

## EN17 Total Primary Energy Intensity

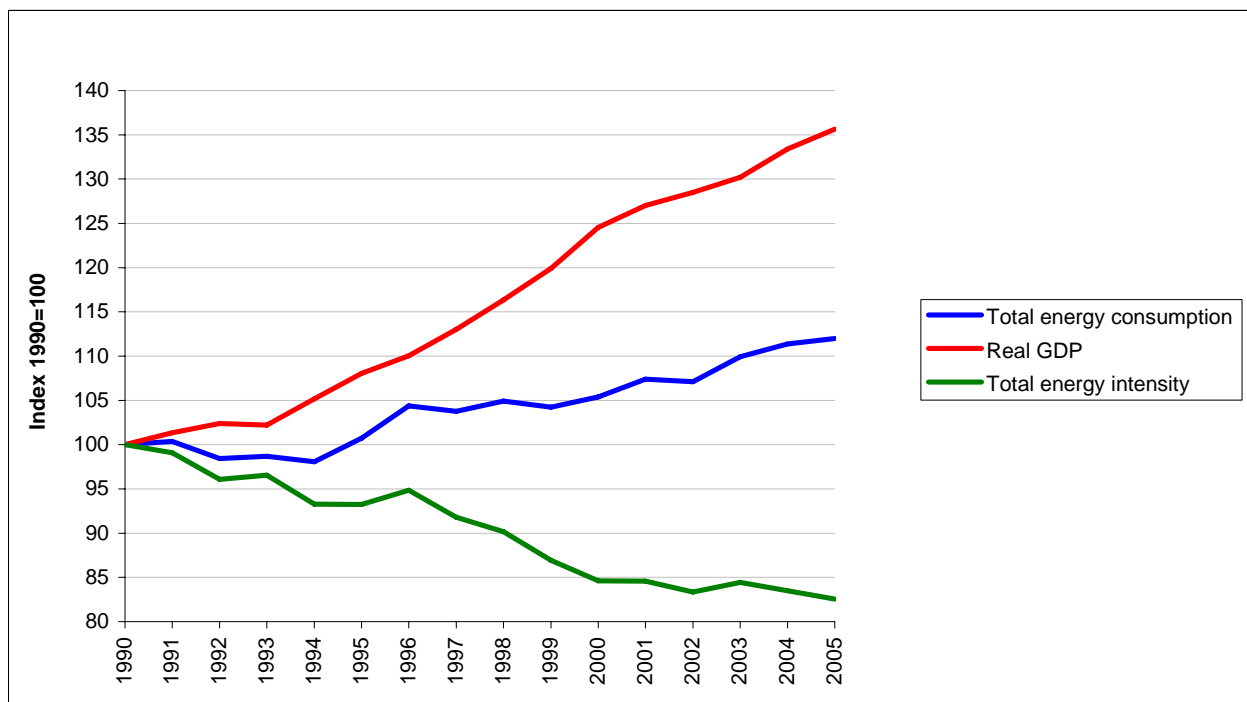
### Key message

Economic growth has required less additional energy consumption over the 1990s, although total energy consumption is still increasing. Thus, there has been a relative decoupling but not an absolute decoupling. Because energy is produced using different fuels, the environmental impact of changes in energy intensity has to be put in the wider context of the fuel mix used in each country. The average EU citizen uses 3.7 tonnes of oil equivalent per year, although this varies widely across countries.

