EN21 Final Energy Consumption Intensity

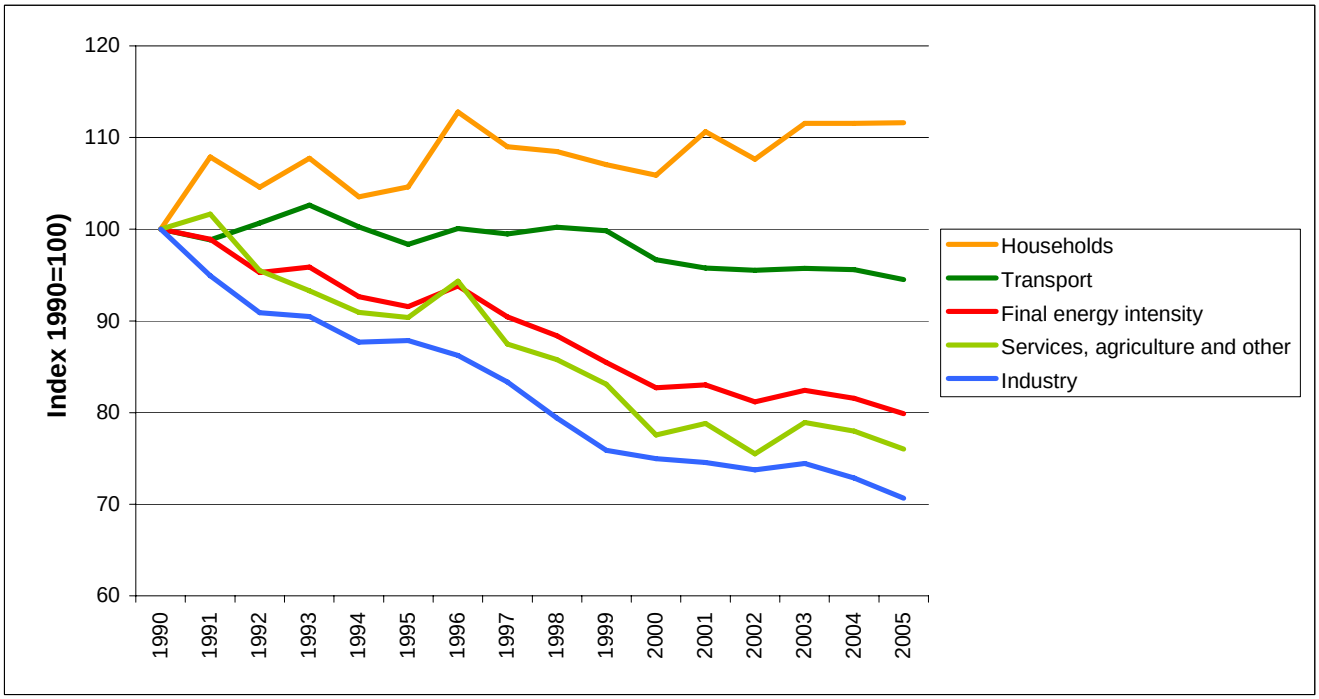
Key message

Economic growth has continued to require less additional final energy consumption within the EU-27 economy. However, this improvement has not been sufficient to prevent total final energy consumption from rising. Decoupling was most successful in the services sector, while private households consumed more energy per capita due to larger and more numerous dwellings, and greater ownership of electrical appliances.

Rationale

Historically, economic growth has driven energy consumption in the end-use sectors of transport, industry and services, while household's final energy consumption is mainly influenced by household wealth, population size and the number of households. The indicator measures to what extent there is a decoupling between final energy consumption and these drivers, indicating one way of reducing the associated environmental pressures.

Fig. 1: Index of final energy intensity and energy intensity by sector, EU-27



Data Source: Eurostat and the European Commission's Ameco database.

Note: Final energy intensities between sectors, and also the total final energy intensity, are not comparable, because the normalising variables are not the same. The indicator serves to highlight the evolution in energy intensity within each sector. The denominators for the total, household, transport, industry (excl. construction) and services (incl. agriculture) sector energy intensities are, respectively; GDP, population, GDP, Gross Value added in industry (excl. construction), and Gross Value Added in Services (incl. agriculture).

1. Indicator assessment

1.1 Trends across the EU-27

Over the period 1990 to 2005 the total gross domestic product (GDP) of the EU-27 grew at an annual average rate of 2.1 % and final energy consumption by 0.6 %. This led to a decrease in final energy consumption intensity at an average annual rate of –1.4 %. However, this trend has slowed in recent years with final energy intensity actually increasing by 1.6 % from 2002 to 2003, before starting to decrease again from this point onwards. Improvements in final energy intensity are, in general terms, influenced both by structural changes of the economy such as a shift from industry towards services and within industry to less energy-intensive industries, as well as improvements in end-use energy efficiency, such as lower energy consuming appliances or use of insulation in buildings.

