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European Union emission inventory report 1990-2016

under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP)

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European Environment Agency

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Units, abbreviations and acronyms

As	Arsenic
B(a)P	Benzo(a)pyrene
B(b)F	Benzo(b)fluoranthene
BC	Black carbon
B(k)F	Benzo(k)fluoranthene
Cd	Cadmium
CDR	Central Data Repository
CEIP	Centre on Emission Inventories and Projections
CH_4	Methane
LRTAP	Long-range Transboundary Air Pollution; (UNECE) Convention on LRTAP
CO	Carbon monoxide
CO_2	Carbon dioxide
COPERT	COmputer Programme to calculate Emissions from Road Transport
Cr	Chromium
Cu	Copper
DG	Directorate-General
EC	European Commission
EEA	European Environment Agency
EEA-5	Non-EU EEA member countries (Iceland, Liechtenstein, Norway, Switzerland and Turkey)
Eionet	European Environment Information and Observation Network
EMEP	European Monitoring and Evaluation Programme (cooperative programme for monitoring and evaluation of the long-range transmissions of air pollutants in Europe)
EPER	European Pollutant Emission Register
E-PRTR	European Pollutant Release and Transfer Register
ERT	Expert review team

ETC/ACM	European Topic Centre on Air Pollution and Climate Change Mitigation (of the EEA)
ETS	Emissions Trading Scheme
EU	European Union
FGD	Flue gas desulphurisation
Gg	1 gigagram = 10^9 g = 1 kilotonne (kt)
GHG	Greenhouse gas
GNFR	Gridding nomenclature for reporting/UNECE nomenclature for reporting of air pollutants
HCB	Hexachlorobenzene
HCE	Hexachloroethane
HFC	Hydrofluorocarbon
Hg	Mercury
HM	Heavy metal
IIR	Informative inventory report
IP	Indeno(1,2,3-cd)pyrene
I-Teq	International toxic equivalent
KCA	Key category analysis
kg	1 kilogram = 10^3 g (gram)
LPS	Large point source
LRTAP	Long-range Transboundary Air Pollution
LTO	Landing/take-off
Mg	1 megagram = 10^6 g = 1 tonne (t)
MMR	Monitoring Mechanism Regulation
MSW	Municipal solid waste
N_2O	Nitrous oxide
n/a	Not available
NEC Directive	EU National Emission Ceilings Directive ((EU) 2016/2284)
NFR	Nomenclature for reporting/UNECE nomenclature for reporting of air pollutants
NFR14	Current format for reporting of air pollutants (Nomenclature for reporting)
NH_3	Ammonia

Ni	Nickel
NMVOC	Non-methane volatile organic compound
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
O_3	Ozone
PAH	Polycyclic aromatic hydrocarbon
Pb	Lead
PCB	Polychlorinated biphenyl
PCDD/F	Polychlorinated dibenzodioxin/dibenzofuran
PFC	Perfluorocarbon
PM	Particulate matter
$PM_{2.5}$	Fine particulate matter with a diameter of 2.5 µm or less
PM_{10}	Particulate matter with a diameter of 10 µm or less
POP	Persistent organic pollutant
QA	Quality assurance
QC	Quality control
SCR	Selective catalytic reduction
Se	Selenium
SNCR	Selective non-catalytic reduction
SO_2	Sulphur dioxide
SO_x	Sulphur oxides
t	1 tonne (metric) = 1 megagram (Mg) = 10^6 g
TERT	Technical Expert Review Team
TFEIP	Task Force on Emission Inventories and Projections
TSP	Total suspended particulate
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile organic compound
WM	With measures (projections)

WaM	With additional measures (projections)
Zn	Zinc

Key category source sector abbreviations

1A1a	Public electricity and heat production
1A1b	Petroleum refining
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals
1A2gvii	Mobile combustion in manufacturing industries and construction
1A2gviii	Stationary combustion in manufacturing industries and construction: Other
1A3bi	Road transport: Passenger cars
1A3bii	Road transport: Light duty vehicles
1A3biii	Road transport: Heavy duty vehicles and buses
1A3biv	Road transport: Mopeds and motorcycles
1A3bv	Road transport: Gasoline evaporation
1A3bvi	Road transport: Automobile tyre and brake wear
1A3bvii	Road transport: Automobile road abrasion
1A3c	Railways
1A3dii	National navigation (shipping)
1A4ai	Commercial/institutional: Stationary
1A4bi	Residential: Stationary
1A4bii	Residential: Household and gardening (mobile)
1A4ci	Agriculture/forestry/fishing: Stationary
1A4cii	Agriculture/forestry/fishing: Off-road vehicles and other machinery
1B2ai	Fugitive emissions oil: Exploration, production, transport
1B2aiv	Fugitive emissions oil: Refining/storage
1B2av	Distribution of oil products
2A5a	Quarrying and mining of minerals other than coal

2A5b	Construction and demolition
2B10a	Chemical industry: Other
2C1	Iron and steel production
2C3	Aluminium production
2C7a	Copper production
2D3a	Domestic solvent use including fungicides
2D3b	Road paving with asphalt
2D3d	Coating applications
2D3e	Degreasing
2D3g	Chemical products
2D3h	Printing
2D3i	Other solvent use
2G	Other product use
2H2	Food and beverages industry
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)
2L	Other production, consumption, storage, transportation or handling of bulk products
3B1a	Manure management — Dairy cattle
3B1b	Manure management — Non-dairy cattle
3B3	Manure management — Swine
3B4gi	Manure management — Laying hens
3B4gii	Manure management — Broilers
3Da1	Inorganic N-fertilisers (includes also urea application)
3Da2a	Animal manure applied to soils
3Da3	Urine and dung deposited by grazing animals
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products
5C1biii	Clinical waste incineration
5C1bv	Cremation
5C2	Open burning of waste
5E	Other waste

Country codes

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GB	United Kingdom
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia

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Executive summary

This document is the annual European Union (EU) emission inventory report under the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (LRTAP Convention) (UNECE, 1979). The report and its accompanying data constitute the official submission by the European Commission on behalf of the EU as a Party to the Executive Secretary of UNECE. The European Environment Agency (EEA) compiled the report in cooperation with the EU Member States and the European Commission.

Box ES.1 The Gothenburg Protocol

The Gothenburg Protocol to the Long-range Transboundary Air Pollution (LRTAP) Convention sets emission ceilings. Parties to the convention must reduce their emissions to these levels. These ceilings, for 2010 and after, are for the pollutants nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), sulphur oxides (SO_x) and ammonia (NH_3). In addition to the ceilings for individual countries, the protocol also specifies ceilings for the EU, which is a Party to the protocol in its own right (UNECE, 1999). The protocol was amended in 2012. The ceilings set for 2010 and years thereafter are still in place, but the amended protocol also specifies new emission reduction commitments in terms of percentage reductions by 2020, relative to base year 2005. Parties are also encouraged to report primary particulate matter (PM) and black carbon (BC) emissions, in line with the revised emission-reporting guidelines (UNECE, 2014a) ([1]). The EU ratified the amended protocol in 2017.

The LRTAP Convention obliges and invites Parties to report emission data for numerous air pollutants:

- main pollutants: Nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), sulphur oxides (SO_x), ammonia (NH_3) and carbon monoxide (CO);
- Particulate matter (PM) emitted directly into the air (primary PM):
  - PM with a diameter greater than 2.5 microns ($PM_{2.5}$, also called fine particulate matter);
  - PM with a diameter greater than 10 microns (PM_{10});
  - BC, the most strongly light-absorbing component of PM;

total suspended particulates (TSPs);

- priority heavy metals (HMs): lead (Pb), cadmium (Cd) and mercury (Hg);
- additional HMs: arsenic (As), chromium (Cr), copper (Cu), nickel (Ni), selenium (Se) and zinc (Zn);
- persistent organic pollutants (POPs): polychlorinated dibenzodioxins/dibenzofurans (PCDD/Fs), polycyclic aromatic hydrocarbons (PAHs), hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs);
- additional reporting of the individual PAHs benzo(a)pyrene (B(a)P), benzo(b)fluoranthene (B(b)F), benzo(k)fluoranthene (B(k)F) and indeno(1,2,3-cd)pyrene (IP), and of their sum as the total of all four.

([1]) The EEA publishes its annual update of the National Emission Ceilings Directive (NEC Directive) reporting (EEA, forthcoming) in June 2018. The briefing analyses the 2016 emission data for EU Member States reported under Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC, known as the new EU National Emission Ceilings (NEC) Directive (EU, 2016). For the EU Member States, the new NEC Directive retains the emission ceilings set for 2010 and years thereafter until 2019, and establishes new national emission reduction commitments for NO_x, NMVOCs, SO_2, NH_3 and $PM_{2.5}$ for 2020-2029 and from 2030 onwards.

Box ES.2 Status of reporting by EU Member States

In 2018, Member States were requested to report emission inventory data and an informative inventory report (IIR). All Member States, except Greece, provided air emission inventories. For the Greek data set and for other countries where data were missing for certain years or pollutants, a gap-filling procedure was applied to obtain as complete as possible a European inventory. By 6 May 2018, 27 Member States had reported activity data, but only 25 Member States had reported activity data for the complete time series (1990-2016). All Member States that provided submissions also provided IIRs, and three Member States provided projection data. The reporting of gridded data, large point sources and projections was not requested in 2018. However, Bulgaria, Croatia, Ireland, Italy and Romania reported gridded data and Finland, Luxembourg (only with additional measures (WaM) projections) and the United Kingdom provided projections. Romania and Finland provided data on large point sources, and Bulgaria, Croatia, Ireland, Italy and Romania provided gridded data. Detailed information on Member States' submissions is given in Appendix 3.

In 2012, the Executive Body of the LRTAP Convention decided that adjustments to emission reduction commitments, or to inventories for the purposes of comparing total national emissions with them, may be applied in some circumstances, if such a circumstance contributes to a Party being unable to meet one of its reduction commitments (UNECE, 2012b). Under the Gothenburg Protocol, the European Monitoring and Evaluation Programme (EMEP) Steering Body Board accepted inventory adjustment applications for emissions from seven countries in 2014, 2015, 2016 and 2017.

Circumstances that allow adjustments to emission inventories are defined as follows:

- There are additional categories of emission sources that were not accounted for when the emission reduction commitments were set.
- Emission factors used to determine emission levels for particular source categories for the year in which emission reduction commitments are to be attained are significantly different from the emission factors applied to these categories at the time the emission reduction commitments were set.
- The methods for determining emissions from specific source categories have changed significantly between when emission reduction commitments were set and the year they are to be attained.

These pollutants harm human health and the environment. Certain species also contribute to the formation of ground-level ozone (O_3) and secondary PM in the atmosphere. Some pollutants have an indirect and direct effect on the sunlight absorbed by the Earth and reflected back to space (radiative forcing) and hence on the climate (EEA, 2014, 2015, 2017a).

This report describes:

- the institutional arrangements and preparation processes behind the EU's emission inventory, methods and data sources, key category analyses, information on quality assurance and control, general uncertainty evaluation, and information on completeness and underestimations (Chapter 1);
- information on approved adjustments and adjustment applications under the Gothenburg Protocol (Chapter 2);
- emission trends for the European Union (EU) as a whole and for individual Member States, and the contribution of key categories to total emissions (Chapter 3);
- sectoral analyses and emission trends for key pollutants (Chapter 4);
- information on recalculations, as well as planned and implemented improvements (Chapter 5).

Emission data presented in this report are in the accompanying annexes and are also available for direct download through the EEA's data service (EEA, 2018a). The following sections summarise the main findings.

EU emission trends

Figures ES.1-ES.3 present the trends in emission of air pollutants between 1990 and 2016 ([2]). They are aggregated across the EU.

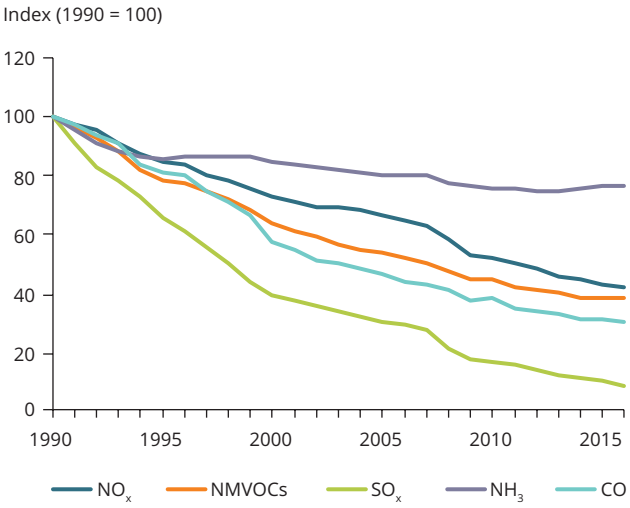
Emission trends of main air pollutants between 1990 and 2016

With reference to the main air pollutants, SO_x was the pollutant type with the greatest reduction in emissions across the EU. SO_x emissions in 2016 were 91 % less than in 1990 (Figure ES.1). This reduction is the result of a combination of measures:

- fuel switching in energy-related sectors, away from solid and liquid fuels with high sulphur content to low-sulphur fuels such as natural gas;
- applying flue gas desulphurisation (FGD) techniques in industrial facilities;
- EU directives relating to the sulphur content of certain liquid fuels.

Emissions of the other main air pollutants have dropped considerably since 1990, including the three air pollutants primarily responsible for the formation of ground-level O_3: CO (69 % reduction), NMVOCs (62 % reduction) and NO_x (58 % reduction). For the main pollutants, emissions have been decreasing more slowly over the past decade. However, emissions of NH_3 have fallen less than emissions of the other main pollutants (23 %) since 1990, and since 2014 a positive NH_3 emission trend has been noticed.

Figure ES.1 EU emission trends for the main air pollutants



Box ES.3 Development of main pollutant emissions between 2015 and 2016

Emissions of NO_x and SO_x dropped by 3.7 % and 15.1 %, respectively, between 2015 and 2016. CO emissions decreased by 0.6 %. Emissions of NMVOCs decreased by 1.7 %, and NH_3 emissions increased by 0.4 %.

The drop in NO_x emissions is mainly due to reductions reported by the United Kingdom, Spain, France, Germany and Italy (in order of largest absolute emission reduction). The 'energy production and distribution' sector recorded the largest reductions of NO_x (in absolute terms) from 2015 to 2016.

NMVOC emissions decreased in 18 Member States between 2015 and 2016. Greece (gap-filled data), the United Kingdom, Italy and the Netherlands (in order of largest absolute emission reduction) were responsible for the highest decreases. The main emitter of NMVOCs is the 'industrial processes and product use' sectors.

From 2015 to 2016, the largest reductions in SO_x emissions in absolute terms were in Poland, the United Kingdom, Romania and Spain (in order of largest absolute emission reduction). The sector 'energy production and distribution' contributed most to the reduction of SO_x emissions.

CO emissions decreased, mainly due to reductions reported by the United Kingdom, Italy and Greece (gap-filled data) (in order of largest absolute emission reduction). The sector 'road transport' contributed most to the decrease in CO emissions.

NH_3 emissions increased in 15 Member States. Italy, the United Kingdom and Ireland reported the highest increases (in order of largest absolute emission increase).

([2]) By 15 February each year, Member States must report emission data for up to and including the last calendar year but one. Thus, by 15 February 2018, Member States were obliged to report for the years before 2017. Typically, it takes countries about 12 to 15 months to compile and report emission inventory data (for both air pollutants and greenhouse gases (GHGs)). This delay is mainly because of the time needed for official national and/or trade statistics to become available (typically up to 12 months after the end of the calendar year), together with the time needed for subsequent data processing, calculations, and quality assurance and quality control (QA/QC) checks.

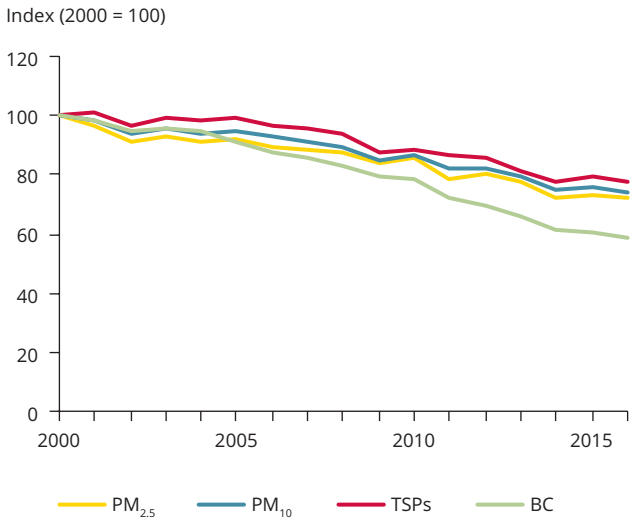
The 'road transport' sector has reduced emissions since 1990 for CO and NMVOCs, and since 1992 the NO_x emissions have also decreased continuously. It has achieved this primarily through legislative measures requiring the abatement of vehicle exhaust emissions. NO_x emissions decreased considerably in the electricity/energy generation sectors as a result of certain technical measures, mainly:

- introduction of combustion modification technologies (e.g. use of low-NO_x burners);
- implementation of flue gas abatement techniques (e.g. NO_x scrubbers, and selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR) techniques);
- fuel switching from coal to gas.

Emission trends of particulate matter between 2000 and 2016

The LRTAP Convention formally requests Parties to report emissions of PM from the year 2000 onwards. Hence, emission trends are shown for 2000 and the subsequent years only. Aggregated emissions of TSPs have fallen by 22 % across the EU since 2000 (and by 54 % since 1990) (Figure ES.2). Emissions of primary PM_{10}, $PM_{2.5}$ and BC have fallen by 26 %, 28 % and 41 %, respectively (since 2000).

Figure ES.2 EU emission trends for PM



Total PM emissions dropped mainly thanks to the introduction or improvement of abatement measures across the 'energy', 'road transport' and 'industry' sectors, coupled with other developments in industrial sectors, such as switching from fuels containing high amounts of sulphur to those with low amounts. SO_x, NO_x and NH_3 play an important role in the formation of secondary PM. Thus, if emissions of these pollutants decrease, this also influences PM formation (EEA, 2018b).

Emission trends of heavy metals and persistent organic pollutants between 1990 and 2016

Emissions of the main HMs (Pb, Cd, Hg), dioxins and furans, total PAHs, HCB and PCBs have also dropped substantially since 1990, by at least 65 % (Figure ES.3).

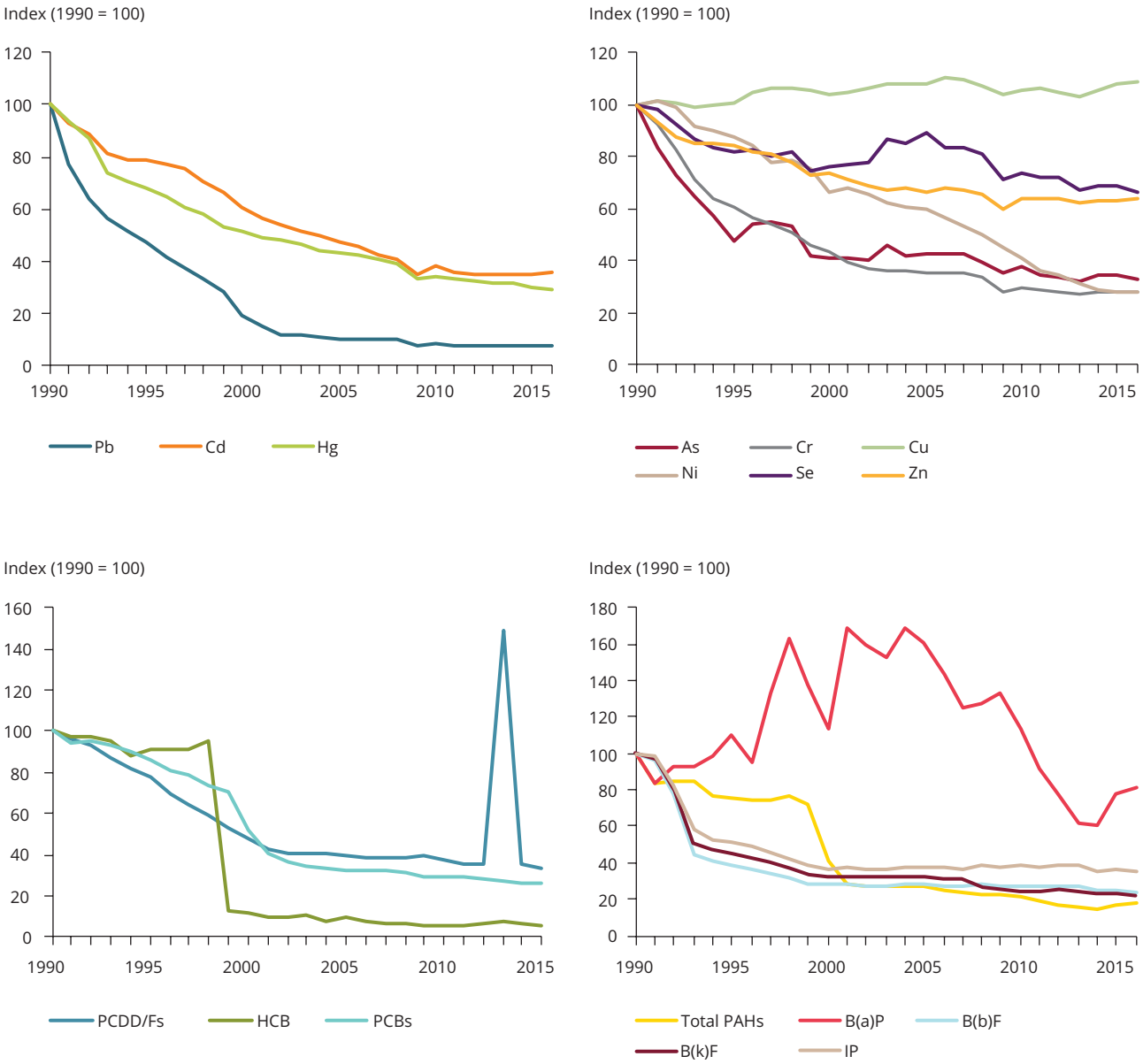
Much progress has been made since the early 1990s in reducing point-source emissions of these substances, particularly from industrial facilities. This has been achieved partially through improved abatement techniques for waste water treatment, and for incinerators in the metal refining and smelting industries. In some countries, the emissions reduction follows the closure of older industrial facilities due to economic restructuring. Total emissions fell faster between 1990 and 2000 than in the following years.

Cu emissions have increased over the years and were 8 % higher in 2016 than in 1990. Emissions of other HMs decreased between 1990 and 2016: As by 67 %, Cr by 72 %, Ni by 72 %, Se by 34 % and Zn by 36 %.

Total PAHs decreased by 83 % from 1990 to 2016 ([3]). For individual PAHs, the reductions were 19 % for B(a)P, 76 % for B(b)F, 78 % for B(k) and 65 % for IP from 1990 to 2016. Dioxins and furans have decreased by 67 % since 1990. The reductions of HCB and PCB emissions were 95 % and 74%, respectively. There have been clear decreases over the last 25 years, but emissions of POPs have remained broadly stable since 2000 (Figure ES.3).

([3]) It is difficult to compare reductions of total PAHs and reductions of the other PAHs. The reporting completeness for the EU (sum of reporting/gap-filling of the Member States) differs strongly between total PAHs and the other PAHs.

Figure ES.3 EU emission trends for HMs and POPs



Notes: The drop in HCB emissions between 1998 and 1999 is due to a considerable reduction reported by the United Kingdom. The peak in PCDD/Fs emissions in 2013 is caused by data reported by Malta.

The trend of B(a)P emissions follows the trend in the data reported by Portugal.

For certain pollutants, not all Member States reported data.

Box ES.4 Effects of recalculated data for previously reported 2015 emissions

In 2018, all Member States that provided submissions, reported recalculations for one or more years, and also changes in gap filling resulted in recalculations. This caused changes of emission inventories for all pollutants for 2015.

In their IIRs (see Appendix 5), Member States gave an account of their reasons for recalculating parts of time series or whole time series. Explanations included methodological improvements, revision of emission factors or newly implemented emission factors, reallocations, availability of new data, revision of activity data and correction of errors. They did not always provide information on the rationale behind recalculations.

EU key categories and main emission sources

EU key categories are the individual sources that contributed the most, overall, to emissions of pollutants in 2016. They were determined by a level assessment ([4]) for NO_x, NMVOCs, SO_x, NH_3, CO, $PM_{2.5}$, PM_{10}, Cd, Pb, Hg, PCDD/Fs, total PAHs, B(a)P, HCB and PCBs.

A total of 55 different emission inventory source categories were identified as being key categories for at least one pollutant. A number of emission categories were identified as being key categories for more than one of the 14 pollutants assessed. Table ES.1 lists the most relevant key categories.

Figure ES.4 shows the share of EU emissions by sector group. As observed in previous years, each main air pollutant has one major source category: for NO_x, this is 'road transport'; for SO_x, 'energy production and distribution'; for NH_3, 'agriculture'; for NMVOCs, 'industrial processes and product use'; and for CO, as well as PM, 'commercial, institutional and households'.

Emissions of NO_x from the 'road transport' sector decreased by 61 % between 1990 and 2016. The road transport sector is, nevertheless, a major source of the ground-level O_3 precursors NO_x, CO and NMVOCs in the EU; in 2016 it contributed 39 %, 20 % and 9 %, respectively, to total emissions of these pollutants in the EU. It is also a major source of primary $PM_{2.5}$, PM_{10} and Pb emissions. Passenger cars, heavy-duty vehicles and buses are the principal contributors to NO_x emissions from this sector; in 2016, passenger cars alone contributed around 70 % of CO emissions from the 'road transport' sector.

The 'commercial, institutional and households' sector is the most important source of $PM_{2.5}$, CO and PM_{10}. Energy- and process-related emissions from industry contribute considerably to the overall emissions of a number of the HMs and POPs.

Adjustments to emission inventories under the Gothenburg Protocol

Table ES.2 lists inventory adjustment applications that the EMEP Steering Body accepted in 2014, 2015, 2016 and 2017.

Table ES.1 Most relevant key categories for air pollutant emissions

Name of key category	Number of occurrences as key category
Residential: Stationary (combustion) (NFR 1A4bi)	14 (NO_x, NMVOCs, SO_x, CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PCDD/Fs, B(a)P, total PAHs, HCB, PCBs)
Public electricity and heat production (NFR 1A1a)	10 (NO_x, SO_x, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PCDD/Fs, HCB, PCBs)
Stationary combustion in manufacturing industries and construction: Non-metallic minerals (NFR 1A2f)	8 (NO_x, SO_x, CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg)
Iron and steel production (NFR 2C1)	8 (CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PCDD/Fs, PCBs)
Stationary combustion in manufacturing industries and construction: Iron and steel (NFR 1A2a)	6 (SO_x, CO, Pb, Cd, Hg, PCDD/Fs)
Road transport: Passenger cars (NFR 1A3bi)	6 (NO_x, NMVOCs, CO, $PM_{2.5}$, PM_{10}, Pb)
Commercial/institutional: Stationary (NFR 1A4ai)	6 (NO_x, SO_x, $PM_{2.5}$, Pb, Cd, Hg)

([4]) A key category level assessment identifies those source categories that have a significant influence on a country's total inventory in terms of their absolute level of emissions. In this report, key categories are those that are collectively responsible for 80 % of the total emissions of a given pollutant (EMEP/EEA, 2016).

Figure ES.4 Share of EU emissions of the main pollutants, by sector group in 2016

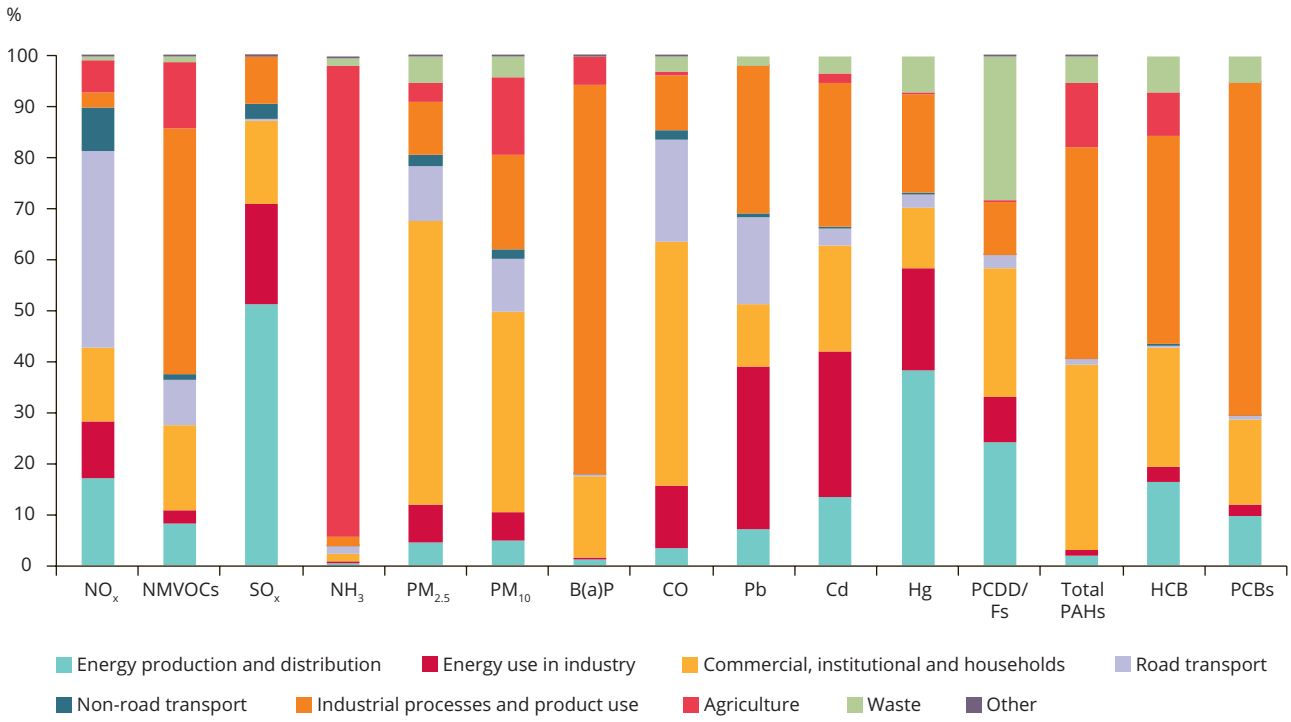


Table ES.2 Accepted inventory adjustment applications (UNECE, 2014b, 2015, 2016, 2017)

Member State	Pollutant	NFR
Belgium	NO_x	Road transport (1A3bi-iv), Agriculture (3B, 3Da1, 3Da2a)
	NMVOCs	Agriculture (3B, 3De)
Denmark	NMVOCs	Agriculture (3B)
	NH_3	Agriculture (3Da1, 3De)
Finland	NH_3	Energy use in industry (1A2gviii), Commercial, institutional and households (1A4ai, 1A4bi, 1A4ci), Road transport (1A3bi-iv)
France	NO_x	Road transport (1A3bi-iv)
Germany	NO_x	Road transport (1A3bi-iv), Agriculture (3B, 3D, 3Da2c, 3I)
	NMVOCs	Agriculture (3B, 3De)
	NH_3	Agriculture (3Da2c, 3I)
Luxembourg	NO_x	Road transport (1A3bi-iv), Agriculture (3B, 3De)
	NMVOCs	Agriculture (3B, 3De)
Spain	NO_x	Road transport (1A3bi, 1A3biii), Agriculture (3B)

Note: For Nomenclature for Reporting (NFR) codes, see Appendix 4.

Table ES.3 Emissions reported for 2016 by EU-15 Member States compared with Gothenburg Protocol EU emission ceilings for 2010 and years thereafter

Pollutant	EU-15 emissions, 2016 (Gg)	EU-15 Gothenburg Protocol, 2010 ceilings (Gg)	Difference (%)	Sum of individual EU-15 ceilings (Gg) ([a])
NO_x	6 004	6 671	-10	6 519
NMVOCs	5 111	6 600	-23	6 510
SO_x	1 332	4 059	-67	3 850
NH_3	3 115	3 129	-0.4	3 110

Notes: For Spain, data for emission comparisons exclude emissions from the Canary Islands. The comparison with emission ceilings is based on reporting on the basis of fuel sold for all Member States.

Under the Gothenburg Protocol, the EMEP Steering Body accepted applications from Belgium, Denmark, Finland, France, Germany, Luxembourg and Spain for emission inventory adjustments in 2014, 2015, 2016 and 2017. However, as the EU-15 itself has not applied for adjustments, this table does not take these adjusted data into account.

([a]) The protocol also specifies emission ceilings for individual EU-15 Member States. In some cases, the sum of these ceilings is different from the ceilings specified for the EU-15 as a whole.

Progress in meeting the EU's current emission ceilings and emission reduction targets for 2020 under the Gothenburg Protocol

The Gothenburg Protocol (1999) set commitments for the European Community, comprising 15 EU Member States. Table ES.3 shows their aggregated emissions for 2016 compared with the emission ceilings it specified for the EU in 2010 and for years thereafter. For NO_x, NMVOCs, SO_x and NH_3, emissions in 2016 were below the ceilings. The Gothenburg Protocol was amended in 2012 to set emission reduction commitments for 2020.

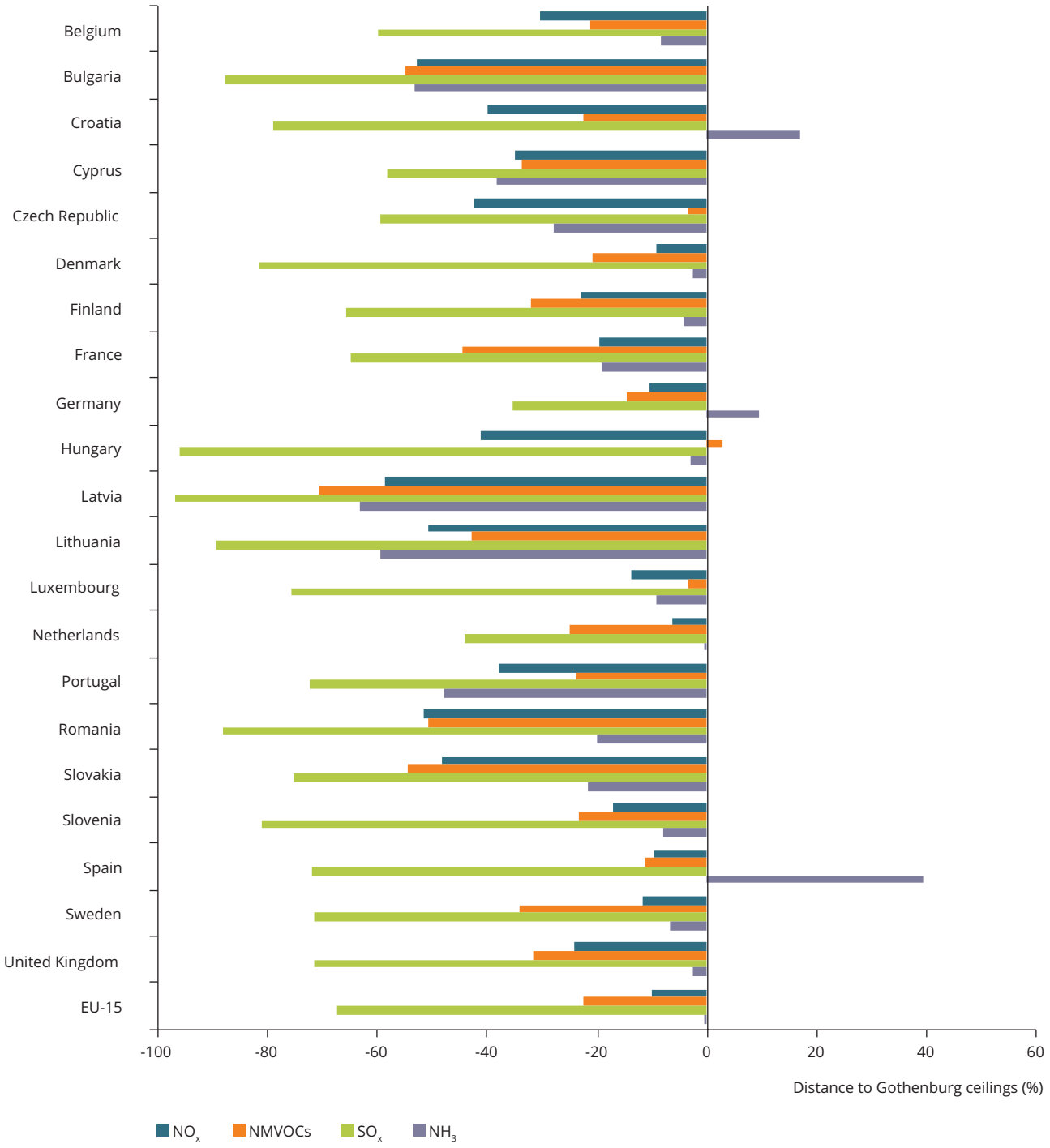
Figure ES.5 shows whether or not each EU Member State met its Gothenburg ceiling in 2016. Estonia and Malta do not have Gothenburg ceilings as they are not yet Parties to the protocol, and Austria, Greece, Ireland, Italy and Poland have signed, but not yet ratified, the Gothenburg Protocol and are therefore excluded from Figure ES.5. Three Parties exceeded their NH_3 ceilings (Croatia, Germany and Spain), and one Member State (Hungary) exceeded its limit for NMVOCs. All Member States complied with their NO_x (adjusted data) and SO_x ceilings.

Progress by non-EU EEA member countries in meeting emission ceilings for 2010 and years thereafter under the Gothenburg Protocol

The Gothenburg Protocol specified emission ceilings for three non-EU EEA member countries (Liechtenstein, Norway and Switzerland) for 2010 and onwards (UNECE, 1979, 1999). Liechtenstein has signed but not yet ratified the protocol. The EEA member countries Iceland and Turkey have not yet signed the Gothenburg Protocol. Emission data for Norway and Switzerland are the latest reported data under the LRTAP Convention (2018 submission round). Emission data are compared with the countries' emission ceilings under the Gothenburg Protocol.

Data from the above-mentioned countries show that, although Norway exceeded its NO_x ceiling from 2010 to 2014, it complied in 2015 and 2016, while it exceeded its NH_3 emission ceiling in all years, and that Switzerland complied with all ceilings for all pollutants (see Table ES.4).

Figure ES.5 Distance to Gothenburg ceilings for EU Member States



Notes: Estonia and Malta have not signed the Gothenburg Protocol and therefore do not have ceilings. Austria, Greece, Ireland, Italy and Poland have a ceiling, but they have not yet ratified the protocol. For Spain, data for emission comparisons exclude emissions from the Canary Islands.

The comparison with emission ceilings is based on reporting on the basis of fuel sold, except for Belgium, Lithuania, Luxembourg, the Netherlands and the United Kingdom. These countries may choose to use the national emissions total calculated on the basis of fuel used in the geographical area of the Party as a basis for ceilings comparisons instead (UNECE, 2014a). For the EU-15, the comparison is based on fuel sold.

Under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Belgium, Denmark, Finland, France, Germany, Luxembourg and Spain in 2014, 2015, 2016 and 2017. This figure takes these adjusted data into account. The EU-15 did not apply for adjustments and thus data for the EU-15 are unadjusted.

Table ES.4 Progress by other EEA member countries in meeting Gothenburg Protocol emission ceilings for 2010 and years thereafter

Member State	NO_x							NMVOCs						
	2010	2011	2012	2013	2014	2015	2016	2010	2011	2012	2013	2014	2015	2016
Norway	×	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓
Switzerland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Member State	SO_2							NH_3						
	2010	2011	2012	2013	2014	2015	2016	2010	2011	2012	2013	2014	2015	2016
Norway	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×
Switzerland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes: '✓' indicates that the final (2010, 2011, 2012, 2013, 2014, 2015) or provisional (2016) emission data that a country reported meet or lie below its respective emission ceiling.
'×' indicates that a ceiling is exceeded.

Actions and recommendations for improved data quality

Reporting has become more complete in recent years. However, a number of data gaps remain in the official data sets received from Member States. The completeness of submissions can therefore be further improved, particularly for historical data for 1990-2000 and for certain pollutants such as HMs and POPs. To compile as complete an EU inventory as possible, missing emission data are gap-filled as far as is feasible (for details see Section 1.4.5).

This report also contains several recommendations that may further improve the quality of the EU inventory in future. Member States should submit complete inventories and use proper notation keys for instances where estimated values are not available. They should recalculate emission data for past years when new methods or new scientific knowledge become available. In this context, Member States are recommended to review and apply the information contained in the updated *EMEP/EEA air pollutant emission inventory guidebook — 2016* (Inventory guidebook for short; EMEP/EEA, 2016) when compiling their emission inventory data sets.

Member States are encouraged to take into account the findings of the annual quality checks performed by the EEA and its European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM) during the compilation of the EU inventory. Where necessary, they can either resubmit inventory data (in the new NFR14 format) or update next year's inventory to reflect new insights gained or errors identified. In 2018, several Member States were contacted with data requests by the EEA. Ten Member States replied and some gave explanations or announced resubmissions.

1 Introduction

The European Commission provides this report and its accompanying data (on behalf of the European Union (EU)) as an official submission to the secretariat for the Executive Body of the Long-range Transboundary Air Pollution (LRTAP) Convention.

The report covers the following subjects: the formal institutional arrangements that underpin the EU's emission inventory, the inventory preparation process, methods and data sources, key category analyses, information on quality assurance (QA) and quality control (QC), general uncertainty evaluation, general assessment of completeness and information on underestimations (Chapter 1); adjustments under the Gothenburg Protocol (Chapter 2); emission trends and the contribution of key categories to total emissions (Chapter 3); sectoral analysis and emission trends for key pollutants (Chapter 4); and information on recalculations and planned improvements (Chapter 5).

EU emission totals are estimated for the pollutants for which data should be reported under the LRTAP Convention (see Appendix 2), i.e. emissions of:

main pollutants:

- nitrogen oxides (NO_x);
- non-methane volatile organic compounds (NMVOCs);
- sulphur oxides (SO_x);
- ammonia (NH_3);
- carbon monoxide (CO);

particulate matter (PM):

- PM_{10};
- fine PM ($PM_{2.5}$);
- total suspended particulates (TSPs);
- black carbon (BC);

priority heavy metals (HMs):

- lead (Pb);
- cadmium (Cd);
- mercury (Hg);

additional HMs:

- arsenic (As);
- chromium (Cr);
- copper (Cu);
- nickel (Ni);
- selenium (Se);
- zinc (Zn);

persistent organic pollutants (POPs):

- polychlorinated dibenzodioxin/polychlorinated dibenzofurans (PCDD/Fs);
- polycyclic aromatic hydrocarbons (PAHs);
- hexachlorobenzene (HCB);
- polychlorinated biphenyls (PCBs);

additional reporting of PAHs:

- benzo(a)pyrene (B(a)P);
- benzo(b)fluoranthene (B(b)F);
- benzo(k)fluoranthene (B(k)F);
- indeno(1,2,3-cd)pyrene (IP).

Emission estimates are not always available for all pollutants in each year, because there are gaps in the data from Member States. A gap-filling process was developed in 2010 for compiling the EU inventory, and was refined in 2011 and 2017 (see Section 1.4.5). Nevertheless, for certain pollutants (additional HMs, BC, individual PAHs), some Member States did not report data for any year, which made it impossible to apply such gap-filling techniques. For these pollutants, the EU total thus remains incomplete.

Several annexes accompany this inventory report:

- Annex A provides a copy of the formal LRTAP Convention data submission of the EU for 1990-2016 for the EU, in the required UNECE reporting format (NFR14).
- Annex B provides the updated EU NO_x emission data for 1987-1989, as the 1988 NO_x protocol of the LRTAP Convention requires.
- Annex C provides results of the key category analysis (KCA) for the EU, showing the main emitting sectors for each pollutant.
- Annex D provides the gap-filled inventory of the EU, colour-coded for the different data sources used and the different additional gap-filling methods applied.
- Annex E provides Member States' projections for NO_x, NMVOCs, SO_x, NH_3, $PM_{2.5}$ and BC emissions for 2020, 2025, 2030, 2040 and 2050.
- Annexes F to I provide the LRTAP Convention data submission of the EU for 1990-2016, for the EU-9, EU-12, EU-15 and EU-27. Table A2.2 of Appendix 2 gives information on the country groupings.
- Annex J provides an overview of the sources of data on emissions of the individual pollutants that the 2018 EU inventory compilation used.
- Annex K provides an overview of the completeness of the gap-filled inventory concerning the notation key 'NE' (not estimated).

1.1 Background

1.1.1 Reporting obligations under the Convention on Long-range Transboundary Air Pollution (LRTAP)

The EU ratified the UNECE's Convention on LRTAP (UNECE, 1979) in 1982. Since 1984, eight protocols have come into force. Table 1.1 presents the status of ratification of each protocol by the EU as a whole. The status differs across Member States.

Table 1.1 EU ratification status of the LRTAP Convention and related protocols

Year	LRTAP Convention and its protocols	Status of ratification
1979	'Geneva Convention': Convention on Long-range Transboundary Air Pollution (UNECE, 1979)	Signed and ratified (approval)
1984	'Geneva Protocol': Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (UNECE, 1984)	Signed and ratified (approval)
1985	'Helsinki Protocol': Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 % (UNECE, 1985)	Not signed
1988	'Sofia Protocol': Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes (UNECE, 1988)	Ratified (accession)
1991	'Geneva Protocol': Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes (1991) (UNECE, 1991)	Signed
1994	'Oslo Protocol': Protocol on Further Reduction of Sulphur Emissions (1994) (UNECE, 1994)	Signed and ratified (approval)
1998	'Aarhus Protocol': Protocol on Persistent Organic Pollutants (1998) (UNECE, 1998a)	Signed and ratified (approval)
1998	'Aarhus Protocol': Protocol on Heavy Metals (1998) (UNECE, 1998b)	Signed and ratified (approval)
1999	'Gothenburg Protocol': Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (1999) (UNECE, 1999)	Ratified (accession)
2012	Amendments to the Gothenburg Protocol (UNECE, 2012a)	Ratified (acceptance)

On 4 May 2012, the Executive Body for the UNECE LRTAP Convention adopted amendments to the Gothenburg Protocol. The new text of the protocol includes national emission reduction commitments for the major air pollutants NO_x, NMVOCs, SO_x and NH_3, as well as for $PM_{2.5}$ (and BC as a component of PM). Countries are to achieve them in 2020 and beyond. For the EU, the emission reduction commitments from 2005 emission levels for 2020 and beyond are (UNECE, 2012a):

- 59 % for sulphur dioxide (SO_2);
- 42 % for NO_x;
- 6 % for NH_3;
- 28 % for NMVOCs;
- 22 % for $PM_{2.5}$.

The EU ratified the amended Gothenburg Protocol on 30 August 2017.

The Executive Body of the LRTAP Convention adopted revised *Guidelines for reporting emissions and projections data under the Convention on Long-range Transboundary Air Pollution* (reporting guidelines) at its 32nd session, in March 2014 (UNECE, 2014a). Parties are to apply them in 2015 and subsequent years. A summary of the reporting requirements is shown in Appendix 2.

The deadline for individual Parties to submit data to the LRTAP Convention is 15 February of each year. There is a separate deadline of 15 March for submitting the accompanying inventory reports. The reporting guidelines specify separate reporting dates for the EU. They allow time to compile an aggregated inventory based on the individual submissions from Member States. The EU should submit EU inventory data to the Executive Secretary of the UNECE by 30 April each year, and the accompanying inventory report by 30 May. The reporting guidelines also request Parties to report emission inventory data using the new European Monitoring and Evaluation Programme (EMEP) NFR14 format.

In 2012, the Executive Body of the LRTAP Convention decided that adjustments to emission reduction commitments, or to inventories for the purposes of comparing total national emissions with them, may be applied in some circumstances, if such a circumstance keeps a Party from meeting one of its reduction commitments (UNECE, 2012b; see also Chapter 2).

The EMEP Steering Body reviews any supporting documentation and assesses if the adjustment is consistent with the circumstances and the guidance for adjustments (UNECE, 2012c). It makes the review available to the Parties, who have the option of making a submission to the Implementation Committee under Decision 2006/2 (UNECE, 2006).

In 2014, the EMEP Steering Body accepted inventory adjustment applications for emissions from Denmark and Germany, in 2015 from Belgium, Denmark, Finland, France, Germany, Luxembourg and Spain, in 2016 from Germany and Luxembourg and in 2017 from Spain (UNECE, 2014b, 2015, 2016, 2017). More information and adjusted emission data can be found in Chapter 2.

1.2 Institutional arrangements

1.2.1 Member States

Member States are responsible for selecting the activity data, emission factors and other parameters used for their national inventories. Member States should also follow the reporting guidelines (UNECE, 2014a) and apply the methodologies contained in the latest version of the EMEP/EEA Inventory guidebook (EMEP/EEA, 2016).

Member States are also responsible for establishing QA and QC programmes for their inventories. The Member States' inventory report should include a description of the QA and QC activities and recalculations.

Member States submit their national LRTAP inventories and inventory reports through participation in Eionet (European Environment Information and Observation Network) (see Section 1.2.2 below). In addition, they take part in the annual review and commenting phase of the draft EU inventory report. Member States check their national data and information used in the inventory report and, if necessary, send updates. They also provide general comments on the inventory report.

1.2.2 The EEA, European Commission, Eionet and ETC/ACM

European Environment Agency

The European Environment Agency (EEA) assists the European Commission's Directorate-General for the Environment (DG Environment) in compiling the annual EU LRTAP inventory.

EEA activities include:

- overall coordination and management of the inventory compilation process;
- coordination of activities of the EEA's European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM), which checks the data, compiles the inventory and writes the draft report;
- communication with the European Commission;
- communication with Member States;
- circulation of the draft EU emission inventory and inventory report;
- hosting the official inventory database, and disseminating the data and the inventory report on the web.

Since 2004, the EEA and EMEP have supported a separate annual quality review of emission data the countries submit. It provides findings to countries each year, to improve the quality of emission data reported. Each year, EMEP publishes a joint report summarising the review findings. Section 1.6 below provides further details of the annual data review process.

European Commission

The European Commission formally submits the EU emission inventory data and inventory report to EMEP through the Executive Secretary of UNECE.

European Topic Centre on Air Pollution and Climate Change Mitigation

The ETC/ACM's ([5]) main activities regarding the EU's LRTAP Convention emission inventory include:

- initial checks, tests and centralised review of Member State submissions in cooperation with the EMEP Centre on Emission Inventories and Projections (CEIP), and compiling results from those checks (status reports, country synthesis and assessment reports, country review reports);
- consulting with Member States (via the EEA) to clarify issues with data and other information provided;
- preparing the gap-filled EU emission inventory by 30 April, based on Member State submissions (which the Commission subsequently submits to UNECE);
- preparing the updated EU emission inventory and inventory report by 30 May.

European Environment Information and Observation Network

Eionet facilitates the work of the EEA and the ETC/ACM (EU, 1999) ([6]). It comprises the EEA (supported by its European topic centres), a supporting network of experts from national environment agencies and other bodies that deal with environmental information (Eionet, 2017). Member States are requested to use the tools of the Central Data Repository (CDR) (Eionet, 2018) of the Eionet Reportnet to make their LRTAP Convention submissions available to the EEA.

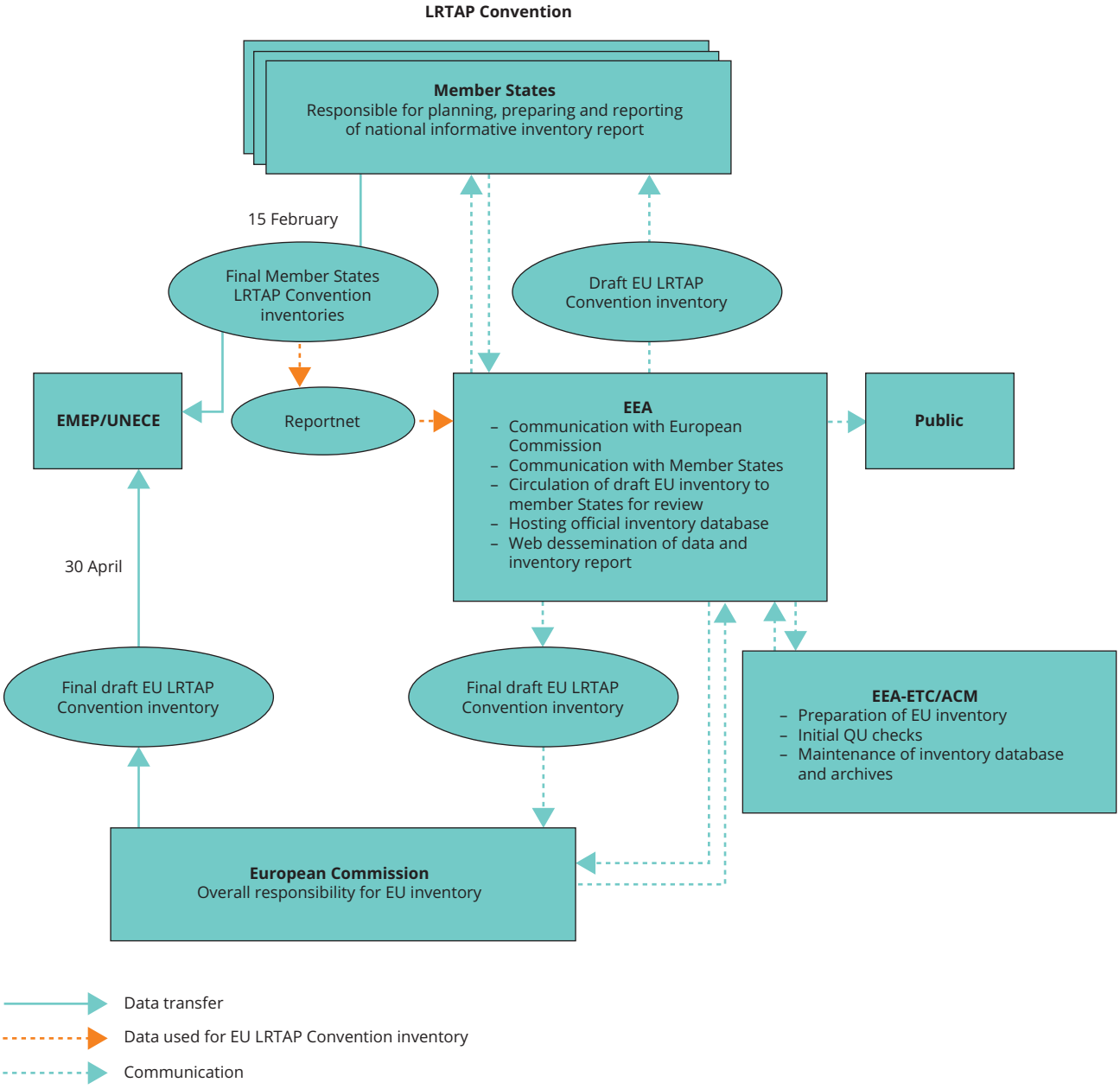
1.3 Inventory preparation process

The basis of reporting for individual Member States and for the EU is the LRTAP Convention (UNECE, 1979), its protocols (Table 1.1) and subsequent decisions taken by the Executive Body. The reporting guidelines describe the data that Parties should report under the LRTAP Convention and its protocols. Under the agreement between Eionet countries and the EEA concerning priority data flows, EU Member States are requested to post a copy of their official submission to the LRTAP Convention in the CDR by 15 February each year. The ETC/ACM subsequently collects the data from the CDR, performs a QA and QC analysis, compiles the gap-filled EU LRTAP Convention emission inventory database, and produces an EU LRTAP Convention emission inventory and inventory report. The European Commission formally submits the EU's emission inventory data and informative inventory report (IIR) to EMEP through the Executive Secretary of UNECE. The inventory and accompanying documentation are then made publicly available through the EEA website (see summary in Figure 1.1).

([5]) The current ETC/ACM was established in 2014 by contract between the EEA and the lead organisation, the National Institute for Public Health and the Environment (Rijksinstituut voor Volksgezondheid en Milieu, RIVM). It works with 14 organisations and institutions across 10 European countries.

([6]) A brochure describing the structure, working methods, outputs and activities of Eionet is available: EEA, *Eionet connects*, http://www.eea.europa.eu/publications/eionet-connects

Figure 1.1 Data flow for compiling the EU LRTAP Convention emission inventory



1.4 Methods and data sources

Reporting obligations under the National Emission Ceilings (NEC) Directive and the EU Greenhouse Gas Monitoring Mechanism

EU Member States report their emissions of NO_x, NMVOCs, SO_2, NH_3, CO, PMs, BC, HMs and POPs under Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC — known as the new EU National Emission Ceilings (NEC) Directive (EU, 2016). The NEC Directive incorporates the reduction commitments for 2020 under the Gothenburg Protocol into the LRTAP Convention. The new NEC Directive came into force on 31 December 2016 and sets 2020 and 2030 emission reduction commitments for five main air pollutants. Furthermore, the emission ceilings for 2010 set in Directive 2001/81/EC remain applicable for Member States until the end of 2019. The reduction commitments agreed for 2030 are more ambitious and designed to reduce the health impacts of air pollution by half compared with 2005.

Table 1.2 Overview of air emission reporting obligations in the EU, 2018

Legal obligation	Emissions to report	Annual reporting deadline for EU Member States	Annual reporting deadline for the EU [a]
LRTAP Convention [b]	NO_x (as nitrogen dioxide (NO_2)), NMVOCs, SO_x (as SO_2), NH_3, CO, HMs, POPs and PMs	15 February 2018	30 April 2018
NEC Directive	NO_x (as NO_2), NMVOCs, SO_x (as SO_2), NH_3, CO, HMs, POPs and PMs	15 February 2018	Not applicable
EU Monitoring Mechanism/ United Nations Framework Convention on Climate Change (UNFCCC)	Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride, NO_x, CO, NMVOCs and SO_2	15 January 2018 to the European Commission and 15 April 2018 to the UNFCCC	15 April 2018

Notes: [a] The European Community and European Union have signed a number of protocols over the years. The commitments include varying numbers of Member States. Therefore, emissions must be reported separately for the EU-9, EU-12, EU-15, EU-27 and EU-28 (see Table A2.2 in Appendix 2 for more information on EU country groupings).

[b] Parties are formally required to report only on the substances and for the years set forth in protocols that they have ratified and that have entered into force.

Table 1.3 Air pollutant reporting obligations comparison: the LRTAP Convention, NEC Directive and UNFCCC/Monitoring Mechanism Regulation (MMR)

Reporting item	NEC	LRTAP	UNFCCC/MMR
Domestic aviation (LTO)	Incl.	Incl.	Incl.
Domestic aviation (cruise)	Not incl.	Not incl.	Incl.
International aviation (LTO)	Incl.	Incl.	Not incl.
International aviation (cruise)	Not incl.	Not incl.	Not incl.
National navigation (domestic shipping)	Incl.	Incl.	Incl.
International inland shipping	Incl.	Incl.	Not incl.
International maritime navigation	Not incl.	Not incl.	Not incl.
Road transport (fuel sold) [a]	Incl.	Incl.	Incl.

Notes: International inland shipping refers to shipping activity on continental waters, and international maritime navigation to shipping activity on marine water. Air emissions resulting from inland shipping are included, as they are more relevant to air quality for the surrounding environment.

[a] In addition, Parties may also report emission estimates based on fuel used as an additional 'memo item': Austria, Belgium, Ireland, Lithuania, Luxembourg, the Netherlands, Switzerland and the United Kingdom may additionally choose to use the national emission total calculated on the basis of fuel used in the relevant geographical area as a basis for compliance (UNECE, 2014a).

Incl., included in national totals; LTO, landing/take-off; Not incl., not included in national totals: memo item.

