Environment at a Glance Indicators

Air quality

Context

Issues at stake

Air pollution is the world's leading environmental health risk and a major cause of environmental degradation. **Atmospheric pollutants** from energy transformation and energy consumption, and from industrial processes, are the main contributors to regional and local air pollution. Major concerns relate to their effects on human health and ecosystems. Human exposure is particularly high in urban areas where economic activities are concentrated and where demand for mobility is highest. Degraded air quality can have substantial economic and social consequences, from health costs and a lower quality of life to infrastructure maintenance, reduced agricultural output and forest damage. Some population groups are especially vulnerable to air pollution. The very young and the very old are the most at risk.

In the atmosphere, **emissions of sulphur and nitrogen** are transformed into acidifying substances such as sulphuric and nitric acid. When these substances reach the ground, acidification of soil, water and buildings occurs which cause severe environmental damage. Nitrogen oxides (NO_x) also contribute to the formation of ground-level ozone (that is effectively and greenhouse gas) and are responsible for eutrophication, reduction in water quality and species richness. They are associated with adverse effects on human health because high concentrations cause respiratory diseases.

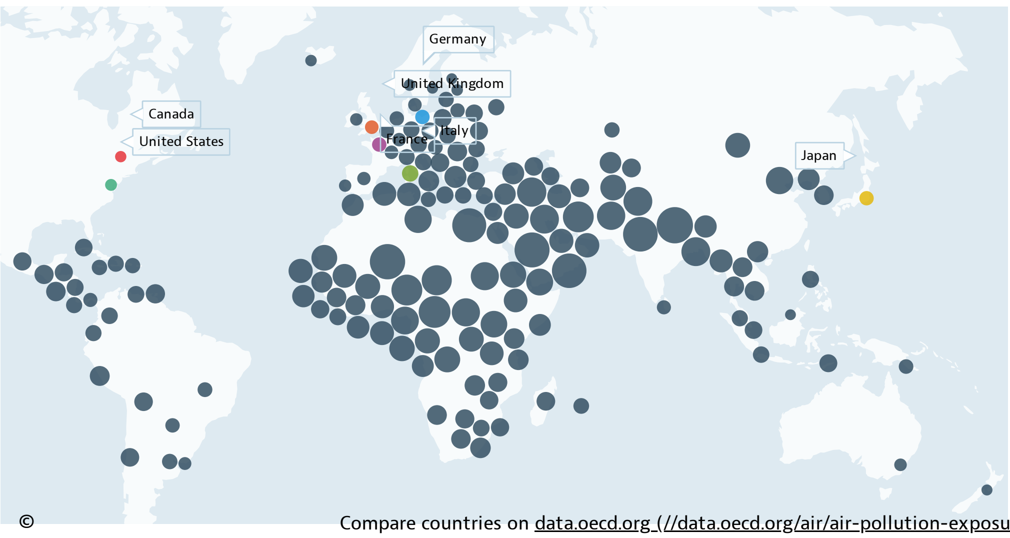
Fine particulate matter ($PM_{2.5}$), is another serious pollutant globally from a human health perspective. Chronic exposure even to moderate levels of $PM_{2.5}$ substantially increases the risk of heart disease and stroke, the leading causes of death in OECD countries. It also increases the risk of respiratory diseases, including lung cancer, chronic obstructive pulmonary disease and respiratory infections. Black carbon, a major component of $PM_{2.5}$, accelerates global warming and fosters snowmelt. Emissions from transport, industry, electricity generation, agriculture and domestic (household) sources are the main contributors to outdoor air pollution.

Policy challenges

The main challenges are to further reduce emissions of local and regional air pollutants, to achieve a strong decoupling of emissions from economic growth and limit people's exposure to polluted air. This implies implementing effective pollution prevention and control policies and sustainable transport and mobility policies**.**

- Emissions can be reduced by **substituting dirty fuels for cleaner ones**, focusing development on cleaner industries, reducing consumption of polluting products and adopting cleaner technologies. Behavioural and lifestyle changes are also important.
- Policies that provide **incentives** across a broad spectrum of firms and consumers (e.g. emission or energy taxes) tend to be more cost-efficient than those that target a specific product, fuel or technology (e.g. subsidies for electric cars).
- Both the **sources of air pollution** and **severity of exposure** vary across and within countries. Hence it is important to tailor policies to specific local circumstances. For example, more stringent measures are required in densely populated areas or for emission sources located upwind from urban areas. Such spatially heterogeneous policies help achieve environmental objectives at lower costs than measures that apply uniformly to sources in all locations and to populations at all risk levels.

Air pollution exposure (//data.oecd.org/air/air-pollution-exposure.htm) Exposure to PM2.5, Micrograms per cubic metre, 2017



© Compare countries on data.oecd.org (//data.oecd.org/air/air-pollution-exposure.htm)

Measuring progress and performance

Environmental performance can be assessed against domestic objectives and international commitments. Reducing negative impacts of degraded air quality is part of the 2030 Agenda for Sustainable Development (New York, September 2015) under *Goal 3 "Ensure healthy lives and promote well-being for all at all ages" and under Goal 11 "Make cities and human settlements inclusive, safe, resilient and sustainable"*.

In Europe and North America, acidification has led to several international agreements among which the Convention on Long-Range Transboundary Air Pollution (1979), and its eight protocols to reduce emissions of sulphur (Helsinki 1985, Oslo 1994, Gothenburg 1999), nitrogen oxides (Sofia 1988, Gothenburg 1999), volatile organic compounds (Geneva 1991, Gothenburg 1999), and ammonia (Gothenburg 1999). The 2012 amendment of the Gothenburg protocol establishes legally binding emissions reduction commitments for 2020 and beyond for the major air pollutants: sulphur dioxide (SO2), nitrogen oxides (NOX), ammonia (NH3), volatile organic compounds (VOCs) and fine Particulate Matter (PM2.5). It specifically includes the short-lived climate pollutant black carbon (or soot) as a component of particular matter. Reducing particulate matter through the implementation of the Protocol is thus a major step in reducing air pollution, while at the same time facilitating climate co-benefits. Two other protocols aim at reducing emissions of heavy metals (Aarhus 1998) and persistent organic pollutants (Aarhus 1998).

Progress can be assessed by measuring the evolution of emissions, the exposure of population to air pollutants, the related health effects and their costs, and the evolution of policy stringency directed at pricing air pollution. The costs of air pollution mainly arise from its detrimental impact on human health. These take the form of shorter life expectancy, increased healthcare costs and reduced labour productivity. Further consequences include reduced agricultural output and damage to ecosystems and built structures.

