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European Union emission inventory report 1990–2015 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP)

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Units, abbreviations and acronyms	
As	Arsenic
B(a)P	Benzo(a)pyrene
B(b)F	Benzo(b)fluoranthene
BC	Black carbon
B(k)F	Benzo(k)fluoranthene
Cd	Cadmium
CDR	Central Data Repository
CEIP	Centre on Emission Inventories and Projections
CH_4	Methane
CLRTAP	(UNECE) Convention on Long-range Transboundary Air Pollution
CO	Carbon monoxide
CO_2	Carbon dioxide
COPERT	COmputer Program to calculate Emissions from Road Transportation
Cr	Chromium
Cu	Copper
DG	Directorate-General
EC	European Commission
EEA	European Environment Agency
Eionet	European Environment Information and Observation Network
EMEP	European Monitoring and Evaluation Programme (cooperative programme for monitoring and evaluation of the long-range transmissions of air pollutants in Europe)
EPER	European Pollutant Emission Register
E-PRTR	European Pollutant Release and Transfer Register
ERT	Expert Review Team
ETC/ACM	European Topic Centre on Air Pollution and Climate Change Mitigation (of the EEA)
ETS	Emissions Trading Scheme
EU	European Union
FGD	Flue-gas desulphurisation
Gg	1 gigagram = 10^9 g = 1 kilotonne (kt)
GHG	Greenhouse gas
GNFR	Gridding nomenclature for reporting/UNECE nomenclature for reporting of air pollutants
HCB	Hexachlorobenzene
HCE	Hexachloroethane
HFC(s)	Hydrofluorocarbon(s)
Hg	Mercury
HM(s)	Heavy metal(s)
IIR	Informative inventory report
IP	Indeno(1,2,3-cd)pyrene
IPCC	Intergovernmental Panel on Climate Change
I-Teq	International toxic equivalent
KCA	Key category analysis
kg	1 kilogram = 10^3 g (gram)
LPS	Large point source

Units, abbreviations and acronyms	
LRTAP	Long-range Transboundary Air Pollution
LTO	Landing/take-off
Mg	1 megagram = 10^6 g = 1 tonne (t)
MMR	Monitoring mechanism regulation
MSW	Municipal solid waste
N_2O	Nitrous oxide
n/a	Not available.
NEC Directive	EU National Emission Ceilings Directive ((EU)2016/2284)
NFR	Nomenclature for reporting/UNECE nomenclature for reporting of air pollutants
NFR14	Current format for reporting of air pollutants (Nomenclature for reporting)
NH_3	Ammonia
Ni	Nickel
NMVOC(s)	Non-methane volatile organic compound(s)
NO_2	Nitrogen dioxide
NO_X	Nitrogen oxides
O_3	Ozone
PAH	Polycyclic aromatic hydrocarbon
Pb	Lead
PCB(s)	Polychlorinated biphenyl(s)
PCDD/F(s)	Polychlorinated dibenzodioxin(s)/dibenzofuran(s)
PFC(s)	Perfluorocarbon(s)
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(s)	Persistent organic pollutant(s)
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
TFEIP	Task Force on Emission Inventories and Projections
TSP	Total suspended particulate(s)
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
VOC(s)	Volatile organic compound(s)
Zn	Zinc

Key category source sector abbreviations	
1A1a	Public electricity and heat production
1A1b	Petroleum refining
1A2a	Stationary combustion in manufacturing industries and construction: iron and steel
1A2b	Stationary combustion in manufacturing industries and construction: non-ferrous metals
1A2c	Stationary combustion in manufacturing industries and construction: chemicals
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals
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 & 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
1B2ai	Fugitive emissions oil: exploration, production, transport
1B2aiv	Fugitive emissions oil: refining/storage
1B2av	Distribution of oil products
2A5a	Quarrying and mining of minerals other than coal
2A5b	Construction and demolition
2B10a	Chemical industry: other
2C1	Iron and steel production
2C5	Lead production
2C7a	Copper production
2D3a	Domestic solvent use including fungicides
2D3b	Road paving with asphalt
2D3d	Coating applications
2D3e	Degreasing
2D3g	Chemical products
2D3h	Printing
2D3i	Other solvent use
2G	Other product use
2H2	Food and beverages industry
2I	Wood processing
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
3B4giv	Manure management — Other poultry
3Da1	Inorganic N-fertilisers (includes also urea application)
3Da2a	Animal manure applied to soils
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products
3Df	Use of pesticides

Key category source sector abbreviations	
3F	Field burning of agricultural residues
5C1bi	Industrial 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	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia
UK	United Kingdom

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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 (CLRTAP) (UNECE, 1979). The report and its accompanying data constitute the official submission by the European Commission on behalf of the EU as a Party to the Executive Secretary of UNECE. The European Environment Agency (EEA) compiled the report in cooperation with the EU Member States and the European Commission.

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

- main pollutants: NO_X, NMVOCs, SO_X, NH_3 and carbon monoxide (CO);
- PM emitted directly into the air (primary PM):
    - PM with a diameter greater than 2.5 microns ($PM_{2.5}$, also called fine particulate matter);
    - PM with a diameter greater than 10 microns (PM_{10});
    - BC, the most strongly light-absorbing component of PM;
    - total suspended particulates (TSPs);
- priority heavy metals (HMs): lead (Pb), cadmium (Cd) and mercury (Hg);
- additional HMs: arsenic (As), chromium (Cr), copper (Cu), nickel (Ni), selenium (Se) and zinc (Zn);
- persistent organic pollutants (POPs): polychlorinated dibenzodioxins/dibenzofurans (PCDD/Fs), polycyclic aromatic hydrocarbons (PAHs), hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs);
- additional reporting of the individual PAHs benzo(a) pyrene (B(a)P), benzo(b)fluoranthene (B(b)F), benzo(k)fluoranthene (B(k)F) and indeno(1,2,3-cd) pyrene (IP), and of their sum as the total of all four.

These pollutants harm human health and the environment. Certain species also contribute to the formation of ground-level ozone (O_3) and secondary PM in the atmosphere. Some pollutants have an indirect and direct effect on the sunlight absorbed by the Earth and reflected back to space (radiative forcing) and hence on the climate (EEA, 2014, 2015a, 2016a).

This report describes:

- the institutional arrangements and preparation processes behind the EU's emission inventory, methods and data sources, key category analyses, information on quality assurance and

Box ES.1 The Gothenburg Protocol

The Gothenburg Protocol to the Long-range Transboundary Air Pollution (LRTAP) Convention sets emission ceilings. Parties to the convention must reduce their emissions to these levels. These ceilings, for 2010 and after, are for the pollutants nitrogen oxides (NO_X), non-methane volatile organic compounds (NMVOCs), sulphur oxides (SO_X) and ammonia (NH_3). In addition to the ceilings for individual countries, the protocol also specifies ceilings for the EU, which is a Party to the protocol in its own right (UNECE, 1999). The protocol was amended in 2012. The ceilings set for 2010 and years thereafter are still in place, but the amended protocol also specifies new emission reduction commitments in terms of percentage reductions by 2020, relative to base year 2005. Parties are also encouraged to report primary particulate matter (PM) and black carbon (BC) emissions, in line with the revised emission-reporting guidelines (UNECE, 2014a) ([1]). The EU has not yet ratified the amended protocol.

([1]) The EEA published its annual update of the National Emission Ceilings Directive (NEC Directive) reporting (EEA, 2017b) in June 2017. The briefing analyses the 2015 emission data for EU Member States reported under Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC, known as the new EU National Emission Ceilings (NEC) Directive (EU, 2016). For the EU Member States, the new NEC Directive retains the emission ceilings set for 2010 and years thereafter until 2019, and establishes new national emission reduction commitments for NO_X, NMVOCs, SO_2, NH_3 and $PM_{2.5}$ for 2020-2029 and from 2030 onward.

Box ES.2 Status of reporting by EU-28 Member States

In 2017, Member States were requested to report emission inventory data and an informative inventory report (IIR). All Member States, except Greece, provided air emission inventories. For the Greek data set and for other countries where data were missing for certain years or pollutants, a gap-filling procedure was applied to obtain as complete as possible a European inventory. By 6 May 2017, 27 Member States had reported activity data, but only 24 Member States had reported activity data for the complete time series (1990-2014). Twenty-six Member States provided IIRs, and 18 Member States provided projection data. In 2017, additional reporting of gridded data and large point sources is required by 1 May 2017. 20 Member States reported gridded data, and 22 Member States provided data on large point sources. Detailed information on Member States' submissions is in Appendix 3.

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

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.

control, general uncertainty evaluation, general assessment of completeness and information on underestimations (Chapter 1);

- information on approved adjustments and adjustment applications under the Gothenburg Protocol (Chapter 2);
- emission trends for the EU-28 as a whole and for individual Member States, and the contribution of key categories to total emissions (Chapter 3);
- sectoral analyses and emission trends for key pollutants (Chapter 4);
- information on recalculations, as well as planned and implemented improvements (Chapter 5).

Emission data presented in this report are in the accompanying annexes and are also available for direct download through the EEA's data service (EEA, 2017a). The following sections summarise the main findings.

EU-28 emission trends

Figures ES.1–ES.3 present the trends in emission of air pollutants between 1990 and 2015 ([2]). They are aggregated across the EU-28.

Emission trends of main air pollutants between 1990 and 2015

With reference to the main air pollutants, SO_x were the pollutants with the greatest reduction in emissions across the EU-28. Emissions of SO_x in 2015 were 89 % less than in 1990 (Figure ES.1). This reduction is the result of a combination of measures:

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

([2]) By 15 February each year, Member States must report emission data for up to and including the last calendar year but one. Thus, by 15 February 2017, Member States were obliged to report for the years before 2016. 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.

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 (68 % reduction), NMVOCs (61 % reduction) and NO_x (56 % reduction). For the main pollutants, emissions have been decreasing more slowly over the past decade. However, emissions of NH_3 have fallen less than emissions of the other main pollutants (23 %) since 1990.

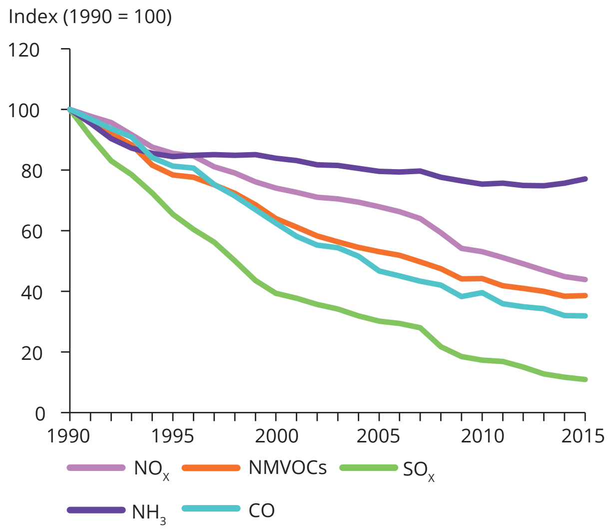
The 'road transport' sector has reduced emissions since 1990 for CO, NMVOCs and NO_x. It has achieved this primarily through legislative measures requiring abatement of vehicle exhaust emissions. NO_x emissions decreased considerably in the electricity/energy generation sectors as a result of certain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

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

Emission trends of particulate matter between 2000 and 2015

The LRTAP Convention formally requests Parties to report emissions of PM from the year 2000 onwards.

Figure ES.1 EU-28 emission trends for the main air pollutants



Hence emission trends are shown for 2000 and the subsequent years only. Aggregated emissions of TSPs have fallen by 23 % across the EU-28 since 2000 (and by 56 % since 1990) (Figure ES.2). Emissions of primary PM_{10}, $PM_{2.5}$ and BC have fallen by 24 %, 26 % and 40 % respectively (since 2000).

Total PM emissions dropped mainly thanks to the introduction or improvement of abatement measures

Box ES.3 Development of main pollutant emissions between 2014 and 2015

Emissions of NO_x and SO_x dropped by 2.1 % and 6.4 % respectively between 2014 and 2015. CO emissions decreased by 0.3 %. Emissions of NMVOCs increased by 0.4 %, and NH_3 emissions increased by 1.8 %.

The drop in NO_x emissions is mainly due to reductions reported by the United Kingdom, France and Germany (in order of largest absolute emission reduction). The 'road transport' sector recorded the largest reductions of NO_x (in absolute terms) from 2014 to 2015.

NMVOC emissions increased in 17 Member States between 2014 and 2015. Italy, Spain and Poland reported the highest increase. The main emitters of NMVOCs are the 'industrial processes and product use' and the 'commercial, institutional and households' sectors.

From 2014 to 2015, the largest reductions in SO_x emissions in absolute terms were in the United Kingdom and Bulgaria. The sector 'energy production and distribution' contributed most to the reduction of SO_x emissions.

CO emissions decreased, mainly due to reductions reported by France, the United Kingdom and Germany. The sector 'road transport' contributed most to the decrease in CO emissions.

NH_3 emissions increased in 20 Member States. Germany and Spain reported the highest increase.

across the 'energy', 'road transport', and 'industry' sectors, coupled with other developments in industrial sectors, such as switching from fuels containing high amounts of sulphur to those with low amounts. SO_x, NO_x and NH_3 play an important role in the formation of secondary PM. Thus, if emissions of these pollutants decrease, this also influences PM formation (EEA, 2015b).

Emission trends of HMs and POPs between 1990 and 2015

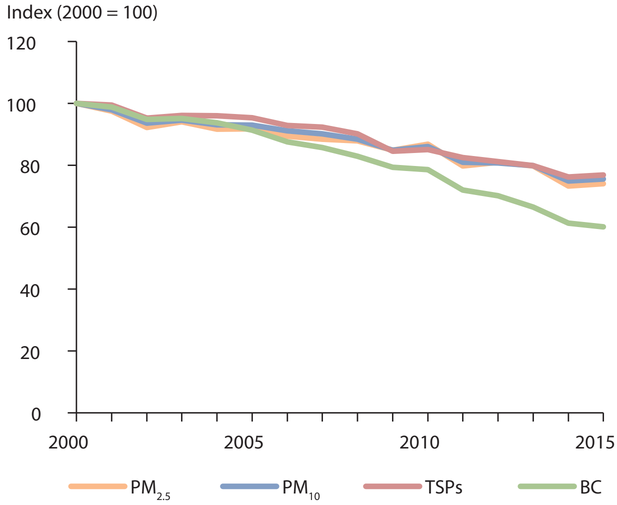
Emissions of the main HMs (Pb, Cd, Hg), dioxins and furans, HCB and PCBs have also dropped substantially since 1990, by at least 67 % or more (Figure ES.3).

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 wastewater treatment, and for incinerators in the metal refining and smelting industries. In some countries, the emissions reduction follows the closure of older industrial facilities due to economic restructuring. Total emissions fell faster between 1990 and 2000 than in the following years.

Copper emissions increased over the years and were 10 % higher in 2015 than in 1990. Emissions of other HMs decreased between 1990 and 2015: As by 62 %, Cr by 73 %, Ni by 74 %, Se by 36 % and Zn by 34 %.

Total PAHs decreased by 88 % from 1990 to 2015 ([3]). For individual PAHs, the reductions were 53 % for B(a)P, 40 % for B(b)F, 48 % for B(k)F and 28 % for IP from 1990 to 2015. Dioxins and furans decreased by 85 % since 1990. The reductions of HCB and PCB emissions were

Figure ES.2 EU-28 emission trends for PM



97 % and 77 %, respectively. There have been clear decreases over the last 25 years, but emissions of POPs have remained broadly stable since 2000 (Figure ES.3).

EU-28 key categories and main emission sources

EU-28 key categories are the individual sources that contributed the most, overall, to emissions of pollutants in 2015. They were determined by a level assessment ([4]) for NO_x, NMVOCs, SO_x, NH_3, CO, $PM_{2.5}$, PM_{10}, Cd, Pb, Hg, PCDD/Fs, total PAHs, B(a)P, HCB and PCBs.

A total of 58 different emission inventory source categories were identified as being key categories for at least one pollutant. A number of emission categories

Box ES.4 Effects of recalculated data for previously reported 2014 emissions

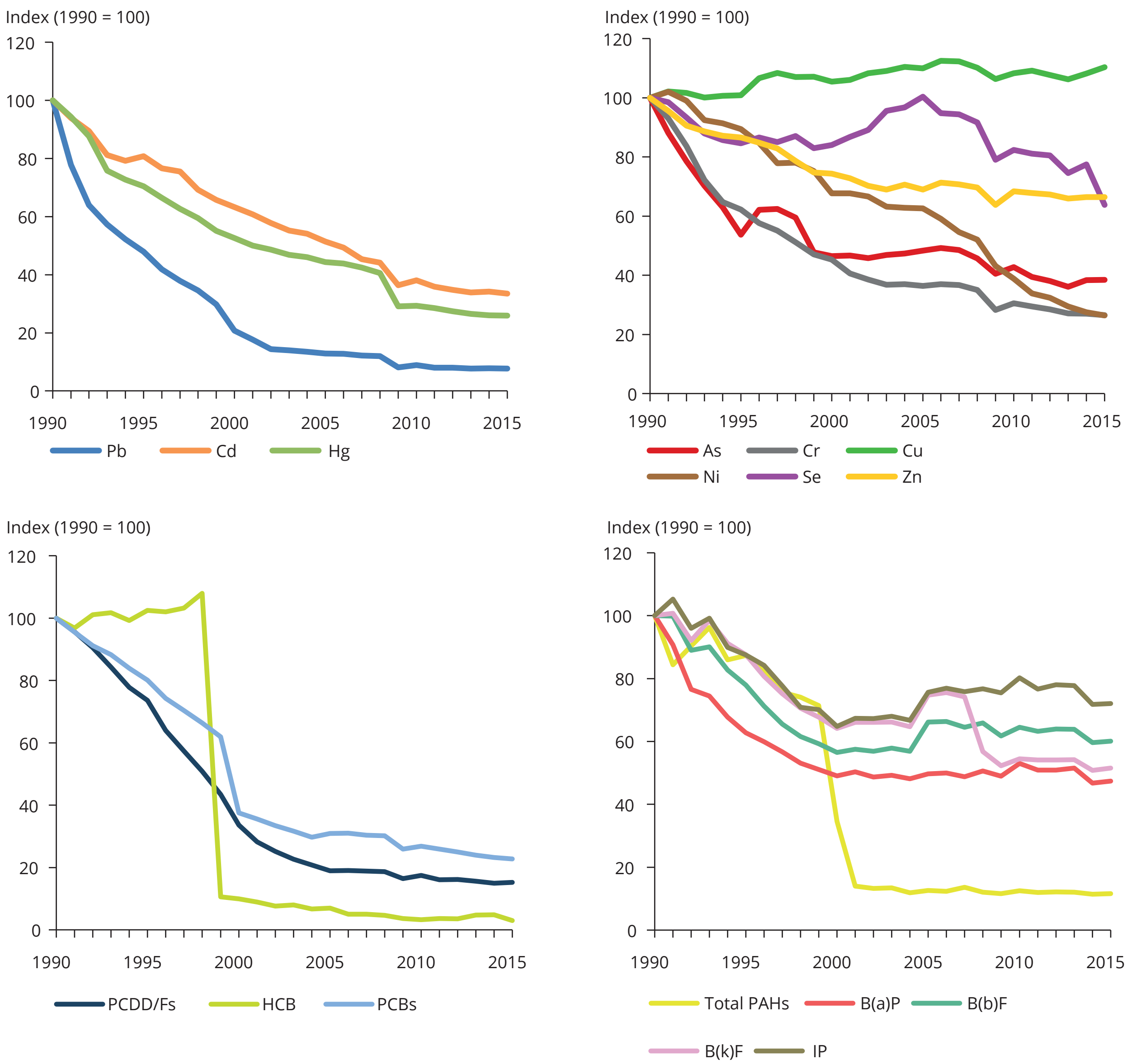
In 2017, all Member States submitted recalculations for one or more years. This resulted in changes of emission inventories for all pollutants for 2014.

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

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

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

Figure ES.3 EU-28 emission trends for HMs and POPs



Notes: The drop in HCB emissions between 1998 and 1999 is due to a considerable reduction reported by the United Kingdom.

For certain pollutants, not all Member States reported data.

were identified as being key categories for more than one of the 14 pollutants assessed. Table ES.1 lists the most relevant key categories.

Figure ES.4 shows the share of EU-28 emissions by sector group. As observed in previous years, each main air pollutant has one major source category: for NO_x, this is 'road transport'; for SO_x, 'energy production and distribution'; for NH_3, 'agriculture'; for NMVOCs, 'industrial processes and product use'; and for CO, as well as PM, 'commercial, institutional and households'.

Emissions of NO_x from the 'road transport' sector decreased by 60 % between 1990 and 2015. The road transport sector is, nevertheless, a major source of the ground-level O_3 precursors NO_x, CO and NMVOCs in the EU; in 2015 it contributed 38 %, 21 % and 10 %, respectively, to total emissions of these pollutants in

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

Name of key category	Number of occurrences as key category
Residential: stationary (combustion) (NFR 1A4bi)	14 (NO_x, SO_x, NMVOCs, CO, $PM_{2.5}$, PM_{10}, 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)
Stationary combustion in manufacturing industries and construction: Non-metallic minerals (NFR 1A2f)	9 (NO_x, SO_x, CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PCDD/Fs)
Iron and steel production (NFR 2C1)	9 (CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PCDD/Fs, HCB, PCBs)
Road transport: passenger cars (NFR 1A3bi)	6 (NO_x, NMVOCs, CO, $PM_{2.5}$, PM_{10}, PCDD/Fs)
Stationary combustion in manufacturing industries and construction: Other (NFR 1A2gviii)	6 (NO_x, SO_x, $PM_{2.5}$, PM_{10}, Cd, Hg)

Notes: For nomenclature for reporting (NFR) codes, see list of source sector abbreviations (Units, abbreviations and acronyms) or Appendix 4.

the EU-28. 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 2015, passenger cars alone contributed around 69 % of CO emissions from the 'road transport' sector.

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

Adjustments to emission inventories under the Gothenburg Protocol

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

Figure ES.4 Share of EU-28 emissions of the main pollutants, by sector group in 2015

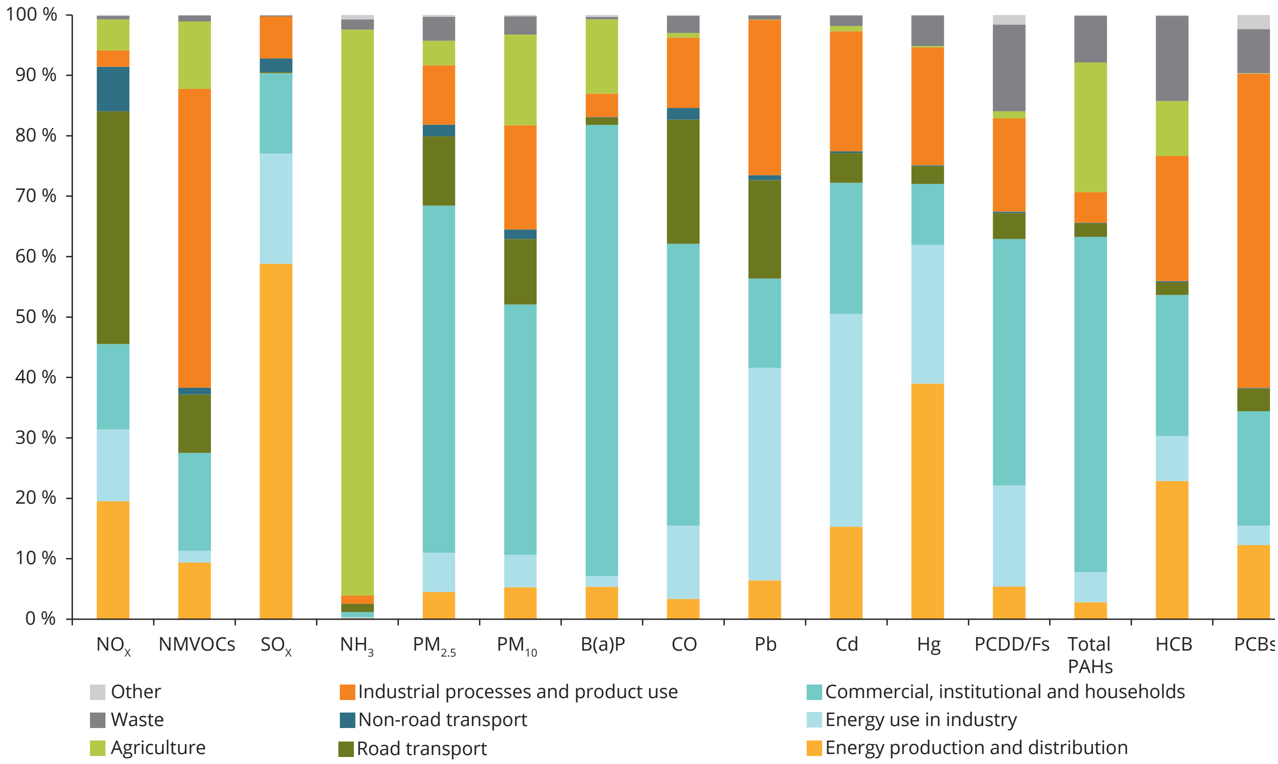


Table ES.2 Accepted inventory adjustment applications (UNECE, 2014b, 2015, 2016)

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	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 (1A3b), Agriculture (3B, 3D, 3Da2c, 3I)
	NMVOCs	Agriculture (3B, 3De)
	NH_3	Agriculture (3Da2c, 3I)
Luxembourg	NO_x	Road transport (1A3bi-iv), Agriculture (3B, 3De)
	NMVOCs	Agriculture (3B, 3De)
Spain	NO_x	Road transport (1A3bi, 1A3biii)

Notes: For NFR codes, see Appendix 4.

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

The Gothenburg Protocol (1999) set commitments for the then European Community, comprising 15 EU Member States. Table ES.3 shows their aggregated emissions for 2015 compared with the emission ceilings it specified for the EU in 2010 and for years thereafter. For NO_x, NMVOCs and SO_x, emissions in 2015 were below the ceilings. For NH_3, the EU-15 (see Appendix 2, Table A2.2 for country information) emissions were above the ceiling. The Gothenburg Protocol was amended in 2012 to set emission reduction commitments for 2020. So far, the EU has not ratified the amended protocol (see Box ES.1).

Figure ES.5 shows whether or not each EU Member State met its Gothenburg ceiling in 2015 (except Estonia and Malta, which do not have Gothenburg ceilings as they are not yet Parties to the protocol). Austria, Greece, Ireland, Italy and Poland have signed, but not yet ratified the Gothenburg Protocol and are therefore excluded from Figure ES.5. Four parties exceeded their NH_3 ceilings (Germany, Spain, Sweden and the EU-15), and one Member State (Hungary) exceeded its limit for NMVOCs. All Member States complied with their NO_x (adjusted data) and SO_x ceilings.

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

The Gothenburg Protocol specified emission ceilings for three non-EU EEA member countries (Liechtenstein,

Table ES.3 Emissions reported for 2015 by EU-15 Member States compared with Gothenburg Protocol EU emission ceilings for 2010 and years thereafter

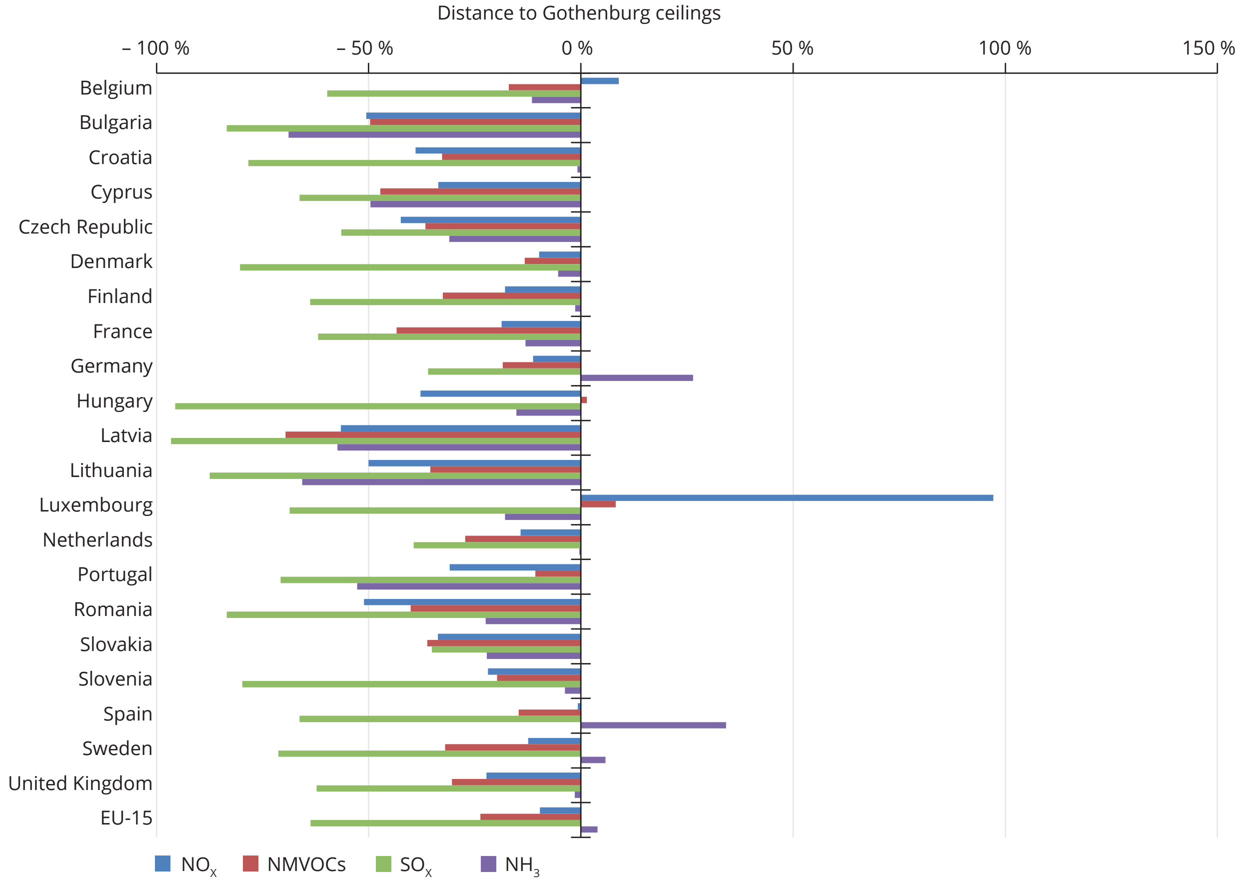
Pollutant	EU-15 emissions, 2015 (Gg)	EU-15 Gothenburg Protocol, 2010 ceilings (Gg)	Difference (%)	Sum of individual EU-15 ceilings (Cg)([a])
NO_x	6 025	6 671	– 10 %	6 519
NMVOCs	5 037	6 600	– 24 %	6 510
SO_x	1 473	4 059	– 64 %	3 850
NH_3	3 252	3 129	3.9 %	3 110

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

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 the United Kingdom as this Member State did not provide data based on fuel sold.

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

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



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

The comparison with emission ceilings is based on reporting on the basis of fuel sold, except for Belgium, Lithuania, Luxembourg, the Netherlands and the United Kingdom. These countries may choose to use the national emissions total calculated on the basis of fuel used in the geographic area of the Party as a basis for ceilings comparisons instead (UNECE, 2014a). For the EU-15, the comparison is based on fuel sold, except the data from the United Kingdom, as this Member State did not provide data based on fuel used.

Under the Gothenburg Protocol, the EMEP Steering Body accepted inventory adjustment applications for emissions from Belgium, Denmark, Finland, France, Germany, Luxembourg and Spain in 2014, 2015 and 2016. 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.

Norway and Switzerland) for 2010 and onwards (UNECE, 1979, 1999). Liechtenstein has signed but not yet ratified the protocol. The EEA member countries Iceland and Turkey have not yet signed the Gothenburg Protocol. Emission data for Norway and Switzerland are the latest reported data under the LRTAP Convention (2017 submission round). Emission data are compared with the countries' emission ceilings under the Gothenburg Protocol.

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

Actions and recommendations for improved data quality

Reporting has become more complete in recent years. However, a number of data gaps remain in the official data sets received from Member States. The completeness of submissions can therefore be further improved, particularly for historical data for 1990–2000 and for certain pollutants such as HMs and POPs. To compile as complete an EU inventory as possible, missing emission data are gap-filled as far as is feasible (for details see Section 1.8).

A key action being undertaken in 2017 to improve the quality of data is the undertaking of a comprehensive expert review of the national emission inventory data submitted in February/March 2017 by the EU Member

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

Country	NO_X						NMVOCs						SO_2						NH_3					
	2010	2011	2012	2013	2014	2015	2010	2011	2012	2013	2014	2015	2010	2011	2012	2013	2014	2015	2010	2011	2012	2013	2014	2015
Norway	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×
Switzerland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓

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

'×' indicates that a ceiling is exceeded.

States under the revised NEC Directive (EU, 2016). Article 10(3) of the directive introduces a regular review to verify inter alia transparency, accuracy, consistency, comparability and completeness of information submitted. Its main objectives are to:

- Check consistency of reported data with LRTAP requirements and to calculate technical corrections where needed;
- Contribute to establish accurate, reliable and verified emission inventories to ensure equal treatment and inform future compliance checking of the national reduction commitments, and to contribute to building capacity where needed.

The scope of the review are national emission inventories and IIRs of all 28 Member States, the main air pollutants SO_2, NO_X, NH_3, NMVOCs and $PM_{2.5}$, all NFR categories, with special focus on key categories for a specific pollutant. The review focusses also on:

- 2005, the base year for calculating the NEC Directive 2020 and 2030 reduction commitments;
- 2015, the latest year for which data are available;
- 2010, the attainment year for the national emission ceilings, and
- Consistency of full time series.

A priority in the review is to perform detailed checks of the completeness and consistency of Member State submissions.

After a desk review starting in May, a centralised review took place at the EEA in June 2017. Draft inventory review reports are expected by the end of October 2017, and Member States will be asked for comments. Final inventory review reports will be compiled by the end of November 2017. An evaluation report of the entire review process will be finalised by end of February 2018, identifying possible improvements for future annual NEC Directive emission inventory reviews.

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

Furthermore, all Member States should report their emission inventories on the basis of fuel sold for the 'road transport' sector, in line with the reporting guidelines (UNECE, 2014a). Reporting fuel sold is a minimum requirement. As outlines in the reporting guidelines, certain countries *may* in addition choose to also report road transport emissions on the basis of fuel used, to check compliance.

Finally, Member States are encouraged to take into account the findings of the annual quality checks performed by the EEA and its European Topic Centre for Air Pollution and Climate Change Mitigation (ETC/ACM) during the compilation of the EU-28 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 2017, 27 Member States were contacted with data requests by the EEA. Fourteen Member States replied and gave explanations or announced resubmissions. Several Member States had sent resubmissions by the time this report was compiled.

1 Introduction

The European Commission 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 quality assurance and control, general uncertainty evaluation, general assessment of completeness and information on underestimations (Chapter 1); adjustments under the Gothenburg Protocol (Chapter 2); emission trends and the contribution of key categories to total emissions (Chapter 3); sectoral analysis and emission trends for key pollutants (Chapter 4); and information on recalculations and planned improvements (Chapter 5).

EU-28 emission totals are estimated for the pollutants for which data should be reported under the LRTAP Convention (see Appendix 2), i.e. emissions of:

main pollutants:

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

particulate matter (PM):

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

priority heavy metals (HMs):

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

additional HMs:

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

persistent organic pollutants (POPs):

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

additional reporting of PAHs:

benzo(a)pyrene (B(a)P)

benzo(b)fluoranthene (B(b)F)

benzo(k)fluoranthene (B(k)F)

indeno(1,2,3-cd)pyrene (IP).

Emission estimates are not always available for all pollutants in each year, because there are gaps in the data from Member States. A gap-filling process was trialled in 2010 for compiling the EU inventory, and was refined in 2011 and 2017 (see Section 1.4.5). Nevertheless, for certain pollutants (PM, TSPs, HMs and POPs), some Member States did not report data for any year, which made it impossible to apply such gap-filling techniques. For these pollutants, the EU-28 total thus remains incomplete.

Several annexes accompany this inventory report.

- Annex A provides a copy of the formal LRTAP Convention data submission of the EU for 1990-2015 for the EU-28, in the required United Nations Economic Commission for Europe (UNECE) reporting format (NFR14).
- Annex B provides the updated EU NO_x emission data for 1987-1989, as the 1988 NO_x protocol of the LRTAP Convention requires.
- Annex C provides results of the key category analysis (KCA) for the EU-28, showing the main emitting sectors for each pollutant.
- Annex D provides the gap-filled inventory of the EU-28, colour-coded for the different data sources used and the different additional gap-filling methods applied.
- Annex E provides Member States' projections for NO_x, NMVOCs, SO_x, NH_3, $PM_{2.5}$ and BC emissions for 2020, 2025, 2030, 2040 and 2050.
- Annexes F to I provide the LRTAP Convention data submission of the EU for 1990-2015, for the EU-9, EU-12, EU-15 and EU-27. Table A2.2 of Appendix 2 gives information on the country groupings.
- Annex J provides an overview of the sources of data on emissions of the individual pollutants that the 2017 EU-28 inventory compilation used.
- Annex K provides gridded data for the EU-28.
- Annex L provides data on large point sources (LPS).

1.1 Background

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

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

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

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

Year	LRTAP Convention and its protocols	Status of ratification
1979	'Geneva Convention': Convention on Long-range Transboundary Air Pollution (UNECE, 1979)	Signed and ratified (approval)
1984	'Geneva Protocol': Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (UNECE, 1984)	Signed and ratified (approval)
1985	'Helsinki Protocol': Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 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)	Not yet ratified

For the EU, the emission reduction commitments from 2005 emission levels for 2020 and beyond are (UNECE, 2012a):

59 % for sulphur dioxide (SO_2)

42 % for NO_x

6 % for NH_3

28 % for NMVOCs

22 % for $PM_{2.5}$.

The EU has not yet ratified the amended Gothenburg Protocol.

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

The deadline for individual Parties to submit data to the LRTAP Convention is 15 February of each year. There is a separate deadline of 15 March for submitting the accompanying inventory reports. The reporting guidelines specify separate reporting dates for the EU. They allow time to compile an aggregated inventory based on the individual submissions from Member States. The EU should submit EU-28 inventory data to the Executive Secretary of the UNECE by 30 April each year, and the accompanying inventory report by 30 May. The reporting guidelines also request Parties to report emission inventory data using the new European Monitoring and Evaluation Programme (EMEP) NFR14 format.

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

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

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

1.2 Institutional arrangements

1.2.1 Member States

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

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

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

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

European Environment Agency (EEA)

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

EEA activities include:

- overall coordination and management of the inventory compilation process;
- coordination of activities of the EEA's European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM), which checks the data, compiles the inventory and writes the draft report;

- communication with the European Commission;
- communication with Member States;
- circulation of the draft EU emission inventory and inventory report;
- hosting the official inventory database, and disseminating the data and the inventory report on the web.

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

European Commission

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

European Topic Centre on Air Pollution and Climate Change Mitigation

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

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

European Environment Information and Observation Network (Eionet)

Eionet facilitates the work of the EEA and the ETC/ACM (EU, 1999) ([6]). It comprises the EEA (supported by its European topic centres), a supporting network of experts from national environment agencies, and other bodies that deal with environmental information (Eionet, 2015a). Member States are requested to use the tools of the Central Data Repository (CDR) (Eionet, 2015b) of the Eionet Reportnet to make their LRTAP Convention submissions available to the EEA.

1.3 Inventory preparation process

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

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, PM, 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

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

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

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

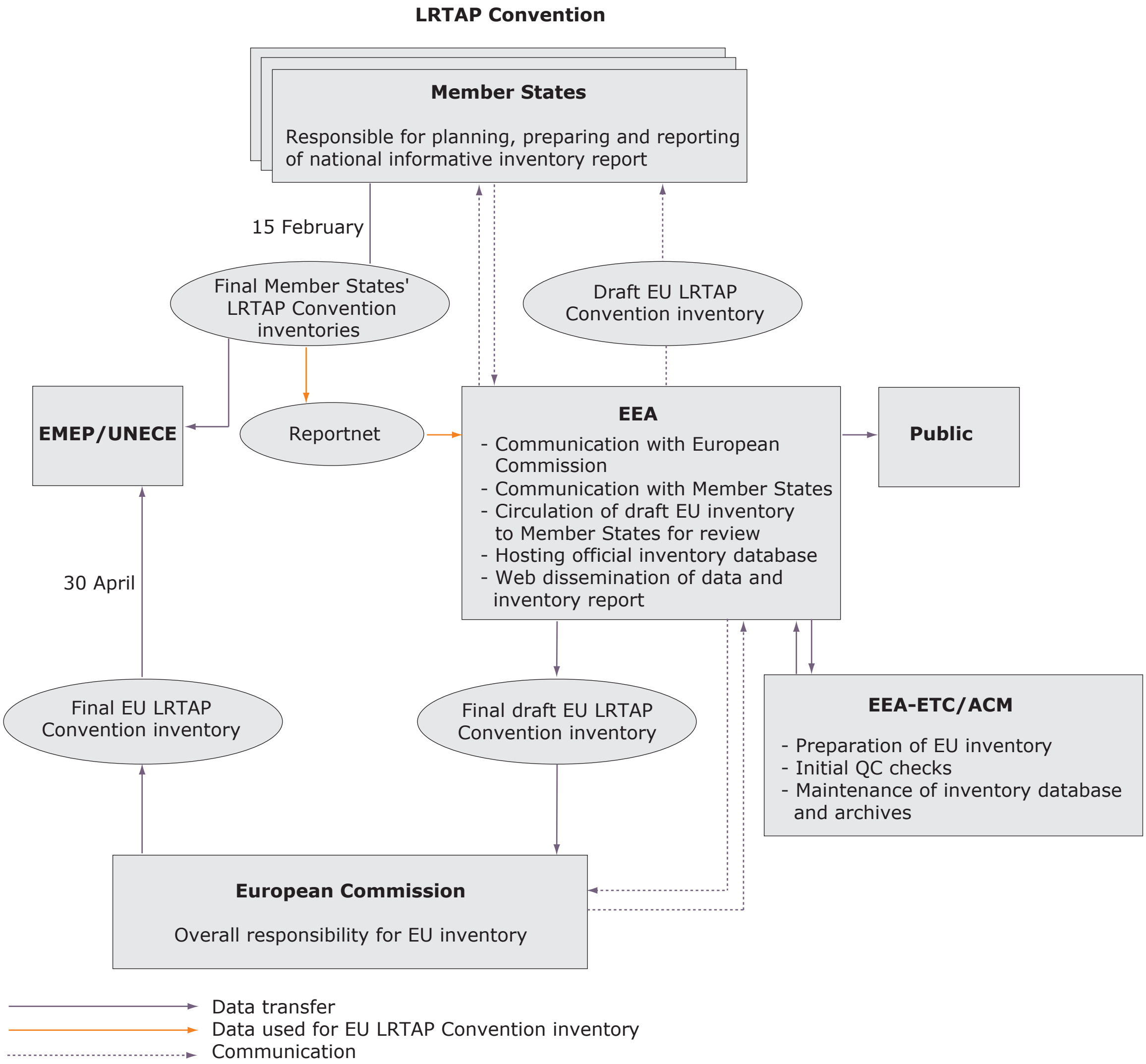


Table 1.2 Overview of air emission reporting obligations in the EU, 2017

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 PM	15 February 2017	30 April 2017
NEC Directive	NO_X (as nitrogen dioxide (NO_2)), NMVOCs, SO_X (as SO_2), NH_3, CO, HMs, POPs and PMs	15 February 2017	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 2017 to the European Commission and 15 April 2017 to the UNFCCC	15 April 2017

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

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

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

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

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

Incl., included in national totals.

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

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

Ceilings (NEC) Directive (EU, 2016). They 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, 2015b). Table 1.2 provides an overview of these different reporting obligations for EU Member States.

Reporting obligations under the LRTAP Convention and NEC Directive have now been harmonised since the adoption of the updated reporting guidelines (UNECE, 2014a) and the revision of the NEC Directive (EU, 2016). They differ from the UNFCCC obligations by including domestic and international aviation and navigation in the reported national totals. Table 1.3 summarises the main differences between the reporting instruments. The overall impact of these differences is small for most Member States.

1.4.2 General methods

The EU LRTAP Convention emission inventory is based on an aggregation of data reported by Member States. Methods used by Member States should follow those described in the *EMEP/EEA Guidebook* (EMEP/EEA, 2016). Overall, Member States do follow this recommendation, which ensures that they use the best available methods to estimate national emissions and that inventories are improved continuously. Moreover, the technical review procedures set up by EMEP CEIP check and assess Parties' data submissions as per the review guidelines, with a view to 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 *EMEP/EEA Guidebook* (EMEP/EEA, 2016), and specification of the sources of default emission factors and methods. It also includes a detailed description of activity data sources where data differ from national statistics. The following two subsections summarise the information that Member States provide in their IIRs. This should help readers understand the foundation of the EU inventory. For detailed descriptions of methodologies and data sources, see the IIRs of Member States (see Appendix 5 for IIR references).

1.4.3 Data submissions and data sources

The deadline for Member States to report was 15 February 2017. In the 2017 reporting cycle, 24 Member States submitted their inventories and time series in time. Greece made no submission, and three Member States submitted their data after the formal deadline for submission (see Appendix 3, Figure A3.1). Three Member States did not provide complete time series in 2017. All 27 Member States that submitted data used the new NFR14 reporting templates. In the submission of Portugal, (resubmission from 15 March 2017), the sum of the data reported for the sectors

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 Emission Register (EPER) and European Pollutant Release and Transfer Register (E-PRTR)
Agriculture	National agricultural statistics, specific studies
Waste	Landfill databases, national studies, national statistics, information from municipalities

did not fit to the National Total reported. Appendix 3 presents detailed information on Member States' submissions.

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

Sources for emission factors vary according to the tier method used. One main source for emission factors is the *EMEP/EEA Guidebook* (EMEP/EEA, 2016), but they 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; Appendix 5 provides references to these reports.

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

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

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

Parties can estimate transport emissions using the amount of fuel sold within the country or using fuel consumed. When fuel purchased within a country is used outside the country (and vice versa), these estimates can differ significantly. The EU inventory compiled in 2017 estimates emissions from road transport based on fuel sold, except for the United Kingdom. This country reported its inventory (national total and data for the single source-sector categories) on the basis of fuel used only. As data about fuel sold are not available for the categories, the EU inventory used UK emission data based on fuel used.

The other decisive factor for achieving consistent numbers for the whole EU is the method Member States use to calculate their emissions from road transport. Most countries use the COmputer Programme to calculate Emissions from Road Transportation (COPERT) (EMEP/EEA, 2016), others use comparable approaches. This report has not quantified the impact of using these different approaches for EU transport emissions.

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

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

1. Emission trends of all pollutants were compiled from 1990 onwards using the LRTAP Convention emission inventories that the Member States provided to the EEA in 2017.
2. LRTAP Convention data submitted to EMEP CEIP in 2017 were the next source used to fill remaining gaps. All reported data (i.e. values and notation keys) were used. In fact, there should be no difference between the Member States' LRTAP Convention emission inventories provided to the EEA and the data submitted to EMEP CEIP.
3. For Member States that did not report complete data, emission data officially reported in the current reporting year by Member States under the EU Greenhouse Gas Monitoring Mechanism are used to fill gaps. In this step, notation keys are not used.
4. Next, emission data reported officially by Member States under the 2016 NEC Directive in the current reporting year are used to fill gaps. In this step, notation keys are not used.
5. In a further step, notation keys reported in the current reporting year by Member States under the EU Greenhouse Gas Monitoring Mechanism are used to fill any remaining gaps.
6. Subsequently, notation keys reported in the current reporting year by Member States under the NEC Directive are used to fill any remaining gaps.
7. Next , Member State LRTAP Convention emission inventories provided to the EEA in previous years are used to fill gaps still remaining (values and notation keys).
8. Older LRTAP Convention data submitted to EMEP CEIP are the next source of official information used to fill gaps (values and notation keys).
9. The gap-filling continues with emission data reported in previous years under the EU Greenhouse Gas Monitoring Mechanism (values and notation keys).
10. For all remaining cases of missing data, further gap-filling procedures are applied:

The further gap-filling procedures described in step 7 are summarised below:

(a) Linear interpolation is performed if 1 or several years in the middle of a time series are missing.

(b) Linear extrapolation is performed if 1 or several years at the beginning or at the end of a time series are missing, and if at least 5 consecutive years showing a clear trend (r2 ≥ 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 (this is the case when $r^2 < 0.6$), the value of the previous or next year is used to fill the gaps.

(d) If the notation key 'NA' or 'NO' is used as a basis for gap-filling, it is treated as '0' and is not gap-filled.was 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.(e.g. above 30 % for $PM_{2.5}$, PM_{10}, As, PCDD/F and total PAHs).

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

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

1.4.5 Data gaps and gap filling

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

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

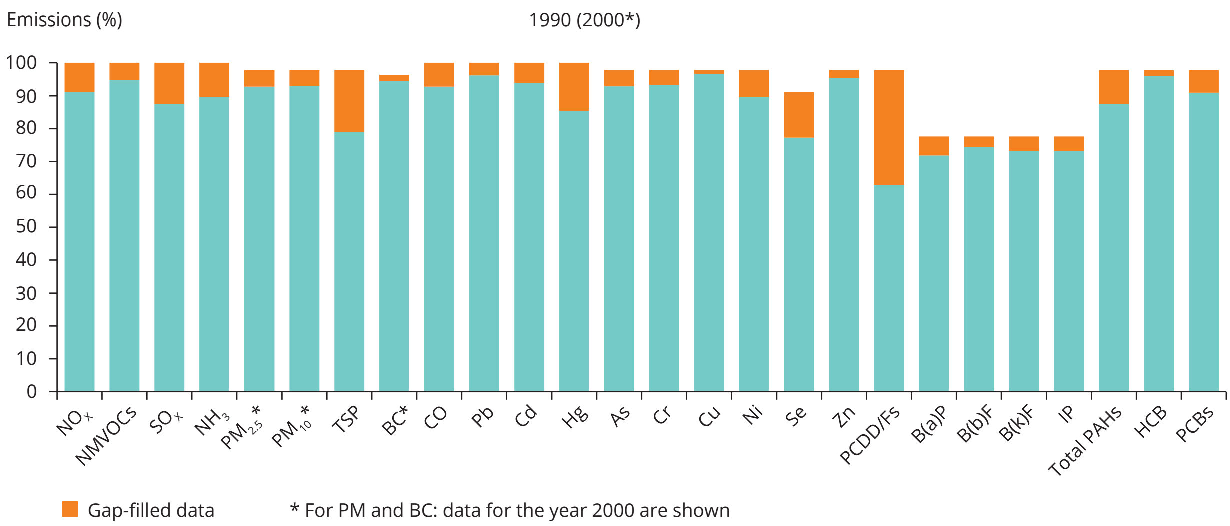
In 2012, the EU LRTAP report was reviewed by an expert review team (ERT) within the CEIP stage 3 review (see Section 1.6). One recommendation was to further improve the gap-filling procedure. This is done by the latest changes.

