EN26 Total Energy Consumption by Fuel

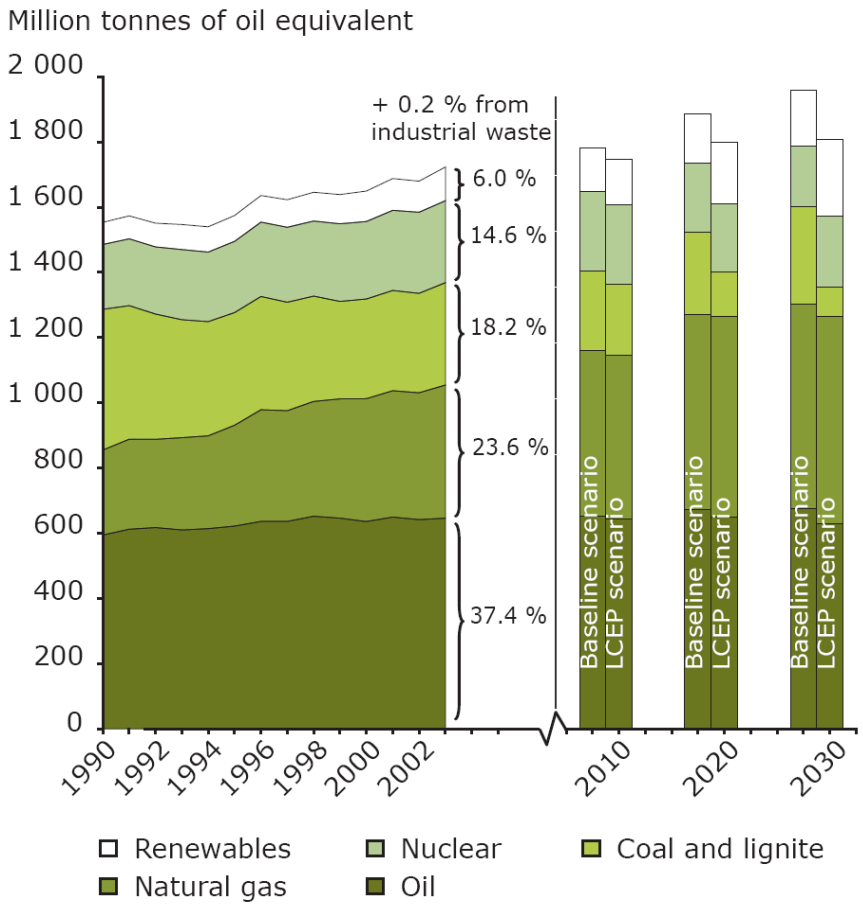
Key message

Fossil fuels continue to dominate total energy consumption, but environmental pressures have been limited by a significant switch from coal and lignite to relatively clean natural gas in the 1990s. The share of renewable energy sources remains small despite an increase in absolute terms. Overall, total energy consumption increased steadily by 0.8 % annually during the period 1990-2003, thus counteracting some of the environmental benefits from the fuel switching.

Rationale

The indicator provides an indication of the environmental pressures originating from energy consumption. The environmental impacts such as resource depletion, greenhouse gas emissions, air pollutant emissions, radioactive waste generation etc. strongly depend on the type and amount of fuel consumed.

Fig. 1: Total energy consumption by fuel, EU-25



Data source: Eurostat (historic data), EEA (2005) for projections.

Notes: EEA baseline projections are consistent with European Commission (2004). The Low-Carbon-Energy Pathway (LCEP) scenario assumes that ambitious future greenhouse gas emission reduction targets will be reached and assumes a CO_2 permit price of 30 €/t CO_2 and 65 €/t CO_2 in 2020 and 2030, respectively. Other energy consumption is not included in the chart as the share (e.g. 0.2 % in 2003) is effectively too small to be seen; it includes consumption of industrial waste and the net balance from imports/exports of electricity.