EU Member States also report emissions of NO_x, SO_2, NMVOCs and CO under EU regulation No 525/2013, known as the EU Greenhouse Gas Monitoring Mechanism (EU, 2013). Member States should also copy this information to the CDR (Eionet, 2018). Table 1.2 provides an overview of the different reporting obligations for EU Member States.

Reporting obligations under the LRTAP Convention and NEC Directive have now been harmonised since the adoption of the updated reporting guidelines (UNECE, 2014a) and the revision of the NEC Directive (EU, 2016). Minor differences still occur between reporting under the LRTAP Convention and NEC Directive:

- Reporting of emission data for B(a)P, B(b)F, B(k)F and IP is voluntary under the LRTAP Convention, but is obligatory under the NEC Directive.
- Under the LRTAP Convention, Parties are invited to report their emissions for the EMEP domain

only. For Portugal, this means that emissions of the Azores and Madeira are included. This differs from reporting under the NEC Directive, for which the Azores and Madeira are excluded.

- Under the NEC Directive, some emissions are not counted for the purpose of compliance (see Directive 2016/2284/EU, Article 4(3)).

- While reporting of projections is required biennially under the NEC Directive, it is obligatory only every 4 years under the LRTAP Convention.

The NEC Directive and LRTAP Convention reporting obligations differ from the United Nations Framework Convention on Climate Change (UNFCCC) obligations by including domestic and international aviation and navigation in the reported national totals. Table 1.3 summarises the main differences between the reporting instruments. The overall impact of these differences is small for most Member States.

1.4.2 General methods

The EU LRTAP Convention emission inventory is based on an aggregation of data reported by Member States. Methods used by Member States should follow those described in the Inventory guidebook (EMEP/EEA, 2016). Overall, Member States do follow this recommendation, which ensures that they use the best available methods to estimate national emissions and that inventories are improved continuously. Moreover, the technical review procedures set up by EMEP CEIP check and assess Parties' data submissions as per the review guidelines, with a view to improve the quality of emission data and associated information reported to the LRTAP Convention.

The recommended structure for an IIR involves a general description of the methodologies and data sources used. This includes an overview of the emission factors used in the national inventory, country specific or default, given in the Inventory guidebook (EMEP/EEA, 2016), and the specification of the sources of default emission factors and methods. It also includes a detailed description of activity data sources where data differ from national statistics. The following two subsections summarise the information that Member States provide in their IIRs. This should help readers to understand the foundation of the EU inventory. For detailed descriptions of methodologies and data sources, see the IIRs of Member States (see Appendix 5 for IIR references).

1.4.3 Data submissions and data sources

The deadline for Member States to report was 15 February 2018. In the 2018 reporting cycle, 25 Member States submitted their inventories and time series in time. Greece made no submission, and Italy and Malta submitted their data after the formal deadline for submission (see Appendix 3, Figure A3.1). Two Member States did not provide complete time series in 2018 (Malta and Romania). All 27 Member States that submitted data used the new NFR14 reporting templates. Appendix 3 presents detailed information on Member States' submissions.

The data source for the EU inventory is Member States' emission inventories. The IIRs should document detailed information on the data sources used by Member States. The level of detail varies widely across Member States, although the main data sources are official national statistics. Table 1.4 summarises commonly used data sources for the various sectors.

Sources for emission factors vary according to the tier method used. One main source for emission factors is the Inventory guidebook (EMEP/EEA, 2016), but emission factors can also be country or even plant specific. It is impossible to survey the emission factors used by the Member States for all emission sources,

Table 1.4 Data sources commonly used for inventory sectors

Sector	Sources
Energy	Energy balances, EU Emissions Trading Scheme (EU ETS) data, large combustion plant data and large point source (LPS) surveys
Transport	Energy balances, vehicle fleet statistics
Industry and product use	National production statistics, trade statistics, data from plant operators (facility reports), reporting under the European Pollutant Release and Transfer Register (E-PRTR) and its predecessor, the European Pollutant Emission Register (EPER)
Agriculture	National agricultural statistics, specific studies
Waste	Landfill databases, national studies, national statistics, information from municipalities

as this information is not uniformly available: some countries report details of their methodologies, while others do not. Detailed information is available in Member States' IIRs; Appendix 5 provides references to these reports.

1.4.4 Comparison of Member States' emissions calculated on the basis of fuel sold versus fuel consumed in road transport

In Article V/A., paragraph 22, the reporting guidelines (UNECE, 2014a) specify how to report emissions from transport: 'For emissions from transport, all Parties should calculate emissions consistent with national energy balances reported to Eurostat or the International Energy Agency. Emissions from road vehicle transport should therefore be calculated on the basis of the fuel sold in the Party concerned. In addition, Parties may voluntarily calculate emissions from road vehicles based on fuel used or kilometres driven in the geographic area of the Party. The method for the estimate(s) should be clearly specified in the IIR.'

Paragraph 23 of the guidelines provides detailed information on the basis for compliance checking: 'For Parties for which emission ceilings are derived from national energy projections based on the amount of fuel sold, compliance checking will be based on fuels sold in the geographic area of the party. Other Parties within the EMEP region (i.e. Austria, Belgium, Ireland, Lithuania, Luxembourg, the Netherlands, Switzerland and the United Kingdom of Great Britain and Northern Ireland) may choose to use the national emission total calculated on the basis of fuels used in the geographic area of the Party as a basis for compliance with their respective emission ceilings.'

Parties can estimate transport emissions using the amount of fuel sold within the country or using fuel consumed. When fuel purchased within a country is used outside the country (and vice versa), these estimates can differ significantly. The EU inventory compiled in 2018 estimates emissions from road transport based on fuel sold for all Member States.

1.4.5 Data gaps and gap filling

Ideally, there should be no need to fill gaps in the reported inventory data, as it is the responsibility of Member States to submit full and accurate inventory data sets. However, Member States' submissions contain various data gaps for particular pollutants or years in the time series. Frequently, whole national inventories, emissions of some pollutants or sectoral emission data are missing.

The EMEP reporting guidelines (UNECE, 2014a) require that submitted emission inventories be complete. The gap-filling procedure in 2018 is identical to 2017 and follows a methodology paper by the EEA and the ETC/ACM (EEA, 2009) and some changes agreed at the meeting of the Task Force on Emission Inventories and Projections (TFEIP) in 2016 ([7]). This procedure is also consistent with the techniques used to fill emission data gaps that the Inventory guidebook suggests (EMEP/EEA, 2016). It uses a stepwise approach using emission data from other reporting obligations to fill gaps in the national data sets, followed by further gap-filling procedures such as inter- or extrapolation and manual changes. For further information on the gap-filling procedure, please see Box 1.1.

However, gap filling was applied only where national total and sectoral data were unavailable, or where a national total was available but there were no sectoral data. In the former instance, sectors were first gap-filled and then summed to determine the total. In the latter instance, the sectoral split of the previous or following year was used to fill the gaps. If a national total was available, but the sectoral data were incomplete, no gap filling was carried out. For BC, additional HMs, B(a)P, B(b)F, B(k)F and IP, some Member States lacked data for all years, and thus gap filling was impossible. In such instances, the EU emission totals for these pollutants are not considered complete (i.e. they are underestimated). Further, inventories cannot be considered complete if the notation keys 'NE' (not estimated) and in some cases 'NR' (not relevant), or the value 0, are reported or are used for gap filling. For further information on the effect of gap filling on the EU inventory, see Section 1.8, Figure 1.5 and Figure 1.6.

Annex J shows how the various officially reported data sets were used to supplement the LRTAP Convention data submissions for those Member States where gap filling was required. Annex D offers a more detailed overview, showing each Member State for which data were gap-filled and how this was performed. The trend tables in Chapter 3 (Table 3.6 to Table 3.31) also provide an initial overview, indicating which data have been derived by gap filling. Two Member States (the Malta and Romania) did not provide complete time series in 2018, and Greece did not send any inventory data.

([7]) TFEIP/Eionet meeting and workshop, 16-18 May 2016 in Zagreb.

Box 1.1 Unified LRTAP gap filling for EU and EMEP inventories (ETC/ACM, 2015)

A stepwise approach was used to fill gaps in the national data sets:

1. Emission trends of all pollutants were compiled from 1990 onwards using the LRTAP Convention emission inventories that the Member States provided to the EEA in 2018.

2. LRTAP Convention data submitted to EMEP CEIP in 2018 were the next source used to fill remaining gaps. All reported data (i.e. values and notation keys) were used. In fact, there should be no difference between the Member States' LRTAP Convention emission inventories provided to the EEA and the data submitted to EMEP CEIP.

3. For Member States that did not report complete data, emission data officially reported in the current reporting year by Member States under the EU Greenhouse Gas Monitoring Mechanism are used to fill gaps. In this step, notation keys are not used.

4. Next, emission data reported officially by Member States under the 2016 NEC Directive in the current reporting year are used to fill gaps. In this step, notation keys are not used.

5. In a further step, notation keys reported in the current reporting year by Member States under the EU Greenhouse Gas Monitoring Mechanism are used to fill any remaining gaps.

6. Subsequently, notation keys reported in the current reporting year by Member States under the NEC Directive are used to fill any remaining gaps.

7. Next, Member State LRTAP Convention emission inventories provided to the EEA in previous years are used to fill gaps still remaining (values and notation keys).

8. Older LRTAP Convention data submitted to EMEP CEIP are the next source of official information used to fill gaps (values and notation keys).

9. The gap filling continues with emission data reported in previous years under the EU Greenhouse Gas Monitoring Mechanism (values and notation keys).

10. For all remaining cases of missing data, further gap-filling procedures are applied:

(a) Linear interpolation is performed if one or several years in the middle of a time series are missing.

(b) Linear extrapolation is performed if one or several years at the beginning or at the end of a time series are missing, and if at least 5 consecutive years showing a clear trend ($r^2 \geq 0.6$) are available. Extrapolation 'backwards' is never allowed to result in negative values.

(c) If fewer than five consecutive years are available as a basis for extrapolation, or if years do not show a clear trend (this is the case when $r^2 < 0.6$), the value of the previous or next year is used to fill the gaps.

(d) If the notation key 'NA' (not applicable) or 'NO' (not occurring) is used as a basis for gap filling, it is treated as '0' and is not gap-filled.

(e) When both national total and sectoral data are unavailable, sectors are first gap-filled and then summed to determine the total.

(f) When the national total is available but there are no sectoral data, the sectoral split of the previous or following year is used to fill the gaps.

11. After this automated gap-filling procedure, some manual corrections are necessary for all cases in which TSP emissions are smaller than PM_{10} emissions, PM_{10} emissions are smaller than $PM_{2.5}$ emissions or $PM_{2.5}$ emissions are smaller than BC emissions. In these cases, PM_{10} data were equated with TSP data, $PM_{2.5}$ data with PM_{10} data and BC data with $PM_{2.5}$ data.

1.4.6 Gridded data

According to the revised reporting guidelines, Parties within the geographical scope of EMEP should report gridded data in the resolution of 0.1 ° × 0.1 ° longitude-latitude every 4 years, commencing in 2017. Since gridded data for the EU were last submitted in 2017 (EEA, 2017c), they are not reported this year. However, in 2018 five Member States (Bulgaria, Croatia, Ireland, Italy and Romania) provided gridded data (see Appendix 3, Table A3.1).

1.4.7 Large point sources

Parties within the geographical scope of EMEP are also required to provide data on large point sources (LPSs) every 4 years, commencing in 2017. LPS data for the EU were last submitted in 2017 (EEA, 2017c) and not reported again this year. In 2018, Romania and Finland provided LPS data.

1.5 Key category analyses

A key category is an emission source category that has a significant influence on an inventory. It may affect the absolute level of emissions, the trend in emissions, or both. This report classifies categories jointly responsible for 80 % of the national total emissions of a given pollutant as key categories (see EMEP/EEA, 2016).

A level analysis of 2016 emissions for each pollutant (following any necessary gap filling) determined EU key categories. When a Member State used the notation 'included elsewhere' (IE) for a particular source/pollutant combination, the KCA is likely to have underestimated the category concerned, and overestimated the one in which emissions were reported instead.

Chapter 3 provides a summary of the top five EU key categories in 2016, for NO_x, NMVOCs, SO_x, NH_3, $PM_{2.5}$, PM_{10}, CO, HMs (Pb, Cd and Hg) and POPs (PCDD/Fs, total PAHs, B(a)P, HCB and PCBs). A complete list of all EU key categories for the emissions of these pollutants is also given in Figure 1.2. Additional HMs, TSPs, BC or the remaining POPs are not considered here.

A total of 55 different emission inventory source categories were identified as being key categories for at least one pollutant. A number of emission categories were identified as being key categories for more than one of the 15 pollutants assessed. '1A4bi — Residential: Stationary' and '1A1a — Public electricity and heat production' were identified as being important emission sources for 14 and ten pollutants, respectively. Similarly, both '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' and '2C1 — Iron and steel production' were key categories for eight pollutants.

For NO_x and CO, 12 and nine key categories were identified, respectively; as expected for both of these pollutants, the key categories with a large share in total emissions reported mainly involve fuel combustion. Ten key categories were identified for SO_x (mainly energy related sectors), and seven for NH_3 (all from the 'agriculture' sector). PM_{10}, $PM_{2.5}$ and NMVOC emission sources are more diverse, so larger numbers of source categories make up the key category threshold of 80 % of total emissions. For the PM pollutants, key categories comprise all sectors, while a key aspect for NMVOCs was high activity levels associated with the sector 'industrial processes and product use'.

For the HM Cd, 12 key categories were identified, as were 10 for Hg and nine for Pb. Emissions from these key categories were mostly related to the energy sectors and 'industrial processes and product use', resulting particularly from processes associated with metal production.

For the POPs, source categories from all sectors except 'road transport' and 'agriculture' have been identified as key categories. On the whole, metal production was quite an important key source of POP emissions. However, emissions from 'Residential: Stationary' also contributed a large share to emissions of many of the POPs.

Several factors may influence the determination of key categories at EU level. The notation key 'IE' (see Appendix 1) means that a Member State can include emission estimates for one NFR sector in those of a different sector. In addition, Member States have different ways of allocating emissions to the (sub)sector 'Other', which might lead to inconsistencies. Given such issues, the EU KCA may not always accurately reflect the share of all main emission sources. It is also crucial to note that the results of a similar analysis of individual Member States will differ from the key sources determined for the EU.

Figure 1.2 EU KCA results for 2016: bubble size indicates amount of emissions

Notes: For NFR14 codes, see list of source sector abbreviations (Appendix 4). All values > 10 % are indicated.

1.6 Quality assurance, quality control and verification methods

Member States are encouraged to use appropriate QA and QC procedures to ensure data quality and to verify and validate their emission data. These procedures should be consistent with those described in the Inventory guidebook (EMEP/EEA, 2016).

The main activities improving the quality of the EU inventory are the checks that the EEA's ETC/ACM performs on the status of each Member State's

Table 1.5 Overview of quality checks within the preparation of the EU LRTAP inventory and report

	Check												
	Completeness	Consistency	Comparability	Accuracy	Transparency	Level	Years	First checks	Subsequent checks (after gap-filling)	Checks within the draft report	Member States will be informed on the finding	Changes/ corrections
Reporting overview	✓		✓		✓	Submissions	1990-2016	✓			If submission is missing or in wrong format	Gap-filling of missing data as far as possible
Adjustment overview	✓		✓		✓	Submissions	2010-2016	✓			If a document is missing or in wrong format	
Completeness	✓				✓	Submissions	1990-2016	✓			Yes	Only in case of resubmissions of the Member State
Time series checks	✓	✓				National Totals, Sectors	1990-2016	✓			Yes	Only in case of resubmissions of the Member State
NFR template line 144 check			✓		✓	National Totals	1990-2016	✓			Yes	Only in case of resubmissions of the Member State
Total PAHs = Sum of PAHs				✓		National Totals	1990-2016	✓			Yes	Only in case of resubmissions of the Member State
TSP-PM_{10} ratio, PM_{10}-$PM_{2.5}$ ratio checks				✓		National Totals	1990-2016	✓			Yes	Only in case of resubmissions of the Member State
TSP ≥ PM_{10}, PM_{10} ≥ $PM_{2.5}$, $PM_{2.5}$ ≥ BC checks				✓		National Totals, Categories	1990-2016	✓			Yes	Only in case of resubmissions of the Member State
National Total = Sum of Sectors	✓			✓		National Totals, Sum of Sectors	1990-2016		✓		If difference is more than 5 %	Only in case of resubmissions of the Member State
'NE' analysis	✓					National Totals, Categories	2016		✓	✓	Within the review of the draft version of the report	Only in case of resubmissions of the Member State
'NA' and 'NO' checks				✓	✓	National Totals, Categories	2016		✓		Yes	Only in case of resubmissions of the Member State
Recalculations		✓				National Totals	1990-2015			✓	Within the review of the draft version of the report	No
Effect of gap-filling	✓				✓	Whole EU inventory	1990, 2016			✓	Within the review of the draft version of the report	No
Completeness of the EU inventory	✓				✓	Whole EU inventory	1990, 2016			✓	Within the review of the draft version of the report	No

submission. In addition, it checks the internal consistency of Member States' data tables before compiling the EU tables. It checked Member State data at national total and sectoral level: when it found outliers, it identified the categories responsible. When it found no explanation for a notable trend in the IIRs, it contacted Member States. The checks focused on data that appreciably affect EU trends. An overview of the checks performed is given in Table 1.5, and of the findings in Table 1.6.

Member States also provide external checks through an Eionet review before the EU submits the final version of the EU inventory to the secretariat of the LRTAP Convention. Further, an important element in improving the quality of national and EU LRTAP Convention inventories is the annual meeting of the TFEIP. This expert meeting discusses quality issues concerning the emission reporting of Member States. The 2018 meeting took place in Sofia, Bulgaria, in April (TFEIP, 2018).

The agreed gap-filling procedure is one of the instruments used to assure and improve the quality of the EU inventory. It analyses and, where possible, fills gaps in reporting of sectoral emissions and total emissions for any year. This improves the key features of completeness, comparability and consistency over the years, and motivates Member States to report their data in the following reporting cycle (further details on gap filling are available in Section 1.4.5).

All inventory documents (submissions, inventory master files, inventory reports, status reports and related correspondence) are archived electronically at the EEA ETC/ACM Forum data portal. Revisions of data sets are recorded.

The EMEP CEIP performs more detailed QA activities in an annual review process (EMEP CEIP, 2018a). It reviews Member State LRTAP Convention emission inventories at the same time as the EEA reviews those reported under the NEC Directive (EU, 2016). The EMEP CEIP technical review of inventories has three stages. Stages 1 and 2 include checks on timeliness, formats, consistency, accuracy, completeness and comparability of existing Member State inventory submissions. Test results, provided to Member States, are used to improve the quality of the national emission inventories. A joint EMEP/EEA review report publishes summary results of the review (stages 1 and 2) each year ([8]).

Stage 3 is a technical in-depth review of selected countries. It checks if submitted emission inventories are complete, consistent over time, properly documented and accurate. The annual in-depth review aims to be consistent across the Parties. The process should ensure that the Parties follow the same approach each year. CEIP selects the countries in cooperation with the EEA and EMEP. In 2017, it reviewed Albania, Austria, the European Union, Kazakhstan, Kyrgyzstan, Liechtenstein, Malta and Monaco. The results are included in individual country-specific reports (EMEP CEIP, 2018c). In 2018, it plans to review Armenia, Azerbaijan, Belarus, Finland, Moldova, Montenegro and Ukraine.

Table 1.6 Findings of the quality checks within the preparation of the EU LRTAP inventory and report

Test/check	Findings	Number of Member States concerned
Completeness	4	4
Time series checks	132	24
NFR template line 144 check	5	4
Total PAHs = sum of PAHs	9	9
TSP:PM_{10} ratio, PM_{10}:$PM_{2.5}$ ratio checks	4	3
TSP ≥ PM_{10}, PM_{10} ≥ $PM_{2.5}$, $PM_{2.5}$ ≥ BC checks	60	17
National total = sum of sectors ([a])	2	1
'NE' analysis ([a])	666	28
'NA' and 'NO' checks ([a])	166	22

Note: ([a]) The check was performed on the gap-filled EU inventory.

([8]) EMEP and EEA will jointly publish a summary of the results of the stage 1 and 2 review performed in 2018 (EMEP/EEA, forthcoming).

1.7 General uncertainty evaluation

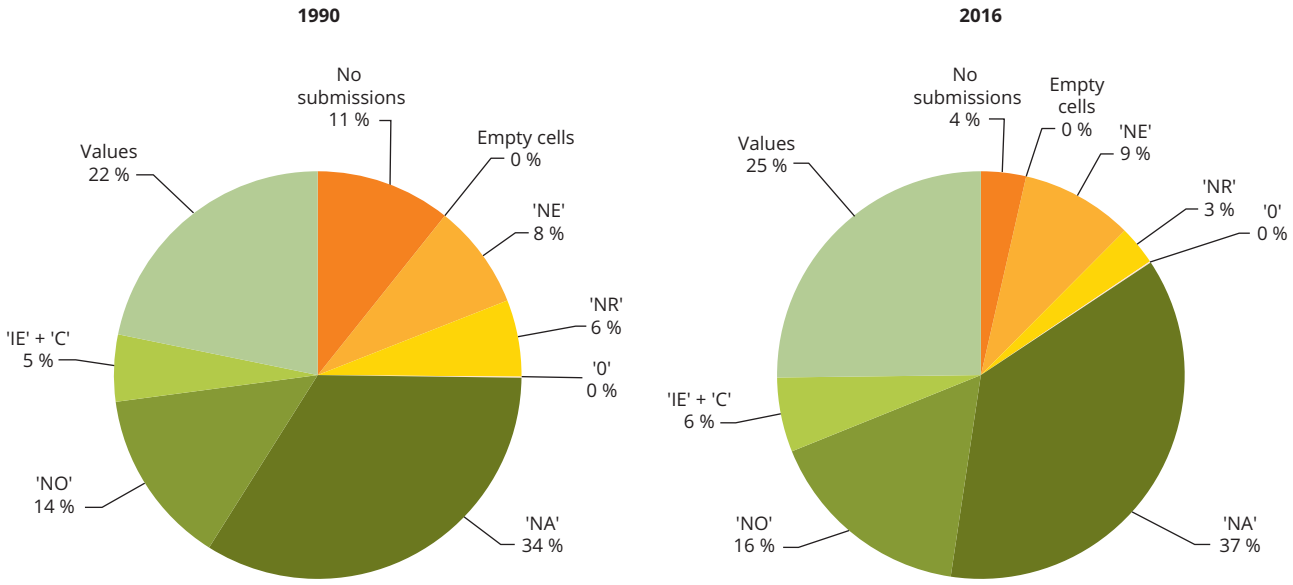
To quantify uncertainty in the EU LRTAP emission inventory, Member States first need to provide detailed information on emission uncertainties. Only 18 Member States (Austria, Belgium, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, Netherlands, Poland, Spain, Sweden and the United Kingdom) quantified uncertainty in their emission inventories of 2016. The pollutants that they consider and the assumptions behind the uncertainty analysis vary across Member States. Because so few Member States provide an uncertainty estimate, the overall uncertainty of the EU LRTAP inventory cannot be estimated.

1.8 Completeness and underestimations

Completeness in this context means that reports include estimates for all pollutants, all relevant source categories, all years and all territorial areas. For substances for which there are existing reporting obligations in the Convention and the protocols as further specified by Executive Body decision 2013/4, as shown in Appendix 3, one Member State (Greece) did not submit any data. Two Member States (Malta and Romania) did not provide complete time series in 2018. For substances and data for which reporting is encouraged, Austria, Luxembourg and Slovenia submitted no data for additional HMs, and Finland and Poland no data for Se. Austria and Luxembourg did not report data for BC; Austria, Finland, Italy and Spain submitted only total PAHs, but no data for all the individual components. A total of 25 Member States reported activity data ([9]) for the complete time series (1990-2016). The stage 1 review provides detailed results for the completeness of Member State submissions (EMEP CEIP, 2018c).

Figure 1.3 shows a simple compilation indicating completeness of reporting by Member States for the inventory years 1990 and 2016. It uses the originally submitted NFR templates, i.e. before gap filling. It gives the percentages of each notation key or values that the reports present for source categories. The data are for all Member States and all pollutants (excluding national totals). The figures show that more data are available for 2016 than for 1990. The notation key 'NA' appears often. That is because an air pollutant is relevant only to specific emission sources (e.g. NH_3 for agriculture). This makes it necessary to use 'NA' for other sources. The use of the notation key 'NE', the reporting of empty cells, '0', and in some circumstances the reporting of

Figure 1.3 Completeness of reporting of NFR templates submitted by Member States (all data entries for all pollutants, excluding national totals)

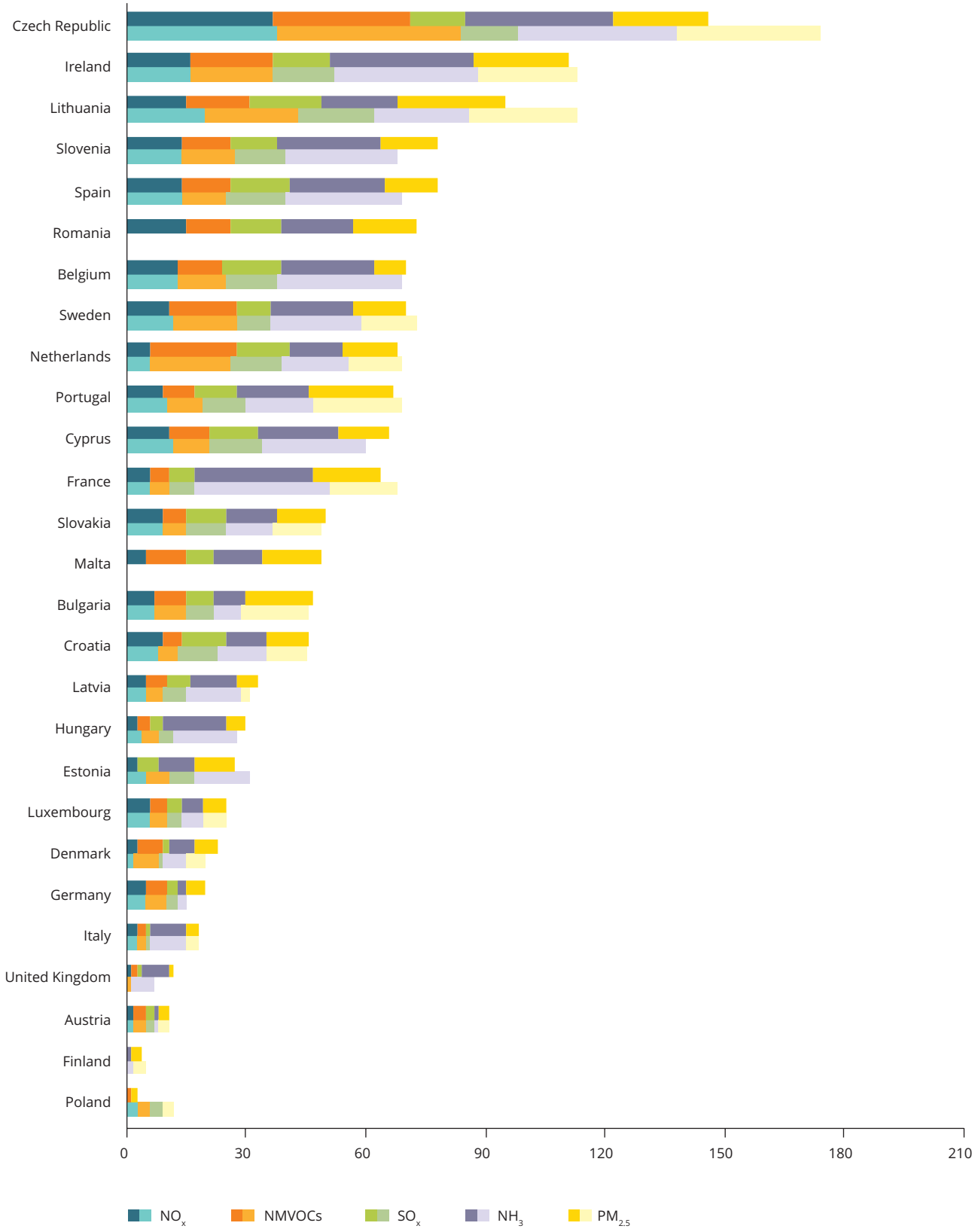


Notes: Appendix 1 provides further explanations on notation keys.

C, confidential; IE, included elsewhere; NA, not applicable; NE, not estimated; NO, not occurring; NR, not relevant.

([9]) Reporting of activity data together with emissions is mandatory from 2009 onwards.

Figure 1.4 Number of 'not estimated' source categories for 2016 (dark shades) and 1990 (light shades)



Note: The LRTAP Convention formally requests Parties to report emissions of PM for 2000 and thereafter. Therefore, 'NE' reporting for $PM_{2.5}$ in 1990 might be high for several countries.

the notation key 'NR' ([10]), as well as 'No submissions' and 'Empty cells', count as incomplete reporting. Member States reported 16 % of the 2016 data entries incompletely, and for 1990 they reported 25 % of the data incompletely.

The EMEP emission-reporting guidelines (UNECE, 2014a) require Parties to report data at least for the base year of the relevant protocol, and from the year it entered into force, and up to the latest year (2 years before the present) (see Appendix 2, Table A2.1). So, ideally, there should be no difference between the availability of data submissions for 1990 and for 2016.

There are many instances where some countries report emissions for a particular NFR category and pollutant, while other countries use the notation key 'NA' or 'NO'. Annex K shows, for each Member State and for all categories, where data were reported, although 80 % or more of the other Member States reported 'NA' or 'NO' for these categories.

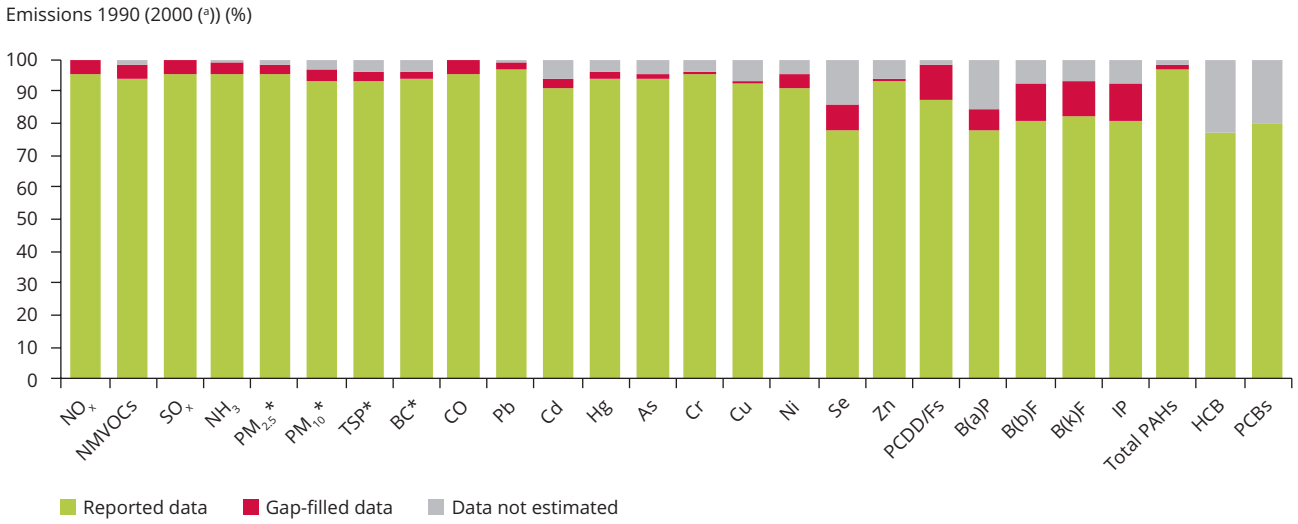
The official reporting guidelines of the LRTAP Convention (UNECE, 2014a) allow countries to report emissions as not estimated ('NE') for some sectors. This is carried out where they know that emissions occur, but have not estimated or reported them. Countries should separately report why they have not estimated emissions.

Certain Member States used the notation key 'NE' for many source categories (see Figure 1.4). The Czech Republic, for example, reported 37 source categories of NH_3 in 2016 as 'NE'. Overall, in most cases, the use of 'NE' in reporting in 2016 is similar to its use in 1990. Most uses of 'NE' (across all pollutants and Member States) are in the categories '1A3ai(i) — International aviation LTO (civil)', '5E — Other waste', '2D3g — Chemical products' and '1A3aii(i) — Domestic aviation LTO (civil)'. Within these categories, more than 25 % of the entries say 'NE'.

Figure 1.5 and Figure 1.6 show the proportions of gap-filled data and the estimated underestimation of the EU inventory for 1990 and 2000. The calculated underestimation comprises missing data (e.g. if emission data of a pollutant were not estimated by a Member State and no data were available for gap filling) and the use of the notation keys 'NE' and 'NO' and zero values. To calculate the underestimation, the specific share of total emissions for each Member State was first assessed. The share was calculated as the mean value of the respective Member State's share of those pollutants, where a national total (gap-filled or reported) from all Member States was available. In the gap-filled inventory, whenever the notation key 'NE' or 'NR' was used, or zero data was reported within a sector, the share of this Member State is used to calculate the missing emissions within the respective sector. The sum of the missing emissions from all sectors and Member States is then calculated as the percentage value of the total emissions of a pollutant.

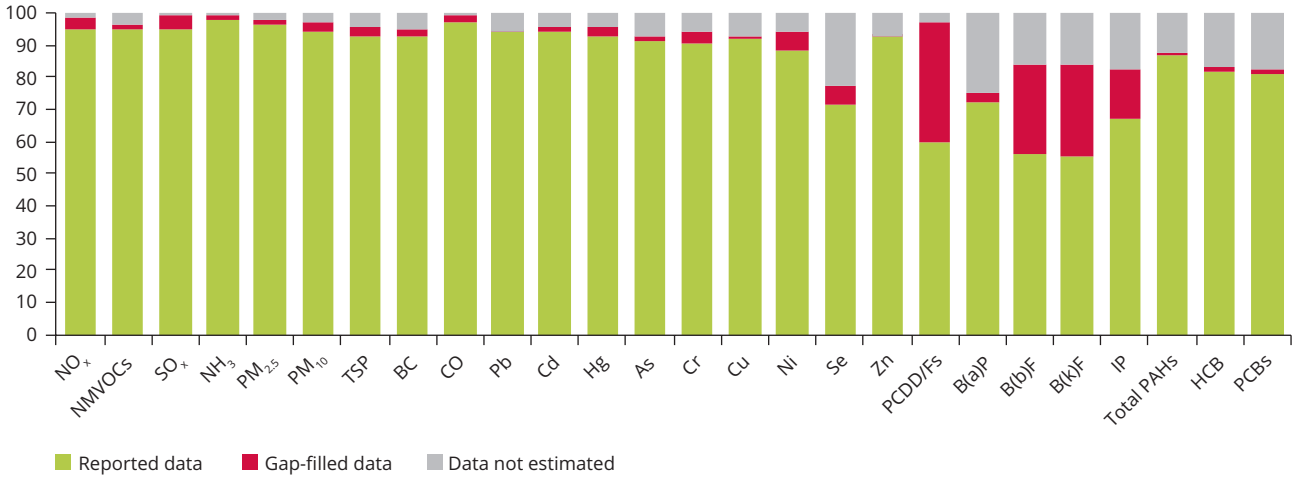
([10]) According to paragraph 9 of the emission-reporting guidelines (UNECE, 2014a), emission inventory reporting should cover all years from 1980 onwards if data are available. However, 'not relevant' (NR) has been added, to ease reporting where the different protocols do not strictly require details of emissions. Only in these circumstances is 'NR' correct and appropriate.

Figure 1.5 Completeness and effect of gap filling on EU emission data for 1990 (TSPs, PMs, BC: 2000)



Note: (a) For TSP, PMs and BC: data for the year 2000 are shown.

Figure 1.6 Completeness and effect of gap filling on EU emission data for 2016



2 Adjustments under the Gothenburg Protocol

In 2012, the Executive Body of the LRTAP Convention decided that adjustments to emission reduction commitments or to inventories may be applied in some circumstances (UNECE, 2012b). The EMEP CEIP leads the adjustment procedure, coordinates the review of any supporting documentation and assesses if the adjustment is consistent with the particular circumstances and the guidance for adjustments (UNECE, 2012c). It makes the review available to the Parties, which have the option of making a submission to the Implementation Committee under Decision 2006/2 (UNECE, 2006).

These circumstances are as follows:

(a) emission source categories are identified that were not accounted for at the time the emission reduction commitments were set;

(b) emission factors used to determine emission levels for particular source categories have changed since the emission reduction commitments were set;

(c) the ways of determining emissions from specific source categories have changed significantly between the time when emission reduction commitments were set and the year they are to be attained.

Table 2.1 lists inventory adjustment applications that the EMEP Steering Body accepted in 2014, 2015, 2016 and 2017.

If a Party is planning to adjust its inventory for the purpose of comparing total national emissions with emission reduction commitments, it indicates in its notification to the UNECE secretariat and CEIP what categories and pollutants are affected. It uses Annex II to the reporting guidelines as a basis (UNECE, 2014a). Table 2.2 shows Member States that submitted their adjustment applications together with their LRTAP submissions via the CDR in 2018.

Table 2.3 gives an overview of reported adjustments within the LRTAP submission 2018. All approved and

Table 2.1 Accepted inventory adjustment applications (UNECE, 2014b, 2015, 2016, 2017)

Year of acceptance	Member State	Pollutant	NFR14 code	Years
2014	Denmark	NH_3	3Da1, 3De	2010-2012
2014	Germany	NO_x	1A3b	2010-2012
2014	Germany	NO_x	3B, 3D	2005-2012
2015	Belgium	NO_x	1A3bi-iv, 3B, 3Da1, 3Da2a	2010-2013
2015	Belgium	NMVOCs	3B, 3De	2010-2013
2015	Denmark	NMVOCs	3B	2010-2013
2015	Finland	NH_3	1A2gviii, 1A4ai, 1A4bi, 1A4ci, 1A3bi-iv	2010-2013
2015	France	NO_x	1A3bi-iv	2010-2013
2015	Germany	NMVOCs	3B, 3De	2010-2013
2015	Luxembourg	NO_x	1A3bi-iv	2010-2013
2015	Spain	NO_x	1A3bi, 1A3biii	2010-2012
2016	Germany	NO_x	3Da2c, 3I	2010-2014
2016	Germany	NH_3	3Da2c, 3I	2010-2014
2016	Luxembourg	NO_x	3B, 3De	2010-2014
2016	Luxembourg	NMVOCs	3B, 3De	2010-2014
2017	Spain	NO_x	3B	2010-2015

Note: For NFR14 codes, see list of source sector abbreviations in Appendix 4.

Table 2.2 Adjustment application within the LRTAP submission 2018 (Annex II to the reporting guidelines (UNECE, 2014a)) (as of 6 May 2018)

Member State	Pollutant	NFR	Years
Hungary	NMVOCs	3B, 3De	2010-2016
United Kingdom	NO_x	1A3b, 1A3dii, 1A4ciii, 3B, 3D	2010

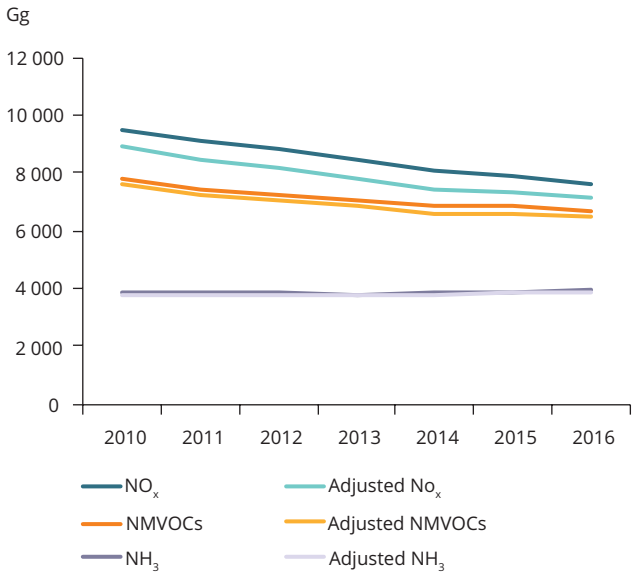
Table 2.3 Reporting of approved adjustments within the LRTAP submission 2018 (Annex I and Annex VII to the reporting guidelines (UNECE, 2014a)) (as of 6 May 2018)

Member State	Pollutant	Years	Annex I ('adjustment row')	Annex VII	Declaration on consistent reporting of approved adjustments
Belgium	NO_x	2010-2016	Yes	Yes	Yes
Denmark	NH_3	2010-2016	Yes	Yes	Yes, within the cover letter
Denmark	NMVOCs	2010-2016	Yes	Yes	Yes, within the cover letter
Finland	NH_3	2010-2016	Yes	Yes	Yes
France	NO_x	2010-2016	Yes	Yes	Yes
Germany	NO_x	2010-2016	Yes	Yes	Yes
Germany	NMVOCs	2010-2016	Yes	Yes	Yes
Germany	NH_3	2010-2016	Yes	Yes	Yes
Luxembourg	NO_x	2010-2016	Yes	Yes	No
Luxembourg	NMVOCs	2010-2016	Yes	Yes	No
Spain	NO_x	2010-2015	Yes	Yes	Yes

reported adjustments also appear in the emission trend tables in Sections 3.3 (NO_x, Table 3.6), 3.4 (NMVOCs, Table 3.7) and 3.6 (NH_3, Table 3.9). Parties shall report details of their approved adjusted aggregated emissions using the appropriate row in the main emissions reporting template (Annex I to the reporting guidelines (UNECE, 2014a)). They shall also provide detailed information by pollutant and sector for each adjustment using the template provided in Annex VII to the reporting guidelines. Reporting of information on adjusted emissions in no way suspends the mandatory requirement for Parties to report unadjusted emissions as laid down in section v, subsections A-D, of the guidelines.

Figure 2.1 shows for the EU the effect of the adjustments on the emissions (sum of Member States' adjustments). For NO_x and NMVOCs, the EU emissions change considerably, but there is only a slight effect on the NH_3 emissions.

Figure 2.1 Adjusted and unadjusted emissions of NO_x, NMVOCs and NH_3 for the EU, 2010-2016



3 Trends and key categories of EU pollutant emissions

The present EU inventory lists emissions for all the main air pollutants: PMs, HMs and POPs. It also reports the individual PAHs for which the LRTAP Convention requires or recommends inventory reporting (UNECE, 1979).

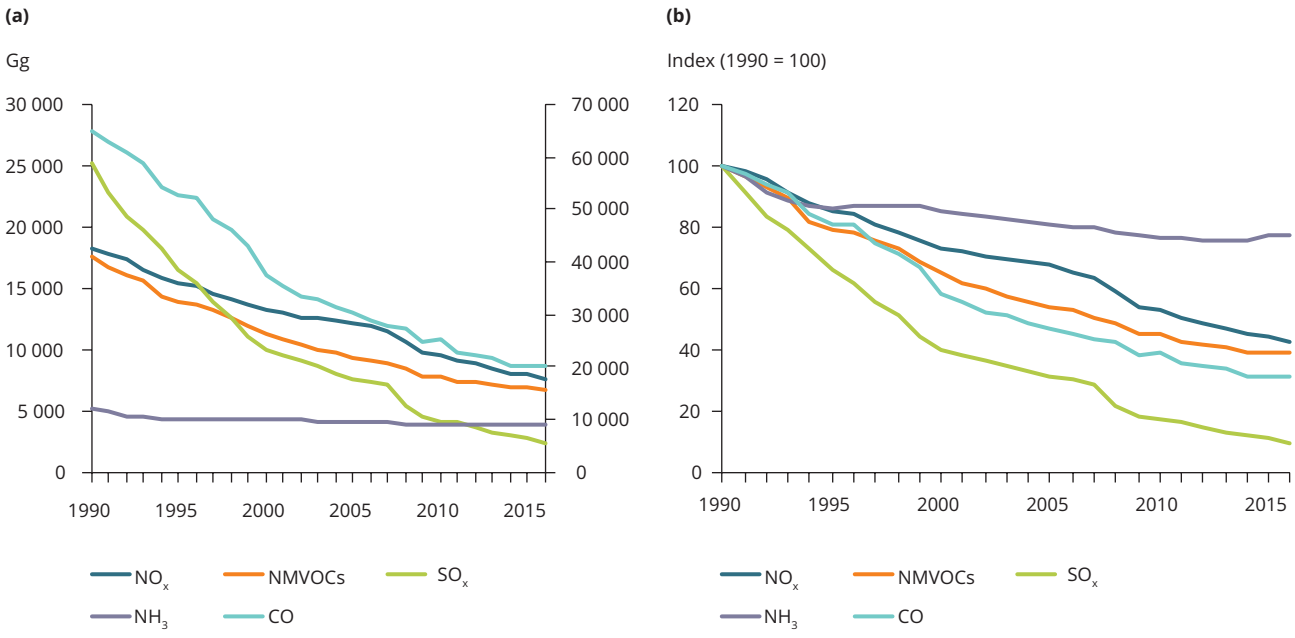
The following sections of Chapter 3 summarise the contributions each Member State has made to the EU total emissions of NO_x, NMVOCs, SO_x, NH_3, CO, $PM_{2.5}$, PM_{10}, TSPs, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/Fs, total PAHs, B(a)P, B(b)F, B(k)F and IP, HCB and PCBs. For the main pollutants and PM, and for the main HMs and POPs, the emission trend of the EU for the five most important key categories is given, as well as the share by sector group and sectoral emission trends. For BC, additional HMs, B(a)P, B(b)P, B(k)F and IP, data for several countries were missing and could not be gap-filled. Therefore, the EU total is not complete (see also Section 1.8).

3.1 Total EU emission trends and progress towards the Gothenburg Protocol 2010 emission ceilings

Emissions of all pollutants except Cu were lower in 2016 than in 1990 (or in 2000 for PM). Among the main air pollutants, the largest reductions across the EU (in percentage terms) since 1990 were for SO_x emissions (which decreased by 91 %), followed by CO (-69 %), NMVOCS (-62 %), NO_x (-58 %) and NH_3 (-23 %) (Figure 3.1).

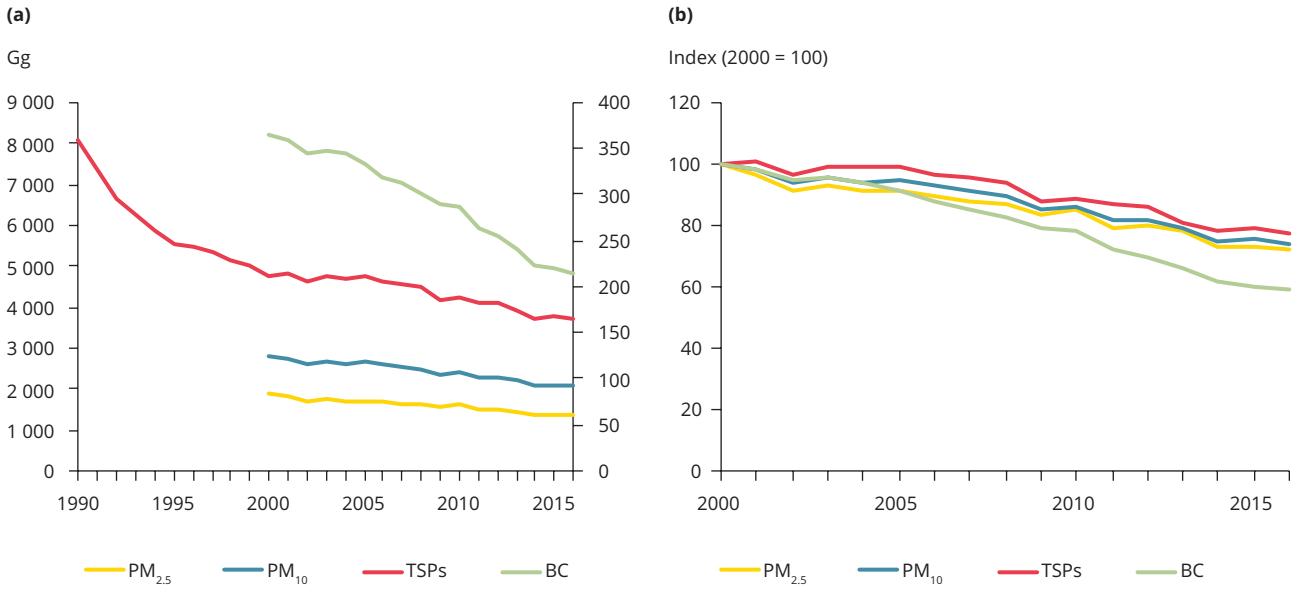
Emissions of PM, BC and TSPs have also dropped substantially since 1990 (Figure 3.2). Emission data for 2000-2016 indicate that $PM_{2.5}$ and PM_{10} emissions have fallen by 28 % and 26 %, respectively (Figure 3.2).

Figure 3.1 (a) EU emission trends and (b) indexed emissions for the main air pollutants



Note: The right-hand axis gives values for CO emissions.

Figure 3.2 (a) EU emission trends and (b) indexed emissions for PM and BC



Notes: The right-hand axis shows values for BC emissions. Not all Member States reported data for BC. The LRTAP Convention formally requests Parties to report emissions of PM for 2000 and thereafter. Thus, emission trends can be shown for these years only.

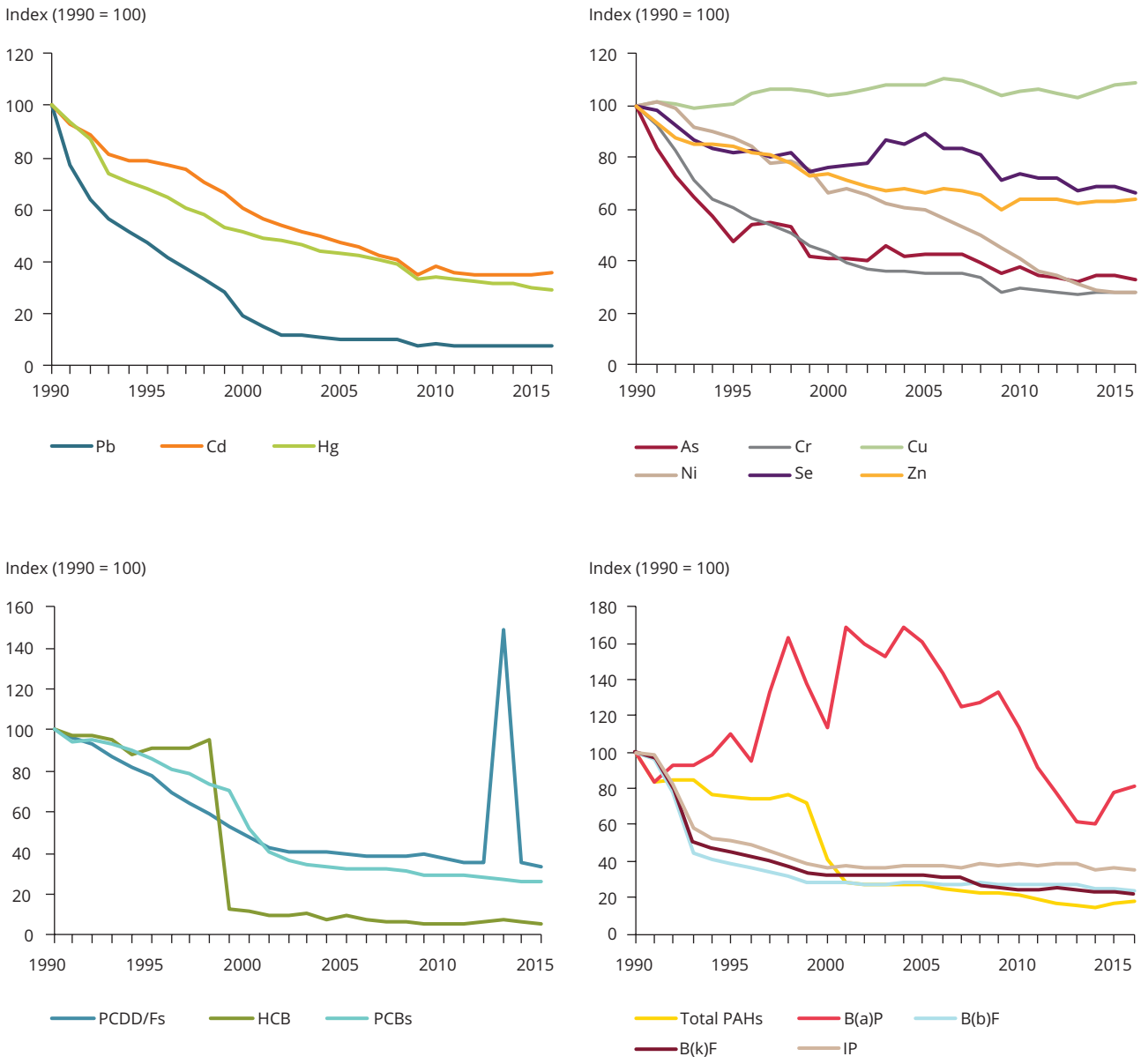
The indexed emissions are based on emissions in 2000 (= 100 %).

In addition, for HMs and POPs, emissions have reduced significantly since 1990 (Figure 3.3). Reductions are especially high for Pb (-93 %) and HCB (-95 %).

For various pollutants (e.g. PM, HMs and POPs), some Member States did not report data, or reported the notation key 'NE' or 'NR' for certain years or the whole time series. In some cases, the data could not be gap-filled, so they were not included in the EU total. See also Section 1.8 for details on completeness and underestimations.

Data tables in Chapter 3 (Table 3.6 to Table 3.31) show each Member State's reported emissions. They indicate instances where emissions of a certain pollutant are unrecorded for all years. Further, information received from the Member States or found in their IIRs is included in the trend sections (see Sections 3.3 to 3.28). If no information on unusual trends is given, Member States are contacted, informed about the findings and requested to send an explanation. As often no information on unusual trends is received, it is very inconsistent in Sections 3.3 to 3.28 which variations in trends are explained and which are not.

Figure 3.3 Indexed EU emission trends for HMs and POPs



Notes: The drop in HCB emissions between 1998 and 1999 is because the United Kingdom reported a considerable reduction over this period. The peak in PCDD/Fs emissions in 2013 is caused by data reported by Malta.

The trend of the B(a)P emissions follows the data reported by Portugal.

Table 3.1 Total EU emissions of the main air pollutants: HMs, POPs and PM

Pollutant	Unit	1990	1995	2000	2005	2015	2016	Change (%) 1990-2016	Change (%) 2015-2016
NO_x	Gg	18 139	15 427	13 202	12 167	7 936	7 644	-58	-3.7
NO_x (adjusted data)*	Gg					7 339	7 184		
NMVOCs	Gg	17 461	13 771	11 254	9 385	6 823	6 707	-62	-1.7
NMVOCs (adjusted data)*	*Gg*					*6 577*	*6 463*		
SO_x	Gg	25 078	16 586	10 035	7 677	2 802	2 378	-91	-15.1
NH_3	Gg	5 080	4 348	4 294	4 078	3 896	3 913	-23	0.4
NH_3 (adjusted data)*	*Gg*					*3 827*	*3 842*		
TSPs	Gg	8 109	5 544	4 768	4 740	3 775	3 707	-54	-1.8
CO	Gg	64 804	52 420	37 356	30 288	20 254	20 142	-69	-0.6
Pb	Mg	22 703	10 749	4 402	2 323	1 673	1 661	-93	-0.7
Cd	Mg	201	159	123	94	70	71	-65	2.0
Hg	Mg	199	136	103	86	60	58	-71	-3.4
As	Mg	524	249	214	222	181	173	-67	-4,4
Cr	Mg	1 226	747	536	432	340	342	-72	0.5
Cu	Mg	3 592	3 616	3 732	3 868	3 864	3 897	8	0.9
Ni	Mg	2 159	1 888	1 438	1 290	601	602	-72	0.2
Se	Mg	265	217	201	236	182	176	-34	-3.0
Zn	Mg	9 878	8 311	7 254	6 520	6 253	6 283	-36	0.5
PCDD/Fs	g I-Teq	9 183	7 143	4 416	3 644	3 076	2 991	-67	-2.8
B(a)P	Mg	1 148	1 257	1 297	1 838	896	935	-19	4.4
B(b)f	Mg	1 074	414	302	300	270	256	-76	-5.0
B(k)f	Mg	502	228	163	162	117	110	-78	-5.6
IP	Mg	414	212	153	154	153	144	-65	-5.8
Total PAHs	Mg	10 563	8 004	4 373	2 817	1 784	1 845	-83	3.4
HCB	kg	5 309	4 825	613	497	269	278	-95	3.5
PCBs	kg	13 480	11 598	6 937	4 408	3 524	3 454	-74	-2.0
								Change (%) 2000-2016	**Change (%) 2015-2016**
$PM_{2.5}$	Gg			1 861	1 706	1 363	1 343	-28	-1.5
PM_{10}	Gg			2 783	2 637	2 099	2 064	-26	-1.7
BC	Gg			364	333	220	214	-41	-2.5

Notes: Negative percentage values indicate that emissions have decreased.

Table 3.1 and subsequent tables (Table 3.6 to Table 3.31) express changes in emissions between 1990 and 2016 as 100 $(E_{2016} - E_{1990}) / E_{1990}$ (%), where E_{2016} and E_{1990} are 2016 and 1990 total emissions, respectively. They express changes in emissions from 2015 to 2016 as 100 $(E_{2016} - E_{2015}) / E_{2015}$ (%), where E_{2016} and E_{2015} are thwe 2016 and 2015 total emissions, respectively.

The bases for the EU inventory shown in Table 3.1 and subsequent tables (Table 3.6 to Table 3.31, inclusive) are national total data of the entire territory, based on fuel sold for all Member States. See Section 1.4.4 for further details.

**Adjusted data*: under the Gothenburg Protocol, the EMEP Steering Board accepted inventory adjustment applications ([11]) for emissions from several Member States. This table takes these adjustments into account, whereas emission data are based on fuel sold. See Chapter 2 for further details.

([11]) In 2012, the Executive Body for the LRTAP Convention decided that adjustments to emission reduction commitments, or to inventories for the purposes of comparing total national emissions with them, may be applied in some circumstances (UNECE, 2012b).

The Gothenburg Protocol to the UNECE LRTAP Convention (UNECE, 1999) contains emission ceilings for the pollutants NO_x, NMVOCs, SO_x and NH_3. Parties to the protocol must meet them by 2010 and thereafter. In 2018, only Finland, Luxembourg (only WaM projectinos) and the United Kingdom voluntarily submitted projection data under the LRTAP Convention. However, the last reporting year for projection data was in 2017, for which several Member States had submitted emission projections. Submitted data are available in Annex E of this report. This report does not provide further detailed analysis of projections that countries reported in relation to the emission ceilings for 2010 in the Gothenburg Protocol.

In June 2018, the EEA publishes its annual NEC Directive reporting, which analyses the emission data reported under the EU NEC Directive for EU Member States (EEA, forthcoming). For the EU Member States, the new NEC Directive (EU, 2016) contains national emission reduction commitments for NO_x, NMVOCs, SO_2, NH_3 and $PM_{2.5}$ for 2020-2029 and for any year from 2030.

The comparison with the EU-15 ceilings of the Gothenburg Protocol in this report is on the basis of fuel sold, except for Austria, Belgium, Ireland, Luxembourg, the Netherlands and the United Kingdom. These countries may choose to calculate emissions on the basis of fuel used for their territories (see Section 1.4.4).

In addition to ceilings for individual countries, the protocol also specifies ceilings for the EU, which is itself a Party to the protocol. Table 3.2 sets out the emissions that the EU-15 Member States reported for 2016, compared with the respective emission ceilings specified for the EU. For all four pollutants, emissions in 2016 were below the ceilings.

