Environment and health

Outdoor air quality in urban areas

Indicator	EU indicator past trend		Selected objective to be met by 2020	Indicative outlook of the EU meeting the selected objective by 2020
Exceedance of air quality limit values in urban areas (nitrogen dioxide: NO_2; coarse dust particles: PM_{10}; ozone: O_3;fine particulate matter: $PM_{2.5}$)	▲ NO_2, PM_{10}	▲ O_3, $PM_{2.5}$	Meet Air Quality Directive standards for the protection of human health — Air Quality Directive	●
Despite reductions in concentrations in urban areas of coarse dust particles and nitrogen dioxide and no significant change in ozone and fine particulate matter, due to their high and widespread exceedance levels in urban areas it is unlikely that the air quality standards for these pollutants will be met by 2020				

The Seventh Environment Action Programme (7th EAP) includes the objective of ensuring that outdoor air quality in the EU has significantly improved by 2020, moving closer to World Health Organization (WHO) guidelines. Observing the existing EU air quality legislation standards is a chief milestone in this respect. Despite some improvements, due to the implementation of EU legislation on emissions of air pollutants and air quality, key EU air quality standards for the protection of human health — concentrations of particulate matter (PM), ozone (O_3) and nitrogen dioxide (NO_2) — are currently not being met in various air quality monitoring stations in the EU. This is particularly true for urban areas, where more than 70 % of the EU population lives. This can be mainly attributed to the high level of emissions from road traffic and residential combustion in urban areas and unfavourable conditions for the dispersion of emissions due to topography and meteorological issues. Based on current trends and because of their high and widespread exceedances in urban areas, it is unlikely that the air quality standards for these pollutants will be met by 2020, while achieving air quality in line with the WHO guidelines is much further away. Further action will be needed, in particular in relation to road traffic and residential combustion in urban areas.

For further information on the scoreboard methodology please see Box I.1 in the EEA Environmental indicator report 2016

Setting the Scene

The 7th EAP (EU, 2013) aims to significantly improve outdoor air quality and move closer to World Health Organization (WHO) guidelines (WHO, 2006) by 2020. Air pollution is the number one environmental cause of death in the EU, responsible for more than 400 000 premature deaths per year (EEA, 2016a). According to WHO studies (WHO, 2013, 2014), exposure to particulate matter (PM) can cause or aggravate cardiovascular and lung diseases, heart attacks and arrhythmias, affect the central nervous system and the reproductive system and cause cancer. Exposure to high ozone (O_3) concentrations can cause breathing problems, trigger asthma, reduce lung function and cause lung diseases. Exposure to nitrogen dioxide (NO_2) increases symptoms of bronchitis in asthmatic children and reduces lung function growth. Health-related external costs range from EUR 330 billion to EUR 940 billion per year, depending on the valuation methodology, with evidence on the impacts of chronic ozone exposure adding around 5 % to this total (EC, 2013).

Policy targets and progress

A chief cornerstone of the EU environmental acquis in the field of air quality is the Air Quality Directive (EU, 2008). This directive set a number of air quality standards not to be exceeded by a certain year and thereafter.

The communication on the ‘Clean Air Programme for Europe’ (EC, 2013) sets the short-term objective of achieving full compliance with existing legislation by 2020 at the latest, as well as the long-term objective of seeing no exceedances of the WHO guideline levels for human health. The most troublesome pollutants in terms of harm to human health are particulate matter (PM), nitrogen dioxide (NO_2) and ground-level ozone (O_3). The European air quality standards and the WHO air quality guidelines (WHO, 2006) for these pollutants are displayed in Table 1.

Table 1. Air quality standards, under the EU Air Quality Directive, and WHO air quality guidelines

