0.873	1.290	Luxembourg	0.654	0.629
Germany	0.543	0.596	Latvia	0.596	0.717
Denmark	0.876	1.002	Malta	0.757	0.757
Spain	0.314	0.420	Netherlands	0.340	0.412
Estonia	0.374	0.583	Poland	0.402	0.634
Finland	0.484	0.787	Portugal	0.472	0.452
France	0.393	0.413	Romania	0.169	0.211
United Kingdom	0.412	0.505	Slovakia	0.752	0.725
United Kingdom (KP)	0.412	0.505	Slovenia	0.115	0.132
Greece	0.784	1.004	Sweden	0.609	0.759
Croatia	0.392	0.256	**EU28+ISL**	**0.494**	**0.559**
Hungary	0.883	1.237			

3.B.2.1 - Dairy Cattle - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.2.1 - Dairy Cattle*, increased in EU28+ISL considerably between 1990 and 2017 by 22.1% or 20.4 kg/head/year. Figure 5.49 shows the trend of the nitrogen excretion rate in EU28+ISL 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 - Dairy Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. Nitrogen excretion rate decreased in two countries and increased in 22 countries. It was in 2017 at the level of 1990 in five countries. Decreases occurred in the Netherlands and Slovakia with a mean absolute value of 2 kg/head/year. The four countries with the largest increases were Hungary, Finland, Estonia and Slovenia with a mean absolute value of 38 kg/head/year.

Figure 5.49: 3.B.2.1 - Dairy Cattle: Trend in nitrogen excretion rate in the EU28+ISL and range of values reported by countries

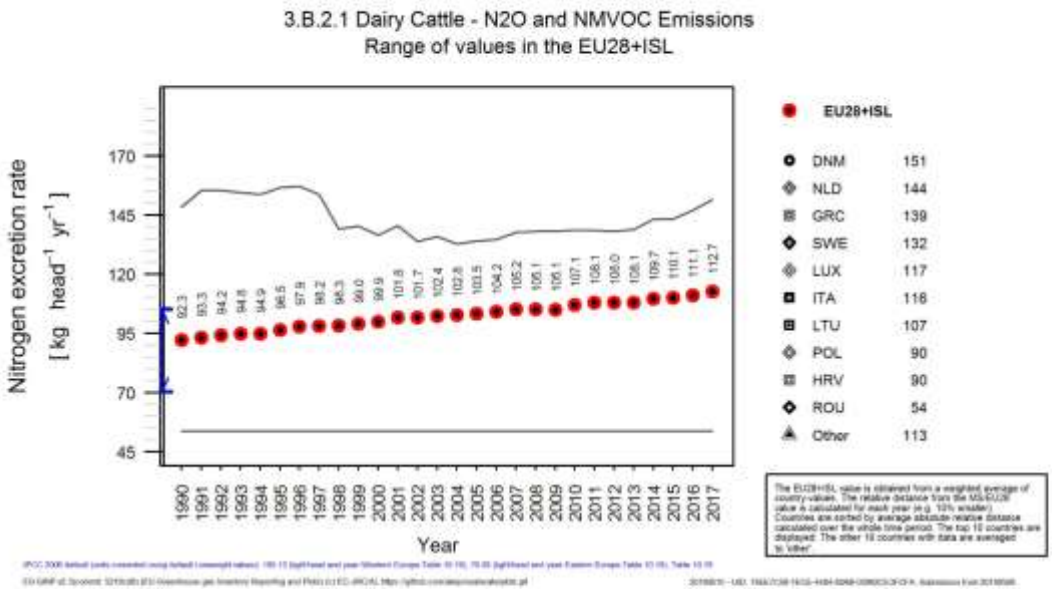


Table 5.35 3.B.2.1 - Dairy Cattle: Member States' and EU28+ISL nitrogen excretion rate (kg/head/year)

Member State	1990	2017	Member State	1990	2017
Austria	77	104	Ireland	96	103
Belgium	114	120	Iceland	72	95
Bulgaria	98	98	Italy	116	116
Cyprus	96	96	Lithuania	80	107
Czech Republic	98	137	Luxembourg	111	117
Germany	97	122	Latvia	86	114
Denmark	129	151	Malta	96	96
Spain	85	113	Netherlands	149	144
Estonia	85	123	Poland	65	90
Finland	91	133	Portugal	86	117
France	102	114	Romania	54	54
United Kingdom	87	110	Slovakia	105	105
United Kingdom (KP)	87	110	Slovenia	82	115

Greece	108	139	|	Sweden	102	132
Croatia	70	90	|	**EU28+ISL**	**92**	**113**
Hungary	83	123	|			

3.B.2.1 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.1 - Non-Dairy Cattle* increased in EU28+ISL barely between 1990 and 2017 by 0.17% or 0.00049 kg/head/year. Figure 5.50 shows the trend of the implied emission factor in EU28+ISL 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 - Non-Dairy Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. The implied emission factor decreased in ten countries and increased in seventeen countries. The largest decreases occurred in Portugal and Croatia with a mean absolute value of 0.1 kg/head/year. The four countries with the largest increases were Finland, the Czech Republic, Bulgaria and Austria with a mean absolute value of 0.3 kg/head/year.

Figure 5.50: 3.B.2.1 - Non-Dairy Cattle: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

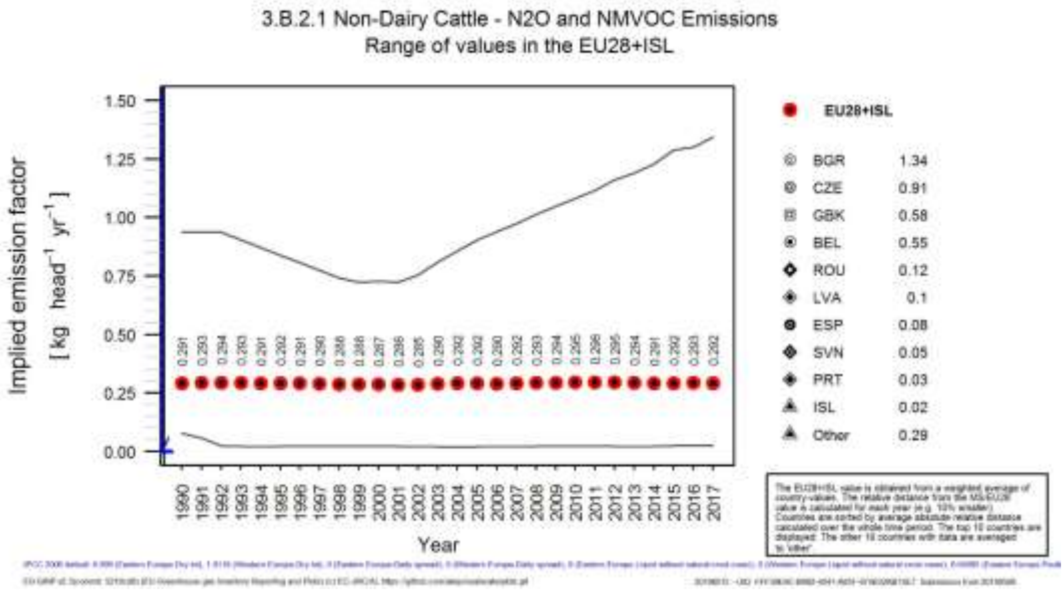


Table 5.36 3.B.2.1 - Non-Dairy Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2017		Member State	1990	2017
Austria	0.276	0.381	|	Ireland	0.130	0.137
Belgium	0.572	0.550	|	Iceland	0.021	0.025
Bulgaria	0.936	1.343	|	Italy	0.384	0.337
Cyprus	0.332	0.314	|	Lithuania	0.242	0.266
Czech Republic	0.578	0.915	|	Luxembourg	0.217	0.195
Germany	0.285	0.340	|	Latvia	0.095	0.099
Denmark	0.292	0.367	|	Malta	0.354	0.331
Spain	0.090	0.082	|	Netherlands	0.167	0.229
Estonia	0.140	0.190	|	Poland	0.215	0.240

Finland	0.223	0.411	|	Portugal	0.078	0.034
France	0.167	0.183	|	Romania	0.092	0.120
United Kingdom	0.629	0.583	|	Slovakia	0.262	0.248
United Kingdom (KP)	0.629	0.583	|	Slovenia	0.058	0.045
Greece	0.241	0.273	|	Sweden	0.209	0.255
Croatia	0.323	0.203	|	**EU28+ISL**	**0.291**	**0.292**
Hungary	0.422	0.531	|			

3.B.2.1 - 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 - Non-Dairy Cattle*, increased in EU28+ISL moderately between 1990 and 2017 by 7.5% or 3.58 kg/head/year. Figure 5.51 shows the trend of the nitrogen excretion rate in EU28+ISL 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 - Non-Dairy Cattle* for the years 1990 and 2017 for all Member States and EU28+ISL. Nitrogen excretion rate decreased in five countries and increased in 21 countries. It was in 2017 at the level of 1990 in one country. The largest decrease occurred in the Netherlands with an absolute value of 16 kg/head/year. The largest increases occurred in Finland and Latvia with a mean absolute value of 14 kg/head/year.

Figure 5.51: 3.B.2.1 - Non-Dairy Cattle: Trend in nitrogen excretion rate in the EU28+ISL and range of values reported by countries

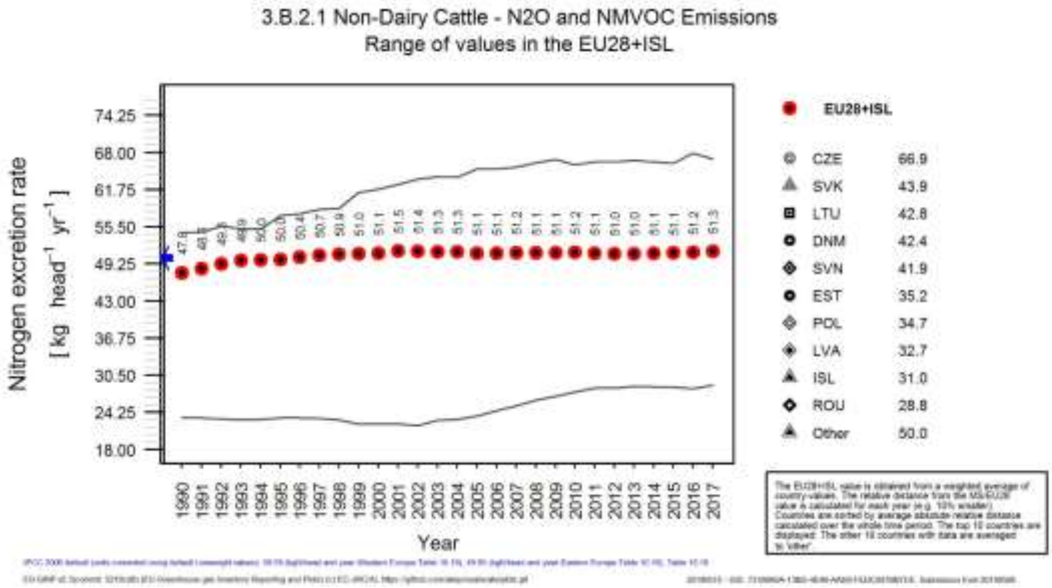


Table 5.37 3.B.2.1 - Non-Dairy Cattle: Member States' and EU28+ISL nitrogen excretion rate (kg/head/year)

Member State	1990	2017		Member State	1990	2017
Austria	40	46	|	Ireland	55	55
Belgium	54	54	|	Iceland	29	31
Bulgaria	54	58	|	Italy	50	51
Cyprus	42	42	|	Lithuania	41	43
Czech Republic	55	67	|	Luxembourg	46	47

Member State	1990	2017		Member State	1990	2017
Germany	43	49	|	Latvia	23	33
Denmark	36	42	|	Malta	45	42
Spain	57	58	|	Netherlands	57	41
Estonia	32	35	|	Poland	33	35
Finland	34	52	|	Portugal	44	50
France	58	60	|	Romania	29	29
United Kingdom	45	45	|	Slovakia	40	44
United Kingdom (KP)	45	45	|	Slovenia	35	42
Greece	48	54	|	Sweden	39	42
Croatia	55	50	|	**EU28+ISL**	**48**	**51**
Hungary	44	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 EU28+ISL considerably between 1990 and 2017 by 17.2% or 0.0112 kg/head/year. Figure 5.52 shows the trend of the implied emission factor in EU28+ISL 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 2017 for all Member States and EU28+ISL. The implied emission factor decreased in twenty countries and increased in seven countries. It was in 2017 at the level of 1990 in one country. No data were available for Iceland. The four countries with the largest decreases were Estonia, Germany and Bulgaria with a mean absolute value of 0.011 kg/head/year. The three countries with the largest increases were Estonia, Germany and Bulgaria with a mean absolute value of 0.011 kg/head/year.

Figure 5.52: 3.B.2.3 - Swine: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

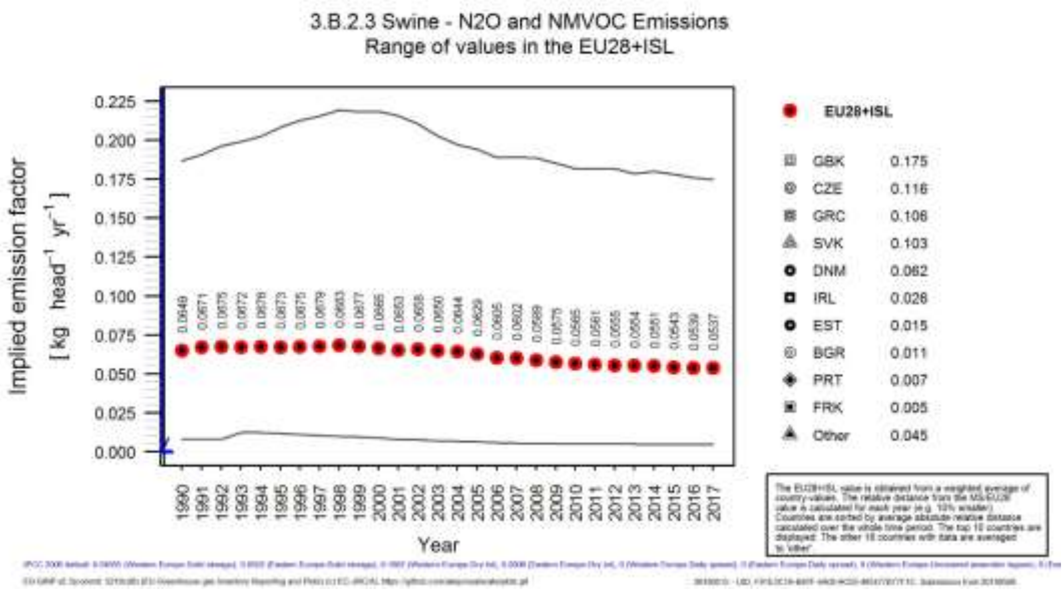


*Table 5.38 3.B.2.3 - Swine: Member States' and EU28+ISL implied emission factor (kg/head/year)**

Member State	1990	2017		Member State	1990	2017
Austria	0.0554	0.0452	|	Hungary	0.0623	0.0610
Belgium	0.0425	0.0311	|	Ireland	0.0277	0.0265
Bulgaria	0.0079	0.0110	|	Italy	0.0944	0.0942
Cyprus	0.0935	0.0400	|	Lithuania	0.1437	0.0127
Czech Republic	0.1221	0.1162	|	Luxembourg	0.0534	0.0458
Germany	0.0477	0.0724	|	Latvia	0.0964	0.0533
Denmark	0.1440	0.0625	|	Malta	0.0326	0.0332
Spain	0.0469	0.0365	|	Netherlands	0.0338	0.0244
Estonia	0.0088	0.0148	|	Poland	0.0784	0.0829
Finland	0.0652	0.0324	|	Portugal	0.0145	0.0066
France	0.0124	0.0046	|	Romania	0.0402	0.0441
United Kingdom	0.1867	0.1749	|	Slovakia	0.1038	0.1027
United Kingdom (KP)	0.1867	0.1749	|	Slovenia	0.0387	0.0291
Greece	0.1061	0.1061	|	Sweden	0.0626	0.0678
Croatia	0.0549	0.0106	|	**EU28+ISL**	**0.0649**	**0.0537**

**not reported by 1 MS (ISL)*

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 EU28+ISL clearly between 1990 and 2017 by 11.1% or 1.37 kg/head/year. Figure 5.53 shows the trend of the nitrogen excretion rate in EU28+ISL 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 2017 for all Member States and EU28+ISL. Nitrogen excretion rate decreased in 22 countries and increased in six countries. It was in 2017 at the level of 1990 in one country. 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 Estonia 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 5.53: 3.B.2.3 - Swine: Trend in nitrogen excretion rate in the EU28+ISL and range of values reported by countries

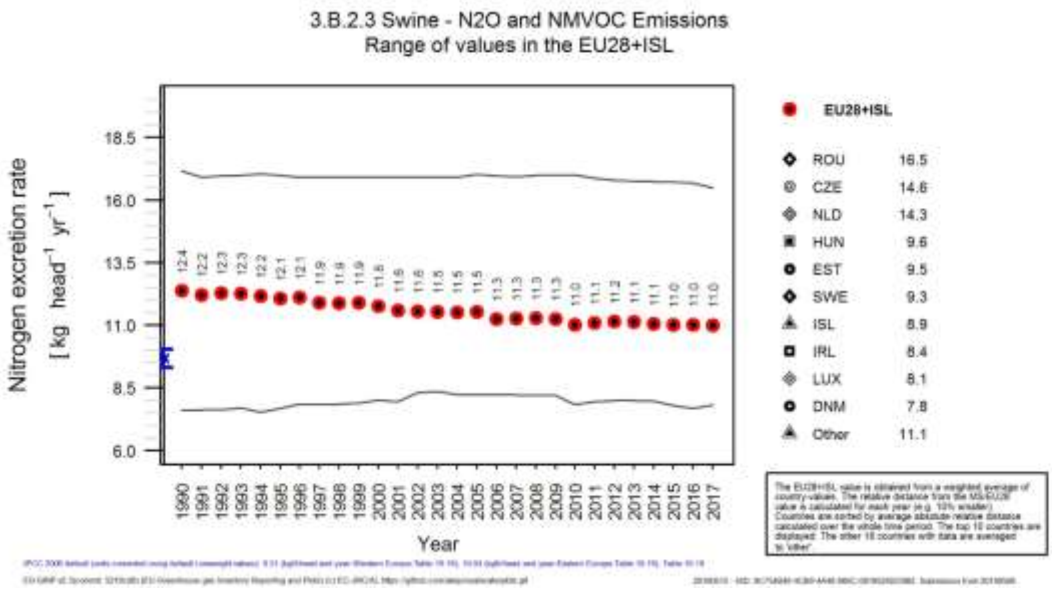


Table 5.39 3.B.2.3 - Swine: Member States' and EU28+ISL nitrogen excretion rate (kg/head/year)

Member State	1990	2017		Member State	1990	2017
Austria	9.8	9.4	|	Ireland	8.8	8.4
Belgium	12.5	9.3	|	Iceland	9.2	8.9
Bulgaria	12.5	11.7	|	Italy	12.0	12.3
Cyprus	11.9	11.3	|	Lithuania	12.4	11.8
Czech Republic	15.4	14.6	|	Luxembourg	8.7	8.1
Germany	12.1	13.2	|	Latvia	12.3	10.7
Denmark	11.9	7.8	|	Malta	10.4	10.6
Spain	12.1	9.6	|	Netherlands	17.2	14.3
Estonia	8.9	9.5	|	Poland	10.0	10.5
Finland	12.2	11.9	|	Portugal	10.3	9.2
France	10.6	9.7	|	Romania	16.9	16.5
United Kingdom	13.3	10.3	|	Slovakia	12.7	12.5
United Kingdom (KP)	13.3	10.3	|	Slovenia	12.7	12.2
Greece	13.5	13.5	|	Sweden	7.6	9.3
Croatia	13.5	12.1	|	**EU28+ISL**	**12.4**	**11.0**
Hungary	9.7	9.6				

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* decreased in EU28+ISL considerably between 1990 and 2017 by 17.8% or 0.000464 kg/head/year. Figure 5.54 shows the trend of the implied emission factor in EU28+ISL 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 2017 for all Member States and EU28+ISL. The implied emission factor decreased in twenty countries and increased in seven countries. It was in 2017 at the level of 1990 in one country. No data were available for the Netherlands. The four countries with the largest decreases were Lithuania, Germany and Romania with a mean absolute value of 0.00021 kg/head/year. The largest increase occurred in Lithuania with an absolute value of 0.00028 kg/head/year.

Figure 5.54: 3.B.2.4.7 - Poultry: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

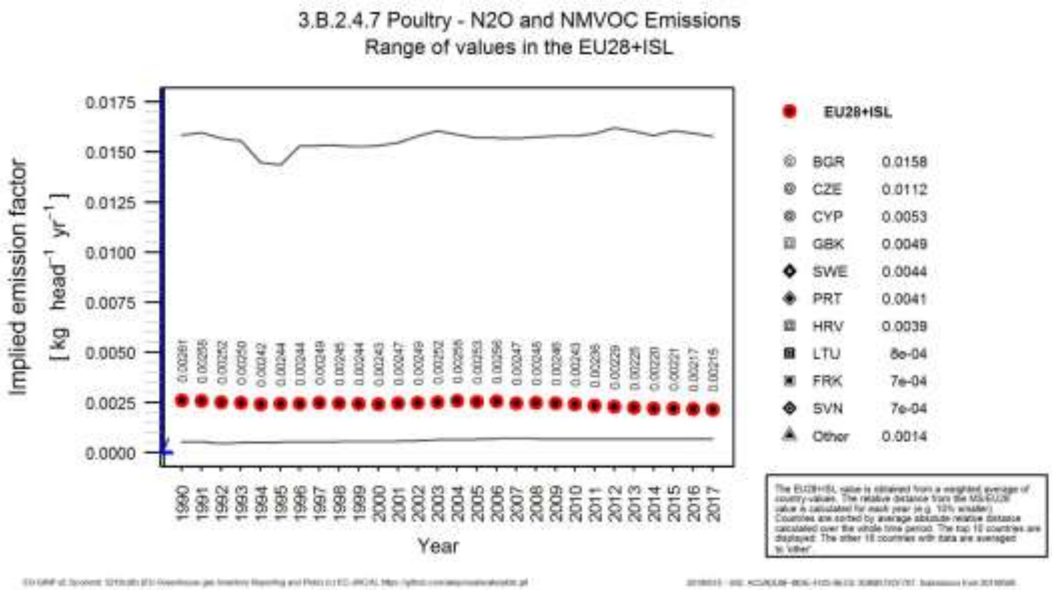


*Table 5.40 3.B.2.4.7 - Poultry: Member States' and EU28+ISL implied emission factor (kg/head/year)**

Member State	1990	2017		Member State	1990	2017
Austria	0.00090	0.00077	|	Hungary	0.00135	0.00150
Belgium	0.00094	0.00092	|	Ireland	0.00109	0.00104
Bulgaria	0.01585	0.01578	|	Iceland	0.00179	0.00082
Cyprus	0.00715	0.00530	|	Italy	0.00409	0.00350
Czech Republic	0.01093	0.01120	|	Lithuania	0.00053	0.00081
Germany	0.00110	0.00130	|	Luxembourg	0.00086	0.00085
Denmark	0.00112	0.00073	|	Latvia	0.00342	0.00201
Spain	0.00112	0.00099	|	Malta	0.00131	0.00132
Estonia	0.00383	0.00335	|	Poland	0.00085	0.00076
Finland	0.00288	0.00170	|	Portugal	0.00435	0.00406
France	0.00074	0.00070	|	Romania	0.00119	0.00136
United Kingdom	0.00654	0.00493	|	Slovakia	0.00181	0.00162
United Kingdom (KP)	0.00654	0.00493	|	Slovenia	0.00062	0.00068
Greece	0.00085	0.00085	|	Sweden	0.00473	0.00441
Croatia	0.00471	0.00392	|	**EU28+ISL**	**0.00261**	**0.00215**

**not reported by 1 MS (NDL)*

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 EU28+ISL moderately between 1990 and 2017 by 9% or 0.0579 kg/head/year. Figure 5.55 shows the trend of the nitrogen excretion rate in EU28+ISL 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 2017 for all Member States and EU28+ISL. Nitrogen excretion rate decreased in eighteen countries and increased in seven countries. It was in 2017 at the level of 1990 in three countries. No data were available for the Netherlands. The three countries with the largest decreases were Iceland, Denmark and the United Kingdom with a mean absolute value of 0.3 kg/head/year. The largest increase occurred in Lithuania with an absolute value of 0.1 kg/head/year.

Figure 5.55: 3.B.2.4.7 - Poultry: Trend in nitrogen excretion rate in the EU28+ISL and range of values reported by countries

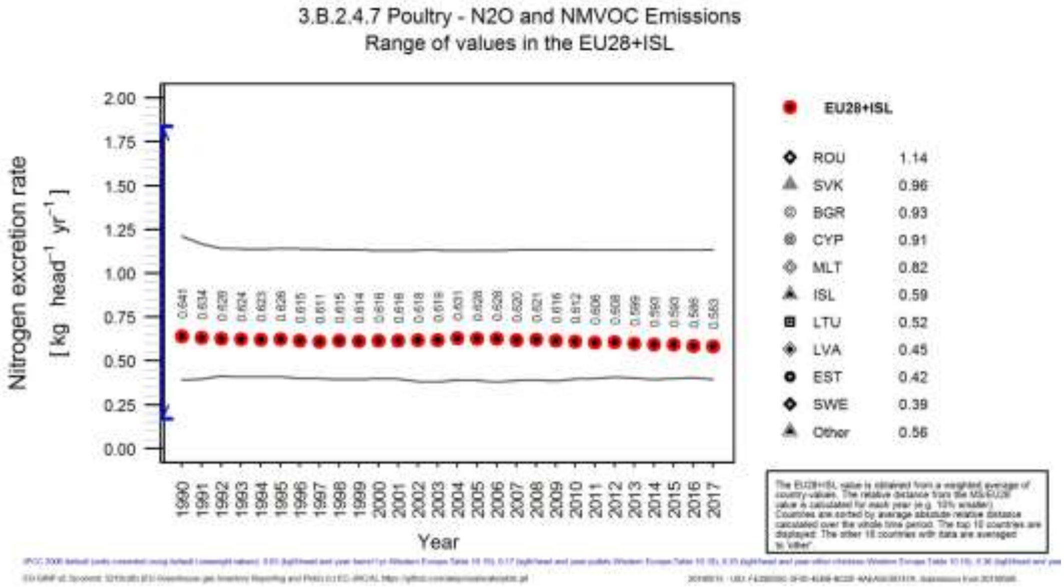


Table 5.41 3.B.2.4.7 - Poultry: Member States' and EU28+ISL nitrogen excretion rate (kg/head/year)

Member State	1990	2017		Member State	1990	2017
Austria	0.59	0.54	|	Hungary	0.48	0.56
Belgium	0.60	0.59	|	Ireland	0.60	0.55
Bulgaria	0.94	0.93	|	Iceland	1.21	0.59
Cyprus	0.91	0.91	|	Italy	0.52	0.50
Czech Republic	0.73	0.75	|	Lithuania	0.39	0.52
Germany	0.70	0.73	|	Luxembourg	0.55	0.54
Denmark	0.63	0.46	|	Latvia	0.45	0.45
Spain	0.71	0.63	|	Malta	0.82	0.82
Estonia	0.44	0.42	|	Poland	0.54	0.48
Finland	0.50	0.56	|	Portugal	0.55	0.53
France	0.49	0.48	|	Romania	1.15	1.14
United Kingdom	0.78	0.58	|	Slovakia	0.99	0.96
United Kingdom (KP)	0.78	0.58	|	Slovenia	0.47	0.51
Greece	0.50	0.50	|	Sweden	0.43	0.39
Croatia	0.70	0.53	|	**EU28+ISL**	**0.64**	**0.58**

The implied emission factor for N_2O emissions in source category *3.B.2.5 - Indirect N_2O emissions from manure management - Indirect N_2O emissions* decreased in EU28+ISL barely between 1990 and 2017 by 0.19% or 3.06e-05 kg N_2O/kg N. Figure 5.56 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.42 shows the implied emission factor for N_2O emissions in source category *3.B.2.5 - Indirect N_2O emissions from manure management - Indirect N_2O emissions* for the years 1990 and 2017 for all Member States and EU28+ISL. The implied emission factor decreased in four countries and increased in seven countries. It was in 2017 at the level of 1990 in eighteen countries. The three countries with the largest decreases were Spain, France and Latvia with a mean absolute value of 2.5e-12 kg N_2O/kg N. The three countries with the largest increases were the Netherlands, Croatia and Cyprus with a mean absolute value of 0.00015 kg N_2O/kg N.

Table 5.42 3.B.2.5 - Indirect N_2O emissions from manure management: Member States' and EU28+ISL implied emission factor (kg N_2O/kg N)

Member State	1990	2017		Member State	1990	2017
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	0.016	0.016	|	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	0.016	|	Romania	0.016	0.016
United Kingdom	0.016	0.016	|	Slovakia	0.016	0.016
United Kingdom (KP)	0.016	0.016	|	Slovenia	0.016	0.016
Greece	0.016	0.016	|	Sweden	0.016	0.016
Croatia	0.025	0.025	|	**EU28+ISL**	**0.016**	**0.016**
Hungary	0.016	0.016	|			

3.B.2.5 - Indirect N_2O emissions from leaching from manure management - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.5 - Indirect N_2O emissions from leaching from manure management - Indirect N_2O emissions* increased in EU28+ISL barely between 1990 and 2017 by 0.8%. Figure 5.56 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.42 shows the implied emission factor for N_2O emissions in source category *3.B.2.5 - Indirect N_2O emissions from leaching from manure management - Indirect N_2O emissions* for the years 1990 and 2017 for all Member States and EU28+ISL. The implied emission factor decreased in five countries and increased in six countries. It was in 2017 at the level of 1990 in four countries. No data were available for fourteen countries (Austria, Bulgaria, the Czech Republic, Germany, Denmark, Croatia, Ireland, Iceland, Luxembourg, Malta, the Netherlands, Slovakia, Slovenia and Sweden). A decrease is observed in Romania and Poland and an increase in Cyprus, but changes are irrelevant.

Figure 5.57: 3.B.2.5 - Indirect N_2O emissions from leaching from manure management: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

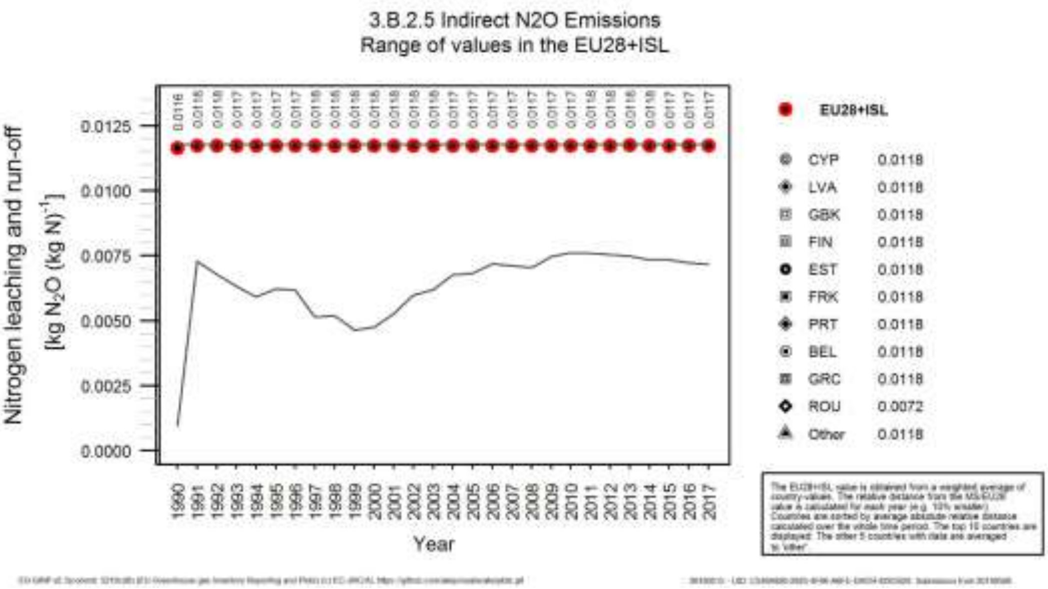


*Table 5.43 3.B.2.5 - Indirect N_2O emissions from leaching from manure management: Member States' and EU28+ISL implied emission factor (kg N_2O/kg N)**

Member State	1990	2017		Member State	1990	2017
Belgium	0.01179	0.0118	|	Hungary	0.01179	0.0118
Cyprus	0.00096	0.0118	|	Italy	0.01179	0.0118
Spain	0.01179	0.0118	|	Lithuania	0.01179	0.0118
Estonia	0.01179	0.0118	|	Latvia	0.01179	0.0118
Finland	0.01179	0.0118	|	Poland	0.01172	0.0117
France	0.01179	0.0118	|	Portugal	0.01179	0.0118
United Kingdom	0.01179	0.0118	|	Romania	0.00741	0.0072
United Kingdom (KP)	0.01179	0.0118	|	**EU28+ISL**	**0.01165**	**0.0117**
Greece	0.01179	0.0118	|			

**not reported by 14 MS*

5.3.4 Direct Emissions from Managed Soils - N_2O (CRF Source Category 3D1)

N_2O emissions in source category *3.D.1 - Direct N_2O Emissions From Managed Soils* are 2.8% of total EU28+ISL GHG emissions and 52% of total EU28+ISL N_2O emissions. They make 30.6% 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 Member States, Figure 5.59 shows the distribution of direct N_2O emissions from managed soils by emission source in all Member States and in the EU28+ISL. 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 EU28+ISL agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2017. 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.

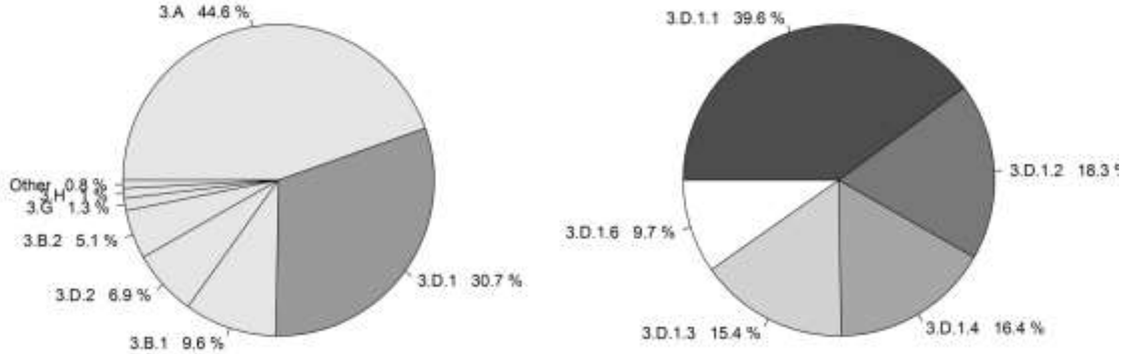
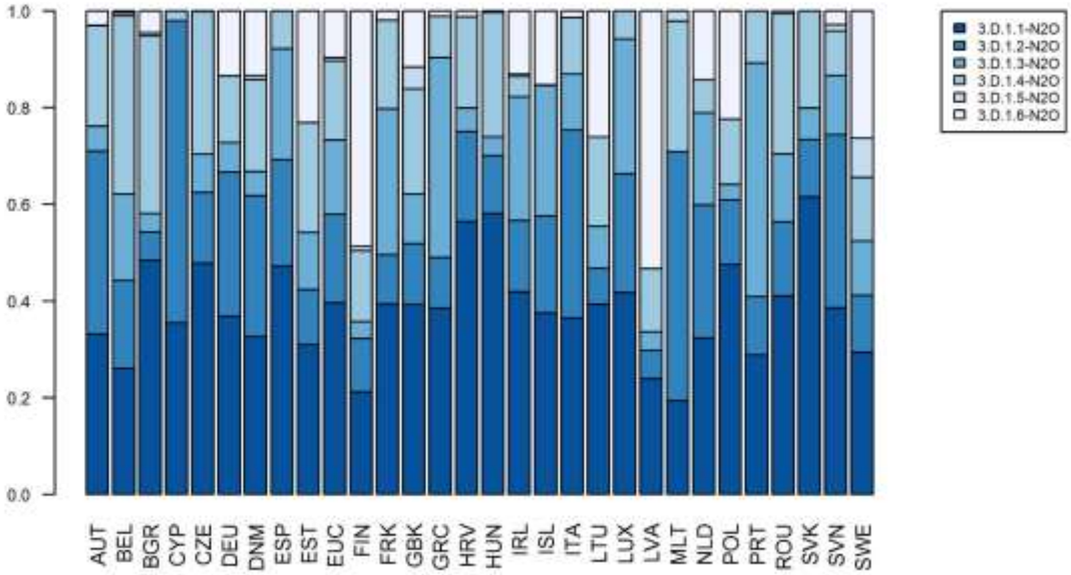


Figure 5.59: Decomposition of emissions in source category 3.D.1 - Direct N_2O Emissions From Managed Soils into its sub-categories by Member State in the year 2017. 3.D.1.1 inorganic N fertilisers, 3.D.1.2 organic N fertilisers, 3.D.1.3 urine and dung deposited by grazing animals, 3.D.1.4 crop residues 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 Member State from 3.D.1 *Direct N_2O Emissions From Managed Soils* are shown in Table 5.44 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2017). Values are given in kt CO_2-eq. Between 1990 and 2017, N_2O emission in this source category decreased by 14% or 22.2 Mt CO_2-eq. The decrease was largest in Slovakia in relative terms (48%) and in Poland in absolute terms (2.7 Mt CO_2-eq). From 2016 to 2017 emissions in the current category increased by 2.6%.

Table 5.44 3.D.1 - Direct N_2O Emissions From Managed Soils: Member States' contributions to total EU-GHG and N_2O emissions

Member States	GHG emissions in 1990 (kt CO_2-eq)	GHG emissions in 2016 (kt CO_2-eq)	GHG emissions in 2017 (kt CO_2-eq)	N_2O emissions in 1990 (kt CO_2-eq)	N_2O emissions in 2016 (kt CO_2-eq)	N_2O emissions in 2017 (kt CO_2-eq)
Austria	1,876	1,774	1,699	1,876	1,774	1,699
Belgium	3,363	2,484	2,696	3,363	2,484	2,696
Bulgaria	4,252	3,389	3,395	4,252	3,389	3,395

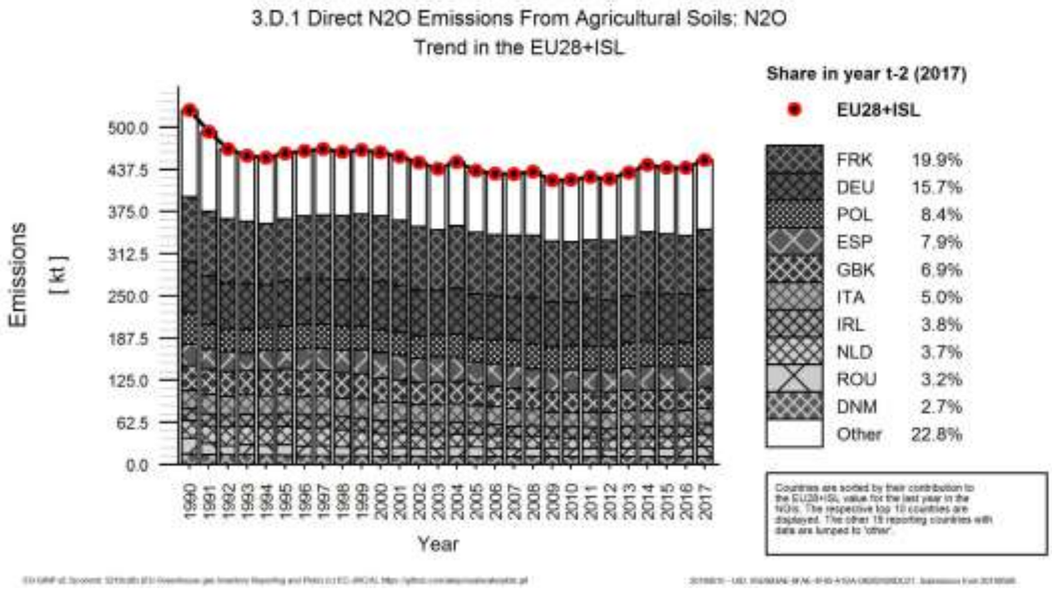
Member States	GHG emissions in 1990 (kt CO_2-eq)	GHG emissions in 2016 (kt CO_2-eq)	GHG emissions in 2017 (kt CO_2-eq)	N_2O emissions in 1990 (kt CO_2-eq)	N_2O emissions in 2016 (kt CO_2-eq)	N_2O emissions in 2017 (kt CO_2-eq)
Croatia	1,056	724	816	1,056	724	816
Cyprus	118	101	104	118	101	104
Czech Republic	4,282	2,787	2,800	4,282	2,787	2,800
Denmark	4,580	3,498	3,574	4,580	3,498	3,574
Estonia	944	542	565	944	542	565
Finland	3,301	3,050	3,078	3,301	3,050	3,078
France	28,532	26,033	26,771	28,532	26,033	26,771
Germany	22,618	21,202	21,096	22,618	21,202	21,096
Greece	3,577	2,259	2,263	3,577	2,259	2,263
Hungary	3,235	3,213	3,345	3,235	3,213	3,345
Ireland	5,314	4,891	5,143	5,314	4,891	5,143
Italy	8,039	6,889	6,720	8,039	6,889	6,720
Latvia	2,233	1,511	1,516	2,233	1,511	1,516
Lithuania	2,689	2,003	1,993	2,689	2,003	1,993
Luxembourg	179	153	153	179	153	153
Malta	16	14	14	16	14	14
Netherlands	7,654	4,791	4,921	7,654	4,791	4,921
Poland	14,088	10,644	11,340	14,088	10,644	11,340
Portugal	1,807	1,640	1,647	1,807	1,640	1,647
Romania	7,003	3,983	4,354	7,003	3,983	4,354
Slovakia	1,807	998	933	1,807	998	933
Slovenia	332	336	329	332	336	329
Spain	9,209	10,145	10,622	9,209	10,145	10,622
Sweden	3,219	2,875	3,162	3,219	2,875	3,162
United Kingdom	11,186	9,000	9,230	11,186	9,000	9,230
EU-28	**156,510**	**130,930**	**134,279**	**156,510**	**130,930**	**134,279**
Iceland	170	154	163	170	154	163
United Kingdom (KP)	11,186	9,000	9,230	11,186	9,000	9,230
EU-28 + ISL	**156,679**	**131,084**	**134,442**	**156,679**	**131,084**	**134,442**

5.3.4.1 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 clearly in EU28+ISL by 14% or 22.2 Mt CO_2-eq in the period 1990 to 2017. Figure 5.60 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from direct N_2O emissions from managed soils for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 77.2% of the total. Emissions decreased in 27 countries and increased in two countries. The three countries with the largest decreases were Poland, the Netherlands and Romania with a total absolute decrease of 8.1 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 EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



The main driving force of direct N_2O emissions from agricultural soils is the use of nitrogen fertiliser and animal manure, which were 22% and 12% below 1990 levels in 2017, 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 considerably in EU28+ISL by 22% or 15.1 Mt CO_2-eq in the period 1990 to 2017. Figure 5.61 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from inorganic N fertilisers for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 79.5% of the total. Emissions decreased in 26 countries and increased in three countries. The three countries with the largest decreases were the United Kingdom, Germany and France with a total absolute decrease of 6.5 Mt CO_2-eq. The largest increases occurred in Hungary, with a total absolute increase of 267 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 considerably in EU28+ISL by 22% or 3.2 kt N/year in the period 1990 to 2017. Figure 5.62 shows the trend of application of inorganic fertilizers indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O application of inorganic fertilizers from inorganic N fertilisers for the different Member States along the inventory period. The ten countries with the highest application of inorganic fertilizers accounted together for 80.5% of the total. 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 1.4 kt N/year. The largest increases occurred in Hungary, with a total absolute increase of 57 kt N/year.

Figure 5.61: 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017

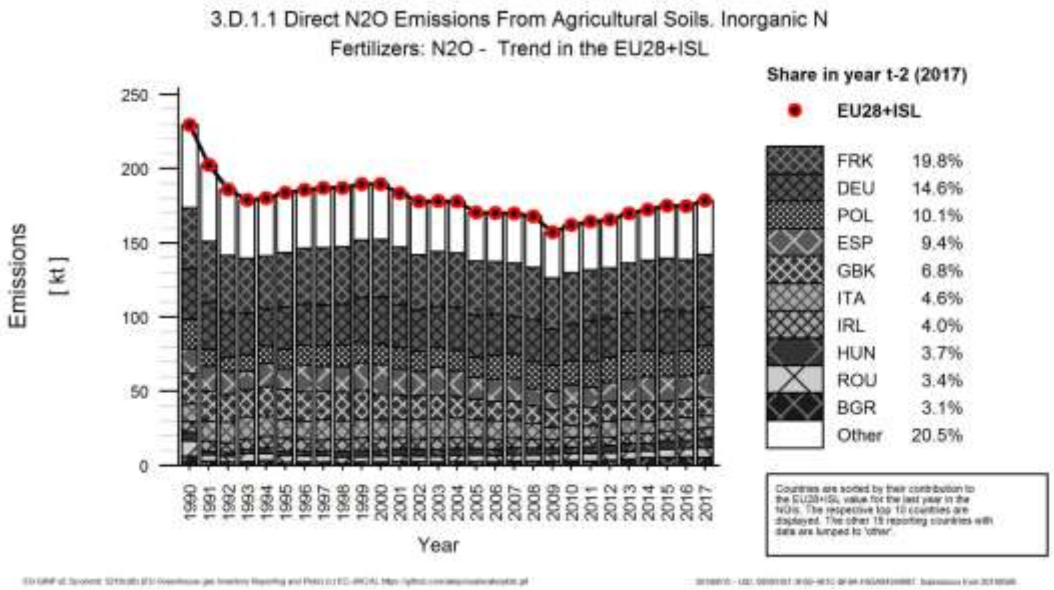
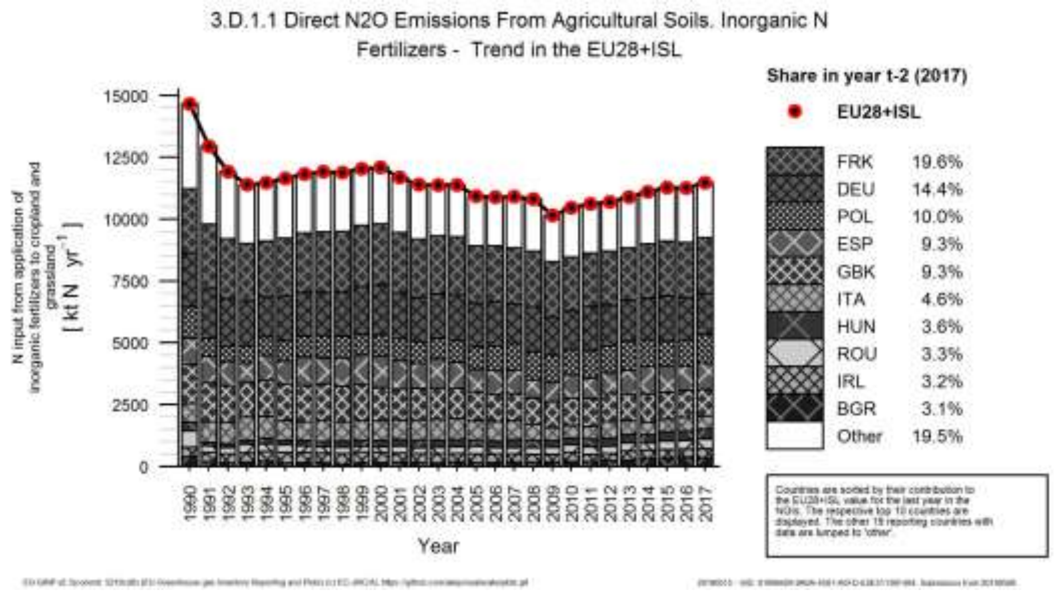


Figure 5.62: 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Trend in application of inorganic fertilizers in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



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 moderately in EU28+ISL by 9.1% or 2.5 Mt CO_2-eq in the period 1990 to 2017. Figure 5.63 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from organic N fertilisers for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 83.3% of the total. Emissions decreased in eighteen countries and increased in eleven countries. The four countries with the largest decreases were Romania, Poland, the Czech Republic and Bulgaria with a total absolute decrease of 2.6 Mt CO_2-eq. The three countries with the largest increases were Spain, the Netherlands and Germany, with a total absolute increase of 1.6 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 EU28+ISL by 12% or 761 kt N/year in the period 1990 to 2017. Figure 5.64 shows the trend of N from applied organic N fertilizers indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O N from applied organic N fertilizers from organic N fertilisers for the different Member States along the inventory period. The ten countries with the highest N from applied organic N fertilizers accounted together for 84.1% of the total. N from applied organic N fertilizers decreased in twenty countries and increased in nine countries. The three countries with the largest decreases were Romania, Poland and the Czech Republic with a total absolute decrease of 464 kt N/year. The largest increases occurred in Spain and Germany, with a total absolute increase of 221 kt N/year.

Figure 5.63: 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017

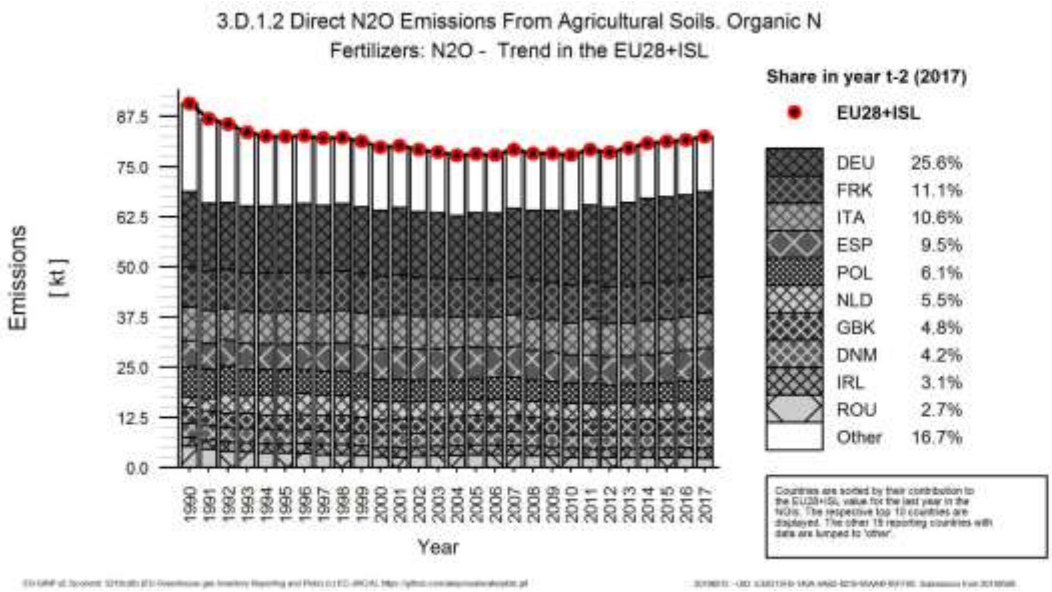
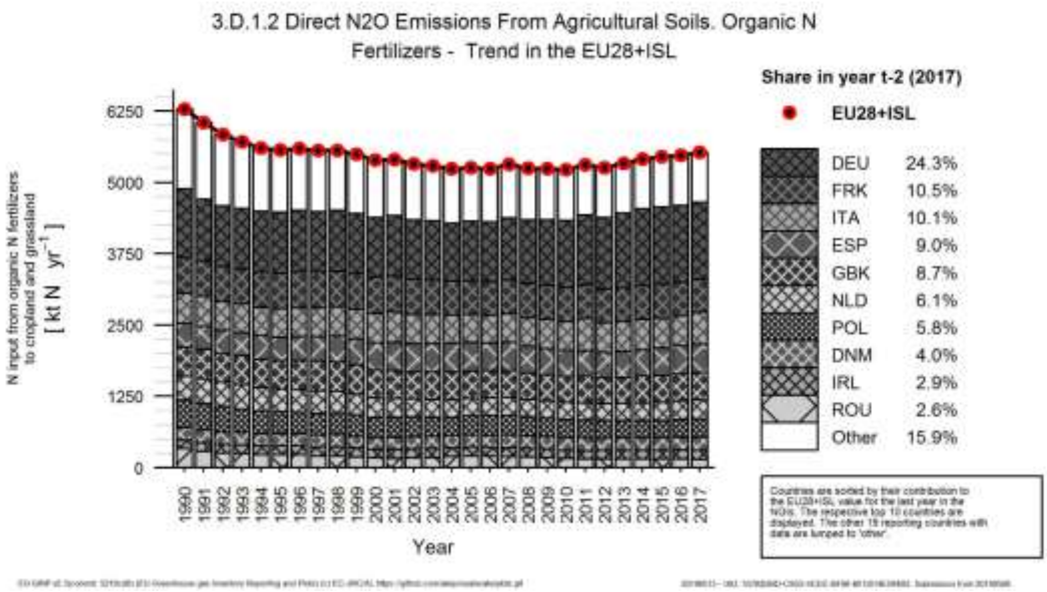


Figure 5.64: 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



3.D.1.3 - Urine and Dung Deposited by Grazing Animals - Emissions

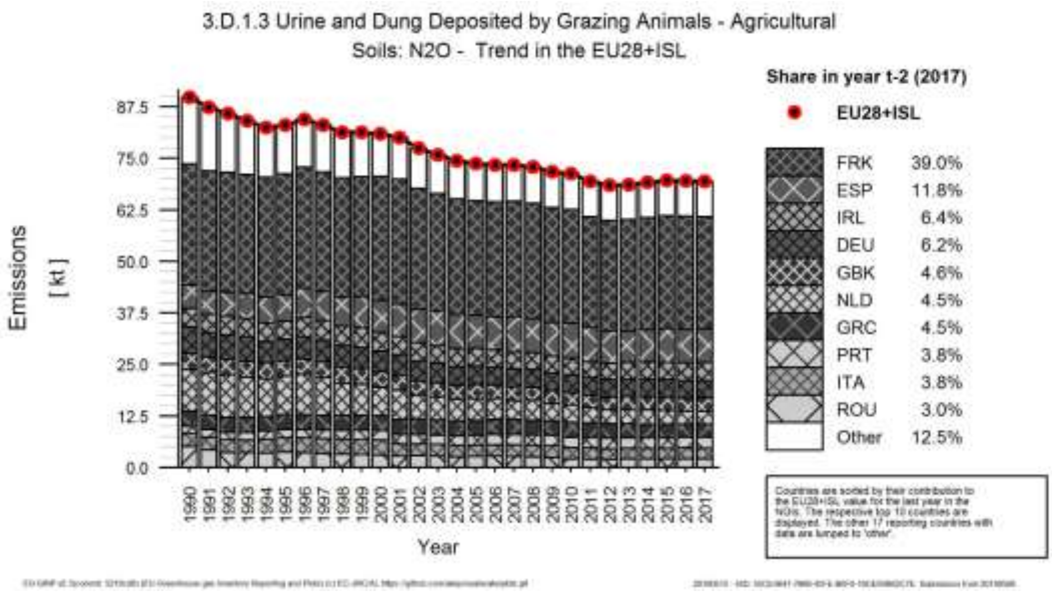
N_2O emissions in source category *3.D.1.3 - Urine and Dung Deposited by Grazing Animals* are 0.43% of total EU28+ISL GHG emissions and 8% of total EU28+ISL N_2O emissions. They make 4.7% of total agricultural emissions and 11% of total agricultural N_2O emissions.

Total GHG and N_2O emissions by Member State from 3.D.1.3 *Grazing Animals* are shown in Table 5.45 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2017). Values are given in kt CO_2-eq. Between 1990 and 2017, N_2O emission in this source category decreased by 23% or 6.1 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). From 2016 to 2017 emissions in the current category decreased by 0.2%. Figure 5.65 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from grazing animals for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 87.5% of the total. Emissions decreased in 23 countries and increased in four countries. The largest decreases occurred in the Netherlands and Romania with a total absolute decrease of 3 Mt CO_2-eq. The largest increases occurred in Portugal and Spain, with a total absolute increase of 980 kt CO_2-eq.

Table 5.45 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: Member States' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	147	87	88	0.4%	-60	-40%	0	1%	T1	D
Belgium	693	491	483	2.3%	-210	-30%	-7	-1%	T1	D
Bulgaria	616	133	129	0.6%	-486	-79%	-4	-3%	T1	D
Croatia	106	40	40	0.2%	-66	-62%	0	1%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	236	224	223	1.1%	-13	-6%	-1	0%	T1	D
Denmark	298	178	176	0.8%	-122	-41%	-2	-1%	T1	D
Estonia	168	66	67	0.3%	-102	-60%	0	0%	T1	D
Finland	151	107	106	0.5%	-45	-30%	-1	-1%	T1	D
France	8 760	8 159	8 069	39.0%	-690	-8%	-89	-1%	T1,T2	D
Germany	1 951	1 292	1 279	6.2%	-672	-34%	-13	-1%	T1	D
Greece	1 059	938	937	4.5%	-122	-12%	-1	0%	T1	D
Hungary	193	127	130	0.6%	-63	-33%	4	3%	T1	D
Ireland	1 310	1 280	1 316	6.4%	6	0%	37	3%	T1	D
Italy	934	796	785	3.8%	-149	-16%	-12	-1%	T1	CS,D
Latvia	150	58	59	0.3%	-91	-60%	1	2%	T1	D
Lithuania	420	178	173	0.8%	-247	-59%	-5	-3%	T1	D
Luxembourg	43	42	43	0.2%	0	-1%	0	1%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 028	927	939	4.5%	-2 089	-69%	12	1%	T1	D
Poland	1 048	356	369	1.8%	-678	-65%	13	4%	T1	CS,D
Portugal	538	778	796	3.8%	257	48%	18	2%	T1	D
Romania	1 522	625	612	3.0%	-911	-60%	-13	-2%	T1	D
Slovakia	137	62	61	0.3%	-76	-55%	-1	-1%	T1	CS
Slovenia	18	41	40	0.2%	22	119%	-1	-2%	T1	D
Spain	1 715	2 420	2 438	11.8%	723	42%	18	1%	CS,T1	D
Sweden	361	351	355	1.7%	-5	-2%	4	1%	T1	D
United Kingdom	1 131	940	948	4.6%	-183	-16%	7	1%	T2	CS
EU-28	**26 734**	**20 695**	**20 661**	**100%**	**-6 073**	**-23%**	**-34**	**0%**	**-**	**-**
Iceland	47	45	44	0.2%	-2	-5%	-1	-2%	-	-
United Kingdom (KP)	1 131	940	948	4.6%	-183	-16%	7	1%	T2	CS
EU-28 + ISL	**26 781**	**20 740**	**20 706**	**100%**	**-6 075**	**-23%**	**-35**	**0%**	**-**	**-**

Figure 5.65: 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



5.3.4.2 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 EU28+ISL barely between 1990 and 2017 by 0.7% or 6.98e-05 kg N_2O-N/kg N. Figure 5.66 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.46 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 2017 for all Member States and EU28+ISL. The implied emission factor decreased in four countries and increased in two countries. It was in 2017 at the level of 1990 in 24 countries. The three countries with the largest decreases were the United Kingdom, Iceland and Iceland with a mean absolute value of 0.00036 kg N_2O-N/kg N. Increases occurred in Ireland and Belgium with a mean absolute value of 0.00015 kg N_2O-N/kg N.

Figure 5.66: 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

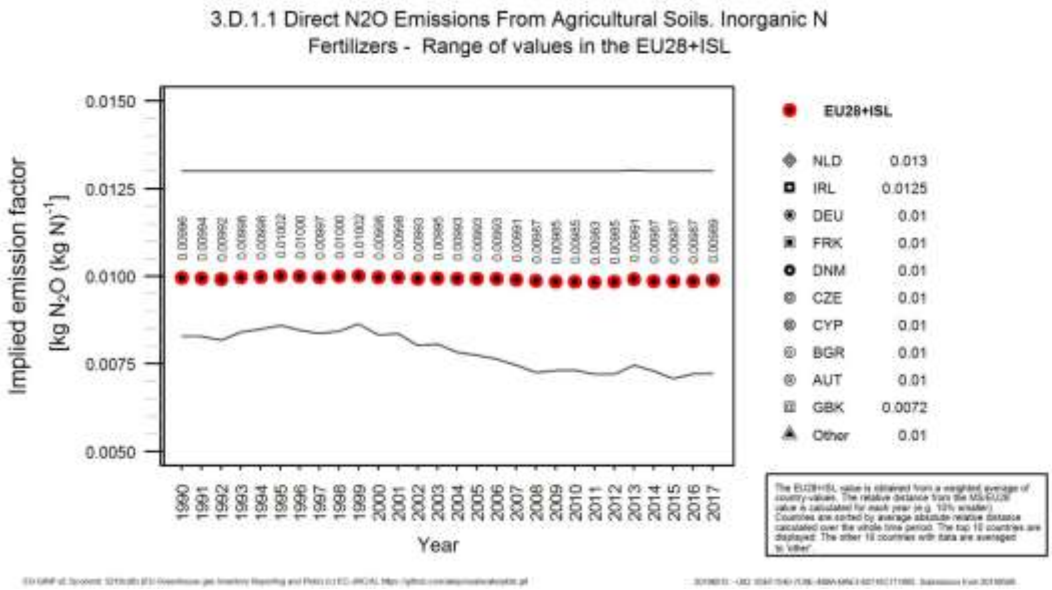


Table 5.46 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Member States' and EU28+ISL implied emission factor (kg N_2O-N/kg N)

Member State	1990	2017	Member State	1990	2017
Austria	0.0100	0.0100	Ireland	0.0122	0.0125
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	0.0100	0.0100	Netherlands	0.0130	0.0130

Estonia	0.0100	0.0100	|	Poland	0.0100	0.0100
Finland	0.0100	0.0100	|	Portugal	0.0100	0.0100
France	0.0100	0.0100	|	Romania	0.0100	0.0100
United Kingdom	0.0083	0.0072	|	Slovakia	0.0100	0.0100
United Kingdom (KP)	0.0083	0.0072	|	Slovenia	0.0100	0.0100
Greece	0.0100	0.0100	|	Sweden	0.0100	0.0100
Croatia	0.0100	0.0100	|	**EU28+ISL**	**0.0100**	**0.0099**
Hungary	0.0100	0.0100	|			

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 EU28+ISL slightly between 1990 and 2017 by 3.4% or 0.000312 kg N_2O-N/kg N. Figure 5.67 shows the trend of the implied emission factor in EU28+ISL 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.1.2 - Direct N_2O Emissions From Organic N fertilisers* for the years 1990 and 2017 for all Member States and EU28+ISL. The only country with observable changes in the implied emission factor was the Netherlands, where the IEF increased with an absolute value of 0.0045 kg N_2O-N/kg N. For all the other countries, values in 2017 are the same as in 1990.

Figure 5.67: 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

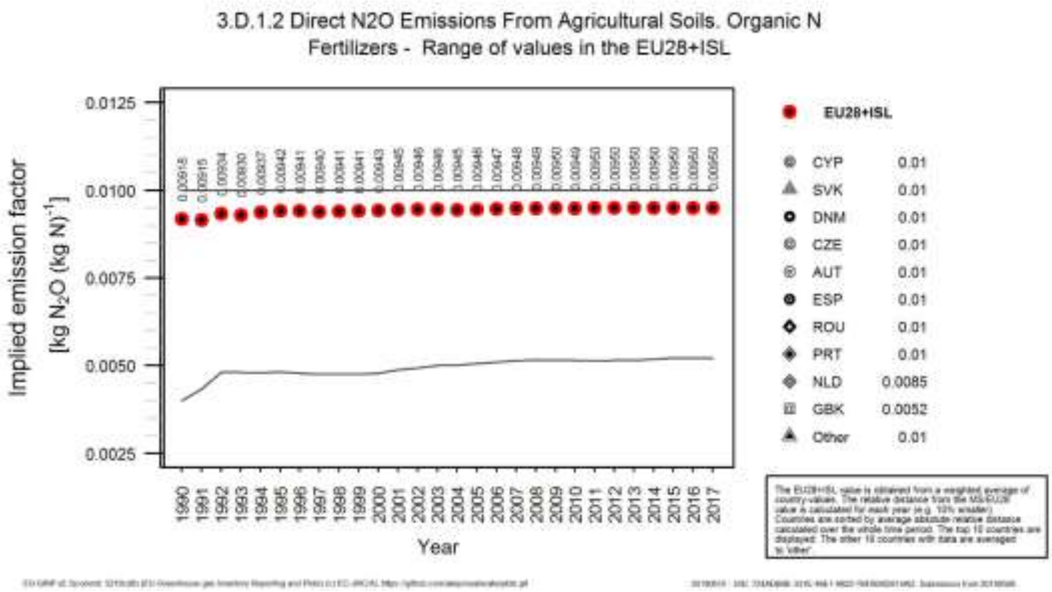


Table 5.47 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Member States' and EU28+ISL implied emission factor (kg N_2O-N/kg N)

Member State	1990	2017		Member State	1990	2017
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

Member State	1990	2017		Member State	1990	2017
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	0.0100	0.0100	|	Netherlands	0.0040	0.0085
Estonia	0.0100	0.0100	|	Poland	0.0100	0.0100
Finland	0.0100	0.0100	|	Portugal	0.0100	0.0100
France	0.0100	0.0100	|	Romania	0.0100	0.0100
United Kingdom	0.0048	0.0052	|	Slovakia	0.0100	0.0100
United Kingdom (KP)	0.0048	0.0052	|	Slovenia	0.0100	0.0100
Greece	0.0100	0.0100	|	Sweden	0.0100	0.0100
Croatia	0.0100	0.0100	|	**EU28+ISL**	**0.0092**	**0.0095**
Hungary	0.0100	0.0100	|			

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* could decreased since 1990 from 0.0152 to 0.0147 kg N_2O-N/kg N at EU28+ISL level. Table 5.48 shows the implied emission factor for the years 1990 and 2017 for all Member States and EU28+ISL. The implied emission factor decreased in fifteen countries and increased in eleven countries. It was in 2017 at the level of 1990 in one country. No data were available for Cyprus and Malta. The three countries with the largest decreases were Croatia, Romania and Austria with a mean absolute value of 0.0023 kg N_2O-N/kg N. The three countries with the largest increases were Spain, Portugal and Poland with a mean absolute value of 0.0016 kg N_2O-N/kg N.

Table 5.48 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: Member States' implied emission factor (kg N_2O-N/kg N)

Member State	1990	2017		Member State	1990	2017
Austria	0.0186	0.0168	|	Ireland	0.0088	0.0086
Belgium	0.0197	0.0195	|	Iceland	0.0108	0.0112
Bulgaria	0.0120	0.0125	|	Italy	0.0112	0.0112
Czech Republic	0.0174	0.0182	|	Lithuania	0.0190	0.0191
Germany	0.0191	0.0191	|	Luxembourg	0.0198	0.0195
Denmark	0.0187	0.0178	|	Latvia	0.0196	0.0189
Spain	0.0145	0.0162	|	Netherlands	0.0330	0.0330
Estonia	0.0190	0.0185	|	Poland	0.0178	0.0192
Finland	0.0179	0.0169	|	Portugal	0.0163	0.0180
France	0.0189	0.0192	|	Romania	0.0174	0.0149
United Kingdom	0.0045	0.0047	|	Slovakia	0.0165	0.0154
United Kingdom (KP)	0.0045	0.0047	|	Slovenia	0.0184	0.0174
Greece	0.0104	0.0105	|	Sweden	0.0174	0.0170
Croatia	0.0141	0.0116	|	**EU28+ISL**	**0.0152**	**0.0147**

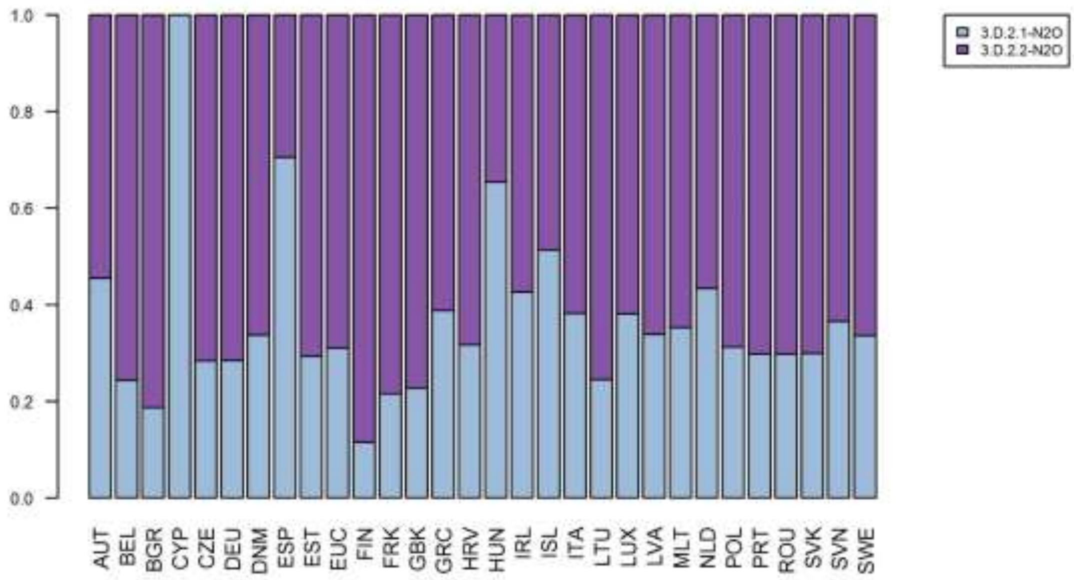
Hungary	0.0138	0.0148

5.3.5 Indirect Emissions from Managed Soils - N_2O (CRF Source Category 3D2)

N_2O the emissions in source category *3.D.2 - Indirect Emissions from Managed Soils* for N_2O emissions in source category *3.D.2 - Indirect Emissions from Managed Soils* are 0.62% of total EU28+ISL GHG emissions and 12% of total EU28+ISL 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 Member States, Figure 5.69 shows the distribution of indirect N_2O emissions from managed soils by emission source in all Member States and in the EU28+ISL. 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 EU28+ISL agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2017.

Figure 5.69: Decomposition of emissions in source category 3.D.2 - Indirect Emissions from Managed Soils into its sub-categories by Member State in the year 2017. 3.D.2.1 Atmospheric Deposition and 3.D.2.2 Nitrogen Leaching and Run-off.



Total GHG and N_2O emissions by Member State from 3.D.2 *Indirect Emissions from Managed Soils* are shown in Table 5.49 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2017). Values are given in kt CO_2-eq. Between 1990 and 2017, N_2O emission in this source category decreased by 19% or 7 Mt CO_2-eq. The decrease was largest in the Netherlands in relative terms (60%) and also in absolute terms (979 kt CO_2-eq). From 2016 to 2017 emissions in the current category increased by 2.2%.

Table 5.49 3.D.2 - Indirect Emissions from Managed Soils: Member States' contributions to total EU-GHG and N_2O emissions

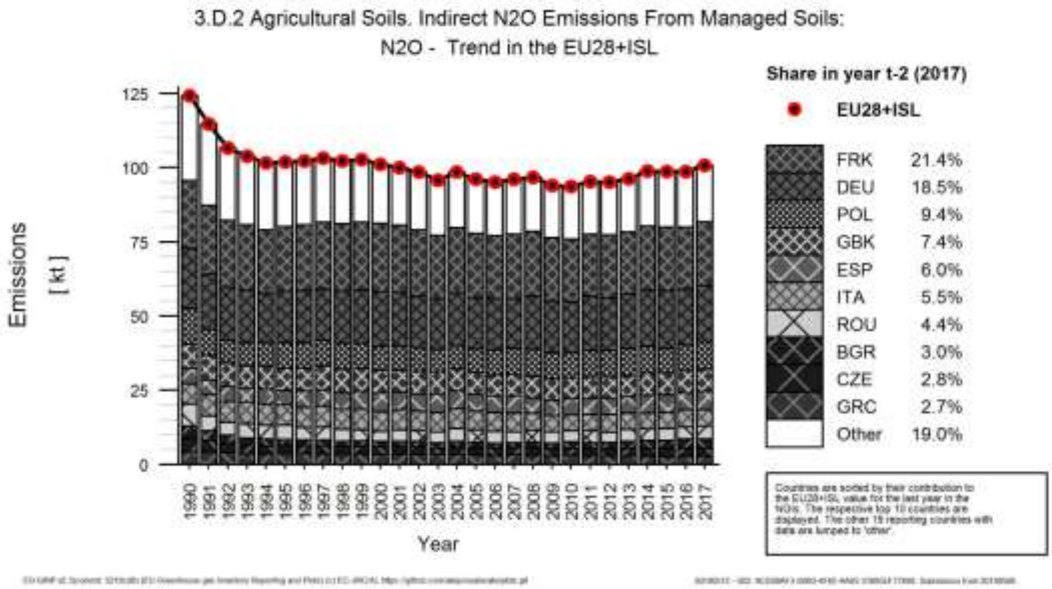
Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	358	345	336	1.1%	-21	-6%	-8	-2%	T1	D
Belgium	1 057	679	724	2.4%	-333	-31%	45	7%	T1	D
Bulgaria	1 252	893	889	3.0%	-363	-29%	-4	0%	T1	D
Croatia	344	231	263	0.9%	-81	-23%	32	14%	T1	D
Cyprus	17	16	17	0.1%	0	-2%	0	2%	T1	D
Czechia	1 345	849	848	2.8%	-498	-37%	-1	0%	T1	D
Denmark	905	568	586	1.9%	-319	-35%	17	3%	T2	D
Estonia	238	123	128	0.4%	-109	-46%	5	4%	D,T1	D
Finland	480	386	390	1.3%	-89	-19%	4	1%	T1	D
France	6 819	6 240	6 423	21.4%	-396	-6%	183	3%	T1,T2	CS,D
Germany	6 037	5 604	5 553	18.5%	-485	-8%	-51	-1%	T1	D
Greece	1 245	806	807	2.7%	-438	-35%	0	0%	T1	D
Hungary	357	262	278	0.9%	-79	-22%	16	6%	T1	D
Ireland	559	535	556	1.9%	-2	0%	21	4%	T1	CS,D
Italy	2 014	1 694	1 641	5.5%	-372	-18%	-53	-3%	T1	CS,D
Latvia	312	176	177	0.6%	-135	-43%	2	1%	T1	D
Lithuania	608	419	414	1.4%	-193	-32%	-4	-1%	T1	D
Luxembourg	56	48	48	0.2%	-8	-15%	0	0%	T1	D
Malta	6	5	5	0.0%	-1	-16%	0	0%	T1	D
Netherlands	1 626	624	647	2.2%	-979	-60%	23	4%	T1	D
Poland	3 565	2 600	2 820	9.4%	-745	-21%	219	8%	T1	D
Portugal	503	414	414	1.4%	-89	-18%	0	0%	T1,T2	CS,D
Romania	2 251	1 231	1 326	4.4%	-925	-41%	94	8%	T1	D
Slovakia	579	308	292	1.0%	-287	-50%	-16	-5%	T1	D
Slovenia	112	110	107	0.4%	-5	-4%	-2	-2%	T1	D
Spain	1 553	1 726	1 799	6.0%	246	16%	73	4%	CS,T1,T2	D
Sweden	369	282	281	0.9%	-89	-24%	-1	0%	CS	D
United Kingdom	2 424	2 192	2 236	7.4%	-187	-8%	45	2%	T1	D
EU-28	**36 991**	**29 367**	**30 007**	**100%**	**-6 984**	**-19%**	**640**	**2%**	**-**	**-**
Iceland	33	30	33	0.1%	0	1%	3	11%	T1b	D
United Kingdom (KP)	2 424	2 192	2 236	7.4%	-187	-8%	45	2%	T1	D
EU-28 + ISL	**37 023**	**29 397**	**30 040**	**100%**	**-6 984**	**-19%**	**643**	**2%**	**-**	**-**

5.3.5.1 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 EU28+ISL by 19% or 7 Mt CO_2-eq in the period 1990 to 2017. Figure 5.70 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from indirect emissions from managed soils for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 81% of the total. 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 2.7 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 246 kt CO_2-eq.

Figure 5.70: 3.D.2 Indirect Emissions from Managed Soils: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



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 considerably in EU28+ISL by 25% or 3 Mt CO_2-eq in the period 1990 to 2017. Figure 5.71 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from atmospheric deposition for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 80.3% of the total. Emissions decreased in 27 countries and increased in two countries. The largest decreases occurred in the Netherlands and Romania with a total absolute decrease of 1.1 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 143 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 considerably in EU28+ISL by 25% or 653 kt N/year in the period 1990 to 2017. Figure 5.72 shows the trend of volatilized N from agricultural N inputs indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O volatilized N from agricultural N inputs from atmospheric deposition for the different Member States along the inventory period. The ten countries with the highest volatilized N from agricultural N inputs accounted together for 80.3% of the total. Volatilized N from agricultural N inputs decreased in 27 countries and increased in two countries. The largest decreases occurred in the Netherlands and Romania with a total absolute decrease of 241 kt N/year. The largest increases occurred in Spain, with a total absolute increase of 30 kt N/year.

Figure 5.71: 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017

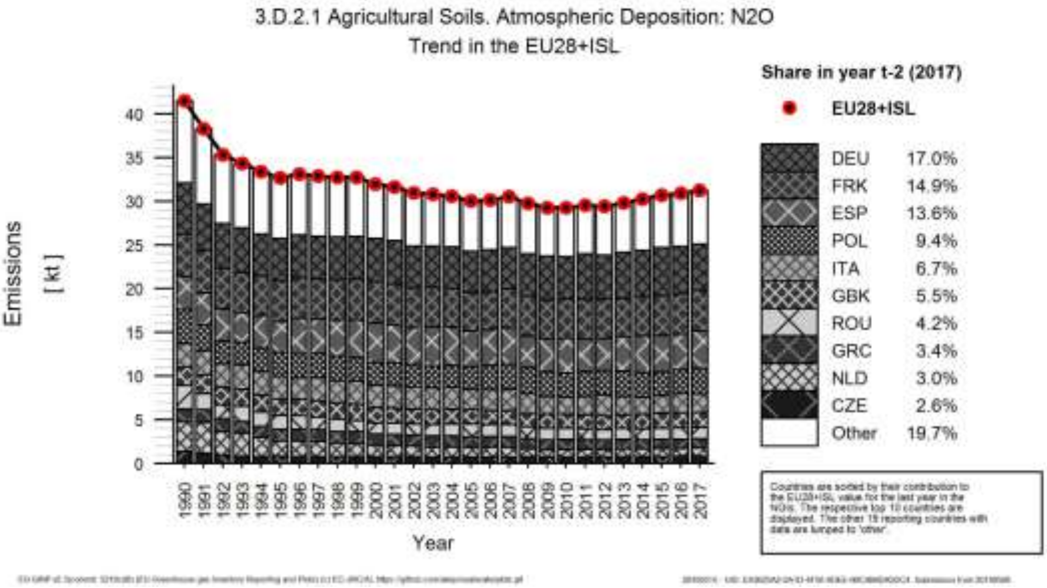
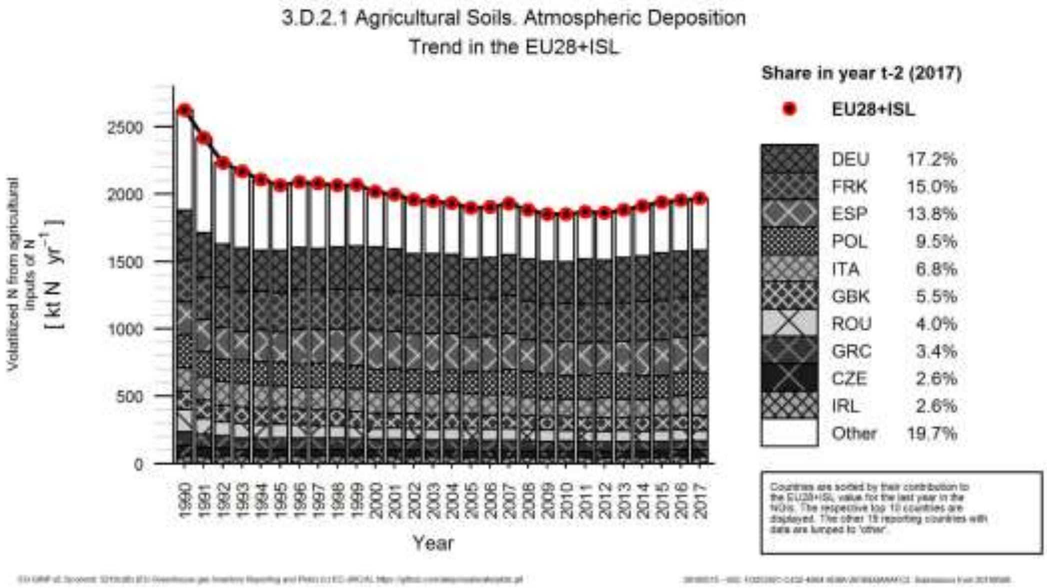


Figure 5.72: 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



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 EU28+ISL by 16% or 3.9 Mt CO_2-eq in the period 1990 to 2017. Figure 5.73 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 82.2% of the total. Emissions decreased in 26 countries and increased in two countries. The largest decreases occurred in Romania and Poland with a total absolute decrease of 976 kt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 103 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 EU28+ISL by 16% or 1.2 kt N/year in the period 1990 to 2017. 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 EU28+ISL 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 Member States 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 81.7% of the total. N from fertilizers and other agricultural inputs that is lost through leaching and run-off decreased in 26 countries and increased in two countries. The largest decreases occurred in Romania and Poland with a total absolute decrease of 278 kt N/year. The largest increases occurred in Spain, with a total absolute increase of 29 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 EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017

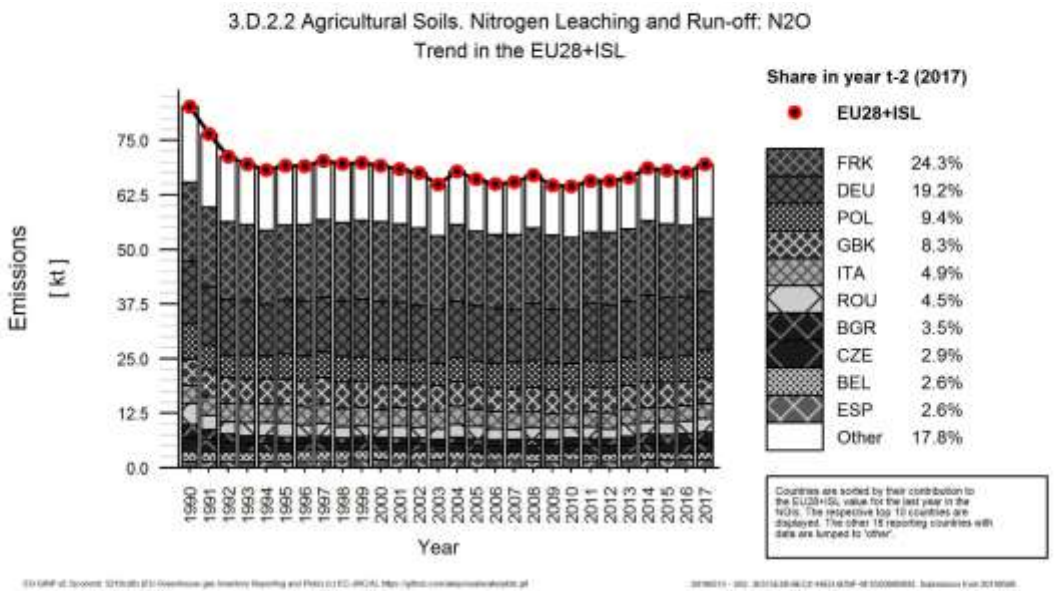
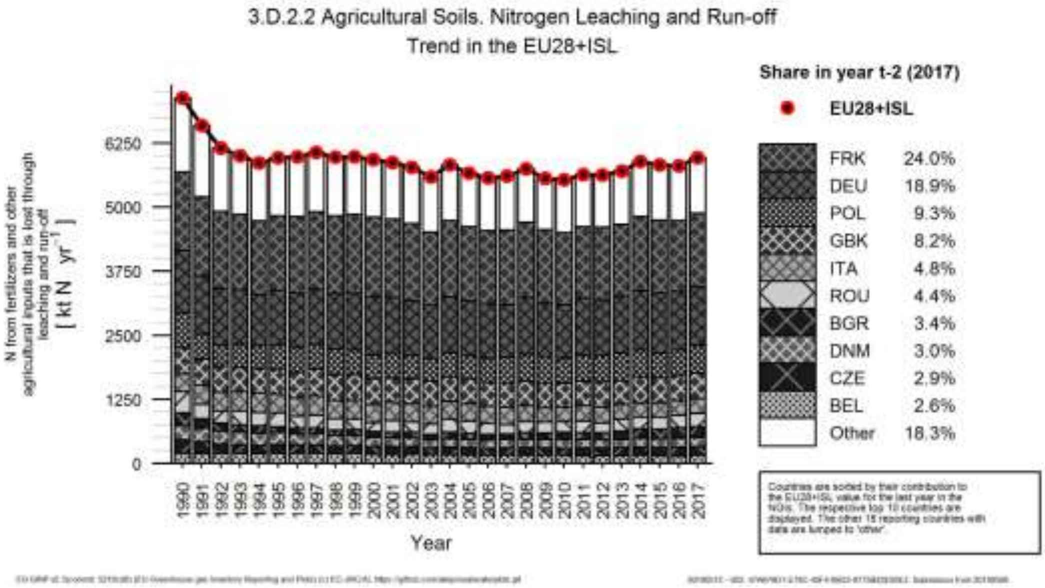


Figure 5.74: 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: Trend N leached from fertilisers and other agricultural inputs in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2017



5.3.5.2 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* increased in EU28+ISL barely between 1990 and 2017 by 0.33% or 3.32e-05 kg N_2O-N/kg N. Figure 5.75 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.50 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 2017 for all Member States and EU28+ISL. The implied emission factor decreased in three countries and increased in six countries. It was in 2017 at the level of 1990 in twenty countries. Decreases occurred in Finland, the United Kingdom and Latvia with a mean absolute value of 1.2e-11 kg N_2O-N/kg N. The three countries with the largest increases were the Netherlands, Romania and Portugal with a mean absolute value of 0.00072 kg N_2O-N/kg N.

Figure 5.75: 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

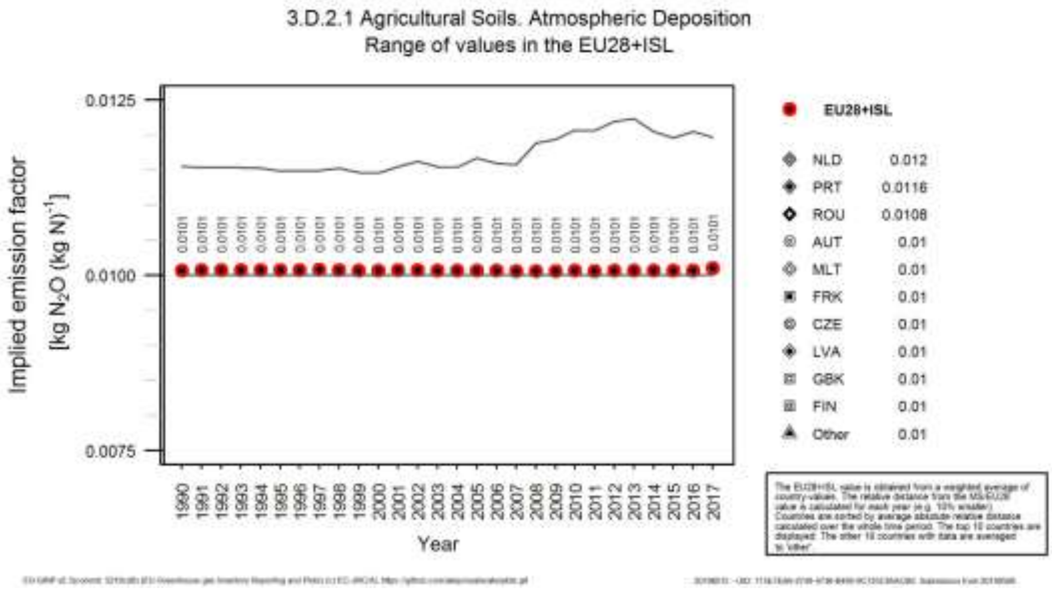


Table 5.50 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Member States' and EU28+ISL implied emission factor (kg N_2O-N/kg N)

Member State	1990	2017	Member State	1990	2017
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	0.012	0.012
France	0.010	0.010	Romania	0.010	0.011
United Kingdom	0.010	0.010	Slovakia	0.010	0.010
United Kingdom (KP)	0.010	0.010	Slovenia	0.010	0.010
Greece	0.010	0.010	Sweden	0.010	0.010
Croatia	0.010	0.010	**EU28+ISL**	**0.010**	**0.010**
Hungary	0.010	0.010			

3.D.2.1 - Indirect emissions from Atmospheric Deposition - FracGASF

The $Frac_{GASF}$, a parameter used for calculating N_2O emissions in source category *3.D.2.1 - Indirect emissions from Atmospheric Deposition*, could not be evaluated at EU28+ISL level. Table 5.51 shows the $Frac_{GASF}$ in source category *3.D.2.1 - Indirect emissions from Atmospheric Deposition* for the years 1990 and 2017 for all Member States and EU28+ISL. The $Frac_{GASF}$ decreased in seven countries and increased in nine countries. It was in 2017 at the level of 1990 in thirteen countries. The largest decrease occurred in Hungary with an absolute value of 0.017. The largest increase occurred in Germany with an absolute value of 0.017.

Table 5.51 3.D.2.1 - Indirect emissions from Atmospheric Deposition: Member States' $Frac_{GASF}$ (-)

Member State	1990	2017		Member State	1990	2017
Austria	0.049	0.059	|	Hungary	0.064	0.047
Belgium	0.064	0.070	|	Ireland	0.030	0.025
Bulgaria	0.064	0.064	|	Iceland	0.029	0.023
Cyprus	0.100	0.100	|	Italy	0.089	0.098
Czech Republic	0.100	0.100	|	Lithuania	0.063	0.069
Germany	0.042	0.059	|	Luxembourg	0.100	0.100
Denmark	0.059	0.052	|	Latvia	0.100	0.100
Spain	0.100	0.100	|	Malta	0.100	0.100
Estonia	0.100	0.100	|	Netherlands	0.039	0.043
Finland	0.016	0.015	|	Poland	0.100	0.100
France	0.060	0.067	|	Portugal	0.062	0.075
United Kingdom	0.032	0.035	|	Romania	0.100	0.100
United Kingdom (KP)	0.032	0.035	|	Slovakia	0.100	0.100
Greece	0.100	0.100	|	Slovenia	0.057	0.055
Croatia	0.100	0.100	|	Sweden	0.022	0.020

3.D.2.2 - Indirect emissions from Atmospheric Deposition - FracGASM

The $Frac_{GASM}$, a parameter used for calculating N_2O emissions in source category *3.D.2.2 - Indirect emissions from Atmospheric Deposition*, could not be evaluated at EU28+ISL level. Table 5.52 shows the $Frac_{GASM}$ in source category *3.D.2.2 - Indirect emissions from Atmospheric Deposition* for the years 1990 and 2017 for all Member States and EU28+ISL. The $Frac_{GASM}$ decreased in eight countries and increased in six countries. It was in 2017 at the level of 1990 in fourteen 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 Finland, France and Ireland with a mean absolute value of 0.0056.

