EEA Report | No 08/2019

European Union emission inventory report 1990-2017

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

ISSN 1977-8449

25 1994-2019
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Luxembourg: Publications Office of the European Union, 2019

ISBN 978-92-9480-078-7
ISSN 1977-8449
doi:10.2800/78220

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Acknowledgements

This report was prepared by the European Environment Agency (EEA) and its European Topic Centre on Air Pollution, Transport, Noise and Industrial pollution (ETC/ATNI, partner Umweltbundesamt, Austria). The lead author of the report was Melanie Tista. Other authors (in alphabetical order) were Michael Gager, Silke Gaisbauer and Bernhard Ullrich. The EEA project manager was Anke Lükewille. The desk officers at the European Commission's Directorate-General for the Environment (DG Environment) were Viviane André and Zlatko Kregar. The authors gratefully acknowledge the technical support received from Robert Wankmüller (ETC/ATNI).

The EEA acknowledges comments received on the draft report from the Eionet National Reference Centres in EEA member countries and the European Commission (DG Environment).

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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 UNECE Executive Secretary. The European Environment Agency (EEA) compiled the report in cooperation with the EU Member States and the European Commission.

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):
  a) PM with a diameter greater than 2.5 microns ($PM_{2.5}$, also called fine particulate matter);
  b) PM with a diameter greater than 10 microns (PM_{10});
  c) BC, the most strongly light-absorbing component of PM;
  d) 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.

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 both 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, 2018a).

This report addresses:

- the institutional arrangements and preparation processes behind the EU's emission inventory, methods and data sources, reporting, key category analyses, information on quality assurance and control, general uncertainty evaluation, and information on completeness and underestimations (Executive Summary);
- information on approved adjustments and adjustment applications under the Gothenburg Protocol (Chapter 2);
- emission trends for the 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);
- brief information on the status of (not mandatory) reporting the condensable component of PM_{10} and $PM_{2.5}$ (sub-chapter 1.5.5).

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, 2018d). The following sections summarise the main findings.

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 version also specifies new emission-reduction commitments in terms of percentage reductions by 2020, relative to the 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.

Box ES.2 Status of reporting by EU Member States

In 2019, 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 a European inventory which was as complete as possible. By 9 May 2019, 27 Member States had reported activity data, but only 25 Member States had reported activity data for the complete time series (1990-2017).

The EU may deliver emission inventories and projections by 30 April, its IIR (i.e. this report) by 30 May and its gridded and large point source (LPS) data by 15 June. By 9 May, 26 Member States had provided IIRs and 23 Member State had submitted projection data. The reporting of projections has been requested in 2019, but not the submission of gridded and LPS data. However, Denmark, Finland, Germany and Spain have provided gridded data. Finland and Spain also reported LPS data in 2019. 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 them with total national emissions, 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, 2017 and 2018.

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.

([1]) The EEA published its annual update of the National Emission Ceilings Directive (NEC Directive) reporting (EEA, 2019a) in June 2019. The briefing analysed the 2017 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, 2016a). For the EU Member States, the new NEC Directive retains the emission ceilings set for 2010 and the 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.

EU emission trends

Figures ES.1-ES.3 present the trends in the emission of air pollutants between 1990 and 2017 ([2]). They are aggregated across the EU.

Emission trends for the main air pollutants between 1990 and 2017

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

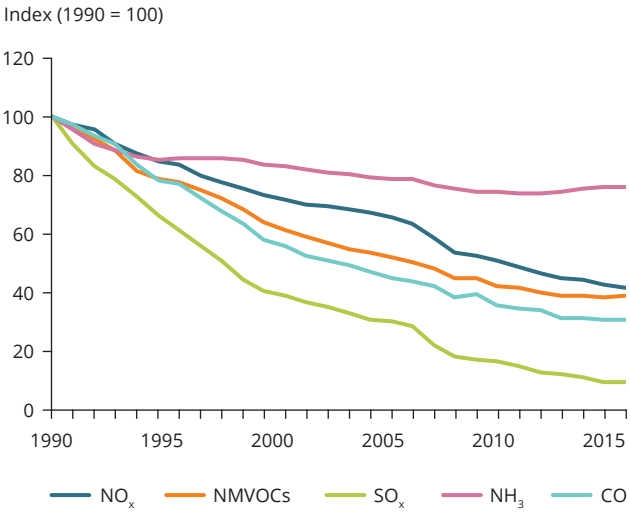
a) fuel switching in energy-related sectors, away from solid and liquid fuels with high sulphur content to low-sulphur fuels such as natural gas;

b) applying flue gas desulphurisation (FGD) techniques in industrial facilities;

c) 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 (61 % reduction) and NO_x (58 % reduction).

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



For most main air pollutants, emissions decreased more slowly from 2007 to 2017. NH_3 emissions have fallen less than emissions of the other main pollutants (24 %) since 1990, and since 2014 a positive NH_3 emission trend has been noted (plus 2.3 % from 2014 to 2017).

Box ES.3 Development of the main pollutant emissions between 2016 and 2017

Between 2016 and 2017, emissions of NO_x and SO_x dropped by 1.8 % and 1.3 %, respectively. Emissions of NMVOCs increased by 1.3 %, CO emissions by 0.2 % and NH_3 emissions by 0.4 %.

The drop in NO_x emissions is mainly due to reductions reported by Italy, Bulgaria, Germany, the United Kingdom and France (in order of the largest absolute emission reduction). The 'road transport' sector recorded the largest reductions of NO_x (in absolute terms) from 2016 to 2017.

NMVOC emissions increased in 15 Member States between 2016 and 2017. Italy, Germany, Poland and Spain (in order of the largest absolute emission increase) were responsible for the highest increases. The main emitter of NMVOCs is the 'industrial processes and product use' sector.

From 2016 to 2017, the largest reductions in SO_x emissions in absolute terms were Poland, Czechia, Finland and Germany (in order of the largest absolute emission reduction). The 'energy production and distribution' sector was the main contributor to the reduction in SO_x emissions.

CO emissions increased, mainly due to increased emissions reported by Poland, Italy, Germany and Greece (gap-filled data) (in order of the largest absolute emission increase). The road transport sector contributed most to the decrease in CO emissions.

NH_3 emissions increased in 15 Member States. Spain and Poland reported the highest increases (in order of the largest absolute emission increase). The rise in Spain was driven by a greater consumption of synthetic nitrogen fertilisers and an increase in the numbers of cattle and swine.

([2]) Each year, by 15 February, Member States must report emission data for up to and including the last calendar year but one. Thus, by 15 February 2019, Member States were obliged to report for the years up to 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 CO and NMVOCs emissions since 1990 and, since 1992, NO_x emissions have also continued to decrease. The sector has achieved this primarily through legislative measures requiring the abatement of vehicle exhaust emissions.

European legislation sets progressively stricter emission limits for air pollutants from cars and vans, lorries, and buses and coaches, the so-called 'Euro standards'. The standards apply to tailpipe emissions of NO_x based on laboratory-based tests. These official tests fail to measure the actual level of emissions that vehicles are producing under real driving conditions, i.e. NO_x emissions are higher than EU limits permit. This has contributed significantly to exceedances of the NO_2 air-quality daily limit value at urban traffic stations ([3]) (EEA, 2019b). New tests under real driving conditions now complement laboratory-based testing. Such tests will become mandatory for all new cars and vans as from September 2019 (EU, 2016b).

NO_x emissions declined considerably in the electricity/energy-generation sectors as a result of certain technical measures, mainly:

1. the introduction of combustion-modification technologies (e.g. use of low-NO_x burners);

2. the implementation of flue-gas-abatement techniques (e.g. NO_x scrubbers, and selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR) techniques);

3. fuel switching from coal to gas.

Emission trends for particulate matter between 2000 and 2017

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 53 % since 1990) (Figure ES.2). Emissions of primary PM_{10}, $PM_{2.5}$ and BC have fallen by 27 %, 29 % and 42 %, respectively (since 2000).

Total PM emissions dropped mainly thanks to the introduction or improvement of abatement measures across the energy, road transport and industry sectors. This has been 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).

NH_3 emissions from agriculture contribute to episodes of high secondary inorganic PM concentrations experienced across certain regions of Europe each spring. Such episodes contribute to exceedances of the PM_{10} daily limit values set in the EU's Air Quality Directive (e.g. CAMS, 2018).

Figure ES.2 EU emission trends for particulate matter

([3]) Stations in urban areas (mainly cities) close to main roads.

Emission trends for heavy metals and persistent organic pollutants between 1990 and 2017

Since 1990, emissions of the main HMs (Pb, Cd, Hg), dioxins and furans, total PAHs, HCB and PCBs have also dropped substantially, 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 reduction in emissions 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 10 % higher in 2017 than in 1990. Emissions of other HMs fell between 1990 and 2017: As by 69 %, Cr by 71 %, Ni by 73 %, Se by 39 % and Zn by 38 %.

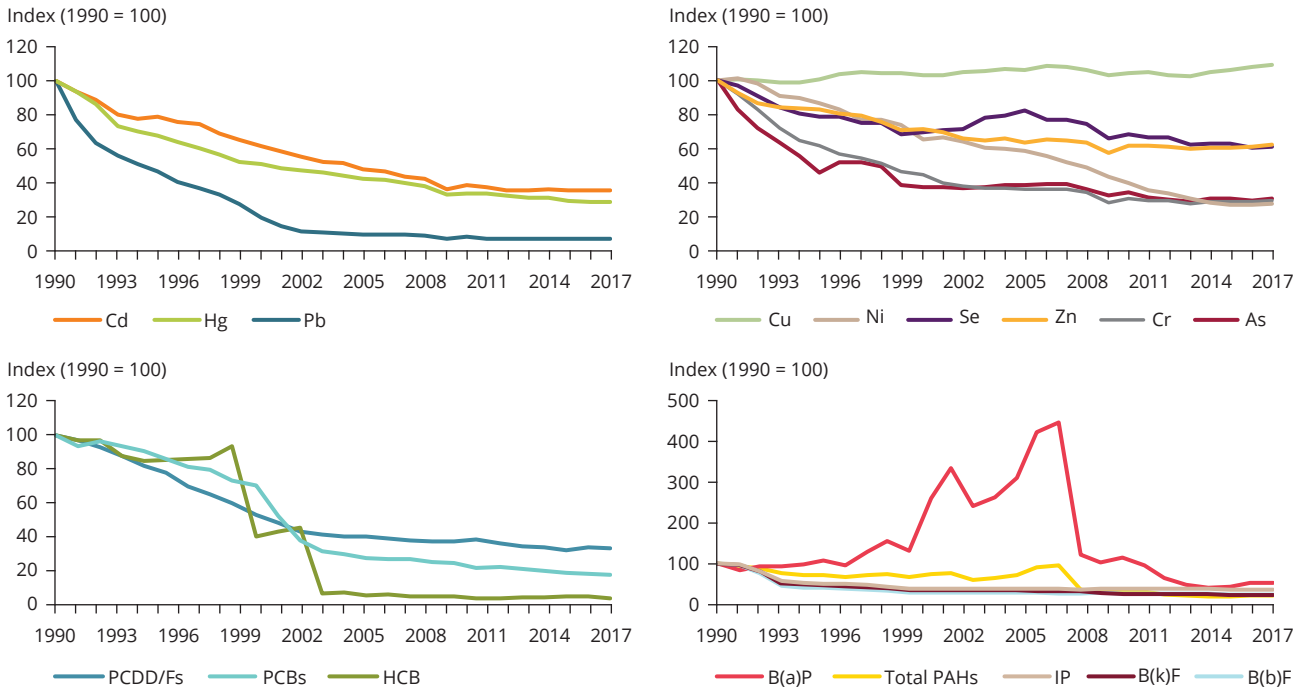
Total PAHs decreased by 78 % from 1990 to 2017 ([4]). For individual PAHs, the reductions from 1990 to 2017 were 47 % for B(a)P, 76 % for B(b)F, 78 % for B(k)F and 65 % for IP. Dioxins and furans have decreased by 67 % since 1990. The reductions in HCB and PCB emissions were 96 % and 83 %, respectively. Although

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

In 2019, all Member States that provided submissions reported recalculations for one or more years; changes in gap filling also resulted in recalculations. This caused changes in emission inventories for all pollutants up to 2017.

In their IIRs (see Appendix 5), Member States gave an account of their reasons for recalculating parts of the time series or the 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 the recalculations.

Figure ES.3 EU emission trends for heavy metals and persistent organic pollutants



Notes: The drop in HCB emissions between 1998 and 1999 is due to a considerable reduction reported by the United Kingdom. The decrease in HCB emissions between 2002 and 2003 is caused by reductions reported by Germany.

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

For certain pollutants, not all Member States reported data.

([4]) 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.

there have been clear decreases over the last 25 years, emissions of POPs have remained broadly stable since 2000 (Figure ES.3).

EU key categories and main emission sources

EU key categories refer to the individual sources that contributed the most, overall, to emissions of pollutants in 2017. They were determined by a level assessment ([5]) for NO_x, NMVOCs, SO_x, NH_3, CO, $PM_{2.5}$, PM_{10}, BC, Cd, Pb, Hg, PCDD/Fs, total PAHs, B(a)P, HCB and PCBs.

A total of 59 different emission inventory source categories were identified as being key for at least one pollutant. A number of emission categories were identified as being key for more than one of the 16 pollutants assessed. Table ES.1 lists the most relevant key categories.

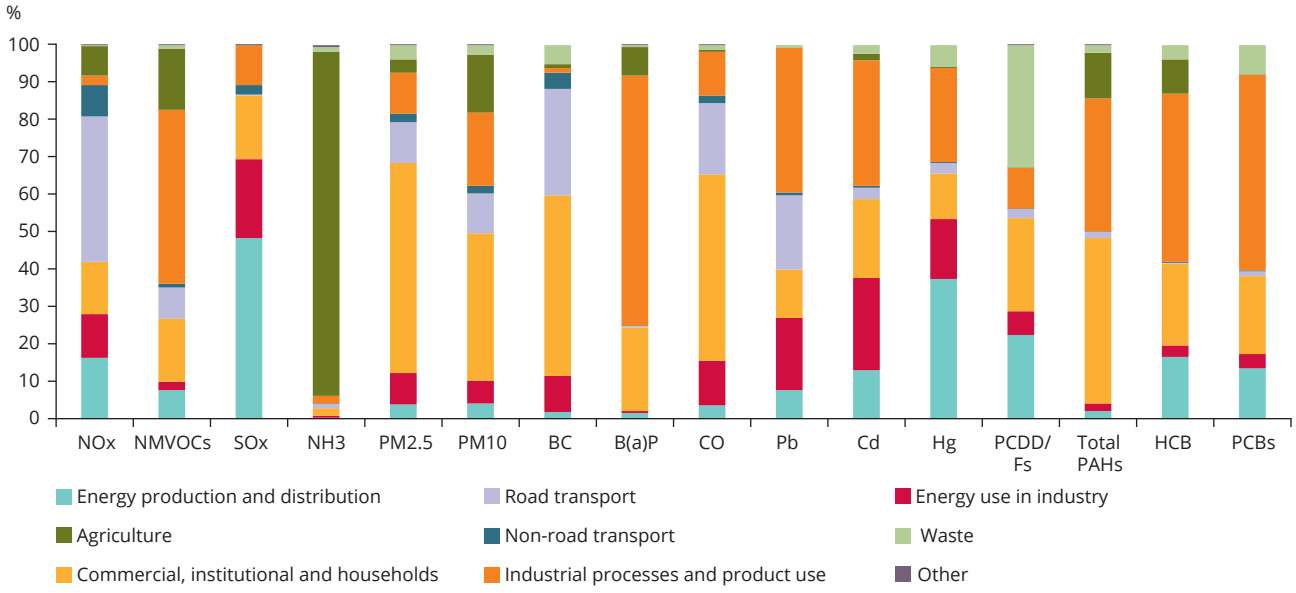
Figure ES.4 shows the share of EU emissions by sector group. As observed in previous years, each main air pollutant has one major source category:

1. for NO_x, the major source category is road transport;
2. for SO_x, the major source category is energy production and distribution;
3. for NH_3, the major source category is agriculture;
4. for NMVOCs, the major source category is industrial processes and product use; and

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)	15 (NO_x, NMVOCs, SO_x, CO, $PM_{2.5}$, PM_{10}, BC, Pb, Cd, Hg, PCDD/Fs, total PAHs, B(a)P, HCB, PCBs)
Public electricity and heat production (NFR 1A1a)	11 (NO_x, SO_x, CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PCDD/Fs, HCB, PCBs)
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: Non-metallic minerals (NFR 1A2f)	7 (NO_x, SO_x, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg)
Stationary combustion in manufacturing industries and construction: Iron and steel (NFR 1A2gviii)	7 (NO_x, SO_x, $PM_{2.5}$, PM_{10}, BC, Cd, Hg)
Road transport: Passenger cars (NFR 1A3bi)	7 (NO_x, NMVOCs, CO, $PM_{2.5}$, PM_{10}, BC, Pb)

Figure ES.4 Share of EU emissions of the main pollutants, by sector group in 2017



([5]) 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 refer to those that are collectively responsible for 80 % of the total emissions of a given pollutant (EMEP/EEA, 2016).

5. for CO, as well as PM, the major source category is 'commercial, institutional and households'.

Emissions of NO_x from the road transport sector fell by 58 % between 1990 and 2017. Nevertheless, in the EU, this sector is a major source of the ground-level O_3 precursors NO_x, CO and NMVOCs: in 2017, it contributed 39 %, 19 % and 8 %, respectively, to the 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 2017, 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 primary $PM_{2.5}$, CO and PM_{10}. Energy- and process-related emissions from industry contribute considerably to the overall emissions of a number of HMs and POPs.

Adjustments to emission inventories under the Gothenburg Protocol

Parties to the LRTAP Convention may 'adjust' their emission inventories downwards if non-compliance with the ceilings set in the Gothenburg Protocol is caused by countries having applied improved emission inventory methods in accordance with updated scientific knowledge since the 2010 ceilings were originally set. This is to avoid disadvantages when applying improved emission inventory methodologies.

Table ES.2 lists inventory adjustment applications that the EMEP Steering Body accepted in 2014, 2015, 2016, 2017 and 2018.

Progress towards 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 2017 compared with the emission ceilings it specified for the EU in 2010 and for the years thereafter. In 2017, emissions of NO_x, NMVOCs and SO_x were below the ceilings. For NH_3, the EU-15 (see Appendix 2, Table A2.2 for country information) emissions were slightly above the ceiling. 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 2017. Estonia and Malta do not have such 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. Four countries exceeded their NH_3 ceilings (Croatia, Germany, the Netherlands and Spain); two Member States (Luxembourg and the Netherlands) did not comply with their ceiling for NMVOCs; and one Member State (Luxembourg) exceeded its NO_x ceilings. All Member States complied with their SO_x ceilings. Luxembourg

Table ES.2 Accepted inventory adjustment applications (UNECE, 2014b, 2015, 2016, 2017, 2018)

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)
Hungary	NMVOCs	Agriculture (3B, 3De)
Luxembourg	NO_x	Road transport (1A3bi-iv), Agriculture (3B, 3De)
	NMVOCs	Agriculture (3B, 3De)
Spain	NO_x	Road transport (1A3bi, 1A3biii), Agriculture (3B)
United Kingdom	NO_x	Road transport (1A3bi-iv)

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

Table ES.3 Emissions reported for 2017 by EU-15 Member States compared with Gothenburg Protocol EU emission ceilings for 2010 and the years thereafter

Pollutant	EU-15 emissions, 2017 (Gg)	EU-15 Gothenburg Protocol, 2010 ceilings (Gg)	Difference	Sum of individual EU-15 ceilings (Gg) [a]
NO_x	5 812	6 671	-13 %	6 519
NMVOCs	5 303	6 600	-20 %	6 510
SO_x	1 275	4 059	-69 %	3 850
NH_3	3 131	3 129	0.1 %	3 110

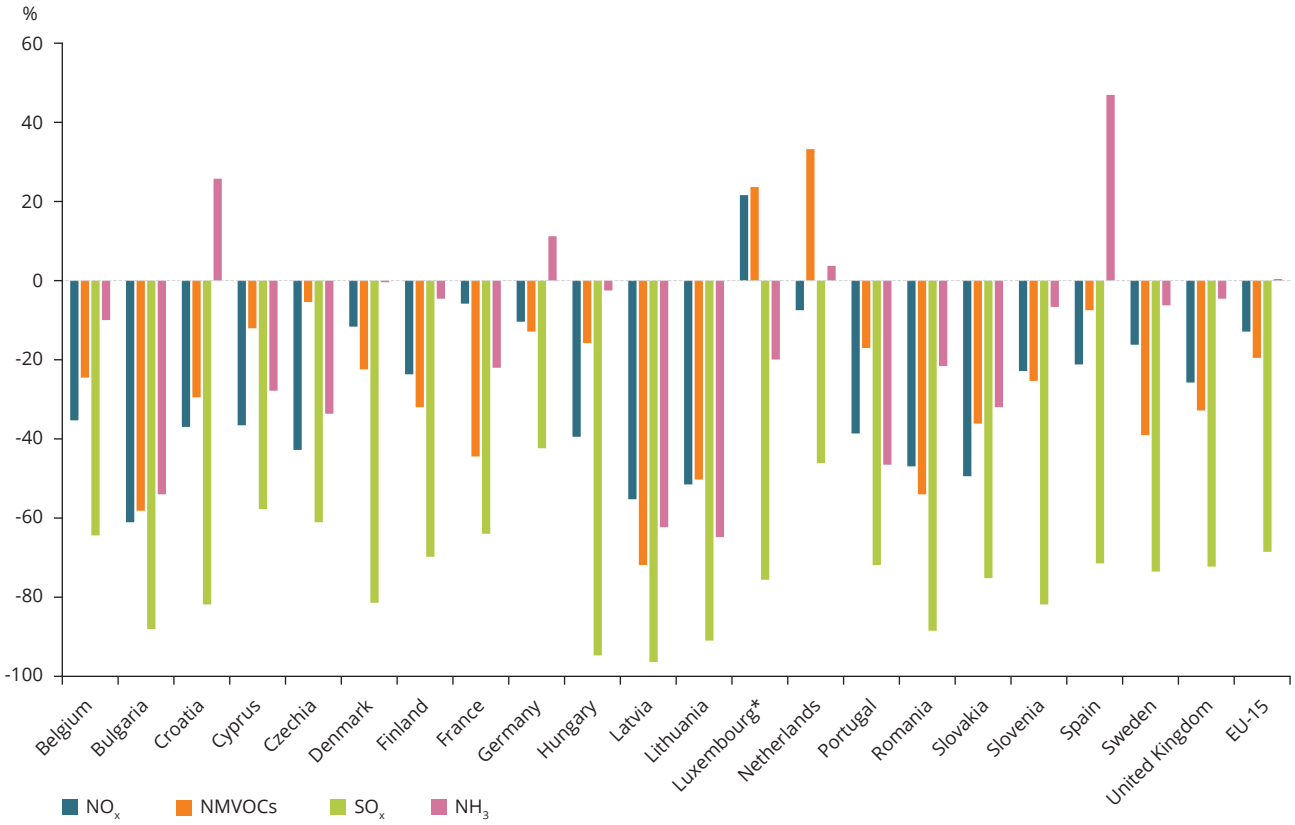
Notes: For Spain, data for emission comparisons exclude emissions from the Canary Islands. The comparison with emission ceilings is based on reporting on the basis of fuel sold for all Member States.

For Portugal's 2010 and 2020 reduction targets the Azores and Madeira emissions are excluded.

Under the Gothenburg Protocol, the EMEP Steering Body accepted applications from Belgium, Denmark, Finland, France, Germany, Hungary, Luxembourg, Spain and the United Kingdom for emission inventory adjustments in 2014, 2015, 2016, 2017 and 2018. 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 to the ceilings specified for the EU-15 as a whole.

Figure ES.5 Distance to Gothenburg ceilings for EU Member States in 2017



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 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, instead, choose to use the total national emissions calculated on the basis of fuel used in the geographical area of the Party as a basis for comparing ceilings (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, Hungary, Luxembourg, Spain and the United Kingdom in 2014, 2015, 2016, 2017 and 2018. 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.

* Luxembourg has not reported adjustments in 2019.

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

Member State	NO_x								NMVOCs							
	2010	2011	2012	2013	2014	2015	2016	2017	2010	2011	2012	2013	2014	2015	2016	2017
Norway	×	×	×	×	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓
Switzerland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Member State	**SO_2**								**NH_3**							
	2010	2011	2012	2013	2014	2015	2016	2017	2010	2011	2012	2013	2014	2015	2016	2017
Norway	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×
Switzerland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes: '✓' indicates that the final (2010, 2011, 2012, 2013, 2014, 2015, 2016) or provisional (2017) emission data reported by a country either meet or fall below its respective emission ceiling.

'×' indicates that a ceiling is exceeded.

exceeded its NMVOC and NO_x ceilings as, in 2019, an approved adjustment application was not sent because of changes to the methodology. The NMVOC and NO_x adjustments were applied for again by Luxembourg.

Progress by non-EU EEA member countries in meeting emission ceilings for 2010 and the 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. EEA members 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 (2019 submission round). Emission data are compared with the countries' emission ceilings under the Gothenburg Protocol.

Data from the above-mentioned countries show that, from 2010 to 2017, Norway exceeded its NO_x and NH_3 ceilings. Switzerland complied with all ceilings for all pollutants (see Table ES.4).

Actions and recommendations for better-quality data

Although reporting has become more complete in recent years, a number of data gaps remain in the official data sets received from Member States. Thus, the completeness of submissions can 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 includes 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 instance 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) and from 2019 onwards an Air Pollution, Transport, Noise and Industry (ETC/ATNI) 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 2019, several Member States were contacted with data requests by the EEA.

1 Introduction

The EC provides this report and its accompanying data (on behalf of the 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 QA and QC, general uncertainty evaluation, general assessment of completeness and information on underestimations (Executive Summary); 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 every 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. Thus, for these pollutants, the EU total remains incomplete.

Several annexes accompany this inventory report:

- Annex A provides a copy of the EU's formal LRTAP Convention data submission for 1990-2017 in the required UNECE reporting format (NFR14).
- Annex B provides the updated EU NO_x emission data for 1987-1989, as required by the 1988 NO_x protocol of the LRTAP Convention.
- Annex C provides results of the key category analyses (KCAs) for the EU, showing the main emitting sectors for each pollutant.
- Annex D presents the EU's gap-filled inventory, colour-coded for the different data sources used and the various 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 present the EU's LRTAP Convention data submission for 1990-2017, 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 gives an overview of the sources of data on emissions of the individual pollutants used when compiling the 2019 EU inventory.
- Annex K provides an overview of the completeness of the gap-filled inventory concerning the notation key 'NE' (not estimated).

1.1 Background

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 ratification status of each protocol across 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	Ratification status
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 per cent (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 protocol's new text 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 levels for 2020 and beyond are (UNECE, 2012a):

1. 59 % for sulphur dioxide (SO_2)
2. 42 % for NO_x
3. 6 % for NH_3
4. 28 % for NMVOCs
5. 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 presented in Appendix 2.

The deadline for individual Parties to submit data to the LRTAP Convention is 15 February 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 purpose of comparing them with total national emissions, may be applied in certain 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 whether or not the adjustment is consistent with the circumstances and 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).

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; in 2017, from Spain; and in 2018, from Hungary and the United Kingdom (UNECE, 2014b, 2015, 2016, 2017, 2018). More information and the 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 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. Each inventory report should include a description of the QA and QC activities and recalculations.

Member States submit their national LRTAP inventories and inventory reports by participating 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/ATNI

European Environment Agency

The EEA helps the European Commission's DG Environment to compile the annual EU LRTAP inventory.

EEA activities include:

- overall coordination and management of the inventory compilation process;

- coordinating the activities of the EEA's European Topic Centre on Air Pollution, Transport, Noise and Industrial pollution (ETC/ATNI) ([6]), which checks the data, compiles the inventory and writes the draft report;
- communication with the EC;
- communication with Member States;
- circulation of the draft EU emission inventory and inventory report;
- hosting the official inventory database and disseminating the data and inventory report on the web.

Since 2004, the EEA and EMEP have supported a separate annual quality review of emission data submitted by the countries. It provides findings for the countries each year in order to improve the quality of emission data reported. Each year, EMEP publishes a joint report summarising the review findings. Section 1.7 below provides further details of the annual data-review process.

European Commission

The EC formally submits the EU emission inventory data and this informative inventory report (IIR) to the EMEP via the Executive Secretary of the UNECE.

European Topic Centre on Air Pollution, Transport, Noise and Industrial Pollution

The main activities of the ETC/ATNI's ([7]) regarding the EU's LRTAP Convention emission inventory include:

- initial checks, tests and a 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 the data and other information provided;
- preparing the gap-filled EU emission inventory by 30 April, based on Member State submissions (which the EC subsequently submits to the UNECE);
- preparing the updated EU emission inventory and inventory report by 30 May.

European Environment Information and Observation Network

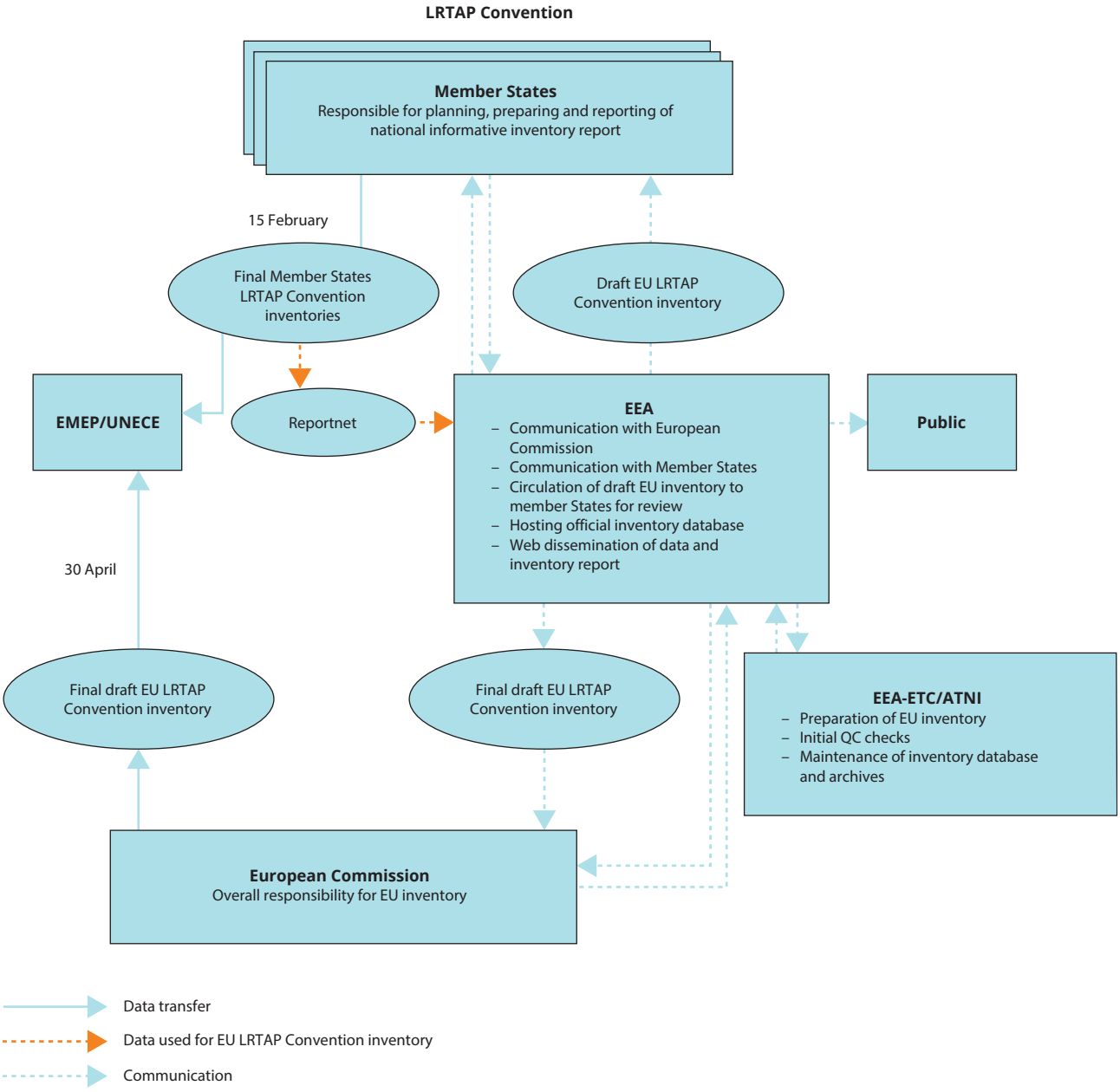
Eionet facilitates the work of the EEA and the ETC/ATNI (EU, 1999) ([8]). It comprises the EEA (supported by its European topic centres), a supporting network of experts from national environment agencies and other bodies that deal with environmental information (Eionet, 2019a). Member States are requested to use the tools of the Central Data Repository (CDR) (Eionet, 2019b) 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/ATNI 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).

(6) The current ETC/ATNI started its operations on 1 January 2019. Until the end of 2018, the EEA cooperated with the ETC on Air Pollution and Climate Change Mitigation (ETC/ACM).
([7]) The current ETC/ATNI was established in 2018 via a contract between the EEA and the lead organisation, the Stiftelsen Norsk Institutt for Luftforskning (Norwegian Institute for Air Research, NILU). It works with nine organisations and institutions across eight European countries.
([8]) 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

1.4.1 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, 2016a). The NEC Directive incorporates the reduction commitments for 2020 under the Gothenburg Protocol into the LRTAP Convention. The new NEC Directive, which came into force on 31 December 2016, 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 to 2005.

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, 2019b). 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, 2016a). Minor differences still occur between reporting under the LRTAP Convention and the NEC Directive:

Table 1.2 Overview of air emission-reporting obligations in the EU, 2019

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 2019	30 April 2019
NEC Directive	NO_x (as NO_2), NMVOCs, SO_x (as SO_2), NH_3, CO, HMs, POPs and PMs	15 February 2019	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 2019 to the European Commission and 15 April 2019 to the UNFCCC	15 April 2019

Notes: [a] Over the years, the European Community and the EU have signed a number of protocols. 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 Comparison of air-pollutant reporting obligations: 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 in continental waters, and international maritime navigation to shipping activity in marine waters. 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': in addition, Austria, Belgium, Ireland, Lithuania, Luxembourg, the Netherlands, Switzerland and the United Kingdom may 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).

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

- 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. For Portugal, this means that emissions from the Azores and Madeira are included. This differs from reporting under the NEC Directive, whereby 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 only obligatory 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 which is small for most Member States.

However, under the LRTAP Convention, the EU may deliver its emission and projections report by 30 April, its IIR by 30 May and its gridded data and LPS by 15 June.

1.4.2 General methods

The EU LRTAP Convention emission inventory is based on an aggregation of data reported by Member States. The methods they use 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 methods available 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 improving 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 specification of the sources of default emission factors and methods. It also provides 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 basis of the EU inventory. For detailed descriptions of methodologies and data sources, see Member States' IIRs (see Appendix 5 for IIR references).

1.4.3 Data sources

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 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 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; see Appendix 5.

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

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 geographical 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 geographical 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 the fuel consumed. When fuel purchased within a country is used outside that country (and vice versa), these estimates can differ significantly. The EU inventory compiled in 2019 estimates emissions from road transport based on the 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 inventory data reported as it is the responsibility of Member States to submit full and accurate inventory data sets. However, Member States' submissions include 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 are complete. In 2019, the gap-filling procedure is identical to that in 2018 and follows a methodology paper by the EEA and the ETC/ACM (EEA, 2009) as well as some changes agreed at the meeting of the Task Force on Emission Inventories and Projections (TFEIP) in 2016 ([9]). This procedure is also consistent with the techniques used to fill emission data gaps proposed by the Inventory guidebook (EMEP/EEA, 2016). It applies 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 is applied only where national total and sectoral data are 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 making gap filling impossible. In such instances, the EU emission totals for these pollutants are considered incomplete (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 1.9, 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. Three Member States (Luxemburg, Malta and Romania) did not provide a complete time series in 2019, and Greece did not send any inventory data.

1.5 Reporting

1.5.1 Emission reporting

The deadline for Member States to report was 15 February 2019. In the 2019 reporting cycle, 22 Member States submitted their inventories and

([9]) 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 for all pollutants have been compiled from 1990 onwards using the LRTAP Convention emission inventories provided by the Member States to the EEA in 2019.

2. LRTAP Convention data submitted to the EMEP CEIP in 2019 are the next source used to fill remaining gaps. All reported data (i.e. values and notation keys) are 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 the EMEP CEIP.

3. For those Member States not reporting 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 any gaps still remaining (values and notation keys).

8. Older LRTAP Convention data submitted to the 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 are missing in the middle of a time series.

    (b) Linear extrapolation is performed if one or several years are missing either at the beginning or at the end of a time series, and if at least five 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 5 consecutive years are available as a basis for extrapolation, or if years do not show a clear trend (as 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 made to the gap-filled data in all cases where TSP emissions are lower than PM_{10} emissions, PM_{10} emissions are lower than $PM_{2.5}$ emissions or $PM_{2.5}$ emissions are lower than BC emissions. In these cases, PM_{10} data are equated with TSP data, $PM_{2.5}$ data with PM_{10} data, and BC data with $PM_{2.5}$ data.

time series on time. Greece made no submission, and Croatia, Hungary, Italy, Malta and Poland submitted their data after the formal deadline for submission (see Appendix 3, Figure A3.1). Three Member States did not provide a complete time series in 2019 (Luxembourg, 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.

1.5.2 Projection data

In 2019, reporting of projection data is mandatory and the deadline for Member States to report was 15 March 2019. 23 Member States have submitted information on their projections so far; three of them after the deadline. Submitted data are available in Annex E of this report.

1.5.3 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 four years, starting in 2017. Since gridded data for the EU were last submitted in 2017 (EEA, 2017a), they are not reported this year. However, in 2019, four Member States (Denmark, Finland, Germany and Spain) provided gridded data (see Appendix 3, Table A3.1).

1.5.4 Large point sources

Parties within the geographical scope of EMEP are also required to provide data on LPSs every four years, commencing in 2017. LPS data for the EU were last submitted in 2017 (EEA, 2017a) and not reported again this year. In 2019, two Member States (Finland and Spain) have provided LPS data.

1.5.5 Reporting on condensable components from $PM_{2.5}$ and PM_{10}

Particulate matter consists of a filterable fraction and a condensable fraction which reacts upon cooling and dilution shortly after release to form solid or liquid PM. The reporting of condensable components is not mandatory and in recent years there has been no clear definition as to whether PM emission reporting includes or excludes the condensable component. However, in 2019, a new reporting table within Annex II to the Reporting Guidelines (CEIP, 2019a), Table A6.1 on 'Inclusion/exclusion of the condensable component from PM_{10} and $PM_{2.5}$ emission factors', was established. In 2019, 15 Member States provided information using this table. However, the level of information is rather inhomogeneous and for many categories no information is available at all.

1.6 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).

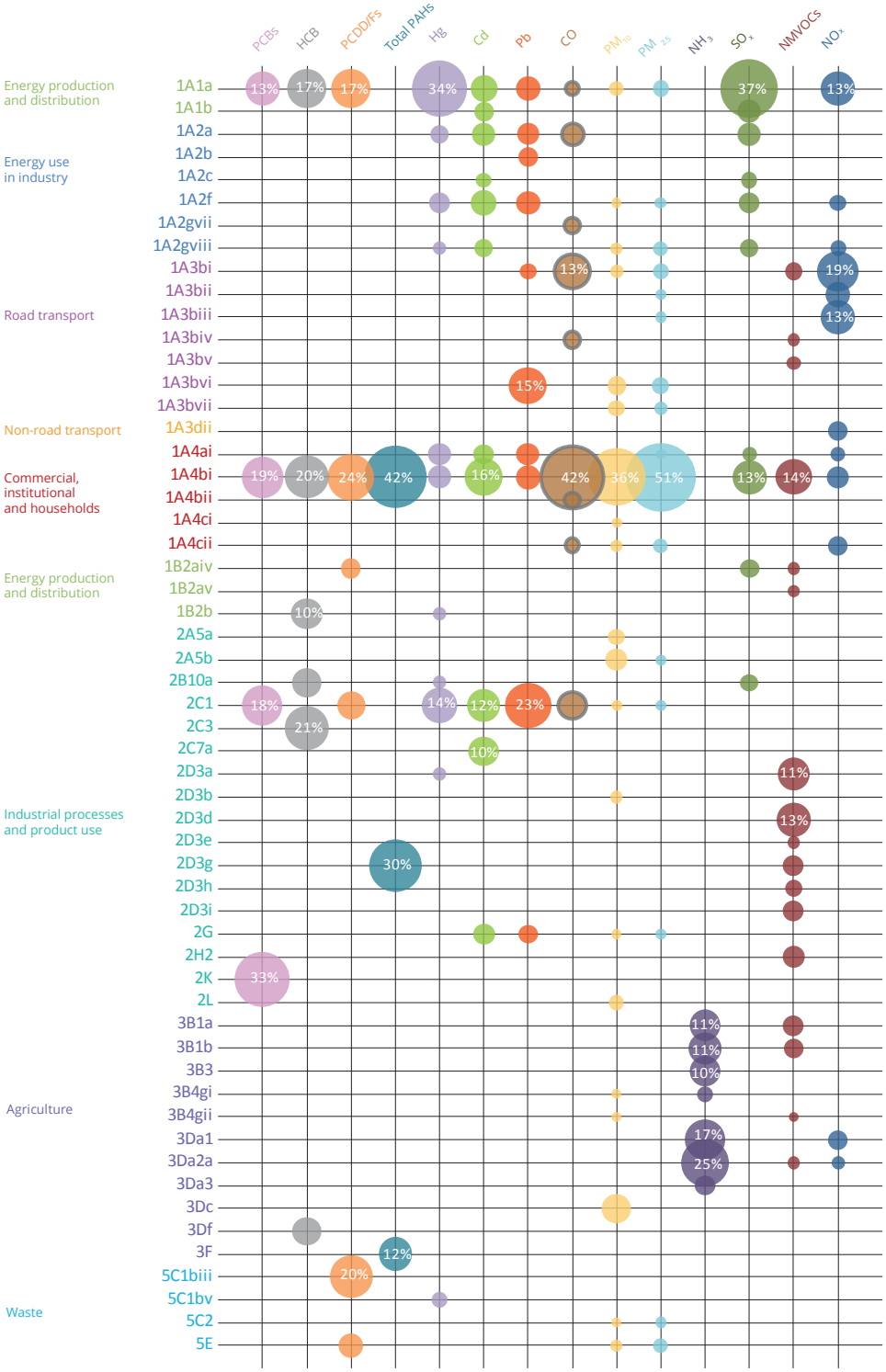
A level analysis of 2017 emissions for each pollutant (following any necessary gap filling) determined EU key categories. When a Member State used the notation 'included elsewhere' (IE) for a particular source/pollutant combination, the KCA is likely to have underestimated the category concerned and overestimated the one in which emissions were reported instead.

Chapter 3 provides a summary of the top five EU key categories in 2017, for NO_x, NMVOCs, SO_x, NH_3, $PM_{2.5}$, PM_{10}, BC, 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 or the remaining POPs are not considered here.

A total of 59 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 16 pollutants assessed. '1A4bi — Residential: Stationary' and '1A1a — Public electricity and heat production' were identified as being important emission sources for 15 and 11 pollutants, respectively. '2C1 — Iron and steel production' was a key category for eight pollutants, and the categories '1A2f Stationary combustion in manufacturing industries and construction: Non-metallic minerals', '1A2gviii Stationary combustion in manufacturing industries and construction: Other' and '1A3bi Road transport: Passenger cars' were key categories for seven pollutants, respectively.

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

Figure 1.2 EU Key Category Analysis results for 2017



Notes: Bubble size indicates amount of emissions.

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

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 industrial processes and product use sector.

For the HM Cd and Hg, 12 key categories were identified, as were 11 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.

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

	Check							First checks	Subsequent checks (after gap-filling)	Checks within the draft report	Member States will be informed on the finding	Changes/ corrections
	Completeness	Consistency	Comparability	Accuracy	Transparency	Level	Years					
Reporting overview	✓		✓		✓	Submissions	1990-2017	✓			If submission is missing or in wrong format	Gap-filling of missing data as far as possible
Adjustment overview	✓		✓		✓	Submissions	2010-2017	✓			If a document is missing or in wrong format	
Completeness	✓				✓	Submissions	1990-2017	✓			Yes	Only in case of resubmissions of the Member State
Time series checks	✓	✓				National Totals, Sectors	1990-2017	✓			Yes	Only in case of resubmissions of the Member State
NFR template line 144 check			✓		✓	National Totals	1990-2017	✓			Yes	Only in case of resubmissions of the Member State
Total PAHs = Sum of PAHs				✓		National Totals	1990-2017	✓			Yes	Only in case of resubmissions of the Member State
TSP-PM_{10} ratio, PM_{10}-$PM_{2.5}$ ratio checks				✓		National Totals	1990-2017	✓			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	1990-2017	✓			Yes	Only in case of resubmissions of the Member State
National Total = Sum of Sectors	✓			✓		National Totals, Sum of Sectors	1990-2017		✓		If difference is more than 5 %	Only in case of resubmissions of the Member State
'NE' analysis	✓					National Totals, Categories	2017		✓	✓	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	2017		✓		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, 2017			✓	Within the review of the draft version of the report	No
Completeness of the EU inventory	✓				✓	Whole EU inventory	1990, 2017			✓	Within the review of the draft version of the report	No

For the POPs, source categories from all sectors except road transport and energy use in industry 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 from 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.

1.7 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/ATNI performs on the status of each Member State's submission. In addition, it checks the internal consistency of Member States' data tables before compiling the EU tables. It checks Member State data at national total and sectoral level: when it finds outliers, it identifies the categories responsible. When it finds no explanation for a notable trend in the IIRs, it contacts the Member States. The checks focus on data that significantly 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 LRTAP Convention secretariat. In addition, 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 Member States' emission reporting. The 2019 meeting took place in Thessaloniki, Greece, in May (TFEIP, 2019).

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/ATNI Forum data portal. Revisions of data sets are recorded.

The EMEP CEIP performs more detailed QA activities in an annual review process (EMEP CEIP, 2019b). It reviews Member State LRTAP Convention emission inventories at the same time as the EEA reviews those reported under the NEC Directive (EU, 2016a). The EMEP CEIP technical review of inventories is carried out in three stages. Stages 1 and 2 include checks on timeliness,

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

Test/check	Findings	Number of MS concerned
Completeness	5	4
Time series checks	141	27
NFR template line 144 check	4	3
Total PAHs = Sum of PAHs	7	6
TSP-PM_{10} ratio, PM_{10}-$PM_{2.5}$ ratio checks	4	4
TSP ≥ PM_{10}, PM_{10} ≥ $PM_{2.5}$, $PM_{2.5}$ ≥ BC checks	51	18
National Total = Sum of Sectors ([a])	4	1
'NE' analysis ([a])	656	27
'NA' and 'NO' checks ([a])	161	24

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

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. Each year, a joint EMEP/EEA review report publishes summary results of the review (stages 1 and 2) ([10]).

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. The CEIP selects the countries in cooperation with the EEA and EMEP. In 2018, it reviewed Armenia, Azerbaijan, Belarus, Finland, Moldova and the Ukraine. The results are included in individual country-specific reports (EMEP CEIP, 2019c). In 2019, it plans to review Albania, Georgia, Norway, the Russian Federation, Serbia and Turkey.

1.8 General uncertainty evaluation

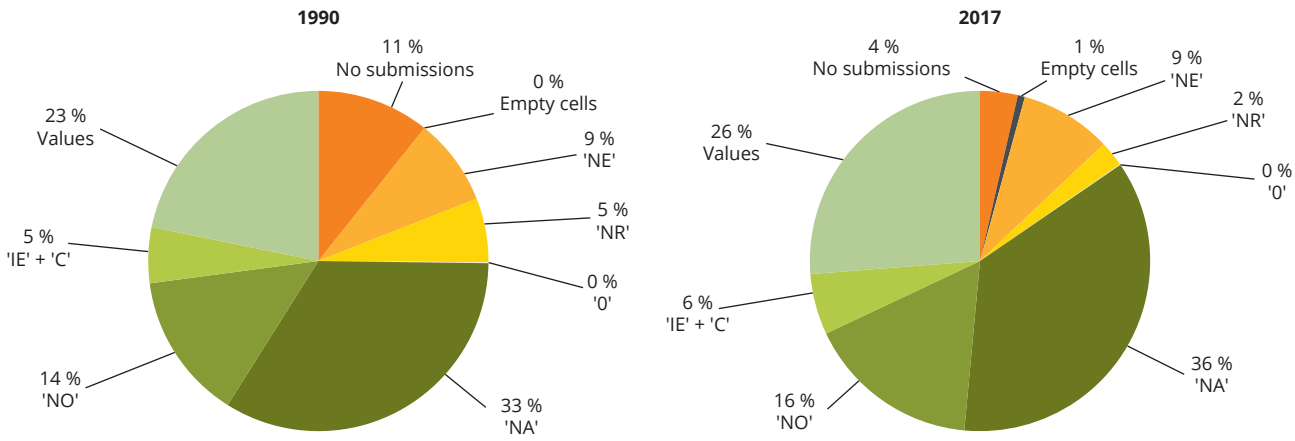
To quantify uncertainty in the EU LRTAP emission inventory, Member States first need to provide detailed information on emission uncertainties. Only 19 Member States (Austria, Belgium, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, Lithuania, the Netherlands, Poland, Spain, Sweden and the United Kingdom) quantified uncertainty in their 2017 emission inventories. The pollutants they consider and the assumptions behind the uncertainty analysis vary across Member States; because so few provide an uncertainty estimate, the overall uncertainty of the EU LRTAP inventory cannot be estimated.

1.9 Completeness and underestimations

In this context, completeness 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. Three Member States (Luxembourg, Malta and Romania) did not provide a complete time series in 2019. For substances and data for which reporting is encouraged, Austria and Luxembourg 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 and Spain submitted only total PAHs, but either no or insufficient data for all the individual components. A total of 27 Member States reported activity data ([11]), and 25 reported activity data for the complete time series (1990-2017). The stage 1 review provides detailed results for the completeness of Member State submissions (EMEP CEIP, 2019d).

Figure 1.3 shows a simple compilation indicating completeness of Member State reporting for the inventory years 1990 and 2017. It uses the NFR

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.

([10]) The EMEP and EEA will jointly publish a summary of the results of the stage 1 and 2 review performed in 2019 (EMEP/EEA, 2019, forthcoming).
([11]) Activity data should be reported together with emissions since 2009 (UNECE, 2009).

templates which were submitted originally, 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 2017 than for 1990. The notation key NA appears often 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 the notation key NR ([12]), as well as 'No submissions' and 'Empty cells', count as incomplete reporting. Member States reported 16 % of the 2017 data entries incompletely, while for 1990 they reported 25 % of the data incompletely.