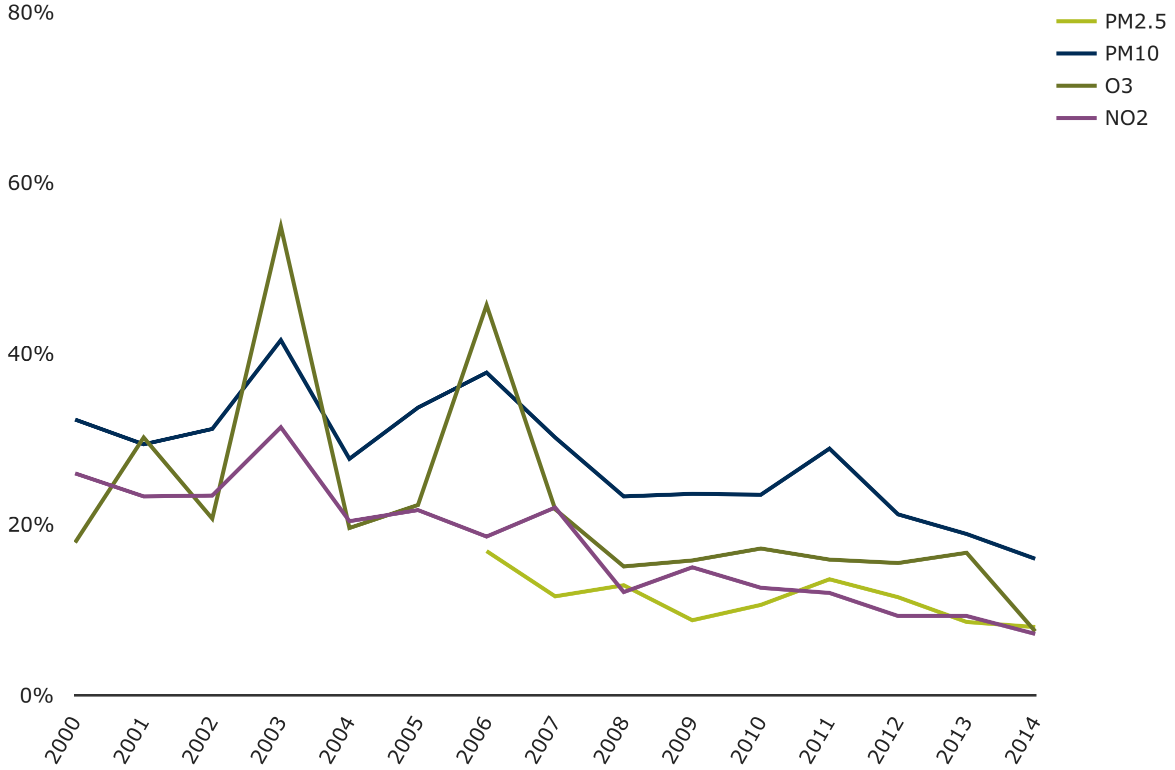
		Air Quality Directive		WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
$PM_{2.5}$	One day			25 µg/m³ (*)	99th percentile (3 days/year)
$PM_{2.5}$	Calendar year	Target value, 25 µg/m³	The target value has become a limit value since 1 January 2015	10 µg/m³	
PM_{10}	One day	Limit value, 50 µg/m³	Not to be exceeded on more than 35 days per year.	50 µg/m³ (*)	99th percentile (3 days/year)
PM_{10}	Calendar year	Limit value, 40 µg/m³ (*)		20 µg/m³	
O_3	Maximum daily 8-hour mean	Target value, 120 µg/m³	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m³	
NO_2	One hour	Limit value, 200 µg/m³ (*)	Not to be exceeded more than 18 times a calendar year	200 µg/m³ (*)	
NO_2	Calendar year	Limit value, 40 µg/m³		40 µg/m³	

Notes:
1. (*) Not considered in the indicator, where only the most stringent EU standards are used: the daily limit value for PM_{10} and the annual limit value for NO_2. According to the WHO air quality guidelines, the annual average for PM takes precedence over the 24-hour average, since, at low levels, there is less concern about episodic excursions.
2. In line with the Air Quality Directive: 'limit value' shall mean a level fixed on the basis of scientific knowledge, with the aim of avoiding, preventing or reducing harmful effects on human health and/or the environment as a whole, to be attained within a given period and not to be exceeded once attained; 'target value' shall mean a level fixed with the aim of avoiding, preventing or reducing harmful effects on human health and/or the environment as a whole, to be attained where possible over a given period.

Source: EU, 2008; WHO, 2006.

