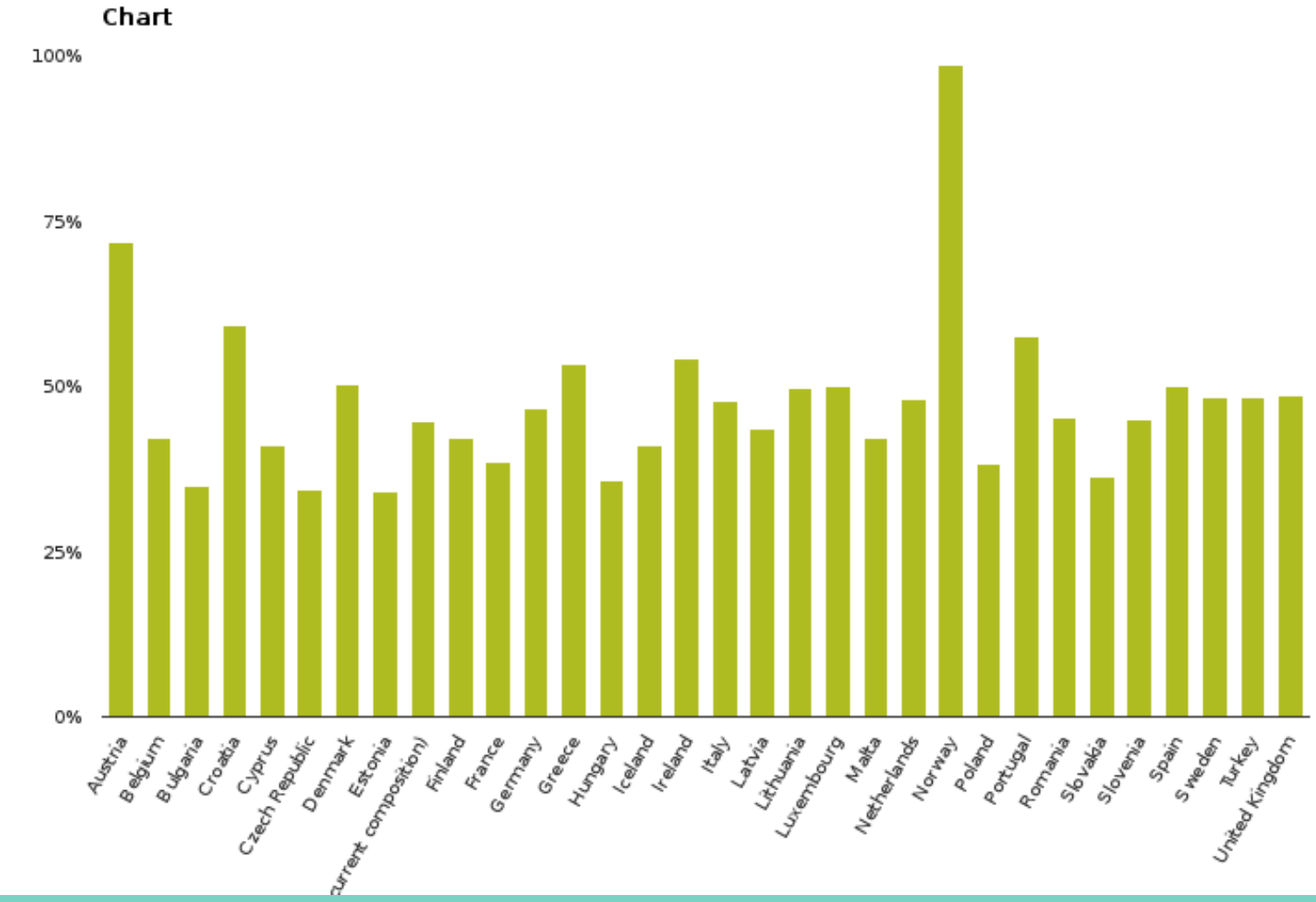
Overview of electricity production and use in Europe



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Overview of electricity production and use in Europe

Key messages

In 2016, low-carbon energy sources (i.e. renewables and nuclear energy) continued to dominate the electricity mix for the second year in a row, together generating more power than fossil fuel sources.

- Fossil fuels (i.e. coal, natural gas and oil) were responsible for 43 % of all gross electricity generation in 2016, a decrease of 11 percentage points across the EU compared with 2005 (54 %).
- By way of contrast, the share of electricity generated from renewable sources has grown rapidly since 2005, but the pace of growth has slowed down after 2014. In 2016, renewable electricity reached almost one third (29 %) of all gross electricity generation in the EU. This is twice as much as in 2005. As such, renewable sources generated more electricity in 2016 than nuclear sources or coal and lignite.
- Nuclear energy sources contributed roughly one quarter (26 %) of all gross electricity generation in 2016.

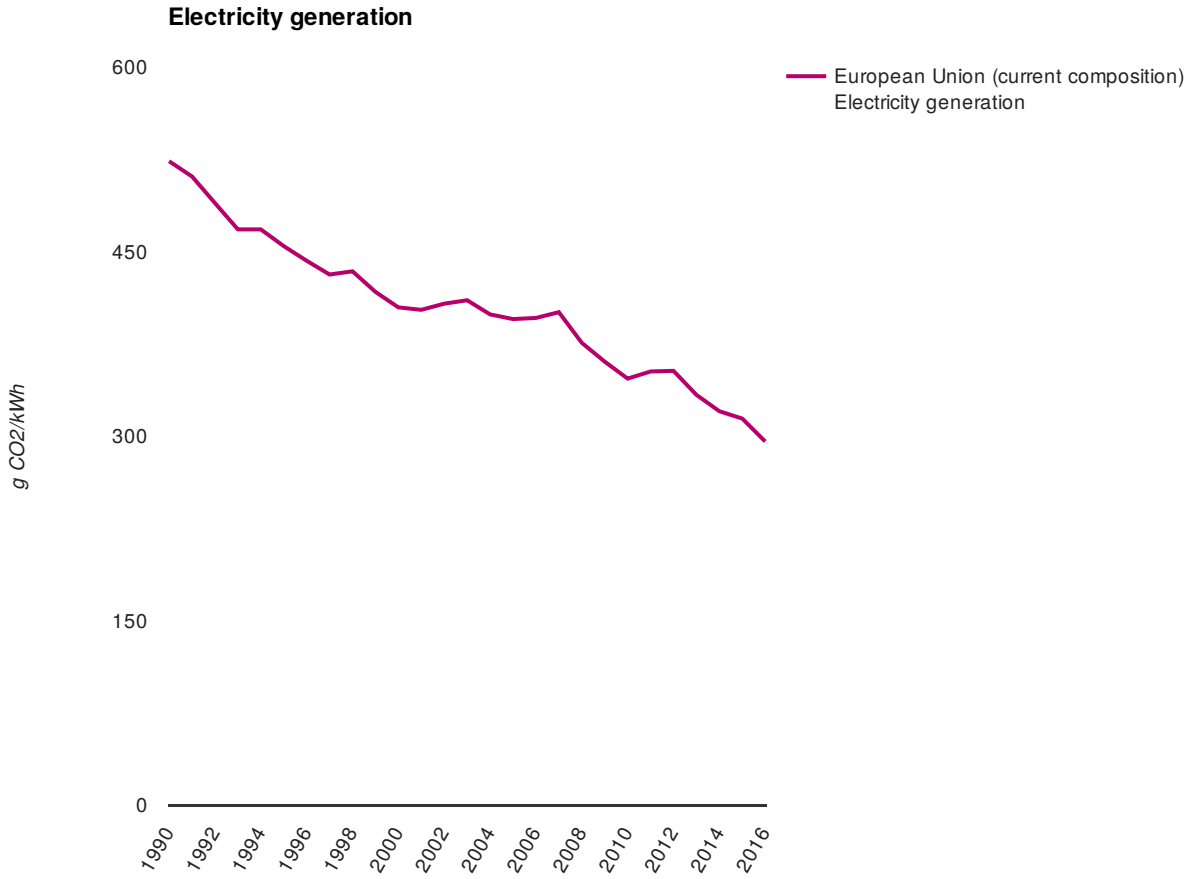
The transition from fossil fuels to renewable fuels, together with improved transformation efficiencies in electricity generation, led to an average annual 2.6 % decrease in CO_2 emissions per kWh between 2005 and 2016.

