02
Air

Emission of air pollutants

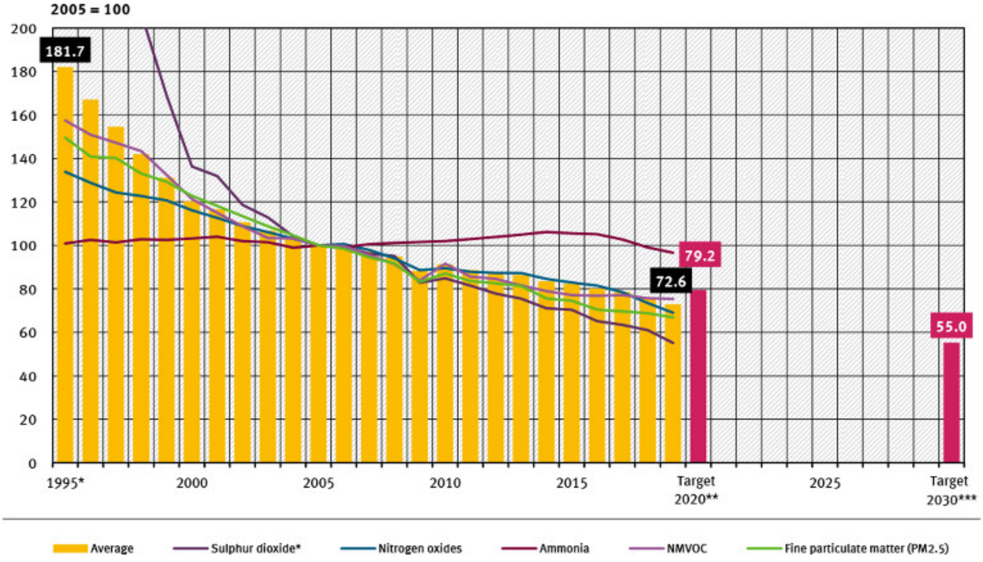
Air quality in agglomerations

Population exposure to particulate matter pollution

Emission of air pollutants

Index of air pollutant emissions

Trend of different air pollutant emissions relative to 2005 emissions (in mean percentage)



* Sulphur dioxide value in 1995: 360
** 2020 target based on the Gothenborg Protocol reduction commitments
*** 2030 target based on the future EU 'national emission ceilings directive' and the target of the Federal Governments' Strategy for Sustainable Development

Source: German Environment Agency, National trend tables for German reporting on atmospheric emissions since 1990, Emissions from 1990 to 2019 (final version of 01/2021)

At a glance

- The mean index of five air pollutants shows an average yearly reduction of almost 5 % between 1995 and 2019.
- The commitments of the Gothenburg Protocol for 2020 are expected to be met.
- Meeting the commitments of the European NEC Directive for 2030, is a major challenge for the German environmental policy.
- Ammonia emissions must be reduced significantly to achieve this.

Indicator online (latest data, data download): http://www.uba.de/57122
Last updated: 16.02.2021

Environmental importance

The indicator is based on the trend of five different pollutants (index) from different sources. Ammonia (NH_3) mainly comes from agriculture through livestock farming and fertilisation. Nitrogen oxides (NO_x) and sulphur dioxide (SO_2) are mainly produced by combustion processes in power stations and engines. Non-methane volatile organic compounds (NMVOCs) mainly arise from the use of solvents in industrial processes. Fine particulate matter with a particle size of less than 2.5 micrometres (PM2.5) is derived from combustion processes in households, road transport and agriculture.

Their impacts on the environment vary. Sulphur dioxide contributes to the acidification of ecosystems by causing 'acid rain'. Ammonia and nitrogen oxides lead to excessive nutrient enrichment (eutrophication). NMVOCs increase the amount of harmful ozone pollution. Among other things, PM2.5 causes respiratory diseases in humans.

Assessing the development

The value of the index has fallen sharply since 1995: Since 1995 it has fallen by 60 %. However, the progress made with the different pollutants varies significantly. Emissions of sulphur dioxide have declined by almost 85 % since 1995. Emissions of ammonia, have declined only by 4 % since then.

Germany has committed to reducing emissions of the five main air pollutants in accordance with the 2012 amendment to the Gothenburg Protocol of the Geneva Convention on Long-Range Transboundary Air (UNECE 2012). Germany must reduce emissions by an average of 21 % by 2020 compared to 2005. This target can be achieved. For the five air pollutants, further reduction obligations have also been set in the new European NEC Directive of December 2016. Accordingly, Germany must reduce emissions of the five air pollutants by an average of 45 % between 2005 and 2030. The Federal Government has included this reduction target in the German Sustainable Development Strategy (BReg 2016).