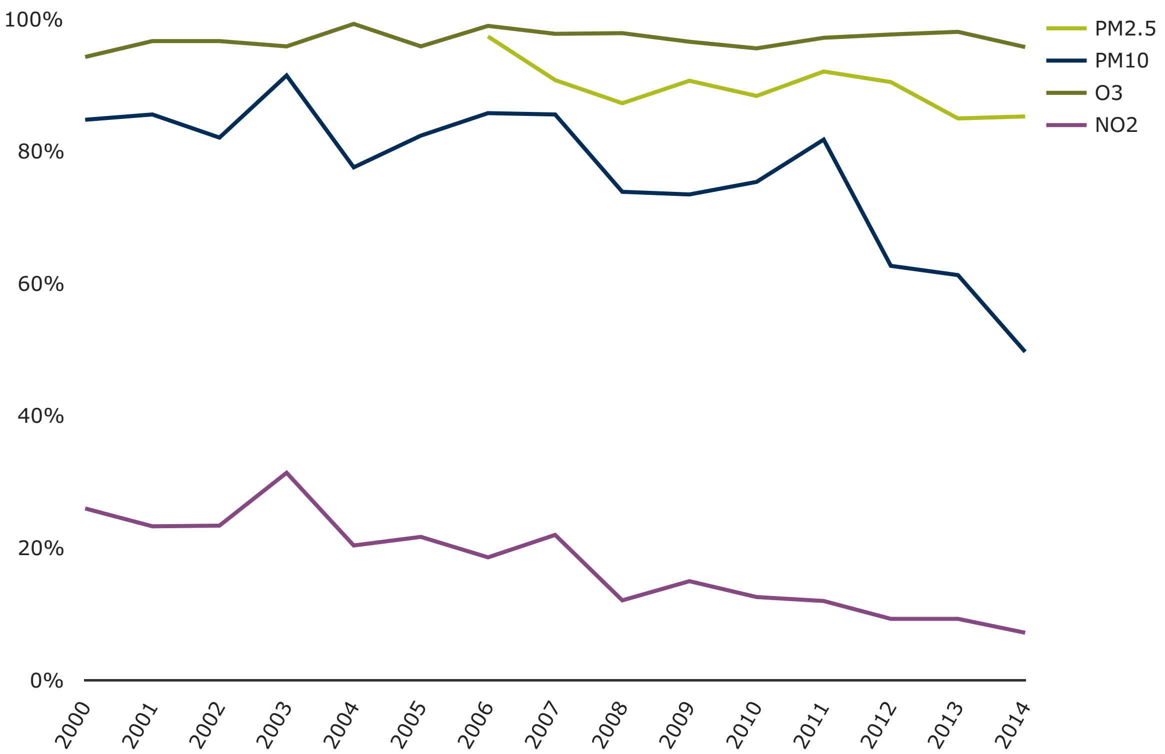
Figures 1 and 2 show the percentage of the urban population exposed to air pollutant concentrations above both EU standards (Figure 1) and WHO guidelines (Figure 2).

Figure 1. EU urban population exposed to air pollutant concentrations above selected air quality standards of the EU Air Quality Directive



Data sources: a. Eurostat. Gisco - Urban Audit 2012 b. EEA. AirBase
c. EEA. Air Quality e-Reporting (AQ e-Reporting) d. EEA – Indicator CSI004

Figure 2. EU urban population exposed to air pollutant concentrations above WHO air quality guidelines



Note:
The rational for selection of pollutants and corresponding WHO guidelines is given in the specification section of indicator CSI 004.

Criteria:
- Percentage of population exposed to annual $PM_{2.5}$ concentrations above 10 µg/m^3.
- Percentage of population exposed to annual PM_{10} concentrations above 20 µg/m^3.
- Percentage of population exposed to maximum daily 8-hour mean O_3 concentrations exceeding 100 µg/m^3 for at least one day a year.
- Percentage of population exposed to annual NO_2 concentrations above 40 µg/m^3.

Data sources: a. Eurostat. Gisco - Urban Audit 2012 b. EEA. Airbase
c. EEA. Air Quality e-Reporting (AQ e-Reporting) d. EEA – Indicator CSI004

Around one sixth of Europeans currently living in urban areas are exposed to air pollutant levels exceeding some EU air quality standards. Moreover, up to 96 % are exposed to levels of some air pollutants deemed damaging to health by the WHO’s more stringent guidelines (EEA, 2016a).

Particulate matter (PM)

Between 2006 and 2014, 8 – 17 % of the EU's urban population is estimated to have been exposed to concentrations of fine particulate matter ($PM_{2.5}$) in excess of the EU target value set for the protection of human health (Figure 1). With respect to the more stringent WHO guideline value (Figure 2), a much larger proportion of the urban population (85 – 97 %) was exposed to concentrations above this threshold. The time series are considered too short to draw any firm conclusions on changes over time.