Final electricity consumption (the total consumption of electricity by all end-use sectors plus electricity imports and minus exports) in the EU increased by one percent in 2016 compared with 2015, reaching the same level as in 2005. The sharpest growth was observed in the services sector (1.2 % per year) and the sharpest decline in industry (-1.0 % per year).

With regards to the non-EU EEA countries, between 2005 and 2016, electricity generation increased by an average of 4.9 % per year in Turkey, 7.1 % per year in Iceland and 0.7 % per year in Norway.

Is electricity production in Europe becoming less carbon intensive?

CO2 emission intensity



Note: The CO_2 emission intensity (g CO_2/kWh) is calculated as the ratio of CO_2 emissions from public electricity production (as a share of CO_2 emissions from public electricity and heat production related to electricity production), and gross electricity production.

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Data sources:

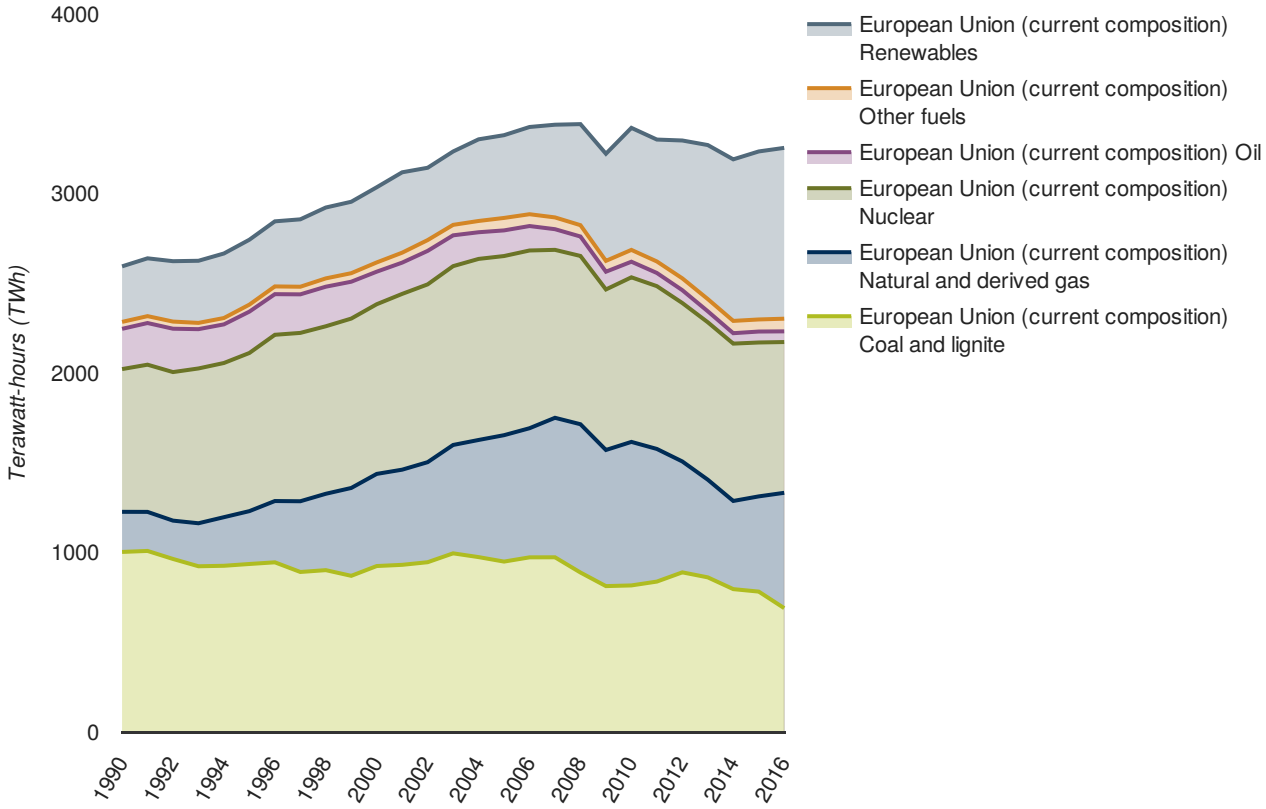
- National emissions reported to the UNFCCC and to the EU Greenhouse Gas Monitoring Mechanism

provided by **European Environment Agency (EEA)**

- Supply, transformation, consumption - all products - annual data provided by **Statistical Office of the European Union (Eurostat)**

Gross electricity production by fuel

Chart-a



Note: Data shown are for gross electricity production and include electricity production from both public plants and auto-producers. Renewables include electricity produced from hydro (excluding pumping), biomass, municipal waste, geothermal, wind and solar photovoltaics. The share of renewables presented in the chart is for production and hence it differs from the share of renewables in consumption (renewable energy consumption targets are set in the Renewable Energy Directive 2001/77/EC). 'Other fuels' includes electricity produced from power plants not accounted for elsewhere, such as those fuelled by certain types of industrial wastes. It also includes the electricity generated as a result of pumping in hydro-power stations.

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Data sources:

- Supply, transformation, consumption - electricity - annual data provided by **Statistical Office of the**

European Union (Eurostat)

Electricity generation

Between 2005 and 2016, gross electricity generation[1] in the EU decreased by 2 % at an average rate of 0.2 % per year. Since 2010, a decrease of 0.6 % per year has been observed.

[1] Gross electricity generation (also called electricity production) refers to gross generation in all types of power plants (not to be confused with final electricity consumption).

Contribution of fuels to electricity generation

In 2016, electricity generation by fuel in the EU was as follows (see Figure 2):

- 29 % from renewables (compared with 14 % in 2005);
- 26 % from nuclear energy (compared with 30 % in 2005);
- 21 % from coal and lignite (compared with 29 % in 2005);
- 20 % from natural and derived gas (compared with 21 % in 2005);
- 2 % from oil (compared with 4 % with 2005); and
- 2 % from other fuels (unchanged from 2005).

Fossil fuel electricity generation

Taken together, fossil fuels continue to dominate the EU electricity mix, although their share of gross electricity generation fell by 21 %, from 54 % in 2005 to 43 % in 2016.

- Electricity generated from coal and lignite decreased by 27 % over the period, at an average rate of 3 % per year. The reduction in the share of solid fuels was driven by changes in the prices of solid fuels compared with natural gas, as well as by support policies for renewables and more stringent environmental regulations.
- The electricity produced from natural and derived gas decreased by 9 % between 2005 and 2016, at an average rate of 1 % per year. After peaking in 2008, the share of natural gas in electricity generation has declined gradually; in 2014, it recorded a 8 percentage point decrease compared with 2010, against the backdrop of increasing gas prices driven by the gas-to-oil price indexation, lower economic activity and low CO_2 prices under the EU Emissions Trading System (ETS). However, after 2014 the share of natural gas increased again, replacing electricity generated from coal and lignite.