The drivers and the pace of final energy intensity improvement are significantly different between the new Member States (EU-10) and the pre-2004 EU-15 (-3.9 % and -1.0 % average annual change, respectively, over the period 1990 to 2005). In the EU-15 during the early 1990s, a combination of low growth in GDP, low fossil fuel prices (see EN31) and a general low priority for energy saving in most Member States contributed to a slowdown in the reduction in final energy consumption intensity. Since then energy-efficiency improvements have become more important (ADEME, 2005). The same trend can be seen for the new Member states (EU-10). Final energy consumption intensity differs widely across countries. In the new Member States it is still around 1.3 times higher than in the EU-15, although there is a converging trend. The main factors leading to improvements in energy intensity of the New Member States were structural changes of the national economies and a rise in energy prices.

1.2 Sectoral trends

Examining trends in final energy consumption intensity by sector for the EU-27 indicates that both the industry and services sectors have seen substantial improvements in their energy intensity over the past decade. In contrast, the energy intensity of the household sector (final energy consumption of the household sector per capita) has actually worsened and the transport sector shows only a very limited decoupling of transport energy consumption from economic growth.

Overall, from 1990 till 2005 energy-intensity of final energy consumption of the EU-27 decreased by approximately 20%. This trend is also seen in CO_2-intensity (EEA, 2007).

The energy intensity of the industry sector fell steadily between 1990 and 1999, and whilst it slowed for a period after this it fell steadily again last year. The average annual decrease over the period 1990-2005 was -2.3 % although industry final energy consumption declined far more slowly. Hence this improvement was mainly due to a rise in value added within the sector during the 1990s (although it has stabilised since), coupled to relatively static final energy consumption. Recently published results indicate that most manufacturing industries (except textiles) experienced increasing energy efficiency between 1990 and 2002 in the EU-15, influenced by improved production processes and innovative technologies (ADEME, 2005). In the new Member States the economic restructuring of the early 1990s led to a substantial initial decline in both the energy consumption and output of heavy industry. Since 1995, industrial production has started to recover, while energy consumption continues in a downward trend, with the overall result that final energy intensity has reduced much more rapidly than in the EU-15. The largest shift to less energy intensive branches of industries between 1996 and 2001 was observed in Hungary and Slovakia (Lapillonne 2004).

The services, agriculture and other sector has a relatively low level of final energy consumption intensity. In the EU-27, energy intensity declined by 1,8% per year on average, largely due to a significant large reduction between 1996 and 2000. The rate of reduction in intensity was about three times faster for the new Member States than for the EU-15, although the overall EU-27 trend is dominated by the EU-15. Drivers impacting on services final energy intensity include: improvements in energy efficiency; use of information and communication technology in offices; the average office or floor space per unit of added value; climatic conditions, and insulation. Fluctuations in energy intensity reflect the cyclical nature of the economy, and also year-on-year fluctuations in climatic conditions which can contribute significantly to energy intensity trends as they affect building requirements for space heating.

The final energy consumption intensity of the household sector increased over the period 1990-2005 (by 0.9% on average per year), with average annual population growth of 0.3 % and final household energy consumption growing by 1.1 % per annum. As the indicator is sensitive to both changing population size and household size, it is measured per capita and not per household. The household sector's energy intensity is also linked closely with climatic conditions, as the major part of the energy is used for space heating[1]. Final energy consumption intensity improved in the EU-10 new Member States by an average of 0.2% per year between 1990 and 2005, compared to an average annual increase of 0.9 %. in the EU15. In general, the lack of improvement in energy intensity in the EU-15 is due to increasing living standards and lifestyle changes. These have outweighed the improvements in the efficiency of large electrical appliances such as refrigerators and TVs, which were

[1] The share of energy used for space heating varies with the outside temperature between years and countries. ADEME (2005) estimates it as being around 70 % in the EU-15.

supported by the introduction of energy efficiency labels and standards (IEA, 2005). Building energy efficiency standards have also been tightened in recent years but because the rate of turnover in the housing stock is slow the effect of these improvements will only be seen over the longer term.

Decoupling of transport energy consumption from economic growth has barely occurred at all – the average annual decrease in energy intensity remained small at 0.3%. This was due to the rapid growth in road transport, which led to a rapid increase in energy consumption despite some improvements in the fuel efficiency of cars. For example, the average fuel efficiency of a new car in the EU has fallen by 12% between 1995 and 2004 (European Commission, 2006). Freight transport is growing faster than the economy. A consequence is that emissions of CO2 from freight transport are growing quickly. Passenger transport continues to grow, particularly in aviation and cars. Increased car usage and a reduced number of passengers per car negate the improvements gained from improvements in vehicle efficiency. Greenhouse gas emissions in the transport sector continue to increase steadily. Although improvements have been made in the energy efficiency of various transport modes and non-fossil fuels have been introduced, increased transport demand is outweighing these benefits (EEA, 2008).

