



Climate change

Context

Issues at stake

Emissions of greenhouse gases (GHGs) from human activities disturb the radiative energy balance of the earth-atmosphere system. They exacerbate the natural greenhouse effect, leading to temperature changes and other disruption of the earth's climate. Land use changes and forestry also play a role by altering the amount of greenhouse gases captured or released by carbon sinks. **Carbon dioxide** (CO₂) from the combustion of fossil fuels and deforestation is a major contributor to greenhouse gases. CO₂ makes up the largest share of greenhouse gases and thus is a key factor in countries' ability to mitigate climate change.

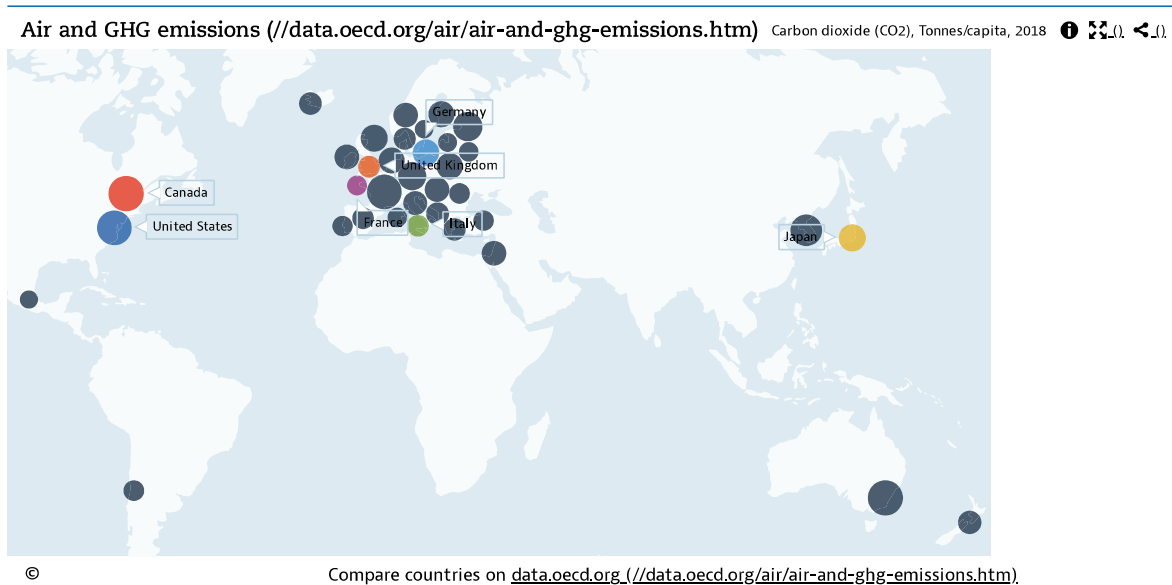
Climate change is threatening ecosystems and biodiversity, human settlements and food production, and the frequency and scale of extreme weather events, with significant consequences for human well-being, socio-economic activities and economic output.

Policy challenges

The main challenges are to **mitigate GHG emissions** and **stabilise GHG concentrations** in the atmosphere at a level that would limit dangerous interference with the climate system, and to adapt to and manage risks from climate change.

- This implies implementing national and international low-carbon strategies and further decoupling GHG emissions from economic growth. It also implies increasing the share of **renewable energy** sources in the supply mix, and reducing **energy intensity** by adopting energy-efficient production processes and increasing the energy efficiency of consumer goods and services.
- Ensuring a proper mix of market-based instruments, for example by promoting **carbon pricing, environmentally-related taxation** and removing government subsidies and other **support for fossil fuels**, plays an important role in this transition.

- With increasing trade flows, interdependent global value chains and the relocation of carbon-intensive production abroad, reductions in domestic emissions can be partially or wholly offset elsewhere in the world. Domestic mitigation efforts must thus be placed in a global context and must build on a good understanding of carbon flows associated with **international trade and final domestic demand**.
- Beyond these steps, governments must **align policies** across a diverse range of non-climate areas and consider synergies between emissions reduction and broader well-being objectives.



Measuring progress and performance

Environmental performance can be assessed against domestic objectives and international goals and commitments. Tackling **climate change** and underlying drivers is part of the 2030 Agenda for Sustainable Development adopted in September 2015 under *Goal 13: "Take urgent action to combat climate change and its impacts"*; *Goal 12: "Ensure sustainable consumption and production patterns"*; *Goal 9: "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation"* and *Goal 7: "Ensure access to affordable, reliable, sustainable and modern energy for all"*.

The main international agreement is the *United Nations Framework Convention on Climate Change* (1992) which is the basis of:

- The *Kyoto Protocol* (1997), setting internationally binding and differentiated **emission reduction** targets for six GHGs **for 2008-12**. It has been ratified by 177 parties, including all but two OECD countries, and has been in force since 2005. 37 industrialised countries and the European Union committed to reduce GHG emissions by an average of 5% below 1990 levels. The "Doha Amendment to the

Kyoto Protocol" (2012), includes **new commitments for the period 2013-20** and a revised list of GHGs. Parties committed to reduce GHG emissions by an average of at least 18% below 1990 levels over 2013-20. The amendment is not yet in force.

- The *Paris Agreement* (2015) builds upon the Convention and strengthens the global response to the threat of climate change. The objective is to keep the average global temperature rise this century well below 2 degrees Celsius and as close as possible to 1.5 degrees Celsius above pre-industrial levels. Parties have expressed their commitments to 2025 or 2030 through nationally determined contributions (NDCs), including a regular report on their emissions and implementation efforts.

In September 2009, Leaders of the Group of Twenty (G20) economies committed to *"phase out and rationalize over the medium term inefficient fossil fuel subsidies while providing targeted support for the poorest."* To follow up on this commitment, G20 members have since engaged in a voluntary process of periodically reporting on their fossil-fuel subsidies.

Indicator groups

- Greenhouse gas emissions: levels, intensities, composition by source.
- Production-based and demand-based (carbon footprint) CO₂ emissions from energy use: levels, intensities, productivity.
- Energy use: energy supply, energy mix by source, intensities, share or renewables in electricity production.
- Fossil-fuel support: fossil fuel subsidies and other support measures.

Greenhouse gas emissions

Key messages

- **Global GHG emissions have increased** by 1.5 fold since 1990, driven by economic growth and increasing fossil energy use.
- In almost all **OECD countries** however, **emissions have been declining** in recent years partly due to the economic slowdown following the 2008 financial crisis, but also to strengthened climate policies.
- The rate of progress in reducing emissions varies significantly across individual OECD countries. **Progress overall is insufficient** and **GHG emissions are expected to rise again** due to recent increase of energy use and CO₂-related emissions.