Indicator groups

- Pollutant emissions and intensities: fine particulates ($PM_{2.5}$), nitrogen oxide (NO_x) and sulphur oxide (SO_x).
- Air quality and health: population exposure to fine particulates ($PM_{2.5}$), mortality from $PM_{2.5}$ and welfare cost of $PM_{2.5}$ mortality.
- Taxes relevant for air pollution abatement: revenue raised and tax base structure.

Pollutant emissions

Key messages

- In most OECD countries, **$PM_{2.5}$ emission levels and intensities** are steadily decreasing since 2000 thanks to optimised combustion processes, a decrease of solid fuels in energy mix, and lower emissions from transport and agriculture.
- Compared to 2000, **SOx emissions** have continued to decrease for the OECD as a whole.
- **NOx emissions** have also decreased in the OECD overall since 2000, but less than SOx emissions.
- By 2017, almost all OECD countries reached their SOx and NOx **emission targets** for 2020 and the other few are on track to meet them.

Main trends and recent developments

In most OECD countries, **$PM_{2.5}$ emission levels and intensities** are steadily decreasing since 2000. These improvements can be attributed to optimised combustion processes (in industries and households heating), a decrease of solid fuels (e.g. coal) in energy mix, and lower emissions from transport and agriculture. However, in large countries (e.g. Canada, United States), emission levels and intensities remain high due to large construction sites, unpaved roads, fields and smokestacks or fire. Most particles form in the atmosphere as a result of complex reactions of chemicals such as SOx and NOx, which are emitted from power plants, industries and automobiles.

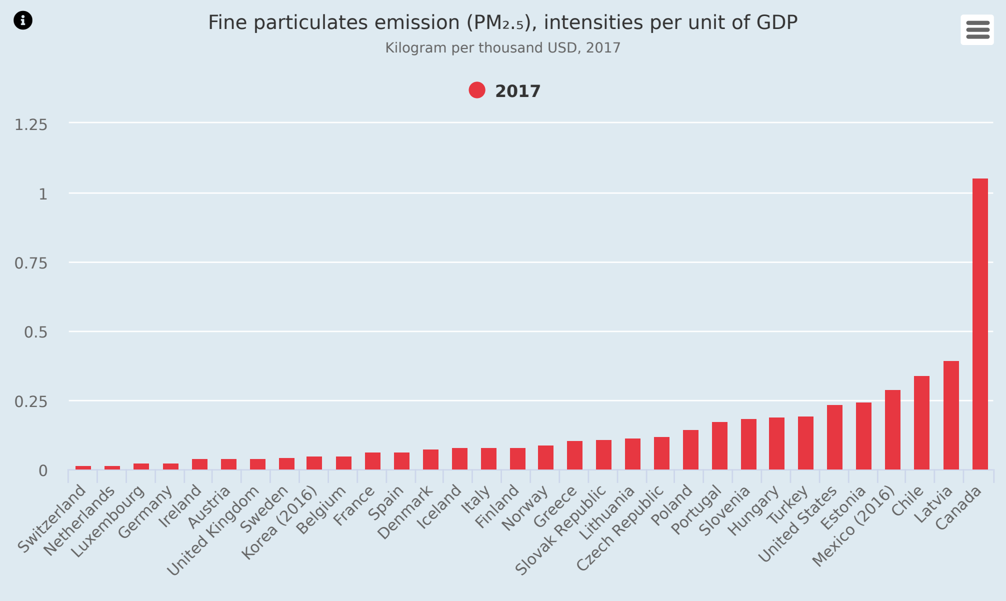
Compared to 2000, **SO_x emissions** have continued to decrease for the OECD as a whole as a combined result of changes in energy demand through energy savings and fuel substitution, pollution control policies and technical progress. All countries reached the goal they fixed under the Gothenburg protocol for 2010.

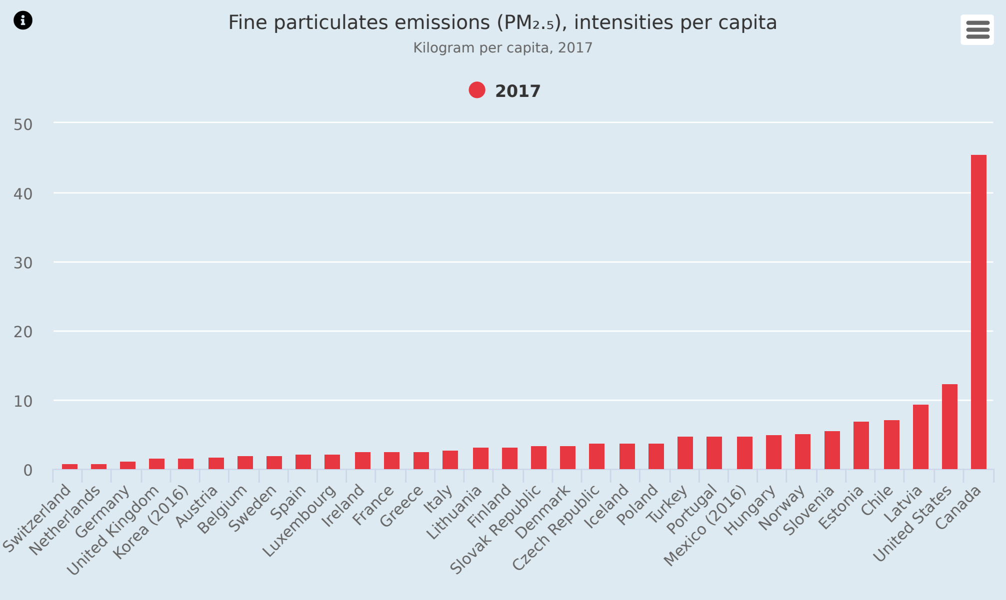
NO_x emissions have also decreased in the OECD overall since 2000, but less than SO_x emissions. This was mainly due to changes in energy demand, pollution control policies and technical progress. In the late 2000s, the slowdown in economic activity following the 2008 economic crisis further contributed to reduce emissions. However, these results have not compensated in all countries for steady growth in road traffic, fossil fuel use and other activities generating NO_x. Several countries attained the emission ceilings of the Gothenburg Protocol for 2010, but other countries had difficulties in doing so.