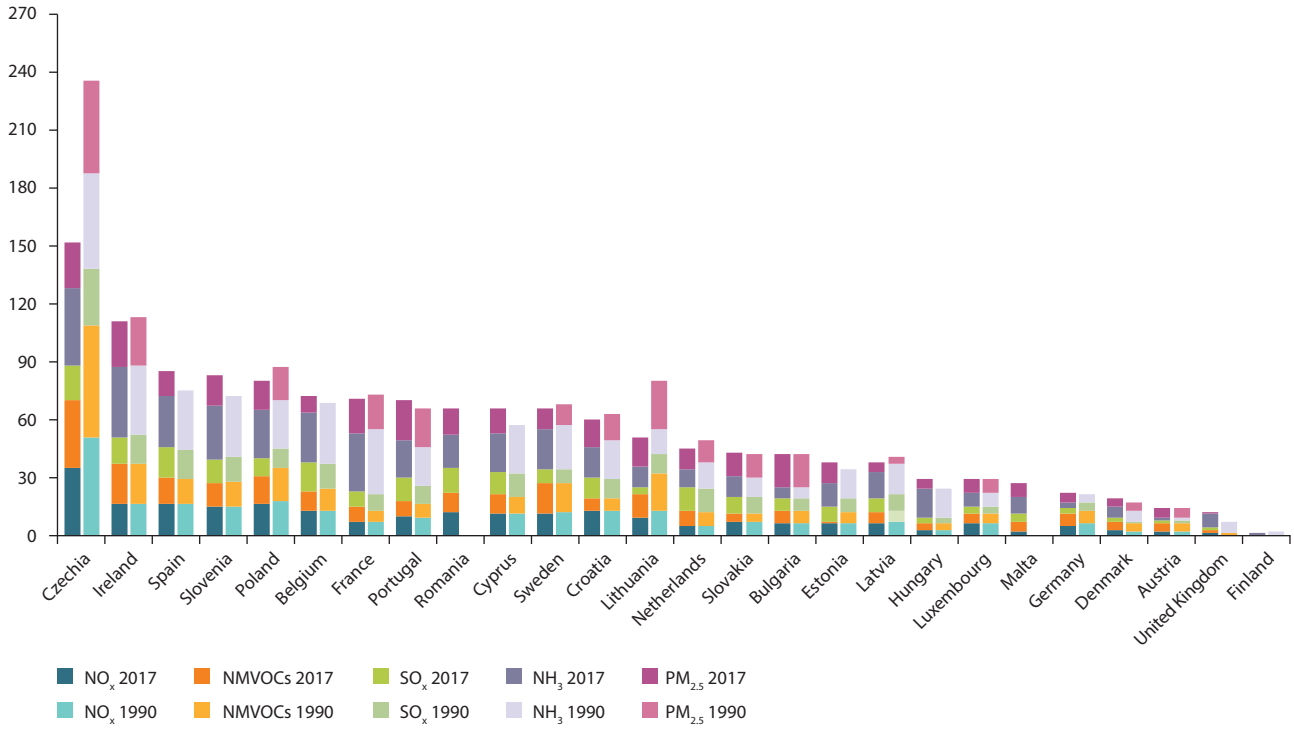
The EMEP emission-reporting guidelines (UNECE, 2014a) require Parties to report data at least for the base year of the relevant protocol, and from the year it entered into force, and up to the latest year (2 years before the present) (see Appendix 2, Table A2.1). So, ideally, there should be no difference between the availability of data submissions for 1990 and for 2017.

There are many instances where some countries report emissions for a particular NFR category and pollutant while others use the notation keys 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 report separately as to why they have not estimated emissions.

Certain Member States use the notation key NE for many source categories (see Figure 1.4). For example, in 1990, Czechia reported 58 source categories of NMVOC as NE. Overall, in most cases, the use of NE in reporting in 2017 is similar to its use in 1990. Most uses (across all pollutants and Member States) are in the categories '5E — Other waste', '1A3ai(i) — International aviation LTO (civil)', '2D3g — Chemical products' and '2D3c — Asphalt roofing'. Within these categories, more than 25 % of the entries mention NE.

Figure 1.4 Number of 'not estimated' source categories for 2017 and 1990

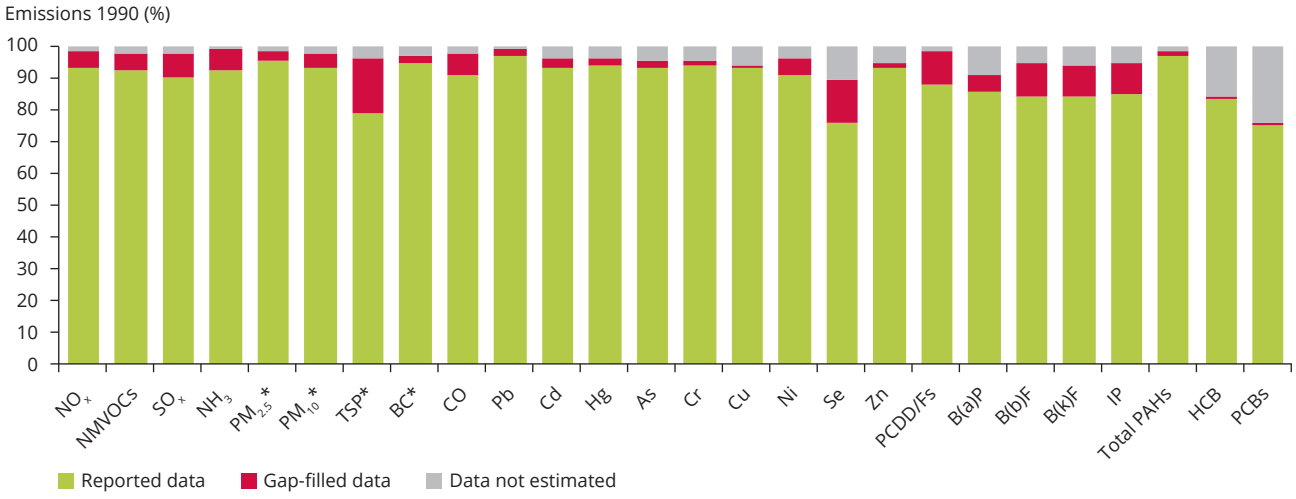


Note: The LRTAP Convention formally requests Parties to report emissions of PM for 2000 and thereafter. Therefore, 'NE' reporting for $PM_{2.5}$ in 1990 might be high for several countries.

([12]) According to the emission-reporting guidelines (UNECE, 2014a), emission inventory reporting should cover all years from 1990 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.

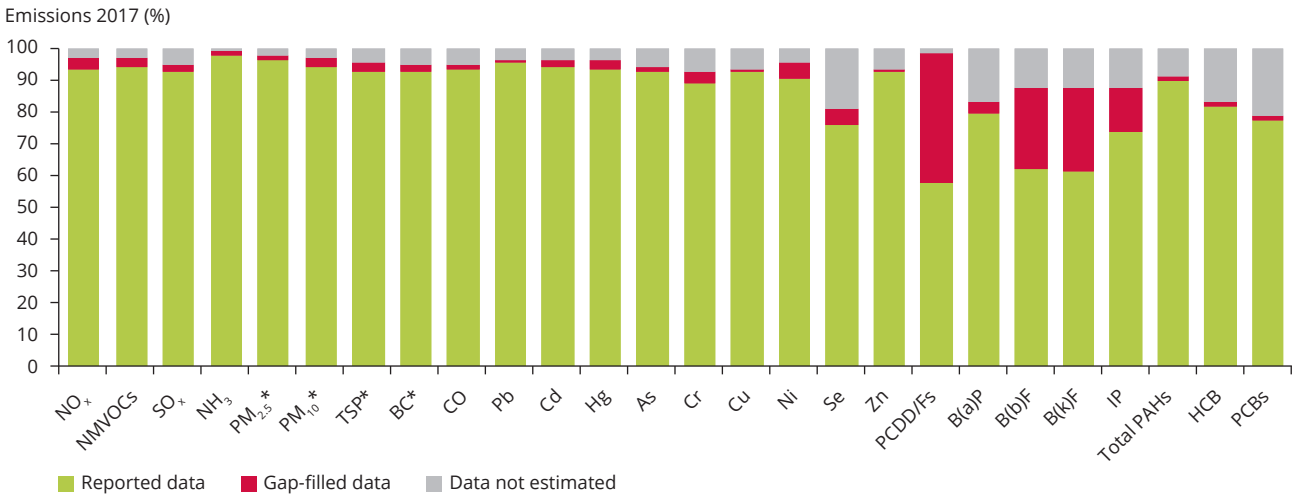
Figure 1.5 and Figure 1.6 show the proportions of gap-filled data and the estimated underestimation of the EU inventory for 1990 (2000 for PMs and BC), and for 2017. The calculated underestimation comprises missing data (e.g. if emission data of a pollutant were not estimated by a Member State and no data were available for gap filling) and the use of the notation keys NE and NO and zero values. To calculate the underestimation, first, the specific share of total emissions for each Member State was 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, this Member State's share was used to calculate the missing emissions within the respective sector. The sum of the missing emissions from all sectors and Member States was then calculated as the percentage value of the total emissions of a pollutant.

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 2017



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 then have the option of making a submission to the Implementation Committee under Decision 2006/2 (UNECE, 2006).

These circumstances are as follows:

- emission source categories are identified that were not accounted for at the time the emission-reduction commitments were set;
- emission factors used to determine emission levels for particular source categories have changed since the emission-reduction commitments were set;
- 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 accepted by the EMEP Steering Body in 2014, 2015, 2016, 2017 and 2018.

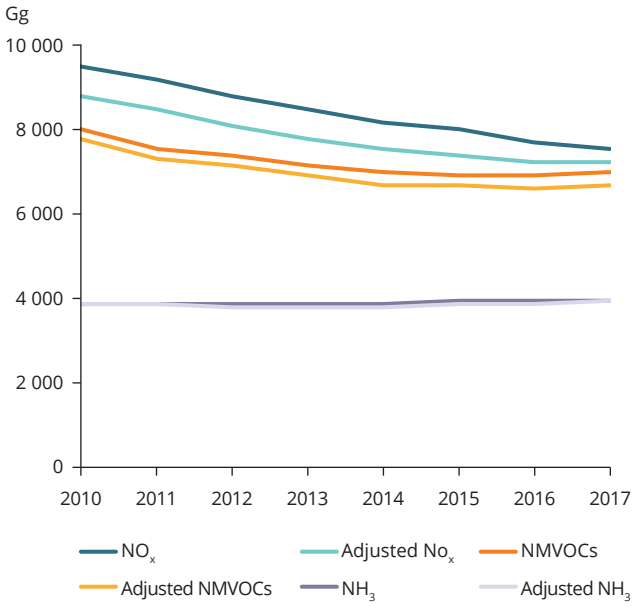
If a Party is planning to adjust its inventory for the purpose of comparing total national emissions with emission-reduction commitments, it indicates in its notification to the UNECE secretariat and the CEIP what categories and pollutants are affected. It uses Annex II

Table 2.1 Accepted inventory adjustment applications (UNECE, 2014b, 2015, 2016, 2017, 2018)

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
2018	Hungary	NMVOCs	3B, 3De	2010-2016
2018	United Kingdom	NO_x	1A3bi-iv	2010

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

Figure 2.1 **Adjusted and unadjusted emissions of NO_x, NMVOCs and NH_3 for the EU, 2010-2017**



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 2019. In 2019, Luxembourg stated that, since activity data, emission factors and methodology of its previously approved adjustments for the sectors 3B and 3D have changed, it must now apply for a new adjustment application.

Table 2.3 gives an overview of reported adjustments within the LRTAP submission in 2019. All approved and 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 must 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 must 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 the effect in the EU of the adjustments on the emissions (sum of Member States' adjustments). Although for NO_x, the EU emissions change considerably, there are only slight effects on the NMVOC and NH_3 emissions.

Table 2.2 **Adjustment application within the LRTAP submission 2019 (Annex II to the reporting guidelines (UNECE, 2014a)) (as of 9 May 2019)**

Member State	Pollutant	NFR	Years
Luxembourg	NO_x	1A3b, 3B, 3D	2010-2017
	NMVOCs	3B, 3D	2010-2017
Netherlands	NH_3	3B, 3Da4	2014-2017
	NMVOCs	3B, 3D	2010-2017

Table 2.3 **Reporting of approved adjustments within the LRTAP submission 2019 (Annex I and Annex VII to the reporting guidelines (UNECE, 2014a)) (as of 9 May 2019)**

Member State	Pollutant	Years	Annex I ('adjustment row')	Annex VII	Declaration on consistent reporting of approved adjustments
Belgium	NO_x	2010-2017	Yes	Yes	Yes
Denmark	NH_3	2010-2017	Yes	Yes	Yes, in the cover letter
Denmark	NMVOCs	2010-2017	Yes	Yes	Yes, in the cover letter
Finland	NH_3	2010-2017	Yes	Yes	Yes
France	NO_x	2010-2017	Yes (years 2010-2016)	Yes	Yes
Germany	NO_x	2010-2017	Yes	Yes	Yes
Germany	NMVOCs	2010-2017	Yes	Yes	Yes
Germany	NH_3	2010-2017	Yes	Yes	Yes
Hungary	NMVOCs	2010-2017	Yes	Yes	Yes
Luxembourg	NO_x	2010-2017	No (Announcement to apply anew due to AD, EF and method changes)		
Luxembourg	NMVOCs	2010-2017	No (Announcement to apply anew due to AD, EF and method changes)		
Spain	NO_x	2010-2017	Yes	Yes	Yes
United Kingdom	NO_x	2010, 2012	Yes	Yes	Yes

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).

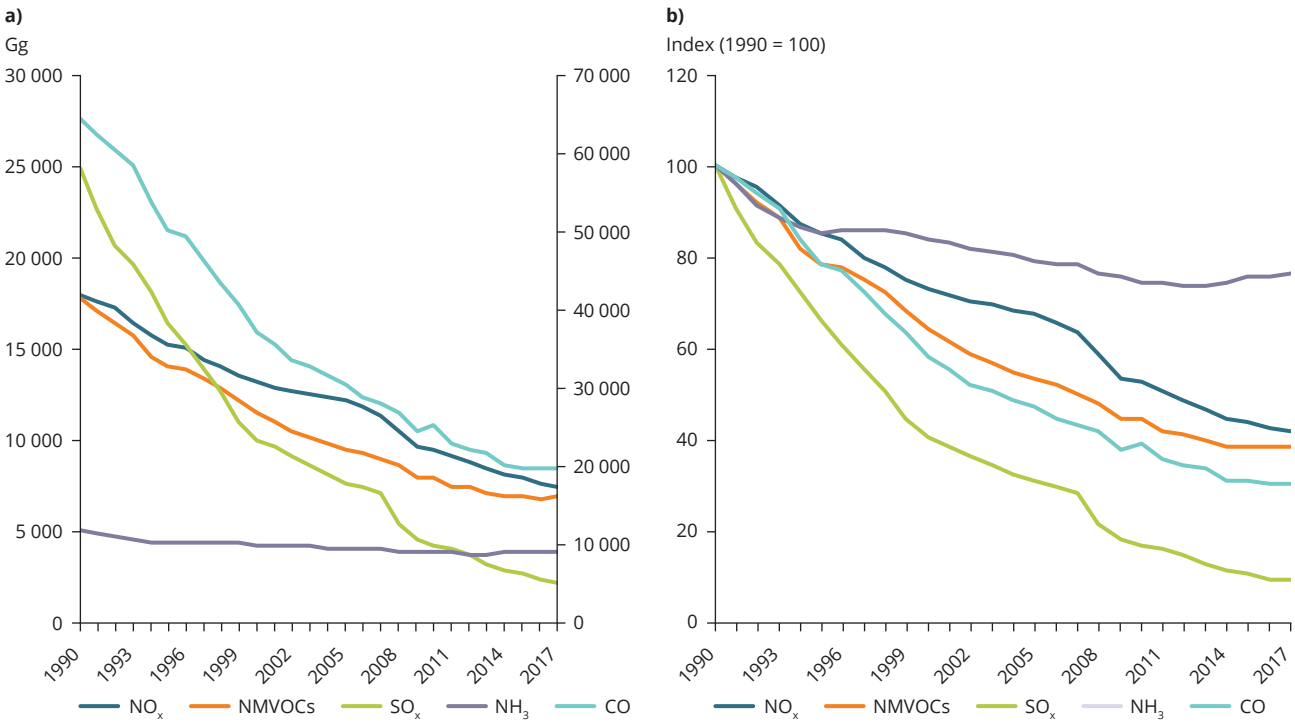
In Chapter 3, the following sections summarise the contributions each Member State has made to total EU emissions of NO_x, NMVOCs, SO_x, NH_3, CO, $PM_{2.5}$, PM_{10}, TSPs, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/Fs, total PAHs, B(a)P, B(b)F, B(k)F and IP, HCB and PCBs. For BC, TSP, additional HMs, B(a)P, B(b)F, B(k)F and IP data for several countries (at least for some years) were missing and could not be gap-filled. Therefore, the EU total is not complete (see also Section 1.9). For the main pollutants and PM, HMs and POPs, and also B(a)P and BC, the EU's emission trend is given for the five most important key categories as well as the share by sector group and sectoral emission trends.

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

3.1.1 Total trends in EU emissions

In 2017, emissions of all pollutants except Cu were lower 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 (-61 %), NO_x (-58 %) and NH_3 (-24 %) (Figure 3.1).

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



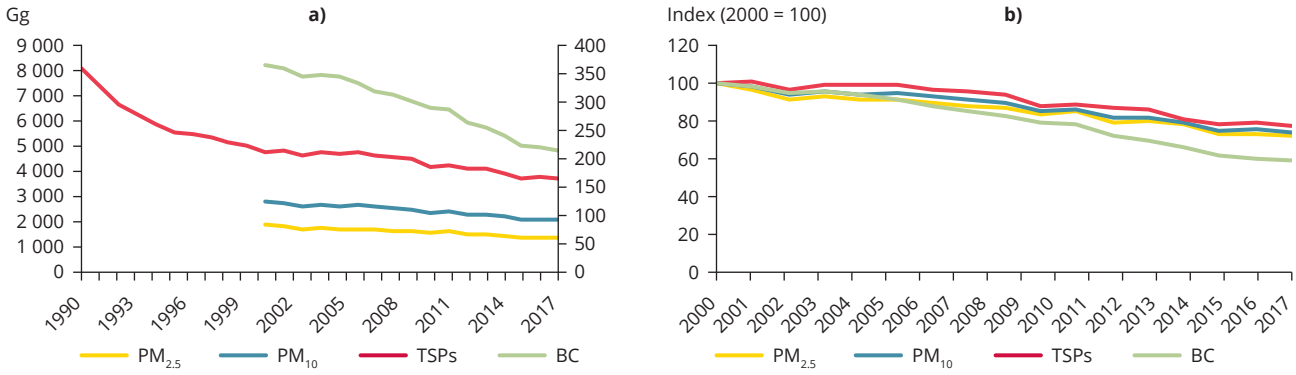
Note: The right-hand axis gives values for CO emissions.

Emissions of PM, BC and TSPs have also dropped substantially since 1990 (Figure 3.2). Emission data for 2000-2017 indicate that $PM_{2.5}$ and PM_{10} emissions have fallen by 29 % and 27 %, respectively. BC emissions have also dropped by 42 % in the same time period (Figure 3.2).

In addition, for HMs and POPs, emissions have reduced significantly since 1990 (Figure 3.3). Reductions are especially high for Pb (-93 %) and HCB (-96 %).

For various pollutants (e.g. BC, HMs and POPs), some Member States either did not report data or reported

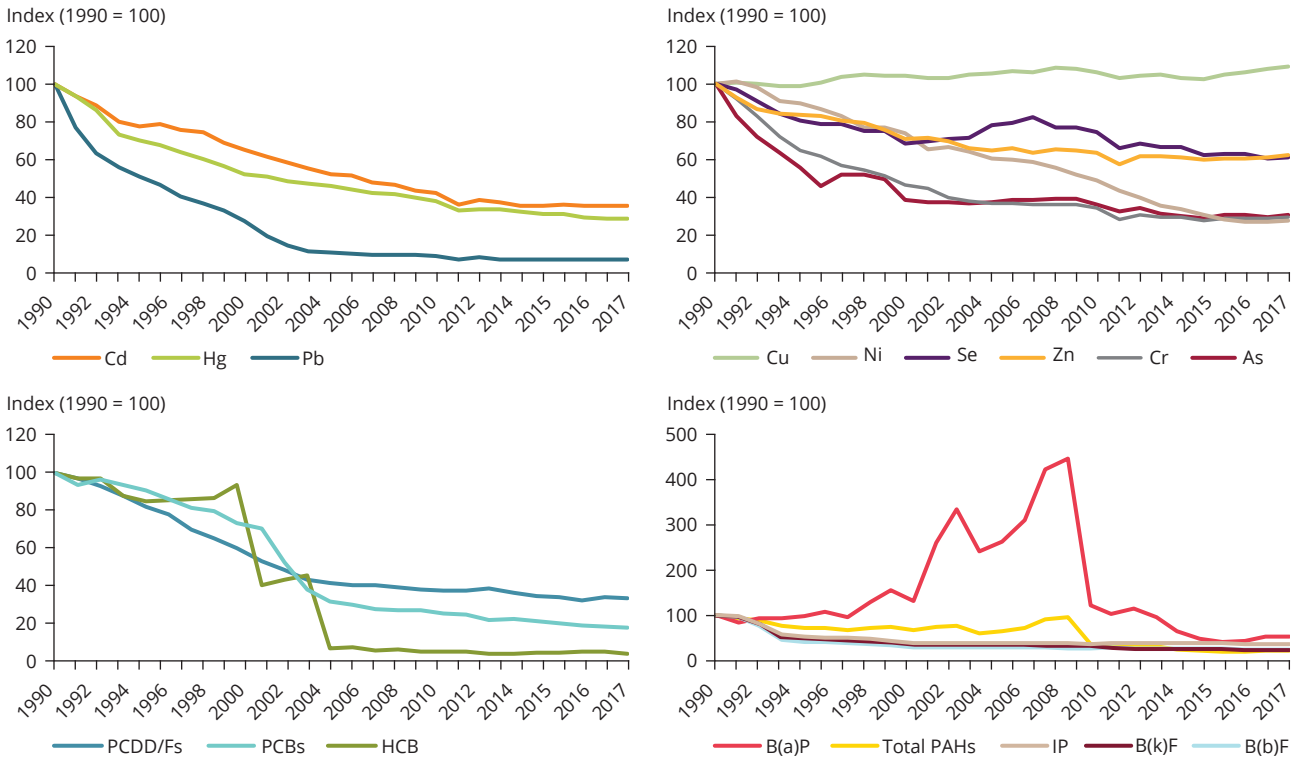
Figure 3.2 (a) EU emission trends and (b) indexed emissions for PM and BC



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 %).

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 drop in HCB emissions between 2001 and 2002 is caused by reductions reported by Germany.

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

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 1.9 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

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

Pollutant	Unit	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	Change 1990-2017	Change 2016-2017
NO_x	Gg	18 007	15 315	13 195	12 146	9 515	9 144	8 808	8 431	8 122	7 956	7 672	7 532	-58 %	-1.8 %
NO_x (adjusted data*)	Gg					8 771	8 497	8 073	7 785	7 490	7 357	7 185	7 235		
NMVOCs	Gg	17 842	14 055	11 476	9 560	7 993	7 553	7 403	7 162	6 939	6 905	6 876	6 964	-61 %	1.3 %
NMVOCs (adjusted data*)	Gg					7 728	7 289	7 135	6 890	6 664	6 633	6 606	6 695		
SO_x	Gg	24 910	16 471	10 083	7 707	4 207	4 111	3 698	3 223	2 958	2 792	2 352	2 323	-91 %	-1.3 %
NH_3	Gg	5 177	4 414	4 335	4 117	3 866	3 862	3 835	3 834	3 864	3 916	3 938	3 954	-24 %	0.4 %
NH_3 (adjusted data*)	Gg					3 816	3 803	3 775	3 765	3 793	3 846	3 867	3 883		
TSPs	Gg	7 950	5 321	4 812	4 742	4 223	4 035	3 892	3 853	3 707	3 739	3 697	3 730	-53 %	0.9 %
CO	Gg	64 191	50 367	37 336	30 325	25 342	22 902	22 219	21 810	20 030	19 999	19 803	19 835	-69 %	0.2 %
Pb	Mg	22 797	10 656	4 354	2 141	1 768	1 561	1 552	1 503	1 526	1 509	1 497	1 521	-93 %	1.6 %
Cd	Mg	191	150	117	92	74	71	68	68	69	67	67	68	-64 %	1.1 %
Hg	Mg	202	137	103	85	68	67	66	63	62	59	57	57	-72 %	-0.7 %
As	Mg	521	239	195	200	177	163	156	149	159	159	153	160	-69 %	4.8 %
Cr	Mg	1 254	775	555	451	383	369	363	347	361	359	359	364	-71 %	1.6 %
Cu	Mg	3 598	3 619	3 702	3 821	3 754	3 784	3 718	3 690	3 775	3 833	3 897	3 943	10 %	1.2 %
Ni	Mg	2 193	1 908	1 438	1 287	867	773	733	666	619	592	594	597	-73 %	0.6 %
Se	Mg	281	221	196	231	192	187	187	175	177	177	170	172	-39 %	1.0 %
Zn	Mg	9 568	7 940	6 837	6 072	5 871	5 910	5 838	5 738	5 798	5 810	5 851	5 956	-38 %	1.8 %
PCDD/Fs	g I-Teq	9 265	7 200	4 458	3 574	3 315	3 180	3 131	2 975	3 140	3 040	2 910	3 033	-67 %	4.2 %
B(a)P	Mg	1 221	1 330	3 198	5 165	1 160	778	599	497	540	638	652	649	-47 %	-0.4 %
B(b)f	Mg	1 089	431	316	311	296	293	301	296	274	272	265	259	-76 %	-2.4 %
B(k)f	Mg	507	237	170	168	128	128	131	130	120	120	116	113	-78 %	-2.3 %
IP	Mg	414	213	157	157	162	158	163	160	148	147	146	143	-65 %	-1.8 %
Total PAHs	Mg	6 506	4 647	4 794	5 994	1 998	1 566	1 413	1 299	1 301	1 410	1 429	1 449	-78 %	1.4 %
HCB	kg	8 116	6 937	3 493	493	299	319	340	392	374	269	270	288	-96 %	6.6 %
PCBs	kg	14 061	12 083	7 355	3 788	3 088	2 905	2 799	2 608	2 497	2 426	2 375	2 366	-83 %	-0.4 %
														Change 2000-2017	Change 2016-2017
$PM_{2.5}$	Gg			1 825	1 667	1 551	1 435	1 443	1 416	1 309	1 313	1 301	1 304	-29 %	0.3 %
PM_{10}	Gg			2 751	2 579	2 348	2 209	2 180	2 147	2 031	2 034	2 012	2 019	-27 %	0.4 %
BC	Gg			354	327	280	258	248	234	217	213	207	203	-42 %	-1.8 %

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 2017 as $100 \times (E_{2017} - E_{1990}) / E_{1990}$ (%), where E_{2017} and E_{1990} are 2017 and 1990 total emissions, respectively. They express changes in emissions from 2016 to 2017 as $100 \times (E_{2017} - E_{2016}) / E_{2016}$ (%), where E_{2017} and E_{2016} are the 2017 and 2016 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 total national data for 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 Body accepted inventory adjustment applications ([13]) 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.

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

Table 3.2 Comparison of emissions reported for 2017 by the EU-15 Member States with emission ceilings for the EU specified in the UNECE Gothenburg Protocol

Pollutant	EU-15 emissions, 2017 (Gg)	EU-15 Gothenburg Protocol, 2010 ceilings (Gg)	Difference	Sum of individual EU-15 ceilings (Gg) [a]
NO_x	5 812	6 671	-13 %	6 519
NMVOCs	5 303	6 600	-20 %	6 510
SO_x	1 275	4 059	-69 %	3 850
NH_3	3 131	3 129	0.1 %	3 110

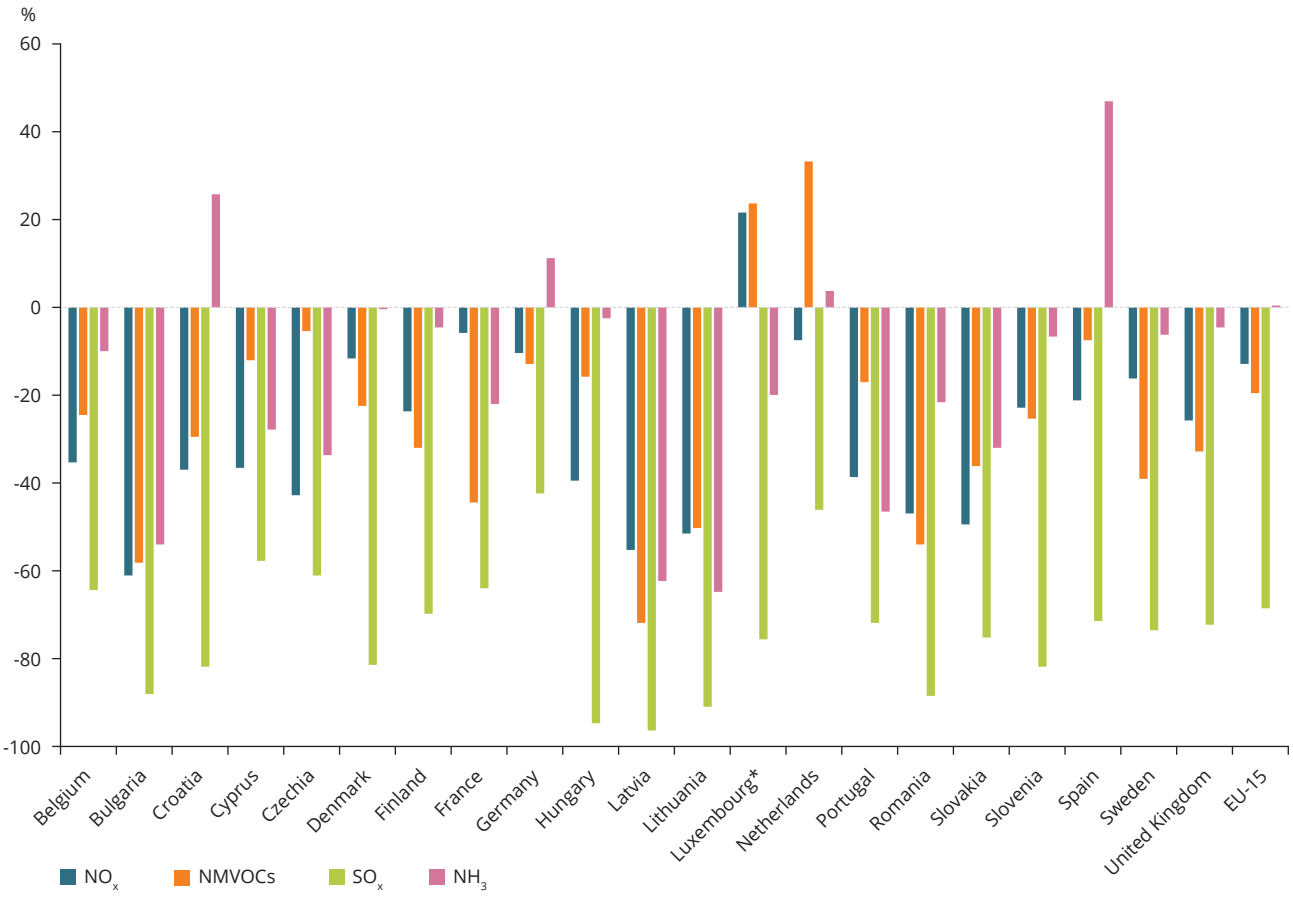
Notes: For Spain, data for emission comparisons exclude emissions from the Canary Islands, i.e. data comprise the EMEP domain only.

For Portugal, 2010 and 2020 reduction targets the Azores and Madeira emissions are excluded .

Under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Belgium, Denmark, Finland, France, Germany, Hungary, Luxembourg, Spain and the United Kingdom in 2014, 2015, 2016, 2017 and 2018. However, as the EU-15 as a whole 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 to Gothenburg ceilings for EU Member States in 2017



Notes: Estonia and Malta do not have Gothenburg ceilings. Austria, Greece, Ireland, Italy and Poland have ceilings but 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 chose instead to calculate their emissions on the basis of fuel used in their territories (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, Hungary, Luxembourg, Spain and the United Kingdom in 2014, 2015, 2016, 2017 and 2018. 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.

* Luxembourg has not reported adjustments in 2019.

States or found in their IIRs is included in the trend sections (see Sections 3.3 to 3.28). If no information is provided on unusual trends, Member States are contacted, informed about the findings and requested to send an explanation. As information on unusual trends is often not received, Sections 3.3 to 3.28 are very inconsistent as regards which variations in trends are explained and which are not.

3.1.2 Progress towards the Gothenburg Protocol 2010 emission ceilings

The Gothenburg Protocol to the UNECE LRTAP Convention (UNECE, 1999) specifies 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 addition to ceilings for individual countries, the protocol also specifies ceilings for the EU, which is also a Party to the protocol. Table 3.2 sets out the emissions reported for 2017 by the EU-15 Member States, compared to the respective emission ceilings specified for the EU. In this report, the comparison with the EU-15 ceilings in the Gothenburg Protocol are based on fuel sold. For all pollutants, except for NH_3, emissions in 2017 were below the ceilings.

Figure 3.4 shows whether or not EU Member States met the Gothenburg ceilings in 2017. 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. Four countries exceeded their NH_3 ceilings (Croatia, Germany, the Netherlands and Spain); two Member States (Luxembourg and the Netherlands) did not comply with its ceiling for NMVOCs; and one Member State (Luxembourg) exceeded its NO_x ceilings. All Member States complied with their SO_x ceilings.

In June 2019, the EEA publishes its annual NEC Directive reporting, which analyses the emission data reported under the EU NEC Directive for EU Member States (EEA, 2019a, forthcoming). For EU Member States, the new NEC Directive (EU, 2016a) 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.

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 2019, all EEA-5 countries (non-EU EEA members Iceland, Liechtenstein, Norway, Switzerland and Turkey) except Liechtenstein submitted their emission data (see Table 3.3).

Table 3.3 Emissions reported by the EEA-5 member countries from 2010 to 2017

EEA Member Country	Emission data (Gg)															
	NO_x								NMVOCs							
	2010	2011	2012	2013	2014	2015	2016	2017	2010	2011	2012	2013	2014	2015	2016	2017
Iceland	27	24	24	23	23	24	22	23	5.7	5.6	5.4	5.3	5.4	5.5	5.7	5.6
Liechtenstein																
Norway	206	207	203	196	189	178	170	163	161	154	154	156	166	164	157	153
Switzerland [a]	75	72	71	71	68	66	65	63	91	88	87	85	82	80	78	78
Turkey	707	745	656	710	705	713	722	785	1 049	1 034	1 094	1 039	1 039	1 077	1 062	1 099
	SO_x								NH_3							
	2010	2011	2012	2013	2014	2015	2016	2017	2010	2011	2012	2013	2014	2015	2016	2017
Iceland	77	84	86	72	66	61	52	50	5.2	5.3	5.1	5.0	5.3	5.3	5.3	5.3
Liechtenstein																
Norway	19	19	17	17	17	17	15	15	33	33	33	33	33	33	33	33
Switzerland [a]	11	8.5	8.8	8.2	7.5	5.8	5.4	5.4	57	57	56	56	56	55	55	55
Turkey	2 557	2 637	2 703	1 940	2 149	1 948	2 250	2 350	606	643	713	755	704	673	683	740

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

Member State	NO_x								NMVOCs							
	2010	2011	2012	2013	2014	2015	2016	2017	2010	2011	2012	2013	2014	2015	2016	2017
Norway	×	×	×	×	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓
Switzerland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Member State	SO_2								NH_3							
	2010	2011	2012	2013	2014	2015	2016	2017	2010	2011	2012	2013	2014	2015	2016	2017
Norway	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×
Switzerland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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

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. EEA members 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.

Data from the above-mentioned countries show that Norway exceeded its NO_x and NH_3 ceilings from 2010 to 2017. 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 2017, NO_x emissions dropped by 58 % in the EU. Between 2016 and 2017, the decrease was 1.8 %, mainly because Italy, Bulgaria, Germany, the United Kingdom and France (countries ranked according to the size of their contribution to the absolute change) reported reductions (Table 3.6). The Member States that contributed most (i.e. more than 10 %) to NO_x emissions in 2017 were Germany, the United Kingdom, France and Poland (countries ranked according to the percentage of their share in the EU total).

In the following pollutant-specific chapters, Chapter 3.3 to Chapter 3.28, the 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 occurs 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 allows for approved adjustments (see also Chapter 2).

Spain stated that the drop in NO_x emissions between 2005 and 2010 (the value for the national total in 2008 was 38 % lower than in the previous year) was due to the closure of the main brown coal mine in Spain in 2007. In addition, the necessary retrofitting in 2008 of the adjacent thermal power plant and the introduction of abatement techniques reduced NO_x emissions during this period(see Spain's IIR, listed in Appendix 5).

The main key categories for NO_x emissions were '1A3bi — Road transport: Passenger cars', '1A3biii — Road transport: Heavy duty vehicles and buses' and '1A1a —

Table 3.6 Member State contributions to EU emissions of NO_x

Member State	NO_x (Gg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	219	199	214	238	183	173	168	169	160	156	151	145	-34	-4.4	1.2	1.9
Belgium	410	381	344	318	246	229	215	208	198	198	186	176	-57	-5.3	2.3	2.3
Adjusted data*					184	167	155	146	137	139	186	176		-5.3		
Bulgaria	302	196	154	191	148	165	152	137	146	147	141	103	-66	-27.3	1.7	1.4
Croatia	110	81	88	87	71	67	62	61	57	57	56	55	-50	-2.4	0.6	0.7
Cyprus	17	19	21	21	19	21	22	16	17	15	15	15	-13	-0.6	0.1	0.2
Czechia	729	370	280	276	232	220	207	191	184	176	167	163	-78	-2.3	4.0	2.2
Denmark	303	291	227	206	150	141	130	125	116	114	115	112	-63	-2.5	1.7	1.5
Estonia	79	48	45	42	43	41	38	37	37	33	32	33	-58	2.6	0.4	0.4
Finland	306	273	241	208	187	171	161	158	151	139	134	130	-58	-3.3	1.7	1.7
France	1 969	1 791	1 618	1 420	1 077	1 020	991	980	909	884	843	807	-59	-4.2	10.9	10.7
Adjusted data*					937	875	844	820	749	728	698	807		15.7		
Germany	2 889	2 181	1 945	1 584	1 356	1 340	1 307	1 309	1 273	1 250	1 224	1 188	-59	-3.0	16.0	15.8
Adjusted data*					1 068	1 039	1 008	1 004	975	968	973	968		-0.5		
Greece	316	321	354	405	318	295	244	242	236	233	230	250	-21	8.3	1.8	3.3
Hungary	242	188	185	176	145	135	127	125	123	124	117	119	-51	2.1	1.3	1.6
Ireland	169	169	177	170	117	105	108	109	109	112	112	110	-35	-1.7	0.9	1.5
Italy	2 063	1 939	1 487	1 280	967	929	871	818	800	775	751	709	-66	-5.6	11.5	9.4
Latvia	95	50	40	42	41	38	38	38	38	38	37	37	-61	2.3	0.5	0.5
Lithuania	138	66	56	62	59	56	58	57	57	58	58	53	-61	-7.1	0.8	0.7
Luxembourg	41	35	41	55	34	34	31	28	26	22	20	18	-56	-10.0	0.2	0.2
Adjusted data*					30	30	27	23	21	18	16	14		-11.1		
Malta	7.4	8.9	8.8	9.9	8.6	8.5	9.0	7.4	7.3	6.3	5.7	5.3	-28	-6.8	0.0	0.1
Netherlands	657	557	465	408	333	317	302	292	272	273	258	252	-62	-2.4	3.6	3.3
Poland	1 090	1 053	852	869	888	872	836	796	747	725	742	804	-26	8.3	6.1	10.7
Portugal	251	286	285	268	192	176	164	161	158	162	156	159	-37	2.0	1.4	2.1
Romania	484	349	280	326	241	252	250	229	225	225	221	232	-52	4.9	2.7	3.1
Slovakia	159	114	107	103	85	77	75	73	73	72	67	66	-59	-1.5	0.9	0.9
Slovenia	71	71	59	55	48	48	46	44	39	35	36	35	-51	-3.5	0.4	0.5
Spain	1 344	1 372	1 356	1 364	921	904	870	757	774	777	741	739	-45	-0.3	7.5	9.8
Adjusted data*					774	767	746	642	665	677	655	665		1.6		
Sweden	281	250	216	184	157	149	141	138	137	132	128	124	-56	-3.2	1.6	1.6
United Kingdom	3 269	2 655	2 051	1 777	1 250	1 161	1 185	1 125	1 054	1 018	928	893	-73	-3.7	18.2	11.9
Adjusted data*					1 148		1 086									
EU-28 (a)	**18 007**	**15 315**	**13 195**	**12 146**	**9 515**	**9 144**	**8 808**	**8 431**	**8 122**	**7 956**	**7 672**	**7 532**	**-58**	**-1.8**	**100**	**100**
EU-28 (b)	17 692	14 994	12 841	11 742	9 197	8 848	8 564	8 189	7 887	7 722	7 442	7 282				
EU-28 (c)	18 007	15 315	13 195	12 146	8 771	8 497	8 073	7 785	7 490	7 357	7 185	7 235				

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.

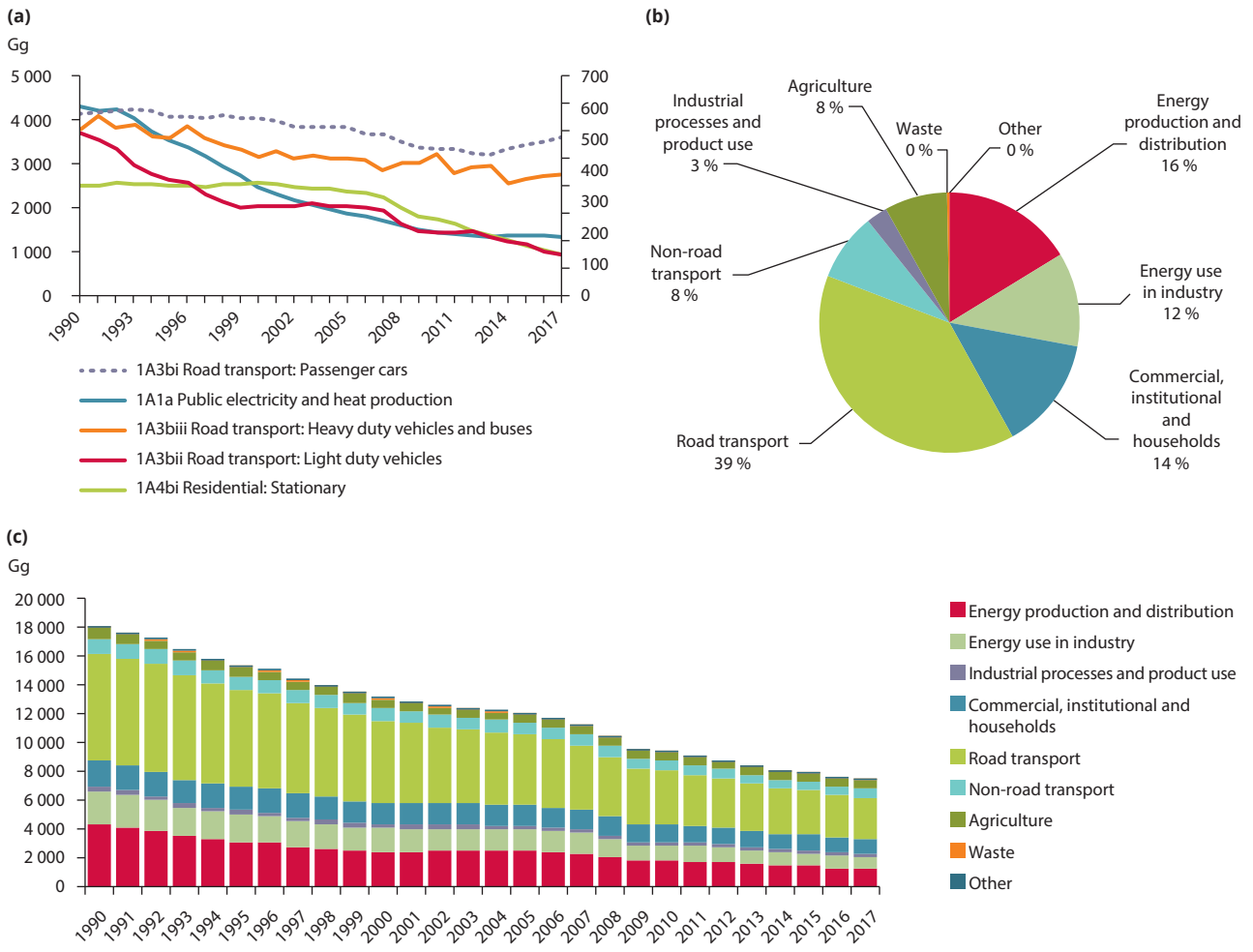
(c) Sum of national totals as reported by Member States allowing for approved adjustments.

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

Public electricity and heat production'. Together, they made up 45 % of total emissions (see Figure 3.5). Of the top five key categories, the highest relative reduction in emissions between 1990 and 2017 occurred in the third most important, '1A1a — Public electricity and heat production' (-74.2 %) (see Figure 3.5(a)). There were also significant reductions in the most important, '1A3bi — Road transport: Passenger cars' (-68.5 %), and in the second most important, '1A3biii — Road transport: Heavy duty vehicles and buses' (-61.7 %).

Figure 3.5(b) shows the contribution made by each aggregated sector group 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, 2018b). 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 2017. The electricity/energy production sectors have also 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 from coal to gas (EEA, 2018b).

Figure 3.5 **NO_x emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2017; (b) share by sector group, 2017; (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

Member State	NMVOCs (Gg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	324	237	180	156	137	131	129	133	120	124	122	120	-63	-1.7	1.8	1.7
Belgium	326	273	212	172	138	126	123	120	114	111	111	109	-67	-1.3	1.8	1.6
Adjusted data*					138											0.0
Bulgaria	557	152	107	94	87	87	85	78	77	79	80	77	-86	-3.1	3.1	1.1
Croatia	178	124	104	116	90	84	78	73	67	68	68	63	-64	-7.1	1.0	0.9
Cyprus	18	18	18	22	20	14	14	12.9	11.7	12.1	12.4	12.3	-31	-0.4	0.1	0.2
Czechia	509	356	287	252	241	230	224	221	214	212	207	207	-59	0.3	2.9	3.0
Denmark	190	191	169	143	122	115	112	112	104	107	103	102	-46	-0.9	1.1	1.5
Adjusted data*					86	80	76	76	68	71	67	66		-2.1		
Estonia	65	41	37	32	23	23	23	22	22	22	22	22	-66	3.4	0.4	0.3
Finland	230	202	177	145	114	105	102	97	94	89	90	88	-62	-1.7	1.3	1.3
France	2 466	2 068	1 644	1 175	817	736	700	685	661	632	619	612	-75	-1.2	13.8	8.8
Germany	3 440	2 066	1 638	1 349	1 257	1 148	1 146	1 102	1 069	1 042	1 043	1 069	-69	2.5	19.3	15.3
Adjusted data*					1 056	947	942	894	858	835	839	866		3.3		
Greece	260	244	247	230	178	167	166	158	156	157	147	148	-43	0.9	1.5	2.1
Hungary	302	212	197	172	146	150	152	151	141	144	142	142	-53	-0.4	1.7	2.0
Adjusted data*					121	125	127	126	116	118	116	115		-0.2		
Ireland	143	136	122	120	110	107	108	111	107	107	109	113	-21	4.4	0.8	1.6
Italy	2 002	2 035	1 602	1 348	1 124	1 033	1 024	996	932	915	899	935	-53	4.0	11.2	13.4
Latvia	80	59	49	48	40	41	42	41	42	40	38	38	-52	-0.4	0.4	0.5
Lithuania	116	75	63	62	55	53	53	50	49	47	46	46	-61	-1.6	0.7	0.7
Luxembourg	27	20	16	15	11	11	12	12	11	11	12	12	-54	4.1	0.1	0.2
Adjusted data*					8.2	8.3	8.8	8.8	7.9	8.1	8.3	8.7		5.1		
Malta	1.5	1.7	3.6	3.7	3.4	3.2	2.9	2.9	2.9	2.9	2.8	2.8	83	1.5	0.0	0.0
Netherlands	604	432	333	266	268	265	261	257	245	253	251	252	-58	0.5	3.4	3.6
Poland	706	825	732	721	712	694	676	633	631	641	674	691	-2	2.5	4.0	9.9
Portugal	256	249	249	210	178	169	166	165	170	170	167	168	-35	0.6	1.4	2.4
Romania	346	238	266	320	261	257	255	246	242	237	237	240	-31	1.4	1.9	3.4
Slovakia	305	203	168	151	133	127	125	107	89	97	95	89	-71	-6.3	1.7	1.3
Slovenia	64	62	52	45	37	35	33	33	30	30	30	30	-54	-0.8	0.4	0.4
Spain	1 004	951	942	802	630	606	583	564	569	588	603	618	-38	2.4	5.6	8.9
Sweden	359	268	224	209	181	174	164	160	156	154	145	147	-59	1.6	2.0	2.1
United Kingdom	2 964	2 315	1 635	1 179	880	861	845	818	813	815	801	809	-73	1.0	16.6	11.6
EU-28 ([a])	**17 842**	**14 055**	**11 476**	**9 560**	**7 993**	**7 553**	**7 403**	**7 162**	**6 939**	**6 905**	**6 876**	**6 964**	**-61**	**1.3**	**100**	**100**
EU-28 ([b])	17 582	13 810	11 229	9 330	7 815	7 385	7 237	7 004	6 783	6 748	6 729	6 815				
EU-28 ([c])	17 842	14 055	11 476	9 560	7 728	7 289	7 135	6 890	6 664	6 633	6 606	6 695				

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 Body accepted inventory adjustment applications for emissions from Denmark, Germany, Hungary and Luxembourg, whereas emission data are based on fuel sold.

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

Between 1990 and 2017, NMVOC emissions dropped by 61 % in the EU. Between 2016 and 2017, Member States reported an increase of 1.3 % (Table 3.7) due to slightly higher emissions in Italy, Germany, Poland and Spain (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing 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 strong decline in emissions reported by Bulgaria between 1990 and 1995 is due to a drop between 1993 and 1994 (not shown in Table 3.7). This was caused mainly by drastically declining emissions from the industrial processes and product use sector, namely '2D3d — Coating applications' and '2D3e — Degreasing' (see Bulgaria's IIR, listed in Appendix 5).

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 38 % of total emissions (Figure 3.6(a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2017 was in the second most important key category, '2D3d — Coating applications' (-58.3 %). Emissions from the fourth largest key category, '2H2 — Food and beverages industry', increased by 6.5 %.

