seai SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Energy in Ireland 1990 – 2011

2012 Report

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Energy Policy Statistical Support Unit

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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

Dr. Brian Motherway

Energy in Ireland is the authoritative analysis of energy use and supply trends in Ireland. This edition examines in detail energy patterns in 2011, and updates the trends from 1990 to 2011. It confirms that energy efficiency and renewable energy measures are having a real impact - reducing Ireland's energy usage and helping to decarbonise our energy system.

The Irish economy grew in 2011 for the first time in four years, but the fall in both energy demand and related CO_2 emissions, which started in 2008 with the economic downturn, has continued. This reduction is welcome and points to an overall improvement in energy efficiency of the economy. However, our fossil fuel import bill was €6 billion in 2011, with oil accounting for three quarters of that. This makes clear that the imperative for greater efficiency gains and for an accelerated move away from fossil fuels remains as strong as ever.

An area of strong progress is renewable electricity – renewables accounting for almost one fifth of electricity usage in 2011. This is bringing a range of benefits, most notably a reduction in our natural gas imports worth almost €300 million, and avoided emissions of 3.6 million tonnes of CO_2. Ireland stands out for its progress in wind energy in particular.

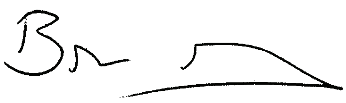
The effect of the return to more average weather conditions in 2011, following the exceptional cold of 2010, is seen in the continued reduction in demand for energy in buildings. Over the five year period to 2011, average fuel and electricity use per home has fallen by almost one fifth. A number of factors may be at work here, including revisions to building regulations to significantly strengthen the insulation, heating system and overall energy performance of newer buildings. The positive impact of grant schemes to retrofit insulation and efficient technologies into the older building stock, and possibly other behaviour change influenced by higher energy prices, is also contributing to the reduction in energy demand and associated CO_2 emissions.

Ireland's industrial firms have continued to show a positive energy efficiency trend, with an overall increase of over 4% in energy productivity in 2011. This reflects the hard work done by this sector in improving its competitiveness through strong energy management and continuous performance improvement.

Transport in Ireland has traditionally been a most challenging sector, and still consumes more energy than that used for either heat (space and process) or electricity generation. Importantly, it is almost exclusively dependent on imported oil. But we are seeing encouraging signs of adoption of more energy efficient technologies and consumer choices. In the four years since the introduction in 2008 of a carbon based vehicle taxation scheme, the average CO_2 emissions of new private cars in Ireland have fallen by 22%. In 2011 such emissions in Ireland were ranked seventh lowest of the EU- 27 countries and are already within the EU target for 2015.

These are areas where good progress is being seen, but there is still much to be achieved to address the key strategic and economic concerns associated with our energy system. Our dependence on fossil fuel imports has begun to fall from its 2006 peak, but we still import 88% of our energy, and this remains a strategic concern, particularly in the context of global fossil fuel prices remaining high. There is also more that can be done to reduce energy-related greenhouse gas emissions, with both energy efficiency and the use of renewables showing that they have much more potential in Ireland.

The energy sector in Ireland is a dynamic one, with much activity among communities, homeowners, businesses, investors and entrepreneurs. It is also an area of very active national policy and programme development, as can be seen in the trends of supply and use set out in this report. *Energy in Ireland* contributes a greater understanding of our energy challenges and opportunities, and helps us measure progress towards our goals. SEAI will continue to work with all interested parties to further the sustainable energy agenda in Ireland. I would like to thank all that have helped make this publication possible through their data, ideas and time, and I look forward to continuing our ongoing dialogue on all energy issues and finding ways collectively to deliver a sustainable energy system for Ireland.



Dr. Brian Motherway, Chief Executive, Sustainable Energy Authority of Ireland

Highlights

Highlights – the year 2011

- Overall (primary) energy use in 2011 fell by 6.4% to 14 Mtoe (similar to 2000 levels). Final energy demand reduced by 6.7% to 11 Mtoe.
- Ireland's economy grew by 1.4% to €159 billion in 2011, while energy-related CO_2 emissions (excluding international aviation) fell by 7.2% to 37 Mt (23% above 1990 levels).
- Ireland's import dependency was 88% in 2011, down from a peak of 90% in 2006.
- In 2011 the cost of all energy imports to Ireland was approximately €6 billion.
- Wind generated electricity grew by 56% in 2011 to 4.4 TWh and avoided 2.1 Mt CO_2.
- In 2011 displacement of fossil fuel for electricity generation by renewable energy resulted in an avoidance of almost €300 million in natural gas imports.
- Oil consumption fell by 7.4% in 2011 to 6.8 Mtoe and represented 49% of Ireland's overall energy supply, 59% of final energy demand and 1.2% of fuel inputs for electricity generation. Oil demand in buildings fell by 15% in 2011.
- Natural gas consumption fell by 12% in 2011 to 4.1 Mtoe, comprising a 17% reduction in use for electricity generation and a 3.6% reduction in final demand.
- In 2011, electricity consumption fell by 2.2% to 25 TWh, while energy-related emissions from electricity generation fell by 10% to 1994 levels. In 2011, electricity accounted for less than one fifth (19%) of final energy demand.
- The carbon intensity of electricity has fallen from 896 g/kWh CO_2 in 1990 to a new low of 489 g/kWh CO_2 in 2011.

Progress towards Targets

- In 2011, renewable energy grew by 24% to 782 ktoe, representing 6.4% of Ireland's gross final energy use. 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 18% of gross electricity consumption (RES-E) in 2011. Ireland's target for 2020 is 40%.
- Renewable energy contribution to thermal energy (RES-H) was 4.8% in 2011. Ireland's target for 2010 was 5% and the year 2020 RES-H target is 12%.
- Renewable energy in transport (RES-T) reached 2.6% in 2011, or 3.6% when weightings are applied to second generation biofuels. Ireland's target was 3% by 2010 and is 10% by 2020.
- The average annual energy-related CO_2 emissions in the period 2008 – 2011 were 40 Mt, or 34% above 1990 levels. Ireland's target for economy-wide greenhouse gas (GHG) emissions is to limit growth to 13% above 1990 levels in the period 2008 – 2012.
- Energy-related CO_2 emissions in 2011 in sectors not included in EU emissions trading (non-ETS) in 2011 were 16% below 2005 levels. Ireland's target is to achieve a 20% reduction in total non-ETS GHG emissions by 2020.
- The average specific emissions from new passenger cars purchased in Ireland in 2011 were 128 g CO_2/km, down from 164 g CO_2/km in 2007. This has already met the target of 130 g CO_2/km set by the EU Directive (443/2009) for 2015.

Sectoral Highlights

- Industrial energy use fell by 1.4% in 2011 while economic output from industry grew by 3.1%.
- Transport energy demand, which was responsible for a third of total energy use in Ireland, fell by 3.8% in 2011. Half of all transport energy consists of diesel.
- Energy use in buildings fell by 14% in 2011 and accounted for 41% of final demand. When corrected for weather, there was a 1.2% reduction in 2011.
- Residential energy use fell by 13% in 2011, but when corrected for weather showed a decrease of 2.2%.
- Energy consumption per household was 4.4% lower in 2011 than in 2010 (corrected for weather).
- The average dwelling was responsible for emitting 6.4 tonnes of energy-related CO_2 emissions in 2011. This was a 24% reduction on 2005 levels.
- Energy use in the services sector fell by 9.7% (1.1% increase when corrected for weather) in 2011 and represented 12% of final energy demand.

Trends since 2007

- Since 2007, Ireland's economy has contracted by 6.8%, reaching close to 2006 levels in 2011. Energy demand has fallen by 16% to 2001 levels and associated CO_2 emissions have fallen by 17% to 1998 levels.
- Transport energy demand in 2011 was 4.4 Mtoe, representing a 23% reduction on 2007 levels, including a 42% reduction in energy use for freight transport.
- Industrial energy demand in 2011 was 2.3 Mtoe. This was 17% lower than 2007 levels even though industrial economic activity was only 2.8% lower. Energy demand in industry was down to approximately 1999 levels in 2011.
- Energy use in buildings has fallen by 7.4% since 2007 to 4.2 Mtoe. Demand fell by 14% in 2011 following a 2.7% growth in 2010, which demonstrates the impact of weather on energy demand.
- Energy use per household fell by 16% since 2007 when corrected for weather.

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1 Introduction

This report examines energy trends in Ireland since 1990 with particular emphasis on 2011, discusses the underlying factors and relates the trends to Government and EU targets in order to inform the development and progression of 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 relevant 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, results of surveys on combined heat and power, renewable energy and 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 2011, using 2005 as a reference year. This acknowledges the 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 – 2012 Report*, is also available, presenting the background data for 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.