Figure 3.4 shows whether or not EU Member States met the Gothenburg ceilings in 2016. Estonia and Malta do not have Gothenburg ceilings, and Austria, Greece, Ireland, Italy and Poland have not yet ratified the Gothenburg Protocol and are therefore excluded from Figure 3.4. Three countries exceeded their NH_3 ceilings (Croatia, Germany and Spain), and one Member State (Hungary) did not comply with its ceiling for NMVOCs. All Member States complied with their NO_x (adjusted data) and SO_x ceilings.

Table 3.2 Comparison of emissions reported for 2016 by EU-15 Member States with emission ceilings for the EU specified in the UNECE Gothenburg Protocol

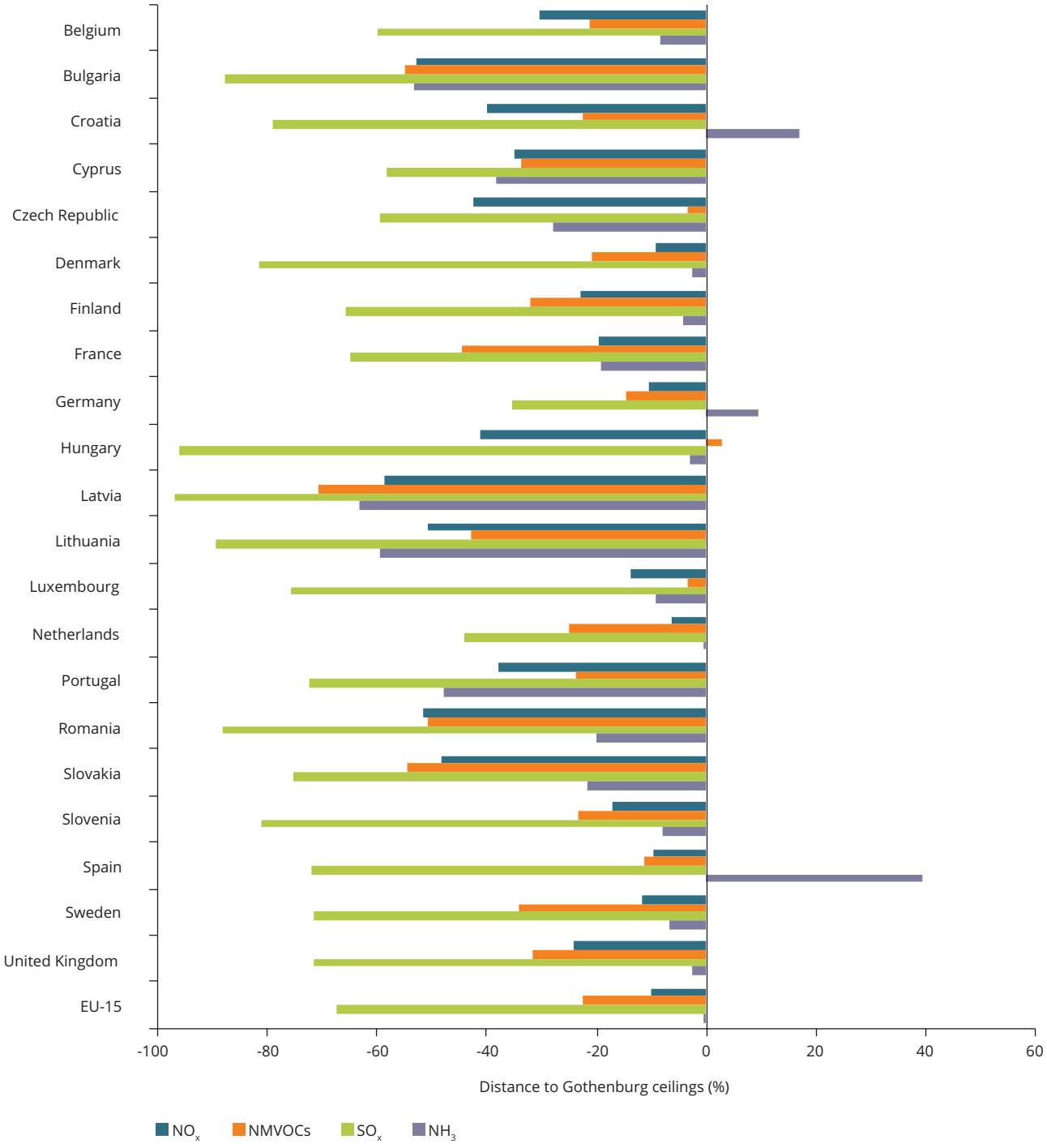
Pollutant	EU-15 emissions, 2016 (Gg)	EU-15 Gothenburg Protocol, 2010 ceilings (Gg)	Difference (%)	Sum of individual EU-15 ceilings (Gg) (a)
NO_x	6 004	6 671	-10	6 519
NMVOCs	5 111	6 600	-23	6 510
SO_x	1 332	4 059	-67	3 850
NH_3	3 115	3 129	-0.4	3 110

Notes: For Spain, data for emission comparisons exclude emissions from the Canary Islands, i.e. data comprise the EMEP domain only.

Under the Gothenburg Protocol, the EMEP Steering Board accepted inventory adjustment applications for emissions from Belgium, Denmark, Finland, France, Germany, Luxembourg and Spain in 2014, 2015, 2016 and 2017. However, as the EU-15 itself has not applied for adjustments, this table does not take these adjusted data into account.

(a) Emission ceilings are also specified for individual EU-15 Member States. The sum of these ceilings is different from the ceilings specified for the EU-15 as a whole.

Figure 3.4 **Distance of Member State emissions in 2016 to the ceilings set in the Gothenburg Protocol for 2010**



Notes: Estonia and Malta do not have Gothenburg ceilings. Austria, Greece, Ireland, Italy and Poland have ceilings, but they have not yet ratified the protocol. For Spain, data for emission comparisons exclude emissions from the Canary Islands.

The comparison with emission ceilings is based on reporting on the basis of fuel sold, except for Belgium, Luxembourg, the Netherlands and the United Kingdom. These countries may choose to calculate their emissions on the basis of fuel used in their territories instead (UNECE, 2014a). For the EU-15, the comparison is based on fuel sold.

Under the Gothenburg Protocol, the EMEP Steering Board accepted inventory adjustment applications for emissions from Belgium, Denmark, Finland, France, Germany, Luxembourg and Spain in 2014, 2015, 2016 and 2017. This table takes these adjusted data into account. The EU-15 did not apply for adjustments and thus data for the EU-15 are unadjusted.

3.2 Progress of non-EU countries in meeting 2010 emission ceilings under the Gothenburg Protocol to the UNECE LRTAP Convention

3.2.1 Emissions of non-EU EEA member countries Iceland, Liechtenstein, Norway, Switzerland and Turkey

In 2018, all EEA-5 (non-EU EEA member countries Iceland, Liechtenstein, Norway, Switzerland and Turkey) countries except Liechtenstein submitted their emission data (see Table 3.3).

3.2.2 Progress in meeting the ceilings

The Gothenburg Protocol of the LRTAP Convention specifies emission ceilings for 2010 and onwards for three EEA-5 member countries (Liechtenstein, Norway and Switzerland) (UNECE, 1979, 1999); see Table 3.4. Liechtenstein has signed but not yet ratified the protocol. The EEA member countries Iceland and Turkey have not yet signed the Gothenburg Protocol. Emission data for Norway and Switzerland are compared with the countries' emission ceilings under the Gothenburg Protocol.

Table 3.3 Emissions reported by the EEA-5 member countries from 2010 to 2016

EEA Member Country	Emission data (Gg)													
	NO_x							NMVOCs						
	2010	2011	2012	2013	2014	2015	2016	2010	2011	2012	2013	2014	2015	2016
Iceland	24	22	22	22	21	22	24	7.3	7.2	7.1	7.1	6.7	6.8	7.4
Liechtenstein														
Norway	189	185	180	169	160	154	151	150	144	144	147	157	157	152
Switzerland (a)	75	71	71	71	68	66	64	81	78	77	75	74	72	70
Turkey	698	737	649	679	680	691	703	1 060	1 043	1 104	1 049	1 046	1 086	1 071
	SO_x							NH_3						
	2010	2011	2012	2013	2014	2015	2016	2010	2011	2012	2013	2014	2015	2016
Iceland	74	73	84	70	63	56	50	5.3	5.3	5.3	5.1	5.4	5.4	5.4
Liechtenstein														
Norway	20	19	17	17	17	16	16	29	28	28	28	29	28	28
Switzerland (a)	10	8.5	8.8	8.5	7.7	6.5	6.2	59	59	58	57	58	57	57
Turkey	2 557	2 638	2 703	1 940	2 149	1 949	2 251	547	567	628	657	667	650	713

Note: (a) Data are based on fuel used for road transport.

Table 3.4 Gothenburg Protocol UNECE LRTAP Convention ceilings

	Gothenburg Protocol Ceilings			
	NO_x	NMVOCs	SO_x	NH_3
Liechtenstein	0.37	0.86	0.11	0.15
Norway	156	195	22	23
Switzerland	79	144	26	63

Table 3.5 Progress in meeting Gothenburg Protocol UNECE LRTAP Convention emission ceilings

	NO_x							NMVOCs						
Member State	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Norway	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Switzerland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

	SO_2							NH_3						
Member State	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Norway	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×
Switzerland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: Switzerland's assessment is based on data for fuel used.

'✓' attained; '×' not attained.

Data from the above-mentioned countries show that, although Norway exceeded its NO_x ceilings from 2010 to 2014, it complied in 2015 and 2016, while it exceeded its NH_3 emission ceilings in all years. Switzerland complied with all ceilings for all pollutants (see Table 3.5).

3.3 Nitrogen oxide (NO_x) emission trends and key categories

Between 1990 and 2016, NO_x emissions dropped in the EU by 58 %. Between 2015 and 2016, the decrease was 3.7 %, mainly because the United Kingdom, Spain, France, Germany and Italy (countries ranked according to the size of their contribution to the absolute change) noted reductions (Table 3.6). The gap-filled data for Greece also contributed to the decrease in NO_x emissions. The Member States that contributed most (i.e. more than 10 %) to NO_x emissions in 2016 were Germany, the United Kingdom, France and Spain (countries ranked according to the percentage of their share in the EU total).

In the following pollutant specific chapters, chapter 1.3 to chapter 1.28, the names of countries in enumerations are always ranked according to certain criteria, e.g. the percentage of their share in the EU total. The criteria for the ranking are specified in brackets.

Table 3.6 to Table 3.31 include two EU totals. The first is the sum of national totals that Member States officially reported. The second is the sum of the sectors of all Member States. A difference between these two EU totals arises when only national totals and no sectoral data are available. There is a third EU total for NO_x (Table 3.6), NMVOCs (Table 3.7) and NH_3 (Table 3.9). This total makes allowance for approved adjustments (see also Chapter 2).

Spain stated that the dramatic drop in NO_x emissions between 2005 and 2010 (the value for the national total in 2008 is 11 % lower than in the previous year) was due to the closure of the main brown coal mine in Spain in 2007 and the necessary retrofitting in 2008 of the adjacent thermal power plant (see Spain's IIR, listed in Appendix 5).

The main key categories for NO_x emissions were '1A3bi — Road transport: Passenger cars', '1A1a — Public electricity and heat production' and '1A3biii — Road transport: Heavy duty vehicles and buses'. Together, they made up 46 % of total emissions (see Figure 3.5). Of the top five key categories, the highest relative reductions in emissions between 1990 and 2016 were in the second most important, '1A1a — Public electricity and heat production' (-71 %) (see Figure 3.5(a)).

Figure 3.5(b) shows the contribution that each aggregated sector group made to total EU emissions. For NO_x, common key emission sources are the energy and transport sectors. Emission reductions from the road transport sector are primarily a result of fitting catalytic converters to vehicles (EEA, 2017b). The legislative standards, known as 'Euro' standards, have driven this move. Nevertheless, the road transport sector represents the largest source of NO_x emissions, accounting for 39 % of total EU emissions in 2016. The electricity/energy production sectors have also

Table 3.6 Member State contributions to EU emissions of NO_x

	NO_x (Gg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	220	201	215	240	185	176	171	172	162	159	154	-30	-3.1	1.2	2.0
Belgium	411	381	344	318	246	228	215	212	202	202	193	-53	-4.2	2.3	2.5
*Adjusted data**					*184*	*167*	*154*	*150*	*141*	*143*	*137*		*-4.5*		
Bulgaria	284	189	147	183	138	158	141	126	132	132	125	-56	-5.0	1.6	1.6
Croatia	106	81	86	84	67	64	58	57	53	54	52	-51	-2.6	0.6	0.7
Cyprus	16	19	22	22	19	22	22	17	18	15	15	-8	-2.7	0.1	0.2
Czech Republic	812	416	295	281	226	213	199	185	179	174	165	-80	-5.2	4.5	2.2
Denmark	303	291	227	205	150	141	130	125	116	115	115	-62	0.4	1.7	1.5
Estonia	79	48	45	42	43	41	38	35	35	32	31	-60	-0.9	0.4	0.4
Finland	306	258	234	205	184	169	160	156	148	134	131	-57	-2.5	1.7	1.7
France	1 953	1 777	1 617	1 417	1 078	1 015	987	970	900	875	842	-57	-3.9	10.8	11.0
*Adjusted data**					*932*	*863*	*833*	*807*	*737*	*715*	*691*		*-3.4*		
Germany	2 888	2 169	1 929	1 577	1 357	1 342	1 304	1 304	1 265	1 241	1 218	-58	-1.8	15.9	15.9
*Adjusted data**					*1 071*	*1 043*	*1 007*	*1 000*	*968*	*961*	*969*		*0.8*		
Greece	369	359	388	440	343	314	275	261	255	253	230	-37	-8.9	2.0	3.0
Hungary	235	184	183	174	142	134	125	123	122	124	117	-50	-6.1	1.3	1.5
Ireland	169	169	175	169	117	105	108	109	108	111	112	-34	0.9	0.9	1.5
Italy	2 068	1 944	1 489	1 281	972	934	876	818	804	783	761	-63	-2.8	11.4	10.0
Latvia	89	49	41	42	39	36	36	36	36	36	35	-61	-3.2	0.5	0.5
Lithuania	129	62	53	59	56	53	56	54	54	54	54	-58	-0.4	0.7	0.7
Luxembourg	40	34	41	55	33	33	31	27	25	22	20	-51	-9.8	0.2	0.3
*Adjusted data**					*30*	*29*	*26*	*23*	*21*	*18*	*16*		*-11.1*		
Malta	7.4	9.2	8.7	9.2	9.6	8.4	8.7	7.3	6.5	5.3	4.8	-35	-9.8	0.0	0.1
Netherlands	656	555	464	406	334	318	302	292	270	268	254	-61	-5.1	3.6	3.3
Poland	1 052	1 035	846	859	858	841	810	774	726	705	726	-31	3.1	5.8	9.5
Portugal	260	290	289	279	202	185	172	169	166	168	161	-38	-4.1	1.4	2.1
Romania	487	392	263	318	234	244	241	224	217	214	211	-57	-1.5	2.7	2.8
Slovakia	215	155	113	112	94	85	83	81	80	75	67	-69	-10.1	1.2	0.9
Slovenia	72	73	60	56	50	49	47	45	40	36	37	-48	2.4	0.4	0.5
Spain	1 391	1 414	1 388	1 387	952	937	902	789	801	805	765	-45	-5.0	7.7	10.0
*Adjusted data**					*816*	*807*	*783*	*670*	*683*	*711*					
Sweden	280	250	216	184	157	150	143	140	139	134	131	-53	-2.7	1.5	1.7
United Kingdom	3 242	2 622	2 026	1 763	1 242	1 154	1 178	1 118	1 045	1 010	916	-72	-9.3	17.9	12.0
EU-28 ([a])	**18 139**	**15 427**	**13 202**	**12 167**	**9 527**	**9 151**	**8 821**	**8 426**	**8 105**	**7 936**	**7 644**	**-58**	**-3.7**	**100**	**100**
EU-28 ([b])	18 139	15 427	13 202	12167	9 527	9 151	8 821	8 426	8 105	7 936	7 644				
EU-28 ([c])	18 139	15 427	13 202	12 167	8 893	8 505	8 184	7 775	7 462	7 339	7 184				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

([a]) Sum of national totals as reported by Member States.

([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

([c]) Sum of national totals as reported by Member States allowing for approved adjustments.

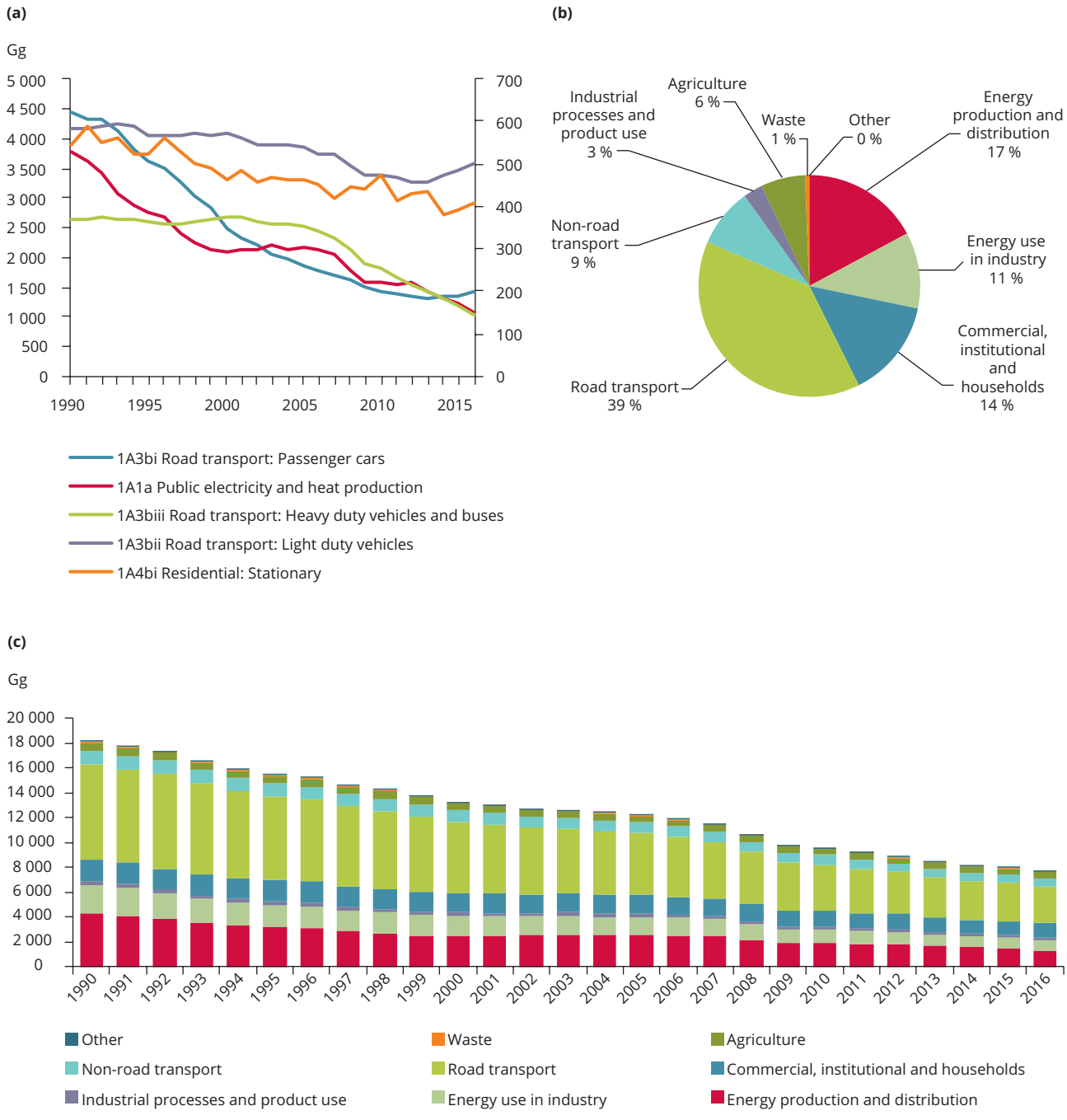
* *Adjusted data*: under the Gothenburg Protocol, the EMEP Steering Board accepted inventory adjustment applications for emissions from Belgium, France, Germany, Luxembourg and Spain, whereas emission data are based on fuel sold.

reduced their emissions, thanks to measures such as introducing combustion modification technologies (e.g. low-NO_x burners), implementing flue gas abatement techniques (e.g. NO_x scrubbers and selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR) techniques), and switching fuel from coal to gas (EEA, 2017b).

Non-methane volatile organic compound (NMVOCs) emission trends and key categories

Between 1990 and 2016, NMVOC emissions dropped in the EU by 62 %. Between 2015 and 2016, Member States reported a decrease of 1.7 %, mainly due to decreased emissions in Greece (gap-filled data), the

Figure 3.5 **NO_x emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions**



Note: In Figure 3.5(a), the right-hand axis shows values for '1A3bii — Road transport: Light duty vehicles' and '1A4bi — Residential: Stationary'.

Table 3.7 Member State contributions to EU emissions of NMVOCs

	NMVOCs (Gg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	303	218	176	160	144	139	139	141	135	138	138	-55	-0.1	1.7	2.1
Belgium	330	278	217	176	142	130	127	124	117	115	114	-65	-0.2	1.9	1.7
*Adjusted data**					*142*										*0.0*
Bulgaria	561	152	107	96	90	91	89	83	82	83	84	-85	1.3	3.2	1.2
Croatia	175	119	106	117	90	85	79	75	68	69	70	-60	1.3	1.0	1.0
Cyprus	15	15	15	18	15	10	10	9.2	8.8	9.0	9.3	-39	2.5	0.1	0.1
Czech Republic	571	385	302	267	242	230	224	223	216	216	213	-63	-1.5	3.3	3.2
Denmark	204	203	172	145	122	115	112	112	103	106	103	-49	-2.8	1.2	1.5
*Adjusted data**					*86*	*80*	*76*	*76*	*68*	*70*	*67*		*-4.2*		
Estonia	66	42	38	33	24	24	24	23	23	23	22	-66	-1.4	0.4	0.3
Finland	233	200	176	145	116	104	101	96	94	88	88	-62	-0.1	1.3	1.3
France	2 417	2 023	1 615	1 164	771	709	684	670	628	615	608	-75	*-1.1*	13.8	9.1
Germany	3 402	2 039	1 609	1 324	1 230	1 146	1 120	1 105	1 029	1 039	1 052	-69	1.2	19.5	15.7
*Adjusted data**					*1 029*	*945*	*916*	*896*	*819*	*832*	*848*		*1.9*		
Greece	331	319	319	308	255	240	223	205	203	208	113	-66	-45.8	1.9	1.7
Hungary	320	223	205	168	144	147	147	149	140	143	141	-56	-1.3	1.8	2.1
Ireland	143	136	122	120	109	107	108	111	106	107	108	-24	1.6	0.8	1.6
Italy	1 996	2 028	1 590	1 339	1 117	1 027	1 019	992	927	918	904	-55	-1.5	11.4	13.5
Latvia	83	62	53	52	42	42	43	43	44	42	40	-52	-4.3	0.5	0.6
Lithuania	117	88	68	67	59	57	56	52	53	52	52	-55	1.7	0.7	0.8
Luxembourg	26	20	16	15	12	12	12	13	12	13	13	-51	2.4	0.2	0.2
*Adjusted data**					*8.1*	*8.4*	*8.9*	*9.0*	*8.3*	*8.9*	*9.1*		*2.7*		
Malta	1.5	1.7	3.1	3.7	3.3	3.2	3.1	3.1	2.9	2.9	3.1	99	4.3	0.0	0.0
Netherlands	498	357	252	190	175	170	166	158	152	149	141	-72	-5.5	2.9	2.1
Poland	495	667	596	606	636	616	611	603	591	591	609	23	3.1	2.8	9.1
Portugal	223	220	224	193	163	156	154	152	156	157	154	-31	-2.4	1.3	2.3
Romania	353	203	281	329	288	280	285	271	266	260	258	-27	-0.5	2.0	3.9
Slovakia	169	150	121	107	90	88	80	71	66	69	64	-62	-7.6	1.0	1.0
Slovenia	64	62	52	43	37	35	33	32	30	30	31	-52	1.2	0.4	0.5
Spain	1 021	955	947	*803*	*637*	*611*	*586*	*567*	*568*	*583*	594	-42	1.8	5.8	8.9
Sweden	353	263	224	212	184	177	167	163	161	162	159	-55	-1.7	2.0	2.4
United Kingdom	2 990	2 340	1 648	1 184	903	890	878	850	842	837	821	-73	-1.9	17.1	12.2
EU-28 (a)	**17 461**	**13 771**	**11 254**	**9 385**	**7 840**	**7 439**	**7 280**	**7 093**	**6 824**	**6 823**	**6 707**	**-62**	**-1.7**	**100**	**100**
EU-28 (b)	17 461	13 771	11 254	9 385	7 840	7 439	7 280	7 093	6 824	6 823	6 707				
EU-28 (c)	17461	13771	11254	9385	7600	7200	7037	6845	6575	6577	6463				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

(a) Sum of national totals as reported by Member States.

(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

(c) Sum of national totals as reported by Member States allowing for approved adjustments.

**Adjusted data*: under the Gothenburg Protocol, the EMEP Steering Board accepted inventory adjustment applications for emissions from Denmark, Germany and Luxembourg, whereas emission data are based on fuel sold.

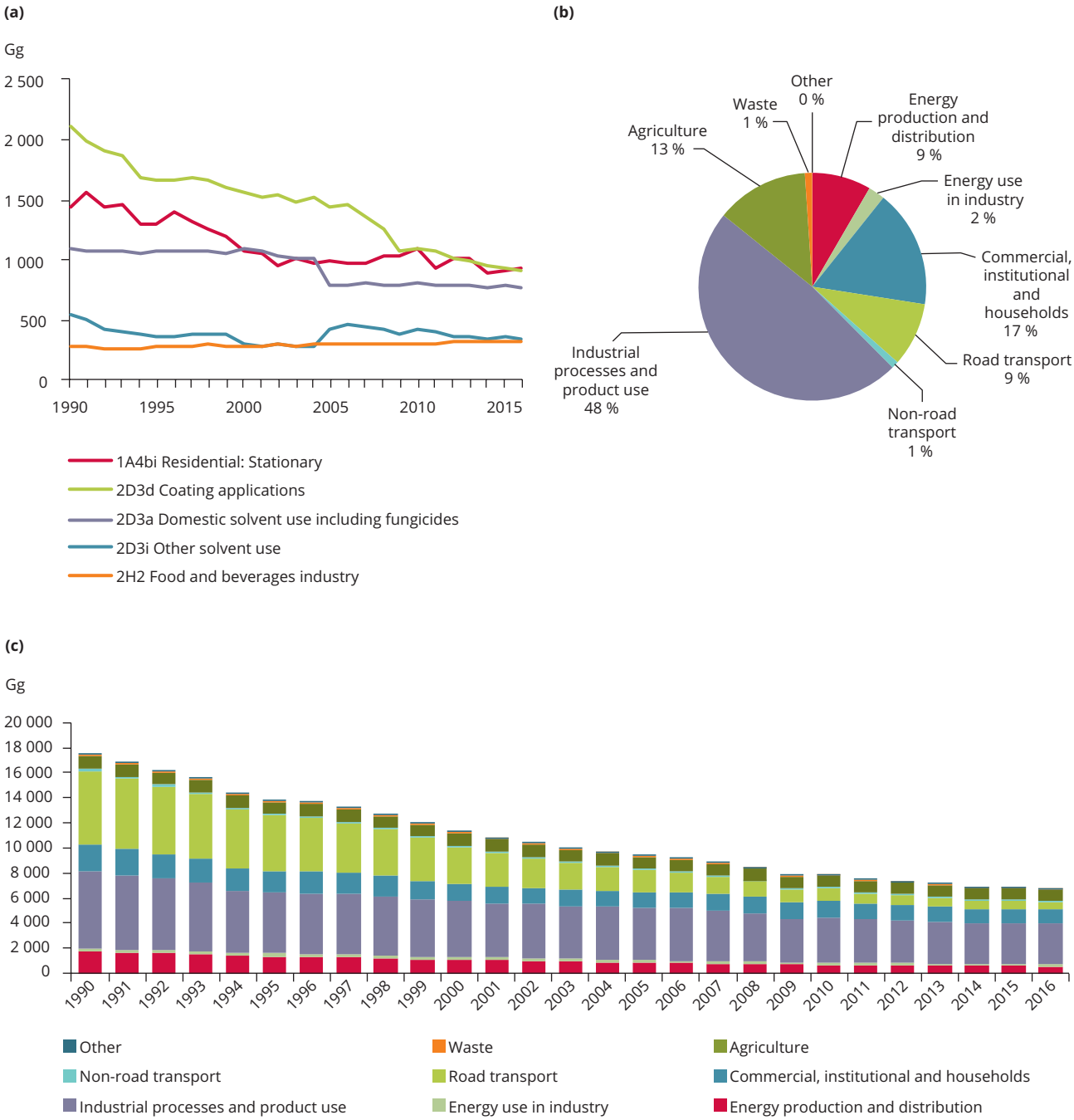
United Kingdom and Italy (countries ranked according to the size of their contribution to the absolute change) (Table 3.7). In 2016, the Member States that contributed most (i.e. more than 10 %) to NMVOC emissions were Germany, Italy and the United Kingdom (countries ranked according to the percentage of their share in the EU total).

The drop in NMVOC emissions between 1993 and 1994 (not shown in Table 3.7) reported by Bulgaria is mainly caused by drastically declining emissions from the 'industrial processes and product use' sector, namely '2D3e — Degreasing' and '2D3d — Coating applications'.

The most important key categories for NMVOC emissions were '1A4bi — Residential: Stationary', '2D3d — Coating applications' and '2D3a — Domestic solvent use including fungicides'. Together, they made up 39 % of total emissions (Figure 3.6(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2016 were in the second most important key category, '2D3d — Coating applications' (-57 %).

Figure 3.6(b) shows the contribution that each aggregated sector group made to total EU emissions. For NMVOCs, the chief emission source is 'industrial processes and product use' (48 %), followed by 'commercial, institutional and households', 'agriculture' and 'road transport'.

Figure 3.6 **NMVOC emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions**



3.5 Sulphur oxide (SO_x) emission trends and key categories

Between 1990 and 2016, SO_x emissions dropped in the EU by 91 %. Between 2015 and 2016, emissions decreased by 15.1 %, mainly thanks to reduced emissions in Poland, the United Kingdom, Romania and Spain (countries ranked according to the size of their contribution to the absolute change) (see Table 3.8).

The Member States that contributed most (i.e. more than 10 %) to SO_x emissions in 2016 were Poland and Germany (countries ranked according to the percentage of their share in the EU total).

Spain stated that the dramatic drop in SO_x emissions in 2008 (the value for the national totals is 63 % lower than in the previous year) was due to the closure of the main brown coal mine in Spain in 2007 and the

necessary retrofitting in 2008 of the adjacent thermal power plant (see Spain's IIR, listed in Appendix 5).

In Slovakia, data reported for 2015 are significantly higher than for the year 2014. Slovakia explained that all SO_x emissions were emitted from the source *Slovenské elektrárne*, which apparently in 2015 did not have any emission limitations or abatement technologies in place. From 2016 onwards, it has been possible to operate such facilities only when they comply with the strict limits set in the legislation. The considerable drop in emissions of SO_x is due to the strict regulations in place (see Slovakia's IIR, listed in Appendix 5).

Table 3.8 Member State contributions to EU emissions of SO_x

	SO_x (Gg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	74	47	32	26	16	15	15	15	15	15	14	-81	-5.6	0.3	0.6
Belgium	365	258	172	142	60	53	47	44	41	41	42	-88	2.1	1.5	1.8
Bulgaria	1 101	1 300	862	778	388	516	330	195	189	142	105	-90	-25.9	4.4	4.4
Croatia	170	78	59	59	35	29	25	17	14	16	15	-91	-6.9	0.7	0.6
Cyprus	31	39	48	38	22	21	16	14	17	13	16	-48	25.0	0.1	0.7
Czech Republic	1 755	1 059	233	208	164	168	160	145	138	133	115	-93	-13.5	7.0	4.8
Denmark	178	146	33	26	15	14	12	13	11	9.7	10	-94	5.4	0.7	0.4
Estonia	272	116	97	76	83	73	41	36	41	32	30	-89	-6.1	1.1	1.3
Finland	249	104	82	70	66	60	50	48	44	41	40	-84	-2.4	1.0	1.7
France	1 282	959	625	458	279	249	240	211	173	162	140	-89	-13.4	5.1	5.9
Germany	5 486	1 746	646	473	411	401	382	374	359	364	356	-94	-2.3	21.9	15.0
Greece	494	504	553	570	219	158	133	119	103	99	108	-78	8.8	2.0	4.5
Hungary	824	615	427	41	31	34	32	31	28	23	23	-97	-1.2	3.3	1.0
Ireland	183	161	140	72	26	25	23	24	17	15	14	-92	-8.3	0.7	0.6
Italy	1 784	1 322	756	409	218	196	178	146	131	124	116	-93	-6.4	7.1	4.9
Latvia	100	49	18	8.5	4.3	4.3	4.4	3.9	3.9	3.7	3.5	-97	-6.5	0.4	0.1
Lithuania	191	77	37	26	20	23	19	18	16	16	15	-92	-3.6	0.8	0.6
Luxembourg	15	8.6	3.3	2.4	1.7	1.3	1.5	1.5	1.5	1.3	1.0	-93	-25.2	0.1	0.0
Malta	10	11	24	12	8.2	8.1	7.9	5.3	4.9	2.3	1.9	-81	-15.7	0.0	0.1
Netherlands	197	136	78	67	35	34	34	30	30	31	28	-86	-8.9	0.8	1.2
Poland	2 649	2 138	1 404	1 164	866	828	794	759	715	702	582	-78	-17.1	10.6	24.5
Portugal	324	331	265	193	68	62	57	51	46	47	47	-86	-0.8	1.3	2.0
Romania	802	697	493	605	354	324	260	227	183	157	108	-87	-31.5	3.2	4.5
Slovakia	418	266	126	89	69	68	58	53	45	68	27	-94	-59.9	1.7	1.1
Slovenia	201	124	94	40	11	13	12	14	10	5.7	5.1	-97	-10.9	0.8	0.2
Spain	2 053	1 774	1 401	1 215	250	287	286	226	250	267	218	-89	-18.4	8.2	9.2
Sweden	103	69	43	36	28	26	25	22	20	18	19	-82	5.8	0.4	0.8
United Kingdom	3 767	2 454	1 286	773	450	415	459	396	322	253	179	-95	-29.3	15.0	7.5
EU-28 ([a])	**25 078**	**16 586**	**10 035**	**7 677**	**4 201**	**4 105**	**3 702**	**3 241**	**2 967**	**2 802**	**2 378**	**-91**	**-15.1**	**100**	**100**
EU-28 ([b])	25 078	16 586	10 035	7 677	4 201	4 105	3 702	3 241	2 967	2 802	2 378				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

([a]) Sum of national totals as reported by Member States.

([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

Category '1A1a — Public electricity and heat production' is the most significant key category for SO_x emissions, making up 39 % of total SO_x emissions (Figure 3.7(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2016 were achieved in the most important, '1A1a — Public electricity and heat production' (-94 %), and the third most important, '1A1b — Petroleum refining' (-86 %). The other three top five key categories also saw high reductions.

For these main emitting sources, several measures have been combined to reduce emissions since 1990: switching fuel in energy-related sectors away from high-sulphur solid and liquid fuels to low-sulphur fuels such as natural gas; fitting flue gas desulphurisation (FGD) abatement technology in industrial facilities; and the impact of EU directives relating to the sulphur content of certain liquid fuels (EEA, 2017b).

Figure 3.7(b) shows the contribution that each aggregated sector group made to total EU emissions. For SO_x, common chief emission sources are the energy sectors.

3.6 Ammonia (NH_3) emission trends and key categories

Between 1990 and 2016, NH_3 emissions in the EU dropped by 23 %. Between 2015 and 2016, emissions increased by 0.4 %, mainly because of increases in Italy, the United Kingdom and Ireland (countries ranked according to the size of their contribution to the absolute change) (see Table 3.9). The Member States that contributed most (i.e. more than 10 %) to NH_3 emissions in 2016 were Germany, France and Spain (countries ranked according to the percentage of their share in the EU total).

In Belgium, the significant decrease in NH_3 emissions between 1999 and 2000 is mainly because of an implementation of successive Manure Action Plans in Flanders (see Belgium's IIR, listed in Appendix 5).

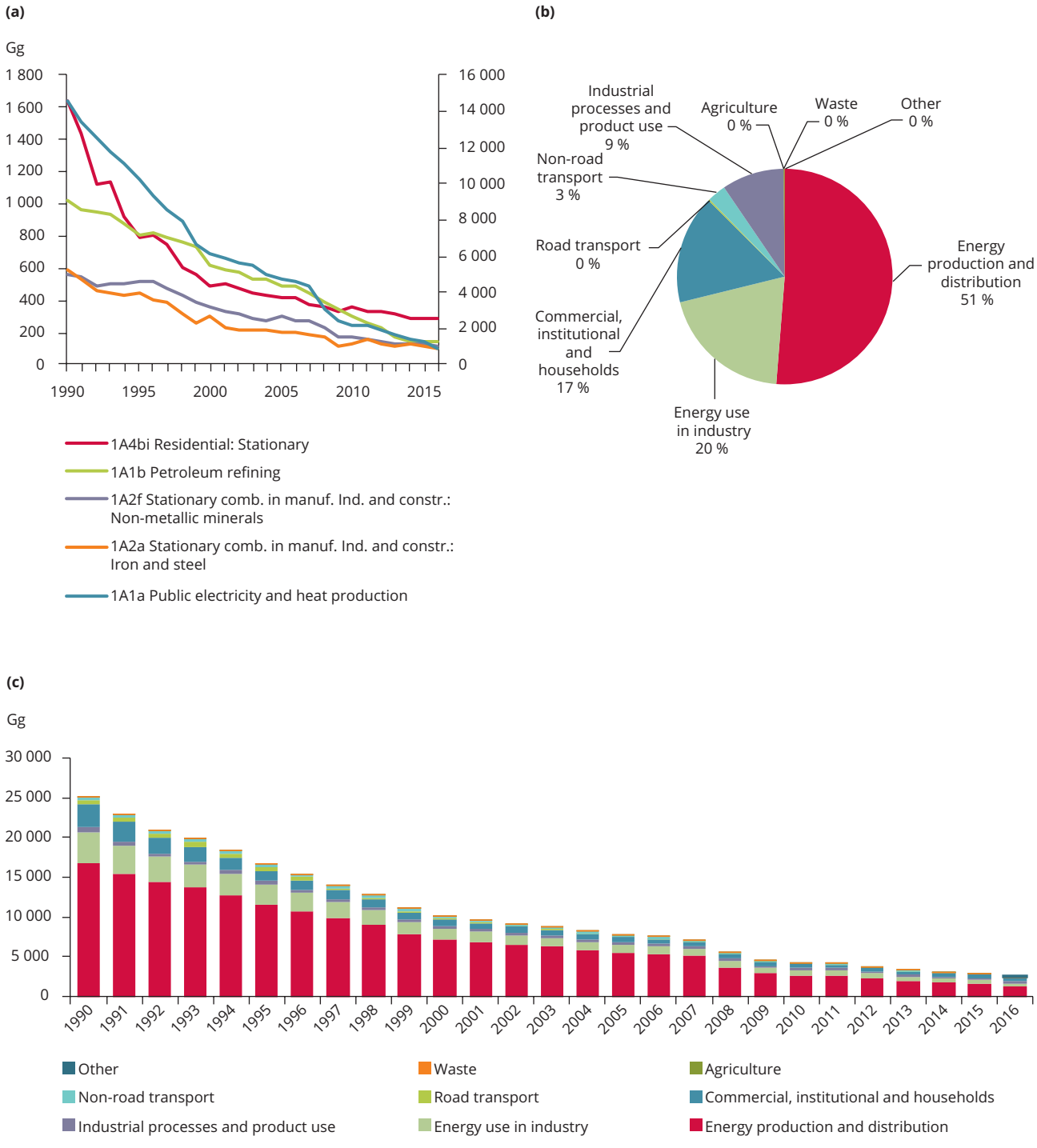
The rising NH_3 emission trend reported by Germany in recent years, especially over the period 2009-2015, reflects mainly data reported for the categories '3Da1 — Inorganic N-fertilisers (includes also urea application)' and '3Da2c — Other organic fertilisers applied to soils (including compost)'.

Spain offered the following explanation for the national NH_3 emission trend observed in the period 1990-2015. In the first part of the time series, agricultural emissions underwent a notable increase, reaching a maximum in 2003. This rise was mainly caused by significant growth in the national cattle herd. The use of synthetic nitrogen fertilisers also increased during that period. Until 2012, a progressive decrease in NH_3 emissions was registered at national level. This reduction of emissions was probably due to a combination of factors, including the use of inorganic fertilisers, reduced growth in the number of cattle and the progressive introduction of abatement techniques in manure management. Total NH_3 emissions increased between 2014 and 2016 compared with 2013 levels. This rise was driven by an increase in the consumption of synthetic nitrogen fertilisers and a renewed increase in the numbers of cattle and pigs (see Spain's IIR, listed in Appendix 5).

The principal key categories for NH_3 emissions are '3Da2a — Animal manure applied to soils', '3Da1 — Inorganic N-fertilisers' and '3B1b — Manure management — Non-dairy cattle'. They jointly make up 52 % of total NH_3 emissions (see Figure 3.8(a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2016 was in the most important, '3Da2a — Animal manure applied to soils' (-38 %).

Figure 3.8(b) shows the contribution that each aggregated sector group made to total EU emissions. A single sector group, agriculture, is responsible for most (92 %) of the NH_3 emissions in the EU.

Figure 3.7 **SO_x emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions**



Note: In Figure 3.7(a), the right-hand axis shows values for '1A1a — Public electricity and heat production'.

Table 3.9 Member State contributions to EU emissions of NH_3

	NH_3 (Gg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	66	69	66	65	67	66	66	66	67	67	68	3	1.0	1.3	1.7
Belgium	123	128	92	75	71	70	70	71	68	68	68	-45	-0.2	2.4	1.7
Bulgaria	121	65	54	52	47	45	45	46	49	50	50	-58	1.0	2.4	1.3
Croatia	54	42	41	42	38	39	38	34	32	35	35	-35	0.4	1.1	0.9
Cyprus	5.3	6.3	6.3	6.4	6.3	6.1	5.8	5.4	5.3	5.4	5.5	5	3.2	0.1	0.1
Czech Republic	190	109	87	78	72	71	70	72	72	73	73	-62	-0.3	3.7	1.9
Denmark	126	108	97	89	80	78	76	74	74	74	75	-40	1.2	2.5	1.9
*Adjusted data**					*72*	*71*	*69*	*66*	*66*	*67*	*67*		*0.4*		
Estonia	24	12	9.3	11	11	11	12	12	12	13	12	-50	-5.4	0.5	0.3
Finland	34	32	34	37	35	34	33	33	33	31	31	-8	-1.3	0.7	0.8
*Adjusted data**					*33*	*32*	*32*	*31*	*32*	*30*	*30*		*-1.2*		
France	668	648	662	625	625	615	616	615	621	628	630	-6	0.4	13.1	16.1
Germany	743	639	647	625	626	656	644	660	662	670	663	-11	-1.2	14.6	16.9
*Adjusted data**					*586*	*606*	*592*	*600*	*601*	*610*	*602*		*-1.3*		
Greece	78	68	66	65	64	63	62	62	61	60	56	-27	-6.4	1.5	1.4
Hungary	149	88	93	86	78	79	79	82	82	87	87	-42	0.2	2.9	2.2
Ireland	110	113	115	113	108	104	106	108	108	111	117	6	5.0	2.2	3.0
Italy	472	452	455	424	387	387	396	378	367	368	382	-19	3.9	9.3	9.8
Latvia	37	17	14	15	15	15	16	16	17	16	16	-56	-0.9	0.7	0.4
Lithuania	80	42	35	38	37	36	35	35	35	35	34	-57	-2.0	1.6	0.9
Luxembourg	6.8	6.9	7.2	6.3	6.3	6.2	6.1	6.2	6.3	6.4	6.5	-4	2.1	0.1	0.2
Malta	1.9	1.9	1.8	1.1	0.9	0.8	0.8	0.9	0.8	0.8	0.8	-58	-4.3	0.0	0.0
Netherlands	350	223	175	153	133	129	123	122	125	126	127	-64	1.3	6.9	3.3
Poland	441	353	319	300	285	285	275	274	270	267	267	-39	-0.1	8.7	6.8
Portugal	82	75	78	63	57	58	56	54	56	57	56	-31	-0.4	1.6	1.4
Romania	131	148	168	206	175	173	172	172	169	171	167	28	-2.3	2.6	4.3
Slovakia	74	48	40	36	31	30	31	30	31	31	30	-59	-2.5	1.5	0.8
Slovenia	22	20	20	19	19	18	18	18	18	18	18	-17	1.9	0.4	0.5
Spain	502	465	540	500	456	446	439	443	464	492	492	-2	0.1	9.9	12.6
Sweden	60	61	60	58	55	54	53	54	54	54	53	-12	-2.2	1.2	1.4
United Kingdom	331	308	312	290	270	271	268	264	276	280	289	-13	3.2	6.5	7.4
EU-28 ([a])	**5 080**	**4 348**	**4 294**	**4 078**	**3 852**	**3 847**	**3 812**	**3 804**	**3 836**	**3 896**	**3 913**	**-23**	**0.4**	**100**	**100**
EU-28 ([b])	5 080	4 348	4 294	4 078	3 852	3 847	3 812	3 804	3 836	3 896	3 913				
EU-28 ([c])	5 080	4 348	4 294	4 078	3 802	3 788	3 752	3 736	3 766	3 827	3 842				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

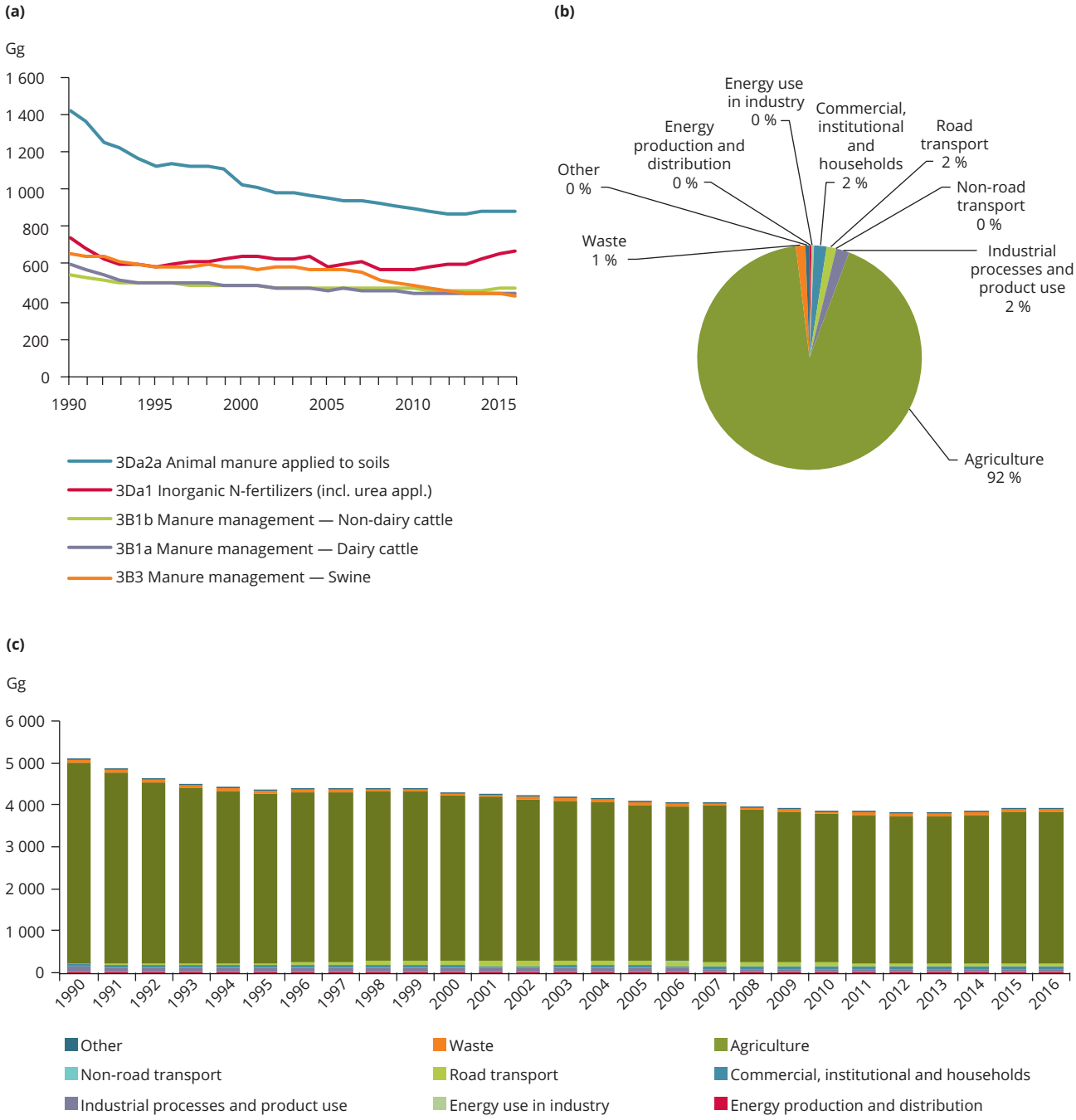
([a]) Sum of national totals as reported by Member States.

([b]) Sum of sectors.

([c]) Sum of national totals as reported by Member States under consideration of approved adjustments.

**Adjusted data*: under the Gothenburg Protocol, the EMEP Steering Board accepted inventory adjustment applications for emissions from Denmark, Finland and Germany, whereas emission data are based on fuel sold.

Figure 3.8 **NH_3 emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions**



3.7 Fine particulate matter ($PM_{2.5}$) emission trends and key categories

Between 2000 and 2016, $PM_{2.5}$ emissions dropped in the EU by 28 %. Between 2015 and 2016, there was a decrease of 1.5 %, mainly because emissions decreased in Greece (gap-filled data), Italy, the United Kingdom and Slovakia (countries ranked according to the size of their contribution to the absolute change) (see Table 3.10).

The Member States that contributed most (i.e. more than 10 %) to $PM_{2.5}$ emissions in 2016 were France, Italy and Poland (countries ranked according to the percentage of their share in the EU total).

Estonia stated that the growth of $PM_{2.5}$ emissions from 2010 to 2011 resulted from growth in electricity production during the same period. The significant growth of PM emissions in 2011 was due to an increase

in electricity production by 34 % at Estonia's Balti power station (Eesti Energia Narva Elektrijaamad AS) and to the incorrect operation of electric precipitators on two of its power units. In 2016, particulate emissions decreased mainly due to the decrease of emissions from energy-related industries, and from the construction/demolition sectors (see Estonia's IIR, listed in Appendix 5).

Domestic fuel use in '1A4bi — Residential: Stationary' is the principal key category for $PM_{2.5}$ emissions, making up 51 % of the total (Figure 3.9(a)). Among the top five key categories, the highest relative reduction in emissions between 2000 and 2016 was in the second most important key category, '1A1a — Public electricity and heat production' (-61 %). There were also high

Table 3.10 Member State contributions to EU emissions of $PM_{2.5}$

	$PM_{2.5}$ (Gg)									Change (%)		Share in EU-28 (%)	
Member State	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2000-2016**	**2015-2016**	**2000**	**2016**
Austria	25	23	20	20	19	20	18	18	18	-28	-1.7	1.3	1.3
Belgium	41	35	32	26	27	29	22	24	25	-38	5.6	2.2	1.9
Bulgaria	26	31	31	34	34	32	31	32	32	24	0.6	1.4	2.4
Croatia	33	41	31	28	26	24	20	21	18	-45	-10.9	1.8	1.4
Cyprus	2.7	2.3	1.8	1.6	1.3	1.2	1.1	1.2	1.3	-51	8.2	0.1	0.1
Czech Republic	51	45	45	43	43	43	41	40	39	-23	-2.6	2.7	2.9
Denmark	24	26	25	23	21	21	19	21	21	-13	-0.4	1.3	1.5
Estonia	15	14	14	18	8.2	11	7.9	9.3	7.5	-51	-19.4	0.8	0.6
Finland	29	28	26	22	22	21	21	19	20	-31	4.2	1.6	1.5
France	329	260	214	186	191	192	167	168	170	-48	1.1	17.7	12.7
Germany	163	135	121	116	110	109	104	103	101	-38	-2.3	8.7	7.5
Greece	58	58	46	40	40	34	34	35	26	-55	-25.2	3.1	1.9
Hungary	48	40	50	57	60	61	52	55	53	10	-2.4	2.6	4.0
Ireland	24	24	19	17	17	17	16	16	16	-36	-4.3	1.3	1.2
Italy	195	173	196	150	177	172	155	166	162	-17	-2.4	10.5	12.0
Latvia	23	23	19	19	20	18	18	16	16	-29	0.3	1.2	1.2
Lithuania	7.2	7.3	7.0	7.0	7.0	6.9	6.6	6.0	6.0	-17	0.7	0.4	0.4
Luxembourg	2.4	2.5	1.8	1.6	1.6	1.6	1.6	1.4	1.5	-37	11.9	0.1	0.1
Malta	1.0	0.7	0.4	0.5	0.4	0.4	0.4	0.3	0.3	-74	-10.3	0.1	0.0
Netherlands	29	22	17	16	15	14	14	13	13	-57	-4.8	1.6	0.9
Poland	170	169	163	155	154	148	140	138	146	-14	5.2	9.1	10.8
Portugal	67	62	51	53	53	48	48	48	47	-29	-0.6	3.6	3.5
Romania	94	123	132	122	125	116	115	110	110	17	-0.3	5.1	8.2
Slovakia	31	38	28	29	29	30	29	30	27	-15	-9.3	1.7	2.0
Slovenia	10	12	14	13	13	13	11	12	12	17	2.5	0.5	0.9
Spain	185	157	139	138	136	131	130	130	128	-31	-1.4	10.0	9.6
Sweden	28	27	23	23	22	22	19	18	18	-33	1.7	1.5	1.4
United Kingdom	151	129	122	111	116	118	112	113	109	-28	-3.5	8.1	8.1
EU-28 ([a])	**1 861**	**1 706**	**1 591**	**1 469**	**1 488**	**1 454**	**1 352**	**1 363**	**1 343**	**-28**	**-1.5**	**100**	**100**
EU-28 ([b])	1 861	1 706	1 591	1 469	1 488	1 454	1 352	1 363	1 343				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

The LRTAP formally requests Parties to report emissions of PM for 2000 and thereafter.

([a]) Sum of national totals as reported by Member States.

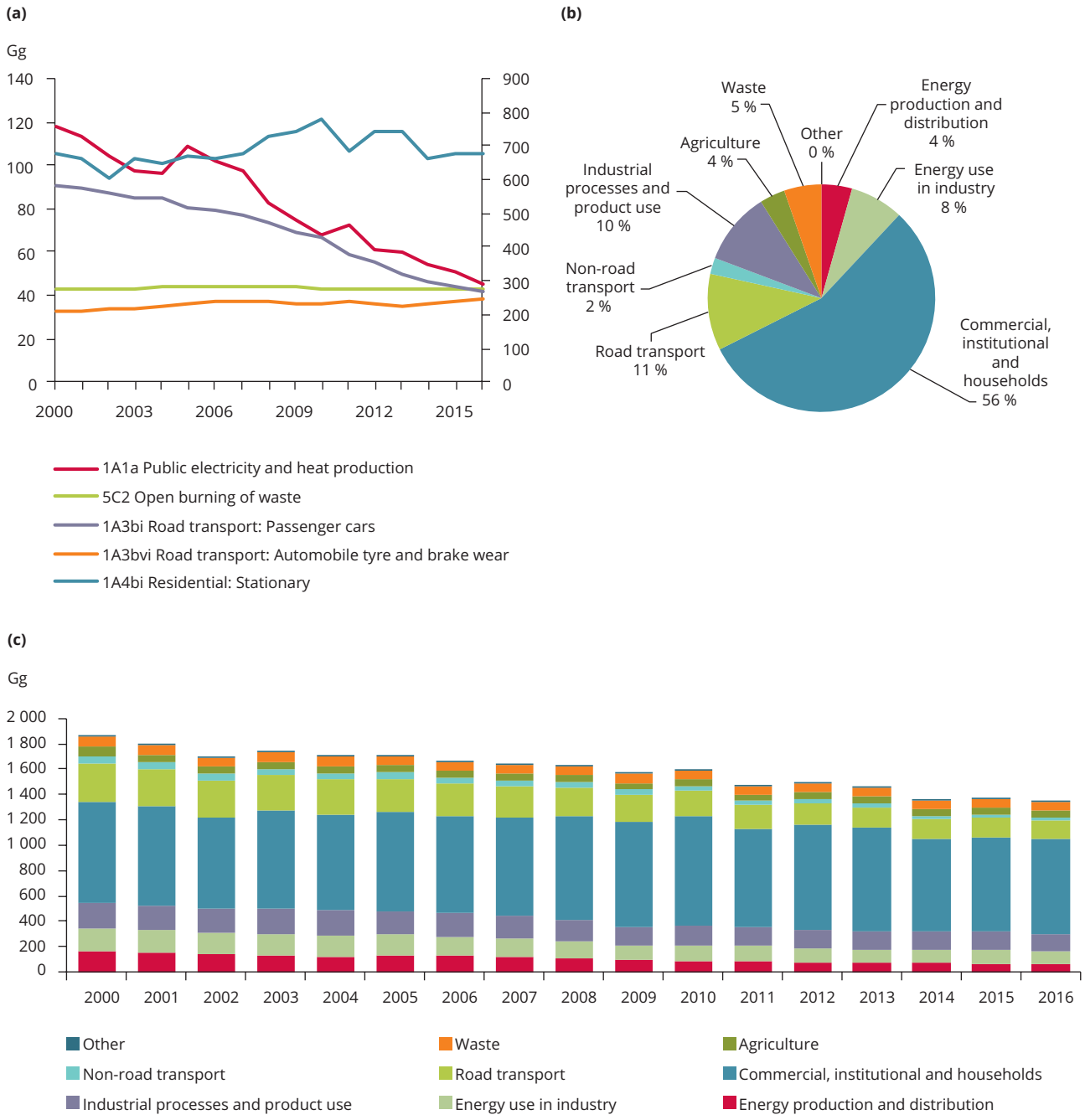
([b]) Sum of sectors.

reductions in the fourth most important category, '1A3bi — Road transport: Passenger cars' (-54 %).

In contrast, the emissions of the fifth most important key category, '1A3bvi — Road transport: Automobile tyre and brake wear' (20 %), have increased significantly since 2000.

Figure 3.9(b) shows the contribution to total EU emissions that each aggregated sector group made. The 'commercial, institutional and households' sector group is a major source of $PM_{2.5}$, and also of PM_{10}, CO and PCDD/F.

Figure 3.9 **$PM_{2.5}$ emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions**



Note: In Figure 3.9(a), the right-hand axis shows values for '1A4bi Residential: Stationary'.

The LRTAP Convention formally requests Parties to report emissions of PM for 2000 and thereafter.

3.8 Particulate matter (PM_{10}) emission trends and key categories

Between 2000 and 2016, PM_{10} emissions in the EU dropped by 26 %. Between 2015 and 2016, the decrease was 1.7%, mainly because emissions dropped in Germany, Greece (gap-filled data) Bulgaria, Hungary and Italy (countries ranked according to the size of their contribution to the absolute change) (see Table 3.11).

The Member States that contributed most (i.e. more than 10 %) to PM_{10} emissions in 2016 were Poland and France (countries ranked according to the percentage of their share in the EU total).