However, gap filling was applied only where national total and sectoral data were unavailable, or where a national total was available but there were no sectoral data. In the former instance, sectors were first gap-filled and then summed to determine the total. In the latter instance, the sectoral split of the previous or following year was used to fill the gaps. If a national total was available, but the sectoral data were incomplete, no gap filling was carried out. 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 used for gap filling. For PM, some HMs and POPs, some Member States lacked data for all years, and thus gap-filling was impossible too. In such instances, the EU-28 emission totals for these pollutants are not considered complete (i.e. they are underestimated).

In 2012, the EU LRTAP report was reviewed by an ERT within the CEIP stage 3 review (see Section 1.6). One recommendation was to give further information on underestimation and the use of notation keys. To follow this recommendation, this information is given in Figure 1.2 and Figure 1.3, as well as in Section 1.8 in Figure 1.5 and in Section 1.9 in Figure 1.6.

Figure 1.2 and Figure 1.3 visualise the amount of gap-filled data and the data missing from the EU inventory (missing Member State data). They show a simple estimation using a factor for the calculations. This factor was derived by taking the mean of the individual Member State's share of completely reported

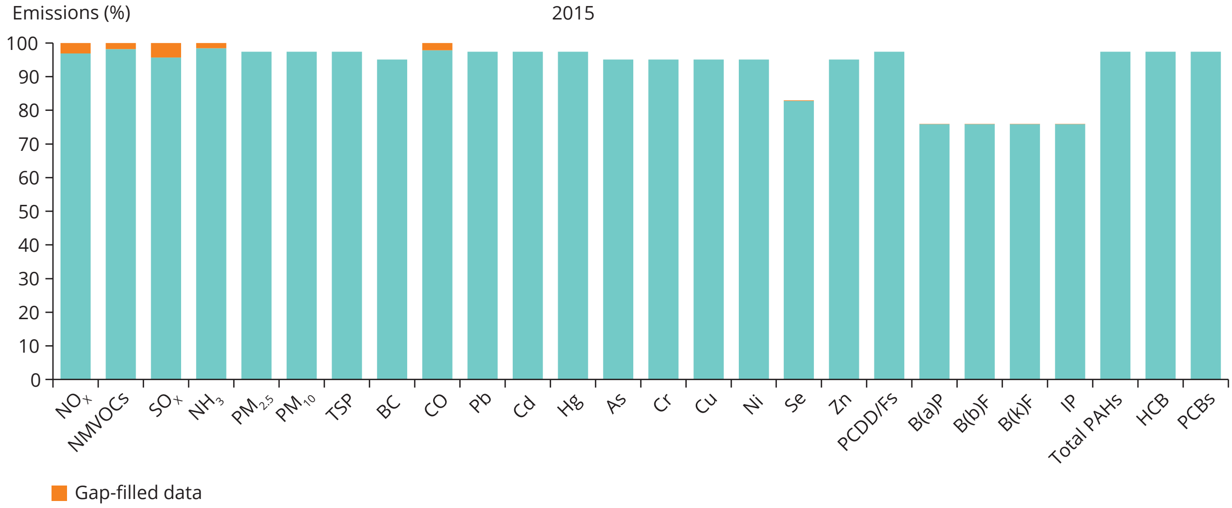
Figure 1.2 Effect of gap filling on EU emissions for 1990 (PM, BC: 2000)



Notes: Incomplete inventory means that gap filling was not possible for all Member States, and emissions are therefore underestimated.

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

Figure 1.3 Completeness and effect of gap filling on EU emission data for 2015



Notes: Incomplete inventory means that gap filling was not possible for all Member States, and emissions are therefore underestimated.

pollutant emissions. That is the Member State's average shares of NO_x, NMVOCs, SO_x, NH_3, CO, Pb, Cd and Hg for 1990, and its average shares of NO_x, NMVOCs, SO_x, NH_3 and CO for 2015.

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 for each Member State which data were gap-filled and how this was performed. The trend tables in Chapter 3 (Table 3.4 to Table 3.29) also provide an initial overview, indicating which data have been derived by gap filling. Three Member States (the Czech Republic, Malta and Romania) did not provide complete time series in 2017, and Greece did not send any inventory data.

1.4.6 Gridded data

According to the revised reporting guidelines, Parties within the geographical scope of EMEP should report gridded data every 4 years, commencing in 2017. The reporting deadline is 1 May 2017. From then on, they are to report gridded emissions in a new resolution (0.1 ° × 0.1 ° long-lat). Gridded data for the EU were last submitted in 2012 (EEA, 2012). Gridded data should be provided not only at national level, but also at sectoral level. NFR codes should be aggregated to a predefined sector, the so-called NFR Aggregation for Gridded and LPS data (GNFR) in Annex V of the reporting guidelines (UNECE, 2014a). In 2017, 20 Member States (Austria, Belgium, Bulgaria, Croatia, the Czech Republic, Denmark, Estonia, Finland, Germany, Ireland, Latvia, Lithuania, Luxembourg, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and the United Kingdom) provided gridded data for one or several years (see Appendix 3, Table A3.1).

The data received are available in Annex K of this report; they comprise spatially disaggregated national totals for the pollutants SO_x, NO_x, NH_3, NMVOCs, CO, PM, POPs and HMs.

1.4.7 Large point sources

Parties within the geographical scope of EMEP are also required to provide data on LPS every 4 years, commencing in 2017. The reporting deadline is 1 May 2017. LPS data for the EU were last submitted in 2012 (EEA, 2012). In the reporting year 2017, Parties are required to report on their LPS. LPS data should be provided not only at national level, but also at sectoral level. NFR codes should be aggregated to a predefined sector, the GNFR in Annex VI of the reporting guidelines (UNECE, 2014a). The data requested include the following: type of source, geographical coordinates (latitude, longitude), emission quantities of the pollutants and, where appropriate, effective chimney height.

In 2017, 21 Member States (Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Ireland, Latvia, Lithuania, Luxembourg, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom provided LPS data (see Appendix 3, Table A3.1). The data are available in Annex L to this report.

1.5 Key category analyses

A key category is an emission source category that has 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 2015 emissions for each pollutant (following any necessary gap filling) determined EU-28 key categories. When a Member State used the notation 'included elsewhere' (IE) for a particular source/pollutant combination, the key category analysis (KCA) is likely to have underestimated the category concerned, and overestimated the one in which emissions were reported instead. In addition, as described earlier, PM, HM and POP data from some Member States could not be gap-filled, as they reported no data for any year. In these instances, emissions were aggregated without including data for all the EU-28 Member States, so that we could present a provisional KCA for these pollutants. The trend tables in Chapter presenting Member State emissions show the instances where data were not reported.

Chapter 3 provides a summary of the top five EU-28 key categories in 2015, for NO_x, NMVOCs, SO_x, NH_3, $PM_{2.5}$, PM_{10}, CO, HMs (Pb, Cd and Hg) and POPs (PCDD/Fs, total PAHs, B(a)P, HCB and PCBs). A complete list of all EU-28 key categories for the emissions of these pollutants is also given in Figure 1.4. We do not consider additional HMs, TSP and the remaining POPs here.

A total of 58 different emission inventory source categories were identified as being key categories for at least one pollutant. A number of emission categories were identified as being key categories for more than one of the 15 pollutants assessed. '1A4bi — Residential: Stationary' and '1A1a — Public electricity and heat production' were identified as being important emission sources for 14 and 11 pollutants, respectively. Similarly, '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' and '2C1 — Iron and steel production' were key categories for nine pollutants, respectively.

For NO_x and CO, 11 and nine key categories were identified, respectively; as expected for both these pollutants, the key categories with a big share in total emissions reported are mainly involving fuel combustion. Eight key categories were identified for SO_x (mainly energy related sectors), and seven for NH_3 (all from the 'agriculture' sector). PM_{10}, $PM_{2.5}$ and NMVOC emission sources are more diverse, so larger numbers of source categories make up the key category threshold of 80 % of total emissions. For the PM pollutants, key categories from all sectors except 'non-road transport' were identified, while a key aspect for NMVOCs was high activity levels associated with the sector 'industrial processes and product use'.

For the HM Cd, 11 key categories were identified, as were nine for Hg and eight for Pb. Emissions from these key categories were mostly related to the energy sectors and 'industrial processes and product use', resulting particularly from processes associated with metal production.

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

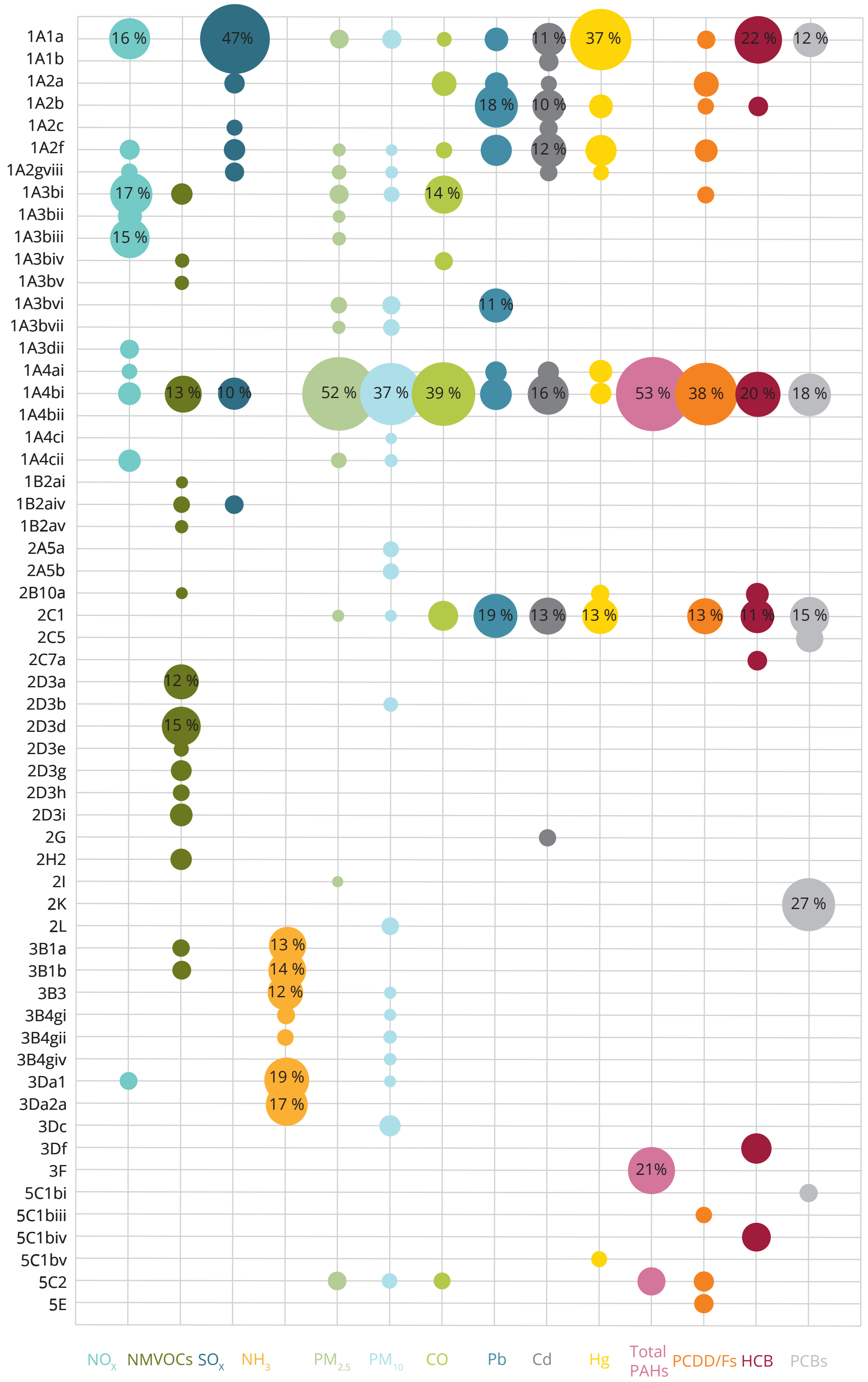
Several factors may influence the determination of key categories at EU-28 level. The notation key 'IE' (see Appendix 1) means that a Member State can include emission estimates for one NFR sector in those of a different sector. Also, Member States have different ways of allocating emissions to the (sub)sector 'Other', which might lead to inconsistencies. Given such issues, the EU-28 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-28.

1.6 Quality assurance, quality control and verification methods

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

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

Figure 1.4 EU-28 KCA results for 2015: bubble size indicates amount of emissions



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

submission. In addition, it checks the internal consistency of Member States' data tables before compiling the EU-28 tables. This year, like last year, it placed more emphasis on analysing the plausibility of sectoral trends. It checked Member State data at sectoral level: when it found outliers, it identified the categories responsible. When it found no explanation for a notable trend in the IIRs, it contacted Member States. The checks focused on data that appreciably affect EU-28 trends. An overview on the checks performed is given in Table 1.5.

Member States also provide external checks through an Eionet review before the EU submits the EU-28 inventory to the secretariat of the LRTAP Convention. Further, an important element in improving the quality of national and EU Convention on Long-range Transboundary Air Pollution (CLRTAP) inventories is the annual meeting of the TFEIP. This expert meeting discusses quality issues concerning the emission reporting of Member States.

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

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

The EEA ETC/ACM and the EMEP CEIP perform more detailed QA activities in an annual review process (EMEP CEIP, 2017a). They review Member State LRTAP Convention emission inventories at the same time as reviewing those reported under the

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

	Check								
	Completeness	**Consistency**	**Comparability**	**Accuracy**	**Level**	**After submission**	**After gap-filling**	**Member States will be informed on the finding**	**Changes/corrections**
Reporting overview	✓		✓		Submissions	×		If submission is missing or in wrong format	Gap-filling of missing data as far as possible
Time series checks	✓	✓			National Totals, Sectors	×		Yes	Only in case of resubmissions of the Member State
Total PAHs = Sum of PAHs				✓	National Totals	×		Yes	Only in case of resubmissions of the Member State
TSP-PM_{10} ratio, PM_{10}-$PM_{2.5}$ ratio checks				✓	National Totals	×		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	×		Yes	Only in case of resubmissions of the Member State
''NE' analysis	✓				National Totals, Categories	×		Within the review of the draft version of the report	Only in case of resubmissions of the Member State
National total = Sum of sectors	✓			✓	National Totals, Sum of Sectors		×	If difference is more than 5 %	Only in case of resubmissions of the Member State
Recalculations		✓			National Totals		×	Within the review of the draft version of the report	No
Effect of gap-filling	✓				Whole EU inventory		×	Within the review of the draft version of the report	No
Completeness of the EU inventory	✓				Whole EU inventory		×	Within the review of the draft version of the report	No

NEC Directive (EU, 2016). The technical review of inventories has three stages. Stages 1 and 2 include checks on timeliness, formats, consistency, accuracy, completeness and comparability of existing Member State inventory submissions. Test results, provided to Member States, are used to improve the quality of the national emission inventories. A joint EMEP/EEA review report publishes summary results of the review (stages 1 and 2) each year ([8]).

Stage 3 is a technical in-depth review of selected countries. It checks if submitted emission inventories are complete, consistent over time, properly documented and accurate. The annual in-depth review aims to be consistent across the Parties. The process should ensure that the Parties follow the same approach each year. CEIP selected the countries in cooperation with the EEA and EMEP. In 2016, it reviewed Estonia, Georgia, Iceland, Luxembourg, Macedonia, Serbia, Switzerland, Turkey and the United Kingdom. The results are in individual country-specific reports (EMEP CEIP, 2017b). In 2017, the European Union will be reviewed by CEIP. It was last reviewed in 2012 and as a part of the QA/QC procedure, review results and improvements are summarised in Table 5.3 and Table 5.4 in Section 5.4.1.

In 2012, the EU LRTAP report was reviewed by an ERT within the CEIP stage 3 review and the recommendations were:

- to give further information on the exact QA/QC procedures. To follow this recommendation, all checks performed are given in Table 1.5.

- to make outlier checks for the Member State inventories to improve the accuracy of the EU inventory and to check and explain the largest variations in trend (peaks and troughs). This is performed through the time series checks.

- to include ratios of TSP to PM_{10} and $PM_{2.5}$ as checks on the data submitted by the Member States. These checks were implemented.

- to encourage the EU to include information on 'significant' recalculations in the IIR. Checks concerning recalculation were undertaken and explanations can be found in Section 5.1.

- to provide explanations about all sources that were not estimated ('NE'), to review the use of 'NE' and revise to 'NA' where appropriate. However, as the EU inventory is an aggregation of the Member State inventories, such explanations cannot be given.

- to perform completeness checks by comparing emissions reported by the Member States for specific source sectors, or to compare them with information from other sources (e.g. Eurostat), as well as to introduce inter-country comparisons. Unfortunately such checks would require considerable effort and would be expected to result in only a relatively small benefit. Such analyses are also not feasible within the limited time frame.

- to provide further clarity on the largest sources included and not included in particular sectors. It was not possible to follow the recommendation of the ERT because it would be very resource intensive to search through Member States' IIRs and aggregate the information.

- to encourage the EU to obtain activity data from each Member State to allow complete reporting. This was not implemented, as accumulation of activity data from the EU Member States is not straightforward due to differences in reporting.

- to encourage the EU to produce an uncertainty analysis for the emission inventory. Again, this was not feasible at the time; see also Section 1.7.

1.7 General uncertainty evaluation

To quantify uncertainty in the EU LRTAP emission inventory, Member States first need to provide detailed information on emission uncertainties. Only 15 Member States (Austria, Belgium, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Latvia, Lithuania, the Netherlands, Poland, Sweden and the United Kingdom) quantified uncertainty in their emissions inventories of 2015. The pollutants that they consider and the assumptions behind the uncertainty analysis vary across Member States. Because so few Member States provide an uncertainty estimate, we cannot estimate the overall uncertainty of the EU-28 LRTAP inventory.

1.8 General assessment of completeness

Completeness in this context means that reports include estimates for all pollutants, all relevant source categories, all years and all territorial areas. For substances for which there are existing reporting obligations in the Convention and the protocols as further specified by Executive Body decision 2013/4, as shown in Appendix 3, only one Member State (Greece) did not submit any data. Three Member States (the

([8]) EMEP and EEA will jointly publish a summary of the results of the stage 1 and 2 review performed in 2017 (EMEP/EEA, 2017).

Czech Republic, Malta and Romania) did not provide complete time series in 2017. For substances and data which are encouraged to be reported, Austria, Luxembourg and Slovenia submitted no data for additional HMs, and Finland and Poland no data for Se. Austria and Luxembourg did not report data for BC; Austria, Finland, Italy and Spain submitted no data for B(a)P, B(b)F, B(k)F and IP. A total of 24 Member States reported activity data ([9]) for the complete time series (1990-2015). The stage 1 review provides detailed results for the completeness of Member State submissions (EMEP CEIP, 2017b).

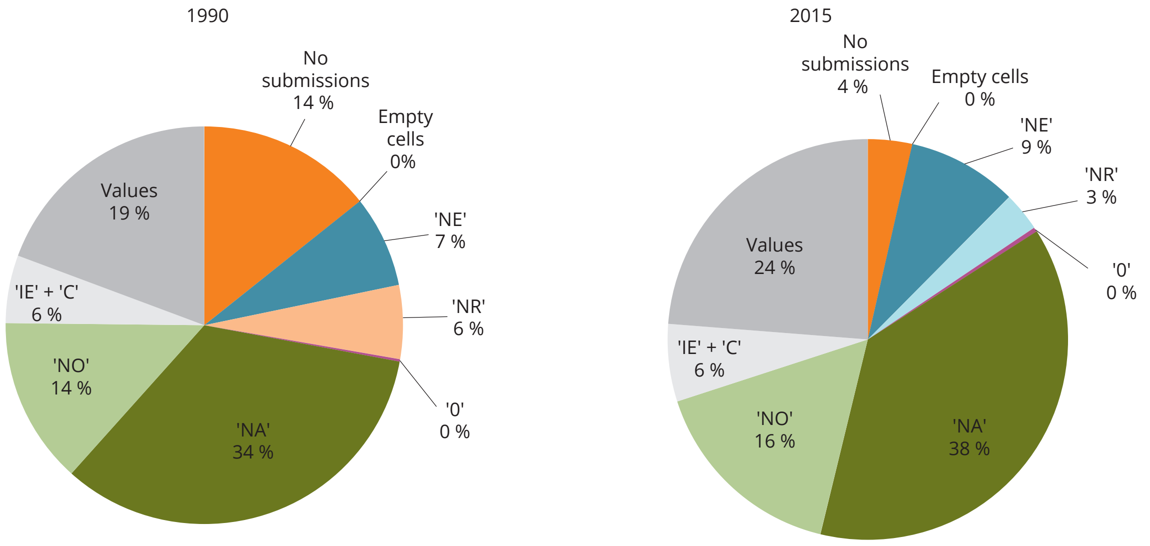
Figure 1.5 shows a simple compilation indicating completeness of reporting by Member States for the inventory years 1990 and 2015. It uses the originally submitted NFR templates, i.e. before gap filling. It gives the percentages of each notation key or values that the reports present for source categories. The data are for all Member States and all pollutants (excluding national totals). The figures show that more data are available for 2015 than for 1990. The notation key 'NA' appears often. That is because an air pollutant is relevant only to specific emission sources (e.g. NH_3 for agriculture). This makes it necessary to use 'NA' for other sources. The use of the notation key 'NE', the reporting of empty cells, '0', and in some circumstances the reporting of the notation key 'NR' ([10]), as well as 'No submissions' and 'Empty cells', count as incomplete reporting. For 2015 Member States reported 16 % of the data incompletely, and for 1990 they reported 28 % 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 2015.

1.9 Underestimations

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

Figure 1.5 Completeness of reporting of NFR templates submitted by Member States (all data entries for all pollutants, excluding national totals)



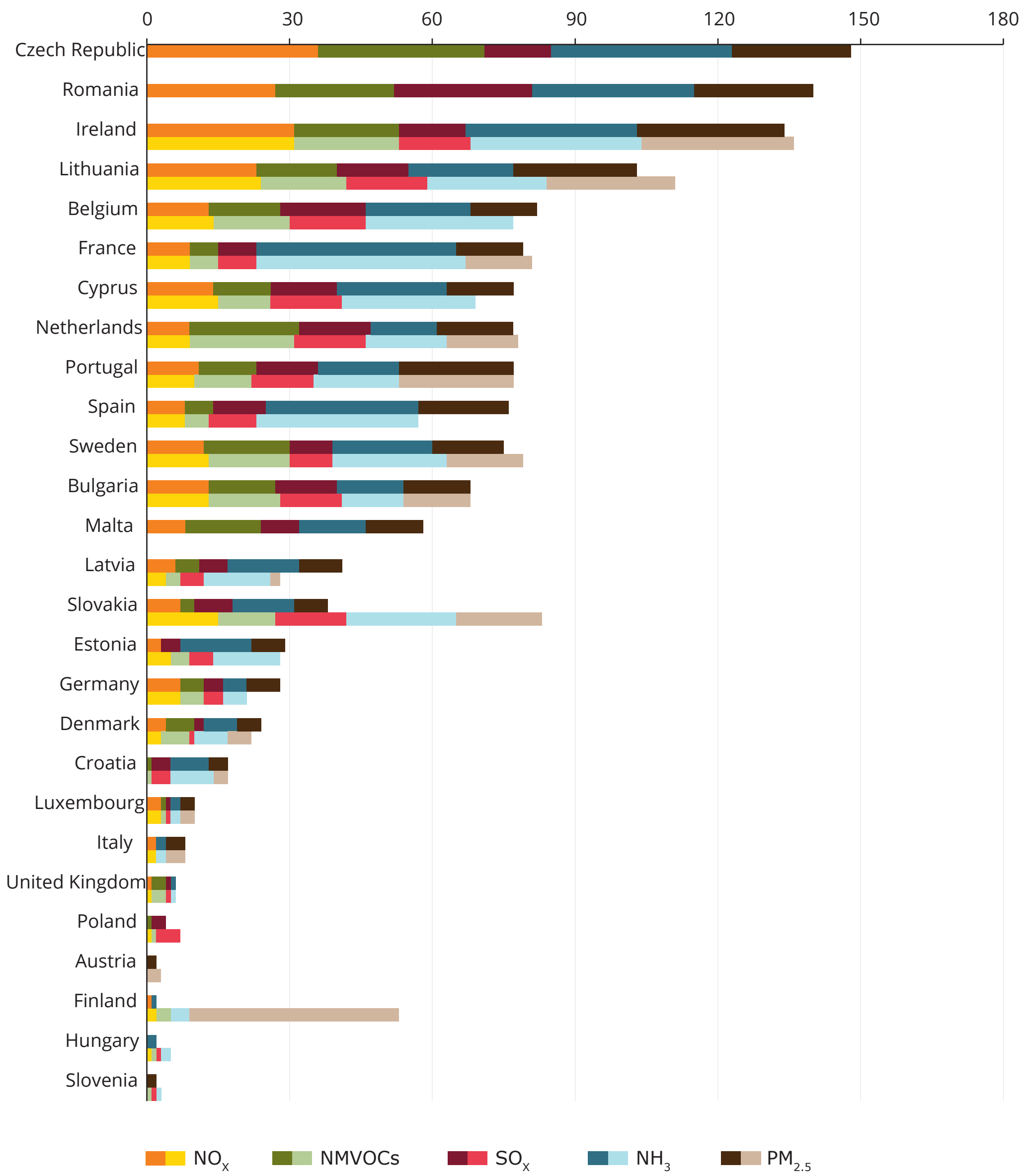
Notes: C, confidential; IE, included elsewhere; NA, not applicable; NE, not estimated; NO, not occurring; NR, not relevant. Appendix 1 explains notation keys further.

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

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

Certain Member States used the notation key 'NE' for many source categories (see Figure 1.6). France, for example, reported 44 source categories of NH_3 for 1990 as 'NE'. In most cases, the use of 'NE' in reporting in 2015 is similar to its use in 1990. Most uses of 'NE' (across all pollutants and Member States) are in the categories '1A3ai(i) — International aviation LTO (civil)', '1A3bvii — Road transport: Automobile road abrasion', '1A3aii(i) — Domestic aviation LTO (civil)' and '2D3g — Chemical products'. Within these categories, more than 23 % of the entries say 'NE'.

Figure 1.6 Number of 'not estimated' source categories for 2015 (dark shades) and 1990 (light shades)



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

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). EMEP CEIP) leads the adjustment procedure, coordinates the review of any supporting documentation and assesses if the adjustment is consistent with the particular circumstances and the guidance for adjustments (UNECE, 2012c). It makes the review available to the Parties, which have the option of making a submission to the Implementation Committee under Decision 2006/2 (UNECE, 2006).

These circumstances are as follows:

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

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

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

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

If a Party is planning to adjust its inventory for the purpose of comparing total national emissions with emission reduction commitments, it indicates in its notification to the UNECE secretariat and CEIP what categories and pollutants are affected. It uses Annex II to the reporting guidelines as a basis (UNECE, 2014a). Table 2.2 shows Member States that submitted their adjustment applications together with their LRTAP submissions via CDR in 2017.

Table 2.3 gives an overview of reported adjustments within the LRTAP submission 2017. All approved and

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

Year of acceptance	Member State	Pollutant	NFR	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

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

Table 2.2 Adjustment application within the LRTAP submission 2017 (Annex II to the reporting guidelines (UNECE, 2014a)) (as of 6 May 2017)

Member State	Pollutant	NFR	Years
Spain	NO_X	3B1a, 3B1b, 3B2, 3B3, 3B4e, 3B4f, 3B4gi, 3B4gii, 3B4giv	2010–2015
Spain	NH_3	3D1a, 3B1a, 3B1b, 3B2, 3B3, 3B4d, 3B4e, 3B4f, 3B4gi, 3B4gii, 3B4giv, 3Da2a, 3Da3	2010–2015

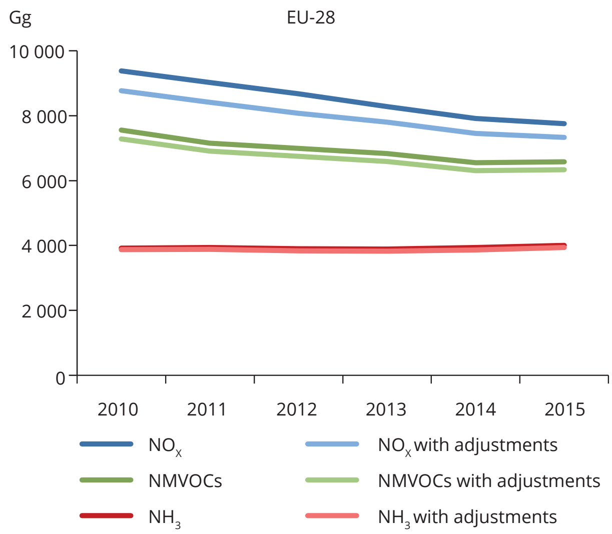
Table 2.3 Reporting of approved adjustments within the LRTAP submission 2017 (Annex I and Annex VII to the reporting guidelines (UNECE, 2014a)) (as of 6 May 2017)

Member State	Pollutant	Years	Annex I ('adjustment row')	Annex VII	Declaration on consistent reporting of approved adjustments
Belgium	NO_X	2010-2015	Yes	Yes	Yes
Belgium	NMVOCs	2010	Yes	Yes	Yes
Denmark	NH_3	2010-2015	Yes	Yes	No
Denmark	NMVOCs	2010-2015	Yes	Yes	No
Finland	NH_3	2010-2015	Yes	Yes	Yes
France	NO_X	2010-2015	Yes	Yes	Yes
Germany	NO_X	2010-2015	Yes	Yes	Yes
Germany	NMVOCs	2010-2015	Yes	Yes	Yes
Germany	NH_3	2010-2015	Yes	Yes	Yes
Luxembourg	NO_X	2010-2015	Yes	Yes	No
Luxembourg	NMVOCs	2010-2015	Yes	Yes	No
Spain	NO_X	2010-2015	partly	Yes	Yes

reported adjustments also appear in the emission trend tables in Sections 3.3 (NO_x, Table 3.4), 3.4 (NMVOCs, Table 3.5) and 3.6 (NH_3, Table 3.7). Parties shall report details of their approved adjusted aggregated emissions using the appropriate row in the main emissions reporting template (Annex I to the reporting guidelines (UNECE, 2014a)). They shall also provide detailed information by pollutant and sector for each adjustment using the template provided in Annex VII to the reporting guidelines. Reporting of information on adjusted emissions in no way suspends the mandatory requirement for Parties to report unadjusted emissions as laid down in section v, subsections A-D, of the guidelines.

Figure 2.1 shows for the EU-28 the effect of the adjustments on the emissions (sum of Member States' adjustments). For NO_x and NMVOCs, the EU-28 emissions change considerably, but there is only a slight effect on the NH_3 emissions.

Figure 2.1 Adjusted and unadjusted emissions of NO_x, NMVOCs and NH_3 for the EU-28, 2010-2015



3 Trends and key categories of EU-28 pollutant emissions

The present EU-28 inventory lists emissions for all the main air pollutants: PM, HMs and POPs. It also reports the individual PAHs for which the LRTAP Convention requires or recommends inventory reporting (UNECE, 1979).

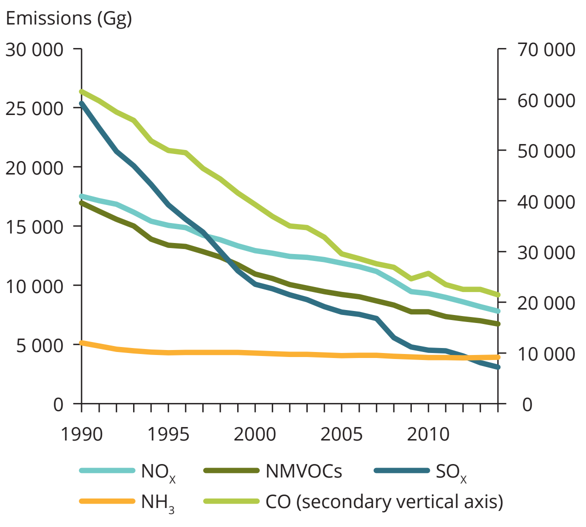
The following sections of Chapter 3 summarise the contributions each Member State has made to the EU-28 total emissions of NO_x, NMVOCs, SO_x, NH_3, CO, $PM_{2.5}$, PM_{10}, TSPs, BC, the HMs Pb, Cd, Hg, As, Cr, Cu, Ni, Se and Zn; and the POPs PCDD/Fs, total PAHs, B(a)P, B(b)F, B(k)F, IP, HCB and PCBs. For the main pollutants and PM, main HMs and main POPs the emission trend of the EU-28 for the five most important key categories is given, as well as the share by sector group and sectoral emission trends. Greece had not submitted an inventory at the time of writing. Data for Greece could not be gap-filled for PM, TSP, HMs and POPs. For BC, additional HMs and single PAHs, data for several countries were missing and could not be gap-filled. Therefore, the EU-28 total is an underestimate.

3.1 Total EU-28 emission trends and progress towards the Gothenburg Protocol 2010 emission ceilings

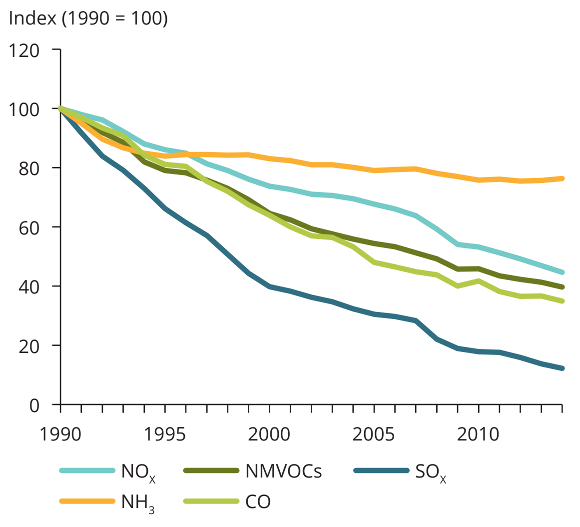
Emissions of all pollutants except Cu were lower in 2015 than in 1990 (or in 2000 for PM). Among the main air pollutants, the largest reductions across the EU-28 (in percentage terms) since 1990 were for SO_x emissions (which decreased by 89 %), followed by CO (−68 %), NMVOCS (−61 %), NO_x (−56 %) and NH_3 (−23 %) (Figure 3.1).

Figure 3.1 (a) EU-28 emission trends and (b) indexed emissions for the main air pollutants

(a)

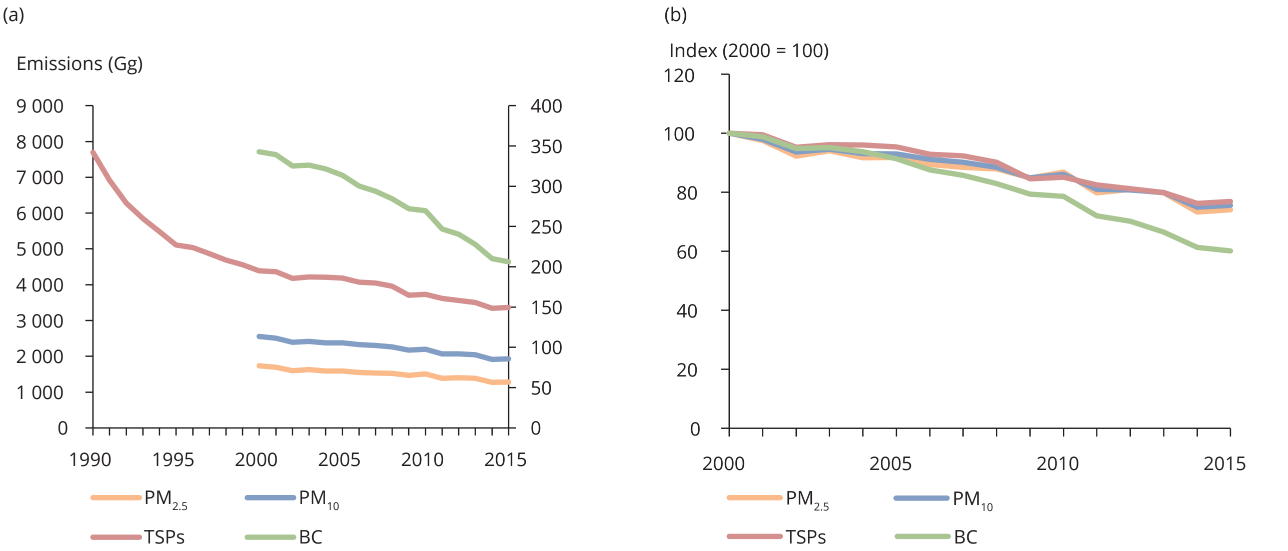


(b)



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

Figure 3.2 (a) EU-28 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.

Emissions of PM, BC and TSP have also dropped substantially since 1990 (Figure 3.2). Emission data for 2000-2015 indicate that $PM_{2.5}$ and PM_{10} emissions have fallen by 26 % and 24 %, respectively (Figure 3.2).

In addition, for heavy metals and POPs, emissions have reduced significantly since 1990 (Figure 3.3). Reductions are especially high for HCB (–97 %), Pb (–92 %), total PAHs (–88 %) and PCDD/Fs (–85 %).

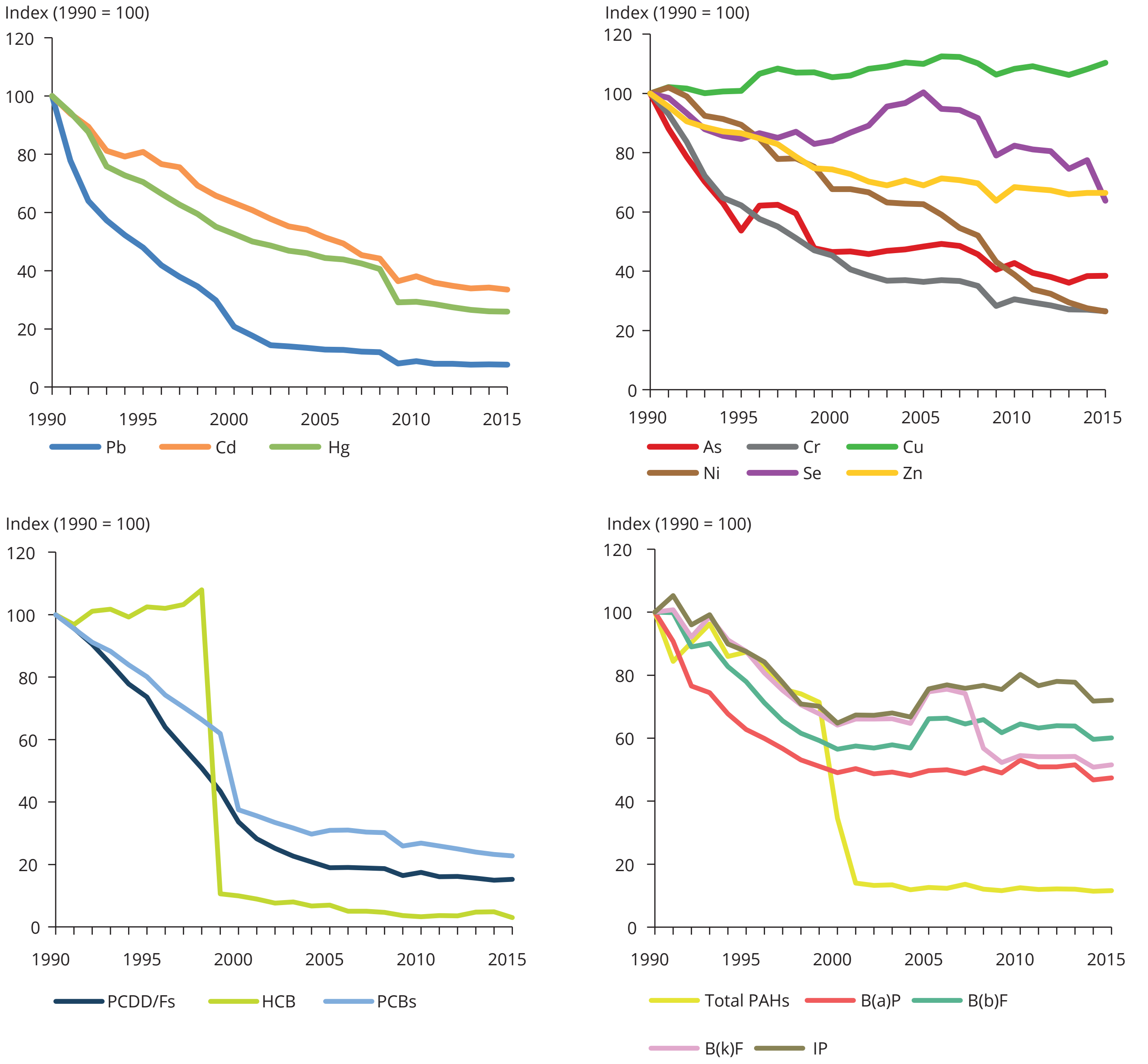
For various pollutants (e.g. PM, HMs and POPs), some Member States did not report data, or reported the notation key 'NE' or 'NR' for certain years or the whole time series. In some cases, the data could not be gap-filled, so they were not included in the EU-28 total. In such instances, the EU-28 emission totals for these pollutants are not considered complete. Data tables in Chapter 3 (Table 3.4 to Table 3.29) show each Member State's reported emissions. Thus they indicate instances where emissions of a certain pollutant are unrecorded for all years.

In 2012, the EU LRTAP report was reviewed by an ERT within the CEIP stage 3 review (see Section 1.6). Among other things, the ERT recommended explaining the largest variations in trend (peaks and troughs) and to include more information on time series of emissions. Therefore, information received from the Member States or found in their IIRs is included in the trend sections (see Sections 3.3 to 3.28). If no information on unusual trends is given, Member States are contacted, informed about the finding and requested to send an explanation. As often no information on unusual trend is received, it is very inconsistent in section 3.3 to 3.28 which variation in trend is explained and which not.

The Gothenburg Protocol to the UNECE LRTAP Convention (UNECE, 1999) contains emission ceilings for the pollutants NOx, NMVOCS, SOx and NH3. Parties to the protocol must meet them by 2010 and thereafter. In their reports to the LRTAP Convention, some Member States have submitted emission projections for 2020, 2025 and 2030; others have submitted them for up to 2050. Submitted data are available in Annex E of this report. This report does not provide further detailed analysis of projections that countries reported in relation to the emission ceilings for 2010 in the Gothenburg Protocol. In June 2017, the EEA publishes its annual NEC Directive reporting, which analyses the emission data reported under the EU NEC Directive for EU Member States (EEA, 2017b). For the EU Member States, the new NEC Directive (EU, 2016) contains national emission reduction commitments for NOx, NMVOCs, SO2, NH3 and PM2.5 for 2020-2029 and for any year from 2030.

The comparison with the EU-15 ceilings of the Gothenburg Protocol in this report is on the basis of fuel sold, except for Austria, Belgium, Ireland, Luxembourg, the Netherlands and the United Kingdom.

Figure 3.3 Indexed EU-28 emission trends for the 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.

These countries may choose to calculate emissions on the basis of fuel used for their territories (see Section 1.4.4).

In addition to ceilings for individual countries, the protocol also specifies ceilings for the EU, which is itself a Party to the protocol. Table 3.2 sets out the emissions that the EU-15 Member States reported for 2015, compared with the respective emission ceilings specified for the EU. For NO_x, NMVOCs and SO_x, emissions in 2015 were below the ceilings. For NH_3, the emissions were above the ceiling.

Figure 3.4 shows whether or not EU Member States met the Gothenburg ceilings in 2015. 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 (Germany, Spain, Sweden and the EU-15), and one Member State (Hungary) did not comply with its ceiling for NMVOCs. All Member States complied with their NO_x (adjusted data) and SO_x ceilings.

Table 3.1 Total EU-28 emissions of the main air pollutants, HMs, POPs and PM

Pollutant	Unit	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	Change 1990–2015	Change 2013–2015
NO_x	Gg	17 644	15 098	13 066	11 986	9 377	9 024	8 669	8 281	7 913	7 751	– 56 %	– 2.1 %
*NO_x (adjusted data *)*	*Gg*	*17 644*	*15 098*	*13 066*	*11 986*	*8 769*	*8 411*	*8 076*	*7 686*	*7 341*	7 240		
NMVOCs	Gg	17 062	13 388	10 919	9 055	7 555	7 149	6 990	6 837	6 552	6 581	– 61 %	0.4 %
*NMVOCs (adjusted data *)*	*Gg*	*17 062*	*13 388*	*10 919*	*9 055*	*7 287*	*6 912*	*6 749*	*6 590*	*6 304*	6 335		
SO_x	Gg	25 337	16 583	9 986	7 650	4 380	4 279	3 813	3 246	2 968	2 779	– 89 %	– 6.4 %
NH_3	Gg	5 200	4 391	4 364	4 138	3 919	3 937	3 898	3 893	3 937	4 009	– 23 %	1.8 %
*NH_3 (adjusted data *)*	*Gg*	*5 200*	*4 391*	*4 364*	*4 138*	*3 869*	*3 879*	*3 838*	*3 824*	*3 865*	*3 936*		
TSPs	Gg	7 697	5 112	4 384	4 180	3 730	3 615	3 562	3 505	3 341	3 368	– 56 %	0.8 %
CO	Gg	63 213	51 401	39 527	29 560	25 027	22 701	22 051	21 685	20 232	20 170	– 68 %	– 0.3 %
Pb	Mg	23 200	11 113	4 807	3 001	2 067	1 859	1 847	1 779	1 807	1 787	– 92 %	– 1.1 %
Cd	Gg	187	151	118	96	71	67	65	63	64	63	– 67 %	– 2.2 %
Hg	Mg	220	155	116	98	65	63	60	58	57	57	– 74 %	– 0.6 %
As	Mg	488	262	227	236	209	193	186	176	187	188	– 62 %	0.3 %
Cr	Mg	1 227	763	555	447	375	361	350	333	331	326	– 73 %	– 1.6 %
Cu	Mg	3 378	3 409	3 564	3 713	3 658	3 687	3 639	3 590	3 656	3 727	10 %	2.0 %
Ni	Mg	2 267	2 027	1 534	1 420	881	768	734	668	625	599	– 74 %	– 4.1 %
Se	Mg	282	239	237	283	232	229	227	210	218	180	– 36 %	– 17.7 %
Zn	Mg	10 491	9 089	7 801	7 235	7 173	7 116	7 063	6 923	6 970	6 966	– 34 %	– 0.1 %
PCDD/Fs	g I-Teq	12 129	8 925	4 078	2 296	2 115	1 957	1 968	1 900	1 817	1 848	– 85 %	1.7 %
Benzo(a) pyrene	Mg	398	250	195	198	211	203	202	205	186	188	– 53 %	1.3 %
Benzo(b) fluoranthene	Mg	314	245	177	208	203	199	201	201	187	189	– 40 %	0.7 %
Benzo(k) fluoranthene	Mg	167	147	107	125	91	91	91	91	85	86	– 48 %	1.5 %
Indeno (1,2,3-cd) pyrene	Mg	162	142	105	123	130	125	127	126	117	117	– 28 %	0.4 %
Total PAHs	Mg	9 781	8 539	3 380	1 235	1 221	1 167	1 184	1 181	1 113	1 135	– 88 %	2.0 %
HCB	Kg	5 837	5 982	580	407	191	213	210	281	285	177	– 97 %	– 38.0 %
PCBs	kg	12 965	10 383	4 868	4 005	3 476	3 365	3 246	3 111	3 014	2 955	– 77 %	– 2.0 %
												Change 2000–2015	**Change 2013–2015**
$PM_{2.5}$	Gg			1 732	1 591	1 504	1 382	1 403	1 382	1 270	1 283	– 26 %	1.0 %
PM_{10}	Gg			2 554	2 375	2 199	2 068	2 063	2 040	1 914	1 929	– 24 %	0.8 %
BC	Gg			343	313	269	247	241	228	210	206	– 40 %	– 1.9 %

Notes: Grey-shaded cells indicate that data for these pollutants are complete (reported and gap-filled data): Member States have not used 'NE', 'NR', '0' or empty cells, or gap-filling without notation keys was possible. Negative percentage values indicate that emissions have decreased. Table 3.1 and subsequent tables (Table 3.4 to Table 3.29) express changes in emissions between 1990 and 2015 as 100 × (E2015 – E1990)/E1990 (%), where E2015 and E1990 are 2015 and 1990 total emissions, respectively. They express changes in emissions from 2014 to 2015 as 100 × (E2015 – E2014)/E2014 (%), where E2015 and E2014 are the 2015 and 2014 total emissions, respectively.

The bases for the EU inventory shown in Table 3.1 and subsequent tables (Table 3.4 to Table 3.29 inclusive) are national total data of the entire territory, based on fuel sold. Data for the United Kingdom are based on fuel used. See Section 1.4.4 for further details.