Main trends and recent developments

Despite some progress achieved in decoupling GHG emissions from GDP growth, emissions are still growing in many countries. **Global GHG emissions have increased** by 1.5 fold since 1990, driven by economic growth and increasing fossil energy use in developing countries. Historically, OECD countries emitted the bulk of global GHGs, but the share of BRIICS countries in global emissions has been increasing to over 40% since 2010. CO₂ determines the overall trend. Together with CH₄ and N₂O, it accounts for about 98% of GHG emissions (IEA, 2019).

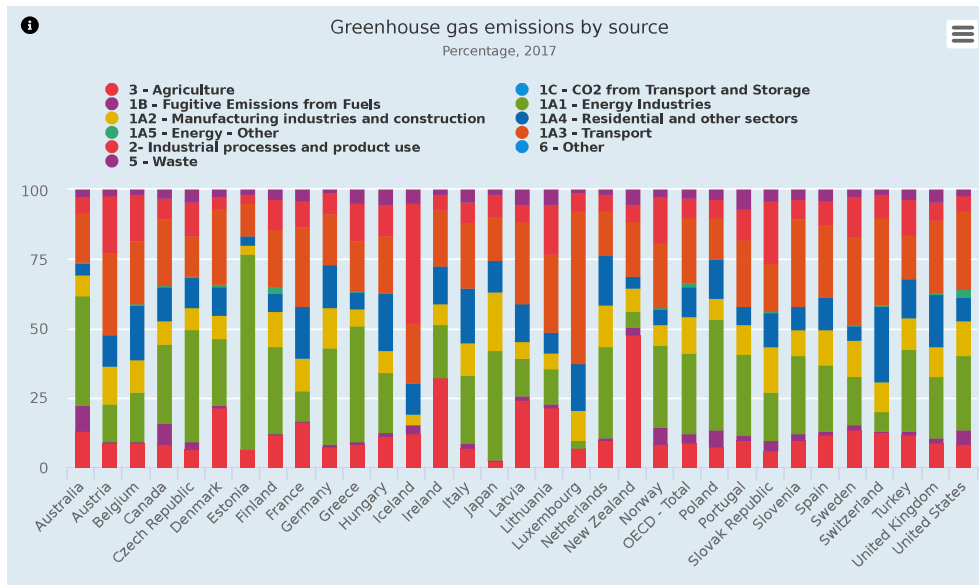
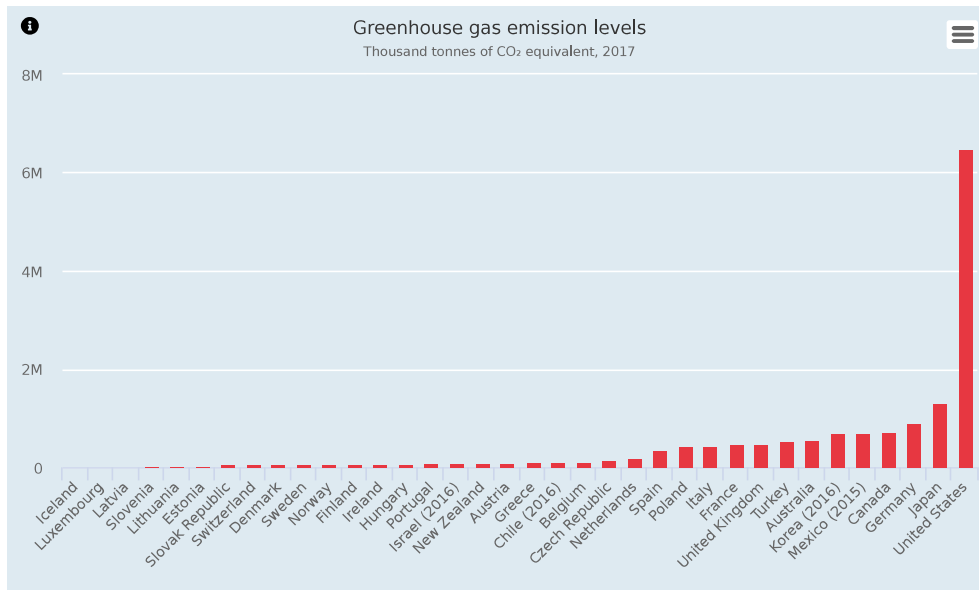
Emissions of OECD countries peaked in 2007, have fallen over the past 10 years (-9%) and now seem to be stabilising. Emissions have been declining in almost all OECD countries, partly due to a slowdown in economic activity following the 2008 economic crisis, but also to strengthened climate policies and changing patterns of energy consumption. **Emission intensities** per unit of GDP and per capita decreased since 2005 in almost all OECD countries, revealing a strong overall decoupling from economic growth. Under the Kyoto Protocol, most OECD countries met their emission **reduction commitments** for the first period 2008-12 and are on track to meet their 2020 target.