Renewable electricity generation

The electricity produced from renewable sources more than doubled between 2005 and 2016 (an increase of 107 %), at an average annual rate of 6.8 %. The increase observed occurred in the

context of national and EU renewable energy support policies and significant cost reductions achieved by certain renewable energy technologies, such as solar photostatic (PV) systems, in recent years. In 2016, 37 % of renewable electricity was generated from hydro (excluding pumped hydro; 68 % in 2005), 32 % from wind (15 % in 2005), 19 % from biomass (15 % in 2005), 12 % from solar (0 % in 2005) and 1 % from geothermal (1 % in 2005).

Nuclear electricity generation

Nuclear electricity decreased by 16 % between 2005 and 2016, at an average annual rate of 1.6 %. Nuclear electricity totally disappeared in Lithuania as a result of decommissioning the last nuclear reactor in 2009. Furthermore, nuclear electricity decreased between 2005 and 2016 in Germany (-5.8 % per year), Slovakia (-1.6 % per year) and Bulgaria (-1.5 % per year), while it increased in countries such as Romania (6.7 % per year) and Hungary (1.4 % per year).

In the wake of the Fukushima accident of 2011, several countries planned to step up the decommissioning of nuclear power plants (Belgium, Germany, Spain and Switzerland, with Germany planning to decommission all of its nuclear plants by 2022, and Spain and Switzerland banning the construction of new reactors). Other countries, however, are still considering to increase their nuclear capacity (Bulgaria, the Czech Republic, Hungary, Poland, Romania and the United Kingdom), have new nuclear power plants under construction (Finland, France and Slovakia), or have paved the way to extend the lifetime of existing nuclear reactors (Sweden). However, the costs of nuclear electricity generation have increased since the Fukushima nuclear accident in 2011 (e.g. by about one fifth in France between 2010 and 2013, because of investments in maintenance and safety measures).

Carbon intensity of EU electricity production

In the light of the increased role of renewable electricity and the fuel shifts observed between 1990 and 2016, the carbon intensity of the total electricity generation in the EU in 2016 was 44 % lower than in 1990 (decreasing from 524 g CO2/kWh in 1990 to 296 g CO2/kWh in 2016) (Figure 1). This represents an average annual decrease of 2 % per year during the whole period. Between 1990 and 2005, CO_2 emissions per kWh generated decreased by 24 %, and by 25 % between 2005 and 2016. This was because of increased transformation efficiencies and the transition from fossil fuels to renewable fuels in electricity generation. The share of fossil fuels in gross electricity production has decreased by roughly 11 percentage points since 2005.

Member countries differ significantly with regard to the CO_2 intensity of their electricity production. Estonia (821 g CO_2/kWh in 2016), Poland (773 g CO_2/kWh), Malta (680 g CO2/kWh) and Cyprus (678 g CO_2/kWh) had the highest intensities as a result of using carbon-intensive fuels and having relatively fewer renewables and limited, or no nuclear sources in their national electricity mixes. On the other hand, Sweden (13 g CO_2/kWh in 2016), Lithuania (18 g CO_2/kWh) and France (58 g CO_2/kWh) had the lowest CO_2 intensities for their electricity production. The highest decarbonisation rates in electricity production over the 1990-2016 period were recorded in

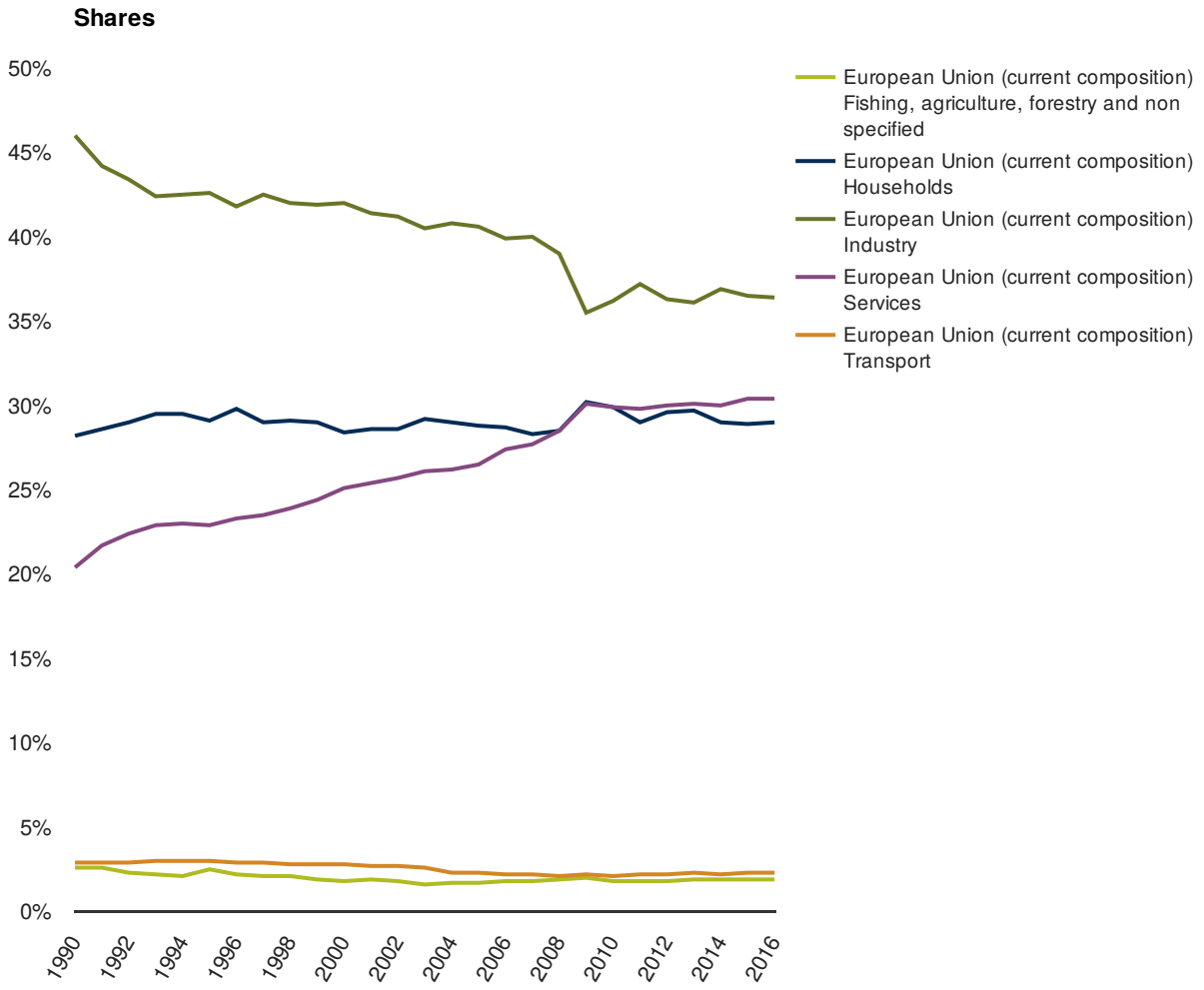
Lithuania (a 89 % decrease) and Denmark (a 74 % decrease), together with Slovakia (a 73 % decrease) and France (a 68 % reduction). Iceland, whose electricity production is entirely based on renewable energy sources (hydro power and geothermal energy), has zero CO_2 emissions for its electricity production.

Non-EU EEA member countries

An assessment of electricity generation for non-EU EEA countries could be performed for Iceland, Norway and Turkey for which energy data were available. In Turkey, electricity production increased by 69 % between 2005 and 2016, at an average rate of 4.9 % per year. Natural gas, coal and renewables contribute equally to electricity production in Turkey (33 % each). In Iceland, electricity production increased by 114 % between 2005 and 2016, at an average rate of 7.1 % per year. All electricity produced in Iceland comes from renewables (hydro and geothermal). In Norway, electricity production increased by 8 % between 2005 and 2016, at an average rate of 0.7 % per year. Renewables (mainly hydro) contribute to almost all electricity production in Norway (97 %).

