EN17 Total Energy Intensity

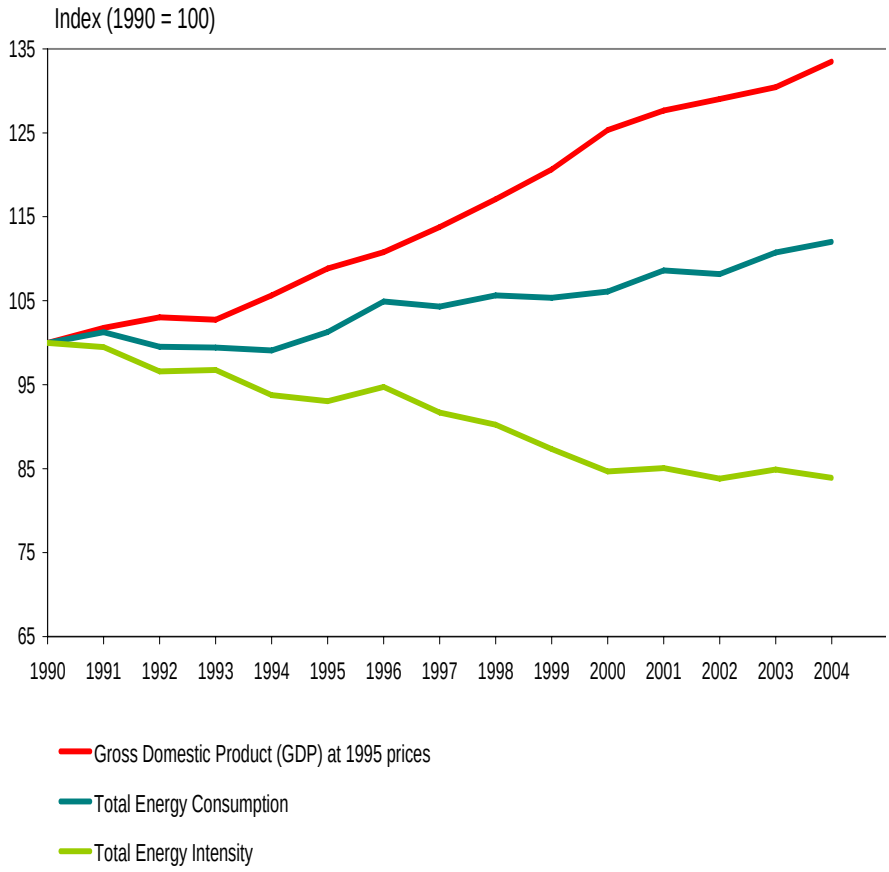
Key message

Economic growth has required less additional energy consumption over the 1990s, although total energy consumption is still increasing. However, since 2000 the rate of decrease in energy intensity has slowed, remaining almost stable to 2004. This was due to a slowdown in the rate of GDP growth, while energy consumption continued to rise strongly.

Rationale

Historically, economic growth has led to increased energy consumption, thus putting increased pressure on the environment. The indicator identifies to what extent there is a decoupling between energy consumption and economic growth.

Fig. 1: Trends in total energy intensity, gross domestic product and total energy consumption, EU-25



Data source: Eurostat and Ameco database, European Commission.

Note: Some estimates have been necessary in order to compute the EU-25 GDP index in 1990. For some EU-25 member states Eurostat data was not available for a particular year. The European Commission's annual macroeconomic database (Ameco) was used as an additional data source. GDP for the missing year is estimated on the basis of the annual growth rate from Ameco, rate which is applied to the latest available GDP from Eurostat. This method was used for the Czech Republic (1990-94), Cyprus (1990-94), Hungary (1990), Poland (1990-94), Malta (1991-1998) and for Germany (1990). For some other countries and years, however, GDP wasn't available from Eurostat or from Ameco. With the purpose of estimating the EU-25, few assumptions were made. For Estonia, GDP in 1990-92 is assumed constant and takes the value observed in 1993. For Slovakia, GDP in 1990-91 takes the value of 1992. For Malta, GDP in 1990 is assumed to be equal to GDP in 1991. These assumptions do not distort the trend observed for the EU-25's GDP, since the latter three countries represent about 0.3-0.4% of the EU-25's GDP.