### 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-27**



**Data source:** EEA, Eurostat and Ameco database, European Commission.

**Note:** Some estimates have been necessary for computing the EU-27 GDP index in 1990. For a few member states Eurostat data was not available: Czech Republic (1990-94), Bulgaria (1990), Romania (1990-98), Cyprus (1990-94), Hungary (1990), Poland (1990-94), Malta (1991-1998) and Germany (1990). The European Commission's annual macroeconomic database (AMECO) was used as an additional data source for filling the gaps, although this could not be done in all cases. With the purpose of estimating the EU-27 aggregate, few assumptions were made: GDP in Germany in 1990 has been estimated by applying the 1990-91 growth rate in West Germany to the 1991 GDP in Germany. The Commission 2004 Autumn forecasts is the source of GDP in 1990 in Hungary. For Estonia, GDP in 1990-92 is assumed constant (in real terms) and takes the value observed in 1993. For Slovakia, GDP in 1990-91 takes the value of 1992. For Malta and Bulgaria, GDP in 1990 is assumed to be equal to GDP in 1991. These assumptions do not distort the trend observed for the EU-27's GDP, since the latter four countries represent about 0.7 of EU-27's GDP.

## 1. Indicator assessment

Total energy consumption in the EU-27 grew at an annual rate of just over 0.8 % over the period from 1990 to 2005, while Gross Domestic Product (GDP) in constant prices 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 -1.3 % per year. Despite this relative decoupling, total energy consumption has increased by 12.0 % overall in the period 1990-2005 (i.e. 0.8 % per year on average).

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, and a shift within the industrial sector from energy intensive industries towards higher value added less energy intensive industries. Furthermore, improvements in the efficiency of power generation (i.e. less energy input to produce the same energy output) as well as in the intensity in some end-use sectors (industry and services) contributed to the reduced overall energy intensity.

There are significant differences in total energy intensity within the EU-27 Member States, with the highest 'economic' intensities (i.e. intensities in terms of GDP) in Bulgaria, Estonia and Slovakia and the lowest in Ireland, Italy and Denmark (when compared at Purchasing Power Standards). The average EU citizen uses 3.7 tonnes of oil equivalent per year but this varies widely across countries, as shown in the table below.

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.

## 2. Indicator rationale

### 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 changes.

### 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 intensity.

In "An energy policy for Europe" (COM(2007)2", the European Commission has put forward a target for improvement of energy-efficiency by 20% in 2020 (vs. the reference development of energy-use). Following the Commission, the Council adopted at 8/9 March the European Council Action Plan (2007 – 2009) "Energy Policy for Europe", which stresses the need for 20% of Europe's energy consumption, compared to projections for 2020. Member States will make National Energy Efficiency Action Plans to reach this purpose.

The reduction of final energy intensity is seen in the context of enhancing the security of energy supply and of reducing greenhouse gas emissions, for which a target of 20 – 30% reduction in 2020 has been set by the Commission and the Council. For the short term, it will help in reaching the target of an 8 % reduction in greenhouse gas emissions by 2008-2012 from 1990 levels for the EU-15 and individual targets for most new Member - States, as agreed in 1997 under the Kyoto Protocol of the United Nations Framework Convention on Climate Change.

On January 23rd 2008 the European Commission presented a new climate change and energy package. This package is a bundle of legislative proposals, including an improvement of the EU Emissions Trading Scheme (with a binding target of 21% emissions reduction in 2020 vs. 2005), and binding targets for Member States for the emissions which fall outside of the EU-ETS. A reduction of absolute energy-intensity will contribute to achieving these targets.

In the Action Plan on Energy Efficiency (20 October 2006), the Commission put forward six pillars and five actions for realising an improvement of energy-efficiency. The actions refer to efficiency-requirements for energy-using equipment, energy-efficient transport, energy-saving behaviour of energy consumers, innovations in energy technology and energy savings from buildings. The Action Plan was supported by the Council 23 november 2006 (15210/06). This Action Plan follows the EU's Green Paper on energy efficiency (COM(2005)265 final) which 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 %).

In line with this, the Directive on energy end-use efficiency and energy services aims at boosting the cost-effective and efficient use of energy in the EU (2006/32/EC) and the Eco Design Directive (2005/32/EC) sets a framework for standards for energy-efficiency of energy-using equipment.