Figure 3.6 NMVOC emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2017; (b) share by sector group, 2017; (c) sectoral trends in emissions

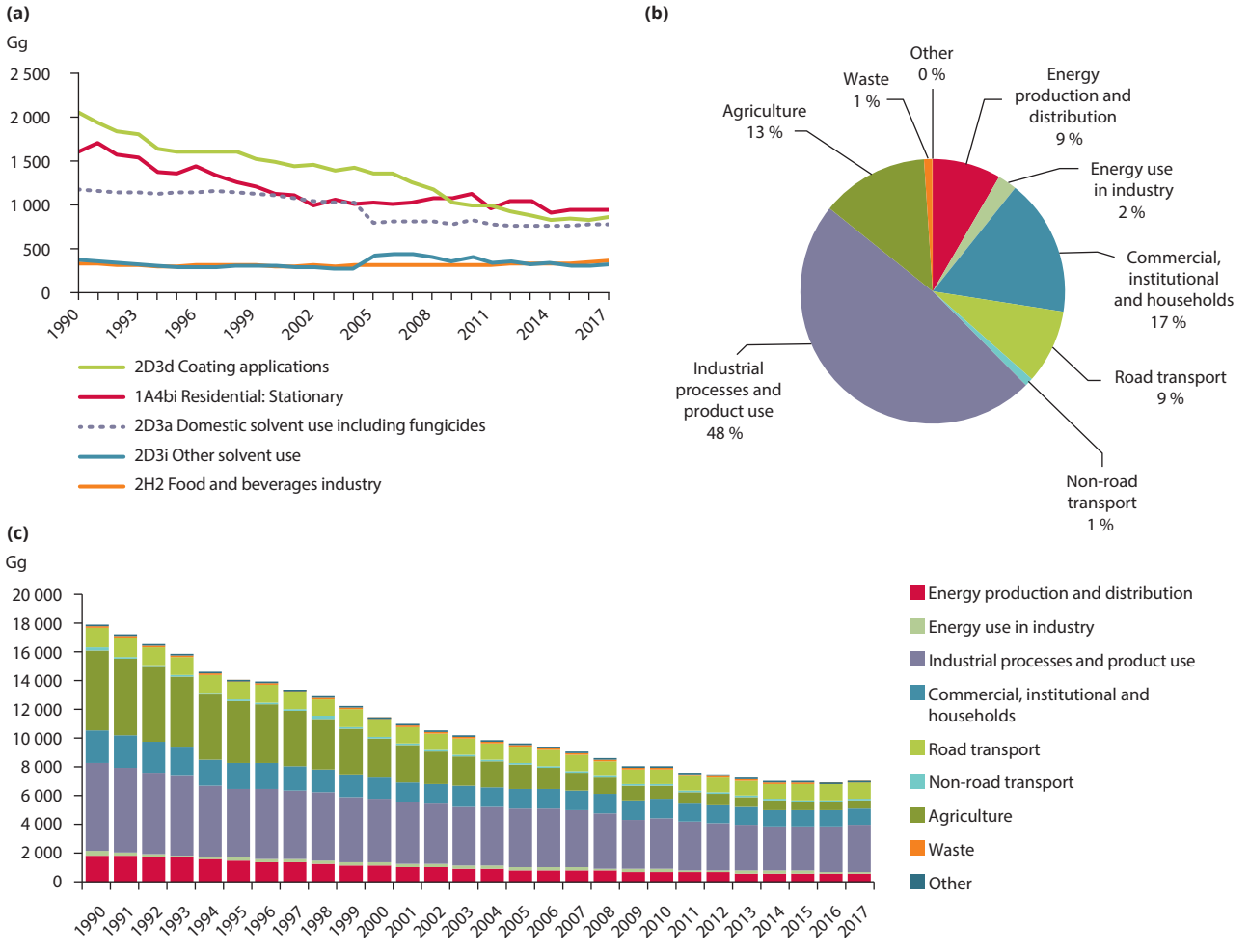


Table 3.8 Member State contributions to EU emissions of SO_x

Member State	SO_x (Gg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	74	47	32	25	16	15	15	14	15	14	14	13	-83	-5.3	0.3	0.6
Belgium	365	258	172	143	61	53	48	43	40	41	39	38	-90	-4.3	1.5	1.6
Bulgaria	1 106	1 302	863	779	387	514	328	194	187	143	105	103	-91	-2.0	4.4	4.4
Croatia	170	78	59	59	35	29	25	17	14	16	15	13	-93	-15.2	0.7	0.5
Cyprus	32	40	48	38	22	21	16	14	17	13	16	16	-49	1.3	0.1	0.7
Czechia	1 755	1 059	233	208	164	168	160	145	134	129	115	110	-94	-4.5	7.0	4.7
Denmark	178	146	32	26	15	14	13	13	11	9.7	10	10	-94	2.1	0.7	0.4
Estonia	272	116	97	76	83	73	43	42	47	36	35	39	-86	10.6	1.1	1.7
Finland	249	105	82	70	66	60	50	48	44	41	40	35	-86	-12.0	1.0	1.5
France	1 283	960	626	460	278	254	236	213	173	163	144	144	-89	-0.1	5.1	6.2
Germany	5 486	1 746	646	472	409	395	375	366	346	343	320	315	-94	-1.3	22.0	13.6
Greece	518	528	575	601	233	171	143	130	114	112	108	106	-80	-1.8	2.1	4.6
Hungary	829	614	427	43	30	34	31	29	26	24	23	28	-97	20.5	3.3	1.2
Ireland	183	163	144	73	26	25	23	23	17	15	14	13	-93	-3.9	0.7	0.6
Italy	1 784	1 322	756	409	218	196	178	146	131	124	117	115	-94	-1.4	7.2	5.0
Latvia	100	49	18	8.5	4.3	4.3	4.4	3.9	3.9	3.6	3.5	4.0	-96	15.2	0.4	0.2
Lithuania	190	73	37	28	18	20	17	15	14	15	15	13	-93	-12.8	0.8	0.6
Luxembourg	15	8.5	3.3	2.4	1.7	1.3	1.5	1.5	1.5	1.3	1.0	1.0	-93	2.0	0.1	0.0
Malta	10	11	24	12	7.9	7.9	7.7	5.0	4.7	2.1	1.8	0.2	-99	-91.6	0.0	0.0
Netherlands	196	136	78	67	35	34	34	30	30	31	29	27	-86	-5.8	0.8	1.2
Poland	2 652	2 141	1 411	1 172	875	836	803	768	724	711	591	583	-78	-1.4	10.6	25.1
Portugal	323	327	301	189	65	59	54	48	44	46	46	48	-85	3.3	1.3	2.0
Romania	790	698	490	606	356	325	261	208	181	157	110	107	-86	-2.6	3.2	4.6
Slovakia	239	134	117	86	68	67	57	52	44	67	26	27	-89	2.5	1.0	1.2
Slovenia	201	124	94	40	11	13	12	14	10	5.4	4.6	4.9	-98	5.1	0.8	0.2
Spain	2 039	1 764	1 389	1 205	244	280	279	221	243	260	217	220	-89	1.4	8.2	9.5
Sweden	103	69	43	36	28	26	25	22	20	18	18	18	-83	-3.8	0.4	0.8
United Kingdom	3 767	2 454	1 286	773	450	415	460	397	322	250	176	173	-95	-1.6	15.1	7.4
EU-28 (a)	**24 910**	**16 471**	**10 083**	**7 707**	**4 207**	**4 111**	**3 698**	**3 223**	**2 958**	**2 792**	**2 352**	**2 323**	**-91**	**-1.3**	**100**	**100**
EU-28 (b)	24 392	15 943	9 508	7 106	3 974	3 941	3 555	3 093	2 844	2 679	2 245	2 217				

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 3.6(b) shows the contribution made by each aggregated sector group to total EU emissions. The chief emission source of NMVOCs is industrial processes and product use (46 %), followed by commercial, institutional and households (17 %), agriculture (16 %) and road transport' (8 %).

3.5 Sulphur oxide (SO_x) emission trends and key categories

Between 1990 and 2017, SO_x emissions dropped by 91 % in the EU. Between 2016 and 2017, emissions decreased by 1.3 % (see Table 3.8), mainly due to reduced emissions in Poland, Czechia, Finland and Germany (countries ranked according to the size of their contribution to the absolute change). The Member States contributing most (i.e. more than 10 %) to SO_x emissions in 2017 were Poland (25.1 % of EU-28) and Germany (13.6 % of EU-28).Spain stated that the dramatic drop in SO_x emissions in 2008 (the value for the national total is 79 % lower than in the previous year) was due to the closure of the main brown coal mine in Spain in 2007. In addition, the necessary retrofitting in 2008 of the adjacent thermal power plant and the implementation of desulphurization abatement

techniques reduced SO_x emissions in this period (see Spain's IIR, listed in Appendix 5).

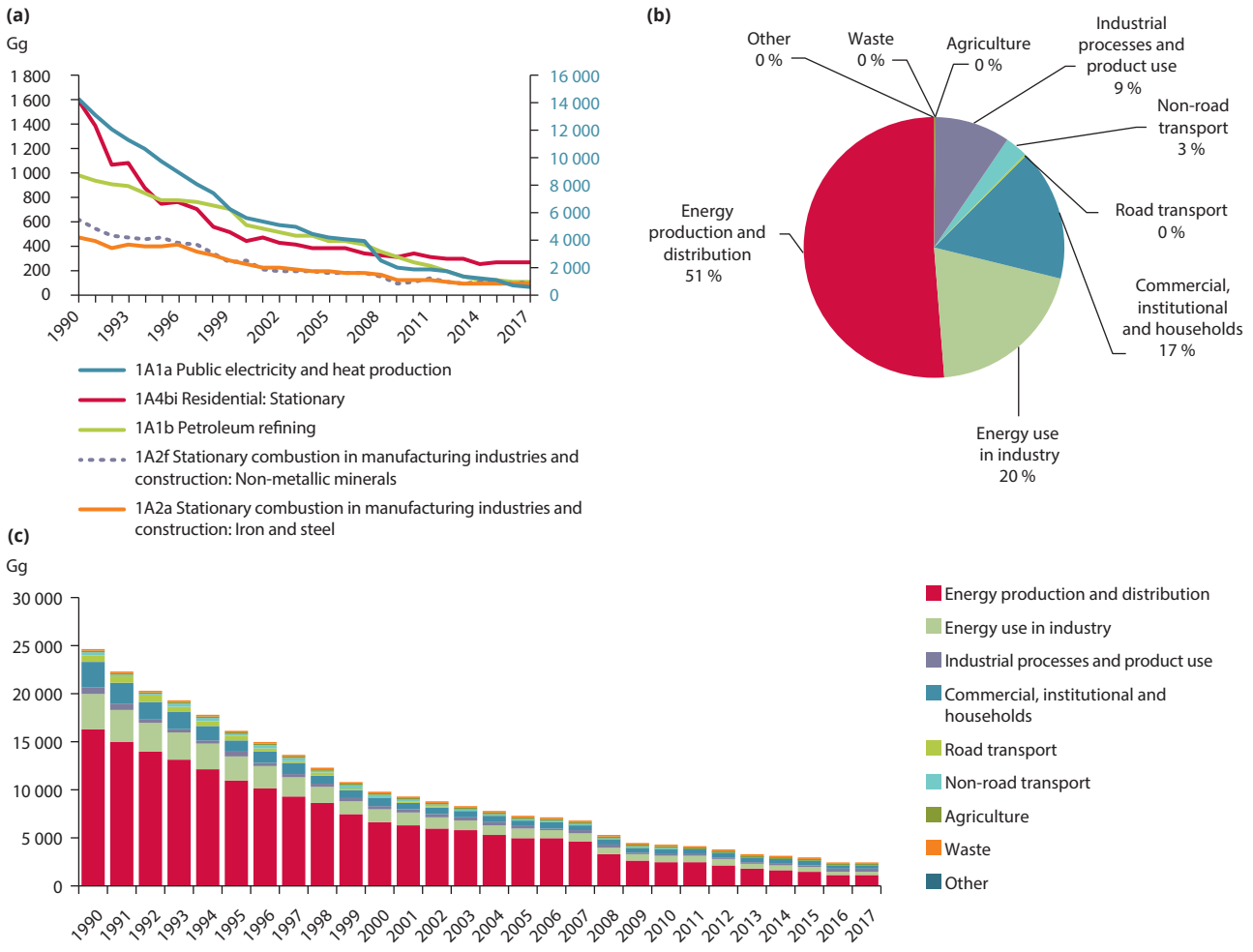
In Slovakia, data reported for 2015 were significantly higher than for the year 2014. Slovakia explained that all SO_x emissions were emitted from the Slovenské elektrárne (electricity company), which apparently had no emission limitations or abatement technologies in place in 2015. From 2016 onwards, it has been possible to operate such facilities only when they comply with the strict limits set in the legislation. The considerable drop in SO_x emissions is due to the strict regulations in place (see Slovakia's IIR, listed in Appendix 5).

Category '1A1a — Public electricity and heat production' is the most significant key category for SO_x emissions, making up 37 % of total SO_x emissions (Figure 3.7(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2017 were achieved in the most important, '1A1a — Public electricity and heat production' (-94.3 %), and the third most important, '1A1b — Petroleum refining' (-87.2 %). The other three top five key categories also saw significant reductions.

Since 1990, several measures have been combined to reduce emissions from these main emitting sources: 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, 2018b).

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

Figure 3.7 SO_x emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2017; (b) share by sector group, 2017; (c) sectoral trends in emissions



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

3.6 Ammonia (NH_3) emission trends and key categories

Between 1990 and 2017, NH_3 emissions dropped by 24 % in the EU. However, between 2016 and 2017, emissions rose by 0.4 % (see Table 3.9) because of increases in Spain, Poland, the Netherlands and Ireland (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing most (i.e. more than 10 %) to NH_3 emissions were Germany, France and Spain (countries ranked according to the percentage of their share in the EU total).

Table 3.9 Member State contributions to EU emissions of NH_3

Member State	NH_3 (Gg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	65	67	64	63	66	65	66	66	67	67	68	69	6	1.1	1.3	1.7
Belgium	122	128	92	75	71	70	70	71	68	68	68	67	-45	-1.2	2.4	1.7
Bulgaria	121	65	54	52	47	45	45	46	49	50	51	49	-59	-2.6	2.3	1.3
Croatia	56	44	45	48	41	42	42	36	34	39	37	38	-33	1.3	1.1	1.0
Cyprus	6.1	7.4	7.3	7.5	7.3	7.1	6.7	6.3	6.2	6.2	6.4	6.5	7	1.4	0.1	0.2
Czechia	149	100	87	77	71	69	69	71	71	72	72	67	-55	-6.7	2.9	1.7
Denmark	126	108	97	89	80	78	77	74	75	75	75	76	-39	1.8	2.4	1.9
Adjusted data*					72	71	70	67	67	67	67	69		2.8		
Estonia	22	11	8.8	10	10	10	10	10	10	10	10	10	-52	3.0	0.4	0.3
Finland	34	33	34	37	36	35	34	33	34	32	32	31	-9	-2.3	0.7	0.8
Adjusted data*					33	32	32	32	32	31	30	30		-2.1		
France	652	633	646	605	604	594	596	594	600	608	609	606	-7	-0.4	12.6	15.3
Germany	756	649	662	640	641	671	659	677	679	689	681	673	-11	-1.1	14.6	17.0
Adjusted data*					601	621	608	617	619	628	620	612		-1.4		
Greece	77	68	66	65	64	64	62	62	60	57	57	55	-28	-2.3	1.5	1.4
Hungary	149	88	93	86	78	79	79	82	82	87	87	88	-41	0.9	2.9	2.2
Ireland	110	113	115	113	108	104	106	108	108	111	116	118	8	2.0	2.1	3.0
Italy	475	454	459	427	390	392	403	387	376	377	392	384	-19	-2.0	9.2	9.7
Latvia	37	17	14	15	16	16	16	16	17	16	16	17	-55	1.3	0.7	0.4
Lithuania	65	31	27	31	31	31	31	30	31	31	30	30	-55	-1.8	1.3	0.7
Luxembourg	6.3	6.6	6.8	5.9	5.6	5.6	5.4	5.4	5.5	5.6	5.7	5.8	-9	1.4	0.1	0.1
Malta	1.9	1.9	1.8	1.5	1.4	1.2	1.2	1.3	1.2	1.2	1.2	1.1	-41	-3.2	0.0	0.0
Netherlands	351	224	176	155	134	131	125	124	128	129	128	132	-62	3.1	6.8	3.3
Poland	449	365	331	324	303	304	294	294	289	285	292	308	-31	5.3	8.7	7.8
Portugal	78	73	77	63	57	57	55	53	56	57	57	58	-26	0.8	1.5	1.5
Romania	273	228	186	206	175	173	172	172	169	172	168	164	-40	-1.9	5.3	4.2
Slovakia	76	50	42	38	33	31	32	32	32	32	28	27	-65	-4.1	1.5	0.7
Slovenia	23	21	22	20	20	19	19	18	18	19	19	19	-19	-1.9	0.4	0.5
Spain	510	467	556	522	459	449	445	451	472	490	498	518	2	4.1	9.8	13.1
Sweden	60	61	60	58	55	54	53	54	54	54	53	53	-12	0.4	1.2	1.3
United Kingdom	326	302	306	285	264	266	262	258	271	276	281	283	-13	0.7	6.3	7.2
EU-28 (a)	**5 177**	**4 414**	**4 335**	**4 117**	**3 866**	**3 862**	**3 835**	**3 834**	**3 864**	**3 916**	**3 938**	**3 954**	**-24**	**0.4**	**100**	**100**
EU-28 (b)	5 177	4 414	4 335	4 117	3 866	3 862	3 835	3 834	3 864	3 916	3 938	3 954				
EU-28 (c)	5 177	4 414	4 335	4 117	3 816	3 803	3 775	3 765	3 793	3 846	3 867	3 883				

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 Body accepted inventory adjustment applications for emissions from Denmark, Finland and Germany, whereas emission data are based on fuel sold.

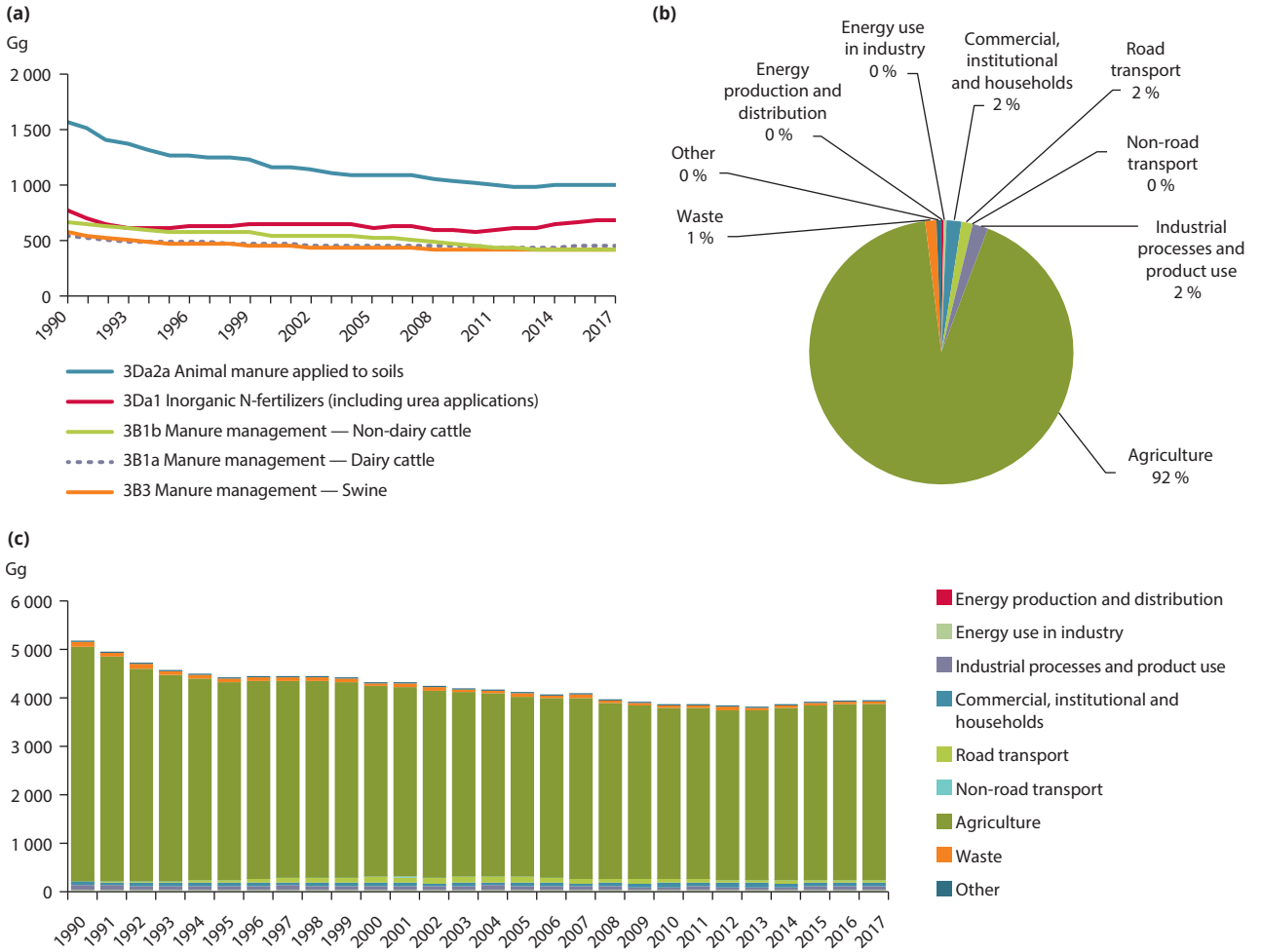
In Belgium, the significant decrease in NH_3 emissions between 1999 and 2000 (not shown in Table 3.9) is mainly because of the implementation of successive manure action plans in Flanders (see Belgium's IIR, listed in Appendix 5).

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

Spain offered the following explanation for the national NH_3 emission trend observed in the period 1990-2015. Between 1990 and 1993, the decline in NH_3 emissions is related to the significant economic recession and the drought in Spain. From 1994 onwards, agricultural emissions underwent a notable increase, reaching a maximum in 2003. This rise was mainly caused by significant growth in both the national cattle herd and in the swine population. The use of synthetic nitrogen fertilisers also increased during that period. Until 2012, a gradual decline in NH_3 emissions was registered at the national level. This reduction was probably due to a combination of factors, including the use of inorganic fertilisers in combination with dry weather conditions (2005-2008), reducing the number of cattle and the gradual introduction of abatement techniques in manure management and improvements in animal feed formulations. Total NH_3 emissions increased between 2012 and 2017, driven by an increase in the consumption of synthetic nitrogen fertilisers and a greater number of cattle and swine (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-fertilizers' and '3B1b — Manure management — Non-dairy cattle'. They jointly make

Figure 3.8 **NH_3 emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2017; (b) share by sector group, 2017; (c) sectoral trends in emissions**



up 54 % 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 2017 was in the fifth most important, '3B3 — Manure management – Swine' (-37.9 %). There were also large reductions in the most important category, '3Da2a — Animal manure applied to soils' (-35.5 %).

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

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

Between 2000 and 2017, $PM_{2.5}$ emissions dropped by 29 % in the EU. Between 2016 and 2017, there was an increase of 0.3 % (see Table 3.10), mainly because emissions rose in Italy, Poland, Spain and Romania (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing most (i.e. more than 10 %) to $PM_{2.5}$ emissions were Italy , France and Poland (countries ranked according to the percentage of their share in the EU total).

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

Member State											Change (%)		Share in EU-28 (%)	
	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	25	25	24	20	18	18	16	16	16	16	-37	-1.7	1.4	1.2
Belgium	41	39	37	34	27	29	22	24	25	23	-43	-7.8	2.2	1.8
Bulgaria	26	24	29	31	34	32	31	32	32	32	24	0.3	1.4	2.5
Croatia	33	36	36	34	26	24	20	21	18	17	-50	-9.4	1.8	1.3
Cyprus	2.6	2.3	2.3	2.1	1.3	1.1	1.1	1.1	1.2	1.3	-50	3.5	0.1	0.1
Czechia	49	50	47	42	43	44	41	40	39	40	-19	2.2	2.7	3.1
Denmark	24	24	23	29	21	21	19	21	21	20	-15	-2.3	1.3	1.5
Estonia	15	16	17	13	8.7	12	8.9	9.6	7.8	9.2	-40	18.7	0.8	0.7
Finland	26	27	27	24	21	20	19	18	18	18	-31	-3.2	1.4	1.4
France	328	316	294	222	192	194	168	170	170	164	-50	-3.4	18.0	12.6
Germany	167	162	155	129	110	109	104	104	101	99	-41	-1.7	9.2	7.6
Greece	53	56	52	49	34	30	30	28	27	26	-51	-4.1	2.9	2.0
Hungary	48	52	37	40	58	59	49	52	50	48	0	-3.8	2.6	3.7
Ireland	20	20	19	18	14	15	14	14	13	12	-41	-6.5	1.1	0.9
Italy	196	189	159	203	177	172	155	161	157	165	-16	4.7	10.8	12.6
Latvia	22	22	22	22	20	19	18	16	16	18	-17	9.4	1.2	1.4
Lithuania	6.9	7.1	7.7	10.3	10.1	11.3	10.0	8.6	8.0	9.1	31	13.3	0.4	0.7
Luxembourg	2.4	2.6	2.3	2.0	1.6	1.6	1.6	1.4	1.5	1.3	-44	-10.9	0.1	0.1
Malta	1.0	1.3	1.3	0.6	0.4	0.3	0.4	0.3	0.3	0.2	-76	-10.2	0.1	0.0
Netherlands	30	28	27	23	16	16	15	15	14	14	-53	-1.0	1.6	1.1
Poland	159	159	159	158	149	144	136	136	142	147	-8	3.8	8.7	11.3
Portugal	74	71	71	62	54	52	51	51	51	51	-31	0.7	4.0	3.9
Romania	103	84	87	114	122	114	115	110	110	112	8	1.4	5.7	8.6
Slovakia	41	41	30	27	24	22	17	18	19	18	-56	-4.2	2.3	1.4
Slovenia	11	11	12	13	13	13	11	12	12	11	6	-3.8	0.6	0.9
Spain	140	130	131	128	110	106	105	105	103	105	-25	1.9	7.7	8.1
Sweden	33	32	31	29	24	24	21	20	20	20	-39	1.5	1.8	1.5
United Kingdom	148	147	131	117	113	114	108	109	107	107	-28	-0.3	8.1	8.2
EU-28 ([a])	**1 825**	**1 774**	**1 670**	**1 598**	**1 443**	**1 416**	**1 309**	**1 313**	**1 301**	**1 304**	**-29**	**0.3**	**100**	**100**
EU-28 ([b])	1 825	1 774	1 670	1 598	1 443	1 416	1 309	1 313	1 301	1 304				

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.

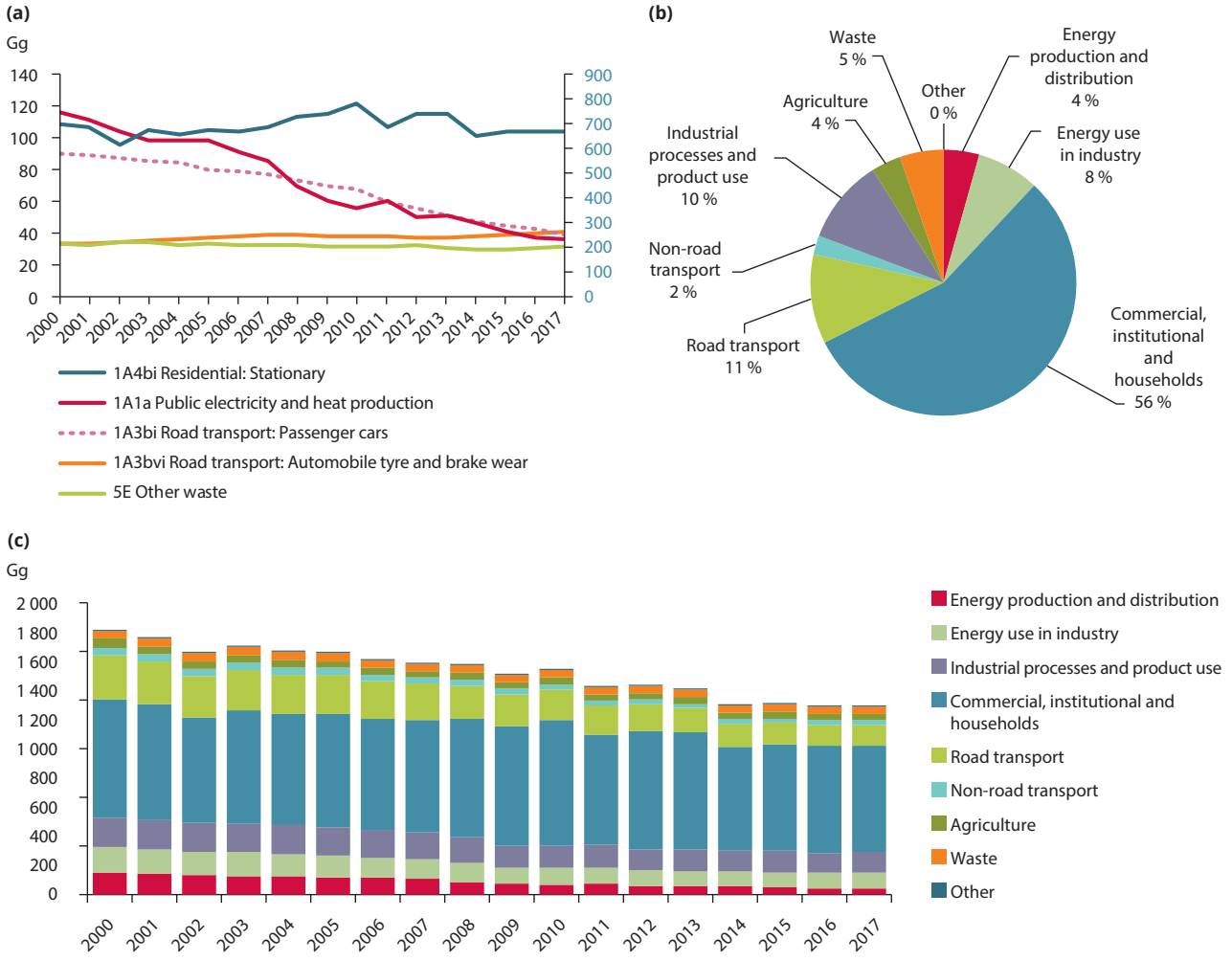
Estonia reported that the growth in $PM_{2.5}$ emissions from 2010 to 2011 resulted from greater electricity production during that period. In 2011, the significant growth in primary PM emissions in general was due to a 34 % increase in electricity production at Estonia's Balti power station (Eesti Energia Narva Elektrijaamad AS) and to the incorrect operation of electric precipitators in two of its power units. In 2017, particulate emissions increased by 15.4 % in comparison to 2016, mainly due to more emissions from industrial combustion (greater wood and wood-waste combustion), 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 2017 was in the fourth most important key category, '1A1a — Public electricity and heat production' (-69 %). There were also large reductions in the third most important category, '1A3bi — Road transport: Passenger cars' (-56.7 %).

In contrast, emissions from the second most important key category, '1A3bvi — Road transport: Automobile tyre and brake wear' (22.8 %), have increased significantly since 2000.

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

Figure 3.9 $PM_{2.5}$ emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2017; (b) share by sector group, 2017; (c) sectoral trends in emissions



Notes: 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 2017, PM_{10} emissions decreased by 27 % in the EU. Between 2016 and 2017, the increase was very low, just 0.4 % (see Table 3.11) mainly because emissions rose slightly in Italy, Poland, Germany and Estonia (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing most (i.e. more than 10 %) to PM_{10} emissions were France, Poland and Germany (countries ranked according to the percentage of their share in the EU total).

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

Member State											Change (%)		Share in EU-28 (%)	
	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	38	38	37	33	30	30	29	28	28	28	-27	-0.2	1.4	1.4
Belgium	55	53	51	45	37	38	32	34	35	33	-40	-4.7	2.0	1.7
Bulgaria	47	44	48	62	56	52	52	55	48	47	1	-1.7	1.7	2.3
Croatia	41	44	45	46	35	32	28	29	27	25	-39	-5.8	1.5	1.3
Cyprus	4.8	4.4	4.3	4.0	2.3	1.9	1.8	1.9	2.0	2.1	-57	3.4	0.2	0.1
Czechia	66	66	61	57	55	55	52	52	50	51	-22	1.9	2.4	2.5
Denmark	36	36	34	41	32	32	30	31	31	31	-14	-0.7	1.3	1.5
Estonia	32	32	28	23	14	20	15	15	12	14	-57	16.7	1.2	0.7
Finland	40	41	42	38	33	32	31	29	30	29	-27	-4.0	1.5	1.4
France	438	424	400	319	284	284	256	258	258	254	-42	-1.6	15.9	12.6
Germany	294	279	273	234	220	222	217	214	203	206	-30	1.4	10.7	10.2
Greece	115	120	117	106	62	59	61	56	57	57	-51	-0.9	4.2	2.8
Hungary	72	79	61	62	73	78	73	74	71	69	-5	-2.3	2.6	3.4
Ireland	39	40	39	41	29	29	28	28	28	27	-29	-0.9	1.4	1.4
Italy	246	239	208	245	209	204	187	193	189	196	-20	3.7	8.9	9.7
Latvia	25	26	26	32	28	26	26	26	24	25	-1	3.4	0.9	1.2
Lithuania	8.7	9	10	15	15	15	15	14	14	14	62	2.2	0.3	0.7
Luxembourg	2.9	3.1	3.1	2.6	2.2	2.1	2.2	2.1	2.1	2.0	-31	-4.9	0.1	0.1
Malta	1.4	2.0	1.9	0.9	0.7	0.5	0.7	0.5	0.4	0.4	-73	-8.2	0.1	0.0
Netherlands	44	42	41	36	29	29	28	28	27	27	-39	-1.0	1.6	1.3
Poland	274	278	280	279	255	245	232	232	241	246	-10	2.4	10.0	12.2
Portugal	109	121	125	97	85	74	68	69	71	73	-33	2.0	4.0	3.6
Romania	135	116	119	154	158	149	150	145	144	143	6	-0.4	4.9	7.1
Slovakia	50	49	38	32	28	26	21	23	24	23	-55	-4.3	1.8	1.1
Slovenia	13	13	14	15	14	14	12	13	13	13	2	-3.1	0.5	0.6
Spain	237	226	232	232	181	174	173	174	173	172	-27	-0.6	8.6	8.5
Sweden	52	51	50	49	42	44	40	39	40	40	-22	1.5	1.9	2.0
United Kingdom	236	242	213	188	169	177	168	169	169	171	-28	0.9	8.6	8.5
EU-28 ([a])	**2 751**	**2 720**	**2 601**	**2 488**	**2 180**	**2 147**	**2 031**	**2 034**	**2 012**	**2 019**	**-27**	**0.4**	**100**	**100**
EU-28 ([b])	2 751	2 720	2 601	2 488	2 180	2 147	2 031	2 034	2 012	2 019				

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.

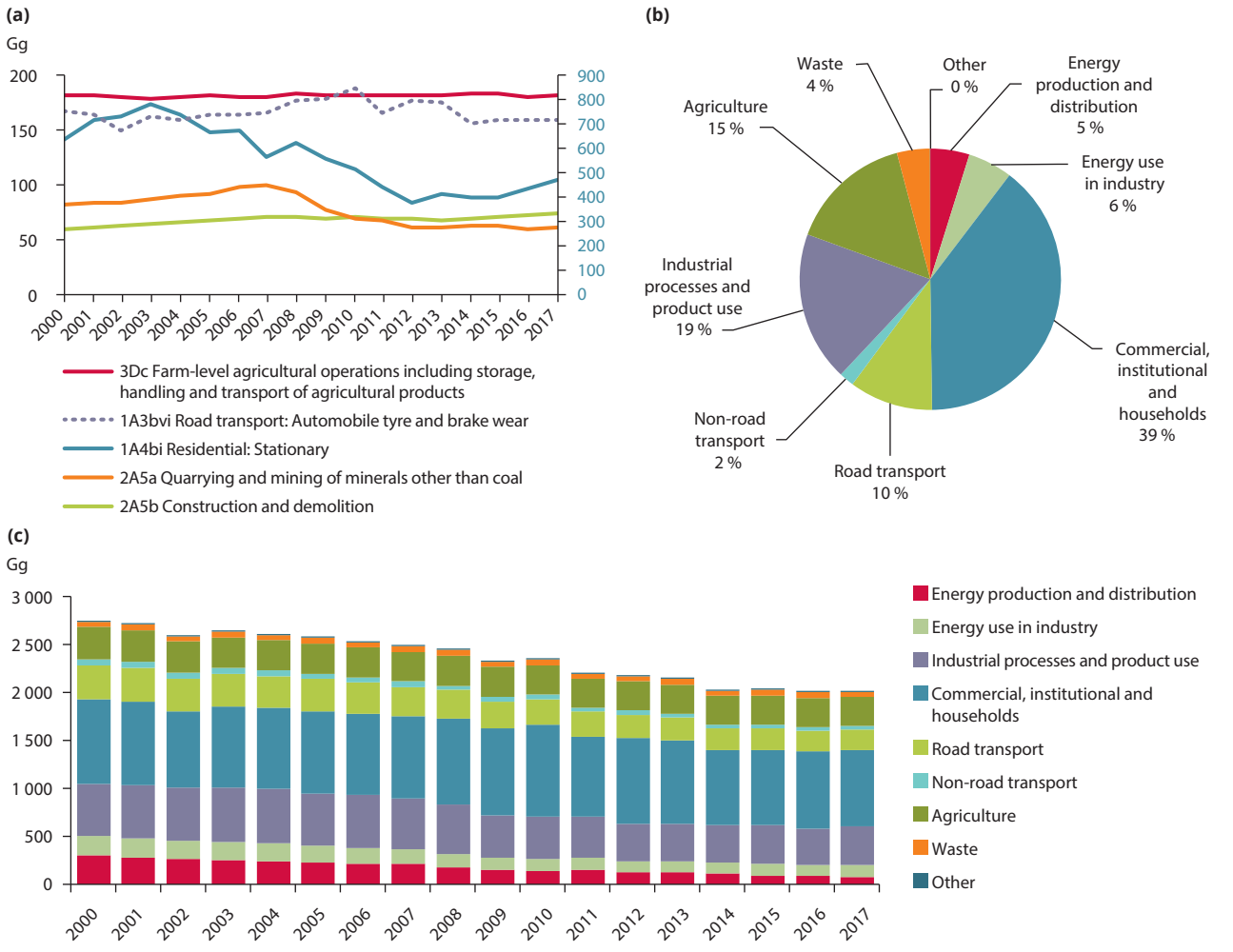
As for $PM_{2.5}$, '1A4bi — Residential: Stationary' is the most significant key category for PM_{10} emissions, accounting for 36 % of total PM_{10} emissions (see Figure 3.10(a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2017 was in the third most important, '2A5b — Construction and demolition' (-25.8 %). Reductions in emissions were also observed in the fifth most important category, '2A5a — Quarrying and mining of minerals other than coal' (-25 %). Emissions of the fourth most important key category, '1A3bvi — Road transport: Automobile tyre and brake wear' (22.6 %), have increased since 2000. Emissions from the other two top five key categories, namely '1A4bi — Residential: Stationary' and '3Dc — Farm-level agricultural operations including storage, handling and transport of agricultural products', remained quite constant (decreased by 4.3 % and 0.1 %, respectively).

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

3.9 Total suspended particulate (TSP) emission trends

Between 1990 and 2017, TSP emissions dropped by 53 % in the EU. Between 2016 and 2017, emissions rose by 0.9 % (Table 3.12), mainly because of increases in the United Kingdom, Germany, Italy and Portugal (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing most (i.e. more than 10 %) to TSP emissions were France and the United Kingdom

Figure 3.10 PM_{10} emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2017; (b) share by sector group, 2017; (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.

(countries ranked according to the percentage of their share in the EU total).

Germany explained that, between 1990 and 2017, total TSP emissions dropped by 82 % due to the application of the former West Germany's stricter regulations in the new German *Länder* following Germany's 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 2004 (not shown in Table 3.12) can be explained by increased road-paving activities. The new 'Via Baltica' motorway was built, connecting the capitals of all Baltic States (see Latvia's IIR, listed in Appendix 5).

Malta reported a significant drop in TSP emissions from 2004 to 2005, reflected mainly by data for the category '1A1a — Public electricity and heat production'.

Table 3.12 Member State contributions to EU emissions of TSPs

Member State	TSPs (Gg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	53	52	51	48	43	42	42	42	41	40	40	40	-24	0.6	0.7	1.1
Belgium	n/a	n/a	85	73	61	53	56	58	50	53	55	54		-1.6		1.4
Bulgaria	101	127	103	154	114	128	114	108	111	139	100	97	-4	-3.5	1.3	2.6
Croatia	59	53	51	71	55	53	49	43	40	42	39	38	-36	-2.4	0.7	1.0
Cyprus	15	12	9.5	6.6	5.5	5.0	3.8	2.9	2.6	2.7	2.9	3.0	-80	5.6	0.2	0.1
Czechia	581	215	89	73	70	67	67	67	64	63	61	62	-89	1.5	7.3	1.7
Denmark	110	106	104	98	98	95	93	92	91	91	91	92	-17	0.6	1.4	2.5
Estonia	279	127	70	36	30	43	21	27	22	20	17	20	-93	15.5	3.5	0.5
Finland	95	65	54	55	54	51	48	47	46	43	46	44	-54	-4.4	1.2	1.2
France	1 243	1 154	1 087	986	898	880	882	878	837	849	855	849	-32	-0.7	15.7	22.8
Germany	1 993	519	482	405	379	384	374	384	379	372	349	362	-82	3.7	25.1	9.7
Greece	101	100	231	211	163	112	99	101	113	105	114	118	17	3.4	1.3	3.2
Hungary	107	98	105	133	106	102	91	105	109	107	101	100	-7	-1.0	1.4	2.7
Ireland	85	68	87	101	81	60	61	61	59	61	60	61	-28	2.1	1.1	1.6
Italy	341	336	292	264	277	222	252	245	226	233	228	237	-31	3.6	4.3	6.3
Latvia	33	32	34	51	43	53	53	48	48	53	47	44	35	-5.7	0.4	1.2
Lithuania	25	12	12	22	22	22	22	22	22	21	20	21	-16	2.8	0.3	0.6
Luxembourg	17	9.1	3.6	3.9	3.2	3.0	3.0	2.9	3.0	3.3	2.9	3.0	-83	1.5	0.2	0.1
Malta	2.8	3.8	4.6	1.2	0.8	0.9	0.9	0.7	0.9	0.6	0.6	0.5	-82	-11.6	0.0	0.0
Netherlands	99	75	53	45	39	38	38	37	37	36	35	34	-66	-1.5	1.2	0.9
Poland	884	678	386	406	390	367	359	345	329	327	335	341	-61	1.6	11.1	9.1
Portugal	183	239	265	298	221	235	211	169	145	151	161	169	-7	5.1	2.3	4.5
Romania	340	230	227	293	281	278	267	246	251	228	215	204	-40	-4.9	4.3	5.5
Slovakia	151	83	71	55	37	35	37	34	30	31	32	31	-80	-4.7	1.9	0.8
Slovenia	11	13	15	18	18	18	17	17	14	15	16	15	32	-2.7	0.1	0.4
Spain	282	297	322	331	258	253	239	229	230	234	232	233	-17	0.4	3.6	6.2
Sweden	83	79	67	67	60	63	57	61	56	55	56	58	-31	1.9	1.0	1.5
United Kingdom	663	525	449	436	414	373	338	378	350	362	386	401	-40	4.0	8.4	10.7
EU-28 ([a])	**7 937**	**5 307**	**4 812**	**4 742**	**4 223**	**4 035**	**3 892**	**3 853**	**3 707**	**3 739**	**3 697**	**3 730**	**-53**	**0.9**	**100**	**100**
EU-28 ([b])	7 950	5 321	4 812	4 742	4 223	4 035	3 892	3 853	3 707	3 739	3 697	3 730				

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.

3.10 Black carbon (BC) emission trends

Between 1990 and 2017, BC emissions dropped by 42 % in the EU. Between 2016 and 2017, emissions fell by 1.8 %), mainly because of slightly fewer emissions from France, Germany, Greece (gap-filled data) and Belgium (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing most (i.e. more than 10 %) to BC emissions were France, Poland, Italy and Spain (countries ranked according to the percentage of their share in the EU total). Austria and Luxembourg did not provide data for BC, and some of these gaps could not be filled with data. Thus, the EU total is an underestimate.

Table 3.13 Member State contributions to EU emissions of BC

Member State	Black Carbon (Gg)										Change (%)		Share in EU-28 (%)	
	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Belgium	8.5	7.4	6.2	5.1	4.9	4.7	3.7	3.7	3.6	3.2	-63	-12.7	2.4	1.6
Bulgaria	2.9	3.8	3.8	4.0	4.2	3.8	3.8	3.9	4.0	3.9	33	-2.3	0.8	1.9
Croatia	4.8	5.9	4.7	4.3	4.0	3.7	3.2	3.3	3.0	2.8	-41	-5.7	1.4	1.4
Cyprus	0.6	0.6	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	-48	4.9	0.2	0.2
Czechia	6.1	5.9	5.5	5.2	5.1	5.0	4.7	4.5	4.4	4.4	-28	0.1	1.7	2.2
Denmark	6.1	6.1	5.6	5.3	4.8	4.7	4.3	4.3	4.2	4.0	-34	-3.9	1.7	2.0
Estonia	3.5	3.5	3.2	3.5	2.2	2.6	2.0	2.5	2.2	2.5	-28	15.0	1.0	1.2
Finland	6.4	5.7	5.6	4.9	5.0	4.6	4.5	4.2	4.3	4.1	-36	-4.2	1.8	2.0
France	67	57	48	43	41	39	34	33	31	28	-59	-9.2	19.1	13.7
Germany	36	29	21	20	18	17	16	15	14	13	-63	-6.6	10.2	6.5
Greece	8.6	8.9	7.7	6.0	5.6	4.9	5.1	5.7	5.6	5.0	-41	-9.1	2.4	2.5
Hungary	7.1	6.5	7.2	7.9	8.1	8.1	7.0	7.4	7.2	6.9	-3	-3.9	2.0	3.4
Ireland	4.0	3.8	3.0	2.7	2.5	2.5	2.4	2.3	2.2	2.0	-50	-10.6	1.1	1.0
Italy	43	39	33	28	28	26	24	24	23	22	-49	-1.9	12.2	10.9
Latvia	3.0	3.6	3.1	3.1	3.3	3.1	3.1	2.8	2.7	2.9	-3	7.8	0.8	1.4
Lithuania	2.3	2.7	2.9	2.9	3.0	2.9	2.8	2.7	2.6	2.5	9	-2.5	0.7	1.3
Luxembourg	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Malta	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	-23	-7.6	0.1	0.1
Netherlands	9.9	8.0	5.5	5.2	4.6	4.2	3.8	3.6	3.2	3.0	-69	-4.0	2.8	1.5
Poland	23	25	23	23	22	21	20	20	21	24	1	12.2	6.6	11.7
Portugal	10.4	9.0	7.9	7.9	7.3	7.1	7.0	6.6	6.5	6.4	-38	-1.2	3.0	3.2
Romania	11.4	14	15	14	14	13	13	13	13	14	18	2.2	3.2	6.7
Slovakia	2.9	3.7	3.4	2.9	3.0	2.8	2.3	2.4	2.4	2.3	-21	-4.1	0.8	1.1
Slovenia	2.0	2.6	2.6	2.5	2.4	2.4	2.1	2.1	2.2	2.1	2	-6.3	0.6	1.0
Spain	35	35	29	29	26	25	23	23	22	22	-38	-1.3	10.0	10.8
Sweden	5.3	4.7	4.1	3.9	3.6	3.4	3.2	2.9	2.9	2.8	-48	-3.2	1.5	1.4
United Kingdom	42	36	28	24	24	22	20	20	19	19	-54	-0.3	11.9	9.5
EU-28 (a)	**354**	**327**	**280**	**258**	**248**	**234**	**217**	**213**	**207**	**203**	**-42**	**-1.8**	**100**	**100**
EU-28 (b)	354	327	280	258	248	234	217	213	207	203				

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 2017, CO emissions fell by 69 % in the EU. Between 2016 and 2017, the increase was 0.2 % (Table 3.14), mainly because emissions ascended in Poland, Italy, Germany and Greece (gap-filled data) (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing most (i.e. more than 10 %) to CO emissions 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 produced lime without oxygen (see Belgium's IIR, listed in Appendix 5).

'1A4bi — Residential: Stationary' and '1A3bi — Road transport: Passenger cars' were the most important key categories for CO emissions, jointly accounting for

Table 3.14 Member State contributions to EU emissions of CO

Member State	CO (Gg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	1 180	915	730	618	553	525	526	566	522	540	535	529	-55	-1.1	1.8	2.7
Belgium	1 387	1108	927	753	497	395	345	519	319	372	361	293	-79	-18.7	2.2	1.5
Bulgaria	749	509	347	298	278	276	272	250	243	240	245	242	-68	-1.5	1.2	1.2
Croatia	557	445	451	419	300	272	254	239	205	219	205	197	-65	-4.3	0.9	1.0
Cyprus	44	38	30	27	19	17	16	15	15	14	14	14	-68	-3.6	0.1	0.1
Czechia	2 066	1561	1075	934	927	897	883	883	843	825	820	819	-60	-0.1	3.2	4.1
Denmark	714	639	465	418	346	305	287	273	250	254	244	241	-66	-1.1	1.1	1.2
Estonia	236	212	199	155	157	132	142	134	129	129	140	138	-42	-1.3	0.4	0.7
Finland	754	665	595	509	454	414	407	389	383	361	368	359	-52	-2.4	1.2	1.8
France	10 285	8 968	6 506	5 240	4 211	3 535	3 195	3 259	2 732	2 688	2 738	2 695	-74	-1.6	16.0	13.6
Germany	12 545	6 484	4 833	3 756	3 350	3 262	2 890	2 862	2 761	2 868	2 805	2 832	-77	1.0	19.5	14.3
Greece	1 178	1 006	1 020	777	564	509	546	445	447	421	387	407	-65	5.0	1.8	2.1
Hungary	1 413	964	830	682	523	530	546	538	460	445	437	423	-70	-3.2	2.2	2.1
Ireland	350	292	246	215	143	131	124	118	111	108	102	88	-75	-13.3	0.5	0.4
Italy	7 213	7 262	4 898	3 510	3 121	2 477	2 704	2 535	2 299	2 344	2 269	2 331	-68	2.7	11.2	11.8
Latvia	450	342	261	221	153	158	161	147	141	119	116	125	-72	7.5	0.7	0.6
Lithuania	460	281	183	176	156	172	167	159	151	145	143	140	-70	-2.4	0.7	0.7
Luxembourg	466	211	43	38	29	26	27	26	25	21	22	22	-95	1.3	0.7	0.1
Malta	20	20	0.7	13	10.6	9.6	6.9	7.0	6.7	6.3	5.9	6.4	>100	9.1	0.0	0.0
Netherlands	1 151	930	762	735	685	660	627	597	574	576	564	564	-51	0.0	1.8	2.8
Poland	3 641	4 659	3 356	3 089	3 077	2 782	2 787	2 658	2 387	2 343	2 456	2 543	-30	3.5	5.7	12.8
Portugal	802	837	690	510	395	363	349	329	312	320	308	325	-59	5.6	1.2	1.6
Romania	2 307	503	750	1 063	897	828	835	794	796	774	779	783	-66	0.5	3.6	3.9
Slovakia	1 134	707	546	557	452	420	428	399	359	370	377	365	-68	-3.1	1.8	1.8
Slovenia	305	281	188	163	130	128	123	122	102	107	110	105	-66	-4.6	0.5	0.5
Spain	3 680	3 059	2 297	1 757	1 421	1 382	1 317	1 298	1 313	1 298	1 292	1 309	-64	1.3	5.7	6.6
Sweden	1 073	931	662	528	454	441	417	411	397	384	385	384	-64	-0.2	1.7	1.9
United Kingdom	8 030	6 536	4 446	3 163	2 040	1 855	1 838	1837	1 747	1 707	1573	1 555	-81	-1.1	12.5	7.8
EU-28 (a)	**64 191**	**50 367**	**37 336**	**30 325**	**25 342**	**22 902**	**22 219**	**21 810**	**20 030**	**19 999**	**19 803**	**19 835**	**-69**	**0.2**	**100**	**100**
EU-28 (b)	63 012	49 361	36 317	29 547	24 777	22 393	21 673	21 364	19 582	19 579	19 416	19 428				

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.

