EN01 Energy and non energy-related greenhouse gas emissions

Key message

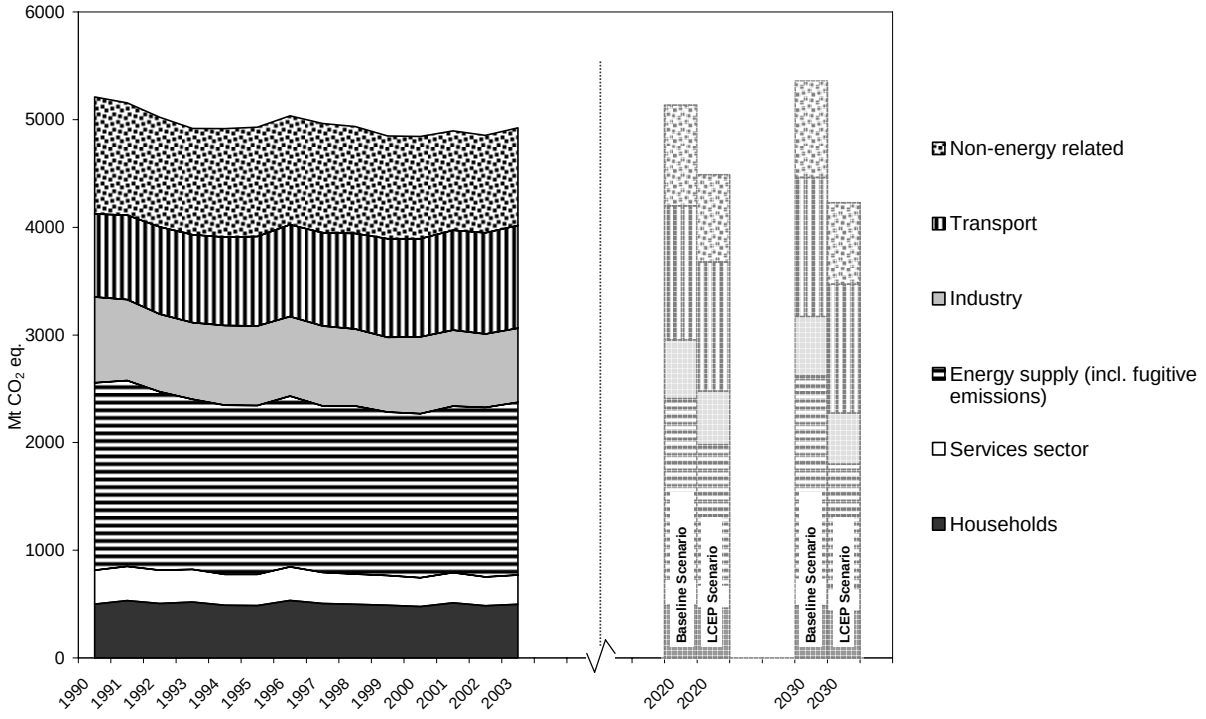
Total EU-25 greenhouse gas emissions fell by 5.5 % between 1990 and 2003, while energy-related emissions — the sector with by far the largest share — fell considerably less (2.6 %). The reduction in energy-related greenhouse gas emissions since 1990 was achieved largely in the energy supply, services and industry sectors, but to a large extent offset by growth in transport emissions. The recent increase since 2000 is mainly due to growing electricity production from thermal power plants, particularly those using coal. Current policies will need to be extended and enhanced and new measures will be required if emission reductions needed in the long term are to be realised.

Rationale

There is growing evidence that global emissions of greenhouse gases are causing global temperatures to increase, resulting in climate change. Efforts to reduce or limit the effects of climate change are focused on limiting the emissions of all greenhouse gases, including those from energy production and consumption. Under the Kyoto Protocol, the pre-2004 EU-15 Member States agreed to reduce their total GHG emissions by 8 % from 1990[1] levels by 2008–2012, while most new Member States have individual targets. The EU Environment Council concluded in March 2005 that developed countries should consider reduction pathways in the order of 15–30 % by 2020 and 60–80 % by 2050 compared to 1990.

This indicator shows past and projected trends in energy and non-energy related greenhouse gas emissions.