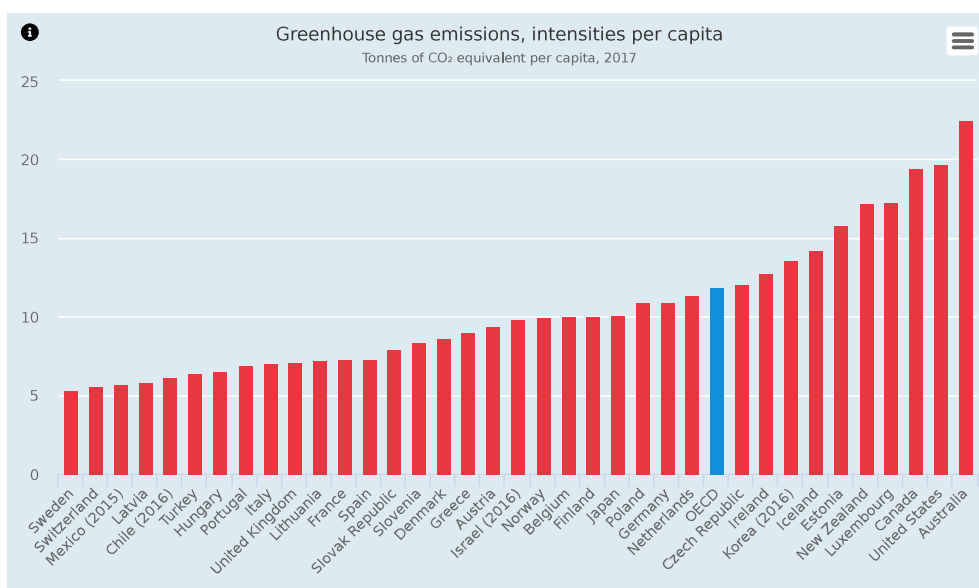
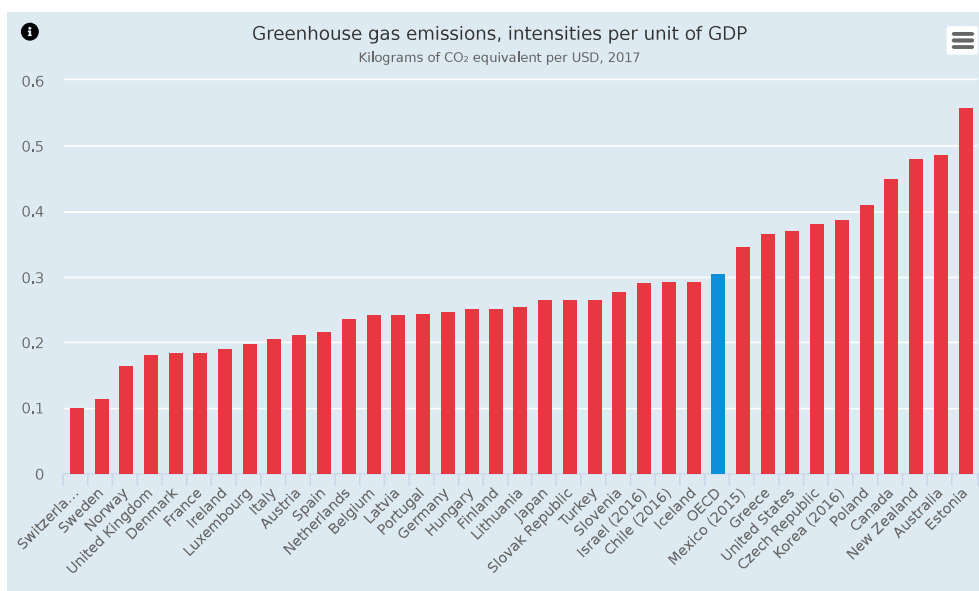
Overall **progress is** however **insufficient**. GHG emissions are expected to rise again due to recent increase of energy use and CO₂-related emissions. Climate change is increasingly impacting people's lives, national economies, biodiversity and ecosystems, including the ocean.

On average, **energy industries** generate 29% of GHG emissions in OECD countries, followed by **transport** (24%), **manufacturing industries** (13%), **agriculture**, (9%), **industrial processes** (7%) and **waste** (3%). While the share of emissions from energy industries have decreased since 2005, those from transport and agriculture increased. In some countries such as Luxembourg, Slovenia, Sweden and Switzerland, emissions from transport account for more than 30% of total emissions, while in New Zealand and Ireland, agriculture is the first GHG emitter (above 30%).

Individual OECD countries' rates of progress vary significantly. This partly reflects different national circumstances, such as composition and rate of economic growth, population growth, energy resource endowment, and the extent to which the countries have taken steps to reduce emissions from various sources.

Indicators





Comparability and interpretation

Data on GHG emissions display a good level of comparability. The high per-GDP emissions of Estonia result from the use of oil shale for electricity generation (oil shale has a high carbon emission factor). The high per-capita emissions of Luxembourg result from a high number of cross-border workers and the lower taxation of road fuels compared to neighbouring countries, which attracts drivers to refuel in the country.

Reductions in national emissions may also be the result of offshoring domestic production (and the associated emissions). Evidence of decoupling based on domestic emissions per unit of GDP or per capita, therefore, may reveal only part of the story.

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

CO₂ emissions from energy use

Key messages

- Despite a slowdown in the OECD area, **global CO₂ emissions continued to grow**. Very few countries have managed to reduce emission levels in absolute terms.
- Today, **OECD countries emit about 35% of global CO₂ emissions** from energy use, compared to more than 50% in 1990.
- A more nuanced picture emerges when emissions are considered from the perspective of final demand. The carbon footprint of OECD countries is generally higher than emissions from domestic production.

Main trends and recent developments

CO₂ from the combustion of fossil fuels and biomass accounts for about 90% of total CO₂ emissions and determines overall GHG emissions trend. After three years of stability, global energy-related CO₂ emissions picked-up again and reached a record high of 32.8 billion tonnes in 2017. Emissions are still growing in many countries mainly due to increases in the transport and the energy sectors.

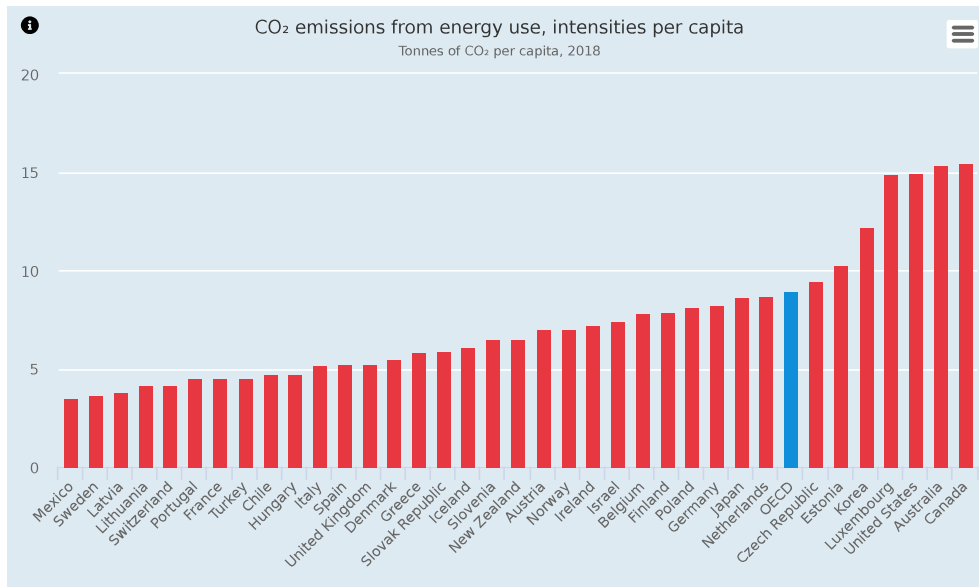
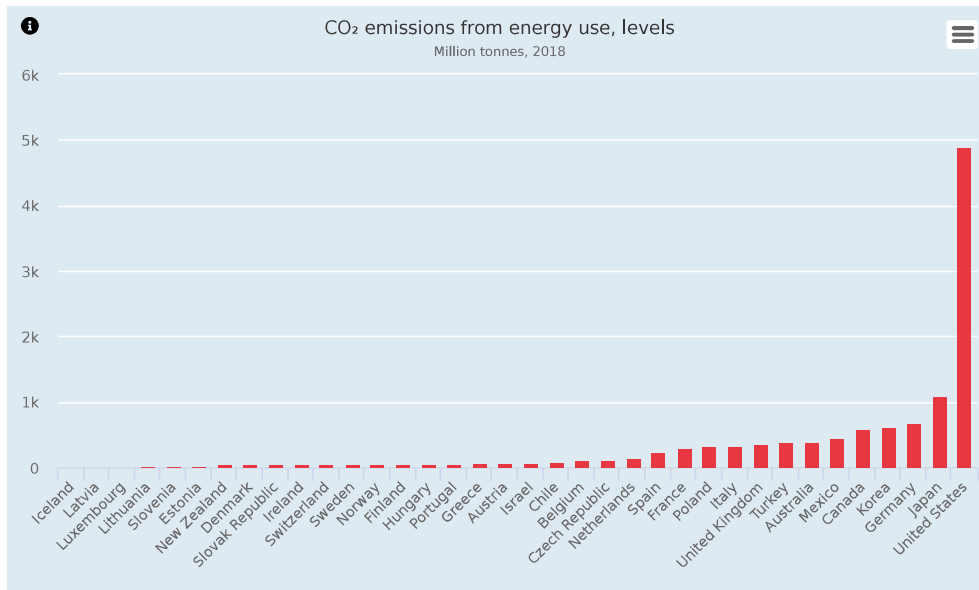
Since 2000, OECD **energy-related CO₂ emissions** have decreased while **economic growth** has been positive. This is due to structural changes in industry and energy supply and improvements in energy efficiency in production processes. Most countries have achieved only a relative decoupling between emissions and economic growth, although some managed to reduce emission levels in absolute terms. While decreasing in OECD America and OECD Europe, energy-related CO₂ emissions continue to grow in the OECD Asia-Oceania region. This is due to energy supply and consumption patterns and trends, often combined with relatively low energy prices.