Some changes, revisions and corrections to the historic energy balance data were implemented during 2012. The most significant of these were:

- Two additional energy flows were added, for navigation and fisheries, based on excise data.
- Calculations for the estimation of geothermal and solar heat were changed to align with EU recommendations.
- Methodology improvements were made to the estimation of coal and wood usage data.
- An improved data source for liquid biofuels was incorporated and biofuels were allocated across all modes of road transport rather than just private cars as previously.
- There was a historic revision of peat calorific values for milled peat use in electricity generation based on data from the Emissions Trading Scheme.
- Some changes were made to the sectoral allocation of electricity and natural gas based on improved data sources.

There may be additional future changes to industry and commercial services energy data based on the results from the joint CSO/SEAI annual Business Energy Use Survey that commenced in 2010.

Energy balance data analysed in this report were frozen on 5th October 2012. 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 SEAI's website at www.seai.ie/Publications/Statistics_Publications/EPSSU_Publications.

An energy data service is also 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.

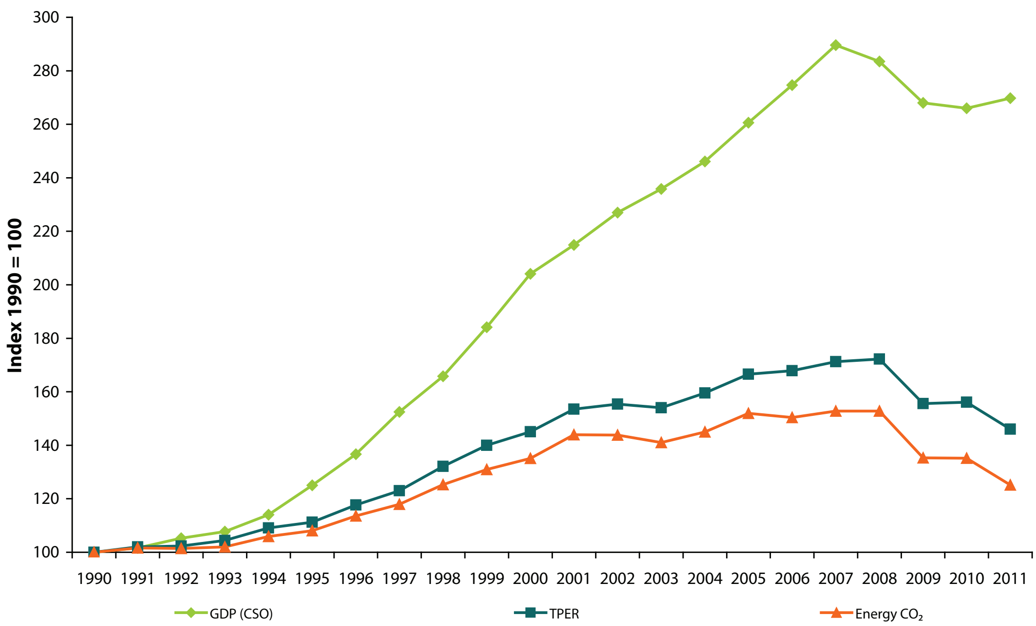
Feedback and comment on the report are welcome and should be addressed by post to the address on the rear cover or by email to epssu@seai.ie.

2 Energy Trends

This section provides an overview of energy trends in Ireland, covering the period 1990 – 2011 with a particular focus on 2011. 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 this likely 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 a significant proportion of energy use is for space heating, experienced increases due to the severe winter conditions both early and late in the year. 2011 was a mild year compared with 2010 and, notwithstanding the growth in GDP, there was a drop in energy demand across all sectors of the economy.

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, 2006 – 2008[2] and 2009 – 2011. 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

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, mainly in the form of low grade heat. 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 a significant factor in the reduction in TPER was the commissioning of two new high-efficiency gas-fired electricity generating plants. A similar situation occurred in 2006 – 2007.

3 Energy-related CO_2 emissions shown here (2011 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.

in the fuel mix. The years 2008 and 2010 are examples of just how factors other than economic factors, as measured by GDP, influence overall energy use patterns. The economy declined in both 2008 and 2010 while energy and energy-related CO_2 rose slightly, due to colder weather in those years. In contrast, in 2011 energy demand and related CO_2 emissions fell even though there was some growth in the economy.

In 2008 when the economy entered recession, GDP fell by 2.1% compared with 2007, while primary energy use grew by 0.6% and energy related CO_2 emissions grew by 0.7%. In 2009, the downturn in the economy deepened with GDP falling by 5.5% and energy and related CO_2 emissions falling by 10% and 11% 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 slowed to 0.8% while overall energy use grew by 0.3% and emissions fell by 0.2%.

In 2011, Ireland's economy grew by 1.4% to €159 billion but in contrast to what happened in 2008, the overall use of energy fell by 6.4% to 13,869 kilo tonnes of oil equivalent (ktoe)[4]. A number of factors contributed to this fall in energy demand. The main contributing factor was that 2011 was much milder than the exceptionally cold winter year of 2010, resulting in a lower heating demand. There was also a large increase (56%) in wind generation which reduced the primary energy requirements for electricity generation and there were also continued improvements in the energy performance of households arising from changes to the building regulations and the retrofit grant schemes.

Table 1 tabulates the growth rates for the economy (GDP), primary energy (TPER) and energy-related CO_2 emissions for the period 1990 – 2011. It highlights the high GDP growth rates compared with those for energy and CO_2 prior to 2008 and the continued decreases in primary energy and energy-related CO_2 in 2011.

It is interesting to compare the trend over the six-year period 2005 – 2011 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 given in section *3.1.1*. Over the six years, energy-related CO_2 emissions have fallen by 3.2% per annum on average, an aggregate decrease of 17.6%, returning to 1998 levels, while the economy has returned to 2005 levels. Over the 21 year period since 1990 by contrast, on average energy-related CO_2 emissions grew by 1% per annum, while the economy grew by 4.8% per annum.

Table 1 *GDP[5], TPER and CO_2 Growth Rates[6]*

	Growth %	Average annual growth rates %					
	1990 – 2011	'90 – '11	'90 – '95	'95 – '00	'00 – '05	'05 – '10	2011
GDP	169.8	4.8	4.6	10.3	5.0	0.4	1.4
TPER	46.0	1.8	2.2	5.4	2.8	-1.3	-6.4
Energy CO_2	25.3	1.1	1.6	4.6	2.4	-2.3	-7.4
Energy CO_2 (excl. international aviation)	22.8	1.0	1.6	4.4	2.2	-2.3	-7.2

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.

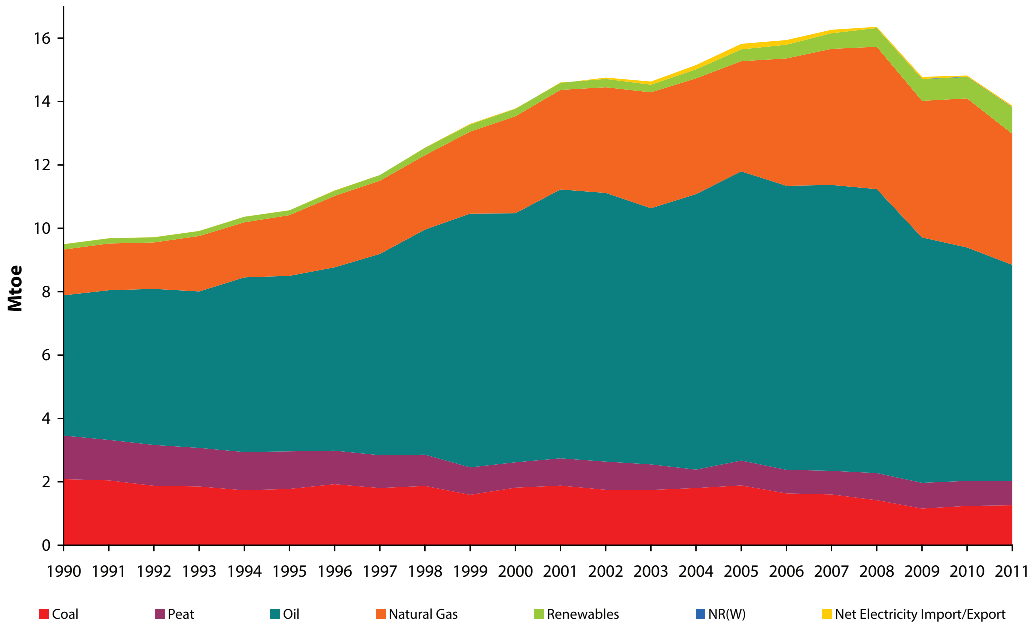
Figure 2 illustrates the trend in energy supply over the period 1990 – 2011, emphasising changes in the fuel mix. Primary energy consumption in Ireland in 2011 was 13,869 ktoe, down from a peak of 16,358 ktoe in 2008 and 955 ktoe lower than in 2010. The increased contribution of wind energy in 2011 (reaching 4380 GWh) was responsible for a 2% drop in calculated primary energy demand compared to 2010, as wind avoids just over two times the primary energy that it produces.