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

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

Table 3.2 Comparison of emissions reported for 2015 by EU-15 Member States with emission ceilings for the EU specified in the UNECE Gothenburg Protocol

Pollutant	EU-15 emissions, 2015 (Gg)	EU-15 Gothenburg Protocol, 2010 ceilings (Gg)	Difference (%)	Sum of individual EU-15 ceilings (Gg)([a])
NO_x	6 025	6 671	– 10 %	6 519
NMVOCs	5 037	6 600	– 24 %	6 510
SO_x	1 473	4 059	– 64 %	3 850
NH_3	3 252	3 129	3.9 %	3 110

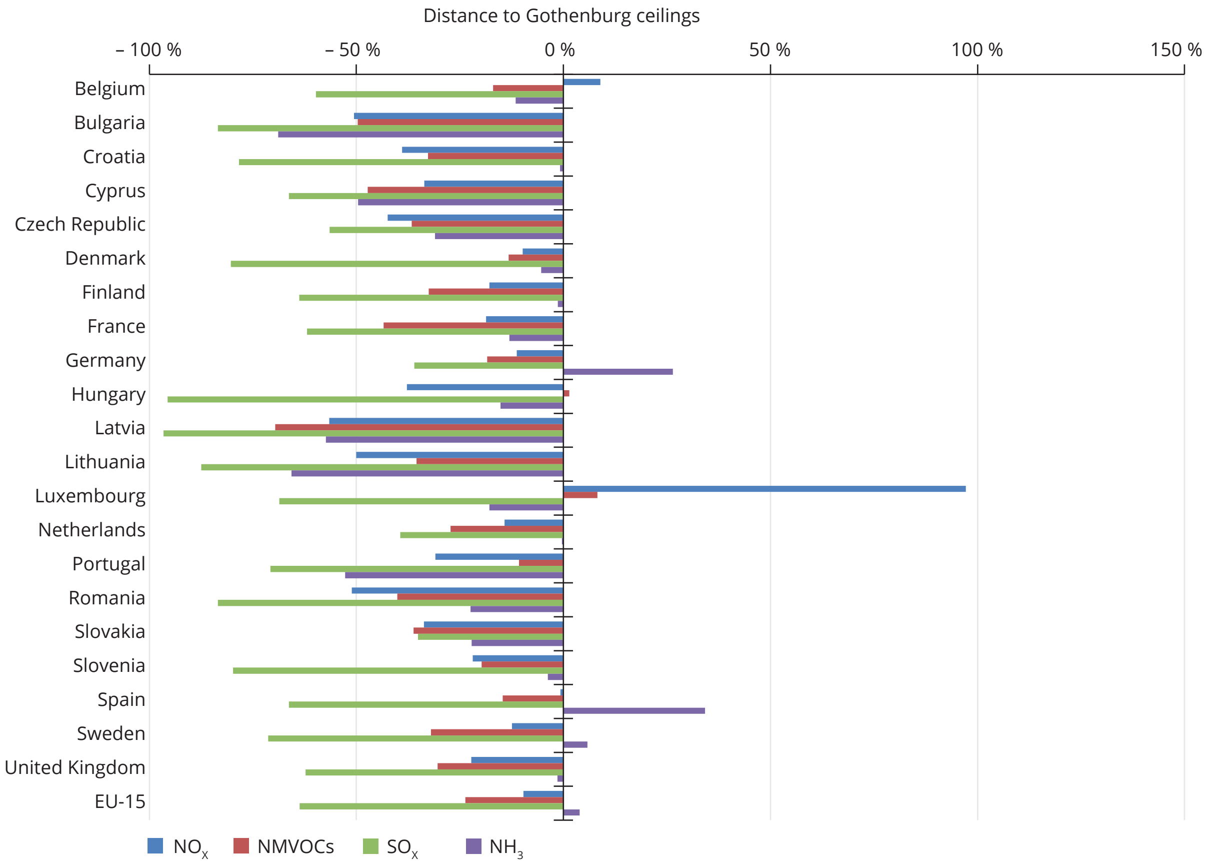
Notes: (a) Emission ceilings are also specified for individual EU-15 Member States. The sum of these ceilings is different from the ceilings specified for the EU-15 as a whole.

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 the United Kingdom as this Member State did not provide data based on fuel sold.

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

Figure 3.4 Distance of Member State emissions in 2015 to the ceilings set in the Gothenburg Protocol for 2010



Notes: Estonia and Malta do not have Gothenburg ceilings. Austria, Greece, Ireland, Italy and Poland have ceilings, but they have not yet ratified the protocol. For Spain, data for emission comparisons exclude emissions from the Canary Islands.
The comparison with emission ceilings is based on reporting on the basis of fuel sold, except for Belgium, Luxembourg, the Netherlands and the United Kingdom. These countries may choose to calculate their
emissions on the basis of fuel used in their territories instead (UNECE, 2014a). For the EU-15, the comparison is based on fuel sold, except the data from the United Kingdom, as this Member State did not provide data based on fuel used.
Under the Gothenburg Protocol, the EMEP Steering Board accepted inventory adjustment applications for emissions from Belgium, Denmark, Finland, France, Germany, Luxembourg and Spain in 2014, 2015 and 2016. This table takes these adjusted data into account. The EU-15 did not apply for adjustments and thus data for the EU-15 are unadjusted.

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

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

Data from the above-mentioned countries show that, although Norway exceeded its NO_x ceilings from 2010 to 2014, it complied in 2015, while it exceeded its NH_3 emission ceilings in all years. Switzerland complied with all ceilings for all pollutants, except for NH_3 in 2010 (see Table 3.3).

3.3 Nitrogen oxide (NO_x) emission trends and key categories

Between 1990 and 2015, NO_x emissions dropped in the EU-28 by 56 %. Between 2014 and 2015, the decrease was 2.1 %, mainly because the United Kingdom, France, Germany and Italy noted reductions (Table 3.4). The Member States that contributed most (i.e. more than 10 %) to NO_x emissions in 2015 were Germany, the United Kingdom, Spain and France.

Table 3.4 to Table 3.29 include two EU-28 totals. The first is the sum of national totals that Member States officially reported. The second is the sum of the sectors of all Member States. A difference between these two EU totals arises when only national totals and no sectoral data are available. There is a third EU-28 total for NO_x (Table 3.4), NMVOCs (Table 3.5) and NH_3 (Table 3.7). This total makes allowance for approved adjustments (see also Chapter 2).

Spain stated that the dramatic drop in NO_x emissions between 2005 and 2010 (the value for the national totals is in 2008 13 % lower compared with the previous year) was due to the closure of the main brown coal

Table 3.3 Progress by other EEA member countries in meeting Gothenburg Protocol UNECE LRTAP Convention emission ceilings

Member State	NO_x Emission data (Gg)						Ceilings (Annex I)	Emission–ceiling comparison						NMVOCs Emission data (Gg)						Ceilings (Annex I)	Emission– ceiling comparison					
	2010	2011	2012	2013	2014	2015		2 010	2 011	2 012	2 013	2014	2015	2010	2011	2012	2013	2014	2015		2 010	2 011	2 012	2 013	2014	2015
Norway	188	183	178	167	157	151	156	×	×	×	×	×	✓	151	144	143	148	158	156	195	✓	✓	✓	✓	✓	✓
Switzerland	74	69	68	66	62	59	79	✓	✓	✓	✓	✓	✓	87	84	82	81	79	77	144	✓	✓	✓	✓	✓	✓

Member State	SO_x Emission data (Gg)						Ceilings (Annex I)	Emission–ceiling comparison						NH_3 Emission data (Gg)						Ceilings (Annex I)	Emission– ceiling comparison					
	2010	2011	2012	2013	2014	2015		2 010	2 011	2 012	2 013	2014	2015	2010	2011	2012	2013	2014	2015		2 010	2 011	2 012	2 013	2014	2015
Norway	20	19	17	17	16	16	22	✓	✓	✓	✓	✓	✓	27	26	26	26	27	27	23	×	×	×	×	×	×
Switzerland	11	9	9	9	8	7	26	✓	✓	✓	✓	✓	✓	64	63	62	61	62	61	63	×	✓	✓	✓	✓	✓

Notes: Emission data for Norway and Switzerland are the latest reported data under the LRTAP Convention (2017 submission round), and are compared with the respective emission ceilings of the Gothenburg Protocol. Switzerland's assessment is based on fuel used data.

Table 3.4 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	1990–2015	2013–2015	1990	2015
Austria	221	200	215	238	181	171	164	164	153	149	– 32 %	– 2.6 %	1.3 %	1.9 %
Belgium	412	383	345	319	246	229	215	207	200	197	– 52 %	– 1.5 %	2.3 %	2.5 %
*Adjusted data **					*185*	*168*	*155*	*147*	*143*	*145*				
Bulgaria	270	188	149	185	140	157	142	127	133	132	– 51 %	– 1.3 %	1.5 %	1.7 %
Croatia	106	81	86	85	67	64	58	57	53	53	– 50 %	0.4 %	0.6 %	0.7 %
Cyprus	16	19	22	22	19	21	22	16	18	15	– 6 %	– 12.7 %	0.1 %	0.2 %
Czech Republic	739	419	290	277	219	206	192	179	170	165	– 78 %	– 3.0 %	4.2 %	2.1 %
Denmark	301	290	225	203	148	139	129	124	115	114	– 62 %	– 0.6 %	1.7 %	1.5 %
Estonia	77	47	44	41	42	40	37	34	34	31	– 60 %	– 9.8 %	0.4 %	0.4 %
Finland	285	255	229	202	189	175	167	159	153	140	– 51 %	– 8.5 %	1.6 %	1.8 %
France	1 949	1 770	1 610	1 415	1 076	1 014	978	954	869	835	– 57 %	– 3.9 %	11.0 %	10.8 %
*Adjusted data **					*928*	*860*	*825*	*801*	*722*	*699*				
Germany	2 883	2 166	1 926	1 574	1 334	1 314	1 272	1 268	1 221	1 187	– 59 %	– 2.7 %	16.3 %	15.3 %
*Adjusted data **					*1 072*	*1 046*	*1 010*	*1 006*	*972*	*959*				
Greece	328	332	364	419	325	303	243	250	248	241	– 27 %	– 2.9 %	1.9 %	3.1 %
Hungary	235	182	180	169	140	132	123	120	119	123	– 48 %	3.7 %	1.3 %	1.6 %
Ireland	136	134	140	137	86	77	79	78	77	80	– 41 %	3.6 %	0.8 %	1.0 %
Italy	2 032	1 907	1 451	1 233	948	915	852	799	787	763	– 62 %	– 3.0 %	11.5 %	9.8 %
Latvia	94	52	44	45	42	36	37	36	36	37	– 61 %	0.5 %	0.5 %	0.5 %
Lithuania	133	64	55	60	57	54	56	55	54	55	– 59 %	1.1 %	0.8 %	0.7 %
Luxembourg	40	34	41	55	34	34	31	27	25	22	– 46 %	– 13.0 %	0.2 %	0.3 %
*Adjusted data **					*30*	*30*	*27*	*23*	*21*	*18*				
Malta	5.7	6.8	8.7	9.3	8.1	7.9	8.6	4.9	3.3	2.9	– 50 %	– 13.6 %	0.0 %	0.0 %
Netherlands	604	505	420	369	300	286	272	259	234	228	– 62 %	– 2.5 %	3.4 %	2.9 %
Poland	1 053	1 029	833	848	852	833	804	769	720	714	– 32 %	– 0.9 %	6.0 %	9.2 %
Portugal	247	278	275	269	191	183	176	174	173	180	– 27 %	4.1 %	1.4 %	2.3 %
Romania	487	392	376	317	235	244	242	220	218	214	– 56 %	– 1.9 %	2.8 %	2.8 %
Slovakia	228	142	115	108	95	91	87	87	89	86	– 62 %	– 3.2 %	1.3 %	1.1 %
Slovenia	67	65	54	52	48	48	47	44	39	35	– 48 %	– 10.8 %	0.4 %	0.5 %
Spain	1 500	1 565	1 535	1 545	1 059	1 042	1 010	896	881	905	– 40 %	2.7 %	8.5 %	11.7 %
*Adjusted data **					*927*	*917*	*894*	*781*	*767*	*815*				
Sweden	278	250	215	183	156	147	140	137	134	130	– 53 %	– 3.4 %	1.6 %	1.7 %
United Kingdom	2 918	2 343	1 817	1 608	1 139	1 061	1 089	1 035	957	918	– 69 %	– 4.0 %	16.5 %	11.8 %
EU-28 (a)	**17 644**	**15 098**	**13 066**	**11 986**	**9 377**	**9 024**	**8 669**	**8 281**	**7 913**	**7 751**	**– 56 %**	**– 2.1 %**	**100 %**	**100 %**
EU-28 (b)	17 634	15 088	13 057	11 976	9 368	9 014	8 660	8 272	7 904	7 741				
EU-28 (c)	17 644	15 098	13 066	11 986	8 769	8 411	8 076	7 686	7 341	7 240				

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

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

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

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

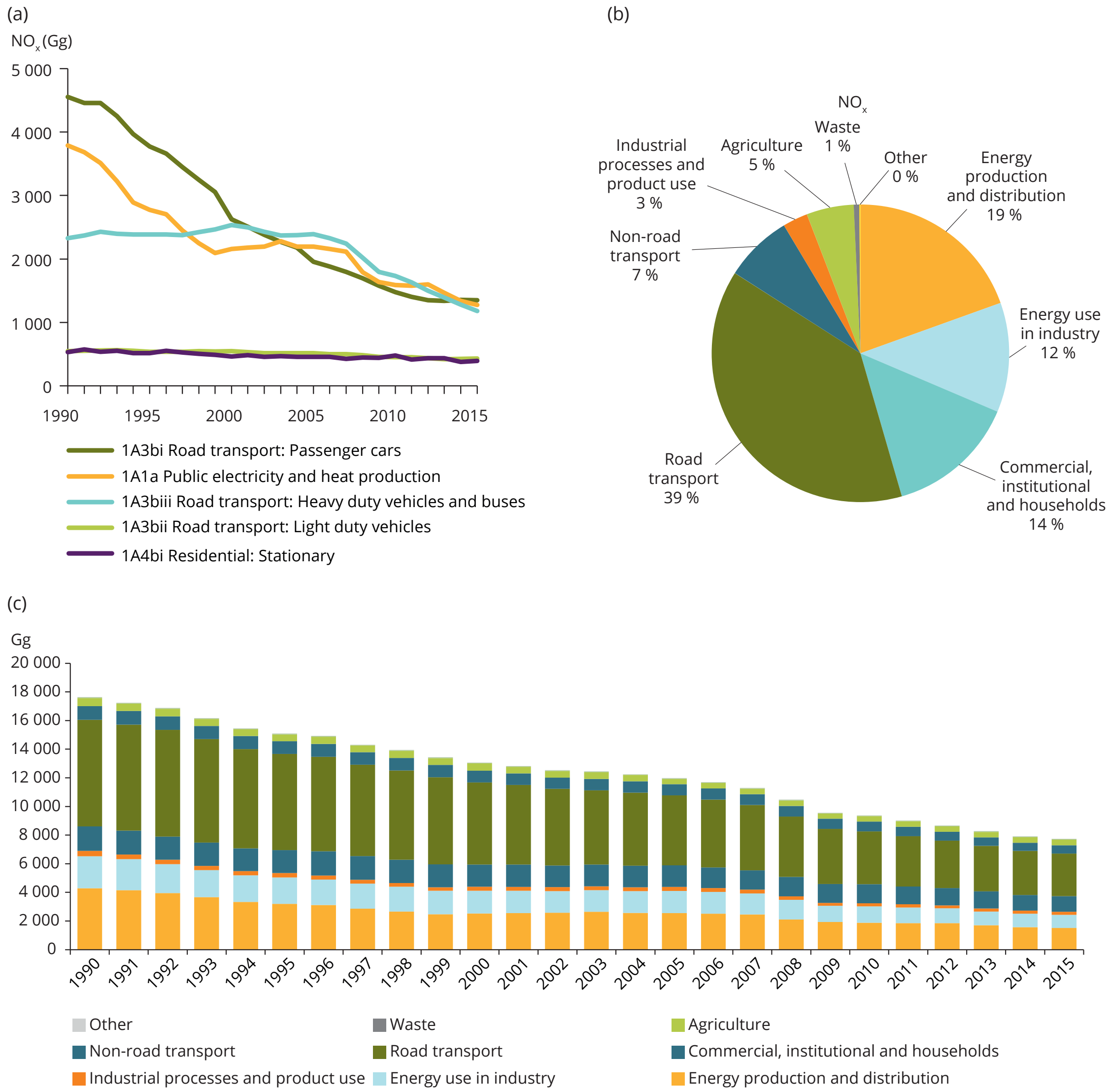
* Adjusted data: under the Gothenburg Protocol, the EMEP Steering Board accepted inventory adjustment applications for emissions from Belgium, France, Germany, Luxembourg and Spain.

mine in Spain in 2007 and the necessary retrofitting in 2008 of the adjacent thermal plant (see Spain's IIR, listed in Appendix 5).

The chief key categories for NO_x emissions were '1A3bi — Road transport: Passenger cars', '1A1a — Public electricity and heat production' and '1A3biii — Road transport: Heavy duty vehicles and buses'. Together, they made up 49 % of total emissions (see Figure 3.5). Of the top five key categories, the highest relative reductions in emissions between 1990 and 2015 were in the most important, '1A3bi — Road transport: Passenger cars' (–70 %) (see Figure 3.5(a)).

Figure 3.5(b) shows the contribution that each aggregated sector group made to total EU-28 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, 2016c). 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-28 emissions in 2015. 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 non-selective catalytic reduction (SNCR) techniques), and switching fuel from coal to gas (EEA, 2016c).

Figure 3.5 NO_x emissions in the EU-28: (a) trend in emissions from the five most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions



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

Between 1990 and 2015, NMVOC emissions dropped in the EU-28 by 61 %. Between 2014 and 2015, Member States reported an increase of 0.4 %, mainly due to increased emissions in Italy, Spain, Poland and Slovakia (Table 3.5). In 2015, the Member States that contributed most (i.e. more than 10 %) to NMVOCS emissions were Germany, Italy and the United Kingdom.

The most important key categories for NMVOC emissions were '2D3d — Coating applications', '1A4bi — Residential: Stationary' and '2D3a — Domestic

Table 3.5 Member State contributions to EU emissions of NMVOCs

	NMVOCs (Gg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	281	204	153	137	119	115	114	116	110	113	– 60 %	2.4 %	1.6 %	1.7 %
Belgium	330	279	218	178	146	134	131	129	121	120	– 64 %	– 1.5 %	1.9 %	1.8 %
*Adjusted data**					*117*									
Bulgaria	606	153	105	104	107	106	97	93	95	93	– 85 %	– 1.8 %	3.6 %	1.4 %
Croatia	151	98	96	103	80	74	68	66	59	61	– 60 %	2.0 %	0.9 %	0.9 %
Cyprus	13	13	13	14	11	8.7	8.4	7.4	7.1	7.4	– 44 %	4.2 %	0.1 %	0.1 %
Czech Republic	301	207	243	209	170	154	148	145	138	139	– 54 %	0.8 %	1.8 %	2.1 %
Denmark	204	204	174	149	125	118	115	115	107	109	– 46 %	2.8 %	1.2 %	1.7 %
*Adjusted data**					*90*	*83*	*79*	*79*	*71*	*74*				
Estonia	65	42	38	33	24	24	23	23	23	23	– 65 %	1.5 %	0.4 %	0.3 %
Finland	270	234	183	151	128	117	116	111	93	88	– 67 %	– 5.9 %	1.6 %	1.3 %
France	2 395	2 007	1 608	1 166	788	732	702	699	646	623	– 74 %	– 3.6 %	14.0 %	9.5 %
Germany	3 390	2 026	1 600	1 312	1 216	1 131	1 105	1 092	1 016	1 020	– 70 %	0.4 %	19.9 %	15.5 %
*Adjusted data**					*1 015*	*930*	*901*	*883*	*805*	*812*				
Greece	238	215	208	178	142	131	125	126	125	122	– 49 %	– 2.3 %	1.4 %	1.9 %
Hungary	297	205	182	157	143	145	145	147	137	139	– 53 %	1.6 %	1.7 %	2.1 %
Ireland	142	135	119	113	101	98	98	100	100	101	– 29 %	1.8 %	0.8 %	1.5 %
Italy	1 936	1 967	1 516	1 232	1 001	911	907	877	821	842	– 56 %	2.5 %	11.3 %	12.8 %
Latvia	82	61	51	49	41	40	43	42	42	41	– 50 %	– 1.6 %	0.5 %	0.6 %
Lithuania	144	103	74	75	67	65	64	60	60	59	– 59 %	– 1.5 %	0.8 %	0.9 %
Luxembourg	21	17	13	13	9.4	9.5	9.9	9.9	9.2	9.7	– 54 %	6.2 %	0.1 %	0.1 %
*Adjusted data**					7.8	7.9	8.3	8.3	7.5	8.0				
Malta	1.6	1.8	3.1	3.3	2.6	3.0	3.2	3.0	2.1	2.1	29 %	– 0.8 %	0.0 %	0.0 %
Netherlands	490	349	244	181	165	160	156	148	143	139	– 72 %	– 2.6 %	2.9 %	2.1 %
Poland	484	616	541	543	571	549	546	535	517	531	10 %	2.5 %	2.8 %	8.1 %
Portugal	276	274	259	216	187	179	174	175	174	180	– 35 %	3.7 %	1.6 %	2.7 %
Romania	353	203	265	388	344	340	343	324	319	313	– 11 %	– 1.8 %	2.1 %	4.8 %
Slovakia	167	141	118	105	100	101	92	86	81	89	– 46 %	9.7 %	1.0 %	1.4 %
Slovenia	72	65	54	46	39	37	35	33	32	32	– 55 %	1.3 %	0.4 %	0.5 %
Spain	1 048	977	982	811	640	609	582	566	569	584	– 44 %	2.6 %	6.1 %	8.9 %
Sweden	359	268	228	215	188	182	172	167	163	164	– 54 %	0.3 %	2.1 %	2.5 %
United Kingdom	2 947	2 321	1 631	1 174	899	878	866	842	841	835	– 72 %	– 0.6 %	17.3 %	12.7 %
EU-28 (a)	17 062	13 388	10 919	9 055	7 555	7 149	6 990	6 837	6 552	6 581	– 61 %	0.4 %	100 %	100 %
EU-28 (b)	17 053	13 379	10 912	9 049	7 550	7 145	6 986	6 833	6 548	6 577				
EU-28 (c)	17 062	13 388	10 919	9 055	7 287	6 912	6 749	6 590	6 304	6 335				

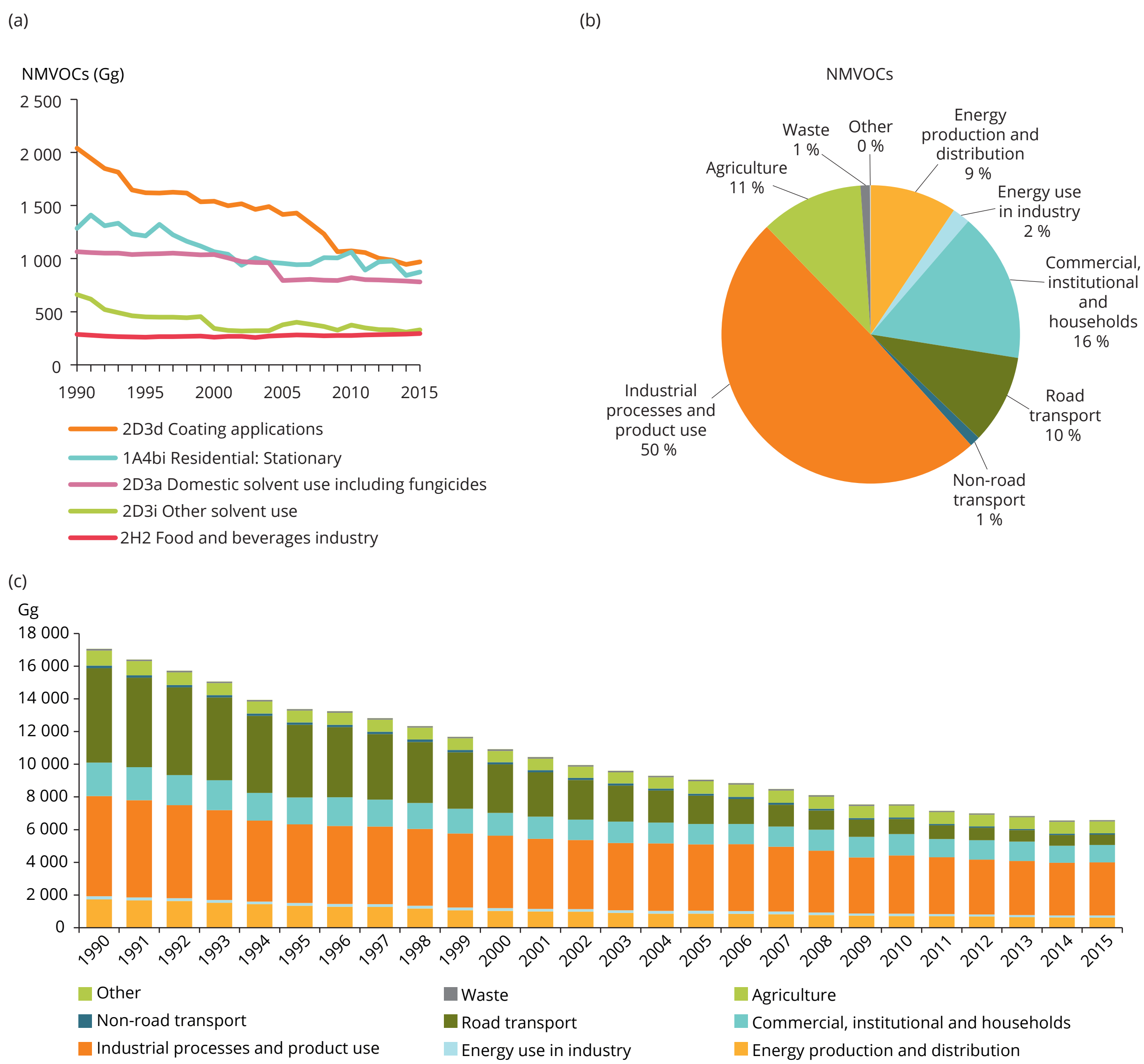
Notes: Grey shaded cells denote gap-filled data. For more detailed information, see Annex D.
(a) Sum of national totals as reported by Member States.
(b) Sum of sectors: differences arise when only national totals and no sectoral data are available.
(c) Sum of national totals as reported by Member States allowing for approved adjustments.

* Adjusted data: under the Gothenburg Protocol, the EMEP Steering Board accepted inventory adjustment applications for emissions from Belgium, Denmark, Germany and Luxembourg.

solvent use including fungicides'. Together, they made up 40 % of total emissions (Figure 3.6(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2015 were in the most important key category, '2D3d — Coating applications' (−52 %).

Figure 3.6(b) shows the contribution that each aggregated sector group made to total EU-28 emissions. For NMVOCs, the chief emission source is 'industrial processes and product use' (50 %), followed by 'commercial, institutional and households', 'agriculture' and 'road transport'.

Figure 3.6 NMVOC emissions in the EU-28: (a) trend in emissions from the five most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions



3.5 Sulphur oxide (SO_x) emission trends and key categories

Between 1990 and 2015, SO_x emissions dropped in the EU-28 by 89 %. Between 2014 and 2015, emissions decreased by 6.4 %, mainly thanks to reduced emissions in the United Kingdom, Bulgaria, Poland and Romania (see Table 3.6). The Member States that contributed most (i.e. more than 10 %) to SO_x emissions in 2015 were Poland and Germany.

Spain stated that the dramatic drop in SO_x emissions in 2008 (the value for the national totals is 55 % lower compared with the previous year) was due to the closure of the main brown coal mine in Spain in 2007 and the necessary retrofitting in 2008 of the adjacent thermal plant (see Spain's IIR, listed in Appendix 5).

In Slovakia, data reported for 2015 are significantly higher than for the year 2014. Slovakia explained, that all SO_X was emitted from the source Slovenské elektrárne elektrárne which apparently in 2015 did not apply any emission limits or abatement technologies. From 2016 onwards, it is possible to operate such facilities only when they comply with strict limits set in the legislation. Therefore considerable drop in emissions of SO_x is expected for 2016 (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 47 % of total SO_x emissions (Figure 3.7(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2015 were achieved in the most important, '1A1a — Public

Table 3.6 Member State contributions to EU emissions of SO_x

	SO_X (Gg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	75	48	32	26	17	16	15	15	15	15	– 80 %	0.8 %	0.3 %	0.5 %
Belgium	365	258	173	142	60	53	47	45	42	43	– 88 %	0.5 %	1.4 %	1.5 %
Bulgaria	1 101	1 301	863	779	389	516	330	196	189	142	– 87 %	– 24.8 %	4.3 %	5.1 %
Croatia	171	78	60	59	36	30	25	17	14	15	– 91 %	7.8 %	0.7 %	0.5 %
Cyprus	31	39	48	38	22	21	16	14	17	13	– 58 %	– 22.3 %	0.1 %	0.5 %
Czech Republic	1 871	1 090	227	208	160	160	155	139	127	123	– 93 %	– 2.9 %	7.4 %	4.4 %
Denmark	179	147	33	26	16	15	13	13	11	11	– 94 %	– 3.9 %	0.7 %	0.4 %
Estonia	272	116	97	76	83	73	41	37	41	32	– 88 %	– 22.1 %	1.1 %	1.1 %
Finland	263	100	80	70	67	61	51	47	43	42	– 84 %	– 2.6 %	1.0 %	1.5 %
France	1 314	956	631	455	280	242	228	200	160	153	– 88 %	– 4.8 %	5.2 %	5.5 %
Germany	5 485	1 744	644	472	409	399	381	373	357	352	– 94 %	– 1.4 %	21.6 %	12.7 %
Greece	478	541	499	541	248	190	151	141	138	120	– 75 %	– 13.3 %	1.9 %	4.3 %
Hungary	825	615	428	42	31	35	32	31	28	24	– 97 %	– 12.4 %	3.3 %	0.9 %
Ireland	184	163	142	74	28	27	25	25	19	18	– 90 %	– 9.0 %	0.7 %	0.6 %
Italy	1 783	1 322	755	408	217	195	177	145	131	123	– 93 %	– 5.9 %	7.0 %	4.4 %
Latvia	100	49	18	8.5	4.3	4.3	4.4	3.9	3.9	3.7	– 96 %	– 6.3 %	0.4 %	0.1 %
Lithuania	173	69	38	31	22	24	21	19	17	18	– 89 %	8.0 %	0.7 %	0.7 %
Luxembourg	15	8.5	3.1	2.4	1.7	1.3	1.5	1.5	1.5	1.3	– 92 %	– 18.7 %	0.1 %	0.0 %
Malta	12	11	24	11	8.1	7.9	7.7	5.0	4.6	3.3	– 72 %	– 28.3 %	0.0 %	0.1 %
Netherlands	193	131	73	64	34	33	34	30	29	30	– 84 %	4.0 %	0.8 %	1.1 %
Poland	2 648	2 135	1 404	1 164	866	828	794	759	715	690	– 74 %	– 3.4 %	10.4 %	24.8 %
Portugal	324	332	264	195	70	65	60	54	48	50	– 85 %	3.1 %	1.3 %	1.8 %
Romania	802	697	491	601	349	320	258	203	176	152	– 81 %	– 13.6 %	3.2 %	5.5 %
Slovakia	524.3	242.0	131	92	73	72	62	57	49	71	– 86 %	46.9 %	2.1 %	2.6 %
Slovenia	201	124	94	41	10	12	11	12	8.8	5.5	– 97 %	– 38.0 %	0.8 %	0.2 %
Spain	2 157	1 826	1 473	1 277	425	461	409	261	257	273	– 87 %	6.2 %	8.5 %	9.8 %
Sweden	105	69	42	36	29	26	25	23	21	19	– 82 %	– 7.3 %	0.4 %	0.7 %
United Kingdom	3 685	2 372	1 220	711	424	393	439	380	305	236	– 94 %	– 22.7 %	14.5 %	8.5 %
EU-28 (a)	**25 337**	**16 583**	**9 986**	**7 650**	**4 380**	**4 279**	**3 813**	**3 246**	**2 968**	**2 779**	**– 89 %**	**– 6.4 %**	**100 %**	**100 %**
EU-28 (b)	25 329	16 573	9 973	7 633	4 363	4 264	3 797	3 232	2 955	2 766				

Notes: Grey 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.

electricity and heat production' (−91 %), the third most important, '1A1b — Petroleum refining' (−85 %), and the second most important '1A4bi — Residential: Stationary' (−84 %).

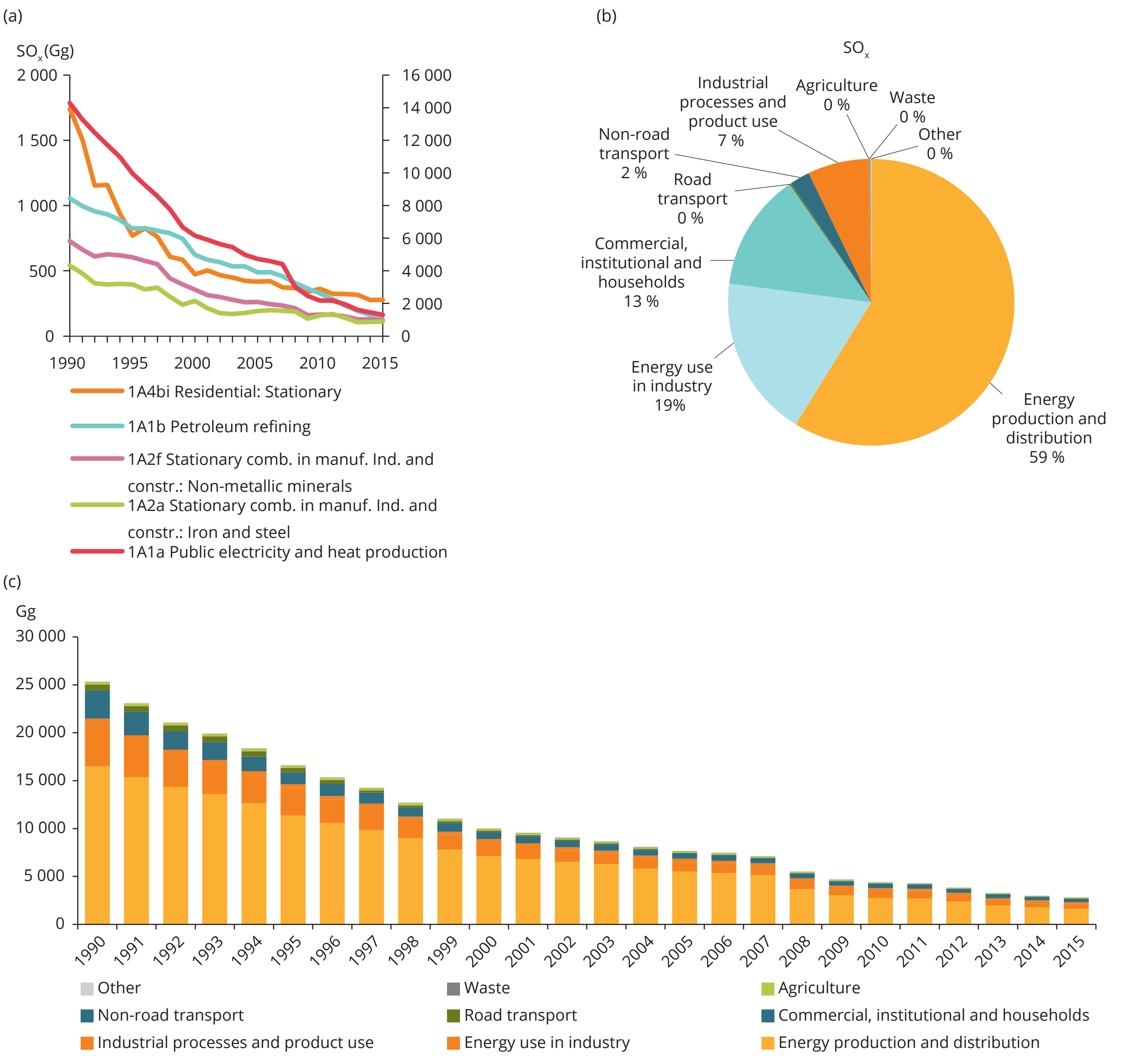
For these main emitting sources, several measures have been combined to reduce emissions since 1990: switching fuel in energy-related sectors away from high-sulphur solid and liquid fuels to low-sulphur fuels such as natural gas; fitting flue gas desulphurisation (FGD) abatement technology in industrial facilities; and the impact of EU directives relating to the sulphur content of certain liquid fuels (EEA, 2016c).

Figure 3.7(b) shows the contribution that each aggregated sector group made to total EU-28 emissions. For SO_X, common chief emission sources are the energy sectors.

3.6 Ammonia (NH_3) emission trends and key categories

Between 1990 and 2015, NH_3 emissions in the EU-28 dropped by 23 %. Between 2014 and 2015, emissions increased by 1.8 %, mainly because of increases in Germany, Spain, France and the United Kingdom (see

Figure 3.7 SO_x emissions in the EU-28: (a) trend in emissions from the five most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions



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

Table 3.7). The Member States that contributed most (i.e. more than 10 %) to NH_3 emissions in 2015 were Germany, France and Spain.

In Belgium, the significant decrease of NH_3 emissions between 1995 and 2000 is mainly because of a strong decrease between 1999 and 2000 due to 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 mainly data reported for the category '3Da1 — Inorganic N-fertilizers (includes also urea application)'.

Spain offered the following explanation for the national NH_3 emissions trend observed in the period 1990-2015. In the first part of the time series agricultural emissions underwent a notable increase, reaching a maximum in 2003. This rise was mainly caused by significant growth in the national cattle herd. The use of synthetic nitrogen fertilisers also increased during that period. Until 2013 a progressive decrease in ammonia emissions was

Table 3.7 Member State contributions to EU emissions of NH_3

	NH_3 (Gg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	66	69	66	65	67	66	66	66	67	67	1 %	0.4 %	1.3 %	1.7 %
Belgium	117	113	83	68	68	67	66	67	66	66	– 44 %	– 0.2 %	2.3 %	1.6 %
Bulgaria	113	58	41	48	42	40	38	31	31	34	– 70 %	8.0 %	2.2 %	0.8 %
Croatia	48	37	37	38	33	33	33	29	27	30	– 37 %	11.0 %	0.9 %	0.7 %
Cyprus	5.2	5.9	5.9	5.8	5.1	4.8	4.6	4.4	4.3	4.5	– 12 %	5.5 %	0.1 %	0.1 %
Czech Republic	156	86	84	74	68	67	67	69	69	70	– 55 %	0.7 %	3.0 %	1.7 %
Denmark	125	106	96	88	78	77	75	72	72	73	– 42 %	0.8 %	2.4 %	1.8 %
*Adjusted data**					*71*	*69*	*68*	*65*	*64*	*65*				
Estonia	22	11	8.6	9.6	11	11	11	11	11	12	– 46 %	4.5 %	0.4 %	0.3 %
Finland	34	33	34	37	35	34	34	33	33	32	– 7 %	– 5.0 %	0.7 %	0.8 %
*Adjusted data**					*33*	*33*	*32*	*32*	*32*	*31*				
France	686	664	692	659	668	661	661	656	669	679	– 1 %	1.4 %	13.2 %	16.9 %
Germany	793	679	698	678	681	723	705	730	737	759	– 4 %	3.0 %	15.3 %	18.9 %
Adjusted data*					641	674	653	669	674	695				
Greece	85	74	71	68	64	62	61	61	61	64	– 24 %	5.7 %	1.6 %	1.6 %
Hungary	139	81	85	77	69	70	70	73	73	76	– 45 %	5.2 %	2.7 %	1.9 %
Ireland	106	110	113	111	107	103	104	105	106	108	2 %	2.0 %	2.0 %	2.7 %
Italy	471	451	453	422	389	402	416	403	394	393	– 16 %	– 0.3 %	9.1 %	9.8 %
Latvia	43	18	16	16	17	17	18	18	19	19	– 57 %	– 0.2 %	0.8 %	0.5 %
Lithuania	66	34	28	32	31	30	29	29	29	29	– 56 %	– 1.2 %	1.3 %	0.7 %
Luxembourg	6.4	6.3	6.5	5.8	5.8	5.7	5.6	5.7	5.7	5.8	– 10 %	0.5 %	0.1 %	0.1 %
Malta	1.9	1.9	1.8	1.6	1.6	1.5	1.5	1.6	1.6	1.5	– 23 %	– 8.0 %	0.0 %	0.0 %
Netherlands	369	227	178	156	135	131	125	124	127	128	– 65 %	0.2 %	7.1 %	3.2 %
Poland	441	353	318	299	284	284	274	273	269	267	– 39 %	– 0.8 %	8.5 %	6.7 %
Portugal	75	68	69	55	51	51	50	48	50	51	– 32 %	2.4 %	1.4 %	1.3 %
Romania	300	217	206	204	168	166	166	165	162	163	– 46 %	0.3 %	5.8 %	4.1 %
Slovakia	70	46	39	34	30	28	29	29	30	30	– 57 %	– 0.3 %	1.3 %	0.8 %
Slovenia	24	22	22	21	20	19	19	19	19	19	– 18 %	1.2 %	0.5 %	0.5 %
Spain	448	429	522	495	447	438	430	436	455	476	6 %	4.6 %	8.6 %	11.9 %
Sweden	65	66	64	63	60	60	58	59	60	60	– 8 %	0.9 %	1.3 %	1.5 %
United Kingdom	**326**	**325**	**326**	**307**	**282**	**284**	**280**	**277**	**288**	**293**	**– 10 %**	**1.7 %**	**6.3 %**	**7.3 %**
EU-28 (a)	5 200	4 391	4 364	4 138	3 919	3 937	3 898	3 893	3 937	4 009	– 23 %	1.8 %	100 %	100 %
EU-28 (b)	5 195	4 385	4 357	4 132	3 912	3 931	3 891	3 887	3 931	4 002				
EU-28 (c)	5 200	4 391	4 364	4 138	3 869	3 879	3 838	3 824	3 865	3 936				

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

(a) Sum of national totals as reported by Member States.
(b) Sum of sectors.
(c) Sum of national totals as reported by Member States under consideration of approved adjustments.

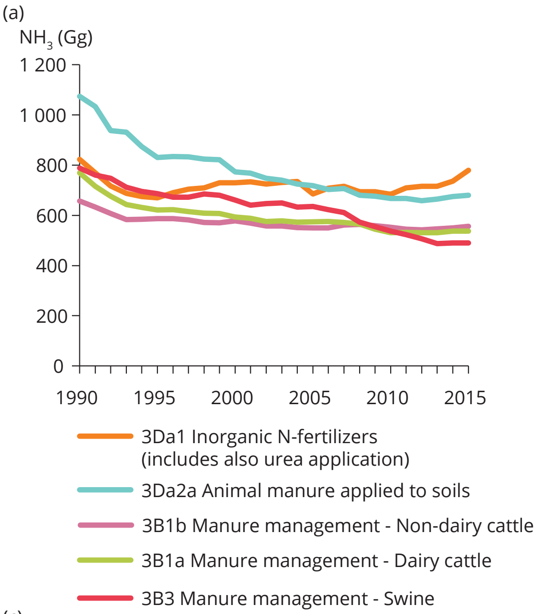
* Adjusted data: under the Gothenburg Protocol, the EMEP Steering Board accepted inventory adjustment applications for emissions from Denmark, Finland and Germany.

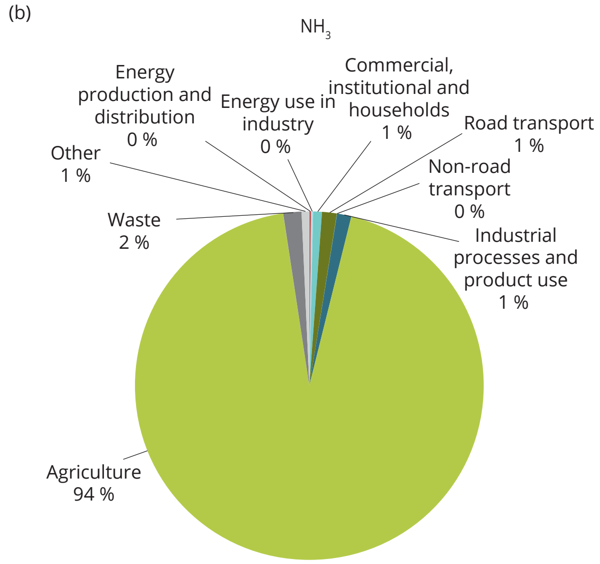
registered at national level. This reduction of emissions was probably due to a combination of factors, including the use of inorganic fertilisers, reduced growth in the number of cattle and the progressive introduction of abatement techniques in manure management. Total NH_3 emissions increased between 2014 and 2015 compared with 2013 levels. This rise, driven by an increase in the consumption of synthetic nitrogen fertilisers and renewed increase in the number of cattle and pigs, brought national total emissions of ammonia back over the national ceiling for the years 2014 and 2015 (see Spain's IIR, listed in Appendix 5).

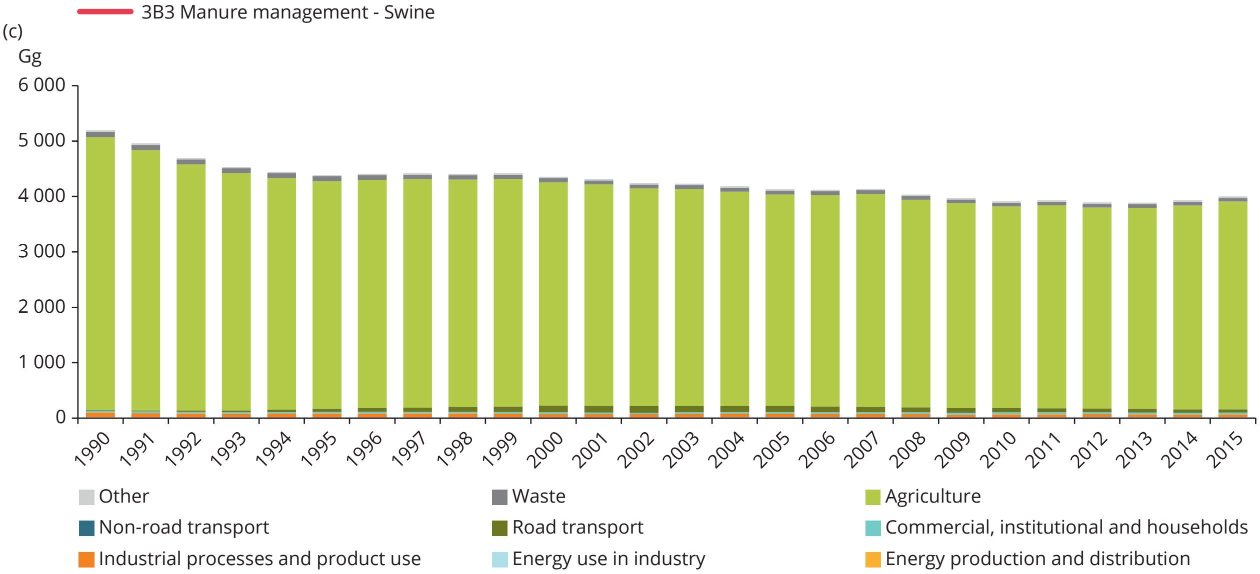
The principal key categories for NH_3 emissions are '3Da1 — Inorganic N-fertilizers', '3Da2a — Animal manure applied to soils' and '3B1b — Manure management — Non-dairy cattle'. They jointly make up 50 % of total NH_3 emissions (see Figure 3.8(a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2015 was in the fifth most important, '3B3 — Manure management — Swine' (−38 %).

Figure 3.8(b) shows the contribution that each aggregated sector group made to total EU-28 emissions. A single sector group, agriculture, is responsible for most (94 %) of the NH_3 emissions in the EU-28.

Figure 3.8 NH_3 emissions in the EU-28: (a) trend in emissions from the five most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions







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

Between 2000 and 2015, $PM_{2.5}$ emissions dropped in the EU-28 by 26 %. Between 2014 and 2015, there was an increase of 1 %, mainly because emissions increased in Italy (see Table 3.8). The Member States that contributed most (i.e. more than 10 %) to $PM_{2.5}$ emissions in 2015 were France and Italy. Greece did not report $PM_{2.5}$ emissions for any year, so data were not gap-filled. The EU-28 total is therefore an underestimate.

