SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Energy in Ireland 1990 – 2010

2011 Report

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Report prepared by
Martin Howley, Emer Dennehy, Mary Holland and Dr. Brian Ó Gallachóir
Energy Policy Statistical Support Unit

December 2011

Sustainable Energy Authority of Ireland

The Sustainable Energy Authority of Ireland was established as Ireland's national energy authority under the Sustainable Energy Act 2002. SEAI's mission is to play a leading role in transforming Ireland into a society based on sustainable energy structures, technologies and practices. To fulfil this mission SEAI aims to provide well-timed and informed advice to Government, and deliver a range of programmes efficiently and effectively, while engaging and motivating a wide range of stakeholders and showing continuing flexibility and innovation in all activities. SEAI's actions will help advance Ireland to the vanguard of the global green technology movement, so that Ireland is recognised as a pioneer in the move to decarbonised energy systems.

SEAI's key strategic objectives are:

- Energy efficiency first – implementing strong energy efficiency actions that radically reduce energy intensity and usage;
- Low carbon energy sources – accelerating the development and adoption of technologies to exploit renewable energy sources;
- Innovation and integration – supporting evidence-based responses that engage all actors, supporting innovation and enterprise for our low-carbon future.

The Sustainable Energy Authority of Ireland is financed by Ireland's EU Structural Funds Programme co-funded by the Irish Government and the European Union.

Energy Policy Statistical Support Unit (EPSSU)

SEAI 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 SEAI'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.

Foreword


Prof J Owen Lewis

The 2011 Energy in Ireland report is the authoritative analysis of energy use and supply trends in Ireland from 1990 to 2010, with a particular emphasis on patterns in 2010. The figures for 2010 clearly illustrate how related the country's energy demand is to two overriding factors – namely the economy, and the weather.

The year under review was a mixed one illustrating both positive and disappointing patterns of energy usage. As is only too apparent, the contraction of the Irish economy continued in 2010, albeit at a slower rate of decline of 0.4% (2009: -7.0%). While it is encouraging to see enterprises seriously tackling energy wastage in their businesses – industry and transport use both declined (by 23% and 18% respectively from 2007 levels), it is disappointing to see energy use in the built environment, residential and commercial and public sectors increasing. However, these increases must be largely due to the untypical and unusually cold periods of weather in January/February and November/December of 2010.

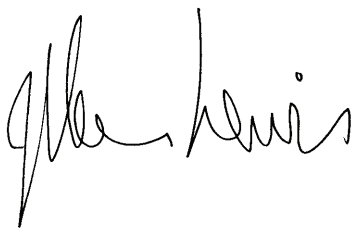
The year thankfully did see a continuation of the appreciation of energy efficiency across all sections of society in Ireland and particularly the residential sector. While consumption in this sector increased by nearly 6% in 2010 in response to the unusually sustained cold weather at the end of the year, when this demand is climate corrected, it indicates a 2.9% decrease in energy use which continues the year-on-year downward trend. It is gratifying to see that the decline indicates the positive impact of the Better Energy Homes Programme and its predecessors, the Home Energy Saving Scheme, the Warmer Homes Scheme and the Greener Homes Scheme. Despite continuing economic pressures facing homeowners, close to €15 million is being invested per month in building energy upgrades.

The weather also had a disappointing impact on renewable energy in 2010. The low North Atlantic Oscillation that occurred for large parts of the year created high pressure for longer than usual periods of time in the winter resulting in a significantly lower average capacity factor for wind energy in Ireland (from annual averages of 31% to 24%). The contribution from hydro also decreased in 2010, resulting in an overall decrease of renewable energy to the electricity mix of 6.7%, made up of a 4.6% decrease in wind's contribution and a 34% decrease in the contribution from hydro.

On a positive note, normalising the statistics for energy from renewables for the effects of climatic variation – a convention allowed for in the Renewable Energy Source Directive (RES) – Ireland used renewables to deliver 14.8% of electricity demand in 2010, surpassing our 2010 RES-E Directive target of 13.2%. In addition, it is worth noting that the capacity to deliver renewable electricity has continued to grow by an average of more than 150 MW per year, reaching 1,585 MW by September 2011.

A particularly encouraging development is the significantly greater involvement of local decision makers and opinion formers in supporting the drive towards sustainable energy. The recent production of renewable energy strategies in counties Mayo and Clare is a clear example of this. Both counties highlight the positive benefits associated with the exploitation of natural renewable resources in a sustainable manner, while critically identifying areas in their counties where such development would be seen in a more favourable light. Another example relates to the GAA, which has become involved in encouraging sustainability with its Sustainability 10k programme which is being piloted in Clonakilty, West Cork. Here is a project stimulating a collective approach to home energy efficiency upgrades which aims to create 10,000 jobs in Ireland.

SEAI's work with Government, communities, enterprises and homeowners shows that there are significant gains to be achieved for Irish society if we continue to invest in sustainable energy solutions. We remain steadfast in pursuing our mission of helping transform Ireland to a society based on sustainable structures, technologies and practices.



Prof J Owen Lewis, Chief Executive, Sustainable Energy Authority of Ireland

Highlights

Highlights – the year 2010

- Ireland's economy contracted by 0.4% in 2010, following a 7.0% decrease in 2009. Overall energy use fell by 0.3%.
- Energy-related CO_2 emissions in 2010 reduced by 1.0% to 42 Mt (34% above 1990 levels).
- Ireland's import dependency was 86% in 2010, down from a peak of 90% in 2006.
- Oil consumption reduced by 4.8% in 2010 and represented 50% of Ireland's overall energy supply. Oil accounted for 61% of final energy demand and 2.8% of electricity generation. Oil demand in buildings increased by 7.1% in 2010.
- Natural gas consumption increased by 9.2% in 2010 and increased its share to 32% of overall energy supply and 61% of electricity generation.
- In 2010, electricity consumption increased by 0.8% while energy-related emissions from electricity increased by 2.9%. In 2010, electricity accounted for less than one fifth (18%) of final energy demand.

Economic recession and energy

- Since 2007, Ireland's economy has contracted by 10%, returning in 2010 to 2005 levels. Energy demand has reduced by 9% to 2003 levels and energy-related CO_2 emissions have fallen by 12% to 2000 levels.
- Transport energy demand in 2010 was 18% lower than 2007 levels, with a 42% reduction in energy use for freight transport.
- Industrial energy demand in 2010 was 23% lower than 2007 levels even though industrial economic activity was 13% higher. Energy demand in industry in 2010 was down to approximately 1997 levels.
- Coal consumption decreased by 24% since 2007.
- Energy in buildings grew by 9% since 2007 despite the economic recession, demonstrating the impacts of weather on energy demand. Natural gas demand in buildings increased by 21% since 2007 and oil by 7%.

Progress towards Targets

- In 2010, gross final energy use from renewable energy was 5.5%. Ireland's target under the EU Renewable Energy Directive is to achieve a 16% renewable energy penetration by 2020.
- Electricity generated from renewable energy (normalised) reached 14.8% of gross electricity consumption (RES-E) in 2010. The national target for 2010 was 15% of electricity consumption generated by renewables and the EU target was 13.2%. Ireland's target for 2020 is 40%.
- Renewable energy contribution to thermal energy (RES-H) was 4.4% in 2010. Ireland's target for 2010 was 5% and the longer-term 2020 RES-H target is 12% .
- Renewable energy in transport (RES-T) reached 2.4% in 2010. Ireland's target was 3% by 2010 and is 10% by 2020.
- Energy-related CO_2 emissions in the non emissions trading (non-ETS) sectors in 2010 were 5.4% below 2005 levels. Ireland's target is to achieve a 20% reduction in total non-ETS emissions by 2020 relative to 2005 levels.
- The average specific emissions from new passenger cars purchased in Ireland in 2010 was 133 g CO_2/km, down from 164 g CO_2/km in 2007. EU Regulation 443/2009 sets a target of 130 g CO_2/km by 2012.

Sectoral Highlights

- Industrial energy use fell by 2.4% in 2010 while economic output from industry increased by 11%.
- Transport energy demand fell by 7.9% in 2010. This comprised of road freight energy falling by 9.5%, private car demand by 2.9% and aviation growing by 2.6%.
- Energy use in buildings increased by 7% in 2010 and accounted for 42% of final demand. Increased energy use in buildings was driven by exceptionally cold weather at the start and end of the year. When corrected for weather, there was a 1.5% reduction in energy use in buildings in 2010.
- Residential energy use increased by 5.9% in 2010, but when climate corrected showed a decrease of 2.9%. Energy consumption per household was 5.2% lower in 2010 than in 2009 (climate corrected).
- Energy use in the services sector increased by 9.4% (1.2% climate corrected) in 2010 and represented 14% of final energy demand.

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1 Introduction

This report examines energy trends in Ireland since 1990 with particular emphasis on 2010, discusses the underlying causes and relates the trends to Government and EU targets in order to inform the development of the policies and measures to meet the targets.

This report is based on data, compiled by SEAI's Energy Policy Statistical Support Unit, which is used to generate the annual energy balance and to fulfil Ireland's legal obligations under the EU Energy Statistics Regulation and to report to the International Energy Agency. The authors are grateful to the Government Departments and Agencies, energy suppliers and distributors for the provision of this data and acknowledge in particular those listed at the end of this report, who provided additional data for this analysis.

This report includes an assessment of the sectoral use of energy. SEAI also publishes individual reports on energy use in the industry, transport, services and residential sectors, which include more detailed analyses. Other reports based on EPSSU's statistical work include analysis of energy efficiency and energy security in Ireland, as well as results of surveys on renewable energy, combined heat and power as well as electricity and gas prices. They are available on our website or in hard copy on request.

This report also examines energy trends between 2005 and 2010, using 2005 as a reference year. This acknowledges the new policy context, aligning with the timescales in the EU Decision 406/2009/EC on Non-Emissions Trading Scheme Effort Sharing on greenhouse gas emissions, which requires a 20% reduction in greenhouse gas emissions for sectors of the EU economy not covered by the EU Emissions Trading Directive.

A companion publication, *Energy Statistics – 2010 Report*, is also available, presenting the background data to the analysis contained herein. It is intended that both these publications serve as resources for policy makers, analysts and researchers with an interest in energy use in Ireland.

Energy balance data analysed in this report were frozen on 17th October 2011. Balance data are updated whenever more accurate information is known. To obtain the most up-to-date balance figures, please visit the statistics publications section on the Sustainable Energy Authority of Ireland's website.

An energy data service is available at http://www.seai.ie/statistics; follow the links for Energy Statistics Databank. This service is hosted by the Central Statistics Office with data provided by SEAI.

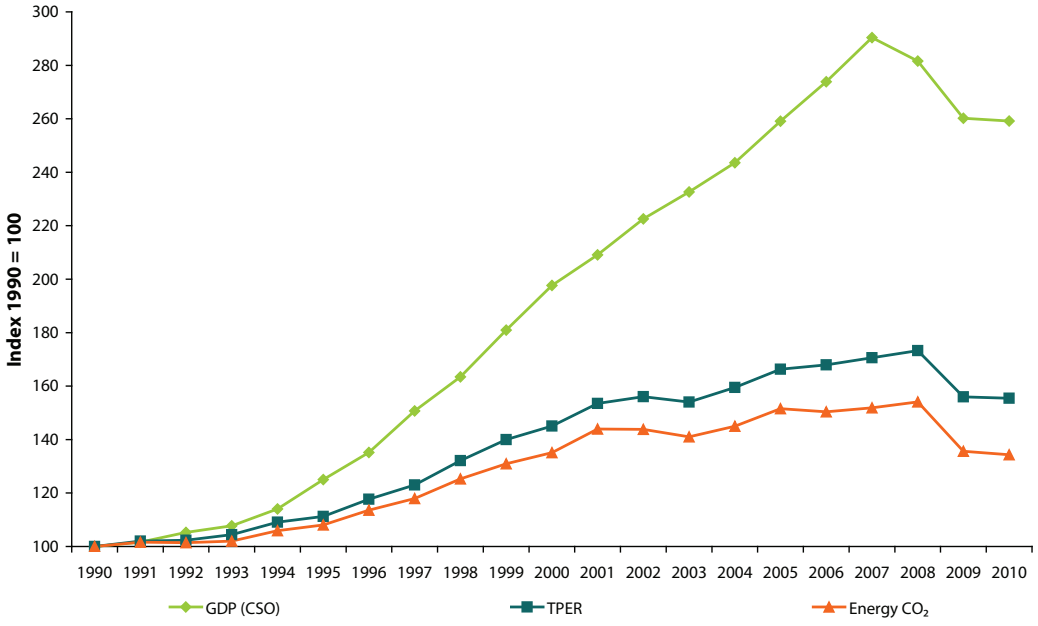
Feedback and comment on the report are welcome and should be addressed by post to the address on the rear cover or by email to epssu@seai.ie.

2 Energy Trends

This section provides an overview of energy trends in Ireland, covering the period 1990 – 2010 with a particular focus on 2010. Ireland's total energy supply (gross energy consumption) is examined first, both in terms of the mix of fuels used and consumption by individual sectors. Trends in final energy demand, i.e. the amount of energy used directly by final consumers, are then assessed. The link between energy use and economic activity, and the impacts of structural and efficiency changes are also discussed and finally electricity production is examined in its own right.

Energy supply depends on i) the demand for energy services and ii) how that demand is delivered. Energy service demand in turn is driven primarily by economic activity. Throughout the 1990s and early 2000s economic growth was particularly strong, especially from 1993 onwards. This resulted in Gross Domestic Product (GDP – a measure of economic growth) in 2007 being almost three times that of 1990. In 2008 the economy experienced a downturn which deepened into 2009. Initially in 2008, certain sectors, namely industry and transport, also experienced reductions in energy use while there was continuing energy growth in the residential and services sectors. This, in part, may be explained by the fact that 2008 was colder than 2007 and undoubtedly contributed to higher energy demand in the heating requirements for residential and services buildings. In 2009, however, all sectors of the economy experienced reductions in energy use and related CO_2 emissions. In 2010, energy use in industry and transport continued to decline; however, both the residential and services sectors, where the energy use is predominantly for space heating, experienced increases due to the severe winter conditions both early and late in the year.

Figure 1 *Index of Gross Domestic Product, Total Primary Energy (TPER) and Energy-Related CO_2*



Source: Based on SEAI and CSO data.

Figure 1 shows the relative decoupling of total primary energy requirement (TPER) (also known as gross inland consumption[1]) from economic growth since 1992, in particular during 2002 – 2003 and 2006 – 2007[2]. This is a result of changes in the structure of the economy and improvements in energy efficiency. To a lesser extent, the decoupling of CO_2 emissions[3] from energy use is also evident, particularly since 1993, and this is due to changes in the fuel mix. The year 2008 is an example of just how factors other than economic factors, as measured by GDP,

1 As energy cannot be created or destroyed energy is not strictly speaking consumed. Energy commodities, or fuels, are in effect energy carriers and allow the energy contained in them to be used for mobility, power and heat purposes. When a commodity is used the energy is not lost but transformed into a state that is no longer readily useful. When this happens the commodity that carried the energy has been consumed and is removed from the energy (commodity) balance. In this way terms such as *Gross Inland Consumption* and *Total Final Consumption* (TFC) may be interpreted as the final consumption of energy commodities.

2 In 2002 and 2003 the reduction in TPER was due to the commissioning of two high-efficiency gas-fired electricity generating plants. A similar situation occurred in 2006 – 2007.

3 Energy-related CO_2 emissions shown here (2010 data are provisional) cover all energy-related CO_2 emissions associated with TPER, including emissions associated with international air transport. These are usually excluded from the national GHG emissions inventory in accordance with the reporting procedures of the UN Framework Convention on Climate Change (UNFCCC) guidelines.

influence overall energy use patterns. The economy declined in 2008 while both energy and energy-related CO_2 continued to rise.

In 2008 the economy entered recession, with GDP falling by 3% compared with 2007, while primary energy use grew by 1.6% and energy related CO_2 emissions grew by 1.4%. In 2009, the downturn in the economy deepened with GDP falling by 7.0% and energy and related CO_2 emissions falling by 10% and 12% respectively. With energy use falling at a faster rate than GDP and emissions falling faster than energy use, there continues to be decoupling of energy use from economic activity and emissions from energy use. In 2010 the rate of decline of the economy reduced to a fall of 0.4% while overall energy use fell by 0.3% and emissions by 1%. *Table 1* tabulates the growth rates for the economy (GDP), primary energy (TPER) and energy-related CO_2 emissions for the period 1990 – 2010. It emphasises the high GDP growth rates compared with those for energy and CO_2 prior to 2008 and the continued decreases in GDP, primary energy and energy-related CO_2 in 2010.

It is interesting to compare the trend over the five-year period 2005 – 2010 with that for the whole period, given the significance of 2005 with respect to the EU Decision 406/2009/EC on Non-Emissions Trading Scheme Effort Sharing. Under the EU Decision Ireland's greenhouse gas emissions in non-ETS sectors (i.e. in transport, agriculture, heating in buildings, waste and small industry) are required to be 20% below 2005 levels by 2020. Estimation of non-ETS energy emissions is shown in section 3.1.1. Over the past five years, all energy-related CO_2 emissions have decreased by 2.4% per annum on average, an aggregate decrease of 11.3% returning to 2000 levels, while the economy has returned to 2005 levels. Over the period since 1990 by contrast, energy-related CO_2 emissions grew by 1.5% per annum, while the economy grew by 4.9% per annum.

Table 1 *GDP[4], TPER and CO_2 Growth Rates[5]*

	Growth %	Average annual growth rates %					
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010
GDP	159.2	4.9	4.6	9.6	5.6	0.0	-0.4
TPER	55.4	2.2	2.2	5.4	2.8	-1.3	-0.3
Energy CO_2	34.4	1.5	1.6	4.6	2.3	-2.4	-1.0
Energy CO_2 (excl. international aviation)	31.4	1.4	1.6	4.4	2.1	-2.4	-1.2

With reference to *Table 1*, the rate of decrease in energy use in 2010 at 0.3% is less than the aggregate per annum decrease between 2005 and 2010 of 1.3%.

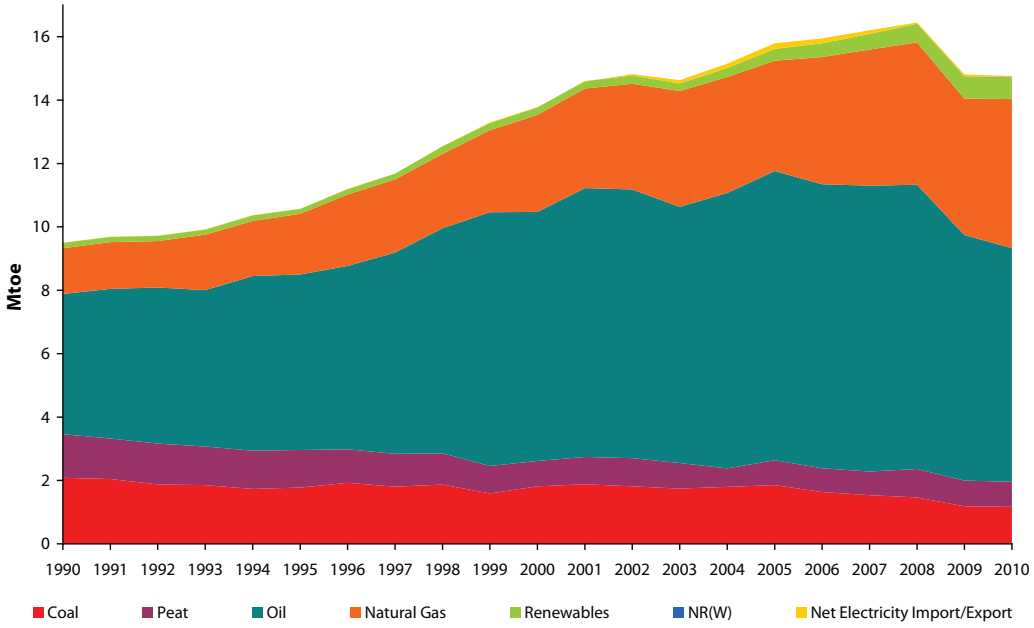
2.1 Energy Supply

Ireland's energy supply is discussed in terms of changes to the total primary energy requirement (TPER), defined as the total amount of energy used within Ireland in any given year. This includes the energy requirements for the conversion of primary sources of energy into forms that are useful for the final consumer, for example electricity generation and oil refining. These conversion activities are not all directly related to the level of economic activity that drives energy use but are dependent to a large extent, as in the case of electricity, on the efficiency of the transformation process and the technologies involved.

Figure 2 illustrates the trend in energy supply over the period 1990 – 2010, emphasising changes in the fuel mix. Primary energy consumption in Ireland in 2010 was 14.8 million tonnes of oil equivalent[6] (Mtoe), down from a peak of 16.5 Mtoe in 2008.

4 Gross Domestic Product (GDP) rates are calculated using constant market prices chain-linked annually and referenced to year 2006.
5 Throughout the report where annual growth rates are across multiple years they always refer to *average annual growth rates*.
6 A tonne of oil equivalent (toe) is a unit of energy roughly equivalent to the energy content of one tonne of crude oil. The definition in energy terms is that 1toe = 10^7 kilocalories = 41.868 gigajoules (GJ).

Figure 2 *Total Primary Energy Requirement*



Over the period 1990 – 2010 Ireland's total annual primary energy requirement grew in absolute terms by 55% (2.2% per annum on average). In 2010 Ireland's primary energy requirement decreased by 0.3%. The individual fuel growth rates and shares are shown in *Table 2*. Primary energy requirement peaked in 2008 and has fallen by 10% since then.

Table 2 *Growth Rates and Shares of TPER Fuels*

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Fossil Fuels (Total)	50.4	2.1	2.2	5.4	2.4	-1.6	-0.1	98.2	95.1
Coal	-44.0	-2.9	-3.1	0.4	0.4	-8.9	-1.3	22.0	7.9
Peat	-42.6	-2.7	-3.0	-7.5	-0.4	0.1	-3.1	14.5	5.4
Oil	66.7	2.6	4.6	7.3	3.0	-4.2	-4.8	46.6	49.9
Natural Gas	225.3	6.1	5.8	9.8	2.6	6.2	9.2	15.2	31.9
Renewables (Total)	304.6	7.2	-1.6	8.7	9.8	12.6	-0.8	1.8	4.6
Hydro	-14.0	-0.8	0.5	3.5	-5.7	-1.0	-33.5	0.6	0.3
Wind	-	-	-	72.4	35.4	20.4	-4.6	0.0	1.6
Biomass	96.3	3.4	-3.3	4.9	9.8	2.8	6.8	1.1	1.4
Other Renewables	7423.6	24.1	4.8	56.5	10.1	31.4	12.2	0.0	1.2
Non-Renewable (Wastes)	-	-	-	-	-	-	-29.4	0.0	0.1
Electricity Imports	-	-	-	53.2	64.7	-18.0	-19.1	0.0	0.4
Total	**55.4**	**2.2**	**2.2**	**5.4**	**2.8**	**-1.3**	**-0.3**		

The following are the main trends in national fuel share:

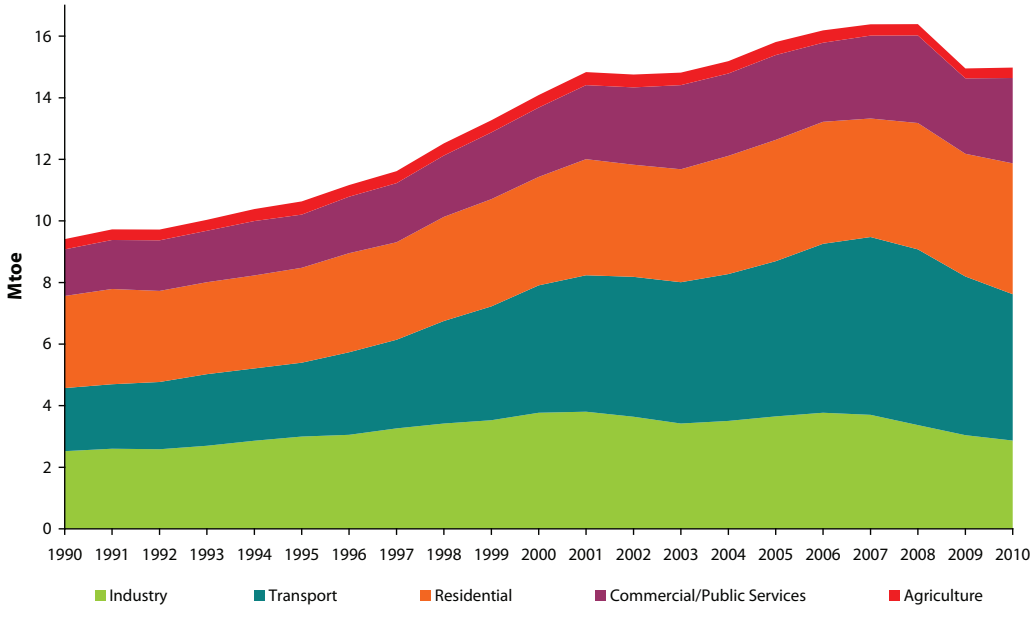
- All fuels, with the exception of natural gas, biomass and other renewables experienced reductions in consumption in 2010. Natural gas use increased by 9.2%, biomass by 6.8% and other renewable use increased by 12%.
- Fossil fuels accounted for 95% of all energy used in Ireland in 2010. This does not include the embodied fossil fuel content of imported electricity. Demand for fossil fuels fell by 0.1% in 2010 and 7.9% since 2005.
- Oil continues to be the dominant energy source with that dominance increasing from a share of 47% in 1990 to a peak of 60% in 1999. The share of oil in primary energy in 2010 fell to just under 50% in 2010. Consumption of oil, in absolute terms, decreased by 4.8% in 2010 following a 14% decrease in 2009. Over the five years 2005 – 2010, oil demand has fallen by 19% (4.2% per annum).
- Natural gas use increased in 2010 by 9.2% and its share of TPER was 32%. Increased gas use in 2010 is mainly due to the severe winter conditions experienced at the start and end of the year and the increased space heating requirements in the residential and services sectors. Gas demand also increased in electricity generation as a

result of the commissioning of new gas fired power stations at Whitegate and Aghada. Over the five years 2005 – 2010, natural gas has increased by 35% (6.2% per annum).

- In absolute terms over the period 1990 – 2010 coal declined by 44%. In 2009 the use of coal fell by 19% over the previous year and continued to fall in 2010 by 1.3% in spite of the exceptionally cold conditions. Coal use in electricity generation increased by 12% in 2010 and fell by 3.5% in the residential sector. Over the five years 2005 – 2010, coal demand has fallen by 37% (8.9% per annum).
- Peat use fell by 3.1% in 2010 and over the period 1990 – 2010 its use declined by 43% and its share in primary energy fell from 14% to 5.4%. The decrease in use of peat in 2010 occurred both in electricity generation (-13%) and the residential sector (-6.7%).
- Wind energy experienced a fall in 2010 of 4.6% following a growth of 23% in 2009. The decrease in energy production from wind was, notwithstanding a 9.9% growth in generating capacity, as a result of the fall in the wind resource (wind blew less) in 2010. Wind energy represented 1.6% of primary energy requirement in 2010.
- Hydro suffered a similar fate as wind in 2010 as there was significantly less rainfall. Energy production from hydro fell by 34% in 2010.
- Renewable energy in total fell slightly by 0.8% during 2010. On average in the period 2005 – 2010, renewable energy demand has increased by 13% per annum. Since 1990 renewable energy has grown by 305% (7.2% per annum on average) in absolute terms.
- Electricity imports decreased by 19% in 2010 but only accounted for 0.4% of primary energy.

Figure 3 allocates Ireland's primary energy supply to each sector of the economy, according to its energy demand. The allocation is straightforward where fuels are used directly by a particular sector. Regarding electricity, the primary energy associated with each sector's electricity consumption is included to yield the total energy supply for each sector.

Figure 3 *Total Primary Energy Requirement by Sector*[7]



Primary energy supply gives a more complete measure than final energy demand (accounted for in the gas, oil, electricity and coal bills) of the impact of the individual sectors on energy use and on energy-related CO_2 emissions.

Table 3 tabulates the growth rates of the different sectors in terms of TPER and also provides the shares for 1990 and 2010. Industry and transport experienced a reduction in primary energy use in 2010 while residential and services experienced increases.

7 International air transport kerosene is included in the transport sector in these graphs. Later graphs showing CO_2 emissions by sector omit air international transport energy emissions following UN Intergovernmental Panel on Climate Change (IPCC) guidelines. In addition, the effects of cross border trade (*fuel tourism*) and smuggling of diesel and petrol are not included in this analysis. Estimates of fuel tourism produced by the Dept. of Environment, Heritage & Local Government are now included in the energy balance and presented in the transport section.

Table 3 *Growth Rates and Shares of TPER by Sector*

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Industry	13.7	0.6	3.5	4.7	-0.6	-4.7	-5.6	26.8	19.2
Transport	132.0	4.3	3.2	11.5	4.0	-1.2	-7.9	21.8	31.7
Residential	42.0	1.8	0.6	2.7	2.3	1.5	6.7	31.8	28.4
Commercial / Public	83.2	3.1	2.7	5.5	4.1	0.1	13.2	16.1	18.5
Agriculture	2.3	0.1	5.4	-1.0	0.5	-4.3	5.3	3.5	2.3
Total	**55.4**	**2.2**	**2.2**	**5.4**	**2.8**	**-1.3**	**-0.3**		

Changes in sectoral primary energy consumption presented in *Table 3* are as follows:

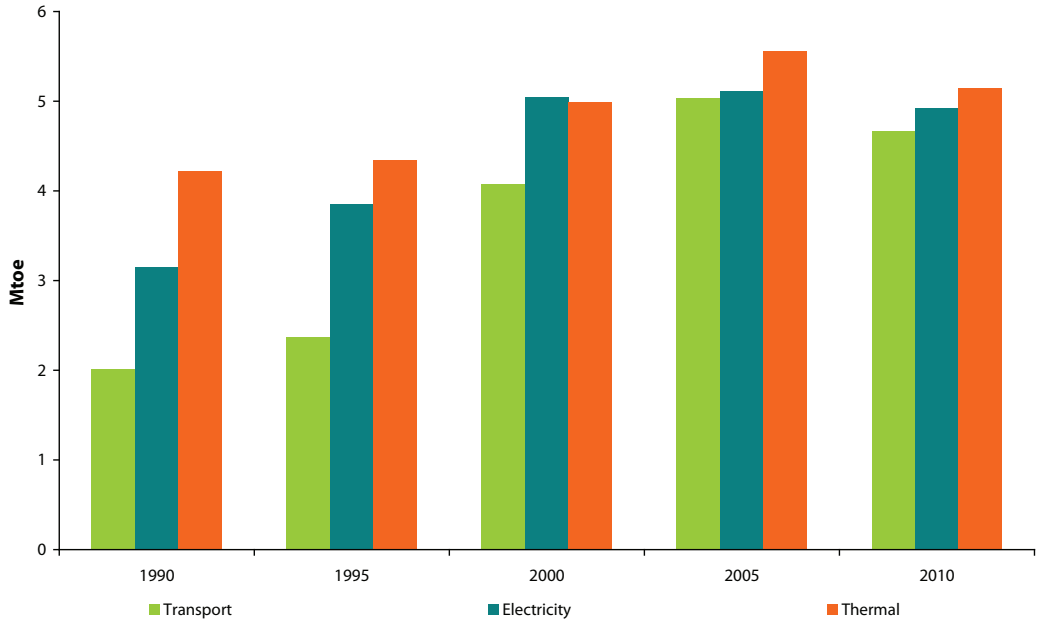
- Transport energy use grew by 132% over the period 1990 – 2010 (4.3% per annum). Transport consumes just less than one third of all energy in Ireland. The highest growth was experienced in the 1995 – 2000 period when the average annual growth was 11.5%. Transport primary energy use fell for the first time during 2008, by 1.2%, as a result of the economic downturn. Transport energy use continued to fall in 2009 and 2010 by 9.6% and 7.9% respectively.
- Industry energy use fell by 5.6% in 2010. Industry's share of primary energy fell to 19% in 2010. Primary energy use in industry has been falling since 2006.
- Residential share of primary energy use increased to 28% in 2010, up from 27% in 2009. In 2010, primary energy use in households increased by 6.7%. This is far in excess of the average annual growth over the last number of years and over the period as a whole. This is primarily due to the exceptionally cold weather in 2010 and as is shown later in the report, when corrected for climate variations, energy demand in this sector was lower in 2010 reflecting improvements in the thermal performance of the building stock.
- Use of primary energy in the commercial and public services sector increased by 13% in 2010 following a fall of 14% in 2009. Over the period 1990 – 2010 the services sector had the second highest growth of all sectors, consuming 83% more in 2010 than in 1990.
- Energy use in the residential sector and services sector can be considered collectively as energy in buildings as most of the energy use is associated with heating/cooling and lighting the buildings. In 2010, primary energy in buildings accounted for 47% of primary energy supply. Overall, primary energy use in buildings increased by 56% since 1990 (2.2% per annum) and in 2010 by 9.2%.
- Agriculture energy use increased by 5.3% in 2010.

2.2 Energy Use by Mode of Application

Energy use can be categorised by its mode of application; that is, whether it is used for mobility (transport), power applications (electricity) or for thermal uses (space or process heating). These modes also represent three distinct energy markets.

In 1990 thermal uses for energy accounted for a significant proportion of all primary energy (45%). Electricity accounted for 33% and transport 22%. This contrasts with the situation in 2010 when the transport share was 32%, thermal was 35% and energy use for electricity generation was 33%. The changes in mode shares are shown graphically in *Figure 4*.

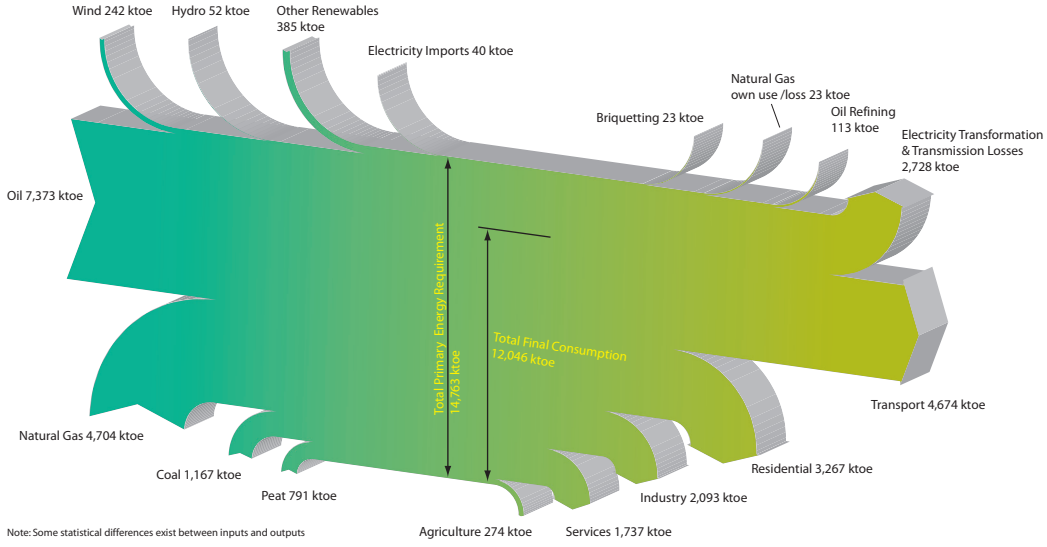
Figure 4 *Primary Energy by Mode of Application*



2.3 Energy Balance for 2010

Figure 5 shows the energy balance for Ireland in 2010 as a flow diagram. This illustrates clearly the significance of each of the fuel inputs as well as showing how much energy is lost in transformation and the sectoral split of final energy demand.

Figure 5 *Energy Flow in Ireland 2010*[8]



Oil dominates as a fuel, accounting for 50% of the total requirement. Renewables are disaggregated into wind, hydro and other renewables in this version of the diagram. Transport continues to be the largest of the end use sectors, using 39% of the final energy demand in Ireland in 2010.

Losses associated with the transformation of primary energy to electricity, power plant in-house load and electricity network losses were 18% of TPER or 2,728 ktoe in 2010 (55% of primary energy used for electricity generation).

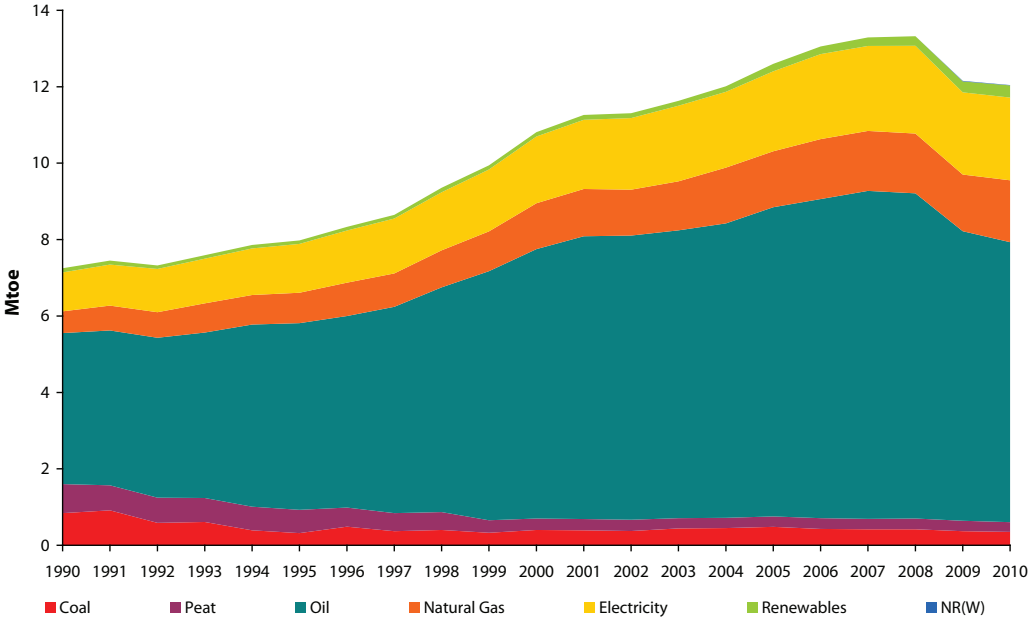
8 All energy inputs shown here represent the sum of indigenous production plus, where applicable, net imports i.e. imports minus exports.