4 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 1 toe = 10^7 kilocalories = 41.868 gigajoules (GJ) = 11.63 Mega Watt hours (MWh)= 11,630 kilo-Watt-hours (kWh)

5 Gross Domestic Product (GDP) rates are calculated using constant market prices chain-linked annually and referenced to year 2010.

6 Throughout the report where annual growth rates are across multiple years they always refer to *average annual growth rates*.

Figure 2 *Total Primary Energy Requirement*



Over the period 1990 – 2011 Ireland's total annual primary energy requirement grew in absolute terms by 46% (1.8% per annum on average). However, in 2011 Ireland's primary energy requirement fell by 6.4%. The individual fuel growth rates, quantities and shares are shown in *Table 2*. Primary energy requirement peaked in 2008 and has fallen by 15% since then.

Table 2 *Growth Rates, Quantities and Shares of TPER Fuels*

	Growth %	Average annual growth rates %				Quantity (ktoe)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Fossil Fuels (Total)	39.1	1.6	2.4	-1.6	-7.9	9,330	12,982	98.2	93.6
Coal	-39.4	-2.4	0.8	-8.0	1.9	2,085	1,264	22.0	9.1
Peat	-44.8	-2.8	-0.4	0.1	-3.8	1,377	761	14.5	5.5
Oil	54.2	2.1	3.0	-4.2	-7.4	4,422	6,820	46.6	49.2
Natural Gas	186.1	5.1	2.6	6.2	-12.0	1,446	4,138	15.2	29.8
Renewables (Total)	395.3	7.9	9.7	12.6	22.9	168	831	1.8	6.0
Hydro	1.4	0.1	-5.7	-1.0	17.9	60	61	0.6	0.4
Wind	-	-	35.4	20.4	55.6	0	377	0.0	2.7
Biomass	99.5	3.3	9.8	2.8	1.5	105	210	1.1	1.5
Other Renewables	7641.3	23.0	9.0	32.3	4.6	2	183	0.0	1.3
Non-Renewable (Wastes)	-	-	-	-	65.8	0	14	0.0	0.1
Electricity Imports	-	-	64.7	-18.0	-3.7	0	42	0.0	0.5
Total	**46.0**	**1.8**	**2.8**	**-1.3**	**-6.4**	**9,497**	**13,869**		

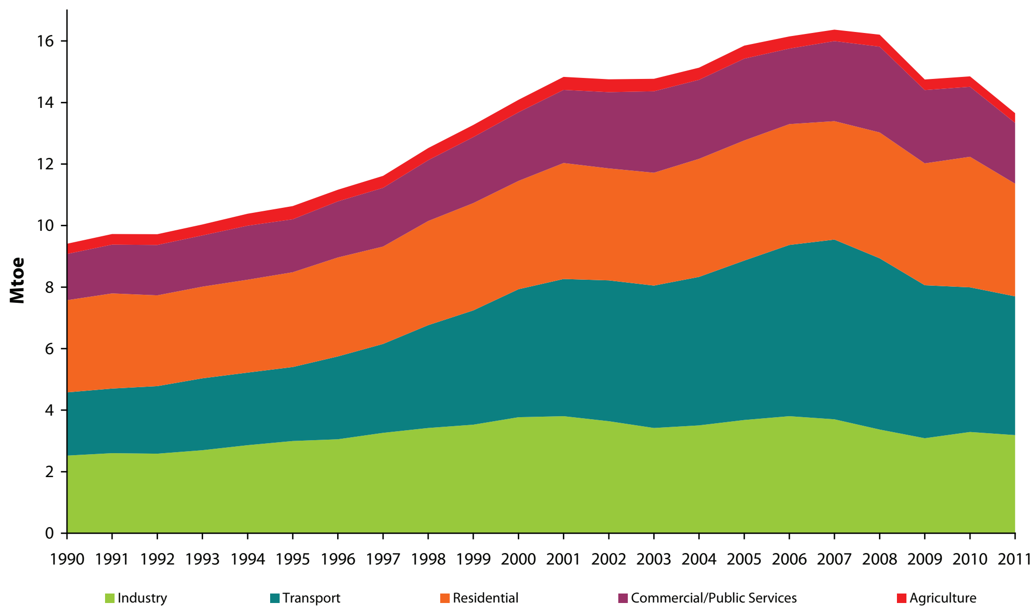
The following are the main trends in national fuel share:

- All fuels, with the exception of coal and renewables, experienced reductions in consumption in 2011. Renewables in aggregate increased by 23% to 831 ktoe and coal use increased by 1.9% to 1,264 ktoe.
- Fossil fuels accounted for 94% of all energy used in Ireland in 2011, excluding the embodied fossil fuel content of imported electricity. Demand for fossil fuels fell by 7.9% in 2011 to 12,982 ktoe and has fallen 15% since 2005.
- Oil continues to be the dominant energy source, increasing from a share of 47% in 1990 to a peak of 60% in 1999, but falling to 49% in 2011. Consumption of oil, in absolute terms, fell by 7.4% in 2011 to 6,820 ktoe. Over the six years 2005 – 2011, oil demand fell by 25% (4.27% per annum).
- Natural gas use fell in 2011 by 12% to 4,138 ktoe and its share of TPER was 30%. The increase in 2010 was 9.2%, mainly due to the severe winter conditions and increased use in electricity generation. Over the six years 2005 – 2011, natural gas use has increased by 19% (2.9% per annum).

- In absolute terms over the period 1990 – 2011 coal declined by 39% to 1,264 ktoe. In 2011 the use of coal increased by 1.9%. Increased use in electricity generation accounted for all of this increase as coal use in final consumption in both industry and the residential sector fell in 2011. Over the five years 2005 – 2010, coal demand fell by 34% (8% per annum).
- Peat use fell by 3.8% in 2011 to 761 ktoe and over the period 1990 – 2011 its use declined by 45% resulting in its share in primary energy falling from 14% to 5.5%. The decrease in use of peat in 2011 occurred both in electricity generation (-2.1%) and the residential sector (-4.8%).
- Wind energy experienced a fall in 2010 of 4.8% but grew by 56% in 2011 to 4,380 GWh (377 ktoe), due to a 13% growth in installed capacity and (3% - 4%) higher than average wind speeds and particularly low wind speeds in 2010. The share of wind in overall energy use in 2011 was 2.7%.
- The Hydro resource recovered in 2011 to average levels (707 GWh or 61 ktoe) resulting in an 18% increase in hydro generated electricity relative to 2010.
- Total renewable energy increased by 23% during 2011 to 831 ktoe. On average in the period 2005 – 2011, renewable energy demand increased by 14% per annum. Since 1990 renewable energy has grown by 395% (7.9% per annum on average) in absolute terms.
- Electricity imports fell by 3.7% in 2011 and accounted for only 0.5% 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 national 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 2011. All sectors experienced a reduction in primary energy use in 2011, varying from a 14% reduction in the residential sector to a 3.2% reduction in industry.

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 the Environment, Community & Local Government are now included in the energy balance and presented in the transport section.

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

	Growth %	Average annual growth rates %				Quantity (ktoe)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Industry	26.2	1.1	-0.5	-2.2	-3.2	2,524	3,186	26.8	23.3
Transport	119.8	3.8	4.5	-1.9	-3.9	2,054	4,515	21.8	33.0
Residential	22.3	1.0	2.1	1.7	-13.7	2,995	3,662	31.8	26.8
Commercial / Public	31.0	1.3	3.6	-3.1	-13.3	1,504	1,971	16.0	14.4
Agriculture / Fisheries	1.9	0.1	2.7	-5.0	-6.9	331	337	3.5	2.5
Total	**46.0**	**1.8**	**2.8**	**-1.3**	**-6.4**	**9,497**	**13,869**		

