

EN02 Energy-related greenhouse gas emissions

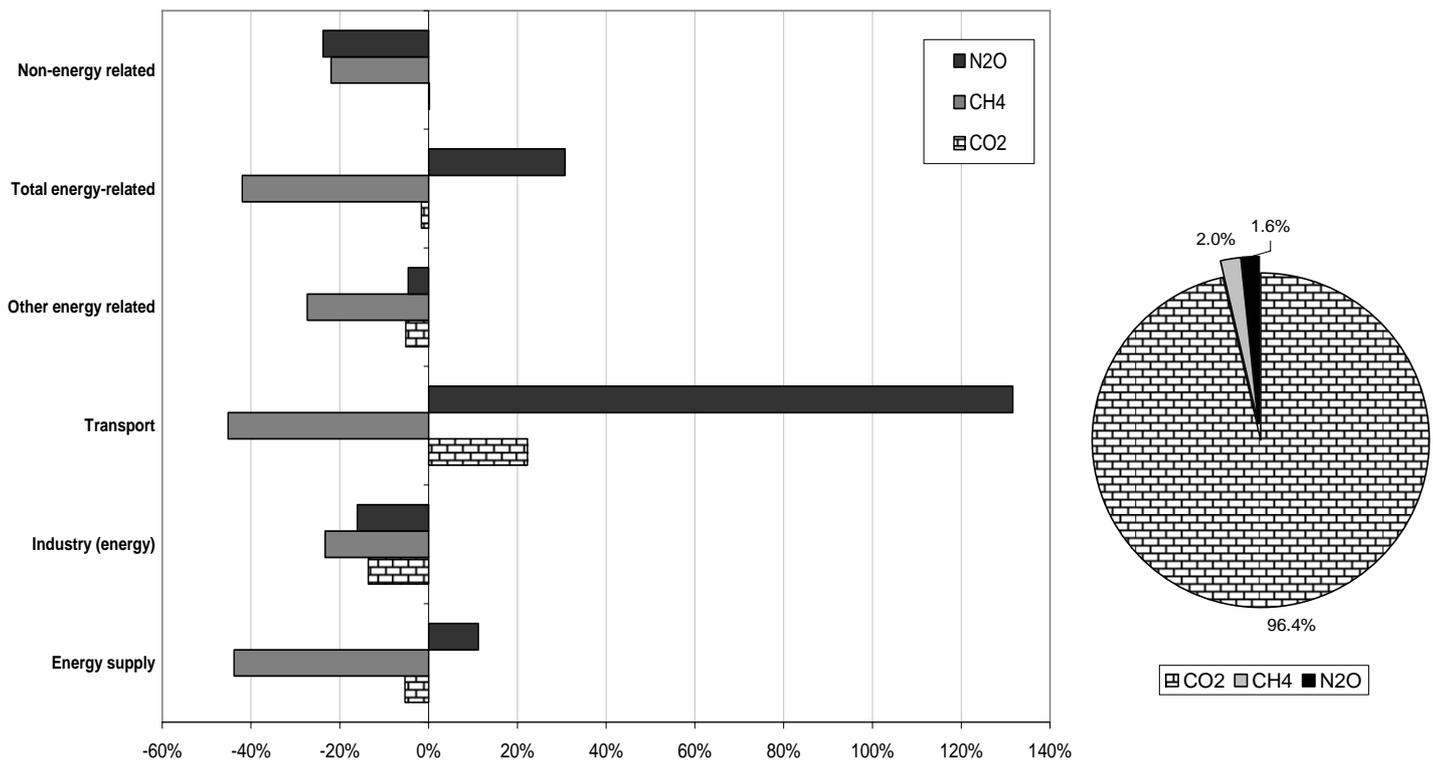
Key message

Energy-related greenhouse gas emissions in the EU-25 decreased by 2.6 % between 1990 and 2003, although they increased by 1.7 % between 2002 and 2003. Recent increases in CO₂, the most important energy-related greenhouse gas, were due to an increase in fossil fuel-based power generation to meet the growing demand for electricity and compensate decreases in hydropower production, and by increased transport.

Rationale

There is growing evidence that emissions of greenhouse gases are causing global temperatures to increase, resulting in climate change. Energy-related greenhouse gas emissions are by far the main contributor to total greenhouse gas emissions in the EU (81.5 % in 2003) and their reduction will therefore be key to tackling the problem of climate change.