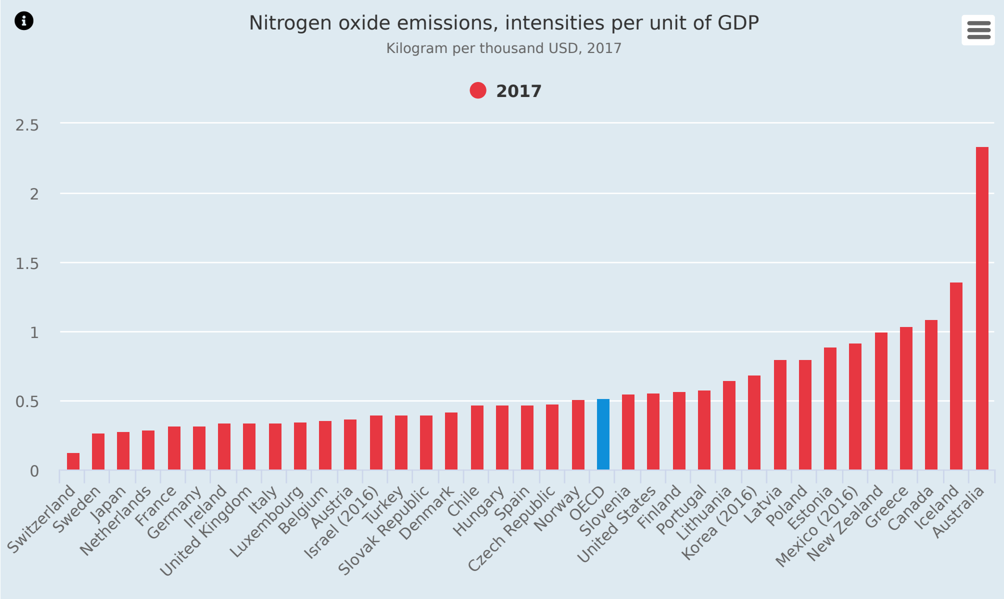
By 2017, almost all OECD countries reached their SO_x and NO_x **emission targets** for 2020 and the other few are on track to meet them. However, some OECD countries with the highest levels of emissions have not ratified the protocol (the United States, Turkey).

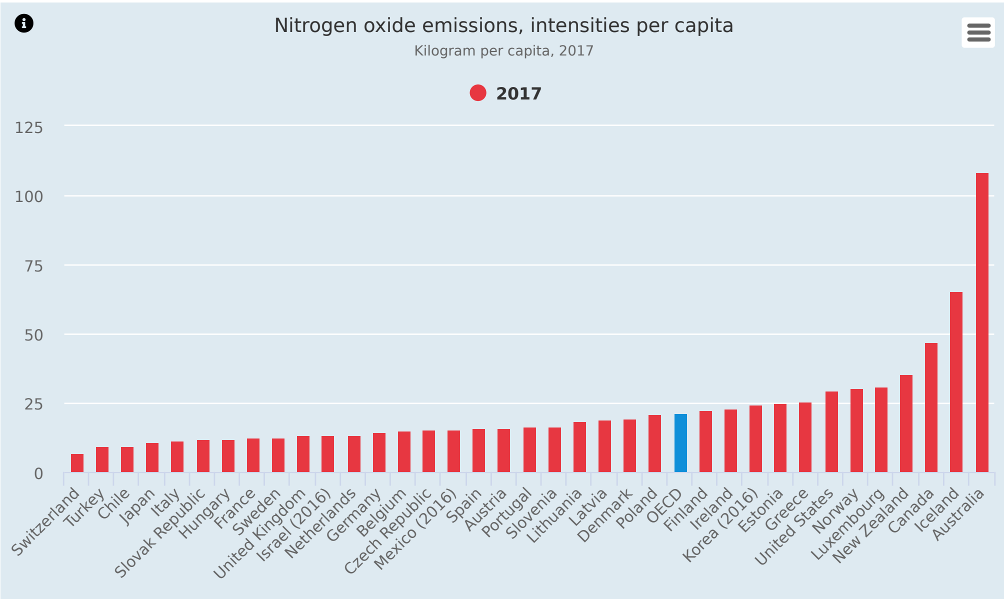
Emission intensities per capita and per unit of GDP show significant variations among OECD countries. Almost all OECD countries have achieved a strong decoupling from economic growth since 2000. High levels and rise of NO_x emissions in Australia are due to industrial combustion, power stations and growing vehicle ownership.