2.4 Energy Demand

Final energy demand is a measure of the energy that is delivered to energy end users in the economy to undertake activities as diverse as manufacturing, movement of people and goods, essential services and other day-to-day energy requirements of living such as space and water heating, cooking, communication, entertainment etc. This is also known as Total Final Consumption (TFC) and is essentially total primary energy less the quantities of energy required to transform primary sources such as crude oil into forms suitable for end use consumers such as refined oils, electricity, patent fuels etc (transformation, processing or other losses entailed in delivery to final consumers are known as "energy overhead").

Figure 6 shows the shift in the pattern of final energy demand by fuel over the period 1990 – 2010.

Figure 6 *Total Final Consumption by Fuel*



Ireland's TFC in 2010 was 12 Mtoe, a decrease of 0.9% on 2009 and 66% above 1990 levels (representing growth of 2.6% per annum on average). This decrease in final consumption in 2010 compares with a 0.3% decrease in primary energy, indicating a small decrease in efficiency of supply. Final consumption peaked in 2008 and has fallen by 9.6% since. The changes in the growth rates and respective shares of individual fuels in final consumption over the period are shown in *Table 4*.

Table 4 *Growth Rates and Shares of TFC Fuels*

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Fossil Fuels (Total)	56.1	2.3	1.5	6.3	2.9	-1.5	-1.6	84.4	79.3
Coal	-58.4	-4.3	-17.7	4.6	4.0	-6.2	-4.8	11.6	2.9
Peat	-66.5	-5.3	-4.2	-13.1	-2.0	-1.5	-6.9	10.4	2.1
Oil	85.5	3.1	4.3	7.6	2.8	-2.0	-3.3	54.5	60.9
Natural Gas	184.0	5.4	7.0	8.6	4.0	2.0	9.1	7.9	13.4
Renewables	197.8	5.6	-3.1	5.1	10.5	10.6	11.0	1.5	2.7
Non-Renewable (Wastes)	-	-	-	-	-	-	-29.4	0.0	0.1
Combustible Fuels (Total)	58.2	2.3	1.5	6.2	3.0	-1.2	-1.3	85.9	81.8
Electricity	112.0	3.8	4.6	6.4	3.7	0.7	0.8	14.1	18.0
Total	**66.2**	**2.6**	**1.9**	**6.3**	**3.1**	**-0.9**	**-0.9**		

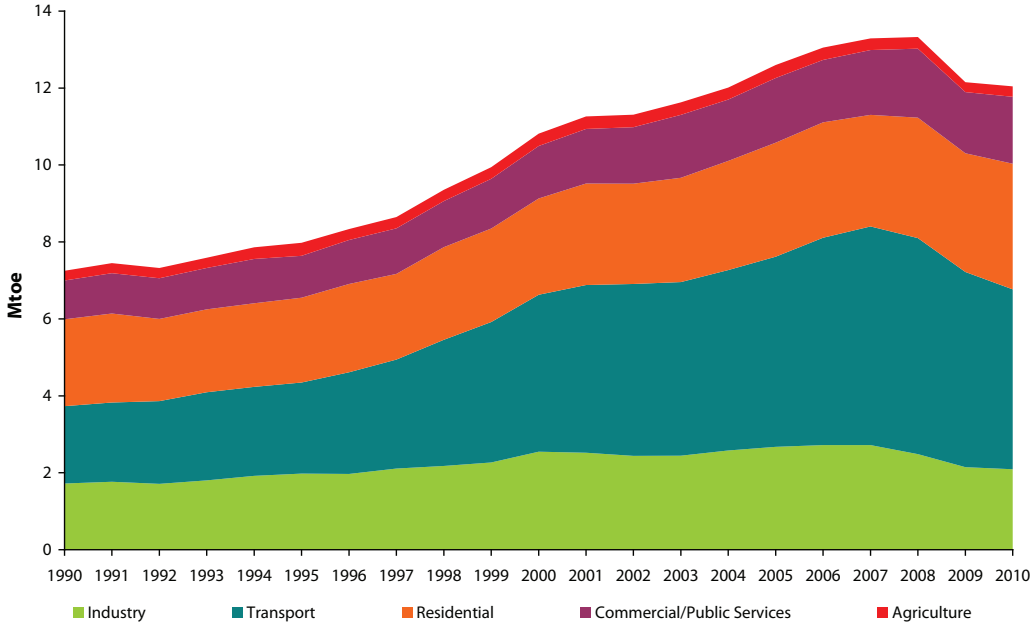
The most significant changes can be summarised as follows:

- Natural gas, energy from renewable sources and electricity were the only categories of final energy that experienced increased use in 2010. Gas consumption increased by 9.1% and renewables by 11%. Electricity final consumption increased slightly by 0.8%.

- Final consumption of oil fell by 3.3% in 2010 following a fall of 11% in 2009. Its share of final energy consumption fell to 61% from 62% in 2009 and 64% in 2008.
- Natural gas experienced an increase in consumption in 2010 with a growth of 9.1%. This increased gas consumption is due mainly to the increased space heating requirements in buildings as a result of the two very cold spells at the beginning and end of the year. Residential and services gas consumption increased by 13.6% and 2.7% respectively. Gas consumption also increased in industry in 2010 – by 8.8%.
- Final consumption of coal decreased by 4.8% following a 12% reduction in 2009. Its share of final use in 2010 was at 2.9%.
- Final consumption of electricity in 2010 increased by 0.8%. In 2010, electricity accounted for 18% of final energy use.
- Final consumption of peat decreased by 6.9% in 2010 following a 2.6% fall in 2009.

Figure 7 also shows the trend in TFC over the period, here allocated to each of the sectors of the economy.

Figure 7 *Total Final Energy Consumption by Sector*



The effect of the economic downturn is evident from 2008 onwards. Transport continued to dominate (since the mid 1990s) as the largest energy consuming sector (on a final energy basis) with a share of 39% in 2010. The shares of industry and residential sectors have decreased since 1990 although the residential share increased by 2% points in 2010 to 27%. Transport's share has been falling since 2006 when it accounted for 43% of final energy use. In 2010, the share of transport was down to 39%.

Table 5 *Growth Rates and Shares of TFC by Sector*

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Industry	21.7	1.0	2.9	5.2	1.0	-4.8	-2.4	23.7	17.4
Transport	132.4	4.3	3.3	11.5	3.9	-1.1	-7.9	27.7	38.8
Residential	44.7	1.9	-0.5	2.6	3.4	2.0	5.9	31.2	27.1
Commercial / Public	72.4	2.8	1.5	4.6	4.3	0.6	9.4	13.9	14.4
Agriculture	8.5	0.4	6.2	-1.4	1.2	-4.0	5.4	3.5	2.3
Total	**66.2**	**2.6**	**1.9**	**6.3**	**3.1**	**-0.9**	**-0.9**		

The changes in growth rates are tabulated in *Table 5* and summarised as follows:

- Overall final energy consumption decreased by 0.9% in 2010, a lower rate of decline than the 8.8% reduction experienced in 2009.
- Transport final energy use increased by 132% over the period 1990 – 2010. Final consumption of energy in

transport was 4.7 Mtoe in 2010. This represents an average annual growth rate of 4.3% and transport's share of TFC increased from 28% to 39%. Energy use in transport fell in 2010 by 7.9%. In the period 2005 – 2010, transport energy demand fell by 1.1% per annum on average.

- Industry experienced continued decrease in final energy use in 2010, falling by 2.4% following a decrease of over 13% in 2009. Over the 1990 – 2010 period industry experienced an average growth rate of 1% per annum (or 22% in absolute terms) and its share of TFC dropped from 24% to 17%. Since 2005, industry energy demand has been falling at a rate of 4.8% per annum on average, in contrast to the growth levels in the late 1990s of more than 5% per annum.
- Final energy use in the residential sector increased by 5.9% in 2010 mainly due to colder weather. Correcting for climate[9], there was a 2.9% decrease in residential energy use.
- The commercial and public services sector also experienced increased final energy use in 2010, growing by 9.4%, again due to the cold weather. Correcting for climate the increase was 1.2%.
- The agricultural sector's relative share fell from 3.5% in 1990 to 2.3% in 2010. In absolute terms, agriculture experienced an increase of 5.4% in energy consumption in 2010.

2.5 Energy Intensities

Energy intensity is defined as the amount of energy required to produce some functional output. In the case of the economy, the measure of output is generally taken to be gross domestic product (GDP)[10]. GDP measured in constant prices is used to remove the influence of inflation. The inverse of energy intensity represents the energy productivity of the economy.

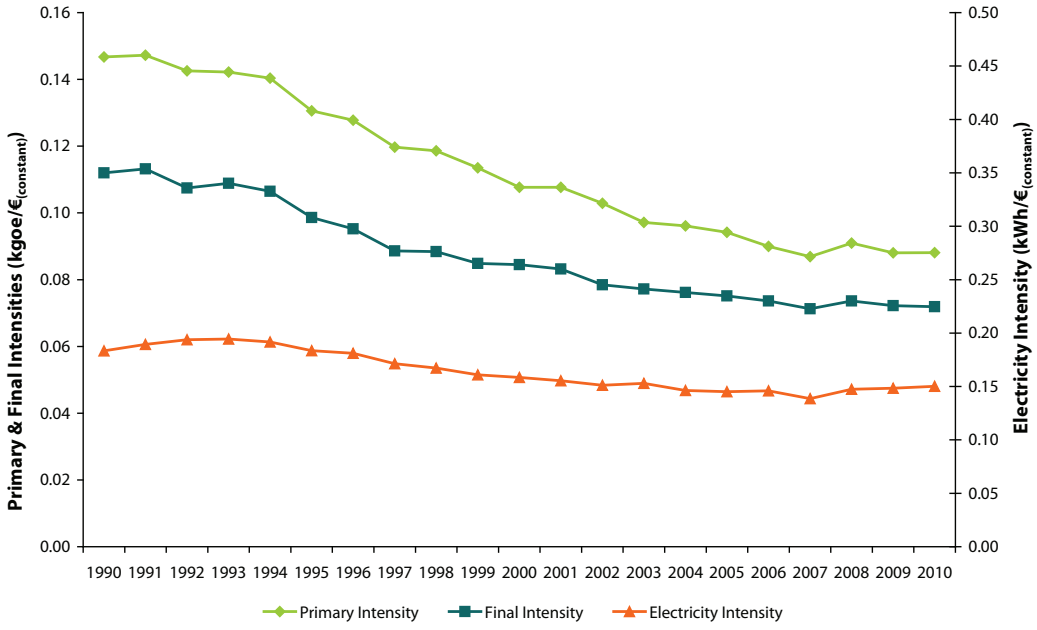
The intensity of primary and final energy and of electricity requirements has been falling (reflecting improving energy productivity) since 1990 as shown in *Figure 8*. The primary energy intensity of the economy fell by 41% between 1990 and 2007 (3% per annum). In 1990 it required 147 grammes of oil equivalent (goe) to produce one euro of GDP (in constant 2006 values) whereas in 2007 just 87 goe was required. However, during 2008 the primary energy intensity increased by 4.7% to 91 goe/€$_{2006}$ before falling again in 2009 to 88 goe/€$_{2006}$ and remained at this level in 2010.

Figure 8 shows the trend in both primary (TPER/GDP) and final (TFC/GDP) energy intensities (at constant 2006 prices). The difference between these two trends reflects the amount of energy required in the transformation from primary energy to final energy – primarily used for electricity generation. Throughout the 1990s there was a slight convergence of these trends, particularly since 1994, mostly reflecting the increasing efficiency of the electricity generation sector. This trend towards convergence intensified from 2001 onwards (increased efficiency in electricity generation) when primary intensity fell at a faster rate than final intensity. The decrease in primary intensity since 2001 was 18% whereas for final intensity the decrease was 14%. Conversely, the increase in final intensity of 3.3% in 2008 is related to the downturn in the economy and the effects of 2008 being colder. In 2009 primary energy intensity fell by 3.2% and final intensity by 1.9%. In 2010 both primary and final intensities remained virtually static as any further efficiency changes were masked by lack of economic growth and weather impacts.

9 See Glossary for description of Climate Correction.

10 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.

Figure 8 *Primary, Final and Electricity Intensity*



Final electricity intensity of the economy has not been falling as fast as primary or final energy intensities. Over the period 1990 – 2007 the electricity intensity fell by 24%. This is attributed to the shift towards increased electricity consumption in energy end use. While electricity consumption increased by 112% since 1990 (3.8% average annual growth), final energy demand increased by 66% (2.6% annual growth). Electricity final intensity increased in 2008 by 6.3%, in 2009 by 0.6% and in 2010 again by 1.2%.

There are many factors that contribute to how the trend in energy intensity evolves. These factors include technological efficiency and choice of fuel mix, particularly in relation to electricity generation; economies of scale in manufacturing, and not least the structure of the economy. Economic structure in Ireland's case has changed considerably over the past twenty years. The structure of the economy has shifted in the direction of the high value-added[11] sectors such as pharmaceuticals and electronics, and more towards the services sector. Relative to traditional "heavier" industries, such as car manufacturing and steel production, these more recently added sectors are not highly energy intensive. Major changes to the industrial structure include the cessation of steel production in 2001, fertiliser production in late 2002 and sugar production in 2007.

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 actual processes used are more energy efficient. There may therefore still be room for improvement.

The increase in intensities in 2008 is interesting if not unexpected. Apart from some loss of economies of scale due to the downturn which would increase intensity, energy use in Ireland is coupled with climate as well as with the economy. As 2008 was considerably colder than 2007, energy use increased at a time when the economy declined.

Interestingly, 2010 was even colder than 2008 yet primary energy intensity remained fairly stable, increasing by just 0.08%. This is partly explained by what happened in industry in 2010. Value added in industry increased by over 11% while energy use fell by 2.4%, giving a 12% improvement in the energy intensity of industry. So while the energy productivity of the economy was being hampered by increased energy demand due to the cold weather this was being offset by increased output from the high value added, low energy consuming, sectors of industry.

2.6 Energy Efficiency

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. For a more detailed discussion on energy efficiency in Ireland see the SEAI's *Energy Efficiency in Ireland 2009 Report*[12]. However the energy-efficiency indicators presented in this report are updated, using 2010 figures.

11 See Glossary.
12 Available from www.seai.ie.

As mentioned in section 2.5 energy intensity is a crude indicator and variation may be as a result of many factors such as economic, structural, technical, behavioural issues, or because real energy efficiency gains have been made. To better understand energy efficiency 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[13]. This type of analysis has been developed since 1993 through the ODYSSEE[14] project, which includes Irish involvement through SEAI. A set of indicators have been developed which measure achievements in energy efficiency at the level of the main end-uses.

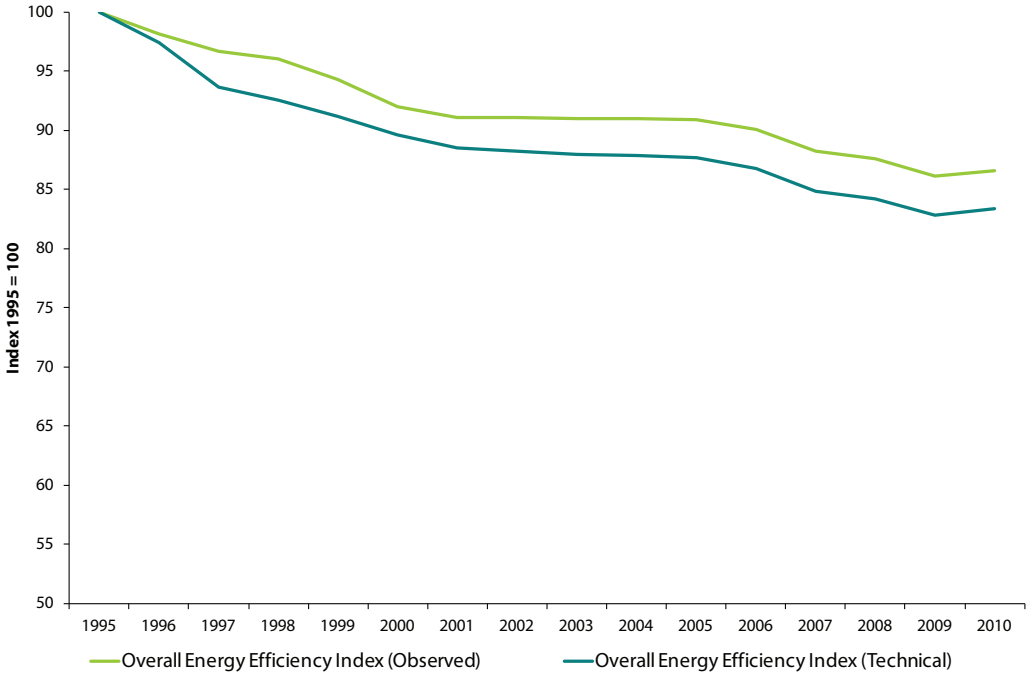
The indicators developed include ODEX indicators which are referenced in the Energy End-Use Efficiency and Energy Services Directive (ESD)[15]. The ODEX indicators are innovative compared to similar indices as they aggregate trends in unit consumption by sub-sector or end-use into one index per sector based on the weight of each sub-sector/end-use in the total energy 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[16]. 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.

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. The services sector is not included due to a lack of sufficiently disaggregated data required to create an ODEX in this sector.

Figure 9 presents both the observed and technical overall energy efficiency indicators for Ireland for the period 1995 to 2010.

Figure 9 *Energy Efficiency 1995 - 2010*



The observed index shows that between 1995 and 2010 there was a 13% (1% per annum on average) decrease, which indicates a 13% improvement in energy efficiency. To separate out the influence of behavioural factors, a

13 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

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

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

16 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

technical index is calculated and used to better assess the technical energy-efficiency progress. As shown in *Figure 9*, technical efficiency improved by 17% (1.2% per annum) from 1995 to 2010.

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.

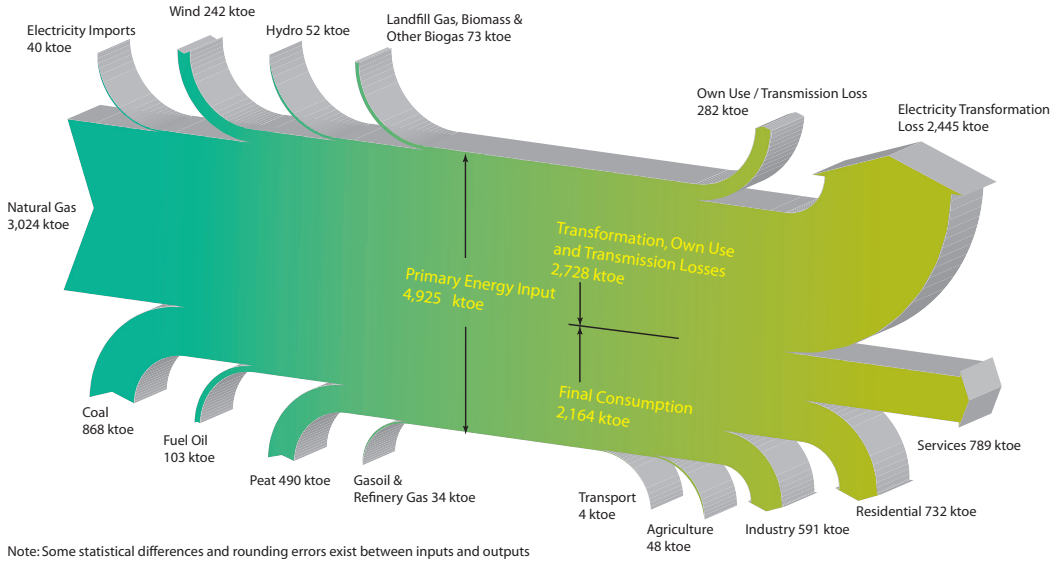
Note that the top-down energy-efficiency index indicators are calculated as a three-year moving average to avoid short-term fluctuations due, for example, to imperfect climatic corrections, behavioural factors, business cycles, etc.

2.7 Electricity Generation[17]

Figure 10 shows graphically the flow of energy in electricity generation. The relative size of the useful final electricity consumption compared to the energy lost in transformation and transmission is striking. These losses represent 55% of the energy inputs. The small, but growing, contribution from renewables (hydro, wind, landfill gas and biomass) is also notable, as is the dominance of gas in the generation fuel mix. In 2010, 61% of electricity generated was from natural gas.

In 2009, renewables accounted for 8.2% of the energy inputs to generate electricity with wind contributing 5.3% of total inputs. In 2010, with reduced wind and hydro resources the contribution of renewables to the generation fuel mix fell to 7.4% with the wind share falling to 4.9%. Wind accounted for 66% of the renewable energy used for electricity generation in 2010.

Figure 10 *Flow of Energy in Electricity Generation 2010*



Note: Some statistical differences and rounding errors exist between inputs and outputs

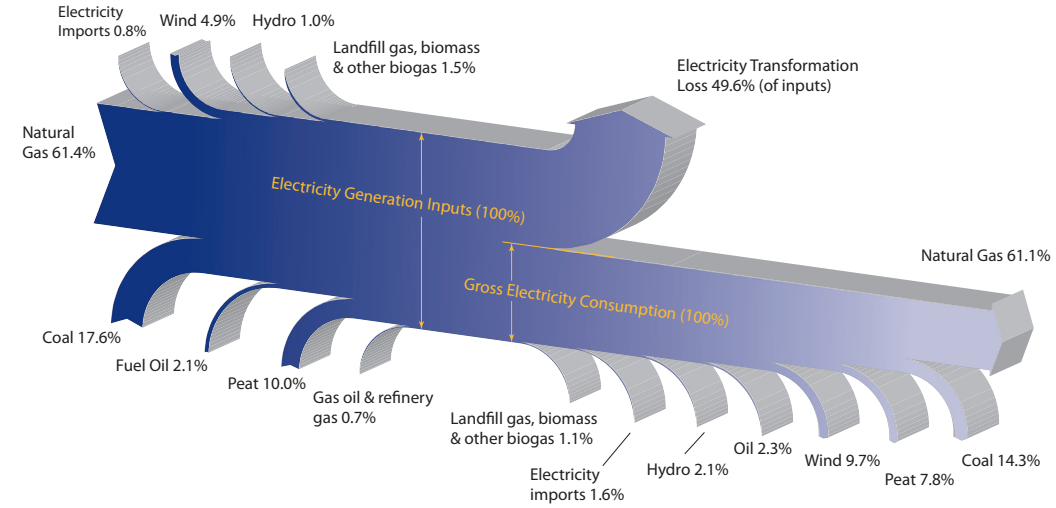
Figure 11 shows a similar picture to *Figure 10* except that the electricity outputs are shown by fuel used to generate the electricity and as percentages for the purposes of comparing with the various targets. Renewable generation consists of wind, hydro, landfill gas, biomass and other biogas and in 2010 in total accounted for 12.9% of gross electricity consumption compared with 14.3% in 2009.

In calculating the contribution of hydropower and wind power for the purposes of the Renewables Directive (2009/28/EC), the effects of climatic variation are smoothed through the use of a normalisation rule[18]. Using normalised figures for wind and hydro, renewables accounted for 14.8% of gross electricity consumption in 2010. The national target is 15% by 2010 and 40% by 2020.

17 Electricity generation is covered by the Emissions Trading Scheme and as such is not covered by the EU Decision 406/2009/EC Effort Sharing. Therefore, CO_2 impact comparison with 2005 is not considered in this section.

18 Article 30 and Annex II of *DIRECTIVE 2009/28/EC* on the promotion of the use of energy from renewable sources.

Figure 11 *Flow of Energy in Electricity Generation 2010 – Outputs by Fuel*

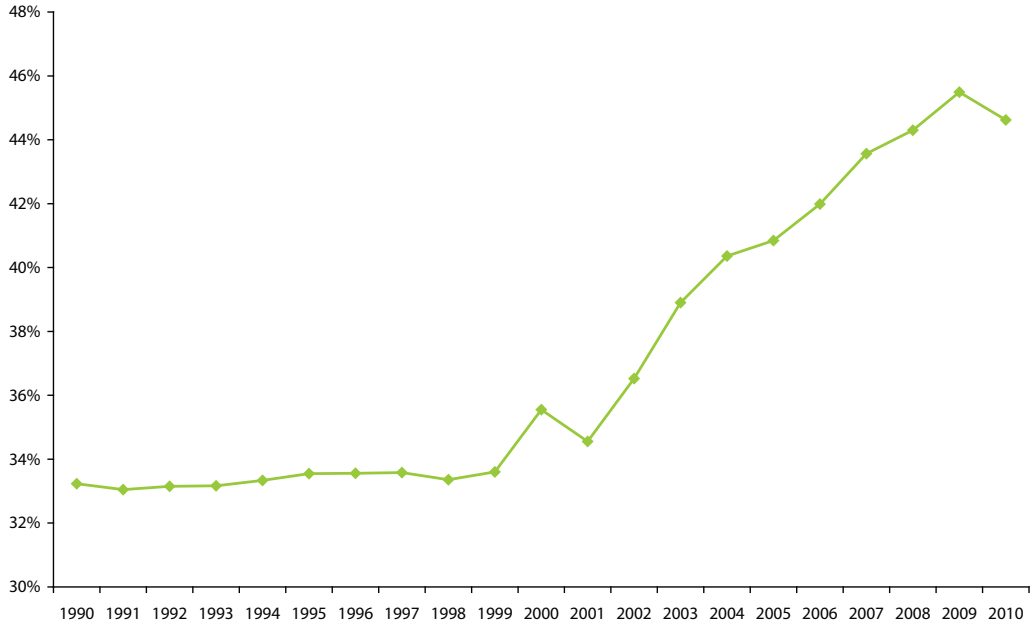


Note: Some statistical differences and rounding errors exist between inputs and outputs.
Percentages of inputs on the left refer to percentages of total inputs.
Percentages of output, with the exception of electricity transformation loss, refer to percentages of gross electricity generated.

Renewables as % of gross electricity consumption = 12.9%
Renewables as % of gross electricity consumption (normalised) = 14.8%
CHP as % of total electricity generation = 6.8%

The efficiency of electricity supply shown in *Figure 12* is defined as final consumption of electricity divided by the fuel inputs required to generate this electricity and expressed as a percentage. The inputs include wind, hydro and imports which are direct electricity inputs and do not have transformation losses associated with them as is the case with the fossil fuels and combustible renewables. The final consumption excludes the generation plant's 'own use' of electricity and transmission and distribution losses. Hence this is supply efficiency rather than generating efficiency.

Figure 12 *Efficiency of Electricity Supply*

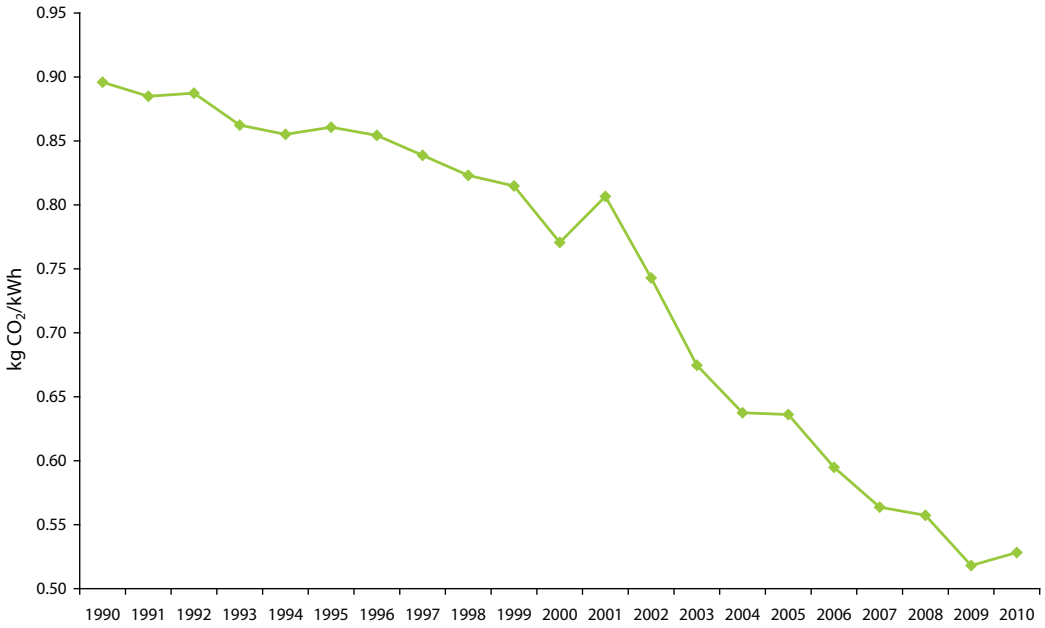


From the mid 1990s onwards the influence of the use of higher efficiency natural gas plants and the increase in production from renewable sources is evident. The sharp rise between 2002 and 2004 (from 35% to 40%) is accounted for, principally, by the coming on stream of new CCGT plant (392 MW in August 2002 and 343 MW in November 2002), an increase in imports of electricity and the closure of old peat fired stations.

There was an increase in electricity supply efficiency from 41.6% in 2006 to 43.3% 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. During 2010 the efficiency decreased to 44.6% from a high of 45.5% in 2009 due

in part to the reduction in wind and hydro resources and also due to the commissioning phases of two new CCGT power plants in Whitegate and Aghada that came online during the year.

Figure 13 *CO_2 Emissions per kWh of Electricity Supplied*



These shifts in generating technology and indeed fuel mix have also resulted in changes in the CO_2 emissions per kWh of electricity supplied, as illustrated in *Figure 13*.

Since 1990 the share of high carbon content fuels such as coal has been reducing with a corresponding rise in the relatively low carbon fuel oil, lower carbon natural gas, and zero carbon renewables. Imported electricity is also considered zero carbon from Ireland's perspective under the Kyoto Protocol as emissions are counted in the jurisdiction in which they are emitted. This resulted in the carbon intensity of electricity dropping from 896 g CO_2/kWh in 1990 to a low of 518 CO_2 g /kWh in 2009. In 2010 the intensity increased marginally to 528 CO_2 g /kWh.

Reasons for the decrease in generating efficiency and increase in carbon intensity of electricity in 2010 are:

- Increases in coal (12%) and gas (9.6%) use in generation.
- A 4.6% decrease in wind generation.
- A 34% decrease in hydro generation.
- A 38% decrease in electricity imports.

Countering these were:

- A 13% decrease in peat use.
- A 36% decrease in oil generation.

2.7.1 Primary Fuel Inputs into Electricity Generation

The trends in the mix of primary fuels employed for electricity generation are shown in *Figure 14*. Energy inputs to electricity generation increased by 3.2% in 2010 while final consumption of electricity increased by 0.8%. The shift from oil to gas since 2001 is also very evident from the graph, as is the decline of coal since 2005 and revival in 2010.

Figure 14 *Primary Fuel Mix for Electricity Generation*

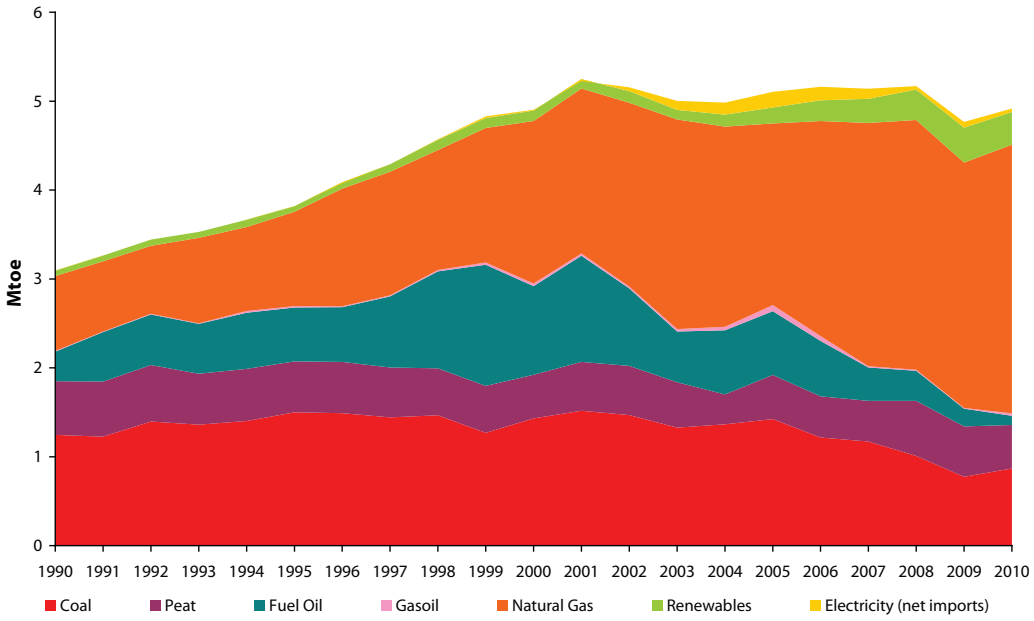


Table 6 presents the growth rates and shares of the primary fuel mix for electricity generation over the period 1990 – 2010.

The primary fuel requirement for electricity generation grew by 69% from 3.1 Mtoe in 1990 to a high of 5.2 Mtoe in 2001. Between 2001 and 2004 the requirement reduced by 4.7%, while at the same time the final consumption of electricity increased by 10%. In 2010, 4.9 Mtoe of energy was used to generate electricity, 3.2% more than in 2009. The fuel inputs to electricity generation were 33% of the total primary energy requirement in 2010. Electricity consumption as a share of total final consumption increased from 14% to 18% between 1990 and 2010.

Table 6 *Growth Rates and Shares of Electricity Generation Fuel Mix (primary fuel inputs)*

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Fossil Fuels (Total)	49.0	2.0	4.4	4.9	-0.1	-1.0	4.7	98.1	91.7
Coal	-30.3	-1.8	3.8	-0.9	-0.1	-9.4	11.9	40.3	17.6
Peat	-18.8	-1.0	-1.0	-3.1	0.2	-0.3	-13.4	19.5	10.0
Oil (Total)	-59.8	-4.5	12.9	10.7	-5.2	-29.6	-36.1	11.0	2.8
Fuel oil	-69.2	-5.7	12.6	10.5	-6.4	-32.2	-48.6	10.8	2.1
Gas oil	263.3	6.7	16.5	13.3	18.8	-17.4	208.4	0.2	0.5
Gas	258.7	6.6	4.7	11.5	2.3	8.1	9.6	27.3	61.4
Renewables (Total)	511.9	9.5	0.9	13.4	8.9	15.3	-6.7	1.9	7.4
Hydro	-14.0	-0.8	0.5	3.5	-5.7	-1.0	-33.5	1.9	1.0
Wind	-	-	-	72.4	35.4	20.4	-4.6	0.0	4.9
Other Renewables	-	-	-	-	4.8	19.6	19.1	0.0	1.5
Non-Renewable (Wastes)	-	-	-	-	-	-	-	0.0	0.0
Combustible Fuels (Total)	51.4	2.1	4.4	5.1	-0.1	-0.8	4.9	98.1	93.2
Electricity Imports (net)	-	-	-	45.6	83.6	-25.5	-38.4	0.0	0.8
Total	**59.3**	**2.4**	**4.3**	**5.2**	**0.8**	**-0.7**	**3.2**		

The main trends are:

- Overall fuel inputs into electricity generation increased by 3.2% in 2010 while final consumption of electricity increased by just 0.8%.
- The share of overall fossil fuel used in electricity generation was 92% in 2010. This was a 1.3% point increase on the previous year.
- Natural gas remains the dominant fuel in electricity generation with its share increasing to 61% in 2010. Natural gas use in electricity generation was 3,024 ktoe in 2010, 9.6% higher than in 2009. The commissioning and

connection of a 435 MW CCGT ESB plant in Aghada and a 445 MW Bord Gáis plant in Whitegate contributed to the increase in gas use in electricity generation.

- Fuel oil had a share in electricity generation of 11% in 1990; this rose to 28% in 1999 but fell back to 2.1% in 2010. Consumption of fuel oil decreased in 2010 by 49% to 0.1 Mtoe.
- The share of coal used in electricity generation has reduced from 40% in 1990 to 18% in 2010. In absolute terms the consumption of coal has fallen by 30% over the period (1.8% per annum) to a figure of 0.9 Mtoe. There was an increase in coal use in 2010 for electricity generation of 12%.
- Peat consumption in electricity generation fell by 13% to 490 ktoe in 2010 and by 19% since 1990.
- Renewable energy use for electricity generation increased its share from 1.9% to 7.4% between 1990 and 2010. In 2010 there was a 6.7% reduction in renewables in the electricity fuel mix due to reduced wind and hydro resources. Wind contribution to electricity generation fell by 4.6% in 2010 while the contribution from hydro fell by 34%. Other renewables in the form of landfill gas, biogas and biomass made up the remainder of the contribution at 1.5% of fuel inputs. Consumption of other renewables in electricity generation increased by 19% in 2010.
- Electricity imports decreased by 38% in 2010 .