Estonia stated that the growth of fine particulate matter emission from 2010 to 2011 resulted from growth in electricity production during the same period. The significant increase of $PM_{2.5}$ emissions in 2011 was due to an increase in electricity production by 34 % at Estonia's Balti power station (Eesti Energia Narva Elektrijaamad AS) and to the incorrect operation of electric precipitators on two of its power units. In 2015, particulate emissions increased mainly due to the increase of emissions from combustion in manufacturing industries (the amount of wood and wood waste burned has increased), 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

Table 3.8 Member State contributions to EU emissions of $PM_{2.5}$

	$PM_{2.5}$ (Gg)								Change		Share in EU-28	
Member State	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2000–2015**	**2013–2015**	**2000**	**2015**
Austria	24	22	19	18	18	18	16	17	– 30 %	2.1 %	1.4 %	1.3 %
Belgium	41	36	35	28	30	31	25	27	– 35 %	8.3 %	2.4 %	2.1 %
Bulgaria	23	28	29	31	31	30	28	29	24 %	1.2 %	1.3 %	2.2 %
Croatia	33	40	31	28	26	23	19	20	– 39 %	3.6 %	1.9 %	1.6 %
Cyprus	3.0	2.7	1.6	1.4	1.2	1.0	1.0	1.0	– 67 %	3.9 %	0.2 %	0.1 %
Czech Republic	38	35	29	25	25	25	23	23	– 39 %	2.0 %	2.2 %	1.8 %
Denmark	23	26	26	23	22	21	18	20	– 13 %	8.9 %	1.3 %	1.6 %
Estonia	15	14	14	18	8.2	11	7.9	9.2	– 40 %	15.8 %	0.9 %	0.7 %
Finland	39	35	37	34	36	34	24	22	– 44 %	– 9.1 %	2.3 %	1.7 %
France	318	252	212	184	185	190	165	165	– 48 %	– 0.2 %	18.4 %	12.8 %
Germany	160	132	117	112	106	106	100	99	– 38 %	– 0.5 %	9.2 %	7.8 %
Greece	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Hungary	48	38	50	57	60	61	51	54	11 %	5.5 %	2.8 %	4.2 %
Ireland	21	19	16	15	15	15	14	14	– 32 %	– 1.1 %	1.2 %	1.1 %
Italy	189	166	190	143	171	166	150	160	– 16 %	6.8 %	10.9 %	12.5 %
Latvia	21	22	18	18	19	18	18	18	– 17 %	– 0.4 %	1.2 %	1.4 %
Lithuania	18	20	20	20	20	20	19	18	– 2 %	– 3.5 %	1.1 %	1.4 %
Luxembourg	2.9	3.1	2.4	2.2	2.2	2.2	2.2	2.0	– 31 %	– 8.9 %	0.2 %	0.2 %
Malta	1.0	1.3	0.7	0.8	0.8	0.8	0.6	0.2	– 76 %	– 59.0 %	0.1 %	0.0 %
Netherlands	28	22	17	16	14	14	13	13	– 54 %	– 1.8 %	1.6 %	1.0 %
Poland	150	159	149	139	140	134	126	125	– 17 %	– 0.8 %	8.6 %	9.7 %
Portugal	63	58	48	48	47	46	46	46	– 27 %	1.0 %	3.6 %	3.6 %
Romania	88	115	129	117	122	116	116	112	28 %	– 3.2 %	5.1 %	8.7 %
Slovakia	30	37	27	29	29	30	29	30	1 %	4.6 %	1.7 %	2.3 %
Slovenia	12	13	14	13	13	13	12	12	– 3 %	1.1 %	0.7 %	0.9 %
Spain	182	153	135	133	131	126	125	125	– 32 %	0.0 %	10.5 %	9.7 %
Sweden	27	27	24	24	23	23	20	19	– 28 %	– 1.8 %	1.5 %	1.5 %
United Kingdom	134	113	113	102	108	109	104	105	– 22 %	0.9 %	7.7 %	8.2 %
EU-28 ([a])	**1 732**	**1 591**	**1 504**	**1 382**	**1 403**	**1 382**	**1 270**	**1 283**	**– 26 %**	**1.0 %**	**100 %**	**100 %**
EU-28 ([b])	1 731	1 590	1 503	1 381	1 402	1 381	1 269	1 282				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

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

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

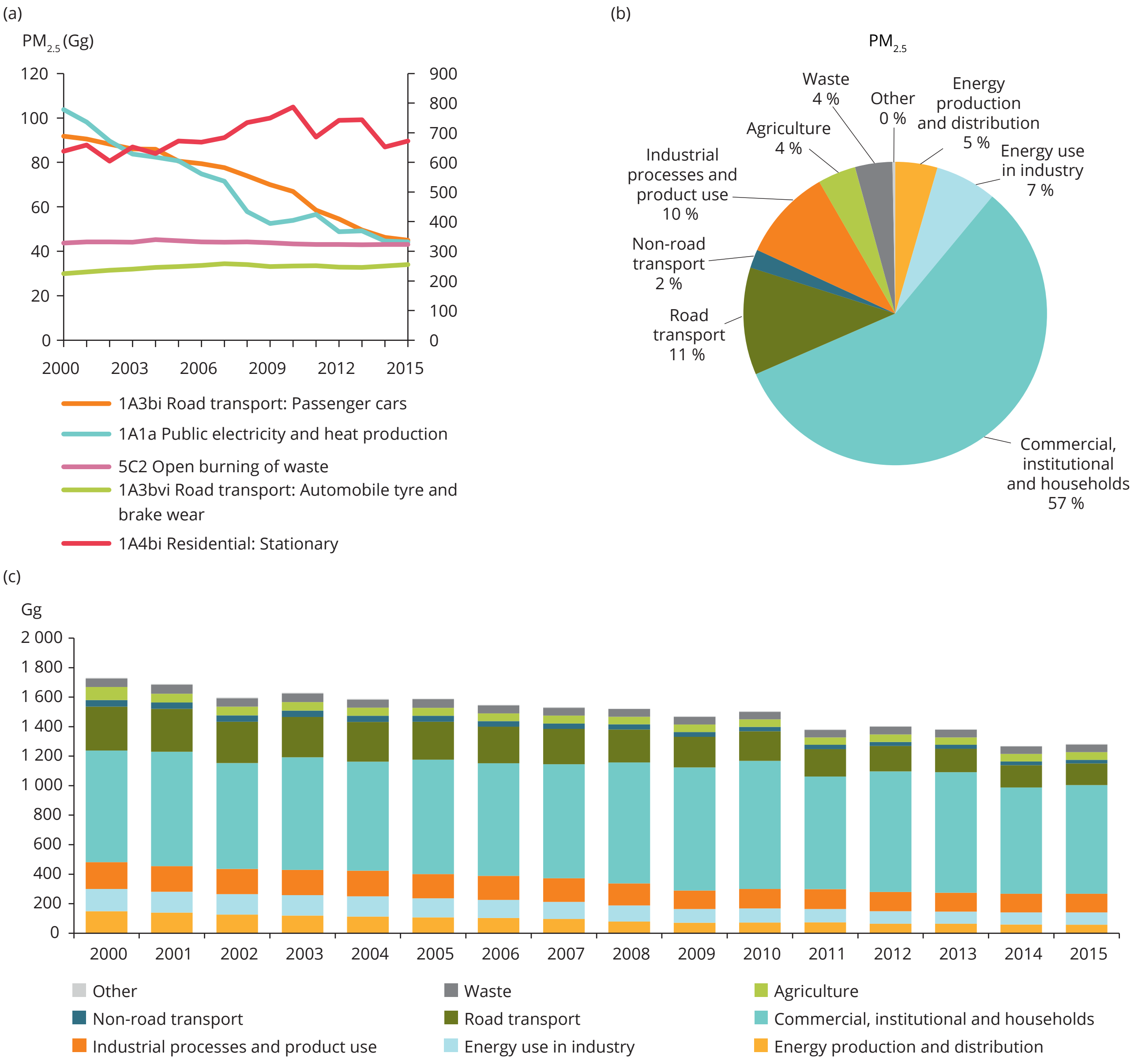
([b]) Sum of sectors.

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

up 52 % of the total (Figure 3.9(a)). Among the top five key categories, the highest relative reductions in emissions between 2000 and 2015 were in the third most important key category, '1A1a — Public electricity and heat production' (−57 %). There were also high reductions in the second most important, '1A3bi — Road transport: Passenger cars' (−51 %). In contrast, the chief, '1A4bi — Residential: Stationary' (5.3 %), and the fifth most important, '1A3bvi — Road transport: Automobile tyre and brake wear' (14 %), increased since 2000.

Figure 3.9(b) shows the contribution to total EU-28 emissions that each aggregated sector group made. The 'commercial, institutional and households' sector group is a major source of $PM_{2.5}$, and also of PM_{10}, CO, B(a)P, total PAHs, HCB and PCDD/F.

Figure 3.9 $PM_{2.5}$ emissions in the EU-28: (a) trend in emissions from the five most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions



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

3.8 PM_{10} emission trends and key categories

Between 2000 and 2015, PM_{10} emissions in the EU-28 dropped by 24 %. Between 2014 and 2015, the increase was 0.8 %, mainly because emissions rose in Italy (see Table 3.9). The Member States that contributed most (i.e. more than 10 %) to PM_{10} emissions in 2015 were France, Germany and Poland. Greece did not report PM_{10} emissions for any year, so data were not gap-filled. The EU-28 total is therefore an underestimate.

Estonia stated that the growth of fine particulate matter emissions from 2010 to 2011 resulted from growth in electricity production during the same period. The significant growth of PM_{10} emissions in 2011 was due to an increase in electricity production by 34 % at Estonia's Balti power station (Eesti Energia Narva Elektrijaamad AS) and to the incorrect operation of electric precipitators on two of its power units. In 2015, particulate emissions increased mainly due to the increase of emissions from combustion in manufacturing industries (the amount of wood and wood waste burned has increased), and from the

Table 3.9 Member State contributions to EU emissions of PM_{10}

	PM_{10} (Gg)								Change		Share in EU– 28	
Member State	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2000–2015**	**2013–2015**	**2000**	**2015**
Austria	39	37	34	33	32	33	31	31	– 20 %	1.3 %	1.5 %	1.6 %
Belgium	57	49	45	38	40	42	35	38	– 35 %	6.4 %	2.2 %	1.9 %
Bulgaria	36	46	56	51	47	48	46	50	38 %	7.9 %	1.4 %	2.6 %
Croatia	40	50	39	35	33	30	26	27	– 33 %	3.2 %	1.6 %	1.4 %
Cyprus	5.4	4.8	3.1	2.8	2.2	1.8	1.7	1.7	– 68 %	2.9 %	0.2 %	0.1 %
Czech Republic	56	51	43	38	38	38	35	35	– 38 %	1.0 %	2.2 %	1.8 %
Denmark	35	38	37	34	32	32	29	30	– 14 %	4.7 %	1.4 %	1.6 %
Estonia	32	22	23	34	13	17	13	14	– 56 %	6.1 %	1.3 %	0.7 %
Finland	55	49	50	47	47	45	34	32	– 42 %	– 6.6 %	2.2 %	1.7 %
France	449	371	317	290	290	295	267	266	– 41 %	– 0.5 %	17.6 %	13.8 %
Germany	290	245	231	232	225	229	223	221	– 24 %	– 0.9 %	11.4 %	11.5 %
Greece	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Hungary	69	56	67	72	75	76	67	70	1 %	4.3 %	2.7 %	3.6 %
Ireland	31	30	26	25	25	25	24	24	– 23 %	– 0.7 %	1.2 %	1.2 %
Italy	225	198	213	165	192	186	169	179	– 21 %	5.9 %	8.8 %	9.3 %
Latvia	25	27	22	24	25	23	23	23	– 6 %	1.8 %	1.0 %	1.2 %
Lithuania	21	27	26	26	26	26	25	25	18 %	– 1.3 %	0.8 %	1.3 %
Luxembourg	2.9	3.1	2.5	2.3	2.3	2.2	2.2	2.0	– 30 %	– 8.5 %	0.1 %	0.1 %
Malta	1.4	2.2	1.3	1.4	1.4	1.3	1.0	0.4	– 74 %	– 63.2 %	0.1 %	0.0 %
Netherlands	43	35	30	29	28	27	27	26	– 38 %	– 0.5 %	1.7 %	1.4 %
Poland	271	289	267	247	248	237	223	221	– 18 %	– 1.0 %	10.6 %	11.5 %
Portugal	87	89	67	66	63	59	56	58	– 33 %	4.4 %	3.4 %	3.0 %
Romania	125	151	165	154	160	153	154	151	20 %	– 1.9 %	4.9 %	7.8 %
Slovakia	43	46	34	36	37	37	36	37	– 13 %	3.7 %	1.7 %	1.9 %
Slovenia	15	15	15	15	15	15	13	13	– 14 %	0.9 %	0.6 %	0.7 %
Spain	257	232	187	183	177	168	167	168	– 34 %	0.5 %	10.0 %	8.7 %
Sweden	45	46	42	44	41	42	38	38	– 15 %	– 0.3 %	1.8 %	2.0 %
United Kingdom	195	166	154	142	149	150	146	145	– 26 %	0.0 %	7.6 %	7.5 %
EU– 28 (a)	**2 554**	**2 375**	**2 199**	**2 068**	**2 063**	**2 040**	**1 914**	**1 929**	**– 24 %**	**0.8 %**	**100 %**	**100 %**
EU– 28 (b)	2 553	2 374	2 198	2 067	2 062	2 039	1 913	1 928				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-grey 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.

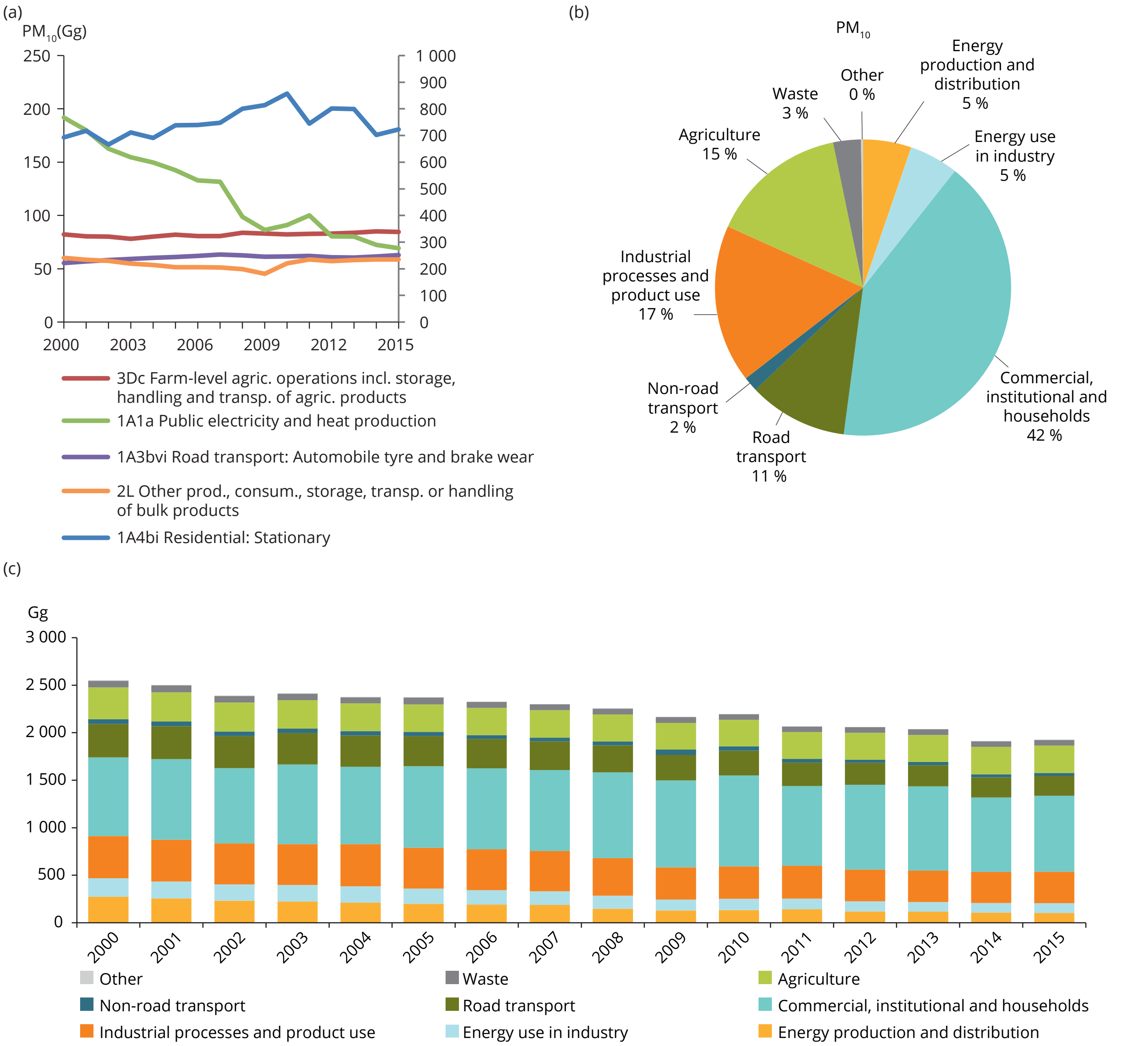
The LRTAP Convention formally requests Parties to report emissions of PM for 2000 and thereafter.

construction/demolition sectors (see Estonia's IIR, listed in Appendix 5).

As it is for $PM_{2.5}$, '1A4bi — Residential: Stationary' is the most significant key category for PM_{10} emissions, accounting for 37 % of total PM_{10} emissions (see Figure 3.10(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2015 were in the third most important, '1A1a — Public electricity and heat production' (−64 %). Reductions in emissions were also observed in the fifth most important category, '2L — Other production, consumption, storage, transport or handling of bulk products' (−2.6 %). Emissions from the other top five key categories increased.

Figure 3.10(b) shows the contribution to total EU-28 emissions that each aggregated sector group made. The 'commercial, institutional and households' sector group is a very significant source of PM_{10}, and also of $PM_{2.5}$, CO, B(a)P, total PAHs, HCB and PCDD/F.

Figure 3.10 PM_{10} emissions in the EU-28: (a) trend in emissions from the five most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions



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

3.9 Total suspended particulate (TSP) emission trends

Between 1990 and 2015, TSP emissions in the EU-28 dropped by 56 %. Between 2014 and 2015, emissions increased by 0.8 %, mainly because Bulgaria, Portugal and Italy increased emissions (Table 3.10). The Member States that contributed most (i.e. more than 10 %) to TSP emissions in 2015 were France and Germany. Greece did not report TSP emissions for any year, so data were not gap-filled. The EU-28 total is therefore an underestimate.

Estonia stated that the growth of TSP emissions from 2010 to 2011 resulted from growth in electricity production during the same period. The significant growth of particulate matter emissions in 2011 was due to an increase in electricity production by 34 % at Estonia's Balti power station (Eesti Energia Narva Elektrijaamad AS) and to the incorrect operation of electric precipitators on two of its power units. In 2015, particulate emissions increased mainly due to the increase of emissions from combustion in manufacturing industries (the amount of wood and wood waste burned has increased), and from the construction/demolition sectors (see Estonia's IIR, listed in Appendix 5).

Germany explained that between 1990 and 2015 total TSP emissions dropped by 82 %, due to the application of the former West Germany's stricter regulations in the new Länder after German reunification, transition

Table 3.10 Member State contributions to EU emissions of TSP

	TSPs (Gg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	62	62	63	61	57	57	56	56	55	55	– 11 %	1.0 %	0.8 %	1.6 %
Belgium	101	91	83	71	60	52	55	57	49	52	– 49 %	4.3 %	1.3 %	1.5 %
Bulgaria	83	113	83	129	99	112	98	93	96	123	48 %	28.2 %	1.1 %	3.7 %
Croatia	55	50	49	69	53	50	46	41	38	39	– 29 %	2.9 %	0.7 %	1.2 %
Cyprus	16	13	10	7.1	4.9	4.4	3.5	2.7	2.3	2.4	– 85 %	2.8 %	0.2 %	0.1 %
Czech Republic	640	202	76	64	52	47	47	47	43	44	– 93 %	1.0 %	8.3 %	1.3 %
Denmark	107	104	102	98	98	95	92	91	89	89	– 17 %	0.1 %	1.4 %	2.7 %
Estonia	279	127	70	36	30	43	20	23	20	21	– 92 %	7.4 %	3.6 %	0.6 %
Finland	41	38	78	74	74	71	71	68	52	50	21 %	– 4.6 %	0.5 %	1.5 %
France	1 248	1 164	1 097	994	897	874	874	888	846	841	– 33 %	– 0.5 %	16.2 %	25.0 %
Germany	1 970	499	461	388	366	370	361	373	366	360	– 82 %	– 1.7 %	25.6 %	10.7 %
Greece	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Hungary	108	99	89	73	80	85	88	89	81	84	– 22 %	4.1 %	1.4 %	2.5 %
Ireland	50	41	38	36	32	31	31	31	30	30	– 41 %	– 0.3 %	0.6 %	0.9 %
Italy	323	317	273	244	260	205	236	229	209	221	– 32 %	5.7 %	4.2 %	6.6 %
Latvia	33	30	34	42	35	41	44	38	39	41	26 %	5.7 %	0.4 %	1.2 %
Lithuania	34	23	26	34	31	31	31	32	31	32	– 5 %	2.9 %	0.4 %	0.9 %
Luxembourg	17	8.9	3.6	4.1	3.4	3.3	3.2	3.2	3.1	2.9	– 82 %	– 6.8 %	0.2 %	0.1 %
Malta	2.8	3.8	4.6	6.0	1.4	1.6	1.5	1.4	0.6	0.3	– 89 %	– 48.5 %	0.0 %	0.0 %
Netherlands	97	73	51	43	37	37	36	35	35	34	– 65 %	– 2.3 %	1.3 %	1.0 %
Poland	968	710	410	430	391	368	365	344	324	318	– 67 %	– 2.1 %	12.6 %	9.4 %
Portugal	130	185	211	250	167	161	147	128	108	122	– 6 %	12.9 %	1.7 %	3.6 %
Romania	271	269	278	293	291	286	279	260	262	242	– 11 %	– 7.7 %	3.5 %	7.2 %
Slovakia	211	126	74	65	45	47	48	48	47	48	– 77 %	2.1 %	2.7 %	1.4 %
Slovenia	22	20	18	18	17	17	16	16	14	15	– 34 %	0.9 %	0.3 %	0.4 %
Spain	318	333	358	344	272	264	251	238	238	241	– 24 %	1.6 %	4.1 %	7.2 %
Sweden	75	70	61	62	58	61	56	60	54	54	– 27 %	0.0 %	1.0 %	1.6 %
United Kingdom	434	341	283	245	216	201	208	210	208	207	– 52 %	– 0.6 %	5.6 %	6.1 %
EU-28 (a)	**7 697**	**5 112**	**4 384**	**4 180**	**3 730**	**3 615**	**3 562**	**3 505**	**3 341**	**3 368**	**– 56 %**	**0.8 %**	**100 %**	**100 %**
EU-28 (b)	7 696	5 111	4 383	4 180	3 729	3 615	3 561	3 504	3 340	3 367				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-grey 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.

from solid to gaseous and liquid fuels, and improved filter technologies for combustion plants and industrial processes (see Germany's IIR, listed in Appendix 5).

Latvia stated that the high TSP emissions in the years 2004 (not shown in Table 3.10) and 2015 can be explained by increased road paving activities (see Latvia's IIR, listed in Appendix 5).

3.10 Black carbon (BC) emission trends

Between 1990 and 2015, BC emissions in the EU-28 dropped by 40 %. Between 2014 and 2015, emissions decreased by 1.9 %, mainly because emissions reduced in France, Germany, the United Kingdom and Italy (Table 3.11). The Member States that contributed most (i.e. more than 10 %) to BC emissions in 2015 were Spain, France and Italy. Several Member States did not provide data for BC, and some of these gaps could not be filled with data. The EU-28 total is therefore an underestimate.

Estonia stated that the growth of fine particulate matter emissions from 2010 to 2011 resulted from growth in electricity production during the same period. The significant growth of PM emissions in 2011 was due to an increase in electricity production by 34 % at Estonia's Balti power station (Eesti Energia Narva Elektrijaamad AS) and to the incorrect operation of electric precipitators on two of its power units. In 2015, particulate emissions increased mainly due to the increase of emissions from combustion in manufacturing industries (the amount wood and

Table 3.11 Member State contributions to EU emissions of BC

	Black Carbon (Gg)								Change		Share in EU-28	
Member State	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2000–2015**	**2014–2015**	**2000**	**2015**
Austria	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	8.9	7.8	6.8	5.6	5.4	5.3	4.3	4.2	– 53 %	– 1.5 %	2.6 %	2.0 %
Bulgaria	0.9	1.6	1.3	1.3	1.4	1.1	1.2	1.3	47 %	6.9 %	0.3 %	0.6 %
Croatia	4.8	5.9	4.7	4.3	4.0	3.7	3.1	3.4	– 30 %	6.8 %	1.4 %	1.6 %
Cyprus	0.7	0.6	0.4	0.4	0.3	0.3	0.3	0.3	– 62 %	– 1.8 %	0.2 %	0.1 %
Czech Republic	5.6	5.6	3.9	3.5	3.4	3.3	3.1	3.1	– 45 %	1.2 %	1.6 %	1.5 %
Denmark	5.7	5.9	5.5	5.1	4.6	4.5	3.9	3.9	– 32 %	– 0.4 %	1.7 %	1.9 %
Estonia	3.4	3.4	3.1	3.5	2.1	2.5	2.0	2.5	– 27 %	26.0 %	1.0 %	1.2 %
Finland	7.2	6.6	6.3	5.3	6.3	5.8	4.8	4.6	– 36 %	– 5.1 %	2.1 %	2.2 %
France	68	57	49	43	41	39	34	32	– 53 %	– 5.0 %	19.7 %	15.4 %
Germany	36	29	21	19	18	17	16	15	– 59 %	– 5.5 %	10.4 %	7.1 %
Greece	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Hungary	7.2	6.5	7.6	8.3	8.5	8.5	7.3	7.7	7 %	4.9 %	2.1 %	3.7 %
Ireland	4.1	3.8	3.0	2.7	2.5	2.5	2.3	2.2	– 45 %	– 2.3 %	1.2 %	1.1 %
Italy	42	38	32	27	28	26	24	24	– 44 %	– 1.7 %	12.4 %	11.4 %
Latvia	2.9	3.5	3.0	3.0	3.2	3.0	2.9	2.9	0 %	– 0.7 %	0.8 %	1.4 %
Lithuania	2.4	2.8	2.7	2.6	2.7	2.6	2.5	2.3	– 4 %	– 7.3 %	0.7 %	1.1 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	> 100 %	– 56.7 %	0.0 %	0.0 %
Netherlands	9.6	7.7	5.3	4.9	4.4	3.9	3.4	3.2	– 66 %	– 6.1 %	2.8 %	1.6 %
Poland	24	26	23	22	22	21	20	20	– 17 %	1.0 %	7.0 %	9.6 %
Portugal	8.8	7.5	6.1	6.0	5.5	5.3	5.3	4.9	– 44 %	– 6.9 %	2.6 %	2.4 %
Romania	7.0	9.9	12	11	12	10	10	10	43 %	– 3.6 %	2.0 %	4.9 %
Slovakia	0.7	1.1	1.0	1.0	1.0	1.0	1.0	1.1	47 %	13.0 %	0.2 %	0.5 %
Slovenia	2.1	2.5	2.7	2.6	2.6	2.6	2.3	2.2	5 %	– 0.7 %	0.6 %	1.1 %
Spain	50	45	40	39	37	36	36	35	– 29 %	– 0.8 %	14.6 %	17.1 %
Sweden	4.6	4.4	4.1	4.0	3.8	3.7	3.4	3.3	– 30 %	– 3.9 %	1.4 %	1.6 %
United Kingdom	36	31	25	22	21	19	18	18	– 51 %	– 2.8 %	10.6 %	8.6 %
EU-28 ([a])	**343**	**313**	**269**	**247**	**241**	**228**	**210**	**206**	**– 40 %**	**– 1.9 %**	**100 %**	**100 %**
EU-28 ([b])	343	313	269	247	240	228	210	206				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-grey 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.

wood waste burned has increased), and from the construction/demolition sectors (see Estonia's IIR, listed in Appendix 5).

3.11 Carbon monoxide (CO) emission trends and key categories

Between 1990 and 2015, CO emissions dropped in the EU-28 by 68 %. Between 2014 and 2015, the decrease was 0.3 %, mainly because emissions decreased in France, the United Kingdom and Germany (Table 3.12). The Member States that contributed most (i.e. more than 10 %) to CO emissions in 2015 were France, Germany, Poland and Italy.

Belgium explained that the peak of CO emissions in 2013 was because one of its plants performed lime production 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 53 % of the total. Among the top five key categories, the highest relative reduction in emissions between 1990 and 2015 was in the second most important key category, '1A3bi — Road transport: Passenger cars' (−90 %) (see Figure 3.11(a)).

Figure 3.11(b) shows the contribution to total EU-28 emissions that each aggregated sector group made. For CO, common major emission sources are 'commercial, institutional and households' and 'road transport'.

Table 3.12 Member State contributions to EU emissions of CO

	CO (Gg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	1 287	988	786	688	583	565	565	586	538	567	– 56 %	5.3 %	2.0 %	2.8 %
Belgium	1 413	1 129	944	771	521	415	367	549	347	398	– 72 %	14.7 %	2.2 %	2.0 %
Bulgaria	781	637	456	408	325	327	321	298	291	288	– 63 %	– 1.2 %	1.2 %	1.4 %
Croatia	557	445	451	417	300	273	255	232	202	216	– 61 %	7.0 %	0.9 %	1.1 %
Cyprus	43	38	31	27	19	17	16	15	15	14	– 68 %	– 3.5 %	0.1 %	0.1 %
Czech Republic	1 069	928	706	643	574	522	521	528	482	503	– 53 %	4.5 %	1.7 %	2.5 %
Denmark	741	662	489	463	408	371	355	342	316	327	– 56 %	3.5 %	1.2 %	1.6 %
Estonia	215	212	195	153	155	130	140	134	128	128	– 40 %	– 0.1 %	0.3 %	0.6 %
Finland	724	607	570	478	412	384	381	368	343	325	– 55 %	– 5.5 %	1.1 %	1.6 %
France	10 426	8 978	6 535	5 278	4 299	3 619	3 224	3 337	3 072	2 994	– 71 %	– 2.6 %	16.5 %	14.8 %
Germany	12 500	6 439	4 794	3 722	3 322	3 235	2 861	2 833	2 720	2 683	– 79 %	– 1.4 %	19.8 %	13.3 %
Greece	1 134	956	925	724	529	495	546	459	463	440	– 61 %	– 4.8 %	1.8 %	2.2 %
Hungary	1 372	891	554	486	470	534	555	547	465	458	– 67 %	– 1.6 %	2.2 %	2.3 %
Ireland	350	291	246	216	144	133	127	119	112	109	– 69 %	– 2.6 %	0.6 %	0.5 %
Italy	7 246	7 297	4 919	3 430	3 059	2 416	2 660	2 489	2 258	2 356	– 67 %	4.3 %	11.5 %	11.7 %
Latvia	386	292	232	203	147	152	157	142	137	131	– 66 %	– 4.1 %	0.6 %	0.7 %
Lithuania	461	284	207	194	175	158	162	143	137	127	– 73 %	– 7.4 %	0.7 %	0.6 %
Luxembourg	463	210	42	38	29	27	27	27	25	22	– 95 %	– 13.3 %	0.7 %	0.1 %
Malta	20.8	26.3	0.7	0.7	11	12	12	12	0.4	0.2	– 99 %	– 37.2 %	0.0 %	0.0 %
Netherlands	1 143	918	752	723	675	653	620	590	563	570	– 50 %	1.3 %	1.8 %	2.8 %
Poland	3 593	4 386	3 209	3 051	3 057	2 771	2 787	2 650	2 407	2 401	– 33 %	– 0.2 %	5.7 %	11.9 %
Portugal	805	804	656	445	327	307	291	284	277	272	– 66 %	– 2.0 %	1.3 %	1.3 %
Romania	2 369	2 332	3 644	957	875	801	824	771	774	751	– 68 %	– 3.0 %	3.7 %	3.7 %
Slovakia	528	394	312	277	226	232	228	224	231	231	– 56 %	– 0.1 %	0.8 %	1.1 %
Slovenia	324	285	190	154	135	132	129	127	108	110	– 66 %	2.0 %	0.5 %	0.5 %
Spain	4 782	4 042	2 936	2 108	1 760	1 718	1 663	1 627	1 645	1 643	– 66 %	– 0.1 %	7.6 %	8.1 %
Sweden	1 102	970	705	585	523	510	486	482	466	461	– 58 %	– 1.2 %	1.7 %	2.3 %
United Kingdom	7 377	5 962	4 043	2 921	1 967	1 792	1 772	1 771	1 709	1 645	– 78 %	– 3.7 %	11.7 %	8.2 %
EU-28 (a)	**63 213**	**51 401**	**39 527**	**29 560**	**25 027**	**22 701**	**22 051**	**21 685**	**20 232**	**20 170**	**– 68 %**	**– 0.3 %**	**100 %**	**100 %**
EU-28 (b)	63 148	51 341	39 509	29 548	25 018	22 693	22 045	21 679	20 225	20 161				

Notes: Light-grey 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.

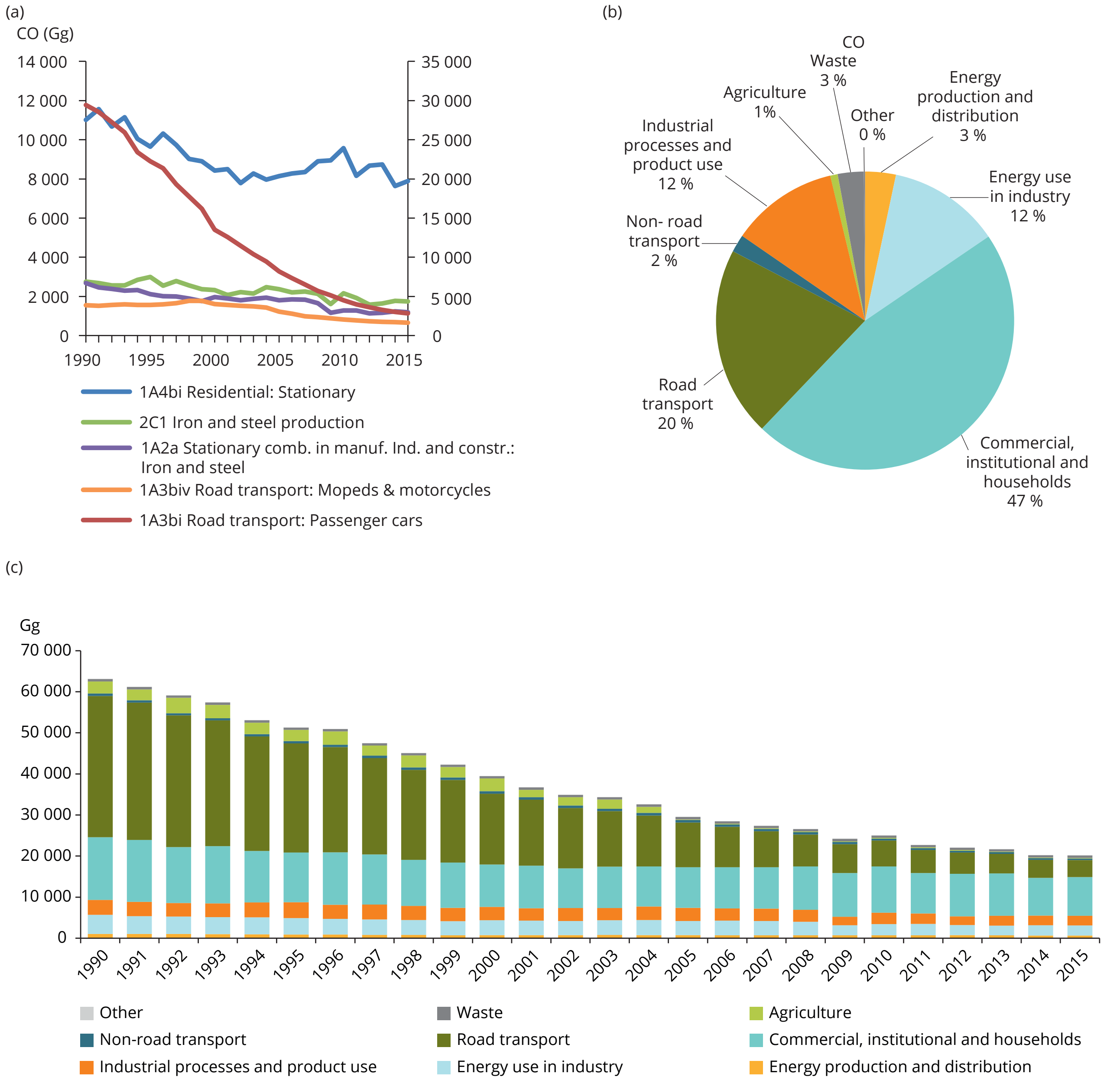
3.12 Lead (Pb) emission trends and key categories

Between 1990 and 2015, Pb emissions dropped in the EU-28 by 92 %. Between 2014 and 2015, emissions decreased by 1.1 %, mainly because emissions decreased in Estonia, France, Poland and Bulgaria (see Table 3.13). The Member States that contributed most (i.e. more than 10 %) to Pb emissions in 2015 were Poland, Italy Germany and Spain. Data for Greece could not be gap-filled for 2010 to 2015, so the EU-28 total is underestimated for those years.

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

Croatia explained that, between 1990 and 2015, Pb emissions from the transport sector decreased by 99 % as a result of legislative efforts to remove lead from petrol. Efforts began in 1996 when the Pb content in leaded petrol was reduced and then

Figure 3.11 CO emissions in the EU-28: (a) trend in emissions from the five most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions



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

even more reduced in 2003. Finally, in 2006 leaded petrol was completely removed from use (personal communication by Croatia in 2017).

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

Latvia's Pb emissions, in comparison with the year 1990, had decreased by 99 % in 2015. The most significant emission decrease occurred in 2011, due to a change of the furnace type used in metal production (see Latvia's IIR, listed in Appendix 5).

Portugal stated that the Pb emissions registered from 1990 to 2015 show a downward trend, falling by 94 %. This is mainly a result of the reduction in emissions from road transport, due to the phasing out of leaded petrol within the EU (see Portugal's IIR, listed in Appendix 5).

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

The largest relative reductions in emissions between 1990 and 2015 were from the most important key category, '2C1 — Iron and steel production' (−73 %) and the fifth most important key category, '1A2f – Stationary combustion in manufacturing industry' (−59 %). The third most important key category, '1A3bvi — Road

Table 3.13 Member State contributions to EU emissions of Pb

	Pb (Mg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	215	16	12	13	15	15	15	16	15	15	– 93 %	0.9 %	0.9 %	0.8 %
Belgium	254	187	107	74	40	29	29	26	24	30	– 88 %	26.9 %	1.1 %	1.7 %
Bulgaria	321	323	256	126	70	75	75	76	86	81	– 75 %	– 6.5 %	1.4 %	4.5 %
Croatia	539	329	277	53	8.0	7.8	7.2	7.3	7.1	7.1	– 99 %	0.2 %	2.3 %	0.4 %
Cyprus	43	50	49	29	31	30	27	24	24	25	– 41 %	4.0 %	0.2 %	1.4 %
Czech Republic	269	180	95	38	25	22	21	22	23	20	– 93 %	– 13.6 %	1.2 %	1.1 %
Denmark	128	26	19	17	12	12	11	12	11	12	– 91 %	2.1 %	0.6 %	0.7 %
Estonia	206	86	37	36	39	38	34	39	37	28	– 86 %	– 22.2 %	0.9 %	1.6 %
Finland	321	66	44	22	23	21	19	18	17	14	– 96 %	– 18.9 %	1.4 %	0.8 %
France	4 296	1 478	282	172	135	130	124	121	118	111	– 97 %	– 5.9 %	18.5 %	6.2 %
Germany	2 250	712	403	286	220	221	212	208	214	220	– 90 %	2.9 %	9.7 %	12.3 %
Greece	470	470	470	470	n/a	n/a	n/a	n/a	n/a	n/a			2.0 %	
Hungary	644	195	23	10.0	8.4	9.2	9.1	8.6	8.2	8.6	– 99 %	5.2 %	2.8 %	0.5 %
Ireland	124	78	19	18	16	15	14	14	13	13	– 89 %	– 0.9 %	0.5 %	0.7 %
Italy	4 344	2 037	957	284	266	263	266	257	260	255	– 94 %	– 1.9 %	18.7 %	14.3 %
Latvia	262	144	156	170	164	3.9	5.5	3.7	3.2	3.2	– 99 %	– 0.4 %	1.1 %	0.2 %
Lithuania	150	92	7.3	4.4	4.8	4.6	4.5	4.6	4.5	4.1	– 97 %	– 8.9 %	0.6 %	0.2 %
Luxembourg	44	19.4	1.3	1.5	1.4	1.8	1.9	1.4	1.5	1.5	– 96 %	3.5 %	0.2 %	0.1 %
Malta	0.4	0.5	0.7	0.8	3.4	5.8	13	8.6	4.2	0.7	83 %	– 84.3 %	0.0 %	0.0 %
Netherlands	332	153	27	30	38	22	16	14	9	9	– 97 %	– 4.0 %	1.4 %	0.5 %
Poland	586	590	470	492	528	513	528	511	514	508	– 13 %	– 1.2 %	2.5 %	28.4 %
Portugal	572	786	37	38	35	35	36	36	36	36	– 94 %	– 0.1 %	2.5 %	2.0 %
Romania	151	125	102	72	42	42	39	36	37	39	– 74 %	6.8 %	0.6 %	2.2 %
Slovakia	74	62	51	59	50	51	48	42	50	53	– 29 %	4.8 %	0.3 %	2.9 %
Slovenia	600	388	130	129	9.7	9.5	8.6	8.4	7.8	7.8	– 99 %	0.0 %	2.6 %	0.4 %
Spain	2 760	953	599	233	208	206	204	189	203	210	– 92 %	3.6 %	11.9 %	11.8 %
Sweden	353	32	22	14	12	11	11	10	11	10	– 97 %	– 6.7 %	1.5 %	0.6 %
United Kingdom	2 892	1 535	155	109	64	63	66	63	69	65	– 98 %	– 5.8 %	12.5 %	3.6 %
EU-28 (a)	**23 200**	**11 113**	**4 807**	**3 001**	**2 067**	**1 859**	**1 847**	**1 779**	**1 807**	**1 787**	**– 92 %**	**– 1.1 %**	**100 %**	**100 %**
EU-28 (b)	22 705	10 610	4 337	2 530	2 067	1 858	1 846	1 779	1 807	1 786				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-grey 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.

transport: Automobile tyre and brake wear', has increased by 26 % since 1990.

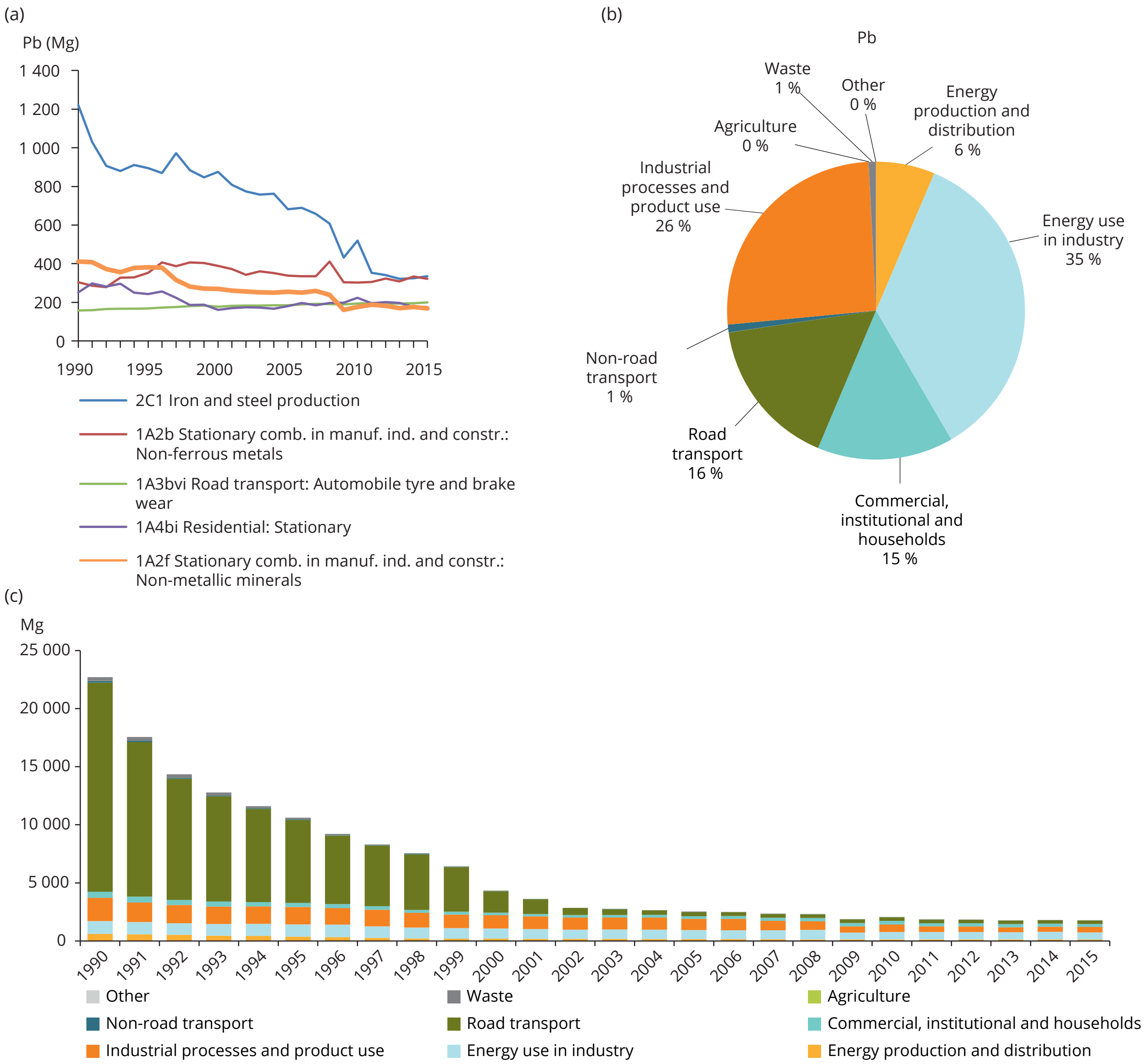
Emissions of Pb from the category '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals' peaked in 2008. That was mainly because Bulgaria reported high emissions for that year.

The strong increase of Pb emissions from 1996 to 1997 is mainly due to emissions reported by a single iron and steel facility in Belgium from 1996 onwards. The emissions are based on measurements performed according to the measuring liabilities included in Vlarem (the Flemish environmental legislation). Before 1996 there were no measuring and reporting obligations for Pb in this facility and hence no emissions were reported (see Belgium's IIR, listed in Appendix 5).

Emissions of Pb have declined to a 10th of the EU total in 1990. This is primarily because countries reduced emissions from the 'road transport' sector. The promotion of unleaded petrol within the EU through a combination of fiscal and regulatory measures has been a notable success story. EU Member States and other EEA member countries have now phased out the use of leaded petrol. In the EU, the Directive on the Quality of Petrol and Diesel Fuels (98/70/EC) regulated that goal (EEA, 2016d).

Figure 3.12(b) shows the contribution that each aggregated sector group made to total EU-28

Figure 3.12 Pb emissions in the EU-28: (a) trend in emissions from the five most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions



emissions. For Pb, common major emission sources are the sectors 'energy use in industry', 'industrial processes and product use', 'road transport' and 'commercial, institutional and households'.

3.13 Cadmium (Cd) emission trends and key categories

Between 1990 and 2015, Cd emissions decreased by 67 % in the EU-28. Between 2014 and 2015, they decreased by 2.2 % (Table 3.14), mainly because emissions decreased in Bulgaria, Portugal, France and Poland. The Member States that contributed most (i.e. more than 10 %) to Cd emissions in 2014 were Poland, Spain, Germany and Italy. Greece did not submit an inventory in 2017. Greece reported an emission value only once (for 1996), which has been used to gap-fill the years up to 2005. Data for 2010 to 2015 could not be gap-filled, so the EU-28 total is underestimated for those years.

'1A4bi — Residential: Stationary', '2C1 – Iron and steel production' and '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' were the principal key categories for Cd emissions, making up 42 % of total Cd emissions (see Figure 3.13(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2015 were in the fourth most important, '1A1a — Public electricity and heat production' (−77 %), and the third most important, '1A2f — Stationary

Table 3.14 Member State contributions to EU emissions of Cd

	Cd (Mg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	1.6	1.0	0.9	1.1	1.2	1.2	1.2	1.2	1.2	1.2	– 25 %	2.0 %	0.8 %	1.9 %
Belgium	6.2	5.0	2.7	2.1	1.9	1.6	1.4	1.4	1.2	1.6	– 75 %	31.2 %	3.3 %	2.5 %
Bulgaria	5.2	3.7	3.5	2.9	1.1	1.2	1.1	1.2	2.1	1.1	– 78 %	– 44.5 %	2.8 %	1.8 %
Croatia	1.2	0.8	0.9	1.1	1.0	0.9	0.9	0.9	0.8	0.9	– 25 %	7.6 %	0.6 %	1.4 %
Cyprus	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	– 39 %	2.3 %	0.0 %	0.1 %
Czech Republic	4.3	3.6	1.3	1.2	0.9	0.8	0.7	0.7	0.7	0.6	– 85 %	– 9.8 %	2.3 %	1.0 %
Denmark	1.1	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	– 40 %	13.2 %	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	– 83 %	– 16.7 %	2.4 %	1.2 %
Finland	6.4	1.7	1.4	1.4	1.5	1.4	1.4	1.3	0.9	0.9	– 86 %	– 2.2 %	3.4 %	1.5 %
France	21	18	14	5.7	3.1	3.0	2.7	2.8	2.9	2.7	– 87 %	– 9.2 %	11.0 %	4.3 %
Germany	24	14	12	9.1	7.1	7.1	6.8	6.9	6.5	6.6	– 72 %	0.9 %	12.6 %	10.5 %
Greece	3.0	3.0	3.0	3.0	n/a	n/a	n/a	n/a	n/a	n/a			1.6 %	
Hungary	1.7	1.6	1.7	1.2	1.5	1.6	1.7	1.7	1.5	1.6	– 9 %	4.4 %	0.9 %	2.5 %
Ireland	0.5	0.5	0.5	0.3	0.3	0.2	0.2	0.2	0.3	0.3	– 49 %	3.5 %	0.3 %	0.4 %
Italy	10	9.4	8.9	8.2	7.0	6.8	7.0	6.6	6.5	6.3	– 37 %	– 3.0 %	5.3 %	10.1 %
Latvia	0.9	0.8	0.9	1.1	1.0	0.6	0.8	0.6	0.6	0.6	– 34 %	0.2 %	0.5 %	1.0 %
Lithuania	0.4	0.4	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.8	89 %	23.4 %	0.2 %	1.3 %
Luxembourg	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	– 16 %	7.1 %	0.1 %	0.1 %
Malta	0.2	0.4	0.5	0.6	0.1	0.0	0.0	0.0	0.0	0.0	– 98 %	– 36.5 %	0.1 %	0.0 %
Netherlands	2.1	1.1	1.0	1.8	2.6	1.2	0.9	0.7	0.6	0.6	– 71 %	– 0.4 %	1.1 %	1.0 %
Poland	22	27	19	15	15	15	15	14	14	13	– 39 %	– 1.6 %	11.9 %	21.5 %
Portugal	6.3	6.6	6.3	7.1	4.6	3.4	3.0	4.6	4.7	4.4	– 31 %	– 6.1 %	3.4 %	7.0 %
Romania	3.8	3.8	3.8	3.8	3.3	3.2	3.2	2.9	2.9	2.9	– 25 %	– 1.2 %	2.1 %	4.6 %
Slovakia	8.4	9	6.9	5.8	1.2	1.1	1.1	1.1	1.2	1.2	– 86 %	1.4 %	4.5 %	1.9 %
Slovenia	1.4	1.0	0.7	0.9	0.7	0.6	0.6	0.7	0.6	0.6	– 55 %	3.8 %	0.7 %	1.0 %
Spain	26	23	19	16	10	9.8	9.4	8.3	8.4	8.6	– 66 %	1.7 %	13.7 %	13.7 %
Sweden	2.3	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	– 77 %	– 1.9 %	1.3 %	0.9 %
United Kingdom	23	12	6.3	4.1	3.3	3.5	3.2	3.2	3.7	3.5	– 85 %	– 5.6 %	12.3 %	5.6 %
EU-28 (a)	**187**	**151**	**118**	**96**	**71**	**67**	**65**	**63**	**64**	**63**	**– 67 %**	**– 2.2 %**	**100 %**	**100 %**
EU-28 (b)	184	148	115	93	71	67	65	63	64	62				

Notes: Dark-gray shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-grey 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.

combustion in manufacturing industries and construction: Non-metallic minerals' (−77 %).

As they have for Pb, industrial sources of Cd emissions have decreased since the early 1990s in all Member States. This is largely because abatement technologies for wastewater treatment and incinerators have improved, and so have metal refining and smelting facilities (EEA, 2016d).