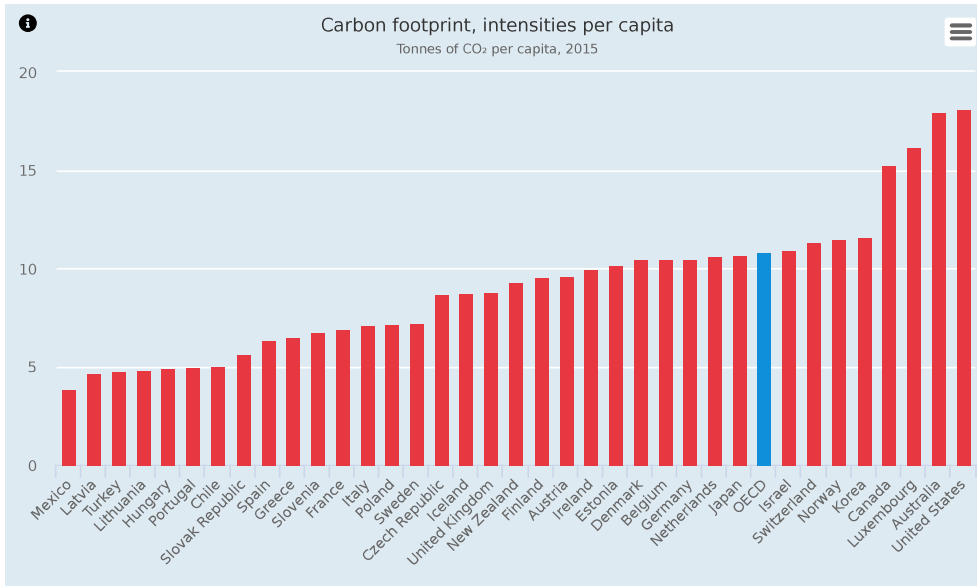
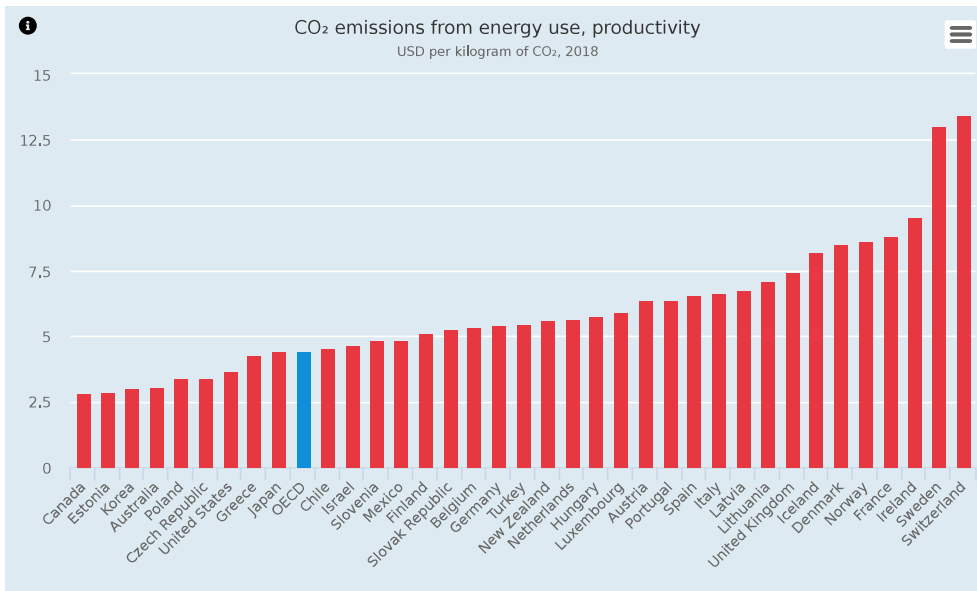
Since 1990, energy-related CO₂ emissions have grown more slowly in OECD countries as a group than they have worldwide. Today, OECD countries emit about 35% of global CO₂ emissions from energy use, compared to more than 50% in 1990.