The primary energy attributed to hydro and wind is equal to the amount of electrical energy generated, rather than the primary energy avoided through the displacement of fossil fuel based generation[19] (see *Renewable Energy in Ireland – 2010 Update*). It is therefore more common to see the share of hydro and wind reported as a percentage of electricity generated. Electricity generated from hydro accounted for 2.1% of the total and wind accounted for 9.7% in 2010.

Overall, the share of electricity generated by renewables was 12.9% in 2010, down from 14.3% in 2009. Normalising for wind and hydro the share of electricity generated from renewables in 2010 was 14.8%.

2.8 Electricity Demand

Figure 15 shows the final electricity consumption in each of the main sectors. The difference between fuel input (see *Figure 14*) and delivered electricity output (*Figure 15*) is accounted for by the transformation losses as shown in *Figure 10* and *Figure 11*. This size of the transformation loss is due to electricity in Ireland being predominantly generated from thermal generation (93% in 2010) and therefore actual energy requirement has always been significantly higher than final electricity consumption. This ratio of primary to final energy in electricity consumption reduced from 3.0 in 1990 to 2.3 in 2010. Final consumption of electricity increased by 0.8% in 2010 with a 3.2% increase in the fuel inputs to electricity generation.

Over the period 2005 – 2010, electricity demand increased by 0.7% per annum on average while the fuel inputs fell by 0.7% per annum.

19 An alternative approach based on *primary energy equivalent* was developed in a separate report: SEAI (2007), *Renewable Energy in Ireland – 2010 Update*. Available from www.seai.ie/statistics.

Figure 15 *Final Consumption of Electricity by Sector*

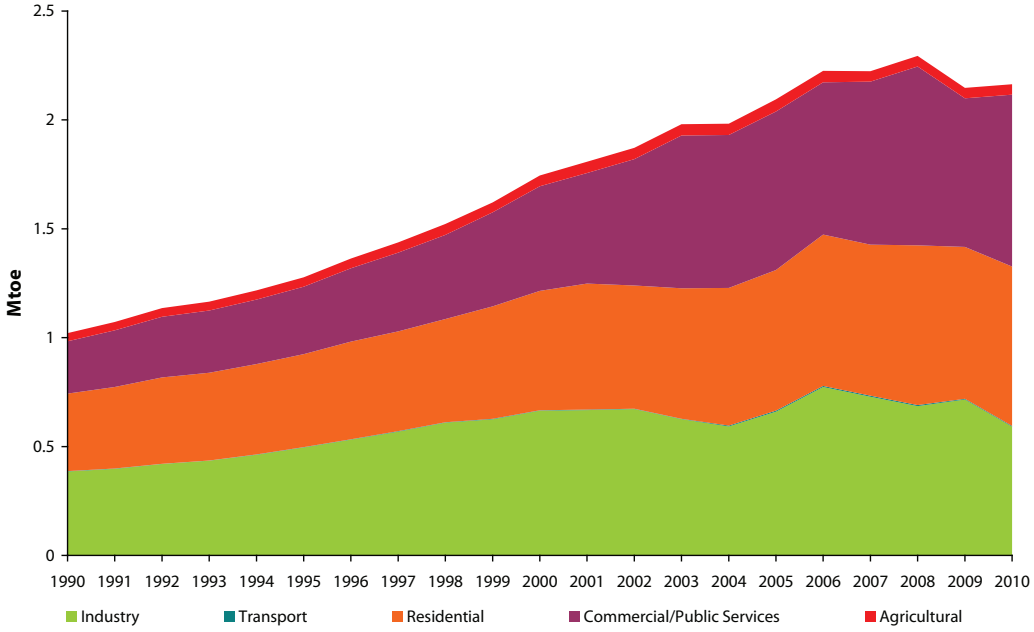


Table 7 tabulates changes in individual sectors' electricity demand and the impact on their shares of final consumption of electricity. The electricity use in transport includes that used by the DART and reflects the arrival (testing and operation) of the Luas. In absolute terms electricity consumption in transport is small at 4 ktoe.

Industry was the only sector that experienced decreased electricity demand during 2010 (-17%). All other sectors experienced increased demand, with a 16% increase in commercial and public services and a 5% increase in the residential sector. It is likely that the increase in electricity demand in the residential and services sectors was due to the use of supplementary electric heaters during the cold snaps both at the beginning and end of 2010.

Table 7 *Growth Rates and Shares of Electricity Final Consumption*

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Industry	53.2	2.2	5.2	6.0	-0.1	-2.2	-17.4	37.8	27.3
Transport	184.8	5.4	2.4	7.6	17.8	-5.0	1.7	0.1	0.2
Residential	105.4	3.7	3.7	5.1	3.3	2.5	5.0	34.9	33.8
Commercial / Public	228.3	6.1	5.2	9.2	8.7	1.6	15.6	23.6	36.5
Agriculture	29.8	1.3	3.1	2.7	2.4	-2.8	0.0	3.6	2.2
Total	**112.0**	**3.8**	**4.6**	**6.4**	**3.7**	**0.7**	**0.8**		

2.9 Energy and the Economic Downturn

In 2008 the economy in Ireland entered recession with gross domestic product (GDP) falling by 3% compared with 2007. Since 2007 in aggregate the economic output fell by 10% while at the same time primary energy use fell by 8.9%. Primary energy use grew initially by 1.6% in 2008 but then fell by 10% in 2009 and a further 0.3% in 2010.

Since 2007 final energy consumption fell by 9.4%, but applying climate corrections for the difference in energy required for heating purposes due to weather variation, the fall in final energy consumption was 11%.

It is clear that while the economic recession affected the energy use of certain sectors more than others, there were other effects, such as weather effects and fuel mix changes, that also had a significant impact on energy use and emissions.

In 2009, the recession deepened sharply with economic activity (GDP) falling by 7.0%. Unlike 2008, however, in 2009 overall energy use decreased at a faster rate than GDP, falling by 10%. Additionally, energy-related CO_2 emissions fell at a faster rate (-12%) than energy use. These changes are largely due to a continued shift away from coal and oil towards gas and renewables, particularly for electricity production where gas conversion is more efficient than for coal and oil.

In 2010 overall energy use contracted in line with the economy, with energy use reducing by 0.3% compared with GDP reduction of 0.4%. Final energy consumption experienced a larger reduction at 0.9% and if adjusted for climate variation, the reduction was 4.2%.

The fuel mix changes contributing to the overall energy changes in 2010 relative to 2009 can be summarised as follows:

- 3.1% decrease in peat consumption
  - 6.9% decrease in end use and
  - 13.4% decrease for electricity generation
- 9.2% increase in gas consumption
  - 9.1% increase in end use and
  - 9.6% increase for electricity generation
- 1.3% decrease in coal consumption
  - 4.8% decrease in end use and
  - 11.9% increase for electricity generation
- 4.8% decrease in oil consumption
  - 3.3% decrease in end use (8.3% drop in oil use in transport, 4.9% increase in industry, 7.2% increase in services and 7.1% increase in households)
  - 36% decrease for electricity generation
- 0.8% decrease in renewables
  - 11% increase in end use
  - 6.7% decrease in renewables in electricity generation (4.6% decrease in wind, 34% decrease in hydro, 19% increase in other renewables)

From a sectoral perspective, all sectors with the exception of the residential sector experienced reductions in energy-related CO_2 emissions because of the economic recession and other factors since 2007. The industry sector experienced the largest reduction with (primary) CO_2 emissions falling by 27%. Transport and the services sectors experienced reductions of 19% and 1.9% respectively. Emissions in the residential sector increased by 7.1%. The largest reductions were experienced in the sectors most affected by the economic downturn, namely industry, transport and services, whereas the residential sector experienced an increase as energy is primarily used here for space heating and is more aligned to climate and weather than the economy.

In industry, energy demand decreased by 23% since 2007. With the exception of renewables, demand for all fuels in industry fell significantly between 2007 and 2010, with oil and gas demand decreasing by 25% and electricity by 19%. Renewables increased slightly by 0.4%.

In transport, certain modes of transport were affected more than others due to the recession. The overall energy demand reduction in transport since the start of the downturn was 18%. Road freight experienced a 42% reduction in demand in part due to the downturn in construction activity and also due to the recession generally. Aviation experienced a 25% reduction, while road private car transport fell by just 4.8%.

Residential energy use increased by 13% since 2007, but when corrections for climate effects are taken into account there was a decrease of 5.7%. 2010 was significantly colder than 2007.

In the services sector, energy demand increased by 2.9% since 2007, or fell by 13% after removing the weather effects from the data. Electricity demand increased by 5.3% while direct fuel use increased by 0.9%. There appears to have been some significant fuel switching as oil demand reduced by 10% while gas demand grew by 24%. Renewable energy grew by 74%, albeit from a very low base.

3 Key Policy Issues

The energy trends discussed in section 2 may be analysed to assess performance with regard to Government policies and targets, in particular those detailed in the Energy White Paper (2007), the National Climate Change Strategy 2007 – 2012, and EU Directives related to renewable energy, CHP, energy efficiency and greenhouse gas and transboundary emissions. This section discusses a number of key energy policy issues, grouped in the three categories of sustainable energy development, namely:

- environmental responsibility;
- security of supply;
- cost competitiveness.

3.1 Environmental Responsibility

The key policy areas, which are discussed in this category, are: limiting energy-related greenhouse gas and transboundary gas emissions; accelerating the penetration of renewable energy and increasing the deployment of CHP.

3.1.1 Greenhouse Gas Emissions

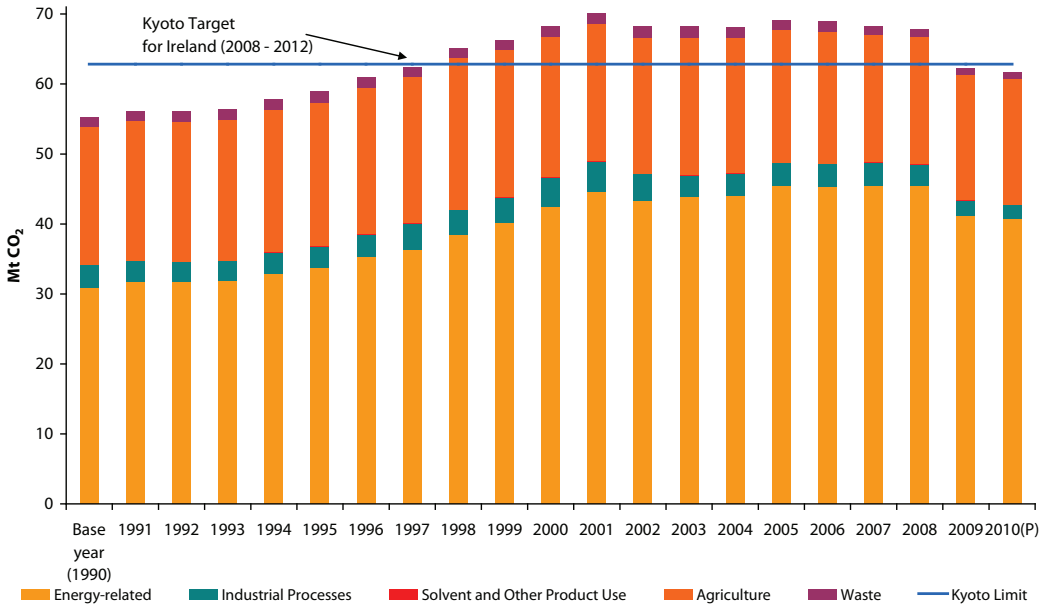
Ireland's target under to the Kyoto Protocol, which is an international legally binding agreement to reduce GHG (greenhouse gas) emissions, is to limit the growth in annual emissions to 13% above 1990 levels in the period 2008 to 2012.

In 2008, the EU agreed a Climate Energy Package that included a target to reduce greenhouse gas emissions across the EU by 20% below 1990 levels by the year 2020. This resulted in two specific pieces of GHG emissions legislation affecting Ireland:

- Directive 2009/29/EC requiring emissions trading scheme (ETS) companies to reduce their emissions by 21% below 2005 levels by 2020;
- Decision 406/2009/EC requiring Ireland to reduce non-ETS emissions by 20% below 2005 levels by 2020.

Figure 16 shows the trend in annual GHG emissions for the period 1990 – 2010. The emissions are grouped according to the individual source. These are energy, industrial processes (including cement production), solvent and other product use, agriculture and waste.

Figure 16 *Greenhouse Gas Emissions by Source 1990 – 2010 (provisional)*[20]



Source: Based on Environmental Protection Agency (EPA) data.

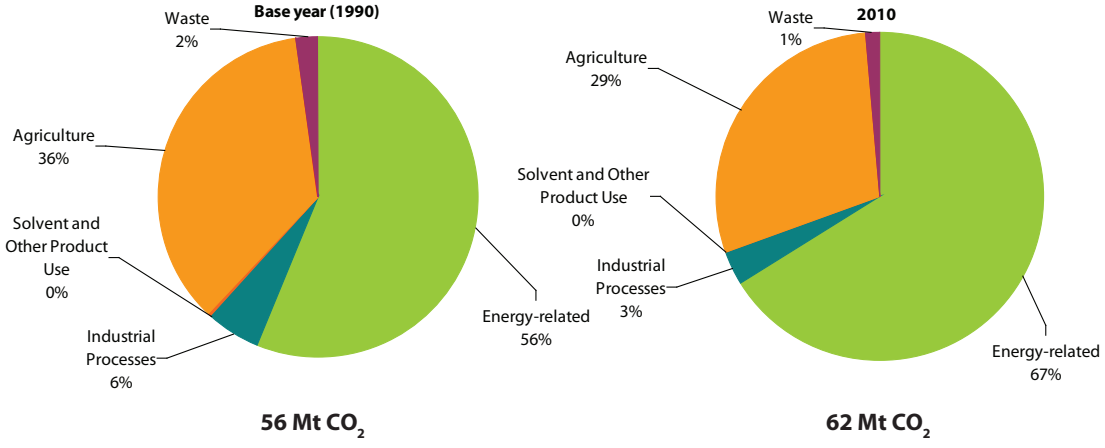
Figure 16 shows that Ireland's Kyoto target for the period 2008 – 2012 was breached in 1998. By 2001, annual GHG emissions peaked at 27% above 1990 levels. It is also evident from *Figure 17* that the most significant area of growth is in energy-related emissions, in particular since 1995 although levelling off since 2001 and falling in 2009/'10.

In 2002 there was a reversal in the upward trend for the first time with GHG emissions dropping to 24% above 1990 levels. This downward trend continued and by 2008 there was a 3.3% reduction on the peak 2001 emissions. Between 2008 and 2010 there was a step change in emissions due mainly to the economic downturn with emissions falling by 9.2% between 2008 and 2010.

Provisional figures from the Environmental Protection Agency (EPA) show that total GHG emissions fell in 2010 by 1.1% to 61.64 million tonnes. Most of the reduction in 2010 came from energy-related emissions as agriculture experienced a 0.2% increase in 2010. While the reduction in emissions brings Ireland below the Kyoto limit of 62.84 Mt CO_2eq, it is necessary to consider both the emission-trading and non-emissions trading sectors in order to assess the current distance to target. The EPA estimates, based on the first three years of the Kyoto period (i.e. 2008 and 2010), that Ireland's distance to target is 6.65 Mt CO_2eq (cumulative of the three years) when the impact of forest sinks and the emissions-trading scheme are included.

Figure 17 shows the GHG emissions by source for 1990 and 2010, illustrating the increased role of energy as an emissions source.

Figure 17 *Greenhouse Gas Emissions by Source*



20 *Figure 16* and *Figure 17* based on provisional data supplied by the EPA (November, 2011).

The share of GHG emissions arising from energy-related activities was 67% in 2010 compared with 56% in 1990. The share from agriculture dropped from 36% to 29% in the same period. It is interesting to note that for the EU as a whole, energy production and use represented 80% of GHG emissions in 1990[21]. The significant role of agriculture in the Irish economy underlies Ireland's variance from the EU average.

Figure 18 *Energy-Related CO_2 Emissions by Sector*[22,23]

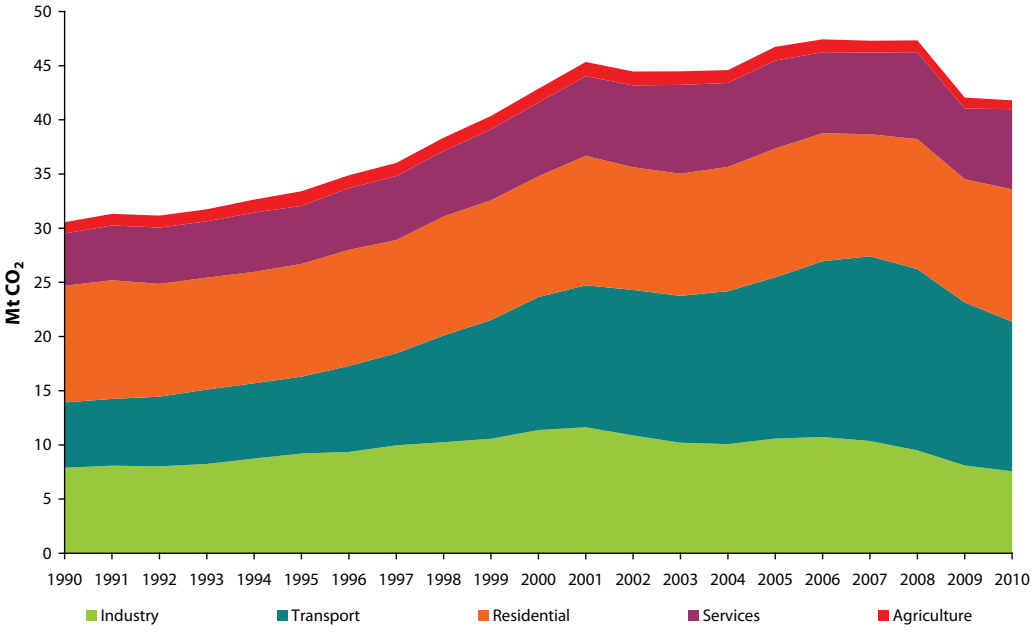


Figure 18 shows the sectoral breakdown of energy-related CO_2 emissions (which represent 96% of energy-related GHG emissions, 4% accounted for by energy-related nitrous oxide [N_2O] and methane [CH4]). Energy-related CO_2 emissions in 2010 were 34% higher than 1990 levels.

These growth rates are also presented in tabular form in *Table 8*.

Table 8 *Growth Rates and Shares of Primary Energy-Related CO_2 by Sector*

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Industry	-4.2	-0.2	3.1	4.3	-1.4	-6.5	-6.6	25.8	18.1
Transport	129.1	4.2	3.3	11.6	4.0	-1.5	-8.3	19.7	33.0
Residential	12.1	0.6	-0.7	1.4	1.3	0.3	5.4	35.2	28.9
Commercial / Public	52.9	2.1	2.1	4.9	3.5	-1.8	13.2	15.8	17.7
Agriculture	-5.6	-0.3	5.1	-1.2	0.2	-4.9	5.2	3.4	2.4
Total	**34.4**	**1.5**	**1.6**	**4.6**	**2.3**	**-2.4**	**-1.0**		

The most significant area of growth overall since 1990 was in the transport sector, where CO_2 emissions in 2010 were 129% higher than in 1990 (4.2% average annual growth rate). In 2007 they were 183% higher. Transport energy-related CO_2 emissions fell for the first time in 2008, by 1.8%. The reduction was higher in 2009 with a fall of 10.1% followed by a smaller reduction of 8.3% in 2010. Energy use in transport accounted for just less than one third (33%) of energy-related CO_2 emissions in 2010. Transport is by far the largest CO_2 emitting sector – emitting 1.8 times the energy-related CO_2 emissions of industry.

21 Eurostat (2008), *Energy, transport and environment indicators pocketbook*.

22 *Figure 18* and *Table 8* are based on SEAI estimates and use a different methodology to that used by EPA for compiling the national inventory. International air transport emissions are excluded from the national GHG emissions inventory in accordance with the reporting procedures of the UN Framework Convention on Climate Change (UNFCCC) guidelines and are also excluded here.

23 Emissions for agriculture shown in the chart and the table are for energy-related emissions only.

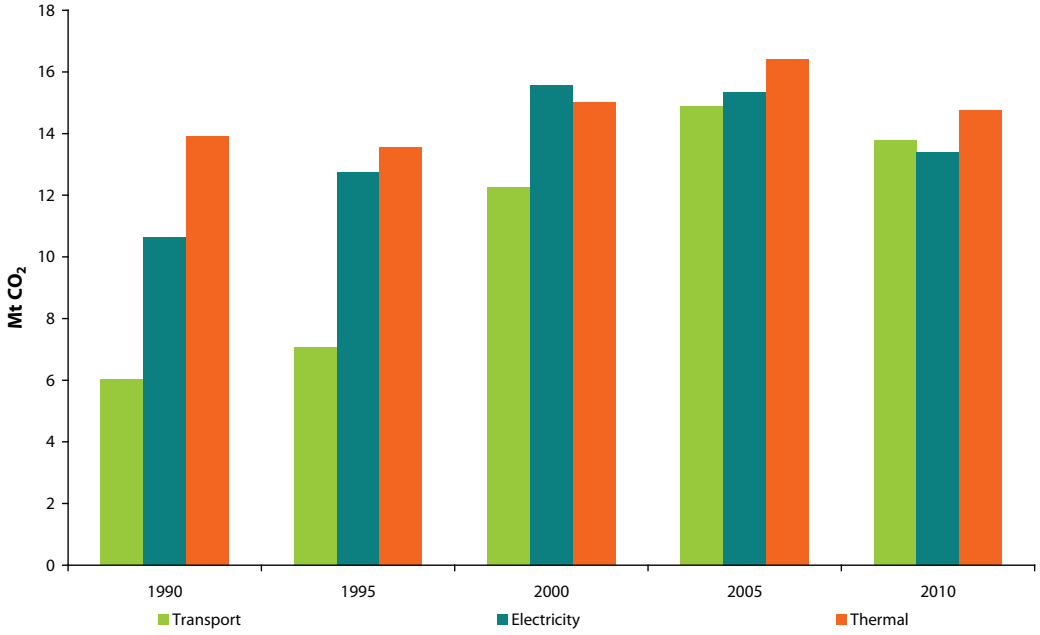
Energy-related CO_2 emissions also fell in industry in 2010, by 6.6%. Under the emissions trading scheme only the emissions directly generated on site by industrial entities are taken into account. If upstream electricity emissions are omitted industry experienced an increase in CO_2 emissions of 3.9% in 2010. This increase in emissions was driven by an 11.2% increase in industrial output as measured by value added.

The residential sector experienced an increase of 5.4% in primary energy-related emissions during 2010 and services experienced an increase of 13%. In both these sectors a significant portion of energy use relates to space heating. Therefore, when looking at yearly changes it is important to take the weather into account.

Agricultural energy-related CO_2 emissions increased by 5.2% in 2010 but the sector's share of these emissions is small at 2%. This is also small compared to other agriculture-related greenhouse gas emissions due primarily to livestock and also fertiliser use.

Figure 19 illustrates the variations in emissions by mode of energy use. Here the emissions are allocated according to whether the energy used is for mobility (transport), in the form of electricity (power) or as thermal energy (for heating). These modes also represent distinct energy markets. The graph presents the emissions at five-yearly intervals up to 2010. In 2010, the shares of energy-related CO_2 emissions from transport, electricity and thermal applications were 33%, 32% and 35% respectively.

Figure 19 *Energy-Related CO_2 Emissions by Mode of Energy Application*



The growth in emissions related to mobility (129% over the period to 2010) is again striking, although they fell slightly in 2008 and more significantly in 2009 and 2010 as mentioned above. Electricity was the dominant mode in terms of emissions from 1996 until 2002. Transport became the dominant mode between 2007 and 2009. Thermal use is the dominant mode in 2010, with a 35% share of energy-related emissions.

In 2010, energy-related emissions from electricity increased by 2.9% from the 2009 level compared to an increase of 0.8% in final consumption of electricity. Factors affecting increased emissions from electricity generation were lower wind and hydro generation and commissioning of new gas generating plant. Overall, electricity generation emissions were 26% above 1990 levels.

Emissions from thermal energy applications increased by 4.6% in 2010 and overall the thermal mode emissions were 5.9% above 1990 levels.

Given the policy focus on the non-emissions trading sectors[24], *Figure 20* shows the trend in energy-related CO_2 emissions for the transport, residential, services and agriculture sectors since 1990 and non-ETS industry from 2005 onwards. This excludes emissions associated with electricity usage by these sectors as these emissions are included in emissions trading. The historical data is not sufficiently disaggregated to include, prior to 2005, the energy-related CO_2 emissions associated with thermal energy usage by manufacturing companies that are not participating in emissions trading.

24 EU Decision 406/2009/EC.

Figure 20 *Non Emissions Trading Energy-related CO_2 (non-ETS industry from 2005 onwards)*

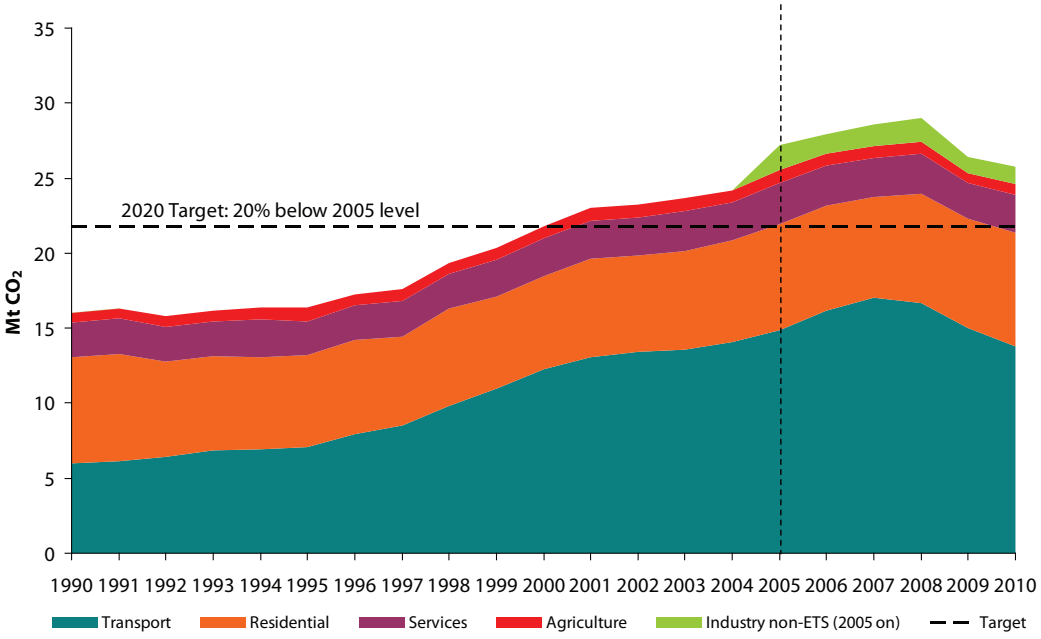


Table 9 *Growth Rates and Shares of ETS and non-ETS Energy-Related CO_2 since 2005*

	Growth %	Average annual growth rates %		Shares %	
	2005 – 2010	'05 – '10	2010	2005	2010
ETS CO_2	-17.8	-3.8	2.6	41.8	38.4
non-ETS CO_2	-5.4	-1.1	-2.5	58.2	61.6
Total Energy-Related CO_2	**-11.3**	**-2.4**	**-1.0**		

Non-ETS sectors (including non-ETS industry) energy-related CO_2 emissions decreased by 1.1% per annum between 2005 and 2010 wth a 2.5% fall in energy-related emissions in 2010. Non-ETS emissions are now 5.4% below 2005 levels. Under EU Decision 406/2009/EC there is a requirement on Ireland to achieve a 20% reduction in total non-ETS emissions on 2005 levels by 2020.

The emissions trading sector experienced an 18% fall in energy-related emissions since 2005 but emissions increased by 2.6% in 2010 compared with the previous year. The share of emissions covered in the emissions trading scheme in overall energy-related emissions has fallen from 42% in 2005 to 38% in 2010.

3.1.2 Transboundary Gas Emissions

Emissions of sulphur dioxide (SO_2) and nitrogen oxides[25] (or NO_x) are associated with acid rain, smog and other environmental impacts (including acidification and eutrophication) that are commonly described as air quality issues. An interrelationship between sulphur emissions in continental Europe and the acidification of Scandinavian lakes was demonstrated by scientists during the 1960s. Following the Stockholm conference in 1992, several studies confirmed the hypothesis that air pollutants could travel several thousands of kilometres before deposition and damage occurred. This also implied that cooperation at the international level was necessary to solve problems such as acidification.

In June 1999 the European Commission presented a proposal for a directive setting national emission ceilings (NECs) for four air pollutants that cause acidification and the formation of ground-level ozone: sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), and ammonia (NH_3). After two years of negotiation, Directive 2001/81/EC, the 'National Emissions Ceiling Directive' was adopted by the Council of Ministers and the European Parliament in July 2001.

The aim of the Directive is to gradually improve, through a stepwise reduction of the four pollutants, the protection both of human health and the environment throughout the EU. By means of EU strategies to combat acidification and ground-level ozone, the directive establishes interim environmental quality targets that are to be attained by 2010. *Table 10* compares 2009 values (from EPA) for SO_2 and NO_x together with the emissions limits for the year 2010.

25 Collective term for nitric oxide (NO) and nitrogen dioxide (NO_2)

The EPA reported that Ireland was already in compliance with the 2010 target for SO_2 in 2009 but the NO_x emissions exceeded the ceiling by 24 kt.

Table 10 *SO_2 and NO_x Emissions and NEC Directive Ceilings for 2010*

	1990 (kt)	2009 (kt)	2010 Ceiling (kt)	% reduction on 2009 to meet 2010 Ceiling
NO_x	129	89	65	27%
SO_2	183	33	42	-

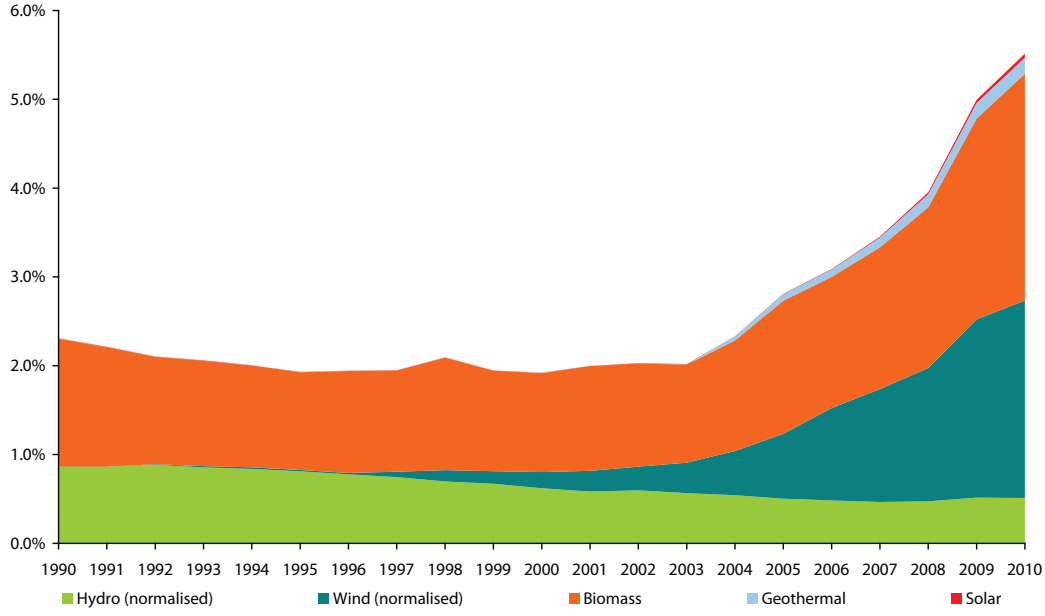
Source: EPA.

3.1.3 Renewable Energy

The target for Ireland in the European Renewable Energy Directive (2009/28/EC) is a 16% share of renewable energy in gross final consumption by 2020. *Figure 21* shows the contribution as per the Directive from 1990 to 2010. The contribution from renewables in 1990 was 2.3%, rising to 5.5% in 2010[26]. Gross Final Consumption (GFC) in the Directive is different from Total Final Consumption (TFC) as conventionally defined in the energy balance. The Directive specifies gross final consumption of energy as the energy commodities delivered for energy purposes to manufacturing industry, transport, households, services, agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution. Total Final Consumption (TFC) is usually calculated as the total primary energy less the quantities of energy required to transform primary energy. Hydro and wind electricity generation are normalised as per the Directive.

A more detailed discussion of renewable energy in Ireland can be found in SEAI's publication *Renewable Energy in Ireland*[27]. This section presents key graphs and updates where available from the Renewables report.

Figure 21 *Renewable Energy (%) Contribution to Gross Final Consumption (Directive 2009/28/EC)*

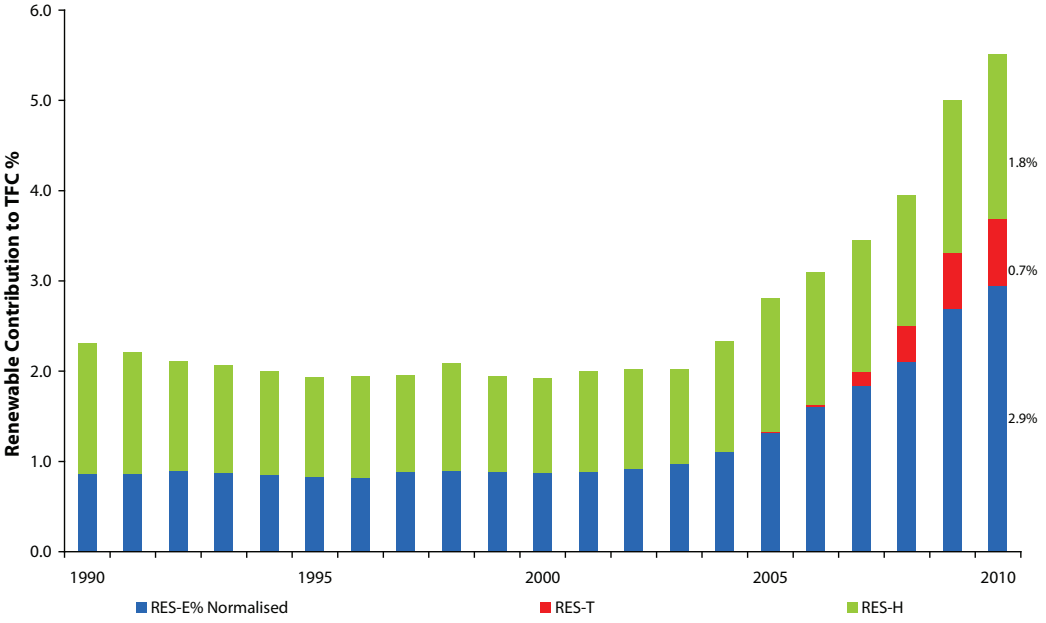


Source: SEAI.

The renewable energy contribution includes electricity generation, transport energy and thermal energy generated by renewable sources; these are termed RES-E, RES-T and RES-H respectively. *Figure 22* shows the renewable energy percentage contribution to TFC by mode with RES-E normalised.

26 Calculated as per Directive 2009/28/EC.
27 Available from www.seai.ie/statistics.

Figure 22 *Renewable Energy (%) Contribution to TFC by Mode*



Source: SEAI

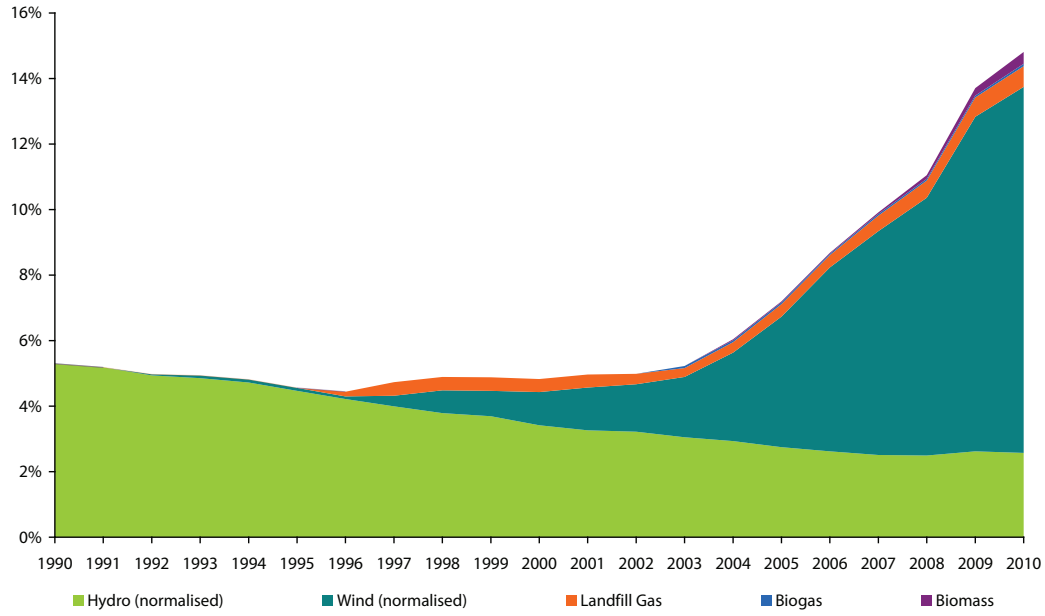
The national target for electricity generation from renewable sources (RES-E) specified in the 2007 Government White Paper is 15% by 2010 and 33% by 2020. It was announced in the Carbon Budget in October 2008 that the 2020 target was to be extended to 40% of gross electricity consumption to come from renewable energy. The contribution of renewable energy to gross electricity consumption[28] from 1990 – 2010 is shown in *Figure 23*. SEAI's *Energy Forecasts for Ireland to 2020*[29] estimates that 40% renewable electricity is required to contribute to meeting the EU Renewable Directive (2009/28/EC) target of 16% renewables in gross final consumption.