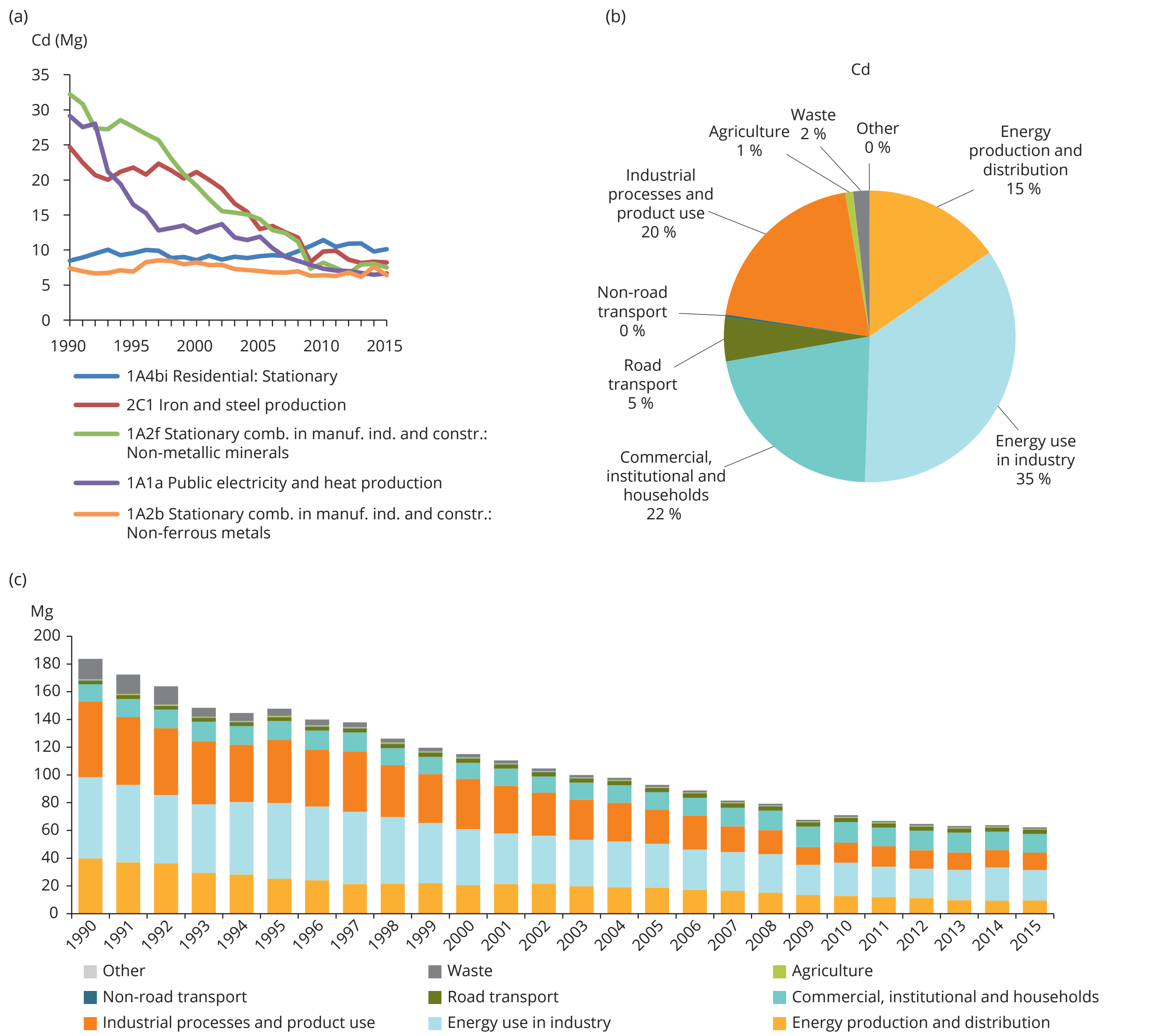
Figure 3.13(b) shows the contribution that each aggregated sector group made to total EU-28 emissions. For Cd, common leading emission sources are the energy sectors and the 'commercial, institutional and households' sector.

3.14 Mercury (Hg) emission trends and key categories

Between 1990 and 2015, Hg emissions dropped by 74 % in the EU-28. Between 2014 and 2015, the decrease was 0.6 % (see Table 3.15), mainly because emissions reduced in the United Kingdom, France, Belgium and Finland. The Member States that contributed most (i.e. more than 10 %) to Hg emissions in 2015 were Poland, Germany and Italy. Data for Greece could not be gap-filled for 2010 to 2015, so the EU-28 total is underestimated for those years.

'1A1a — Public electricity and heat production', '2C1 — Iron and steel production' and '1A2f — Stationary

Figure 3.13 Cd emissions in the EU-28: (a) trend in emissions from the five most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions



combustion in manufacturing industries and construction: Non-metallic minerals' were the chief key categories for Hg emissions, making up 58 % of the total (see Figure 3.14(a)). Among the top five key categories, the highest relative reduction in emissions between 1990 and 2015 was in the most important, '1A1a — Public electricity and heat production' (−66 %). The third most important, '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' (−58 %), and the second most important, '2C1 — Iron and steel production' (−43 %), also show high reductions.

Table 3.15 Member State contributions to EU emissions of Hg

	Hg (Mg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	2.1	1.2	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	– 55 %	– 1.7 %	1.0 %	1.7 %
Belgium	5.7	3.0	3.0	1.9	1.7	1.6	1.2	1.4	1.5	1.1	– 81 %	– 27.8 %	2.6 %	1.9 %
Bulgaria	2.4	2.0	1.5	1.6	0.9	1.0	0.8	0.8	0.8	0.8	– 68 %	1.5 %	1.1 %	1.4 %
Croatia	1.2	0.3	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.5	– 58 %	– 3.1 %	0.5 %	0.8 %
Cyprus	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	– 5 %	– 9.0 %	0.0 %	0.2 %
Czech Republic	7.5	7.4	2.9	3.0	2.8	2.8	2.4	2.2	2.2	2.1	– 72 %	– 2.8 %	3.4 %	3.7 %
Denmark	3.2	2.3	1.0	0.7	0.4	0.4	0.3	0.3	0.3	0.3	– 91 %	– 11.0 %	1.4 %	0.5 %
Estonia	1.2	0.6	0.6	0.5	0.7	0.7	0.6	0.7	0.7	0.5	– 53 %	– 20.3 %	0.5 %	1.0 %
Finland	1.1	0.8	0.6	0.9	0.9	0.7	0.8	0.7	1.0	0.6	– 40 %	– 33.1 %	0.5 %	1.1 %
France	25	21	12	6.4	4.5	4.6	4.0	3.7	3.9	3.4	– 86 %	– 11.1 %	11.3 %	6.0 %
Germany	35	20	18	14	11	10	10	9.6	9.2	9.1	– 74 %	– 1.6 %	15.8 %	16.0 %
Greece	13	13	13	13	n/a	n/a	n/a	n/a	n/a	n/a			5.9 %	
Hungary	3.1	2.4	2.2	1.6	1.4	1.3	1.2	1.0	1.0	1.1	– 64 %	9.1 %	1.4 %	2.0 %
Ireland	0.8	0.7	0.4	0.4	0.4	0.3	0.4	0.3	0.3	0.4	– 56 %	4.9 %	0.4 %	0.6 %
Italy	12	10	9.2	9.9	8.7	8.6	8.4	8.2	8.2	8.2	– 29 %	0.4 %	5.3 %	14.4 %
Latvia	0.3	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	– 73 %	6.3 %	0.1 %	0.1 %
Lithuania	0.6	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.7	11 %	> 100 %	0.3 %	1.2 %
Luxembourg	0.4	0.2	0.3	0.2	0.1	0.1	0.1	0.2	0.1	0.1	– 81 %	26.2 %	0.2 %	0.1 %
Malta	0.4	0.5	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	– 99 %	– 40.5 %	0.2 %	0.0 %
Netherlands	3.6	1.5	1.1	1.0	0.6	0.7	0.6	0.6	0.5	0.6	– 84 %	1.8 %	1.6 %	1.0 %
Poland	14	13	10	10.0	9.6	9.6	9.9	10	9.6	11	– 25 %	10.2 %	6.4 %	18.6 %
Portugal	3.3	3.4	3.1	2.7	1.8	1.7	1.7	1.7	1.7	1.8	– 46 %	6.3 %	1.5 %	3.1 %
Romania	11	9.4	7.7	5.4	2.2	2.4	2.2	1.9	2.0	2.1	– 81 %	5.7 %	5.1 %	3.7 %
Slovakia	19	4.1	4.6	2.8	1.3	1.1	1.2	1.2	1.2	1.1	– 94 %	– 7.3 %	8.6 %	2.0 %
Slovenia	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	– 51 %	– 1.7 %	0.1 %	0.3 %
Spain	15	17	13	11	6.8	6.5	6.3	5.5	5.4	5.4	– 64 %	0.7 %	6.9 %	9.5 %
Sweden	1.5	1.0	0.7	0.7	0.5	0.5	0.5	0.5	0.4	0.4	– 73 %	– 4.1 %	0.7 %	0.7 %
United Kingdom	37	20	8.3	7.4	6.4	5.9	5.6	5.9	5.3	4.8	– 87 %	– 10.2 %	17.0 %	8.4 %
EU-28 (a)	**220**	**155**	**116**	**98**	**65**	**63**	**60**	**58**	**57**	**57**	**– 74 %**	**– 0.6 %**	**100 %**	**100 %**
EU-28 (b)	207	142	103	85	64	63	60	58	57	57				

Notes: Grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

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

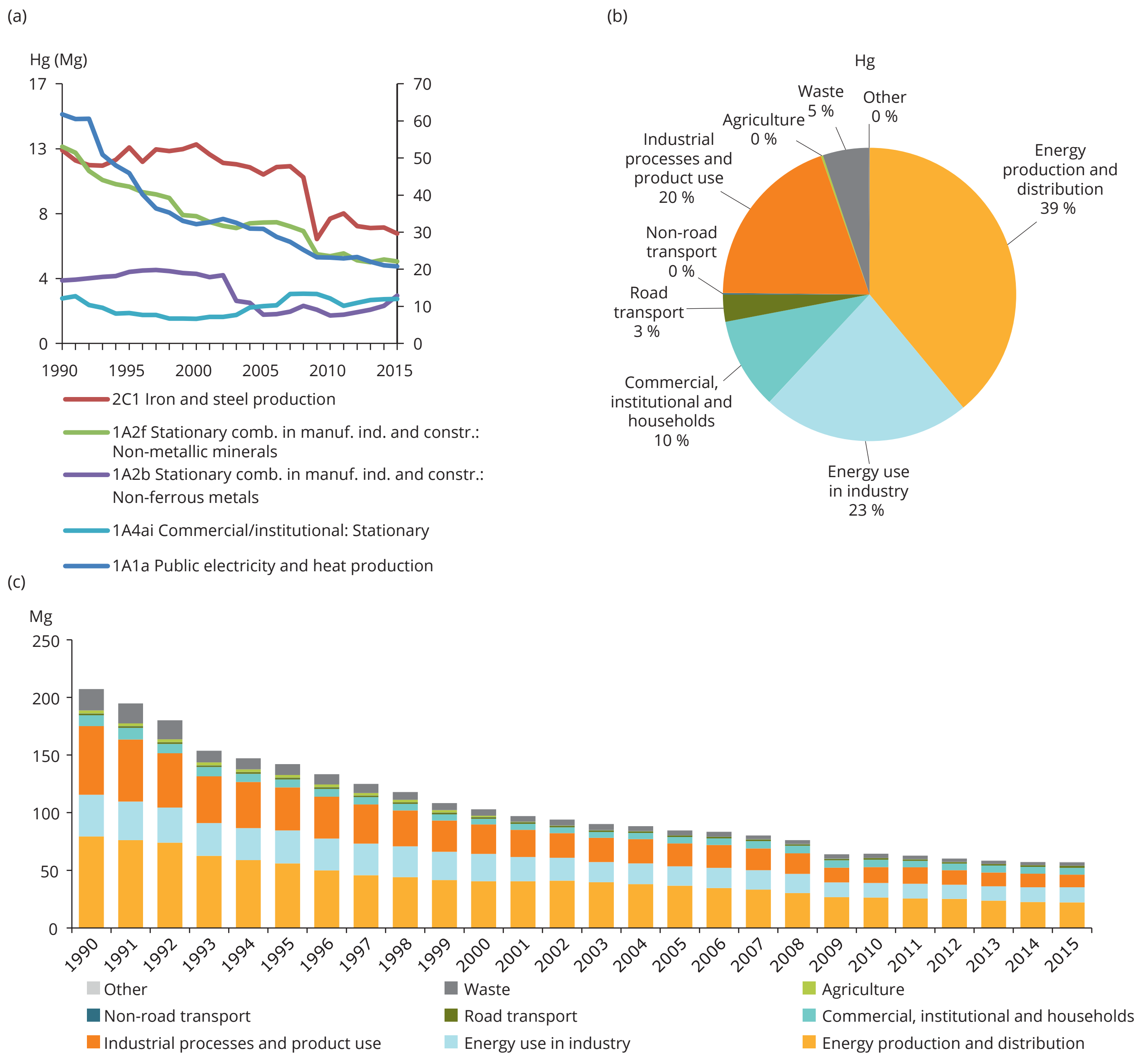
(a) Sum of national totals as reported by Member States.

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

The decrease in mercury emissions since 1990 in the industrial sector is mainly due to improving emission controls on mercury cells and replacing them with diaphragm or membrane cells, and switching from coal to gas and other energy sources in the power- and heat-generating sectors in many countries (EEA, 2016d).

Figure 3.14(b) shows the contribution that each aggregated sector group made to total EU-28 emissions. For Hg, principal emission sources are the energy sectors and the sector 'industrial processes and product use'.

Figure 3.14 Hg emissions in the EU-28: (a) trend in emissions from the five most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions



3.15 Arsenic (As) emission trends

Between 1990 and 2015, As emissions in the EU-28 dropped by 62 %. Between 2014 and 2015, emissions increased by 0.3 %, mainly because emissions increased in Slovakia, Italy and Spain (see Table 3.16). The Member States that contributed most (i.e. more than 10 %) to As emissions in 2015 were Italy, Poland and Slovakia. Greece reported an emission value only once (for 1996), which has been used to gap-fill the years up to 2005. Luxembourg, Austria and Slovenia did not provide emission data for As. Therefore, the EU-28 total is an underestimate.

Table 3.16 Member State contributions to EU emissions of As

	As (Mg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	6.2	6.0	3.8	3.1	2.0	1.8	1.6	1.5	1.2	1.4	– 78 %	10.3 %	1.3 %	0.7 %
Bulgaria	19	15	7.3	15	3.5	4.2	3.0	2.9	4.4	3.0	– 84 %	– 31.1 %	3.9 %	1.6 %
Croatia	8.6	1.2	1.0	1.1	0.8	0.6	0.6	0.4	0.3	0.5	– 95 %	35.0 %	1.8 %	0.2 %
Cyprus	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0 %	– 2.7 %	0.0 %	0.1 %
Czech Republic	7.4	5.5	3.7	2.0	1.6	1.4	1.3	1.5	1.2	1.3	– 82 %	10.1 %	1.5 %	0.7 %
Denmark	1.3	0.8	0.9	0.5	0.3	0.3	0.3	0.4	0.3	0.3	– 77 %	– 5.3 %	0.3 %	0.2 %
Estonia	19	10	8.6	9.2	11	11	9.6	11	10	7.8	– 59 %	– 24.4 %	3.9 %	4.1 %
Finland	33	3.5	4.4	2.8	3.7	3.4	2.9	2.9	3.0	2.4	– 93 %	– 20.0 %	6.8 %	1.3 %
France	17	17	15	12	7.6	6.8	6.1	6.3	5.4	5.2	– 70 %	– 3.2 %	3.6 %	2.8 %
Germany	82	6.9	5.9	5.9	5.5	5.3	5.2	5.3	5.0	5.0	– 94 %	– 1.3 %	16.9 %	2.6 %
Greece	4.0	4.0	4.0	4.0	n/a	n/a	n/a	n/a	n/a	n/a			0.8 %	
Hungary	4.1	3.3	3.1	2.6	2.3	2.3	2.2	1.9	2.0	2.2	– 47 %	9.6 %	0.8 %	1.2 %
Ireland	1.6	1.6	1.6	1.5	1.2	1.2	1.3	1.2	1.2	1.2	– 22 %	4.6 %	0.3 %	0.7 %
Italy	36	27	45	40	45	46	45	44	44	45	24 %	2.1 %	7.5 %	24.1 %
Latvia	17	8.6	15	17	16	0.1	0.1	0.1	0.1	0.1	– 99 %	6.6 %	3.5 %	0.1 %
Lithuania	0.8	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.5	– 44 %	68.9 %	0.2 %	0.2 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.1	0.2	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	– 99 %	– 6.0 %	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	– 49 %	– 1.2 %	0.3 %	0.3 %
Poland	52	53	40	46	47	45	45	44	44	44	– 16 %	– 1.0 %	10.6 %	23.2 %
Portugal	2.9	3.1	3.0	3.0	1.7	1.6	1.8	1.7	1.6	1.8	– 38 %	10.0 %	0.6 %	1.0 %
Romania	14	12	10	8.2	5.1	5.7	4.8	4.1	4.2	4.4	– 68 %	5.6 %	2.8 %	2.4 %
Slovakia	87	27	6.6	22	22	23	19	14	24	28	– 68 %	16.8 %	17.8 %	14.9 %
Slovenia	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Spain	17	17	21	20	15	15	17	13	15	16	– 5 %	6.2 %	3.5 %	8.6 %
Sweden	5.6	1.5	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.7	– 87 %	– 21.5 %	1.1 %	0.4 %
United Kingdom	51	37	24	18	16	16	17	18	17	16	– 68 %	– 6.1 %	10.4 %	8.7 %
EU-28 (a)	**488**	**262**	**227**	**236**	**209**	**193**	**186**	**176**	**187**	**188**	**– 62 %**	**0.3 %**	**100 %**	**100 %**
EU-28 (b)	484	258	223	232	209	193	186	176	187	188				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-grey 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 2015, Cr emissions in the EU-28 dropped by 73 %. Between 2014 and 2015, emissions decreased by 1.6 % (see Table 3.17), mainly because emissions decreased in Finland and the Estonia. The Member States that contributed most (i.e. more than 10 %) to Cr emissions in 2015 were Germany, Poland and Italy. Greece did not submit an inventory in 2017. However, Greece reported an emission value only once (for 1996), which has been used to gap-fill the years up to 2005. Luxembourg, Austria and Slovenia did not provide emission data for Cr. Therefore, the EU-28 total is an underestimate.

Table 3.17 Member State contributions to EU emissions of Cr

	Cr (Mg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	33	28	18	17	13	11	11	5.9	5.7	5.6	– 83 %	– 1.7 %	2.7 %	1.7 %
Bulgaria	21	11	7.6	9.9	5.3	5.9	5.3	5.1	5.6	6.2	– 70 %	11.8 %	1.7 %	1.9 %
Croatia	5.3	3.6	3.1	3.7	2.6	2.6	2.4	2.1	2.0	2.1	– 60 %	8.3 %	0.4 %	0.6 %
Cyprus	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	22 %	– 1.1 %	0.0 %	0.1 %
Czech Republic	11	12	12	13	11	11	10	10	10	10	– 11 %	– 3.1 %	0.9 %	3.0 %
Denmark	5.8	3.0	1.5	1.6	1.6	1.5	1.4	1.5	1.5	1.6	– 73 %	9.3 %	0.5 %	0.5 %
Estonia	18	10.0	8.4	9.1	11	10	9.2	11	9.8	7.6	– 59 %	– 22.9 %	1.5 %	2.3 %
Finland	29	22	28	18	22	18	18	18	24	16	– 46 %	– 33.8 %	2.4 %	4.8 %
France	393	190	104	45	28	25	23	23	20	20	– 95 %	0.1 %	32.0 %	6.1 %
Germany	142	77	66	60	58	59	57	58	57	57	– 60 %	0.0 %	11.6 %	17.4 %
Greece	10	10	10	10	n/a	n/a	n/a	n/a	n/a	n/a			0.8 %	
Hungary	18	12	12	12	11	12	11.0	8.0	8.9	11	– 35 %	27.2 %	1.4 %	3.5 %
Ireland	3.8	3.8	4.0	2.7	2.1	2.0	2.0	2.0	2.1	2.1	– 45 %	3.4 %	0.3 %	0.6 %
Italy	91	74	52	59	52	52	50	46	44	45	– 51 %	1.6 %	7.4 %	13.8 %
Latvia	2.6	1.9	2.2	2.6	2.5	1.2	1.4	1.3	1.3	1.4	– 47 %	1.2 %	0.2 %	0.4 %
Lithuania	2.6	1.3	1.3	1.5	1.5	1.5	1.6	1.6	1.6	1.7	– 34 %	5.2 %	0.2 %	0.5 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.6	0.9	1.2	1.5	1.3	1.3	1.3	1.3	0.0	0.0	– 92 %	11.4 %	0.0 %	0.0 %
Netherlands	12	8.5	5.0	4.3	3.8	3.7	3.7	3.6	3.5	3.4	– 71 %	– 4.4 %	1.0 %	1.0 %
Poland	99	76	47	46	53	51	51	49	47	47	– 52 %	0.1 %	8.1 %	14.5 %
Portugal	13	14	15	14	11	11	11	11	11	11	– 17 %	0.6 %	1.1 %	3.3 %
Romania	37	31	26	19	12	12	12	11	11	12	– 67 %	6.6 %	3.0 %	3.7 %
Slovakia	59	7.2	5.8	4.9	4.6	4.3	4.5	4.7	4.8	4.7	– 92 %	– 1.3 %	4.8 %	1.4 %
Slovenia	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Spain	35	39	42	42	31	30	29	26	27	27	– 23 %	1.1 %	2.9 %	8.4 %
Sweden	24	12	7.2	11	5.5	6.9	5.4	5.4	5.0	5.9	– 75 %	18.4 %	1.9 %	1.8 %
United Kingdom	161	116	76	39	29	28	27	28	29	28	– 83 %	– 2.3 %	13.1 %	8.5 %
EU-28 (a)	**1 227**	**763**	**555**	**447**	**375**	**361**	**350**	**333**	**331**	**326**	**– 73 %**	**– 1.6 %**	**100 %**	**100 %**
EU-28 (b)	1 216	753	545	437	374	361	349	332	331	326				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-grey 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 2015, Cu emissions in the EU-28 increased by 10 %. Between 2014 and 2015, emissions increased by 2 %, mainly because emissions increased in Germany and Spain (see Table 3.18). The Member States that contributed most (i.e. more than 10 %) to Cu emissions in 2015 were Germany and Poland. Greece reported an emission value only once (for 1996), which has been used to gap-fill the years up to 2005. Luxembourg, Austria and Slovenia did not provide emission data for Cu. Therefore, the EU-28 total is an underestimate.

Table 3.18 Member State contributions to EU emissions of Cu

	Cu (Mg)										Change		Share in EU-28	
Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	1990–2015	2013–2015	1990	2015
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	40	40	39	36	34	33	32	30	30	30	– 24 %	2.4 %	1.2 %	0.8 %
Bulgaria	103	74	56	97	19	20	20	19	20	25	– 76 %	25.3 %	3.1 %	0.7 %
Croatia	8.7	5.4	6.8	7.6	7.7	7.5	7.4	7.6	7.2	7.6	– 12 %	4.7 %	0.3 %	0.2 %
Cyprus	1.3	1.7	2.2	2.3	2.4	2.4	2.3	2.0	2.0	2.0	54 %	3.2 %	0.0 %	0.1 %
Czech Republic	15	29	42	63	59	58.4	57.1	57.1	59	61	> 100 %	2.4 %	0.4 %	1.6 %
Denmark	32	37	39	41	42	42	41	41	41	43	0	5.0 %	1.0 %	1.2 %
Estonia	10	5.0	3.7	4.6	5.0	4.9	4.7	5.0	5.0	4.5	– 56 %	– 11.8 %	0.3 %	0.1 %
Finland	159	90	80	62	50	45	45	45	43	40	– 75 %	– 7.0 %	4.7 %	1.1 %
France	222	217	218	220	211	216	207	211	209	212	– 4 %	1.7 %	6.6 %	5.7 %
Germany	1714	1857	2035	2057	2114	2157	2142	2156	2199	2240	31 %	1.9 %	50.7 %	60.1 %
Greece	14	14	14	14	n/a	n/a	n/a	n/a	n/a	n/a			0.4 %	
Hungary	19	14	17	21	22	21	20	19	20	16	– 18 %	– 23.0 %	0.6 %	0.4 %
Ireland	9.6	11	18	21	18	18	17	17	18	19	93 %	5.6 %	0.3 %	0.5 %
Italy	136	148	145	149	131	133	128	120	124	120	– 12 %	– 3.4 %	4.0 %	3.2 %
Latvia	5.5	3.7	4.0	5.4	5.9	5.0	4.8	5.0	5.3	5.7	3 %	7.5 %	0.2 %	0.2 %
Lithuania	9.5	4.9	4.5	5.4	6.1	6.0	5.9	6.0	6.0	7	– 31 %	9.5 %	0.3 %	0.2 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.6	0.7	0.8	0.9	27	27	27	27	1.1	1.2	> 100 %	15.6 %	0.0 %	0.0 %
Netherlands	37	38	39	41	45	43	43	43	43	41	10 %	– 4.7 %	1.1 %	1.1 %
Poland	369	402	357	411	433	423	418	401	409	416	13 %	1.6 %	10.9 %	11.1 %
Portugal	22	29	38	39	35	33	30	30	31	31	37 %	0.3 %	0.7 %	0.8 %
Romania	14	17	19	22	19	20	21	20	21	21	44 %	1.3 %	0.4 %	0.6 %
Slovakia	88	48	25	43	54	56	51	39	50	56	– 36 %	10.9 %	2.6 %	1.5 %
Slovenia	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Spain	137	160	232	250	228	221	225	200	223	241	75 %	7.8 %	4.1 %	6.5 %
Sweden	65	52	46	37	38	39	38	38	38	39	– 40 %	1.5 %	1.9 %	1.0 %
United Kingdom	144	111	82	64	53	56	51	51	52	52	– 64 %	– 0.5 %	4.3 %	1.4 %
EU-28 ([a])	**3 378**	**3 409**	**3 564**	**3 713**	**3 658**	**3 687**	**3 639**	**3 590**	**3 656**	**3 727**	**10 %**	**2.0 %**	**100 %**	**100 %**
EU-28 ([b])	3 363	3 394	3 549	3 698	3 657	3 686	3 638	3 589	3 654	3 726				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-grey 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 2015, Ni emissions in the EU-28 dropped by 74 %. Between 2014 and 2015, emissions decreased by 4.1 %, mainly because the United Kingdom reported reductions (see Table 3.19). The Member States that contributed most (i.e. more than 10 %) to Ni emissions in 2015 were Poland, Spain, the United Kingdom and Germany. Greece reported an emission value once only (for 1996), which has been used to gap-fill the years up to 2005. Luxembourg , Austria and Slovenia did not provide emission data for Ni. Therefore, the EU-28 total is an underestimate.

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

3.19 Selenium (Se) emission trends

Between 1990 and 2015, Se emissions in the EU-28 dropped by 36 %. Between 2014 and 2015, emissions decreased by 17.7 %, mainly because emissions decreased in Spain (see Table 3.20). The Member States that contributed most (i.e. more than 10 %) to

Table 3.19 Member State contributions to EU emissions of Ni

	Ni (Mg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	72	67	33	26	8.9	8.7	6.1	4.6	4.3	4.3	– 94 %	0.0 %	3.2 %	0.7 %
Bulgaria	30	30	7.6	23	6.6	6.9	5.3	5.6	5.7	5.8	– 81 %	1.7 %	1.3 %	1.0 %
Croatia	26	20	17	20	15	12	10	7.5	6.6	6.4	– 76 %	– 3.2 %	1.2 %	1.1 %
Cyprus	5.9	7.2	9.9	12	7.1	8.9	9.4	5.2	5.2	5.3	– 10 %	1.6 %	0.3 %	0.9 %
Czech Republic	17	16	14	12	8	7	6.0	5.3	5.4	5.1	– 70 %	– 4.0 %	0.8 %	0.9 %
Denmark	21	16	8.7	7.8	5.3	4.7	4.5	4.2	3.7	3.7	– 83 %	0.1 %	0.9 %	0.6 %
Estonia	27	10	6.4	6.4	6.6	6.4	5.6	6.5	6.0	4.6	– 83 %	– 22.8 %	1.2 %	0.8 %
Finland	64	36	36	28	24	21	20	17	19	17	– 74 %	– 9.1 %	2.8 %	2.8 %
France	293	212	186	148	92	80	67	52	46	40	– 86 %	– 12.3 %	12.9 %	6.7 %
Germany	286	164	120	133	112	100	96	94	81	80	– 72 %	– 1.6 %	12.6 %	13.4 %
Greece	101	101	101	101	n/a	n/a	n/a	n/a	n/a	n/a			4.5 %	
Hungary	24	32	21	7.7	6.9	7.8	6.7	6.1	6.1	5.4	– 77 %	– 10.6 %	1.1 %	0.9 %
Ireland	8.7	11	16	9.9	2.3	1.5	1.5	1.4	1.6	1.7	– 80 %	10.4 %	0.4 %	0.3 %
Italy	113	108	103	108	38	36	34	30	29	30	– 74 %	3.6 %	5.0 %	5.0 %
Latvia	15	8.5	6.8	6.6	5.9	0.6	1.0	0.5	0.4	0.4	– 97 %	5.7 %	0.7 %	0.1 %
Lithuania	26	13	6.3	4.5	3.3	2.4	3.3	2.1	1.6	2.3	– 91 %	42.0 %	1.1 %	0.4 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	8.3	13	17	21	6	0.7	0.7		0.0	0.9	– 89 %	> 100 %	0.4 %	0.2 %
Netherlands	73	84	19	10	2.1	2.4	2.1	2.0	1.8	2.0	– 97 %	8.0 %	3.2 %	0.3 %
Poland	241	239	162	162	171	155	153	141	134	139	– 43 %	3.5 %	10.6 %	23.1 %
Portugal	108	111	99	94	43	37	32	26	22	22	– 80 %	– 1.0 %	4.8 %	3.7 %
Romania	67	51.2	35.5	20.3	7.9	8.8	7.5	5.0	5.0	5.3	– 92 %	6.3 %	2.9 %	0.9 %
Slovakia	38	12.0	13	14	13	13	13	13	14	13	– 65 %	– 3.5 %	1.7 %	2.2 %
Slovenia	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Spain	267	327	307	291	172	150	136	117	111	113	– 58 %	1.9 %	11.8 %	18.8 %
Sweden	32	31	19	19	17	13	11	10	8.5	6.9	– 78 %	– 19.3 %	1.4 %	1.1 %
United Kingdom	301	306	170	133	109	84	102	111	108	85	– 72 %	– 20.8 %	13.3 %	14.3 %
EU-28 (a)	**2 267**	**2 027**	**1 534**	**1 420**	**881**	**768**	**734**	**668**	**625**	**599**	**– 74 %**	**– 4.1 %**	**100 %**	**100 %**
EU-28 (b)	2 162	1 921	1 427	1 311	873	760	727	662	619	593				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-grey 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.

Se emissions in 2015 were Spain, Portugal, the Czech Republic and Bulgaria. Greece reported an emission value only once (for 1996), which has been used to gap-fill the years up to 2005. Luxembourg, Austria, Poland and Slovenia did not provide emission data for Se. Therefore, the EU-28 total is an underestimate.

In 2005, Belgium reported high Se emissions in the category '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals'. They occurred because of one glass plant in Wallonia. The plant gives annual emissions based on measurements, and the concentration of Se was very high in 2005 (personal communication by Belgium in 2014). Likewise, Belgium's high emissions in 2010 are mainly attributable to the operations of a particular company in the glass industry in Wallonia (personal communication by Belgium in 2012).

3.20 Zinc (Zn) emission trends

Between 1990 and 2015, Zn emissions in the EU-28 dropped by 34 %. Between 2014 and 2015, emissions decreased slightly by 0.1 %, mainly because Poland,

Table 3.20 Member State contributions to EU emissions of Se

	Se (Mg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	5.0	6.3	6.3	27	11	3.8	3.4	3.4	4.1	4.0	– 21 %	– 3.3 %	1.8 %	2.2 %
Bulgaria	41	12	5.2	13	14	16	15	16	19	20	– 51 %	6.2 %	14.6 %	11.3 %
Croatia	0.5	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.4	0.3	– 31 %	– 9.1 %	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	6 %	– 4.3 %	0.0 %	0.0 %
Czech Republic	28	28	28	30	25.6	25.3	24.1	22.4	22.2	21.6	– 22 %	– 2.6 %	9.9 %	12.0 %
Denmark	4.9	4.5	2.9	2.1	1.9	1.5	1.3	1.6	1.6	1.3	– 73 %	– 15.8 %	1.7 %	0.7 %
Estonia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	90 %	> 100 %	0.0 %	0.0 %
Finland	0.7	0.8	0.9	0.9	1.3	1.1	0.9	0.9	1.2	0.4	– 35 %	– 64.1 %	0.2 %	0.2 %
France	15	15	16	15	12	12	12	11	11	11	– 27 %	0.4 %	5.4 %	6.2 %
Germany	3.5	3.8	3.9	4.1	3.7	3.6	3.6	3.5	3.4	3.4	– 2 %	0.0 %	1.2 %	1.9 %
Greece	0.2	0.2	0.2	0.2	n/a	n/a	n/a	n/a	n/a	n/a			0.1 %	
Hungary	6.6	5.9	5.8	4.2	3.6	3.7	3.6	3.6	3.4	3.3	– 49 %	– 2.8 %	2.3 %	1.9 %
Ireland	2.0	2.2	2.2	2.1	1.4	1.5	1.8	1.5	1.6	1.7	– 14 %	11.8 %	0.7 %	1.0 %
Italy	9	10	11	12	11	11	11	10	9.8	10	9 %	4.0 %	3.3 %	5.7 %
Latvia	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	– 85 %	– 0.3 %	0.1 %	0.0 %
Lithuania	0.5	0.3	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.3	– 31 %	85.3 %	0.2 %	0.2 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.0	0.0	0.0	0.0	0.2	0.1	2.1	0.1	0.0	0.0	> 100 %	75.4 %	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	> 100 %	27.6 %	0.1 %	0.5 %
Poland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE				
Portugal	12	17	23	27	30	30	32	32	32	32	> 100 %	– 1.2 %	4.3 %	17.6 %
Romania	14	14	13	13	12	14	12	9.2	9.6	9.8	– 30 %	2.3 %	5.0 %	5.5 %
Slovakia	9	9.1	7.1	9.4	12	11	12	9.9	10.4	13	43 %	20.2 %	3.1 %	7.0 %
Slovenia	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Spain	50	57	76	85	71	73	71	66	70	32	– 37 %	– 54.6 %	17.8 %	17.7 %
Sweden	1.0	1.2	1.1	1.2	1.3	1.3	1.3	1.3	1.2	1.2	22 %	0.0 %	0.3 %	0.7 %
United Kingdom	77	50	33	34	17	17	20	17	16	13	– 83 %	– 16.3 %	27.4 %	7.5 %
EU-28 (a)	**282**	**239**	**237**	**283**	**232**	**229**	**227**	**210**	**218**	**180**	**– 36 %**	**– 17.7 %**	**100 %**	**100 %**
EU-28 (b)	282	238	237	283	232	229	227	210	218	180				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-grey 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.

Italy and the Netherlands reported decreased emissions (see Table 3.21). The Member States that contributed most (i.e. more than 10 %) to Zn emissions in 2015 were Germany, Poland and Italy. Greece reported an emission value only once (for 1996), which has been used to gap-fill the years up to 2005. Luxembourg, Austria and Slovenia did not provide emission data for Zn. Therefore, the EU-28 total is an underestimate.

Ireland explained the emission decline after 2000 by the closure of Ireland's only steel plant in 2001. From 1990 to 2001, the main determinant of the trend in Zn emissions was metal production. It accounted on average for 54 % of national total emissions throughout that period (see Ireland's IIR, listed in Appendix 5).

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

Between 1990 and 2015, PCDD/F emissions dropped in the EU-28 by 85 %. Between 2014 and 2015, the increase was 1.7 % (see Table 3.22), mainly because Italy, Poland and Hungary reported increased emissions. The Member States that contributed most

Table 3.21 Member State contributions to EU emissions of Zn

	Zn (Mg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	235	190	183	131	110	103	89	81	81	83	– 65 %	2.4 %	2.2 %	1.2 %
Bulgaria	222	153	292	175	120	134	125	125	136	124	– 44 %	– 8.5 %	2.1 %	1.8 %
Croatia	39	32	30	37	36	35	35	35	32	35	– 10 %	9.6 %	0.4 %	0.5 %
Cyprus	3.8	4.6	6.0	6.9	5.3	5.8	5.8	4.3	4.5	4.5	19 %	0.8 %	0.0 %	0.1 %
Czech Republic	71	74	75	87	78	76	71	66	66	66	– 7 %	– 1.0 %	0.7 %	0.9 %
Denmark	69	63	54	57	61	58	55	56	56	60	– 13 %	7.1 %	0.7 %	0.9 %
Estonia	107	64	50	53	63	61	55	63	57	47	– 56 %	– 18.4 %	1.0 %	0.7 %
Finland	598	349	98	142	165	138	145	139	141	129	– 78 %	– 8.7 %	5.7 %	1.9 %
France	2218	1418	1004	571	506	503	499	482	468	476	– 79 %	1.7 %	21.1 %	6.8 %
Germany	1712	1732	1897	1903	1972	2001	1984	2004	2031	2071	21 %	2.0 %	16.3 %	29.7 %
Greece	52	52	52	52	n/a	n/a	n/a	n/a	n/a	n/a			0.5 %	
Hungary	72	53	57	49	56	63	70	65	58	65	– 10 %	11.5 %	0.7 %	0.9 %
Ireland	54	49	55	26	21	19	19	20	20	20	– 63 %	2.3 %	0.5 %	0.3 %
Italy	966	953	916	987	915	973	941	882	876	860	– 11 %	– 1.8 %	9.2 %	12.3 %
Latvia	30	29	26	31	29	26	30	27	27	28	– 9 %	0.7 %	0.3 %	0.4 %
Lithuania	28	20	20	25	26	25	27	27	28	32	16 %	12.8 %	0.3 %	0.5 %
Luxembourg	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Malta	0.4	0.5	0.6	0.7	10	11	8.5	10	2.4	1.4	> 100 %	– 40.4 %	0.0 %	0.0 %
Netherlands	224	146	95	88	102	93	94	85	117	101	– 55 %	– 13.3 %	2.1 %	1.5 %
Poland	1820	1808	1287	1348	1526	1449	1496	1436	1428	1407	– 23 %	– 1.4 %	17.3 %	20.2 %
Portugal	72	79	95	97	93	96	95	93	94	95	32 %	0.7 %	0.7 %	1.4 %
Romania	144	136	136	137	126	119	122	115	116	116	– 20 %	0.0 %	1.4 %	1.7 %
Slovakia	99	77	71	80	74	75	76	77	83	86	– 13 %	3.2 %	0.9 %	1.2 %
Slovenia	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Spain	386	412	480	514	482	486	479	459	475	486	26 %	2.3 %	3.7 %	7.0 %
Sweden	197	156	111	123	136	125	126	120	117	121	– 38 %	3.6 %	1.9 %	1.7 %
United Kingdom	1072	1041	710	512	459	442	416	451	456	453	– 58 %	– 0.5 %	10.2 %	6.5 %
EU-28 (a)	**10 491**	**9 089**	**7 801**	**7 235**	**7 173**	**7 116**	**7 063**	**6 923**	**6 970**	**6 966**	**– 34 %**	**– 0.1 %**	**100 %**	**100 %**
EU-28 (b)	10 439	9 036	7 748	7 182	7 172	7 115	7 062	6 922	6 969	6 965				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

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

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

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

(i.e. more than 10 %) to PCDD/F emissions in 2015 were Poland, Italy and the United Kingdom. Greece did not report PCDD/F emissions for any year, so data were not gap-filled. The EU-28 total is therefore an underestimate.

Cyprus explained that its PCDD/F emissions decreased by 81 % from 1990 to 2015, and especially between 2000 and 2005 mainly due to reductions in the category '5C1biii — Clinical waste incineration', as a clinical waste incineration plant was terminated in 2003 and all clinical wastes are subjected to sterilization (see Cyprus's IIR, listed in Appendix 5).

Finland stated that the inventories of PCDD/F emissions from the year 2005 onwards are not comparable with those for earlier years due to changes in the methodologies of several sectors. Recalculation of the time series is scheduled for the submission in 2018 (see Finland's IIR, listed in Appendix 5).

The decrease of dioxin emissions in France (1990-2012) was due to regulations limiting emissions, especially in the field 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

Table 3.22 Member State contributions to EU emissions of PCDD/Fs

	PCDD/Fs (g I-TEQ)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990—2015**	**2014—2015**	**1990**	**2015**
Austria	161	59	52	38	36	33	34	38	31	33	– 79 %	7.4 %	1.3 %	1.8 %
Belgium	576	398	117	60	52	43	49	42	34	36	– 94 %	8.0 %	4.8 %	2.0 %
Bulgaria	74	97	112	110	43	51	57	60	50	50	– 32 %	0.4 %	0.6 %	2.7 %
Croatia	46	40	38	45	32	29	28	25	21	21	– 53 %	2.7 %	0.4 %	1.2 %
Cyprus	2.1	2.4	2.6	0.5	0.5	0.4	0.4	0.6	0.4	0.4	– 81 %	11.0 %	0.0 %	0.0 %
Czech Republic	1252	1135	57	56	38	30	30	30	31	26	– 98 %	– 18.5 %	10.3 %	1.4 %
Denmark	67	49	32	27	26	24	23	22	23	24	– 64 %	5.7 %	0.6 %	1.3 %
Estonia	8.1	5.6	6.7	5.7	6.4	6.3	4.7	3.7	4.0	4.1	– 49 %	2.2 %	0.1 %	0.2 %
Finland	34	37	34	12	15	13	14	12	12	14	– 58 %	14.3 %	0.3 %	0.8 %
France	1782	1723	557	236	140	132	118	122	117	114	– 94 %	– 2.0 %	14.7 %	6.2 %
Germany	750	245	166	80	71	68	65	66	62	62	– 92 %	0.2 %	6.2 %	3.3 %
Greece	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Hungary	105	66	72	60	78	86	89	83	73	81	– 23 %	10.5 %	0.9 %	4.4 %
Ireland	66	49	40	38	31	29	28	29	27	27	– 60 %	– 1.4 %	0.5 %	1.4 %
Italy	503	484	404	327	309	268	287	282	269	280	– 44 %	4.2 %	4.1 %	15.2 %
Latvia	23	25	23	27	17	17	18	16	16	16	– 33 %	0.0 %	0.2 %	0.9 %
Lithuania	28	21	23	27	26	27	26	26	24	24	– 16 %	– 2.2 %	0.2 %	1.3 %
Luxembourg	43	34	5.7	1.7	2.1	2.1	1.5	1.5	1.7	1.6	– 96 %	– 7.4 %	0.4 %	0.1 %
Malta	1.0	1.0	1.0	1.0	8.6	1.0	1.0	12	4.5	0.0	– 97 %	– 99.4 %	0.0 %	0.0 %
Netherlands	742	66	31	30	31	31	25	25	22	22	– 97 %	– 1.7 %	6.1 %	1.2 %
Poland	328	369	271	282	298	293	307	286	282	290	– 12 %	2.9 %	2.7 %	15.7 %
Portugal	527	526	330	99	168	103	91	74	80	77	– 85 %	– 3.4 %	4.3 %	4.2 %
Romania	3073	2063	1053	210	203	212	220	191	179	180	– 94 %	0.3 %	25.3 %	9.7 %
Slovakia	111	77	72	57	45	43	46	44	49	49	– 56 %	0.0 %	0.9 %	2.7 %
Slovenia	19	13	12	14	16	16	15	16	14	14	– 24 %	1.9 %	0.2 %	0.8 %
Spain	384	419	176	150	151	154	152	153	158	163	– 58 %	3.1 %	3.2 %	8.8 %
Sweden	67	47	40	42	43	38	31	30	28	28	– 57 %	2.2 %	0.5 %	1.5 %
United Kingdom	1356	876	349	262	228	205	208	210	205	211	– 84 %	2.5 %	11.2 %	11.4 %
EU-28 (a)	**12 129**	**8 925**	**4 078**	**2 296**	**2 115**	**1 957**	**1 968**	**1 900**	**1 817**	**1 848**	**– 85 %**	**1.7 %**	**100 %**	**100 %**
EU-28 (b)	12 128	8 925	4 077	2 295	2 115	1 956	1 967	1 899	1 812	1 848				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

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

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

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

I-Teq, international toxic equivalent.

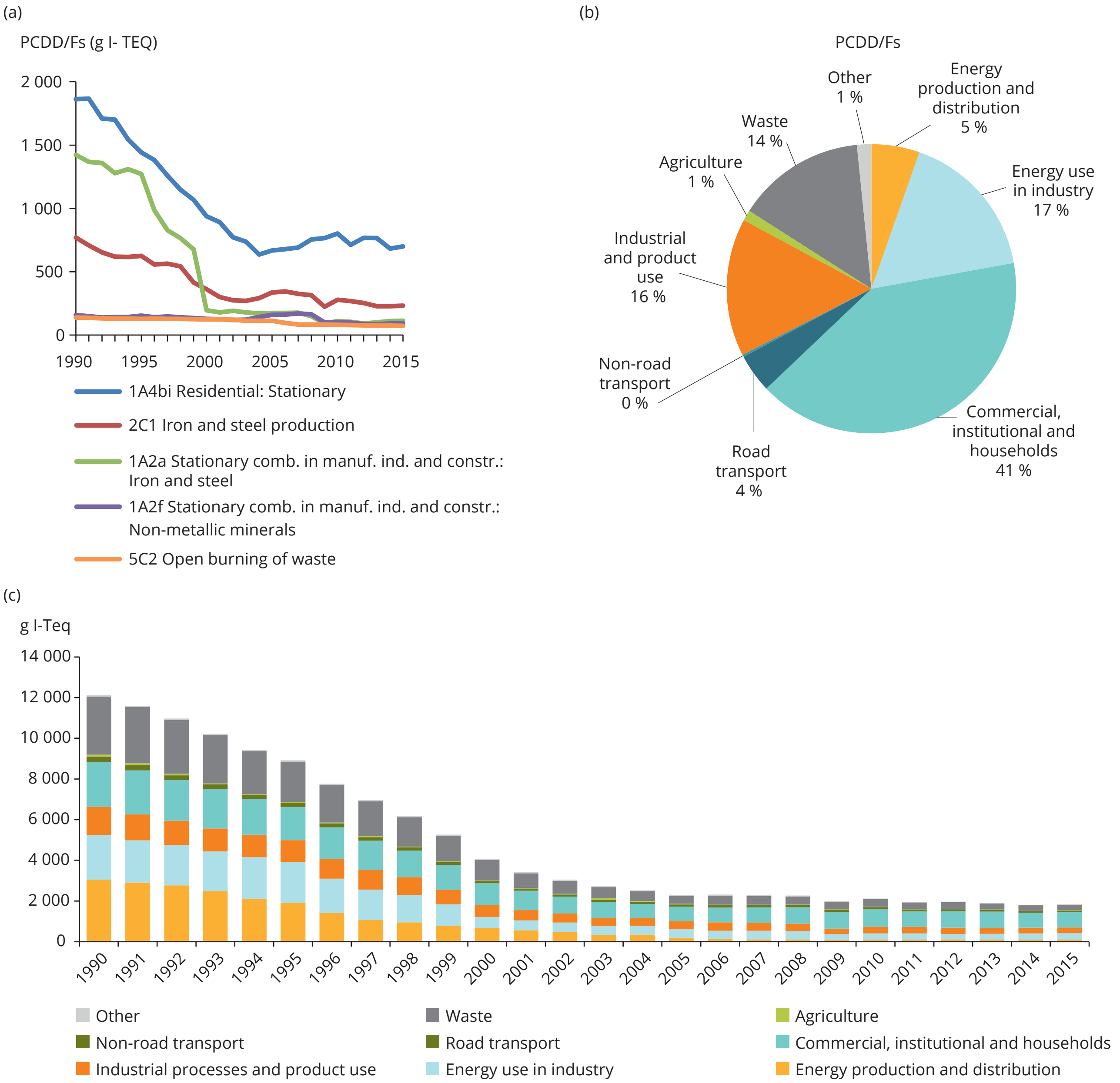
was due to improvements in sinter plants (personal communication by France in 2013).

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

'1A4bi — Residential: Stationary' and '2C1 — Iron and steel production' were the primary key categories for PCDD/F emissions, together making up 51 % of total PCDD/F emissions (see Figure 3.15(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2015 were in the third most important, '1A2a — Stationary combustion in manufacturing industry and construction: Iron and steel' (−92 %).

Figure 3.15(b) shows the contribution that each aggregated sector group made to total EU-28 emissions. The 'commercial, institutional and households' sector group is an important source of PCDD/Fs and also of $PM_{2.5}$, PM_{10}, CO, B(a)P, total PAHs and HCB.

Figure 3.15 PCDD/F emissions in the EU-28: (a) trend in emissions from the five most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions



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

Between 1990 and 2015, total PAH emissions dropped in the EU-28 by 88 %. Between 2014 and 2015, they increased by 2 %, mainly because Germany and Italy reported increased emissions (see Table 3.23). The Member States that contributed most (i.e. more than 10 %) to total PAH emissions in 2015 were Spain, Germany, Poland and Portugal. Greece did not report PAH emissions for any year, so data were not gap-filled. The EU-28 total is therefore an underestimate.

