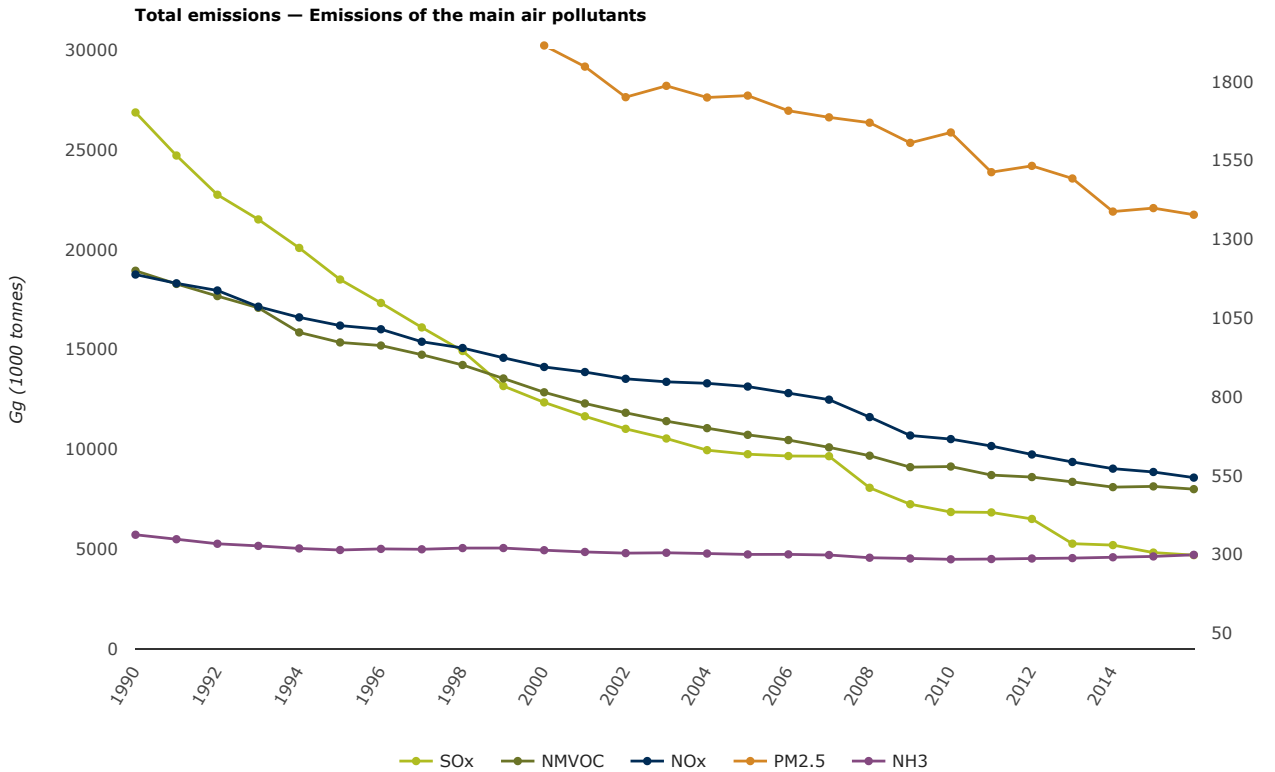
Emissions of the main air pollutants in Europe

Key messages

- Anthropogenic emissions of the main air pollutants decreased significantly in most EEA member countries between 1990 and 2016:
  - emissions of nitrogen oxides decreased by 54 % (58 % in the EU-28);
  - emissions of sulphur oxides decreased by 82 % (91 % in the EU-28);
  - emissions of non-methane volatile organic compounds decreased by 57 % (62 % in the EU-28);
  - emissions of ammonia decreased by 17 % (23 % in the EU-28);
  - emissions of fine particulate matter decreased by 28 % (28 % in the EU-28) from 2000.
- The EU-28 met its continuing obligation to maintain emissions of nitrogen oxides, sulphur dioxide, ammonia and non-methane volatile organic compounds below legally binding targets, as specified by the National Emission Ceilings Directive (NECD). Some individual EU Member States reported emissions that were above their NECD emission ceilings and two additional EEA member countries (Norway and Switzerland) reported emissions above their Gothenburg Protocol emission ceilings.
- Emission reduction commitments for 2020 and 2030 have been set under the NECD, and for 2020 under the revised Gothenburg Protocol. The EU-28 as a whole is on track to meet its future reduction commitments.

What progress is being made in reducing emissions of the main air pollutants across Europe?

Fig. 1: Emissions of the main air pollutants



Note:
The graph shows the emission trends of the air pollutants sulphur oxides (SO_x), nitrogen oxides (NO_x), ammonia (NH_3), non-methane volatile organic compounds (NMVOCs) and primary fine particulate matter ($PM_{2.5}$) over the 1990 to 2016 period (2000 to 2016 for PM).
$PM_{2.5}$ emissions are shown on the secondary y-axis.

