Energy Policy Statistical Support Unit

Energy Efficiency in Ireland

2009 REPORT

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Sustainable Energy Ireland | Energy Policy Statistical Support Unit

Sustainable Energy Ireland

Sustainable Energy Ireland was established as Ireland's national energy agency under the Sustainable Energy Act 2002. SEI's mission is to promote and assist the development of sustainable energy. This encompasses environmentally and economically sustainable production, supply and use of energy, in support of Government policy, across all sectors of the economy including public bodies, the business sector, local communities and individual consumers. Its remit relates mainly to improving energy efficiency, advancing the development and competitive deployment of renewable sources of energy and combined heat and power, and reducing the environmental impact of energy production and use, particularly in respect of greenhouse gas emissions.

SEI is charged with implementing significant aspects of government policy on sustainable energy and climate change abatement, including:

- Assisting deployment of superior energy technologies in each sector as required;
- Raising awareness and providing information, advice and publicity on best practice;
- Stimulating research, development and demonstration;
- Stimulating preparation of necessary standards and codes;
- Publishing statistics and projections on sustainable energy and achievement of targets.

It is funded by the Government through the National Development Plan, with programmes part-financed by the European Union.

Energy Policy Statistical Support Unit (EPSSU)

SEI has a lead role in developing and maintaining comprehensive national and sectoral statistics for energy production, transformation and end use. This data is a vital input in meeting international reporting obligations, for advising policy makers and informing investment decisions. Based in Cork, EPSSU is SEI's specialist statistics team. Its core functions are to:

- Collect, process and publish energy statistics to support policy analysis and development in line with national needs and international obligations;
- Conduct statistical and economic analyses of energy services sectors and sustainable energy options;
- Contribute to the development and promulgation of appropriate sustainability indicators.

Highlights

Overall Economy

- Energy efficiency in Ireland improved by 10% (or 0.9% on average per annum) between 1995 and 2007. The cumulative effect of energy efficiency gains between 1995 and 2007 was energy savings of 1.1 Mtoe in 2007.
- Total final consumption of energy would have been 8.4% higher in 2007 but for energy efficiency improvements over the period 1995 to 2007. Final energy consumption was 13,265 ktoe in 2007.
- The efficiency of thermal electricity generation (excluding Wind, Hydro, etc.) was 39% in 1995 and improved to 46% in 2007.

Industry

- Energy efficiency for industry improved by 16% (1.5% per annum) between 1995 and 2007. The cumulative effect between 1995 and 2007 was energy savings of 524 ktoe.
- In the industrial sector, over the period 1995 to 2007 final energy usage increased by 36% (2.6% per annum) to 2,692ktoe.
- Energy intensity (energy use per unit value added) decreased by 47% (5.1% per annum). Two-thirds of this trend was accounted for by structural change in the make up of the industry sector.

Residential

- Energy efficiency for the residential sector improved by 15% over the period 1995 to 2007 (1.3% per annum). The cumulative effect between 1995 and 2007 was energy savings of 539 ktoe.
- Technical energy efficiency of the residential sector improved by 25% (2.4% per annum), implying that significant efficiency gains were made but behavioural effects[1] (for example higher internal temperatures) reduced some of the gains.
- Final energy usage in the residential sector increased by 32% (2% per annum) over the period 1995 to 2007 to 2,918 ktoe.
- Over the same period, average energy use per dwelling decreased by 4% (0.3%) to 22,621 kWh/dwelling.

Transport

- Energy efficiency in the transport sector improved by 1.4% over the period 1995 to 2007. The cumulative effect between 1995 and 2007 was 51 ktoe of energy savings.
- Technical energy efficiency of the transport sector improved by 7.9% (0.9% per annum) over the period 1995 to 2007.
- In the transport sector energy intensity increased by 3% over the period 1995 – 2007. In other words, transport energy use grew faster than the economy.
- Transport energy usage was 5,685 ktoe in 2007, an increase of 138% (8% per annum) on 1995.

Services

- Final energy usage in the services sector increased by 53% (4.0% per annum) over the period 1995 to 2007 to 1,670ktoe while energy intensity decreased by 31% (3% per annum).

International Comparison

- For the period 1995 to 2007 Ireland experienced improvement in energy efficiency of 10% compared with a 9% improvement for the EU-15.
- Ireland recorded the largest improvement in energy efficiency in the residential sector (where sectoral energy efficiency indicators are compared).
- In the industrial sector Ireland achieved the second largest improvement, behind the Netherlands.
- However in the transport sector, Ireland recorded the second lowest improvement in energy efficiency, being placed 12th for the 13 countries compared.
- Ireland recorded the largest per annum reduction in primary intensity over the period 1990 to 2005 for the EU-15 countries and Norway (where data is available). Ireland recorded the second largest reduction in final intensity.

1 Behavioural effects here refer to the energy use resulting from how technologies are used. Behavioural effects can also refer to the choices made in the purchase of more efficient technologies or the improvements to insulation.

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1. Introduction

Energy efficiency is defined as a ratio between an output of performance, service, goods or energy and an input of energy. Essentially improvements in energy efficiency enable achievement of the same result with less energy or achieving an improved performance with the same energy.

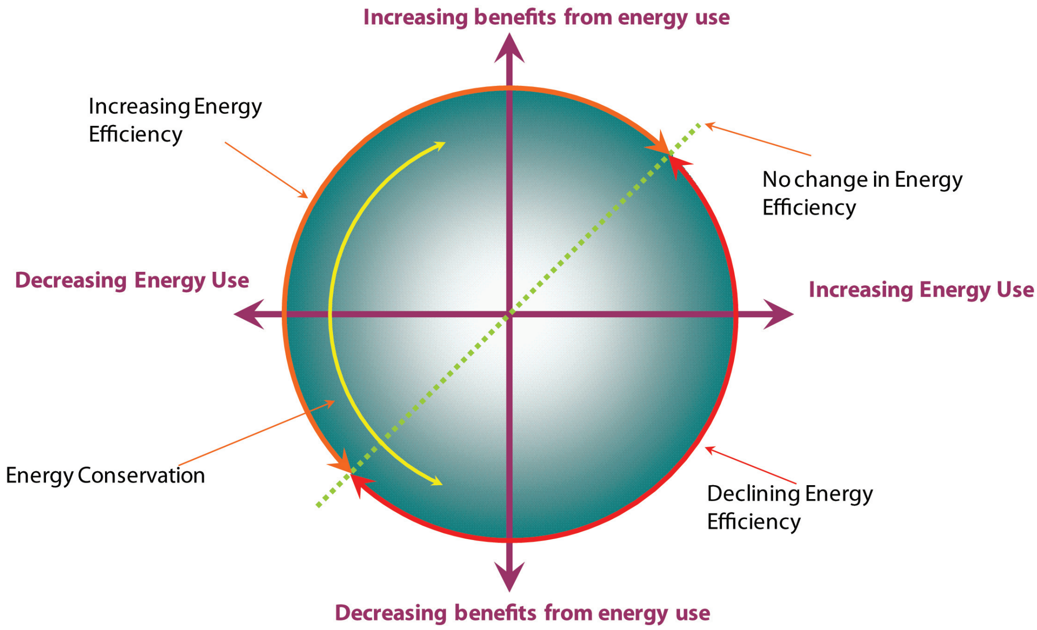
Energy efficiency can contribute to meeting all three goals of energy policy, namely security of supply, competitiveness and protection of the environment through reduced green house gas (GHG) emissions. The economic benefits include direct savings, lower fuel costs and a reduction in the need for investment in supply. Energy efficiency can be achieved through technological, behavioural or economic changes. The International Energy Agency (IEA) regards it as one of the cheapest and most effective means of reducing GHG emissions[2].

Figure 1 shows how energy efficiency relates to energy use and the benefits derived from energy use. The horizontal axis indicates the change in energy use, increasing from left to right. The vertical axis shows the change in benefits derived from the energy use, increasing from bottom to top. The left hand side of the graph corresponds to energy conservation, i.e. a reduction in energy usage. The green dotted line that moves from the bottom left quadrant to the top right quadrant separates the graph into two areas associated with increasing or decreasing energy efficiency. This shows that:

- Energy efficiency can coincide with increasing energy usage (top-right quadrant to the left of the green dotted line), as long as the benefits of energy usage are increasing at a faster rate than the energy.
- Energy conservation does not always result in increasing energy efficiency, when the benefits are decreasing more rapidly than the energy use is (bottom-left quadrant to the right of the green dotted line).

A decline in energy use with increasing benefits (top-left quadrant) always corresponds to increasing energy efficiency.

Figure 1 Explaining Energy Efficiency



Source: Energy Efficiency and Conservation Authority, New Zealand (2006)[3]

Energy efficiency is the sum of a myriad of actions. Potential measures to improve the efficiency with which we use energy exist across all sectors of the economy. They can be considered in terms of *supply side efficiencies* (e.g. in the generation, transmission and distribution of energy sources) and *demand side efficiencies* (e.g. at the point of end-use of energy sources).

Introducing more efficiency power plants, such as combined cycle gas turbine plants (CCGT), in electricity generation has

2 International Energy Agency, 2008, *Worldwide Trends in Energy Use and Efficiency*

3 Available from: www.iea.org/Textbase/work/2006/indicators_apr27/Tromop_New_Zealand.pdf

already increased the efficiency of electricity supply in Ireland by 11 percentage points since 1995. On the demand side, it is estimated that 18% of the world electricity demand is used for lighting[4]. Existing technical improvements in lighting could lead to saving of 40% of the total energy for lighting, such as switching from incandescent light bulbs to compact fluorescent light bulbs (CFLs) or light emitting diodes (LEDs). Purchasing A-rated energy-efficient appliances is another technical change that can lead to large savings in both energy and cost. It is estimated that over the lifetime of an appliance the energy costs of running a device can be up to twice the capital costs[5].

In the built environment insulating attics can lead to savings of 20%[6] in the heating energy required. Savings in the transport sector can be made by increasing the number of users of public transport or in private transport by adopting eco-driving measures such as avoiding over-revving of engines and keeping the tyres at the recommended pressure. It is also estimated that savings of over 40% of the energy used by pumps in industry can be achieved by switching from single-speed to variable-speed pumps[7].

Analysis by the International Energy Agency (IEA) has shown that energy efficiency improvements between 1973 and 2004 enabled IEA economies to use 56% less energy in 2004 than they would have needed for the same level of energy services had those efficiency gains not occurred[8]. That is to say, over the last four decades energy efficiency was the largest energy resource, contributing more to energy services than any single fuel. Thus energy efficiency offers a powerful and cost-effective tool for limiting energy demand. This is the reason why energy efficiency is now described by many as the 'fuel of choice'.

The analysis in this report has benefited greatly from SEI/EPSSU's involvement in the pan-European ODYSSEE project[9]. The project was set up in 1993 through a joint collaboration between ADEME, the SAVE programme of the General Directorate of the European Commission in charge of energy and all energy-efficiency agencies in the EU-15 and Norway. The primary objective of the project was to develop indicators of energy efficiency. The collection and improvement of data relating to energy usage drivers, energy efficiency and CO_2-related indicators were later added to the objectives. The ODYSSEE project is co-ordinated by ADEME, with the technical support of ENERDATA[10] and the Fraunhofer Institute for Systems and Innovation Research[11].

A key development in the ODYSSEE project has been the formulation of a new set of energy-efficiency indicators, known as ODEX. ODEX indicators provide an alternative to the usual energy intensities used to assess energy-efficiency changes at the sectoral or economy level, as they include factors only related to energy-efficiency and exclude changes in energy use due to other effects such as climate fluctuations, changes in economic and industry structures, lifestyle changes, etc.

This report also draws on a doctoral research project at University College Cork, funded by SEI, on modelling energy efficiency in industry. One part of this research compares the different approaches to measuring energy efficiency in industry. The results were presented at a recent ODYSSEE meeting[12]. In this way, Ireland is now more actively contributing to the development of energy-efficiency indicators, in addition to applying the methodologies in Ireland.

This is the second SEI/EPSSU report that focuses exclusively on energy efficiency in Ireland. The purpose of the report is to provide timely and comprehensive data on energy efficiency and intensity, in order to provide context and background to discussions on future policy options. It may also in time provide the basis for reporting progress on energy efficiency towards meeting Irish and European targets.

The structure of this report is as follows:

- The international, European and Irish policy landscape is examined in **section 2.**

4 International Energy Agency, 2006, *Lights Labour Lost –Fact Sheet.*

5 International Energy Agency, 2006, *Can Energy-efficient Electrical Goods be considered "Environmental Goods"?* Available at www.iea.org/Textbase/publications/free_new_Desc.asp?PUBS_ID=1810

6 www.sei.ie/Your_Home/Energy_Saving_Tips/Heating_Insulation_Tips/

7 International Energy Agency, 2007, *Tracking Industrial Energy Efficiency and CO_2 Emissions*.

8 International Energy Agency, 2008, *Worldwide Trends in Energy Use and Efficiency.*

9 www.ODYSSEE-indicators.org/

10 www.enerdata.fr/enerdatauk/

11 www.fraunhofer.de

12 Cahill C. and Ó Gallachóir B. P., 2008, *Evaluating the effectiveness of ODEX in measuring true energy efficiency achievements: Case study Irish Industry.* Presentation to EU – ODYSSEE Workshop Nov 6 2008 Prague.

- To provide context for the analysis, recent trends in energy usage are discussed in **section 3**.
- **Section 4** examines energy efficiency and intensity at the economy level.
- Energy efficiency and intensity are analysed at the sub-sectoral level for industry, residential, transport and services, respectively, in **sections 5 to 8**.
- **Section 9** looks at monitoring the progress of measuring energy efficiency.
- In **section 10** trends in Ireland are compared with trends internationally.
- Finally, **section 11** presents conclusions and outlines the next steps required to expand the available statistics and to shed further light on the trends.

The national energy balance data presented in this report are the most up-to-date at the time of writing. Balance data are updated whenever more accurate information is known. To obtain the most up-to-date balance figures, visit the statistics publications section on Sustainable Energy Ireland's website. An energy data service is available at www.sei.ie/statistics (follow the links for Energy Statistics Databank). This service is hosted by the Central Statistics Office with data provided by SEI.

Feedback and comment on the report are welcome and should be addressed by post to the address on the back cover or by email to epssu@sei.ie.

2. Energy Efficiency – the Policy Context

2.1 International Policies

International Energy Agency (IEA) analysis of energy efficiency identifies best practice, highlighting the possibilities for improvements and policy approaches to realise the full potential of energy efficiency for member countries. The IEA identified 25 energy-efficiency policy measures[13] which cover all major energy end-uses and have the potential to reduce global energy demand by 20% by 2030, were all economies to adopt them.

At the last 2008 G8 summit in Hokkaido, Japan, G8 leaders committed themselves to maximising their implementation of 25 energy-efficiency policy measures recommendations. The policy measures suggested range across technology in buildings, appliances, transport and industry, as well as end-use applications such as lighting and cross-sectoral policy measures. IEA member countries (including Ireland) will report on the progress of implementing the recommended 25 energy-efficiency policy measures in 2009.

2.2 European Policies

Energy efficiency is currently the subject of significant policy activity in both Ireland and Europe. **An Energy Policy for Europe**[14] specified a target of saving 20% of the European Union's (EU's) energy consumption compared to projections for 2020. This has formed a key ingredient in the **EU Energy and Climate Change Package** agreed at the European Council in December 2008, (i.e. 20% efficiency improvement, 20% renewable energy penetration and 20% greenhouse-gas emissions reduction by 2020). This target is not currently binding and a method for calculating the national targets has not yet been finalised by the European Commission (EC) but Ireland has reflected this commitment by adopting a national 20% target.

The **EU Energy Services Directive (ESD)** [15] sets an indicative target for Member States to achieve a 1% per annum energy-efficiency improvement, resulting in a cumulative target of a 9% improvement in energy efficiency by 2016. The ESD is an overarching directive that seeks to promote cost-effective energy efficiency in the EU member states through various promotional, awareness and support measures and through the removal of institutional, financial and legal barriers. Unlike the 2020 energy-efficiency target, the ESD target excludes energy used by enterprises involved in the EU Emissions Trading Scheme (ETS)[16] and also international aviation.

Since the last Energy Efficiency in Ireland report[17], the European **Energy Performance of Buildings Directive (EPBD)**[18] has been adopted into Irish law as Statutory Instrument (S.I. No. 666 of 2006). This is a cross-sectoral measure encompassing energy efficiency in the built environment as a whole. This directive includes a common methodology for calculating the integrated energy performance of buildings; minimum standards on the energy performance of new buildings and existing buildings that are subject to major renovation; systems for the energy certification of new and existing buildings and for public buildings; regular inspection of boilers and central air-conditioning systems in buildings and an assessment of heating installations in which the boilers are more than 15 years old.

As part of the EPB Directive, a **Building Energy Rating**[19] (BER) certificate, which is effectively an energy label, is now required at the point of sale or rental of a building, or on completion of a new building. Since January 2009 this labelling system applies to existing buildings as well as new domestic and non-domestic buildings in Ireland.

A European **Combined Heat and Power (CHP)** Directive[20] to promote the on-site generation of power and use of the associated heat produced was approved in 2004. CHP is promoted due to the improved efficiencies and reduced emissions

13 International Energy Agency, 2008, *25 Energy Efficiency Policy Recommendations by IEA to G8*
14 Commission of the European Communities, 2007, *An Energy Policy for Europe*.
15 Commission of the European Communities, 2006, Directive 2006/32/EC on Energy End Use Efficiency and Energy Services Directive http://eurlex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&lg=en&type_doc=Directive&an_doc=2006&nu_doc=32
16 European Union Emissions Trading Scheme *http://ec.europa.eu/environment/climat/emission/index_en.htm*
17 Sustainable Energy Ireland *Energy Efficiency in Ireland 2007 Report* www.sei.ie/Publications/Statistics_Publications/EPSSU_Publications/Energy_Efficiency_in_Ireland_2007/EPSSU_Energy_Efficiency_Report_2007Fnl.pdf
18 Commission of the European Communities, 2002 and recast 2008 Energy Performance of Buildings Directive www.ec.europa.eu/energy/strategies/2008/doc/2008_11_ser2/buildings_directive_proposal.pdf
19 Building Energy Rating www.sei.ie/Your_Building/BER/
20 Commission of the European Communities, 2004, *Combined Heat and Power (Co-generation) Directive (2004/8/EC)*. Available at: www.eurlex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&lg=en&type_doc=Directive&an_doc=2004&nu_doc=8

compared to conventional separate electricity and heat generation. Since the introduction of this Directive, Irish governments have provided funding for a CHP deployment programme including micro-CHP, as well as price support mechanisms for the electricity generated from CHP and the commitment to remove regulatory barriers to the deployment of CHP and district heating

Ireland is also committed to implementation of the following EU Directives (proposed and extant) relating to the **energy efficiency of products**[21]:

- Eco-design of Energy-Using Products Directive (2005/32/EC) – to set minimum energy performance standards for a broad range of energy usage and related technologies;
- Energy Labelling of Domestic Appliances Directive (2003/66/EC) – to ensure the provision of consistent, detailed information to consumers on the energy use of domestic appliances;
- Proposal for a Directive on the indication, by labelling and standard product information, of the consumption of energy and other resources by energy-related products;
- Proposal for a Directive of the European Parliament and of the Council on labelling of tyres with respect to fuel efficiency and other essential parameters.

2.3 Irish Policies

The Government of Ireland sets out in the 2007 **Government White Paper**, *Delivering a Sustainable Energy Future for Ireland*[22], a target for a 20% improvement in energy efficiency across the whole economy by 2020. The White Paper also states an ambition to surpass the EU target of 20% with an indicative target of 30% energy efficiency by 2020. The public service is to take an exemplar role in energy efficiency, with an energy savings target of 33% by 2020.

A draft **National Energy Efficiency Action Plan (NEEAP)** was released for public consultation in October 2007 and the finalised version is due in 2009. The plan details the current package of energy-efficiency policies and measures that will contribute to both the national 20% savings target for 2020, and the EU ESD 9% energy-savings target for 2016.

In fulfilling its requirements under the ESD, the Irish Government submitted its first Energy Efficiency Action Plan to the European Commission in September 2007[23]. Subsequent plans are due in 2011 and 2014 to further detail Ireland's progress toward the ESD target of 9% savings by 2016.

New building regulations[24] (Technical Guidance Document L - Conservation of Fuel and Energy) came into effect on the 1st July 2008. The goal of the new standards is to reduce energy requirements by 40% in new dwellings, depending on the type and size of the dwelling. Since March 31st 2008, when installing a replacement oil or gas boiler it is now a requirement that the boiler be condensing, where practical (Section L3, Building Regulations Part L amendment – S.I. No. 847 of 2007).

In 2007 the Government introduced changes to **Vehicle Registration Tax**[25] (VRT) and annual motor tax for new cars registered on or after 1st July 2008. Both taxes for new registered cars are now calculated on the basis of carbon dioxide (CO_2) emissions from vehicles. Initial indications are that, in the short term at least, purchasing behaviour has altered towards buying lower CO_2 vehicles, which are also more energy-efficient.

The **2008 Finance Bill provides relief for hybrid, electric and flexible-fuel vehicles** of up to €2,500 for cars registered between 1st July 2008 and 31st December 2010 on the VRT payable, in addition to the benefit of the new VRT CO_2 emission-related system.

The Government has assigned the public sector an exemplar role in improving energy efficiency due to its significant size and its considerable purchasing power. The **Public Sector Programme** promotes energy-efficient design, technologies and services in new and retrofit public-sector projects. These projects are excellent examples of good practice and a demand leader for the services and technologies involved. The programme has three main elements:

21 Details available at: www.europa.eu/scadplus/leg/en/s14003.htm
22 The full text of the White Paper is available at http://www.dcmnr.gov.ie/Energy/Energy+Planning+Division/Energy+White+Paper.htm.
23 Available at: http://ec.europa.eu/energy/efficiency/end-use_en.htm
24 Building Regulations (Part L Amendment), 2008, www.environ.ie/en/Legislation/DevelopmentandHousing/BuildingStandards/FileDownLoad,17840,en.pdf
25 Vehicle Registration Tax, www.environ.ie/en/LocalGovernment/MotorTax/

- A **Design Study Support Scheme** which provides support for professional expertise to examine the technical and economic feasibility of design and technology solutions;
- A **Model Solutions Investment Support Scheme** which supports energy management and technology solutions in existing buildings and new build specifications;
- An **Energy Management Bureau** which supports outsourced energy management services to report on energy usage and identify energy-related projects.

2.4 Sustainable Energy Ireland Programmes

Other energy-efficiency programme activities include a **pilot Home Energy Savings Scheme,** introduced in 2008 to reduce energy and CO_2 emissions from the existing housing stock. The subsequent full national **Home Energy Saving Scheme**[26] was launched on 8th February 2009, with a budget of €50 million in 2009. The scheme is expected to support the upgrade of at least 25,000 homes.

Sustainable Energy Ireland also operates a number of key energy efficiency programmes for businesses, including:

- The **Large Industry Energy Network**[27] **(LIEN)** for the largest industrial energy consumers in Ireland. The LIEN is developing a set of role-model companies to demonstrate better energy management:
- The **Energy Agreement** programme for industry, based on the Irish energy management standard **IS 393**[28];
- **SEI's service for small and medium enterprises (SME's)**, which offers energy advice, assessment and monitoring, with the aim of cutting their energy use by 20%;
- The **Accelerated Capital Allowance**[29] (ACA) scheme introduced in the Finance Act 2008. This scheme enables businesses to write off the entire cost of a specified set of energy efficient motors, lighting and building energy-management systems in the first year of purchase;
- The **Combined Heat and Power Deployment Scheme** which provides grant support to assist the deployment of small-scale (<1MWe) fossil fired CHP and biomass (anaerobic digestion and wood residue) CHP systems.