Historically, hydro was the largest contributor to renewable electricity in Ireland. While the contribution from hydro has declined in percentage terms, *Figure 23* shows how electricity production from wind energy has increased to the point that it accounted for 76% of the renewable electricity generated in 2010. Electricity generated from biomass accounted for 8.3% of renewable electricity in 2010. Biomass consists of contributions from solid biomass, landfill gas and waste water biogas. Wind, hydro and biomass-generated electricity in 2010, respectively, accounted for 9.7%, 2.1% and 1.1% of Ireland's gross electricity consumption.

The total contribution from renewable energy to gross electricity consumption in 2010 was 12.9% (compared with 14.3% in 2009 and 4.9% in 1990). Using normalised hydro and wind figures as specified in the Directive (2009/28/EC) the share in 2009 was 13.7% and in 2010 it was 14.8%.

28 Defined as total electricity generated plus net imports.
29 http://www.seai.ie/Publications/Statistics_Publications/Energy_Modelling_Group/Energy_Forecasts_for_Ireland_to_2020-2010_report.pdf

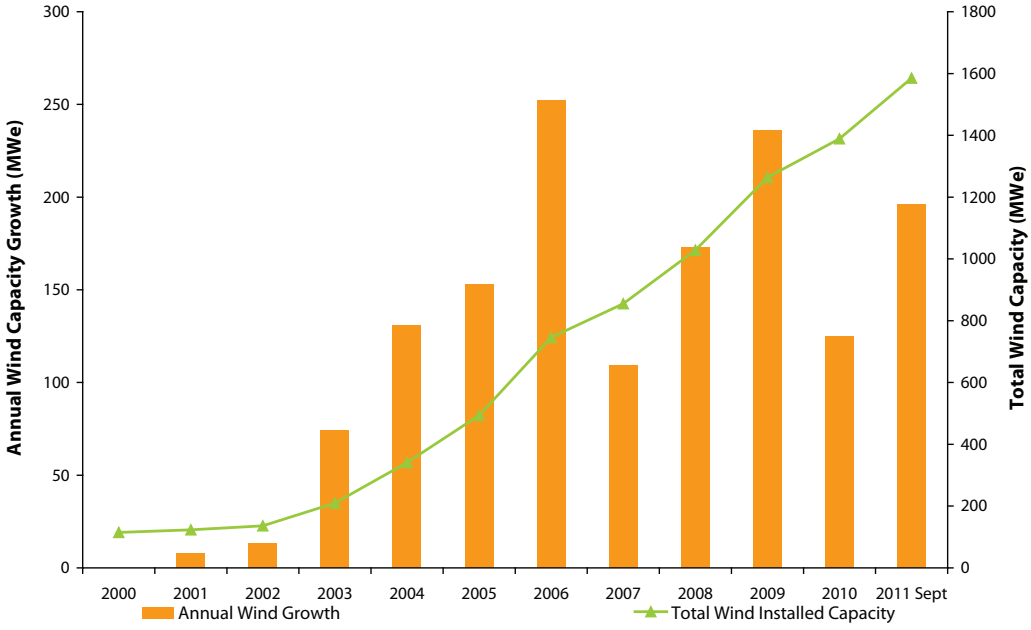
Figure 23 *Renewable Energy Contribution to Gross Electricity Consumption (RES-E normalised)*



The share of electricity from renewable energy has almost tripled between 1990 and 2010 – from 5.3% to 14.8%, an increase of almost 10 percentage points over twenty years. Most of this increase took place in the ten years since 2000.

A key focus of national renewable energy policy has been wind energy, due to the size of the wind energy resource in Ireland and the cost competitiveness of the technology. *Figure 24* shows how electricity production from wind energy has increased. Wind energy in 2010 accounted for 9.7% of gross electricity consumption (10.3% in 2009).

Figure 24 *Installed Wind Generating Capacity 2000 - 2011 (September)*[30]



Source: Eirgrid

Figure 24 shows the annual growth in installed wind generating capacity and overall cumulative capacity since 2000. By September 2011 the installed capacity of wind generation reached 1,585 MW. The peak recorded wind power

30 November 2011 from Eirgrid with data to September 2011.

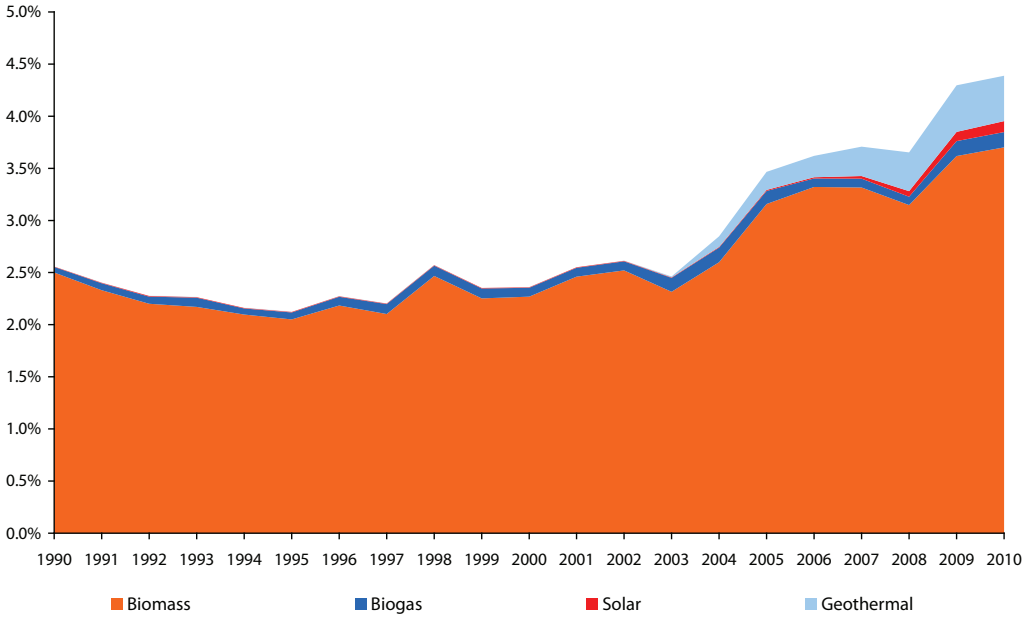
output was 1,412 MW delivered on 2nd November 2011[31]. *Figure 24* also shows the rate of growth in wind power in terms of installed capacity.

Based on data published on Eirgrid's website there are 147 MW of wind contracted for connection before the end of 2011 and a further 471 MW by the end of 2012. There are an additional 729 MW contracted, approximately 3,600 MW of live offers and a further 13,202 MW in the queue for grid connection.

Figure 25 shows the contribution from renewable energy to heat or thermal energy uses. The increasing activity in specific sub-sectors of industry, as well as some incentives for residential biomass heat systems, has led to biomass increasing from 108 ktoe in 1990 to 229 ktoe in 2010, representing a growth of 112%. In 2010 renewable thermal energy grew by 8% and the renewable share of thermal energy increased from 4.3% in 2009 to 4.4% in 2010. The national target specified in the Government White Paper is: 5% of all heat to come from renewable energy sources by 2010 and 12% by 2020.

There was a decline in the contribution from renewable energy to thermal energy in the early 1990s, from 2.6% in 1990 to 2.1% in 1995. Between 2000 and 2010 RES-H grew from 2.4 % to 4.4%. This growth in renewable energy (dominated by biomass) is mostly due to increased use of wood waste as an energy source in the wood products and food sub-sectors of industry. There has also been recent growth in renewable energy use in the residential and services sectors with the introduction of grant support schemes.

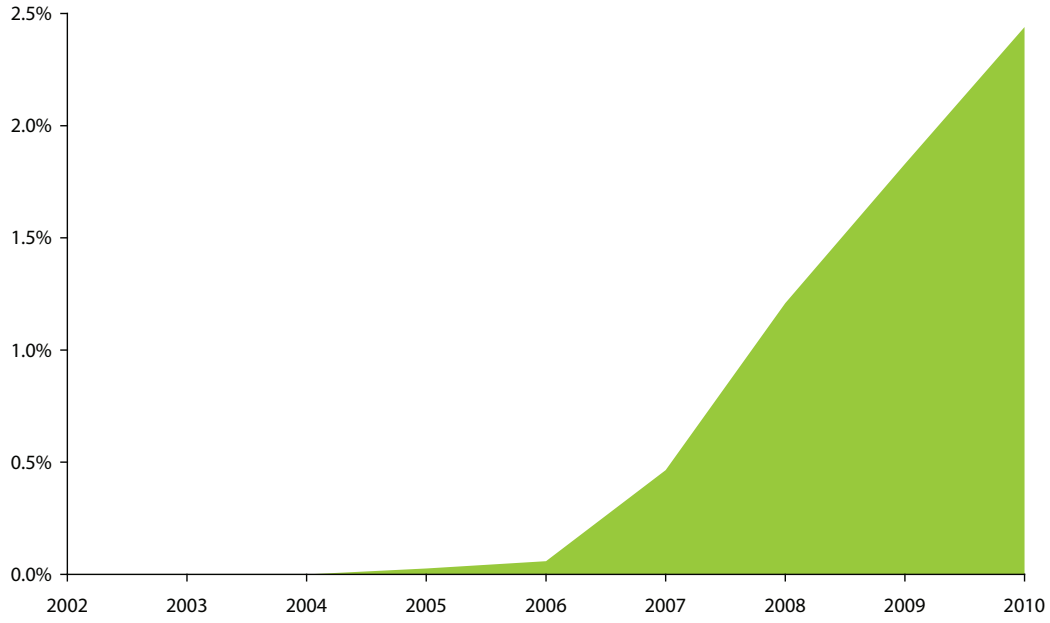
Figure 25 *Renewable Energy Contribution to Thermal Energy (RES-H)*



The White Paper target for Renewable Energy Sources in Transport (RES-T) is to achieve 5.75% of road and rail transport energy from renewable energy by 2010 and 10% by 2020. The Minister for Energy issued a consultation paper[32] on the introduction of a biofuels obligation scheme in October 2008 and proposed therein that the 2010 target be reduced from 5.75% to 3%. The 2020 target of 10% is a European target and remains unchanged. On 9th November 2009 the Minister published details of regulations which compel fuel suppliers to include biofuels in their annual sales. Under the Biofuels Obligation Act 2010, fuel suppliers must include an average of 4% (by volume) biofuels (equivalent to approx. 3% in energy terms) in their annual sales since July 2010.

31 Wind generation data, Eirgrid, (http://www.eirgrid.com/operations/systemperformancedata/windgeneration/).
32 DCENR 2008 *Public Consultation on the Biofuels Obligation Scheme, September 2008.* Available from www.dcenr.ie

Figure 26 *Renewable Energy as a Proportion of (Petrol & Diesel) Transport (RES-T)*

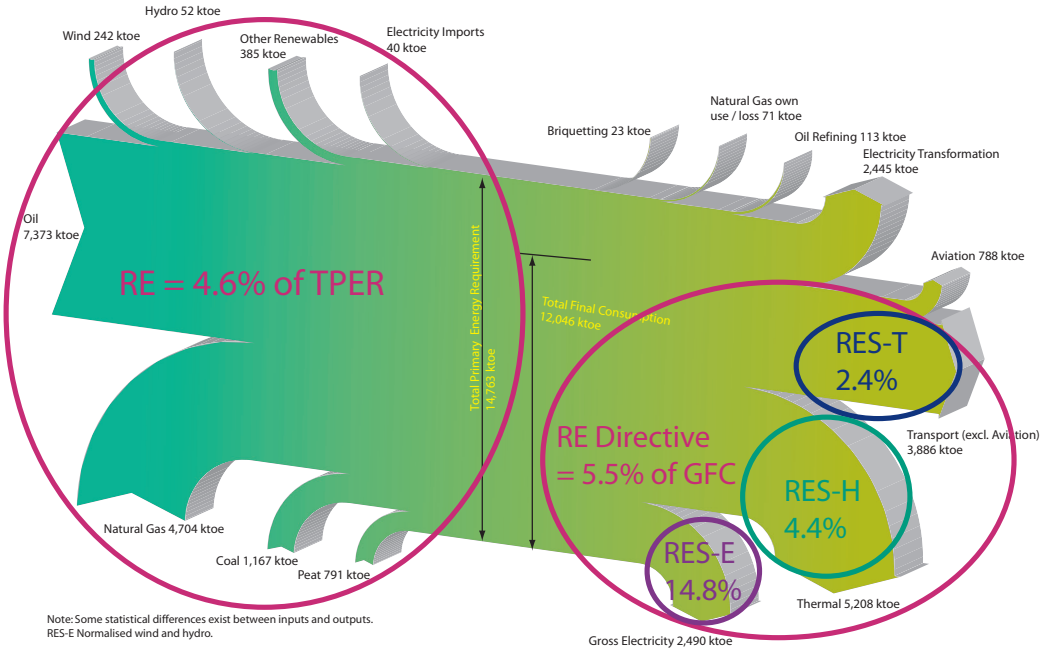


There has been significant increase in the share of transport energy from biofuels since 2006, albeit from a low base. In absolute terms, biofuels in transport increased from 1 ktoe in 2005 (0.03%) to 92 ktoe in 2010 (2.4% in energy terms).

3.1.4 Progress towards Renewable Energy Targets

Figure 27 illustrates where the various renewable targets fit within overall energy use in Ireland and the position with regard to progress towards those targets in 2010. Towards the right of the figure the transport, heat and electricity targets' current percentages are shown relative to the respective amount of final energy that they refer to. Also shown is how these relate to the EU Renewable Directive target (see also *Table 11*).

Figure 27 *Progress to Targets 2010*



Towards the left of *Figure 27* the overall contribution of renewable energy to total primary energy requirement

(TPER) is shown at 4.6%. Whilst there is no specific target for this measure it does help to illustrate the position of renewables in the overall energy use in Ireland.

Table 11 *Renewable Energy Progress to Targets*[33]

% of each target	1990	1995	2000	2005	2006	2007	2008	2009	2010	2010	2020
RES-E (normalised)	5.3	4.6	4.8	7.2	8.7	9.9	11.1	13.7	14.8	15	40
RES-T	0.0	0.0	0.0	0.0	0.1	0.5	1.2	1.8	2.4	3	10
RES-H	2.6	2.1	2.4	3.5	3.6	3.7	3.6	4.3	4.4	5	12
Directive (2009/29/EC)	**2.3**	**1.9**	**1.9**	**2.8%**	**3.1%**	**3.5%**	**4.0%**	**5.0%**	**5.5%**		**16**

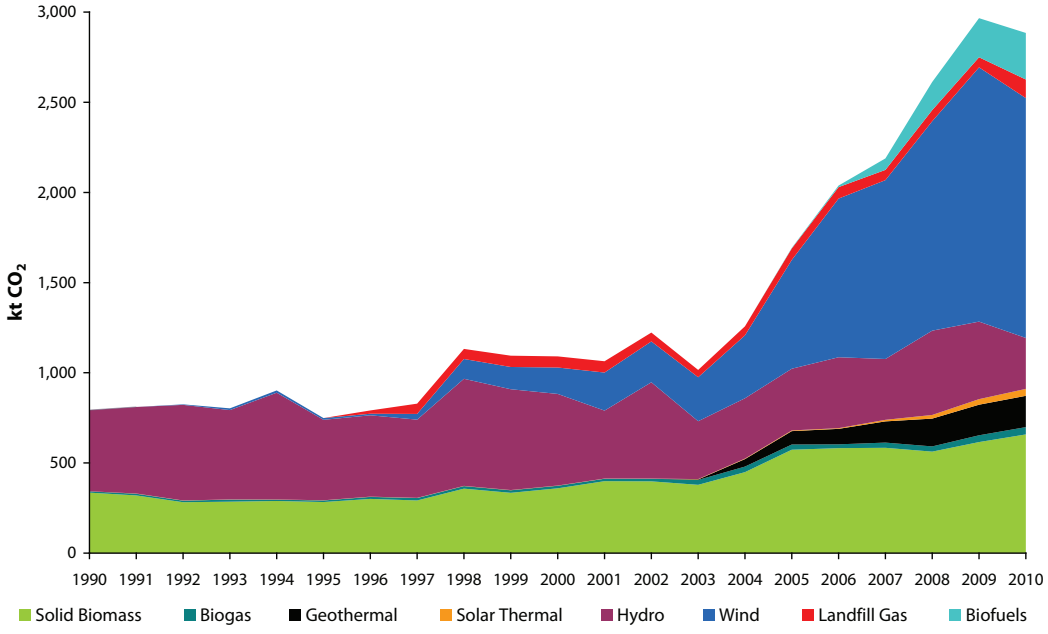
Source: SEAI

Table 11 tabulates progress towards the individual national modal targets and to the overall Directive target for the period 1990 – 2010. Here the percentages in each row (RES-E, RES-T and RES-H) relate to the specific modal targets and the percentages in the final row relate to the overall target using the definition in the EU RE Directive 2009/29/EC. The latter two columns show the targets for 2010 and 2020.

3.1.5 CO_2 Displacement

Figure 28 shows the trend in avoided CO_2 emissions from renewable energy for the period 1990 – 2010. See *Renewable Energy in Ireland – 2010 Update* for details on the methodology used to calculate the avoided emissions.

Figure 28 *Avoided CO_2 from Renewable Energy 1990 to 2010*



The estimated amount of CO_2 avoided from renewable energy increased by 267% (6.7% per annum on average) over the period 1990 to 2010, reaching 2,966 kt CO_2 in 2009 and falling to 2,885 kt CO_2 in 2010, illustrated in *Figure 28*. The emissions avoided from wind were most significant again in 2010, 1,329 kt CO_2, followed by solid biomass 658 kt CO_2 and hydro 282 kt CO_2.

3.1.6 Combined Heat and Power

Combined Heat and Power (CHP) is the simultaneous generation of usable heat and electricity in a single process. In conventional electricity generation much of the input energy is lost to the atmosphere as waste heat. Typically 60% of the input energy is lost with just 40% being transformed into electricity. Combined Heat and Power (CHP) systems channel this extra heat to useful purposes so that usable heat and electricity are generated in a single process. The efficiency of a CHP plant can typically be 20% to 25% higher than the combined efficiency of heat-only boilers and conventional power stations. Also, if embedded in the network close to the point of electrical consumption, CHP

33 Note: Individual target percentages are not additive.

can avoid some of the transmission losses incurred by centralised generation. Therefore in the right circumstances CHP can be an economic means of improving the efficiency of energy use and achieving environmental targets for emissions reduction.

The installed capacity[34] of CHP in Ireland at the end of 2010 was 307 MWe (227 units[35]) – up from 299 MWe (206 units) in 2009, an increase of 2.7%. Of the 227 units 154 of them were reported as being operational. The operational installed capacity decreased by 0.7 MWe, to 286 MWe, in 2010 compared with 2009.

Table 12 *Number of Units and Installed Capacity by Fuel 2010*

	No. of Units	Installed Capacity MWe	No. of Units %	Installed Capacity %
Natural Gas	214	288	94.3	93.8
Solid Fuels	2	5.2	0.9	1.7
Biomass	2	5.4	0.9	1.7
Oil Fuels	9	8.4	4.0	2.7
Total	227	307	100	100

Source: SEAI

The installed capacity at the end of 2010 was 77% of the Government 2010 target. Natural gas was the fuel of choice for 288 MWe (214 units) in 2010. It is worth noting that there is one single 160 MWe gas plant which dominates. Oil products[36] made up the next most significant share with 8.4 MWe (9 units) and the remainder being biomass at 5.35 MWe (2 units) and solid fuels 5.2 MWe (2 units).

Figure 29 illustrates the contribution from CHP to Ireland's energy requirements in the period 1994 – 2010[37]. Fuel inputs have increased by 164% (6.3% per annum) while the thermal and electrical outputs increased by 206% (7.2% per annum) and 642% (13% per annum) respectively over the period. This suggests that the overall stock of CHP installations has become more efficient over the period. In 2010 fuel input increased by 8.3%, thermal output increased by 9.3% while electricity increased by 6.8%. The large increase in 2006 is accounted for by the Aughinish Alumina plant which came online in that year.

Figure 29 *CHP Fuel Input and Thermal/Electricity Output 1994 – 2010*

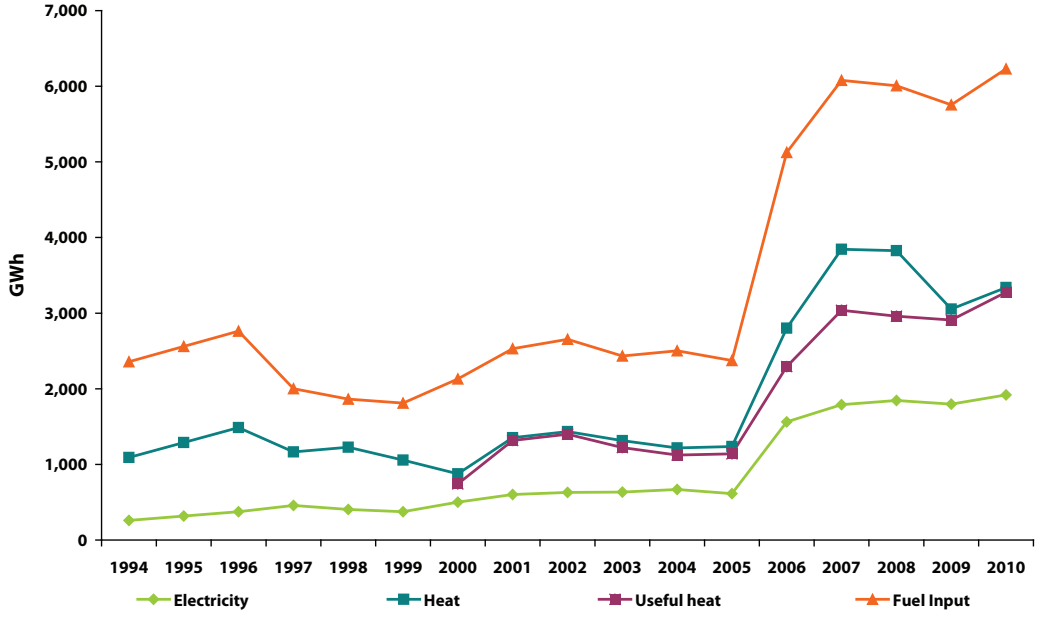


Figure 30 focuses on CHP generated electricity in Ireland as a proportion of gross electricity consumption (i.e. electricity generation plus net imports) in the period 1990 to 2010. In 2010, 6.8% of total electricity generation was generated in CHP installations compared with 6.4% in 2009.

34 Megawatt electrical or MWe is the unit by which the installed electricity generating capacity or size of a CHP plant is quantified, representing the maximum electrical power output of the plant. The figures above include a number of units that were not operational (5.7 MWe, 7 units) and a number whose status is currently unknown (4 MWe, 6 units).

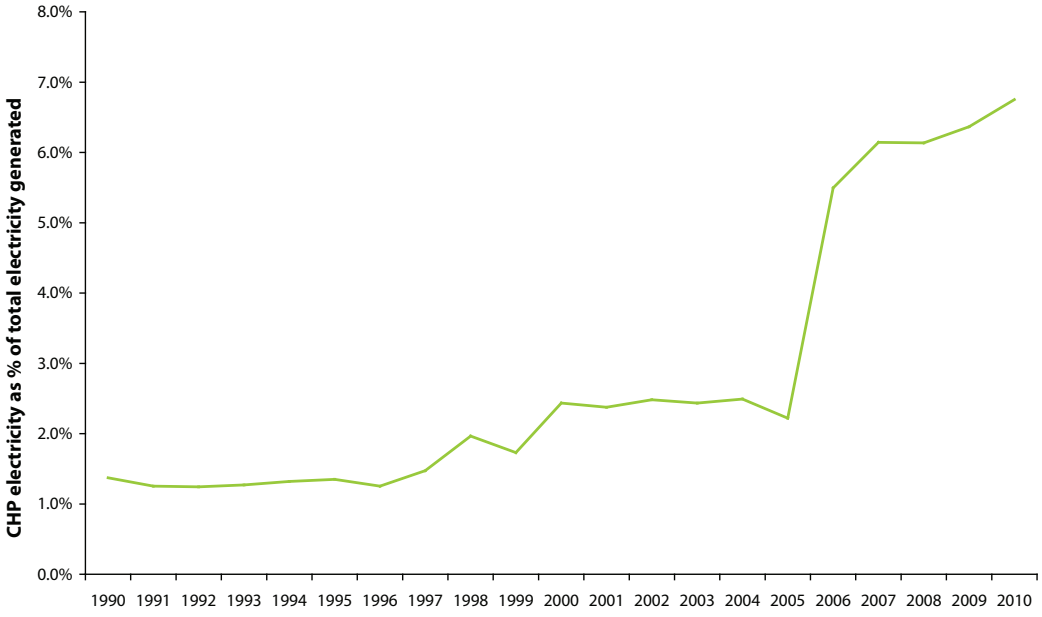
35 Note that units are distinct from CHP plants or schemes and that there may be more than one CHP unit at a site.

36 Oil products are comprised of LPG and heavy fuel oil and refinery gas.

37 CHP in Ireland is examined in more detail in a separate SEAI publication: Sustainable Energy Ireland (2011), *Combined Heat and Power in Ireland: Trends and Issues – 2010 Update,* available from www.seai.ie.

Some CHP units export electricity to the national grid. In 2010 there were 14 units exporting electricity to the grid. These units exported 1,347 GWh of electricity in 2010, an increase of 3.0% on 2009.

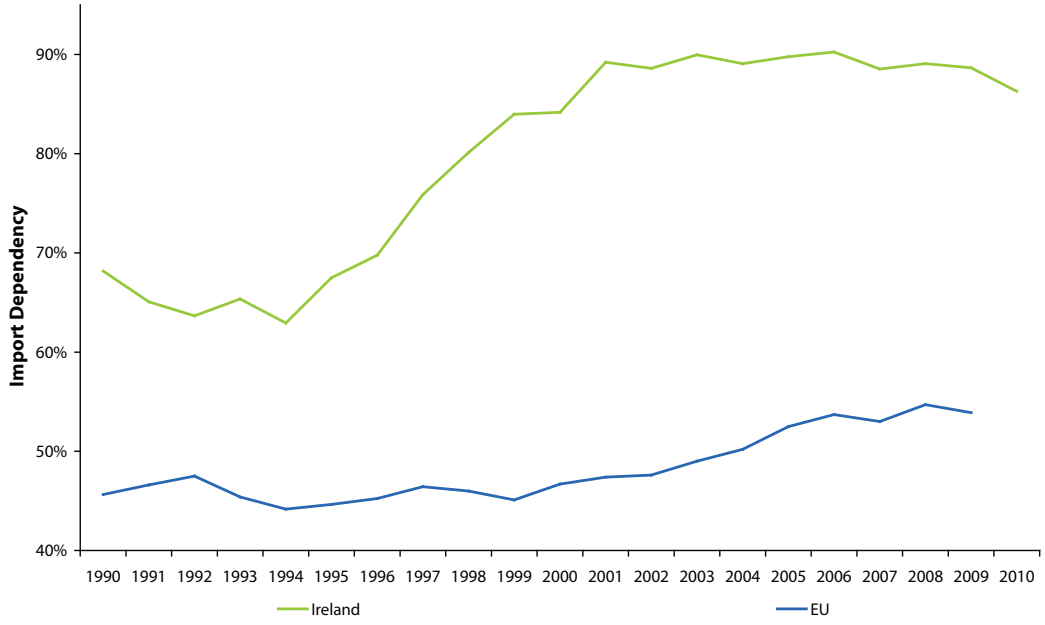
Figure 30 *CHP Electricity as percentage of Total Electricity Generation 1990 – 2010*



3.2 Energy Security

Energy security relates to import dependency, fuel diversity and the capacity and integrity of the supply and distribution infrastructure. Ireland's energy security is closely linked to EU security of supply, but import dependency is examined here for Ireland in its own right. Energy security is treated in more detail in a separate SEAI publication[38]. *Figure 31* illustrates the trend in import dependency since 1990, comparing it with that for the EU as a whole.

Figure 31 *Import Dependency of Ireland and EU*



Source: SEAI and Eurostat

Domestic production accounted for 32% of Ireland's energy requirements in 1990. However, since the mid-1990s import dependency has grown significantly, due to the increase in energy use together with the decline in indigenous natural gas production at Kinsale since 1995 and decreasing peat production. Imported oil and gas accounted for 82% of TPER in 2010, compared with 50% in the early 1990s. Ireland's overall import dependency reached 90% in 2006 but has decreased to 86% in 2010.

This trend reflects the fact that Ireland is not endowed with significant indigenous fossil fuel resources and has to date not harnessed significant quantities of renewable resources. *Figure 32* shows the indigenous energy fuel mix for Ireland over the period. The reduction in indigenous supply of natural gas is clearly evident from the graph as is the switch away from peat. Production of indigenous gas decreased by 83% over the period since 1990 and peat by 30%. Renewable energy in contrast increased by 278%. Indigenous production peaked in 1995 at 4.1 Mtoe and there has been a 53% reduction since then.

The share of total indigenous fuels contribution from native gas was 16% in 2010, compared with 54% in 1990. The share of peat increased from 41% in 1990 to 51% in 2010 but in absolute terms peat production declined by 30%. Renewable energy accounted for 41% of indigenous produced fuels in 2009 but fell back to 33% in 2010 due to poor wind and hydro production.

Although peat production increased in 2010 by 75%, peat consumption decreased by 3.1%, with significant stock changes accounting for this difference.

Some proposed developments are likely to impact on this trend including the plans to extract and utilise gas at the Corrib Gas Field and the targets for increasing the deployment of renewable energy.

38 Sustainable Energy Ireland (2011), *Energy Security in Ireland – 2011 Report*, www.seai.ie.

Figure 32 *Indigenous Energy by Fuel*[39]

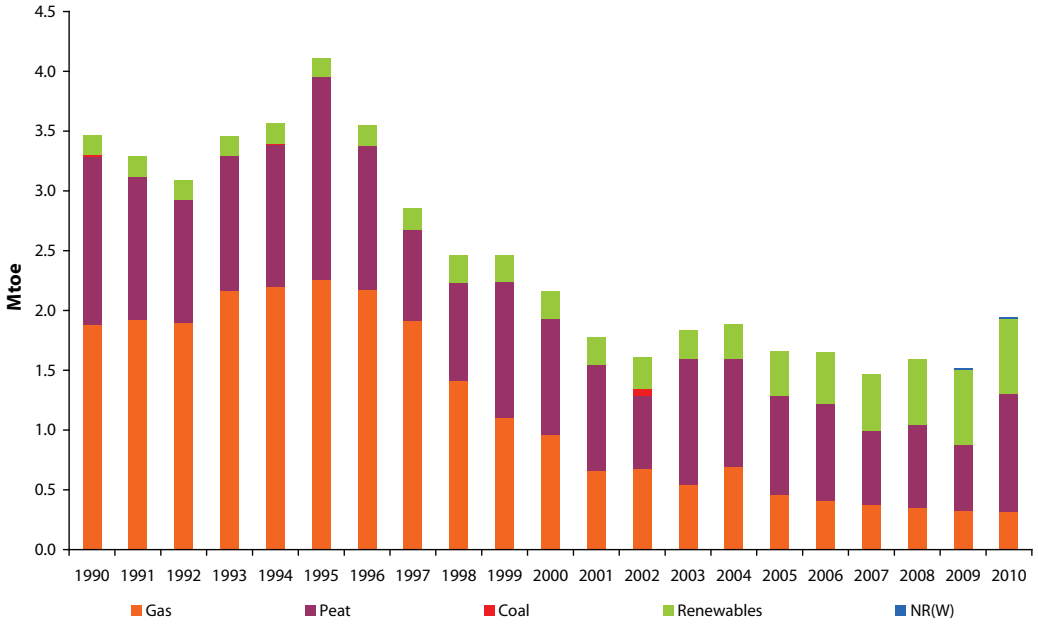
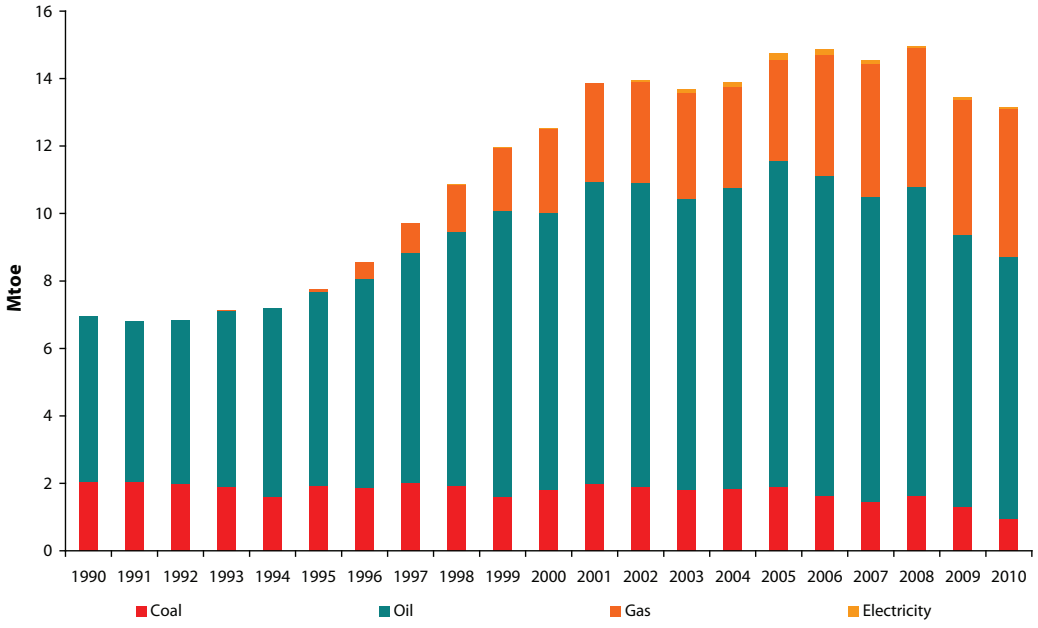


Figure 33 shows the trend for net fuel imports (imports minus exports) over the period 1990 – 2010. The growing dependence on oil due largely to increase in energy use in transport is the most striking feature. There was a 117% increase in the total net imports up to 2008, with a 87% increase in net imports of oil. Net imports have fallen since and are now 90% above 1990 levels, with oil imports 57% above. The decline of indigenous natural gas reserves at Kinsale is also indicated by the growth in imported natural gas in the latter part of the decade. Coal imports have remained stable over the period, reflecting the base load operation of Moneypoint electricity generating plant, although they fell by 42% since 2008. In 2010, oil, gas and coal accounted for 59%, 33% and 7.2% of net imports respectively.

Figure 33 *Imported Energy by Fuel*



39 NR(W) is Non-renewable energy from wastes.

3.3 Cost Competitiveness

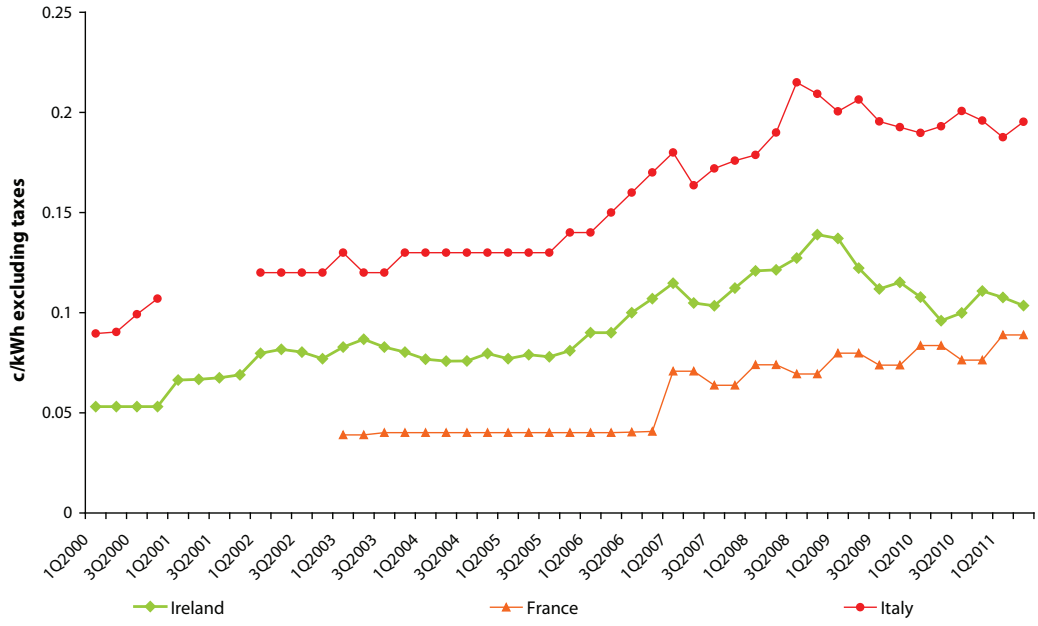
Energy use is an important part of economic activity and therefore the price paid for this energy is a determining factor in the competitiveness of the economy. The EU has introduced competition into the electricity and gas markets through the liberalisation process in order to reduce energy costs to final consumers.

