

Energy Efficiency Trends and Policies in the EU 27

Results of the ODYSSEE-MURE project

October 2009



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ISBN

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Acknowledgements

This publication on energy efficiency and policy monitoring is supported by the Intelligent Energy Executive Agency (IEEA) and 29 national teams, generally with co-funding from their own governments. These teams comprise the partners of the ODYSSEE-MURE network from the 27 EU Member States, Norway and Croatia. This study would not have been possible without the active participation of the national teams and their associated partners in terms of data supply and expertise on energy policy evaluation.

This report was prepared by Bruno Lapillonne from Enerdata, Wolfgang Eichhammer from the Fraunhofer Institute for Systems and Innovation Research and Piet Boonekamp from ECN. The information on energy efficiency indicators is taken from the Odyssee database and website, managed by Karine Pollier at Enerdata in France. The information on policy measures relies on the MURE database, developed and maintained at ISIS in Italy by Stefano Faberi, Michela Fioretto and Nicola Piccioni and coordinated by Wolfgang Eichhammer and Barbara Schlomann from Fraunhofer ISI in Germany. These researchers continually propose improvements which resulted in the ODYSSEE-MURE tools becoming the leading instrument in European monitoring and evaluation of energy efficiency trends.

Among the many participants in the ODYSSEE-MURE network, particular thanks are due to¹: Bettina Emmerling and Reinhard Jellinek (AEA, Austria), Yvonne Baillot and Francis Altdorfer (Econotec, Belgium), Filip Fikov and Ludmil Kostadinov (EEA (Bulgaria), Helena Bozic, Branko Vuk and Dino Novosel (EIHP, Croatia), Kyriatos Kitsios (CIE, Cyprus), Jiri Spitz (Enviros, Czech Republic), Ali A. Zarnaghi and Peter Dal (DEA, Denmark), Sulev Soosaar (TUT, Estonia), Martin Howley and Dennehy Emer (SEI, Ireland), Emidio d'Angelo, Pier Giorgio Catoni and Giulia Iorio (ENEA, Italy), Saara Elväs and Lea Gynther (Motiva, Finland), Gregory Chedin (ADEME, France), Lazlo Elek (ENCEN, Hungary), Barbara Schlomann and Wolfgang Eichhammer (Fraunhofer ISI, Germany), Minas Iatridis (CRES, Greece), Gaidis Klavs (IPE, Latvia), George Cassar (MRA, Malta), Joost Gerdes and Piet Boonekamp (ECN, the Netherlands), Eva Rosenberg (IFE, Norway), Ryszard Wnuk (KAPE, Poland), Grazyna Berent-Kowalska and Szymon Peryt (GUS, Poland), Alberto Tavares (ADENE, Portugal), Maria Rugina and Vasile Rugina (Icemenerg, Romania), Iulia Lazar (ARCE, Romania), Jan Rousek, Pavel Starinsky and Maria Svobodova (SEA, Slovak Republic), Fouad Al Mansour (JSI, Slovenia), Pilar de Arriba Segurado and Jesús Pedro García (IDAE, Spain), Linn Stengård, Helen Lindblom, Malin Lagerquist, and Emma Ostensson (STEM, Sweden), Heather Haydock, Tom Hazeldine and Tricia Wiley (AEA Technology, United Kingdom).

Finally, we extend our thanks to Vasco de Janeiro from the Intelligent Energy for Europe Programme (IEE) and Ms Pirjo-Liisa Koskimaki from the DG-TREN for their support and belief in this project and their encouragement and advice.

Didier Bosseboeuf
project leader

¹ Alphabetic order of countries

Key Messages

This publication presents an overall view on energy efficiency policies and trends in energy use and energy efficiency in the EU27. It relies on the following two databases that cover all EU-27 member countries plus Croatia and Norway:

- ✓ The **ODYSSEE** database on energy efficiency indicators, with data on energy trends, drivers for energy use, explaining variables and energy-related CO₂ emissions (www.odyssee-indicators.org).
- ✓ The **MURE** database with policy measures on energy efficiency, including the impact of the measures (www.mure2.com).

Both tools are used to support energy policy formulation by the European Commission, e.g. as contribution to the monitoring and evaluation of the Energy Service Directive. The following points summarise the key messages from the analysis in this study:

Overall energy efficiency trend and policies

- The energy efficiency of final consumers improved by 13 % on average in the EU-27 between 1996 and 2007. This resulted in energy savings of about 160 Mtoe, of which half in industry.
- Energy efficiency improvements, for the EU-27 as a whole, as measured with ODEX, seemed to be in line or above the indicative target of the Directive for Energy Efficiency and Energy Services (ESD) for many countries. However, the definition of energy savings is not directly comparable.
- In most countries and sectors, there has been a slowdown in energy efficiency progress since 2000, which is partly explained by the slower economic growth (business cycle effect). The performances achieved by the various countries range from 2 to 20 %.
- The decoupling between energy use and economic activity is continuing: since 1990, energy consumption has been growing at only one third of the rate of GDP. In the period 2004-2007 this rate has further slowed down to nearly a full decoupling². Electricity use was still growing with three quarters of the GDP rate since 1990, slowing down to around 60 % of GDP growth in 2004-2007.
- CO₂ emissions of final consumers were in 2007 5 % below their 1990 level. Almost 40 % of this reduction is due to substitution by fuels with lower emission factors, the rest is due to a reduction in energy intensity.
- Major new energy efficiency policies have been introduced over the past years and are at present implemented. But some of them face major delays and/or

² Final energy normalised for annual climate variations. The uncorrected final energy use was even decreasing during that period.

strong debate about the exact design, such as the revised Energy Performance Directive for Buildings (EPBD), the Eco-design Directive and its implementing regulation, the CO₂ strategy for cars and the Energy Efficiency and Services Directive. The latter was confronted with methodological questions how to measure energy efficiency. However, the Odyssee indicators will contribute to its implementation with their use as top-down evaluation methods.

- The patterns of policy measures undertaken across the different Member States and the different sectors vary according to the national debate and practices and to the specific energy uses.
- EU energy efficiency policies have an increasing impact at the national level. However, the impact is still quite different from sector to sector. While EU measures represent already nearly one third of all measure in the residential sector (in particular due to the appliance labelling Directives) and of cross-cutting measures (due to measures such as the CHP Directive, renewables policies which impact on decentralised renewables, and the eco-design Directive), it is still weaker in the other sectors.

Industry

- Energy efficiency regulations have played a smaller and not always efficient role in the past in the industrial sector. This is going to change in future with more and more energy performance standards being emitted under the Eco-design Directive for Energy-using Products for industrial cross-cutting technologies, such as electric motors, pumps, ventilators and lighting.
- Financial and fiscal incentives continue to be the most widespread measures to improve industrial energy efficiency. Increasingly, those incentives are combined in measure packages with other measures such as mandatory auditing and information measures.
- Negotiated/voluntary agreements originally have targeted mainly energy-intensive industries, partially to avoid taxation of industrial energy use. Despite the implementation of EU Emission Trading Scheme ETS in 2005, such measures continue to be renewed and to spread partially within the new EU Member States. They are in particular attractive for industries outside the EU ETS and are explicitly mentioned in the EU Directive for Energy Efficiency and Energy Services.
- Different types of innovative measures for energy efficiency have been introduced in the different EU Member States: e.g. Eco-design standards for energy-using products, new market-based instruments and the EU ETS.
- The industrial sector was 30 % more energy-efficient (measured by the ODEX) in 2007 than in 1990 which makes industry the sector with the largest

improvement. All industrial branches improved considerably, in particular the chemical sector and the engineering sectors.

- Energy-intensive industrial products have improved unit consumption between 2000 and 2007 by average rates of 0.2 %/year for glass, 0.7 %/year for paper and up to 2 %/year for steel and cement. Individual countries showed much larger annual improvements in energy efficiency.
- With the economic crisis, energy efficiency improvement will probably be slower in the next two to three years because the economic stimulus plans were mainly focused on the building and transport infrastructure. However, it can be expected in future that due to energy efficiency improvement with electrical equipment (e.g. due to standards for electric motors), even electricity uses will be stabilising in the industrial sector;
- The industrial sector 's CO₂ emissions in 2007 were 22 % below their 1990 level. Despite the fact that this was a substantial achievement, further reduction potentials are possible by means of improving energy efficiency. The industrial sector, like households and the tertiary sector, may also contribute to lower CO₂ emissions from the electricity sector by a lower demand for electricity.

Transport

- In terms of policy measures, the main focus was on cars, and especially on increasing the efficiency of new cars. Those measures have already led to significant improvements in efficiency and specific emission reduction.
- Since 2007/2008 measures on new cars have clearly been reinforced, involving increased subsidy schemes and a new EU Directive on mandatory emission limits for new cars.
- Most countries have established some form of greening of tax systems related to car use and ownership. However, the lack of comparable data makes it difficult to compare the total amount of those taxes.
- Trucks and light-duty vehicles are not sufficiently addressed by policies, despite the rapid growth of their energy consumption.
- Modal shift measures are still scarce, especially with regard to freight transport, and only very limited results have been achieved in that area.
- Innovative measures in the transport sector include "green" car taxation by linking purchase and/or annual tax to specific CO₂ emissions, car labels combined with easily accessible web-based information for comparing the energy performance of cars, innovative toll systems for trucks and cars, innovative information campaigns aimed at promoting mobility management, and modal shift.

- The transport sector was 15 % more energy efficient in 2007 than in 1990. Most of the gains come from cars.
- The energy efficiency of cars is improving on a regular basis (by 1.3 %/year since 1990); on average in the EU, cars consumed 1 litre/100 km less in 2007 than in 1990.
- As a result of the agreement between the Commission and the associations of car manufacturers (ACEA, JAMA and KAMA), as well as the increase in fuel prices, new cars sold in 2007 were 15 % more efficient than new cars sold in 1995. Part of the improvement in the performance of new cars is offset by a general shift towards larger cars over most of the periods, although in 2007 and 2008 that trend was reversed, seeing an increase in smaller cars.
- The transport sector is the only end-use sector in which CO₂ emissions continue to increase: emissions in 2007 were 26 % above their 1990 levels. However, some countries have reversed this trend, and first figures from the economic year 2009 show a strong impact on transport energy use.
- The CO₂ emissions of new cars have decreased by 17 % since 1995. However, in 2008 the average specific emissions were 10 % above the 2008 target of 140 g/km stipulated in the agreement between the European Commission and the associations of car manufacturers.

Households

- In the period 1997-2006, the overall energy efficiency improvement was 0.8 % per year. The rate has decreased somewhat since the nineties. Just over half of the countries realise less than the 1 % requested in the Energy Service Directive.
- Due to liberalisation of energy markets new policy measure types have emerged, such as White Certificates systems, Energy Performance Contracting and Energy Efficiency Commitments. Within a prescribed overall target for energy savings it is left to the managers of these programs how the savings are realised.
- More and more policy measures are directly or indirectly the result of EU policy, such as the directives on Labels (electrical appliances), Energy Performance of Buildings (EPBD), Energy efficiency and Energy Services (ESD) and Eco-design (energy using products). After joining the EU the amount of new policy measures for new member states increased considerably.
- However, because up to 2007 the EPBD, ESD and Eco-design directives did hardly result in implemented policy measures yet, these EU policy cannot have had much effect on the energy savings analysed here for 1997-2007. Above average savings were realised for electric appliances, probably with help of the EU labelling policy from 1993 on.

- Fuel use per household more or less stabilises with moderate economic growth and a reasonable amount of energy savings. However, in countries with high economic growth and/or lack of saving efforts fuel use keeps increasing.
- Electricity use per household increases despite energy savings, even for countries with low economic growth. In case of high economic growth (Ireland, Spain), taking up modern life styles (Eastern European countries) or introduction of air-conditioning (Southern countries) the electricity growth is substantial.

For households the most innovative and effective measures are performance standards on dwellings and appliances, performance programs such as White Certificate systems and broad action plans with a combination of measure types that addresses all conditions for implementation.

- Taxes on energy or CO₂, policy addressing energy poverty and policy measures on inspection and maintenance are regarded as innovative complementary policy measures.

Services

- Since 1997, the decrease in energy consumption per employee (-3 %) is in strong contrast with that for electricity (+14 %). Large increases in electricity use are probably due to the introduction of cooling in summer (all southern countries), to strong economic growth (Ireland) or more electricity consumption per employee (eastern European countries).
- The fuel consumption (including heat) per employee shows differences between countries that are partly explained by the winter climate, but there is no clear correlation with the stage of economic development.
- New member states often lag behind as to the broadness of the package of policy measures. EU wide standards, financial support and information are most applied, energy taxes and voluntary agreements are hardly used.
- In total about one-fifth of all national policy measures is due to EU policy, e.g. transposition of EU directives.
- Energy Performance Contracting using ESCOs is regarded as an innovative policy measure because the whole process of implementing saving measures is in one hand.

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1. Introduction

The aim of this report is to provide insight into past developments for energy efficiency trends and related policy measures across all sectors of the economy in the EU-27. The report summarises the content of 4 sectoral brochures prepared in the framework of the ODYSSEE MURE project. These four brochures analyse the overall development of energy efficiency, the industrial sector, the transport sector, and finally the residential and tertiary sectors. This report should help policymakers and other parties involved in energy efficiency and CO₂ emission reduction in adapting present policy and formulating new effective policy measures. Although the main focus is on energy efficiency improvement and the effect of various policy measures, other drivers affecting the energy demand trends are also considered, such as the impact of economic growth, economic cycles and energy prices.

This analysis is based on two databases, ODYSSEE on energy efficiency indicators (**Box 1.1**) and MURE (**Box 1.2**) on policy measures that cover the EU-27 plus Croatia and Norway.

Box 1.1: ODYSSEE database

The ODYSSEE database (www.odyssee-indicators.org) is used for the monitoring and evaluation of annual energy efficiency trends and energy-related CO₂ emissions. The energy indicators are calculated for the years from 1990 on (EU-15 countries) or from 1996 on (new Member States). The inputs for the indicators are provided by national energy agencies or institutes according to harmonised definitions and guidelines.

ODYSSEE encompasses the following types of indicators³:

- Energy/CO₂ intensities: relate the energy used in the economy or a sector to macroeconomic variables (e.g. GDP, value added).
- Specific energy consumption: relate energy consumption to physical indicators (e.g. specific consumption per ton of product);
- Energy efficiency indices by sector (ODEX) to evaluate energy efficiency progress (in %).
- Energy savings to measure the amount of energy saved through energy efficiency improvements.
- Adjusted indicators to allow the comparison of indicators across countries (in particular adjustments for differences in industrial structure).
- Benchmark/target indicators by sector to show the potential improvement based on countries with the best performance (evaluation based on adjusted indicators).
- Indicators of diffusion to monitor the market penetration of energy-efficient technologies (e.g. share of high efficiency motors).

The indicators from the ODYSSEE database are now used to monitor trends in energy efficiency among countries in a harmonised way. They are increasingly used by the European Commission as well as by several international organisations, among others:

- DG-TREN: the EC has made explicit reference to the ODEX indicators in the Energy Service Directive as a way of contributing towards monitoring the Directive in a so-called “top-down” approach. The EMOS database (Energy

³ The methodological issues and precise definitions of indicators and data are dealt with at the end in a specific section “Definitions and Glossary”.

Market Observatory) includes about 20 indicators from ODYSSEE. The Energy Demand Management Committee of ESD has proposed indicators similar to those of ODYSSEE to measure energy savings with top-down methods.

- EEA (European Environmental Agency): uses data and indicators taken from the ODYSSEE database for different annual reports: Energy and Environment Report⁴ and TERM report⁵, for instance. ODYSSEE indicators were also used in the fourth pan-European environment assessment report (UNECE).
- IEA, The International Energy Agency: ODYSSEE data are used by the IEA to construct their own indicators for European countries. In addition, IEA has developed a questionnaire to collect the data necessary to calculate the indicators similar to the ODYSSEE data template.

Box 1.2: MURE database

The MURE database (www.mure2.com) provides an overview of the most important energy efficiency policy measures by sector (households, industry, transport and tertiary), as well as general or cross-cutting measures. Information about these measures is collected by national energy agencies or institutes according to harmonised guidelines. The measures are classified according to various criteria:

- their status (completed, on-going or planned);
- their year of introduction and completion;
- their type: legislative/normative (e.g. standards for new dwellings), legislative/informative (e.g. obligatory labels for appliances), financial (e.g. subsidies), fiscal (e.g. tax deductions), information/education, cooperative (e.g. voluntary agreements) and taxes (on energy or CO₂-emissions).
- their qualitative impact: low, medium or high impact, based on quantitative evaluations or expert estimates (see methodological issues)
- the targeted energy users, the actors involved, etc.

For each policy measure a detailed description is available which contains, if available, a quantitative impact in terms of energy-savings and/or CO₂ emission reduction.

The MURE database provides a structuring format to EU Member States for reporting measures in the National Energy Efficiency Action Plans requested by the European Commission within the implementation of the Energy Service Directive (ESD). In addition, the MURE simulation tool, attached to the database, has been used by the EU Commission to assess the energy-saving potentials over the period 2010-2030⁶.

⁴ EEA: Energy and environment report 2008, November 2008;

http://www.eea.europa.eu/publications/eea_report_2008_6

⁵ TERM monitors indicators tracking transport and environment integration in the European Union;

<http://www.eea.europa.eu/publications/transport-at-a-crossroads>

⁶ DG TREN: Energy Savings Potentials in EU Member States, Candidate Countries and EEA Countries, March 2009 http://ec.europa.eu/energy/efficiency/studies/efficiency_en.htm

2. Overall energy efficiency policies and trends

2.1. Policies

2.1.1. Present state of European energy efficiency policies and recent developments

Energy efficiency strategy development and cross-cutting policy measures

In 2006 the EU published an **Energy Efficiency Action Plan**⁷ to cut its energy consumption by 20 % by 2020, to reduce CO₂ emissions and improve supply security while generating new employment. End 2009 the EU Commission was to present a **new Energy Efficiency Action Plan**. However, the debate about whether or not to go for mandatory targets for energy efficiency and the interaction with other policy instruments such as the EU Emission Trading Scheme (EU ETS) has delayed its publication.

The **revised Lisbon Strategy for Growth and Jobs – Towards a Green and Innovative Economy**⁸ for the period beyond 2010 shall set incentives for a greener economy including energy efficiency as a major element. A consultation paper⁹ of the EU Commission mentions that “*the EU should compete more effectively and increase its productivity by a lower and more efficient consumption of non-renewable energy and resource...*”. In the context of the economic crisis that started in 2008, a lot of financial means were directed towards supporting the economy. Part of this support went to improve energy efficiency although there is critics that, in difference to some Asian countries, too little opportunities have been seized to direct those substantial means towards a strong restructuring of the economy in the direction of more energy efficiency and a greener economy¹⁰.

The important **Directive on Energy End-use Efficiency and Energy Services**¹¹ was adopted in December 2005. The directive requires member states to draw up National Energy Efficiency Action Plans (NEEAPs) to achieve 9 % (final) energy savings between 2008 and 2016 including transport fuels. The target is only indicative but the National Energy Efficiency Action Plans need approval from the Commission and is reviewed every three years. The first wave of NEEAPs was submitted in 2007/2008 and reviewed by the EU Commission¹². The deadline for the second round of national action plans is 30 June 2011.

⁷ http://ec.europa.eu/energy/action_plan_energy_efficiency/doc/com_2006_0545_en.pdf

⁸ http://ec.europa.eu/growthandjobs/index_en.htm

⁹ http://ec.europa.eu/eu2020/index_en.htm

¹⁰ See for example <http://euractiv.com/en/enterprise-jobs/eu-outflanked-asian-rivals-green-economy/article-186846>

¹¹ http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&lg=en&type_doc=Directive&an_doc=2006&nu_doc=32

¹² http://ec.europa.eu/energy/efficiency/doc/sec_2009_0889.pdf

Measure patterns: each sector is characterised by particular patterns of energy efficiency measures

Each sector has its own measure patterns and dynamics.

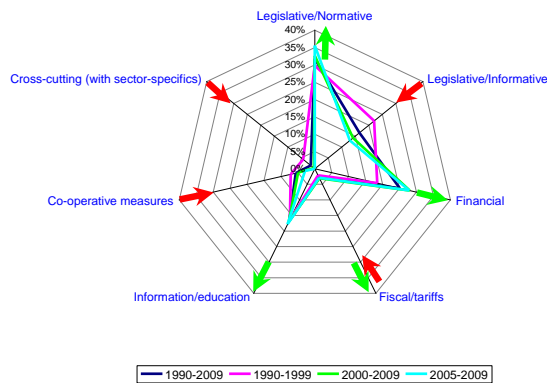
Figure 2.1 shows the measure patterns for each sector. More details can be found in the sectoral chapters.

- **Households:** The prevalent measure types are legislative/normative (in particular standards for new dwellings) and financial (addressing mainly existing dwellings). These measure types have even strengthened their dominant position. Legislative/informative measures such as labels have decreased in importance. However, this was the consequence of the fact that the very comprehensive labelling policy for electric appliances has stabilised and more or less taken over by the minimum efficiency standards from the Eco-design Directive.
- **Tertiary:** The tertiary sector is equally dominated by legislative/normative and financial measures as buildings are also the most important energy use in this sector. However, information/education/training measures and to a lesser degree cooperative measures play a larger role than in the household sector. Legislative/informative measures such as labels increase in importance due to building certificates that have been more largely implemented for larger buildings.
- **Transport:** The transport sector is not dominated by two or three measure types but shows a large coverage in measure types. Infrastructure measures as well as information/education/training, fiscal/tariffs and financial measures tend to be more largely employed. Regulation and co-operative measures are on the rise.
- **Industry:** The industry sector is largely dominated by financial measures to support audits and investment in energy efficiency. New market-based instruments such as the EU ETS and education/training are on the rise while co-operative measures such as voluntary agreements have lost ground.
- **General cross-cutting measures:** These types of measures cover the sectors with the same type of instruments. The coverage is broad with market-based instruments (such as measures to promote Energy Service Companies ESCOs, White Certificates etc.) being on the rise. Also legislative/normative measures such as regulation for CHP, certain types of energy carriers (e.g. district heat) or mandatory targets for energy suppliers become more important.

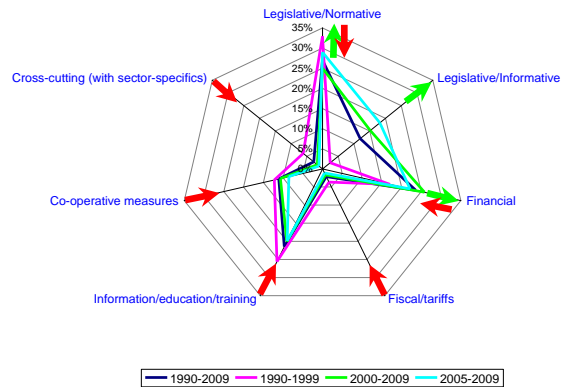
It must be emphasised that these patterns have also country-specifics. This is presented in detail in the sectoral chapters.

Figure 2.1 : Patterns of energy efficiency policies by sector (1990-2010)

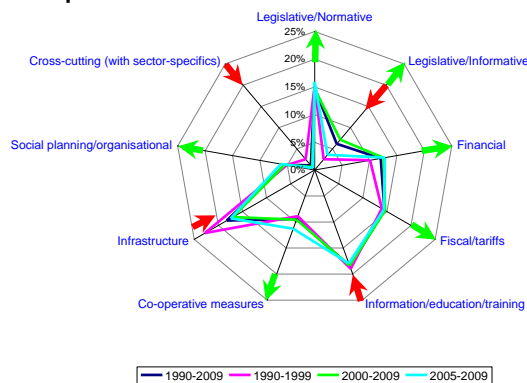
Households



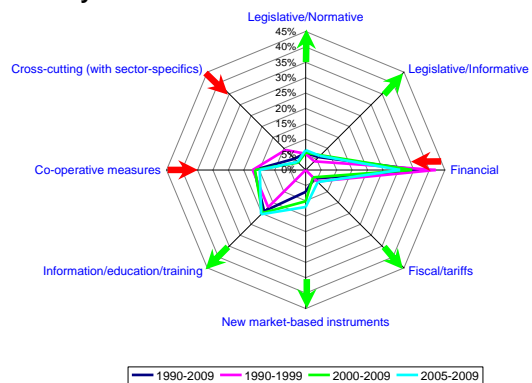
Tertiary Sector



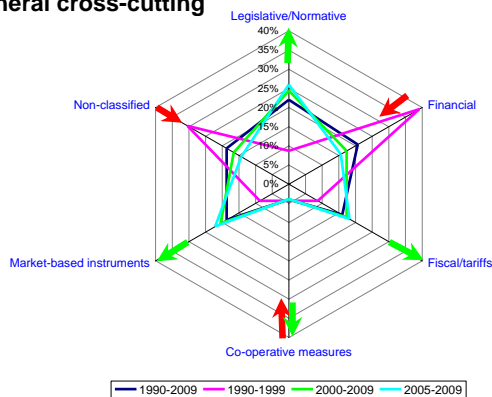
Transport



Industry



General cross-cutting



Note: red arrows indicate shrinking importance, green arrows increasing importance

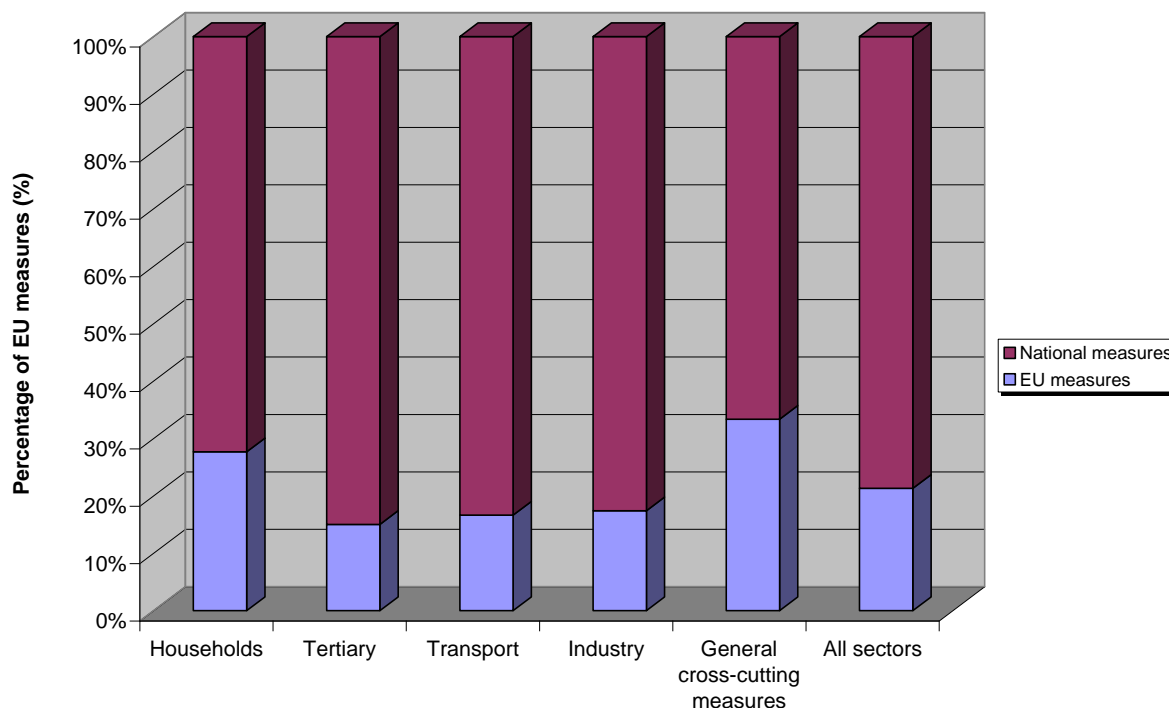
Source: MURE database

2.1.2. The weight of policies determined at the central EU level

EU energy efficiency policies have an increasing impact on the national level. However, the impact is still quite different from sector to sector. While EU measures represent already nearly one third of all measure in the residential sector (in particular due to the impact of the appliance labelling Directives) and in the general cross-cutting measures (due to measures such as the CHP Directive, renewables policies which impact also on decentralised renewables, and the Eco-design Directive), it is still weaker in transport, industry and the tertiary sectors (around 15 % of all measures are EU-related). On

average around 20 % of all measure are directly inspired by EU legislation. It can be expected that the impact of EU-wide triggered energy efficiency measures at national level will considerably increase with central measures such as the Eco-Design Directive, the revised Energy Performance of Buildings Directive (EPBD) and the forthcoming revision of the EU Energy Efficiency Action Plan.

Figure 2.2 : Share of EU-related measures (1990-2010)



Source: MURE database

2.1.3. Innovative energy efficiency policies

There are several ways how innovative measures for energy efficiency are introduced in the different EU Member States:

- (1) First there are measures which are **innovative compared to the past with respect to their comprehensiveness**. This is the case with European legislation on Eco-design standards for Energy-using Products which comprises now 40 products of which around ten standards are already published. This is much more comprehensive as the few Minimum Energy Efficiency Standards published in the nineties, e.g. on cold appliances.
- (2) Further, measures may be **innovative through the dynamic aspects they include in the measure design**. Also here the EuP Directive is a good example as it sets dynamic standards that get tighter over time for most products in order to cope with the foreseeable technical progress. A second example is the CO₂ strategy for cars which aims to provide a foreseeable frame for the further tightening of standards, although this is – in difference to the Eco-design standards - not yet translated to the legislative provisions.

- (3) Measures may further be **innovative through the new context in which they are set** that is in which combination of measures they are applied (e.g. the combination of a learning process with the development of adapted tools, investment subsidies and information in “Learning Energy Efficiency Networks” in Germany for the industrial sector).
- (4) Measures may be **innovative because they constitute a completely new type** of measures to improve energy efficiency such as the new market-based instruments like the EU Emission Trading Scheme, White Certificates and Clean Development Mechanism.
- (5) Further, a measure type may develop further **innovative features** such as for example the EU ETS where - to encounter the danger of carbon leakage¹³ - benchmarking systems are developed to limit the amount of free carbon allocation.
- (6) Measures may be innovative in combining energy and social goals, such as combating energy poverty (poor households in energy wasting dwellings causing health problems).
- (7) Finally, **measures for energy efficiency may be innovative in a direct sense through the contribution they could make to the Lisbon strategy for growth and employment and the greening of the economy**. It is difficult to point particular policies out but high energy or CO₂ taxes, replacing taxes on labour or profits, could direct the European economies in a sustainable direction and at the same time make companies more competitive and decrease the dependence on uncertain energy sources.

All innovation strategies are followed in the Community and have led to a substantial amount of new measures across all sectors in the past years.

2.1.4. Quantitative impact of energy efficiency policies

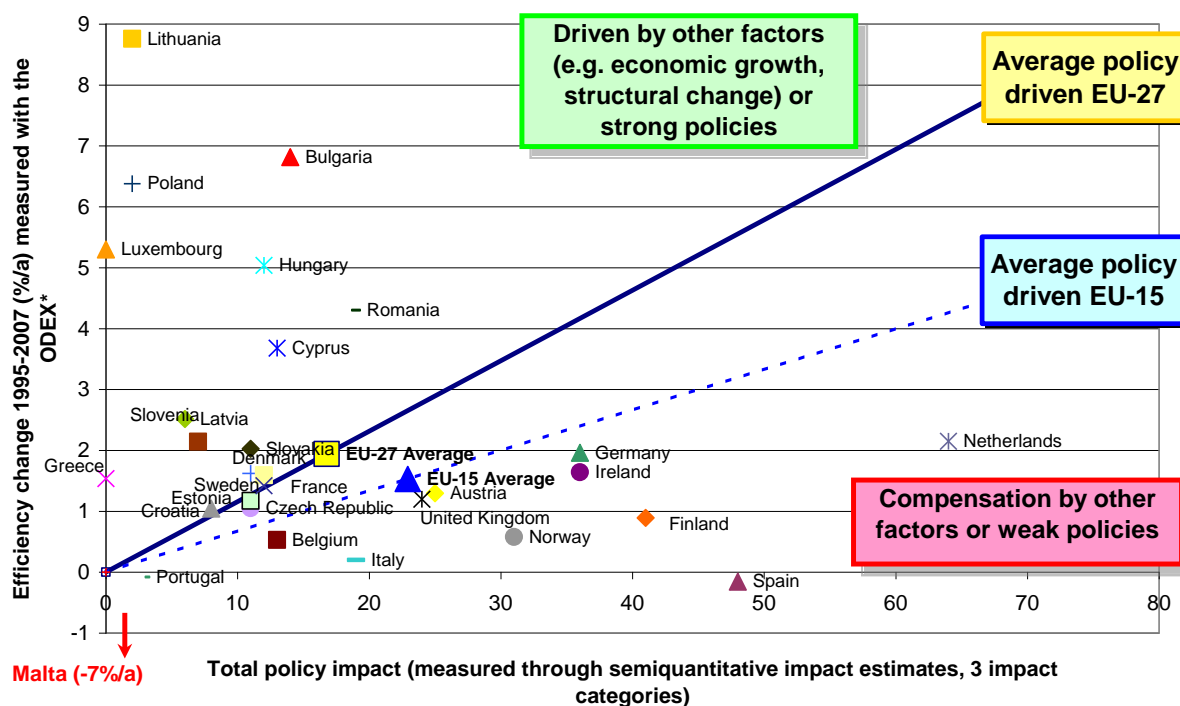
Determining the quantitative impact of energy efficiency is still a rather difficult exercise. In the Odyssee-MURE project we have developed so-called **efficiency-impact plots** that present the evaluation of energy efficiency development with the ODEX (period 1995-2007) compared to the semi-quantitative impact¹⁴ estimates of the measures collected under MURE (period 1990-2007, assuming that measures introduced several years earlier have also an impact on the ODEX). These plots are shown below for the industrial, residential and transport sectors. They indicate that there is not a straightforward link between the ODEX and the impact analysis, although some trends can be seen. Nevertheless, also other factors impact very strongly on the position of a country in the efficiency-impact plot such as its economic development or the increase in comfort. This is most visible when comparing the different graphs among each other.

¹³ Displacement of carbon emissions outside the EU, for example to China, as production sites may close in Europe due to higher charges on the companies from the carbon price. This could undermine their competitiveness.

¹⁴ The semi-quantitative estimate of the impact for each policy measure (ratings: High, Medium or Low based on fractions of the sector energy consumption that are addressed by the measure) is translated into a quantitative estimate by using weighting factors (Low > 1, Medium > 3, High > 5), and the total weighted impact is obtained as $Nb\text{-high} * 5 + Nb\text{-med} * 3 + Nb\text{-low} * 1$

- The **industry sector (Figure 2.3)** is much more dominated by additional factors beyond energy efficiency policies such as the economic development, which tends to increase the efficiency improvement, especially in the new EU Member States which had a very strong economic development. However, also in the EU-15 these additional factors increase the efficiency as can be seen from the EU-15 average as compared to the other sectors. On the opposite there are, however, also countries such as Spain which despite strong economic growth (but mainly driven by the construction industry) have achieved little impact in terms of energy efficiency.