European Environment Agency

Data sources:

- Emissions of main air pollutants provided by **European Environment Agency (EEA)**

The National Emission Ceilings Directive (NECD) and the Gothenburg Protocol under the Convention on Long-range Transboundary Air Pollution (LRTAP) set emission ceilings for European countries for sulphur dioxide/oxides (SO_2/SO_x), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs) and ammonia (NH_3). The NECD sets emission ceilings for 2010 (and years thereafter) for these pollutants , and emission reduction commitments for 2020 and 2030 for the same pollutants and in addition for primary fine particulate matter (PM2.5) emissions. The 2012 amended Gothenburg Protocol sets 2010 ceilings and 2020 emission reduction commitments for the same pollutants (see indicator specification for details).

The aim of the NECD and the Gothenburg Protocol is to restrict the emissions of selected air pollutants, including ozone and particulate matter (PM) precursors and pollutants that contribute to ecosystem acidification and eutrophication. Information on the exceedance of air quality standards for the protection of human health, and the exposure of ecosystems to acidification, eutrophication and ozone is available in the EEA indicators CSI004 and CSI005, respectively.

Note: *The new NECD establishes a process that allows Member States to 'adjust' the reported emissions in their inventories downwards to comply with the emission ceilings if certain conditions are met. Nine Member States have requested their data be 'adjusted' in this manner; the European Commission is presently reviewing the applications. The numbers of exceeded ceilings described in the EEA's briefing will be lower if these applications are approved later in 2018.*

Sulphur oxides

In 2016, SO_x emissions were approximately 9 % of 1990 levels for the EU-28. Emissions continue to fall and for the EEA-33 they are just below 17 % of 1990 emission levels. All countries continue to meet their 2010 emission ceilings commitments.

Nitrogen oxides

In 2016, NO_x emissions for the EEA-33 and the EU-28 continued to fall and are now at about half of their 1990 values. These reductions have been primarily due to the introduction of three-way catalytic converters in cars. However, the observed reductions in emissions from some modern vehicles have not met initial expectations and actual emissions from vehicles (often termed 'real-world driving emissions') may exceed the emissions reported during the test-cycle specified by the European emission standards

for each vehicle type. Two EU Member States (Austria and Ireland) reported emissions above their NECD emission ceilings whereas two additional EEA member countries (Norway and Switzerland) reported emissions above their Gothenburg Protocol emission ceilings.

Non-methane volatile organic compounds

In 2016, NMVOC emissions for the EEA-33 and the EU-28 had fallen to less than half of their 1990 levels. Only Hungary and Norway reported emissions above their emission ceilings, respectively under the NECD and the Gothenburg Protocol.

Ammonia

In 2016, NH_3 emissions had fallen less than those of the other NECD pollutants. Between 1990 and 2016, they decreased by approximately 23 % in the EU-28 and 18 % in the EEA-33, but since 2014 emissions have increased each year. The majority of countries reported meeting their 2010 NECD emission ceiling commitments: among EU Member States, Austria, Croatia, Germany, Ireland and Spain reported emissions above their ceiling whereas Norway reported emissions above its Gothenburg Protocol ceiling.