Is electricity consumption in Europe increasing?

Final energy consumption of electricity by sector



Notes: Final electricity consumption is the electricity consumption of the final energy demand sectors. It does not include the electricity producer's own use or transformation, transmission and distribution losses.

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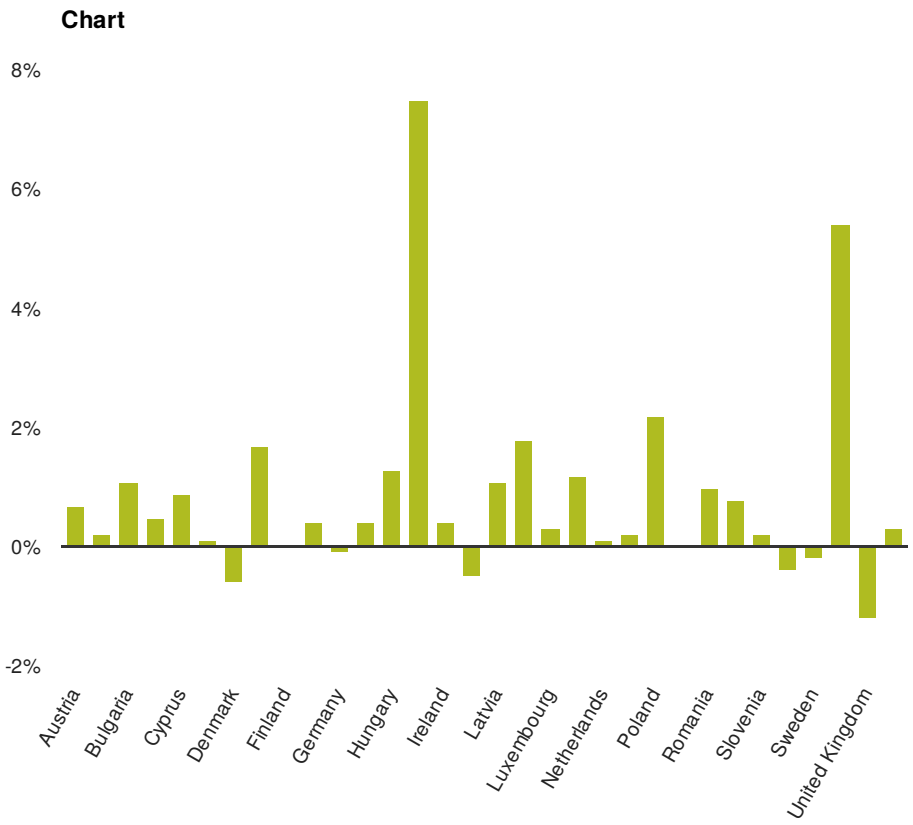
Data sources:

- Supply, transformation, consumption - electricity - annual data provided by **Statistical Office of the European Union (Eurostat)**

Average annual percentage change in final electricity consumption



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Data sources:

- Supply, transformation, consumption - all products - annual data provided by **Statistical Office of the European Union (Eurostat)**

Electricity consumption

Final electricity consumption (i.e. the total consumption by all end-use sectors plus electricity imports and minus exports) increased every year between 1994 and 2008. After a fall in 2009, during the financial crisis, final electricity consumption rebounded again in 2010. Thereafter, it

decreased year-on-year until 2015, when it began to rise again. In 2016, final electricity consumption reached the same level it had in 2005 (see Figure 4). Power stations' own electricity consumption (for instance in transformers, per unit of electricity produced), associated transmission and distribution network losses and different developments in electricity imports and exports led to different growth rates for electricity consumption and electricity generation.

- Over the period 2005-2016, 20 EU Member States (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, France, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Romania, Slovakia and Slovenia) experienced an overall increase in final electricity consumption and six countries experienced an overall decrease (Denmark, Germany, Italy, Spain, Sweden and the United Kingdom).
- The average annual growth rate of electricity consumption varied greatly by country, ranging from -1.2 % per year in the United Kingdom, to about 2.2 % per year in Poland.
- The increase in electricity consumption in the new Member States was a combined result of economic growth and the decrease or low growth of the population in those countries.
- Within the EU, electricity consumption peaked in 2008, after which it began to decrease slowly, driven by a more pronounced decrease in the industry sector (see Fig. 3). By 2016, the final energy consumption of electricity was 2.7 % below the 2008 level (before the recession).

Of the non-EU EEA countries, electricity consumption increased by 7.5 % per year, between 2005 and 2016, in Iceland, by 5.4 % per year in Turkey and by 0.2 % per year in Norway. In absolute terms, the growth of electricity consumption in non-EU EEA countries was dominated by the increased electricity consumption in Turkey. Here, the high consumption rate is due to Turkey's rapid transition to a modernised economy, with the associated increase in electricity generation and use.

Electricity consumption by sector

The increase in electricity consumption since 2005 can be traced back to an increase in consumption in the services (14.5 %) and agricultural (10.6 %) sectors (see Figure 3). Electricity consumption in industry decreased (by 10.4 %) over the same period because of improvements in industrial processes and a slight decrease in activity.

In 2016:

- Industry remained the largest electricity-consuming sector in the EU-28, accounting for 36 % of all electricity consumption (compared with 41 % in 2005). Between 2005 and

2016, electricity consumption in the industry sector decreased by an average of 1.0 % per year.

- The consumption of electricity in the services sector was 30 % in 2016, compared with 27 % in 2005. It is the sector with the fastest growing consumption. Since 2005, electricity consumption in the service sector has increased by 14.5 %, at an average annual rate of 1.2 %. The main reasons for increased electricity consumption in the services sector were the sustained growth of this sector throughout the EU and the increased use of air conditioning and IT equipment.
- Electricity consumption in the households sector accounted for 29 % of all electricity consumption in the EU, the same as in 2005. Between 2005 and 2016, electricity consumption in the household sector increased by 0.8 %. Improvement in the energy efficiency of large electrical appliances such as refrigerators, freezers, washing machines, dishwashers, TVs and dryers was offset by the use, number and size of large appliances as well as by a growing number of smaller appliances, including new IT appliances.
- The transport sector was responsible for only 2.3 % of all electricity consumption in the EU (also 2.3 % in 2005). Between 2005 and 2016, electricity consumption in the EU transport sector decreased slightly from 64.5 TWh in 2005 to 63.7 TWh in 2016. The increased consumption of electricity for transport purposes (railways) in some countries, such as France and Italy, counterbalanced a decrease in electricity consumed for railways in other Member States, such as Poland and the Czech Republic.
- Agriculture, forestry and fishing were responsible for 1.9 % of all electricity consumption in the EU (1.7 % in 2005). Electricity consumption in these sectors has been growing since 2005 at an average annual rate of 0.9 %.

With regard to non-EU EEA countries, between 2005 and 2016, overall electricity consumption in all sectors increased by 78 % in Turkey (5.4 % per year, on average), 122 % in Iceland (7.5 % per year, on average) and 3 % in Norway (0.2 % per year, on average). In the main sectors, the average growth rates recorded between 2005 and 2016 by Turkey, Iceland and Norway were:

- Industry: 5.2 % per year (Turkey), 8.8 % per year (Iceland) and -1.2 % per year (Norway)
- Services: 6.4 % per year (Turkey), 3.0 % per year (Iceland) and 1.6 % per year (Norway)
- Households: 4.7 % per year (Turkey), 1.9 % per year (Iceland) and 1.2 % per year (Norway).