1. Indicator assessment

Total energy consumption in the EU-25 grew at an annual rate of just over 0.8 % over the period from 1990 to 2004, while Gross Domestic Product (GDP) grew at an average annual rate of 2.1 % during the same period. As a result, total energy intensity in the EU-25 fell at an average rate of -1.2 % per year (a total decrease of -16 % between 1990 and 2004). Despite this relative decoupling, total energy consumption has increased by 12.0 % overall in the period 1990-2004. Energy intensity declined over 1990-2000 (and continuously during 1996-2000) but has remained broadly stable since then.

The reduction of total energy intensity has been influenced both by improvements in energy efficiency and structural changes within the economy. The latter included a shift from industry towards services, which are typically less energy intensive, a shift within the industrial sector from energy intensive industries towards higher value added, less energy intensive industries[1], and one-off changes in some Member States (e.g. most new Member States as well as Luxembourg and Germany). Furthermore, improvements in the efficiency of power generation (see EN19) as well as in intensity in some end-use sectors contributed to the reduced overall energy intensity. On the level of end-use sectors, trends in final energy consumption intensity suggest that there have been substantial improvements in the industry and services sectors over the period 1990-2004 (see EN21 for more details). In contrast, the transport and households sectors show only limited decoupling of energy consumption from economic and population growth respectively. The stagnating trend since 2000 was primarily due to a slowing in the rate of GDP growth from this point, compared to a continued growth in overall energy consumption.

There are significant differences in total energy intensity within the EU-25 Member States, with the highest intensities in Estonia, Finland and Slovakia and the lowest in Ireland, Italy and Denmark (when compared at Purchasing Power Standards). Total energy intensity in the new EU-10 Member States is on average still around 1.4 times higher than in the pre-2004 EU-15 Member States, despite a converging trend: the average annual decrease since 1990 is -3.4 % in the new EU Member countries, while it was –1.0 % in the pre-2004 EU-15 Member States.

Energy intensity is a measure of total energy consumption in relation to economic activity. Total energy consumption by fuel (see relevant core set indicator) is needed in addition for understanding the resulting pressures on the environment, since these pressures are very different for the various fuels and the use of renewable energy sources, with relatively low environmental pressures, in total energy consumption varies widely across EU countries. Therefore, comparing energy intensities across countries has to be put in the wider context of the fuel mix used in the production of the energy needs of a country.

All EU-25 Member States with the exception of Portugal, Italy, and Austria experienced a decrease in total energy intensity between 1995 and 2004[2]. The largest decrease occurred in the new Member States, in particular in Latvia, Estonia, Poland, and Lithuania which improved their total energy consumption intensity by more than 4 % annually over that period. The opening up of their economies, changes in ownership structures (through increasing privatisation), and rises in the price of raw materials and energy also increased the priority for efficiency in industry. The removal of energy subsidies in order to lower state budget costs and improve the economics of national energy utilities has been a major factor in price increases. However, many industries have been unable to survive in internationally competitive markets and, as a result, their production has decreased dramatically. In the pre-2004 EU-15 Member States the shift towards less energy intensive industry and high value added services continues to be observed. In particular, Ireland, the U.K., Sweden and Denmark improved their total energy consumption intensity considerably between 1995 and 2004 (by more than 2% annually). In Ireland, rapid economic growth and a booming service sector has been the primary cause, whereas in the U.K. changes have been driven by reductions across manufacturing sectors combined with an increased service sector.

PRIMES projections for the energy sector suggest that total energy consumption intensity could continue to decline, decreasing to roughly one third of its 2000 value by year 2030 (European Commission 2006). A Low Carbon Energy Pathway scenario projection, which assumes a CO_2 permit price of up to EUR 65/tCO_2, shows a slightly higher rate of improvement (EEA 2005). Both of these projections indicate a somewhat faster decrease than has been seen in recent years and are based on an expectation that the trend towards economic growth in sectors representing low energy intensity goods and services will continue, that the increase in demand for transportation will slow and that further efforts will be made to improve energy efficiency. These results do not imply that total energy consumption will fall in absolute terms. The PRIMES scenario projects it to rise by almost 15 % between 2000 and 2030.