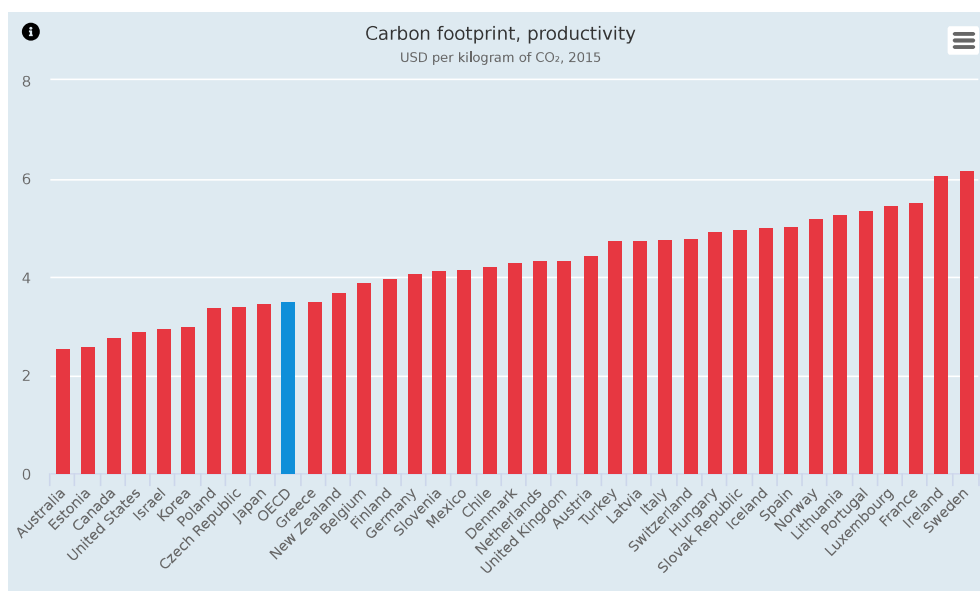
On a per-capita basis, OECD countries still emit far more CO₂ than most other world regions, with 8.9 tonnes of CO₂ emitted per capita on average in OECD countries in 2018, compared to 4.3 tonnes in the rest of the world. Individual OECD countries' rates of progress vary significantly, regardless of whether they are considered in absolute numbers, per capita amounts or per unit of GDP.

A more nuanced picture emerges when emissions are considered from the perspective of final demand. The **carbon footprint** of OECD countries is generally higher than emissions from domestic production.

Indicators







Comparability and interpretation

The CO₂ emission estimates are affected by the quality of the underlying energy data, but in general the comparability across countries is quite good. The low CO₂ emissions productivity of Estonia result from the use of oil shale for electricity generation. Oil shale has a high-carbon emission factor. The high per-capita emissions of Luxembourg result from the lower taxation of road fuels compared to neighbouring countries, which attracts drivers to refuel in the country.

Carbon productivity indicators inform about the relative decoupling between economic activity and carbon emissions into the atmosphere. They provide insight into how much carbon productivity has improved. They also measure how much of the improvement is due to domestic policies and how much to displacement or substitution effects. The demand perspective helps explain production-based trends.

Reductions in national emissions can also be achieved by offshoring domestic production and, thus, the related emissions. Evidence of decoupling based on domestic emissions, therefore, may reveal only part of the story.

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

Energy use

Key messages

- OECD countries continue to rely on **fossil fuels** for about 80% of their energy; **renewables** still play only a relatively minor role in energy mixes.
- **Energy intensity** decreased for OECD countries overall, but while some decoupling of environmental effects from growth in energy use has been achieved, results to date are insufficient to effectively reduce air and GHG emissions from energy use.

Main trends and recent developments

The **supply structure** varies considerably among countries. It is influenced by demand from industry, transport and households, by national energy policies and by national and international energy prices. Developments in TPES were accompanied by changes in the fuel mix. Since 2000, OECD countries' reliance on fossil fuels declined although it remains close to 80%. The shares of solid fuels and oil slightly fell, while those of natural gas and renewable energy rose. Biofuels and waste, followed by hydro represent the largest renewable sources.

In the 1990s and 2000s, **energy intensity** per unit of GDP decreased for OECD countries overall as a consequence of structural changes in the economy and energy conservation measures, and, since 2009, as a consequence of the slowdown in economic activity following the economic crisis. In some countries, the decrease was due to the transfer of energy-intensive industries to other countries. Such outsourcing may increase pressures on the global environment if less energy efficient techniques are involved. Progress in per capita terms has been slower, reflecting overall trends in energy supply and energy demand for transport.

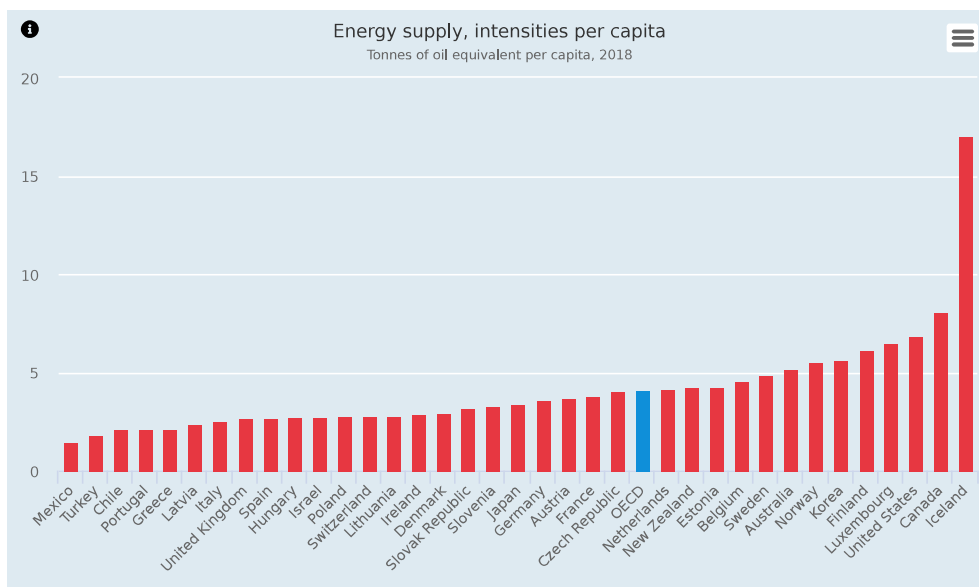
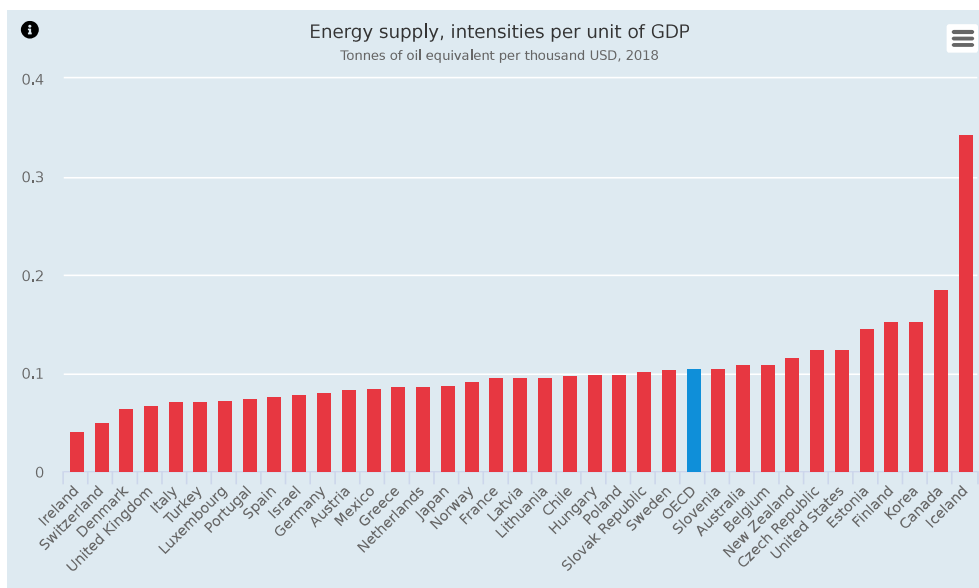
Variations in **energy intensity** among OECD countries are wide. They depend on national economic structure and income, geography, energy policies and prices, and countries' endowment in different types of energy resources. While some decoupling of environmental effects from growth in energy use has been achieved, results to date are insufficient to effectively reduce air and GHG emissions from energy use. Relative decoupling between TPES and GDP is occurring in all regions of the OECD, however, in OECD Asia-Oceania, it began much later (2003) than in OECD Europe and OECD America (1990).