A complete list of all the existing and committed to measures that will contribute towards meeting Ireland energy-efficiency targets is contained in the National Energy Efficiency Action Plan (NEEAP). The document is discussed in section 9. The complete list of Sustainable Energy Ireland's energy-efficiency programmes is available on the SEI website www.sei.ie.

26 Sustainable Energy Ireland Home Energy Savings Scheme: www.sei.ie/Grants/Home_Energy_Saving_Scheme/
27 Large Industry Energy Network: www.sei.ie/Your_Business/Large_Industry_Energy_Network/
28 Energy Management System, I.S. 393 (2005): www.sei.ie/Your_Business/Energy_Agreements/IS393_Energy_Management_System/
29 Accelerated capital allowance scheme: www.sei.ie/Your_Business/Accelerated_Capital_Allowance/

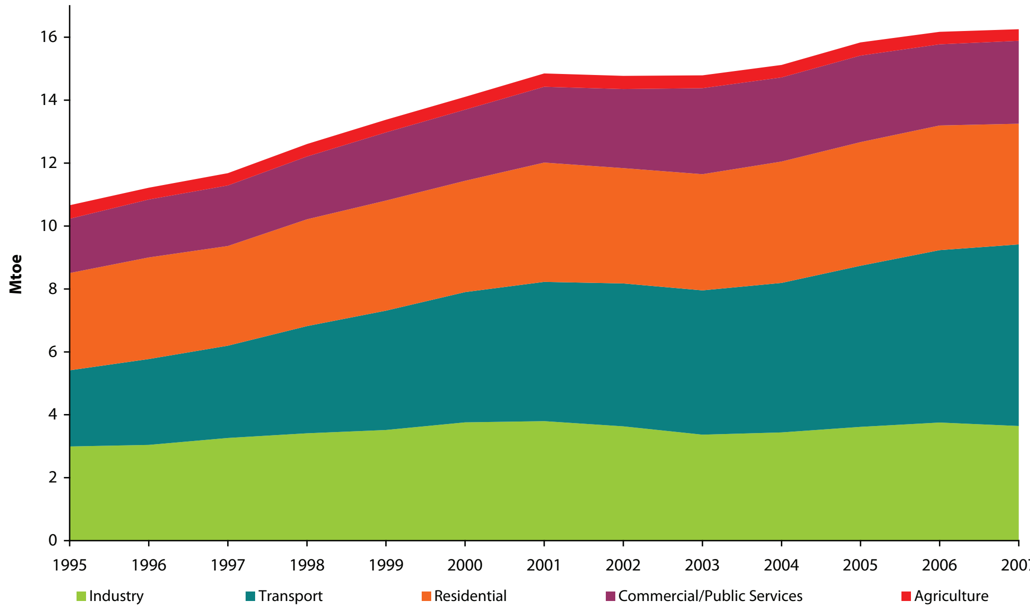
3. Energy Trends

This section provides a brief overview of energy trends in Ireland to provide context and background to the analysis of energy efficiency. A detailed analysis of energy trends over the period 1990 to 2007 is available in a separate SEI publication[30]. In this report, 1995 is used as the base year as energy-efficiency indicator data is only available from that year onwards.

3.1 Primary Supply

The amount of energy used in Ireland in a given year is defined as the total primary energy requirement (TPER). This is the measure used to discuss changes to Ireland's energy supply. Figure 2 shows the TPER[31] of the five principal sectors of the economy in Ireland for the period 1995 to 2007. The average annual growth rate in energy usage during this period was 3.6%. Total growth over the period was 53%. Table 1 presents growth rates of shares of the different sectors over the period.

Figure 2 Total Primary Energy Requirement by Sector 1995 – 2007



Source: SEI

Table 1 Growth Rates and Shares of TPER by Sector

	Growth %	Average annual growth rates%					Shares %	
	'95 – '07	'95 – '07	'95 – '00	'00 – '05	'05 – '07	2007	1995	2007
Industry	21.7	1.7	4.7	-0.8	0.4	-2.9	28.1	22.4
Transport	138.6	7.5	11.3	4.4	6.1	5.3	22.7	35.5
Residential	24.0	1.8	2.8	2.1	-1.2	-3.2	29.0	23.6
Commercial / Public	52.7	3.6	5.5	4.1	-2.1	2.3	16.2	16.2
Agriculture	-14.9	-1.3	-1.0	0.5	-6.7	-7.8	4.0	2.2
Total	52.5	3.6	5.5	2.7	1.1	1.4		

Source: SEI

3.2 Energy Demand

Final energy demand is a measure of the energy delivered to energy end users in the economy to undertake activities as diverse

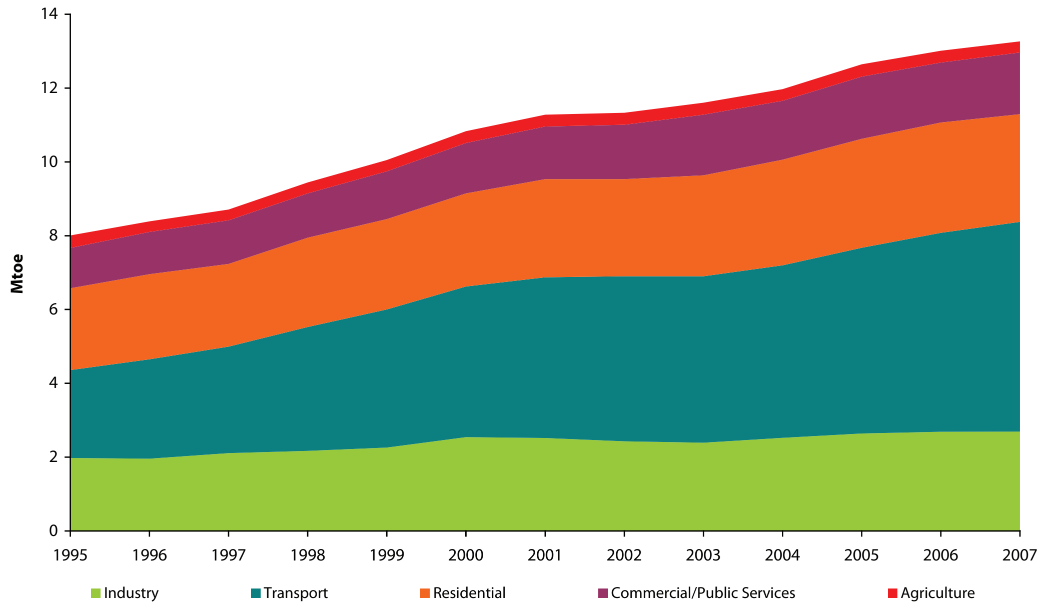
30 SEI ,2007, *Energy in Ireland 1990–2007, 2008 Report*. Available from: www.sei.ie/Publications/Statistics_Publications/Energy_in_Ireland/Energy_in_Ireland_1990-2007.pdf.

31 Primary energy usage includes all the fuels used directly by each sector plus the primary energy used to generate electricity attributed to each sector in proportion to its electricity demand.

as manufacturing, movement of people and goods, essential services and other day-to-day energy requirements of living. This is also known as Total Final Consumption (TFC) and is essentially total primary energy less the quantities of energy required to transform sources such as crude oil into forms suitable for end-use consumers such as refined oils, electricity, patent fuels [32], etc. (Transformation, processing or other losses entailed in delivery to final consumers are known as 'energy overhead').

Figure 3 shows the trend in TFC over the period, here allocated to each of the sectors of the economy. The changes in growth rates are tabulated in Table 2.

Figure 3 Total Final Energy Consumption by Sector 1995 – 2007



Source: SEI

Transport has continued to increase its dominance (since the mid-1990s) as the largest energy-consuming sector (on a final energy basis) with a share of 43%. The share of industry and residential have decreased. It is worth noting that transport final energy use is larger than that of both industry and commercial/public services combined.

Table 2 Growth Rates and Shares of TFC by Sector

	Growth %	Average annual growth rates %					Shares %	
	'95 – '07	'95 – '07	'95 – '00	'00 – '05	'05 – '07	2007	1995	2007
Industry	36.1	2.6	5.2	0.8	0.9	0.1	24.7	20.3
Transport	138.4	7.5	11.3	4.3	6.3	5.5	29.8	42.9
Residential	31.7	2.3	2.6	3.2	-0.6	-2.4	27.7	22.0
Commercial / Public	53.3	3.6	4.6	4.2	-0.4	3.0	13.6	12.6
Agriculture	-11.5	-1.0	-1.4	1.2	-5.4	-6.5	4.2	2.3
Total	65.7	4.3	6.2	3.1	2.4	1.9		

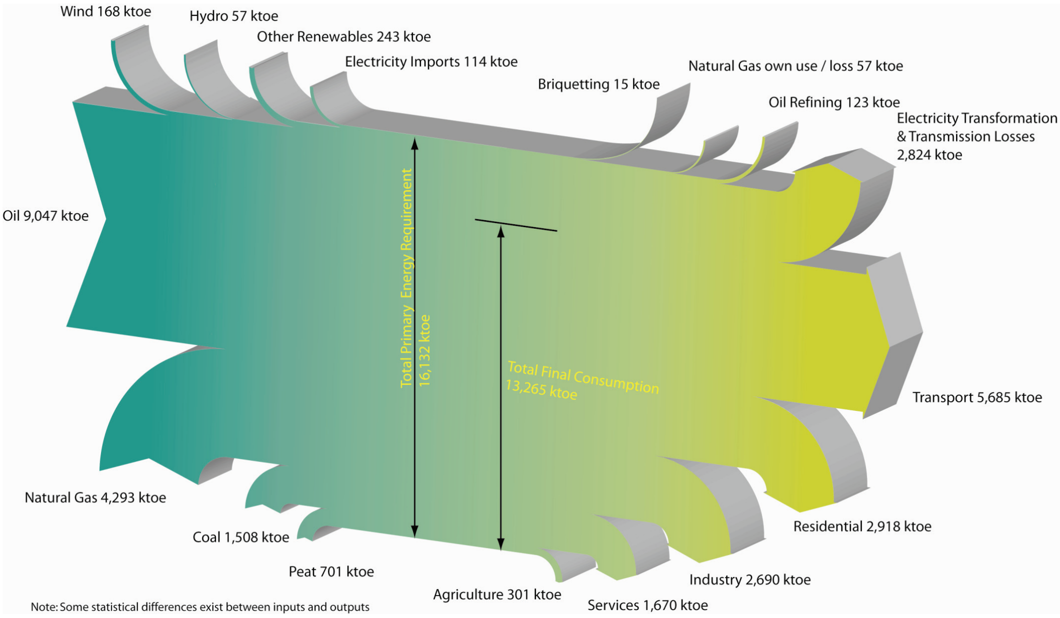
Source: SEI

3.3 Energy Balance for 2007

Figure 4 shows the energy balance for Ireland in 2007 as a flow diagram. Primary fuel inputs are shown on the left while TFC outputs, by sector, are illustrated to the right. Figure 4 illustrates clearly the significance of each of the fuel inputs as well as showing how much energy is lost in transformation.

32 Patent fuel is a composition fuel manufactured from hard coal fines with the addition of a binding agent.

Figure 4 Energy Flow in Ireland 2007[33]



Source: SEI

Oil dominates as a fuel, accounting for 56% of the total requirement. Oil consumption decreased by 0.8% in 2007. Almost two-thirds of the total oil consumption is used in the transport sector. Renewables energy supply is disaggregated into wind, hydro and other renewables.

Transport continues to be the largest of the end-use sectors, using 43% of the final energy demand in Ireland in 2007. Transport also experienced the highest final consumption growth (5.5%) in 2007. Losses associated with the transformation of primary energy to electricity were 18% of TPER or 2824 ktoe in 2007.

33 All energy inputs shown here represent the sum of indigenous production plus, where applicable, net imports i.e. imports minus exports.

4. Energy Intensity and Efficiency – Economy Level

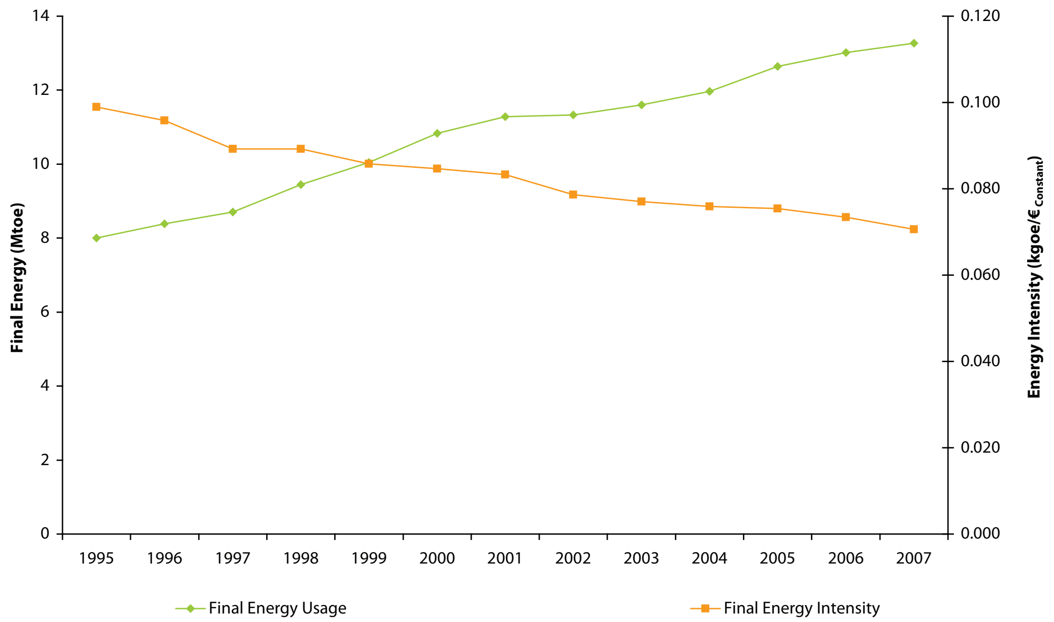
4.1 Energy Efficiency Intensities

Energy intensity is defined as the amount of energy required to produce some functional output. It represents the inverse of energy productivity. In the case of the economy, the measure of output is generally taken to be gross domestic product (GDP[34]). GDP measured in constant prices is used to remove the influence of inflation.

Figure 5 graphs final energy usage and final energy intensity over the period 1995 to 2007 for the economy as a whole. Final energy usage increased by 66% (4.3% per annum on average) to 13,265 ktoe while final energy intensity decreased by 29% (2.8% per annum on average) to 71 goe /$€_{2006}$[35]. Note that falling energy intensity equates to increasing energy productivity.

Examining these metrics in isolation implies that a significant improvement in energy productivity has occurred over the period. This reduction in energy intensity, however, is due to a number of factors contributing to how the trends in energy intensities evolve. These factors may be, inter alia, technological efficiency, behavioural effects, fuel mix, economies of scale and changes in the structure of the economy. In Ireland, economic structure has changed considerably over the past twenty years. There has been a shift from energy-intensive industries, such as fertiliser and steel production, to the high value-added sectors such as pharmaceuticals, electronics and commercial services. In general, these sub-sectors are less energy-intensive than traditional manufacturing industries. (The industry sector is examined in more detail in section 5.)

Figure 5 Final Energy Usage and Intensity 1995 – 2007



Source: SEI

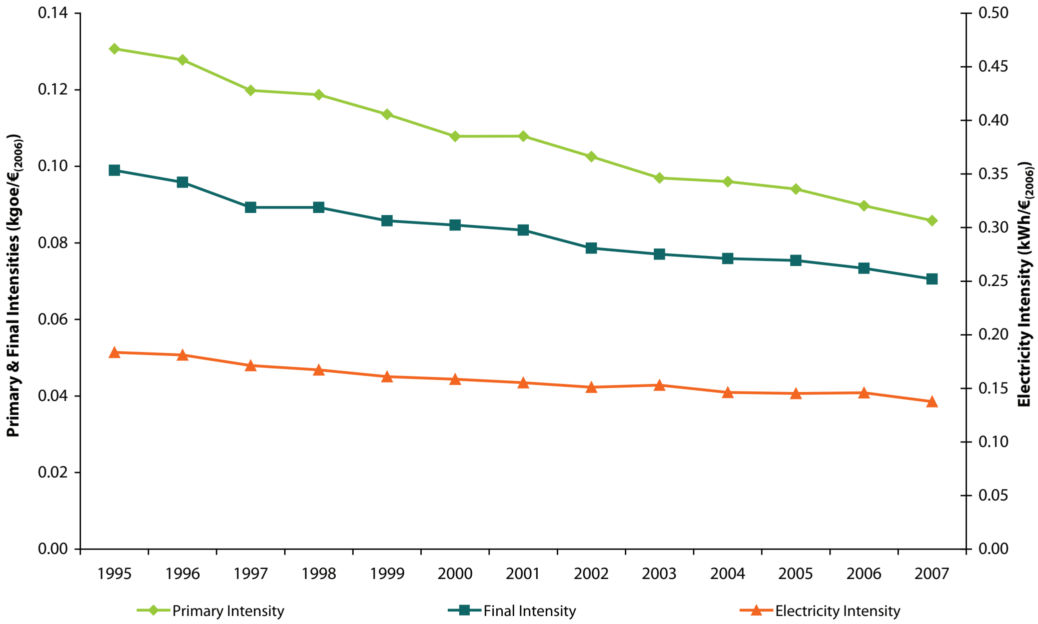
Energy intensity will continue to show a decreasing trend if, as expected, the economy continues to move away from low value-added, high energy-consuming sectors to one that is dominated by high value-added, low energy-consuming sectors. This results in a more productive economy from an energy perspective but does not necessarily mean that the processes used have become more energy-efficient. The improved energy productivity is likely to be adversely affected by the current economic downturn in the Irish economy.

34 It can be argued that, in Ireland's case, gross national product (GNP) should be used to address the impacts due to the practice of transfer pricing by some multinationals. The counter argument is that energy is used to produce the GDP and by using GNP some of the activity would be omitted. The practice internationally is to use GDP, so for comparison purposes it is sensible to follow this convention.

35 Intensity as measured by the ratio of final energy usage to GDP in constant 2006 money value. This is expressed as kilograms of oil equivalent per euro of GDP (kgoe /$€_{2006}$).

Figure 6 shows the primary and final energy, and electricity intensities of the economy They have all been falling (improving in terms of energy productivity) since 1990.

Figure 6 Primary, Final and Electricity Intensity



Source: SEI

The primary energy intensity of the economy fell by 34% between 1995 and 2007 (3.4% per annum). In 1995 it required 131 grams of oil equivalent (goe) to produce one euro of GDP (in constant 2006 values), whereas in 2007 just under 86 goe was required. Final energy intensity fell by 29% over the period.

The difference between primary and final energy intensity reflects the amount of energy required in the transformation from primary energy to final energy – largely used for electricity generation. Throughout the late 1990s, there has been a slight convergence of these trends, particularly since 1997, mostly reflecting the increasing efficiency of the electricity generation sector. The recent improvement in the transformation sector is evident from 2001 onwards, when primary intensity fell at a faster rate than final intensity. The decrease in primary intensity since 2001 was 20% whereas for final intensity the decrease was 15%.

Final electricity intensity of the economy has not been falling as fast as primary or final energy intensities. Over the period 1995 to 2007, the period for comparison with the energy-efficiency index, the electricity demand per unit of GDP fell by 24%. This is attributed to the shift towards increased electricity consumption in energy end use. While electricity consumption increased by 74% since 1995, final energy demand increased by 66%.

The efficiency of electricity supply, shown in Figure 7, is defined as the final consumption of electricity divided by the fuel inputs required to generate this electricity, expressed as a percentage. The inputs (denominator) include renewable sources and imports. The final consumption (numerator) excludes the generation plant's 'own use' of electricity as well as transmission and distribution losses.

Figure 7 Efficiency of Electricity Supply 1995 – 2007

Source: SEI

Newer transformation units coming on stream, such as combined cycle gas turbine generators (CCGT), tend to be of higher efficiency. This has contributed to increasing the aggregate efficiency of the transformation process. In August 2002, the 392 MW Dublin Bay Power CCGT plant was commissioned, thus improving 2002 generating efficiency. Huntstown's 343 MW CCGT plant also contributed from late 2002. These developments had full effect in 2003, with both plants operational all year. In addition, increasing contributions from renewable sources, imports and the closure of old peat-fired stations have increased the efficiency of electricity supply and helped bring the trends in primary and final energy intensity (Figure 6) closer together.

There was an increase in electricity supply efficiency from 42% in 2006 to 45% in 2007, due largely to the commissioning of two further CCGT plants – Tynagh (384 MW) in 2006 and Huntstown 2 (401 MW) in 2007 – and the increase in renewable electricity. Renewables contributed 9.4%[36] of Ireland's gross electricity in 2007. Combined heat and power plants (CHP) contributed 6.2% of Ireland's gross electricity in 2007. The CHP contribution also increased significantly in 2006 due to the commissioning of the Aughinish Alumina 160MW_e plant.

Figure 8 shows the efficiency of thermal electricity generation. This relates only to combustible fossil fuels. The thermal efficiency is calculated as the total electricity generated from fossil fuels divided by the total fossil-fuel input to electricity generation. The efficiency in this case was 39% in 1995 and improved to 46% in 2007. There was a decrease in the efficiency gains in 2005 due to a decrease in gas generation that year, with a resulting increase in coal and peat generation.

36 SEI, 2008, *Renewable Energy in Ireland 2008 Report*. Available from: www.sei.ie/Publications/Statistics_Publications/SEI_Renewable_Energy_2008_Update/Renewable%20Energy%20Update%202008.pdf

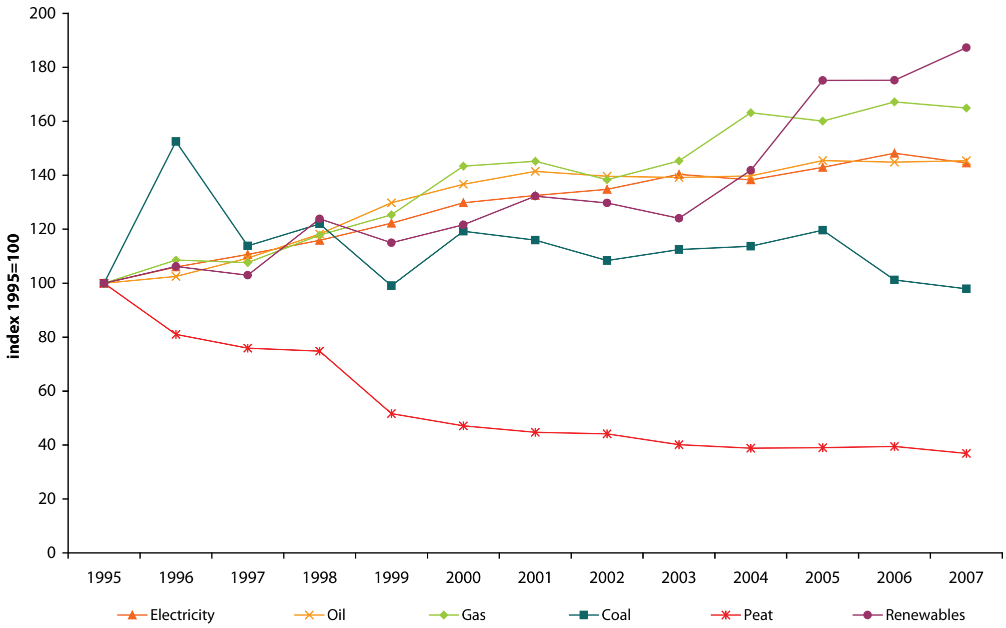
Figure 8 Efficiency of Thermal Electricity Generation 1995 – 2007

Source: SEI

Another often quoted indicator is per capita energy usage. Over the period 1995 to 2007 total final energy usage per capita increased by 38% (2.7% per annum on average) to 36 MWh/capita. Figure 9 shows the trend for a number of fuels for the same period. The fuel consumption per capita is indexed to the consumption in 1995. The actual values of the final consumption per capita as well as growth rates are given in Table 3.