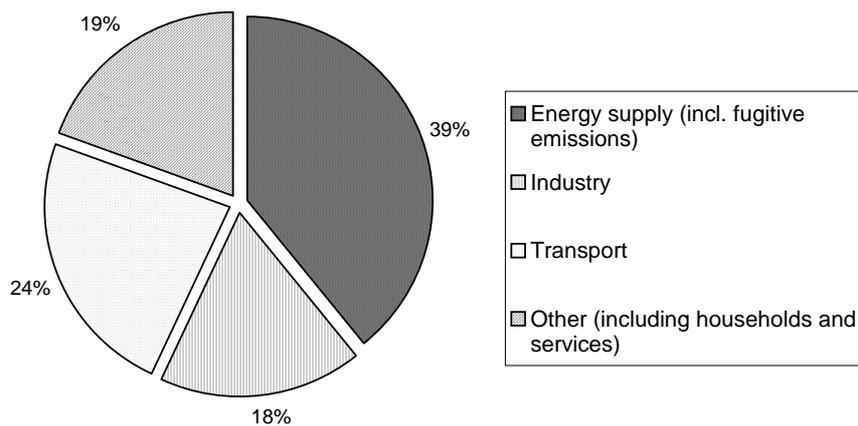
Fig. 1: Change (%) in emissions of energy-related greenhouse gas emissions by gas and sector in the EU-25 between 1990 and 2003, and share (%) of energy-related GHG emissions in 2003



Note: Greenhouse gas emissions have been calculated in equivalent tonnes of carbon dioxide using the following Global Warming Potential (GWP): 1 t CH₄ = 21 t CO₂-equivalent, 1 t N₂O = 310 t CO₂-equivalent. Emissions from international marine and aviation bunkers are reported separately to the UNFCCC and are not included in the graph.

Source: EEA, 2005a

Fig. 2: Energy-related CO₂ emissions by sector in the EU-25 in 2003



Note: Emissions from international marine and aviation bunkers are reported separately to the UNFCCC and are not included in the graph.

Source: EEA, 2005a

1. Indicator assessment¹

Energy-related greenhouse gas emissions in the EU-25 decreased by 2.6 % between 1990 and 2003. Between 2002 and 2003 energy-related greenhouse gas emissions actually increased by 1.7 % mainly due to increases in thermal power production (in particular based on coal), a continued rise in transport emissions and due to colder weather in the first quarter of 2003, as well as a hot summer.

Examining energy-related carbon dioxide, methane and nitrous oxide emissions separately shows marked differences in their shares and trends. Carbon dioxide is by far the most significant energy-related greenhouse gas. Methane and nitrous oxide emissions are only a small fraction of total energy-related emissions (2 % and 1.6 %, respectively, see Fig 1).

Energy-related emissions of **carbon dioxide** account for 96 % of total energy-related greenhouse gas emissions and of 79 % of total greenhouse gas emissions in the EU-25. In the EU-25 energy-related emissions of carbon dioxide decreased by 1.6 % over the period 1990 to 2003, with most EU-15 Member States seeing a rise and most new Member States a decrease in emissions.

CO₂ emissions from the energy supply sector decreased by 5 % between 1990 and 2003, with some new Member States and the United Kingdom and Germany showing large decreases in absolute terms in their emissions, largely due to fuel switching and the introduction of more energy-efficient technologies, such as combined cycle gas turbines. Estimates suggest that around 60 % of the reduction in energy-related CO₂ emissions in Germany were a result of the economic restructuring after 1990 in the five new German Länder which resulted in fuel switch to natural gas and improvements in energy efficiency in power generation. A similar share of the reduction in UK energy-related CO₂ emissions resulted from the liberalisation of the energy market (Fraunhofer Institute, 2001) leading to a fuel switch from coal to natural gas. Most other EU-15 Member States increased their energy-related GHG emissions, reflecting a continued growth in energy demand and reliance on fossil fuels (see EN26 for the share of energy consumption by fuel). Since 1999, CO₂ emissions from energy supply have been rising (+ 7 % between 1999 and 2003), mainly driven by an increase in fossil-fuel-based power generation, in particular from coal (see EN27), to meet the growing demand for electricity (see EN18) and to compensate for a decrease in hydroelectricity production due to low rainfall in 2002 and 2003 (see EN30). Further action is required to ensure that future reductions in CO₂ emissions are achieved in the energy supply sector.