Fig. 1: Total energy and non-energy related greenhouse gas emissions by sector, EU-25

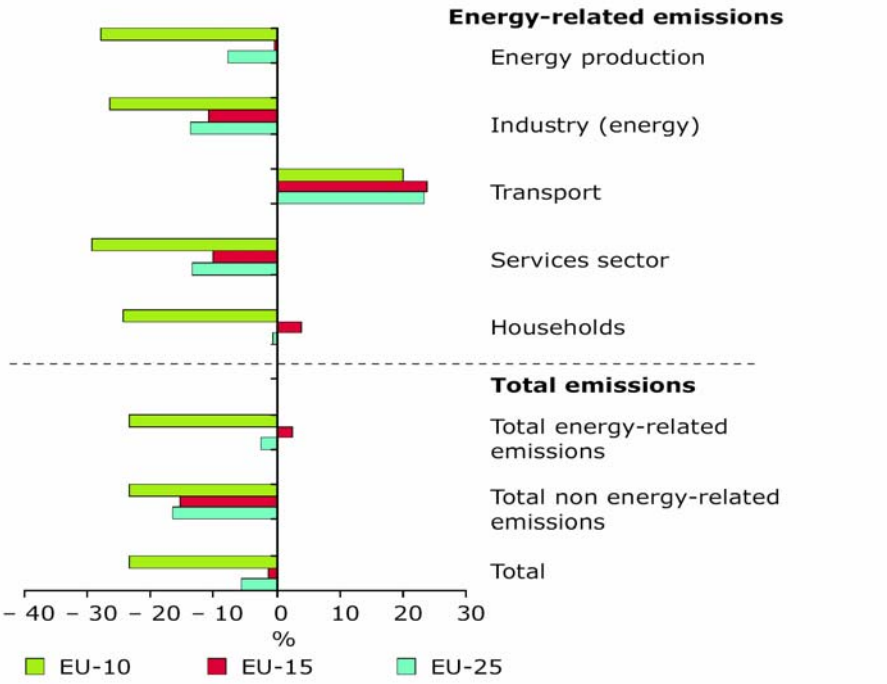


Source: EEA (2005a), EEA (2005c)
Notes:

[1] Base-year level of GHG emissions for EU-15 is calculated by using 1990 emissions for carbon dioxide, methane and nitrous oxide from all Member States, and 1990 or 1995 emissions for fluorinated gases depending on which the Member State has chosen. All EU-15 Member States except Finland and France chose 1995. See for more details on the base year emissions and the individual EU MS targets the annual EU GHG inventory report (EEA, 2005a).

1. Greenhouse gas emissions are those covered by the Kyoto Protocol and include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and three fluorinated gases, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).
2. For the period 1990–2010 the greenhouse gas emissions have been calculated in t CO_2 equivalent using the following Global Warming Potentials (GWP) as specified in the Kyoto Protocol: 1 t CH_4 = 21 t CO_2-equivalent, 1 t N_2O = 310 t CO_2-equivalent, 1 t SF6 = 23 900 t CO_2-equivalent. HFCs and PFCs have a wide range of GWPs depending on the gas and emissions are already reported in t CO_2-equivalent. For 2020 and 2030, revised Global Warming Potentials from the IPCC Third Assessment Report (2001) are used of 1 t CH_4 = 23 t CO_2-equivalent and 1 t N_2O = 296 t CO_2-equivalent.
3. Emissions from international marine and aviation bunkers are not included in national total emissions but are reported separately to the UNFCCC and are therefore not included in the graph.
4. The energy supply sector includes public electricity and heat production, refineries and the manufacture of solid fuels. Energy-related fugitive emissions include releases of gases from exploration, production, processing, transmission, storage and use of fuels. The vast majority of energy-related fugitive emissions are connected with activities of the energy supply sector. Only a very small percentage of fugitive emissions are connected with activities of the transport sector. All energy-related fugitive emissions have therefore been attributed to the energy supply sector.
5. 'Services sector' also includes military and energy-related emissions from agriculture.
6. Past emission data are as reported by countries to UNFCCC and the EU GHG Monitoring Mechanism Decision, more details are provided in the annual EU GHG inventory report (EEA, 2005a). Projections are from the Primes model (NTUA, 2005) for CO_2 and from AEA (2005) for non-CO_2 greenhouse gases and published in EEA (2005c). The Low-Carbon-Energy Pathway (LCEP) scenario assumes that ambitious future greenhouse gas emission reduction targets will be reached, with a CO_2 permit price of EUR 30/t CO_2 and EUR 65/t CO_2 in 2020 and 2030, respectively. National projections for 2010 provided by countries are usually different from these EU-wide projections. EEA annually assesses progress of countries to their national burden-sharing targets in another publication (EEA, 2005b). For those assessments only projections are used as reported by countries.