Notwithstanding limitations in data coverage in the early 2000s, a significant proportion of the EU urban population (16 – 42 %) was exposed to concentrations of coarse dust particles (PM_{10}) in excess of the EU daily limit value set for the protection of human health during the 2000–2014 period (Figure 1). A slightly decreasing tendency can be observed throughout the whole period.

For the more stringent WHO guideline value (Figure 2), a higher proportion of the urban population (50 – 92 %) was exposed to concentrations above this threshold. Here, a decreasing tendency is also observed, as in the case of the EU limit value.

PM may be categorised as either primary (i.e. directly emitted to the atmosphere) or secondary (i.e. formed in the atmosphere from the so-called precursor gases).

Primary PM originates from both natural and anthropogenic sources. The main emitter sectors are 'commercial, institutional and household fuel combustion' and 'industry'. In third place, 'agriculture' is listed for PM_{10} and transport for $PM_{2.5}$. All these sectors reduced their PM emissions in the EU in the 2000–2014 period, although higher relative reductions were observed for industry and transport and only small reductions were observed for the other two sectors.

With the exception of ammonia, the reductions in emissions of the other secondary PM precursors (nitrogen oxides, sulphur oxides, and non-methane volatile organic compounds) were much larger than the reductions in primary PM from 2000 to 2014 in the EU.

However, the reductions in both primary PM and precursors have not led to equivalent drops in the concentrations of PM. This is due to the fact that, due to chemical reactions of the precursors to form secondary particles, the relationships between emissions and concentrations are not linear. It can also be explained by uncertainties in the reported emissions of primary PM from the 'commercial, institutional and household fuel combustion' sector, by intercontinental transport of PM and its precursor gases from outside Europe, and by the contribution of natural sources to PM concentrations (EEA, 2016b).

The contributions of the different emission sources to ambient air concentrations depend not only on the amount of pollutant emitted, but also on proximity to source, emission conditions (such as height and temperature) and other factors, such as dispersion conditions and topography. Sectors with low emission heights, such as traffic and household fuel combustion, generally make a more significant contribution to surface concentrations than emissions from high stacks.

Ozone (O_3)

Although reductions in European emissions of O_3 precursors have led to lower peak concentrations of O_3, the current target value is frequently exceeded on more than 25 days a year. In the 2000–2014 period, between 8 % (in 2014) and 55 % (in 2003) of the urban population was exposed to concentrations above the target value (Figure 1). In the last 7 years, the proportion of the urban population exposed has not exceeded 20 %, with no significant change over time.

In relation to the more stringent WHO guideline (Figure 2), the proportion of the population exposed to concentrations above the guideline value is as high as 94 – 99 %, with no discernible change over time.

O_3 concentrations are determined by emissions of its precursors and by meteorological conditions: ozone is formed in sunny conditions with high temperatures. Apart from reductions in anthropogenic emissions of O_3 precursors, there have been increases in natural emissions and also in intercontinental transport of O_3 and its precursors. Additional factors are also likely to mask the effects of European measures to reduce anthropogenic emissions of O_3 precursors, including climate change, emissions of non-methane volatile organic compounds from vegetation (difficult to quantify) and fire plumes from forest and other biomass fires (EEA, 2010). Formation of tropospheric ozone from increased concentrations of methane may also contribute to the sustained O_3 levels in Europe.

Nitrogen dioxide (NO_2)

Between 2000 and 2014, the fraction of the urban population exposed to concentrations in excess of the EU limit value and the identical WHO guideline value gradually decreased to around 10 %, with a minimum of 7 % in 2014 (Figures 1 and 2). The highest exposure of the urban population to NO_2, 31 %, occurred in 2003.

Enforcement of current legislation has resulted in a reduction in NO_x emissions in all sectors. Nevertheless, emissions from transport keep NO_2 concentrations high close to main roads.

Based on the current trends, explained above, and because of their high and widespread exceedances in urban areas, it is unlikely that air quality standards for these pollutants will be met by 2020, while achieving air quality in line with the WHO guidelines is much further away. Effective air quality policies require action and cooperation on global, European, national and local levels, which must reach across most economic sectors and engage the public. Holistic solutions must be found that involve technological development, structural changes — including the optimisation of infrastructures and urban planning — and behavioural changes. These will be necessary to deliver a level of air quality across the EU that is conducive to the protection of human health (EEA, 2016b).