Table 5.52 3.D.2.2 - Indirect emissions from Atmospheric Deposition: Member States' $Frac_{GASF}$ (-)

Member State	1990	2017		Member State	1990	2017
Austria	0.168	0.172	|	Hungary	0.188	0.185
Belgium	0.175	0.176	|	Ireland	0.082	0.085
Bulgaria	0.200	0.200	|	Iceland	0.226	0.229
Cyprus	0.200	0.200	|	Italy	0.233	0.214
Czech Republic	0.200	0.200	|	Lithuania	0.200	0.200
Germany	0.197	0.162	|	Luxembourg	0.200	0.200
Denmark	0.141	0.087	|	Latvia	0.200	0.200
Spain	0.200	0.200	|	Malta	0.200	0.200
Estonia	0.200	0.200	|	Poland	0.200	0.200
Finland	0.076	0.087	|	Portugal	0.202	0.166

Member State	1990	2017		Member State	1990	2017
France	0.095	0.098	|	Romania	0.200	0.200
United Kingdom	0.081	0.079	|	Slovakia	0.200	0.200
United Kingdom (KP)	0.081	0.079	|	Slovenia	0.227	0.184
Greece	0.200	0.200	|	Sweden	0.172	0.161
Croatia	0.200	0.200	|			

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 EU28+ISL barely between 1990 and 2017 by 0.42% or 3.08e-05 kg N_2O-N/kg N. Figure 5.76 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.53 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 2017 for all Member States and EU28+ISL. The implied emission factor was in 2017 at the level of 1990 in all countries except for Denmark, where the IEF increased of 0.0002 N_2O-N/kg N. 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 EU28+ISL and range of values reported by countries

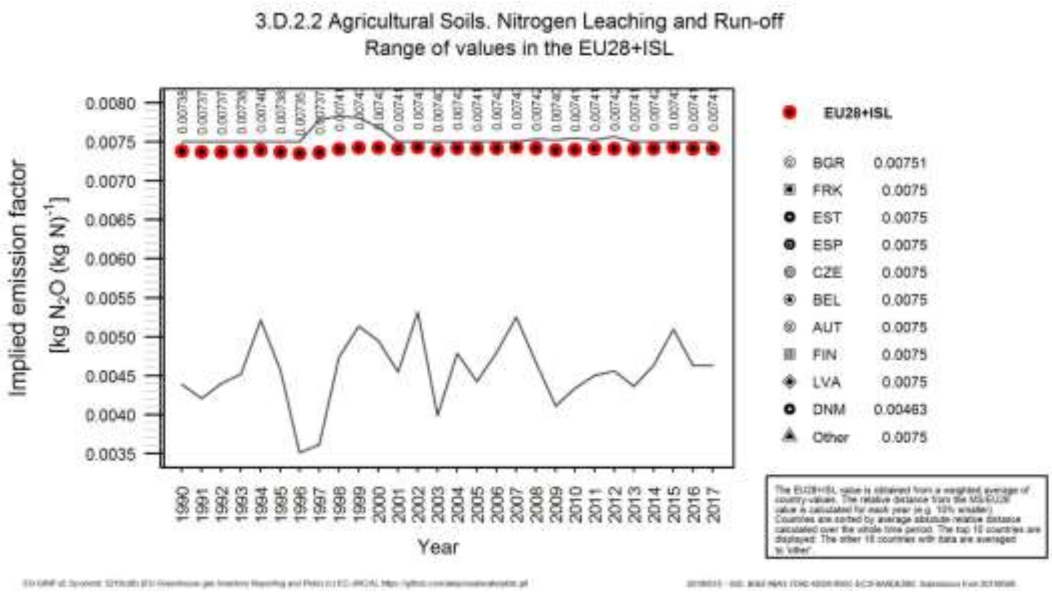


*Table 5.53 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: Member States' and EU28+ISL implied emission factor (kg N_2O-N/kg N)**

Member State	1990	2017		Member State	1990	2017
Austria	0.0075	0.0075	|	Ireland	0.0075	0.0075
Belgium	0.0075	0.0075	|	Iceland	0.0075	0.0075
Bulgaria	0.0075	0.0075	|	Italy	0.0075	0.0075
Czech Republic	0.0075	0.0075	|	Lithuania	0.0075	0.0075
Germany	0.0075	0.0075	|	Luxembourg	0.0075	0.0075
Denmark	0.0044	0.0046	|	Latvia	0.0075	0.0075

Spain	0.0075	0.0075	Malta	0.0075	0.0075
Estonia	0.0075	0.0075	Netherlands	0.0075	0.0075
Finland	0.0075	0.0075	Poland	0.0075	0.0075
France	0.0075	0.0075	Portugal	0.0075	0.0075
United Kingdom	0.0075	0.0075	Romania	0.0075	0.0075
United Kingdom (KP)	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	**EU28+ISL**	**0.0074**	**0.0074**

**not reported by 1 MS (CYP)*

3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off - FracLEACH

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*, could not be evaluated at EU28+ISL level. Table 5.54 shows the $Frac_{LEACH}$ in source category *3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off* for the years 1990 and 2017 for all Member States and EU28+ISL. $Frac_{leach}$ decreased in three countries and increased in two countries. It was in 2017 at the level of 1990 in 23 countries. No data were available for Cyprus. The largest decrease occurred in Sweden with an absolute value of 0.1. Increases occurred in the United Kingdom and Spain with a mean absolute value of 0.018.

Table 5.54 3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off: Member States' $Frac_{LEACH}$ (-)

Member State	**1990**	**2017**	**Member State**	**1990**	**2017**
Austria	0.152	0.152	Ireland	0.100	0.100
Belgium	0.300	0.300	Iceland	0.300	0.300
Bulgaria	0.300	0.300	Italy	0.207	0.207
Czech Republic	0.300	0.300	Lithuania	0.300	0.300
Germany	0.300	0.300	Luxembourg	0.300	0.300
Denmark	0.332	0.278	Latvia	0.230	0.230
Spain	0.077	0.083	Malta	0.300	0.300
Estonia	0.300	0.300	Netherlands	0.150	0.130
Finland	0.300	0.300	Poland	0.300	0.300
France	0.300	0.300	Portugal	0.300	0.300
United Kingdom	0.173	0.204	Romania	0.300	0.300
United Kingdom (KP)	0.173	0.204	Slovakia	0.300	0.300
Greece	0.300	0.300	Slovenia	0.300	0.300
Croatia	0.300	0.300	Sweden	0.165	0.114
Hungary	0.300	0.300			

5.3.6 Agriculture- non-key categories

In this chapter, we do not present a detailed analysis of non-key categories of the agriculture sector, but Table 5.55 shows a summary of emissions from non-key categories in 1990, 2016 and 2017, the share of those categories in total emissions from agriculture, emission changes from the base year 1990 until the last reported year and emission changes between the last two reported years. More details on these sectors can be found in the individual country reports.

Table 5.55 Aggregated GHG emissions from non-key categories in the agriculture sector

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 3. Agriculture in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO_2 equ	%	kt CO_2 equ	%
3.A.1 Enteric Fermentation: Growing Cattle (CH4)	5 440.0	3 067.6	2 925.7	0.67%	-2 514	-46%	-142	-5%
3.A.1 Enteric Fermentation: Other Mature Cattle (CH4)	775.4	668.2	659.8	0.15%	-116	-15%	-8	-1%
3.A.3 Enteric Fermentation: Other Swine (CH4)	5 618.6	4 291.7	4 304.5	0.98%	-1 314	-23%	13	0%
3.C.1 Irrigated: Farming (CH4)	3 002.8	2 751.7	2 671.5	0.61%	-331	-11%	-80	-3%
3.C.2 Rainfed: Farming (CH4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.C.3 Deep Water: Farming (CH4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.C.4 Other Rice Cultivation: Farming (CH4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.E Prescribed Burning of Savannas: Farming (CH4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.E Prescribed Burning of Savannas: Farming (N2O)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.E Forest land (specify ecological zone): Farming (CH4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.E Forest land (specify ecological zone): Farming (N2O)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.E Grassland (specify ecological zone): Farming (CH4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.E Grassland (specify ecological zone): Farming (N2O)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.F.1 Field Burning of Agricultural Residues: Cereals (CH4)	997.0	528.9	430.1	0.10%	-567	-57%	-99	-19%
3.F.1 Field Burning of Agricultural Residues: Cereals (N2O)	333.8	182.8	146.3	0.03%	-187	-56%	-36	-20%
3.F.2 Field Burning of Agricultural Residues: Pulses (CH4)	1.3	0.4	0.4	0.00%	-1	-71%	0	-1%
3.F.2 Field Burning of Agricultural Residues: Pulses (N2O)	0.5	0.2	0.2	0.00%	0	-62%	0	1%
3.F.3 Field Burning of Agricultural Residues: Tubers and Roots (CH4)	257.6	5.6	5.9	0.00%	-252	-98%	0	7%
3.F.3 Field Burning of Agricultural Residues: Tubers and Roots (N2O)	83.1	2.6	2.7	0.00%	-80	-97%	0	6%
3.F.4 Field Burning of Agricultural Residues: Sugar Cane (CH4)	4.1	1.3	1.3	0.00%	-3	-68%	0	1%
3.F.4 Field Burning of Agricultural Residues: Sugar Cane (N2O)	1.3	0.4	0.4	0.00%	-1	-68%	0	1%
3.F.5 Field Burning of Agricultural Residues: Other Agricultural residues (CH4)	203.7	77.2	75.8	0.02%	-128	-63%	-1	-2%
3.F.5 Field Burning of Agricultural Residues: Other Agricultural residues (N2O)	76.9	38.2	36.8	0.01%	-40	-52%	-1	-4%
3.G.1 Limestone CaCO3: Farming (CO2)	8 030.0	4 781.7	4 751.5	1.08%	-3 279	-41%	-30	-1%
3.G.2 Dolomite CaMg(CO3)2: Farming (CO2)	2 389.2	1 011.8	786.5	0.18%	-1 603	-67%	-225	-22%
3.H Urea Application: Farming (CO2)	3 765.9	4 542.5	4 515.1	1.03%	749	20%	-27	-1%
3.I Other Carbon-containing Fertilizers: Farming (CO2)	564.4	310.6	317.9	0.07%	-246	-44%	7	2%
3.J Other agriculture emissions: Farming (CH4)	275.8	1 545.9	1 562.8	0.36%	1 287	467%	17	1%
3.J Other agriculture emissions: Farming (CO2)	2.7	2.5	2.5	0.00%	0	-10%	0	0%
3.J Other agriculture emissions: Farming (N2O)	131.3	354.1	358.8	0.08%	227	173%	5	1%

5.4 Uncertainties

Table 5.56 shows the total EU-28 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-28 see Chapter 1.6.

Table 5.56 Sector Agriculture: EU-28 uncertainty estimates

Source category	Gas	Emissions Base Year	Emissions 2017	Emission trends Base Year-2017	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	251 238	194 987	-22.4%	10.7%	0.0%
3.A Enteric Fermentation	N2O	0	0		0.0%	
3.B Manure Mangement	CO2	0	0		0.0%	
3.B Manure Mangement	CH4	52 818	42 126	-20.2%	20.3%	0.0%
3.B Manure Mangement	N2O	30 120	22 230	-26.2%	68.0%	0.1%
3.C Rice Cultivation	CO2	0	0		0.0%	
3.C Rice Cultivation	CH4	2 715	2 202	-18.9%	30.9%	0.4%
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	196 797	164 376	-16.5%	124.3%	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	1 534	513	-66.5%	52.6%	0.3%
3.F Field Burning of Agricultural Residues	N2O	361	184	-49.1%	54.2%	0.1%
3.G Liming	CO2	10 212	5 499	-46.2%	24.2%	0.1%
3.G Liming	CH4	0	0		0.0%	
3.G Liming	N2O	0	0		0.0%	
3.H Urea application	CO2	3 450	3 947	14.4%	16.8%	0.0%
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	590	316	-46.4%	10.2%	0.1%
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	277	1 564	464.7%	45.1%	2.0%
3.J Other	N2O	132	360	172.3%	90.6%	2.0%
3 (where no subsector data were submitted)	all	0	0		0.0%	0.0%
Total - 3	**all**	**550 243**	**438 304**	**-20.3%**	**47.0%**	**2.5%**

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 each of this 28 EU Member States

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 Member States is given.

This is followed by brief summaries 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. The list is not comprehensive.

5.5.2 Improvements

5.5.2.1 Brief overview of the development of the QA/QC in the agriculture sector

A major revision of the present chapter on methodological issues and uncertainty in the sector agriculture was done for the submission in 2006 giving for the first time a complete overview of all relevant parameters required for the estimation of GHG emissions and the calculation of all background parameter in the CRF tables for agriculture.

The changes were partly due to a natural evolution of the inventory generation over the years and partly motivated by recommendations made by the UNFCCC review team on the occasion of the in-country review in 2005. The main issues raised by the Expert Review Team in 2005 and the major changes included (i) more transparent overview tables on methodological issues; (ii) better presentation of trend development; (iii) streamlining information contained in CRF and NIR; (iv) continuous working with Member States in order to improve the inventory and allowing the quantification of all background data; (v) including a summary of workshops. For the submission in 2007, several errors identified in the background tables of the Member States could be eliminated, thus improving the calculation of EU-wide background information. Further details were added to the inventory report for the submission in 2008, based on recommendations by the Expert Review Team of the in-country review in 2007. For the submissions in 2009 through 2014, background information was further developed.

In 2008, a novel approach to calculate uncertainties at the EU level including the assessment of the quality of the emission estimates at MS and EU level has been implemented and described in the NIR. This method was presented during the in-country-review in 2007 and its implementation in the EC-IR was suggested by the ERT. This has been complemented by a series of tables giving background information for the estimates of the uncertainty levels for activity data and emission factors.

Over the time, several sections were added describing specific QA/QC and verification activities (see also sections below), such as:

- Summary of the workshop on 'Inventories and Projections of Greenhouse Gas Emissions from Agriculture' (2003)
- Summary of the findings of the GGELS project (Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions.
- A comparison between submissions and data from the FAO GHG database (2014)
- An analysis on the share of manure excretion by IPCC climate zones with EU wide independent data
- A description of the Survey on agricultural production methods (SAPM 2010)
- A summary of the LiveDate project on Nitrogen Excretion factors
- Workshop on improving national inventories for agriculture (2013)
- Comparison of Cultivated Organic Soil at the FAO GHG database and JRC calculations

5.5.2.2 Major changes for the 2015 submissions

The submission in the year 2015 the QA/QC system brought a complete revision of the approach taken for the EU GHG inventory report in general and for the agriculture chapter in particular, driven by the need to adapt to new CRF software, increased number of countries to describe, and a series of new communication software products (e.g. EEA review tool, EU-GIRP). For this purpose, the EU GHG inventory was thoroughly revised. While this was true for the whole EU GHG inventory, this was particularly true for the agriculture sector. The following specific issues with regard to the GHG inventory in the agriculture sector were identified to require improvements:

- Focusing of the agriculture chapter in the EU-GHG inventory report on key categories and factors and parameters which have a significant relevance for EU total emissions.
- The agriculture chapter applied a specific methodology to calculate "Tier levels" and aggregated uncertainties to more accurately account for correlation between the uncertainty estimates of the individual countries. The methodology was developed for the EU GHG inventory and published in peer-reviewed literature[40]. While this method was shown to provide additional

[40] Leip, A., 2010. Quantitative quality assessment of the greenhouse gas inventory for agriculture in Europe. Clim. Change. 103, 245-261. doi:http://dx.doi.org/10.1007/s10584-010-9915-5.

insight for the uncertainty assessment of the EU GHG inventory, it was of no practical relevance for the overall GHG inventory, as a different method was used for other sectors. It was therefore decided to be not continued.

- One major drawback of previous GHG inventories was the difficulties to account for 'other' animal types or nitrogen inputs. With the new data processing framework[41], *all* data are now available so that a comprehensive analysis is possible
- Streamlining with other sector chapters was improved, not the least by using of harmonized plots to present trend-data at EU level while also showing data from those countries contributing most to EU values.
- The writing of the agriculture chapter of the EU-GHG inventory report has been highly automated[42]. The process is directly based on the data submitted by the countries and are calculated on the fly thus no quantitative data are introduced 'manually'. This allows to provide a report with quantitative information avoiding inconsistencies with the CRF data.

The system is described in the section QA/QC system in the agriculture sector.

5.5.2.3 Main improvements since 2016

Since the 2016 submission, the system implemented in 2015 was further developed, providing now some additional 'checks' that identify issues requiring clarification or justification. Particular attention is paid to 'country outlier' and 'time series' checks, together with recommendations from former ESD and UNFCCC reviews, as well as to a series of specific checks for the agriculture sector focusing on consistency of the data reported and on the completeness of background data which are important for transparency.

Furthermore, chapters comparing GHG emissions and activity data reported by countries with data from the FAO-STAT data base and the CAPRI model are included.

In particular, in the last year, a few improvements have been implemented as a result of the UNFCCC review: we have worked with Member States to improve the use of notation keys, discussing with them which notation keys are more appropriate and ensuring that an explanation is included when needed. We have also worked with Member States to gain completeness and transparency, in particular an issue regarding the lack of data on the distribution of manure per livestock category and manure management system, which has been open for one country for a few years, has already been resolved. Some additional consistency checks have been performed regarding the consistency in the area reported of organic soils in agriculture and in LULUCF sectors, which has to be further studied next year. Finally, an additional sector-specific check has been introduced, comparing digestible energy with milk yield in dairy cows, so as to understand if Member States are using updated feeding plans for livestock.

5.5.2.4 Further improvements

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 analysis of the consistency between the area of organic soils reported in the agriculture and in the LULUCF sectors.

[41] EU-GIRP: EU-Greenhouse gas Inventory Reporting and Plots, see https://github.com/aleip/eealocatorplots.git

[42] For an overview of the QA/QC system of the agriculture sector for the 2013 GHG inventory see presentation given for the ICR2013 at https://prezi.com/f1d3elxzd4qn/20131002_icr_agri/

- Further development of the comparison with FAO and CAPRI data.

5.5.3 QA/QC system in the agriculture sector

5.5.3.1 Quality checks

Several quality checks are performed in the EU-GIRP[43] 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. From all recommendations, 16 were still unresolved and therefore the corresponding issues were reopened.
- **Check on NEs**[44] and empty cells has been done by extracting all reported 'NE's and the empty cells, respectively, from the data base. The results were compared with the data contained in the file NE_checks_20180122.xlsx provided which also contained a list of empty cells.
- **Notation keys**: we identified emission categories where a Member State reported a notation key, while 20 or more Member States reported emission estimates, in order to assess the potential over/underestimations (these also contained in NE checks in the file above).
- **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 EU28+ISL 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 instead 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 EU28+ISL level) is important to ensure correct comparison of countries' values and a correct calculation of EU28+ISL background data. An automated check[45] 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[46]. 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 criterion, 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 removed cases where a country uses a country-specific parameter while most countries use the default value.

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43 EU-GIRP: EU-Greenhouse gas Inventory Reporting and Plots, see https://github.com/aleip/eealocatorplots.git

44 https://github.com/aleip/eealocatorplots/blob/master/eugirp_checknes.r

45 https://github.com/aleip/eealocatorplots/blob/master/eugirp_checkunits.r

46 https://github.com/aleip/eealocatorplots/blob/master/eugirp_checkoutliers.r

- **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 criterion of a share of 0.05% 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[47]. All outliers were 'manually' cross-checked and analysed. Countries were notified on the results of the analysis.
- **Time series outliers:** 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**:**
- **Sector-specific checks**: Several checks were performed tailored to the reporting in the sector agriculture[48,49]. First, the data are checked on consistency in reporting of activity data throughout the tables. Further, several other tests are performed: Link to the guidance doc on checks??
  - 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 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%.

47 See function `ispotentialissue()` in the file https://github.com/aleip/eealocatorplots/blob/master/eugirp_functions.r

48 https://github.com/aleip/eealocatorplots/blob/master/agrichecks1ADs.r

49 https://github.com/aleip/eealocatorplots/blob/master/agrichecks2Nex.r

– 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 Table 50.23 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.

– Comparison of time trend of digestible energy and milk yield in dairy cows. In principle, these two parameters should have the same trend (both increasing or both decreasing). A situation with increasing milk yields and decreasing or constant DE might indicate that feeding plans are not updated in the country inventory.

- **Recalculation**: Countries were asked for justifications of recalculations of more than 0.05% of national total emissions (excluding LULUCF) for years 1990 and 2017, focusing on key categories.

The total number of issues identified in 2019 submission is 162, of which:

- 26 completeness issues (related to ‘NE’/’empty’/’notation keys’)
- 42 country-outlier issues
- 11 recalculation issues
- 2 time trend issues
- 18 recommendations from previous ESD reviews or UNFCCC reviews
- 36 agricheck issues
- 27 other issues (wrong units, same values reported for 2016 and 2017)

The status of responses as of April 15, 2019 is given in Table 5.57:

Table 5.57 Status of issues as of April 15, 2019

Check	Resolved	Partially resolved	Unresolved/ not yet responded
Completeness	58%	31%	12%
Outliers	67%	14%	19%
Recalculations	100%	0%	0%
Time series	0%	100%	0%
Recommendations	33%	56%	11%
Agrichecks	42%	31%	28%
Other	78%	22%	0%

All issues had been responded by April 15, being the ‘recalculations’ the only type of issues with a hundred percent resolution, followed in percentage by the ‘other’ (unit errors, same values for the last two years, etc.) and outliers. Most of the recalculation and the ’other’ issues required just an explanation or were due to mistakes which have mostly been corrected. The agrichecks are the type of issues with the highest share of questions still unresolved, followed by the outliers, both types often requiring detailed information that sometimes the countries cannot easily obtain. Similarly happens with the recommendations, 11% of which remain unresolved, but countries are working on getting the necessary data for the resolution of the issues.

5.5.3.2 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].

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 EU28+ISL 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 EU28+ISL weighted averages to avoid biases in the results. Therefore, the EU28+ISL weighted averages - in some cases - could not represent 100% of EU28+ISL activity data.

5.5.3.3 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.

5.5.4 Workshops and activities to improve the quality of the inventory in agriculture

5.5.4.1 Workshop on 'Inventories and Projections of Greenhouse Gas Emissions from Agriculture' (2003)

As a first activity to assure the quality of the inventory by Member States, a workshop on "Inventories and Projections of Greenhouse Gas Emissions from Agriculture" was held at the European Environment Agency in February 2003. The workshop focused on the emissions of methane (CH_4) and nitrous oxide (N_2O) induced by activities in the agricultural sector, not considering changes of carbon stocks in agricultural soils, but including emissions of ammonia (NH_3). The consideration of ammonia emissions allows the validation of the N_2O emission sources and it further strengthens the link between greenhouse gas and air pollutant emission inventories reported under the UNFCCC, the EC Climate Change Committee, the UNECE Long-Range Transboundary Air Pollution Convention, and the EU national emission ceiling directive. Objectives of the workshop were to compare the Member States methodologies and to identify and explain the main differences. The longer term objective is to further improve the methods used for inventories and projections in the different Member States and to identify how national and common agricultural policies could be integrated in EU-wide emission scenarios.

The workshop report including the Recommendations formulated at the workshop are available here[51]

5.5.4.2 Survey on agricultural production methods (SAPM 2010)

The Survey on agricultural production methods, abbreviated as SAPM, is a once-only survey carried out in 2010 to collect data at farm level on agri-environmental measures. EU Member States could choose

[50] https://github.com/aleip/eealocatorplots/blob/master/eugirp_euweightedaverages.r

[51] Leip, A., 2005. N2O emissions from agriculture. Report on the expert meeting on 'improving the quality for greenhouse gas emission inventories for category 4D', Joint Research Centre, 21-22 October 2004, Ispra. Office for Official Publication of the European Communities, Luxembourg. doi:http://dx.doi.org/10.13140/RG.2.1.4706.7607.

whether to carry out the SAPM as a sample survey or as a census survey. Data were collected on tillage methods, soil conservation, landscape features, animal grazing, animal housing, manure application, manure storage and treatment facilities and irrigation. With reference to irrigation, Member States were asked to provide estimation (possibly by means of models) of the volume of water used for irrigation on the agricultural holding.

The characteristics that were collected are given in the Regulation (EC) No 1166/2008 of the European Parliament and of the Council 19 November 2008 on farm structure surveys[52] and the survey on agricultural production methods and further defined in the Commission Regulation (EC) No 1200/2009 of 30 November 2009 implementing Regulation (EC) No 1166/2008 of the European Parliament and of the Council on farm structure surveys and the survey on agricultural production methods, as regards livestock unit coefficients and definitions of the characteristics[53].

A list of characteristics of potential relevance for the quantification of GHG emissions is given in Table 5.58.

Table 5.58 Selected characteristics included in the 'Survey on agricultural production methods' (SAPM)

Characteristic			Units/categories
Animal Grazing	Grazing on holding	Area grazed during the last year	ha
		Amount of time when animals are outdoors on pasture	Month per year
	Common land grazing	Total number of animals grazing on common land	Head
		Amount of time when animals are grazing on common land	Month per year
Animal housing	Cattle	Stanchion-tied table - with solid dung and liquid manure	Places
		Stanchion-tied table - with slurry	Places
		Loose housing - with solid dung and liquid manure	Places
		Loose housing - with slurry	Places
		Other	Places
	Pigs	On partially slatted floors	Places
		On completely slatted floors	Places
		On straw beds (deep litter housing)	Places
		Other	Places
	Laying hens	On straw beds (deep litter housing)	Places
		Battery cage (all types)	Places
		Battery cage with manure belt	Places
		Battery cage with deep pit	Places

52 http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32008R1166

53 http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1448050507039&uri=CELEX:32009R1200

		Battery cage with stilt house	Places
		Other	Places
Manure application	Used agricultural area on which solid/farmyard manure is applied	Total	UAA % band ([2])
	Used agricultural area on which solid/farmyard manure is applied	With immediate incorporation	UAA % band ([2])
	Used agricultural area on which slurry is applied	Total	UAA % band ([2])
	Used agricultural area on which slurry is applied	With immediate incorporation	UAA % band ([2])
	Percent of the total produced manure exported from the holding		Percentage band ([3])
Manure storage and treatment facilities	Storage facilities for:	Solid dung	Yes/No
		Liquid manure	Yes/No
		Slurry: Slurry tank	Yes/No
		Slurry: Lagoon	Yes/No
	Are the storage facilities covered?	Solid dung	Yes/No
		Solid dung	Yes/No
		Slurry	Yes/No

Note 1: Utilised agricultural area (UAA) percentage band: (0), (> 0-< 25), (=25-< 50), (=50-< 75), (=75)

Note 2: Percentage band: (0), (> 0-< 25), (=25-< 50), (=50-< 75), (=75).

5.5.4.3 The LiveDate project on Nitrogen Excretion factors

The key indicator 'Gross Nutrient Balance' (GNB) is part of the set of agri-environmental indicators defined in the Commission Communication on the "Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy"[54]. The Eurostat/OECD Methodology and Handbook on Nutrient Budgets has been updated and amended in 2013[55]. Nitrogen excretion coefficients have been identified of a major source of uncertainty for the estimation of the GNB, with high relevance for other reporting obligations, including the nitrate directive, reporting of ammonia emissions under the CLRTAP and the NEC directive, as well (and importantly) for the quantification of N_2O emissions from manure management and agricultural soils. An expert workshop was therefore organized on 28/03/2014 at Eurostat to discuss the possibility to improve the quality of N-excretion data by using a common improved methodology. A recommendation on such a common methodology served as the basis for discussion. The workshop was co-organized by JRC under the WG on Annual GHG inventories under the EU Climate Change Committee and was attended by agricultural experts of the EU GHG inventory system.

[54] http://epp.eurostat.ec.europa.eu/portal/page/portal/agri_environmental_indicators/introduction

[55] http://epp.eurostat.ec.europa.eu/portal/page/portal/agri_environmental_indicators/documents/Nutrient_Budgets_Handbook_%28CPSA_AE_109%29_corrected3.pdf

The following gives some information on the project that prepared the recommendations, as extracted from the report from Oenema et al. (2014)[56].

The general objective of the study "Nitrogen and phosphorus excretion coefficients for livestock; Methodological studies in the field of Agro-Environmental Indicators; Lot1" (2012/S 87-142068) is "to bring clarity into the issue of excretion coefficients so that a recommendation on a single, common methodology to calculate N and P excretion coefficients can be identified". The recommendation for a uniform and standard methodology for estimating N and P excretion coefficients must be based on a thorough analysis of the strength and weaknesses of the existing methodologies and on the data availability and quality in the Member States.

The specific objectives of the study were:

- To create an overview of the different methodologies used in Europe to calculate excretion factors for N and P, and analyse their strengths and weaknesses;
- To set up a database with the excretion factors presently used in different reporting systems and describe the main factors that cause distortion within a country and across the EU;
- To provide guidelines for a coherent methodology, consistent with IPCC and CLTRP guidelines, for calculating N and P excretion factors, and taking into consideration the animal balance and taking into account different methodologies identifies under the first bullet point;
- To create default P-excretion factors that can be used by the countries who do not have yet own factors calculated;

The recommendations of the LiveDate project from the authors of the report were:

- It is recommended to use the mass balance as a common and universally applicable method to estimate N and P excretion coefficients per animal category across EU-28:
  - $N_{excretion} = N_{intake} - N_{retention}$
  - $P_{excretion} = P_{intake} - P_{retention}$
- We recommend that the European Commission encourages Member States to invest in Tier 2 and 3 methods for key animal categories (and hence in country-specific, region-specific and/or year-specific excretion coefficients).
- We recommend that the European Commission encourages Member States to use a 3-Tier approach for the collection of data and information needed to estimate N and P excretion coefficients, so as to address differences between countries in livestock production and data collecting/processing infrastructure, and to economize on data collection/processing efforts. The three Tiers differ in the origin, scale and frequency of data and information collection.
- We recommend that the European Commission encourages Member States to use a Tier 3 approach for all key animal categories when livestock density in a country is > 2 livestock units per ha (>2 LSU per ha), equivalent to an excretion of about > 200 kg N or the inter-annual variation in N excretion by key animal categories is relatively large due to the effects of changing weather conditions and market prices.
- We recommend that the European Commission encourages Member States to use a Tier 2 approach for all main animal categories when livestock density in a country is between 0.5 and 2 LSU per ha

[56] Oenema, O., Sebek, L., Kros, H., Lesschen, J.P., van Krimpen, M., Bikker, P., van Vuuren, A., Velthof, G., 2014. Guidelines for a common methodology to estimate nitrogen and phosphorus excretion coefficients per animal category in eu-28. final report to eurostat, in: Eurostat (Ed.), Methodological studies in the field of Agro-Environmental Indictors. Eurostat, Luxembourg, pp. 1?108.

(equivalent to an excretion of between about 50 and 200 kg N, under the condition that the inter-annual variation in N excretion by key animal categories is relatively small.

- We recommend that the European Commission reviews the current default N and P excretion coefficients of all animal categories and decides on a list of N and P excretion coefficients. Member States are recommended to use this list as a Tier 1 approach for all animal categories within a country when livestock density is <0.5 livestock units per ha (<0.5 LSU per ha, also at regional levels), which is equivalent to about 50 kg N and 10 kg P per ha agricultural land per year.
- We recommend that the European Commission encourages Member States to use region-specific N and P excretion coefficients when N and P excretion coefficients of the main animal categories differ significantly (>20%) between regions.
- We recommend that the European Commission makes computer programs available to Member States to encourage the calculation of the N and P excretion per animal category at regional and national levels in a uniform way. It is also recommended to provide training courses for the use of these programs and the calculation of the N and P excretion coefficients.
- We recommend that the European Commission encourages Member States to have well-documented and accessible methods for the estimation of N and P excretion coefficients per animal category. These reports should be updated once every 3-5 years and reviewed by external experts.
- We recommend that the European Commission encourages Member States to harmonise the various animal categories in formal policy reporting. We recommend that the FSS categorization is taken as the main list of animal categories for policy reporting, also because the inventory of the number of animals takes place regularly according to the FSS list of animal categories. We recommend also that a transparent scheme and computer program is developed for translating the inventory data of FSS into the animal categories of secondary databases (e.g., UNFCCC/IPCC-2006, EMEP/EEA, Nitrates Directive, FAO and OECD). The development of a uniform nomenclature for animal categories would be useful too, which should include definitions about key, main, minor, primary, secondary, functional categories
- We recommend that the European Commission encourages Member States to conduct a secondary animal categorization for key animal categories (e.g., cattle, pigs and poultry), when more than 20% of the animals are in another system and when the N and/or P excretion coefficients differ by more than 20% from the overall mean N and P excretion coefficients. We recommend that the following aspects are considered for distinguishing different production systems:
  - Fast-growing and heavy breeds vs slow-growing breeds
  - Organic production systems vs common production systems
  - Housed ruminants vs grazing ruminants
  - Caged poultry vs free-range poultry
- Equally important is that the excretion coefficients can be translated in a transparent and well-documented manner from such secondary categories to the main categories of the FSS.
- We recommend that the European Commission conducts a review of the diversity of production systems and feeding practices within a country for the main animal categories cattle, pigs and poultry once in 5 yrs, so as to trace changes in production systems, including organic versus conventional systems, housed vs grazing ruminants, caged versus free range poultry, and fast growing breeds versus slow growing breeds.
- We recommend that the European Commission encourages Member States to review and update the N and P retention coefficients for all animal categories once in 5-10 yrs. All data should be stored in a database accessible by all Member States.

- We recommend that the European Commission conducts a review and adjusts/modifies/updates the classification system of livestock units (as presented also in Table 5 of this report), and livestock density, so as to better reflect the diversity of animals within an category and more in general the impact of livestock on the environment.

5.5.4.4 Regionalisation of the Gross Nutrient Budget with the CAPRI model

The JRC was cooperating with EUROSTAT on a methodology to use the CAPRI model[57] for the regionalisation of the Gross Nutrient Budget (GNB) indicators (nitrogen and phosphorus) that needs to be reported regularly by countries to EUROSTAT and OECD. The GNBs are identified as one of the key agro-environmental indicators. Current reporting occurs at the national level. For policy making, a higher resolution, matching with legislative and environmental boundaries (NVZ, watershed) rather than administrative boundaries (country) is required. The CAPRI model is an economic model for agriculture, which has an environmental accounting model integrated. It has a spatial resolution of NUTS2 and reports, a.o. Nitrogen Balances at this level. The CAPRI model has a down-scaling module integrated which estimates land use shares and environmental indicators at the pixel level (1 km by 1 km). The use of the CAPRI model is motivated in view of the lack of methodology for regionalisation of the GNB and the high costs associated with building up such systems in the countries at one hand, and the thrive to harmonise the conceptual approaches.

The Working Group (WG) on agri-environmental indicators (AEI, February 2012) and the subsequent Standing Committee for Agricultural Statistics (CPSA, May 2012) decided to start a pilot projects on regionalising Gross Nitrogen Balance (GNB) with the CAPRI model. The objective of the pilot project is to evaluate differences between national GNB and the GNB calculated with CAPRI at the country and the NUTS2 scale. Italy, France, Germany and Hungary volunteered for this pilot project. The RegNiBal project (Regionalisation of Nitrogen Balances with the CAPRI Model - Pilot Project) started in February 2013. The overall goal was to use the CAPRI model to provide (operationally) regional GNB data to complement the national Eurostat/OECD GNBs.

Four countries volunteered to share their national GNB estimates with the CAPRI team which were analysed on differences with CAPRI estimates and recommendations were formulated to improve both national methods and the CAPRI model:

- France
- Germany
- Italy
- Hungary

The conclusions formulated in the final RegNiBal report[58] included:

A total of 31 'issues' were identified that were related to major discrepancies between the methods and warranted further assessment. At the end of the project, 12 of the identified issues were solved, one was partially solved and 18 could not be solved, but some progress was achieved and concrete recommendations were made for almost all of them. The results and achievements of RegNiBal are summarised in Annex 12.

57 http://www.capri-model.org/

58 Özbek, F.S., Leip, A., Weiss, F., Grassart, L., Hofmeier, M., Kukucka, M., Pallotti, A., Patay, A., Thuen, T., 2015. Regionalisation of Nitrogen Balances with the CAPRI Model (RegNiBal) Pilot project in support of the Eurostat Working Group on Agri-Environmental Indicators. Publications Office of the European Union, Luxembourg. doi: http://dx.doi.org/10.2788/078406.

At the start of the RegNiBal project CAPRI data was generally judged to be more reliable than national data. The situation has changed with the improvements described above; at present, further analysis is needed to see whether CAPRI or national data is ?better? with regard to the remaining unresolved issues.

Overall, N excretion by swine and N removal by grass are considered the most important unresolved issues because of their considerable impact on N-input and N-output. The animal budget analysis for swine of DE and FR shows that CAPRI estimates higher feed intake than the national methodologies. Countries are not always sufficiently accurate in estimating and/or using the average number of animals and N-excretion coefficients in N manure excretion estimations. For the estimates of dry matter yields of grassland, the differentiation of permanent grassland according to the proposal of the GRASSDATE project (Velthof et al 2014)[59] would likely help (grassland out of production but maintained, unimproved grassland (including both sole use and common land) and improved grassland (by N-input levels <50, 50-100, >100 kg N/ha/yr, sole use and common land).

The CAPRI model is very strong in several parts of GNB calculations, and the RegNiBal project enabled us to identify several possible improvements in national data and methods. The use of the animal budget to estimate N excretion is a major asset in the CAPRI methodology, but runs the risk of outliers if the use of feed in the statistical sources is overestimated. There is large uncertainty in grass yield and other (non-marketable) fodder yield and their N content. This affects the accuracy of national data as well. The other major areas of difficulties for the CAPRI model are the following: (i) Seed and planting materials should be explicit in the CAPRI GNB; (ii) N from organic fertilisers (other than manure) and manure withdrawal, stocks, and import estimations are not considered in the CAPRI model.

The CAPRI model can be used to calculate both land N budgets (GNB) and farm N budgets. The possibility of comparing the GNB with the farm N-budget helps to constrain the N-surplus results. For the farm N-budget, feed and fodder produced in the country (or region) and manure excreted and applied within the country (or region) are considered as internal flows and thus do not need to be estimated to quantify the N-surplus; data on imported feed and exported animal products are needed instead (for details on the comparison of the two approaches, see Leip et al 2011[60]). In the CAPRI model, data on animal products and imported feeds are available from statistical sources and are thus more reliable than the data on the N intake of fodder and manure excretion, which would not be required. Generally, the RegNiBal project showed that the CAPRI model could be adequate to provide national (and later regional and spatially explicit) GNBs. However, for the four countries assessed, additional work needs to be carried out to understand residual disagreements in the data.

5.5.4.5 Workshop on improving national inventories for agriculture (2014)

Under the WG1 on Annual GHG inventories under the EU Climate Change Committee a workshop on improving GHG inventories in the sector agriculture was organized by the Joint Research Centre as part of the 7th Non-CO_2 Greenhouse Gas Conference (NCGG7), held November 5-7, 2014 Amsterdam, the Netherlands[61]. The workshop was co-organized by CEH in support of the UK greenhouse gas inventory programme.

The session raised a high interest, contained high quality presentations and allowed scientists, IPCC and FAO representatives and country delegates to discuss about greenhouse accounting methods, their difficulties and challenges to use 2006 IPCC Guidelines, to select the appropriate tier methods and to design country-specific methodologies which allow reducing uncertainties. From a total attendance of

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59 Velthof, G.L., Lesschen, J.P., Schils, R.L.M., Smit, A., Elbersen, B.S., Hazeu, G.W., Mucher, C.A., Oenema, O., 2014. Grassland areas , production and use. Lot 2. Methodological studies in the field of Agro-Environmental Indicators. Alterra Wageningen UR, Wageningen, The Netherlands.

60 Leip, A., Britz, W., Weiss, F., de Vries, W., 2011. Farm, land, and soil nitrogen budgets for agriculture in Europe calculated with CAPRI. Environ. Pollut. 159, 3243?53. doi: http://dx.doi.org/10.1016/j.envpol.2011.01.040.

61 http://www.ncgg.info/

about 200 conference participants and five parallel sessions, this session was temporary attended by almost 100 scientists.

The workshop focused on N_2O emissions from agricultural soils, as they are highly uncertain yet are often estimated with default methodology in lack of country-specific data of sufficient quality. N_2O emissions from agricultural soils are dominating the uncertainty of the total GHG emissions for many countries. The programme included presentations covering the whole range of aspects of N_2O emission estimates: the availability of flux data in Europe and network design strategies (Rene Dechow, Thuenen Institute, DE), use of process-based models in GHG inventories (Steve del Grosso, USDA) to inverse methods to estimated national total N_2O emissions (Rona Thompson, NILU, NO). Further presentation gave national examples on GHG improvements, such as UK (general), NZ (pasture emissions), Thailand (emissions from rice), Norway (emissions from dairy farms) and on the link to 2006 IPCC Guidelines and the IPCC Emission Factor Database (Kiyoto Tanabe (see below) and Baasansuren Jamsranjav, IPCC TFI TSU). A broader picture was given on the basis of the FAOSTAT GHG Database (FrancescoTubiello) and the CAPRI model (Carmona and Leip: The calculation of greenhouse gas emissions in the European agricultural sector; how much does the method matter?). Introduction and expectations were formulated by a presentation from Velina Pendolovska (DG Climate Action).

A final brainstorming exercise was done about how modelling and measurements could be improved in a way to reduce uncertainties, improve accuracy of measures and optimise resources. There was a debate around whether new models are needed or focusing on reducing the uncertainty in current models would be preferable, for example using the results of inverse modelling to contrast results. There is an agreement on the acceptability of simple models or inverse models for emission accounting at high scales, while more complex process-based models are needed when designing mitigation options. The problem of nitrogen surplus was pointed out as a proxy of N_2O emissions, which also informs about other additional pollution problems. About the estimation of uncertainties, the group agreed on the need, first of all, to improve their estimation. It seemed a general impression that uncertainties are usually overestimated, but it is difficult to quantify objectively. Another point that needs attention is the activity data: statistics do not always match at national level, and sometimes models demand a high quantity of data which is not available. Getting better activity data is important prior to focus on emission estimations.

As a conclusion, the combination of an expert meeting in support of the EU GHG inventory system and an international scientific conference was very successful, as it provided a high density of expertise that country delegates could use. The NCGG conference series is ideal for this purpose.

5.5.5 Verification

5.5.5.1 Allocation to climate regions

In the year 2013, an analysis was performed to compare the allocation of livestock over the IPCC climate regions at the national scale between data available at high spatial resolution at the Joint Research Centre and data provided in the national GHG inventory reports.

For the submission in the year 2014, this section had been updated and is available at the JRC website[62]

5.5.5.2 Comparison of national inventories with EU-wide calculations with the CAPRI model

In the context of the GGELS project (http://afoludata.jrc.ec.europa.eu/group/ggels-results), an in-depth comparison between data provided by Parties in the national inventories and greenhouse gases estimates as calculated with the CAPRI model for the year 2002 was done. A summary of this project was included in previous EU GHG emission inventories in the agriculture chapter. The Joint Research

62 ftp://mars.jrc.ec.europa.eu/Afoludata/Public/363_eughginventory2014/koeble_leip2014.livestockallocation.pdf

Centre is working on a more comprehensive comparison between CAPRI and the national GHG inventories and compare the development of emissions over the timespan 1990 to last reported year.

To this purpose, for the submission in the year 2016, a pilot project was carried out to provide a preliminary comparison. In the CAPRI model, GHG emissions are calculated based on activity data contained in the CAPRI database drawing mainly from data obtained from Eurostat and complemented with other sources (e.g. FAOSTAT). First results of that project were presented in the EU National Inventory Report of the year 2016.

The results revealed considerable differences for certain sub-categories of emissions, due to diverse reasons such as: some discrepancies in population numbers, the use of different emission factors, underlying assumptions taken in the model for certain parameters, and different methodologies for the calculation of emissions. For example, for the nitrogen compounds emitted, CAPRI uses a mass-preserving N balance approach, which consistently accounts for all nitrogen flows and quantifies available N at each step of the system (see [63], [64]). Furthermore, while countries may use different Tiers according to the emission category and their availability of resources, and often country specific methods and parameters, CAPRI applies the same calculation method for all reporting parties, always in compliance with 2006 2006 IPCC Guidelines.

Since 2016, we have been working on the improvement of a comparison module in the CAPRI model, which incorporates some elements allowing the comparison with national inventory data along the whole time series. The module considers dynamic evolution of parameters which were originally considered as fixed, and in particular feed requirements. It is now possible to compare data for the whole time series from 1990 until the last year that is available in the CAPRI data base, which is currently the year 2014. For the year 2016, a CAPRI 'now-casting' is made. This is a projection of the data for the year 2016 based on a trend analysis keeping consistency between all variables (i.e., areas and herd sizes, yields, production volumes, technology development etc.).

Preliminary results show that for some emission categories there are differences whose reasons have to be analysed. For example, Figure 5.77 shows emissions from enteric fermentation from non-dairy cattle. As we can see, emissions calculated by CAPRI are higher than emissions reported by NI. According to Figure 5.78, differences in population between the two databases are much smaller, therefore another reason other than activity data must be behind discrepancies in emissions (for example feed rations or feed digestibility etc).

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[63] Leip, A., 2010. Quantitative quality assessment of the greenhouse gas inventory for agriculture in Europe. Clim. Change. 103, 245-261. doi:http://dx.doi.org/10.1007/s10584-010-9915-5.

[64] Velthof, G.L., D.A. Oudendag, and O. Oenema. 2007. Development and application of the integrated nitrogen model MITERRA-EUROPE. Task 1 of Service contract "Integrated measures in agriculture to reduce ammonia emissions. Alterra Rep.1663.1. Alterra, Wageningen, the Netherlands.

Figure 5.77: 3.A.1: Comparison of CH_4 emissions from enteric fermentation of non-dairy cattle in the EU28+ISL and range of values reported by countries in the UNFCCC and the CAPRI

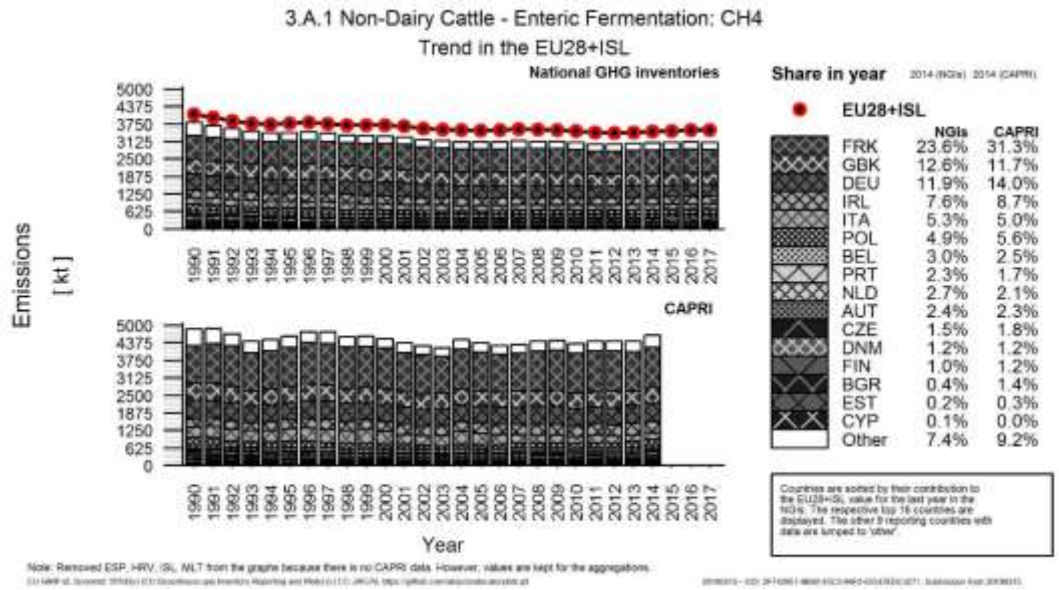

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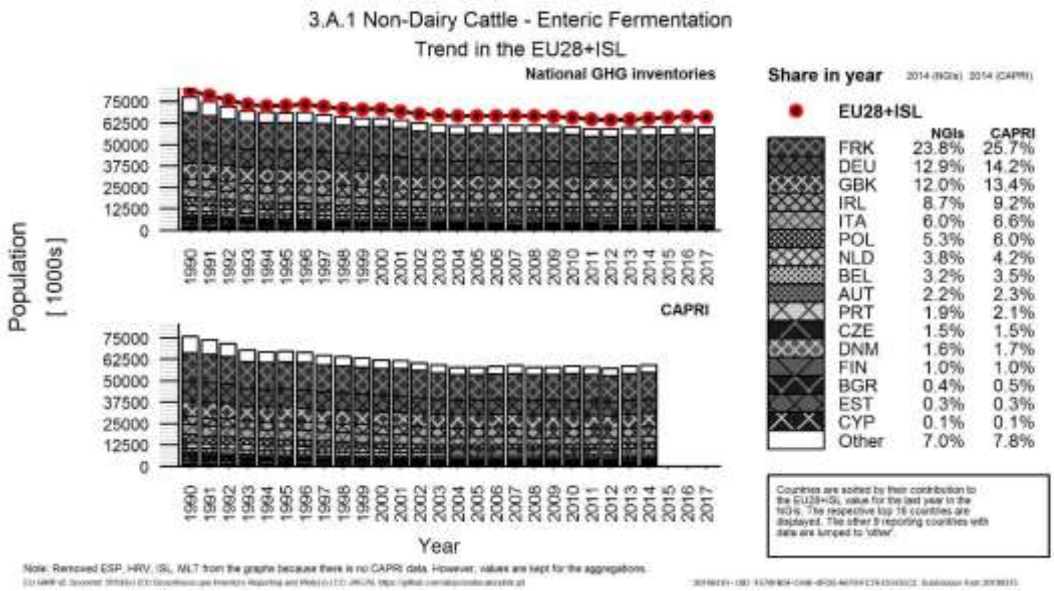
Figure 5.78: 3.A.1: Comparison of non-dairy cattle population in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.



5.5.5.3 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 1990-2017. 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 Guidelinesfor 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-28+Iceland and year 2017 (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-28+ISL, averaged over the years 2000 to 2016, 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**	196,121	45.0	193,951	44.7
3.B.1 - CH_4 Emissions	*CH_4*	*43,808*	*10.0*	*50,126*	*11.6*
3.B.2 - N_2O Emissions	*N_2O*	*23,250*	*5.3*	*14,046*	*3.2*
3.C - Rice Cultivation	*CH_4*	*2,715*	*0.6*	*5,348*	*1.2*
3.D.1.1 - Direct N_2O Emissions - Inorganic N Fertilizers	**N_2O**	51,321	11.8	46,965	10.8
3.D.1.2 - Direct N_2O Emissions - Organic N Fertilizers	**N_2O**	23,617	5.4	24,581	5.7
3.D.1.3 - Urine and Dung Deposited by Grazing Animals	**N_2O**	21,741	5.0	22,366	5.2
3.D.1.4 - Crop Residues	**N_2O**	19,800	4.5	14,925	3.4
3.D.1.5 - Mineralization of Soil Organic Matter	**N_2O**	733	0.2	0	0.0
3.D.1.6 - Cultivation of Organic Soils	**N_2O**	13,157	3.0	24,395	5.6
3.D.2 - Indirect N_2O Emissions	**N_2O**	28,907	6.6	35,554	8.2
3.F - Field Burning of Agricultural Residues	**CH_4**	816	0.2	1,325	0.3
3.F - Field Burning of Agricultural Residues	**N_2O**	297	0.1	410	0.1
3.G - Liming	**CO_2**	5,892	1.4	0	0.0
3.H - Urea Application	**CO_2**	3,705	0.8	0	0.0
3.I - Other Carbon-containing Fertilizers	**CO_2**	327	0.1	0	0.0
Total	**GHGs**	436,206	100.0	433,992	100.0

Comparing both databases, we can see that UNFCCC reports slightly higher total emissions than FAOSTAT (436.2 versus 434) 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 (425.5 versus 434) 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:

1. 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.
2. 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:

- N_2O emissions from category 3.D.1.6 - Cultivation of Organic Soils (-11238 kt CO_2-eq yr^{-1}, with larger emissions reported by FAO), followed by
- N_2O emissions from category 3.B.2 (9204 kt CO_2-eq yr^{-1}, with larger emissions reported by NIR) and
- Indirect N_2O emissions from category 3.D.2 (-6647 kt CO_2-eq yr^{-1}, with larger emissions reported by FAO).

These three emission categories represent a significant share of the total agricultural emissions in the NIR and FAO databases, accounting for 3-5.6%, 3.2-5.3% and 6.6-8.2%, respectively.

The largest three differences in relative terms are:

- CH_4 emissions from category 3.C - Rice Cultivation (-97 %, with larger emissions reported by FAO), followed by
- N_2O emissions from category 3.D.1.6 - Cultivation of Organic Soils (-85.4 %, with larger emissions reported by FAO) and
- CH_4 emissions from category 3.F - Field Burning of Agricultural Residues (-62.4 %, with larger emissions reported by FAO).

The three source categories with the highest absolute and relative differences are N_2O emissions from category 3.D.1.6 - Cultivation of Organic Soils, CH_4 emissions from category 3.C - Rice Cultivation and NA emissions from category NA.

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 (1990-2017).

We will employ two types of figures throughout this section. Figure of the type as in Figure 5.79 show the trend of EU28+ISL 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 5.80 show three different perspectives on the comparison of the two data sets, using the average of data for the years 1990-2017: 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 countries, as compared to the EU28+ISL total: $(FAO_{country}-NIR_{country})/NIR_{EU}$.

Animal populations

Trends of population data in the two data sets and a comparison of average data in the period 1990 to 2017 are shown for dairy Cattle (Figure 5.79 and Figure 5.80), non-dairy Cattle (Figure 5.81 and Figure 5.82), sheep (Figure 5.83 and Figure 5.84), swine (Figure 5.85 and Figure 5.86) and poultry (Figure 5.87 and Figure 5.88). The trends in the NIR data are discussed in detail in Section 5.2.

Dairy cattle population data from FAO are sometimes smaller and sometimes larger than NIR data. Differences are in the range between -100% and 0.5%. 26 years showing values that are larger in NIR (on average by 1988.6 thousand heads) and 2 years when FAO data are larger (on average by 64 thousand heads). Comparing all years, NIR is larger by 1842 thousand heads or -6.69% 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, 1990), corresponding to 2.7% of total EU dairy cattle population in this year (NIR), -532 thousand heads (Romania, 1991), and -503 thousand heads (Romania, 1993).

Non-dairy cattle population data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 4682 thousand heads or -6.75% 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, 1991), corresponding to 3% of total EU non-dairy cattle population in this year (NIR), 2022 thousand heads (Romania, 1990), and 1610 thousand heads (Romania, 1991).

Sheep population data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 5981 thousand heads or -5.09% 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, 1999), and -2868 thousand heads (Ireland, 1993).

Swine population data from FAO are sometimes smaller and sometimes larger than NIR data. Differences are in the range between -100% and 2.8%. 14 years showing values that are larger in NIR (on average by 17405.7 thousand heads) and 14 years when FAO data are larger (on average by 2283 thousand heads). Comparing all years, NIR is larger by 7561 thousand heads or -4.87% 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, 1991), corresponding to 5.1% of total EU swine population in this year (NIR), 7675 thousand heads (Germany, 1990), and 4927 thousand heads (Germany, 1994).

Poultry population data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 279721 thousand heads or -17.8% 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, 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 5.79: 3.A.1: Comparison of dairy cattle population in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

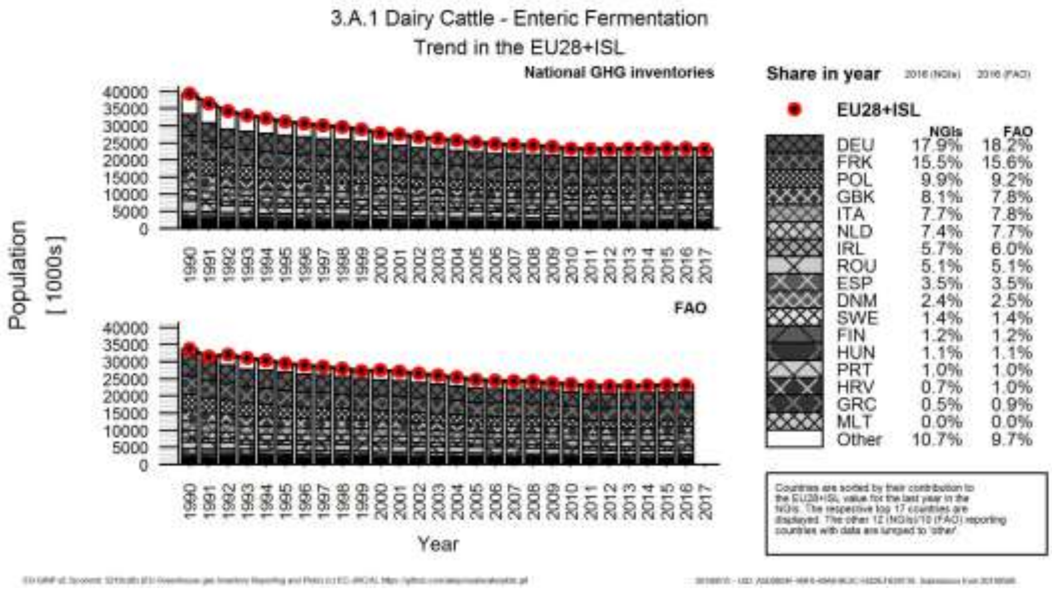


Figure 5.80: 3.A.1: (a) Average Dairy Cattle population in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

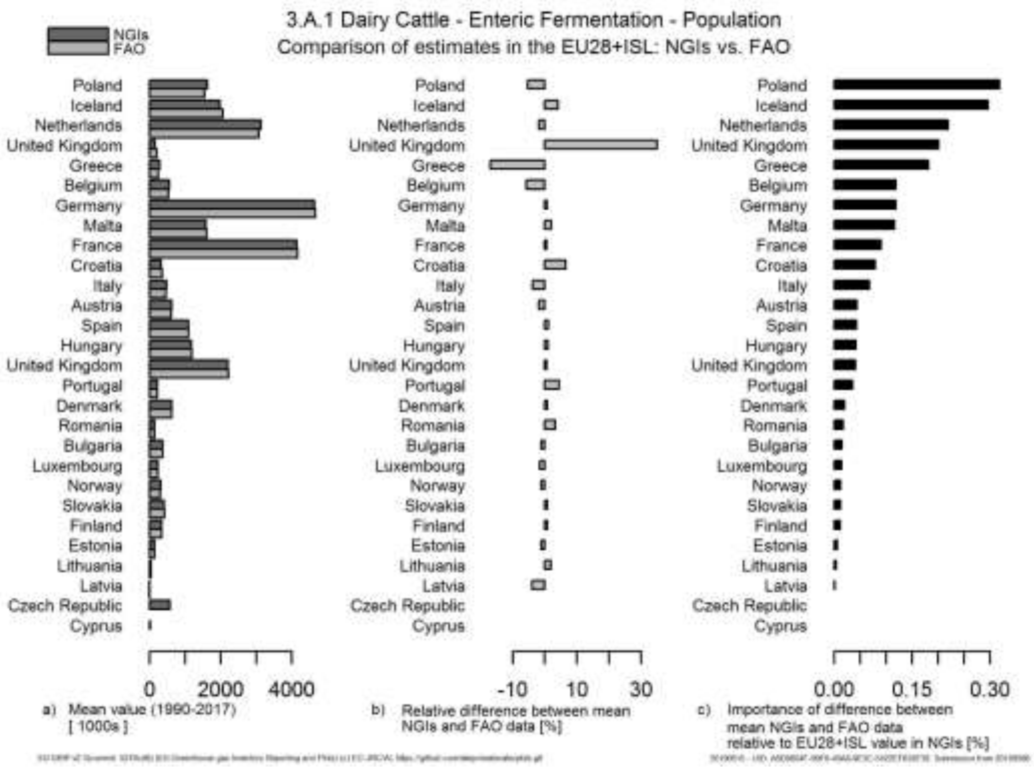


Figure 5.81: 3.A.1: Comparison of non-dairy cattle population in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

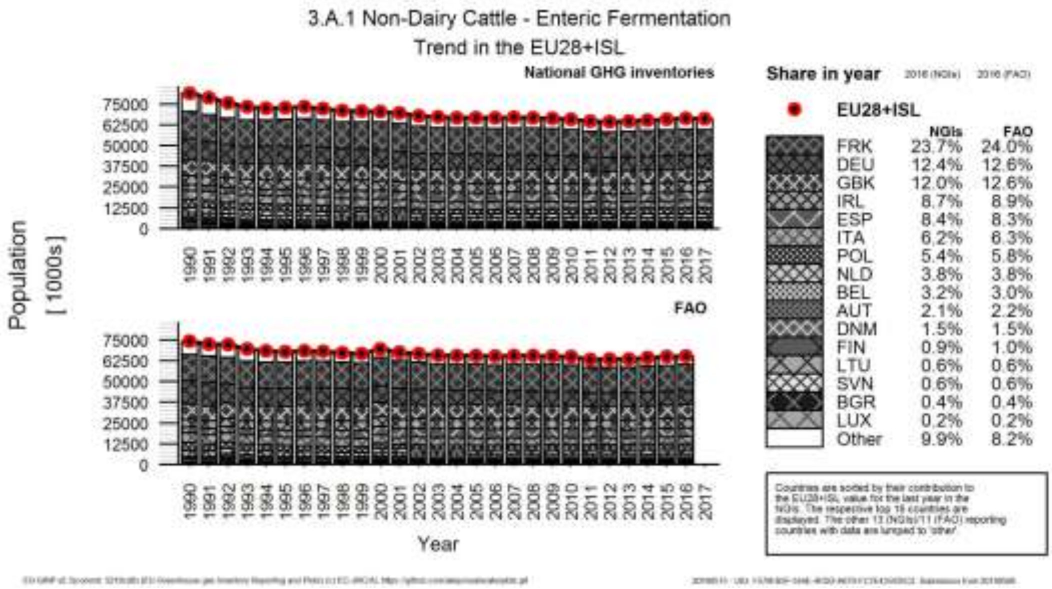


Figure 5.82: 3.A.1: (a) Average Non-Dairy Cattle population in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

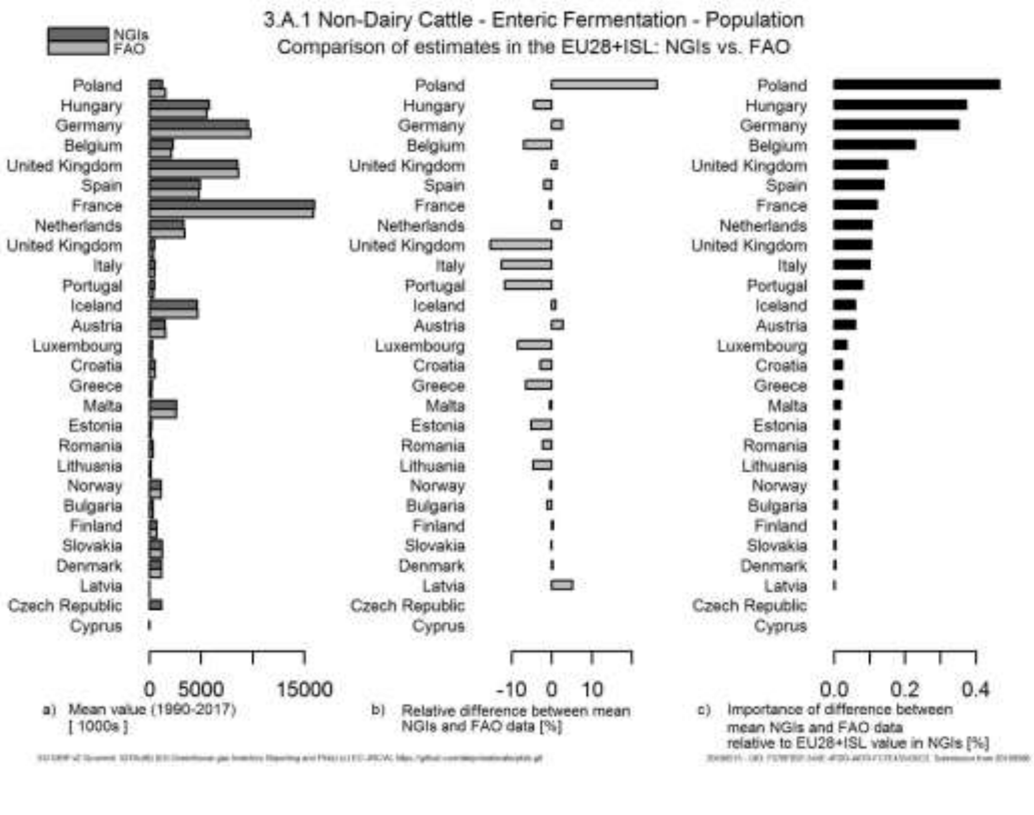


Figure 5.83: 3.A.1: Comparison of sheep population in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

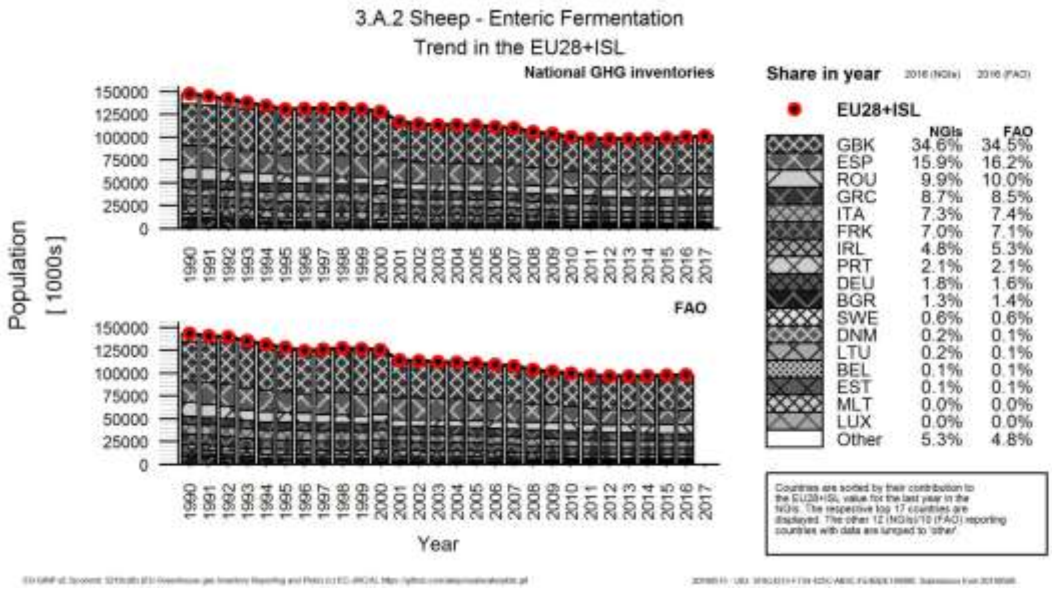


Figure 5.84: 3.A.1: (a) Average Sheep population in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

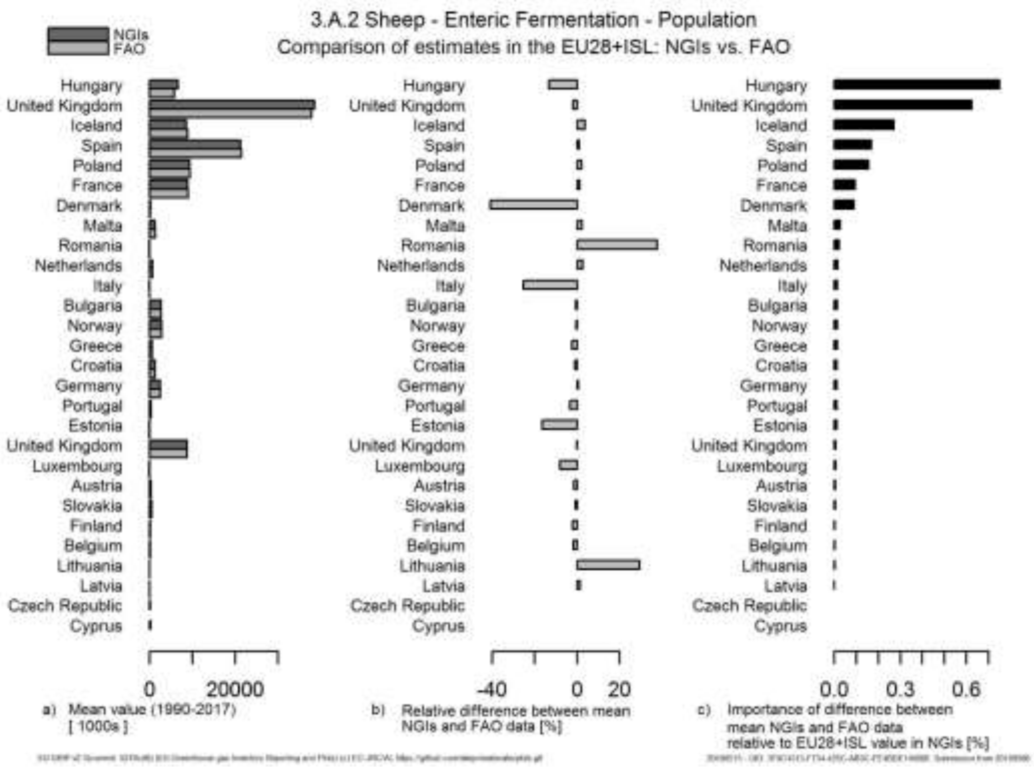


Figure 5.85: 3.A.1: Comparison of swine population in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

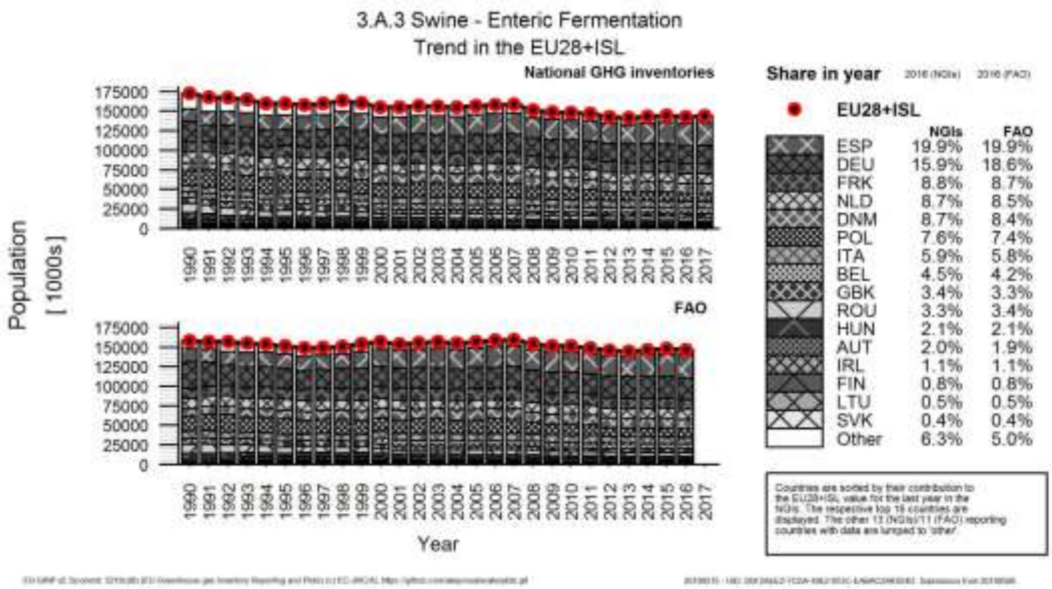


Figure 5.86: 3.A.1: (a) Average Swine population in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

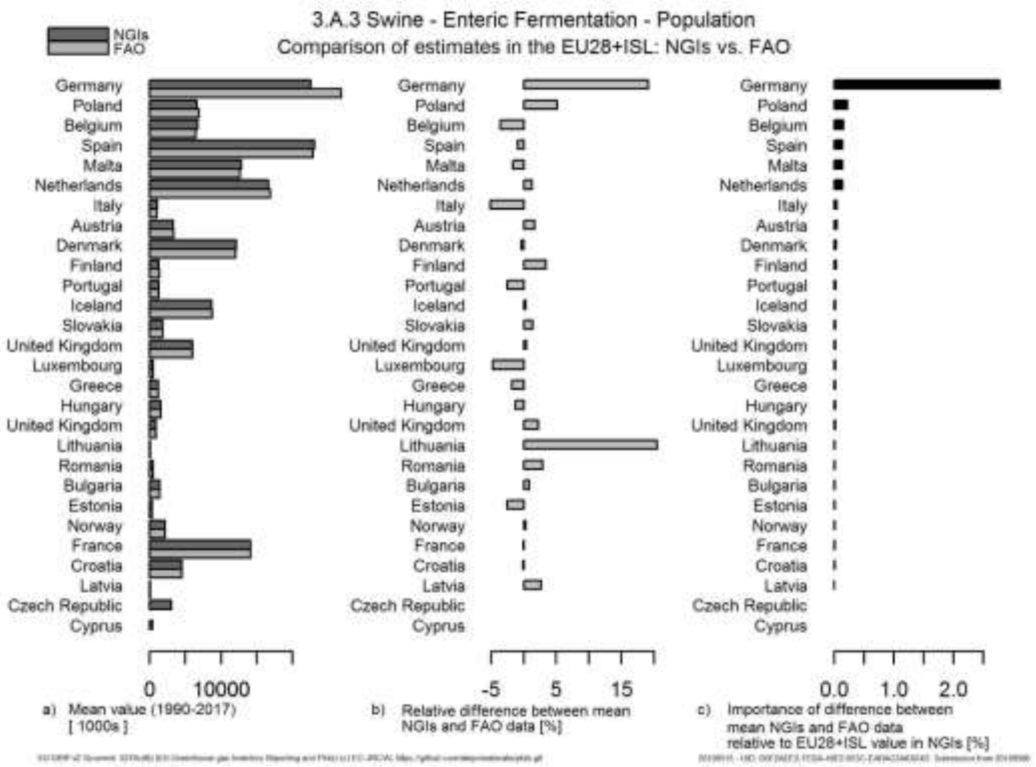


Figure 5.87: 3.A.1: Comparison of poultry population in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

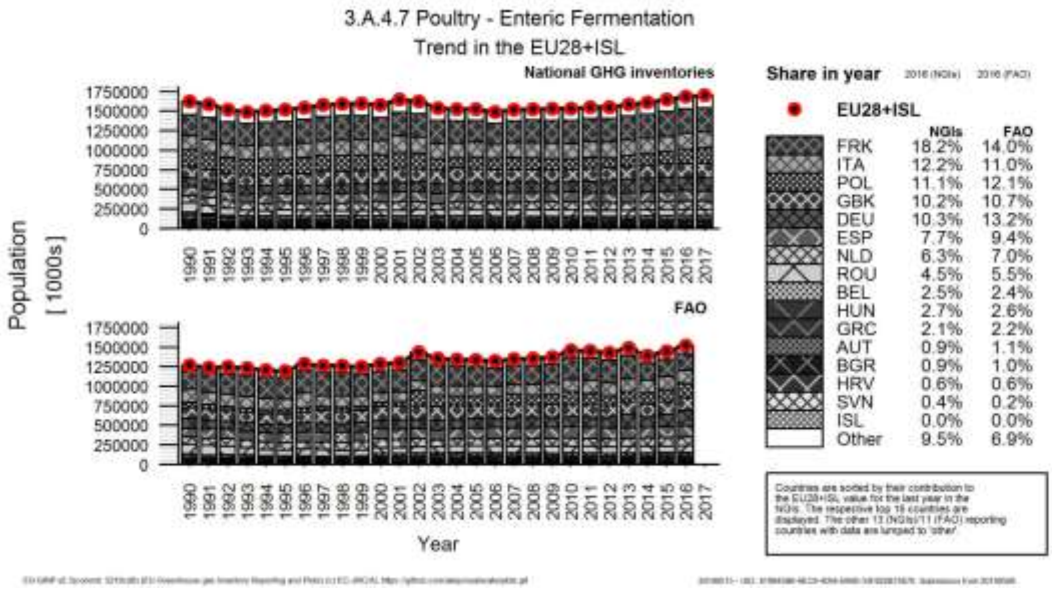
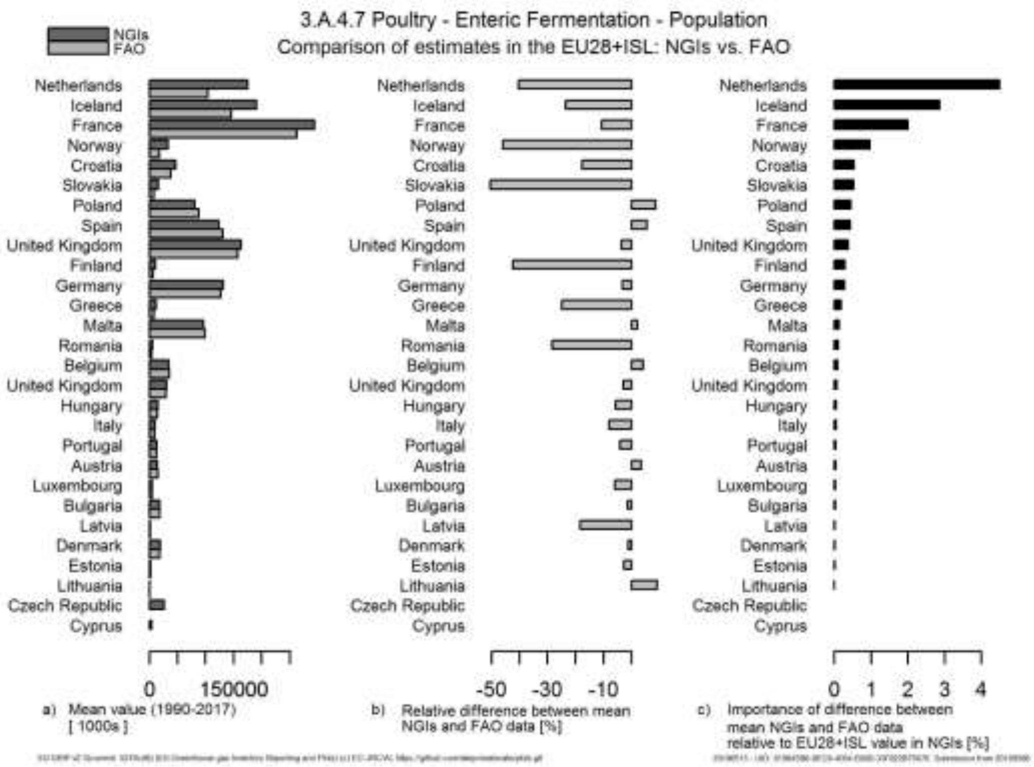


Figure 5.88: 3.A.1: (a) Average Poultry population in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.



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 5.89 through Figure 5.98 compare UNFCCC vs. FAOSTAT data related to N excretion rate for the main livestock categories: dairy cattle, non-dairy cattle, sheep, swine and poultry.

Dairy cattle total N excretion data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 775 kt N/year or -27.7% of the average value in the EU. The three countries with the largest differences in single years are the Netherlands, Germany and France. The largest deviations (FAO minus NIR) are -159 kt N/year (Germany, 2016), corresponding to 6.1% of total EU dairy cattle total n excretion in this year (NIR), -155 kt N/year (Germany, 2015), and -149 kt N/year (Germany, 2014).

Non-dairy cattle total N excretion data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 1250 kt N/year or -35.6% of the average value in the EU. The three countries with the largest differences in single years are France, Ireland and Germany. The largest deviations (FAO minus NIR) are -435 kt N/year (France, 2001), corresponding to 12% of total EU non-dairy cattle total n excretion in this year (NIR), -426 kt N/year (France, 2000), and -419 kt N/year (France, 2002).

Sheep total N excretion data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 663 kt N/year or -72.5% of the average value in the EU. The three countries with the largest differences in single years are the United Kingdom, Italy and Greece. The largest deviations (FAO minus NIR) are -158 kt N/year (Italy, 2000), corresponding to 16% of total EU sheep total n excretion in this year (NIR), -157 kt N/year (Italy, 1999), and -156 kt N/year (Italy, 1996).

Swine total N excretion data from FAO are sometimes smaller and sometimes larger than NIR data. Differences are in the range between -100% and 12.8%. 11 years showing values that are larger in NIR (on average by 241 kt N/year) and 17 years when FAO data are larger (on average by 127 kt N/year). Comparing all years, NIR is larger by 18 kt N/year or -1.03% 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 76 kt N/year (Germany, 1991), corresponding to 3.8% of total EU swine total n excretion in this year (NIR), 69 kt N/year (Germany, 1990), and -62 kt N/year (Romania, 1990).

Poultry total N excretion data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 190 kt N/year or -21% of the average value in the EU. The three countries with the largest differences in single years are Poland, Romania and Germany. The largest deviations (FAO minus NIR) are -85 kt N/year (Romania, 1990), corresponding to 8.6% of total EU poultry total n excretion in this year (NIR), -83 kt N/year (Poland, 1990), and -82 kt N/year (Poland, 1994).

Figure 5.89: 3.B.2: Comparison of dairy cattle total nitrogen excretion in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

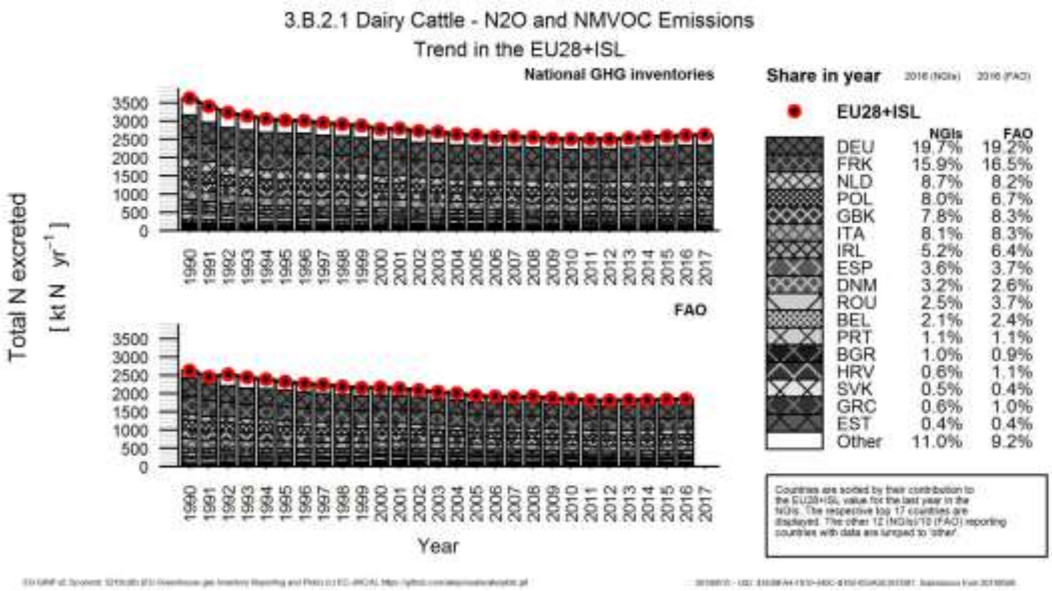


Figure 5.90: 3.B.2: (a) Average Dairy Cattle total nitrogen excretion in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

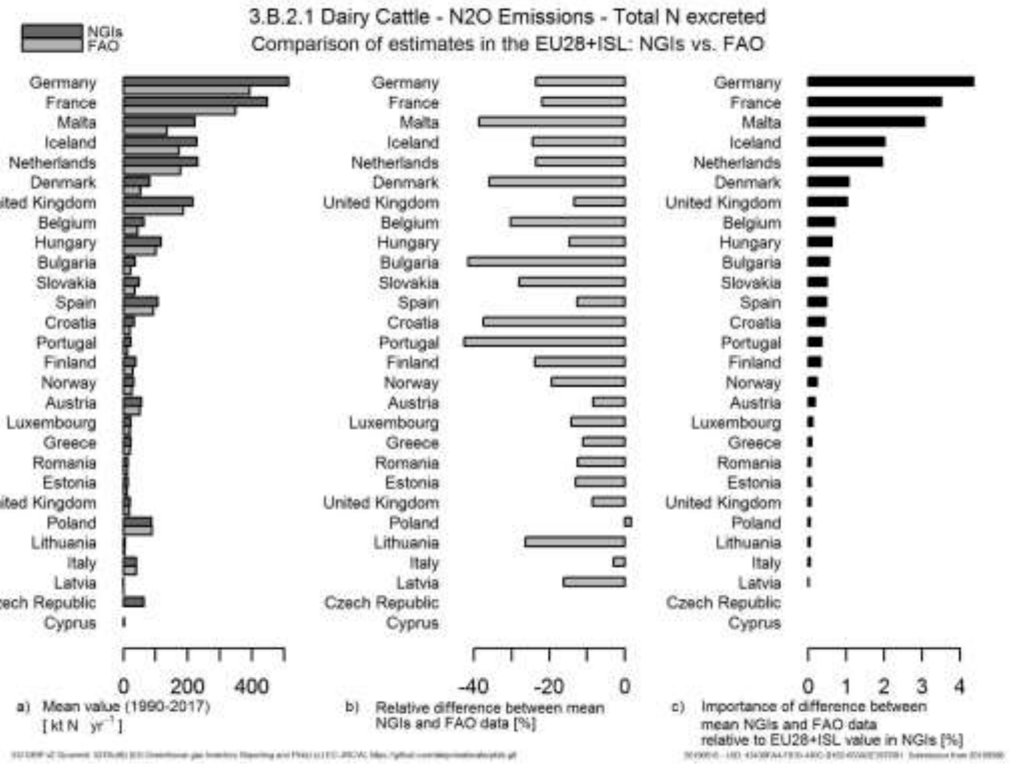


Figure 5.91: 3.B.2: Comparison of non-dairy cattle total nitrogen excretion in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

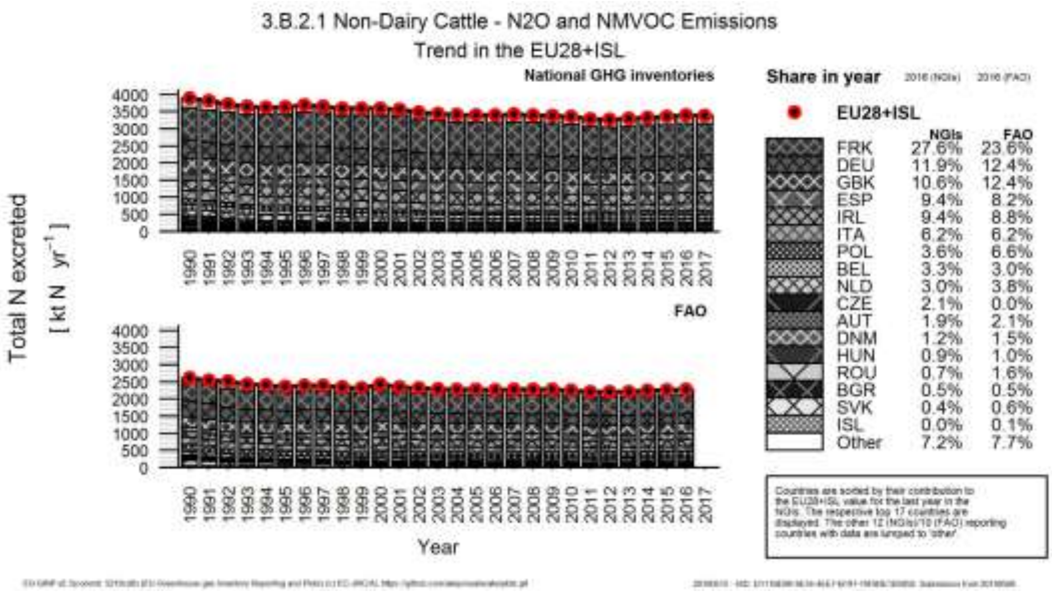


Figure 5.92: 3.B.2: (a) Average Non-Dairy Cattle total nitrogen excretion in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

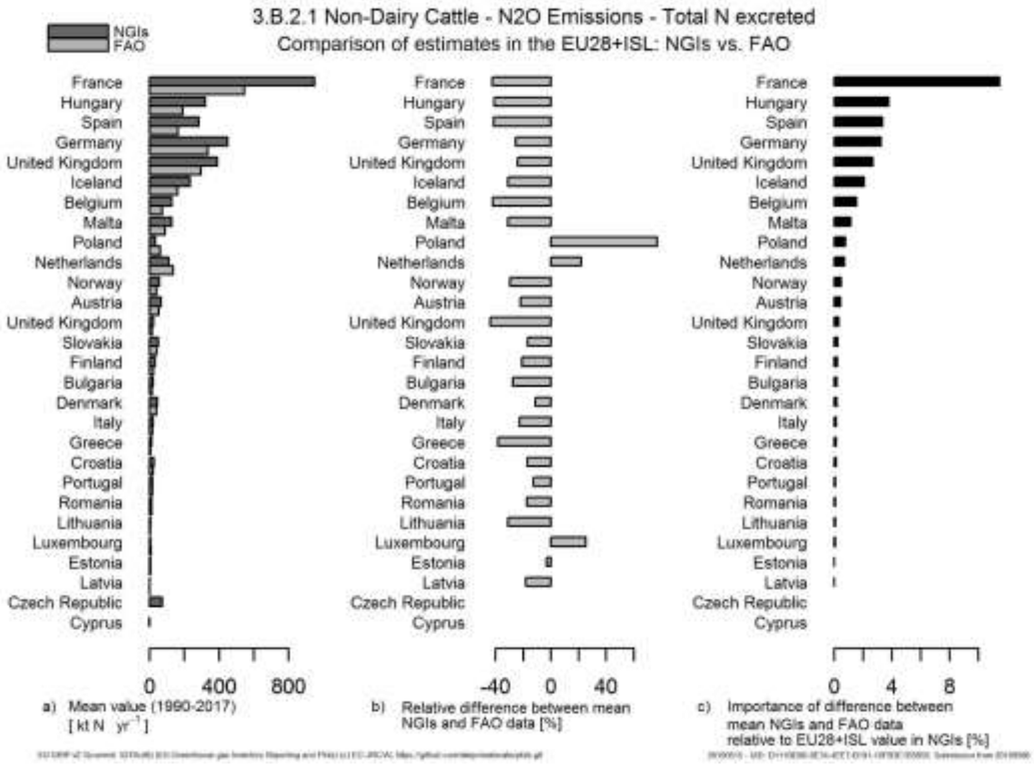


Figure 5.93: 3.B.2: Comparison of sheep total nitrogen excretion in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

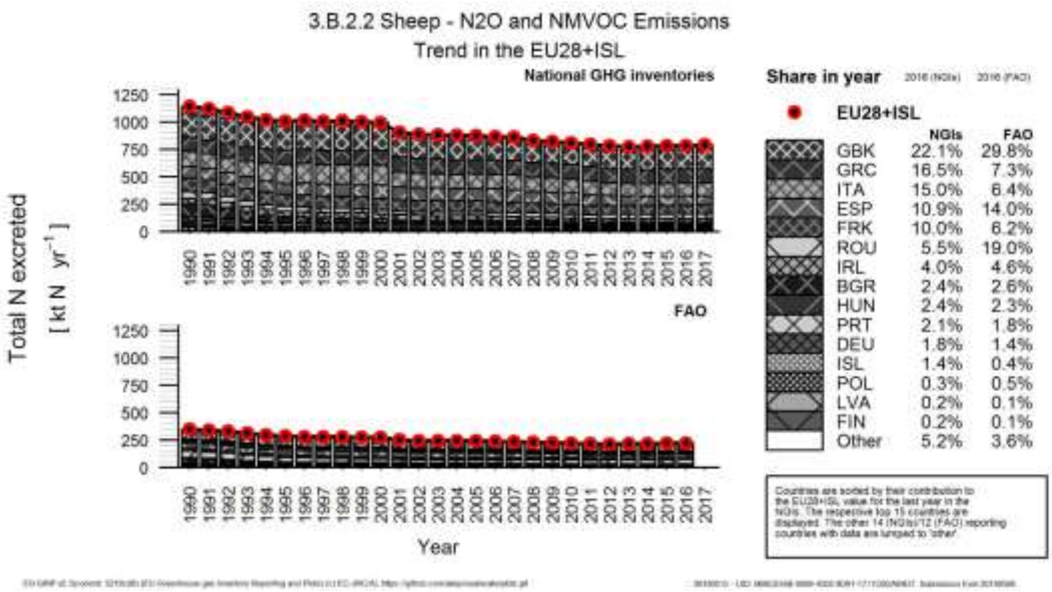


Figure 5.94: 3.B.2: (a) Average Sheep total nitrogen excretion in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

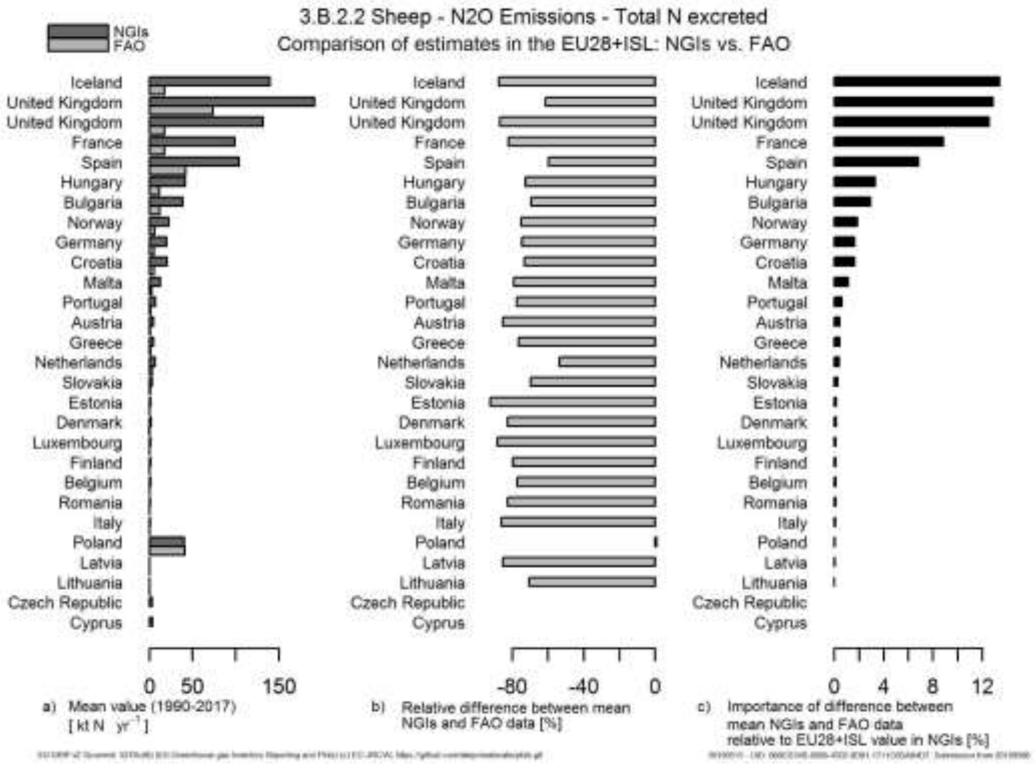


Figure 5.95: 3.B.2: Comparison of swine total nitrogen excretion in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

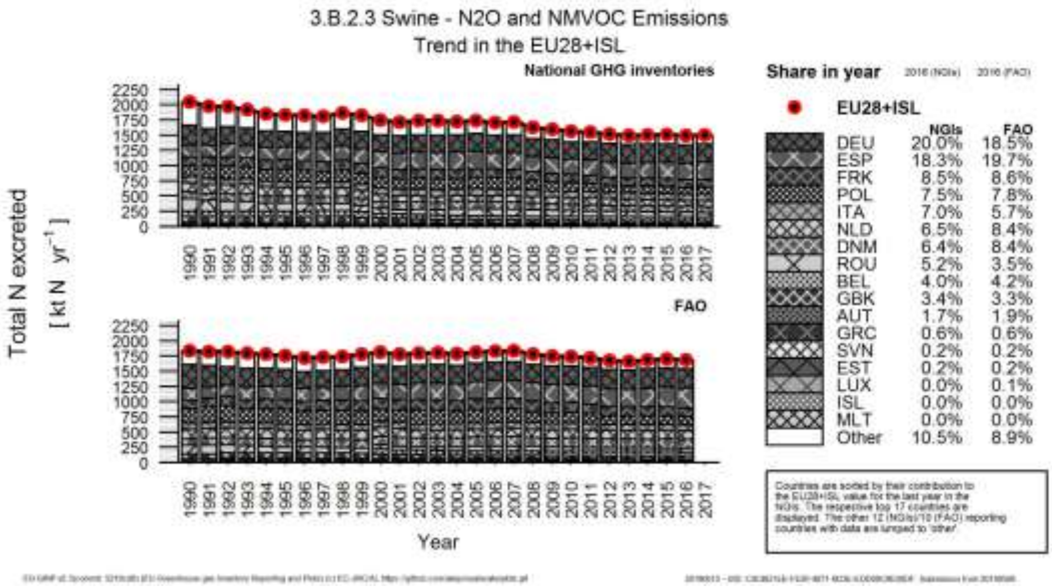


Figure 5.96: 3.B.2: (a) Average Swine total nitrogen excretion in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

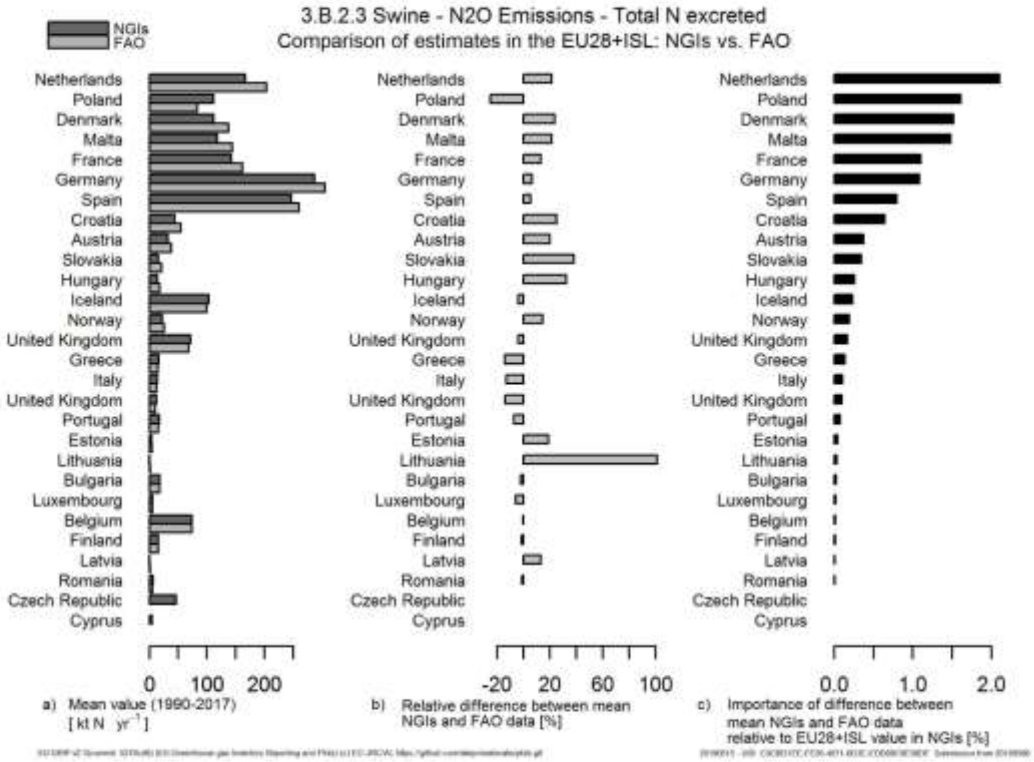


Figure 5.97: 3.B.2: Comparison of poultry total nitrogen excretion in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

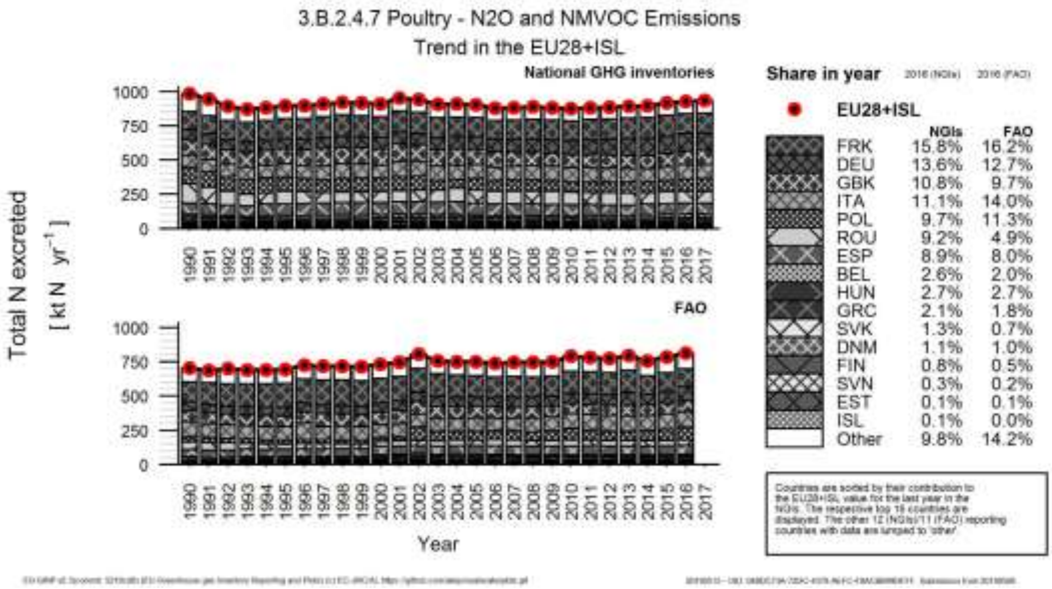
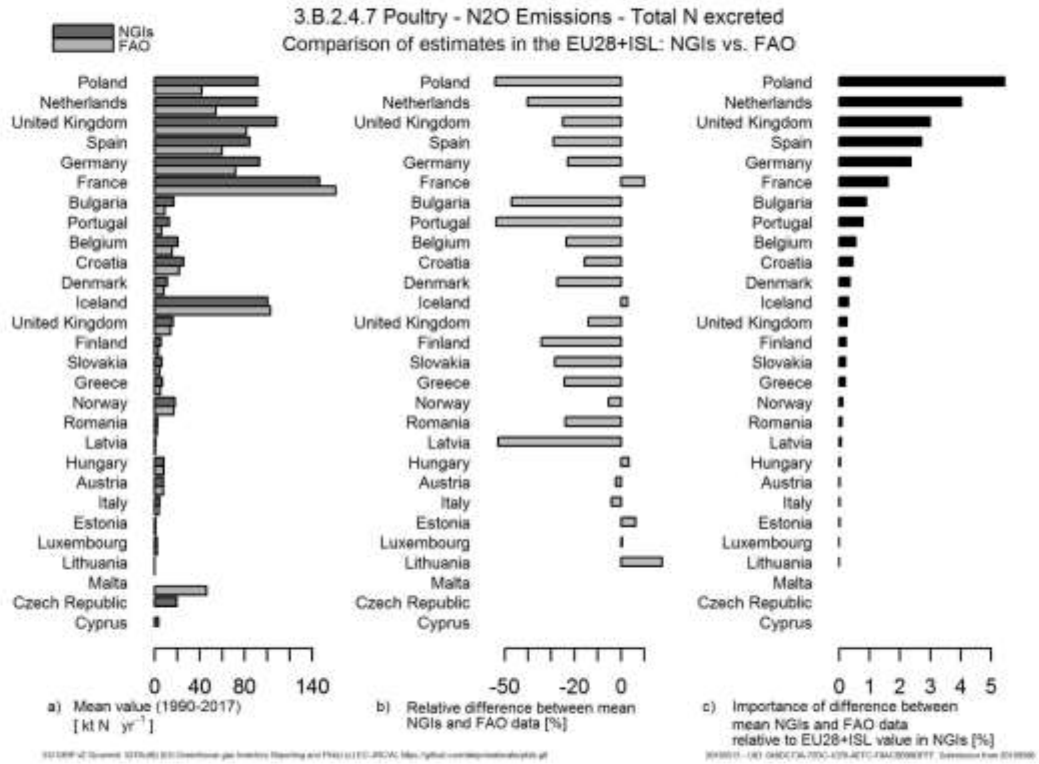


Figure 5.98: 3.B.2: (a) Average Poultry total nitrogen excretion in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.