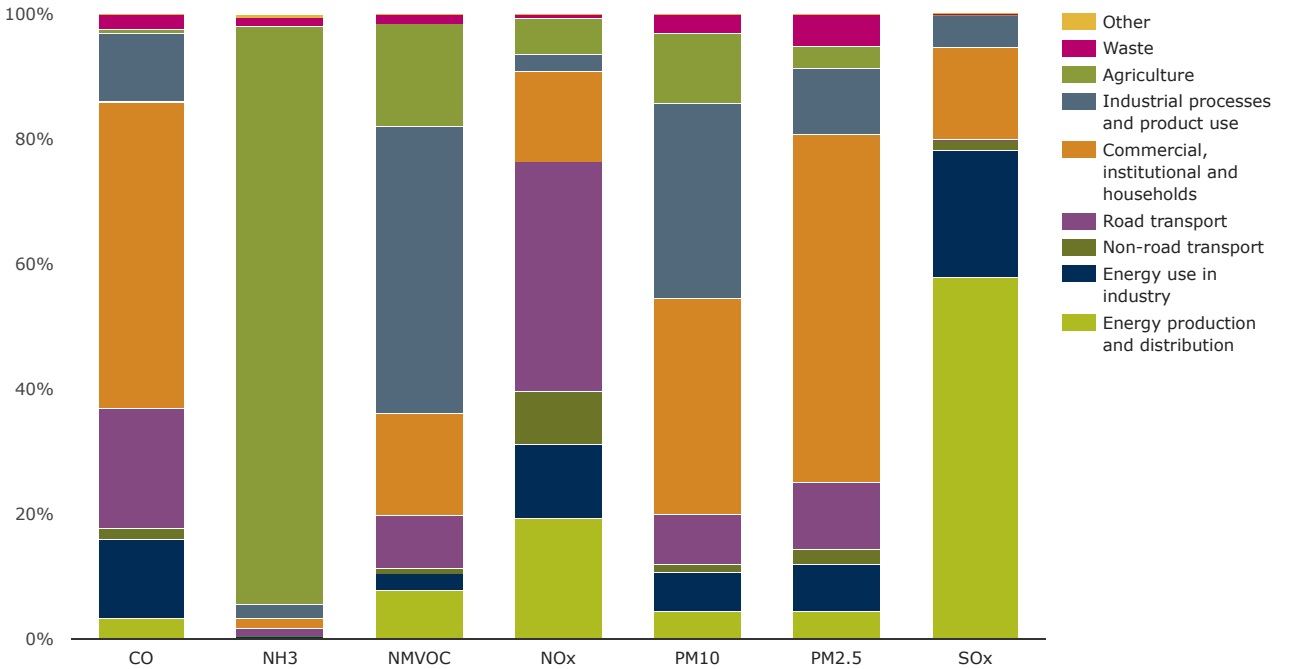
Fine particulate matter

In 2016, emissions of primary $PM_{2.5}$ had decreased to about a quarter of their 1990 levels in both the EEA-33 and the EU-28. The timeline of emission reductions shows that the EU-28 as a whole is on track towards achieving the reduction target set by the NECD. The country-specific $PM_{2.5}$ timelines suggest that eight countries are not on track to meeting their individual commitments by 2020. These countries may therefore need to implement emission reduction measures beyond those currently in place.

How do different sectors and processes contribute to emissions of the main air pollutants?

Fig. 2: Emissions of the main air pollutants by sector group in the EEA-33

Chart — Emissions of the main air pollutants by sector group in the EEA-33



Note:
CO: Carbon monoxide;
NH3: ammonia;
NMVOCs: non-methane volatile organic compounds, such as benzene, ethanol, etc.
NOx: nitrogen oxides is a generic term for the mono-nitrogen oxides NO and NO2;
PM10: Fine particular matter consisting of fine particles with a diameter of 10 micrometers or less;
PM2.5: fine particular matter consists of fine particles with a diameter of 2.5 micrometers or less;
SOx: sulphur oxides is a term that refers to many types of sulphur- and oxygen-containing components (SO, SO_2, SO_3, S_7O_2, S_6O_2, S_2O_7, etc.).

Last year a separate sector, 'Solvent and product use', was included. This is now part of the 'Industrial processes and product use' sector.

European Environment Agency

Data sources:

- Emissions of main air pollutants provided by **European Environment Agency (EEA)**

European legal instruments directly and indirectly address the mitigation of air pollutant emissions from specific source sectors (for details see Indicator Specification).

The newer Member States of the European Union have, in a number of cases, undergone major economic and structural changes since the early 1990s, which has led to significant reductions. In many cases, these changes have led to a general decline in some activities that previously contributed significantly to the total emissions of air pollutants (e.g. heavy industry), such as the closure of older, less efficient power plants, etc. Over recent years, there has also been a modernisation of the road vehicle fleet, including the introduction of more vehicles with improved emission control.

Sulphur oxides

Emissions of SOx are dominated by emissions from the 'Energy production and distribution' sector, which typically accounts for about 60 % of total emissions from the EEA-33. This source is also responsible for the largest reduction in emissions since 1990.

Stationary combustion: Substantial SOx emission reductions have been made across a number of sectors. The three largest sectors ('Energy production and distribution', 'Energy use in industry' and 'Commercial, institutional and households') have all reduced their emissions by more than 75 % since 1990. However, despite these large reductions, the 'Energy production and distribution' sector (encompassing activities such as power and heat generation) still remains the most significant source of SOx in the EEA-33 region, contributing over half of the current total of SOx emissions.

Shipping: Across Europe, there has also been an increase in the awareness of the contribution made by national and international shipping traffic to SO_x emissions, particularly the contribution made to air pollution in nearby urban areas by ships at berth (a more detailed discussion of this issue is contained in the 'Transport and environment reporting mechanism' (TERM) indicator fact sheet TERM03 — Transport emissions of air pollutants).

A combination of measures has led to reductions in SO_x emissions:

- **Fuel switching**: There have been substantial changes from high-sulphur solid (e.g. coal) and liquid (e.g. heavy fuel oil) fuels to low-sulphur fuels (such as natural gas) for power and heat production purposes within the energy, industry and domestic sectors.
- **Abatement equipment**: Where high-sulphur fuels are used, flue gas desulphurisation equipment is now installed in new industrial facilities and has also been retro-fitted to existing facilities.
- **Improvements in energy efficiency**: Improvements in energy efficiency have brought about decreases in the demand for energy, which has reduced associated emissions.
- **Sulphur content of fuel**: The implementation of several directives within the EU limiting the sulphur content of transport fuel has also contributed to the decrease.
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Nitrogen oxides

Emissions from 'Road transport' and 'Non-road transport' combine to account for around half of the current NO_x emissions in the EEA-33.

Road transport: Since 1990, there have been considerable reductions in NO_x and other ozone precursor pollutants in the road transport sector, despite the general increase in transport activity within this sector over the period. This sector alone has contributed to over 40 % of the total reduction in NO_x emissions. These emission reductions have primarily been achieved as a result of fitting three-way catalytic converters to petrol-fuelled cars (driven by the legislative European emission standards). Disparities between trends in NO_x emissions and ambient NO_2 concentrations (see CSI004) are due in part to the increase in the use of diesel vehicles and the fact that the 'real-world' emission performance of modern diesel vehicles has not improved to the extent initially suggested by the test-cycle emission factors used in emission inventories — however, improvements have been made to many emission inventories for the EU-28 countries in an attempt to address this. The disparities are also due to the increase in the proportion of NO_x emitted directly as NO_2 (primary NO_2) from the exhausts of modern diesel vehicles, as a result of emission control systems that aim to reduce total NO_x and particulate matter emissions.