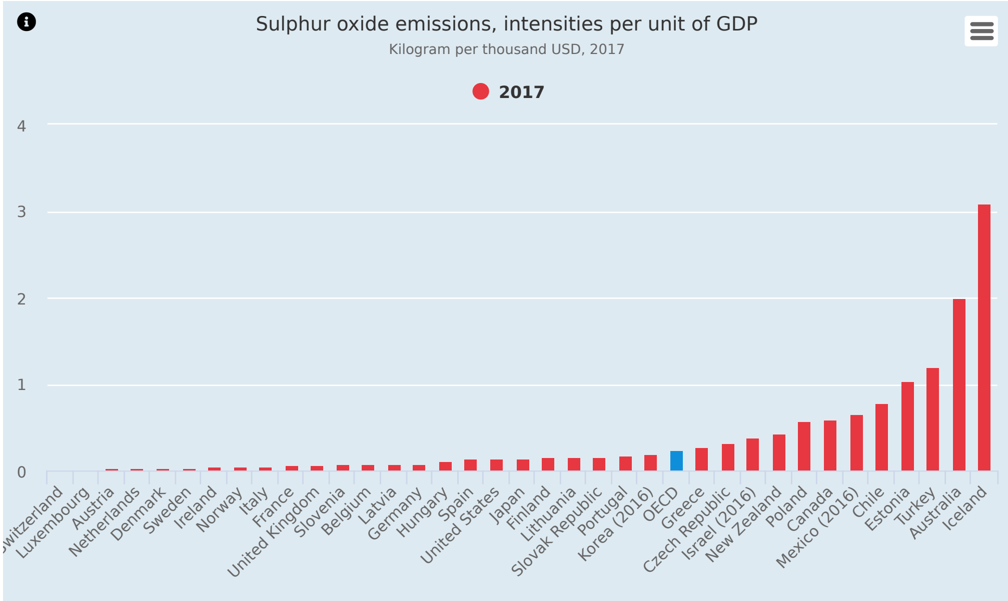
Indicators

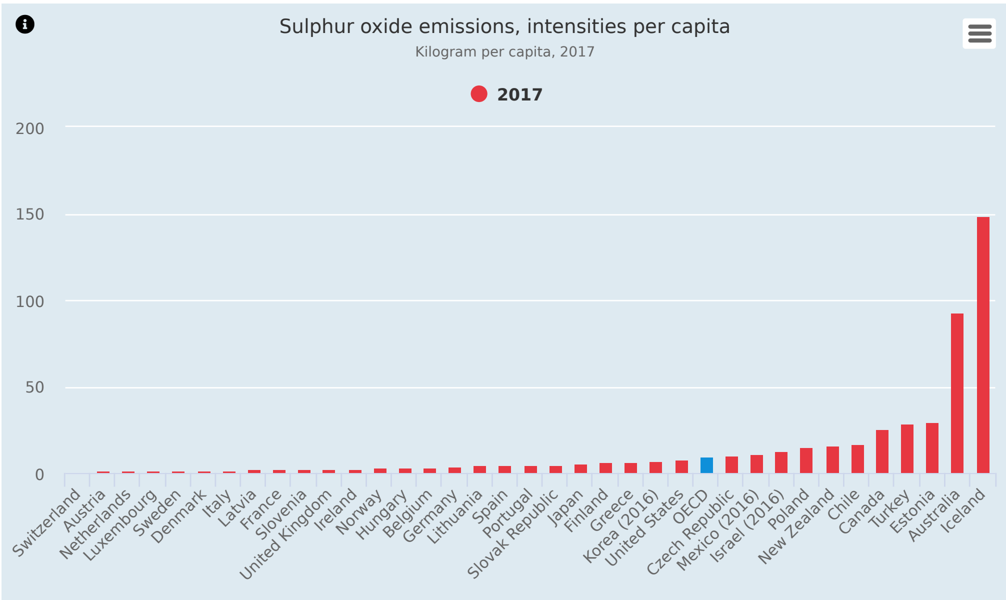

Fine particulates emission (PM2.5), intensities per unit of GDP
Kilogram per thousand USD, 2017
2017
1.25
1
0.75
0.5
0.25
0
Switzerland
Netherlands
Luxembourg
Germany
Ireland
Austria
United Kingdom
Sweden
Korea (2016)
Belgium
France
Spain
Denmark
Iceland
Italy
Finland
Norway
Greece
Slovak Republic
Lithuania
Czech Republic
Poland
Portugal
Slovenia
Hungary
Turkey
United States
Estonia
Mexico (2016)
Chile
Latvia
Canada


Fine particulates emissions (PM2.5), intensities per capita
Kilogram per capita, 2017
2017
50
40
30
20
10
0
Switzerland
Netherlands
Germany
United Kingdom
Korea (2016)
Austria
Belgium
Sweden
Spain
Luxembourg
Ireland
France
Greece
Italy
Lithuania
Finland
Slovak Republic
Denmark
Czech Republic
Iceland
Poland
Turkey
Portugal
Mexico (2016)
Hungary
Norway
Slovenia
Estonia
Chile
Latvia
United States
Canada


Nitrogen oxide emissions, intensities per unit of GDP
Kilogram per thousand USD, 2017
2017
2.5
2
1.5
1
0.5
0
Switzerland
Sweden
Japan
Netherlands
France
Germany
Ireland
United Kingdom
Italy
Luxembourg
Belgium
Austria
Israel (2016)
Turkey
Slovak Republic
Denmark
Chile
Hungary
Spain
Czech Republic
Norway
OECD
Slovenia
United States
Finland
Portugal
Lithuania
Korea (2016)
Latvia
Poland
Estonia
Mexico (2016)
New Zealand
Greece
Canada
Iceland
Australia


Nitrogen oxide emissions, intensities per capita
Kilogram per capita, 2017
2017
125
100
75
50
25
0
Switzerland
Turkey
Chile
Japan
Italy
Slovak Republic
Hungary
France
Sweden
United Kingdom
Israel (2016)
Netherlands
Germany
Belgium
Czech Republic
Mexico (2016)
Spain
Austria
Portugal
Slovenia
Lithuania
Latvia
Denmark
Poland
OECD
Finland
Ireland
Korea (2016)
Estonia
Greece
United States
Norway
Luxembourg
New Zealand
Canada
Iceland
Australia





Comparability and interpretation

International data on emissions are available for almost all OECD countries. The details of estimation methods for emissions such as emission factors and reliability, extent of sources and pollutants included in estimation, etc., may differ from one country to another. The high emission levels of SO_X for Iceland are due to H_2S emissions from geothermal power plants (expressed as SO_2). The high emission levels of $PM_{2.5}$ for Canada is due to dust from construction operations and unpaved and paved roads (around 60% of total emissions in 2017). OECD totals do not include Chile and Mexico.

For further details see the metadata in the source databases listed under *Sources* below.

Air quality and health

Key messages

- Despite some progress, **exposure to fine particulate matter** ($PM_{2.5}$) remains high. Mean population exposure to $PM_{2.5}$ has decreased in all OECD countries, however exposure remains above the WHO guideline of 10 µg/m^3 in two out of three members.
- **Premature deaths due to $PM_{2.5}$ pollution** have increased worldwide whereas they dropped in the OECD area. East European countries are the most affected (Czech Republic, Hungary, Lithuania, Latvia, Poland, Slovak Republic), with more than 500 estimated deaths per million inhabitants.
- The **welfare costs** associated to $PM_{2.5}$ pollution represent about 3% of GDP equivalent on average in the OECD area, compared to about 4% worldwide. They have decreased in almost all OECD countries while they have increased in the rest of the world.