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 (sheep (-72.7) the EU28+ISL 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 EU28+ISL 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 EU28+ISL), 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 EU28+ISL 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 EU28+ISL 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 Luxembourg. Regarding their contribution to total EU28+ISL 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 EU28+ISL 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 Luxembourg. 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 EU28+ISL N excretion, while the other livestock categories do not have one only main contributor.

Rice cultivation

Regarding CH_4 emissions from rice cultivation, the related activity data is the rice cultivated area. Figure 5.99 and Figure 5.100 compare rice area of both databases, UNFCCC inventories and FAOSTAT, first total values for all EU-28 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 0.1%. 20 years showing values that are larger in NIR (on average by 0.3 thousand km^2 $year^{-1}$) and 8 years when FAO data are larger (on average by 0.0037 thousand km^2 $year^{-1}$). Nevertheless, the data show very similar trends for both datasets. Comparing all years, NIR is larger by 0.21 thousand km^2 $year^{-1}$ or -4.85% of the average value in the EU. The one country with the largest differences in single years are France. The largest deviations (FAO minus NIR) are -0.092 thousand km^2 $year^{-1}$ (France, 2004), corresponding to 2.1% of total EU rice harvested area in this year (NIR), -0.091 thousand km^2 $year^{-1}$ (France, 1990), and NA thousand km^2 $year^{-1}$ (NA, NA).

Figure 5.99: 3.C: Comparison of rice area in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

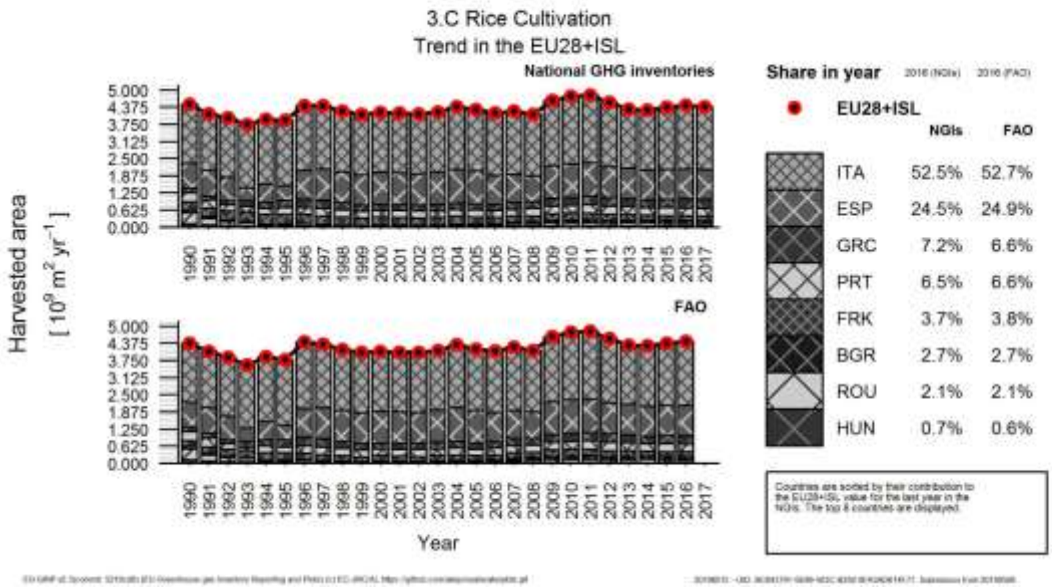
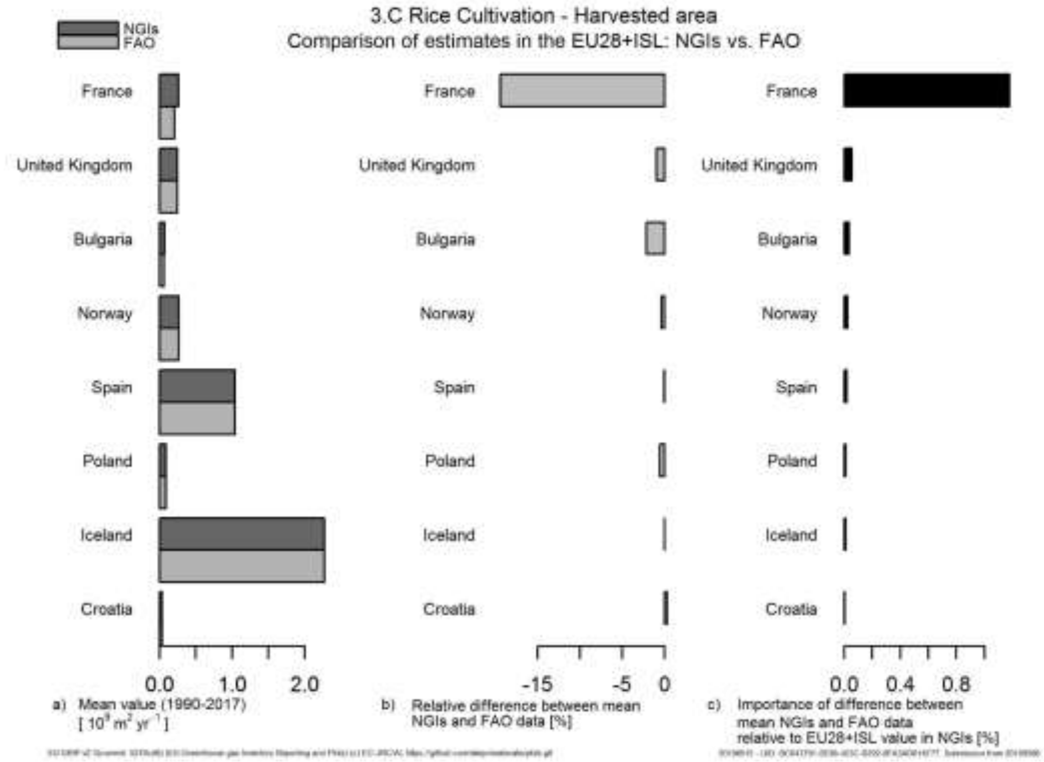


Figure 5.100: 3.C: (a) Average Rice area in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.



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 5.101 and Figure 5.102), applied organic fertilisers (Figure 5.103 and Figure 5.104), and crop residues (Figure 5.105 and Figure 5.106).

Nitrogen input from application of inorganic fertilizers to cropland and grassland data from FAO are sometimes smaller and sometimes larger than NIR data. Differences are in the range between -100% and 1.7%. 26 years showing values that are larger in NIR (on average by 1415.5 kt N/year) and 2 years when FAO data are larger (on average by 133 kt N/year). Comparing all years, NIR is larger by 1305 kt N/year or -11.4% of the average value in the EU. The three countries with the largest differences in single years are Germany, France and Poland. The largest deviations (FAO minus NIR) are -2252 kt N/year (France, 2017), corresponding to 20% of total EU nitrogen input from application of inorganic fertilizers to cropland and grassland in this year (NIR), -2239 kt N/year (France, 2016), and -1711 kt N/year (Germany, 2016).

Nitrogen input from organic nitrogen fertilisers to cropland and grassland data from FAO are sometimes smaller and sometimes larger than NIR data. Differences are in the range between -100% and 3.1%. 18 years showing values that are larger in NIR (on average by 442.2 kt N/year) and 10 years when FAO data are larger (on average by 65 kt N/year). Comparing all years, NIR is larger by 261 kt N/year or -4.77% of the average value in the EU. The three countries with the largest differences in single years are France, Germany and Italy. The largest deviations (FAO minus NIR) are -589 kt N/year (Germany, 2015), corresponding to 11% of total EU nitrogen input from organic nitrogen fertilisers to cropland and grassland in this year (NIR), -583 kt N/year (Germany, 2014), and -575 kt N/year (Germany, 2016).

Nitrogen in crop residues returned to soils data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 1186 kt N/year or -28.2% of the average value in the EU. The three countries with the largest differences in single years are France, Belgium and Bulgaria. The largest deviations (FAO minus NIR) are -404 kt N/year (France, 2007), corresponding to 10% of total EU nitrogen in crop residues returned to soils in this year (NIR), -372 kt N/year (France, 1993), and -368 kt N/year (France, 1994).

Figure 5.101: 3.D: Comparison of Inorganic N fertilizers N input in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

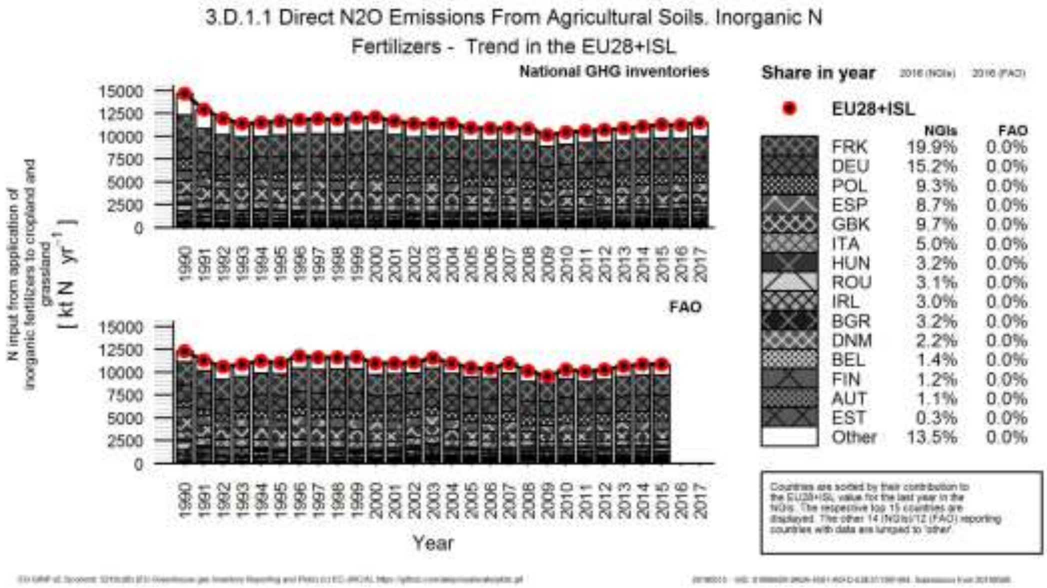


Figure 5.102: 3.D: (a) Average Inorganic N fertilizers N input in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

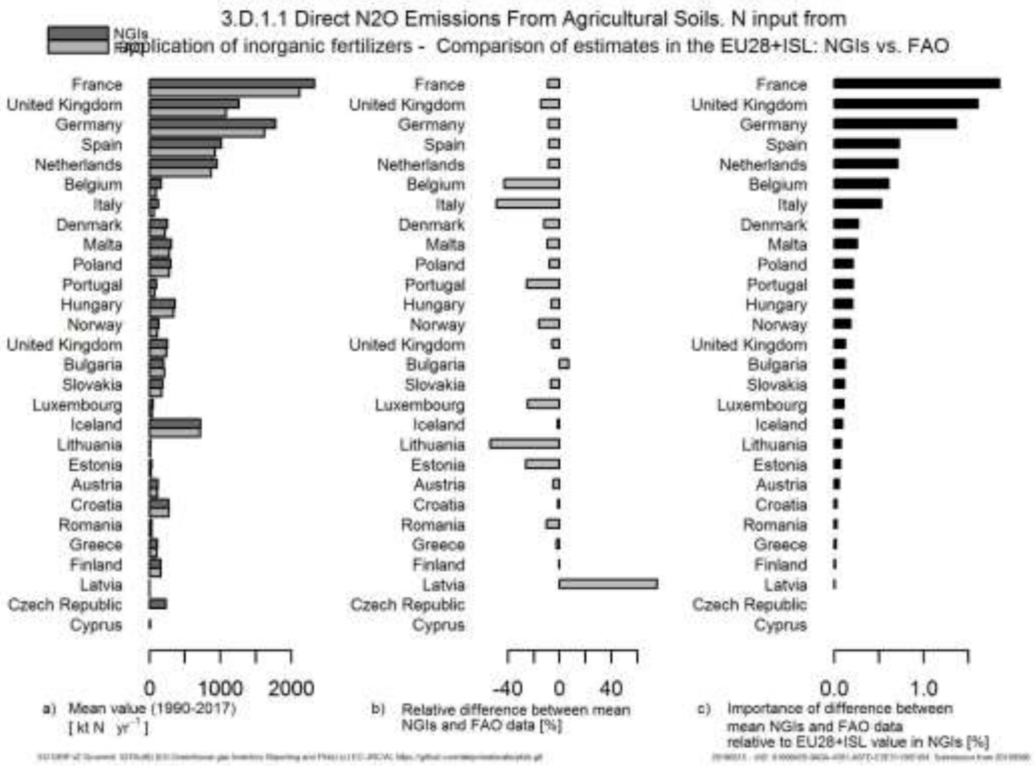


Figure 5.103: 3.D: Comparison of Organic N fertilizers N input in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

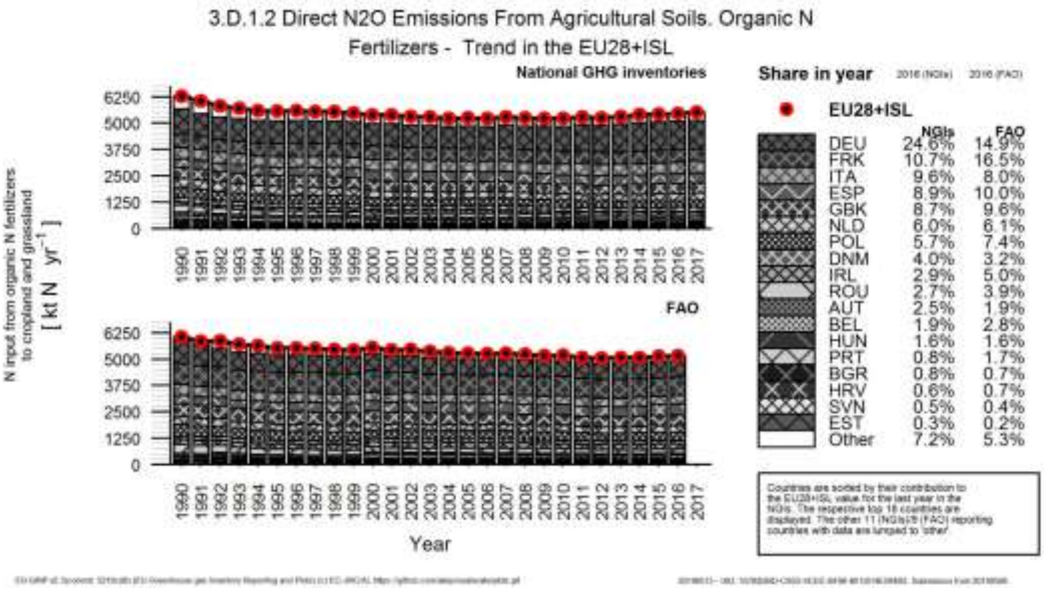


Figure 5.104: 3.D: (a) Average Organic N fertilizers N input in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

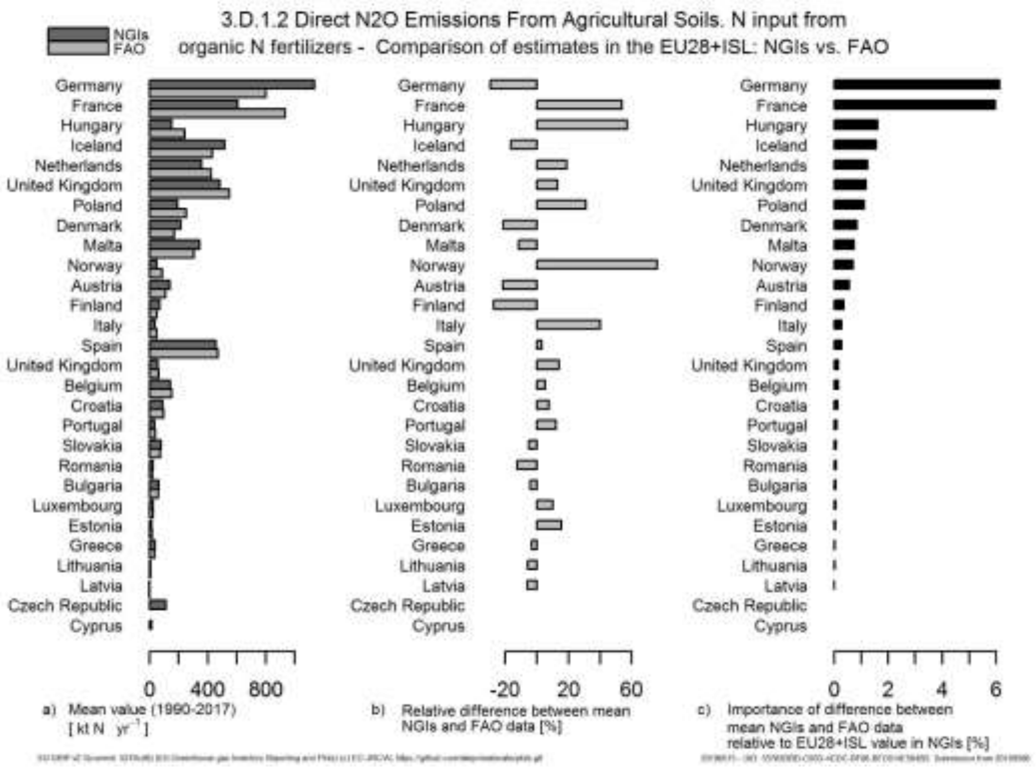


Figure 5.105: 3.D: Comparison of crop residues N input in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

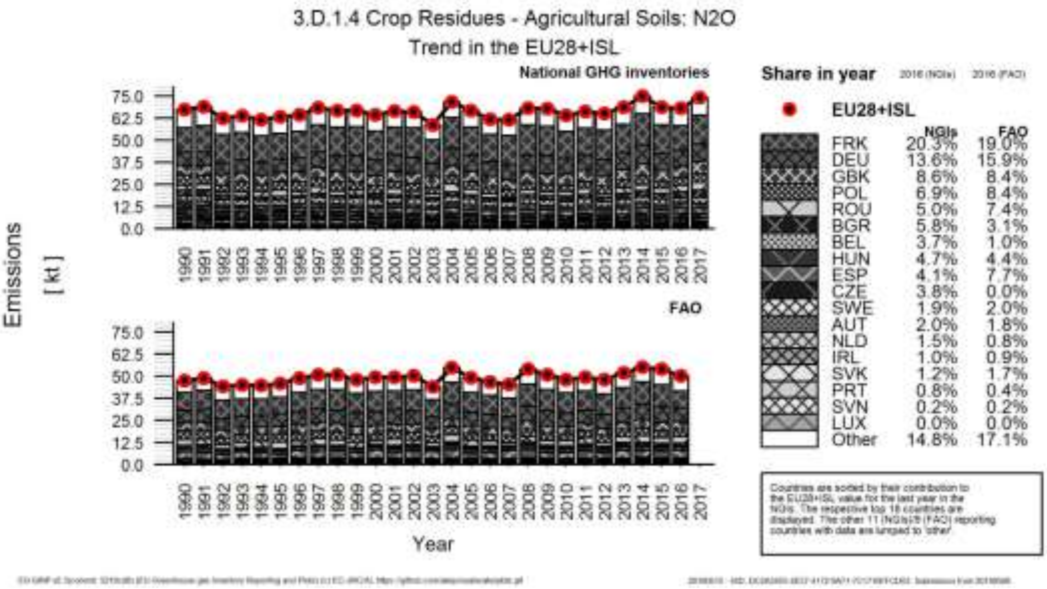
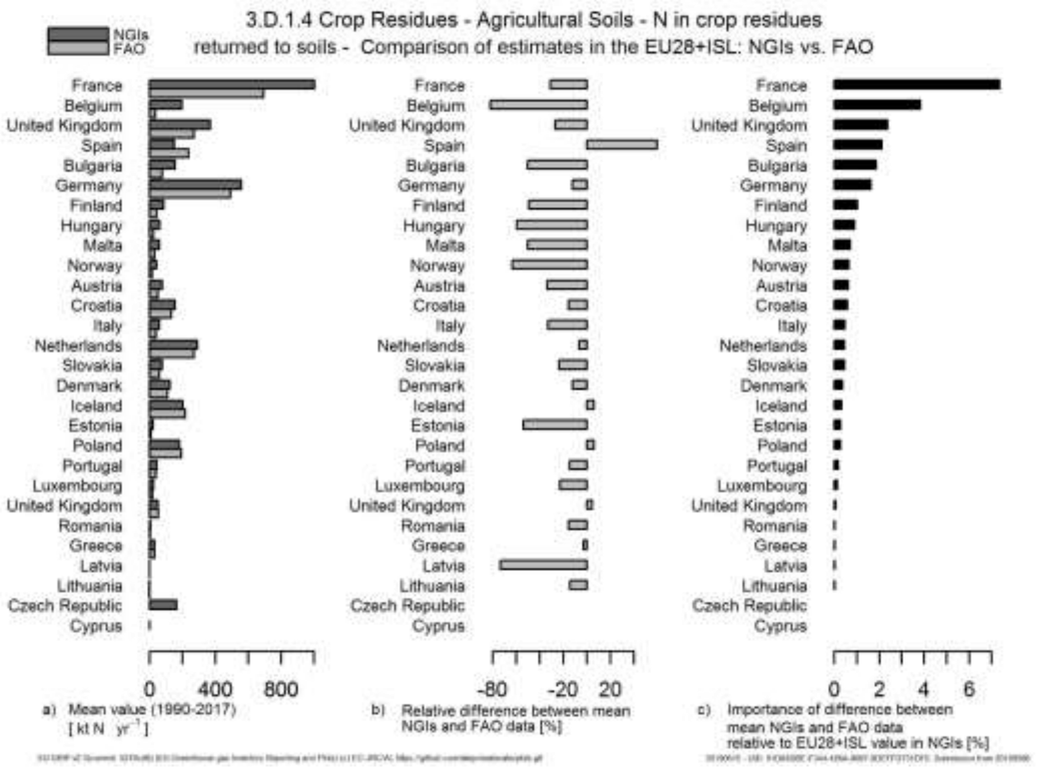


Figure 5.106: 3.D: (a) Average Crop residues N input in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.



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.

Cultivation of histosols

Focusing on the area of cultivated organic soils, we can see in Figure 5.107 and Figure 5.108 that total EU-28 area provided by FAOSTAT is higher than the area reported by countries to UNFCCC, constant in both databases for nearly the whole time series.

Figure 5.107: 3.D.1.6: Comparison of histosols area in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

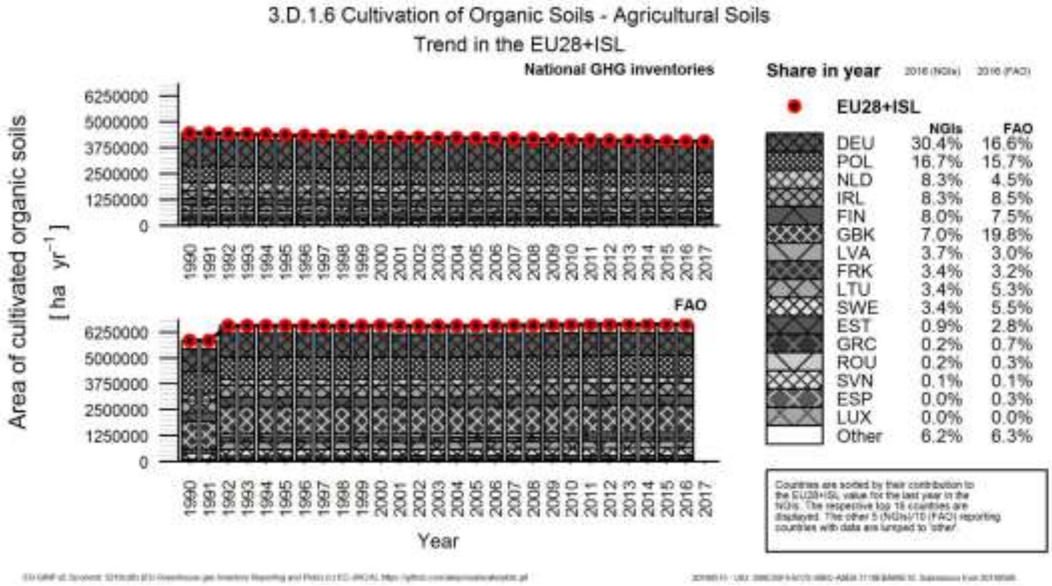
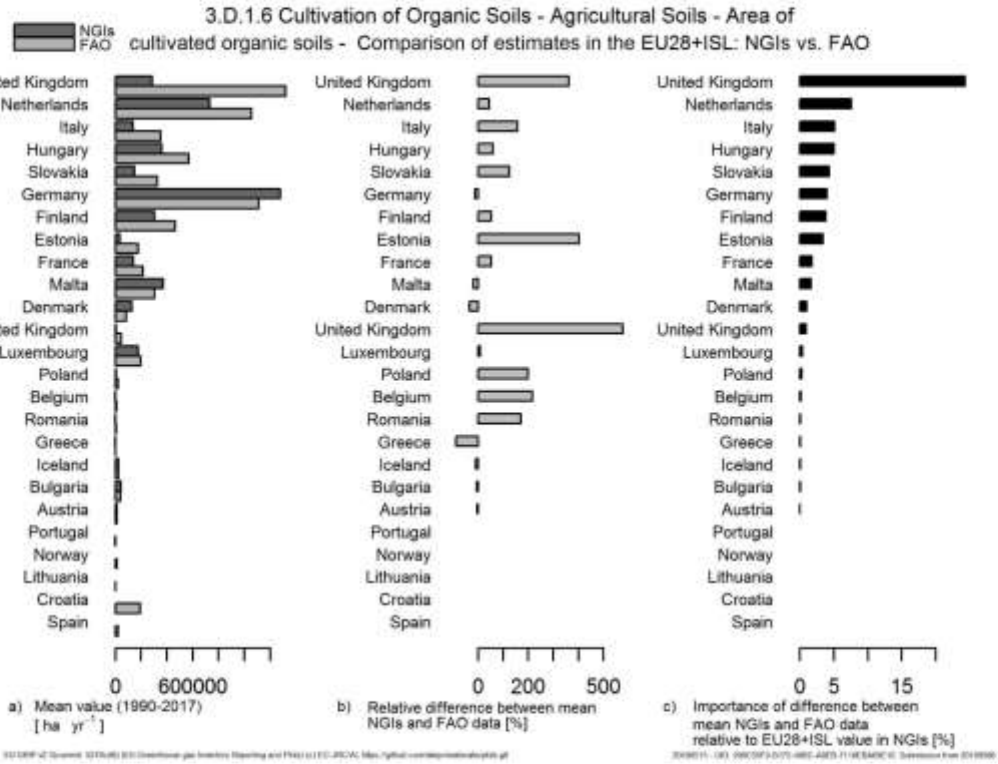


Figure 5.108: 3.D.1.6: (a) Average Histosols area in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.



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 5.109. 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'

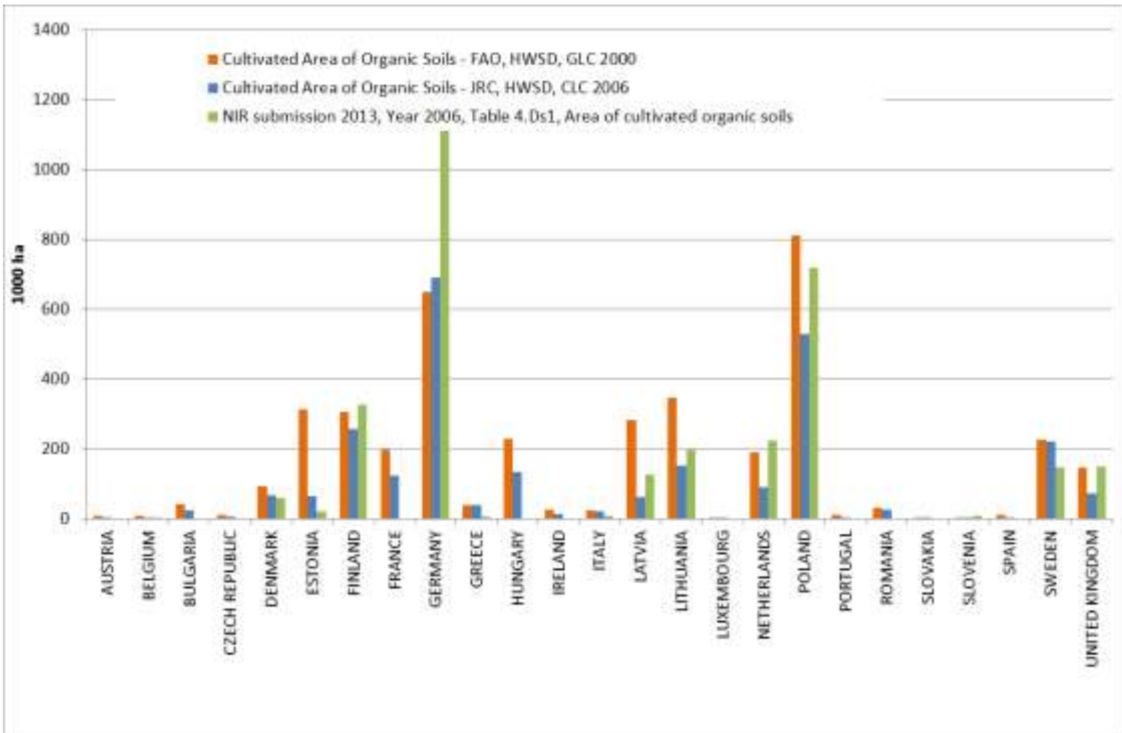
(1) if the topsoil organic carbon content is > 18% or

(2) if the topsoil organic carbon content is higher than the topsoil clay content * 0.1 + 12. All STUs in the EU27 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.

Figure 5.109: Area of cultivated organic soils based on two studies and the values given in the National Inventory Reports (2013) for the year 2006



Conclusion

Differences in the reported emissions between FAO and UNFCCC databases can be due, as explained before, to diverse activity data or to the methodologies used for the estimation of emissions. If we focus on the emission categories holding the biggest discrepancies between the two databases, different explanations can be found. Emissions reported for category 3.B.2 N_2O emissions from manure management are around 40% larger in the country submissions. This can be explained by estimations of total N excretion data, which are smaller in FAO than in country data for dairy cattle, non-dairy cattle, sheep and poultry for all years (27.7%, 35.6%, 72.6% and 20.5% larger, respectively, as an average of all years for EU total). Only swine shows similar values in the two databases, with numbers which are sometimes higher in the NIRs and sometimes in the FAO database. Many countries use Tier 2 approach, more detailed and using more country specific data than Tier 1 used by FAOSTAT, which can explain differences between databases.

Also emissions in category 3C Rice cultivation were identified as one of the categories with the largest differences in relative terms, in this case showing double values in FAO. Rice area is not always but mostly higher in country submissions (20 years out of 28), with an average difference of 4.85% for all years and with a different sign than emission differences. Therefore, rice area data cannot explain discrepancies in emissions from rice cultivation. Differences must be due to the consideration of different water regimes (continuously flooded/multiple aeration) and the selection of scaling factors, which are country specific in national submissions but estimated values in FAOSTAT.

For category 3.D.1.6 Cultivation of organic soils, we found that FAO reports 85% higher emissions. Activity data is also larger in FAO for all years, but the difference in areas does not fully explain deviations in emission estimations. Some additional explanation might be that, although countries use mostly Tier 1 approach, some of them apply country specific emission factors.

Regarding category 3.D.2 Indirect N_2O emissions from soils, where FAO reports 23% higher emissions than country submissions, we find that activity data and direct emissions from the application of inorganic fertilisers, organic fertilisers and urine and dung deposited on pastures are very close in both databases. Therefore, differences in activity data cannot explain the differences in indirect emissions, but these are due to the methodologies used in the estimations. Most countries use Tier 1 approach and default emission factor, but many of them use country specific fractions (especially $Frac_{GASM}$ and $Frac_{GASF}$).

5.6 Sector-specific recalculations, including changes in response of to the review process and impact on emission trend

Table 5.60 to Table 5.63 provide information on the contribution of Member States to EU-28+ISL recalculations in sectors 3A (CH_4), 3B (CH_4 and N_2O) and 3D (N_2O) for 1990 and 2017 and main explanations for the largest recalculations in absolute terms.

Table 5.60 3A Enteric fermentation: Contribution of MS to EU-28+ISL recalculations in CH_4 emissions for 1990 and 2017 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	NA
Belgium	-0.4	-0.01	30	0.7	Revised allocation of ponies and updated animal numbers for Flanders, revised feed coefficient (Ca) and revised milk production.
Bulgaria	-	-	2	0.1	Revised sheep population.
Croatia	-	-	3	0.3	Error correction for swine and young cattle. New data are included for poultry.
Cyprus	-	-	-	-	NA
Czech Republic	-154	-2.7	-69	-2.3	Changes in the calculation of GE intake and reduced Ym for non-dairy cattle, as a response to UNFCCC review. Updated animal body weight.
Denmark	-	-	5	0.1	For 2016, the number of animals has been updated due to new data from Statistics Denmark.
Estonia	-17	-1.3	-1	-0.3	Updated activity data for calves (distribution of calves aged 0-6 and 6-12 months). Change in calculations of GE intake for swine. Ym of growing cattle now calculated as weighted average of its sub-categories. Also, corrections in activity data for horses.
Finland	-	-	-	-	NA
France	15	0.04	-8	-0.02	Update of EF for horses and sows and consideration of two-phase development for category ‚other swine‘.
Germany	689	2.0	1 316	5.4	New activity data for non-dairy cattle and swine. Updated GE for heifers, milk yield, live weight and feeding data for dairy cattle and heifers and bulls. Updated live weight for swine.
Greece	-	-	-9	-0.3	Updated activity data
Hungary	-	-	-	-	NA
Ireland	-	-	-35	-0.3	Revised activity data for the number of dairy and beef heifers in the national herd for 2015 and 2016.
Italy	-	-	-	-	NA
Latvia	-	-	-	-	NA
Lithuania	-23	-0.5	-2	-0.1	Recalculation of gross energy intake and emission factor of dairy cattle and non-dairy cattle, considering the number of animals in subcategories.
Luxembourg	-46	-10.6	-34	-7.9	Revised livestock categories, feed intake and feed characterisation. Revised length that cattle and sheep are kept on pastures. Revised live weights of cattle and sheep, birth and weaning weight of lambs, wool production of sheep, milk yield of suckler cows, percentage of pregnancy for cattle and sheep and Ym for sheep.
Malta	-2	-5.0	2	6.1	Revisions in live body weights of cattle categories Bulls and Growing Cattle and a change in the proportion of mature female.
Netherlands	-	-	-	-	NA
Poland	-	-	-	-	NA
Portugal	-0	-0.0	17	0.5	Update of 2016 dairy cow milk production and sheep population, both revised by INE (National Statistics Authority)
Romania	747	4.0	320	3.0	Was made recalculations for 2016 due to of the modification livestock other sheep, pigs (pigs between 20 and 50 kg, pigs

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					fattening, boars, breeding sows) , adult poultry for eggs and poultry for meat of the modification of animal weight for dairy cattle use in the calculation gross energy intake (GE).
Slovakia	-	-	-	-	NA
Slovenia	-	-	-	-	NA
Spain	1 979	14.9	2 609	18.3	Updated zootechnical document for dairy and non-dairy cattle, involving revised parameters for enteric fermentation EF and other parameters as gross energy , Ym, and auxiliary data (weight, milk yield, DE of feed, etc.)
Sweden	0	0.0	1	0.0	Revised number of goats, due to updated data from the Swedish Board of Agriculture, and reindeers, due to an update from the Sami parliament of Sweden. Revised data from the Swedish Dairy Association on total milk delivered in 2016.
United Kingdom	-600	-2.3	-550	-2.5	Correction to an error in the energy balance equations for other dairy cattle.
EU28	2 587	1.1	3 596	1.9	
Iceland	-0.2	-0.1	0.2	0.1	Slight changes in activity data
United Kingdom (KP)					Correction to an error in the energy balance equations for other dairy cattle.
EU28+ISL	3 187	1.5	4 146	2.4	

Table 5.61 3B Manure Management: Contribution of MS to EU-28+ISL recalculations in CH_4 emissions for 1990 and 2017 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-43	-7.3	101	23.0	Revised activity data: share of manure treated in each manure management system and livestock feeding data. CH_4 calculations for sheep, goats, horses, poultry and deer have been improved by applying Tier 2 methodology.
Belgium	-0.04	-0.003	7	0.6	Revised activity data in Flanders, which results in a change in CH_4 emissions from manure management, revised Ca and milk production.
Bulgaria	-	-	0.1	0.1	Revised sheep population.
Croatia	1	0.4	1	0.3	Correction of VS and B0 for sheep.
Cyprus	-	-	-	-	NA
Czech Republic	0.3	0.02	0.1	0.01	NA
Denmark	-0	-0.0	-1	-0.1	Updated number of animals, changes in the amount of biogas treated manure and distribution of animals on housing types.
Estonia	3	1.8	1	1.3	Updated activity data for calves, poultry and horses.
Finland	-	-	-	-	NA
France	-160	-4.4	-408	-10.0	Update of dairy cow population. Strong decrease due to the improvement in the characterisation of cattle manure (increase of solid storage). Revised VS for quail and for swine, taking account of the two-phase feeding.
Germany	27	0.3	166	2.7	Updated activity data for non-dairy cattle and swine, GE for heifers, feeding data for dairy, heifers and bulls, live weight of swine, VS excretion for sheep and horses, poultry meat production data.
Greece	-	-	-18	-2.7	Updated livestock activity data.
Hungary	-	-	-	-	NA
Ireland	-	-	-5	-0.3	Revised activity data for number of dairy cattle, beef heifers, sheep and poultry.
Italy	-2	-0.0	693	22.3	Update of parameters values for biodigesters emission calculation
Latvia	0.2	0.1	-0	-0.0	Due to revised data
Lithuania	0.1	0.02	-9	-3.7	Recalculations of methane emissions for non-dairy cattle, fur-bearing and small animals and poultry have been made due to recalculated animal population, distribution in subcategories and updated GE indicators.

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Luxembourg	-6	-11.3	-6	-8.4	Revision of livestock categories. Corrected EF for laying hens and broilers.
Malta	-0	-0.6	0.5	11.2	Revisions in live body weights of cattle categories Bulls and Growing Cattle and a change in the proportion of mature female.
Netherlands	-1	-0.02	-141	-3.5	VS excretion for swine was updated
Poland	4	0.2	26	1.6	AD correction for poultry and fur animals
Portugal	-0.003	-0.0004	1	0.1	Update of 2016 dairy cow milk production and sheep population, both revised by INE (National Statistics Authority)
Romania	55	1.2	236	17.6	Was made recalculations for 2016 due to of the modification livestock other sheep, pigs (pigs between 20 and 50 kg, pigs fattening, boars, breeding sows) , adult poultry for eggs and poultry for meat of the modification of animal weight for dairy cattle use in the calculation gross energy intake (GE). Was made the recalculations and due to of the change of the digestible energy expressed as a percentage of gross energy (DE%) necessary in the calculation volatile solid excretion rates (VS) for Ewes and Ewe mounted and Pigs under 20 kg. Was made the recalculations due to of the modification VS for dairy cattle as a result of GE.
Slovakia	-160	-29.2	-35	-23.5	New country specific data following the Tier 2 approach for the category 3.B.1.3 (swine) was implemented according to the recommendations made during the ESD and UNFCCC reviews.
Slovenia	-	-	-	-	NA
Spain	108	1.5	-78	-1.1	205, 223
Sweden	0.004	0.002	-0.3	-0.1	Updated number of goats and reindeer. Emissions from digesters and composting are now implemented in the inventory.
United Kingdom	-131	-2.7	-122	-2.8	Correction to an error in the energy balance equations for other dairy cattle.
EU28	-303	-0.6	408	1.0	
Iceland	-0	-0.0	-1	-1.0	Slight changes in activity data
United Kingdom (KP)					Correction to an error in the energy balance equations for other dairy cattle.
EU28+ISL	-172	-0.4	530	1.4	

Table 5.62 3B Manure Management: Contribution of MS to EU-28+ISL recalculations in N_2O emissions for 1990 and 2017 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	4	0.9	7	1.5	Revised activity data: share of manure treated in each manure management system and livestock feeding data.
Belgium	-22	-2.4	-17	-2.4	Revised activity data in Flanders, which results in a change in N_2O emissions from manure management, revised FracGASM, revised Nex for fur animals.
Bulgaria	-	-	-	-	NA
Croatia	-	-	0.01	0.003	Revised activity data for poultry (emission changes close to zero)
Cyprus	-6	-8.0	-0.4	-0.6	Introduction of an EF for anaerobic digestion instead of 0 and reduction of leaching losses from solid storage from 10% to 1%.
Czech Republic	-0.1	-0.003	-	-	NA
Denmark	-	-	0.1	0.02	Updated number of animals. Inclusion of ammonia reducing technology in housing.
Estonia	-8	-6.0	-3	-5.9	Updated activity data for calves, poultry and horses. Changes in manure allocation in MMS for poultry. Inclusion of N2 emissions in indirect emissions from manure management.
Finland	-	-	-	-	NA
France	-87	-2.9	-64	-2.4	Update of dairy cow population. Update of Nex for sheep, goats, horses and one of the cattle sub-categories.
Germany	-1 181	-23.2	-521	-13.7	Updated activity data for non-dairy cattle and swine, live weight of swine, new N_2O emission factor for solid storage to

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					default, as formerly used was higher than the EF for deep bedding, which was contradictory, and quantity of digested manure.
Greece	-	-	2	0.8	Updated livestock activity data.
Hungary	-	-	0.2	0.05	NA
Ireland	-	-	-2	-0.3	Revised activity data for number of dairy cattle, beef heifers, sheep and poultry.
Italy	7	0.2	185	8.7	Update of parameters values for biodigesters emission calculation
Latvia	-	-	0.3	0.4	Update of Tier 2 methodology assumptions to calculate N lost due to volatilisation of NH_3 and NO_x from livestock buildings and storage facilites
Lithuania	129	21.4	-0.5	-0.2	N excretion rates were recalculated due to updated animal numbers in subcategories.
Luxembourg	-5	-10.0	-4	-10.7	Revision of livestock categories and Nex. Use of default values from Table 10.22 for dairy cows to estimate N losses due to volatilisation (NH_3 and NO_x)from manure.
Malta	0.1	0.9	-1	-6.0	Changes in the Nrate(T) of all cattle categories, poultry and sheep and in nitrogen loss due to volatilisation of NH_3 and NO_x from manure management for layers.
Netherlands	19	2.0	81	11.8	Emissions from manure management were split by livestock category.
Poland	12	0.4	76	3.8	Improvement of the country specific parameters. Revision of the conservative approach introduced in response to Saturday Paper.
Portugal	-0.1	-0.04	0.1	0.1	Update of 2016 dairy cows milk production and sheep population, both revised by INE (National Statistics Authority)
Romania	-	-	6	1.0	Was made recalculations for 2016 due to of the modification livestock other sheep, pigs (pigs between 20 and 50 kg, pigs fattening, boars, breeding sows) , adult poultry for eggs and poultry for meat.
Slovakia	-16	-3.1	-2	-1.1	New nitrogen excretion rates for the category 3.B.2.3 were implemented in line with the Tier 2 approach (based on the IPCC 2006 GL). Changes are connected with 3.B.1.3 and due to these changes, also 3.B.2.5 emissions were recalculated.
Slovenia	-90	-57.4	-55	-54.1	Improved EF - default EF from EMEP/EEA GB 2016
Spain	22	1.5	-139	-7.3	183, 205, 223
Sweden	5	1.5	-5	-1.5	Updated number of goats and reindeer. Emissions from digesters and composting are now implemented in the inventory.
United Kingdom	-65	-1.8	-65	-2.3	Correction to an error in the energy balance equations for other dairy cattle.
EU28	-1 282	-4.1	-521	-2.3	
Iceland	-36	-60.7	-30	-59.1	Update of EFs (wrong reference table was being used)
United Kingdom (KP)					Correction to an error in the energy balance equations for other dairy cattle.
EU28+ISL	-1 253	-4.5	-486	-2.4	

Table 5.63 3D Agricultural Soils: Contribution of MS to EU-28+ISL recalculations in N_2O emissions for 1990 and 2017 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-13	-0.6	-28	-1.3	Revised activity data: share of manure treated in each manure management system, livestock feeding data, fertiliser application techniques. Also updated mineral fertiliser and other organic fertiliser application data, inclusion of N2 losses in manure management systems and improved NO_x calculations affecting animal manure applied to soils.
Belgium	-47	-1.1	-29	-0.9	Update of animal numbers and revised Nex for fur animals in Flanders also affect N_2O emissions from soils. Also in Flanders, revised area of clover and alfalfa, revised inorganic fertiliser

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					revised FracGASM and FracGASF, updated quantity of applied compost and amount of processed/exported manure, and update of Fsom. In Wallonia, emissions under ‚cultivation of organic soils' subtracted because they do not happen in agricultural soils.
Bulgaria	-	-	54	1.3	Revised sheep population and updated activity data on synthetic fertilisers.
Croatia	-0.2	-0.01	-118	-11.0	Change of data source for mineral fertilisers and changes in livestock activity data and in manure emissions (VS and B0 correction). Also changes in activity data on crop production, affecting crop residues. New values for soil carbon stock for all land use categories and new C:N ratio.
Cyprus	-86	-64.2	-84	-67.1	EF1 changed from IPCC default to CS; Change in fraction of N-loss due to an error correction; New data on sewage sludge applied on land. Regarding indirect emissions, changes are due to revised quantities of animal manure applied to soils.
Czech Republic	95	1.7	32	0.9	Error correction for the calculation of emissions from crop residues and N-fixing forage.
Denmark	-5	-0.1	37	0.9	For 2016, the number of animals and the area of crops have been updated due to new data from Statistics Denmark. The area of organic soils has been updated due to updating of areas in the LULUCF sector. Updated EF for NH_3 for manure applied to soil and inclusion of ammonia reducing technology in housing.
Estonia	58	5.2	48	7.8	Updated mineral fertiliser data. Animal manure applied to soils changed due to updated activity data for horses and poultry, to changes in poultry manure per MMS and to recalculation of indirect emissions from manure management. Recalculations in 3.D.1.5 subcategory due to an error correction. Drained grasslands were included in the calculations of emissions from cultivated organic soils, and correction in C:N ratio of soil organic matter.
Finland	-15	-0.4	23	0.7	New area estimates for cultivated organic soils were calculated due to an update of the National Forest Inventory data (see Section 6.2). New monthly weather data was introduced in the Yasso07-modelling and the method to calculate the weather time series was harmonized harmonised across land use categories (Section 6.4.5). Five years running average to smooth the Yasso results was introduced to agricultural soils (Section 6.4.5).
France	-436	-1.2	-424	-1.3	Decrease of emissions from manure application due to changes in manure management category. Decrease of emissions from manure excretion on pastures due to the revised Nex for sheep. Update of compost application and crop data, influencing emissions from crop residues. Indirect emissions revised due to lower NH_3 and NO_x emissions as a consequence of Nex changes
Germany	263	0.9	370	1.4	New data on straw beddings in housing for non-dairy cattle. New data for digestion of manure and energy crops. New activity data for sewage sludge used in agriculture and for N in crop residues.
Greece	-	-	17	0.6	Updated activity data
Hungary	2	0.0	3	0.1	Revision of the AD for synthetic fertilizer use by the data provider (HCSO).
Ireland	19	0.3	-173	-3.1	Changes in 3.D.1.5 and 3.D.1.6; area of cropland remaining cropland and the area cultivation of organic soils
Italy	-344	-3.3	-274	-3.1	Update of the amount of N to the soil according to the ESD review recommendation
Latvia	4	0.2	103	6.5	Recalculations are done due to updated information about organic soil areas, as well as updated information on sewage sludge applied to managed soils data for specific years
Lithuania	-0.5	-0.01	49	2.1	Updated activity data on inorganic N fertilizers consumption. Emissions from manure application and manure deposited on pastures changed due to recalculations in 3.B. Revised activity data for sewage sludge and other organic fertilizers applied to soils. Recalculations for 3.D.1.5 associated with loss/gain of soil organic matter and 3.D.1.6 were made due to recalculations made in the LULUCF sector.
Luxembourg	-7	-2.8	-4	-2.0	Revised statistics of sewage sludge and compost. Error correction in the calculation of emissions from compost.

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					Revised N from crop residues. Changes in livestock numbers and Nex also affected emissions from soils.
Malta	2	7.2	0	0.3	Revisions in the Nrate(T) as well as livestock weights resulted in recalculations for the sector Agricultural Soils.
Netherlands	44	0.5	-192	-3.4	Updated inorganic fertiliser data.
Poland	17	0.1	135	1.0	Improvement of the country specific parameters. Revision of the conservative approach introduced in response to Saturday Paper.
Portugal	11	0.5	-33	-1.6	Update of 2016 amount of N fertilizers revised by INE (National Statistics Authority). Correction of the formulas to calculate above ground biomass of orchards, legumes and olive groves
Romania	407	4.6	249	5.0	Modification of livestock other sheep, pigs (pigs between 20 and 50 kg, pigs fattening, boars, breeding sows), adult poultry for eggs and poultry for meat, and update of annual amount of synthetic fertiliser N applied to soils (FSN). For crop residues, change in the amount of biomass burned, available from FAO, used in the calculation of burned areas for cereals.
Slovakia	17	0.7	5	0.4	The recalculations in the category 3.B.2.3 impacted emissions in the category 3.D.1.2.a.
Slovenia	-3	-0.6	0	0.1	Correction of NH_3 EF and improved EF from MM
Spain	957	9.8	1 541	14.9	Partly due to the implementation of the new zootechnical documents for dairy and non-dairy cattle, and also to a new methodology to estimate N from crop residues.
Sweden	22	0.6	-8	-0.3	Updated number of goats and reindeer. Emissions from digesters and composting are now implemented in the inventory. Total area of mineral and organic fertilisers updated due to method changes in LUCUCF. Updated amount of applied sludge and of crop residues.
United Kingdom	-27	-0.2	-72	-0.6	Revised N excretion from other dairy cattle (due to energy balance equations correction). Revised urea fertiliser N use due to: (i) corrections to the emission factor calculation for ammonium sulphate and diammonium phosphate fertiliser types applied to grassland (across the time series), and (ii) (specifically for 2016 only) a correction to the estimate of urea fertiliser N applied to tillage land. Also impacts from model corrections for laying hens and for nitrate leaching from cattle.
EU28	935	0.5	1 226	0.8	
Iceland	-0.1	-0.03	-0	-0.0	Updated area of organic soils and Nfert used in forestry.
United Kingdom (KP)					Revised N excretion from other dairy cattle (due to energy balance equations correction). Revised urea fertiliser N use due to: (i) corrections to the emission factor calculation for ammonium sulphate and diammonium phosphate fertiliser types applied to grassland (across the time series), and (ii) (specifically for 2016 only) a correction to the estimate of urea fertiliser N applied to tillage land. Also impacts from model corrections for laying hens and for nitrate leaching from cattle.
EU28+ISL	962	0.5	1 299	0.9	

6 LULUCF (CRF SECTOR 4)

With almost all lands under more or less intensive management, Europe is a fine-grained mosaic of different land uses resulting in a highly fragmented landscape. This variety is well recognized as a value 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 sign of the impact of these practices on the carbon stock depends on several factors, but it is well know that, while certain patterns prevent the release of the carbon, or enhance the carbon sink, others stimulate the release of the carbon that is naturally stored in the pools.

With more than three-quarters of the European Union (EU) territory covered by forests and agricultural lands, EU‘s environmental and agricultural policies have had for many years a paramount impact on the current landscape.

In particular, over the last years, the Common Agricultural Policy, and the rural development programs, have stimulated less intensive agricultural practices, and have implemented measurements towards sustainability and enhancement of rural environments. Furthermore, with the aim of protecting ecosystems and enhance their services, the EU environmental policy (e.g. Natura 2000 network) has resulted in an increase of the area under conservation regime, and it has contributed to preserve the biodiversity and landscapes.

Overall, throughout the reporting period the resulting trend on land uses from these policies is a decrease of the arable lands that is compensated by an increase of forests, and to a lesser extent, by urban areas. This is itself one of the main drivers of the final carbon balance in the LULUCF sector. However, of utmost importance is also the fact that at the EU level felling accounts for only about two thirds of the net annual wood increment, which explain the significant build-up of biomass over time (i.e. carbon removal) in the forests.

6.1 Overview of the sector

Complying with relevant EU provisions (i.e. Regulation No 525/2013[65]), LULUCF sector of the EU GHG inventory is a compilation of the inventories submitted by individual Member States (MS). Submissions by MS in 2019 are used as the primary source of data and information, unless otherwise specified and referenced in the text.

This chapter provides the general trends of GHG emissions and CO_2 removals from LULUCF at EU level, including information from Iceland. It provides general information on the methods used by the individual national inventories, 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 (NIR) and common reporting format tables (CRF) submitted by MS 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

[65] *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; and an overview of cross-cutting issues including uncertainties, QA/QC procedures, time series consistency, recalculations and verification.

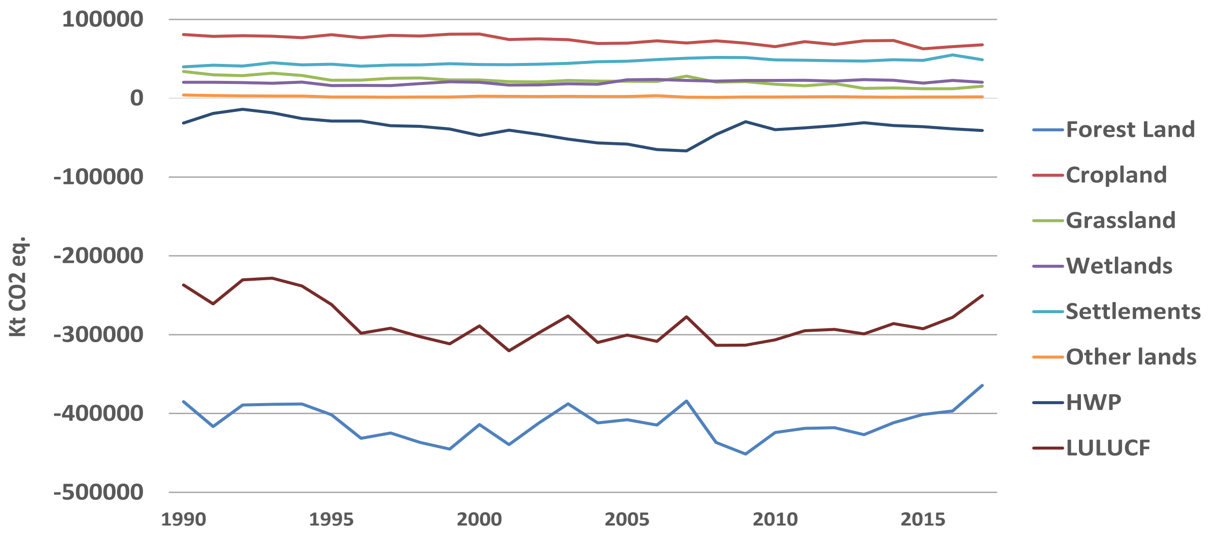
6.1.1 Trends by land use categories

The LULUCF sector within the EU GHG inventory results in a net carbon sink from higher removals by sinks than emissions by sources. In terms of land use categories the only net carbon sinks is represented by Forest land and by Harvested Wood Products. Cropland is the largest source of emissions, and Grasslands, along with the other land use categories, represent a small source of emissions.

In 2017, the LULUCF sector of the EU MS and ISL results in a total net sink of - 278.729 kt CO_2, which corresponds to an increase of about 5% as compared to the net carbon sink reported for the year 1990 (Table 6. 1). Harvested Wood Products carbon pool in 2017 is reported as a net carbon sink of -40.597 kt CO_2. Emissions of CH_4 and N_2O offset in 2017, 11% of total annual carbon removals, an unusual value that result from the high incidence of wildfires in Mediterranean countries, which can be observed in the EU trend.

Within the EU, few MS have also reported in the CFR table 4, under the category “Other”, additional emissions of GHG. 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. And Germany, N_2O emissions from managed soils in Settlements.

Figure 6.1 Sector 4 LULUCF: EU and ISL GHG net emissions (+) / removals (-) for 1990–2017, in CO_2 eq. (kt).



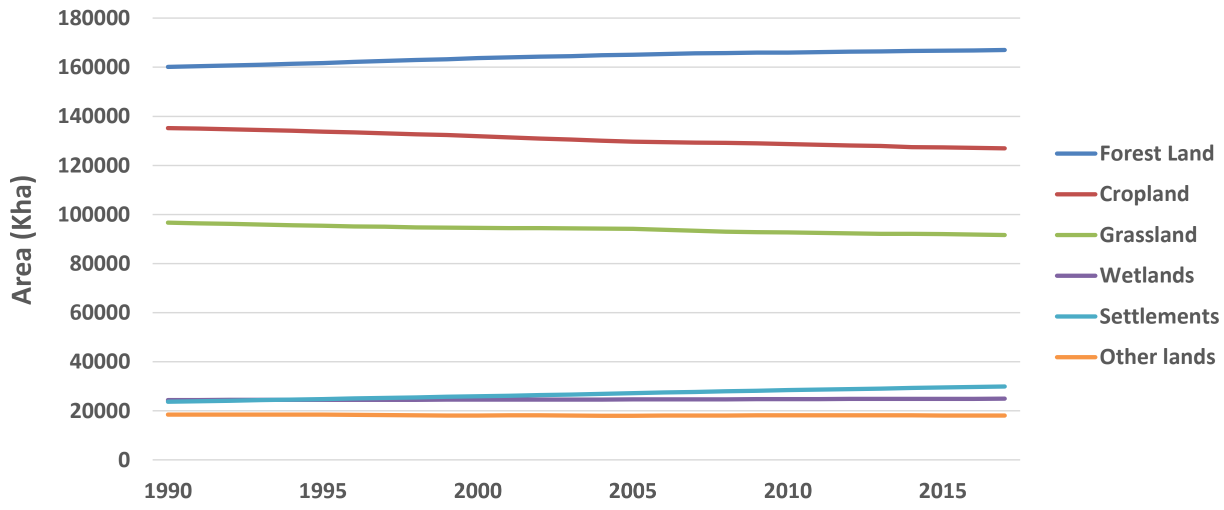
Source: MS and ISL submissions 2019, CRF Table10s1

The overall trend of the LULUCF sector since 1990 is largely affected 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 attributable to a general increase in harvest rates. In the late 2000s harvest rate decreased (mainly due to the economic crisis) and the sink increased again. Inter-annual variations are mainly related with natural disturbance events, for instance, major wind storms in central-western Europe (e.g. 2000, 2005, 2007 and 2009) and wildfires (e.g.1990, 2003, 2005, 2007, 2016 and 2017) in Mediterranean countries. However, in some specific years the methods implemented by MS to derive carbon stock changes had also an impact in the EU trend. For instance, the decrease of the forest carbon sink in 2002 is due to a drop in the carbon sink reported by Germany in the subcategory 4A1, which takes place in a single year due to the stock-difference method used. It resulted in a reduction by half of its net carbon sink. 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 in 2017 is about 459.000 kha. The trend on these categories (Figure 6. 2) confirms the trends known from other EU statistics (e.g. Eurostat). However, absolute numbers may slightly differ due to different definitions used under each dataset.

As compared with the base year, the changes in total area reported in 2019 for each land use category for 2017 are: Settlements (+26%), Croplands (-6%), Grassland (-5%), Forest land (+4%), Wetlands (2%), Other lands (-2%).

Figure 6. 2 Total area for each of the land use categories (kha), as reported in EU MS and ISL in 2019.



Although, as shown above, the LULUCF sector results in a net carbon sink at the level of EU and Iceland, the LULUCF sector reported by individual inventories ranges from a net source (e.g. Denmark, Netherlands, Ireland, Portugal) to a small sink (e.g. Latvia, Belgium) or a large sinks (e.g. France, Spain, Sweden).

Compared to 1990, for 2017, individual inventories report either a significant increase in the carbon sink or a substantial reduction. Changes are driven by the harvested rates and natural disturbances events.

Table 6. 1 Sector 4 LULUCF: MS' contributions to net CO_2 removals in 2017 (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	-12 157	-4 540	-5 069	1.8%	7 088	58%	-529	-12%
Belgium	-3 325	-443	-422	0.2%	2 903	87%	20	5%
Bulgaria	-12 441	-8 851	-8 598	3.1%	3 843	31%	253	3%
Croatia	-6 689	-5 640	-4 965	1.8%	1 723	26%	674	12%
Cyprus	-251	60	-535	0.2%	-283	-113%	-594	-998%
Czechia	-5 310	-5 218	-2 203	0.8%	3 107	59%	3 015	58%
Denmark	4 717	4 277	2 750	-1.0%	-1 967	-42%	-1 527	-36%
Estonia	-1 792	-3 074	-2 121	0.8%	-329	-18%	953	31%
Finland	-18 436	-21 541	-23 401	8.4%	-4 965	-27%	-1 860	-9%
France	-26 366	-37 833	-36 213	13.0%	-9 847	-37%	1 621	4%
Germany	-33 018	-15 634	-16 914	6.1%	16 103	49%	-1 280	-8%
Greece	-2 177	-3 522	-3 243	1.2%	-1 066	-49%	279	8%
Hungary	-2 584	-4 363	-5 515	2.0%	-2 931	-113%	-1 152	-26%
Ireland	4 162	2 989	4 902	-1.8%	740	18%	1 913	64%
Italy	-5 590	-37 370	-20 349	7.3%	-14 759	-264%	17 022	46%
Latvia	-10 906	-1 442	-2 858	1.0%	8 048	74%	-1 415	-98%
Lithuania	-5 197	-6 210	-5 485	2.0%	-289	-6%	725	12%
Luxembourg	103	-464	-355	0.1%	-459	-444%	109	23%
Malta	3	3	4	0.0%	1	23%	0	7%
Netherlands	6 486	5 484	5 504	-2.0%	-982	-15%	19	0%
Poland	-31 850	-32 581	-37 440	13.4%	-5 590	-18%	-4 859	-15%
Portugal	278	-6 263	5 404	-1.9%	5 126	1845%	11 667	186%
Romania	-20 250	-24 949	-23 525	8.4%	-3 276	-16%	1 423	6%
Slovakia	-9 807	-6 777	-6 642	2.4%	3 165	32%	134	2%
Slovenia	-4 516	-2 435	-1 553	0.6%	2 963	66%	882	36%
Spain	-36 560	-38 701	-38 791	13.9%	-2 230	-6%	-90	0%
Sweden	-36 163	-46 205	-45 382	16.3%	-9 219	-25%	823	2%
United Kingdom	-1 996	-11 263	-11 323	4.1%	-9 327	-467%	-60	-1%
EU-28	**-271 631**	**-312 507**	**-284 341**	**102%**	**-12 709**	**-5%**	**28 166**	**9%**
Iceland	5 635	5 642	5 618	-2.0%	-18	0%	-24	0%
United Kingdom (KP)	-2 012	-11 266	-11 330	4.1%	-9 318	-463%	-64	-1%
EU-28 + ISL	**-266 012**	**-306 868**	**-278 729**	**100%**	**-12 717**	**-5%**	**28 138**	**9%**

At EU level, in the year 2017 the LULUCF sector offsets about 6% 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 most important driver in the LULUCF sector, offsetting itself about 8.4% of total emissions from other sectors. In 2017 this category resulted, in terms of CO_2 equivalent, a net sink for all the MS with the exception of Malta and Portugal (Table 6. 2, column b). The most significant contributors to the total net sink reported for Europe under the category 4A are France, Germany and Sweden (Table 6. 2, column c).

Table 6. 2 Sector 4 LULUCF: Contribution of Sector 4 (column a) and category 4A (column b) to total MS emissions (CO_2 eq. without LULUCF); and MS contribution to total EU category 4A (column c)

Member States	LULUCF over total inventory excluding LULUCF	Category 4A over total inventory excluding LULUCF	MS contribution to total EU category 4A
	(a)	*(b)*	*(c)*
Austria	-6.0%	-5.2%	1.2%
Belgium	-0.2%	-1.3%	0.4%
Bulgaria	-13.1%	-11.7%	2.0%
Croatia	-19.1%	-18.0%	1.2%
Cyprus	-6.1%	-3.4%	0.1%
Czech Republic	-1.7%	-1.3%	0.4%
Denmark	6.2%	-0.2%	0.0%
Estonia	-8.6%	-9.3%	0.5%
Finland	-36.8%	-48.8%	7.4%
France	-6.9%	-11.4%	14.7%
Germany	-1.7%	-6.4%	15.9%
Greece	-3.4%	-2.2%	0.6%
Hungary	-8.5%	-7.7%	1.4%
Ireland	9.9%	-6.1%	1.0%
Italy	-4.3%	-5.0%	5.9%
Latvia	-15.1%	-44.3%	1.4%
Lithuania	-25.9%	-38.5%	2.2%
Luxembourg	-3.4%	-4.0%	0.1%
Malta	0.2%	NO,NA	-----
Netherlands	2.9%	-0.9%	0.5%
Poland	-8.2%	-8.9%	10.2%
Portugal	10.2%	5.9%	-1.2%
Romania	-19.1%	-19.8%	6.2%
Slovakia	-15.2%	-10.2%	1.2%
Slovenia	-8.7%	-6.6%	0.3%
Spain	-11.3%	-10.1%	9.4%
Sweden	-83.0%	-82.0%	11.9%
United Kingdom	-2.1%	-3.8%	5.0%
EU 28	**-6.0%**	**-8.4%**	**100%**
Iceland	196.0%	-7.3%	0.1%

Source: MS submissions 2019, CRF Table10s1

6.1.2 Contribution of land use changes

The conversion of lands at the level of EU and ISL for the year 2017 results in a net source of 31.563 kt CO_2 (Table 6. 3). Land use changes represent 9% of the total reported land area in EU and ISL. The carbon sink resulting from conversions to Forest Land, Grassland and Other land is by far balanced by emissions from conversions to Cropland, Wetlands and Settlements.

Table 6. 3 Contribution of land use changes in 2017 for EU +ISL, in terms of area (columns a-b) and net CO_2eq. (Columns c-d) (As aggregation of data from CRF Table 4.)

Land conversions	**a) land area (Kha)**	**b) % of area of the corresponding category[1]**	**c) Emissions (+) and removals (-) (Kt CO_2eq.)**	**d) % of net emissions of the corresponding category[1,2]**
4A2. Land converted to Forest Land	7 229	4%	-41 512	11%
4B2. Land converted to Cropland	10 373	8%	46 349	71%
4C2. Land converted to Grassland	12 939	14%	-21 914	172%
4D2. Land converted to Wetlands	1 203	5%	4 180	28%
4E2. Land converted to Settlements	6 436	21%	44 627	92%
4F2. Land converted to Other Land	1 120	6%	- 167	100%
Total land use changes	**39 301**	**9%**	**31 563**	**29%**

[1] The corresponding category is 4A (Forest land) for 4A2, 4B (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 the year 2017, from total area under conversion, 33% is reported as converted to Grassland, 26% as converted to Cropland, 18% as converted to Forest land, 16% as converted to Settlements, and 3% as converted to Wetlands and 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 taken from the individual inventories submitted in the year 2019.

This table along with Table 6. 5 aims to provide an overview of the completeness status. Empty cells should not be directly associated with an incomplete reporting as in many cases the expected carbon stock changes are assumed in balance in line with the 2006 IPCC Guidelines, or none methods exist for their estimation (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 under the subcategories “land converted to” there are a wide range of methods and status of completeness; for instance, a pools can be a source in forest converted to cropland, and a sink in grassland converted to cropland. This large variety cannot be displayed in these tables given the length that would be required for the tables. However, more information is provided, with a different format in other sections. See for instance tables on implied emission factors and more detailed explanation can be found in individual inventories.

The three main land uses categories, Forest Land, Cropland and Grassland, including their sub-categories, are mostly completed. 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, lack of quantitative estimates also associates often with the absence of lands being converted to certain subcategories or the lack of organic soils.

Thus, any judge on completeness would require a comprehensive case by case assessment, for which specific information can be found in the GHG inventories of MS.

Table 6. 4 Sector 4 LULUCF: Coverage of CO_2 emissions and removals for each of the LULUCF sub-categories for the year 2017, as derived from individual 2019 GHGI submissions

MS	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	E		E		E		E	R
Belgium	R	R	E	E	R	R		R		E			R
Bulgaria	R	R	E	E		R		E		E		R	R
Croatia	R	R	E	E	E	R		E		E			R
Cyprus	R	R	R	R	R	R		R		E		E	E
Czech Republic	R	R	E	E	R	R		E		E			R
Denmark	E	R	E	R	E	E	E	R		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		E	R
Germany	R	R	E	E	E	R	E	E	E	E			R
Greece	R	R	R	E	E	R		E		E		E	E
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	E	E	E	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
Luxembourg	R	R	E	E		R		E		E		E	
Malta			R	E	R	R				E		E	
Netherlands	R	R	E	E	E	R	R	E	E	E		E	E
Poland	R	R	E	E	E	R	E	E	R	E			R

MS	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	
Portugal	E	R	R	E	R	E		E		E		R	R
Romania	R	R	R	E	R	E		E		E		E	R
Slovakia	R	R	R	E		R				E		E	R
Slovenia	R	R	R	E	R	R		E	R	E		E	R
Spain	R	R	R	E		R	E	E		E		E	R
Sweden	R	R	E	E	R	E	E		E	E		R	R
United Kingdom	R	R	E	E	R	R	E	E	E	E			R
Iceland	R	R	E	E	E	E	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 tiers methods, in comparison to the main land use categories. Specifically, looking at their subcategories “land remaining in” whose carbon stock changes are often assumed in equilibrium. On the contrary, carbon stock changes are estimated and reported for land use changes involving such categories.

Table 6. 5 shows with more detail the completeness 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 (e.g. Cyprus and France).

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 Tier 1 assumptions, demonstrating the insignificance of the resulting carbon stock changes, because the lack of IPCC methods, or because 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 year 2017.

MS	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		E		R		R	E	E				R	E	E	E	R					
BEL	R					R	R	R	R		R		E	E	R		E				R	E	E	E	R					
BGR	R					R		R	E		E		E		E		E						E		R					
HRV	R					R	R	R	E		E		R	E	R		E					E	E		R					
CYP	R			R		R	E	R	R		R				R	E	R		R				R	R	R					
CZE	R					R	R	R	R		R		E		E	E	R				R		R	E	R					
DNM	E	E	R		E	R	R	R	R	E	E		R	E	R	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	R		R	E				
FRA	R	E				R	R	R	R		E		R		E	E	E		R		E		E	E	R					
DEU	R	E	E	R	E	R	R	R	E	E	E			E	E	E	E	E	R		E	E	E	E	R	E				
GRC	R					R					R			E	E	E	E		E				E	E	R					
HUN	R				E	R	R	R	R		E		R		R	E	E				E		R	E	R					
IRL	R		R	E	E	R		R	R	E	R		R								R	E	E	E	R	E				
ITA	R	R	R			R	R	R	R		E			E	E		E		E	R		E			R					
LVA	R	R			E	R	R	R		E	R	E		E		E	E	E	R	R		E				E				
LTU	R	R				R		R	R		R		R		E		E						R		R					
LUX	R					R	R	R	R		E		R		E	E	E						E	E	R					
MLT											R		R		R		E		R		R				R					
NDL	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					
PRT	R		E	E		R		R	R		R		R		E	E	E				R		E	E	E					
ROU	R	R	R		R	E	R	E	R		R	E	R	E	E															

MS	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
SVK	R					R		R	R		R		R				R						E	E	R	
SLV	E	R				R	R	R	R		R		E	E	R			E	R		R		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	R		E	E	E		R		E	E	R	E
ISL	R				E	R		R	R	E			R	E	E		R	E	R	R	R	E	R	R	R	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 sols under certain land use categories). Only in few cases the lack of quantitative estimates associates with incompleteness. See more details in following sections.

Source: MS and Iceland submissions 2019, CRF table 4A-4C

For the sake of completeness, a number of improvements have been introduced this year by Member States that have resulted in an increasing completeness of the sector. Specifically, carbon stock changes are now including in:

- GBK: DW under the category 4.A.1 and 4.A.2
- IRL: SOCmin under the category 4.A.1 and 4.A.2
- NDL: SOCorg under the careory 4.A.1
- SLV: LB and SOCmin under the category 4.C.1 and DOM under 4.A.2
- GRC: DOM under the category 4.B.2
- LVA: DOM under the category 4.B.2
- POL: LB under the category 4.B.2
- HRV: DW under 4.A.2

6.1.4 Data and methods

This section provides an overview of the information on methods and data used by MS 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 MS in terms of ecological and socio-economic conditions, there is not a common definition of land use categories. Methods used to estimate GHG emissions and CO_2 removals from the LULUCF sector also differ among MS 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) is likely to result in more accurate GHG 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 this year 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 (i.e. different approaches and data sources are often used for forest converted to grassland than for cropland converted to grassland), Table 6. 6 is intended to show only a summary of the main information on methods and carbon stock changes factors used by individual MS and Iceland.

Finally, because of different underlying methods applied by each MS and Iceland, 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 MS to calculate CO_2 emissions and removals of different carbon pools in the LULUCF sector, as reported in the GHGI 2019 submissions.

MS	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

MS	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)
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
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 2019, CRF table 4A-4C

(D: default; CS: country-specific; NA: not applicable; NE: not estimated; NO: not occurring). Grey heading 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 derivate 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 2006 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 2 notations 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
1(3) for LB carbon stock change in CL-CL is assumed only for perennial woody crops. Biomass of annual crops is generally assumed in balance.
(4) for SOC MIN on CL and GL the 2 notation keys separated by 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" indicate 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 2 notation keys used mean: first one refers to FL-CL and second 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	2017		1990	2017
4.A.1 Forest Land: Land Use (CO_2)	-356 186	-331 368	T	L	L
4.A.2 Forest Land: Land Use (CO_2)	-38 223	-42 117	T	L	L
4.B.1 Cropland: Land Use (CO_2)	24 526	18 631	0	L	L
4.B.2 Cropland: Land Use (CO_2)	48 709	40 781	T	L	L
4.C.1 Grassland: Land Use (CO_2)	47 667	34 014	0	L	L
4.C.2 Grassland: Land Use (CO_2)	-17 981	-22 191	0	L	L
4.D.1 Wetlands: Land Use (CO_2)	7 993	10 728	T	0	L
4.D.2 Wetlands: Land Use (N_2O)	4 094	109	T	0	0
4.E.2 Settlements: Land Use (CO_2)	34 508	40 831	T	L	L
4.G Harvested Wood Products: Wood product (CO_2)	-30 835	-40 597	0	L	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 land use category in the LULUCF sector. It represents about 36% of the total area. According to the information provided in individual submissions, in 2017 total forest area reached 167.039 Kha, which represents an increase of 4% as compared with 1990.

About 4% of the total forest area is represented by lands under conversion to forest land. This trend, which is also reflected in different official statistics of the EU, is given by the expansion of forests due to less grazing pressure and the decrease of agricultural activities, which together promote the natural forest expansion. But an important driver behind then has also been the promotion of national afforestation programs, including grant-aid.

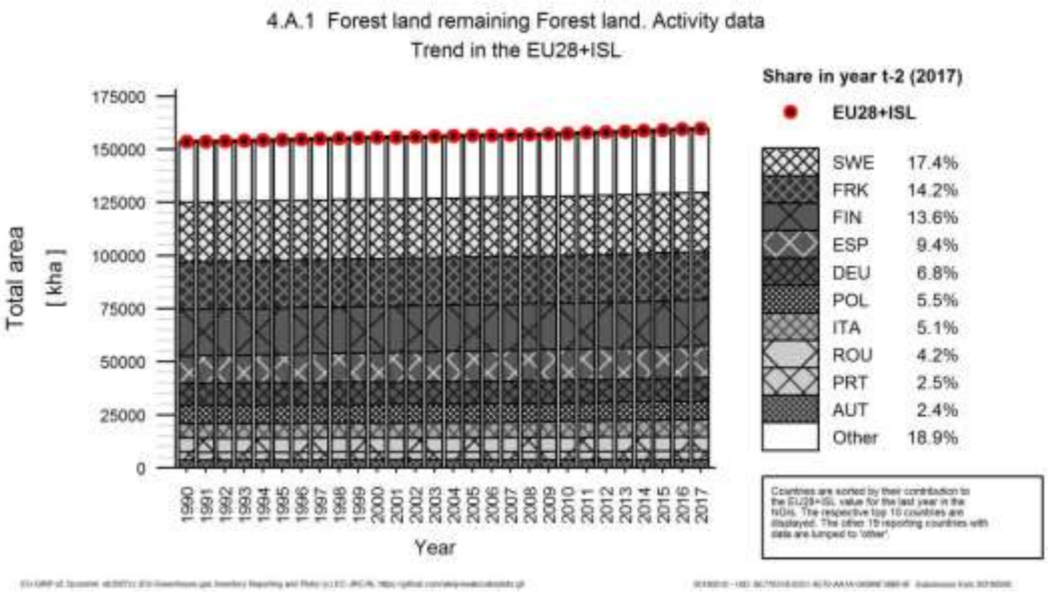
The largest forest area is reported by Sweden, France and Finland, which together report about 45% of the total forest area at EU level. Deforestation does not appear to be a major issue in Europe. Moreover, because the absolute area under conversion from forest is far compensated by new planting areas 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 year 2017 slightly increased by 4% as compared with 1990. However, at the level of individuals submissions there are significant differences. For instance, UK reports an increase of about 35%, while Netherlands reports a decrease of about 11% respect 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 MS and Iceland (kha, 1990-2017)



For the year 2017, the total land area reported under the sub category 4.A1 reached 159.809 Kha out of which about 84% corresponds to the 10 MS with the higher contribution.

In terms of GHG emissions the category 4.A1 resulted in a net sink of -331.368 kt CO_2, decreasing by 7% as compared in 1990. The major contributors are Germany, France, and Sweden (Table 6. 8).

Table 6. 8 4A1 Forest Land remaining Forest Land: MS and Iceland' contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	-7 849	-2 579	-2 578	0.8%	5 272	67%	1	0%
Belgium	-1 733	-1 095	-1 092	0.3%	640	37%	2	0%
Bulgaria	-11 548	-6 286	-6 284	1.9%	5 264	46%	2	0%
Croatia	-6 689	-5 292	-4 424	1.3%	2 265	34%	868	16%
Cyprus	-65	345	-257	0.1%	-191	-294%	-601	-174%
Czechia	-4 282	-3 509	-1 011	0.3%	3 271	76%	2 498	71%
Denmark	-554	702	117	0.0%	671	121%	-586	-83%
Estonia	-3 320	-3 093	-2 047	0.6%	1 272	38%	1 046	34%
Finland	-24 014	-28 358	-29 661	9.0%	-5 647	-24%	-1 303	-5%
France	-33 901	-49 522	-47 763	14.4%	-13 863	-41%	1 759	4%
Germany	-70 327	-53 618	-53 702	16.2%	16 625	24%	-84	0%
Greece	-1 142	-2 055	-2 076	0.6%	-933	-82%	-20	-1%
Hungary	-2 971	-3 141	-3 597	1.1%	-625	-21%	-455	-14%
Ireland	-3 855	-893	-587	0.2%	3 268	85%	306	34%
Italy	-15 002	-30 629	-18 475	5.6%	-3 473	-23%	12 154	40%
Latvia	-17 405	-3 688	-5 677	1.7%	11 727	67%	-1 990	-54%
Lithuania	-7 365	-7 664	-7 316	2.2%	49	1%	349	5%
Luxembourg	142	-435	-337	0.1%	-479	-337%	98	23%
Malta	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Netherlands	-1 767	-1 327	-1 340	0.4%	426	24%	-14	-1%
Poland	-34 000	-34 000	-33 584	10.1%	416	1%	416	1%
Portugal	-4 146	-6 001	4 392	-1.3%	8 538	206%	10 393	173%
Romania	-19 875	-19 871	-18 696	5.6%	1 179	6%	1 175	6%
Slovakia	-6 347	-4 179	-4 080	1.2%	2 267	36%	99	2%
Slovenia	-4 581	-1 414	-645	0.2%	3 936	86%	768	54%
Spain	-21 396	-29 216	-29 429	8.9%	-8 033	-38%	-214	-1%
Sweden	-37 739	-42 733	-43 170	13.0%	-5 431	-14%	-437	-1%
United Kingdom	-14 426	-18 117	-17 980	5.4%	-3 553	-25%	137	1%
EU-28	**-356 157**	**-357 665**	**-331 298**	**100%**	**24 859**	**7%**	**26 368**	**7%**
Iceland	-16	-35	-34	0.0%	-19	-121%	1	3%
United Kingdom (KP)	-14 441	-18 153	-18 016	5.4%	-3 575	-25%	137	1%
EU-28 + ISL	**-356 186**	**-357 737**	**-331 368**	**100%**	**24 818**	**7%**	**26 369**	**7%**

For the year 2017, not all individual submissions report a net sink of carbon in Forest Land remaining Forest Land.