Energy production and energy use in industry: Emissions of NO_x have also declined in the 'Energy production and distribution' sector, and current emissions are at approximately half the emission level of 1990. Furthermore, there have been substantial reductions in emissions from the 'Energy use in industry' sector.

These reductions have been achieved through the implementation of measures such as combustion modification (for example the use of low NO_x burners), the introduction of flue-gas abatement techniques and fuel-switching from coal to gas. One of the most common forms of combustion modification is the use of low-NO_x burners, which can typically reduce emissions by up to 40 %. Flue gas treatment techniques (such as NO_x scrubbers, or selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) techniques) can also be used to remove NO_x from flue gases. Emissions of NO_x are higher from coal-fired power plants than from gas-fired plants, as coal (unlike gas) contains significant amounts of nitrogen.

Shipping: There has been an increase in the focus on the relative contribution made to NO_x pollutant emissions by national and international shipping traffic (a more detailed discussion of this issue is available in the TERM indicator fact sheet TERM03 — Transport emissions of air pollutants).

Non-methane volatile organic compounds

Solvent and product use: The largest source of current NMVOC emissions is the 'Solvent and product use' sector (approximately 50 % of total EEA-33 emissions). Emissions have been reduced to less than two thirds of 1990 emission levels. Important EU regulatory measures — the Solvent Emissions Directive (1999) and the Paints Directive (2004) — were introduced and have led to reductions in the solvent content of products and emissions from industries using solvents.

Road transport and non-road transport: Emissions from the 'Road transport' and 'Non-road transport' sectors combine to contribute approximately 10 % of total NMVOC emissions. Emissions from the 'Commercial, institutional and households' sector make a 15 % contribution to the total.

Since 1990, a considerable reduction in ozone precursor pollutant emissions (NMVOCs and NO_x) has occurred in the road transport sector, despite the general increase in transport activity within this sector over the period. Road transport alone accounts for half of the total NMVOC reductions since 1990. These emission reductions have primarily been achieved as a result of fitting three-way catalytic converters to petrol-fuelled cars (driven by the legislative European emission standards).

Ammonia

Agriculture: Agriculture dominates emissions of NH_3, accounting for 92 % of total emissions in the EEA-33 region. Emissions arise primarily from the decomposition of urea in animal wastes and uric acid in poultry wastes. Emissions depend on the animal species, age, weight, diet, housing system, waste management and liquid manure storage techniques.

Emissions of NH_3 have decreased by approximately 23 % since 1990 in the EEA-33 region, as a result of changes in the agriculture sector. These changes include a reduction in livestock numbers (especially cattle) and changes in the handling and management of both organic manure and synthetic fertilisers.

Fine particulate matter

Commercial, institutional and households: Emissions from the 'Commercial, institutional and households' sector account for over half of the current primary $PM_{2.5}$ emissions for the EEA-33 region. Within this sector, emissions are almost exclusively from households (over 95 %) and current emissions are 7 % lower than those in 1990. However, since 2007, emissions have fluctuated — this has been strongly influenced by $PM_{2.5}$ emissions from wood combustion in the residential sector.

Energy production and energy use in industry: These sources account for a combined contribution to current EEA-33 emissions of only approximately 4 %, but they account for nearly half of the emission reductions since 1990. This reflects several changes in the electricity generating and heavy industrial sectors. Fuel switching away from coal has reduced emissions of $PM_{2.5}$, and the introduction of abatement equipment, such as electrostatic precipitators, has also significantly reduced emissions of $PM_{2.5}$.

Road transport: Emissions from road transport account for approximately 11 % of total $PM_{2.5}$ emissions in the EEA-33 region, but account for one quarter of the reduction in total EEA-33 emissions since 1990. This reflects the improved emission control technologies that have been introduced, particularly for diesel vehicles.

Indicator specification and metadata

Indicator definition

This indicator tracks trends since 1990 in anthropogenic emissions of the main air pollutants — NO_x, NH_3, SO_x and NMVOCs. The indicator further tracks trends since 2000 in anthropogenic emissions of PM with a diameter of up to 2.5 µm (i.e. $PM_{2.5}$) emitted directly into the air (primary PM). All named pollutants have direct or indirect negative

effects on human health, vegetation or ecosystems.

The indicator also provides information on emissions by sector, addressing the following source aggregations:

- 'Energy production and distribution'
- 'Energy use in industry'
- 'Industrial processes'
- 'Road transport'
- 'Non-road transport'
- 'Commercial, institutional and households'
- 'Solvent and product use'
- 'Agriculture'
- 'Waste'
- 'Other'.

Geographically, the indicator covers the EU-28 and EEA-33 countries. The EEA-33 countries include the EU-28 countries (Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom) plus European Free Trade Association (EFTA) countries (Iceland, Liechtenstein, Norway and Switzerland) and Turkey.

Temporally, the indicator covers the 1990–2016 period (2016 is the most recent year for which there are officially reported emission inventories; EEA, 2015b).

Units

The total emissions per country are given in gigagrams (Gg; i.e. 1 000 tonnes). The aggregated sector contributions for the emissions of each main pollutant are given in percentages (%).