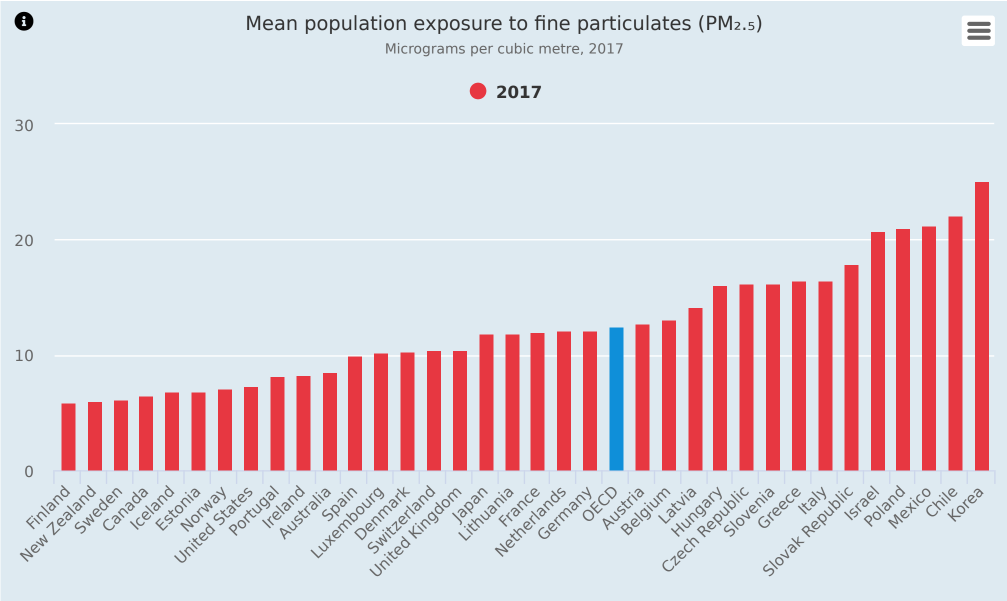
Main trends and recent developments

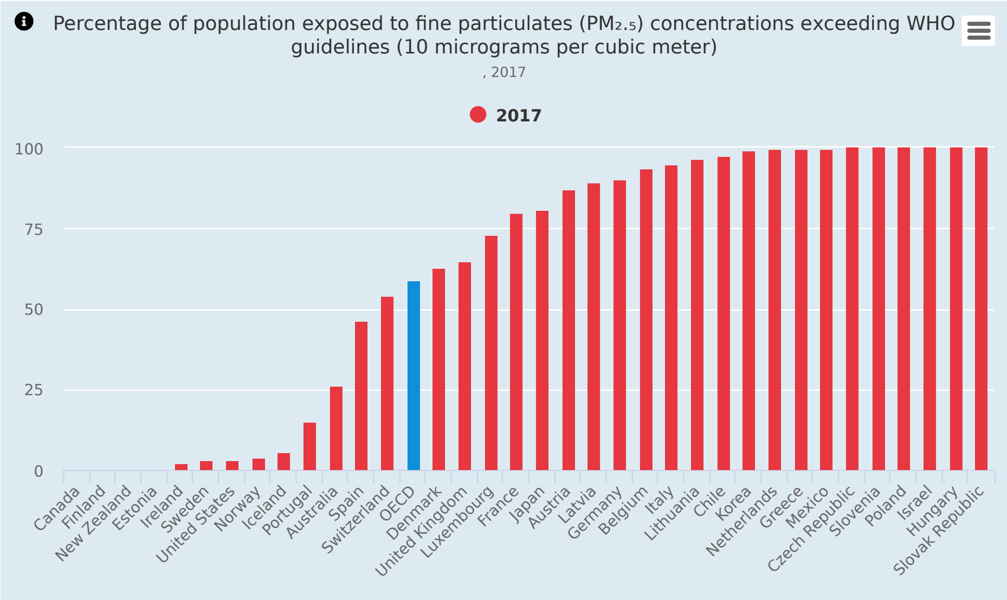
Despite some progress, **exposure to fine particulate matter** ($PM_{2.5}$) remains high. Mean population exposure to fine particulate matter has decreased in all OECD countries; however, two out of three still exceed the WHO guideline of 10 µg/m^3. Worldwide, population **exposure to air pollution** has on average recently stabilised but is particularly severe in some countries in Asia, the Middle East and Africa.

Premature deaths due to $PM_{2.5}$ pollution have increased worldwide whereas they dropped in the OECD area. East European countries are the most affected (Czech Republic, Hungary, Lithuania, Latvia, Poland, Slovak Republic), with more than 500 estimated deaths per million inhabitants.

In OECD countries, **associated welfare costs of premature deaths due to $PM_{2.5}$ pollution**, represent on average about 3% of GDP equivalent, compared to about 4% worldwide. They have decreased in almost all OECD countries while they have increased in the rest of the world. The welfare costs associated to $PM_{2.5}$ pollution are higher in Europe than in other OECD regions.

Indicators


Mean population exposure to fine particulates (PM2.5)
Micrograms per cubic metre, 2017
2017
30
20
10
0
Finland
New Zealand
Sweden
Canada
Iceland
Estonia
Norway
United States
Portugal
Ireland
Australia
Spain
Luxembourg
Denmark
Switzerland
United Kingdom
Japan
Lithuania
France
Netherlands
Germany
OECD
Austria
Belgium
Latvia
Hungary
Czech Republic
Slovenia
Greece
Italy
Slovak Republic
Israel
Poland
Mexico
Chile
Korea


Percentage of population exposed to fine particulates (PM2.5) concentrations exceeding WHO guidelines (10 micrograms per cubic meter)
, 2017
2017
100
75
50
25
0
Canada
Finland
New Zealand
Estonia
Ireland
Sweden
United States
Norway
Iceland
Portugal
Australia
Spain
Switzerland
OECD
Denmark
United Kingdom
Luxembourg
France
Japan
Austria
Latvia
Germany
Belgium
Italy
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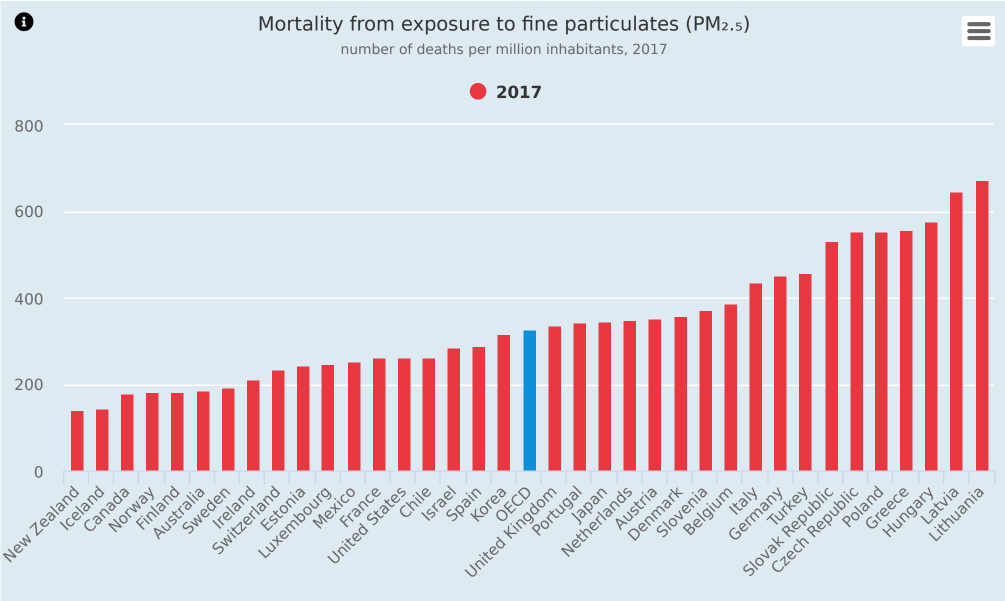
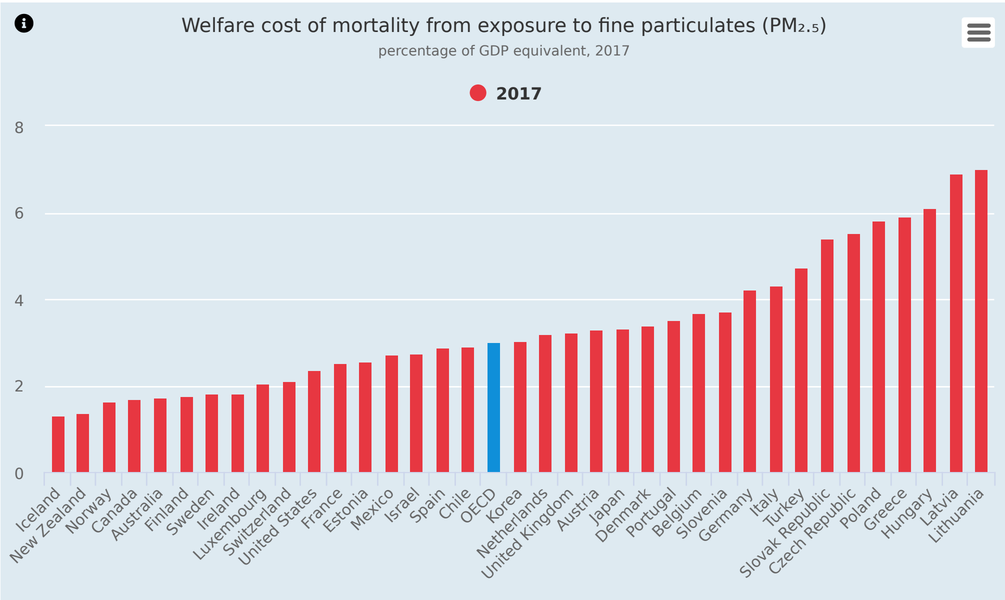
Israel
Hungary
Slovak Republic