Estonia stated that the growth of fine particulate matter emissions from 2010 to 2011 resulted from growth in electricity production during the same period. The significant growth of PM emissions

Table 3.11 Member State contributions to EU emissions of PM_{10}

	PM_{10} (Gg)									Change (%)		Share in EU-28 (%)	
Member State	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2000-2016**	**2015-2016**	**2000**	**2016**
Austria	39	37	33	33	33	33	31	31	31	-21	-0.8	1.4	1.5
Belgium	55	46	41	34	35	37	30	33	34	-37	5.4	2.0	1.7
Bulgaria	47	57	53	57	56	52	52	55	48	2	-13.4	1.7	2.3
Croatia	41	51	39	36	34	31	27	28	26	-37	-8.4	1.5	1.2
Cyprus	4.9	4.3	3.4	3.1	2.3	1.9	1.9	1.9	2.1	-58	6.4	0.2	0.1
Czech Republic	70	61	59	56	56	56	53	53	52	-26	-2.5	2.5	2.5
Denmark	36	37	36	34	32	32	30	31	31	-13	-0.2	1.3	1.5
Estonia	32	22	23	34	13	18	13	14	11	-65	-20.3	1.2	0.5
Finland	44	43	41	37	35	34	34	32	33	-25	3.8	1.6	1.6
France	439	361	306	278	283	282	255	257	255	-42	-0.6	15.8	12.4
Germany	288	242	227	226	219	221	216	214	203	-30	-5.0	10.4	9.8
Greece	98	110	91	82	83	63	63	64	56	-43	-12.3	3.5	2.7
Hungary	75	68	69	80	76	79	74	78	73	-3	-6.5	2.7	3.5
Ireland	40	43	37	31	30	31	29	30	29	-28	-2.0	1.5	1.4
Italy	245	218	231	183	209	204	187	197	193	-21	-1.9	8.8	9.4
Latvia	27	30	25	28	28	26	26	26	24	-11	-5.6	1.0	1.2
Lithuania	9.5	15	14	14	14	14	14	13	13	38	2.0	0.3	0.6
Luxembourg	3.1	3.3	2.6	2.5	2.4	2.4	2.4	2.2	2.3	-27	0.5	0.1	0.1
Malta	1.4	0.9	0.7	0.7	0.7	0.6	0.7	0.4	0.4	-75	-11.7	0.1	0.0
Netherlands	44	36	30	30	28	28	27	27	26	-40	-1.7	1.6	1.3
Poland	309	321	300	280	280	269	252	249	259	-16	4.2	11.1	12.6
Portugal	100	102	79	89	107	67	63	64	65	-35	1.4	3.6	3.2
Romania	117	157	166	157	159	148	148	142	141	21	-1.3	4.2	6.8
Slovakia	44	47	35	36	36	37	36	37	34	-23	-8.1	1.6	1.6
Slovenia	12	14	15	15	15	15	13	13	13	12	2.5	0.4	0.6
Spain	286	264	216	212	206	199	197	198	200	-30	1.3	10.3	9.7
Sweden	46	46	41	43	39	41	37	37	38	-18	2.2	1.7	1.8
United Kingdom	232	201	185	171	174	181	173	175	172	-26	-1.7	8.3	8.3
EU-28 ([a])	**2 783**	**2 637**	**2 401**	**2 282**	**2 286**	**2 203**	**2 085**	**2 099**	**2 064**	**-26**	**-1.7**	**100**	**100**
EU-28 ([b])	2 783	2 637	2 401	2 282	2 286	2 203	2 085	2 099	2 064				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

The LRTAP Convention formally requests Parties to report emissions of PM for 2000 and thereafter.

([a]) Sum of national totals as reported by Member States.

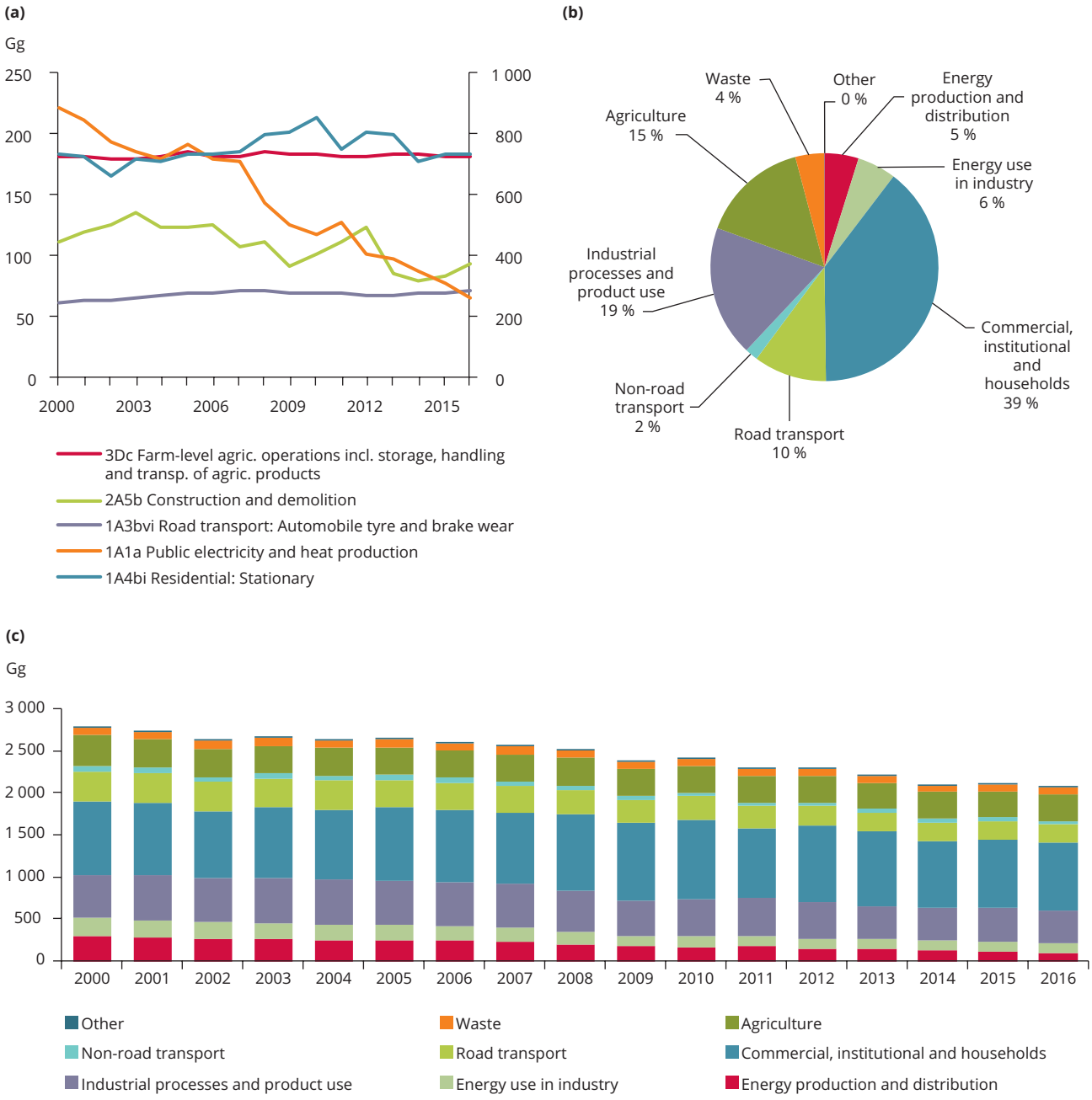
([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

in 2011 was due to an increase in electricity production by 34 % at Estonia's Balti power station (Eesti Energia Narva Elektrijaamad AS) and to the incorrect operation of electric precipitators on two of its power units. In 2016, particulate emissions decreased mainly due to the decrease of emissions from energy-related industries, and from the construction/demolition sectors (see Estonia's IIR, listed in Appendix 5).

The peak in PM_{10} emissions reported by Portugal for 2012 was mainly caused by a rise followed by a sudden decrease in the values reported for the category '2A5b — Construction and demolition'.

As it is for $PM_{2.5}$, '1A4bi — Residential: Stationary' is the most significant key category for PM_{10} emissions, accounting for 36 % of total PM_{10} emissions (see Figure 3.10(a)). Among the top five key categories,

Figure 3.10 PM_{10} emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions



Note: In Figure 3.10(b), the right-hand axis shows values for '1A4bi Residential: Stationary'.

The LRTAP Convention formally requests Parties to report emissions of PM for 2000 and thereafter.

the highest relative reduction in emissions between 1990 and 2016 was in the fifth most important, '1A1a — Public electricity and heat production' (-71 %). Reductions in emissions were also observed in the third most important category, '2A5b — Construction and demolition' (-16 %). Emissions of the fourth most important key category, '1A3bvi — Road transport: Automobile tyre and brake wear' (18 %), have increased since 2000. Emissions from the other two top five key categories remained constant (decreased by only 0.4% and increased by 0.2%, respectively).

Figure 3.10(b) shows the contribution to total EU emissions that each aggregated sector group made. The 'commercial, institutional and households' sector group is a major source of $PM_{2.5}$, and also of PM_{10}, CO and PCDD/F.

3.9 Total suspended particulate (TSP) emission trends

Between 1990 and 2016, TSP emissions in the EU dropped by 54 %. Between 2015 and 2016, emissions decreased by 1.8 %, mainly because of emission reductions in Bulgaria, Germany, Hungary and Romania (countries ranked according to the size of their contribution to the absolute change) (Table 3.12). The Member States that contributed most (i.e. more than 10 %) to TSP emissions in 2016 were France and the United Kingdom (countries ranked according to the percentage of their share in the EU total).

Estonia stated that the growth of TSP emissions from 2010 to 2011 resulted from growth in electricity production during the same period. The significant growth in PM emissions in 2011 was due to an increase in electricity production of 34 % at Estonia's Balti power station (Eesti Energia Narva Elektrijaamad AS) and to the incorrect operation of electric precipitators on two of its power units. In 2016, particulate emissions decreased mainly due to the decrease of emissions from energy-related industries, and from the construction/demolition sectors (see Estonia's IIR, listed in Appendix 5).

Germany explained that between 1990 and 2016, total TSP emissions dropped by 83 %, due to the application of the former West Germany's stricter regulations in the new Länder after German reunification, the transition from solid to gaseous and liquid fuels, and improved filter technologies for combustion plants and industrial processes (see Germany's IIR, listed in Appendix 5).

Latvia stated that the high TSP emissions in the year 2004 (not shown in Table 3.12) can be explained by increased road paving activities (see Latvia's IIR, listed in Appendix 5).

The peak of TSP emissions reported by Portugal for 2012 is mainly caused by a rise followed by a sudden decrease reported for the category '2A5b — Construction and demolition'.

3.10 Black carbon (BC) emission trends

Between 1990 and 2016, BC emissions in the EU dropped by 41 %. Between 2015 and 2016, emissions decreased by 2.5 %, mainly because emissions reduced in France, the United Kingdom, Italy and Spain (countries ranked according to the size of their contribution to the absolute change) (Table 3.13). The Member States that contributed most (i.e. more than 10 %) to BC emissions in 2016 were Spain, France and Italy (countries ranked according to the percentage of their share in the EU total). Several Member States did not provide data for BC, and some of these gaps could not be filled with data. The EU total is therefore an underestimate.

Estonia stated that the growth of fine particulate matter emissions from 2010 to 2011 resulted from growth in electricity production during the same period. The significant growth of PM emissions in 2011 was due to an increase in electricity production by 34 % at Estonia's Balti power station (Eesti Energia Narva Elektrijaamad AS) and to the incorrect operation of electric precipitators on two of its power units. In 2016, particulate emissions decreased mainly due to the decrease of emissions from energy-related industries, and from the construction/demolition sectors (see Estonia's IIR, listed in Appendix 5).

Table 3.12 Member State contributions to EU emissions of TSPs

	TSPs (Gg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	53	53	52	50	46	46	46	46	44	44	44	-17	-0.3	0.7	1.2
Belgium	97	90	85	72	60	52	55	57	49	51	54	-44	4.9	1.2	1.4
Bulgaria	100	126	97	143	114	128	113	108	110	138	100	0	-27.8	1.2	2.7
Croatia	56	51	51	70	54	52	48	42	39	40	38	-33	-7.3	0.7	1.0
Cyprus	15	12	9.7	6.8	5.7	5.1	3.8	3.0	2.7	2.8	3.0	-81	6.6	0.2	0.1
Czech Republic	599	219	91	75	69	67	66	66	63	62	61	-90	-2.1	7.4	1.6
Denmark	110	106	104	98	98	95	93	92	91	91	91	-17	-0.4	1.4	2.5
Estonia	279	127	70	36	30	43	20	23	20	21	16	-94	-21.9	3.4	0.4
Finland	99	68	58	58	57	53	51	49	49	46	48	-51	5.1	1.2	1.3
France	1 243	1 156	1 088	986	896	876	880	874	835	846	842	-32	-0.5	15.3	22.7
Germany	1 985	511	474	399	376	380	371	383	376	369	347	-83	-6.0	24.5	9.4
Greece	110	109	150	188	162	148	153	100	101	102	113	3	10.6	1.4	3.1
Hungary	123	114	115	117	94	118	95	103	108	116	101	-18	-12.7	1.5	2.7
Ireland	88	71	91	104	86	63	64	63	62	64	64	-28	-0.7	1.1	1.7
Italy	342	337	291	263	277	222	252	246	226	238	234	-31	-1.6	4.2	6.3
Latvia	33	33	37	51	43	53	53	48	48	53	47	41	-10.7	0.4	1.3
Lithuania	29	14	14	20	19	19	19	19	19	18	18	-39	1.7	0.4	0.5
Luxembourg	18	9.7	4.5	5.3	4.5	4.5	4.4	4.3	4.3	4.5	4.1	-77	-8.9	0.2	0.1
Malta	2.8	3.8	4.6	1.3	0.8	0.8	0.8	0.7	0.8	0.5	0.5	-82	-7.5	0.0	0.0
Netherlands	98	74	52	44	37	37	37	36	35	34	33	-66	-2.1	1.2	0.9
Poland	991	734	441	462	424	398	393	373	347	342	352	-64	3.0	12.2	9.5
Portugal	180	239	252	289	200	230	294	156	136	142	148	-18	4.4	2.2	4.0
Romania	188	193	203	290	281	276	265	242	245	221	207	10	-6.6	2.3	5.6
Slovakia	196	149	69	64	45	46	47	47	47	47	44	-78	-7.2	2.4	1.2
Slovenia	13	14	15	17	18	18	17	17	15	15	16	21	2.6	0.2	0.4
Spain	331	344	368	355	278	271	258	249	248	251	250	-24	-0.5	4.1	6.7
Sweden	75	70	62	62	57	60	54	59	53	53	54	-27	2.7	0.9	1.5
United Kingdom	655	517	423	412	403	366	335	373	347	361	378	-42	4.6	8.1	10.2
EU-28 (a)	**8 109**	**5 544**	**4 768**	**4 740**	**4 236**	**4 127**	**4 087**	**3 878**	**3 720**	**3 775**	**3 707**	**-54**	**-1.8**	**100**	**100**
EU-28 (b)	8 109	5 544	4 768	4 740	4 236	4 127	4 087	3 878	3 720	3 775	3 707				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

(a) Sum of national totals as reported by Member States.

(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

Table 3.13 Member State contributions to EU emissions of BC

	Black Carbon (Gg)									Change (%)		Share in EU28 (%)	
Member State	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2000-2016**	**2015-2016**	**2000**	**2016**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	8.6	7.5	6.4	5.2	5.0	4.8	3.8	3.8	3.9	-55	0.3	2.4	1.8
Bulgaria	2.9	3.8	3.8	4.0	4.2	3.8	3.8	3.9	4.0	36	1.9	0.8	1.8
Croatia	4.8	5.9	4.7	4.3	4.0	3.7	3.2	3.3	3.0	-38	-9.5	1.3	1.4
Cyprus	0.7	0.6	0.4	0.4	0.3	0.3	0.3	0.3	0.3	-54	4.8	0.2	0.1
Czech Republic	6.7	6.5	5.2	5.0	4.9	4.8	4.6	4.6	4.6	-32	-0.9	1.8	2.1
Denmark	6.1	6.1	5.6	5.3	4.8	4.8	4.3	4.3	4.2	-32	-1.8	1.7	2.0
Estonia	3.5	3.5	3.2	3.5	2.2	2.6	2.0	2.6	2.2	-37	-14.6	0.9	1.0
Finland	7.6	6.5	6.3	5.3	5.4	5.0	4.9	4.5	4.7	-38	4.0	2.1	2.2
France	68	57	48	42	41	39	34	32	31	-54	-4.5	18.6	14.4
Germany	36	29	21	19	18	17	16	15	14	-61	-5.0	9.8	6.5
Greece	8.1	8.4	7.3	5.7	5.3	4.6	4.8	5.3	5.1	-37	-3.7	2.2	2.4
Hungary	7.1	6.5	7.4	8.1	8.4	8.4	7.2	7.7	7.5	5	-2.8	1.9	3.5
Ireland	4.2	3.9	3.1	2.8	2.6	2.6	2.4	2.3	2.2	-47	-4.4	1.1	1.0
Italy	42	39	33	27	28	26	24	24	23	-46	-4.7	11.6	10.8
Latvia	2.9	3.6	3.0	3.1	3.2	3.0	3.0	2.7	2.6	-11	-1.8	0.8	1.2
Lithuania	2.3	2.5	2.5	2.6	2.6	2.5	2.5	2.4	2.3	2	-1.7	0.6	1.1
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-48	-5.8	0.0	0.0
Netherlands	9.9	7.9	5.4	5.1	4.5	4.1	3.7	3.4	3.2	-67	-5.9	2.7	1.5
Poland	24	26	23	23	23	21	20	20	21	-12	7.4	6.7	9.9
Portugal	8.9	8.0	6.6	6.5	5.9	5.7	5.6	5.2	5.1	-43	-2.6	2.4	2.4
Romania	9.9	11	12	11	12	11	11	10	10	6	0.6	2.7	4.9
Slovakia	0.9	1.2	1.2	0.9	1.0	0.9	0.9	0.8	0.6	-36	-26.4	0.3	0.3
Slovenia	1.9	2.4	2.6	2.5	2.5	2.5	2.2	2.1	2.2	14	3.4	0.5	1.0
Spain	52	49	43	42	40	38	37	37	36	-30	-2.1	14.2	16.8
Sweden	4.8	4.4	3.9	3.8	3.5	3.4	3.2	3.0	2.9	-39	-1.9	1.3	1.4
United Kingdom	41	34	27	23	23	21	19	19	18	-56	-6.7	11.2	8.4
EU-28 (a)	**364**	**333**	**287**	**263**	**254**	**240**	**224**	**220**	**214**	**-41**	**-2.5**	**100**	**100**
EU-28 (b)	364	333	287	263	254	240	224	220	214				

Notes: Dark-blue shaded cells indicate that no emission values are available . See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

(a) Sum of national totals as reported by Member States.

(b) Sum of sectors.

3.11 Carbon monoxide (CO) emission trends and key categories

Between 1990 and 2016, CO emissions dropped in the EU by 69 %. Between 2015 and 2016, the decrease was 0.6 %, mainly because emissions decreased in the United Kingdom, Italy and Greece (gap-filled data) (countries ranked according to the size of their contribution to the absolute change) (Table 3.14). The Member States that contributed most (i.e. more than 10 %) to CO emissions in 2016 were Germany, France, Poland and Italy (countries ranked according to the percentage of their share in the EU total).

Belgium explained that the peak of CO emissions in 2013 was because one of its plants performed lime

Table 3.14 Member State contributions to EU emissions of CO

	CO (Gg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	1 191	930	743	672	585	570	574	592	546	568	565	-53	-0.6	1.8	2.8
Belgium	1 389	1 112	931	756	499	396	345	523	322	375	368	-74	-2.0	2.1	1.8
Bulgaria	748	507	347	297	278	277	272	249	243	240	245	-67	2.0	1.2	1.2
Croatia	557	444	451	419	300	273	255	232	203	217	202	-64	-6.5	0.9	1.0
Cyprus	43	38	30	27	19	17	16	15	15	14	15	-66	2.7	0.1	0.1
Czech Republic	2 102	1 401	948	844	823	805	803	821	798	795	798	-62	0.4	3.2	4.0
Denmark	718	639	464	417	345	306	288	274	250	253	244	-66	-3.7	1.1	1.2
Estonia	236	212	199	155	157	132	142	134	129	129	140	-41	8.4	0.4	0.7
Finland	721	630	562	475	410	373	364	350	344	322	324	-55	0.4	1.1	1.6
France	10 579	9 152	6 633	5 304	4 225	3 517	3 204	3 254	2 735	2 682	2 737	-74	2.1	16.3	13.6
Germany	12 522	6 463	4 812	3 737	3 337	3 250	2 878	2 850	2 744	2 850	2 864	-77	0.5	19.3	14.2
Greece	1 163	999	953	799	575	515	543	453	458	433	386	-67	-10.8	1.8	1.9
Hungary	1 395	952	825	679	531	541	557	550	471	458	450	-68	-1.7	2.2	2.2
Ireland	347	291	248	218	145	134	127	119	112	109	103	-70	-5.6	0.5	0.5
Italy	7 210	7 257	4 855	3 448	3 075	2 435	2 670	2 502	2 268	2 378	2 310	-68	-2.8	11.1	11.5
Latvia	460	355	280	222	152	158	164	147	141	118	115	-75	-3.0	0.7	0.6
Lithuania	519	336	195	181	158	175	168	162	153	146	145	-72	-1.0	0.8	0.7
Luxembourg	463	210	42	38	29	26	27	26	25	21	22	-95	4.5	0.7	0.1
Malta	20	20	0.7	13	10.5	9.4	8.5	8.7	8.1	7.8	5.3	-74	-31.4	0.0	0.0
Netherlands	1 142	915	750	722	675	652	619	589	562	569	559	-51	-1.8	1.8	2.8
Poland	3 588	4 367	3 252	3 059	3 069	2 784	2 798	2 664	2 419	2 370	2 506	-30	5.7	5.5	12.4
Portugal	728	788	667	513	400	373	361	342	326	334	322	-56	-3.6	1.1	1.6
Romania	2 369	2 332	685	960	868	792	814	762	766	744	742	-69	-0.2	3.7	3.7
Slovakia	505	405	376	378	277	260	255	247	254	247	240	-52	-2.8	0.8	1.2
Slovenia	306	278	182	150	131	128	124	123	106	107	110	-64	2.4	0.5	0.5
Spain	4 712	3 989	2 877	2 155	1 802	1 757	1 694	1 652	1 663	1 649	1 661	-65	0.7	7.3	8.2
Sweden	1 076	939	679	559	491	479	455	450	437	427	429	-60	0.6	1.7	2.1
United Kingdom	7 995	6 460	4 369	3 090	2 016	1 835	1 818	1 815	1 726	1 689	1 536	-81	-9.1	12.3	7.6
EU-28 ([a])	**64 804**	**52 420**	**37 356**	**30 288**	**25 384**	**22 969**	**22 343**	**21 907**	**20 222**	**20 254**	**20 142**	**-69**	**-0.6**	**100**	**100**
EU-28 ([b])	64 804	52 420	37 356	30 288	25 384	22 969	22 343	21 907	20 222	20 254	20 131				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

([a]) Sum of national totals as reported by Member States.

([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

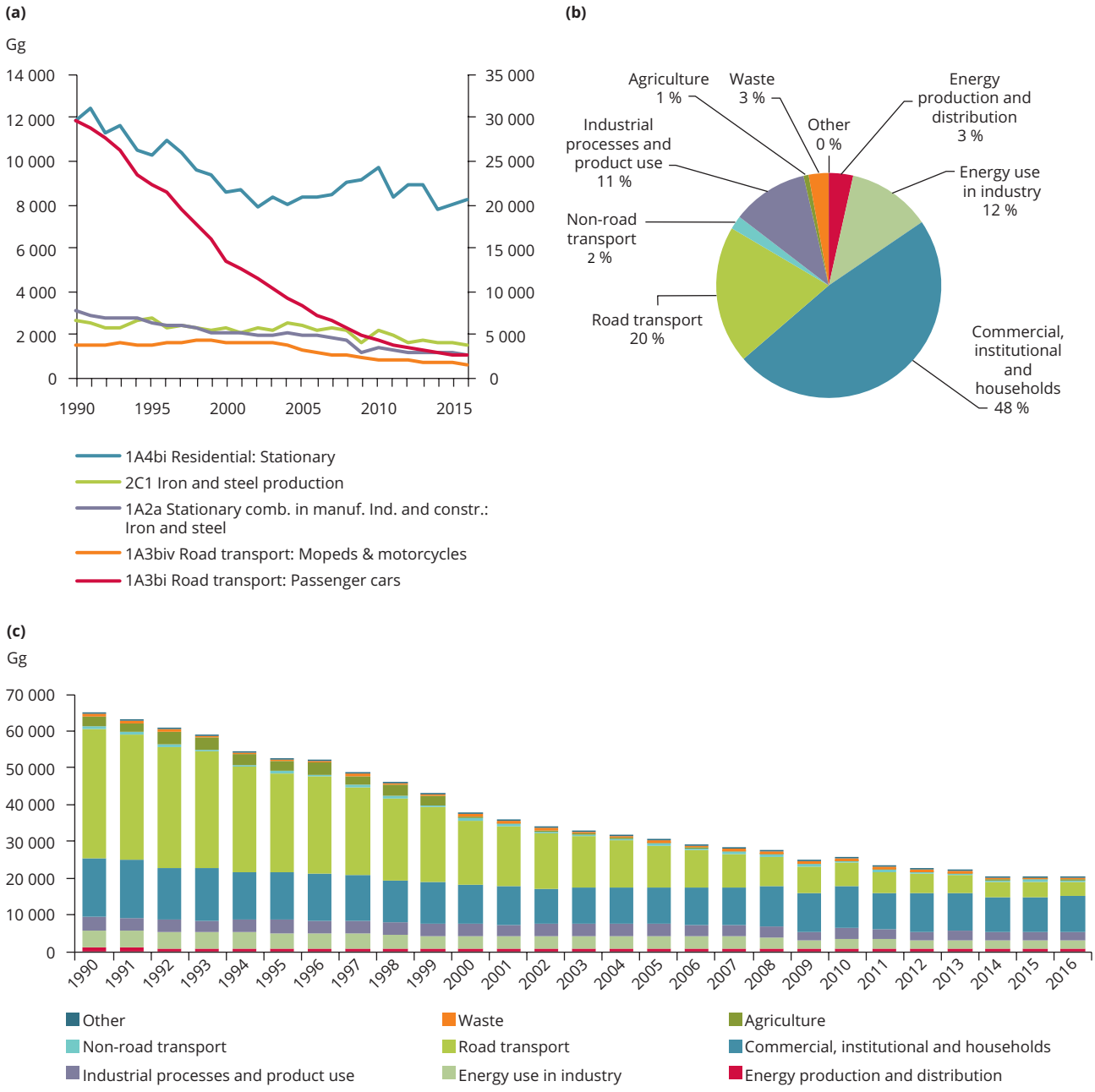
production without oxygen (see Belgium's IIR, listed in Appendix 5).

The slight increase in emissions reported by Finland between 2015 and 2016 was mainly caused by increased emissions reported in the category '1A4bi — Residential: Stationary'.

'1A4bi — Residential: Stationary' and '1A3bi — Road transport: Passenger cars' were the most important key categories for CO emissions, jointly accounting for 55 % of the total. Among the top five key categories, the highest relative reduction in emissions between 1990 and 2016 was in the second most important key category, '1A3bi — Road transport: Passenger cars' (-91%) (see Figure 3.11(a)).

Figure 3.11(b) shows the contribution to total EU emissions that each aggregated sector group made. For CO, common major emission sources are 'commercial, institutional and households' and 'road transport'.

Figure 3.11 CO emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions



Note: In Figure 3.11(a), the right-hand axis gives values for '1A3bi Road transport: Passenger cars'.

3.12 Lead (Pb) emission trends and key categories

Between 1990 and 2016, Pb emissions dropped in the EU by 93 %. Between 2015 and 2016, emissions decreased by 0.7 %, mainly because emissions decreased in the United Kingdom, Greece (gap-filled data) and Bulgaria (countries ranked according to the size of their contribution to the absolute change) (see Table 3.15). The Member States that contributed most (i.e. more than 10 %) to Pb emissions in 2016 were Poland, Italy and Germany (countries ranked according to the percentage of their share in the EU total).

Austria stated that the significant reduction of Pb emissions from 1990 to 1995 is linked to emission limits for cars and trucks, as well as more stringent requirements for fuels. In this period, emissions arising from the transport sector decreased by nearly 100 % (see Austria's IIR, listed in Appendix 5).

Belgium explained that the decrease in Pb emissions between 1995 and 2000 is mainly due to some measures taken in two large plants in Flanders. At Umicore Hoboken (2C7c), a number of installations were taken out of service at the end of 1997 (electric kiln, agglomeration and roasting) and the ore park was evacuated. This led to a significant decrease in Pb, Cd and Zn emissions. For ArcelorMittal (2C1), there were lower mass flows for Pb, possibly caused by replacement of the electro-filter of the sintering plant by a sleeve filter in 1997. Another factory (2A3) that reported Pb emissions in 1997 did not make an annual industrial report in 1998 and stopped activities in 1999 (personal communication by Belgium in 2018).

Croatia explained that, between 1990 and 2015, Pb emissions from the transport sector decreased by 99 % as a result of legislative efforts to remove Pb from petrol. Efforts began in 1996 when the Pb content in leaded petrol was reduced and then even more reduced in 2003. Finally, in 2006 leaded petrol was completely removed from use (personal communication by Croatia in 2017).

The Czech Republic explained that a decrease in Pb emissions since the year 2000 is due to the ban on leaded fuel in 2001 (personal communication by the Czech Republic in 2017).

Latvia's Pb emissions, in comparison with the year 1990, had decreased by 99 % in 2016. The most significant emission decrease occurred in 2011, due to a change of the furnace type used in metal production (see Latvia's IIR, listed in Appendix 5).

Portugal stated that the Pb emissions registered from 1990 to 2016 show a downwards trend, falling by 93 %. This is mainly a result of the reduction in emissions from road transport, due to the phasing out of leaded petrol within the EU (see Portugal's IIR, listed in Appendix 5).

'2C1 — Iron and steel production', '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals' and '1A3bvi — Road transport: Automobile tyre and brake wear' were the leading key categories for Pb emissions in 2016, together making up 48 % of total Pb emissions (see Figure 3.12(a)).

The largest relative reductions in emissions between 1990 and 2016 were from the fifth most important key category, '1A1a — Public electricity and head production' (-81%), and the most important key category, '2C1 — Iron and steel production' (-76 %). The third most important key category, '1A3bvi — Road transport: Automobile tyre and brake wear', has increased by 32 % since 1990.

The peak in the category '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals' in 2008 was mainly caused by the high emissions reported by Bulgaria for that year.

EU total emissions of Pb have declined to less than a 10th of the emissions in 1990. This is primarily because countries reduced emissions from the 'road transport' sector. The promotion of unleaded petrol within the EU through a combination of fiscal and regulatory measures has been a notable success story. EU Member States and other EEA member countries have now phased out the use of leaded petrol. In the EU, the Directive on the Quality of Petrol and Diesel Fuels (98/70/EC) regulated that goal (EEA, 2017d).

Figure 3.12(b) shows the contribution that each aggregated sector group made to total EU emissions. For Pb, common major emission sources are the sectors 'energy use in industry', 'industrial processes and product use', 'road transport' and 'commercial, institutional and households'.

Table 3.15 Member State contributions to EU emissions of Pb

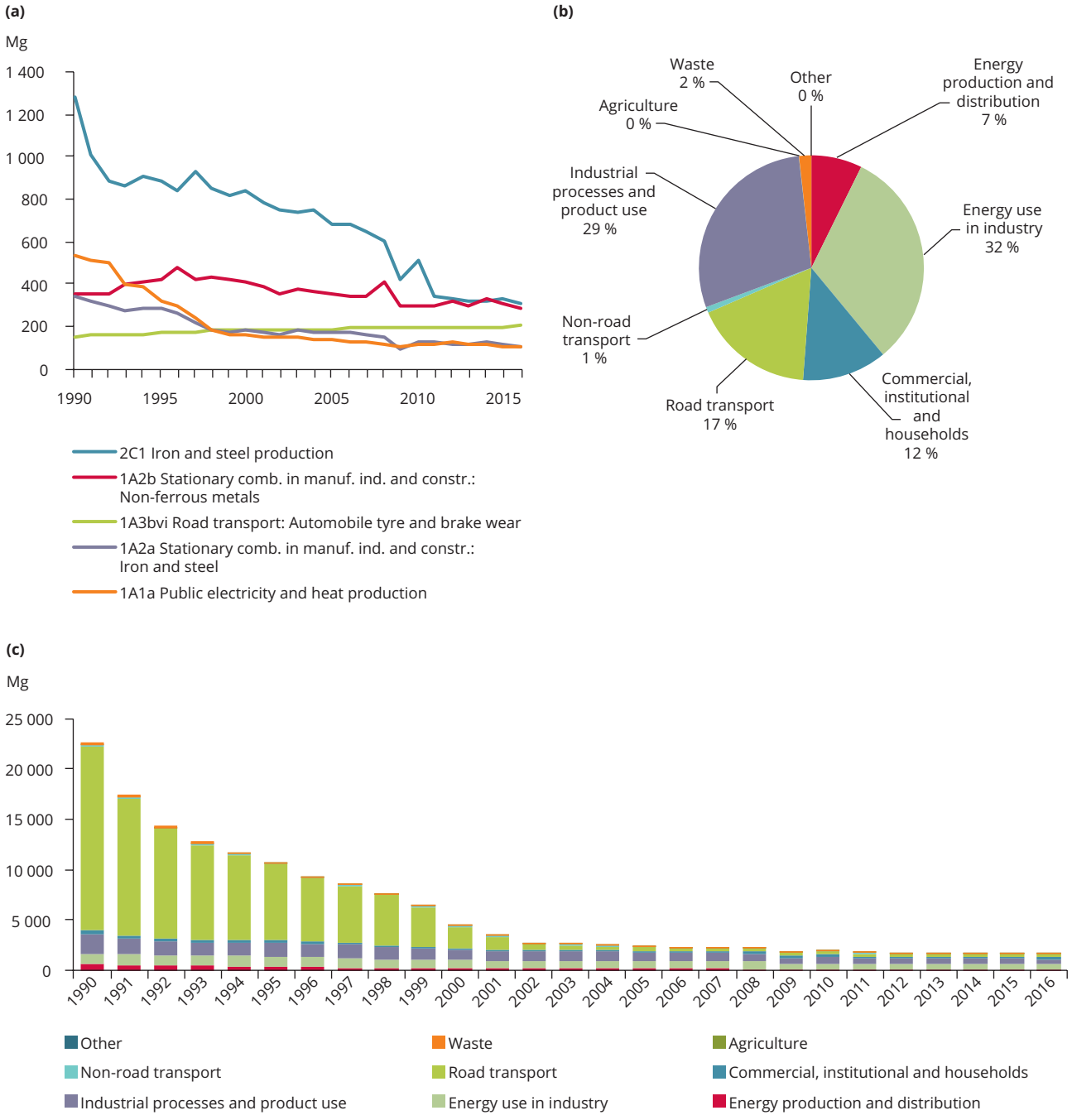
	Pb (Mg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	217	17	14	14	16	16	16	17	16	15	16	-93	1.1	1.0	0.9
Belgium	254	187	105	73	39	28	28	25	22	29	27	-89	-7.1	1.1	1.6
Bulgaria	440	366	274	121	61	65	67	70	79	73	67	-85	-8.5	1.9	4.0
Croatia	540	330	277	56	8.1	7.9	7.3	8.4	7.9	8.0	8.0	-99	0.0	2.4	0.5
Cyprus	43	50	49	29	31	30	27	25	25	26	27	-38	4.3	0.2	1.6
Czech Republic	305	229	95	38	26	22	22	23	23	20	17	-94	-15.0	1.3	1.0
Denmark	129	25	19	16	12	12	11	11	11	11	11	-91	0.7	0.6	0.7
Estonia	205	86	37	36	39	39	34	40	36	28	32	-84	14.2	0.9	2.0
Finland	151	76	34	22	21	20	17	16	17	15	16	-89	6.8	0.7	1.0
France	4 291	1 474	279	170	132	123	122	119	115	108	111	-97	3.0	18.9	6.7
Germany	2 285	742	429	304	238	238	229	225	231	237	234	-90	-1.5	10.1	14.1
Greece	472	371	299	25	19	16	15	14	16	15	8.3	-98	-45.7	2.1	0.5
Hungary	839	305	21	9.9	8.2	9.2	8.9	8.3	7.9	8.2	8.9	-99	8.4	3.7	0.5
Ireland	160	100	20	19	17	16	15	15	14	14	13	-92	-2.9	0.7	0.8
Italy	4 285	2 000	956	287	268	266	268	259	262	259	272	-94	5.2	18.9	16.4
Latvia	235	128	156	170	164	3.5	5.1	3.3	2.8	2.7	2.7	-99	0.3	1.0	0.2
Lithuania	88	53	5.1	3.2	3.0	2.9	3.0	3.0	2.8	2.7	2.3	-97	-12.1	0.4	0.1
Luxembourg	44	19	1.3	1.5	1.2	1.7	1.9	1.4	1.5	1.6	1.5	-97	-4.1	0.2	0.1
Malta	0.4	0.5	0.7	4.0	3.8	2.6	10	3.4	4.5	1.3	0.8	> 100	-44.2	0.0	0.0
Netherlands	332	153	27	30	38	22	16	14	9.0	8.6	8.9	-97	3.7	1.5	0.5
Poland	483	477	408	403	417	417	428	417	427	421	418	-13	-0.6	2.1	25.2
Portugal	578	796	54	44	41	41	41	41	41	41	40	-93	-1.8	2.5	2.4
Romania	15	31	49	67	43	43	40	37	37	40	39	> 100	-2.6	0.1	2.3
Slovakia	76	65	49	59	39	37	35	29	34	39	45	-42	15.8	0.3	2.7
Slovenia	343	192	36	9.0	8.4	8.6	8.0	7.6	7.0	6.9	7.0	-98	1.3	1.5	0.4
Spain	2 631	893	520	174	152	150	150	136	147	157	153	-94	-2.2	11.6	9.2
Sweden	353	32	22	14	13	11	11	10	11	10	11	-97	7.3	1.6	0.7
United Kingdom	2 909	1 549	167	123	73	72	76	71	78	77	64	-98	-16.3	12.8	3.9
EU-28 (a)	**22 703**	**10 749**	**4 402**	**2 323**	**1 929**	**1 720**	**1 711**	**1 647**	**1 686**	**1 673**	**1 661**	**-93**	**-0.7**	**100**	**100**
EU-28 (b)	22 703	10 749	4 402	2 323	1 929	1 720	1 711	1 647	1 686	1 673	1 661				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

(a) Sum of national totals as reported by Member States.

(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

Figure 3.12 Pb emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions



3.13 Cadmium (Cd) emission trends and key categories

Between 1990 and 2016, Cd emissions decreased by 65 % in the EU. Between 2015 and 2016, they increased by 2 % (Table 3.16), mainly because emissions increased in Belgium, Poland, France and Italy (countries ranked according to the size of their contribution to the absolute change). The Member States that contributed most (i.e. more than 10 %) to Cd emissions in 2016 were Poland and Germany (countries ranked according to the percentage of their share in the EU total).

'1A4bi — Residential: Stationary', '2C1 — Iron and steel production' and '2C7a — Copper production' were the principal key categories for Cd emissions, making up 36 % of total Cd emissions (see Figure 3.13(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2016

Table 3.16 Member State contributions to EU emissions of Cd

	Cd (Mg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	1.7	1.1	1.0	1.1	1.2	1.2	1.2	1.3	1.2	1.2	1.2	-28	-0.1	0.9	1.7
Belgium	6.2	5.1	2.8	2.1	2.0	1.7	1.5	1.5	1.2	1.6	2.8	-56	70.5	3.1	3.9
Bulgaria	5.5	3.7	3.7	3.2	1.4	1.6	1.5	1.5	2.4	1.5	1.7	-69	14.6	2.7	2.4
Croatia	1.2	0.9	0.9	1.1	1.0	0.9	0.9	0.9	0.8	0.9	0.8	-29	-4.8	0.6	1.2
Cyprus	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	-36	4.1	0.0	0.1
Czech Republic	4.0	2.0	1.6	1.5	1.3	1.3	1.2	1.2	1.2	1.2	1.1	-72	-3.9	2.0	1.6
Denmark	1.2	0.7	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.7	-39	3.6	0.6	1.0
Estonia	4.5	2.2	0.8	0.8	0.9	0.9	0.8	1.0	0.9	0.7	0.8	-82	8.4	2.2	1.1
Finland	6.5	2.0	1.3	1.3	1.3	1.3	1.2	1.1	0.9	0.9	1.0	-85	5.3	3.2	1.4
France	21	18	14	5.9	3.3	3.1	2.9	3.0	3.1	2.8	3.3	-84	18.4	10.3	4.7
Germany	30	20	19	13	13	13	13	13	13	13	13	-58	0.1	15.1	18.2
Greece	1.9	2.1	1.8	1.9	2.0	1.6	1.7	1.4	2.0	2.0	1.4	-25	-27.9	0.9	2.0
Hungary	1.7	1.5	1.7	1.2	1.5	1.6	1.6	1.7	1.5	1.5	1.5	-11	-0.3	0.9	2.1
Ireland	0.6	0.5	0.6	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3	-49	-0.4	0.3	0.4
Italy	10	9.5	9.0	8.3	7.1	6.8	7.0	6.6	6.6	6.4	6.8	-32	5.8	5.0	9.6
Latvia	0.9	0.8	0.9	1.1	1.0	0.6	0.8	0.6	0.6	0.6	0.6	-41	-2.4	0.5	0.8
Lithuania	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	-11	-2.1	0.2	0.5
Luxembourg	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-13	1.1	0.0	0.1
Malta	0.2	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-98	80.5	0.1	0.0
Netherlands	2.1	1.1	1.0	1.8	2.6	1.2	0.9	0.7	0.6	0.6	0.7	-70	2.9	1.1	0.9
Poland	19	23	17	14	13	13	13	13	12	12	13	-32	6.6	9.6	18.5
Portugal	6.4	6.7	6.5	7.3	4.9	3.7	3.3	4.9	4.9	4.6	3.6	-44	-22.7	3.2	5.0
Romania	3.0	3.1	3.2	3.8	3.5	3.4	3.3	3.0	3.0	3.0	3.0	3	2.4	1.5	4.3
Slovakia	8.6	9.7	6.9	6.3	1.3	1.1	1.1	1.1	1.2	1.2	1.4	-84	17.3	4.3	2.0
Slovenia	0.8	0.5	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	-21	3.2	0.4	0.8
Spain	37	31	20	12	7.4	7.5	7.5	6.7	6.9	7.2	7.0	-81	-1.8	18.6	9.9
Sweden	2.3	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	-77	-0.5	1.2	0.8
United Kingdom	23	12	6.4	4.2	3.5	3.7	3.3	3.4	3.8	3.8	3.5	-85	-7.1	11.6	4.9
EU-28 ([a])	**201**	**159**	**123**	**94**	**76**	**73**	**71**	**70**	**70**	**70**	**71**	**-65**	**2.0**	**100**	**100**
EU-28 ([b])	201	159	123	94	76	73	71	70	70	70	71				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

([a]) Sum of national totals as reported by Member States.

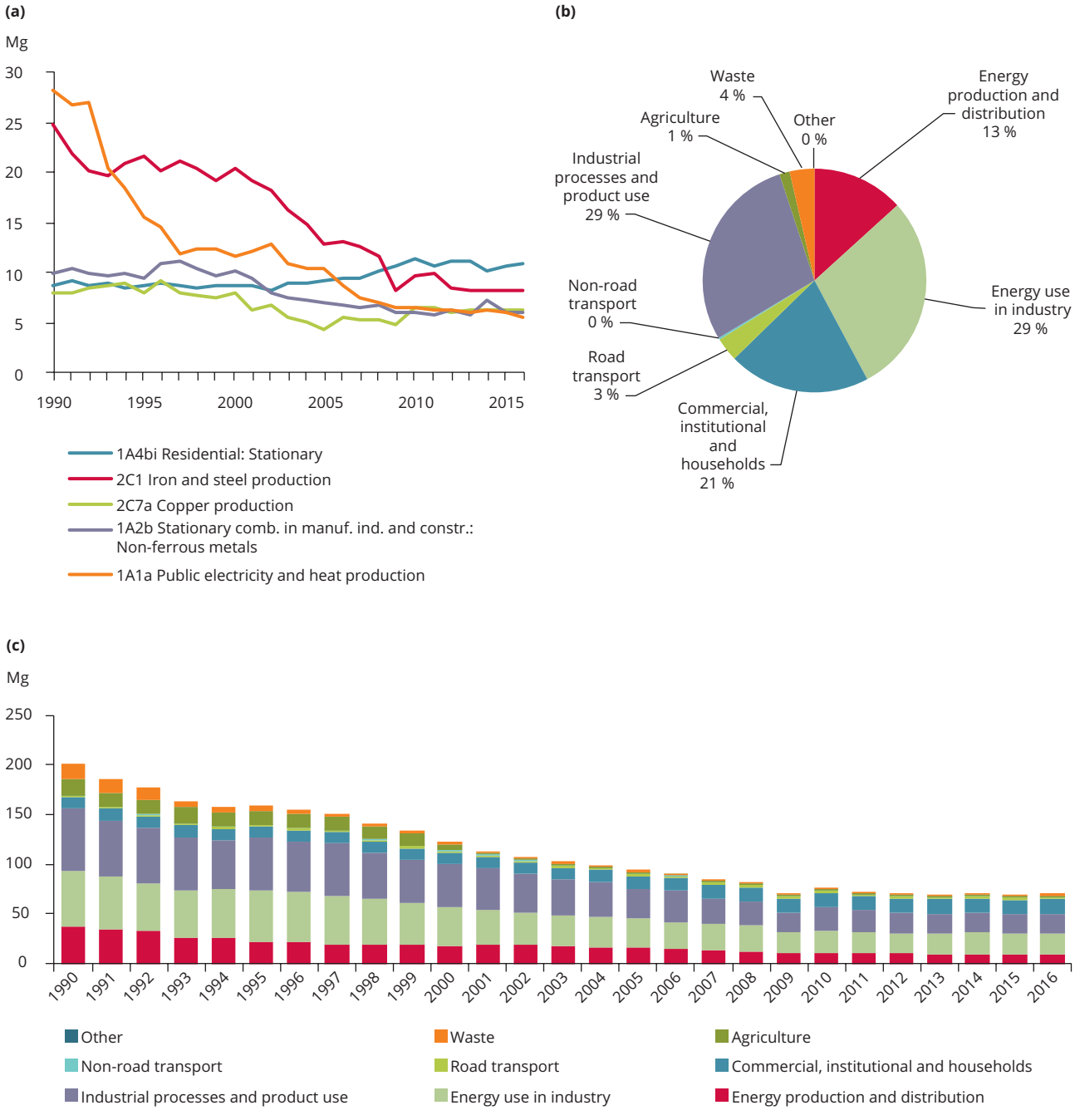
([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

were in the fifth most important, '1A1a — Public electricity and heat production' (-80 %), and the second most important, '2C1 — Iron and steel production' (-67 %). In the most important key category, '1A4bi — Residential: Stationary', the values of reported emissions increased since 1990 (23 %).

As they have for Pb, industrial sources of Cd emissions have decreased since the early 1990s in all Member States. This is largely because abatement technologies for waste water treatment and incinerators have improved, and so have metal refining and smelting facilities (EEA, 2017d).

Figure 3.13(b) shows the contribution that each aggregated sector group made to total EU emissions. For Cd, common leading emission sources are the energy sectors, 'industrial processes and product use' and the 'commercial, institutional and households' sector.

Figure 3.13 Cd emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions



3.14 Mercury (Hg) emission trends and key categories

Between 1990 and 2016, Hg emissions dropped by 71 % in the EU. Between 2015 and 2016, the decrease was 3 % (see Table 3.17), mainly because of reduced emissions in the United Kingdom, Greece (gap-filled data), France and Italy (countries ranked according to the size of their contribution to the absolute change). The Member States that contributed most (i.e. more than 10 %) to Hg emissions in 2016 were Poland, Germany and Italy (countries ranked according to the percentage of their share in the EU total).

T'1A1a — Public electricity and heat production' and '2C1 — Iron and steel production' and '1A4bi — Residential: Stationary' were the main key categories for Hg emissions, making up 53 % of the total (see Figure 3.14(a)). Among the top five key categories, the highest relative reduction in emissions between

Table 3.17 Member State contributions to EU emissions of Hg

	Hg (Mg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	2.2	1.2	0.9	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	-56	-5.6	1.1	1.6
Belgium	5.7	3.1	3.0	2.0	1.7	1.6	1.3	1.4	1.5	1.1	1.4	-76	28.1	2.9	2.4
Bulgaria	2.5	1.9	1.5	1.6	0.9	0.9	0.8	0.8	0.7	0.8	0.8	-68	6.3	1.3	1.4
Croatia	1.2	0.3	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	-57	1.6	0.6	0.9
Cyprus	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-2	1.0	0.0	0.2
Czech Republic	5.0	4.3	3.4	3.5	3.3	3.3	3.0	2.8	2.8	2.7	2.7	-46	-2.1	2.5	4.6
Denmark	3.2	2.3	1.0	0.7	0.4	0.4	0.3	0.3	0.3	0.3	0.3	-90	15.4	1.6	0.6
Estonia	1.2	0.6	0.6	0.6	0.7	0.7	0.6	0.7	0.7	0.5	0.6	-47	12.3	0.6	1.1
Finland	1.1	0.8	0.6	0.9	0.9	0.8	0.7	0.8	0.7	0.6	0.6	-46	-4.6	0.6	1.0
France	25	20	12	6.6	4.4	4.6	4.2	4.0	4.4	3.6	3.2	-87	-10.8	12.4	5.6
Germany	36	20	18	14	11	11	10	9.9	9.9	10	9.8	-72	-2.5	17.9	16.9
Greece	2.7	2.6	2.8	3.0	3.6	3.4	2.9	2.6	2.4	2.2	1.7	-38	-24.1	1.3	2.9
Hungary	3.1	2.5	2.2	1.6	1.4	1.3	1.2	1.0	1.0	1.0	1.2	-63	11.5	1.6	2.0
Ireland	0.8	0.7	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-59	-0.8	0.4	0.6
Italy	15	14	14	12	10	10	11	9.7	10	9.3	8.9	-41	-3.9	7.7	15.4
Latvia	0.3	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	-65	24.5	0.1	0.2
Lithuania	0.3	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	-69	-0.8	0.2	0.2
Luxembourg	0.4	0.2	0.3	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	-71	53.6	0.2	0.2
Malta	0.4	0.5	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-99	-19.9	0.2	0.0
Netherlands	3.6	1.5	1.1	1.0	0.6	0.7	0.6	0.6	0.5	0.6	0.6	-83	8.6	1.8	1.0
Poland	14	12	10	10	9.5	9.6	9.9	10	9.6	11	10	-25	-2.1	7.0	17.9
Portugal	3.4	3.7	3.4	3.0	2.1	2.0	2.0	1.9	1.9	2.1	1.9	-45	-7.8	1.7	3.3
Romania	1.0	1.4	1.8	2.2	1.7	1.8	1.6	1.4	1.4	1.5	1.4	38	-2.8	0.5	2.5
Slovakia	20	5.4	5.7	5.5	2.6	1.6	1.6	1.4	1.6	1.5	1.7	-91	17.7	10.1	3.0
Slovenia	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-48	3.6	0.2	0.3
Spain	12	14	9	7	3.9	4.0	4.2	3.7	3.8	3.9	3.9	-67	-1.2	5.8	6.7
Sweden	1.5	1.0	0.7	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.4	-73	0.7	0.8	0.7
United Kingdom	38	20	8.4	7.5	6.5	6.0	5.7	6.0	5.4	4.8	4.0	-90	-17.8	19.0	6.9
EU-28 ([a])	**199**	**136**	**103**	**86**	**68**	**66**	**65**	**62**	**62**	**60**	**58**	**-71%**	**-3%**	**100%**	**100%**
EU-28 ([b])	199	136	103	86	68	66	65	62	62	60	58				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

([a]) Sum of national totals as reported by Member States.

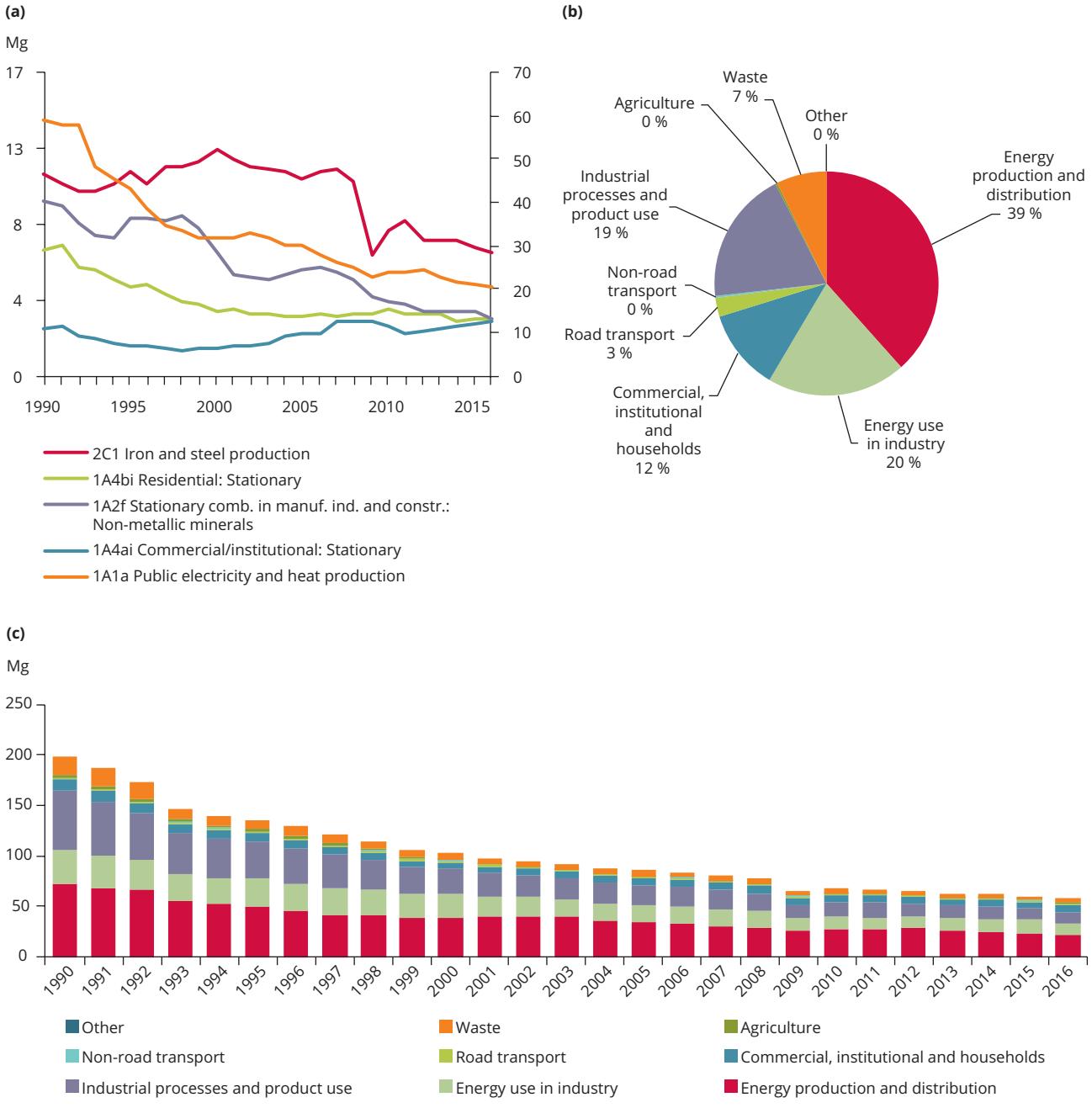
([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

1990 and 2016 was in the fourth most important, '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' (-68 %).The most important key category, '1A1a — Public electricity and heat production' (-66 %) and the third most important, '1A4bi — Residential: Stationary' (-54 %) also show high reductions.

The decrease in Hg emissions since 1990 in the industrial sector is mainly due to improving emission controls on Hg cells and replacing them with diaphragm or membrane cells, and switching from coal to gas and other energy sources in the power- and heat-generating sectors in many countries (EEA, 2017d).

Figure 3.14(b) shows the contribution that each aggregated sector group made to total EU emissions. For Hg, principal emission sources are the energy sectors and the sector 'industrial processes and product use'.

Figure 3.14 Hg emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions



Note: In Figure 3.14(a), the right-hand axis shows values for '1A1a Public electricity and heat production'.

3.15 Arsenic (As) emission trends

Between 1990 and 2016, As emissions in the EU dropped by 67 %. Between 2015 and 2016, emissions decreased by 4.4 %, mainly because emissions decreased in Italy, Poland and the United Kingdom (countries ranked according to the size of their contribution to the absolute change) (see Table 3.18).

The Member States that contributed most (i.e. more than 10 %) to As emissions in 2016 were Italy, Slovakia and Poland (countries ranked according to the percentage of their share in the EU total). Austria, Luxembourg and Slovenia did not provide emission data for As. Therefore, the EU total is an underestimate.

Table 3.18 Member State contributions to EU emissions of As

	As (Mg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	6.3	6.0	3.5	2.9	1.8	1.6	1.4	1.3	1.0	1.1	0.9	-85	-18.5	1.2	0.5
Bulgaria	25	15	7.4	16	3.4	4.1	2.9	2.8	4.3	3.0	3.6	-85	21.0	4.7	2.1
Croatia	8.6	1.2	1.0	1.1	0.8	0.6	0.6	0.5	0.4	0.5	0.4	-95	-16.7	1.6	0.2
Cyprus	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.1	7	4.7	0.0	0.1
Czech Republic	69	17	3.8	2.1	1.7	1.5	1.4	1.6	1.3	1.5	1.4	-98	-5.3	13.2	0.8
Denmark	1.3	0.8	0.8	0.5	0.3	0.3	0.2	0.3	0.3	0.2	0.3	-78	19.2	0.2	0.2
Estonia	19	10	8.6	9.2	11	11	9.6	11	10	7.8	9.0	-52	15.9	3.6	5.2
Finland	35	5.2	4.3	2.9	3.4	2.9	2.6	2.7	2.7	2.4	2.5	-93	5.0	6.6	1.5
France	17	17	15	12	7.5	6.5	6.1	6.3	5.5	5.3	5.7	-67	6.6	3.3	3.3
Germany	87	11	10	8.8	9.3	9.1	8.9	9.0	8.7	8.7	8.7	-90	-0.5	16.6	5.0
Greece	2.6	2.9	3.2	3.4	2.5	2.3	2.6	2.2	3.6	3.3	2.5	-5	-23.6	0.5	1.4
Hungary	4.2	3.3	3.1	2.6	2.3	2.3	2.2	1.9	2.0	2.2	2.0	-53	-9.0	0.8	1.2
Ireland	1.6	1.7	1.7	1.5	1.2	1.2	1.3	1.2	1.2	1.3	1.3	-23	-0.1	0.3	0.7
Italy	37	27	46	40	45	46	45	44	45	46	38	4	-16.1	7.0	22.3
Latvia	17	8.6	15	17	16	0.1	0.1	0.1	0.1	0.2	0.2	-99	19.0	3.2	0.1
Lithuania	0.5	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-88	-13.9	0.1	0.0
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-98	-4.5	0.0	0.0
Netherlands	1.3	0.9	0.9	1.3	0.6	1.0	0.8	0.7	0.7	0.6	0.7	-45	8.8	0.2	0.4
Poland	36	36	31	33	31	31	30	29	31	31	28	-23	-7.9	7.0	16.4
Portugal	2.9	3.1	3.1	3.1	1.7	1.6	1.8	1.7	1.7	1.8	1.6	-44	-10.6	0.6	0.9
Romania	2.7	4.1	5.7	6.8	5.1	5.7	4.8	4.3	4.3	4.5	4.4	61	-1.8	0.5	2.5
Slovakia	78	23	4.5	21	21	22	19	13	24	28	31	-61	11.3	14.9	17.7
Slovenia	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Spain	15	14	19	18	13	14	15	12	14	15	14	-3	-3.4	2.8	8.2
Sweden	5.6	1.5	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.7	-88	-3.2	1.1	0.4
United Kingdom	51	38	25	19	16	16	17	18	18	17	15	-71	-9.7	9.8	8.8
EU-28 ([a])	**524**	**249**	**214**	**222**	**196**	**182**	**175**	**166**	**180**	**181**	**173**	**-67**	**-4.4**	**100**	**100**
EU-28 ([b])	524	249	214	222	196	182	175	166	180	181	173				

Notes: Dark-blue shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

([a]) Sum of national totals as reported by Member States.