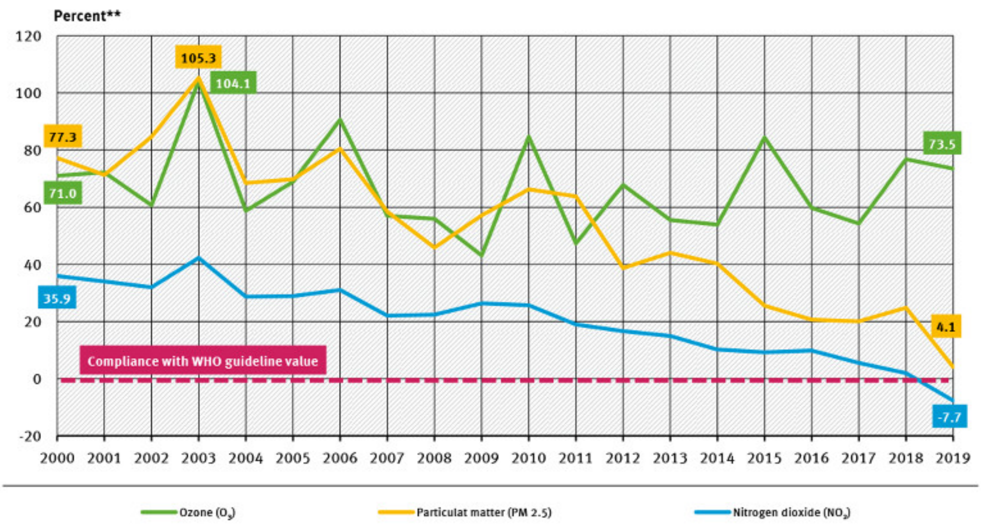
Achieving these targets is a major challenge for German environmental policy. Additional measures are needed, especially to reduce ammonia emissions from agriculture. Significant progress must also be made in the areas of e-mobility and the expansion of public transport, in building modernization, and in particulate matter emissions from small combustion plants (stoves and fireplaces) in order to ensure that the 2030 target values are safely achieved.

Methodology

The indicator is based on the relative trend of the emissions of five pollutants since 2005. Emissions of that year were set at 100 (indexed). The indicator is calculated from the annual average for the five pollutants. The calculation is based on data from the respective air pollutant inventories calculated by the German Environment Agency. These calculations are described in detail in the UBA's 'German Informative Inventory Report' (UBA 2020a).

Air quality in agglomerations

Discrepancy between average pollutant concentrations and WHO recommendations* in urban background locations in German agglomerations



* WHO guideline values: O_3: 100 µg/m³ as max. daily 8-hour mean; PM2.5: 10 µg/m³ in annual mean (WHO Air quality guidelines - global update 2005); recommendation for NO_2: 20 µg/m³ in annual mean (HRAPIE Project, WHO 2013)
** The y-axis was extended into the negative value range. Negative values correspond to a desirable undercutting of the WHO recommendations.

Source: German Environment Agency 2020

At a glance

- The background levels of two main air pollutants (PM2.5, ozone) in German agglomerations still exceed World Health Organisation (WHO) guideline values.
- Close to sources, pollutant levels can even be significantly higher.
- The situation regarding nitrogen dioxide and particulate matter has greatly improved since 2000.
- Ozone and particulate matter pollution is very dependent on the weather. Levels thus fluctuate significantly.

Indicator online (latest data, data download): http://www.uba.de/57123
Last updated: 23.07.2020

Environmental importance

Nitrogen dioxide (NO_2), particulate matter (PM2.5) and ozone (O_3) are of particular concern to human health. All three pollutants affect the respiratory organs. Many premature deaths are also attributed to particulates. Ecosystems are also damaged by ozone.

The World Health Organisation WHO has defined air quality guideline values for particulates and ozone (WHO 2006). A new recommendation for NO_2 has been proposed in a research paper (WHO 2013). Above these levels, health risks increase significantly. These values are stricter than the limits defined in the EU Air Quality Directive.

Air quality is particularly precarious in agglomerations, where one third of the German population lives. Here, industry, traffic and residential areas exist in close proximity. The indicator incorporates data from monitoring stations which measure background urban pollution levels. At busy locations in cities pollution levels may be significantly higher. The indicator represents the average discrepancy of all monitoring stations of urban background from WHO guideline values, respectively. Even with negative indicator values, individual monitoring stations can still be above the target value.

Assessing the development

Levels of nitrogen dioxide and particulate matter have fallen considerably. 2019 is the first year in which nitrogen dioxide falls below the newly considered WHO recommendation in agglomerations. If this trend continues for particulate matter (PM2.5), concentrations may fall also below the WHO recommendations in the foreseeable future.

However, ozone concentrations fluctuate widely. This is largely due to the influence of the weather. In hot summers such as 2003 or 2015, ozone concentrations rise sharply. Thus it is impossible to make a meaningful statement about the trend in recent years.