This section presents comparisons of the cost of energy in various forms in Ireland with that in selected EU countries. The source of the data presented here is the International Energy Agency (IEA) Energy Prices and Taxes. This data source was chosen because it is produced quarterly and the latest complete data is available for the second quarter of 2011. Prices shown are in current (nominal) money. Graphical comparisons with other countries in money terms are restricted to euro-zone countries (subject to data availability) to avoid difficulties in adjusting for exchange rates. To avoid confusion in the graphs, only data for Ireland and the highest and lowest price countries (as of the 2nd quarter 2011) are presented. Relative price increases since 2005, however, are tabulated for all the EU-15 countries in index format in both nominal and real terms.

SEAI has also published a number of reports titled *Understanding Electricity and Gas Prices in Ireland*[40] based on the new methodology for the revised EU Gas & Electricity Price Transparency Directive[41] which came into effect on the 1st January 2008. These reports focus specifically on gas and electricity prices and are a useful reference for this section on cost-competitiveness. These reports help in understanding the key contributing factors and the precise impact of energy price increases. The new methodology reflects more accurately the actual cost of gas and electricity to final consumers as it incorporates all the factors in the cost of their use such as capacity charges, levies, standing charges etc.

3.3.1 Energy Prices in Industry

Figure 34 *Electricity Prices to Industry*



Source: Energy Prices & Taxes © OECD/IEA, 2011.

40 Sustainable Energy Ireland (various dates), *Understanding Electricity and Gas Prices in Ireland*, www.seai.ie.
41 http://europa.eu/legislation_summaries/energy/internal_energy_market/l27002_en.htm

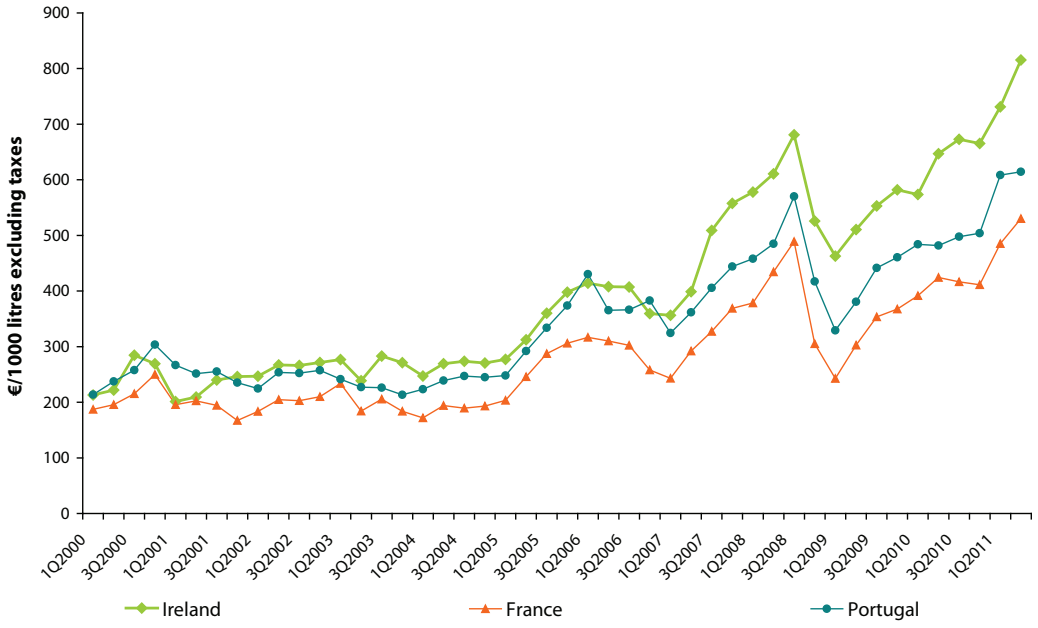
Table 13 *Electricity Price to Industry Increase since 2005*

Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2011 (nominal)	157	141	145	116	145	222	159	172	**130**	139	104	..	117	129	187	169
2nd qtr 2011 (real)	132	121	112	98	114	195	142	130	**135**	120	84	..	100	108	163	129

Source: Energy Prices & Taxes © OECD/IEA, 2011.

Electricity prices to Irish industry have increased by 35% in real[42] terms between 2005 and 2010. Based on this data, France experienced the highest increase since 2005 with a 95% increase in real terms between 2005 and 2010. The fuel mix for electricity generation is one factor that has a key bearing on the variation in the price of electricity. Ireland has the highest overall dependency of electricity generation on fossil fuels in the OECD EU-15 countries. Ireland and Italy have 62% and 66% respectively of electricity generated by gas and oil.

Figure 35 *Fuel Oil Prices to Industry*



Source: Energy Prices & Taxes © OECD/IEA, 2011.

Table 14 *Oil Price to Industry Increase since 2005*

Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2011 (nominal)	141	138	140	139	147	132	145	161	**144**	130	138	132	147	141	137	156
2nd qtr 2011 (real)	118	118	108	118	116	116	129	121	**148**	111	111	104	126	118	120	119

Source: Energy Prices & Taxes © OECD/IEA, 2011.

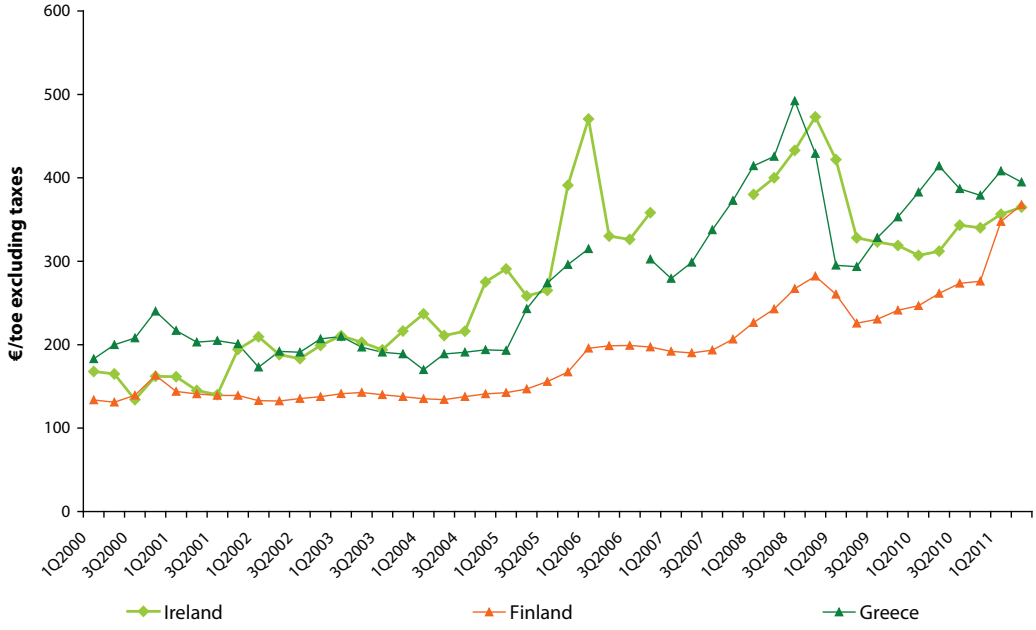
Oil prices to industry in Ireland were 48% higher in real terms in mid 2011 than in the year 2005. This was the largest

42 See Glossary for definition of 'real' and 'nominal' values.

increase in real terms of the EU-15 countries. The average increase in oil price in Europe was 18%.

Crude oil prices doubled between July 2007 and July 2008. During the first semester (S1) of 2008, nominal crude oil prices increased by 39% reaching $140/barrel. After July 2008, there was a sharp decline in the price of crude oil to a low of around $34/barrel in late December. Prices in the first half of 2011 averaged around the $110/barrel level.

Figure 36 *Natural Gas Prices to Industry*[43]



Source: Energy Prices & Taxes © OECD/IEA, 2011.

Table 15 *Natural Gas Price to Industry Increase since 2005*

Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2011 (nominal)	145	132	100	..	240	158	134	157	**121**	133	138	148	162	149	..	148
2nd qtr 2011 (real)	121	112	77	..	189	139	120	119	**124**	115	111	116	139	124	..	113

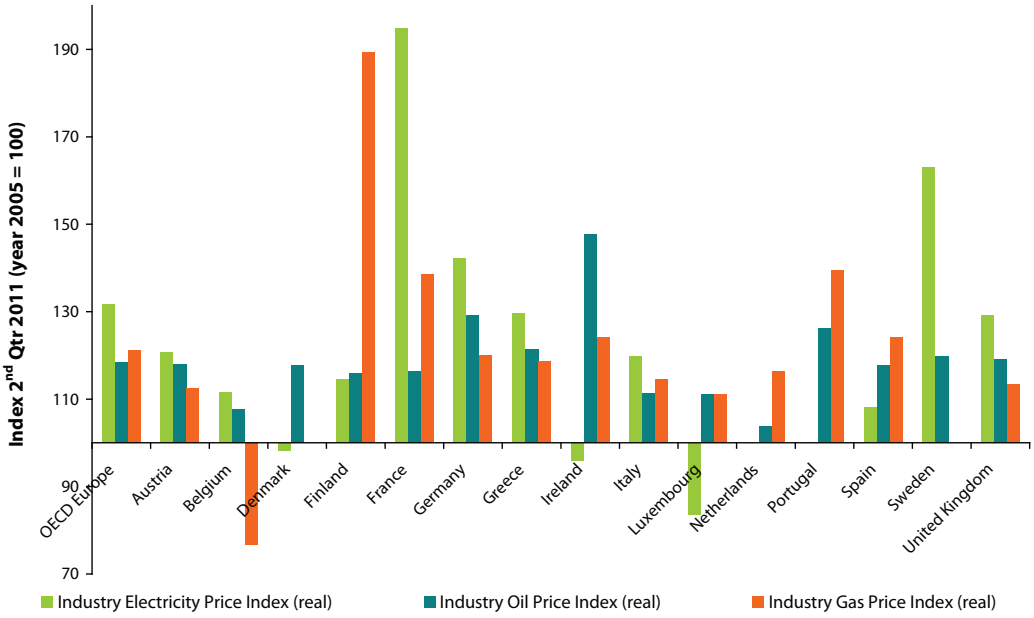
Source: Energy Prices & Taxes © OECD/IEA, 2011

With reference to *Figure 36*, natural gas prices to Irish industry have been increasing since 2nd quarter 2010. In the second quarter of 2011 gas prices to industry were 24% above 2005 levels in real terms.

Figure 36 also shows the dramatic increase in gas prices to industry during 2008, the subsequent fall from the start of 2009 and the steady rise since early 2010, mirroring changes in global energy prices.

43 Breaks in the trends for Ireland and Greece are due to non-availability of data.

Figure 37 *Real Energy Price Change to Industry since 2005 in EU-15 (index)*

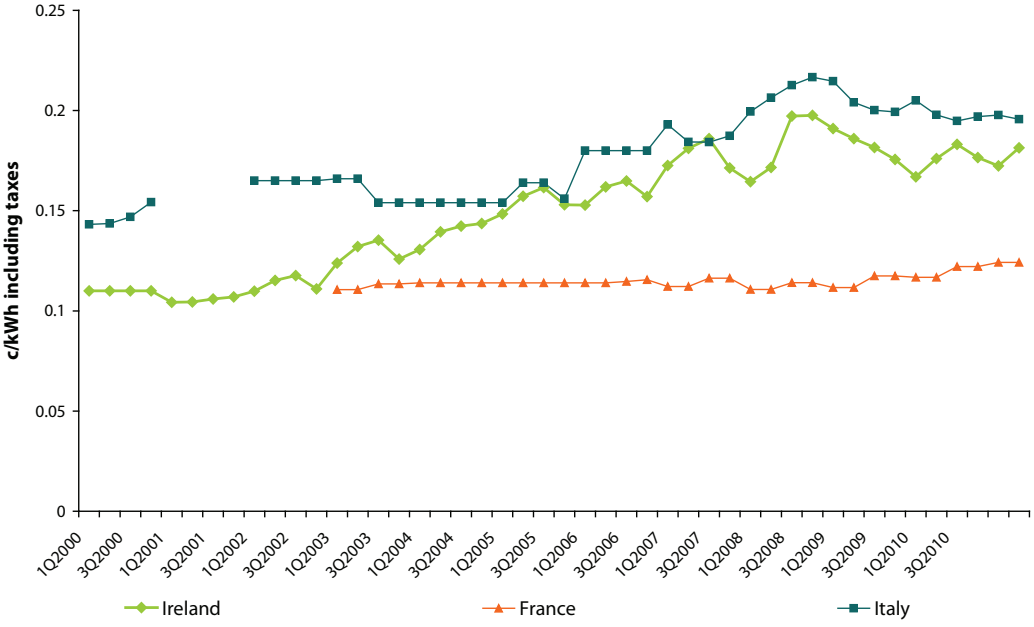


Source: Energy Prices & Taxes © OECD/IEA, 2011.

Figure 37 summarises the data presented in tables 13, 14 and 15. The IEA publishes an overall energy price index (real) for industry which shows that overall energy costs for Irish industry between 2005 and 2011 increased by 36% compared with 22% for OECD Europe. This should be considered in the context of the weighting of energy in the cost base of Irish industry[44].

3.3.2 Household Energy Prices

Figure 38 *Household Electricity Prices*



Source: Energy Prices & Taxes © OECD/IEA, 2011.

44 See Sustainable Energy Ireland (2007), *Energy in Industry 2007 Report*, available from www.seai.ie.

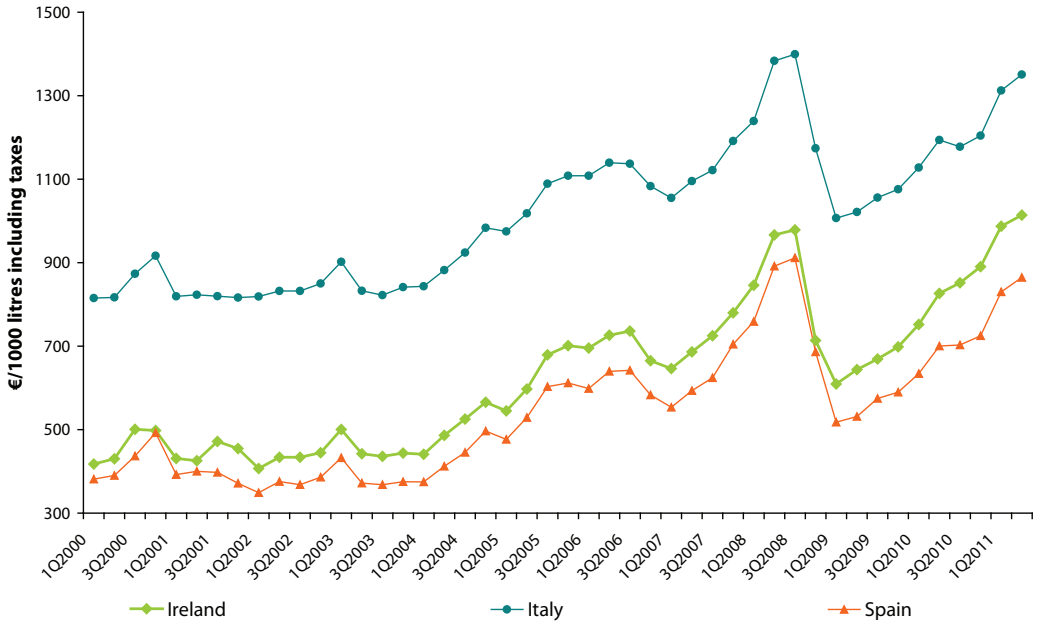
Table 16 *Electricity Price to Households Increase since 2005*

Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2011 (nominal)	137	142	131	124	158	109	158	139	**113**	123	153	90	114	128	145	157
2nd qtr 2011 (real)	117	125	115	108	140	99	143	114	**103**	109	133	81	101	110	131	128

Source: Energy Prices & Taxes © OECD/IEA, 2011.

Electricity prices to Irish householders increased by 3% in real terms since 2005. In France and the Netherlands the price of electricity is lower in 2011 than in 2005 but in Germany it is 43% higher.

Figure 39 *Household Heating Oil Prices*



Source: Energy Prices & Taxes © OECD/IEA, 2011.

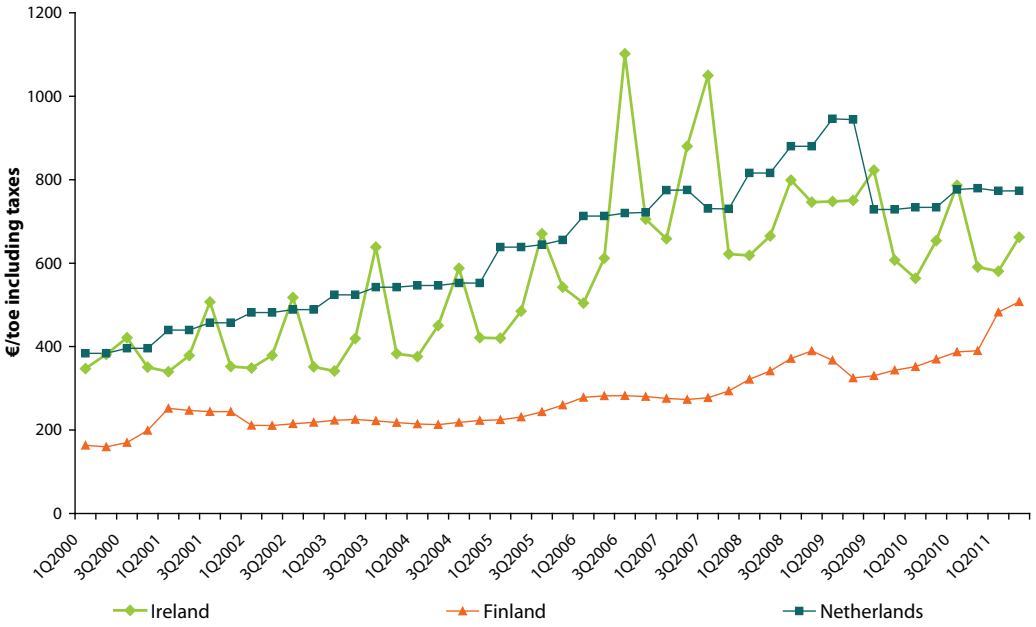
Table 17 *Oil Price to Households Increase since 2005*

Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2011 (nominal)	139	138	140	136	139	136	133	172	**146**	127	134	124	138	143	130	157
2nd qtr 2011 (real)	120	122	122	119	122	124	120	141	**133**	112	116	112	122	123	117	128

Source: Energy Prices & Taxes © OECD/IEA, 2011.

Heating oil prices to Irish householders increased in real terms by 33% since 2005, the largest amongst the EU-15 countries. On average in Europe the price of oil to households increased by 20% in real terms.

Figure 40 *Household Natural Gas Prices*



Source: Energy Prices & Taxes © OECD/IEA, 2011.

Note that the peaks shown in the Irish gas price in *Figure 40* reflect fixed standing charges and low consumption during summer months resulting in higher unit prices. From October 2007 onwards this trend has flattened out as a result of the new standard rate tariff which has a low annual standing charge.

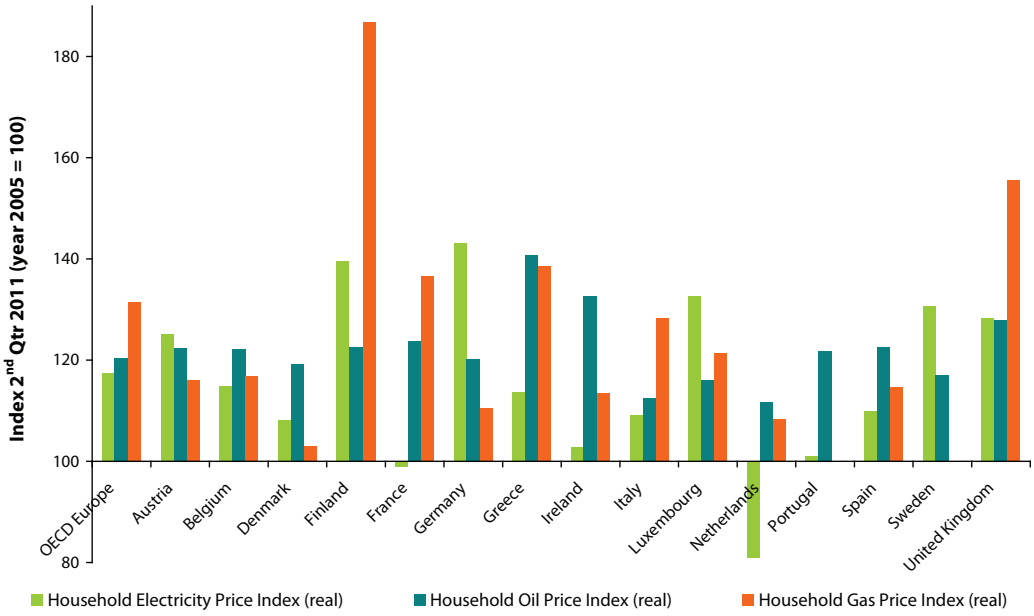
Table 18 *Natural Gas Price to Households Increase since 2005*

Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2011 (nominal)	154	131	134	118	212	151	122	169	**125**	145	140	120	..	134	..	190
2nd qtr 2011 (real)	132	116	117	103	187	137	111	139	**113**	128	121	108	..	115	..	156

Source: Energy Prices & Taxes © OECD/IEA, 2011.

In 2011, gas prices to householders in Ireland were 13% above 2005 levels in real terms. Prices in OECD Europe as a whole were 32% above and the UK 56% above 2005 levels.

Figure 41 *Real Energy Price Change to Households since 2005 in EU-15 (index)*



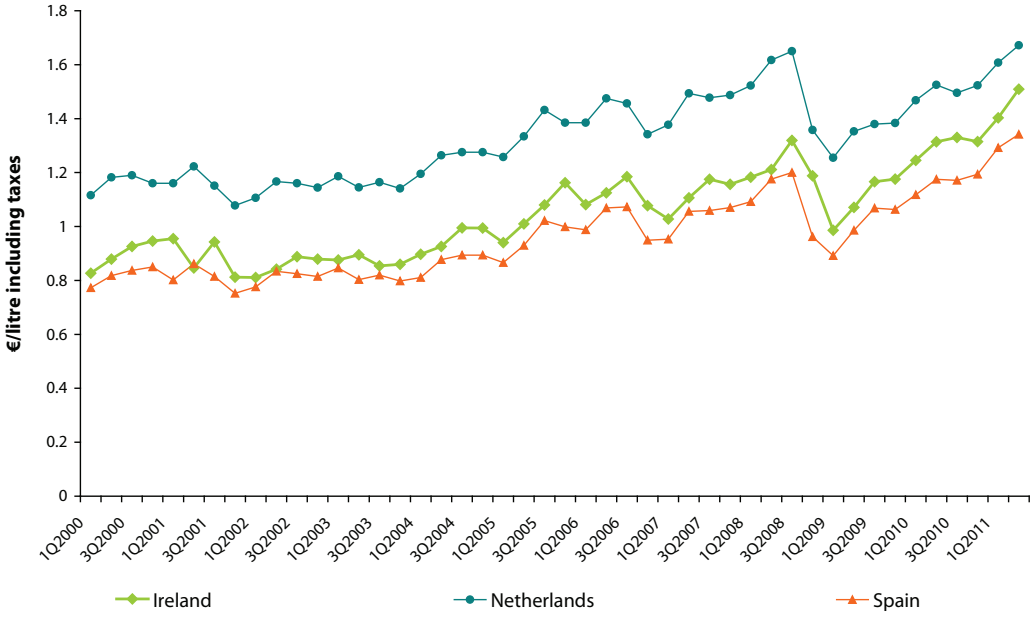
Source: Energy Prices & Taxes © OECD/IEA, 2011.

Figure 41 summarises the data presented in tables 16, 17 and 18. The IEA publishes separately an overall energy index (real) for households which shows that overall energy costs for Irish households increased by 21%; the increase for OECD Europe was also 21%.

3.3.3 Transport Energy Prices

Petrol and diesel prices shown here are inclusive of both excise and VAT.

Figure 42 *Retail Unleaded Petrol Prices (95 RON[45])*



Source: Energy Prices & Taxes © OECD/IEA, 2011.

45 RON is the research octane number used in Europe to rate the characteristics of petrol.

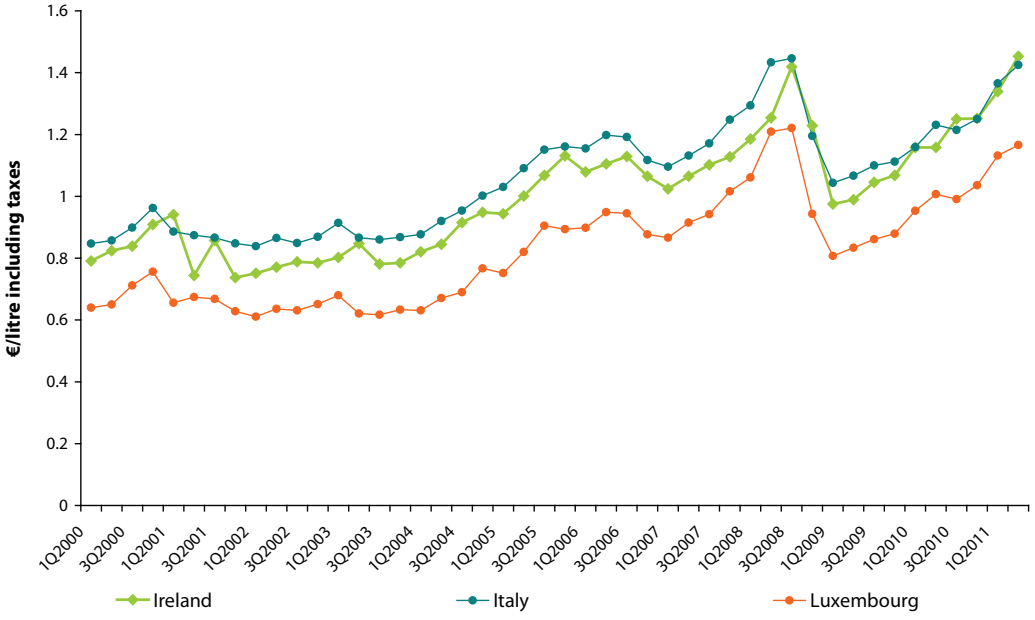
Table 19 *Petrol Price Increase since 2005*

Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2011 (nominal)	138	134	128	135	131	131	128	190	**145**	126	128	124	138	141	130	156
2nd qtr 2011 (real)	119	118	112	118	115	119	116	155	**132**	112	111	112	122	121	117	128

Source: Energy Prices & Taxes © OECD/IEA, 2011.

Figure 42 shows that petrol prices in Ireland are in the mid range in the euro-zone countries (for clarity only highest and lowest of the euro-zone countries are shown). Petrol prices in Ireland in the 2nd quarter of 2011 were 32% above the level in 2005 in real terms. Petrol prices have been increasing since the 1st quarter of 2009 and have increased by 53% since then.

Figure 43 *Retail Road Diesel Prices*



Source: Energy Prices & Taxes © OECD/IEA, 2011.

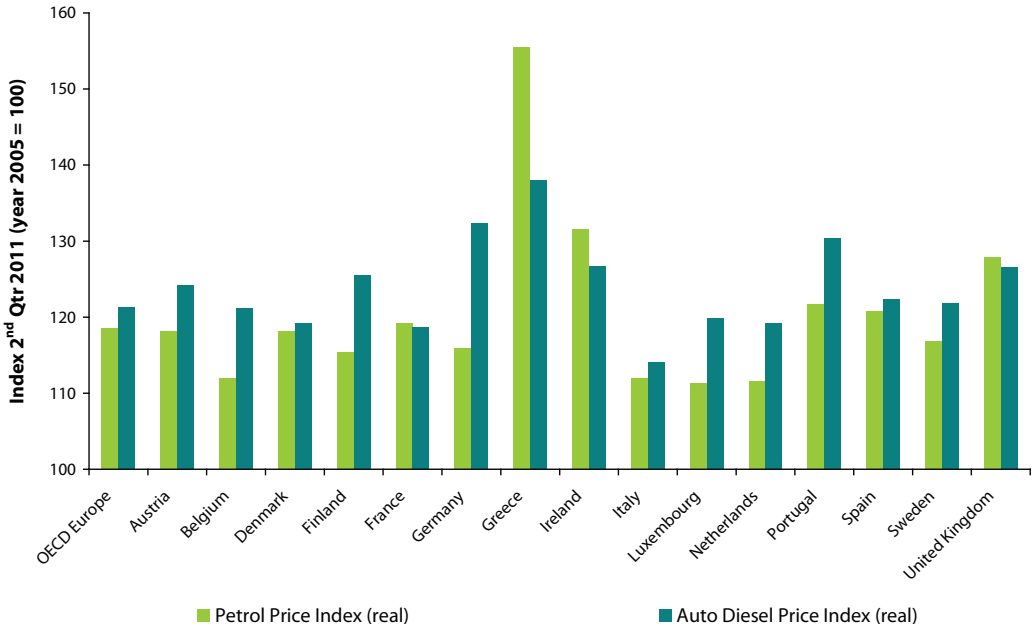
Table 20 *Auto Diesel Price Increase since 2005*

Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2011 (nominal)	141	141	139	136	142	131	146	168	**140**	129	138	132	147	142	135	155
2nd qtr 2011 (real)	121	124	121	119	125	119	132	138	**127**	114	120	119	130	122	122	127

Source: Energy Prices & Taxes © OECD/IEA, 2011.

Figure 43 shows that diesel prices in Ireland are in the upper range for the euro-zone countries. Diesel prices in Ireland increased by 27% in real terms since 2005 which is above the 21% average increase for OECD Europe countries. Again diesel prices have been increasing since the 1st quarter of 2009 and are 49% higher since then.

Figure 44 *Real Energy Price Change in Transport since 2005 in EU-15 (index)*



Source: Energy Prices & Taxes © OECD/IEA, 2011.

Figure 44 summarises the data presented in *Table 19* and *Table 20*. While no overall index is provided for transport, *Figure 44* indicates Ireland has experienced greater price increases for transport energy in the last 5 years than most of the OECD Europe countries.

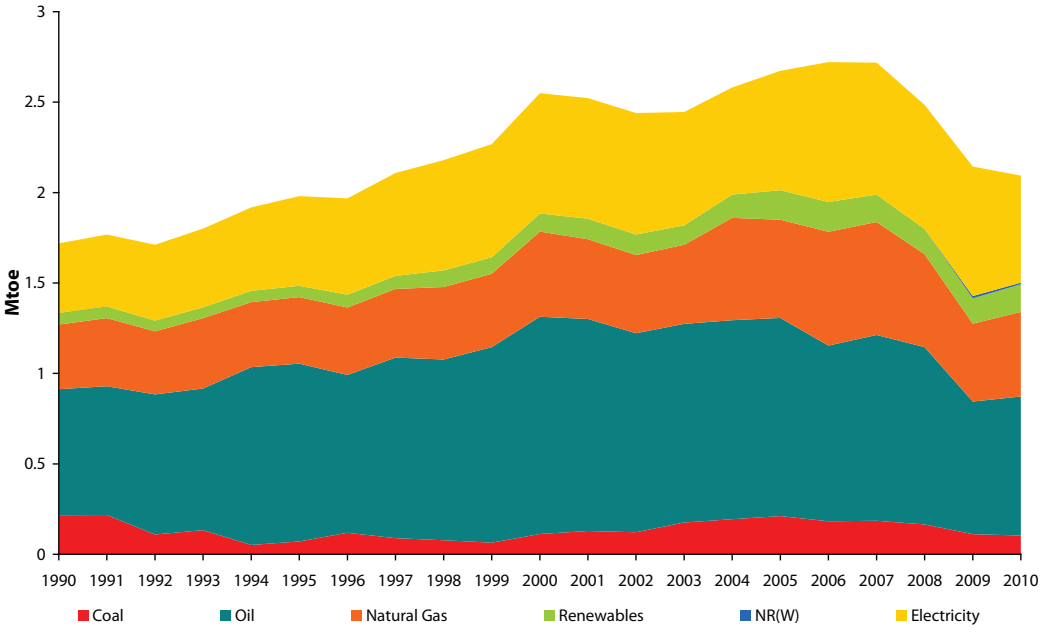
4 Sectoral Indicators

This section explores the changes in energy trends that are taking place at a sectoral level to deepen our understanding of energy use patterns generally and to assist in assessing the likely impacts of policies and measures to achieve a particular target.

4.1 Industry

Final energy use in industry had grown by 58% (2.9% per annum) to a high of 2.7 Mtoe over the period 1990 – 2006, but by 2010 fell back to 22% above 1990 levels (2.1 Mtoe). Over the 19 year period only electricity, natural gas and renewables have increased their share. The share of electricity has risen from 22% to 28%, natural gas from 21% to 22% and renewables from 3.7% to 7.3%. The increase in renewables is mainly due to the use of biomass in the wood processing industry and the use of tallow in the rendering industry.

Figure 45 *Industry Final Energy Use by Fuel*



In 2010, oil consumption in industry grew by 4.9% and became once again the dominant energy form in industry at 37% with electricity falling into second place at 28%. Growth of electricity use in industry averaged 2.2% per annum over the period 1990 – 2010. In 2010 electricity consumption in industry fell by 17%, while renewables and gas consumption grew by 8.9% and 8.8% respectively.

Table 21 *Growth Rates and Shares of Final Consumption in Industry*

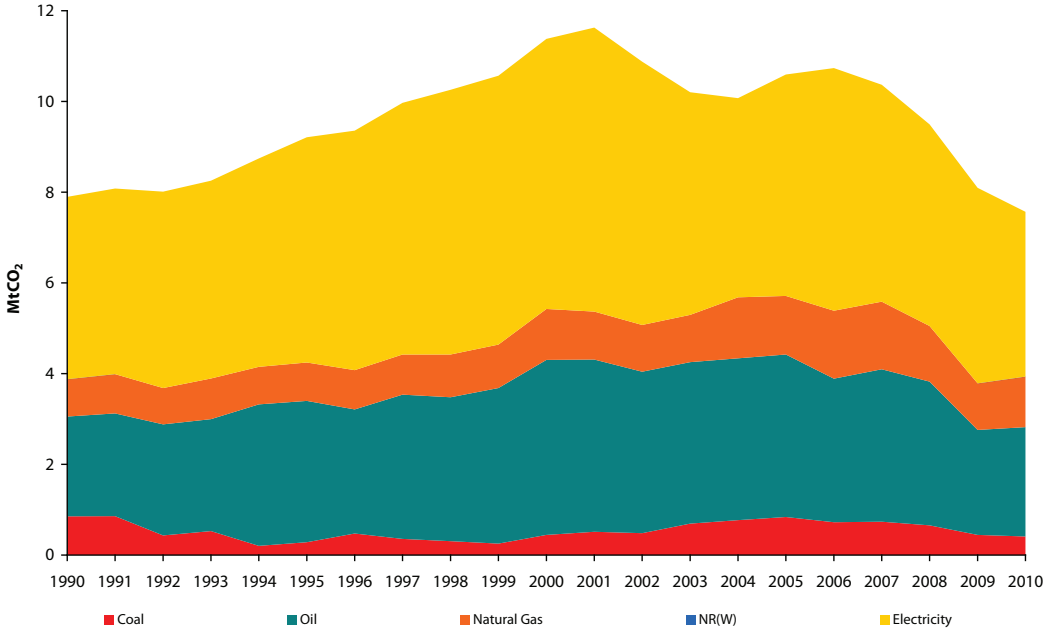
	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Fossil Fuels (Total)	5.5	0.3	2.3	4.6	0.7	-6.2	5.1	73.9	64.0
Coal	-52.2	-3.6	-19.9	9.6	13.4	-13.4	-7.6	12.6	4.9
Oil	10.4	0.5	7.1	4.1	-1.8	-6.8	4.9	40.5	36.7
Gas	30.6	1.3	0.6	5.0	2.9	-2.9	8.8	20.8	22.4
Renewables	142.3	4.5	-0.3	10.1	10.3	-1.3	8.9	3.7	7.3
Non-Renewable (Wastes)	-	-	-	-	-	-	-29.4	0.0	0.4
Combustible Fuels (Total)	12.6	0.6	2.2	4.9	1.3	-5.7	5.1	77.6	71.8
Electricity	53.2	2.2	5.2	6.0	-0.1	-2.2	-17.4	22.4	28.2
Total	**21.7**	**1.0**	**2.9**	**5.2**	**1.0**	**-4.8**	**-2.4**		

Overall final energy use in industry decreased by 2.4% in 2010 following a 13.7% fall in 2009 relative to the previous year. Coal use decreased by 7.6% but the reduction in electricity had the biggest effect on the overall reduction. Renewable energy use in industry grew by 8.9% in 2010 and its share increased to 7.3%.

In order to determine industry's total energy-related CO_2 emissions it is necessary to view electricity on a primary energy basis, i.e. the fuels required to generate the electricity consumed by industry. In 2010 electricity represented 48% of energy used in industry, when calculated on a primary energy basis, compared to 28% on a final energy basis.

Figure 46 shows the primary energy-related CO_2 emissions of industry, showing the on-site CO_2 emissions associated with direct fuel use and the upstream emissions associated with electricity consumption.