1. Indicator assessment

Total energy consumption in the EU-25 increased by 10.8 % between 1990 and 2003. Over the same period, the share of fossil fuels such as coal, lignite, oil and natural gas in the total energy consumption declined only slightly to reach 79.3 % in 2003. Their use has considerable impact on the environment and is the main cause of greenhouse gas emissions. Nevertheless, changes to the fossil fuel mix have brought environmental benefits, with coal being replaced by relatively cleaner natural gas, which now has a 23.6 % share. Since 1999, this trend has slowed down with the share of coal remaining almost constant. Benefits to the environment of the fuel switching have been mainly offset by the overall increase in total energy consumption of 10.9 % between 1990 and 2003.

Most of the switching from coal to gas occurred in the power generation sector (see EN27 for more details). In the pre-2004 EU-15 Member States this was supported by implementation of environmental legislation and liberalisation of electricity markets, which stimulated the use of combined-cycle gas plants due to their high efficiency, low capital cost and low gas prices in the early 1990s, and by the expansion of the trans-EU gas network. Fuel mix changes in the new Member States were induced by the process of economic transformation, which led to changes in fuel prices, taxation, the removal of certain energy subsidies and policies to privatise and restructure the energy sector. Since 1999, this trend has slowed down, with the share of coal and lignite remaining almost constant until 2003 (18.2 %), compared to a steep decrease between 1990 and 1999 (from 27.7 % to 18.2 %). This is mainly due to increased gas prices (as well as a shortfall in hydro production due to low rainfall), which have led to a switch back to more use of coal for electricity production in some Member States, such as Austria, Czech Republic, Denmark, Estonia, Finland, Italy, the Netherlands and the United Kingdom. Whether this trend continues over the long term will depend upon factors such as the sharp rise in price of oil (as the price of gas is strongly linked to it) and its expected higher average price over the longer term, as well as counterbalancing factors such as the introduction of the EU emissions trading scheme in 2005 which favours a switch to natural gas to help power generators reduce their CO_2 emissions.

Oil accounted for around 37 % of total energy consumption in 2003 and continued to be the major source of fuel in the transport sector. Consumption increased at an average annual rate of 0.6 % over the period 1990-2003, mainly as a result of increased demand for petrol and diesel in the transport sector on the one hand, and a decline of the use of oil in other sectors, such as for power generation, on the other. Oil consumption is expected to continue to increase into the future but at a slower rate than at present as the growth in demand from the transport sector is expected to slow down and will be partially offset by the decrease in oil fired power production.

Renewable energy, which typically has lower environmental impacts than fossil fuels, has seen rapid growth in absolute terms, but from a low starting point. Renewables were the fastest growing energy source, together with natural gas, but despite increased support at the EU and national level, their contribution to total energy consumption remains low at approximately 6 % in 2003. The share of nuclear power has grown slowly to reach almost 15 % of total energy consumption in 2003 although this was less rapid than during the 1980s as fewer nuclear plants were commissioned. While nuclear power produces little pollution under normal operations there is a risk of accidental radioactive releases, and highly radioactive wastes are accumulating for which no generally acceptable disposal route has yet been established (see EN13 for more details).