55 % of the total. Among the top five key categories, the highest relative reduction in emissions between 1990 and 2017 was in the second most important key category, '1A3bi — Road transport: Passenger cars' (-91.1 %) (see Figure 3.11(a)). Reductions in emissions were also observed in the other four top-five key categories: '1A4bi — Residential: Stationary' (-37.5 %), '2C1 — Iron and steel production' (-41.8 %), '1A2a — Stat. combustion in manufacturing ind. and constr.: Iron &steel' (-69.5 %) and '1A3biv — Road transport: Mopeds & motorcycles' (-63.1 %) (key categories ranked according to their contribution to the total emissions).

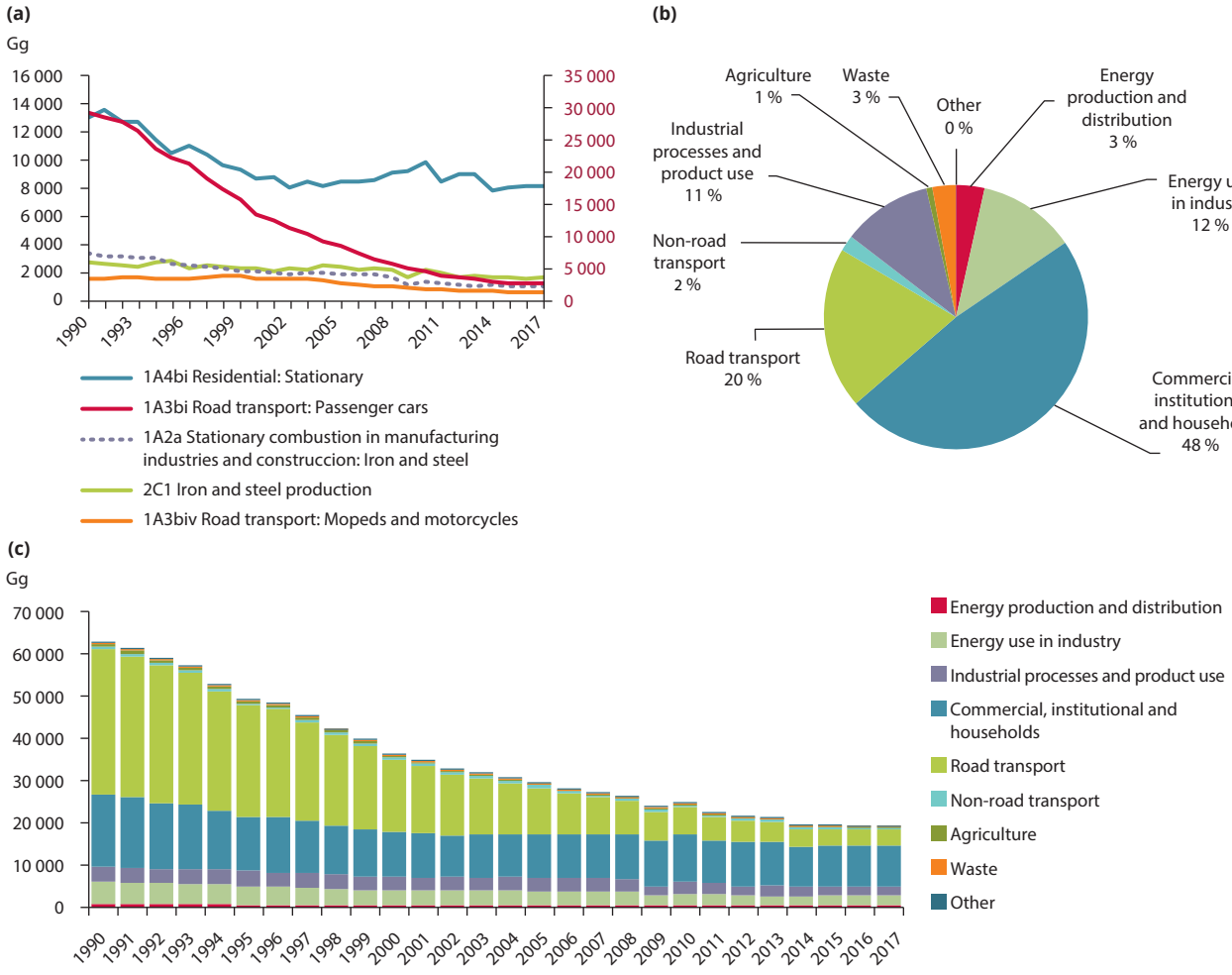
Figure 3.11(b) shows the contribution to total EU emissions made by each aggregated sector group. For CO, the common major emission sources are commercial, institutional and households and road transport.

3.12 Lead (Pb) emission trends and key categories

Between 1990 and 2017, Pb emissions dropped by 93 % in the EU. Between 2016 and 2017, emissions increased by 1.6 % (see Table 3.15), mainly in Poland, Bulgaria, Italy and Germany (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing most (i.e. more than 10 %) to Pb emissions were Poland, Italy) and Germany (countries ranked according to the percentage of their share in the EU total).

Austria stated that the significant reduction in Pb emissions from 1990 to 1995 was linked to the ban on lead in gasoline, abatement techniques and product substitutions. During this period, emissions from the transport sector fell by nearly 100 %. Compared to 2016, Pb emissions increased by 3.1 % in 2017 as a

Figure 3.11 CO emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2017; (b) share by sector group, 2017; (c) sectoral trends in emissions



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

result of growing iron and steel production activities (see Austria's IIR, listed in Appendix 5).

Belgium explained that the decrease in Pb emissions between 1995 and 2000 was mainly due to certain 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. At ArcelorMittal (2C1), there were lower mass flows of Pb emissions in 1997, possibly as the result of replacing the sintering plant's electro-filter with a sleeve filter. Another factory (2A3) reporting Pb emissions in 1997 did not produce an annual industrial report in 1998 and stopped activities in 1999 (personal communication by Belgium in 2018).

Croatia explained that, between 1990 and 2017, Pb emissions from the transport sector fell by 99 % as the result of legislative moves to remove Pb from petrol. Efforts began in 1996 when the Pb content in leaded petrol was reduced before being reduced again in 2003. Finally, in 2006, leaded petrol was completely

Table 3.15 Member State contributions to EU emissions of Pb

Member State	Pb (Mg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	216	17	14	14	15	16	16	17	16	15	15	16	-93	3.1	0.9	1.0
Belgium	254	187	106	74	39	28	28	25	23	29	27	25	-90	-6.4	1.1	1.7
Bulgaria	440	366	274	121	61	65	67	70	79	73	67	73	-83	9.0	1.9	4.8
Croatia	540	330	277	56	8.2	8.0	7.3	8.5	8.0	8.0	8.0	8.0	-99	-0.1	2.4	0.5
Cyprus	36	41	39	20	20	20	17	15	14	15	17	18	-48	7.7	0.2	1.2
Czechia	328	266	219	35	23	21	21	22	23	20	17	17	-95	2.3	1.4	1.1
Denmark	130	26	20	17	13	13	12	12	12	12	12	12	-91	-0.4	0.6	0.8
Estonia	205	86	37	36	39	38	34	39	36	28	32	34	-83	5.1	0.9	2.2
Finland	320	72	30	21	20	19	16	16	17	15	16	16	-95	-0.3	1.4	1.0
France	4 293	1 476	280	172	134	125	126	122	118	112	112	113	-97	0.7	18.8	7.4
Germany	2 285	742	429	304	238	238	229	225	231	237	232	235	-90	1.2	10.0	15.4
Greece	462	361	288	12	11	10	9	9	10	9	9	9	-98	2.4	2.0	0.6
Hungary	839	305	21	9.9	8.2	9.2	8.9	8.3	7.8	8.2	8.8	8.6	-99	-3.3	3.7	0.6
Ireland	159	98	14	8	6	6	6	6	5	6	5	5	-97	-5.1	0.7	0.3
Italy	4 277	1 991	953	284	266	263	265	257	259	256	270	275	-94	1.8	18.8	18.1
Latvia	233	127	153	169	164	4.3	5.9	3.8	3.6	3.4	3.4	3.5	-99	3.0	1.0	0.2
Lithuania	90	53	5.9	3.8	3.1	3.0	3.1	3.1	2.9	2.8	2.4	2.5	-97	5.0	0.4	0.2
Luxembourg	19	9	1.1	1.4	1.0	1.5	1.7	1.1	1.2	1.3	1.3	1.4	-93	5.8	0.1	0.1
Malta	0.4	0.5	0.7	3.9	3.8	2.6	10	3.5	4.5	1.4	0.8	0.2	-48	-76.6	0.0	0.0
Netherlands	333	154	27	30	38	22	16	14	9.0	8.7	9.0	8.6	-97	-4.1	1.5	0.6
Poland	424	395	305	279	304	302	316	308	312	302	296	305	-28	3.3	1.9	20.1
Portugal	569	785	43	44	40	41	41	40	41	41	40	41	-93	2.1	2.5	2.7
Romania	68	64	49	67	43	43	40	36	37	40	39	39	-43	0.2	0.3	2.5
Slovakia	66	55	45	54	36	36	33	27	33	37	43	44	-34	0.9	0.3	2.9
Slovenia	342	192	36	9.6	8.9	8.9	8.5	7.8	7.1	7.3	7.3	7.2	-98	-1.9	1.5	0.5
Spain	2 585	854	473	126	111	106	99	97	99	106	103	100	-96	-2.6	11.3	6.6
Sweden	354	32	22	14	12	11	11	10	11	10	11	11	-97	0.1	1.6	0.7
United Kingdom	2 928	1 570	194	155	102	101	105	100	108	106	94	95	-97	0.6	12.8	6.2
EU-28 ([a])	**22 797**	**10 656**	**4 354**	**2 141**	**1 768**	**1 561**	**1 552**	**1 503**	**1 526**	**1 509**	**1 497**	**1 521**	**-93**	**1.6**	**100**	**100**
EU-28 ([b])	22 797	10 656	4 354	2 141	1 768	1 561	1 552	1 503	1 526	1 509	1 497	1 521				

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.

removed from use (personal communication by Croatia in 2017).

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

In 2017, Latvia's Pb emissions had fallen by 99 % compared to 1990. In 1999, a significant drop in lead emissions can be seen in the transport sector, which can be explained by changes in international legislation that prohibited the use of liquid fuels with high lead content. The most significant drop of 97.4 % in emissions occurred in 2011, due to a change in the type of furnace used in metal production (see Latvia's IIR, listed in Appendix 5).

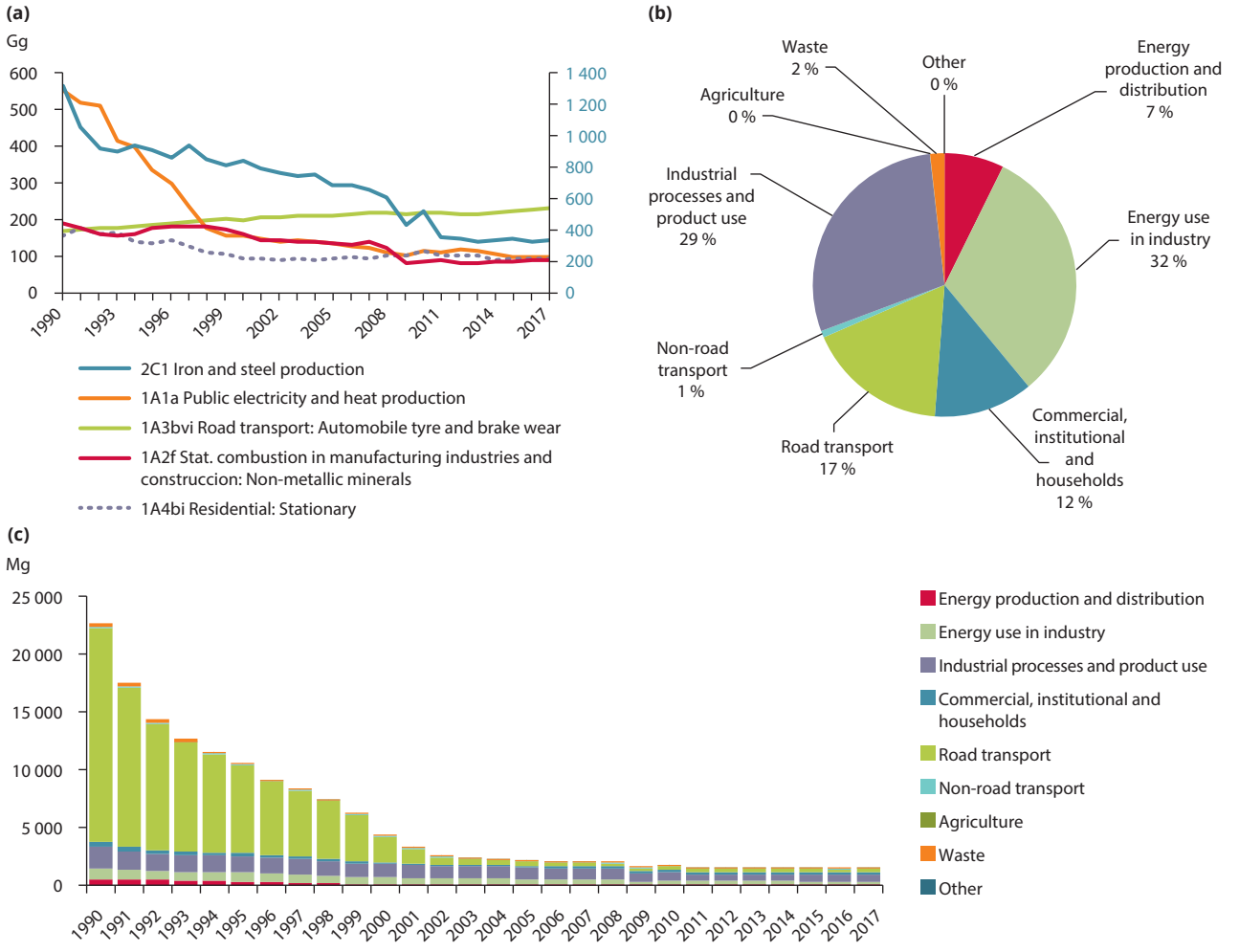
In 2012, the Pb emission peak reported by Malta was caused by higher emissions in the category '1A1a — Public electricity and heat production'.

Portugal stated that the Pb emissions registered from 1990 to 2017 showed a downwards trend, falling by 93 %. This was mainly the result of fewer emissions from road transport, due to the phasing out of leaded petrol in the EU (see Portugal's IIR, listed in Appendix 5).

'2C1 — Iron and steel production', '1A3bvi — Road transport: Automobile tyre and brake wear' and '1A1a — Public electricity and heat' were the leading key categories for Pb emissions in 2017, together making up 45 % of total Pb emissions (see Figure 3.12(a)).

The largest relative reductions in emissions between 1990 and 2017 were from the third most important key category, '1A1a — Public electricity and head production' (-82 %), and the most important key category, '2C1 — Iron and steel production' (-74 %). The second most important key category, '1A3bvi — Road transport: Automobile tyre and brake wear', has increased by 35.5 % since 1990.

Figure 3.12 Pb emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2017; (b) share by sector group, 2017; (c) sectoral trends in emissions



Note: In Figure 3.12(a), the right-hand axis gives values for '2C1 — iron and steel production'.

EU total emissions of Pb have declined to less than a 10th of the emissions in 1990, primarily because of reduced emissions from the road transport sector. Thanks to a combination of fiscal and regulatory measures, the promotion of unleaded petrol within the EU has proved a notable success. 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, 2018c).

Figure 3.12(b) shows the contribution that each aggregated sector group made to total EU emissions. The industrial processes and product use, road transport, energy use in industry and commercial, institutional and households sector groups are important sources of Pb.

3.13 Cadmium (Cd) emission trends and key categories

Between 1990 and 2017, Cd emissions fell by 64 % in the EU. However, between 2016 and 2017, they increased by 1.1 % (Table 3.16), mainly due to a slight increase in Portugal, Poland, the United Kingdom and

Table 3.16 Member State contributions to EU emissions of Cd

Member State	Cd (Mg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	1.8	1.1	1.0	1.1	1.2	1.2	1.2	1.3	1.2	1.2	1.2	1.2	-31	3.1	0.9	1.8
Belgium	6.2	5.1	2.8	2.1	2.0	1.7	1.5	1.5	1.2	1.6	2.6	1.3	-78	-47.9	3.3	2.0
Bulgaria	5.5	3.7	3.7	3.2	1.4	1.6	1.5	1.5	2.4	1.5	1.7	1.7	-70	-1.6	2.9	2.4
Croatia	1.1	0.8	0.8	1.0	0.9	0.9	0.9	0.9	0.8	0.9	0.8	0.8	-27	0.4	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	0.1	-38	0.6	0.0	0.1
Czechia	4.1	2.1	1.7	1.6	1.4	1.3	1.2	1.3	1.3	1.2	1.2	1.2	-71	-1.0	2.1	1.7
Denmark	1.2	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	-36	2.3	0.6	1.1
Estonia	4.5	2.2	0.8	0.8	0.9	0.9	0.8	1.0	0.9	0.7	0.8	0.8	-82	-0.7	2.4	1.2
Finland	6.7	2.1	1.4	1.5	1.3	1.2	1.2	1.1	0.9	0.9	0.9	1.0	-86	1.9	3.5	1.4
France	21	18	14	5.9	3.3	3.1	3.0	3.0	3.2	2.9	3.4	3.2	-85	-6.3	10.8	4.6
Germany	30	20	19	13	13	13	13	13	13	13	13	13	-57	1.6	15.9	19.2
Greece	1.8	2.0	1.6	1.7	1.9	1.5	1.6	1.3	1.9	1.6	1.4	1.5	-18	0.4	0.9	2.1
Hungary	1.7	1.5	1.7	1.2	1.5	1.6	1.6	1.7	1.5	1.5	1.5	1.5	-15	-3.8	0.9	2.1
Ireland	0.6	0.6	0.6	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-49	-0.4	0.3	0.4
Italy	11	10.2	9.6	9.0	7.7	7.5	7.7	7.3	7.2	7.1	7.5	7.5	-30	-0.5	5.5	10.9
Latvia	0.9	0.8	0.9	1.1	1.0	0.6	0.8	0.7	0.7	0.6	0.6	0.6	-33	7.5	0.5	0.9
Lithuania	0.4	0.4	0.4	0.7	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6	1.8	0.2	0.6
Luxembourg	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-24	-8.3	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	0.0	-100	-87.8	0.1	0.0
Netherlands	2.2	1.2	1.0	1.8	2.6	1.2	0.9	0.7	0.7	0.7	0.7	0.8	-65	12.9	1.1	1.1
Poland	20	23	17	13	13	13	13	13	12	12	12	12	-37	2.5	10.2	18.1
Portugal	6.4	6.7	6.6	7.3	4.9	3.7	3.3	4.9	4.9	4.7	3.6	4.6	-28	27.7	3.3	6.8
Romania	3.8	3.1	3.3	3.7	3.4	3.3	3.3	3.0	3.0	2.9	2.9	3.0	-20	1.8	2.0	4.4
Slovakia	8.1	9.2	6.7	5.7	1.0	0.9	1.0	0.9	0.9	1.0	1.1	1.2	-85	8.7	4.2	1.8
Slovenia	0.7	0.5	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	-15	-0.1	0.4	0.9
Spain	26	21	14	9	4.9	5.4	4.6	4.4	4.2	4.3	4.1	4.2	-84	2.6	13.6	6.2
Sweden	2.3	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-78	8.7	1.2	0.8
United Kingdom	24	12	6.6	4.4	3.7	3.9	3.5	3.6	4.1	3.9	3.8	4.0	-83	7.7	12.3	5.9
EU-28 (a)	**191**	**150**	**117**	**92**	**74**	**71**	**68**	**68**	**69**	**67**	**67**	**68**	**-64**	**1.1**	**100**	**100**
EU-28 (b)	191	150	117	92	74	71	68	68	69	67	67	68				

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.

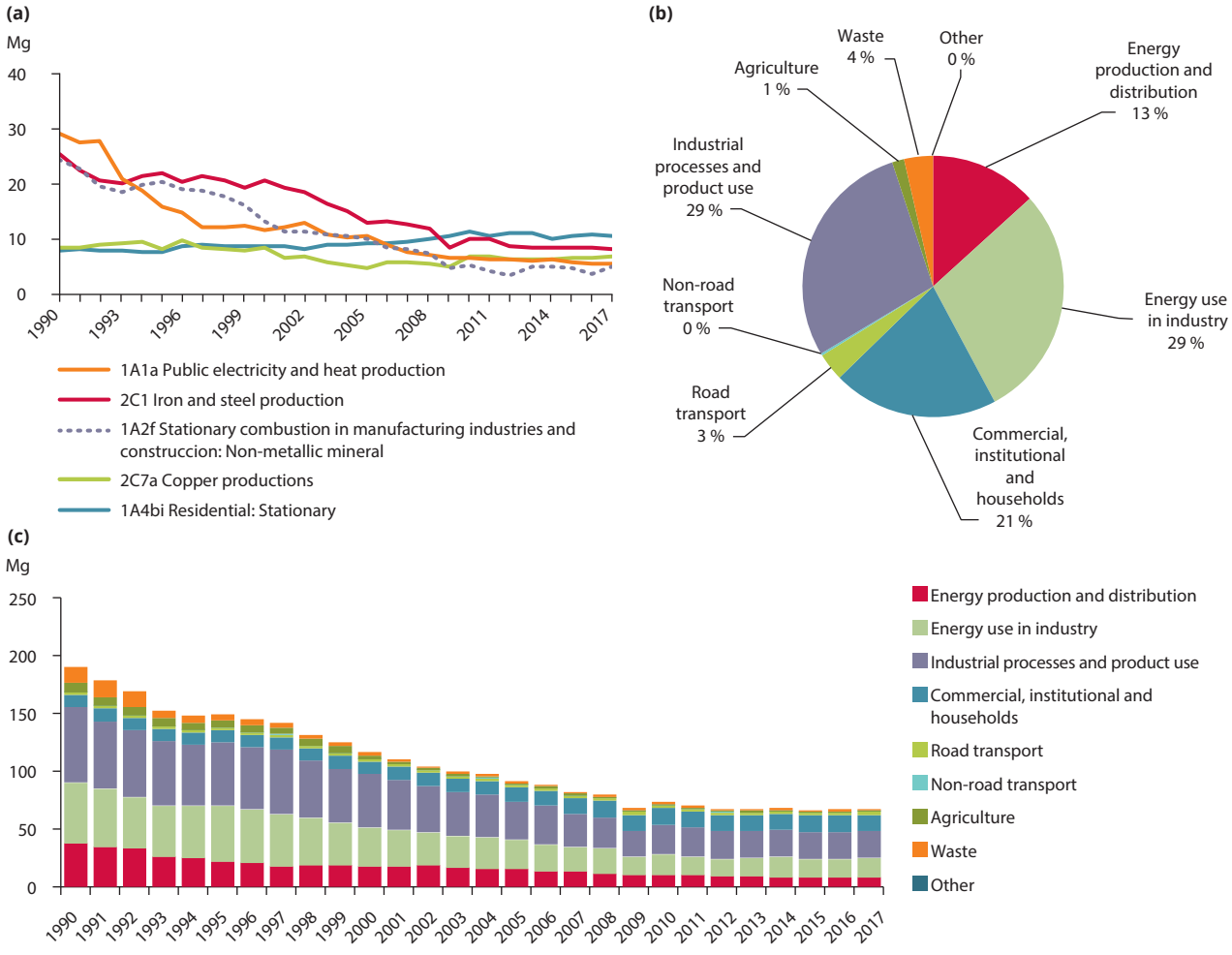
Germany (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing most (i.e. more than 10 %) to Cd emissions were Germany and Poland (countries ranked according to the percentage of their share in the EU total).

'1A4bi — Residential: Stationary', '2C1 — Iron and steel production' and '2C7a — Copper production' were the principal key categories for Cd emissions, making up 37 % of total Cd emissions (see Figure 3.13(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2017 were in the fourth most important, '1A1a — Public electricity and heat production' (-81.6 %), the fifth most important, '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' (-80.1 %) and the second most important, '2C1 — Iron and steel production' (-67.8 %). In the most important key category, '1A4bi — Residential: Stationary', the values of reported emissions have increased since 1990 (35.1 %).

As for Pb, industrial sources of Cd emissions have fallen since the early 1990s in all Member States. This is largely because the abatement technologies for waste-water treatment and incinerators have improved, as have the metal-refining and smelting facilities (EEA, 2018c).

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

Figure 3.13 Cd emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2017; (b) share by sector group, 2017; (c) sectoral trends in emissions



3.14 Mercury (Hg) emission trends and key categories

Between 1990 and 2017, Hg emissions dropped by 72 % in the EU. Between 2016 and 2017, the decrease was 1 % (see Table 3.17), mainly because of fewer emissions in Belgium, Germany, Greece (gap-filled data) and the Netherlands (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing most (i.e. more than 10 %) to Hg emissions were Poland, Germany and Italy (countries ranked according to the percentage of their share in the EU total).

'1A1a — Public electricity and heat production', '2C1 — Iron and steel production' and '1A4bi — Residential: Stationary' were the main key categories for Hg emissions, making up 54 % of the total (see Figure 3.14(a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2017 was in the fifth most important, '1A2f —

Table 3.17 Member State contributions to EU emissions of Hg

Member State	Hg (Mg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	2.2	1.3	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.1	-52	7.6	1.1	1.8
Belgium	6.1	3.4	3.2	2.2	1.7	1.7	1.3	1.4	1.5	1.1	1.4	1.0	-83	-24.2	3.0	1.8
Bulgaria	2.6	2.0	1.5	1.6	0.9	1.0	0.8	0.8	0.8	0.8	0.8	0.9	-66	2.7	1.3	1.5
Croatia	1.2	0.3	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	-62	-13.5	0.6	0.8
Cyprus	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0	3.7	0.0	0.2
Czechia	5.0	4.3	3.4	3.5	3.3	3.3	3.0	2.8	2.8	2.7	2.6	2.6	-47	-1.6	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	0.3	-91	-13.5	1.6	0.5
Estonia	1.2	0.6	0.6	0.6	0.7	0.7	0.6	0.7	0.7	0.5	0.6	0.6	-49	-4.6	0.6	1.0
Finland	1.1	0.8	0.6	0.9	0.9	0.7	0.7	0.8	0.7	0.6	0.6	0.6	-47	-1.3	0.5	1.0
France	26	21	12	7.3	4.8	5.1	4.5	4.4	4.8	4.2	3.7	3.8	-85	2.7	12.6	6.7
Germany	36	20	18	14	11	11	10	9.8	9.9	10	9.6	9.4	-74	-2.9	17.6	16.4
Greece	2.1	2.0	2.1	2.2	3.1	3.1	2.5	2.3	2.0	1.9	1.7	1.4	-32	-15.7	1.0	2.5
Hungary	3.3	2.6	2.3	1.7	1.5	1.4	1.2	1.1	1.1	1.1	1.2	1.3	-59	10.0	1.6	2.4
Ireland	0.8	0.7	0.4	0.4	0.4	0.3	0.4	0.4	0.3	0.4	0.4	0.3	-59	-4.7	0.4	0.6
Italy	15	14	14	12	10	10	11	9.7	10	9.3	9.0	9.2	-40	2.3	7.5	16.1
Latvia	0.3	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	-64	-2.9	0.1	0.2
Lithuania	0.4	0.2	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-60	49.9	0.2	0.3
Luxembourg	0.4	0.2	0.3	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	-85	-49.1	0.2	0.1
Malta	0.4	0.5	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-93	-10.4	0.2	0.0
Netherlands	3.6	1.5	1.1	1.0	0.7	0.8	0.7	0.7	0.6	0.7	0.7	0.6	-83	-15.8	1.8	1.0
Poland	16	14	11	11	10.0	10.1	10.5	10	9.7	10	9	10	-41	1.1	8.0	16.8
Portugal	3.5	3.7	3.4	3.1	2.1	2.0	2.1	2.0	1.9	2.1	2.0	2.1	-40	5.6	1.7	3.7
Romania	3.4	2.5	1.8	2.2	1.7	1.9	1.7	1.5	1.5	1.5	1.4	1.4	-57	0.5	1.7	2.5
Slovakia	19	3.9	4.5	2.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3	-93	5.4	9.3	2.2
Slovenia	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-50	1.0	0.2	0.3
Spain	10	13	9	7	4.2	4.3	4.5	4.0	4.1	4.2	4.3	4.2	-59	-1.6	5.2	7.4
Sweden	1.5	1.0	0.7	0.7	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	-74	0.5	0.8	0.7
United Kingdom	38	20	8.3	7.5	6.5	6.0	5.8	6.1	5.4	4.8	3.9	4.0	-89	2.1	18.7	7.0
EU-28 [a]	**202**	**137**	**103**	**85**	**68**	**67**	**66**	**63**	**62**	**59**	**57**	**57**	**-72**	**-1.0**	**100**	**100**
EU-28 [b]	202	137	103	85	68	67	66	63	62	59	57	57				

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.

Stationary combustion in manufacturing industries and construction: Non-metallic minerals' (-70.1 %). The most important key category, '1A1a — Public electricity and heat production' (-68 %) and the third most important, '1A4bi — Residential: Stationary' (-52.4 %) also show high reductions. In the fourth most important key category, '1A4ai — Commercial/institutional: Stationary', the values of reported emissions have increased since 1990 (14.6 %).

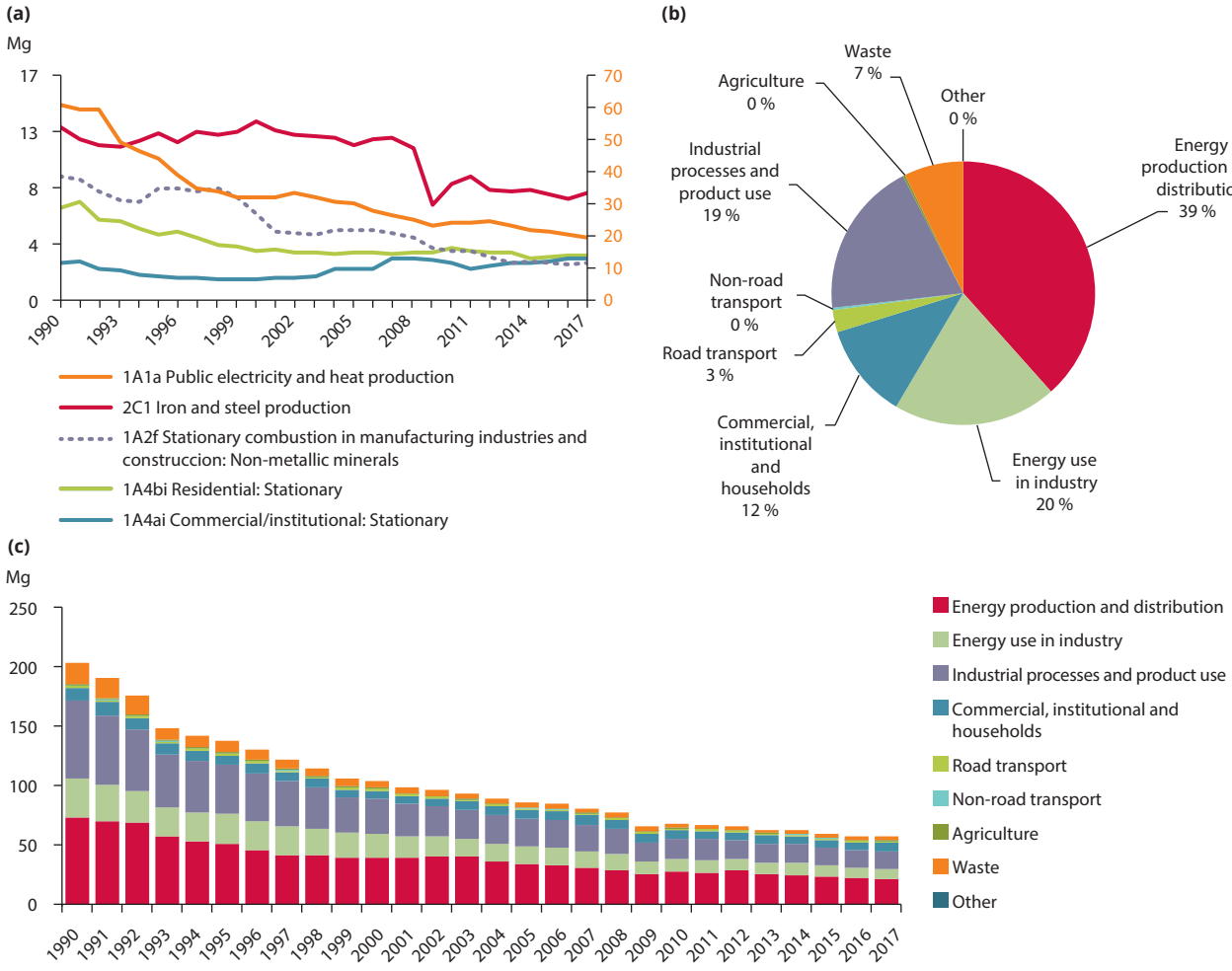
Since 1990, the fall in Hg emissions in the industrial sector is mainly due to better emission controls on Hg cells and replacing them with diaphragm or membrane cells, and switching from coal to gas and other energy sources in many countries' power- and heat-generating sectors (EEA, 2018c).

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

3.15 Arsenic (As) emission trends

Between 1990 and 2017, As emissions dropped by 69 % in the EU. Between 2016 and 2017, emissions ascended by 4.8 % (Table 3.18), mainly because emissions increased in 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 As emissions in 2017 were Italy , Slovakia and Poland (countries ranked

Figure 3.14 Hg emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2017; (b) share by sector group, 2017; (c) sectoral trends in emissions



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

according to the percentage of their share in the EU total). As Austria and Luxembourg did not provide emission data for As, the EU total is an underestimate.

The strong decline of As emissions reported by Slovakia from 1995 to 2000 is mainly caused by the category '2C7a — Copper production'. During this period, the As emission trend resulted from the economic and political situation in Slovakia, especially in 1995, when the biggest state copper-producing company was sold to the private sector and in 1999 when the company stopped using outdated and energy ineffective technology to produce copper (see Slovakia's IIR, listed in Appendix 5).

Table 3.18 Member State contributions to EU emissions of As

Member State	As (Mg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Belgium	6.4	6.1	3.6	3.0	1.8	1.6	1.4	1.3	1.0	1.1	0.9	0.8	-87	-9.2	1.2	0.5
Bulgaria	25	15	7.5	16	3.5	4.1	2.9	2.9	4.4	3.0	3.6	3.7	-85	1.4	4.8	2.3
Croatia	8.6	1.2	1.0	1.1	0.8	0.6	0.6	0.5	0.4	0.5	0.4	0.5	-94	28.9	1.7	0.3
Cyprus	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	5	0.8	0.0	0.1
Czechia	69	17	3.8	2.0	1.6	1.5	1.4	1.6	1.3	1.4	1.3	1.5	-98	8.5	13.3	0.9
Denmark	1.3	0.8	0.8	0.5	0.3	0.3	0.2	0.3	0.3	0.2	0.3	0.3	-81	-12.1	0.2	0.2
Estonia	19	10	8.6	9.2	11	11	9.6	11	10	7.8	9.0	9.5	-50	5.7	3.6	5.9
Finland	35	5.2	4.4	3.0	3.4	3.0	2.6	2.7	2.7	2.5	2.6	2.4	-93	-5.1	6.7	1.5
France	17	17	15	12	7.5	6.5	6.2	6.5	5.6	5.5	5.6	5.5	-68	-2.7	3.3	3.4
Germany	87	11	10	8.8	9.3	9.1	8.9	9.1	8.8	8.7	8.8	8.6	-90	-2.0	16.7	5.4
Greece	2.3	2.6	2.9	3.1	2.3	2.1	2.4	2.1	3.4	3.1	2.5	2.5	6	-0.7	0.4	1.6
Hungary	4.2	3.3	3.1	2.6	2.3	2.3	2.2	1.9	2.0	2.2	2.0	2.2	-48	9.8	0.8	1.4
Ireland	1.6	1.7	1.7	1.5	1.2	1.2	1.3	1.2	1.2	1.3	1.3	1.2	-28	-6.7	0.3	0.7
Italy	37	27	46	40	45	46	45	44	45	46	39	47	27	21.6	7.1	29.3
Latvia	17	8.5	15	17	16	0.1	0.2	0.1	0.2	0.2	0.2	0.2	-99	11.8	3.2	0.1
Lithuania	0.7	0.3	0.2	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-90	44.9	0.1	0.0
Luxembourg	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Malta	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-99	-2.9	0.0	0.0
Netherlands	1.3	0.9	0.9	1.3	0.6	1.0	0.8	0.7	0.7	0.7	0.7	0.5	-58	-25.6	0.2	0.3
Poland	27	26	19	18	18	18	18	17	17	17	17	17	-39	0.0	5.3	10.5
Portugal	3.1	3.4	3.6	3.7	1.9	1.7	1.9	1.8	1.8	1.9	1.7	1.8	-41	6.8	0.6	1.1
Romania	10.7	7.8	5.8	6.5	5.0	5.7	5.2	4.3	4.3	4.5	4.1	4.1	-62	-0.3	2.1	2.6
Slovakia	79	23	4.6	21	21	22	19	13	24	28	31	29	-63	-5.1	15.1	18.2
Slovenia	0.9	0.8	0.8	0.9	0.9	0.9	0.8	0.8	0.6	0.6	0.7	0.7	-27	-0.6	0.2	0.4
Spain	11	10	10	10	5	6	6	5	5	5	5	5	-51	10.4	2.1	3.3
Sweden	5.6	1.5	0.8	0.9	0.9	0.9	0.9	0.8	0.9	0.7	0.7	0.7	-87	12.7	1.1	0.5
United Kingdom	52	38	25	19	17	17	17	19	18	17	15	15	-71	-2.3	9.9	9.4
EU-28 (a)	**521**	**239**	**195**	**200**	**177**	**163**	**156**	**149**	**159**	**159**	**153**	**160**	**-69**	**4.8**	**100**	**100**
EU-28 (b)	521	239	195	200	177	163	156	149	159	159	153	160				

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 2017, Cr emissions dropped by 71 % in the EU. Between 2016 and 2017, emissions rose by 1.6 % (see Table 3.19), mainly because of increases in Hungary, Poland, Sweden and the United Kingdom (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing most (i.e. more than 10 %) to Cr emissions were Germany, Poland, Italy and the United Kingdom (countries ranked according to the percentage of their share in the EU total). As Austria and Luxembourg did not provide emission data for Cr, the EU total is an underestimate.

Table 3.19 Member State contributions to EU emissions of Cr

Member State	Cr (Mg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Belgium	33	28	19	17	13	12	11	6.2	5.9	5.9	6.1	4.6	-86	-24.8	2.7	1.3
Bulgaria	21	10	7.5	9.8	5.2	5.7	5.3	5.2	5.6	6.2	6.6	6.9	-67	4.1	1.7	1.9
Croatia	5.3	3.7	3.1	3.7	2.6	2.5	2.4	2.2	2.0	2.2	2.0	2.1	-60	5.1	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	0.2	30	3.2	0.0	0.1
Czechia	26	17	12	12	11	11	11	10	11	10	10	10	-61	-1.3	2.1	2.8
Denmark	6.0	3.1	1.6	1.7	1.7	1.6	1.5	1.6	1.6	1.7	1.7	1.8	-70	2.2	0.5	0.5
Estonia	18	10	8.4	9.1	11	10	9.2	11	9.9	7.6	8.7	9.2	-50	5.5	1.5	2.5
Finland	47	36	28	20	26	17	18	18	23	17	18	16	-65	-8.3	3.8	4.5
France	392	190	104	45	28	24	24	24	21	21	21	21	-95	-0.5	31.3	5.8
Germany	170	101	90	83	80	81	80	79	81	82	83	84	-51	0.5	13.5	23.0
Greece	5.6	6.1	6.6	6.9	7.2	8.4	8.8	7.3	14	15	13	13	>100	0.2	0.4	3.5
Hungary	18	12	12	12	11	12	11	7.9	8.8	11	9.5	12.3	-30	29.2	1.4	3.4
Ireland	4.5	4.6	4.9	3.5	2.7	2.5	2.5	2.5	2.4	2.5	2.5	2.5	-45	-1.8	0.4	0.7
Italy	87	69	44	49	43	43	42	39	38	38	39	39	-55	1.8	7.0	10.8
Latvia	2.5	1.9	2.2	2.6	2.5	1.3	1.5	1.3	1.4	1.3	1.3	1.4	-46	7.7	0.2	0.4
Lithuania	3.1	1.5	1.2	1.4	1.0	1.0	1.0	1.0	5.6	5.5	5.3	4.9	57	-8.6	0.2	1.3
Luxembourg	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Malta	0.6	0.9	1.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-92	-2.4	0.0	0.0
Netherlands	12	8.6	5.1	4.3	3.9	3.7	3.8	3.7	3.6	3.5	3.7	3.6	-70	-3.8	0.9	1.0
Poland	91	67	45	41	43	42	42	41	40	41	40	42	-54	3.6	7.2	11.4
Portugal	13	15	16	15	12	12	11	11	11	11	11	11	-16	2.8	1.1	3.0
Romania	19.0	17	16	19	13	12	12	11	11	12	12	12	-39	-2.0	1.5	3.2
Slovakia	58	6.3	5.1	4.9	4.5	4.2	4.6	4.7	4.5	4.6	4.8	5.1	-91	6.3	4.6	1.4
Slovenia	1.6	1.4	1.4	1.7	1.7	1.6	1.5	1.5	1.3	1.3	1.4	1.4	-11	-0.5	0.1	0.4
Spain	23	25	26	26	18	18	18	16	16	17	17	17	-25	4.2	1.8	4.8
Sweden	23	12	6.9	10	5.0	6.3	4.9	4.9	4.5	5.4	5.5	6.6	-71	20.3	1.9	1.8
United Kingdom	173	127	87	51	36	35	35	36	37	36	36	37	-79	2.9	13.8	10.0
EU-28 ([a])	**1254**	**775**	**555**	**451**	**383**	**369**	**363**	**347**	**361**	**359**	**359**	**364**	**-71**	**1.6**	**100**	**100**
EU-28 ([b])	1254	775	555	451	383	369	363	347	361	359	359	364				

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 2017, Cu emissions in the EU increased by 10 %. Between 2016 and 2017, they rose by 1.2 % (see Table 3.20), mainly because of increases in Germany, Poland, the Netherlands and Spain (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member State contributing most (i.e. more than 10 %) to Cu emissions was Germany (62.7 % of EU-28). As Austria and Luxembourg did not provide emission data for Cu, the EU total is an underestimate.

Table 3.20 Member State contributions to EU emissions of Cu

Member State	Cu (Mg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Belgium	41	42	43	41	39	37	37	35	35	35	35	34	-18	-2.8	1.2	0.9
Bulgaria	105	75	56	97	18	20	19	19	19	20	21	22	-79	6.7	2.9	0.6
Croatia	8.9	6.0	7.1	8.9	7.8	7.6	7.4	8.2	7.7	8.1	8.3	8.9	0	7.2	0.2	0.2
Cyprus	1.4	1.7	2.1	2.4	2.5	2.4	2.3	2.0	2.0	2.1	2.2	2.3	64	3.7	0.0	0.1
Czechia	32	26	21	27	26	26	26	26	27	27	27	27	-15	2.3	0.9	0.7
Denmark	33	37	40	42	43	43	42	42	42	43	43	43	31	0.0	0.9	1.1
Estonia	11	5.6	4.3	5.4	5.8	5.8	5.6	5.9	6.0	5.4	5.8	5.9	-46	2.7	0.3	0.2
Finland	150	110	59	52	38	38	37	38	39	37	37	36	-76	-2.5	4.2	0.9
France	223	218	218	221	212	217	209	212	208	211	210	206	-8	-1.5	6.2	5.2
Germany	1 884	2 023	2 205	2 212	2 270	2 314	2 299	2 309	2 360	2 404	2 449	2 474	31	1.0	52.4	62.8
Greece	22	26	29	33	35	32	26	26	31	29	29	29	33	1.7	0.6	0.7
Hungary	15	11	12	15	15	14	13	13	14	15	16	17	17	8.4	0.4	0.4
Ireland	11	12	19	22	19	19	18	19	19	20	21	20	92	-1.7	0.3	0.5
Italy	190	214	215	222	193	195	184	176	183	178	178	171	-10	-3.9	5.3	4.3
Latvia	5.3	3.3	3.5	4.8	5.3	4.6	4.5	4.7	5.0	5.2	5.3	5.6	6	6.1	0.1	0.1
Lithuania	10.4	5.2	4.5	5.4	5.9	5.8	5.7	5.7	5.6	5.5	5.1	4.6	-55	-8.4	0.3	0.1
Luxembourg	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Malta	0.6	0.7	0.8	0.0	6.0	7.0	7.7	8.8	9.8	10.8	11.8	12.8	>100	8.5	0.0	0.3
Netherlands	36	37	38	40	43	42	41	41	41	39	40	45	24	13.7	1.0	1.1
Poland	205	207	163	169	195	191	191	182	181	183	188	204	-1	8.0	5.7	5.2
Portugal	26	32	43	46	37	33	31	30	31	31	30	31	18	2.3	0.7	0.8
Romania	8.5	7.6	6.1	19	20	20	21	20	21	21	22	23	>100	5.2	0.2	0.6
Slovakia	76	38	16	38	43	44	39	27	37	46	52	50	-34	-4.5	2.1	1.3
Slovenia	3.5	4.0	4.2	5.2	5.8	6.0	6.1	5.6	5.4	5.5	5.8	6.0	68	3.4	0.1	0.2
Spain	100	120	155	174	163	152	145	135	140	145	148	151	50	2.1	2.8	3.8
Sweden	65	51	45	37	38	38	37	37	38	38	39	40	-38	3.3	1.8	1.0
United Kingdom	333	306	293	284	267	269	262	262	268	268	268	271	-19	0.9	9.3	6.9
EU-28 ([a])	**3 598**	**3 619**	**3 702**	**3 821**	**3 754**	**3 784**	**3 718**	**3 690**	**3 775**	**3 833**	**3 897**	**3 943**	**10**	**1.2**	**100**	**100**
EU-28 ([b])	3 598	3 619	3 702	3 821	3 754	3 784	3 718	3 690	3 775	3 833	3 897	3 943				

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 2017, Ni emissions dropped by 73 % in the EU. Between 2016 and 2017, they increased by 0.6 %, mainly because the United Kingdom, Spain, Germany and Romania (countries ranked according to the size of their contribution to the absolute change) reported increases (see Table 3.21). In 2017, the Member States contributing most (i.e. more than 10 %) to Ni emissions were Germany, the United Kingdom and Poland (countries ranked according to the percentage of their share in the EU total). As Austria and Luxembourg did not provide emission data for Ni, the EU total is an underestimate.

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

Table 3.21 Member State contributions to EU emissions of Ni

Member State	Ni (Mg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Belgium	76	70	35	27	9.2	8.7	6.0	4.5	4.2	4.2	4.1	3.3	-96	-20.0	3.5	0.6
Bulgaria	33	28	7.8	23	6.7	7.0	5.3	5.5	5.7	5.5	5.7	6.2	-81	8.9	1.5	1.0
Croatia	17	14	11	14	8	7	6	4.6	3.9	4.5	4.2	4.3	-75	2.3	0.8	0.7
Cyprus	5.9	7.2	9.9	12	7.1	8.9	9.4	5.2	5.2	5.3	5.7	5.6	-4	-0.8	0.3	0.9
Czechia	55	28	14	12	8	7	6.1	5.5	5.5	5.3	5.0	5.3	-90	6.9	2.5	0.9
Denmark	19	13	7.6	7.1	4.7	4.1	3.9	3.8	3.2	2.9	2.9	3.1	-83	7.3	0.8	0.5
Estonia	27	10	6.5	6.5	6.6	6.5	5.7	6.5	6.1	4.7	5.4	5.7	-79	6.6	1.2	1.0
Finland	78	47	35	26	23	20	19	17	17	16	16	15	-81	-5.8	3.6	2.5
France	276	218	178	142	82	74	59	47	43	38	37	30	-89	-17.3	12.6	5.1
Germany	342	212	169	180	157	145	142	138	131	138	151	155	-55	2.8	15.6	26.0
Greece	42	47	50	55	60	56	59	50	34	40	37	28	-34	-25.3	1.9	4.7
Hungary	24	32	21	7.4	6.7	7.6	6.5	5.9	5.8	5.5	5.2	5.3	-78	0.4	1.1	0.9
Ireland	22.3	27	34	27	14	11	10	9.5	8.4	8.3	8.4	8.3	-63	-0.7	1.0	1.4
Italy	115	111	106	111	40	38	36	32	31	31	31	27	-76	-12.7	5.2	4.5
Latvia	15	8.5	6.8	6.5	6.0	0.7	1.1	0.6	0.5	0.5	0.5	0.6	-96	9.3	0.7	0.1
Lithuania	36	16	9.7	9.2	4.9	4.0	4.7	2.7	1.7	1.7	1.3	1.2	-97	-8.9	1.6	0.2
Luxembourg	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Malta	8.3	13	17	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	-98	-8.0	0.4	0.0
Netherlands	75	86	20	10	2.1	2.4	2.1	2.0	1.8	2.0	2.2	2.1	-97	-4.1	3.4	0.4
Poland	187	176	131	115	108	103	97	88	86	93	92	90	-52	-1.8	8.5	15.1
Portugal	113	118	108	107	48	40	35	30	26	26	24	24	-78	-0.4	5.2	4.1
Romania	60	51	30	23	12	13	12	9.9	8.6	8.4	6.7	8.6	-86	29.5	2.7	1.4
Slovakia	34	10	12	14	13	12	12	13	13	13	13	14	-60	4.1	1.6	2.3
Slovenia	2.8	2.3	2.6	2.5	2.2	2.1	1.8	1.8	1.4	1.4	1.6	1.5	-48	-6.0	0.1	0.2
Spain	179	205	209	180	96	82	62	46	40	39	39	43	-76	11.0	8.1	7.2
Sweden	29	28	16	15	14	10	9.4	8.4	6.8	5.7	5.9	5.8	-80	-1.8	1.3	1.0
United Kingdom	323	330	192	154	129	103	120	128	129	93	89	103	-68	16.5	14.7	17.3
EU-28 (a)	**2 193**	**1 908**	**1 438**	**1 287**	**867**	**773**	**733**	**666**	**619**	**592**	**594**	**597**	**-73**	**0.6**	**100**	**100**
EU-28 (b)	2 193	1 908	1 438	1 287	867	773	733	666	619	592	594	597				

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.

3.19 Selenium (Se) emission trends

Between 1990 and 2017, Se emissions dropped by 39 % in the EU. However, between 2016 and 2017, they rose by 1 % (see Table 3.22), mainly because of slight increases in the United Kingdom, France, Bulgaria and Portugal (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing most (i.e. more than 10 %) to Se emissions were Portugal, Bulgaria and Czechia (countries ranked according to the percentage of their share in the EU total). As Austria, Luxembourg and Poland did not provide emission data for Se, the EU total is an underestimate.