Country-level information

Table 2 provides information on the urban population exposed to concentrations of air pollutants above the EU air quality objectives by country for the year 2014. Variations from country to country are not only related to the different pollutant concentrations but also to:

- the number of available data series (monitoring stations and/or selected cities), which will influence the total monitored population;
- the uneven distribution of traffic and background stations in the different countries.

Table 2. Urban population exposed to concentrations of air pollutants above selected air quality standards of the Air Quality Directive, 2014

COUNTRIES	PM10 (daily limit value)	O3 (target value)	NO2 (annual limit value)
Austria	0	13	1
Belgium	1	0	2
Bulgaria	97	0	0
Croatia	NA	NA	NA
Cyprus	6	0	0
Czech Repuplic	27	0	1
Denmark	0	0	2
Estonia	0	0	0
Finland	0	0	0
France	1	4	3
Germany	1	4	7
Greece	2	48	2
Hungary	29	7	0
Ireland	0	0	0
Italy	39	26	15
Latvia	4	0	4
Lithuania	3	0	0
Luxembourg	0	NA	0
Malta	100	NA	NA
Netherlands	0	0	2
Poland	84	0	1
Portugal	0	0	1
Romania	3	0	0
Slovakia	46	9	1
Slovenia	0	0	0
Spain	2	20	3
Sweden	0	0	1
United Kingdom	0	0	21
EU–28	16	7	7

The colour coding of exposure estimates refers to the fraction of urban population exposed to concentrations above the reference level:

0%	< 5%	5–50%	50–75%	> 75%

Note: NA = no available data, for further information please see indicator CSI004.
Source: Air pollution country fact sheets (EEA, 2014) updated with 2014 data. The 2014 data aggregated at EU level are also available (EEA, 2016a, 2016c).

Outlook beyond 2020

In 2013, the European Commission proposed a Clean Air Policy Package for Europe (EC, 2013), which aims to achieve full compliance with existing air quality legislation by 2020, and to further improve Europe's air quality by 2030 and beyond. As a result of this package, it has recently been agreed to revise the 2001 National Emission Ceilings Directive (EU, 2001). The proposed new directive establishes new national emission reduction commitments applicable from 2020 and stricter commitments from 2030 for sulphur dioxide, nitrogen oxides, non-methane volatile organic compounds, ammonia and $PM_{2.5}$. In addition, and as part of the package, a new directive, the Medium Combustion Plant Directive, was approved in November 2015 (EU, 2015). This directive regulates sulphur dioxide, nitrogen oxides and dust emissions from the combustion of fuels in medium-sized combustion plants (with a rated thermal input of 1and up to 50 megawatt).

These new commitments, together with the on-going implementation of air quality improvement measures at national, regional and local levels, are expected to improve air quality in Europe. However, the changes in meteorological conditions due to climate change are expected to increase O_3 concentrations as a result of expected increased emissions of both specific O_3 precursors and emissions from wildfires; these can increase under periods of extensive drought (EEA, 2015).

Finally, it is expected that the age group composition of the EU population will continue to shift towards higher numbers of the elderly because of continuing increases in life expectancy (Eurostat, 2016). The overall potential air pollution-related health impact of this change remains uncertain.

About the indicator

This briefing shows the proportion of the EU urban population that is exposed to various potentially harmful concentrations of pollutants in excess of both EU standards and WHO guidelines set for the protection of human health. For further information on the methodology, please refer to the EEA indicator ‘Exceedance of air quality limit values in urban populations’ (EEA, 2016a).

The indicator focuses on those pollutants that are most relevant in terms of health effects and urban concentrations: PM, both PM_{10} and fine PM or $PM_{2.5}$; O_3; and NO_2. When there is more than one standard, only the most stringent one is used. The indicator is based on measurements of air pollutants reported under the Air Quality Directive (EU 2008) and the Decisions on the exchange of information (EU, 2011).

Most air pollution is man-made and derives from combustion of fossil or biomass fuels used in industry, transport and heating; industrial and agricultural processes; and other sources (EEA, 2016b). As most of these sources, particularly emissions from cars, are concentrated in urban areas, where most of the European population lives, air quality in urban areas is a useful proxy for tracking progress towards meeting the standards set out in the Air Quality Directive.

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