([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

3.16 Chromium (Cr) emission trends

Between 1990 and 2016, Cr emissions in the EU dropped by 72 %. Between 2015 and 2016, emissions increased by 0.5 % (see Table 3.19), mainly because emissions increased in Finland, Germany, Poland and Estonia (countries ranked according to the size of their contribution to the absolute change). The Member States that contributed most (i.e. more than 10 %) to Cr emissions in 2016 were Germany and Italy (countries ranked according to the percentage of their share in the EU total). Austria, Luxembourg and Slovenia did not provide emission data for Cr. Therefore, the EU total is an underestimate.

Table 3.19 Member State contributions to EU emissions of Cr

	Cr (Mg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	33	28	19	17	13	12	11	6.2	5.9	5.9	6.1	-82	4.7	2.7	1.8
Bulgaria	21	10	7.5	9.8	5.3	5.8	5.4	5.3	5.7	6.3	6.7	-68	6.2	1.7	2.0
Croatia	5.3	3.7	3.1	3.7	2.6	2.6	2.4	2.2	2.0	2.2	2.0	-62	-5.7	0.4	0.6
Cyprus	0.2	0.2	0.3	0.3	0.2	0.3	0.3	0.2	0.2	0.2	0.2	29	4.4	0.0	0.1
Czech Republic	28	18	13	14	13	13	12	12	12	12	12	-57	1.2	2.2	3.5
Denmark	6.0	3.1	1.6	1.7	1.7	1.6	1.5	1.6	1.6	1.7	1.7	-71	2.5	0.5	0.5
Estonia	18	10	8.4	9.1	11	10	9.2	11	9.9	7.6	8.7	-53	14.2	1.5	2.5
Finland	46	29	27	19	25	16	17	17	22	16	17	-63	9.1	3.7	5.0
France	392	190	104	45	28	24	23	23	20	21	21	-95	4.2	32.0	6.3
Germany	170	101	90	83	80	81	80	79	81	82	83	-51	1.7	13.8	24.4
Greece	6.5	7.1	7.6	8.0	8.0	8.9	9.4	7.8	15	15	13	96	-18.0	0.5	3.7
Hungary	17	12	12	12	11	12	11	7.9	8.8	11	9.5	-46	-15.9	1.4	2.8
Ireland	4.5	4.5	4.9	3.5	2.7	2.5	2.5	2.4	2.4	2.5	2.5	-45	1.1	0.4	0.7
Italy	87	69	44	49	43	43	42	39	38	38	39	-56	1.5	7.1	11.3
Latvia	2.4	1.8	2.1	2.5	2.3	1.1	1.3	1.2	1.2	1.1	1.1	-55	-0.1	0.2	0.3
Lithuania	2.7	1.1	0.7	0.5	0.4	0.4	0.4	0.4	5.1	4.9	4.8	75	-2.7	0.2	1.4
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.6	0.9	1.2	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.1	-91	20.4	0.0	0.0
Netherlands	12	8.5	5.0	4.3	3.8	3.7	3.7	3.6	3.5	3.4	3.7	-69	7.6	1.0	1.1
Poland	85	60	38	33	35	35	35	33	32	33	34	-60	3.8	6.9	9.9
Portugal	12	14	14	15	12	12	11	11	11	11	11	-13	-5.1	1.0	3.2
Romania	6.4	10	15	19	13	12	12	11	12	12	12	91	-0.1	0.5	3.6
Slovakia	58	7.4	5.3	5.0	4.5	4.3	4.5	4.7	4.8	4.7	4.9	-91	3.3	4.7	1.4
Slovenia	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Spain	25	27	27	27	19	19	18	16	16	18	17	-32	-2.7	2.0	5.0
Sweden	23	12	7.1	10	5.4	6.8	5.3	5.3	4.9	5.8	6.0	-75	2.1	1.9	1.7
United Kingdom	164	118	77	40	27	26	25	26	26	26	25	-85	-2.1	13.4	7.3
EU-28 (a)	**1 226**	**747**	**536**	**432**	**367**	**352**	**344**	**328**	**342**	**340**	**342**	**-72**	**0.5**	**100**	**100**
EU-28 (b)	1 226	747	536	432	367	352	344	328	342	340	342				

Notes: Dark-blue shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

(a) Sum of national totals as reported by Member States.

(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

3.17 Copper (Cu) emission trends

Between 1990 and 2016, Cu emissions in the EU increased by 8 %. Between 2015 and 2016, emissions increased by 0.9 %, mainly because emissions increased in Germany, Slovakia and Spain (countries ranked according to the size of their contribution to the absolute change) (see Table 3.20). The Member State that contributed most (i.e. more than 10 %) to Cu emissions in 2016 was Germany. Austria, Luxembourg and Slovenia did not provide emission data for Cu. Therefore, the EU total is an underestimate.

Table 3.20 Member State contributions to EU emissions of Cu

	Cu (Mg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	40	40	39	36	34	33	32	30	29	30	31	-24	1.5	1.1	0.8
Bulgaria	107	77	58	100	22	24	24	23	24	25	26	-76	1.9	3.0	0.7
Croatia	9.0	6.0	7.2	8.9	7.8	7.6	7.4	8.2	7.7	8.1	8.4	-6	4.1	0.3	0.2
Cyprus	1.3	1.7	2.2	2.4	2.4	2.4	2.3	2.0	2.0	2.1	2.2	62	4.1	0.0	0.1
Czech Republic	65	45	43	63	59	59	58	58	60	61	62	-5	1.6	1.8	1.6
Denmark	33	37	40	42	43	43	42	42	41	43	43	31	-0.6	0.9	1.1
Estonia	11	5.6	4.3	5.4	5.8	5.9	5.7	5.9	6.0	5.5	5.8	-47	6.0	0.3	0.1
Finland	170	130	78	58	50	51	47	47	45	40	41	-76	2.5	4.7	1.1
France	222	217	218	220	211	216	207	209	206	208	208	-6	0.1	6.2	5.3
Germany	1 884	2 023	2 205	2 212	2 271	2 314	2 299	2 309	2 360	2 404	2 443	30	1.6	52.4	62.7
Greece	23	27	30	35	36	33	27	27	32	31	29	23	-5.4	0.7	0.7
Hungary	14	11	12	14	15	14	14	13	14	15	16	12	6.1	0.4	0.4
Ireland	10	11	19	22	19	19	18	18	19	20	20	98	2.9	0.3	0.5
Italy	190	214	215	222	192	193	183	175	182	177	176	-7	-0.2	5.3	4.5
Latvia	2.6	1.6	1.6	2.2	2.2	1.9	1.9	2.0	2.1	2.2	2.3	-13	4.5	0.1	0.1
Lithuania	9.3	4.7	4.4	5.1	5.9	5.7	5.7	5.7	5.7	5.5	5.1	-46	-7.5	0.3	0.1
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.1	1.1	100	5.2	0.0	0.0
Netherlands	37	38	39	41	45	43	43	43	43	45	41	13	-8.6	1.0	1.1
Poland	300	323	300	331	331	329	324	312	324	330	317	5	-4.0	8.4	8.1
Portugal	23	29	38	39	36	34	31	31	31	32	31	34	-1.0	0.7	0.8
Romania	4.6	4.4	4.8	19	19	20	21	20	20	21	22	> 100	6.2	0.1	0.6
Slovakia	89	50	22	47	49	48	43	30	41	50	57	-36	13.6	2.5	1.5
Slovenia	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Spain	130	152	220	236	218	212	216	190	207	215	219	68	1.6	3.6	5.6
Sweden	65	51	46	37	38	38	38	38	38	39	39	-39	1.7	1.8	1.0
United Kingdom	150	116	86	68	56	60	55	54	55	55	51	-66	-6.6	4.2	1.3
EU-28 ([a])	**3 592**	**3 616**	**3 732**	**3 868**	**3 769**	**3 806**	**3 744**	**3 693**	**3 796**	**3 864**	**3 897**	**8**	**0.9**	**100**	**100**
EU-28 ([b])	3 592	3 616	3 732	3 868	3 769	3 806	3 744	3 693	3 796	3 864	3 897				

Notes: Dark-blue shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

([a]) Sum of national totals as reported by Member States.

([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

3.18 Nickel (Ni) emission trends

Between 1990 and 2016, Ni emissions in the EU dropped by 72 %. Between 2015 and 2016, emissions increased slightly by 0.2 %, mainly because Slovakia and Germany (countries ranked according to the size of their contribution to the absolute change) reported increased emissions (see Table 3.21). The Member States that contributed most (i.e. more than 10 %) to Ni emissions in 2016 were Germany, the United Kingdom and Poland (countries ranked according to the percentage of their share in the EU total).

Table 3.21 Member State contributions to EU of emissions Ni

	Ni (Mg)											Change (%)		Share in EU28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	76	70	34	27	9.2	8.7	6.0	4.5	4.2	4.2	3.9	-95	-6.5	3.5	0.7
Bulgaria	33	28	7.9	24	6.8	7.1	5.4	5.6	5.9	5.7	5.8	-82	2.3	1.5	1.0
Croatia	26	20	17	20	15	12	10	7.5	6.6	8.3	7.8	-70	-4.9	1.2	1.3
Cyprus	5.9	7.2	9.9	12	7.1	8.9	9.4	5.2	5.2	5.3	5.7	-3	7.1	0.3	0.9
Czech Republic	55	28	14	12	8	7	6.2	5.6	5.6	5.4	5.1	-91	-5.0	2.6	0.8
Denmark	19	13	7.6	7.2	4.7	4.1	3.9	3.8	3.2	3.0	2.9	-84	-3.7	0.9	0.5
Estonia	27	10	6.5	6.4	6.6	6.4	5.7	6.5	6.1	4.7	5.4	-80	14.2	1.3	0.9
Finland	77	46	34	26	23	20	19	17	17	16	16	-80	-2.5	3.6	2.6
France	276	218	178	142	86	75	63	47	43	39	34	-88	-10.8	12.8	5.7
Germany	342	212	169	180	157	145	142	138	131	138	145	-58	4.8	15.8	24.1
Greece	43	48	51	57	61	57	60	50	34	40	37	-13	-7.5	2.0	6.2
Hungary	24	31	21	7.4	6.7	7.6	6.5	5.9	5.8	5.5	5.2	-78	-5.1	1.1	0.9
Ireland	22.3	27	34	27	14	11	10	9.5	8.5	8.4	8.5	-62	1.4	1.0	1.4
Italy	115	111	106	111	40	38	36	32	31	31	30	-73	-2.2	5.3	5.1
Latvia	15	8.5	6.8	6.5	5.8	0.5	1.0	0.5	0.4	0.4	0.4	-97	11.6	0.7	0.1
Lithuania	28	13	5.9	4.3	3.8	2.7	3.4	2.4	2.1	1.8	1.2	-96	-31.5	1.3	0.2
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	8.3	13	17	0.2	0.4	0.2	0.3	0.4	0.1	0.1	0.2	-97	131.2	0.4	0.0
Netherlands	73	84	19	10	2.1	2.4	2.1	2.0	1.8	2.0	2.2	-97	10.8	3.4	0.4
Poland	175	163	121	105	98	92	87	78	75	82	82	-53	0.9	8.1	13.7
Portugal	109	112	100	95	45	38	33	27	23	23	22	-79	-3.7	5.0	3.7
Romania	35	35	31	26	12	13	11	8.6	8.8	8.5	8.0	-77	-5.1	1.6	1.3
Slovakia	33	11	13	14	13	12	12	13	13	13	21	-38	59.7	1.5	3.4
Slovenia	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Spain	190	216	228	201	114	99	81	61	57	57	57	-70	0.3	8.8	9.5
Sweden	29	28	16	16	14	11	9.6	8.5	7.1	6.1	6.1	-79	1.1	1.4	1.0
United Kingdom	324	331	191	153	128	102	119	127	127	92	88	-73	-4.5	15.0	14.7
EU-28 ([a])	**2 159**	**1 888**	**1 438**	**1 290**	**880**	**781**	**743**	**668**	**625**	**601**	**602**	**-72**	**0.2**	**100**	**100**
EU-28 ([b])	2 159	1 888	1 438	1 290	880	781	743	668	625	601	602				

Notes: Dark-blue shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

([a]) Sum of national totals as reported by Member States.

([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

Austria Luxembourg and Slovenia did not provide emission data for Ni. Therefore, the EU total is an underestimate.

In Bulgaria, Ni emissions in 2000 and 2001 were much lower than in the years before and after, because Ni emissions from primary Cu production decreased (personal communication by Bulgaria in 2012).

3.19 Selenium (Se) emission trends

Between 1990 and 2016, Se emissions in the EU dropped by 34 %. Between 2015 and 2016, emissions decreased by 3 %, mainly because emissions decreased in the United Kingdom and Greece (gap-filled data) (countries ranked according to the size of their contribution to the absolute change) (see Table 3.22).

The Member States that contributed most (i.e. more than 10 %) to Se emissions in 2016 were Portugal, Bulgaria and the Czech Republic (countries ranked according to the percentage of their share in the EU total). Austria, Luxembourg, Poland and Slovenia did not provide emission data for Se. Therefore, the EU total is an underestimate.

In 2005, Belgium reported high Se emissions in the category '2A3 — Glass production'. This occurred because of one glass plant in Wallonia. The plant gives annual emissions based on measurements, and the concentration of Se was very high in 2005 (personal communication by Belgium in 2014). Likewise, Belgium's high emissions in 2010 are mainly attributable to the operations of a particular company in the glass industry in Wallonia (personal communication by Belgium in 2012).

Table 3.22 Member State contributions to EU emissions of Se

	Se (Mg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	5.0	6.3	6.4	27	11	3.9	3.5	3.6	4.3	4.1	4.1	-18	0.5	1.9	2.3
Bulgaria	41	12	5.2	13	14	16	15	16	19	20	22	-45	10.7	15.5	12.7
Croatia	0.5	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.4	0.3	0.4	-23	8.0	0.2	0.2
Cyprus	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	11	3.8	0.0	0.1
Czech Republic	33	29	28	30	26	25	24	23	22	22	22	-31	2.1	12.3	12.7
Denmark	4.2	3.9	2.3	1.4	1.3	1.0	0.7	1.0	0.9	0.7	0.7	-84	-8.4	1.6	0.4
Estonia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	74	-1.2	0.0	0.0
Finland	1.7	0.3	0.4	0.4	0.6	0.5	0.7	0.4	0.4	0.4	0.4	-77	-11.2	0.6	0.2
France	15	15	16	15	13	13	12	12	12	12	12	-23	-3.5	5.8	6.6
Germany	7.0	12	10	7.6	9.2	9.5	9.2	9.2	9.2	9.2	9.3	33	1.9	2.7	5.3
Greece	14	14	17	17	15	15	16	14	13	11	8.9	-36	-22.3	5.2	5.0
Hungary	6.5	5.8	5.8	4.1	3.5	3.7	3.6	3.5	3.4	3.4	3.3	-50	-3.9	2.5	1.9
Ireland	8.8	6.5	5.1	4.7	4.0	3.8	4.0	4.0	3.6	3.8	3.6	-59	-5.5	3.3	2.0
Italy	10	11	12	12	11	11	11	11	10	12	12	16	-0.7	3.8	6.6
Latvia	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-85	5.8	0.2	0.0
Lithuania	0.5	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-66	-1.2	0.2	0.1
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	> 100	-25.5	0.0	0.0
Netherlands	0.4	0.3	0.5	2.6	1.5	0.8	0.8	0.5	0.8	1.0	0.6	65	-34.1	0.1	0.4
Poland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE				
Portugal	12	17	23	27	30	30	32	32	32	32	32	> 100	0.0	4.6	18.0
Romania	6.0	8.7	12	13	12	14	12	10	10	10	10	68	-2.9	2.3	5.8
Slovakia	11	12	9.8	12	14	13	13	11	11	14	15	38	7.2	4.0	8.3
Slovenia	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Spain	9.7	11	13	13	9.8	9.8	10	9.0	9.7	10	10	4	-3.5	3.7	5.7
Sweden	0.9	1.1	1.0	1.1	1.2	1.2	1.2	1.2	1.1	1.1	1.1	15	2.0	0.4	0.6
United Kingdom	78	50	33	34	17	17	20	17	16	14	8.8	-89	-35.1	29.3	5.0
EU-28 (a)	**265**	**217**	**201**	**236**	**196**	**191**	**190**	**178**	**181**	**182**	**176**	**-34**	**-3.0**	**100**	**100**
EU-28 (b)	265	217	201	236	196	191	190	178	181	182	176				

Notes: Dark-blue shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

(a) Sum of national totals as reported by Member States.

(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

3.20 Zinc (Zn) emission trends

Between 1990 and 2016, Zn emissions in the EU dropped by 36 %. Between 2015 and 2016, emissions increased by 0.5 %, mainly because Germany, Italy, France and Slovakia (countries ranked according to the size of their contribution to the absolute change) reported increased emissions (see Table 3.23). The Member States that contributed most (i.e. more than 10 %) to Zn emissions in 2016 were Germany, Italy and Poland (countries ranked according to the percentage of their share in the EU total). Austria, Luxembourg and Slovenia did not provide emission data for Zn. Therefore, the EU total is an underestimate.

Table 3.23 Member State contributions to EU emissions of Zn

	Zn (Mg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	235	189	183	131	110	103	89	81	81	84	75	-68	-9.9	2.4	1.2
Bulgaria	181	106	257	141	94	104	104	110	116	110	116	-36	5.2	1.8	1.8
Croatia	39	32	31	37	37	35	35	35	32	35	34	-11	-2.8	0.4	0.5
Cyprus	3.8	4.7	6.0	6.9	5.3	5.8	5.9	4.4	4.6	4.6	4.8	26	5.0	0.0	0.1
Czech Republic	119	89	76	87	79	77	72	67	68	67	64	-46	-4.9	1.2	1.0
Denmark	72	65	55	59	63	61	58	59	58	61	63	-12	3.1	0.7	1.0
Estonia	106	63	49	53	62	60	54	62	57	46	52	-51	12.2	1.1	0.8
Finland	687	409	135	124	140	136	138	134	140	127	135	-80	6.5	7.0	2.1
France	2 217	1 417	1 004	576	508	500	502	487	473	480	495	-78	3.1	22.4	7.9
Germany	1 687	1 692	1 847	1 854	1 918	1 945	1 929	1 946	1 974	2 015	2 053	22	1.9	17.1	32.7
Greece	52	56	60	60	57	52	49	43	48	47	32	-38	-31.4	0.5	0.5
Hungary	69	51	54	48	55	65	69	64	57	60	60	-13	0.0	0.7	1.0
Ireland	53	48	54	25	20	19	19	19	20	20	20	-62	0.3	0.5	0.3
Italy	940	927	889	960	887	944	913	856	849	834	864	-8	3.6	9.5	13.8
Latvia	29	28	25	30	28	25	29	26	26	24	24	-18	-0.5	0.3	0.4
Lithuania	24	17	17	18	18	17	17	16	16	15	15	-40	-3.4	0.2	0.2
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.4	0.5	0.6	2.0	2.3	2.4	2.5	2.1	2.1	1.4	1.1	> 100	-19.2	0.0	0.0
Netherlands	224	146	95	88	102	93	94	85	112	103	100	-55	-3.2	2.3	1.6
Poland	1 228	1 136	918	832	848	855	872	837	873	863	837	-32	-3.1	12.4	13.3
Portugal	73	79	95	97	93	97	96	94	95	96	97	34	1.8	0.7	1.6
Romania	79	88	100	133	128	119	122	116	117	116	119	50	2.0	0.8	1.9
Slovakia	108	85	65	77	59	58	61	62	65	67	80	-25	20.0	1.1	1.3
Slovenia	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Spain	376	391	424	458	412	415	412	388	397	412	409	9	-0.8	3.8	6.5
Sweden	192	145	100	107	111	102	101	93	96	96	92	-52	-4.2	1.9	1.5
United Kingdom	1 083	1 047	714	516	460	444	417	451	452	468	441	-59	-5.8	11.0	7.0
EU-28 ([a])	**9 878**	**8 311**	**7 254**	**6 520**	**6 298**	**6 334**	**6 261**	**6 138**	**6 227**	**6 253**	**6 283**	**-36**	**0.5**	**100**	**100**
EU-28 ([b])	9 878	8 311	7 254	6 520	6 298	6 334	6 261	6 138	6 227	6 253	6 283				

Notes: Dark-blue shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

([a]) Sum of national totals as reported by Member States.

([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

Ireland explained the emission decline after 2000 by the closure of Ireland's only steel plant in 2001. From 1990 to 2001, the main determinant of the trend in Zn emissions was metal production. It accounted on average for 48 % of national total emissions throughout that period (see Ireland's IIR 2017, listed in Appendix 5).

3.21 Dioxin and furan (PCDD/Fs) emission trends and key categories

Between 1990 and 2016, PCDD/F emissions dropped in the EU by 67 %. Between 2015 and 2016, the decrease was 2.8 % (see Table 3.24), mainly because Greece (gap-filled data), Bulgaria, the United Kingdom and France (countries ranked according to the size of their contribution to the absolute change) reported decreased emissions. The Member State that contributed most (i.e. more than 10 %) to PCDD/F emissions in 2016 was Greece (gap-filled data).

Cyprus explained that its PCDD/F emissions decreased by 78 % from 1990 to 2016 because a clinical waste incineration plant was terminated in 2003 and all clinical wastes are subjected to sterilisation (see Cyprus's IIR, listed in Appendix 5).

The Czech republic explained that the decrease between 2007 and 2009 was due to the installation of new fabric filters in the Třinecké železárny sinter plant (personal communication by the Czech Republic in 2018).

The decrease of dioxin emissions in France (1990-2012) was due to regulations limiting emissions, especially in the fields of waste incineration, industrial energy processes (steel and metallurgy) and combustion in manufacturing (see France's IIR, listed in Appendix 5). The drop in dioxin emissions between 1995 and 2000 was due to improvements in sinter plants (personal communication by France in 2013).

The peak in 2013 represents data reported by Malta and seems to be a potential erroneous value reported in the category '5C1bv — Cremation'.

The increased PCDD/F emissions in Slovakia in 2016 are mainly due to reported emissions in the category '1A2gviii — Stationary combustion in manufacturing industries and construction: Other'.

In Spain, the decrease in PCDD/F emissions after 1995 was related to the adaptation of municipal solid waste (MSW) incineration facilities with energy recovery (included under category '1A1a — Public electricity and heat production'), to comply with the maximum levels imposed in legislation, and also related to the implementation of particle and acid gas abatement techniques as from 1996 (personal communication by Spain in 2017).

Table 3.24 Member State contributions to EU emissions of PCDD/Fs

	PCDD/Fs (g I-Teq)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	124	60	54	40	43	41	43	47	42	44	44	-65	0.0	1.3	1.5
Belgium	586	406	124	66	54	45	49	41	30	31	32	-95	2.9	6.4	1.1
Bulgaria	118	140	157	156	65	75	64	66	56	56	41	-66	-27.7	1.3	1.4
Croatia	48	42	41	49	33	31	30	26	22	23	20	-58	-11.3	0.5	0.7
Cyprus	2.1	2.4	2.6	0.5	0.5	0.5	0.4	0.6	0.4	0.4	0.5	-78	10.5	0.0	0.0
Czech Republic	92	73	62	61	46	38	39	39	41	35	27	-71	-24.8	1.0	0.9
Denmark	69	50	32	27	25	23	22	22	20	22	23	-67	4.4	0.7	0.8
Estonia	8.1	5.6	6.7	5.7	6.4	6.3	4.7	3.7	4.0	4.1	4.0	-50	-2.8	0.1	0.1
Finland	18	19	19	14	16	14	15	15	16	14	16	-13	9.0	0.2	0.5
France	1 782	1 723	557	236	140	131	119	123	117	115	105	-94	-9.2	19.4	3.5
Germany	806	332	253	151	128	124	121	122	118	119	119	-85	0.0	8.8	4.0
Greece	866	888	1 046	1 168	1 262	1 219	1 158	1 070	1 346	1 186	1 125	30	-5.2	9.4	37.6
Hungary	105	67	72	60	78	86	89	83	73	82	81	-23	-1.6	1.1	2.7
Ireland	62	44	34	31	30	27	26	25	22	24	21	-66	-12.4	0.7	0.7
Italy	503	484	404	327	309	268	287	282	269	281	279	-45	-0.8	5.5	9.3
Latvia	26	28	26	29	19	20	23	19	18	16	16	-41	-2.9	0.3	0.5
Lithuania	28	21	22	25	23	24	23	22	21	19	19	-32	-1.7	0.3	0.6
Luxembourg	43	34	5.7	1.7	2.1	2.1	1.5	1.5	1.7	1.7	2.6	-94	55.9	0.5	0.1
Malta	1.1	1.1	1.1	1.1	7.8	1.0	0.2	10 620	0.2	0.1	0.1	-86	30.5	0.0	0.0
Netherlands	744	68	33	31	33	33	26	27	24	23	23	-97	-1.1	8.1	0.8
Poland	328	369	271	282	298	294	307	286	282	290	282	-14	-2.6	3.6	9.4
Portugal	531	530	335	104	171	107	95	77	84	59	83	-84	41.1	5.8	2.8
Romania	104	122	144	182	178	185	192	167	154	156	155	49	-0.5	1.1	5.2
Slovakia	323	244	127	112	70	58	62	59	65	63	83	-74	30.1	3.5	2.8
Slovenia	19	14	13	15	17	18	17	17	15	15	16	-16	2.8	0.2	0.5
Spain	403	444	190	172	166	171	169	168	172	178	171	-58	-3.7	4.4	5.7
Sweden	67	47	40	42	35	30	27	25	24	23	24	-64	4.8	0.7	0.8
United Kingdom	1 377	887	344	256	220	209	211	209	196	194	181	-87	-6.8	15.0	6.0
EU-28 ([a])	**9 183**	**7 143**	**4 416**	**3 644**	**3 478**	**3 280**	**3 220**	**13 665**	**3 234**	**3 076**	**2 991**	**-67**	**-2.8**	**100**	**100**
EU-28 ([b])	9 183	7 143	4 416	3 644	3 478	3 280	3 220	13 665	3 234	3 076	2 991				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

([a]) Sum of national totals as reported by Member States.

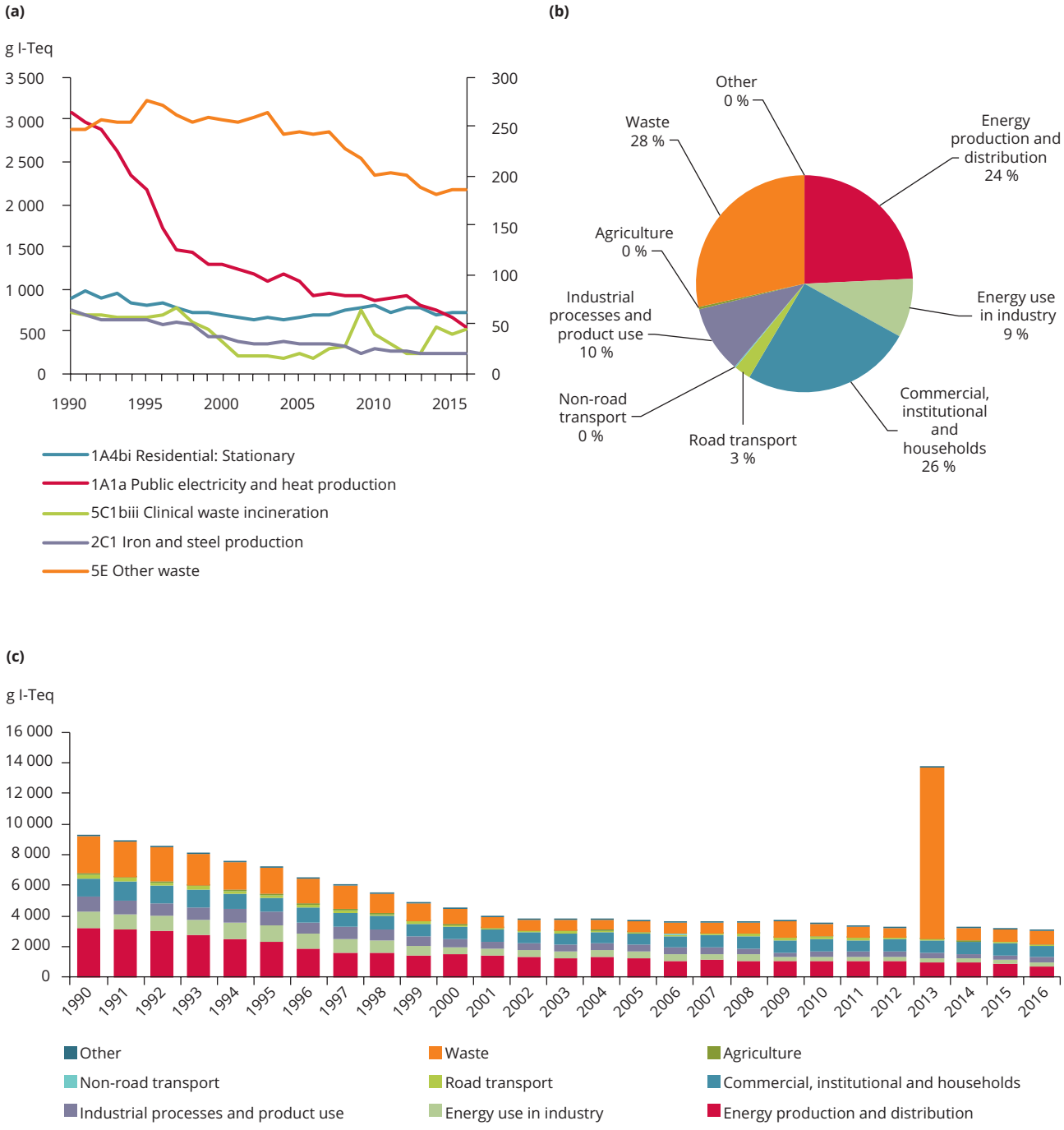
([b]) Sum of sectors: differences arise when only national totals and no sectoral data are available.

I-Teq, international toxic equivalent.

'1A4bi — Residential: Stationary' and '1A1a — Public electricity and heat production' were the primary key categories for PCDD/F emissions, together making up 43 % of total PCDD/F emissions (see Figure 3.15(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2016 were in the second most important, '1A1a — Public electricity and head production' (-82 %), and the fourth most important, '2C1 — Iron and steel production' (-69 %).

Figure 3.15(b) shows the contribution that each aggregated sector group made to total EU emissions. The 'waste', 'energy production and distribution' and 'commercial, institutional and households' sector groups are an important source of PCDD/Fs.

Figure 3.15 PCDD/F emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions



Note: In Figure 15(a), the right-hand axis shows values for '5E — Other waste'.

3.22 Total polycyclic aromatic hydrocarbon (PAH) emission trends and key categories

Between 1990 and 2016, total PAH emissions dropped in the EU by 83 %. Between 2015 and 2016, they increased by 3.4 %, mainly because Portugal, Germany, Poland and Spain (countries ranked according to the size of their contribution to the absolute change) reported increased emissions (see Table 3.25). The Member State that contributed most (i.e. more than 10 %) to total PAH emissions in 2016 was Portugal and Spain (countries ranked according to the percentage of their share in the EU total).

Belgium explained that the strong decrease in PAH emissions in 2000 is due to the installation of dust abatement technology in the pig iron tapping installations in 1999 in Wallonia (2C1) (personal communication by Belgium in 2018).

Spain explained that estimated total PAH emissions are mainly driven by '3F — Field burning of agricultural residues'. This activity and the related emissions have notably decreased due to a progressive abandonment of this practice, driven by legislation to prevent forest fires, the entry into force of the EU common agricultural policy's conditionality rules and mitigation programmes for the reduction of field burning of agricultural waste, particularly between 1999 and 2003 (personal communication by Spain in 2017).

'2D3g — Chemical products' was the principal key category for these emissions in 2016, making up 39 % of total PAH emissions (see Figure 3.16(a)). Among the key categories, the largest change could be observed for the third most important key category, '3F — Field burning of agricultural residues' (-97 %). On the other hand the most important key category, '2D3g — Chemical product', shows an increase (65 %) compared to the value reported in 1990.

The data Portugal reported in 2018 mainly contributes to the total PAH emissions in the key category '2D3g — Chemical products'.

The sudden decrease of Total PAH emissions in the category '3F — Field burning of agricultural residues' from 1999 to 2001 resembles the data reported by the Spain.

Figure 3.16(b) shows the contribution that each aggregated sector group made to total EU emissions. The 'industrial processes and product use' and the 'commercial, institutional and households' sector groups are very important sources of total PAHs.

Table 3.25 Member State contributions to EU total emissions of PAHs

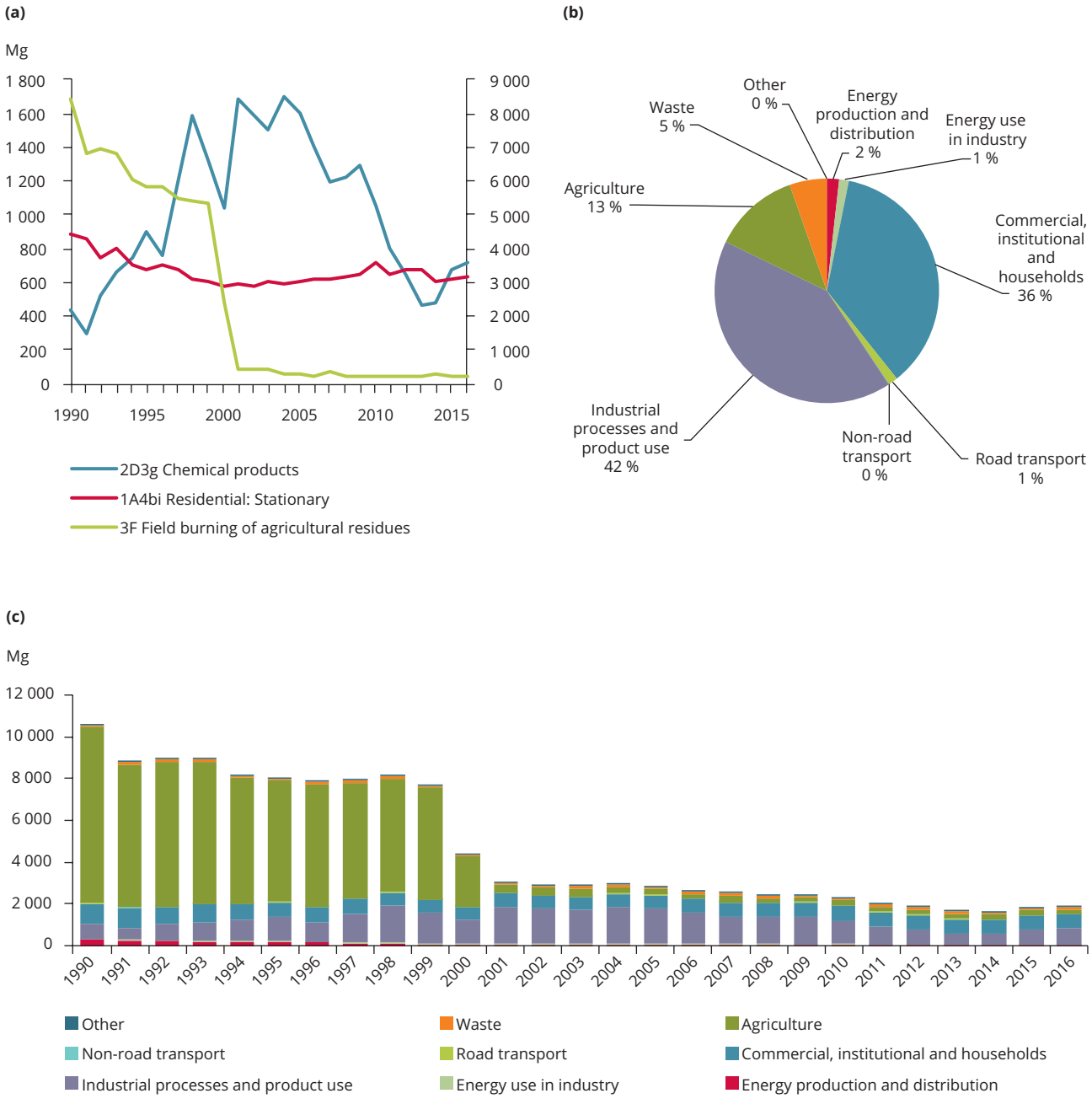
	Total PAHs (Mg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	20	12.8	10.5	8.2	8.4	7.8	8.2	8.8	7.7	8.2	8.3	-59	0.8	0.2	0.5
Belgium	55	45	24	18	15	14	12	12	8.1	8.3	9.1	-83	10.2	0.5	0.5
Bulgaria	37	40	29	28	18	20	20	18	16	16	17	-54	6.8	0.4	0.9
Croatia	24	17	15	18	14	12	11	10	8.0	8.2	6.9	-71	-14.9	0.2	0.4
Cyprus	14	11	6.2	3.8	0.9	1.0	1.0	0.8	0.7	0.9	0.7	-95	-23.7	0.1	0.0
Czech Republic	280	179	45	40	47	46	48	49	47	47	46	-84	-2.8	2.7	2.5
Denmark	5.3	5.8	6.0	7.8	8.2	7.3	6.9	7.1	6.5	7.2	7.3	38	2.2	0.1	0.4
Estonia	8.2	10	8.5	7.7	8.3	7.1	7.1	7.1	7.1	7.0	7.0	-15	-1.0	0.1	0.4
Finland	7.1	7.6	7.6	8.7	11	9.6	10	9.7	9.8	9.4	10	44	9.2	0.1	0.6
France	46	44	35	26	22	19	20	21	18	19	19	-59	2.0	0.4	1.0
Germany	374	160	153	142	205	180	170	182	157	169	182	-51	7.7	3.5	9.8
Greece	27	27	29	26	21	19	19	17	17	18	11	-59	-39.5	0.3	0.6
Hungary	79	30	25	24	30	34	36	36	29	31	32	-60	2.1	0.7	1.7
Ireland	49	31	23	21	20	18	18	19	16	16	15	-69	-6.0	0.5	0.8
Italy	99	101	68	73	95	73	91	86	76	82	82	-17	-0.2	0.9	4.4
Latvia	19	18	19	14	11	11	12	10	10	8.3	8.3	-56	-0.5	0.2	0.4
Lithuania	20	9.1	9.1	9.6	10	10	10	10	9.2	8.5	8.6	-58	0.4	0.2	0.5
Luxembourg	4.3	2.1	0.5	0.5	0.5	0.4	0.5	0.5	0.6	0.6	0.6	-86	10.7	0.0	0.0
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	-26	10.8	0.0	0.0
Netherlands	20	10	5.1	5.1	4.8	5.0	4.6	4.6	4.7	4.7	4.8	-76	0.7	0.2	0.3
Poland	147	211	148	169	157	150	153	152	140	139	146	0	4.9	1.4	7.9
Portugal	590	1 053	1 190	1 721	1 166	924	769	581	595	787	829	41	5.2	5.6	44.9
Romania	67	71	78	77	73	68	77	67	68	69	67	0	-2.9	0.6	3.6
Slovakia	20	2.5	13	20	19	19	19	20	19	20	19	-7	-7.8	0.2	1.0
Slovenia	8.4	5.7	4.7	5.2	6.2	6.1	6.0	6.1	5.3	5.3	5.4	-35	2.2	0.1	0.3
Spain	7 174	5 788	2 385	307	261	269	270	260	281	261	271	-96	3.9	67.9	14.7
Sweden	17	17	14	17	13	13	13	13	12	12	13	-26	2.1	0.2	0.7
United Kingdom	1 354	95	20	18	22	19	22	24	21	22	22	-98	-2.1	12.8	1.2
EU-28 (a)	**10 563**	**8 004**	**4 373**	**2 817**	**2 268**	**1 965**	**1 834**	**1 632**	**1 592**	**1 784**	**1 845**	**-83**	**3.4**	**100**	**100**
EU-28 (b)	10 563	8 004	4 373	2 817	2 268	1 965	1 834	1 632	1 592	1 784	1 845				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

(a) Sum of national totals as reported by Member States.

(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

Figure 3.16 **Total PAH emissions in the EU: (a) trend in emissions from the three most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions**



Note: In Figure 3.16(a), the right-hand axis gives values for '3F — Field burning of agricultural residues'.

3.23 Benzo(a)pyrene (B(a)P) emission trends and key categories

Between 1990 and 2016, B(a)P emissions in the EU fell by 19 %. Between 2015 and 2016, they increased by 4.4 %, mainly because emissions increased in Portugal (see Table 3.26). The Member State that contributed most (i.e. more than 10 %) to B(a)P emissions in 2016 was Portugal. Austria, Italy and Spain did not provide data for B(a)P and gap filling was not possible. The EU total is therefore an underestimate.

Table 3.26 Member State contributions to EU emissions of B(a)P

	Benzo(a)pyrene (Mg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	11	9.7	8.3	6.9	5.3	5.0	4.1	4.0	2.6	2.6	2.9	-74	11.3	1.0	0.3
Bulgaria	7.5	6.4	4.9	5.4	5.6	6.2	6.2	5.8	5.1	5.1	5.5	-27	7.0	0.7	0.6
Croatia	7.6	5.7	5.1	6.3	4.6	4.1	3.7	3.4	2.6	2.7	2.3	-70	-15.3	0.7	0.2
Cyprus	2.4	1.9	1.1	0.7	0.2	0.2	0.2	0.1	0.1	0.2	0.1	-95	-21.7	0.2	0.0
Czech Republic	91	60	17	14	17	17	17	18	16	16	16	-83	-2.9	7.9	1.7
Denmark	1.6	1.8	1.9	2.5	2.6	2.3	2.2	2.3	2.1	2.3	2.3	43	1.6	0.1	0.2
Estonia	2.4	2.8	2.4	2.2	2.4	2.0	2.0	2.1	2.0	2.0	2.0	-15	-1.0	0.2	0.2
Finland	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	27	0.1	0.0	0.0
France	13	13	9.8	7.3	6.1	5.2	5.6	5.8	5.1	5.1	5.2	-60	2.3	1.1	0.6
Germany	139	48	31	23	34	30	28	30	25	27	29	-79	7.9	12.1	3.2
Greece	38	41	41	41	37	37	36	36	34	34	28	-27	-18.7	3.3	3.0
Hungary	26	9.7	8.3	7.8	9.9	11	12	12	9.9	10	11	-59	1.9	2.3	1.1
Ireland	14	8.7	6.2	5.8	5.4	5.0	4.9	5.2	4.6	4.4	4.2	-70	-6.2	1.2	0.4
Italy	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE				
Latvia	6.8	6.6	7.4	5.0	4.0	4.1	4.0	3.6	3.6	3.0	3.0	-56	-0.1	0.6	0.3
Lithuania	6.6	3.1	3.1	3.3	3.6	3.6	3.5	3.5	3.2	3.0	3.0	-55	0.4	0.6	0.3
Luxembourg	1.2	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	-85	12.1	0.1	0.0
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-30	17.6	0.0	0.0
Netherlands	5.2	3.1	1.8	1.8	1.6	1.6	1.6	1.6	1.6	1.6	1.7	-68	1.0	0.5	0.2
Poland	35	49	35	39	45	43	44	44	40	40	42	20	4.5	3.1	4.5
Portugal	460	931	1 070	1 624	1 075	831	675	486	500	693	736	60	6.2	40.1	78.8
Romania	25	25	26	22	24	22	26	22	22	22	21	-14	-3.4	2.2	2.3
Slovakia	5.1	1.2	3.7	5.2	5.0	5.3	5.4	5.6	5.3	5.5	5	1	-7.3	0.4	0.5
Slovenia	2.8	2.1	1.9	2.0	2.5	2.5	2.5	2.5	2.1	2.2	2.2	-20	2.7	0.2	0.2
Spain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Sweden	5.2	5.1	4.3	5.4	4.0	4.1	3.9	3.9	3.7	3.8	3.9	-25	2.0	0.5	0.4
United Kingdom	241	23	6.8	5.9	7.9	6.8	7.8	8.3	7.3	7.7	7.6	-97	-1.9	21.0	0.8
EU-28 ([a])	**1 148**	**1 257**	**1 297**	**1 838**	**1 302**	**1 049**	**896**	**704**	**700**	**896**	**935**	**-19**	**4.4**	**100**	**100**
EU-28 ([b])	1 148	1 257	1 297	1 838	1 302	1 049	896	704	700	896	935				

Notes: Dark-blue shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

([a]) Sum of national totals as reported by Member States.

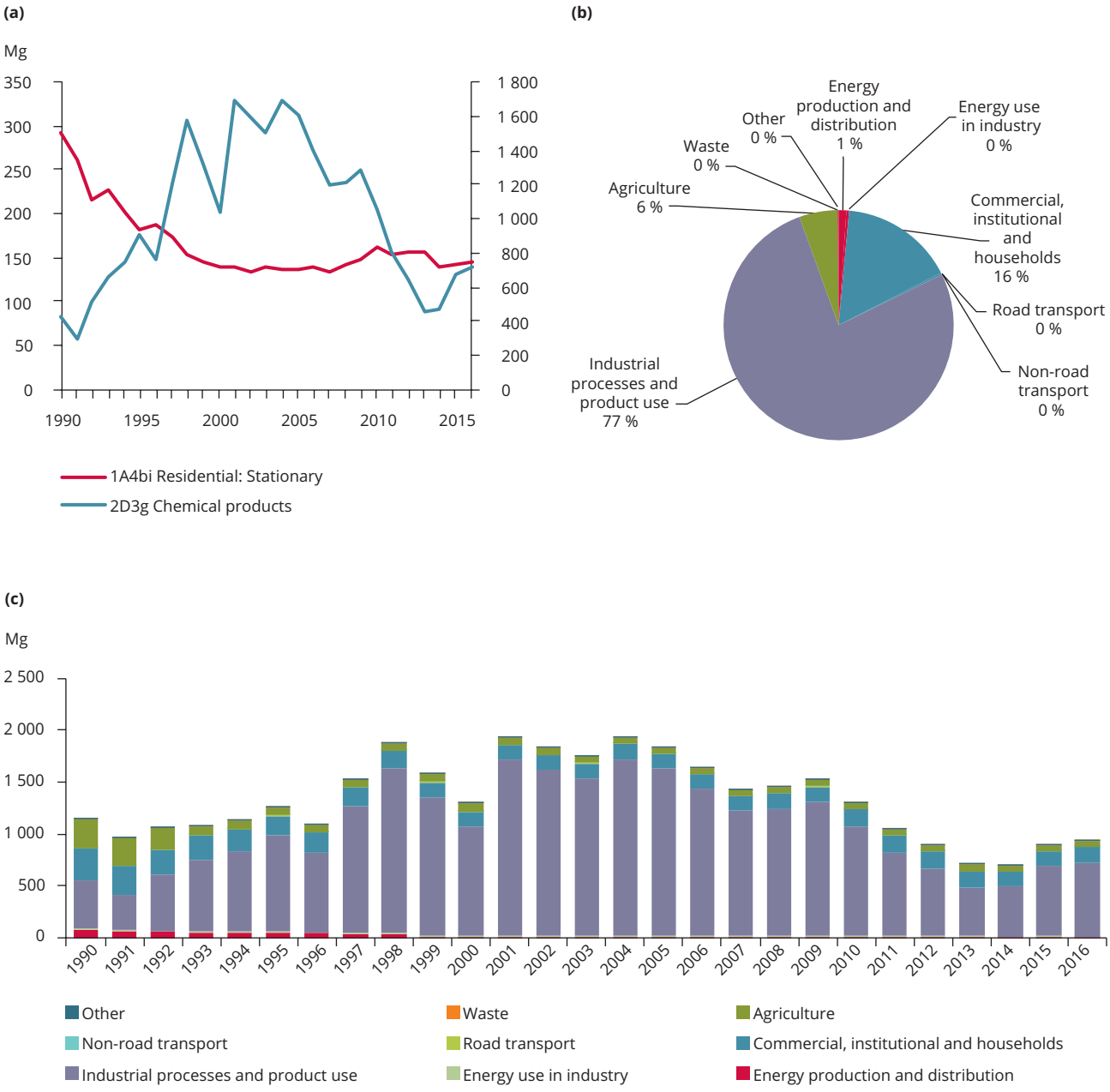
([b]) Sum of sectors.

'2D3g — Chemical products' was the principal key category for B(a)P emissions, accounting for 76 % of the total. Among the key categories, the largest change could be observed for the most important key category, '2D3g — Chemical products' (65 %) (see Figure 3.17(a)). Emissions from the second largest key category '1A4bi — Residential: Stationary' decreased by 50 %.

The data Portugal reported in 2018 mainly contributes to B(a)P emissions in the key category '2D3g — Chemical products'.

Figure 3.17(b) shows the contribution that each aggregated sector group made to total EU emissions. The 'industrial processes and product use' sector group is the chief emission source of B(a)P.

Figure 3.17 B(a)P emissions in the EU: (a) trend in emissions from the two most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions



Note: In Figure 3.17(a), the right-hand axis shows values for '2D3g — Chemical products'.

3.24 Benzo(b)fluoranthene (B(b)F) emission trends

Between 1990 and 2016, B(b)F emissions in the EU decreased by 76 %. Between 2015 and 2016, they decreased by 5 %, mainly because emissions decreased in Greece (gap-filled data) (see Table 3.27).

The Member States that contributed most (i.e. more than 10 %) to B(b)F emissions in 2016 were Greece, Poland and Portugal (countries ranked according to the percentage of their share in the EU total). Austria, Italy and Spain did not provide data for B(b)F, and gap filling was not possible. The EU total is therefore an underestimate.

Table 3.27 Member State contributions to EU emissions of B(b)F

	Benzo(b)fluoranthene (Mg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	7.9	7.1	6.3	5.5	4.7	4.1	3.9	4.1	2.8	2.9	3.2	-60	9.3	0.7	1.2
Bulgaria	10	7.9	5.7	6.2	6.1	7	7	6.3	5.4	5.4	5.8	-43	7.8	1.0	2.3
Croatia	8.1	5.6	4.9	6.0	4.5	4.0	3.7	3.4	2.7	2.8	2.4	-70	-12.9	0.8	1.0
Cyprus	6.6	5.2	3.0	1.8	0.4	0.5	0.5	0.4	0.3	0.4	0.3	-95	-24.4	0.6	0.1
Czech Republic	90	57	11	9.5	11	11	12	12	11	11	11	-88	-2.7	8.4	4.3
Denmark	1.7	1.9	2.0	2.6	2.8	2.5	2.4	2.4	2.3	2.5	2.6	53	2.9	0.2	1.0
Estonia	2.8	2.8	2.5	2.4	2.6	2.2	2.2	2.2	2.3	2.3	2.3	-17	-1.4	0.3	0.9
Finland	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	29	0.6	0.0	0.1
France	15	15	12	8.6	7.3	6.3	6.7	7.0	6.1	6.2	6.3	-59	1.7	1.4	2.5
Germany	3.2	1.4	1.3	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.4	-57	3.0	0.3	0.5
Greece	92	102	99	101	92	93	92	91	86	85	71	-23	-16.5	8.6	27.8
Hungary	30	11	8.9	8.4	10	12	12	12	9.9	10	11	-65	3.0	2.8	4.2
Ireland	20	13	9.7	9.1	8.3	7.6	7.4	7.8	6.8	6.7	6.3	-69	-5.8	1.9	2.4
Italy	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE				
Latvia	6.6	5.8	5.9	4.7	3.8	3.8	3.8	3.5	3.4	2.9	2.8	-57	-0.7	0.6	1.1
Lithuania	7.9	3.2	3.1	3.2	3.5	3.5	3.4	3.4	3.1	2.9	2.9	-63	0.6	0.7	1.1
Luxembourg	1.4	0.7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-83	10.0	0.1	0.1
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-19	3.8	0.0	0.0
Netherlands	7.8	3.3	1.7	1.6	1.6	1.7	1.5	1.5	1.5	1.5	1.5	-81	0.9	0.7	0.6
Poland	33	52	38	43	47	46	47	46	42	42	44	34	5.2	3.1	17.3
Portugal	55	51	50	44	41	42	42	43	43	43	42	-23	-1.2	5.1	16.4
Romania	20	21	21.6	21	22	20	23	20	20	21	20	-3	-3.1	1.9	7.8
Slovakia	6.2	1.1	4.5	6.9	6.5	6.9	7.0	7.1	7.0	7.2	7	7	-8.4	0.6	2.6
Slovenia	2.6	1.7	1.2	1.3	1.5	1.4	1.4	1.4	1.3	1.3	1.3	-51	1.3	0.2	0.5
Spain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Sweden	5.5	5.3	4.5	5.6	4.2	4.4	4.2	4.2	4.0	4.1	4.2	-23	2.8	0.5	1.6
United Kingdom	639	40	5.5	5.4	6.9	5.9	6.9	7.4	6.7	7.0	6.8	-99	-2.5	59.5	2.7
EU-28 (a)	**1 074**	**414**	**302**	**300**	**291**	**287**	**291**	**288**	**271**	**270**	**256**	**-76**	**-5.0**	**100**	**100**
EU-28 (b)	1 074	414	302	300	291	287	291	288	271	270	256				

Notes: Dark-blue shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

(a) Sum of national totals as reported by Member States.

(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.

Sweden explained that the marked decline in its B(b)F emissions between 2005 and 2010 was because aluminium production changed ('2C3 — Aluminium production'). Until 2008, aluminium production at the only operating plant (Kubikenborg Aluminium AB) in Sweden was a key source of B(b)F emissions. All the pot-lines in the plant that operated using Söderberg technology were shut down in 2008. For this reason, there was an abrupt decrease in B(b)F emissions between 2008 and 2009 (personal communication by Sweden in 2017).

3.25 Benzo(k)fluoranthene (B(k)F) emission trends

Between 1990 and 2016, B(k)F emissions in the EU decreased by 78 %. Between 2015 and 2016, they fell by 5.6 %, mainly because emissions decreased in Greece (gap-filled data) (see Table 3.28). The Member States that contributed most (i.e. more than 10 %) to B(k)F emissions in 2016 were Greece, Portugal and Poland (countries ranked according to the percentage of their share in the EU total). Austria, Italy and Spain did not provide data for B(k)F, and gap filling was not possible. The EU total is therefore an underestimate.

3.26 Indeno(1,2,3-cd)pyrene (IP) emission trends

Between 1990 and 2016, IP emissions in the EU fell by 65 %. Between 2015 and 2016, emissions decreased by 5.8 %, mainly because Lithuania and Greece (gap-filled data) (countries ranked according to the size of their contribution to the absolute change) reported decreased emissions (see Table 3.29). The Member States that contributed most (i.e. more than 10 %) to IP emissions in 2016 were Poland, Greece (gap-filled data) and Portugal (countries ranked according to the percentage of their share in the EU total). Austria, Italy and Spain did not provide data for IP, and gap filling was not possible. The EU total is therefore an underestimate.

Lithuania reported increased IP emissions in 2015 in the category '5C1bii — Hazardous waste incineration'.

Table 3.28 Member State contributions to EU emissions of B(k)F

	Benzo(k)fluoranthene (Mg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	5.0	4.3	3.7	3.0	2.3	2.3	2.0	2.0	1.3	1.3	1.4	-71	9.0	1.0	1.3
Bulgaria	4.1	3.7	2.3	2.5	2.4	2.8	2.7	2.5	2.2	2.2	2.3	-44	6.8	0.8	2.1
Croatia	3.4	2.1	1.9	2.3	1.7	1.5	1.4	1.3	1.0	1.1	0.9	-73	-13.0	0.7	0.8
Cyprus	2.8	2.2	1.3	0.8	0.2	0.2	0.2	0.2	0.1	0.2	0.1	-95	-24.6	0.6	0.1
Czech Republic	50	32	7.6	6.6	7.6	7.6	7.8	8.0	7.5	7.5	7.3	-85	-2.8	9.9	6.6
Denmark	0.7	0.8	0.9	1.0	1.1	1.0	1.0	1.0	0.9	1.0	1.0	46	2.4	0.1	0.9
Estonia	1.5	1.8	1.5	1.3	1.4	1.2	1.2	1.3	1.2	1.2	1.2	-23	-0.9	0.3	1.1
Finland	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	21	1.9	0.0	0.1
France	9.4	9.1	7.3	5.5	4.6	3.9	4.2	4.3	3.8	3.8	3.9	-58	1.8	1.9	3.5
Germany	1.9	1.0	1.1	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.1	-45	3.0	0.4	1.0
Greece	40	44	43	44	40	41	40	39	38	37	31	-22	-16.0	7.9	28.3
Hungary	12	4.5	3.6	3.4	4.0	4.6	4.8	4.8	4.0	4.1	4.3	-64	2.9	2.4	3.9
Ireland	7.8	5.0	3.6	3.4	3.1	2.9	2.8	3.0	2.6	2.6	2.4	-69	-6.0	1.6	2.2
Italy	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE				
Latvia	2.5	2.3	2.4	1.7	1.3	1.4	1.4	1.2	1.2	1.0	1.0	-61	-0.6	0.5	0.9
Lithuania	3.0	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.2	1.1	1.1	-64	0.6	0.6	1.0
Luxembourg	0.9	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-90	10.2	0.2	0.1
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-30	14.9	0.0	0.0
Netherlands	4.0	2.3	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	-80	-0.7	0.8	0.7
Poland	33	52	38	43	12	12	12	12	12	12	12	-64	3.7	6.6	10.9
Portugal	27	25	24	21	21	22	22	22	22	22	21	-22	-2.2	5.4	19.2
Romania	8.9	8.9	9.2	9.2	9.2	8.6	9.9	8.5	8.7	8.8	8.5	-5	-3.5	1.8	7.7
Slovakia	3.0	1.1	2.0	2.9	2.8	2.8	2.9	2.9	2.9	3.0	2.8	-7	-7.3	0.6	2.5
Slovenia	1.6	1.2	1.0	1.1	1.4	1.4	1.4	1.4	1.2	1.2	1.2	-20	3.0	0.3	1.1
Spain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Sweden	2.7	2.6	2.3	3.1	1.6	1.6	1.6	1.6	1.5	1.5	1.5	-43	2.1	0.5	1.4
United Kingdom	277	20	3.6	3.1	2.9	2.5	2.9	3.1	2.8	2.9	2.8	-99	-3.0	55.1	2.6
EU-28 (a)	**502**	**228**	**163**	**162**	**124**	**124**	**125**	**124**	**117**	**117**	**110**	**-78**	**-5.6**	**100**	**100**
EU-28 (b)	502	228	163	162	124	124	125	124	117	117	110				

Notes: Dark-blue shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

(a) Sum of national totals as reported by Member States.

(b) Sum of sectors.