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

'1A4bi — Residential: Stationary' was the principal key category for these emissions, making up 53 % of total

Table 3.23 Member State contributions to EU total emissions of PAHs

	Total PAHs (Mg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	16	8.9	7.4	6.7	5.9	5.3	5.4	6.2	4.8	5.3	– 67 %	10.7 %	0.2 %	0.5 %
Belgium	50	42	22	17	16	14	13	13	9.1	9.4	– 81 %	3.7 %	0.5 %	0.8 %
Bulgaria	50	66	57	55	29	32	32	30	28	27	– 45 %	– 1.9 %	0.5 %	2.4 %
Croatia	24	17	15	19	14	12	11	10	8.0	8.2	– 65 %	2.5 %	0.2 %	0.7 %
Cyprus	14	11	6.6	4.2	1.3	1.3	1.3	1.1	1.0	1.2	– 91 %	22.9 %	0.1 %	0.1 %
Czech Republic	752	1357	25	24	24	20	22	22	18	20	– 97 %	6.9 %	7.7 %	1.7 %
Denmark	5.5	6.2	6.5	8.4	8.9	7.9	7.3	7.5	6.6	7.3	33 %	10.2 %	0.1 %	0.6 %
Estonia	8.2	10	8.5	7.7	8.3	7.1	7.1	7.1	7.1	7.0	– 14 %	– 1.1 %	0.1 %	0.6 %
Finland	16	17	14	13	18	16	17	17	9.7	9.4	– 42 %	– 3.1 %	0.2 %	0.8 %
France	45	44	34	26	23	20	20	22	19	19	– 58 %	0.4 %	0.5 %	1.7 %
Germany	373	159	153	142	205	180	170	181	153	164	– 56 %	7.0 %	3.8 %	14.4 %
Greece	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Hungary	79	30	25	24	30	34	36	36	30	31	– 61 %	4.9 %	0.8 %	2.7 %
Ireland	49	31	23	21	20	18	18	19	16	16	– 68 %	– 2.5 %	0.5 %	1.4 %
Italy	99	101	68	73	96	74	91	86	76	82	– 17 %	7.0 %	1.0 %	7.2 %
Latvia	17	16	16	14	11	11	12	10	10	9.7	– 43 %	– 3.5 %	0.2 %	0.9 %
Lithuania	19	8.9	9.5	12	11	11	11	11	11	11	– 42 %	1.4 %	0.2 %	1.0 %
Luxembourg	4.3	2.1	0.5	0.5	0.5	0.4	0.5	0.5	0.6	0.5	– 88 %	– 4.1 %	0.0 %	0.0 %
Malta	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	> 100 %	– 16.9 %	0.0 %	0.0 %
Netherlands	20	10	5.1	5.1	4.9	5.0	4.6	4.6	4.7	4.7	– 76 %	1.8 %	0.2 %	0.4 %
Poland	147	211	148	169	157	150	153	152	140	139	– 5 %	– 0.5 %	1.5 %	12.3 %
Portugal	156	148	145	117	110	115	116	119	117	116	– 25 %	– 1.3 %	1.6 %	10.2 %
Romania	274	182	91	88	87	84	83	79	80	81	– 71 %	0.5 %	2.8 %	7.1 %
Slovakia	20	15	13	19	18	19	19	20	19	20	– 1 %	3.5 %	0.2 %	1.7 %
Slovenia	8.7	6.0	5.1	5.7	6.3	6.4	6.3	6.4	5.6	5.6	– 35 %	1.0 %	0.1 %	0.5 %
Spain	7314	5927	2446	328	282	291	294	285	305	308	– 96 %	0.7 %	74.8 %	27.1 %
Sweden	18	17	15	18	13	13	13	13	12	12	– 31 %	1.5 %	0.2 %	1.1 %
United Kingdom	206	95	20	18	22	19	22	23	20	22	– 89 %	6.3 %	2.1 %	1.9 %
EU-28 (a)	**9 781**	**8 539**	**3 380**	**1 235**	**1 221**	**1 167**	**1 184**	**1 181**	**1 113**	**1 135**	**– 88 %**	**2.0 %**	**100 %**	**100 %**
EU-28 (b)	9 779	8 538	3 379	1 233	1 219	1 165	1 182	1 178	1 111	1 132				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

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

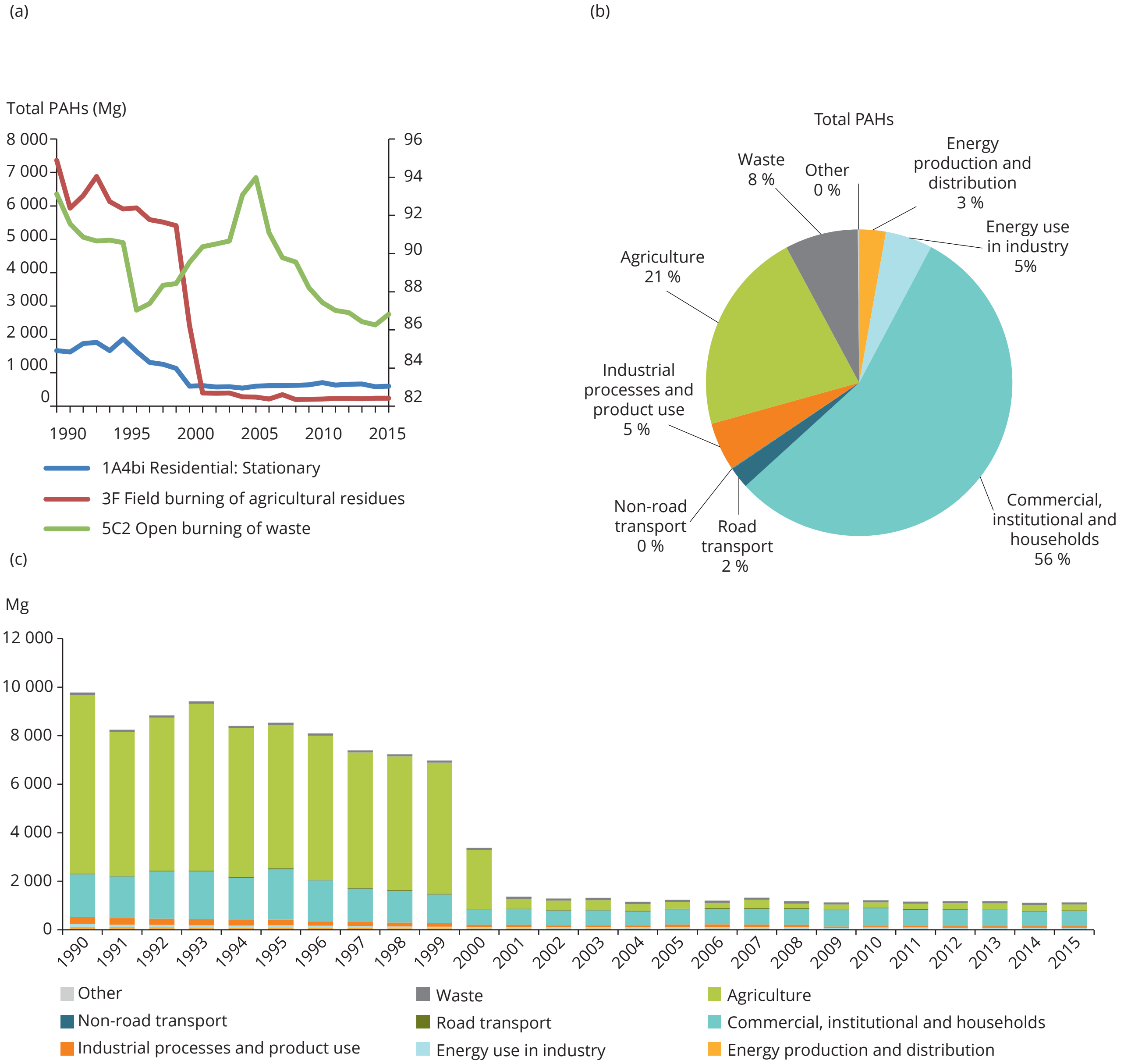
([a]) Sum of national totals as reported by Member States.

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

PAH emissions (see Figure 3.16(a)). Among the key categories, the highest relative reductions in emissions between 1990 and 2015 were in the second most important, '3F — Field burning of agricultural residues' (−97 %).

Figure 3.16(b) shows the contribution that each aggregated sector group made to total EU-28 emissions. The 'commercial, institutional and households' sector group is a very important source of total PAHs, as well as of CO, $PM_{2.5}$, PM_{10} B(a)P, HCB and PCDD/Fs.

Figure 3.16 Total PAH emissions in the EU-28: (a) trend in emissions from the three most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions.



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

Between 1990 and 2015, B(a)P emissions in the EU-28 dropped by 53 %. Between 2014 and 2015, they increased by 1.3 %, mainly because emissions increased in Germany, the Czech Republic, Hungary and the United Kingdom (see Table 3.24). The Member States that contributed most (i.e. more than 10 %) to B(a)P emissions in 2015 were Poland, Germany, Romania and Portugal. Austria, Greece, Italy and Spain did not provide data for B(a)P, and gap-filling was not possible. The EU-28 total is therefore an underestimate.

'1A4bi — Residential: Stationary' was the principal key category for B(a)P emissions, accounting for

Table 3.24 Member State contributions to EU emissions of B(a)P

	Benzo(a)pyrene (Mg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	12	10	8.6	7.2	5.6	5.3	4.5	4.5	3.0	3.1	– 73 %	2.4 %	2.9 %	1.6 %
Bulgaria	8.0	6.2	6.6	7.6	8.1	8.9	9.0	8.5	7.8	7.7	– 4 %	– 1.5 %	2.0 %	4.1 %
Croatia	7.6	5.7	5.1	6.4	4.8	4.2	3.9	3.6	2.7	2.8	– 64 %	2.9 %	1.9 %	1.5 %
Cyprus	2.4	1.9	1.1	0.7	0.2	0.2	0.2	0.1	0.1	0.2	– 93 %	30.7 %	0.6 %	0.1 %
Czech Republic	10	10	10	10	10	8.3	8.8	9	7.5	8.0	– 23 %	7.3 %	2.6 %	4.3 %
Denmark	1.7	1.9	2.0	2.7	2.9	2.5	2.4	2.4	2.1	2.3	37 %	11.1 %	0.4 %	1.2 %
Estonia	2.4	2.8	2.4	2.2	2.4	2.0	2.0	2.1	2.0	2.0	– 14 %	– 1.0 %	0.6 %	1.1 %
Finland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	– 10 %	0.0 %	0.0 %	0.0 %
France	13	12	10	7.2	6.2	5.4	5.6	6.1	5.3	5.3	– 59 %	0.1 %	3.2 %	2.8 %
Germany	139	48	31	23	34	30	28	30	25	26	– 81 %	7.1 %	34.9 %	14.1 %
Greece	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Hungary	26	10	8.3	7.8	9.9	11.5	12.1	12.1	9.9	10.4	– 60 %	5.1 %	6.5 %	5.5 %
Ireland	14	8.7	6.2	5.8	5.4	5.0	4.9	5.2	4.5	4.4	– 68 %	– 2.6 %	3.5 %	2.4 %
Italy	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE				
Latvia	6.2	5.9	6.2	5.0	3.9	4.1	4.0	3.6	3.6	3.5	– 44 %	– 3.9 %	1.6 %	1.8 %
Lithuania	5.5	2.9	3.1	3.7	3.8	3.7	3.7	3.7	3.5	3.4	– 38 %	– 1.8 %	1.4 %	1.8 %
Luxembourg	1.2	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	– 87 %	– 4.9 %	0.3 %	0.1 %
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	– 94 %	10.7 %	0.0 %	0.0 %
Netherlands	5.2	3.1	1.8	1.8	1.6	1.6	1.6	1.6	1.6	1.6	– 69 %	1.3 %	1.3 %	0.9 %
Poland	35	49	35	39	45	43	44	44	40	40	14 %	– 0.2 %	8.9 %	21.5 %
Portugal	26	26	27	22	20	23	23	24	24	23	– 13 %	– 3.7 %	6.7 %	12.2 %
Romania	7.8	11	14	26	27	26	26	24	25	25	> 100 %	– 0.5 %	2.0 %	13.1 %
Slovakia	5.1	4.0	3.7	5.2	5.0	5.3	5.3	5.5	5.3	5.5	8 %	3.5 %	1.3 %	2.9 %
Slovenia	2.9	2.2	2.0	2.2	2.6	2.6	2.5	2.6	2.2	2.3	– 22 %	2.4 %	0.7 %	1.2 %
Spain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Sweden	5.2	5.1	4.3	5.4	4.0	4.1	3.9	3.9	3.7	3.8	– 27 %	1.6 %	1.3 %	2.0 %
United Kingdom	62	22	6.8	5.8	7.8	6.8	7.7	8.1	7.1	7.5	– 88 %	6.2 %	15.5 %	4.0 %
EU-28 (a)	**398**	**250**	**195**	**198**	**211**	**203**	**202**	**205**	**186**	**188**	**– 53 %**	**1.3 %**	**100 %**	**100 %**
EU-28 (b)	397	249	195	197	210	202	202	204	185	188				

Notes: Dark grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

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

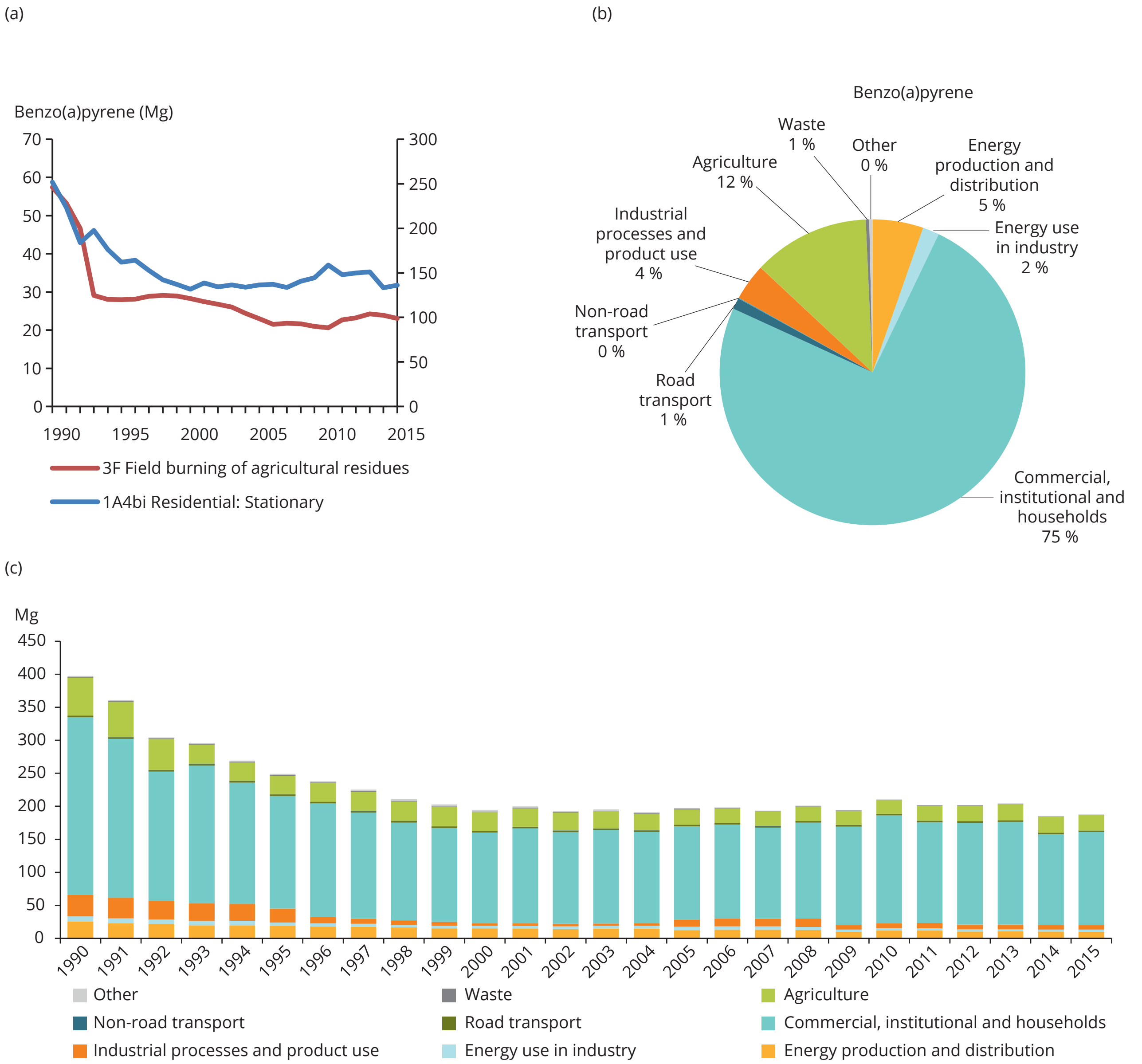
(a) Sum of national totals as reported by Member States.

(b) Sum of sectors.

72 % of the total. The highest relative reductions in emissions between 1990 and 2015 were in the second most important key category, '3F — Field burning of agricultural residues' (−60 %), and the most important, '1A4bi — Residential: Stationary' (−46 %) (see Figure 3.17(a)).

Figure 3.17(b) shows the contribution that each aggregated sector group made to total EU-28 emissions. The 'commercial, institutional and households' sector group is the chief emission source of B(a)P, and this sector group is a very important source of total PAHs, CO, $PM_{2.5}$, PM_{10}, HCB and PCDD/Fs.

Figure 3.17 B(a)P emissions in the EU-28: (a) trend in emissions from the two most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions



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

Between 1990 and 2015, B(b)F emissions in the EU-28 decreased by 40 %. Between 2014 and 2015, they increased by 0.7 %, mainly because emissions increased in the Hunary, the United Kingdom, the Czech Republic, Slovakia and Denmark (see Table 3.25). The Member States that contributed most (i.e. more than 10 %) to B(b)F emissions in 2015 were Poland, Portugal and Romania. Austria, Greece, Italy and Spain did not provide data for B(b)F, and gap-filling was not possible. The EU-28 total is therefore an underestimate.

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

Table 3.25 Member State contributions to EU emissions of B(b)F

	Benzo(b)fluoranthene (Mg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	8.1	7.3	6.5	5.7	4.8	4.2	4.1	4.4	3.1	3.2	– 60 %	4.0 %	2.6 %	1.7 %
Bulgaria	11	8.3	7.9	8.8	9.3	10	10	9.6	8.7	8.5	– 21 %	– 1.3 %	3.4 %	4.5 %
Croatia	8.1	5.6	4.9	6.0	4.5	4.0	3.7	3.4	2.7	2.8	– 65 %	3.2 %	2.6 %	1.5 %
Cyprus	6.7	5.4	3.1	2.0	0.6	0.7	0.6	0.5	0.5	0.6	– 91 %	22.1 %	2.1 %	0.3 %
Czech Republic	5.1	5.1	5.2	5.2	5.1	4.3	4.5	4.6	3.9	4.2	– 18 %	6.7 %	1.6 %	2.2 %
Denmark	1.7	2.0	2.1	2.8	3.0	2.7	2.5	2.6	2.3	2.6	46 %	10.7 %	0.6 %	1.4 %
Estonia	2.7	2.8	2.5	2.4	2.6	2.2	2.2	2.2	2.3	2.3	– 15 %	0.1 %	0.9 %	1.2 %
Finland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	– 25 %	0.0 %	0.0 %	0.0 %
France	15	14	11	8.6	7.5	6.5	6.8	7.3	6.3	6.4	– 58 %	0.6 %	4.8 %	3.4 %
Germany	3.1	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.3	– 59 %	1.9 %	1.0 %	0.7 %
Greece	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Hungary	30	11	8.9	8.4	10.1	11.6	12.0	12.1	9.9	10.4	– 66 %	4.5 %	9.7 %	5.5 %
Ireland	20	13	9.7	9.1	8.3	7.6	7.4	7.8	6.8	6.7	– 67 %	– 2.5 %	6.5 %	3.5 %
Italy	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE				
Latvia	5.8	5.1	5.0	4.6	3.7	3.8	3.8	3.4	3.4	3.3	– 43 %	– 3.7 %	1.8 %	1.7 %
Lithuania	7.3	3.1	3.2	4.2	4.0	4.0	4.0	4.1	3.8	3.9	– 46 %	3.9 %	2.3 %	2.1 %
Luxembourg	1.4	0.7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	– 85 %	– 3.5 %	0.4 %	0.1 %
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	– 83 %	14.5 %	0.0 %	0.0 %
Netherlands	7.8	3.3	1.7	1.6	1.6	1.7	1.5	1.5	1.5	1.5	– 81 %	1.8 %	2.5 %	0.8 %
Poland	33	52	38	43	47	46	47	46	42	42	28 %	– 0.5 %	10.5 %	22.3 %
Portugal	54	51	49	43	41	42	42	43	43	42	– 22 %	– 0.8 %	17.3 %	22.4 %
Romania	0.1	0.1	0.1	29	29	28	28	26	27	27	> 100 %	0.4 %	0.0 %	14.3 %
Slovakia	6.2	4.9	4.4	6.9	6.5	6.9	6.9	7.1	6.9	7.2	17 %	3.7 %	2.0 %	3.8 %
Slovenia	2.7	1.8	1.4	1.5	1.5	1.5	1.5	1.5	1.4	1.4	– 50 %	– 0.8 %	0.9 %	0.7 %
Spain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Sweden	6.7	6.5	5.5	7.5	4.2	4.4	4.2	4.2	4.0	4.1	– 39 %	1.3 %	2.1 %	2.2 %
United Kingdom	76	40	5.4	5.3	6.8	5.8	6.7	7.2	6.5	6.9	– 91 %	6.7 %	24.3 %	3.7 %
EU-28 (a)	**314**	**245**	**177**	**208**	**203**	**199**	**201**	**201**	**187**	**189**	**– 40 %**	**0.7 %**	**100 %**	**100 %**
EU-28 (b)	313	244	177	207	202	198	200	200	186	188				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-grey 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.

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

Between 1990 and 2015, B(k)F emissions in the EU-28 decreased by 48 %. Between 2014 and 2015, they rose by 1.5 %, mainly because emissions increased in Romania, the Czech Republic, Hungary and the United Kingdom (see Table 3.26). The Member States that contributed most (i.e. more than 10 %) to B(k)F emissions in 2015 were Portugal, Romania and Poland. Austria, Greece, Italy and Spain did not provide data for B(k)F, and gap-filling was not possible. The EU-28 total is therefore an underestimate.

Table 3.26 Member State contributions to EU emissions of B(k)F

	Benzo(k)fluoranthene (Mg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	5.0	4.3	3.7	3.0	2.3	2.3	2.0	2.0	1.3	1.4	– 72 %	1.9 %	3.0 %	1.6 %
Bulgaria	4.6	3.6	4.0	4.6	5.0	5.4	5.4	5.2	4.8	4.7	2 %	– 1.5 %	2.7 %	5.4 %
Croatia	3.4	2.1	1.9	2.3	1.7	1.5	1.4	1.3	1.0	1.1	– 69 %	2.7 %	2.0 %	1.2 %
Cyprus	2.9	2.4	1.4	1.0	0.4	0.4	0.4	0.3	0.3	0.3	– 88 %	18.3 %	1.7 %	0.4 %
Czech Republic	4.4	4.5	4.5	4.4	4.3	3.6	3.9	3.9	3.3	3.5	– 20 %	7.1 %	2.6 %	4.1 %
Denmark	0.7	0.8	0.9	1.1	1.2	1.0	1.0	1.0	0.9	1.0	41 %	11.6 %	0.4 %	1.2 %
Estonia	1.5	1.8	1.5	1.3	1.4	1.2	1.2	1.3	1.2	1.2	– 22 %	– 1.8 %	0.9 %	1.4 %
Finland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	– 10 %	0.0 %	0.0 %	0.0 %
France	9.2	9.0	7.1	5.4	4.7	4.1	4.2	4.5	3.9	4.0	– 57 %	0.5 %	5.5 %	4.6 %
Germany	1.8	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	1.0	– 47 %	2.9 %	1.1 %	1.1 %
Greece	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Hungary	12	4.5	3.6	3.4	4.0	4.6	4.8	4.8	4.0	4.2	– 65 %	4.4 %	7.1 %	4.8 %
Ireland	7.8	5.0	3.6	3.4	3.1	2.9	2.8	3.0	2.6	2.6	– 67 %	– 2.3 %	4.7 %	3.0 %
Italy	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE				
Latvia	2.3	2.1	2.0	1.7	1.3	1.4	1.4	1.2	1.2	1.2	– 49 %	– 2.9 %	1.4 %	1.4 %
Lithuania	2.9	1.2	1.3	1.6	1.6	1.5	1.5	1.6	1.5	1.5	– 48 %	4.3 %	1.7 %	1.8 %
Luxembourg	0.9	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	– 92 %	– 4.5 %	0.5 %	0.1 %
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	– 72 %	13.1 %	0.0 %	0.0 %
Netherlands	4.0	2.3	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	– 80 %	2.9 %	2.4 %	0.9 %
Poland	33	52	38	43	12	12	12	12	12	12	– 65 %	0.3 %	19.8 %	13.4 %
Portugal	27	25	24	20	20	21	21	22	21	21	– 20 %	– 0.3 %	15.9 %	24.7 %
Romania	0.1	0.1	0.1	18	17	17	16	16	16	16	> 100 %	2.6 %	0.1 %	18.9 %
Slovakia	3	2.2	2.0	2.9	2.8	2.8	2.9	2.9	2.9	3.0	– 1 %	2.8 %	1.8 %	3.4 %
Slovenia	1.7	1.3	1.1	1.3	1.5	1.5	1.5	1.5	1.3	1.3	– 22 %	2.8 %	1.0 %	1.5 %
Spain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Sweden	1.7	1.7	1.4	1.6	1.6	1.6	1.6	1.6	1.5	1.5	– 10 %	1.6 %	1.0 %	1.8 %
United Kingdom	38	20	3.6	3.1	2.9	2.5	2.9	3.0	2.7	2.9	– 92 %	5.8 %	22.6 %	3.3 %
EU-28 (a)	**167**	**147**	**107**	**125**	**91**	**91**	**91**	**91**	**85**	**86**	**– 48 %**	**1.5 %**	**100 %**	**100 %**
EU-28 (b)	167	146	107	125	91	90	90	90	84	86				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-grey 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.

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

Between 1990 and 2015, IP emissions in the EU-28 fell by 28 %. Between 2014 and 2015, emissions increased by 0.4 %, mainly because Hungary, the Czech Republic, the United Kingdom and Slovakia reported increased emissions (see Table 3.27). The Member States that contributed most (i.e. more than 10 %) to IP emissions in 2015 were Poland, Portugal and Romania. Austria, Greece, Italy and Spain did not provide data for IP, and gap-filling was not possible. The EU-28 total is therefore an underestimate.

Table 3.27 Member State contributions to EU emissions of IP

	Indeno(1,2,3-cd)pyrene (Mg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR				
Belgium	4.5	4.1	3.6	3.2	2.7	2.5	2.3	2.4	1.7	1.8	– 60 %	6.6 %	2.8 %	1.5 %
Bulgaria	4.1	3.3	4.0	4.6	5.1	5.5	5.6	5.3	5.0	4.9	19 %	– 1.6 %	2.5 %	4.2 %
Croatia	4.0	3.3	3.0	3.7	2.7	2.4	2.2	1.9	1.5	1.5	– 61 %	1.4 %	2.4 %	1.3 %
Cyprus	2.0	1.6	0.9	0.6	0.1	0.1	0.1	0.1	0.1	0.1	– 93 %	30.3 %	1.2 %	0.1 %
Czech Republic	4.9	4.9	4.9	4.8	4.9	4.1	4.3	4.4	3.7	3.9	– 19 %	7.3 %	3.0 %	3.4 %
Denmark	1.4	1.4	1.4	1.8	1.8	1.6	1.5	1.5	1.3	1.4	5 %	7.2 %	0.8 %	1.2 %
Estonia	1.6	2.6	2.2	1.7	1.9	1.6	1.6	1.6	1.5	1.5	– 5 %	– 2.5 %	1.0 %	1.3 %
Finland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	– 6 %	0.0 %	0.0 %	0.0 %
France	8.0	7.7	6.1	4.7	4.1	3.6	3.8	4.0	3.5	3.5	– 56 %	0.2 %	4.9 %	3.0 %
Germany	1.3	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	– 46 %	0.4 %	0.8 %	0.6 %
Greece	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Hungary	11	4.6	4.6	4.2	5.7	6.5	6.9	7.0	5.7	6.1	– 45 %	5.5 %	6.7 %	5.2 %
Ireland	6.7	4.2	3.0	2.8	2.7	2.5	2.4	2.6	2.2	2.2	– 67 %	– 2.3 %	4.1 %	1.9 %
Italy	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE				
Latvia	2.8	3.0	3.1	2.6	2.0	2.1	2.1	1.9	1.8	1.8	– 37 %	– 2.8 %	1.7 %	1.5 %
Lithuania	2.7	1.6	1.8	2.1	2.1	2.1	2.1	2.1	1.9	1.9	– 29 %	0.1 %	1.7 %	1.7 %
Luxembourg	0.9	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	– 89 %	– 3.7 %	0.5 %	0.1 %
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	– 87 %	15.0 %	0.0 %	0.0 %
Netherlands	2.8	1.4	0.8	0.8	0.8	0.9	0.8	0.8	0.8	0.8	– 71 %	1.8 %	1.7 %	0.7 %
Poland	45	59	37	45	53	49	50	50	46	45	0 %	– 0.9 %	27.9 %	38.8 %
Portugal	19	18	18	15	15	16	16	16	16	16	– 19 %	– 1.3 %	11.9 %	13.4 %
Romania	0.1	0.1	0.1	14	14	13	13	12	13	13	> 100 %	– 0.2 %	0.0 %	10.8 %
Slovakia	5.7	3.8	3.1	4.0	3.8	3.9	4.0	4.0	3.9	4.1	– 28 %	3.8 %	3.5 %	3.5 %
Slovenia	0.8	0.5	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.4	– 49 %	– 2.9 %	0.5 %	0.4 %
Spain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Sweden	3.0	3.0	2.6	3.1	2.4	2.4	2.3	2.3	2.2	2.2	– 27 %	1.4 %	1.8 %	1.9 %
United Kingdom	30	13	3.9	3.4	4.6	4.0	4.5	4.7	4.1	4.4	– 85 %	5.9 %	18.3 %	3.7 %
EU-28 (a)	**162**	**142**	**105**	**123**	**130**	**125**	**127**	**126**	**117**	**117**	**– 28 %**	**0.4 %**	**100 %**	**100 %**
EU-28 (b)	162	142	105	123	130	124	126	126	116	117				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 or an explanation of the notation keys reported by Member States.

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

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

(b) Sum of sectors.

3.27 Hexachlorobenzene (HCB) emission trends and key categories

Between 1990 and 2015, HCB emissions in the EU-28 fell by 97 %. Between 2014 and 2015, the decrease was 38 %, mainly because emissions decreased in Austria (see Table 3.28). The Member States that contributed most (i.e. more than 10 %) to HCB emissions in 2015 were Austria, the United Kingdom, Finland and Italy. Greece did not report HCB emissions for any year, so data were not gap-filled. The EU-28 total is therefore an underestimate.

Austria explained that the increase in HCB emissions from 2012 to 2014 reflects the data reported in the category '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals'. Due to unintentional releases in 2012, 2013 and 2014 the emissions rose to a very high level: HCB-contaminated material (lime) was co-incinerated in a cement plant at temperatures which were too low and which failed to destroy the HCB. The sharp decrease in emissions between 2014 and 2015 by 74 % therefore marks a return to usual levels (see Austria's IIR, listed in Appendix 5).

Table 3.28 Member State contributions to EU emissions of HCB

	HCB (kg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	92	53	44	43	39	35	61	144	140	36	– 61 %	– 74.5 %	1.6 %	20.3 %
Belgium	41	116	22	20	14	30	20	8.6	7.8	5.9	– 86 %	– 24.2 %	0.7 %	3.3 %
Bulgaria	23	25	20	21	19	22	16	14	16	14	– 38 %	– 10.9 %	0.4 %	8.0 %
Croatia	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	5 %	11.0 %	0.0 %	0.2 %
Cyprus	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	– 83 %	– 7.3 %	0.0 %	0.0 %
Czech Republic	4.5	10.6	17	11.1	8.2	6.4	5.9	6.1	5.3	5.2	14 %	– 2.2 %	0.1 %	2.9 %
Denmark	27	8.4	5.6	3.8	2.8	2.7	2.5	2.7	2.5	2.3	– 91 %	– 5.4 %	0.5 %	1.3 %
Estonia	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	45 %	– 0.3 %	0.0 %	0.2 %
Finland	41	41	44	39	16	33	17	25	26	21	– 49 %	– 19.4 %	0.7 %	11.9 %
France	1196	70	43	11	6.0	5.9	6.1	5.6	5.8	5.9	– 100 %	1.8 %	20.5 %	3.3 %
Germany	27	8.0	9.5	8.7	6.9	6.8	6.2	6.5	8.4	8.5	– 69 %	0.7 %	0.5 %	4.8 %
Greece	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Hungary	2.6	2.8	2.9	2.0	2.0	1.9	1.6	1.5	1.4	1.4	– 44 %	2.8 %	0.0 %	0.8 %
Ireland	41	41	1.1	1.8	1.6	1.6	1.7	1.6	1.6	1.7	– 96 %	3.0 %	0.7 %	1.0 %
Italy	43	38	25	21	14	17	22	21	20	20	– 54 %	– 2.7 %	0.7 %	11.3 %
Latvia	0.2	0.3	0.2	0.3	0.2	0.2	0.3	0.3	0.3	0.3	48 %	1.3 %	0.0 %	0.2 %
Lithuania	11	4.8	2.0	1.9	1.3	1.0	0.8	0.7	0.3	0.4	– 97 %	23.6 %	0.2 %	0.2 %
Luxembourg	0.4	1.3	0.6	0.6	0.9	0.9	0.5	0.5	0.5	0.6	38 %	14.4 %	0.0 %	0.3 %
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	– 32 %	2.0 %	0.0 %	0.0 %
Netherlands	45	1.2	1.5	1.6	2.4	2.5	2.7	2.8	2.9	3.3	– 93 %	12.9 %	0.8 %	1.9 %
Poland	7.5	9.6	11	9.8	13	13	14	13	14	13	77 %	– 1.9 %	0.1 %	7.5 %
Portugal	3.9	4.6	4.1	1.3	1.0	1.0	1.1	1.0	1.0	1.2	– 69 %	14.5 %	0.1 %	0.7 %
Romania	99	64	29	4.1	3.3	3.6	3.3	2.9	2.9	3.0	– 97 %	2.9 %	1.7 %	1.7 %
Slovakia	2.4	1.8	1.6	1.5	1.0	1.2	1.0	0.9	1.1	1.2	– 53 %	8.3 %	0.0 %	0.7 %
Slovenia	47	38	38	0.5	0.6	0.6	0.6	0.6	0.5	0.5	– 99 %	2.8 %	0.8 %	0.3 %
Spain	327	150	178	132	0.5	0.5	0.6	0.6	0.5	0.5	– 100 %	1.5 %	5.6 %	0.3 %
Sweden	1.4	1.7	1.6	2.2	2.7	2.6	2.7	2.7	2.5	2.5	80 %	1.4 %	0.0 %	1.4 %
United Kingdom	3753	5291	77	69	32	23	22	18	23	27	– 99 %	21.6 %	64.3 %	15.5 %
EU-28 (a)	**5 837**	**5 982**	**580**	**407**	**191**	**213**	**210**	**281**	**285**	**177**	**– 97 %**	**– 38.0 %**	**100 %**	**100 %**
EU-28 (b)	5 837	5 982	580	407	191	213	210	281	285	177				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-grey 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.

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

France reported a pronounced decrease in HCB emissions between 1990 and 1995. This decrease was mainly due to the aluminium industry, which used chlorine to refine aluminium by eliminating magnesium traces. Until the early 1990s, it used hexachloroethane (HCE) as a core source, which resulted in HCB emissions. This was the main HCB source within the national inventory. In 1993, France banned HCE for secondary aluminium refining. Following this ban, the secondary aluminium industry no longer emits HCB (personal communication by France in 2015).

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

Spain explained that the total estimated HCB emissions in Spain are mainly driven by '2B10a —Chemical industry: Other', which includes the production of tetrachloromethane, trichlorethylene and perchlorethylene. The activity variable information was provided by FEIQUE (Spanish Chemical Industry Federation). Production of these chemicals registered an important decline in 2006 and ceased in Spain in 2009 (personal communication by Spain in 2017).

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

'1A1a — Public electricity and heat production' and '1A4bi — Residential: Stationary' were the chief key categories for HCB emissions in 2015, accounting for 42 % of the total (see Figure 3.18(a)). Among the top five key categories, the highest relative reductions in emissions between 1990 and 2015 were in the fourth most important, '3Df — Use of pesticides' (−92 %), and the fifth most important, '5C1biv — Sewage sludge incineration' (−79 %).

The emission peak in 1995 in the category '1A1a — Public electricity and heat production' was due to high levels of emissions from Belgium. This Member State explained that the reason was higher levels of sludge burning in Flanders in 1995 (personal communication by Belgium in 2017).

Data from the United Kingdom account for the decreases in emissions from 1998 to 2000 in the category '3Df — Use of pesticides'.

Figure 3.18(b) shows the contribution that each aggregated sector group made to total EU-28 emissions. For HCB, primary emission sources are the sector groups 'energy production and distribution', 'commercial, institutional and households' and 'industrial processes and product use'.

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

3.28 Polychlorinated biphenyl (PCBs) emission trends and key categories

Between 1990 and 2015, PCB emissions dropped in the EU-28 by 77 %. Between 2014 and 2015, they decreased by 2 %, mainly because of large reductions reported by the United Kingdom (see Table 3.29). The Member States that contributed most (i.e. more than 10 %) to the emissions of PCBs in 2015 were Poland, the United Kingdom and Croatia. Greece did not report emissions for any year. The EU-28 total is therefore an underestimate.

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

Denmark explained that the strong decrease of PCB emissions between 1990 and 1995 was due to the phase out of leaded gasoline, which has a high

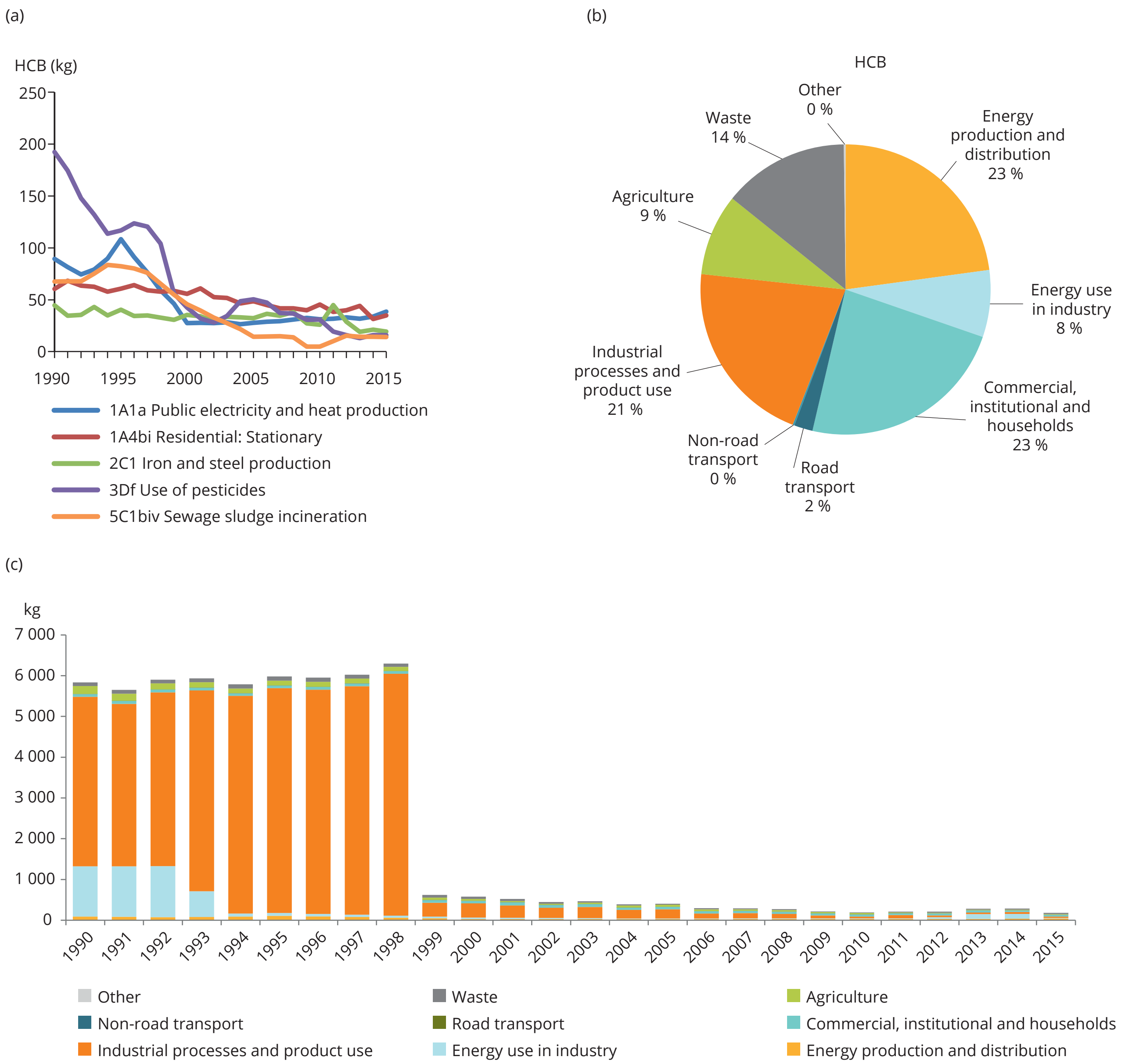
PCBs emission factor (see Denmark's IIR, listed in Appendix 5).

The emission peak in Ireland in 2003 (not shown in Table 3.29) was caused by an increase of 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).

The high PCB emissions of Portugal in 2005 were because PCB trends are related to category

Figure 3.18 HCB emissions in the EU-28: (a) trend in emissions from the five most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions



'5C1bi — Industrial waste incineration', which represents the main source of the national total emissions for this pollutant (99.8 % in 2015). Emissions depend on how much industrial waste was combusted (see Portugal's IIR, listed in Appendix 5).

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

'2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)' and '1A4bi — Residential: Stationary' were the chief key

Table 3.29 Member State contributions to EU emissions of PCBs

	PCBs (kg)										Change		Share in EU-28	
Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990–2015**	**2013–2015**	**1990**	**2015**
Austria	194	162	163	176	179	182	176	180	180	177	– 9 %	– 1.8 %	1.5 %	6.0 %
Belgium	105	88	92	71	95	57	9.2	4.8	11	2.8	– 97 %	– 74.7 %	0.8 %	0.1 %
Bulgaria	6.2	5.3	3.8	4.0	4.2	4.7	5.0	4.7	3.4	3.4	– 45 %	0.5 %	0.0 %	0.1 %
Croatia	483	468	441	436	434	433	431	430	429	425	– 12 %	– 0.9 %	3.7 %	14.4 %
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5 %	– 4.0 %	0.0 %	0.0 %
Czech Republic	773	623	2.0	1.9	1.7	1.7	1.6	1.6	1.6	1.6	– 100 %	3.0 %	6.0 %	0.1 %
Denmark	111	40	39	43	42	43	40	39	41	42	– 62 %	0.9 %	0.9 %	1.4 %
Estonia	8.4	4.1	2.6	3.7	4.2	3.6	3.5	3.9	4.2	4.2	– 49 %	0.2 %	0.1 %	0.1 %
Finland	321	293	228	181	156	157	154	152	157	152	– 53 %	– 3.2 %	2.5 %	5.1 %
France	183	160	107	75	60	54	56	56	48	46	– 75 %	– 2.8 %	1.4 %	1.6 %
Germany	1736	1484	948	195	234	244	234	240	232	232	– 87 %	0.2 %	13.4 %	7.9 %
Greece	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Hungary	36	19	16	15	12	13	12	7.5	8.8	12	– 66 %	41.6 %	0.3 %	0.4 %
Ireland	43	36	36	39	16	14	14	15	16	17	– 61 %	3.9 %	0.3 %	0.6 %
Italy	289	301	266	278	211	218	225	204	198	195	– 33 %	– 1.3 %	2.2 %	6.6 %
Latvia	4.3	1.1	0.4	0.5	0.4	0.4	0.3	0.3	0.3	0.2	– 95 %	– 18.0 %	0.0 %	0.0 %
Lithuania	9.4	5.0	3.6	39	12	3.2	2.8	2.9	2.7	2.6	– 73 %	– 5.7 %	0.1 %	0.1 %
Luxembourg	40	36	11.6	12.4	18.8	26.5	9.1	4.3	5.1	5.0	– 88 %	– 3.4 %	0.3 %	0.2 %
Malta	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	– 100 %	4.5 %	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	– 100 %	0.0 %	0.0 %	0.0 %
Poland	801	927	580	673	810	781	791	754	685	678	– 15 %	– 1.0 %	6.2 %	22.9 %
Portugal	63	69	83	160	51	74	103	59	60	61	– 3 %	1.5 %	0.5 %	2.1 %
Romania	135	87	39	182	52	42	31	29	29	31	– 77 %	7.1 %	1.0 %	1.0 %
Slovakia	85	57	51	55	51	51	53	53	58	58	– 31 %	1.2 %	0.7 %	2.0 %
Slovenia	610	422	312	242	209	166	139	143	148	150	– 75 %	1.3 %	4.7 %	5.1 %
Spain	25	37	32	37	33	31	27	26	27	27	8 %	0.4 %	0.2 %	0.9 %
Sweden	8.9	9.4	9.8	9.5	9.2	9.8	8.8	8.6	9.0	9.1	2 %	0.6 %	0.1 %	0.3 %
United Kingdom	6894	5049	1400	1077	779	756	719	693	661	623	– 91 %	– 5.7 %	53.2 %	21.1 %
EU-28 (a)	**12 965**	**10 383**	**4 868**	**4 005**	**3 476**	**3 365**	**3 246**	**3 111**	**3 014**	**2 955**	**– 77 %**	**– 2.0 %**	**100 %**	**100 %**
EU-28 (b)	12 965	10 383	4 868	4 005	3 476	3 365	3 246	3 111	3 014	2 955				

Notes: Dark-grey shaded cells indicate that no emission values are available (n/a, not available). See Appendix 1 for an explanation of the notation keys reported by Member States.

Light-grey 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.

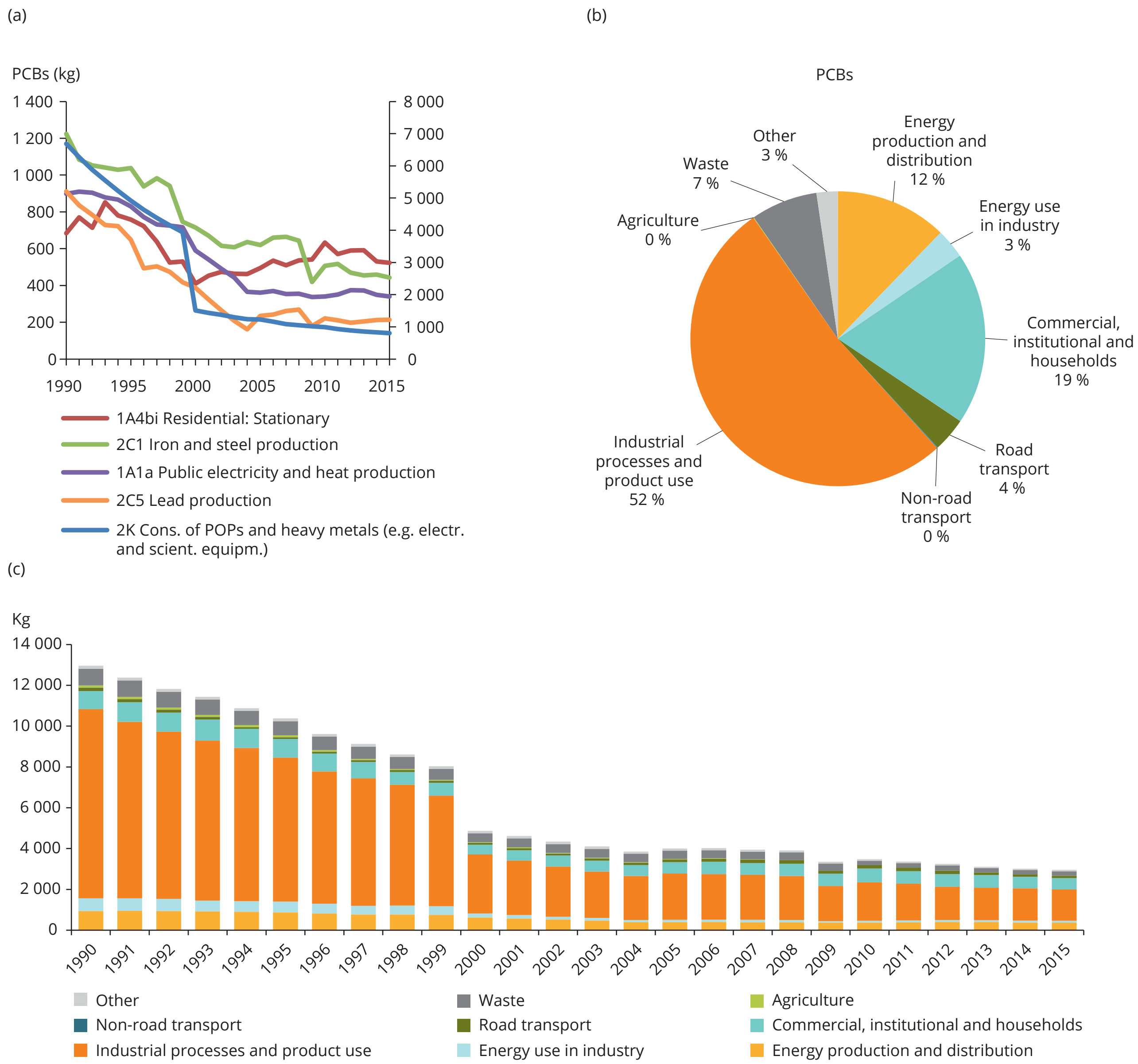
categories for PCB emissions, together making up 45 % of the total. Among the top five key categories, the highest relative reductions in emissions between 1990 and 2015 were in the principal key category, '2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)' (−88 %) (see Figure 3.19(a)).

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

The strong decrease of PCB emissions in '2C1 — Iron and steel production' and '2C5 — Lead production' between 2008 and 2009 can be explained by the economic recession, which negatively affected the volume of production.

Figure 3.19(b) shows the contribution that each aggregated sector group made to total EU-28 emissions. For PCBs, common important emission sources are the 'industrial processes and product use', the 'commercial, institutional and households' and the 'energy production and distribution' sector groups.

Figure 3.19 PCB emissions from key categories in the EU-28: (a) trend in emissions from the five most important key categories, 1990-2015; (b) share by sector group, 2015; (c) sectoral trends in emissions



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.

In 2012, the EU LRTAP report was reviewed by an ERT within the CEIP stage 3 review (see Section 1.6). Among other things, the ERT encourages the EU to include more information on sector description, time series of emissions and explanations of trends, and to introduce sector-specific QA/QC checks. Therefore, information received from the Member States or found in their IIRs is included in the sections on sectoral analysis and emission trends of the sectors (see Sections 4.1 to 4.8). If no information on unusual sector trends is given, Member States are contacted, informed about the finding and requested to send an explanation.

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%).

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. Despite considerable past reductions, this sector group contributes 59 % of the total EU-28 emissions of this pollutant.