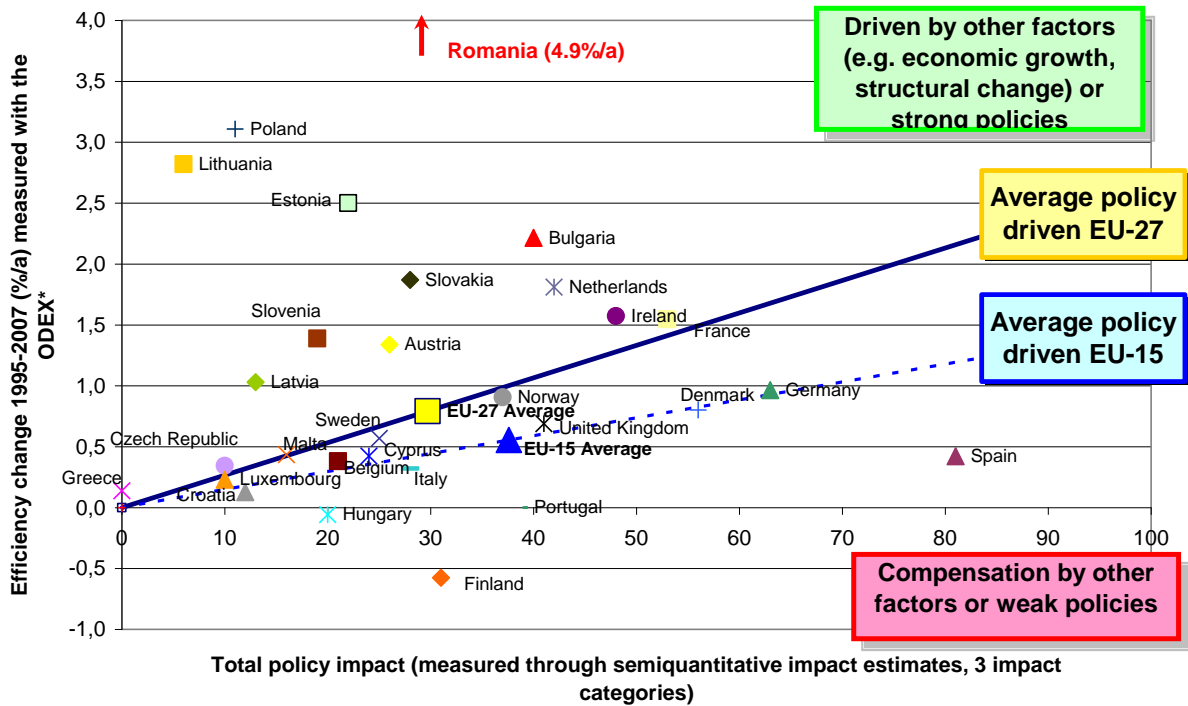
Figure 2.3 : Efficiency-Impact plot industrial sector



Source: Calculations based on Odyssee database, MURE database

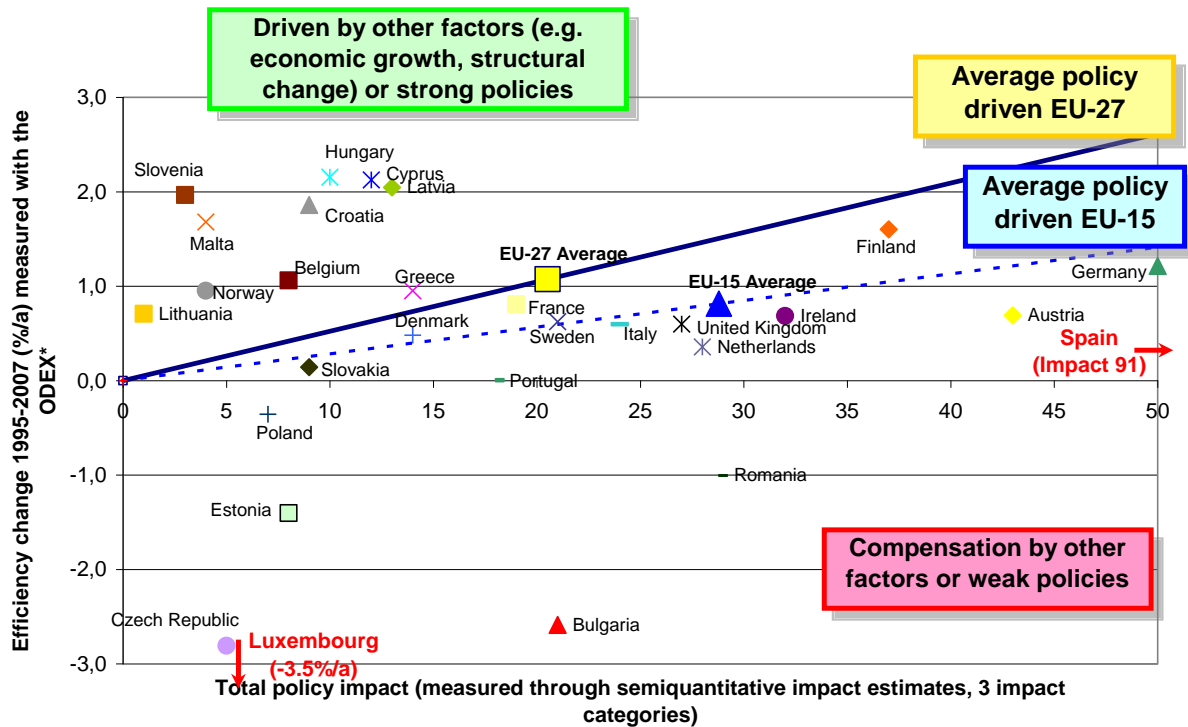
- The **residential sector (Figure 2.4)** takes an intermediate position between the industrial sector and the transport sector. It is relatively strongly dominated by energy efficiency policy while factors such as economic growth or increase in comfort have less impact than in the industrial sector or the transport sector. Nevertheless, also in the residential sector, the strong economic growth in most of the new EU Member States has supported the renewal and rehabilitation of the building stock which was also accompanied by the thermal improvement of the building shell and the heating systems. EU-15 countries with higher improvement of the ODEX as compared to the expected energy efficiency policy impacts are Austria, France, Netherlands, Sweden and also Norway, most of which had quite ambitious policies for the buildings. The impact could therefore have been larger than estimated.
- The **transport sector (Figure 2.5)** is strongly dominated by compensating factors such as increased engine size; this is why the annual efficiency improvement is lowest compared to the industrial and residential sector.

Figure 2.4 : Efficiency-Impact plot residential sector



Source: Calculations based on Odyssee database, MURE database

Figure 2.5 : Efficiency-Impact plot transport sector



Source: Calculations based on Odyssee database, MURE database

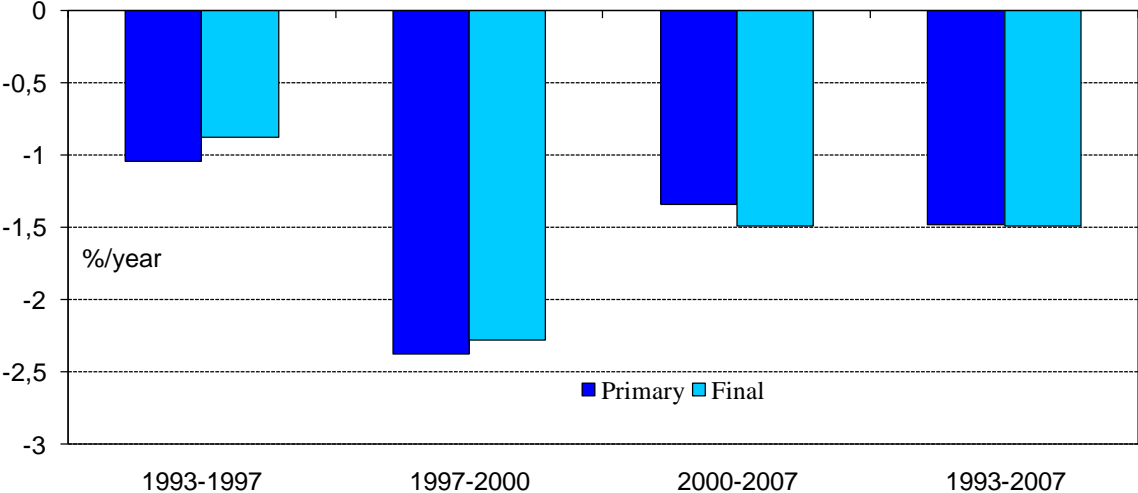
2.2. Overall energy efficiency trends

2.2.1. Trends in primary and final energy intensities

Since 1993, there is a continuous decoupling between energy use and GDP

Since 1993, primary and final energy intensities have been decreasing by about 1.5 %/year in the EU-27; in 2007, these intensities were 20 % below their 1992 values. If we take into account the average economic growth over this period, this effectively means that energy consumption is growing three times less rapidly than the GDP. Between 1997 and 2000, the reduction in energy intensities was more rapid, and slightly more pronounced for the primary than for the final energy intensity: 2.4 %/year and 2.3 %/year respectively (Figure 2.6). Since 2000, there is a slowdown in the intensity reduction, 1.3 %/year and 1.5 %/year for the primary and final energy intensity respectively.

Figure 2.6 : Primary and final energy intensities in the EU-27¹⁵

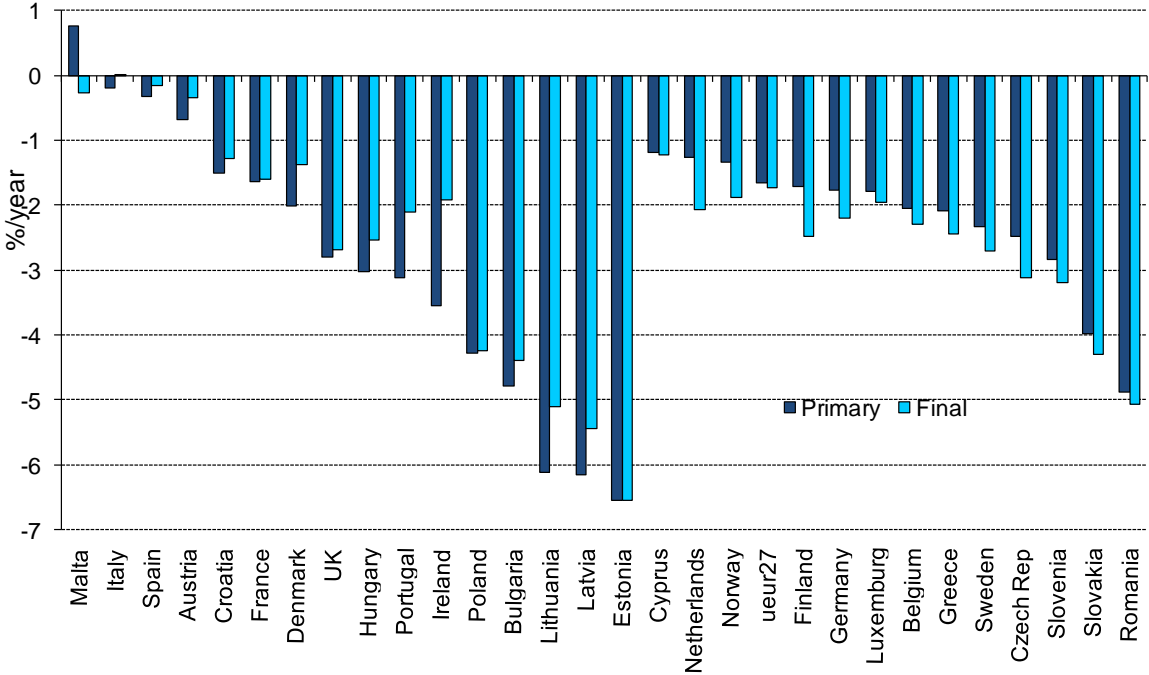


The primary energy intensity has decreased faster than the final intensity in half of the countries because of an improvement in the efficiency of electricity generation

Since 1997, the primary energy intensity decreased faster on average – or increased slower- than the final energy intensity in half of the countries (Figure 2.7). This tendency results from an overall improvement in the average efficiency of power generation linked to the rapid penetration of gas-combined cycles, cogeneration and wind.

¹⁵ Under normal climate conditions.

Figure 2.7 : Variation of primary and final energy intensities in EU countries¹⁶



In the other countries, part of the reduction in the final energy intensity is offset by increasing losses in energy transformation

For the other countries as well as for the EU-27 as a whole, the final energy intensity has decreased faster than the primary energy intensity: this means that increasing losses in energy transformation offset part of the reduction in the final energy intensity. These higher losses may come from more rapid growth in electricity consumption for final end-users (compared to fossil fuels), which results in increased losses in the electricity sector¹⁷, and/or changes in the electricity generation mix (towards less efficient technologies, such as nuclear). A third reason for a larger increase in primary energy use than in final energy is the non-energy use of fuels, in particular in the chemical industry. This phenomenon is particularly apparent in Norway, Finland and The Netherlands, where about one third of the final energy intensity decrease "disappears" at the level of primary energy intensity.

2.2.2. Energy efficiency progress in the EU-27

Energy intensities assess global energy productivity and not energy efficiency progress from a technical viewpoint

Trends in final energy intensities cannot be used to assess the results of policy measures dedicated to energy efficiency and more generally to monitor trends in energy

¹⁶ Under normal climate conditions (1997-2007)
¹⁷ If electricity is produced by nuclear or thermal power plants, there are significant losses in electricity generation that are accounted for in the transformation sector (losses of 66 % for nuclear and between 65 and 50 % on average for conventional thermal power plants)

efficiency. This is even true if they are adjusted for the influence of changes in the structure of economic and industrial activities. Indeed, three types of factors influence trends in final energy intensity, of which only the first two may be considered to measure energy efficiency:

- Spread of energy-efficient technologies and equipment, behaviour and practices.
- Energy substitutions in favour of energy carriers with high end-use efficiency (e.g. district heating, natural gas or electricity);
- Economic and social changes not captured in the GDP structure:
 - in the mix between transport modes: substitution between cars and public urban transport modes in passenger traffic, or between road and rail goods transportation;
 - in the mix of products and processes within industrial branches (e.g. a larger share of electric steel);
 - or, finally, in living standards: increasing appliance or car ownership, changes in the size of cars and household appliances, changes in the share of single family houses in the building stock; increased heating comfort, diffusion of new services and appliances (air conditioning, PC's...).

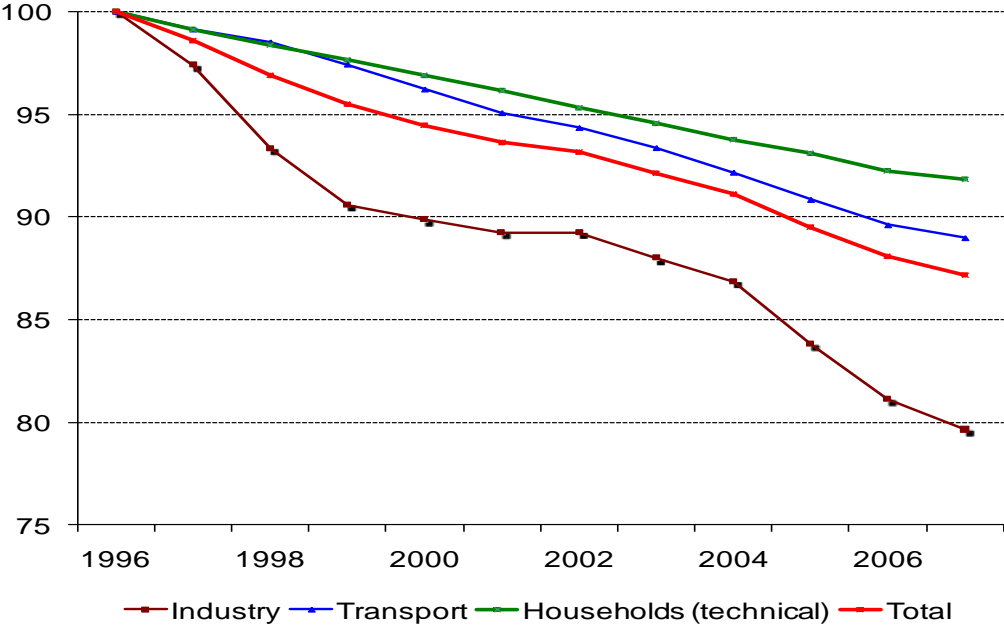
These factors usually have contradictory influences on energy intensities: the first two factors contribute to curbing final energy intensities at constant structure, whereas the third one often tends to increase these intensities, all other things being equal. The contribution of the last factor is all the more significant if the country is less developed: it probably plays a decisive role in Southern, Central and Eastern European countries.

In order to well identify the role of energy efficiency and better assess the actual results of energy efficiency policy measures, specific energy efficiency indicators, expressed as indices, have been developed in ODYSSEE to measure the achievements observed at the level of the main end-uses and appliances, the so-called “**ODEX**”. This index aggregates the trends revealed by the detailed indicators by end-use and equipment in a single indicator. It provides an alternative indicator for energy intensities (industry and transport) or unit consumption (per dwelling for households) to describe the overall trends by sector (see glossary).

Energy efficiency in the EU-27 improved by about 13 % between 1996 and 2007

Energy efficiency policies and measures implemented as well as autonomous technological progress have contributed to improving the energy efficiency by 1.2 %/year on average between 1996 and 2007 at the EU level (**Figure 2.8**).

Figure 2.8 : Energy efficiency progress in the EU-27¹⁸



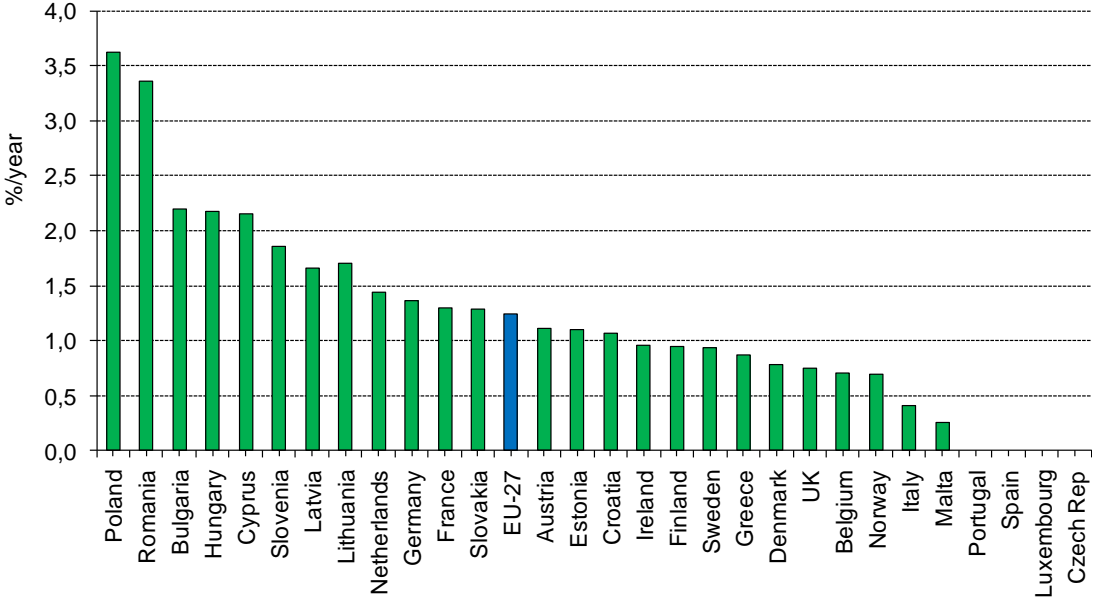
Industry is the sector which achieved the largest energy efficiency improvement, with a regular energy efficiency gain of 1.9 %/year on average between 1996 and 2007. For households and transport, regular but lower progress has been registered (respectively 0.7 % and 1 %/year). The progression is rather regular over time in all sectors: about the same annual decrease is observed after 2000 than over the whole period.

Compared to pure bottom-up evaluations, energy efficiency gains measured in ODYSSEE have a broader scope as they include all sources of energy efficiency improvements, whatever their driving factor: policy measures, price changes, autonomous technical progress or other market forces; in other words, the ODEX measures total energy savings.

The improvement in energy efficiency is higher or close to 2 %/year for six new member countries, Poland, Romania, Bulgaria, Hungary, Cyprus and Slovenia (**Figure 2.9**); for 11 countries this improvement is close to 1%/year (1.2%/year for the EU-27 average). In four countries (Czech Republic, Luxembourg, Spain and Portugal), no energy efficiency gains have been registered over the period 1997-2007. These results should be obviously considered carefully because the energy efficiency gains are dependent on the time period; the results can also be influenced by the data quality and availability, especially in transport where a split of the energy consumption of road transport by mode (cars, trucks and light vehicles, bus) is not always available.

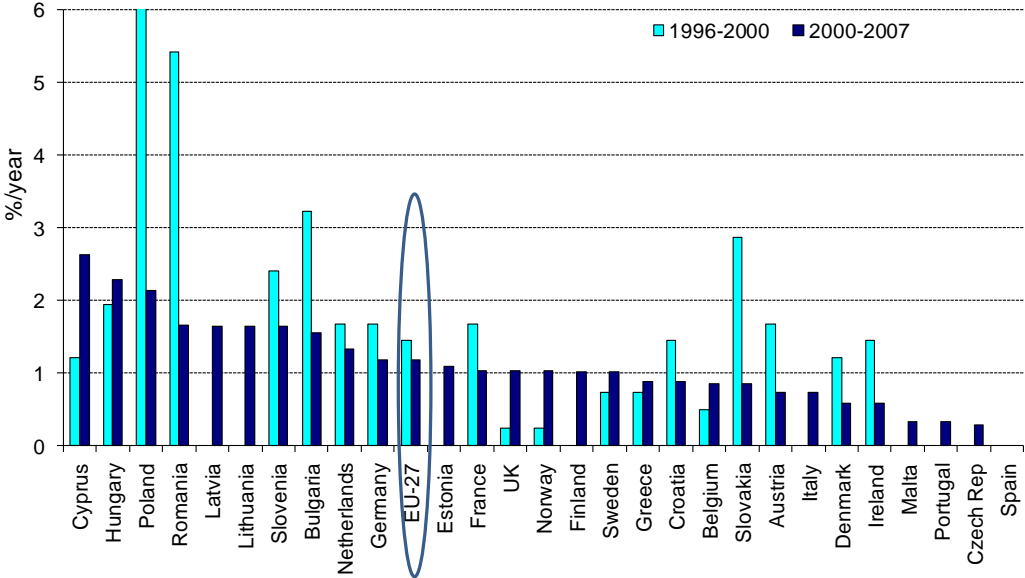
¹⁸ The ODEX is calculated as a 3 years moving average to avoid short-term fluctuations (imperfect climatic corrections, behavioural factors, business cycles).

Figure 2.9 : Energy efficiency progress by country (1996-2007)



In almost all countries, there has been a slowdown in energy efficiency progress since 2000 except for some countries such as Cyprus, Hungary, UK, Norway, Sweden, Greece and Belgium (Figure 2.10).

Figure 2.10 :Energy efficiency progress in EU countries by period¹⁹



For some countries such as The Czech Republic, Portugal, Italy energy efficiency gains appeared since 2000 (no gain over the period 1996-2000). For Spain, no energy efficiency improvement has been registered since 1996 mainly due the transport sector.

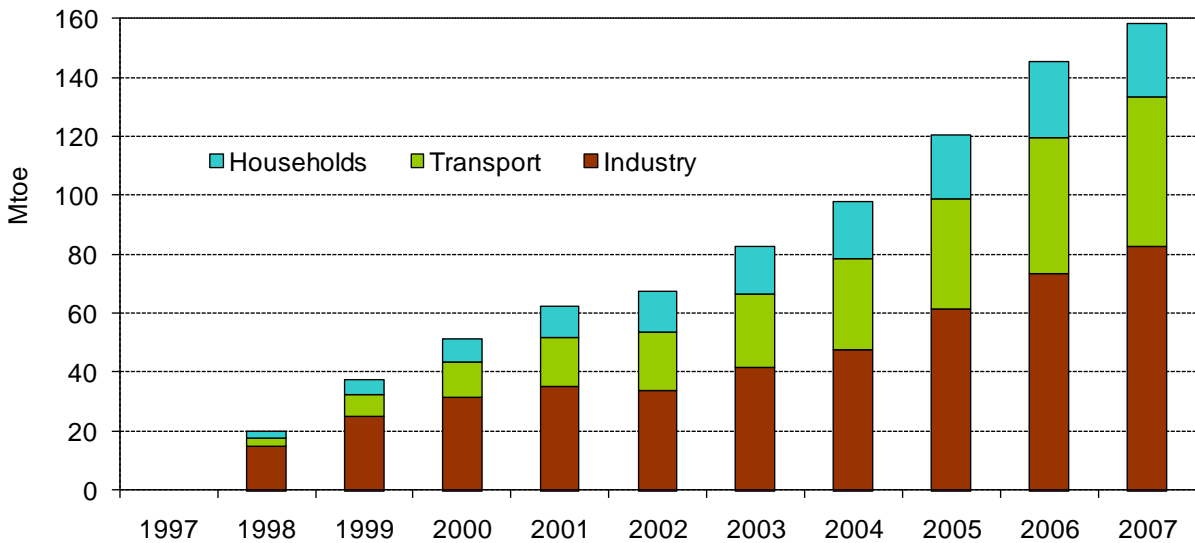
¹⁹ For Malta, Lithuania and Latvia, data is only available over the period 2000-2007.

In more than half of the countries and in the EU as a whole, the rate of energy savings is in line or above the annual target set in the ESD²⁰.

About 160 Mtoe energy savings in 2007

Energy savings can be directly derived from ODEX indicator as it also represents the ratio between energy consumption and a fictive consumption that would have occurred without the savings²¹. In 2007, the energy savings reached 160 Mtoe for the EU as a whole in comparison to 1997. In other words, without energy savings, final energy consumption would have been 160 Mtoe higher in 2007. More than half of the savings come from industry (52 %) and 32 % from transport (Figure 2.11).

Figure 2.11 :Energy savings in the EU-27²²



2.2.3. Explanatory indicators of the consumption variation

The variation of the final energy consumption can be explained from the variation of the indicators that have been presented earlier:

- The unit consumption and ODEX can be used to capture the energy savings;
- Change in the energy intensity in industry can be used to measure the impact of structural changes in the industrial production
- Changes in size of dwellings and in the level of ownership of household appliances can be used to measure the effect of changes in lifestyles, as well as changes in the number of kilometres driven with private cars and the share of larger cars.

²⁰ This is a very approximate estimate of the ESD savings, as savings measured with ODEX include energy intensive industries (ETS) and exclude savings in services.

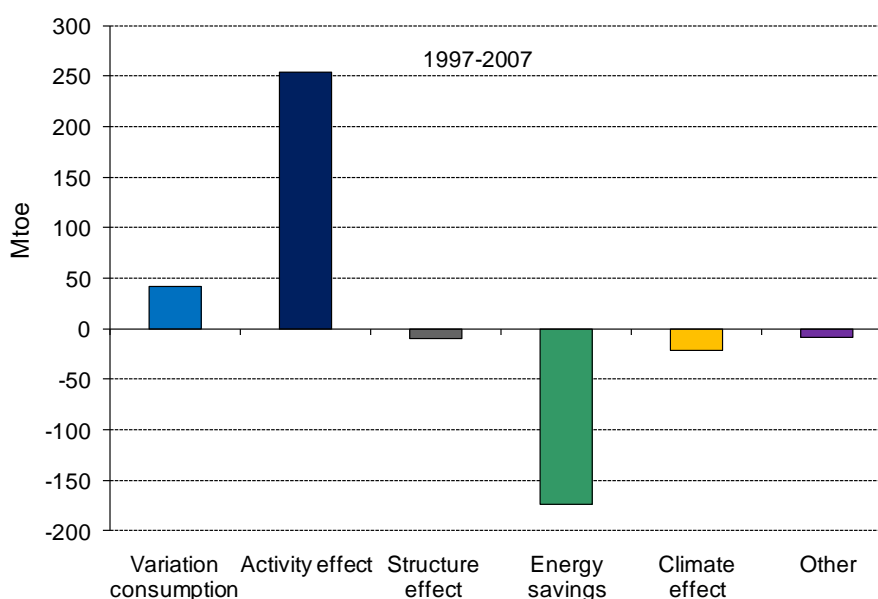
²¹ If for instance the energy consumption is equal to 50 Mtoe and ODEX = 80, the energy savings can be calculated as follows =50* ((100/80)-1) = 12.5 Mtoe.

²² Energy savings in services have not been accounted for due to data limitations.

- Changes in the volume of the industrial activity, in the volume of goods traffic and in the number of employees in services can finally show the impact on the energy consumption of increase in the economic activity.

The analysis carried out on the EU as a whole shows that there are two dominant drivers that offset each others: the activity effect that would have contributed, all things being equal, to increase the consumption by 230 Mtoe between 1997 and 2007 and energy savings (175 Mtoe)²³ that contributed to limit the consumption increase (**Figure 2.12**).

Figure 2.12 : Drivers of the variation of the final energy consumption in the EU



2.2.4. Comparison of energy intensities

Energy intensities need to be adjusted before any comparison

The amount of energy required to generate one Euro of GDP varies quite a lot from one country to another, e. g. by a factor above 5 between Ireland or Denmark, the least energy-intensive countries in the EU, and Bulgaria, at the other extreme. Only 7 countries are within a range of 10 % around the EU average energy intensity. Some of the differences observed in the final energy intensity levels can be explained by specific national characteristics (e.g. climate, industrial specialisation, transport infrastructures, urban patterns). In order to make a more realistic comparison, the final energy intensities need to be corrected to account for these national characteristics.

Three types of adjustments are quantified in the ODYSSEE database :

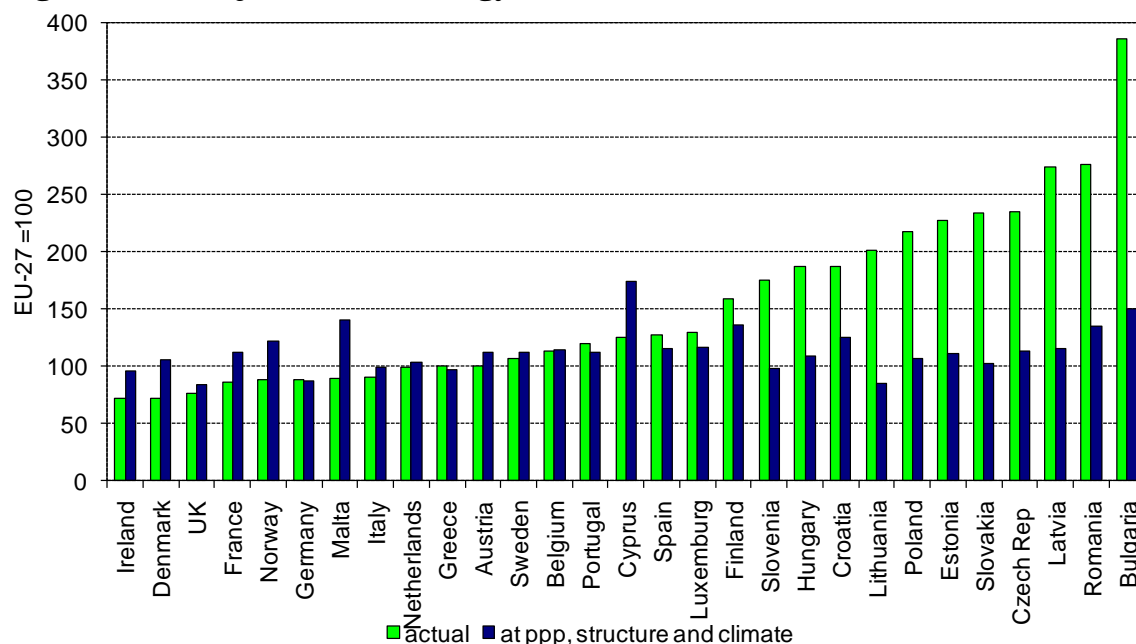
²³ These energy savings include the energy savings in transport, households and industry, as shown above in **Figure 2.11**, and an estimate of energy savings in services and agriculture.

- adjustment of the GDP in purchasing power parities to account for differences in the general price level;
- adjustment in heating requirements to account for climatic differences
- and finally, adjustment in the economic structures to account for differences in the nature of the economic and industrial activities.

These adjustments narrow the gap among countries (**Figure 2.13**). This is particularly true for new member countries where the average price level is much lower than in EU-15 countries: for instance, the adjusted intensity is twice lower than the observed one in Bulgaria, Romania, Latvia, Czech Republic and Estonia: for these countries, their adjusted intensity is more in line with other EU countries. For countries with energy-intensive industrial activities (e. g. Finland and Greece), or with low general price levels (e. g. new Member countries, Portugal or Greece), or with cold climate (e.g. Nordic and Baltic countries), the adjusted value is below the observed intensity.

For most other countries (12 out of 29), the adjustments have the opposite effect and increase the final energy intensity: the adjustments show that in fact they require more energy per unit of GDP than indicated by the observed intensity: the adjustment is significant in Ireland, Denmark, UK, France, Norway, Italy, Austria and Sweden. After these adjustments, UK turns out to be the country with the lowest final energy intensity, followed by Lithuania and Germany

Figure 2.13 : Adjusted final energy intensities²⁴ (2007)



²⁴ For Finland, a large part of the industry is dependant from the paper production: so the adjusted intensity is based on the physical production instead of value added. For Luxemburg, transport consumption is artificially high because of fuel purchase by foreign vehicles; for Malta and Cyprus, as the climate is much warmer than the EU average, no adjustment on climate is done. In addition in Malta, as the industrial activity is only based on few industries (water processing and machinery), no adjustment is done on the industrial structure.

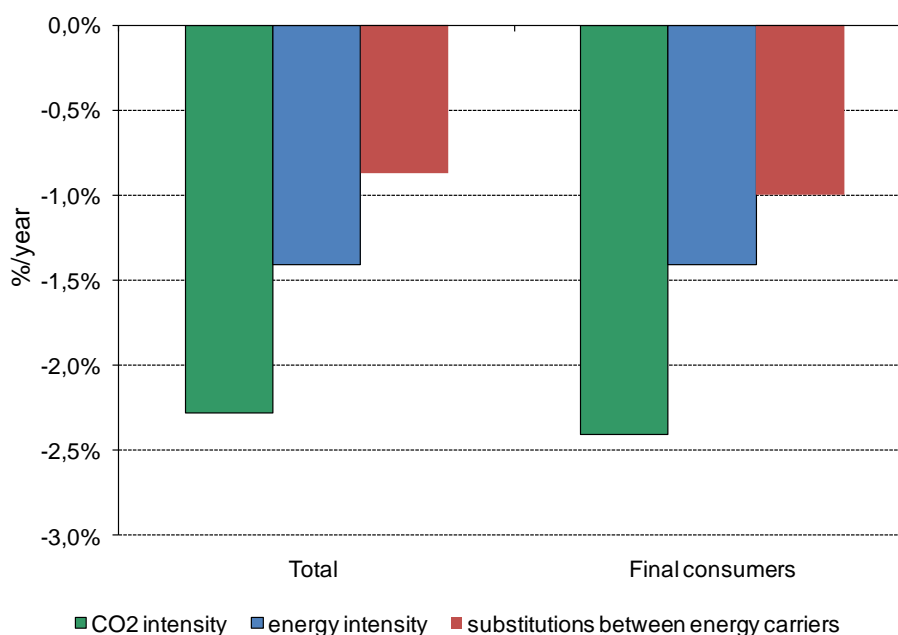
2.2.5. CO₂ trends

Total CO₂ emissions²⁵ from energy use were 5 % below their 1990 level in 2007. Over the period 1990-2007, CO₂ emissions from energy use have decreased on average by 0.3 %/year although the economic activity (GDP) increased by 2.3 %/year. After dropping until 1994 (-1.6 %/year), the CO₂ emissions have increased steadily (0.4 %/year on average) until 2003 and decreased slowly again since (on average by 0.6 %/year). Total CO₂ emissions per capita decreased from 8.7 t in 1990 to 7.8 t in 2007, that is to say a decrease by 10 %.