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

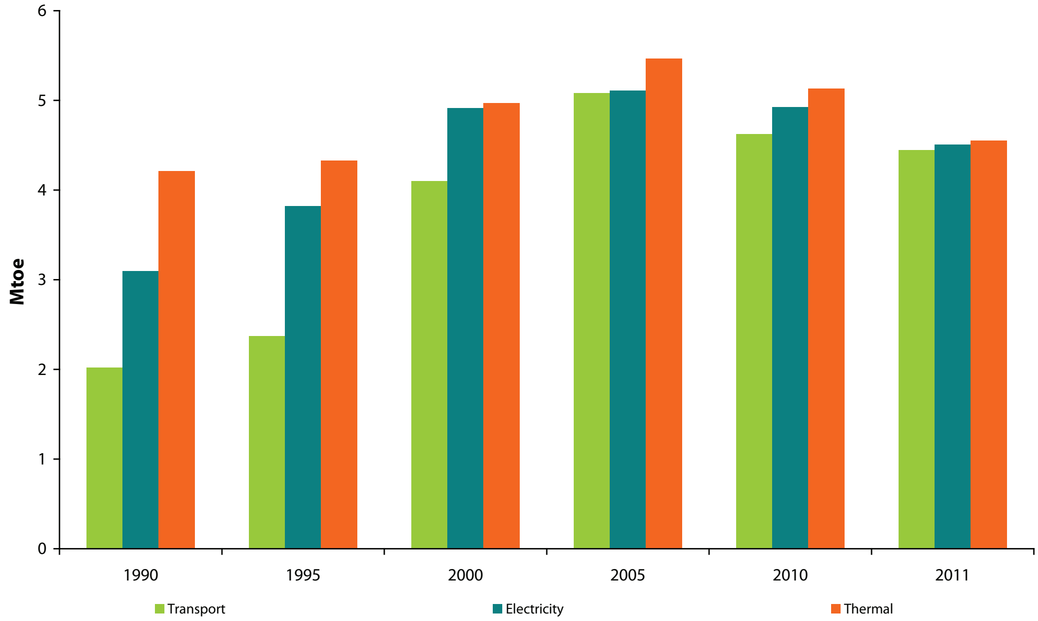
- Transport primary energy use grew by 120% over the period 1990 – 2011 to 4,515 ktoe (3.8% per annum). Transport consumes one third of all energy in Ireland. The highest growth was experienced in the 1995 – 2000 period when the average annual growth was 11.6%. Transport primary energy use fell for the first time during 2008, by 4.7%, as a result of the economic downturn. Transport energy use continued to fall in 2009, 2010 and 2011 by 10.7%, 5.5% and 3.9% respectively. The total reduction in transport energy demand since the peak in 2007 is 23% with consumption levels now back at those of a decade ago (2001/2002 levels).
- Industry primary energy use fell by 3.2% in 2011 to 3,186 ktoe. Industry's share of primary energy was 23% in 2011. Primary energy use in industry has been falling since 2006, with 2010 being the exception.
- Residential share of primary energy use increased to 28% in 2010 but fell back to 27% in 2011. In 2011, primary energy use in households decreased by 14% to 3,662 ktoe. 2010 was an exceptionally cold year which saw primary energy use in the residential sector increase by 7.1%.
- Use of primary energy in the commercial and public services sector fell by 13% in 2011 to 1,971 ktoe. Over the period 1990 – 2011 the services sector had the second highest growth of all sectors, consuming 31% more in 2011 than in 1990.
- Primary 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 2011, primary energy in buildings accounted for 41% of primary energy supply. Overall, primary energy use in buildings increased by 25% since 1990 (1.1% per annum) and in 2011 it fell by 14% to 5,634 ktoe.
- Agriculture/fisheries energy use decreased by 6.9% in 2011 to stand at 337 ktoe.

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 (4,211 ktoe) accounted for a significant proportion of all primary energy (45%), while electricity accounted for 33% (3,094 ktoe) and transport 22% (2,019 ktoe). This contrasts with the situation in 2011 when the transport share had risen to 33% (4,448 ktoe), thermal had fallen to 34% (4,550 ktoe) and the share of energy use for electricity generation was unchanged at 33% (4,506 ktoe). The changes in mode shares are shown graphically in *Figure 4*.

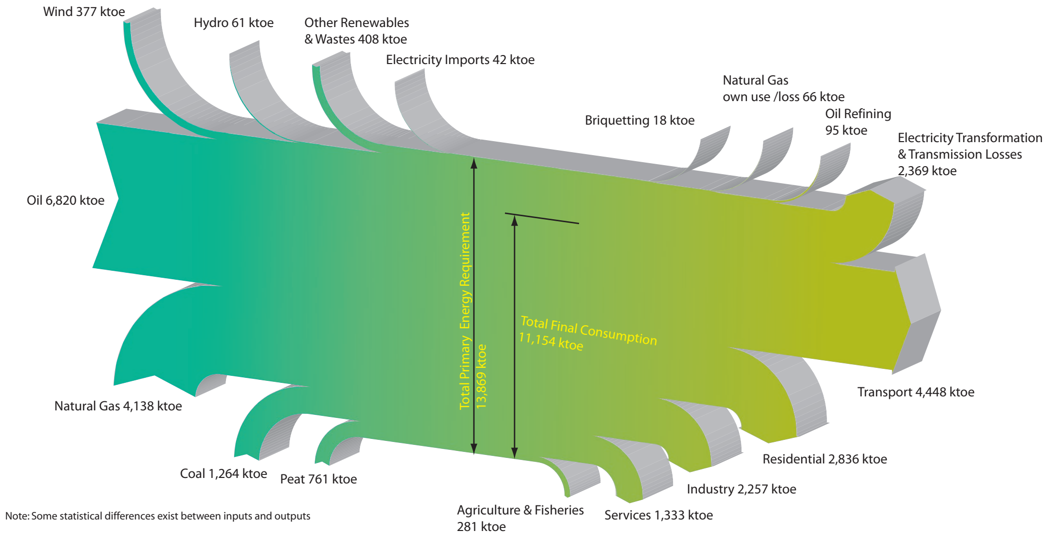
Figure 4 *Primary Energy by Mode of Application*



2.3 Energy Balance for 2011

Figure 5 shows the energy balance for Ireland in 2011 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 2011*[8]



Note: Some statistical differences exist between inputs and outputs

Oil dominates as a fuel, accounting for 6,820 ktoe, representing 49% 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, accounting for 4,448 ktoe, representing 40% of total final energy consumption (TFC) in 2011.

Losses associated with the transformation of primary energy to electricity, power plant in-house load and electricity network losses were 17% of TPER or 2,369 ktoe in 2011 (53% of primary energy used for electricity generation).

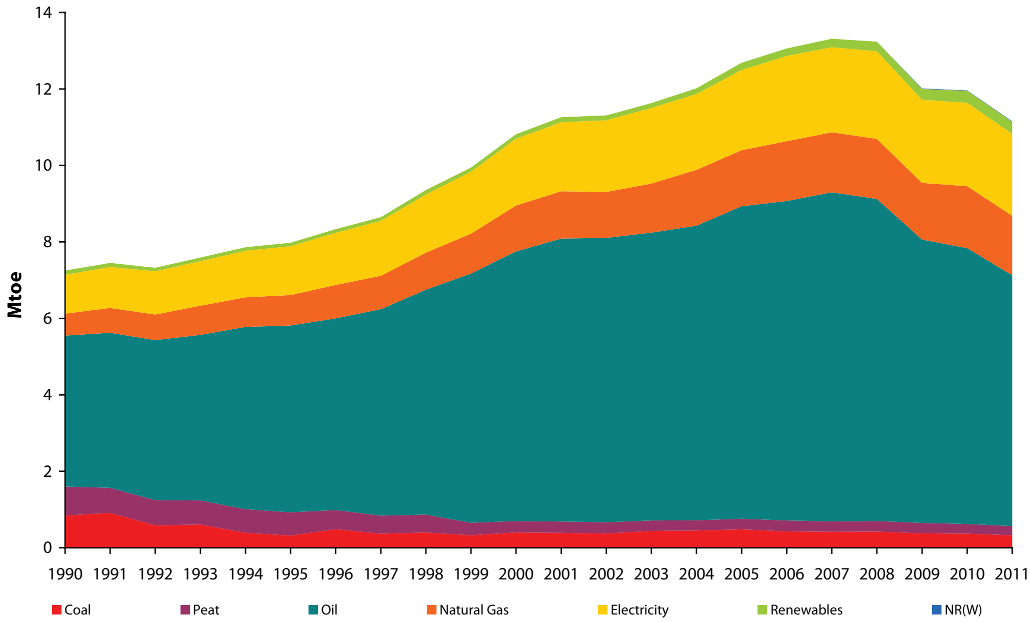
8 All energy inputs shown here represent the sum of indigenous production plus, where applicable, net imports i.e. imports minus exports.

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 – 2011.

Figure 6 *Total Final Consumption by Fuel*



Ireland's TFC in 2011 was 11,154 ktoe, a decrease of 6.7% on 2010 and 54% above the 1990 level of 7,249 ktoe, (representing growth of 2.1% per annum on average). When corrected for climate the fall in final consumption in 2011 was 2.4%. Final consumption peaked in 2007 and has fallen by 16% since. The changes in the growth rates, quantities and respective shares of individual fuels in final consumption over the period are shown in *Table 4*. For absolute values associated with *Table 4* see the companion document *Energy Statistics 1990 – 2011*.