Comparability and interpretation

International data on particulate emissions are available for many but not all OECD countries. The estimation methods for emissions, the extent of sources and particles included in estimation, may differ from one country to another.

Exposure indicators provide only a partial view of air pollution severity and consequences aggregated across the entire population. Importantly, there is generally no “safe level” of exposure for many pollutants. Even where guideline or target exposures are met, substantial public health and economic benefits can be realised through further improvements in air quality. Better estimates are needed for exposure to both outdoor and indoor air pollution. Particular attention should be paid to exposure of sensitive groups and quantitative impact on human health (and associated distributional and equity issues). Although many important gaps remain, available data are improving.

For further details see the metadata in the source databases listed under *Sources* below.

Taxes relevant for air pollution

Key messages

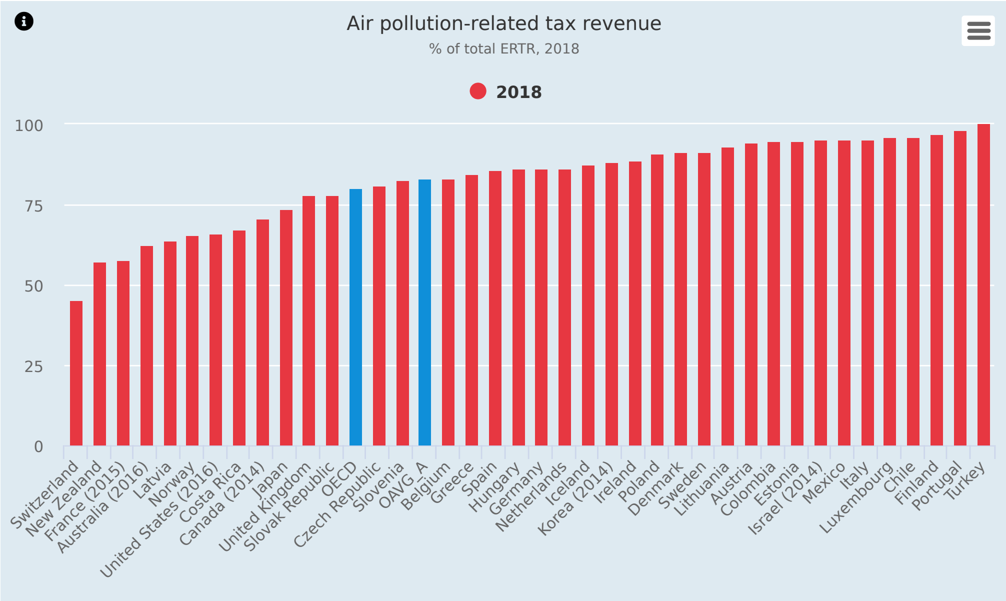
- In the OECD area, **air pollution-related taxes** raised USD 642 billion in 2018, representing a large percentage of environmentally related tax revenue (80%).
- Revenue from air pollution-related taxes is raised primarily from taxing **energy** and **transport**, while pollution and resource tax bases play a minor role in generating revenue.
- Overall, the share of **environmentally related tax revenue** (ERTR) continues to decline in OECD countries, amounting to 5.3% of total tax revenue in 2018, down from 6.1% in early 2000s. Compared to GDP, ERTR is also decreasing and reached 1.5% of GDP in 2018.