The largest change in absolute terms reported as compared with 1990 corresponds to a significant decrease of the carbon sink reported by Germany due to changes in harvesting rates. France reports a significant increase of the carbon sink driven by a steady increase of the forest area.

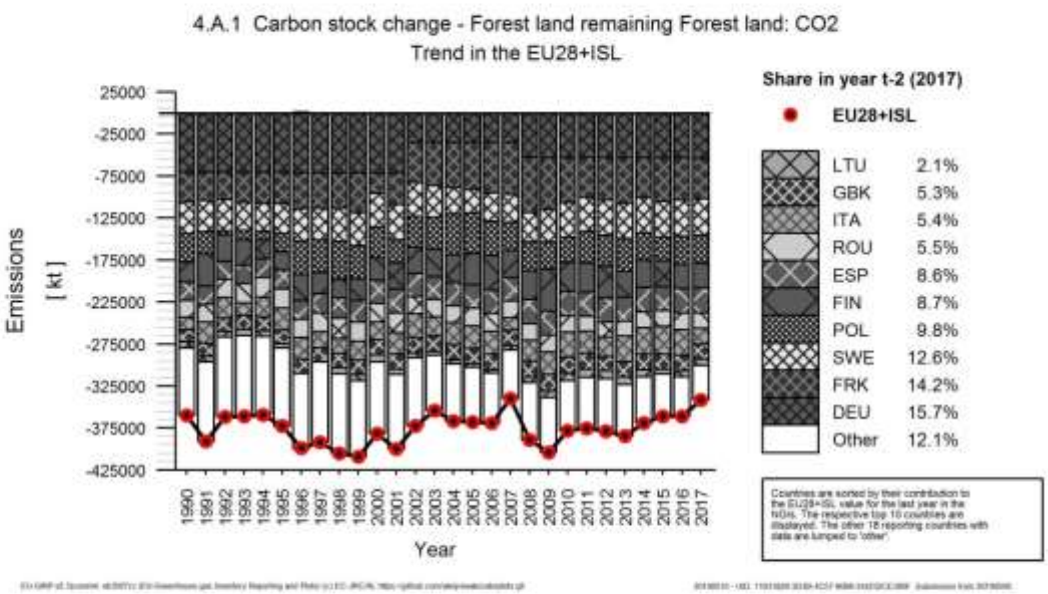
In other cases, along the time series, this category has shifted between a net source and a net sink of carbon, as occurred in Denmark due to the age distribution of the forests.

A particular case is given by Malta that having 0.072 Kha of forest does not report the carbon stock changes in this land use category following a recommendation of the ERT. Indeed, the ERT noted that the use of IPCC factors, which are not suited for Malta's 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 acquired 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 protection regime

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 MS and Iceland (kt CO_2, 1990-2017)



Inter-annual variations in this subcategory are closely related with natural disturbances that mostly affect direct GHG emissions in forests areas. In this respect, wildfires, in southern European countries, and windstorms, in several European countries, resulted in a significant source of GHG emissions for specific years that are reflected in the trend at EU level.

Specifically, as compared with the previous year, Portugal and Italy report huge forest area affected by fires. For the year 2017, together they report a reduction on the sink of about 22.550 kt CO_2 due to wildfires which has driven the trend of this category.

The CO_2 emissions from biomass burning are, in many cases, implicitly included 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 budget (e.g. Portugal, Spain).

Windstorms (mainly in central Europe) in specific years affected a large amount of forest areas. However, given that the biomass affected by storms is either treated as salvage logging or enters into the dead organic matter carbon pool, emissions peaks due to storms are often not so visible in the GHG inventories. Other type of disturbances generally have a much localized effects and low magnitude. In general, they are difficult 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 long term in 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 and 2005, 2017; Italy in 1990, 1993 and 2007, 2017).
- Windstorms (e.g. France in 1999 and 2009, and Denmark in 2000, Sweden in 2005);

Or they are attributed to the estimation method:

- For instance, Germany uses the stock-difference method between subsequent forest inventories. This method is accurate for estimating carbon stock changes over a time period but it may results in discontinuities in trends, i.e. “steps” in single years (e.g. 2002), because the significant decrease of the sink, which occurred over a period since the previous forest inventory, is counted in a single year when carbon stocks of the more recent inventory are integrated in the calculation.

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 MS slightly differ in terms of 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, thus, additional qualitative criteria complement the forest definitions provided (i.e. treatment of forest roads, nurseries, willow crops, etc.).

Few MS 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 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 (i.e. land fragmentation, land use change frequency, transition period, land registry systems, GHG estimation methodology, etc.), but it is likely to be small.

Table 6. 9 Quantitative thresholds used to define forests as selected by individual MS and Iceland

Member State	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	-
Netherlands	20	5	0.5	30
Malta	30	5	1.0	-
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	10	5	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

**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.

Member State	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.
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 it does not include municipal parks and gardens.
Czech Republic	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 are used.
Hungary	Forest land 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.

Member State	Forest land definition
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.
Malta	No additional criteria are used.
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 awaiting 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. Nevertheless, this information is, in some case, also taken from forest management plan databases (especially, 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 in 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, EU's MS have made considerable efforts to adjust their forest inventories to the specific requirements of UNFCCC/KP reporting, but also there were some steps toward a slight harmonization at European scale (e.g. COST E43 Action)[66].

Given that annual data are barely available for this sector, efforts are devoted to adjust 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 Corine Land Cover maps.

Furthermore, MS usually have disaggregated forest land 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, and management type (e.g. coppice, high stands).

For Forest land category, 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 soils 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.

[66] *http://www.metla.fi/eu/cost/e43*

Table 6. 11 Explicit information on forest carbon pools definitions as reported by EU MS and Iceland.

MS	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.
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	Modeled 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	Modeled 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.

MS	Description
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.
Czech Republic, 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 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.
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.

MS	Description
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 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 top soil.
Bulgaria	Organic carbon in 0-40 cm top soil, includes also the C stock of the litter layer (humus layer).
Croatia	Organic carbon in 0-40 cm top soil.
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 are expected to occur.

Individual submissions of GHG inventories follow 2006 IPCC GL 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 by MS and Iceland for estimating carbon stock changes in Living Biomass.

Member State	Estimation method
Austria	Gain-loss
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 national inventories, upon data availability. Nowadays, national forest inventories represent the primary source of information for most of MS, while others rely on 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 MS 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 2017 range from 1.12 to -0.43 T C ha^{-1} among MS and Iceland (Table 6. 13). Generally, low values of IEF are shown by countries with most intensive forestry or with less favorable climatic conditions (i.e. lower growth and also more losses by natural disturbances); while higher values are for countries where planting 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 2019.

Member State	Net carbon stock change factor in living biomass t C/ha	
	1990	2017
AUT	0.77	0.31
BEL	0.67	0.44
BGR	0.90	0.47
HRV	0.79	0.61
CYP	0.06	0.22
CZE	0.45	0.11
DNM	0.37	-0.43
EST	0.27	0.12
FIN	0.34	0.30
FRK	0.43	0.60
DEU	1.43	1.03
GRC	0.10	0.17
HUN	0.47	0.52
IRL	2.55	0.77
ITA	0.55	0.60
LVA	1.55	0.39
LTU	0.96	0.93
LUX	-0.49	0.99
MLT	NA	NA
NLD	1.32	1.12
POL	1.04	0.97
PRT	0.40	0.28
ROU	0.83	0.78
SVK	0.96	0.57
SVN	1.18	-0.01
ESP	0.46	0.54
SWE	0.35	0.36
GBK	1.16	0.79
ISL	0.05	0.10

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, the notation key NO (or NE) is used in the corresponding CRF table (see also Table 6. 5 and Table 6. 6 on completeness).

When they are estimated, MS 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, and increasing number of MS document on the ongoing efforts to estimate emissions and removals from dead organic matter and mineral soils, and more MS as compared with previous submissions report, using country-specific approaches, quantitative estimates for these pools during the last year.

When data is available, they are either directly used for estimating carbon stock change using stock difference or gain-loss methods, or 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) and some MS include their estimates within soil organic carbon pool (e.g. Finland).

Finally, particularities are given by France and Luxembourg that report carbon stock changes in dead organic matter only for part of the time-series.

France, in line with the IPCC, reports this carbon stock changes since 1999 as a result of the significant carbon inputs that entered into the pool after some windstorm that affected dramatically the forest area in that year.

By other hand, Luxembourg uses the stock-difference method, which has resulted in a measured increase of dead wood between two consecutive NFI period between 2000 and 2010, for years before and after the Tier 1 assumption of equilibrium was used. Luxembourg has developed a methodology to extrapolate carbon stock changes in dead wood for the years currently not estimated. The methodology is under review and as soon as Luxembourg has received feedback, the new estimates of carbon stock changes in dead wood will be integrated in the next submission.

Table 6. 14 Implied carbon stock change factors in DOM carbon pool in 4A1 (t C ha-1 yr-1) reported in individual GHGI 2019.

Member States	Net carbon stock change in dead wood per area (t C/ha)		Net carbon stock change in litter per area (t C/ha)	
	1990	2017	1990	2017
AUT	0.02	0.06	NE,IE	NE,IE
BEL	NO	NO	NO	NO
BGR	NO	NO	NO	NO
HRV	NE	NE	NE	NE
CYP	NO	NO	NO	NO
CZE	NO	NO	NO	NO
DNM	0.01	-0.15	-0.01	0.58
EST	0.02	0.01	NO	NO
FIN	IE	IE	IE	IE
FRK	NE	-0.02	NE	NE
DEU	0.04	-0.05	-0.01	-0.01
GRC	NA,NO	NO,NA	NA,NO	NO,NA
HUN	NO	NO	NO	NO
IRL	IE	IE	0.11	0.01
ITA	0.02	0.01	0.03	0.01
LVA	0.05	0.18	NA	NA
LTU	0.07	0.03	NO	NO
LUX	NO	NO	NO	NO
MLT	NA	NA	NA	NA
NLD	0.08	0.07	NO	NO
POL	NO	NO	NO	NO
PRT	IE	IE	0.00	0.00
ROU	NO	NO	NO	NO
SVK	NO	NO	NO	NO
SVN	0.10	0.17	NO	NO
ESP	NA	NA	NA	NA
SWE	0.04	0.07	-0.10	-0.12
GBK	0.26	0.31	0.05	0.03
ISL	NO,IE	NO,IE	NE	NE

Carbon stock changes in mineral soils under forest land remaining forest land in this submission are quantitatively estimated by 10 MS, generally as a small net sink of carbon. (Table 6. 15).

Most of the MS report absence or insignificant areas of organic soils under this land use subcategory. However, when organic soils are presented, they are reported, in most of the cases, as resulting in a net source of emissions.

12 MS reports CO_2 emissions from organic soils associated with managed forests (e.g. drainage of soils to establish plantations), and only UK reports a sink from organic soils in this category, justified in its national inventory report.

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 2019.

Member States	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	2017	1990	2017
AUT	-0.19	-0.18	NO	NO
BEL	NO	NO	NO	NO
BGR	NO	NO	NO	NO
HRV	NO	NO	NO	NO
CYP	0.06	0.22	NO	NO
CZE	NO	NO	NO	NO
DNM	NA	NA	-1.95	-1.30
EST	0.17	0.17	-0.16	-0.16
FIN	0.15	0.17	-0.56	-0.19
FRK	NE	NE	NO	NO
DEU	0.41	0.41	-2.10	-2.24
GRC	NA,NO	NO,NA	NA,NO	NO,NA
HUN	NO	NO	-2.60	-2.60
IRL	-0.05	-0.04	-0.55	-0.45
ITA	NA,NO	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	NO	NO	-1.05	-1.04
POL	0.05	0.10	-0.68	-0.68
PRT	0.02	0.00	NO	NO
ROU	NO	NO	-0.68	-0.68
SVK	NO	NO	NO	NO
SVN	NO	NO	NO	NO
ESP	NA	NA	NO	NO
SWE	0.16	0.19	-0.37	-0.35
GBK	0.19	0.36	-0.11	0.86
ISL	NA	NA	-0.37	-0.37

6.2.1.3 Land converted to Forest Land (CRF 4A2)

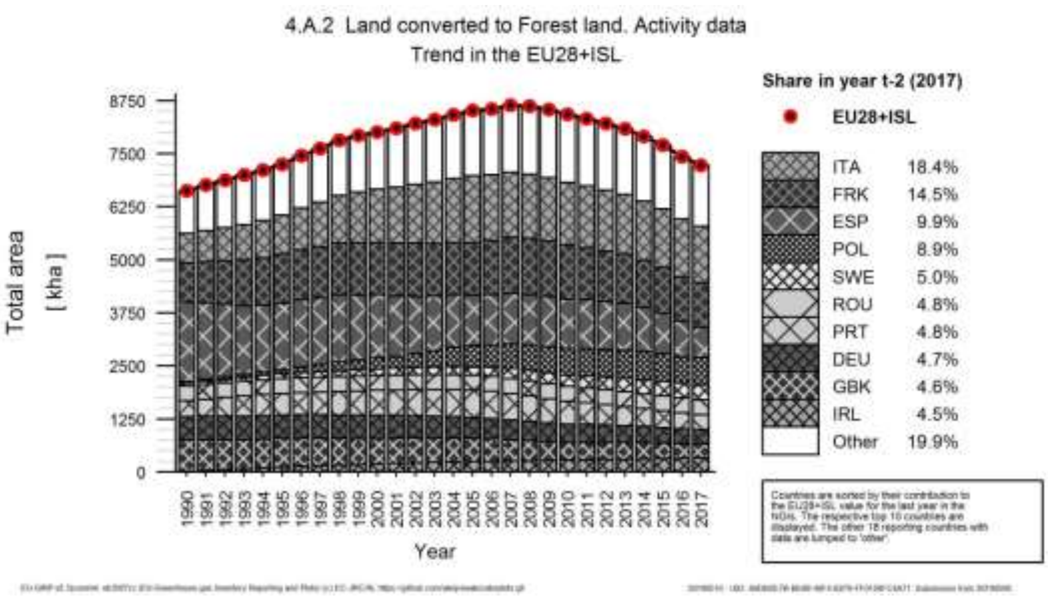
Overview of Land converted to Forest Land category

In this submission, the area reported under this subcategory represents 4% of the total Forest Land area reported. This subcategory has increased by 9% as compared with 1990 (Figure 6. 5), from 6.631 Kha in 1990 to 7.229 Kha in 2017.

Most of the new forest lands take place from former Grasslands and Cropland areas, and although within the overall category they have a low share in terms of areas, they contribute by 11% to the total carbon sink of the European forest.

In term of areas, Italy, France and Spain together contribute with about 43% of the total areas of land being converted to forest land.

Figure 6. 5 Trend of activity data in subcategory 4A2 "Land converted to Forest Land" in EU MS and Iceland (kha, 1990-2017)



This subcategory has been always reported as a net carbon sink. In this submission, it reaches 42.117 Kt CO_2, which represents an increase of 10% as compared with 1990, and a decrease of 9% compared with in previous year. This trend in removals is well associated with the trend on areas (Figure 6. 6; Table 6. 16).

Nevertheless, some MS (e.g. Finland, Netherlands, and Slovenia) 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 are previous to 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: MS and Iceland' contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	-3 043	-1 741	-1 735	4.1%	1 308	43%	6	0%
Belgium	-9	-414	-447	1.1%	-438	-5098%	-33	-8%
Bulgaria	-620	-955	-985	2.3%	-365	-59%	-29	-3%
Croatia	-29	-223	-176	0.4%	-147	-508%	48	21%
Cyprus	-13	-43	-38	0.1%	-26	-202%	5	11%
Czechia	-409	-658	-671	1.6%	-262	-64%	-13	-2%
Denmark	-20	144	-254	0.6%	-234	-1179%	-398	-276%
Estonia	-11	-219	-196	0.5%	-185	-1651%	23	10%
Finland	161	-194	-180	0.4%	-341	-211%	14	7%
France	-4 621	-6 529	-6 388	15.2%	-1 767	-38%	142	2%
Germany	-5 215	-4 222	-4 059	9.6%	1 157	22%	163	4%
Greece	NE,NO	-104	-46	0.1%	-46	-∞	58	56%
Hungary	-310	-1 441	-1 379	3.3%	-1 069	-345%	62	4%
Ireland	-7	-3 914	-3 427	8.1%	-3 420	-50532%	487	12%
Italy	-2 849	-6 443	-4 259	10.1%	-1 410	-49%	2 184	34%
Latvia	-1	-176	-164	0.4%	-163	-22488%	12	7%
Lithuania	-792	-992	-1 018	2.4%	-225	-28%	-26	-3%
Luxembourg	-306	-86	-71	0.2%	234	77%	15	17%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	32	-496	-486	1.2%	-518	-1601%	10	2%
Poland	-141	-2 514	-3 310	7.9%	-3 169	-2245%	-796	-32%
Portugal	-2 155	-2 495	-1 157	2.7%	998	46%	1 338	54%
Romania	-3 859	-3 858	-3 858	9.2%	1	0%	0	0%
Slovakia	-2 210	-395	-369	0.9%	1 841	83%	26	6%
Slovenia	21	-604	-511	1.2%	-532	-2538%	93	15%
Spain	-11 279	-5 859	-5 105	12.1%	6 174	55%	754	13%
Sweden	74	-1 345	-1 320	3.1%	-1 394	-1888%	24	2%
United Kingdom	-563	-195	-194	0.5%	368	65%	1	1%
EU-28	**-38 173**	**-45 971**	**-41 802**	**99%**	**-3 629**	**-10%**	**4 169**	**9%**
Iceland	-27	-291	-313	0.7%	-286	-1055%	-22	-8%
United Kingdom (KP)	-586	-197	-196	0.5%	390	67%	1	0%
EU-28 + ISL	**-38 223**	**-46 263**	**-42 117**	**100%**	**-3 894**	**-10%**	**4 147**	**9%**

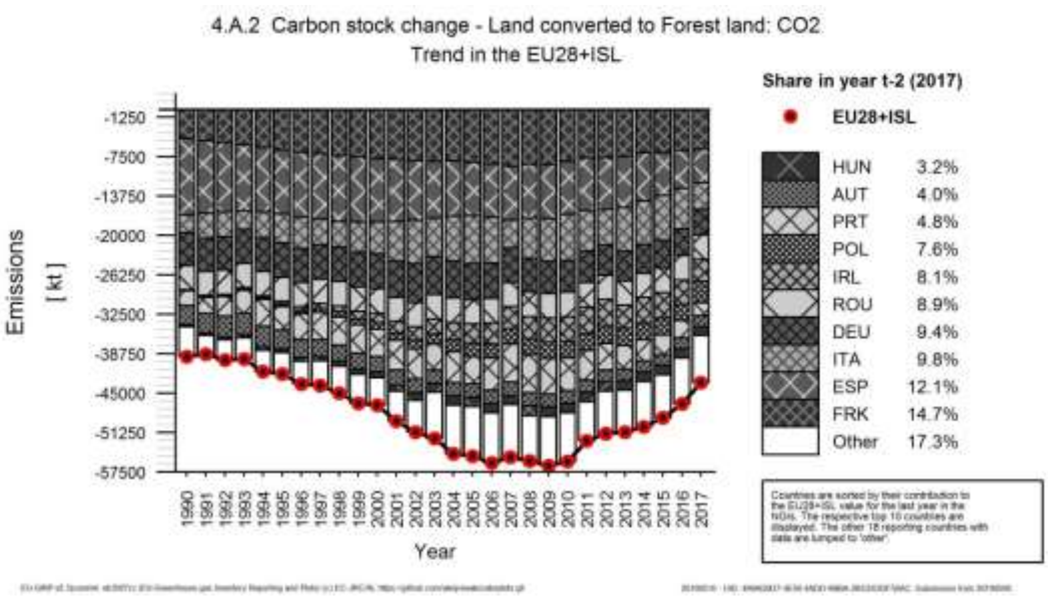
As shown in Table 6. 16, in this year, some MS reported significant changes in this subcategory as compared with 1990, for instance Finland, Ireland and Spain.

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 the lands converted in forest. While in 1990 emissions from drainage organic soils in lands converted in forests balanced the removals; much less drainage of organic soils occur in the last years of the time series and therefore much more large sink was reported.

In the case of Ireland, the increase on removals by the post-1990 forest is due to an increase in forests 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, Spain reports a constant decrease of areas in this category that result in much less absolute sink at the end of the time series than in the base year.

Figure 6. 6 Trend of emissions (+)/removals (-) in subcategory 4A2 "Land converted to Forest Land" in EU MS and Iceland (kt CO_2, 1990-2017)



For this year, about 45% of total carbon sink reported in the subcategory 4A.2 was reported by France, Spain, and Italy, while the 10 MS with the larger contribution represent about the 83% 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 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 on the 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 years, Italy has been requested to probe that its method does not result in bias estimates. Italy has informed that its 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 FL-FL and L-FL on the basis of the % of the FL-FL and L-FL area in a yearly basis. On top of that an analysis carried out by Italy across European forest reports showed that the approach does not cause any bias in the GHG estimates, so far as can be judged.

Most of the MS 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, and 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 MS, 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 MS 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 estimated CO_2 emissions from previous land use, 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 EU GHG budget. This category, which includes arable lands for annual crops, permanent crops, set aside lands and rice-fields, represents the larger source of emissions among the six land use categories.

Based on individual submissions, total Cropland areas covered in 2017 about 127.000 kha, which represent 28% of total lands, although they show a constant decreasing trend of about 5% as compared with the year 1990.

6.2.2.2 Cropland remaining Cropland (CRF 4B1)

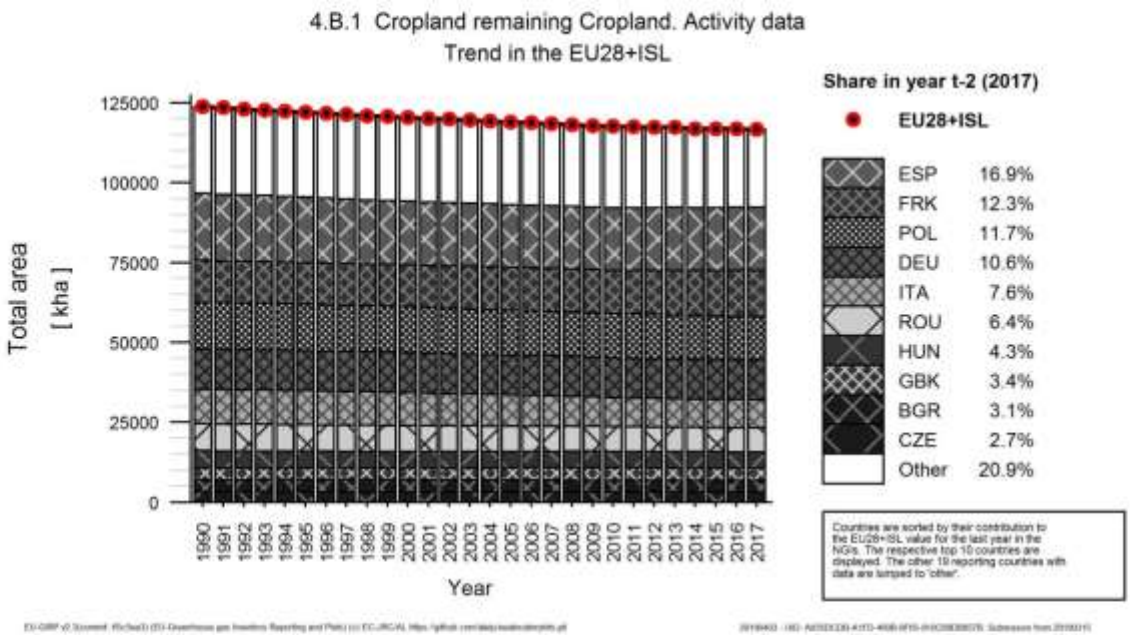
Overview of Cropland remaining Cropland category

In line with the overall category, this subcategory has constantly decreased since 1990 (Figure 6. 7) from 123.714 kha in 1990 to 116.616 kha in 2017. This represents a decrease of 6%.

With the exception of France, UK, Malta, Slovakia and Iceland, all MS 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 MS and Iceland (kha, 1990-2017)



In terms of emissions, at EU level, this subcategory has been always reported as a net source. For the year 2017, GHG emissions reached 18.631 kt CO_2 which represents a decrease of 24% as compared to 1990 (Table 6. 17).

This trend is mainly driven by Germany, UK and Finland that reports the larger 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 significant carbon sink in Cropland remaining Cropland. For instance, France, Romania and Spain which report a substantial net carbon sink in mineral soils and, in some case, 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 that those implemented 20 years before. And also, in MS with significant areas of woody crops (i.e. orchards, vineyards, Christmas trees, fruits, bushes, and olive trees) that provide a net sink of carbon.

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.

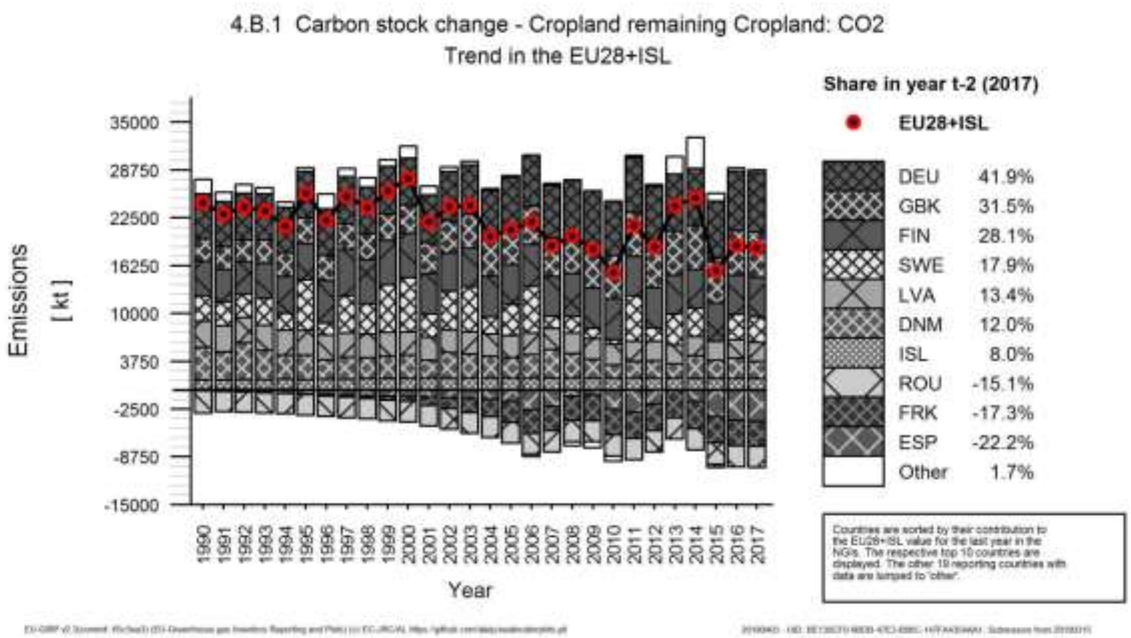
Table 6. 17 4B1 Cropland remaining Cropland: MS and Iceland contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	-18	-274	-244	-1.3%	-226	-1266%	30	11%
Belgium	213	189	187	1.0%	-26	-12%	-2	-1%
Bulgaria	-702	601	541	2.9%	1 243	177%	-61	-10%
Croatia	197	290	245	1.3%	48	24%	-45	-15%
Cyprus	-135	-131	-132	-0.7%	3	2%	-1	0%
Czechia	90	36	12	0.1%	-78	-86%	-24	-66%
Denmark	4 223	2 602	2 219	11.9%	-2 003	-47%	-383	-15%
Estonia	568	256	178	1.0%	-390	-69%	-78	-31%
Finland	4 549	5 101	5 216	28.0%	666	15%	114	2%
France	77	-3 281	-3 210	-17.2%	-3 287	-4288%	71	2%
Germany	5 880	7 783	7 788	41.8%	1 908	32%	5	0%
Greece	-808	-265	-140	-0.8%	668	83%	125	47%
Hungary	30	-379	-359	-1.9%	-389	-1312%	20	5%
Ireland	-9	-136	-84	-0.5%	-75	-845%	52	38%
Italy	1 638	953	997	5.4%	-641	-39%	44	5%
Latvia	3 466	2 441	2 495	13.4%	-971	-28%	54	2%
Lithuania	100	-77	-55	-0.3%	-155	-154%	22	29%
Luxembourg	-1	1	1	0.0%	3	199%	0	-12%
Malta	-1	-1	-1	0.0%	0	-42%	0	2%
Netherlands	1 636	627	586	3.1%	-1 050	-64%	-41	-7%
Poland	800	310	242	1.3%	-559	-70%	-68	-22%
Portugal	21	-206	-206	-1.1%	-227	-1085%	-1	0%
Romania	-2 898	-2 804	-2 812	-15.1%	87	3%	-7	0%
Slovakia	-1 416	-1 205	-1 209	-6.5%	207	15%	-3	0%
Slovenia	-249	-179	-176	-0.9%	72	29%	2	1%
Spain	-154	-3 986	-4 126	-22.1%	-3 971	-2573%	-139	-3%
Sweden	3 291	3 351	3 331	17.9%	40	1%	-20	-1%
United Kingdom	2 910	5 788	5 845	31.4%	2 936	101%	57	1%
EU-28	**23 299**	**17 403**	**17 130**	**92%**	**-6 169**	**-26%**	**-273**	**-2%**
Iceland	1 217	1 500	1 491	8.0%	274	23%	-10	-1%
United Kingdom (KP)	2 920	5 799	5 856	31.4%	2 936	101%	57	1%
EU-28 + ISL	**24 526**	**18 914**	**18 631**	**100%**	**-5 895**	**-24%**	**-283**	**-1%**

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 contribute 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.

Bulgaria shifted from a sink of carbon reported for the year 1990 to a source of emissions reported in this year due to carbon stock changes in living biomass in perennial woody crops. Bulgaria uses the IPCC tier 1 method to report carbon stock changes in this carbon pool, and this resulted in a source of emissions due to a higher loss of biomass in old perennial crops than a sink of carbon in young perennial crops (i.e. less than 30 years).

Figure 6. 8 Trend of emissions (+)/removals (-) in subcategory 4B1 "Cropland remaining Cropland" in EU MS and Iceland (kt CO_2, 1990-2017)



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 MS.

In some cases, because of the absence of annual information on activity data, along with the fact that management practices include crops-rotation cycles and fallow lands; some croplands areas may not be clearly separated from grasslands areas. In these cases, MS have implemented a number of years before a land is shifted from/to cropland and grassland.

Table 6. 18 Definitions of lands included by MS and Iceland under the category 4B: Cropland

MS	***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.
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

MS	Definition
	(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).
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").

MS	Definition
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. Two subcategories of Cropland are defined on the Land use map, “Cropland” and “Cropland on drained soils”.

In overall, following IPCC approach, the living biomass carbon pool is assumed in balance for annual crops, while carbon stock changes are often reported for conversions among annual and woody crops (e.g. Austria, Croatia, and Bulgaria). Concerning carbon stock changes in woody crops, MS 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, which is not always transparently provided is how the lands in which woody crops have reached the 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 IPPC assumption that the dead wood and litter 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. Latvia and Romania).

A particular case is given by Finland which report the notation key IE since the net carbon stock change in dead organic matter is included in losses in living biomass, explaining that the amount 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.

About 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 soils management practices along the time series. By contrary, as reported by all MS, for cropland areas under organic soils, the net result of carbon stock changes associates 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 approach, where carbon stock changes are estimated as the difference on the carbon stock in soils at two moments in time. In few cases, carbon stock changes have been also estimated by using models (e.g. C-tool by Denmark and ICBM by Sweden).

Applied Tier 2 methods consist on 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.

Carbon stock change factors 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 crops and agro-forestry 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 in GHGI 2019.

Member States	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	2017	1990	2017	1990	2017	1990	2017
AUT	0.003	-0.007	NO	NO	0.000	0.057	NO	NO
BEL	NO	0.002	NO	NO	-0.041	-0.041	-10.000	-10.000
BGR	0.054	-0.040	NE	NE	-0.001	-0.001	NO	NO
HRV	-0.018	-0.027	NO	NO	0.000	0.000	-10.000	-10.000
CYP	0.147	0.150	NO	NO	NO	NO	NO	NO
CZE	0.000	0.000	NO	NO	-0.007	-0.001	NO	NO
DNM	0.007	-0.012	NO	NO	-0.044	0.070	-9.295	-8.828
EST	0.000	0.000	NO	NO	NO	0.090	-6.100	-6.100
FIN	0.000	0.000	IE	IE	0.004	-0.049	-6.480	-6.588
FRK	-0.002	-0.002	NE	NE	0.001	0.064	IE	IE
DEU	0.001	0.000	NA	NA	NE	NE	-8.100	-8.100
GRC	0.073	0.033	NO	NO	NO	NO	-10.000	-10.000
HUN	-0.002	-0.003	NO	NO	0.000	0.023	NO	NO
IRL	0.003	0.002	NO	NO	0.000	0.028	NO	NO
ITA	-0.018	-0.001	NO	NO	NO	NO	-10.000	-10.000
LVA	0.001	0.004	0.000	0.000	NA	NA	-7.900	-7.900
LTU	-0.015	0.006	NO	NO	-0.005	0.006	IE	IE
LUX	0.005	-0.007	NO	NO	0.001	0.001	NO	NO
MLT	0.162	0.202	NE	NE	0.048	0.015	NO	NO
NLD	NE	NE	NE	NE	NO	NO	-4.226	-4.025
POL	0.030	0.035	NO	NO	-0.002	-0.001	-1.000	-1.000
PRT	-0.002	0.018	NO	NO	NO	0.008	NO	NO
ROU	0.018	0.037	-0.004	-0.004	0.083	0.074	-5.000	-5.000
SVK	0.249	0.205	NO	NO	0.009	0.015	NO	NO
SVN	0.329	0.326	NO,NE	NO,NE	0.000	-0.001	-10.000	-10.010
ESP	0.002	0.031	NA	NA	NO	0.026	NO	NO
SWE	0.004	0.018	0.002	0.000	0.005	-0.049	-6.220	-6.220
GBR	-0.002	-0.002	NO	NO	-0.090	-0.291	-5.000	-5.001
ISL	NO	NO	NO	NO	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, MS used the notation key NO or in some cases, NE, in accordance with the Decision 24/CP19, when the insignificant provision was applied, or in some cases also NA as requested by the ERT.

It should be noted that some efforts have been implemented during the last years and are still ongoing to harmonize the use of the notation keys among MS, however due to resources constrains the main focus has been given to increase the completeness and accuracy of the estimates.

6.2.2.3 Land converted to Cropland (CRF 4B2)

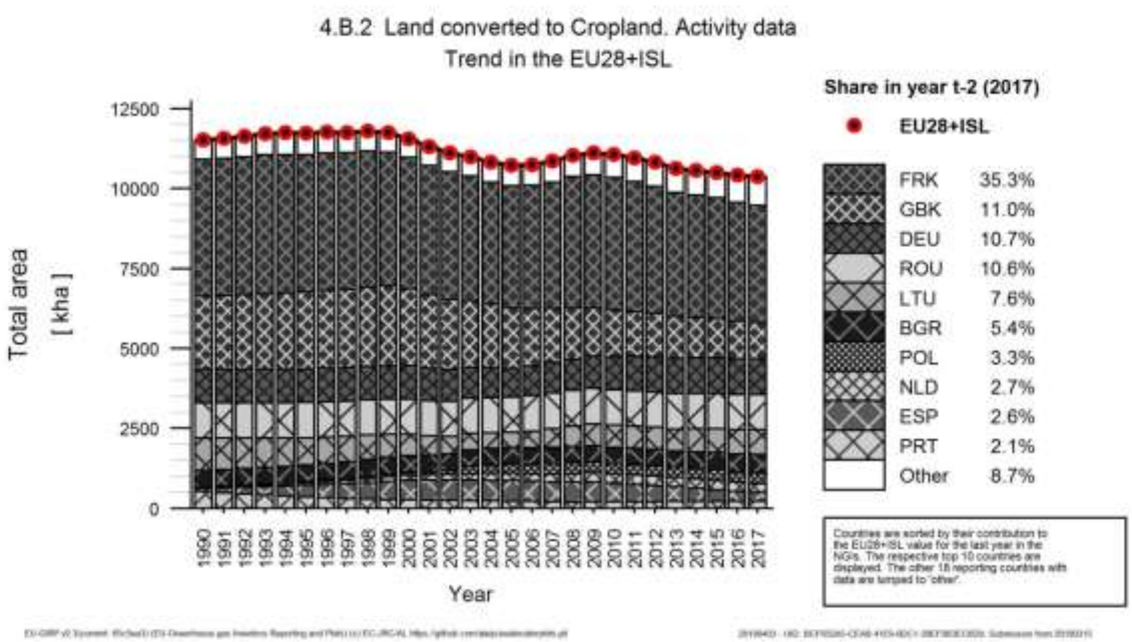
Overview of Land converted to Cropland category

In terms of area, this subcategory represents 8% of the total cropland areas reported at the level of EU and Iceland, however it accounts for 71% of the net CO_2 emissions that are reported under this category.

In overall, area reported for 2017 decreased by 10% as compared with 1990 from 11.528 kha, reported for the year 1990, to 10.373 Kha (Figure 6. 9). Despite of this, contrary to the trend on areas reported under subcategory 4B.1, the decrease was not constant.

Main conversions of lands to Cropland take place from areas of Grassland and Forest land. At the level of EU MS and Iceland the trend is mainly driven by France, UK, Romania and Germany 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 MS and Iceland (kha, 1990-2017)



In term of emissions, this subcategory is in overall reported as a net source of emissions that reaches 40.781 Kt CO_2 in 2017. This represents a decrease of 16% as compared to 1990 (Table 6. 20). The major driver of the trend is France that reports about 46 % of the total emissions in this subcategory; followed by Germany and UK (Figure 6. 10)

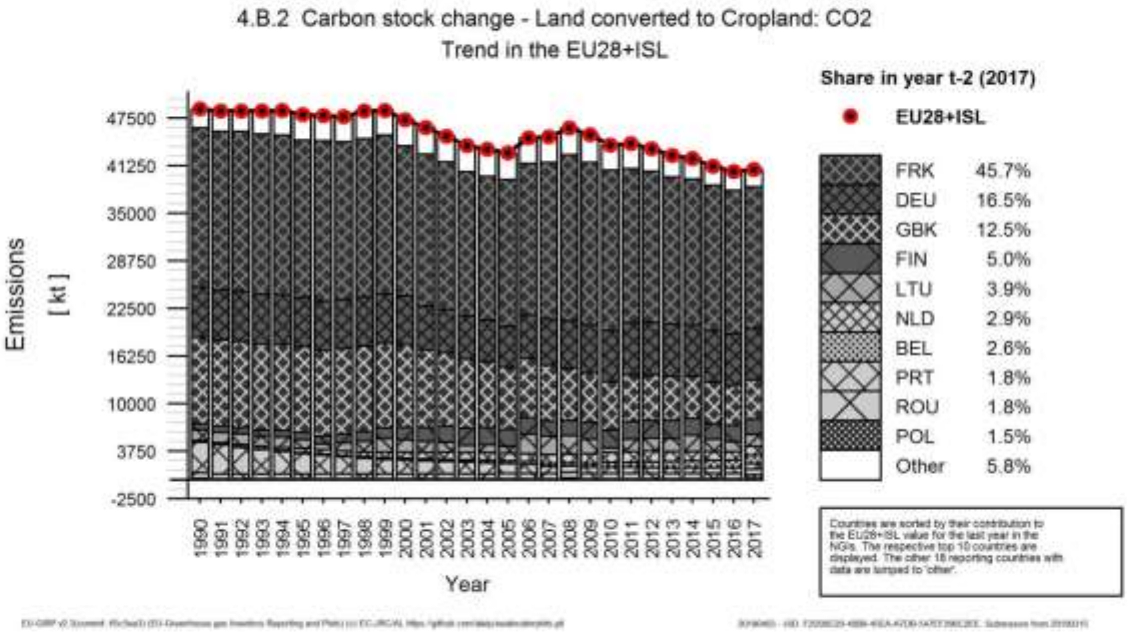
Nevertheless, some individual inventories report this subcategory as a small carbon sink as a result of removals from the living biomass carbon pool when Grassland or Other lands are converted to Croplands with woody vegetation (e.g. Cyprus and Denmark). With some few exceptions, all the other carbon pools have been reported as a net source of emissions.

Table 6. 20 4B2 Land converted to Cropland: MS and Iceland' contributions to net CO_2 emissions (+)/ removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	194	224	244	0.6%	51	26%	21	9%
Belgium	34	1 011	1 079	2.6%	1 045	3111%	68	7%
Bulgaria	37	234	203	0.5%	166	451%	-31	-13%
Croatia	23	22	14	0.0%	-9	-39%	-8	-35%
Cyprus	-4	-27	-24	-0.1%	-21	-533%	3	11%
Czechia	87	27	19	0.0%	-68	-78%	-8	-28%
Denmark	1	47	-13	0.0%	-14	-2046%	-61	-128%
Estonia	NO	60	57	0.1%	57	∞	-2	-4%
Finland	851	2 110	2 055	5.0%	1 204	142%	-55	-3%
France	20 901	18 792	18 619	45.7%	-2 282	-11%	-173	-1%
Germany	6 556	6 794	6 718	16.5%	162	2%	-75	-1%
Greece	52	16	16	0.0%	-36	-70%	0	0%
Hungary	130	340	288	0.7%	158	122%	-52	-15%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	534	146	231	0.6%	-303	-57%	85	58%
Latvia	1	368	388	1.0%	388	45912%	20	6%
Lithuania	1 378	1 299	1 570	3.9%	192	14%	271	21%
Luxembourg	75	31	31	0.1%	-43	-58%	0	1%
Malta	4	3	4	0.0%	0	-2%	0	6%
Netherlands	180	1 119	1 166	2.9%	986	548%	47	4%
Poland	123	63	607	1.5%	484	393%	545	871%
Portugal	4 048	766	752	1.8%	-3 296	-81%	-14	-2%
Romania	742	742	742	1.8%	0	0%	0	0%
Slovakia	466	67	66	0.2%	-400	-86%	-1	-2%
Slovenia	130	21	25	0.1%	-106	-81%	4	19%
Spain	171	714	575	1.4%	404	237%	-140	-20%
Sweden	17	155	143	0.3%	126	757%	-12	-8%
United Kingdom	11 346	5 238	5 092	12.5%	-6 253	-55%	-146	-3%
EU-28	**48 074**	**40 379**	**40 667**	**100%**	**-7 407**	**-15%**	**287**	**1%**
Iceland	635	91	91	0.2%	-544	-86%	0	0%
United Kingdom (KP)	11 346	5 261	5 115	12.5%	-6 231	-55%	-146	-3%
EU-28 + ISL	**48 709**	**40 493**	**40 781**	**100%**	**-7 928**	**-16%**	**288**	**1%**

As in other land use subcategories that involve the conversion of areas, major changes 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 and Netherlands that report a rather constant 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 and UK, which report significant reduction of emissions in this category driven by the same trend in areas.

Figure 6. 10 Trend of emissions (+)/ removals (-) in subcategory 4B2 "Land converted to Cropland" in EU MS and Iceland (kt CO_2, 1990-2017)



Methodological issues for Land converted to Cropland

For estimating and reporting carbon stocks changes in this subcategory, IPCC default methodology is generally used. However, the implementation of country-specific emissions factors or default factors depend on which type of lands is being converted to Cropland and, the carbon pool to be estimated. For instance, concerning the living biomass carbon pool, some MS consider the carbon stocks from one year of growth in Cropland following conversion, while other simply consider the oxidation of all 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 IPPC methodology, MS often apply a 20 years transition period before the carbon stock of the soils converted to Cropland reach and equilibrium.

For this year, improviments have been implemented also in this subcategory, including the use of higher methods, which have resulted in an overall increase of accuracy and completeness of the sector.

Greece used country-specific data for the reporting of DOM from the conversion of Forest land to Cropland. Moreover, Latvia used also country-specific data and Biosoil Project's data to report carbon stock changes from DOM following the conversion from Forest land to Cropland. In adittion, also Poland increased the reporting quality of the category with the inclusion of carbon stock changes in living biomass following the conversion from Grassland to Cropland.

On the contrary, France reports the notation NE for reporting carbon stock change 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.

6.2.3 Grassland (CRF 4C)

6.2.3.1 Overview of Grassland category (CRF 4C)

Under this category are included, among others, natural and artificial meadows, range lands, moors, forage crops, that can be subject to economical 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 forest thresholds.

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 from the emissions reported under Cropland.

Based on individual submissions, total Grassland covers 91.656 Kha in 2017.This represents 20% of the total reported areas. However, as for Cropland, these areas have constantly decreased, and in 2017 it was reported a decrease of 5% compared with the base year.

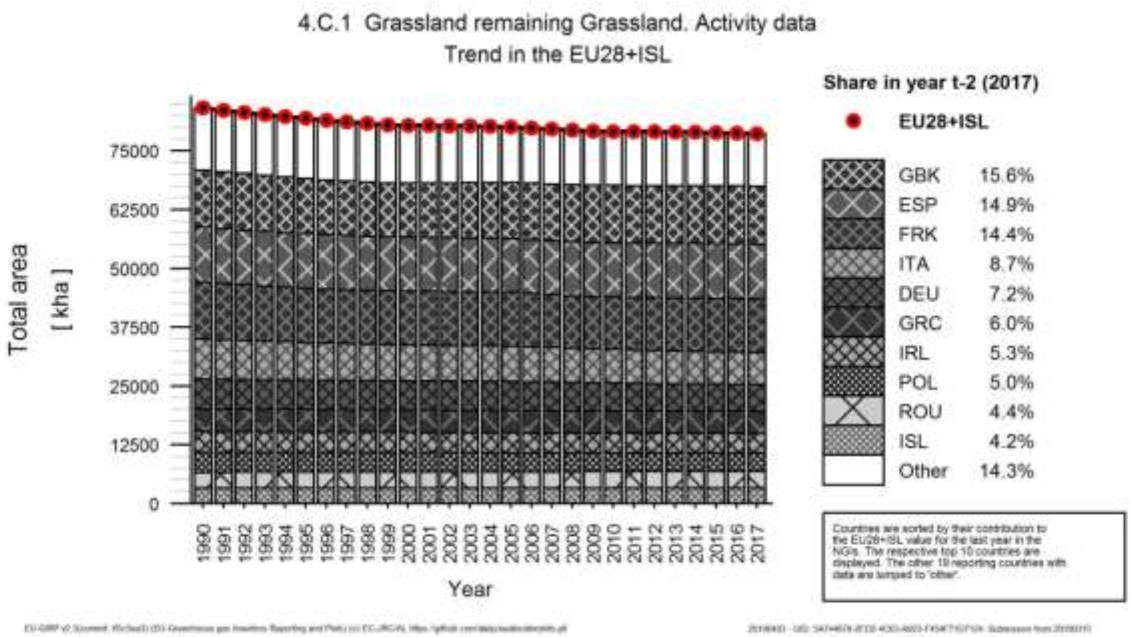
6.2.3.2 Grassland remaining Grassland (CRF 4C1)

Overview of Grassland remaining Grassland category

For the year 2017, total area reported under this subcategory reaches 78.717 Kha. Following the general trend of these lands, this subcategory has also constantly decrease since 1990, and in 2017 it represents 6% less than in 1990 (Figure 6. 11).

UK, Spain and France reported togueter 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 MS and Iceland (kha, 1990-2017)



In terms of emissions, this subcategory has always resulted in a net source at EU level. In 2017, emissions reported reached 34.014 Kt CO_2, which represents a decrease of 29% as compared with the year 1990 (Table 6. 21).

Nevertheless, individual MS have reported this subcategory either as a net source or as a net sink of emissions. As in the case of Cropland areas, the net result of carbon stock changes in Grassland depends on the one hand on whether these areas are subject to agricultural activities, but also, on the presence or absences of significant woody biomass and the intensity and variation of management practices across the years of the time series, and whether they took play in Organic soils.

Table 6. 21 4C1 Grassland remaining Grassland: MS and Iceland' contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

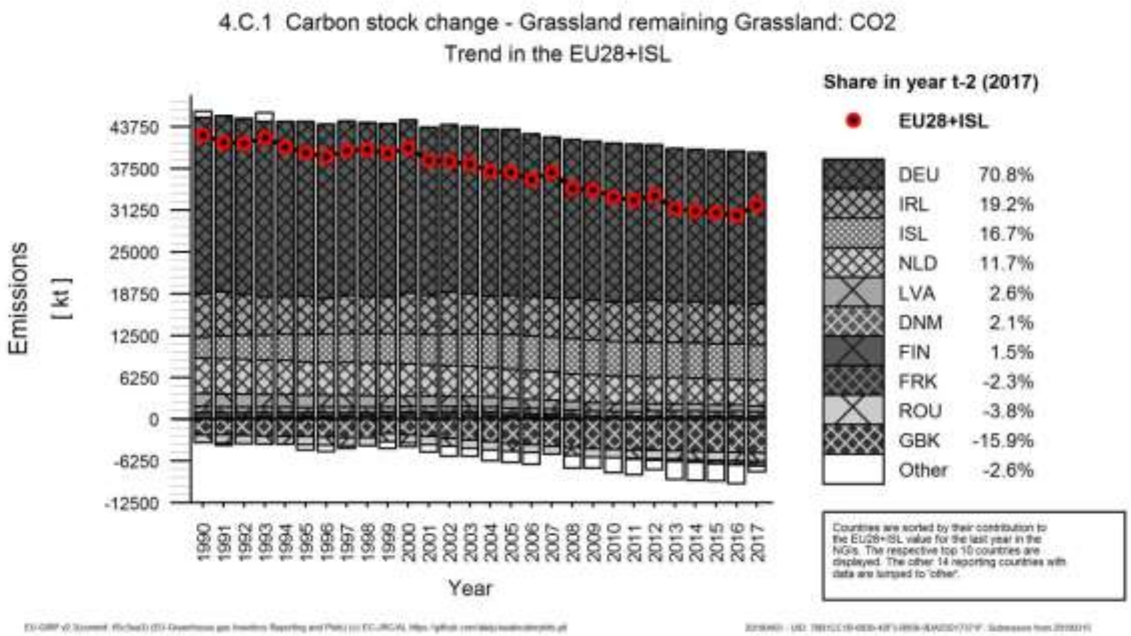
Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	294	296	296	0.9%	2	1%	0	0%
Belgium	-424	-355	-350	-1.0%	74	17%	5	1%
Bulgaria	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Croatia	2	2	2	0.0%	0	0%	0	0%
Cyprus	-134	-118	-118	-0.3%	16	12%	0	0%
Czechia	48	-479	-131	-0.4%	-179	-372%	348	73%
Denmark	914	678	666	2.0%	-248	-27%	-12	-2%
Estonia	55	49	50	0.1%	-5	-8%	1	2%
Finland	728	473	478	1.4%	-250	-34%	5	1%
France	210	-619	-744	-2.2%	-954	-454%	-125	-20%
Germany	26 368	22 729	22 667	66.6%	-3 701	-14%	-62	0%
Greece	0	0	1	0.0%	1	366%	1	413%
Hungary	51	14	0	0.0%	-51	-100%	-14	-100%
Ireland	6 509	6 119	6 139	18.0%	-370	-6%	20	0%
Italy	5 268	-673	1 895	5.6%	-3 373	-64%	2 568	382%
Latvia	1 951	980	847	2.5%	-1 104	-57%	-134	-14%
Lithuania	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	-2	0	0	0.0%	2	91%	0	25%
Netherlands	5 317	3 802	3 761	11.1%	-1 556	-29%	-41	-1%
Poland	979	329	460	1.4%	-518	-53%	131	40%
Portugal	NO	-405	-437	-1.3%	-437	-∞	-31	-8%
Romania	-1 222	-1 222	-1 222	-3.6%	0	0%	0	0%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	162	-342	-332	-1.0%	-494	-305%	10	3%
Spain	NO,NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
Sweden	-193	-179	-183	-0.5%	10	5%	-4	-2%
United Kingdom	-2 344	-5 011	-5 082	-14.9%	-2 738	-117%	-71	-1%
EU-28	**44 537**	**26 068**	**28 663**	**84%**	**-15 874**	**-36%**	**2 595**	**10%**
Iceland	3 130	5 325	5 351	15.7%	2 220	71%	26	0%
United Kingdom (KP)	-2 344	-5 011	-5 082	-14.9%	-2 738	-117%	-71	-1%
EU-28 + ISL	**47 667**	**31 393**	**34 014**	**100%**	**-13 654**	**-29%**	**2 621**	**8%**

The EU trend in emissions from this subcategory is well affected by Germany, Ireland, Iceland and Netherlands (Figure 6. 12). While for some of these MS, the overall share in areas of grassland remaining grassland areas is not significant at EU level, all of them report important areas of grasslands managed in organic soils that generate significant of emissions.

By contrary some others MS have reported this subcategory as a net carbon sink. For instance, Romania that reports significant carbon sink from woody vegetation on grassland areas or UK that reports a significant net sink from mineral soils.

In some Mediterranean countries, as in the case of Italy, inter-annual variability is driven wildfires affecting woody biomass in grassland areas.

Figure 6. 12 Trend of emissions (+)/removals (-) in subcategory 4C1 "Grassland remaining Grassland" in EU MS and Iceland (kt CO_2, 1990-2017)



Methodological issues for Grassland remaining Grassland category

Despite different eco-regions and management approaches existing among the countries, definitions provided by MS and Iceland of Grassland category show good match with the IPCC land use definition (Table 6. 22). One of the most significant differences that should be considered when comparing implied emissions factor is the presence or absence of reported unmanaged grassland.

In general, there are a wide-spread use of Tier 1 method for reporting carbon stock changes in living biomass and dead organic matter, which assumes no carbon stock changes for these pools (e.g. Spain, Bulgaria, and Slovenia). However, some MS 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 MS have demonstrated that there are no changes over the time in the type of management practices that impact the carbon storage in the soils, or the absence of managed soils (e.g. Spain, Bulgaria, Lithuania and Slovenia). In these cases, MS have not provided quantitative estimates, and the notation keys were used instead. However, some others MS report this carbon pool by using IPCC methodology, with country-specific or default data.

For those MS that report presence of organic soils areas under grassland, this carbon pool has been always reported as a net source of emissions (Table 6. 23).

Table 6. 22 Definitions of lands included by MS and Iceland under the category 4C: Grasslands

MS	***Definition***
Austria	Meadows cut once/twice/several times, cultivated pastures, litter meadows, rough pastures, alpine meadows and pastures and abandoned grassland.
Belgium	Rangelands and pasture land 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 pasture land 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 main land-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.
Italy	Grazing lands, forage crops, permanent pastures, and set-aside lands since 1970, all shrub lands (data derived from NFI) and other woodlands that don’t fulfil forest definition.

MS	Definition
Latvia	The grassland category consists of lands used as pastures, as well as glades and bush-land 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 are 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	Pasture land, 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. 23 Implied net carbon stock change factors for carbon pools in 4C1 (t C ha-1 yr-1) reported by individual submissions in GHGI 2018.

Member States	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	2017	1990	2017	1990	2017	1990	2017
AUT	NO	NO	NO	NO	0.002	0.002	-6.402	-6.402
BEL	NO	NO	NO	NO	0.156	0.213	-1.521	-1.891
BGR	NE	NE	NE	NE	NE	NE	NO	NO
HRV	NO	NO	NO	NO	NO	NO	-2.500	-2.500
CYP	0.241	0.247	NO	NO	NO	NO	NO	NO
CZE	NO	NO	NO	NO	-0.017	0.040	NO	NO
DNM	-0.027	-0.088	NO	NO	IE	IE	-6.790	-6.746
EST	0.001	0.001	NO	NO	NO	NO	-0.340	-0.331
FIN	0.306	0.303	NE	NE	NA	NA	-3.500	-3.500
FRK	-0.006	0.022	NE	NE	0.001	-0.004	IE	IE
DEU	-0.011	0.032	NO	NO	0.002	-0.002	-6.341	-6.175
GRC	0.000	0.000	NO	NO	NO	NO	NO	NO
HUN	NO	NO	NO	NO	-0.011	0.000	NO	NO
IRL	NO	NO	NO	NO	-0.009	0.137	-4.668	-6.579
ITA	-0.011	0.000	0.004	0.004	NA,NO	NO,NA	-2.500	-2.500
LVA	0.007	0.083	0.001	0.007	NA	NA	-6.100	-6.100
LTU	NO	NO	NO	NO	NO	NO	IE	IE
LUX	NO	NO	NO	NO	NO	NO	NO	NO
MLT	0.000	0.000	NE	NE	0.032	0.004	NO	NO
NLD	0.006	0.003	NO	NO	0.000	0.003	-4.556	-4.586
POL	NO	NO	NO	NO	-0.047	-0.022	-0.250	-0.250
PRT	NO	NO	NO	NO	NO	0.263	NO	NO
ROU	0.098	0.095	NE	NE	NE	NE	0.250	0.250
SVK	NO	NO	NO	NO	NO	NO	NO	NO
SVN	-0.088	0.241	NO	NO	-0.006	0.024	NO	NO
ESP	NE	NE	NA	NA	NE	NE	NO	NO
SWE	0.155	0.250	0.136	0.171	-0.058	-0.181	-1.311	-1.696
GBR	0.015	-0.001	NO	NO	0.042	0.126	NO,IE	NO,IE

Member States	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	2017	1990	2017	1990	2017	1990	2017
ISL	0.000	0.001	0.000	0.000	0.000	0.000	-5.691	-5.690

6.2.3.3 Land converted to Grassland (CRF 4C2)

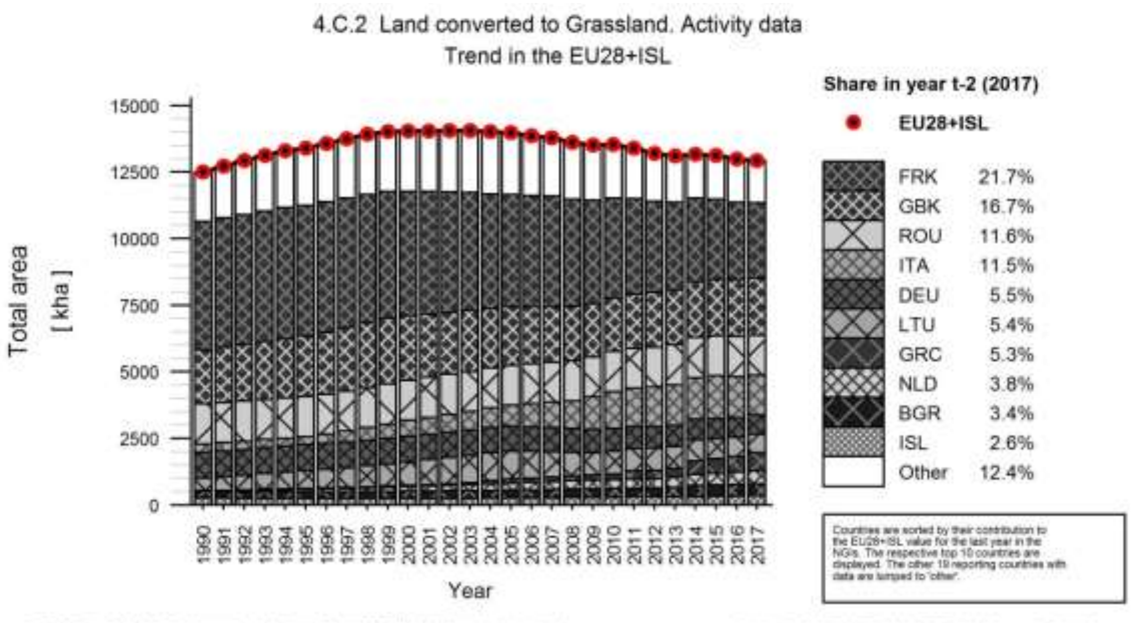
Overview of Land converted to Grassland category

In terms of area, this subcategory represents 14% of the total grassland areas, however the carbon sink reported offsets about 63% of the emissions resulting from grassland remaining grassland.

The area reported under this subcategory for the year 2017 reaches 12.939 Kha, which represents an increase of 3% 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 are France, UK, Romania and Italy that together report more that 60% of the total are converted to Grassland.

Figure 6. 13 Trend of activity data in subcategory 4C2 "Land converted to Grassland" in EU MS and Iceland (kha, 1990-2017)



In term of emissions, for the year 2017, lands in conversion to Grassland represent a total net sink of 22.191 kt CO_2 that results in an increase of about 33% compared to the year 1990 (Table 6. 24).

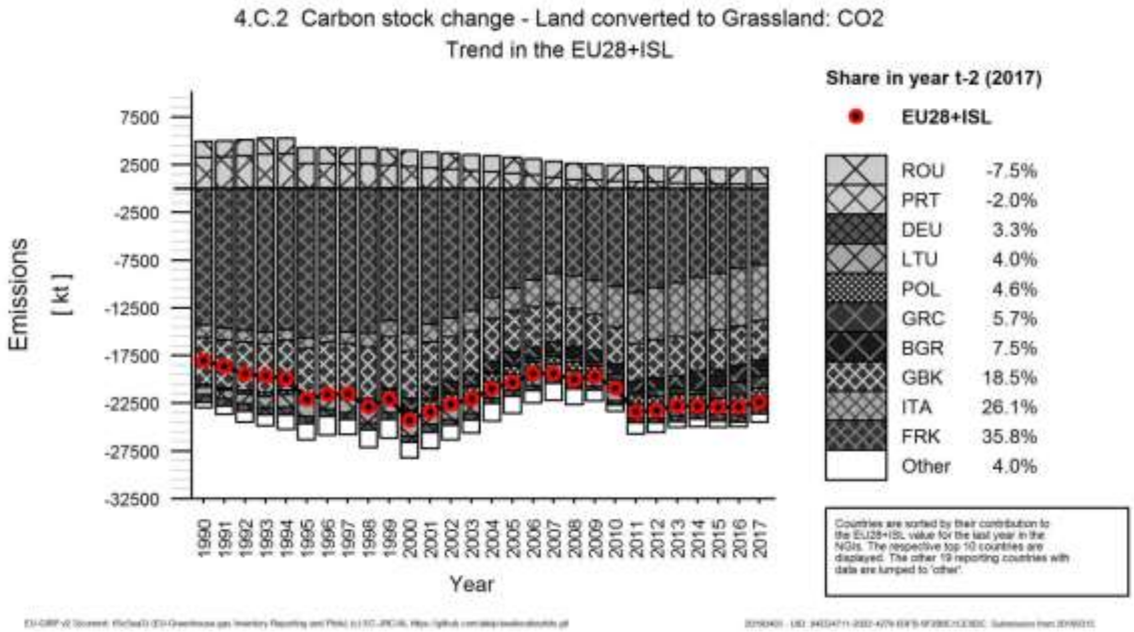
The trend in GHG emissions for this subcategory is driven by France, Italy and UK that report a significant carbon sink on mineral soils a result of the conversion of croplands areas to grassland. By contrary, final net emissions from this subcategory, as it has been reported for several MS (e.g. Romania and Sweden), are associated with emissions from the conversion of Forest land, and to a lesser extent, from woody crops, to Grassland.

Table 6. 24 4C2 Land converted to Grassland: MS and Iceland' contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	332	37	19	-0.1%	-313	-94%	-18	-48%
Belgium	50	-271	-313	1.4%	-364	-723%	-43	-16%
Bulgaria	27	-1 768	-1 687	7.6%	-1 714	-6433%	81	5%
Croatia	-104	-218	-163	0.7%	-59	-56%	55	25%
Cyprus	NO,NE	-6	-6	0.0%	-6	-∞	0	-3%
Czechia	-188	-255	-248	1.1%	-59	-32%	7	3%
Denmark	2	78	52	-0.2%	49	2104%	-27	-34%
Estonia	1	-5	-12	0.1%	-14	-1080%	-8	-165%
Finland	172	188	153	-0.7%	-19	-11%	-35	-18%
France	-14 317	-8 397	-8 011	36.1%	6 306	44%	386	5%
Germany	-825	-732	-732	3.3%	93	11%	0	0%
Greece	0.03	-1 393	-1 277	5.8%	-1 277	-4552565%	116	8%
Hungary	-36	-136	-359	1.6%	-323	-903%	-222	-163%
Ireland	3	24	5	0.0%	2	82%	-19	-78%
Italy	-1 275	-6 070	-5 834	26.3%	-4 559	-358%	237	4%
Latvia	13	46	47	-0.2%	34	269%	1	3%
Lithuania	-787	-802	-904	4.1%	-117	-15%	-102	-13%
Luxembourg	32	-43	-43	0.2%	-74	-235%	0	0%
Malta	-3	0	0	0.0%	3	91%	0	25%
Netherlands	220	7	-47	0.2%	-268	-121%	-54	-787%
Poland	-259	-1 265	-1 027	4.6%	-768	-297%	238	19%
Portugal	3 228	461	450	-2.0%	-2 778	-86%	-11	-2%
Romania	1 676	1 676	1 676	-7.6%	0	0%	0	0%
Slovakia	-206	-179	-165	0.7%	41	20%	14	8%
Slovenia	-352	-22	-12	0.1%	339	96%	9	43%
Spain	-2 696	-212	-85	0.4%	2 611	97%	127	60%
Sweden	498	403	250	-1.1%	-248	-50%	-153	-38%
United Kingdom	-4 935	-3 797	-3 929	17.7%	1 007	20%	-132	-3%
EU-28	**-19 730**	**-22 650**	**-22 203**	**100%**	**-2 473**	**-13%**	**447**	**2%**
Iceland	1 757	60	40	-0.2%	-1 717	-98%	-20	-34%
United Kingdom (KP)	-4 943	-3 821	-3 957	17.8%	987	20%	-136	-4%
EU-28 + ISL	**-17 981**	**-22 614**	**-22 191**	**100%**	**-4 210**	**-23%**	**423**	**2%**

Major changes in the time series of emissions from Land converted to Grassland have been reported by Greece and Bulgaria as driven by the activity data. Specifically by the abandonment of cropland areas that resulted in an increase of grassland areas and consequently in a larger carbon sink reported in mineral soils at the end of the time series as compared with the base year.

Figure 6. 14 Trend of emissions (+)/removals (-) in subcategory 4C2 "Land converted to Grassland" in EU MS and Iceland (kt CO_2, 1990-2017)



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 is being converted to Grassland and, the carbon pool that is being estimated. For instance, while some MS only consider a gross quantity of carbon loss from the conversion of forest lands to grassland, some other provide a net estimate on this carbon pool, by considering also one year of growth after the establishment of the grass.

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 IPPC methodology, MS often apply a 20 years 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, Wetlands represents 24.933 Kha, which is 5% of the total area reported at the level of EU and Iceland. As compared with the base year, the category has shown a constant trend, slightly increasing by 2%.

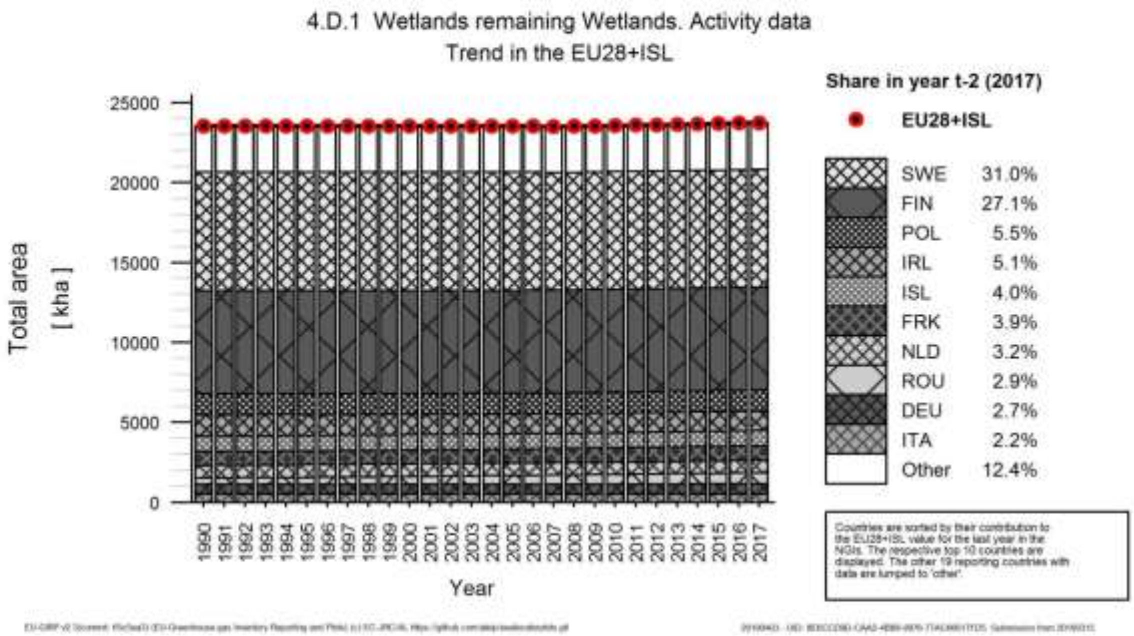
The trend in areas is strongly dominated by Sweden and Finland which, as the other inventories, have reported rather constant values across the time series, at least, as regards to the dominant subcategory of wetlands remaining wetlands (Figure 6. 155).

In terms of emissions, Wetlands remaining Wetlands reaches for the year 2017 about 10.728 kt CO_2. Both sub-categories, 4D1 and 4D2, have been in overall reported as a net source of emissions resulting mostly from MS managing peatland areas. Nevertheless, in some instances, they have been also reported as a net carbon sink

Indeed, the main driver of emissions is represented by peat extraction which, even if affecting small areas, has a big impact on final emissions. Within the EU, Poland, Germany, Ireland and Finland are the main drivers of the trend in emissions

By contrary, an exception is given by Iceland under 4D1, which reports a significant amount of GHG removals as a result of intact mires.

Figure 6. 155 Trend of activity data and emissions (+)/removals (-) in subcategory 4D1 "Wetlands remaining Wetlands" in EU MS and Iceland (kha, Kt CO_2, 1990-2017)



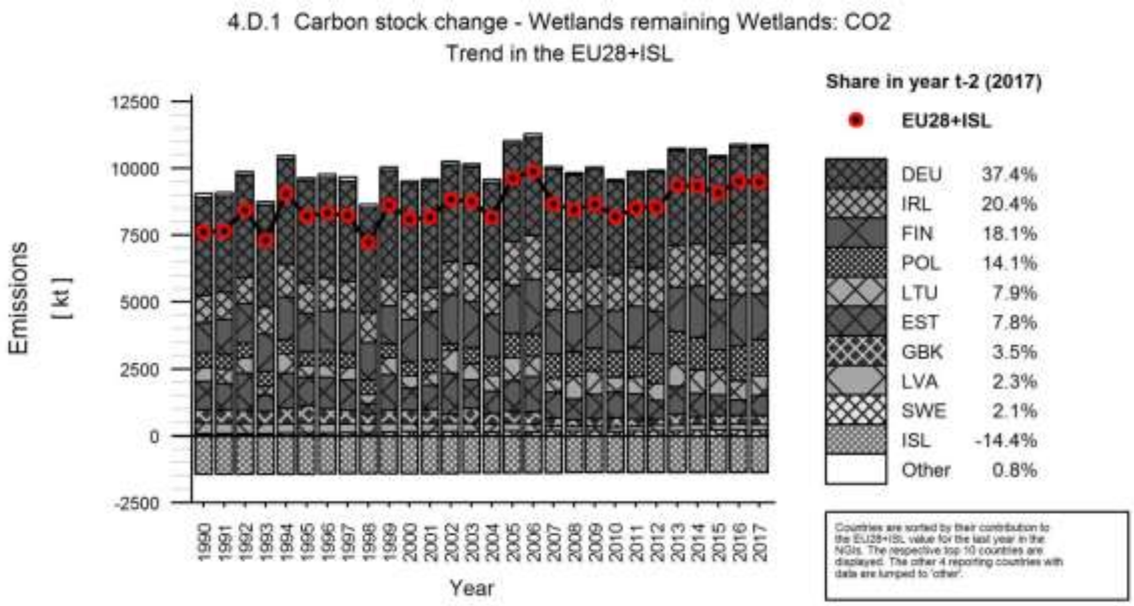

4.D.1 Carbon stock change - Wetlands remaining Wetlands: CO2
Trend in the EU28+ISL
Share in year t-2 (2017)
EU28+ISL
DEU 37.4%
IRL 20.4%
FIN 18.1%
POL 14.1%
LTU 7.9%
EST 7.8%
GBK 3.5%
LVA 2.3%
SWE 2.1%
ISL -14.4%
Other 0.8%
Countries are sorted by their contribution to the EU28+ISL value for the last year in the NGIs. The respective top 10 countries are displayed. The other 4 reporting countries with data are lumped to 'other'.
Emissions
[kt]
12500
10000
7500
5000
2500
0
-2500
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year

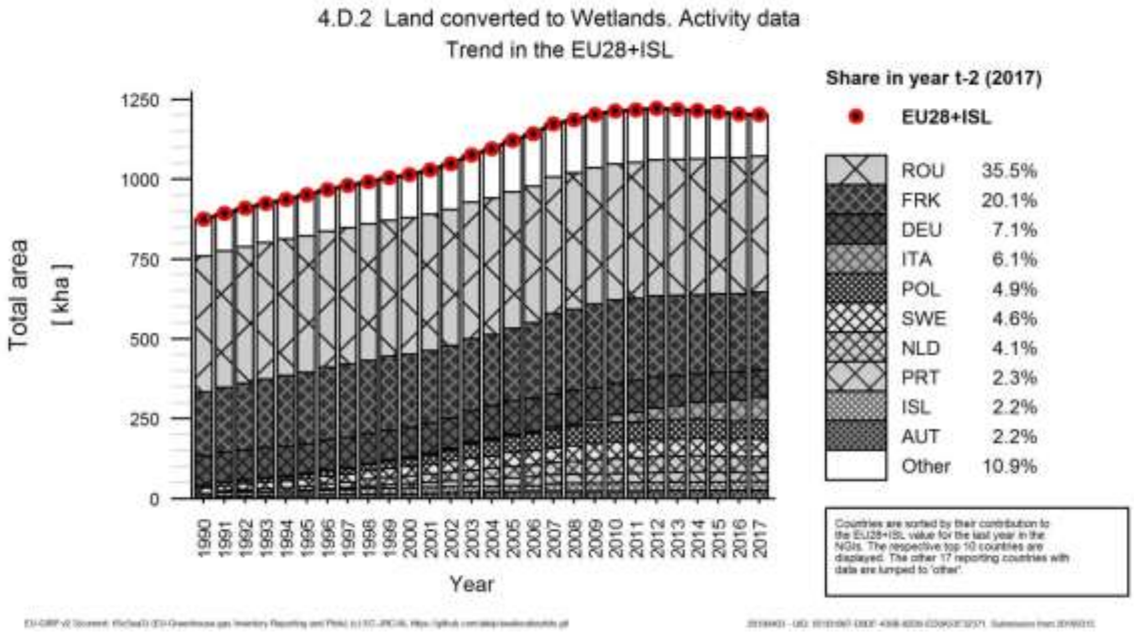
Table 6. 25 CO_2 Emissions and removals from 4.D.1 wetlands remaining wetlands contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		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	NO	NO	NO	-	-	-	-	-
Denmark	100	42	31	0.3%	-69	-69%	-12	-28%
Estonia	1 064	588	746	7.0%	-318	-30%	158	27%
Finland	1 138	1 922	1 717	16.0%	579	51%	-205	-11%
France	NO,NE,IE	NO,NE,IE	NO,NE,IE	-	-	-	-	-
Germany	3 675	3 604	3 551	33.1%	-124	-3%	-53	-1%
Greece	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Hungary	10	6	0	0.0%	-10	-100%	-6	-100%
Ireland	1 388	1 975	3 167	29.5%	1 779	128%	1 192	60%
Italy	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Latvia	408	230	220	2.0%	-188	-46%	-10	-4%
Lithuania	517	715	747	7.0%	230	44%	32	4%
Luxembourg	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Malta	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Netherlands	NO,NE,IE	-2	-2	0.0%	-2	-∞	0	-1%
Poland	536	1 298	1 342	12.5%	806	150%	44	3%
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Spain	31	50	50	0.5%	19	63%	0	0%
Sweden	73	206	195	1.8%	122	166%	-11	-5%
United Kingdom	487	313	337	3.1%	-150	-31%	24	8%
EU-28	**9 426**	**10 947**	**12 100**	**113%**	**2 674**	**28%**	**1 153**	**11%**
Iceland	-1 433	-1 373	-1 372	-12.8%	61	4%	1	0%
United Kingdom (KP)	487	313	337	3.1%	-150	-31%	24	8%
EU-28 + ISL	**7 993**	**9 574**	**10 728**	**100%**	**2 735**	**34%**	**1 154**	**12%**

The other subcategory, land converted to wetlands, represents only 5% of the wetlands area but results in about 30% of the final net emissions reported within the category. For the year 2017, the category has reached respectively 1.203 Kha, and 4.061 kt CO_2

However, these areas that are dominated, in overall, by Romania and France, have increased by 32%, as compared with 1990, mainly driven by new areas reported by Sweden, Poland and Italy in the second half of the time series. (Figure 6.17). However, they are not always linked to carbon stock changes. This fact is due to that new wetlands 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 MS and Iceland (kha, Kt CO_2, 1990-2017)



Emissions in this subcategory are mainly reported by Romania and France as a result of the loss of carbon from living biomass existing before the conversion to wetlands.

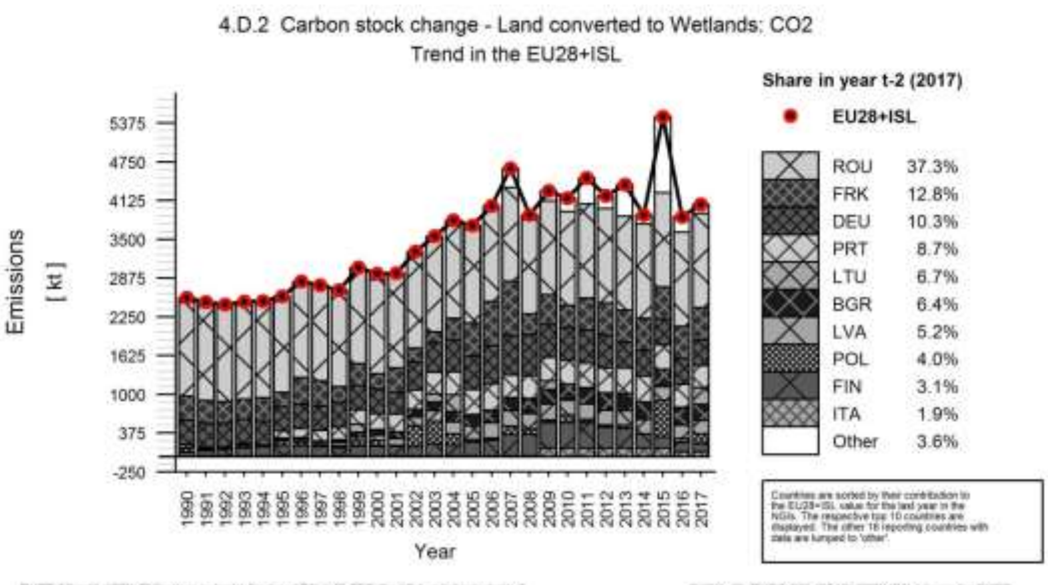


Table 6. 26 CO_2 Emissions and removals from 4.D.2 land converted to wetlands contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	42	77	67	1.7%	25	59%	-10	-13%
Belgium	13	-10	-10	-0.2%	-23	-172%	0	1%
Bulgaria	IE,NO	272	260	6.4%	260	∞	-13	-5%
Croatia	47	11	9	0.2%	-38	-81%	-2	-17%
Cyprus	-1	-11	-10	-0.2%	-9	-864%	1	8%
Czechia	22	26	21	0.5%	-1	-4%	-5	-18%
Denmark	1	-2	-1	0.0%	-2	-163%	1	65%
Estonia	8	13	3	0.1%	-4	-59%	-9	-75%
Finland	65	147	126	3.1%	60	92%	-21	-14%
France	386	519	519	12.8%	133	34%	0	0%
Germany	389	416	418	10.3%	29	7%	2	0%
Greece	NO	0	0	0.0%	0	∞	0	-54%
Hungary	3	-1	-1	0.0%	-4	-121%	0	0%
Ireland	NO,IE	100	11	0.3%	11	∞	-89	-89%
Italy	NO	79	79	1.9%	79	∞	0	0%
Latvia	4	219	212	5.2%	208	4987%	-7	-3%
Lithuania	56	9	271	6.7%	215	383%	262	2801%
Luxembourg	15	5	4	0.1%	-11	-72%	-1	-11%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	87	44	40	1.0%	-47	-54%	-4	-9%
Poland	66	60	161	4.0%	95	144%	101	168%
Portugal	NO,IE	374	353	8.7%	353	∞	-21	-6%
Romania	1 516	1 516	1 516	37.3%	0	0%	0	0%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	3	2	2	0.0%	-1	-40%	0	-5%
Spain	-167	-7	5	0.1%	172	103%	12	175%
Sweden	NO,NA	NO,NA	NO,NA	-	-	-	-	-
United Kingdom	0	0	0	0.0%	0	123%	0	3585%
EU-28	**2 555**	**3 858**	**4 055**	**100%**	**1 500**	**59%**	**197**	**5%**
Iceland	0	6	6	0.1%	5	1093%	0	-2%
United Kingdom (KP)	0	0	0	0.0%	0	123%	0	3585%
EU-28 + ISL	**2 556**	**3 864**	**4 061**	**100%**	**1 506**	**59%**	**197**	**5%**

Under this category, MS 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.

Table 6. 27 Definitions of lands included by MS and Iceland under the category 4D: Wetlands

MS	***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 water-courses 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), river bed (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 water-courses 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.

MS	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 29.942 kha, which is 7% of the total reported areas. For the 2017, Settlements areas have resulted in an increase of 26 % as compared with 1990.

The expansion of these areas, which generally include urban areas, either sealed or unsealed, transport infrastructures, and industrial and commercial units, has been driven by the abandonment of agricultural lands.

In terms of emissions this land use category is reported as a net source that reaches, in 2017, 44.746 Kt CO_2. Out of this, 92% are due to emissions resulting from Land converted to Settlement, which although in term of areas it represents only 21% of the total category, it results in significant emissions when forest, other woody lands, or high- carbon content soils are disturbed and converted to urban areas.

Definitions of lands included under this category vary across individual inventories (Table 6. 28).

Table 6. 28 Definitions of lands included by MS and Iceland under the category 4E: Settlements

MS	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 road sides) 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.
Czech Republic	Settlements include two categories built-up areas and courtyards and other lands. Other lands includes 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 fire-breaks; 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.

MS	*Definition*
Luxemburg	Developed land, including transportation and any size of human settlement unless already included under other category.
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.

MS	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”.

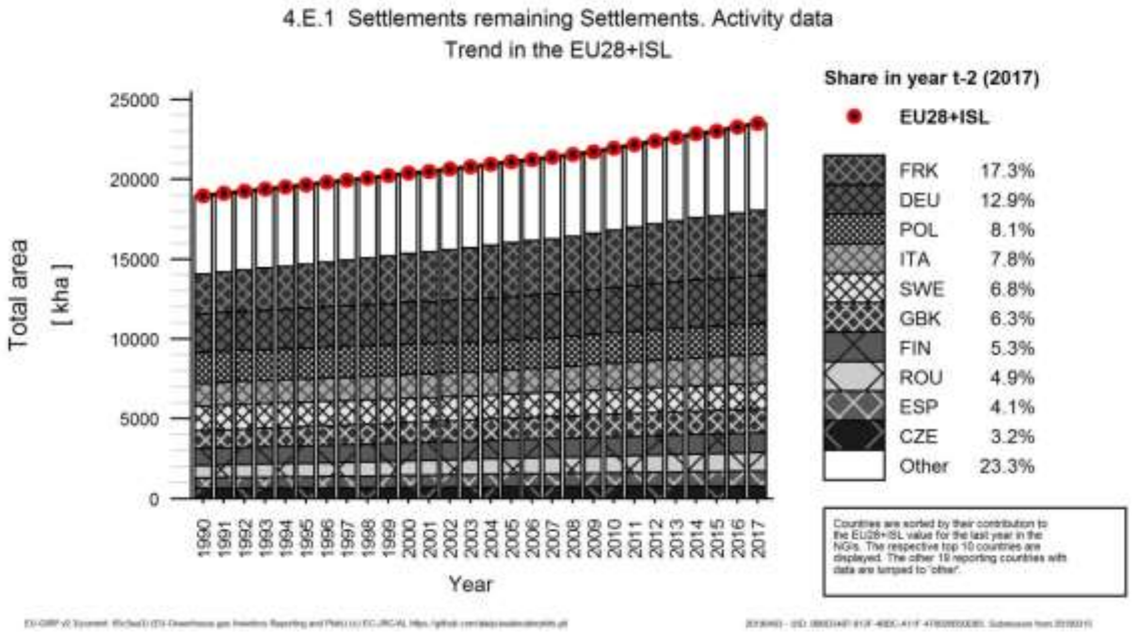
As regards with the methods used for reporting carbon stock changes in these areas, many MS have used the Tier 1 assumption of equilibrium under the subcategory 4E1, therefore no carbon stock changes are reported, and the notation key NO is therefore included in the CRF tables.

Nevertheless, few MS have reported this subcategory as a net source of emissions. For instance, Germany, France and Netherlands that have reported emissions as a result of disturbed organic soils in these areas, or UK from disturbed mineral soils.

By contrary, Latvia, Poland and Slovenia have reported the subcategory 4E1 as a net sink of carbon due to carbon removals 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. Carbon stock changes in living and dead biomass 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 increase of age and gross increment of trees growing on settlements, as well as area of settlements covered by woody vegetation. Reduction of increment in 2017 is result of changes in age structure of woody vegetation, respectively, due to more intensive extraction of trees in settlements like roadsides, buffer zones of drainage ditches and other settlements. The losses due to extraction of wood in settlements is 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 MS and Iceland (kha, kt CO_2 1990-2017)



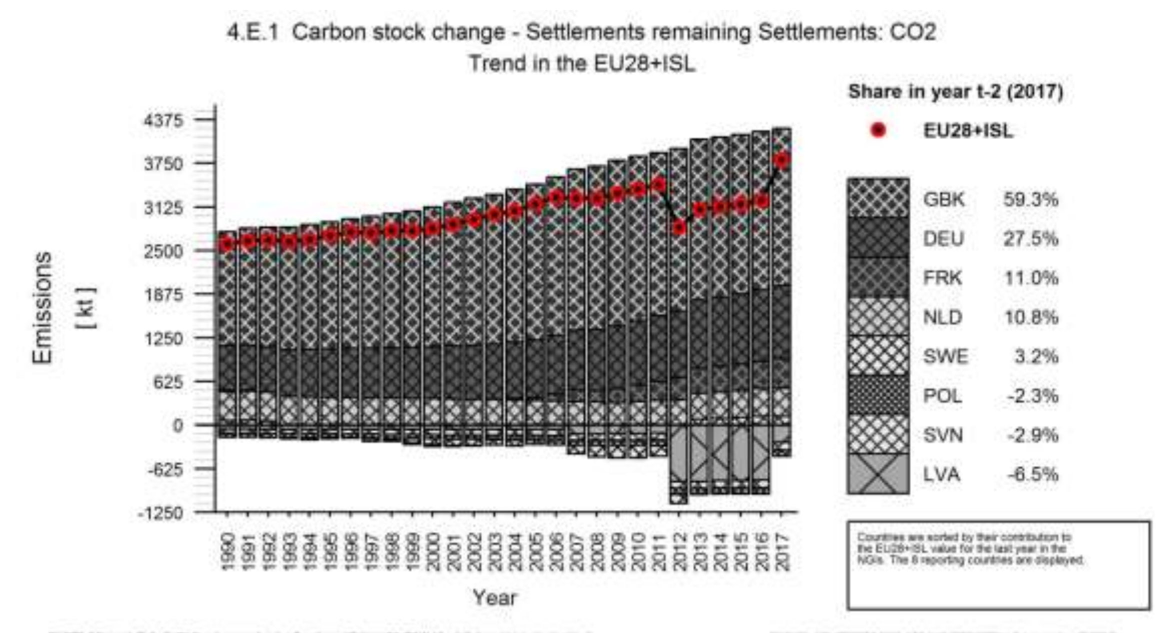
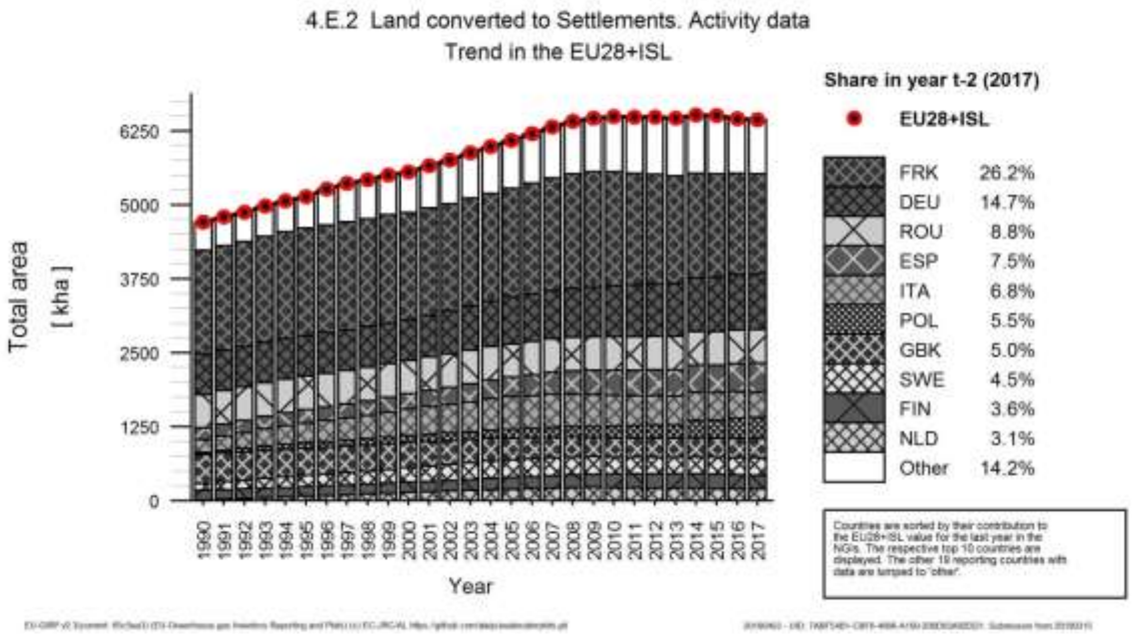
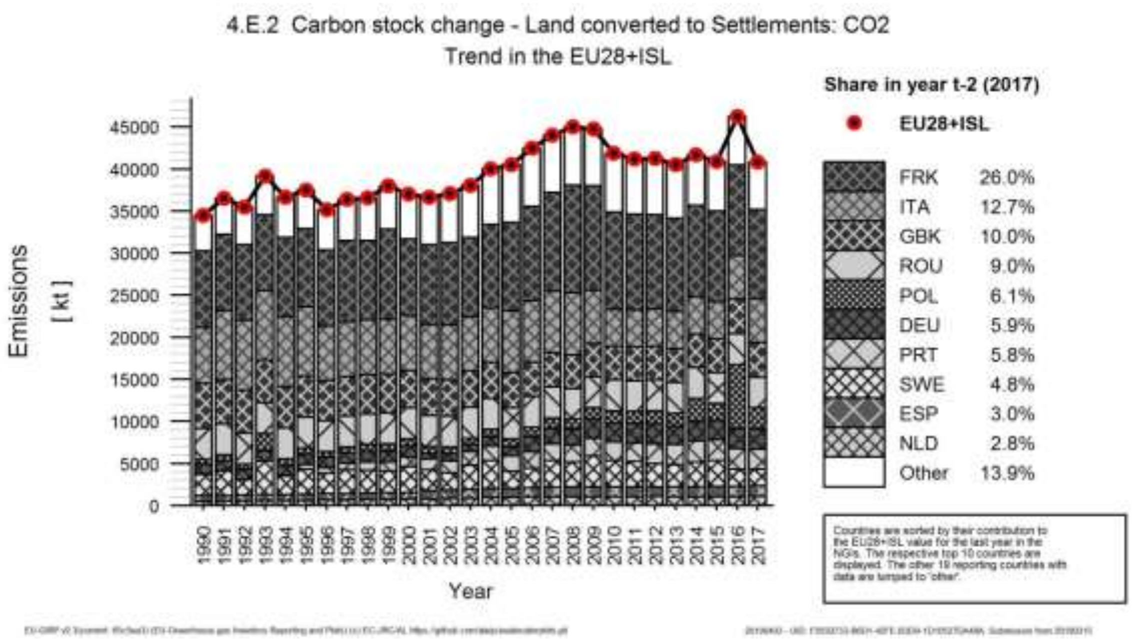


Figure 6. 18 Trend of activity data and emissions (+)/removals (-) in subcategory 4E2 "Land converted to Settlements" in EU 28 and Iceland (kha, kt CO_2 1990-2017)





As regards, with the subcategory 4E2, annual emissions from Land converted to Settlements have increased by 18% since 1990 (Table 6. 29). For the year 2017 this subcategory was reported as a net source of emissions reaching 40.831 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 (France, Italy, Romania and UK). In fact, the conversion of forests in Settlements is an important component of the total deforestation, being around 30% of total area reported as deforested; and 15% of the Land converted to Settlements. While conversions to Wetlands and 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 sealed, 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. 29 4E2 Land converted to Settlements: MS and Iceland' contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	570	394	389	1.0%	-181	-32%	-5	-1%
Belgium	146	728	749	1.8%	603	412%	21	3%
Bulgaria	469	775	788	1.9%	319	68%	13	2%
Croatia	166	533	535	1.3%	369	223%	2	0%
Cyprus	2	20	20	0.0%	18	1044%	0	0%
Czechia	1 035	536	584	1.4%	-451	-44%	48	9%
Denmark	17	131	68	0.2%	52	311%	-62	-48%
Estonia	NO	257	218	0.5%	218	∞	-39	-15%
Finland	865	720	687	1.7%	-178	-21%	-33	-5%
France	9 108	10 712	10 618	26.0%	1 510	17%	-94	-1%
Germany	1 174	2 342	2 427	5.9%	1 253	107%	85	4%
Greece	50	134	131	0.3%	82	164%	-2	-2%
Hungary	110	213	183	0.4%	73	66%	-30	-14%
Ireland	80	72	101	0.2%	21	26%	29	41%
Italy	6 639	5 176	5 178	12.7%	-1 461	-22%	2	0%
Latvia	23	216	220	0.5%	197	843%	4	2%
Lithuania	15	652	549	1.3%	533	3482%	-104	-16%
Luxembourg	145	62	58	0.1%	-87	-60%	-3	-5%
Malta	4	1	1	0.0%	-3	-80%	0	-13%
Netherlands	494	1 071	1 124	2.8%	630	128%	53	5%
Poland	562	7 649	2 481	6.1%	1 920	342%	-5 168	-68%
Portugal	30	2 412	2 366	5.8%	2 336	7661%	-46	-2%
Romania	3 682	3 682	3 682	9.0%	0	0%	0	0%
Slovakia	96	80	98	0.2%	3	3%	19	23%
Slovenia	461	307	289	0.7%	-172	-37%	-19	-6%
Spain	657	1 207	1 221	3.0%	564	86%	14	1%
Sweden	2 542	2 051	1 973	4.8%	-569	-22%	-78	-4%
United Kingdom	5 324	4 104	4 061	9.9%	-1 263	-24%	-43	-1%
EU-28	**34 466**	**46 235**	**40 800**	**100%**	**6 334**	**18%**	**-5 435**	**-12%**
Iceland	24	6	6	0.0%	-18	-75%	0	0%
United Kingdom (KP)	5 342	4 130	4 086	10.0%	-1 256	-24%	-44	-1%
EU-28 + ISL	**34 508**	**46 267**	**40 831**	**100%**	**6 323**	**18%**	**-5 435**	**-12%**

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 larger carbon stock and therefore a more carbon lost from their conversions.