Table 4 *Growth Rates, Quantities and Shares of TFC Fuels*

	Growth %	Average annual growth rates %				Quantity (ktoe)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Fossil Fuels (Total)	41.9	1.7	3.0	-1.9	-8.1	6,121	8,685	84.4	77.9
Coal	-61.1	-4.4	4.0	-5.3	-11.4	843	328	11.6	2.9
Peat	-68.1	-5.3	-2.0	-1.5	-4.8	757	241	10.4	2.2
Oil	65.9	2.4	3.0	-2.5	-9.1	3,952	6,558	54.5	58.8
Natural Gas	173.5	4.9	4.0	2.0	-3.6	570	1,558	7.9	14.0
Renewables	192.6	5.2	10.2	10.3	1.2	108	315	1.5	2.8
Non-Renewable (Wastes)	-	-	-	-	65.8	-	14	0.0	0.1
Combustible Fuels (Total)	44.3	1.8	3.1	-1.6	-7.8	6,229	8,989	85.9	80.6
Electricity	109.6	3.6	3.7	0.9	-2.2	1,021	2,140	14.1	19.2
Total	**53.9**	**2.1**	**3.2**	**-1.2**	**-6.7**	**7,249**	**11,154**		
Total Climate Corrected	**49.1**	**1.9**	**3.4**	**-2.2**	**-2.4**	**7,423**	**11,110**		

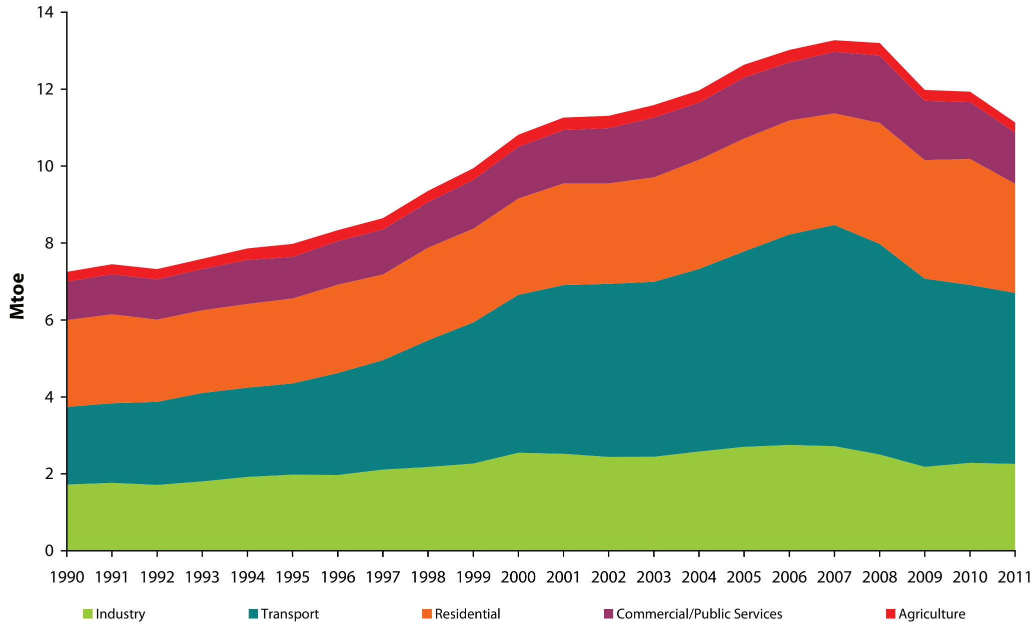
The most significant changes can be summarised as follows:

- All fuels with the exception of renewables and energy from wastes experienced reductions in use in 2011. Renewables consumption increased by 1.2% to 315 ktoe and wastes by 66%, although the quantity of energy from non-renewable wastes is small (14 ktoe).

- Final consumption of oil fell by 9.1% in 2011 to 6,558 ktoe following falls in the previous four years. Its share of final energy consumption fell to 59% from 65% in 2007. Most (4,346 ktoe) of this oil was used in transport with the remaining 2,212 ktoe used for thermal energy.
- Natural gas experienced a decrease in consumption in 2011 of 3.6% to 1,558 ktoe. This decreased gas consumption is due mainly to the decreased space heating requirements in buildings compared with the requirements during the very cold weather in 2010. Residential and services gas consumption decreased by 20% and 17% respectively. Conversely gas consumption increased in industry in 2011 – by 34%.
- Final consumption of coal decreased by 11.4% to 328 ktoe. Its share of final use in 2011 was at 3%.
- Final consumption of electricity in 2011 decreased by 2.2% to 2,140 ktoe (or 24,881 GWh). In 2011, electricity accounted for 19% of final energy use.
- Final consumption of peat decreased by 4.8% in 2011 to 241 ktoe following falls the previous three years.

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. It is also evident from *Figure 7* that transport continues to dominate (since the mid 1990s) as the largest energy consuming sector (on a final energy basis) with a share of 40% in 2011. The shares of the industry and residential sectors have decreased since 1990. In 2011 industry accounted for approximately one fifth of final energy use and the residential sector approximately one quarter.

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

	Growth %	Average annual growth rates %				Quantity (ktoe)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Industry	31.2	1.3	1.2	-3.3	-1.4	1,720	2,257	23.7	20.2
Transport	120.3	3.8	4.4	-1.9	-3.8	2,019	4,448	27.8	39.9
Residential	25.6	1.1	3.2	2.2	-13.4	2,258	2,836	31.2	25.4
Commercial / Public	33.2	1.4	3.4	-1.4	-9.7	1,001	1,333	13.8	11.9
Agriculture / Fisheries	11.3	0.5	3.9	-4.9	-5.8	252	281	3.5	2.5
Total	**53.9**	**2.1**	**3.2**	**-1.2**	**-6.7**	**7,249**	**11,154**		

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

- Overall final energy consumption decreased by 6.7% in 2011 to 11,154 ktoe.
- Transport final energy use increased by 120% over the period 1990 – 2011. Final consumption of energy in transport was 4,448 ktoe in 2011. This represents an average annual growth rate of 3.8% and transport's share of TFC increased from 28% to 40%. Energy use in transport fell in 2011 by 3.8%. In the period 2005 – 2010, transport energy demand fell by 1.9% per annum on average.

- Industry experienced a continued decrease in final energy use in 2011, falling by 1.4% to 2,257 ktoe following an increase of 4.9% in 2010. Over the 1990 – 2011 period, industry experienced an average growth rate of 1.3% per annum (or 31% in absolute terms) and its share of TFC dropped from 24% to 20%. Since 2005, industry energy demand has been falling at a rate of 3.3% 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 decreased by 13% in 2011 to 2,836 ktoe mainly due to milder weather compared with 2010. Correcting for climate[9], there was still a 2.2% decrease in residential energy use in 2011.
- The commercial and public services sector also experienced decreased final energy use in 2011, falling by 9.7% to 1,333 ktoe, again due to the cold weather. Correcting for weather there was an increase of 1.1% in services energy consumption in 2011.
- The agricultural/fisheries sectors' relative share fell from 3.5% in 1990 to 2.5% in 2011. In absolute terms, agriculture experienced a decrease of 5.8% in energy consumption in 2011 to 281 ktoe.

2.5 Heating Degree Days

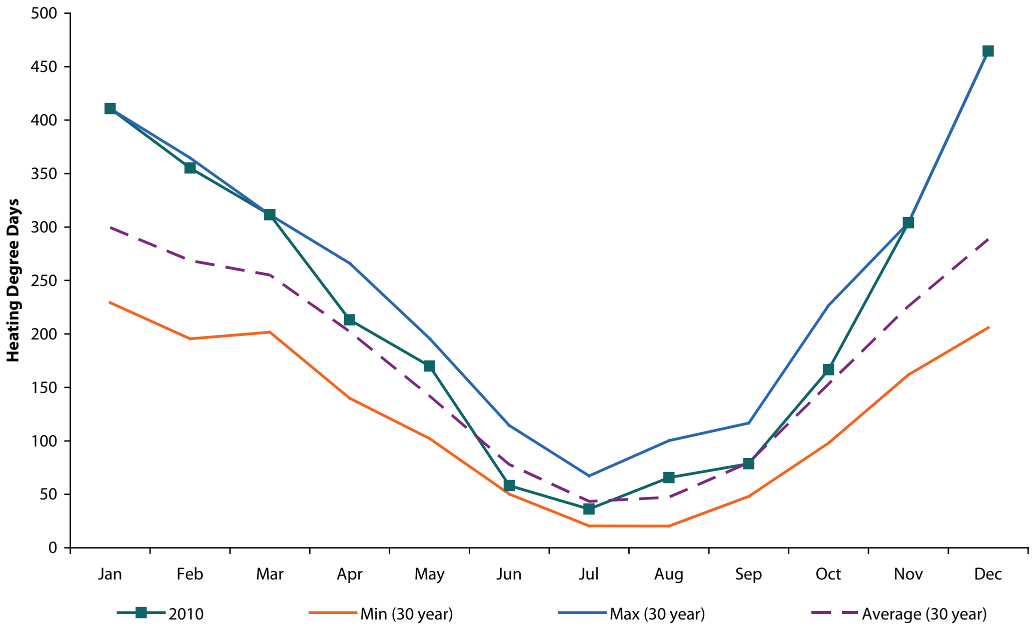
Weather variations from year to year can have a significant effect on the energy demand of a country and in particular on the portion of the energy demand associated with space heating. A method to measure the weather or climatic variation is through the use of degree days.