Energy-related CO₂ emissions from industry (manufacturing industry and construction) fell by 14 % between 1990 and 2003. This was predominantly due to reduced emissions from the industry sector in the new Member States and in Germany, which achieved a 34 % reduction in CO₂ emissions between 1990 and 2003. Reductions in Germany were influenced by the economic restructuring following the reunification, with a move towards less energy-intensive industry in the five new Länder, as well as energy efficiency improvements. These reductions have been partly offset by increased emissions in other Member States, in particular in Ireland, Portugal and Spain, which were due to strong economic growth in the industry sector.

¹ See for a more detailed analysis of past emissions the annual EU GHG inventory report (EEA, 2005a). Note that 2004 GHG emission data and revised past trend GHG emission data were published by EEA in June 2006. These data are not included in this and other energy/environment fact sheets, but will be included in an update of the fact sheets due for publication by EEA early 2007.

As a result of continued transport growth and the sector's almost total reliance on fossil fuels, energy-related CO₂ emissions from transport increased by 22 % between 1990 and 2003. During this period, CO₂ emissions from transport increased in nearly all EU-25 Member States. The increase was higher than 80 % in Ireland, Luxembourg, Portugal, Cyprus, Czech Republic and Austria. Only Lithuania and Estonia reduced their emissions. The continued growth in the transport sector presents a problem for most Member States in terms of meeting targets under the Kyoto Protocol.

Energy-related CO₂ emissions from other sectors (consisting mainly of the household and services sectors) decreased by 5 % between 1990 and 2003. Emissions are closely linked to outdoor temperature. Due to colder weather in the first quarter of 2003 and a hot summer in many EU-25 Member States compared with 2002, emissions were higher in 2003 than in 2002, as there was an increased demand for heating and cooling. Important factors influencing the emissions from this source are fuel switching from oil and coal to natural gas in space heating in the new Länder following re-unification, increased energy efficiency in buildings, and increased use of district heating in particular in the Nordic countries. Services are one of the fastest-growing sectors in the economy and could present a challenge for limiting CO₂ emissions in future.

Energy-related emissions of **methane** accounted for about 2 % of total energy-related greenhouse gas emissions in 2003. They decreased by 42 % in the EU-25 over the period 1990-2003. Of these emissions, 84 % were from the energy supply sector and the vast majority of emissions from the energy supply sector arise from fugitive emissions from the extraction, production and distribution of fossil fuels.

Most fugitive emissions result from leaks and planned releases from natural gas distribution and storage and from coal mining. Between 1990 and 2003 the emissions from energy supply fell, partly due to the replacement of old gas distribution networks in many EU-25 Member States and the decline of coal production. Improved practices in oil and gas extraction, such as reduced flaring and venting, have also contributed to the reduction. In a few EU-25 Member States, including Germany, Poland and Spain, fugitive emissions from coal mines remain a significant source of methane emissions. However, coal production in the EU-25 is expected to further decline, which would lead to reduced CH₄ emissions from this source in the future.

Energy-related **nitrous oxide** emissions represented less than 2 % of total energy-related greenhouse gas emissions in 2003, but increased by 31 % since 1990, with the transport sector being the most significant source. Transport sector N₂O emissions increased by 132 % over the period 1990 to 2003, increasing the share of transport sector N₂O emissions in total energy-related N₂O emissions from 24 % to 42 %. This increase was mainly due to the greater use of catalytic converters within a growing road transport sector. Although catalysts reduce emissions of NO_x, CO, NMVOC² and hydrocarbons, a side effect is increased N₂O emissions. However, for newer catalytic converters, N₂O emissions are much lower. N₂O emissions from the energy supply sector increased by 11 % due to rising energy production, while emissions from both industry and households and services fell.

2. Indicator rationale

2.1 Environmental context

This indicator shows trends in energy-related greenhouse gas emissions by gas. Energy-related emissions contribute to 81.5 % of total GHG emissions in EU-25. There is strong evidence that global emissions of greenhouse gases are causing temperatures to increase, resulting in climate change. The potential consequences at the global level include rising sea levels, increased frequency and intensity of floods and droughts, changes in biota and food productivity and increases in diseases. Efforts to reduce or limit the effects of climate change are focused on limiting the emissions of all greenhouse gases covered by the Kyoto Protocol.