2. Indicator rationale

[1] Creating one unit of GDP in the services sector requires around 1/8 of the energy that would be needed to create one unit of GDP in the manufacturing sector (EU-15 average); creating one unit of value added in energy-intensive industries (such as producing primary metals) requires 11 times more energy than creating one unit in the equipment branch (ADEME, 2005)

[2] GDP was not available for all countries in 1990, particularly in the EU-10 new members. Country comparisons use 1995 as the reference year to avoid using country-specific estimates before 1995. See metadata for more details.

2.1 Environmental context

The type and extent of energy-related pressures on the environment, such as air pollution and global warming, depends on the sources of energy and how and in what quantities they are used. One way of reducing energy-related pressures on the environment is to use less energy. This may result from reducing the demand for energy-related activities (e.g. for warmth, passenger or freight transport), or by using energy in a more efficient way (thereby using less energy per unit of activity), or a combination of the two.

The indicator identifies the extent, if any, of decoupling between energy consumption and economic growth. Relative decoupling occurs when energy consumption grows, but more slowly than gross domestic product. Absolute decoupling occurs when energy consumption is stable or falls while GDP grows. From an environmental point of view, however, overall impacts depend on the total amount of energy consumption and the fuels and technology used to produce the energy.

The indicator does not show any of the underlying reasons that affect the trends. A reduction in total energy intensity can be the result of improvements in energy efficiency or changes in energy demand resulting from other factors including structural, societal, behavioural or technical change.

2.2 Policy context

Even though there is no target for total energy intensity, a number of EU Directives, Action Plans and Community strategies directly or indirectly relate to energy efficiency, e.g. the sixth Environmental Action Plan calls for the promotion of energy efficiency. The indicative target for final energy consumption intensity in the EU, set in the 1998 Communication 'Energy Efficiency in the European Community: Towards a Strategy for the Rational Use of Energy', COM(98) 246 final, proposes an improvement in the intensity of final energy consumption from 1998 of 1 % per year 'over and above that which would otherwise be attained'. Following on from this, the directive on energy end-use efficiency and energy services (2006/32/EC) sets indicative targets for Member States to save 9 % per year of energy compared with business-as-usual after nine years of its implementation.

The EU's 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 focuses also on the demand side and 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. The EU Green Paper on secure, competitive and sustainable energy (COM(2006)105 final) for Europe reiterated the need to curb energy demand and indicated that the EU will propose an Action Plan on Energy Efficiency to address barriers and realise this potential.

In addition, most of the new Member States have officially made energy efficiency a priority goal and all have some policies aimed at improving the energy intensity of the national economy. These will play an important role in meeting the EU's and new Member States targets under the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) to reduce greenhouse gas emissions.

Fig. 2: Total energy intensity 1995-2004 (index 1995=100)