"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. It should be noted that the larger the number of heating degree days, the colder the weather. Also note that the typical heating season in Ireland is October to May. If, for example, the outdoor temperature for a particular day is 10 degrees lower than the base temperature (15.5 degrees), this would contribute 10 degree days to the annual or monthly total.

Met Eireann calculates degree day data for each of its synoptic weather stations. SEAI calculates a population weighted average of these data to arrive at a meaningful degree day average for Ireland that is related to the heating energy demand of the country.

Figure 8 and *Figure 9* show the heating degree days per month for 2010 and 2011. Section 2.10 discusses the impacts of 2010 being a cold year and 2011 being mild in comparison to 2010. These figures put that discussion into context.

Figure 8 *Heating Degree Day Trend 2010*

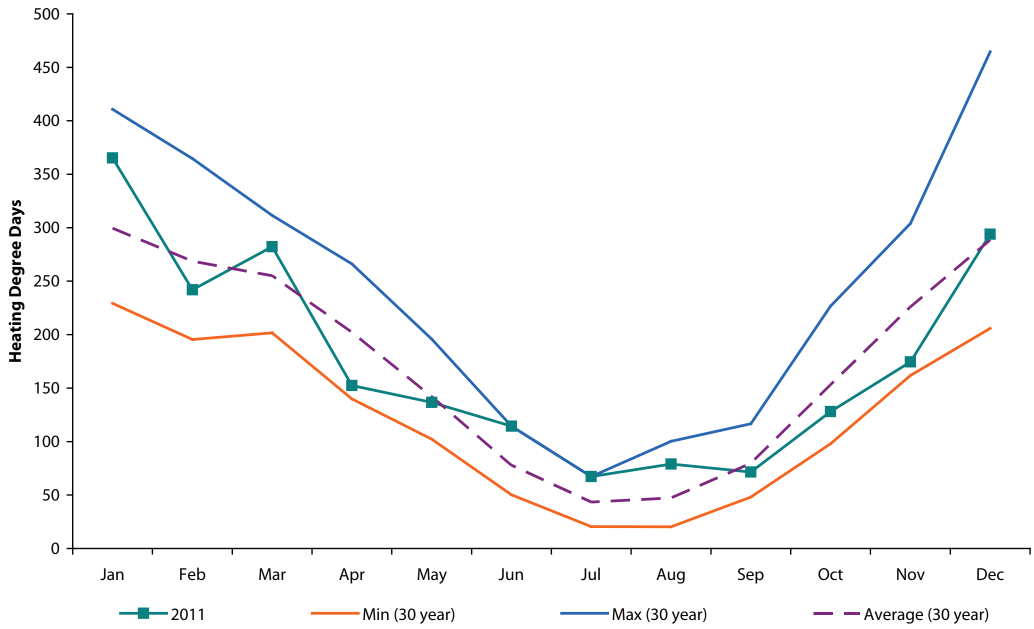


Source: Met Eireann & SEAI

9 See Glossary for description of Climate Correction.

The graphs show the minimum, maximum and average degree days for each month for the last 30 years together with the monthly degree days for the respective year. *Figure 8* shows that in 2010, January/February/March and November/December the degree days more or less matched the 30 year maximum. In other words, it was one of the coldest years since 1981. For the year as a whole, there were 26% more degree days in 2010 than the long-term 30 year average. This explains to some extent why energy consumption in 2010 didn't fall as the economy declined.

Figure 9 *Heating Degree Day Trend 2011*



Source: Met Eireann & SEAI

The trend in 2011 in contrast is closer to normal or average in the earlier part of the year and below average towards the year end. As shown in *Figure 9* it was colder than average in January and March but warmer in February and April. Later in the year, October and November were warmer than average and December was very slightly above average. For the year as a whole, there were just 1.2% more degree days in 2011 than the 30 year average and 20% less than in 2010. In terms of space heat requirements that are weather dependent, 2011 could be considered average.

2.6 Energy Intensities

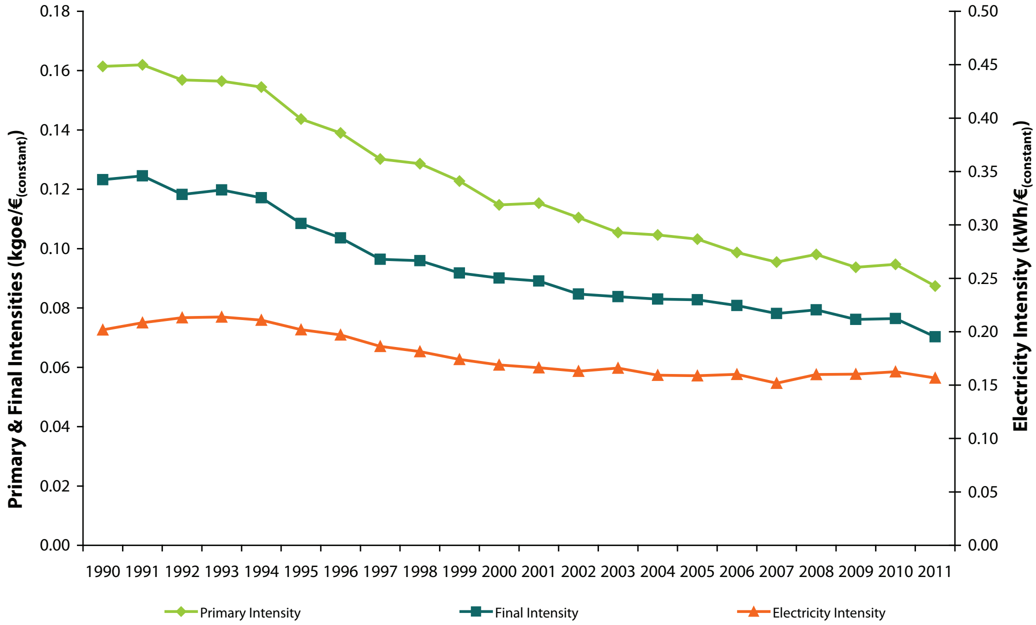
Energy intensity is defined as the amount of energy required to produce some functional output. In the case of the economy, the measure of output is generally taken to be gross domestic product (GDP)[10]. GDP measured in constant prices is used to remove the influence of inflation. The inverse of energy 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 10*. The primary energy intensity of the economy fell by 41% between 1990 and 2007 (3% per annum). In 1990 it required 161 grammes of oil equivalent (goe) to produce one euro of GDP (in constant 2010 values) whereas in 2007 just 95 goe was required. However, during 2008 the primary energy intensity increased by 2.7% to 98 goe/$€_{2010}$ but by 2011 energy intensity has fallen further to 87 goe/$€_{2010}$ or 46% lower than 1990.

Figure 10 shows the trend in both primary (TPER/GDP) and final (TFC/GDP) energy intensities (at constant 2010 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 to 2007 (increased efficiency in electricity generation) when primary intensity fell at a faster rate than final intensity. The decrease in primary intensity between 2001 and 2007 was 17% whereas for final intensity the decrease was 12%.

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 10 *Primary, Final and Electricity Intensity*



Conversely, the increase in final intensity of 1.6% in 2008 is related to the downturn in the economy and the effects of 2008 being colder. In 2009 primary energy intensity fell by 4.4% and final intensity by 4.0%. 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.

In 2011, the primary and final intensity trends diverged slightly with final energy intensity falling at a slightly faster rate, 8.1%, compared with a 7.8% fall in primary intensity. This is in part due to the fact that final energy reduced by 6.7% in 2011, whereas electricity demand dropped only by 2.2% as evident from *Table 4*.

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 primary intensity of 2.7% 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 with 20% more heating degree days, so energy use increased at a time when the economy declined.

Similarly, 2010 was even colder than 2008; heating degree days were 26% above the long-term average (2008 was 7% above the average), resulting in a primary energy intensity increase of 1.1%. With the return to mild weather in 2011 the effect of the increased energy productivity becomes apparent again with the reduction in primary energy intensity of 7.8%.

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 25%. This is attributed to the shift towards increased electricity consumption within energy end use. While electricity consumption increased by 118% between 1990 and 2007 (4.7% average annual growth), final energy demand increased by 84% (3.6% annual growth). Electricity final intensity increased in 2008 by 5.4%, in 2009 by 0.2% and in 2010 by 1.4% but fell by 3.5% in 2011.