In 2016, the shares of electricity consumption in the agricultural, fishing and forestry sectors of Turkey, Iceland and Norway were 3.0 %, 1.7 % and 1.8 %, respectively. This constituted an

average annual increase of 4.7 % in Turkey, -0.3 % in Iceland and -0.3 % in Norway since 2005. For all three countries, electricity consumption in the transport sector had a share of less than 1 % in 2016.

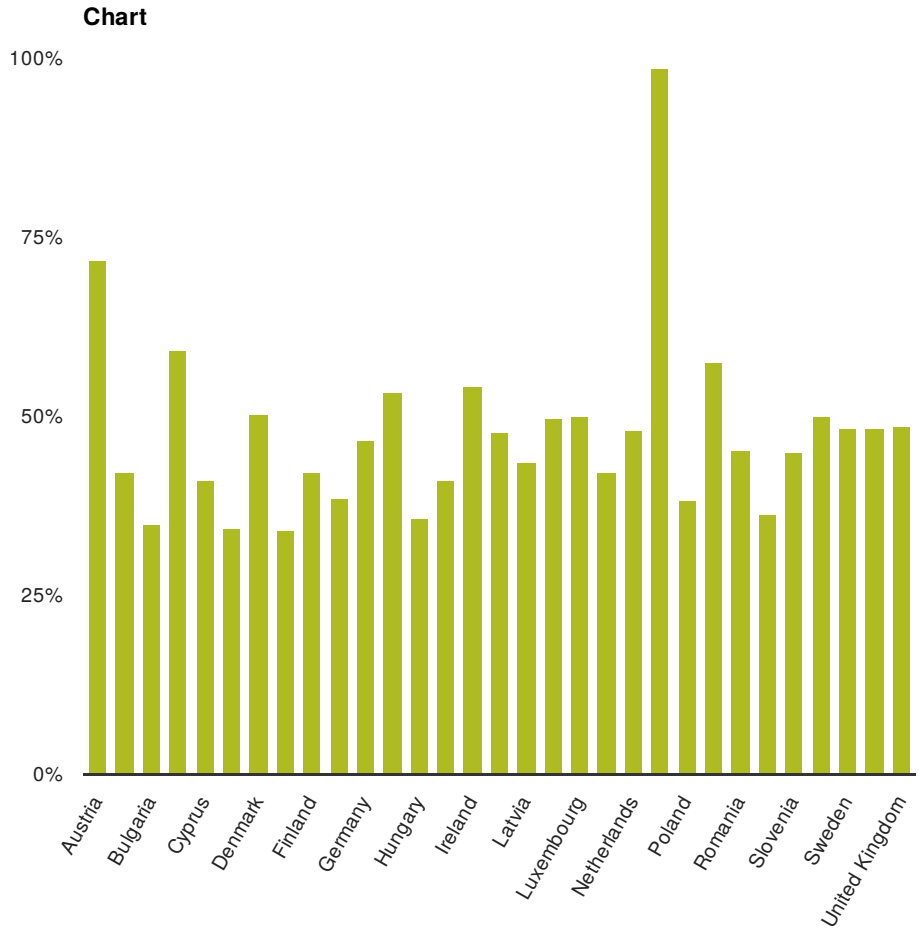
Electricity consumption per capita

Electricity consumption per capita decreased by 3.0 % in the EU between 2005 (5 620 kWh/capita) and 2016 (5 450 kWh/capita). The EU-wide consumption average varies greatly between countries, with a low per-capita consumption observed in 2016 in Member States such as Romania (2 196 kWh/capita), Latvia (3 308 kWh/capita), Lithuania (3 399 kWh/capita), Poland (3 499 kWh/capita), Croatia (3 667 kWh/capita) and Hungary (3 782 kWh/capita), and a high per-capita consumption observed in other Member States, including Finland (14 709 kWh/capita), Sweden (12 848 kWh/capita) and Luxembourg (10 940 kWh/capita). In Sweden, this is partially due to the high market penetration of electrical heating linked to the low-cost of hydropower produced electricity. The increasing use of air conditioning in southern European countries also contributes to a large increase in electricity consumption during the summer months.

Between 2005 and 2016, electricity consumption per capita in non-EU EEA countries decreased at an average annual rate of 0.9 % in Norway, while it grew rapidly in Iceland and Turkey at an average annual rate of 6.3 % and 4.0 %, respectively. In 2016, per capita electricity consumption reached 21 711 kWh for Norway and 51 583 kWh for Iceland, whereas for Turkey it was one order of magnitude smaller (2 881 kWh).

Are power plants becoming more efficient?

Average efficiency of the electricity sector per country (without pumped hydro)



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Data sources:

- Supply, transformation, consumption - all products - annual data provided by **Statistical Office of the European Union (Eurostat)**
- Supply, transformation, consumption - electricity - annual data provided by **Statistical Office of the European Union (Eurostat)**
- Supply, transformation, consumption - renewable energies - annual data provided by **Statistical Office of the European Union (Eurostat)**

Power generation is becoming more efficient in the EU, with average efficiency having increased from 40 % in 2005 to 45 % in 2016. Efficiency depends mainly on the mix of fuels (fossil, nuclear or renewables) and the mix of power and heat generation:

- high efficiencies are related to hydro (excluding pumped hydro) and wind (100 % efficiency, given that electricity is the first measurable primary equivalent energy for these renewable energy technologies);
- low efficiencies are associated with old fossil fuel fired power and/or heat plants (<30 %), nuclear power plants (typically 33 %, with heat being the first measurable primary equivalent energy), direct biomass burning (20-25 %) or geothermal power and/or heat generation (around 10 % or less, with heat being the first measurable primary equivalent energy). The co-firing of fossil fuel plants with biomass does not decrease the efficiency of these plants significantly.
- between 2005 and 2016, the share of electricity in the output of conventional thermal plants and district heating (electricity and heat) decreased slightly in combination with increasing efficiencies (see ENER 019).

The EEA member countries with an average power generation efficiency of 50 % or more in 2016 were: Norway (99 %), Austria (72 %), Croatia (59 %), and Portugal (58 %).

The largest efficiency improvements occurred in Lithuania and Greece due to the decommissioning of nuclear and inefficient fossil fuel-fired power plants and the increased share of hydro, wind and/or solar. In Lithuania, generation efficiency increased from 31 % in 2005 to 50 % in 2016, while in Greece it increased from 40 % to 52 % in the same period.

Indicator specification and metadata

Indicator definition

Total gross electricity generation covers gross electricity generation in all types of power plants. Gross electricity generation at plant level is defined as the electricity measured at the outlet of the main transformers, i.e. the consumption of electricity in the plant auxiliaries and in transformers is included.

Electricity production by fuel is the gross electricity generation from plants using the following fuels: coal and lignite, oil, nuclear, natural and derived gas, renewables (wind, hydro, biomass and waste, solar photovoltaics and geothermal) and other fuels. The latter include electricity produced from power plants not accounted for elsewhere such as those fuelled by certain types of industrial wastes, which are not classed as renewable. Other fuels also include the electricity produced as a result of pumping in hydro power stations.

The share of each fuel in electricity production is taken as the ratio of electricity production from the relevant category against total gross electricity generation. It should be noted that the share of renewable electricity in this indicator, based on production, is not directly comparable with the share required under Directive 2001/77/EC, which is based on the share of renewables in electricity consumption. The difference between both shares is accounted for by the net balance between imports and exports of electricity and by how much domestic electricity generation is increased or reduced as a result.