2.2 Policy context

The indicator analyses the trend in energy-related greenhouse gas emissions by gas with a focus on EU-25. Under the Kyoto Protocol, the pre-2004 EU-15 Member States are committed to cutting their combined emissions of the greenhouse gases controlled by the Protocol to 8 % below the 1990 level³ over the period 2008-2012. This overall target has been translated into a specific legally binding target for each Member State, based on its capacity to curb emissions (Council Decision 2002/358/EC). New Member States have different targets under the Kyoto Protocol. The Czech Republic, Estonia, Latvia, Lithuania, Slovakia and Slovenia have reduction targets of 8 % from the base-year, while Hungary and Poland have reduction targets of 6 %. Cyprus and Malta have no Kyoto target.

² NMVOC: non methane volatile organic compounds.

³ In fact, the reference year (base year) for the 8 % reduction of the EU-15 is 1990 only for CO₂, CH₄ and N₂O. For the fluorinated gases Member States can choose either 1990 or 1995 as base year; all EU-15 Member States except Finland and France chose 1995. The base-year emissions of the EU-15 are the sum of the EU-15 Member States' base years emissions.

Energy-related emissions account for 82 % of total EU-25 greenhouse gas emissions (see EN01-EU-25) and so reducing these emissions is important if the EU countries are to reach their Kyoto Protocol targets and advance towards achieving a significant long-term reduction in greenhouse gas emissions. The EU has a wide range of policies and measures across all supply and demand sectors that will contribute to reducing total greenhouse gas emissions. These include measures that reduce energy-related emissions by means of increasing energy efficiency and measures that aim to change the fuel mix in favour of fuels that emit smaller amounts of greenhouse gases. The European Climate Change Programme (COM(2000) 88 final), launched in June 2000, is responsible for identifying and developing further policies and measures to ensure that the EU Kyoto Protocol target is met. A new phase of the European Climate Change Programme (ECCP II) was launched in October 2005; it will review progress and explore new actions to systematically exploit cost effective emission-reduction options in synergy with the Lisbon strategy.

The EU Environment Council meeting of 20 December 2004 reaffirmed the EU target of limiting global temperature increase to 2 °C above pre-industrial levels. Following this, the March 2005 meeting of the Environment Council concluded that developed countries should consider reduction pathways in the order of 15–30 % by 2020 and 60–80 % by 2050 compared to the base-year envisaged in the Kyoto Protocol.

References

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IPCC (1997) Revised 1996 IPCC guidelines for national greenhouse gas inventories

IPCC (2000) Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. National Greenhouse Gas Inventories Programme, Japan

UNFCCC (2000) Guidelines on reporting and review, UNFCCC Secretariat, Bonn

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Meta data

Technical information

1. Data source (incl. data of most recent update):

Historical data:

Official data (national total and sectoral emissions) reported to the United Nations Framework Convention on Climate Change (UNFCCC) and under the EU Monitoring Mechanism and EIONET. For the EU-25, the data are compiled by EEA in the European greenhouse gas inventory report (and related database) (EEA, 2005a). Data for the EU-25 Member States were included up to 20 May 2005. EEA published 2004 GHG emission data and revised past trend emission data in June 2006. These updated data are not yet included in this and other related fact sheets, but will be included in an update of the fact sheets due for publication by EEA early 2007. Data on gross inland energy consumption and population are taken from Eurostat (<http://europa.eu.int/comm/eurostat/>).

2. Description of data / Indicator definition

Historical data:

Annual emissions of CO₂, CH₄, N₂O, HFC, PFC and SF₆ in UNFCCC reporting format (In Mtonnes = million tonnes) converted to their global warming potential (100 year time horizon) for addition and comparison with the Kyoto Protocol targets (1 t CH₄ = 21 t CO₂-equivalent, 1 t N₂O = 310 t CO₂-equivalent, 1 t SF₆ = 23 900 t CO₂-equivalent. HFCs and PFCs have a wide range of GWPs depending on the gas and emissions are already reported in t CO₂-equivalent).

For CO₂ only, the (national) totals do not include emissions from biomass burning or emissions or removals from land-use change and forestry (LUCF).

The energy sector (CRF 1) is responsible for energy-related emissions, such as those arising from fuel combustion activities (CRF 1A) and fugitive emissions from fuels (CRF 1B). Fuel combustion activities include: energy industries (CRF 1A1), manufacturing industries and construction (CRF 1A2), transport (CRF 1A3), other sectors (CRF 1A4) and other stationary or mobile emissions from fuel combustion (CRF 1A5). Fugitive emissions from fuels include: solid fuels (1B1) and oil and natural gas (1B2).

'Energy supply' includes 'Energy industries (CRF 1A1)' (i.e. public electricity and heat production, petroleum refining and the manufacture of solid fuels) and 'Fugitive emissions' (CRF 1B) (i.e. emissions from production, processing, transmission, storage and use of fuels, in particular coal mining and gas production).