Renewables recorded the largest per capita increase (in relative terms) with an increase of 87% (5.4% per annum) followed by gas (65%, 4.3% per annum), oil (45%, 3.2% per annum) and electricity (45%, 3.1% per annum). Over the same period, per capita final usage of peat declined by 63% (80% per annum) while use of coal declined by 2% (0.2% per annum).

Figure 9 Final Consumption per Capita 1995 – 2007



Source: SEI and CSO

Table 3 Growth Rates and Values of Final Consumption per Capita 1995 – 2007

	Growth %	Average annual growth rates %					kgoe/capita	
	'95 – '07	'95 – '07	'95 – '00	'00 – '05	'05 – '07	2007	1995	2007
Electricity	45	3.1	5.4	1.9	0.6	-2.5	0.36	0.51
Oil	45	3.2	6.4	1.3	-0.02	0.4	1.36	1.98
Gas	65	4.3	7.5	2.2	1.5	-1.4	0.22	0.37
Coal	-2	-0.2	3.6	0.1	-9.5	-3.3	0.09	0.09
Peat	-62	-8.0	-14.0	-3.7	-2.8	-6.6	0.17	0.06
Renewables	87	5.4	4.0	7.6	3.4	6.9	0.03	0.05
Total Final Energy	38	2.7	5.1	1.4	-0.1	-0.5	2.3	3.1

Source: SEI

As mentioned, energy intensity expressed as energy use related to economic output is an aggregated indicator (with units kgoe /$€_{2006}$) and variation may be a result of many factors such as economic, structural, technical, behavioural issues and/or because real energy-efficiency gains have been made.

4.2 Energy Efficiency Indicators

To better understand the trends and to clarify the role of the energy-related factors, an approach focusing on techno-economic effects is required to clean or remove changes due to macro-economic or structural effects[37]. This type of analysis has been developed since 1993 through the ODYSSEE[38] project, which includes Irish involvement through SEI/EPSSU. A set of indicators have been developed which measure achievements in energy efficiency at the level of the main end-uses.

The indicators developed include ODEX indicators which are referenced in the Energy End-Use Efficiency and Energy Services Directive (ESD)[39]. The ODEX indicators are innovative compared to similar indices as they aggregate trends in unit consumption by sub-sector or end-use into one index per sector based on the weight of each sub-sector/end-use in the total energy

37 Bosseboeuf D. et al, 2005, *Energy Efficiency Monitoring in the EU-15*, published by ADEME and the European Commission. Available from: www.ODYSSEE-indicators.org

38 For full details of the project go to www.ODYSSEE-indicators.org

39 See www.ec.europa.eu/energy/demand/legislation/end_use_en.htm for details and a copy of the Directive.

consumption of the sector. The sectoral indicators can then be combined into an economy-wide indicator.

Top-down energy-efficiency indices (including ODEX) provide an alternative to the usual energy intensities used to assess energy-efficiency changes at the sectoral level or at the level of the whole country. This is because these indices include effects related only to energy efficiency. It is important to note that ODEX indicators only provide measurement of the gross energy savings realised within a sector or type of end-use. In addition to savings that result from energy-efficiency policies and measures, these savings include a number of factors – for example, price effects and autonomous progress[40]. They exclude the changes in energy use due to other effects (such as climate fluctuations, changes in economic and industry structures, lifestyle changes, etc) at the economy or sectoral level.

Savings calculated using ODEX are data-rich but not linked to specific measures and are an example of a 'top-down' approach in the ESD whereas aggregating savings from individual policy measures is an example of a 'bottom-up' approach. An alternative approach is to track energy savings associated with individual measures and aggregate them to calculate overall energy savings. This latter, bottom-up, approach requires ex-ante and ex-post analyses of measures and will require data on energy use by households or companies targeted by specific measures.

The savings calculated by the two different methods won't necessarily yield the same results, but both provide useful insights into energy savings due to energy-efficiency improvement measures and trends. Two EU projects, MURE[41] and EMEES[42], have focused on the two approaches and it is an area that is at an early stage of development in Ireland[43][44][45].

Data is not available to create an ODEX indicator for the services sector in Ireland, so the overall economy-wide indicator consists of just three sectors: the industry, residential and transport sectors. The residential and transport ODEX are combined with an index for industrial intensity at constant structure[46] in this report in order to calculate an economy-wide top-down[47] energy-efficiency indicator for Ireland. The overall energy-efficiency index is calculated in this manner due to a methodological question about the suitability of the industrial ODEX calculation for Ireland. (This methodological question is discussed further in section 5.)

Figure 10 presents both the observed and technical energy efficiency indicators for Ireland for the period 1995 to 2007.

40 Bosseboeuf D., Lapillonne Dr B., Desbrosses N., 2007, *Top Down Evaluative Methods for Monitoring Energy Savings,* EMEEES European Expert Group Meeting, La Colle-sur-Loup

41 MURE (Mesures d'Utilisation Rationnelle de l'Energie). www.mure2.com/

42 EMEEES (Evaluation and Monitoring for the EU Directive on Energy End-Use Efficiency and Energy Services): www.evaluate-energy-savings.eu/emeees/en/home/index.php

43 Hull D., Ó Gallachóir B. P. and Walker N., 2009, *Development of a modelling framework in response to new European energy efficiency regulatory obligations: the Irish experience*. Energy Policy (In review).

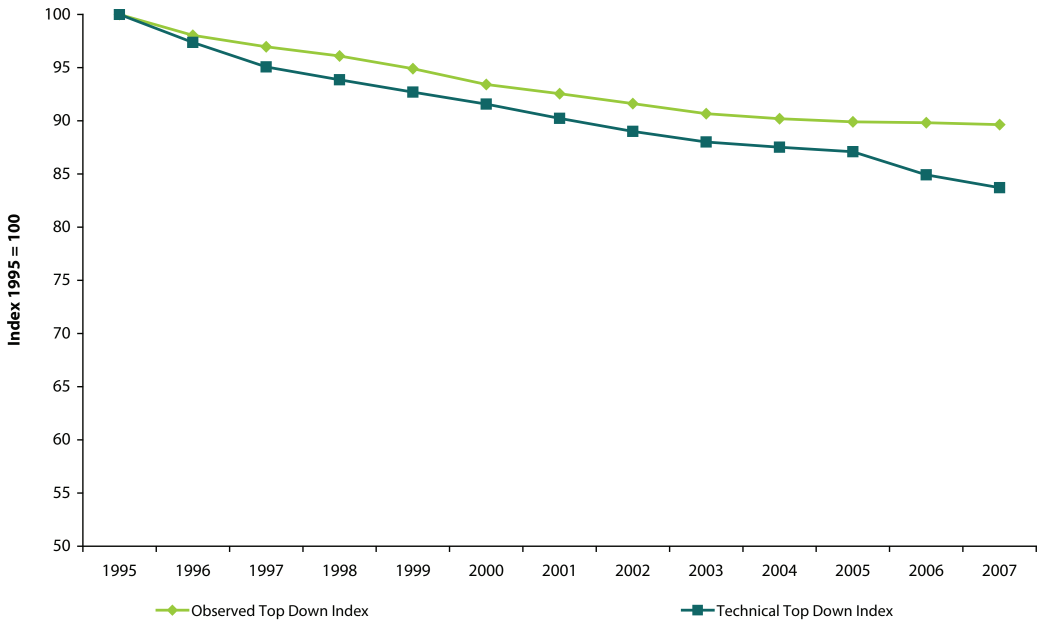
44 Rogan F., 2009, *Improving Ireland's National Energy Efficiency Action Plan – A Sensitivity, Ex-Ante & Ex-Post Analysis of Specific Measures.* MEngSc Preliminary Research Report, UCC.

45 Dineen D., 2008, Energy Efficiency in the Residential Sector 1990 – 2020. MEngSc Minor Thesis, UCC.

46 Cahill C. and Ó Gallachóir B. P., 2009, *Comparing the use of ODEX indicators with Divisia decomposition analysis to measure true energy efficiency achievements: Case study Irish industry*. Proceedings of European Council for an Energy Efficient Economy (ECEEE) Summer School 1–6 June 2009, Côte d'Azur, France.

47 The amount of energy savings is calculated using national or larger-scale aggregated sectoral levels of energy savings as the starting point.

Figure 10 Ireland Energy Efficiency Indices 1995 – 2007



Source: SEI

The observed index shows that between 1995 and 2007 there was a 10% (0.9% per annum on average) decrease, which indicates a 10% improvement in energy efficiency. To separate out the influence of behavioural factors, a technical index is calculated and used to better assess the technical energy-efficiency progress. As shown in Figure 10, technical efficiency improved by 16% (1.5% per annum) from 1995 to 2007.

Technical efficiency gains arise from the use of more energy-efficient technologies whereas behavioural gains are the result of how technologies are used. The difference between the observed and technical indicators is the influence of behavioural effects, i.e. Ireland would have achieved the greater improvement in energy efficiency but for the increases in energy usage due to behaviour. It is important to note that behavioural effects can also be beneficial – for example, the purchase of more efficient technologies or improvements in insulation.

Note that the top-down energy-efficiency index indicators are calculated as a three year moving average to avoid short-term fluctuations due, for example, to imperfect climatic corrections, behavioural factors, business cycles, etc.

5. Energy Intensity and Efficiency – Industry

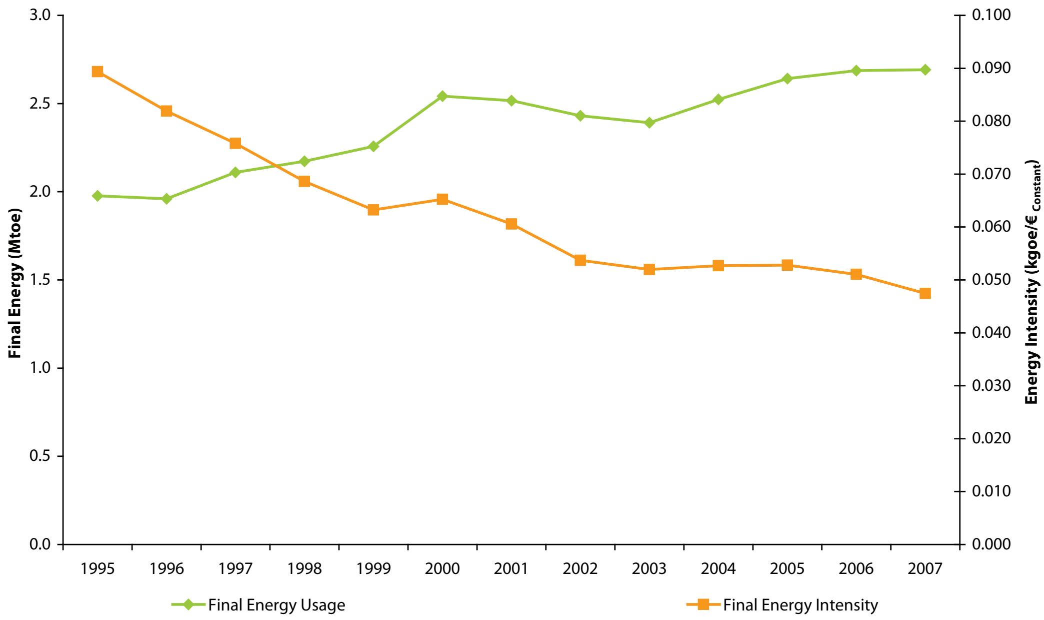
A more detailed discussion of energy trends in the industry[48] sector is contained in the report *Energy in Industry - 2007 Report* (available in the 'Statistics' section of www.sei.ie).

5.1 Industry Energy Intensities

Figure 11 graphs final energy usage and final energy intensity for the industry sector over the period 1995 to 2007. Energy intensity in industry is measured by the ratio of final energy usage to gross value added (GVA) in constant 2006 money value.

Final energy usage increased by 36% (2.6% per annum on average) to 2,692ktoe while energy intensity[49] decreased by 47% (5.1% per annum on average) to 47 goe /€ $_{2006}$.

Figure 11 Industry - Final Energy Usage and Intensity 1995 – 2007



Source: SEI

As mentioned in section 4, energy intensity in this form is a crude indicator of energy efficiency and its variation is the result of many factors, particularly structural changes in the case of industry in Ireland. To illustrate the impact of structural changes, Figure 12 compares an index of energy intensity with an index at constant structure[50].

This indicator measures the impact of structural changes in industry by comparing the variations of the actual intensity with that of a notional intensity at constant structure (using 1995 structure as a reference). It can be seen that structural changes have had a significant effect but other factors are also responsible for the improvement in energy productivity.

The green line in Figure 12 is the trend in energy intensity in industry. The red line represents the evolution of industrial energy intensity had the structure not changed over time. Over the period 1995 to 2007, the intensity of industry declined by 44% (4.7% per annum). However, if this structural change had not occurred, the intensity decline would have been 16% (1.5% per annum).

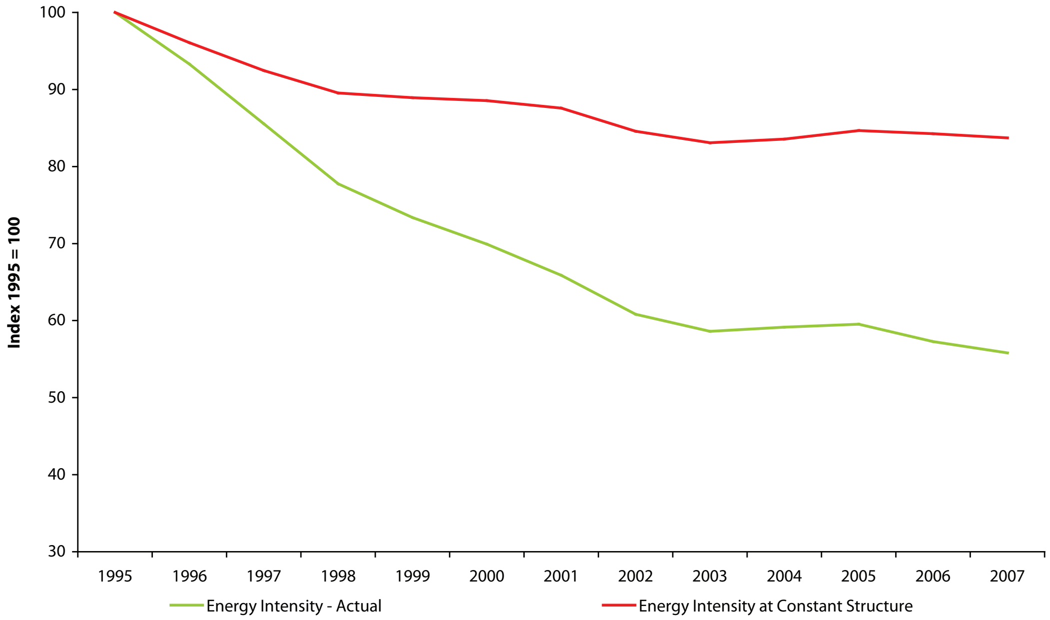
48 The industrial sector referred to in this report consists of manufacturing industry. The full list of NACE sub-sectors covered by the term 'Industry' is included in Table 4.

49 Intensity as measured by the ratio of final energy usage to gross value added (GVA) in constant 2006 money value. This is expressed as kilograms of oil equivalent per euro of GDP (kgoe /€ $_{2006}$).

50 This section draws on methodology developed under the ODYSSEE project. See Bosseboeuf D. et al, 1999, *Energy Efficiency Indicators – The European Experience* and Bosseboeuf D. et al, 2005, *Energy Efficiency Monitoring in the EU-15,* both published by ADEME and the European Commission: www.ODYSSEE-indicators.org/

These structural changes were brought about by global economic influences and Irish industrial policy. Over the period, industrial policy concentrated on moving the sector up the value chain to manufacture high-value goods such as pharmaceuticals, electronics and value-added foodstuffs. This resulted in increased economic efficiencies, contributing to the further reduction in intensity, shown in Figure 12.

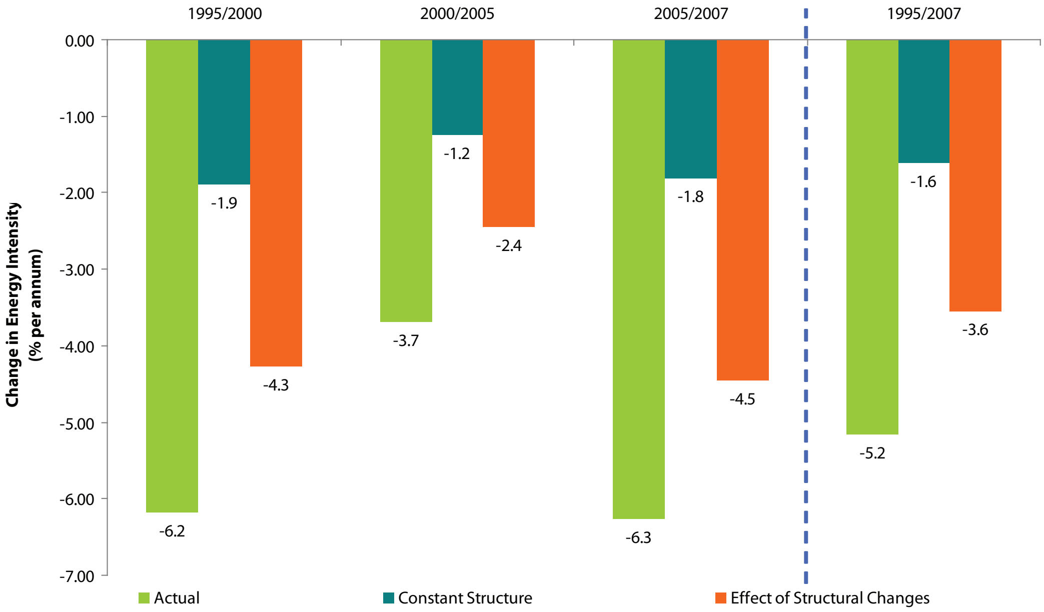
Figure 12 Index of Energy Intensity of Industry 1995 – 2007



Source: SEI

The contribution of structural changes is examined further in Figure 13. For three periods (1995 to 2000, 2000 to 2005 and 2005 to 2007), the changes in final energy intensity are compared with those of the intensity at constant structure. The difference between the intensities shows the influences of structural changes in the sector.

Figure 13 Intensity Trends in Industry: The Role of Structural Changes



Source: SEI

It can be seen that structural changes were significant in each of the three periods. In other words, changes in the makeup of Irish industry between 1995 and 2007 accounted for slightly more than two-thirds of the reduction in industrial energy intensity[51]. The remainder of the change in intensity is due to other effects such as change in fuel mix, quantity effects (economies of scale), other behavioural effects and/or real efficiency gains.

5.2 Industry Sub-Sectoral Analysis

To examine which sectors were responsible for the structural component of change in intensity, it is useful to consider the industrial intensity at a sub-sectoral level. The same three time periods are covered again. The total reduction in energy intensity due to structural changes is shown to the left of the dotted line in Figures 14 to 18. The contribution of each sub-sector[52] shown on the right. Sub-sectors registering a positive change contribute to a decrease in the energy productivity of industry, whereas a negative value implies an increase in energy productivity.

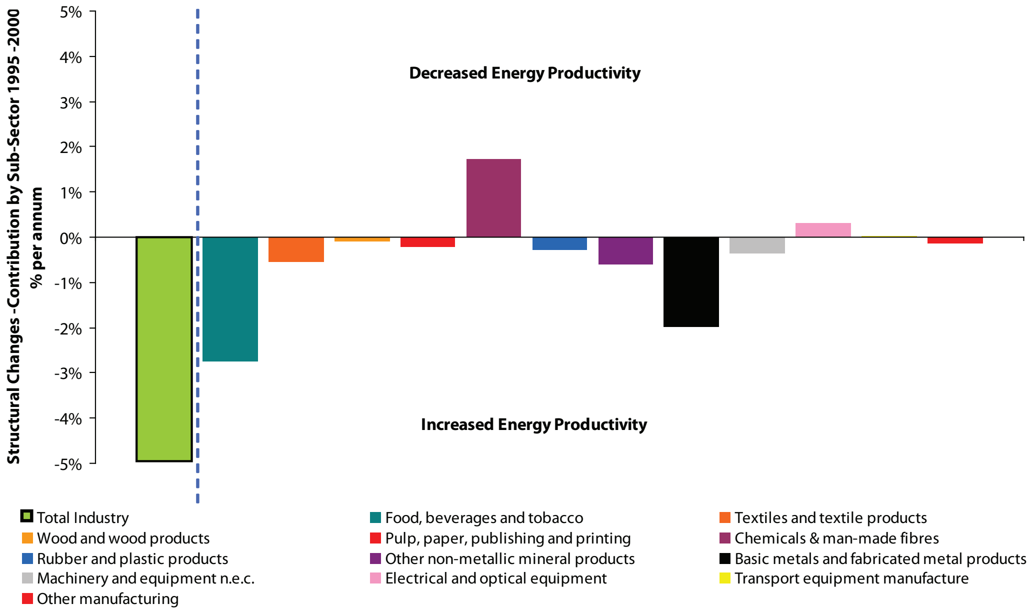
The contribution of the food products and basic metals sub-sectors were the most significant over the period 1995 to 2000. Food products contributed 55%[53] of the decrease due to structural changes and basic metals 40%. The non-metallic mineral products (which include cement) and electrical and optical equipment sub-sectors experienced an increase in energy intensity but this effect was outweighed by the decreases in the other sectors.

51 Structural changes accounted for 62% of total changes between 1995 and 2000, 63% between 2000 and 2005 and 74% between 2005 and 2007. For the overall period 1995 to 2007, structural changes accounted for 63% of the total change in intensity.