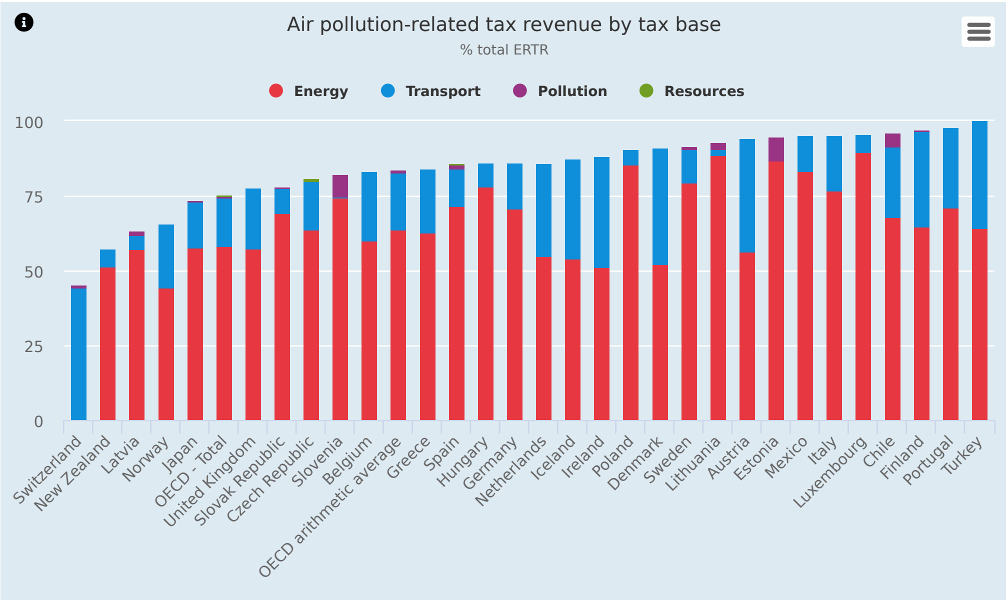
Main trends and recent developments

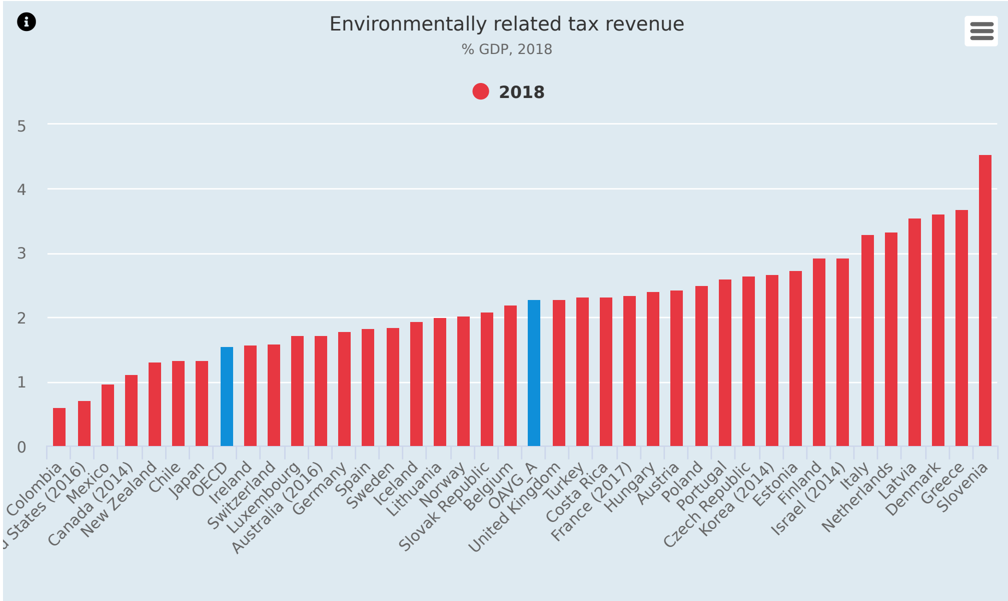
In the OECD area, air pollution taxes raised USD 642 billion in 2018, representing a large percentage of environmentally related tax revenue (80%). This is down from 85% in 2000. The revenue from taxes directed at air pollution is raised from taxing energy (77%), in particular motor fuels, and transport (21%), while pollution and resource tax bases play a minor role in generating revenue.

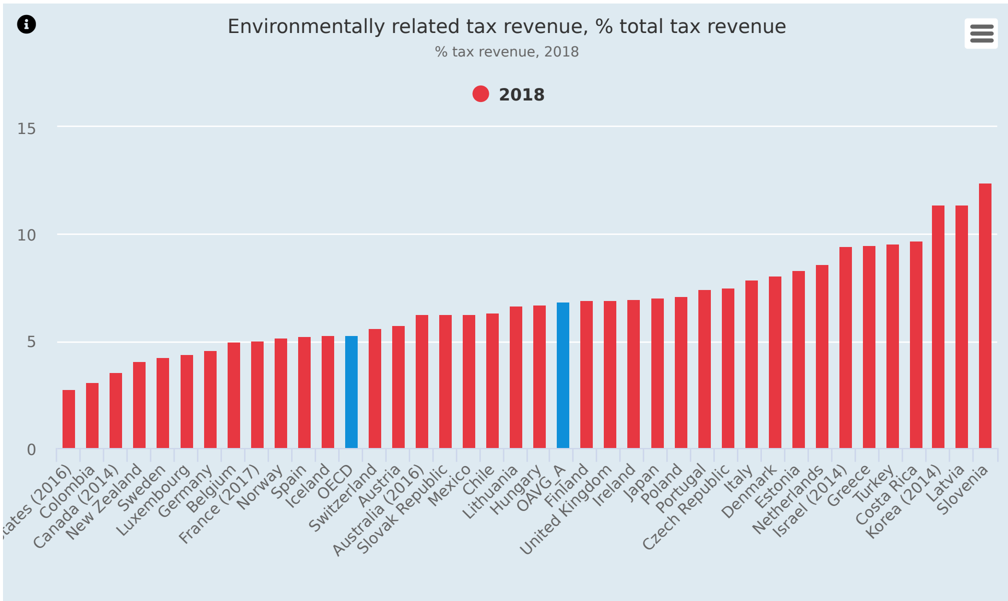
Overall, the share of environmentally related tax revenue (ERTR) continues to decline in OECD countries, amounting to 5.3% of total tax revenue in 2018, down from 6.1% in early 2000s. Compared to GDP, ERTR is also decreasing and reached 1.5% of GDP in 2018. The decreasing trend is a combination of factors, namely, that tax rates are typically defined in physical units (e.g. per litre) and hence are set in nominal terms. Without inflation adjustment, these rates decrease in real terms over time. While countries such as Denmark, the Netherlands and Sweden have implemented such adjustments, most OECD countries do not yet apply inflation adjustments to environmentally related taxes. Another factor contributing to this trend is the increase in crude oil prices up until mid-2014, which triggered substitution away from motor fuel use, also making adjustments in nominal tax rates on motor fuels politically difficult. Yet some countries, such as Slovenia, Costa Rica, Turkey and Estonia strengthened the role of environmentally related taxes and have tripled their share of tax revenue since 2000.

Indicators


Air pollution-related tax revenue
% of total ERTR, 2018
2018
100
75
50
25
0
Switzerland
New Zealand
France (2015)
Australia (2016)
Latvia
Norway
United States (2016)
Costa Rica
Canada (2014)
Japan
United Kingdom
Slovak Republic
OECD
Czech Republic
Slovenia
OAVG_A
Belgium
Greece
Spain
Hungary
Germany
Netherlands
Iceland
Korea (2014)
Ireland
Poland
Denmark
Sweden
Lithuania
Austria
Colombia
Estonia
Israel (2014)
Mexico
Italy
Luxembourg
Chile
Finland
Portugal
Turkey


Air pollution-related tax revenue by tax base
% total ERTR
Energy
Transport
Pollution
Resources
100
75
50
25
0
Switzerland
New Zealand
Latvia
Norway
Japan
OECD - Total
United Kingdom
Slovak Republic
Czech Republic
Slovenia
Belgium
OECD arithmetic average
Greece
Spain
Hungary
Germany
Netherlands
Iceland
Ireland
Poland
Denmark
Sweden
Lithuania
Austria
Estonia
Mexico
Italy
Luxembourg
Chile
Finland
Portugal
Turkey





Comparability and interpretation

The indicators on environmentally related taxes should not be used to assess the "environmental friendliness" of the tax systems. For such analysis, additional information, describing the economic and taxation structure of each country, is required. Moreover, a number of environmentally related taxes can have important environmental impacts even if they raise little (or no) revenue. In addition, revenue from fees and charges, and from royalties related to resource management, is not included.