Table 3.29 Member State contributions to EU emissions of IP

	Indeno(1.2.3-cd)pyrene (Mg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	4.2	3.7	3.3	2.9	2.4	2.2	2.0	2.1	1.4	1.4	1.6	-61	11.3	1.0	1.1
Bulgaria	4.0	4.5	2.7	3.1	3.2	3.6	3.5	3.3	3.0	3.0	3.2	-20	5.3	1.0	2.2
Croatia	4.0	3.3	3.0	3.7	2.7	2.4	2.2	1.9	1.5	1.5	1.3	-67	-16.0	1.0	0.9
Cyprus	2.0	1.6	0.9	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-95	-23.0	0.5	0.1
Czech Republic	49	31	10	9.4	11	11	12	12	12	12	11	-77	-2.3	11.9	7.9
Denmark	1.3	1.4	1.3	1.7	1.7	1.5	1.4	1.5	1.3	1.4	1.4	8	1.6	0.3	1.0
Estonia	1.6	2.6	2.2	1.7	1.9	1.6	1.6	1.6	1.5	1.5	1.5	-5	-0.4	0.4	1.0
Finland	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	8	1.0	0.0	0.1
France	8.1	7.8	6.3	4.8	4.0	3.5	3.7	3.9	3.4	3.4	3.5	-57	2.1	1.9	2.4
Germany	1.4	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	-44	2.5	0.3	0.6
Greece	28	32	31	31	29	29	28	28	27	26	22	-23	-16.7	6.9	15.2
Hungary	11	4.6	4.6	4.2	5.7	6.5	6.9	7.0	5.7	6.0	6.1	-44	0.6	2.6	4.2
Ireland	6.7	4.2	3.0	2.8	2.7	2.5	2.4	2.6	2.2	2.2	2.1	-69	-5.9	1.6	1.4
Italy	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE				
Latvia	3.1	3.3	3.5	2.6	2.0	2.1	2.1	1.9	1.8	1.5	1.5	-52	-0.2	0.7	1.0
Lithuania	2.8	1.6	1.8	1.8	2.0	1.9	1.9	1.9	1.7	7.3	1.6	-43	-77.8	0.7	1.1
Luxembourg	0.9	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-87	10.4	0.2	0.1
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-32	17.6	0.0	0.0
Netherlands	2.8	1.4	0.8	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.8	-71	0.8	0.7	0.6
Poland	45	59	37	45	53	49	50	50	46	45	48	5	5.4	11.0	33.1
Portugal	20	19	18	16	15	16	16	16	16	16	16	-21	-2.9	4.8	10.8
Romania	12	12	12.1	11	12	11	13	11	11	11	11	-6	-2.3	2.9	7.7
Slovakia	5.7	2.6	3.1	4.1	3.8	4.0	4.0	4.0	3.9	4.1	3.8	-33	-7.7	1.4	2.6
Slovenia	0.8	0.5	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	-50	0.5	0.2	0.3
Spain	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE				
Sweden	2.6	2.7	2.2	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.2	-15	1.2	0.6	1.5
United Kingdom	197	13	3.9	3.5	4.7	4.0	4.6	4.8	4.2	4.4	4.3	-98	-1.4	47.5	3.0
EU-28 (a)	**414**	**212**	**153**	**154**	**162**	**157**	**161**	**159**	**148**	**153**	**144**	**-65**	**-5.8**	**100**	**100**
EU-28 (b)	414	212	153	154	162	157	161	159	148	153	144				

Notes: Dark-blue shaded cells indicate that no emission values are available. See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

(a) Sum of national totals as reported by Member States.

(b) Sum of sectors.

3.27 Hexachlorobenzene (HCB) emission trends and key categories

Between 1990 and 2016, HCB emissions in the EU fell by 95 %. Between 2015 and 2016, the increase was 3.5 %, mainly because emissions increased Finland (see Table 3.30). The Member States that contributed most (i.e. more than 10 %) to HCB emissions in 2016 were Finland, Portugal, Austria and the United Kingdom (countries ranked according to the percentage of their share in the EU total) .

Austria explained that the increase in HCB emissions from 2012 to 2014 reflects the data reported in the category '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals'. Due to unintentional releases in 2012, 2013 and 2014, the emissions rose to a very high level: HCB-contaminated material (lime) was co-incinerated in a cement plant at temperatures that were too low and failed to destroy the HCB. The sharp decrease in emissions between 2014 and 2015 by 71 % therefore marks a return to usual levels (see Austria's IIR, listed in Appendix 5).

The peak in HCB emissions (the increase between 1990 and 1995 and the decrease between 1995 and 1999) reported by Belgium is mostly due to higher amounts of burned sludge (personal communication by Belgium in 2017). The strong decrease in HCB emissions from 1999 to 2000 is because the sewage sludge incineration sector used a lower emission factor from 2000 onwards (personal communication by Belgium in 2016).

The Czech Republic explained that the increase from 2009 to 2010 was due to the implementation of new statistical data on hard coal consumption, and the increase between 2011 and 2012 was because of an increase in hard coal consumption (personal communication by the Czech Republic in 2018).

The data reported by Finland shows an increase from 2015 to 2016 by 216 % for HCB emissions. The main reason is the reporting of increased emissions in the category '2B10a — Chemical industry: Other', which is responsible for 88 % of Finland's national total.

France reported a pronounced decrease in HCB emissions between 1990 and 1995. The decrease in the category '1Ab2 — Stationary combustion in manufacturing industries and construction: Non-ferrous metals' was mainly due to the aluminium industry, which used chlorine to refine aluminium by eliminating magnesium traces. Until the early 1990s, it used hexachloroethane (HCE) as a core source, which resulted in HCB emissions. This was the main HCB source within the national inventory. In 1993, France banned HCE for secondary aluminium refining. Following this ban, the secondary aluminium industry no longer emits HCB (personal communication by France in 2015).

Ireland reported a marked decrease in HCB emissions between 1995 and 2000. HCB emissions from '2C2 — Ferroalloys production' dominated the inventory for the period up to and including 1996, with a contribution of 40 kg per year. This is no longer a source of HCB emissions within Ireland due to the banning of HCE-based cover gas use (HCB was present as a contaminant in such cover gases) (see Ireland's IIR from 2017, listed in Appendix 5).

Spain stated in its IIR that the sudden reduction of HCB emissions between 2005 and 2006 and the further decrease from 2008 to 2010 is due to a new regulation in line with the framework of the 'Stockholm Convention on Persistent Organic Pollutants'. The fluctuations before reflect variations in the productions of POPs in Spain (see Spain's IIR, listed in Appendix 5).

The United Kingdom explained that the largest source of HCB emissions for the years 1990-1998 was the use of HCE as a degassing agent in secondary aluminium smelting reported in the category '2C3 — Aluminium production'. Specific regulation controlling the use of HCE led to emissions from this sector being zero from 1999 onwards, and thus led to an overall sharp decrease in HCB emissions between 1998 and 1999 (personal communication by the United Kingdom in 2017).

Table 3.30 Member State contributions to EU emissions of HCB

	HC_B (kg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	76	55	47	42	44	41	67	149	147	42	43	-44	0.8	1.4	15.3
Belgium	41	116	22	20	15	30	20	8.7	7.8	5.9	5.6	-86	-6.2	0.8	2.0
Bulgaria	0.3	0.3	0.5	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-29	1.4	0.0	0.1
Croatia	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	9	-0.2	0.0	0.1
Cyprus	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-82	0.6	0.0	0.0
Czech Republic	106	44	19	14	22	19	25	22	22	23	22	-79	-4.0	2.0	7.9
Denmark	27	8.3	5.6	3.7	2.7	2.6	2.3	2.6	2.3	2.2	2.3	-92	6.8	0.5	0.8
Estonia	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	47	1.4	0.0	0.1
Finland	37	35	38	32	8.3	26	9.0	17	21	16	59	62	> 100	0.7	21.3
France	1.196	70	43	11	6.0	5.9	6.1	5.7	5.8	5.5	5.8	-100	4.3	22.5	2.1
Germany	112	23	23	14	9.9	10	8.8	9.4	14	12	15	-87	21.9	2.1	5.4
Greece	2.1	2.2	2.6	2.9	3.1	3.0	2.8	2.6	3.3	2.8	2.5	18	-10.8	0.0	0.9
Hungary	2.6	2.8	2.9	2.0	2.0	1.8	1.5	1.4	1.4	1.2	1.5	-42	19.4	0.0	0.5
Ireland	41	41	1.1	1.9	1.6	1.6	1.7	1.6	1.6	1.7	1.7	-96	-0.4	0.8	0.6
Italy	43	38	25	21	17	22	27	22	22	22	22	-50	1.6	0.8	7.9
Latvia	0.2	0.3	0.2	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	42	3.7	0.0	0.1
Lithuania	11	4.7	1.9	1.9	1.3	1.0	0.8	0.7	0.3	0.4	0.4	-96	2.7	0.2	0.1
Luxembourg	0.4	1.3	0.6	0.6	0.7	0.7	0.5	0.5	0.5	0.6	0.6	34	-3.1	0.0	0.2
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	> 100	-9.3	0.0	0.0
Netherlands	45	1.2	1.5	1.6	2.4	2.5	2.7	2.8	2.9	3.3	3.4	-93	3.7	0.9	1.2
Poland	6.3	6.1	4.9	5.1	5.0	5.1	5.4	5.3	4.9	4.8	4.9	-22	1.9	0.1	1.8
Portugal	59	74	100	108	112	113	130	112	84	88	49	-17	-44.8	1.1	17.5
Romania	1.3	1.8	2.3	2.8	2.8	3.1	2.7	2.4	2.3	2.3	2.3	80	-1.0	0.0	0.8
Slovakia	2.4	1.6	1.6	1.6	1.1	1.3	1.2	1.1	1.2	1.2	1.4	-44	9.7	0.0	0.5
Slovenia	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.6	17	7.0	0.0	0.2
Spain	327	151	178	133	0.9	0.9	1.1	1.0	1.0	1.0	1.3	-100	23.5	6.2	0.5
Sweden	16	17	11	4.6	6.6	4.3	3.8	4.3	3.4	3.8	2.7	-84	-29.7	0.3	1.0
United Kingdom	3 155	4 130	81	71	34	24	23	20	24	27	31	-99	12.2	59.4	11.1
EU-28 ([a])	**5 309**	**4 825**	**613**	**497**	**300**	**320**	**344**	**394**	**374**	**269**	**278**	**-95**	**3.5**	**100**	**100**
EU-28 ([b])	5 309	4 825	613	497	300	320	344	394	374	269	278				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

([a]) Sum of national totals as reported by Member States.

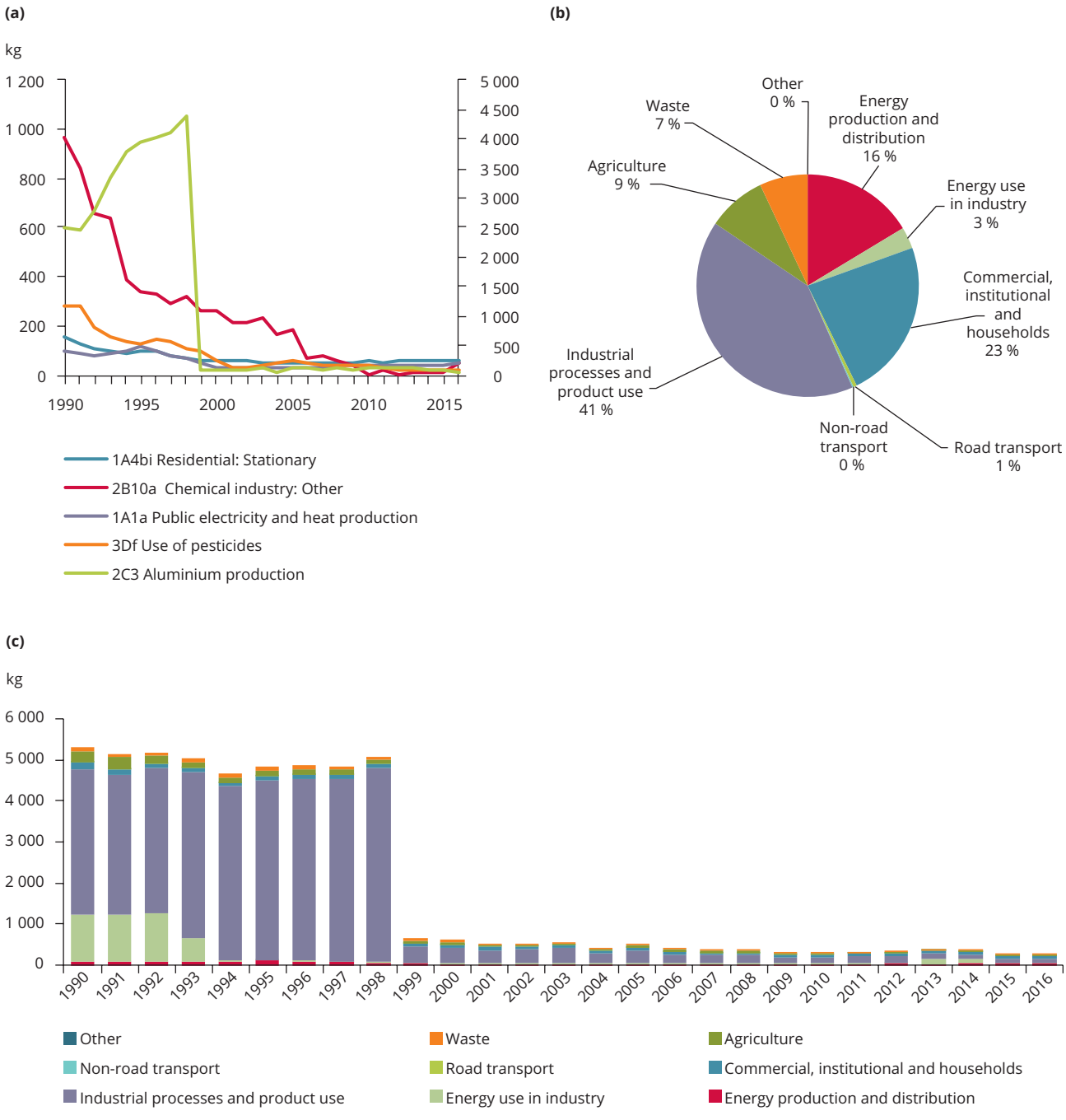
([b]) Sum of sectors.

'1A4bi — Residential: Stationary', '2B10a — Chemical industry: Other' and '2C3 — Aluminium production' were the chief key categories for HCB emissions in 2016, together accounting for 57 % of the total (see Figure 3.18(a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2016 was in the third most important '2C3 — Aluminium production' (-98 %).

Figure 3.18(b) shows the contribution that each aggregated sector group made to total EU emissions. For HCB, the primary emission source is the 'industrial processes and product use' sector group.

The drop in HCB emissions between 1998 and 1999 visible in Figure 3.18(a) and Figure 3.18(c) is due to a considerable reduction reported by the United Kingdom in the category '2C3 — Aluminium production' (for an explanation see above).

Figure 3.18 HCB emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions



3.28 Polychlorinated biphenyl (PCB) emission trends and key categories

Between 1990 and 2016, PCB emissions dropped in the EU by 74 %. Between 2015 and 2016, they decreased by 2 %, mainly because of large reductions reported by the United Kingdom (see Table 3.31). The Member States that contributed most (i.e. more than 10 %) to the emissions of PCBs in 2016 were Portugal, Poland, the United Kingdom and Croatia (countries ranked according to the percentage of their share in the EU total).

Belgium stated that PCB emissions reported in the category '2A1 — Cement production' from one of the plants were very high in 2010 and 2011 because of the use of an alternative raw material containing high concentrations of PCBs. After the removal of the raw material causing high PCB emissions at the end of 2011, emissions decreased significantly (see Belgium's IIR, listed in Appendix 5).

Denmark explained that the strong decrease of PCB emissions between 1990 and 1995 in the category '1A3bi — Road transport: Passenger cars' was due to the phase out of leaded petrol, which has a high PCB emission factor (see Denmark's IIR, listed in Appendix 5).

The emission peak in Ireland in 2003 (not shown in Table 3.31) was caused by an increase of household waste reported in the category '5E — Other waste' (see Ireland's IIR from 2017, listed in Appendix 5).

Lithuania explained that the high PCB emissions in 2005 occurred because emissions from electrical transformer oil were estimated (personal communication by Lithuania in 2017).

The national total of PCBs reported by Portugal is strongly linked to the development of emissions in the category '2C1 — Iron and steel production'; therefore, this category is also a main driver for the emission drop from 2000 to 2002.

The United Kingdom explained that the strong decrease of PCB emissions between 1995 and 2000 was because of measures to end use of PCBs in capacitors and dielectric fluid transformers, etc., resulting in a sharp drop in activity data between 1999 and 2000 (personal communication by the United Kingdom in 2017).

'2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)' was the chief key category for PCB emissions, making up 52 % of the total. Among the top four key categories, the highest relative reductions in emissions between 1990 and 2016 were in the third most important key category, '2C1 — Iron and steel production' (-83 %), and the principal key category, '2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)' (-76 %) (see Figure 3.19(a)).

The large decrease in emissions from '2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)' between 1999 and 2000 is due to reductions reported by the United Kingdom (for an explanation see above).

The strong decrease of PCB emissions between 2000 and 2002 in '2C1 — Iron and steel production' is mainly caused by data reported from Portugal. This decrease can be explained by the significant changes in the only integrated iron and steel plant that existed in Portugal, particularly the end of the production of coke and sinter and the closure and dismantling of the blast furnace (see Portugal's IIR, listed in Appendix 5). The decrease from 2008 to 2009 can be explained by the economic recession, which negatively affected the volume of production.

Figure 3.19(b) shows the contribution that each aggregated sector group made to total EU emissions. For PCBs, the common important emission source is the 'industrial processes and product use' sector group.

Table 3.31 Member State contributions to EU emissions of PCBs

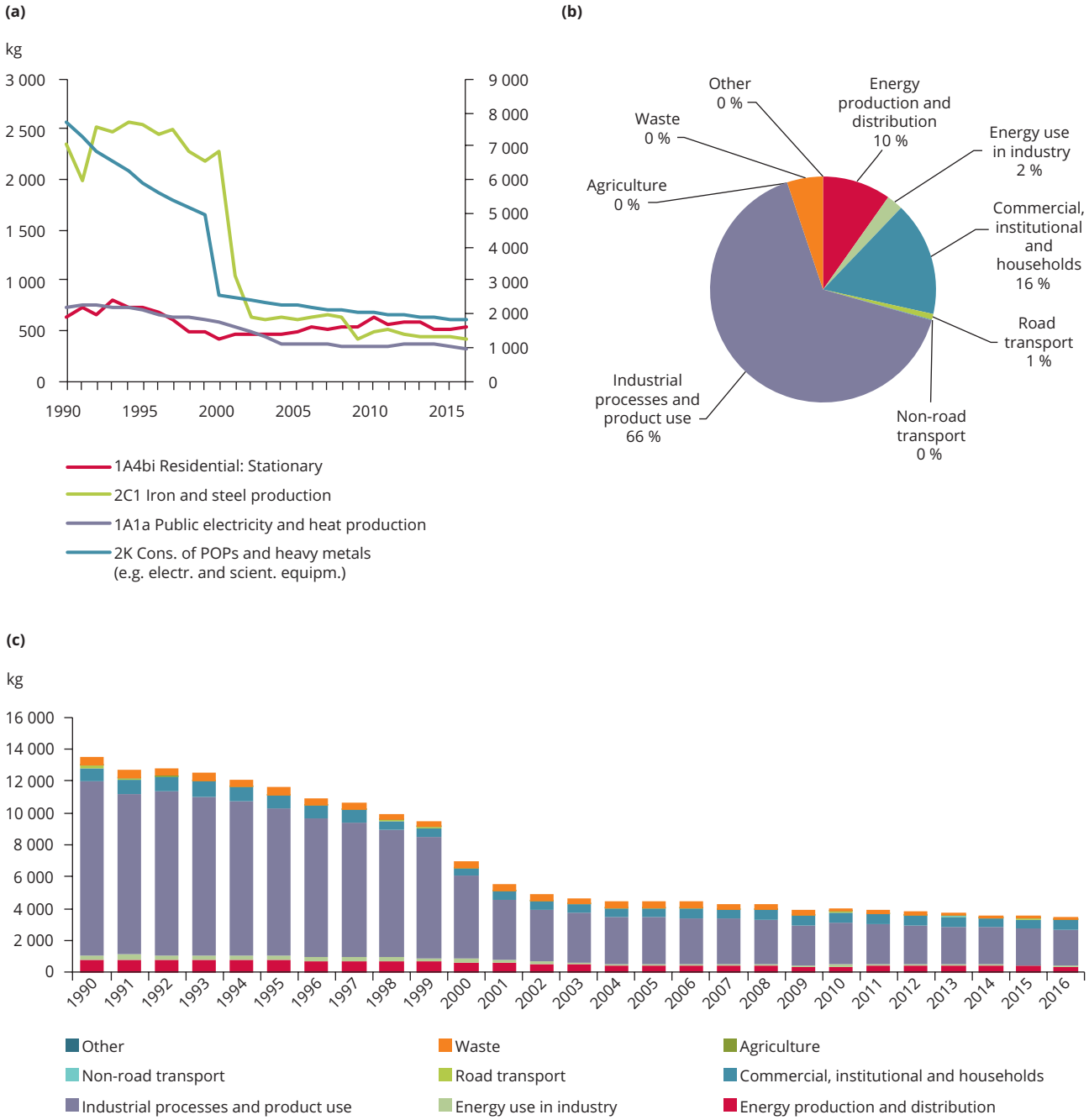
	PC_B (kg)											Change (%)		Share in EU-28 (%)	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016**	**2015-2016**	**1990**	**2016**
Austria	47	29	30	35	35	35	35	37	37	36	35	-27	-2.8	0.4	1.0
Belgium	107	89	93	72	96	58	9.6	5.2	11	3.1	5.9	-94	90.4	0.8	0.2
Bulgaria	14	16	11	10	4.3	5.0	4.7	4.1	3.1	3.0	3.1	-78	1.9	0.1	0.1
Croatia	483	468	441	436	434	433	431	430	429	425	422	-13	-0.7	3.6	12.2
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9	0.6	0.0	0.0
Czech Republic	3.7	2.8	2.1	2.0	1.8	1.8	1.7	1.7	1.7	1.8	1.8	-52	0.0	0.0	0.1
Denmark	111	40	39	43	42	43	41	40	41	41	43	-61	3.9	0.8	1.2
Estonia	8.4	4.1	2.6	3.7	4.2	3.6	3.5	3.9	4.2	4.2	4.2	-50	-0.9	0.1	0.1
Finland	33	36	40	41	39	40	37	36	37	36	37	11	3.6	0.2	1.1
France	177	152	97	67	54	47	51	50	43	42	41	-77	-1.5	1.3	1.2
Germany	1 736	1 483	948	198	232	235	223	226	228	229	228	-87	-0.7	12.9	6.6
Greece	22	22	22	35	43	39	38	36	37	37	30	38	-17.1	0.2	0.9
Hungary	26	12	9.9	11	8.9	9.7	8.7	7.0	7.3	11	9.8	-62	-9.0	0.2	0.3
Ireland	41	34	33	36	14	12	12	11	10	15	12	-69	-14.4	0.3	0.4
Italy	289	302	266	279	211	219	226	206	200	195	190	-34	-2.6	2.1	5.5
Latvia	4.3	1.1	0.4	0.5	0.4	0.8	2.4	0.7	0.3	0.2	0.2	-95	-10.5	0.0	0.0
Lithuania	6.2	1.8	0.7	37	10	1.8	1.4	1.6	1.4	1.3	1.4	-78	5.6	0.0	0.0
Luxembourg	40	36	11	12	19	26	9.1	4.3	5.1	3.1	3.7	-91	22.0	0.3	0.1
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	> 100	-34.7	0.0	0.0
Netherlands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-100	0.0	0.0	0.0
Poland	761	894	539	597	707	673	687	693	635	627	634	-17	1.1	5.6	18.4
Portugal	2 306	2 666	2 687	1 214	1 112	1 134	1 160	1 110	1 105	1 093	1 095	-52	0.2	17.1	31.7
Romania	3.7	14	28	38	21	20	18	17	18	20	19	427	-4.3	0.0	0.6
Slovakia	66	38	25	21	17	17	18	18	18	18	18	-73	-3.2	0.5	0.5
Slovenia	417	290	213	135	76	51	44	41	41	39	39	-91	0.0	3.1	1.1
Spain	26	40	32	37	33	31	27	26	27	27	24	-6	-10.1	0.2	0.7
Sweden	9.0	9.4	9.9	9.5	9.2	9.8	8.8	8.6	9.0	9.1	9.2	3	1.3	0.1	0.3
United Kingdom	6 744	4 915	1 355	1 038	768	745	708	679	645	609	547	-92	-10.1	50.0	15.8
EU-28 ([a])	**13 480**	**11 598**	**6 937**	**4 408**	**3 991**	**3 892**	**3 805**	**3 695**	**3 594**	**3 524**	**3 454**	**-74**	**-2.0**	**100**	**100**
EU-28 ([b])	13 480	11 598	6 937	4 408	3 991	3 892	3 805	3 695	3 594	3 524	3 454				

Notes: Light-blue shaded cells denote gap-filled data. For more detailed information, see Annex D.

([a]) Sum of national totals as reported by Member States.

([b]) Sum of sectors.

Figure 3.19 **PCB emissions from key categories in the EU: (a) trend in emissions from the four most important key categories, 1990-2016; (b) share by sector group, 2016; (c) sectoral trends in emissions**



Note: In Figure 3.19(a), the right-hand axis shows values for '2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)'.

4 Sectoral analysis and emission trends for key pollutants

Chapter 4 sets out emission trends and detailed methodologies of the key pollutants, aggregated into the following main sector groups:

- energy production and distribution;
- energy use in industry;
- industrial processes and product use;
- commercial, institutional and households;
- road transport;
- non-road transport;
- agriculture;
- waste.

Appendix 4 of this report provides a conversion chart showing how the aggregated sector groups include the individual NFR source categories (see Table A4.1). Box 4.1 gives some general explanations relevant to the figures and tables in this chapter.

Sectoral analysis and emission trends for 'energy production and distribution'

The 'energy production and distribution' sector grouping comprises emissions from a number of activities that employ fuel combustion to produce energy products and electricity, for instance. It is a primary source of many pollutants, especially SO_x. Despite considerable past reductions, this sector group contributes 51 % of the total EU emissions of this pollutant.

The sector is an important source of SO_x, Hg, PCDD/Fs and NO_x. The following ranking of the countries is according to the size of the absolute values they reported. Poland, Germany and Spain contributed most (in absolute terms) to the emissions of SO_x for this sector in 2016. Germany, Poland and Spain reported the highest emissions of Hg. Germany, Poland and the United Kingdom contributed most to the NO_x emissions. The United Kingdom reported the highest emissions of HCB in this sector in 2016.

For emissions of the main pollutants (see Figure 4.1), the highest absolute and relative reduction within this sector group was for SO_x (-93 %) between 1990 and 2016. NO_x and NMVOC emissions dropped between 1990 and 2016 by 69 % and 68 %, respectively. $PM_{2.5}$ and PM_{10} emissions have decreased notably since 2000, $PM_{2.5}$ by 63 % and PM_{10} by 67 %.

The strong decrease in NO_x emissions between 2007 and 2008 is mainly because of emission reductions reported by Spain and the United Kingdom in the category '1A1a — Public electricity and heat production'. The United Kingdom remarked that, since 1988, electricity generators have adopted a programme of progressively fitting low NO_x burners to their 500 MWe (megawatt electric) or larger coal-fired units, and since 2007 a programme of fitting over-fire-air burners has further reduced NO_x emissions from the sector (see the United Kingdom's IIR, listed in Appendix 5). Furthermore, emission reductions reported for the same category in Spain are mainly responsible for the strong decrease in SO_x emissions in the same year. Spain explained that the dramatic drop in both NO_x and SO_x emissions in 2008 was due to the closure of the main brown coal mine in Spain in 2007

Box 4.1 Explanations of the figures in this chapter

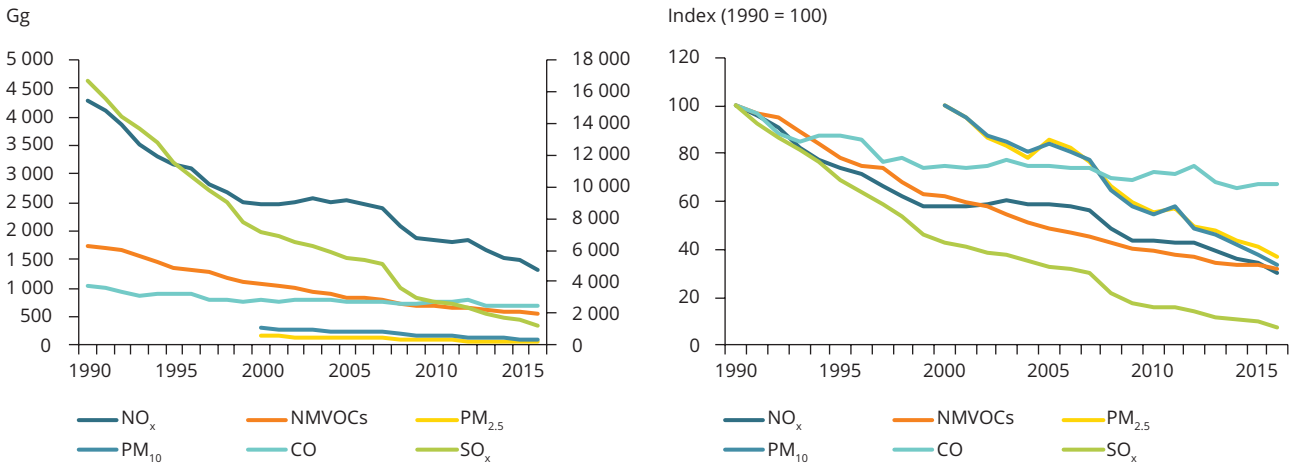
- The LRTAP Convention formally requests Parties to report emissions of PM for 2000 and thereafter. The figures in this chapter show only data from 2000 onwards.
- The figures showing indexed values (in percentages) use 1990 as the index year (1990 = 100 %), with the exception of PM_{10} and $PM_{2.5}$, for which the index year is 2000 (2000 = 100 %).

and the necessary retrofitting in 2008 of the adjacent thermal plant (see Spain's IIR, listed in Appendix 5).

The peak in CO emissions in 2012 is because between 2011 and 2012 Estonia and Italy reported increases in the category '1A1c — Manufacture of solid fuels and other energy industries'. The United Kingdom reported a steep increase in the category '1A1a — Public electricity and heat production' in 2012. Furthermore, between 2012 and 2013 Croatia, France and Portugal reported decreases in the category '1B2aiv — Fugitive emissions oil: Refining/storage' and Italy and Poland reported decreases in the categories '1A1a — Public electricity and heat production' and '1A1c — Manufacture of solid fuels and other energy industries'. France reported that CO emissions were mainly caused by the regeneration of catalytic crackers. In 2013, a plant was equipped with a CO boiler and, since then, emissions have decreased. (see France's IIR, listed in Appendix 5).

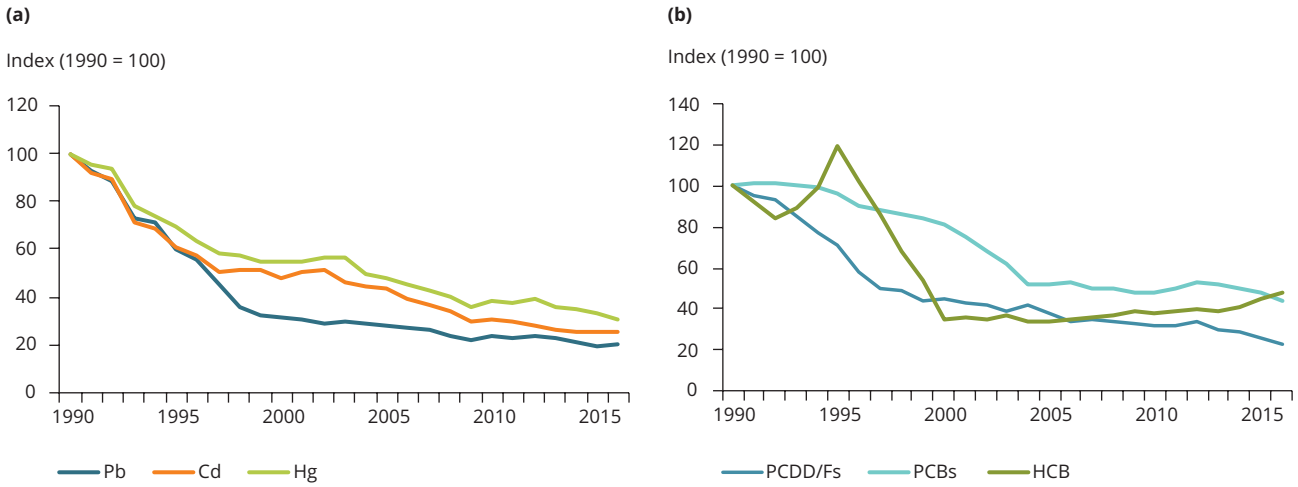
The peak in $PM_{2.5}$ and PM_{10} emissions in 2011 comes from high emission values that Estonia reported in the category '1A1a — Public electricity and heat production'. The Member State explained that the significant growth of $PM_{2.5}$ emissions in 2011 was due to an increase in electricity production by 34 % in Balti Power Plant (Eesti Energia Narva Elektrijaamad plc) and that it is a result of the incorrect operation of electric precipitators on two power units of this power plant (see Estonia's IIR, listed in Appendix 5).

Figure 4.1 **EU emission trends in the sector 'energy production and distribution' for NO_x, NMVOCs, SO_x, PMs and CO between 1990 (2000) and 2016**



Note: In the left panel, the right-hand axis gives values for SO_x.

Figure 4.2 **EU emission trends in the sector group 'energy production and distribution' (a) for the HMs (Pb, Cd and Hg), and (b) for POPs (PCDD/Fs, PCBs and HCB) between 1990 and 2016**



Of the three main HMs, Pb shows the highest reduction in relative terms (-80 %) (see Figure 4.2(a)). Since 2000, the trend of the Hg emissions mainly follows Italy's reported emissions in the category '1B2d — Other fugitive emissions from energy production'.

For emissions of POPs, the highest relative reduction was in PCDD/Fs (-77 %) (see Figure 4.2(b)). The peak in HCB emissions in 1995 reflects high emission values reported by Belgium in the category '1A1a — Public electricity and heat production'. The Member State explained that the reason for high HCB emissions is higher levels of sludge burning in Flanders in 1995 (personal communication by Belgium in 2017). HCB emission data from the United Kingdom reported for the category '1A1a — Public electricity and heat production' also show an increasing trend in recent years. The United Kingdom reported that the HCB emissions are from burning municipal solid waste, and that increasing emissions reflect changes in quantities of waste burnt (see the United Kingdom's IIR, listed in Appendix 5).

In Table 4.1, the number of Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories are shown. Table 4.2 shows the recalculations within the sector group 'energy production and distribution'. For explanations of EU recalculations, see Section 5.1.

Table 4.1 Number of Member States reporting notation keys within the key categories of the sector group 'energy production and distribution'

Key categories		NA	NO	NR	NE
NO_x	1A1a	0	0	0	0
NMVOC	1B2ai	1	5	0	0
	1B2aiv	0	0	0	0
	1B2av	0	2	0	2
SO_x	1A1a	0	0	0	0
	1A1b	0	6	0	0
	1B2aiv	2	4	0	1
$PM_{2.5}$	1A1a	0	0	0	0
PM_{10}	1A1a	0	0	0	0
Pb	1A1a	0	0	0	0
Cd	1A1a	0	0	0	0
	1A1b	0	6	0	2
Hg	1A1a	0	0	0	0
PCDD/Fs	1A1a	0	0	0	0
	1B2aiv	9	4	0	3
HCB	1A1a	1	0	0	0
PCB	1A1a	1	0	0	0

Table 4.2 **Relative difference in reported emissions when comparing the 2017 and 2018 submissions of the EU (relative data, percentage of EU national totals) for the sector group 'energy production and distribution'**

								%						
Pollutant	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
NO_x	0	-1	-2	-1	-1	-2	-1	-2	-1	-2	-2	-2	-2	-2
NMVOCs	1	1	4	-2	-3	-4	-5	-4	-5	-5	-5	-6	-5	-5
SO_x	2	2	0	0	0	0	-1	-1	-1	-1	0	1	-1	1
NH_3	123	162	264	245	219	132	130	115	111	102	73	91	73	81
TSPs	6	5	3	15	15	16	20	24	15	15	16	16	19	19
CO	2	2	2	7	7	7	5	5	6	4	4	3	2	4
Pb	0	0	-1	3	3	2	3	4	3	1	2	0	2	4
Cd	-7	-10	-13	-14	-15	-17	-17	-17	-11	-9	-7	-1	0	0
Hg	-10	-11	-3	-6	-6	-9	-5	-3	4	6	12	9	11	7
As	0	1	1	2	2	2	2	3	2	3	4	4	8	8
Cr	1	-1	-8	-12	-13	-13	-14	-13	-11	-10	-8	-7	4	3
Cu	1	-1	-3	-5	-7	-7	-6	-7	-6	0	0	0	6	8
Ni	0	1	1	-2	-2	-2	-2	-3	2	4	3	3	-3	2
Se	5	8	19	21	20	21	21	25	24	25	22	28	27	27
Zn	3	2	4	0	-3	-3	-2	-4	-5	1	1	0	1	1
PCDD/Fs	6	20	116	522	816	891	849	1 011	876	867	890	853	803	735
B(a)P	195	165	-2	1	1	0	1	1	1	1	1	1	1	1
B(b)F	470	424	5	-1	-1	-2	-2	-3	-2	-2	-2	-2	-4	-4
B(k)F	307	271	2	-2	-2	-3	-3	-4	-3	-3	-2	-2	-3	-3
IP	251	218	4	1	1	1	1	1	1	1	1	0	0	0
Total PAHs	118	99	-6	-2	-2	-2	-3	-1	-3	-4	-3	0	2	3
HCB	5	3	16	13	11	12	11	11	10	11	10	11	10	5
PCBs	-19	-16	0	1	1	0	-1	0	0	0	0	0	2	2
			2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
$PM_{2.5}$			6	25	26	25	31	32	23	24	22	17	17	13
PM_{10}			10	26	26	25	32	35	24	24	24	19	18	13
BC			13	22	25	20	24	22	18	16	-4	12	20	16

4.2 Sectoral analysis and emission trends for 'energy use in industry'

The 'energy use in industry' sector is a primary source for HMs. According to the size of the absolute values the countries reported, Poland, Italy and Spain contributed most to the emissions of Pb in this sector in 2016. For Cd, Poland, Spain and Italy reported the highest emissions. Poland, Italy and France contributed most to the emissions of Hg.

Energy use (fuel combustion) in industry is an important source of many pollutants. For the main pollutants, the highest absolute and relative reduction (-88 %) between 1990 and 2016 was for SO_x (see Figure 4.3).

The strong decrease in CO emissions between 2008 and 2009 results from emission reductions reported by several countries, especially Belgium, France, Germany and Italy, and might have been caused by the economic crisis.

The dip in $PM_{2.5}$ and PM_{10} emissions in 2009 is due to data reported by several countries, and might have been caused by the economic crisis. Data reported by Estonia, Spain and the United Kingdom in the category '1A2gviii — Stationary combustion in manufacturing industries and construction: Other' mainly caused the increase of the $PM_{2.5}$ and PM_{10} in 2015.

Of the three HMs, Hg shows the highest reduction in relative terms (-66 %) (see Figure 4.4(a)).

Figure 4.3 **EU emission trends in the sector group 'energy use in industry' for NO_x, SO_x, PMs and CO between 1990 (2000) and 2016**

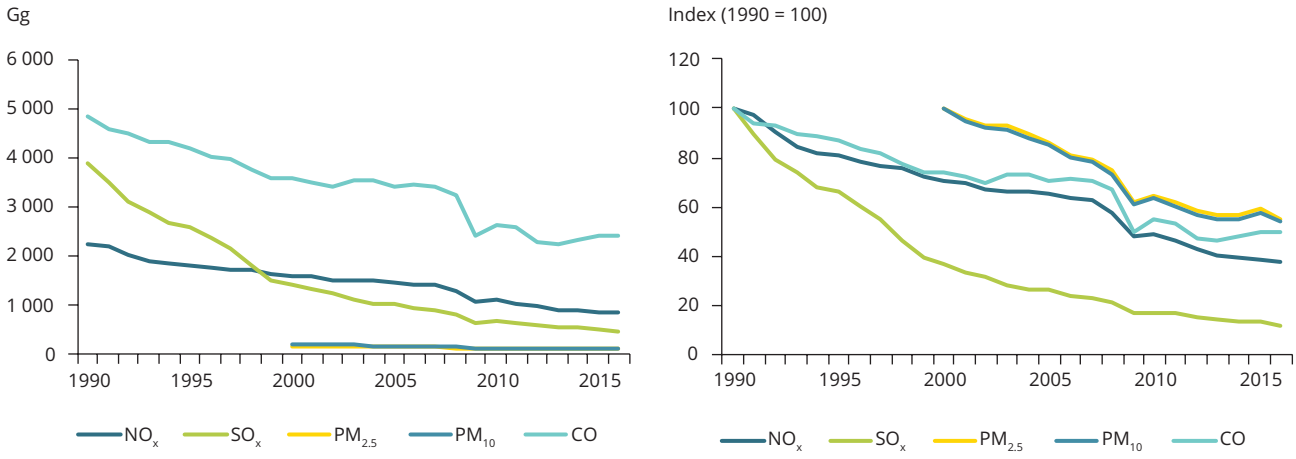
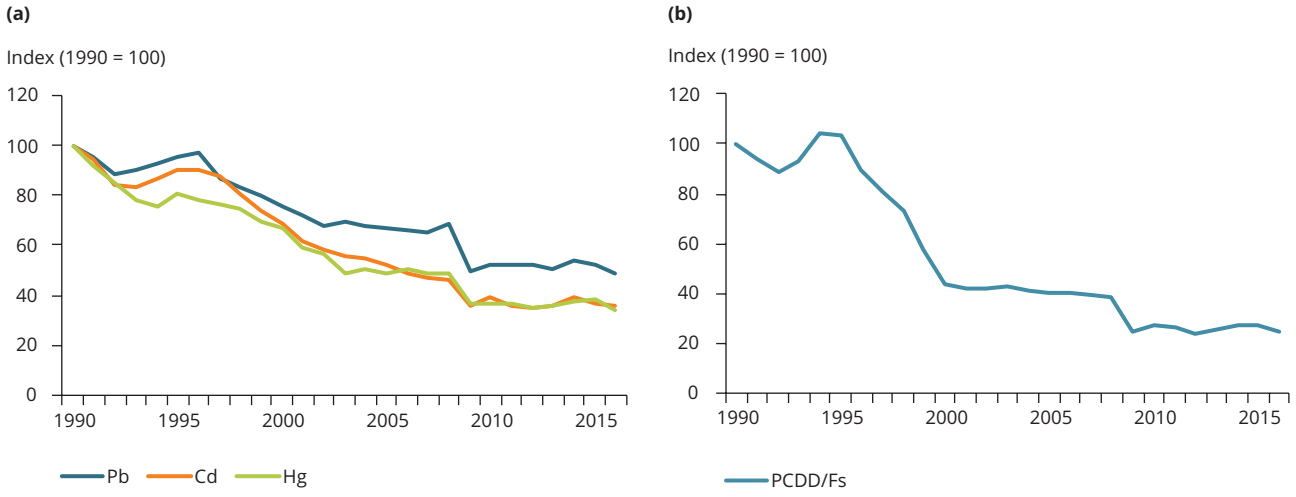


Figure 4.4 **EU emission trends in the sector group 'energy use in industry' (a) for the HMs (Pb, Cd and Hg), and (b) for POPs (PCDD/Fs and HCB) between 1990 and 2016**



Pb emissions decreased between 1996 and 1997, peaked in 2008, decreased considerably between 2008 and 2009, and increased between 2013 and 2014. This pattern is mainly because of Bulgaria's data for '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals', accentuated by drops in Pb emissions in the categories '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel' and '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals' reported by Italy from 1996 to 1997 as well as between 2008 and 2009.

The strong decrease in Hg emissions between 2008 and 2009 is due to reductions that several countries reported, especially Italy and Slovakia, and might have been caused by the economic crisis in 2009.

The high Cd emissions from 1995 to 1997 reflect high levels reported by Poland. The decrease in Cd emissions between 2008 and 2009 is caused by reductions that several countries reported.

Among POPs, PCDD/Fs are key pollutants in the sector group 'energy use in industry'. Figure 4.4(b) presents trends for these pollutants.

The trend in PCDD/F emissions from 1990 until 2000 is mainly attributable to the data reported by France, with PCDD/F emissions peaks from 1994 to 1995 in the categories '1A2a — Stationary combustion

Table 4.3 Number of Member States reporting notation keys within the key categories of the sector group 'energy use in industry'

Key categories		NA	NO	NR	NE
NO_x	1A2f	0	1	0	0
	1A2gvii	0	0	0	0
	1A2gviii	1	0	0	1
SO_x	1A2a	0	2	0	0
	1A2c	0	1	0	0
	1A2f	0	1	0	0
	1A2gviii	1	0	0	1
$PM_{2.5}$	1A2f	0	1	0	0
	1A2gviii	1	0	0	1
PM_{10}	1A2f	0	1	0	0
	1A2gviii	1	0	0	1
CO	1A2a	0	2	0	0
	1A2f	0	1	0	1
	1A2gvii	0	0	0	0
Pb	1A2a	0	2	0	2
	1A2b	0	4	0	1
	1A2f	0	1	0	2
Cd	1A2a	1	2	0	2
	1A2b	1	4	0	1
	1A2c	1	1	0	1
	1A2f	0	1	0	1
	1A2gviii	1	0	0	1
Hg	1A2a	1	2	0	1
	1A2b	1	4	0	2
	1A2f	0	1	0	2
PCDD/Fs	1A2gviii	0	2	0	1

in manufacturing industries and construction: Iron and steel' and '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals'. The dip 2009 is due to data reported by several countries, and might have been caused by the economic crisis.

In Table 4.3, the number of Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories are shown. Table 4.4 shows the recalculations within the sector group 'energy use in industry'. For explanations of EU recalculations, see Section 5.1.

4.3 Sectoral analysis and emission trends for 'industrial processes and product use'

The 'industrial processes and product use' sector grouping refers to emissions from industrial sources other than those arising from fuel combustion within the industrial sector. This is the primary sector group for NMVOC, B(a)P, total PAH, HCB and PCB emissions, and makes significant contributions to emissions of HMs, PMs, and PCDD/Fs. The following ranking of the countries is according to the size of the absolute values they reported. Of all the countries that reported data, Germany, the United Kingdom and Italy contributed most to NMVOC emissions. The largest contributions to B(a)P and total PAH emissions were reported by Portugal. For HCB emissions, the largest contributions were reported by Finland, Portugal and Austria. Portugal, the United Kingdom and Italy contributed most to PCB emissions in the 'industrial processes and product use' sector in 2016. Figure 4.5 shows past trends in emissions of the relevant main pollutants.

Table 4.4 **Relative difference in reported emissions when comparing the 2017 and 2018 submissions of the EU (relative data, percentage of EU national totals) for the sector group 'energy use in industry'**

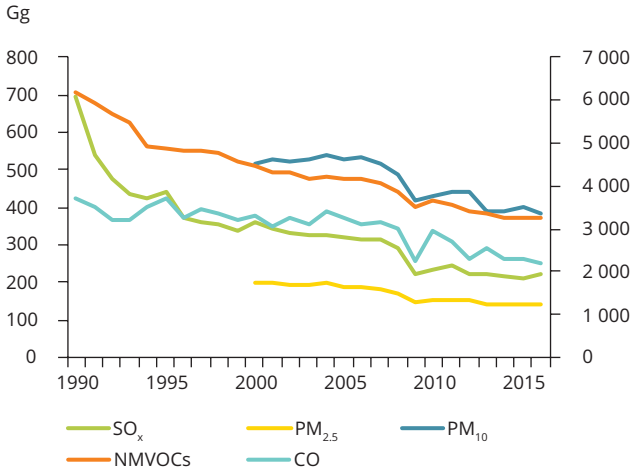
														%
Pollutant	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
NO_x	1	-1	0	-5	-6	-4	-4	-4	-5	-4	-5	-5	-6	-5
NMVOCs	23	32	32	20	20	22	22	22	22	23	25	23	23	27
SO_x	-11	-11	-1	-1	-3	-4	-7	-16	-20	-20	-16	-4	0	2
NH_3	56	56	78	61	55	72	69	75	79	51	54	50	44	63
TSPs	3	4	-5	1	0	2	1	-2	-2	-3	-3	-1	-1	2
CO	4	5	-1	-2	-2	-2	-2	-2	-3	-6	-5	-6	-7	-2
Pb	-2	-3	-7	-7	-7	-9	-8	-10	-10	-12	-11	-11	-11	-11
Cd	-3	-6	-4	-6	-5	-5	-5	-6	-6	-7	-6	-6	-7	-6
Hg	-6	-5	-4	-3	-2	-2	-2	-3	-2	-3	-2	-1	-1	-1
As	3	0	-3	-2	-2	-2	-3	-3	-3	-3	-3	-3	-2	-2
Cr	3	-8	-23	-16	-17	-15	-16	-18	-12	-19	-20	-19	-21	-18
Cu	2	0	-2	-1	-1	-3	-3	-2	-3	-3	-3	-3	-4	-3
Ni	-9	-11	-13	-15	-11	-7	-10	-10	-9	-9	-9	-12	-11	-16
Se	-36	-52	-64	-68	-64	-65	-63	-62	-64	-61	-61	-60	-60	-36
Zn	0	-2	-5	-5	-7	-7	-7	-8	-9	-10	-10	-10	-10	-7
PCDD/Fs	-52	-45	-13	4	2	-1	3	-1	-2	-5	-5	-4	-5	-7
B(a)P	36	82	138	102	95	93	105	111	92	67	69	67	78	71
B(b)F	92	164	256	68	53	64	69	72	62	45	47	45	51	48
B(k)F	65	131	244	79	73	72	80	83	70	49	51	48	57	52
IP	60	128	255	79	72	73	81	85	72	51	55	52	61	57
Total PAHs	-49	-46	-19	-18	-20	-21	-23	-30	-32	-40	-41	-45	-43	-43
HCB	-8	-78	-75	-23	-24	-28	-29	-40	-42	-37	-15	-4	-4	-37
PCBs	-49	-44	13	16	15	12	13	16	12	-1	-2	-5	-3	-7
			2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
$PM_{2.5}$			22	24	23	27	26	24	25	25	27	29	28	32
PM_{10}			9	13	12	15	15	12	13	12	13	15	15	19
BC			8	10	9	11	11	11	11	11	13	11	7	17

Data from France for the category '2C1 — Iron and steel production' have a great influence on the trend in emissions of CO. In France, the emissions of CO from category 2C1 fluctuate over the years, depending on the amount of blast furnace gas that is produced, reused or flared. The amounts depend on the operating conditions and how feasible it is for iron and steel or colliery plants to reuse the gas that blast furnaces continuously produce. This may fluctuate a great deal from one year to another, resulting in peaks (1995, 2004 and 2010) or troughs (1992, 2001 and 2009) (personal communication by France in 2013). The CO emissions peak in 2013 follows the peak reported by Belgium in the category '2A2 — Lime production'. Belgium reported that the sudden increase in 2013 was due to a plant where the lime production occurred without oxygen (reducing atmosphere) (see Belgium's IRR, listed in Appendix 5).

The decrease in SO_x emissions from 1990 to 1991, the increase from 1999 to 2000 and the decrease from 2008 to 2009 mainly reflect emission data from Germany reported for several categories. The decrease in SO_x emissions from 1990 to 1991 is caused by reductions in categories '2H1 — Pulp and paper industry', '2B10a — Chemical industry: Other', '2C1 — Iron and steel production' and '2A6 — Other mineral products'. The increase from 1999 to 2000 and the decrease from 2008 to 2009 in SO_x emissions mainly reflect emission data reported in the category '2C1 — Iron and steel production'. The decrease in SO_x emissions from 1995 to 1996 is due to reductions in the category '2B10a — Chemical industry: Other' that Italy reported.

In 2009, many countries reported a decrease in the PM_{10} emissions, for instance France, Germany and the United Kingdom. The high PM_{10} emissions between 2010 and 2012 mainly reflect the data reported by Greece and Portugal in the category '2A5b — Construction and demolition'. In 2015, Bulgaria and Hungary reported peaks in the PM_{10} emissions in the categories '2D3b — Road paving with asphalt' and '2A5b — Construction and demolition', respectively.

Figure 4.5 EU emission trends in the sector group 'industrial processes' for NMVOCs, SO_x CO and PM between 1990 (2000) and 2016



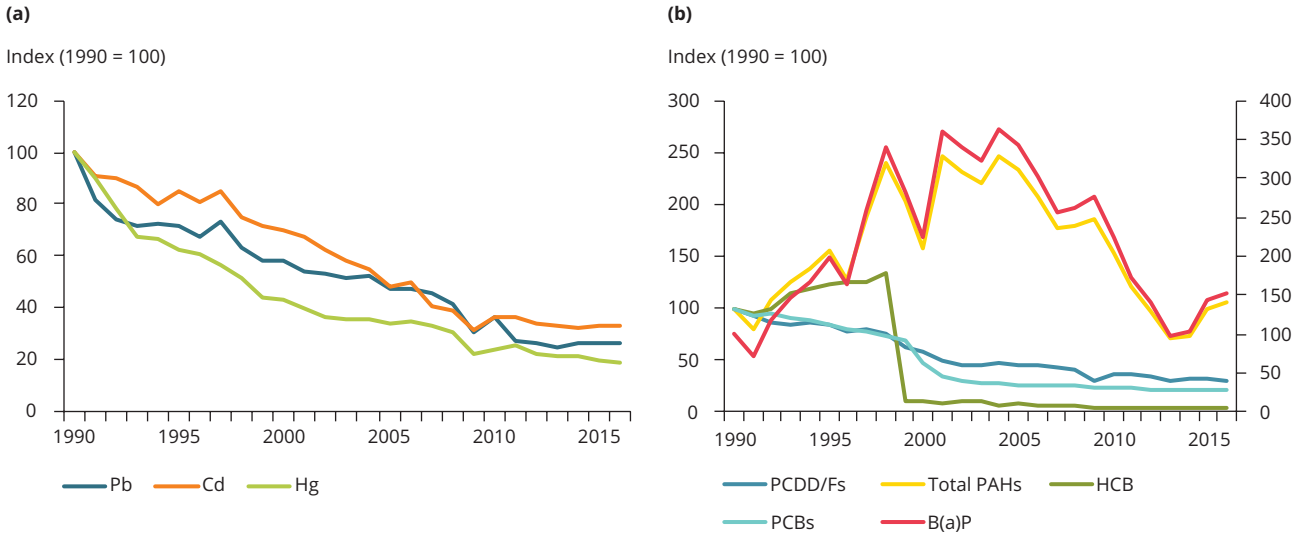
Note: The right-hand axis gives values for CO and NMVOCs.

'Industrial processes and product use' make a considerable contribution to the total EU emissions of HMs, despite seeing considerable reductions since 1990. Figure 4.6(a) shows past emission trends for these pollutants. Hg shows the highest relative reduction in emissions between 1990 and 2016 (81 %).

The trend in Cd emissions between 1990 and 2007 mainly reflects emission data from Slovakia reported in the category '2A3 — Glass production'. In 2007, most Slovak glass operators ceased production. (see Slovakia's IRR, listed in Appendix 5). In following years, the trend in Cd emissions is due to data reported by several countries. The decrease in Pb emissions between 2008 and 2009 is caused by reductions that several countries reported, presumably due to the economic crisis in 2009. The reduction in Pb emissions between 2010 and 2011 reflects the significant emission decrease in Latvia in the category '2C1 — Iron and steel production' due to change of furnace type in metal production. Overall, between 2010 and 2011, Latvia's total emissions of Pb (national total) decreased by 98 % (see Latvia's IIR, listed in Appendix 5).

Among POPs, the highest relative reduction between 1990 and 2016 occurred for HCB (97 %) (Figure 4.6(b)).

Figure 4.6 EU emission trends in the sector group 'industrial processes and product use' (a) for the HMs (Pb, Cd, Hg), and (b) for the POPs (PCDD/Fs, total PAHs, HCB and PCBs) and B(a)P between 1990 and 2016



Notes: The right-hand axis gives values for B(a)P.

For B(a)P, data from Austria, Italy and Spain could not be gap-filled, as the countries did not report values for any year. To enable presentation of provisional EU emission trends, the emissions have been aggregated without including data for these Member States.

The considerable change in HCB emissions is mainly the result of an increase in '2C3 — Aluminium production' in the United Kingdom until 1998. The largest source of HCB emissions for the years 1990-1998 in the United Kingdom was the use of HCE as a degassing agent in secondary aluminium smelting. Specific regulation controlling the use of HCE led to emissions from this sector being zero from 1999 onwards, and thus led to an overall sharp decrease in HCB emissions between 1998 and 1999 (personal communication by the United Kingdom in 2017).

The steep drop in PCBs from 1999 to 2000 is caused by falls in emissions from the category '2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)' that the United Kingdom reported. This Member State explained that there was a sharp decrease in PCB emissions generated by capacitors between 1999 and 2000 (personal communication by the United Kingdom in 2017).

The changes in the total PAHs follow the data reported by Portugal in the category '2D3g — Chemical products'. For 2016, 76 % of the total B(a)P emissions can be attributed to the sector group 'industrial processes and product use' due to data reported by Portugal in the category '2D3g — Chemical products'.

In Table 4.5, the number of Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories are shown. Table 4.6 shows the recalculations within the sector group 'industrial processes and product use'. For explanations of EU recalculations see Section 5.1.