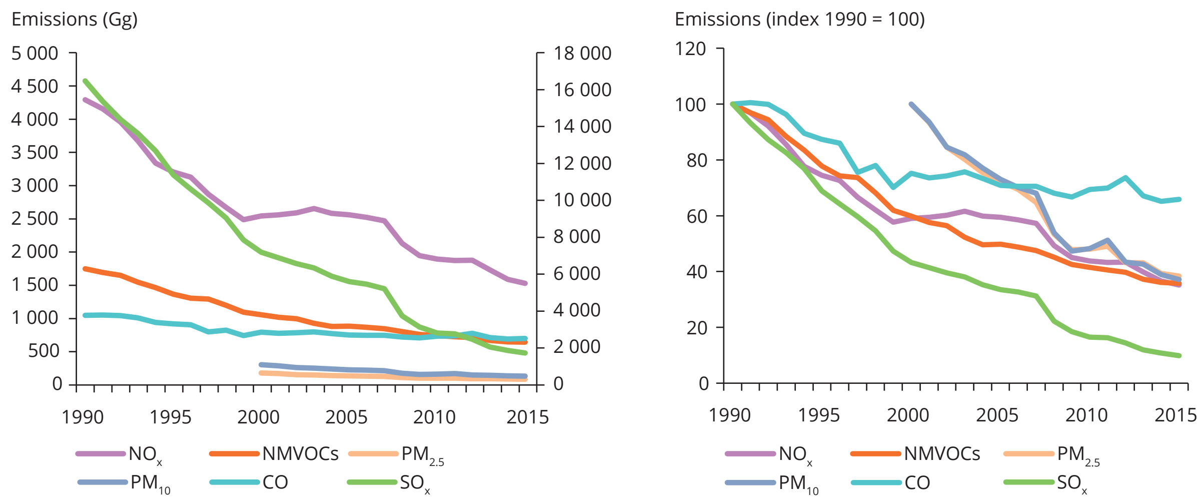
The sector is an important source of SO_x, Hg, NO_x and HCB. Poland, Germany, Spain and the United Kingdom contributed most (in absolute terms) to the emissions of SO_x in this sector in 2015. Germany, Poland and Spain reported the highest emissions of Hg. Germany, the United Kingdom and Poland contributed most to NO_x emissions. The United Kingdom reported the highest emissions of HCB in this sector in 2015.

For emissions of the main pollutants (see Figure 4.1), the highest absolute and relative reduction within this sector group was for SO_x ( ) between 1990 and 2015. NO_x and NMVOC emissions dropped between 1990 and 2015 by 65% and 64 %, respectively. $PM_{2.5}$ and PM_{10} emissions have decreased notably since 2000, $PM_{2.5}$ by 62 % and PM_{10} by 63 %.

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

The peak in CO emissions in 2012 is because between 2011 and 2012 Italy and Estonia reported increases in the category '1A1c — Manufacture of solid fuels and other energy industries' and the United Kingdom reported a steep increase in the category '1A1a — Public electricity and heat production'. Furthermore, between 2012 and 2013 France and Croatia reported decreases in the category '1B2aiv — Fugitive emissions oil: Refining/storage' and Italy and Poland reported

Figure 4.1 **EU-28 emission trends in the sector 'energy production and distribution' for NO_x, NMVOCs, SO_x, PM and CO between 1990 (2000) and 2015**



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

decreases in the categories '1A1a — Public electricity and heat production' and '1A1c— Manufacture of solid fuels and other energy industries'.

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

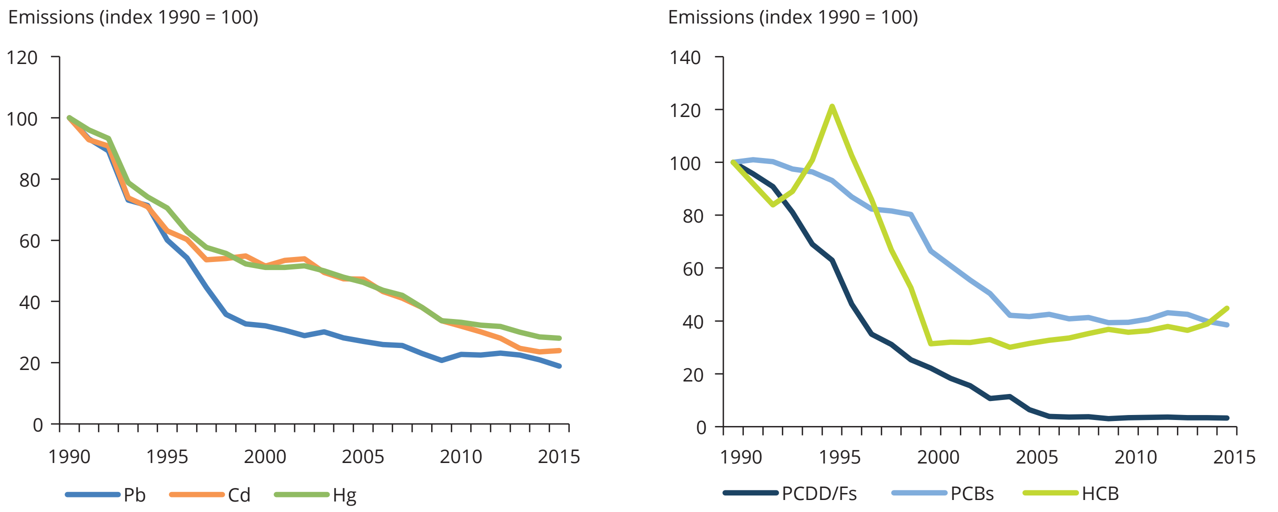
For PM, data from Greece could not be gap-filled, as it did not report values for any year. To show provisional EU-28 emission trends, the emissions have been aggregated without including data for this Member State.

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

There was an apparent strong decrease in PCB emissions between 1999 and 2000. That is mainly due to the difference between reported data for the Czech Republic, starting in 2000, and gap-filled data up to 1999 in the category '1A1a — Public electricity and heat production'.

For emissions of POPs, the highest relative reduction was in PCDD/Fs (−97 %) (see Figure 4.2(b)). The peak in HCB emissions in 1995 reflects high emission values reported by Belgium in the category '1A1a — Public electricity and heat production'. The Member State explained that the reason for high HCB emissions is higher levels of sludge burning in Flanders in 1995 (personal communication by Belgium in 2017).

Figure 4.2 EU-28 emission trends in the sector group 'energy production and distribution' (a) for the HMs (Pb, Cd and Hg), and (b) for POPs (PCDD/Fs, PCBs and HCB) between 1990 and 2015



Notes: For the HMs, no data for Greece from 2009 to 2015 were available. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including emission data for this Member State.

For PCDD/Fs, HCB and PCBs, data from Greece could not be gap-filled, as it did not report values for any year. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including emission data for this Member State.

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

The 'energy use in industry' sector is a primary source for heavy metals. Poland, Spain and Italy contributed most (in absolute terms) to the emissions of Pb in this sector in 2015. For Cd, Poland, Spain and Portugal reported the highest emissions. Poland and Italy contributed most to the emissions of Hg.

Energy use (fuel combustion) in industry is an important source of many pollutants. For the main pollutants, the highest absolute and relative reduction (−88 %) between 1990 and 2015 was for SO_x (see Figure 4.3).

The strong decrease in CO emissions between 2008 and 2009 results from emission reductions reported by several countries, especially France, Italy, Belgium and Germany.

The dip in $PM_{2.5}$ and PM_{10} emissions in 2009 is due to data reported by several countries, and might be caused by the economic crisis.

Of the three HMs, Hg shows the highest reduction in relative terms (−64 %) (see Figure 4.4(a)).

Lead emissions decreased between 1996 and 1997, peaked in 2008, decreased considerably between 2008 and 2009 and increased between 2013 and 2014. This pattern is mainly because of Bulgaria's data for '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals', accentuated by drops in Pb emissions in the category '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals' reported by Italy from 1996 to 1997 as well as between 2008 to 2009.

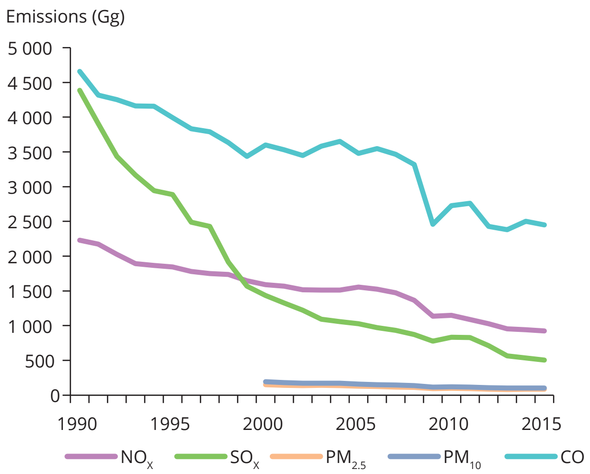
The strong decrease in Hg emissions between 2008 and 2009 is due to reductions that several countries reported, especially Slovakia and Italy, and might have been caused by the economic crisis in 2009.

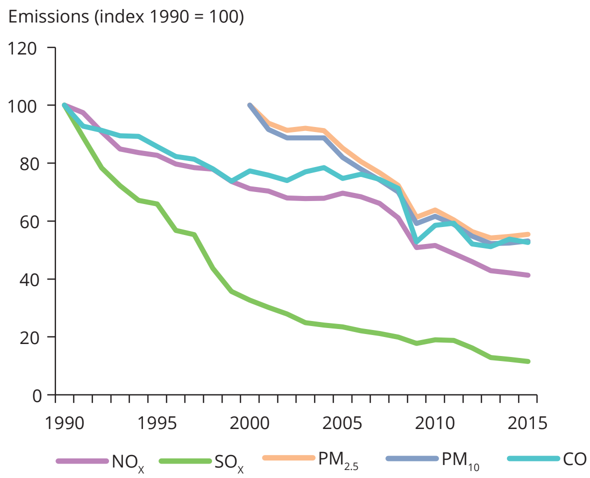
The high Cd emissions from 1995 to 1997 reflect high levels reported by Poland. The decrease in Cd emissions between 2008 and 2009 is caused by reductions that several countries reported.

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

The trend in PCDD/F emissions has much to do with gap-filled and reported data from the Czech Republic for the category '1A2a — Stationary combustion in manufacturing industries and construction: Iron and steel'. In addition, the PCDD/F emissions peak from 1994 to 1995 is attributable to data from France for the same category.

Figure 4.3 EU-28 emission trends in the sector group 'energy use in industry' for NO_x, SO_x, PM and CO between 1990 (2000) and 2015



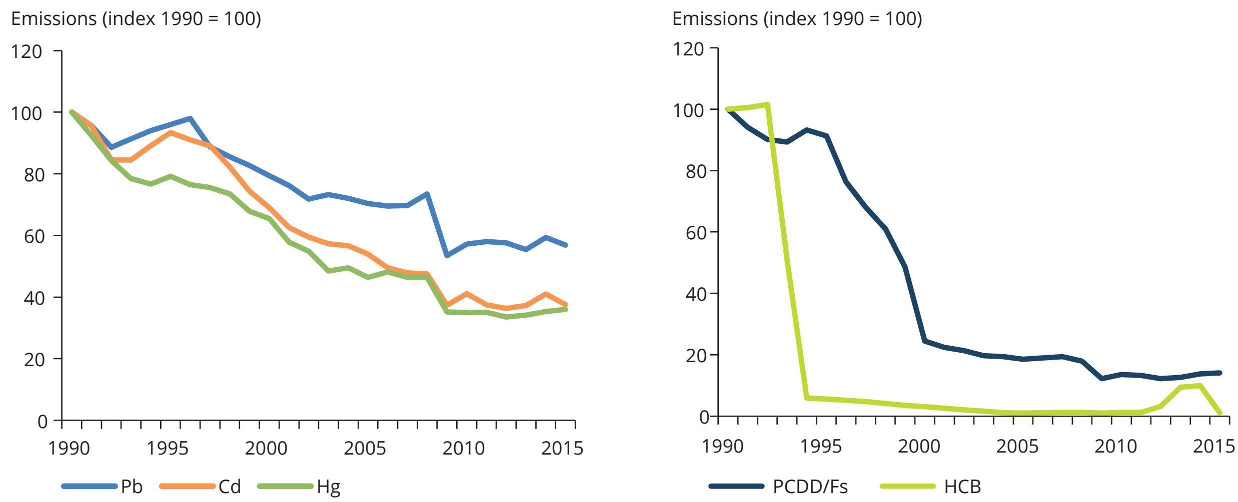


Notes: For PM, data from Greece could not be gap-filled, as it did not report values for any year. To enable presentation of provisional EU-28 emission trends, emissions have been aggregated without including data for this Member State.

The huge reduction in HCB emissions from 1992 to 1994 is influenced by emissions in the category '1A2b — Stationary combustion in manufacturing industries and construction: Non-ferrous metals' reported by France. France explained that since 1994, the activity 'secondary aluminium fusion' has used substitution products that emit no longer HCB. The emission factor was 5 g/Mg from 1990 to 1992, then decreased by 50% in 1993 and is null since 1994 (personal communication by France in 2013).

The increase in HCB emissions from 2012 to 2014 reflects the data reported by Austria in the category '1A2f — Stationary combustion in manufacturing industries and construction: Non-metallic minerals'. The Member State explained, that 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 which were too low, and which failed to destroy the HCB. In 2015 the emissions from HCB decreased back to the emission level before the unintentional releases that occurredin the years before. The short-term trend of HCB is influenced by this accidental release, as already mentioned, which is the reason for the decrease of 74 % in total Austrian's emissions of HCB between 2014 and 2015 (see Austria's IIR, listed in Appendix 5).

Figure 4.4 EU-28 emission trends in the sector group 'energy use in industry' (a) for the HMs (Pb, Cd and Hg), and (b) for POPs (PCDD/Fs and HCB) between 1990 and 2015



Notes: For the HMs, no data for Greece from 2009 to 2015 were available. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including emission data for this Member State.

For PCDD/Fs and HCB, data from Greece could not be gap-filled, as it did not report values for any year. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including data for this Member State.

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

The 'industrial processes and product use' sector grouping refers to emissions from industrial sources other than those arising from fuel combustion within the industrial sector. This is the primary sector group for NMVOCs and PCB emissions, and makes significant contributions to emissions of HCB, HMs, PM, CO and PCDD/Fs. Of all the countries that reported data, Germany, the United Kingdom and Italy contributed most to NMVOC emissions, and the United Kingdom, Austria and Slovenia contributed most to PCB emissions in the 'industrial processes and product use' sector in 2015. Figure 4.5 shows past trends in emissions of the relevant main pollutants.

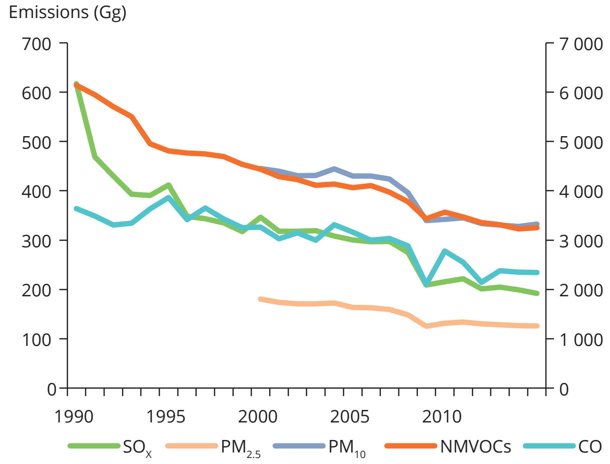
Data from France for the category '2C1 — Iron and steel production' have a great influence on the trend in emissions of CO. The emissions of CO from category 2C1 fluctuate over the years, depending on the amount of blast furnace gas that is produced, reused or flared. The amounts depend on the operating conditions and how feasible it is for iron and steel or collieries plants to reuse the gas that blast furnaces continuously produce. This may fluctuate a great deal from one year to another, resulting in peaks (1995, 2004 and 2010) or troughs (1992, 2001 and 2009) (personal communication by France in 2013).

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

'Industrial processes and product use' make a considerable contribution to the total EU-28 emissions of HMs, despite seeing considerable reductions since 1990. Figure 4.6(a) shows past emission trends for these pollutants. Hg shows the highest relative reduction in emissions between 1990 and 2015 (−81 %).

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

Figure 4.5 EU-28 emission trends in the sector group 'industrial processes' for NMVOCs, SO_x CO and PM between 1990 (2000) and 2015



Notes: For PM, data from Greece could not be gap-filled, as the country did not report values for any year. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including data for this Member State.

Among POPs, the highest relative reduction between 1990 and 2014 occurred for HCB ( ) (Figure 4.6(b)).

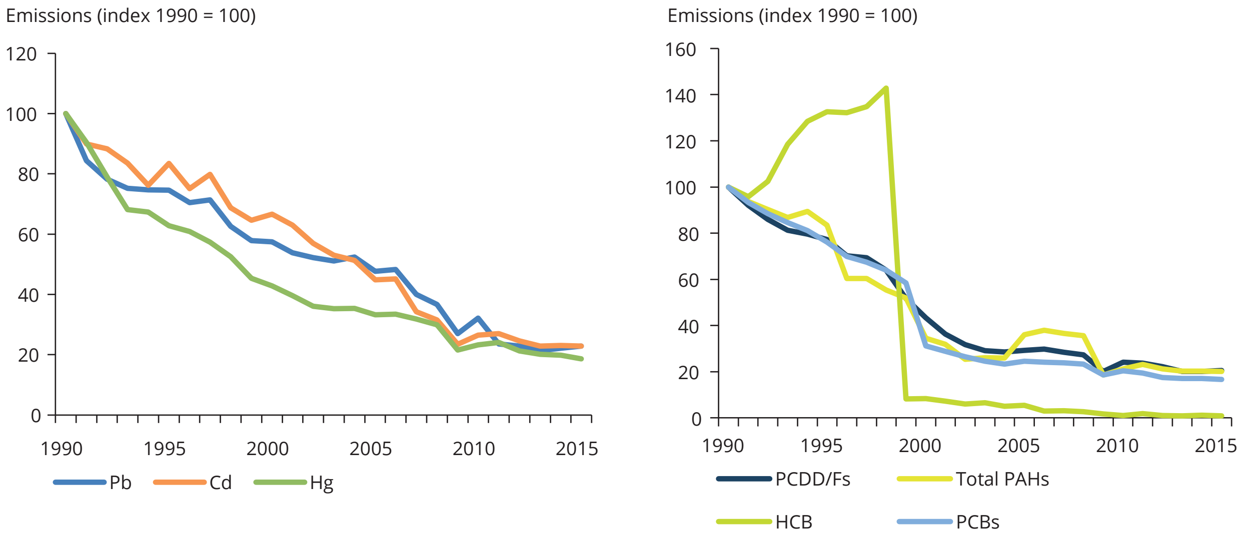
The considerable change in HCB emissions is mainly the result of an increase in '2C3 — Aluminium production' in the United Kingdom until 1998. The largest source of HCB emissions for the years 1990-1998 in the United Kingdom was the use of HCE as a degassing agent in secondary aluminium smelting. Specific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

The steep drop in PCBs from 1999 to 2000 is caused by falls in emissions from the category '2K — Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)' that the United Kingdom reported. This

Member State explained that there was a sharp decrease in PCB emissions generated by capacitors between 1999 and 2000 (personal communication by the United Kingdom in 2017).

The decrease in total PAHs from 1994 to 1996 reflects data from the United Kingdom in the category '2C3 — Aluminium production'. The decrease in total PAHs from 1999 to 2000 is because Italy reported a drop in emissions in the category '2C1 — Iron and steel production'. Italy explained that since 2000 the emission factor has been updated in accordance with the EMEP Guidebook 2006 (0.95 g/Mg) and from 1990 to 1999 the emission factor had been updated on the basis of a sectoral study (APAT, 2003) which reports the development of abatement technologies in the '90s in Italy and the consequent evolution in plants fabric filters were fabric filters were installed (see Italy's IIR, listed in Appendix 5). The increase in total PAHs between 2004 and 2005 is due to the difference between reported data for Romania, starting in 2005, and gap-filled data up to 2004 in the category '2C3 — Aluminium production'.

Figure 4.6 **EU-28 emission trends in the sector group 'industrial processes and product use' (a) for the HMs (Pb, Cd, Hg), and (b) for the POPs (PCDD/Fs, total PAHs, HCB and PCBs) between 1990 and 2015**



Notes: For the HMs, no data for Greece from 2009 to 2015 were available. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including emission data for this Member State.

For PCDD/Fs, total PAHs, HCB and PCBs data from Greece could not be gap-filled, as the country did not report values for any year. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including data for this Member State.

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

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

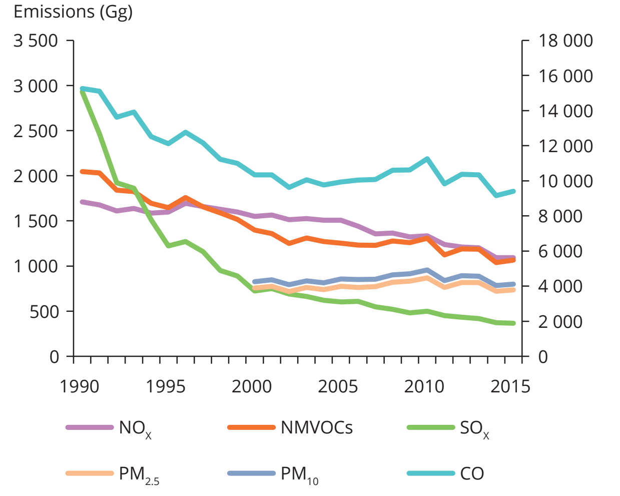
The 'commercial, institutional and households' is the primary sector group for B(a)P, total PAHs, $PM_{2.5}$, PM_{10}, CO, PCDD/Fs and an important sector group for HCB and PCB emissions. Poland, Germany and Romania contributed most (in absolute terms) to the emissions of B(a)P, and Germany, Poland and Italy contributed most to the emissions of total PAHs in this sector in 2015. For $PM_{2.5}$ Italy, Romania and France reported the highest emissions. Poland, Italy and Romania emitted the largest proportion of PM_{10} in 2015. Italy, Poland and France contributed most to CO emissions.

Of the main pollutants, the highest relative reduction between 1990 and 2015 for the sector grouping was again in SO_x (−87 %). In contrast, PM emissions have changed little since 2000 (see Figure 4.7).

The decrease of CO emissions between 1990 and 1992 reflects data from Germany in the categories '1A4ai — Commercial/institutional: Stationary' and '1A4bi — Residential: Stationary'. The Member State explained that the main driver of the CO emission trends is the decreasing lignite consumption: Since 1990 the fuel use changed from solid fuels causing high CO emissions to gaseous fuels producing much lower emissions (see German's IIR, listed in Appendix 5). The increase of 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, and gap-filled data for Romania. The low CO emissions in 2002 and the decrease from 2010 to 2011 reflect datafrom Italy for the category '1A4bi — Residential: Stationary'.

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

Figure 4.7 EU-28 emission trends in the sector group 'commercial, institutional and households' for NO_x, NMVOCs, SO_x, PM and CO between 1990 (2000) and 2015



Notes: For PM, data from Greece could not be gap-filled, as it did not report values for any year. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including data for this Member State.

fuels causing high NMVOC emissions to gaseous fuels producing much lower emissions (see German's IIR, listed in Appendix 5).

Data from several countries are responsible for the peak in reported NMVOC emissions in 2010.

Of the three HMs in the sector 'commercial, institutional and households', Pb shows the highest reduction, both absolutely and relatively (−49 %) (see Figure 4.8(a)).

The trends in emissions of Cd and Pb largely reflect data from Poland for the category '1A4bi — Residential: Stationary'. This Member State explained that the highest decrease noted for Cd is due to lower use of coal in households (see Poland's IIR, listed in Appendix 5). However, the Cd dip in 2011 reflects the drop in emissions reported by Italy, and the decrease in Pb emissions from 1990 to 1992 is the result of emission reductions reported by several countries, especially Italy and Germany. The trend for Hg largely reflects data from Italy for the category '1A4ai — Commercial/institutional: Stationary'. Italy's emissions of Hg from non-industrial combustion plants reported in the sector group 'commercial, institutional and households' represent 31 % of the national total emissions of Hg in 2015 (see Italy's IIR, listed in Appendix 5). The Hg peak in 1991 reflects data from France for the category '1A4bi — Residential: Stationary'.

Among POPs relevant to the 'commercial, institutional and households' sector, the highest absolute and relative reduction occurred for dioxins and furans (− 66 %) (see Figure 4.8(b)).

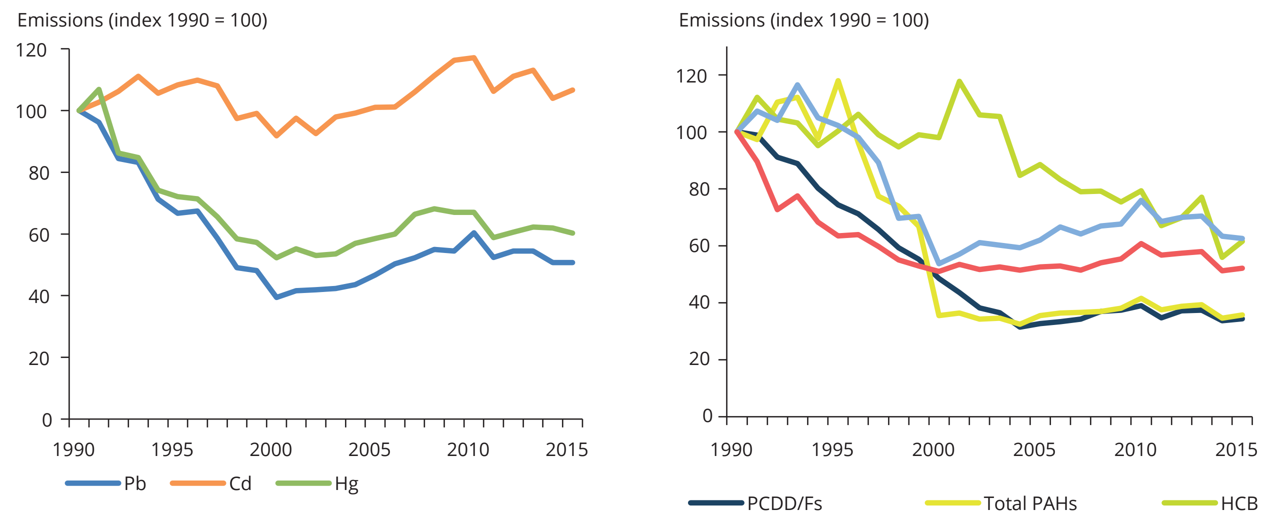
The trend in emissions of PCB largely reflects data from Poland for the category '1A4bi — Residential: Stationary'. Poland's emissions of PCB from non-industrial combustion plants reported in the sector group 'commercial, institutional and households' are the dominant source of PCB emissions making 66 % of the national total emissions of PCB in 2015. Compared to 2014, national total emissions in 2015 decreased by about 1%. The main reason for this change is lower coal consumption in the residential sector (see Poland's IIR, listed in Appendix 5).

Further, the trend for HCB largely reflects data from Austria for the category '1A4bi — Residential: Stationary'. This Member State remarked that the subcategory '1.A.4 — Small Combustion' (with the main source of emissions from the category '1A4bi — Residential: Stationary') had a share of 59 % in 1990 and 82 % in 2015 of national total emissions of HCB and is the highest contributor within the sector '1.A — Combustion' due to the high amounts of biomass used in the residential sector. Since 1990 emissions in the subcategory '1.A.4 — Other Sectors' decreased by 46 %. Compared to the previous year an increase of 13 % can be observed, due to the higher biomass use as a consequence of the colder winter and the corresponding higher demand for space heating. The peak in 2001 and the high HCB emission data from 2001 to 2003 result from reported high emissions from the Czech Republic in the category '1A4bi — Residential: Stationary' and Italy in the category '1A4ai — Commercial/institutional: Stationary'. The Czech Republic explained that emissions from local household heating are related to the trend in the consumption of solid fuels. The overall consumption of solid fuels in the period 2000–2013 changed solely depending on the course of temperatures during heating seasons (see the Czech Republic's IIR, listed in Appendix 5).

The trend in total emissions of PAHs between 1990 and 2000 largely reflects gap-filled data from the Czech Republic.

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

Figure 4.8 EU-28 emission trends in the sector group 'commercial, institutional and households' (a) for the HMs (Pb, Cd and Hg), and (b) for the POPs (PCDD/Fs, total PAHs, B(a)P, HCB and PCBs) between 1990 and 2015



Notes: For the HMs, no data for Greece from 2009 to 2015 were available. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including emission data for this Member State.

For PCDD/Fs, total PAHs, HCB and PCBs, data from Greece could not be gap-filled, as it did not report values for any year. For B(a)P, several Member States (Austria, Greece, Italy and Spain) did not provide emission data and were not gap-filled. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including data from these countries.

4.5 Sectoral analysis and emission trends for 'road transport'

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

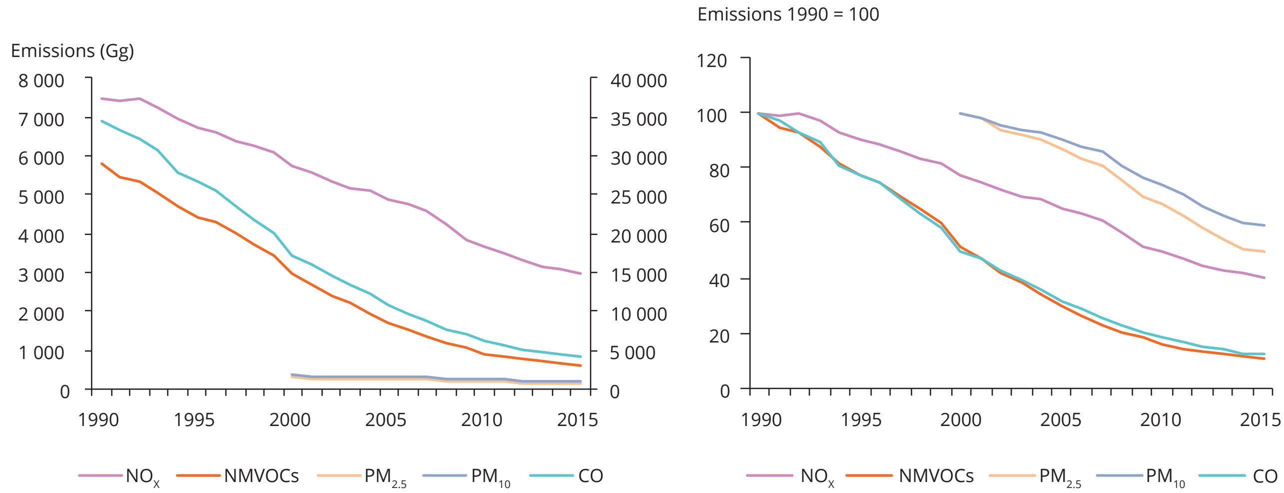
France, Germany and Italy contributed most (in absolute terms) to NO_x, $PM_{2.5}$ and PM_{10} emissions in the 'road transport' sector in 2015. For CO, Germany, Poland and Italy reported the highest emissions. Germany, France and Spain contributed most to the emissions of Pb, and Italy, Germany and Poland most to the emissions of NMVOCs in this sector in 2015.

For the 'road transport' sector, the main HM is Pb, showing a high relative reduction in emissions (−98 %) between 1990 and 2015 (see Figure 4.10(a)). However, in recent years, little progress has been made in reducing emissions from road transport further, and in the last year total emissions of Pb have even slightly increased. The promotion of unleaded petrol within the EU and in other EEA member countries through a combination of fiscal and regulatory measures has been a success story. For example, EU Member States have completely phased out the use of leaded petrol. Directive 98/70/EC relating to the quality of petrol and diesel fuels (EU, 1998) regulated that goal. Nevertheless, the 'road transport' sector remains a key source of Pb, contributing around 16 % of total Pb emissions in the EU-28.

Of the POPs, PCBs and PCDD/Fs are the most important in the 'road transport' sector group. Figure 4.10(b) shows past emission trends for these pollutants. The highest absolute and relative reduction occurred for PCDD/Fs (−70 %).

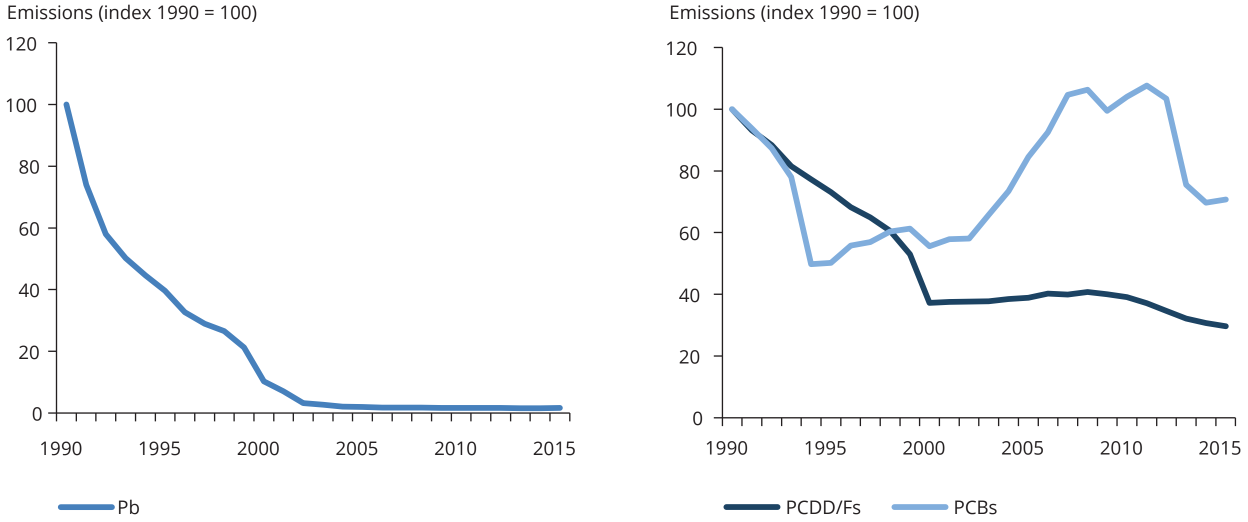
The trend in emissions of PCBs is largely due to data reported by Poland in the category '1A3biii — Road transport: Heavy duty vehicles and buses'. However, the strong decrease from 1993 to 1994 reflects data reported by Denmark in the category '1A3bi — Road transport: Passenger cars'. Denmark explained that the main reason is the switch from leaded gasoline to unleaded gasoline with a lower PCB emission factor. The trend in emissions of PCDD/Fs reflects data reported by the United Kingdom in the category '1A3bi — Road transport: Passenger cars'.

Figure 4.9 EU-28 emission trends in the sector group 'road transport' for NO_x, NMVOCs, PM and CO between 1990 (2000) and 2015



Notes: For PM, data from Greece could not be gap-filled, as it did not report values for any year. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including data for this Member State.

Figure 4.10 EU-28 emission trends in the sector group 'road transport' (a) for the priority HM Pb, and (b) for PCBs and PCDD/Fs between 1990 and 2015



Notes: For Pb, no data for Greece were available. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including emission data for these Member States.

For PCBs and PCDD/Fs, data from Greece could not be gap-filled, as it did not report values for any year. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including data from Greece.

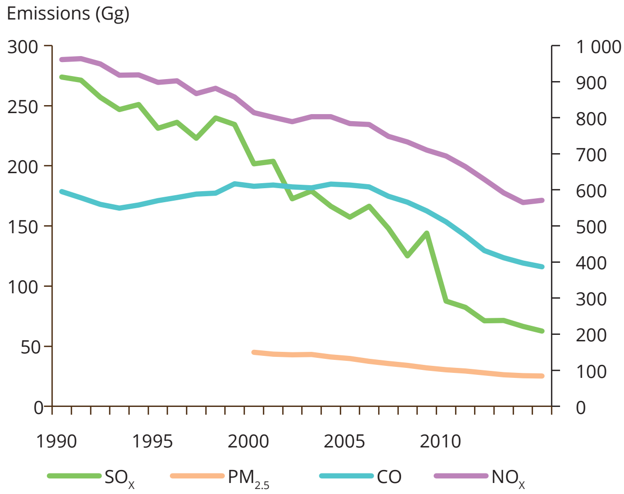
4.6 Sectoral analysis and emission trends for 'non-road transport'

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

An important pollutant in the 'non-road transport' sector group is NO_x. The United Kingdom, Italy and Spain contributed most (in absolute terms) to the emissions of NO_x, Italy, Spain and Greece most to the emissions of SO_x and France, Italy and the United Kingdom most to the emissions of CO emissions in 2015.

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

Figure 4.11 EU-28 emission trends in the sector group 'non-road transport' for NO_x, $PM_{2.5}$, SO_x and CO between 1990 (2000) and 2015



Notes: For PM, data from Greece could not be gap-filled, as it did not report values for any year. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including data for this Member State.

4.7 Sectoral analysis and emission trends for 'agriculture'

The 'agriculture' sector group is responsible for the vast majority of NH_3 emissions in the EU-28. Germany, France and Spain contributed most (in absolute terms) to emissions of NH_3 in 2015.

Agricultural emissions of NH3 have decreased by 24 % since 1990 (see Figure 4.12).

The decrease in emissions of NMVOCs between 1990 and 1991 reflects data reported by Germany mainly in categories '3B1b — Manure management — Non-dairy cattle' and '3B1a — Manure management — Dairy cattle'. The drop in data between 1991 and 1992 reflects emissions reported by Bulgaria. The increase in emissions of NMVOCs from 2004 to 2005 is due to the difference between gap-filled (up to 2004) and reported data (from 2005) of Romania.

For the POPs, this sector contributes considerably to emissions of total PAHs, B(a)P and HCB. Figure 4.13 shows past emission trends for these pollutants.

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

The trend in emissions of total PAHs largely reflects data that Spain reported for the category '3F — Field burning of agricultural residues'. Spain explained that high emissions of total PAHs have notably decreased, particularly between 1999 and 2003. This is due to a progressive decrease in field burning of agricultural residues, which has been restricted by a combination of legislation aiming at preventing forest fires, the fact that the EU's Common Agricultural Policy's conditionality rules entered into force and national mitigation programs aiming at the reduction of field burning of agricultural waste (personal communication by Spain in 2017).

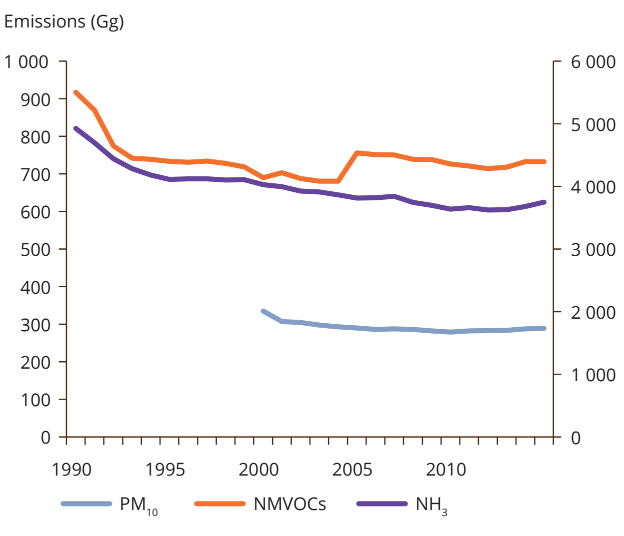
The strong decrease in B(a)P emissions from 1990 to 1993 reflects data that the United Kingdom reported for the category '3F — Field burning of agricultural residues'.

4.8 Sectoral analysis and emission trends for 'waste'

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

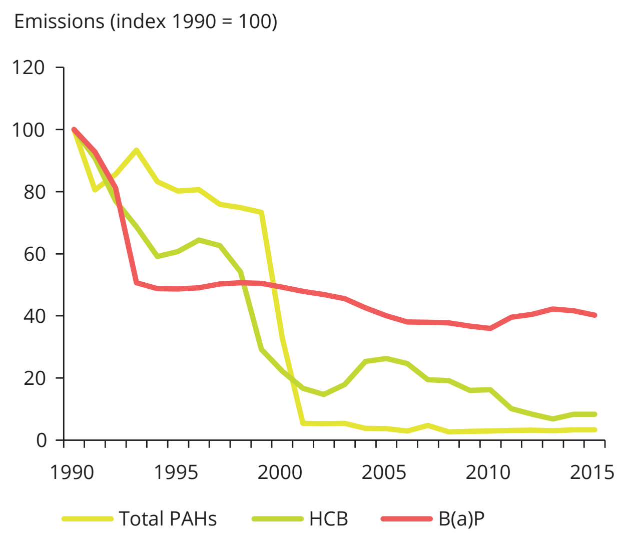
The decrea se in PCB emissions between 1990 and 2008 reflects data reported by several countries. However, the drop between 1999 and 2000 is due to the difference between gap-filled (up to 1990) and reported data (from 2000 onwards) for the Czech Republic. The trend in PCBs emissions from 2008 onwards reflects mainly data that Portugal reported for the category '5C1bi — Industrial waste incineration'. PCBs emissions reported by this Member State

Figure 4.12 EU-28 emission trends in the sector group 'agriculture' for NMVOCs, NH_3 and PM_{10} between 1990 (2000) and 2015



Notes: For PM, data from Greece could not be gap-filled, as it did not report values for any year. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including data for this Member State.

Figure 4.13 EU-28 emission trends in the sector group 'agriculture' for POPs (total PAHs, B(a)P and HCB) between 1990 and 2015

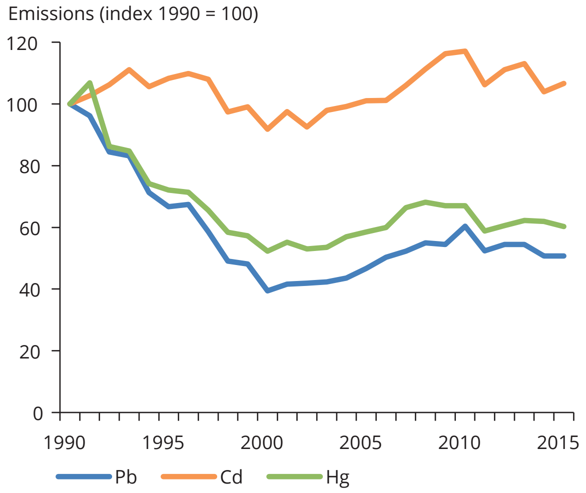


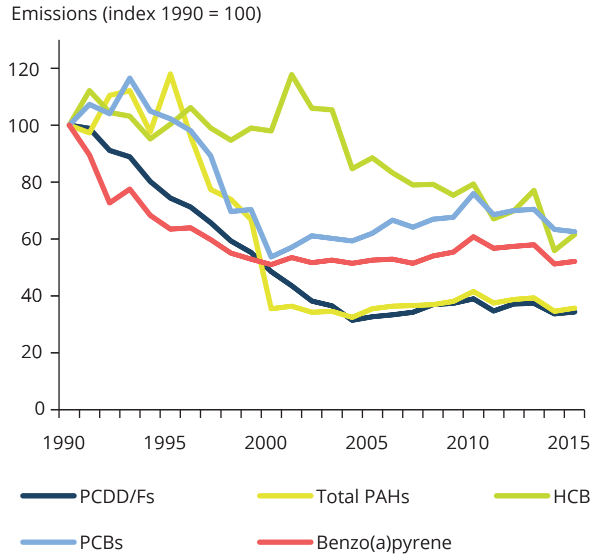
Notes: For total PAHs and HCB, data from Greece could not be gap-filled, as it did not report values for any year. For B(a) P, several Member States (Austria, Greece, Italy and Spain) did not provide emission data and were not gap-filled. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including data from these countries.

closely correspond with the amount of waste burnt in respective industrial incineration plants. Portugal explained that the fluctuations industrial waste incineration results, at least partially, from the variation of fluxes to other treatments (landfilling, shipping abroad and recycling), as a consequence of the annual waste market demand (see Portugal's IIR, listed in Appendix 5).

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

Figure 4.14 EU-28 emission trends in the sector group 'waste' for the HM Hg, and for the POPs (PCDD/Fs, total PAHs, HCB and PCBs) between 1990 and 2015





Notes: For the HMs, no data for Greece from 2009 to 2015 were available. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including emission data for this Member State.

For PCDD/Fs, total PAHs, HCB and PCBs data from Greece could not be gap-filled, as it did not report values for any year. To enable presentation of provisional EU-28 emission trends, the emissions have been aggregated without including data from these countries.

5 Recalculations, and implemented or planned improvements

5.1 Recalculations

5.1.1 Recalculations

Recalculations are changes made to past emission estimates (for one or more years) to eliminate errors, consider additional factors and to incorporate new data. The *EMEP/EEA 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 emissions source category has become a key category;
- the previously used method does not reflect mitigation activities transparently;

Table 5.1 Comparison of data submitted in 2016 and 2017 by Member States (relative data, percentage of EU-28 national total)

Pollutant	Unit	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
NO_x	Gg	1 %	0 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %
NMVOCs	Gg	1 %	0 %	0 %	– 2 %	– 2 %	– 2 %	– 3 %	– 3 %	– 3 %	– 3 %	– 2 %	– 2 %	– 3 %
SO_x	Gg	0 %	– 1 %	– 1 %	– 1 %	– 1 %	– 1 %	– 2 %	– 2 %	– 3 %	– 4 %	– 5 %	– 6 %	– 4 %
NH_3	Gg	1 %	2 %	2 %	2 %	1 %	1 %	1 %	1 %	1 %	1 %	1 %	0 %	0 %
TSPs	Gg	0 %	2 %	3 %	1 %	1 %	1 %	1 %	0 %	0 %	0 %	0 %	1 %	0 %
CO	Gg	3 %	3 %	1 %	0 %	0 %	– 1 %	– 1 %	– 2 %	– 2 %	– 3 %	– 2 %	– 4 %	– 6 %
Pb	Mg	1 %	1 %	– 2 %	5 %	6 %	7 %	6 %	8 %	8 %	0 %	0 %	0 %	– 6 %
Cd	Mg	1 %	– 1 %	– 1 %	1 %	1 %	1 %	1 %	1 %	3 %	3 %	3 %	3 %	2 %
Hg	Mg	4 %	1 %	– 1 %	– 1 %	0 %	0 %	– 1 %	0 %	– 1 %	– 1 %	– 1 %	– 1 %	0 %
As	Mg	– 8 %	– 2 %	4 %	6 %	7 %	7 %	7 %	7 %	7 %	– 1 %	– 1 %	– 1 %	0 %
Cr	Mg	– 1 %	– 1 %	– 1 %	0 %	0 %	1 %	0 %	1 %	– 1 %	0 %	0 %	– 1 %	0 %
Cu	Mg	– 1 %	1 %	1 %	3 %	3 %	3 %	3 %	3 %	2 %	3 %	3 %	3 %	2 %
Ni	Mg	0 %	0 %	0 %	0 %	0 %	0 %	1 %	1 %	0 %	0 %	1 %	0 %	1 %
Se	Mg	7 %	8 %	8 %	7 %	7 %	8 %	9 %	9 %	10 %	9 %	2 %	1 %	1 %
Zn	Mg	1 %	2 %	2 %	3 %	2 %	3 %	3 %	3 %	2 %	3 %	3 %	2 %	2 %
PCDD/Fs	g I-Teq	2 %	4 %	– 6 %	– 6 %	4 %	4 %	– 1 %	1 %	2 %	1 %	7 %	2 %	0 %
Benzo(a) pyrene	Mg	4 %	6 %	8 %	9 %	8 %	7 %	6 %	7 %	7 %	7 %	7 %	5 %	0 %
Benzo(b) fluoranthene	Mg	6 %	7 %	9 %	10 %	9 %	9 %	8 %	9 %	9 %	8 %	9 %	7 %	1 %
Benzo(k) fluoranthene	Mg	5 %	5 %	7 %	8 %	7 %	7 %	6 %	6 %	6 %	6 %	6 %	6 %	– 19 %
Indeno (1,2,3-cd) pyrene	Mg	5 %	5 %	7 %	12 %	11 %	11 %	10 %	12 %	12 %	11 %	11 %	7 %	1 %
Total PAHs	Mg	253 %	196 %	190 %	16 %	8 %	19 %	7 %	6 %	6 %	6 %	13 %	2 %	0 %
HCB	kg	0 %	– 1 %	– 4 %	0 %	0 %	0 %	0 %	– 1 %	0 %	– 1 %	– 1 %	– 1 %	– 3 %
PCBs	kg	– 1 %	– 3 %	– 6 %	– 11 %	– 13 %	– 16 %	– 18 %	– 19 %	– 10 %	– 20 %	– 10 %	– 20 %	– 20 %
				2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
$PM_{2.5}$	Gg			7 %	6 %	5 %	5 %	5 %	6 %	5 %	6 %	6 %	6 %	5 %
PM_{10}	Gg			5 %	4 %	3 %	3 %	3 %	3 %	3 %	3 %	3 %	4 %	2 %
BC	Gg			48 %	49 %	49 %	49 %	46 %	47 %	46 %	49 %	50 %	50 %	47 %

- the capacity (resources) for inventory preparation has increased;
- new inventory methods become available;
- correction of errors is necessary.

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

In 2012, the EU LRTAP report was reviewed by an ERT within the CEIP stage 3 review (see Section 1.6). One recommendation was to include information on 'significant' recalculations in the IIR. This is provided within this section (see below).

Table 5.1compares total emissions from the EU-28 according to the submissions in 2016 with those in 2017. In a few cases, recalculations might reflect changes in the gap-filling (see Section 1.4.5) rather than 'true' recalculations by the countries themselves.

The highest recalculations are for total PAHs, BC, PCBs and B(k)F. These are ascribable to differences between data submitted in the 2017 inventory and data submitted in the 2016 inventory, especially from Spain for total PAHs from 1990 to 2000, Spain, Germany and Poland for BC, Lithuania and Portugal for PCBs, and Malta for B(k)F in 2014.