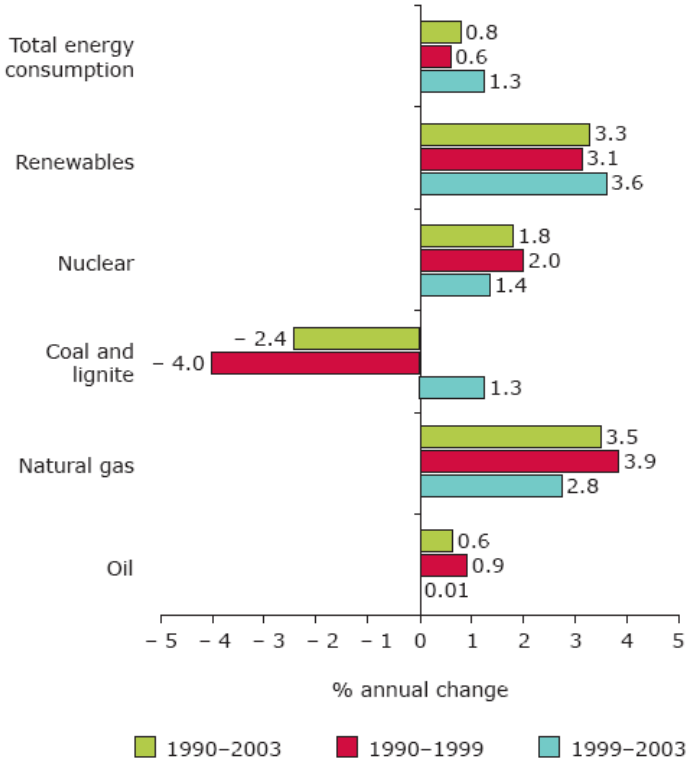
The changes in the fuel mix meant that the greenhouse gas emissions intensity of total energy consumption fell by an average of 1.0 % a year from 1990-2003. However, total energy-related greenhouse gas emissions decreased by only 0.2 % per year on average over the same period (see EN01), as rising total energy consumption counteracted some of the environmental benefits of the fuel switch.

Total energy consumption in the EU-25 increased during the period 1990-2003 at an average rate of 0.8 % per year, although the increase from 2002 to 2003 was 2.5 %, due primarily to lower winter temperatures, compared to 2002. This was less than half the average growth rate of the economy over the same period (2 % p.a.) and, as a result, the energy intensity of the economy declined (see EN17). Important factors behind the relative decoupling in total energy consumption were the economic recession in the pre-2004 EU-15 in the early 1990s, combined with economic restructuring in many of the new EU-10 Member States and in Germany after reunification.

Projections indicate that under a baseline scenario the shares of nuclear and oil in total energy consumption would decline over the period to 2030, with rising shares of natural gas and renewables (EEA, 2005). The share of coal and lignite is expected to decline until around 2015 when it starts to rise again, primarily due to its low relative cost and a need to meet increasing overall demand for energy. The rate of increase in total energy consumption is expected to slow after 2010 due to restructuring in the economy, with continued moves away from energy intensive industries towards lighter industries and services with lower energy intensity (see EN21), and improvements in efficiency. Assuming the introduction of a carbon permit price of up to EUR 65/tCO_2 would primarily result in a is a much more rapid decline in the consumption and hence share of coal and lignite, which is replaced by a more rapid expansion in the share of renewables as well as slightly higher levels of natural gas and nuclear energy consumption (EEA, 2005). The level of total energy consumption would still increase under such a low-carbon energy scenario, but at a slower rate than in the baseline projections due to more rapid improvements in efficiency.

Even in the absence of a carbon-permit price substantial reductions in energy consumption could be realized by a dedicated energy efficiency policy as modeled in a scenario being prepared for DG Transport (European Commission, 2004, 'Energy Efficiency Case'). This scenario assumes that energy efficiency policies and measures were implemented along the lines of the Action Plan on Energy Efficiency. As a result, EU-25 gross inland energy consumption would remain almost stable between 2000 and 2030 instead of increasing by 19 % under a baseline scenario, resulting in a decrease of CO_2 emissions of 4.5 % compared to 1990 instead of a rise of by 14 % as in the baseline.

Fig. 2: Average annual growth rates in total energy consumption by fuel, EU-25



Data source: Eurostat

Note: Other energy consumption is not included in the chart as the share is small (e.g. 0.2 % in 2003); it includes consumption of industrial waste and the net balance from imports/exports of electricity.

2. Indicator rationale

2.1 Environmental context

Total energy consumption is a driving force indicator providing an indication of the extent of environmental pressures caused (or at the risk of being caused) by energy production and consumption. It is disaggregated by fuel source as the environmental impact of each fuel is very specific.