52 Full definitions of the sub-sectors used can be found on page 60.

53 This indicates that out of the total variation due to structural changes, food contributed 55%.

Figure 14 Variation in Energy Intensity due to Structural Changes – Contribution by Sub-Sector 1995 – 2000

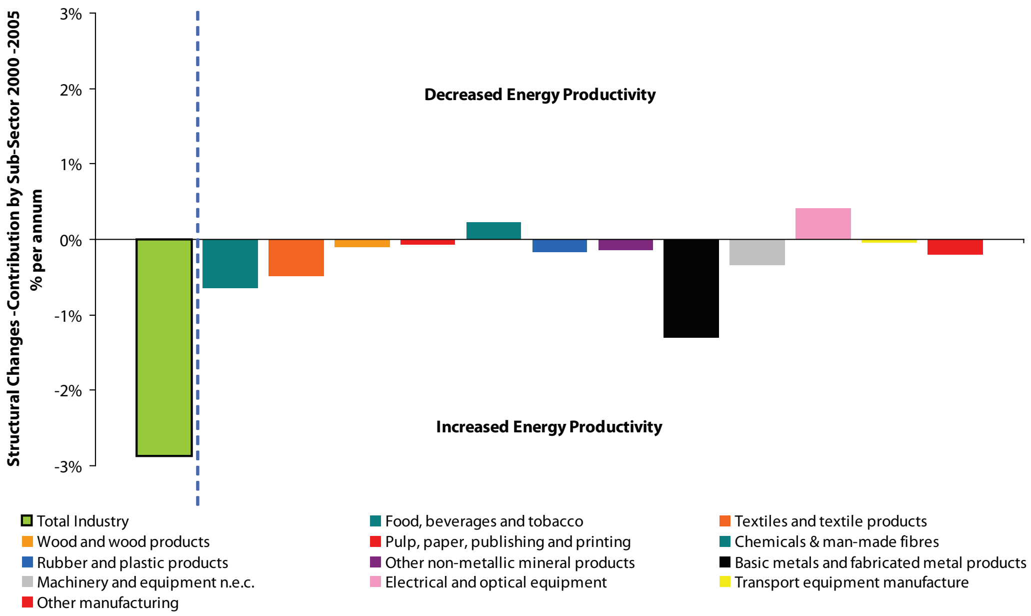


Source: SEI

Figure 15 examines the period from 2000 to 2005. The sub-sectors that contributed most to the overall variation were basic metals (responsible for 46%) and food, beverages and tobacco products (22%).

The electrical and optical equipment sub-sector increased in energy intensity again along with the chemical and man-made fibres sector in the period 2005-2005. However, the increases are both under half a percentage point. The other non-metallic mineral products (including cement) sub-sector recorded an improvement in energy intensity. The total reduction in energy intensity due to structural changes between 2000 and 2005 at 3% was smaller than the change between 1995 and 2000.

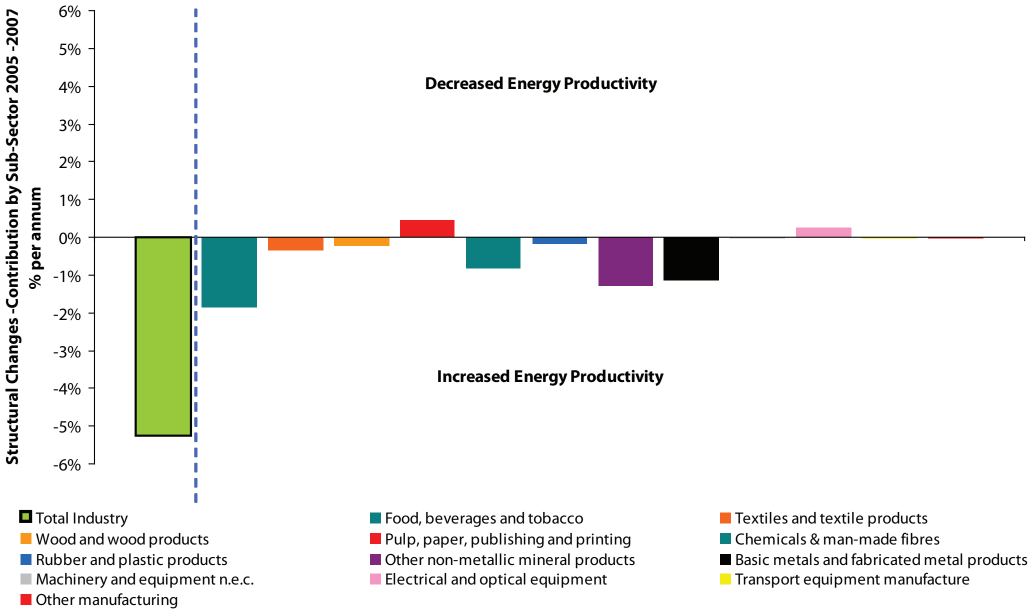
Figure 15 Variation in Energy Intensity due to Structural Changes – Contribution by Sub-Sector 2000 – 2005



Source: SEI

Figure 16 examines the period from 2005 to 2007. The sub-sectors which contributed most to the overall variation were food, beverages and tobacco products (35%), other non-metallic mineral products (25%) and basic metals (22%).

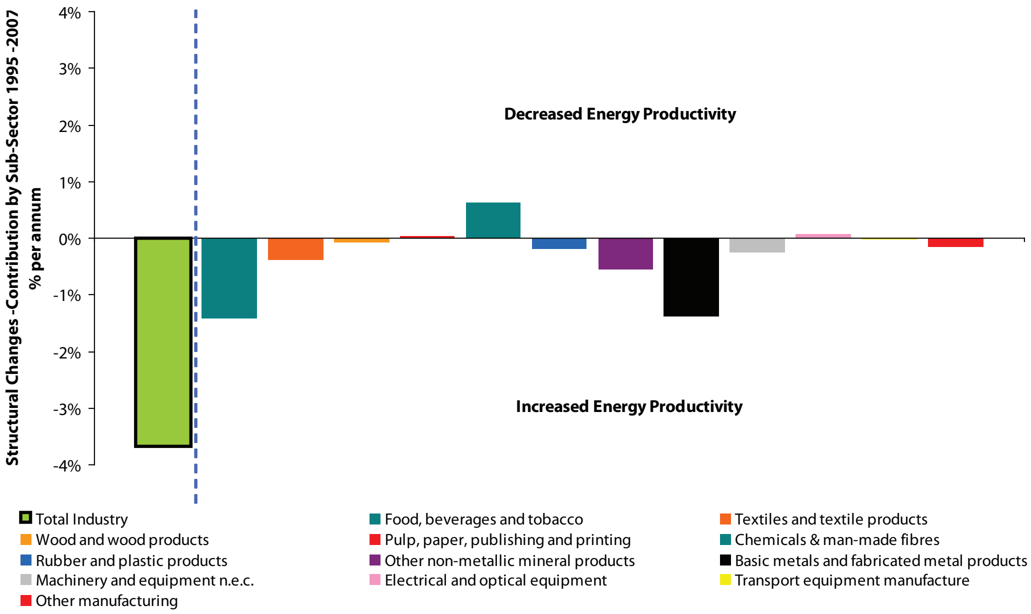
Figure 16 Variation in Energy Intensity due to Structural Changes – Contribution by Sub-Sector 2005 – 2007



Source: SEI

Figure 17 looks at the percentage per annum variation in energy intensity due to structural changes over the period 1995 to 2007 as a whole, while Table 4 details the overall growth rates of the different sub-sectors over the same period.

Figure 17 Variation in Energy Intensity due to Structural Changes – Contribution by Sub-Sector 1995 – 2007



Source: SEI

The food sub-sector was the most significant, accounting for 39% of the variation, followed by the basic metals sub-sector, responsible for 37%. The contribution from these sectors outweighed the increases in the chemical and man-made fibres, electrical and optical equipment and the transport equipment manufacture sub-sectors.

Table 4 Variation in Structural Energy Intensity – Contribution to Overall Change by Sub-Sector

	NACE	'95 – '00	'00- '05	'05-'07	'95 – '07
Total Industry					
Food, beverages and tobacco	15 - 16	55%	22%	35%	39%
Textiles and textile products	17 - 18	11%	17%	7%	10%
Wood and wood products	20	2%	4%	4%	2%
Pulp, paper, publishing and printing	21 - 22	4%	3%	-9%	-1%
Chemicals & man-made fibres	24	-35%	-8%	16%	-17%
Rubber and plastic products	25	6%	6%	3%	5%
Other non-metallic mineral products	26	12%	5%	25%	15%
Basic metals and fabricated metal products	27 - 28	40%	46%	22%	37%
Machinery and equipment n.e.c.	29	7%	12%	0%	7%
Electrical and optical equipment	30 - 33	-6%	-14%	-5%	-2%
Transport equipment manufacture	34 - 35	-1%	1%	1%	1%
Other manufacturing	36 - 37, 19	3%	7%	1%	4%

Source: SEI

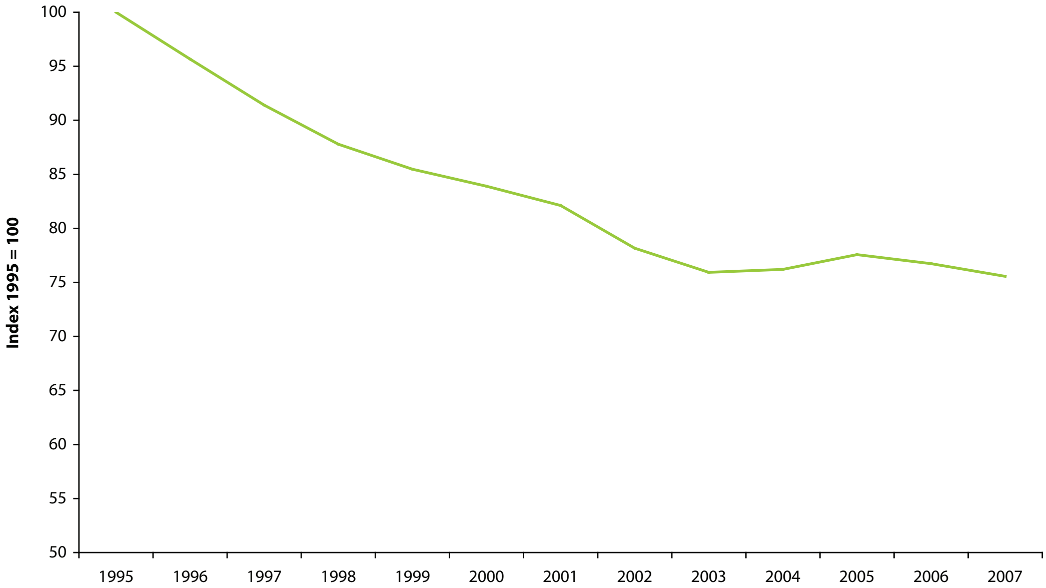
5.3 Industry Energy Efficiency

Energy intensity at constant structure provides a proxy measure of energy efficiency by removing the changes in energy intensity due to structural changes in industry. An alternative approach is the ODEX indicator for industry that has been constructed over the period 1995 to 2007 for Ireland. The ODEX indicator aggregates unit consumption for individual sub-sectors, weighted according to the share of industry energy demand of that sub-sector.

The unit consumptions are expressed in terms of energy used per unit of physical output (where data are available) and production indices for the other sub-sectors relative to that in the base year (in this case 1995). It is important to note that, for some sub-sectors the trends also include some non-technical changes, especially in the chemical industry as a result of the shift to light chemicals. Data for this sector are currently not available at a sufficiently disaggregated level to enable detailed analysis.

As shown in Figure 18, the industry ODEX for Ireland decreased from 100 in 1995 to 76 in 2007, indicating a 24% improvement in energy efficiency. Due to changes in the methodology, the Industry ODEX is not directly comparable with the version in the first energy-efficiency report. The change relates to the number of industrial sub-sectors used in addition to updates on energy consumption shares of the sub-sectors and gross value-added generated.

Figure 18 Industry ODEX 1995 – 2007



Source: SEI

There is a significant difference between the estimated energy-efficiency improvement calculated using energy intensity at constant structure (16%) and using the ODEX methodology (24%), which is currently subject to academic investigation on behalf of SEI[54]. Initial analysis suggests that, for the industrial sector in Ireland, energy intensity at constant structure is a better measure of efficiency. This is the metric used for energy efficiency of industry in this report.

It is important to note that the Energy Services Directive (ESD) does not include branches of industry that fall under the emission trading scheme (ETS), so the directive only targets smaller industrial users. A new energy-efficiency index is being developed, as part of the ODYSSEE project, which will exclude all ETS branches in order to create an index that can be used to measure progress towards meeting the ESD targets.

Using the index of intensity at constant structure, the quantification of the energy savings as a result of energy-efficiency improvements is shown in Figure 19. The total energy savings in 2007 due to improvements in energy efficiency over the period 1995 to 2007 were 524 ktoe. This suggests that industry energy use would have been 3,216 ktoe in 2007 (20% higher) but for the energy-efficiency improvements over the previous 12 years.

54 Cahill C. and Ó Gallachóir B. P., 2008, *Evaluating the effectiveness of ODEX in measuring true energy efficiency achievements: Case study Irish Industry.* Presentation to EU – ODYSSEE Workshop Nov 6 2008 Prague.

Figure 19 Industry at Constant Structure Energy Efficiency Indicator – Estimated Savings 1996 – 2007

Source: SEI

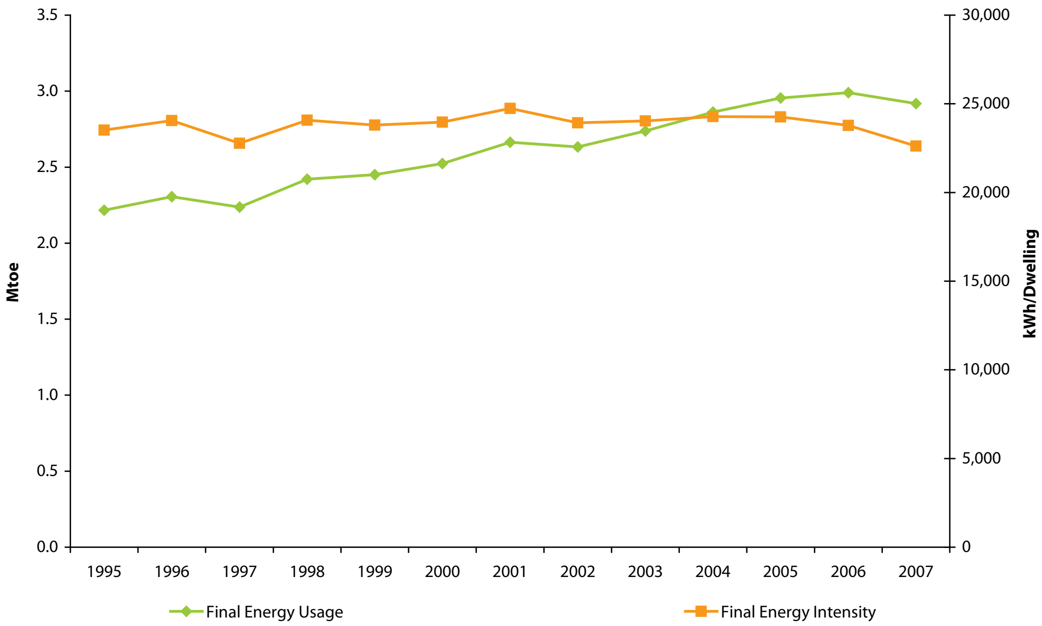
6. Energy Intensity and Efficiency – Residential

A more detailed discussion of energy trends in the residential sector is contained in the report *Energy Consumption in the Residential Sector* (available from the 'Statistics' section of www.sei.ie).

6.1 Unit Consumption of the Residential Sector

Figure 20 graphs the final energy usage and unit consumption[55] for the residential sector over the period 1995 to 2007. Final energy usage in the sector increased by 32% to 2,918 ktoe (2.0% per annum on average) while average energy use per dwelling decreased by 4% (0.3% per annum), to 22,621[56] kWh (or 1,945 kgoe) per dwelling.

Figure 20 Residential – Final Energy Usage and Unit Consumption 1995 – 2007



Source: SEI

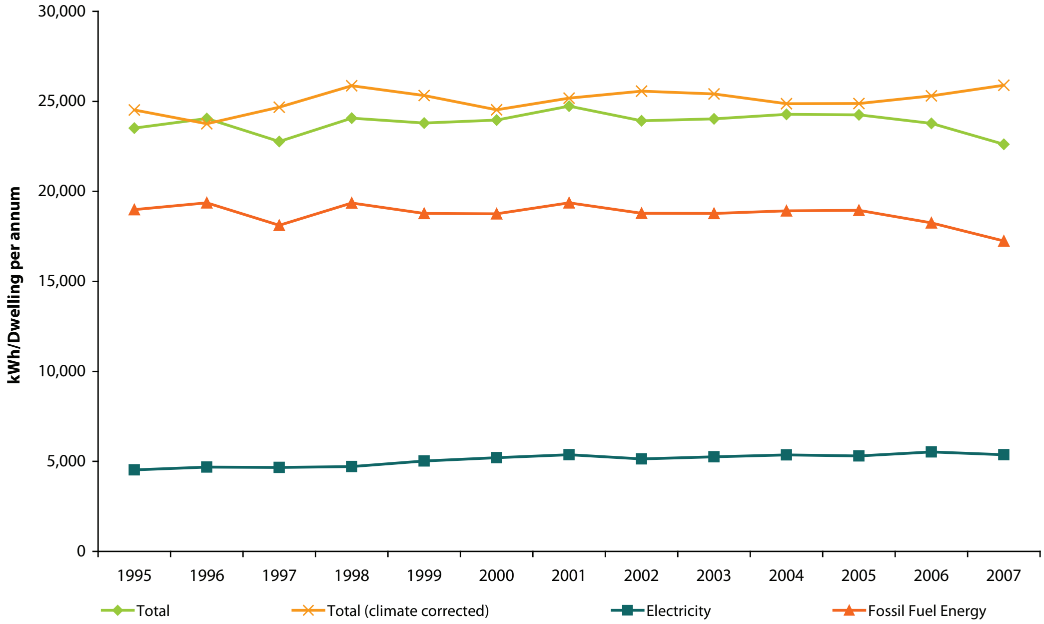
Over the period 1995 to 2007, the number of households[57] in the State increased by 37% (2.7% per annum on average) from approximately 1.1 million to 1.5 million. Figure 21 shows the trend in unit consumption per dwelling (actual values and climate-corrected), with a distinction between electricity and fossil fuels.

Figure 21 shows an increasing trend in electricity consumption per dwelling. This has risen by 18% since 1995. The increasing penetration of household electrical appliances such as washing machines, dishwashers, clothes driers, computers and multiple televisions as well as convenience appliances is believed to have contributed to this increase. In contrast, fossil-fuel consumption per dwelling has decreased by 9.2% over the period.

In 2007 the 'average'[58] dwelling consumed a total of 25,999 kWh of energy, based on climate-corrected data. This comprised 20,395 kWh (79%) in the form of direct fossil fuels and the remainder (5,505 kWh) as electricity.

55 The energy intensity of the residential sector is measured using unit consumption, defined as energy usage per dwelling.
56 Not climate-corrected.
57 Defined as the number of private households in permanent housing units.
58 This average is calculated as the total energy consumption divided by the number of private households in permanent housing units.

Figure 21 Unit Consumption of Energy per Dwelling (Permanently Occupied) 1995 – 2007



Source: Based on SEI, CSO and Met Éireann data

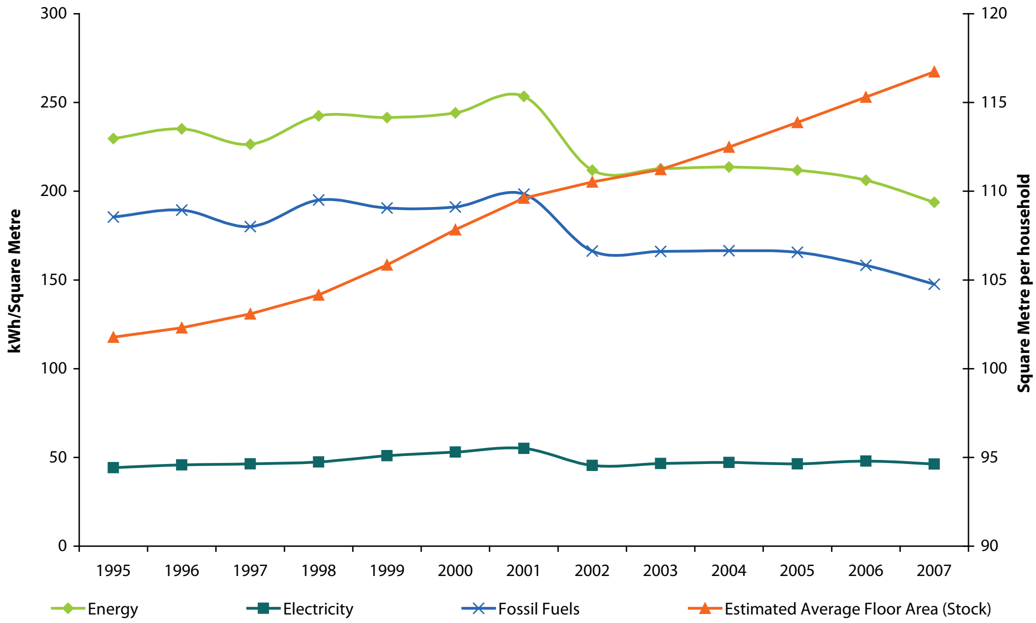
Figure 21 also shows overall unit energy use per dwelling and corrected for climate variations. The overall energy use per dwelling has remained relatively constant. The increase in climate-corrected energy use per dwelling over the period 1995 to 2007 was 5.6% while the uncorrected energy use decrease was 3.8%. (A more detailed discussion is available in the *Energy in the Residential Sector* 2008 report: www.sei.ie/statistics.)

Figure 22 and Table 5 present the trend in energy, electricity and fossil fuels per estimated square metre[59] for the residential sector.

Over the period 1995 to 2007, energy usage per square metre fell by 16% (1.4% per annum), fossil-fuel usage decreased by 20% (1.9% per annum) while electricity usage increased by 5% (0.4% per annum). Over the same period, the average floor area of the housing stock is estimated to have increased by 15% (1.1% per annum).

59 The methodology for estimating the floor area of the stock is contained in *Energy Consumption and CO_2 Emissions in the Residential Sector*, available from the 'Statistics' section of www.sei.ie

Figure 22 Estimated Energy Usage per Square Metre 1995 – 2007



Source: SEI and CSO

Table 5 Estimated Energy Usage per Square Metre 1995 – 2007

	Growth %	Average Annual Growth Rates %				
Usage per Square Metre	**1995 – '07**	**'95 – '07**	**'95 – '00**	**'00 – '05**	**'05 – '07**	**2007**
Energy	-16	-1.4	1.2	-2.8	-4.4	-6.0
Electricity	5	0.4	3.7	-2.7	-0.1	3.6
Fossil Fuel	-20	-1.9	0.6	-2.8	-5.6	-6.8
Est. Average Floor Area Stock	15	1.1	1.2	1.1	1.2	1.2

Source: SEI and CSO

6.2 Residential Sector Energy Efficiency

Two ODEX indicators are shown in Figure 23 for the household sector. The observed ODEX decreased by 15% over the period (1.3% per annum) indicating an improvement in energy efficiency. To remove the influence of behavioural factors a technical ODEX is also calculated. Technical efficiency gains arise from the penetration of more energy-efficient technologies whereas behavioural gains are the result of how technologies (for example, heating systems and appliances) are used.

The technical ODEX decreased by 25% (2.4% per annum) [60]. This implies that significant additional efficiency gains would have been made if not for behaviour. The term 'rebound effect' is generally used to describe increased energy (for example, increased energy usage due to higher internal temperatures) which offsets energy-efficiency gains as a result of increased comfort levels.