Fig. 2: Changes (%) in greenhouse gas emissions by source category, 1990-2003



Source: EEA (2005a)

Note: 'Services sector' also includes military and energy-related emissions from agriculture.

1. Indicator assessment[2]

Energy production and consumption are the largest sources of greenhouse gas emissions in the EU-25, accounting for more than 80 % of the total. Energy-related greenhouse gas emissions in the EU-25 decreased by 2.6 % between 1990 and 2003. This was much less than the 16.4 % reduction observed for non-energy related emissions, which resulted in total GHG emissions being 5.5 % below 1990 levels. Between 2002 and 2003 energy-related greenhouse gas emissions actually increased by 1.7 % in the EU-25 mainly due to increases in thermal power production (in particular based on coal; see EN27) and due to colder weather in the first quarter of 2003, which led to an increased use of fuels for heating (see EN16).

The reductions in energy-related emissions since 1990 were helped by structural changes in the economies of the new Member States in central and eastern Europe in the early 1990s, combined with reductions within Germany due to economic restructuring in its new Länder and in the United Kingdom due to a switch from coal to gas (see EN27 and EN26). In addition, a range of specific policies and measures contributed to emission reductions in a number of EU Member States. Sectors showing

[2] See for a more detailed analysis of past and projected emissions the annual EU GHG inventory report (EEA, 2005a) and the annual assessment of GHG emission trends and projections (EEA, 2005b). Note that 2004 GHG emission data and revised past trend GHG emission data were published by EEA in June 2006. Furthermore EEA will publish an updated report on GHG emission projections in Oct/Nov 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.

the largest decreases in greenhouse gas emissions in the EU-25 between 1990 and 2003 were energy supply, services and industry. Emissions from transport in the EU-25 increased by almost 24 % over the same period as a result of a continuous increase in road transport demand (in particular freight), triggered by growing trade volumes.

In the EU-15, overall energy related emissions increased by 2.5 % between 1990 and 2003. As analysed and reported in the EEA report 'Greenhouse gas emission trends and projections 2005' (EEA, 2005b), on the basis of their emissions in 2003 and including Kyoto Mechanisms, most of the EU-15 countries – except Luxembourg, the United Kingdom, Sweden, Germany, France and the Netherlands - were not on track to meet their individual greenhouse gas limitation or reduction targets in 2010, as defined under the EU's burden-sharing agreement (European Council, 2002). In all EU-15 countries, energy-related emissions between 1990 and 2003 either fell less or increased more than total greenhouse gas emissions.

Greenhouse gas emissions have declined substantially more in almost all new Member States. In 2003, energy-related emissions were more than 23 % below 1990 emissions, mainly due to the introduction of market economies and the consequent restructuring or closure of heavily polluting and energy-intensive industries. Transport represents the most rapidly growing source of emissions in these countries. Most new Member States were on track to meet their individual Kyoto targets of 8 % (Czech Republic, Estonia, Latvia, Lithuania, Slovakia and Slovenia) and 6 % (Hungary and Poland) on the basis of their emissions in 2003.

The latest national projections[3] show that in the EU-15, existing measures mean that emissions of greenhouse gases are projected to be 1.6 % below base-year levels in 2010. Including the reductions that Member States forecast they will achieve through additional measures and through the use of Kyoto mechanisms, projected emissions in 2010 are 9.3 % below base - year emissions in EU-15. Seven new Member States project to meet or even over-comply with their Kyoto targets by the use of existing domestic policies and measures. However, in most new Member States, emissions are projected to increase between 2003 and 2010 (EEA, 2005b).

Those existing policies and measures that are currently projected to help most in reducing energy-related emissions include:

- promotion of renewable energy (including electricity from renewable sources, see EN29 and EN30);
- promotion of combined heat and power (CHP, see EN20);
- improvements in the energy performance of buildings;
- increased energy efficiency in large industrial installations;
- promotion of energy-efficient appliances (see EN16 and 21);
- promotion of alternative fuels in transport (in particular biofuels);
- reduction of the average carbon dioxide emissions of new passenger cars.

The new EU emissions trading scheme has created a market for carbon dioxide allowances and aims to ensure that emissions reductions can be made where it is most economically efficient.

Nevertheless, in a long-term perspective, baseline projections for the EU-25 beyond 2010indicate that energy-related CO_2 emissions may start rising again unless further action is taken. By 2030, energy-related CO_2 emissions could reach a level almost 14 % above 1990 levels (EEA, 2005c). It is likely that by 2030, many options for abatement of non energy-related greenhouse gas emissions will have been already exploited, putting a greater burden on the energy sector to achieve reductions. Current policies will therefore need to be extended and enhanced and new measures will be required if long-term emission reductions and the required changes in energy production and consumption patterns (power plants, buildings, transport etc) are to be realised. Given the long lead-times in the energy sector, such changes will be determined by actions taken in the immediate future. Therefore, reducing future energy-related emissions requires additional policy action now.