Almost 40 % of the reduction in CO₂ intensity is due to increased use of energy carriers with lower emission factors

Total CO₂ emissions per unit of GDP, the “CO₂ intensity”, decreased more rapidly than energy intensity: by 2.3 %/year and 1.4 %/year, respectively, on average between 1990 and 2007 (Figure 2.14).

Figure 2.14 : Variation of CO₂ intensity in the EU between 1990 and 2007



This gap is due to switching to energy sources with lower CO₂ emissions factors: the average emission factor of one toe consumed decreased by 12 % over the period from 2.35 to 2.06 tCO₂/toe. In other words, the energy used contained less and less carbon contributing thus to the “decarbonisation” of the economy. These fuel switches explain around 40 % of the reduction in the total CO₂ intensity, the rest (60 %) is linked to the reduction in energy intensity.

²⁵ This section deals with CO₂ emissions from energy combustion published in official inventories from the European Environment Agency. The indicators are not expressed under normal climate conditions (i. e. with climate corrections) to comply with the official definition of CO₂ inventories. CO₂ emissions of final consumers include the emissions of auto producers.

3. Industry

3.1. Policies

3.1.1. Overview of main measures in industry

A substantial renewal of policy implementation in industry

A total of around 260 measures have been implemented or considered in the industrial sector for all EU countries, plus Norway and Croatia, of which 180 measures are being applied. Although the industrial sector has been the target of energy efficiency measures for quite some time, most of the on-going measures are relatively recent: nearly 70% were implemented since 2000 and more than 40% since 2005. This indicates a substantial renewal of energy efficiency measures targeting the industrial sector over the last years. In addition, most of the measures are national measures and are not linked to EU Directives or to EU involvement (~82%). However, this counting of measures does not properly reflect the real impact of a measure such as the EU ETS. The EU ETS²⁶, which aims both at the energy industry and large industrial emitters, is by far the most important European-wide instrument to reduce GHG emissions in the industrial sector and, at the same time, to improve energy efficiency. This scheme was recently newly defined²⁷ for the period 2013-2020 by including large shares of auctioning for the allowances (for the energy sector and the industrial sectors which are not threatened by international competition) and by making use of benchmarks to define the allocation to the other industrial sectors based on the level of the 10% best Europe-wide. Another important EU-wide measure for the industrial sector is the Eco-design Directive 2005/32/EC²⁸ which sets minimum standards for a variety of industrial cross-cutting technologies such as electric motors. A further relevant EU-wide measure for the industrial sector is the CHP Directive 2004/8/EC²⁹.

Financial incentives are the most frequent measures followed by informational and cooperative measures

Financial incentives are the most frequent measures (34% of all on-going measures) (**Figure 3**). Then follow at some distance information/education/training measures (with 19% of the total) and cooperative measures (voluntary/negotiated agreements, 15% of the total). Around 10% are in the category new market-based instruments which is essentially the EU ETS and White Certificates as far as relevant in the industrial

²⁶ Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community.

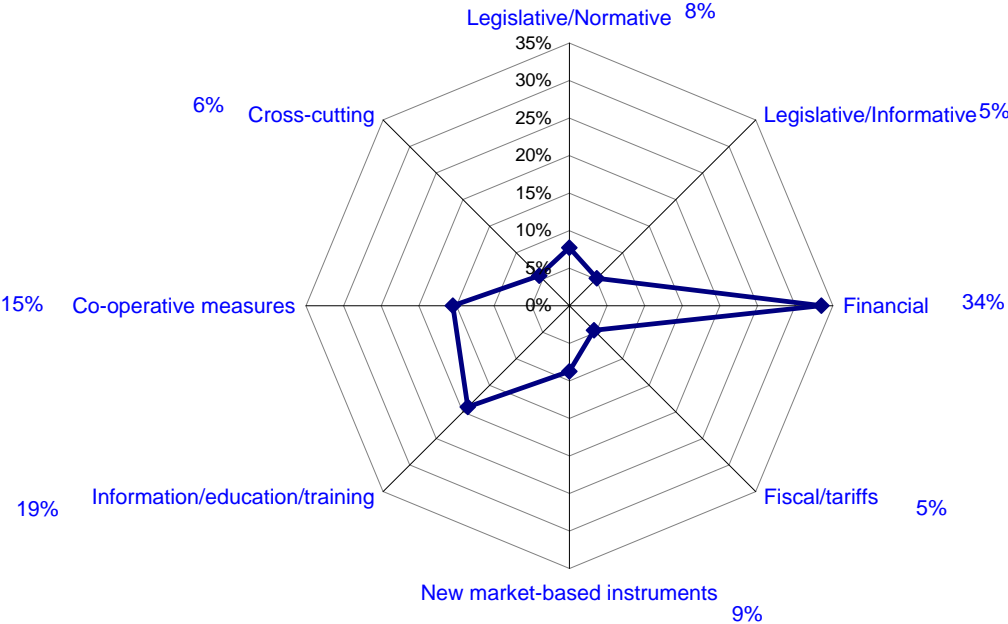
²⁷ Directive 2009/29/EC amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community.

²⁸ Directive 2005/32/EC establishing a framework for the setting of Eco-design requirements for energy-using products.

²⁹ Directive 2004/8/EC on the promotion of cogeneration based on a useful heat demand in the internal energy market.

sector. Legislative-normative measures (e.g. the Eco-design Directive) and legislative-informative measures (mandatory audits) play a less important role in terms of measure numbers. Due to the Eco-design Directive legislative-normative measures are, however, increasing in importance.

Figure 3.1 : Number of measures by type in industry in the EU



Note: on-going measures since 1990

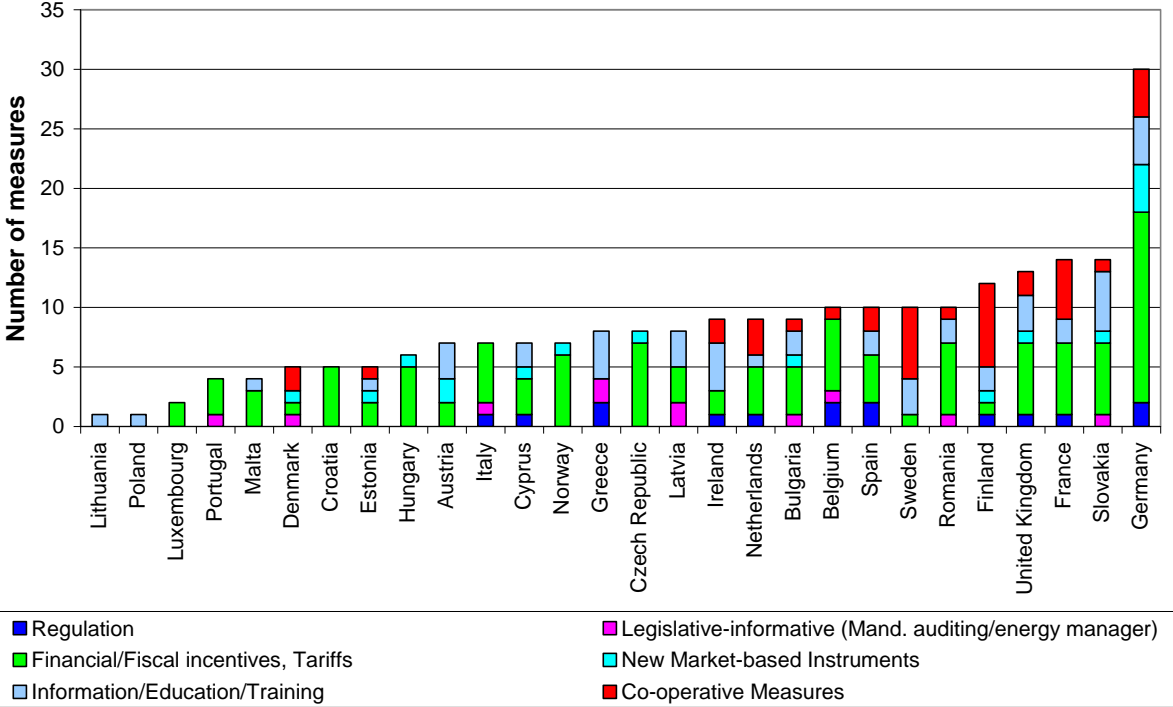
Source: Adapted from MURE

A large discrepancy in the number of measures by country

There is a large discrepancy among countries in the number of measures: twelve EU countries are above average, which is around 8 measures per country and eight countries have a low number of measures (equal or below 5 measures). Germany stands out with 30 measures targeting the industrial sector (**Figure 3.2**).

Most countries with a larger number of measures show a broader mix of measures by type. However, in nearly all countries there is a preference for financial and fiscal measures. Exceptions are Denmark, Austria, Greece, Ireland, Sweden and Finland which show a broader mix of measures or a different focus (e.g. on informational measures). Informational measures in the industrial sector tend also to be used broadly by all countries. Cooperative measures (voluntary/negotiated agreements) are used by half of the countries, mainly in the EU-15 (in particular in the Netherlands, Sweden, Finland, France and Germany) but also in Estonia, Bulgaria and Slovakia. This reflects national circumstances, in particular preferences for specific types of policy interventions.

Figure 3.2 : Number of measures by country in industry in the EU

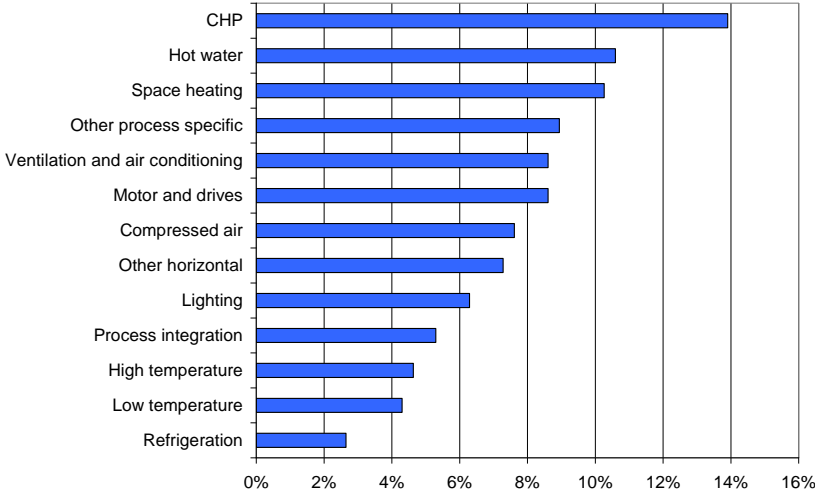


Source: Adapted from MURE

Broad coverage of measure targets with some focus on CHP

There is a broad coverage of measure targets across the different energy uses (**Figure 3.3**). Some focus appears to be on Combined Heat and Power Generation (CHP), on hot water/steam generation and on space heating. Otherwise the measures aim broadly at all cross-cutting technologies (compressed air, electric motors etc) and process technologies.

Figure 3.3 : Distribution of measures by target in industry in the EU



Source: Adapted from MURE

An increasing influence of EU Directives and measures in the industrial sector

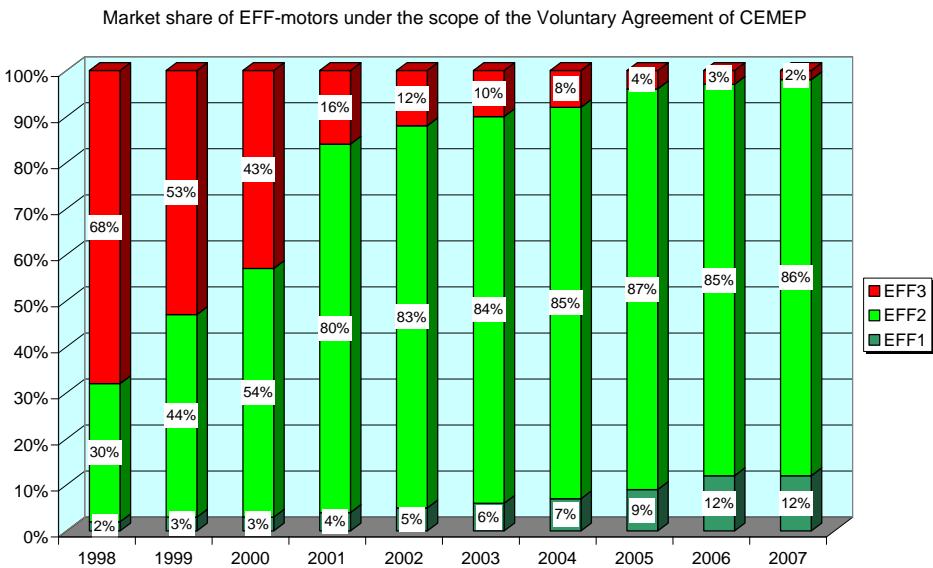
Before the introduction of the EU Emission Trading Scheme in 2005, the EU limited its activities in the industrial sector to rather soft measure such as guidelines for voluntary agreements and to some informational measures, such as the Motor Challenge programme. In addition to the EU ETS since 2008/2009 there is now in particular also the issue of mandatory standards arising for the cross-cutting applications in the framework of the Eco-design Directive.

From the CEMEP voluntary agreement to Eco-design standards for efficient electric motors

At the beginning of the decade, electric motors were the target of a voluntary agreement from the motor organisation CEMEP. Their aim was to phase so-called eff3 motors out of the market and to replace them with eff2 motors. The eff-2 motors had a market share of 86 % in 2007. Also the share of eff1 motors increased in that period (**Figure 3.4**).

The next step in the improvement of motor efficiency will be through market regulation and Eco-design standards. For this purpose a new classification for motor efficiency was introduced. The standard aims to phase IE1 and after 2015 also IE2 out of the market. In the USA, “IE2” and “IE3” motors have a market share of 70%, whereas in Europe their market share is about 15 % at present (see EC, 2008, Brunner, 2007). One reason for this is that with 60 Hz (which is the common grid frequency in the US), it is easier to achieve higher efficiencies than with 50 Hz (which is the standard grid frequency in Europe). However, undeniably there was also an earlier start to ambitious motor standards in the US.

Figure 3.4 : Diffusion indicator for efficient electric motors



Source: CEMEP, http://www.cemep.org/fileadmin/downloads/agreement_1998-2007.pdf

At present, there are no signs that there could be substantial delays in implementing the Eco-design Directive. The regulation passed by the European Union for each product concerned is, after possible transitional periods, binding for the Member States. None of the countries at present goes beyond the standards set by the EU and in some cases there may also be the danger that the standards are weakened or detailed under the pressure of industrial associations or some of the Member States.

3.1.2. Mandatory energy managers, mandatory energy audits and reporting

Mandatory energy management is so far not a wide-spread type of measure.

- In the framework of the National Energy Efficiency Action Plan, Greece envisages implementing an obligatory Energy Management System.
- Hungary is proposing the mandatory application of energy management by large energy consumers.

In practice, mandatory energy management does not play a very prominent role. One reason may be that large companies have energy managers while small and medium-sized companies, where this is most relevant, may have problems to support the activities with enough staff. Also **mandatory energy audits** do not seem to be widespread. Disadvantages of mandatory audits include producers' perceptions of the mandatory nature of instruments as an administrative burden rather than a process helping them to reduce their costs or to become more competitive. They will tend not to comply with the regulation, or worse, they will comply formally, but will not integrate the basic idea of energy audits in the company culture. Finally, in case the audits are coupled with mandatory benchmarks, compliance becomes difficult to prove, given the complexity of industrial processes.

3.1.3. Financial/fiscal measures

The most frequent measure type, increasingly used in a larger frame together with other types of measures.

Financial incentives and fiscal measures constitute by far the most widespread and oldest type of measures used in the industrial sector. Quite frequently, however, in contrast to earlier days, financial incentives are used in a larger frame together with other types of measures such as energy auditing and implementation of energy management procedures in a continuous process of improving energy efficiency. This tends to increase their efficiency. Subsidies help to overcome the investment barrier (although they may not help to overcome barriers such as information deficits).

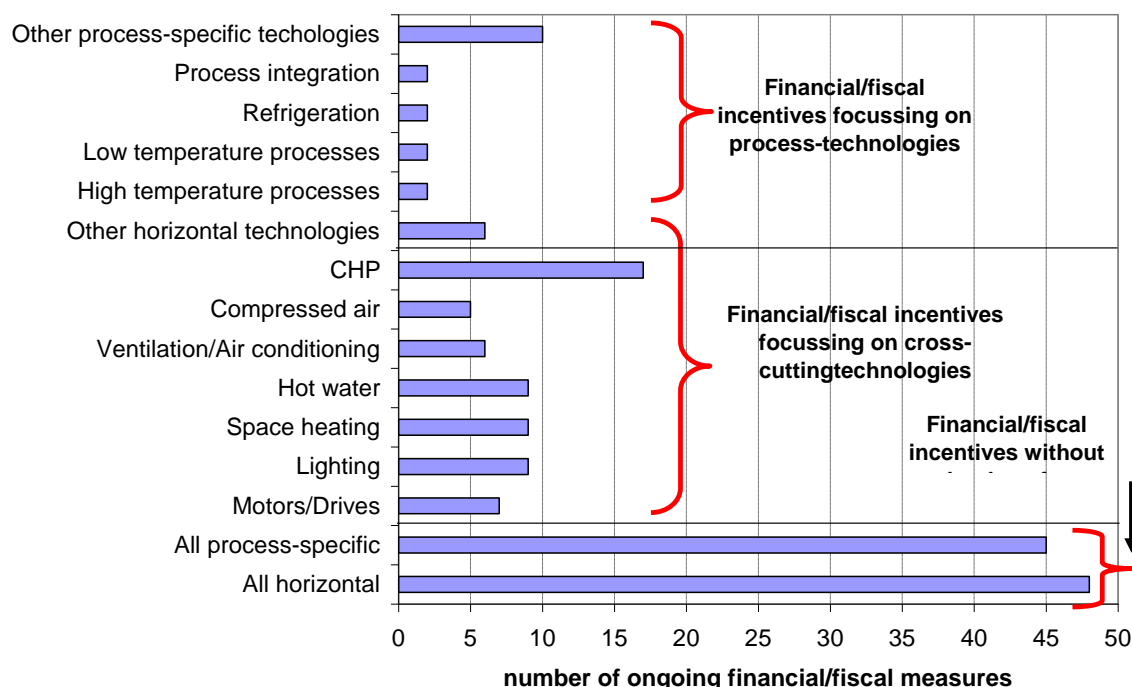
There are several reasons why cross-cutting technologies are better covered in subsidy schemes than process-specific technologies, in particular:

- First, for the public bodies that provide the subsidies it is much easier to define the cases which are relevant for the subsidies in a standardised way. Process-specific improvements are, generally, only possible in combination with detailed energy audits, frequently to be provided by external auditors.

- Second, a variety of companies refrain, however, from initiating detailed external audits on process technologies because they consider them to be at the heart of their business and are reluctant to accept external energy audits. This barrier could be overcome by mandatory audits or by audits based on voluntary agreements as mentioned in the EU Directive on Energy Efficiency and Energy Service. This could constitute an important field of the energy services to be developed under this Directive.

CHP is particularly well covered, due to the general attention that is given to this technology, the existence of an own CHP Directive (Directive 2004/8/EC) and the progress that was achieved in this Directive in defining high-quality CHP that may be subject to subsidies.

Figure 3.5 : Technology focus of on-going financial and fiscal measures



Source: Adapted from MURE

Most programmes are generally targeted towards all companies. However, there are differences in the amount of incentives that can be received by large companies in contrast to SMEs. This is restricted by competition laws (within the EU and internal agreements through the World Trade Organisation WTO). Generally, it is much easier to give aid to SMEs than to large companies. The state aid cases for environmental investments fall into different categories such as investments to exceed standards or to accelerate the introduction of standards. This would cover for example a subsidy scheme to accelerate the introduction of MEPS for electric motors etc.

3.1.4. Cooperative measures

Considered as high impact measures; still in use despite the EU Emission Trading Scheme

Cooperative measures such as voluntary/negotiated agreements are considered as high impact measures. This is certainly the case of the Long-term Agreements and the Benchmarking Agreements in the Netherlands. Frequently, cooperative measures are considered as a trade-off for other types of measures, in particular taxation measures (see the example of Norway and the exemption of energy-intensive companies from the electricity tax). Roughly half of all EU countries have introduced such types of measures.

3.1.5. Information/education/training

Relevant complements to other measures despite the fact that possible direct impacts are considered as low

Information/education/training measures for the industrial sector tend to be implemented by most EU Member States without exception despite the relatively low impact cited above, and even with slightly increasing frequency over the past few years. In fact, more informational programmes may be directed towards the industrial sector but generally they are part of more general information campaigns across all sectors.

The information offer may cover a broad range of issues such as energy costs mentoring³⁰ by energy advisors for smaller companies, information on financial assistance, guidance documents, educational road shows, training of energy managers, energy awareness resources etc.

3.1.6. New market-based instruments

Yet to prove the impacts in the field of industrial energy efficiency

There are essentially three types of new market-based instruments which strive to improve energy efficiency based on market forces:

- White Certificates
- The EU Emission Trading Scheme EU ETS
- The use of Clean Development Mechanism and Joint Implementation to improve energy efficiency in countries outside the EU and getting the savings accounted for under the Kyoto Protocol obligations

A White Certificate is both an accounting tool, which proves that a certain amount of energy has been saved in a specific place and time, and a tradable commodity, which belongs initially to the subject that has induced the savings (implemented a project) or

³⁰ Small companies are coached to improve their procedures to follow and reduce energy costs.

owns the rights to these savings, and then can be traded according to the market rules, always keeping one owner at the time. The White Certificate systems have so far only been implemented in a limited manner in the industrial sector. More countries, e.g. Poland, are experimenting further in this direction, but most likely a few more years will pass before an EU-wide introduction or even harmonisation takes place.

The EU Emission Trading Scheme is considered to be one of the most important instruments for the reduction of greenhouse gases in the industrial sector. As energy efficiency improvements are considered to be cornerstones of greenhouse gas reduction policies, the question is legitimate to what extent the emission trading scheme has led to improved energy efficiency. The first trading phase was characterised by mostly low carbon prices which gave limited incentives to energy efficiency. Due to the economic slow-down, carbon prices are currently as low as 10-15 euro/t CO₂. Such a price corresponds to an increase in the cost of one tonne of crude oil of around 10%, in the final products such as heavy or light fuel oil it may correspond to an increase between 5-8 %. So far there are only partial studies of the impacts of the EU ETS³¹ on energy efficiency, at least for the impacts concerning the industrial sector.

A very innovative feature within the EU ETS is the **development of benchmarks** to limit the number of free allowances. Under the revised EU ETS Directive the European Commission is to define fully harmonised rules for free allocation of CO₂ allowances, which should be based – as far as is feasible – on ex-ante benchmarks

The Clean Development Mechanism and Joint Implementation have been set up as flexibility mechanisms under the Kyoto Protocol to save greenhouse gas emissions, and in particular also energy, outside the EU in developing countries (CDM) or other signatory states of the Protocol (JI) if the country itself cannot fulfil its target. So far the CDM mechanism has been little used to save energy: only 1% of the projects concern energy demand. Two main reasons may explain this situation: on the one hand, energy efficiency projects are frequently of smaller size, on the other hand, baselines are fairly complex to determine for energy efficiency.

3.1.7. Specific measures directed towards small and medium-sized companies

Small and medium-sized enterprises (SMEs) have particular characteristics which require special attention:

- they often have limited access to information,
- the energy share of their expenditure is generally not high enough to encourage them to undertake energy-saving measures, and
- finally, due to their size, searching for funding for energy-saving measures would cost too much in transaction expenses.

³¹ The EU impact assessment for the EU ETS concentrates on the interaction with renewables and the reduction of greenhouse gas emissions but is not explicit about energy efficiency.

SMEs therefore need a **special coaching process** which enables them to adopt energy-efficient solutions. SMEs also need **special tool boxes** which help them reduce the transaction costs (see the BESS project which prepares tool boxes for benchmarking and energy management in industrial SMEs).

In the future it is important that such activities are promoted more strongly through **energy efficiency funds for SMEs** in the different countries to overcome the investment barriers, e.g. by dedicating some part of the revenues arising from the EU Emission Trading Scheme to measures for energy efficiency as prescribed by the EU Directive on the EU ETS and advocated by the forthcoming EU Energy Efficiency Action Plan which should set up national funds for energy efficiency.

3.1.8. Innovation in measure development

There are several ways in which innovative measures for energy efficiency are introduced in the different EU Member States: (1) First there are measures which are innovative compared to the past with respect to their comprehensiveness. This is the case with European legislation on Eco-design standards for energy-using products which comprises now 40 products for which 10 standards are already published (2) measures may be innovative through the dynamic aspects they include in the measures design as they may be more ambitious over time (3) Measures may further be innovative through the new context in which they are set that is in which combination of measures they are applied (e.g. the combination of a learning process with the development of adapted tools, investment subsidies and information in “Learning Energy Efficiency Networks”). (4) Measures may be innovative because they constitute a completely new type such as the new market-based instruments mentioned above. (5) Finally, a measure type may develop further innovative features such as for example the EU ETS where - to preclude the danger of carbon leakage³² - benchmarking systems are developed to limit the amount of free carbon allocation. All four innovation strategies are pursued in the Community and have led to a substantial number of new measures in the industrial sector in the past years.

3.1.9. Measure packages

In general, a specific energy use is frequently targeted by several measures. The measures in the package may reinforce each other but they could also counteract against each other. In this section we briefly present the main interactions:

- **“Meta-Interactions”**: By this we understand the interaction between measures such as regulation or financial incentives for energy efficiency that lead to a reduction of CO₂ emissions which on the other hand lowers the need for allowances under flexible instruments such as the EU ETS. This interaction could be negative as long as the cap set for the EU ETS does not take into account, at

³² Displacement of carbon emissions outside the EU, for example to China, as production sites may close in Europe due to higher charges on the companies from the carbon price. This could undermine their competitiveness.

least approximately the amount of CO₂ saved by such measures. It could lead to falling prices in the EU ETS thus hampering its further development and impacts.

- **Regulation** is frequently thought to be a standalone measure but could benefit in packages from informational measures as well as from subsidies (which may enhance an earlier introduction of regulation or could provide incentives to exceed regulation. One example are electric motors under the Eco-design Directive. IE3 Motors will be obligatory from 2015/17 at the latest but could benefit from earlier actions to accelerate the transition.
- **Information measures, including energy audits and subsidies** are increasingly utilised in support of other measures. As standalone measures they are frequently judged as having a lower impact than cooperative measures such as voluntary agreements. However, they are considered essential, for example, in combination with voluntary schemes (see for example the MOTIVA approach to voluntary agreements in Finland).
- **SMEs** may need specific measure packages which help them to lower the transaction costs (see section 3.1.7). However, subsidies, preferential loans or credit guarantees are also relevant in this context to help overcome the investment barrier.
- **Specific measure packages** are necessary to overcome **non-economic barriers**. One example are specific measures to overcome the producer/user dilemma for electric motors which are built in by OEMs into machines or sold by wholesalers without consideration for energy efficiency. Specific measures such as voluntary agreements, information or regulation are necessary to address this barrier.

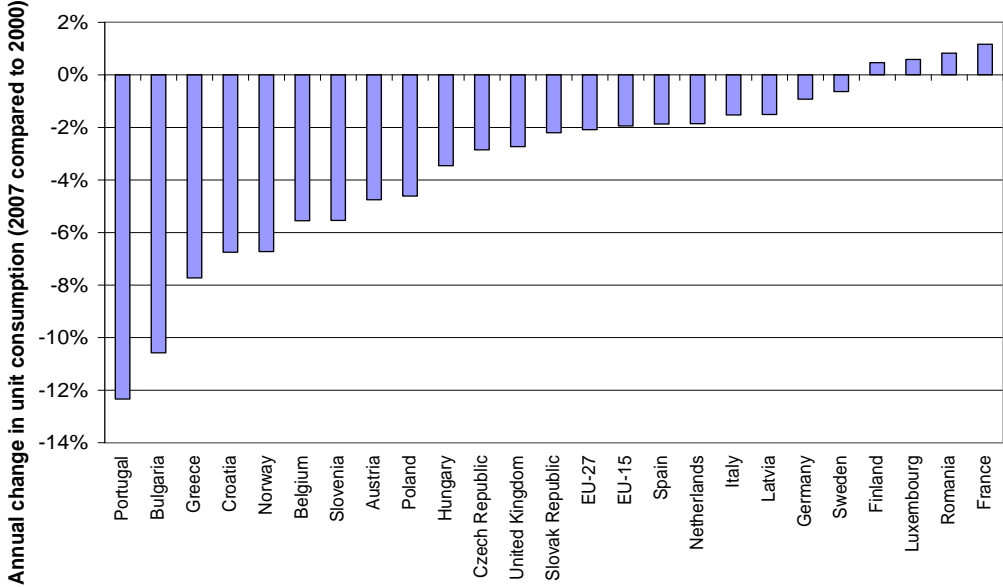
3.2. Energy efficiency trends in industry

3.2.1. Energy trends in some energy-intensive industries

3.2.1.1. Steel

The specific consumption per ton of steel has been decreasing in the EU as a whole as well as in most countries, with a very rapid reduction in new member countries. Part of the reduction may be explained by an increasing share of steel produced with the electric process (EAF) that is much less energy intensive than the traditional blast furnace/oxygen process (BOF).

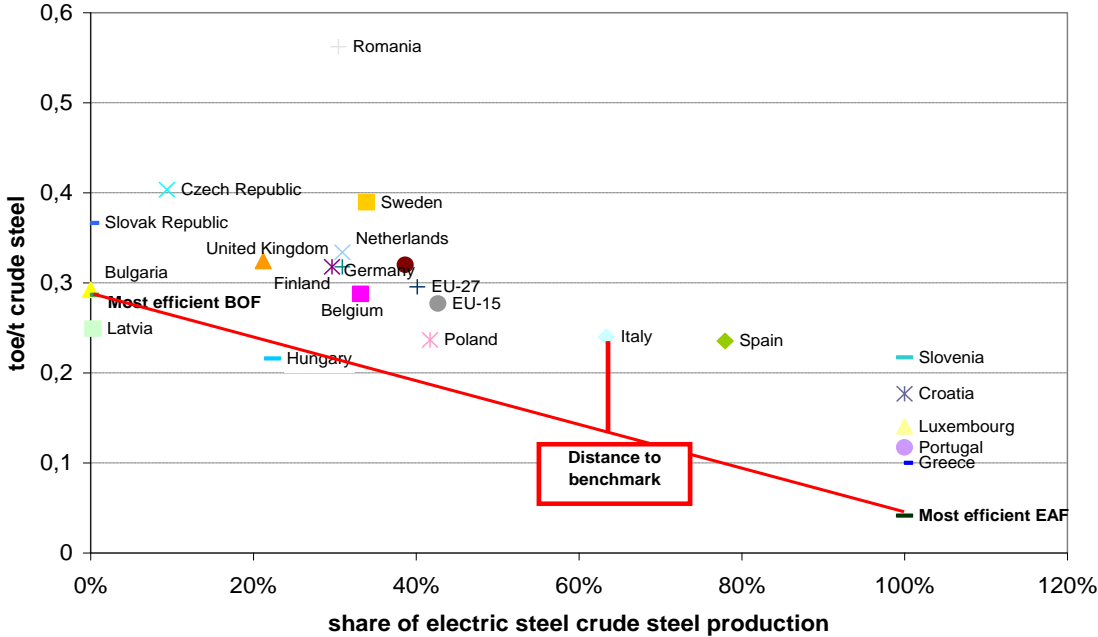
Figure 3.6 : Annual change in the unit energy consumption of steel in EU countries



Note : a negative value represents an improvement in energy efficiency; source: Odyssee

Figure 3.7 shows a more detailed comparison of the performance of the European steel sector across the different countries in relation to the process mix. The vertical distance to the red line indicates the distance to the benchmark. The figure shows that some new EU Member States have reached good performance levels due to the renewal of the production equipment. However, in some countries such as Romania or Czech Republic still further improvement is possible.

Figure 3.7 : Performance of the steel sector as a function of steel process (2007)³³



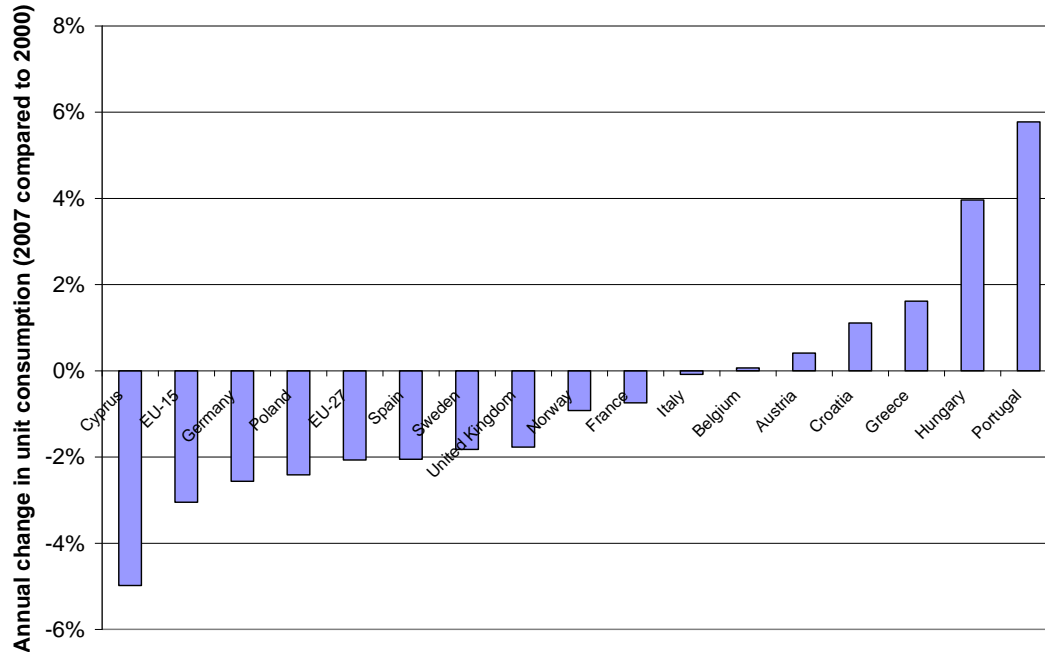
Note: electricity use is expressed in final energy in this graph; source: Odyssee.

³³ BOF: blast furnace route; EAF: electric arc furnace route.