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

Table 3.22 Member State contributions to EU emissions of Se

Member State	Se (Mg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Belgium	5.0	6.3	6.4	27	11	3.9	3.5	3.6	4.3	4.1	4.1	4.1	-18	-0.2	1.8	2.4
Bulgaria	41	12	5.2	13	14	16	15	16	19	20	22	23	-44	2.9	14.6	13.5
Croatia	0.5	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.4	0.3	0.4	0.4	-21	2.6	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	0.1	8	1.7	0.0	0.1
Czechia	33	29	28	30	26	25	24	23	22	22	22	22	-32	-0.7	11.6	12.9
Denmark	4.2	3.9	2.3	1.4	1.3	1.0	0.8	1.0	0.9	0.7	0.7	0.6	-86	-11.3	1.5	0.3
Estonia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6	-45.0	0.0	0.0
Finland	1.8	0.4	0.5	0.5	0.6	0.5	0.7	0.4	0.4	0.5	0.4	0.9	-52	116.0	0.6	0.5
France	15	15	16	15	13	13	12	12	12	12	12	12	-19	6.4	5.4	7.2
Germany	7.0	12	10	7.6	9.2	9.5	9.2	9.2	9.2	9.2	9.4	9.4	34	0.4	2.5	5.5
Greece	14	14	16	17	15	15	16	14	13	11	8.9	7.8	-43	-12.4	4.9	4.5
Hungary	6.5	5.8	5.8	4.1	3.5	3.7	3.6	3.5	3.4	3.4	3.3	3.1	-53	-5.8	2.3	1.8
Ireland	8.7	6.5	5.1	4.6	4.0	3.8	4.0	4.0	3.6	3.8	3.5	3.1	-65	-12.7	3.1	1.8
Italy	10	11	12	12	11	11	11	11	10	12	11	11	9	1.4	3.6	6.4
Latvia	0.4	0.3	0.2	0.1	0.3	0.3	0.3	0.2	0.2	0.3	0.2	0.2	-42	5.5	0.1	0.1
Lithuania	0.4	0.2	0.2	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-73	23.8	0.1	0.1
Luxembourg	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Malta	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	>100	-56.8	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	0.2	-47	-67.6	0.1	0.1
Poland	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Portugal	12	17	23	27	30	30	32	32	32	32	32	32	>100	1.6	4.4	18.8
Romania	23.9	15.7	12	12	12	14	13	10	10	10	9	9	-61	0.8	8.5	5.4
Slovakia	9	9	7.3	9	12	11	11	9	9	11	12	12	40	-1.7	3.1	7.1
Slovenia	2.9	2.5	2.4	2.5	2.5	2.5	2.4	2.3	1.8	1.9	2.0	2.0	-32	-1.2	1.0	1.2
Spain	6.4	7	8	8	5.6	5.8	6	5.4	5.4	6	6	6	-11	2.1	2.3	3.3
Sweden	1.0	1.1	1.0	1.1	1.2	1.2	1.2	1.1	1.1	1.0	1.1	1.1	12	6.1	0.4	0.7
United Kingdom	78	50	34	34	17	17	20	17	17	14	9.1	10.5	-87	15.6	27.7	6.1
EU-28 (a)	**281**	**221**	**196**	**231**	**192**	**187**	**187**	**175**	**177**	**177**	**170**	**172**	**-39**	**1.0**	**100**	**100**
EU-28 (b)	281	221	196	231	192	187	187	175	177	177	170	172				

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 2017, Zn emissions dropped by 38 % in the EU. However, between 2016 and 2017, they increased by 1.8 %, mainly because Italy, Poland, Germany and the United Kingdom (countries ranked according to the size of their contribution to the absolute change) reported higher emissions (see Table 3.23). In 2017, the Member States contributing most (i.e. more than 10 %) to Zn emissions were Germany, Italy and Poland (countries ranked according to the percentage of their share in the EU total). As Austria and Luxembourg did not provide emission data for Zn, the EU total is an underestimate.

Ireland explained the decline in its emissions after 2000 by the closure of its only steel plant in 2001. From 1990 to 2001, metal production was the main determinant of the trend in Zn emissions. On average, it accounted for 54.9 % of national total emissions throughout that period (see Ireland's IIR, listed in Appendix 5).

Table 3.23 Member State contributions to EU emissions of Zn

Member State	Zn (Mg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Belgium	235	189	184	132	111	104	90	82	82	85	76	70	-70	-7.1	2.5	1.2
Bulgaria	180	105	256	139	92	101	102	107	113	107	113	118	-34	4.8	1.9	2.0
Croatia	39	32	31	38	37	36	35	35	32	36	35	35	-11	0.5	0.4	0.6
Cyprus	3.8	4.7	5.9	6.9	5.4	5.9	5.9	4.4	4.5	4.5	4.8	4.9	27	1.6	0.0	0.1
Czechia	101	76	62	65	57	56	52	46	47	45	41	41	-59	0.1	1.1	0.7
Denmark	72	65	55	59	63	60	57	58	57	61	63	64	-11	2.2	0.8	1.1
Estonia	106	63	49	53	62	60	54	62	57	46	52	55	-48	6.3	1.1	0.9
Finland	678	401	126	114	129	124	127	123	131	117	125	119	-82	-5.4	7.1	2.0
France	2 219	1 419	1 006	577	512	503	511	495	480	488	497	495	-78	-0.4	23.2	8.3
Germany	1 687	1 692	1 847	1 854	1 918	1 945	1 929	1 946	1 974	2 015	2 060	2 080	23	0.9	17.6	34.9
Greece	39	42	46	43	46	44	41	36	39	38	34	34	-13	0.2	0.4	0.6
Hungary	69	51	54	48	55	65	69	64	57	60	60	57	-17	-4.1	0.7	1.0
Ireland	53	48	54	25	20	19	19	19	20	20	20	20	-63	-2.1	0.6	0.3
Italy	941	927	889	960	888	946	914	856	849	835	865	906	-4	4.8	9.8	15.2
Latvia	30	28	26	31	29	26	30	27	27	25	25	27	-10	7.9	0.3	0.5
Lithuania	23	16	17	19	19	18	19	18	17	17	16	17	-27	1.7	0.2	0.3
Luxembourg	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Malta	0.4	0.5	0.6	1.6	2.3	2.4	2.4	2.0	2.0	1.3	1.0	0.5	24	-48.2	0.0	0.0
Netherlands	225	147	97	89	103	95	95	86	113	103	101	95	-58	-6.2	2.4	1.6
Poland	1 121	984	716	624	632	643	658	636	654	642	623	652	-42	4.7	11.7	11.0
Portugal	72	78	93	95	92	95	95	93	94	95	97	99	37	2.7	0.8	1.7
Romania	100	90	103	125	120	111	113	107	107	107	108	109	9	0.8	1.0	1.8
Slovakia	73	58	51	65	54	52	55	55	57	60	63	66	-10	4.5	0.8	1.1
Slovenia	18.5	16.9	15.7	21.1	22.3	22.6	22.0	22.2	20.1	21.1	21.8	21.7	17	-0.6	0.2	0.4
Spain	217	228	243	265	229	230	225	209	209	219	218	224	3	2.7	2.3	3.8
Sweden	182	131	88	94	98	89	89	81	84	84	80	79	-57	-1.5	1.9	1.3
United Kingdom	1 081	1 045	724	528	477	456	430	466	469	478	451	466	-57	3.4	11.3	7.8
EU-28 (a)	**9568**	**7940**	**6837**	**6072**	**5871**	**5910**	**5838**	**5738**	**5798**	**5810**	**5851**	**5956**	**-38**	**1.8**	**100**	**100**
EU-28 (b)	9568	7940	6837	6072	5871	5910	5838	5738	5798	5810	5851	5956				

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.

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

Between 1990 and 2017, PCDD/F emissions dropped by 67 % in the EU. However, between 2016 and 2017, the increase was 4.2 % (see Table 3.24), mainly because Greece (gap-filled data), Romania, Slovakia and Italy (countries ranked according to the size of their contribution to the absolute change) reported higher emissions. In 2017, the Member State contributing most (i.e. more than 10 %) to PCDD/F emissions was Greece (gap-filled data) with a contribution of 40.2 % of EU-28 emissions.

Cyprus explained that, from 1990 to 2017, its PCDD/F emissions decreased by 69 % because a clinical-waste-incineration plant was closed down in 2003 and all clinical waste is now sterilised (see Cyprus's IIR, listed in Appendix 5).

Czechia explained that the fall in emissions between 2007 and 2009 was due to the installation of new fabric filters in the Třinecké železárny sinter plant (personal communication by Czechia in 2018).

In France (1990-2012), the decrease in dioxin emissions resulted from regulations limiting emissions, especially

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

Member State	PCDD/Fs (g I-TEQ)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	123	59	54	35	41	39	39	43	39	41	40	41	-67	0.9	1.3	1.3
Belgium	589	408	124	66	54	45	49	41	30	32	32	33	-94	1.9	6.4	1.1
Bulgaria	118	140	157	156	65	75	64	66	56	56	41	42	-65	3.3	1.3	1.4
Croatia	49	43	41	49	34	32	31	27	22	23	20	16	-67	-20.8	0.5	0.5
Cyprus	2.1	2.4	2.8	0.8	0.7	0.7	0.7	0.8	0.6	0.6	0.7	0.7	-69	-3.1	0.0	0.0
Czechia	93	73	62	62	47	39	40	40	41	36	27	26	-72	-3.6	1.0	0.9
Denmark	69	50	32	27	25	23	22	22	20	22	23	22	-69	-4.5	0.7	0.7
Estonia	8.1	5.6	6.7	5.7	6.4	6.3	4.7	3.7	4.0	4.1	4.0	4.3	-47	7.4	0.1	0.1
Finland	18	19	19	14	16	14	15	15	16	14	15	13	-26	-12.0	0.2	0.4
France	1 782	1 723	557	236	140	131	120	124	118	116	104	102	-94	-2.3	19.2	3.4
Germany	806	331	253	151	127	124	121	121	118	119	119	119	-85	0.1	8.7	3.9
Greece	851	871	1 029	1 148	1 249	1 210	1 148	1 062	1 336	1 230	1 125	1 218	43	8.3	9.2	40.2
Hungary	105	67	72	60	76	84	86	81	71	79	77	67	-36	-13.8	1.1	2.2
Ireland	62	45	34	31	30	27	26	25	23	24	21	20	-68	-4.7	0.7	0.7
Italy	503	484	404	328	309	268	287	282	269	275	273	288	-43	5.4	5.4	9.5
Latvia	26	27	25	29	19	20	23	19	18	16	16	18	-30	16.6	0.3	0.6
Lithuania	27	20	22	25	24	24	23	22	21	19	19	20	-25	4.6	0.3	0.7
Luxembourg	43	34	6.1	2.2	2.4	2.3	1.7	1.6	1.8	1.4	2.3	2.0	-95	-13.6	0.5	0.1
Malta	0.2	0.2	0.2	0.2	7.8	1.0	3.8	4	4.0	3.6	3.3	3.3	>100	-0.7	0.0	0.1
Netherlands	744	68	33	31	33	33	26	27	24	23	23	23	-97	-0.6	8.0	0.8
Poland	324	359	251	281	303	279	285	274	256	256	261	259	-20	-0.7	3.5	8.5
Portugal	548	544	347	60	43	44	46	41	40	40	41	44	-92	6.7	5.9	1.5
Romania	134	131	149	184	184	195	205	172	159	158	168	190	42	13.3	1.4	6.3
Slovakia	374	312	190	108	42	40	42	42	43	44	60	75	-80	26.1	4.0	2.5
Slovenia	18	15	15	17	17	18	17	17	15	15	16	15	-15	-2.4	0.2	0.5
Spain	411	447	188	171	165	168	168	167	172	177	171	168	-59	-1.9	4.4	5.5
Sweden	69	48	41	43	36	31	28	26	24	23	25	25	-64	0.0	0.7	0.8
United Kingdom	1 370	874	343	256	219	208	210	209	196	193	182	179	-87	-2.0	14.8	5.9
EU-28 (a)	**9 265**	**7 200**	**4 458**	**3 574**	**3 315**	**3 180**	**3 131**	**2 975**	**3 140**	**3 040**	**2 910**	**3 033**	**-67**	**4.2**	**100**	**100**
EU-28 (b)	9 265	7 200	4 458	3 574	3 315	3 180	3 131	2 975	3 140	3 040	2 910	3 033				

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.

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).

Slovakia claimed the slightly increasing trend since 2010 was the result of waste-management politics in Slovakia, giving preference to combustion rather than landfilling waste. The main contributor is the 1A2gviii category, which includes incineration of industrial and clinical waste with energy recovery (see Slovakia's IIR, listed in Appendix 5).

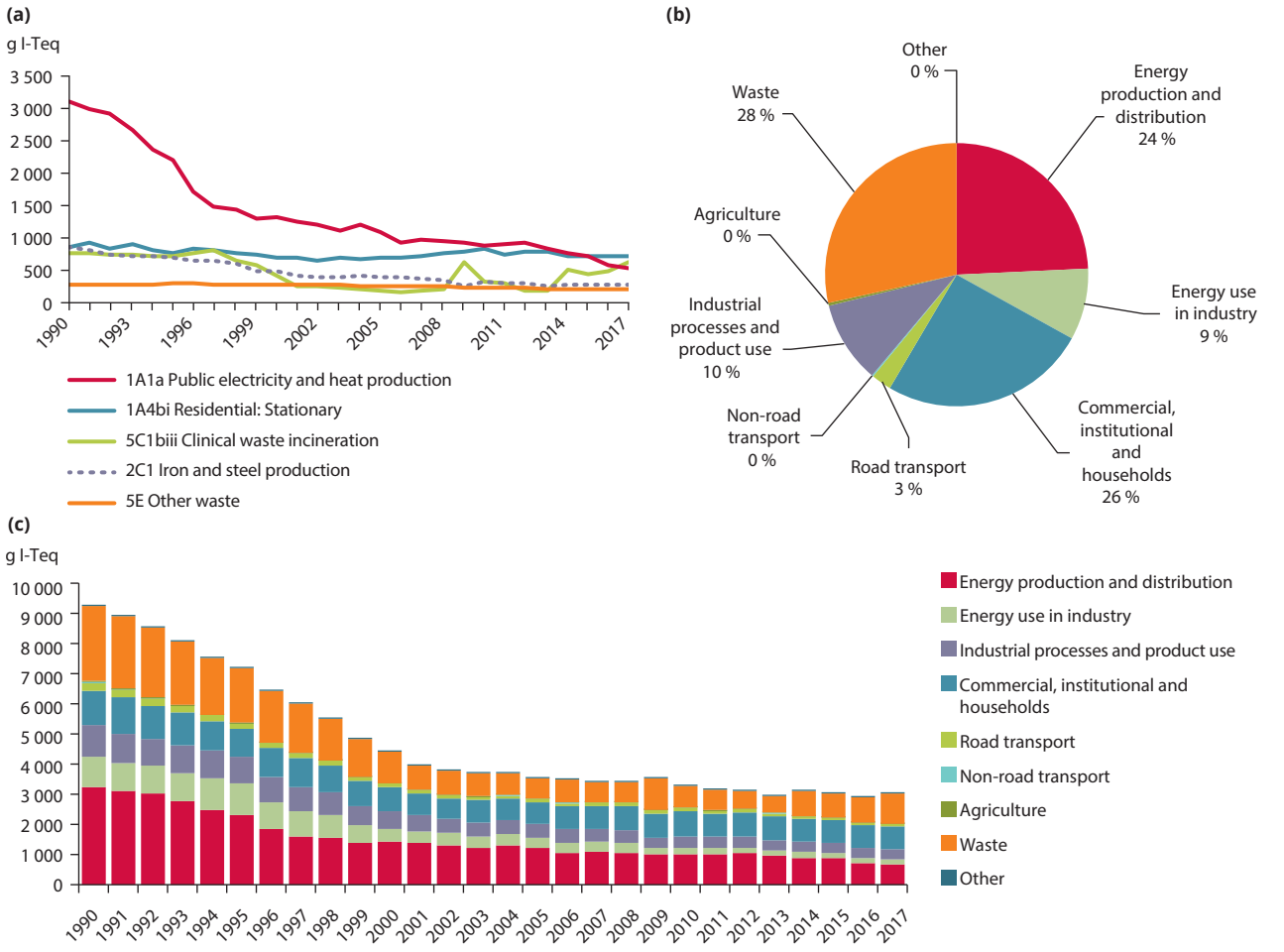
In Spain, the fall in PCDD/F emissions after 1995 was linked to the adaptation of municipal solid waste (MSW) incineration facilities with energy recovery (included under category '1A1a — Public electricity and heat production'), to comply with the maximum levels imposed in legislation; it was also related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

The '5C1biii — Clinical waste incineration' category contributed most to the trend in PCDD/F emissions reported by Portugal. The dramatic drop between 2000 and 2005 was caused by the closing of 25 incinerators on the country's mainland, with just one remaining clinical waste incinerator in operation since 2004. Other clinical waste received alternative treatment or was sent abroad (see Portugal's IIR, listed in Appendix 5).

The United Kingdom reported in its IIR, that the strong decrease in PCDD/F emissions from 1990 to 1995 was associated with increases in sales of unleaded petrol, particularly as a result of the increased use of cars fitted with three-way catalysts. Leaded petrol was phased out from general sale at the end of 1999, by large reduction in pollutant emissions (see the United Kingdom's IIR, listed in Appendix 5).

'1A4bi — Residential: Stationary' and '5C1biii — Clinical waste incineration' were the primary key categories for PCDD/F emissions, together making up 44 % of total PCDD/F emissions (see Figure 3.15(a)).

Figure 3.15 PCDD/F emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2017; (b) share by sector group, 2017; (c) sectoral trends in emissions



Among the top five key categories, the highest relative reductions in emissions between 1990 and 2017 were in the third most important, '1A1a — Public electricity and heat production' (-83.3 %), and the fourth most important, '2C1 — Iron and steel production' (-69.3 %).

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

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

Between 1990 and 2017, total PAH emissions dropped by 78 % in the EU. However, between 2016 and 2017, they rose by 1.4 % (see Table 3.25), mainly because Portugal, Italy, Bulgaria and Czechia (countries ranked according to the size of their contribution to the absolute change) reported slightly higher emissions. In 2017, the Member States contributing most (i.e. more

Table 3.25 Member State contributions to EU emissions of total PAHs

Member State	Total PAHs (Mg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	20	12.7	10.5	6.8	7.0	7.6	7.1	8.2	7.0	7.4	7.6	7.8	-61	3.2	0.3	0.5
Belgium	50	39	25	19	15	13	12	13	8.5	8.7	8.6	7.9	-84	-8.4	0.8	0.5
Bulgaria	112	110	1 924	3 452	32	44	52	55	111	117	113	114	2	1.1	1.7	7.9
Croatia	24	17	15	18	14	12	11	10	8.0	8.2	6.9	5.9	-75	-14.6	0.4	0.4
Cyprus	14	11	6.2	3.8	0.9	1.0	1.0	0.8	0.7	0.9	0.7	0.6	-96	-12.3	0.2	0.0
Czechia	280	179	45	40	47	47	49	50	47	47	46	47	-83	2.0	4.3	3.2
Denmark	5.1	5.6	5.8	7.5	8.0	7.1	6.8	6.9	6.3	6.9	7.1	7.0	36	-1.5	0.1	0.5
Estonia	8.2	10	8.5	7.7	8.3	7.1	7.1	7.1	7.1	7.0	7.0	7.7	-6	11.1	0.1	0.5
Finland	7.1	7.7	7.7	8.7	11	9.7	10	9.8	10.0	9.5	10	10	43	-1.6	0.1	0.7
France	46	44	35	26	22	19	20	21	18	19	19	18	-60	-2.7	0.7	1.3
Germany	375	161	155	144	206	181	172	183	158	170	182	177	-53	-3.0	5.8	12.2
Greece	17	17	18	14	13	13	13	12	11	12	12	12	-30	1.3	0.3	0.8
Hungary	79	30	25	24	29	33	35	35	28	30	30	30	-63	-1.6	1.2	2.0
Ireland	49	31	23	21	20	18	18	19	16	16	15	14	-72	-8.7	0.8	0.9
Italy	95	96	63	68	90	68	86	81	72	76	76	80	-15	5.3	1.5	5.5
Latvia	18	16	17	14	11	11	12	10	10	8.3	8.2	9.0	-49	9.8	0.3	0.6
Lithuania	21	9.5	9.6	11.0	12	11	11	11	10.3	9.4	9.6	9.8	-53	2.8	0.3	0.7
Luxembourg	4.5	2.3	0.6	0.6	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.6	-87	-4.0	0.1	0.0
Malta	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.1	21	-6.3	0.0	0.0
Netherlands	21	11	6.0	5.9	5.8	5.9	5.5	5.5	5.6	5.7	5.7	5.8	-72	1.3	0.3	0.4
Poland	159	227	160	184	164	159	169	160	152	156	154	152	-5	-1.3	2.4	10.5
Portugal	608	1 070	1 205	1 632	1 017	637	446	344	350	439	456	491	-19	7.6	9.3	33.9
Romania	61	60	80	77	73	68	76	67	68	69	67	64	6	-4.3	0.9	4.4
Slovakia	9	5.7	5	4	4	3	4	4	4	4	4	4	-52	8.4	0.1	0.3
Slovenia	8.1	5.9	5.1	6.0	6.1	6.1	5.9	6.0	5.0	5.3	5.4	5.2	-35	-3.9	0.1	0.4
Spain	3 046	2 354	905	164	148	152	151	146	156	146	146	137	-96	-6.1	46.8	9.4
Sweden	19	19	15	17	12	12	11	11	10	10	10	10	-45	1.0	0.3	0.7
United Kingdom	1 354	96	20	18	22	19	22	23	21	22	23	22	-98	-2.6	20.8	1.5
EU-28 (a)	**6 506**	**4 647**	**4 794**	**5 994**	**1 998**	**1 566**	**1 413**	**1 299**	**1 301**	**1 410**	**1 429**	**1 449**	**-78**	**1.4**	**100**	**100**
EU-28 (b)	6 506	4 647	4 794	5 994	1 998	1 566	1 413	1 299	1 301	1 410	1 429	1 449				

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

Bulgaria has meanwhile confirmed that the high values in 2000 and 2005 have been identified as erroneous and that they will be corrected in the next reporting round.

(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.

than 10 %) to total PAH emissions were Portugal, Germany and Poland (countries ranked according to the percentage of their share in the EU total).

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

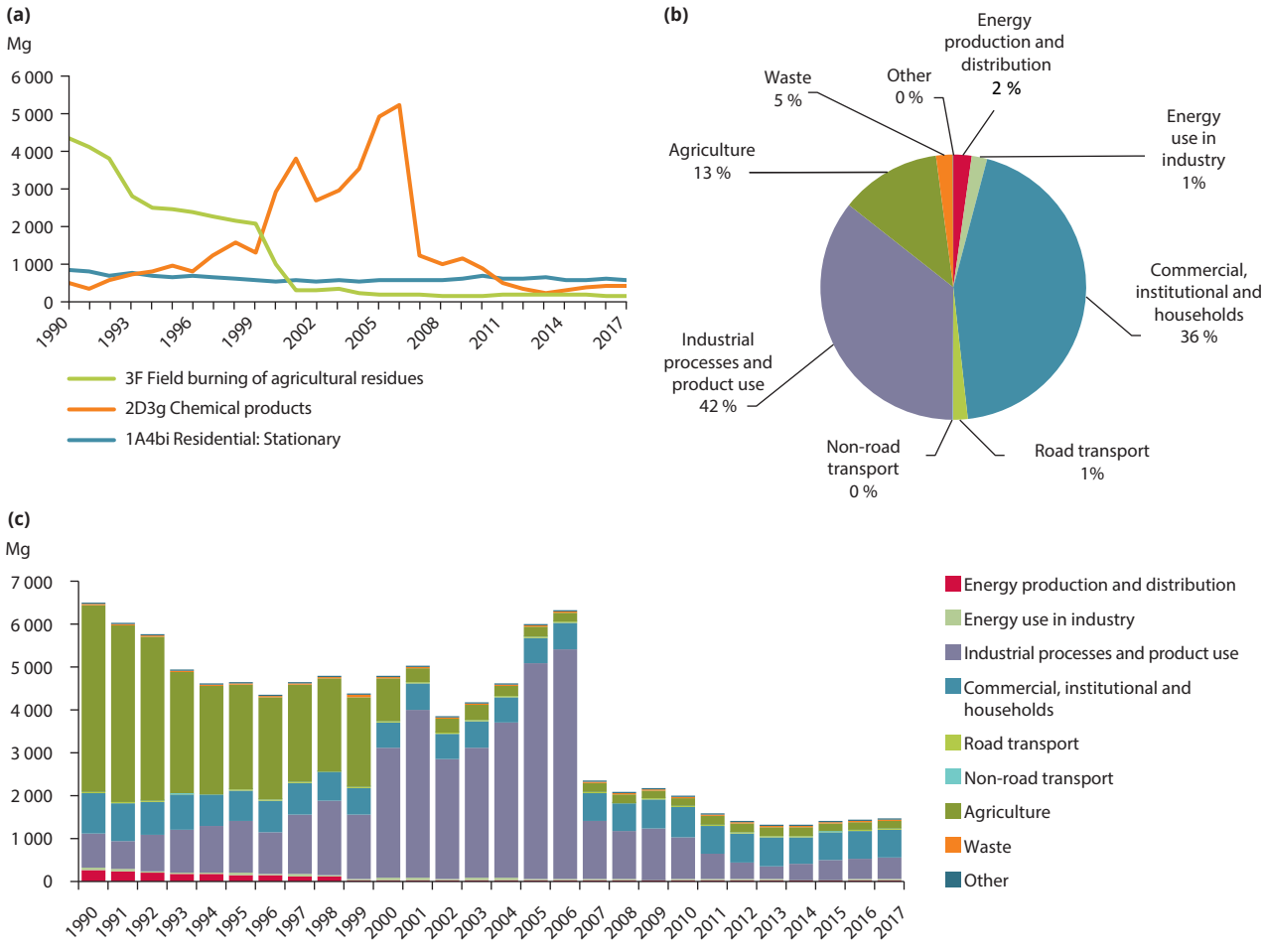
The high levels reported by Bulgaria for the period 2000 to 2006 are mostly arising from emissions reported in the category '2D3g — Chemical products'.

Spain reported 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 the gradual abandoning of this practice, driven by legislation to prevent forest fires, and 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). In 2017, the increase in PAH emissions from 'a public power' (+20 % compared to 2016) is linked to the higher share of biomass in the fuel mix (see Spain's IIR, listed in Appendix 5).

In 2017, '1A4bi — Residential: Stationary' and '2D3g — Chemical products' were the principal key categories for these emissions, making up 72 % of total PAH emissions (see Figure 3.16(a)). Among the key categories, the largest change could be observed for the third most important, '3F — Field burning of agricultural residues' (-95.9 %).

The data reported in 2019 by Portugal and Bulgaria mainly contribute to the total PAH emissions in the key category '2D3g — Chemical products'.

Figure 3.16 Total PAH emissions in the EU: (a) trend in emissions from the three most important key categories, 1990-2017; (b) share by sector group, 2017; (c) sectoral trends in emissions.



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

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

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

Between 1990 and 2017, B(a)P emissions fell by 47 % in the EU. Between 2016 and 2017, they decreased by 0.4 % (see Table 3.26), mainly because emissions fell in Bulgaria, Greece (gap-filled data), Romania and Germany (countries ranked according to the size of their contribution to the absolute change). In 2017,

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

Member State	Benzo(a)pyrene (Mg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Belgium	11	10.0	8.5	7.0	5.4	4.8	4.2	4.2	2.7	2.7	2.7	2.5	-78	-8.5	0.9	0.4
Bulgaria	82.0	76.2	1899.9	3429.2	20.2	30.4	38.7	42.8	99.9	106.0	101.5	70.6	-14	-30.5	6.7	10.9
Croatia	7.6	5.7	5.1	6.3	4.6	4.1	3.7	3.4	2.6	2.7	2.3	1.9	-75	-16.1	0.6	0.3
Cyprus	2.4	1.9	1.1	0.7	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0.1	-95	-12.2	0.2	0.0
Czechia	91	60	17	14	17	17	17	18	16	16	16	16	-82	1.7	7.5	2.5
Denmark	1.5	1.7	1.8	2.4	2.5	2.2	2.1	2.1	1.9	2.2	2.2	2.2	41	-1.9	0.1	0.3
Estonia	2.4	2.8	2.4	2.2	2.4	2.0	2.0	2.1	2.0	2.0	2.0	2.2	-5	11.7	0.2	0.3
Finland	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
France	13	13	9.8	7.3	6.0	5.2	5.6	5.8	5.1	5.1	5.2	5.1	-61	-2.9	1.1	0.8
Germany	139	48	31	24	35	30	28	30	26	28	30	29	-79	-3.2	11.4	4.4
Greece	34	38	37	37	34	35	34	35	30	29	28	26	-25	-6.6	2.8	4.0
Hungary	26	9.7	8.3	7.8	9.6	11	12	12	9.4	10	10	10	-62	-2.0	2.1	1.5
Ireland	14	8.7	6.2	5.8	5.4	5.0	4.9	5.2	4.5	4.4	4.1	3.8	-73	-9.1	1.1	0.6
Italy	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Latvia	6.3	5.9	6.2	5.0	4.0	4.1	4.0	3.7	3.6	3.0	3.0	3.3	-48	9.5	0.5	0.5
Lithuania	6.6	3.1	3.2	3.7	3.9	3.8	3.8	3.7	3.4	3.1	3.2	3.2	-51	2.5	0.5	0.5
Luxembourg	1.2	0.6	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	-87	-5.9	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	0.0	-15	-4.2	0.0	0.0
Netherlands	5.5	3.3	2.0	2.1	1.9	1.9	1.8	1.8	1.9	1.9	1.9	1.9	-64	0.9	0.4	0.3
Poland	36	51	37	42	46	45	46	45	43	43	44	43	20	-1.3	2.9	6.6
Portugal	470	940	1 078	1 530	922	539	348	244	251	340	360	393	-16	9.3	38.5	60.6
Romania	17	16	26	22	24	22	26	22	22	22	21	20	22	-4.9	1.4	3.1
Slovakia	2.5	1.6	1.3	0.9	0.9	0.8	0.8	0.9	0.8	0.8	1	1	-54	31.7	0.2	0.2
Slovenia	2.8	2.2	2.0	2.4	2.5	2.5	2.4	2.5	2.0	2.2	2.2	2.1	-25	-5.6	0.2	0.3
Spain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Sweden	6.7	6.9	5.5	6.0	4.1	4.1	3.9	3.8	3.5	3.5	3.5	3.5	-47	0.0	0.5	0.5
United Kingdom	241	23	6.9	6.0	7.8	6.8	7.7	8.2	7.2	7.8	7.9	7.7	-97	-2.8	19.8	1.2
EU-28 (a)	**1 220**	**1 329**	**3 197**	**5 164**	**1 159**	**777**	**598**	**496**	**539**	**637**	**651**	**648**	**-47**	**-0.4**	**100**	**100**
EU-28 (b)	1 221	1 330	3 198	5 165	1 160	778	599	497	540	638	652	649				

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.

Bulgaria has meanwhile confirmed that the high values in 2000 and 2005 have been identified as erroneous and that they will be corrected in the next reporting round.

(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.

the Member State contributing most (i.e. more than 10 %) to B(a)P emissions were Portugal and Bulgaria. As Austria and Spain did not provide sufficient data for B(a)P and gap filling was not possible, the EU total is an underestimate.

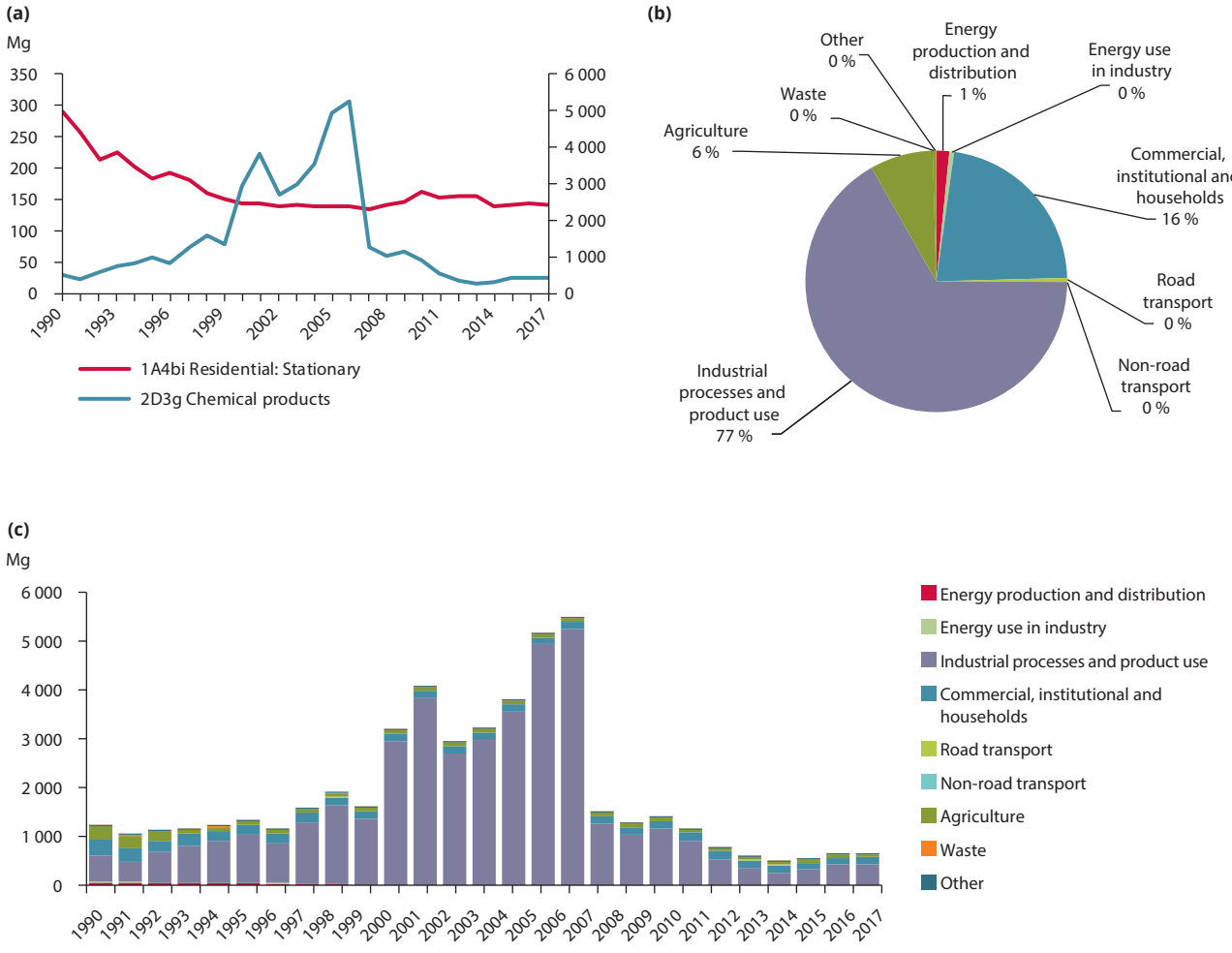
In 1990, the large emissions of B(a)P in the United Kingdom were mostly from the agriculture sector due to field burning. Following a ban on the practice of field burning in agriculture, emissions from this source fell to zero by 1994. Emissions from the Industrial Processes source sector in 1990 were dominated by aluminium production and the process of anode baking. B(a)P emissions from this source have substantially declined since the mid-1990's, and anode baking no longer takes place in the UK, as a result of plant closures (see the United Kingdom's IIR, listed in Appendix 5).

'2D3g — Chemical products' was the principal key category for B(a)P emissions, accounting for 66 % of the total. Among the key categories, the largest change could be observed for the second most important key category, '1A4bi — Residential: Stationary' (-51.5 %) (see Figure 3.17(a)). Emissions from the most important key category '2D3g — Chemical products' fell by 15.3 % (1990 to 2017).

The data reported in 2019 by Portugal and Bulgaria mainly contribute to B(a)P emissions in the key category '2D3g — Chemical products'.

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

Figure 3.17 B(a)P emissions in the EU: (a) trend in emissions from the two most important key categories, 1990-2017; (b) share by sector group, 2017; (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 2017, B(b)F emissions fell by 76 % in the EU. Between 2016 and 2017, they dropped by 2.4 % (see Table 3.27), mainly because of a slight decrease in Greece (gap-filled data), Romania, Poland and Ireland (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing most (i.e. more than 10 %) to B(b)F emissions were Greece (gap-filled data), Portugal and Poland (countries ranked according to the percentage of their share in the EU total). As Austria and Spain did not provide sufficient data for B(b)F and gap filling was not possible, the EU total is an underestimate.

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

Member State	Benzo(b)fluoranthene (Mg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Belgium	8.3	7.4	6.6	5.7	4.8	3.8	4.1	4.3	3.0	3.1	3.0	2.8	-67	-8.5	0.8	1.1
Bulgaria	10	8.0	5.7	6.2	6.1	7	7	6.3	5.4	5.4	5.8	5.9	-42	2.0	0.9	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	2.1	-74	-12.8	0.7	0.8
Cyprus	6.6	5.2	3.0	1.8	0.4	0.5	0.5	0.4	0.3	0.4	0.3	0.3	-96	-12.3	0.6	0.1
Czechia	90	57	11	9.5	11	11	12	12	11	11	11	11	-87	2.4	8.3	4.4
Denmark	1.6	1.8	1.9	2.5	2.7	2.4	2.3	2.4	2.2	2.4	2.5	2.5	52	-1.0	0.1	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	2.6	-5	14.1	0.3	1.0
Finland	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
France	15	15	12	8.6	7.3	6.3	6.7	7.0	6.1	6.2	6.2	6.1	-60	-2.1	1.4	2.4
Germany	3.9	2.0	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.9	1.9	-51	1.0	0.4	0.7
Greece	89	98	95	97	89	91	90	91	79	76	72	67	-25	-7.2	8.2	25.9
Hungary	30	11	8.9	8.4	10	11	12	12	9.6	10	10	10	-67	-1.0	2.8	3.9
Ireland	20	13	9.7	9.1	8.3	7.6	7.4	7.8	6.8	6.7	6.3	5.7	-72	-8.3	1.9	2.2
Italy	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Latvia	6.2	5.4	5.2	4.7	3.7	3.8	3.8	3.5	3.4	2.8	2.8	3.1	-51	9.1	0.6	1.2
Lithuania	7.7	3.2	3.2	3.7	3.9	3.9	3.9	3.8	3.5	3.2	3.2	3.4	-56	3.7	0.7	1.3
Luxembourg	1.5	0.8	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	-83	-2.8	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	0.0	80	-8.3	0.0	0.0
Netherlands	8.1	3.6	2.0	1.9	1.9	2.0	1.8	1.8	1.8	1.8	1.9	1.9	-77	1.3	0.7	0.7
Poland	41	59	43	49	50	49	54	49	48	49	47	47	15	-1.2	3.7	18.2
Portugal	70	65	62	55	50	51	51	52	52	52	51	52	-26	1.1	6.4	20.1
Romania	16	16	22.0	21	22	20	22	20	20	20	20	19	18	-4.1	1.5	7.4
Slovakia	2.9	1.8	1.4	1.4	1.1	1.0	1.1	1.1	1.1	1.2	1	1	-58	3.7	0.3	0.5
Slovenia	2.6	1.7	1.3	1.5	1.5	1.4	1.4	1.4	1.2	1.3	1.3	1.2	-53	-2.4	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	n/a				
Sweden	6.3	6.4	5.0	5.8	4.0	4.1	3.9	3.8	3.5	3.5	3.6	3.6	-43	0.9	0.6	1.4
United Kingdom	639	40	5.6	5.5	6.7	5.8	6.7	7.3	6.5	7.0	7.1	6.9	-99	-2.1	58.8	2.7
EU-28 (a)	**1 087**	**429**	**314**	**309**	**294**	**291**	**299**	**294**	**272**	**271**	**263**	**257**	**-76**	**-2.4**	**100**	**100**
EU-28 (b)	1 089	431	316	311	296	293	301	296	274	272	265	259				

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 of changes in aluminium production ('2C3 — Aluminium production'). Until 2008, aluminium production at the country's only operating plant (Kubikenborg Aluminium AB) was a key source of B(b)F emissions. In 2008, all the pot-lines in the plant that used Soderberg technology were shut down, which caused an abrupt decline 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 2017, B(k)F emissions in the EU decreased by 78 %. Between 2016 and 2017, they fell by 2.2 % (see Table 3.28), mainly in Greece (gap-filled data), Romania, Ireland and Poland (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing most (i.e. more than 10 %) to B(k)F emissions were Greece (gap-filled data), Portugal and

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

Member State	Benzo(k)fluoranthene (Mg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Belgium	5.2	4.5	3.9	3.2	2.4	2.0	2.0	2.1	1.4	1.4	1.3	1.2	-76	-7.4	1.0	1.1
Bulgaria	4.1	3.8	2.3	2.5	2.4	2.8	2.7	2.5	2.2	2.2	2.3	2.4	-43	1.8	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	0.8	-76	-12.9	0.7	0.7
Cyprus	2.8	2.2	1.3	0.8	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1	-96	-12.4	0.6	0.1
Czechia	50	32	7.6	6.6	7.6	7.6	7.8	8.0	7.5	7.5	7.3	7.4	-85	1.9	9.8	6.6
Denmark	0.7	0.8	0.8	1.0	1.1	1.0	0.9	0.9	0.9	1.0	1.0	1.0	46	-0.3	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	1.3	-15	9.6	0.3	1.1
Finland	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
France	9.4	9.1	7.2	5.5	4.6	3.9	4.2	4.4	3.8	3.8	3.9	3.8	-60	-3.1	1.8	3.4
Germany	2.1	1.3	1.3	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	-41	1.6	0.4	1.1
Greece	38	42	41	42	39	40	39	39	35	33	31	29	-24	-6.9	7.5	26.0
Hungary	12	4.5	3.6	3.4	3.9	4.5	4.6	4.7	3.8	4.0	4.1	4.1	-66	-0.7	2.4	3.6
Ireland	7.8	5.0	3.6	3.4	3.1	2.9	2.8	3.0	2.6	2.6	2.4	2.2	-72	-8.9	1.5	1.9
Italy	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Latvia	2.4	2.1	2.1	1.7	1.3	1.4	1.4	1.2	1.2	1.0	1.0	1.1	-54	9.8	0.5	1.0
Lithuania	3.2	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.4	1.2	1.3	1.3	-60	3.6	0.6	1.2
Luxembourg	0.9	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-90	-0.9	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	0.0	-13	-3.3	0.0	0.0
Netherlands	4.1	2.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-76	1.8	0.8	0.9
Poland	35	56	41	47	15	15	17	15	15	16	15	14	-59	-1.2	6.9	12.8
Portugal	33	31	30	25	24	25	25	26	25	25	25	25	-24	1.8	6.6	22.6
Romania	7.4	7.3	10.0	9.2	9.2	8.6	9.8	8.5	8.7	8.8	8.5	8.1	9	-5.3	1.5	7.2
Slovakia	1.7	1.2	1.1	1.2	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	-38	0.7	0.3	0.9
Slovenia	1.6	1.2	1.1	1.3	1.4	1.4	1.3	1.4	1.1	1.2	1.2	1.2	-25	-5.5	0.3	1.0
Spain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Sweden	3.1	3.0	2.5	3.1	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.3	-58	0.4	0.6	1.1
United Kingdom	277	20	3.7	3.2	2.9	2.5	2.9	3.0	2.7	2.9	2.9	2.9	-99	-1.9	54.7	2.6
EU-28 (a)	**506**	**236**	**169**	**167**	**127**	**127**	**130**	**128**	**119**	**119**	**115**	**112**	**-78**	**-2.2**	**100**	**100**
EU-28 (b)	507	237	170	168	128	128	131	130	120	120	116	113				

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.

Poland (countries ranked according to the percentage of their share in the EU total). As Austria and Spain did not provide sufficient data for B(k)F, and gap filling was not possible, the EU total is an underestimate.

The strong decline in emissions reported by Poland between 2005 and 2010 was due to a drop between 2007 and 2008 (not shown in Table 3.28), caused mainly by drastically declining emissions from the commercial, institutional and households sector, namely '1A4bi — Residential: Stationary'.

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

Between 1990 and 2017, IP emissions fell by 66 % in the EU. Between 2016 and 2017, they decreased by 1.8 %, mainly because Greece (gap-filled data) and Poland (countries ranked according to the size of their contribution to the absolute change) reported lower emissions (see Table 3.29). In 2017, the Member States contributing most (i.e. more than 10 %) to IP emissions were Poland, Greece

Table 3.29 Member State contributions to EU emissions of IP

Member State	Indeno(1,2,3-cd)pyrene (Mg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Belgium	4.3	3.9	3.4	3.0	2.5	1.9	2.1	2.2	1.4	1.5	1.5	1.4	-68	-8.9	1.0	1.0
Bulgaria	4.0	4.6	2.7	3.1	3.2	3.6	3.5	3.3	3.0	3.0	3.2	3.2	-20	0.8	1.0	2.3
Croatia	4.0	3.3	3.0	3.7	2.7	2.4	2.2	1.9	1.5	1.5	1.3	1.1	-73	-17.0	1.0	0.8
Cyprus	2.0	1.6	0.9	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-96	-12.3	0.5	0.1
Czechia	49	31	10	9.4	11	11	12	12	12	12	11	12	-76	1.9	11.9	8.2
Denmark	1.3	1.4	1.3	1.7	1.7	1.5	1.4	1.5	1.3	1.4	1.4	1.4	5	-2.5	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	1.6	1	6.8	0.4	1.1
Finland	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
France	8.0	7.8	6.2	4.8	4.0	3.5	3.7	3.9	3.4	3.4	3.5	3.4	-58	-2.8	1.9	2.4
Germany	1.5	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	-42	1.6	0.4	0.6
Greece	27	30	29	30	28	28	28	28	24	23	22	20	-25	-7.2	6.6	14.4
Hungary	11	4.6	4.6	4.2	5.4	6.3	6.6	6.7	5.5	5.7	5.8	5.6	-49	-2.7	2.6	3.9
Ireland	6.7	4.2	3.0	2.8	2.7	2.5	2.4	2.6	2.2	2.2	2.1	1.9	-72	-8.7	1.6	1.3
Italy	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Latvia	2.9	3.0	3.1	2.6	2.0	2.1	2.1	1.9	1.8	1.5	1.5	1.6	-43	11.6	0.7	1.2
Lithuania	2.8	1.6	1.8	1.9	2.1	2.0	2.0	2.0	1.8	1.7	1.7	1.7	-39	1.2	0.7	1.2
Luxembourg	0.9	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-88	-6.5	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	0.0	-16	-3.1	0.0	0.0
Netherlands	2.9	1.5	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	-67	1.5	0.7	0.7
Poland	47	61	39	46	53	50	52	50	47	47	48	48	1	-1.3	11.4	33.5
Portugal	26	25	24	20	19	20	20	20	20	20	19	20	-25	2.0	6.4	13.8
Romania	7	7	12.1	11	12	11	13	11	11	11	11	11	49	-2.8	1.8	7.6
Slovakia	1.4	1.0	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.7	0.7	0.7	-54	-0.8	0.3	0.5
Slovenia	0.8	0.5	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-50	-0.8	0.2	0.3
Spain	0	0	0	0	0	0	0	0	0	0	0	0			0.0	0.0
Sweden	3.1	3.3	2.5	2.5	2.0	2.0	1.9	1.8	1.7	1.6	1.6	1.6	-48	-0.7	0.8	1.1
United Kingdom	197	13	4.1	3.7	4.8	4.1	4.7	4.9	4.3	4.5	4.6	4.5	-98	-3.4	47.7	3.1
EU-28 (a)	**414**	**213**	**156**	**156**	**162**	**157**	**162**	**159**	**147**	**146**	**145**	**142**	**-66**	**-1.8**	**100**	**100**
EU-28 (b)	414	213	157	157	162	158	163	160	148	147	146	143				

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.

(gap-filled data) and Portugal (countries ranked according to the percentage of their share in the EU total). As Austria and Spain did not provide sufficient data for IP, and gap filling was not possible, the EU total is an underestimate.

3.27 Hexachlorobenzene (HCB) emission trends and key categories

Between 1990 and 2017, HCB emissions fell by 96 % in the EU. However, between 2016 and 2017, they increased by 6.6 % (see Table 3.30), mainly in Belgium, Portugal, the United Kingdom and Slovakia (countries ranked according to the size of their contribution to the absolute change). In 2017, the Member States contributing most (i.e. more than 10 %) to HCB emissions were Portugal, Austria, the United Kingdom, Belgium and Finland (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

Table 3.30 Member State contributions to EU emissions of HCB

Member State	HCB (kg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	76	55	47	36	40	37	62	146	145	39	40	40	-47	1.7	0.9	14.0
Belgium	41	116	22	20	15	30	18	7.4	7.8	5.9	5.2	35.1	-14	570.0	0.5	12.2
Bulgaria	0.3	0.3	0.5	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-28	2.7	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	0.3	3	-4.2	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	0.0	-81	3.7	0.0	0.0
Czechia	106	44	19	14	22	19	25	22	22	23	22	22	-79	-0.4	1.3	7.6
Denmark	27	8.4	5.6	3.7	2.7	2.6	2.4	2.6	2.4	2.2	2.3	2.3	-92	-2.3	0.3	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	0.3	58	9.2	0.0	0.1
Finland	37	36	39	32	8.8	26	9.5	17	22	16	60	34	-9	-44.0	0.5	11.7
France	1 196	70	44	11	6.9	6.5	6.9	6.4	6.5	6.9	6.4	6.5	-99	1.0	14.7	2.3
Germany	2 897	2 118	2 883	14	9.9	10	8.8	9.4	14	12	15	15	-99	-0.7	35.7	5.2
Greece	2.1	2.2	2.5	2.8	3.1	3.0	2.8	2.6	3.2	2.8	2.5	2.7	29	7.0	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	1.4	-44	-2.8	0.0	0.5
Ireland	41	41	1.1	1.8	1.9	1.9	2.1	2.0	2.0	2.1	2.1	2.0	-95	-2.5	0.5	0.7
Italy	43	38	25	21	17	22	27	22	22	22	11	11	-74	-2.8	0.5	3.9
Latvia	0.2	0.3	0.2	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	56	10.4	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	0.4	-96	10.0	0.1	0.1
Luxembourg	0.4	1.3	0.6	0.5	0.6	0.6	0.4	0.4	0.4	0.5	0.5	0.4	5	-3.3	0.0	0.2
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	>100	1.9	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	3.3	-93	-2.1	0.6	1.2
Poland	4.6	4.7	3.4	4.0	4.9	4.3	4.5	4.4	4.0	4.0	4.1	4.0	-11	-2.0	0.1	1.4
Portugal	59	74	101	108	112	113	130	112	84	88	49	59	0	21.0	0.7	20.5
Romania	3.8	2.6	2.3	2.7	2.7	3.1	3.0	2.4	2.3	2.3	2.2	2.4	-38	5.9	0.0	0.8
Slovakia	3.7	3.0	2.9	2.7	1.5	1.8	1.6	1.5	1.7	1.8	2.7	3.4	-8	28.5	0.0	1.2
Slovenia	19.0	15.3	19.1	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.6	0.5	-97	-4.5	0.2	0.2
Spain	328	151	179	133	1.6	1.6	1.7	1.6	1.7	1.7	1.9	1.9	-99	-0.5	4.0	0.7
Sweden	16	17	11	4.6	6.6	4.3	3.8	4.3	3.4	3.8	2.7	3.0	-82	14.0	0.2	1.1
United Kingdom	3 155	4 130	81	71	34	24	23	20	24	27	33	36	-99	7.9	38.9	12.5
EU-28 (a)	**8 116**	**6 937**	**3 493**	**493**	**299**	**319**	**340**	**392**	**374**	**269**	**270**	**288**	**-96**	**6.6**	**100**	**100**
EU-28 (b)	8 116	6 937	3 493	493	299	319	340	392	374	269	270	288				

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.

manufacturing industries and construction: Non-metallic minerals'. Due to unintentional releases in 2012, 2013 and 2014, emissions rose to a very high level: HCB-contaminated material (lime) was co-incinerated in a cement plant at temperatures that were too low to destroy the HCB. Thus, the sharp 73 % decrease in emissions between 2014 and 2015 marks a return to usual levels. Between 2016 and 2017, HCB emissions rose slightly by 1.7 % due to higher emissions from iron and steel production and residential heating (increased biomass consumption) (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 was mainly due to higher amounts of burned sludge (personal communication by Belgium in 2017). The strong decline in HCB emissions from 1999 to 2000 was because the sewage-sludge incineration sector used a lower emission factor from 2000 onwards (personal communication by Belgium in 2016).