Regarding the transport-sector the Commission has made a voluntary agreement with car manufacturers, with a target of 140 g CO<sub>2</sub>/km by 2008/2009. Although some improvements have been made, it is expected that this will not be met. Beyond these voluntary agreements, the European Commission prepares legislative proposals aiming at a reduction of CO<sub>2</sub>-emission to 120–130 g/km by 2012. In addition measures on tyre pressures are being taken, as better tyre pressures can also reduce fuel consumption by over 5%.

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 1995-2005 (index 1995=100)**

	1995	2000	2004	2005	Annual average change 1995-2005	Relative energy intensity in 2005 (GDP in PPS, EU-27=100)	Per capita gross inland energy consumption in 2005 (TOE per inhabitant)
EEA	100.0	90.6	89.2	88.0	-1.3%	101	3.4
EU-27	100.0	90.0	88.7	87.4	-1.3%	100	3.7
EU-15	100.0	92.6	91.5	90.2	-1.0%	95	3.9
World	100.0	94.0	94.6	94.1	-0.6%	-	1.8
MENA	100.0	102.4	105.2	106.4	0.6%	-	2.0
United States	100.0	91.1	83.5	81.0	-2.1%	-	7.8
China	100.0	68.3	68.1	67.2	-3.9%	-	1.3
Russia	100.0	103.5	85.4	80.9	-2.1%	-	4.5
Belgium	100.0	99.1	89.4	88.6	-1.2%	116	5.2
Bulgaria	100.0	83.2	68.6	68.0	-3.8%	198	2.6
Czech Republic	100.0	91.8	90.6	85.3	-1.6%	154	4.4
Denmark	100.0	84.4	83.2	78.4	-2.4%	77	3.6
Germany	100.0	91.0	91.0	89.6	-1.1%	99	4.2
Estonia	100.0	64.5	59.1	52.1	-6.3%	181	4.1
Ireland	100.0	83.3	75.3	68.3	-3.7%	69	3.6
Greece	100.0	98.3	89.5	88.0	-1.3%	88	2.8
Spain	100.0	98.2	99.2	97.9	-0.2%	88	3.3
France	100.0	94.0	93.6	92.9	-0.7%	104	4.4
Italy	100.0	97.4	100.8	101.8	0.2%	82	3.2
Cyprus	100.0	100.2	91.3	88.6	-1.2%	94	3.2
Latvia	100.0	63.8	55.2	51.4	-6.4%	111	2.1
Lithuania	100.0	64.8	62.0	54.2	-5.9%	127	2.5
Luxembourg	100.0	80.8	91.7	90.0	-1.0%	106	10.2
Hungary	100.0	79.4	70.4	71.7	-3.3%	116	2.8
Malta	100.0	76.2	89.7	92.8	-0.7%	84	2.4
Netherlands	100.0	84.6	88.2	85.4	-1.6%	103	5.0
Austria	100.0	93.0	100.9	102.4	0.2%	87	4.1
Poland	100.0	69.8	63.4	62.2	-4.6%	131	2.5
Portugal	100.0	100.6	105.6	107.2	0.7%	91	2.5
Romania	100.0	83.8	70.6	67.0	-3.9%	143	1.8
Slovenia	100.0	84.8	82.6	81.5	-2.0%	117	3.6
Slovakia	100.0	83.4	77.5	74.0	-3.0%	163	3.6
Finland	100.0	88.9	92.8	83.3	-1.8%	156	6.6
Sweden	100.0	80.9	81.5	77.6	-2.5%	130	5.7
United Kingdom	100.0	90.6	81.9	80.5	-2.1%	87	3.8
Turkey	100.0	102.8	94.5	91.6	-0.9%	112	1.2
Iceland	100.0	110.3	104.2	100.4	0.0%	245	12.0
Norway	100.0	91.9	91.6	101.7	0.2%	106	6.9

**Data source:** EEA, Eurostat, IEA, IMF, United Nations Statistics Division.

**Notes:** The year for the reference index value is 1995 because GDP was not available for all EU countries in 1990. The second to last column shows the energy intensity measured in purchasing power standards relative to the EU-27. These are currency conversion rates that both convert to a common currency and equalise the purchasing power of different currencies (by analysing the prices paid in each country for a basket of similar 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. Purchasing power standard estimates of GDP were not available for the World, the MENA-countries, United States, China and Russia.