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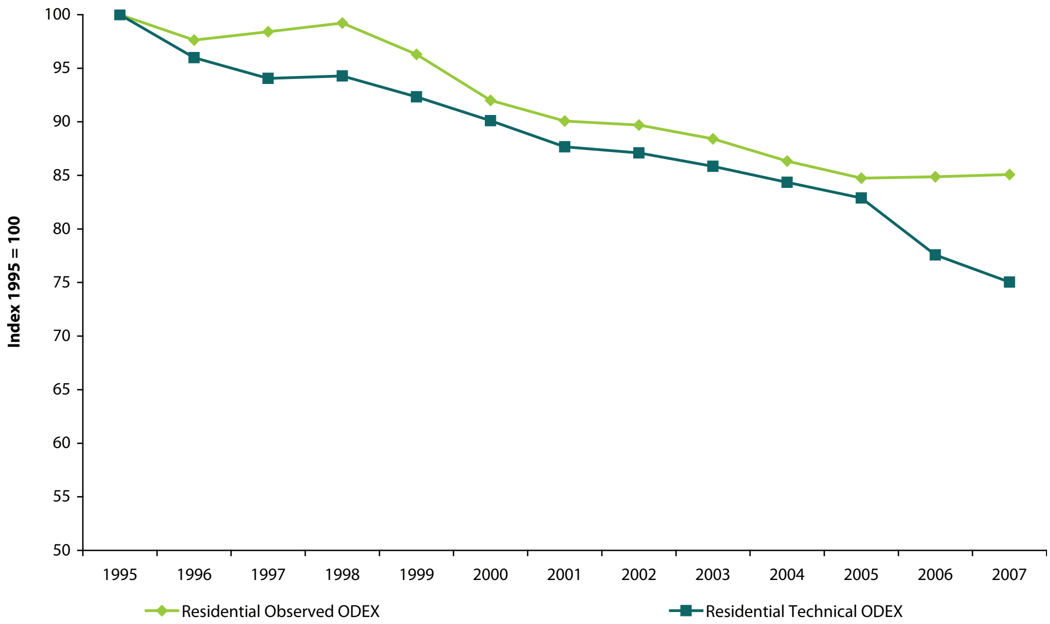
60 The technical ODEX is different to the technical ODEX published in *Energy in Ireland 1990 - 2007* due to changes to the theoretical new consumption of houses and flats.

Figure 23 Household ODEX 1995 – 2007

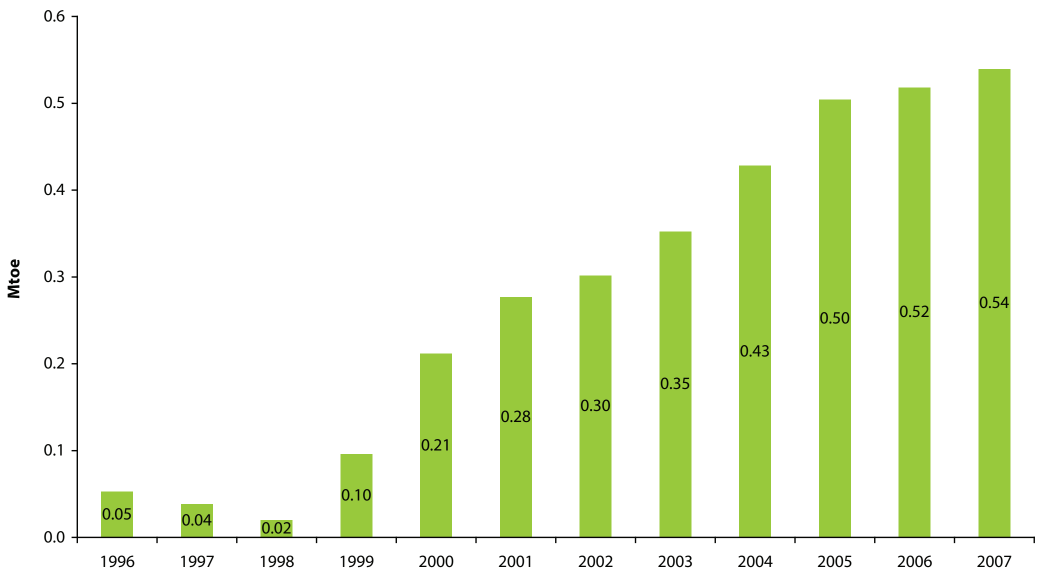


Source: SEI

The ODEX methodology also allows for calculation of the amount of savings due to energy efficiency, shown in Figure 24.

The energy savings calculated using the residential observed ODEX from 1995 to 2007 was 539 ktoe in 2007, which indicates that residential energy use would have been 3,457 ktoe in 2007 (19% higher) but for the energy-efficiency improvements over the previous 12 years.

Figure 24 Cumulative Residential Energy Savings 1996 – 2007



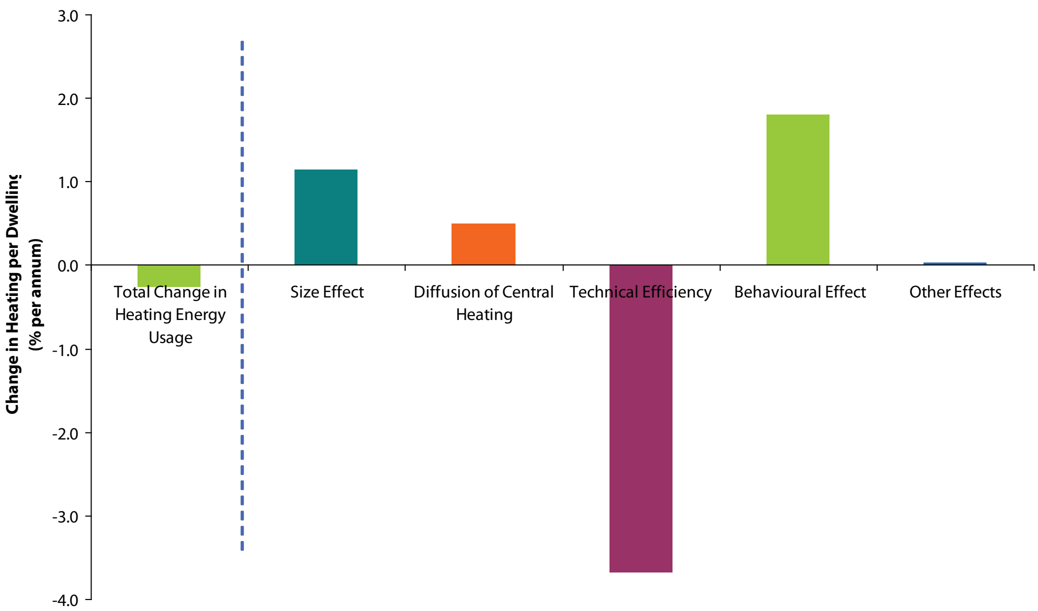
Source: SEI

Using the ODEX methodology, it is possible to quantify variations in energy use associated with individual factors. Figure 25 and Table 6 examine the factors influencing home heating only (excluding water heating) over the period 1995 to 2007. The methodology for calculating the technical ODEX separately removes the effects of house size and the penetration of central heating.

As shown in Figure 25 and Table 6, these have both contributed to increasing the energy use per household, the size effect having a larger impact.

The technical ODEX captures the technical energy efficiency (also shown in Figure 25). The technical efficiency improvements more than compensate for the impacts of larger homes and central heating. The observed ODEX captures the observed efficiency improvements, also separated from the size and central-heating effects. The difference between the observed ODEX and technical ODEX constitutes the behavioural effect shown in Figure 25 and Table 6, capturing factors that include increased comfort levels, longer heating periods and non-compliance with Building Regulations. The residual column refers to other factors (such as possible non-compliance with the Building Regulations) not accounted for elsewhere.

Figure 25 Drivers of Change in Heating Consumption per Dwelling 1995 – 2007



Source: SEI

Table 6 Drivers of Variation in Heating Consumption per Dwelling 1995 – 2007

% per annum	1995-2007
Total Change in Heating Energy Usage	-0.25
Size Effect	1.15
Diffusion of Central Heating	0.50
Technical Efficiency	-3.68
Behavioural Effect	1.81
Residual	0.03

Source: SEI

In Figure 25, the total per annum reduction in heating consumption per dwelling is shown to the left of the dotted line, with the contributory factors illustrated to the right. Over the period as a whole, larger dwellings (size effect) have increased the average consumption per dwelling by 1.15% per annum and the diffusion of central heating contributed a 0. 5% increase per annum. These factors have been more than offset by the decrease in heating consumption brought about by dwellings becoming more efficient (4% increase per annum).

7. Energy Intensity and Efficiency – Transport

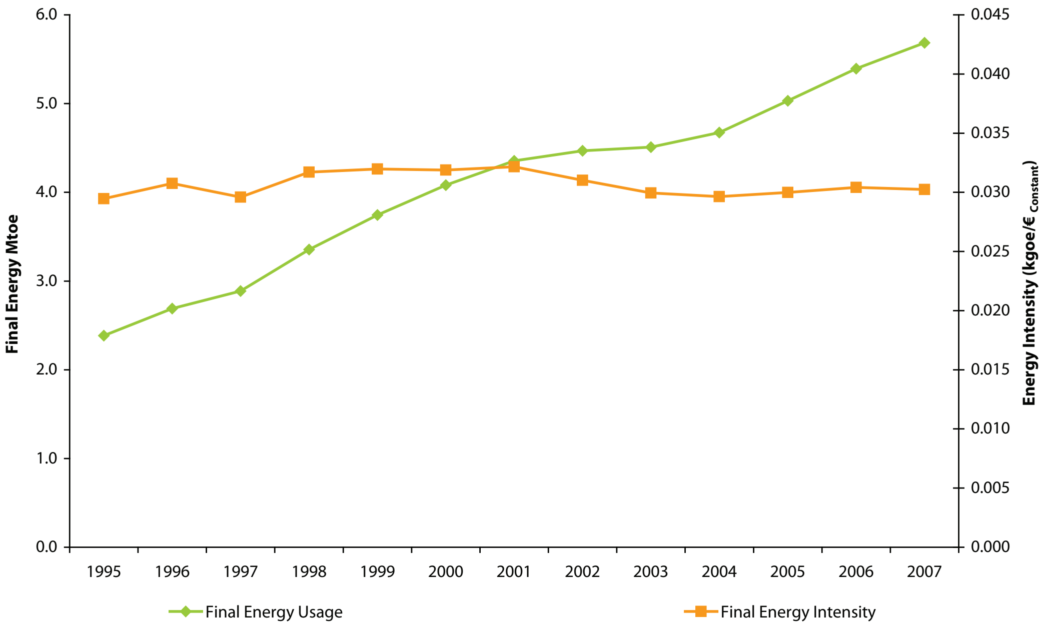
A more detailed discussion of energy trends in the transport sector is contained in the report *Energy in Transport* (available from the 'Statistics' section of www.sei.ie).

7.1 Transport Energy Intensities

Figure 26 graphs final energy usage and final energy intensity[61] for the transport sector over the period 1995 to 2007. Energy intensity in the transport sector is measured by the ratio of final energy usage to GDP in constant 2006 money value.

Transport energy usage was 5,685 ktoe in 2007, an increase of 138% (7.5% per annum) on 1995. It can be seen that the transport energy intensity increased by 3% over the period from 29.5 goe /€ $_{2006}$ in 1995 to 30.2 goe /€ $_{2006}$ in 2007 (0.2% per annum). In other words, transport energy use grew marginally faster than GDP, which had an increase of 132% over the period (7.3% per annum).

Figure 26 Transport – Final Energy Usage and Intensity 1995 – 2007



Source: SEI

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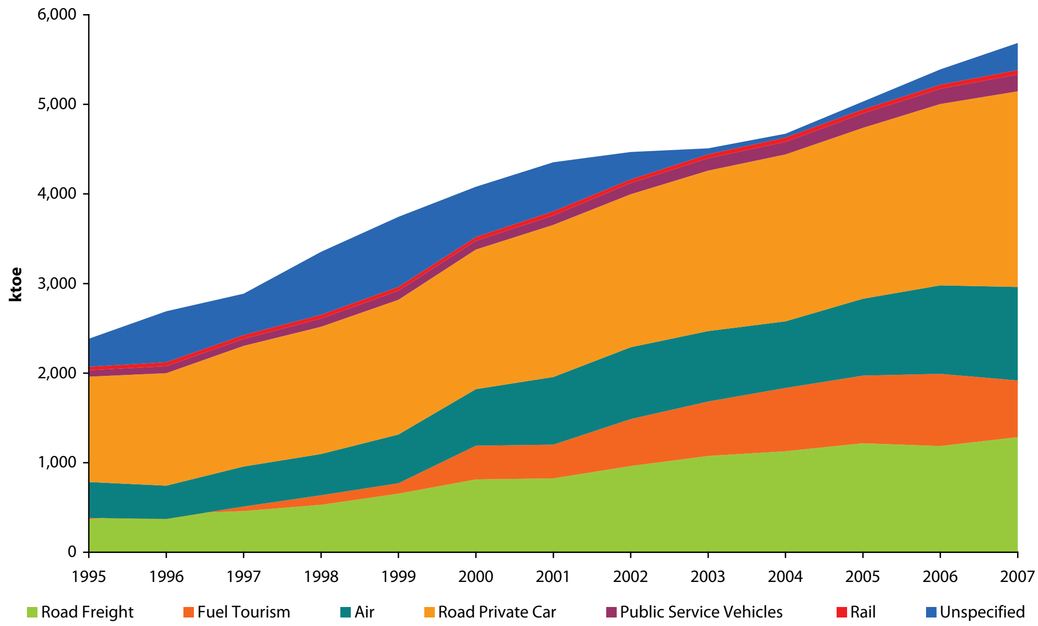
The contribution from each mode of transport to energy demand is shown in Figure 27[62].

61 Intensity as measured by the ratio of final energy usage to GDP in constant 2006 money value. This is expressed as kilograms of oil equivalent per euro of GDP (kgoe /€ $_{2006}$).

62 Fuel tourism is defined as fuel that is bought within the State by private motorists and hauliers but consumed elsewhere.

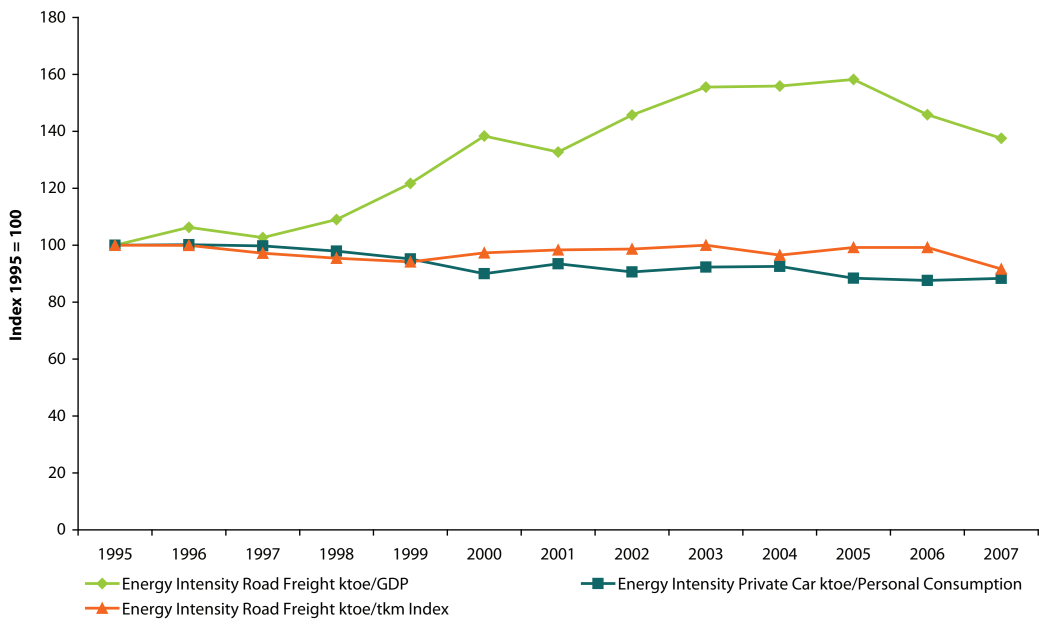
Figure 27 Transport Energy Demand by Mode 1995 – 2007



Source: SEI

Energy use in transport was 5,685 ktoe in the year 2007[63]. Road transport accounted for 64% of this energy use (72% if fuel tourism is excluded). Private car transport was responsible for 2,183 ktoe of energy use in 2007. This represents 51% of road transport energy use (60% excluding fuel tourism) and 38% of all transport energy use (43% excluding fuel tourism). Figure 27 also illustrates the relative weighting of private car transport compared to road passenger services (bus) and rail travel.

Figure 28 Road Freight and Road Private Car Final Energy Intensity 1995 – 2007



Source: SEI

63 The category 'unspecified' in the figure refers to the difference between estimates of fuel consumption and data from the national energy balance. Included in 'unspecified' is fuel consumption by motorcycles, service vehicles (ambulances, etc), construction vehicles (excavators, loadalls, etc), lawnmowers, etc.

Figure 28 shows three transport intensity indicators for the period 1995 to 2007. Road freight is measured against GDP while private car final energy is compared with personal consumption of goods and services[64] in constant 2006 money value. Also shown in Figure 28 is the ratio of fuel usage of road freight (excluding light-duty vehicles) and tonne kilometres travelled.

Focusing on energy intensity of road freight, it can be seen that there has been an increase of 38% (2.7% per annum) in the index since 1995, indicating deterioration in the energy productivity of freight transport. It is likely that this is influenced by the large and increasing amount of transport for construction purposes (especially road building) that was experienced in recent years – i.e. large quantities of heavy, relatively low value goods were being transported. The latest Road Freight Survey[65] backs up this assertion as it states that, in 2007, 29% of the total tonne kilometre of goods carried was in the group 'Crude and Manufactured Minerals, Building Materials'.

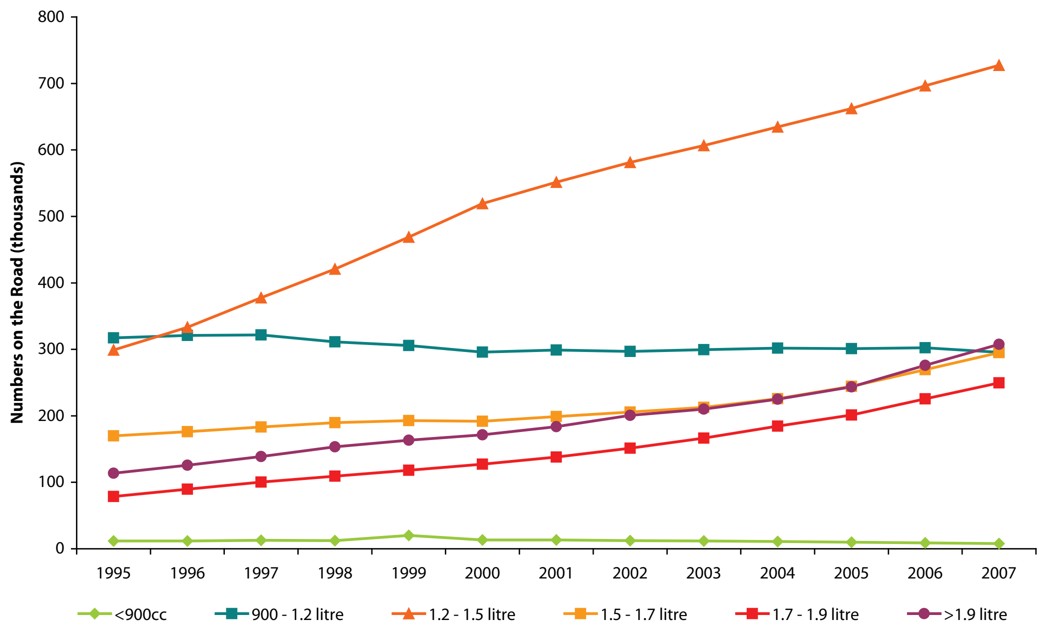
It can be seen that the ratio of fuel usage of road freight (excluding light-duty vehicles) and tonne kilometres decreased by 8.33% (0.01% per annum). This suggests that energy efficiency (i.e. the amount of energy required to transport a given quantity of goods) has started to improve, having remained relatively constant over most of the period.

Finally in Figure 28, the ratio of fuel consumption of private cars and personal consumption of goods and services is shown for the period 1995 to 2007. There was a 12% (1.02% per annum) reduction in energy intensity over the period.

7.2 Private Car Analysis

It is also possible to examine the efficiencies of private cars in more detail. In recent years the number of private cars increased rapidly in Ireland. The number of vehicles on Irish roads exceeded two million[66] for the first time in 2004, reaching 2,441,564 vehicles by the end of 2007. Of these, there were 1.88 million private cars (77% of the total). While the numbers of cars increased, there was also a trend towards purchasing larger cars (in terms of engine size). Figure 29 and Table 7 show how purchasing patterns with respect to engine size have changed over time.

Figure 29 Change in Car Engine Size 1995 – 2007



Source: Based on Vehicle Registration Unit data.

64 Central Statistics Office, 2008, *National Income and Expenditure (*Table 6). In constant 2006 money value.

65 Central Statistics Office, various years, *Road Freight Surveys.* Available from www.cso.ie.

66 Vehicle Registration Unit (Department of the Environment, Heritage & Local Government), various years, *Irish Bulletin of Vehicle and Driver Statistics.*

Table 7 Growth Rates and Shares of Car Engine Size 1995 – 2007

	Growth %	Average annual growth rates %					Shares %	
CC Bands	**'95 – '07**	**'95 – '07**	**'95 – '00**	**'00 – '05**	**'05 – '07**	**2007**	**1995**	**2007**
<900cc	-33.7	-3.4	2.5	-5.9	-10.9	-13.1	1.2	0.4
900 - 1.2 litre	-6.8	-0.6	-1.4	0.4	-0.9	-2.3	32.0	15.7
1.2 - 1.5 litre	143.2	7.7	11.7	5.0	4.8	4.4	30.2	38.6
1.5 - 1.7 litre	73.6	4.7	2.5	4.9	9.9	9.5	17.2	15.7
1.7 - 1.9 litre	217.2	10.1	10.1	9.6	11.4	10.7	7.9	13.3
>1.9 litre	170.4	8.6	8.6	7.3	12.4	11.4	11.5	16.3
Total	90.1	5.5	5.9	4.7	6.4	5.8		

Source: SEI

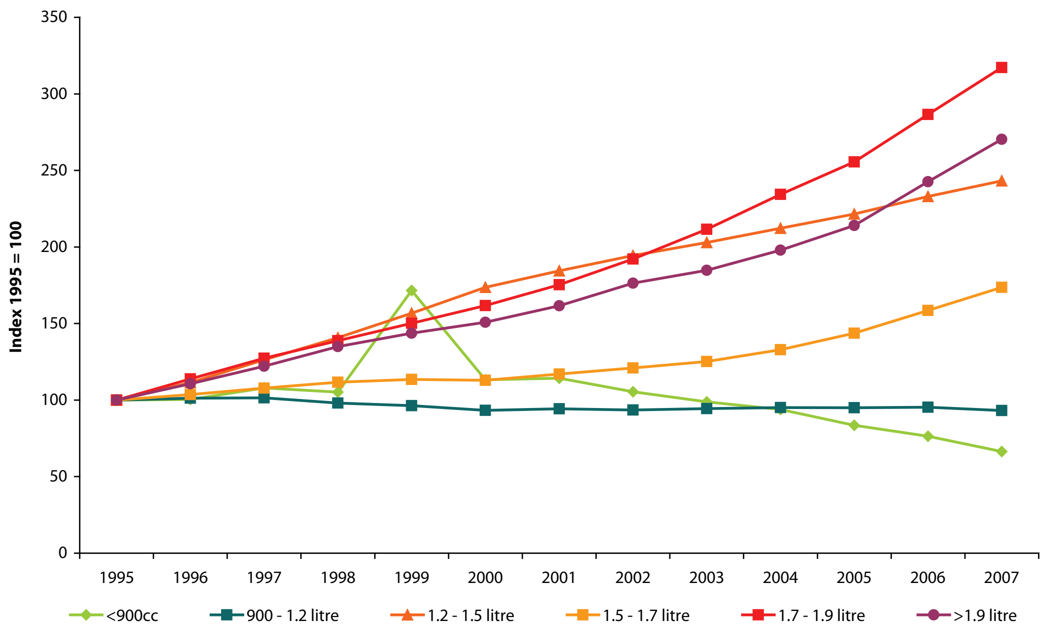
Cars with an engine size of 1.2 litres or less show steady or declining numbers whereas those with an engine size of larger than 1.2 litres all show increasing trends. The 1.2 to 1.5 litre engine size has the largest share of private cars, 39% of the total in 2007. This was over twice the share of the second most popular class, the greater than 1.9 litre band which accounted for 16.3% of the total. The year 2007 was the first in which the greater than 1.9 litre band became the second most popular class, passing the 0.9 to 1.2 litre band which had a share of 15.7%.