Czechia explained that the increase from 2009 to 2010 was due to implementation of new statistical data on hard-coal consumption, and the rise between 2011 and 2012 was linked to higher hard-coal consumption (personal communication by Czechia in 2018).

In 2017, the data reported by Finland shows a 267 % increase from 2015 to 2016 followed by a fall in HCB emissions. This is mainly caused by emissions from the category '2B10a — Chemical industry: Other'.

France reported a pronounced drop 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, the main HCB source in the national inventory. In 1993, France banned HCE in secondary aluminium refining, as a result of which this 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, contributing 40 kg per year. However, this is no longer a source of HCB emissions in 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, listed in Appendix 5).

In Germany, the drop in HCB emissions from 2001 to 2002 was mainly attributed to data reported in the category '2C3 — Aluminium production'. Values up to 2001 were reported, after which the notation key 'NA' has been used.

Portugal's HCB emissions reported in 2019 mainly occur in metal industry/aluminium production (2C3), energy industries (1A1) and waste-incineration sources (5C) (see Portugal's IIR, listed in Appendix 5).

Slovakia explained that HCB emissions are connected to energy utilisation from industrial waste. The general declining trend until 2013, with several jumps in 2003, 2005 and 2008, resulted from tightening legislation on waste-incineration plants. Since 2014, emissions have increased due to a greater use of biomass waste as a fuel compared to other fuels in industry (see Slovakia's IIR, listed in Appendix 5).

Spain stated in its 2019 IIR that the sudden reduction in HCB emissions between 2005 and 2006 and the further drop from 2008 to 2010 was due to a new regulation in line with the framework of the Stockholm Convention on Persistent Organic Pollutants. The previous fluctuations 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 '2C3 — Aluminium production' category. A specific regulation controlling the use of HCE reduced emissions from this sector to zero from 1999 onwards, resulting in an overall sharp drop in HCB emissions between 1998 and 1999 (personal communication by the United Kingdom in 2017).

In 2017, '2C3 — Aluminium production', '1A4bi — Residential: Stationary' and '1A1a — Public electricity and heat production' were the chief key categories for HCB emissions, together accounting for 57 % of the total (see Figure 3.18(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2017 were in the most important '2C3 — Aluminium production' (-98.9 %) and in the fifth most important '3Df — Use of pesticides' (-90.5 %) category. Emissions from the fourth most important key category '2A1 — Cement production' increased by 238.1 %, caused by a high

value reported by Belgium in this category for 2017, shown in Figure 3.18 (a). The HCB emissions reported in 2017 by Belgium in this category were due to high concentrations measured at the kiln stack of one of the four plants in Wallonia in 2017. Belgium is the only Member State reporting values in this category.

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

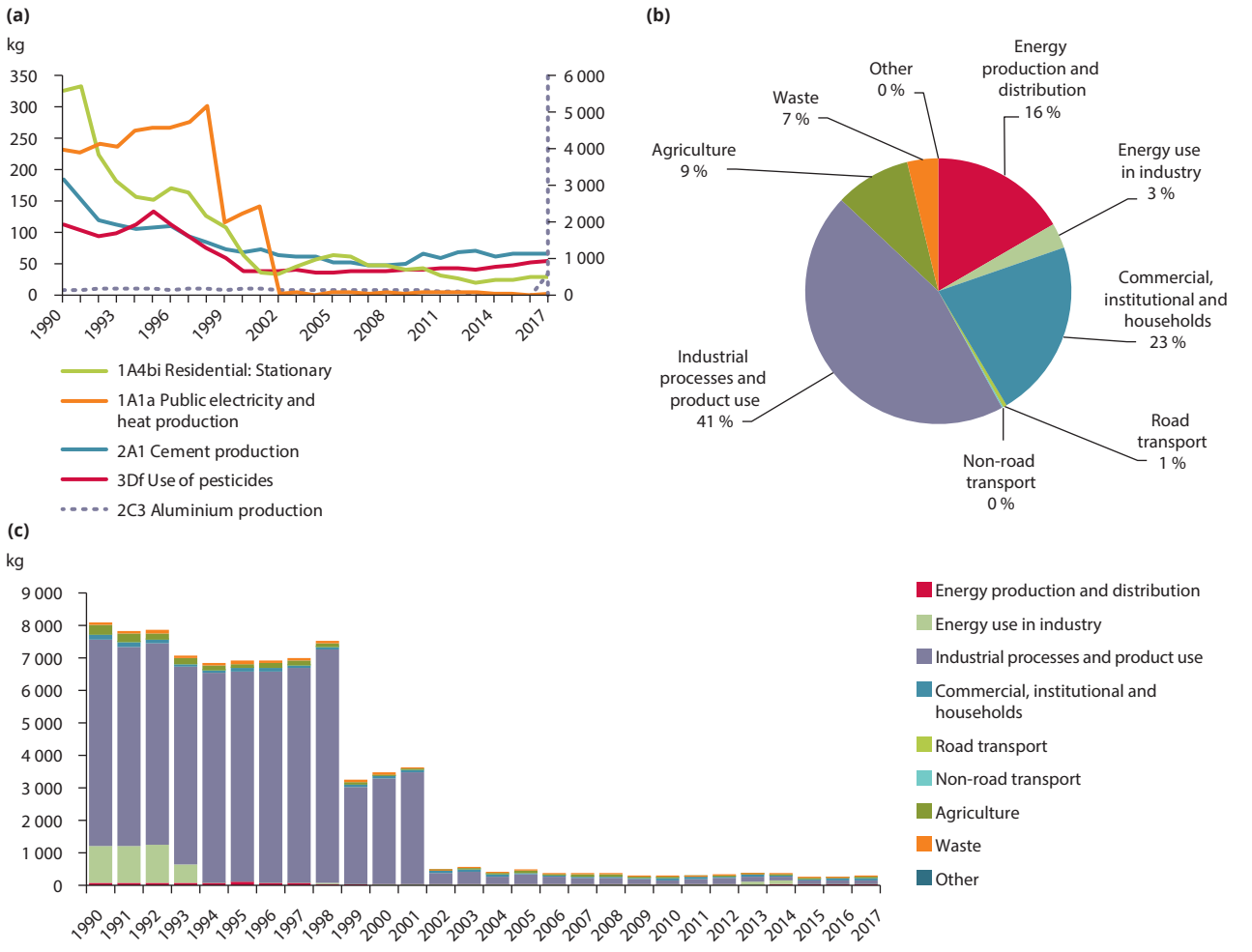
The drop in HCB emissions from 1998 to 1999, shown in Figure 3.18 (a) and Figure 3.18(c), is due to a considerable reduction reported by the United Kingdom in the category '2C3 — Aluminium production' (see explanation above). Furthermore, the notation key 'NA' has been used from 1999 onwards. The drop between 2001 and 2002, in the same category, is caused by reductions reported by Germany.

3.28 Polychlorinated biphenyl (PCB) emission trends and key categories

Between 1990 and 2017, PCB emissions dropped by 83 % in the EU. Between 2016 and 2017, they fell by 0.4 %, mainly because of reductions reported by the United Kingdom, Croatia, Slovenia and Belgium (countries ranked according to the size of their contribution to the absolute change (see Table 3.31). In 2017, the Member States contributing most (i.e. more than 10 %) to PCB emissions were 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 its plants were very high in 2010 and 2011 because of the use of an alternative raw material containing high concentrations of PCBs. Having removed this

Figure 3.18 HCB emissions in the EU: (a) trend in emissions from the five most important key categories, 1990-2017; (b) share by sector group, 2017; (c) sectoral trends in emissions



Note: In Figure 3.18(a), the right-hand axis shows values for '2C3 — Aluminium production'.

raw material at the end of 2011, emissions decreased significantly (see Belgium's IIR, listed in Appendix 5).

Denmark explained that the strong drop in PCB emissions between 1990 and 1994 in the '1A3bi — Road transport: Passenger cars' category was due to the phasing out of leaded petrol, which has a high PCB emission factor (see Denmark's IIR, listed in Appendix 5).

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

Table 3.31 Member State contributions to EU emissions of PCBs

Member State	PCB (kg)												Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	1990-2017	2016-2017	1990	2017
Austria	47	29	30	35	34	35	35	37	37	36	35	38	-19	10.0	0.3	1.6
Belgium	107	89	93	72	96	58	9.6	5.3	12	3.2	5.8	2.8	-97	-51.0	0.8	0.1
Bulgaria	14	16	11	10	4.3	5.0	4.7	4.1	3.1	3.0	3.1	3.7	-73	21.3	0.1	0.2
Croatia	483	468	441	436	434	433	431	430	429	425	422	415	-14	-1.6	3.4	17.6
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14	4.1	0.0	0.0
Czechia	3.7	2.8	2.1	2.0	1.8	1.8	1.7	1.7	1.7	1.8	1.8	1.7	-53	-3.0	0.0	0.1
Denmark	111	40	39	43	42	43	40	39	40	41	43	43	-61	1.4	0.8	1.8
Estonia	8.4	4.1	2.6	3.7	4.2	3.6	3.5	3.9	4.2	4.2	4.2	5.0	-40	20.2	0.1	0.2
Finland	29	29	30	31	28	28	25	23	25	24	26	26	-9	0.6	0.2	1.1
France	177	152	97	67	54	48	51	51	43	42	41	43	-76	4.6	1.3	1.8
Germany	1 735	1 483	948	198	232	234	223	226	228	229	230	236	-86	2.7	12.3	10.0
Greece	9	9	8	19	32	32	30	29	29	29	31	31	>100	0.3	0.1	1.3
Hungary	26	12	9.9	11	8.9	9.7	8.7	7.0	7.3	11	9.8	8.5	-67	-13.5	0.2	0.4
Ireland	41	34	33	36	15	12	12	11	11	14	12	11	-72	-0.7	0.3	0.5
Italy	289	302	266	276	212	220	226	206	200	195	192	189	-34	-1.5	2.1	8.0
Latvia	4.3	1.1	0.4	0.6	0.4	0.8	2.4	0.7	0.3	0.2	0.2	0.2	-96	-13.6	0.0	0.0
Lithuania	6.8	2.1	1.0	37	11	2.2	1.8	1.9	1.7	1.6	1.7	1.8	-73	9.3	0.0	0.1
Luxembourg	40	36	11	12	19	26	9.1	4.3	5.1	3.1	3.8	3.6	-91	-4.3	0.3	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	0.0	>100	-0.1	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	0.0	21	0.6	0.0	0.0
Poland	749	803	515	557	621	597	608	604	564	563	578	578	-23	0.1	5.3	24.4
Portugal	2 922	3 259	3 161	670	323	251	262	140	105	86	84	96	-97	13.9	20.8	4.0
Romania	39.4	39	28	38	21	20	18	17	18	20	20	19	-53	-6.0	0.3	0.8
Slovakia	26	18	18	15	10	10	10	11	12	11	14	16	-38	16.6	0.2	0.7
Slovenia	415	290	213	135	76	51	44	41	41	39	39	36	-91	-8.5	3.0	1.5
Spain	26	40	32	35	33	30	27	27	27	27	24	26	2	8.6	0.2	1.1
Sweden	9.2	9.5	9.8	9.5	9.2	9.8	8.8	8.5	9.0	9.1	9.2	9.5	3	3.9	0.1	0.4
United Kingdom	6 744	4 915	1 355	1 038	767	745	708	679	645	608	547	525	-92	-4.0	48.0	22.2
EU-28 (a)	**14 061**	**12 083**	**7 355**	**3 788**	**3 088**	**2 905**	**2 799**	**2 608**	**2 497**	**2 426**	**2 375**	**2 366**	**-83**	**-0.4**	**100**	**100**
EU-28 (b)	14 061	12 083	7 355	3 788	3 088	2 905	2 799	2 608	2 497	2 426	2 375	2 366				

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.

Portugal's total PCBs is strongly linked to the development of emissions in the category '2C1 — Iron and steel production', which means this category is also a main driver for the drop in emissions from 2000 to 2002.

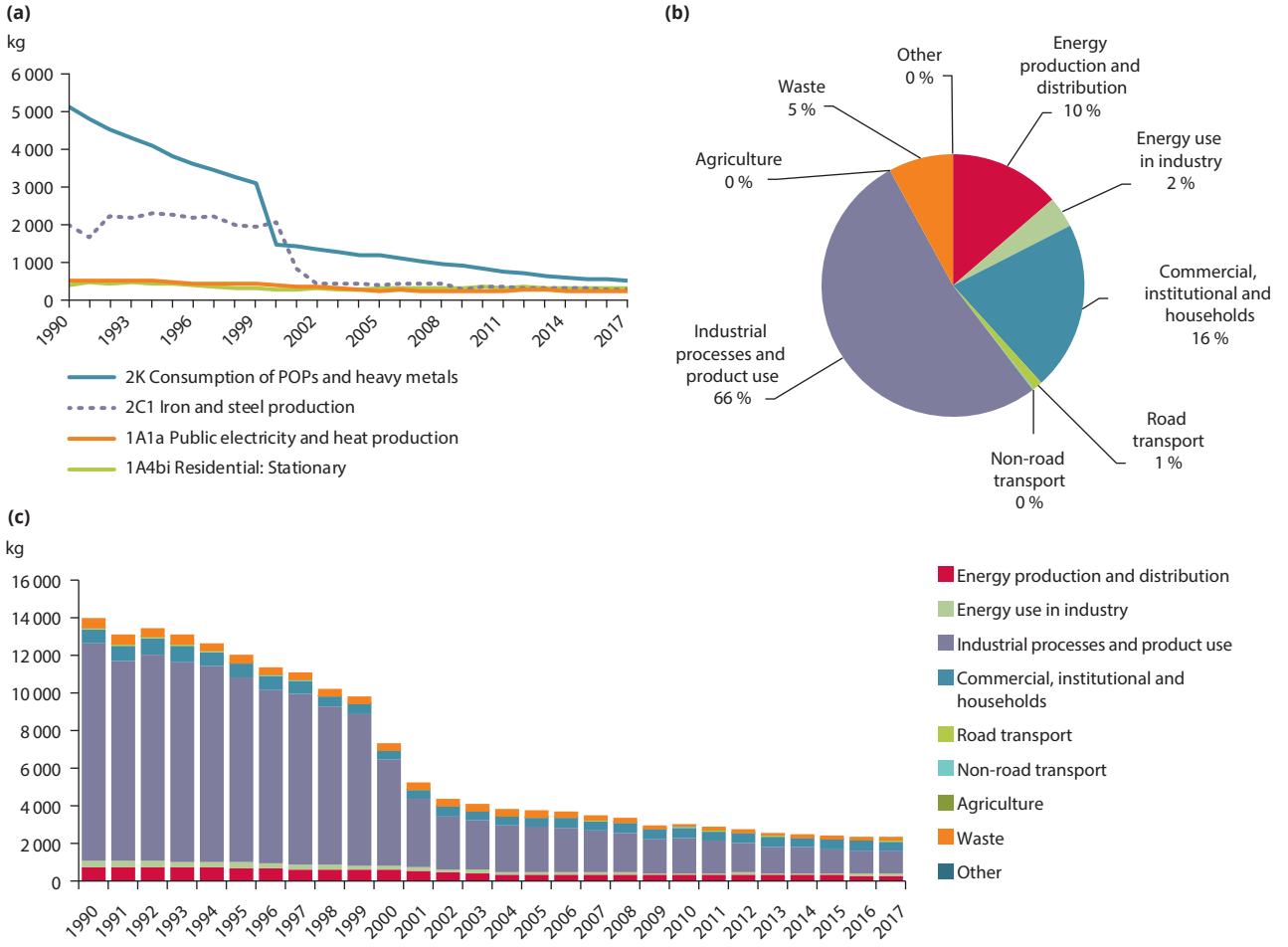
The increase in PCB emissions from 2015 to 2017 reported by Slovakia was mainly caused by the sector 'Energy use in industry', in particular by category '1A2gviii — Stationary combustion in manufacturing industries and construction: Other'. Slovakia noted that the increasing trend since 2013 is the result of the greater use of biomass waste as a fuel (see Slovakia's IIR, listed in Appendix 5).

The United Kingdom explained that the strong decrease in PCB emissions between 1995 and 2000 came from measures to end the 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 2017 were in the third most important key category, '2C1 — Iron and steel production' (-82.8 %), the principal key category, '2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)' (-89.9 %) and in the third most important key category, '2C1 — Iron and steel production' (-85.9 %) (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 2001 is

Figure 3.19 PCB emissions from key categories in the EU: (a) trend in emissions from the four most important key categories, 1990-2017; (b) share by sector group, 2017; (c) sectoral trends in emissions



due to reductions reported by the United Kingdom (see explanation above).

The strong drop in PCB emissions between 2000 and 2002 in '2C1 — Iron and steel production' is mainly caused by data reported from Portugal. This can be explained by significant changes in the only integrated iron and steel plant operating in Portugal, in particular the end of coke and sinter production 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 production volumes.

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

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.

4.1 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 and Hg. Despite considerable previous reductions, this sector group contributes 49 % of the total EU emissions of SO_x, as well as 37 % of Hg emissions.

The sector is an important source of SO_x, Hg, PCDD/Fs, NO_x, HCB and PCBs. The countries are ranked according to the size of the absolute values they reported. In 2017, Poland, Germany and Spain contributed most (in absolute terms) to the emissions of SO_x for this sector. Germany, Poland and Spain reported the highest emissions of Hg in the same year. In addition, in 2017, Germany, Poland and the United Kingdom contributed most to the NO_x emissions, and Greece was primarily responsible for emissions from PCDD/F (gap-filled data). The United Kingdom reported the highest emissions of HCB. Poland, Germany and Italy primarily accounted to PCB emissions in this sector in 2017.

For emissions of the main pollutants (see Figure 4.1), between 1990 and 2017, the highest absolute and relative reduction within this aggregated sector was for SO_x (-93 %). Between 1990 and 2017, NO_x and NMVOC emissions dropped by 72 % and 71 %, respectively. $PM_{2.5}$ and PM_{10} emissions have decreased notably since 2000: $PM_{2.5}$ by 69 % and PM_{10} by 72 %. In addition, B(a)P emissions fell significantly by 86 % from 1990 to 2017.

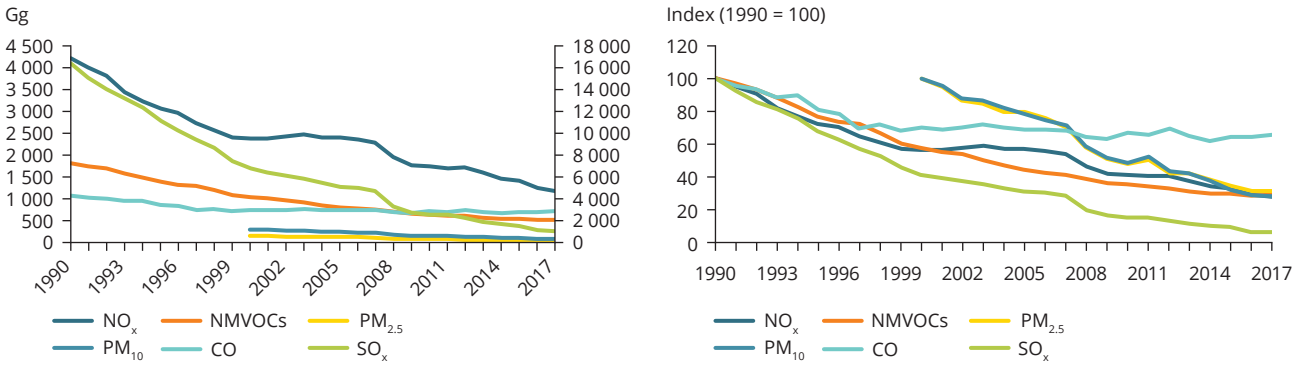
The significant reduction in NO_x emissions between 2007 and 2008 was mainly because of decreases reported by Spain and the United Kingdom in the category '1A1a — Public electricity and heat production'. The United Kingdom noted that, since 1988, electricity generators have adopted a programme of progressively 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. Since 1990, greater use of nuclear generation and the introduction of CCGT (combined cycle gas turbine) plant burning natural gas, replacing older coal stations, have further reduced NO_x emissions (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 decline 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 country's main brown coal mine in 2007. In addition, the necessary retrofitting

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.

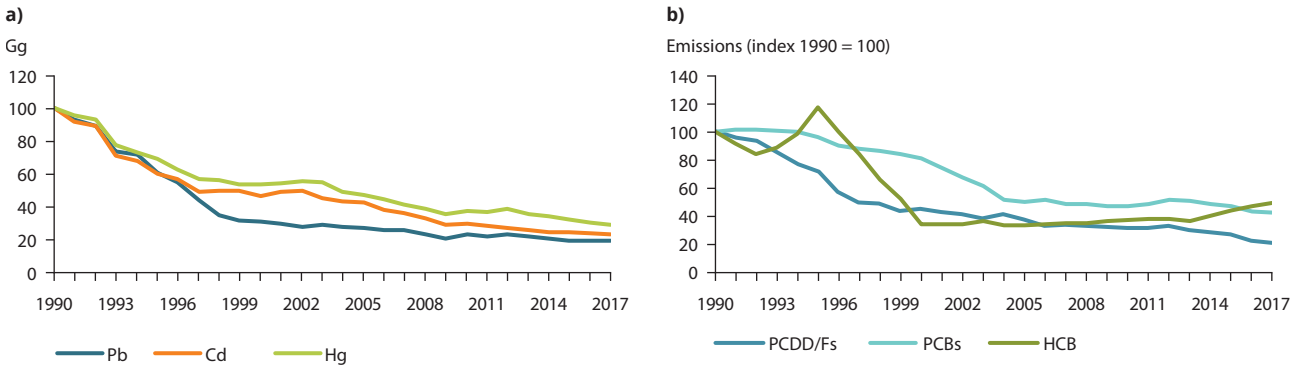
The figures showing indexed values (in percentages) use 1990 as the index year (1990 = 100 %), with the exception of PM_{10} and $PM_{2.5}$, for which the index year is 2000 (2000 = 100 %).

Figure 4.1 **EU emission trends in the energy production and distribution sector for NO_x, NMVOCs, PMs, CO and SO_x between 1990 (2000) and 2017**



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

Figure 4.2 **EU emission trends in the energy production and distribution sector group: (a) for the HMs (Pb, Cd and Hg), and (b) for POPs (PCDD/Fs, PCBs and HCB) between 1990 and 2017**



in 2008 of the adjacent thermal power plant and the introduction of abatement techniques reduced NO_x and SO_x emissions in this period (see Spain's IIR, listed in Appendix 5).

The declining trend in SO_x emissions between 1990 and 2017 mainly reflects data from Germany and Poland in the categories '1A1a — Public electricity and heat production' and '1A1b — Petroleum refining'. Since 1990, several measures have been combined to reduce emissions from these main emitting sources: 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, 2018b).

In 2012, the peak in CO emissions was due to reported increases between 2011 and 2012 from Estonia and Italy 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, Portugal and especially France reported reductions in the category '1B2aiv — Fugitive emissions oil: Refining/storage', and Italy reported decreases in the categories '1A1a — Public electricity and heat production' and '1A1c — Manufacture of solid fuels and other energy industries'. Between 2012 and 2013, Poland's reported CO emissions show a decline in the category '1A1c — Manufacture of solid fuels and other energy industries'. France explained 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 fallen (see France's IIR, listed in Appendix 5).

In 2011, peaks in $PM_{2.5}$ and PM_{10} emissions arose from high emission values reported by Estonia 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 a 34 % increase in electricity production at the Balti Power Plant (Eesti Energia Narva Elektrijaamad) which resulted from the incorrect operation of electric precipitators in two of the plant's power units (see Estonia's IIR, listed in Appendix 5).

Of the three main HMs, Pb shows the highest reduction in relative terms (-81 %) (see Figure 4.2(a)).

For emissions of POPs, the highest relative reduction was in total PAHs (-88 %) (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 these high HCB emissions were the result of higher levels of sludge burning in Flanders in 1995 (personal communication by Belgium in 2017). HCB emission data reported by the United Kingdom for the category '1A1a — Public electricity and heat production' also show a rising trend in recent years. The Member State stated that the HCB emissions were the result of burning municipal solid waste, and that more emissions reflect changes in quantities of waste burnt (see the United Kingdom's IIR, listed in Appendix 5).

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

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

The energy use in industry sector is an important source of HMs and SO_x. According to the size of the absolute values reported, Italy, Bulgaria and France contributed most to Pb emissions in this sector in 2017. For Cd, Poland, Portugal and Italy reported the highest emissions, while Italy and France contributed most to Hg emissions. In addition, in 2017, Poland, France and Spain contributed most to the SO_x emissions.

Energy use (fuel combustion) in industry is an important source of many pollutants. For the main ones, the highest absolute and relative reduction (-88 %) between 1990 and 2017 was for SO_x (see Figure 4.3).

The strong decrease in CO emissions between 2008 and 2009 resulted from emission reductions reported by several countries, especially Belgium, France and Italy, in the main category '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel', and may have been caused by the economic crisis.

The negative peak in $PM_{2.5}$ and PM_{10} emissions in 2009 was due to data reported by several countries and might also have been caused by the economic crisis. In 2015, data reported by Estonia and Spain in the category '1A2gviii — Stationary combustion in manufacturing industries and construction: Other' was the main reason for the increase in $PM_{2.5}$ and PM_{10} emissions. The rising trend from 2016 to 2017 was mainly caused by higher emissions reported by Estonia, Poland and the United Kingdom. Estonia and the United Kingdom reported higher emissions for the category '1A2gviii — Stationary combustion in

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

Key categories		NA	NO	NR	NE
NO_x	1A1a	0	0	0	0
NMVOC	1B2aiv	0	5	0	0
	1B2av	1	0	0	0
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
CO	1A1a	0	0	0	0
Pb	1A1a	0	0	0	0
Cd	1A1a	0	0	0	0
	1A1b	0	6	0	1
Hg	1A1a	0	0	0	0
PCDD/Fs	1A1a	0	0	0	0
	1B2aiv	7	5	0	1
HCB	1A1a	1	0	0	0
PCB	1A1a	0	0	0	1

Figure 4.3 **EU emission trends in the energy use in industry sector group for NO_x, SO_x, PMs, CO and BC between 1990 (2000) and 2017**

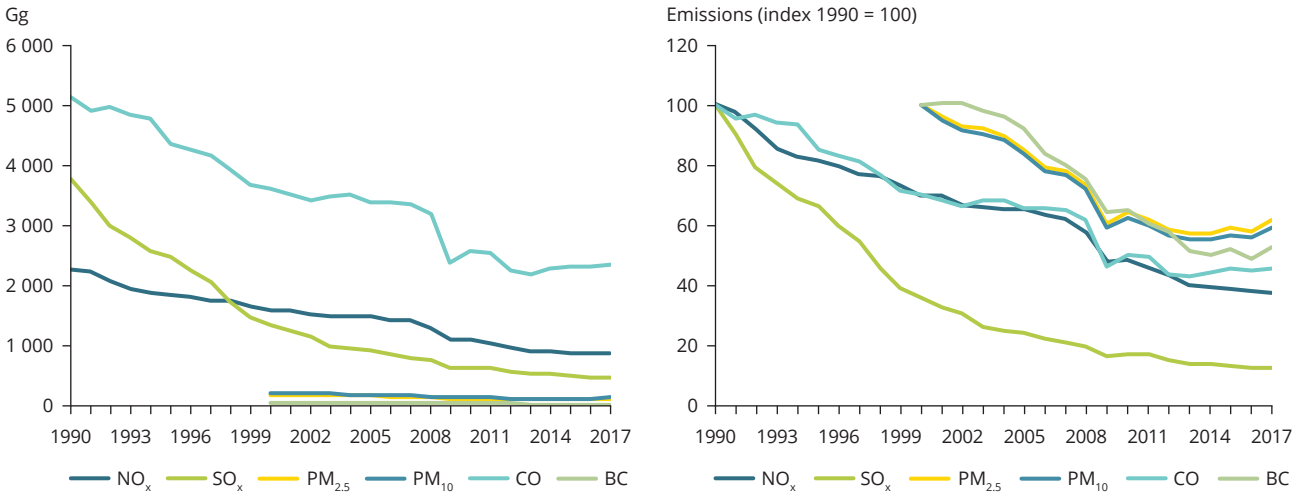


Table 4.2 **Relative difference in reported emissions when comparing the EU's 2018 and 2019 submissions (relative data, percentage of EU national totals) for the energy production and distribution sector group**

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
NO_x	-2	-4	-4	-5	-5	-6	-6	-7	-7	-7	-6	-5	-5	-5	-6
NMVOCs	4	2	-4	-6	-6	-6	-6	-7	-7	-6	-7	-7	-8	-8	-8
SO_x	-2	-4	-6	-8	-7	-8	-10	-11	-7	-5	-5	-6	-5	-6	-8
NH_3	9	3	1	1	2	2	2	2	2	3	4	11	12	10	19
TSPs	-4	-7	0	-6	-6	-7	-8	-10	-10	-8	-10	-5	-6	-13	-9
CO	3	-6	-4	-5	-5	-5	-5	-6	-5	-6	-5	-2	-3	-2	-3
Pb	3	4	-1	-1	0	0	-1	-1	-1	-1	0	-1	-1	-1	-1
Cd	3	2	0	1	1	1	0	0	0	0	1	0	0	-3	-2
Hg	3	2	1	1	1	1	0	0	0	0	0	0	0	0	1
As	5	5	1	1	2	1	1	1	2	2	3	2	1	1	1
Cr	2	1	0	0	0	0	0	0	1	0	1	1	0	0	0
Cu	1	1	0	0	0	0	0	0	0	0	1	1	1	0	0
Ni	2	1	0	-1	0	-1	-1	-1	-1	-1	-1	0	-1	-1	1
Se	14	7	0	-1	0	0	0	0	-1	0	2	0	-1	-1	-4
Zn	2	2	1	1	1	1	0	0	1	1	1	1	1	1	0
PCDD/Fs	1	1	0	0	0	0	0	0	0	0	0	0	0	6	0
B(a)P	-1	0	0	2	1	2	1	0	1	0	1	0	0	0	0
B(b)F	-1	0	2	6	4	5	4	5	1	3	3	3	2	3	3
B(k)F	0	1	3	7	5	6	4	7	1	3	3	3	2	3	3
IP	0	1	3	3	2	3	2	6	0	2	2	2	1	2	2
Total PAHs	0	0	1	2	1	1	1	3	0	1	1	-2	-2	-2	-1
HCB	3	1	0	1	1	1	-4	-4	1	1	-2	-3	1	1	0
PCBs	-1	-1	-2	-4	-3	-4	-4	-4	-3	-3	-3	-3	-4	-3	-3
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
$PM_{2.5}$			0	-7	-8	-9	-12	-14	-14	-13	-15	-12	-12	-16	-14
PM_{10}			1	-6	-6	-7	-9	-10	-10	-9	-10	-7	-8	-14	-11
BC			0	0	0	0	-3	-4	-4	-3	-8	-5	-3	-1	-3

manufacturing industries and construction: Other', while Poland's reported value for the '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel' category was higher in 2017 than in the previous year.

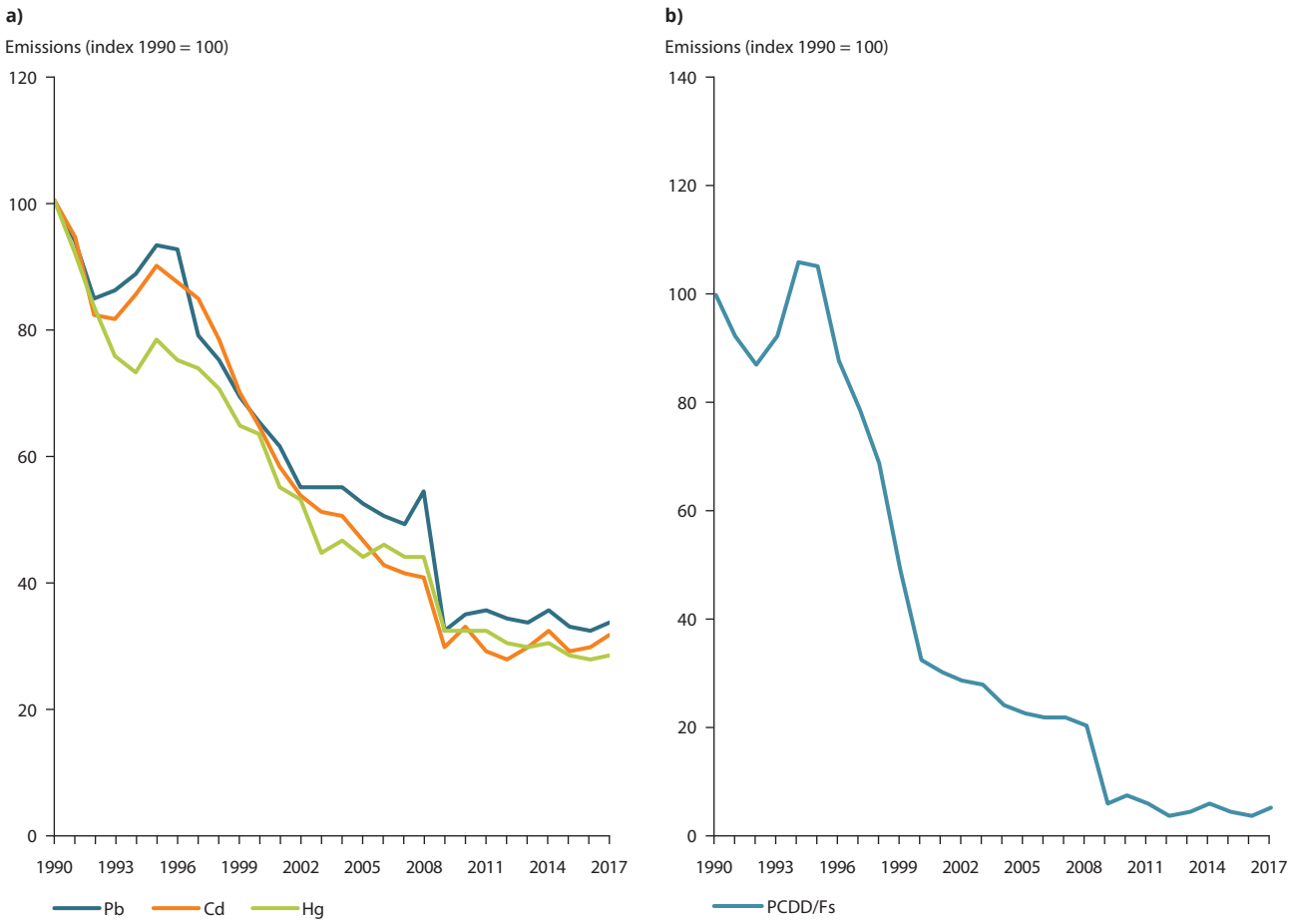
The trend in BC emissions mainly followed the data reported by the United Kingdom in the category '1A2gviii — Stationary combustion in manufacturing industries and construction: Other'.

Of the three HMs, Hg shows the biggest reduction in relative terms (-72 %) (see Figure 4.4(a)).

Pb emissions fell abruptly between 1996 and 1997, peaked in 2008, decreased considerably between 2008 and 2009, and increased between 2013 and 2014. This pattern was mainly the result 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, and between 2008 and 2009.

The increase in Hg emissions between 1994 and 1995 can be linked to higher emissions reported by Spain for '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals'. Stationary combustion in non-metallic minerals manufacturing industries (1A2f) accounted for 14 % of total Hg emissions in 1990 but reduced its emissions by 72 % in 2017. This reduction resulted from the implementation of abatement techniques in thermal power plants and the shift from coal power plants to combined cycle gas plants (see Spain's IIR, listed in Appendix 5). The strong decline in Hg emissions between 2008 and 2009 was due to reductions reported by several countries, especially Italy and Slovakia in the category '1A2a — Stationary combustion

Figure 4.4 **EU emission trends in the energy use in industry sector group: (a) for the HMs (Pb, Cd and Hg), and (b) for POPs (PCDD/Fs) between 1990 and 2017**



in manufacturing industries and construction: Iron and steel', and may have been caused by the economic crisis in 2009.

The high Cd emissions from 1995 to 1997 mainly reflect the high levels reported by Poland in several categories. The drop in Cd emissions between 2008 and 2009 was caused by reductions noted by several countries, in particular Portugal in the category '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' and Italy in the '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel' category. The declining trend in Cd emissions during this period can be explained by the economic recession, which negatively affected the volume of production (personal communication by Portugal in 2019).

Among the POPs, PCDD/Fs are key pollutants in the energy use in industry sector group. HCB registered the largest reduction compared to 1990 values, of 99 % up to 2017. Figure 4.4(b) presents trends for these pollutants.

The trend in PCDD/F emissions from 1990 until 2000 was mainly attributable to the data reported by France, with peaks from 1994 to 1994 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'. The sudden drop from 2008 to 2009 was due to data reported by several countries, especially Belgium, France, Italy and Czechia, mainly in the category '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel', and may have been caused by the economic crisis.

Table 4.3 presents the number of Member States reporting the notation keys NA, NO, NR and NE

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

Key categories		NA	NO	NR	NE
NO_x	1A2f	0	1	0	0
	1A2gviii	1	1	0	0
SO_x	1A2a	0	2	0	0
	1A2c	0	1	0	0
	1A2f	0	1	0	0
	1A2gviii	1	1	0	0
$PM_{2.5}$	1A2f	0	1	0	0
	1A2gviii	1	1	0	0
PM_{10}	1A2f	0	1	0	0
	1A2gviii	1	1	0	0
BC	1A2gvii	0	0	0	0
	1A2gviii	0	0	0	0
CO	1A2a	0	2	0	0
	1A2gvii	0	0	0	0
Pb	1A2a	0	2	0	3
	1A2b	0	3	0	1
	1A2f	0	1	0	0
Cd	1A2a	0	2	0	3
	1A2c	1	1	0	1
	1A2f	0	1	0	0
	1A2gviii	1	1	0	0
Hg	1A2a	0	2	0	2
	1A2f	0	1	0	0
	1A2gviii	1	1	0	0

within the key categories. Table 4.4 shows the recalculations within the energy use in industry sector group. For explanations of EU recalculations, see Section 5.1.

4.3 Sectoral analysis and emission trends for the industrial processes and product use sector

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 B(a)P, PCB, NMVOC, HCB, Pb and Cd emissions, as well as an important source of total PAH which makes significant contributions to PMs, CO and PCDD/Fs emissions. The countries are ranked according to the size of the absolute values they reported. Portugal

Figure 4.5 **EU emission trends in the industrial processes sector group for NMVOCs, SO_x, PMs and CO between 1990 (2000) and 2017**

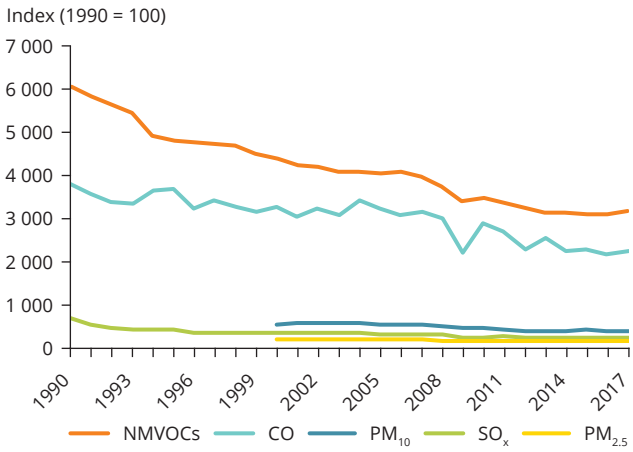


Table 4.4 **Relative difference in reported emissions when comparing the EU's 2018 and 2019 submissions (relative data, percentage of EU national totals) for the energy use in industry sector group**

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
NO_x	-2	-4	-4	-5	-5	-6	-6	-7	-7	-7	-6	-5	-5	-5	-6
NMVOCs	4	2	-4	-6	-6	-6	-6	-7	-7	-6	-7	-7	-8	-8	-8
SO_x	-2	-4	-6	-8	-7	-8	-10	-11	-7	-5	-5	-6	-5	-6	-8
NH_3	9	3	1	1	2	2	2	2	2	3	4	11	12	10	19
TSPs	-4	-7	0	-6	-6	-7	-8	-10	-10	-8	-10	-5	-6	-13	-9
CO	3	-6	-4	-5	-5	-5	-5	-6	-5	-6	-5	-2	-3	-2	-3
Pb	3	4	-1	-1	0	0	-1	-1	-1	-1	0	-1	-1	-1	-1
Cd	3	2	0	1	1	1	0	0	0	0	1	0	0	-3	-2
Hg	3	2	1	1	1	1	0	0	0	0	0	0	0	0	1
As	5	5	1	1	2	1	1	1	2	2	3	2	1	1	1
Cr	2	1	0	0	0	0	0	0	1	0	1	1	0	0	0
Cu	1	1	0	0	0	0	0	0	0	0	1	1	1	0	0
Ni	2	1	0	-1	0	-1	-1	-1	-1	-1	-1	0	-1	-1	1
Se	14	7	0	-1	0	0	0	0	-1	0	2	0	-1	-1	-4
Zn	2	2	1	1	1	1	0	0	1	1	1	1	1	1	0
PCDD/Fs	1	1	0	0	0	0	0	0	0	0	0	0	0	6	0
B(a)P	-1	0	0	2	1	2	1	0	1	0	1	0	0	0	0
B(b)F	-1	0	2	6	4	5	4	5	1	3	3	3	2	3	3
B(k)F	0	1	3	7	5	6	4	7	1	3	3	3	2	3	3
IP	0	1	3	3	2	3	2	6	0	2	2	2	1	2	2
Total PAHs	0	0	1	2	1	1	1	3	0	1	1	-2	-2	-2	-1
HCB	3	1	0	1	1	1	-4	-4	1	1	-2	-3	1	1	0
PCBs	-1	-1	-2	-4	-3	-4	-4	-4	-3	-3	-3	-3	-4	-3	-3
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
$PM_{2.5}$			0	-7	-8	-9	-12	-14	-14	-13	-15	-12	-12	-16	-14
PM_{10}			1	-6	-6	-7	-9	-10	-10	-9	-10	-7	-8	-14	-11
BC			0	0	0	0	-3	-4	-4	-3	-8	-5	-3	-1	-3

reported the largest contributions to B(a)P and total PAH emissions. The United Kingdom, Italy and Germany contributed most to PCB emissions in this sector in 2017. Of all the countries that reported data, Germany, the United Kingdom and Italy contributed most to NMVOC emissions. For HCB emissions, the largest contributions were reported by Portugal, Finland and Belgium. For the heavy metal Pb, the greatest contributions came from Poland, Germany and Italy. The EU-28 Cd emission value is mainly driven by data reported by Germany, Poland and Spain. Figure 4.5 shows previous trends in emissions of the relevant main pollutants.

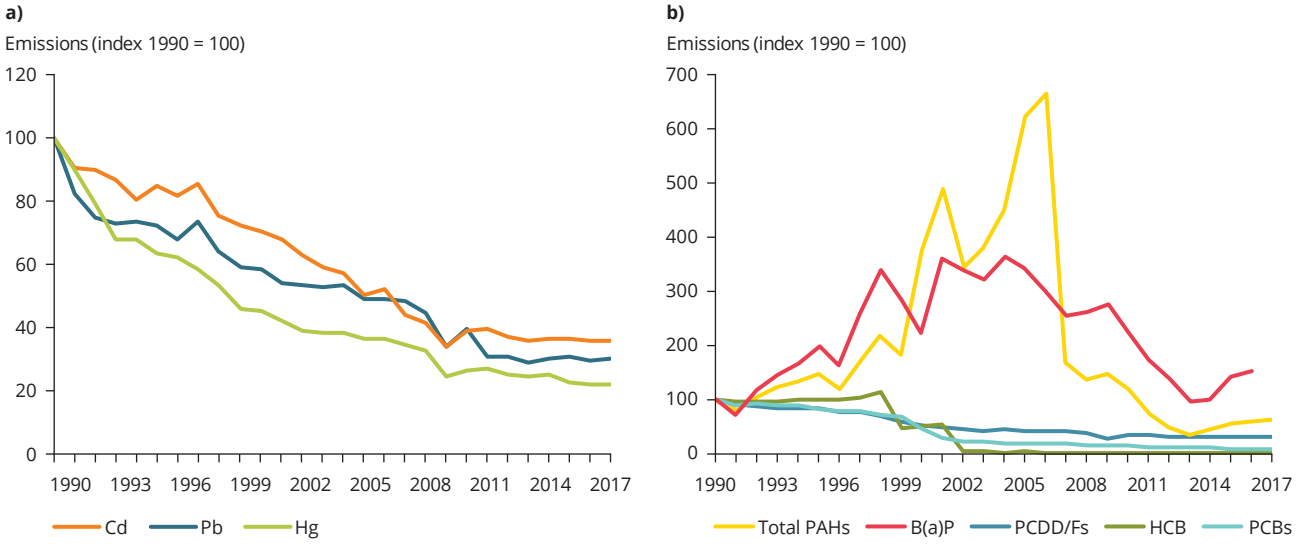
Data from France and Germany for the category '2C1 — Iron and steel production' have a great influence on the trend in CO emissions. In France, CO emissions from the 2C1 category have fluctuated over the years, depending on the amount of blast furnace gas that has been produced, reused or flared. These amounts depend on the operating conditions and how feasible it is for iron and steel or colliery plants to reuse the gas being produced continuously by blast furnaces. 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 negative peak in 2009 was also influenced by the data reported by several countries, mainly from Belgium, France, Germany, and the United Kingdom, in the category '2C1 — Iron and steel'. Spain stated that the sharp drop in CO emissions in 2008 in this category was linked to the economic downturn (see Spain's IIR, listed in Appendix 5). The CO emissions peak in 2013 followed that reported by Belgium in the '2A2 — Lime production' category. Belgium reported that the sudden increase in 2013 was due to a plant where lime production was taking place without oxygen (reducing atmosphere) (see Belgium's IIR, listed in Appendix 5).

The fall 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 reported by Germany for several categories. The drop in SO_x emissions from 1990 to 1991 resulted from reductions in categories '2H1 — Pulp and paper industry', '2B10a — Chemical industry: Other' and '2C1 — Iron and steel production'. The increase in SO_x emissions from 1999 to 2000 and the decrease from 2008 to 2009 mainly reflect data reported in the '2C1 — Iron and steel production' category. Germany explained that all the categories showed a reduction in SO_x emissions between 1990 and 2017 due to West Germany's stricter regulations, which applied to the new German *Länder* following German reunification; the fuel mix was changed from sulphur-rich solid fuels to liquid and gaseous fuels (see Germany's IIR, listed in Appendix 5). The drop in SO_x emissions from 1995 to 1996 was due to reductions in the category '2B10a — Chemical industry: Other' reported by Italy.

In 2009, many countries reported a fall in PM_{10} emissions, such as France, Germany and the United Kingdom. In 2015, Bulgaria reported a peak in PM_{10} emissions in the category '2D3b — Road paving with asphalt'.

Despite considerable reductions since 1990, the industrial processes and product use sector continues to contribute significantly to total EU emissions of HMs. Figure 4.6(a) presents previous emission trends for these pollutants. Hg shows the highest relative reduction in emissions between 1990 and 2017 (-78 %).

Figure 4.6 EU emission trends in the industrial processes and product use sector group: (a) for the HMs (Pb, Cd, Hg), and (b) for POPs (PCDD/Fs, total PAHs, B(a)P, HCB, PCBs) between 1990 and 2017



The trend in Cd emissions between 1990 and 2007 mainly reflects data reported by Slovakia in the category '2A3 — Glass production'. In 2007, most Slovak glass operators ceased production (see Slovakia's IIR, listed in Appendix 5). In the following years, the trend in Cd emissions was the result of data reported by several countries.

The decrease in Pb emissions between 2008 and 2009 was mainly caused by reductions in the category '2C1 — Iron and steel' in several countries, such as Belgium, Germany, Italy and Spain, presumably due to the economic crisis in 2009. The reduction in Pb emissions between 2010 and 2011 reflected the significant drop in emissions reported by Latvia in the category '2C1 — Iron and steel production' resulting from a change in the type of furnace used in metal production. Overall, between 2010 and 2011, Latvia's total Pb emissions (national total) fell by 98 % (see Latvia's IIR, listed in Appendix 5).

Among the POPs, HCB recorded the highest relative reduction (-98 %) between 1990 and 2017 (Figure 4.6(b)).

The considerable change in HCB emissions mainly resulted from an increase in '2C3 — Aluminium production' in the United Kingdom until 1998; from 1999 onwards, the United Kingdom has reported the notation key NA. In this Member State, the largest source of HCB emissions for the years 1990-1998 was the use of HCE as a degassing agent in secondary aluminium smelting. Specific regulations controlling the use of HCE resulted in zero emissions from this sector from 1999 onwards, and thus to an overall sharp fall in HCB emissions between 1998 and 1999 (personal communication by the United Kingdom in 2017). The steep drop in HCB emissions from 2002 to 2003 was reported by Germany in the category '2C3 — Aluminium production'. Since 2003, Germany has reported the notation key NA in this category. The country's secondary aluminum production has been prohibited by law since 2002, resulting in an omission of the source for HCB (see Germany's IIR, listed in Appendix 5).