Final electricity consumption covers electricity supplied to the final consumer's door for all energy uses. It does not include the electricity producer's own use or transmission and distribution losses. It is calculated as the sum of final electricity consumption from all sectors. These are disaggregated to cover industry, transport, households and services (including agriculture and other sectors).

Units

- Electricity generation is measured in either gigawatt hours (GWh) or terawatt hours (TWh) (1 TWh = 1 000 GWh).
- Final electricity consumption is measured in terawatt hours (TWh).
- CO_2 emissions are measured in teragrams (Tg; 1 Tg = 1 megatonne).

Rationale

Justification for indicator selection

Electricity generation gives rise to negative impacts on the environment and human health throughout all stages of its life-cycle, from resource extraction to electricity use. The fuel mix used in electricity production provides a broad indication of the type and magnitude of pressures on the environment and human health. Impacts stemming from electricity production depend on the (fossil) fuel employed, how it was extracted and processed, the actual technology (and its efficiency) used to produce electricity, as well as the use of abatement technologies. Electricity generated from renewable energy sources generally has a lower environmental impact (e.g. emissions of greenhouse gases and air pollutants) over its life-cycle than electricity generated from fossil fuels. A higher share of renewable electricity thus helps to diminish the environmental pressures stemming from electricity generation.

An almost full decarbonisation of the electricity sector will be needed in order to meet the EU's objective of reducing greenhouse gas emissions by 80-95 % by 2050.

Increasing electricity generation and use throughout Europe — without reforming the current energy system — will lead to higher overall health and environmental impacts. Nevertheless, an increase in electricity consumption in the transport sector might signal a positive modal shift towards rail transport or a higher penetration of electric vehicles.

Scientific references

- Annual European Union greenhouse gas inventory report
- Electricity information - IEA statistics
- EEA - Greenhouse gas data viewer

Policy context and targets

Context description

Environmental context

This indicator describes the trends observed in electricity generation and use in Europe. Electricity generation has a number of negative impacts on the environment and human health. These arise at all stages of the electricity life-cycle, for instance:

- impacts on climate change and air quality due to the emission of CO_2 and other greenhouse gases and air pollutants (e.g. SO_2, NO_x and PM) arise from combustion processes;
- impacts on water quality and quantity as a result of dam construction for hydropower, water retention for energy and crops, and water use for the cooling of power plants;
- direct and indirect impacts on land resources, including natural habitats and ecosystems, as a result of further deforestation in the tropics for the production of bioenergy, as well as the fragmentation of habitats due to resource extraction and the construction of pipelines, grids and infrastructures needed for power generation.
- a broad range of specific social and environmental impacts due to the extraction of conventional and unconventional fossil fuels.

Most of these impacts tend to be fuel-specific. For instance, nuclear power produces fewer greenhouse gas emissions and atmospheric pollution throughout its life-cycle, compared with conventional sources, but carries a certain risk of accidental radioactive release. Moreover, the management and disposal of spent fuel and radioactive waste is problematic. While electricity from natural gas gives rise to approximately 40 % fewer carbon dioxide emissions per unit than coal and 25 % fewer carbon dioxide emissions than oil, and contains only marginal quantities of sulphur (see ENER 036), increasing the use of unconventional gas resources (such as shale gas and coal-bed methane) would lead to other specific environmental pressures.

In total gross electricity production, the shares of electricity generation from different fuels aim to indicate to what extent the decarbonisation of electricity generation in Europe has occurred. Pressure exerted on the environment and human health due to energy consumption can be diminished by decreasing electricity consumption through efficiency improvements and energy conservation, and switching to those sources and technologies that have a lower impact on the environment and human health.

Policy context

- Conclusions of the 2030 Climate and Energy Policy Framework, European Council, 23 and 24 October 2014, SN 79/14.
- A policy framework for climate and energy between 2020 and 2030 (COM(2014) 15

final) presents an integrated policy framework with binding EU-wide targets for greenhouse gas emission reductions and the development of renewable energy sources, and includes objectives for energy efficiency improvements up to 2030.

- A roadmap for moving to a competitive low carbon economy in 2050 (COM(2011) 112 final) presents plans for action in line with an 80-95 % reduction in greenhouse gas emissions by 2050.
- Energy 2020 — A strategy for competitive, sustainable and secure energy (COM(2010) 639 final) — presents the five priorities of the new energy strategy defined by the Commission.
- On 6 April, the Council adopted the climate-energy legislative package, known as the climate action and renewable energy (CARE) package, containing measures to fight climate change and promote renewable energy. This package is designed to achieve the EU's overall environmental target of a 20 % reduction in greenhouse gases and a 20 % share of renewable energy in the EU's total energy consumption by 2020.
- Directive 2009/29/EC of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emissions allowance trading scheme of the community.
- Directive 2009/31/EC of the European Parliament and of the Council on the geological storage of carbon dioxide.
- Directive 2009/28/EC of the European Parliament and of the Council on the promotion of the use of energy from renewable sources.
- Directive 2009/125/EC of the European Parliament and of the Council establishing a framework to set eco-design requirements for energy-related products.
- Directive 2010/30/EC of the European Parliament and of the Council on indications of the consumption of energy and other resources by energy-related products via labelling and standard product information.
- Community guidelines on state aid for environmental protection (2008/c 82/01).
- Directive 2008/101/EC of the European Parliament and of the Council amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emissions allowance trading within the Community.
- Regulation (EC) No. 443/2009 of the European Parliament and of the Council, setting emission performance standards for new passenger cars as part of the Community's integrated approach to reducing CO_2 emissions from light-duty vehicles.
- Second Strategic Energy Review; COM(2008) 781 final. Strategic review on short, medium and long term targets for EU energy security.

Targets

No targets have been specified

Related policy documents

- 2008/c 82/01

Community guidelines on state aid for environmental protection (2008/c 82/01)

- 2009/29/ec

Directive 2009/29/ec of the European parliament and of the Council amending directive 2003/87/ec so as to improve and extend the greenhouse gas emission allowance trading scheme of the community.

- 2009/31/EC

Directive 2009/31/ec of the European parliament and of the Council on the geological storage of carbon dioxide.

- 2009/125/EC - Ecodesign Directive

The Ecodesign Directive is a framework Directive: it does not set binding requirements on products by itself, but through implementing measures adopted on a case by case basis for each product group. All guiding principles for developing implementing measures are set in the framework Directive 2009/125/EC . The list of product groups to be addressed through implementing measures is established in the periodic Working Plan . Standardisation supports the implementation of the Ecodesign Directive (notably through harmonised standards giving presumption of conformity with all or some Ecodesign legal requirements).

- COM (2011) 112 - A Roadmap for moving to a competitive low carbon economy in 2050

With its "Roadmap for moving to a competitive low-carbon economy in 2050" the European Commission is looking beyond these 2020 objectives and setting out a plan to meet the long-term target of reducing domestic emissions by 80 to 95% by mid-century as agreed by European Heads of State and governments. It shows how the sectors responsible for Europe's emissions - power generation, industry, transport, buildings and construction, as well as agriculture - can make the transition to a low-carbon economy over the coming decades.

- COM(2008) 16 final

Directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the greenhouse gasemission allowance trading system of the Community

- COM(2008) 781

COM(2008) 781 final - Second Strategic Energy Review

- COM(2010) 639 final: Energy 2020 – A strategy for competitive, sustainable and secure energy

A strategy for competitive, sustainable and secure energy

- COM(2014) 15 final A policy framework for climate and energy in the period from 2020 to 2030

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "A policy framework for climate and energy in the period from 2020 to 2030". 22 January 2014, COM(2014) 15 final; {SWD(2014) 15 final}, {SWD(2014) 16 final}. This Communication p resents an integrated policy framework with binding EU-wide targets for greenhouse gas emission reductions and the development of renewable energy sources and with objectives for energy efficiency improvements for the period up to 2030.