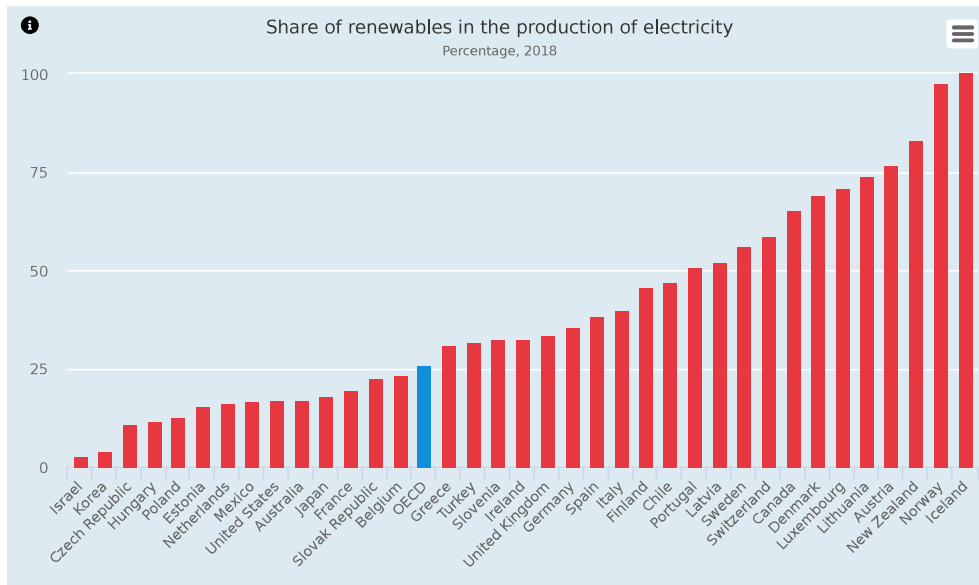
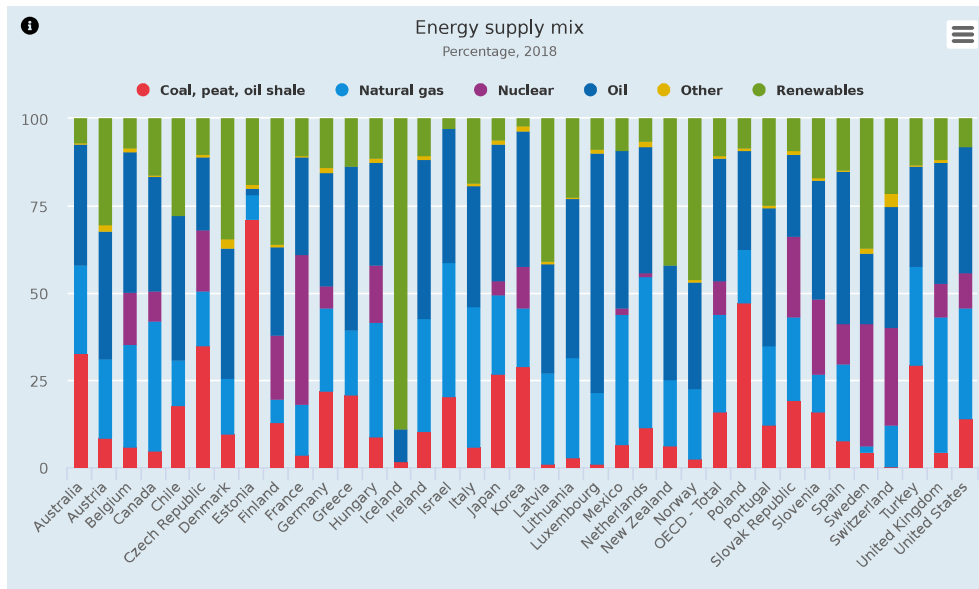
TPES per capita has declined by 10% on average across the OECD, with about two thirds of countries reducing their TPES intensity per capita. The highest decrease occurred in the United Kingdom. However, intensities per capita have risen in several Eastern European countries, Turkey and Iceland.

Renewables with the lowest shares in TPES (i.e. solar, wind, liquid biofuels and biogases) exhibited the highest growth rates over the last decade, now making up almost a quarter of electricity production. The growth in renewables was not affected by

the economic crisis and was driven by OECD Europe, mostly due to the implementation of policies that promote renewable energy. Europe's energy mix also has the lowest share of fossil fuels and oil among OECD regions.

Indicators





Comparability and interpretation

Data quality is not homogeneous for all countries. In some countries, data are based on secondary sources, and where incomplete, estimates were made by the IEA. In general, data are likely to be more accurate for production and trade than for international bunkers or stock changes; and statistics for biofuels and waste are less accurate than those for traditional commercial energy data. The high values for Iceland are due to a significant increase in the production of hydro- and geothermal power mainly used in aluminium smelters. The supply structure, which may vary considerably among countries is dependent on final demands by industry, transport and the household sector, and is highly influenced by national energy policies and endowments in energy resources.

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

Fossil fuel subsidies and other support measures

Key messages

- OECD countries provided around USD 80 billion in **support for fossil fuels** in 2017, 26% lower than the highest level in 2013. Progress in reducing subsidies and government support for fossil-fuel production and use has slowed down since 2015.
- **Hard-coal industry** in Western Europe has been phased out and efforts to end state aid to coal-fired power generation in the European Union are continuing.
- The **oil and gas** sector continues to benefit from government incentives in several countries, mostly through tax provisions that provide preferential treatment for cost recovery.