'Transport' (CRF 1A3) includes road transportation, national civil aviation, railways and navigation, and other non-road transportation. In accordance with UNFCCC and UNECE guidelines, emissions from international aviation and navigation are not included.

'Industry' (CRF 1A2) includes fossil fuel combustion (for heat and electricity) in manufacturing industries and construction (such as iron and steel, non-ferrous metals).

'Households' (CRF 1A4b) includes fossil fuel combustion in households.



'Services sector' (CRF 1A4a + 1A4c + 1A5) includes fossil fuel combustion (for heat and electricity) from small commercial businesses, public institutions, agricultural businesses and military.

Non-energy related emissions include 'Industry' (CRF 2) (i.e. processes in manufacturing industries and construction without fossil fuel combustion including production and consumption of fluorinated gases), 'Agriculture' (CRF 4) (i.e. domestic livestock (dairy and non-dairy cattle) keeping, in particular manure management and enteric fermentation and emissions from soils) 'Waste' (CRF 6) (i.e. waste management facilities, in particular landfill sites and incineration plants and 'Other non-energy' (CRF 3 + 7) (i.e. solvent and other product use).

3. Geographical coverage

EU-25 includes EU-15 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, the United Kingdom) and the ten new EU Member States (Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Malta, Poland, Slovakia, Slovenia.).

4. Temporal coverage

1990-2003. Historical data gaps exist for a few countries and were filled according the implementing provisions under the EU Monitoring Mechanism. For more details see EEA (2005a).

5. Methodology and frequency of data collection (past emission data)

Annual official data submission by EU Member States to UNFCCC and EU Monitoring mechanism. Compilation of emission estimates by Member States is based on combining sectoral activity data, calorific values and carbon emission factors. Recommended methodologies for emission data estimation are compiled in the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (IPCC, 1997), supplemented by the 'Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories' (IPCC, 2000) and UNFCCC Guidelines (UNFCCC, 2000).

6. Methodology of data manipulation:

The data has been weighted according to the following global warming potentials (GWP) for each greenhouse gas: CO₂=1. CH₄=21. N₂O=310 SF₆=23900 to give total GWP emissions in Mt CO₂ equivalent. HFCs and PFCs have a wide range of GWPs depending on the gas and emissions have been reported by the Member States as Mt CO₂ equivalent. Where data is not available for EU Member States, the data gap filling procedure has been used as agreed under the Monitoring Mechanism (EEA. 2005a).

Greenhouse gas intensity of energy use: energy related greenhouse gas emissions from / gross inland energy consumption
Average annual rate of growth calculated using: $[(\text{last year}/\text{base year})^{1/\text{number of years}} - 1] \times 100$

Qualitative information

7. Strength and weaknesses (at data level)

Strength: Officially reported data following agreed procedures. e.g. regarding source sector split. The GWP weighting is the agreed UNFCCC and EU Monitoring Mechanism procedure (IPCC, 1996).

Weakness: HFC, PFC and SF₆ are not reported by all Member States; for Poland, 2003 data was estimated by gap filling.

8. Reliability, accuracy, robustness, uncertainty (at data level):

Indicator uncertainty (historic data)

The IPCC (IPCC, 2000) suggests that the uncertainty in the total GWP-weighted emission estimates, for most European countries, is likely to be less than +/- 20 %. In 2005 for the first time uncertainty estimates were calculated for the EU-15 in EEA (2005a). The results suggest that uncertainties at EU-15 level are between +/- 4 % and 8 % for total EU-15 greenhouse gas emissions. For energy related greenhouse gas emissions the results suggest uncertainties of +/- 1 % (stationary combustion), +/- 3 % (transport) and +/- 11 % (fugitive emissions). Uncertainties for specific gases and for specific sectors are also available at the EU-15 level. For example, the uncertainties associated with public heat and electricity production (CRF 1A1a) are 3 % for CO₂, 25 % for CH₄ and 39 % for N₂O. For stationary combustion as a whole (CRF 1A), the uncertainties are 1 %, 28 % and 105 %, respectively. For the new Member States and some other EEA countries, uncertainties are assumed to be higher than for the EU-15 Member States because of data gaps. Uncertainties in trends are much lower than in absolute values.

9. Overall scoring (1 = no major problems, 3 = major reservations):

Relevance: 1

Accuracy: 1.5

Comparability over time: 2

Comparability over space: 1