- Decision No 406/2009/EC (Effort Sharing Decision)

Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

- DIRECTIVE 2008/101/EC

DIRECTIVE 2008/101/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community

- DIRECTIVE 2009/28/EC

DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

- Directive 2010/30/EU

Energy labelling directive Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products

- EEA greenhouse gas - data viewer

The EEA GHG viewer provides easy access and analysis of the data contained in the Annual European Union greenhouse gas inventory and inventory report. The EEA GHG data viewer can show emission trends for the main sectors and allows for comparisons of emissions between different countries and activities.

- EU Council Conclusion SN79/14 on 2030 Climate and Energy Framework

EU Council conclusions of 23 October 2014 on 2030 Climate and Energy Framework

- Kyoto Protocol to the UN Framework Convention on Climate Change

Kyoto Protocol to the United Nations Framework Convention on Climate Change; adopted at COP3 in Kyoto, Japan, on 11 December 1997

- REGULATION (EC) No 443/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL 443/2009

Regulation (ec) no 443/2009 of the European parliament and of the Council setting emission performance standards for new passenger cars as part of the community's integrated approach to reduce CO2 emissions from light-duty vehicles.

- The EU climate and energy (CARE) Package

The climate and energy package is a set of binding legislation which aims to ensure the European Union meets its ambitious climate and energy targets for 2020. These targets, known as the "20-20-20" targets, set three key objectives for 2020: A 20% reduction in EU greenhouse gas emissions from 1990 levels; Raising the share of EU energy consumption produced from renewable resources to 20%; A 20% improvement in the EU's energy efficiency.

Methodology

Methodology for indicator calculation

Geographical coverage:
The EEA had 33 member countries at the time of writing. These are the 28 European Union Member States and Turkey, plus the EFTA countries (Iceland, Norway and Switzerland). Iceland and Liechtenstein are no longer covered separately by Eurostat.

Methodology and frequency of data collection:
Data collected annually.
Eurostat metadata for energy
statistics https://ec.europa.eu/eurostat/cache/metadata/en/nrg_10_esms.htm

Methodology of data manipulation: Average annual rate of growth calculated using: [(last year/base year) ^ (1/number of years) –1]*100
Share of electricity production by fuel calculated as the ratio of electricity production by fuel type to total gross electricity generation.
The coding (used in the Eurostat database) for the gross electricity generation is:

Coal fired power stations

- Anthracite: main electricity activity 22_108501, main activity CHP 22_108502, autoproducers electricity 22_108503, autoproducers CHP 22_108504
- Coking coal: main electricity activity 22_108511, main activity CHP 22_108512, autoproducers electricity 22_108513, autoproducers CHP 22_108514
- Bituminous: main electricity activity 22_108521, main activity CHP 22_108522, autoproducers electricity 22_108523, autoproducers CHP 22_108524
- Sub Bituminous: main electricity activity 22_108531, main activity CHP 22_108532, autoproducers electricity 22_108533, autoproducers CHP 22_108534
- Lignite/brown coal: main electricity activity 22_108541, main activity CHP 22_108542, autoproducers electricity 22_108543, autoproducers CHP 22_108544
- Peat: main electricity activity 22_108551, main activity CHP 22_108552, autoproducers electricity 22_108553, autoproducers CHP 22_108554
- Patent fuel: main electricity activity 22_108561, main activity CHP 22_108562, autoproducers electricity 22_108563, autoproducers CHP 22_108564
- Coke oven coke: main electricity activity 22_108571, main activity CHP 22_108572, autoproducers electricity 22_108573, autoproducers CHP 22_108574
- Gas coke: main electricity activity 22_108581, main activity CHP 22_108582, autoproducers electricity 22_108583, autoproducers CHP 22_108584
- Coal tar: main electricity activity 22_108591, main activity CHP 22_108592,

autoproducers electricity 22_108593, autoproducers CHP 22_108594

- BKB/briquettes: main electricity activity 22_108601, main activity CHP 22_108602, autoproducers electricity 22_108603, autoproducers CHP 22_108604

Oil fired power stations

- Crude oil: main electricity activity 22_108701, main activity CHP 22_108702, autoproducers electricity 22_108703, autoproducers CHP 22_108704
- NGL (Natural Gas Liquid) : main electricity activity 22_108711, main activity CHP 22_108712, autoproducers electricity 22_108713, autoproducers CHP 22_108714
- Refinery gas: main electricity activity 22_108721, main activity CHP 22_108722, autoproducers electricity 22_108723, autoproducers CHP 22_108724
- Liquefied Petroleum Gas (LPG): main electricity activity 22_108731, main activity CHP 22_108732, autoproducers electricity 22_108733, autoproducers CHP 22_108734
- Naphta: main electricity activity 22_108741, main activity CHP 22_108742, autoproducers electricity 22_108743, autoproducers CHP 22_108744
- Kerozene type jet fuel: main electricity activity 22_108751, main activity CHP 22_108752, autoproducers electricity 22_108753, autoproducers CHP 22_108754
- Other Kerosene: main electricity activity 22_108761, main activity CHP 22_108762, autoproducers electricity 22_108763, autoproducers CHP 22_108764
- Gas/diesel oil: main electricity activity 22_108771, main activity CHP 22_108772, autoproducers electricity 22_108773, autoproducers CHP 22_108774
- Residual fuel oil: main electricity activity 22_108781, main activity CHP 22_108782, autoproducers electricity 22_108783, autoproducers CHP 22_108784
- Bitumen: main electricity activity 22_108791, main activity CHP 22_108792, autoproducers electricity 22_108793, autoproducers CHP 22_108794
- Petroleum coke: main electricity activity 22_108801, main activity CHP 22_108802, autoproducers electricity 22_108803, autoproducers CHP 22_108804
- Other oil products: main electricity activity 22_108811, main activity CHP 22_108812, autoproducers electricity 22_108813, autoproducers CHP 22_108814

Natural gas fired power stations

- Main electricity activity 22_108891, main activity CHP 22_108892, autoproducers electricity 22_108893, autoproducers CHP 22_108894

Derived gas fired power stations

- Gas works gas: main electricity activity 22_108611, main activity CHP 22_108612, autoproducers electricity 22_108613, autoproducers CHP 22_108614

- Coke oven gas: main electricity activity 22_1086211, main activity CHP 22_108622, autoproducers electricity 22_108623, autoproducers CHP 22_108624
- Blast furnace gas: main electricity activity 22_108631, main activity CHP 22_108632, autoproducers electricity 22_108633, autoproducers CHP 22_108634
- Oxygen steel furnace gas: main electricity activity 22_108641, main activity CHP 22_108642, autoproducers electricity 22_108643, autoproducers CHP 22_108644

Biomass fired power stations

- Industrial wastes: main electricity activity 22_108901, main activity CHP 22_108902, autoproducers electricity 22_108903, autoproducers CHP 22_108904
- Municipal wastes (renewable): main electricity activity 22_108911, main activity CHP 22_108912, autoproducers electricity 22_108913, autoproducers CHP 22_108914
- Municipal wastes (non-renewable): main electricity activity 22_108921, main activity CHP 22_108922, autoproducers electricity 22_108923, autoproducers CHP 22_108924
- Wood, wood wastes and other solid fuels: main electricity activity 22_108931, main activity CHP 22_108932, autoproducers electricity 22_1089313, autoproducers CHP 22_108934
- Landfill gas: main electricity activity 22_108941, main activity CHP 22_108942, autoproducers electricity 22_1089343, autoproducers CHP 22_108944
- Sludge gas: main electricity activity 22_108951, main activity CHP 22_108952, autoproducers electricity 22_1089353, autoproducers CHP 22_108954
- Other biogas: main electricity activity 22_108961, main activity CHP 22_108962, autoproducers electricity 22_1089363, autoproducers CHP 22_108964
- Other liquid biofuels: main electricity activity 22_108971, main activity CHP 22_108972, autoproducers electricity 22_1089373, autoproducers CHP 22_108974

Solar

- Main electricity from photovoltaics 14_1070421, main solar thermal 14_1070422, autoproducers solar 14_1070423

Pumped hydro

- Main electricity from pumped hydro 15_107036, autoproducers pumped hydro 14_107037

Nuclear

- Main electricity activity 15_107030, main activity CHP 15_107031, autoproducers electricity 15_107032, autoproducers CHP 15_107033

It should be noted that in the Eurostat database 'Other fuels – 107012' also includes 'gross production from photovoltaic systems - 107023' and although almost negligible in overall terms, it has been subtracted from 107012 in the calculation of the indicator. For the denominator, where required: total gross electricity generation 107000.