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

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

Key categories		NA	NO	NR	NE
NMVOC	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	0	0	1
	2H2	0	0	0	0
SO_x	2B10a	2	5	0	1
$PM_{2.5}$	2A5b	0	0	0	5
	2C1	0	4	0	0
	2G	0	0	0	0
PM_{10}	2A5a	0	1	0	4
	2A5b	0	0	0	6
	2C1	0	4	0	0
	2D3b	2	0	0	3
	2G	0	0	0	0
	2L	6	13	0	1
CO	2C1	0	4	0	2
Pb	2A3	1	3	0	0
	2C1	0	4	0	0
	2G	0	0	0	0
Cd	2A3	1	3	0	0
	2C1	1	4	0	0
	2C7a	1	10	0	1
	2G	0	0	0	0
Hg	2A1	7	1	0	5
	2B10a	4	7	0	3
	2C1	1	4	0	0
	2C6	4	12	0	1
	2D3a	8	0	0	3
PCDD/Fs	2C1	1	4	0	1
Total PAHs	2D3g	15	4	0	7
B(a)P	2D3g	14	3	1	8
HCB	2A1	10	1	0	9
	2B10a	14	5	0	7
	2C3	5	9	0	7
PCB	2C1	1	4	0	1
	2K	8	7	0	5

Table 4.6 Relative difference in reported emissions when comparing the EU's 2018 and 2019 submissions (relative data, percentage of EU national totals) for the industrial processes and product use sector group

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
NO_x	-2	-4	-4	-5	-5	-6	-6	-7	-7	-7	-6	-5	-5	-5	-6
NMVOCs	4	2	-4	-6	-6	-6	-6	-7	-7	-6	-7	-7	-8	-8	-8
SO_x	-2	-4	-6	-8	-7	-8	-10	-11	-7	-5	-5	-6	-5	-6	-8
NH_3	9	3	1	1	2	2	2	2	2	3	4	11	12	10	19
TSPs	-4	-7	0	-6	-6	-7	-8	-10	-10	-8	-10	-5	-6	-13	-9
CO	3	-6	-4	-5	-5	-5	-5	-6	-5	-6	-5	-2	-3	-2	-3
Pb	3	4	-1	-1	0	0	-1	-1	-1	-1	0	-1	-1	-1	-1
Cd	3	2	0	1	1	1	0	0	0	0	1	0	0	-3	-2
Hg	3	2	1	1	1	1	0	0	0	0	0	0	0	0	1
As	5	5	1	1	2	1	1	1	2	2	3	2	1	1	1
Cr	2	1	0	0	0	0	0	0	1	0	1	1	0	0	0
Cu	1	1	0	0	0	0	0	0	0	0	1	1	1	0	0
Ni	2	1	0	-1	0	-1	-1	-1	-1	-1	-1	0	-1	-1	1
Se	14	7	0	-1	0	0	0	0	-1	0	2	0	-1	-1	-4
Zn	2	2	1	1	1	1	0	0	1	1	1	1	1	1	0
PCDD/Fs	1	1	0	0	0	0	0	0	0	0	0	0	0	6	0
B(a)P	-1	0	0	2	1	2	1	0	1	0	1	0	0	0	0
B(b)F	-1	0	2	6	4	5	4	5	1	3	3	3	2	3	3
B(k)F	0	1	3	7	5	6	4	7	1	3	3	3	2	3	3
IP	0	1	3	3	2	3	2	6	0	2	2	2	1	2	2
Total PAHs	0	0	1	2	1	1	1	3	0	1	1	-2	-2	-2	-1
HCB	3	1	0	1	1	1	-4	-4	1	1	-2	-3	1	1	0
PCBs	-1	-1	-2	-4	-3	-4	-4	-4	-3	-3	-3	-3	-4	-3	-3
			2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
$PM_{2.5}$			0	-7	-8	-9	-12	-14	-14	-13	-15	-12	-12	-16	-14
PM_{10}			1	-6	-6	-7	-9	-10	-10	-9	-10	-7	-8	-14	-11
BC			0	0	0	0	-3	-4	-4	-3	-8	-5	-3	-1	-3

Changes in the total PAHs follow the data reported by Portugal in the category '2D3g — Chemical products' up to 1999 and from 2007 to 2016. From 2000 to 2006, the trend followed emissions reported by Bulgaria in the category '2D3g — Chemical products'.

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

4.4 Sectoral analysis and emission trends for the commercial, institutional and households sector

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

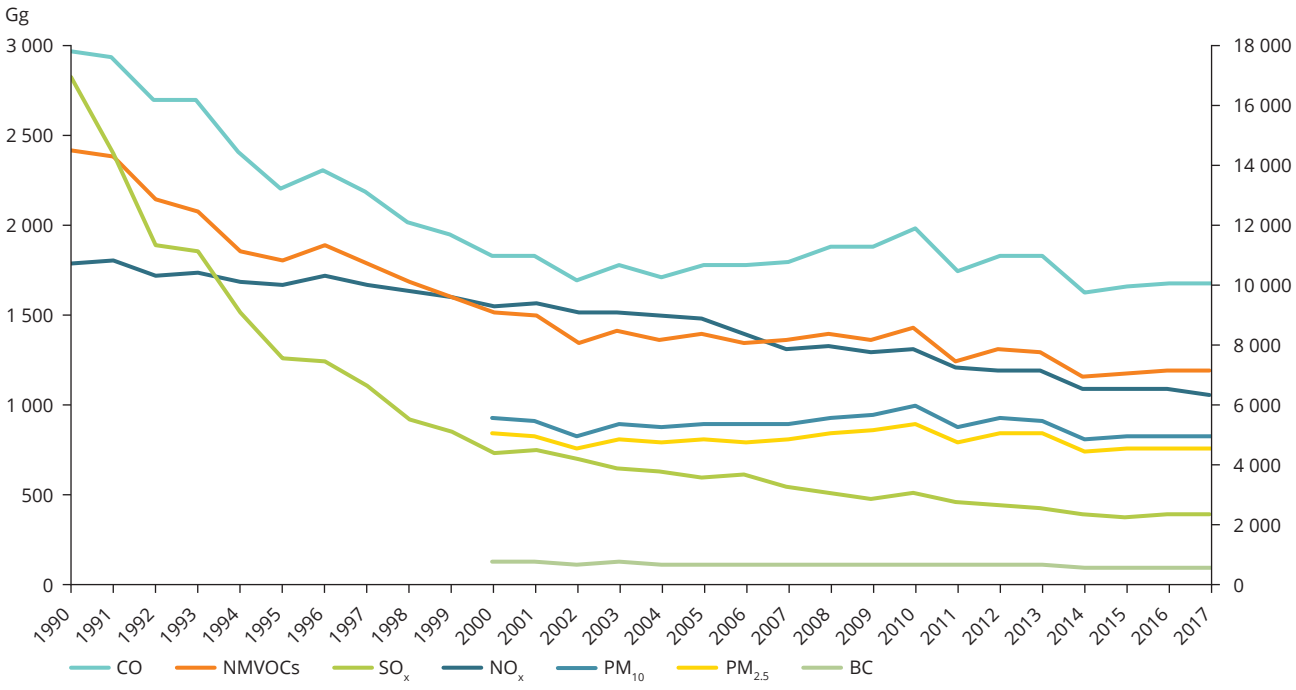
The commercial, institutional and households sector is the primary sector group for $PM_{2.5,}$ CO, total PAHs and PM_{10}, as well as an important sector group for PCDD/F, B(a)P, HCB, Cd, SO_x, NMVOC and PCB emissions. The countries are ranked according to the size of the absolute values they reported. For primary $PM_{2.5}$, Italy, Romania and Poland reported the highest emissions. Poland, Italy and France contributed most to CO emissions. Poland, Italy and Romania emitted the largest proportion of PM_{10} in 2017.

Of the main pollutants, once again the highest relative reduction between 1990 and 2017 for the sector grouping was for SO_x (-86 %). In contrast, PM emissions have changed little since 2000 (see Figure 4.7).

The drop in 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 was declining 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 in the same category. Low CO emissions in 2002 and the decreases in 2011 and 2014 reflect data from Italy and France for the category '1A4bi — Residential: Stationary'.

Lower SO_x and NMVOC emissions between 1990 and 1992 were the result of reductions of these air pollutants in Germany. The Member State explained that the lower SO_x emissions resulted from the fuel switch from coal (especially lignite with a high emission factor) to natural gas (with a lower emission factor). From 2008 onwards, a further reduction in SO_2 emissions can be explained by the increasing use of fuel oil with low sulphur content. The main reason behind the NMVOC emissions reported by Germany concerns less 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 and France in

Figure 4.7 EU emission trends in the commercial, institutional and households sector group for NO_x, NMVOCs, SO_x, PMs, BC and CO between 1990 (2000) and 2017



the '1A4bi — Residential: Stationary' category were the main cause of the dip in NMVOC emissions in 2010.

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

The trend in Cd emissions largely reflects data from Italy, whereas Italy and Poland contribute most to the Pb emission trend. The Cd emissions mainly relate to the '1A4ai — Commercial/institutional: Stationary' category in Italy. As regards the positive trend in Cd emissions in 2008, Romania also reported an increase in the category '1A4bi — Residential: Stationary'.

The fall 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'. The peak in Pb emissions in 2010 relates to Poland's emission data in the '1A4bi — Residential: Stationary' category.

The trend in Hg largely reflects data from Italy for the category '1A4ai — Commercial/institutional: Stationary'. Italy's Hg emissions from non-industrial combustion plants reported in the commercial, institutional and households sector group represent 32 % of the national total emissions of Hg in 2017 and show the strongest increase (382 %) (see Italy's IIR, listed in Appendix 5). The Hg peak in 1991 reflects data from France for the '1A4bi — Residential: Stationary' category.

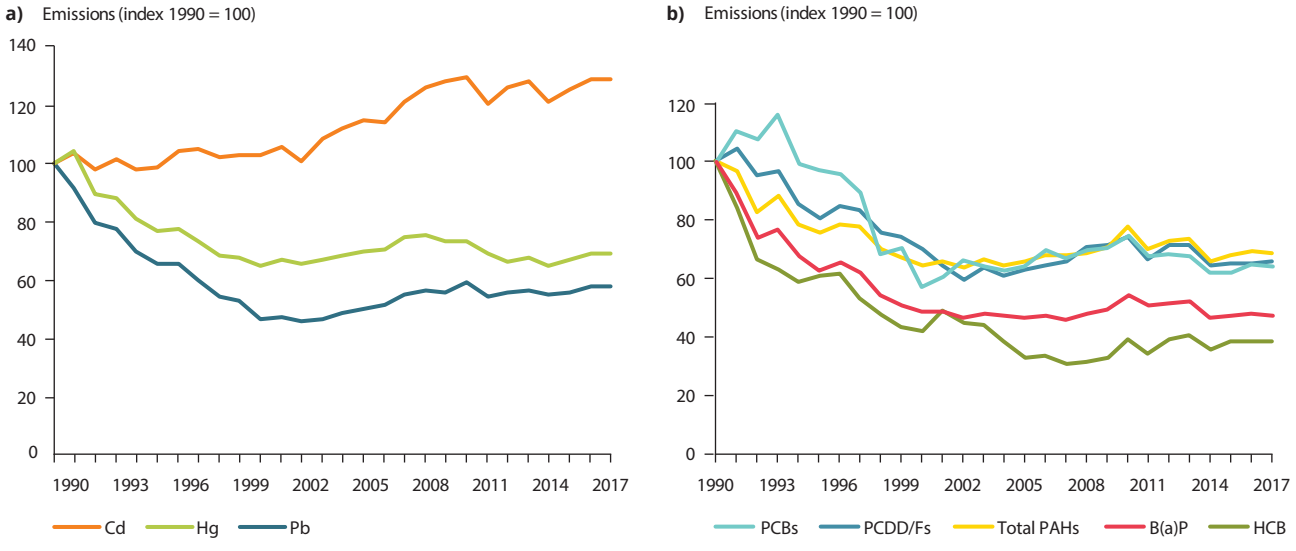
Among the POPs relevant to the commercial, institutional and households sector, the highest absolute and relative reduction occurred for HCB (-62 %) (see Figure 4.8(b)).

The trend in PCB emissions largely reflects data from Poland for the '1A4bi — Residential: Stationary' category. This country's PCB emissions from non-industrial combustion plants reported in the commercial, institutional and households sector group are the dominant source making up 68 % of the national total emissions of PCB in 2017. Compared to 2016, national total emissions in 2017 rose slightly by about 0.1 %. The increase in production in the iron and steel subsector was decisive for the country's higher overall total (see Poland's IIR, listed in Appendix 5).

Furthermore, the HCB trend largely reflects data from Austria and Czechia for the category '1A4bi — Residential: Stationary'.

The trend in total emissions of PAHs between 1990 and 2000 largely reflects data from Czechia, Germany and Poland in the category '1A4bi — Residential: Stationary'. The strong decline in total PAHs and B(a)P from 1990 to 1992 and the peaks in 2010 and 2013 reflect data reported by Germany in the '1A4bi' category. Emissions

Figure 4.8 EU emission trends in the commercial, institutional and households sector group: (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 2017



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

from Poland reported in the same category caused the peak in total PAHs and B(a)P total emissions in 1993.

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

4.5 Sectoral analysis and emission

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

Key categories		NA	NO	NR	NE
NO_x	1A4ai	0	0	0	0
	1A4bi	0	0	0	0
	1A4cii	0	0	0	0
NMVOC	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
BC	1A4bi	0	0	0	0
	1A4cii	0	0	0	0
CO	1A4bi	0	0	0	0
	1A4bii	0	0	0	0
	1A4cii	0	0	0	0
Pb	1A4ai	0	0	0	0
	1A4bi	0	0	0	1
Cd	1A4ai	0	0	0	0
	1A4bi	0	0	0	1
Hg	1A4ai	0	0	0	0
	1A4bi	0	0	0	1
PCDD/Fs	1A4bi	0	0	0	1
Total PAHs	1A4bi	0	0	0	1
B(a)P	1A4bi	0	0	0	1
HCB	1A4bi	0	0	0	1
PCB	1A4bi	0	0	0	2

Table 4.8 **Relative difference in reported emissions when comparing the EU's 2018 and 2019 submissions (relative data, percentage of EU national totals) for the commercial, institutional and households sector group**

								%							
	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
NO_x	-1	-3	-5	-7	-7	-7	-7	-6	-6	-7	-6	-5	-5	-5	-6
NMVOCs	7	3	3	4	3	4	2	2	2	3	1	2	1	1	2
SO_x	-3	-4	-4	-4	-4	-3	-3	-3	-1	-1	-2	-1	-2	-1	-4
NH_3	0	8	14	16	17	17	16	14	15	17	16	15	15	15	14
TSPs	1	-3	2	0	0	0	0	-1	0	-1	-1	-1	-2	-2	-2
CO	7	1	1	1	1	1	0	0	0	1	0	0	0	0	0
Pb	-1	-2	-1	-1	0	0	0	0	0	0	0	0	-1	-1	-1
Cd	-8	-9	-1	-2	-1	-1	-1	-1	-1	-1	-1	-1	-2	-2	-1
Hg	1	1	1	2	2	2	1	2	3	4	3	3	1	1	1
As	4	4	6	8	5	5	4	4	3	2	2	2	2	0	-1
Cr	2	1	4	4	4	4	3	3	3	4	3	3	2	3	3
Cu	5	7	16	18	10	11	9	8	6	5	5	5	5	4	3
Ni	3	4	5	7	5	5	4	4	4	4	3	2	2	2	1
Se	3	2	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1
Zn	-5	-4	0	0	0	0	0	0	0	0	0	0	0	0	0
PCDD/Fs	-4	-3	1	0	1	1	0	0	0	0	0	0	0	-1	-1
B(a)P	-1	0	3	1	1	0	0	0	-1	-1	-1	-1	-1	-1	-1
B(b)F	-2	0	2	-1	-1	-1	-2	-2	-2	-2	-2	-3	-3	-3	-3
B(k)F	-2	0	1	0	0	0	-1	-1	-2	-2	-2	-2	-2	-2	-2
IP	-4	-2	1	-1	-1	-1	-1	-2	-2	-2	-2	-2	-2	-2	-2
Total PAHs	-4	-3	-2	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3
HCB	0	0	1	-9	-8	-8	-8	-6	-6	-6	-7	-3	-3	-4	-4
PCBs	-6	-13	-8	-9	-9	-9	-9	-9	-14	-14	-15	-16	-15	-14	-12
			2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
$PM_{2.5}$			3	0	1	1	0	0	0	0	-1	-1	-2	-2	-2
PM_{10}			2	0	0	0	0	-1	0	-1	-1	-1	-2	-2	-2
BC			4	3	3	3	3	2	2	2	2	2	1	2	2

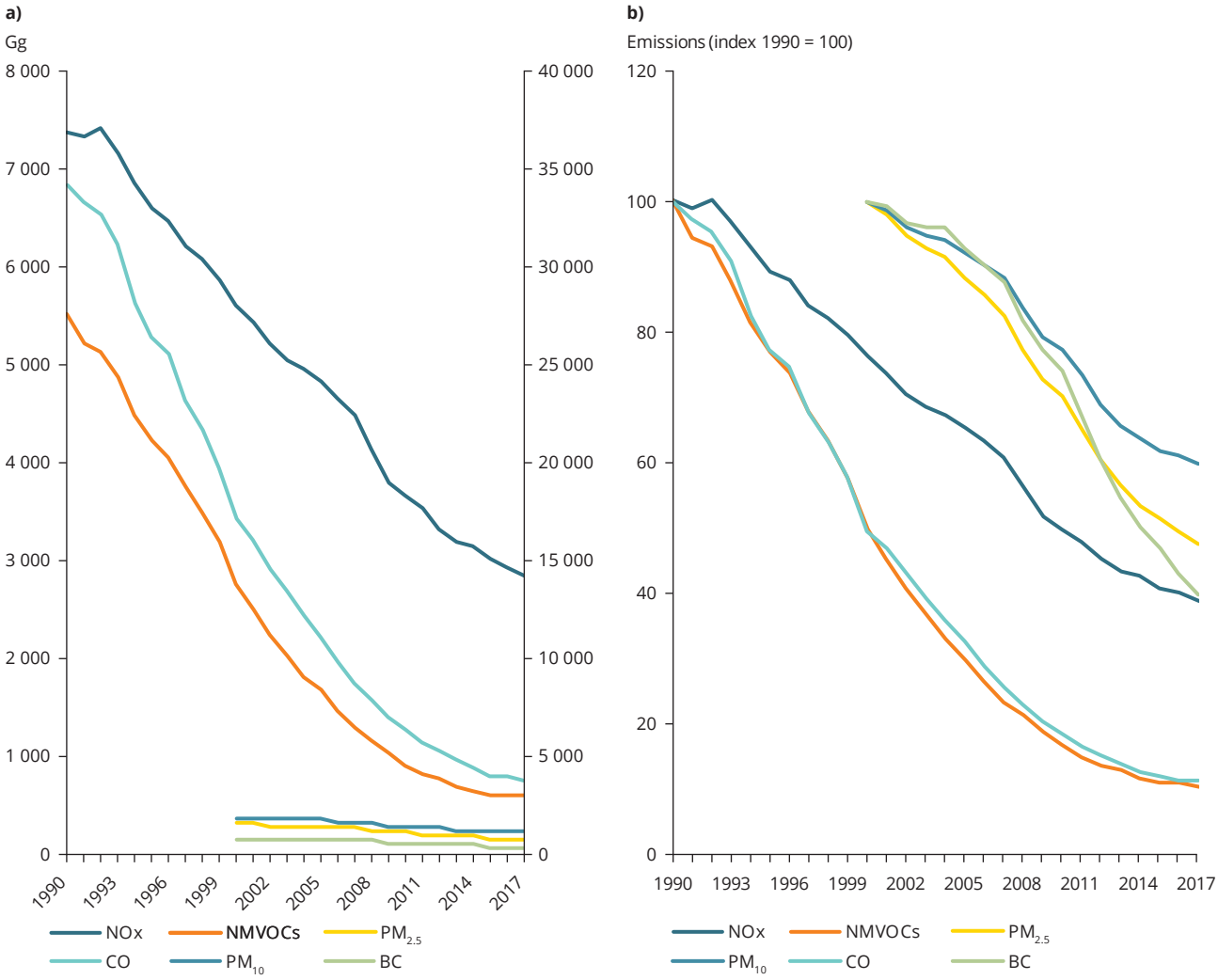
trends for the road transport sector

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

The countries are ranked according to the size of the absolute values they reported. 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 2017. For CO, Germany, Poland and Italy reported the highest emissions. Germany, France and Spain contributed most to Pb emissions, and Italy, Germany and Poland contributed most to the NMVOCs emissions in this sector in 2017.

The main HM for the road transport sector is Pb, which shows a high relative reduction in emissions (-98 %) between 1990 and 2017 (see Figure 4.10(a)). However, in recent years, little progress has been made in further reducing emissions from road transport and, over the last 3 years, total Pb emissions have actually increased slightly. The promotion of unleaded petrol in the EU and other EEA member countries, by means of 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 objective. Nevertheless, the road transport sector remains a key

Figure 4.9 **EU emission trends in the road transport sector group for NO_x, NMVOCs, PMs, BC and CO between 1990 (2000) and 2017**



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

source of Pb, contributing around 20 % of total Pb emissions in the EU.

PCDD/Fs are the most important POPs in the road transport sector group. Figure 4.10(b) shows past emission trends for this group of pollutants, with a 73 % reduction from 1990 to 2017.

The trend in emissions of PCDD/Fs mainly reflects data reported by the United Kingdom in the category '1A3bi — Road transport: Passenger cars'. The United Kingdom reported that the emissions were associated with compounds previously added to leaded petrol. From 1990, sales of unleaded petrol rose, particularly as a result of greater use of cars fitted with three-way catalysts. Leaded petrol was then phased out from general sale at the end of 1999, giving rise to the large reduction in emissions. Consequently, PCDD/F emissions fell in line with Pb emissions from the road transport sector (see the United Kingdom's IIR, listed in Appendix 5).

The steep drop in PCB emissions from 1990 to 1994 was mainly caused by data reported by Denmark in the '1A3bi — Road transport: Passenger car' category. The unsteady trend in recent years can also be aligned with emissions from this country and category. Transport accounts for 71 % of the estimated national PCB emissions in 2017, coming mainly from the combustion of diesel in road transport. Emissions from transport have dropped by 67 % since 1990, due to the phasing out of leaded petrol. This has resulted in diesel fuel use becoming the most important source of PCB emissions from transport in recent years (see Denmark's IIR, listed in Appendix 5).

Figure 4.10 EU emission trends in the road transport sector group: (a) for the priority HM Pb, and (b) for PCBs and PCDD/Fs between 1990 and 2017

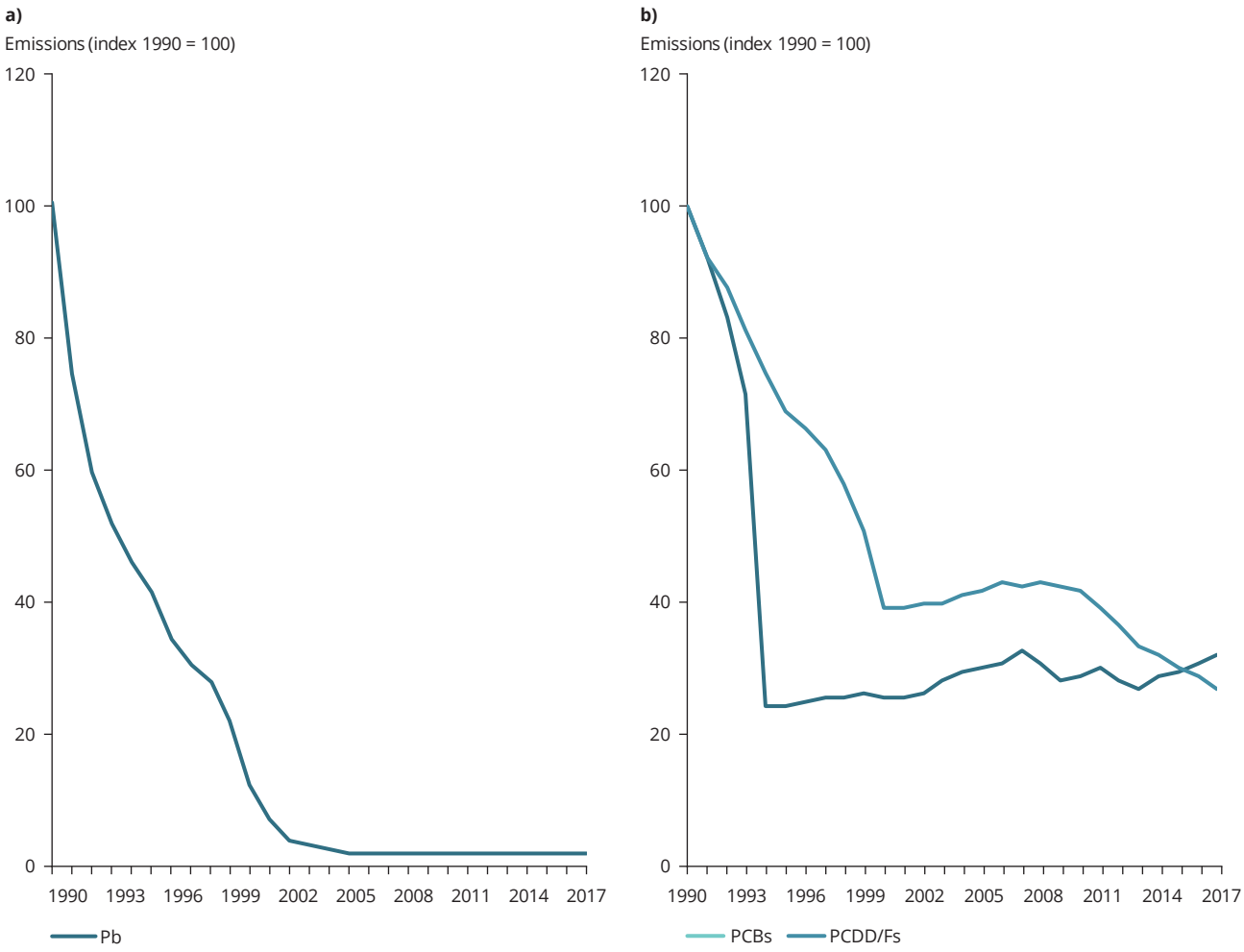


Table 4.9 presents the number of Member States reporting the notation keys NA, NO, NR and NE within the key categories. Table 4.10 shows the recalculations within the road transport sector group. For explanations of EU recalculations see Section 5.1.

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

Key categories		NA	NO	NR	NE
NO_x	1A3bi	0	0	0	0
	1A3bii	0	0	0	0
	1A3biii	0	0	0	0
NMVOC	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	0
PM_{10}	1A3bi	0	0	0	0
	1A3bvi	0	0	0	0
	1A3bvii	0	0	0	0
BC	1A3bi	0	0	0	0
	1A3bii	0	0	0	0
	1A3biii	0	0	0	0
CO	1A3bi	0	0	0	0
	1A3biv	0	0	0	0
Pb	1A3bi	0	0	0	0
	1A3bvi	1	0	0	1

Table 4.10 Relative difference in reported emissions when comparing the EU's 2018 and 2019 submissions (relative data, percentage of EU national totals) for the road transport sector group

								%							
	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
NO_x	-4	-3	-2	-2	-3	-3	-2	-2	-1	-1	-1	-1	-1	-1	-1
NMVOCs	-6	-5	-5	-6	-6	-6	-5	-5	-4	-4	-4	-5	-5	-5	-3
SO_x	-5	-4	-3	-1	-5	-2	-3	-6	4	5	6	6	6	6	5
NH_3	-10	-6	0	-1	-1	-1	-1	-1	-1	-2	-2	-2	-2	-1	-1
TSPs	-7	-3	-1	1	1	1	2	3	3	3	3	3	3	4	3
CO	-3	-2	-3	-3	-3	-3	-3	-3	-2	-2	-2	-2	-4	-4	-4
Pb	1	0	6	1	1	1	0	1	1	1	1	2	2	2	3
Cd	-6	-5	-6	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9
Hg	1	1	0	2	2	2	2	3	3	3	3	3	3	3	3
As	28	28	29	29	30	30	30	29	28	27	27	26	27	27	26
Cr	21	20	19	17	17	16	17	17	17	17	17	17	16	16	16
Cu	6	6	6	6	6	5	5	5	5	5	5	6	6	6	6
Ni	2	3	2	0	0	0	0	0	0	1	1	1	1	0	0
Se	8	8	8	8	8	8	8	8	8	8	8	8	8	7	8
Zn	-2	-1	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-1
PCDD/Fs	1	1	2	2	3	3	2	3	3	3	2	2	1	2	1
B(a)P	15	15	17	23	25	26	25	24	24	25	24	24	26	26	26
B(b)F	15	16	16	21	22	22	22	22	22	23	22	22	23	23	23
B(k)F	15	15	16	21	22	22	22	22	22	23	23	23	24	24	24
IP	17	18	18	21	24	24	23	23	23	23	22	22	24	24	24
Total PAHs	1	1	0	1	1	1	1	1	1	1	1	1	1	1	2
HCB	-2	-4	-5	-6	-6	-7	-7	-8	-8	-8	-8	-8	-9	-9	-9
PCBs	-10	-25	-1	-1	-2	-2	-3	-3	-3	-3	-3	-2	-2	-2	-3
			2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
$PM_{2.5}$			-1	0	0	0	1	1	2	2	2	2	2	2	1
PM_{10}			-1	0	0	0	1	1	2	1	2	2	2	2	2
BC			-1	2	2	2	3	4	4	4	5	6	6	6	6

4.6 Sectoral analysis and emission trends for the non-road transport sector

In 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 its geographical boundaries. However, since the guidelines (UNECE, 2014a) define international emissions as those that start in one country and finish in another, the reporting matches the guidelines.

Within the non-road transport sector group, NO_x is a major pollutant. The countries are ranked according to the size of the absolute values they reported. The United Kingdom, Spain and Italy contributed most (in absolute terms) to the emissions of NO_x. Italy, the United Kingdom and Spain accounted for most of the SO_x emissions, and France, Italy and the United Kingdom contributed most to CO emissions in 2017.

The increase in NO_x and SO_x emissions reflects data reported by Spain for 2016 and 2017 in the category '1A3dii — National navigation (shipping)'. The 109 % increase in SO_x in this category and period is the result of more domestic navigation (see Spain's IIR, listed in Appendix 5).

BC emissions reported by Poland, Portugal and Spain have shown an increasing trend over the last few years. Poland's emissions reported in the category '1A3c — Railways', Portugal's '1A3ai(i) — International aviation LTO (civil)' emissions, and Spain's '1A3dii — National navigation (shipping)' emissions were responsible for this trend.

As the non-road transport sector group does not contribute very much to HM and POP emissions, trends for pollutants from these two groups of substances are not shown.

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

Figure 4.11 EU emission trends in the non-road transport sector group for SO_x, CO, $PM_{2.5}$, NO_x and BC between 1990 (2000) and 2017

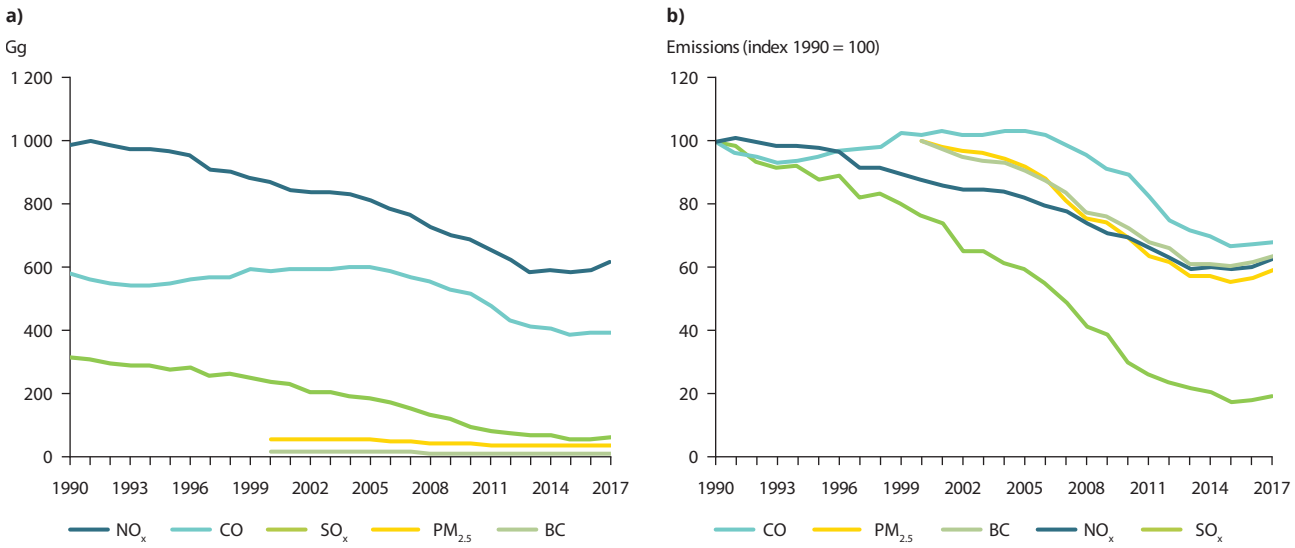


Table 4.11 Number of Member States reporting notation keys within the key categories of the non-road transport sector group

Key categories		NA	NO	NR	NE
NO_x	1A3dii	0	0	0	0

Table 4.12 Relative difference in reported emissions when comparing the EU's 2018 and 2019 submissions (relative data, percentage of EU national totals) for the non-road transport sector group

								%							
	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
NO_x	-6	-5	-6	-8	-9	-9	-9	-12	-10	-10	-10	-10	-9	-10	-10
NMVOCs	-1	-2	-2	-1	-1	-1	-1	-1	-1	0	0	0	0	0	-1
SO_x	-3	-2	-1	0	0	-1	-1	-1	-2	-2	-1	-2	-1	-2	-18
NH_3	-83	-20	-5	-6	-6	-6	-7	-7	8	-7	-7	-7	-7	-7	-7
TSPs	-2	-3	-1	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
CO	0	-1	-2	-1	-1	-1	-1	-1	-1	-1	-1	0	-1	-1	-1
Pb	0	0	0	3	3	3	3	3	3	2	2	2	1	2	2
Cd	-11	-9	-7	-6	-6	-7	-7	-7	-7	-8	-7	-7	-6	-7	-7
Hg	2	2	0	2	1	1	0	0	0	0	0	0	1	2	2
As	1	0	0	0	0	-1	-1	-1	-1	-2	-1	-2	-1	-1	-1
Cr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cu	0	0	0	0	0	1	1	2	3	3	4	5	5	6	6
Ni	6	5	3	3	2	2	2	3	2	2	3	3	3	3	3
Se	0	0	-1	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1	0
Zn	3	0	-2	-2	-3	-3	-4	-3	-4	-4	-4	-4	-3	-4	-4
PCDD/Fs	-8	-9	-11	-11	1	1	1	1	1	1	1	1	1	2	-3
B(a)P	-31	-28	-20	-22	-22	-22	-20	-19	-18	-18	-18	-17	-16	-15	-15
B(b)F	1	0	0	-1	0	0	0	0	0	0	0	0	0	0	0
B(k)F	1	1	1	1	2	1	1	2	2	2	2	2	3	3	3
IP	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
Total PAHs	-29	-27	-27	-20	-21	-19	-20	-21	-21	-19	-17	-17	-15	-14	-24
HCB	2	2	2	1	1	0	-1	0	0	-1	0	-1	0	0	-1
PCBs	-4	-5	-4	-4	-4	-5	-4	-5	-5	-5	-5	-5	-5	-5	-6
			2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
$PM_{2.5}$			0	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1
PM_{10}			0	0	0	0	-1	-1	-1	-1	-1	-1	0	-1	-1
BC			0	0	0	0	0	-1	-1	-1	0	-1	0	0	0

4.7 Sectoral analysis and emission trends for the agriculture sector

This sector group is responsible for the vast majority of NH_3 emissions in the EU — namely 92 %. According to the size of the absolute values the countries reported, Germany, France and Spain contributed most (in absolute terms) to NH_3 emissions in 2017.

Agricultural emissions of NH_3 fell by 25 % since 1990 (see Figure 4.12). However, between 2014 and 2017, NH_3 emissions rose again by 2.2 %.

In addition, the agriculture sector produces considerable emissions of NMVOC, PM_{10} and NO_x. The drop 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'.

During the period 2000-2016, PM_{10} emissions fell slightly by just 7 %. Data reported by Spain in the category '3F — Field burning of agricultural residues', reflects the decline of PM_{10} emissions in 2001.

As regards the POPs, the agriculture sector contributes considerably to emissions of total PAHs and HCB. Figure 4.13 shows previous emission trends for these pollutants.

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

Figure 4.12 EU emission trends in the agriculture sector group for NH_3, PM_{10}, NMVOCs and NO_x between 1990 (2000) and 2017

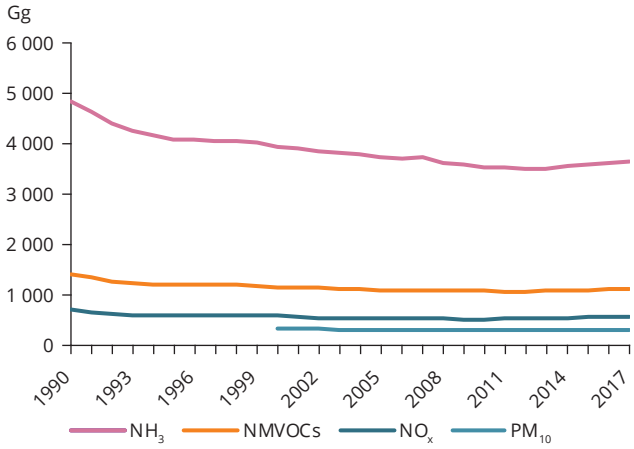


Figure 4.13 EU emission trends in the agriculture sector group for total PAHs between 1990 and 2017

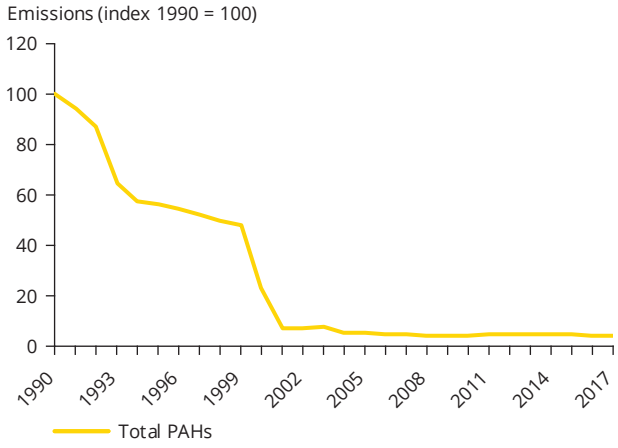


Table 4.13 Number of Member States reporting notation keys within the key categories of the agriculture sector group

Key categories		NA	NO	NR	NE
NO_x	3Da1	0	0	0	1
	3Da2a	1	0	0	2
NMVOC	3B1a	0	0	0	2
	3B1b	0	0	0	1
	3B4gii	0	0	0	1
	3Da2a	11	1	0	4
	3De	0	1	0	1
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	0	1	0	0
Total PAHs	3F	4	12	0	1
HCB	3Df	9	6	0	6

burning of agricultural residues' category. The Member State explained that high emissions of total PAHs fell significantly, particularly between 1999 and 2003, due to a gradual reduction in the field burning of agricultural residues. This practice 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 reducing the field burning of agricultural waste (personal communication by Spain in 2017).

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

Table 4.14 Relative difference in reported emissions when comparing the EU's 2018 and 2019 submissions (relative data, percentage of EU national totals) for the agriculture sector group

								%							
	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
NO_x	1	-5	5	7	7	7	7	7	7	7	8	8	9	9	13
NMVOCs	31	27	20	19	19	20	20	21	22	22	22	22	22	24	26
SO_x	-48	-55	-53	-33	-28	-41	-32	-31	-30	-31	-29	-30	-29	-27	-10
NH_3	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0
TSPs	-2	-3	-3	-1	-1	-1	0	0	0	0	0	0	0	0	0
CO	-70	-81	-49	-25	-21	-32	-24	-23	-23	-23	-23	-23	-22	-21	-22
Pb	-44	-44	-33	-6	-5	-10	-3	-5	-3	-3	-4	-4	-5	-4	-4
Cd	-52	-53	-47	4	8	-15	10	7	5	5	7	7	3	5	5
Hg	-50	-50	-41	5	10	-14	11	8	6	6	8	8	4	5	6
As	-39	-38	-28	-8	-7	-10	-6	-6	-5	-5	-5	-6	-7	-6	-6
Cr	-52	-53	-47	-12	-10	-25	-8	-9	-9	-9	-9	-9	-12	-11	-12
Cu	-50	-50	-42	-3	-1	-13	-1	-1	-3	-3	-2	-2	-4	-3	-4
Ni	-53	-54	-50	-16	-14	-29	-11	-13	-12	-12	-12	-12	-15	-14	-16
Se	-49	-49	-42	-8	-6	-16	-4	-5	-5	-5	-6	-5	-7	-7	-7
Zn	-26	-24	-13	0	0	-2	0	0	0	0	0	0	-1	0	0
PCDD/Fs	-32	-70	-66	-72	-67	-73	-60	-50	-43	-55	-76	-46	-65	-72	-42
B(a)P	0	1	6	7	7	5	5	4	4	5	7	5	3	2	5
B(b)F	2	8	8	9	8	7	6	5	6	6	9	7	4	3	7
B(k)F	1	7	8	8	8	6	6	5	5	6	8	7	3	3	6
IP	1	6	7	8	8	6	6	5	5	6	8	7	3	3	6
Total PAHs	-48	-58	-58	-20	-15	-44	-13	-16	-18	-17	-14	-16	-18	-14	-22
HCB	0	0	0	0	0	0	0	1	1	1	2	2	2	2	11
PCBs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
$PM_{2.5}$			-28	-9	-9	-12	-9	-8	-8	-8	-8	-8	-9	-9	-9
PM_{10}			-8	-3	-3	-4	-3	-3	-3	-3	-3	-3	-2	-2	-3
BC			-35	-10	-8	-11	-6	-5	-4	-6	-10	-4	-8	-10	-5

4.8 Sectoral analysis and emission trends for the waste sector

This sector group is a primary source of PCDD/Fs and an important source of certain pollutants, including HCB, Hg and PCBs. Figure 4.14 shows the previous emission trends for these pollutants.

Between 1990 and 2006, the decline 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 2007 onwards the PCB emissions reported by Portugal in the '5C1bi — Industrial waste incineration' category. PCB emissions reported by this Member State correspond closely to the amount of waste burnt in industrial incineration plants. Portugal explained that the fluctuations in the results from industrial waste incineration arose, at least partially, from variations in fluxes in 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 '5C1bii — Hazardous waste incineration' category.

The trend in PCDD/F emissions reported by Portugal from 1990 until 2001 contributed most to the drop in the '5C1biii — Clinical waste incineration' category. In its IIR, Portugal stated that 25 incinerators had been closed in recent years on its mainland, with just one remaining clinical waste incinerator in operation since 2004. Other clinical waste receives alternative treatment or is sent abroad (see Portugal's IIR, listed in Appendix 5).

From 2008 onwards, the PCDD/F emission trend reflected Greek data on the '5C1biii — Clinical waste incineration' category: for example, the peak in 2009 and rising emissions from 2013 to 2014. In recent years, the upward trend was also caused by data reported by Greece until 2016, while for 2017 the value has been extrapolated.

The decrease in HCB emissions between 1990 and 2005 largely reflected data from France for the category '5C1biv — Sewage sludge incineration'. However, high HCB emissions between 1993 and 1997 were also influenced by data reported by Belgium under the same category. This Member State commented that this category has disappeared as a key source for HCB because nearly all incineration plants now have energy recuperation, and emissions are allocated to the category '1A1a — Public electricity and heat production' (see Belgium's IIR, listed in Appendix 5). The trend in HCB emissions from 2005 onwards reflects data reported by Italy in the category '5C1biv — Sewage sludge incineration'. It is important to point out that industrial waste incineration is the major source of

Figure 4.14 EU emission trends in the waste sector group for the HM Hg, for the POPs (PCDD/Fs, PCBs, HCB, B(a)P) and for the PMs between 1990 and 2017

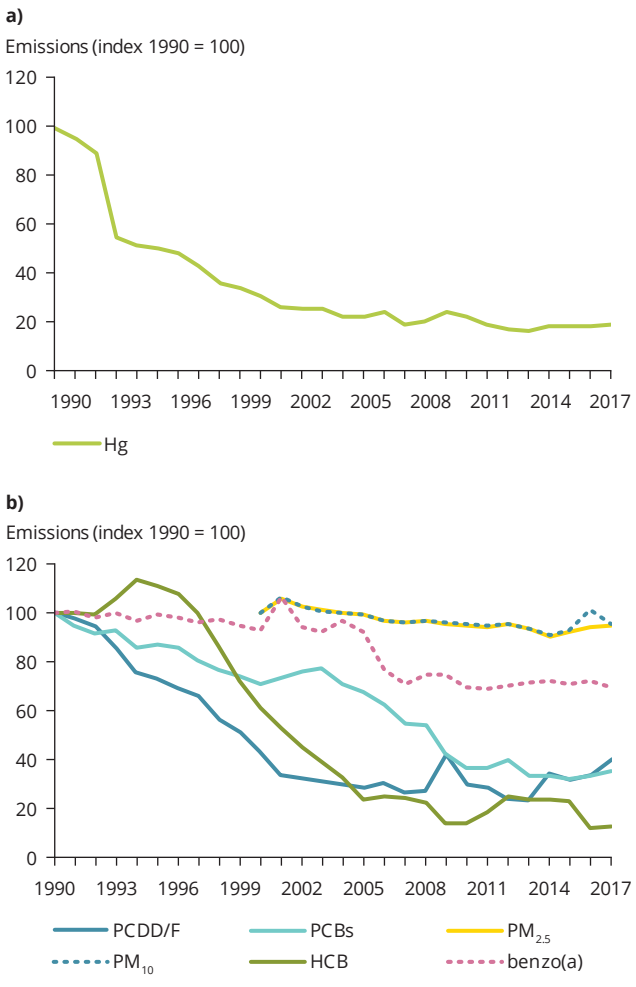


Table 4.15 Number of Member States reporting notation keys within the key categories of the waste sector group

Key categories		NA	NO	NR	NE
$PM_{2.5}$	5C2	0	12	0	3
	5E	0	0	0	0
PM_{10}	5C2	0	12	0	3
	5E	0	0	0	0
CO	5C2	0	0	0	0
Hg	5C1bv	0	0	0	3
PCDD/Fs	5C1biii	0	7	0	0
	5E	0	1	0	1

Italy's HCB emissions (30 % of the national total) (see Italy's IIR, listed in Appendix 5).

The United Kingdom contributed most to reducing Hg emissions in the '5C1a — Municipal waste incineration' category from 1992 to 1993. This is because of better controls introduced for waste incineration. In addition, there was a general decline in ferrous and non-ferrous metal production, while the use of coal as a fuel in all sectors declines (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'. The country 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).

The cause of the PM_{10} emission peak in 2016 is data reported by Spain in the category '5E — Other waste'. The uptick in Spain's PM_{10} emissions resulted from accidental fires (see Spain's IIR, listed in Appendix 5).

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

Table 4.16 Relative difference in reported emissions when comparing the EU's 2018 and 2019 submissions (relative data, percentage of EU national totals) for the waste sector group

								%							
	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
NO_x	-49	-51	-55	-57	-58	-59	-58	-58	-58	-58	-58	-58	-58	-58	-58
NMVOCs	12	12	14	5	6	7	7	4	4	2	3	0	-1	-2	0
SO_x	-7	-10	-16	-18	-18	-19	-19	-20	-24	-25	-24	-24	-26	-24	-24
NH_3	25	28	32	0	-1	-1	-1	-1	-1	-3	-1	-3	-4	-3	-3
TSPs	-42	-41	-43	-47	-40	-40	-37	-37	-36	-36	-37	-38	-33	-32	-27
CO	-50	-55	-55	-56	-56	-56	-56	-56	-56	-57	-56	-56	-57	-56	-56
Pb	-5	-12	-6	-32	-24	-27	-30	-20	-23	-18	-16	-17	-14	-12	-58
Cd	0	7	17	-8	9	6	2	15	6	24	25	26	31	36	-35
Hg	-5	-8	-13	-41	-16	-23	-33	-10	-26	-9	-10	-5	-8	-4	-24
As	-2	-2	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Cr	0	0	11	-1	-1	-1	-1	0	-1	0	0	0	0	0	-1
Cu	4	6	8	-26	-8	-8	-17	4	-11	10	11	15	17	19	10
Ni	0	0	2	-2	3	3	1	6	4	9	9	10	12	14	1
Se	-50	-53	-54	-60	-60	-60	-60	-58	-58	-57	-58	-55	-58	-57	-57
Zn	-36	-40	-45	-47	-48	-48	-47	-45	-46	-47	-47	-48	-48	-49	-50
PCDD/Fs	4	5	8	1	1	-11	-12	-8	-13	-5	-2	-95	-3	0	-2
B(a)P	145	145	141	100	136	154	169	173	170	166	169	178	185	178	180
B(b)F	147	158	155	103	125	136	153	156	148	142	147	155	164	159	164
B(k)F	156	170	160	88	125	146	170	178	162	155	159	171	182	171	175
IP	44	48	49	52	56	59	61	59	61	57	60	61	64	-84	68
Total PAHs	-63	-63	-63	-64	-66	-67	-66	-66	-67	-67	-66	-66	-66	-66	-59
HCB	0	0	0	1	3	4	7	11	19	6	5	4	4	9	-47
PCBs	0	0	0	-9	-14	-19	-23	-31	3	-5	-9	-4	-1	-2	-1
			2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
$PM_{2.5}$			-28	-30	-30	-30	-29	-29	-29	-28	-28	-29	-29	-29	-29
PM_{10}			-40	-43	-38	-38	-36	-36	-35	-35	-36	-37	-34	-33	-31
BC			-56	-57	-58	-58	-57	-58	-58	-58	-58	-58	-58	-58	-57

5 Recalculations and implemented or planned improvements

5.1 Recalculations

Recalculations are changes made to previous emission estimates (for one or more years) to eliminate errors, consider additional factors and 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 to 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 2018 with those in 2019.

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 have been compensated for by recalculations from other Member States, and therefore EU recalculations are only moderate.

Recalculations due to gap filling: Recalculations for Romania for the years 1995-1999 are as reported by the Member State this year using data from 1995, while last year the data were gap-filled up to 1999. For Greece data have been gap-filled for the whole time series this year, as no submission was made. The year before, submitted data were available.

Recalculations for the main pollutants and CO: Recalculations for NO_x, NMVOCs, SO_x and CO that are relevant for the EU recalculations were done by several countries (see also Table 5.2).

Recalculations for PMs, TSPs and BC: The highest recalculations for $PM_{2.5}$, PM_{10}, TSPs and BC, reducing emissions and relevant for the EU recalculations, were carried out by Spain. This is the result of recalculations mainly in the category 5C2 (open burning of waste) Romania's recalculations led to an increase in EU emissions; mainly recalculations carried out for the category 1A1a (public electricity and heat production).

Recalculations for HMs: Recalculations carried out by Spain, Poland, Romania, Slovakia, Czechia, Finland and the United Kingdom and by several other countries are relevant for the EU recalculations for heavy metals (see also Table 5.2).

For **Pb**, Poland carried out significant recalculations relevant for the EU for the complete set of time series from 1990-2016. This is mainly because of reduced emissions reported in the category '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals'. Poland stated in its IIR that emissions of HMs, dioxins and PAH have been moved from this category to the relevant '2C' categories, hence the reduction (see Poland's IIR, listed in Appendix 5). Other major contributions come from Finland for 1990-1992 and Czechia (high recalculation in 2000), both in the category '1A3bi – Road transport: Passenger cars'. Czechia explained in its IIR that the COPERT V model was introduced in summer 2018 (see Czechia's IIR, listed in Appendix 5). The United Kingdom also contributed to the recalculations on EU

level by reporting values in category '1A3bvi – Road transport: Automobile tyre and brake wear' instead of the notation key 'NA'.

As regards **As** emissions, Slovakia provided recalculations for 2003 in the category '2C7a — Copper Production', which have an impact on EU recalculations. Spain and Poland recalculated the whole time series in the category '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals', while Romania recalculated up to 1998 in the category '1A1a — Public electricity and heat production'. Poland stated in its IIR that emissions of HMs, dioxins and PAH have been moved from '1A2b' to the relevant '2C' categories (see Poland's IIR, listed in Appendix 5).