The largest average annual increase was in the 1.7 to 1.9 litre band, at 12%. The 1.7 to 1.9 litre band now has a share of 13.3%. In 1995 the 0.9 to 1.2 litre engine size had the largest share of private cars, 40% of the total.

The combined result is a switch in the dominant share from the 900cc – 1.2 litre engine size to the 1.2 – 1.5 litre size.

Figure 30 presents the same data but in this case expressed as an index, with 1995 as the reference year.

Figure 30 Change in Car Engine Size 1995 – 2007 (Index)

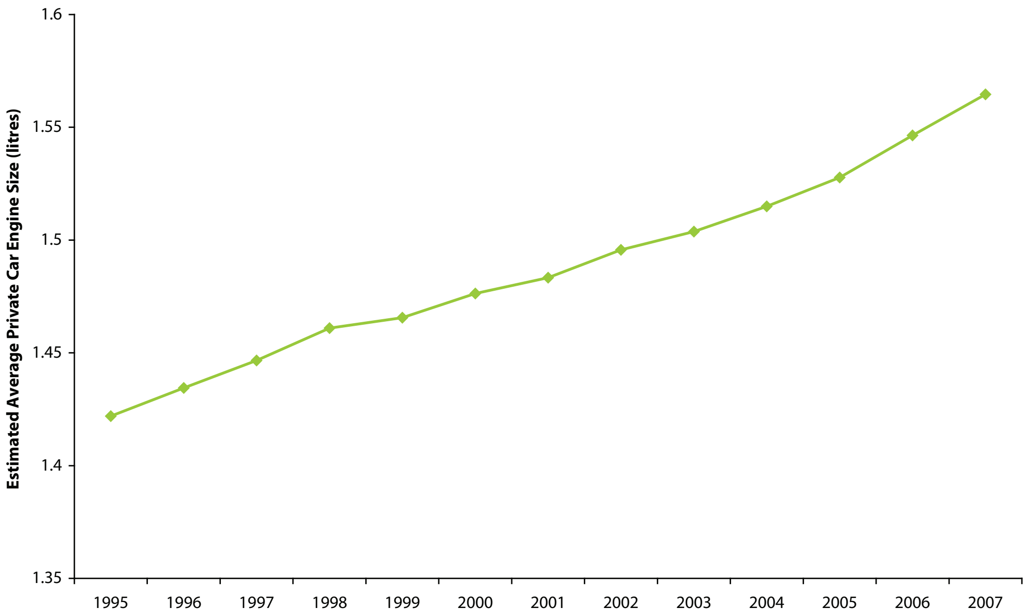


Source: Based on DEHLG Data.

Figure 30 gives a clearer indication of the rates of increase of the differing size classes. Cars with engines less than 0.9 litre and 0.9 to 1.2 litre show steady or declining numbers, whereas the other classes show an increase. The fastest growing range is the 1.7 to 1.9 litre category, the greater than 1.9 litre is the second fastest. This clearly shows a changing preference towards larger cars. The number of cars in the 1.7 to 1.9 litre range grew by 217% since 1995 and those in the greater than 1.9 litre range grew by 170%.

Estimates of the average car engine size for the period 1995 to 2007 are shown in Figure 31.

Figure 31 Estimated Average Private Car Engine Size 1995 – 2007



Source: Based on Vehicle Registration Unit data.

The estimates assume that the median value for each engine size range is 0.1 litres below the maximum limit of the band. While this may not be the case for all engine size bands, it does allow for a comparison to be made. Therefore, in Figure 31, the trend is more important than any actual yearly value.

Over the period 1995 to 2007 the average engine size of the private car stock increased by 10% (0.8% per annum). Average engine size grew by 1.2% in 2006, a faster rate than over the period as a whole.

Another trend in the Irish car market is the modal shift from petrol to diesel cars. This shift over the period was largely driven by fuel price differences between petrol and diesel as well as the better fuel-consumption performance of diesel engines. To measure the extent to which this shift represents a saving, it is necessary to aggregate petrol and diesel consumption.

The growth in diesel cars from 1990 to 2007 was 360% (as shown in Table 8), while petrol cars grew by 114% in the same period. Most recently, between 2005 and 2007, the growth rate of petrol cars was 4.4% while diesel cars increased by just over 17%.

Table 8 Stock of private cars by fuel

	Growth %	Average annual growth rates%					Shares %	
	'95 – '07	'95 – '07	'95 – '00	'00 – '05	'05 – '07	2007	1995	2007
Petrol	80.6	5.1	6.1	4.3	4.4	3.7	86.2	81.9
Diesel	149.7	7.9	5.0	7.3	17.2	16.2	13.7	17.9
Petrol & Gas	-94.7	-21.7	-31.1	-19.2	0.0	0.0	0.1	0.0
Other[66]	482.3	15.8	-13.1	18.7	123.1	145.9	0.1	0.2
Total	90.1	5.5	5.9	4.7	6.4	5.8	100.0	100.0

Source: SEI and VRU

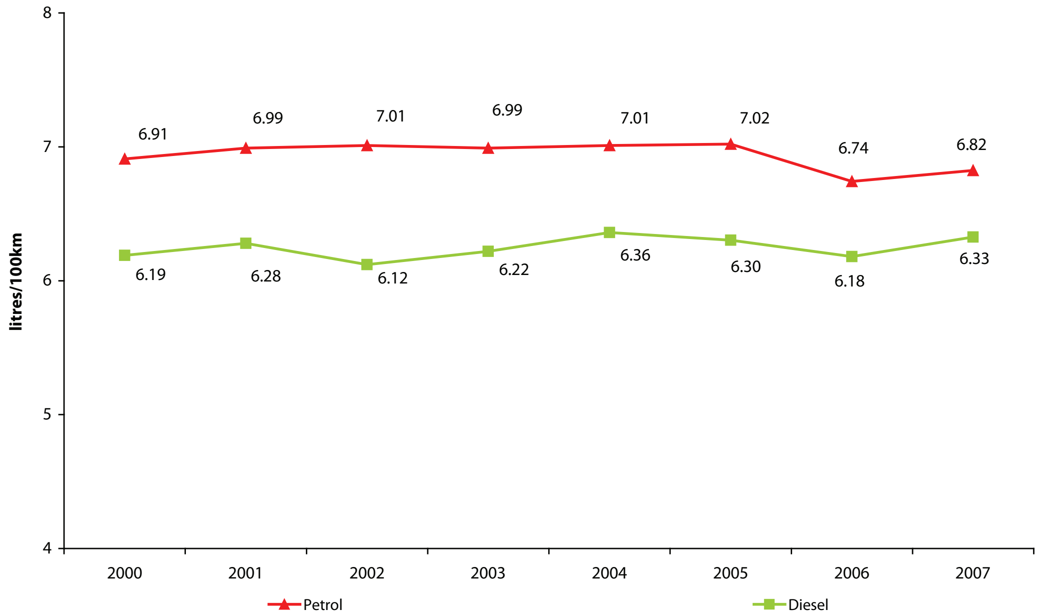
67 Other vehicles include hybrids and electric vehicles.

As a result of improved engine design, newer cars entering the Irish fleet have higher efficiency levels. However, the purchasing trend towards larger engine sizes reduces the impact on these efficiency benefits, as shown in the following analysis.

All new cars have specific fuel-consumption figures[68] associated with them (measured under test conditions) quoted for urban, extra-urban and combined driving. An average specific fuel-consumption figure for new cars entering the national fleet may be calculated by weighting the test values by the sales figures for each individual model. If the voluntary agreements with car manufacturers are effective, over time a gradual reduction in the weighted average fuel efficiency of new cars being registered should be seen.

Figure 32 presents the weighted average specific fuel consumption (combined urban and extra-urban test values) of new private cars first registered in the years 2000 to 2007. This was calculated using an extract from the Vehicle Registration Unit's national database and data on fuel consumption of individual models.

Figure 32 Specific Fuel Consumption of New Cars – litres/100 km: 2000 – 2007



Source: Based on Vehicle Registration Unit & UK Vehicle Certification Agency data

The specific fuel consumption for new petrol cars on the road in Ireland in 2005 was 7.02 litres/100km (40 miles per gallon, mpg). This represented an increase of 1.6% (decrease in fuel efficiency) on the average consumption in 2000. In 2006, there was an improvement in the weighted average fuel efficiency of petrol cars, the specific fuel consumption improved by 4% to 6.74 litres/100km on the 2005 figures. However, in 2007 these increased to 6.82 litres/100km, an increase of 1.2%.

For diesel cars the average fuel efficiency improved slightly over the period 2000 – 2006, by 0.2% to 6.18 litres/100km. There was an improvement in 2006 over the 2005 figures of 2%. As with petrol, there was a disimprovement in 2007, when the average fuel efficiency of diesel cars decreased by 2.4% to 6.3 litres/100km.

Generally, until 2005, the decrease in fuel efficiency suggests that the purchasing trend towards large cars over the period did outweigh the efficiency benefits of engine improvements. This applied to both petrol and diesel cars, with the exception of diesel cars in 2002 where an improvement was noted and also in 2005 when a slight improvement was recorded.

The efficiency improvement in 2006 for both new petrol and diesel cars is due to one or a combination of the following;

- The purchasing trend within engine size bands was towards more fuel-efficient cars

68 Fuel consumption and CO_2 emissions data were sourced from the UK Vehicle Certification Agency. The database can be downloaded at www.vca.gov.uk/fcb/new-car-fuel-consump.asp.

- The efficiency improvements in individual cars outweighed the purchasing trend towards larger cars

The trend in 2007 was the reverse of that in 2006. It should be noted that Figure 32 refers to new cars only. The percentage of second-hand imports, which tend to have larger engines, may affect the specific fuel consumption of additional cars (new and second-hand imports) in any particular year.

The litres/100km provides an indication of the volumetric fuel economy of cars and does not take into account the difference in energy content between petrol and diesel. A better indicator of energy efficiency is captured by the test values in terms of mega joules per kilometre (MJ/ km), shown in Figure 33.

In this case, the trends for petrol and diesel are closer; indeed, they converge in 2006 and 2007. The specific energy consumption for all new cars on the road in Ireland in 2007 was 2.3 MJ/km. In 2007, the weighted average energy efficiency for new petrol and diesel cars was equal. New petrol cars had an average energy use of 2.30 MJ/km and new diesel cars of 2.32 MJ/km. However, on average, diesel cars purchased in Ireland tend to be larger than petrol cars.

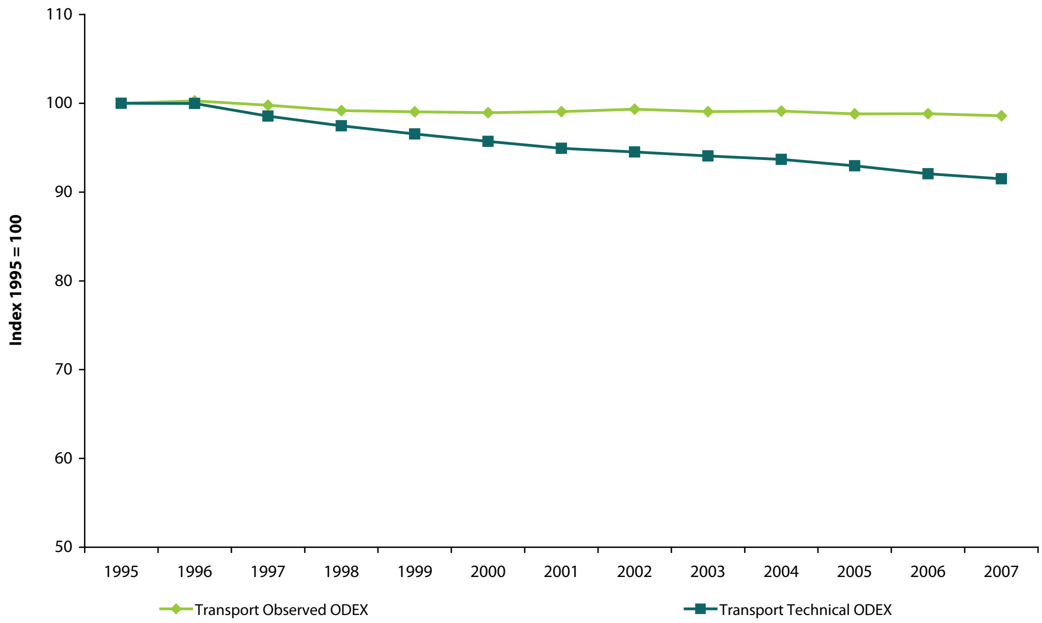
Figure 33 Specific Fuel Consumption of New Cars – MJ/km: 2000 – 2007

Source: Based on SEI and DEHLG Data

7.3 Transport Sector Energy Efficiency

Finally, the individual ODEX indicators for each mode are combined into two overall ODEX indicators for the transport sector (shown in Figure 34). Air transport is not included, as per the Energy Services Directive.

Figure 34 Transport ODEX 1995 – 2007



Source: SEI

The transport observed ODEX fell by 1.4% over the period 1995 to 2007 while the technical ODEX decreased by 7.9% (0.7% per annum). This implies that additional efficiency gains would have been made, if not for behavioural effects such as the purchase of larger cars and lower load factors in road freight.

The energy savings were 51 ktoe in 2007, which indicates that transport energy use would have been 5,736 ktoe in 2007 (0.9% higher) but for the energy-efficiency improvements over the previous 12 years.

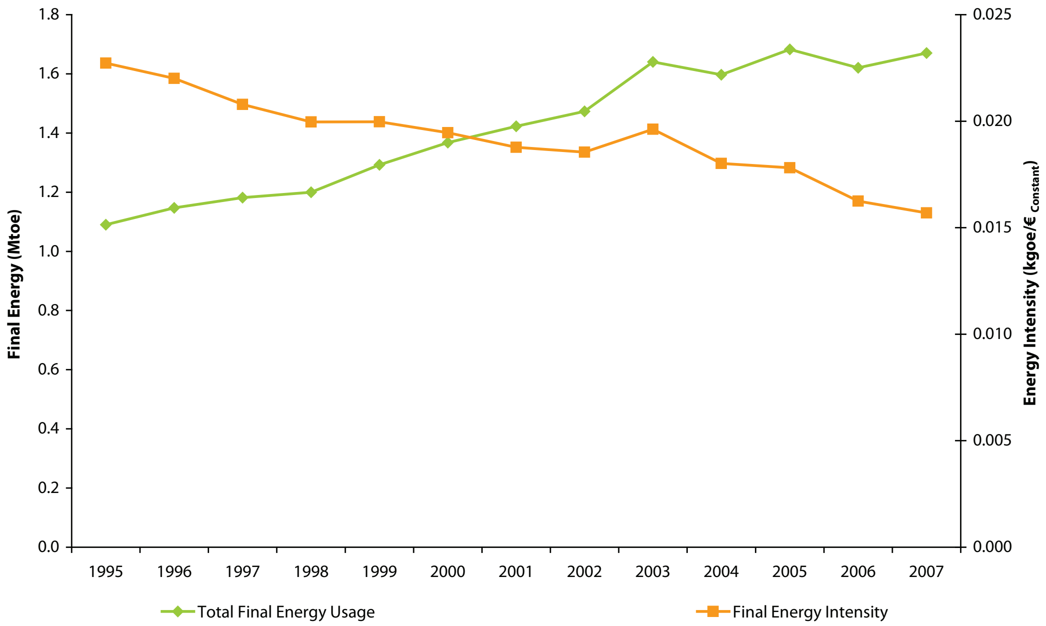
8. Energy Intensity and Efficiency – Services

A more detailed discussion of energy trends in the services sector is contained in the report *Profiling Energy and CO_2 Emissions in the Services Sector* (available from the 'Statistics' section of www.sei.ie).

Figure 35 graphs final energy usage and final energy intensity[69] for the services sector over the period 1995 to 2007. Energy intensity in the services sector is measured by the ratio of final energy usage to GVA in constant 2006 money value.

In 2007, final energy usage in the sector was 1,670 ktoe, an increase of 53% (3.6% per annum on average) on 1995. Over the same period, energy intensity decreased by 31% (3.0% per annum) to a figure of 15.7 goe /€ $_{2006}$ in 2007. The decrease in energy intensity is partly attributable to the rapid growth in the value-added of the sector.

Figure 35 Services Final Energy Usage and Intensity 1995 – 2007



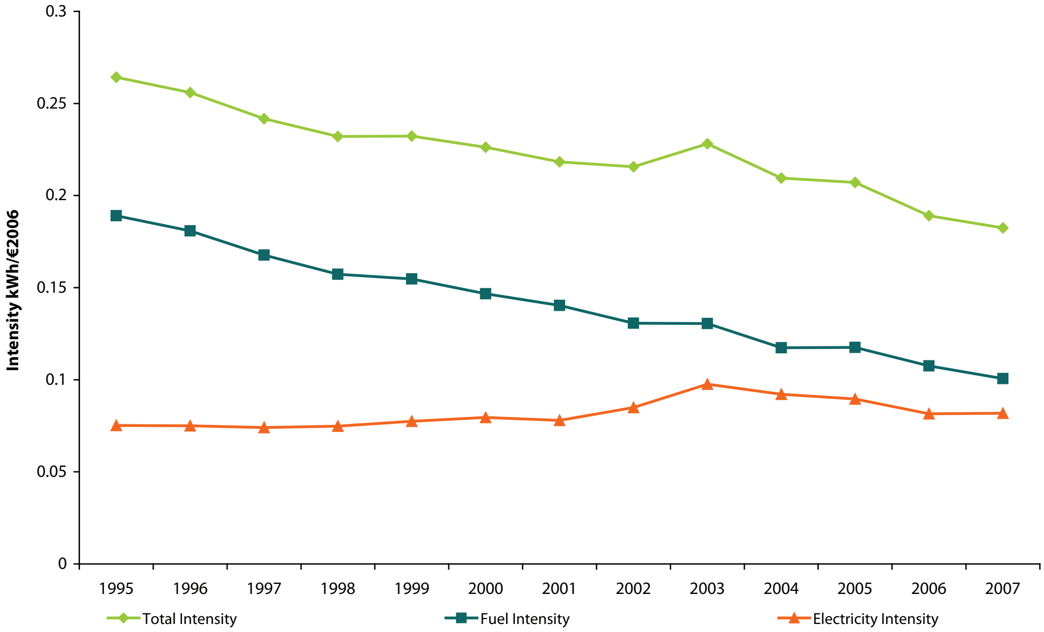
Source: SEI

Overall energy intensity is separated into fuel and electricity intensity in Figure 36. The overall energy intensity of the services sector was 31% lower in 2007 than in 1995, principally because of the rapid growth in the value-added in the sector. The downward trend was reversed in 2003 but continued downwards from 2004 onwards.

As can be seen in Figure 36, the fuel intensity of services continued to fall and was 47% lower in 2007 than in 1995. Electricity intensity increased by 30% from 1995 to 2003, but decreased by 16% since then.

69 Intensity as measured by the ratio of final energy usage to GVA in constant 2006 money value. This is expressed as kilograms of oil equivalent per euro of GDP (kgoe /€ $_{2006}$).

Figure 36 Energy Intensity of Services Sector 1995 – 2007



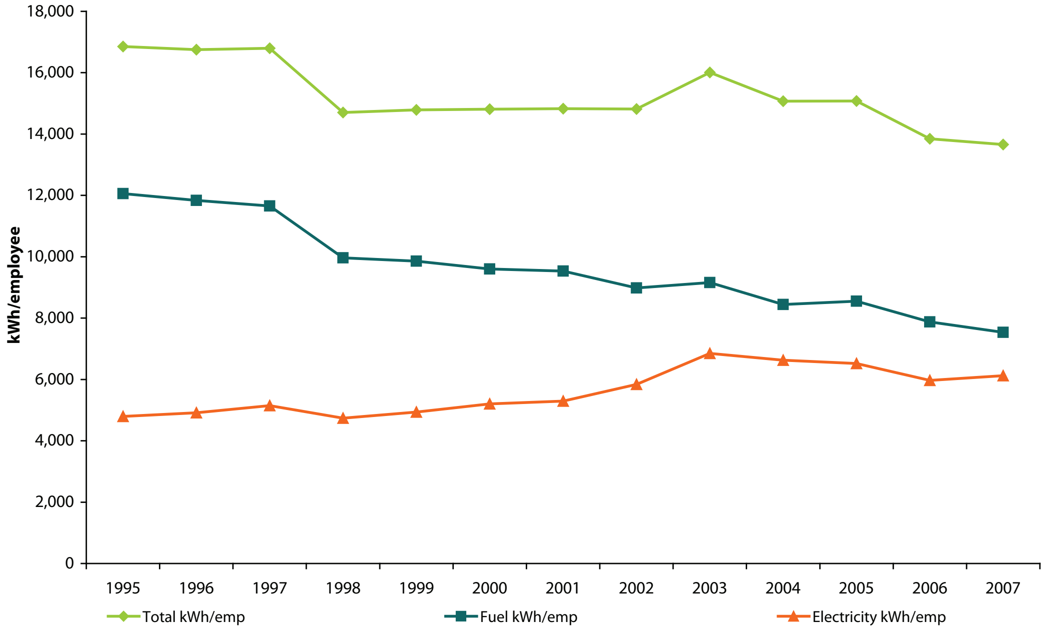
Source: SEI

Two other indicators can be used to measure energy efficiency in this sector: energy use per unit of floor area and per employee. The rationale is that consumption of oil and gas is mainly for heating purposes and is related to the floor area heated and not directly related to the number of people occupying a building at a given time. It is not currently possible to calculate the consumption per unit of floor area due to an absence of data on floor area in the sector.

Unit consumption of electricity per employee is used as an indicator of energy use in the services sector because, in the main, there is a correlation between electricity use and the number of employees.

It can be seen that the unit consumption of electricity rose since 1995. By 2003 it was 43% higher than in 1995 but fell back to 27% above 1995 levels in 2007. This can be linked to the increasing use of office equipment, computers, printers, photocopiers, etc during this time. By contrast, the fuel consumption per employee declined by 38% since 1995.

Figure 37 Unit Consumption of Electricity per Employee in the Service Sector 1995 – 2007



Source: SEI

It should be noted that energy statistics relating to fuel consumption for the services sector in Ireland are calculated as a residual once other sectors, for which more robust data exists, have been accounted for in the energy balance. This approach is unsatisfactory, not least because the energy use in the services sector is affected by uncertainties in all other sectors.

As a result of the heterogeneous nature of the services sector it is difficult to assess the amount of energy consumed in it (this is why ODEX indicators have not been constructed for the sector). The increasing number of energy suppliers in the liberalised market makes this task all the more difficult. The lack of data in the services sector has been highlighted internationally by the IEA as an area that all member countries need to improve. Sustainable Energy Ireland is collaborating with the Central Statistics Office to improve the energy data available for the services sector.