Rationale

Justification for indicator selection

Anthropogenic emissions of the main air pollutants — SO_x, nitrogen dioxide (NO_2), NH_3, NMVOCs, PM and methane (CH_4) — contribute to air quality problems in Europe. The consequences are adverse health effects caused particularly by PM, ground-level ozone (O_3) and NO_2. PM can be emitted directly into the air (so-called primary PM) or it can be formed in the atmosphere (so-called secondary PM) from airborne precursor substances. NO_2, NMVOCs and CH_4 are precursors of ozone, which is created in the atmosphere via photo-chemical reactions and contributes to the formation of secondary PM. Ground-level ozone not only has negative effects on human health, but also on crops and natural ecosystems. Excess deposition of sulphur and nitrogen compounds can lead to disturbances in the functioning and structure of ecosystems, i.e. causing acidification of soils and waters as well as, in the case of nitrogen, eutrophication in nutrient-poor ecosystems such as grasslands.

A more detailed summary of the effects of air pollution on human health and ecosystems is included in the EEA's indicators 'Exceedance of air quality limit values in urban areas' (CSI 004) and 'Exposure of ecosystems to acidification, eutrophication and ozone' (CSI 005).

This indicator supports the assessment of progress towards meeting the national emission ceilings under the EU's NEC Directive (2016/2284/EU) and the Gothenburg Protocol under the 1979 LRTAP Convention (see, for example, EEA, 2016a, and EEA, 2016b). The Gothenburg Protocol of 1999 was amended in 2012 (UNECE, 2012).

Scientific references

- EEA, 2012 Evaluation of progress under the EU National Emission Ceilings Directive — Progress towards EU air quality objectives, EEA Technical Report No 14/2012, European Environment Agency.
- EEA, 2016a NEC Directive status report 2015 — Reporting by the Member States under Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants, EEA 2015, European Environment Agency.
- EEA, 2016b European Union emission inventory report 1990–2012 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP), EEA Report No 16/2016, European Environment Agency.
- EEA, 2016c 'Air pollutant emissions data viewer (LRTAP Convention)', European Environment Agency.
- Hettelingh J-P, Posch M, Velders JM, Ruyssenaars, Adam M, de Leeuw, F, Lükewille A, Maas R, Sliggers J and Slootweg J, 2013 Assessing interim objectives for acidification, eutrophication and ground-level ozone of the EU National Emissions Ceilings Directive with 2001 and 2012 knowledge, Atmospheric Environment 75: 129–140.
- EU, 2016 Directive 2016/2284/EU of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC
- EC, 2005 Communication from the Commission to the Council and the European Parliament 'Thematic Strategy on air pollution' (COM(2005) 0446 final 21.9.2005).
- EU, 2008a Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe.
- EU, 2013 Environment Action Programme to 2020 'Living well, within the limits of our planet'.
- UNECE, 1979 The Geneva Convention on Long-range Transboundary Air Pollution.
- UNECE, 2012 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone to the Convention on Long range Transboundary Air Pollution, as amended on 4 May 2012.
- EC, 2013 Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions 'A Clean Air Programme for Europe' (COM(2013) 918 final).

Policy context and targets

Context description

Current EU air pollution policy is underpinned by the objectives and long-term goals of e.g. the Sixth Environment Action Programme (6EAP; EC, 2002) (covering the 2002–2012 period) to further reduce air pollution and its impacts on ecosystems and biodiversity by 2020, i.e. to attain 'levels of air quality that do not give rise to significant negative impacts on, and risks to, human health and the environment'. This goal has been reinforced in the Seventh Environment Action Programme (7th EAP), which will run until 2020 (EU, 2013). To move towards achieving the TSAP objectives, EU air pollution legislation has followed a twin-track approach of implementing both emission mitigation controls and air-quality standards. A new strategy, the Clean Air Programme for Europe, was proposed by the European Commission at the end of 2013 (EU, 2013).

Internationally, the 1979 UNECE LRTAP Convention (UNECE, 1979) was a first step towards addressing the impacts of air pollution on health and the environment. A centrepiece of the convention is the 1999 'Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone', subsequently amended in 2012 (UNECE, 2012). The amended protocol sets emission ceilings (limits) for the year 2010 and national emission reduction commitments for the emission of the main air pollutants, namely SO_x, NO_x, NH_3 and NMVOCs. It also includes reduction commitments for $PM_{2.5}$ emissions for 2020. Under the protocol, the critical loads concept was established as a tool for informing political discussions related to damage to sensitive ecosystems (see CSI 005). Critical ozone levels (concentrations) for vegetation were also defined under the LRTAP Convention.

The 1999 Gothenburg Protocol was followed in 2001 by the EU's NECD which has since been repealed by a revised NEC Directive in 2016 (EU, 2016). The original directive introduced legally binding national emission limits for four main air pollutants: SO_2, NO_x, NH_3 and NMVOCs. The directive requires EU Member States to have met emission ceilings by 2010 and in the years thereafter, with emission reduction commitments established for 2020 and 2030 for the four main pollutants and PM2.5. The goal is to comply with the amended Gothenburg Protocol by 2020, followed by more ambitious reductions from 2030 onwards. The human health and environmental objectives defined in the NECD, the Gothenburg Protocol and the EU's Air Quality Directive (EU, 2008a) are addressed by indicators CSI004 and CSI005.