Table 4.5 Number of Member States reporting notation keys within the key categories of the sector group 'industrial processes and product use'

Key categories		NA	NO	NR	NE
NM_{VOC}	2B10a	1	5	0	0
	2D3a	0	0	0	0
	2D3d	0	0	0	1
	2D3e	0	2	0	0
	2D3g	0	0	0	0
	2D3h	0	0	0	0
	2D3i	0	2	0	1
	2H2	0	0	0	0
SO_x	2B10a	1	5	0	1
$PM_{2.5}$	2C1	0	4	0	0
	2G	0	0	0	0
	2A5a	1	1	0	4
	2A5b	0	0	0	5
PM_{10}	2C1	0	4	0	0
	2D3b	3	0	0	2
	2L	6	13	0	1
CO	2C1	0	4	0	2
Pb	2C1	0	4	0	0
Cd	2C1	1	4	0	0
	2C7a	3	10	0	0
	2G	0	0	0	0
Hg	2B10a	5	5	0	3
	2C1	1	4	0	0
PCDD/Fs	2C1	1	4	0	1
Total PAHs	2D3g	17	0	0	10
B(a)P	2D3g	16	0	1	10
HCB	2B10a	11	5	1	6
	2C3	8	7	0	8
PCB	2C1	2	4	0	0
	2K	9	7	0	4

Table 4.6 **Relative difference in reported emissions when comparing the 2017 and 2018 submissions of the EU (relative data, percentage of EU national totals) for the sector group 'industrial processes and product use'**

								%						
Pollutant	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
NO_x	4	4	6	4	3	3	3	3	5	6	6	5	6	5
NMVOCs	0	1	1	2	2	2	2	2	2	2	2	1	1	1
SO_x	13	7	4	6	7	6	5	6	10	11	10	9	10	10
NH_3	38	30	32	37	28	18	27	38	28	34	26	30	32	43
TSPs	14	16	19	29	31	26	30	31	36	36	40	25	25	27
CO	2	-4	1	4	4	5	5	7	6	7	8	8	-3	-2
Pb	-8	-11	-7	-8	-10	4	4	5	5	7	7	7	7	7
Cd	14	16	21	23	27	36	39	52	58	54	58	62	61	63
Hg	0	-1	0	2	2	2	0	3	2	3	3	5	7	4
As	34	13	7	6	6	7	6	11	10	14	15	19	13	12
Cr	-3	-4	0	4	4	4	4	4	1	2	4	3	2	5
Cu	28	60	66	56	49	51	50	63	60	58	63	73	65	62
Ni	11	10	8	10	11	13	12	12	13	17	20	17	16	25
Se	29	31	24	58	30	35	27	28	33	20	21	21	23	22
Zn	0	0	1	1	1	1	0	1	1	1	1	2	1	2
PCDD/Fs	-29	-22	-6	10	9	8	6	7	6	7	8	8	11	9
B(a)P	1 331	4 308	26 652	14 869	11 726	10 370	9 425	17 813	14 319	9 812	8 953	6 338	6 810	9 123
B(b)F	3	2	18	-59	-61	-59	-65	-70	-74	-71	-72	-71	-71	-71
B(k)F	12	14	81	-48	-49	-49	-58	-71	-74	-71	-71	-71	-70	-71
IP	7	7	47	-37	-47	-35	-46	-15	-33	-29	-34	-38	-38	-41
Total PAHs	152	372	1 055	1 530	1 266	1 127	1 174	2 396	1 720	1 202	1 056	781	809	1 151
HCB	-15	-21	13	39	84	55	85	114	230	121	257	257	150	204
PCBs	18	31	80	28	29	27	29	46	40	43	50	50	49	50
			2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
$PM_{2.5}$			11	15	15	14	14	16	16	15	15	11	12	14
PM_{10}			16	23	24	21	24	24	26	28	32	19	19	21
BC			45	67	58	41	59	106	117	47	72	49	52	61

4.4 Sectoral analysis and emission trends for 'commercial, institutional and households'

As indicated in Chapter 2, fuel combustion by commercial and institutional facilities and households makes an important contribution to the total emissions of many pollutants.

The 'commercial, institutional and households' sector is the primary sector group for $PM_{2.5}$, PM_{10} and CO, and an important sector group for NO_x, NMVOC, SO_x, B(a)P, Pb, Cd, Hg, PCDD/F, total PAH, HCB and PCB emissions. The following ranking of the countries is according to the size of the absolute values they reported. For $PM_{2.5}$, Italy, Romania and France reported the highest emissions. Poland, Italy and Romania emitted the largest proportion of PM_{10} in 2016. Poland, Italy and France contributed most to CO emissions.

Of the main pollutants, the highest relative reduction between 1990 and 2016 for the sector grouping was again in SO_x (86 %). In contrast, PM emissions have changed little since 2000 (see Figure 4.7).

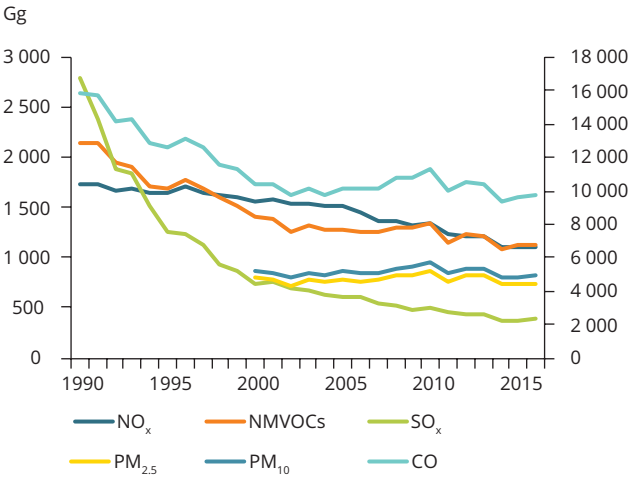
The decrease of CO emissions between 1990 and 1992 reflects data from Germany in the categories '1A4ai — Commercial/institutional: Stationary' and '1A4bi — Residential: Stationary'. The Member State explained that the main driver of the CO emission trends is decreasing lignite consumption. Since 1990, fuel use has changed from solid fuels, causing high

CO emissions, to gaseous fuels, producing much lower emissions (see Germany's IIR, listed in Appendix 5). The increase in CO emissions from 1992 to 1993 reflects data from Poland in the category '1A4bi — Residential: Stationary'. The peak in 1996 reflects data from France and Poland. The low CO emissions in 2002 and the decreases in 2011 and 2014 reflect data from Italy and France for the category '1A4bi — Residential: Stationary'.

The decreases in SO_x and NMVOC emissions between 1990 and 1992 are because Germany reduced emissions. Germany explained that SO_2 emissions decreased due to the fuel switch from coal (especially lignite with a high emission factor) to natural gas with a lower emission factor. A further reduction in emissions of SO_2 from 2008 onwards can be explained by the increasing use of fuel oil with low sulphur content. The main driver of the NMVOC emissions reported by Germany is decreasing lignite consumption. In the residential sector the emission trend is also affected by the increasing use of firewood with high emission factors, which counteracts the reduction in SO_2 emissions. Since 1990, fuel use has changed from solid fuels causing high NMVOC emissions to gaseous fuels producing much lower emissions (see Germany's IIR, listed in Appendix 5).

The data reported by Italy in the category '1A4bi — Residential: Stationary' caused the dip in NMVOC emissions in 2011.

Figure 4.7 EU emission trends in the sector group 'commercial, institutional and households' for NO_x, NMVOCs, SO_x, PMs and CO between 1990 (2000) and 2016

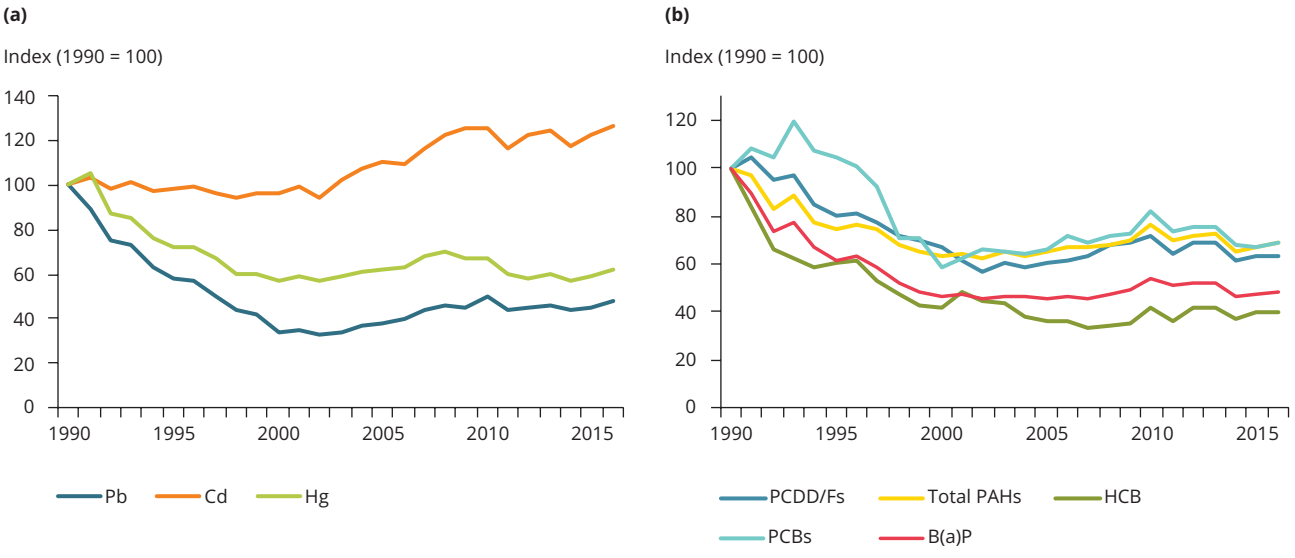


Note: The right-hand axis gives values for CO.

Of the three HMs in the sector 'commercial, institutional and households', Pb shows the highest reduction, both absolutely and relatively (52 %) (see Figure 4.8(a)).

The trend in emissions of Cd largely reflects data from Italy, whereas Italy and Poland contribute most

Figure 4.8 EU emission trends in the sector group 'commercial, institutional and households' (a) for the HMs (Pb, Cd and Hg), and (b) for the POPs (PCDD/Fs, total PAHs, B(a)P, HCB and PCBs) between 1990 and 2016



Notes: For B(a)P, data from Austria, Italy and Spain could not be gap-filled, as the countries did not report values for any year. To enable presentation of provisional EU emission trends, the emissions have been aggregated without including data for these Member States.

Table 4.7 **Number of Member States reporting notation keys within the key categories of the sector group 'commercial, institutional and households'**

Key categories		NA	NO	NR	NE
NO_x	1A4ai	0	0	0	0
	1A4bi	0	0	0	0
	1A4cii	0	0	0	0
NM_{VOC}	1A4bi	0	0	0	0
SO_x	1A4ai	0	0	0	0
	1A4bi	0	0	0	0
$PM_{2.5}$	1A4ai	0	0	0	0
	1A4bi	0	0	0	1
	1A4cii	0	0	0	0
PM_{10}	1A4bi	0	0	0	0
	1A4ci	0	0	0	0
	1A4cii	0	0	0	0
CO	1A4bi	0	0	0	0
	1A4bii	0	0	0	1
Pb	1A4ai	0	0	0	0
	1A4bi	1	0	0	0
Cd	1A4ai	0	0	0	0
	1A4bi	1	0	0	0
Hg	1A4ai	0	0	0	0
	1A4bi	1	0	0	0
PCDD/Fs	1A4bi	1	0	0	0
B(a)P	1A4bi	1	0	0	0
Total PAHs	1A4bi	1	0	0	0
HC_B	1A4bi	1	0	0	0
PCB	1A4bi	1	0	0	2

to the Pb emission trend. The Cd emissions mainly relate to Italy's category '1A4ai — Commercial/institutional: Stationary'. Concerning the positive trend in Cd emissions in 2008, Romania also reported an increase in the category '1A4bi — Residential: Stationary'. The decrease in Pb emissions from 1990 to 1992 is the result of emission reductions reported by several countries, especially Germany and Italy, which reduced their emissions considerably in the categories '1A5b — Other, mobile (including military, land based and recreational boats)' and '1A4cii — Agriculture/forestry/fishing: Off-road vehicles and other machinery', respectively. The peak visible in 2010 in the Pb emissions relates to the emission data of Poland in the category '1A4bi — Residential: Stationary'.

The trend for Hg largely reflects data from Italy for the category '1A4ai — Commercial/institutional: Stationary'. Italy's emissions of Hg from non-industrial combustion plants reported in the sector group 'commercial, institutional and households' represent 32 % of the national total emissions of Hg in 2016 (see Italy's IIR from 2017, listed in Appendix 5). The Hg peak in 1991 reflects data from France for the category '1A4bi — Residential: Stationary'.

Among POPs relevant to the 'commercial, institutional and households' sector, the highest absolute and relative reduction occurred for HCB (61 %) (see Figure 4.8(b)).

The trend in emissions of PCB largely reflects data from Poland for the category '1A4bi — Residential: Stationary'. Poland's emissions of PCB from non-industrial combustion plants reported in the sector group 'commercial, institutional and households' are the dominant source of PCB emissions making up 73 % of the national total emissions of PCB in 2016. Compared with 2015, national total emissions in 2016 increased by about 1 %. The main reason for this change was a higher consumption of hard coal in the residential sector (see Poland's IIR, listed in Appendix 5).

Further, the trend for HCB largely reflects data from Austria and the Czech Republic for the category '1A4bi — Residential: Stationary'. The increase in the emission data from 2001 to 2003 also results from high emissions reported by Italy in the category '1A4ai — Commercial/institutional: Stationary'.

The trend in total emissions of PAHs between 1990 and 2000 largely reflects data from the Czech Republic and Poland. The strong decrease of total PAHs and B(a)P from 1990 to 1992 and the peaks in 2010 and 2013 reflect data that Germany reported in the category '1A4bi — Residential: Stationary'. Emissions from Poland reported in the same category are the reason for the peak in total PAHs and B(a)P total emissions in 1993.

In Table 4.7, the number of Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories are shown. Table 4.8 shows the recalculations within the sector group 'commercial, institutional and households'. For explanations of EU recalculations see Section 5.1.

Table 4.8 **Relative difference in reported emissions when comparing the 2017 and 2018 submissions of the EU (relative data, percentage of EU national totals) for the sector group 'commercial, institutional and households'**

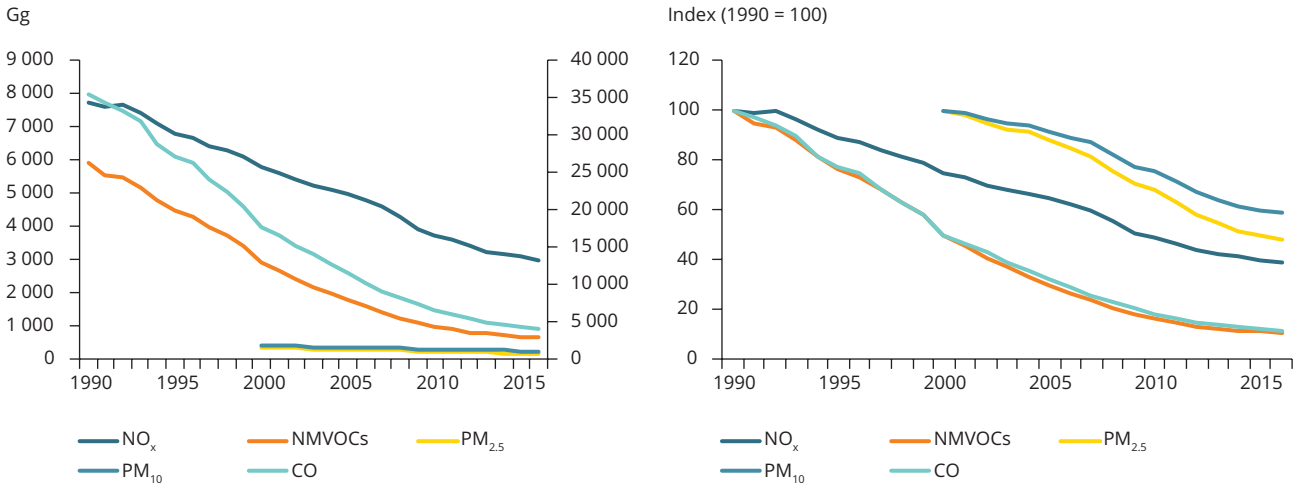
								%						
Pollutant	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
NO_x	1	3	1	0	0	0	0	0	0	0	1	0	1	1
NMVOCs	5	3	1	2	2	2	2	2	2	3	4	3	5	5
SO_x	-5	3	2	1	0	-1	-1	-2	0	1	1	1	2	3
NH_3	111	117	110	111	107	104	99	100	104	102	104	110	111	110
TSPs	2	8	4	0	0	0	-1	-1	0	0	0	0	2	1
CO	4	4	1	2	1	1	1	1	1	1	1	1	2	2
Pb	-19	-30	-30	-34	-36	-31	-32	-33	-33	-33	-33	-31	-29	-27
Cd	-9	-17	-4	-1	-2	0	0	-2	-2	0	1	1	3	5
Hg	14	14	25	22	21	17	17	14	14	18	10	10	6	12
As	-49	-53	-48	-58	-62	-60	-61	-62	-64	-63	-63	-63	-63	-63
Cr	-10	-12	-8	-15	-18	-17	-18	-18	-20	-18	-19	-18	-18	-16
Cu	-32	-35	-32	-37	-39	-38	-38	-38	-39	-38	-38	-37	-36	-35
Ni	-25	-26	-16	-22	-27	-25	-27	-29	-43	-40	-40	-39	-37	-36
Se	84	59	50	55	54	54	60	65	58	62	62	62	54	73
Zn	-43	-48	-34	-43	-47	-44	-44	-44	-46	-44	-44	-43	-43	-41
PCDD/Fs	-45	-41	-25	1	1	1	0	0	0	1	1	0	0	0
B(a)P	15	12	6	1	1	1	2	2	3	4	4	4	5	4
B(b)F	26	17	17	1	1	1	1	2	3	3	3	3	4	3
B(k)F	24	15	10	-1	-1	-1	-1	0	1	2	2	2	3	2
IP	30	19	17	1	1	0	2	2	3	4	5	5	5	5
Total PAHs	-45	-65	-3	0	1	0	1	1	1	2	2	2	4	3
HCB	145	48	4	1	7	3	5	13	28	31	46	33	61	57
PCBs	-9	-7	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
			2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
$PM_{2.5}$			5	0	0	0	0	-1	0	0	0	0	2	1
PM_{10}			5	0	0	0	0	-1	0	0	0	0	2	1
BC			8	5	5	4	5	4	5	6	5	4	6	5

4.5 Sectoral analysis and emission trends for 'road transport'

The individual NFR sources that make up the 'road transport' sector group together contribute considerably to emissions of a number of pollutants, including NO_x, CO, Pb, $PM_{2.5}$, PM_{10} and NMVOCs. Figure 4.9 and Figure 4.10 show the past emission trends for these pollutants in this sector.

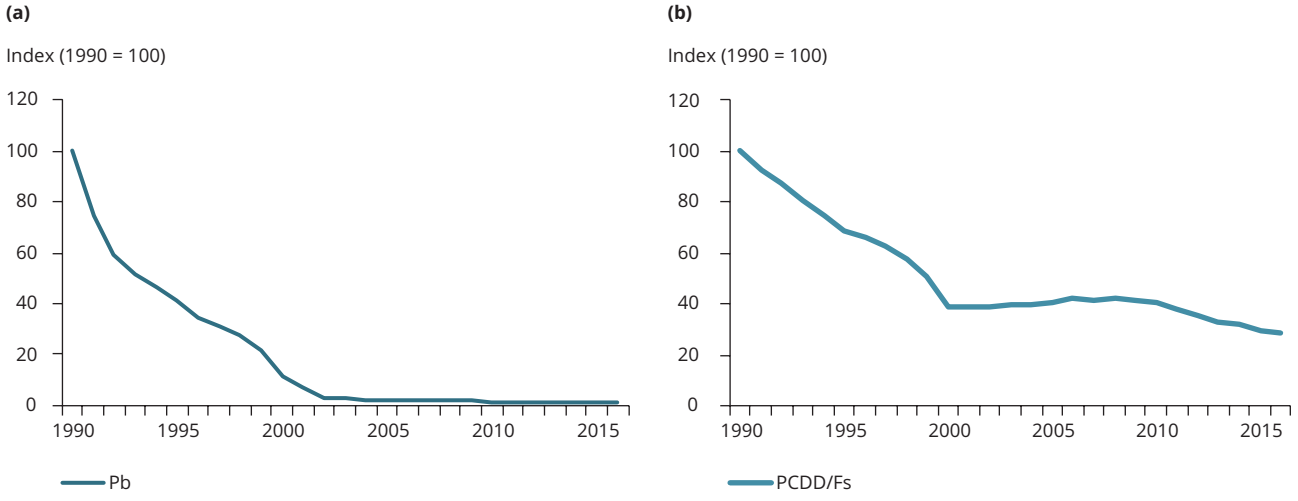
France, Germany and Italy contributed most (in absolute terms) to NO_x, $PM_{2.5}$ and PM_{10} emissions in the 'road transport' sector in 2016. The following ranking of the countries is according to the size of the absolute values they reported. For CO, Germany, Poland and Italy reported the highest emissions. Germany, France and Spain contributed most to the emissions of Pb, and Italy, Germany and Poland most to the emissions of NMVOCs in this sector in 2016.

Figure 4.9 **EU emission trends in the sector group 'road transport' for NO_x, NMVOCs, PMs and CO between 1990 (2000) and 2016**



Note: The right-hand axis gives values for CO.

Figure 4.10 **EU emission trends in the sector group 'road transport' (a) for the priority HM Pb, and (b) for PCDD/Fs between 1990 and 2016**



For the 'road transport' sector, the main HM is Pb, showing a high relative reduction in emissions (98 %) between 1990 and 2016 (see Figure 4.10(a)). However, in recent years, little progress has been made in further reducing emissions from road transport, and in the last 3 years total emissions of Pb have even slightly increased. The promotion of unleaded petrol within the EU and in other EEA member countries through a combination of fiscal and regulatory measures has been a success story. For example, EU Member States have completely phased out the use of leaded petrol. Directive 98/70/EC relating to the quality of petrol and diesel fuels (EU, 1998) regulated that goal. Nevertheless, the 'road transport' sector remains a key source of Pb, contributing around 17 % of total Pb emissions in the EU.

Of the POPs, PCDD/Fs are the most important in the 'road transport' sector group. Figure 4.10(b) shows past emission trends for this group of pollutants. Its reduction from 1990 to 2016 was 72 %.

The trend in emissions of PCDD/Fs reflects mainly data reported by the United Kingdom in the category '1A3bi — Road transport: Passenger cars'. The United Kingdom reported that the emissions are associated with compounds previously added to leaded petrol. Consequently, the emissions of PCDD/Fs decreased in line with Pb emissions from the 'road transport' sector (see the United Kingdom's IIR, listed in Appendix 5).

In Table 4.9, the number of Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories are shown. Table 4.10 shows the recalculations within the sector group 'road transport'. For explanations of EU recalculations see Section 5.1.

Table 4.9 Number of Member States reporting notation keys within the key categories of the sector group 'road transport'

Key categories		NA	NO	NR	NE
NO_x	1A3bi	0	0	0	0
	1A3bii	0	0	0	0
	1A3biii	0	0	0	0
NM_{VOC}	1A3bi	0	0	0	0
	1A3biv	0	0	0	0
	1A3bv	0	0	0	0
$PM_{2.5}$	1A3bi	0	0	0	0
	1A3bii	0	0	0	0
	1A3biii	0	0	0	0
	1A3bvi	0	0	0	0
	1A3bvii	0	0	0	2
PM_{10}	1A3bi	0	0	0	0
	1A3biii	0	0	0	0
	1A3bvi	0	0	0	0
	1A3bvii	0	0	0	2
CO	1A3bi	0	0	0	0
	1A3biv	0	0	0	0
Pb	1A3bi	0	0	0	0
	1A3bvi	4	0	0	1

Table 4.10 **Relative difference in reported emissions when comparing the 2017 and 2018 submissions of the EU (relative data, percentage of EU national totals) for the sector group 'road transport'**

														%
Pollutant	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
NO_x	3	1	0	1	1	1	0	1	1	1	1	2	2	2
NMVOCs	1	1	-3	2	2	3	3	2	3	3	3	3	3	1
SO_x	0	-1	-7	-1	1	-2	-2	-6	-5	-2	-7	-7	-7	-6
NH_3	2	5	2	0	0	0	-1	0	0	0	-1	0	0	0
TSPs	-4	1	2	4	4	4	3	4	4	3	3	3	4	3
CO	3	2	2	5	3	3	4	2	2	2	1	2	2	1
Pb	1	6	14	0	0	-1	-2	-1	-3	-3	-3	-3	-3	-3
Cd	-25	-23	-20	-17	-17	-17	-18	-18	-19	-20	-20	-20	-20	-22
Hg	19	21	27	29	29	30	30	31	26	30	29	28	29	-8
As	2	1	1	1	1	1	1	1	-1	-1	-2	-2	0	-8
Cr	4	0	-2	-2	-2	-2	-3	-2	-5	-5	-6	-6	4	3
Cu	4	3	2	2	2	2	1	1	0	0	0	0	1	0
Ni	85	20	17	17	17	16	14	15	12	11	10	10	12	8
Se	19	19	17	17	17	16	15	16	14	13	12	12	13	9
Zn	-6	-6	-7	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6
PCDD/Fs	-3	-9	0	2	1	1	1	0	0	0	0	-1	0	-3
B(a)P	5	5	6	7	7	7	7	8	8	8	8	8	9	9
B(b)F	7	6	6	8	8	8	8	9	9	9	8	8	9	8
B(k)F	7	6	6	8	8	8	8	9	9	9	8	8	9	9
IP	7	6	6	8	8	8	8	9	9	9	8	9	9	8
Total PAHs	-35	-39	-8	-2	-2	-2	-3	-2	-2	-2	-3	-4	-1	-4
HCB	-24	-27	-35	-42	-45	-48	-52	-56	-58	-59	-58	-61	-62	-62
PCBs	-36	-63	-74	-80	-81	-82	-83	-83	-84	-84	-84	-79	-76	-76
			2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
$PM_{2.5}$			2	3	3	3	2	3	3	3	2	3	3	2
PM_{10}			2	4	4	4	4	5	4	4	4	4	5	4
BC			4	6	6	6	5	6	6	6	6	6	6	6

4.6 Sectoral analysis and emission trends for 'non-road transport'

Within this report, emissions from international/domestic aviation and shipping are reported as a simple sum of the emissions from each of the Member States. Accordingly, emissions from international/domestic aviation and shipping are not divided into those occurring within the EU and those that cross the geographical boundaries of the EU. However, the guidelines (UNECE, 2014a) define international emissions as those that start in one country and finish in another. Thus, the reporting matches the guidelines.

An important pollutant in the 'non-road transport' sector group is NO_x. The following ranking of the countries is according to the size of the absolute values they reported. The United Kingdom, Italy and Spain contributed most (in absolute terms) to the emissions of NO_x, Italy, the United Kingdom and Greece most to the emissions of SO_x and France, Italy and the United Kingdom most to the CO emissions in 2016.

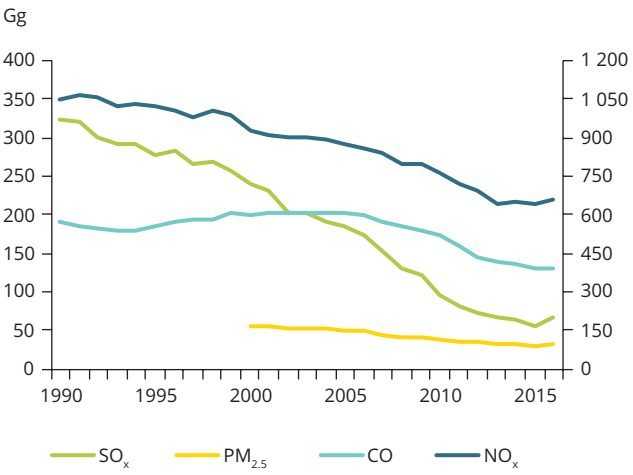
The increase in SO_x emissions reflects the gap-filled data for Greece in 2016 in the category '1A3dii — National navigation (shipping)'.

The 'non-road transport' sector group does not contribute a great deal to HM and POP emissions. Therefore, trends for pollutants from these two groups of substances are not shown.

For B(a)P, data from Austria, Italy and Spain could not be gap-filled, as the countries did not report values for any year. To enable presentation of provisional EU emission trends, the emissions have been aggregated without including data for these Member States.

In Table 4.11, the number of Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories are shown. Table 4.12 shows the recalculations within the sector group 'non-road transport'. For explanations of EU recalculations see Section 5.1.

Figure 4.11 EU emission trends in the sector group 'non-road transport' for NO_x, $PM_{2.5}$, SO_x and CO between 1990 and 2016



Notes: The right-hand axis gives values for NO_x.

Table 4.11 Number of Member States reporting notation keys within the key categories of the sector group 'non-road transport'

Key categories		NA	NO	NR	NE
NO_x	1A3dii	0	0	0	0
$PM_{2.5}$	1A3dii	0	0	0	0

Table 4.12 Relative difference in reported emissions when comparing the 2017 and 2018 submissions of the EU (relative data, percentage of EU national totals) for the sector group 'non-road transport'

								%						
Pollutant	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
NO_x	9	13	14	12	10	12	9	12	9	9	10	9	14	13
NMVOCs	-6	-1	-2	-2	-3	-2	-3	-3	-4	-5	-6	-7	-6	-8
SO_x	18	20	18	18	3	3	3	-16	8	-1	3	-5	-3	-14
NH_3	1	8	9	7	6	6	6	6	6	5	5	5	6	8
TSPs	24	26	25	30	33	30	27	32	30	26	28	27	30	29
CO	-4	-3	-1	-2	-2	-1	-2	-2	1	1	0	0	2	0
Pb	9	0	1	2	2	2	2	2	2	2	2	2	2	2
Cd	-20	-20	-19	-19	-18	9	6	12	10	8	10	11	12	9
Hg	37	45	50	44	42	48	41	50	49	47	44	47	63	66
As	52	69	87	107	88	104	96	120	105	87	104	91	107	60
Cr	2 075	1 845	2 366	2 499	2 393	2 733	2 840	2 501	2 696	2 738	3 133	3 043	3 719	3 821
Cu	139	132	117	119	126	133	130	122	129	127	132	132	150	155
Ni	136	138	184	214	191	253	248	252	249	233	274	252	305	258
Se	15	21	21	22	20	22	18	27	22	19	19	18	23	22
Zn	48	63	67	67	65	71	70	83	78	76	79	85	97	95
PCDD/Fs	-18	-16	-14	-14	-23	-11	-13	-10	-8	-13	-13	-14	5	1
B(a)P	2	3	2	5	5	4	5	5	4	4	3	3	3	2
B(b)F	11	14	13	15	15	14	13	13	11	10	8	8	8	7
B(k)F	6	6	5	4	4	4	3	4	3	3	2	2	1	1
IP	18	22	20	17	17	18	16	17	16	16	12	12	12	12
Total PAHs	-31	-38	-7	5	4	4	4	5	5	4	4	5	7	8
HCB	23	31	37	34	32	37	31	44	39	33	33	32	44	33
PCBs	8	13	17	21	20	21	19	26	21	17	18	16	17	11
			2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
$PM_{2.5}$			21	26	29	25	22	27	25	20	21	20	23	21
PM_{10}			29	34	38	34	26	-12	-2	13	24	10	19	22
BC			10	12	13	11	8	14	11	8	7	6	8	9

4.7 Sectoral analysis and emission trends for 'agriculture'

The 'agriculture' sector group is responsible for the vast majority of NH_3 emissions in the EU. According to the size of the absolute values the countries reported Germany, France and Spain contributed most (in absolute terms) to emissions of NH_3 in 2016.

Agricultural emissions of NH_3 have decreased by 24 % since 1990 (see Figure 4.12).

In addition, the 'agriculture' sector causes considerable NMVOCs and PM_{10} emissions.

The decrease in emissions of NMVOCs between 1990 and 1991 reflects data reported by Germany mainly in categories '3B1b — Manure management — Non-dairy cattle' and '3B1a — Manure management — Dairy cattle'. The emissions of NMVOCs increased in 2000 because Romania started to report data in this year. Between 1990 and 1999, data for Romania could not be gap-filled.

During the period 2000-2016, PM_{10} emissions decreased by merely 13 %. Data, reported by Spain in the category '3F — Field burning of agricultural residues', reflect the decrease of PM_{10} emissions in 2001.

For the POPs, the sector 'agriculture' contributes considerably to emissions of total PAHs and HCB emissions.Figure 4.13 shows past emission trends for these pollutants.

The trend in emissions of total PAHs largely reflects data that Spain reported for the category '3F — Field

Figure 4.12 **EU emission trends in the sector group 'agriculture' for NMVOCs, NH_3 and PM_{10} between 1990 (2000) and 2016**

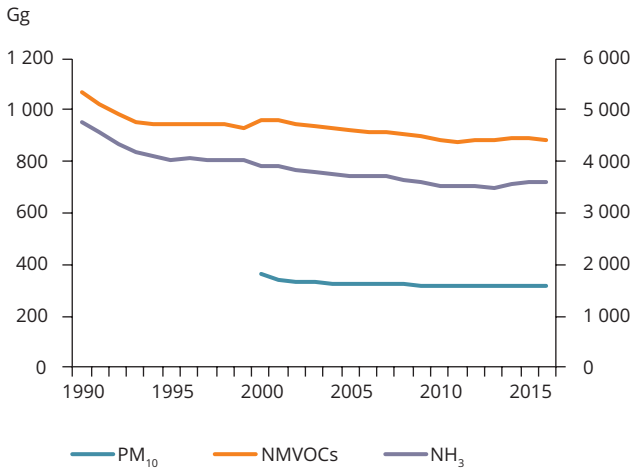
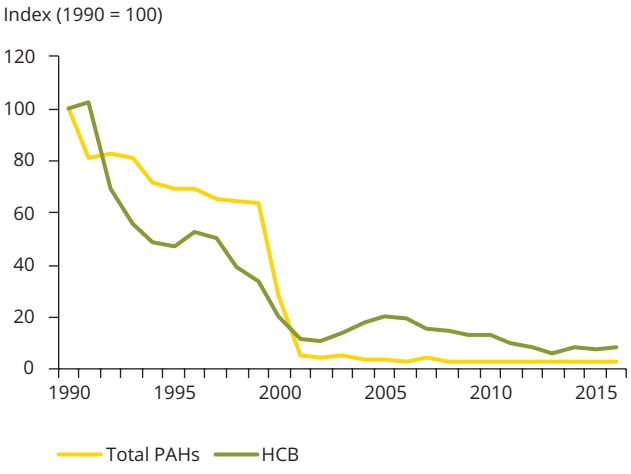


Figure 4.13 **EU emission trends in the sector group 'agriculture' for POPs (total PAHs and HCB) between 1990 and 2016**



Note: The right-hand axis gives values for NH_3.

burning of agricultural residues'. Spain explained that high emissions of total PAHs have notably decreased, particularly between 1999 and 2003. This is due to a progressive decrease in field burning of agricultural residues, which has been restricted by a combination of legislation aimed at preventing forest fires, the fact that the EU's common agricultural policy's conditionality rules entered into force and national mitigation programmes aimed at the reduction of field burning of agricultural waste (personal communication by Spain in 2017).

The trend in emissions of HCB largely reflects data that the United Kingdom reported for the category '3Df — Use of pesticides', but in 1991 also the emissions reported by Germany in the same category. HCB occurs as an impurity or a by-product in the manufacture of several pesticides currently in use in the United Kingdom (chlorothalonil and chlorthal-dimenthyl) or used in the past (quintozene). Following the application to agricultural land, pesticides would volatilise from deposits on plant or soil into the atmosphere. Estimates for HCB assume that more than 70 % of the new HCB is emitted into the atmosphere. Over 95 % of the HCB emission into the atmosphere is through the use of chlorthalonil (see the United Kingdom's IIR, listed in Appendix 5).

In Table 4.13, the number of Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories are shown. Table 4.14 shows the recalculations within the sector group 'agriculture'. For explanations of EU recalculations see Section 5.1.

Table 4.13 **Number of Member States reporting notation keys within the key categories of the sector group 'agriculture'**

Key categories		NA	NO	NR	NE
NO_x	3Da1	2	0	0	1
NMVOC	3B1a	1	0	0	2
	3B1b	1	0	0	2
NH_3	3B1a	0	0	0	0
	3B1b	0	0	0	0
	3B3	0	0	0	0
	3B4gi	0	0	0	0
	3Da1	0	0	0	0
	3Da2a	0	0	0	0
	3Da3	0	1	0	0
PM_{10}	3B4gi	0	0	0	0
	3B4gii	0	0	0	0
	3Dc	1	1	0	0
Total PAHs	3F	1	12	0	3
HCB	2Df	21	2	0	4

Table 4.14 Relative difference in reported emissions when comparing the 2017 and 2018 submissions of the EU (relative data, percentage of EU national totals) for the sector group 'agriculture'

							%							
Pollutant	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
NO_x	27	31	9	34	33	33	32	32	32	28	30	29	28	29
NMVOCs	17	29	39	22	21	22	23	22	22	22	23	23	21	22
SO_x	15	2	7	53	49	42	65	57	53	53	52	53	48	43
NH_3	-3	-2	-3	-3	-3	-3	-3	-3	-3	-4	-3	-4	-4	-4
TSPs	-1	4	8	10	9	9	9	9	9	9	9	9	9	9
CO	-4	-1	-82	-1	-1	-1	-1	-1	-2	-2	-3	-4	-5	-3
Pb	1	1	3	10	9	9	12	11	10	11	10	10	9	7
Cd	2 014	1 723	679	169	142	201	138	135	130	137	135	130	134	119
Hg	1	1	5	51	54	38	64	59	52	53	50	52	46	39
As	1	1	3	7	7	7	8	7	7	7	7	7	7	5
Cr	1	1	5	34	35	28	42	37	35	35	34	35	32	26
Cu	1	1	5	22	22	19	27	25	23	23	22	23	21	18
Ni	1	1	5	41	42	32	51	44	41	41	39	41	37	30
Se	1	1	5	21	21	18	24	22	21	21	20	21	20	18
Zn	0	1	1	2	2	2	3	3	2	3	3	3	-29	2
PCDD/Fs	-13	1	2	2	2	2	3	3	4	3	2	4	63	2
B(a)P	383	156	150	164	163	179	186	185	166	156	163	144	139	144
B(b)F	816	174	181	207	200	204	242	236	214	214	212	205	196	193
B(k)F	719	157	163	193	187	188	218	206	185	183	182	175	169	166
IP	612	160	163	188	183	189	214	207	186	181	183	172	166	165
Total PAHs	14	-2	-1	4	6	6	6	6	5	5	8	5	5	-4
HCB	44	12	32	11	13	13	13	17	19	44	47	29	40	32
PCBs	-97	-98	-98	-97	-97	-97	-97	-97	-97	-97	-97	-97	-96	-96
			2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
$PM_{2.5}$			-3	-3	-3	-3	-3	-3	-3	-4	-4	-4	-4	-5
PM_{10}			8	13	13	12	13	13	13	12	11	11	10	10
BC			4	10	10	9	12	12	11	11	10	11	10	8

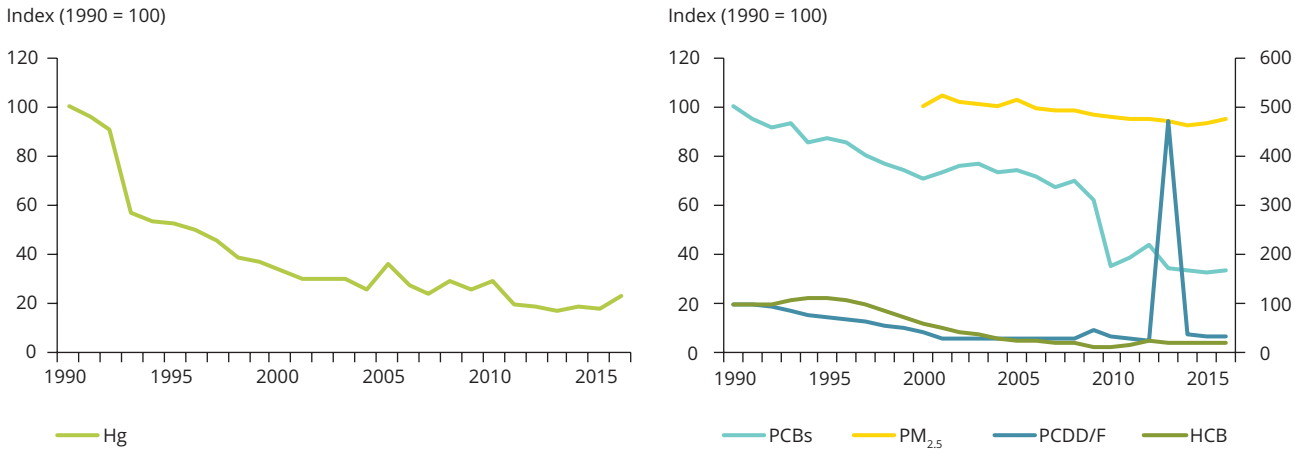
4.8 Sectoral analysis and emission trends for 'waste'

The 'waste' sector group is an important source of certain pollutants, including PCDD/Fs, Hg , HCB, $PM_{2.5}$, $PM_{2.5}$ and PCBs. Figure 4.14 shows the past emission trends for these pollutants.

Between 1990 and 2006 the decrease in PCB emissions mainly reflects the data reported by the United Kingdom in the categories '5C2 — Open burning of waste' and '5E — Other waste' and from 2006 onwards data mainly reflects PCB emissions reported by Portugal in the category '5C1bi — Industrial waste incineration'. PCB emissions reported by this Member State closely correspond with the amount of waste burnt in industrial incineration plants. Portugal explained that the fluctuations of industrial waste incineration results, at least partially, from the variation of fluxes to other treatments (landfilling, shipping abroad and recycling) as a consequence of the annual waste market demand (see Portugal's IIR, listed in Appendix 5). The slight increase in 1993 reflects the data reported by France in the category '5C1bii — Hazardous waste incineration'.

The trend in PCDD/F emissions from 1990 until 2001 contributed to the decrease reported by several countries. From 2009 onwards, the PCDD/F emission trend reflects the data of Greece in the category '5C1biii — Clinical waste incineration'. The peak in PCDD/F emissions in 2013 is reflects data reported by Malta in the category '5C1bv — Cremation'.

Figure 4.14 **EU emission trends in the sector group 'waste' for the HM Hg, for the POPs PCDD/Fs, HCB and PCBs, and for $PM_{2.5}$ between 1990 and 2016**



Note: The right-hand axis gives values for PCDD/F.

The decrease in emissions of HCB between 1990 and 2005 largely reflects data for the category '5C1biv — Sewage sludge incineration' from France. However, high HCB emissions between 1993 and 1999 are due to data reported in the same category by Belgium. This Member State commented that this category disappears as key source for HCB, because nearly all incineration plants have energy recuperation and emissions are now allocated to the category '1A1a — Public electricity and heat production') see Belgium's IIR, listed in Appendix 5). The trend in emissions of HCB from 2005 onwards reflects data reported by Italy in the category '5C1biv — Sewage sludge incineration'.

The United Kingdom contributed most to decreasing Hg emissions from 1990 until 2004. This is because controls introduced for the incineration of waste were improved. In addition, there was a general decline in ferrous and non-ferrous metal production, and the use of coal as a fuel in all sectors decreased (see the United Kingdom's IIR, listed in Appendix 5). From 2005 onwards, the Hg emission trend mainly reflects the data reported by Slovakia in the category '5C1biii — Clinical waste incineration'. Slovakia reported that the highs and lows were a result of economic progress and the strengthening of national legislation (see Slovakia's IIR, listed in Appendix 5).

In Table 4.15, the number of Member States reporting the notation keys 'NA', 'NO', 'NR' and 'NE' within the key categories are shown. Table 4.16 shows the recalculations within the sector group 'waste'. For explanations of EU recalculations see Section 5.1.

Table 4.15 **Number of Member States reporting notation keys within the key categories of the sector group 'waste'**

Key categories		NA	NO	NR	NE
$PM_{2.5}$	5C2	0	14	0	3
	5E	1	0	0	1
PM_{10}	5C2	0	14	0	3
	5E	1	0	0	1
CO	5C2	1	14	0	4
Hg	5C1biii	2	6	0	0
	5C1bv	0	0	0	3
PCDD/Fs	5C1biii	1	6	0	1
	5E	0	2	0	2

Table 4.16 **Relative difference in reported emissions when comparing the 2017 and 2018 submissions of the EU (relative data, percentage of EU national totals) for the sector group 'waste'**

								%						
Pollutant	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
NO_x	-1	0	-1	0	0	0	0	0	0	-1	-1	-1	-1	-2
NMVOCs	-3	2	0	7	2	5	9	9	9	7	7	4	5	7
SO_x	-11	-5	-6	-1	-1	3	0	0	0	1	2	2	-9	-9
NH_3	-33	-28	-28	-11	-11	-12	-12	-14	-16	-17	-17	-15	-16	-20
TSPs	28	32	32	32	36	36	38	38	39	38	36	36	27	29
CO	2	2	2	1	1	1	1	1	1	1	1	1	1	1
Pb	-1	-2	1	17	6	10	15	8	14	5	1	3	6	3
Cd	-1	-1	3	29	3	10	30	21	18	10	-2	-1	8	7
Hg	-1	1	11	57	20	31	56	26	42	19	12	7	25	15
As	-3	-1	-1	0	0	0	0	-7	0	0	0	0	0	0
Cr	0	0	-1	0	-1	0	0	-10	0	-1	0	-1	-1	-1
Cu	7	8	11	44	22	24	39	23	34	12	10	6	16	11
Ni	-1	-4	-2	3	1	2	3	1	4	0	-1	-2	0	-2
Se	-5	-4	-4	0	0	0	0	-1	0	0	0	-1	-1	-1
Zn	-3	-4	-3	-2	-3	-2	-2	-2	-1	-2	-2	-1	-2	-3
PCDD/Fs	-17	-13	-2	79	65	74	91	200	122	128	91	3715	225	196
B(a)P	39	38	34	24	32	50	46	42	39	39	37	37	34	34
B(b)F	23	25	22	15	17	24	22	17	16	16	15	14	13	12
B(k)F	7	8	7	4	2	9	8	5	6	6	6	5	4	4
IP	22	23	17	15	17	24	20	12	10	9	9	8	4	1011
Total PAHs	1	1	1	0	0	1	0	0	0	0	0	0	0	0
HCB	-3	-3	-7	-20	-16	-18	-19	-24	-29	-23	-19	-19	-20	-24
PCBs	-34	-32	-13	-3	-4	-2	1	-2	-9	-9	-9	-13	-16	-19
			2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
$PM_{2.5}$			31	29	37	37	40	39	41	39	37	36	34	36
PM_{10}			38	38	41	41	42	42	43	41	41	40	33	35
BC			7	8	8	8	8	8	8	8	8	7	7	7

5 Recalculations, and implemented or planned improvements

5.1 Recalculations

Recalculations are changes made to past emission estimates (for one or more years) to eliminate errors, consider additional factors and to incorporate new data. The Inventory guidebook (EMEP/EEA, 2016) stipulates that it is good practice to change or refine data and/or methods when:

- available data have changed;
- the previously used method is not consistent with good practice for a certain category;
- an emission source category has become a key category;
- the previously used method does not reflect mitigation activities transparently;
- the capacity (resources) for inventory preparation has increased;
- new inventory methods become available;
- the correction of errors is necessary.

It is important to identify inventory recalculations and to understand their origin, in order to evaluate officially reported emission data properly. Member States often do not document why they report different numbers compared with the previous year.

5.1.1 Recalculations of the EU inventory

Table 5.1 compares total emissions from the EU according to the submissions in 2017 with those in 2018.

Details of recalculations that influenced the EU recalculations are given below. In some cases, recalculations reflect changes in gap filling (see also Section 1.4.5) rather than 'true' recalculations by the countries themselves. Often, high recalculations for Member States were compensated by recalculations of other Member States, and therefore EU recalculations are only moderate.

Recalculations due to gap filling: the high recalculations for Romania for the years 1990-1999 are due to improvements in gap filling. This concerns especially the pollutants NH_3, TSP, Pb, Hg, Cr, Ni, Zn, PCDD/Fs, Total PAHs, HCB and PCB. For the Czech Republic, high recalculations for the years 1990-1999 are as the Czech Republic submitted this year for the first time data for these years, whereas in previous years these data were gap-filled. This concerns almost all pollutants. In addition, for Greece data for gap filling are now available where no data have been available before. Therefore, for some pollutants the EU total changed considerably due to gap-filled data from Greece. This concerns especially NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSPs, BC, Hg, Cr, Ni, Se, Zn, PCDD/Fs, B(b)F, B(k)F, and IP.

Recalculations for the main pollutants and CO: the highest recalculations for NO_x, NMVOCs, SO_x and CO that are relevant for the EU recalculations were done by the United Kingdom, especially in the transport and shipping sectors. The United Kingdom stated in its IIR that, among other reasons, the recalculations for NO_x and CO emissions were carried out because of improved activity data from vessel movement, while emissions from NMVOCs were recalculated in the 'road transport' sector due to the availability of revised estimates. SO_x emissions were also recalculated due to improvements made in the shipping inventory (see the United Kingdom's IIR, listed in Appendix 5). Further, new reported data from Romania for NO_x and CO in the years 2000-2004 differed from the earlier gap-filled data. Greece and Italy made extensive recalculations of the whole time series of NMVOCs, which are relevant for the EU recalculations. Italy's recalculations concern especially the agriculture sector. Italy mentioned in its IIR that NMVOC emissions for the category '3B' have been updated on the basis of the emission factors provided in the Inventory guidebook (EMEP/EEA, 2016); NMVOC emissions for poultry and other animals, such as rabbits, have also been included (see Italy's IIR, listed in Appendix 5). Spain reported EU-relevant recalculations of SO_x emissions from 1997 to 2003, especially in the category '1A2gviii — Stationary combustion in manufacturing industries and construction: Other'.

Table 5.1 Comparison of data submitted in 2017 and 2018 by Member States (relative data, percentage of EU national total)

		%													
Pollutant	**Unit**	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
NO_x	Gg	3	2	1	2	1	1	1	1	2	1	2	2	2	2
NMVOCs	Gg	2	3	3	4	3	4	4	4	4	4	4	4	4	4
SO_x	Gg	-1	0	0	0	0	-1	-2	-4	-4	-4	-3	0	0	1
NH_3	Gg	-2	-1	-2	-1	-2	-2	-2	-2	-2	-2	-2	-2	-3	-3
TSPs	Gg	5	8	9	13	14	12	13	13	14	14	15	11	11	12
CO	Gg	3	2	-5	2	2	2	2	1	1	1	1	1	0	0
Pb	Mg	-2	-3	-8	-23	-24	-21	-21	-6	-7	-8	-7	-7	-7	-6
Cd	Mg	8	6	4	-2	-1	0	0	4	7	8	9	10	10	11
Hg	Mg	-10	-12	-11	-12	-13	-14	-13	2	6	5	7	6	8	5
As	Mg	7	-5	-6	-6	-7	-6	-7	-6	-6	-6	-6	-6	-4	-4
Cr	Mg	0	-2	-4	-3	-4	-4	-4	-3	-2	-3	-2	-1	3	4
Cu	Mg	6	6	5	4	4	4	4	4	3	3	3	3	4	4
Ni	Mg	-5	-7	-6	-9	-9	-7	-9	-1	0	2	1	0	0	0
Se	Mg	-6	-9	-15	-16	-18	-17	-17	-15	-16	-17	-16	-15	-17	1
Zn	Mg	-6	-9	-7	-10	-11	-10	-11	-12	-12	-11	-11	-11	-11	-10
PCDD/Fs	g I-Teq	-24	-20	8	59	54	57	58	84	64	68	64	619	78	66
B(a)P	Mg	188	404	565	830	725	637	624	682	518	418	342	244	276	375
B(b)F	Mg	242	69	70	45	40	42	47	51	43	45	45	44	45	43
B(k)F	Mg	200	56	51	29	26	26	39	43	36	37	38	37	38	36
IP	Mg	155	49	45	26	23	24	27	28	24	26	27	26	27	31
Total PAHs	Mg	8	-6	29	128	115	89	102	113	86	68	55	38	43	57
HCB	kg	-9	-19	6	22	36	24	35	40	57	51	64	40	31	52
PCBs	kg	4	12	42	10	10	9	10	17	15	16	17	19	19	19
				2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
$PM_{2.5}$	Gg			7	7	7	7	7	6	6	6	6	5	6	6
PM_{10}	Gg			9	11	11	11	11	9	9	10	11	8	9	9
BC	Gg			6	6	6	6	6	6	6	6	6	5	6	6

Recalculations for PMs, TSPs and BC: the highest recalculations for $PM_{2.5}$, PM_{10}, TSPs and BC that are relevant for the EU recalculations were done by Greece and the United Kingdom. The high recalculations by Greece arose in 2017 because no data for Greece were available for gap filling. The recalculations by the United Kingdom occurred especially in the categories '1A3dii — National navigation (shipping)' and '2A5b — Construction and demolition'. The United Kingdom explained in its IIR that the emissions in '2A5b — Construction and demolition' increased due to the revision of emission factors for some sources (fireworks, quarrying and construction); furthermore, the methodology for the calculation of PM from construction has been updated. For the category '1A3diii — National navigation (shipping)' an improvement in the method applied is the main reason for the reporting of increased emissions (see the United Kingdom's IIR, listed in Appendix 5). Poland made some $PM_{2.5}$ recalculations in categories belonging to the 'energy use in industry' sector. Those recalculations were mainly due to the implementation of new emission factors from the Inventory guidebook (see Poland's IIR, listed in Appendix 5). Recalculations from Poland for PM_{10} and TSPs are mainly because data are now reported in the category '3Dc — Farm-level agricultural operations including storage, handling and transport of agricultural products', which was not the case in 2017. Poland stated that this is due to a new emission source for this category (see Poland's IIR, listed in Appendix 5). Portugal made recalculations for PM_{10} and TSPs mainly in the industry sector. Spain made recalculations for PM_{10}, especially in the category '3Dc — Farm-level agricultural operations including

storage, handling and transport of agricultural products', where activity data have been updated, and for BC in several categories. Those recalculations were mainly carried out due to the implementation of new estimates from the Inventory guidebook (see Spain's IIR, listed in Appendix 5). Ireland reported TSP emissions in the category '2D3b — Road paving with asphalt', which were not reported in 2017.

Recalculations for HMs: new gap-filled data for Greece are now available, which were not available last year. Therefore, several recalculations for Greece were made, which for some pollutants, such as Hg, Cr, Ni, Se and Zn, are rather high, and strongly influence the EU recalculations. For Pb, high recalculations that are relevant for the EU were made by Slovenia in the category '2C5 — Lead production', performed due to the use of the new Inventory guidebook (see Slovenia's IIR, listed in Appendix 5), and by Hungary, in the category '1A3bi — Road transport: Passenger cars', performed due to updated fuel consumption data and the use of the latest COPERT model (see Hungary's IIR, listed in Appendix 5). Germany made recalculations for all HMs, influencing the EU recalculations especially of Cd, Cr, Cu and Ni, mainly due to changes in the categories '1A3c — Railways' (Cr, Cu, Ni) and '2C7a — Copper production' (Cd, Cu). Germany stated in its IIR that recalculations were carried out due to the application of new emission factors (see Germany's IIR, listed in Appendix 5). Spain made recalculations for all HMs, influencing the EU recalculations especially for Cd, Ni and Se due to changes mainly in the category '3F — Field burning of agricultural residues' (Cd) and in the sector 'energy use in industry' (Ni, Se) and 'energy production and distribution' (Ni). Further recalculations that have an impact on EU recalculations were made by Poland for all HMs, especially for Pb, As, Cr, Cu, Ni and Zn due to changes in the category '1A4bi — Residential: Stationary'. Romania reported data for the years 2000-2004 for the first time. These data differed from the earlier gap-filled data, and thus gap-filled data for the years 1990-1999 changed as well, especially for Pb, Hg, As and Cr. For Cu, recalculations by Italy in the 'road transport' and 'energy use in industry' sectors also influenced the EU recalculations.

Recalculations of PCDD/Fs: the highest recalculations for the EU are because of gap-filled data from Greece, which were not available last year. Further, changes in gap-filled data from Romania, and changes due to the availability of reported data from the Czech Republic resulted in considerable recalculations for the EU.

Recalculations of B(a)P, B(b)F, B(k)F and IP: high recalculations by the EU were caused by changed data from the United Kingdom for the years 1990-1992 in the category '3F — Field burning of agricultural residues' because updated emission factors were used to calculate the emissions (see the United Kingdom's IIR, listed in Appendix 5). Further EU recalculations are because of gap-filled data from Greece, which were not available last year. Romania reported data for the years 2000-2004 for the first time. These data differed from the earlier gap-filled data, and thus gap-filled data for the years 1990-1999 changed as well. Only for B(a)P, there are very conspicuously high levels reported by Portugal in the category '2D3g — Chemical products' in 2018, which were not reported in 2017. Data values from Portugal are extraordinarily high.

Recalculations of total PAHs: high recalculations by the EU were caused by changed data from the United Kingdom for the years 1990-1992 in the category '3F — Field burning of agricultural residues' because updated emission factors were used to calculate the emissions (see the United Kingdom's IIR, listed in Appendix 5). There are very conspicuously high levels reported by Portugal in the category '2D3g — Chemical products' in 2018, which were not reported in 2017. The levels in these data are extraordinarily high. High recalculations of data for the Czech Republic for the years 1990-1999 are due to the change from gap-filled to reported data. Romania reported data for the years 2000-2004 for the first time. These data differed from the earlier gap-filled data.

Recalculations of HCB: the United Kingdom reported results for the years 1990-1998 in the category '2D3 — Aluminium production' that were much lower than in 2017. The reason for this was the implementation of revised activity data from aluminium production. This recalculation happened because activity data for aluminium production were revised downwards (see the United Kingdom's IIR, listed in Appendix 5).

Recalculations of PCBs: there are very conspicuously high values reported by Portugal in the categories '2C1 — Iron and steel production' and '2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)' in 2018, which were not reported in 2017. High recalculations of data for the Czech Republic for the years 1990-1999 are due to the change from gap-filled to reported data. In 2017, Finland reported data for '5E — Other waste' and in 2018 'NA' was reported for this category for the complete time series. This resulted in high recalculations. The reason for this was that the method used to calculate PCB emissions in earlier submissions was considered uncertain and therefore the emissions were removed from the current submission (see Finland's IIR, listed in Appendix 5). Austria made high recalculations in the category '2C5 — Lead production', and reported in 2018 'NA' for category '2C7c — Other metal production', which led to high recalculations

Table 5.2 Recalculations of EU countries (gap-filled inventory) that have a significant impact on the EU recalculations

Pollutant	EU countries with significant recalculations	
	Countries for which recalculations had a 'negative' effect	Countries for which recalculations had a 'positive' effect
NO_x	RO 2000-2004, 2006; ES 1990-2015; CZ 1993, 1996-1999	GB 1990-2015
NM_{VOCs}	RO 2005-2015; PT 1990-2015, BG 1990-1991; FI 1990-1999; LT 1990-1997; ES 1990-2001	GR 1990-2015; IT 1990-2015; CZ 2000-2015; PL 1995-2015; GB 1990-1997
SO_x	CZ 1990-1994, 1997; ES 1990-2012; SK 1990-1991; GR 1991-1996, 1999, 2007, 2009, 2013-2015;	GB 1990-2015; GR 2000-2002, 2005; RO 2003-2004, 2013
NH_3	RO 1990-2000, DE 1990-2015; FR 1997-2015; IT 2012-2015	ES 1990-1999, 2009; CZ 1990-1999
$PM_{2.5}$	RO 2001-2002	GR 2000-2015; PL 2000-2015; GB 2000-2015; CZ 2000-2015
PM_{10}	RO 2001-2002	GR 2000-2015; GB 2000-2015; PL 2000-2015; PT 2011-2012; ES 2000-2015;
TSPs	RO 2000-2004, 2007, 2015; FI 2012	GB 2000-2015; GR 2000-2015; PT 2000-2014; IE 2000-2015; HU 2008-2009; PL 2000-2015
BC	FR 2006	GR 2000-2015; GB 2000-2015; BG 2000-2015; RO 2000, 2004; ES 2000-2015
CO	RO 2000-2004; FR 2014-2015	CZ 2000-2015; GB 1990-2008; FR 1990-2000; HU 2000-2005
Pb	GR 1994-2008, SI 1990-2006; LT 1998; FI 1990-1992; RO 1990-1995; HU 1999; PL 1990-1997, 2006-2015	HU 1990-1998; BG 1990
Cd	PL 1990-1999; ES 2001-2011	ES 1990-1999; DE 1990-2015
Hg	GR 1990-2008; RO 1990-2004	IT 1990-2003; GR 2009-2011
As	PL 1990-2015; RO 1990-2000, SK 1990-1995	CZ 1990-1995, SK 2003
Cr	RO 1990-2002; PL 1990-2015; ES 1990-2015; IT 2003-2015	DE 1990-2015; GR 2014-2015, FI 1990-1999; CZ 1990-1993
Cu	PL 1990-2015	DE 1990-2015; IT 1990-2015; CZ 1990-1991
Ni	ES 1990-2005; PL 1990-2015; GR 1990-2008	GR 2009-2015; DE 1990-2015
Se	ES 1990-2015	GR 1990-2015
Zn	PL 1990-2015	GR 2009-2015, FI 1990-2003
PCDD/Fs	RO 1990-2003; CZ 1990-1999	MT 2013; GR 1990-2015
B(a)P		PT 1990-2015
B(b)F	RO 2005-2015	GB 1990-1992; GR 1990-2015; CZ 1990-1995
B(k)F	RO 2005-2015	GB 1990-1992; GR 1990-2015; CZ 1990-1991
IP		GB 1990-1992; GR 1990-2015; CZ 1990-1996
Total PAHs	CZ 1990-1999; RO 1990-1998; ES 1990-2000	PT 1990-2015, GB 1990-1992
HCB	GB 1990-1998; RO 1990-1996	DE 1990-1992, 1999; CZ 1990-1996; PT 1990-2015
PCBs	CZ 1990-1999; FI 1990-2015, SI 1990-2015, AT 1990-2015; RO 1990-1996, 2005-2008; GB 1990-2001; PL 2003-2015	PT 1990-2015

Notes: EU countries with significant recalculations are listed in descending order, reflecting the impact on recalculated emissions for the EU as a whole.