There is a positive trend in the EU recalculations of **Cr** emissions. This is mainly due to emissions being reported for the first time (from 1995-1999) and gap-filled data (until 1994) for Romania in the category '2C1 — Iron and steel production'. In addition, recalculations carried out by the United Kingdom in the category '1A3bvi — Road transport: Automobile tyre and brake wear' and values reported by Poland in the category '2C7a — Copper production' used to be marked as included elsewhere ('IE') in previous inventory submissions. In its IIR, the United Kingdom

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**	**2016**
NO_x	Gg	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
NMVOCs	Gg	2	2	2	2	2	2	2	2	2	2	2	1	2	1	3
SO_x	Gg	-1	-1	0	0	0	0	0	1	0	0	0	-1	0	0	-1
NH_3	Gg	2	2	1	1	1	1	0	0	0	0	1	1	1	1	1
TSPs	Gg	-2	-4	1	0	0	0	1	1	0	-2	-5	-1	0	-1	0
CO	Gg	-1	-4	0	0	0	0	0	0	0	0	-1	0	-1	-1	-2
Pb	Mg	0	-1	-1	-8	-8	-7	-8	-9	-8	-9	-9	-9	-9	-10	-10
Cd	Mg	-5	-6	-4	-3	-2	-3	-3	-3	-3	-3	-3	-3	-3	-3	-5
Hg	Mg	2	1	0	-1	0	0	-1	1	0	1	1	1	1	-1	-1
As	Mg	-1	-4	-9	-10	-10	-9	-9	-10	-10	-10	-11	-11	-12	-12	-12
Cr	Mg	2	4	4	4	4	4	4	5	4	5	6	6	5	6	5
Cu	Mg	0	0	-1	-1	-1	-1	-1	0	0	-1	-1	0	-1	-1	0
Ni	Mg	2	1	0	0	0	-1	-1	-1	-1	-1	-1	0	-1	-1	-1
Se	Mg	6	2	-3	-2	-2	-2	-2	-2	-2	-2	-1	-2	-2	-3	-4
Zn	Mg	-3	-4	-6	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7
PCDD/Fs	g I-Teq	1	1	1	-2	-2	-4	-4	-4	-5	-3	-3	-78	-3	-1	-3
B(a)P	Mg	6	6	147	181	235	5	-13	-9	-11	-26	-33	-29	-23	-29	-30
B(b)F	Mg	1	4	5	4	3	2	2	2	2	2	3	3	1	1	3
B(k)F	Mg	1	4	5	4	4	3	4	4	3	4	5	4	3	3	5
IP	Mg	0	1	3	2	1	1	1	1	0	0	1	1	0	-4	1
Total PAHs	Mg	-38	-42	10	113	144	-7	-13	-10	-12	-20	-23	-20	-18	-21	-23
HCB	kg	53	44	470	-1	-1	-1	-1	-1	0	-1	-1	-1	0	0	-3
PCBs	kg	4	4	6	-14	-15	-18	-20	-23	-23	-25	-26	-29	-31	-31	-31
				2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
$PM_{2.5}$	Gg			-2	-2	-2	-3	-2	-3	-2	-2	-3	-3	-3	-4	-3
PM_{10}	Gg			-1	-2	-2	-2	-2	-2	-2	-3	-5	-3	-3	-3	-3
BC	Gg			-3	-2	-2	-2	-2	-2	-2	-2	-2	-2	-3	-3	-3

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

Pollutant	EU countries making significant recalculations	
	Countries for which recalculations had a 'negative' effect	**Countries for which recalculations had a 'positive' effect**
NO_x	EL 1990-2015; ES 1990-2016; CZ 1990-2003; RO 1995-1999; SK 1990-1999	UK 1990-2008; PL 1990-1999, 2005-2016; DE 1998-2003; BG 2014-2016
NMVOCs	EL 1990-2015; CZ 1990-1995; UK 2011-2016; RO 2008-2016	NL 1990-2016; PL 1990-2016; SK 1990-1994, 2010-2013
SO_x	SK 1990-2002, 2004; DE 2011-2016; ES 1999-2012; RO 2001, 2013; PT 2003-2006; LT 2007-2008; PL 2003;	EL 1990-2015; PT 1999-2002; PL 2008, 2010-2016; EE 2014, 2016
NH_3	FR 1990-2016; CZ 1990-1995; LT 1990-2008; UK 2016	RO 1990-2004; PL 2003-2016; DE 1998-2016; ES 2000-2008
$PM_{2.5}$	ES 2000-2016; SK 2014	RO 2000-2004; LT 2005, 2008-2009, 2011-2015; PT 2006-2010, 2013-2016; SE 2009-2010, 2012; SK 2000-2001
PM_{10}	ES 2000-2016; PL 2000-2016; SK 2014	EL 2000-2002, 2004, 2008-2009; PT 2005-2007, 2010-2011, 2013-2016; RO 2000-2004; SE 2007, 2011-2012
TSPs	PL 2000-2011, 2013-2016; PT 2012; ES 2000-2010, 2013-2016; EL 2011-2012; SK 2014-2016	EL 2000-2009, 2014; PT 2010, 2013, 2015-2016; UK 2001-2005, 2011; FR 2016
BC	ES 2000-2016	RO 2002-2003, 2005-2016; SK 2000-2001, 2003-2013, 2016
CO	ES 1990-2016; RO 1995-1999; FR 1991-1992, 2001-2002	SK 1990-2016; PL 1994-1999; CZ 1996-1997, 2009-2012
Pb	PL 1990-2016; ES 1990-2016	UK 1994-2016; CZ 1993-2004; FI 1990-1993; RO 1990-1998
Cd	ES 1990-2016; PL 2016	IT 1990-2016; RO 1990-1993, 1996-1998; UK 2013-2014, 2016
Hg	SK 1990-2016; PL 2015-2016; EL 1990-2015; ES 1990-1999	PL 1990-2013; FR 1998-2016; RO 1990-1997; ES 2009-2010, 2013-2016
As	PL 1990-2016; SK 2003; ES 1990-2016	RO 1990-1998, 2012; SI 1997-2016; PT 1999-2007; UK 2008-2011, 2013-2014
Cr	CZ 1990-2016; ES 1990-2000; EL 1990-2015; SK 1994-1999	UK 1990-2016; RO 1990-1998; PL 1990-2016; FI 1993-1995
Cu	PL 1990-2016, ES 1996-2016	UK 1990-2016
Ni	ES 1990-2016; HR 1990-2011; BE 2002; SK 2003, 2016	PL 1990-2016; RO 1990-1997; PT 1998-2009; DE 2016
Se	ES 1990-2016; SK 1990-2016	SI 1994-2016; RO 1990-1997, 2012
Zn	ES 1990-2016; PL 1990-2016	SI 1990-2016; RO 1990-1994, 1996-1998; UK 1999-2016
PCDD/Fs	MT 2013; PT 2005-2012, 2014-2016; EL 1990-2006; PL 1995-2001, 2003-2004, 2012, 2014-2016; NL 1991-1992; UK 1990, 1993-1995; SK 2006, 2014-2016	EL 2015; SK 1990-2004; RO 1990-1992, 1996-1998, 2004-2008, 2010-2014, 2016; PT 2003-2004; MT 2014; PL 2008-2010; SI 2005-2007
B(a)P	PT 2005-2006, 2008-2016; RO 1990-1995, 1999; EL 1990-2004, 2006-2007; SK 1996-2004, 2006-2007	BG 1990-2006, 2008-2016; PT 1998-1999, 2007; PL 2009
B(b)F	SK 1990-1993, 1996-2016; RO 1990-1995; EL 1990-2012, 2014-2015	PT1990-2016; PL 1990-2015
B(k)F	SK 1990-1993, 1996-2016; EL 1990-2012, 2014-2015; RO 1990-1995	PT1990-2016; PL 1991-2016
IP	SK 1990-2016; RO 1990-1995, 1999; EL 1996-2012, 2014-2015; LT 2015;	PT 1990-2016; PL 1990-2006, 2012, 2014-2015
Total PAHs	ES 1990-2016; PT 2005, 2008-2016	BG 1990-2006, 2008, 2010-2016; PT 1998-1999, 2007; PL 1997-1999, 2008-2012
HCB	PL 1990-2004, 2014-2015; AT 2005-2016; IT 2016; BE 2008-2009, 2013; CZ 2003	DE 1990-2001; SK 2002-2009, 2016; UK 2016; FI 2006-2007; FR 2010-2015; ES 2002, 2004-2007, 2009-2014
PCBs	PT 2001-2016; PL 1993-2000; SK 1990-1999; EL 1991-1992, 1999-2000	PT 1990-2000; LT 2001-2003; RO 2004; IE 2011, 2014; FR 2005-2006, 2011-2013, 2015; BE 2002, 2007; DE 2016; IT 2010, 2016; CZ 2003, 2005-2015

Notes: EU countries making 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.

clarified that these recalculations were carried out as a result of the implementation of emission factors from the Inventory guidebook (EMEP/EEA, 2016) (see the United Kingdom's IIR, listed in Appendix 5).

Several countries are responsible for the EU recalculation trends for **Ni** and **Se** emissions (see also Table 5.2).

For **Zn**, significant recalculations influencing the EU results were carried out by Spain and Poland in the categories '5C2 — Open burning of waste' (only Spain) and '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals' (both countries). Spain's IIR explains that the values for '5C2' have been revised downwards because of new information available in the technical document 'Balance of Nitrogen and Phosphorus of Spanish Agriculture'. For '1A2b', the IIR states that an updated methodology from the Inventory guidebook (EMEP/EEA, 2016) had been used for the recalculations (see Spain's IIR, listed in Appendix 5). In its IIR, Poland stated that emissions of HMs, dioxins and PAH have been moved from '1A2b' to their relevant '2C' categories (see Poland's IIR, listed in Appendix 5).

Recalculations of POPs: For **dioxin** emissions, several countries carried out recalculations, which affected the EU results. By far the highest recalculation was carried out by Malta for 2013 in the category '5C1bv — Cremation'. The negative impact on EU recalculations in 2010 was mainly caused by those conducted by Portugal in the category '5C1biii — Clinical waste incineration'.

EU recalculations for **B(a)P** emissions were mainly influenced by recalculations in the '2D3g — Chemical products' category carried out by Bulgaria (positive impact) from 2000-2006 and by Portugal (negative impact) in recent years.

Lithuania reported a high recalculation in the category '5C1bii — Hazardous waste incineration' for **Indeno(1,2,3-cd)pyrene** emissions for 2015. In its IIR, Lithuania reported that recalculations in this category were carried out as the result of improved methodologies and activity data (see Lithuania's IIR, listed in Appendix 5).

The highest recalculations for **total PAH** emissions were made by Spain from 1990-2000 in the category '3F — Field burning of agricultural residues' and Bulgaria from 2000-2006 in the category '2D3g — Chemical products', where the country had previously only reported the notation key NA. In more recent years, the negative trend in EU recalculations can be attributed to recalculations carried out by Portugal and Spain in the categories '2D3g — Chemical products' and '5C2 — Open burning of waste', respectively. In its IIR, Spain stated that the recalculations in the '3F' category were carried out due to the availability of new data, namely the 'MAPA Statistics Yearbook' which provides numbers for the agricultural soils sector. The values for '5C2' have been revised downwards because of new information available in the technical document 'Balance of Nitrogen and Phosphorus of Spanish Agriculture' (see Spain's IIR, listed in Appendix 5).

For **HCB** emissions, by far the highest contribution came from Germany in the category '2C3 — Aluminium production' for the years 1990-2002; after that period, the country reported the notation key NA. In its IIR, Germany explained the reason for recalculations were the newly implemented emission estimates (see Germany's IIR, listed in Appendix 5).

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, new estimates, updates of activity data, updated models, improvements in methodologies and emission factors (see Austria's IIR, listed in Appendix 5).

Belgium provided detailed information on its recalculations for its individual regions (Brussels, Flanders and Walloon) for the energy sector. The main reasons for recalculations at the sectoral level were the application of emission factors from the Inventory guidebook (EMEP/EEA, 2016), the availability of new data (for example, mobility data), and the application of new approaches (see Belgium's IIR, listed in Appendix 5).

Bulgaria reported that it had made recalculations in several sectors, such as 1B2aiv, 2C1 and 2D3i, for 2017, according to recommendations from the Technical Expert Review Team (TERT) during the NECD Review in 2018 (see Bulgaria's IIR, listed in Appendix 5).

Croatia provided detailed information on its recalculations for all pollutants. The main reasons for the recalculations were, among others, the availability of new information, the implementation of higher-tier methods, changed methodology and the correction of inconsistencies in the time series. Table ES4-1 in Croatia's IIR provides 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 2016 according to methodologies proposed in the Inventory guidebook (EMEP/EEA, 2016) and suggestions from the TERT 2017. Another reason for recalculations concerned the availability of new activities (see Cyprus's IIR, listed in Appendix 5).

Czechia stated that recalculations were carried out because of updated data and the introduction of the COPERT V model (see Czechia's IIR, listed in Appendix 5).

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

Estonia provided detailed information on its recalculations for the period 1990 to 2016. The reasons for the recalculations were the correction of activity data, emission factors and other data, newly available and additionally calculated data, new methodologies, more detailed allocation of data and more detailed calculation methods (see Estonia's IIR, listed in Appendix 5).

Finland provided detailed information on its recalculations, which were carried out for several reasons, such as the addition of new sources and emissions, updates following the information in the Inventory guidebook (EMEP/EEA, 2016) and the correction of errors (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 on its recalculations, which were carried out for several reasons, namely the revision of activity data, update and revision of the entire German emission inventory 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. These were mainly carried out because of methodological changes, the use of the new COPERT model and the revision of activity data, as well as the availability of updated fuel consumption data (see Hungary's IIR, listed in Appendix 5).

Ireland provided information on recalculations in its sector-specific chapters, which were mainly related to updated activity data, as well as revised emission factors, calculation procedures and methodology (see Ireland's IIR, listed in Appendix 5).

Italy stated that recalculations were mainly carried out due to updated emissions factors, the update to the COPERT 5.2.2 model, error correction and updated as well as revised activity data (see Italy's IIR, listed in Appendix 5)

Latvia provided detailed information on recalculations that were carried out due to updated activity data and emission factors, as well as the implementation of sector-specific research results and following recommendations from the TERT (see Latvia's IIR, listed in Appendix 5).

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

Luxembourg presented its main revisions and recalculations in a table in its IIR (p. 390). The reasons for the recalculations were updated activity data, methodology and emission factors, as well as error correction for category '3B'. For the '2G' category, a new emission source was the reason for the recalculation (see Luxembourg's IIR, listed in Appendix 5).

The Netherlands provided detailed information on the recalculations carried out. The main reasons for these were the inclusion of new emission sources, error correction, updated emission 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 updated activity data, revised methodologies, updated emission factors in line with the Inventory guidebook (EMEP/EEA, 2016), new emission sources not estimated previously and the update to the latest version of the COPERT 5 software (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 (EMEP/EEA, 2016) (see Portugal's IIR, listed in Appendix 5).

Romania noted that, following the review of the emission inventory, recalculations of emissions have been carried out based on updated statistics, new sources, the application of a higher-tier level, the update to the latest version of COPERT 5, and new estimates (see Romania's IIR, listed in Appendix 5).

Slovakia provided detailed information and tables on its recalculations. The main reasons were new estimates, the implementation of a higher Tier method, error correction and new/ improved methodology (see Slovakia's IIR, listed in Appendix 5).

Slovenia provided detailed information on its recalculations, which were carried out due to error correction, first-time reporting of emissions, new activity data, as well as improved data and the implementation of emission factors from the Inventory guidebook (EMEP/EEA, 2016). Many of these recalculations were carried out following recommendations from the TERT (see Slovenia's IIR, listed in Appendix 5).

Spain provided very detailed information on its recalculations, the main reasons for which were revision of data sources, error correction and methodology changes (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 and activity data, reallocation of emissions, availability of new data, updated emission inventory 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, 2019, forthcoming) presents a summary of the individual recalculations reported by Member States. This yearly report will be available on the CEIP website in July 2019 (EMEP CEIP, 2019c).

5.1.3 Member States' emission changes due to improvements based on the review

In addition, EMEP CEIP has the task of reviewing the submitted emissions to help Parties improve their national inventories (EMEP CEIP, 2019b; EMEP/EEA, 2019, forthcoming). These yearly reviews should help Member States compile their individual emission estimates and submit their improved inventories together with their IIRs.

The stage 1 review — an automated test — is held 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 nominated by the Parties. Each year, the plan is for two teams to review 10 Parties' inventories.

In 2018, EMEP CEIP reviewed Armenia, Azerbaijan, Belarus, Finland, Moldova and Ukraine resulting in individual country-specific reports (EMEP CEIP, 2019c). In 2019, the plan is to review Albania, Georgia, Norway, the Russian Federation, Serbia and Turkey.

5.1.4 Improvements planned at EU level

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

- Further progress concerning the **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. In addition, 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 previous years: the ETC/ATNI 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 includes inconsistencies. Therefore, the quality of the EU's inventory will be enhanced if the consistency and completeness of Member States' submissions improve. Such improvements would help reliable trend analysis to inform policy. Since 2017, a review process has been conducted related to the NEC Directive (EU, 2016a). The results of the review of this process should also improve the quality of the LRTAP submissions.

- **Review of the current gap-filling procedures** to ensure they use the best approach, reflecting real emissions: although the improved inventory gap-filling procedure carried out in 2011 has helped to develop a more complete EU emission inventory, there is still room for improvement (for example, by including manual changes in the procedure).

- **Reducing the need for gap filling**: this is achievable if the Member States report complete time series as far as possible, and 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. However, because of the review process under the NEC Directive, it is expected that the completeness of submissions (under NECD and LRTAP Convention) will improve.

- **More explanatory information** on trends and recalculations would only be possible if the IIRs included such information. Thus, countries are encouraged to provide it.

- Further research on **outliers in Member States' emission data** to help ensure they reflect real emissions: a comparison of Member State contributions to the EU total reveals extraordinarily high proportions in some instances: for example, for SO_x in Poland (25 %), TSP in France (23 %), Cu in Germany (63 %), As in Italy (29 %), Ni in Germany (26 %), Zn in Germany (35 %), PCDD/Fs in Greece (gap-filled data, 40 %), B(a)P in Portugal (61 %), B(b)F in Greece (gap-filled data, 26 %), B(k)F in Greece (gap-filled data, 26 %), IP in Poland (33 %) and total PAHs in Portugal (34 %).Future investigation could determine whether these high proportions reflect actual emissions or they are attributable 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.

5.2 Improvements implemented

The joint EMEP/EEA annual review of inventory data helps to improve Member States' inventories. The review of data reported under the LRTAP Convention is held 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 under the LRTAP Convention review process (EMEP CEIP, 2019b). 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, 2017) was reviewed (UNECE/CEIP, 2017). The findings (EEA, 2017c) and their implementation are summarised in Table 5.3, while Table 5.4 shows the findings that have not or cannot be implemented.

5.2.1 Improvements in response to the stage 3 review of the EU inventory in 2017

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

5.2.2 Further improvements undertaken in 2019

- Restructuring section 1.5 (Reporting) to enable a better overview of the reporting situation.

- Inclusion of section 1.5.5 in the reporting of condensable components from $PM_{2.5}$ and PM_{10}.

- More focus on BC: extended description of BC in the trend section (section 3) and BC was included in the sector analysis of section 4.
- Further improvement of Figure 1.2 (EU KCA results for 2017).
- Again, explanations on unusual trends, peaks and troughs were improved.
- Manual corrections for PM_{10}, $PM_{2.5}$ and BC improved the gap-filled inventory.

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 the 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 the addition of an explanation in the IIR about the use of notation key NE	Yes	Analysis given in 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 1.9)
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 selection	Partly	Inconsistency checks were made (compare Section 1.7) and communicated to the Member States; comparisons between Member States were not made as such checks would require considerable effort and the time frame is limited
Member State comparisons	The IIR could contain more information on the consistency of reporting across countries and could indicate the number of countries not providing estimates for each NFR category	Partly	Analysis included in Chapter 4; see also 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.)

Completeness			
Gap-filling procedure	Further improvement in the gap-filling procedures, such as the development of more manual interventions. 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	Yes	Manual changes have been conducted (compare Section 1.4.5)
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 Annex K
Completeness assessment	The ERT encourages the EU to provide sector-specific assessments of completeness	Partly	Analysis included in Chapter 4; see also 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 in particular to explain recalculations resulting from 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 the 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 already been performed for many years
Comparability			
Consistent reporting	The ERT encourages the EU to continue 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 require 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 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 Member State inventories that could then be addressed by those countries	Yes	Analysis included in Annex K; see also Section 1.9
Accuracy			
Emission basis	The EU inventory for road transport was based on a mixture of fuel sold and fuel used (one Member State)	Yes	The whole EU inventory is based on fuel sold now (compare Section 1.4.4)

Table 5.4 EU stage 3 review results 2017, findings not implemented 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 required 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 any 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 in 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
Relation between pollutants and sectors	The ERT encourages the EU to implement procedures to assess the relation between different pollutants and sectors	No	As the inventory is an aggregation of 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 that the EU provides a 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; there is a huge amount of data and there is no need to provide such large annexes when data are readily available on 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

Table 5.4 EU stage 3 review results 2017, findings not implemented and rationale (cont.)

	Review findings (2017)		
Topic	**Finding**	**Implemented**	**Comment**
Uncertainty analysis	The EU clarified that uncertainty analysis is in the improvement plan for the near future, since, under the new NEC Directive, the Member States will provide information on uncertainties; it is therefore planned to assess and evaluate if the uncertainty analysis for the EU can be generated	No	Further improvement required
Uncertainty linked to gap filling	The ERT recommends that the EU assesses 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 State inventory uncertainties.	No	Further improvement required

5.2.3 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 but 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; EMEP CEIP, 2019a) request that Parties to the LRTAP Convention provide emission data using the NFR14 format. All the 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	Required methodological changes and planned improvements are presented in the respective sectoral chapters (Appendix 5, Austria's IIR)
Belgium	Belgium's IIR lists planned improvements in Sections 8.1-8.4 and in the corresponding sector-analysis chapters (Appendix 5, Belgium's IIR)
Bulgaria	Planned improvements: • application of higher-tier method for estimating 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 the national emission inventory (Appendix 5, Bulgaria's IIR)
Croatia	Table ES6-1 in Croatia's IIR details planned improvements, including calculation methodologies, recalculations, updating of emission factors, and collection of new data (Appendix 5, Croatia's IIR)
Cyprus	Cyprus reports no planned improvements
Czechia	Improvements are planned for the road transport, energy, industrial processes andagriculture sectors. Alongside other improvements Czechia plans to estimate emissions that are not yet reported and to revise emissions(Appendix 5, Czechia's IIR)
Denmark	The relevant sectoral chapters describe planned sector-specific improvements; priority will be given to key categories with a significant impact on the national total emissions (Appendix 5, Denmark's IIR)
Estonia	Estonia's IIR lists planned source-specific improvements; checking POP emissions from the energy sector and waste incineration, the correction of activity data and emission factors in energy industries, and the comprehensive check of activity data and emissions in the waste sector are priorities for future inventory improvements (Appendix 5, Estonia's IIR)
Finland	Table 8.3 in Finland's IIR sets out sector-specific improvement needs and the sectoral chapters describe the planned source-specific improvements (Appendix 5, Finland's IIR)
France	Some planned and ongoing improvements are 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 EMEP/EEA developments; • improving existing methods to reduce NH_3 emissions • 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 based on the results from the uncertainty analysis; planned improvements for the source category stationary combustion include revision of biogas and liquid biomass activities 2004-2011 in order to improve the consistency of time series, new measurements and revision of emission factors for SO_2, CO and NH_3; for the mobile combustion category, planned improvements include the implementation of new emissions as well as the validation and revision of the approach for abrasive emissions from railways; Germany lists the revision of emission factors within refinery processes as a planned improvement in the fugitives category (Appendix 5, Germany's IIR)
Greece	No IIR available

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

Member State	Improvements planned
Hungary	Hungary plans to further improve the coordination with E-PRTR reporting and the reporting process and to execute a quantitative uncertainty analysis; another planned improvement is better QA/QC actions (Appendix 5, Hungary's IIR)
Ireland	In the sectoral chapters of Ireland's IIR, the planned source-specific improvements have been compiled (Appendix 5, Ireland's IIR)
Italy	For the energy and industrial processes sectors, significant progress is planned to harmonise information reported under different obligations; this collates data collected under various obligations (Large Combustion Plant Directive, E-PRTR and ETS) to highlight major discrepancies and detect potential errors For the agriculture and waste sectors, improvements relating 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 to enhance accuracy (Appendix 5, Italy's IIR)
Latvia	For the industrial processes and product use sector, planned improvements include the review of data already submitted for 2017 in order to gather more precise data on delayed submissions from enterprises; planned improvements in the agriculture sector include the continued quantification and preparation of detailed documentation of abatement strategies for ammonia emissions to provide for their implementation in the inventory; furthermore, reporting will include final data on emissions from the use of pesticides; research activities regarding the evaluation of pesticide use in Latvia will be finished in 2019 (Appendix 5, Latvia's IIR)
Lithuania	There are no source-specific planned improvements listed in the IIR, but the country sees a necessity for inventory improvements in the future and 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. 391); they mainly concern updating 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 (information from 2013 IIR)	Malta provided a short paragraph on planned improvements, which includes improving the methodology for sectors 5.A and 5.E.
Netherlands	The remaining actions in the recommendations, issued in the NECD review in 2018, will be prioritised and are planned for implementation in the 2019 and 2020 inventories; some planned source-specific improvements are described in the sectoral chapters of the Netherlands' IIR (Appendix 5, the Netherland's IIR)
Poland	The planned improvement programme focuses on the following: gathering additional activity data to verify the trends for 1990-2000, and developing the methodology further by applying higher-tier methods for the estimation methodology (Appendix 5, Poland's IIR)

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

Member State	Improvements planned
Portugal	Each source-specific section presents a detailed explanation of the planned sectoral improvements (Appendix 5, Portugal's IIR)
Romania	Romania is focused on gathering additional activity data to include new emission sources, correlation with other reporting, and better QA/QC actions; further improvements include completion of the inventory time series for all pollutants (Appendix 5, Romania's IIR)
Slovakia	General and sectoral uncertainty analysis is one of its main future goals; Slovakia plans a total change in approach to most of the categories in the energy and industrial processes and product use sectors and to move the key category analysis from the current tier 1 methodology to tier 2 Several sector-specific chapters also provide information on planned improvements (Appendix 5, Slovakia's IIR)
Slovenia	Planned improvements relate to the transport and solvents and product use categories; the main aims are to estimate new emissions, use a new model for emission calculation from road transport, find the correct emission factors and use improved data from the Slovenian HOS database; a detailed list of the planned improvements can be found in Slovenia's IIR (Appendix 5, Slovenia's IIR)
Spain	The principal areas for improvement are: • harmonising the inventory with other registries and inventories (e.g. E-PRTR, EU ETS); • calculating emissions based on methodologies, which are provided in the 2016 EMEP/EEA guidebook; • continuing the development of the Inventory Quality Management Tool; new modules and functionalities are expected to be included in future editions; • including information on the condensable fraction of particulate matter in the sector-specific chapter; • continuing to develop the external audit; • Sections 8.4.2-8.4.5 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 energy, industrial processes, agriculture, waste and other sectors (Appendix 5, the United Kingdom's IIR)

Note: Blue shaded cells indicate those countries that did not submit an IIR in 2019.

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
CCGT	Combined cycle gas turbine
Cd	Cadmium
CDR	Central Data Repository
CEIP	Centre on Emission Inventories and Projections
CH_4	Methane
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)
ETC/ATNI	European Topic Centre on Air Pollution, Transport, Noise and Industry (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
IE	Included elsewhere
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; (UNECE) Convention on LRTAP
LTO	Landing/take-off
Mg	1 megagram = 10^6 g = 1 tonne (t)
MMR	Monitoring Mechanism Regulation
MSW	Municipal solid waste
MWe	Megawatt electric
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
NR	Not relevant
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 referred to in the main text

1A1a	Public electricity and heat production
1A1b	Petroleum refining
1A1c	Manufacture of solid fuels and other energy industries
1B2aiv	Fugitive emissions oil: Refining/storage
1B2av	Distribution of oil products
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
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, paper and print
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco
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
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
1A5b	Other, mobile (including military, land based and recreational boats)
2A1	Cement production
2A3	Glass production
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
2C6	Zinc 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
2H1	Pulp and paper industry
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-fertilizers (includes also urea application)
3Da2a	Animal manure applied to soils
3Da2c	Other organic fertilisers applied to soils (including compost)
3Da3	Urine and dung deposited by grazing animals
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products
3De	Cultivated crops
3Df	Use of pesticides
3F	Field burning of agricultural residues
5C1bii	Hazardous waste incineration
5C1biii	Clinical waste incineration
5C1biv	Sewage sludge incineration
5C1bv	Cremation
5C2	Open burning of waste
5E	Other waste

Country codes

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czechia
DE	Germany

DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
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
UK	United Kingdom

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Appendix 1 Notation keys

Where there are methodological or data gaps in the inventories, 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 excluding them. 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 in the NFR inventory. This approach helps in assessing how complete the emission data reports are. The notations are as follows ([14]).

NO 'Not occurring' means an emission source or process does not exist in 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 the 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, for example, some Parties 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.

([14]) 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 2019

Emission data should be submitted to the EMEP CEIP by **15 February 2019**. IIRs should reach the centre no later than **15 March 2019**. Table A2.1 summarises information in the revised emission-reporting guidelines (UNECE, 2014a).

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	1990-2017
2. Particulate matter [b]	$PM_{2.5}$, PM_{10} (TSPs, BC)	2000-2017
3. Heavy metals [b]	Pb, Cd, Hg, (As, Cr, Cu, Ni, Se, Zn)	1990-2017
4. Persistent organic pollutants [b]	PCDD/Fs, total PAHs, PCBs, HCB (PAHs: B(a)P, B(b)F, B(k)F, IP)	1990-2017
B. Emissions by NFR source category		
1. Main pollutants	NO_x, NMVOCs, SO_x, NH_3, CO	1990-2017
2. Particulate matter [b]	$PM_{2.5}$, PM_{10}, (TSPs, BC)	2000-2017
3. Heavy metals [b]	Pb, Cd, Hg, (As, Cr, Cu, Ni, Se, Zn)	1990-2017
4. Persistent organic pollutants [b]	PCDD/Fs, total PAHs, PCBs, HCB (PAHs: B(a)P, B(b)F, B(k)F, IP)	1990-2017
C. Activity data	NO_x, NMVOCs, SO_x, NH_3, CO	1990-2017
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/Fs, PAHs, HCB, PCBs	2015 (1990, 1995, 2000, 2005, 2010 if not previously reported)
E. Emissions from LPSs	NO_x, NMVOCs, SO_x, NH_3, CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PCDD/Fs, PAHs, HCB, PCBs	2015 (1990, 1995, 2000, 2005, 2010 if not previously reported)
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 19 March 2019)
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		

Notes: [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.

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 format, 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 by making it easier 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 A2.2 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 (UK)
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), Czechia (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 2019: date received by the EEA, years covered and information provided (as of 9 May 2019)

Country	Reporting date and format									Comments
Member State	Submission date*	Resubmission date	Adjustment date (information or Annex submission)	Projection submission date	Grid submission date	LPS submission date	Date of additional information	Date of IIR	NFR template version	
Austria	14.02.2019			15.03.2019			15.02.2019[a] 15.03.2019[b]	15.03.2019	NFR 2014-2	[a] Cover Letter [b] Projection report (draft)
Belgium	15.02.2019	15.03.2019	15.02.2019 15.03.2019	15.03.2019				15.03.2019	NFR 2014-2	
Bulgaria	15.02.2019			15.03.2019				15.03.2019	NFR 2014-1	
Croatia	16.02.2019	15.03.2019		15.03.2019				15.03.2019	NFR 2014-1	
Cyprus	15.02.2019	15.03.2019		15.03.2019				15.03.2019	NFR 2014-2	
Czechia	15.02.2019	15.03.2019 30.04.2019 09.05.2019		15.03.2019 14.04.2019				15.03.2019 30.04.2019	NFR 2014-2	
Denmark	15.02.2019		15.02.2019[a]	15.03.2019	17.01.2019		15.02.2019[b]	15.03.2019	NFR 2014-1	[a] Cover letter (includes information on consistent adjustment reporting) [b] Cover letter
Estonia	13.02.2019	13.03.2019		13.03.2019				15.03.2019	NFR 2014-2	
Finland	15.02.2019	13.03.2019	15.02.2019 13.03.2019	15.02.2019	05.01.2019	05.01.2019	15.02.2019[a] 13.03.2019[a]	14.03.2019 05.05.2019	NFR 2014-2	[a] IIR appendices concerning Adjustments
France	15.02.2019		15.02.2019 15.03.2019				15.02.2019[a] 15.03.2019[a]	15.03.2019	NFR 2014-2	[a] Adjustment complementary info
Germany	12.02.2019	12.03.2019	12.02.2019		25.04.2019			15.03.2019	NFR 2014-2	
Greece										
Hungary	16.02.2019	18.03.2019	16.02.2019	18.03.2019				18.03.2019	NFR 2014-2	
Ireland	15.02.2019			15.03.2019				15.03.2019 07.05.2019	NFR 2014-2	
Italy	28.02.2019	14.03.2019 19.04.2019		14.03.2019				24.03.2019 19.04.2019	NFR 2014-1	
Latvia	15.02.2019	15.03.2019		28.03.2019				15.03.2019 28.03.2019	NFR 2014-2	
Lithuania	14.02.2019	15.02.2019		15.03.2019 02.04.2019				15.03.2019	NFR 2014-2	
Luxembourg	15.02.2019	15.03.2019 26.03.2019 26.04.2019	15.03.2019[a]	15.03.2019			15.02.2019[b]	15.03.2019	NFR 2014-2	[a] Adjustments will be applied anew, because of a methodology change. Annex VII and Declaration missing. [b] Cover letter (e-mail)

Malta	18.02.2019								NFR 2014-1	
Netherlands	14.02.2019	04.04.2019	14.02.2019 24.04.2019[a]	15.03.2019 04.04.2019				15.03.2019 04.04.2019	NFR 2014-2	[a] Adjustment application: NH_3 + NMVOC Agriculture
Poland	21.02.2019	15.03.2019		15.03.2019				15.03.2019	NFR 2014-1	
Portugal	15.02.2019	15.03.2019 30.04.2019						15.03.2019 30.04.2019	NFR 2014-1	
Romania	14.02.2019	15.03.2019		15.03.2019				15.03.2019	NFR 2014-2	
Slovakia	15.02.2019	15.03.2019		16.03.2019				15.03.2019	NFR 2014-2	
Slovenia	05.02.2019			13.03.2019				14.03.2019	NFR 2014-2	
Spain	13.02.2019		13.02.2019	14.03.2019	26.04.2019	26.04.2019	13.02.2019[a] 14.03.2019[b] 15.03.2019[c]	15.03.2019	NFR 2014-2	[a] Cover note [b] Projection report [c] e-mail concerning adjustment reporting
Sweden	06.02.2019			14.03.2019				08.03.2019	NFR 2014-2	
United Kingdom	15.02.2019		15.02.2019	15.03.2019				15.03.2019 12.04.2019	NFR 2014-2	

Notes: Dates in red indicate that data were submitted after the formal deadline for submissions (submissions: 15 February; resubmissions: 15 March; Projections: 15 March; IIR: 15 March).

(*) Refers to the first submission of inventory data to the CDR; submission of other data is possible at later dates.

Table A3.2 Member State LRTAP Convention submissions of 2017 data (as of 09 May 2019)

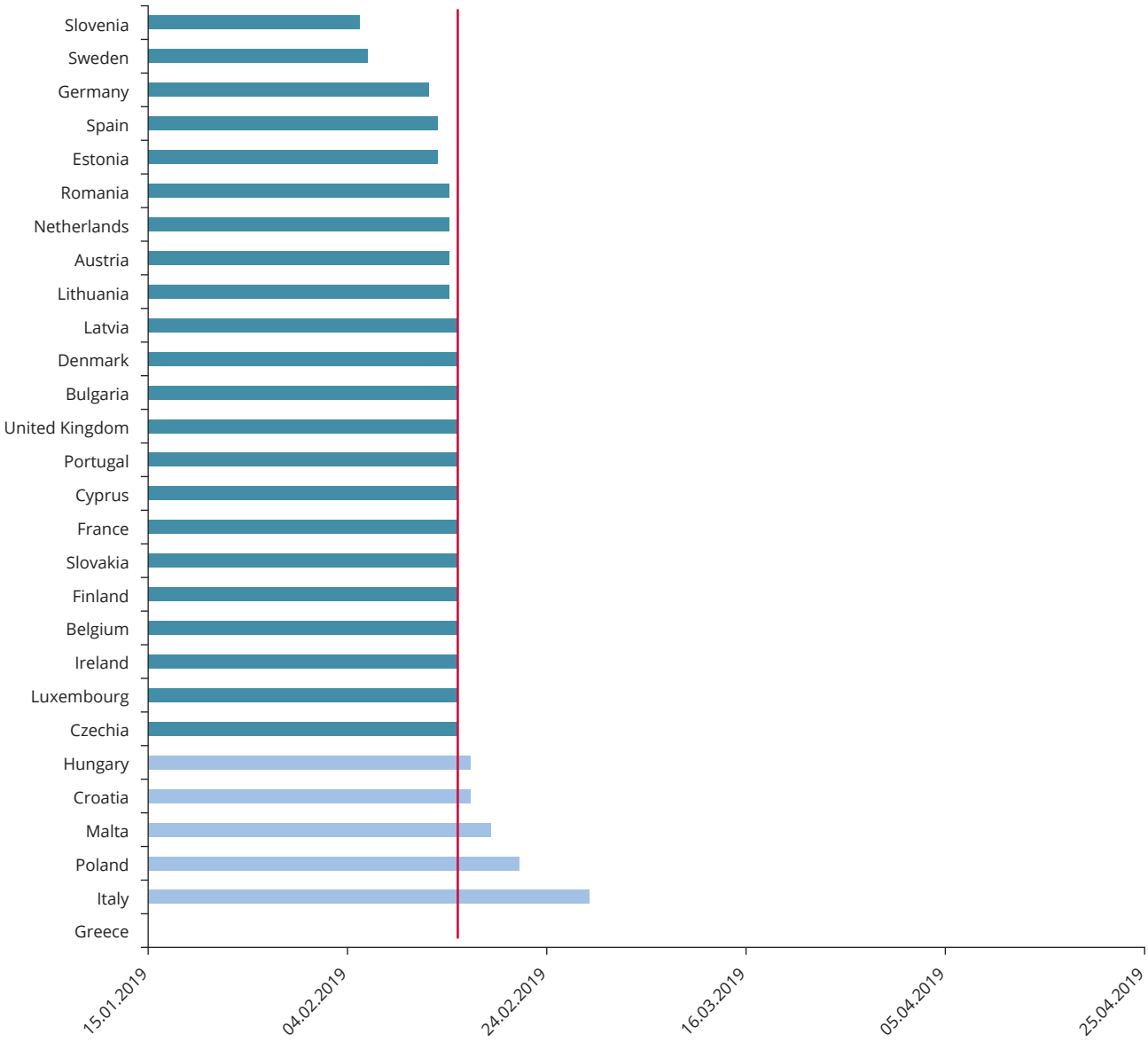
Country	Years reported									Comments
Member State	SO_2, NO_x, CO, NH_3, NMVOC	Cd, Hg, Pb	additional HM	$PM_{2.5}$, PM_{10}	TSP	BC	POPs: PAH, DIOX, HCB, PCB	Additional PAHs: BaP, BbF, BkF, IP	Activity data	
Austria	1990-2017	1990-2017	-	1990, 1995, 2000-2017	1990, 1995, 2000-2017	-	1990-2017	-	1990-2017	
Belgium	1990-2017	1990-2017	1990-2017	2000-2017	2000-2017	2000-2017	1990-2017	2010-2017	1990-2017	
Bulgaria	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	
Croatia	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	
Cyprus	1990-2017	1990-2017	1990-2017	2000-2017	2000-2017	2000-2017	1990-2017	1990-2017	1990-2017	
Czechia	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	
Denmark	1985-2017[a]	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1980-2017	[a] SO_x: 1980-2017
Estonia	1990-2017	1990-2017	1990-2017	2000-2017	1990-2017	2000-2017	1990-2017	1990-2017	1990-2017	
Finland	1980-2017[a]	1990-2017	1990-2017[b]	1990-2017	1990-2017	1990-2017	1990-2017	-	1990-2017	[a] CO:1990-2017, NMVOC: 1987-2017 (b) Se not reported
France	1980-2017[a]	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1980-2017	[a] NMVOC: 1988-2017
Germany	1990-2017	1990-2017	1990-2017	1995-2017	1990-2017	2000-2017	1990-2017	1990-2017	1990-2017	
Greece										
Hungary	1990-2017	1990-2017	1990-2017	2000-2017	2000-2017	2000-2017	1990-2017	1990-2017	1990-2017	
Ireland	1990-2017[a]	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	[a] NO_x, NMVOC, SO_x: also 1987
Italy	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	-	1990-2017	
Latvia	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	
Lithuania	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	
Luxembourg	1990-2017	1990-2016	-	1990-2017	1990-2017	-	1990-2016	1990-2016	1990-2017	
Malta	2000-2017	2000-2017	2000-2017	2000-2017	2000-2017	2005-2017	2005-2017	2005-2017	2000-2017	
Netherlands	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	
Poland	1990-2017	1990-2017	1990-2017[a]	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	[a] Se not reported
Portugal	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	
Romania	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	
Slovakia	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	
Slovenia	1980-2017[a]	1990-2017	1990-2017	2000-2017	2000-2017	2000-2017	1990-2017	1990-2017	1990-2017	[a] NMVOC: 1990-2017, NH_3: 1986-2017
Spain	1990-2017	1990-2017	1990-2017	2000-2017	2000-2017	2000-2017	1990-2017	-	1990-2017	
Sweden	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	2000-2017	1990-2017	1990-2017	1990-2017	
United Kingdom	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	

Notes: Years in red indicate that time series reporting is incomplete.

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 9 May 2019)



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 appeared 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
1A3eii	Other	Non-road transport

Table A4.1 Conversion chart for aggregated sector groups (cont.)

NFR code	Full name	EEA aggregated sector name
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
2D3e	Degreasing	Industrial processes and product use

Table A4.1 Conversion chart for aggregated sector groups (cont.)

NFR code	Full name	EEA aggregated sector name
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
5C1bv	Cremation	Waste
5C1bvi	Other waste incineration	Waste

Table A4.1 Conversion chart for aggregated sector groups (cont.)

NFR code	Full name	EEA aggregated sector name
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 9 May 2019)

Country code	Title of IIR	Source	Date of submission
AT	Austria's Informative Inventory Report (IIR) 2019. 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/envxipjvq	15.3.2019
BE	Informative Inventory Report — about Belgium's air emissions submitted under the Convention on Long-range Transboundary Air Pollution LRTAP and the National Emission Ceilings Directive NECD. March 2019	http://cdr.eionet.europa.eu/be/un/clrtap/iir/envxiu4ga	15.3.2019
BG	Bulgaria's Informative Inventory Report 2019 (IIR). Submission under the UNECE Convention on Long-range Transboundary Air Pollution	http://cdr.eionet.europa.eu/bg/un/clrtap/iir/envxitqmq	15.3.2019
CY	Cyprus Informative Inventory Report 2017	https://cdr.eionet.europa.eu/cy/un/clrtap/iir/envxiumzw	15.3.2019
CZ	Czech Informative Inventory Report 2019. Submission under the UNECE Convention on Long-range Transboundary Air Pollution	https://cdr.eionet.europa.eu/cz/un/clrtap/iir/envxftobq	15.3.2019
	Czech Informative Inventory Report 2019. Submission under the UNECE Convention on Long-range Transboundary Air Pollution	https://cdr.eionet.europa.eu/cz/un/clrtap/iir/envxkxacq	30.4.2019
DE	German Informative Inventory Report 2019	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 2017	http://cdr.eionet.europa.eu/dk/un/clrtap/iir/envxgkjdw	15.3.2019
EE	Estonian Informative Inventory Report 1990-2017. Submitted under the Convention on Long-Range Transboundary Air Pollution. Tallinn 2019	http://cdr.eionet.europa.eu/ee/un/clrtap/iir/envxiughw	15.3.2019
EL	No IIR available		
ES	1990-2017. Spain — Informative Inventory Report. Submission to the Secretariat of the Geneva Convention and EMEP Programme	https://cdr.eionet.europa.eu/es/un/clrtap/iir/envxitmsq	15.3.2019

Table A5.1 List of submitted IIRs including source and date of submission (as of 9 May 2019) (cont.)

Country code	Title of IIR	Source	Date of submission
FI	Finland's Informative Inventory Report 2019. Air Pollutant Emissions 1980-2017 under the UNECE LRTAP Convention and the EU NECD. Part I – General A. March 2019	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envxipybq	14.3.2019
	Finland's Informative Inventory Report 2019. Air Pollutant Emissions 1980-2017 under the UNECE LRTAP Convention and the EU NECD. Part 1B – General. March 2019	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envxipybq	14.3.2019
	Finland's Informative Inventory Report 2019. Air Pollutant Emissions 1980-2017 under the UNECE LRTAP Convention and the EU NECD. Part 2 - Energy. March 2019	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envxipybq	14.3.2019
	Finland's Informative Inventory Report 2019 under the UNECE LRTAP Convention and the EU NEC Directive. Air Pollutant Emissions 1980-2017. Part 3 – Transport. March 2019	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envxipybq	14.3.2019
	Finland's Informative Inventory Report 2019. Air Pollutant Emissions 1980-2017 under the UNECE LRTAP Convention and the EU NECD. Part 4 — IPPU. March 2019	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envxipybq	14.3.2019
	Finland's Informative Inventory Report 2019. Air Pollutant Emissions 1980-2017 under the UNECE LRTAP Convention and the EU NECD. Part 5 — Agriculture	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envxipybq	14.3.2019
	Finland's Informative Inventory Report 2019. Air Pollutant Emissions 1980-2017 under the UNECE LRTAP Convention and the EU NECD. Part 6 — Waste. March 2019	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envxipybq	14.3.2019
	Air Pollutant Emissions in Finland 1990-2017. Informative Inventory Report to the Secretariat of the UNECE Convention on Long-Range Transboundary Air Pollution. Part 7 — Annexes. March 2019	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envxipybq	14.3.2019
FI	Finland's IIR 2019 Part 5. Annex 7. Uncertainty Analysis	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envxm7vzw	05.05.2019
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. CEE – NU / NFR & NEC. Mars 2019	https://cdr.eionet.europa.eu/fr/un/clrtap/iir/envxit_xw	15.3.2019
HR	Republic of Croatia 2019 — Informative Inventory Report (1990-2017). Submission under the Convention on Long-range Transboundary Air Pollution (CLRTAP) and National Emission Ceilings Directive (NECD 2016/2284/EU)	https://cdr.eionet.europa.eu/hr/un/clrtap/iir/envxivgmg	15.3.2019
HU	Informative Inventory Report — Hungary 2017	http://cdr.eionet.europa.eu/hu/un/clrtap/iir/envxioupq	18.3.2019
IE	Ireland Informative Inventory Report 2019. Air Pollutant Emissions in Ireland 1990-2017 reported to the Secretariat of the UN/ECE Convention on Long-range Transboundary Air Pollution and to the European Union	https://cdr.eionet.europa.eu/ie/un/clrtap/iir/envxivxkg	15.3.2019
	Ireland Informative Inventory Report 2019. Air Pollutant Emissions in Ireland 1990-2017 reported to the Secretariat of the UN/ECE Convention on Long-range Transboundary Air Pollution and to the European Union	https://cdr.eionet.europa.eu/ie/eu/nec_revised/iir/envxfruiw	
IT	Italian Emission Inventory 1990-2017 — Informative Inventory Report 2019	https://cdr.eionet.europa.eu/it/un/clrtap/iir/envxlnuca	19.4.2019
LT	Lithuanian Pollutants Emission Inventory for period 1990-2017	https://cdr.eionet.europa.eu/lt/un/clrtap/iir/envxiuonq	15.3.2019
LU	Luxembourg's Informative Inventory Report 1990-2017. Submission under the UNECE Convention on Long-Range Transboundary Air Pollution. DRAFT	https://cdr.eionet.europa.eu/lu/eu/nec_revised/iir/envxivlia	15.3.2019

Table A5.1 List of submitted IIRs including source and date of submission (as of 9 May 2019) (cont.)

Country code	Title of IIR	Source	Date of submission
LV	2019. Latvia's Informative Inventory Report. Submitted under the Convention on Long-Range Transboundary Air Pollution	https://cdr.eionet.europa.eu/lv/un/clrtap/iir/envxiupja	15.3.2019
	2019. Latvia's Informative Inventory Report. Submitted under the Convention on Long-Range Transboundary Air Pollution	https://cdr.eionet.europa.eu/lv/un/clrtap/iir/envxjy7ug	28.3.2019
MT	Informative Inventory Report for Malta 2016	https://cdr.eionet.europa.eu/mt/un/clrtap/iir/envwurgoa	03.5.2018
NL	Informative Inventory Report 2019. Emissions of transboundary air pollutants in the Netherlands 1990-2017	https://cdr.eionet.europa.eu/nl/un/clrtap/iir/envwtc5fa	15.3.2019
	Informative Inventory Report 20198. Emissions of transboundary air pollutants in the Netherlands 1990-2017	https://cdr.eionet.europa.eu/nl/un/clrtap/iir/envxkzfcg	04.4.2019
PL	Poland's Informative Inventory Report 2019. Submission under the UN ECE Convention on Long-range Transboundary Air Pollution and the Directive (EU) 2016/2284	https://cdr.eionet.europa.eu/pl/un/clrtap/iir/envxit0qa	15.3.2019
PT	Portuguese Informative Inventory Report 1990-2017. Submitted under the NEC Directive (EU) 2016/2284 and the UNECE Convention on Long-range Transboundary Air Pollution	https://cdr.eionet.europa.eu/pt/un/clrtap/iir/envxivcxw	15.3.2019
	Portuguese Informative Inventory Report 1990-2017. Submitted under the NEC Directive (EU) 2016/2284 and the UNECE Convention on Long-range Transboundary Air Pollution	https://cdr.eionet.europa.eu/pt/un/clrtap/iir/envxmhsdq	30.4.2019
RO	Romania's Informative Inventory Report 2019. Submission under the UNECE Convention on Long-range Transboundary Air Pollution	https://cdr.eionet.europa.eu/ro/un/clrtap/iir/envxiu0cw	15.3.2019
SE	Informative Inventory Report Sweden 2019. Submitted under the Convention on Long-range Transboundary Air Pollution	https://cdr.eionet.europa.eu/se/un/clrtap/iir/envxij8_q	08.3.2019
SI	Slovenia's Informative Inventory Report 2019. 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	https://cdr.eionet.europa.eu/si/un/clrtap/iir/envxioyq	14.3.2019
SK	Slovak Republic. Informative Inventory Report 2018. Submission under the LRTAP Convention and under the NEC Directive	https://cdr.eionet.europa.eu/sk/un/clrtap/iir/envxiursg	15.3.2019
UK	UK Informative Inventory Report (1990 to 2017)	https://cdr.eionet.europa.eu/gb/un/clrtap/iir/envxio6oq	15.3.2019
	UK Informative Inventory Report (1990 to 2017)	https://cdr.eionet.europa.eu/gb/un/clrtap/iir/envxk2x3a	12.4.2019

European Environment Agency

**European Union emission inventory report 1990-2017
under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP)**

2019 — 143 pp. — 21 x 29.7 cm

ISBN 978-92-9480-078-7
doi:10.2800/78220

TH-AL-19-010-EN-N
doi:10.2800/78220

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Publications Office
of the European Union

European Environment Agency