Regulation addressing ambient air concentrations

The European directives currently regulating the ambient air concentrations of the main pollutants are designed to avoid, prevent or reduce the harmful effects of air pollutants on human health and the environment by implementing limit or target values for ambient concentrations of air pollutants. They are:

- Directive 2008/50/EC on ambient air quality and cleaner air for Europe, which regulates ambient air concentrations of SO_2, NO_2 and other nitrogen oxides, PM_{10} and $PM_{2.5}$, lead, benzene (C_6H_6), carbon monoxide (CO) and ozone (EU, 2008a);
- Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air (EU, 2004).

In the case of non-compliance with the air quality limit and target values stipulated in European legislation, air quality management plans must be developed and implemented in the areas in which exceedances occur. These plans should aim to bring concentrations of air pollutants to levels below the limit and target values. To ensure overall coherence, and consistency between different policies, air quality plans should be consistent (if feasible) and integrated with plans and programmes in line with the directives regulating air pollutant emissions.

Legal instruments at European level that address emissions directly or indirectly

Source-specific EU legislation focuses on industrial emissions, road and off-road vehicle emissions, fuel quality standards, etc., by setting emission standards, requiring the use of best-available technology or setting requirements on fuel composition. In addition, several legal instruments are used to reduce environmental impacts from different activities or to promote environmentally friendly behaviour, and these also contribute indirectly to reducing air pollution, as summarised below.

End-of-pipe control in industrial installations:

- Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants (the LCP Directive; EC, 2001); the overall aim of the LCP Directive is to reduce emissions of acidifying pollutants, PM and ozone precursors, and the directive addresses emissions from large combustion plants — i.e. those whose rated thermal input is equal to or greater than 50 MW;
- Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (EU, 2010), which targets certain industrial, agricultural and waste treatment installations.

Emission standards for cars:

- The Euro Regulations set standards for road vehicle emissions. The Euro 5 and 6 standards are defined in Regulations (EC) No 692/2008 (EU, 2008b) and No 595/2009 (EU, 2009a). The Communication CARS 2020 (EC, 2012) sets out a timetable for implementation of the Euro 6 vehicle standards in real-world driving conditions, and for the revision of the non-road mobile machinery legislation.

Handling and storage:

- Directive 94/63/EC on the control of volatile organic compound (VOC) emissions resulting from the storage of petrol and its distribution from terminals to service stations (EU, 1994) and Directive 2009/126/EC on Stage II petrol vapour recovery during refuelling of motor vehicles at service stations (EU, 2009b);
- Directive 1999/13/EC on the limitation of emissions of VOCs due to the use of organic solvents in certain activities and installations (EU, 1999a).

Fuel quality:

- Directive 2012/33/EU (EU, 2012) amending Directive 1999/32/EC as regards the sulphur content of marine fuels, Directive 1999/32/EC on the reduction of the sulphur content of certain liquid fuels (EU, 1999b) and Directive 2003/17/EC (amending Directive 98/70/EC) relating to the quality of petrol and diesel fuels (EU, 2003a).

International shipping:

- The Marine Pollution Convention, MARPOL73/78 (IMO, 1973), is the main international convention on preventing ships from polluting as a result of operational or accidental causes. Annex VI sets limits on emissions of SO_x, NO_x, VOCs and PM in ship exhausts, and prohibits deliberate emissions of ozone-depleting substances.
- For international shipping, tighter shipping fuel standards and emission standards at IMO/MARPOL level resulted in the recent revision of the Sulphur Content of Fuel Directive (adopted as 2012/33/EU; EU, 2012).

In addition to the policy instruments outlined above, there are several EU directives that also contribute indirectly to efforts to minimise air pollution. These directives are intended to reduce environmental impacts, including on climate change, and/or to promote environmentally friendly behaviour. Some examples are outlined below.

Agriculture:

- The Nitrates Directive, i.e. Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources (EU, 1991), particularly through the implementation of agricultural practices that limit fertiliser application and prevent nitrate losses, helps to reduce agricultural emissions of nitrogen compounds to air.

Energy taxation:

- The Energy Taxation Directive, i.e. Directive 2003/96/EC restructuring the Community framework for the taxation of energy products and electricity (EU, 2003b), establishes minimum taxes for motor fuels, heating fuels and electricity, depending on the energy content of the product and the amount of CO_2 it emits. This directive aims to promote energy efficiency and less-polluting energy products.

Ecodesign:

- The Ecodesign Directive, i.e. Directive 2009/125/EC establishing a framework for the setting of ecodesign requirements for energy-related products, provides consistent EU-wide rules for improving the environmental performance of energy-related products through ecodesign (EU, 2009). This should benefit both businesses and consumers by enhancing product quality, achieving energy savings and thereby increasing environmental protection. Energy-related products (the use of which impacts energy consumption) include products that use, generate, transfer or measure energy (electricity, gas and fossil fuel). This includes boilers, computers, televisions, transformers, industrial fans and industrial furnaces. Some energy-related products do not use energy, but do have an impact on energy, and can therefore contribute to related savings, such as windows, insulation material, shower heads and taps.
- The Ecodesign Directive is complemented and supported by the Energy Labelling Directive (EU, 2010b) and Directive 2006/32/EC on energy end-use efficiency and energy (EU, 2006).