Comparisons of ERTRs in OECD countries provide a useful starting point for analysing the impact of environmental taxation, however, comparing only the levels of revenue does not provide the full picture of a country's environmental policy, as it does not provide information on the levels of tax rates or the exemptions applied. Other parts of the OECD PINE database, including information on tax rates and exemptions, allows deeper assessment of the environmental impacts of these taxes. In addition, governments may choose to implement environmental policy using a range of other instruments, including fees and charges, expenditures (both direct and subsidies) and regulation, some of which are also detailed in the PINE database (see *http://oe.cd/pine* for information on the use of alternative instruments in countries).

For further details see the metadata in the source databases listed under *Data sources* below.

Glossary

Air pollution related-tax revenue	Revenue raised from taxes and auctioning of tradable permits directed at air pollution. These include specific taxes on i) energy products for road transport; ii) taxes on the use of roads and vehicles; iii) specific taxes on SO_x or NO_x pollution, revenue from auctioning tradable allowances and iv) resource extraction directly impacting emissions of air pollutants (e.g. dust and gravel taxes on mining). The information on taxes and the associated tax revenue is extracted from the OECD Policy Instruments for the Environment (PINE) database (*http://oe.cd/pine*). The PINE database, contains quantitative and qualitative information on over 3500 policy instruments in 110 countries worldwide. Policy instruments are tagged into 13 environmental domains that represent the focal issues (environmental externalities). Instruments can have both a direct and an indirect effect on several environmental domains; however, only the domain to which the instrument has a direct effect is considered. For more details, see the metadata to the OECD *Environmentally related tax revenue dataset.*
Fine particulates ($PM_{2.5}$) emissions	National man-made emissions only. Emissions from international transport (aviation, marine) are excluded. Fine particulates ($PM_{2.5}$) refer to suspended particulates smaller than 2.5 microns in diameter that are capable of penetrating very deep into the respiratory tract and causing severe health effects. Fine particulates are potentially more toxic than small particulates (PM_{10}) and may include heavy metals and toxic organic substances.
Mean population exposure to fine particulates ($PM_{2.5}$)	Expressed as the mass of $PM_{2.5}$ per cubic metre. Calculated as the mean annual outdoor $PM_{2.5}$ concentration weighted by population living in the relevant area, that is, the concentration level, expressed in µg/m^3, to which a typical resident is exposed throughout a year. The guideline set by the World Health Organization (WHO) for $PM_{2.5}$ is that annual mean concentrations should not exceed 10 micrograms per cubic meter, representing the lower range over which adverse health effects have been observed. The WHO has also recommended guideline values for emissions of $PM_{2.5}$ from burning fuels in households.
Mortality from exposure to fine particulates ($PM_{2.5}$)	Estimated number of premature deaths attributed to exposure to environmental risks, expressed per million inhabitants.
Percentage of population exposed to more than 10 micrograms per cubic meter	The proportion of people living in areas with annual $PM_{2.5}$ concentrations exceeding the WHO Air Quality Guideline value of 10 micrograms per cubic meter.
Nitrogen oxide (NO_x) emissions	National man-made emissions only, expressed as NO2. Emissions from international transport (aviation, marine) are excluded.
Sulphur oxide (SO_x) emissions	National man -made emissions only, expressed as SO2. Emissions from international transport (aviation, marine) are excluded.
Welfare cost of mortality from exposure to fine particulates ($PM_{2.5}$)	Welfare costs are expressed in millions constant 2010 USD using PPP, and as percentage points of GDP equivalent. Cost estimates represent only the cost of premature mortalities. They are calculated using estimates of the "Value of a Statistical Life" (VSL) and the number of premature deaths attributable to exposure to fine particulates. They exclude any morbidity impacts (labour productivity losses, treatment costs and willingness to pay to avoid pain and suffering from illness). They also exclude impacts other than those on human health (e.g. on built structures, agricultural productivity, ecosystem health). The total social cost of the exposure to fine particulates is thus greater than the cost of mortalities presented here. Yet the available evidence suggests that mortality costs account for the bulk of the total costs to society. Finally, VSL also captures non-market values that are unrelated to expenditures and therefore not an integral part of the calculation of GDP. Consequently, the cost estimates are compared with GDP only for illustration.

Data sources

OECD, "Air and climate: Air emissions by source", *OECD Environment Statistics* (database), *https://doi.org/10.1787/data-00598-en*.

OECD, "Air quality and health: Mortality and welfare cost from exposure to air pollution", *OECD Environment Statistics* (database), *https://doi.org/10.1787/c14fb169-en*.

OECD, "Environmentally related tax revenue", *OECD Environment Statistics* (database), *http://stats.oecd.org/Index.aspx?DataSetCode=ERTR*

OECD, “Policy Instruments for the Environment (PINE)” (database), *http://oe.cd/pine*

References and further reading

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Mackie, A., I. Haščič and M. Cárdenas Rodríguez (2016), "Population Exposure to Fine Particles: Methodology and Results for OECD and G20 Countries", OECD Green Growth Papers, No. 2016/02, OECD Publishing, Paris. *http://dx.doi.org/10.1787/5jlsqs8g1t9r-en*.

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Roy, R. and N. Braathen (2017), "The Rising Cost of Ambient Air Pollution thus far in the 21st Century: Results from the BRIICS and the OECD Countries", *OECD Environment Working Papers*, No. 124, OECD Publishing, Paris, *https://doi.org/10.1787/d1b2b844-en*.

United Nations Framework Convention on Climate Change, *https://unfccc.int/*.

UNECE, “Convention on Long-Range Transboundary Air Pollution”, *https://www.unece.org/env/lrtap/multi_h1.html*.

WHO Guidelines for Air Quality, *https://www.who.int/airpollution/guidelines/en/*.

Citation

OECD, "Environment at a Glance: Air quality", *Environment at a Glance: Indicators*, *http://www.oecd.org/environment/env-at-a-glance*.

Metadata, Legal and Rights

https://doi.org/10.1787/ac4b8b89-en