2. Indicator rationale

2.1 Environmental context

A main target in European policy is the strengthening of the economic position (Lisbon strategy). Meanwhile, from the point of view of security of energy-supply and reduction of greenhouse gases, European Energy Policy has set a target of 20% reduction on the use of energy.

Achieving these two goals requires decoupling of economic growth and energy-consumption. This indicator shows the development of energy-intensity (the quotient between energy use and economic activity) for the four main sectors of energy use: households, services, industry and transport.

The level of consumption has historically been driven by economic growth, the value added of different economic sectors and population growth. This indicator identifies the extent, if any, of decoupling between final energy consumption and these drivers in the main economic sectors. The differentiation between sectors allows a more detailed analysis of the effect of structural changes (e.g. the shift away from energy intensive industry) within these sectors and to identify those with a particular need for further action.

Relative decoupling occurs when energy consumption grows, but more slowly than the underlying driver. Absolute decoupling occurs when energy consumption is stable or falls while the driver grows. From an environmental point of view, however, overall impacts depend on the total amount of energy consumption and the fuels used to produce the energy.

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.

The reduction of final energy consumption is seen in the context of enhancing the security of energy supply and of reducing greenhouse gas emissions, for which a target of 20% unilaterally – 30% if other countries join 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. For the term to 2020 it helps reaching the target of 20 – 30% reduction of greenhouse gas-emissions from the EU Energy Policy.

On January 23th 2008 the European Commission presented a new climate change and energy package (COM(2008)16, 17 and 19). This package is a bundle of legislative proposals, including an improvement of the EU Emissions Trading Scheme (with a binding target of 21% emission reduction of greenhouse gases in 2020 vs. 2005), and binding targets for Member States for the emissions covered outside the EU-ETS. A reduction of energy-intensity will strongly contribute to achieving these targets.

The package of proposals from the Commission follows the “Energy policy for Europe” (COM(2007)2”, in which the European Commission did set a target for improvement of energy-efficiency by 20% in 2020 (vs. the reference development of energy-use). Member States will make National Energy Efficiency Action Plans to reach this purpose.

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). The Action Plan sets 10 priority actions.

For the household and the service sectors, important actions are the development of minimum energy performance standards. These standards will be made for 14 priority groups of products (e.g. televisions, computers and stand-by modes) in the form of Directives, which are planned to be adopted by 2008. This follows the Eco Design directive (2005/32/EC). Furthermore, for buildings, the building performance requirements will be expanded in a revision of the Energy Performance of Buildings Directive (2002/91/EC) and financing of energy efficiency investments (e.g. by Energy Service Companies) will be stimulated.

For transport, targets are being set for CO_2-emissions from cars. In the transport sector, the Commission is currently preparing legislation concerning the emissions of CO_2/km. This follows slow progress under an earlier voluntary commitment of the European, Japanese and Korean car manufacturers aimed at reducing the fuel efficiency of new passenger cars to 140g CO_2/km in 2008 for the European and 2009 for the Japanese and Korean manufacturers (European Commission, 2006).

For industry, the main policy-instrument is the EU ETS for CO_2-emissions. With the aim of limiting CO_2 emissions from large industrial sources, the Directive has established a cap-and-trade system covering combustion installations over 20 MW, as well as specific industrial processes (oil refining, cement production, iron and steel manufacture, glass and ceramics, and paper and pulp production). In addition to encouraging improved generation efficiency and fuel switching in the energy production sector, it will also encourage improved end-use energy efficiency within the industrial sector (as many companies both produce and consume their own heat and power) and cleaner processes in the other sectors directly covered.

The Action Plan on Energy-efficiency also puts forward several generic actions to improve energy efficiency, such as education and raising energy efficiency awareness and facilitating a coherent use of taxation.

References

Directive 202/91/EC on the Energy Performance of the builing directive

Directive 2005/32/EC (amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC) on the eco-design of Energy-using Products

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

COM(2008) 19 Proposal for a Directive on the use of renewable energy sources

Directive 2006/32/EC on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC

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

COM(2006)463 Communication: Implementing the Community Strategy to Reduce CO_2 Emissions from Cars: Sixth annual Communication on the effectiveness of the strategy;

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

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IEA (2004) Oil crises and climate challenges: 30 years of energy use in IEA countries, International Energy Agency

IEA (2005) The experience with energy efficiency policies and programmes in IEA countries: Learning from the critics, International Energy Agency Information Paper.