Figure 46 *Industry Energy-Related CO_2 Emissions by Fuel*



As detailed in *Table 22*, industrial energy-related CO_2 emissions fell by 6.6% in 2010 following a 14.7% reduction in 2009. Electricity consumption was responsible for 48% of industry's energy related emissions in 2010. Electricity is indirectly responsible for almost half of CO_2 emissions in industry, more than all the other fuels used by industry combined.

Table 22 tabulates the growth rates and relative shares of energy related CO_2 emissions in industry.

Table 22 *Growth Rates and Shares of Energy-related CO_2 Emissions in Industry*

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Coal	-52.2	-3.6	-19.9	9.6	13.4	-13.4	-7.6	10.8	5.4
Oil Total	9.7	0.5	7.2	4.4	-1.5	-7.6	4.1	27.8	31.9
Kerosene	564.7	9.9	20.1	16.3	6.8	-2.0	-23.3	0.6	4.4
Fuel Oil	-26.1	-1.5	6.7	2.9	-6.8	-8.0	21.8	17.0	13.1
LPG	66.6	2.6	2.7	4.1	-3.3	7.1	28.7	2.1	3.6
Gas Oil	7.8	0.4	7.3	-1.9	0.8	-4.3	6.7	5.7	6.5
Petroleum Coke	72.4	2.8	10.2	16.0	7.5	-18.8	-18.5	2.3	4.2
Natural Gas	35.2	1.5	0.6	5.7	2.8	-2.9	8.8	10.4	14.7
Non-Renewable (Wastes)	-	-	-	-	-	-	-	0.0	0.0
Total Combustible Fuels	1.5	0.1	1.8	5.0	1.0	-7.2	3.9	49.1	52.0
Electricity	-9.7	-0.5	4.3	3.7	-3.9	-5.7	-15.8	50.9	48.0
Overall Total	**-4.2**	**-0.2**	**3.1**	**4.3**	**-1.4**	**-6.5**	**-6.6**		

If upstream electricity-related emissions are omitted then there was a 3.9% increase in CO_2 emissions from combustible fuels used on-site in industry in 2010. This is a direct result of the 5.1% increase in fossil fuel use in industry (detailed in *Table 21*) which was driven by an 11.2% increase in the output of industry in 2010 as measured by value added[46].

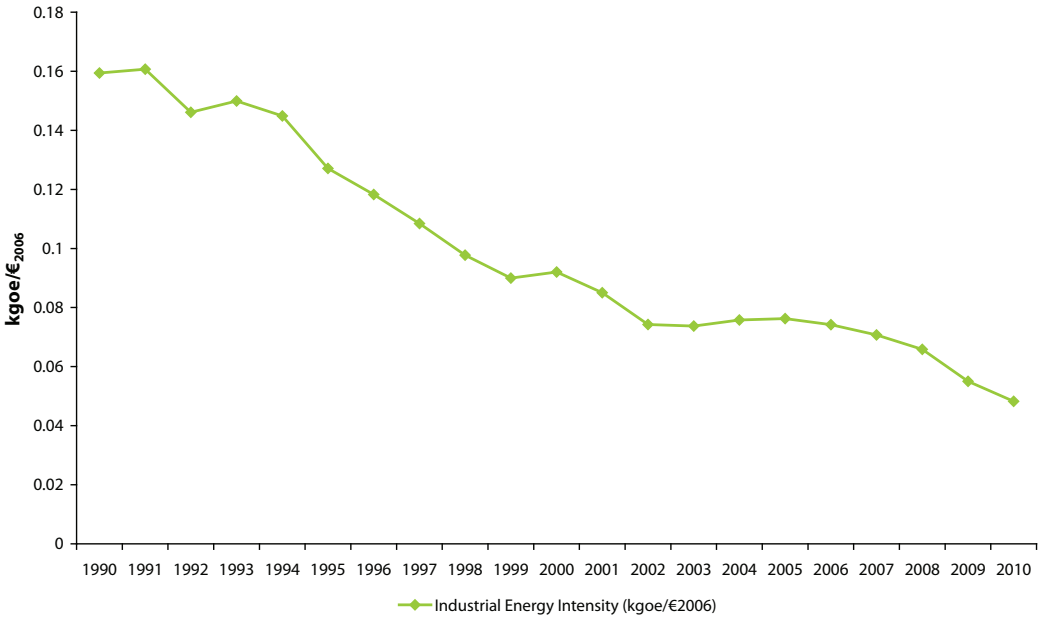
46 CSO (2011) *National Income and Expenditure - Annual Results for 2010*, www.cso.ie.

4.1.1 Industry Energy Intensity

Industrial energy intensity is the amount of energy required to produce a unit of value added, measured in constant money values. *Figure 47* shows the industrial energy intensity between 1990 and 2010 in kilograms of oil equivalent per euro of industrial value added (in 2006 values) (kgoe/€$_{2006}$). Over the period, industrial energy consumption increased by 22% while value added increased by 302% resulting in a reduction in intensity of 70%. In other words to generate a euro of value added in 2010, it takes about one-third of the amount of energy it took in 1990. It should be noted that a downward trend in energy intensity signifies an increase in energy productivity.

Value added output from industry increased by 11% in 2010 compared with the 0.4% fall in the economy overall. Energy use in industry fell by 2.4% resulting in a 12.3% increase in energy productivity in industry.

Figure 47 *Industry Energy Intensity*



As mentioned in section 2.5, energy intensity in this form is a crude indicator and variation may be the result of many factors. To eliminate the effects of structural changes an index of energy intensity at constant structure [47] is also shown, in *Figure 48*.

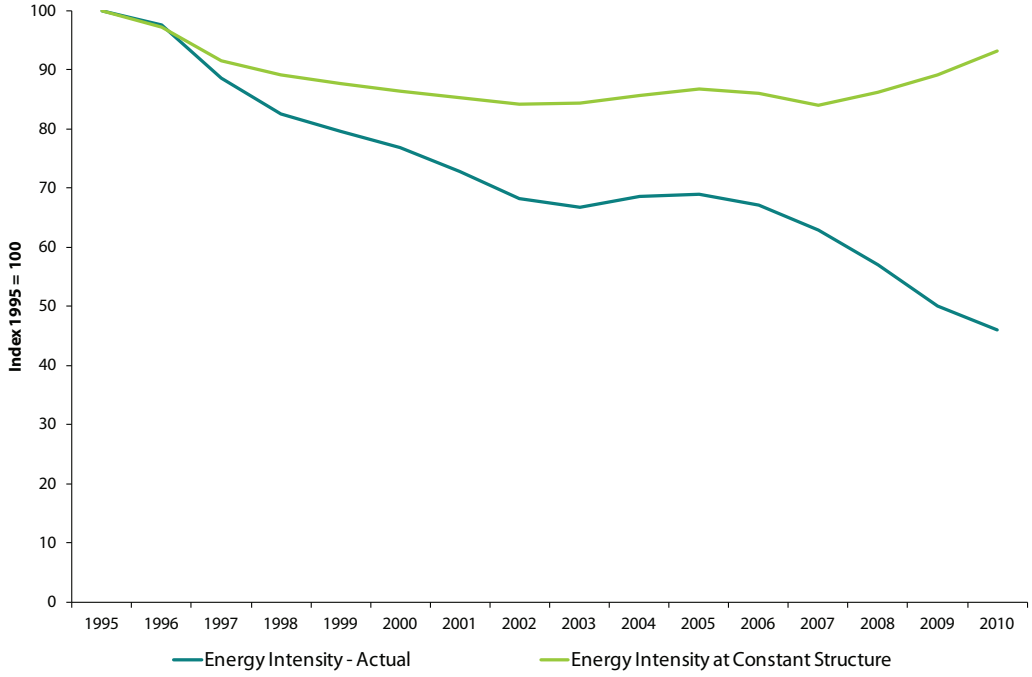
This indicator measures the impact of structural changes in industry by comparing the variations of the actual intensity with that of a fictitious or notional intensity at constant structure (using 1995 structure as a reference). It can be seen that structural changes have had a significant effect but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

The dark green line in *Figure 48* is the trend in energy intensity in industry. The light green line represents the evolution of industrial energy intensity had the structure not changed over time. Over the period 1995 to 2010, the intensity of industry fell by 54% (5.0% per annum). However, if this structural change had not occurred, the intensity fall would have been 6.8% (0.5% per annum).

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 48*.

47 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. http://www.odyssee-indicators.org/

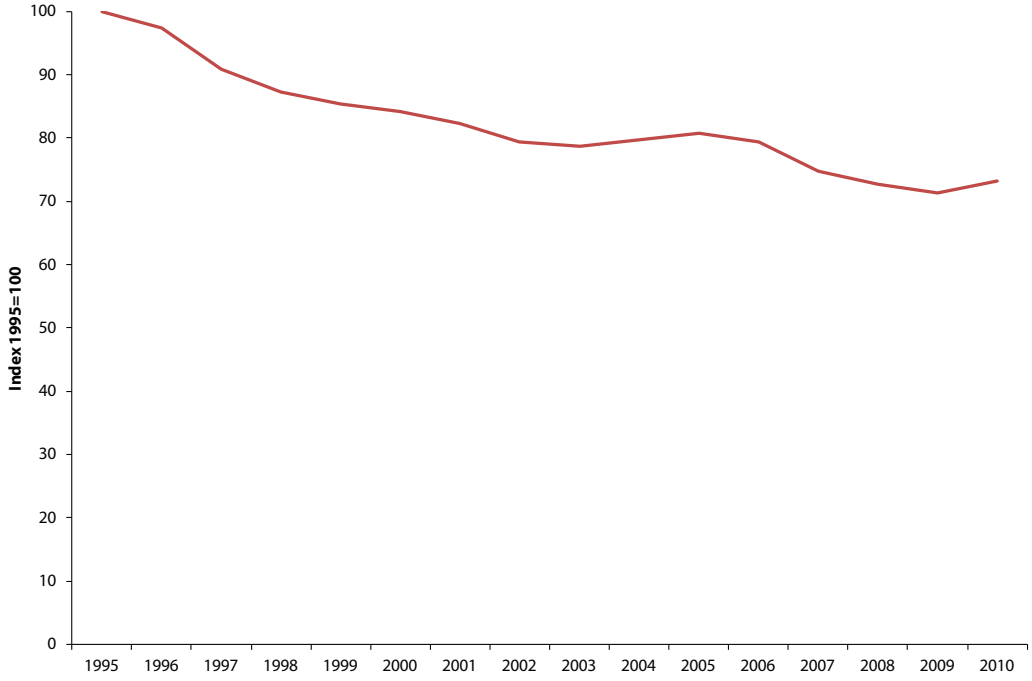
Figure 48 *Index of Energy Intensity of Industry 1995 - 2010*



To further remove non-efficiency effects from the energy intensity at constant structure an ODEX indicator for industry in Ireland has been constructed over the period 1995 to 2010, shown in *Figure 49*. Again here, as with intensity, a downward trend signifies improvement, this time in efficiency. The index decreased from 100 in 1995 to 73 in 2010, indicating a 27% (2.1% per annum) improvement in energy efficiency.

The ODEX indicator is based on production indices for all of the industry 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.

Figure 49 *Industry ODEX 1995 - 2010*

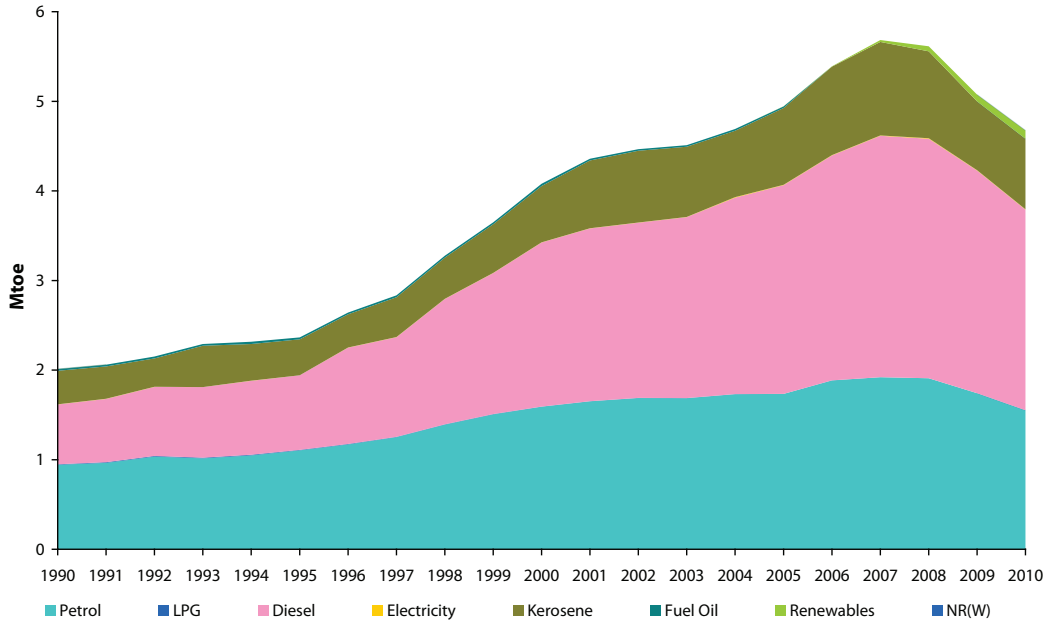


There is a significant difference between the estimated energy-efficiency improvement calculated using energy intensity at constant structure (6.8%) and using the ODEX methodology (27%). This issue is currently the subject of academic investigation, on behalf of SEAI. As initial analysis suggested that, 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 creating the overall energy-efficiency index in this report.

4.2 Transport

In 2008 transport energy use decreased for the first time since 1990, by 1.3% to 5.6 Mtoe. In 2009 the decrease was more significant with a fall of 9.6% to 5.1 Mtoe. There was a further decrease in 2010 of 7.9%, bringing energy consumption in the transport sector down to 4.6 Mtoe, a cumulative fall of 18% to approximately the same level of consumption as in 2004.

Figure 50 *Transport Final Energy Use by Fuel*[48]



The growth rates for the different transport fuels over the period are shown in *Table 23*. Overall energy use in transport fell in 2010 by 7.9%. Renewables, in the form of biofuels, was the only fuel to experience significant growth with an increase of 20% following the introduction of the Biofuels Obligation in mid 2010. Of the oil based fuels, kerosene consumption increased by 2.6% while all other petroleum based fuel decreased. Kerosene in transport is exclusively used for aviation. The share of diesel in transport energy has risen from 33% to 48% over the period 1990 – 2010 while conversely the share of petrol has declined from 47% to 33%.

Table 23 *Growth Rates and Shares of Final Consumption in Transport*

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Fossil Fuels (Total)	127.7	4.2	3.3	11.5	3.9	-1.5	-8.3	99.9	97.9
Total Oil	127.7	4.2	3.3	11.5	3.9	-1.5	-8.3	99.9	97.9
Petrol	64.7	2.5	3.2	7.6	1.7	-2.2	-10.9	46.8	33.2
Diesel	235.4	6.2	4.5	17.1	4.9	-0.8	-9.9	33.2	47.9
Kerosene	110.5	3.8	1.4	9.5	6.4	-1.7	2.6	18.6	16.8
LPG	-92.6	-12.2	-2.8	-18.4	-13.2	-13.6	-12.3	0.3	0.0
Renewables	-	-	-	-	-	143.5	19.6	0.0	2.0
Combustible Fuels (Total)	132.3	4.3	3.3	11.5	3.9	-1.1	-7.9	99.9	99.9
Electricity	184.8	5.4	2.4	7.6	17.8	-5.0	1.7	0.1	0.1
Total	**132.4**	**4.3**	**3.3**	**11.5**	**3.9**	**-1.1**	**-7.9**		

Petrol consumption in transport was at 1.6 Mtoe in 2010, a decrease of 11% on the previous year.

Diesel consumption in transport was 2.2 Mtoe in 2010, a decrease of 10% on the previous year. Diesel consumption grew by 235% between 1990 and 2010.

The growth rates and shares of the energy-related CO_2 emissions from the different transport fuels are tabulated

48 This is based on data of fuel sales in Ireland rather than fuels consumed in Ireland. As a result the effect of cross border trade (fuel tourism) or smuggling is not taken into account in the figures presented here. SEAI's report *Energy in Transport (2009)* presents estimates of fuel tourism and these are shown in *Figure 51*.

in *Table 24*. Transport experienced for the third year in a row a decrease in primary energy-related CO_2 emissions, which fell by 8.3% in 2010 following a 10.1% reduction in 2009. Emissions from aviation increased by 2.6% in 2010.

Table 24 *Growth Rates and Shares of Energy-Related CO_2 Emissions in Transport*

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Total Oil Products	129.2	4.2	3.3	11.6	3.9	-1.5	-8.3	99.8	99.8
Petrol	64.7	2.5	3.2	7.6	1.7	-2.2	-10.9	45.8	33.0
Diesel	235.4	6.2	4.5	17.1	4.9	-0.8	-9.9	34.0	49.8
Kerosene	110.5	3.8	1.4	9.5	6.4	-1.7	2.6	18.6	17.1
LPG	-92.6	-12.2	-2.8	-18.4	-13.2	-13.6	-12.3	0.3	0.0
Electricity	67.9	2.6	1.6	5.3	13.3	-8.5	3.7	0.2	0.2
Total	**129.1**	**4.2**	**3.3**	**11.6**	**4.0**	**-1.5**	**-8.3**		

4.2.1 Transport Energy Demand by Mode

Fuel consumption in transport is closely aligned to the mode of transport used: kerosene is almost all used for air transport, fuel oil for shipping and electricity currently is consumed by the Dublin Area Rapid Transport (DART) system and, since 2004, by Luas. Liquefied petroleum gas (LPG) is almost exclusively used for road transport, as is petrol. The bulk of petrol consumption for road transport can be assumed to be for private car use although there are a significant number of petrol-driven taxis in operation. Diesel consumption is used for navigation, rail and road purposes, including: freight transportation, public transport in buses and taxis, private car transport and other applications such as agricultural, construction and other machines.

SEAI's report *Energy in Transport*[49] presents an estimation of the energy use in transport by different mode. The contribution from each mode of transport to energy demand is shown in *Figure 51* and detailed in *Table 25*, updated with 2010 data. The road freight category recorded the largest fall in demand again in 2010, decreasing by 9.5%. Indeed, all modes with the exception of air travel experienced reduced demand in 2010.

Table 25 *Growth Rates and Shares of Transport Final Energy Demand by Mode, 1990 – 2010*

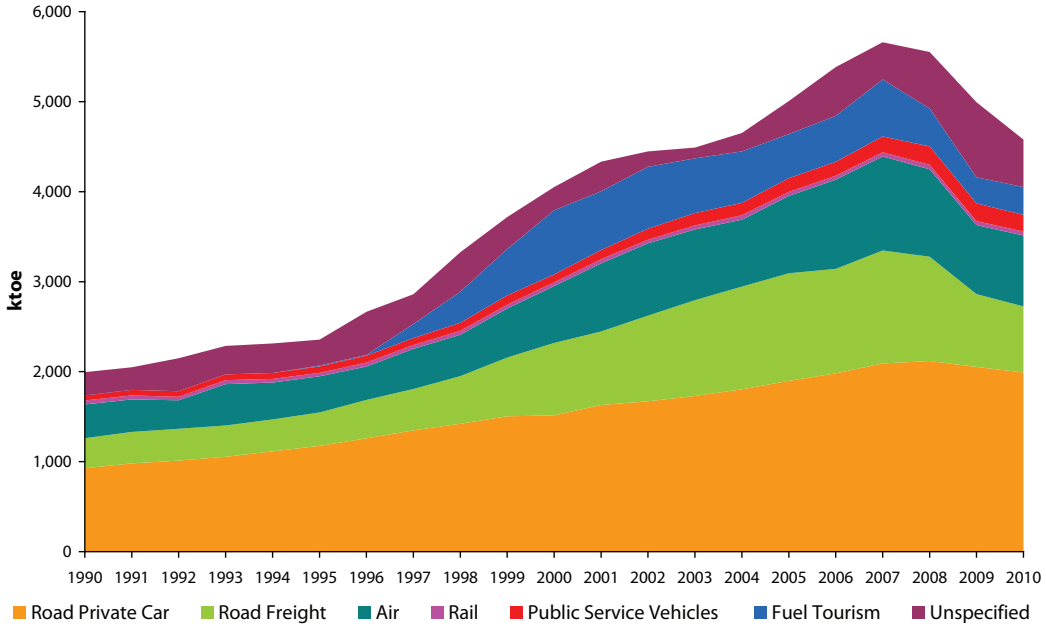
	Growth %	Average annual growth rates %						Shares %	
Mode	1990 - '10	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Road freight	119.4	4.0	2.1	16.8	8.2	-9.3	-9.5	16.7	16.0
Air	110.2	3.8	1.4	9.5	6.4	-1.7	2.6	18.8	17.2
Road private car	115.1	3.9	4.9	5.2	4.6	1.0	-2.9	46.4	43.5
Public-service vehicles	229.2	6.1	4.8	4.2	11.8	4.0	-5.3	2.8	4.1
Rail	-2.6	-0.1	-3.3	2.3	1.1	-0.6	-0.5	2.2	1.0
Total	**132.4**	**4.3**	**3.3**	**11.5**	**3.9**	**-1.1**	**-7.9**		

Air transport, following two years of decline, experienced an increase in energy consumption in 2010 of 2.6%.

Combined petrol and diesel fuel tourism is also included in *Figure 51*. Only fuel tourism out of the Republic of Ireland (ROI) is included in this graph (i.e. fuel which is purchased in here but consumed elsewhere). Before 1995 the trend was negative, meaning fuel was purchased outside and consumed within the State.

49 Sustainable Energy Authority of Ireland (2009), *Energy in Transport – 2009 Report*, http://www.seai.ie/statistics.

Figure 51 *Transport Energy Demand by Mode 1990 - 2010*



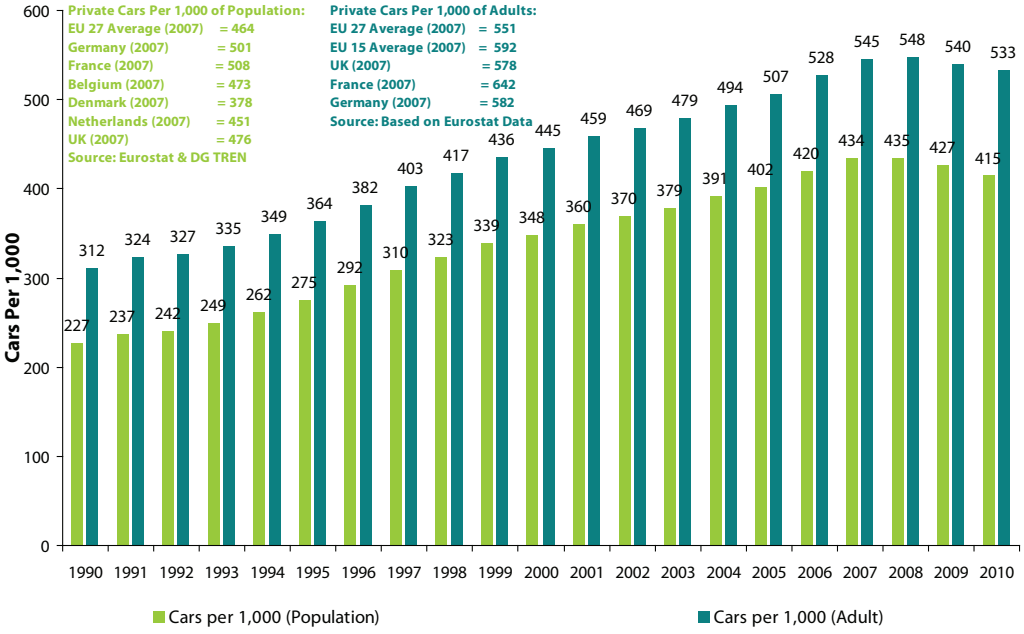
Energy use in transport was 4.7 Mtoe in the year 2010. Road transport accounted for 62% of this. SEAI estimates that private car transport was responsible for 2 Mtoe of energy use in 2010. This represents 67% of road transport energy use and 52% of all transport energy use. *Figure 51* also illustrates the relative weighting of private car transport compared to road passenger services (bus) and rail travel.

4.2.2 Private Car Transport

The number of vehicles on Irish roads exceeded two million[50] for the first time in 2004, reaching 2,497,568 vehicles by the end of 2008. In 2009 for the first time the number of vehicles on the road fell and continued to fall into 2010 to 2,416,387 vehicles. Of these there were 1.9 million private cars or 78% of the total. Private car numbers fell by 1.6% in 2010 following a 1.1% reduction in 2009. This resulted in a decrease in car density (as shown in *Figure 52*) to 533 cars per 1000 adults (548 in 2008), compared to an EU-27 average of 551 and a UK average of 578 (both in 2007).

50 Source: Vehicle Registration Unit, Department of Transport (various years) *Irish Bulletin of Vehicle and Driver Statistics.*

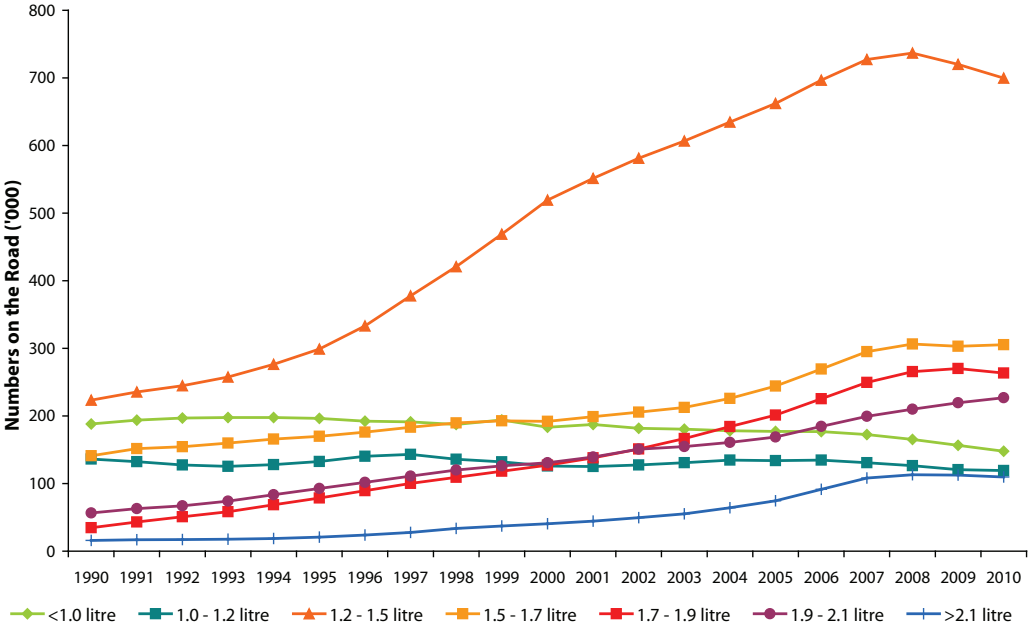
Figure 52 *Private Cars per 1000 of Population*



Source: Based on Vehicle Registration Unit and CSO data.

Figure 53 shows how purchasing patterns with respect to engine size have changed over time. Cars with an engine size of 1.5 litres or less are showing declining numbers from 2008 onwards. The numbers of cars with engine size of larger than 1.5 litres are all showing increasing trends until 2009. In 2010, only the 1.9 – 2.1 litre and the 1.5 – 1.7 litre categories increased in numbers, growing by 3.4% and 0.8% respectively.

Figure 53 *Change in Car Engine Size*



Source: Based on Vehicle Registration Unit data.

The 1.2 to 1.5 litre engine size has the largest share of private cars – 37% of the total in 2010. This was over twice the share of the second most popular class, the 1.5 to 1.7 litre band, which accounted for 16% of the total. In 1990 the less than 1.0 litre engine size had the second largest share of private cars, 24% of the total. This share fell to 7.9% in 2010.

It is also interesting to note that cars with an engine size of greater than 1.9 litres have increased their share of the total, from 9.1% in 1990 to 18% in 2010. Indeed, cars with engines greater than 1.7 litres have increased their share

from 13.5% in 1990 to 32% in 2010.

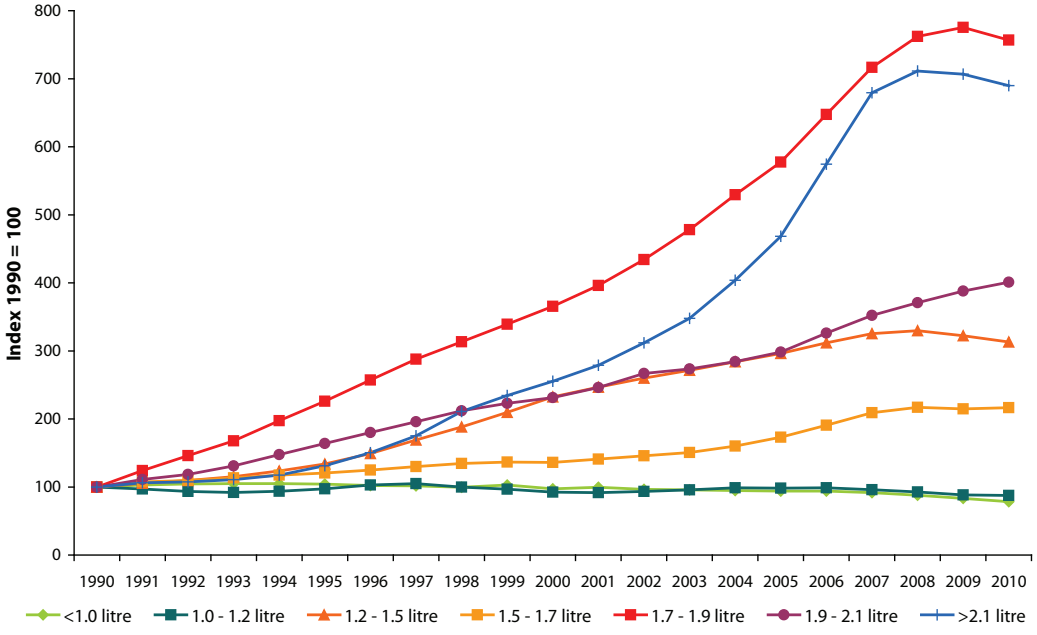
Table 26 *Growth Rates & Shares of Private Cars by Engine Size Band 1990 to 2010*

	Growth %	Average annual growth rates %						Shares %	
CC Bands	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
<1.0 litre	-21.5	-1.3	0.9	-1.4	-0.7	-4.4	-5.6	23.6	7.9
1.0 - 1.2 litre	-12.4	-0.7	-0.6	-1.0	1.2	-2.8	-0.9	17.1	6.4
1.2 - 1.5 litre	213.2	6.2	6.0	11.7	5.0	1.4	-2.8	28.1	37.4
1.5 - 1.7 litre	116.5	4.2	3.8	2.5	4.9	5.8	0.8	17.7	16.3
1.7 - 1.9 litre	656.8	11.2	17.7	10.1	9.6	7.0	-2.4	4.4	14.1
1.9 - 2.1 litre	301.0	7.6	10.4	7.1	5.2	7.7	3.4	7.1	12.1
>2.1 litre	589.9	10.7	5.6	14.2	12.9	10.2	-2.4	2.0	5.9
Total	**135.1**	**4.6**	**4.5**	**5.9**	**4.7**	**3.0**	**-1.6**		

Source: Based on Dept. of Transport Data.

Figure 54 presents change in car engine size over time expressed as an index, with 1990 as the reference year. This gives a clearer indication of the rate of increase of the differing size classes. Cars with engines less than 1.2 litre are showing declining numbers. The other classes are showing increases up to 2008.

Figure 54 *Change in Car Engine Size (Index)*



Source: Based on Vehicle Registration Unit data.

Most engine size bands experienced a fall in numbers in 2010 with the exception of the 1.5 – 1.7 litre and 1.9 – 2.1 litre categories. These grew by 0.8% and 3.4% respectively. The less than 1.0 litre category experienced the largest rate of decline in 2010, falling by 5.6%. This clearly shows, together with growth in the 1.9 – 2.1 litre category, a changing preference towards larger cars. The number of cars in the 1.7 to 1.9 litre range grew by 657% since 1990 and those in the greater than 2.1 litre range grew by 590%.

4.2.3 CO_2 based Vehicle Registration and Road Tax Bands

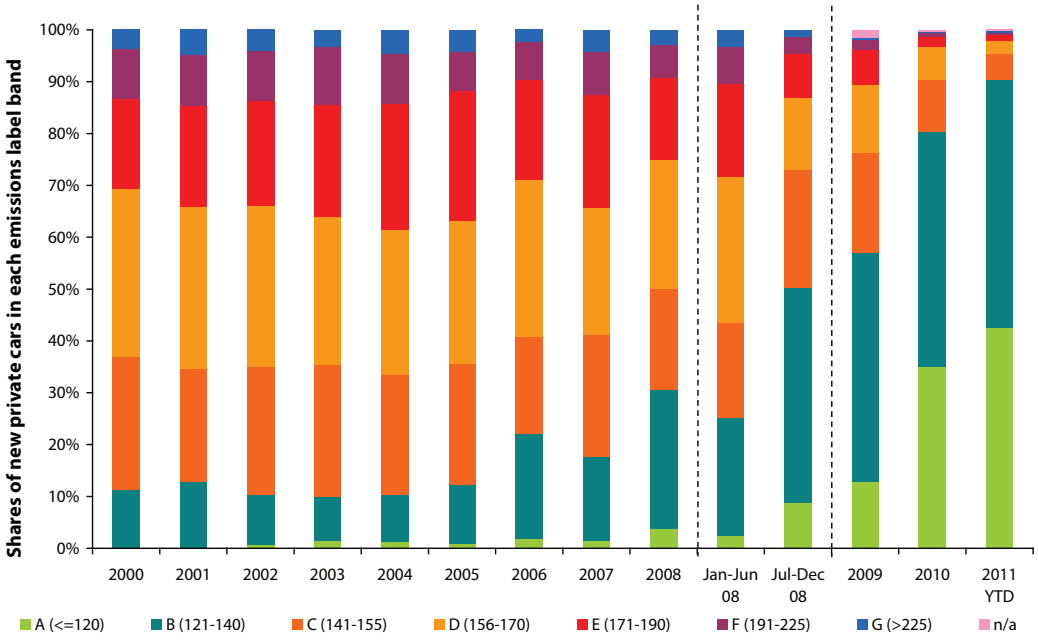
A new system of assessing private cars for Vehicle Registration Tax (VRT) and annual motor tax (AMT) came into effect from July 2008. This was signalled in the December 2007 Budget. The new system has moved away from assessing vehicles based on engine size to one that is based solely on the CO_2 emissions per kilometre. Seven tax bands are used for the assessment with the bands corresponding to the EU labelling system. The bands are shown in *Table 27.*

Table 27 *CO_2 based Vehicle Registration and Road Tax Bands*

Band	CO_2 Emissions (CO_2 g/km)
Band A	less than 120
Band B	greater than 120 and less than or equal to 140
Band C	greater than 140 and less than or equal to 155
Band D	greater than 155 and less than or equal to 170
Band E	greater than 170 and less than or equal to 190
Band F	greater than 190 and less than or equal to 225
Band G	greater than 225

Since the change in VRT and AMT, SEAI has been monitoring the impact of the changes by tracking the sales of new private cars and comparing sales by emissions band before and after the change on 1st July 2008.

Figure 55 *Shares of New Private Cars in each Emission Band 2000 – 2010 (+2011 to October)*



Source: Based on Vehicle Registration Unit data.

Figure 55 shows the shares of new-car sales[51] between 2000 and October 2011 classified by emissions label band with the year 2008 also shown split between before and after the taxation changes. Between 2000 and 2005 the share of label bands A, B or C was on average 35% while in 2006/07 it rose to 41%. For the first half of 2008, before the new taxes came into effect, the share of these three bands was 44%. In the period after the introduction of the change, July to December, the share of these bands rose to 73%. During 2009 it increased again to 76%. This is a significant shift in purchasing patterns towards lower-emissions vehicles. This has to be tempered by the fact that the motor industry experienced a severe downturn during 2008/'09 and that most car purchases in 2008 (78%) took place in the first six months, before the introduction of the new taxation system.

A scrappage scheme was introduced in 2010 that only applied if a car ten years or older was being scrapped and the new car being purchased was in emissions band A or B. This has had the effect of further shifting purchasing pattern in 2010 towards the lower emission vehicles, with 80% of private cars falling into the A or B band (up from 57% in 2009) and 90% in the A, B or C band. This trend strengthened into 2011 with the shares being 91% A or B and 95% A, B or C.

Table 28 tabulates the data shown in *Figure 55*. The largest increase in share was in the B label band, rising from 16% in 2007 to 48% in the year to September 2011. The share of high emitting cars in label bands E, F and G only amounted to 2% of new cars sold during 2011 (up to October).