Noteworthy is also Poland that 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 rates.

For reporting carbon stock changes in dead organic matter, it is generally assumed that the 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 per area average carbon stock of these carbon pools determined either at national or regional scale or specific to each deforestation site.

For reporting soils organic matter different assumptions have been implemented by MS, generally based on expert judgment or, occasionally, from some scientific studies. For instance, in Sweden carbon stock in Settlements is estimated as the weighted average of carbon stocks in two strata: unsealed and sealed. Unsealed area is usually considered to cover 40-60% of national settlements area (e.g. Austria, Luxembourg), going down to 2-3% in 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 for the year 2017, 18.082 Kha, which represents about 4% of the total reported areas. This land use category has been reported rather constant across the time series as a result of the balance among the decrease in the subcategory 4F1 and the increase in the subcategory 4F2 (Figure 6. 19).

Main 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 but without a common pattern on the origin of these lands.

In terms of emissions, Inter-annual variation 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 plays also an important role at the beginning of the time series. Consequently, this category is reported as a net source of emissions for the year 1990, 1991 and 1992 due to the loss of carbon in living biomass, and then, as a net sink of carbon, which increase until 2009 and then decrease, following the trend in agricultural areas. 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 a significant amount of 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 there and the area was reclassified as Other land. Ireland has informed that a process is ongoing to improve the reporting of these areas.

Finally, Bulgaria calculates the area in this category as the difference of the area of all land-use categories and the whole area of the country, so intended 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, Bulgaria reports a leap on activity data and associated emissions of "Land converted to Other Land" that is reflected in the EU trend.

Definitions of Other land are close among MS and match in overall IPCC general description (Table 6. 30). In most of the cases, following the IPCC approach, this category is used to ensure that total area reported under LULUCF is constant along the time series, and it matches official country area. To this aim, this land category has the lower level of hierarchy and it includes all the areas that were not identified under any other land use category, that are in all the 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. But furthermore, Finland, UK and Portugal were requested to confirm that all the areas included in this category are unmanaged.

As regards with Finland, which includes under this category "mineral soils on poorly productive forest lands" it should be noted that such lands correspond with a national defined category of its National forest inventory that are unmanaged. That areas do not fulfil the threshold values for Forest Land and does 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. And that contain unmanaged land that include inland rock, standing water and canals and rivers and streams broad habitat types that do not falls in Wetlands.

A particular case is given by Portugal that included under this category shrubland areas. This country specific definition, although different than 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 next submission, as an interim solution, in 2019 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.

Table 6. 30 Definitions of lands included by MS and Iceland under the category 4F: Other lands

MS	***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).
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.

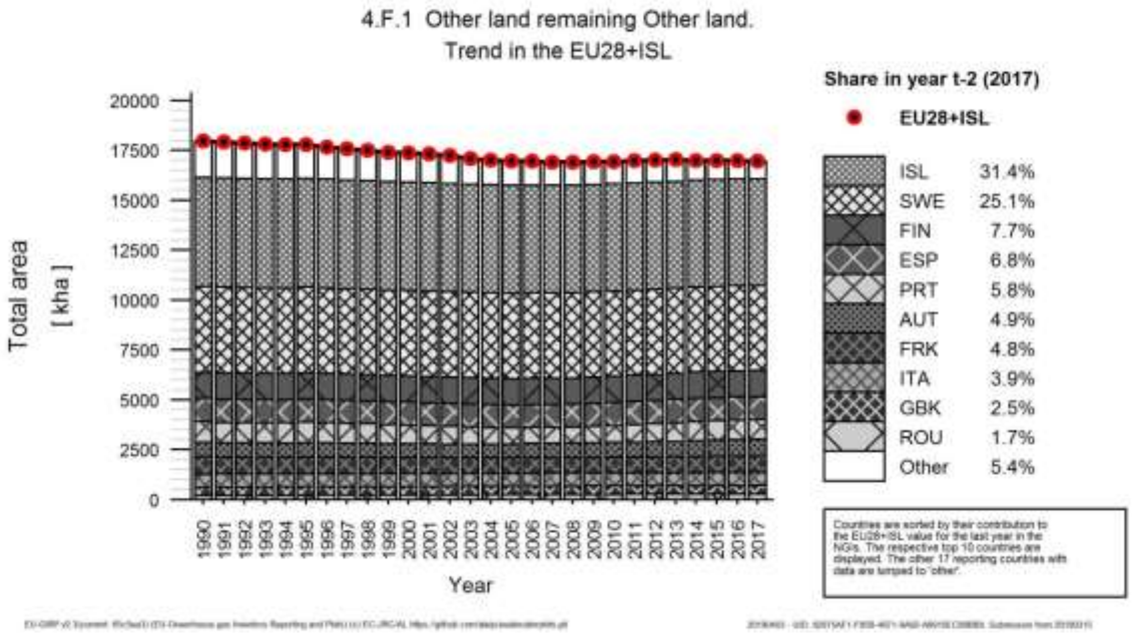
MS	Definition
Romania	Other land includes following categories: rocky areas, excavations, stone quarries (active, closed), stony debris, gravel/sand/earth pits, drilling perimeters and locally degraded lands.
Slovakia	Other land represents bare soil, rock and all unmanaged land areas that do not fall 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 sink as a result of the conversion from other categories to Other land. It reaches for the year 2017, 167 kt CO_2.

Specifically, Some MS report emissions as a result of carbon oxidation from living biomass and soils, when lands are converted to Other land as in the case of Romania. However, in overall, MS have reported a net sink of carbon in mineral soils, following such conversions

As explained above, a particular case is given by 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 its 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 MS and Iceland (kha, kt CO_2 1990-2017)



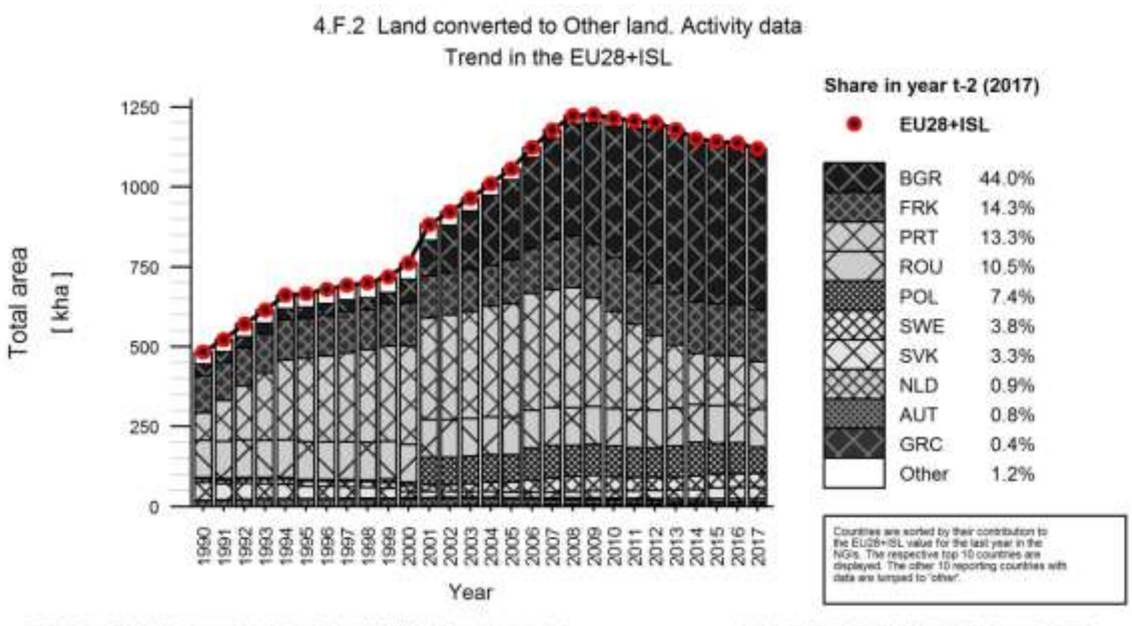
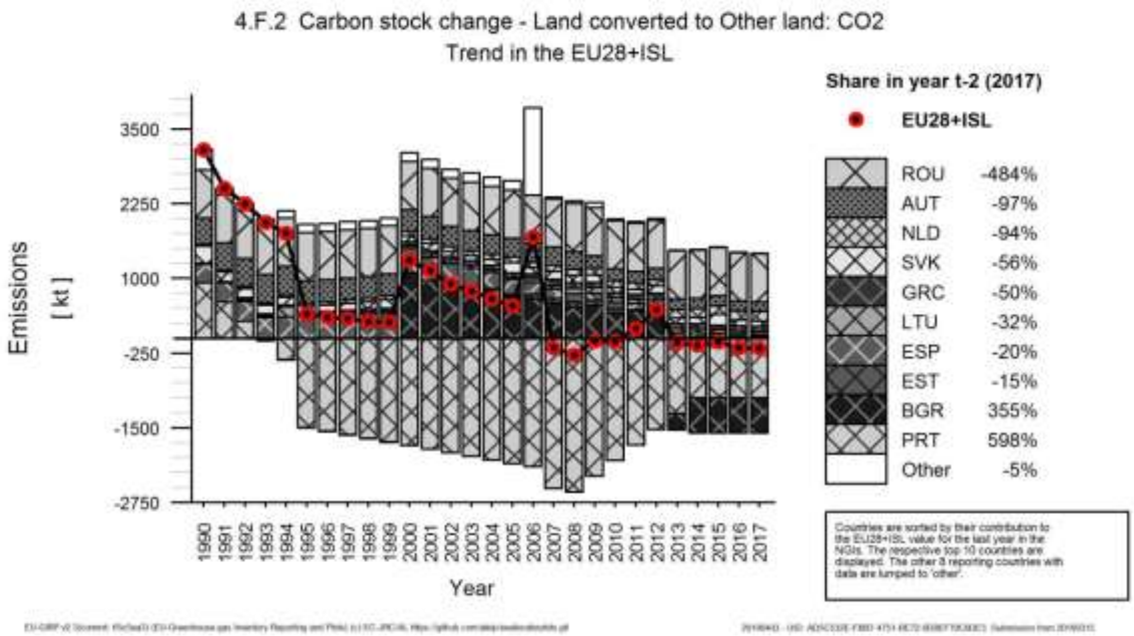


Figure 6. 20 Trend of emissions (+)/removals (-) in subcategory 4F2, "Land converted to Other lands" in EU MS and Iceland (kt CO_2, 1990-2017)



6.2.5 Harvest Wood Products (CRF 4G)

6.2.5.1 Overview of the Harvest Wood Products category

This carbon reservoir covers emissions and removals, from carbon stock changes in harvested wood products (HWP), resulting from the annual carbon inflow to the pool (i.e. gains), and carbon outflow from the pool (i.e. losses).

According to the 2006 IPCC GL, HWP includes all wood material (including bark) that leaves harvest sites. 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.

Harvested wood products carbon pool represents at the level of EU MS and Iceland a net carbon sink of about -40.597 kt CO_2 in 2017. Most of the countries reported this carbon pool as a net sink, however Cyprus, Greece and Netherlands estimated that HWP resulted in a small net source of emissions for the year 2017.

The main contributors to the carbon sink are Poland, Romania, Sweden, Finland and Germany.

In line with the recommendations provided during the EU QA/QC checks, and with the information contained in the improvement plans of individual submissions, more MS have provided more accuracy and complete estimates for this carbon pool in recent submissions. For instance, Cyprus, Iceland and Poland. In the last case, its estimates have significantly contributed to an increase in the sink reported at EU level.

Moreover, Belgium that in previous submissions reported only HWP 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 HWP are consistent with methodologies provided by 2006 IPCC GL. Individual inventories implemented the IPCC Approach B (i.e. production approach) to provide estimates on HWP consistently with the reporting of the carbon pool under the KP reporting.

MS reported carbon stock changes in HWP considering individual estimates for the semi-finished wood products categories of (i) Solid wood, disaggregated in Sawnwood and wood panels, and (ii) Paper and paperboard. To this aim, the IPCC default half-life values have been used by all MS in individual inventories.

In addition, some MS have stated that carbon stock changes in HWP are insignificant or that the pool, as considered under the Approach B, does not exist (e.g. Luxembourg, Malta).

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: MS and Iceland contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	-3 122	-1 140	-1 690	4.2%	1 432	46%	-550	-48%
Belgium	-1 616	-226	-226	0.6%	1 391	86%	0	0%
Bulgaria	-101	-1 133	-841	2.1%	-740	-736%	292	26%
Croatia	-302	-763	-1 008	2.5%	-707	-234%	-245	-32%
Cyprus	3	25	24	-0.1%	21	644%	0	-2%
Czechia	-1 713	-941	-779	1.9%	934	55%	162	17%
Denmark	-2	-174	-162	0.4%	-160	-6716%	12	7%
Estonia	-157	-1 004	-1 143	2.8%	-986	-629%	-139	-14%
Finland	-2 952	-3 649	-3 990	9.8%	-1 039	-35%	-341	-9%
France	-5 098	-829	-1 195	2.9%	3 903	77%	-366	-44%
Germany	-1 330	-1 759	-3 037	7.5%	-1 706	-128%	-1 278	-73%
Greece	-349	64	63	-0.2%	412	118%	-1	-2%
Hungary	-388	-112	-415	1.0%	-28	-7%	-303	-270%
Ireland	-413	-806	-872	2.1%	-459	-111%	-65	-8%
Italy	-543	91	-162	0.4%	381	70%	-253	-277%
Latvia	-166	-2 144	-2 236	5.5%	-2 070	-1246%	-92	-4%
Lithuania	-253	-1 043	-1 045	2.6%	-792	-314%	-1	0%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	-157	83	133	-0.3%	290	185%	50	61%
Poland	-456	-4 421	-4 723	11.6%	-4 267	-935%	-302	-7%
Portugal	-1 674	-172	-113	0.3%	1 561	93%	59	34%
Romania	-817	-5 615	-5 360	13.2%	-4 543	-556%	256	5%
Slovakia	-470	-1 064	-1 077	2.7%	-607	-129%	-13	-1%
Slovenia	-67	-102	-86	0.2%	-19	-28%	16	16%
Spain	-2 037	-1 436	-1 929	4.8%	108	5%	-493	-34%
Sweden	-5 016	-8 226	-6 714	16.5%	-1 698	-34%	1 513	18%
United Kingdom	-1 639	-2 167	-2 016	5.0%	-377	-23%	151	7%
EU-28	**-30 835**	**-38 663**	**-40 597**	**100%**	**-9 761**	**-32%**	**-1 934**	**-5%**
Iceland	NO,NA	0	0	0.0%	0	-∞	0	-154%
United Kingdom (KP)	-1 639	-2 166	-2 016	5.0%	-377	-23%	151	7%
EU-28 + ISL	**-30 835**	**-38 663**	**-40 597**	**100%**	**-9 761**	**-32%**	**-1 934**	**-5%**

6.2.6 LULUCF – non-key categories

In this section, general overview of emissions and removals for non-key categories is provided.

Table 6. 31 Aggregated GHG emission from non-key categories in the LULUCF sector

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 4. LULUCF in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO_2 equ.	%	kt CO_2 equ.	%
4.A Forest Land: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	1 941.1	1 452.0	1 467.0	-0.59%	-474	-24%	15	1%
4.A Forest Land: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	404.5	463.4	468.5	-0.19%	64	16%	5	1%
4.A Forest Land: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	4 302.2	4 218.7	4 219.6	-1.69%	-83	-2%	1	0%
4.A.1 Forest Land: Land Use (CH_4)	1 935.2	1 356.1	2 760.1	-1.10%	825	43%	1 404	104%
4.A.1 Forest Land: Land Use (N_2O)	814.7	593.4	742.5	-0.30%	-72	-9%	149	25%
4.A.2 Forest Land: Land Use (CH_4)	128.6	73.7	269.0	-0.11%	140	109%	195	265%
4.A.2 Forest Land: Land Use (N_2O)	498.3	338.1	335.8	-0.13%	-163	-33%	-2	-1%
4.B Cropland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	817.7	773.4	767.3	-0.31%	-50.5	-6.2%	-6.1	-1%
4.B Cropland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	2 177.3	1 839.7	1 858.0	-0.74%	-319	-15%	18	1%
4.B Cropland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	0.0	0.0	0.0	0.00%	0	0%	0	0%
4.B.1 Cropland: Land Use (CH_4)	89.1	70.1	117.3	-0.05%	28	32%	47.2	67%

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 4. LULUCF in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO_2 equ.	%	kt CO_2 equ.	%
4.B.1 Cropland: Land Use (N_2O)	56.3	45.7	57.8	-0.02%	2	3%	12	26%
4.B.2 Cropland: Land Use (CH_4)	57.2	55.6	59.0	-0.02%	2	3%	3	6%
4.B.2 Cropland: Land Use (N_2O)	4 250.2	3 211.6	5 509.4	-2.20%	1 259	30%	2 298	72%
4.C Grassland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	1 529.1	1 391.5	1 395.5	-0.56%	-134	-9%	4	0%
4.C Grassland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	933.2	963.5	970.7	-0.39%	37	4%	7	1%
4.C Grassland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	86.0	98.1	98.6	-0.04%	13	15%	0.4	0.5%
4.C.1 Grassland: Land Use (CH_4)	850.6	237.8	420.9	-0.17%	-430	-51%	183	77.0%
4.C.1 Grassland: Land Use (N_2O)	386.5	146.3	213.2	-0.09%	-173	-45%	67	46%
4.C.2 Grassland: Land Use (CH_4)	46.4	47.4	46.4	-0.02%	0	0%	-1	-2%
4.C.2 Grassland: Land Use (N_2O)	275.8	235.6	230.3	-0.09%	-46	-17%	-5.3	-2%
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	3 461.6	3 413.1	3 406.7	-1.36%	-55	-2%	-6	0%
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	1 949.6	1 370.0	1 391.4	-0.56%	-558	-29%	21	2%
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	123.2	141.9	138.3	-0.06%	15	12%	-4	-3%
4.D.1 Wetlands: Land Use (CH_4)	62.7	8.8	204.3	-0.08%	142	226%	196	2226%
4.D.1 Wetlands: Land Use (N_2O)	18.8	2.7	61.3	-0.02%	43	226%	58.6	2176%
4.D.2 Wetlands: Land Use (CH_4)	7.3	9.5	9.4	0.00%	2	30%	0	0%

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 4. LULUCF in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO_2 equ.	%	kt CO_2 equ.	%
4.D.2 Wetlands: Land Use (CO_2)	2 555.6	3 864.4	4 061.3	-1.62%	1 506	59%	197	5%
4.E Settlements: Biomass Burning (CH_4)	53.1	71.3	69.4	-0.03%	16	31%	-2	-3%
4.E Settlements: Biomass Burning (CO_2)	40.0	135.6	110.2	-0.04%	70.1	175%	-25.4	-19%
4.E Settlements: Biomass Burning (N_2O)	4.9	10.0	8.8	0.00%	4	80%	-1	-13%
4.E.1 Settlements: Land Use (CH_4)	13.5	21.8	22.2	-0.01%	9	64%	0	2%
4.E.1 Settlements: Land Use (CO_2)	2 594.8	3 218.5	3 805.0	-1.52%	1 210	47%	587	18%
4.E.1 Settlements: Land Use (N_2O)	140.1	201.9	201.3	-0.08%	61	44%	-1	0%
4.E.2 Settlements: Land Use (CH_4)	10.5	22.0	23.0	-0.01%	12.4	118%	0.9	4.2%
4.E.2 Settlements: Land Use (N_2O)	2 327.8	4 988.7	3 781.4	-1.51%	1 454	62%	-1 207	-24%
4.F.2 Other Land: Land Use (CH_4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
4.F.2 Other Land: Land Use (CO_2)	3 155.8	-154.8	-166.7	0.07%	-3 323	-105%	-12	-7.7%
4.F.2 Other Land: Land Use (N_2O)	0.1	0.0	0.0	0.00%	0	-83%	0	-22%
4.F.3 Other Land: Direct N_2O Emissions from N Mineralization/Immobilization (N_2O)	627.7	1 365.8	1 362.3	-0.54%	735	117%	-4	0%
4.F.4 Other Land: Biomass Burning (CH_4)	141.4	211.8	399.2	-0.16%	258	182%	187	88%
4.F.4 Other Land: Biomass Burning (CO_2)	0.0	0.0	0.0	0.00%	0	0%	0	0%
4.F.4 Other Land: Biomass Burning (N_2O)	23.2	34.7	65.4	-0.03%	42	182%	31	88%
4.H Other LULUCF: Land Use (CH_4)	0.0	219.8	219.2	-0.09%	219	100%	-1	0%
4.H Other LULUCF: Land Use (CO_2)	0.0	68.8	60.0	-0.02%	60	100%	-9	-13%
4.H Other LULUCF: Land Use (N_2O)	104.6	156.0	160.3	-0.06%	56	53%	4	3%

6.2.7 Other source 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) MS 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 MS stated that fertilization is not part of the management practices of forests, while, if any, emissions from the addition of nitrogen inputs in Wetlands, and or Settlements, or in few cases also under forests, are often reported under Agriculture sector when it was not possible to separate emissions by land use category. Therefore under the LULUCF almost all the MS have reported these emissions using the notation key NO or IE (Table 6. 32).

Exceptions are given by Finland, Sweden, UK and Iceland, which 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. And, Finland also significant emissions in this category as a result of forest growth fertilizations and, to a lesser extent, forest vitality fertilizations. By last, UK and Iceland report low emissions in this source as a result of inorganic nitrogen fertilizers applied to forest when absolutely necessary. When in the case of UK is during the first rotation on 'poor' soils, such as reclaimed slag heaps, impoverished brown field sites and upland organic soils, and in Iceland, in some cases for 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 mainly used to derive N_2O emissions from nitrogen inputs to managed soils.

For the year 2017 this source of emissions reaches 54 kt CO_2 equivalents, which represent about 24% less than in 1990.

Table 6. 32 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		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	NO	NO	-	-	-	-	-
Denmark	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Estonia	NA,NO	NO,NA	NO,NA	-	-	-	-	-
Finland	21	17	29	54.4%	9	42%	12	69%
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	4	4	7.7%	4	∞	0	-5%
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,NE,IE	NO,IE,NA	NO,NE,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	21	18	33.0%	-31	-64%	-3	-14%
United Kingdom	9	2	3	4.8%	-6	-70%	0	5%
EU-28	**78**	**45**	**54**	**100%**	**-24**	**-31%**	**9**	**20%**
Iceland	0	0	0	0.1%	0	103%	0	185%
United Kingdom (KP)	9	2	3	4.8%	-6	-70%	0	5%
EU-28 + ISL	**78**	**45**	**54**	**100%**	**-24**	**-31%**	**9**	**20%**

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 are already covered under other sectors, so countries shall 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 16.342 kt CO_2 equivalent (table 6.34, 6.35 and 6.36) that occurred mostly in organic soils and that are mainly reported by UK, Finland, Sweden and Iceland.

Table 6. 33 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2	%	kt CO2	%
Austria	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Belgium	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	37	28	28	0.6%	-9	-24%	0	0%
Estonia	IE,NA,NO	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Finland	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
France	863	863	863	18.4%	0	0%	0	0%
Germany	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Greece	NO	NO	NO	-	-	-	-	-
Hungary	786	273	122	2.6%	-664	-84%	-151	-55%
Ireland	464	446	445	9.5%	-19	-4%	-1	0%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	856	856	1 039	22.2%	183	21%	183	21%
Lithuania	1 933	1 640	1 661	35.4%	-272	-14%	21	1%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Netherlands	),NE,IE,NA	),NE,IE,NA	),NE,IE,NA	-	-	-	-	-
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	0	0	0.0%	0	63%	0	0%
Sweden	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
United Kingdom	177	177	177	3.8%	0	0%	0	0%
EU-28	**5 116**	**4 284**	**4 335**	**92%**	**-781**	**-15%**	**52**	**1%**
Iceland	348	353	353	7.5%	5	1%	0	0%
United Kingdom (KP)	177	177	177	3.8%	0	0%	0	0%
EU-28 + ISL	**5 465**	**4 637**	**4 689**	**100%**	**-776**	**-14%**	**52**	**1%**

Table 6. 34 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		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	NO	NO	-	-	-	-	-
Denmark	27	24	24	0.5%	-3	-10%	0	0%
Estonia	243	248	248	5.4%	5	2%	0	0%
Finland	2 081	2 043	2 041	44.2%	-40	-2%	-2	0%
France	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Germany	235	313	317	6.9%	82	35%	4	1%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	0	1	0	0.0%	0	184%	-1	-68%
Ireland	105	184	186	4.0%	82	78%	2	1%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	574	570	570	12.3%	-4	-1%	0	0%
Lithuania	39	40	40	0.9%	1	3%	0	0%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Netherlands	),NE,IE,NA	NO,NE,NA	),NE,IE,NA	-	-	-	-	-
Poland	NA	NA	NA	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	27	27	27	0.6%	0	0%	0	0%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0	0	0	0.0%	0	63%	0	0%
Sweden	1 180	1 047	1 044	22.6%	-136	-12%	-3	0%
United Kingdom	54	57	57	1.2%	3	6%	0	0%
EU-28	**4 564**	**4 554**	**4 555**	**99%**	**-9**	**0%**	**0**	**0%**
Iceland	52	60	62	1.3%	10	19%	1	2%
United Kingdom (KP)	54	57	57	1.2%	3	6%	0	0%
EU-28 + ISL	**4 616**	**4 615**	**4 617**	**100%**	**1**	**0%**	**2**	**0%**

Table 6. 35 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	24	24	24	0.3%	0	0%	0	0%
Belgium	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	193	193	192	2.7%	-1	0%	-2	-1%
Estonia	59	61	61	0.9%	2	4%	0	0%
Finland	1 531	920	919	13.1%	-612	-40%	-1	0%
France	57	57	57	0.8%	0	0%	0	0%
Germany	845	819	817	11.6%	-27	-3%	-2	0%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Ireland	376	370	370	5.3%	-6	-2%	0	0%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	475	507	523	7.4%	47	10%	16	3%
Lithuania	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Netherlands	O,NE,IE,NA	O,NE,IE,NA	O,NE,IE,NA	-	-	-	-	-
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	0	0	0.0%	0	63%	0	0%
Sweden	470	435	432	6.1%	-37	-8%	-3	-1%
United Kingdom	NO,NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
EU-28	**4 030**	**3 388**	**3 396**	**48%**	**-634**	**-16%**	**8**	**0%**
Iceland	3 720	3 642	3 641	51.7%	-79	-2%	-2	0%
United Kingdom (KP)	NO,NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
EU-28 + ISL	**7 750**	**7 030**	**7 036**	**100%**	**-713**	**-9%**	**6**	**0%**

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 the MS. This implies significant efforts by MS to increase the completeness for this source of emissions during the last years.

For this year, net emissions from this source category reached 11.510 kt CO_2 equivalent, which represent an increase of 6% as compared to 1990. Significant emissions under this category are reported by France, Romania, UK and Poland (Table 6. 36) and in most of the cases they were estimated using IPCC methodologies and default emissions factors.

Table 6. 36 Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matte 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-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	129	123	125	1.1%	-4	-3%	1	1%
Belgium	6	157	163	1.4%	157	2464%	6	4%
Bulgaria	179	438	435	3.8%	256	143%	-3	-1%
Croatia	32	81	81	0.7%	49	153%	0	0%
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	9	5	4	0.0%	-5	-51%	0	-6%
Denmark	0	8	4	0.0%	4	2857%	-3	-43%
Estonia	0	15	15	0.1%	15	138764%	0	1%
Finland	25	32	31	0.3%	6	24%	-1	-3%
France	2 191	2 207	2 204	19.1%	13	1%	-3	0%
Germany	482	446	446	3.9%	-37	-8%	0	0%
Greece	1	14	14	0.1%	13	973%	0	-1%
Hungary	24	39	38	0.3%	14	57%	-1	-2%
Ireland	18	204	195	1.7%	177	1002%	-9	-5%
Italy	551	369	377	3.3%	-174	-32%	7	2%
Latvia	1	44	46	0.4%	45	6729%	2	4%
Lithuania	73	113	125	1.1%	51	70%	12	10%
Luxembourg	17	10	9	0.1%	-8	-46%	-1	-6%
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Netherlands	6	94	96	0.8%	90	1633%	2	2%
Poland	4 605	6 492	3 555	30.9%	-1 051	-23%	-2 938	-45%
Portugal	507	324	315	2.7%	-192	-38%	-9	-3%
Romania	1 305	1 816	1 816	15.8%	511	39%	0	0%
Slovakia	75	18	18	0.2%	-57	-76%	0	0%
Slovenia	41	24	22	0.2%	-19	-46%	-1	-6%
Spain	83	155	142	1.2%	59	72%	-13	-8%
Sweden	60	158	155	1.3%	96	161%	-3	-2%
United Kingdom	1 772	1 096	1 079	9.4%	-693	-39%	-17	-2%
EU-28	**12 193**	**14 484**	**11 511**	**100%**	**-682**	**-6%**	**-2 972**	**-21%**
Iceland	0	0	0	0.0%	0	514%	0	0%
United Kingdom (KP)	1 774	1 103	1 085	9.4%	-688	-39%	-17	-2%
EU-28 + ISL	**12 195**	**14 491**	**11 518**	**100%**	**-677**	**-6%**	**-2 972**	**-21%**

6.2.7.4 Indirect nitrous oxide (N_2O) emissions from managed soils (CRF Table 4(IV))

This source category covers indirect N_2O emissions from managed soils. Under certain conditions and land use categories, these emissions can be reported under Agriculture sector. For instance, those 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 also under the Agriculture sector.

Therefore, given that most of the fertilizer are added in Cropland and Grassland areas according to the CRF table 4 (I) and that direct nitrogen emissions are mostly reported so far under Cropland remaining Cropland, an important number of the MS have reported in the CRF table 4(IV) the notation key IE (i.e. included elsewhere).

Nevertheless, the 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, indirect N_2O emissions reported under LULUCF reached 1.025 kt CO_2 equivalents (Table 6. 37). These emissions are mainly reported by Germany, UK and France. To a lesser extent, others MS have provided for first time also minor quantities of indirect N_2O emissions.

Table 6. 37 Indirect nitrous oxide (N_2O) emissions from managed soils (kt CO_2 eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	15	14	14	1.4%	0	-3%	0	1%
Belgium	IE	IE	IE	-	-	-	-	-
Bulgaria	40	112	113	11.0%	72	179%	0	0%
Croatia	IE	IE	IE	-	-	-	-	-
Cyprus	NE	NE	NE	-	-	-	-	-
Czechia	2	1	1	0.1%	-1	-51%	0	-7%
Denmark	IE	IE	IE	-	-	-	-	-
Estonia	0	3	3	0.3%	3	138764%	0	1%
Finland	2	2	2	0.2%	0	16%	0	-5%
France	491	454	448	43.8%	-42	-9%	-5	-1%
Germany	109	100	100	9.8%	-8	-8%	0	0%
Greece	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Hungary	3	6	6	0.5%	2	63%	0	-4%
Ireland	IE	IE	IE	-	-	-	-	-
Italy	10	2	3	0.3%	-7	-68%	2	100%
Latvia	0	1	1	0.1%	1	8576%	0	5%
Lithuania	16	23	23	2.3%	7	43%	0	2%
Luxembourg	4	2	2	0.2%	-2	-46%	0	-6%
Malta	IE	IE	IE	-	-	-	-	-
Netherlands	IE	IE	IE	-	-	-	-	-
Poland	IE	IE	IE	-	-	-	-	-
Portugal	20	21	46	4.5%	26	128%	25	120%
Romania	IE	IE	IE	-	-	-	-	-
Slovakia	15	5	5	0.5%	-10	-67%	0	1%
Slovenia	9	5	5	0.5%	-5	-49%	-1	-11%
Spain	3	6	5	0.5%	2	72%	0	-8%
Sweden	8	3	3	0.3%	-5	-62%	0	-14%
United Kingdom	401	247	244	23.8%	-158	-39%	-4	-2%
EU-28	**1 149**	**1 009**	**1 025**	**100%**	**-124**	**-11%**	**16**	**2%**
Iceland	IE	IE	IE	-	-	-	-	-
United Kingdom (KP)	401	247	244	23.8%	-158	-39%	-4	-2%
EU-28 + ISL	**1 149**	**1 009**	**1 025**	**100%**	**-124**	**-11%**	**16**	**2%**

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 as a result of wildfires and controlled burning, on all the land use categories.

Following the IPCC approach, many MS 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, MS have also used the notation keys NO or NA when wildfires or controlled burning do not take 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, controlled burning on managed lands is not a common practice in the EU, with few exceptions for confined areas (.e.g. Finland, Sweden, and UK in forest lands and, Spain and UK in grasslands). In addition, northern countries report negligible 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 also used for estimation of CH_4 and N_2O emissions resulting from fires.

Overall, emissions from biomass burning decreased in 2017 compared to 1990 (Table 6. 38, Table 6. 39 and Table 6. 40) although increased significantly compared with previous year. The reason behind is that Portugal and Italy, report a significant increase of emissions from wildfires in forests as compared with recent years. Due to the high incidence of this disturbance.

Nevertheless, in overall, this source of emissions present a very variable trend and inter-variability that is related with several factors, in many cases driven by climate conditions. MS that often report the larger quantities of emissions as a result of the biomass burning are Italy, France, Spain, and Greece.

Table 6. 38 CO_2 emissions from Biomass Burning (in kt CO_2)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		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	100	824	5.5%	809	5402%	724	726%
Cyprus	0	112	4	0.0%	3	622%	-108	-97%
Czechia	16	17	20	0.1%	4	26%	4	21%
Denmark	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Estonia	NO,NE,IE	NO,NE,IE	NO,NE,IE	-	-	-	-	-
Finland	3	3	4	0.0%	1	21%	1	34%
France	1 741	505	588	3.9%	-1 153	-66%	84	17%
Germany	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Greece	146	38	17	0.1%	-130	-88%	-21	-56%
Hungary	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Ireland	478	61	1 550	10.3%	1 072	224%	1 489	2447%
Italy	5 071	863	2 037	13.5%	-3 034	-60%	1 173	136%
Latvia	25	57	36	0.2%	12	47%	-21	-36%
Lithuania	1	0	1	0.0%	-1	-61%	0	117%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Netherlands	4	5	5	0.0%	1	26%	0	0%
Poland	107	58	13	0.1%	-94	-88%	-45	-78%
Portugal	1 683	2 603	9 409	62.3%	7 726	459%	6 806	262%
Romania	4	7	18	0.1%	14	371%	12	172%
Slovakia	43	47	80	0.5%	38	89%	33	70%
Slovenia	21	16	12	0.1%	-9	-42%	-4	-26%
Spain	843	177	154	1.0%	-689	-82%	-23	-13%
Sweden	NO,IE	NO,IE	NO,IE	-	-	-	-	-
United Kingdom	95	369	328	2.2%	232	244%	-41	-11%
EU-28	**10 297**	**5 038**	**15 100**	**100%**	**4 803**	**47%**	**10 062**	**200%**
Iceland	NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
United Kingdom (KP)	95	369	328	2.2%	232	244%	-41	-11%
EU-28 + ISL	**10 297**	**5 038**	**15 100**	**100%**	**4 803**	**47%**	**10 062**	**200%**

Table 6. 39 CH_4 emissions from Biomass Burning (in kt CO_2 eq.)

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	0	0	0	0.0%	0	-82%	0	87%
Belgium	1	NO	NO	-	-1	-100%	-	-
Bulgaria	2	15	11	0.2%	8	339%	-4	-28%
Croatia	1	9	69	1.6%	68	5527%	60	676%
Cyprus	0	12	0	0.0%	0	622%	-12	-97%
Czechia	44	33	38	0.9%	-6	-14%	5	16%
Denmark	1	0	0	0.0%	-1	-96%	0	-12%
Estonia	0	1	0	0.0%	0	-59%	0	-77%
Finland	3	0	0	0.0%	-2	-84%	0	14%
France	943	898	922	21.2%	-21	-2%	24	3%
Germany	7	2	2	0.1%	-5	-67%	1	41%
Greece	63	32	19	0.4%	-44	-70%	-13	-41%
Hungary	23	9	19	0.4%	-4	-17%	10	109%
Ireland	85	11	267	6.1%	182	215%	256	2303%
Italy	1 483	396	1 481	34.0%	-2	0%	1 085	274%
Latvia	24	13	11	0.2%	-13	-55%	-2	-16%
Lithuania	3	1	0	0.0%	-3	-90%	0	-55%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Netherlands	0	0	0	0.0%	0	32%	0	0%
Poland	44	42	38	0.9%	-7	-15%	-5	-11%
Portugal	300	450	1 259	28.9%	958	319%	808	180%
Romania	0	1	2	0.0%	2	371%	1	156%
Slovakia	10	19	21	0.5%	11	110%	2	11%
Slovenia	2	1	1	0.0%	-1	-42%	0	-26%
Spain	314	162	164	3.8%	-150	-48%	2	1%
Sweden	2	3	2	0.1%	0	8%	-1	-28%
United Kingdom	16	33	28	0.7%	12	78%	-5	-15%
EU-28	**3 371**	**2 142**	**4 355**	**100%**	**984**	**29%**	**2 213**	**103%**
Iceland	NE,NA	NO,NE,NA	0	0.0%	0	∞	0	∞
United Kingdom (KP)	16	33	28	0.7%	12	78%	-5	-15%
EU-28 + ISL	**3 371**	**2 142**	**4 355**	**100%**	**984**	**29%**	**2 213**	**103%**

Table 6. 40 N_2O emissions from Biomass Burning (in kt CO_2 eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	0	0	0	0.0%	0	-82%	0	87%
Belgium	5	NO	NO	-	-5	-100%	-	-
Bulgaria	2	10	7	0.6%	5	339%	-3	-28%
Croatia	1	6	49	4.4%	48	5599%	42	652%
Cyprus	0	4	0	0.0%	0	622%	-4	-97%
Czechia	29	22	25	2.3%	-4	-14%	3	16%
Denmark	0	0	0	0.0%	0	-93%	0	-12%
Estonia	0	0	0	0.0%	0	-53%	0	-85%
Finland	2	0	0	0.0%	-2	-83%	0	14%
France	524	417	431	38.9%	-94	-18%	14	3%
Germany	4	1	1	0.1%	-3	-67%	0	41%
Greece	5	3	2	0.1%	-4	-70%	-1	-41%
Hungary	15	6	13	1.2%	-2	-10%	7	121%
Ireland	23	3	72	6.5%	49	214%	69	2199%
Italy	262	45	109	9.8%	-153	-59%	63	140%
Latvia	3	2	1	0.1%	-1	-52%	0	-12%
Lithuania	3	1	0	0.0%	-3	-90%	0	-58%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Netherlands	0	0	0	0.0%	0	28%	0	0%
Poland	10	3	2	0.1%	-8	-84%	-1	-47%
Portugal	49	74	206	18.6%	157	319%	133	180%
Romania	0	0	1	0.1%	1	371%	0	156%
Slovakia	7	13	14	1.3%	7	110%	1	11%
Slovenia	1	1	1	0.1%	0	-42%	0	-26%
Spain	285	149	151	13.7%	-134	-47%	2	2%
Sweden	0	0	0	0.0%	0	8%	0	-28%
United Kingdom	14	24	20	1.8%	6	43%	-4	-17%
EU-28	**1 245**	**784**	**1 106**	**100%**	**-139**	**-11%**	**323**	**41%**
Iceland	NE,NA	NO,NE,NA	0	0.0%	0	∞	0	∞
United Kingdom (KP)	14	24	20	1.8%	6	43%	-4	-17%
EU-28 + ISL	**1 245**	**784**	**1 106**	**100%**	**-139**	**-11%**	**323**	**41%**

6.2.8 Emissions from organic soils in the EU GHG inventory

At the level of the EU MS and Iceland, organic soils reported under the three main land use categories (i.e. Forest land, Cropland and Grassland) cover about 18.200 kha that are mainly located in northern countries.

Total CO_2 emissions linked to that area in 2017, reached 92.802 kt CO_2 which represents about 33% of total EU net removals from LULUCF (Table 6. 41). 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, MS with small areas of organic soil often use default IPCC factors to report emissions from this carbon pool.

Overall, among these 3 main land use categories, most of the organic soils area is reported under Forest land, however most of the emissions are due to managed organic soils in Grasslands and Croplands (Table 6. 41).

In Finland, organic soils areas were derived from NFI database and geo-referenced soil database across all land uses. In Sweden, data is also provided by NFI 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 correspond to UK that reports a net sink in this pool by using CARBINE model.

Table 6. 41 Area, CO_2 emissions and average implied C stock change factors in the EU MS and Iceland reported for the year 2017 for organic soils.

Land use subcategory	Area (Kha)	ICECF (tC/ha)	CO_2 emissions (Kt CO_2)
4A1	12 148	[-2.60; 0.86]	12 136
4A2	373		1 260
4B1	1 647	[-10.01; -1.00]	27 113
4B2	285		5 929
4C1	3 535	[-6.75; 0.25]	43 419
4C2	177		2 945

6.3 Uncertainties

For the year 2017, LULUCF uncertainty was estimated in 34.4% for the uncertainty of the level and 13.9 % for the uncertainty of the trend (Table 6. 42).

For more information on the uncertainty analysis please refer to chapter 1.6.

Table 6. 42 Level and trend uncertainty assessment of the annual EU-28 emission/removal on LULUCF land subcategories and GHG sources.

Source category	Gas	Emissions Base Year	Emissions 2017	Emission trends Base Year-2017	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
4.A Forest Land	CO2	-360 336	-357 492	-0.8%	20.2%	0.1%
4.A Forest Land	CH4	2 072	3 194	54.1%	55.6%	0.2%
4.A Forest Land	N2O	2 848	2 503	-12.1%	99.1%	0.1%
4.B Cropland	CO2	74 546	59 561	-20.1%	49.9%	0.1%
4.B Cropland	CH4	729	747	2.5%	111.1%	0.2%
4.B Cropland	N2O	3 752	5 411	44.2%	68.1%	0.1%
4.C Grasland	CO2	23 477	7 926	-66.2%	232.6%	0.4%
4.C Grasland	CH4	1 679	1 073	-36.1%	132.8%	0.3%
4.C Grasland	N2O	702	431	-38.6%	99.9%	0.3%
4.D Wetlands	CO2	10 313	12 348	19.7%	56.2%	0.1%
4.D Wetlands	CH4	3 405	3 330	-2.2%	53.5%	0.0%
4.D Wetlands	N2O	4 367	364	-91.7%	56.3%	0.6%
4.E Settlements	CO2	36 436	43 662	19.8%	31.9%	0.1%
4.E Settlements	CH4	77	115	48.6%	97.9%	0.4%
4.E Settlements	N2O	2 315	3 705	60.0%	82.3%	0.3%
4.F Other Land	CO2	3 044	404	-86.7%	114.3%	0.1%
4.F Other Land	CH4	141	399	182.2%	29.7%	0.5%
4.F Other Land	N2O	535	1 162	117.3%	32.1%	0.3%
4.G Harvested wood products	CO2	-32 017	-38 897	21.5%	40.6%	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	60		30.4%	
4.H Other	CH4	0	219		100.0%	
4.H Other	N2O	493	490	-0.7%	93.6%	0.1%
4.I	CO2	0	0		0.0%	0.0%
4.I	CH4	0	0		0.0%	0.0%
4.I	N2O	21	29	42.0%	198.7%	0.8%
4.II	CO2	1 970	1 689	-14.3%	57.2%	0.1%
4.II	CH4	1 731	1 118	-35.4%	110.6%	0.4%
4.II	N2O	2 147	2 105	-1.9%	113.0%	0.0%
4.III	CO2	0	0		0.0%	0.0%
4.III	CH4	0	0		0.0%	0.0%
4.III	N2O	132	136	2.5%	812.0%	4.7%
4.IV	CO2	0	0		0.0%	0.0%
4.IV	CH4	0	0		0.0%	0.0%
4.IV	N2O	441	302	-31.6%	138.5%	0.6%
4.V	CO2	61	908	1393.7%	94.4%	12.5%
4.V	CH4	15	91	498.7%	71.0%	4.1%
4.V	N2O	10	63	539.3%	72.3%	4.4%
4 (where no subsector data were submitted)	*all*	*302*	*-176*	-158.3%	*197.3%*	*53.8%*
Total - 4	**all**	**-214 591**	**-243 019**	**13.2%**	**34.3%**	**13.9%**

6.4 Sector-specific quality assurance and quality control and verification

6.4.1 Time series consistency

The EU greenhouse gas inventory is compiled by aggregation of national inventories, thus, its consistency strictly depends on the consistency of MS and Iceland 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[67]. Consistency is checked, in terms of each land use subcategory category, and the overall land representation system, across time and space, noting for instance that the sum of all land use areas must be constant over time and match the official country area. Moreover, there is none circumstances that justify discontinuities on areas across years. Thereof ere, the

[67] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0525

area for each land use category, and KP activity, at the end of one year have to be the same as the area at the beginning of the next year.

For the sake of consistency all the parameters used to estimate the GHG fluxes are checked. In this sense, activity data, implied carbon stock change factors, and emissions reported for each land use subcategory across the years of the time series are cheeked to spot potential outliers and to ensure the plausibility of their trends.

MS provide early submissions to the European Commission that is in charge of implementing a set of quality checks aim 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 they do not provide data on an annual basis.

Land use definitions are not identical among MS. As shown in previous chapters, each MS has its own definition according with its land representation and data collection systems. However, they are in accordance with IPCC definitions. Differences are given by slightly different treatment of particular lands and in many cases related to historical definitions and available databases. Some examples are the different thresholds used for forest definitions; 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 these years of implementing QA/QC procedures and because of the efforts devoted by MS to overcome with issues, and to improve their inventories, it can be appreciated a substantial improvement on the consistency of the information. Moreover, every year new projects are launched, and new data are involved, to further improve the land representation system and the estimation of carbon stock changes and other GHG emissions that result in recalculations that aim to enhance the reported numbers.

6.4.2 Quality Assurance and Quality control

Information submitted under the LULUCF sector by EU MS 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, that is performed at EU level by the Joint Research Centre of the European Commission in collaboration with MS, the EEA, DG CLIMA and European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM)

At the EU level, 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, and 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 previously raised issues 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 or 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 the 2019 submissions, around 150 findings (i.e. potential issues) were communicated to the MS and Iceland on, for instance, the use and justifications of notations keys, potential inconsistencies in land representation, wrong interpretation on how to fill in some tables, inconsistent reporting of activity data among CRF tables and between CRF tables and NIR, outliers in IEFs values for all categories, and lack of transparency for specific national circumstances that affected the EU trend.

The following list aims to provide an overall view of the checks that are implemented on the LULUCF and KP-LULUCF data, 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 MS. Furthermore, the check also aim 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 on 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 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 from the EU' ERT to ensure this 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 were included in CRF 4.1. This leads to an inconsistency among the information of these tables that is directly affecting LULUCF sector of the EU GHG inventory.
    c. The area reported for each land use category 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 (i.e. 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 to MS '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 at EU level have been implemented during the past years that were meant to improve the quality of both national GHG inventories of the MS and Iceland, and EU, 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 MS in their GHG inventories and those reported in EFFIS[68].
- The JRC have collaborated during the past years, and is doing it 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 MS, and also for 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, 16-17 May 2018 Arona (Italy), Italy
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 26-27 April 2017 Stresa (Italy), Italy
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 02-03 May 2016 Stresa (Italy), Italy.
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 26-27 May 2015 Arona (NO), Italy.
- 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.

[68] *http://forest.jrc.ec.europa.eu/effis/*

- 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[69], Pilli et al. 2016[70],[71]), to estimate carbon stock changes in all forest carbon pools for 26 MS (all countries except Malta and Cyprus). 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' 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 MS submissions has been also carried out in 2015[72]. In this context, some inconsistencies were found that were communicated to concerned MS 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 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

[69] 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 modeling. 266, 144-171.

[70] 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

[71] 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

[72] 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

The following improvements were introduced to address the recommendations received from the UNFCCC's ERT; to correct issues identified during our internal quality control process and/or the results of our internal peer review:

- More references have been introduced to the work carried out along with MS to address identified issues. For instance, as requested by the ERT, we have provided explicit information from Italy on why its reporting on the subcategory 4.A. does not result in bias estimates.
- Sections 6.4.1, 6.4.2 and 6.4.3 have been reformulated to allow readers a better undertstanding of the QA/QC process implemented on LULUCF.
- 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.
- The overall completeness of the sector has been increased (see details in section 6.1.3). For instance, this year Belgium provided information on carbon stock change in HWP for the entire time series.
- Explicit information on the improvement plan of Luxembourg for the reporting of dead organic matter under forest land has been added.
- More detailed explanations have been included across the sections to explain the underlying reasons for the use of the notation key NE. For instance for the reporting of Forest land by Malta.
- Correction of identified typo errors introduced across the text.
- Correction of some of the inconsistencies identified across the activity data reported in CRF tables 4.1 and 4.A-4.F. More improvement are expected on this regards in next submission.
- The information on Wetlands category has been improved with the addition of more tables.
- In section 6.2.2.3, new text has been added to describe the improvements that have been implemented this year to increase the complements, including the use of higher tiers, and the explanation of why France uses the notation key NE for reporting the conversion from Other land to Cropland as was requested by ERT.
- A new table on HWP information has been added to harmonize the type of tables across the sections.
- The table 6.5 was improved with the addition of one column to report separately information on DW and LT. In addition, in that section information on improvements done on completeness was added to highligh changes with respect to previous year.
- More transparent explanations of the planned improvements have been added.

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 no resolved this year are addressed.
- Follow up individual submissions to enhance the harmonization of the use of notation keys for the implementation of the IPCC assumption of equilibrium, under Tier 1 methods.
- Follow up the submission of Luxembourg to track the planned improvement to be implemented in the reporting of dead wood in forest along the time series.
- 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)
- Continue assessing the need for updating and improving the text across the different sections.

6.5 Sector-specific recalculations, including changes in response of to the review process and impact on emission trend

Table 6. 43 to Table 6. 48 provide information on the contribution of member States to EU-28+ISL recalculations in sectors 4A, 4B, 4C, 4D, 4E and 4F (all GHGs) for 1990 and 2016 and main explanations for the largest recalculations in absolute terms.

Table 6. 43 4A Forest Land: Contribution of MS to EU-28+ISL Recalculations in CO_2 for 1990 and 2016 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	774	30.8	1 722	53.3	CO_2 emissions of wildfires were excluded during this submission. The reason for this correction is that these emissions are considered implicitly included in the carbon stock change method. Revisions in Wallonia of forest inventory data and BEF. Soil organic carbon in Forest land remaining Forest land is now assumed stable (no change in SOC, following IPCC Tier 1 approach), taking into account the 2018 review findings and the latest results from studies (see section 6.2.2.1.C)
Bulgaria	1 440	10.1	-2 355	-38.6	In the current submission emissions and removals from DOM and soil in subcategory FLrFL are assumed to be 0 (Tier 1 assumption). This has been changed since Submissions 2017 and 2018, where Bulgaria reported emissions and removals from these pools by using directly and then extrapolating the results from a study, conducted by JRC and published in a report. Bulgaria understands that using the results from this study leads to a lack of comparability between the methods and assumptions used to estimates the changes in the living biomass pool and the methods and assumptions used to calculate the carbon stock changes in deadwood, litter and soil, estimated by CBM
Croatia	6	0.1	32	0.6	Ccorrections in litter estimation; estimation for the dead wood pool has been performed; corrections in emissions due to the fires
Cyprus	17	18.3	-7	-2.3	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	458	8.9	407	8.9	Estimates of carbon stock change in biomass was revised, including the newly acquired data on mortality of the Czech National Forest Inventory. See CZE NIR, for further details.
Denmark	11	1.8	-14	-1.6	Minor adjustments, as a consequence of updated Land Use Matrix and related area estimates.
Estonia	-159	-5.0	-164	-5.2	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. Soil emission factors were updated for Land remaining forest land and Land converted to forest land.
Finland	-1 219	-5.4	7 551	20.9	New area estimates were calculated due to the updating of NFI data (see Section 6.2). Gains were recalculated due to new NFI data. CSCs in mineral soils were recalculated due to new and differently applied weather data. N_2O emissions on drained organic soils were recalculated due to correction of erroneous EF. For biomass burning EFs from 2006 Guidelines were applied.

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
France	1 987	4.9	1 129	2.0	AD change slightly due to the incorporation of a new teruti dataset for 2015 which modifies the results over the entire period covered. It is this modification on the surfaces that causes a slight change in gains over the period before 2014. After 2014, the data are significantly updated thanks to the addition of a new IGN campaign. This update also impacts the years after 2014 which are obtained by average of the previous five years. Throughout the series, the losses have been modified downward or upward depending on the case mainly due to the smoothing of data on wood energy consumption over 3 years that are taken into account in the calculation of the samples (they were only smoothed over 2 years ago).
Germany	-	-	-	-	
Greece	-	-	-0	-0.0	
Hungary	0	0.0	0	0.0	This year, the recalculations in the forestry sector only included recalculations of indirect N_2O emissions from leaching and run off related to N mineralization associated with loss of SOM where the entire time series where a formula had to be corrected; and revising the entire time series of the area of mineral soils where a formula had to be corrected.
Ireland	-1 169	-43.4	-931	-24.0	Ireland has in this submission used the CBM model for the first time to derive emission and removal estimates for the sector
Italy	-217	-1.2	-991	-2.7	Update of land use and land use change data derived from the IUTI assessment of 2016, affecting the ratio of annual land use change data
Latvia	616	3.4	-71	-1.9	Recalculations are introduced due to continuous improvement of activity data. CO_2 emissions from biomass burning are recalculated to avoid of double accounting - CO_2 emissions due to controlled burning are already reported as losses in living biomass.
Lithuania	-0	-0.0	2 678	24.6	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service (started in 2017). Database review was done 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. 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 yeas were replaced with actual values.
Luxembourg	76	31.8	39	7.0	revision of AD and method: time series for wood harvest was modified and is now based on harvest per area applied to total forest land
Malta	-	-	-	-	
Netherlands	78	4.3	450	19.8	First a new land-use map representing land-use on 1 January 2017 was included. As a result now the actual land-use changes observed between the previous land-use map of 1 January 2013 and the new map have been used. This replaces the previous estimates of land-use changes from 2013 onwards that were based on the extrapolation of changes observed in the land-use change matrix 2009-2013.
Poland	-	-	5	0.0	
Portugal	-	-	-	-	
Romania	1 300	5.2	191	0.8	CO_2 emissions from this category were recalculated for entire time series, do to updating/correcting of activity data
Slovakia	66	0.8	123	2.6	Carbon fraction of dry matter specified in accordance with IPCC 2006 Guidelines (0.48 for broadleaves and 0.51 for conifers). This led to recalculation of in recalculation of CO_2 in the whole time period since 1990 in 4.A.1 and 4.A.2 categories.
Slovenia	-406	-9.8	3 125	60.8	Recalculations were performed due to inclusion of new forest data from the FECS. As forest were subject to substantial natural disturbances since 2014, the removals in

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
					this category were decreased. The trend in the period 2012-2017 was corrected by applying the surrogate method. The net emissions were correlated by the wood production amount from FAOSTAT database.
Spain	2 657	7.5	2 216	5.9	New country specifi data for BECF, R and carbon fraction. New biomass stock value for DW. Incorporation of updated information on AD.
Sweden	1 081	2.8	-1 503	-3.5	Recalculation due to changes in activity data (areas and carbon stocks)
United Kingdom	2 420	13.9	5 700	23.7	Improvements and corrections to forestry model and forestry activity data updates.
EU28	9 817	2.4	19 331	4.6	
Iceland	-	-	-0	-0.0	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
United Kingdom (KP)					Improvements and corrections to forestry model and forestry activity data updates.
EU28+ISL	7 397	1.9	13 631	3.4	

Table 6. 44 4B Cropland: Contribution of MS to EU-28+ISL Recalculations in CO_2 for 1990 and 2016 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	1	0.3	-90	-229.9	The 2014, 2015 and 2016 values of the cropland areas and the LUC areas between grassland and cropland of 2015 and 2016 had to be updated according to the most recent agricultural statistics which has an impact on the C stock changes in these years.
Belgium	-3	-1.1	-40	-3.2	Above ground biomass annual gain in new orchards is now calculated considering a period of 10 years to reach a steady state. The average C stock in orchards has been revised, using data which better reflects the orchards type encountered in Belgium.
Bulgaria	-	-	-	-	
Croatia	-	-	4	1.3	Ccorrections in litter estimation; estimation for the dead wood pool has been performed;
Cyprus	-1	-0.6	-0	-0.2	NA
Czechia	-27	-13.2	-57	-47.9	Land converted to Cropland were altered due to changes made in categories Forest land and Settlemens, which are pronounced in emission estimates for the associated land use conversions to Cropland. These changes resulted in altered emissions for the entire category 4.B Cropland
Denmark	-49	-1.1	-642	-19.4	Minor adjustments, as a consequence of updated Land Use Matrix and related area estimates.
Estonia	75	15.1	-320	-50.3	Updated data about management of mineral soils.
Finland	-201	-3.6	53	0.7	New area estimates were calculated due to the updating of NFI data (see Section 6.2). CSCs in mineral soils were recalculated due to new and differently applied weather data, and harmonization harmonisation of estimation between land use categories.
France	-2	-0.0	-626	-3.7	AD change slightly due to the incorporation of a new teruti dataset for 2015, which modifies the results over the entire period covered and has a significant impact on changes between grasslands and crops since 2004.
Germany	-	-	-0	-0.0	
Greece	-	-	-86	-52.8	Update of the land use, land-use change matrices for the period 1990 – 2017. Inclusion in the NIR of a complete set of both annual and 20-years land use, land-use change matrices for the period 1990 – 2017 following previous ERT's recommendation. Update of croplands area in 2014, 2016 as a result of the final 2016 ELSTAT report.
Hungary	-	-	-	-	
Ireland	7	45.0	-5	-3.9	Revised assessment of crop and temporary grassland areas
Italy	-	-	-1 361	-55.3	The 2016 estimates for cropland category has been recalculated on the basis of the updated activity data (i.e. area

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
					of annual and woody crops in cropland remaining cropland and land converted to cropland).
Latvia	1	0.0	783	38.6	Recalculations are introduced due to continuous improvement of activity data.
Lithuania	-0	-0.0	-246	-9.4	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.
Luxembourg	-	-	-3	-8.1	revision of AD : land use changes between cropland and grassland now based on data from LPIS database from 2009-2017
Malta	-	-	-	-	
Netherlands	169	10.3	-1 005	-36.5	Use of updated soil and land use maps
Poland	-135	-12.7	-361	-49.2	Update of initial biomass C stock values for annual crops for 1988-2016
Portugal	-	-	-	-	
Romania	115	5.1	84	3.9	Part of the activity data have been updated
Slovakia	-216	-29.5	17	1.4	Implemented improvement according to the review recommendations - perennial and annual cropland split was introduced - please see Chapter LULUCF
Slovenia	-141	-621.5	-31	-24.1	Improved AD, improved EF (biomass and mineral soil)
Spain	789	102.1	-306	-10.3	New activity data on woody crops and information on their management practices.
Sweden	41	1.3	-66	-1.8	Recalculation due to changes in activity data (carbon stock change due to land use change) Recalculation due to changes in activity data (areas and carbon stocks)
United Kingdom	-768	-5.1	-436	-3.8	Updated emission factors used for non-forest biomass CSC as a result of LUC.
EU28	-344	-0.5	-4 740	-7.4	
Iceland	-	-	-0	-0.0	Revised area estimates
United Kingdom (KP)					Updated emission factors used for non-forest biomass CSC as a result of LUC.
EU28+ISL	424	0.7	-4 304	-7.9	

Table 6. 45 4C Grassland: Contribution of MS to EU-28+ISL Recalculations in CO_2 for 1990 and 2016 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	0	0.1	
Belgium	-15	-4.1	-138	-28.4	Belgium: Soils C is now considered stable since 2000 (soil represented a sink of about 1350 kt CO_2 in recent years). In Wallonia, adjustments were also brought to the biomass estimates (impact: reduction of the sink of around 350 kt): adjustment of the regional forest inventory volume took place in 2018. Although the impact of these revision is limited regarding the total wood volume (2 to 3 % of the total volume), they do have a much more significant impact on the carbon stock change estimate according to stock difference method, as the total volume stock change between 2001 and 2012 was diminished by around 22%. The central year of the last cycle was also revised (2012 instead of 2011), according to progress of the ongoing second cycle of the permanent forest inventory and the number of sampling plots measured up to now
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	0	0.0	
Czechia	-43	-44.8	-72	-10.9	Land converted to Grassland were recalculated due to changes made in categories Forest land and a newly implemented soil estimate applicable to Settlements, which are pronounced in emission estimates for the associated land use conversions to Grassland.
Denmark	7	0.8	-362	-32.2	Minor adjustments, as a consequence of updated Land Use Matrix and related area estimates.
Estonia	5	10.4	13	42.7	Adjustment of BCEFS values, updated emission factors for mineral and organic soils.

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Finland	38	4.4	-9	-1.3	New area estimates were calculated due to the updating of NFI data (see Section 6.2). CSCs in mineral soils were recalculated due to new and differently applied weather data, and harmonization harmonisation of estimation between land use categories.
France	1	0.0	1 620	15.6	AD change slightly due to the incorporation of a new teruti dataset for 2015, which modifies the results over the entire period covered and has a significant impact on changes between grasslands and crops since 2004.
Germany	-0	-0.0	-	-	
Greece	-	-	-74	-5.6	Update of the land use, land-use change matrices for the period 1990 – 2017. Inclusion in the NIR of a complete set of both annual and 20-years land use, land-use change matrices for the period 1990 – 2017 following previous ERT's recommendation
Hungary	-	-	-35	-40.2	Corrections of last year's transcription errors.
Ireland	-465	-6.3	-369	-5.4	Revised assessment of grassland areas, soil characteristics (mineral vs organic) and grassland management regimes
Italy	0	0.0	-99	-1.5	Update of land use and land use change data derived from the IUTI assessment of 2016, affecting the ratio of annual land use change data, including land converted to grassland; land use changes have been derived, by the way of land use change matrices, smoothing the amount of changes over a 5 year period, harmonizing the whole time series. Recalculation of the C released from fires occurred in shrubland
Latvia	10	0.5	-59	-5.4	Recalculations are introduced due to continuous improvement of activity data.
Lithuania	0	0.0	-4	-0.5	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service (started in 2017). Database review was done 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	-	-	3	6.3	revision of AD: land use changes between cropland and grassland (see CRF 4.B. - Cropland) from 2008-2017
Malta	-	-	-	-	
Netherlands	149	2.8	-360	-8.6	First a new land-use map representing land-use on 1 January 2017 was included. As a result now the actual land-use changes observed between the previous land-use map of 1 January 2013 and the new map have been used. This replaces the previous estimates of land-use changes from 2013 onwards that were based on the extrapolation of changes observed in the land-use change matrix 2009-2013.
Poland	4	0.6	4	0.5	Update of initial biomass C stock values for grassland and annual crops for 1988-2016
Portugal	-	-	-	-	
Romania	252	125.4	321	243.1	Emissions from this category were recalculated for entire time series, do to updating/correcting of activity data. Revegetation removals and emissions related estimates were maintained, considering total area managed as revegetated land in each of the base year and commitment period years
Slovakia	-2	-1.0	-0	-0.0	Carbon fraction of dry matter specified in accordance with IPCC 2006 Guidelines (0.48 for broadleaves and 0.51 for conifers). This led to recalculation of in recalculation of CO_2 in the whole time period since 1990 in 4.C.2 category.
Slovenia	240	55.8	-407	-947.8	Emissions were recalculated due to inclusion of new data on biomass growth obtained from SORS as well as biomass growth after conversion to perennial grassland, which improved EFs. In the NIR 2019 soil carbon stock values were updated, excluding forest land, based on data from soil monitoring, carried out on agricultural land (Mali et al., 2016, Mali et al., 2017, Mali et al., 2018).
Spain	14	0.5	20	8.8	New biomass stock value of dead wood wich impact the transition FLcGL.
Sweden	429	345.7	327	319.1	Recalculation due to changes in activity data (areas and carbon stocks)
United Kingdom	647	8.3	714	7.6	Updated emission factors used for non-forest biomass CSC as a result of LUC.
EU28	1 271	5.2	1 035	32.2	
Iceland	-1 488	-22.9	-1 694	-23.5	Revised area estimates
United Kingdom (KP)					Updated emission factors used for non-forest biomass CSC as a result of LUC.

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
EU28+ISL	-865	-2.2	-1 372	-6.9	

Table 6. 46 4D Wetlands: Contribution of MS to EU-28+ISL Recalculations in CO_2 for 1990 and 2016 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	-4	-21.7	0	3.6	update of areas in the three regions following last data available.
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czechia	0	1.1	1	2.0	The changes reflect the improvements made in the category of Forest land and the land use conversion from that category
Denmark	-0	-0.0	-1	-3.3	Minor adjustments, as a consequence of updated Land Use Matrix and related area estimates.
Estonia	-11	-1.0	-4	-0.7	Updated activity data
Finland	-220	-15.4	-31	-1.5	New area estimates were calculated due to the updating of NFI data (see Section 6.2). N_2O emissions on drained organic soils were recalculated due to correction of erroneous EF
France	-	-	21	4.2	
Germany	-	-	-	-	
Greece	-	-	-	-	
Hungary	-	-	-	-	
Ireland	-1	-0.1	82	4.0	Revised assessment of wetland areas that impacted the final estimates.
Italy	-	-	79	100.0	
Latvia	217	20.6	-145	-10.2	Recalculations are introduced due to continuous improvement of activity data and due to implementation of country specific data of area of peat extraction remaining peat extraction. Emissions are reported in new categories - 4.D.2.3 Land Converted to Other Wetlands (Net carbon stock change in organic soils); 4(II) Rewetted organic soils.
Lithuania	-0	-0.0	-0	-0.0	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service (started in 2017). Database review was done 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	-	-	-	-	
Malta	-	-	-	-	
Netherlands	1	0.9	-16	-27.0	First a new land-use map representing land-use on 1 January 2017 was included. As a result now the actual land-use changes observed between the previous land-use map of 1 January 2013 and the new map have been used. This replaces the previous estimates of land-use changes from 2013 onwards that were based on the extrapolation of changes observed in the land-use change matrix 2009-2013
Poland	-3 907	-86.7	-3 177	-70.7	Update of biomass C stock values for land use transitions
Portugal	-	-	-	-	
Romania	-	-	13	0.9	Part of the activity data have been updated
Slovakia	-	-	-	-	
Slovenia	-0	-13.6	-24	-92.9	Improved AD, improved EF (biomass and mineral soil)
Spain	0	0.0	16	61.5	New data on peat prodduction. New biomass stock value of dead wood wich impact the transition FLcWL
Sweden	-	-	-	-	
United Kingdom	0	0.0	-7	-2.2	New activity data on area of peat extraction.
EU28	-3 925	-22.2	-3 193	-16.7	
Iceland	-551	-82.0	-576	-97.5	Revised area estimates
United Kingdom (KP)					New activity data on area of peat extraction.
EU28+ISL	-4 477	-27.2	-3 762	-20.7	

Table 6. 47 4E Settlements: Contribution of MS to EU-28+ISL Recalculations in CO_2 for 1990 and 2016 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-7	-1.3	15	4.0	The emission factor for annual settlement biomass was also adjusted for the improved information on the sealed share of settlement area introduced a few years ago
Belgium	-16	-10.1	-149	-17.0	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 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.
Bulgaria	-	-	56	7.8	Recalculations are due to N_2O emissions from N mineralization associated with loss of soil organic matters resulting from change of land use have been included in the current submission.
Croatia	-41	-19.9	-140	-20.8	corrections in litter estimation; estimation for the dead wood pool has been performed;
Cyprus	-	-	-	-	
Czechia	949	1 099.1	412	331.9	the estimates for soil carbon pools are newly introduced for Settlements in this inventory submission
Denmark	4	30.2	-23	-14.7	Minor adjustments, as a consequence of updated Land Use Matrix and related area estimates.
Estonia	-	-	16	6.8	Updated emission factors for litter and soil
Finland	-6	-0.6	149	26.1	New area estimates were calculated due to the updating of NFI data (see Section 6.2).
France	11	0.1	206	1.9	AD change slightly due to the incorporation of a new teruti dataset for 2015, which modifies the results over the entire period.
Germany	0	0.0	-0	-0.0	
Greece	-	-	-	-	
Hungary	-	-	-	-	
Ireland	-0	-0.0	-19	-20.8	Revised assessment of lands converted to settlements
Italy	-0	-0.0	-3 839	-42.6	Update of land use and land use change data derived from the IUTI assessment of 2016, affecting the ratio of annual land use change data, including land converted to grassland; land use changes have been derived, by the way of land use change matrices, smoothing the amount of changes over a 5 year period, harmonizing the whole time series.
Latvia	2	5.2	45	7.2	Recalculations are introduced due to continuous improvement of activity data.
Lithuania	0	0.2	-12	-1.8	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service (started in 2017). Database review was done 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	-	-	-	-	
Malta	-	-	-	-	
Netherlands	40	4.6	-149	-9.2	Use of updated soil and land use maps
Poland	25	5.2	313	4.3	Recalculation of CO_2, CH_4 and N_2O emissions from on-site degradation of the peat combined with mined loss of organic matter
Portugal	-	-	-	-	
Romania	-17	-0.5	-171	-4.4	Part of the activity data have been updated
Slovakia	-0	-0.2	-0	-0.1	Carbon fraction of dry matter specified in accordance with IPCC 2006 Guidelines (0.48 for broadleaves and 0.51 for conifers). This led to recalculation of in recalculation of CO_2 in the whole time period since 1990 in 4.E.2 categories.
Slovenia	55	15.9	-57	-22.3	Improved AD, improved EF (biomass and mineral soil)
Spain	11	1.6	47	4.0	New biomass stock value of dead wood wich impact the transition FLcSL.
Sweden	-7	-0.3	-341	-13.6	Recalculation due to changes in activity data (areas and carbon stocks)
United Kingdom	106	1.5	113	1.8	Updated emission factors used for non-forest biomass CSC as a result of LUC.
EU28	1 107	3.1	-3 529	-6.6	
Iceland	10	79.0	1	23.6	Revised area estimates
United Kingdom (KP)					Updated emission factors used for non-forest biomass CSC as a result of LUC.
EU28+ISL	1 012	3.5	-3 641	-7.8	

Table 6. 48 4F Other land: Contribution of MS to EU-28+ISL Recalculations in CO_2 for 1990 and 2016 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2016		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	-	-	-	-	
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czechia	-	-	-	-	
Denmark	-	-	-	-	
Estonia	-	-	-5	-17.9	Updated emission factors for litter and soil
Finland	-	-	-	-	
France	-	-	-	-	
Germany	-	-	-	-	
Greece	-	-	-	-	
Hungary	-	-	-	-	
Ireland	0	46.4	-12	-81.8	Revised assessment of area of other land
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-	-	0	0.0	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service (started in 2017). Database review was done 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	-	-	-	-	
Malta	-	-	-	-	
Netherlands	0	0.7	24	18.3	Use of updated soil and land use maps
Poland	-	-	-	-	
Portugal	-	-	-	-	
Romania	-4	-0.5	-37	-4.4	Part of the activity data have been updated
Slovakia	-2	-0.8	-0	-0.3	Carbon fraction of dry matter specified in accordance with IPCC 2006 Guidelines (0.48 for broadleaves and 0.51 for conifers). This led to recalculation of in recalculation of CO_2 in the whole time period since 1990 in 4.F.2 category.
Slovenia	1	9.0	-16	-75.2	Improved AD, improved EF (biomass and mineral soil)
Spain	-0	-0.0	-0	-0.0	
Sweden	-34	-12.9	-2	-25.0	Recalculation due to changes in activity data (areas and carbon stocks)
United Kingdom	-	-	-	-	NA
EU28	-39	-1.2	-49	-46.5	
Iceland	-	-	-	-	
United Kingdom (KP)					NA
EU28+ISL	-39	-1.2	-49	-46.5	

7 WASTE (CRF SECTOR 5)

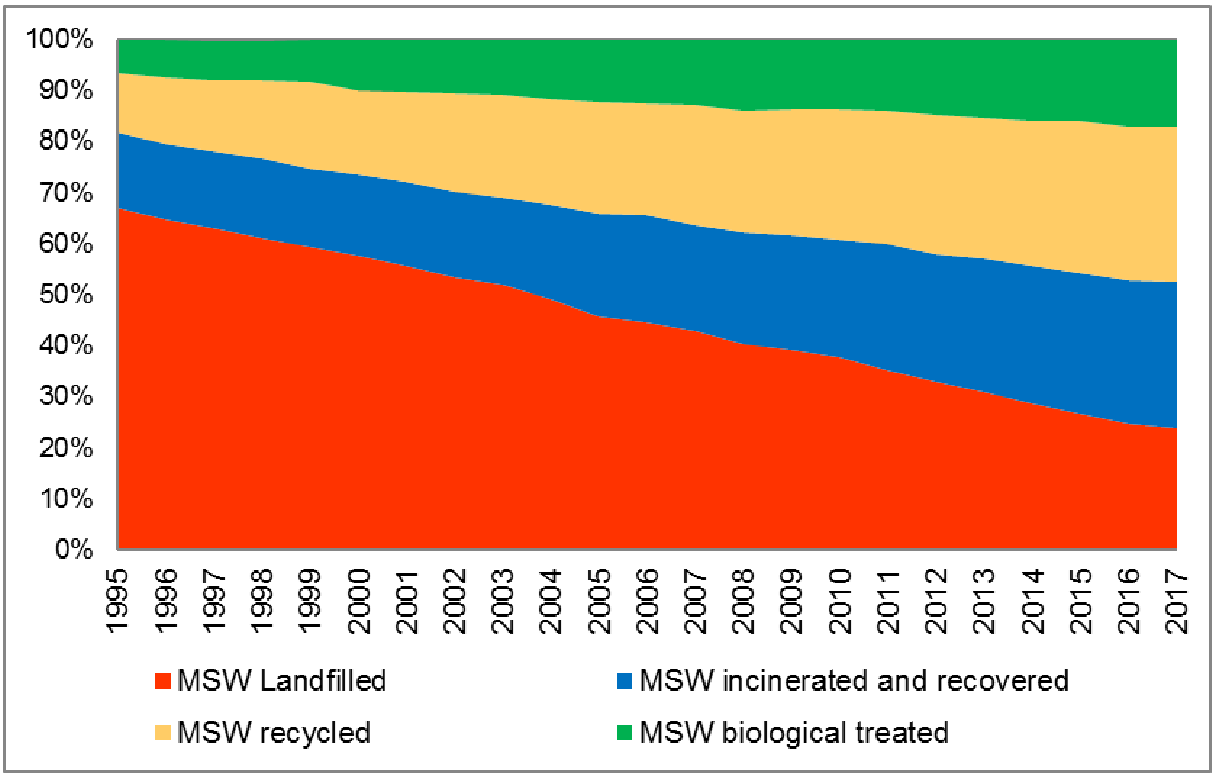
GHG emissions in the waste sector are generated from the treatment and disposal of liquid and solid waste. According to the IPCC 2006 Guidelines emission estimates in the waste sector need to be carried out for four subcategories:

- 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 waste treatments over the time series 1995 to 2017 based on activity data for municipal waste. 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 and 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 Member States 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 2017 the amount of municipal waste landfilled is continuously decreasing in the EU Member States and Iceland and other waste treatment methods like recycling, biological treatment of waste and waste incineration with energy recovery are applied more. In 1995 67 % of waste has been landfilled, 15 % was incinerated, 12 % recycled and only 7 % of the waste has been composted or digested. In 2017 the share of waste landfilled decreased to 24 % of total waste treated while incineration including energy recovery increased to 29 %, recycling increased to 30 % and biological treatment of waste makes up 17 % of total municipal solid waste (MSW) treated.

Figure 7.1 Sector 5 Waste: Development of municipal waste treatment in the EU-28+ISL

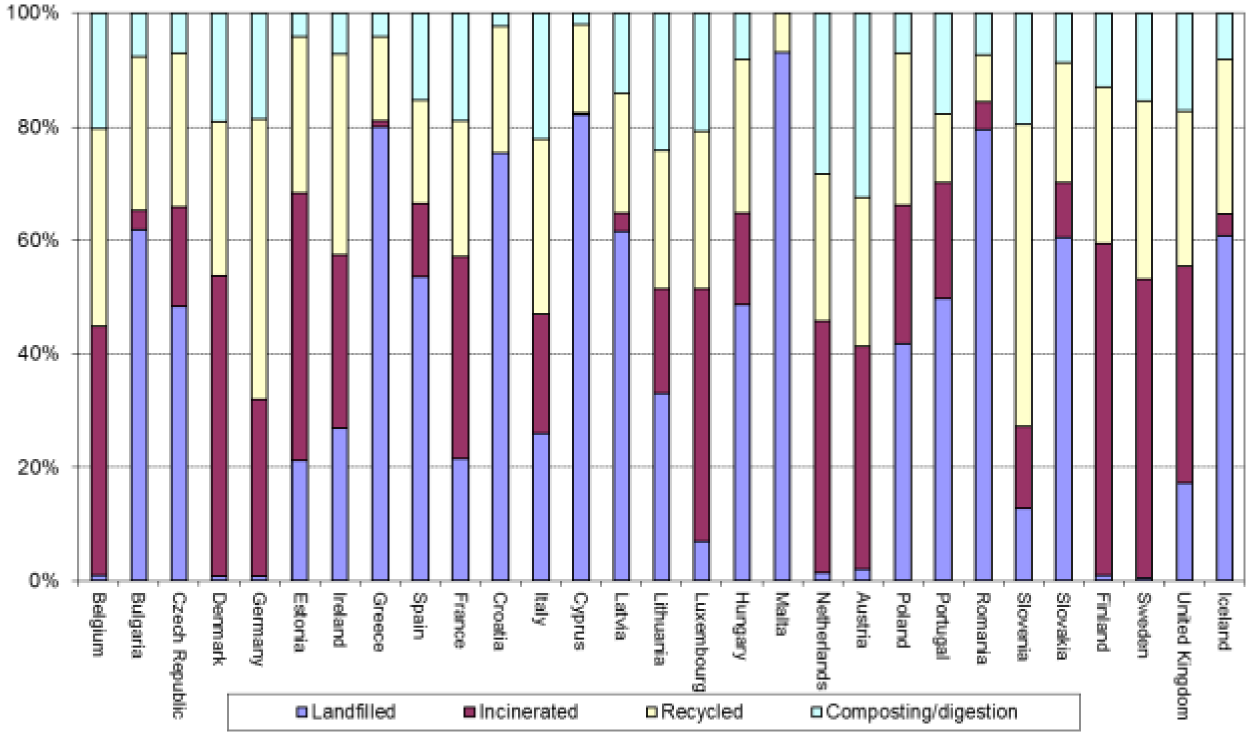


Note: Missing 2013, 2015 and 2017 data for Ireland, 2010 data for Denmark and 2017 data for Iceland have been gap filled by using previous year value,
Source: EUROSTAT 2019, own calculation

Many Member States 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 Member States in 2017 (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 Member States. For example, disposing municipal waste on SWDS is the predominant (>60%) municipal waste disposal route in Bulgaria, Greece, Croatia, Cyprus, Latvia, Malta and Romania with correspondingly fewer quantities of waste incinerated, recycled or biological treated. In Belgium, Denmark, Germany, 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-28+ISL (shares) in 2017



Note: In comparison to Inventory data Eurostat data only contains municipal solid waste and does not contain industrial waste and sludge ; Data concerning Ireland, Iceland and Latvia relate to 2016
Source: EUROSTAT 2019, own calculations

7.1 Overview of sector

CRF Sector 5 Waste is the fourth largest sector in the EU-28+ISL, after energy, agriculture and industrial processes, contributing 3 % to total GHG emissions without LULUCF in 2017. Total emissions from waste decreased by 42 % from 241 Mt in 1990 to 139 Mt in 2017 (Figure 7.3). In 2017, emissions decreased by 1 % compared to 2016.

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 87 % of total emission reductions in the waste sector (between 1990 and 2017). Emissions from the waste sector show a continuously decreasing trend during the last years, but as many Member States 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 Member States, the declining emission trend is slowing down.

Figure 7.3 Sector 5 Waste: EU-28+ISL GHG emissions, 1990-2017

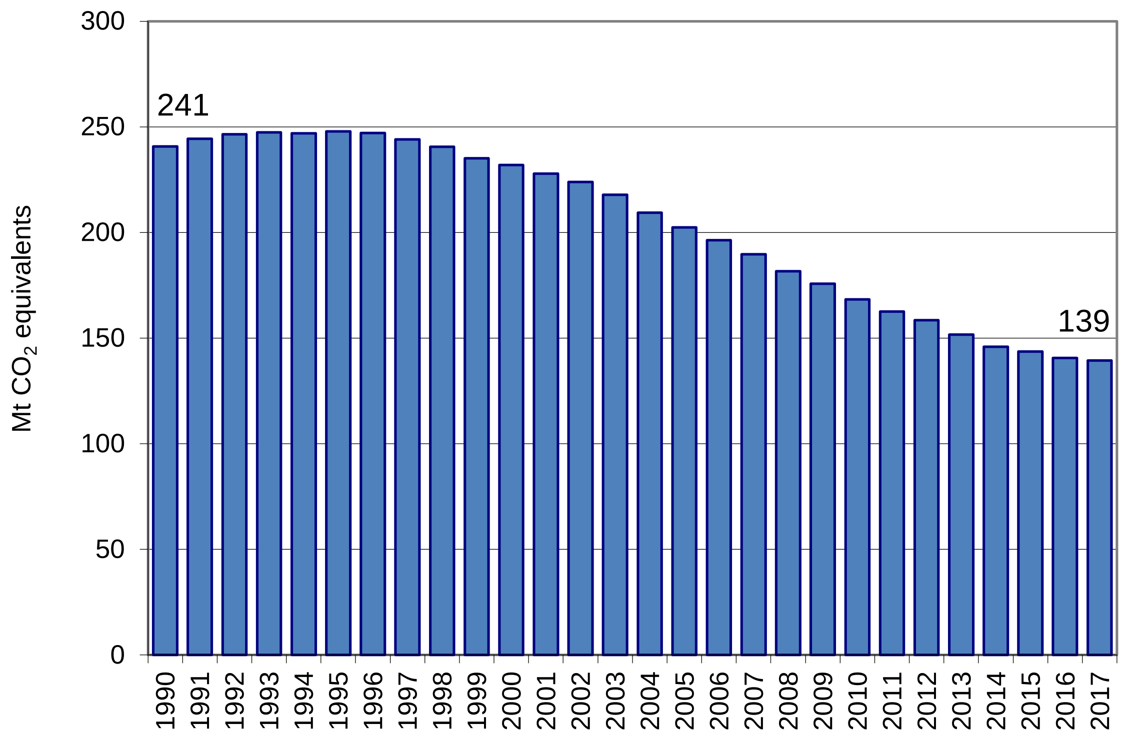
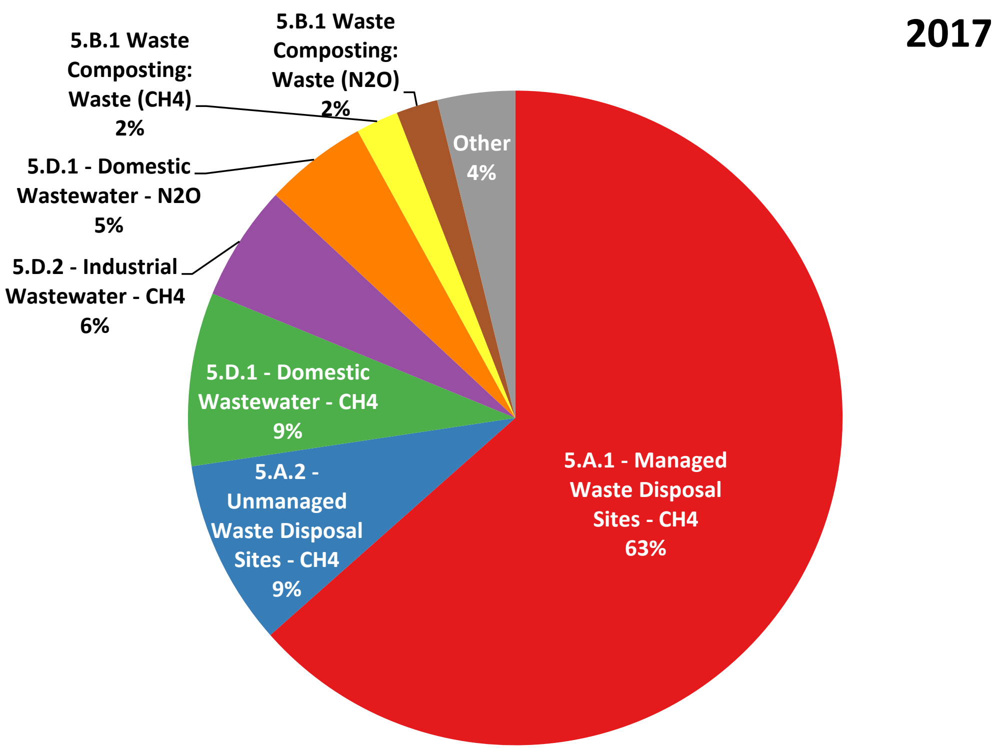


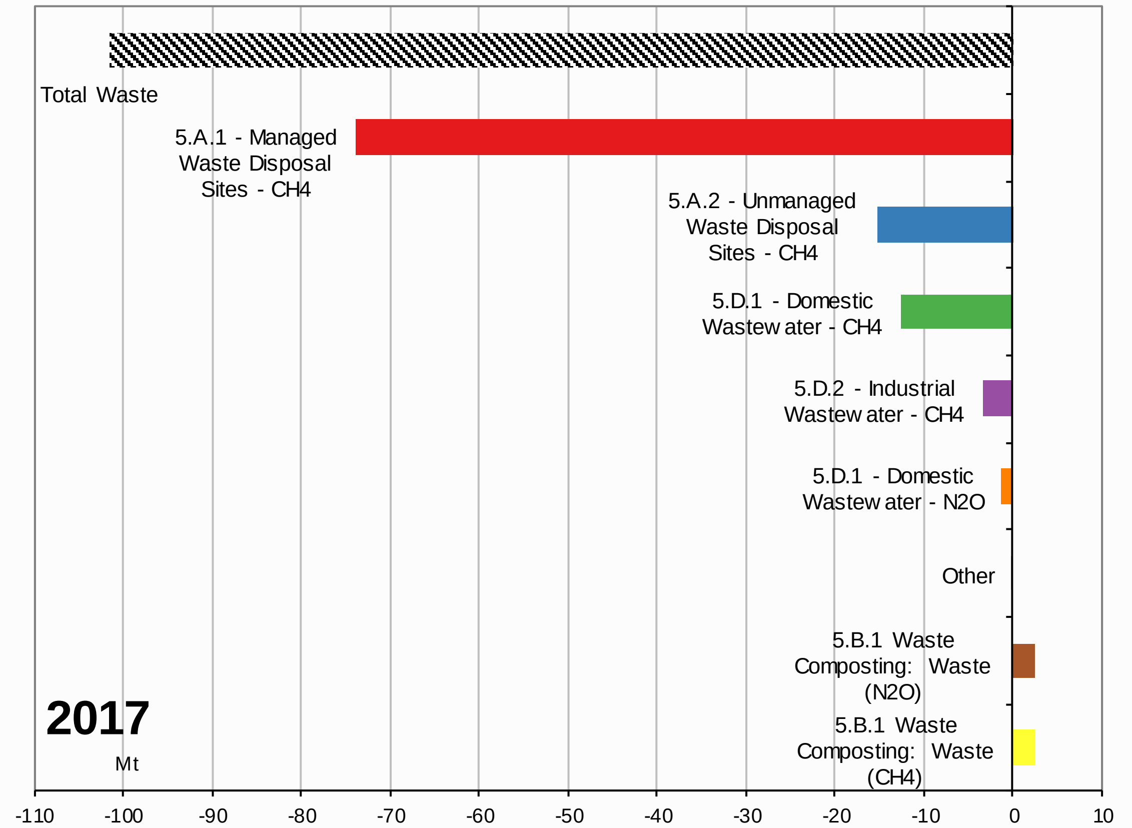
Figure 7.5 shows that CH_4 emissions from 5A1 Managed Waste Disposal on Land had the greatest decrease of all waste-related emissions, but still accounts for 63 % of waste-related GHG emissions in the EU-28+ISL in 2017 as shown in Figure 7.4.