3.2.1.2. Cement

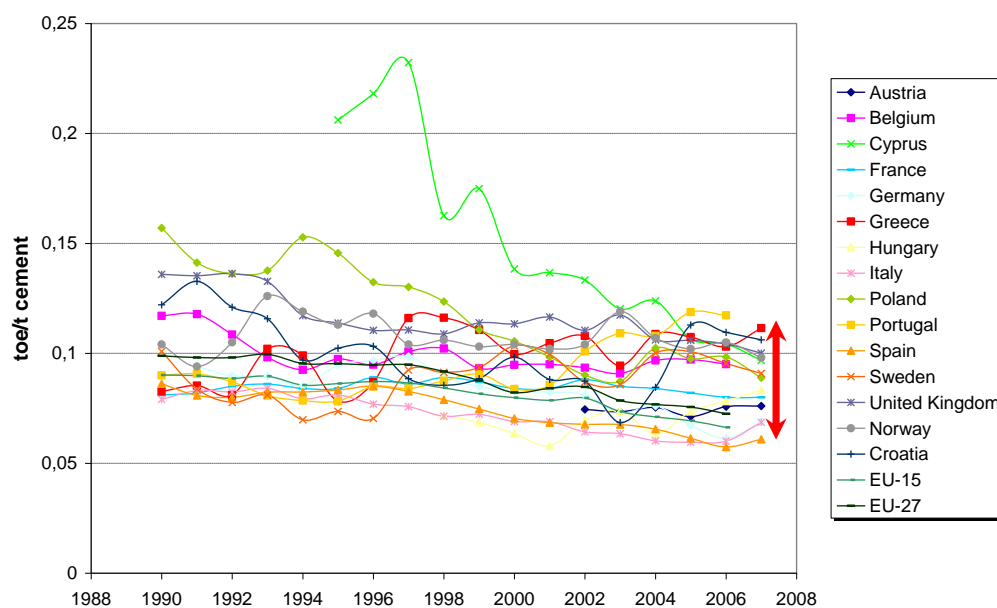
The unit energy consumption decreased in the EU-27 with an average annual rate of more than 2 % from 2000 to 2007 (Figure 3.8). The spread in the performance of the cement industries has been considerably reduced over the past ten years. However, there is still a long-term potential of up to 50% reduction by increased energy efficiency and increased use of wastes as indicated by Figure 3.9.

Figure 3.8 : Annual change in the unit energy consumption of cement



Note: a negative value represents an improvement in energy efficiency; source: Odyssee

Figure 3.9 : Unit consumption trends for cement production

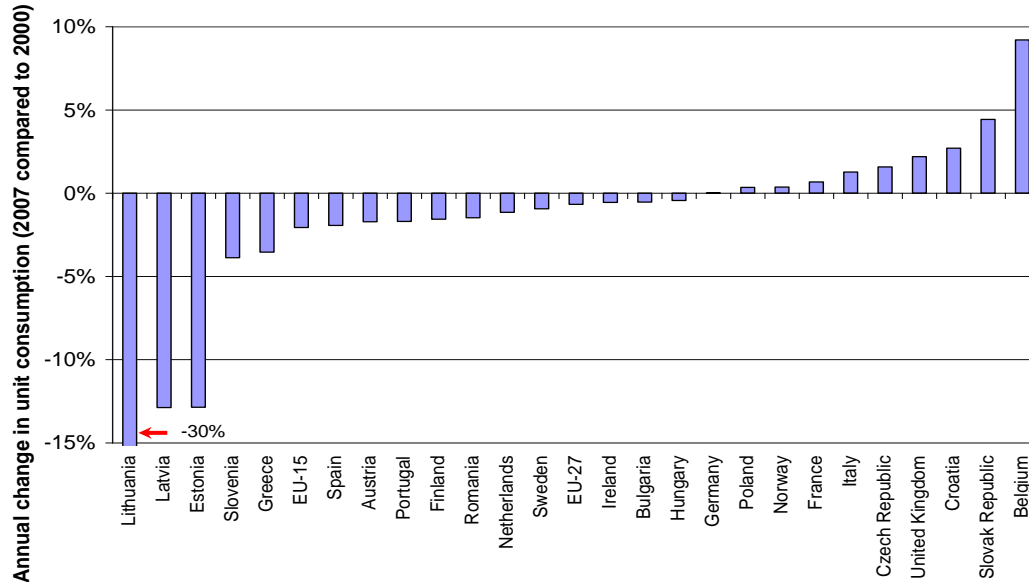


Source: Odyssee

3.2.1.3. Paper

The unit energy consumption decreased in the EU-27 at an average rate of 0.7 %/year from 2000 to 2007 (**Figure 3.10**), although some countries among the new Member States had considerably higher rates of decrease. Generally, countries that increased the production also succeeded in lowering the unit energy consumption, which indicates that they have profited from a renewal of production facilities to improve energy efficiency.

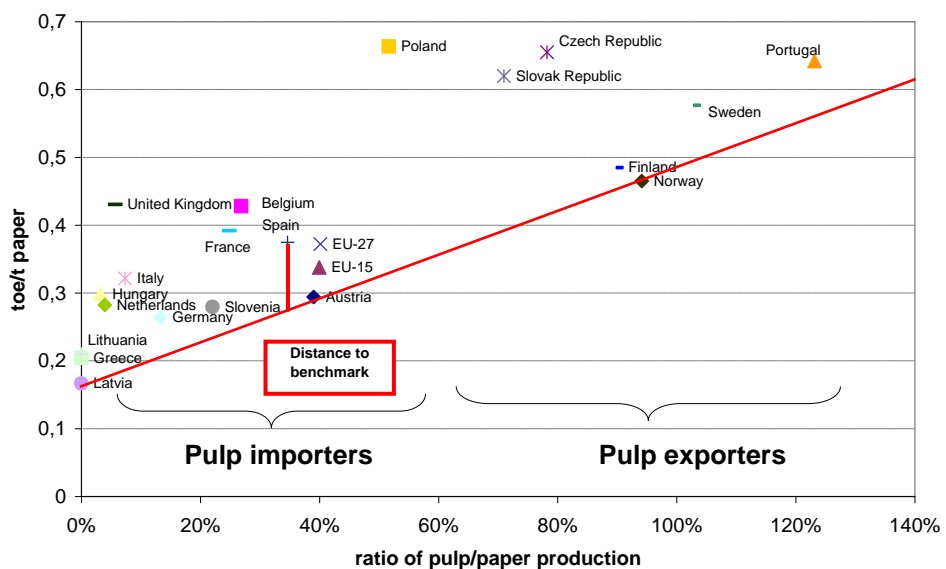
Figure 3.10 : Trends in unit energy consumption of paper in EU countries



Note: a negative value represents an improvement in energy efficiency; source: Odyssee

The ratio of pulp to paper production strongly determines the unit energy consumption: the higher the ratio the higher the unit energy consumption, as pulp is very energy-intensive. Taking into account the pulp to paper ratio allows establishing a benchmark across the countries (**Figure 3.11**).

Figure 3.11 : Unit consumption of paper as a function of the pulp to paper ratio



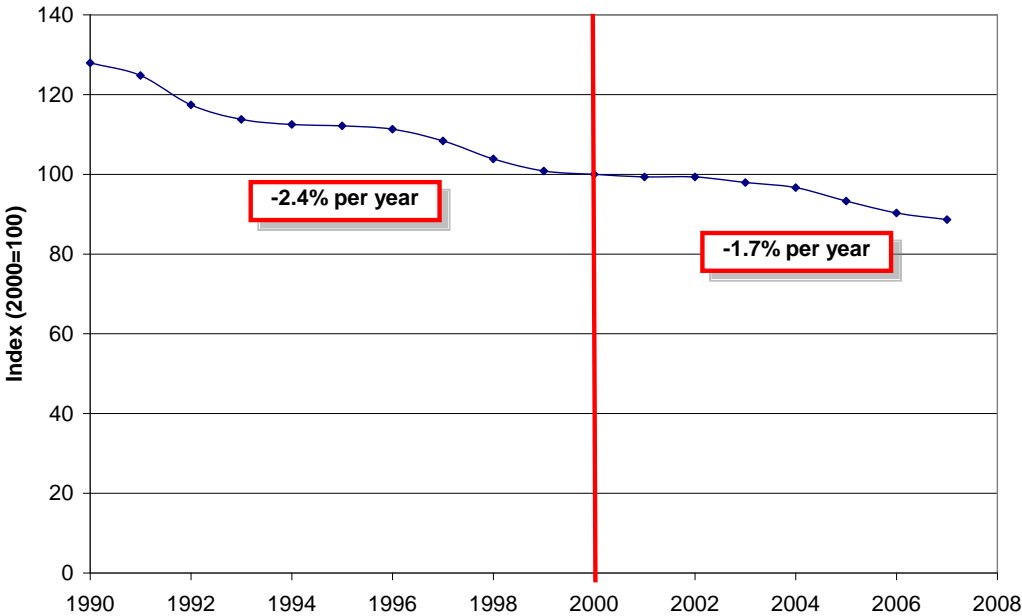
Source: Odyssee

3.2.2. General energy efficiency trend

Regular and strong improvement (2.1% per year since 1990) of the energy efficiency of industry in the EU interrupted by business cycles.

The energy efficiency of industry in the EU-27 improved by more than 30 % between 1990 and 2007 (2.1 %/year) (Figure 3.12)³⁴. Greater progress was achieved in the nineties (2.4 % per year than after 2000 so far with 1.7 %) but the improvement was fairly continuous, mainly influenced by the business cycles. The acceleration after 2004 could, however, also been influenced to some degree by rising energy prices. Due to the economic crisis in 2008/ 2009 it can be expected that the energy efficiency index will not decrease much in the next 2-3 years.

Figure 3.12 :Energy efficiency progress in industry in the EU (ODEX)

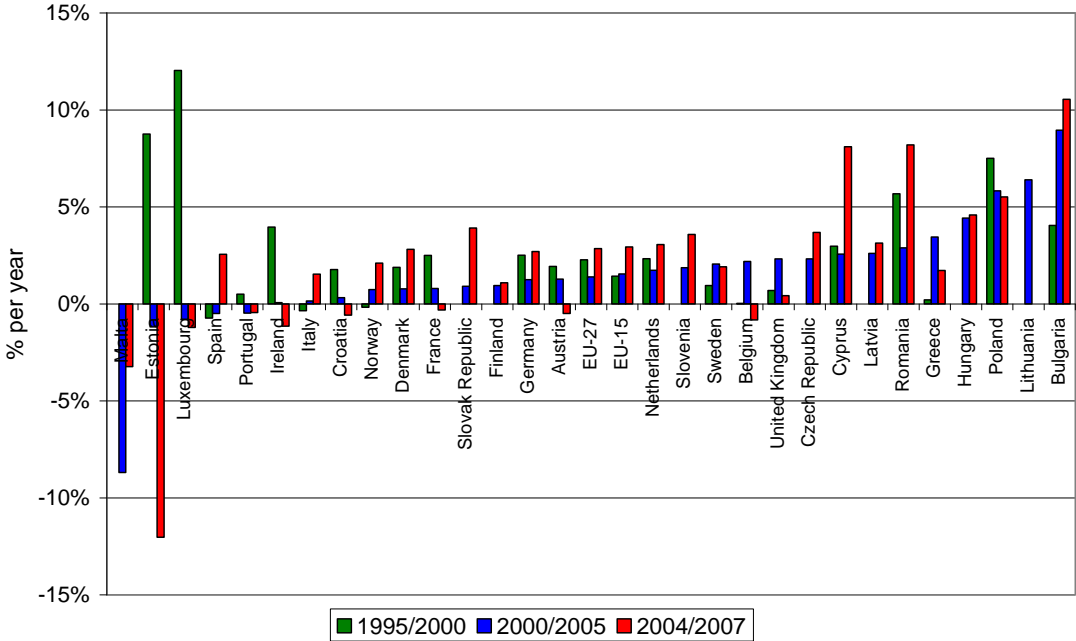


Source: Odyssee

With few exceptions all countries showed energy efficiency progress in the industrial sector after 2000 (Figure 3.13). In eighteen countries the rate of progress was above 1 %/year in the period 2000/2005, i.e. above the target of the Energy Service Directive. Only in Malta, Estonia, Luxembourg, Spain and Portugal a deterioration in the efficiency of industry was observed during that period, to some degree because of non-disaggregated structural change (that is structural change occurring within one industrial branch which in statistical terms is not further broken down).

³⁴ Energy efficiency progress is captured by a unit consumption measured in GJ/tonne for some energy-intensive products such as iron/steel, cement and paper. For the other branches the progress is measured by relating energy consumption to the production index. The overall trend is a weighted average of the trend by branch (ODEX) over 11 branches.

Figure 3.13 :Energy efficiency progress in industry in EU countries (ODEX)



Note : a positive percentage means energy efficiency progress, a negative percentage a deterioration (or non-disaggregated structural change).

Source: Odysee

When looking at different periods (1995/2000, 2000/2005, 2004/2007), the period 2004/2007 appears as the one where in most EU Member States the rate of improvement in energy efficiency was highest. Partially this was due to the high economic growth in that period but energy prices (and more stringent energy efficiency policies) may also have played a role.

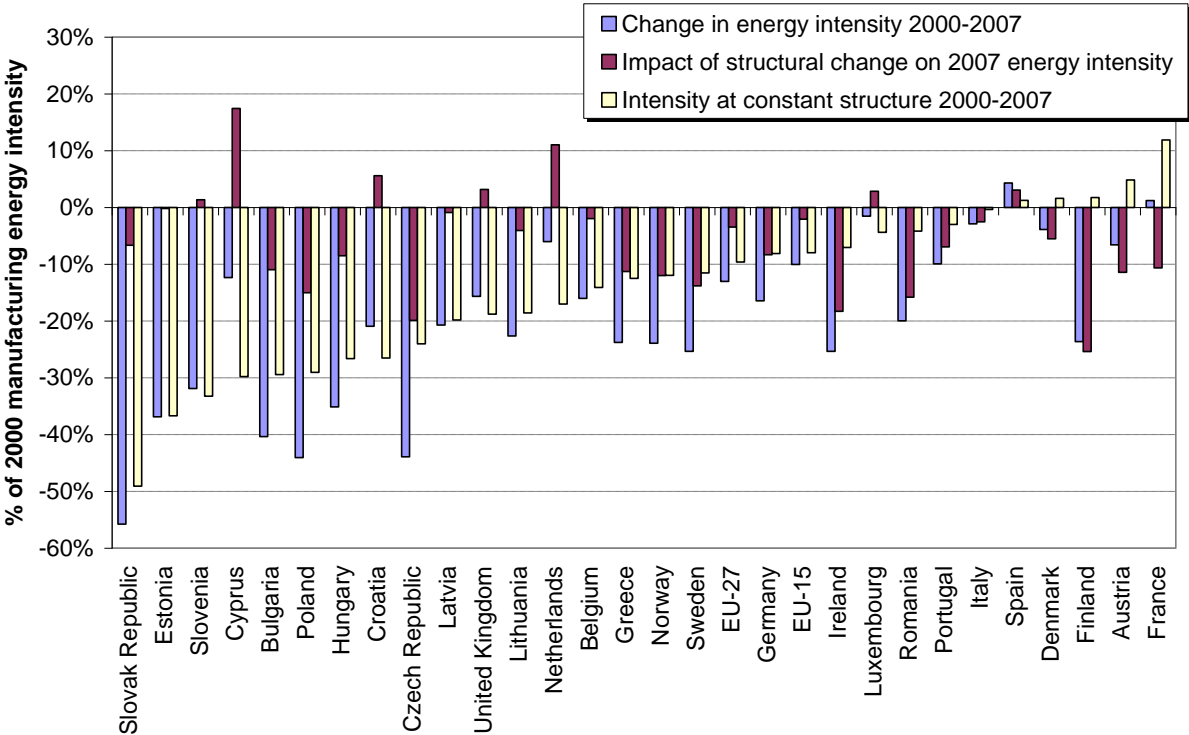
Among the ten countries with the highest improvement in energy efficiency there are eight new EU Member States. This is a consequence of the fact that those countries generally started from a much lower level of energy consumption (even considering the year 2000), while at the same time there was a much faster stock turnover due to the large economic growth and hence a much faster improvement of energy efficiency than in the EU-15.

3.2.3. Impact of structural change

Structural changes contribute to lower energy intensities but not in all countries

An important question in industry is to what extent structural change has supported or offset energy efficiency improvement. Structural change occurs for example when the industrial structure shifts to less energy-intensive industries. **Figure 3.14** shows the impact of structural change on energy intensity (second bar). The third bar shows by how much energy intensity would have decreased if structural changes had not taken place. The combined impact is shown in the first bar.

Figure 3.14 : Impact of structural change



Source: Odyssee

It is evident that in most countries structural changes have reduced further energy intensity, on average for the EU-27 (30% of the intensity reduction is due to structural changes). For the EU-15 the contribution is somewhat less important. In some countries the industrial structures have become more energy-intensive since the year 2000 (Slovenia: due to primary metals and chemicals, Croatia: paper and non-metallic minerals, the UK: chemicals, the Netherlands: chemicals, Spain: non-metallic minerals, Cyprus: all energy-intensive branches). It is difficult to attribute such structural changes to one particular reason such as delocalisation.

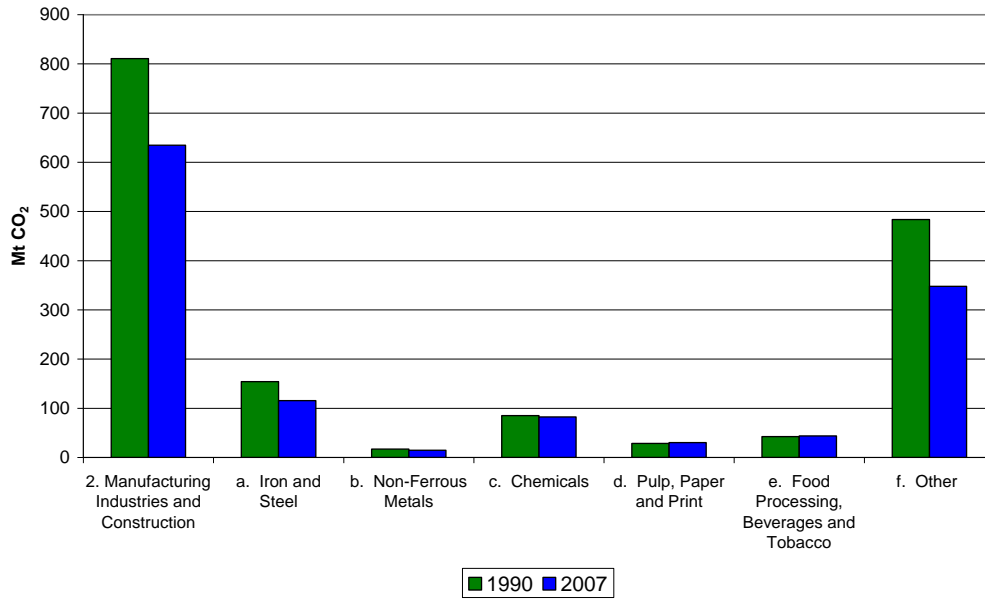
3.2.4. CO₂ emission trends in industry

CO₂ emissions in the industrial sector have decreased by 22 % since 1990

The industrial sector is contributing towards reducing the CO₂ emissions from energy use: direct CO₂ emissions from industry have decreased by almost 22 % since 1990³⁵ (Erreur ! Source du renvoi introuvable.). As a result, the industrial sector represents a decreasing share of the total emission of final consumers (i.e. excluding power sector: 43% in 2007 compared to 32% in 1990).

³⁵ Source: EEA inventory (2009)

Figure 3.15 : (Direct) CO₂ emissions from industry (EU-27)



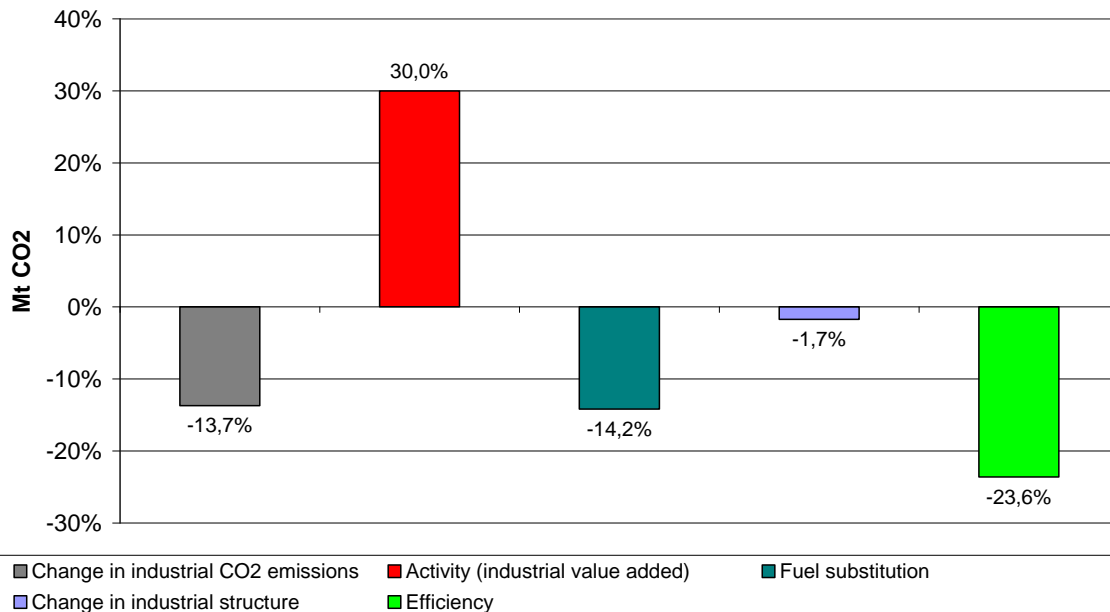
Note: excluding process-related GHG emissions and non-CO₂ gases.

Source: EEA (2009)

CO₂ savings have largely over-compensated the activity increase that would otherwise have led to an increase in CO₂ emissions of 33% since 1990

The growing industrial production should have increased CO₂ emissions by 30% between 1995 and 2007 (**Figure 3.16**). However, fuel substitution (-14%)³⁶, energy efficiency (-24%) and to a smaller degree structural change (-2%) have over-compensated this increase, leading to a final decrease in emissions of close to 14%.

Figure 3.16 : Variation of (direct) CO₂ emissions in industry 1995/2007 (EU-27)



Note: as only direct emissions are considered, the shift towards electricity also contributes to a possible reduction of emissions in this graph; source: calculated from Odyssee data

³⁶ In some countries the fuel shift may have more strongly contributed had it not have been for the fact that those countries increased proportionally the use of coal in industry.

4. Transport

4.1. Overview of the main measures

A total of around 350 measures have been implemented in the transport sectors of EU countries, Norway and Croatia, and 270 of those measures are still in place. It is fair to conclude that decision makers have only recently started to consider this sector seriously, since most of the ongoing measures are quite recent: 70% were implemented after 2000 and almost 40% after 2005. This situation is mainly explained by the fact that the large number of players concerned makes transport a difficult sector to tackle. In addition, most of the measures are national measures and are not linked to EU Directives or to EU involvement (~85%). Until recently, the only actions taken by the Commission in that sector were the agreement signed in 1995 with car manufacturers regarding a CO₂ emissions target for new cars, and the 1999 Directive on the mandatory introduction of car labelling³⁷. Since then this sector has become a much higher priority for the Commission, which issued a Directive on mandatory efficiency standards for new cars and a Directive promoting the use of biofuels³⁸.

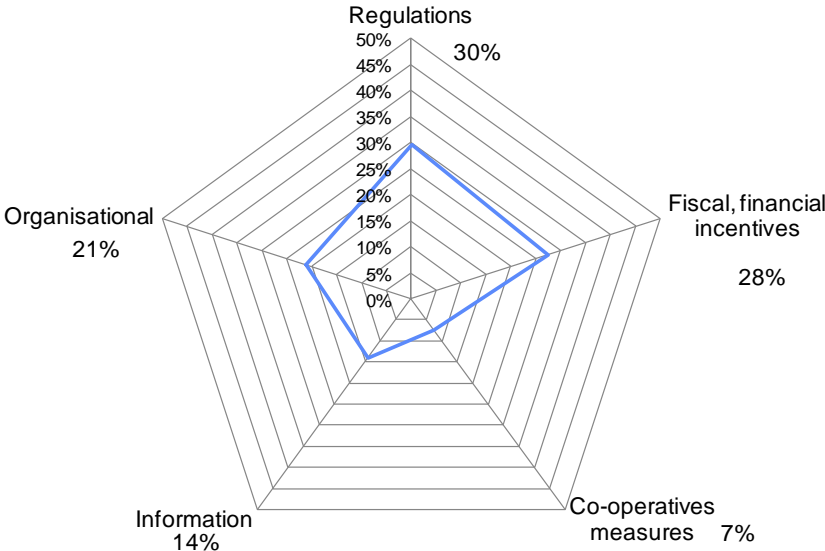
Regulations: the most common measures, followed by fiscal and financial incentives

Regulations (EU Directives or national regulations such as speed limits) are the most common measures (30% of all ongoing measures) (**Figure 4.1**). They are very closely followed by fiscal and financial incentives (with 28% of the total), which mainly consist of taxes on motor fuels (e.g. ecotax, CO₂ tax), incentives for the purchase of efficient new cars, and taxes linked to the efficiency/emissions of new cars. Around 20% of the measures are organisational measures aimed at the development of public transport infrastructures or bicycle paths, and at the implementation of mobility plans for companies, schools, administrations or other institutions; such measures are mainly targeted at a modal shift from cars to public transport or the use of bicycles. Next come information-related measures intended to enhance the information available to consumers (14%), and voluntary agreements with transport companies or vehicle manufacturers (known as “cooperative measures” in MURE) (7%).

³⁷ Directive 1999/94/EC relating to the availability of consumer information on fuel economy and CO₂ emissions in respect of the marketing of new passenger cars.

³⁸ Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport, setting a target of 5.75% by 2010.

Figure 4.1: Number of measures by type in transport in the EU

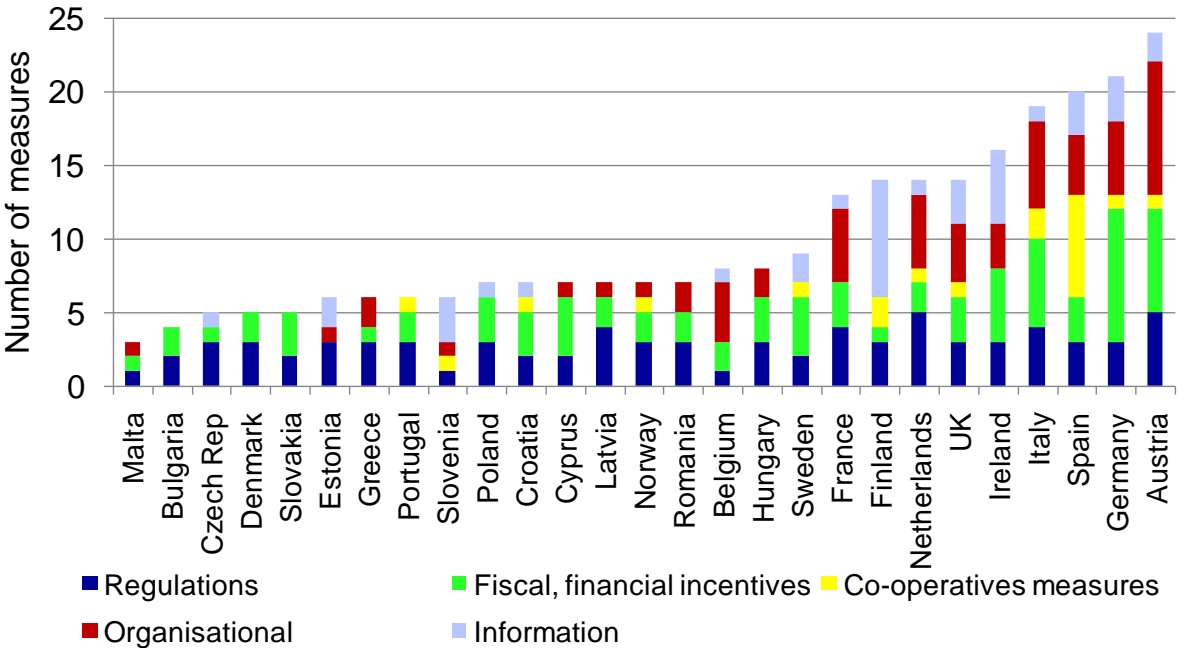


Source: Adapted from MURE

The number of measures per country varies greatly

The number of measures taken by each country varies greatly: in nine EU-15 countries the number of measures is above average, which is about 10 measures per country, and in six countries the number of measures is low (equal to or below 5 measures). Three countries stand out with more than 20 measures targeted at the transport sector: Austria, Germany and Spain (Figure 4.2).

Figure 4.2: Number of measures by country in transport in the EU



Source: Adapted from MURE

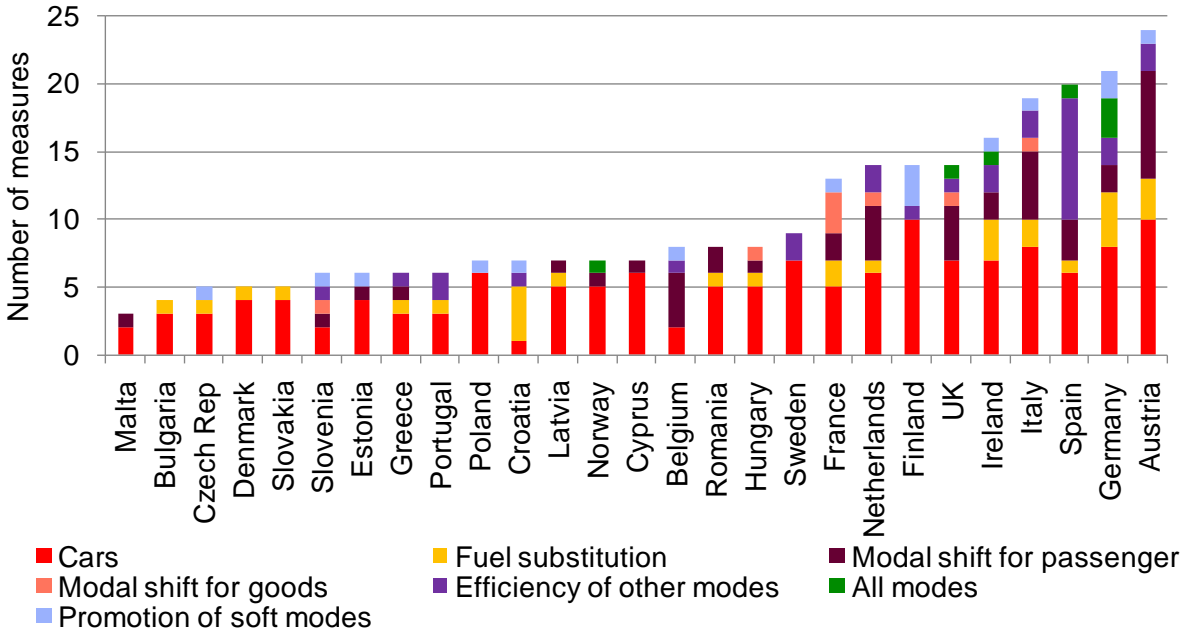
On the whole, in the countries with the largest number of measures the distribution of measures per type tends to be well balanced. However, six countries (Germany, Austria, Italy, Ireland, Sweden and Cyprus) show a preference for financial and fiscal measures. Organisational measures (mobility plans, infrastructures) too are mainly used in six countries (Austria, the Netherlands, Italy, France, Germany and UK). France and the Netherlands primarily focus on regulations, Spain on voluntary agreements and Finland on information. This reflects national circumstances, and in particular preferences for specific types of policy interventions.

More than half of the measures target cars

On average in the EU, half of the measures are directly targeted at cars, and that share rises to 60% if measures on fuel substitution (e.g. on the promotion of biofuels) are included. Around 40% of the measures correspond to technological measures aimed at the improvement of the energy efficiency of transport vehicles or the reduction of their specific CO₂ emissions (30% of which for cars alone). Around 15% of the measures target a modal shift from cars to public transport. Finally, only a limited number of measures address freight transport, despite it being the transport mode with the most rapid increase in its energy consumption.

Cars are given special priority in eleven countries in which more than two-thirds of the measures target cars (**Figure 4.3**): all Scandinavian and Baltic countries, Bulgaria, Slovakia, Cyprus and Malta. Four countries stand out for prioritising measures aimed at modal shift for passengers, namely Belgium, the Netherlands, the UK and Austria. France is the only country with several measures to encourage a modal shift for freight from road to rail and water transport.

Figure 4.3: Distribution of measures by target in transport in the EU



Source: Adapted from MURE

4.2. Cars

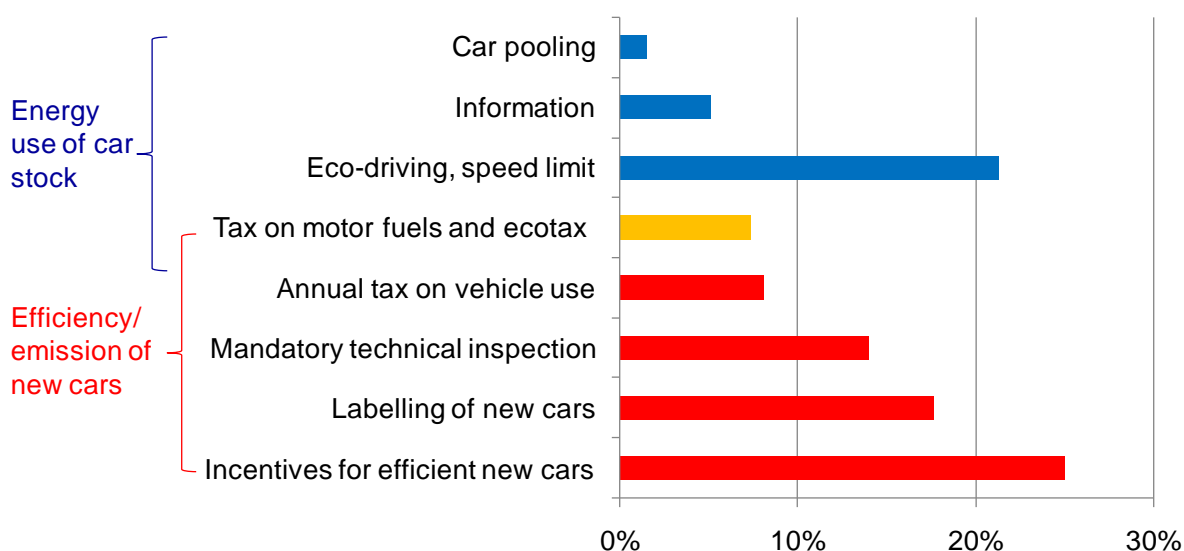
4.2.1. Policies on cars

4.2.1.1. Overview of measures

Two-thirds of measures on new cars

Two-thirds of national measures target the improvement of the efficiency (or the reduction of CO₂ emissions) of new cars, with financial incentives to purchase more efficient/low emission new cars being the most common measure (**Figure 4.4**). One-third of the measures are aimed at reducing the fuel consumption of the car fleet (e.g. eco-driving, speed limit). Although fiscal measures affecting energy prices -with clear objectives regarding energy efficiency or emissions- are more limited, they are likely to have the greatest impact, since they impact the efficiency/CO₂ emissions of new cars as well as the energy consumption of the existing fleet.

Figure 4.4: Distribution of measures for cars by type



Source: Adapted from MURE

4.2.1.2. Measures on the energy efficiency/emissions of new cars

While most national measures are targeted at car owners and users, the measures aimed at car manufacturers are EU-wide measures initiated by the European Commission and voted by the European Parliament.