The consumption of fossil fuels (such as crude oil, oil products, hard coal, lignite and natural and derived gas) provides a proxy indicator of resource depletion, CO_2 and other greenhouse gas emissions and air pollution levels (e.g. SO_2 and NO_X). The degree of environmental impact depends on the relative share of different fossil fuels and the extent to which pollution abatement measures are used. Natural gas, for instance, has approximately 40 % less carbon than coal per unit of energy content, and 25 % less carbon content than oil, and contains only marginal quantities of sulphur.

The level of nuclear energy consumption provides an indication of the trends in the amount of nuclear waste generated and of the risks associated with radioactive leaks and accidents. Increasing consumption of nuclear energy at the expense of fossil fuels would on the other hand contribute to reductions in CO_2 emissions.

Renewable energy consumption is a measure of the contribution from technologies that are, in general, more environmentally benign, as they produce no (or very little) net CO_2 and usually significantly lower levels of other pollutants. Renewable energy can, however, have impacts on landscapes and ecosystems (for example, potential flooding and changed water levels from large hydro power) and the incineration of municipal waste (which is generally made up of both renewable and non-renewable material) may also generate local air pollution.

2.2 Policy context

Total energy consumption disaggregated by fuel type is valuable in determining the overall environmental burden of energy consumption in the EU. Trends in the shares of different fuels and the level of total energy consumption will be one of the major determinants of whether the EU meets its target of reduction in greenhouse gas emissions as agreed in 1997 under the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC). The overall Kyoto target for the pre-2004 EU-15 Member States requires an 8 % reduction by 2008-2012 from base year levels (1990 for most greenhouse gases), while most new Member States have individual targets under the Kyoto Protocol.

Moreover, the White Paper 'Energy for the Future: Renewable Sources Of Energy' (COM(97) 599 final) provides a framework for Member States action to develop renewable energy and sets an indicative target to increase the share of renewable energy in total energy consumption in the pre-2004 EU-15 to 12 % by 2010.

Another important policy is the Directive establishing a scheme for greenhouse gas emission allowance trading within the Community (2003/87/EC), which is intended to contribute to the European Union fulfilling its commitments under the Kyoto Protocol. Under the Directive, Member States have to draw up a National Allocation Plan that will include setting caps on CO_2 emissions from all thermal electricity generating plant greater than 20 MW. A shift to less carbon intensive fuels for electricity generation, such as gas, and improvements in efficiency are important options to help generators meet their requirements under the directive. The Large Combustion Plant Directive (2001/80/EC), which aims to control emissions of SO_x NO_x and particulate matter from large (>50MW) combustion plants, will also have a sizeable effect on the shares of energy consumption by fuel type, as it effectively favours the use of higher efficiency gas plant as opposed to coal plant.

The EU's recent Green Paper on energy efficiency (COM(2005)265 final) estimates that the EU could reduce its current level of energy consumption by up to 20 % in a cost-effective manner (with a technical potential of almost 40 %). It aims to identify and address the reasons why these cost effective improvements are not already being taken up (for example, lack of information or appropriate financing mechanisms) – as well as aiming to drive forward a new EU-wide energy efficiency initiative.