9. Monitoring Energy Efficiency

Monitoring savings achieved through energy-efficiency measures is necessary in order to assess policy impacts and to assist in the development of new policies. It will be necessary to quantify energy savings and improvement in energy efficiency for each sector of the economy in order to demonstrate progress towards targets and compliance with legal obligations.

It is also important to analyse general energy-efficiency trends and to compare with other countries to identify best practice. Data is required on the factors that have enabled change and the number of opportunities available, as well as on costs and savings, in order to focus on cost-effective measures that generate the largest energy savings in the shortest time.

9.1 Energy Efficiency Targets and the National Energy Efficiency Action Plan

The indicative target for the ESD is a 9% energy saving between January 2008 and the end of 2016. This target is set as a percentage value of a reference level of the total final energy consumption, excluding that covered by the EU Emissions Tranding Scheme (ETS), aviation and marine bunkers. The reference consumption is calculated as the average of 2001–2005 data of unadjusted final energy consumption expressed as 'primary energy equivalent'. The methodology for measuring energy savings due to energy-efficiency improvement measures is detailed in the National Energy Efficiency Action Plan (NEEAP)[70].

New methodologies are being proposed to measure energy efficiency for the ESD. The reporting methodology will allow using both top-down (for example ODEX) and bottom-up (savings related to specific measures) methodologies in order to accurately measure the effect of specific policy measures. Only monitored contributions from specified programmes can contribute towards the achievement of the ESD target. The individual energy savings due to energy-efficiency improvement measures proposed in the Irish NEEAP will largely be measured using a bottom-up approach in the short term.

The comprehensive list of measures that will count towards meeting Ireland's targets will be available in the NEEAP. The sectors covered in the NEEAP are: residential, transport, business and public sector (industry and services), and energy supply.

Measures in the draft NEEAP to improve energy efficiency in business and public sector include the Accelerated Capital Allowance (ACA) scheme to increase the diffusion of energy efficient equipment in the industrial sector, the Energy MAP (Management Programme) and training for small businesses, Demand Side Management (DSM) initiatives from the ESB, and the inclusion of more companies in the IS393 energy efficiency standard and in the energy agreements for SEI's Large Industry Energy Network programme (LIEN). Revisions of the building regulations for non-residential buildings will also lead to energy savings due to improvements in energy efficiency in the built environment. The public service is to play an exemplar role in energy efficiency, with a specific government target of 33% improvement by 2020

In the residential sector most of the proposed savings in the NEEAP to meet the ESD are expected to come from successive revisions of the Building Regulations. Improvements to these can be included as early actions for the ESD. Other energy-efficiency schemes in the residential sector include the national insulation scheme, called the Home Energy Savings Scheme, to improve the efficiency of the housing stock and the introduction of minimum efficiency standards for lighting and boilers.

Programmes to increase the energy efficiency of the transport sector in the NEEAP include improving the fuel economy of private cars and introducing mobility management plans. Changes to the vehicle registration tax and the road tax introduced in July 2008, with the taxes based on emission bands as opposed to engine size, have already resulted in a significant increase in the share of lower emission[71], hence more fuel efficient, cars.

Programmes in the energy supply sector include a winter peak demand reduction scheme and improving the transmission and distribution system efficiency.

There has been significant activity to promote energy efficiency on the supply side of energy services (electricity generation). However, the European Commission has highlighted to all member states that it is also necessary to create stronger incentives on the demand side management. Significant competition in products and services is required to improve energy efficiency

70 A draft NEEAP was released in October 2007 and the finalised version is due to be released in 2009. More information at: www.dcenr.gov.ie/Energy/Energy+Efficiency+and+Affordability+Division/National+Energy+Efficiency+Action+Plan.htm

71 Ó Gallachóir B. P., Howley M., Cunningham S. & Bazilian M., 2009, *How Changing Car Fleet Structure Offset Engine Efficiency Gains and the Successful Energy Policy Response - Case Study on New Private Cars in Ireland.* Energy Policy Special Issue Carbon in Motion (In Press).

on the demand side. SEI commissioned research into demand side management in Ireland. The report[72] analysed the Irish residential, commercial and industrial sectors and their usage of oil, gas and electricity, considers the paths to delivering these targets and the costs and benefits entailed. It also examined the potential in these sectors for reducing peak electricity demand to underpin efficiency, security and carbon reduction objectives. The analysis encompassed four categories of energy-efficiency potential: technical, economic, programme and naturally occurring potentials. The results of this study were used to inform the NEEAP on potential energy savings schemes.

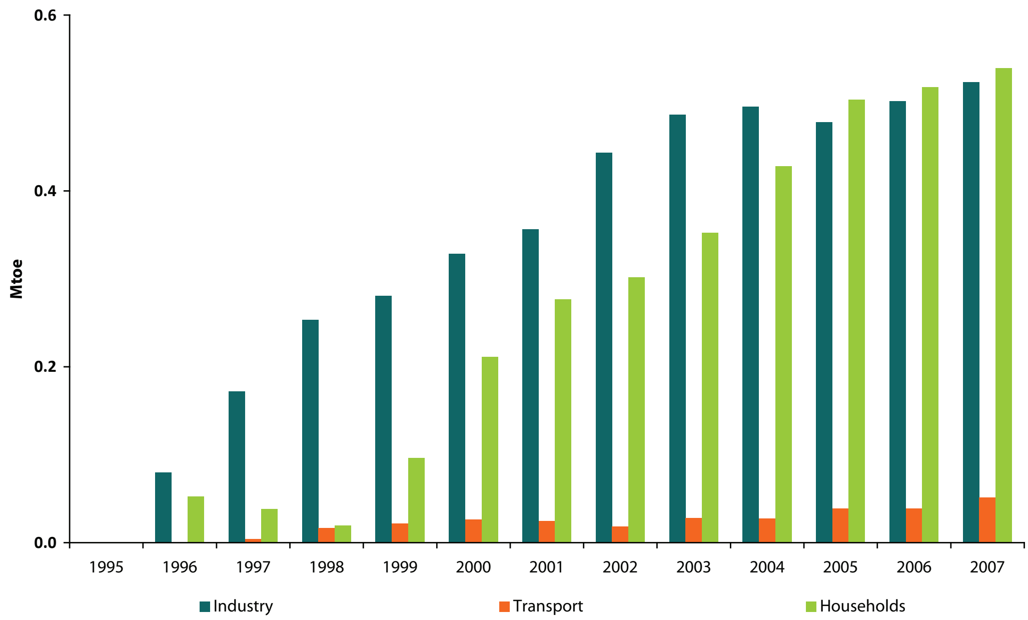
The European Commission also recently launched a study to provide a database of harmonised energy savings potentials for each EU Member State and for Croatia, Norway, Iceland and Liechtenstein. This database covers the potentials for the industry, transport, households and services sectors. The database also indicates the main drivers used to estimate these potentials and present the trends in some energy-efficiency indicators associated with the different potentials. The objective of this database is to provide the Commission with a tool to assess national energy-efficient action plans (EEAPs) and to help identify the sectors where the national savings targets established under the ESP Directive can be met most cost effectively.

The analysis of the potentials relies mainly on the *MURE simulation tool* (Mesures d'Utilisation Rationnelle de l'Énergie), which has a rich description of end-use technologies in order to elucidate the impact of the penetration of energy-efficient technologies in detail. Three potentials are assessed: low economic potential, high economic potential and a technical potential. These three potentials are used to compare four different scenarios: an autonomous or baseline scenario, a low policy intensity scenario, a high policy intensity scenario and a technical scenario.

9.2 Energy Efficiency Indicator Analysis

Figure 38 shows the energy-efficiency saving per sector as calculated by the energy-efficiency index method described in Section 4. The savings in any particular year are the result of cumulative energy efficiency gains from 1995 to that particular year. Most of the early savings are from the industrial sector, but since 2000 the residential sector also made a significant contribution. Since 2005, the residential sector contributed the most to energy efficiency.

Figure 38 Ireland's Savings as calculated using the sectoral Energy Efficiency Index Method 1995 – 2007



Source: SEI

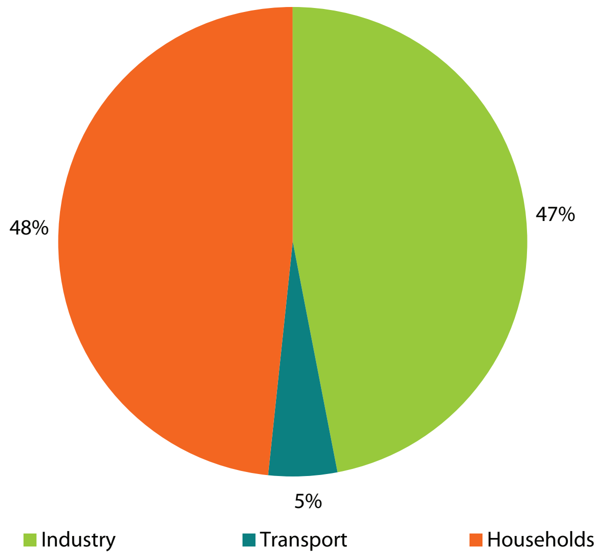
Section 9

Figure 39 shows the sector shares of the energy savings in 2007 from improvements in energy efficiency over the period 1995 – 2007. In 2007, the savings achieved due to energy efficiency since 1995 amounted to 524 ktoe from the industrial sector, 51

72 A study by Kema for Sustainable Energy Ireland, 2007, *Demand Side Management in Ireland – Evaluating the Energy Efficiency Opportunities.*

ktoe from the transport sector and 539 ktoe from the household sector, giving a total saving of 1.1Mtoe.

Figure 39 Ireland's Savings as calculated using the sectoral Energy Efficiency Index Method

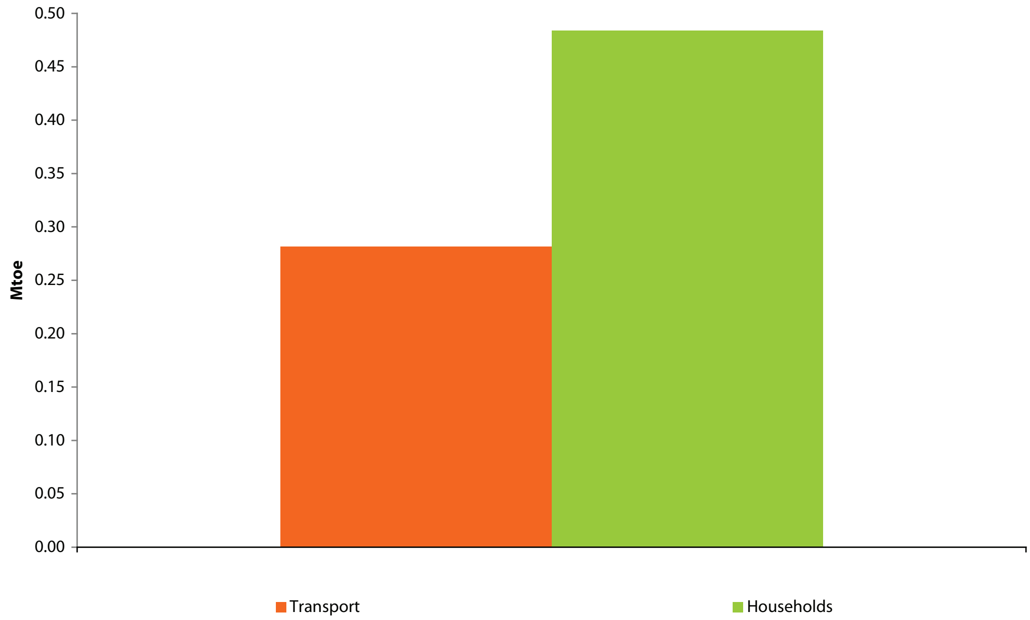


Source: SEI

Figure 40 shows the difference between the technical and observed ODEX indicators for the transport and residential sectors. It highlights the potential savings that are technically achievable in the residential and transport sectors, but have not yet been realised and will require behavioural changes. The potential energy savings in the residential sector was 484 ktoe and 282 ktoe in the transport sector. However, it is not realistic to assume that all the theoretical technical savings can be achieved.

Since the industrial energy savings due to improvements in energy efficiency are calculated using an index of energy intensity at constant structure, a technical index was not calculated for industry.

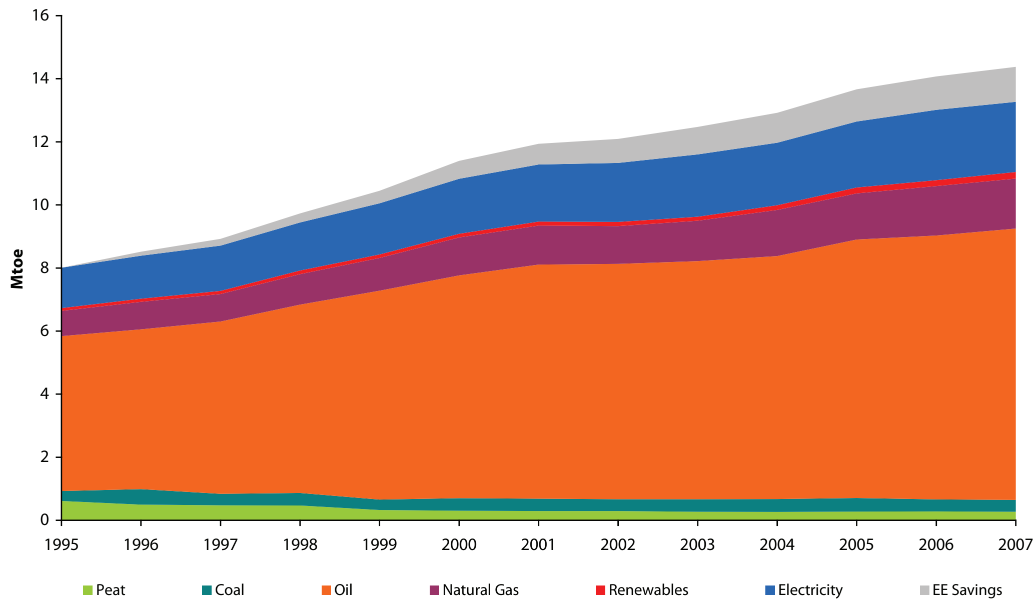
Figure 40 Ireland's potential additional energy savings using the sectoral Technical ODEX indicators



Source: SEI

To make energy efficiency tangible, it is useful to consider it as a fuel (the quantity of fuel saving attributed to energy efficiency) and graph the savings with other fuels. Energy efficiency, indeed, is sometimes referred to as the 'fuel of choice' due to its benefits for the environment and security of supply, as well as for its cost benefits. Figure 41 includes estimated energy savings due to energy efficiency improvement measures from 1995 to 2007. The methodology for calculating these savings is to use the sum of the sectoral savings as calculated by top-down index indicators (as discussed in section 4). The savings in 2007 due to energy efficiency represent slightly less than the total amount of gas consumed for non-electricity generation purposes.

Figure 41 Energy Savings compared to the Total Final Consumption of Fuels 1995 – 2007



Source: SEI

Table 9 Growth Rates and Shares of TFC by Fuels

	Growth %	Average annual growth rates%					Shares %	
	'95 – '07	'95 – '07	'95 – '00	'00 – '05	'05 – '07	2007	1995	2007
Peat	-55.6	-6.5	-13.1	-2.0	-0.4	-4.3	7.6	2.0
Coal	17.9	1.4	4.6	1.8	-7.3	-0.9	4.0	2.8
Oil	75.2	4.8	7.5	3.0	2.5	2.8	61.3	64.9
Natural Gas	98.7	5.9	8.6	4.0	4.0	1.1	10.0	11.9
Renewables	127.2	7.1	5.1	9.4	6.0	9.5	1.1	1.6
Electricity	74.1	4.7	6.4	3.7	3.1	-0.1	16.0	16.8
TD EE savings	-	-	-	12.5	4.4	5.1	0	8.4[72]
Total	82.6	4.3	6.2	3.1	2.4	1.9		

Source: SEI

It is interesting to note that energy efficiency had a faster average annual growth rate than any other fuel over the period 2000 to 2005 (12.5% per annum). It was the second fastest-growing fuel in the period 2005 – 2007, with an average annual growth of 4.4%. The fastest growth rate was 6.0% per annum for renewables. This pattern is repeated in the 2007 growth rates, with renewables growing by 9.5% and energy efficiency by 5.1%. However, the contribution of energy efficiency, at 1.1Mtoe, is over five times that of renewables (0.2 Mtoe). The TFC of renewables is what is used in transport and thermal end use by mode of application. If the total contribution of renewables is taken into account (i.e. including renewables used in electricity generation) energy efficiency is over two and a half times the contribution of renewables.

73 Energy efficiency represents an energy saving. The total final consumption of fuel would have been 8.4% higher had it not been for the energy savings due to energy-efficiency improvement measures in the period 1995 to 2007.

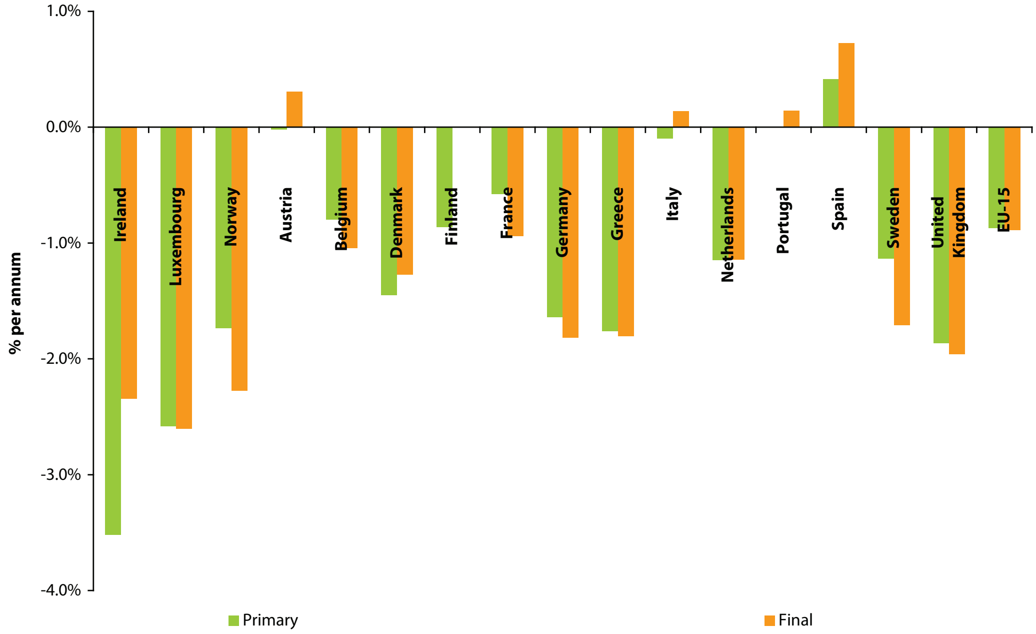
10. International Comparison

In this section, trends in Ireland are compared with trends internationally, using data from the EU ODYSSEE[74] project.

10.1 Energy Efficiency Intensities

Figure 42 and Table 10 illustrate the per annum change in primary and final energy intensity for EU-15 countries and Norway over the period 1990 to 2005. It can be seen that Ireland recorded the largest per annum reduction in primary intensity over the period. Only Luxembourg experienced a slightly greater reduction in final intensity.

Figure 42 Variation of Energy Intensity in EU-15 Countries and Norway 1990 – 2005



Source: ODYSSEE

Primary energy intensity has decreased faster (or increased slower) than final intensity for four countries, (Ireland, Austria, Italy and Spain), indicating an overall improvement in the efficiency of electricity-generating power plants. This has been achieved by the increasing use of combined cycle gas, combined heat and power and wind. The other countries (and the EU-15 as a whole) either recorded similar trends or final intensity decreased at a faster rate than primary intensity. This was the trend for all countries before the advent of new electricity-generating technologies.

74 ODYSSEE is a cross-European project which develops and maintains a database of energy-efficiency indicators. More information can be found at www.ODYSSEE-indicators.org/.

Table 10 Variation of Energy Intensity in EU-15 Countries and Norway 1990 – 2005

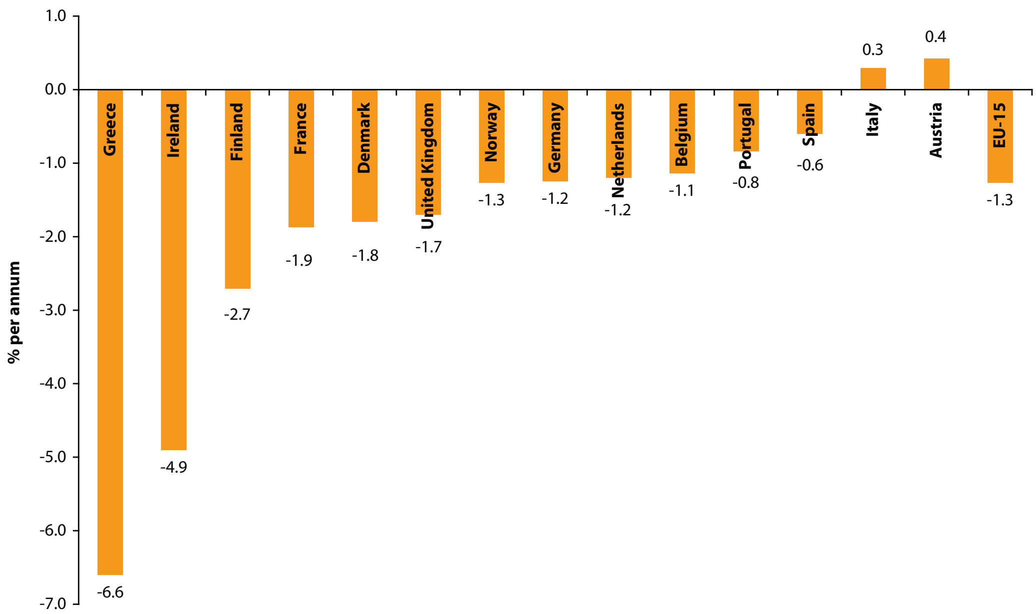
	Primary	Final
Ireland	**-3.52%**	**-2.34%**
Luxembourg	**-2.58%**	**-2.60%**
Norway	**-1.74%**	**-2.27%**
Austria	**-0.02%**	**0.31%**
Belgium	**-0.80%**	**-1.04%**
Denmark	**-1.45%**	**-1.27%**
Finland	**-0.86%**	-
France	**-0.58%**	**-0.94%**
Germany	**-1.64%**	**-1.81%**
Greece	**-1.76%**	**-1.80%**
Italy	**-0.10%**	**0.14%**
Netherlands	**-1.15%**	**-1.14%**
Portugal	-	**0.14%**
Spain	**0.41%**	**0.73%**
Sweden	**-1.13%**	**-1.71%**
United Kingdom	**-1.86%**	**-1.96%**
EU-15	**-0.87%**	**-0.89%**

Source: ODYSSEE

The percentage change in energy intensity per annum in industry is shown in Figure 43. The wide range is evident, with Austria's intensity increasing by 0.4% per annum and Greece's decreasing by 6.6% per annum.

Ireland had the second largest decrease over the period (4.9% per annum) while the intensity for the EU-15 average declined by 1.3% per annum. Note that structural changes, efficiency changes and fuel switching all contribute to these variations.