Electricity consumption

Electricity consumption per capita is calculated by dividing final electricity consumption by the population for each country (demo_pjan).
The coding (used in the Eurostat New Cronos database) and specific components of the indicator (in relation to the product '6000 - electrical energy') are:
Numerator: final electricity consumption industry 101800 + final electricity consumption transport 101900 + final electricity consumption households 102010 + final electricity consumption services/agriculture calculated as (final electricity consumption households/services 102000 - final electricity consumption households 102010).
Only if needed for shares; denominator: (total) final electricity consumption 101700.

Efficiency of the electric sector

The efficiency of the electric sector is calculated as the ratio between electricity production and the inputs used to produce electricity: transformation input for thermal power stations (coal, oil, gas, biomass) + nuclear production, hydro, geothermal, solar, wind and biofuel).

CO_2 emission intensity of total electricity production

The CO_2 intensity of total electricity generation is taken as the ratio of CO_2 emissions from all electricity production, both from public main activity producers and autoproducers, against total electricity generation including electricity from nuclear plants and renewable sources. The CO_2 emissions used in this indicator (the numerator, expressed in $TgCO_2$) were derived from the reported total CO_2 emissions from public electricity and heat generation from the EEA greenhouse gas data viewer (code: 1A1a). As the 1A1a category shows, CO_2 emissions for all energy production from Public Electricity Generation, Public Combined Heat and Power, and Public Heat Plants, the following estimations were performed:

- First, the CO_2 emissions of gross electricity production were calculated. This was done by multiplying total CO_2 emissions (1A1a from the EEA data viewer), with the ratio of electricity production from public conventional thermal power stations (ESTAT: B101121) and all electrical energy production from public conventional thermal power stations (ESTAT: B101121) and district heating (B101109). The ratio for calculating the share of CO_2 emissions of electricity production was calculated as electrical

energy/(electrical energy + derived heat).

- Transformation output — Main Activity Conventional Thermal Power Stations; Electrical Energy; nrg_105a, 6000_B101121;
- Transformation output — Main Activity Conventional Thermal Power Stations; Derived Heat; nrg_106a, 5200_B101121;
- Transformation output — District Heating Plants; Derived heat; nrg_106a; 5200_B101109.

- Second, the reported CO_2 emissions in class 1A1a do not include CO_2 emissions from autoproducers. Emissions from autoproducers were therefore estimated by multiplying the electricity output of autoproducers (nrg_105a, 6000_B101122) by a calculated CO_2 emission ratio for main activity producers. This CO_2 emission ratio was calculated as the CO_2 emissions from public electricity production (as derived above), against the amount of electricity produced in public conventional power plants.

A zero CO_2 emission factor was applied to nuclear power and to renewables, including to biomass energy. In the case of the former, this is because the method does not take into account life-cycle greenhouse gas emissions. For the latter, this is because — according to the United Framework Convention on Climate Change (UNFCCC) Reporting Guidelines — biomass-related emissions have to be reported as a memorandum item in greenhouse gas inventories, with the assumption being that biomass harvesting would be shown as changes in carbon stocks in the Land Use, Land Use Change and Forestry (LULUCF) sector, and thus not in the energy sector. This should not be interpreted, however, as an endorsement of default biomass sustainability or carbon neutrality.

The denominator of the CO_2 intensity of total electricity production is the sum of electricity produced from public conventional thermal power stations (ESTAT: B101121), from autoproducer conventional thermal power stations (ESTAT: B101122), nuclear power stations (ESTAT: B101102) and electricity from renewables (hydro power, wind power, tide, wave and ocean, and solar PV). These data are presented by ESTAT category B101200 (Exchanges and transfers).

Qualitative information

Overall scoring – historic data (1 = no major problems. 3 = major reservations):

- Relevance: 1
- Accuracy: 1
- Comparability over time: 1
- Comparability over space: 1

Methodology for gap filling

Population data for France, for the year 1990, were missing in the data sets shown by ESTAT. Therefore, when calculating the electricity consumption per capita, the data point for population in France in 1991 was applied as proxy for 1990.

Methodology references

No methodology references available.

Uncertainties

Methodology uncertainty

Care is needed when using estimates for the CO_2 emission intensity of total electricity production. Assumptions are used to estimate these intensities, given that the CO_2 emissions data from the EEA greenhouse gas data viewer (category 1A1a, Public Electricity and Heat production) include both the emissions from power and heat generation. Specifically, for the allocation of CO_2 emissions from combined heat and power (CHP) plants, the EEA has chosen a proportionality approach based on the electricity and heat output data from Eurostat. This implies an equal average efficiency for both heat and electricity generation, which is likely to overstate the electricity efficiency and to understate heat efficiency for CHP plants.

Data sets uncertainty

Data have been traditionally compiled by Eurostat using the annual joint questionnaires, which are shared by Eurostat and the International Energy Agency, following a well established and harmonised methodology. Methodological information on the annual joint questionnaires and data compilation can be found on the Eurostat web page for metadata on energy statistics: http://ec.europa.eu/eurostat/web/energy/methodology.

Rationale uncertainty

Biomass and wastes, as defined by Eurostat, cover organic, non-fossil material of biological origin, which may be used for heat production or electricity generation. They comprise wood and wood waste, biogas, municipal solid waste (MSW) and biofuels. MSW comprises biodegradable and non-biodegradable wastes produced by different sectors. Non-biodegradable municipal and solid wastes are not considered to be renewable, but current data availability does not allow the non-biodegradable content of wastes to be identified separately, except for that from industry.

Also, electricity data (unlike that for overall energy consumption) for 1990 refer to the western part of Germany only.

Electricity consumption within the national territory includes imports of electricity from neighbouring countries. It also excludes electricity produced nationally but exported abroad. In some countries, the contribution of electricity trade to total electricity consumption and the changes observed from year to year need to be looked at carefully when analysing trends in electricity production by fuel. Impacts on the (national) environment are also affected, since emissions are counted where electricity is produced, whereas consumption is counted where electricity is consumed.

Data sources

- National emissions reported to the UNFCCC and to the EU Greenhouse Gas Monitoring Mechanism
  provided by **European Environment Agency (EEA)**
- Electricity Consumption (dataset URL is not available)
  provided by **International Energy Agency (IEA)**
- Energy statistics (Eurostat)
  provided by **Statistical Office of the European Union (Eurostat)**

Generic metadata

Topics:

Energy

DPSIR: Driving force

Typology: Efficiency indicator (Type C - Are we improving?)

Indicator codes

- ENER 038

1990-2016

Contacts and ownership

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Ownership

- European Environment Agency (EEA)

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