Main trends and recent developments

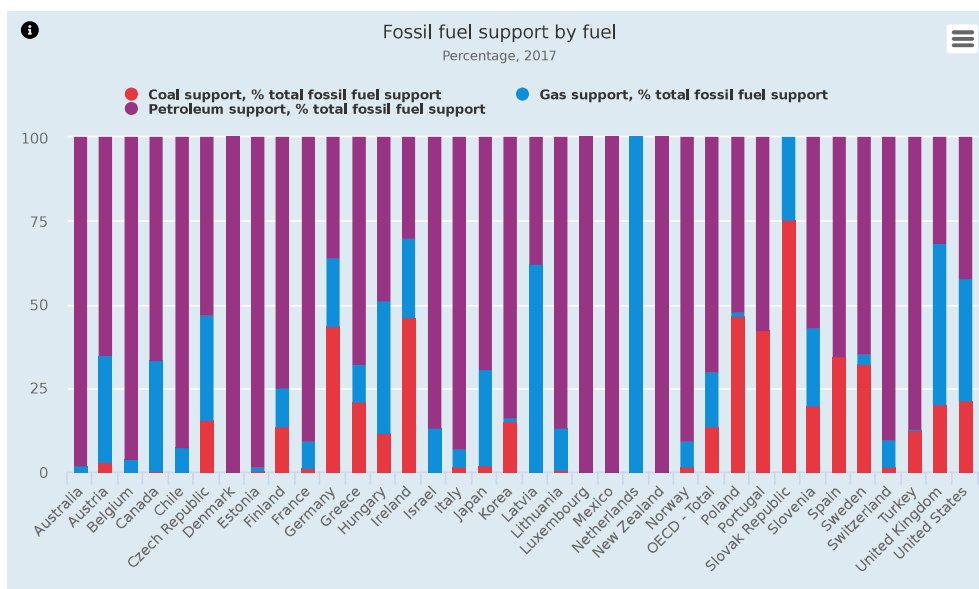
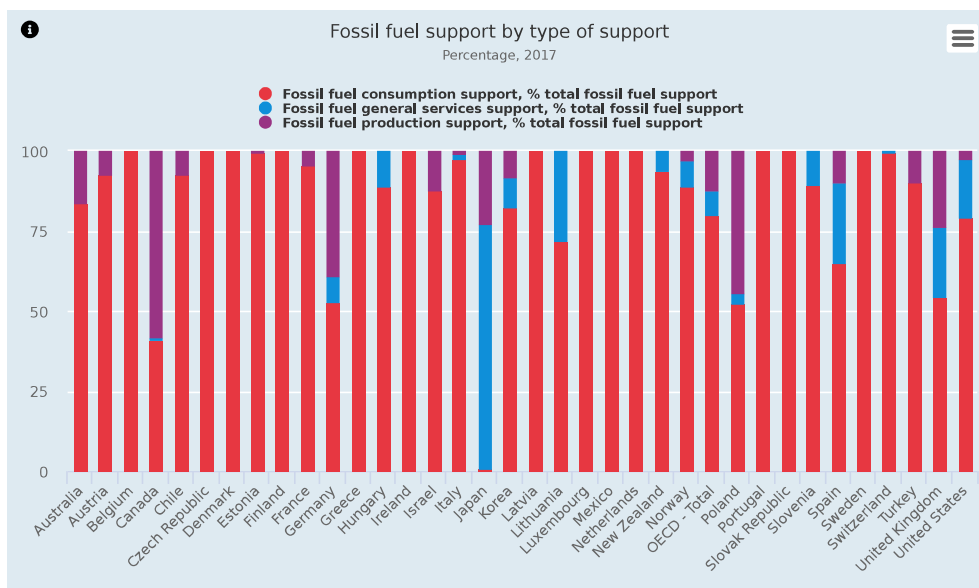
OECD countries provided around USD 80 billion in **support for fossil fuels** in 2017, 26% lower than the highest level in 2013. Progress in reducing subsidies and government support for fossil-fuel production and use has slowed down since 2015.

The recent decrease in support is in large part explained by reductions in general services support estimates (GSSE) and producer support estimates (PSE). Most of the support in OECD countries (80%) goes to the **consumption of fossil fuels**, and in particular petroleum. For several countries, estimates of support pertain exclusively to consumption, a feature that has much to do with geological factors and the decline in coal production observed throughout Europe. In the cases of countries possessing abundant fossil resources, the share of producer support tends to be higher.

On the **production** side, the subsidised hard-coal industry in Western Europe has been phased out and efforts to end state aid to coal-fired power generation in the European

Union are continuing. A recent EU decision aims at ending state aid to high-emission power plants and effectively eliminating subsidies to coal by 2025 . At the same time, the oil and gas sector continues to benefit from government incentives in several countries, mostly through tax provisions that provide preferential treatment for cost recovery. Such policies could go against domestic efforts to reduce global greenhouse gas (GHG) emissions.

Indicators



Comparability and interpretation

The OECD Inventory of Support Measures for Fossil Fuels identifies and estimates policies that support the production or consumption of fossil fuels. It includes direct budgetary transfers and tax expenditures that may provide a benefit or preference for fossil-fuel production or consumption relative to alternatives. Unlike direct budgetary expenditures, where outlays can usually be measured, tax expenditures are estimates of the fiscal revenue that is foregone due to a particular feature of the tax system that reduces a tax rate relative to a benchmark tax rate. It is important to note that definitions of tax expenditures, and the benchmarks used to estimate their size, are nationally determined. Therefore, tax expenditure estimates require caution when used for international comparability of fossil fuel support.