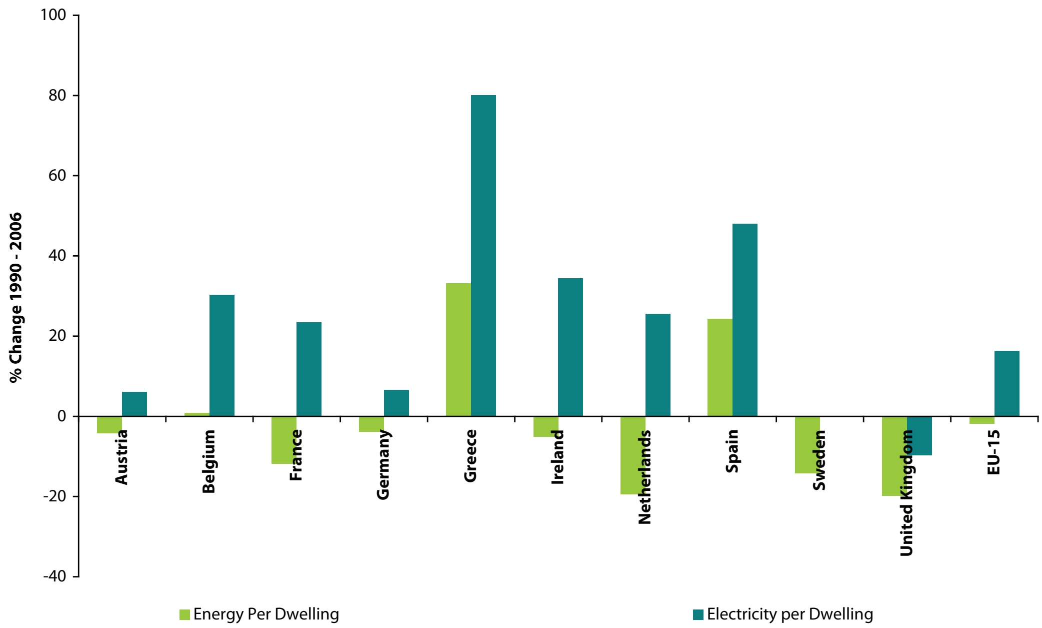
Figure 43 Variation in Industry Energy Intensity 1990 – 2006



Source: ODYSSEE

Figure 44 and Table 11 show the change in energy and electricity per dwelling over the period 1990 to 2006. Only EU-15 countries with a full dataset are included. The data on energy usage per dwelling are climate corrected.

Figure 44 Variation in Energy and Electricity per Dwelling 1990 – 2006



Source: ODYSSEE

Table 11 Variation in Energy and Electricity per Dwelling 1990 – 2006

	Energy per Dwelling (%)	Electricity per Dwelling (%)
Austria	-4.2	6.1
Belgium	0.9	30.3
France	-11.8	23.4
Germany	-3.9	6.6
Greece	33.1	80.1
Ireland	**-5.2**	**34.4**
Netherlands	-19.4	25.5
Spain	24.3	48.0
Sweden	-14.2	-
United Kingdom	-19.8	-9.7
EU-15	-1.9	16.3

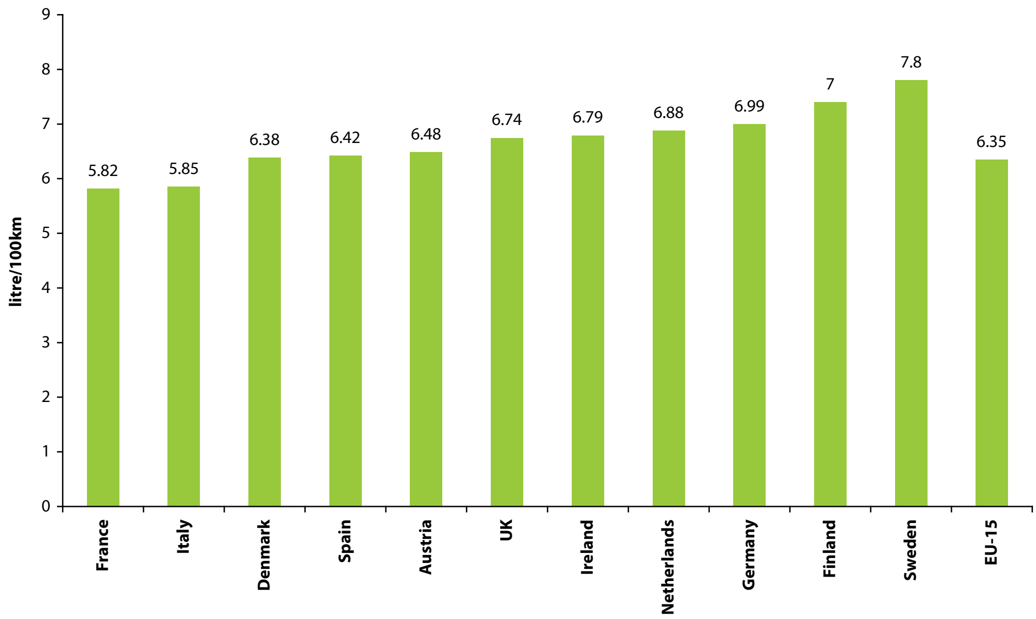
Source: ODYSSEE

It can be seen that all the countries shown have experienced an increase in electricity usage per dwelling over the period. Greece and Spain recorded the largest increases (80% and 48%). The increasing use of air conditioning is one reason for these large values. Ireland increased its electricity usage per dwelling by 34% while the EU-15 average increased by 16%.

The trends in energy usage per dwelling are more mixed. Greece (33%), Spain (24%) and Belgium (0.9%) recorded an increase. Energy per dwelling fell in the other counties. The UK showed the largest decrease (20%) followed by the Netherlands (19%). Energy usage per dwelling in Ireland fell by 5%. The average for the EU-15 fell by 1.9%.

Figure 45 illustrates the specific consumption of new cars in the EU-15 for 2006. The range between the lowest and highest is 1.98 litres/100km. Ireland (6.79 litres/100km) is in the middle of the range, slightly above the EU-15 average (6.35 litres/100km).

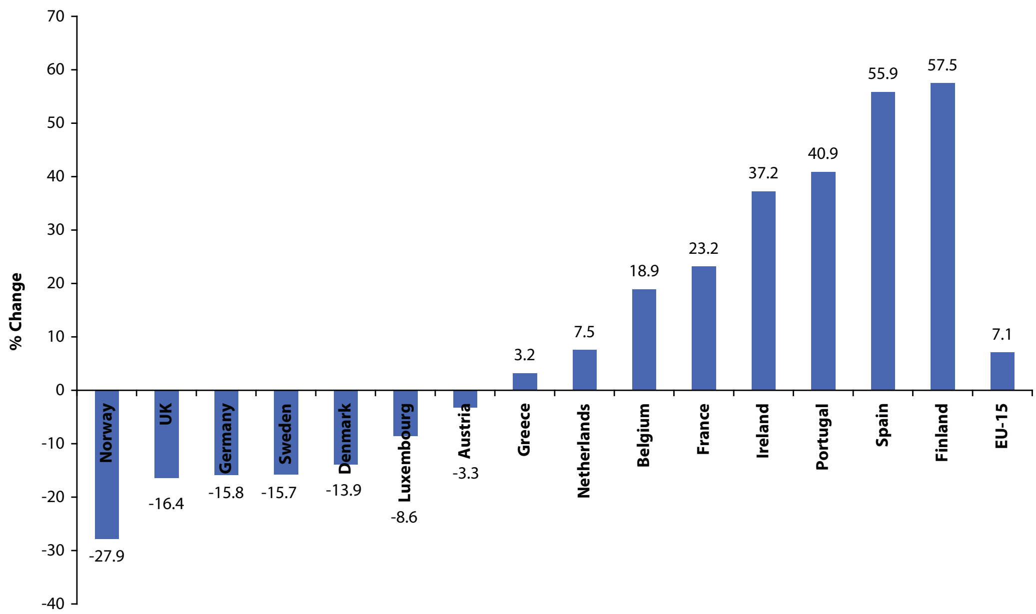
Figure 45 Specific Consumption of New Cars 2006



Source: ODYSSEE

Figure 46 shows the change in the services sector's electricity intensity for the period 1990 to 2005.

Figure 46 Variation in Services Sector Electricity Intensity 1990 – 2005



Source: ODYSSEE

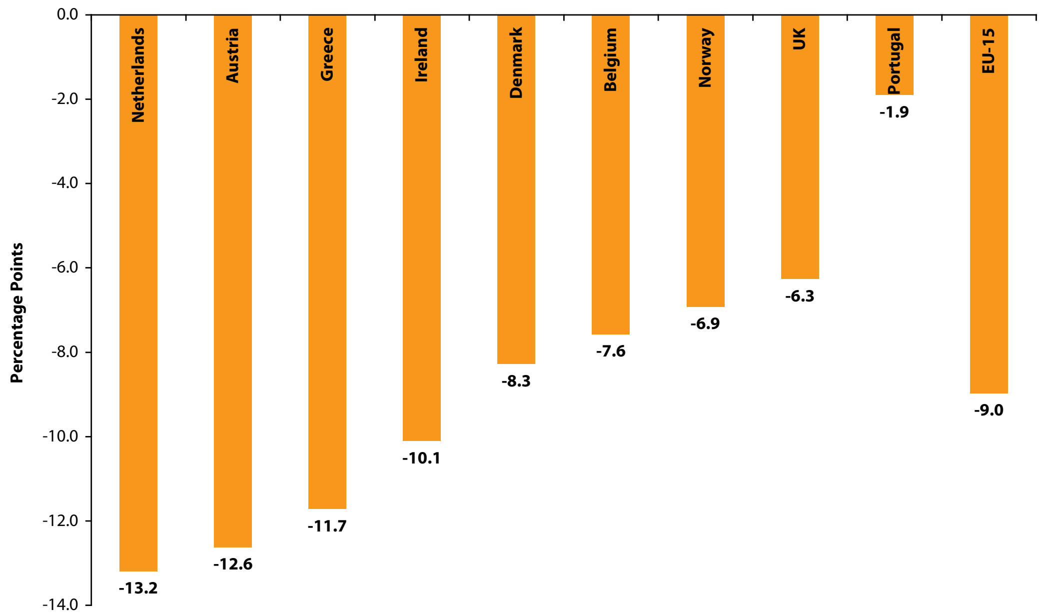
Again, a wide range between countries is evident. Norway recorded the largest reduction (28%) while Finland experienced an increase of 58%. Ireland had the fourth largest increase (37%). The EU-15 average increased by 7%. As discussed in section 4, any change in energy intensity may be due to a number of factors, not necessarily including energy efficiency. Therefore, when examining energy-efficiency trends it is more correct to compare ODEX indicators across countries.

10.2 Energy Efficiency Indicators

Figure 47 shows the change in the observed ODEX for the EU-15 and a selection of countries[75] for the period 1995 to 2005. In the case of Ireland, the contribution from industry to the overall index is an index of intensity at constant structure as opposed to the industry ODEX. The overall energy-efficiency index for Ireland is the weighted sum of this industrial index and the ODEX calculation for both the residential sector and transport.

It can be seen that Ireland experienced the fourth largest reduction of the countries shown. This reduction was greater than the EU-15 average. The improvements are largely from the industry and residential sectors in Ireland's case.

Figure 47 Variation in Energy Efficiency for EU-15 and Selected Countries 1995 – 2005



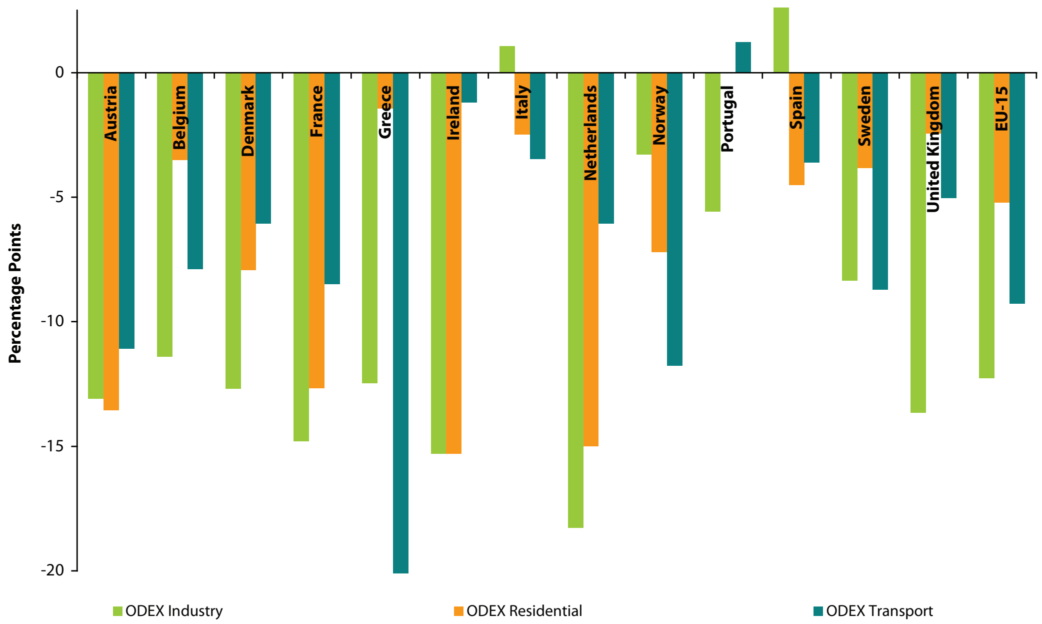
Source: ODYSSEE

Figure 48 and Table 12 show the change since 1995 in sectoral ODEX (observed) for the residential and transport sectors indicators for the EU-15 and Norway. The index of industrial intensity at constant structure for Ireland is compared to the industrial ODEX for all other countries. For countries where all three indicators are available and also for the EU-15, it can be seen that industry has experienced greater improvement in energy efficiency than the transport and residential sectors.

Ireland recorded the largest improvement in energy efficiency in the residential sector (where sectoral energy efficiency indicators are compared). In the industrial sector Ireland achieved the second largest improvement behind the Netherlands. However in the transport sector, Ireland recorded the second lowest improvement in energy efficiency, being placed 12th for the 13 countries compared. Transport in Greece has had a significant improvement.

75 Where data is available for the whole period.

Figure 48 Variation in Sectoral Energy Efficiency for EU-15 and selected Countries 1995 – 2005



Source: ODYSSEE

Table 12 Variation in Sectoral Energy Efficiency 1995 – 2005

	Energy Efficiency Index Industry % Point Change	ODEX Residential % Point Change	ODEX Transport % Point Change
Austria	-13.1	-13.6	-11.09
Belgium	-11.4	-3.5	-7.90
Denmark	-12.7	-7.9	-6.07
France	-14.8	-12.7	-8.48
Greece	-12.5	-1.4	-20.31
Ireland	**-15.3**	**-15.3**	**-1.20**
Italy	1.1	-2.5	-3.46
Netherlands	-18.3	-15.0	-6.06
Norway	-3.3	-7.2	-11.77
Portugal	-5.6	-	1.22
Spain	6.1	-4.5	-3.61
Sweden	-8.4	-3.8	-8.70
United Kingdom	-13.7	-2.5	-5.04
EU-15	-12.3	-5.2	-9.29

Source: ODYSSEE

The industry and residential energy efficiency improvements for Ireland compare well with the other EU-15 countries, but this comparison highlights that a lot more energy-efficiency improvements can be achieved in the transport sector.

11. Conclusions and Next Steps

Energy efficiency provides the quickest and most effective way to respond to the challenges of growing energy dependence, reducing emissions and enhancing security of supply. There are economic benefits to energy efficiency through direct savings on fuel costs and moderation in prices. Energy efficiency also provides the opportunity for innovation and the development of an energy services industry.

This report examines energy usage, intensity and efficiency in order to provide context and background for discussions on future policy options. Analysis has been conducted to understand trends in energy efficiency in Ireland and comparisons made with Ireland's EU counterparts. It is intended that this report will offer timely and comprehensive data on the progress towards meeting the various Irish and European energy-efficiency targets. Subsequent versions of this publication will expand on the progress made, following publication of the National Energy Efficiency Action Plan in 2009.

Ireland's final energy usage increased by 66% (4.3% per annum) over the period 1995 to 2007. The final energy demand would have been higher (8.4%) had it not been for energy-efficiency improvements as measured using the energy-efficiency indicators since 1995. The overall improvement in the observed energy efficiency between 1995 and 2007 was 10% and resulted in a saving of 1.1 Mtoe in 2007. The saving consists of 524 ktoe from the industrial sector, 51 ktoe from the transport sector and 539 ktoe from the household sector.

The difference between the observed and technical energy efficiency for the residential and transport sectors highlights that behavioural changes would result in additional energy-efficiency improvements of an additional six percentage points (766 ktoe in 2007), with existing technology.

Ireland had the fourth largest overall improvement in energy efficiency when compared to the EU-15 and selected other countries[76] since 1995. Ireland recorded the largest improvement in energy efficiency of households and the second largest improvement in energy efficiency in industry. The improvement in energy efficiency in the transport sector is a lot less than in the other countries and the EU-15 average, with Ireland placed 12th out of 13 countries for improvements in this sector.

The European Commission is looking to develop new harmonised top-down and bottom-up indicators for energy efficiency. These two methods of measuring energy efficiency are complementary, as top-down methods assess gross energy savings but do not provide exact measurements of energy savings at the detailed level required to show cause-and-effect relationships and to quantify the individual savings of programmes.

The ODYSSEE project is also developing new indicators. A new global ODEX that will exclude any branches of industry involved in the Emissions Trading Scheme is proposed. This new ODEX could be used as a measure of the progress towards the ESD targets and is to be known as an ESD ODEX. There is also a proposal to develop a competitiveness and innovation indicator for energy-efficient technologies.

There are significant data gaps which require additional effort in data collection in order to model energy efficiency accurately. These gaps appear in all sectors but are most significant in the services sector.

The publication of the final version of the National Energy Efficiency Action Plan in 2009 will provide the detail and direction for the most significant energy-efficiency initiatives that will facilitate meeting the Irish and European targets for energy-efficiency improvements. The recent activity in energy-efficiency initiatives (as mentioned in section 2), such as the VRT changes, the introduction of the Home Energy Savings scheme and the Accelerated Capital Allowance scheme for the industrial sector should lead to a significantly greater improvement in energy efficiency than achieved to date.

This report is presented as a discussion document. Comments from the energy, environment, enterprise and economic policy community are most welcome[77].

76 Where data is available from countries for the whole period.

77 Contact by post to the address on the back cover or by email to epssu@sei.ie

Data Sources

Central Statistics Office

Department of Environment, Heritage and Local Government

International Energy Agency

Met Éireann

ODYSSEE

Vehicle Certification Agency (UK)

Vehicle Registrations Unit

Glossary of Terms

Bottom Up: Energy savings obtained through implementating specific energy-efficiency improvement measures. These improvements are measured in kilowatt –hours (kWh), in Joules (J) or in kilogram oil equivalent (kgoe).

Climate Correction: Annual variations in climate affect the space heating requirements of occupied buildings. Climate correction involves adjusting the energy used for space heating by benchmarking the climate in a particular year with that of a long-term average measured in terms of number of degree days (see Heating Degree Days below).

Energy Intensity: The amount of energy used per unit of activity. Examples of activity used in this report are gross domestic product (GDP), value added, number of households, employees, etc. Where possible, the monetary values used are in constant prices.

Gross Domestic Product: The gross domestic product represents the total output of the economy over a period.

Heating Degree Days: 'Degree Days' is the measure or index used to take account of the severity of the weather when looking at energy use in terms of heating (or cooling) 'load' on a building. A 'Degree Day' is an expression of how cold (or warm) it is outside, relative to a day on which little or no heating (or cooling) is required. It is thus a measure of cumulative temperature deficit (or surplus) of the outdoor temperature relative to a neutral target temperature (base temperature) at which no heating or cooling is required.

Structural Effect: As it affects energy intensity, structural change is a change in the shares of activity accounted for by the energy-consuming sub-sectors within a sector – for instance, in industry the structural effect caused by the change in emphasis of individual sub-sectors such as pharmaceuticals, electronics, textiles, steel, etc in their contribution to gross domestic product.

Total Final Consumption (TFC): This is the energy used by the final consuming sectors of industry, transport, residential, agriculture and tertiary. It excludes the energy sector (electricity generation, oil refining, etc).

Total Primary Energy Requirement (TPER): This is the total requirement for all uses of energy, including energy used to transform one energy form to another (eg burning fossil fuel to generate electricity) and energy used by the final consumer.

Top Down (TD): The amount of energy savings is calculated using national or larger-scale aggregated sectoral levels of energy savings as the starting point.

Value Added: Value added is an economic measure of output. The value added of industry, for instance, is the additional value created by the production process through the application of labour and capital. It is defined as the value of industry's output of goods and services less the value of the intermediate consumptions of goods (raw materials, fuel, etc) and services.

NACE Classification

Section A Agriculture, hunting and forestry

01 Agriculture hunting and related service activities
02 Forestry logging and related service activities

Section B Fishing

05 Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing

Section C Mining and quarrying

10 Mining of coal and lignite; extraction of peat
11 Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction, excluding surveying
12 Mining of uranium and thorium ores
13 Mining of metal ores
14 Other mining and quarrying

Section D Manufacturing

15 Manufacture of food products and beverages
16 Manufacture of tobacco products
17 Manufacture of textiles
18 Manufacture of wearing apparel; dressing and dyeing of fur
19 Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
21 Manufacture of pulp, paper and paper products
22 Publishing, printing and reproduction of recorded media
23 Manufacture of coke, refined petroleum products and nuclear fuel
24 Manufacture of chemicals and chemical products
25 Manufacture of rubber and plastic products
26 Manufacture of other non-metallic mineral products
27 Manufacture of basic metals
28 Manufacture of fabricated metal products, except machinery and equipment
29 Manufacture of machinery and equipment n.e.c.
30 Manufacture of office machinery and computers
31 Manufacture of electrical machinery and apparatus n.e.c.
32 Manufacture of radio, television and communication equipment and apparatus
33 Manufacture of medical, precision and optical instruments, watches and clocks
34 Manufacture of motor vehicles, trailers and semi-trailers
35 Manufacture of other transport equipment
36 Manufacture of furniture; manufacturing n.e.c.
37 Recycling

Section E Electricity, gas and water supply

40 Electricity, gas, steam and hot water supply
41 Collection, purification and distribution of water

Section F Construction

45 Construction

Section G Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods

50 Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel
51 Wholesale trade and commission trade, except of motor vehicles and motorcycles

52 Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods

Section H Hotels and restaurants

55 Hotels and restaurants

Section I Transport, storage and communication

60 Land transport; transport via pipelines
61 Water transport
62 Air transport
63 Supporting and auxiliary transport activities; activities of travel agencies
64 Post and telecommunications

Section J Financial intermediation

65 Financial intermediation, except insurance and pension funding
66 Insurance and pension funding, except compulsory social security
67 Activities auxiliary to financial intermediation

Section K Real estate, renting and business activities

70 Real estate activities
71 Renting of machinery and equipment without operator and of personal and household goods
72 Computer and related activities
73 Research and development
74 Other business activities

Section L Public administration and defence; compulsory social security

75 Public administration and defence; compulsory social security

Section M Education

80 Education

Section N Health and social work

85 Health and social work

Section O Other community, social and personal service activities

90 Sewage and refuse disposal, sanitation and similar activities
91 Activities of membership organisations n.e.c.
92 Recreational, cultural and sporting activities
93 Other service activities

Section P Private households with employed persons

95 Private households with employed persons

Section Q Extra-territorial organisations and bodies

99 Extra-territorial organisations and bodies

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