	1995	2000	2001	2002	2003	2004	Annual average change 1995-2004	Energy intensity in 2004 (TOE per million GDP in PPS relative to EU-25)	Total energy intensity in 2004 (TOE per capita)
EEA	100.0	90.9	91.1	89.7	91.2	89.9	-1.2%	102	3.4
EU-25	100.0	91.0	91.5	90.1	91.3	90.2	-1.1%	100	3.8
EU-15	100.0	92.7	93.2	91.8	93.0	92.1	-0.9%	96	4.0
EU-10	100.0	76.1	75.9	74.2	73.8	70.3	-3.8%	137	2.8
Belgium	100.0	99.3	95.7	89.0	93.7	89.7	-1.2%	117	5.3
Czech Republic	100.0	92.4	91.9	91.1	92.8	88.7	-1.3%	160	4.3
Denmark	100.0	84.3	85.9	83.9	86.7	82.7	-2.1%	80	3.7
Germany	100.0	91.1	93.2	91.2	91.9	90.6	-1.1%	102	4.2
Estonia	100.0	66.1	69.2	62.9	64.2	62.1	-5.2%	214	4.2
Greece	100.0	98.2	96.3	95.3	92.3	89.5	-1.2%	89	2.8
Spain	100.0	98.2	97.6	97.7	98.1	99.4	-0.1%	89	3.3
France	100.0	93.8	94.9	93.9	94.4	93.4	-0.8%	105	4.5
Ireland	100.0	81.5	80.1	77.2	72.6	73.4	-3.4%	74	3.9
Italy	100.0	97.4	95.9	95.8	101.0	101.0	0.1%	79	3.2
Cyprus	100.0	100.5	97.6	96.2	102.5	93.2	-0.8%	107	3.4
Latvia	100.0	62.4	62.2	57.9	56.7	54.4	-6.5%	122	2.0
Lithuania	100.0	68.0	70.6	71.5	67.4	64.0	-4.8%	147	2.7
Luxembourg	100.0	80.8	81.8	83.4	86.2	92.1	-0.9%	114	10.4
Hungary	100.0	78.8	76.9	75.2	74.7	70.0	-3.9%	113	2.6
Malta	100.0	76.2	72.1	85.6	87.9	89.6	-1.2%	83	2.2
Netherlands	100.0	84.6	85.1	85.7	88.3	88.8	-1.3%	107	5.1
Austria	100.0	92.2	97.8	96.6	102.2	100.2	0.0%	86	4.0
Poland	100.0	69.8	69.0	67.0	66.3	63.4	-4.9%	131	2.4
Portugal	100.0	100.6	101.3	105.4	104.2	106.2	0.7%	91	2.5
Slovenia	100.0	85.2	87.1	86.0	84.2	83.2	-2.0%	119	3.6
Slovakia	100.0	81.8	85.0	82.1	78.4	72.1	-3.6%	168	3.4
Finland	100.0	89.8	91.1	94.2	97.3	95.0	-0.6%	169	7.2
Sweden	100.0	81.1	86.3	84.5	82.5	82.6	-2.1%	133	5.9
United Kingdom	100.0	90.1	88.7	84.9	84.3	82.4	-2.1%	88	3.9
Bulgaria	100.0	83.0	83.0	77.6	76.1	70.0	-3.9%	209	2.4
Romania	100.0	83.8	78.7	76.3	77.9	70.6	-3.8%	149	1.8
Turkey	100.0	102.8	102.5	100.2	99.7	94.5	-0.6%	105	1.2
Iceland	100.0	119.5	119.4	121.8	117.9	112.5	1.3%	247	12.0
Norway	100.0	92.2	92.6	82.7	91.6	90.3	-1.1%	103	6.0

Data source: Eurostat.
Note: The reference year is 1995 because GDP was not available for all EU countries in 1990. The penultimate column (TEI at PPS 2004) shows the energy intensity measured in purchasing power standards. These are currency conversion rates that both convert to a common currency and equalise the purchasing power of different currencies (based on a consistent group of goods and services). They eliminate the differences in price levels between countries, allowing meaningful volume comparisons of GDP. They are an optimal unit for benchmarking country performance in a particular year. Energy data is not available for Liechtenstein or Switzerland from Eurostat.

References

ADEME (2005): Energy-efficiency monitoring in the EU-15.

COM(1998) 246 final - Energy Efficiency in the European Community: Towards a Strategy for the Rational Use of Energy.

COM(2003) 739 - Proposal for a Directive of the European Parliament and the Council on energy end-use efficiency and energy services.

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.

COM(2006)105 final – Green Paper on A European Strategy for Sustainable, Competitive and Secure Energy http://ec.europa.eu/energy/green-paper-energy/doc/2006_03_08_gp_document_en.pdf

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

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http://ec.europa.eu/dgs/energy_transport/figures/trends_2030_update_2005/index_en.htm

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

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

WWF (2004): Ending Wasteful Energy Use in Central and Eastern Europe
http://www.panda.org/downloads/europe/endingwastefulenergyincentraleasterneurope.pdf.

Meta data

Technical information

1. Data source:
   Gross inland energy consumption, Gross domestic product: Eurostat (historical data) http://europa.eu.int/comm/eurostat/.
   GDP growth rates used in the estimation of missing Eurostat data from European Commission Ameco database (historical data)
   http://europa.eu.int/comm/economy_finance/indicators/annual_macro_economic_database/ameco_en.htm
   Projection data: PRIMES energy model (European Commission 2006)
   Total energy intensity 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:
   http://themes.eea.eu.int/IMS/CSI
   Total energy intensity is the ratio between the gross inland consumption of energy (or total energy consumption) and Gross Domestic Product (GDP) calculated for a calendar year. The gross inland consumption of energy is calculated as the sum of the gross inland consumption of the five sources of energy: solid fuels, oil, gas, nuclear and renewable sources. To monitor trends, GDP is in constant prices to avoid the impact of inflation, base year 1995 (ESA95).
   Units: Gross inland energy consumption is measured in 1000 tonnes of oil equivalent (ktoe) and GDP in million Euro at 1995 market prices. To make comparisons of trends across countries more meaningful, the indicator is presented as an index. For country comparisons, two additional columns are included to show the actual energy intensity in GDP in purchasing power standards for the latest available year, and also the energy intensity in terms of consumption per capita.