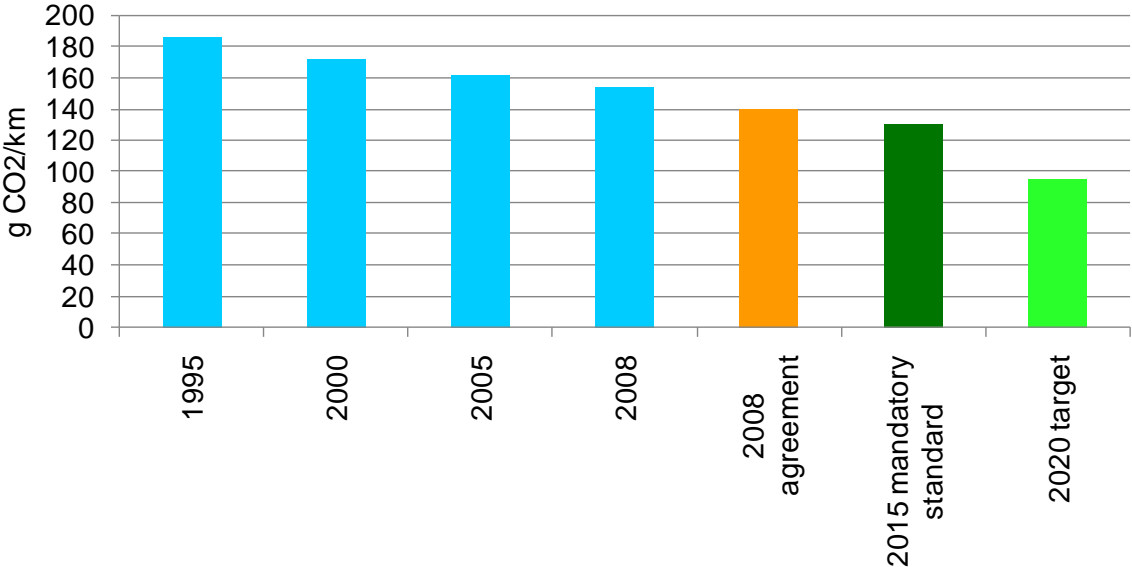
The first such measure consisted of the so-called Voluntary Agreements signed with three car manufacturers' associations (ACEA, JAMA and KAMA)³⁹ on carbon

³⁹ ACEA, European Automobile Manufacturers Association; JAMA, Japan Automobile Manufacturers Association; KAMA, Korean Automobile Manufacturers Association.

emissions, fixing a target of 140 g of CO₂/km for the average emissions of all new cars sold in 2008 at EU level by all the members of those associations⁴⁰.

Since that target was not reached, the Commission decided to go for a stricter measure in the form of a maximum emission standard. In December 2008 the European Parliament adopted a regulation on mandatory CO₂ emissions for new cars fixing a limit for each manufacturer of 130 g CO₂ per km for the average of its sales⁴¹ to be achieved in 2015 (**Figure 4.5**). Moreover, the regulation sets intermediate targets: in 2012, 65% of each manufacturer's newly registered cars must comply with the limit value. This will rise to 75% in 2013 and 80% in 2014. Penalty payments for excess emissions are to be paid by the manufacturers for each car registered: €5 for the first g/km of exceedance, €15 for the second g/km, €25 for the third g/km, and €95 for each subsequent g/km. As of 2019, the penalty will be increased to €95 for the first g/km of exceedance. The Directive specifies a long-term target of 95 g/km for the year 2020.

Figure 4.5: CO₂ emissions of new cars: observed values versus target



4.2.1.3. Incentives to buy more efficient/low emission new cars

- **Car labelling**

Mandatory car labelling of CO₂ emissions was imposed by an EU Directive approved in 1999 and was supposed to be implemented by Member States by January 2001⁴². The purpose of the label is to provide consumer information on fuel economy and the CO₂ emissions of new passenger cars. The Directive did not require the standardisation of the presentation of the labels, as was the case for electrical appliances, for instance. As a result, around 80% of the countries used comparative colour-coded labels with efficiency class A, B, C, similar to those for electrical appliances, and 20 % imposed the

⁴⁰ Commission Recommendation of February 1999 on the reduction of CO₂ emissions from cars.
⁴¹ Directive 443/2009 of April 2009 setting emission performance standards for new passenger cars.
⁴² Directive 1999/94 relating to the availability of consumer information on fuel economy and CO₂ emissions in respect of the marketing of new passenger cars.

minimum requirement only, in other words, a simple indication of the value of the emissions (so without coloured tags). Labels usually display both CO₂ emissions and specific fuel consumption in litre/100 km.

- **Fiscal and financial incentives to purchase efficient/low emission new cars**

These measures tend to be introduced at the national level, which is why a great variety of approaches can be found among EU member States. Three main categories can be pinpointed:

- Purchase tax linked to energy efficiency performance;
- Annual car tax linked to energy efficiency performance;
- Subsidies for efficient/low emission cars or combined tax and subsidies

Historically, most countries set up car purchase taxes to be paid by the buyers of new cars. Those taxes were usually linked to the type of fuel (e.g. gasoline, diesel, LPG), the size of the car (based on engine power or engine size) and the status (private versus company cars). Some countries have changed those taxes, making them dependent on the energy efficiency or CO₂ emissions of the new cars, thereby encouraging buyers to pay attention to the energy consumption or emissions of the car they are about to buy. The first country to introduce such a measure was Austria in 1991, followed by Denmark in 2000. At present, 12 countries have a purchase tax linked to energy efficiency/CO₂ performance: Austria, Denmark, UK, Hungary, the Netherlands, Portugal, Sweden, Cyprus, Ireland, Spain, France and Finland. The levels of tax now tend to be linked to the CO₂ classes introduced through the labelling schemes.

In addition, certain countries have also linked the annual car tax to energy efficiency performance. That is the case of Denmark, since 1999, the UK, Sweden, Ireland and France (company cars only). Four countries have even linked both the purchase tax and the annual registration tax to specific CO₂ emissions and/or energy efficiency performances: Denmark, UK, Sweden and, more recently, Ireland.

The previous two measures act as disincentives to the purchase of inefficient cars but may not lead consumers to buy the most efficient cars on the market. Therefore, many countries have implemented subsidy schemes for very low emission or very efficient new cars. Initially, these subsidies were only available for electric and hybrid cars; today several countries have extended these schemes to efficient fuel powered cars, linking eligibility for the subsidy to car labels.

France has taken innovative action in that area by setting up a combined subsidy and tax scheme, called “bonus-malus”, with a subsidy for low emission cars (<130 g CO₂/km) and a tax on cars with high emissions (above 161 g CO₂/km)⁴³. The most innovative aspect of this measure is that it limits the burden of the subsidies on the public budget since they are paid from the income of the tax. In addition, the measure aims to foster technical progress by lowering the emissions class over time.

⁴³ The maximum subsidy is €1000 for cars below 100 gCO₂/km, and the tax can reach €1600 for cars with emissions between 201-250 gCO₂/km and even €2600 for emissions above 250 gCO₂/km.

4.2.1.4. Measures on car energy use

Several measures are aimed at reducing the energy use of cars after they have been purchased; instead of targeting new cars, they look at the entire car fleet. Most of those measures address the behaviour of car users: reduction of the average speed, eco-driving, speed limits, car pooling. One specific measure is to impose regular technical inspections so as to maintain the efficiency of cars as close as possible to their initial technical performance. It is difficult to assess the effect of all these measures.

4.2.1.5. Taxes on motor fuels

Different strategies among countries

One of the most important drivers of the energy consumption and energy efficiency trends in the transport sector is the price of motor fuels. Since these prices are deregulated, the main source of difference between countries comes from the level of tax. The tax is usually made up of two main components: an excise tax and the general VAT rate.

Excise taxes are generally seen as a source of income for the public budget. However, certain countries have recently increased those taxes with the clear intention of saving fuels (e.g. UK through the fuel escalator). Five countries have introduced an additional component similar to a new excise tax, a CO₂ or environmental tax: 4 Scandinavian countries and Germany⁴⁴. Sweden has the highest CO₂ tax (€23 cents/l for gasoline), followed by Germany (€15 cents/l) and Norway (€10 cents/l). CO₂/environmental taxes enjoy greater acceptance among the general public, especially if part of the revenue is recycled to support energy/CO₂ efficiency measures.

Gasoline prices in the EU are very diverse, with a gap of 70% (or €0.6/l) between the 3 countries with the highest price and the 3 countries with the lowest price (**Figure 4.6**). Ten countries have particularly high gasoline prices, above €1.3/l, with 3 of those countries rising above €1.4/l. Five countries have gasoline prices below €1/l. Countries with high taxes do not necessarily impose CO₂/environmental taxes. The Netherlands, Belgium, UK and Portugal, for example, all have very high taxes but no CO₂/environmental tax.

In the case of diesel, there is an even wider gap (60%, or €0.53/l) between the three countries with the highest diesel price and the three countries with the lowest price (below €0.9/l) (**Figure 4.7**). Eight countries have prices above €1.1/l, and two of those countries have very high prices (UK and Cyprus > €1.4/l).

⁴⁴ France recently (September 2009) decided to introduce a CO₂ tax as of January 2010, which will increase the price of motor fuels by €4-€5 cents/litre.

In eleven countries diesel is much cheaper than gasoline (by more than €0.1/l), and in five of those countries (Portugal, Belgium, the Netherlands, Denmark, Finland) the gap is significant (above €0.2/l). Those five countries have the highest penetration of diesel cars.

Figure 4.6: Gasoline price in EU countries (2007) (€/l)⁴⁵

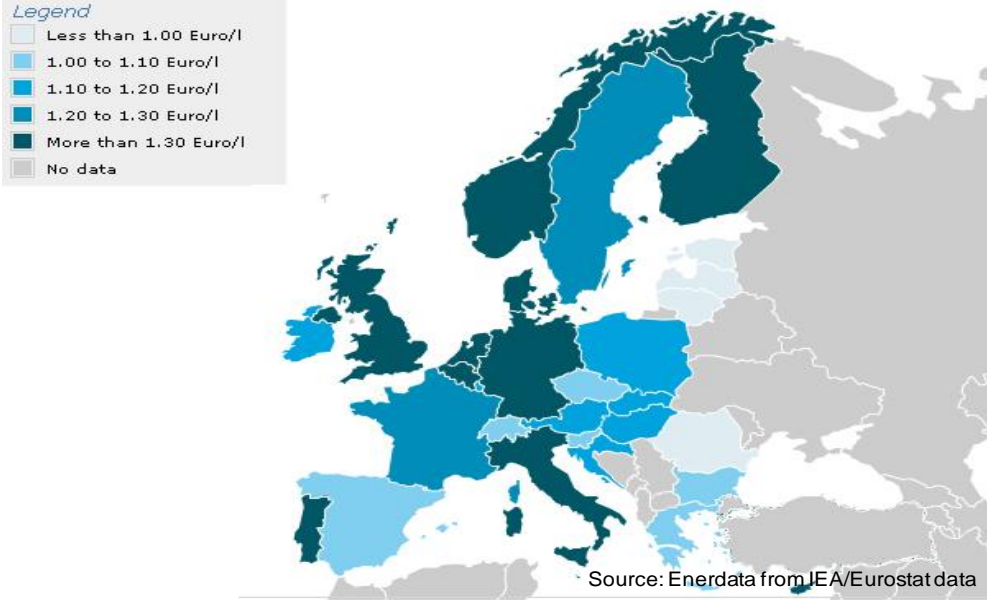
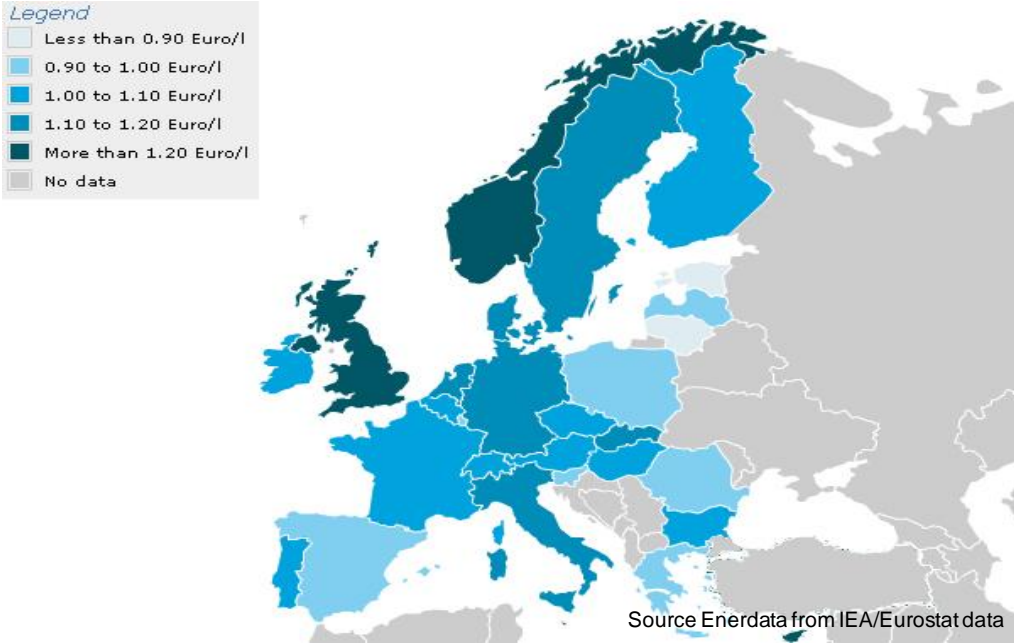


Figure 4.7: Diesel price in EU countries (2007) (€/l)⁴⁶



⁴⁵ The prices shown here purposely do not reflect the most recent prices as they have to be related to the analysis of energy efficiency and consumption trends that mainly relate to the period up to 2007.

⁴⁶ For non-commercial uses (i.e. for cars).

4.2.2. Energy efficiency and CO₂ trends for cars

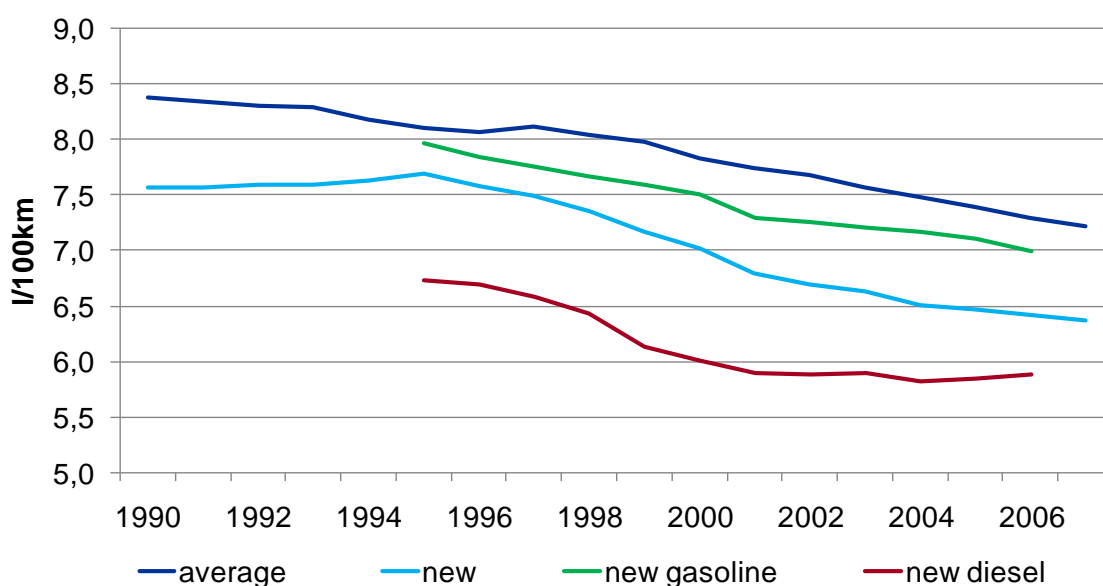
4.2.2.1. New cars

A rapid drop in the specific consumption of new cars since 1995

In the EU, the specific energy consumption of new cars⁴⁷ remained fairly stable between 1990 and 1995 (**Figure 4.8**). Between 1995 and 2006 there was a net reduction, from 7.7 l/100 km to 6.4 l/100 km (from 8 l/100 km to 6.7 l/100 km for new gasoline cars and from 6.7 l/100 km to 5.9 l/100 km for new diesel cars). However, since 2001 that reduction has slowed down because of the saturation of new diesel cars at 5.9 l/100 km.

Since about 80% of the cars on the road in 2006 had been purchased after 1995⁴⁸, the energy efficiency gains achieved in new cars had a direct impact on the average performance of the car fleet. As a result, the average specific consumption of the car fleet decreased from 8.4 l/100 km to 7.3 l/100 km over 1990-2006 (from 8.6 l/100 km to 7.9 l/100 km for gasoline cars and from 7.1 l/100 km to 6.6 l/100 km for diesel).

Figure 4.8: Specific consumption of new cars⁴⁹ and fleet average (EU-27)



Source: ODYSSEE⁵⁰

The specific consumption of new cars differs greatly among countries: a difference of 2 l/100km can be seen between Portugal or France (5.8 l/100km) and Sweden

⁴⁷ The energy efficiency progress of new cars is usually assessed using an average “test specific consumption” measured through a fuel consumption test for all new cars sold each year.

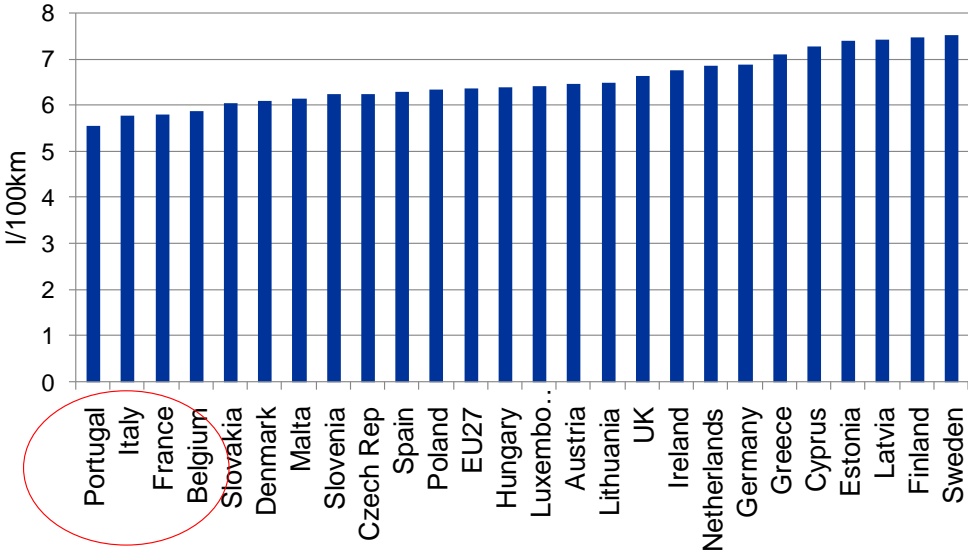
⁴⁸ Every year new cars represent about 8%, on average, of the total car fleet in the EU.

⁴⁹ Test values for new cars.

⁵⁰ The data regarding new cars is based on data from ACEA, JAMA and KAMA since 1995, EU Commission reports and national data for the car fleet.

(7.8 l/100km), which corresponds to a difference of about 40 % (Figure 4.9). The high share of diesel cars, which have a lower specific consumption than gasoline cars for a given type of car, largely explains the good performances of Belgium and France, where diesel cars made up more than 70 % of the new registrations in 2007. This is true too in the cases of Portugal, Italy and Austria, with diesel shares of between 60 % and 70 % (EU average between 40 % and 50 %).

Figure 3.11: Specific consumption of new cars in the EU (2006)



Source: estimation ODYSSEE from EU monitoring report and T&E

Until 2005, part of the technical progress was offset by a shift to larger and more powerful cars; since then, and especially since 2008, there has been a clear trend towards smaller cars

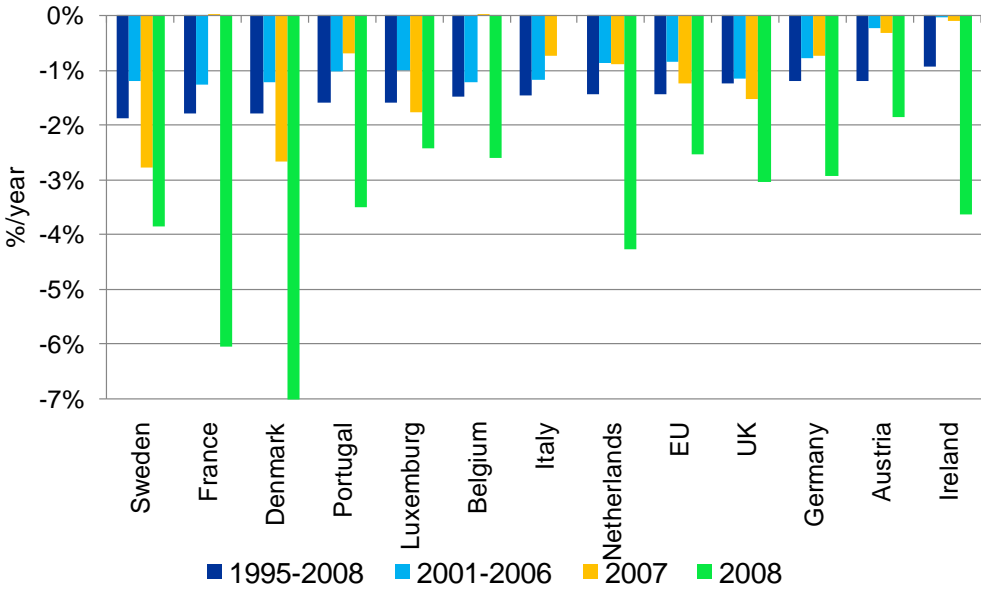
The reduction in the specific consumption of new cars ranges between 1-2%/year depending on the country (1.5%/year on average for the EU). This trend not only reflects changes in energy efficiency from a technical point of view, but also changes in the structure of new car registrations by size or fuel type (gasoline/diesel). For instance, a shift towards larger cars increases the average test specific consumption, all other things being equal.

Clearly, over the past ten years there has been a shift to heavier and more powerful cars in most countries. The average mass of new cars sold in the EU increased by 100 kg, at a rate of around 10-15 kg/year, between 1995 and 2007. Since 2000, this trend has reversed in four countries (Austria, Denmark, France and the Netherlands) and in three more countries (Germany, Italy and UK) and in the EU as a whole since 2005⁵¹. In 2008, the reduction was very significant almost everywhere and has to be linked to the recent measures mentioned above and to the high oil price. Therefore, before 2005 the actual technical progress achieved was even more pronounced than is suggested by the changes in the test specific consumption of new cars.

⁵¹ Source ACEA statistics over 1995-2008 (www.acea.be, 2009).

The average specific CO₂ emissions of new cars sold in the EU decreased from 186 g/km in 1995 to 154 g/km in 2008; that corresponds to an average reduction of 1.4%/year. The average level achieved in 2008 was 10% above the target of 140 g/km fixed for 2008 in the agreement between the European Commission and the associations of car manufacturers (ACEA, JAMA and KAMA). The specific emissions of new cars decreased rapidly in 2007 and especially in 2008 (almost 3% on average in 2008) (**Figure 4.10**). Those good results have to be linked to the reduction in the average horsepower of cars, as shown above.

Figure 4.10: Trends in the specific emissions of new cars⁵²



In 2008, the overall market share of new cars sold by ACEA members (i.e. European car companies) with CO₂ emissions below 140 g/km stood at 42%, up from 35% in 2007, 31% in 2006 and 27% in 2004. The increase in 2008 was more rapid than in previous years. The market share of cars below 120 g/km increased from 9% in 2006 to 16% in 2008.

4.2.2.2. Performance of the car fleet average

The average specific consumption of the car fleet has decreased steadily in all EU countries. Over the period 1990-2006 there was an average reduction of 1.3%/year at EU level: in 2007, cars consumed 1 litre/100 km less than in 1990.

Each country saw its specific consumption decrease, although to varying degrees ranging between 0.4-1.6%/year. The fall was more rapid than the EU average in Austria, Italy, Slovenia, UK, Greece and Germany. This continual improvement stems from the

⁵² Provisional data based on a compilation of various sources; accordingly, it is not available for all countries.

oldest and less efficient cars being replaced by new ones and in many countries also from the increasing share of diesel vehicles in the car fleet.

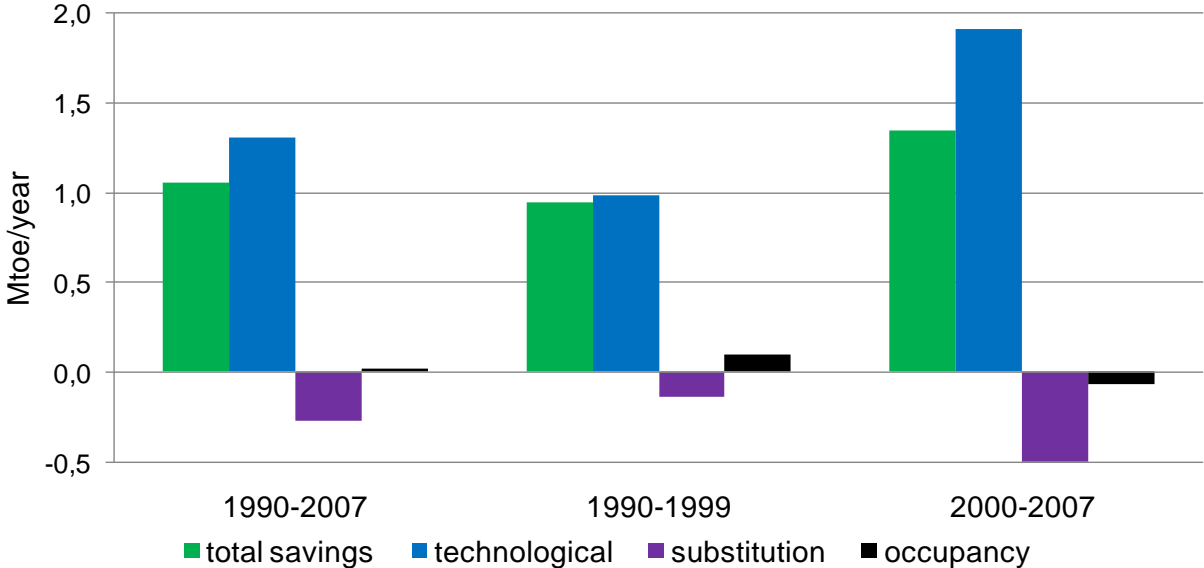
The average specific consumption of the car fleet ranged between 6.3 l/100 km (Italy) and 8.3 l/100 km (Sweden) in 2007, with an EU average of around 7.3 l/100km. There is no real correlation between the average specific consumption of the car fleet in l/100km and the average fuel price: average car size and horsepower and the share of diesel are probably the most important factors. The high value seen in Sweden can be partly explained by the fact that it is the country with the most powerful cars and the lowest share of diesel cars. Italy, on the contrary, is the country with the least powerful cars and a high penetration of diesel.

Technological savings reached 25 Mtoe in 2007 in the EU

“Technological savings” resulting from the decrease in the average specific consumption per car are estimated at 25 Mtoe for the EU in 2007 (compared to 1990), i.e. about 14% of the total consumption of cars; in other words, without these savings, the consumption of cars in 2007 would have been 25 Mtoe above its actual level or 14% higher. The average annual savings amount to 1.3 Mtoe/year (Figure 4.11). The volume of savings has been increasing since 2000 and over the period 2000-2007 almost reached an average of 2 Mtoe/year. Fuel switching from gasoline to diesel contributed to increase energy consumption by about 0.3 Mtoe/year between 1990 and 2007, and since 2000 even by 0.5 Mtoe/year, as a result of the penetration of biofuels⁵³. Changes in car occupancy, which is a behavioural factor, had a small effect.

In 2007 total savings were still 25% below technological savings. The overall energy savings due to both technical and non-technical factors averaged 1.1 Mtoe/year over 1990-2007 and totalled 18 Mtoe in 2007:

Figure 4.11: Energy savings from cars in the EU



⁵³ The heat content of diesel and biofuels, in toe/litre, is higher than for gasoline.

4.3. Passengers and freight transport

4.3.1. Passengers

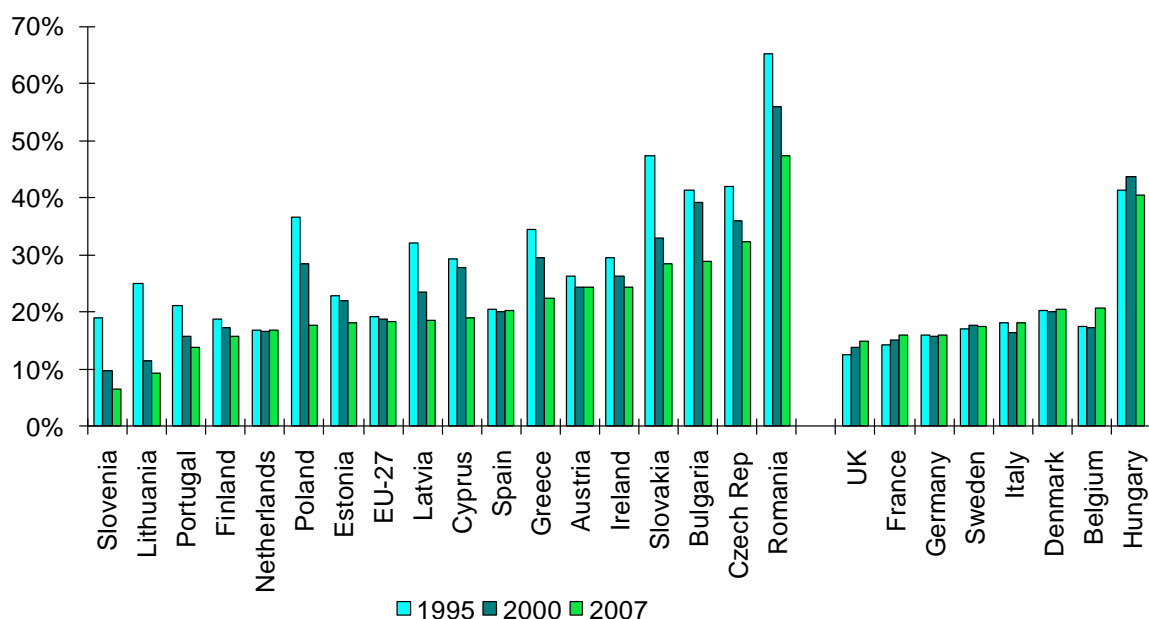
The energy efficiency of cars has improved significantly but the number of cars on the roads and the passenger traffic are still increasing. Another source of energy savings is to slow down the traffic by car and to move part of the traffic to public transport (rail, metro, buses). All countries are implementing national and local measures to transform passenger traffic patterns and to reduce the role of cars.

Various types of measures are aimed at reducing the role of cars and at promoting public transport or soft modes: information campaigns, development of new public transport infrastructures or bicycles lanes, mobility management for companies, administrations, schools, etc. Mobility management is a new concept to promote sustainable transport. The objective of mobility management is to reduce the number of one-person car journeys. One of the most active countries in that area is Austria.

The share of public transport in passenger traffic is decreasing almost everywhere

The share of public transport in passenger traffic is decreasing in most countries. Only eight countries show a different trend and seem to have reversed the increasing role of cars (right side of **Figure 4.12**): on the one hand, Germany, Sweden, Denmark and Hungary, where the share of cars is stable; and on the other hand France, UK, Italy and Belgium, where there is a slight increase in the share of public transport. At the EU level the share of public transport in passenger traffic decreased by five points between 1990 and 2007, from 22% to 17%.

Figure 4.12: Share of public transport in total passenger traffic⁵⁴



⁵⁴ Traffic measured in passenger-km.

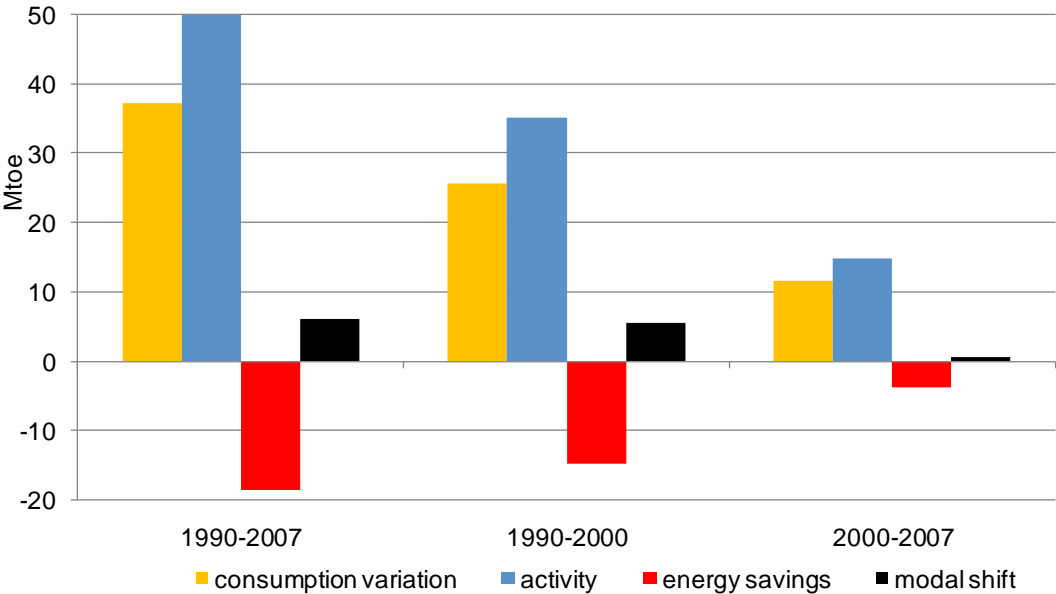
Negative energy savings due to the decline of the share of public transport

As on average, cars require 4 times more energy to transport one passenger-km than public transport (rail transport and buses), and 5 times more energy than rail transport alone (trains, metros and tramways)), the decreasing share of public transport in passenger traffic leads to negative savings.

On average, the loss of one market share point for public transport corresponds to an increased consumption (i.e. negative savings) of about 1.3 Mtoe at EU level. As a result, the ongoing modal shift contributed to increase the consumption by 6 Mtoe (or 0.35 Mtoe/year) between 1990 and 2007. In the four countries in which the share of public transport increased slightly (Spain, France, UK and Belgium), modal shift resulted in energy savings that can be added to the savings registered for the different transport modes, especially cars.

The growth in traffic caused consumption to increase by 50 Mtoe. Energy savings (change in specific consumption per unit of traffic) amounted to 19 Mtoe and offset the effect of traffic growth and modal shifts, as well as limiting the increase of the energy consumption to 37 Mtoe (Figure 4.13).

Figure 4.13: Breakdown of the energy consumption variation for passenger transport in the EU-27⁵⁵



This trend is expected to reverse in the future. First of all, the decline of the role of public transport has slowed down (1 point reduction since 1995 compared to 5 points since 1990). Secondly, many government and local authorities are developing or

⁵⁵ The energy consumption variation of passenger transport is broken down into 3 explanatory effects: activity effect (increase in traffic), modal shift effect (from private transport to public transport modes) and energy savings (change in specific consumption per unit of traffic).

planning new public transport infrastructures, the impact of which is slow given the long lead time in that area.

4.3.2. Freight transport

Limited measures for freight transport

Very few countries have introduced measures to improve the energy efficiency of freight transport. The most innovative country is Germany with its Toll Collect system, aimed both at raising the efficiency of trucks and moving part of the road traffic to rail and water transport. Some countries have measures to improve the efficiency of vehicle fuel use, such as Finland with its voluntary/negotiated agreements with transport companies, or Spain and Ireland with training and information programmes for truck drivers . In countries that have implemented a CO2 tax, that tax also applies to trucks.

The fact that only a limited number of measures address freight transport may be explained by various factors. First of all, in most countries this sector is facing strong competition, either from other modes or from other countries and, in addition, diesel prices are increasing; national governments are therefore reluctant to increase the burden on their companies, all the more since in certain countries previous attempts to introduce reforms in this sector led to serious trouble. Secondly, the fleet is very heterogeneous and labelling or standardisation schemes, like the scheme for cars, are difficult to design. Finally, measures on infrastructures, such as the promotion of combined rail/road traffic, take time to materialise and in many countries are still at a planning stage.