11 See Glossary.

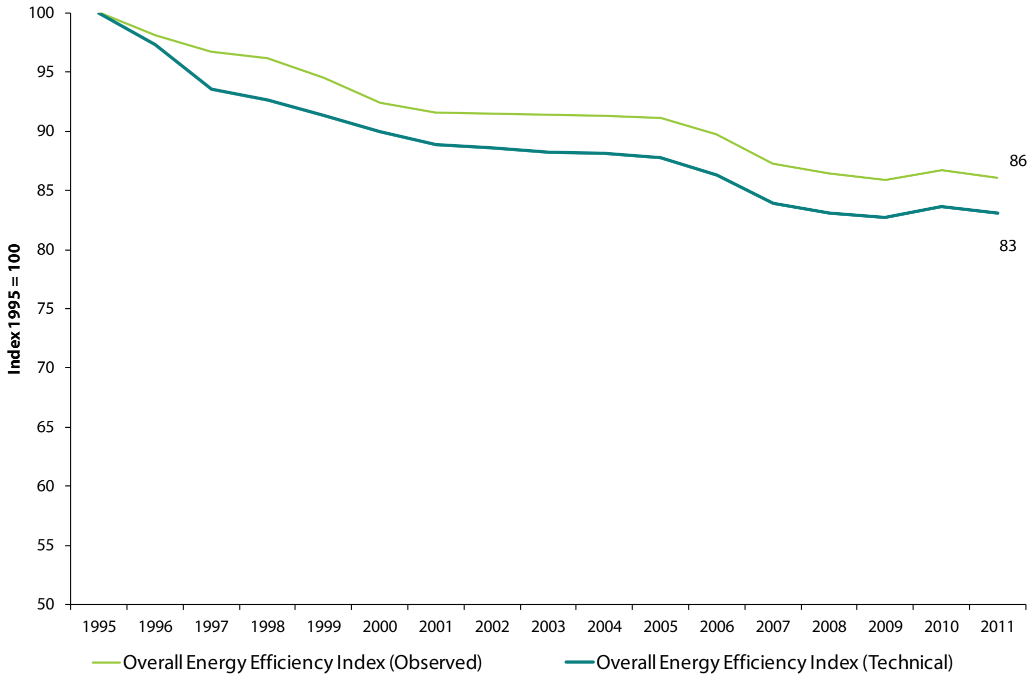
2.7 Energy Efficiency

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 2011 figures.

As mentioned in section *2.6* 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 (**OD**YSSEE Energy **E**fficiency Inde**X**) 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.

Figure 11 *Energy Efficiency 1995 - 2011*



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.

12 Available from www.seai.ie.

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

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 11 presents both the observed and technical overall energy efficiency indicators for Ireland for the period 1995 to 2011.

The observed index shows that between 1995 and 2011 there was a 14% (0.9% per annum on average) decrease, which indicates a 14% improvement in energy efficiency. To separate out the influence of behavioural factors, a technical index is calculated and used to better assess the technical energy-efficiency progress. As shown in *Figure 11*, technical efficiency improved by 17% (1.2% per annum) from 1995 to 2011.

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.

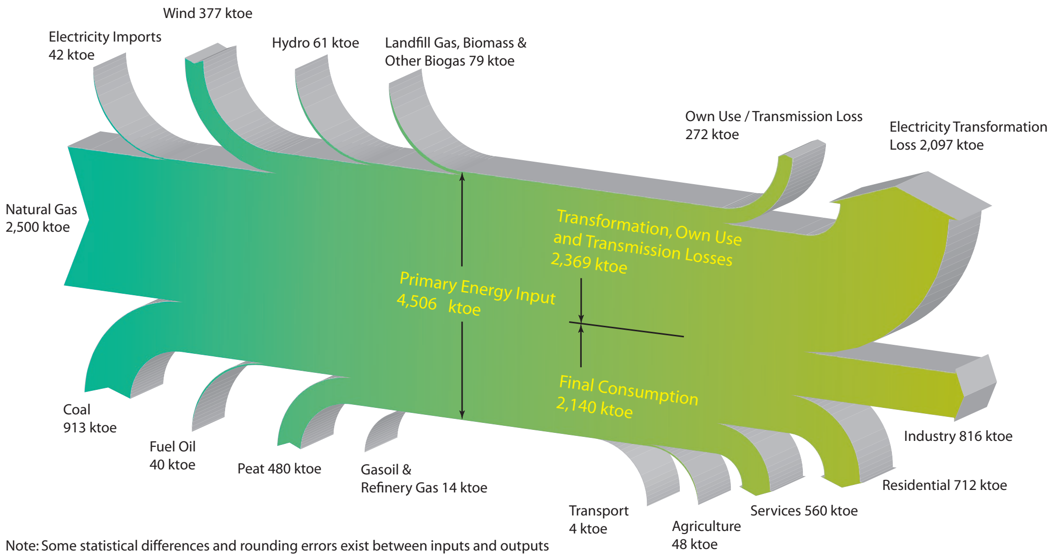
Note that the top-down energy-efficiency index indicators are calculated as a three-year moving average to avoid short-term fluctuations due, for example, to imperfect climatic corrections, behavioural factors, business cycles, etc.

2.8 Electricity Generation

Figure 12 shows graphically the flow of energy in electricity generation[17]. Total energy inputs to electricity generation in 2011 amounted to 4,506 ktoe. The relative size of the useful final electricity consumption compared to the energy lost in transformation and transmission is striking. These losses represent 53% of the energy inputs. The 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 2011, natural gas accounted for 56% (2,500 ktoe) of the fuel inputs to electricity generation.

In 2010 there were reduced wind and hydro resources which resulted in the contribution of renewables to the generation fuel mix input falling to 7.5% with the wind share falling to 4.9%. Wind and hydro resources were more normal in 2011 and, when combined with increased wind installed capacity, the share of renewables in the generation fuel mix increased to 11.5%.

Figure 12 *Flow of Energy in Electricity Generation 2011*



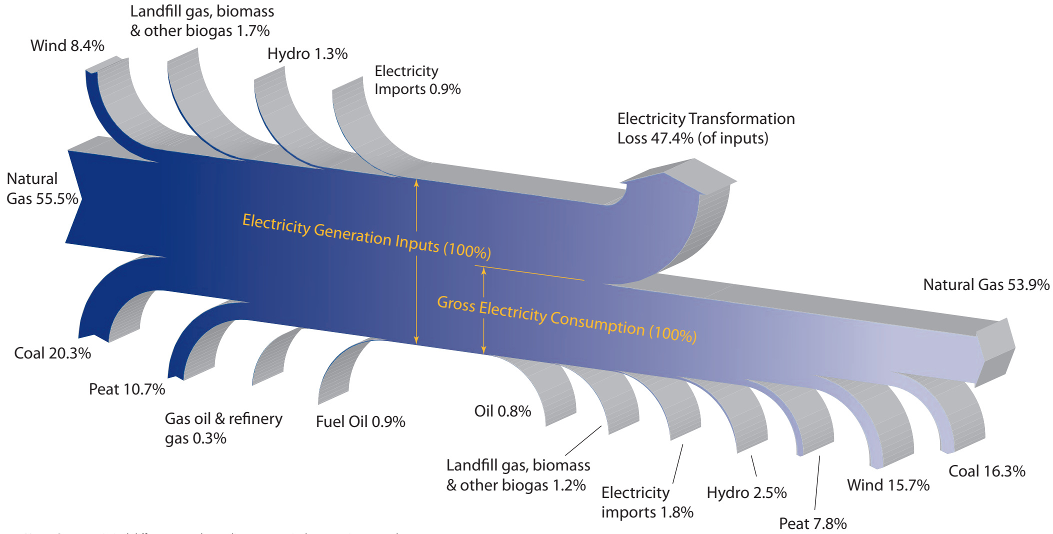
Note: Some statistical differences and rounding errors exist between inputs and outputs

Figure 13 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 2011 in total reached 5,425 GWh, accounting for almost one fifth (19.4%) of gross electricity consumption compared with 12.9% in 2010.

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.

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 17.6% of gross electricity consumption in 2011. The national target is to achieve at least a 40% share by 2020.