51 Licensed as private cars.

Table 28 *Shares of New Private Cars in each Emissions Band, 2000, 2005 – 2010 (+2011 to October)*

CO_2 band	2000	2005	2006	2007	2008	Jan - Jun 2008	July - Dec 2008	2009	2010	2011 to October
A	0.0%	0.9%	1.8%	1.5%	3.8%	2.4%	8.8%	12.7%	35.1%	42.5%
B	11.3%	11.4%	20.3%	16.3%	26.8%	22.8%	41.3%	44.1%	45.2%	48.0%
C	25.6%	23.2%	18.8%	23.4%	19.3%	18.3%	22.9%	19.5%	10.1%	4.9%
D	32.4%	27.6%	30.2%	24.7%	25.0%	28.1%	13.8%	13.1%	6.2%	2.6%
E	17.5%	25.1%	19.3%	21.6%	15.9%	17.9%	8.5%	6.8%	2.0%	1.0%
F	9.5%	7.5%	7.2%	8.4%	6.4%	7.3%	3.3%	1.8%	0.6%	0.6%
G	3.7%	4.2%	2.3%	4.2%	2.8%	3.2%	1.3%	0.4%	0.3%	0.2%

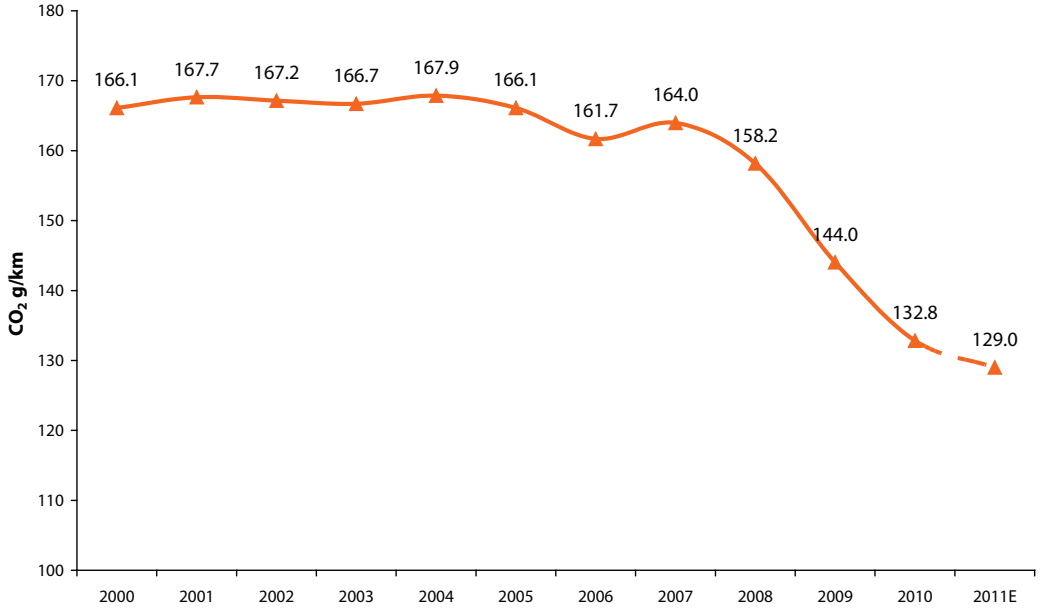
Source: Based on Vehicle Registration Unit data.

The average weighted emissions per car in 2007 were approximately 164 g CO_2/km which is encompassed within band D. Bands A, B & C are all below the current average; between 2000 and 2007 they collectively ranged from a 37% share of new cars to 41%. During the first half of 2008, before the application of the new registration and road taxes, the share grew slightly to 44%, but, after the introduction of the new tax regime, the share increased to a remarkable 73% and further to 76% during 2009. Conversely, the combined share of bands E, F & G fell from 28% in early 2008 to 13% after the change. This resulted in the weighted average going from 161 g CO_2/km before July 2008 to 147 g CO_2/km afterwards (11% reduction). The overall weighted average for 2008 was 158 g CO_2/km, a 3.5% reduction on 2007.

Figure 56 shows the evolution of the weighted average specific CO_2 emissions of new cars between 2000 and 2010. It also shows the effect of the change to the CO_2 taxation during 2008 which resulted in the average emissions of new cars falling to 158.2 CO_2 g/km. If 2008 is taken in isolation, over the first six months before the changeover, the average emissions for both petrol and diesel cars were approximately at the 2006 level. After the changeover in July, the average emissions fell by 8.6% from 161 CO_2 g/km to 147 CO_2 g/km with a further drop into 2009 of 1.4% to 145 CO_2 g/km.

Between 2000 and 2007 the average CO_2 emissions were approximately 166 CO_2 g/km for both petrol and diesel. For 2008 as a whole, there was a 3.5% reduction. In 2009 there was a further reduction of 9% and in 2010 average emissions fell by 7.8% to 132.8 CO_2 g/km.

Figure 56 *Specific CO_2 Emissions of New Cars, 2000 – 2010 (2011 estimated)*



Source: Based on Vehicle Registration Unit & VCA data.

In label terms and with reference to *Figure 56*, the average new car before the change would have been a D whereas after July 2008 and in 2009 the average new car was a low C.

In 2010, the additional effect of the scrappage scheme has increased the shares of A and B labeled cars being sold

and this resulted in the average new private car in 2010 and 2011 being a B label. The average specific CO_2 emissions of new cars were 132.8 CO_2 g/km in 2010 and an estimated 129 CO_2 g/km in 2011.

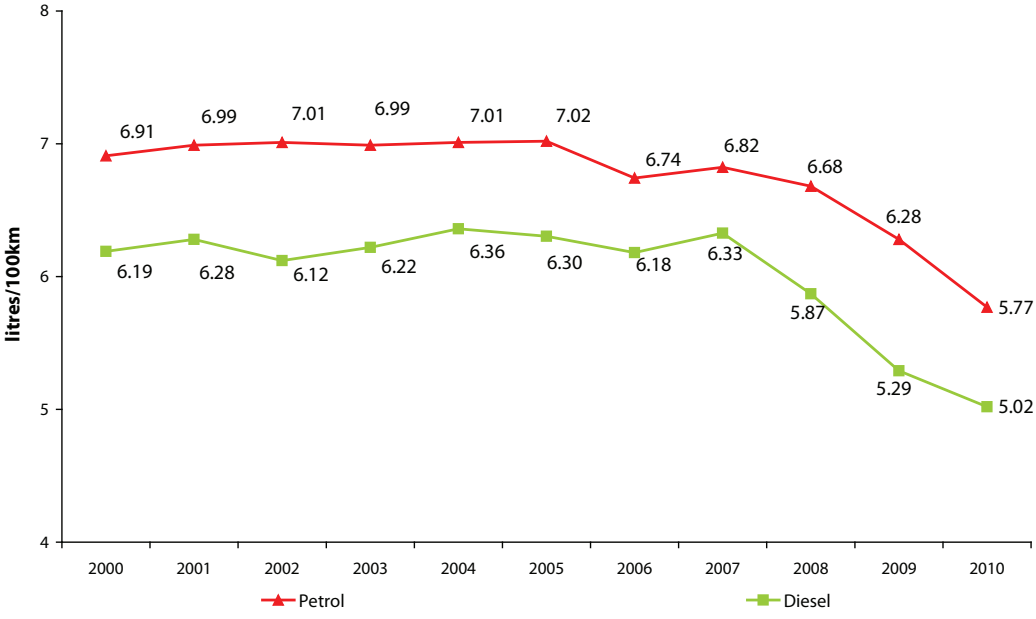
4.2.4 Fuel Efficiency of New Cars in Ireland

New cars entering the Irish fleet exhibit the efficiency benefits over time of improved engine design by car manufacturers. The purchasing trend towards larger engine sizes shown in *Figure 54* can negate the efficiency benefits. In order to assess energy policy decisions regarding VRT and/or annual road tax change, it is important to assess the extent to which the purchasing trends have offset the efficiency gains and also to assess changes in purchasing decisions following the introduction of taxation measures designed to influence those decisions. This may be achieved using an approach adopted by SEAI[52], which measures the overall efficiency of new cars entering the fleet.

All new cars have fuel consumption figures (measured under test conditions) quoted for urban, extra-urban and combined driving. It is possible to arrive at an average test efficiency figure for new cars entering the national fleet weighted by the sales figures for each individual model.

The weighted average of the fuel consumption of new cars first registered in the years 2000 – 2010 was calculated by SEAI using an extract from the Vehicle Registration Unit's national database and data on fuel consumption of individual models. The detailed results of this and other analysis were presented in SEAI's *Energy in Transport – 2009 Report* and updated data are presented here.

Figure 57 *Weighted Average Specific Fuel Consumption of New Cars 2000 – 2010*



Source: Based on Vehicle Registration Unit & VCA 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. The specific fuel consumption of petrol private cars remained relatively stable between 2000 and 2007 but has since been falling to 6.68 litres/100km (-2%) in 2008, 6.28 litres/100km (-6%) in 2009 and 5.77 litres/100km (-8.1%) in 2010, helped by the change in taxation.

For diesel cars the average fuel efficiency improved slightly over the period 2000 - 2006 by 0.2% to 6.18 litres/100km. As with petrol cars, diesel private car specific fuel consumption has been falling since 2007. In 2008 the taxation change had more of an effect on new diesel cars when the average fuel efficiency fell to 5.87 litres/100km, an improvement of 7.3%, and there was a further improvement in 2009 to 5.29 litres/100km (-9.9%) and to 5.02 litres/100km (-5.1%) in 2010.

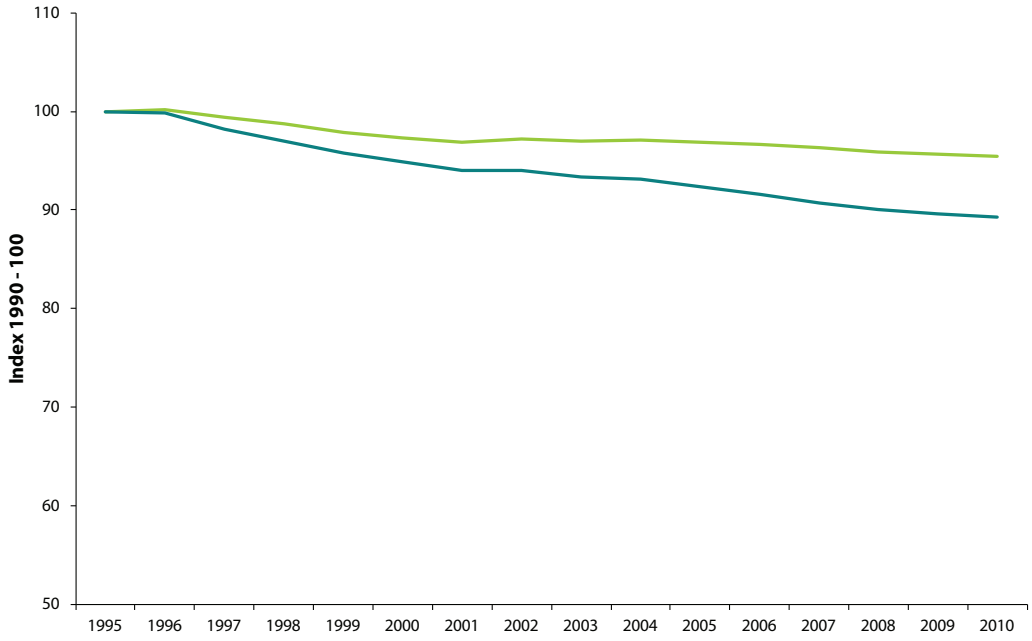
Generally, until 2005 the decrease in fuel efficiency suggests that the purchasing trend towards large cars over the period did outweigh the efficiency benefits of engine improvements. This appears to have changed during 2008 following the introduction of the new car tax systems. Since then, purchasing decisions appear to have been focused on better fuel efficiency and lower emissions.

52 Sustainable Energy Ireland (2007), *Energy in Transport – 2007 Report*, www.seai.ie/statistics. .

4.2.5 Transport Sector Energy Efficiency

Two ODEX indicators examine efficiency for the transport sector as a whole in *Figure 58*. Note that air transport is not included as per the Energy Services Directive 2006/32/EC.

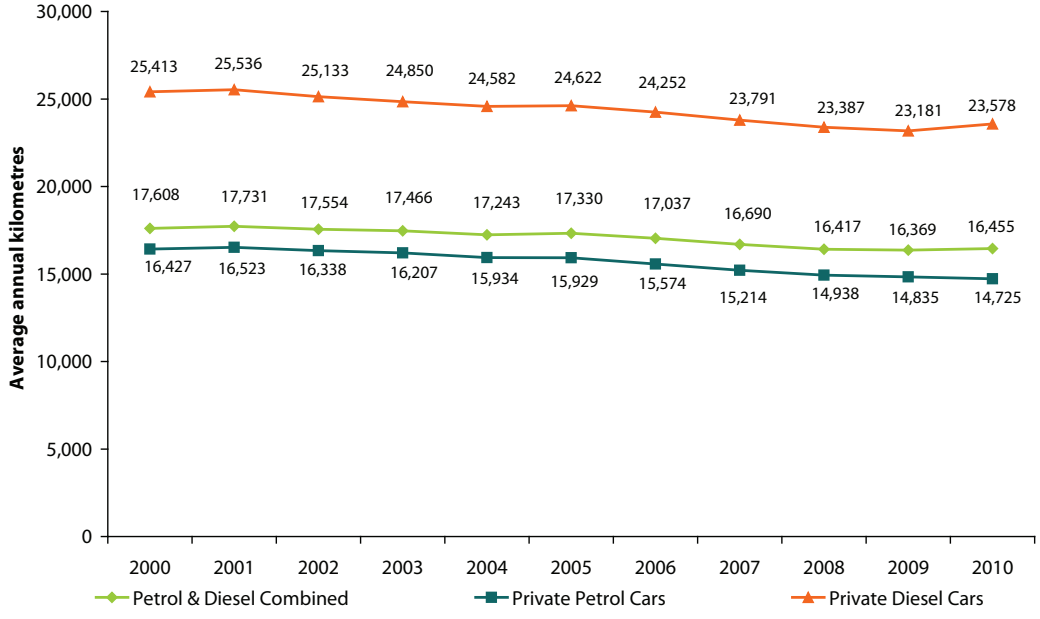
Figure 58 *Transport ODEX 1995 - 2010*



The transport observed ODEX fell by 4.5%[53] (0.3% per annum) over the period 1995 – 2010 while the technical ODEX decreased by 10.8% (0.8% per annum).

4.2.6 Private Car Average Annual Mileage

Figure 59 *Private Car Average Annual Mileage 2000 – 2010*



Source: Based on NCT Data

53 4.5% improvement in transport sector energy efficiency

SEAI's report *Energy in Transport - 2007 Report*[54] first profiled private car average annual mileage. Refining and updating of the results took place during 2010 and the revised figures are presented here. These are based on the analysis of 9.3 million National Car Test (NCT) results.

Figure 59 presents the results of the NCT analysis for the period 2000 – 2010. The combined average mileage for petrol and diesel cars in 2010 was 16,455 kilometres (10,225 miles). Diesel cars had an average mileage of 23,578 km (14,650 miles) with the average for petrol being 14,725 km (9,150 miles). The historic figures differ slightly from those reported in the 2007 report due to a recalculation of the average, as more cars were tested, and a refinement of the methodology. The trend from year to year is more important than the absolute values.

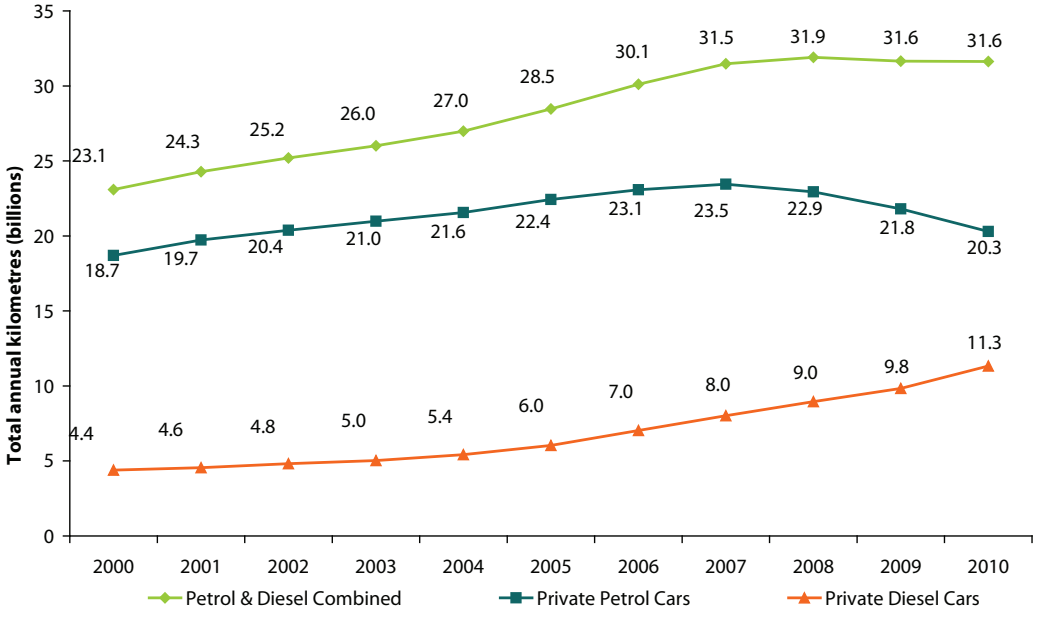
Overall average annual mileage per private car increased by 0.5% in 2010 compared to 2009. Petrol car mileage decreased by 0.7% and diesel car mileage increased by 1.7%.

Average mileage for all private cars has fallen by 6.6% (0.7% per annum on average) over the period 2000 to 2010. Petrol car annual mileage fell by 10.4% (1.1% per annum) while diesel car average mileage fell by 7.2% (0.7% per annum).

The data suggests that average annual mileage has been decreasing in Ireland up to 2009 while section 4.2.2 showed that ownership rates are increasing.

Many households now own two cars. This will typically increase the transport energy usage per household but will also reduce the per car average mileage. Overall, the total number of kilometres travelled has increased which in turn has led to increased private car fuel consumption, as detailed in section 4.2.1. Total mileage by all private cars increased by 37% over the period 2000 to 2010 (see *Figure 60*). Total mileage by petrol cars increased by 8.5% and diesel cars by 158%.

Figure 60 *Total Private Car Annual Mileage 2000 – 2010*



Source: Based on NCT Data

During 2008, overall private car mileage remained constant, but, as seen in *Figure 60*, overall travel in petrol cars has been falling since 2007, a 13% reduction, while travel by diesel cars continued to rise. Indeed the rate of increase of overall travel by diesel cars increased after 2007 to 12% per annum compared with 9% per annum between 2000 and 2008. This reduction in travel by petrol and increased travel by diesel is due to the changing ownership patterns since the change in the VRT and Annual Road Tax introduced in 2008.

In 2000, 81% of total mileage was fuelled by petrol and 19% by diesel. In 2010, petrol accounted for 64% and diesel for 36%.

54 Sustainable Energy Ireland (2007), *Energy in Transport – 2007 Report*, www.seai.ie/statistics.

4.3 Residential

Residential final energy use grew by 45% (1.9% per annum) over the period 1990 – 2010 to a figure of 3.3 Mtoe in real terms. Corrected for climate the growth was 21%. During this time the number of households[55] in the State increased by 61% from approximately 1.0 million to 1.6 million[56]. Residential energy use increased by 5.9% during 2010. 2010 was significantly colder than 2009 in terms of degree days (18% more degree days[57]). When corrections for climate effects[58] are taken into account there was a decrease of 2.9% in energy use (see *Table 29*).

Figure 61 *Residential Final Energy Use by Fuel*

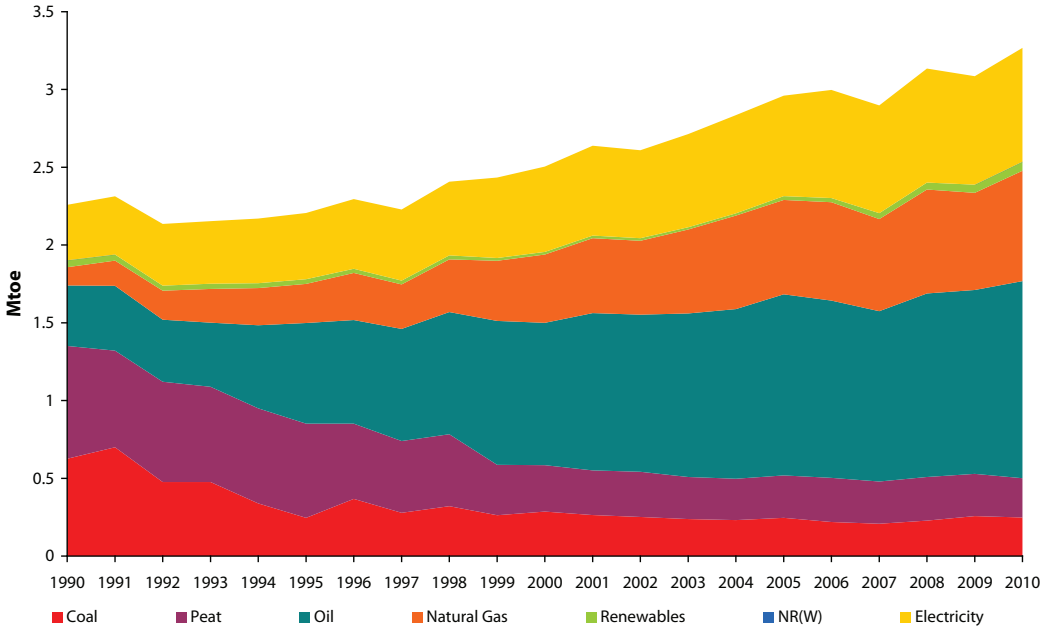


Figure 61 shows significant changes in the mix of fuels that have been consumed in the residential sector over the period. This can largely be explained by the move away from the use of open fires and solid fuel fired back-boiler heating systems that were popular in the 1970s and 1980s. New houses built in the 1990s predominantly had oil or gas-fired central heating or perhaps even electric storage heating and there has also been a trend to convert existing back-boiler systems to either oil or gas.

Central heating systems are generally more energy efficient than individual room heating appliances, so for a given requirement of space heating less energy would be expected to be used. On the other hand, a considerable increase in the level of comfort, in the form of higher temperatures and a move towards whole house heating, is often associated with the introduction of central heating. There may also be greater convenience using timer controls, particularly with oil and gas fired systems, which may result in greater usage.

The revisions of building regulations also had an impact on residential final energy use. Revisions were introduced in 1992, 2002, May 2006 and July 2008, all of which had the effect of reducing the energy requirements of the new housing stock.

The increase in electricity usage in households can be explained by an increase in the use of appliances, such as washing machines, driers, dishwashers, microwave ovens, computers, televisions, games consoles etc. in the home.

As can be seen from *Figure 61*, oil has become the dominant fuel in the residential sector, more than doubling its share from 17% in 1990 to 39% in 2010. Electricity is the second most dominant fuel in the sector at a little over 22%. Natural gas usage increased by a factor of almost six over the period to become the third fuel of choice at 22% share. The renewables share of energy used in households in 2010 was 1.8%.

The growth rates and shares are tabulated in *Table 29*.

55 Defined as the number of private households in permanent housing units.
56 Based on Central Statistics Office (2010), *Census 2011 Preliminary Results.*
57 See Glossary for definition of 'degree days'.
58 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.

Table 29 *Growth Rates and Shares of Final Consumption in Residential Sector*

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Fossil Fuels (Total)	33.4	1.5	-1.2	2.1	3.4	1.6	6.1	82.2	75.8
Coal	-60.4	-4.5	-17.0	3.0	-3.0	0.1	-3.5	27.7	7.6
Peat	-65.0	-5.1	-3.5	-13.2	-1.8	-1.5	-6.7	32.1	7.8
Briquettes	-43.2	-2.8	-5.0	0.0	-5.5	-0.5	-14.6	6.9	2.7
Oil	225.3	6.1	10.7	7.2	4.9	1.7	7.1	17.2	38.8
Gas	505.2	9.4	16.5	11.8	6.7	3.2	13.6	5.2	21.7
Renewables	30.1	1.3	-7.8	-10.4	7.9	18.3	11.1	2.0	1.8
Combustible Fuels (Total)	32.0	1.4	-1.3	1.9	3.3	1.7	6.2	84.2	76.8
Electricity	105.4	3.7	3.7	5.1	3.3	2.5	5.0	15.8	22.4
Total	**44.7**	**1.9**	**-0.5**	**2.6**	**3.4**	**2.0**	**5.9**		
Total Climate Corrected	**21.1**	**1.0**	**-1.2**	**2.0**	**4.0**	**-0.9**	**-2.9**		

The salient trends in energy use in the residential sector are as follows:

- Direct renewables usage in households increased by 11% in 2010 to 58 ktoe but its share dropped from 2% to 1.8% since 1990.
- Oil usage increased by 225% over the period 1990 – 2010 to 1.3 Mtoe and its share in the residential sector grew from 17% to 39%. There was a 7.1% increase in oil consumption in households in 2010.
- Electricity consumption increased by 5% in 2010 and its share of residential final consumption now stands at 22%.
- Natural gas usage increased by 13.6% in 2010 to 710 ktoe.
- Solid fuels in aggregate were the only fuels to experience a reduction in use in households in 2010. Coal, peat and peat briquettes consumption in aggregate fell by 5.2% in 2010.
- Coal usage decreased by 3.5% in 2010 to 248 ktoe.
- Sod peat usage fell by 6.7% in 2010 and peat briquette usage decreased by 14.6%.
- Overall fossil fuel use in households increased by 6.1% in 2010.

In 2010 residential sector energy-related CO_2 emissions were 12,062 kt CO_2 representing 29% of the total (energy-related). The residential sector total was the second largest after transport (33%).

Over the period 1990 to 2010 energy-related CO_2 emissions from the residential sector increased by 12.1% (0.6% on average per annum) while those in transport, services, and industry rose, respectively, by 129% (4.2% per annum), 53% (2.1% per annum), and -4.2% (-0.2% per annum).

The residential sector is specifically examined in more detail with respect to energy-related CO_2 emissions in *Figure 62* and the relatively constant or flat, overall trend can be seen. While final energy use in the sector increased by 45% over the period, its energy-related CO_2 emissions increased by 12%, illustrating the effect of the changing fuel mix on energy related emissions.

Figure 62 *Residential Energy-related CO_2 by Fuel*

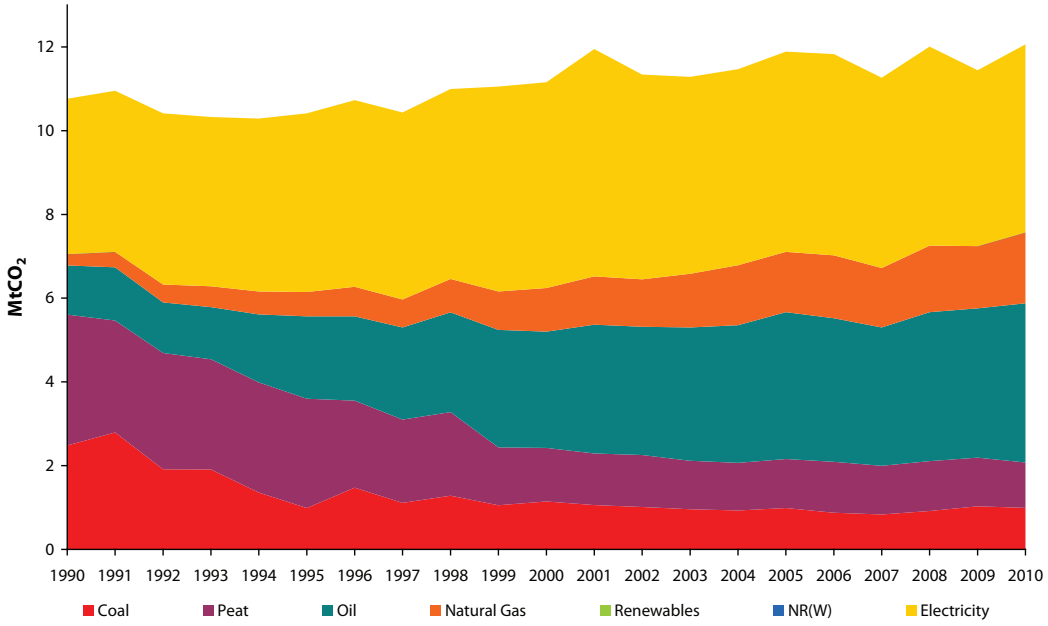


Table 30 *Growth Rates and Shares of Energy-Related CO_2 Emissions in Residential Sector*

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Coal	-60.1	-4.5	-16.8	3.0	-2.9	0.0	-3.7	23.1	8.2
Peat	-65.3	-5.1	-3.5	-13.3	-1.7	-1.5	-6.5	29.0	9.0
Briquettes	-43.2	-2.8	-5.0	0.0	-5.5	-0.5	-14.6	6.0	3.0
Oil	223.5	6.0	10.8	7.2	4.8	1.6	6.7	10.9	31.5
Gas	526.5	9.6	16.5	12.5	6.7	3.2	13.6	2.5	14.0
Renewables	-	-	-	-	-	-	-	0.0	0.0
Combustible Fuels (Total)	7.3	0.4	-2.7	0.3	2.6	1.3	4.5	65.5	62.7
Electricity	21.1	1.0	2.8	2.8	-0.6	-0.5	7.0	34.5	37.3
Total	**12.1**	**0.6**	**-0.7**	**1.4**	**1.3**	**0.6**	**5.4**		

4.3.1 Unit Consumption of the Residential Sector

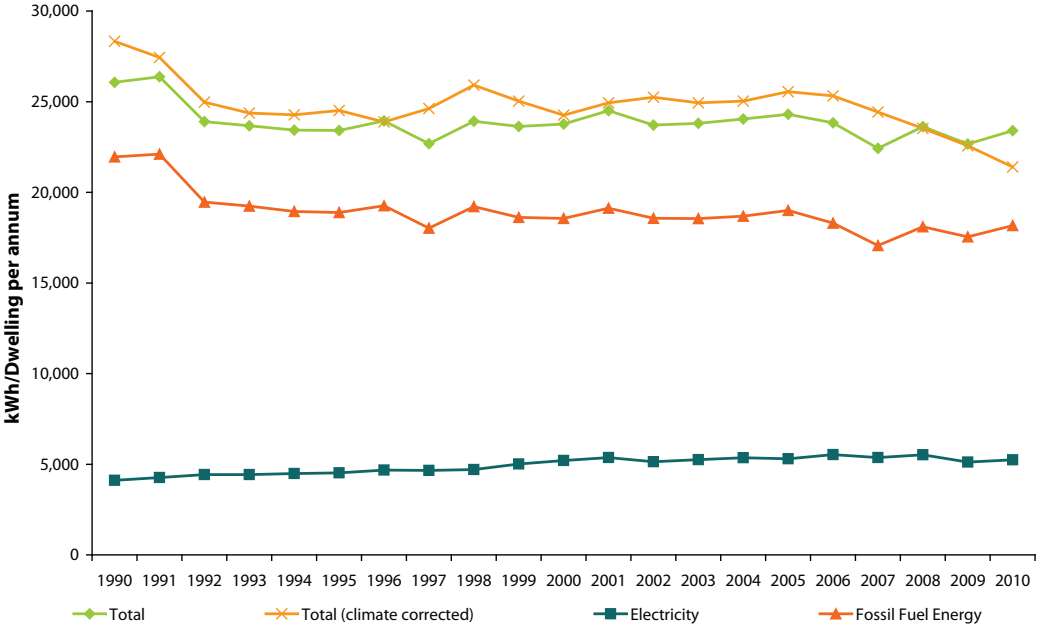
The unit consumption of the residential sector is typically defined in terms of the unit consumption of energy or the energy consumed per dwelling. *Figure 63* shows the trend in unit consumption per dwelling, which decreased by 10.2% during the period 1990 – 2010.

While overall unit energy use per dwelling has decreased by 10.2% since 1990, *Figure 63* also shows an increasing trend in electricity consumption per dwelling. This has increased by 27% since 1990. 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 2010, due to the extended cold periods, it is likely that there was some increase in electricity use for space heating. In contrast, fossil fuel consumption per dwelling has decreased by 17% over the period.

In 2010 the "average" dwelling consumed a total of 21,401 kWh of energy based on climate corrected data, 5.2% below the 2009 level. This was comprised of 16,232 kWh (76%) in the form of direct fossil fuels and the remainder (5,170 kWh) as electricity.

Figure 63 also shows overall unit energy use per dwelling, corrected for climate variations. Looking at this and in conjunction with *Table 33*, it can be seen that the decrease in climate corrected energy use per dwelling over the period was 24% while the uncorrected energy use decrease was 10.2%. It can be seen that most of the improvement in climate corrected per unit use occurred during the early 1990s and again from 2006 onwards with the increasing penetration of new housing stock and improved energy performance of these new houses. Some of the improvements are also due to improvements in the existing housing stock resulting from schemes such as the Greener Homes Scheme, Home Energy Saving Scheme and Warmer Home Scheme.

Figure 63 *Unit Consumption of Energy per Dwelling (permanently occupied)*



Source: Based on SEAI, CSO and Met Éireann data

One reason for the slowing trend in the late 1990s may be the trend towards larger houses as shown in *Table 31* and *Figure 64*. Larger houses have higher space-heat requirements and they also have proportionally greater surface area and therefore higher heat losses. *Table 31* shows that the largest rate of growth in the floor area of new houses and flats occurred in the 2005 – 2010 period.

Table 31 *Growth Rates in Residential Floor Areas per New Dwelling*[59]

	Growth %	Average annual growth rates %					
	1990 – 2010	1990 – '10	1990 – '95	1995 – '00	2000 – '05	2005 – '10	2010
New Houses	47.2	2.0	-0.1	2.0	0.9	5.1	9.2
New Flats	41.7	1.8	0.3	3.1	0.5	3.1	-1.9

Average floor areas of new houses grew from 130 square metres in 1990 to 192 square metres in 2010 (an increase of 47%). The average declined slightly in the early 1990s and then grew at a rate of 2% per annum in the latter half of the decade. Average floor areas of houses increased by 9.2% in 2010. Average floor areas of new flats showed a stronger growth over the period from 64 square metres to 91 square metres (42%). The average floor area of flats decreased by 1.9% in 2010.

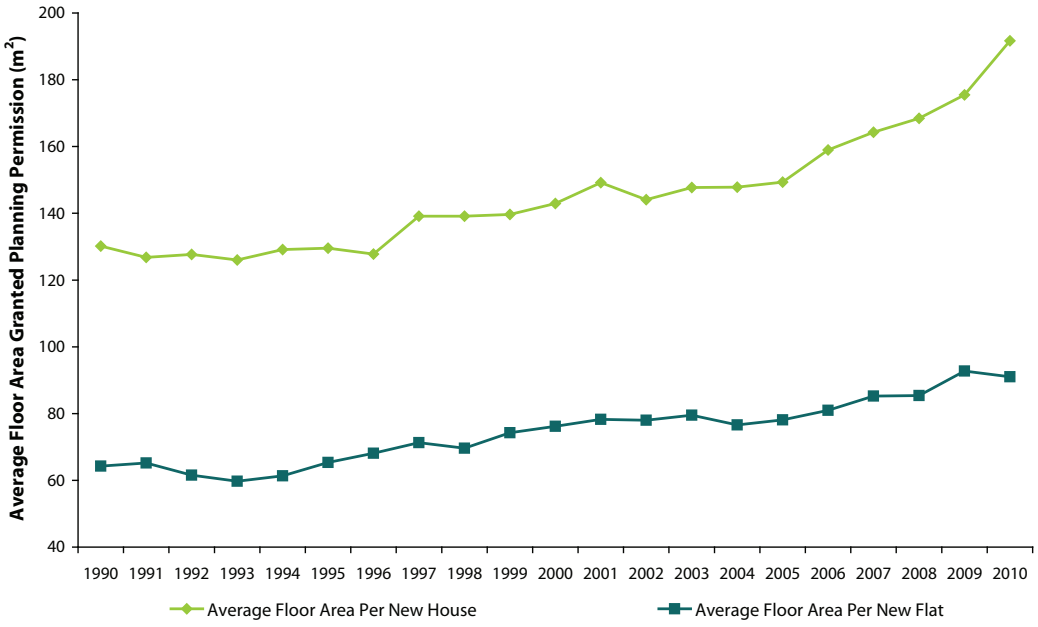
The ratio of new houses to new flats built in 1990 was approximately 25 to 1 whereas in 2010 it was approximately 7 to 1.

The 2006 Census[60] notes that in 1991, 6.5% of the housing stock consisted of apartments or flats whereas in 2011 the share was 10%.

59 Note that the figures used in *Table 31* and *Figure 64* are for the average floor area of new houses that were granted planning permission. It is not known if all those granted permission were actually built but the figures provide a plausible proxy for the trend in new house size.

60 CSO (2007), *2006 Census of Population – Volume 6 – Housing*.

Figure 64 *Floor Areas of New Houses and New Flats*



Source: CSO

While the above only refers to new dwellings it is also possible to estimate the trend in the stock[61] as a whole using the CSO dataset and a model of the stock of dwellings derived using, inter alia, data from DEHLG studies in the mid 1990s[62]. Data from this model is updated incrementally, using planning permission data and estimates of the number of permanently occupied dwellings. The results are presented in *Figure 65*. *Table 32* summarises the growth rates during the period. Over the period 1990 to 2010 the estimated average floor area of the stock of dwellings increased from 100 square metres in 1990 to 119 square metres in 2010.

Table 32 *Growth in Average Floor Area – Housing Stock*

	Growth %	Average annual growth rates %					
	1990 – 2010	1990 – '10	1990 – '95	1995– '00	2000 – '05	2005 – '10	2010
Average Floor Area	19.2	0.9	0.3	1.2	1.1	0.9	0.3

Average floor area has increased steadily over the period as larger dwellings are added to the stock. Growth of 0.3% was recorded in 2010. The increasing trend in floor area has been offset somewhat by the growing number of flats. However, overall the dominant driving force is the number and size of large one off or non-estate dwellings that have been built in recent years. For example in 2010, the average floor area of non-estate houses granted permission was 250 square metres compared to 135 square metres for houses in estates and 92 square metres for flats[63].