A few other countries have introduced subsidies to support the development of alternative transport infrastructures to road or rail/road combined traffic, in order to shift part of the road traffic to rail and water transport .

Road charges for heavy goods vehicles already exist in many countries. The innovative aspect of the German Toll Collect system is that it uses satellite-guided systems rather than conventional tolls; links road charges to the emissions of vehicles; and, in theory, uses the toll revenues to subsidise rail and water transport infrastructures. This system might pave the way for the introduction of road charging on a European scale.

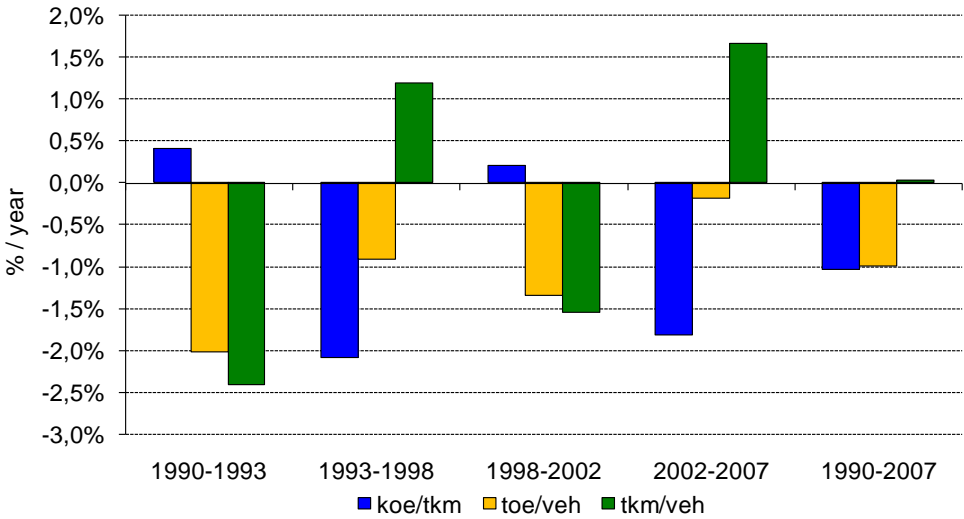
Italy and Spain want to make greater use of maritime transport. Italy, for instance, has introduced a subsidy scheme to render maritime transport more attractive (“Ecobonus)

Lower efficiency of road freight transport since 2000

Between 1993 and 1998, and between 2002 and 2007, the energy consumption per tonne-km dropped. This can be explained by improvements in the economic situation after 1993, which enabled the volume of traffic to grow rapidly (nearly 5%/year in tonne–km), combined with the more efficient management of freight transport (higher

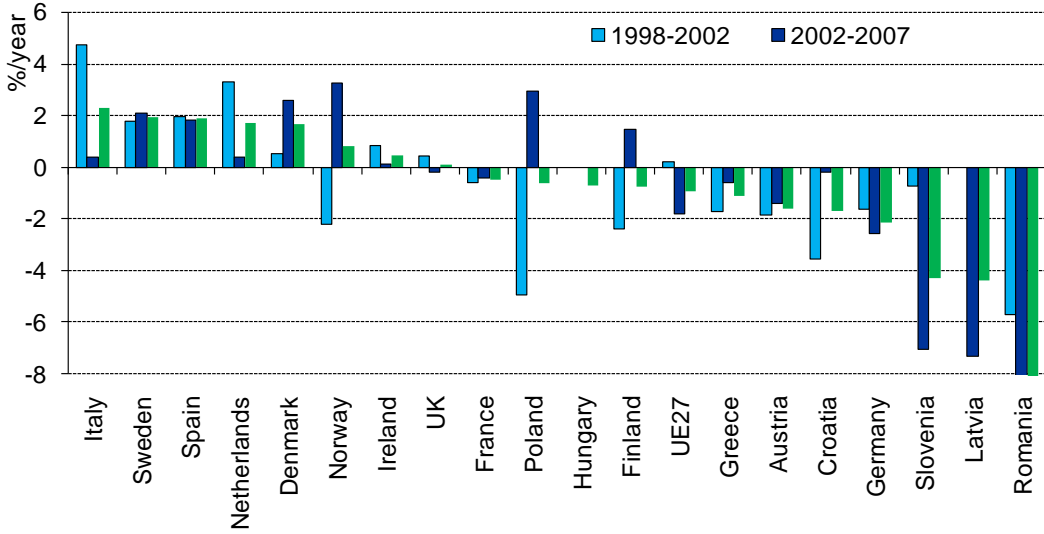
load factors and reduction of empty running, as shown by the increase in the ratio tonne-km/vehicle) and a shift to bigger trucks (Figure 4.14).

Figure 4.14: Change in the unit consumption of road freight transport (EU-27)⁵⁶



In most EU countries the average energy consumption per tonne–km has decreased since 1998 because of better vehicle fleet management (increase in tonne-km/vehicle). However, a reverse trend can be seen in several EU-15 countries, especially in Italy, Sweden, Spain, the Netherlands and Denmark (Figure 4.15).

Figure 4.15: Change in the unit consumption of road freight transport



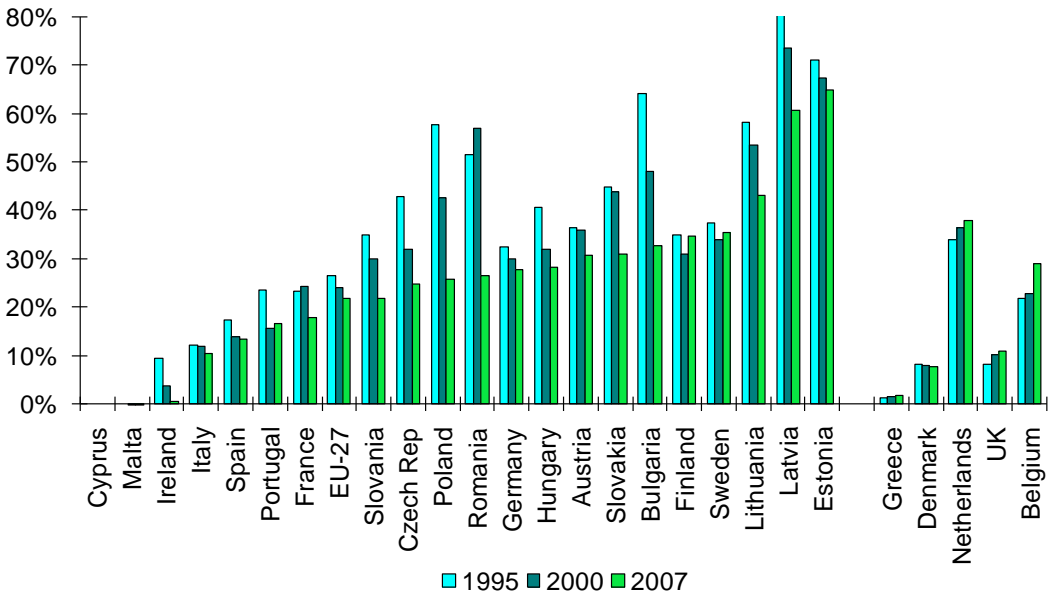
Decreasing share of the efficient transport modes (rail and water)

In most countries the share of efficient transport modes (rail and water) is decreasing; in other words, the trend is moving in the direction opposite to the direction in which policy makers plan for it to move. The greatest reduction can be seen in new member countries, especially in Poland and Bulgaria. The share of road transport has fallen in only three countries, namely the Netherlands, Belgium and the UK (Figure 4.16). In

⁵⁶ Unit energy consumption measured in goe (gram oil equivalent)/tonne-km.

2007 the share of rail and water varied greatly among countries, ranging from less than 10% for Italy and Ireland to 60-65% for Estonia and Latvia.

Figure 4.16: Share of rail and water in total freight traffic



The modal shift from rail and water to road transport contributed to increase the consumption of freight transport by 10 Mtoe at EU level between 1990 and 2007. The increase in freight traffic in tonne-km was responsible for a consumption increase of 46 Mtoe. Energy savings (21 Mtoe) (change in specific consumption per unit of traffic) have limited both these effects by limiting the variation of the total energy consumption to 35 Mtoe.

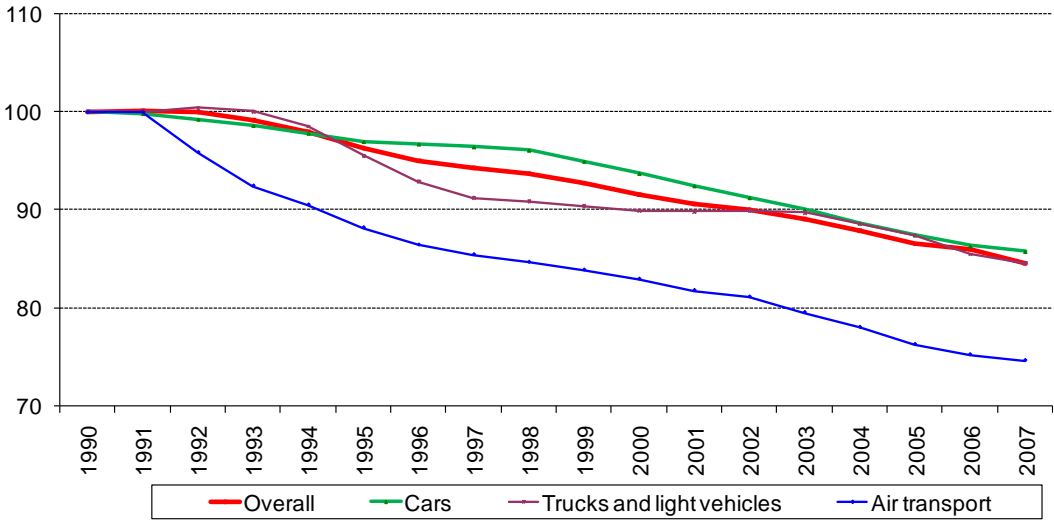
4.4. Overall energy efficiency and CO₂ trends

4.4.1. Energy efficiency trends

Regular improvement of 1 %/year in the energy efficiency of transport in the EU

The energy efficiency of transport in the EU-27 improved by about 15 % between 1990 and 2007 (1 %/year), as measured according to the ODEX indicator. Greater progress was achieved in the energy efficiency of both cars and airplanes than in the rest of the sector (Figure 4.17).

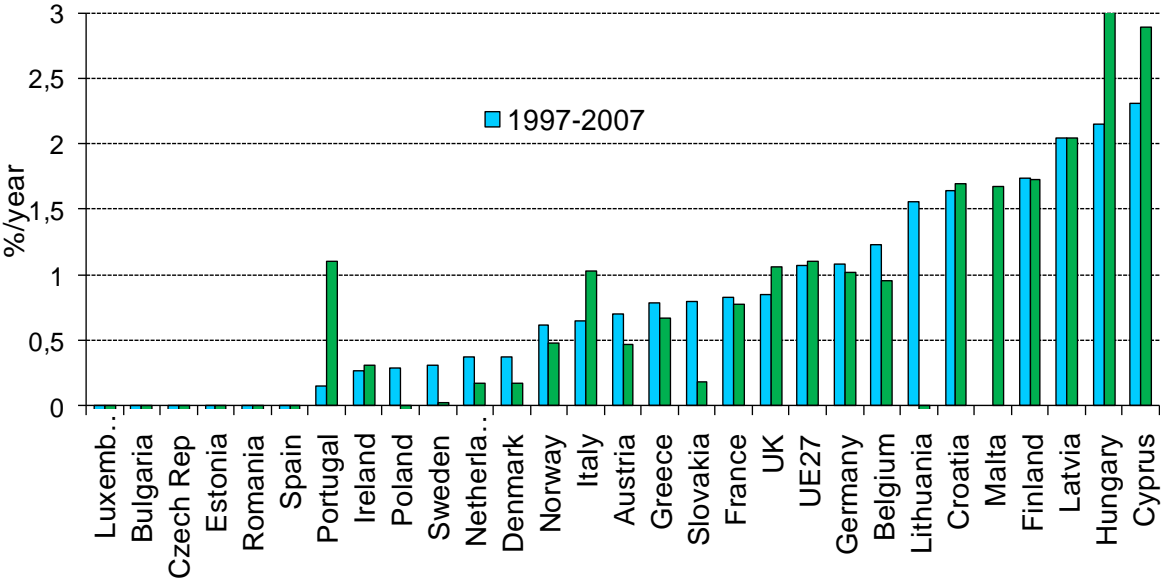
Figure 4.17: Energy efficiency progress in transport in the EU⁵⁷



In nine EU countries the rate of energy efficiency progress is above 1 %/year

In nine EU countries, and in Norway, the rate of progress was above 1%/year, i.e. above the target of the Energy Service Directive (Figure 4.18). In seven countries the efficiency of transport decreased because of road freight transport.

Figure 4.18: Energy efficiency progress in transport in EU countries⁵⁸



⁵⁷ Only the trends of the main modes are shown in the graph.

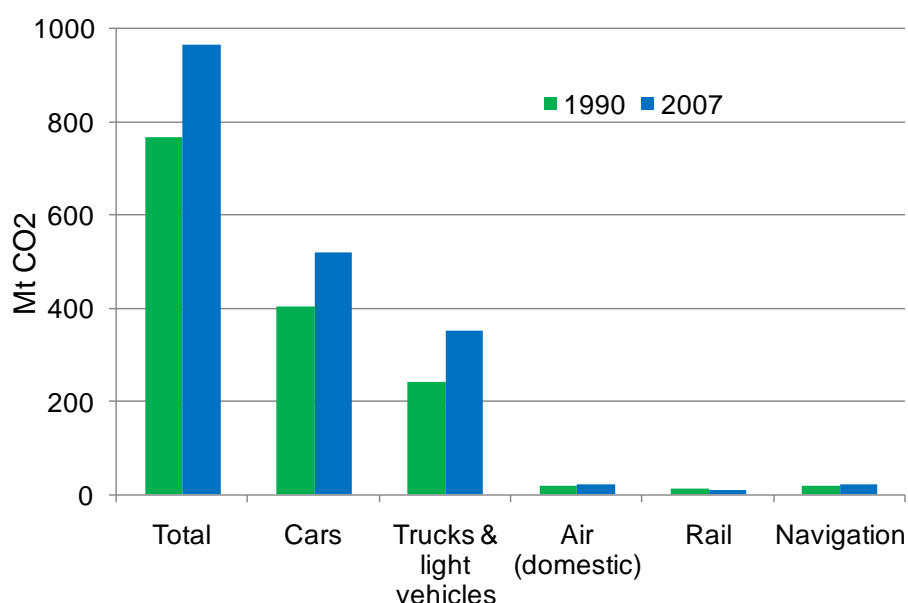
⁵⁸ Countries with an increase in the ODEX indicator are shown as having no energy efficiency progress.

4.4.2. CO₂ emission trends in transport

CO₂ emissions in the transport sector have increased by 26 % since 1990

The transport sector is driving total CO₂ emissions from energy use: CO₂ emissions from transport have increased by almost 26 % since 1990, whereas in all other sectors these emissions are far below their 1990 levels (reduction of 22% in industry and 18% in households, services and agriculture)⁵⁹ (**Figure 4.19**). As a result, transport represents a growing share of the total emissions of final consumers (i.e. excluding the power sector): 43 % in 2007 compared to 32 % in 1990. Since 2000, the increase of emissions from transport has slowed down (1 %/year compared to 1.6 %/year over 1990-2000).

Figure 4.19: Variation of CO₂ emissions from transport (EU-27)



Source: EEA for total emissions and ODYSSEE for the emissions by mode

Road freight transport is driving CO₂ emissions from transport

Road transport represents 94% of total emissions from transport. The emissions from road freight transport increased by nearly 47% between 1990 and 2007 and made up 36% of the sector's emissions (compared to 31% in 1990)⁶⁰ (**Figure 4.20**); this is the main source of the sector's rapid growth in emissions. Emissions from cars have increased by 29%. Although emissions from domestic air transport⁶¹ have increased by 30% since 1990, they represent less than 3% of the total.

⁵⁹ Source : EEA inventory (2009)

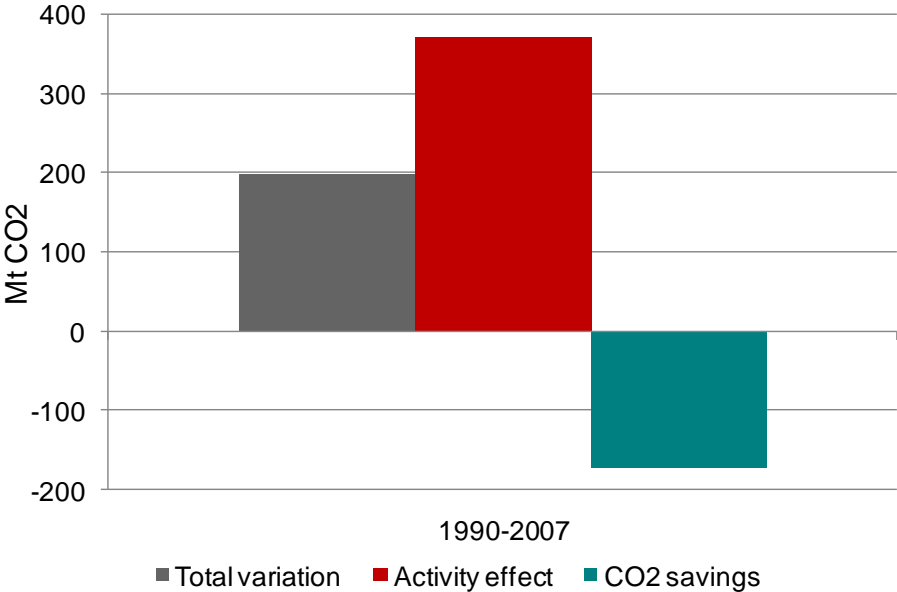
⁶⁰ Source: ODYSSEE estimates

⁶¹ Emissions from international air transport are not included in countries' emissions, in accordance with the UNFCCC methodology.

Around 170 Mt CO₂ avoided in 2007, which has offset almost half of the increase in CO₂ emissions since 1990

The increase in the traffic of passengers and freight should have increased CO₂ emissions by 370 Mt CO₂ between 1990 and 2007. Savings in CO₂ amounted to 170 Mt and were almost exclusively due to the reduction in the specific emissions of road vehicles per unit of traffic. These savings limited the increase in CO₂ emissions to 200 Mt and have offset almost half of the CO₂ emission increase since 1990 (**Figure 5.4**). Around 40% of the savings come from trucks and light vehicles and 30% from cars.

Figure 4.20: Variation of CO₂ emissions in transport (EU-27)



5. Households

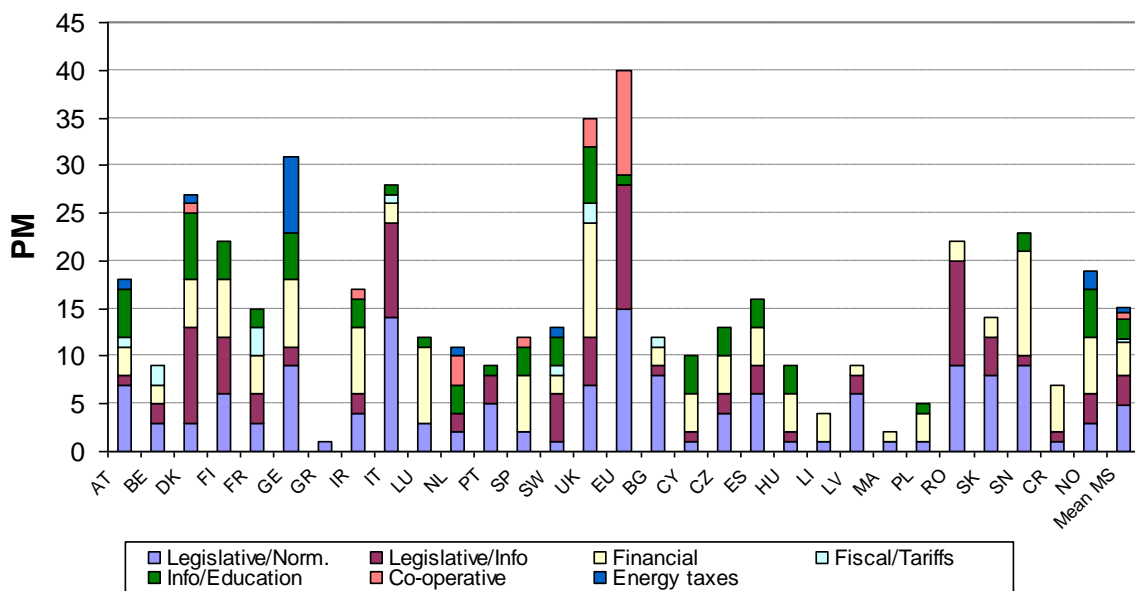
5.1. Policy measure developments

5.1.1. Overall policy development

Most countries deploy standards and subsidies, but few deploy taxes

The overview of policy measure types in **Figure 5.1** shows very diverse combinations per country and the EU itself. However, legislative and financial measures are very common, while co-operative and tax measures are sparsely applied.

Figure 5.1: Policy measures per type for households (ongoing, 2006)



Financial measures often have a short life time

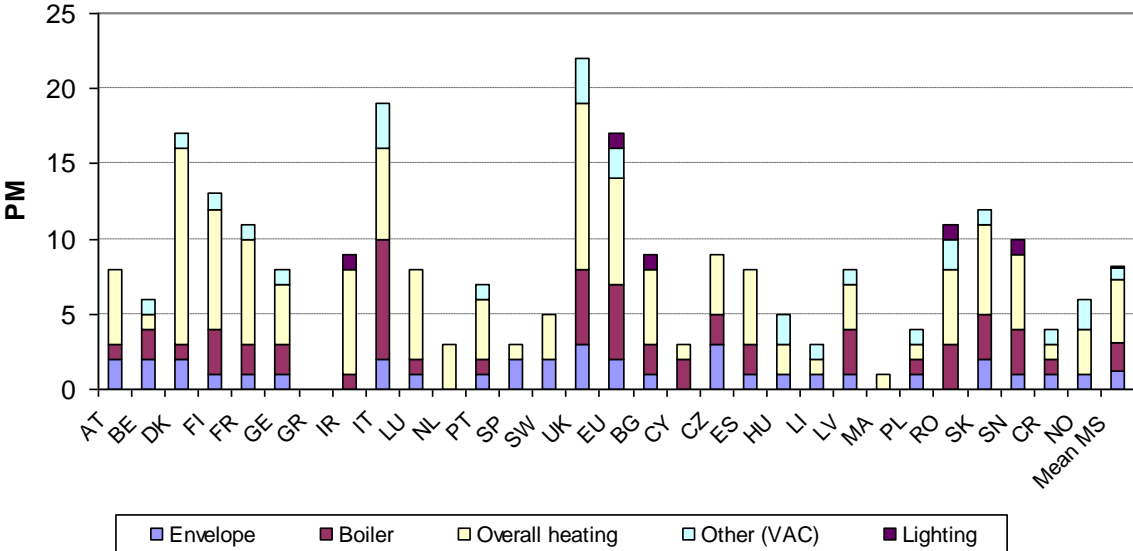
From all policy measures ever introduced presently about 20% have been scrapped. Especially financial measures, such as subsidies, do not have a long lifetime. The opposite is true for standards (legislative/normative) as completed measures are replaced by stricter standards.

Performance standards on dwelling as a whole are applied the most

Household policy measures targeted at dwelling related uses can regard the envelope, boilers, overall heating, ventilation/air-conditioning and lighting (see **Figure 5.2**). In the past policy measures on heating were targeted at the envelope (prescribed thickness of insulation) or boiler efficiency separately. Presently these are both the target of performance standards. Very few policy measures were focused on lighting in

households, only recently a ban on incandescent lamps was introduced. There is also a lack of policy on fuels for cooking.

Figure 5.2: Policy measures targeted at dwelling related uses (2006)



Few or no policy measures to influence daily energy use

Most policy measures focus on buying more efficient appliances or investing in energy savings. However, there is also a need to influence daily energy use, e.g. by monthly information on energy consumption or by energy taxes. Yet, some countries do not have any such policy measures (Belgium, Lithuania, Malta, Poland and Croatia). Recently the obligation in the Energy Service directive to inform customers about their electricity or gas consumption has led to some national policy measures on the introduction of smart meters.

5.1.2. EU based policy measures

For the households sector the most important EU policy constitutes:

- Directive on mandatory labels for appliances
- Energy Performance of Buildings directive (EPBD)
- Energy Services directive (ESD)
- Eco-design directive.

The introduction of obligatory labels on appliances has stimulated the market for more efficient appliances and thus decreased electricity use for refrigerators, washing machines, cloth dryers, etc.

The EPBD demands that countries should renew their standards every few year in line with possibilities for cost-effective measures. However, the EU has not defined a common maximum energy use because of differences for climate and building practices. Therefore, the effort put into energy saving new dwellings can differ. The EPBD also

demands energy efficiency certificates for dwellings to be sold or rented which should lead to retrofit measures. Finally the Directive requests that boilers should be regularly inspected and maintained in order to prevent a deterioration of the conversion efficiency.

The ESD expects that countries will realise 9 % energy savings in the period 2008-2016 and facilitates this in different ways. Although the ESD does not introduce specific policy measures it will probably have much influence on the introduction of (new) policy measures by countries.

The Eco-design directive takes a further step by introducing minimum efficiency standards for a larger array of energy using appliances and systems compared to the labelling directive. The Eco-design directive does not introduce directly binding requirements for specific products, but establishes a framework of condition and criteria that need to be respected when introducing implementing measures. The binding requirements for each product group regard also maximum energy use.

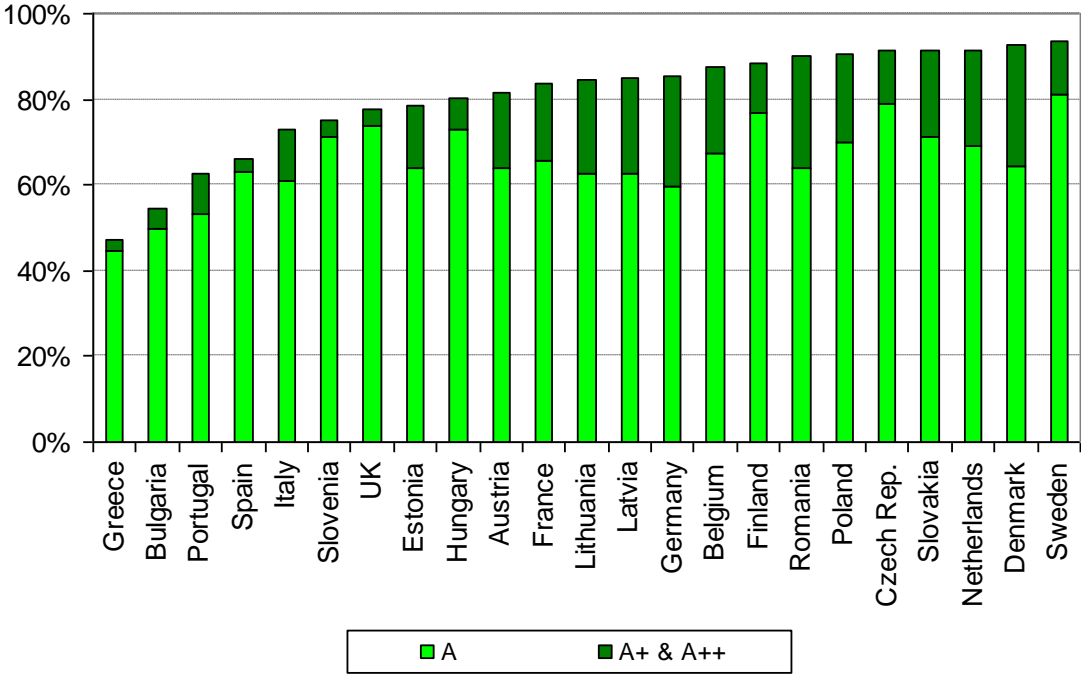
Substantial part of national policy measures due to EU policy

EU policy has influence on national energy efficiency in three ways: directly by EU policy measures, e.g. covenants with European appliance manufacturers (EU-defined), transposition of EU directives into national policy, e.g. labels for appliances (EU-follow-up), and national measures stimulated by EU policy, e.g. municipal action plans or regional information centres (EU-related). About one-third of all policy measures in the countries is more or less due to EU policy.

Southern countries slowest on buying efficient appliances

For refrigerators **Figure 5.3** shows the penetration of the labels categories A and A+ plus A++ in 2006. The average penetration rate for all labelling categories together is 81 % and the share for the most efficient A+ and A++ appliances is 15 %. Remarkably the shares for new member states are slightly higher than for EU-27. Especially for southern countries there is still potential for more sales of efficient appliances.

Figure 5.3: Penetration of labels A and A+/A++ for refrigerators (2006)



For washing machines only room for the most efficient versions

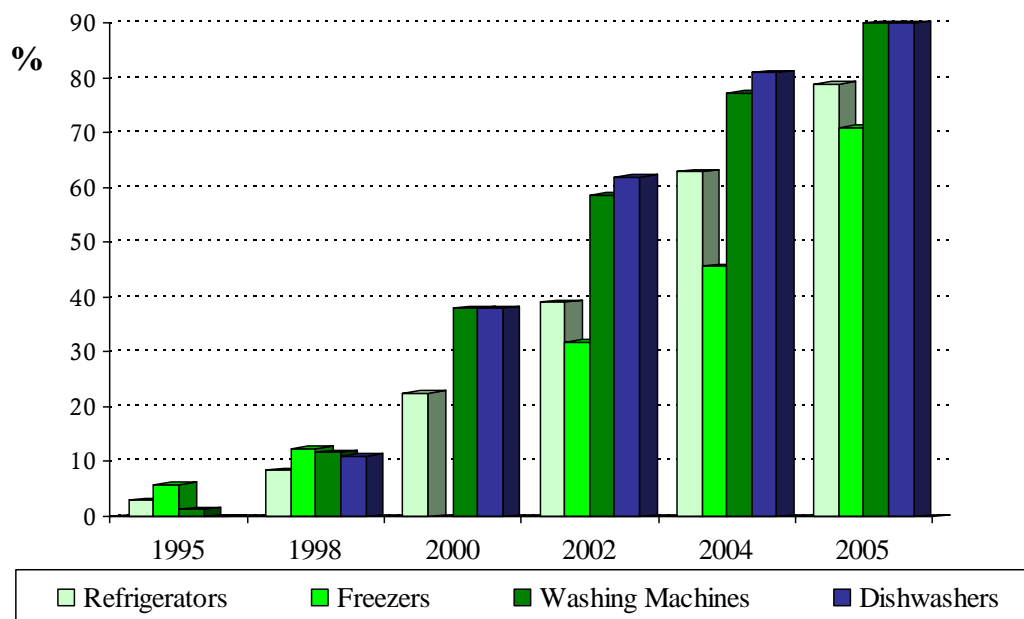
For washing machines the penetration of all A-label categories together is about 90 % on average, with a share of 28 % for the most efficient A+ appliances. Northern and western countries score highest, also on A+ shares. Four southern countries score lowest (Bulgaria, Greece, Portugal and Spain), as was also the case for refrigerators. Because three-quarters already have penetration levels above 90 % there is not much room any more for sales of A and A+ washing machines.

Substantial impact of labels on the market for efficient appliances

During the past decade the EU Directives have deeply transformed the market for (more efficient) large appliances, in combination with national measures to increase the purchasing awareness and habits of the consumers.

Figure 5.4 shows the steady increase of energy efficient appliances. This has led, as highlighted earlier, to an overall energy efficiency improvement of 11 % in the period 1997-2006.

Figure 5.4: Market share of A/A+ labels for cold and washing appliances (EU)



Combination of EU labels with national supporting measures decisive for success

Along with the transposition of the Labelling Directives, a dozen of countries have decided to reinforce the market transformation effect of these directives by establishing ‘accompanying or supporting measures’. Most of these measures consist in subsidies or rebates granted to citizens to support the purchase of highly efficient appliances labelled A/A+ or compact fluorescent lamps.

5.1.3. Innovative policy measure types for households

The following criteria has been used in the selection of most innovative measures:

- Providing large energy savings
- Effective: meeting the conditions for implementing saving measures
- Small rebound effect, lasting savings and positive side effects.

Standards on (new) dwellings have evolved from prescribing the thickness of wall insulation to overall performance standards. In this way the same savings can be realised in a more cost-effective way, depending on the actual circumstances. Due to the introduction of the Energy Performance of Buildings directive, the few countries without own (performance) standards were forced to introduce them. Strict standards for new dwellings are a powerful tool to realise savings, provided that compliance with the standards is assured. However, the total amount of savings is dependent on the number of new dwellings built.

Minimum efficiency standards on appliances can only be formulated at the EU level, due to the international market for electric appliances. The first standard only regarded refrigerators. The Eco-design directive of the EU will formulate a large number of minimum efficiency standards for all kind of energy using systems and appliances in the coming years. In this way a market transformation is accomplished, with savings at

almost no extra costs, and without bothering the consumers with decisions on more or less efficient appliances.

The EU now has formulated **minimum efficiency standards for lighting** that forces manufacturers to only offer compact fluorescent lamps (CFLs) instead of incandescent bulbs. Some countries, such as Italy and France had already planned comparable legislation and Ireland planned a levy on incandescent lamps. Here, the same advantages are present as for appliances.

Performance programs oblige parties in the energy field to realise energy savings at the place of energy users. Presently two forms are deployed, a **White Certificate system** and an **Energy Efficiency Commitment**. In both cases it is believed that these performance programs will deliver more savings at lower costs than with conventional policy measures, like subsidy schemes from the government.

National **Energy Efficiency Action Plans** have been drawn up in 2007 in response to the demands of the directive on Energy End Use Efficiency and Energy Services (ESD). These plans often contain a set of policy measures to stimulate energy saving measures in the different sectors (households, industry, transport and tertiary sectors). Most of the plans are based on, or even equal to, already formulated national action plans (see table). As highlighted in the first section a well designed combination of policy measures will be more effective than individual policy measures.

A number of countries have introduced **energy and/or CO₂ taxes** (e.g. the Netherland, Denmark and, more recently, UK) that increase energy prices for end-users. Especially the shifting of taxes on labour to a tax on energy use is innovative as it does not decrease the income of households and companies. A large advantage of substantial taxes is that it also steers the economy in a less energy intensive direction and stimulates innovation on energy efficient technologies.

Far reaching policy on energy savings can lead to **energy poverty**, high costs that are difficult to cope with by poor families. Moreover, poor families pay relatively much money for energy due to the low quality of the houses. Therefore a specific policy on poor household must be part of savings policy. Some countries already have (conventional) policy measures in place that combat energy poverty as well. Examples are the UK fuel poverty schemes and the Scheme for households with low income from Slovakia.

Finally policy measures on **inspection and maintenance** are needed, in order to assure that the potential savings of efficient systems are realised in the longer term. The EPBD asks for regular inspection and maintenance of boilers and air-conditioning.