Recalculations concern the gap-filled inventory.

because data were reported in 2017. The calculations on non-ferrous metals have been improved, partly due to available facility data and partly due to the application of the 2016 EMEP/EEA Inventory guidebook (see Austria's IIR, listed in Appendix 5). Slovenia made recalculations in the categories '2C5 — Lead production' and '2C7a — Copper production'. These recalculations were performed due to the introduction of the methodologies described in the Inventory guidebook (see Slovenia's IIR, listed in Appendix 5). Further recalculations that were relevant for the EU recalculations were done by the United Kingdom for the categories '2C1 — Iron and steel production', '3Da2b — Sewage sludge applied to soils' and '5E — Other waste'. The United Kingdom explained that emissions have been revised downwards for all years, primarily affected by revisions to the emission factors used, which are now following the 2016 EMEP/EEA Inventory guidebook (see the United Kingdom's IIR, listed in Appendix 5). Romania made recalculations for the years 2005-2008 mainly for metal production ('2C5 — Lead production', '2C6 — Zinc production' and '2C7a — Copper production'), which influenced the EU recalculations.

5.1.2 Member States' recalculations

Under the revised reporting guidelines (UNECE, 2014a), all countries should submit explanatory IIRs, which should include details addressing any recalculations made. Some Member States provide very detailed explanations for their recalculations of parts of or the whole time series (e.g. methodological improvements, revisions of emission factors, reallocations, revisions of activity data and corrections of errors).

Austria provided detailed information concerning its recalculations, which were carried out due to revisions, updates of activity data, updated models, and improvements of methodologies and emission factors (see Austria's IIR, listed in Appendix 5).

Belgium provided detailed information on its recalculations for all of its regions (Flanders, Wallonia and Brussels) for the 'energy' sector. The main reasons for recalculations on the sectoral level were the application of emission factors from the Inventory guidebook, the availability of new data (including activity data) tools, and error corrections and revision of data (see Belgium's IIR, listed in Appendix 5).

Bulgaria reported that it made recalculations in several sectors for 2016 according to the recommendations of the Technical Expert Review Team (TERT) (see Bulgaria's IIR, listed in Appendix 5).

Croatia provided detailed information on its recalculations for all pollutants. The main reason for recalculations was that improved methodologies had been applied. Table ES4-1 in Croatia's IIR offers an overview of the recalculations (see Croatia's IIR, listed in Appendix 5).

Cyprus stated that it had made some methodological improvements to the national emission inventory. This resulted in recalculations of the time series from 1990 to 2015 according to methodologies proposed in the Inventory guidebook and the TERT 2017 suggestions. Other reasons for recalculations include the update from COPERT 4 to COPERT 5, new activity data and the correction of erroneous formulas (see Cyprus's IIR, listed in Appendix 5).

The **Czech Republic** stated that recalculations were carried out because of error correction, updated methodology and the implementation of new estimates (see the Czech Republic's IIR, listed in Appendix 5).

Denmark provided detailed information on its recalculations. It had put considerable work into improving the inventory. The submission includes recalculated inventories for the whole time series. The reasons for recalculation were changed methodology, updated activity data, new data, correction of errors and updated emission factors. The sector-specific chapters provide additional information on recalculations (see Denmark's IIR, listed in Appendix 5).

Estonia provided detailed information on its recalculations for the period from 1990 to 2015. The reasons for recalculating were the correction of data, activity data and emission factors, newly available and additionally calculated data, new methodology, more detailed allocation of data and more detailed calculation methods (see Estonia's IIR, listed in Appendix 5).

Finland provided detailed information on recalculations. The country is recalculating the time series for several subcategories and is waiting for the finalisation of recalculations for the 'energy' sector. At present, the country is checking basic data, methods and underlying assumptions on an ad hoc basis. Once the recalculations are done, systematic checks and reallocations of emissions will be carried out (see Finland's IIR, listed in Appendix 5).

France stated that recalculations were due to methodological improvements, correction of errors and the availability of new information (see France's IIR, listed in Appendix 5).

Germany provided detailed information. Recalculations were carried because of several reasons, namely revision of activity data, revision of the entire model, newly implemented emission factors, revision of emission factors, and reallocation of activity data and emissions (see Germany's IIR, listed in Appendix 5).

Hungary provided information on recalculations in the sector-specific chapters. Recalculations were carried out due to the update of the methodology for the category '5A', the reallocation of data and the revision of activity data, as well as the availability of new activity data (see Hungary's IIR, listed in Appendix 5).

Italy provided detailed information on its recalculations. The main reasons for recalculations were updated activity data and new estimates. Other reasons were updates of methodology and emission factors in line with the Inventory guidebook, revised model parameters, a new emission factor and the use of the COPERT 5 model for calculations (see Italy's IIR, listed in Appendix 5).

Ireland provided information on recalculations in its sector specific chapters. Recalculations were mainly carried out due to revised emission data, included new emission data, updated emission factors, error correction, the reallocation of emissions and revised methodology (see Ireland's IIR, listed in Appendix 5).

Latvia provided detailed information on recalculations. Recalculations were carried out due to updated activity data, corrected emission factors, updated calculation methods/methodologies, corrected/new data (see Latvia's IIR, listed in Appendix 5).

Lithuania stated that it had recalculated emissions due to improved data, enhanced methodology and error corrections (see Lithuania's IIR, listed in Appendix 5).

Luxembourg presented the main revisions and recalculations in a table in its IIR (p. 336). Reasons for recalculations were updated activity data, methodology and emission factors, as well as error correction for the category '3B'. For the category '2G', the reason for recalculation was a new emission source (see Luxembourg's IIR, listed in Appendix 5).

Malta provided no information about recalculations in its IIR.

The Netherlands provided detailed information on the recalculations carried out. The main reasons for recalculations were the inclusion of new emission sources, the revision of data, changed emissions factors, as well as the use of improved activity data. (see the Netherlands' IIR, listed in Appendix 5).

Poland reported that recalculations were carried out mainly due to revised methodologies, updated activity data and the correction of data (see Poland's IIR, listed in Appendix 5).

Portugal provided detailed information on its recalculations. Since the last submission, recalculations were mainly carried out due to revised data/emission factors/estimates, error correction and the implementation of emission factors from the Inventory guidebook (see Portugal's IIR, listed in Appendix 5).

Romania noted that, following the emission inventory review, recalculations of emissions from 2005-2015 have been carried out due to updated statistics and corrected activity data. Emission factors have been updated as well to be in line with the ones provided in the Inventory guidebook (see Romania's IIR, listed in Appendix 5).

Slovakia provided detailed information and tables on its recalculations. The main reasons were error correction and improved methodology. Other reasons were the reallocation of emissions and the modification of emissions (see Slovakia's IIR, listed in Appendix 5).

Slovenia provided detailed information on its recalculations. They were carried out due to methodological changes, error correction, an improved calculation model, the reallocation of emission data, the availability of new data and updated activity data, which were mainly due to the implementation of emission factors from the Inventory guidebook. Many of these recalculations were carried out following recommendations from the TERT (see Slovenia's IIR, listed in Appendix 5).

Spain provided detailed information on its recalculations. The main reasons were changes in estimation methods as well as new estimations, updates of emission factors, new methodologies and error correction (see Spain's IIR, listed in Appendix 5).

Sweden provided detailed information on its recalculations. The reasons were the revision and update of emission factors, reallocation of emissions, availability of new data, updated models and the correction of emissions (see Sweden's IIR, listed in Appendix 5).

The **United Kingdom** provided detailed information on recalculations made since its last LRTAP Convention submission. Reasons were improved emission estimates, new or additional data sources, the use of updated emission factors, revision/reallocation of data and methodological changes (see the United Kingdom's IIR, listed in Appendix 5).

The annual joint EMEP/EEA inventory review report (EMEP/EEA, forthcoming) presents a summary of the individual recalculations that Member States reported. This report will be available from the CEIP website in July of each year (EMEP CEIP, 2018b).

5.2 Member States' emission changes due to review improvements

In addition, EMEP CEIP has the task of reviewing the submitted emissions, to help Parties improve national inventories (EMEP CEIP, 2018a; EMEP/EEA, forthcoming). These yearly reviews should help Member States to prepare and improve their inventories. Member States compile their individual emission estimates and submit their inventories together with their IIRs.

The stage 1 review — an automated test — happens every year to assess timeliness, completeness and format. The stage 2 review assesses recalculations, KCA, inventory comparison, trends and time series. Stage 3 is an in-depth review by experts whom the Parties nominate. Each year, the plan is for two teams to review 10 Parties' inventories.

In 2017, EMEP CEIP reviewed Albania, Austria, the EU, Kazakhstan, Kyrgyzstan, Liechtenstein, Malta and Monaco. The results are in individual country-specific reports (EMEP CEIP, 2018c). In their IIRs, some of these countries refer explicitly to improvements planned as a consequence of these reviews. In 2018, it is planned to review Armenia, Azerbaijan, Belarus, Finland, Moldova, Montenegro and Ukraine.

5.3 Planned improvements at EU level

The EEA and ETC/ACM have noted that the main future challenge for EU Member States remains improving the quality of data submissions, to obtain more complete and timely UNECE LRTAP Convention emission inventories. Improvements cannot be implemented at EU level alone; the Member States themselves also need to develop and prioritise reliable and timely inventory reporting systems.

- Further progress concerning **completeness of reporting:** although clear progress has been made in recent years on making reporting complete, a full set of emission inventory data for air pollutants is still not available for all Member States, as noted earlier in this report. Further, for certain pollutants (including PM, HMs and POPs), data could not be fully gap-filled, because some Member States had not reported emission values in any years; this is especially the case for pollutants where reporting is not obligatory (see Figure 1.5 and Figure 1.6).
- **Updating of emission data** by Member States, including for past years: the ETC/ACM has also identified a problem with gap filling by using data submitted several years ago. In a number of cases, because countries have not since submitted corrected or updated data sets, the EU inventory unavoidably contains inconsistencies. The quality of the EU's inventory will thus be enhanced if the consistency and completeness of Member States' submissions improves. Such improvements would help reliable trend analysis to inform policy. Within the 2018 gap-filled inventory, some inconsistencies caused by this problem were corrected manually as an interim solution.
- **Reviewing current gap-filling procedures** to ensure that they use the best approach, reflecting real emissions: the improved inventory gap-filling procedure performed in 2011 has helped develop a more complete EU emission inventory, but there is room for improvement (e.g. by including manual changes in the procedure).
- **Reducing the need for gap filling:** this is achievable if Member States report complete time series as far as possible, and also if they have already provided the data in earlier submissions under the LRTAP Convention. Current gap-filling procedures first use submissions received in the current reporting years under various reporting mechanisms, and then use older LRTAP submissions.
- **More explanatory information** on trends and recalculations: this would be possible if the IIRs contained such information.
- Further research on **outliers in Member States' emission data** to help ensure that they reflect real emissions: a comparison of Member States' contributions to the EU total reveals extraordinarily high proportions in some instances, e.g. for Pb in Poland (25 %), Cu in Germany (63 %), Zn in Germany (33 %), PCDD/Fs in Greece (gap-filled data, 38 %), B(a)P in Portugal (79 %), B(b)F in Greece (gap-filled data, 28 %), B(k)F in Greece (gap-filled data, 28 %), IP in Poland (33 %), total PAHs in Portugal (45 %), and PCB in Portugal (32 %). Future investigation could determine whether these high proportions reflect actual emissions or they are ascribable to incomplete reporting (or underestimates) by other Member States.
- More attention to **data quality:** in several submissions from Member States and as a result

of the gap-filling procedure, values of BC exceed $PM_{2.5}$ values, values of $PM_{2.5}$ exceed PM_{10} values, or values of PM_{10} exceed TSP values — which should be impossible. Changes in the gap-filling results and improved Member State emission data should resolve these problems.

5.4 Implemented improvements

The joint EMEP/EEA annual review of inventory data helps improve Member States' inventories. The review of data reported under the LRTAP Convention happens jointly with the review of data reported by Member States under the NEC Directive. Since 2009, there has been a centralised stage 3 review process. Two teams of emission experts perform the reviews. Member States are encouraged to nominate reviewers for the EMEP roster of emission review experts; nomination process details are available on the CEIP website. In 2017, the EU emission inventory report (1990-2015) under the UNECE LRTAP Convention (EEA, 2017c) was reviewed (UNECE/CEIP, 2017). The findings and their implementation are summarised in Table 5.3, and Table 5.4 shows the findings that have not been implemented or cannot be implemented.

5.4.1 Improvements as response to the stage 3 review of the EU inventory in 2012

Table 5.3 and Table 5.4 list the improvements implemented or not implemented in response to the stage 3 review by an expert review team (ERT) in 2017.

Table 5.3 EU stage 3 review results 2017 and improvements implemented

Review findings (2017)			
Topic	**Finding**	**Implemented**	**Comment**
	Transparency		
Gap-filling procedure	More detailed information at a sectoral level	Partly	Already given in Annex D
Notation keys	The ERT encourages the EU to create a summary for each subsector on how many Member States reported emissions and how many used notation keys; the ERT encourages adding an explanation in the IIR about the use of notation key 'NE'	Yes	Analysis given in the new Annex K
Under-reporting	The IIR sections on *General assessment of completeness* and *Underestimations*, and the graphs present a somewhat misleading picture of the level of under-reporting in the EU inventories; the ERT strongly encourages the EU to revise and expand these sections of the IIR	Yes	Analysis changed (see Section 1.8)
Key categories	The ERT encourages the EU to include information on reported/not reported sectors and pollutants for the key categories for each year and each Member State	Partly	Analysis included in Chapter 4
Member State comparisons	The ERT encourages the EU to conduct a more detailed analysis of the Annex D information to identify and communicate potential outliers and inconsistencies between Member States in their methods and emission factor(EF) selection	Partly	Inconsistency checks were made (compare Section 1.6) and communicated to the Member States; comparisons between Member States were not made, as such checks would mean considerable effort and there is only a limited time frame
Member State comparisons	The IIR could contain more information on the consistency of reporting across countries and could indicate the number of countries that do not provide estimates for each NFR category	Partly	Analysis included in Chapter 4, see also the new Annex K
Sector descriptions	The ERT encourages the EU to continue improving the transparency of the inventory by including more information and detail in sector and subsector descriptions and an explanation of emission trends	Partly	Sectoral emission trends are described to the greatest possible extent in Chapter 4

Table 5.3 EU stage 3 review results 2017 and improvements implemented (cont.)

Review findings (2017)			
Topic	**Finding**	**Implemented**	**Comment**
	Completeness		
Gap-filling procedure	Further improvement in the gap-filling procedures, such as the development of more manual interventions	Yes	Manual changes have been conducted in 2018 (compare Section 1.4.5)
Gap-filling procedure	The ERT encourages the EU to strengthen its QA/QC of the gap-filling procedures to minimise the risk of (1) under-reporting in the EU submission; and (2) the gap-filling process itself introducing implausible step-changes in the reported trends	Partly	Manual changes have been conducted in 2018 (compare Section 1.4.5) to correct implausible step-changes in the trends
Assessment after gap filling	It would be useful to include details at the level of individual NFR categories (assessment of the significance of the remaining gaps after gap filling) for the sectors	Partly	Analysis included in Chapter 4, see also the new Annex K
Completeness assessment	The ERT encourages the EU to provide sector-specific assessments of completeness	Partly	Analysis included in Chapter 4 see also the new Annex K
	Consistency		
Recalculations	The main recalculations are explained in the IIR of each Member State; the ERT encourages the EU to also explain the rest of the recalculations including their implications for the trends, and especially to explain recalculations due to changes in the EU gap-filling method	Partly	Recalculations and their implications for trends are explained to the greatest possible extent, including recalculations that are caused by the gap-filling procedure (compare Section 5.1)
Sector-specific recalculations	The ERT encourages EU to provide sector-specific recalculation information wherever possible (similar to that in Table 5.1)	Yes	Analysis included in Chapter 4
Time series checks	The ERT encourages the EU to conduct time series consistency checks on Member State submissions	Yes	Time series checks have been performed for many years already
	Comparability		
Consistent reporting	The ERT encourages the EU to continue with its efforts to develop more consistent reporting (regarding allocations to specific NFR sectors) by Member States	Partly	Checks on the allocations to specific NFR sectors would mean considerable effort; such an analysis is not feasible within the limited time frame
Notation keys	There are many instances where some countries report emissions for a particular NFR category and pollutant, while other countries use the notation key 'NA'; the ERT believes that it would be immensely useful for this type of issue to be highlighted in the IIR at the level of individual NFR categories: it would highlight issues in the inventories of Member States that could then be addressed by those countries	Yes	Analysis included in Annex K, see also Section 1.8
	Accuracy		
Emission basis	The EU inventory for road transport was based on a mixture of fuel sold and fuel used (one Member State)	Yes	In 2018, the whole EU inventory is based on fuel sold (compare Section 1.4.4)

Table 5.4 EU stage 3 review results 2017, not implemented findings and rationale

Review findings (2017)			
Topic	**Finding**	**Implemented**	**Comment**
	Transparency		
Notation keys	The EU data inventory uses notation keys 'NE' and 'NR'; the ERT recommends improving the use of notation keys in the inventory	No	Further improvement required
Key categories	More detailed information to highlight key data and information deficiencies in the Member State submissions, including (1) data gaps for key categories; (2) outlier level and trend emission data from Member States for key categories; and (3) identifying where lower-tier methods are used by Member States that contribute significantly to the reported EU total for a key category	No	Such checks would mean considerable effort; such an analysis is not feasible within the limited time frame
Key categories	The ERT encourages the EU to summarise information about methodologies used by the different Member States for specific pollutants for the key categories	No	Information on methods and data used by Member States to calculate emissions from the individual sectors have been provided for some years in the EU inventory report (2012-2015); however, providing this information was a considerable effort and was hardly feasible within the limited time frame
Activity data	No activity data are provided; the ERT recommends further enhancing the gap-filling procedure to finally provide activity data at EU level: for example, gap filling by utilising data from Eurostat statistics, or data from another country (e.g. with a similar population, gross domestic product or other indicator) that could be an interim solution to overcome the difficulties	No	Further improvement required
	Completeness		
EU-level inventory improvement programme	The ERT recommends developing the EU-level inventory improvement programme, which should include actions at the EU level to target improvements of the completeness of reporting from the Member States; the ERT encourages the EU to include more detailed information about QA/QC procedures used by Member States	No	Political decision
Relations between pollutants and sectors	The ERT encourages the EU to implement procedures to assess relations between different pollutants and sectors	No	As the inventory is an aggregation of the Member State inventories, this is not an easy task and would mean too much effort in the limited time frame
Gridded data, LPSs and projections	The ERT recommends the EU to provide full assessment of the gridded data, LPSs and projections submitted by Member States in its future submission	No	Data are already available via the CEIP and CDR websites; it is a huge amount of data and there is no need to provide such large annexes when data are available easily at these websites
	Accuracy		
Gap-filling procedure	In some cases, the gap-filling procedure does not generate a reliable representation of the emissions from the source categories	No	Further improvement required
Uncertainty analysis	The EU clarified that uncertainty analysis is in the improvement plan for the near future, since, under the new NEC Directive Member States shall provide information on uncertainties; it is therefore planned to assess and evaluate if the uncertainty analysis for the EU can be generated	No	Not in 2018; further improvement required
Uncertainty linked to gap filling	The ERT recommends that the EU assess the impact of the gap-filling procedure on inventory uncertainty, e.g. assessment of uncertainties linked to the EU gap-filling process and its combination with Member States' inventory uncertainties	No	Further improvement required

5.4.2 Further improvements undertaken in 2018

- The figure showing KCA results for 2016 (Figure 1.2) has been improved to show sector affiliation.
- Again, explanations on unusual trends, peaks and troughs were improved.
- Manual corrections for BC improved the gap-filled inventory.
- An overview of the findings from the early and extended data checks on submitted Member State inventories was included (see Table 1.6).
- Analysis of the reporting of notation keys within the key categories of each sector group were made (see Section 4).
- Sector recalculations were included (see Section 4).

5.4.3 Improvements at Member State level

Improvements at Member State level also automatically improve the EU inventory. For this reason, it is of interest to note which countries have planned to improve their inventories. Table 5.5 provides an overview of these. However, it is not easy to gain a systematic overview of the overall situation, as Member States provide varying amounts of information.

The updated reporting guidelines (UNECE, 2014a) request that Parties to the LRTAP Convention provide emission data using the new NFR14 format. All EU Member States that submitted data used the new template.

Table 5.5 Overview of improvements planned at Member State level

Member State	Improvements planned
Austria	The corresponding sector analysis chapters describe required methodological changes and planned improvements (Appendix 5, Austria's IIR)
Belgium	Belgium's IIR lists planned improvements in Sections 8.1-8.4. The relevant sectoral chapters also describe them (Appendix 5, Belgium's IIR)
Bulgaria	Planned improvements: • application of higher tier method for estimation of emissions • incorporation of ETS and E-PRTR databases into the emission inventory in NFR sector 1 'energy' and NFR sector 2 'industrial processes and other solvents and product use' • incorporation of data provided by branch business associations • revision of activity data in NFR sector 3 'agriculture', in line with agro-statistical data from the Ministry of Agriculture and Food • improving the accuracy of the estimates • improving transparency, completeness and consistency, including recalculations of time series and comparability of national emission inventory (Appendix 5, Bulgaria's IIR)
Croatia	Table ES6-1 of Croatia's IIR lists planned improvements in detail, including recalculations, updating of emission factors and collection of new data (Appendix 5, Croatia's IIR)
Cyprus	The 2018 IIR reports no planned improvements
Czech Republic	For the sectors 'road transport' and 'agriculture', improvements are planned (Appendix 5, the Czech Republic's IIR)
Denmark	The relevant sectoral chapters describe sector-specific planned improvements (Appendix 5, Denmark's IIR)
Estonia	Estonia's IIR lists source-specific planned improvements; the correction of activity data, recalculation of POP emissions from the energy sector, the inclusion of more detailed vehicle subsectors, a more detailed emission estimation, correction of allocations and obtaining new activity data for some categories in the 'industrial processes and product use' sector, the introduction of higher tier methods and the improvement of activity data are priorities for future inventory improvement (Appendix 5, Estonia's IIR)
Finland	Table 8.3 of Finland's IIR sets out sector-specific improvement needs and the sectoral chapters describe the source-specific planned improvements (Appendix 5, Finland's IIR)
France	There are some planned and ongoing improvements mentioned in the French IIR: • conducting research to improve accuracy, especially for key categories • establishing measures to determine uncertainties • reducing the number of non-considered or poorly determined pollutants; there are still plans to improve the estimation of emissions from heating boilers in the residential sector, which could strongly influence NO_x emissions • introducing further splits for energy consumption in the industry sector • adopting the recent developments of EMEP/EEA • strengthening all activities for better QA and QC of the system, especially towards the implementation of procedures and tools, cooperation with experts from different fields and maintaining the ISO 9001 certification system (Appendix 5, France's IIR)
Germany	Germany is planning to prioritise improvements on the basis of results of the uncertainty analysis; planned improvements for the source category 'stationary combustion' include revision of the reporting structure, new measurements, improvement of the emission factor for waste incineration plants, revision of emission factors for SO_2, further comparison with other inventory data (namely E-PRTR and ETS), as well as the calculation of a complete time series for two subsectors. For the category 'mobile combustion', planned improvements include the implementation of new emissions, as well as the validation and revision of the approach for abrasive emissions from railways (Appendix 5, Germany's IIR)
Greece	No IIR available
Hungary	Hungary plans to further improve the coordination with E-PRTR reporting and the reporting process, as well as to execute a quantitative uncertainty analysis; another planned improvement is the improvement of QA/QC actions (Appendix 5, Hungary's IIR)
Ireland	The sectoral chapters of Ireland's IIR describe the source-specific planned improvements (Appendix 5, Ireland's IIR)

Table 5.5 Overview of improvements planned at Member State level (cont.)

Member State	Improvements planned
Italy	For the 'energy' and 'industrial processes' sectors, significant progress is planned to harmonise information reported under different obligations; this collates data collected under different obligations (Large Combustion Plant Directive, E-PRTR and ETS), to highlight major discrepancies and to detect potential errors For the sectors 'agriculture' and 'waste', improvements related to the availability of new information on emission factors, activity data, etc., are planned Further work is planned to update/change emission factors for PAHs, dioxins and HMs in order to increase accuracy (Appendix 5, Italy's IIR)
Latvia	For the 'industrial processes and product use' sector, planned improvements include the review of already submitted data for the year 2016 in order to consider delayed submissions from enterprises and the research of the export impact of solvent use emission; planned improvements in the 'agriculture' sector include the continued quantification of abatement strategies and the inclusion of emission data from the use of pesticides (Appendix 5, Latvia's IIR)
Lithuania	There are no source-specific planned improvements listed in the IIR, but the country sees a priority in the estimation of KCA categories using a tier 2 or higher approach (Appendix 5, Lithuania's IIR)
Luxembourg	The IIR lists planned improvements (Luxembourg's IIR, p. 337); they mainly concern the updating of the methodology, activity data and emission factors, as well as notation key correction, reallocation of emissions and new emission sources (Appendix 5, Luxembourg's IIR)
Malta	Malta provided a short paragraph on planned improvements. It is planned to improve the methodology for the sectors 5.A and 5.E (Appendix 5, Malta's IIR)
Netherlands	Some source-specific improvements are planned. These are described in the sectoral chapters of the Netherlands' IIR (Appendix 5, the Netherland's IIR)
Poland	The planned programme of improvement focuses on the following tasks: verifying NMVOC emissions from solvent use; gathering additional activity data to verify the trends for 1990-2000; and further methodology development by applying higher tier methods of estimation methodology (Appendix 5, Poland's IIR)
Portugal	Each source-specific section presents a detailed explanation of the planned sectoral improvements (Appendix 5, Portugal's IIR)
Romania	The country plans to harmonise data trends over the whole time series, in order to remove inconsistencies in the data trends (Appendix 5, Romania's IIR)
Slovakia	Slovakia's IIR mentions an improvement plan for the sector 'agriculture', and Table 5.3 in the IIR provides details about implemented recommendations. Several sector specific chapters also provide information on planned improvements, for example the collection of more detailed data. Further, Slovakia is planning an uncertainty analysis (Appendix 5, Slovakia's IIR)
Slovenia	Planned improvements relate to sectors 1 and 2. The main aims are to estimate new emissions, find the correct emission factors and undertake error correction in order to improve time series data. A detailed list of the planned improvements can be found in Slovenia's IIR (Appendix 5, Slovenia's IIR)
Spain	The principal areas of improvement are: • provision of more detailed sector-specific information on QA/QC procedures • more detailed documentation in relation to the inventory preparation • harmonising the inventory with other registries and inventories (e.g. E-PRTR, large combustion plants • continuing to update emission factors and methodologies based on guidance in the Inventory guidebook • carrying out quantitative estimations of uncertainty and improvements in the methodology for identifying key categories • continuing with the development of the external audit • Sections 8.6.2-8.6.5 list planned improvements at sectoral level (Appendix 5, Spain's IIR)
Sweden	For a number of sectors, planned improvements will be decided after the finalisation of the submission as part of the national QA/QC plan; other than that, there is no information about planned improvements (Appendix 5, Sweden's IIR)
United Kingdom	A number of improvements to the inventory are planned and described in detail in the relevant sector chapters; planned improvements are relevant for the sectors 'energy', 'industrial processes', 'agriculture', 'waste' and 'other' (Appendix 5, the United Kingdom's IIR)

Note: Grey text indicates those countries that did not submit an IIR in 2018.

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Appendix 1 Notation keys

Where methodological or data gaps in inventories exist, information on these gaps should be presented in a transparent manner. Parties should clearly indicate the sources they have not considered in their inventories, although the Inventory guidebook (EMEP/EEA, 2016) includes them, and explain the reason for the exclusion. Similarly, each Party should indicate if it has excluded part of its territory, and explain why. In addition, each Party should use the notations presented below to fill the blanks in all the tables of the NFR inventory. This approach helps assess how complete emission data reports are. The notations are as follows ([12]).

NO 'Not occurring' means an emission source or process does not exist within a country.

NE 'Not estimated' means emissions occur, but have not been estimated or reported. Where an inventory uses 'NE', the Party should indicate why it could not estimate emissions.

NA 'Not applicable' means a source exists, but relevant emissions are considered never to occur.

IE 'Included elsewhere' is for emissions that are estimated and included in the inventory, but are not presented separately for the relevant source. Where it uses 'IE', the Party should indicate where the inventory includes the emissions from the displaced source category, and should give the reasons for deviating from the expected category.

C 'Confidential' is for aggregated emissions that the inventory includes elsewhere, because reporting at a disaggregated level could lead to the disclosure of confidential information. Where an inventory uses 'C', it should make reference to the protocol provision that authorises it.

NR 'Not relevant' eases reporting where different protocols do not strictly require details of emissions. According to Article III, paragraph 9, in the emission-reporting guidelines, emission inventory reporting should cover all years from 1980 onwards if data are available. However, some Parties, for example, do not need to report emissions of NMVOCs prior to 1988.

If a Party estimates emissions from country-specific sources, it should explicitly describe which source categories these are, as well as which methodologies, emission factors and activity data it has used to estimate them.

([12]) Further explanation and guidance concerning the use of these notation codes are in the EMEP emission-reporting guidelines (UNECE, 2014a).

Appendix 2 LRTAP Convention emission-reporting programme for 2018

Emission data should be submitted to EMEP CEIP by **15 February 2018**. IIRs should reach the centre no later than **15 March 2018**. Table A2.1 summarises information contained in the revised emission-reporting guidelines (UNECE, 2014a).

Reporting format

Each Party should use the reporting format in Annex IV of the reporting guidelines (UNECE, 2014a) for its annual submissions. It should submit the information to the CEIP formally, preferably in electronic form, and notify the UNECE secretariat. The reporting format, including the NFR, is standardised for reporting estimates of emissions. It includes activity data, projected activity data, projected emissions and other relevant information. The reporting format aims to facilitate electronic submissions. This should make it simpler to process emission information and prepare useful documentation about technical analysis and synthesis.

The new NFR14 format covers:

- national annual emissions and national annual sector emissions (Annex I);
- total and aggregated sector emissions for reporting emissions of NO_x, NMVOCs, SO_x, NH_3, PM, BC, CO, Pb, Cd, Hg, PCDD/Fs, PAHs, HCB and PCBs, for the EMEP 0.1° × 0.1° grid cell and from LPSs (Annexes V and VI);
- for 2020, 2025, 2030, 2040 and 2050, projected activity data and projected national total emissions of NO_x, NMVOCs, sulphur and NH_3, which Parties are to report for the source categories listed in Annex IV (A- with measures (WM), B-WM, A- with additional measures (WaM), B-WaM).

Table A2.1 Summary of the information requested in the EMEP emission-reporting guidelines

Description of contents		Pollutant(s)	Reporting years ([a])
Yearly: minimum (and additional)			
A.	**National total emissions**		
1.	Main pollutants	NO_x, NMVOCs, SO_x, NH_3, CO	1990-2016
2.	Particulate matter ([b])	$PM_{2.5}$, PM_{10} (TSPs, BC)	2000-2016
3.	Heavy metals ([b])	Pb, Cd, Hg, (As, Cr, Cu, Ni, Se, Zn)	1990-2016
4.	Persistent organic pollutants ([b])	PCDD/Fs, total PAHs, PCBs, HCB (PAHs: B(a)P, B(b)F, B(k)F, IP)	1990-2016
B.	**Emissions by NFR source category**		
1.	Main pollutants	NO_x, NMVOCs, SO_x, NH_3, CO	1990-2016
2.	Particulate matter ([b])	$PM_{2.5}$, PM_{10}, (TSPs, BC)	2000-2016
3.	Heavy metals ([b])	Pb, Cd, Hg, (As, Cr, Cu, Ni, Se, Zn)	1990-2016
4.	Persistent organic pollutants ([b])	PCDD/Fs, total PAHs, PCBs, HCB (PAHs: B(a)P, B(b)F, B(k)F, IP)	1990-2016
C.	**Activity data**	NO_x, NMVOCs, SO_x, NH_3, CO	1990-2016
4-yearly: minimum reporting (from 2017 onwards to the next reporting year: 2021)			
D.	**Gridded data in the EMEP 0.1 ° × 0.1 ° long/lat grid — sector emissions (GNFR14) (c) and national totals (optional)**	NO_x, NMVOCs, SO_x, NH_3, CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCBs	2015 (1990, 1995, 2000, 2005, 2010 if not reported before)
E.	**Emissions from LPSs**	NO_x, NMVOCs, SO_x, NH_3, CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCBs	2015 (1990, 1995, 2000, 2005, 2010 if not reported before)
F.	**Projected emissions and projected activity data**		
1.	National total emission projections	NO_x, NMVOCs, SO_x, NH_3, $PM_{2.5}$, BC	2020, 2025, 2030, where available 2040 and 2050
2.	Emission projections by NFR14	NO_x, NMVOCs, SO_x, NH_3, $PM_{2.5}$, BC	2020, 2025, 2030, where available 2040 and 2050
3.	Projected activity data by NFR14		2020, 2025, 2030, where available 2040 and 2050
5-yearly: additional reporting for review and assessment purposes			
Volatile organic compound (VOC) speciation/height distribution/temporal distribution			Parties are encouraged to review the information used for modelling at http://www.ceip.at/ms/ceip_home1/ceip_home/webdab_emepdatabase/emissions_emepmodels/ online (accessed 9 March 2018)
Land-use data/Hg breakdown			
Percentage of toxic congeners of PCDD/F emissions			
Pre-1990 emissions of PAHs, HCB, PCDD/Fs and PCBs			
Information on natural emissions			

Note: ([a]) As a minimum, data for the base year of the relevant protocol and from the year of entry into force of that protocol and up to the latest year (i.e. the second-last before the current year) should be reported.

([b]) Parties report the pollutants listed in brackets voluntarily.

([c]) Gap-filled NFR14.

Table A2.2 European Union: country grouping

EU-9 refers to the nine Member States up to 31 December 1980: Belgium (BE), Denmark (DK), France (FR), Germany (DE), Ireland (IE), Italy (IT), Luxembourg (LU), the Netherlands (NL) and the United Kingdom (GB)
EU-12 refers to the 12 Member States from 1 January 1981 to 31 December 1994: the EU-9 plus Greece (EL), Portugal (PT) and Spain (ES)
EU-15 refers to the 15 Member States from 1 January 1995 to 30 April 2003: the EU-12 plus Austria (AT), Finland (FI) and Sweden (SE)
EU-27 refers to the 27 Member States from 1 May 2003 to 30 June 2013: the EU-15 plus Bulgaria (BG), Cyprus (CY), the Czech Republic (CZ), Estonia (EE), Hungary (HU), Latvia (LV), Lithuania (LT), Malta (MT), Poland (PL), Romania (RO), Slovakia (SK) and Slovenia (SI)
EU-28 refers to the 28 Member States from 1 July 2013: the EU-27 plus Croatia (HR)

Appendix 3 Status of reporting and timeliness

Table A3.1 Member State inventory submissions 2018: date received by the EEA, years covered and information provided (as of 8 May 2018)

	Annual reporting								Minimum 4-year reporting		
Member State	Submission date [a]	Resubmission date	Projection submission date	New adjustment information date	Approved adjustments date	Date of IIR 2017	NFR template	Activity data [b]	Projections	Gridded data date	LPS emissions date
Austria	15.02.2018	15.03.2018				15.03.2018	NFR 2014-2	1990-2016			
Belgium	15.02.2018				15.02.2018	15.03.2018	NFR 2014-2	1990-2016			
Bulgaria	15.02.2018	14.03.2018				14.03.2018	NFR 2014-1	1990-2016		30.03.2018	
Croatia	13.02.2018					14.03.2018	NFR 2014-1	1990-2016		02.05.2018	
Cyprus	15.02.2018					14.03.2018	NFR 2014-2	1990-2016			
Czech Republic	15.02.2018	15.03.2018 16.03.2018				15.03.2018	NFR 2014-2	1990-2016			
Denmark	15.02.2018				15.02.2018	15.03.2018	NFR 2014-1	1980-2016			
Estonia	13.02.2018					15.03.2018	NFR 2014-2	1990-2016			
Finland	15.02.2018	15.03.2018 13.04.2018	15.02.2018		15.02.2018 15.03.2018	15.03.2018 03.05.2018 06.05.2018 07.05.2018 08.05.2018	NFR 2014-1	1990-2016	2020, 2025, 2030a)		06.05.2018
France	15.02.2018				15.02.2018	15.03.2018	NFR 2014-2	1980-2016			
Germany	13.02.2018				13.02.2018	14.03.2018	NFR 2014-2	1990-2016			
Greece											
Hungary	15.02.2018	15.03.2018		15.02.2018 15.03.2018		15.03.2018	NFR 2014-2	1990-2016			
Ireland	14.02.2018	15.03.2018				20.04.2018	NFR 2014-2	1990-2016		15.03.2018	
Italy	22.02.2018	15.03.2018				16.03.2018	NFR 2014-1	1990-2016		22.02.2018	
Latvia	15.02.2018	15.03.2018				15.03.2018	NFR 2014-2	1990-2016			
Lithuania	15.02.2018	23.02.2018, 08.03.2018				15.03.2018	NFR 2014-2	1990-2016			
Luxembourg	08.02.2018	15.03.2018	15.03.2018		15.03.2018	15.03.2018	NFR 2014-2	1990-2016	2020, 2025, 2030a) b)		
Malta	27.04.2018					03.05.2018	NFR 2014-1	2000-2016			
Netherlands	28.12.2017	13.4.2018				13.04.2018	NFR 2014-1	1990-2016			
Poland	15.02.2018					15.03.2018	NFR 2014-1	1990-2016			
Portugal	15.02.2018	15.02.2018, 15.03.2018				15.03.2018	NFR 2014-1	1990-2016			
Romania	15.02.2018					15.03.2018	NFR 2014-2	2000-2016		27.04.2018	27.04.2018

Table A3.1 Member State inventory submissions 2018: date received by the EEA, years covered and information provided (as of 8 May 2018) (cont.)

	Annual reporting									Minimum 4-year reporting		
Member State	Submission date [a]	Resubmission date	Projection submission date	New adjustment information date	Approved adjustments date	Date of IIR 2017	NFR template	Activity data [b]	Projections	Gridded data date	LPS emissions date
Slovakia	15.02.2018	15.03.2018				15.03.2018 13.04.2018	NFR 2014-2	1990-2016			
Slovenia	13.02.2018					14.03.2018	NFR 2014-2	1990-2016			
Spain	23.01.2018	07.03.2018			23.01.2018	7.03.2018	NFR 2014-2	1990-2016			
Sweden	14.02.2018					13.03.2018	NFR 2014-1	1990-2016			
United Kingdom	15.02.2018		15.03.2018	15.02.2018 15.03.2018		15.03.2018	NFR 2014-2	1990-2016	2020, 2025, 2030		

Notes: Red-coloured dates indicate that data were submitted after the formal deadline for submissions (submissions: 15 February; resubmissions: 15 March; IIR: 15 March), or time series reporting is not complete.

[a] Refers to the first submission of inventory data to the CDR; submission of other data is possible at later dates.

[b] Activity data reported in 2018.

Table A3.2 Member State LRTAP Convention submissions of 2017 (as of 8 May 2018)

Member State	SO_2, NO_x, CO, NH_3, NMVOC	Cd, Hg, Pb	Additional HMs (a)	$PM_{2.5}$, PM_{10}, TSP (b), BC	POPs	Comments
Austria	1990-2016	1990-2016	-	1990, 1995, 2000-2016 (a)	1990-2016 (b)	(a) no BC (b) no individual PAHs
Belgium	1990-2016	1990-2016	1990-2016	2000-2016	1990-2016 (a)	(a) Individual PAHs: only 2010-2016
Bulgaria	1990-2016	1990-2016	1990-2016	1990-2016	1990-2016	
Croatia	1990-2016	1990-2016	1990-2016	1990-2016	1990-2016	
Cyprus	1990-2016	1990-2016	1990-2016	2000-2016	1990-2016	
Czech Republic	1990-2016	1990-2016	1990-2016	1990-2016 (a)	1990-2016	(a) BC: 2000-2016
Denmark	1985-2016 (a)	1990-2016	1990-2016	1990-2016	1990-2016	(a) SO_x: 1980-2016
Estonia	1990-2016	1990-2016	1990-2016	2000-2016 (a)	1990-2016	(a) TSP: 1990-2016
Finland	1980-2016 (b)	1990-2016	1990-2016 (c)	1990-2016	1990-2016 (d)	(a) BC only 2030; NH_3 also 2050 (b) NMVOC: only 1987-2016; CO: only 1990-2016 (c) no Se (only a few sector data (d) no individual PAHs (only a few sector data
France	1980-2016 (a)	1990-2016	1990-2016	1990-2016	1990-2016	(a) NMVOC: only 1988-2016
Germany	1990-2016	1990-2016	1990-2016	1990-2016 (a)	1990-2016	(a) $PM_{2.5}$, PM_{10}: only 1995-2016; BC: only 2000-2016
Greece						
Hungary	1990-2016	1990-2016	1990-2016	2000-2016	1990-2016	
Ireland	1990-2016 (a)	1990-2016	1990-2016	1990-2016	1990-2016	(a) NO_x, NMVOC, SO_x: also 1987
Italy	1990-2016	1990-2016	1990-2016	1990-2016	1990-2016(a)	(a) no individual PAHs
Latvia	1990-2016	1990-2016	1990-2016	1990-2016	1990-2016	
Lithuania	1990-2016	1990-2016	1990-2016	1990-2016	1990-2016	Resubmission only for the year 2013
Luxembourg	1990-2016	1990-2016	-	1990-2016 (a)	1990-2016	(a) no BC (b) WaM projetions only
Malta	2000-2016	2000-2016	2000-2016	2000-2016 (a)	2005-2016	(a) BC: 2005-2016
Netherlands	1990-2016	1990-2016	1990-2016	1990-2016	1990-2016 (a)	(a) PCB: only 1995-1998, 2002, 2004-2005
Poland	1990-2016	1990-2016	1990-2016 (a)	1990-2016	1990-2016	(a) no Se
Portugal	1990-2016	1990-2016	1990-2016	1990-2016	1990-2016	
Romania	2000-2016	2000-2016	2000-2016	2000-2016	2000-2016	
Slovakia	1990-2016	1990-2016	1990-2016	1990-2016	1990-2016	
Slovenia	1980 - 2016 (a)	1990-2016	-	2000-2016	1990-2016	(a) NH_3: only 1986-2016; NMVOC: only 1990-2016
Spain	1990-2016	1990-2016	1990-2016	2000-2016	1990-2016(a)	(a) no individual PAHs
Sweden	1990-2016	1990-2016	1990-2016	1990-2016 (a)	1990-2016	(a) BC: only 2000-2016
United Kingdom	1990-2016	1990-2016	1990-2016	1990-2016	1990-2016	

Notes: Reporting of additional HMs is not mandatory.

Member States do not have to report TSPs if they report PM emissions.

Figure A3.1 Dates of first data submissions received from Member States (as of 8 May 2018)

Appendix 4 Conversion chart for aggregated sector groups

To enable the presentation of sectoral emission trends (Chapter 3), individual NFR source categories for the EU-28 inventory were aggregated into the following main sector groups:

- energy production and distribution;
- energy use in industry;
- industrial processes and product use;
- commercial, institutional and households;
- road transport;
- non-road transport;
- agriculture;
- waste.

Table A4.1 provides a conversion chart showing which of the individual NFR source categories was in each of the aggregated sector groups.

Table A4.1 Conversion chart for aggregated sector groups

NFR code	Full name	EEA aggregated sector name
1A1a	Public electricity and heat production	Energy production and distribution
1A1b	Petroleum refining	Energy production and distribution
1A1c	Manufacture of solid fuels and other energy industries	Energy production and distribution
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Energy use in industry
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	Energy use in industry
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	Energy use in industry
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, paper and print	Energy use in industry
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Energy use in industry
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Energy use in industry
1A2gvii	Mobile combustion in manufacturing industries and construction	Energy use in industry
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	Energy use in industry
1A3ai(i)	International aviation LTO (civil)	Non-road transport
1A3aii(i)	Domestic aviation LTO (civil)	Non-road transport
1A3bi	Road transport: Passenger cars	Road transport
1A3bii	Road transport: Light duty vehicles	Road transport
1A3biii	Road transport: Heavy duty vehicles and buses	Road transport
1A3biv	Road transport: Mopeds and motorcycles	Road transport
1A3bv	Road transport: Gasoline evaporation	Road transport
1A3bvi	Road transport: Automobile tyre and brake wear	Road transport
1A3bvii	Road transport: Automobile road abrasion	Road transport
1A3c	Railways	Non-road transport
1A3di(ii)	International inland waterways	Non-road transport
1A3dii	National navigation (shipping)	Non-road transport
1A3ei	Pipeline transport	Non-road transport

Table A4.1 Conversion chart for aggregated sector groups (cont.)

NFR code	Full name	EEA aggregated sector name
1A3eii	Other	Non-road transport
1A4ai	Commercial/institutional: Stationary	Commercial, institutional and households
1A4aii	Commercial/institutional: Mobile	Commercial, institutional and households
1A4bi	Residential: Stationary	Commercial, institutional and households
1A4bii	Residential: Household and gardening (mobile)	Commercial, institutional and households
1A4ci	Agriculture/forestry/fishing: Stationary	Commercial, institutional and households
1A4cii	Agriculture/forestry/fishing: Off-road vehicles and other machinery	Commercial, institutional and households
1A4ciii	Agriculture/forestry/fishing: National fishing	Non-road transport
1A5a	Other stationary (including military)	Commercial, institutional and households
1A5b	Other, mobile (including military, land-based and recreational boats)	Commercial, institutional and households
1B1a	Fugitive emission from solid fuels: Coal mining and handling	Energy production and distribution
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	Energy production and distribution
1B1c	Other fugitive emissions from solid fuels	Energy production and distribution
1B2ai	Fugitive emissions oil: Exploration, production, transport	Energy production and distribution
1B2aiv	Fugitive emissions oil: Refining/storage	Energy production and distribution
1B2av	Distribution of oil products	Energy production and distribution
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	Energy production and distribution
1B2c	Venting and flaring (oil, gas, combined oil and gas)	Energy production and distribution
1B2d	Other fugitive emissions from energy production	Energy production and distribution
2A1	Cement production	Industrial processes and product use
2A2	Lime production	Industrial processes and product use
2A3	Glass production	Industrial processes and product use
2A5a	Quarrying and mining of minerals other than coal	Industrial processes and product use
2A5b	Construction and demolition	Industrial processes and product use
2A5c	Storage, handling and transport of mineral products	Industrial processes and product use
2A6	Other mineral products	Industrial processes and product use
2B1	Ammonia production	Industrial processes and product use
2B2	Nitric acid production	Industrial processes and product use
2B3	Adipic acid production	Industrial processes and product use
2B5	Carbide production	Industrial processes and product use
2B6	Titanium dioxide production	Industrial processes and product use
2B7	Soda ash production	Industrial processes and product use
2B10a	Chemical industry: Other	Industrial processes and product use
2B10b	Storage, handling and transport of chemical products	Industrial processes and product use
2C1	Iron and steel production	Industrial processes and product use
2C2	Ferroalloys production	Industrial processes and product use
2C3	Aluminium production	Industrial processes and product use
2C4	Magnesium production	Industrial processes and product use
2C5	Lead production	Industrial processes and product use
2C6	Zinc production	Industrial processes and product use
2C7a	Copper production	Industrial processes and product use
2C7b	Nickel production	Industrial processes and product use
2C7c	Other metal production	Industrial processes and product use
2C7d	Storage, handling and transport of metal products	Industrial processes and product use
2D3a	Domestic solvent use including fungicides	Industrial processes and product use
2D3b	Road paving with asphalt	Industrial processes and product use
2D3c	Asphalt roofing	Industrial processes and product use
2D3d	Coating applications	Industrial processes and product use

Table A4.1 Conversion chart for aggregated sector groups (cont.)

NFR code	Full name	EEA aggregated sector name
2D3e	Degreasing	Industrial processes and product use
2D3f	Dry cleaning	Industrial processes and product use
2D3g	Chemical products	Industrial processes and product use
2D3h	Printing	Industrial processes and product use
2D3i	Other solvent use	Industrial processes and product use
2G	Other product use	Industrial processes and product use
2H1	Pulp and paper industry	Industrial processes and product use
2H2	Food and beverages industry	Industrial processes and product use
2H3	Other industrial processes	Industrial processes and product use
2I	Wood processing	Industrial processes and product use
2J	Production of POPs	Industrial processes and product use
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	Industrial processes and product use
2L	Other production, consumption, storage, transportation or handling of bulk products	Industrial processes and product use
3B1a	Manure management — Dairy cattle	Agriculture
3B1b	Manure management — Non-dairy cattle	Agriculture
3B2	Manure management — Sheep	Agriculture
3B3	Manure management — Swine	Agriculture
3B4a	Manure management — Buffalo	Agriculture
3B4d	Manure management — Goats	Agriculture
3B4e	Manure management — Horses	Agriculture
3B4f	Manure management — Mules and asses	Agriculture
3B4gi	Manure management — Laying hens	Agriculture
3B4gii	Manure management — Broilers	Agriculture
3B4giii	Manure management — Turkeys	Agriculture
3B4giv	Manure management — Other poultry	Agriculture
3B4h	Manure management — Other animals	Agriculture
3Da1	Inorganic N-fertilisers (includes also urea application)	Agriculture
3Da2a	Animal manure applied to soils	Agriculture
3Da2b	Sewage sludge applied to soils	Agriculture
3Da2c	Other organic fertilisers applied to soils (including compost)	Agriculture
3Da3	Urine and dung deposited by grazing animals	Agriculture
3Da4	Crop residues applied to soils	Agriculture
3Db	Indirect emissions from managed soils	Agriculture
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	Agriculture
3Dd	Off-farm storage, handling and transport of bulk agricultural products	Agriculture
3De	Cultivated crops	Agriculture
3Df	Use of pesticides	Agriculture
3F	Field burning of agricultural residues	Agriculture
3I	Agriculture other	Agriculture
5A	Biological treatment of waste — Solid waste disposal on land	Waste
5B1	Biological treatment of waste — Composting	Waste
5B2	Biological treatment of waste — Anaerobic digestion at biogas facilities	Waste
5C1a	Municipal waste incineration	Waste
5C1bi	Industrial waste incineration	Waste
5C1bii	Hazardous waste incineration	Waste
5C1biii	Clinical waste incineration	Waste
5C1biv	Sewage sludge incineration	Waste

Table A4.1 Conversion chart for aggregated sector groups (cont.)

NFR code	Full name	EEA aggregated sector name
5C1bv	Cremation	Waste
5C1bvi	Other waste incineration	Waste
5C2	Open burning of waste	Waste
5D1	Domestic waste water handling	Waste
5D2	Industrial waste water handling	Waste
5D3	Other waste water handling	Waste
5E	Other waste	Waste
6A	Other (included in national total for entire territory)	Other

Note: LTO, landing/take-off.

Appendix 5 Member State informative inventory reports (IIRs)

Table A5.1 List of submitted IIRs including source and date of submission (as of 8 May 2018)

Country code	Title of IIR	Source	Date of submission
AT	Austria's Informative Inventory Report (IIR) 2018. Submission under the UNECE Convention on Long-range Transboundary Air Pollution and Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants	http://cdr.eionet.europa.eu/at/un/clrtap/iir/envwqadww/	15.3.2018
BE	Informative Inventory Report — about Belgium's air emissions submitted under the Convention on Long Range Transboundary Air Pollution LRTAP Convention and National Emissions Ceiling Directive NEC Directive — March 2018	http://cdr.eionet.europa.eu/be/un/clrtap/iir/envwqqx9w	15.3.2018
BG	Bulgaria's Informative Inventory Report 2018 (IIR). Submission under the UNECE Convention on Long-Range Transboundary Air Pollution	http://cdr.eionet.europa.eu/bg/un/clrtap/iir/envwqkz5a/	14.3.2018
CY	Cyprus Informative Inventory Report 2016	http://cdr.eionet.europa.eu/cy/un/clrtap/iir/envwqkb6q/	14.3.2018
CZ	Czech Informative Inventory Report 2018. Submission under the UNECE Convention on Long-range Transboundary Air Pollution	http://cdr.eionet.europa.eu/cz/un/clrtap/iir/envwqfvog	15.3.2018
DE	German Informative Inventory Report 2018	http://iir-de.wikidot.com	No submission
DK	Annual Danish Informative Inventory Report to UNECE. Emission inventories from the base year of the protocols to year 2016	http://cdr.eionet.europa.eu/dk/un/clrtap/iir/envwqogaa/	15.3.2018
EE	Estonian Informative Inventory Report 1990-2016. Submitted under the Convention on Long-Range Transboundary Air Pollution	http://cdr.eionet.europa.eu/ee/un/clrtap/iir/envwqpsxa	15.3.2018
ES	Spain — Informative Inventory Report 1990-2016	http://cdr.eionet.europa.eu/es/un/clrtap/iir/envwplua	07.3.2018
FI	Finland's Informative Inventory Report 2018. Air Pollutant Emissions 1980-2016 under the UNECE LRTAP Convention and the EU NECD. Part I – General A. May 2018	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envwvikqq/	08.5.2018
	Air Pollutant Emissions in Finland 1990-2016. Informative Inventory Report to the Secretariat of the UNECE Convention on Long-Range Transboundary Air Pollution. Part 5 Annexes	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envwvgx2g/	08.5.2018
	Finland's Informative Inventory Report 2018. Air Pollutant Emissions 1980-2016 under the UNECE LRTAP Convention and the EU NECD. Part 1B – General. May 2018	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envwvc6vq/	07.5.2018
	Finland's Informative Inventory Report 2018. Air Pollutant Emissions 1980-2016 under the UNECE LRTAP Convention and the EU NECD. Part — IPPU. May 2018	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envwu9vkg/	06.5.2018
	Finland's Informative Inventory Report 2018. Air Pollutant Emissions 1980-2016 under the UNECE LRTAP Convention and the EU NECD. Part 4. Agriculture and Waste	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envwuuaga/	03.5.2018
	Finland's Informative Inventory Report 2018. Air Pollutant Emissions 1980-2016 under the UNECE LRTAP Convention and the EU NECD. Part 2 Energy & Transport. May 2018	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envwupctq/	03.5.2018
	Finland's Informative Inventory Report 2017. Air Pollutant Emissions 1980-2016 under the UNECE LRTAP Convention and the EU NEC Directive	http://cdr.eionet.europa.eu/fi/un/clrtap/iir/envwqm4qa/	15.3.2018

Table A5.1 List of submitted IIRs including source and date of submission (as of 8 May 2018) (cont.)

Country code	Title of IIR	Source	Date of submission
FR	Inventaire des émissions de polluants atmosphériques en France au titre de la convention sur la pollution atmosphérique transfrontalière à longue distance et de la directive Européenne concernant la réduction des émissions nationales de certains polluants atmosphériques	https://cdr.eionet.europa.eu/fr/un/clrtap/iir/envwqqndq/	15.3.2018
GB	UK Informative Inventory Report (1990 to 2016)	http://cdr.eionet.europa.eu/gb/un/clrtap/iir/envwqfzza/	15.3.2018
GR	No IIR available		
HR	Republic of Croatia 2018 — Informative Inventory Report (1990-2016) under the Convention on Long-range Transboundary Air Pollution (LRTAP Convention) and National Emission Ceilings Directive (NECD 2016/2284/EU)	http://cdr.eionet.europa.eu/hr/un/clrtap/iir/envwqjz5w/	14.3.2018
HU	Informative Inventory Report — Hungary 2016	http://cdr.eionet.europa.eu/hu/un/clrtap/iir/envwql3ag/	15.3.2018
IE	Ireland's Informative Inventory Report 2018. Air Pollutant Emissions in Ireland 1990-2016	https://cdr.eionet.europa.eu/ie/un/clrtap/iir/envwtn_3q	20.4.2018
IT	Italian Emission Inventory 1990-2016 — Informative Inventory Report 2018	https://cdr.eionet.europa.eu/it/un/clrtap/iir/envwqv2kq	16.3.2018
LT	Lithuanian Pollutants Emission Inventory for Period 1990-2016	http://cdr.eionet.europa.eu/lt/un/clrtap/iir/envwqqdsg/	15.3.2018
LU	Luxembourg's Informative Inventory Report 1990-2016. Submission under the UNECE Convention on Long-Range Transboundary Air Pollution. DRAFT	http://cdr.eionet.europa.eu/lu/eu/nec_revised/iir/envwqp9tw	15.3.2018
LV	Latvia's Informative Inventory Report 2018. Submitted under the Convention on Long-Range Transboundary Air Pollution	https://cdr.eionet.europa.eu/lv/un/clrtap/iir/envwqqvhw/	15.3.2018
MT	Informative Inventory Report for Malta 2016	https://cdr.eionet.europa.eu/mt/un/clrtap/iir/envwurgoa/	03.5.2018
NL	Informative Inventory Report 2018. Emissions of transboundary air pollutants in the Netherlands 1990-2016	https://cdr.eionet.europa.eu/nl/un/clrtap/iir/envwtc5fa/	13.4.2018
PL	Poland's Informative Inventory Report 2018. Submission under UN ECE Convention on Long-range Transboundary Air Pollution and the DIRECTIVE (EU) 2016/2284	http://cdr.eionet.europa.eu/pl/un/clrtap/iir/envwqolng/	15.3.2018
PT	Portuguese Informative Inventory Report 1990-2016. Submitted under the NEC Directive (EU) 2016/2284 and the UNECE Convention on Long-range Transboundary Air Pollution	http://cdr.eionet.europa.eu/pt/un/clrtap/iir/envwqqpq	15.3.2018
RO	Romania's Informative Inventory Report 2018. Submission under the UNECE Convention on Long Range Transboundary Air Pollution	http://cdr.eionet.europa.eu/ro/un/clrtap/iir/envwqpiwq/	15.3.2018
SE	Informative Inventory Report Sweden 2018. Submitted under the Convention on Long-Range Transboundary Air Pollution	http://cdr.eionet.europa.eu/se/un/clrtap/iir/envwqeogg/	13.3.2018
SI	Slovenia's Informative Inventory Report 2018. Submission under the UNECE Convention on Long-Range Transboundary Air Pollution and Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants	http://cdr.eionet.europa.eu/si/un/clrtap/iir/envwqjfag/	14.3.2018
SK	Informative Inventory Report 2018. Slovak Republic. Air Pollutant Emissions 1990-2016	https://cdr.eionet.europa.eu/sk/un/clrtap/iir/envwtcyiq/	13.4.2018
	Informative Inventory Report 2018. Slovak Republic. Air Pollutant Emissions 1990-2016	https://cdr.eionet.europa.eu/sk/un/clrtap/iir/envwqqoig/	15.3.2018

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