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

Glossary

Carbon dioxide (CO ₂) emissions from energy use (production-based CO ₂ emissions)	Refer to gross direct CO ₂ emissions from fossil fuel combustion, emitted within the national territory. Human-caused emissions from other sources are not included. Emissions from oil held in international marine and aviation bunkers are excluded. CO ₂ removal by sinks, indirect emissions from land use changes and indirect effects through interactions in the atmosphere are not taken into account.
Carbon footprint (demand-based CO ₂ emissions)	Refer to the CO ₂ from energy use emitted during the various stages of production (in the country or abroad) of goods and services consumed in domestic final demand.
Greenhouse gas emissions statistics	<p>The following sources of greenhouse gas statistics are used in this document:</p> <ul style="list-style-type: none"> • National GHG inventories: OECD Environment Statistics (database) based on national inventory submissions to the United Nations Framework Convention on Climate Change (UNFCCC, CRF tables), and replies to the OECD State of the Environment Questionnaire. These statistics come from official submissions of GHG emissions data by Parties to the UNFCCC. Complete data sets including and excluding land use, land-use change and forestry (LULUCF) are available for Annex I Parties to the UNFCCC and partial data sets are available for non-Annex I Parties. • IEA statistics on CO₂ emissions: IEA estimates of CO₂ emissions from fuel combustion are calculated using IEA energy data and the default methods and emission factors from the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. • IEA/EDGAR statistics on total GHG emissions: This dataset combines IEA statistics on CO₂ from fossil fuel combustion with data for CO₂ from non-energy-related sources and gas flaring, and emissions of methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride from the Emissions Database for Global Atmospheric Research (EDGAR). The EDGAR database includes partial coverage of emissions from land use, land-use change and forestry (direct emissions from forest fires, emissions from decay of aboveground biomass that remains after logging and deforestation, emissions from peat fires and decay of drained peat soils).
Greenhouse gas emissions	<p>Greenhouse gas (GHG) emissions refer to the sum of GHGs that have direct effects on climate change and are considered responsible for a major part of global warming: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF₆) and nitrogen trifluoride (NF₃).</p> <p>Greenhouse gas emission estimates are divided into main sectors, which are groupings of related processes, sources and sinks:</p> <ul style="list-style-type: none"> • 1 - Energy (energy industries, manufacturing industries, transport and other energy uses) • 2 - Industrial Processes and Product Use (IPPU) • 3 - Agriculture • 5 - Waste • 6 - Other (e.g., indirect emissions from nitrogen deposition from non-agriculture sources). <p>They refer to GHGs emitted within the national territory and exclude CO₂ emissions and removals from category 4 - Land use change and forestry. They do not cover international transactions of emission reduction units or certified emission reductions.</p>
Total fossil fuel support	<p>Comprises Consumer Support Estimates (CSE), Producer Support Estimates (PSE) and General Services Support Estimate (GSSE), for petroleum, coal and natural gas. Measures that benefit individual producers are classified under the PSE, while those that benefit individual consumers are classified under the CSE. Measures benefitting producers or consumers collectively are classified under the GSSE, as are measures that do not increase current production or consumption of fossil fuels but that may do so in the future. The definition of support encompasses policies that can induce changes in the relative prices of fossil fuels in the support estimate level.</p> <p>Fossil fuel support by type of support refer the share of consumption, production and general services support in total fossil fuel support.</p> <p>Fossil fuel support by fuel refer to the share of petroleum, coal and gas support in in total fossil fuel support.</p>
Total primary energy supply	<p>Total primary energy supply (TPES) is made up of production + imports - exports - international marine bunkers - international aviation bunkers ± stock changes. Primary energy comprises coal, peat and peat products, oil shale, natural gas, crude oil and oil products, nuclear, and renewable energy (bioenergy, geothermal, hydropower, ocean, solar and wind). Electricity trade is also included in total primary energy supply, but excluded from the calculation of the breakdown by source.</p> <p>The share of renewables in the production of electricity. The main renewable forms are hydro, geothermal, wind, biomass, waste and solar energy.</p>

Total fossil fuel support	<p>Comprises Consumer Support Estimates (CSE), Producer Support Estimates (PSE) and General Services Support Estimate (GSSE), for petroleum, coal and natural gas. Measures that benefit individual producers are classified under the PSE, while those that benefit individual consumers are classified under the CSE. Measures benefitting producers or consumers collectively are classified under the GSSE, as are measures that do not increase current production or consumption of fossil fuels but that may do so in the future. The definition of support encompasses policies that can induce changes in the relative prices of fossil fuels in the support estimate level.</p> <p>Fossil fuel support by type of support refer to the share of consumption, production and general services support in total fossil fuel support.</p> <p>Fossil fuel support by fuel refer to the share of petroleum, coal and gas support in in total fossil fuel support.</p>
---------------------------	--

Data sources

IEA, "Emissions of CO₂, CH₄, N₂O, HFCs, PFCs and SF₆", *IEA CO₂ Emissions from Fuel Combustion Statistics* (database), <https://doi.org/10.1787/data-00431-en>.

IEA, "Detailed CO₂ estimates", *IEA CO₂ Emissions from Fuel Combustion Statistics* (database), <https://doi.org/10.1787/data-00429-en>.

IEA, "World energy statistics", *IEA World Energy Statistics and Balances* (database), <https://doi.org/10.1787/data-00510-en>.

OECD, "Air and climate: Greenhouse gas emissions by source", *OECD Environment Statistics* (database), <https://doi.org/10.1787/data-00594-en>.

OECD, "Carbon dioxide embodied in international trade", *OECD Structural Analysis Statistics: Input- Output* (database), http://stats.oecd.org/Index.aspx?DataSetCode=IO_GHG_2019.

OECD, "Green growth indicators", *OECD Environment Statistics* (database), <https://doi.org/10.1787/data-00665-en>.

OECD, *OECD Inventory of Support Measures for Fossil Fuel Support* (database).

References and further reading

OECD Data Portal, <https://data.oecd.org/environment.htm>.

OECD/IEA (2019), "Update on recent progress in reform of inefficient fossil-fuel subsidies that encourage wasteful consumption", <https://oecd.org/fossil-fuels/publication/OECD-IEA-G20-Fossil-Fuel-Subsidies-Reform-Update-2019.pdf>.

OECD (2019), *Taxing Energy Use 2019: Using Taxes for Climate Action*, OECD Publishing, Paris, <https://doi.org/10.1787/058ca239-en>.

OECD (2018), *OECD Companion to the Inventory of Support Measures for Fossil Fuels 2018*, OECD Publishing, Paris. <http://dx.doi.org/10.1787/9789264286061-en>.

OECD (2018), *Effective Carbon Rates 2018: Pricing Carbon Emissions Through Taxes and Emissions Trading*, OECD Publishing, Paris, <https://doi.org/10.1787/9789264305304-en>.

OECD (2015), *Aligning Policies for a Low-Carbon Economy*, OECD Publishing, Paris, <http://dx.doi.org/10.1787/9789264233294-en>.

OECD (2015), *Climate Change Mitigation: Policies and Progress*, OECD Publishing, Paris. <http://dx.doi.org/10/1787/9789264238787-en>.

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

Wiebe, K.S. and N. Yamano (2016), "Estimating CO2 Emissions Embodied in Final Demand and Trade Using the OECD ICIO 2015: Methodology and Results", OECD Science, Technology and Industry Working Papers, No. 2016/05, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5jlrcm216xkl-en>.

Citation

OECD, "Environment at a Glance: Climate change", *Environment at a Glance: Indicators*, www.oecd.org/environment/env-at-a-glance.