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

Lapillonne, B. (2004) Cross-country comparisons of energy efficiency trends and performance in CEEC's Enerdata Energy Efficiency Indicators Project for Central and Eastern European Countries Energy Efficiency Indicators Project for Central and Eastern European Countries, http://www.ceec-indicators.org/synthesis.pdf

Meta data

Technical information

1. Data source:
   Total final energy consumption and final energy consumption by sector, Gross domestic product, Gross Value Added for Industry:

Eurostat (historical data) http://europa.eu.int/comm/eurostat/ . GDP growth rates and Gross Value Added rates used for the estimation of missing GDP en GVA data from Eurostat: European Commission Ameco database.

2. Description of data / Indicator definition:
   Final energy consumption covers energy supplied to the final consumer for all energy uses. It is calculated as the sum of final energy consumption of all sectors. These are disaggregated to cover industry, transport, households, and services and agriculture.
   Total final energy intensity is defined as total final energy consumption (consumption of transformed energy such as electricity, publicly supplied heat, refined oil products, coke, etc, and the direct use of primary fuels such as gas or renewables, e.g. solar heat or biomass) divided by gross domestic product (GDP) at constant (1995) prices. The GDP figures are taken at constant prices to avoid the impact of inflation, base year 1995 (ESA95). Comparisons of intensity in specific years are however made using GDP in purchasing power standards.
   - Household energy intensity is defined as household final energy consumption divided by population.
   - Transport energy intensity is defined as transport final energy consumption divided by GDP at constant (1995) prices.
   - Industry energy intensity is defined as industry final energy consumption divided by industry Gross Value Added at constant (1995) prices. This excludes final energy consumption and gross value added from construction.
   - Services energy intensity is defined as services final energy consumption divided by services Gross Value Added at constant (1995) prices. Services includes agriculture and other sectors, and this is aggregation is consistent with that used in the projections.

   Units:
   Final energy consumption is measured in 1000 tonnes of oil equivalent (ktoe) and GDP in million Euro at 1995 market prices. Energy intensity is measured in tonnes of oil equivalent per million Euro (GDP or GVA), except in the case of household energy intensity which is measured in tonnes of oil equivalent per 1000 people.

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, Iceland, Norway and Switzerland.

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

6. Methodology of data manipulation:
   The coding (used in the Eurostat New Cronos database) and specific components of the indicators are:
   - Total final energy intensity: final energy consumption 101700 divided by GDP - Constant (2000) prices.
   - Household energy intensity: Final energy consumption households 102010 divided by PJAN Population by sex and age on 1. January of each year.
   - Transport energy intensity: Final energy consumption transport 101900 divided by B1GM GDP and main components - Constant (1995) prices.
   - Industry energy intensity: (Final energy consumption industry 101800) minus (Final energy consumption – other non-classified industries – 'Construction' – 101850) divided by (nace c_d_e Total industry GVA - excluding construction).
   - Services, agriculture and other energy intensity: (Final energy consumption Households/Services/Agriculture and Others 102000) minus (Final energy consumption households 102010) divided by (Services, agriculture and other sectors GVA provided by NTUA).

   It should be noted that value added in industry during 1990-94 was not available from Eurostat. Estimates for that period were gap-filled based on the linear trend, using the gross value added in 2000 from Eurostat as the reference value.
   Average annual rate of growth calculated using: [(last year / base year) ^ (1 / number of years) –1]*100. For some EU-27 member states Eurostat data was not available for a particular year. The European Commission's annual macroeconomic database (Ameco) was used as 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-25's GDP, since the latter three countries represent about 0.3-0.4% of the EU-25's GDP.

Qualitative information

7. Strength and weaknesses (at data level)
   Data gap procedure needed, as highlighted in section 6.

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
Gross Value Added data from the NTUA has been used for the Services, agriculture and other sectors as well as to gap-fill for the industry sector prior to 1995 to ensure completeness (due to gaps in Eurostat data) and also to ensure consistency with the projection data.

8. Reliability, accuracy, robustness, uncertainty (at data level):
Indicator uncertainty (historic data)
The sectoral breakdown of final energy consumption includes industry, transport, households, services, agriculture, fisheries and other sectors. To be consistent with projection data, the indicator aggregates agriculture, fisheries and other sectors together with the services sector. The inclusion of agriculture and fisheries together with the services sector is however questionable given their divergent trends. Because the main focus of the indicator is on trends, energy intensity is presented as an index. It should be noted that the final energy intensities between sectors, and also the total final energy intensity, are not directly comparable, because as described above, the definitions of energy intensity within each sector not identical. The indicator serves to highlight the evolution in energy intensity within each sector..

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