No data was available from Eurostat for Switzerland. No data was available from IEA for Djibouti, Iran or Palestinian territories. There was also no data available from the IMF for Iraq and the Palestinian Territories.

TOE refers to Ton of Oil equivalent. MENA refers to Middle East and North Africa



## References

- 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](http://europa.eu.int/comm/energy/efficiency/doc/2005_06_green_paper_text_en.pdf).
- COM (2006) 32 Directive of the European Parliament and the Council on energy end-use efficiency and energy services.
- COM (2006) 545 final – Action Plan for Energy Efficiency, realising the potential
- COM (2007)2 final – Limiting Global Climate Change to 2 degrees Celsius. The way ahead for 2020 and beyond.
- Directive 2005/32/EC – Eco design directive
- COM(2008) 16 Proposal for a Directive amending Directive 2003/87/EC (EU ETS)
- COM(2008) 17 Proposal for a Decision on the effort of Member States to reduce their greenhouse gas emissions
- EEA, Greenhouse gas emission trends and projections in Europe 2007, 2007
- European Commission, climate action, energy for a changing world (climate change and energy package),  
[http://ec.europa.eu/news/energy/080123\\_1\\_en.htm](http://ec.europa.eu/news/energy/080123_1_en.htm)
- European Council, 23 november 2006, Brussels (15210/06): Sustainability of energy production and consumption: Promoting Energy Efficiency and Renewable Energy
- Kyoto Protocol to the United Nations Framework Convention on Climate Change; adopted at COP3 in Kyoto, Japan, on 11 December 1997
- Directive 2005/32/EC – Eco design directive
- Presidency conclusions European Council (7224/1/07), 8/9 march, Brussels

## Meta data

### Technical information

1. Data source:
  - Gross inland energy consumption, Gross domestic product: Eurostat (historical data) <http://europa.eu.int/comm/eurostat/>.
  - Total Primary Energy Supply non European countries: IEA <http://data.iea.org/IEASTORE/DEFAULT.ASP>
  - Gross Domestic product at 2000 market prices non European countries: UNSD (World Bank, World Development Indicators (WDI)): [http://unstats.un.org/unsd/cdb/cdb\\_simple\\_data\\_extract.asp?strSearch=gdp&from=simple](http://unstats.un.org/unsd/cdb/cdb_simple_data_extract.asp?strSearch=gdp&from=simple)
  - Gross Domestic product at current prices non European countries: IMF: <http://www.imf.org/external/pubs/ft/weo/2007/02/weodata/download.aspx>
  - 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](http://europa.eu.int/comm/economy_finance/indicators/annual_macro_economic_database/ameco_en.htm)
  - 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 2000 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 27 European Union Member States and Turkey, plus the EFTA4 countries (Iceland, Switzerland and Norway). There are 20 MENA (Middle East and North Africa) countries. The factsheet also covers the US, China and Russia.
  - No energy data is available for Switzerland, Djibouti, Iran and Palestinian territories.
4. Temporal coverage: 1990-2005
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](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 (2000) 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 (2000) 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:  $[(\text{last year} / \text{base year})^{(1 / \text{number of years})} - 1] * 100$

The coding (used in the IEA database) and specific components of the indicator are:

- Numerator: Total Primary Energy Supply

The coding (used in the United Nations Statistic Division) and specific components of the indicator are

- Denominator: United Nations Statistic Division: Source name and citation World Bank, World Development Indicators (WDI) [code 45]

Some estimates have been necessary in order to compute the EU-27 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-27, 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-27's GDP, since the latter three countries represent about 0.3-0.4% of the EU-27'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](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](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-27 in 1990. Moreover, data was not available for a particular year for some EU-27 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-27 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.

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

Relevance: 1

Accuracy: 1

Comparability over time: 1

Comparability over space: 1