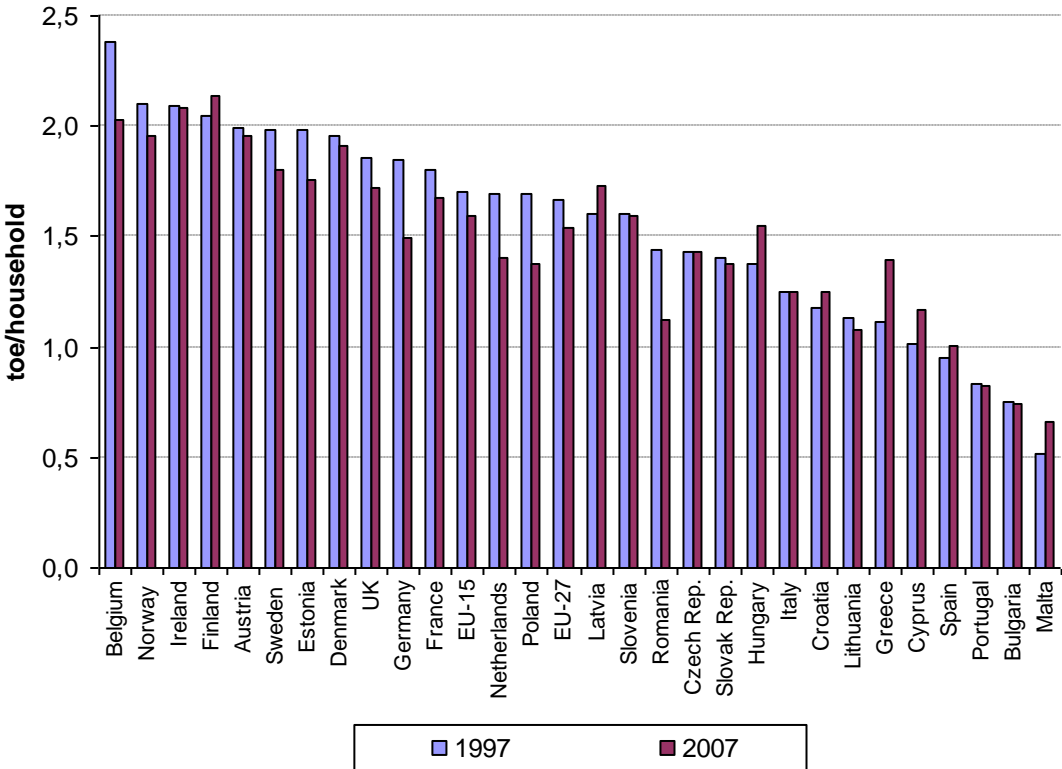
5.2. Energy efficiency trends

5.2.1. Trends in the energy consumption per dwelling

In new member states largest decrease in energy consumption per household

Figure 5.5 shows that the average energy consumption per households in 2007 was at or below the 1997 level in most countries, with Greece, Hungary, Latvia, Finland and Spain as important exceptions. The unit consumption is mostly in the range of 1-2 toe/dwelling, with Belgium and Malta as outliers. Overall, new member states show a much larger decrease than EU-15 countries (10 % against 5 %) from 1997 to 2007, especially Poland and Romania (about 20 %).

Figure 5.5: Average energy consumption per household (climate corrected)



Large electricity consumption for some countries is due to use for space heating

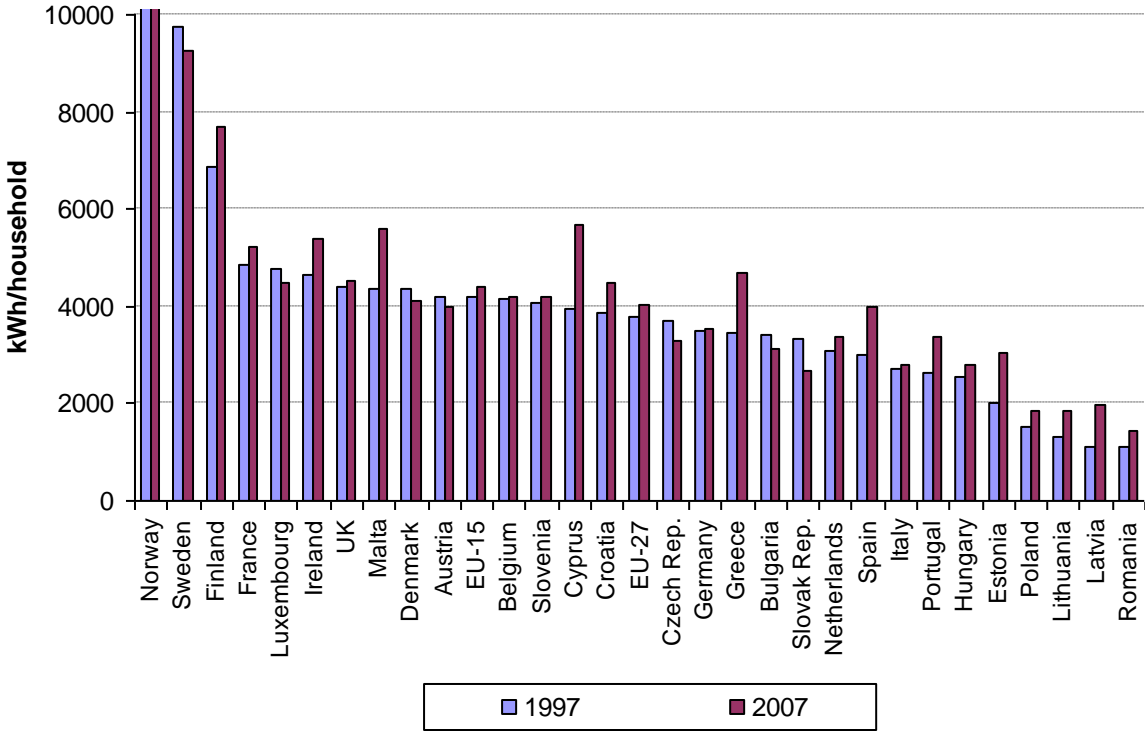
Average electricity use per household in EU-27 is about 4000 kWh per year (see **Figure 5.6**). However, electricity use is much higher in Norway⁶², Sweden and Finland due to their high use of electricity for space heating.

⁶² Norway 17930 kWh in 1997 and 16280 kWh in 2006 (not visible in the Figure)

Growth of electricity use per household is mitigated by smaller households

Between 1997 and 2007 the average EU household uses about 7 % more electricity. However, in that period average electricity use per household person increased with 14 %. The difference is due to the lower number of persons per household which influences the part of household electricity use that is dependent on the number of persons (appliances and number of lighted rooms used at the same time). With a constant size of households the growth in electricity use per household could have been between 7 and 14 %.

Figure 5.6: Average electricity consumption per household



Electricity use increases most for southern and new “taking up” member states

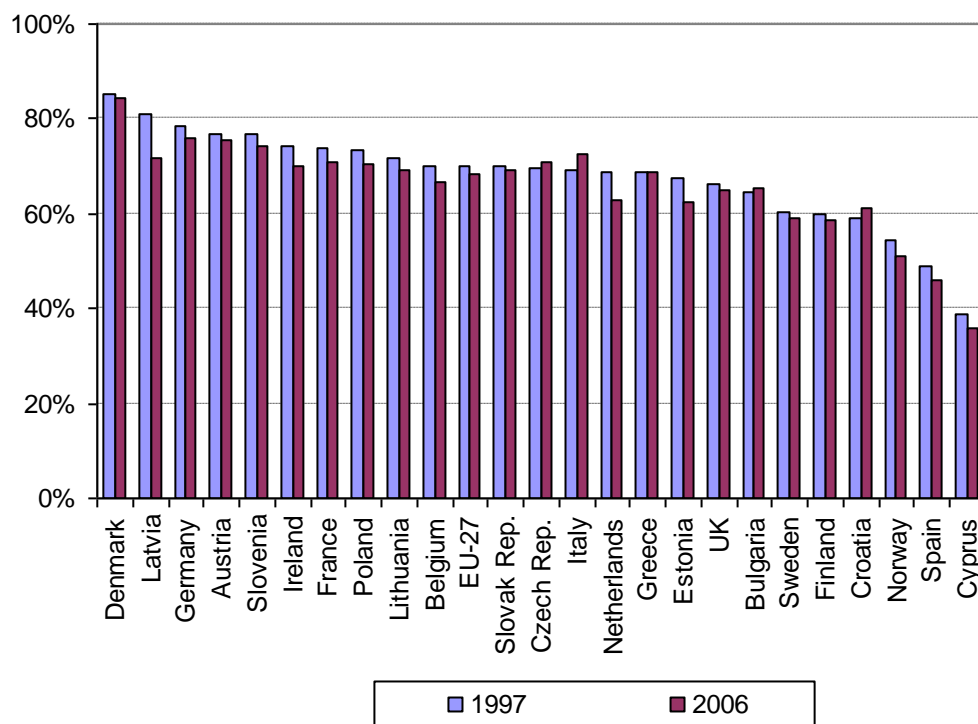
Electricity consumption per household increased between 1997 and 2007 in most countries. The EU-15 exceptions are Denmark, Austria and Sweden and, for the new member states, Slovakia, Bulgaria and Czech Republic. For Sweden the decrease could be caused by less electricity for space heating. Very high growth rates are shown for EU-15 countries Greece and Spain (+35%) and even higher numbers for the new member states Cyprus, Estonia and Latvia. But in most new member states electricity use remains at a relatively low level (less than 60% of EU average) and does not really catch up with EU-15 countries.

5.2.2. Space heating

Large part of total energy use for space heating

Energy use for space heating, normally 60-80% of total energy consumption, is the most important part of household energy use (see **Figure 5.7**). Lower fractions are generally found for Mediterranean countries with mild winters, like Cyprus and Spain.

Figure 5.7: Space heating fraction in household energy consumption⁶³



Space heating less important in total energy consumption

In general the space heating fraction decreases between 1997 and 2006, partly due to the relative strong growth of electricity consumption (the second largest part of household energy use). Exceptions are Italy, Czech Republic, Croatia and Bulgaria where the fraction increases a few %-points (see explanation below).

Highest use for space heating in countries with moderate climate

The highest values for the share of space heating energy use are **not** found in countries with cold winters, like Finland and Sweden, but in countries with moderate winters, such Ireland, Belgium, Denmark and Germany.

⁶³ Climate corrected figures, selected countries

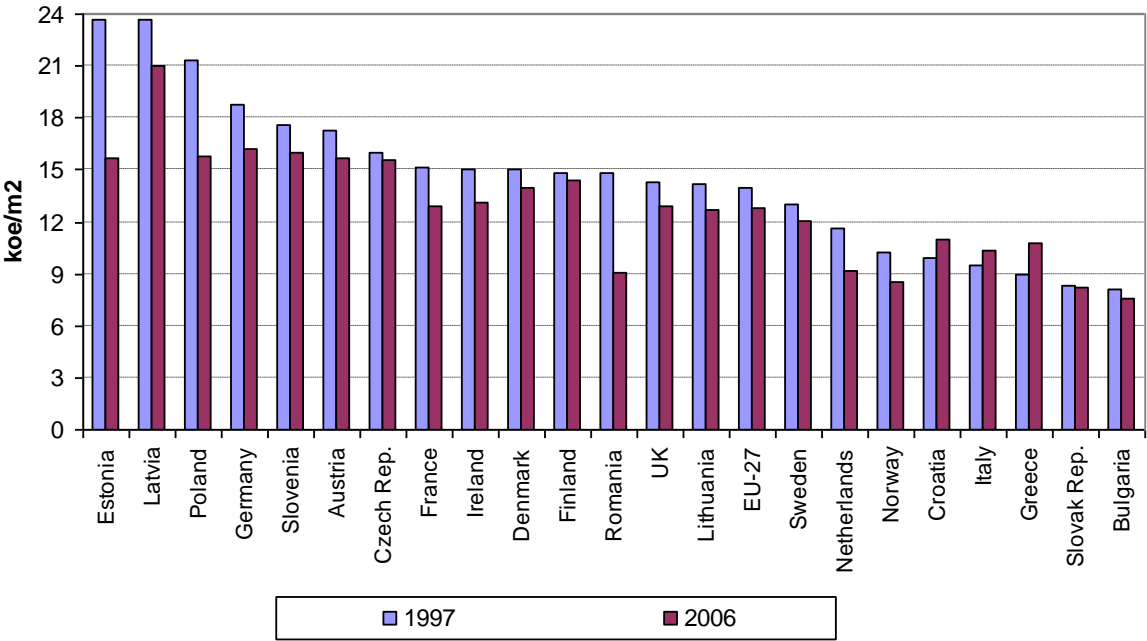
After adjustments⁶⁴ for climate Estonia, Latvia, Poland and Germany show highest use for space heating

Average energy consumption per dwelling will be dependent on the average size of dwellings and warmer or colder winters. Therefore it is more relevant to compare energy use per m² instead of use per dwelling. Moreover an adjustment should be made for differences in average winter temperature. **Figure 5.8** shows energy consumption per m² floor area taking the EU-27 average winter temperature instead of the country average. The EU average is about 13 koe/m² (150 kWh/m²).

Earlier the highest energy use per dwelling was found for Ireland, Belgium, Denmark and Germany. After adjustments Estonia, Latvia and Poland take over the lead while Germany maintains its high ranking.

The efficiency trend for space heating is measured on basis of the decrease in (climate corrected) energy use per m² floor space⁶⁵. In the period 1997-2006 the decrease for EU-27 was almost 9%.

Figure 5.8: Energy use for space heating per m² floor area adjusted to the EU climate⁶⁶



⁶⁴ Adjustments for differences in floor area and average temperature between countries. Countries with cold winters will often show higher energy use than countries with mild winters. Therefore the (yearly climate corrected) energy use for a country is corrected for the difference between national and EU-27 average climate.

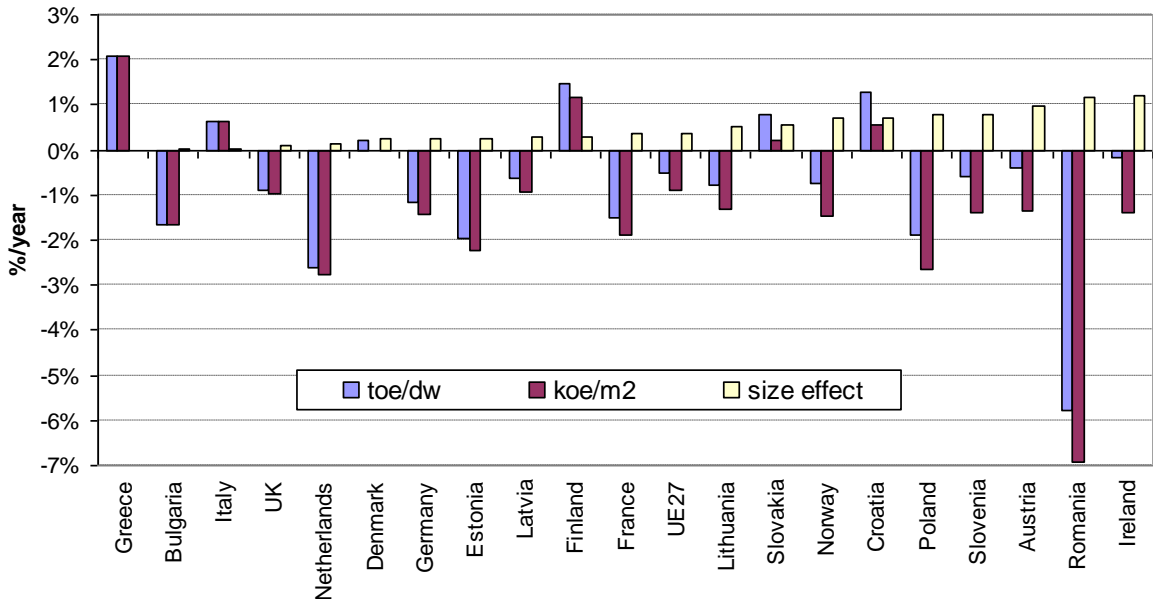
⁶⁵ Corrected for more central heating, the energy efficiency improvement due to substitution between energy carriers is included

⁶⁶ Total energy use excluding electricity, adjusted to EU mean climate.

Up to 40 % of efficiency gains in space heating is offset by larger dwellings

In **Figure 5.9** the change in energy use per dwelling for space heating (1997-2007) has been decomposed into a change in floor area and a change in specific energy use per m². The average dwelling size increased, especially in Eastern European countries (about 10%). As a result, energy consumption per dwelling decreased less (0.5%/year) than consumption per m² (0.9%/year) in the EU-27. This means that 40% of the energy efficiency progress for thermal uses has been offset, all things being equal, by the fact that dwellings are becoming larger. For new member states the size effect in %/year is much larger, but compared with the large decrease in energy use per m² the offsetting is relatively smaller.

Figure 5.9: Heating energy use: per dwelling, per m² and size effect (1997-2007)



Limited number of new dwellings restricts energy savings for space heating

Due to more strict standards new dwellings have much lower energy consumption for space heating than the average existing dwelling. However, the effect of standards on total savings for space heating is restricted by the often limited amount of new dwellings built. At a yearly basis most EU countries extend their dwelling stock with less than 1%. The main exceptions are Ireland, Greece, Spain and Portugal. Eastern European countries have built very few new dwellings.

5.2.3. Electrical appliances

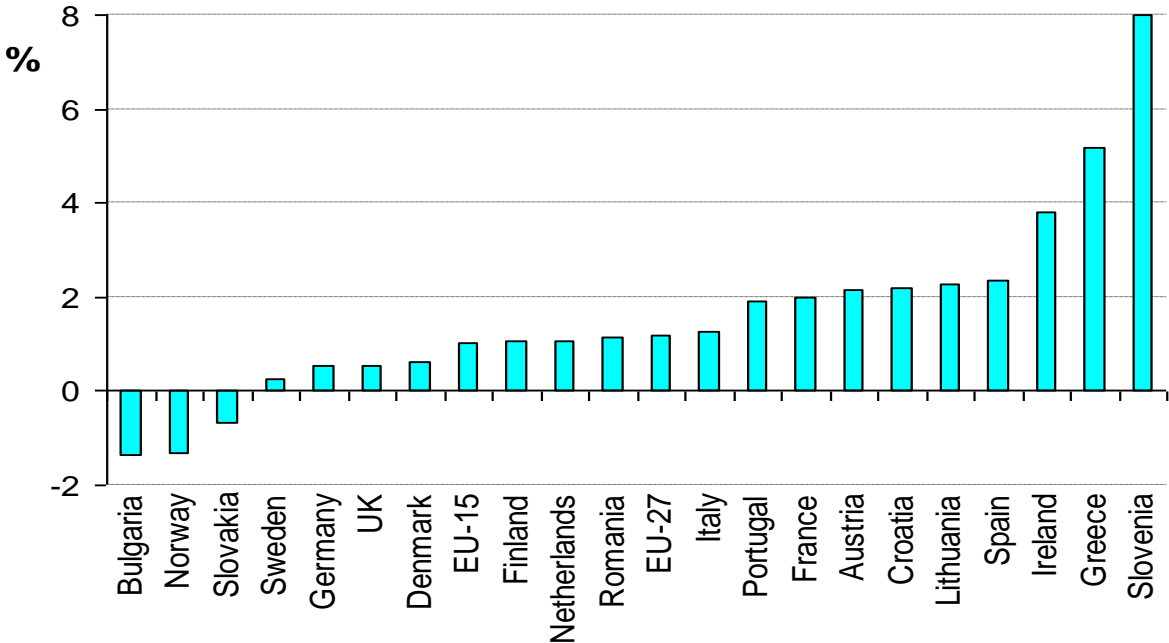
For most EU countries the largest part of electricity consumption per households is for appliances and lighting. But thermal uses are very large for Norway⁶⁷ and Sweden, and substantial for Finland, France and Ireland.

⁶⁷ Total for Norway is 16000 kWh (not shown)

Appliance electricity use increases, but high growth only due to specific factors

Figure 5.10 shows that during the period 1997-2006 electricity consumption for appliances & lighting increased in all countries, except for Bulgaria and Slovakia (relative low consumption level of about 2500 kWh) as well as Norway (higher consumption level of about 4500 kWh). The progression has been rather moderate in Sweden, Germany, UK and Denmark which are countries with an already high electricity use. It is substantial for Ireland, with the highest economic growth, and in all southern countries where the use of air-conditioning systems has grown.

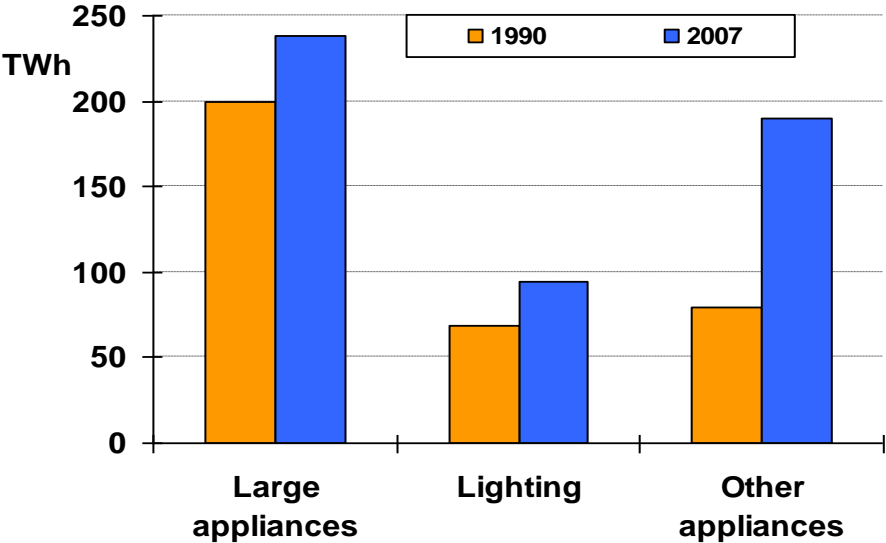
Figure 5.10: Yearly growth in electricity use per household for appliances & lighting (1997-2006)



Growth of electricity consumption concentrated at small appliances

The breakdown of appliances consumption (see **Figure 5.11**) shows that the strongest growth is recorded for the category small appliances. These appliances registered an increase of its market share from 23% in 1990 to 36% in 2007. The consumption by large appliances records a growth at moderate rate and its market share declines from 58% to 46%. With a market share of approximately of 20%, the category lighting is stable.

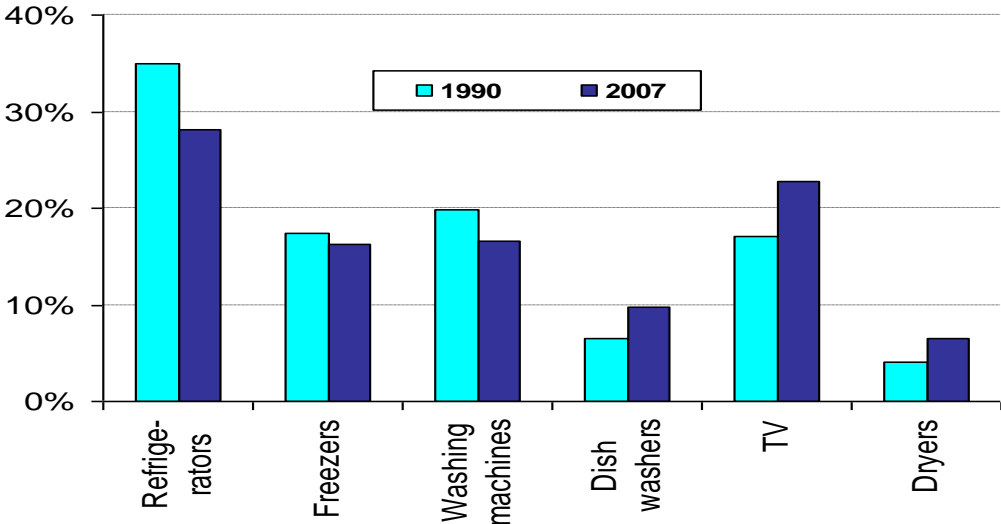
Figure 5.11: Change in total electricity use for large/small appliances and lighting



Clothes dryers and dishwashers drive electricity consumption upwards

Figure 5.12 shows the development of electricity consumption by appliances being heavy users in terms of their fraction in the total for all appliances. Televisions, dryers and dish washers increased their share during the years 1990-2007. For dryers and dishwashers this was due to higher penetration rates. Refrigerators and washing machines registered a decline, mainly due to substantial electricity savings.

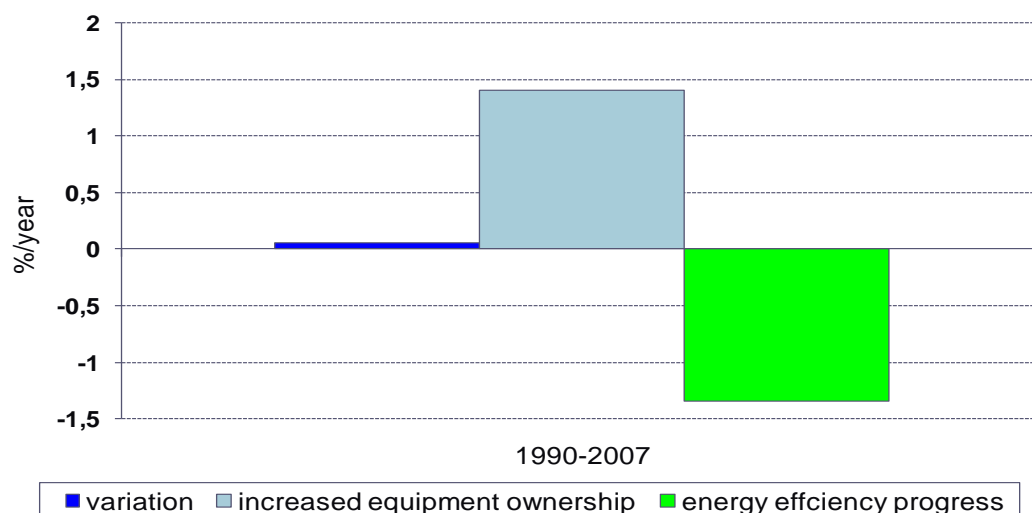
Figure 5.12: Shares of large appliances in total appliance electricity use



Efficiency increase appliances has been offset by increased ownership

The decomposition of the observed change in electricity use by large appliances in **Figure 5.13** shows that almost all energy efficiency gains over the last years have been offset by an increase in equipment ownership. As a result, electricity consumption per household for large appliances is only slightly lower in 2006 than in 1997.

Figure 5.13: Decomposition of change in electricity use of large appliances



5.2.4. Savings by renewable energy technologies

The deployment of renewable energy sources in dwellings can lower (fossil) energy consumption. Therefore the output of these “renewables-behind-the-meter” technologies is counted as energy savings. Examples are photovoltaic cells (PV) that produce electricity, solar collectors that produce heat and heat pumps that transform ambient heat into useful heat with help of electricity.

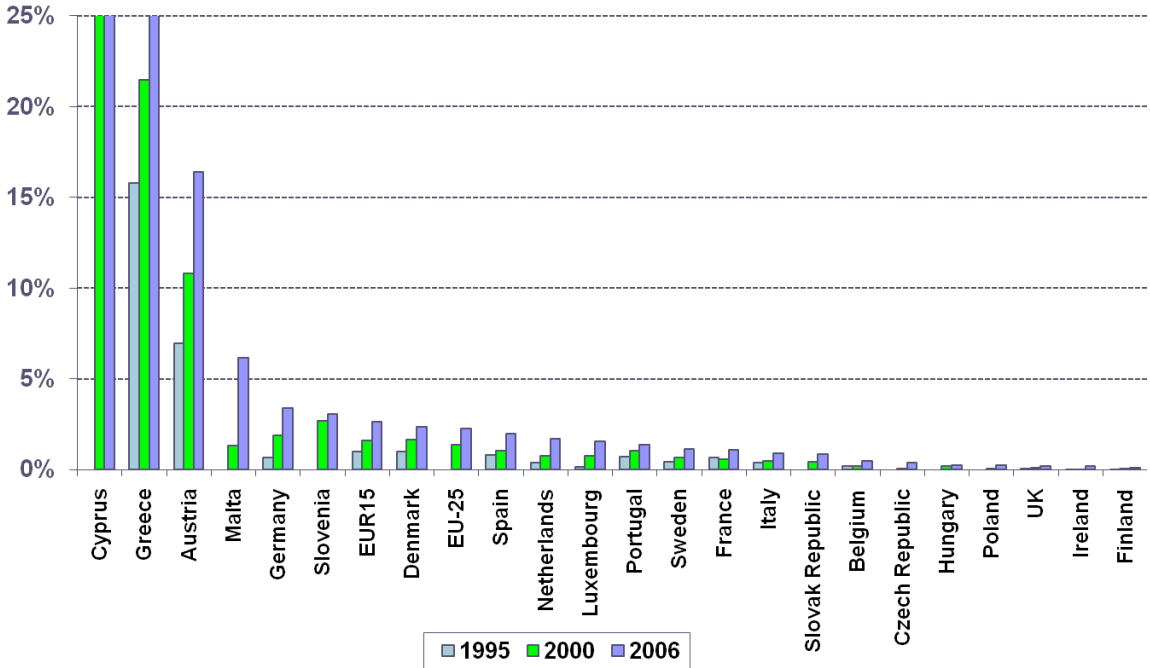
Penetration of solar water heaters more dependent on policy than on sunshine

Solar water heaters are mainly used for the supply of hot water, in combination with a system using fossil fuels or electricity.

The amount of dwellings with solar water heaters in European countries generally is only a few percent (see **Figure 5.14**). Some countries with a sunny climate, such as Cyprus and Greece, score much higher. But comparable countries like Italy and Spain show below average figures. On the other hand, Austria performs much above average, probably due to successful stimulation programs.

Between 1995 and 2006 the relative amount of solar water heaters has more than doubled in most countries; at EU level there was an increase of 50% between 2000 and 2006.

Figure 5.14: Development of the fraction of dwellings with a solar water heater



5.2.5. Overall energy efficiency and CO₂ emission reduction

5.2.5.1. Overall energy efficiency trends

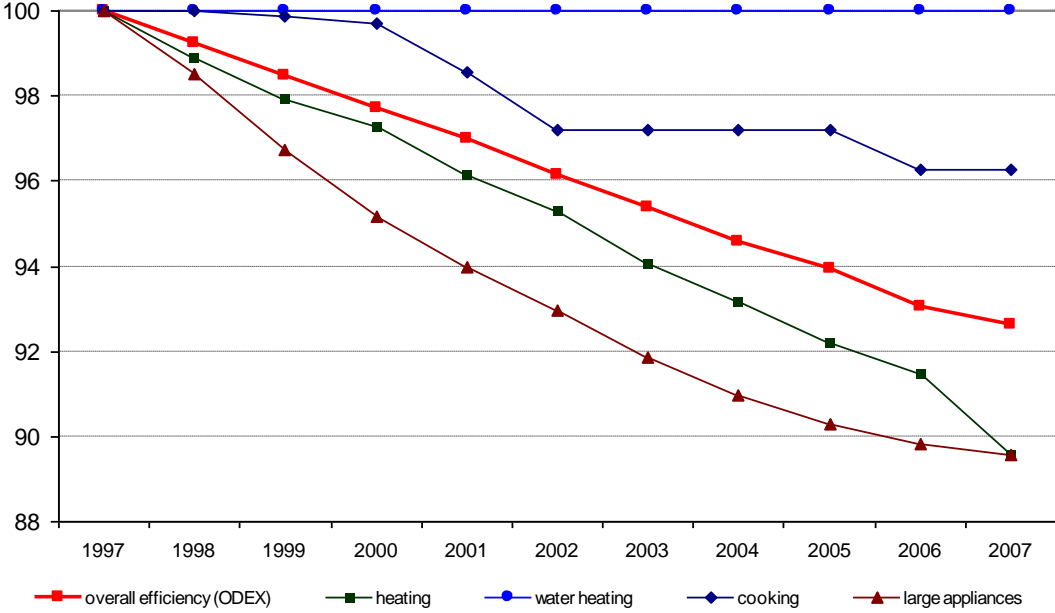
Household energy efficiency for EU-27 has improved by 8-10 % since 1997

The ODEX overall efficiency trend⁶⁸ for European households shows an improvement of almost 8 % for the period 1997-2007 (see **Figure 5.15**), or about 0.8 % per year. The efficiency improvement for both heating and large appliances reaches more than 10 %. But for cooking the figure is much lower and for hot water no savings have been observed. Therefore overall efficiency lags behind that for heating/appliances.

The energy savings are largely due to the deployment of technologies that reduce energy demand (e.g. double glazing), convert fuels more efficiently (e.g. high efficiency boilers) or use less electricity more efficiently (e.g. label A washing machines). There are other technologies available that are important for future energy savings but have not contributed up to now substantially to total savings.

⁶⁸ The yearly figures for ODEX have been converted into three-year moving average values (see chapter 5).

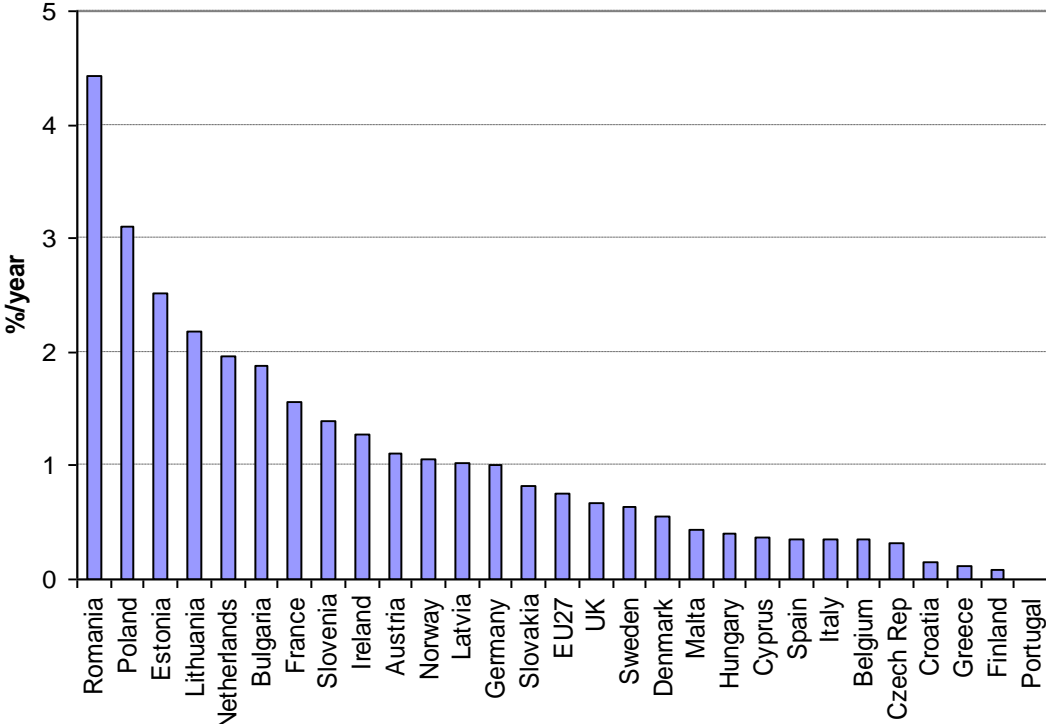
Figure 5.15: Overall efficiency index ODEX of households for EU-27



New member states show very high overall efficiency improvement

The four EU countries with by far the highest efficiency improvement are the new Member States Romania, Poland, Estonia and Lithuania (see **Figure 5.16**). Most other new Member States also do better than the EU-27 average improvement of 0.8%/year.