Fig. 3: Share of total energy consumption by fuel in 2003

	Coal and lignite	Oil	Gas	Nuclear	Renewables	Industrial waste	Imports-exports of electricity	Total energy consumption (1000 TOE)
EEA members	18.7	36.9	23.7	13.6	6.9	0.2	0.0	1,891,474
EU-25	18.2	37.4	23.6	14.6	6.0	0.2	0.0	1,726,187
EU-15 pre-2004 members	14.7	39.4	24.2	15.3	6.1	0.1	0.2	1,513,568
EU-10 new members	43.2	23.4	19.7	9.2	5.3	0.3	-1.1	212,619
Belgium	11.1	38.0	25.8	21.9	1.9	0.2	1.0	55,785
Czech Republic	47.4	19.7	18.0	15.3	2.8	0.2	-3.2	43,665
Denmark	27.4	40.3	22.5	0.0	13.3	0.0	-3.5	20,676
Germany	24.7	36.4	23.0	12.4	3.4	0.3	-0.1	344,487
Estonia	61.9	19.1	12.5	0.0	9.5	0.0	-3.0	5,456
Greece	29.5	58.0	6.7	0.0	5.1	0.0	0.6	30,160
Spain	15.0	50.0	15.9	11.9	7.0	0.0	0.1	134,055
France	5.1	34.0	14.6	42.0	6.4	0.0	-2.1	270,621
Ireland	16.5	57.1	24.1	0.0	1.7	0.0	0.7	15,269
Italy	8.2	48.6	34.8	0.0	5.9	0.1	2.4	182,007
Cyprus	1.5	97.1	0.0	0.0	1.5	0.0	0.0	2,547
Latvia	2.2	28.5	30.8	0.0	33.4	0.0	5.2	4,378
Lithuania	2.1	26.4	26.5	44.4	7.8	0.0	-7.2	9,004
Luxembourg	1.9	63.8	25.4	0.0	1.4	0.0	7.6	4,196
Hungary	14.0	25.3	44.4	10.6	3.4	0.0	2.2	26,744
Malta	0.0	100.0	0.0	0.0	0.0	0.0	0.0	874
Netherlands	10.9	38.8	44.7	1.3	2.5	0.0	1.8	80,455
Austria	12.1	42.2	23.1	0.0	20.3	0.8	1.5	32,725
Poland	61.3	21.7	12.0	0.0	5.4	0.6	-0.9	94,109
Portugal	13.0	58.7	10.4	0.0	17.0	0.0	0.9	25,331
Slovenia	21.4	35.4	13.1	19.3	10.5	0.1	0.2	6,948
Slovakia	24.2	18.9	30.1	24.4	3.3	0.1	-1.0	18,894
Finland	22.2	27.9	11.0	15.8	21.2	0.8	1.1	37,101
Sweden	5.3	30.4	1.6	34.2	26.3	0.1	2.2	50,878
United Kingdom	16.7	34.5	37.4	10.0	1.4	0.0	0.1	229,822
Bulgaria	38.0	23.3	13.0	23.1	4.9	0.1	-2.4	19,279
Romania	23.5	26.3	37.5	3.1	9.9	0.2	-0.4	40,504
Turkey	26.7	38.4	22.2	0.0	12.6	0.0	0.1	79,721
Iceland	2.8	24.4	0.0	0.0	72.8	0.0	0.0	3,373
Norway	3.5	22.1	23.9	0.0	47.3	0.1	3.0	22,410

Data source: Eurostat

Notes: Negative values mean there were more exports than imports of electricity. No data is available from Eurostat for Liechtenstein.

References

COM(97) 599 final - Energy for the future: Renewable sources of energy. White Paper for a Community strategy and action plan

COM (2005) 265 final – Green Paper on energy efficiency, or doing more with less , European Commission http://europa.eu.int/comm/energy/efficiency/doc/2005_06_green_paper_text_en.pdf

Council Decision 2002/358/EC to ratify the Kyoto Protocol under the United Nations Framework Convention on Climate Change

DG TREN Energy sources and demand management legislation website http://europa.eu.int/comm/energy/index_en.html

Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants

Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC

EEA (2005) Climate change and a low-carbon European energy system, European Environment Agency report No 1/2005

European Commission (2004) European energy and transport – scenarios on key drivers, Directorate General for Transport and Energy

UNFCCC (1997) Kyoto Protocol to the United Nations Framework Convention on Climate Change

adopted at COP3 in Kyoto, Japan, on 11 December 1997

Meta data

Technical information

1. Data source:
   Energy Consumption by fuel and total: Eurostat (historical data): http://europa.eu.int/comm/eurostat/
   Projection data: European Environment Agency (2005) – baseline projections are consistent with European Commission (2004).
   Total energy consumption by fuel is one of the European Environment Agency's core-set indicators. More information can be found at http://themes.eea.eu.int/IMS/CSI.