Figure 7.4 Sector 5 Waste: Share of key source categories and all remaining categories in 2017



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

Figure 7.5 Sector 5 Waste: Absolute change between 1990 and 2017 of GHG emissions (in CO_2 equivalents) by large key source categories



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 Member States 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 Member States' national inventory reports will be provided in the Annex III.

In this section we present information relevant for the EU-28+ISL key source categories in the sector 5 Waste. Source categories considered in detail are:

Table 7.1 Key source categories for level and 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	2017		1990	2017	
5.A.1 Managed Waste Disposal Sites: Waste (CH_4)	160227	87422	T	L	L	96 %
5.A.2 Unmanaged Waste Disposal Sites: Waste (CH_4)	28118	12787	T	L	L	100 %
5.B.1 Waste Composting: Waste (CH_4)	378	2892	T	0	0	30 %
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	24495	11904	T	L	L	48 %
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	8268	6996	0	0	L	23 %
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	11286	7937	0	L	L	42 %

The share of higher Tier corresponds to the share of EU emissions documented by member states reporting the method as an IPCC Tier 2 method (T2) or a country-specific method (CS), or member states reporting EF as country-specific (CS). Almost all Member States 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 Member States using a higher Tier method is much lower. For CH_4 emissions from composting (5.B.1) Germany mainly influences the share of higher Tiers because Germany has the highest share for this gas (11 %) in this category and is using a higher Tier. For CH_4 emissions from domestic wastewater treatment (5.D.1) Poland, which represents 19% of the EU emissions from this category, mainly influences the share of higher Tiers. For CH_4 emissions from industrial wastewater Spain and Greece contribute respectively 15% and 11% to the 42 % 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 4.2.6). 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 (1990-2017) 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 2017.

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 2006 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 47 % between 1990 and 2017 in the EU-28+ISL. Sixteen EU-28 Member States reduced their emissions from this source, while Croatia, Cyprus, the Czech Republic, Greece, Hungary, Italy, Latvia, Malta, Portugal, Romania, Slovakia, Spain and Iceland did not. In many of these Member States waste disposal changed from unmanaged to managed landfills during the time period 1990 and 2017 which leads to increasing CH_4 emissions from managed landfills.

Table 7.2 5A Solid Waste Disposal on Land: Member States' + ISL contributions to total GHG emissions and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2017 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2017 (kt)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2017 (kt CO2 equivalents)
Austria	3 644	1 114	NO,NA	NO,NA	3 644	1 114
Belgium	3 053	857	NA,NO	NO,NA	3 053	857
Bulgaria	4 945	2 832	NO	NO	4 945	2 832
Croatia	539	1 775	NA,NO	NO,NA	539	1 775
Cyprus	258	476	NA,NO	NO,NA	258	476
Czechia	1 979	3 720	NE,NO	NO,NE	1 979	3 720
Denmark	1 536	593	NO,NA	NO,NA	1 536	593
Estonia	214	211	NO,NA	NO,NA	214	211
Finland	4 328	1 533	NO	NO	4 328	1 533
France	12 594	12 333	NA	NA	12 594	12 333
Germany	34 250	8 075	NO,NA	NO,NA	34 250	8 075
Greece	2 243	3 239	NA,NO	NO,NA	2 243	3 239
Hungary	2 562	2 828	NO,NA	NO,NA	2 562	2 828
Ireland	1 318	742	NO	NO	1 318	742
Italy	12 206	13 645	NO,NA	NO,NA	12 206	13 645
Latvia	283	403	NO,NA	NO,NA	283	403
Lithuania	1 029	772	NO,NA	NO,NA	1 029	772
Luxembourg	92	51	NO,NA	NO,NA	92	51
Malta	41	141	NO,NA	NO,NA	41	141
Netherlands	13 679	2 569	NO,NA	NO,NA	13 679	2 569
Poland	14 166	8 816	NO,NA	NO,NA	14 166	8 816
Portugal	2 821	3 593	NO	NO	2 821	3 593
Romania	1 372	3 613	NA	NA	1 372	3 613
Slovakia	646	1 141	NO	NO	646	1 141
Slovenia	433	341	NA,NO	NO,NA	433	341
Spain	5 474	10 368	NO,NA	NO,NA	5 474	10 368
Sweden	3 422	841	NO,NA	NO,NA	3 422	841
United Kingdom	60 203	14 078	NO,NE	NO,NE	60 203	14 078
EU-28	**189 331**	**100 702**	**NE,NA,NO**	**NE,NA,NO**	**189 331**	**100 702**
Iceland	158	205	NO	NO	158	205
United Kingdom (KP)	60 367	14 244	NO,NE	NO,NE	60 367	14 244
EU-28 + ISL	**189 653**	**101 073**	**NE,NA,NO**	**NE,NA,NO**	**189 653**	**101 073**

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 % of total EU-28+ISL GHG emissions. Between 1990 and 2017, CH_4 emissions from managed landfills declined by 45 % in the EU-28+ISL.

Thirteen EU-28 Member States reduced their emissions from this source during that period while Croatia, the Czech Republic, Greece, Hungary, Italy, Portugal, Spain and Iceland did not. Bulgaria, Cyprus, Estonia, Ireland, Latvia, Malta, Romania and Slovakia did not report CH_4 emissions from managed landfills in 1990. In 2017, CH_4 emissions from managed landfills decreased by 0,3% compared to 2016.

Table 7.3 5A1 Managed Waste Disposal on Land: Member States'+ ISL contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 1995-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	3 644	1 186	1 114	1.3%	-2 530	-69%	-2 241	-67%	-72	-6%	T2	CS,D
Belgium	3 053	887	857	1.0%	-2 196	-72%	-2 511	-75%	-30	-3%	T2	D
Bulgaria	NO	1 034	1 075	1.2%	1 075	∞	1 075	∞	41	4%	T2	CS,D
Croatia	27	1 546	1 616	1.8%	1 589	5957%	1 572	3545%	71	5%	T2	CS
Cyprus	NO	68	76	0.1%	76	∞	76	∞	8	11%	T2	D
Czechia	1 979	3 671	3 720	4.3%	1 741	88%	1 315	55%	49	1%	T1	CS,D
Denmark	1 536	619	593	0.7%	-944	-61%	-739	-55%	-27	-4%	CS,T2	CS,D
Estonia	NO	214	211	0.2%	211	∞	-43	-17%	-3	-2%	T2	D
Finland	4 328	1 640	1 533	1.8%	-2 795	-65%	-2 712	-64%	-107	-6%	T2	CS,D
France	12 594	12 229	12 333	14.1%	-261	-2%	-3 010	-20%	104	1%	T2	CS,D
Germany	34 250	8 575	8 075	9.2%	-26 175	-76%	-27 800	-77%	-500	-6%	T2	CS
Greece	80	1 573	1 730	2.0%	1 650	2062%	1 255	264%	157	10%	T2	CS,D
Hungary	2 562	2 831	2 828	3.2%	266	10%	-67	-2%	-4	0%	T2	D
Ireland	NO	768	742	0.8%	742	∞	742	∞	-26	-3%	T2	CS,D
Italy	6 386	11 332	11 456	13.1%	5 070	79%	2 098	22%	125	1%	T2	CS
Latvia	NO	256	264	0.3%	264	∞	264	∞	8	3%	T2	D
Lithuania	879	684	705	0.8%	-174	-20%	-248	-26%	21	3%	T2	D
Luxembourg	92	50	51	0.1%	-41	-45%	-33	-39%	1	3%	T1	D
Malta	NO	133	137	0.2%	137	∞	137	∞	4	3%	T2	PS
Netherlands	13 679	2 782	2 569	2.9%	-11 111	-81%	-9 392	-79%	-213	-8%	T2	CS
Poland	5 829	5 168	5 118	5.9%	-711	-12%	187	4%	-50	-1%	T2	CS,D
Portugal	744	2 823	2 821	3.2%	2 077	279%	1 594	130%	-2	0%	T2	CS,D
Romania	NO	1 505	1 639	1.9%	1 639	∞	1 618	7779%	134	9%	T2	CS,D
Slovakia	NO	851	871	1.0%	871	∞	865	12761%	20	2%	T2	CS,D
Slovenia	433	355	341	0.4%	-92	-21%	-141	-29%	-14	-4%	T2	CS,D
Spain	4 324	9 732	9 681	11.1%	5 357	124%	3 782	64%	-51	-1%	T2	CS,D,OTH
Sweden	3 422	904	841	1.0%	-2 580	-75%	-2 369	-74%	-63	-7%	T2	CS,D
United Kingdom	60 203	13 947	14 078	16.1%	-46 125	-77%	-49 014	-78%	131	1%	T2	CS
EU-28	**160 045**	**87 365**	**87 077**	**100%**	**-72 968**	**-46%**	**-83 740**	**-49%**	**-288**	**0%**	**-**	**-**
Iceland	19	185	179	0.2%	160	848%	64	56%	-6	-3%	T2	CS,D
United Kingdom (KP)	60 367	14 112	14 244	16.3%	-46 123	-76%	-49 016	-77%	132	1%	T2	CS
EU-28 + ISL	**160 227**	**87 715**	**87 422**	**100%**	**-72 805**	**-45%**	**-83 677**	**-49%**	**-293**	**0%**	**-**	**-**

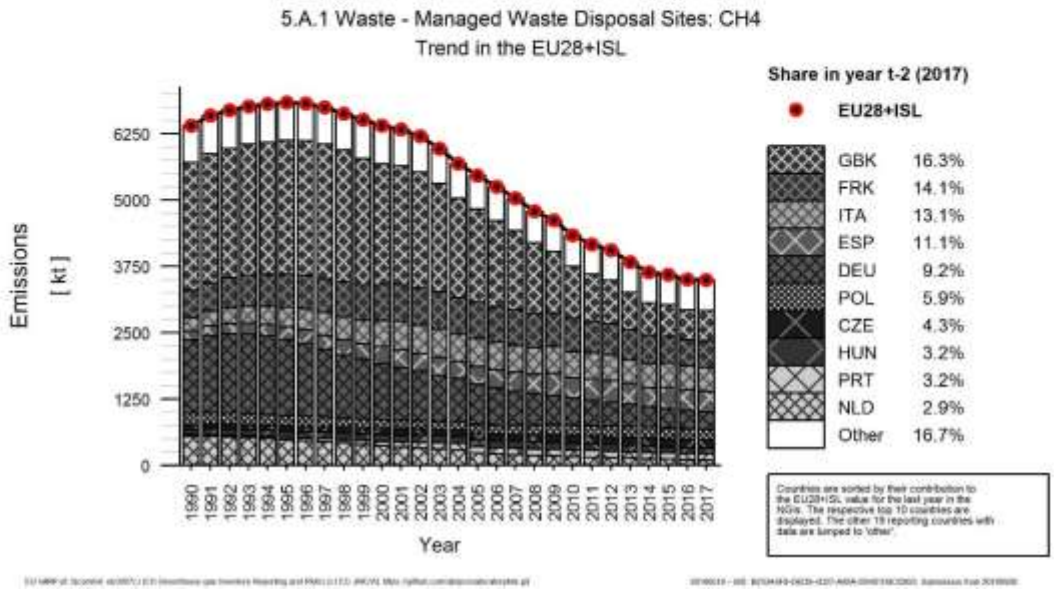
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data

CH_4 emissions from solid waste disposal on managed land decreased considerably between 1990 and 2017 by 45 %. *Figure 7.6* shows the trend of emissions indicating the countries contributing most to EU-28 total.

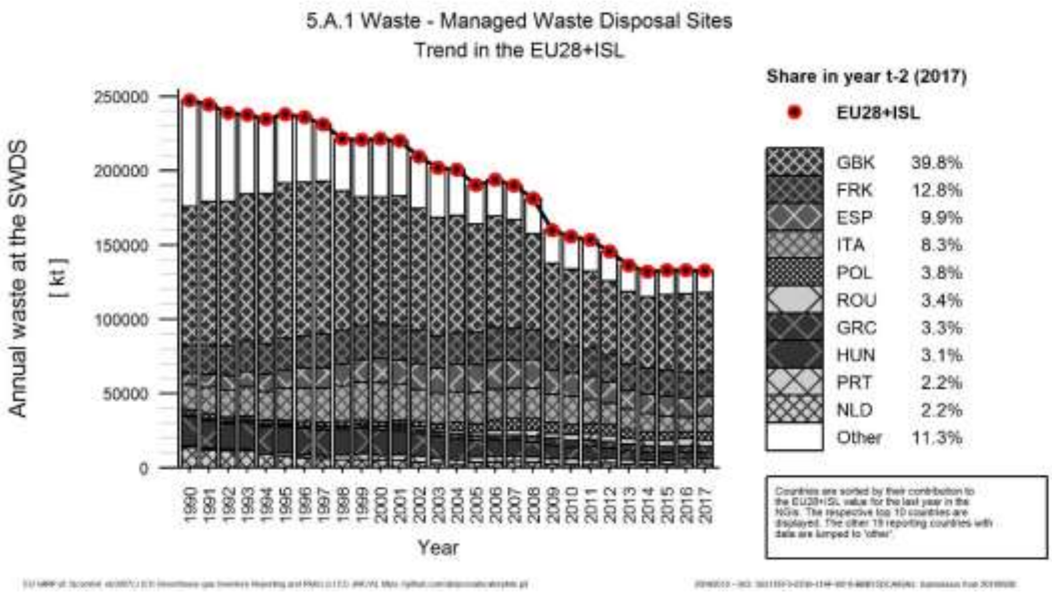
The Member States with highest emissions from this source in 2017 were the United Kingdom, France, Italy, Spain and Germany. These MS account for 64 % of EU-28+ISL CH_4 emissions from 5A1 in 2017. The largest reductions in absolute terms between 1990 and 2017 were reported by the United Kingdom (–46 Mt CO_2 equiv.) and Germany (–26 Mt CO_2 equiv.). The emission reductions are partly due to the (early) implementation of the landfill waste directive or similar legislation in the Member States. 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 MS)



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 2018 the yearly total amount of waste disposal on managed landfills declined by 40 % between 1990 and 2017 (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-28+ISL since 1990 (see Figure 7.8).

Figure 7.7 5A1 Managed waste disposal on land: Waste disposal (Trend in relevant MS)



In the following description more information is provided for the Member States that are contributing most to the trend of this key category on the level of the EU-28 + ISL.

The **United Kingdom (KP)** has a high share of CH_4 emissions from managed landfills among Member States contributing 16.3 % to EU-28 + ISL emissions in 2017. 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, which leads to an increase of CH_4 emissions by 0.9 % between 2016 and 2017.

France, contributing with 14.1 % to EU-28 emissions in 2017, increased its emissions from managed solid waste disposal sites steadily until 2003; followed by a declining trend thereafter. Emissions followed the increased amount of municipal waste going to landfills until 2000, which decreased afterwards. 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, which leads to a decrease in CH_4 emissions by 0.9 % between 2016 and 2017.

Italy, contributing with 13.1 % to EU-28+ISL emissions in 2017, 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. 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 2017 CH_4 emissions from managed solid waste disposal increased by 1.1 % compared to 2016.

CH_4 emissions in **Spain**, contributing with 11.1 % to EU-28 emissions in 2017, increased almost continuously between 1990 and 2008 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. Due to fluctuations in the amount of CH_4 recovery, CH_4 emissions show a fluctuating trend from 2008 onwards. CH_4 recovery and flaring of CH_4 has already been practiced in earlier years and increased significantly from 2002 onwards. The highest amounts of CH_4 recovery are found in 2014, while in 2015 to 2017 recovery rates declined again. In 2017, CH_4 emissions from solid waste disposal decreased slightly by -0.5 % compared to 2016.

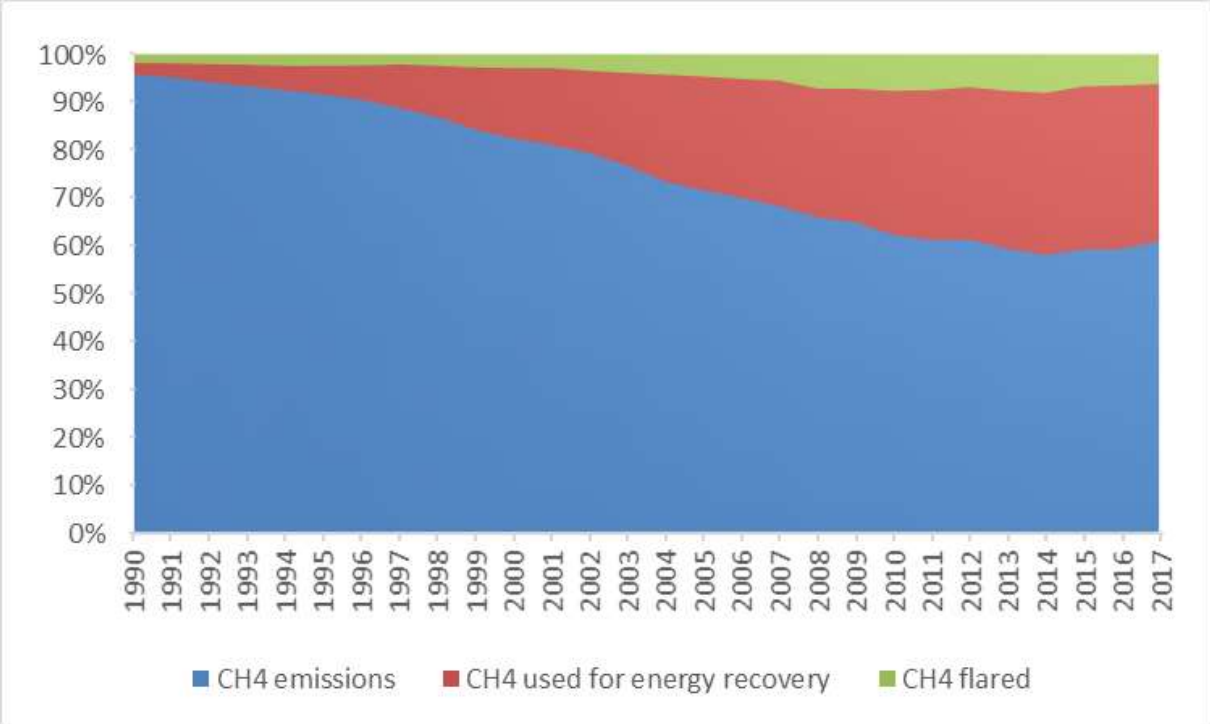
Germany, contributing with 9.2 % to EU-28 emissions in 2016, managed to reduce CH_4 emissions steadily until now from 1993 onwards. The amount of waste disposed on landfills shows a strong decrease from 1990 onwards, while in parallel CH_4 recovery increased. The highest share of CH_4 recovery could 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-28+ISL increased from 4.3 % of the total amount of CH_4 generated ("emitted" = excluding CH_4 flared and recovered; "generated" = including CH_4 flared and recovered) in managed landfills (only 5A1) in 1990 to 39 % in 2017 (Figure 7.8). 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 2016, CH_4 recovery and CH_4 flaring decreased by 6.8 % in 2017 in managed landfills. This is caused by reduced amounts of waste landfilled and the ban of organic material in the landfilled waste.

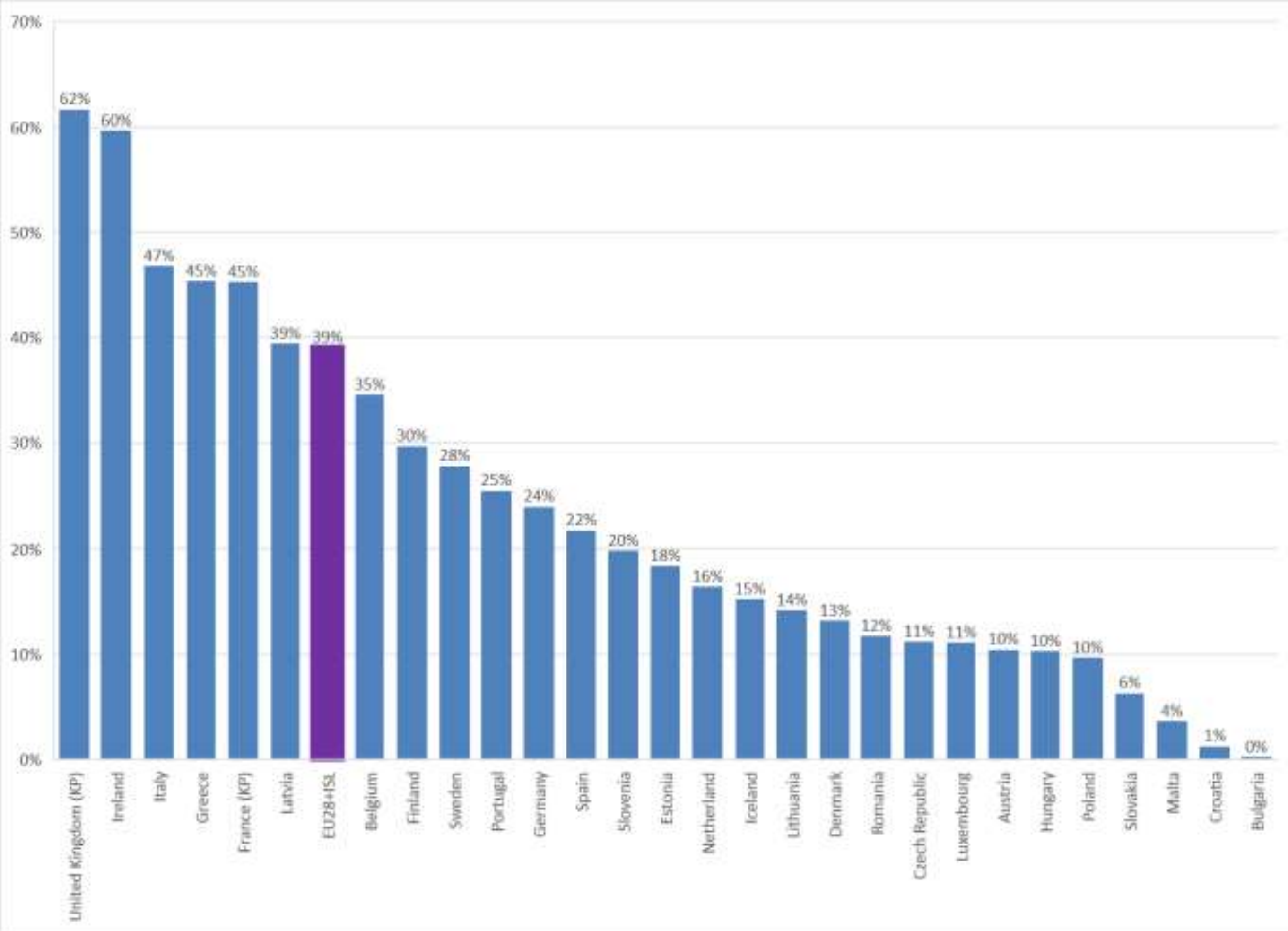
Figure 7.8 5A1 Managed Solid Waste Disposal: Evolution of the share of methane used for energy recovery, methane flared and CH_4 emissions in managed landfills in the EU 28+ISL



Source: CRF 2019, 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 Member States between 0.1 % in Bulgaria and 62 % in the United Kingdom 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 2017. 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 2017



CH_4 recovery and flaring in % = CH_4 recovery in Gg + CH_4 flared in Gg/ (CH_4 recovery in Gg + CH_4 flared + CH_4 emissions 5A1 in Gg)
CH_4 emissions from 5A2 unmanaged landfills are not included in this calculation
Source: CRF 2019 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 Member States 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.

Member States 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-28 Member States 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 Member States 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 Member States do not provide any information on industrial waste landfilled, while other Member States report that industrial waste is not reported separately and included under municipal solid waste. Further information on the reporting of industrial waste by the Member States 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-28+ISL. Country specific information on waste composition is provided in the Annex III.

Landfill gas recovery

Member States use different methods to determine CH_4 recovery. Several Member States combine different methods and sources to estimate the amounts of CH_4 recovered for flaring or for energy purposes, while other Member States 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 single Member States 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. Member States 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 member states + ISL.

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-28+ISL GHG emissions in 2017. Between 1990 and 2017, CH_4 emissions from this source decreased by 55 % (Table 7.4). In 2017, CH_4 emissions from unmanaged landfills decreased by 6 % compared to 2016. Almost all Member States 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 2017 (respectively +55 % and +44 %). In Cyprus CH_4 emissions from unmanaged landfills are almost constant between 2016 and 2017. Untill 2016 the emissions still yearly raised in Cyprus due to an increasing amount of solid waste disposal on unmanaged landfills until 2009. Between 2009 and 2017 the amount of solid waste disposed on unmanaged landfills in Cyprus decreased by 43 %. However, there is a small increase of waste disposal on unmanaged landfills since 2015. In Romania CH_4 emissions from unmanaged waste disposal sites increased until 2010, but showed a decreasing trend from 2010 onwards. Between 2010 and 2017 the CH_4 emissions decreased by 22 % in Romania.

Table 7.4 5A2 Unmanaged Waste Disposal on Land: 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-28+ISL Emissions in 2017	Change 1990-2017		Change 1995-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Bulgaria	4 945	1 973	1 757	13.7%	-3 188	-64%	-3 176	-64%	-216	-11%	T2	CS,D
Croatia	512	171	159	1.2%	-353	-69%	-462	-74%	-12	-7%	T2	CS
Cyprus	258	399	400	3.1%	142	55%	116	41%	1	0%	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	1 569	1 509	11.8%	-654	-30%	-648	-30%	-59	-4%	T2	CS,D
Hungary	IE	IE	IE	-	-	-	-	-	-	-	NA	NA
Ireland	1 318	IE	IE	-	-1 318	-100%	-1 593	-100%	-	-	NA	NA
Italy	5 820	2 290	2 189	17.1%	-3 631	-62%	-3 576	-62%	-101	-4%	T2	CS
Latvia	283	155	140	1.1%	-143	-51%	-209	-60%	-15	-10%	T2	CS,D
Lithuania	150	71	66	0.5%	-83	-56%	-83	-56%	-5	-7%	T2	D
Luxembourg	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Malta	41	7	4	0.0%	-38	-92%	-67	-95%	-3	-46%	M	M
Netherlands	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Poland	7 244	3 051	2 833	22.2%	-4 411	-61%	-4 515	-61%	-218	-7%	T2	CS,D
Portugal	2 076	829	773	6.0%	-1 304	-63%	-1 574	-67%	-56	-7%	-	-
Romania	1 372	2 062	1 974	15.4%	602	44%	424	27%	-88	-4%	T2	CS,D
Slovakia	646	286	270	2.1%	-376	-58%	-413	-60%	-16	-6%	T2	CS,D
Slovenia	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Spain	1 150	723	687	5.4%	-463	-40%	-814	-54%	-36	-5%	T2	D
Sweden	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
United Kingdom	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
EU-28	**27 979**	**13 583**	**12 760**	**100%**	**-15 219**	**-54%**	**-16 589**	**-57%**	**-823**	**-6%**	**-**	**-**
Iceland	139	28	26	0.2%	-113	-81%	-77	-75%	-2	-6%	T2	CS,D
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
EU-28 + ISL	**28 118**	**13 611**	**12 787**	**100%**	**-15 332**	**-55%**	**-16 667**	**-57%**	**-825**	**-6%**	**-**	**-**

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 2017 by 55 %. *Figure 7.10* shows the trend of emissions indicating the countries contributing most to EU-28+ISL 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 Member States 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, Slovenia, Sweden and the United Kingdom) or they are included elsewhere (Hungary, Ireland). Bulgaria, Greece, Italy, Poland and Romania are responsible for about 80 % of the total EU-28+ISL emissions from unmanaged waste disposal sites in 2017. Italy, Bulgaria and Poland show large absolute reductions between 1990 and 2017.

Figure 7.10 5A2 Waste disposal on unmanaged landfills: CH_4 emissions (Trend in relevant MS)

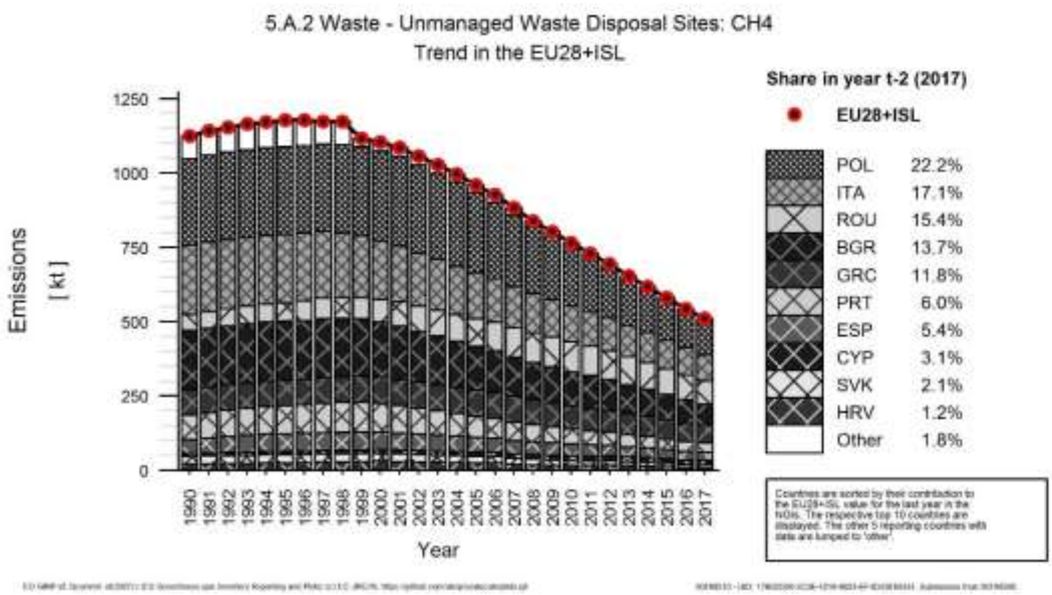
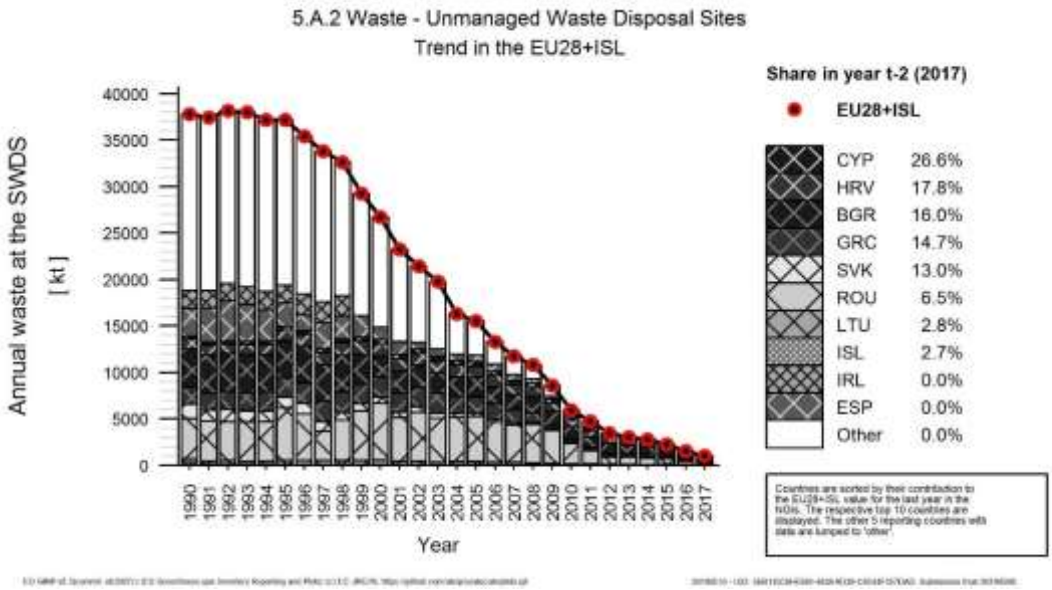


Figure 7.11 shows the relevant trends for the amount of waste disposed on unmanaged landfills. In this description we focus on the member states with the biggest share in the disposal amounts on unmanaged SWDS in 2017. After all, in some member states, waste disposal in unmanaged landfills was practiced but does not exist anymore: Ireland since 1999, Italy since 2000, Portugal and Malta since 2005, Poland since 2012, Latvia and Spain since 2013. For member states still using unmanaged landfills, in Bulgaria, Croatia, Cyprus, Greece, Iceland, Lithuania, Romania and Slovakia, 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 2017are found for Romania and Bulgaria. In member states which still dispose waste in unmanaged landfills in 2017), the relative decrease of waste disposed is higher than 90%, except in Croatia and Cyprus. While in the year. However, emissions are still produced from the waste disposed in the past.

Figure 7.11 5A2 Waste disposal on unmanaged landfills: Total waste disposed on unmanaged landfills (Trend in relevant MS)



Poland's CH_4 emissions from the disposal of solid waste on unmanaged landfills contribute 22.2 % to EU-28+ISL emissions from this source category in 2017. 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 17.1 % to EU-28 emissions in 2017, 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 15.4 % to EU-28 CH_4 emissions from unmanaged landfills in 2017. From 2010 CH_4 emissions are declining.

Bulgaria is contributing with 13,7 % to EU-28 CH_4 emissions from unmanaged landfills. CH_4 emissions are declining over the time series, due to a reduction of waste disposed on unmanaged landfills.

Methodological issues

CH_4 emissions from unmanaged solid waste disposal sites were reported in 15 Member States (Bulgaria, Croatia, Cyprus, Greece, Italy, France, Latvia, Lithuania,, Poland, Portugal, Romania, Slovakia, Czech republic and Spain) and Iceland in 2017. Only seven of these Member States (Bulgaria, Croatia, Cyprus, Greece, Lithuania, Romania and Slovakia) 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 2017 (see Table 7.4). 100% of all EU-28+ISL 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 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 2017. All Member States use a MCF between 0.4 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 2017

Member State	MCF
Bulgaria	0.8
Croatia	0.8
Cyprus	0.4
Czech republic	0,6
Greece	0.8
Iceland	0.2
Italy	0.6
Latvia	0.7
Lithuania	0.4
Malta	0.6
Poland	0.8
Portugal	0.6
Romania	0.7
Slovakia	0.4
Spain	0.6

Source: CRF Table 5.A 2018, NIR 2019

7.2.1.3 Recalculations (CRF Source Category 5A)

Table 7.6 provides information on the contribution of Member States to EU recalculations in CH_4 emissions from 5A Solid Waste Disposal on Land for 1990 and 2016 and main explanations (as available in the national inventory reports) for the largest recalculations in absolute terms. Member

States contributing most to the recalculations in the year 2016 for the sector 5.A in absolute terms are Poland, France, Croatia, Germany, Portugal, Spain and Slovakia.

Table 7.6: 5A Solid Waste Disposal on Land: Contribution of member states to EU recalculations in CH_4 emissions for 1990 and 2016 (difference between latest submission and previous submission)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-25	-2.1	Update of the recovered methane in the landfill gas on the basis of a study.
Belgium	-	-	-1	-0.2	In the Flemish region the amounts of CH_4 recovered for energy production was revised for 1 company in 2016.
Bulgaria	-	-	-	-	
Croatia	190	54.6	438	34.2	New data on industrial waste and sludge are included.
Cyprus	-	-	-	-	Revision of the 2015 activity data of solid waste production by the Statistical Service.
Czechia	-	-	-	-	
Denmark	-0	-0	1	0.1	Recalculation have been made for the years 2011-2017 due to updated activity data in the Danish waste reporting system.
Estonia	-	-	54	33.4	Correcting the amount of flared landfillgas, please see Chapter 7.2.5.
Finland	-	-	-	-	
France	0.01	0.0001	782	6.8	Following the avalability of the ITOM database 2016 provided by ADEME : update oft he amount of waste disposed and of the waste composition in 2016 Impact on 2015, which is an interpolation between 2014 and 2016 (survey performed each 2 years)
Germany	-	-	200	2.4	Correction oft he activity data 2016; Correction of typing errors in CH_4 emissions, 2013- 2016 ; Update of population data by census;
Greece	-	-	-45	-1.4	updated data
Hungary	-113	-4.2	-137	-4.6	Revised amount of disposed waste in line with Eurostat categories (mostly affected: construction and demolition waste), national average for waste composition.
Ireland	-	-	-	-	
Italy	-	-	-	-	
Latvia	-	-	26	6.8	Recalculation is done for year 2016 due to bioreactor activity took place since 2016. New data for disposed amount are used.
Lithuania	-	-	-	-	
Luxembourg	-	-	-	-	
Malta	-	-	-10	-7.0	The recalculation in SWD resulted in the Net Emissions from unmanaged SWDS ($GgCO_2$ eq) due to the change in Gross emissions (Gg CH_4) from the FOD model unmanged which was affected by the aeration factor in the unmanaged model (the proportion between carbon dioxide and methane from landfill gas).
Netherlands	-	-	-	-	
Poland	3 351	31.0	1 070	13.2	Data on amounts of landfilled industrial solid waste for 1950-1974 applied; update of data on amounts of landfilled sewage sludge in 1995-2001 and application of data of landfilled sewage sludge for 1950-1994
Portugal	-0.1	-0.003	-192	-5.0	A thorough revision of sectoral/industrial waste was performed by INE for the years 2008-2016, according to a new methodological procedure (scope of the universe / sample and levels of stratification). Further to changes in the context and scope of the sample and adjustments in stratification, a new methodology of identification and treatment of outliers and a new procedure of imputation of non-responses were also applied. These revisions were also reflected in the recalculation of the historic trends of industrial waste.
Romania	-	-	-	-	NA

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Slovakia	35	5.8	165	17.0	New distribution of waste fraction (published in paper Benešová, L. at all) influenced categories 5.A (emissions), 5.C (amount of waste incinerated) and 5.F (memo items).
Slovenia	-	-	-	-	
Spain	-	-	-180	-1.7	Correction of a mistake in the activity data used
Sweden	-	-	-4	-0.5	Recalculaion for the years 2010-2011 due to minor corrections of historical data, and for the years 2015-2016 due to the availability of new data on landfilled waste and new estimates on DOC content for some of the waste categories.
United Kingdom	-	-	113	0.8	Correction of mis-reported LFG flaring data for the years 2008-2016. Updated activity data for waste landfilled in NI in 2016.
EU28	3 463	1.9	2 252	2.3	
Iceland	0	0	-0.1	-0.03	
United Kingdom (KP)					Correction of mis-reported LFG flaring data for the years 2008-2016. Updated activity data for waste landfilled in NI in 2016.
EU28+ISL	3 463	2.8	2 139	2.5	

7.2.2 Biological treatment of solid waste (CRF Source Category 5B)

Source category 5B Biological treatment of solid waste includes the key sources 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 0.2 % to EU+ISL total GHG emissions without LULUCF in 2017. 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. Eleven countries (Bulgaria, Croatia, Cyprus, Czech Republic, Greece, Iceland, Ireland, Luxembourg, Malta, 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: Member States' contributions to total GHG emissions and CH_4 and N_2O emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2017 (kt CO2 equivalents)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2017 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2017 (kt CO2 equivalents)
Austria	36	178	23	97	13	81
Belgium	7	61	4	37	3	24
Bulgaria	NO	41	NO	17	NO	24
Croatia	NE,IE,NO	6	NO,NE,IE	3	NO,NE,IE	4
Cyprus	NO	6	NO	2	NO	3
Czechia	NE,IE	714	NE,IE	64	NE,IE	650
Denmark	52	403	12	86	40	317
Estonia	1	29	0	12	1	17
Finland	44	104	18	39	26	65
France	134	581	88	343	46	238
Germany	41	1 019	16	310	25	709
Greece	NO	39	NO	16	NO	22
Hungary	9	149	4	40	5	109
Ireland	NO	19	NO	8	NO	11
Italy	25	643	20	522	5	121
Latvia	41	49	17	20	24	28
Lithuania	0	81	0	22	0	59
Luxembourg	NA,IE,NO	26	NA,NO	5	NO,IE	21
Malta	NO	1	NO	NO,NA	NO	1
Netherlands	20	207	7	88	14	118
Poland	22	161	9	67	13	94
Portugal	9	35	4	13	5	22
Romania	NO	60	NO	25	NO	35
Slovakia	111	186	46	78	65	108
Slovenia	NO	17	NO	7	NO	10
Spain	132	635	55	256	77	378
Sweden	12	120	5	32	7	88
United Kingdom	31	1 916	13	726	18	1 191
EU-28	**727**	**7 486**	**341**	**2 938**	**386**	**4 548**
Iceland	NA,NO	4	NO,NA	2	NO,NA	2
United Kingdom (KP)	31	1 919	13	727	18	1 192
EU-28 + ISL	**727**	**7 492**	**341**	**2 940**	**386**	**4 551**

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 0.1 % of total EU-28+ISL GHG emissions in 2017. Between 1990 and 2017, CH_4 emissions from this source increased considerably from 378 kt CO_2 equivalents to 2892 kt CO_2 equivalents in 2017 (Table 7.8). Malta reports emissions from composting only in the period 1993 - 2006. All Member States that practice composting feature an increasing emission trend from 1990 onwards. Nevertheless between 2016 and 2017 nine Member States experienced a (mostly minor) decrease in CH_4 emissions from composting. Total CH_4 emissions from composting in EU-28 + ISL decreased by 1.2 % between 2016 and 2017 with as most important reasonthe 52 % decrease of the amount of waste composted in Poland between 2016 and 2017.

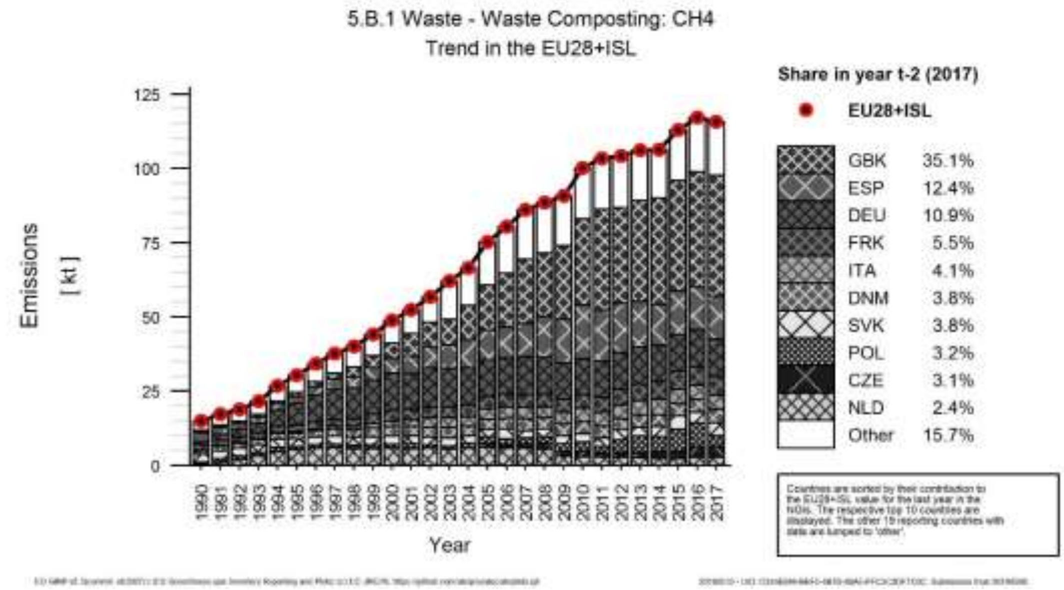
Table 7.8: 5B1 Waste Composting: Member States + Iceland contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 1995-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	13	60	60	2.1%	47	359%	34	129%	0	0%	T2	CS
Belgium	3	22	24	0.8%	21	826%	19	370%	2	10%	T1	CS
Bulgaria	NO	26	24	0.8%	24	∞	24	∞	-3	-10%	T1	D
Croatia	IE,NE	4	4	0.1%	4	∞	4	∞	0	0%	T1	D
Cyprus	NO	4	3	0.1%	3	∞	3	∞	-1	-24%	T1	D
Czechia	NE	89	90	3.1%	90	∞	90	∞	1	1%	T1	D
Denmark	35	107	110	3.8%	76	218%	64	138%	4	4%	CS,T1	CS,OTH
Estonia	1	20	17	0.6%	16	2392%	16	1797%	-3	-17%	T1	D
Finland	26	54	55	1.9%	29	114%	12	29%	1	2%	T1	D
France	44	154	160	5.5%	116	266%	102	179%	6	4%	T2	CS
Germany	25	314	314	10.9%	289	1140%	133	74%	0	0%	T2	CS
Greece	NO	18	22	0.8%	22	∞	22	∞	4	23%	D	D
Hungary	5	55	57	2.0%	52	1031%	50	708%	2	3%	T1	D
Ireland	NO	12	11	0.4%	11	∞	11	∞	-1	-5%	T1	D
Italy	5	120	119	4.1%	114	2473%	108	1011%	-2	-2%	D	CS
Latvia	24	33	28	1.0%	4	19%	6	27%	-4	-13%	D	D
Lithuania	0	30	31	1.1%	31	14962%	30	8408%	1	3%	T1	D
Luxembourg	NO	8	8	0.3%	8	∞	5	223%	0	-3%	T1	D
Malta	NO	NO	NO	-	-	-	-2	-100%	-	-	NA	NA
Netherlands	14	67	69	2.4%	55	401%	-66	-49%	2	2%	T1	CS
Poland	13	198	94	3.2%	81	639%	69	275%	-105	-53%	T1	D
Portugal	5	20	18	0.6%	13	266%	7	67%	-1	-6%	T1	D
Romania	NO	35	35	1.2%	35	∞	35	∞	0	0%	T1	D
Slovakia	65	93	108	3.8%	44	67%	42	63%	16	17%	T1	D
Slovenia	NO	7	10	0.3%	10	∞	10	∞	2	32%	T1	D
Spain	77	358	358	12.4%	281	366%	296	473%	0	0%	T1	D
Sweden	7	48	45	1.6%	38	535%	20	83%	-3	-5%	T1	D
United Kingdom	18	969	1 015	35.1%	997	5497%	983	3036%	46	5%	T1	D
EU-28	**378**	**2 925**	**2 888**	**100%**	**2 511**	**665%**	**2 128**	**280%**	**-36**	**-1%**	-	-
Iceland	NO,NA	2	2	0.1%	2	∞	2	985%	0	-5%	T2	CS,D
United Kingdom (KP)	18	970	1 016	35.1%	998	5504%	984	3040%	46	5%	T1	D
EU-28 + ISL	**378**	**2 928**	**2 892**	**100%**	**2 514**	**666%**	**2 131**	**280%**	**-36**	**-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 MS)

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.2.a) and composting of other waste (5.B.2.b). As stated in figure Figure 7.14 5B1b Waste Composting of other waste : CH4 emissions (Trend in relevant MS), only 10 member states (Denmark, Slovakia, Netherland, Czach republic, Finland, Hungary, Estonia, Lithuania, Poland and Lusembourg) report emissions form other waste composting. Other member states 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 type of waste.

Figure 7.13 5B1a Waste Composting of municipal waste: CH_4 emissions (Trend in relevant MS)

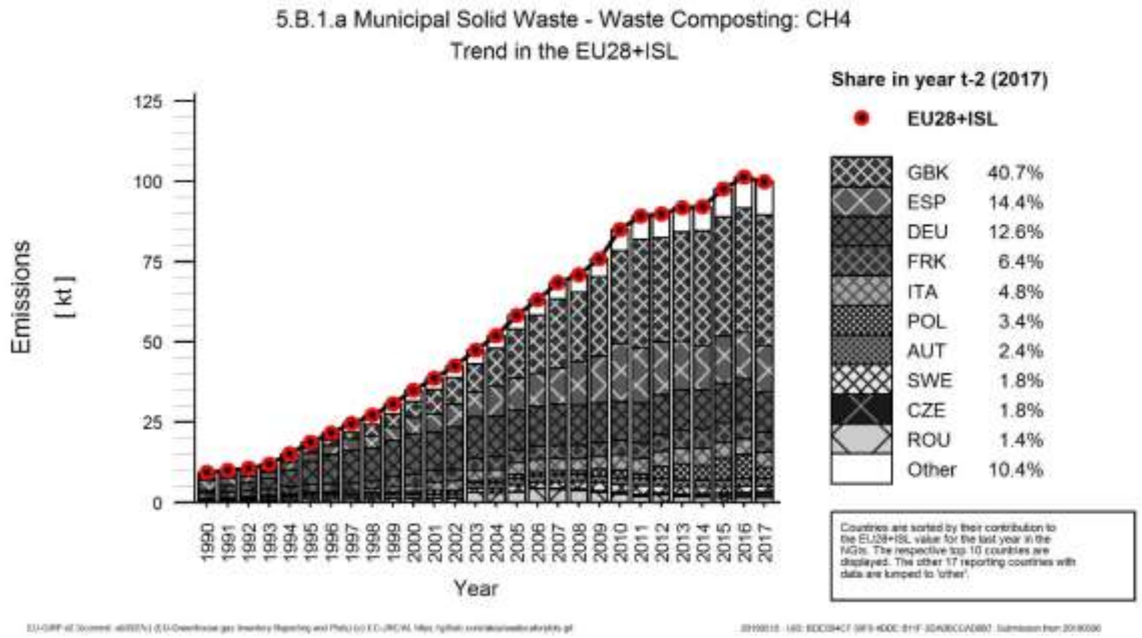
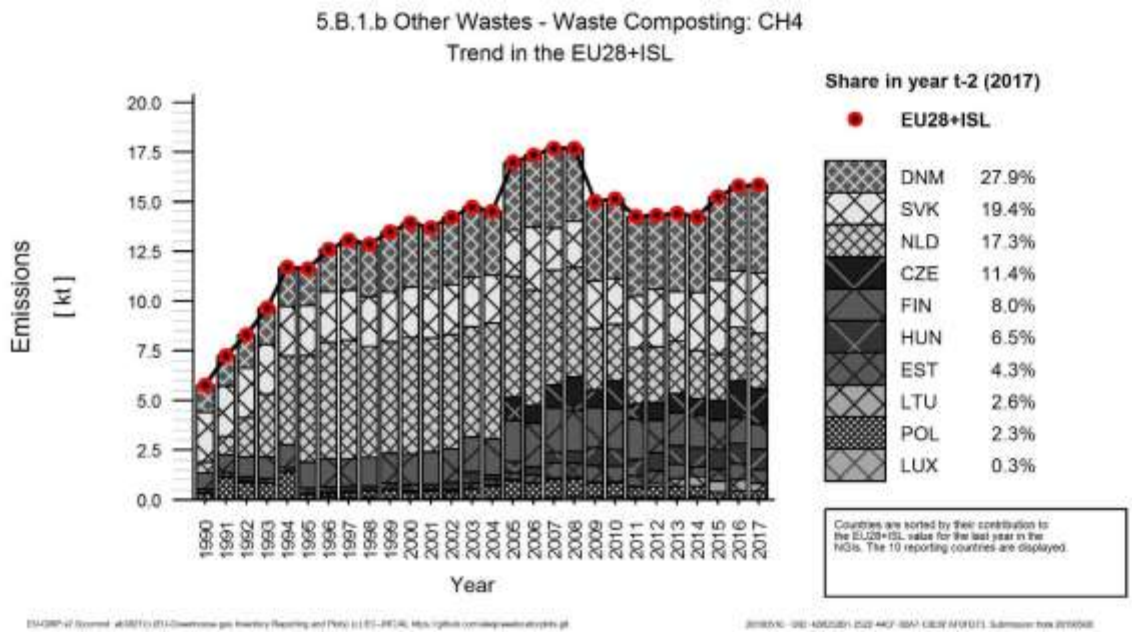


Figure 7.14 5B1b Waste Composting of other waste : CH_4 emissions (Trend in relevant MS)



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 Member States apply the default EF for CH_4 emissions based on a wet weight basis, while Hungary, Lithuania, Sweden and the United Kingdom use activity data in kt dry matter in the CRF tables (see **Table 7.9**). Only Austria, Belgium, Denmark, France, Germany, Italy, and the Netherlands apply country specific EFs and these EFs are within the interval indicated in the 2006 2006 IPCC Guidelines. For Finland and Luxembourg the EF reported in the CRF Table 5.B. and summarized in **Table 7.9** are higher than for the other MS as they include composting of sludge, which is mainly reported on a dry weight basis. In most cases country specific EFs are much lower than the IPCC default EF.

Table 7.9: 5B1 Composting: EFs applied by Member States in 2016 in g CH_4/kg waste treated

Member state	CH4 IEF (g/kg dry matter)	Member state	CH4 IEF (g/kg dry matter)
Austria	1,83	Ireland	4,00
Belgium	0,75	Italy	1,63
Bulgaria	4,00	Latvia	4,00
Croatia	4,00	Lithuania	10,00
Cyprus	4,00	Luxembourg	9,68
Czech Republic	4,00	Malta	NO
Denmark	4,00	Netherlands	0,82
Estonia	4,00	Norway	4,00
Finland	5,81	Poland	4,00
France	1,89	Portugal	4,00
Germany	1,40	Romania	4,00
Great Britain	10,00	Slovakia	4,00
Greece	4,00	Slovenia	4,00
Hungary	10,00	Spain	4,00
Iceland	4,00	Sweden	11,43

Further methodological information for all Member States 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 Member States to EU recalculations in CH_4 from 5B Biological treatment of solid waste for 1990 and 2016 and main explanations (if available in Member States' inventories) for the largest recalculations in absolute terms.

Table 7.10: 5B Biological treatment: Contribution of Member States to EU recalculations in CH_4 for 1990 and 2016 (difference between latest submission and previous submission)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	-4	-13.9	In Wallonia, activity data (amount of waste composted) of 2016 has been updated. In the Flemish region, the activity data are revised by the waste institute from 2013 onwards.
Bulgaria	-	-	-	-	
Croatia	-	-	1	36.6	Corrected data are included.
Cyprus	-	-	-	-	
Czechia	-	-	-	-	
Denmark	0.002	0.01	-87	-24.3	Recalculations have been made throughout the time series due to corrections in the decimal places of the EF value for composting resulting and improved data on the amount of biowaste types going to biogas and composting plants
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	-	-	-2	-1.0	Update of activity data concerning composting and biogas production in 2016 (publication of the official national data)
Germany	-	-	18	2.6	Update oft he activity data for composting and biogas production since the waste statistics of the Federal Statistical Öffice appear with a one-year time lag.
Greece	-	-	0.0001	0.0003	
Hungary	-	-	-	-	
Ireland	-	-	0.01	0.1	
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-	-	17	44.3	The biogas emissions from anaerobic digestion of waste separated in MBT facilities have been included for the first time (2003-2016).
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-0.1	-0.5	27	30.8	Manure digestion added
Poland	8	159.8	-	-	Data on amounts of other composted waste for 1988-1997 were applied.
Portugal	-	-	1	2.4	From 2013 onwards: AD were revised for the Autonomous Region of Azores.
Romania	-	-	0.03	0.1	CH_4 emissions were recalculated for 2016 year taking into account the final data associated to the amount of composted waste.
Slovakia	-	-	-	-	-
Slovenia	-	-	-	-	
Spain	-	-	-16	-4.2	Recalculations due to a AD update by the data provider
Sweden	-	-	-0.0002	-0.0002	
United Kingdom	13	230.8	65	6.1	Revision to NNFCC data on anaerobic digestion, MBT and other waste treatment plant.
EU28	20	5.6	20	0.4	*See per member state*
Iceland	-	-	-	-	Error in population number for 2016 corrected
United Kingdom (KP)					Revision to NNFCC data on anaerobic digestion, MBT and other waste treatment plant.
EU28+ISL	8	2.2	-46	-1.3	*See per member state*

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 ond open burning of waste is not a key category the European Union. Some additional information can be found in the chapter 4.2.6 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[73]. 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 contributing to an EU key source and are therefore not further analysed in this chapter.

Domestic wastewater includes the handling of liquid wastes and sludge 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 can industrial wastewater be treated on site and then the resulting emissions will be accounted under the separate category 5D2 industrial wastewater.

Total emissions from 5.D wastewater handling, including N_2O and CH_4 emissions account for 0.6 % of total EU-28+ISL GHG emissions in 2017. Table 7.11 shows total GHG, CH_4 and N_2O emissions by Member State from 5D Wastewater Handling. Between 1990 and 2017, total emissions from wastewater handling decreased by 39.2 % in EU-28+ISL. All Member States except for France, Ireland and Iceland decreased their emissions from wastewater treatment and discharge between 1990 and 2017. Due to the implementation of new wastewater treatment technologies CH_4 emission decreased considerably by 44.5 % between 1990 and 2017, while N_2O emissions decreased moderately by 17.0 %.

[73] 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.

Table 7.11 5D Wastewater handling: Member states' + Icelands contributions to total GHG, CH_4 and N_2O emissions from 5D

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2017 (kt CO2 equivalents)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2017 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2017 (kt CO2 equivalents)
Austria	217	190	96	166	121	24
Belgium	973	284	138	102	835	182
Bulgaria	3 011	895	198	141	2 812	754
Croatia	512	313	67	89	445	224
Cyprus	128	80	12	17	116	63
Czechia	1 124	1 079	234	198	890	881
Denmark	150	118	109	66	41	51
Estonia	151	87	39	32	113	55
Finland	300	251	79	83	221	169
France	2 214	2 650	724	398	1 490	2 252
Germany	4 060	1 014	1 421	455	2 639	559
Greece	2 620	1 348	279	310	2 341	1 037
Hungary	1 086	363	148	80	938	283
Ireland	136	148	75	97	61	51
Italy	4 474	3 789	1 266	1 340	3 209	2 450
Latvia	375	113	53	32	322	81
Lithuania	538	184	67	44	471	140
Luxembourg	13	7	6	4	7	3
Malta	27	9	10	6	17	3
Netherlands	481	298	172	75	309	223
Poland	7 038	3 305	723	760	6 315	2 545
Portugal	1 717	1 011	200	181	1 517	830
Romania	3 652	2 207	505	535	3 146	1 672
Slovakia	596	345	130	51	466	295
Slovenia	322	172	39	37	282	134
Spain	3 370	2 394	863	966	2 507	1 428
Sweden	263	229	226	200	38	29
United Kingdom	4 962	4 119	765	702	4 197	3 417
EU-28	**44 512**	**27 000**	**8 644**	**7 166**	**35 867**	**19 834**
Iceland	8	13	6	7	2	6
United Kingdom (KP)	4 987	4 155	780	722	4 207	3 433
EU-28 + ISL	**44 544**	**27 048**	**8 665**	**7 193**	**35 879**	**19 855**

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-28+ISL GHG emissions in 2017. Between 1990 and 2017, CH_4 emissions decreased by 51 % (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 2017, CH_4 emissions decreased by 2 % in comparison to 2016.

Table 7.12 5D1 Domestic and commercial wastewater: Member States' + Iceland contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 1995-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	121	24	24	0.2%	-98	-80%	-81	-77%	0	1%	T2	CS,D
Belgium	835	191	182	1.5%	-653	-78%	-629	-78%	-9	-5%	CR,T1	CR,D
Bulgaria	591	565	531	4.5%	-60	-10%	-144	-21%	-33	-6%	T2	D
Croatia	348	193	120	1.0%	-228	-65%	-209	-63%	-72	-38%	T1	D
Cyprus	92	33	34	0.3%	-58	-64%	-66	-66%	0	1%	T1	D
Czechia	527	443	443	3.7%	-84	-16%	-78	-15%	0	0%	T1	CS,D
Denmark	41	50	51	0.4%	10	24%	8	18%	1	2%	CS	CS
Estonia	113	49	49	0.4%	-64	-57%	-55	-53%	0	-1%	T1	D
Finland	194	146	144	1.2%	-50	-26%	-38	-21%	-2	-1%	CS,T2	CS,D
France	1 401	2 150	2 156	18.1%	755	54%	377	21%	6	0%	T1	D
Germany	2 630	529	515	4.3%	-2 115	-80%	-659	-56%	-15	-3%	CS,D	CS,D
Greece	1 520	154	154	1.3%	-1 366	-90%	-1 208	-89%	0	0%	D	D
Hungary	803	256	259	2.2%	-544	-68%	-502	-66%	3	1%	T1	D
Ireland	61	50	51	0.4%	-10	-17%	-12	-19%	1	1%	T1,T2	CS,D
Italy	1 688	1 048	1 039	8.7%	-650	-38%	-495	-32%	-9	-1%	T1	D
Latvia	185	98	79	0.7%	-106	-57%	-95	-55%	-19	-20%	T2	CS
Lithuania	471	142	140	1.2%	-331	-70%	-257	-65%	-2	-2%	T1	D
Luxembourg	7	3	3	0.0%	-4	-61%	-4	-55%	0	-13%	T1	CS
Malta	17	2	3	0.0%	-14	-82%	-15	-83%	1	40%	D	CS
Netherlands	203	197	199	1.7%	-4	-2%	28	16%	2	1%	-	-
Poland	5 688	2 252	2 269	19.1%	-3 420	-60%	-2 563	-53%	17	1%	T1,T2	CS,D
Portugal	1 258	596	589	4.9%	-669	-53%	-555	-49%	-7	-1%	T2	CS,D
Romania	2 768	1 497	1 442	12.1%	-1 326	-48%	-1 367	-49%	-55	-4%	D	D
Slovakia	437	295	289	2.4%	-148	-34%	-104	-26%	-6	-2%	CS,D	D
Slovenia	186	136	127	1.1%	-59	-32%	-57	-31%	-9	-6%	T1	CS,D
Spain	788	239	240	2.0%	-548	-70%	-465	-66%	0	0%	T1,T2	D
Sweden	31	24	24	0.2%	-7	-24%	-6	-20%	0	1%	T2	CS
United Kingdom	1 477	726	729	6.1%	-748	-51%	-717	-50%	2	0%	CS	CS
EU-28	**24 483**	**12 090**	**11 883**	**100%**	**-12 601**	**-51%**	**-9 966**	**-46%**	**-207**	**-2%**	**-**	**-**
Iceland	2	5	6	0.0%	3	167%	2	69%	0	2%	T1	CS,D
United Kingdom (KP)	1 487	742	744	6.2%	-743	-50%	-711	-49%	2	0%	CS	CS
EU-28 + ISL	**24 495**	**12 110**	**11 904**	**100%**	**-12 591**	**-51%**	**-9 958**	**-46%**	**-207**	**-2%**	**-**	**-**

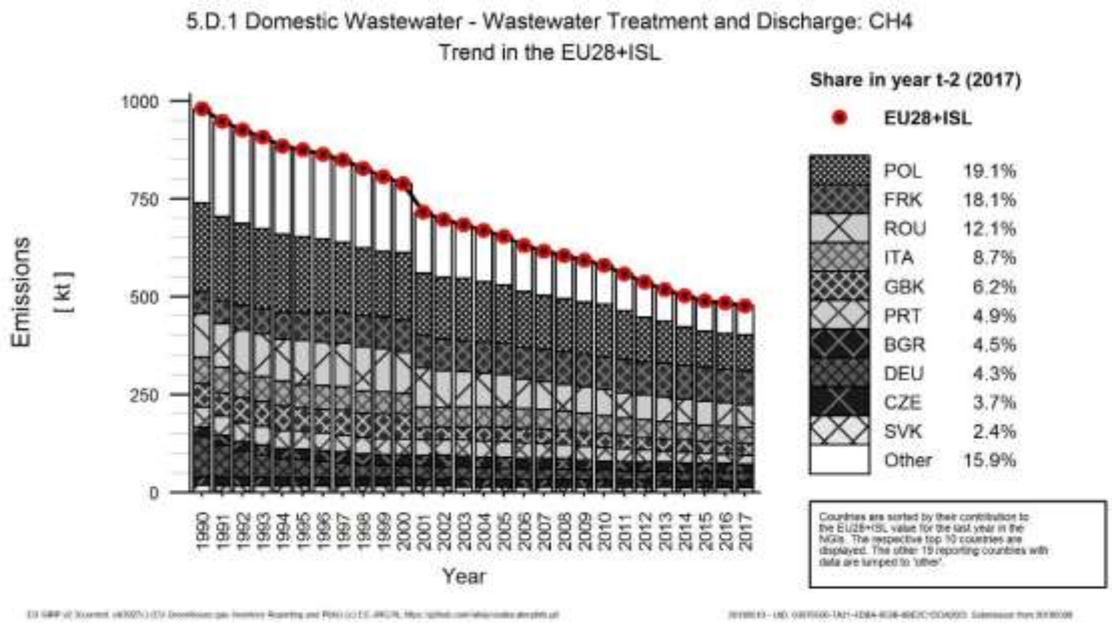
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

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 2017 by 51.2 %. Figure 7.15 shows the trend of emissions indicating the countries contributing most to EU-28+ISL total.

Large decreases in absolute terms between 1990 and 2017 are reported by Poland, Germany, Greece and Romania, contributing together to only 37 % of EU-28+ISL emissions from source 5D1 in 2017. Whereas France shows significant emission increases (Table 7.12). France is responsible for 18.0 %, Poland for 19.0 %, Romania for 12.1 % and Italy for 8.7 % of EU-28+ISL emissions from this source in 2017. Although France increased its emissions between 1990 and 2017 by 54 %, the trend of EU-28+ISL 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.

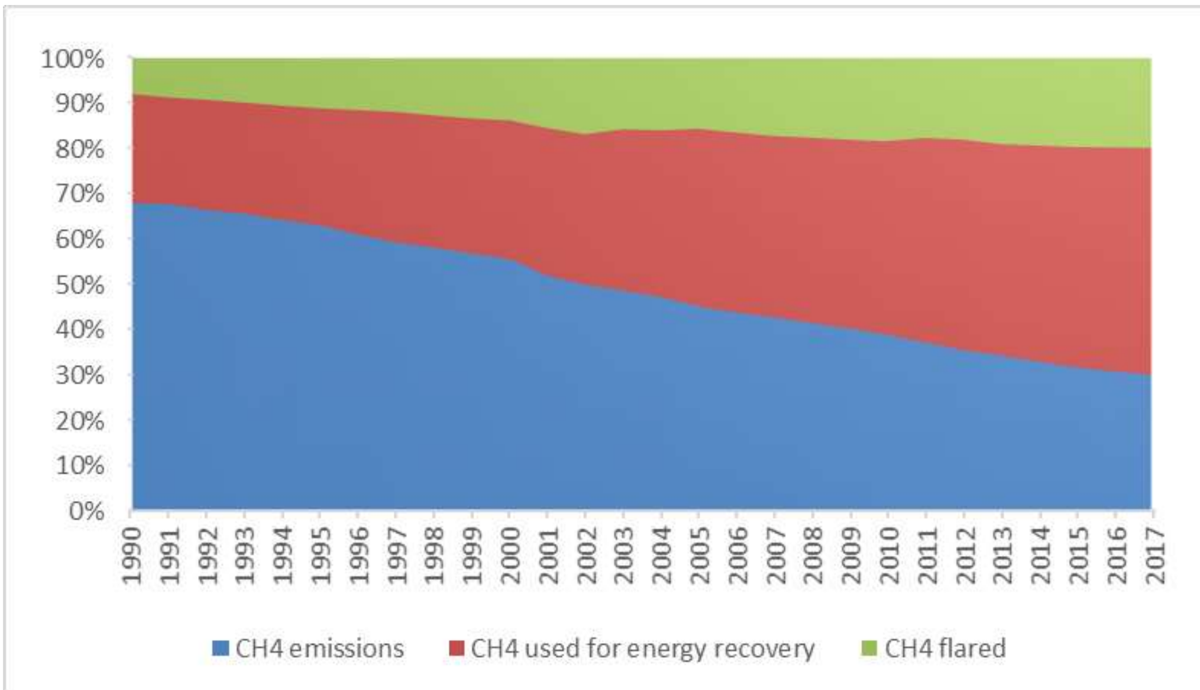
Figure 7.15 5D1 Domestic wastewater: CH_4 emissions (Trend in relevant MS)



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 2019, Table 5D

In 2017 20 % of the CH_4-emissions generated by Domestic Wastewater Handling were flared and 50 % was recovered for energy purposes.

An important driver for the total CH_4 emissions from 5D Wastewater Handling for the EU-28 + ISL 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 %). In the same period, the share of the population ith 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. According to the NIR 2019 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 2017 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 2017, 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 58% in 2017 and the share of urban populations using autonomous treatments decreased from 55 % to 5,5 % in the same period. The treatment pathway using advanced wastewater treatment plants increased from 0 % to 59 % between 1990 and 2017.

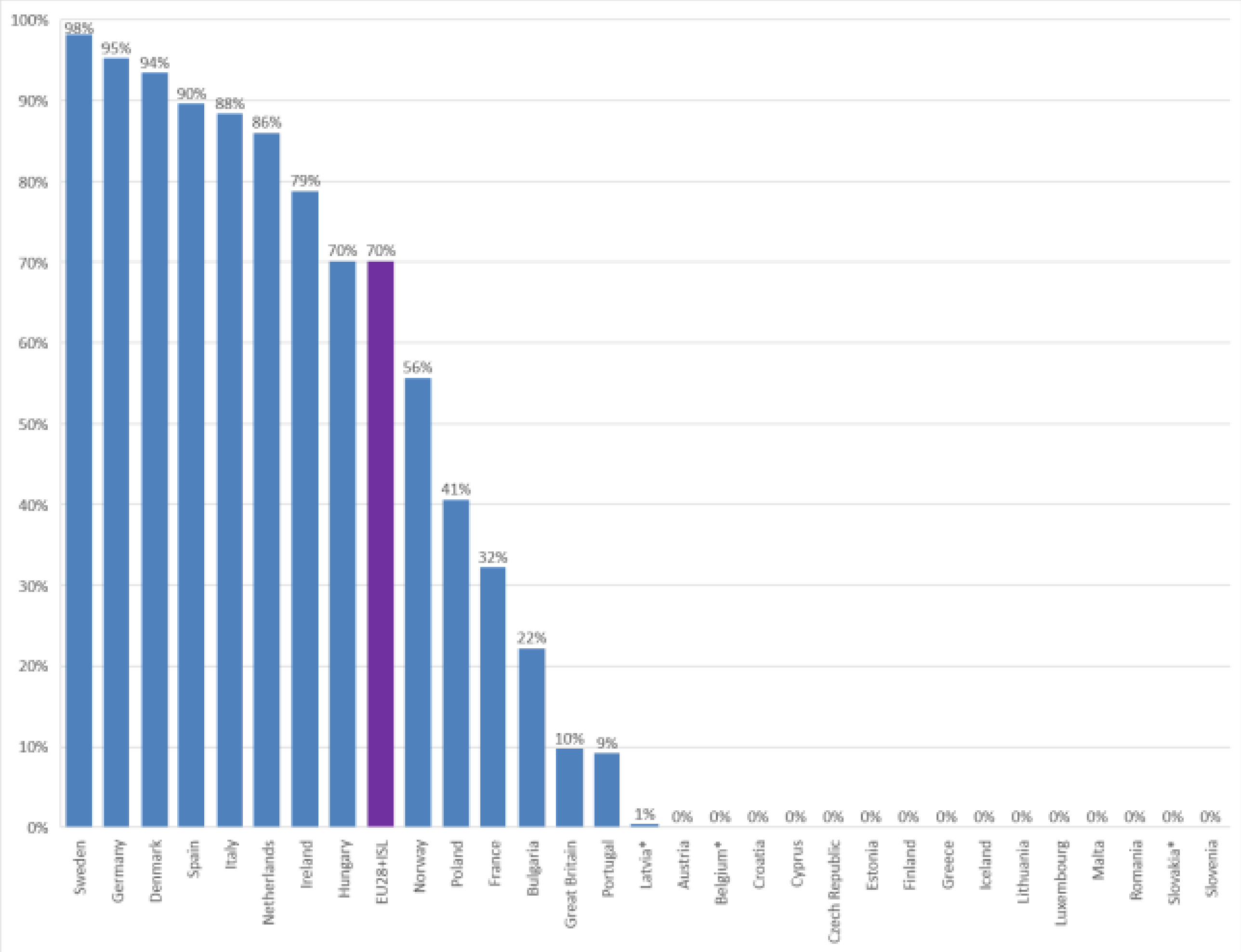
Methodological information for CH_4 emissions from domestic wastewater

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 Member States 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 Member States 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.

As stated in figure Figure 7.17 5D1 Managed Solid Waste Disposal: Methane recovery fraction (energy use and flaring) for 2017, not all member states are reporting data related to CH_4 recovery, (for energy use of flaring) in table CRF 5D. This CH_4 is generally recovered during sludge digestion for biogas production.Tree member states are reporting this information as included elsewhere (notation key IE), whereas others member states are reporting as not occurring (NO), not applicable (NA) or not estimated (NE). Indeed, information related to the amount of CH_4 recovered on sludge digesters is not necessary to apply the 2006 IPCC Guidebook and estimate CH_4 emissions neither from waste water 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 2017



Note; Belgium, Latvia and Slovakia are reporting CH_4 use for energy as IE

Further methodological information for all Member States is provided in the Annex III of this submission.

N_2O emissions

N_2O emissions from domestic wastewater treatment and discharge decreased moderately between 1990 and 2017 by 15 % (Table 7.13). *Figure 7.18* shows the trend of emissions indicating the countries contributing most to EU-28+ISL total.

Table 7.13 5D1 Domestic and commercial wastewater: Member States' + Icelands contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 1995-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	96	165	166	2.4%	70	73%	56	50%	1	1%	CS	CS,D
Belgium	138	103	102	1.5%	-36	-26%	-34	-25%	0	0%	D	D
Bulgaria	198	142	141	2.0%	-58	-29%	-34	-19%	-1	-1%	T1	D
Croatia	67	88	89	1.3%	22	32%	16	23%	0	0%	T1	D
Cyprus	12	16	16	0.2%	4	36%	2	17%	0	1%	T1	D
Czechia	234	197	198	2.8%	-36	-15%	-8	-4%	0	0%	T1	CS,D
Denmark	61	59	61	0.9%	0	0%	-7	-11%	3	4%	CS	CS
Estonia	39	33	32	0.5%	-6	-16%	-2	-5%	0	-1%	T1	D
Finland	58	70	70	1.0%	12	21%	17	31%	0	0%	CS,T1	D
France	681	361	363	5.2%	-318	-47%	-327	-47%	1	0%	T1	D
Germany	1 390	431	430	6.1%	-960	-69%	-523	-55%	-2	0%	CS,D	CS,D
Greece	274	304	304	4.3%	30	11%	13	4%	0	0%	D	CS
Hungary	148	76	80	1.1%	-68	-46%	-42	-35%	4	5%	CS	D
Ireland	75	97	97	1.4%	22	29%	24	33%	0	0%	T1	D
Italy	1 198	1 290	1 288	18.4%	90	8%	124	11%	-2	0%	T1	D
Latvia	51	32	32	0.5%	-19	-37%	-11	-25%	0	0%	D	D
Lithuania	67	44	44	0.6%	-24	-35%	-23	-35%	-1	-1%	T1	D
Luxembourg	6	5	4	0.1%	-1	-24%	-2	-30%	0	-8%	T1	D
Malta	10	6	6	0.1%	-4	-39%	-5	-46%	0	6%	D	D
Netherlands	23	25	25	0.4%	3	11%	2	11%	0	1%	-	-
Poland	723	760	760	10.9%	37	5%	51	7%	0	0%	T1	D
Portugal	200	181	181	2.6%	-19	-10%	-36	-17%	-1	0%	D	CS,D
Romania	505	530	535	7.6%	29	6%	19	4%	5	1%	D	D
Slovakia	119	49	49	0.7%	-70	-59%	-47	-49%	0	-1%	CS,T2	D
Slovenia	39	37	37	0.5%	-2	-5%	1	4%	0	0%	T1	D
Spain	863	963	966	13.8%	103	12%	177	22%	3	0%	D	D
Sweden	208	190	190	2.7%	-17	-8%	-21	-10%	0	0%	T1	CS,D
United Kingdom	765	695	702	10.0%	-63	-8%	-88	-11%	7	1%	T1	D
EU-28	**8 248**	**6 951**	**6 969**	**100%**	**-1 279**	**-16%**	**-706**	**-9%**	**18**	**0%**	**-**	**-**
Iceland	6	7	7	0.1%	1	21%	1	14%	0	2%	T1	D
United Kingdom (KP)	780	715	722	10.3%	-57	-7%	-83	-10%	7	1%	T1	D
EU-28 + ISL	**8 268**	**6 978**	**6 996**	**100%**	**-1 273**	**-15%**	**-701**	**-9%**	**18**	**0%**	**-**	**-**

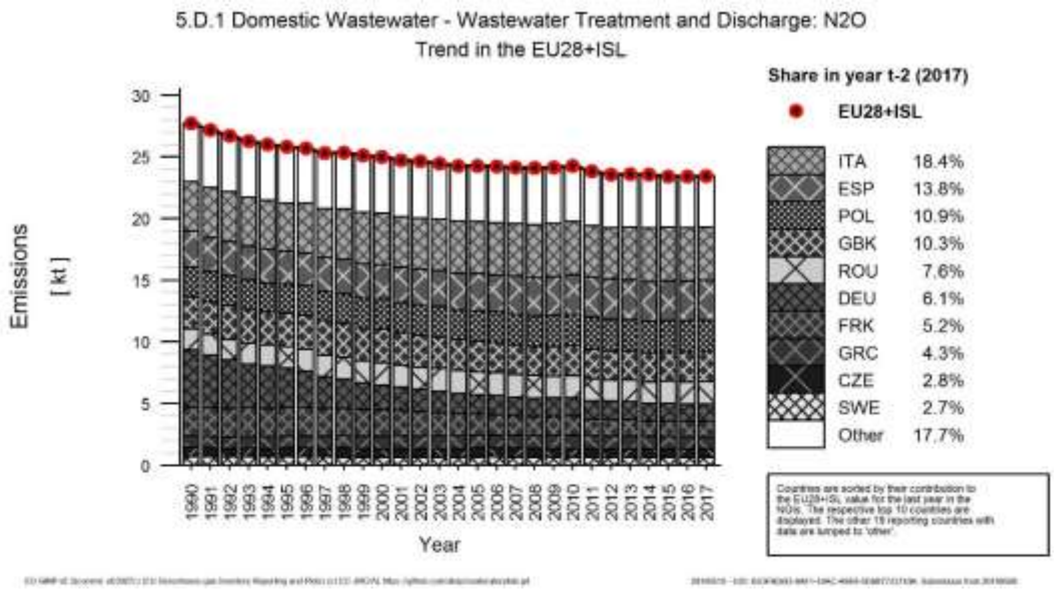
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data for N_2O emissions

According to the key category analysis N_2O emissions from domestic wastewater treatment are an EU key source. Between 1990 and 2017 N_2O emissions from domestic wastewater and discharge decreased only moderately by 15 %. *Figure 7.18* shows the trend of emissions indicating the countries contributing most to EU-28+ISL total.

Member States with large population have a high share of EU-28+ISL N_2O emissions from this source in general. In 2017 Italy is responsible for 18.4 %, Spain for 13.8 %, Poland for 10.9 % of EU-28+ISL N_2O emissions from wastewater treatment (see Table 7.13). Large decreases in absolute terms are reported by Germany and France between 1990 and 2017, 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 MS)



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 2006 IPCC Guidelines. According to Table 7.13 only Austria, Denmark, Finland, Germany, Hungary, Portugal and Slovakia apply a country specific methodology.

Further methodological information for all Member States 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-28+ISL GHG emissions in 2017. Between 1990 and 2017, CH_4 emissions decreased by 30 %. 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. In 2017, CH_4 emissions increased by 1 % in comparison to 2016 (see Table 7.14).

Table 7.14 5D2 Industrial wastewater: Member States' + Icelands contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2017	Change 1990-2017		Change 1995-2017		Change 2016-2017		Method	Emission factor Informa-tion
	1990	2016	2017		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NA	NA	NA	-	-	-	-	-	-	-	NA	NA
Belgium	NA	NA	NA	-	-	-	-	-	-	-	NA	NA
Bulgaria	2 221	310	222	2.8%	-1 999	-90%	-971	-81%	-88	-28%	T2	D
Croatia	97	104	104	1.3%	7	7%	2	2%	0	0%	T1	D
Cyprus	24	30	30	0.4%	6	23%	1	3%	0	0%	T1	D
Czechia	363	422	438	5.5%	75	21%	124	39%	16	4%	CS,T1	CS,D
Denmark	IE	IE	IE	-	-	-	-	-	-	-	NA	NA
Estonia	NO	8	6	0.1%	6	∞	6	∞	-2	-21%	T1	D
Finland	27	24	25	0.3%	-2	-7%	-2	-7%	0	1%	CS,T2	CS,D
France	90	96	96	1.2%	7	8%	4	5%	0	0%	T1	D
Germany	9	44	45	0.6%	35	384%	29	188%	1	2%	CS,T2	CS
Greece	821	871	883	11.1%	63	8%	25	3%	13	1%	CS,D	CS,D
Hungary	135	24	24	0.3%	-111	-82%	-74	-75%	0	1%	T1	D
Ireland	IE	IE	IE	-	-	-	-	-	-	-	NA	NA
Italy	1 520	1 436	1 411	17.8%	-109	-7%	-87	-6%	-25	-2%	T1	D
Latvia	137	4	2	0.0%	-135	-99%	-16	-90%	-2	-54%	T1	PS
Lithuania	IE	IE	IE	-	-	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Malta	IE	IE	IE	-	-	-	-	-	-	-	NA	NA
Netherlands	7	10	10	0.1%	2	33%	0	3%	0	0%	T2	CS
Poland	627	256	276	3.5%	-350	-56%	-81	-23%	20	8%	T1	CS,D
Portugal	259	235	242	3.0%	-17	-7%	-24	-9%	7	3%	T2	CS,D
Romania	378	187	230	2.9%	-148	-39%	-18	-7%	43	23%	D	D
Slovakia	29	6	5	0.1%	-24	-82%	-16	-75%	0	-5%	CS,T2	D
Slovenia	96	7	7	0.1%	-89	-93%	-67	-90%	0	2%	T1	CS,D
Spain	1 719	1 174	1 188	15.0%	-531	-31%	-439	-27%	14	1%	T1	CS,D
Sweden	6	5	5	0.1%	-1	-22%	-4	-46%	0	0%	T2	CS
United Kingdom	2 720	2 612	2 689	33.9%	-32	-1%	-32	-1%	77	3%	T1	D
EU-28	**11 286**	**7 863**	**7 937**	**100%**	**-3 349**	**-30%**	**-1 638**	**-17%**	**74**	**1%**	**-**	**-**
Iceland	IE	IE	IE	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 720	2 612	2 689	33.9%	-32	-1%	-32	-1%	77	3%	T1	D
EU-28 + ISL	**11 286**	**7 863**	**7 937**	**100%**	**-3 349**	**-30%**	**-1 638**	**-17%**	**74**	**1%**	**-**	**-**

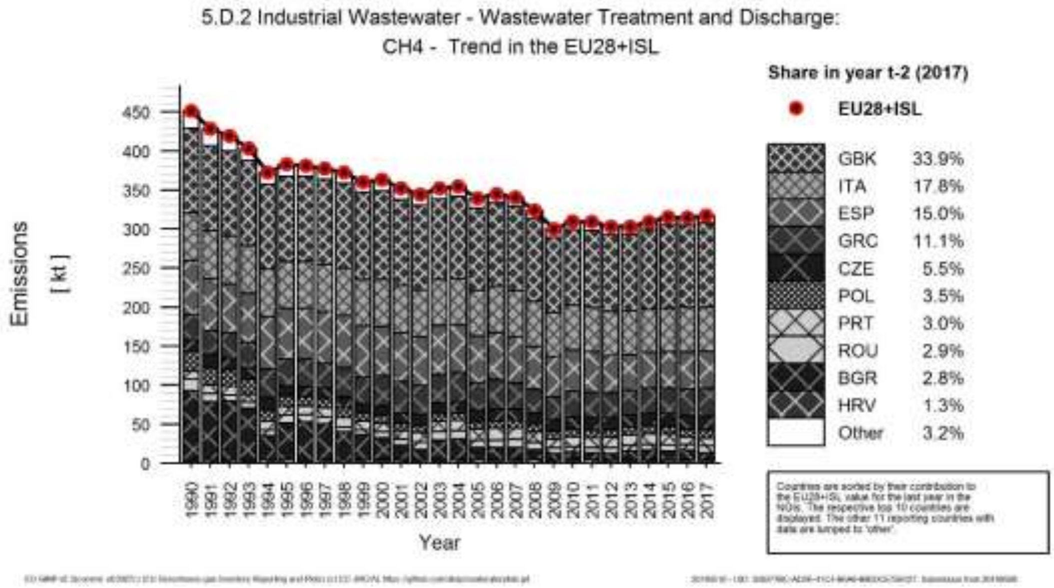
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data

CH_4 emissions from industrial wastewater treatment and discharge decreased between 1990 and 2017 by 30 %. *Figure 7.19* shows the trend of emissions indicating the countries contributing most to EU-28+ISL total.

The largest decrease in absolute terms is reported by Bulgaria, followed by Spain and Poland contributing together to 21 % of EU-28+ISL emissions from source 5D2 in 2017, whereas Czech Republic, Germany and Greece show moderate absolute emission increases between 1990 and 2017 (Table 7.14). The United Kingdom is responsible for 33.9 %, Italy for 17.8 %, Spain for 15 % and Greece for 11,1 % of EU-28+ISL CH_4 emissions from this source in 2017. The emission trends in this sector are mainly influenced by the strong decrease in Bulgaria, Spain and Poland.

Figure 7.19 5D2 Industrial wastewater: CH_4 emissions (Trend in relevant MS)



CH_4 emissions from industrial wastewater in the **United Kingdom** are quite constant throughout the time series 1990 and 2017 with lowest emissions during the economic break down in 2009 and 2010. Between 1990 and 2017 CH_4 emissions slightly decreased by 1 %. Given the high share of UKs CH_4 emissions in EU-28+ISL of 33.9 % the United Kingdom points out that this estimate is very conservative and likely to be over-estimated as there is a lack of data.

In **Spain**, CH_4 emissions from industrial wastewater decreased by 31 % until 2017 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 7% between 1990 and 2017. 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.

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 0.11 billion m^3 in 2017. Between 1990 and 2017 CH_4 emissions decreased by 90 %.

CH_4 emissions from industrial wastewater in **Poland** decreased by 56 % between 1990 and 2017, 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.

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 21 Member States, while Austria, Belgium report CH_4 emissions as not applicable, Luxembourg reports CH_4 emissions under 5D2 as not occurring and Denmark, Ireland, Iceland, Lithuania and Malta report CH_4 emissions from industrial wastewater elsewhere.

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 Member States. In contrast, the MCF has to be determined country specifically and varies strongly among the Member States 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 member states and Iceland to EU recalculations in CH_4 for 1990 and 2016 (difference between latest submission and previous submission)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	0.02	0.01	Correction occurred in the CH_4 emissions of septic tanks in the year 2016. Indeed, it was a bissextile year and it was not taken into account in the 2018 submission.
Bulgaria	-	-	-	-	
Croatia	-122	-21.6	-170	-36.4	New data on sludge removed are included.
Cyprus	-	-	1	2.1	Emissions from Industrial Wastewater Treatment and Discharge were recalculated for 2016 due to revision of the activity data of solid waste production by the Statistical Service
Czechia	-	-	-	-	
Denmark	-55	-57.0	-61	-54.7	For 5.D Wastewater treatment and discharge, recalculations occur throughout the time series due to a reduction in the EF value for scattered houses, which are not connected to the collective sewer system from 0.5 to 0.0467 kg CH_4/kg BOD. The changes are based on Danish monitoring data on septic tanks
Estonia	-	-	0.1	0.2	Updated the number of people living in high and low density settlements
Finland	-	-	-	-	

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
France	-43	-2.8	51	2.3	Update of the database concerning DCO discharge by operators
Germany	0.002	0.0001	-2	-0.3	Adjustments of population figures
Greece	-	-	41	4.2	updated data for the period 2011 - 2016
Hungary	-	-	-	-	
Ireland	-	-	-	-	
Italy	-14	-0.4	-4	-0.2	Update of domestic wastewater activity data
Latvia	-	-	-151	-59.6	Changes in principles of estimating activity data for emissions in industrial wastewater sector
Lithuania	-	-	5	3.3	Recalculations for the years 2013-2016 were done after the revision of activity data
Luxembourg	-	-	-	-	
Malta	0.2	1.3	-	-	
Netherlands	-	-	2	0.8	final statistics
Poland	2 537	67.1	2 007	400.9	Developement of IPCC 2006 methodology (methane recovery/sludge treatment) in domestic wastewater subsector and change of data on urban and rural pathways population shares
Portugal	-882	-36.8	-1 485	-64.1	Under the framework of the Portuguese Road Map for Carbon Neutrality in 2050, the Waste Water Treatment Sector was revisited. The need to revise the estimates was identified and a set of changes were implemented for this submission. These include revisions concerning: Domestic WW (5D1): new data for 2015 were collected and considered in this 2019 submission. These data is based on AdP (Águas de Portugal) universe which represents approx. 60% of WW Treatment in Portugal and other main WW Treatment Plants information that is registered at the APA Industrial WW (5D2) : 1) changes in AD due to the exclusion or revision of some sub-activities (e.g. in cork industry, some dairy products); 2) change in CQO pollution coeficients for some sectors (cork, pulp and organic chemicals industry); 3) updates of treatment types.
Romania	-	-	0.4	0.03	CH_4 emissions were recalculated for 2016 year taking into account the final data associated to the amount of composted waste.
Slovakia	-	-	-	-	-
Slovenia	84	42.0	6	4.3	Modification of the methodology for IWW.
Spain	-	-	0.3	0.02	Correction of mistakes in the emission factors used
Sweden	-	-	-	-	
United Kingdom	-0.1	-0.003	-54	-1.6	Minor revisions to proxy data (e.g. Index of Production by sector) used for individual industry sector activity, which inform some waste water estimates.
EU28	1 504	4.4	186	0.9	*See recalculations per member state*
Iceland	0.00001	0.0005	-0.1	-1.7	More detailed waste amount data back to 2014 as discussed in 5A and 5C, better data on sludge removed became available for the years 2014-2016.
United Kingdom (KP)					Minor revisions to proxy data (e.g. Index of Production by sector) used for individual industry sector activity, which inform some waste water estimates.
EU28+ISL	1 504	5.0	241	1.5	*See recalculations per member state*

Table 7.16: 5D Waste water treatment: Contribution of member states and Iceland to EU recalculations in N_2O for 1990 and 2016 (difference between latest submission and previous submission)

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	1	0.8	
Belgium	-	-	-0.005	-0.004	In Wallonia, the activity data for N sludge has been improved and the N sludge is now taken into account since 1994 until now.
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	

	1990		2016		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Cyprus	-	-	-	-	
Czechia	-	-	-	-	
Denmark	-	-	-0.3	-0.4	-
Estonia	0.03	0.1	2	8.3	Updating the timeseries of protein consumed. Please see Chapter 7.5.5
Finland	-	-	-	-	
France	1	0.2	-6	-1.5	Update of the database concerning N discharge by operators
Germany	-2	-0.1	-1	-0.3	- Adjustments of population figures - Updated data on protein intake for the years 1990-2010 from FAOSTATsee NIR 2019, chapter 7.5.1.1.5
Greece	-	-	-17	-5.2	updated data
Hungary	-	-	-	-	
Ireland	-	-	-	-	
Italy	-	-	-9	-0.7	Update of domestic wastewater activity data
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Luxembourg	-3	-36.2	-3	-35.0	revision of method (use of T1 for N_2O) following UNFCCC review recommendations (ARR 2016, W.2, W.3, W.4)
Malta	0.1	0.9	0.4	8.3	Both the changes in Per Capita Protein Consumption (Protein in Kg/person/yr) (the data obtained from the FAOSTAT website does not provide the annual figures of the years between 2014 and 2017. Hence, an extrapolation was worked out by using the formula ''=TREND'' five-year moving average) and swine manure nitrogen going to sewers (pigs) (kt) (which has been updated due to some changes/revisions in the Agriculture's sector methodology), affected the Total N2O emissions (Gg CO_2 eq.).
Netherlands	-	-	3	4.0	
Poland	0.1	0.02	-	-	
Portugal	-	-	-69	-27.6	Changes made in the context of a thorough revision of the sector (please see explanation for CH_4), following the work under the Portuguese Road Map for Carbon Neutrality in 2050. N_2O emissions from wastewater: new accounting for direct emissions from nitrification and denitrification at centralised wastewater treatment plants.
Romania	-	-	1	0.1	The N_2O emissions from wastewater treatment and discharged were recalculated for 2016 year taking into account the final data associated to total number of population, data provided by National Institute of Statistics.
Slovakia	-	-	2	4.3	Correction of protein consumption based on updated data from the Statistical Office of the Slovak Republic (2015 and 2016).
Slovenia	-	-	-	-	
Spain	-	-	-	-	
Sweden	-	-	-6	-2.9	Emissions of nitrous oxide from CRF 5.D.1 Domestic wastewater and CRF 5.D.2 Industrial wastewater has been recalculated for years 2015 and 2016 to the availability of new data on discharges of nitrogen and population connected to municipal wastewater treatment plants.
United Kingdom	-	-	-1	-0.1	Update to use protein intake data for 2016 not available in time for the previous submission.
EU28	-4	-0.04	-103	-1.4	*See recalculations per member state*
Iceland	0	0	0.003	0.04	More detailed waste amount data back to 2014 as discussed in 5A and 5C, better data on sludge removed became available for the years 2014-2016.
United Kingdom (KP)					Update to use protein intake data for 2016 not available in time for the previous submission.
EU28+ISL	-4	-0.05	-102	-1.6	*See recalculations per member state*

7.2.5 Waste – non-key categories

Table 7.17 Aggregeted GHG emission from non-key categories in the waste sector

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 5. Waste in 2017	Change 1990-2017		Change 2016-2017	
	1990	2016	2017		kt CO_2 equ.	%	kt CO_2 equ.	%
5.A.1 Managed Waste Disposal Sites: Waste (CO2)	0	0	0	0	0	0%	0	0%
5.A.2 Unmanaged Waste Disposal Sites: Waste (CO2)	0.0	0.0	0.0	0.00%	0	0%	0	0%
5.A.3 Uncategorized Waste Disposal Sites: Waste (CH4)	1 307.1	952.3	864.3	0.62%	-443	-34%	-88	-9%
5.A.3 Uncategorized Waste Disposal Sites: Waste (CO2)	0.0	0.0	0.0	0.00%	0	0%	0	0%
5.B.1 Waste Composting: Waste (N2O)	341.4	2 843.8	2 819.9	2.02%	2 479	726%	-24	-1%
5.B.2 Anaerobic Digestion at Biogas Facilities: Waste (CH4)	8.3	1 589.1	1 659.5	1.19%	1 651	19820%	70	4%
5.B.2 Anaerobic Digestion at Biogas Facilities: Waste (N2O)	0.0	120.0	120.3	0.09%	120	100%	0	0%
5.C.1 Waste Incineration: Waste (CH4)	112.2	3.9	4.1	0.00%	-108	-96%	0	5%
5.C.1 Waste Incineration: Waste (CO2)	5 104.3	3 016.4	3 113.6	2.23%	-1 991	-39%	97	3%
5.C.1 Waste Incineration: Waste (N2O)	193.1	198.2	206.5	0.15%	13	7%	8	4%
5.C.2 Open Burning of Waste: Waste (CH4)	191.1	147.5	143.2	0.10%	-48	-25%	-4	-3%
5.C.2 Open Burning of Waste: Waste (CO2)	97.3	35.1	35.1	0.03%	-62	-64%	0	0%
5.C.2 Open Burning of Waste: Waste (N2O)	102.9	95.0	94.2	0.07%	-9	-8%	-1	-1%
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (N2O)	242.9	147.1	146.2	0.10%	-97	-40%	-1	-1%
5.D.3 Wastewater Treatment and Discharge: Other Wastewater (CH4)	98.2	15.4	14.1	0.01%	-84	-86%	-1	-9%
5.D.3 Wastewater Treatment and Discharge: Other Wastewater (N2O)	153.4	51.0	51.0	0.04%	-102	-67%	0	0%
5.E Other Disposal: Waste (CH4)	46.3	13.0	6.5	0.00%	-40	-86%	-6	-50%
5.E Other Disposal: Waste (CO2)	20.3	44.7	15.7	0.01%	-5	-23%	-29	-65%
5.E Other Disposal: Waste (N2O)	0.0	70.6	69.4	0.05%	69	100%	-1	-2%

7.3 EU-28+ISL uncertainty estimates

Table 7.18 shows the total EU-28 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 the lowest for CO_2 from 5C. Regarding the uncertainty on trend, CH_4 from 5B and 5E shows the highest uncertainty estimates, CH_4 from 5A, CO_2 from 5C and CH_4 from 5D the lowest. For a description of the Tier 1 uncertainty analysis carried out for the EU-28 and Iceland see Chapter 1.6.