Targets

National Emission Ceilings Directive (2001/81/EC)

The NECD (EU, 2001) sets pollutant-specific and legally binding emission ceilings for NO_x, NMVOCs, SO_x and NH_3 for each EU Member State. The directive requires Member States to have met the ceilings and interim environmental objectives by 2010 and in the years thereafter (EEA, 2016a). The directive sets specific environmental objectives that address the impacts of acidification and eutrophication on ecosystems, and the harmful effects of ozone on vegetation and human health (see CSI 005).

The NECD was reviewed as part of the Clean Air Policy Package. In December 2016, the Council adopted the new directive and reporting under this directive already started in February 2017. The new directive repeals and replaces the current EU regime on the annual capping of national emissions of air pollutants, as defined in Directive 2001/81/EC. By doing so, it ensures that the national emission ceilings (NECs) set in the current NECD (2001/81/EC) for 2010 onwards for SO_x, NO_x, NMVOCs and NH_3 shall apply until 2020, and it establishes new national emission 'reduction commitments', which are applicable from 2020 and from 2030, for SO_x, NO_x, NMVOCs, NH_3 and $PM_{2.5}$. The reduction commitments are binding for the period from 2020 to 2029 and from 2030 onwards. In principle, the commitments are indicative for 2025 by a linear emission reduction trajectory. A non-linear reduction trajectory is permissible if it is economically and technically more efficient, and provided that, from 2025, it progressively converges with the linear reduction trajectory.

UNECE Convention on Long-range Transboundary Air Pollution Gothenburg Protocol (1999; amended in 2012)

The amended Gothenburg Protocol sets national ceilings (limits) for the emission of the main air pollutants, namely SO_x, NO_x, NH_3, NMVOCs and primary $PM_{2.5}$ (UNECE, 2012). The EU as a whole has ratified the protocol, and reports EU emissions to the UNECE (EEA, 2016b).

The target under the amended protocol (UNECE, 2012) is to ensure that — in the long term and using a stepwise approach that takes into account advances in scientific knowledge — atmospheric depositions or concentrations do not exceed critical loads for the nutrient nitrogen (see CSI 005). Critical levels for the protection of crops (AOT40c) and for the protection of forests (AOT40f) have also been defined under the LRTAP Convention, and the critical level for crops is consistent with the EU long-term objective for vegetation (see CSI 005).

The 2010 targets under the NECD and Gothenburg Protocol are included in the EEA's NEC data viewer and the LRTAP data viewer.

Related policy documents

- 7th Environment Action Programme

DECISION No 1386/2013/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet'. In November 2013, the European Parliament and the European Council adopted the 7 th EU Environment Action Programme to 2020 'Living well, within the limits of our planet'. This programme is intended to help guide EU action on the environment and climate change up to and beyond 2020 based on the following vision: 'In 2050, we live well, within the planet's ecological limits. Our prosperity and healthy environment stem from an innovative, circular economy where nothing is wasted and where natural resources are managed sustainably, and biodiversity is protected, valued and restored in ways that enhance our society's resilience. Our low-carbon growth has long been decoupled from resource use, setting the pace for a safe and sustainable global society.'

- A Clean Air Programme for Europe

Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions - "A Clean Air Programme for Europe", COM(2013) 918 final

- Directive 2008/50/EC, air quality

Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe.

- Gothenburg Protocol (LRTAP Convention)

1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone to the Convention on Long range Transboundary Air Pollution, as amended on 4 May 2012.

- Sixth Environment Action Programme (decision No 1600/2002/EC)
DECISION No 1600/2002/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 July 2002 laying down the Sixth Community Environment Action Programme
- UNECE Convention on Long-range Transboundary Air Pollution
UNECE Convention on Long-range Transboundary Air Pollution.

Methodology

Methodology for indicator calculation

This indicator is based on national total and sectoral emissions officially reported to the EEA and the UNECE 'Co-operative programme for monitoring and evaluation of the long-range transmissions of air pollutants in Europe' (EMEP) LRTAP Convention (submitted in 2012). For the EU-28 Member States, the data used are consistent with the emission data reported by the EU in its annual submission to the LRTAP Convention.

Recommended methodologies for emission inventory estimation are compiled in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (EMEP/EEA, 2016). Base data are available from the EEA Data Service and the EMEP website (Centre on Emission Inventories and Projections (CEIP)). Where necessary, gaps in reported data are filled by the European Topic Centre on Air and Climate Change using simple interpolation techniques (see below). The final gap-filled data used in this indicator are available from the EEA's LRTAP data viewer.

Base data, reported in the UNECE/EMEP nomenclature for reporting (NFR) sector format, are aggregated into the following EEA sector codes to obtain a consistent reporting format across all countries and pollutants:

- **Energy production and distribution**: emissions from public heat and electricity generation, oil refining, production of solid fuels, extraction and distribution of solid fossil fuels and geothermal energy;
- **Energy use in industry**: emissions from combustion processes used in the manufacturing industry including boilers, gas turbines and stationary engines;
- **Industrial processes and product use**: emissions derived from non-combustion related processes such as the production of minerals, chemicals and metal production, non-combustion-related emissions mainly in the services and household sectors including from activities such as paint application, dry-cleaning and other uses of solvents;
- **Road transport**: light and heavy duty vehicles, passenger cars and motorcycles;
- **Non-road transport**: railways, domestic shipping, certain aircraft movements and non-road mobile machinery used in agriculture and forestry;
- **Commercial, institutional and households**: emissions principally occurring from fuel combustion in the services and household sectors;
- **Agriculture**: manure management, fertiliser application, field-burning of agricultural wastes;
- **Waste**: incineration, wastewater management;
- **Other**: emissions included in national totals for the entire territory that are not allocated to any other sector.