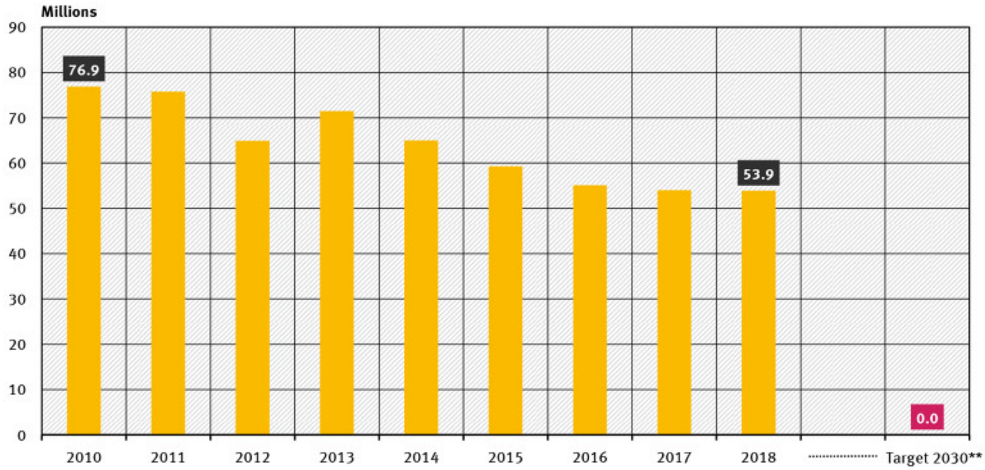
In 2008 the EU set out its air quality objectives in the Air Quality Directive (EU Directive – 2008/50/EC). The German Environment Agency believes that, in the long term, the limit values defined in the directive should be reduced to the WHO recommendations. Even then, large parts of Germany would still fail to meet the less ambitious targets of the EU directive (UBA 2019a). There is still a long way to go until the air in agglomerations is sufficiently 'clean'.

Methodology

The indicator is based on measurement data from the network of German air quality monitoring stations. All monitoring sites within an agglomeration were included in the measurement of urban and suburban background pollution levels. Measurements of these monitoring sites are used to calculate the extent to which the three pollutants NO2, PM2.5 and O_3 exceed or fall short of WHO recommendations. The average discrepancy between the values recorded at all monitoring stations and the WHO recommendation is calculated for each agglomeration. The average discrepancies are then averaged across all agglomerations and expressed in a standardised form with the WHO recommendation.

Population exposure to particulate matter pollution

Population exposed to PM2.5-concentrations exceeding the WHO annual mean guideline value*



* Guideline value: 10 µg/m³; The calculations are based on present population density results (population census 2011).
** Target set by UBA compared to the German Sustainable Development Strategy (PM10)

Source: German Environment Agency 2020

At a glance

- The exposure of the population to particulate matter (excluding traffic-related measuring points) was significantly lower in 2018 than in 2010.
- Particulate matter concentrations in ambient air are considerably affected by weather conditions which may vary substantially within the year and from one year to another.
- The German Environment Agency (UBA) proposes a target of keeping the exposure of the entire population below the World Health Organisation's (WHO) guideline value for particulate matter (PM2.5) of 10 µg/m³ as an annual average by 2030.

Indicator online (latest data, data download): http://www.uba.de/57183
Last updated: 05.03.2020

Environmental importance

Particulate matter in ambient air is harmful to human health. The particles enter the human body through the respiratory system. Depending on the size of the particles, they can penetrate deeply into the respiratory system. Particularly small particles can enter the blood stream when penetrating the pulmonary tissue. There is clear evidence that particulate matter can trigger various diseases (see 'Particulate matter').

Particulate matter is mainly the result of human activities (e.g. combustion processes), but is also released by mechanical processes (e.g. the abrasion of tires and brakes). Part of the particulate matter is produced in the atmosphere by chemical reactions of other pollutants (such as nitrogen oxides and ammonia) and is therefore referred to as "secondary" particulate matter.

The indicator focuses on the particulate matter exposure levels from rural and urban background areas, but does not take into account areas with increased particulate matter concentrations such as roads with high traffic volumes or areas that are close to large industrial plants. It can therefore be assumed that the approach used here underestimates the overall exposure level of the German population.

Assessing the development

At almost 54 million in 2018, the number of people in Germany exposed to concentrations of particulate matter (PM2.5 – particles with a diameter up to 2.5 µm) above the WHO guideline is significantly lower than at the beginning of the time series. This is mainly due to the fact that measures to reduce emissions are proving successful, especially in the transport sector. Furthermore, weather conditions have a direct influence on the particulate matter concentrations in ambient air.

The EU Air Quality Directive defines a mean annual limit value of 25 µg/m³ for PM2.5 in ambient air to protect human health (EU DIR 2008/50/EC). In Germany, this annual limit value has not been exceeded in recent years. However, the UBA proposes that by 2030 the exposure of the population should be below the WHO guideline value for particulate matter (PM2.5) of 10 µg/m³ as an annual average.

Impulses for a reduction in particulate matter pollution can be expected above all from the measures of the national air pollution control programme (BReg 2019b). These measures (in particular the phasing out of coal combustion and the reduction of ammonia emissions from agriculture) will significantly reduce emissions of particulate matter and its precursor gases by 2030.

Methodology

The indicator is calculated by combining modelled data from the REM-CALGRID chemical transport model, PM10 measurement data provided by the Federal States of Germany and the UBA and additional spatial interpolation procedures. The PM10 data are converted to PM2.5 data using a constant conversion factor of 0.7 and are then combined with population density maps to introduce a population weighting scheme. Only those measuring stations that are not directly exposed to particulate matter emissions, for example from traffic, are considered for the indicator. For more methodical details, see Kallweit et al. 2013.