The Low Carbon Energy Pathway scenario (EEA, 2005c) provides an illustration of how further reductions in greenhouse gases can be achieved through a combination of greater use of renewables, increased energy efficiency and further fuel switching to lower carbon fuels. Under this scenario, EU-25 energy-related CO_2 emissions in 2030 are projected to be 11 % lower than in 1990, as a result of the assumed introduction of a carbon permit price of up to EUR 65/t CO_2 in 2030 (EEA, 2005c).

[3] The national projections are the official projections provided separately by each Member State under the EU Monitoring Mechanism of Greenhouse Gas Emissions (Decision No 280/2004/EC). These projections are then aggregated to give projections for the EU-25, EU-15, etc. Note that the data presented here are those reported by MS until mid 2005 and presented by EEA in a report published in Dec. 2005 (EEA, 2005b). As mentioned in footnote 2 the EEA will update the energy and environment fact sheets with more recent projection data by early 2007.

2. Indicator rationale

2.1 Environmental context

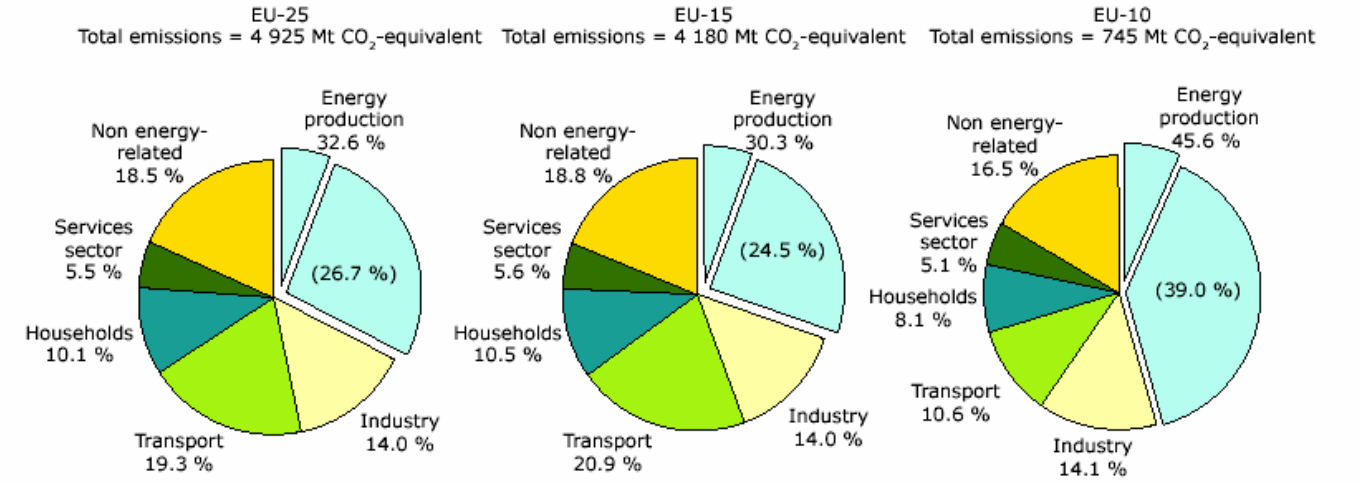
This indicator shows past and projected trends in energy and non-energy-related greenhouse gas emissions. There is growing evidence that global emissions of greenhouse gases are causing global and European surface air temperatures to increase, resulting in climate change (IPCC, 2001). The potential consequences 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. This indicator uses a breakdown in non-energy emissions and energy-related emissions by economic sector.

2.2 Policy context

The indicator analyses the trend in energy and non-energy related greenhouse gas emissions for the EU-25, EU-15 and the new Member States (EU-10). Under the Kyoto Protocol, the pre-2004 Member States (EU-15) are committed to reducing their combined emissions of the greenhouse gases controlled by the Protocol to 8 % below the base year level 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). The new Member States have individual 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. There is no joint Kyoto target for the EU-25.

The EU Environment Council meeting in 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 baseline envisaged in the Kyoto Protocol.