Figure 5.16: Yearly energy efficiency improvement by country (1997-2007)



Most EU-15 countries realise less savings than according to EU targets

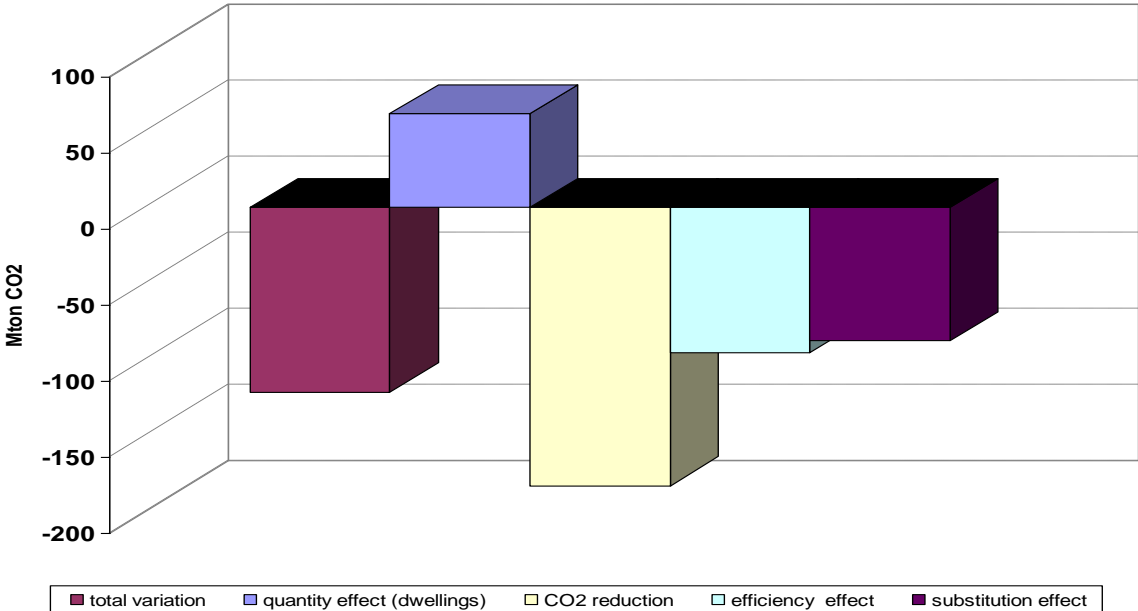
The historical improvement of household energy efficiency for EU-27 is lower than the overall 1%/year, requested in the Energy Service directive by the European Commission (see section on EU policy). Especially some EU-15 countries show a much lower efficiency improvement than they should attain in the period 2008-2016.

5.2.5.2. Trends in CO₂ emissions

Energy savings and fuel switching reduced direct CO₂ emissions in the EU-27

Direct CO₂ emissions regard the emissions at the dwellings, thus without the emissions elsewhere for district heat or electricity. In the period 1996-2007 emissions of EU-27 households decreased from 534 to 413 Mt, or 8 % (see “variation” of 121 Mt⁶⁹ in **Figure 5.17**). This result was achieved despite an increase in the stock of dwellings and the increased number of appliances owned. These two developments would have implied, all other things being equal, an emission increase of about 60 Mt. The lower level of emissions was made possible by efficiency improvements and substitution between energy carriers, which each provided half of the CO₂ reduction of about 180 Mt. This large contribution of substitution is due to switches to fuels with a lower CO₂ content (e.g. gas, heat and biomass) or to electricity, the emissions of which are not included in the household sector.

Figure 5.17: Decomposition of 1996-2007 variation in CO₂ emissions for EU 27



⁶⁹ All the figures given here are not corrected for climate variations.

5.2.6. Analysis of drivers and factors behind trends

Many drivers and explaining variables define energy consumption trends

Drivers are explanatory factors that have a direct physical relationship with energy use, such as population, number of households, number and size of dwellings, central/local heating and ownership of appliances. The influence of drivers can be shown in so-called decomposition analyses, where the change for energy quantities is attributed to changes for the drivers.

Explaining variables are the factors that influence energy consumption indirectly, e.g. by changing energy using behaviour. Examples are income, energy prices and savings policy, but also saturation could play a role in explaining energy trends. The influence of explaining variables can only be analysed by comparing visually the relationship between values or changes for energy quantities and explaining variables.

Energy trends can be understood by either time series or country comparison

Trends show changes over a period for (groups of) countries, which can be related to changes in drivers or explaining variables. Differences between countries can also be related to differences in drivers or explaining variables. Both time series and cross section analysis are used for understanding developments in energy use and savings.

General trend for more central heating drives energy use up

For space heating the most important drivers for energy use are the number of dwellings, average floor space, penetration of central heating and fuel substitution. Dwellings and average floor space have already been presented in the section on energy use for space heating.

In past decades local heating with one or more stoves per room has gradually been replaced by individual central heating using a boiler or, in some countries, by district heating. In EU-15 countries the relatively high penetration has increased further, except in Sweden where it was already 100 %. In most new member states the penetration has increased from a much lower level. The decrease in Bulgaria for both individual central heating (-6 %-points) and district heat (-4 %-points) is probably due to high prices and low incomes.

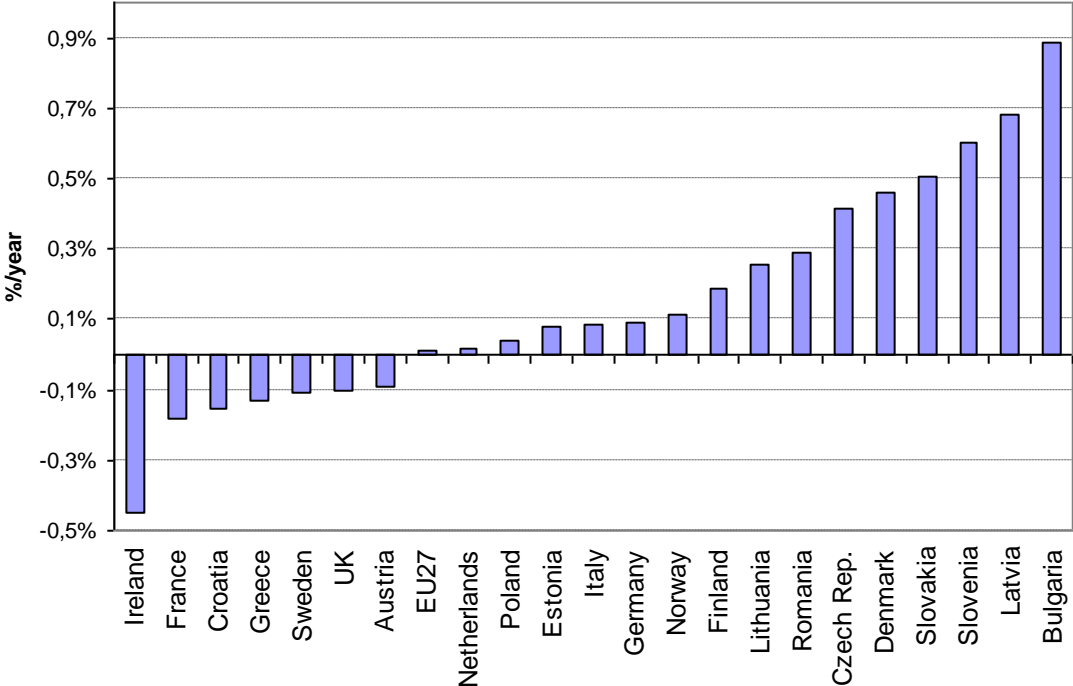
The increasing energy use for space heating due to the penetration of central heating is not always visible in the change in unit consumption as shown earlier. This is because at the same time energy is saved in space heating.

Fuel substitution saves energy but not if district heat is replaced

Fuel substitution is defined here as any change in type of energy carrier. In EU-15 countries “old fashioned” energy carriers, such as peat (in Ireland), wood (Austria) or coal are replaced by gas. By nature gas has a higher conversion than coal or peat; thus fuel substitution leads to more efficiency (see **Figure 5.14**). In some new member states,

such as Bulgaria, district heating is replaced by (individual) heating using gas. Because district heat is produced very efficiently in cogeneration plants the conversion losses for households increase when changing to gas. In these cases fuel substitution results in increased (final energy) unit consumption (see **Figure 5.14**). It must be remarked that the effects of both types of substitution can compensate each other, e.g. for Poland where both coal to gas and district heating to gas play a role.

Figure 5.14: Contribution of fuel substitution to unit consumption per m²



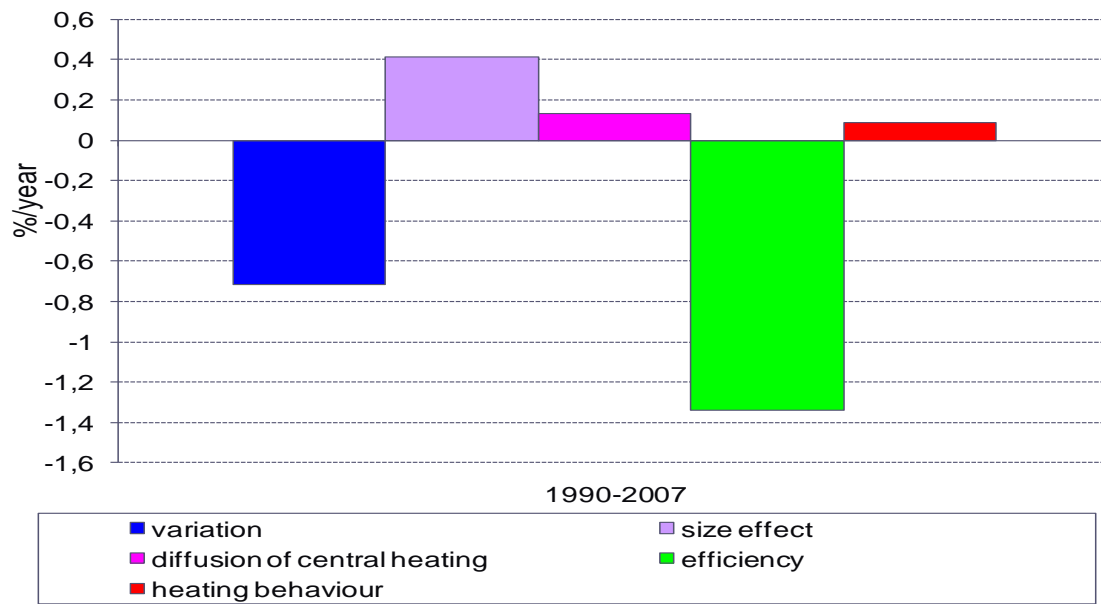
Efficiency increase is the most important factor in observed lower unit consumption

Figure 5.19 shows how the change (variation) in unit consumption per dwelling that can be decomposed into the effects of explanatory factors: size (floor space), central heating, energy efficiency and behaviour/other (e.g. fuel substitution).

For EU-15 countries, the size effect is smaller than for new member states that take up from a low average dwelling floor area. The effect of the penetration of central heating regards both groups of countries. This effect will reach a saturation level, as it already did for some EU-15 countries.

The net unit consumption decrease (variation) is about 0.5% per year. This is considerable lower than the efficiency gain of 1.1% per year.

Figure 5.19: Decomposition of change in heating energy use per dwelling (EU-27)



6. Tertiary sector

6.1. Energy intensity and unit consumption

Due to lack of data, no separate analysis of space heating and electrical appliances is executed, as it was the case for households.

Energy intensity trends remarkably stable, since 1997 also for new member states

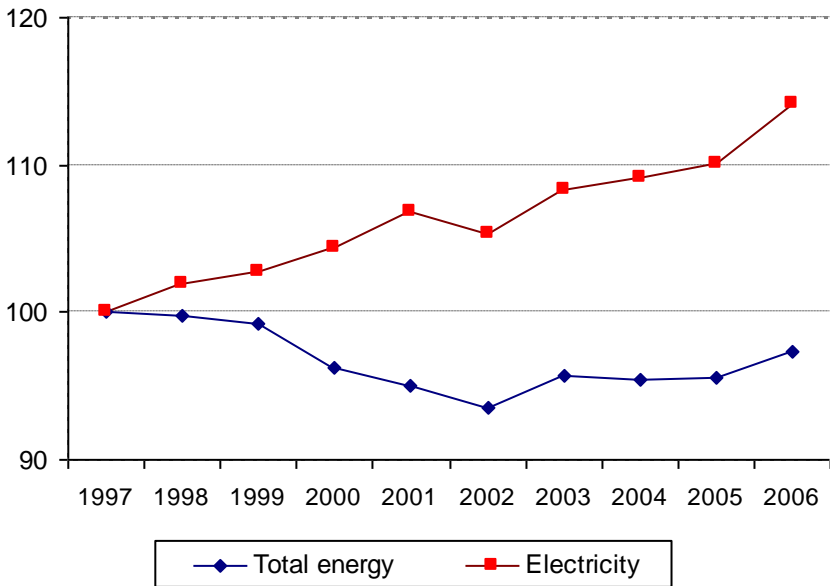
The trend for energy intensity for 1997-2006 is rather stable, both for EU-15 and new member states. For new MS it fell only by 7%; the intensity for EU-15 decreased faster with about 11%. However, for the years 1990-1997 the intensity for some new member states decreased rapidly, due to the large changes in the political-economic system.

At EU level less energy is used per employee but substantially more electricity

Total energy consumption per employee decreased until 2002 but more or less stabilized afterwards (see

Figure 6.1). The overall decrease (-3 %) is in contrast with the substantial increase in electricity consumption per employee (+14 %). Per European employee 600 extra kWh were used in 2006 compared to 1997 (from 4520 to 5160 kWh/employee). These developments suggest that increased productivity of labour is accompanied by more electricity using appliances and systems.

Figure 6.1: Total energy and electricity use per employee for tertiary (EU-27)



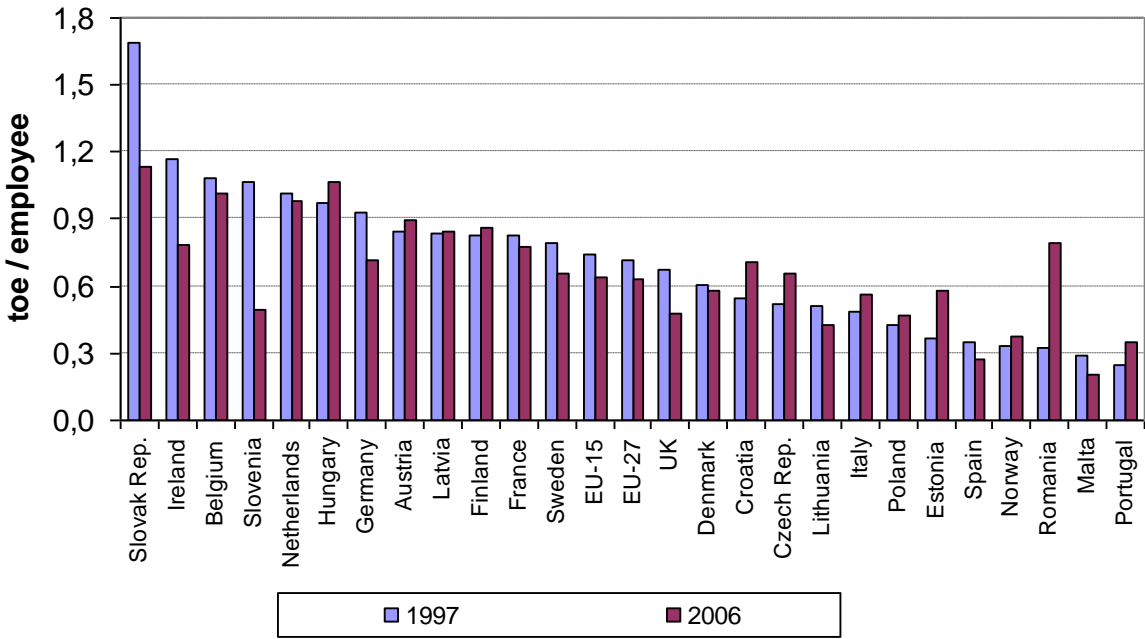
Fuel consumption per employee is not easily related to the climate or economy in the countries

The fuel consumption (including heat) per employee in **Figure 6.2** shows differences between countries that are not easy to explain. Countries with moderate winters, like Belgium and Ireland, show higher values than countries with cold winters (e.g. Sweden). The values for Eastern European countries, with a comparable economic development, are sometimes rather high and sometimes rather low.

Both increasing and decreasing fuel use per employee in EU countries

Between 1997 and 2006 fuel use per employee (climate corrected) for EU-27 decreases slightly. A decrease is visible for about half of the countries, among which mostly EU-15 countries (e.g. Germany, Ireland, Spain and UK). One-third shows an increase, mainly new member states or southern European countries. For new member states very large differences occur with regard to changes, e.g. twice as low (Slovenia) versus twice as high (Romania). It must be remarked that statistical figures on energy use for services are relatively uncertain compared to other sectors.

Figure 6.2: Fuel consumption per employee in 1997 and 2006 for Tertiary



Electricity use in Scandinavian countries is not comparable due to use for space heating

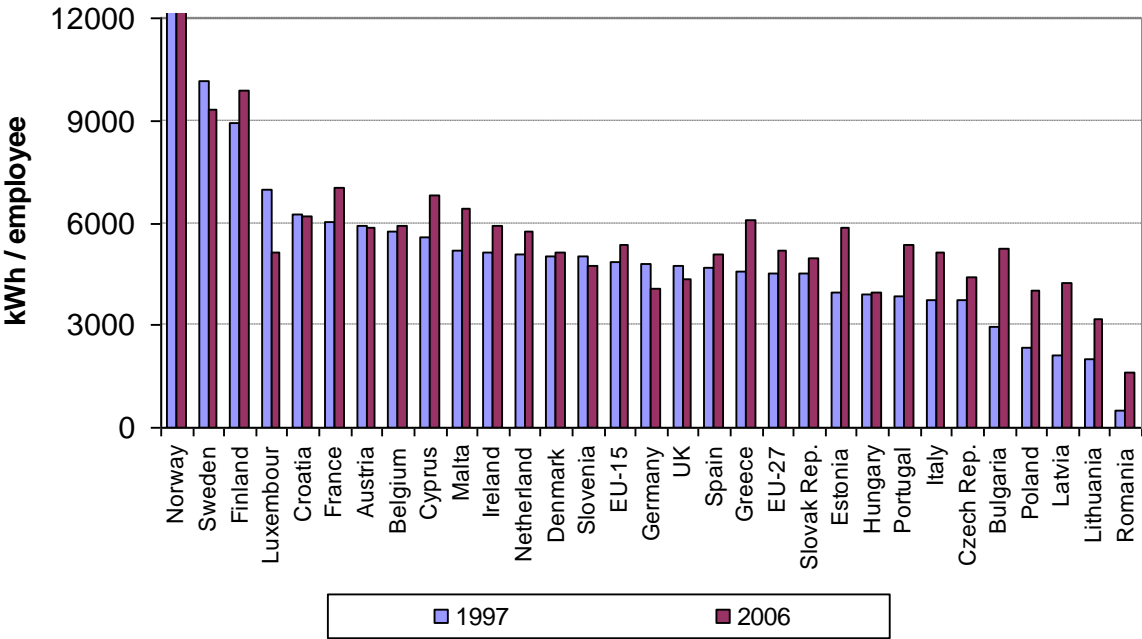
Norway, Sweden and Finland use by far the largest amount of electricity per employee, which probably has to do with electric heating (see **Figure 6.3**). This could also be the

case, for some degree, for France but not for Malta. There other causes, such as air-conditioning, are responsible for the relatively high use.

Fast take-up by eastern European countries from 1997 on

The new member states used only about half the amount used in EU-15 countries. However, in 2006 the difference has narrowed considerably (3900 kWh versus 5300 kWh).

Figure 6.3: Electricity use per employee and change, per country for Tertiary



Increase in electricity use per employee due to air-conditioning or strong growth

Generally electricity consumption per employee is increasing, except in Germany, UK and Slovenia. Large increases can be observed for all southern countries, probably due to the penetration of cooling in summer. The high growth for Ireland and eastern European countries is probably due to fast economic growth.

Rich countries show saturation for electricity use per employee

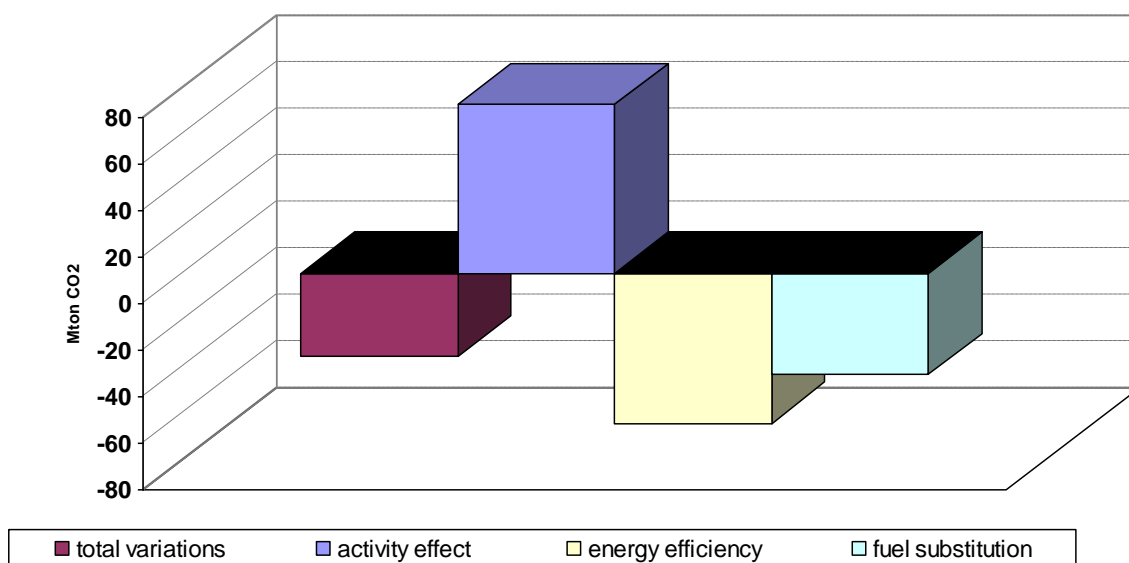
For the EU-15 countries with a sustained high level of economic welfare, electricity use per employee is stable or sometimes decreasing. This could signal that electricity use reaches a saturation level after the “computerisation” of offices, shops, schools, etc. since the eighties. However, saturation will not be reached if these countries apply air-conditioning at a larger scale in buildings, for instance due to warmer summers. Also the strong growth in ICT networks could lead to the continuation of the trends for increased electricity use (see also report on ICT⁷⁰).

⁷⁰ Energy Efficiency Trends of IT Appliances in Households, Monitoring of Energy Efficiency in EU 27, Norway and Croatia (ODYSSEE-MURE), Fraunhofer ISI, Karlsruhe, September 2009.

Fuel substitution also important for lower CO₂ emissions

Tertiary represents 8 % of CO₂ emissions in the EU-27 in 2007. From 1996 to 2007, the direct CO₂ emissions have decreased by 18% (see “variation” in **Figure 6.4**). The value added has increased by 36 %, which would have implied an increase of 73 Mt CO₂ (see activity effect”). The reduction of CO₂ emissions by energy efficiency and fuel substitution has more than offset the effect of economic growth. Nearly 40 % of these reductions are linked to a switch to natural gas and the increased use of electricity. However, if the indirect CO₂ emissions from electricity production are also taken into account the emissions increase substantially.

Figure 6.4: Decomposition of change in direct CO₂ emissions for Tertiary (EU-27, 1996-2007)



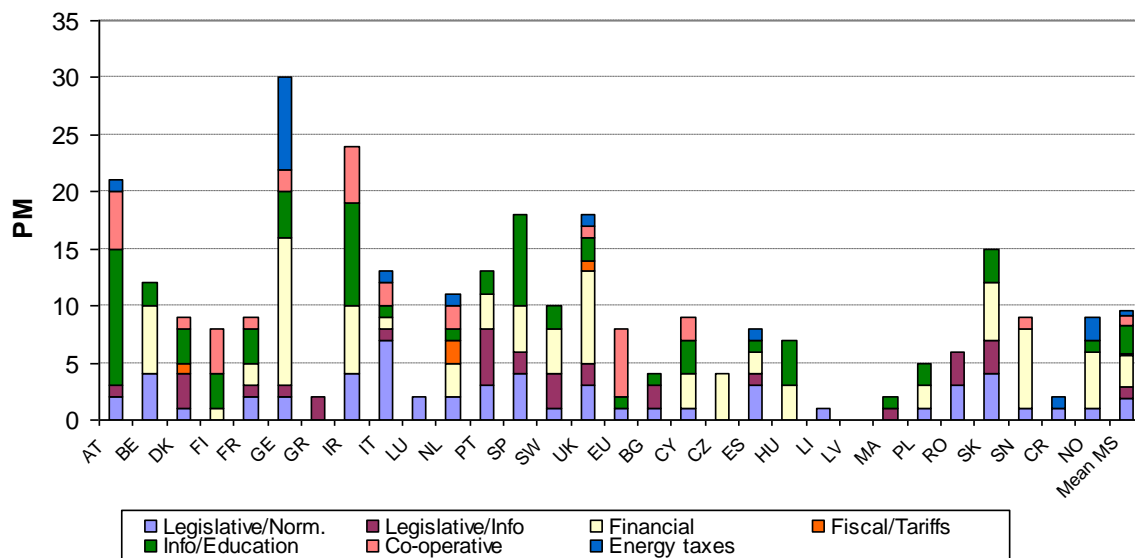
6.2. Policy measure developments

6.2.1. Overall picture

New member states have restricted set of policy measure types

Figure 6.5 shows the ongoing policy measures for the seven measure types. Eight countries, almost all new member states, deploy only one or two types of policy measures. The application of at least five measure types is mainly restricted to EU-15 countries. Standards (legislative/normative), financial support (financial/fiscal) and information are most applied, but energy taxes and voluntary agreements (cooperative) are hardly used.

Figure 6.5: Policy measure per type for tertiary sectors (ongoing, 2006)



In tertiary sectors more “softer” policy measure types than for households

In comparison to households not all countries have standards (legislative-normative). The type legislative/informative is also used less, mainly because appliance labels play a minor role in tertiary sectors. The policy measure types information/education and voluntary agreements (cooperative) are more often applied.

Many policy measures have a broad scope

EU wide about half of all policy measures for the tertiary sectors has a broad scope, covering many parts of total energy use. These comprise mandatory audits, financial support for non-specified saving measures, voluntary agreement and energy taxes.

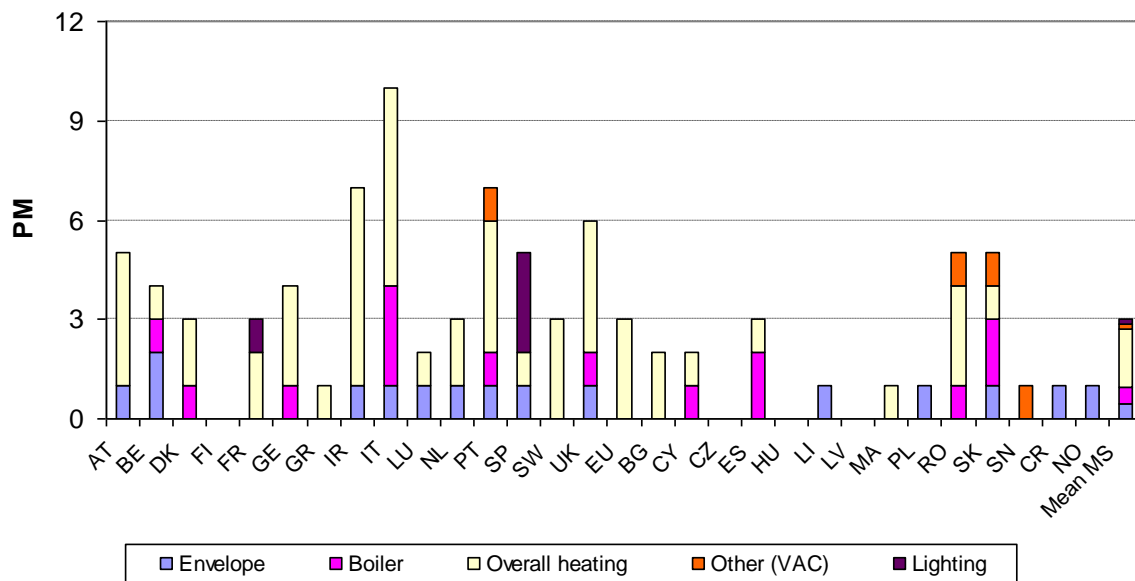
For buildings the scope of policy measures is much more on the whole building than specifically on the shell or the heating system.

Very few policy measures are targeted at lighting in buildings

From the policy measures targeted at buildings almost none are specifically focused on the lighting system⁷¹ or ventilation/air-conditioning (see “Mean MS” in **Figure 6.6**). However, it is possible that the amply available performance standards also provide energy efficient lighting and air-conditioning.

⁷¹ The policy measures on lighting for Spain regard street lighting

Figure 6.6: Policy measures targeted at building related uses (2006)



Few policy measures are targeted at the public sector

Specific measures for the public sector regard public lighting standards, mandatory action plans and reporting of municipalities and governing by example. On average countries only deploy 0.6 policy measure and two-third of the countries deploy none.

6.2.2. EU based policy measures

For tertiary sectors the most important policy measures of the EU are the same as for households (Energy Performance of Buildings directive, Energy Service directive (ESD) and Eco-design directive), but in addition there is the Directive on combined heat and power (CHP). The **CHP directive** asks from countries to remove barriers for the implementation of combined production of electricity and heat. This is especially important for the smaller CHP units in tertiary sectors.

6.2.3. Innovative policy measure types for tertiary sectors

About the same criteria as for households are valid for tertiary sectors. But here less attention is needed for rebound effects and more to tailor-made solutions that fit the large diversity in energy use.

Standards for buildings are requested by the EPBD and taken up by all European countries as described for households. **Standards for appliances** regard only some office appliances but the Eco-design directive could be extended to all energy using systems. The existing **White Certificate systems** do focus also on tertiary sectors; it regards mainly the public sector. For commercial sectors **Energy Performance Contracting** is a new way of realising energy savings. In both cases an **ESCO** can play a role in providing a tailor-made approach. This last property is generally not valid for

the **broad action plans** of governments and agencies. That is possibly the reason that national action plans focus relatively less on tertiary sectors with their very diversified energy use and characteristics. **Energy or CO₂ taxes** for tertiary sectors do not affect competitiveness because the companies are not energy intensive and most do not compete in the international market. But so far substantial tax levels that really count have been applied in a few countries only. A very new and promising policy measure is **national emission trading** for energy users that are not part of the European emission trading scheme. The Dutch horticulture sector itself has proposed such a scheme, probably because it fits better to their needs and possibilities. In the UK the CO₂ Reduction Commitment demands from actors to reduce emissions, possibly by energy savings. Finally, for **inspection and maintenance** the same holds as for households, i.e. safeguarding the potential savings from new systems.

Bibliography

ADEME (2008): Energy Efficiency in the European Union – Overview of policies and good practices. Agency for Environment and Energy Management ADEME. Paris, November 2008.

<http://www2.ademe.fr/servlet/getDoc?sort=-1&cid=96&m=3&id=58128&ref=14149&nocache=yes&p1=111>

AEA Technology/Fraunhofer ISI/Ecofys (2009): Quantification of the effects on greenhouse gas emissions of policies and measures. Final Report Appendix I: Detailed policy methodology and results chapters. Reference: ENV.C.1/SER/2007/0019. Final report. Didcot/Karlsruhe/Utrecht 2009.

BGBI (2008): Gesetz zur Neuregelung des rechts der Erneuerbaren Energien im Strombereich und zur Änderung von damit zusammenhängenden Vorschriften. Vom 25. Oktober 2008. Bundesgesetzblatt Jahrgang 2008 Teil I Nr. 49, Bonn 31. Oktober 2008

<http://www.erneuerbare-energien.de/inhalt/40508/>

BMU (2009): Erneuerbare Energien in Zahlen. Nationale und Internationale Entwicklung. Stand: Juni 2009. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)

http://www.bmu.de/erneuerbare_energien/downloads/doc/2720.php

EEA (2009) : Annual European Community greenhouse gas inventory 1990–2007 and inventory report 2009. Submission to the UNFCCC Secretariat, May 2009

EEA (2008): Energy and environment report 2008, November 2008;
http://www.eea.europa.eu/publications/eea_report_2008_6

EEA (2008): TERM monitors indicators tracking transport and environment integration in the European Union (EEA Report No 3/2009);
<http://www.eea.europa.eu/publications/transport-at-a-crossroads>

European Commission (1999) : Commission Recommendation of February 1999 on the reduction of CO₂ emissions from cars.

European Commission (2009): Communication from the Commission to the Council and the European Parliament “Monitoring the CO₂ emissions from cars in the EU.

Eurostat (2009): Taxation trends in the European Union, Luxembourg, 2009, p. 391

CEC (2009): 7 Measures for 2 Million New EU Jobs. A Low Carbon Eco-efficient & Cleaner Economy for European Citizens. Communication from the Commission to the Council and the European Parliament. Commission of the European Communities. Draft October 2009.

http://www.euractiv.com/pdf/Draft_COM_IS_Oct2009-1%5B1%5D.pdf

Fraunhofer/ENERDATA/ISIS/Wuppertal (2009): Study on the Energy Savings Potentials in EU Member States, Candidate Countries and EEA Countries. Final Report for the European Commission, Directorate-General Energy and Transport. EC Service Contract Number TREN/D1/239-2006/S07.66640.

http://ec.europa.eu/energy/efficiency/studies/efficiency_en.htm

IEA (2007): Energy use in the Millennium: trends in IEA countries, 164 p, Paris.

IEA (2009): Energy Prices & Taxes, OECD, Paris

Official Journal of the European Union: Directive 1999/94/EC relating to the availability of consumer information on fuel economy and CO₂ emissions in respect of the marketing of new passenger cars.

Official Journal of the European Union: Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport.

Official Journal of the European Union: Directive 443/2009 of April 2009 setting emission performance standards for new passenger cars.

Official Journal of the European Union: Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC.

Official Journal of the European Union: Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community.

Official Journal of the European Union: Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of Eco-design requirements for energy-using products and amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC of the European Parliament and of the Council.

Official Journal of the European Union: Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration

based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC.

WEC (2008): Energy Efficiency Policies around the World – Review and Evaluation. Case study on Mandatory audits and benchmarking - Synthesis of Country Experiences and Evaluation. World Energy Council January 2008
http://www.worldenergy.org/publications/energy_efficiency_policies_around_the_world_review_and_evaluation/default.asp

Annex: Data sources

All data used to calculate the indicators come from the ODYSSEE data base. This data base is updated by national teams using national energy and economic statistics.

Energy statistics include data on energy consumption by main sector and industrial branch from the energy balance, using the same methodology and definitions as Eurostat. These data are completed by more detailed energy consumption data by end-use for households and by type of vehicles for road transport. As such detailed data are not available for all countries, Enerdata has proposed methodologies to make estimates.

The methodology was a top-down approach, i.e. starting from official statistics and breaking them down by end-use or type of vehicle. This guaranteed the consistency between data by end-use and the total consumption. It relied on all statistics available by country, so the approach was not exactly the same, even if there was a general template.

For road transport, the statistics used were the stock of vehicle by fuel type and if available the average mileage per vehicle (km/year). The estimation was done for one type of vehicle (e.g. cars) and the others were derived on the residual consumption. This is the approach followed to do these breakdown in countries in which data are available (e.g. France for instance).

For households, the statistics used were the following (adapted to each specific case): number of dwellings, number of households connected to gas and district heating, % of end-use by fuel type (e.g. % of water heating in the total district heating consumption); the fuel shares were either taken from Eurostat⁷² or from similar countries; national experts validated or completed the values proposed by the technical coordination.

⁷² Eurostat has set up reference heating share by fuel and by country to make climatic corrections.