Table 7.18 Sector 5 -Waste: EU-28 +ISL uncertainty estimates

Source category	Gas	Emissions Base Year	Emissions 2017	Emission trends Base Year-2017	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	188 845	100 523	-46.8%	28.2%	0.1%
5.A Solid Waste Disposal	N2O	0	0		0.0%	
5.B Waste Water Handling	CO2	0	0		0.0%	
5.B Waste Water Handling	CH4	390	4 511	1056.8%	85.0%	5.1%
5.B Waste Water Handling	N2O	344	2 936	754.3%	87.7%	3.1%
5.C Waste Incineration	CO2	5 185	3 155	-39.2%	30.2%	0.6%
5.C Waste Incineration	CH4	215	92	-57.2%	27.9%	0.3%
5.C Waste Incineration	N2O	203	200	-1.2%	95.6%	0.5%
5.D Wastewater treatment and discharge	CO2	0	0		0.0%	
5.D Wastewater treatment and discharge	CH4	36 390	19 808	-45.6%	50.2%	0.1%
5.D Wastewater treatment and discharge	N2O	8 733	7 181	-17.8%	899.3%	4.3%
5.E Other	CO2	20	16	-22.7%	300.2%	0.7%
5.E Other	CH4	2	6	139.2%	154.0%	1.8%
5.E Other	N2O	0	69		60.0%	
Total - 5	**all**	**240 327**	**138 497**	**-42.4%**	**51.5%**	**19.4%**

***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 of the EU-NIR because uncertainty estimates are not available for all source categories in each of this 28 EU Member Statesand Iceland;*

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 Member States data in particular for completeness, time series consistency of emissions and implied emission factors, comparisons of implied emission factors across Member States 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 Member States 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 Member States 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 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 March 2016, during the WG1-meeting, a note/paper on wastewater treatment and discharge was discussed with the Member States. 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 Member States. 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 Member States on specific aspects that were handled and discussed during the ESD review round in 2018.

7.5 Sector-specific improvements

After the implementation of the new 2006 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 and 2018, 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.

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 Guidelinessuch 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 2006 IPCC Guidelines only estimated indirect N_2O emissions from agricultural sources of nitrogen. The 2006 IPCC Guidelinesinclude 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 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 MS. 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]. Seven countries provided values for indirect CO_2 emissions. The highest shares of the EU-28 total of indirect CO_2 emissions are held by Czechia (42 %) and Netherlands (27 %). Eight countries reported indirect N_2O emissions in 2017, with Romania and Italy accounting for more than 70% 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-28 in 201

Member States	indirect CO_2 [kt CO_2 equ.]	Share in EU-28 [%]	indirect N_2O [kt CO_2 equ.]	Share in EU-28 [%]
Austria	0.4	0.02%	14	0.4%
Belgium	NO,NE	-	NO,NE	-
Bulgaria	NO	-	NO	-
Croatia	NO,NA	-	NO,NA	-
Cyprus	NE	-	NE	-
Czechia	708	42%	259	7%
Denmark	281	16%	271	7%
Estonia	NO,NE,IE	-	NO,NE	-
Finland	53	3%	176	5%
France	IE,NA	-	NO,NE	-
Germany	NE	-	NE,IE	-
Greece	NO,NE	-	NO,NE	-
Hungary	NO,NE	-	NO,NE	-
Ireland	NO,NE,IE	-	NO,NE	-
Italy	NO	-	1 062	28%
Latvia	19	1%	NO,IE,NA	-
Lithuania	NO,NE,IE	-	NO,NE	-
Luxembourg	NO,NE	-	NO,NE	-
Malta	NO,NE	-	NO,NE	-
Netherlands	453	27%	NO,NE	-
Poland	NE,IE,NA	-	226	6%
Portugal	190	11%	NO,NE,NA	-
Romania	NO,NE	-	1 699	45%
Slovakia	NO,NE,IE	-	NO,NE	-
Slovenia	NO,NE	-	NO,NE	-
Spain	NE,NA	-	NE,NA	-
Sweden	NO	-	NO	-
United Kingdom	NO,NE	-	109	3%
EU-28	**1 705**	**100%**	**3 815**	**100%**
United Kingdom (KP)	NO,NE	-	107	3%
Iceland	NO	-	NO	-
EU-28+ISL	**1 705**	**100%**	**3 813**	**100%**

7

In general, the methodologies for the estimation of indirect emissions in EU countries are in line with the 2006 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 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, NO_x 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. The highest percentage decrease has been noted in Finland, while in absolute terms Czechia had the biggest share in the EU reduction, decreasing its indirect CO_2 emissions by more than 1.6 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)[74] 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 Member States 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.

[74] 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 (>+/- 1000 kt CO_2 equiv.) in the year 1990 and 2016 for each EU-28 Member State. For explanations of the recalculations (including recalculations <+/- 1000 kt CO_2 equiv see the sectoral chapters of the EU NIR and the information provided by the Member States' submissions.

Recalculations presented are calculated from MS submissions used for the EU submission in May 2018 and MS submissions received until 8 May 2019.

Table 10.1 Main recalculations by source category for 1990

Category	MS	1990	
		kt CO_2 equiv.	%
1A1 Energy Industries CO_2	Bulgaria	-2 128	-5.5
1A2 Manufacturing Industries and Construction CO_2	Czechia	-4 107	-8.1
1A3 Transport CO_2	Czechia	4 187	59.5
1A3 Transport CO_2	France	2 099	1.8
1A4 Other sectors CO_2	Romania	-1 307	-12.1
1B1 Solid Fuels CH_4	Romania	1 968	50.5
3A Enteric fermentation CH_4	Spain	1 979	14.9
3B Manure management N_2O	Germany	-1 181	-23.2
5A Solid waste disposal on land CH_4	Poland	3 351	31.0
5D Waste water treatment and discharge CH_4	Poland	2 537	67.1
4A Forest land CO_2	Bulgaria	2 097	14.7
4A Forest land CO_2	Finland	-1 219	-5.4
4A Forest land CO_2	France	1 987	4.9
4A Forest land CO_2	Ireland	-1 169	-43.4
4A Forest land CO_2	Romania	1 300	5.2
4A Forest land CO_2	Spain	2 657	7.5
4A Forest land CO_2	Sweden	1 081	2.8
4A Forest land CO_2	United Kingdom	2 420	13.9
4C Grassland CO_2	Iceland	-1 488	-22.9
4D Wetlands CO_2	Poland	-3 907	-86.7
4G Harvested wood products CO_2	Belgium	-1 616	100.0
4G Harvested wood products CO_2	France	1 704	25.1
4 Land use, land-use change and forestry (net) CO_2	Bulgaria	2 653	17.6
4 Land use, land-use change and forestry (net) CO_2	Czechia	1 337	20.1
4 Land use, land-use change and forestry (net) CO_2	Finland	-1 608	-9.6
4 Land use, land-use change and forestry (net) CO_2	France	3 701	12.3
4 Land use, land-use change and forestry (net) CO_2	Ireland	-1 628	-28.1
4 Land use, land-use change and forestry (net) CO_2	Poland	-4 019	-14.4
4 Land use, land-use change and forestry (net) CO_2	Romania	1 673	7.6
4 Land use, land-use change and forestry (net) CO_2	Spain	3 471	8.7
4 Land use, land-use change and forestry (net) CO_2	Sweden	1 511	4.0
4 Land use, land-use change and forestry (net) CO_2	United Kingdom	2 381	54.4
4 Land use, land-use change and forestry (net) CO_2	Iceland	-2 029	-26.5

Table 10.2 Main recalculations by source category for 2016

Category	MS	2016	
		kt CO_2 equiv.	%
1A1 Energy Industries CO_2	Romania	1 137	4.4
1A1 Energy Industries CO_2	United Kingdom	1 466	1.3
1A2 Manufacturing Industries and Construction CO_2	France	2 136	4.4
1A2 Manufacturing Industries and Construction CO_2	Germany	3 878	3.1
1A2 Manufacturing Industries and Construction CO_2	Italy	4 212	9.0
1A3 Transport CO_2	France	1 496	1.1
1A3 Transport CO_2	Italy	-1 377	-1.3
1A3 Transport CO_2	Poland	1 265	2.4
1A4 Other sectors CO_2	Belgium	-1 900	-7.6
1A4 Other sectors CO_2	France	-1 144	-1.3
1A4 Other sectors CO_2	Germany	-4 702	-3.5
1B1 Solid Fuels CH_4	Romania	5 127	565.6
1B2 Oil and natural gas CH_4	Romania	-5 276	-59.9
2C Metal industry CO_2	Germany	1 325	7.8
2F Product uses as substitute for ODS HFC	Poland	-2 227	-24.9
3A Enteric fermentation CH_4	Germany	1 316	5.4
3A Enteric fermentation CH_4	Spain	2 609	18.3
3D Agricultural soils N_2O	Spain	1 541	14.9
5A Solid waste disposal on land CH_4	Poland	1 070	13.2
5D Waste water treatment and discharge CH_4	Poland	2 007	400.9
5D Waste water treatment and discharge CH_4	Portugal	-1 485	-64.1
4A Forest land CO_2	Belgium	1 722	53.3
4A Forest land CO_2	Bulgaria	-1 145	-18.8
4A Forest land CO_2	Finland	7 551	20.9
4A Forest land CO_2	France	1 129	2.0
4A Forest land CO_2	Lithuania	2 678	24.6
4A Forest land CO_2	Slovenia	3 125	60.8
4A Forest land CO_2	Spain	2 216	5.9
4A Forest land CO_2	Sweden	-1 503	-3.5
4A Forest land CO_2	United Kingdom	5 700	23.7
4B Cropland CO_2	Italy	-1 361	-55.3
4B Cropland CO_2	Netherlands	-1 005	-36.5
4C Grassland CO_2	France	1 620	15.6
4C Grassland CO_2	Iceland	-1 694	-23.5
4D Wetlands CO_2	Poland	-3 137	-69.8
4E Settlements CO_2	Italy	-3 839	-42.6
4G Harvested wood products CO_2	United Kingdom	-1 322	-156.5
4 Land use, land-use change and forestry (net) CO_2	Bulgaria	-1 678	-23.4
4 Land use, land-use change and forestry (net) CO_2	Denmark	-1 043	-19.6
4 Land use, land-use change and forestry (net) CO_2	Finland	7 706	26.3
4 Land use, land-use change and forestry (net) CO_2	France	3 083	7.5
4 Land use, land-use change and forestry (net) CO_2	Ireland	-1 261	-29.7
4 Land use, land-use change and forestry (net) CO_2	Italy	-6 292	-20.2

Category	MS	2016	
		kt CO_2 equiv.	%
4 Land use, land-use change and forestry (net) CO_2	Lithuania	2 416	28.0
4 Land use, land-use change and forestry (net) CO_2	Netherlands	-1 059	-16.2
4 Land use, land-use change and forestry (net) CO_2	Poland	-3 362	-11.5
4 Land use, land-use change and forestry (net) CO_2	Romania	1 362	5.2
4 Land use, land-use change and forestry (net) CO_2	Slovenia	2 590	51.5
4 Land use, land-use change and forestry (net) CO_2	Spain	2 499	6.1
4 Land use, land-use change and forestry (net) CO_2	Sweden	-1 585	-3.6
4 Land use, land-use change and forestry (net) CO_2	United Kingdom	4 762	29.7
4 Land use, land-use change and forestry (net) CO_2	Iceland	-2 268	-28.7

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-28 + ISL. 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 5 570 kt (0.1 %). EU-28 + ISL GHG emissions for 2016 increased by 11 916 kt (+0.3 %) due to recalculations.

Table 10.3 Overview of recalculations of EU-28 and Iceland total GHG emissions (difference between latest submission and previous submission in kt CO_2 equivalents)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total CO_2 equivalent emissions including LULUCF (absolute in kt)	17306	23152	24393	21825	24437	14697	15925	21865	15553	16750	19603	19417	29343	21666	21939
Total CO_2 equivalent emissions including LULUCF (percent)	0.4	0.5	0.6	0.5	0.6	0.3	0.4	0.6	0.4	0.4	0.5	0.5	0.8	0.6	0.6
Total CO_2 equivalent emissions excluding LULUCF (absolute in kt)	5570	12749	10786	12343	11109	6911	8312	13044	9840	10101	9488	9326	8914	9376	11916
Total CO_2 equivalent emissions excluding LULUCF (percent)	0.1	0.3	0.2	0.3	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.3

Table 10.4 provides an overview of recalculations for the key categories for 1990 and 2016 (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 1A2 ‘Manufacturing Industries’ for 1990 and 2016.

Table 10.5 and Table 10.6 give an overview of absolute and percentage changes of Member States’ emissions due to recalculations for 1990 and 2016. Recalculations of more than 1 million tonnes of CO_2 equivalents were made in Bulgaria, France, Germany, Italy, Netherlands, Portugal, Romania, Slovakia, Spain United Kingdom. Recalculations in relative terms of more than 2 % were made in Bulgaria, Malta, Portugal, Romania, Slovakia.

Table 10.4 Recalculations for the EU-28 and Iceland key source categories 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 equivalents and in percentage)

Greenhouse Gas Source Categories	Gas	Recalculations 1990		Recalculations 2016	
		(kt CO_2 equivalents)	(%)	(kt CO_2 equivalents)	(%)
1.A.1. Energy Industries	CO_2	- 2 281	-0.2%	1 291	0.1%
1.A.2. Manufacturing Industries	CO_2	- 4 193	-0.6%	9 761	2.3%
1.A.3. Transport	CO_2	5 962	0.9%	973	0.1%
1.A.3. Transport	CH_4	160	3.0%	13	1.1%
1.A.3. Transport	N_2O	- 12	-0.2%	- 137	-1.6%
1.A.4. Other Sectors	CO_2	- 2 691	-0.4%	- 7 689	-1.4%
1.A.4. Other Sectors	CH_4	- 357	-1.7%	- 215	-1.3%
1.A.5. Other	CO_2	171	1.0%	- 153	-3.0%
1.B.1. Solid Fuels	CH_4	1 883	2.6%	5 305	20.4%
1.B.2. Oil and Natural Gas	CH_4	- 162	-0.3%	- 5 094	-18.0%
1.B.2. Oil and Natural Gas	CO2	- 84	-0.5%	441	2.5%
2.A. Mineral Industry	CO_2	- 570	-0.4%	- 139	-0.1%
2.B. Chemical Industry	CO_2	170	0.3%	545	1.2%
2.B. Chemical Industry	Unspecified mix of HFCs and PFCs	-	0.0%	-	0.0%
2.B. Chemical Industry	N_2O	246	0.3%	381	5.8%
2.B. Chemical Industry	HFCs	-	0.0%	1	0.2%
2.C. Metal Industry	CO_2	91	0.1%	1 445	2.1%
2.C. Metal Industry	PFC	- 0	0.0%	0	0.0%
2.D. Non-energy products from fuels and solv	CO_2	- 280	-2.1%	- 460	-4.7%
2.F. Product uses as substitute for ODS	HFC	64	871.8%	- 2 632	-2.8%
3.A. Enteric Fermentation	CH_4	3 188	1.5%	4 146	2.4%
3.B. Manure Management	CH_4	- 172	-0.4%	530	1.4%
3.B. Manure Management	N_2O	- 1 225	-4.4%	- 477	-2.4%
3.D. Agricultural Soils	N_2O	1 070	0.6%	1 359	0.9%
5.A. Solid Waste Disposal	CH_4	3 463	2.8%	2 139	2.5%
5.B. Biological Treatment of Solid Waste	CH_4	8	2.2%	- 46	-1.3%
5.D. Waste Water treatment and discharge	CH_4	1 504	5.0%	241	1.5%
5.D. Waste Water treatment and discharge	N2O	- 4	0.0%	- 102	-1.6%

Note: Many of these source categories are more aggregated than the EU-28 + ISL key source categories identified in Section 1.5.

Table 10.5 Contribution of Member States to EU-28 recalculations of total GHG emissionswith indirect CO_2 and without LULUCF for 1990–2016 (difference between latest submission and previous submission kt of CO_2 equivalents)

Member State	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Austria	-20	-146	-17	-88	286	370	-135	210	-178	11	-106	175	238	42	-77
Belgium	-67	-79	-54	-122	-202	-154	-301	36	210	141	93	-387	-504	-462	-1 944
Bulgaria	-2 140	39	-2	0	0	1	2	-1	2	2	0	-21	-54	-39	25
Croatia	-36	7	30	78	135	77	361	-74	99	180	108	-9	65	59	81
Cyprus	78	116	116	111	83	91	61	39	39	-13	-26	-38	-54	-24	-32
Czechia	-355	-738	334	505	212	216	210	141	167	221	232	211	193	146	160
Denmark	-117	-86	7	-90	-86	-82	-53	2	-304	-305	-165	-247	-262	-368	-324
Estonia	34	51	55	58	59	59	62	96	83	102	90	95	81	78	38
Finland	-10	-13	90	129	213	199	133	189	163	69	150	-109	-122	-224	-692
France	1 700	1 728	1 641	2 037	1 490	505	245	3 331	287	1 185	504	1 242	765	1 808	2 478
Germany	-643	-334	219	253	313	513	365	-130	-241	1	-17	246	520	439	1 645
Greece	0	0	0	0	0	0	0	69	73	66	62	46	25	20	90
Hungary	-141	-174	-187	-406	-425	-425	-454	-378	-394	-448	-418	-458	-526	-243	-325
Ireland	-73	-7	-76	-48	-33	-38	-39	-54	-128	-117	-125	-205	-218	-215	-276
Italy	-618	-221	-358	-251	-5	-1 131	-271	965	1 784	1 098	1 113	1 487	935	1 166	4 257
Latvia	-170	-35	-25	-48	-55	-53	-49	-11	-94	-61	-63	-38	-59	-62	-20
Lithuania	106	38	33	28	27	29	19	20	20	12	9	1	3	31	104
Luxembourg	-30	-2	11	16	14	18	21	16	13	12	13	12	21	20	24
Malta	1	-18	-43	-69	-75	-72	-64	-53	-58	-43	-34	-31	-34	-37	-14
Netherlands	424	382	426	390	373	356	375	427	394	375	1 298	953	1 188	1 233	593
Poland	7 070	6 798	5 867	5 763	5 889	5 826	5 957	5 781	5 696	5 652	5 519	5 293	5 257	5 275	3 299
Portugal	-725	-1 298	-1 059	-1 195	-1 205	-1 210	-964	-930	-1 141	-1 401	-1 388	-1 422	-1 376	-1 676	-1 684
Romania	1 321	6 700	2 393	3 525	2 474	133	1 494	1 961	1 723	1 354	1 070	1 043	957	252	1 730
Slovakia	-618	-788	-375	-7	77	180	62	140	36	295	15	92	188	738	1 117
Slovenia	12	-8	1	-30	-35	-44	-37	-41	-39	-40	-42	-41	-43	-40	-36
Spain	836	1 127	1 956	1 968	1 719	1 688	1 474	1 466	1 794	1 903	1 744	1 523	1 795	1 789	1 677
Sweden	-211	-260	-166	-135	-105	-113	-132	-143	-129	-117	-108	-48	-35	-294	50
United Kingdom	-2 219	-1 949	-1 478	-1 847	-1 969	-1 874	-1 500	-1 539	-1 503	-1 227	-1 228	-384	-96	189	420
EU-28	**3 387**	**10 828**	**9 338**	**10 524**	**9 169**	**5 065**	**6 840**	**11 534**	**8 371**	**8 907**	**8 299**	**8 978**	**8 848**	**9 599**	**12 365**
Iceland	-36	-28	-29	-29	-28	-28	-28	-29	-34	-33	-39	-36	-30	-34	-29

Member State	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
United Kingdom (KP)	-1 968	-1 693	-1 119	-1 493	-1 547	-1 377	-1 067	-1 226	-1 155	-844	-830	-22	340	703	761
EU-28 + ISL	**5 570**	**12 749**	**10 786**	**12 343**	**11 109**	**6 911**	**8 312**	**13 044**	**9 840**	**10 101**	**9 488**	**9 326**	**8 914**	**9 376**	**11 916**

Table 10.6 Contribution of Member States to EU-28 recalculations of total GHG emissions with indirect CO_2 and without LULUCF for 1990–2016 (difference between latest submission and previous submission in percentage)

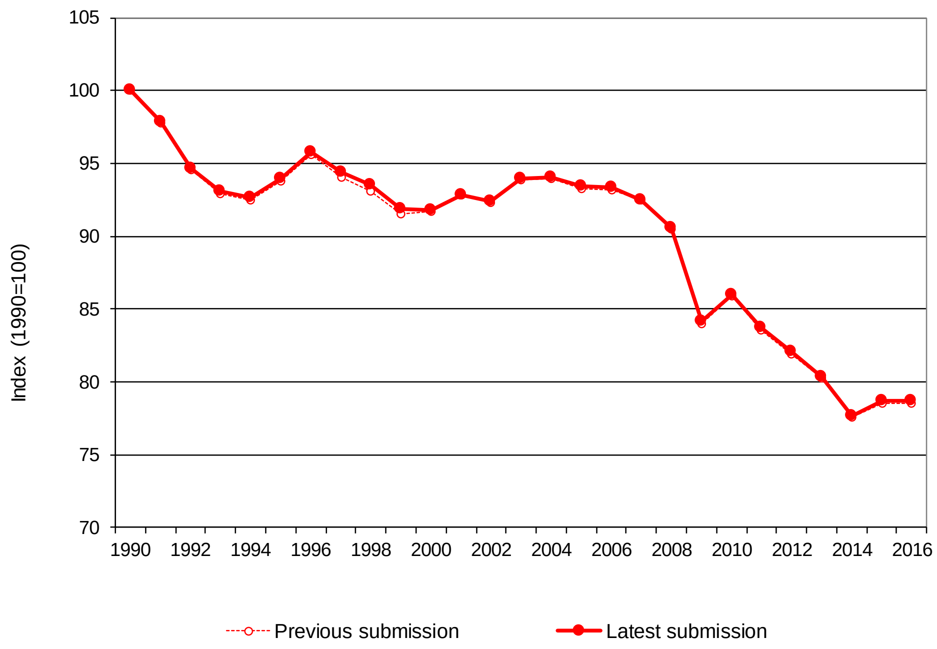
Member State	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Austria	-0.03	-0.18	-0.02	-0.10	0.32	0.42	-0.15	0.26	-0.21	0.01	-0.13	0.22	0.31	0.05	-0.10
Belgium	-0.05	-0.05	-0.04	-0.08	-0.14	-0.11	-0.22	0.03	0.16	0.12	0.08	-0.32	-0.44	-0.39	-1.65
Bulgaria	-2.06	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.04	-0.09	-0.06	0.04
Croatia	-0.11	0.03	0.12	0.26	0.45	0.24	1.18	-0.26	0.35	0.65	0.42	-0.04	0.27	0.24	0.33
Cyprus	1.39	1.67	1.40	1.20	0.87	0.93	0.61	0.41	0.42	-0.14	-0.30	-0.48	-0.66	-0.29	-0.36
Czechia	-0.18	-0.46	0.22	0.34	0.14	0.14	0.14	0.10	0.12	0.16	0.17	0.16	0.15	0.11	0.12
Denmark	-0.17	-0.11	0.01	-0.14	-0.12	-0.12	-0.08	0.00	-0.48	-0.52	-0.31	-0.45	-0.51	-0.76	-0.64
Estonia	0.08	0.25	0.32	0.30	0.32	0.27	0.31	0.58	0.39	0.48	0.45	0.44	0.39	0.43	0.19
Finland	-0.01	-0.02	0.13	0.18	0.26	0.25	0.19	0.28	0.22	0.10	0.24	-0.17	-0.21	-0.40	-1.18
France	0.31	0.32	0.30	0.37	0.28	0.09	0.05	0.66	0.06	0.24	0.10	0.26	0.17	0.39	0.54
Germany	-0.05	-0.03	0.02	0.03	0.03	0.05	0.04	-0.01	-0.03	0.00	0.00	0.03	0.06	0.05	0.18
Greece	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.06	0.06	0.04	0.03	0.02	0.10
Hungary	-0.15	-0.23	-0.25	-0.54	-0.57	-0.58	-0.64	-0.58	-0.60	-0.70	-0.70	-0.80	-0.91	-0.40	-0.53
Ireland	-0.13	-0.01	-0.11	-0.07	-0.05	-0.06	-0.06	-0.09	-0.21	-0.21	-0.22	-0.36	-0.38	-0.36	-0.45
Italy	-0.12	-0.04	-0.06	-0.04	0.00	-0.20	-0.05	0.19	0.35	0.22	0.24	0.34	0.22	0.27	0.99
Latvia	-0.64	-0.27	-0.24	-0.42	-0.46	-0.42	-0.41	-0.09	-0.76	-0.52	-0.56	-0.34	-0.53	-0.54	-0.18
Lithuania	0.22	0.17	0.17	0.12	0.12	0.11	0.08	0.10	0.10	0.06	0.04	0.00	0.02	0.15	0.52
Luxembourg	-0.23	-0.02	0.12	0.12	0.11	0.15	0.17	0.14	0.10	0.10	0.11	0.10	0.19	0.20	0.24
Malta	0.05	-0.69	-1.52	-2.31	-2.46	-2.31	-2.05	-1.80	-1.95	-1.42	-1.07	-1.07	-1.16	-1.66	-0.74
Netherlands	0.19	0.16	0.19	0.18	0.18	0.17	0.18	0.21	0.18	0.19	0.67	0.49	0.64	0.63	0.30
Poland	1.51	1.55	1.51	1.45	1.43	1.41	1.47	1.49	1.40	1.39	1.39	1.34	1.38	1.37	0.83
Portugal	-1.21	-1.84	-1.27	-1.37	-1.46	-1.51	-1.25	-1.25	-1.63	-2.03	-2.07	-2.18	-2.11	-2.41	-2.48
Romania	0.54	3.71	1.70	2.38	1.65	0.09	1.01	1.54	1.41	1.06	0.86	0.90	0.83	0.22	1.54
Slovakia	-0.84	-1.46	-0.76	-0.01	0.15	0.37	0.13	0.31	0.08	0.65	0.03	0.22	0.46	1.80	2.72
Slovenia	0.06	-0.04	0.00	-0.15	-0.17	-0.21	-0.17	-0.21	-0.20	-0.20	-0.22	-0.23	-0.26	-0.24	-0.20

Member State	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Spain	0.29	0.34	0.51	0.45	0.40	0.38	0.36	0.40	0.50	0.54	0.50	0.47	0.55	0.53	0.52
Sweden	-0.30	-0.35	-0.24	-0.20	-0.16	-0.17	-0.21	-0.24	-0.20	-0.19	-0.19	-0.09	-0.06	-0.55	0.09
United Kingdom	-0.28	-0.26	-0.21	-0.27	-0.29	-0.28	-0.23	-0.26	-0.25	-0.22	-0.21	-0.07	-0.02	0.04	0.09
EU-28	**0.06**	**0.20**	**0.18**	**0.20**	**0.18**	**0.10**	**0.14**	**0.25**	**0.18**	**0.19**	**0.18**	**0.20**	**0.21**	**0.22**	**0.29**
Iceland	-0.99	-0.81	-0.72	-0.72	-0.62	-0.57	-0.53	-0.58	-0.70	-0.71	-0.85	-0.79	-0.65	-0.71	-0.63
United Kingdom (KP)	-0.25	-0.23	-0.16	-0.21	-0.22	-0.20	-0.16	-0.20	-0.19	-0.15	-0.14	0.00	0.06	0.14	0.16
EU-28 + ISL	**0.11**	**0.28**	**0.24**	**0.27**	**0.25**	**0.15**	**0.19**	**0.32**	**0.24**	**0.25**	**0.24**	**0.24**	**0.24**	**0.25**	**0.31**

10.3 Implications for emission trends, including time series consistency

Figure 10.1 shows that due to the fact that both 1990 and 2016 emissions have been recalculated in the same order of magnitude the emission trend in the EU-28 + ISL did hardly change. In the previous submission the trend of GHG with indirect CO_2 and excluding LULUCF between 1990 and 2016 was - 21.5 %. In the latest submission the trend is - 21.3 %.

Figure 10.1: Comparison of EU-28 and Iceland GHG emission trends 1990–2016 (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. The table focuses on UNFCCC recommendations made in the review reports 2015 and 2016.

Table 10.7 Improvements made in 2017 and 2018 in response to UNFCCC review findings as indicated in Tables 3 of the ARR 2015 and ARR 2016

ID#		Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale	status of implementation (text will be included in NIR Table)
G.1	2015/2016	Activity data (15, 2014) Transparency	Provide justifications in the NIR as to why the use of international data sources to report AD at individual Party level would lead to strongly inaccurate reporting	Not resolved. During the review, the European Union explained that according to its QA/QC programme, member States are responsible for the quality of the AD, EFs and other parameters used for their inventories. Therefore, using international data sources for the European Union would imply that the data reported by the countries to international data sources are considered more accurate than those used by the national inventory compilers and would lead to inconsistencies with member States' inventories, which would contradict the QA/QC programme of the European Union. The ERT agrees with the explanation provided by the Party. The European Union further stated that it would include this information in the NIR of the 2017 GHG inventory submission	An explanation has been inclued in the Introduction chapter (in section 1.7.3).
G.3	2015/2016	Methods (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 European Union explained that it conducts initial checks on its member States focusing on the notation key 'NE'. The European Union further explained that the recommendation will continue to be carried out after the 2016 reviews of member States submissions have been completed	The notation key checks are part of the routine initial checks performed on MS submissions every inventory year.
G.5	2015/2016	National registry (141, 2014) Transparency	Include in the NIR all information in response to the findings in the SIAR in accordance with decision 15/CMP.1, annex, chapter I.G	Not resolved. The Party's submission did not contain information related to the national registry, including the responses to previous recommendations of the ERT pertaining to the national registry	Missing information has been included in chapter 14
G.8	2016	Uncertainty analysis (33, 2014) Transparency	Describe any changes in overall uncertainty estimates in the NIR on an annual basis	Not resolved. During the review, the Party stated that the uncertainty estimates were conducted for the first time under the new UNFCCC Annex I inventory reporting guidelines and that any differences in the overall uncertainty can only be described from 2017 onwards	Description of changes in overall uncertainty estimates has been included in the NIR section 1.6 - General uncertainty evaluation Included in NIR 2018
E.2	2015/2016	1. General (energy sector) (40, 2014) Transparency	Present methodological summaries that are consistent among member States and categories, at least for the key categories	Addressing. The European Union provided summary tables in the NIR on methodologies and EFs used by each member State for key categories in the energy sector and summary information on methodological descriptions as an annex. However, summary tables for significant key categories, such as public electricity and heat production (1.A.1.a) and manufacture of solid fuels and other energy industries (1.A.1.c), were not provided	Tables on methodologies used and emision factory applied are now included in the NIR for categories 1A1a and 1A1c.
E.3	2015/2016	Feedstocks, reductants and other NEU of fuels (45, 2014) Transparency	Provide transparent information on recalculations for CRF table 1.A(d) in the NIR	Not resolved. The European Union did not provide transparent information on recalculations for CRF table 1.A.(d) and stated in the NIR that it will implement the recommendation from the previous review in its 2017 annual submission (p. 720 of the NIR)	The table on recalculations is inlcuded in Chapter 3.9

ID#		Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale	status of implementation (text will be included in NIR Table)
E.5	2015/2016	Feedstocks, reductants and other NEU of fuels (47, 2014) Comparability*	Continue with efforts to ensure the consistency of the reporting among member States, in particular with regard to the allocation of emissions between the energy and IPPU sectors	Not resolved. The ERT welcomes the intention of the European Union to consider the consistent allocation of emissions by all member States (see E.12 in table 5). The European Union further stated that, for key categories and largest contributing member States, it will document in the NIR the reasons why member States do not follow the allocation of emissions in accordance with the 2006 IPCC, in order to resolve the recommendation. The ERT agrees with the approach suggested by the European Union	Chapters 4.2.2.1 and 4.2.3.1 include explanations for those MS that do not allocate emissions from amonia production and iron and steel production respectively according to the 2006 IPCC Guidelines. In addition, Chapter 4.2.4.1 includes a table making transparent the reporting of MS on non-energy-use of fuels und category 2D3.
E.6	2016	International bunkers and multilateral operations (44, 2014) Accuracy*	Use the most recent results from the collaboration with Eurocontrol to improve the accuracy of the emission estimates for the European Union and for the member States, ensuring consistency in the time series in accordance with the IPCC good practice guidance and report on the results of the collaboration in the NIR	Addressing. The data on fuel and emissions for the years 2005–2014 calculated by Eurocontrol were provided to each member State to support the inventory process for the 2016 submission and have been used by member States for checking purposes and/or emission calculations directly. However, the European Union did not describe in the NIR the results of the Eurocontrol collaboration	The results of the Eurocontrol collaboration and the use of Eurocontrol data in MS NIRs is included in chapter 3.4 of the EU NIR
E.7	2015/2016	1.A.1 Energy industries all fuels – CO_2 (48, 2014) Transparency	Continue to improve the QA/QC procedures to ensure consistency between the CRF tables and the NIR	Addressing. The European Union has made further efforts to eliminate inconsistencies between the CRF tables and the NIR. However, there are still inconsistent values between the CRF tables and the NIR, for example for CO_2 emissions from civil aviation (1.A.3.a), because the NIR was not updated whereas the CRF tables were updated based on the resubmission of CRF tables from member States	The EU has implemented QA/QC procedures checking the consistency between the NIR and CRF. All chapter are proof read by sectoral experts not involved in the compliationof the specific chapter between the April and the May submission.
E.8	2015/2016	1.A.3.a Domestic aviation – liquid fuels – CO_2 (49, 2014) Accuracy*	Promote the use of the results of the collaboration between the European Union and Eurocontrol to improve the accuracy of the inventory and report on the results of the collaboration in the NIR	Addressing. The data on fuel and emissions for the years 2005–2014 calculated by Eurocontrol were provided to each member State to support the inventory process for the 2016 submission and have been used by member States for checking purposes and/or emission calculations directly (see E.6). However, the European Union did not describe in the NIR the results of the Eurocontrol collaboration	The results of the Eurocontrol collaboration and the use of Eurocontrol data in MS NIRs is included in chapter 3.4 of the EU NIR
I.1	2015/2016	2. General (IPPU) (56, 2014) Transparency	Provide justifications in the NIR as to why the use of international data sources to report AD at the European Union level would lead to strongly inaccurate reporting	Not resolved. The ERT accepts the explanation provided by the European Union during the review and requests the European Union to include this information in its NIR (see G.1)	An explanation has been inclued in the Introduction chapter (in section 1.7.3).
I.7	2015/2016	2.A.1 Cement production – CO_2 (63, 2014) Transparency	Include the relevant information from the NIR of Poland in the NIR of the European Union rather than just referring to the NIR of the member State	Addressing. Annex III to the NIR contains a reference to the NIR of Poland where the EFs and AD used to estimate emissions from cement production in Poland can be found. However, the information provided in annex III to the NIR is not correct as it states that a tier 1 method and default EFs are used by Poland, whereas Poland uses plant-specific and country-specific AD and EFs	Methodological information on estimating emissions from cement production in Poland is included in Annex III.

ID#		Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale	status of implementation (text will be included in NIR Table)
I.9	2015/2016	2.A.2 Lime production – CO_2 (64, 2014) Transparency	Provide more information for Italy about the methods used to estimate emissions from lime production for the entire time series; in particular, there should be transparent documentation on whether the method is based on the amount of calcium carbonate from raw material or on the amount of calcium and magnesium oxides in the lime produced for each of the periods	Not resolved. The European Union included in the NIR only the description of the collection of AD for estimating CO_2 emissions from lime production. The information on the method applied by Italy and on whether the method is based on the amount of calcium carbonate from raw material or on the amount of calcium and magnesium oxides is not provided in the NIR	Documentation of the methods applied by Italy was included in Annex III
I.11	2015/2016	2.B.1 Ammonia production – CO_2 (66, 2014) Transparency	Provide in the NIR adequate and transparent methodology overviews for France and Germany to enable the ERT to conduct a thorough review of the AD and EFs used in the ammonia production emission estimates of these countries	Not resolved. The description of the methodologies, type of feedstocks, AD and EFs used, including a reference as to where the information could be found in the respective member States' NIRs, was provided during the review but was not included in the NIR	To improve transparency on how the Member States allocate emissions between the Energy and IPPU sector, the NIR includes information on the approach taken by the six Member States with largest ammonia production emissions - including France and Germany which do make a split between energy and IPPU for ammonia production emissions.
I.12	2015/2016	2.B.1 Ammonia production – CO_2 (67, 2014) Consistency	Make efforts to ensure that Greece completes the ongoing work to obtain more accurate data on the amount of liquid fuel used as feedstock and the updated AD for the emission estimates	Not resolved. Greece did not implement the planned improvement to accurately determine the amount of liquid fuel used as feedstock in ammonia production in the period 1992–1999 (see section 4.6.6 of the 2016 NIR of Greece). Greece reported emissions from liquid fuel used for ammonia production under the energy sector for the periods 1990–1993 and 1995–1998, rather than under the IPPU sector (see section 4.6.1 of the NIR of Greece)	The EU made efforts to address the recommendation during its initial QA/QC checks on member States' submissions and had further discussions with Greece. It is not possible to obtain better historical data. This situation is described in Greece's NIR (section 4.6.1).
I.15	2015/2016	2.B.7 Soda ash production – CO_2 (65, 2014) Consistency*	Work with Croatia to ensure the consistency of the time series of limestone and dolomite use	Not resolved. The time series of carbonate use in Croatia is inconsistent for limestone (1990–1999), dolomite (1997–2004) and soda ash (1990–1991)	HR NIR 2018: Soda ash production (2.B.7) This category does not exist in Croatia.
I.19	2015/2016	2.C.3 Aluminium production – CO_2 and PFCs (73, 2014) Transparency	Provide in the NIR adequate methodological overviews to enable the ERT to conduct a thorough review of the AD and EFs used in the aluminium production emission estimates provided by Greece, the Netherlands and Sweden	Not resolved. During the review, the European Union provided information on the methodology and EFs for the respective member States. However, this information is not included in the NIR of the European Union	The information is provided in chapter 4.2.3.2 of the NIR.
I.20	2015/2016	2.F. Product uses as substitutes for ozone depleting substances – HFCs, PFCs and SF_6 (74, 2014) Transparency	Endeavour to provide in the NIR summary overviews of methodologies used to estimate emissions from consumption of halocarbons and SF_6 for key categories based on the relevant methodological descriptions reported in the NIR's of member States	Not resolved. The ERT noted that the European Union provided, in annex III to the NIR, the description of the methodologies for estimating emissions from refrigeration and air-conditioning equipment (category 2.F.1). However, summary overviews of methodologies for the other key categories (2.F.2 and 2.F.4) were not included	While some information on the methodologies is provided in the NIR, it should be noted that the approaches used are quite different and vary between subcategories. To increase readability of the EU NIR not all descriptions of all MS methodologies are provided but can be retrieved from the respective NIRs.

ID#		Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale	status of implementation (text will be included in NIR Table)
I.21	2015/2016	2.F. Product uses as substitutes for ozone depleting substances – HFCs, PFCs and SF_6 (75, 2014) Transparency	Make the necessary corrections in the use of the notation keys to ensure the transparency of the reporting	Addressing. The ERT noted that the use of notation keys for reporting information on product uses as substitutes for ozone-depleting substances has been corrected by Denmark, Finland, the Netherlands and Spain. However, there are still instances where notation keys are incorrectly used; for example, Ireland still uses the notation keys "NE" and "NA" to report AD and emission estimates for refrigeration and air conditioning in CRF table 2(II)B-H	Process of updating is ongoing. Please note that notation keys represent a problem area of the CRF reporter software. Please also see status of issue G.3.
I.24	2015/2016	2.F.3 Fire protection – HFCs, PFCs and SF_6 (78, 2014) Accuracy*	Work with Greece in order to implement appropriate country-specific methodologies to estimate HFC and/or PFC emissions in accordance with the IPCC good practice guidance	Not resolved. During the review, the European Union stated that the implementation of a country-specific methodology is ongoing. However, the ERT noted that no information was provided in the NIR on the steps taken in resolving the recommendation. The ERT also noted from the information provided in annex III to the NIR that no changes have been made with regard to the methodology used by Greece	The implementation of this new country-specific methodology is still ongoing. Respective questions were asked during the initial checks and Greece confirmed that data collection and methodology development are being implemented.
I.25	2015/2016	2.F.6 Other applications (product uses as substitutes for ozone depleting substances) – HFCs, PFCs and SF_6 – (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 European Union accurately reflects the information in the NIRs of member States	Not resolved. The NIR of the Netherlands indicates that emissions from foam-blowing agents (subcategory 2.F.2), fire protection (subcategory 2.F.3), aerosols (subcategory 2.F.4) and solvents (subcategory 2.F.5) are all included under the subcategory other (2.F.6) owing to the sensitivity of the information, as many processes related to the use of HFCs take place in only one or two companies (see section 4.7.1 of the NIR of the Netherlands). However, the reporting of information (e.g. notation keys) in tables 4.36 and 4.37 of the NIR of the European Union, on the contribution of each member State to HFC emissions from subcategories 2.F.2 and 2.F.3, respectively, does not reflect the information reported in the NIR of the Netherlands. Moreover, the ERT also noted that the notation keys used by the Netherlands in its CRF table 2(II) do not appear to be consistent with the information in the NIR of the Netherlands on how emissions from subcategories 2.F.2, 2.F.3, 2.F.4 and 2.F.5 are reported	This matter was addressed during the initial checks for several years. The Netherlands stated that a new methodology is being elaborated and will be implemented in the course of the year.

ID#		Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale	status of implementation (text will be included in NIR Table)
A.4	2015/2016	3.B.3 Swine – N_2O (90, 2014) Consistency*	Elaborate an explanation for the increase in the nitrogen excretion rate for swine for Sweden in the NIR	Not resolved. During the review, the European Union explained that the issue was raised and followed up during the annual review process under the European Union effort-sharing decisionf and the results therein indicate that: (1) the gap in the excretion rate between 2001 and 2002 is an outlier and not linked with events in 2002; and (2) the updated values for the swine nitrogen excretion rate for 2002 are relevant for 2002 and the following years, and it is likely that the values used for the previous years are underestimated; and (3) it would be recommended to keep 1990 with the current nitrogen excretion rate (if relevant) and interpolate this parameter between 1990 and 2002 in order to avoid the outlier. The ERT noted that the trend of nitrogen excretion rates for swine for Sweden (CRF table 3.B(b) of Sweden) still shows a stepwise increase in the nitrogen excretion rate from 7.7 kg N/head/year to 9.0 kg N/head/year between 2001 and 2002. The ERT further noted that information on this issue is not yet provided in the NIR	The issue has been resolved; data from SE does not show the time trend irregularities identified in the past.
A.7	2015/2016	3.D Direct and indirect N_2O emissions from agricultural soils – N_2O (92, 2014) Comparability*	Work with member States to ensure more consistent reporting of the area of organic soils between the agriculture and LULUCF sectors	Addressing. During the review, the European Union explained that member States' submissions were checked for consistency between the agriculture and LULUCF sectors and four issues were identified and included in the European Environment Agency Emission Review Tool.g However, in the submission of 9 September 2016, the ERT still observed a discrepancy in the total area of organic cultivated soils, which is reported in CRF table 3.D as 3,904.26 kha, and is reported as the total area of organic soils in CRF tables 4.B and 4.C as 5,689.18 kha for 2014 in the European Union submission of 9 September 2016. During the review, the European Union informed that the issue will be solved in the 2017 annual submission	The issue has been resolved, we do not find inconsistencies in 2017 and 2018
L.1	2016	4. General (LULUCF) (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 ERT noted that multiple instances of the use of the notation key "NE" in the CRF tables from the 2014 GHG inventory submission have been addressed by the Party (see L.18, L.22 and KL.5, KL.8, KL.9, KL.10, KL.11 and KL.14 in table 5)	Issues were comunicated to MS, and some improvements have been implemented to increase the completeness and transparency of the reporting of carbon stock changes in AR. Further improvements are expected for future submissions..
	2015			Addressing. The ERT noted that multiple instances of the use of the notation key "NE" in the CRF tables from the 2014 GHG inventory submission have been addressed by the Party (see L.17, L.21 and KL.5, KL.8, KL.9, KL.10, KL.11 and KL.14 in table 5)	

ID#		Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale	status of implementation (text will be included in NIR Table)
L.2	2015/2016	4. General (LULUCF) (95, 2014) (76, 2013) (86, 2012) Completeness*	Work with member States with a view to reporting mandatory pools and categories which are currently not estimated in order to increase the completeness of the inventory	Addressing. See L.1	Issues were comunicated to MS, and some improviments have been implemented to increase the completeness, and transparency, of the reporting of carbon stock changes in AR. Further improvements are expected for future submissions..
L.4	2015/2016	4.A.2 Land converted to forest land – CO_2 (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	Not resolved. The ERT noted that there is no information in the NIR to confirm whether the European Union made progress with Italy on the methodological issue referred to in the 2013 and 2014 individual review reports of the European Union	Information on this regard has been included in the NIR. See section 6.2.1.3
L.6	2015/2016	4.B.2 Land converted to cropland – CO_2 (99, 2014) Transparency	Provide transparent explanations in the annual submission, indicating the key drivers for the changes in the trend and recalculations	Not resolved. The European Union has not provided the requested information in its NIR. During the review, the Party provided the requested information, but it is not included in the NIR	Information on this regard has been included in the NIR. See section 6.2.2.3 and 6.5
L.7	2015/2016	4.B.2 Land converted to cropland – CO_2 (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. The ERT notes that the current reporting approach does not allow for the review of completeness under land converted to cropland by country and by pool. Nevertheless, the ERT notes that the notation key “NE” is still used for reporting information on mineral soils under land converted to cropland for Cyprus (see table 6.6 of the NIR)	Work has been done to ensure the completeness of the reporting of carbon stock changes under 4B2. Cyprus provides quantitative estimates of carbon stock changes for this subcategory in 2018
L.10	2015/2016	4.F.2 Land converted to other land – CO_2 (104, 2014) (85, 2013) Transparency	Include transparent explanations in the NIR for the inter-annual variations and work with the member States to improve the consistency of their reporting	Not resolved. The European Union has not provided the requested information in its NIR. During the review, the Party provided the requested information, but it is not included in the NIR	Information on this regard has been included in the NIR. See section 6.2.4.3
L.11	2015/2016	4 (V) Biomass burning – CO_2, CH_4 and N_2O (105, 2014) Transparency	Include the reasons for the use of the notation key “NE” where applicable and make efforts to increase the completeness of the reporting	Not resolved. The ERT notes that the information regarding the use of the notation key “NE” is not included in the NIR	Information on this regard has been included in the NIR. See section 6.2.5.5
KL.1	2015/2016	General (KP-LULUCF) (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	Not resolved. The ERT noted that consistency in the use of notation keys and transparency are still an issue (e.g. the notation key “NO” is used by some member States when the activity exists and there are no changes in management, while others consider the activity insignificant and use the notation key “NE”)	The EU has worked with MS to improve the consistency in the use of NK by its MS. Every year this isse is subject to a dedicated presentation during the annual JRC LULUCF workshop and during the WG-I meetings. More improvements are also expected for future submissions.
KL.3	2015/2016	Deforestation – CO_2 (125, 2014) Transparency	Work with member States so that they use the appropriate notation keys and provide a synthesis in the NIR of the explanations and justifications provided by member States	Not resolved. The synthesis of explanations and justifications provided by member States on the use of notation keys was not included in the NIR	Information on this regard has been included in the NIR. See section 11.3.2

ID#		Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale	status of implementation (text will be included in NIR Table)
KL.5	2015/2016	Forest management – CO_2, (130, 2014) Completeness*	Work with member States to ensure that future reporting on forest management is complete and accurate	Not resolved. The information on member States' forest management is not complete (e.g. France underestimates unmanaged forests, while Cyprus and Malta do not report all pools and Hungary does not report the dead organic matter and soil organic carbon pools)	Issues were comunicated to MS, and some improviments have been implemented to increase the completeness, and transparency, of the reporting of carbon stock changes in FM. Further improvements are expected for future submissions..

Table 10.8 Improvements made in 2017 and 2018 in response to UNFCCC review findings as indicated in Tables 5 of the ARR 2015 and ARR 2016

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
G.12	2015/2016	Yes. Adherence to UNFCCC Annex I inventory reporting guidelines	Key category analysis	The ERT noted that in table 11.4 of the NIR, the information on the key category analysis is not reported for many member States. Furthermore, the European Union did not report any information in CRF table NIR-3 on a summary overview for the key categories for KP-LULUCF activities. During the review, the European Union explained that information was not reported in CRF table NIR-3 owing to technical issues with the CRF Reporter for several member States. In addition, the Party also explained that all member States except three (Cyprus, Malta and Portugal) provided a key category analysis in their NIR. Furthermore, the European Union explained that the issue was already being addressed The ERT recommends that the European Union improve the collaboration with member States and provide complete reporting of the key categories for KP-LULUCF activities in CRF table NIR-3	Included in table 11.4 of the EU NIR and CRF table NIR-3
E.9	2015/2016	Accuracy	1. General (energy sector) – gaseous, liquid and solid fuels – CO_2, CH_4 and N_2O	The European Union has provided information in tabular format on the methods and EFs used by individual member States to estimate emissions from the energy sector (e.g. see tables 3.12, 3.14, 3.21–3.23, 3.25, 2.26, 3.28–3.30, 3.33, 3.35, 3.37–3.39 and 3.41–3.43 of the NIR). Based on this information, some member States use a tier 1 method for estimating emissions from some key categories of the European Union inventory. The ERT considers that if most of the key categories in the GHG inventory of the European Union are also key categories in the individual member States, then emissions from these key categories should be estimated using a tier 2 or higher methodology. During the review, the European Union informed that the consideration of the key category by member States should reflect the conclusions of the 3rd lead reviewers meeting conclusions and should consider the categories that are key at the level of the compiled inventory, and the contribution of individual national inventories to the total emissions in these key categories. Where estimates of individual national inventories represent a high proportion of emissions in a key category (e.g., the relative contribution of the estimates of these inventories ranked by level account for 60% – 75 % of emissions in the category), the ERT should assess whether these estimates were prepared using an appropriate (e.g. higher-tier) method The ERT recommends that the European Union work with its 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 2006 IPCC	In the second half of 2018 capacity builing activities are carried out and it is forseen to support countries in moving to higher tier methods for key categories.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
				Guidelines, the key category analysis of the European Union and the importance of the contribution of member State emissions to total emissions at European Union level	
E.10/E.11	2015/2016	Transparency	1. General (energy sector) – CO_2 and CH_4	The ERT noted that some member States (e.g. Romania, Slovakia and the United Kingdom) reported CH_4 recovery from coal mining, and oil and natural gas production. In the NIR, the European Union stated that CH_4 recovered is excluded from the category where it is recovered and emissions from its combustion are reported under the respective fuel combustion category. However, there is no clear description of the fuel combustion categories under which the emissions from the combustion of CH_4 recovered are included The ERT recommends that the European Union provide information in the NIR on the fuel combustion categories under which the emissions from the combustion of CH_4 recovered are included.	If member States have reported CH_4 recovery as include elsewere (IE) it has been explained in the EU NIR where it is reported, e.g. see table '1.B.1 Fugitive Emissions from Solid Fuels: Member States Contribution' in chapter 'Fugitive emissions from Solid Fuels (1.B.1)'
E.11	2016	Transparency		The ERT noted that information on emission trends, methodologies and EFs is missing for the following key categories: (1) CO_2 emissions from public electricity and heat production – peat (subcategory 1.A.1.a); (2) CH_4 emissions from residential – solid fuels (subcategory 1.A.4.b); and (3) CO_2 emissions from venting and flaring (subcategory 1.B.2.c). During the review, the European Union explained that these are new key categories and would be considered in detail in the 2017 GHG emissions inventory, as stated in footnote 18 to the NIR (p. 99) The ERT recommends that the European Union include in the NIR summary information on emission trends, methodologies and EFs for the following key categories: (1) CO_2 emissions from public electricity and heat production – peat (subcategory 1.A.1.a); (2) CH_4 emissions from residential – solid fuels (subcategory 1.A.4.b); and (3) CO_2 emissions from venting and flaring (subcategory 1.B.2.c)	1.A.1.a - peat, 1.A.4.b - solid fuels (CH_4), 1.B.2.c - CO_2: information on emission trends, methodologies and EFs are included
E.12	2015/2016	Transparency	Feedstocks, reductants and other NEU of fuels – all fuels – CO_2	The ERT noted that the European Union included in the NIR information on feedstocks and other NEU of fuels as provided by member States (table 3.119, p. 350), whereas the data reported in CRF table 1.A(d) on feedstocks, reductants and other NEU of fuels was taken directly from Eurostat. The ERT also noted that the information provided in the NIR is not consistent among member States and does not provide a transparent description of feedstocks, reductants and other NEU of fuels. During the review, the European Union confirmed that it is working on improving the transparency for the reporting of feedstocks, reductants and other NEU of fuels, but that this improvement is planned for the 2017 GHG inventory submission The ERT recommends that the European Union provide in the NIR information explaining why information reported in CRF table 1.A(d) on feedstocks, reductants and other NEU, is different from that reported by the Parties in order to ensure a transparent reporting of feedstocks, reductants and NEU of fuels	For the 2018 submission the EU has changed its approach: now all data used for CRF table 1A(d) is the sum of Member States submissions. This is described in Chapter 3.9. The whole chapter has been made more transparent.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
E.13	2015/2016	Transparency	1.A. Fuel Combustion- Sectoral Approach – all fuels – CO_2	The European Union reported for some key categories the mean and standard deviation of all reported IEFs of individual member States and the IEFs of member States that lie outside this range for the entire time series (e.g. figures 3.39, 3.44, 3.46, 3.48, 3.50, 3.55, 3.62, 3.69, 3.73 and 3.82 of the NIR) and compared the IEFs with the default EFs provided in the 2006 2006 IPCC Guidelines. The ERT noted that in some instances it was not entirely clear how the EFs from the 2006 IPCC Guidelinesshown in the NIR were selected, why the EFs did not correspond to the IEFs in the corresponding CRF tables of the European Union, and why some IEFs of individual member States lay far outside the IPCC default range. During the review, the European Union provided detailed information regarding the choice of default EFs from the 2006 IPCC Guidelinesand explained why the mean values shown in the figures in the NIR (e.g. in figures 3.50, 3.73 and 3.82) were different from the IEFs provided in the CRF tables and why the IEFs of individual countries lay outside the IPCC default range The ERT recommends that the European Union report information regarding the choice of default EFs from the 2006 IPCC Guidelinesand the reasons for particularly high or low IEFs of individual member States	The figures showing the default EF and standard deviation of all reported IEFs are amongst the set of figures used for quality checking MS submissions during the initial check phase. They are not included anymore in the EU NIR because they do not make transparent the magnitude of the IEF for every MS. Instead the NIR now inlcudes figures showing the IEFs of every Member State. The EU has provided explanations for additional high or low IEFs of individual MS. Examples are 1A1a, solid fuels, CO_2, Greece or 1A2f, other fuels, CO_2, Poland.
E.15	2015/2016	Comparability	1.A.3.b Road transportation – liquid fuels – CO_2, CH_4 and N_2O	Emissions from lubricants that are intentionally mixed with fuel and combusted in two-stroke engines should be accounted for in the energy sector and emissions from primary usage of lubricants (i.e. for lubrication or coating) should be accounted for in the IPPU sector in accordance with the 2006 2006 IPCC Guidelines. However, there is no clear information in the NIR on how the European Union and each member State reported emissions from the use of lubricants under the transport (1.A.3) and/or lubricant use (2.D.1) categories. During the review, the European Union explained that it checks the allocation of emissions from use of lubricants between the transport and lubricant use categories for each member State, and only Belgium and Germany reported emissions from lubricants under the transport category, whereas other member States reported these emissions under the lubricant use category 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 2006 IPCC Guidelines	For Member States that have provided information in their NIR on how they have reported the emissions from use of lubricants, the recommendation is considered implemented. In cases, where no clear conclusion can be drawn on what is implemented by the Member States, additional actions are needed, which will take place in the next submission.
I.26	2015/2016	Transparency	2. General (IPPU)	The ERT noted that information on the methods used to estimate GHG emissions from the IPPU sector was provided in section 4 and in annex III to the NIR. However, the ERT noted that the identification of the tier methods and data sources was often inconsistent between the NIR and annex III to the NIR. For example, the information in table 4.4 of the NIR on the tier method and EF used by Denmark, France, Greece and Lithuania to estimate emissions from cement production is not consistent with the information provided in annex III to the NIR. Similar inconsistencies were identified for other categories of the IPPU sector The ERT recommends that the European Union 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	This will be corrected in Annex III

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
I.27	2015/2016	Transparency	2. General (IPPU)	The ERT noted that the information on the tier method complexity, as required by paragraph 50(b) of the UNFCCC Annex I inventory reporting guidelines was frequently not provided for the categories of several member States in annex III to the NIR. Often, the European Union identified only the general approach followed (e.g. country-specific, plant-specific) instead of the tier method used (i.e. tier 1, 2 or 3 of the 2006 2006 IPCC Guidelines). The lack of information on the method used in these cases does not allow the ERT to assess whether the methods used for the key categories are in accordance with the 2006 IPCC Guidelines(see ID#s I.29 and I.30 below) The ERT recommends that the Party identify which tier method was used to estimate emissions under each key category of the IPPU sector, in accordance with the 2006 2006 IPCC Guidelines, and provide the corresponding tier method when a country-specific method is used	This will be corrected in Annex III
I.28	2015/2016	Transparency	2.A.1 Cement production – CO_2	The European Union reported in the NIR that Poland used a tier 1 method and default EF to estimate CO_2 emissions from cement production. During the review, the European Union explained that Poland no longer uses a tier 1 method and that a tier 2 method has been used to calculate CO_2 emissions from cement production since 2005, when plant-specific data became available under the EU ETS, and that this information is provided in the NIR of Poland The ERT recommends that the European Union correct the information provided in the NIR on the method used by Poland to estimate CO_2 emissions from cement production	The correct information has been updated.
I.29	2015/2016	Transparency	2.A.1 Cement production – CO_2	The European Union reported in the NIR that Cyprus, Greece, Hungary, the Netherlands and Sweden used a country-specific method to estimate CO_2 emissions from cement production (see table 4.4 of the NIR), without specifying the corresponding level of complexity (IPCC tier) in accordance with decision 24/CP.19, annex I, paragraph 50(b). During the review, the European Union explained that member States' submissions are part of the European Union submission and that the information on the level of complexity of the methodology used may be found in the member States' submissions The ERT recommends that the European Union 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	This will be followed up in a future submission
I.30	2015/2016	Transparency	2.A.2 Lime production – CO_2	The ERT noted that the European Union did not report information on the methods and EFs used by Austria and France to estimate CO_2 emissions from lime production (see table 4.5 of the NIR). Moreover, the European Union used the notation key "NA" to report the method and CO_2 EF for Malta even though emissions occurred in the country in the period 1990–1998 (see p.64 of the NIR of Malta). Furthermore, the European Union reported that Greece, Hungary and Sweden used a country-specific method to estimate CO_2 emissions from lime production, without specifying the corresponding level of complexity (IPCC tier) of those methods The ERT recommends that the European Union 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	The information on tier and emissions refer to the last inventory year.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
I.31	2015/2016	Comparability	2.A.2 Lime production – CO_2	The European Union used the notation key "IE" to report CO_2 emissions from lime production in the Netherlands (see table 4.6 of the NIR), without specifying where in the inventory the emissions have been included. During the review, the European Union explained that CO_2 emissions from lime production in the Netherlands are included under the energy sector (subcategory 1.A.2.e) because lime production in the Netherlands occurs only in four sugar industry plants and it is not possible to separate emissions from lime production from other emissions. The ERT considers that, in accordance with the 2006 2006 IPCC Guidelines, emissions from lime production are to be reported under the IPPU sector The ERT recommends that the European Union 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 2006 IPCC Guidelines	With reference to the notation key "IE" to report CO_2 emissions from lime production in the Netherlands, these are included in 2D2 Food industries. This information is provided in the EU NIR sector chapter.
I.32	2015/2016	Comparability	2.A.2 Lime production – CO_2	The ERT noted that the CO_2 IEFs for lime production for the United Kingdom (0.45 t/t), Latvia (0.55 t/t) and Croatia (0.58 t/t) for 2014 are significantly lower than the average value for the European Union (0.71 t/t) (see table 4.6 of the NIR). However, no information is provided in the NIR on why these IEFs are lower than the average value for the European Union. During the review, the European Union clarified that member States use different approaches to estimate emissions and, therefore, the IEFs are not comparable. The European Union further explained that the IEF may refer to tonnes of CO_2 per tonne of lime produced (i.e. in the case of Croatia and Latvia) but also tonnes of CO_2 per tonne of limestone consumed (i.e. in the case of the United Kingdom). Based on the response provided by European Union, the ERT considers that the CO_2 IEFs for lime production are not transparently reported in the NIR The ERT recommends that the European Union indicate in the NIR the units in which the AD and IEFs for the lime production category are reported (lime production or carbonate use) and report the comparison analysis of the IEFs used by member States, including the reasons for significant deviations from the average value for the European Union and from the default IPCC EFs, if such deviations occur.	Not all countries show production as the activity data for this emissions category. Gap-filled values are shown against Lime production for EU activity and the EU IEF.
I.33	2015	Comparability	2.A.3 Glass production – CO_2	The ERT noted that the CO_2 IEFs for glass production for Spain for 1990 and 2014 (130.67 and 107.08 t CO_2/t glass, respectively) are significantly higher than the average IEFs for the European Union for the same years (0.16 and 0.14 t CO_2/t glass, respectively) (see table 4.8 of the NIR). During the review, the European Union clarified that Spain had mistakenly introduced the AD for glass produced in the CRF Reporter by entering the data expressed in thousands of kt instead of kt, as requested by the CRF Reporter. The European Union further clarified that although there is a mistake in the IEFs for Spain, the CO_2 emission data are correctly reported The ERT recommends that the European Union report the correct CO_2 IEFs for glass production for Spain in the NIR and CRF tables	This has ben corrected. See section on 2.A.3 in the EU NIR
I.33/I.34	2016/2015	Transparency	2.A.4 Other process uses of carbonates – CO_2	The ERT noted that CO_2 emissions from other process uses of carbonates is a key category (2.A.4). However, the European Union did not report information on the methodologies, assumptions, EFs and AD used to estimate CO_2 emissions from this category. During the review, the European Union provided a summary of the AD, EFs and CO_2 emissions for each member State for 1990 and 2014 The ERT recommends that the European Union report a summary description of the	A summary description of the methodologies, EFs and AD used to estimate emissions from 2.A.4 is included.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
				methodologies, assumptions, EFs and AD used to estimate emissions from other process uses of carbonates (2.A.4) for each member State	
I.34/I. 35	2016/2015	Comparability	2.B.1 Ammonia production – CO_2	The ERT noted in the European Union submission of 9 September 2016 that the CO_2 IEF for ammonia production for Hungary (0.06 t CO_2/t ammonia) is significantly lower that the range of IEFs from other member States (1–2 t CO_2/t ammonia) During the review, the European Union explained that the AD for ammonia production reported by Hungary refers to the consumption of natural gas rather than ammonia produced as reported by other member States. The European Union further explained that, owing to the automatic aggregation performed by the European Union for its reporting in the CRF tables, natural gas consumption has been automatically and incorrectly added as ammonia production. Moreover, the European Union clarified that the IEFs reported in the NIR are not comparable between Hungary and other member States and that the average IEF for the European Union was estimated incorrectly The ERT recommends that the European Union correct the reporting of the AD, CO_2 emissions and CO_2 IEF for ammonia production for Hungary and recalculate the aggregated values for the European Union in the CRF tables, and correct the average CO_2 IEF for the European Union reported in the NIR	Not all countries show production as the activity data for this emissions category. Gap-filled values were calculated for EU ammonia production and the EU IEF for 2016.
I.35/I. 36	2016/2015	Accuracy	2.B.1 Ammonia production – CO_2	The European Union reported that the Czech Republic used a tier 1 method and country-specific EF to estimate CO_2 emissions from ammonia production (see table 4.13 of the NIR). The ERT noted that CO_2 emissions from ammonia production is a key category for the Czech Republic. In addition, the ERT noted that the Czech Republic used a default CO_2 EF (3.273 t CO_2/t NH_3) from the 2006 IPCC Guidelines(volume 3, chapter 3, table 3.1, p. 3.15) instead of a country-specific EF as stated in the NIR. During the review, the European Union clarified that the Czech Republic was not able to use a higher-tier method because the Czech Statistical Office only reports information on the sector where the fuel was used (i.e. chemical and petrochemical industry), and does not disaggregate for specific production outputs The ERT recommends that the European Union work with the Czech Republic 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 2006 IPCC Guidelines	This is planned for future submission
I.37	2015	Transparency	2.B.2 Nitric acid production – N_2O	The ERT noted that the IEF for nitric acid production for 2014 reported by the European Union in the NIR is 0.00 t/t for most member States (see table 4.16 of the NIR). During the review, the European Union provided the IEFs for nitric acid production for each member State expressed in kg N_2O/t nitric acid The ERT recommends that the European Union report in the NIR the N_2O IEF for nitric acid production in a transparent manner by expressing the value in kg N_2O/t nitric acid production, instead of t N_2O/t nitric acid production	The IEFs are shown as kg N_2O per tonne of production as recommended by the ERT.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
I.36/I. 38	2016/2015	Transparency	2.B.2 Nitric acid production – N_2O	The European Union reported that the AD used to estimate N_2O emissions from nitric acid production in Lithuania for 1990 and 2013 are 355 437 kt and 1 049 172 kt, respectively (see table 4.16 of the NIR). The ERT noted that the increase in nitric acid production in Lithuania would contribute to a significant increase in the average nitric acid production in the European Union. During the review, the European Union stated that the AD values reported for Lithuania were incorrect and provided the correct AD for 1990 (335.437 kt) and 2014 (1 140.746 kt) The ERT recommends that the European Union correct the AD for nitric acid production and recalculate the N_2O IEF for Lithuania	EU NIR Table 4.17 2B2 Nitric acid production: Information on methods applied, activity data, emission factors for N_2O emissions; has the correct the AD, emissions and IEF for Lithuania.
I.37/I. 39	2016/2015	Comparability	2.B.3 Adipic acid production – N_2O	The ERT noted in the European Union submission of 9 September 2016 that the N_2O IEF for adipic acid production for 1990 reported in CRF table 2(I).A-H (3.25 t N_2O/t adipic acid) is significantly higher than the IPCC default EF (0.3 t N_2O/t adipic acid). During the review, the European Union explained that the IEF was calculated incorrectly, as much of the AD are confidential and it is not possible to apply gap-filling techniques. The European Union further explained that Germany, France, Italy, Poland, Romania and the United Kingdom produced adipic acid in 1990 but the four largest emitters reported the AD as confidential The ERT recommends that the European Union recalculate and report the European Union average N_2O IEF for adipic acid production, taking into account only N_2O emissions for which there are AD available and explain in the NIR the approach used to calculate the IEF	Adipic acid production is used as activity data but the information is confidential in France and Germany. Because the IEF is calculated automatically by the inventory software, where the activity data is not included but emissions are shown, then this will result in an apparently high IEF. 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 2016. Activity data for categriy 2.B.3 cannot be gap filled due to the fact that only 20% of emission are calculated on the basis of the same activity data.
I.38/I. 40	2016/2015	Accuracy	2.B.4 Caprolactam, glyoxal and glyoxylic acid production – N_2O	The ERT noted that the annual N_2O emissions from caprolactam production in the Czech Republic (0.25 kt N_2O) are the same throughout the whole time series. During the review, the European Union explained that, based on a study conducted at the plant (Bernauer and Markvart, 2014–2015), the N_2O emissions were approximately 0.25 kt N_2O, which is reported by the Czech Republic as a constant value for the whole time series. The European Union further explained that, according to the NIR of the Czech Republic, N_2O emissions from the production of caprolactam has been continuously measured as of 2012 as a consequence of the inclusion of caprolactam production in the scope of the EU ETS. The ERT considers that the reported N_2O emissions from caprolactam production are not accurate The ERT recommends that the European Union work with the Czech Republic to recalculate and report more accurate N_2O emissions from caprolactam production, taking into account the data collected under the EU ETS	The EU continues to work with Czechia to report more accurate emissions from caprolactam production, taking into account the data collected under the EU ETS.
I.39/I. 41	2016/2015	Transparency	2.B.8 Petrochemical and carbon black production – CO_2	The ERT noted that CO_2 emissions from petrochemical and carbon black production is identified as a key category (see p. 365 of and annex III to the NIR), but no information is provided on the methodologies, assumptions, EFs and AD used to estimate CO_2 emissions from petrochemical and carbon black production in, for example, the Czech Republic, France, the Netherlands, Romania, Slovakia and Spain. During the review, the European Union provided the required information The ERT recommends that the European Union include information on the methodologies, assumptions, EFs and AD used to estimate CO_2 emissions from petrochemical and carbon black production, which is a key category	A summary description of the methodologies, EFs and AD used to estimate emissions from 2.B.8 is included.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
I.40/I. 42	2016/2015	Comparability	2.B.8 Petrochemical and carbon black production – CO_2	The ERT noted that the IEF for ethylene production for France (0.0005 t CO_2/t ethylene) is significantly lower than the IPCC default EF (0.95–2.29 t CO_2/t ethylene). During the review, the European Union clarified that CO_2 emissions from fuel consumption in ethylene production in France were allocated to the energy sector The ERT recommends that the European Union 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 2006 IPCC Guidelines	Planned for future submission
I.41/I. 43	2016/2015	Comparability	2.B.9 Fluorochemical production – HFCs	The ERT noted in the submission of 9 September 2016 that the European Union reported in CRF table 2(II)B-H CF4 emissions as a by-product of HCFC-22 production (213 t CF4 for 2013). The ERT notes that according to the 2006 2006 IPCC Guidelines, only HFC-23 emissions are considered as a by-product of HCFC-22 production. During the review, the European Union clarified that CF4 emissions were reported under the subcategory production of HCFC-22 (2.B.9.a.1) by Italy and that the methodology used to estimate CF4 emissions is based on measured data of CF4 concentration in one chemical plant. In addition, the abatement system used in the plant collects the flow gases not only from HCFC-22 production but also from the production of other chemical substances where CF4 can also be formed. The ERT considers that it is not clear how CF4 emissions from the production of HCFC-22 occur The ERT recommends that the European Union explain in the NIR how CF4 emissions from the production of HCFC-22 occur and work with Italy to allocate CF4 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)	Included in EU NIR, chapter 4.1.2.5.
I.42/I. 44	2016/2015	Transparency	2.B.9 Fluorochemical production – HFCs and PFCs	The ERT noted in the submission of 9 September 2016 that emissions from unspecified mix of HFCs and PFCs reported under the subcategory fluorochemical production – by-product emissions (other) (2.B.9.a.2) decreased from about 5 567.08 kt in 1990 to 46.70 kt in 2013. However, a description of the methodology used and information to explain the trend was not provided in the NIR. During the review, the European Union explained that these emissions were reported by Germany and since there are less than three producers in Germany, the data are confidential The ERT recommends that the European Union provide a description of the methodology used and information explaining the trend of emissions of unspecified HFCs and PFCs reported under the subcategory fluorochemical production – by-product emissions (other) (2.B.9.a.2)	Included in EU NIR, chapter 4.1.2.5.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
I.43/I.45	2016/2015	Accuracy	2.C.1 Iron and steel production – CO_2	The ERT noted that Romania used a default EF (1.72 t CO_2/t steel, provided in volume 3, chapter 4, table 4.1, of the 2006 2006 IPCC Guidelines) to estimate emissions from steel production in OHFs. The ERT further noted that CO_2 emissions from iron and steel production is a key category. The ERT also noted that the use of the IPCC default EF might include the CO_2 emissions from fuel combustion in OHFs and in pig iron production. During the review, the European Union confirmed that CO_2 emissions from fuel combustion in OHFs in Romania were estimated under the energy sector. The ERT notes that CO_2 emissions from fuel combustion in OHFs are double counted owing to the use of a tier 1 method. With regard to the risk of double counting of CO_2 emissions from pig iron production, the European Union provided no clarification The ERT recommends that the European Union work with Romania to move to a higher-tier method and ensure that double counting does not occur when estimating CO_2 emissions from iron and steel production	Following the 2016 review, the EU worked with Romania on this issue. In order to avoid double-counting, Romania re-calculated the time series in category 1.A.2 in the 2017 submission. This recalculation is described in Table 3.24 (page 152) of the 2017 EU NIR. The same approach is applied in the 2018 submission.
I.45/I.47	2016/2015	Transparency	2.C.1 Iron and steel production – CO_2	The ERT noted that the European Union used the notation key "NA" to report CO_2 emissions from sinter production in Italy for 2014, while also reporting 8 358 kt of sinter production as AD for the same year (see p. 409 of the NIR). During the review, the European Union clarified that sinter production in Italy is carried out at two integrated iron and steel production plants and that the emissions from sinter production are not reported separately but rather aggregated and reported under the category pig iron (2.C.1.b) The ERT recommends that the European Union use the notation key "IE", instead of "NA", when reporting on CO_2 emissions from sinter production in Italy in the NIR and specify where in the inventory these emissions are included	The notation key has been changed to IE. It is explained in the NIR (chapter 4.2.3.1) that Italy reports emissions from sinter production under 2.C.1.b Pig iron.
I.46/I.48	2016/2015	Accuracy	2.C.1 Iron and steel production – CO_2	In the NIR, the European Union reported that pig iron production in Slovakia for 1990 and 2014 is 17 kt and 24 kt, respectively (see figure 4.14, p. 411 of the NIR). The ERT noted that pig iron production in Slovakia is expected to be higher, taking into account its level of CO_2 emissions from iron and steel production. During the review, the European Union explained that, according to the Steel Statistical Yearbook 2015 of the World Steel Association, pig iron production in Slovakia for 2014 amounts to 3 838 kt. The ERT believes that this issue should be considered further in future reviews to confirm there is not an underestimation of emissions The ERT recommends that the European Union work with Slovakia to correct the reported AD for total pig iron production used to estimate CO_2 emissions from iron and steel production	Planned for future submission.
I.49	2016	Transparency	2.C.1 Iron and steel production – CO_2	The ERT noted that the European Union reported a CO_2 IEF for sinter production of 5.28 t CO_2/t and 5.35 t CO_2/t for 1990 and 2014, respectively, for Hungary (figure 4.14, p.409 of the NIR), which is significantly higher than the IPCC default EF (0.20 t CO_2/t sinter produced). During the review, the European Union explained that, in reference to CRF table 2(I).A-H of Hungary, the reported IEF refers to tonnes of CO_2 emissions per tonne of coke used for sinter and pellet production, not tonnes of CO_2 emissions per tonne of sinter production. Therefore, the ERT considers that the IEF for sinter production for Hungary reported by the European Union in its NIR is not relevant and comparable with the IEFs of other member States The ERT recommends that the European Union work with Hungary to estimate and report the CO_2 IEF, expressed in tonnes of CO_2 per tonne of sinter produced	Planned for future submission.

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I.47/I.50	2016/2015	Transparency	2.C.3 Aluminium production – CO_2	The ERT noted that the European Union did not include in the NIR information on CO_2 emissions from aluminium production, but reported those emissions in the CRF tables The ERT recommends that the European Union include in the NIR information on the method, assumptions, EFs and AD used to estimate CO_2 emissions from aluminium production	The information has been included in the NIR (chapter 4.2.3.2).
I.48/I.51	2016/2015	Transparency	2.C.7 Other (metal industry) – CO_2	The ERT noted that the European Union did not include in the NIR information on CO_2 emissions reported under the subcategory metal industry – other (2.C.7), but reported those emissions in CRF table 2(I). During the review, the European Union clarified that the CO_2 emissions reported under the subcategory metal industry – other (2.C.7) include: (1) all process emissions from the non-ferrous sector (including lead and zinc) in Belgium; (2) silicium production in Spain; (3) copper and nickel smelting in Finland; emissions 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 (4) emissions from anode burn-off during the anode baking process (used for aluminium production) in Slovenia The ERT recommends that the European Union include in the NIR information on the sources and amount of emissions reported under the subcategory metal industry – other (2.C.7)	The information has been included in the NIR (chapter 4.2.3.3).
I.49/I.52	2016/2015	Transparency	2.D Non-energy products from fuels and solvents use – CO_2	The ERT noted that the European Union did not include 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, but reported the emissions in the CRF tables. The ERT also noted that CO_2 emissions from non-energy products from fuel and solvent use is a key category. During the review, the European Union clarified that it would include the required information in the NIR of the 2017 GHG inventory submission The ERT recommends that the European Union 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	The information has been included in the NIR (chapter 4.2.3.4).
A.8	2015/2016	Transparency	3. General (agriculture) – CO_2	The ERT noted that the European Union used the notation key "IE" to report indirect CO_2 emissions from the agriculture sector in CRF table 6 for the Netherlands and Slovakia. The ERT also noted that the European Union did not provide in the NIR any indication of where in the inventory these emissions have been included. During the review, the European Union clarified that indirect emissions of CO_2 from the agriculture sector are included in the IPPU sector in the case of the Netherlands. However, in the case of Slovakia, the ERT did not find any indication in the NIR of Slovakia that indirect CO_2 emissions are estimated, and concluded that the correct notation key for reporting indirect CO_2 emissions from the agriculture sector should be "NE" The ERT recommends that the European Union indicate in the NIR where in the inventory of the Netherlands indirect CO_2 emissions from the agriculture sector are included. The ERT also recommends that the European Union 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	Resolved. Slovakia changed the notation key to 'NE', the Netherlands include in its submission 2019 an explanation of the use of 'IE' for indirect CO_2 emissions from agriculture in (see NLD CRF Table9)

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A.9	2015/2016	Transparency	3. General (agriculture) – CH_4	The ERT noted that the NIR does not include information on the methodology and CH_4 EFs used to estimate emissions from cattle, sheep and swine for Austria, France and Iceland (see tables 5.2, 5.3, 5.13 and 5.14 of the NIR). During the review, the European Union explained that information from specific member States was missing owing to problems encountered in the new CRF Reporter software and that member States would deliver complete information for the next GHG inventory submission The ERT recommends that the European Union compile and report information on the methodology and CH_4 EFs used to estimate emissions from cattle, sheep and swine for all member States	We are working with the countries in order to include all information about methodologies in their next submission
A.10	2015/2016	Transparency	3.A Enteric fermentation – CH_4 and N_2O	In table 5.54 of the NIR, the European Union reported the contribution of member States' recalculations to the total change in emissions from enteric fermentation, including background information on the recalculations. However, the ERT noted that no information was provided on the recalculations for France, Iceland and Luxembourg. During the review, the European Union explained that, according to the NIRs of the member States, Iceland did not perform any recalculations while the reason for the recalculation for Luxembourg was the change to the use of the 2006 IPCC Guidelinesand the revision of AD. The recalculation by France corresponds to about 0.0% of emissions from enteric fermentation and was therefore deemed insignificant The ERT recommends that the European Union include in the NIR background information on the recalculations of emissions from enteric fermentation for all member States where differences between the latest and the previous submissions occur	This has been resolved: in the last NIR (2017) explanations on recalculations are included for all countries.
A.11	2015/2016	Transparency		In the NIR, the European Union stated that milk yield data for the Netherlands were not available (see p.451 of the NIR). However, in annex III to the NIR, the methodological description for the estimation of CH_4 emissions from dairy cattle in the Netherlands indicates that milk production per cow increased as a result of genetic changes (due to breeding programmes for milk yield) and the increase in feed intake and higher feeding quality of cattle diets, suggesting that milk yield data are available. During the review, the European Union explained that it is working with member States to ensure that the European Union submission includes correct information from member States. The European Union further explained that as the NIRs of the member States are provided to the European Union one month before the submission of the European Union, some minor inconsistencies between the 29 NIRs of the member States and the NIR of the European Union cannot be excluded. Moreover, the European Union explained that it introduced a new process in 2016 whereby the methodological tables are shared with the European Union member States during the consultation of the NIR of the European Union and revised information is taken into account to the extent possible in the final report The ERT welcomes the efforts of the European Union and its member States in implementing the new checking process for reporting methodological information and recommends that the European Union work with the Netherlands to include the Netherlands' milk yield for dairy cattle in the NIR of the European Union, as it is the case for all other member States	Information on milk yield in the NL is included in the EU NIR.

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A.12	2015/2016	Comparability	3.B Manure management – N_2O	The European Union used the notation key "IE" to report the contribution of the Netherlands to total N_2O emissions from manure management of cattle in the NIR (see table 5.26, p. 479), without specifying where in the inventory the emissions have been included. During the review, the European Union explained that the Netherlands reported in the documentation box of CRF table 3.B(b) that data on individual animals are not available and, therefore, the total N_2O emissions from liquid systems and solid storage and dry lot in the Netherlands are reported under the subcategory other livestock (3.B.4) The ERT recommends that the European Union work with the Netherlands to investigate whether N_2O emissions from manure management can be estimated and reported separately for each livestock category	This is resolved: the Netherlands have reported the amount of manure managed in each system in May 2018 submission
A.13	2015/2016	Transparency	3.B Manure management – N_2O	The European Union used the notation key "NE" to report the allocation of manure from each livestock species to each manure management system (see CRF table 3.B(a)). However, the ERT noted that no explanation is provided in the documentation box of CRF table 3.B(a) and in the NIR on why the notation key "NE" is used. During the review, the European Union explained that its reporting is the aggregated sum of the member States' values and that it would consider whether the allocation of manure from each livestock species to each manure management system can be calculated and reported in future GHG inventory submissions The ERT recommends that the European Union include information on the use of the notation key "NE" to report the allocation of manure per livestock species and per manure management system and work with member States to calculate such allocations based on the data provided by member States	The allocation of livestock species to each manure management system, as well as methane conversion factors, has been implemented in CRF table 3.B(a) in the resubmission by 27 May 2018.
A.14	2015/2016	Transparency	3.B Manure management – N_2O	In its submission of 9 September 2016, the European Union used the notation key "IE" to report direct N_2O emissions from anaerobic lagoons (see CRF table 3.B(b)). However, no explanation is provided on where in the inventory the emissions have been included. During the review, the European Union explained that it reports the notation keys used by member States and that all member States except Spain used the notation key "NO" to report direct N_2O emissions from anaerobic lagoons. The European Union further explained that manure in Spain undergoes a series of concatenated processes which makes it impossible to associate them with any of the definitions of manure management systems considered in the 2006 2006 IPCC Guidelines. Therefore, direct N_2O emissions from manure management in Spain were considered under the subcategory other management systems. The issue has been addressed and Spain has included the information in the 2017 inventory submission The ERT recommends that the European Union provide information on the use of the notation key "IE" by Spain to report direct N_2O emissions from anaerobic	This has been resolved. After discussions with Spain, in the last inventory submission (2017), they changed the way to allocate manure to the different manure management systems, which is now in line with the other countries and allowed the EU to properly fill Table 3.B(b) of the CRF. Now the notation key 'IE' was replaced by numbers.
A.15	2015/2016	Comparability	3.B.1 Cattle – N_2O	The ERT noted significant inter-annual changes in the trend of the nitrogen excretion rate for non-dairy cattle for 1998/1999 (–27.3%) and 1999/2000 (37.5%) (see figure 5.49, p. 490 of the NIR). However, no information is provided in the NIR to explain such inter-annual changes. During the review, the European Union explained that the excretion rate for non-dairy cattle for 1999 is an outlier because the excretion rate for France was reported as zero for 1999 owing to a technical error and that France provided correct values in its latest GHG inventory submission The ERT recommends that the European Union correct the reporting of the nitrogen excretion rate for non-dairy cattle for 1999	This has been resolved. In the last NIR (2017), nitrogen excretion rate is reported correctly, including the values from France that were missing, and now no outliers can be observed.

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A.16	2015/2016	Accuracy	3.B.3 Swine – CH_4	The European Union stated in the NIR that Cyprus, the Czech Republic, Greece, Slovakia and Slovenia use a tier 1 method and default EFs to estimate CH_4 emissions from swine manure management (see table 5.14, p.462 of the NIR). However, the ERT noted that CH_4 emissions from manure management is a key category. During the review, the European Union explained that it had already identified this issue for Cyprus and Greece during a review conducted under the framework of the European Union effort-sharing decision. The European Union further explained that for the Czech Republic and Slovakia, CH_4 emissions from manure management is not a key category and that Slovenia used a tier 2 methodology with default values for volatile solids and maximum Bo of the manure. The ERT noted that CH_4 emissions from manure management from swine for the Czech Republic and Slovakia is a significant subcategory as it contributes, together with manure management from cattle, to more than 60% of the emissions from the key category (3.B) The ERT recommends that the European Union work with Cyprus, the Czech Republic, Greece and Slovakia to move to a higher-tier method to estimate CH_4 emissions from manure management from swine	Efforts are on-going to make the Parties concerned move to a higher tier.
A.18	2015/2016	Transparency	3.I Other carbon-containing fertilizers – CO_2	In the European Union submission of 9 September 2016, the ERT noted significant inter-annual changes in the trend of CO_2 emissions from other carbon-containing fertilizers in CRF table 10, including for 1996/1997 (–36.0%) and 2003/2004 (49.7%). However, no information was provided by the European Union to explain the significant inter-annual changes. During the review, the European Union explained that the strong increase in emissions from other carbon-content fertilizers was due to an increase observed in Germany. During the review the European Union indicated that this will be solved in the 2018 annual submission The ERT recommends that the European Union include in the NIR information explaining the trend of CO_2 emissions from other carbon- containing fertilizers	The issue has been solved; no time trend issues are observed in 2018 submission any more
L.12	2015/2016	Comparability	4. General (LULUCF) – CO_2	The ERT noted that several member States used the notation key “NO” to report carbon pools where there are no changes in the type of management and where net emissions are equal to net removals and therefore deemed carbon-neutral. For example, Bulgaria, Croatia, Denmark, Estonia, France, Greece, Italy, Latvia, Lithuania, Luxembourg, Romania and Slovakia used the notation key “NO” to report carbon stock changes in mineral soils under grassland remaining grassland. The ERT considers that in this situation it is not accurate to report that the carbon pool is not occurring. Instead, the ERT considers that, where a tier 1 method is applied to assume no net change for a specific carbon pool, the use of the notation key “NA” is consistent with decision 2/CP.19 because the pool does occur, however it does not result in net emissions or removals. During the review, the European Union explained that, despite the efforts implemented to harmonize the use of notation keys among member States and despite the implementation of decision 24/CP.19, there is no common understanding on the use of the notation keys for reporting information from carbon pools, and that different interpretations seem possible. The European Union further noted that, as it occurred in the past, and was recognized in the conclusions from the ninth meeting of GHG inventory lead reviewers, further guidance on the use of notation keys could be needed, specifically for the LULUCF sector The ERT recommends that the European Union use the notation key “NA” to report carbon	The EU has worked with MS towards the use of the notation key NA where carbon stock changes are considered neutral. During the JRC annual LULUCF workshop a dedicated presentation was given on this regard, and all MS have been requested to address the ERT's recommentadion.