Table 5.2 EU countries with significant recalculations

Pollutant	EU countries with high recalculations
NO_X	ES 1990-2014; PL 1993-1996, 2002-2004; IT 2009-2011; UK 1900-1996; SK 1993-1995
NMVOCs	UK 1990-2014; PL 1990-2014; IT 1990-2014; GR 1990-2013; SK 1990-2000, 2014; ES 2003-2006, 2013-2014; DE 2011-2014;
SO_X	PL 1990-2014; DE 1990-1996, 2010-2014; GR 2010-2013; RO 1990-2004; FR 2010-2014
NH_3	ES 1990-2014; FR 1990-2014; PL 1990-2007; HU 1990; LT 1990-1991
$PM_{2.5}$	ES 2000-2014; HR 2000-2013; HU 2001-2002, 2004-2014; SK 2000; PL 2000-2014
PM_{10}	ES 2000-2014; HR 2000-2013; HU 2009-2014; PL 2010-2014; SK 2001; DE 2000-2006
TSPs	HU 1990-2014; ES 1990-2014; PL 1990-2014; DE 1990-2014; UK 1990-2014; HR 2000-2010; SK 2000-2002
BC	ES 1990-2014; DE 1990-2014; PL 1990-2014
CO	PL 1990-2009, 2011-2014; ES 1990-1999, 2009-2011, 2013-2014; UK 1990-2014; DE 2009-2014; IT 2001-2011, HR 2001-2010
Pb	LV 1990-2010; DE 1990-1994; CZ 2000; BG 2014; IT 1990-1991; SK 2000;
Cd	DE 1990-1994; HU 1990-1999; CZ 2000-2009; SK 1900-1995, 2000
Hg	SK 1990-1998, 2000; DE 1990-1994; ES 1990, 1995, 1997-1999; LI 1990-1991; CZ 2003-2014
As	SK 1990-1993, 1995-1998; LV 1990-2010; CZ 1990-2015
Cr	SK 1990-1995; CZ 1990-2014; DE 1990-2007; FI 2014; PL 2005-2009, 2011-2014; ES 2012-2014
Cu	PL 1990-2014; SE 1990-2014; SK 1990; NL 1990-2014; FI 2010-2014
Ni	BE 1990–1999; SK 1990-2014; LT 1992; FR 1996-1997, 2011-2014; CZ 1990-2007; PL 2010-2014; DE 2014
Se	CZ 1990-2014; ES 2012-2014, SK 2001-2010
Zn	ES 1990-2014; PL 1990-2009, 2011-2014; SE 2001-2014; CZ 2001
PCDD/Fs	CZ 2000-2005, 2008, 2010-2011; ES 1990-1995, 1997-2014; PL 1990-2014; PT 2006-2011, 2013-2014; UK 1990-1998, 2014; SK 1990-2000; HR 2004-2013; HU 2014; RO 2014
B(a)P	BE 1990-2014; HR 1991-2013; MT 2014; PL 2002-2004, 2013-2014; CY 1990-1999
B(b)F	BE 1990-2014; CY 1990-2004; MT 2014; HR 1990-2013; PL 2002-2012
B(k)F	MT 2014; BE 1990-2014; PL 2002-2007; CY 1990-1999; HR 1990-2013; SK 1990-1992
IP	BE 1990-2014; PL 2002-2012; MT 2014; HU 1990-2001, 2003-2014; UK 2014; SK 1990-1992; HR 1990-2005; CY 1990-1997; CZ 1990-2001
Total PAHs	ES 1990-2014; MT 2014; BE 1990-2014; HU 2011-2014
HCB	BE 1990-2000; LT 1990-1993, 2005-2010; ES 2002-2014; FI 2000-2013; PT 2005-2014; CZ 2001-2014
PCBs	LT 1990-1997, 1999-2014; PT 2004-2014; UK 1990-1992, 2003-2014; DE 1990; PL 2002-2012; AT 2013-2014

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

Spain made significant recalculations for total PAHs, especially from 1990 to 2000, which are reported mainly in the category '3F'. This Member State explained that it has developed a new estimation model to calculate agricultural emissions. However, only activity '3Da1' had been completely processed at the closing date (see Spain's IIR, listed in Appendix 5).

Spain also made recalculations for BC for the whole time series. The Member State explained that an update of emission factors in the EMEP/EEA guidebook had led to a recalculation. Moreover, the highest recalculations occurred in the category '5C2', where the Member State explained the recalculation through introduction of the incineration of agricultural waste. Due to its great significance in terms of waste treated, this has had a substantial influence over the total emissions from this sector (see Spain's IIR, listed in Appendix 5). Additionally, Germany and Poland submitted BC data in 2017 but not in 2016, making the differences between data submitted in 2017 and 2016 by all Member States even stronger.

Recalculation results submitted by Lithuania and Portugal resulted in reductions of PCB emissions. Recalculations reported by the United Kingdom for 1990 to 1992 showed an increase for PCBs.

Lithuania commented that main reasons for the differences between the current and the previous submissions are recalculations of large parts of the inventory due to the use of the latest 2016 EMEP/EEA guidebook (see Lithuania's IIR, listed in Appendix 5). The significant PCB recalculations made by Portugal result mainly from updates of emission factors proposed by the latest EEA guidebook and 2006 Intergovernmental Panel on Climate Change (IPCC) guidelines (IPCC, 2006) (see Portugal's IIR, listed in Appendix 5).

The recalculations in B(a)F, B(b)F, B(k)F and IP for the whole time series are to a large extent because Belgium submitted emission data in 2017 but not in 2016. From 2002 to 2012 differences between data submitted in the 2017 inventory and data submitted in the 2016 inventory in IP emissions are even higher because Poland made significant recalculations for this period.

The significant reduction in recalculations for B(k)F in 2014 result from data reported by Malta and are due to the correction of erroneous data (error in decimals used; personal communication by Malta in 2016).

Belgium made recalculations for HCB and explained that the reason was correction of mistakes for the HCB emission factors for coal combustion in textile industry in the category '1A2gviii' (see Belgium's IIR, listed in Appendix 5). Data reported by this Member State from 1990 to 2000 have a considerable impact on the EU recalculations, especially in 1999.

The reduction due to recalculations for PCDD/F emissions between 2000 and 2005 reflects data reported by the Czech Republic. All recalculations made by this Member State are mainly because of correction of data reported for 2000 to 2014 (personal communication by the Czech Republic in 2017).

There are some significant differences in HM recalculations. For Pb they are mainly caused by an increase in emissions due to recalculations by Latvia from 1990 to 2010 as well as Germany from 1990 to 1994. However, reductions in EU emissions due to recalculations for 2000 and 2014 are because of data reported by the Czech Republic in 2000 and Bulgaria in 2014. The high reduction in emissions due to recalculations for As from 1990 to 1991 are caused by data reported by Slovakia. Significant increases in recalculated emissions for this pollutant reflect mainly data reported by Latvia and partially, between 1996 and 1998, also by Slovakia. For Se, high recalculated emissions for the whole time series are mostly due to data reported by the Czech Republic. However, from 2012 to 2014, the reduction in recalculated emissions reported by Spain lead to lower EU emissions than in other years.

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 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 due to revisions, updates of activity data, and improvements of methodologies and emission factors (see Austria's IIR, listed in Appendix 5).

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

Bulgaria reported that it recalculated the Pb emissions for the sector 1A2b because there was a technical error in previous calculations (see Bulgaria's IIR, listed in Appendix 5).

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

Cyprus stated that it had made some methodological improvements to the national emissions inventory. This resulted in recalculations of the time series from 1990 to 2014 according to methodologies proposed in the *Inventory Guidebook* in advance of the 2015 submission. Other reasons for recalculations include the update from COPERT 4 to COPERT 5, new activity data and the correction of erroneous formulas (see Cyprus's IIR, listed in Appendix 5).

The **Czech Republic** provided sector-specific information on recalculations made for data submitted in March 2017 and data submitted in the 2016 inventory (see the Czech Republic's IIR, listed in Appendix 5). However, in April 2017 this Member State resubmitted NFR data making significant corrections of data reported for 2000 to 2014 but did not report an updated IIR explaining current recalculations.

Denmark provided detailed information on its recalculations. It had put considerable work into improving the inventory. The submission includes recalculated inventories for the whole time series. The reasons for recalculation were changed methodology, updated activity data, new data for secondary aluminium production gathered by contacting the industry, 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 from 1990 to 2014. The reasons for recalculating were new and corrected emission factors (the *EMEP/EEA Guidebook* (EMEP/EEA, 2016)), corrected sulphur contents in fuels, corrected activity data, more detailed allocation of data and the correction of errors (see Estonia's IIR, listed in Appendix 5).

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

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

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

Hungary provided detailed information on recalculations. Recalculations were carried out mainly due to the update of emission factors and methodologies in accordance with the new Inventory guidebook and the revision of activity data, as well as the availability of new activity data (see Hungary's IIR, listed in Appendix 5).

Italy provided detailed information on its recalculations. The main reason for recalculations was updated activity data. Other reasons were updates of methodology and emissions factors, revision of emission estimates and the availability of new data (see Italy's IIR, listed in Appendix 5).

Latvia provided detailed information on recalculations. Recalculations were carried out due to improved activity data, updated methodology and new/revised emission factors (see Latvia's IIR, listed in Appendix 5).

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

The Netherlands provided detailed information on the recalculations carried out. Reasons for changes in emissions were recalculations with emission factors for the road transport sector, updated versions of the model for calculation of emissions from non-road transport and civil aviation (LTO), as well as an update of emission factors in the railways sector and NH_3 emission factor updates for fertilizers and human transpiration and breathing (see the Netherlands' IIR, listed in Appendix 5).

Poland reported that recalculations were carried out mainly due to updated activity data. Other reasons were new estimations, error correction and updated methodology (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 updated activity data, revised data, error correction and the implementation of tier 2 methodology from the *Inventory guidebook* (see Portugal's IIR, listed in Appendix 5).

Romania noted that it had recalculated emissions from road transport for the year 2014 due to the availability of updated fleet data (see Romania's IIR, listed in Appendix 5).

Slovakia provided information on its recalculations. The reasons were corrections of double-counted emissions, new emission factors in compliance with the *Inventory guidebook*, and updated activity data (see Slovakia's IIR, listed in Appendix 5).

Slovenia provided detailed information on its recalculations. They were carried out due to corrections, availability of better data and improved activity data, new estimations, and emission factors from the *Inventory guidebook* (see Slovenia's IIR, listed in Appendix 5).

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

Sweden provided detailed information on its recalculations. The reasons were reallocation of emissions, revisions and updates of activity data and emission factors, the adjustment of estimates, the correction of emissions, correction of the calculation model and updates of methodology (see Sweden's IIR, listed in Appendix 5).

The **United Kingdom** provided detailed information on recalculations made since its last CLRTAP 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 EMEP/EEA Guidebook (EMEP/EEA, 2016) presents a summary of the individual recalculations that Member States reported. This report will be available from the CEIP website in July of each year (EMEP CEIP, 2017b).

5.2 Member States' emission changes due to review improvements

In addition, EMEP CEIP has the task of reviewing the submitted emissions, to help Parties improve national inventories (EMEP CEIP, 2017a; EMEP/EEA, 2017). These yearly reviews should help Member States to prepare and improve their inventories. Member States compile their individual emission estimates and submit their inventories together with their IIRs.

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

In 2016, EMEP CEIP reviewed Estonia, Georgia, Iceland, Luxembourg, the former Yugoslav Republic of Macedonia, the Russian Federation, Serbia, Switzerland, Turkey and the United Kingdom. In their IIRs, some of these Member States refer explicitly to improvements planned as a consequence of these reviews.

5.3 Planned improvements at EU level

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

- Further progress concerning **completeness of reporting**: although clear progress has been made in recent years on making reporting complete, a full set of emission inventory data for air pollutants is still not available for all Member States, as noted earlier in this report. Further, for certain pollutants (including PM, HMs and POPs), data could not be fully gap-filled, because some Member States had not reported emission values in any years (see Figure 1.2 and Figure 1.3).

- **Updating of emission data** by Member States, for past years too: the ETC/ACM has also identified a problem with filling gaps 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-28 inventory unavoidably contains inconsistencies. The quality of the EU's inventory will thus be enhanced if the consistency and completeness of Member States' submissions improves. Such improvements would help reliable trend analysis to inform policy.

- **Reviewing current gap-filling procedures** to ensure that they use the best approach, reflecting real emissions: the improved inventory gap-filling procedure performed in 2011 has helped develop a more complete EU emission inventory, but there is room for improvement (e.g. by including manual changes in the procedure).

- **Reducing the need for gap-filling**: this is achievable if Member States report complete time series as far as possible, and also if they have already provided the data in earlier submissions under the LRTAP. Current gap-filling procedures first use submissions received in the current reporting years under various reporting mechanisms, and then use older LRTAP submissions.

- **More explanatory information** on trends and recalculations: this would be possible if the IIRs contained such information.

- Further research on **outliers in Member States' emission data** to help ensure that they reflect real emissions: a comparison of Member States' contributions to the EU-28 total reveals extraordinarily high proportions in some instances, e.g. for SO_x in Poland (25 %), Pb in Poland (28 %), Cu in Germany (57 %), Zn in Germany (30 %), IP in Poland (40 %) and total PAHs in Spain (28 %). Future investigation could determine whether these high proportions reflect actual emissions or they are ascribable to incomplete reporting (or underestimates) by other Member States.

- More attention to **data quality**: in several submissions from Member States and as a result of the gap-filling procedure, values of BC exceed $PM_{2.5}$ values, values of $PM_{2.5}$ exceed PM_{10} values, or values of PM_{10} exceed TSP values — which should be impossible. Changes in the gap-filling results and improved Member State emission data should resolve these problems.

- Basis of **emissions from transport**: according to the reporting guidelines (UNECE, 2014a), all Member States should calculate and report emissions from road vehicle transport on the basis of fuel sold. For the purpose of comparison with the ceilings only, Austria, Belgium, Ireland, Lithuania, Luxembourg, the Netherlands and the United Kingdom may choose to use the national emission total calculated on the basis of fuel used. This year again, the United Kingdom submitted data based only on fuel used. The aim is to compile EU total emissions based on fuel sold from transport.

5.4 Implemented improvements

The joint EMEP/EEA annual review of inventory data helps improve Member States' inventories. The review of data reported under the LRTAP Convention happens jointly with the review of data reported by Member States under the NEC Directive. Since 2009, there has been a centralised stage 3 review process. Two teams of emission experts perform the reviews. Member States are encouraged to nominate reviewers for the EMEP roster of emission review experts; nomination process details are available on the CEIP website. In 2012, the EU emission inventory report (1990-2010) under the UNECE LRTAP Convention was reviewed (EEA, 2012). The findings and their implementation are summarised in Table 5.3 and Table 5.4. The next review of the EU emission inventory report is in 2017.

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

Table 5.3 and Table 5.4 list the improvements implemented or not implemented in response to the stage 3 review by an ERT in 2012. Since the last stage 3 review, tables on methods and data used by Member States to calculate emissions from the individual sectors were removed from the inventory report, although they were regarded as very useful by the ERT. Information within these tables was of rather high uncertainty and it was very time-consuming to gather and compile the required information.

Table 5.3 EU stage 3 review results 2012 and improvements implemented

Topic	Finding	Implemented	Comment
	Transparency		
Information on QA/QC	It is recommended that further information on the exact QA/QC procedures be given	Yes	See Section 1.6, Table 1.5
More information	If there are unique circumstances governing the reporting of a particular pollutant(s) in a particular Member State, the ERT suggests that this should be highlighted in the IIR	Yes	If information is available
Time series	Explain the largest variations in trend (peaks and troughs), at least for the key categories	Partly	Explanations are given as far as possible; see Chapters 3 and 4
International/domestic aviation and shipping	The ERT recommends that explanations and contextual information be included in the IIR on the emissions from international/domestic aviation and shipping (as these are reported as a sum of the emissions from each Member State), or to split these emissions into activities within the EU and those that cross the geographical boundary of the EU	Yes	Explanation is included in the IIR; see Section 4.6
	Completeness		
Improvement programme	Recommendation to assess an annual improvement plan including a timescale: - further improvement to the gap-filling procedure; - outlier checks for the Member State inventories to improve the accuracy of the EU inventory; - review of the sectoral methods supplied by Member States	Partly	Implemented: further improvement in the gap-filling and outlier checks
Underestimation	The ERT recommends that the EU undertake the following steps to address potential underestimation: - review the use of 'NO' and 'NA' by Member States; - review the use of 'NE' by Member States and, where necessary, perform proxy estimates in cooperation with Member States	Partly	See Sections 1.8 and 1.9
More information	The ERT encourages the EU to include more information on sector description, time series of emissions and explanations of trends and activity data	Yes	As far as possible in the limited time frame; see Chapters 3 and 4
Use of notation keys	QA/QC: check on Member State use of the notation keys 'NA', 'NO' and 'NE' is recommended	Partly	Checks included; see Section 1.6, Table 1.5
	Consistency		
Recalculations	The ERT encourages the EU to request information on recalculations by Member States in subsequent years	Partly	Information on extensive recalculations was gathered from the IIRs and in special cases (exceptionally extensive recalculations not explained in the IIR) after requests to the Member States; see Section 5.1
Recalculations	The ERT encourages the EU to include information on 'significant' recalculations in the IIR	Yes	See Section5.1.
Consistency checks	Recalculations and time series: check consistency of the data sent by Member States	Yes	Checks are implemented; see Section 1.6, Table 1.5
	Accuracy		
Accuracy checks	The ERT recommends that the EU include ratio of TSP to PM_{10} and $PM_{2.5}$ as a check on the data submitted by Member States	Yes	New checks included; see Section 1.6, Table 1.5
Sector-specific checks	The ERT recommends that the EU introduce sector-specific QA/QC checks	Partly	Such checks would mean considerable effort and are not feasible within the given time frame Explanations of unusual sector trends are given in Chapter 4
Emission basis	Emission data for road transport shall be reported on a consistent basis (not as a mix of fuel sold and fuel used)	Partly	The United Kingdom is the only country in 2017 that still did not provide data based on fuel sold; see Section 1.4.4

Table 5.4 EU stage 3 review results 2012, not implemented findings and rationale

Topic	Finding	Implemented	Comment
	Review findings (2012)		
Notation keys	For all sources that are not estimated, the ERT recommends that the EU provides an explanation in the IIR	No	As the inventory is an aggregation of the Member State inventories, explanations cannot be given
Sources of sectors	Providing further clarity on the largest sources included and not included in particular sectors	No	It would be very resource intensive to search in Member States' IIRs and aggregate the information
	Completeness		
Improvement programme	The ERT encourages the EU to develop the EU-level inventory programme: actions to target improvements of the completeness of reporting by Member States	No	Political decision
Inter-country checks	The ERT recommends that the EU performs completeness checks by comparing emissions reported by the Member States for specific source sectors	No	Such checks would mean considerable effort and are expected to result only in a relatively small benefit; such an analysis is not feasible within the limited time frame
Completeness checks	The ERT recommends that the EU performs completeness checks by comparing emissions reported by the Member States with information from other sources (e.g. Eurostat)	No	Such checks would mean considerable effort and are expected to result only in a relatively small benefit; such an analysis is not feasible within the limited time frame
Use of notation keys	The EU uses the notation key 'NE' (and 'NR') for reporting where estimates are unavailable or unnecessary. This does not always provide a true reflection of the status. The EU should review the use of 'NE' and revise to 'NA' where necessary	No	Further improvement required
Inter-country checks	The ERT strongly encourages the EU to introduce important inter-country comparisons into the QA/QC procedures	No	Such checks would mean considerable effort and are expected to result only in a relatively small benefit; such an analysis is not feasible within the limited time frame
	Consistency		
Use of notation keys	Amend notation keys when they are considered to be erroneous and no information is forthcoming from the relevant Member State	No	Further improvement required
	Comparability		
Activity data	The ERT encourages the EU to obtain activity data from each Member State to allow complete reporting	No	Compilation of activity data from the Member States is not straightforward due to differences in reporting
Comparability checks	The ERT recommends that the EU develop tools to ensure the comparability of data (methods used) between Member States	No	Checks on the methods of the Member State would mean considerable effort and are not feasible within the given time frame
	Accuracy		
Uncertainty analysis	The ERT strongly encourages the EU to produce an uncertainty analysis for the emission inventory	No	Not feasible at the moment
Accuracy checks	The ERT recommends that the EU develops checks to ensure that compounds that should be included as components of the SO_X and NO_2 emissions are captured in the individual Member State emissions inventories	No	Not feasible
Accuracy checks	The ERT recommends that the allocation of emissions between the industrial processes and energy sectors is checked	No	As the inventory is an aggregation of the Member State inventories, this is not an easy task and would mean too much effort in the limited time frame

Table 5.5 Overview of improvements planned at Member State level

	Overview of improvements planned at Member State level
Austria	The corresponding sector analysis chapters describe required methodological changes and planned improvements (Appendix 5, Austria's IIR)
Belgium	Belgium's IIR lists planned improvements in Sections 8.1-8.4. The relevant sectoral chapters also describe them (Appendix 5, Belgium's IIR)
Bulgaria	Planned improvements: • application of higher tier method for estimation of emissions; • incorporation of ETS and E-PRTR databases into emission inventory in NFR sector 1 'energy' and NFR sector 2 'industrial processes and other solvents and product use'; • incorporation of data provided by branch business associations; • revision of activity data in NFR sector 3 'agriculture', in line with agro-statistical data from the Ministry of Agriculture and Food; • improving the accuracy of the estimates; • improving transparency, completeness and consistency, including recalculations of time series and comparability of national emission inventory (Appendix 5, Bulgaria's IIR)
Croatia	Table ES6-1 of Croatia's IIR lists planned improvements in detail, including recalculations, the updating of emission factors and collection of new data (Appendix 5, Croatia's IIR)
Cyprus	The 2017 IIR reports no planned improvements
Czech Republic	For the sectors 'energy' (mobile sources) and 'agriculture' (manure management) improvements are planned (Appendix 5, Czech Republic's IIR)
Denmark	The relevant sectoral chapters describe sector-specific planned improvements (Appendix 5, Denmark's IIR)
Estonia	Estonia's IIR lists source-specific planned improvements. The checking of POPs from the energy sector and waste incineration, as well as checking of activity data and emission factors in the energy industry, are priorities for future inventory improvement (Appendix 5, Estonia's IIR)
Finland	Table 14.3 of Finland's IIR sets out sector-specific improvement needs. Further, the sectoral chapters describe the source-specific planned improvements (Appendix 5, Finland's IIR)
France	There are some planned and ongoing improvements mentioned in the French IIR: • conducting research to improve accuracy, especially for key categories; • establishing measures to determine uncertainties; • reducing the number of non-considered or poorly determined pollutants.; there are still plans to improve the estimation of emissions from heating boilers in the residential sector, which could strongly influence NO_X emissions; • introducing further splits for energy consumption in the industry sector; • adopting the recent developments of EMEP/EEA; • strengthening all activities for better QA and QC of the system, especially towards the implementation of procedures and tools, cooperation with experts from different fields and maintaining the ISO 9001 certification system (Appendix 5, France's IIR)
Germany	Germany is planning to prioritise improvements on the basis of results of the uncertainty analysis. Planned improvements for the source category 'stationary combustion' include revision of the reporting structure, new measurements, improvement of the emission factor for waste incineration plants, revision of emission factors for SO_2, further comparison with other inventory data (namely E-PRTR and ETS), as well as the calculation of a complete time series for two subsectors (Appendix 5, Germany's IIR)
Greece	No IIR available
Hungary	A research program was started in 2015 called 'Pig Farming Strategy'. The planned output will include country specific NH_3 emissions factors for pig husbandry and manure spreading.
Ireland	The sectoral chapters of Ireland's IIR describe the source-specific planned improvements (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 different obligations (Large Combustion Plants Directive, E-PRTR and Emissions Trading Scheme), to highlight major discrepancies and to detect potential errors For the sectors 'agriculture' and 'waste', improvements related to the availability of new information on emission factors, activity data, etc. are planned Further work is planned to update/change emission factors for the PAH, dioxin and HMs in order to increase accuracy (Appendix 5, Italy's IIR)
Lithuania	There are no source-specific planned improvements listed in the IIR, but the country sees a priority in the estimation of KCA categories using a tier 2 or higher approach (Appendix 5, Lithuania's IIR)
Luxembourg (information from 2016 IIR)	The IIR lists planned improvements (Luxembourg's IIR, p. 324). They mainly concern updating the method of calculating emissions, correction of errors and notation keys, reallocation of emissions and completeness
Malta (information from 2013 IIR)	The time series may be updated with respect to HM emissions (Malta's IIR, p. 20).

5.42 Further improvements undertaken in 2017

- More explanations on unusual trends, peaks and troughs are included.
- A table on improvements after the stage 3 review in 2012 is included (Table 5.3).
- Again, manual corrections for BC, $PM_{2.5}$ and PM_{10} improved the gap-filled inventory.
- Early and extended data checks on submitted Member State inventories were performed (see Table 1.5), and the Member States were informed of the results. Twelve of 27 Member States sent answers with explanations, and several Member States sent resubmissions as a consequence.

5.43 Improvements at Member State level

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

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

	Overview of improvements planned at Member State level
Netherlands	In 2015 the IIR and NFR tables were examined in a stage 3 review. The findings were considered in this year's inventory, and the remaining issues will be implemented in the 2017 and 2018 inventories Some source-specific improvements are planned. These are described in the sectoral chapters of the Netherlands' IIR
Poland	The planned programme of improvement focuses on the following tasks: verifying NMVOC emissions from solvent use; verifying of heavy metal emissions from non-industrial combustion; gathering additional activity data to include new emission sources (e.g. venting and flaring); and further methodology development by applying higher tiers of estimation methodology (especially for key categories) (Appendix 5, Poland's IIR)
Portugal	Each source-specific section presents a detailed explanation of the planned sectoral improvements (Appendix 5, Portugal's IIR)
Romania	The country plans to recalculate the whole time series from 2005 to 2015, using the new version of COPERT 5 for the 2018 submission (Appendix 5, Romania's IIR)
Slovakia	Each source-specific section presents a detailed explanation of the planned sectoral improvements Further, Slovakia is planning an uncertainty analysis (Appendix 5, Slovakia's IIR)
Slovenia	Planned improvements relate to sectors 1, 2 and 3. The main aims are to use the new the EMEP/EEA Guidebook (EMEP/EEA, 2016) for calculations, to estimate emissions that were not estimated before and to check and improve the methodology used. A detailed list of the planned improvements can be found in Slovenia's IIR (Appendix 5, Slovenia's IIR)
Spain	The principal areas of improvement are: • harmonising the inventory with other registries and inventories (e.g. E-PRTR, large combustion plant); • continuing to update emission factors and methodologies based on guidance in the Inventory guidebook ; • carrying out quantitative estimations of uncertainty and improvements in the methodology for identifying key categories; • implementing a QA programme based on external audits; • continuing to integrate the ERT recommendations from the 2014 in-depth review • Sections 8.6.1-8.6.4 list planned improvements at sectoral level (Appendix 5, Spain's IIR)
Sweden	Some information can be found under the source-specific planned improvements. For one sector the reallocation of emissions is planned. For a number of sectors planned improvements will be decided after the finalisation of the submission as part of the national QA/QC plan (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 to the sectors 'energy', 'industrial processes', 'agriculture' and 'waste' (Appendix 5, the United Kingdom's IIR)

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Appendix 1 Notation keys

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

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

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

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

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

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

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

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

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

Appendix 2 LRTAP Convention emission-reporting programme for 2017

Emission data should be submitted to EMEP CEIP by **15 February 2017**. IIRs and projection data should reach the centre no later than **15 March 2017**, gridded data and LPS by **1 May 2017**. Table A2.1 below summarises information contained 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	1990-2015
2. Particulate matter (b)	$PM_{2.5}$, PM_{10}, (TSPs, BC)	2000-2015
3. Heavy metals (b)	Pb, Cd, Hg, (As, Cr, Cu, Ni, Se, Zn)	1990-2015
4. Persistent organic pollutants (b)	PCDD/Fs, total PAHs, PCBs, HCB (PAHs: B(a)P, B(b)F, B(k)F, IP)	1990-2015
B. Emissions by NFR source category		
1. Main pollutants	NO_X, NMVOCs, SO_X, NH_3, CO	1990-2015
2. Particulate matter (b)	$PM_{2.5}$, PM_{10}, (TSPs, BC)	2000-2015
3. Heavy metals (b)	Pb, Cd, Hg, (As, Cr, Cu, Ni, Se, Zn)	1990-2015
4. Persistent organic pollutants (b)	PCDD/Fs, total PAHs, PCBs, HCB (PAHs: B(a)P, B(b)F, B(k)F, IP)	1990-2015
C. Activity data	NO_X, NMVOCs, SO_X, NH_3, CO	1990-2015
4-yearly: minimum reporting (from 2017 onwards)		
D. Gridded data in the EMEP 0.1° x 0.1° long/lat grid — sector emissions (GNFR14) and national totals (optional)	NO_X, NMVOCs, SO_X, NH_3, CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCBs	2015 (1990, 1995, 2000, 2005, 2010 if not reported before)
E. Emissions from LPS	NO_X, NMVOCs, SO_X, NH_3, CO, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCBs	2015 (1990, 1995, 2000, 2005, 2010 if not reported before)
F. Projected emissions and projected activity data		
1. National total emission projections	NO_X, NMVOCs, SO_X, NH_3, $PM_{2.5}$, BC	2020, 2025, 2030, where available 2040 and 2050
2. Emission projections by NFR14	NO_X, NMVOCs, SO_X, NH_3, $PM_{2.5}$, BC	2020, 2025, 2030, where available 2040 and 2050
3. Projected activity data by NFR14		2020, 2025, 2030, where available 2040 and 2050
5-yearly: additional reporting for review and assessment purposes		
Volatile organic compound (VOC) speciation/height distribution/temporal distribution		Parties are encouraged to review the information used for modelling at http://www.ceip.at/ms/ceip_home1/ceip_home/webdab_emepdatabase/emissions_emepmodels/ online (accessed 21 March 2017)
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		

(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.

Reporting format

Each Party should use the reporting format in Annex IV of the reporting guidelines (UNECE, 2014a) for its annual submissions. It should submit the information to the CEIP formally, preferably in electronic form, and notify the UNECE secretariat. The reporting format, including the NFR, is standardised for reporting estimates of emissions. It includes activity data, projected activity data, projected emissions and other relevant information. The reporting format aims to facilitate electronic submissions. This should make it simpler to process emission information and prepare useful documentation about technical analysis and synthesis.

The new NFR14 format covers:

- national annual emissions and national annual sector emissions (Annex I);
- total and aggregated sector emissions for reporting emissions of NO_x, NMVOCs, SO_x, NH_3, PM, BC, CO, Pb, Cd, Hg, PCDD/Fs, PAHs, HCB and PCBs, for the EMEP 0.1° × 0.1° grid cell and from LPS (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-WM, B-WM, A-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), the Czech Republic (CZ), Estonia (EE), Hungary (HU), Latvia (LV), Lithuania (LT), Malta (MT), Poland (PL), Romania (RO), Slovakia (SK) and Slovenia (SI)
EU-28	refers to the 28 Member States from 1 July 2013: the EU-27 plus Croatia (HR)

Appendix 3 Status of reporting and timeliness

Table A3.1 Member State inventory submissions 2017: date received by the EEA, years covered and information provided (as of 6 May 2017)

Member State	Annual reporting							Minimum 4-year reporting		
	Submission date ([a])	Resubmission date	Project submission date	Adjustment information date	Date of IIR 2017	NFR template	Activity data([b])	Projections	Gridded data Date	LPS emissions Date
Austria	15.02.2017				"15.03.2017 28.04.2017"	NFR 2014-2	1990-2015	np	28.04.2017	28.04.2017
Belgium	15.02.2017		15.03.2017	"15.02.2017 15.03.2017"	"15.03.2017 27.04.2017"	NFR 2014-2	1990-2015	2020/2025/2030	27.04.2017	27.04.2017
Bulgaria	15.02.2017		15.02.2017		14.03.2017	NFR 2014-1	1990-2015	2020/2025/2030 (NT only)	29.04.2017	29.04.2017
Croatia	14.02.2017	15.03.2017	"14.02.2017 15.03.2017"		"15.03.2017 23.03.2017"	NFR 2014-1	1990-2015	2020/2025/2030	28.04.2017	28.04.2017
Cyprus	15.02.2017	20.04.2017	16.03.2017		15.03.2017	NFR 2014-2	1990-2015 (Liquid Fuels, Biomass); 2008-2015 (Solid Fuels)	2020/2025/2030	np	27.04.2017
Czech Republic	15.02.2017	"15.03.2017 27.04.2017"	15.03.2017		15.03.2017	NFR 2014-2	2000-2015	2020/2025/2030	27.04.2017	27.04.2017
Denmark	15.02.2017		15.03.2017	15.02.2017	15.03.2017	NFR 2014-1	1980-2015	2020/2025/2030	27.04.2017	27.04.2017
Estonia	14.02.2017	15.03.2017	14.02.2017		"15.03.2017 01.05.2017"	NFR 2014-2	1990-2015	2020/2025/2030	28.04.2017	28.04.2017
Finland	15.02.2017	15.03.2017	"15.02.2017 15.03.2017 28.04.2017"	"15.02.2017 15.03.2017"	"15.03.2017 28.04.2017"	NFR 2014-1	1980/2005/2008-2015	2020/2025/2030	28.04.2017	28.04.2017
France	14.02.2017	09.03.2017		"14.02.2017 09.03.2017"	15.03.2017	NFR 2014-2	1980-2015	np	np	np
Germany	13.02.2017		16.03.2017	13.02.2017	07.02.2017	NFR 2014-2	1990-2015	2020/2025/2030	26.04.2017	np
Greece					np			np	np	np
Hungary	17.02.2017	14.03.2017			04.04.2017	NFR 2014-1	1990-2015	np	np	np
Ireland	15.02.2017	15.03.2017	09.05.2017		15.03.2017	NFR 2014-2	1990-2015	2020/2025/2030	28.04.2017	28.04.2017
Italy	20.02.2017	15.03.2017	15.03.2017		15.03.2017	NFR 2014-1	1990-2015	2020/2025/2030	np	np
Latvia	10.02.2017	15.03.2017			15.03.2017	NFR 2014-2	1990-2015	np	28.04.2017	28.04.2017
Lithuania	15.02.2017	"17.02.2017 14.03.2017"	15.03.2017		15.03.2017	NFR 2014-2	1990-2015	2020/2025/2030	27.04.2017	27.04.2017
Luxembourg	15.02.2017	"15.03.2017 31.03.2017"	15.03.2017	15.03.2017	15.03.2017	NFR 2014-2	1990-2015	2020/2025/2030	28.04.2017	28.04.2017
Malta	21.02.2017				np	NFR 2014-1	2000-2013/2015 (Liquid Fuels, Gaseous Fuels)	np	np	np
Netherlands	15.02.2017				14.04.2017	NFR 2014-1	1990-2015	np	np	np
Poland	15.02.2017	15.03.2017			15.03.2017	NFR 2014-1	1990-2015	np	28.04.2017	28.04.2017
Portugal	15.02.2017	15.03.2017	15.03.2017		"15.03.2017 28.04.2017"	NFR 2014-1	1990/1997-2015	2020/2025/2030	28.04.2017	28.04.2017
Romania	15.02.2017		15.03.2017		15.03.2017	NFR 2014-1	2005-2015	2020/2025/2030	28.04.2017	28.04.2017
Slovakia	15.02.2017	15.03.2017	"16.03.2017 15.04.2017"		15.03.2017	NFR 2014-2	1990-2015	2020/2025/2030/2040	28.04.2017	28.04.2017
Slovenia	13.02.2017		01.03.2017		13.03.2017	NFR 2014-2	1990-2015	2020/2025/2030	25.04.2017	06.04.2017
Spain	14.02.2017	15.03.2017		"14.02.2017 14.03.2017 15.03.2017"	15.03.2017	NFR 2014-2	1990-2015	np	28.04.2017	28.04.2017
Sweden	14.02.2017	15.02.2017			01.03.2017	NFR 2014-1	1990-2015	np	np	27.04.2017
United Kingdom	15.02.2017		15.03.2017		15.03.2017	NFR 2014-2	1990-2015	2020/2025/2030	28.04.2017	28.04.2017

Notes: ([a]) Refers to the first submission of inventory data to the CDR; submission of other data is possible at later dates.
([b]) Activity data reported in 2017.
np, not provided.
Red-coloured dates indicate that data were submitted after the formal deadline for submissions (Submissions: 15 February; Resubmissions: 15 March; Projections: 15 March; IIR: 15 March).

Table A3.2 Member State LRTAP Convention submissions of 2017 (as of 6 May 2017)

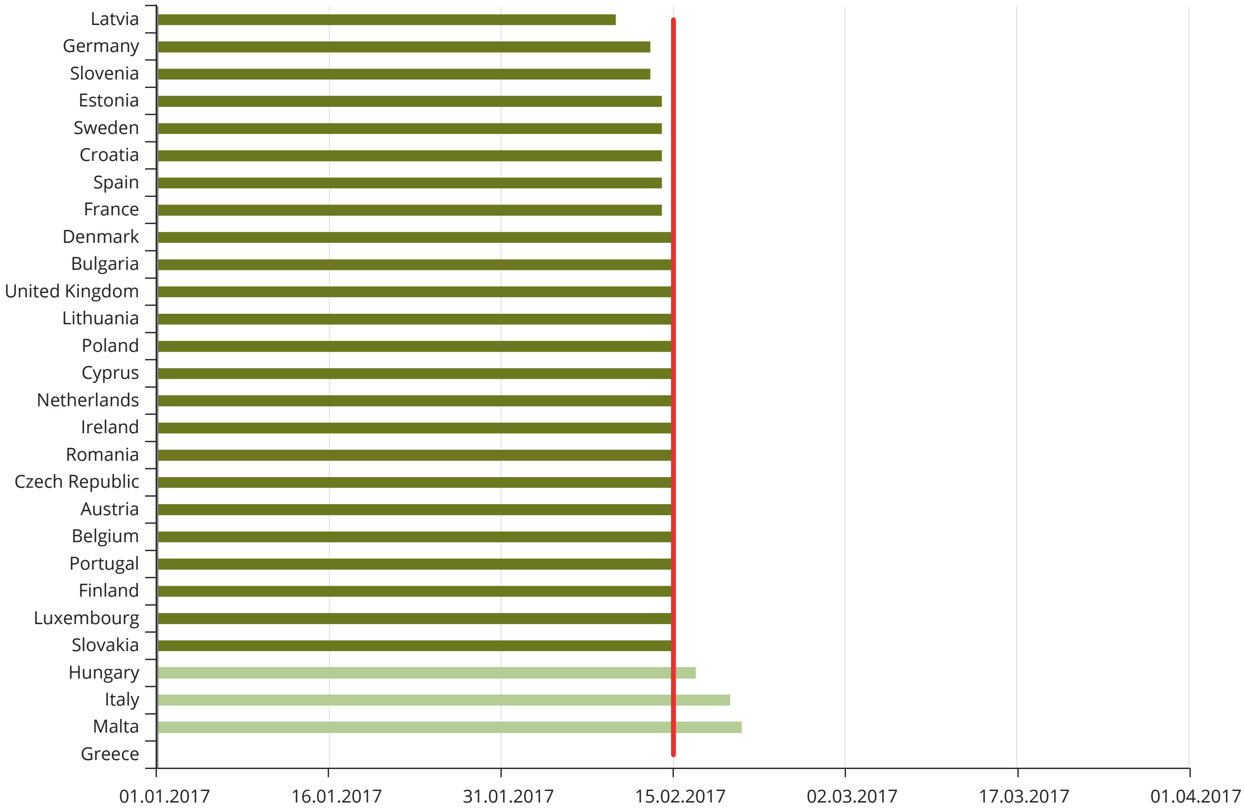
Member State	NO_X, NMVOC, SO_X, NH_3, CO	$PM_{2.5}$, PM_{10}, TSP ([a]), BC	Pb, Cd, Hg	Additional HMs ([b])	POPs (PCDD/F, PAHs, HCB, PCBs)
Austria	1990-2015	1990, 1995, 2000-2015 ($PM_{2.5}$, PM_{10}, TSP)	1990-2015	np	1990-2015 (Total PAHs)
Belgium	1990-2015	2000-2015	1990-2015	1990-2015	1990-2009 (Total PAHs); 2010-2015
Bulgaria	1990-2015	1990-2015	1990-2015	1990-2015	1990-2015
Croatia	1990-2015	1990-2015	1990-2015	1990-2015	1990-2015
Cyprus	1990-2015	2000-2015	1990-2015	1990-2015	1990-2015
Czech Republic	2000-2015	2000-2015	2000-2015	2000-2015	2000-2015
Denmark	1980/1985-2015	1990-2015	1990-2015	1990-2015	1990-2015
Estonia	1990-2015	1990/2000-2015	1990-2015	1990-2015	1990-2015
Finland	1980/1987/1990-2015	1990-2015	1990-1998, 2000-2015	1990-1998, 2000-2015 (As, Cr, Cu, Ni, Zn)	1990-2015 (Total PAHs)
France	1980/1988-2015	1990-2015	1990-2015	1990-2015	1990-2015
Germany	1990-2015	1990/1995/2000-2015	1990-2015	1990-2015	1990-2015
Greece	np	np	np	np	np
Hungary	1990-2015	2000-2015	1990-2015	1990-2015	1990-2015
Ireland	NO_X, NMVOCs, SO_X: 1987, 1990-2015; NH_3, CO: 1990-2015	1990-2015	1990-2015	1990-2015	1990-2015
Italy	1990-2015	1990-2015	1990-2015	1990-2015	1990-2015 (Total PAHs)
Latvia	1990-2015	1990-2015	1990-2015	1990-2015	1990-2015
Lithuania	1990-2015	1990-2015	1990-2015	1990-2015	1990-2015
Luxembourg	1990-2015	1990-2015 ($PM_{2.5}$, PM_{10}, TSP)	1990-2015	np	1990-2015
Malta	2000-2015	2000-2015; BC: 2012-2015	2000-2015	2000-2015	2005 (dioxins); 2008 (Total PAHs); 2010; 2011-2013 (dioxins, PAHs, HCB); 2014-2015
Netherlands	1990-2015	1990-2015	1990-2015	1990-2015	1990-2015; PCBs: 1995-1998, 2002, 2004-2005
Poland	1990-2015	1990-2015	1990-2015	1990-2015 (As, Cr, Cu, Ni, Zn)	1990-2015
Portugal	1990-2015	1990-2015	1990-2015	1990-2015	1990-2015
Romania	2005-2015	2005-2015	2005-2015	2005-2015	2005-2015
Slovakia	1990-2015	1990-2015	1990-2015	1990-2015	1990-2015
Slovenia	1980/1986/1990-2015	2000-2015	1990-2015	np	1990-2015
Spain	1990-2015	2000-2015	1990-2015	1990-2015	1990-2015 (Total PAHs)
Sweden	1990-2015	1990/2000-2015	1990-2015	1990-2015	1990-2015
United Kingdom	1990-2015	1990-2015	1990-2015	1990-2015	1990-2015

Note: ([a]) Member States do not have to report TSPs if they report PM emissions.

([b]) Reporting of additional HMs is not mandatory.

np, not provided.

Figure A3.1 Dates of first data submissions received from Member States (as of 6 May 2017)



Appendix 4 Conversion chart for aggregated sector groups

To enable the presentation of sectoral emission trends (Chapter 3), individual NFR source categories for the EU-28 inventory were aggregated into the following main sector groups:

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

Table A4.1 provides a conversion chart showing which of the individual NFR source categories was in each of the aggregated sector groups.

Table A4.1 Conversion chart for aggregated sector groups

NFR code	Full name	EEA aggregated sector name
1A1a	Public electricity and heat production	Energy production and distribution
1A1b	Petroleum refining	Energy production and distribution
1A1c	Manufacture of solid fuels and other energy industries	Energy production and distribution
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Energy use in industry
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	Energy use in industry
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	Energy use in industry
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, paper and print	Energy use in industry
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Energy use in industry
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Energy use in industry
1A2gvii	Mobile combustion in manufacturing industries and construction	Energy use in industry
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	Energy use in industry
1A3ai(i)	International aviation LTO (civil)	Non-road transport
1A3aii(i)	Domestic aviation LTO (civil)	Non-road transport
1A3bi	Road transport: Passenger cars	Road transport
1A3bii	Road transport: Light duty vehicles	Road transport
1A3biii	Road transport: Heavy duty vehicles and buses	Road transport
1A3biv	Road transport: Mopeds & 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
1A4ai	Commercial/institutional: Stationary	Commercial, institutional and households

NFR code	Full name	EEA aggregated sector name
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
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

NFR code	Full name	EEA aggregated sector name
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
5C2	Open burning of waste	Waste
5D1	Domestic wastewater handling	Waste
5D2	Industrial wastewater handling	Waste
5D3	Other wastewater 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 (cut-off date 6 May 2017)

Country code	Title of IIR	Source	Date of submission
AT	Austria's Informative Inventory Report (IIR) 2017. 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/envwmz8yg/	15.3.2017
	Austria's Informative Inventory Report (IIR) 2017. 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 (Resubmission)	http://cdr.eionet.europa.eu/at/un/clrtap/iir/envwqhh_g	28.4.2017
BE	Informative Inventory Report. About Belgium's annual submission of air emission data reported in February 2016 under the Conv ention on Long-range Transboundary Air Pollution CLRTAP	http://cdr.eionet.europa.eu/be/un/clrtap/iir/envwmlmba	15.3.2017
	Chapter 10. Gridded Data and LPS	http://cdr.eionet.europa.eu/be/un/clrtap/iir/envwqikaa	
BG	Bulgaria's Informative Inventory Report 2017 (IIR). Submission under the UNECE Convention on Long-Range Transboundary Air Pollution	http://cdr.eionet.europa.eu/bg/un/clrtap/iir/envwme5fw/	14.3.2017
CY	No IIR available		
CZ	Czech Informative Inventory Report 2015. Submission under the UNECE Convention on Long-range Transboundary Air Pollution	http://cdr.eionet.europa.eu/cz/un/clrtap/iir/envwmaiwa/	15.3.2017
DE	German Informative Inventory Report 2017	http://iir-de.wikidot.com	09.2.2017
DK	Annual Danish Informative Inventory Report to UNECE. Emission inventories from the base year of the protocols to year 2015	http://cdr.eionet.europa.eu/dk/un/clrtap/iir/envwmkrwg	15.3.2017
EE	Estonian Informative Inventory Report 1990-2015. Submitted under the Convention on Long-Range Transboundary Air Pollution	http://cdr.eionet.europa.eu/ee/un/clrtap/iir/envwmllmg	15.3.2017
	Estonian Informative Inventory Report 1990-2015. Gridded Emissions ad Large Point Sources. Submitted under the Convention on Long-Range Transboundary Air Pollution		
ES	Spain. Informative Inventory Report. 1990-2015	https://cdr.eionet.europa.eu/es/un/clrtap/iir/envwmj6ma	15.3.2017
FI	Finland's Informative Inventory Report 2017. Air Pollutant Emissions 1980-2015 under the UNECE CLRTAP and the EU NECD	https://cdr.eionet.europa.eu/fi/un/clrtap/iir/envwmky3g	15.3.2017
	Finland's Informative Inventory Report 2017. Air Pollutant Emissions 1980-2015 under the UNECE CLRTAP and the EU NECD (Resubmission)	http://cdr.eionet.europa.eu/fi/un/clrtap/iir/envwqnrma	28.4.2017
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	http://cdr.eionet.europa.eu/fr/un/clrtap/iir/envwjoe9g	15.3.2017
GR	No IIR available		

Country code	Title of IIR	Source	Date of submission
HR	Republic of Croatia 2017. Informative Inventory Report (1990-2015) under the Convention on Long-rangeTransboundary Air Pollution (CLRTAP) and National Emission Ceilings Directive (NECD 2016/2284/EU)	https://cdr.eionet.europa.eu/hr/un/clrtap/iir/envwmkttq	15.3.2017
	Inventory Report (1990-2015) under the Convention on Long-rangeTransboundary Air Pollution (CLRTAP) and National Emission Ceilings Directive (NECD 2016/2284/EU) (final version)	http://cdr.eionet.europa.eu/hr/un/clrtap/iir/envwmkttq	
HU	Informative Inventory Report Hungary 2015	http://cdr.eionet.europa.eu/hu/un/clrtap/iir/envwonj3q	04.4.2017
IE	Ireland's Informative Inventory Report 2017. Air Pollutant Emissions in Ireland 1990-2015	http://cdr.eionet.europa.eu/ie/un/clrtap/iir/envwmlohg	15.3.2017
IT	Italian Emission Inventory 1990-2015 Informative Inventory Report 2017	http://cdr.eionet.europa.eu/it/un/clrtap/iir/envwmkaca	15.3.2017
LT	Lithuanian Informative Inventory Report 2015. Lithuanian Pollutant Emission Inventory for Period 1990-2015 Reported to the Secretariat of the UN/ECE Convention on Long-range Transboundary Air Pollution	http://cdr.eionet.europa.eu/lt/un/clrtap/iir/envwmlxtq	15.3.2017
LU	No IIR available		
LV	Latvia's Informative Inventory Report 2017. Submitted under the Convention on Long-Range Transboundary Air Pollution	http://cdr.eionet.europa.eu/lv/un/clrtap/iir/envwmlmda	15.3.2017
MT	No IIR available		
NL	No IIR available		
PL	Poland's Informative Inventory Report 2017. Submission under UN ECE Convention on Long-range Transboundary Air Pollution and the DIRECTIVE (EU) 2016/2284	http://cdr.eionet.europa.eu/pl/un/clrtap/iir/envwmk9zw	15.3.2017
PT	Portuguese Informative Inventory Report 1990-2015. Submitted under the NEC Directive (EU) 2016/2284 and the UNECE Convention on Long-range Transboundary Air Pollution	http://cdr.eionet.europa.eu/pt/un/clrtap/iir/envwmmhog	15.3.2017
	Portuguese Informative Inventory Report 2017. Chapter 10: Reporting of gridded emissions and LPS. Submitted under the NEC Directive (EU) 2016/2284 and the UNECE Convention on Long-range Transboundary Air Pollution	http://cdr.eionet.europa.eu/pt/un/clrtap/iir/envwqnw3q	28.4.2017
RO	Romania's Informative Inventory Report 2017. Submission under the UNECE Convention on Long Range Transboundary Air Pollution. Revised National Emission Ceiling Directive (NECD)	http://cdr.eionet.europa.eu/ro/un/clrtap/iir/envwmlttw	15.3.2017
SE	Informative Inventory Report Sweden 2017. Submitted under the Convention on Long-Range Transboundary Air Pollution	http://cdr.eionet.europa.eu/se/un/clrtap/iir/envwla5dw	01.3.2017
SI	Slovenia's Informative Inventory Report 2017. 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/envwmaww	13.3.2017
SK	Informative Inventory Report 2017. Slovak Republic. Under the Convention on Long-range Transboundary Air Pollution	http://cdr.eionet.europa.eu/sk/un/clrtap/iir/envwmma7w	15.3.2017
UK	UK Informative Inventory Report (1990 to 2015)	https://cdr.eionet.europa.eu/gb/un/clrtap/iir/envwmfebw	15.3.2017

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