The following table shows the conversion of nomenclature for reporting (NFR14) sector codes used for reporting by countries into EEA sector codes:

EEA classification	Non-greenhouse gases (GHGs; NFR14)
National totals	National total
Energy production and distribution	1A1, 1A3e, 1B
Energy use in industry	1A2
Road transport	1A3b
Non-road transport (non-road mobile machinery)	1A3 (exl 1A3b)
Industrial processes and product use	2
Agriculture	3
Waste	5
Commercial, institutional and households	1A4ai, 1A4aii, 1A4bi, 1A4bii, 1A4ci, 1A4cii, 1A5a, 1A5b
Other	7

Methodology for gap filling

An improved gap-filling methodology was implemented in 2010 that enables a complete time-series trend for the main air pollutants (e.g. NO_x, SO_x, NMVOCs, NH_3 and CO) to be compiled. In cases in which countries did not report emissions for any year, gap-filling could not be applied. For these pollutants, therefore, the aggregated data are not yet complete and are likely to underestimate true emissions. Further methodological details of the gap-filling procedure are provided in section 1.4.5 'Data gaps and gap-filling' of the European Union emission inventory report 1990–2016 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP) (EEA, 2018).

Methodology references

- EEA, 2018 European Union emission inventory report 1990 — 2016 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP). EEA technical report No 6/2018. Copenhagen.

- • EMEP/EEA, 2016 EMEP/EEA Air Pollutant Emission Inventory Guidebook.
- EMEP, 2010 Transboundary, acidification, eutrophication and ground level ozone in Europe in 2008 Estimated dispersion of acidifying and eutrophying compounds and comparison with observations.

Uncertainties

Methodology uncertainty

The use of a gap-filling methodology for countries that have not reported emissions for one or more years can potentially lead to artificial trends, but it is considered unavoidable if a comprehensive and comparable set of emission data for European countries is required for policy analysis purposes.

Data sets uncertainty

NO_x emission estimates in Europe are thought to have an uncertainty of about ±20 % (EMEP (2010), as the NO_x emitted is from both the fuel burnt and the combustion of air and so cannot be estimated accurately from fuel nitrogen alone. However, because of the need for interpolation to account for missing data, the complete data set used will have a higher degree of uncertainty. The overall trend is likely to be more accurate than individual absolute annual values — the annual values are not independent of each other.

Overall scoring (1–3; 1 = no major problems, 3 = major reservations):

- relevancy: 1
- accuracy: 2
- comparability over time: 2
- comparability over space: 2.

SO_x emission estimates in Europe are thought to have an uncertainty of about ±10 %, as the sulphur comes from only the fuel burnt and therefore can be more accurately estimated than emissions of NO_x. However, because of the need for interpolation to account for missing data, the complete data set used will have a higher degree of uncertainty. EMEP has compared modelled and measured concentrations throughout Europe (EMEP, 2010). From these studies, differences in the annual averages have been estimated to be ±30 %, which is consistent with an inventory uncertainty of ±10 % (there are also uncertainties in the measurements and especially the modelling). The trend is likely to be much more accurate than individual absolute values.

Overall scoring (1–3; 1 = no major problems, 3 = major reservations):

- relevancy: 1
- accuracy: 2
- comparability over time: 2
- comparability over space: 2.

NH_3 emission estimates in Europe are more uncertain than those for NO_x, SO_x and NMVOCs, largely because of the diverse nature of major agricultural sources. It is estimated that they have an uncertainty of around ±30 % (EMEP, 2009). The overall trend is likely to be more accurate than the individual absolute annual values — the annual values are not independent of each other.

Overall scoring (1–3; 1 = no major problems, 3 = major reservations):

- relevancy: 1
- accuracy: 2
- comparability over time: 2
- comparability over space: 2.

Rationale uncertainty

This indicator is regularly updated by the EEA and is used in state of the environment assessments. The uncertainties related to methodology and data sets are therefore important.

Data sources

- National Emission Ceilings (NEC) Directive Inventory
  provided by **Directorate-General for Environment (DG ENV)**

Generic metadata

Topics:

Air pollution

Tags:

DPSIR: Pressure
Typology: Policy-effectiveness indicator (Type D)

Indicator codes

- CSI 040
- AIR 005

Temporal coverage:

1990-2016

Geographic coverage:

Countries

Austria , Belgium , Bulgaria , Croatia , Cyprus , Czech Republic , Denmark , Estonia , Finland , France , Germany , Greece , Hungary , Iceland , Ireland , Italy , Latvia , Liechtenstein , Lithuania , Luxembourg , Malta , Netherlands , Norway , Poland , Portugal , Romania , Slovakia , Slovenia , Spain , Sweden , Switzerland , Turkey , United Kingdom

Contacts and ownership

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Ownership

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