2. Description of data/Indicator definition:
   Total energy consumption or gross inland energy consumption represents the quantity of energy necessary to satisfy the inland consumption of a country. It is calculated as the sum of the gross inland consumption of energy from solid fuels, oil, gas, nuclear and renewable sources, and a small component of 'other' sources (industrial waste and net imports of electricity). The relative contribution of a specific fuel is measured by the ratio between the energy consumption originating from that specific fuel and the total gross inland energy consumption calculated for a calendar year.
   Units: Energy consumption is measured in thousand tonnes of oil equivalent (ktoe). The share of each fuel in total energy consumption is presented in the form of a percentage.
   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.

3. Geographical coverage:
   The Agency had 31 member countries at the time of writing of this fact sheet. These are the 25 European Union Member States and Bulgaria, Romania and Turkey, plus Iceland, Norway and Liechtenstein. On 1 April 2006, Switzerland joined the EEA, bringing its number of member countries to 32.
   No energy data available for Switzerland and Liechtenstein. No projection data are available for Iceland, Liechtenstein.

4. Temporal coverage: 1990-2003, projections to 2030 in 10 year intervals.

5. Methodology and frequency of data collection:
   Data collected annually.
   Eurostat definitions for energy statistics http://forum.europa.eu.int/irc/dsis/coded/info/data/coded/en/Theme9.htm
   Eurostat metadata for energy statistics http://europa.eu.int/estatref/info/sdds/en/sirene/energy_base.htm

6. Methodology of data manipulation:
   Average annual rate of growth calculated using: [(last year/base year) ^ (1/number of years) –1]*100
   The coding (used in the Eurostat New Cronos database) and specific components of the indicator are:
   • Numerator: solid fuels 2000 gross inland consumption 100900 + oil 3000 gross inland consumption 100900 + gas 4000 gross inland consumption 100900 + nuclear energy 5100 gross inland consumption 100900 + renewable energies 5500 gross inland consumption 100900 + industrial waste 7100 gross inland consumption + 6000 electrical energy 100900 gross inland consumption.
   • Denominator: (total) gross inland consumption (of energy) 100900

Qualitative information

7. Strengths and weaknesses (at data level)
   Officially reported data, updated annually. No obvious weaknesses.
   Data have been traditionally compiled by Eurostat through the annual Joint Questionnaires, 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 in Eurostat's web page for metadata on energy statistics.
   http://europa.eu.int/estatref/info/sdds/en/sirene/energy_sm1.htm

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

   Indicator uncertainty (historic data)
   The share of energy consumption for a particular fuel could decrease even though the actual amount of energy used from that fuel grows, as the development of the share for a particular fuel depends on the change in its consumption relative to the total consumption of energy.
   From an environmental point of view, however, the relative contribution of each fuel has to be put in the wider context. Absolute (as opposed to relative) volumes of energy consumption for each fuel are the key to understanding the environmental pressures. These depend on the total amount of energy consumption as well as on the fuel mix used and the extent to which pollution abatement technologies are used.
   Total energy consumption may not accurately represent the energy needs of a country (in terms of final energy demand). Fuel switching may in some cases have a significant effect in changing total energy consumption even though there is no change in (final) energy demand. This is because different fuels and different technologies convert primary energy into useful energy with different efficiency rates.

   Indicator uncertainty (scenarios/projections)
   Scenario analysis always includes many uncertainties and the results should thus be interpreted with care:
   - uncertainties related to future socioeconomic developments (e.g. GDP) and human choices;
   - uncertainties in the underlying statistical and empirical data (e.g. on future technology costs and performance);
   - uncertainties in the choice of indicators (representativeness);
   - uncertainties in the dynamic behaviour of systems and its translation into models;
   - uncertainties in future fuel costs and the impact on low carbon technologies.

   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 (e.g. TIMER), 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: 1
   Comparability over time: 1
   Comparability over space: 1