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				stock changes from carbon pools where carbon stock changes are neutral (i.e. where net emissions are equal to net removals)	
L.13	2015/2016	Yes. Adherence to UNFCCC Annex I inventory reporting guidelines	4. General (LULUCF)	The ERT noted that no information is provided on the inventory improvement status and improvement plans in section 11.3.6 of the NIR. The ERT notes that the reporting of planned inventory improvements is a mandatory requirement under the UNFCCC Annex I inventory reporting guidelines. During the review, the European Union stated that the planned improvements were reported in chapter 10 of the NIR. However, the ERT noted that no information is reported on planned inventory improvements for the LULUCF sector or KP-LULUCF activities. Additionally, the ERT noted that some planned inventory improvements are already in progress The ERT recommends that the European Union include in the NIR information on planned inventory improvements for the LULUCF sector and KP-LULUCF activities	The information is now included in the NIR, sections 6..4.4 and 11.3.6
L.15/L.16	2016/2015	Yes. Adherence to UNFCCC Annex I inventory reporting guidelines	4. General (LULUCF)	In the submission of 9 September 2016, the ERT noted that the information reported by the European Union is not consistent. Inconsistencies were found in: (1) land areas reported in CRF tables 4.1, 4.A–4.F and NIR-2 and table 11.3 of the NIR; and (2) net emissions reported in CRF table 4(KP) and table 11.5 of the NIR. In addition, inconsistencies were found between the European Union submission and the reporting by member States. For example, the European Union used the notation key "NO" to report on the change in area under forest management activity for France in CRF table NIR-2 for year 2013, whereas France reported in CRF table NIR-2 a change in area of 21 586,71 kha in the same year. During the review, the European Union explained that it relies on the data provided by member States. Additionally, the European Union stated that some member States' submissions were affected by technical problems related to the CRF Reporter software, which consequently affected the European Union's submission The ERT recommends that the European Union correct the inconsistencies in the reported areas in CRF tables 4.1, 4.A–4.F and NIR-2 and table 11.3 of the NIR	The EU has worked with MS in order to avoid such inconsistencies. During the JRC annual LULUCF workshop, a dedicated presentation was given on this issue, and all MS were requested to address the ERT's recomentadion.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
L.16		Consistency	4.A.1 Forest land remaining forest land– CO_2	In the submission of 9 September 2016, the ERT noted that 11 member States used the notation keys "NA", "NE" or "NO" to report the net carbon stock changes in dead wood for the whole time series due to the fact that these member States used a tier 1 method, which results in zero carbon changes or carbon emissions from this pool (see ID# L.12 above). The ERT further noted that Malta, which also used a tier 1 method, reported the carbon stock changes as "zero", rather than using a notation key. The ERT further noted that France reported the notation key "NO" for the period 1990–1999 using the tier 1 method from the 2006 IPCC Guidelinesand provided estimates for the period thereafter using a country-specific method. Lastly, the ERT noted that Luxembourg reported net carbon stock change estimates for the period 2001–2010 and "zero" or a notation key for the remainder of the time series. During the review, the European Union explained that the reporting of net carbon changes in dead wood is, in overall, considered consistent as member States either used a tier 1 (i.e. carbon-neutrality) or a country-specific method for the whole time series. In addition, the European Union provided detailed explanations on the reasons behind the lack of quantitative estimates for the whole time series in the cases of France and Luxembourg The ERT recommends that the European Union work with Luxembourg to improve the time-series consistency of net carbon stock changes in dead wood in forest land remaining forest land	On going (see section 1.2.1.2 of the NIR)
L.17/L 18	2016/2015	Completeness	4.B.1 Cropland remaining cropland– CO_2	The ERT noted that France reported "zero" CO_2 emissions from cropland remaining cropland for the whole time series (see table 6.17 of the NIR). The ERT further noted that in CRF table 4.B, the gain in carbon stock changes in living biomass for France, estimated to be 1 331.94 kt C for 2014, equals the absolute value of the loss in the same year (–1 331.94 kt C), resulting in a carbon-neutral balance. During the review, the European Union explained that, owing to the lack of information on the accumulation of woody biomass in the cropland land-use category, France considers that the carbon stock gains in woody biomass in cropland remaining cropland are offset by the losses due to biomass harvest under that land-use category. The ERT notes that information on the accumulation of woody biomass can be found in the 2006 2006 IPCC Guidelines. The further ERT notes that gains and losses of woody biomass are balanced during the cycle of planting, maturing, felling and replanting when changes in crops or management practices do not occur. However, if areas of woody crops are replaced by non-woody crops, there is a loss of living biomass. Moreover, based on FAOSTAT information, the area of vineyards in France has been steadily decreasing from 907,778 ha in 1990 to 771,530 ha in 2010, which suggests changes in crops The ERT recommends that the European Union work with France to estimate the carbon stock changes in living biomass, taking into account changes in woody biomass owing to changes in crops and management practices under cropland remaining cropland	Carbon stock changes in living biomass are now reported by France for the subcategory 4B1

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L.19/L. 20	2016/2015	Completeness	4.F Other land – CO_2	The ERT noted that some of the definitions for the categorization of other land included in the NIR (see table 6.6.28 of the NIR) do not follow the definitions included in the 2006 2006 IPCC Guidelines. In particular, “natural grasslands not in use for agricultural purposes” in Ireland, “mineral soils on poorly productive forest land, which do not fulfil the threshold values for forest” in Finland, “standing water and canals and rivers and streams” in the United Kingdom and “shrub lands” in Portugal are defined as “other land”. During the review, the European Union explained that the 2006 IPCC Guidelinesstate that “countries will use their own definitions of these categories”. Additionally, the European Union explained that Ireland has included natural grassland in unmanaged grassland; therefore, the information provided in the NIR would have to be updated for the next GHG inventory submission. Moreover, the European Union stated that member States include under ‘other lands’ all those areas that do not fall under any other land use category. The European Union also explained why “mineral soils on poorly productive forest lands” in Finland are reported under ‘other lands’ and why soil organic carbon stock increased in ‘other lands’ in Portugal. The ERT notes that, in accordance with the 2006 2006 IPCC Guidelines, the land-use category other land concerns unmanaged areas which are not included in inventory estimates. However, some member States included significant carbon pools under other land remaining other land that can be subject to variations which are not reported in the CRF tables and for which there is no clear indication in the NIR that they are unmanaged areas The ERT recommends that the European Union include in the NIR information on whether land areas reported under other land in Finland, Portugal and the United Kingdom 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 as well as to update the information provided in the NIR regarding the definitions for the categorization of “other land” used by the member States	The requested information has been included in section 6.2.4.3. In addition, the information in table 6.28 has been updated.
L.20/L. 21	2016/2015	Comparability	4.G Harvested wood products– CO_2	In the European Union submission of 9 September 2016, the ERT noted that the annual stock change of HWP reported in CRF table 4.G under approach A (stock change approach) is not consistent with the net emissions/removals from HWP reported in the same table. The ERT also noted that no information is reported in CRF table 4.G under approach B (production approach), although it is stated in the NIR that the majority of member States used approach B to calculate emission/removal estimates for HWP (see pp.638–640 of the NIR). The ERT considers that the application of a single approach to the reporting of HWP among member States and Iceland would reduce the chance of omissions or double counting due to trade between member States. During the review, the Party confirmed the problems with the information reported in the CRF tables which do not allow for the reporting of information under approach A and approach B simultaneously. The European Union further confirmed that all member States used approach B and that information was incorrectly reported under approach A by Latvia, Lithuania and Romania The ERT recommends that the European Union correct the reporting of information on HWP in CRF table 4.G by reporting the information according to the approaches used by member States to estimate emissions/removals associated with HWP and correct the information on approaches used by member States to estimate emissions/removals associated with HWP in the NIR	The information is now correct in table CRF table 4.G and in the NIR. See table 6.38 for further details.

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L.21/ L.22		Completeness	4.G Harvested wood products– CO_2	In the European Union submission of 9 September 2016, the ERT noted that a number of member States do not report information on HWP for all or part of the time series. For example, estimates for HWP in CRF table 4.G were not provided for Cyprus for the whole time series and, for the period prior to 2000, were not provided for Belgium. During the review, the European Union explained that estimates are under preparation for Belgium and Cyprus and would be submitted when they become available. The Party also indicated that it would follow up on this issue prior to the next GHG inventory submission The ERT recommends that the European Union work with Belgium and Cyprus to ensure that the information on HWP in CRF table 4.G is complete for the whole time series	Cyprus report emissions for HWP in 2018. In addition, Belgium informed that work is in progress to report emissions/removals from HWP for the whole time series in future submission.
KL.6	2016/2015	Transparency	General (KP-LULUCF)	In its report to facilitate the calculation of the assigned amount, the European Union stated that the information on how the national system under Article 5, paragraph 1, of the Kyoto Protocol will identify land areas associated with activities under Article 3, paragraph 4, of the Kyoto Protocol and on how member States ensure that land that was accounted for in the first commitment period continues to be accounted for in the second commitment period is provided in the individual initial reports of the member States and Iceland or in their NIRs. The European Union further stated that the development of the methodological approach to identify land areas is part of member States' responsibilities The ERT noted that the report to facilitate the calculation of the assigned amount does not contain transparent information on how member States ensure that land that was accounted for in the first commitment period continues to be accounted for in the second commitment period The ERT recommends that the European Union provide summary information on how member States ensure that land that was accounted for in the first commitment period continues to be accounted for in the second commitment in its NIR	Information on this matter has been added in section 11.1.7 of the EU NIR

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
KL.7	2016/2015	Transparency	General (KP-LULUCF)	In the European Union submission of 9 September 2016, the ERT notes some issues that challenge the accuracy and completeness of the European Union submission. Inconsistencies were found between different the CRF tables (e.g. areas in CRF table NIR-2 and in CRF tables 4(KP)A.I to 4(KP)B.5), between the NIR and the CRF tables (e.g. between table 11.3 of the NIR and CRF table NIR-2, and between table 11.5 of the NIR and CRF table 4(KP)), and between the values reported by the European Union and by member States (e.g. forest management activities for France were reported using the notation key "NO" in CRF table 4(KP)B.1, although quantitative data were available in the CRF tables of France). During the review, the European Union stated that technical issues with the CRF Reporter affected the overall quality of member States submissions and, consequently, the quality of the European Union submission as its submission relies on the data provided by member States. The European Union further stated that an error found in the aggregation process also explain some of these inconsistencies. The ERT noted that additional automated QA/QC checks may identify potential problems in the CRF tables that can be addressed prior to the Party's submission, in particular for completeness and consistency. For example, such checks may include comparisons between AD for summary and sectoral tables (e.g. CRF table NIR-2 and sectoral CRF tables 4(KP-I)A.1 to 4(KP-I)C) In those cases where the reported data were unclear, incomplete or inaccurate in the member States' submissions, the European Union was not able to provide clarifying and conclusive information during the review. For example, the Party did not provide information to clarify the inconsistency in the area between the sectoral tables (CRF tables 4.A–4.F and CRF tables 4(KP-I)A.1, 4(KP-I)A.2 and 4(KP-I)B.1–B.5) and the land matrix for the LULUCF sector and KP-LULUCF activities; the area of unmanaged forests in France; the approaches used to identify HWP from deforestation events in member States that report HWP from deforestation; or the background level of emissions from natural disturbances included in the FMRL The ERT recommends that the European Union correct the error found in its aggregation process to ensure the consistency of information among the European Union and its member States and ensure that issues identified during the aggregation process, that affect the accuracy and completeness of its submission, are resolved	Improvements in the aggregation process have been implemented in order to ensure the consistency of information among the European Union and its MS. Inconsitencies have been now resolved.
KL.8	2016/2015	Completeness	General (KP-LULUCF) – CO_2	The ERT noted that the information reported in table 11.5 of the NIR is not consistent with that reported in CRF tables 4(KP-I)A.1, 4(KP-I)A.2 and 4(KP-I)B.1 in the submission of 9 September 2016. In particular, the European Union used the notation key "NO" to report the net carbon stock changes for France and the Netherlands in CRF tables 4(KP-I)A.1, 4(KP-I)A.2 and 4(KP-I)B.1, although quantitative information is provided in table 11.5 of the NIR. During the review, the European Union explained that these issues resulted from errors in the automatic aggregation process of information provided by member States. The Party also explained that the Netherlands faced technical difficulties when using the CRF Reporter software for its submission The ERT recommends that the European Union correct the information on afforestation/reforestation, deforestation and forest management for France and the Netherlands by providing the correct estimates in CRF tables 4(KP-I)A.1, 4(KP-I)A.2 and 4(KP-	Errors have been resolved in the CRF tables, ensuring the consistency with the EU NIR

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
				I)B.1 and ensure that the information in these tables is consistent with that reported in table 11.5 of the NIR	
KL.9	2016/2015	Completeness	Afforestation and reforestation – CO_2	In the European Union submission of 9 September 2016, the ERT noted that Cyprus and Malta used the notation key “NE” to report net CO_2 emissions/removals from afforestation and reforestation activities (see CRF table 4(KP-I)A.1). Additionally, Hungary used the notation key “NE” to report net CO_2 emissions/removals for the DOM and SOC pools from afforestation and reforestation activities (see CRF table 4(KP-I)A.1), demonstrating that the pools do not result in net CO_2 emissions The ERT recommends that the European Union work with Cyprus and Malta to estimate net CO_2 emissions/removals from afforestation and reforestation activities	Issues were communicated to MS, and some improviments have been implemented to increase the completeness, and transparency, of the reporting of carbon stock changes in AR. Further improvements are expected for future submissions.
KL.10	2016/2015	Completeness	Deforestation – CO_2	In the European Union submission of 9 September 2016, the ERT noted that Cyprus used the notation key “NE” to report net CO_2 emissions/removals from deforestation activity (see CRF table 4(KP-I)A.2) The ERT recommends that the European Union work with Cyprus to estimate net CO_2 emissions/removals from deforestation activity	Cyprus has included estimates for carbon stock changes for Deforestation in 2018
KL.11	2016/2015	Completeness	Article 3.4 activities – CO_2	In the European Union submission of 9 September 2016, the ERT noted that the United Kingdom used the notation key “NE” to report the net carbon stock changes in the litter and dead wood pools under cropland and grazing land management (see CRF tables 4(KP-I)B.2 and 4(KP-I)B.3). The ERT further noted that the United Kingdom used the notation key “NE” to report CO_2 emissions/removals from wetland drainage and rewetting activities (see CRF table 4(KP-I)B.5) The ERT recommends that the European Union work with the United Kingdom to estimate the net carbon stock changes in the litter and dead wood pools under cropland and grazing land management and CO_2 emissions/removals from wetland drainage and rewetting activities	The UK has communicated that research and methodological development programme is ongoing that will allow to ensure the completeness reporting of carbon stock changes for those activities. See section 11.3.3 for further details.
KL.12	2016/2015	Accuracy	Article 3.4 activities	In the European Union submission of 9 September 2016, the ERT noted that in CRF table NIR-2, the European Union reported areas where activities under Article 3, paragraph 4, of the Kyoto Protocol occur for member States that have not elected such activities. For example, the European Union reported cropland management and grazing land management areas for Romania, whereas this member State did not elect such activities. This misallocation of areas affects the total areas for activities under Article 3, paragraph 4. During the review, the European Union stated that it was aware of the issue and that it would be corrected in close collaboration with the affected countries for its next GHG inventory submission. The ERT noted that this issue was not listed among the planned improvements included in the NIR of the European Union The ERT recommends that the European Union ensure that the reporting under Article 3, paragraph 4, only includes the areas of those activities that were voluntary selected by the member States	In close cooperation with MS the EU has resolved this issue in 2018. Areas for non-elected activities are not excluded from the reporting.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
KL.14	2016/2015	Completeness	Forest management – CO_2	The ERT noted that Cyprus and Malta used the notation key “NE” to report net CO_2 emissions/removals from forest management activities. The ERT further noted that Greece and Hungary also used the notation key “NE” to report the net carbon stock changes in the litter, dead wood and organic soils pools (see CRF table 4(KP-I)B.1 of the submission of 9 September 2016) to indicate that these pools are not included in accounting as they do not result in net CO_2 emissions The ERT recommends that the European Union work with Cyprus and Malta to estimate net CO_2 emissions/removals from forest management activities	Issues were comunicated to MS, and some improviments have been implemented to increase the completeness, and transparency, of the reporting of carbon stock changes inFM. Further improvements are expected for future submissions.
KL.15	2016/2015	Transparency	Forest management– CO_2	In the European Union submission of 9 September 2016, the ERT noted that the overall technical correction to the FMRL for the European Union has not been included in the NIR, and the information included in CRF table 4(KP-1)B.1.1 is not complete with respect to all member States and is also not accurate. For example, information on the technical correction in CRF table 4(KP-1)B.1.1 is not complete for a number of member States (Belgium, Cyprus, the Czech Republic, Estonia, France, Germany, Iceland, Italy, Luxembourg, Malta, the Netherlands, Poland, Slovakia, Slovenia and Spain) and in some cases it is unclear from the information included in the NIR whether this is because there is no need for a technical correction for that member State, or for another reason. The value reported in CRF table 4(KP-1)B.1.1 for the value of the FMRL inscribed in decision 2/CMP.7 does not match the one provided in the appendix to the annex to decision 2/CMP.7. During the review, the European Union explained that the FMRL and the technical correction do not include information for all member States owing to problems with the automatic aggregation of information from member States. The European Union further explained that there is an error in the FMRL reported in table 11.21 of the NIR and in CRF table 4(KP-I)B.1.1 because the reported technical correction for Bulgaria represents the revised FMRL (FMRLcorr), not the value of the technical correction. The European Union further stated that owing to the incomplete information reported in the CRF tables of the member States, the FMRL reported in CRF table 4(KP-I)B.1.1 is also incorrect and does not match the FMRL inscribed in the appendix to the annex to decision 2/CMP.7. The ERT notes that changing the number of member States from 27 to 28 plus Iceland will also result in changes to the FMRL by means of technical corrections. However, the ERT noted that information on the European Union’s technical correction was not provided in the NIR. During the review, the Party indicated that such information would be provided in the next GHG inventory submission. The ERT notes that KP-LULUCF accounting is to be undertaken individually by the member States and Iceland, and that the European Union will neither issue nor cancel Kyoto Protocol units based on reported KP-LULUCF emissions. However, because the European Union has an FMRL inscribed in the appendix to the annex to decision 2/CMP.7, and because the Party has made an annual GHG inventory submission, the ERT considers that the requirements of annex II to decision 2/CMP.8 apply to the information reported by the European Union The ERT recommends that the European Union 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 European Union as a whole and for each of the member States plus Iceland, in accordance with the requirements of decision	Detailed information on this matter has been included in the NIR, section 11.5.2.2, and in the CRF table to address the ERTs recommendation.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
				2/CMP.8, annex II, paragraph 5(f) and taking into consideration the changes made in the coverage of FMRL	
KL.16	2016/2015	Transparency	Forest management– CO_2	The ERT noted that the European Union did not include in its annual submission information on the background level of emissions associated with annual natural disturbances that have been included in the FMRL for the European Union, in accordance with the requirements of decision 2/CMP.7, annex, paragraph 33(a) During the review, the European Union explained that in most cases the average levels of past disturbances would be included automatically in the FMRL of the individual member States through the calibration procedure. The ERT notes that the background level of disturbance emissions is a specific calculated value for which summary information may be transparently reported in the NIR. The ERT further notes that the calculation of the background level in accordance with the Kyoto Protocol Supplement will not always equal the average levels of past disturbances, and the approach described by the European Union may lead to an expectation of net credits from the application of the natural disturbances approach. Furthermore, the approach described by the European Union may also result an inconsistency between the FMRL and the reporting on forest management. The ERT noted that many member States have applied the approach proposed by the European Commission Joint Research Centre (JRC) to calculate the FMRL. For these member States, the European Union has the opportunity to provide support to improve consistency and implement good practice, such as the tests contained in box 2.3.6 of the Kyoto Protocol Supplement The ERT recommends that the European Union provide transparent information on the background level of emissions associated with natural disturbances included in its FMRL 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 forest management in relation to the treatment of natural disturbances, and to calculate a technical correction where required	Detailed information on this matter has been included in the NIR, sections 11.4.4 and 11.5.3 in order to address the ERTs recommendation.
KL.17	2016/2015	Accuracy	Cropland management– CO_2	In the submission of 9 September 2016, the ERT noted that the European Union used the notation key "NO" to report the area of organic soils in CRF table 4(KP-I)B.2 for Italy, while reporting a net carbon stock change in organic soils of 246.92 kt C for 2014 (2013). Likewise, an area of 10 704.36 kha of mineral soils is reported for Italy for 2014, while the net carbon stock change in mineral soils is reported using the notation key "NO". During the review, the European Union explained that emissions from organic soils were incorrectly reported and that it would correct this problem in its next GHG inventory submission and confirmed that the reporting of net carbon stock changes in organic soils is correct and that "NO" is the correct notation key for reporting the net carbon stock changes in mineral soils The ERT recommends that the European Union correct the reporting of the area of mineral and organic soils for Italy in CRF table 4(KP-I)B.2	Error has been resolved. See CRF table for further details.
KL.18	2016/2015	Accuracy	Revegetation	The ERT noted that the European Union reported in CRF table 4(KP-I)B.4 of the submission of 9 September 2016 an area of 256 838 598 666 677 kha of mineral soils under revegetation activity in Iceland. During the review, the European Union explained that the area was incorrectly reported and that the correct area was 256.84 kha The ERT recommends that the European Union correct the reporting of the area of mineral soils under revegetation activity in Iceland in CRF table 4(KP-I)B.4	Error has been resolved. See CRF table for further details.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
KL.19	2016/2015	Completeness	Harvested wood products – CO_2	The ERT noted that Belgium used the notation key “NE” to report net CO_2 emissions/removals from HWP for the years prior to 2000 (see CRF table 4(KP-I)C of the submission of 9 September 2016) The ERT recommends that the European Union work with Belgium to estimate net CO_2 emissions/removals from HWP	Belgium informed that work is in progress to report emissions/removals from HWP for the whole time series in future submission.
KL.20	2016/2015	Accuracy	Harvested wood products– CO_2	The ERT noted that a number of member States reported HWP from deforestation lands in CRF table 4(KP-I)C of the submission of 9 September 2016. The ERT notes that these HWP may be derived from trees regrown on previously deforested lands in accordance with the land classification hierarchy. The ERT further notes that any HWP originating from deforestation events should be reported using instantaneous oxidation consistent with decision 2/CMP.8, annex II, paragraph 2(g)(v). The ERT noted that most member States report aggregated HWP under forest management due to the lack of information to disaggregate HWP originating from different activities under Article 3, paragraph 3, of the Kyoto Protocol and forest management. Further, a number of member States reported annual deforestation occurring on afforestation/reforestation and forest management lands in CRF table NIR-2. This suggests that HWP statistics for afforestation/reforestation and forest management lands may include HWP from deforestation events occurring on those lands. In particular, a number of member States have reported deforestation occurring on afforestation/reforestation and forest management lands or reported HWP from deforestation lands, but did not provide information on the amount of harvest originating from deforestation events in CRF table 4(KP-I)C. During the review, the Party explained that most member States stated that HWP from deforestation are not estimated and, consequently, are not included in the accounting in CRF table 4(KP-I)C and, therefore, HWP are accounted for on the basis of instantaneous oxidation. The ERT considers that this is not a sufficient explanation to transparently demonstrate that HWP from deforestation events are not included in aggregate HWP AD. The European Union further explained during the review that there were only a few cases where explicit information was provided by the member States that reported HWP from regrowth on deforestation lands and how these HWP are distinguished from HWP from deforestation events. The European Union also explained that, owing to the complexity introduced by the CMP decisions on KP-LULUCF activities, the reporting of HWP by member States needs to be enhanced The ERT recommends that the Party 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 Kyoto Protocol Supplement (p.2.119)	The EU has worked with MS to ensure that HWP from deforestation events are accounted for on the basis of IO. During the JRC annual LULUCF workshop a dedicated presentation was given on this regard and all MS have been requested to address the ERT's recommentadion.

10.4.2 Improvements implemented in response to the internal peer review of the EU NIR

In 2017, a team of Member States' experts (Czech Republic - Eva Krtková and Beáta Ondrušová, energy, IPPU; Denmark - Ole-Kenneth Nielsen, waste, LULUCF; Finland - Pia Forsell, IPPU; Greece - Spyridoula Ntemiri, IPCC & general; Ireland (Paul Duffy - agriculture) reviewed the EU GHG NIR and provided suggestions for improvements.

Several of these recommendations have been implemented already in the current submission:

- Inclusion of outcome of completeness checks in the introduction chapter of the EU NIR, e.g. Table on NEs and Cs visible in the EU CRF
- Explanation of differences between EU KCA and CRF KCA have been included in the introduction chapter of the EU NIR
- Providion of overview table for each sector on emission trends, share and change for non key categories, which is performed on the same category level as the key category analysis
- Harmonization and improvement of the presentation and the consistency between sector chapters of emission trends
- Improvement of data presentation in graphs (e.g. trend in EU activity data, emissions and IEFs)
- More focus on methodologies in sectoral chapters and less on lengthy explanations on general emission trends
- Improvement of completeness of sectoral recalculation tables
- More detailed information on the implementation of improvements provided in Chapter 10
- Further consultation with Member States concerning changes in methodologies as presented in Annex III
- Annex III provides reference to the corresponding sections of Member States NIRs
- Improvement of formatting issues
    - Quality and readability of figures and tables
    - Harmonization of section headings
    - Consistent use of units

10.4.3 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 to implement relevant suggestions made from MS sector experts during the peer review of the EU NIR in 2018
- Continue sector-specific QA/QC activities within the EU internal review;
- Further develop the EU QA/QC activities on the basis of the experience in 2016/2017

PART 2: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

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 Member States (MS) and Iceland. For the voluntary activities under the Article 3(4), information is included only for those that elected to account for these activities during the second commitment period (CP2) of the KP.

It is important to note that each MS and Iceland will account for net emissions and removals for each activity under Article 3(3), and 3(4) if elected, by issuing RMUs or cancelling Kyoto Protocol units based on their own reported emissions and removals from these 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 EU relevant supplementary information for KP-LULUCF activities, as reported by EU MS and Iceland. In the absence of an official annotated outline for the provision of supplementary information under the CP2 of the KP, the JRC[75] provided MS with a proposal on the outline for reporting KP-LULUCF supplementary information within the national inventory reports (NIR). Nevertheless, the type and amount of information reported by MS and Iceland slightly differs among inventories. Therefore, note that this chapter does not aim to provide an exhaustive compilation of all supplementary information reported by MS 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 MS and Iceland.

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 MS 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 MS and Iceland have implemented technical corrections, and information about conversion from natural to planted forests).

The main assumption 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 MS and Iceland GHG inventories with good practices is checked twice every year before national GHG inventories are officially submitted to the UNFCCC. A first check is carried out in the context of MS' 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.

[75] Joint Research Centre of the European Commission. https://ec.europa.eu/jrc/en

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; 7 MS have elected to account for Cropland Management, 6 MS for Grazing Land Management, 1 MS and Iceland for Revegetation, and 1 MS for Wetland Drainage and Rewetting. Concerning the accounting frequency, with the exception of 2 MS, all other MS 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.

Member State	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 to all MS and Iceland for 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 and Iceland for each mandatory and elected activity.

Carbon stock changes are estimated in most cases for biomass pools, but for dead organic matter and soil organic matter pools notation keys are also used. “NE” is mainly used 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, 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 matter pools are estimated by using models not capable to apportion net carbon stock changes among those pools.

Despite the continuous improvements implemented by MS 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 to other sources of emissions, at European level, a full set of quantitative estimates is not yet provided, especially with regard to N_2O emissions from management of soils. 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) or when such emissions are already reported under the agriculture sector. For instance, 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 and Iceland, based on table NIR-1 and sectorial tables (for the year 2017)

Member State	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	NO	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	NE	NE	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
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

Member State	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
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	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	R	R	R	R	R	R	IE	NO	NE	NE	R	NO	R	R	R
Poland	R	R	R	R	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	NE	R	R	R	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	NO	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	NO	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	IE	IE	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	NE	R	IE	R	R	R
Poland	R	R	R	R	R	R	R	NO	NO	NO	NO	NO	NO	NO	NO
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	R	R	NO,NR	NR	NO	NO	NO	NO	NO	NO	NO	NO

Member State	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
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	IE	IO	NO	NO	NO	R	R	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	NO	NO	NO	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	NR	NR	NR	NR	NR	NO	NR	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	NO, R	NO, 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	R	R	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	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	R	NO	NE	NE	R	NO	R	R	R
Poland	R	R	R	R	R	R	R	NO	NO	NO	NO	NO	NO	NO	NO
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	NE	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,NO	R	R			NO, 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		NO		R	R	R
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

Member State	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
United Kingdom	R	IE	NR	NR	R	R			NE		R		NE	R	R
Grassland Management															
Denmark	R	R	NO	NO	R	R			R		R		NO	NO	NO
Germany	R	R	IE	IE,NO	R	R			NO, 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		NO		R	R	R
Portugal	R	R	R	NO	R	NO			NO		R		R	R	R
United Kingdom	R	IE	NR	NR	R	R			NE		R		NE	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		NR		NE	NE	NE		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 and Iceland is about 250,000.00 kha, which is approximately 54% of the total area reported under the Convention (Table 11.3).

The activity that covers the largest area at EU level is Forest Management (61%), followed by Cropland Management (22%), Grazing land Management (11%), Afforestation/Reforestation (4%) and Deforestation (2%), while Wetland Drainage and Rewetting, and Revegetation cover less than 1%.

With the exception of Finland, Netherlands and Romania all GHG inventories reports larger areas under afforestation/reforestation than under deforestation. Consequently, forest area reported under KP increases over time at EU level.

Regardless of specific activities, most of the area under the KP accounting is reported by Spain, Germany, Sweden, France, UK and Finland. The largest area under AR is reported by Italy, the largest under D is reported by France, and the largest under FM is reported by Sweden.

Table 11.3 Synthesis of total area (kha) reported under KP-LULUCF activities by EU MS and Iceland in GHG inventories 2017, based on NIR-2 tables. Grey cells indicate that the activity has not been elected.

Member State	Art. 3.3 activities		Art. 3.4 activities					TOTAL
	AR	D	FM	CM	GM	RV	WDR	
Austria	232.54	77.33	3807.96					4117.83
Belgium	44.16	39.13	668.86					752.15
Bulgaria	288.50	5.44	3621.88					3915.83
Croatia	63.24	4.71	2311.02					2378.97
Cyprus	9.65	1.12	143.97					154.74
Czech Republic	62.55	18.47	2609.11					2690.13

Member State	Art. 3.3 activities		Art. 3.4 activities					TOTAL
	AR	D	FM	CM	GM	RV	WDR	
Denmark	105.88	11.82	532.72	2858.88	182.65			3691.95
Estonia	53.54	20.25	2384.82					2458.60
Finland	189.82	418.62	21656.09					22264.53
France	1585.91	1229.53	21445.23					24260.67
Germany	562.28	302.04	10611.50	14706.49	6241.21			32423.52
Greece	34.25	5.56	1247.69					1287.49
Hungary	173.50	16.48	1766.55					1956.53
Ireland	323.15	20.33	446.24	769.75	4163.60			5723.08
Italy	1961.66	58.86	7452.98	8980.58	544.05			18998.13
Latvia	78.26	54.92	3113.37					3246.55
Lithuania	52.88	2.41	2155.42					2210.70
Luxembourg	8.95	5.90	87.23					102.08
Malta	NO,NA	NO,NA	0.07					0.07
Netherlands	47.44	74.75	308.41					430.59
Poland	779.95	32.71	8645.79					9458.45
Portugal	623.00	373.20	3744.22	2341.43	592.67			7674.53
Romania	35.07	408.88	6959.84			106.07		7509.87
Slovakia	47.03	8.68	1977.34					2033.06
Slovenia	NO,NA	26.28	1116.24					1142.51
Spain	1262.80	121.25	14428.48	20173.43				35985.95
Sweden	356.08	314.11	27883.86					28554.05
United Kingdom	549.08	67.01	2961.51	5208.80	15014.60		NE,NA	23801.00
EU	**9531.16**	**3719.80**	**154088.38**	**55039.36**	**26738.78**	**106.07**	**0.00**	**249223.54**
Iceland	47.01	0.06	93.58			295.35		436.00
EU + Iceland	**9578.17**	**3719.86**	**154181.96**	**55039.36**	**26738.78**	**401.42**	**0.00**	**249659.55**

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 MS and Iceland in CRF table NIR-3. However, in some cases the information was taken from the NIR because, as explained by some MS during the EU QA/QC procedures, remaining open issues in the CRF Reporter used to generate the CRF tables prevented the provision of this information in 2019, in the same way as already happened in previous years.

Table 11.4 Synthesis of KP-LULUCF activities being key category as reported by EU MS and Iceland (from table NIR-3) in 2019 submissions. "KC" indicates a key category.

Member State	Art. 3.3 activities		Art. 3.4 activities				
	AR	D	FM	CM	GM	RV	WDR
Austria	KC	KC	KC				
Belgium	KC	KC	KC				
Bulgaria	KC	KC	KC				
Croatia	KC	KC	KC				
Cyprus	KC	KC	KC				

Member State	Art. 3.3 activities		Art. 3.4 activities				
	AR	D	FM	CM	GM	RV	WDR
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			KC				
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		
Iceland	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) net emissions and removals, and (ii) accounted quantities, for individual MS and Iceland for each of the KP activities; and the sum for total EU and total EU plus Iceland, when relevant.

The total net accounted amount at EU level, as reported so far for CP2 by EU MS in the accounting tables is: -1,123,743.04 CO_2eq. With the addition of Iceland the total net accounting results in a net sink of -1,125,996.74 kt 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 MS,

Emissions from deforestation offset about 75% 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 EU and Iceland.

Tables 11.5 Net emissions and removals (kt CO_2eq.) from KP-LULUCF activities for the period 2013-2017, as reported by EU MS and Iceland. Based on MS CRF accounting tables

MS	Net emissions (+) and removals (-), kt CO_2eq														
	Art 3.3 activities										Art. 3.4 activities				
	A.1 AR					A.2 D					B.1 FM				
	2013	**2014**	**2015**	**2016**	**2017**	**2013**	**2014**	**2015**	**2016**	**2017**	**2013**	**2014**	**2015**	**2016**	**2017**
AUT	-2017.59	-2031.51	-2065.31	-2098.52	-2142.02	536.48	524.77	518.33	511.89	505.45	-3480.36	-3672.14	-3517.85	-3365.90	-3863.98
BEL	-315.42	-348.27	-380.80	-413.02	-444.92	1006.19	1026.05	1045.98	1065.56	1084.40	-1275.79	-1264.68	-1307.00	-1316.40	-1313.41
BGR	-1289.99	-1448.09	-1590.46	-1744.30	-1899.88	140.22	66.39	176.69	150.54	160.84	-7285.78	-7211.77	-7184.56	-7348.32	-7049.27
HRV	-88.52	-97.35	-136.05	-235.24	-186.69	44.84	23.67	58.59	23.72	17.70	-7070.99	-6967.67	-6310.85	-6288.76	-5536.30
CYP	-37.75	-42.98	-41.64	-36.56	-37.12	0.82	0.70	0.58	0.47	0.37	-144.59	-145.63	-141.22	-22.62	-133.01
CZE	-634.49	-699.95	-746.09	-793.13	-851.82	290.49	287.41	233.76	274.25	300.77	-5619.53	-5514.35	-4586.33	-4387.43	-1725.05
DNM	8.56	-341.86	-620.66	27.58	-600.50	38.51	116.33	252.32	147.38	23.67	-2546.39	-3774.33	667.52	677.72	337.49
EST	-134.21	-149.73	-164.19	-168.47	-179.69	356.32	325.03	315.94	298.59	244.90	-3111.44	-3318.56	-3850.89	-4019.02	-3089.98
FIN	-271.96	-555.64	-98.37	-514.03	-254.81	3954.07	3610.97	3182.85	3051.64	2922.99	-48130.32	-47010.64	-42679.90	-38776.25	-39316.50
FRA	-9664.00	-9651.53	-10142.84	-10450.66	-10726.10	12022.79	11980.03	12027.10	12075.83	12045.37	-55435.50	-48069.79	-50633.90	-47977.98	-45875.94
DEU	-6230.29	-6451.30	-6688.59	-6918.32	-7159.53	2035.72	2064.05	2094.69	2124.11	2149.07	-54367.62	-54913.99	-54648.74	-54454.26	-55694.91
GRC	-135.85	-146.89	-124.41	-138.41	-80.13	47.33	47.28	44.90	56.17	52.39	-1964.66	-1964.66	-1953.56	-1922.38	-1952.18
HUN	-1248.27	-1087.11	-1241.08	-1189.01	-1281.56	122.45	150.67	218.24	288.24	294.68	-2260.91	-3384.99	-4347.19	-3070.24	-4320.84
IRL	-3812.44	-4095.04	-4142.92	-4094.14	-3718.46	1065.06	261.00	1346.10	361.97	283.02	-1195.48	-919.48	-1158.86	-1291.61	-918.88
ITA	-7841.80	-8383.66	-8854.38	-8394.44	-5244.94	2011.72	2022.73	2033.48	2043.66	1942.97	-30169.88	-31129.58	-32509.02	-29302.03	-14118.04
LVA	-132.38	-142.89	-152.94	-163.21	-171.41	339.18	345.69	351.84	358.18	363.97	-6481.98	-743.74	-2566.87	-3673.79	-4612.60

MS	Net emissions (+) and removals (-), kt CO_2eq														
	Art 3.3 activities										Art. 3.4 activities				
	A.1 AR					A.2 D					B.1 FM				
	2013	**2014**	**2015**	**2016**	**2017**	**2013**	**2014**	**2015**	**2016**	**2017**	**2013**	**2014**	**2015**	**2016**	**2017**
LTU	-333.89	-364.10	-406.80	-464.19	-407.89	205.99	263.37	25.55	50.46	23.90	-8993.37	-8032.74	-5018.92	-6734.28	-6343.91
LUX	-179.37	-176.28	-173.19	-170.10	-167.01	46.90	44.68	42.46	40.24	38.02	-399.18	-317.89	-261.49	-350.97	-240.99
MLT	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NE,NO	NE,NO	NE,NO	NO,NE	NO,NE
NLD	-600.27	-601.01	-601.05	-600.61	-602.07	1110.50	1150.57	1192.13	1233.63	1302.62	-1069.97	-1070.07	-1039.86	-1054.17	-990.04
POL	-2841.87	-2815.78	-2852.32	-2832.82	-3011.07	203.44	316.52	301.20	5522.36	448.65	-42827.82	-35591.68	-31762.84	-37960.95	-37839.29
PRT	-3414.76	-3600.81	-3392.46	-2441.65	-596.79	2124.72	2100.53	2075.63	2066.64	2068.01	-7364.70	-8964.12	-7898.57	-2104.25	7828.78
ROU	-511.81	-521.62	-529.65	-535.84	-543.89	8076.74	8076.74	8076.74	8076.74	8076.74	-75536.03	-80922.58	-85072.81	-90772.92	-88646.68
SVK	-443.28	-462.92	-497.16	-523.25	-543.92	43.35	62.69	61.19	28.65	57.20	-6546.02	-4601.01	-5153.27	-4974.48	-4892.02
SVN	NA	NA	NO,NA	NO,NA	NO,NA	234.58	234.79	235.38	236.50	238.09	-5167.08	-4081.05	-2936.30	-1512.37	-724.79
ESP	-8172.47	-7875.09	-7260.39	-6679.89	-6146.76	640.87	638.13	634.85	633.65	633.12	-28226.95	-29074.22	-29871.64	-29449.56	-29930.43
SWE	-1246.78	-1310.24	-1344.17	-1408.06	-1470.07	2684.90	2703.57	2842.18	1875.89	1483.76	-46226.86	-47729.15	-48152.68	-49924.45	-49168.64
UK	-1208.95	-1485.40	-1817.48	-2138.66	-2440.76	1212.44	1325.05	1249.48	1610.47	1439.05	-19097.08	-18660.53	-18247.14	-17985.44	-17478.27
EU	**-52799.89**	**-54887.05**	**-56065.41**	**-55118.93**	**-50909.79**	**40596.62**	**39769.40**	**40638.18**	**44207.42**	**38201.72**	**-471996.29**	**-459051.03**	**-452144.73**	**-449363.10**	**-417609.66**
ISL	-185.45	-206.28	-227.43	-232.85	-258.85	0.16	0.11	0.65	0.27	0.46	-79.83	-83.02	-86.76	-91.68	-86.78
EU+ISL	**-52985.34**	**-55093.33**	**-56292.84**	**-55351.79**	**-51168.64**	**40596.78**	**39769.51**	**40638.83**	**44207.69**	**38202.18**	**-472076.12**	**-459134.05**	**-452231.49**	**-449454.77**	**-417696.43**

MS	Net emissions (+) and removals (-), kt CO_2eq					
	Art. 3.4 activities					
	B.2 CM					
	1990	**2013**	**2014**	**2015**	**2016**	**2017**
DNM	4470.10	2043.95	3152.12	2608.81	2854.47	2429.18
DEU	12668.64	14657.92	14452.56	14656.53	14875.24	14797.01
IRL	-5.44	-27.66	-84.39	-93.85	-132.94	-80.59
ITA	-119.52	396.99	336.54	349.69	-847.89	-787.93
PRT	3352.41	347.02	358.35	356.34	356.27	400.68
ESP	-95.02	1657.86	65.92	-2130.73	-2757.60	-3016.73
UK	14401.10	13025.57	12818.23	12773.90	12656.12	12589.48
EU	**34672.25**	**32101.64**	**31099.33**	**28520.69**	**27003.66**	**26331.11**

MS	Net emissions (+) and removals (-), kt CO_2eq					
	Art. 3.4 activities					
	B.3 GM					
	1990	**2013**	**2014**	**2015**	**2016**	**2017**
DNM	1000.51	844.01	954.02	783.29	789.24	775.17
DEU	25771.82	22365.06	22316.58	22159.22	22043.31	21953.52
IRL	6843.22	6448.84	6411.75	6445.64	6422.22	6657.61
ITA	-5.13	-133.98	-30.61	-33.75	-156.82	-61.77
PRT	1442.74	43.32	22.55	-39.59	-100.62	-146.88
UK	-6768.73	-5558.15	-5603.80	-5675.97	-5724.53	-5789.73
EU	**28284.43**	**24009.09**	**24070.49**	**23638.85**	**23272.79**	**23387.93**

MS	Net emissions (+) and removals (-), kt CO_2eq					
	Art. 3.4 activities					
	B.3 RV					
	1990	**2013**	**2014**	**2015**	**2016**	**2017**
ROU	-1698.59	-1211.36	-1222.00	-1254.60	-1297.36	-1330.60
ISL	-347.70	-547.52	-556.98	-567.34	-575.53	-592.84
EU+ISL	**-2046.30**	**-1758.88**	**-1778.98**	**-1821.94**	**-1872.88**	**-1923.44**

MS	Net emissions (+) and removals (-), kt CO_2eq
	Art. 3.4 activities
	B.3 WDR

	1990	2013	2014	2015	2016	2017
United Kingdom	NE	NE	NE	NE	NE	NE
EU	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

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 2013-2017 of KP-LULUCF activities as reported by EU MS and Iceland (Kt CO_2eq), based on 2019 MS and Iceland CRF accounting tables*

Member State	Accounting quantity							
	Article 3.3		Article 3.4					MS accounting amount on LULUCF activities (RMUs)
	AR	D	FM	CM	GM	RV	WDR	
Austria	-10354.95	2596.92	-14435.23					-22193.27
Belgium	-1902.44	5228.19	-3752.28					-426.54
Bulgaria	-7972.72	694.68	3670.31					-3607.74
Croatia	-743.86	168.51	-5253.73					-5829.08
Cyprus	-196.05	2.94	197.92					4.81
Czech Republic	-3725.49	1386.68	1597.32					-741.48
Denmark	-1526.89	578.20	-6269.90	-9261.95	-856.83			-17337.36
Estonia	-796.29	1540.77	-3684.87					-2940.39
Finland	-1694.81	16722.52	-58888.60					-43860.89
France	-50635.12	60151.12	-19918.10					-10402.10
Germany	-33448.02	10467.64	-188329.51	10096.04	-18021.39			-219235.24
Greece	-625.69	248.07	-1659.44					-2037.06
Hungary	-6047.02	1074.27	-12180.56					-17153.31
Ireland	-19862.99	3317.14	-106.35	-392.22	-1830.03			-18874.46
Italy	-38719.23	10054.56	-17998.24	45.01	-391.30			-47009.19
Latvia	-762.83	1758.87	4914.05					5910.09
Lithuania	-1976.87	569.27	-7753.23					-9160.83
Luxembourg	-865.95	212.30	-388.92					-1042.57
Malta	NO	NO	0.00					0.00
Netherlands	-3005.00	5989.46	1900.90					4885.36
Poland	-14353.86	6792.16	-50317.58					-57879.28
Portugal	-13446.47	10435.52	-656.80	-14943.37	-7434.94			-26046.05
Romania**	-2642.81	40383.72	-499916.02			2177.04		-459998.07
Slovakia	-2470.53	253.08	-14926.81					-17144.26
Slovenia	NO,NA	1179.34	1433.40					2612.74
Spain	-36134.60	3180.62	-31052.80	-5706.16				-69712.94
Sweden	-6779.32	11590.29	-81220.96					-76410.00
United Kingdom	-9091.25	6836.49	-3208.46	-8142.20	5491.47		NE	-8113.94
EU	**-269781.08**	**203413.35**	**-1008204.49**	**-28304.84**	**-23043.01**	**2177.04**	**NE**	**-1123743.04**
Iceland	-1110.86	1.64	-42.81	NA	NO,NA	-1101.68		-2253.71
EU + Iceland	**-270891.94**	**203414.99**	**-1008247.31**	**-28304.84**	**-23043.01**	**1075.37**	**NE**	**-1125996.74**

**any information on EU KP-LULUCF activities presented here is shown for information purpose only.*
*** The FM accounting quantity of Romania is not correct, therefore the sum at EU level in this table does not represent the proper sum of the quantities. The high value reported by Romania is an artifact that results from the inclusion in its CRF Accounting table of a FMRL value with a positive sign. Romania has been informed on the need to report the FMRL value inscribed on the decision 2/CMP7 twice during the QA/QC checks of this year, implemented as an essential step of the compilation of this inventory, however Romania has not corrected the inventory on time. See Section 6.5.2.2 for more details.*
To know the real value of the FM Accounting quantity at EU level, the readers are suggested to check the EU CRF Accounting table where a correct FMRL value for Romania and the EU is included, therefore resulting in the correct FM accounting quantity at EU level.

11.1.6 Definition of forest and any other criteria

The threshold values applied to define "forest" under the KP by EU MS and Iceland are summarized in Table 11.7.

With few exceptions, threshold values and definitions applied for reporting forest areas under the KP are identical to those used to report forest area under the Convention. An exception is Finland that 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.

Member State	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 MS provided explicit definitions on what is considered as natural forests. The vast majority of MS reported that conversions of natural to planted forests do not take place in their territories, based on the fact that (i) all natural forests are under strict protection (e.g. Czech Republic), or mainly, because (ii) there are no natural forests within the MS.

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 of trees, 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-LULUCF 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 MS considered all national pre-1990 forest area to be subject to management and, therefore, associated to FM activity. Only in few cases, MS 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 MS 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, MS 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, MS 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, all EU MS and Iceland 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 of MS and Iceland 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, MS and Iceland 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 MS, 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 none 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 to check the consistency of the reported areas for land categories and KP activities across the time series.

Annual areas for KP activities are estimated by MS 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 combine also 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 MS and Iceland, 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 and Iceland

Member State	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 (especially to derive 1990), so most MS 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)

Member State	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 MS. 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 individual MS. 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 MS 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 MS 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 MS, however some differences on which notation key have to be used when the “not a source” provision is implemented, still remain across MS .

Table 11.10 Implied carbon stock change factors (tC ha^{-1}yr^{-1}) by pool reported under AR activity by EU MS and Iceland (for the year 2017), based on KP CRF tables.

AR						
Member State	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Austria	0.97	0.26	0.79	0.02	0.46	NO,NA
Belgium	1.57	0.29	NO,NA	NO,NA	0.89	NO,NA
Bulgaria	2.67	NO,IE	0.22	NO,NE	-0.97	NO
Croatia	0.73	0.24	0.22	0.02	-0.25	NO,NA
Cyprus	0.62	0.17	0.28	NO	0.01	NO
Czech Republic	2.05	0.45	0.47	0.03	0.72	NO
Denmark	1.03	0.25	0.32	0.00	0.11	-1.30
Estonia	0.88	0.37	0.30	0.00	-0.72	-0.34
Finland	0.63	0.21	IE,NA	IE,NA	0.09	-1.18
France	1.14	0.47	0.14	0.03	0.09	NO,IE

AR						
Member State	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Germany	2.87	0.53	0.47	0.03	-0.19	-2.24
Greece	0.54	0.10	NE,NA	NE,NA	NE,NA	NA
Hungary	1.58	0.40	NE,NA	0.07	NE,NA	NO,NA
Ireland	1.89	0.35	0.46	0.64	0.10	-0.74
Italy	0.53	0.10	0.01	0.01	0.12	NO,NA
Latvia	0.37	0.09	0.08	0.09	NA	-0.52
Lithuania	1.24	-0.14	0.09	NO,NA	0.40	3.81
Luxembourg	3.37	0.68	0.36	0.11	0.58	NO
Malta	NO	NO	NO	NO	NO	NO
Netherlands	3.08	0.43	NO,NE	0.10	0.01	-1.14
Poland	0.81	0.22	NO	NO	0.05	-0.68
Portugal	0.78	0.05	0.05	NO,IE	0.21	NO
Romania	2.79	NO,IE	0.06	NO,IE	1.31	NO,IE
Slovakia	1.25	0.28	0.42	NO,NA	1.21	NO,NA
Slovenia	NA	NA	NA	NA	NA	NA
Spain	0.94	IE,NA	0.08	0.03	0.32	NO,NA
Sweden	0.80	0.26	0.22	0.03	-0.06	-2.10
United Kingdom	1.35	0.45	0.04	0.11	-0.67	-0.95
Iceland	0.81	0.20	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 MS for more clarification.

Under Deforestation, there is a rather full reporting of carbon pools (Table 11.11). A particular case is given by Germany that reports a sink in mineral soils associated with conversions of cropland to grassland, in previously deforested lands. Estimations are based on country-specific data. Or Malta that did not report areas of Deforestation.

Moreover, some MS used also 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, Romania and Croatia.

Furthermore, also the notation key "NO" is 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 is also valid for other similar tables.*

Table 11.11 Implied carbon stock change factors (tC ha-1yr-1) by pool reported under D activity in EU MS and Iceland (for the year 2017), based on KP CRF tables.

D						
Member State	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Austria	-0.64	-0.16	-0.50	0.00	-0.43	NO,NA
Belgium	-4.35	-0.90	-0.44	-0.11	-1.61	NO,NA
Bulgaria	-4.47	NO,IE	-0.48	-0.27	-2.62	NO
Croatia	0.80	-0.02	-0.01	-0.01	-1.62	NO,NA
Cyprus	0.16	0.05	-0.16	NO	-0.28	NO
Czech Republic	-2.69	-0.58	-0.35	-0.08	-0.74	NO,NA
Denmark	-0.04	-0.01	-0.02	0.00	-0.08	-5.47
Estonia	-1.12	-0.26	-0.71	-0.06	-1.00	-1.85
Finland	-0.43	-0.13	IE,NA	-0.01	-0.29	-4.84
France	-1.42	-0.39	-0.16	-0.05	-0.60	NO,IE
Germany	-0.94	-0.11	-0.48	-0.05	0.09	-5.86
Greece	-0.32	-0.13	-0.15	-0.01	-1.80	NO,NA
Hungary	-2.22	-0.56	-0.91	-0.32	-0.79	NO
Ireland	-0.31	-0.06	-0.03	-0.02	-0.29	-0.96
Italy	-2.79	-0.59	-0.18	-0.09	-4.93	NO,NA
Latvia	-0.11	-0.02	-0.11	-0.15	-0.16	-4.46
Lithuania	-0.62	-0.17	-0.42	-0.10	-1.30	-1.30
Luxembourg	-0.63	-0.15	-0.13	-0.04	-0.71	NO,NA
Malta	NO	NO	NO	NO	NO	NO
Netherlands	-2.98	-0.39	-1.12	-0.08	0.09	-2.54
Poland	-1.83	-0.37	0.00	-0.05	-1.49	NO
Portugal	-0.28	-0.04	-0.05	IE	-1.01	NO
Romania	-3.44	IE,NA	-0.29	IE,NA	-1.44	NO,NA
Slovakia	-1.30	-0.28	-0.12	-0.07	-0.02	NO,NA
Slovenia	-0.95	-0.12	-0.13	-0.07	-1.09	NA
Spain	-1.03	IE,NA	-0.07	-0.03	-0.26	NO,NA
Sweden	-0.13	-0.05	-0.41	0.00	-0.60	-1.90
United Kingdom	-2.05	NO,IE,NA	-0.07	IE,NA	-2.14	NO,IE,NA
Iceland	NO,IE,NA	NO,IE,NA	NO,IE,NA	NO,IE,NA	-0.62	-7.87

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.

In addition, as reported in Malta's NIR, removals and emissions from FM were not estimated 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.

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 use 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 C stock changes are insignificant. Furthermore, considering that agricultural practices within the European Union policies are increasingly sustainable and climate-friendly 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.

Moreover, as regard with SOC in mineral and DOM soils under CM, Italy has also argued that mineral soils does not result in a source of emissions under CM. A detailed justification for the implementation of the "not a source" provision is included in its NIR.

With regards to WDR, the UK informed to be implementing a program to develop the corresponding quantitative estimates based on then 2013 IPCC KP Wetland supplement that will be submitted in the next years.

Table 11.12. Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under FM activity in EU MS and Iceland (for the year 2017), based on MS CRF tables.

FM						
Member State	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Austria	0.26	0.03	NO,NE,IE,NA	0.06	-0.19	NO,NA
Belgium	0.38	0.06	NO,NA	NO,NA	NO,NA	NO,NA
Bulgaria	0.47	NO,IE	NO	NO	NO	NO
Croatia	0.12	0.12	NE,NA	NE,NA	NE,NA	NO,NA
Cyprus	0.23	0.06	NO	0.00	NO	NO
Czech Republic	0.09	0.02	NO,IE	NO	NO,NE	NO
Denmark	-0.60	-0.06	0.64	-0.15	NO,NA	-1.30
Estonia	0.12	IE,NA	NA,NE	0.01	0.20	-0.16
Finland	0.26	0.04	IE,NA	IE,NA	0.17	-0.19
France	0.42	0.16	0.00	-0.03	NO,IE	IE
Germany	0.90	0.13	-0.01	-0.05	0.41	-2.24
Greece	0.33	0.12	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NA
Hungary	0.42	0.10	NE,NA	NE,NA	NE,NA	-2.60
Ireland	0.69	0.09	0.08	-0.07	-0.04	-0.45
Italy	0.46	0.09	0.00	0.00	NO,NE,NA	NO,NA
Latvia	0.26	0.06	0.00	0.06	NO,NA	-0.52

FM						
Member State	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Lithuania	0.78	0.18	0.01	-0.03	NO,NA	-1.46
Luxembourg	0.62	0.14	0.00	0.00	0.00	NO
Malta	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO
Netherlands	0.85	0.15	NO	0.06	NO	-1.03
Poland	0.77	0.20	NO,NA	NO,NA	0.10	-0.68
Portugal	0.15	0.12	0.00	NO,IE	-0.01	NO
Romania	3.39	NO,IE,NA	0.00	NO,NA	0.09	-0.68
Slovakia	0.44	0.09	NO,NA	NO,NA	NO,NA	NO,NA
Slovenia	-0.01	0.01	NO,NA	0.17	NO,NA	NO,NA
Spain	0.54	NO,IE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NA
Sweden	0.27	0.09	-0.11	0.07	0.19	-0.32
United Kingdom	0.49	0.16	0.02	0.32	0.42	1.00
Iceland	0.19	0.05	0.01	NO,IE,NA	0.01	-0.37

Table 11.13 Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under CM activity in EU MS (for the year 2017), based on MS CRF tables.

CM						
Member State	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Denmark	-0.006	-0.006	NO	NO	0.066	-8.829
Germany	0.003	-0.005	IE,NA	NO,IE,NA	-0.054	-7.411
Ireland	0.002	IE	NO	NO	0.027	NO
Italy	-0.001	NO,IE	NE	NE	NE	10.000
Portugal	0.014	-0.003	-0.001	IE	-0.042	NO
Spain	0.027	IE	0.000	NO	0.015	NO
United Kingdom	0.012	NE,IE	NE	NE	-0.548	-5.001

Table 11.14 Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under GM activity in EU MS (for the year 2017), based on MS CRF tables.

GM						
Member State	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Denmark	-0.1392	0.0289	NO	NO	-0.0047	-6.9062
Germany	-0.0081	0.0035	IE,NA	NO,IE,NA	0.0810	-6.3435
Ireland	-0.0003	NO,IE	NO	NO	0.1331	-6.5791
Italy	NO	NO	NE	NE	0.0310	NO
Portugal	-0.0103	-0.0082	0.0005	IE	0.1150	NO
United Kingdom	-0.0109	NE,IE	NE	NE	0.1393	-0.0371

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 2017), based on MS CRF tables.

RV						
Member State	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Romania	3.16	IE	0.01	NO	0.25	NO
Iceland	0.06	IE	IE	NO,IE	0.51	NA

Table 11.16 Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under WDR activity in EU MS and Iceland (for the year 2017), based on MS CRF tables.

WDR						
Member State	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
United Kingdom	NE	NE	NE	NE	NE	NE

Information used to estimate direct and indirect N_2O emissions from N fertilization (4(KP-II)1)

Only few MS report fertilization of mature forests (e.g. Sweden) or young plantations (e.g. UK). For the majority of MS and Iceland, 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 MS 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 MS 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 MS 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 JRC, and MS and Iceland 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, MS 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 MS and Iceland concerned. Table 11.17 summarized the demonstrations provided by the individual inventories when a carbon pool was omitted.

Table 11.17 Overview of information provided by MS and Iceland to demonstrate that omitted carbon pools are not a net source of emissions.

Member State	Activity	Carbon pool	Reasoning
Belgium	AR, FM	DW, LT	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 a very 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

Member State	Activity	Carbon pool	Reasoning
			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	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.
Croatia	FM	DW, LT, SOC	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	DW, LT, SOC	A justification is provided for for omitting the soil carbon pool and inherently the litter carbon pool from the reporting under FM activity. 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, CM, GM	DW, LT, SOC	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

Member State	Activity	Carbon pool	Reasoning
			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.
Germany	CM, GM	DW, LT	Dead wood and litter do not occur in connection with cropland management and grassland management
Greece	AR, FM	DW, LT, SOC	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. Quantitaive demostration is also provided in the NIR.
Hungary	AR, FM	SOC, DW, LT	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, GM	DW, LT	Based on the decision tree in Section 2.9.4.1 of the 2013 KP Supplement to the 2006 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, CM, GM	SOC, DW, LT	Italy has decided not to account for the soil carbon stock changes from activities under Article 3.4, providing transparent and verifiable information to demonstrate that soils pool is not a source in Italy.
Latvia	AR, FM	SOC	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, FM	DW, SOC	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

Member State	Activity	Carbon pool	Reasoning
			decay in one year. For estimation of carbon stock change of dead wood it was assumed to be zero and reported as 'NO'.
Malta	FM	LB, DW, LT, SOC	Considered in equilibrium following a recommendation of its ERT during the in country review.
Netherlands	AR, FM	LT, SOC	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 take into account 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, FM	DW, LT	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 in 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	RV, FM	DW, LT, SOC	DW reported as not occurring or it is considered as a very small sink in AR and RV since initial mass is null, then it could only increase in time, or in any case it cannot decrease. Under FM, Quantitative and qualitative arguments are involved to demonstrate that SOC, DW and LT are not sources of emissions over commitment period.
Slovakia	AR, FM	DW, LT, SOC	It can be demonstrates 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 were obtained from comparison of carbon stocks in litter. The litter C stock in 2006 were even found slightly higher compared the first evaluation (1993).
Slovenia	FM	LT, SOC	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

Member State	Activity	Carbon pool	Reasoning
			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, CM	LT,DW, SOC.	It is assumed that the pool are not a net source in line with the IPCC Tier 1 assumption. The carbon stock in this pool increased since the base year therefore it would result in a sink, however the quantity of this sink is not yet estimated.
United Kingdom	CM, GM, WDR	LB, DOM, SOC	The UK has elected three additional Article 3.4 activities: Cropland Management, Grazing Land Management and Wetland Drainage and Rewetting. We are not yet in a position to report emissions and removals from all of these activities and the relevant tables are filled in with the notation key NE. The UK is putting in place a research and methodological development programme for these activities to enable full reporting by the end of the commitment period.
Iceland	AR,	DW	Harvest Wood Products are not estimated in this year submission. Data on domestic wood utilization and production of wood products from domestic wood are not official data and the official statistical agency in Iceland (Statistics Iceland) has fragmented, unverified and incomplete reporting of these data

For a consistent demonstration of 'not a source', MS 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)

Member State	Overview of reasons for recalculations
Austria	The HWP production figures for 2016 were updated in the most recent FAO statistics. Consequently, the removal figures for this year had to be updated accordingly and led to a change in the annual removals of forest management for the year 2016 by –96 kt CO_2e per year and minor changes in the related HWPs from AR.
Belgium	Soil organic carbon in Forest land remaining Forest land is now assumed stable (no change in SOC, following IPCC Tier 1 approach), taking into account the 2018 review findings and the latest results from studies. Wallonia: Update of solid wood volumes in the regional forest inventory, update of the central year of the current inventory cycle (2012 instead of 2011) and revision of biomass expansion factors, according to new methodology that takes into account diameter and height. These methodological improvement bring a decrease of the annual sink in Wallonia.
Bulgaria	Recalculations reflects the changes made in estimation of the average biomass growth of stands from first and second age classes as the expansion and conversion factors have been recalculated. The losses of biomass and dead wood due to deforestation have been recalculated as a technical error in its previous estimations have been found. N_2O Emissions from N mineralization associated with a loss of soil organic matter have been estimated and reported.
Croatia	Information on recalculation as compared to the submission 2018 has not been provided.
Cyprus	Information on recalculation as compared to the submission 2018 has not been provided.
Czech Republic	Following a number of recommendation from the Expert Review Team a number of recalculations have been implemented affecting the estimation of the carbon pool.
Denmark	Minor recalculations have been made due to updates in NFI. Also minor changes in the Land Use Matrix have occurred.
Estonia	Areas subject to Afforestation/reforestation, Deforestation and Forest management are annually updated by the NFI, new data is integrated into overall activity data.
Finland	The areas of Article 3.3 activities and Forest Management were recalculated. For the forest management tree growth a recalculation was applied due to new NFI data. Previously daily weather data was used in Yasso07 modelling for FM and AR, whereas in this submission monthly weather data was used. For drained organic FM soils, the EF for N_2O emissions was corrected, it was found being erroneous due to instrument malfunction. Biomass removal estimates on afforestation were recalculated due to new NFI data. For harvested wood products, small updates in the FAOSTAT production data caused a minor recalculation for the year 2016. Emissions from biomass burning were recalculated due to implementation of 2006 IPCC Guidelinesinstead of previous GPG 2003 guidance and also due to recalculated activity data.
France	The outcome changes for the UNFCCC logically and directly impact the results in Kyoto format. As a reminder, the main improvements are Consideration of the latest available results from the National Forest Inventory, which updates biomass growth and mortality and Modification of the extrapolation of forest growth and mortality parameters for recent years, Modification of N_2O emissions related to soil mineralization when conversions result in soil carbon loss.
Germany	NO recalculation were made in the current submission.
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 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	This year, as mentioned before, we completed the methodology by adding the estimation of carbon stock changes in the deadwood pool on AR land, and by also adding estimates of indirect N_2O emissions from mineral soils due to leaching/runoff. We also corrected an error for 2015 for carbon stock changes in the HWP pool
Ireland	Recalculations for the Article 3.3. ARD and 3.4 FM (CRF 4(KP) are due to the Use of the CBM model, which replaced CARBWARE for the first time in the 2019 submission. Mineral SOC CSCs are estimated for the first time using the CBM model. Pervious submissions assumed the tier 1 steady state transition. There was an adjustment to the soil/land use category matrix for AR lands, which reassigned crop land conversions to forestry to grassland conversions to forestry. This is because most cropland continuously transition between cropland and grassland and previous area estimated to be cropland before afforestation are pastures. Estimation of CSC in deforested grasslands mineral soils using the new tier 2 SOCref and Flu factors for mineral SOC; Calculation of N_2O emission due to mineralization associated with land use change from forests to grass lands using the new SOC estimates). Recalculation of biomass, DOM and organic soil estimates for 2013-2016 using the latest NFI 2017 data

Member State	Overview of reasons for recalculations
Italy	Comprehensive comparison of 2019 and 2018 submissions has been carried out; in Table 9.8 a summary related to the ARD and FM activities is reported. With reference to the ARD activities, the 2019 submission results in a slight deviation for the Afforestation/Reforestation activities (average increase of 0.29%), due to the update of the 2016 activity data, and no deviations for Deforestation activities, respect the previous estimates. An average increase of 0.37% results by the comparison of the last two submissions for FM activities, due to the update of the 2016 activity data.
Latvia	Since research data are available, historical figures on mortality are recalculated and provided in the inventory considering 20 years decay period for dead biomass, respectively; calculations are done for the period 1970-2017.
Lithuania	Recalculation of area represented by single sampling plot and thus had an impact to the total area of Forest management.
Luxembourg	No recalculations have occurred in the KP-LULUCF inventory since submission 2017. The changes mentioned in section 7.11 have no repercussions on the calculations under KP rules as only the activities afforestation, deforestation and Forest management were selected
Malta	Information on recalculation as compared to the submission 2018 has not been provided.
Netherlands	This year, two methodological changes have been implemented and additionally new data were included in existing methodologies and two errors were corrected, resulting in changes in various carbon stock changes and associated emissions and removals along the whole time series (see Chapter 6.1). These also resulted in recalculations for AR, D and FM. Because the separate changes may interact with each other, the effects of the separate changes cannot be quantified.
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	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	No recalculations were implemented in the current submission
Slovakia	The emissions/removals for ARD activities were recalculated in 2019 submission. The whole time series were recalculated. The main reason for recalculation was the change of carbon fraction of dry matter, for coniferous 0.51 and for broadleaves 0.48, following the ERT recommendation.
Slovenia	Considering ERT revision report and recommendations data and methodologies were internally revised and recalculations were made.
Spain	The results of this edition of the National Inventory modify those of the 1990-2016 series of the LULUCF sector, collected in the previous edition, due to changes in the basic information available or in the methodology applied. As a novelty, for the preparation of this 2019 edition of the National Inventory (1990-2017 series) in the ORACLE database of the National Inventory have been implemented. This implementation has allowed, in some cases, to make estimates at a higher level of disaggregation (provincial, instead of national, for example).
Sweden	The forest management reference level was recalculated to -32.2 Mt CO_2-eq. and the technical correction applied to the original value was estimated to 9.2 Mt CO_2-eq.
UK	Reconciliation of harvest volume and forest age data. Correction of double-counting of dead wood. Adjustment of average biomass densities due to error correction. Changes to the average deforestation rate for soil CSC calculation.
Iceland	Data on area in CF slightly revised. This will lead to revision on area dependent stock changes. Emission/removal factors used are unchanged

11.3.6 Improvement status and plan

During this submission, 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 layout of some tables was changed for a better readability of the information.
- More clear description on whether Malta intends to apply the natural disturbances provision has been added.
- An error found in the reporting of HWP from Deforestation in Hungary was discussed and resolved. Hungary do not have HWP from tress growing in deforested lands.

- Information has been added to better explain how the current reporting of HWP under deforestation is done by Latvia, Romania and Denmark
- Inclusion of information on KC for all the MS, despite of remaining bugs in the CRF Reporter Software, which prevent the inclusion of that information in the CRF table NIR-3 for some MS.
- We have added information on the approach used by Iceland for the implementation of the ND provision.
- Belgium estimated carbon stock changes in HWP for the whole time series, which has resulted in the current reporting of this carbon pool in KP.
- More information on HWP originating from Deforestation events is now provided in the CRF tables (i.e. information item) of the MS for which this source of HWP is relevant.

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 the remaining inconsistencies reported by individual inventories.
- To continue enhancing the information on how HWP under deforestation is implemented in Latvia.
- To continue working with MS to ensure the completeness of the inventory, in particular with Cyprus and Malta for the mandatory KP activities, and with UK in order to provide quantitative estimates for the KP activities including WDR.
- To continue supporting MS 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 Romani to ensure that the FMRL value that is reported in its CRF table matches the Values of the appendix to the Dec 2.CMP/7.
- To continue working with MS towards the harmonization on the use of the notation keys.

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.

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 ensure 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 and Iceland aimed at demonstrating that Afforestation/Reforestation activities are direct human-induced.

Member State	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 MS, so that around 90% of the total area reported under conversion to forest land is assumed as directly human-induced AR. However, some MS 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 MS 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 MS 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 MS and Iceland in their GHG inventories.

Member State	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 photo-interpretation 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 a 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.

Member State	Short description
Finland	When a clear-cut area is located in a 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. 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 taken into account by classifying the sample plot as non-forest.
France	The method used to monitoring 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 doesn't 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 during 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.

Member State	Short description
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 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 are 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; 14 MS 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, MS 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 MS and Iceland 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 MS 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 MS intend to exclude emissions only from areas affected by windstorms, while some others considered all disturbances types as a safeguard measured in case some of these events occur in the future.

Overall, MS 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 MS 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.

MS 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, MS 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 MS 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 MS and Iceland that intend to apply the natural disturbance provision under AR activity during CP2, as reported in individual NIR

Member States	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
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 MS 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 MS 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 MS 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 MS GHG inventories.

Some MS 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 MS 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, MS 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, MS 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 MS report, and account, for emissions and removals from HWP originated from trees growing in lands subject to deforestation. While, some MS 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 5.51 kt CO_2 and Latvia 0.84 kt CO_2. During this year, these MS were requested to provide information on how HWP from Deforestation events (i.e. to be accounted for as instantaneous oxidation) are distinguished from HWP resulting from tress growing in previously deforested lands.

In the case of Denmark, it was explained that 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 time period 1990 – 2017, 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 lands.

Furthermore, Latvia provides information to explain that the trees extracted during the land use change from forest land to other land use categories or deforestation (Kyoto protocol reporting) are subtracted from the total harvest rate and accounted using the instant oxidation approach, but it was not clarified how that 0.84 kt CO_2 reported for HWP reported under Deforestation is estimated.

As with regards to the former reporting of HWP under deforestation by Hungary and Romania, it has been clarified that the former reporting approach was due to an error in the data importing procedure that has now been resolved.

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 enter 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 (as understood by Romania and Iceland), are management activities, they always qualify as direct human-induced. In most of the cases, MS 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 years ago. Currently, each MS 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 MS 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 comparisons 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 inventory compilers has 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 all natural forests are under strict conservation and protection regimes (e.g. Czech Republic) that prevent such conversions.

For the year 2017, only Romania (17, 53 Kha) have provided estimates of such areas in the CRF table NIR 2.1, and, their corresponding estimates of emissions/removals were included under the FM activity.

11.5.2.2 Forest Management Reference Level (FMRL)

For the construction of the FMRL, EU MS 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 the EU, EU MS, and Iceland before the beginning of the CP2; or to the individual GHG inventories.

As regards with approaches used in the construction of the FMRL; 11 MS 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. 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 and Iceland in 2019 submissions.

Member State	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	1954		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	-10939	X		
France	-67410	21795		X	
Germany	-22418	5268	X		
Greece	-1830	210			X
Hungary	-1000	-40		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	NE		X	
Poland	-27133	NA	X		
Portugal	-6830	3261	X		
Romania	-15793	NE		X	
Slovakia	-1084	-1164		X	
Slovenia	-3171	NE	X		
Spain	-23100	NO		X	
Sweden	-41336	9340	X		
UK	-8268	-9384	X		
EU*	-315323	35344			
Iceland	-154	77	X		
EU + Iceland *	-315476.5	35421.4			

**The FMRL value for EU and EU + Iceland is: The value inscribed in the Appendix to the annex to decision 2/CMP.7 for EU27 applying FOD function for HWP for those MS for which this value is available in the decision, plus the values applying instantaneous oxidation inscribed for: Croatia, Iceland (when relevant), plus values applying instantaneous oxidation for those MS for which a FMRL value applying FOD function for HWP was not available.*

It should be noted that the FMRL value inscribed in the decision 2/CMP.7 for the EU corresponds to the 27 MS that were part of the Union at that moment. Such values as inscribed in the appendix of the decision are:

I. -253336 kt CO_2 eq/yr, applying instantaneous oxidation,
II. -306736 kt CO_2 eq/yr, applying first-order decay function for HWP.

Nevertheless, although these values are included here for information purposes. It is important to bear in mind that the accounting quantities for the KP activity FM as reported by MS depend on the FMRL values and their technical corrections (TC). Thus, in order to ensure the consistency among the EU GHG inventory (i.e. as a sum of MS's 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 MS involved in the Union plus Iceland:

I. -315476.5 kt CO_2 eq/yr
II. 35421.4 kt CO_2 eq/yr

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 CRF table 'Accounting" and in the Table 11.6 of this chapter.

However, note that for this year, despite significant efforts implemented by the EU during the QA/QC checks implemented as an essential step of the compilation of this inventory, Romania has included in its submission a FMRL that do correspond with the values applying FOD functions for HWP but with opposite sign. Consequently, for this year a small discrepancy among the accounting quantity for FM as reported for the EU and the sum of accounting quantities for FM as reported by the MS is expected. See footnote in table 11.6 of this chapter for further details.

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, MS 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, 20 MS 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 MS 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. the Netherlands, Spain).

To this regard, the JRC has always encouraged MS 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 did for some 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 MS 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

Member State	Information on the need for TC
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 year's 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 reported 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.
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.

Member State	Information on the need for TC
Finland	IThe 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 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 Programme 2015 (Ministry of Agriculture and Forestry 2008).
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 Guidelinesand 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.
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.

Member State	Information on the need for TC
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.
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 was (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. - 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;

11.5.2.4 Carbon equivalent Forest Conversion

This provision is not relevant for EU MS, nor for its MS, nor for Iceland.

11.5.3 Information related to the natural disturbances provision under article 3(4)

In accordance with decision 2/CMP.7; 19 MS 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 MS and Iceland that intends to apply the natural disturbance provision under FM activities during CP2.

Member States	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 MS 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 MS have reported quantitative information on CRF table 4(KP-I) C. All the other MS 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 MS 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 will account for emissions and removals from the activity WDR. Nevertheless, 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 programme and efforts on methodological development.

Definitions implemented by the MS and Iceland 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 corresponding 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 use 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.

11.6 Other information

11.6.1 Key category analysis for Article 3(3) activities and any elected Article 3(4) activity

MS 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 MS 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 2018 for the EU[76] 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 31.12.2018 as well as information on transfers of the units in 2018 to and from other Parties of the Kyoto Protocol.

The joint assigned amount of the EU, its Member States and Iceland for the second commitment period of the Kyoto Protocol is equal to the percentage inscribed for the Union, its Member States 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.[77] The emission levels define the Member States' 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'[78]. 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[79] and was established upon the completion of the initial review[80]. 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.

[76] The Community registry was replaced by the Union registry in 2012

[77] OJ L 207, 4.8.2015, p. 17

[78] 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.

[79] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52016SC0316&from=en

[80] 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)

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	ES	NO	NO	NO	22.316	NO	NO	NO	NO	NO	174.349	NO	NO
2	GB	NO	NO	NO	5.775.293	NO	NO	NO	NO	NO	405.983	NO	NO
3	DE	NO	NO	NO	3.805.830	NO	NO	NO	NO	NO	283.839	NO	NO
4	LI	NO	NO	NO	NO	NO	NO	NO	NO	NO	28.938	NO	NO
5	CH	NO	NO	NO	8.469.849	NO	NO	NO	NO	NO	4.113.163	NO	NO
6	SE	NO	NO	NO	2.465.927	NO	NO	NO	NO	NO	162.030	NO	NO
7	NL	NO	NO	NO	8.531.061	NO	NO	NO	NO	NO	256.230	NO	NO
8	NO	NO	NO	NO	121.637	NO	NO	NO	NO	NO	109.909	NO	NO
9	FI	NO	NO	NO	58.031	NO	NO	NO	NO	NO	90.271	NO	NO
10	IT	NO	NO	NO	4.789	NO	NO	NO	NO	NO	105.000	NO	NO
11	AU	NO	NO	NO	975.901	NO	NO	NO	NO	NO	1.458.014	NO	NO
12	DK	NO	NO	NO	2.559	NO	NO	NO	NO	NO	952	NO	NO
13	BE	NO	NO	NO	107.616	NO	NO	NO	NO	NO	NO	NO	NO
14	FR	NO	NO	NO	NO	NO	NO	NO	NO	NO	336.000	NO	NO
	Sub-total	NO	NO	NO	30.340.809	NO	NO	NO	NO	NO	7.524.678	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:

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

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

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

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
TOTAL		**0**	**0**	**0**	**162.044.372**

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

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
TOTAL		**0**	**0**	**0**	**49.755.578**

No ERUs, CERS, AAUs or RMUs were transferred to other registries in 2018.

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
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
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
TOTAL	**0**	**0**	**0**	**8.916.731**

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
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[81], 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.

[81] 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)

13 INFORMATION ON CHANGES IN NATIONAL SYSTEM

The European Union 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 2018 inventory submission related to the national system.

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, which includes 28 Member States[82] and Iceland.

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 at the start of the second commitment period. 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 Air Pollution and Climate Change Mitigation (ETC/ACM) as well as the following other Directorates General of the European Commission: Eurostat, and the Joint Research Centre (JRC).

[82] 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 therefore occurred in 2018. Note that the 2018 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	The versions of the EUCR released after 8.0.8 (the production version at the time of the last Chapter 14 submission) introduced minor changes in the structure of the database. These changes were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. The database model is provided in Annex A. 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	Changes introduced since version 8.0.8 of the national registry are listed in Annex B. 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 were successfully 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.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No changes regarding security occurred during the reported period.
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.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	The registry internet address changed during the reported period. The new URL is https://unionregistry.ec.europa.eu/euregistry/EU/index.xhtml
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	Changes introduced since version 8.0.8 of the national registry are listed in Annex B. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission.

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" (European Commission 2015a).

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 (European Commission 2015a, "Better Regulation Toolbox", p. 266):

- 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 (esp. 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 competiveness of exporters in developing countries in terms of intended or unintended trade barriers?
- What are the impacts on 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 FDI) 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 workforce – low-skilled vs. high skilled workforce, wages level, working conditions)?
- What are the impacts on main stakeholders and institutions affected by the proposal?
- 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 ecosystem approach?
- 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 the low carbon technology transfer and its availability in developing countries?
- What is the impact on the 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)[83], the Extractive Industries Transparency Initiative (EITI)[84] or the Kimberley agreement[85]?

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 be 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 Third Biennial Report (European Commission 2017) 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[86]. In addition to the general approach described above to address adverse

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[83] 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

[84] The Extractive Industries Transparency Initiative is a global coalition of governments, companies and civil society working together to improve openness and accountable management of revenues from natural resources. https://eiti.org/eiti.

[85] 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/

[86] http://ec.europa.eu/transparency/regdoc/?language=en

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 for a more complete overview on the ways how the EU is striving to minimize adverse impacts.

Major EU policies such as the Directive (EU) 2018/2001 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.

Directive on the promotion of the use of renewable energy - Promotion of biomass and biofuels

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 EU's Directive on renewable energy sources creates pioneering "sustainability criteria", applicable to all biofuels (biomass used in the transport sector) and bioliquids. The sustainability criteria adopted include:

- establish a threshold for GHG emission reductions that have to be achieved from the use of biofuels;
- exclude the use of biofuels from land with high biodiversity value (primary forest and wooded land, protected areas or highly biodiverse grasslands),
- exclude the use of biofuels from land with high C 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.

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 covers also 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 installation 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).

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[87]. 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.

On 1 February 2017, the European Commission published its regular Renewable Energy Progress Report (European Commission 2017a) under the framework of the 2009 Renewable Energy Directive. The report includes information on the assessment of sustainability of EU biofuels. The 2017 report and its accompanying staff working document (European Commission 2017b) report that the net savings in greenhouse gas emissions resulting from the use of renewable energy in transport of around 35 Mt CO_2-equivalent in 2014. Indirect Land Use Change (ILUC) emissions associated to biofuels consumed in the EU are estimated to be 23 Mt CO_2-equivalent, leaving a net saving of 12 Mt CO_2-equivalent. Recent modelling work of the ILUC impacts of individual biofuel feedstock confirms that ILUC emissions can be much higher for biofuels produced from vegetable oils compared to

[87] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0296&from=EN

biofuels produced from starch or sugar. Advanced biofuels from non-food crops have generally very low or no ILUC emissions. In 2014, around 10% of bioethanol and around 26% of biodiesel consumed in the EU was imported.

The main exporting countries for biodiesel were Malaysia (palm oil), Brazil and the US (Soybean) and for bioethanol Guatemala, Bolivia, Pakistan, Russia, Peru, Ukraine, Canada and Moldova.

Projections for 2020 foresee that the EU biofuel policy could lead to an expansion of 1.8 Mha of cropland in the EU and to 0.6 Mha in the rest of the world, with 0.1 Mha at the expense of forest. Expansion of cropland at global level would occur at the expense of grassland (-1.1 Mha), abandoned land (-0.9 Mha) and other natural vegetation (-0.4 Mha). No significant negative effects from the production of biofuels and bioliquids on biodiversity, water resources, water quality and soil quality were found in the EU. However, indirect land use change can cause biodiversity losses if additional land expansion takes place in sensitive areas, such as forests and highly biodiverse grassland. The EU ethanol consumption had negligible impact on cereal prices given that the EU share in the global ethanol market did not exceed 7%, and the global cereal market is driven mainly by demand for feed. In the future, the strongest biofuel consumption growth is expected in developing countries, while the increased demand for food and feed for a growing and more affluent population is projected to be mostly met through productivity gains, with yield improvements expected to account for about 80% of the increase in crop output. Regarding land use right, the most recent reports on large-scale land deals confirm the finding of the 2015 Commission progress report on renewable energy that only very small share of biofuel projects outside the EU have been developed with the EU market in mind.

The Communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme (European Commission 2010) 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 2019) recognised 17 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), Roundtable on Sustainable Palm Oil RED (RSPO RED), Biograce GHG calculation tool, HVO Renewable Diesel Scheme for Verification of Compliance with the RED sustainability criteria for biofuels, Gafta Trade Assurance Scheme, KZR INIG System, Trade Assurance Scheme for Combinable Crops **and Universal Feed Assurance Scheme, Universal Feed Assurance Scheme, U.S. Soybean Sustainability Assurance Protocol (SSAP)**[88].

[88] https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/voluntary-schemes

The 2030 climate and energy framework

In 2018, the main legislation was adopted to implement the 2030 climate and energy framework which sets three key targets for the year 2030:

- **At least 40% cuts in greenhouse gas emissions by 2030 (from 1990 levels)**
- **At least 32% share for renewable energy**
- **At least 32.5% improvement in energy efficiency**

To achieve the at least 40% target the EU emissions trading system (ETS) sectors will have to cut emissions by 43% (compared to 2005) – to this end, the ETS was reformed and strengthened. The non-ETS sectors will need to cut emissions by 30% (compared to 2005) – this was translated into individual binding targets for Member States. While binding at the EU level, there are no binding renewable targets for Member States individually but the objective is to be fulfilled through clear commitments decided by the Member States themselves. These should be guided by the need to deliver collectively the EU-level target and build upon what each Member State should deliver in relation to their current targets for 2020. While not foreseeing national-level energy targets, the 2030 climate and energy framework makes use of a new governance framework based on national plans for competitive, secure and sustainable energy.

As a part of the proposal for this new legislation, an impact assessment was conducted (European Commission 2014), which gives significant detail on costs and savings achieved on the basis of the proposed policy under different scenarios. All scenarios demonstrate reduced GHG emissions compared to the Reference scenario. All scenarios show reduced energy consumption (both primary and final) compared to the Reference scenario, with more pronounced energy savings and improved energy intensity in scenarios with strong energy efficiency policies, with highest improvements in those scenarios that next to ambitious energy efficiency policies also include a renewables target. Future fuel consumption in the EU will have economic impacts on fuel prices as well as trade effects for fuel exporting countries, therefore the impacts on future fuel use are summarized:

With regard to fuel use, the impact assessment analysed that solid fuel consumption declines substantially under all scenarios until 2030. Also oil consumption decreases in all scenarios, but much faster in those with policies that promote transport electrification. Natural gas absolute consumption also declines in all scenarios (in general less sharply than oil) but slightly more under the scenarios that include renewable targets. By 2050 in all scenarios natural gas becomes the main fossil fuel. Net energy imports decrease significantly – between 4% to 22% below 2010 levels in all scenarios by 2030 and approx. 50% below 2010 levels in most scenarios by 2050.[89]

Regulation for energy efficiency labelling

[89] For a more detailed analysis and explanation on the scenarios, see the Impact Assessment Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A policy framework for climate and energy in the period from 2020 up to 2030, available: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014SC0015

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. By 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[90]. 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 (Waide et al. 2014). 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 unnecessary obstacles, while also providing the right to implement measures to achieve legitimate policy objectives.

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

[90] http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2015/swd_2015_0139_en.pdf

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.” 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 worldwide 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”[91] 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 on 9 April 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 June 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

[91] Official Journal No C 82, 1.4.2008, p.1

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. Based on the ETS Directive (2003/87/EC as amended), the Commission shall compile a list of sectors and sub-sectors deemed exposed to significant risk of carbon leakage. Sectors on the list will 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 will be 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"[92] 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.

[92] http://ec.europa.eu/economy_finance/publications/economic_briefs/2015/pdf/eb40_en.pdf

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, France, Germany, Greece, India, Italy, Japan, Korea, Mexico, 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)". 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 will also promote awareness and champion legal, regulatory, financial, and institutional environments conducive to such technologies. In 2017 a new 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. In 2017 the CSLF held its 7th Ministerial Meeting in Abu Dhabi. The highlight of the meeting was the Ministerial Conference on December 6, which was focused on advancing the business case for carbon capture, utilization, and storage (CCUS). Ministers and designates who attended the conference identified key actions needed to accelerate the large-scale deployment of CCUS. These included the following:

- Working together to ensure that CCUS is broadly accepted and supported as part of the suite of clean energy technologies, along with other low-emission energy solutions.
- Leveraging the success of operational CCUS projects worldwide while emphasizing the urgency of developing and executing new CCUS projects in the future.
- Encouraging the development of regional strategies that strengthen the business case for CCUS and accelerate its deployment.
- Exploring new utilization concepts beyond carbon dioxide (CO_2) enhanced oil recovery (EOR) that have the potential to add commercial value.
- Supporting collaborative research and development (R&D) on innovative, next-generation CCUS technologies with broad application to both the power and industrial sectors.
- Expanding stakeholder engagement and strengthening links with other global clean energy efforts to increase public awareness of the role of CCUS and build momentum.

Increasing global shared learnings on CCUS by disseminating best practices and lessons learned from CCUS projects and strengthening coordination on R&D efforts globally.The portfolio of CSLF-recognized projects, as of October 2016 was 54 projects spread out over five continents, one additional project was added in 2017.

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)[93], in particular in the working sub-group on energy efficiency. As part of the EU's research programme, a project called "EUROGULF" was launched with the objective of analysing 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 Commission has started a project with the specific objective to create and facilitate the operation of an EU-GCC Clean Energy Network. The network is to be set up to act as a catalyst and element of coordination for development of cooperation on clean energy. A website was created[94] where further information on the EU-GCC Clean Energy Network and 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.

In 2016 a background paper on "Areas of potential EU GCC Clean Energy Cooperation" was published (EU-GCC Clean Energy Network II, 2016). As an 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
- Climate change policies

The areas of future cooperation were outlined as

- Networking and Partnership development
- Organisation of experts' events, thematic discussions, seminars, webinars, training sessions and high level conferences
- Operation of Working Groups
- Dissemination of information
- Promotion and facilitation of joint demonstration and pilot projects.

[93] The Gulf Cooperation Council covers Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

[94] http://www.eugcc-cleanergy.net

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 (see here GEEREF and the Mediterranean Solar Plan, MSP).

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. As explained in more detail in the EU's Third Biennial Report (European Commission 2017a) several support programmes exist in this respect. These 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 (9^{th} EDF) only one CfP was launched committing EUR 196 million to supporting projects; under the second EF (10^{th} 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. A specific website for the monitoring of the ACP-EU Energy Facility was created[95]. The present website emphasizes the dissemination of project results. It allows the EU to:

- contribute to the quality in implementation through the dissemination of results, success stories and lessons learned from the Energy Facility projects;
- encourage a community of practice that fosters the exchange of experience between projects.

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.

[95] http://www.energyfacilitymonitoring.eu/

- Promoting equitable and sustainable socio-economic development through the improvement of social services infrastructure and support for small- and medium-sized enterprises (SMEs).

In 2009-2016 the Facility has had at its disposal a total budget of approximately € 323 million, made available under the EU's Development Cooperation Instrument (DCI). Of this amount, LAIF has approved almost € 305 million in grants to projects with a combined investment cost of over € 8 billion.

Caribean 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. The EDF earmarked a minimum of € 40 million in direct funding for CIF for the period 2012-2015. An additional allocation of € 30.2 million was made available from the National Indicative Programme of Guyana in 2013. Since it was officially launched in March 2013, CIF has provided a total contribution of around € 68.6 million to finance nine projects with a total investment cost of over € 541 million.

Global Energy Efficiency and Renewable Energy Fund (GEEREF)

The European Commission has launched an innovative pilot instrument to involve the private sector. The Global Energy Efficiency and Renewable Energy Fund (GEEREF), 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:

In the regions where the funds operate, there is a lack of equity investment available through the market for these types of projects. It is envisaged that GEEREF will invest in regional sub-funds for the African, Caribbean and Pacific region, North Africa, non-EU Eastern Europe, Latin America and Asia. Together the European Commission, Germany and Norway have committed about €112 million to the GEEREF over the period 2009-2013, the majority of which is provided by from the EU budget. Further financing from other public and private sources was fundraised by GEEREF increasing the total funds under management to € 222 million as of May 2015. GEEREF invests in private equity funds which, in turn, invest in private sector projects, thereby further enhancing the leveraging effect of GEEREF's investments. It is estimated that, with € 222 million of funds under management, over €10 billion could be mobilised through the funds in which GEEREF participates and the final projects in which these funds invest.

The EU through the Directorate General Development and Cooperation – EuropeAid also supports African, Caribean and Pacific countries in diversifying their economies; however, these activities are not limited to fossil fuel exporting countries, but are open to ACP countries based on Economic partnership agreements (EPAs). 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. In 2008 the EU signed a comprehensive EPA with 13 CARIFORUM countries. In January 2009, Côte d'Ivoire and Cameroon have signed interim EPAs. Some ACP partners have signed interim economic partnership agreements with the EU as a first step towards comprehensive regional EPAs. The interim agreements secure and improve ACP access to the EU market and provide for more favourable rules of origin. Negotiations are ongoing with the African and Pacific regions to move from interim agreements to comprehensive regional agreements. The negotiations cover regional trade integration, trade in services, investment and trade-related rules. The strategy for private sector development in the ACP recommends the use of horizontal instruments (applicable to all ACP countries) in five priority areas where the Commission has a good experience and comparative advantages:

(1) Improvement of the macroeconomic framework and regulatory environment for enterprise development (Private Sector Enabling Environment Facility of the Business Environment (PSEEF) or BizClim with €20 million for 5 years);

(2) Investment and inter-enterprise co-operation promotion activities (PROINVEST – € 110 million for 7 years);

(3) Facilitation of investment financing and development of financial markets (Investment Facility managed by the European Investment Bank (EIB) as revolving fund;

(4) Support for Small and Medium- sized Enterprises in the form of non-financial services (Centre for the Development of Enterprise (CDE) with € 18 million per year, PROINVEST);

(5) Support for micro-enterprises and micro-finance (ACP-EU Microfinance Framework Programme with € 15 million for 6 years, in collaboration with Consultative Group to Assist the Poor program (CGAP) and investment in debt and equity for banks and microfinance institutions provided by the EIB Investment Facility).

15.3 EU 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 (European Commission 2015b) and the European Council Conclusions of 19-20 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 (Council of the European Union 2015). 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 (European Commission 2015c).

IRENA is the International Renewable Energy Agency that 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 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
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/ACC	European Topic Centre on Air and Climate Change
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
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	
T1a — IPCC Tier 1a				

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**
T1b — IPCC Tier 1b				
T1c — IPCC Tier 1c				
T2 — IPCC Tier 2				
T3 — IPCC Tier 3				