Fig. 3: Total greenhouse gas emissions by sector, 2003



Source: EEA (2005a)

Note: The numbers in parentheses indicate the share of emissions from public heat and electricity production which form the major part of emissions from energy production. Annual emissions of CO_2, CH_4, N_2O, HFC, PFC and SF_6 in the UNFCCC reporting format are converted to their global warming potential GWP (100 year time horizon) for addition and comparison with the Kyoto Protocol targets: 1 t CH_4 = 21 t CO_2-equivalent, 1 t N_2O = 310 t CO_2-equivalent, 1 t SF_6 = 23 900 t CO_2-equivalent. HFCs and PFCs have a wide range of GWPs depending on the gas and emissions are already reported in tonnes CO_2-equivalent.

References

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EEA 2005c: *Climate change and a low-carbon European energy system*, EEA report No 1/2005.

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Meta data

Technical information

1. Data source (incl. data of most recent update)
   Greenhouse-gas emissions is one of the European Environment Agency's core-set indicators. More information can be found at http://themes.eea.eu.int/IMS/CSI.
   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. Data for other EEA countries are compiled for the EEA report Greenhouse gas emission trends and projections in Europe 2005 (EEA, 2005b). Data for these countries were included up to July 2005. EEA published 2004 GHG emission data and revised past trend emission data in June 2006. In Oct/Nov 2006 EEA will publish revised emission projection data. 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/).
   Projection data:
   European Environment Agency (2005) – baseline projections are consistent with European Commission (2004)

2. Description of data/Indicator definition

   Historical data:
   Annual emissions of CO_2, CH_4, N_2O, HFC, PFC and SF_6 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 CH_4 = 21 t CO_2-equivalent, 1 t N_2O = 310 t CO_2-equivalent, 1 t SF_6 = 23 900 t CO_2-equivalent. HFCs and PFCs have a wide range of GWPs depending on the gas and emissions are already reported in t CO_2-equivalent).
   For CO_2 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, and 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).

Projection data:
The PRIMES model was used by the EEA to analyse possible future developments of the European energy sector, including a baseline scenario without a permit price and the low carbon energy pathway (LCEP) scenario. It describes the least-cost response of the EU-25 energy system to the introduction of a carbon permit price that rises to EUR 65 / t CO_2-equivalent by 2030.
Projections of non-CO_2 emissions (CH_4, N_2O and fluorinated gases) were estimated by AEAT for EEA (EEA, 2005c)
National projections are also presented for the Kyoto period (2008–2012, usually countries only provide projections for the year 2010). These are the official projections provided separately by each Member State under the EU Monitoring Mechanism of Greenhouse Gas Emissions (Decision No 280/2004/EC). These projections are then aggregated to give projections for the EU-25, EU-15, EU-10 for 2010. These are published in EEA, 2005b.
National projections for 2010 provided by countries are usually different from the EU-wide projections. EEA annually assesses progress of countries to their national burden sharing targets (EEA, 2005b). For these assessments only projections are used as reported by countries. The EU-wide projections for 2010 provided in this fact sheet are for comparison purposes, but do not replace national projections.

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, Slovenia, Slovakia, Slovenia).

4. Temporal coverage
1990-2003 and projections for 2010 (national projections), 2020 and 2030 (PRIMES model projections). 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 (EEA, 2005a). 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: CO_2 = 1. CH_4=21. N_2O =310 SF6=23900 to give total GWP emissions in Mt CO_2 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 CO_2 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: $[(\text{last year/base year})^{(1 / \text{number of years})} - 1] \times 100$

Qualitative information

7. Strengths 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 (historical 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 CO_2, 25 % for CH4 and 39 % for N_2O. 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.

Indicator uncertainty (scenarios)
Scenario analysis always includes many uncertainties and the results should thus be interpreted with care.

- uncertainties related to future socioeconomic and other developments (e.g. GDP);
- uncertainties in the underlying statistical and empirical data (e.g. on future technology costs and performance);
- uncertainties in the representativeness of the indicator;
- uncertainties in the dynamic behaviour of the energy system and its translation into models;
- uncertainties in future fuel costs and the share of low carbon technologies in the future.

The LCEP scenario uses relatively optimistic assumptions on economic growth, compared with other scenarios. The same level of carbon prices as in the LCEP scenario would lead to higher CO_2 emission reduction when simulated with other models, which may partly result from the fact, that carbon capture and storage was not included in the PRIMES LCEP scenario.

9. Overall scoring – historical data (1 = no major problems, 3 = major reservations):
   Relevance: 1
   Accuracy: 2
   Comparability over time: 2
   Comparability over space: 1