3. Geographical coverage:
   The Agency had 32 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 Switzerland, Iceland, Norway and Liechtenstein.
   No energy data available for Switzerland and Liechtenstein. No projection data are available for Iceland, Liechtenstein.

4. Temporal coverage: 1990-2004, projections to 2030 in 5 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:
   Total energy intensity (TEI) is defined as gross/total inland energy consumption (GIEC) divided by gross domestic product (GDP) at constant (1995) prices (i.e. to illustrate trends in economic energy intensity). The coding (used in the Eurostat New Cronos database) and specific components of the indicator are:
   - Numerator: 100900 Gross inland consumption (of energy).
   - Denominator: B1GM Gross domestic product at (1995) market prices (GDP in PPS is used for cross-country comparisons of energy intensity in a particular year)

   Average annual rate of growth calculated using: [(last year / base year) ^ (1 / number of years) –1]*100
   Some estimates have been necessary in order to compute the EU-25 GDP index in 1990. For some EU-25 member states Eurostat data was not available for a particular year. The European Commission's annual macroeconomic database (Ameco) was used as an additional data source. GDP for the missing year is estimated on the basis of the annual growth rate from Ameco, rate which is applied to the latest available GDP from Eurostat. This method was used for the Czech Republic (1990-94), Cyprus (1990-94), Hungary (1990), Poland (1990-94), Malta (1991-1998) and for Germany (1990). For some other countries and years, however, GDP wasn't available from Eurostat or from Ameco. With the purpose of estimating the EU-25, few assumptions were made. For Estonia, GDP in 1990-92 is assumed constant and takes the value observed in 1993. For Slovakia, GDP in 1990-91 takes the value of 1992. For Malta, GDP in 1990 is assumed to be equal to GDP in 1991. These assumptions do not distort the trend observed for the EU-25's GDP, since the latter three countries represent about 0.3-0.4% of the EU-25's GDP.

Qualitative information

7. Strengths and weaknesses (at data level)
   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
   Gross domestic product (GDP) is the central aggregate of National Accounts. Some estimates have been necessary using the procedure described in 6. Methodological information related to GDP can be found at http://europa.eu.int/estatref/info/sdds/en/aggs/aggs_base.htm

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

   Indicator uncertainty (historic data):
   There is no GDP available from Eurostat for the EU-25 in 1990. Moreover, data was not available for a particular year for some EU-25 Member States. The European Commission's annual macroeconomic database (Ameco) has been used to estimate GDP for the missing years and countries by applying annual growth rates from Ameco to the latest available GDP data from Eurostat. This allowed us to get a reasonable estimate of the EU-25 in 1990. The year 1995 was chosen as the base year for the indices in the country table in order to avoid using country-specific estimates before 1995.
   The intensity of energy consumption is relative to changes in real GDP. Cross-country comparisons of energy intensity based on real GDP are relevant for trends but not for comparing energy intensity levels in specific years and specific countries. This is why the indicator is expressed as an index. In order to compare the energy intensity between countries for a specific year, two additional columns are included showing energy intensity in purchasing power standards (PPS) and energy intensity per capita. PPS are currency conversion rates that convert to a common currency and equalise the purchasing power of different currencies. They are an optimal unit for benchmarking country performance in a particular year.
   Energy intensity is not sufficient for measuring the environmental impact of energy use and production. Even when two countries have the same energy intensity or show the same trend over time there could be important environmental differences between them. The link to environmental pressures has to be made on the basis of the absolute amounts of the different fuels used to produce that energy. Energy intensity should therefore always be put in the broader context of the actual fuel mix used to generate the energy.

   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.

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