In 2007, 52% of the number of units granted planning permission were estate dwellings, 22% non-estate and 26% were apartments. In 2010 these ratios were 33%, 30% and 37% respectively. This explains why there is an increase in the average floor area in 2010 as it's dominated by the number of non-estate units which tend to be large.

The evidence suggests that there has been a trend towards larger dwellings (although estate houses' floor area has remained stable since 2008). Taken in isolation, this should have had a significant impact on the amount of energy demanded in the residential sector as bigger dwellings tend to have a larger demand for heating as they have a proportionally greater wall surface area and therefore higher heat loss. This has been offset somewhat by the increasing insulation standards promoted through iterations of the building regulations. Other variables such as the changing fuel mix, more efficient heating systems, falling occupancy levels and the declining average number of persons per household have also had an impact.

61 This section draws on data first presented in a separate SEAI report entitled *Energy Consumption and CO_2 Emissions in the Residential Sector 1990 to 2004.* The report is available at www.seai.ie.

62 Kevin O' Rourke (2005), *Personal Communication*.

63 CSO (2011), *Planning Permissions – Quarter 2 2011*. Available at www.cso.ie.

Figure 65 *Average Floor Area of the Housing Stock 1990 – 2010*

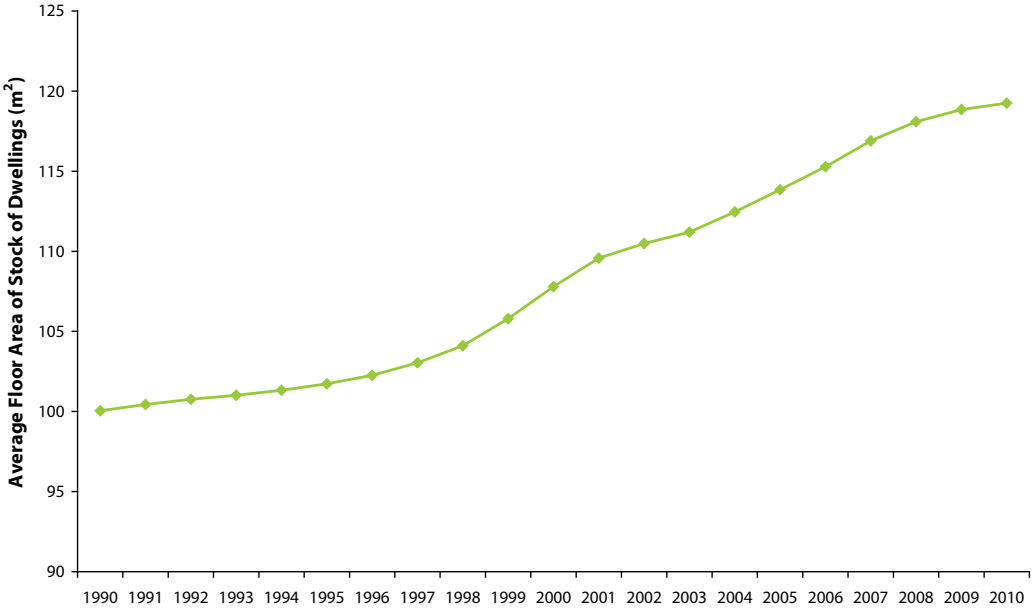


Table 33 *Growth Rates of Residential Unit Energy Consumption and Unit CO_2 Emissions*

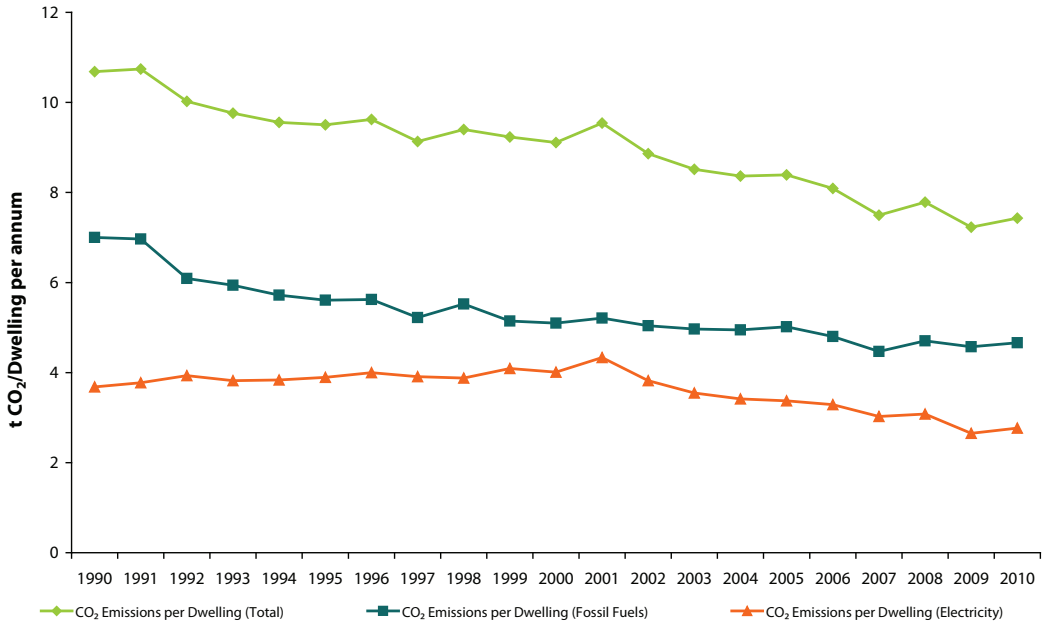
	Growth %	Average annual growth rates %					
Unit Energy Consumption	**1990 – 2010**	**'90 – '10**	**'90 – '95**	**'95 – '00**	**'00 – '05**	**'05 – '10**	**2010**
Total Energy	-10.2	-0.5	-2.1	0.3	0.4	-0.7	3.3
Fossil Fuel Energy	-17.3	-0.9	-3.0	-0.3	0.5	-0.9	3.5
Electrical Energy	27.5	1.2	1.9	2.8	0.4	-0.2	2.4
Unit Energy Consumption Climate Corrected							
Total Energy Climate Corrected	-24.5	-1.4	-2.9	-0.2	1.0	-3.5	-5.2
Fossil Fuel Energy Climate Corrected	-32.8	-2.0	-3.8	-0.9	1.2	-4.3	-6.9
Electrical Energy Climate Corrected	24.0	1.1	1.8	2.7	0.5	-0.7	0.7
Unit Energy-Related CO_2 Emissions							
Total Energy CO_2	-30.4	-1.8	-2.3	-0.8	-1.6	-2.4	2.8
Fossil Fuel CO_2	-33.4	-2.0	-4.3	-1.9	-0.3	-1.5	1.9
Electricity CO_2	-24.9	-1.4	1.1	0.6	-3.4	-3.9	4.4

Examining *Table 33* and *Figure 66* over the period 1990 to 2010, the emissions of energy-related CO_2 per dwelling decreased by 30% while the reduction for unit energy use was 10.2%. The unit fossil fuel CO_2 emission levels decreased by 33% over the period as a result of consumers switching away from coal and peat to lower CO_2 emitting fuels such as gas and oil. However, the downward trend was reversed in 2008 and again in 2010 when the energy use per household increased by 5.3% and 3.3% respectively. Total unit energy-related CO_2 emissions in 2010 rose by 2.8%. This was as a result of 2010 being much colder than 2009. Climate corrected, the unit energy consumption per household was 5.2% lower in 2010 than in 2009 compared with an uncorrected 3.3% increase.

Emissions associated with the use of electricity per dwelling fell by 25% over the period, despite the 27% increase in electricity consumption per dwelling. This is an indirect result of the reduced carbon intensity of electricity generation. This is particularly the case since 2002 when high efficiency Combined Cycle Gas Turbine (CCGT) plants were brought on line and because of the growing contribution of renewables in electricity generation. The increasing use of electrical appliances will, however, have offset some of the gains.

In 2010 the "average" dwelling was responsible for emitting approximately 7.4 tonnes of CO_2. A total of 4.7 tonnes CO_2 (63%) came from direct fuel use and the remainder indirectly from electricity use.

Figure 66 *Unit Energy-Related CO_2 Emissions per Dwelling*

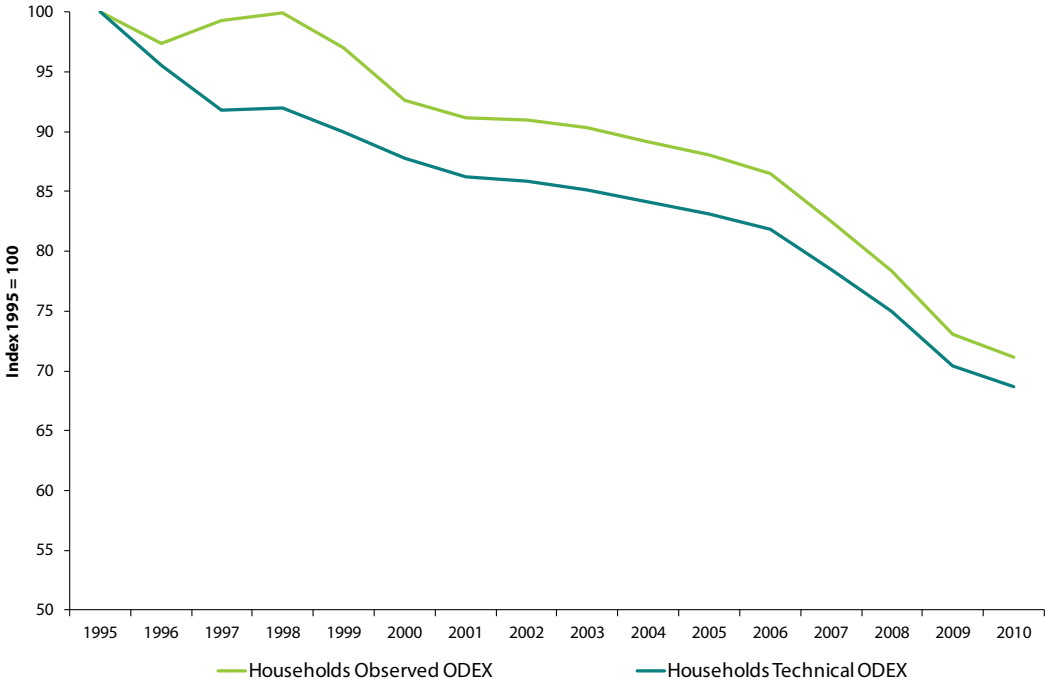


4.3.2 Residential Sector Energy Efficiency

Two ODEX indicators are shown in *Figure 67* for the household sector. The observed energy efficiency index is calculated based on actual energy consumption, whereas the technical energy efficiency index is calculated using theoretical consumption figures based on building regulations. Both indices are corrected for climatic variations; however, as a result of the methodology, there may be over-correction in mild years. This may be seen, for example, in 1998. Both indices are calculated as a three year moving average in order to avoid these short term fluctuations due to imperfect climate correction.

The observed ODEX decreased by 29% over the period (2.2% per annum), indicating an improvement in energy efficiency. As the ODEX is a "top-down" energy efficiency indicator it provides a measurement for gross energy efficiency savings in the residential sector but cannot be linked directly to specific energy efficiency measures or programmes. The technical ODEX decreased by 31% (2.5% per annum). It can be seen that the observed ODEX is approaching the technical ODEX, indicating an overall energy efficiency improvement, but energy efficiency gains can be negated by rebound effects. Rebound effects are where there is increased energy usage through higher comfort levels, the move towards whole house heating, larger dwellings, use of power showers etc.

Figure 67 *Household ODEX 1995 - 2010*



4.4 Commercial and Public Services

Final energy use in the commercial and public services sector grew by 72% (2.8% per annum) over the period 1990 – 2010 to a figure of 1.7 Mtoe. Growth was 45% if climate corrected energy use is considered. During this period the value added generated by the sector grew by 135% while the numbers employed increased by 118%.

Figure 68 *Commercial and Public Services Final Energy Use by Fuel*

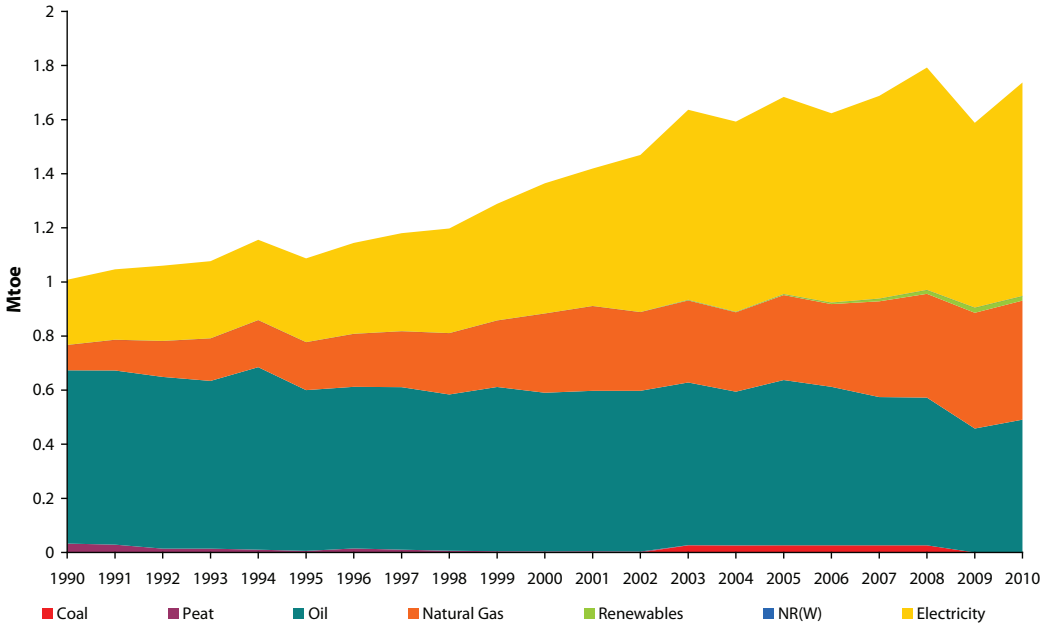


Figure 68 shows the changes in the fuel mix in the services sector over the period. One interesting feature is the small range of fuels utilised in this sector – essentially oil, gas and electricity accounting for 99% of the energy use. Oil and gas are used predominantly for space-heating purposes but also for water heating, cooking and, in some subsectors, laundry. Gas consumption increased by 368% although this was from a low base.

Electricity consumption in services increased by 228% (6.1% per annum) between 1990 and 2010 and has a higher share at 45% than any other individual fuel in services, up from 24% in 1990. This growth is fuelled by the changing structure of this sector and the general increase in the use of information and communication technology (ICT) and air conditioning.

Growth rates and shares are tabulated in *Table 34*.

Table 34 *Growth Rates and Shares of Final Consumption in the Commercial & Public Services Sector*

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Fossil Fuels (Total)	21.3	1.0	0.3	2.6	1.5	-0.4	5.0	76.1	53.6
Coal	-	-	-	-	-	-	-	0.1	0.0
Oil	-23.4	-1.3	-1.5	-0.3	0.8	-4.3	7.2	63.6	28.3
Natural Gas	368.0	8.0	13.5	10.6	1.4	7.0	2.7	9.3	25.3
Renewables	-	-	-	-	-	34.0	-9.0	0.0	1.0
Combustible Fuels (Total)	23.3	1.1	0.3	2.6	1.6	-0.2	4.7	76.1	54.4
Electricity	228.3	6.1	5.2	9.2	8.7	1.6	15.6	23.9	45.4
Total	**72.4**	**2.8**	**1.5**	**4.6**	**4.3**	**0.6**	**9.4**		
Total Climate Corrected	**45.3**	**1.9**	**0.7**	**4.1**	**4.8**	**-2.0**	**1.2**		

The key trends are as follows:

- Final energy use grew by 72% over the period 1990 – 2010 (2.8% per annum). The increase was 45% when corrected for climate. Overall energy use in this sector increased by 9.4% in 2010 or just 1.2% on a climate corrected basis.
- Oil, gas and electricity make up 99% of energy consumed in the services sector. The contributions from coal and peat were small in the early 1990s but are now negligible.

- Electricity became the dominant "fuel" in this sector in 2005. Consumption of electricity increased by 228% over the period 1990 – 2010 and its share went from 24% to 45%. Electricity consumption in services increased by 16% in 2010 to 789 ktoe.
- Oil consumption increased by 7.2% in 2010 to 491 ktoe. The share of oil in final consumption of the sector fell from almost 64% in 1990 to 28% in 2010.
- Natural gas consumption grew by 2.7% in 2010 and 368% (8% per annum) over the period 1990 to 2010 to 440 ktoe. Its share has grown from 9.3% in 1990 to 25% in 2010.
- Overall fossil fuel use in services increased by 5% in 2010.
- Renewable energy use in services fell by 9% in 2010. The share of renewables in services was 1% in 2010.

Figure 69 shows the primary energy-related CO_2 emissions of the services sector, distinguishing between the on-site CO_2 emissions associated with direct fuel use and the upstream emissions associated with electricity consumption. Emissions from non-electrical energy increased by 9.3% over the period and the emissions associated with electricity consumption increased by 94%. In 2010 the non-electricity emissions increased by 5.3% and the electricity associated emissions in services increased by 18%. Overall energy-related CO_2 emissions in this sector grew by 13% in 2010 to 7.4 Mt CO_2 – up from 6.5 Mt CO_2 in 2009.

In the services sector, the share of emissions associated with electricity demand in 2010 was approximately two thirds (66%) compared to the combustion of oil and gas. In 1990 the proportion was closer to half and half respectively (52% electricity and 48% fuels).

Figure 69 *Commercial and Public Services Sector CO_2 Emissions by Fuel*

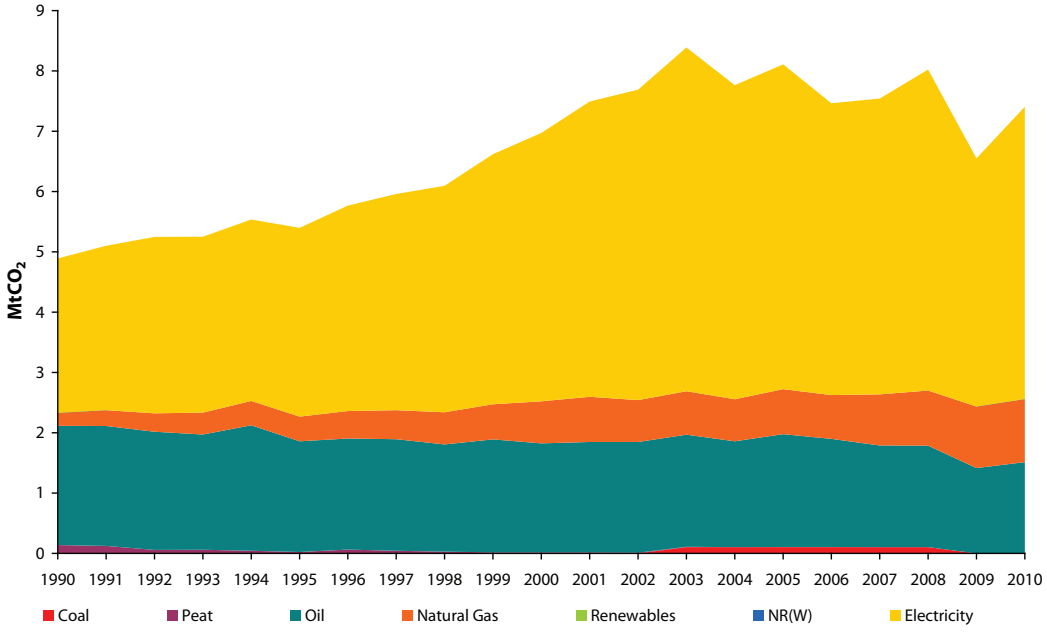


Table 35 *Growth Rates and Shares of CO_2 Emissions in Commercial/Public Services*

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2010	'90 – '10	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2010	1990	2010
Combustible Fuels	9.3	0.4	-0.6	2.1	1.6	-1.3	5.3	48.2	34.5
Electricity	93.5	3.4	4.4	6.8	4.6	-2.1	17.8	51.8	65.5
Total	**52.9**	**2.1**	**2.1**	**4.9**	**3.5**	**-1.8**	**13.2**		

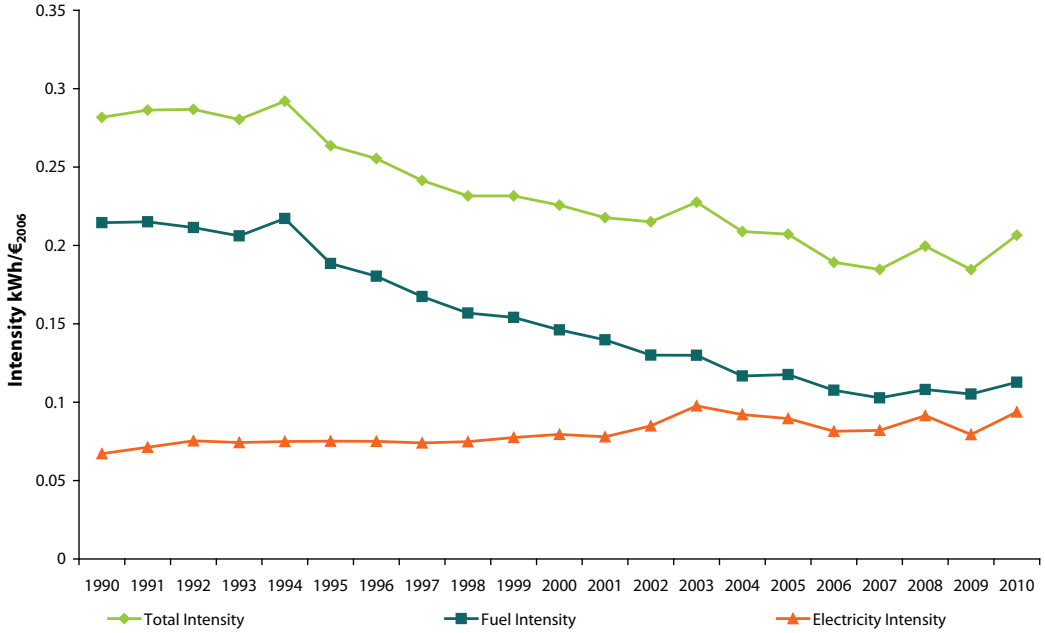
4.4.1 Energy Intensity of the Services Sector

The energy intensity of the services sector is generally measured with respect to the value added generated by services activities. As shown in *Figure 70*, this intensity is much flatter than that of industry although it is showing a declining trend since 1994. The overall energy intensity of the services sector was 27% lower in 2010 than it was in 1990, 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. A reversal also occurred in 2008 and again in 2010, principally

due to the colder than normal weather experienced in those years.

Electricity intensity increased by 45% up to 2003, decreased by 16% up to 2007 and increased again by 14% up to 2010. Services electricity intensity was 40% above 1990 levels in 2010 with an 18% increase on the 2009 level.

Figure 70 *Energy Intensity of Commercial and Public Services Sector*



Two other measures in this sector are energy use per unit of floor area and per employee. The consumption of oil and gas is mainly for heating purposes and is related to the floor area heated, not directly related to the number of people occupying a building at a given time. Due to an absence of data on floor area in the services sector it is not currently possible to calculate the consumption per unit of floor area.

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. With reference to *Figure 71* it can be seen that unit consumption of electricity was rising steadily since 1990. By 2003 it was 58% higher than in 1990 but it had fallen back to 28% above 1990 levels in 2009 and was at 51% above in 2010. Electricity use per employee increased by 17% in 2010.

By contrast, the fuel consumption per employee increased by 6.2% in 2010 and stood at 43% below 1990 levels. If corrections are made for the effects of climate then the fuel consumption per employee was 5.4% lower in 2010 than in 2009.

Figure 71 *Unit Consumption of Energy & Electricity per Employee in the Services Sector*

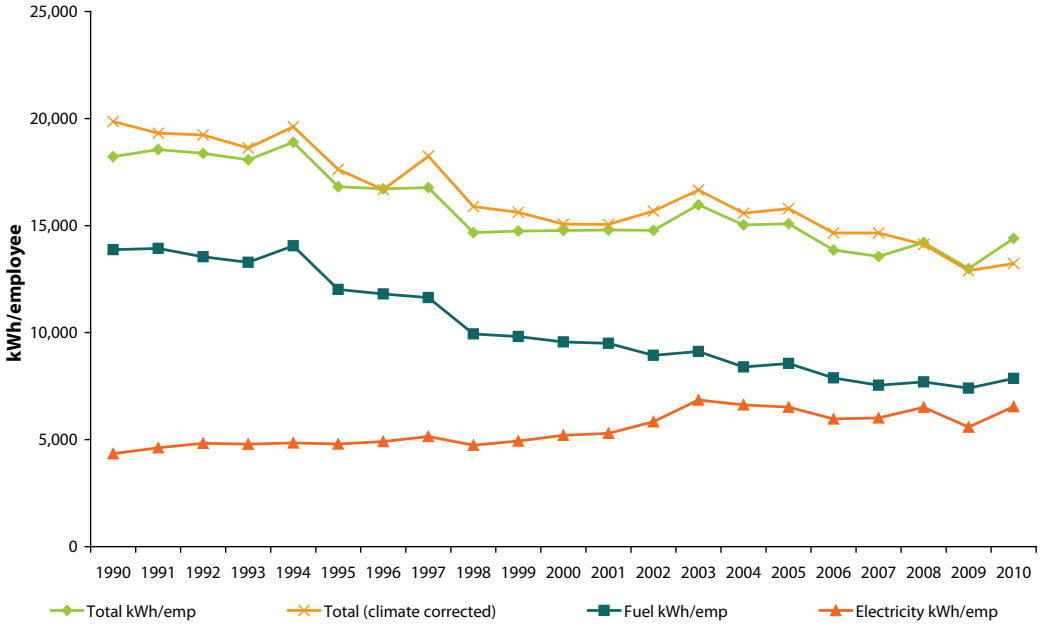


Table 36 *Growth Rates and Shares of Unit Consumption per Employee in Commercial/Public Services*

	Growth %	Average annual growth rates %					
	1990 – 2010	1990 – '10	1990 – '95	1995 – '00	2000 – '05	2005 – '10	2010
Total kWh/employee	-21.0	-1.2	-1.6	-2.6	0.4	-0.9	10.9
Fuel kWh/employee	-43.4	-2.8	-2.8	-4.5	-2.2	-1.7	6.2
Electricity kWh/employee	50.5	2.1	2.0	1.7	4.6	0.1	17.2
Climate Corrected (cc)							
Total kWh/employee (cc)	-33.4	-2.0	-2.4	-3.1	0.9	-3.5	2.6
Fuel kWh/employee (cc)	-55.0	-3.9	-3.7	-5.1	-1.4	-5.4	-5.4
Electricity kWh/employee (cc)	40.9	1.7	1.7	1.5	4.8	-1.1	13.2

As a result of the heterogeneous nature of the services sector it is difficult to assess the amount of energy that is consumed in this sector. Energy statistics relating to fuel consumption for the services sector in Ireland are calculated as a residual. 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, there is only limited information available to policy-makers with which to formulate and target energy efficiency policies and measures for the sector.

The increasing number of energy suppliers in the liberalised market makes this task all the more difficult. Thus, the data does not allow for ODEX indicators to be formulated at this point for the services sector. Work is on-going, however, within the ODYSSEE project to address this situation.

Glossary of Terms

Carbon Dioxide (CO_2): A compound of carbon and oxygen formed when carbon is burned. Carbon dioxide is one of the main greenhouse gases. Units used in this report are t CO_2 – tonnes of CO_2, kt CO_2 – kilo-tonnes of CO_2 (103 tonnes) and Mt CO_2 – mega-tonnes of CO_2 (106 tonnes).

Carbon Intensity (kg CO_2/kWh): This is the amount of carbon dioxide that will be released per kWh of energy of a given fuel. For most fossil fuels the value of this is almost constant, but in the case of electricity it will depend on the fuel mix used to generate the electricity and also on the efficiency of the technology employed. Renewable sources of electricity generation, such as hydro and wind, have zero carbon intensity.

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.

Combined Heat & Power Plants: Combined heat and power (CHP) refers to plants which are designed to produce both heat and electricity. CHP plants may be autoproducer (generating for own use only) or third-party owned selling electricity and heat on-site as well as exporting electricity to the grid.

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 and Net Calorific Value (GCV & NCV): The gross calorific value (GCV) gives the maximum theoretical heat release during combustion, including the heat of condensation of the water vapour produced during combustion. This water is produced by the combustion of the hydrogen in the fuel with oxygen to give H_2O (water). The net calorific value (NCV) excludes this heat of condensation because it cannot be recovered in conventional boilers. For natural gas, the difference between GCV and NCV is about 10%, for oil it is approximately 5%.

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

Gross Final Consumption (GFC): The Renewable Energy Directive (2008/28/EC) defines gross final consumption of energy as the energy commodities delivered for energy purposes to manufacturing industry, transport, households, services, agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution.

Gross Electrical Consumption: Gross electricity production is measured at the terminals of all alternator sets in a station; it therefore includes the energy taken by station auxiliaries and losses in transformers that are considered integral parts of the station. The difference between gross and net production is the amount of own use of electricity in the generation plants.

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) would be 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 would be required.

Nominal and Real Values: Nominal value refers to the current value expressed in money terms in a given year, whereas real value adjusts nominal value to remove effects of price changes and inflation to give the constant value over time indexed to a reference year.

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 services. It excludes the energy sector such as electricity generation and 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.

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.

Energy Conversion Factors

To: / *From:*	toe *Multiply by*	MWh	GJ
toe	1	**11.63**	**41.868**
MWh	0.086	**1**	**3.6**
GJ	0.02388	**0.2778**	**1**

Energy Units

joule (J): Joule is the international (S.I.) unit of energy.

kilowatt hour (kWh): The conventional unit of energy that electricity is measured by and charged for commercially.

tonne of Oil Equivalent (toe): This is a conventional standardised unit of energy and is defined on the basis of a tonne of oil having a net calorific value of 41686 kJ/kg. A related unit is the kilogram of oil equivalent (kgoe), where 1 kgoe = 10-3 toe.

Decimal Prefixes

deca (da)	10^{1}	deci (d)	10^{-1}
hecto (h)	10^{2}	centi (c)	10^{-2}
kilo (k)	10^{3}	milli (m)	10^{-3}
mega (M)	10^{6}	micro (μ)	10^{-6}
giga (G)	10^{9}	nano (n)	10^{-9}
tera (T)	10^{12}	pico (p)	10^{-12}
peta (P)	10^{15}	femto (f)	10^{-15}
exa (E)	10^{18}	atto (a)	10^{-18}

Calorific Values

Fuel	Net Calorific Value toe/t	Net Calorific Value MJ/t
Crude Oil	1.0226	42,814
Gasoline (petrol)	1.0650	44,589
Kerosene	1.0556	44,196
Jet Kerosene	1.0533	44,100
Gasoil / Diesel	1.0344	43,308
Residual Fuel Oil (heavy oil)	0.9849	41,236
Milled Peat	0.1860	7,787
Sod Peat	0.3130	13,105
Peat Briquettes	0.4430	18,548
Coal	0.6650	27,842
Liquefied Petroleum Gas (LPG)	1.1263	47,156
Petroleum Coke	0.7663	32,084
	Conversion Factor	**Conversion Factor**
Electricity	86 toe/GWh	3.6 TJ/GWh

Emission Factors

	t CO_2/TJ (NCV)	g CO_2/kWh (NCV)
Liquid Fuels		
Motor Spirit (Gasoline)	70.0	251.9
Jet Kerosene	71.4	257.0
Other Kerosene	71.4	257.0
Gas/Diesel Oil	73.3	263.9
Residual Oil	76.0	273.6
LPG	63.7	229.3
Naphta	73.3	264.0
Petroleum Coke	92.9	334.5
Solid Fuels and Derivatives		
Coal	94.6	340. 6
Milled Peat	116.7	420.0
Sod Peat	104.0	374.4
Peat Briquettes	98.9	355.9
Gas		
Natural Gas	56.9	204.7
Electricity		
(2010)	161.5	528.2

Sources

Applus+ (National Car Test)

Central Statistics Office

Department of Communications, Energy and Natural Resources

Department of Environment, Heritage and Local Government

Department of Transport

Eirgrid

Environmental Protection Agency

European Commission DG TREN

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Eurostat

International Energy Agency

Met Éireann

Revenue Commissioners

Vehicle Registration Unit

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Energy Balance 2010

kilo tonnes of oil equivalent (ktoe)	Coal	Peat	Oil	Natural Gas	Renewables	Electricity	Total
Indigenous Production	-	981	-	318	634	-	1,942
Imports	956	-	8,855	4,393	46	65	14,315
Exports	7	10	1,152	-	0	25	1,195
Mar. Bunkers	-	-	139	-	-	-	139
Stock Change	218	-181	70	-7	-1	-	100
Primary Energy Supply (incl non-energy)	**1,167**	**791**	**7,634**	**4,704**	**679**	**40**	**15,024**
Primary Energy Requirement (excl. non-energy)	**1,167**	**791**	**7,373**	**4,704**	679	**40**	**14,763**
Transformation Input	**868**	**605**	**3,158**	**3,026**	**73**	**41**	**7,770**
Public Thermal Power Plants	868	481	129	2,768	63	-	4,309
Combined Heat and Power Plants	-	9	8	255	10	-	282
Pumped Storage Consumption	-	-	-	-	-	25	25
Briquetting Plants	-	115	-	-	-	-	115
Oil Refineries & other energy sector	-	-	3,021	2	-	16	3,039
Transformation Output	**-**	**105**	**3,032**	**-**	**27**	**2,144**	**5,308**
Public Thermal Power Plants	-	-	-	-	23	1,960	1,984
Combined Heat and Power Plants - Electricity	-	-	-	-	3	168	172
Combined Heat and Power Plants - Heat	-	-	-	-	-	-	-
Pumped Storage Generation	-	-	-	-	-	15	15
Briquetting Plants	-	105	-	-	-	-	105
Oil Refineries	-	-	3,032	-	-	-	3,032
Exchanges and Transfers	**24**	**-**	**-17**	**-**	**-320**	**320**	7
Electricity	-	-	-	-	-320	320	-
Heat	-	-	-	-	-	-	-
Other	24	-	-17	-	-	-	7
Own Use and Distribution Losses	**-**	**23**	**113**	**71**	**-**	**282**	489
Available Final Energy Consumption	323	268	7,378	1,608	312	2,182	12,080
Non-Energy Consumption	-	-	261	-	-	-	261
Final non-Energy Consumption	-	-	261	-	-	-	261
Total Final Energy Consumption	351	254	7,330	1,618	321	2,164	12,046
Industry	**103**	**-**	**769**	**468**	**153**	**591**	**2,093**
Non-energy Mining	-	-	71	10	-	43	124
Food, beverages and tobacco	22	-	189	88	40	128	466
Textiles and textile products	-	-	4	1	-	8	13
Wood and wood products	0	-	4	2	100	26	131
Pulp, paper, publishing and printing	1	-	4	3	-	14	22
Chemicals & man-made fibres	-	-	42	54	0	109	206
Rubber and plastic products	-	-	10	4	-	26	40
Other non-metallic mineral products	77	-	128	14	12	38	278
Basic metals & fabricated metal products	-	-	224	177	-	49	451
Machinery and equipment n.e.c.	-	-	6	5	-	15	26
Electrical and optical equipment	0	-	38	104	-	74	216
Transport equipment manufacture	-	-	5	2	-	13	19
Other manufacturing	4	-	45	5	-	49	103
Transport	**-**	**-**	**4,578**	**-**	**92**	**4**	**4,674**
Road Freight	-	-	733	-	-	-	733
Road Private Car	-	-	1,899	-	92	-	1,991
Public Passenger Services	-	-	187	-	-	-	187
Rail	-	-	40	-	-	4	44
Domestic Aviation	-	-	14	-	-	-	14
International Aviation	-	-	774	-	-	-	774
Fuel Tourism	-	-	309	-	-	-	309
Unspecified	-	-	623	-	-	-	623
Residential	**248**	**254**	**1,267**	**710**	**58**	**732**	**3,267**
Commercial/Public Services	**-**	**-**	**491**	**440**	**17**	**789**	**1,737**
Commercial Services	-	-	319	193	14	566	1,092
Public Services	-	-	171	247	3	223	645
Agricultural	-	-	226	-	-	48	274
Statistical Difference	**-28**	**15**	**-213**	**-10**	**-9**	**18**	**-227**

Note: This is the "short" version of the energy balance. A more detailed "expanded" balance showing detailed sub-fuel data is available on the SEAI website at http://www.seai.ie/statistics.

Sustainable Energy Authority of Ireland
Energy Policy Statistical Support Unit
Building 2100
Cork Airport Business Park
Co. Cork
Ireland

t +353 1 808 2100
f +353 1 808 2066
e epssu@seai.ie
w www.seai.ie

Sustainable Energy Authority of Ireland
Wilton Park House
Wilton Place
Dublin 2
Ireland

t +353 1 808 2100
f +353 1 808 2002
e info@seai.ie
w www.seai.ie

Ireland's EU Structural Funds Programmes 2007 - 2013
Co-funded by the Irish Government and the European Union

EUROPEAN REGIONAL DEVELOPMENT FUND

The Sustainable Energy Authority of Ireland is partly financed by Ireland's EU Structural Funds Programme co-funded by the Irish Government and the European Union