Figure 13 *Flow of Energy in Electricity Generation 2011 – 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 = 19.4%
Renewables as % of gross electricity consumption (normalised) = 17.6%
CHP as % of total electricity generation = 7.0%

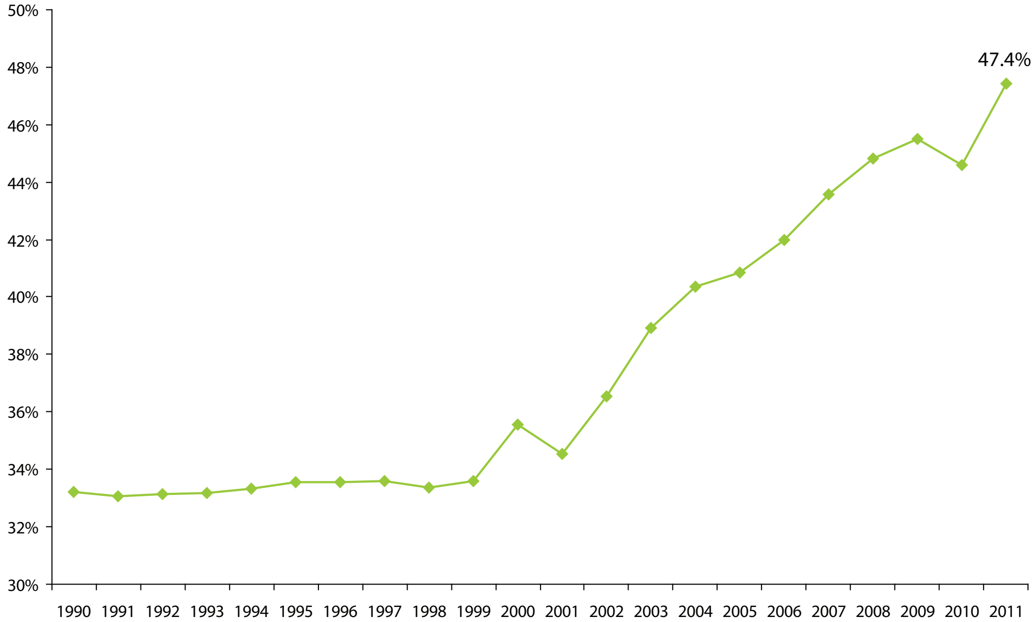
The efficiency of electricity supply shown in *Figure 14* is defined as final consumption of electricity divided by the fuel inputs required to generate this electricity and expressed as a percentage. The inputs include wind, hydro and imports which are direct electricity inputs and do not have transformation 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.

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 2001 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 41.9% in 2006 to 43.6% 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.

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

Figure 14 *Efficiency of Electricity Supply*



In 2011, with these new CCGT plant fully operational and with the increased contribution from wind and hydro, the efficiency increased to 47.4%. 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 15*.

Figure 15 *CO_2 Emissions per kWh of Electricity Supplied*

Since 1990 the share of high carbon content fuels such as coal has been reducing with a corresponding rise in the relatively 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 by 45% from 896 g CO_2/kWh in 1990 to a new low of 489 g CO_2/kWh in 2011.

The reasons for the increase in generating efficiency and decrease in carbon intensity of electricity in 2011 are:

- A 56% increase in wind generation.
- A 18% increase in hydro generation.
- A 4.2% increase in electricity imports.
- A 17% decrease in gas generation.
- A 60% decrease in oil and 2.1% decrease in peat generation.

Countering these was:

- A 5.3% increase in coal use for electricity generation.

2.8.1 Primary Fuel Inputs into Electricity Generation

The trends in the mix of primary fuels employed for electricity generation are shown in *Figure 16*. The shift from oil to gas since 2001 is evident, as is the decline of coal since 2005 and revival in 2010 and 2011.

Figure 16 *Primary Fuel Mix for Electricity Generation*

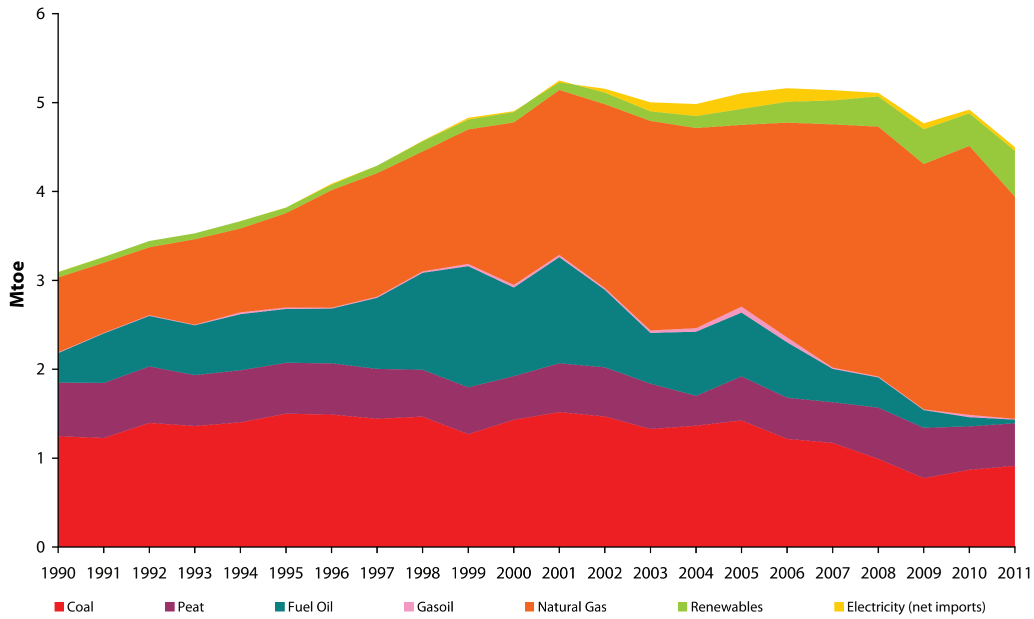


Table 6 presents the growth rates, quantities and shares of the primary fuel mix for electricity generation over the period 1990 – 2011.

The primary fuel requirement for electricity generation grew by 69% from 3,094 ktoe in 1990 to a high of 5,237 ktoe 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 2011, 4,506 ktoe of energy was used to generate electricity, 8.6% less than in 2010 and 14% lower than peak levels in 2001. The fuel inputs to electricity generation were one third (33%) of the total primary energy requirement in 2011. Electricity consumption as a share of total final consumption increased from 14% to 19% between 1990 and 2011.

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

	Growth %	Average annual growth rates %				Quantity (ktoe)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Fossil Fuels (Total)	30.1	1.3	-0.1	-1.0	-12.7	3,034	3,947	98.1	87.6
Coal	-26.7	-1.5	-0.1	-9.4	5.3	1,245	913	40.2	20.3
Peat	-20.5	-1.1	0.2	-0.3	-2.1	604	480	19.5	10.6
Oil (Total)	-84.0	-8.4	-5.2	-29.6	-60.1	343	55	11.1	1.2
Fuel oil	-87.9	-9.6	-6.4	-32.2	-60.6	334	40	10.8	0.9
Gas oil	5.7	0.3	18.6	-17.4	-70.8	7	8	0.2	0.2
Gas	196.6	5.3	2.3	8.2	-17.4	843	2,500	27.2	55.5
Renewables (Total)	760.9	10.8	8.9	15.4	40.2	60	516	1.9	11.5
Hydro	1.4	0.1	-5.7	-1.0	17.9	60	61	1.9	1.3
Wind	-	-	35.4	20.4	55.6	-	377	-	8.4
Other Renewables	-	-	4.8	20.1	5.6	-	79	-	1.7
Non-Renewable (Wastes)	-	-	-	-	-	-	-	-	-
Combustible Fuels (Total)	32.7	1.4	-0.1	-0.8	-12.4	3,034	4,026	98.1	89.4
Electricity Imports (net)	-	-	83.6	-25.5	4.2	-	42	-	0.9
Total	**45.6**	**1.8**	**0.8**	**-0.7**	**-8.6**	**3,094**	**4,506**		

The main trends are:

- Overall fuel inputs into electricity generation fell by 8.6% in 2011 to 4,506 ktoe while final consumption of electricity fell by just 2.2% to 2,140 ktoe (or 24,881 GWh).
- The share of overall fossil fuel used in electricity generation was 88% in 2011. This was a 4.1 percentage point decrease in share or 12.7% in absolute terms relative to 2010.
- Natural gas remains the dominant fuel in electricity generation but its share fell from 61% in 2010 to 55% in 2011. Natural gas use in electricity generation was 2,500 ktoe in 2011, 17% lower than in 2010.
- Fuel oil had a share in electricity generation of 11% in 1990; this rose to 28% in 1999 but in 2011 is minimal at 0.9%. Consumption of fuel oil in electricity generation in 2011 was 40 ktoe.
- The share of coal used in electricity generation has reduced from 40% in 1990 to 20% in 2011. In absolute terms the consumption of coal has fallen by 27% over the period (1.5% per annum) to a figure of 913 ktoe. There was an increase in coal use in 2011 for electricity generation of 5.3%.
- Peat consumption in electricity generation fell by 2.1% to 480 ktoe in 2011 and by 21% since 1990.
- Renewable energy use for electricity generation increased its share from 1.9% to 11.5% between 1990 and 2011. In 2011 there was a 40% increase in renewables contribution to the electricity fuel mix due mainly to the increased contribution from wind. Wind contribution to electricity generation increased by 56% in 2011 while the contribution from hydro increased by 18%. Other renewables in the form of landfill gas, biogas and biomass make up the remainder of the contribution at 1.7% of fuel inputs and their use in electricity generation increased by 5.6% in 2011.
- Electricity imports increased by 4.2% in 2011.

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 – 2011*). 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 2.5% of the total and wind accounted for 16% in 2011.

Overall, the share of electricity generated by renewables was 19.4% in 2011, up from 12.9% in 2010. Normalising for wind and hydro as per the *Renewable Directive (2009/29/EC)* the share of electricity generated from renewables in 2011 was 17.6%.

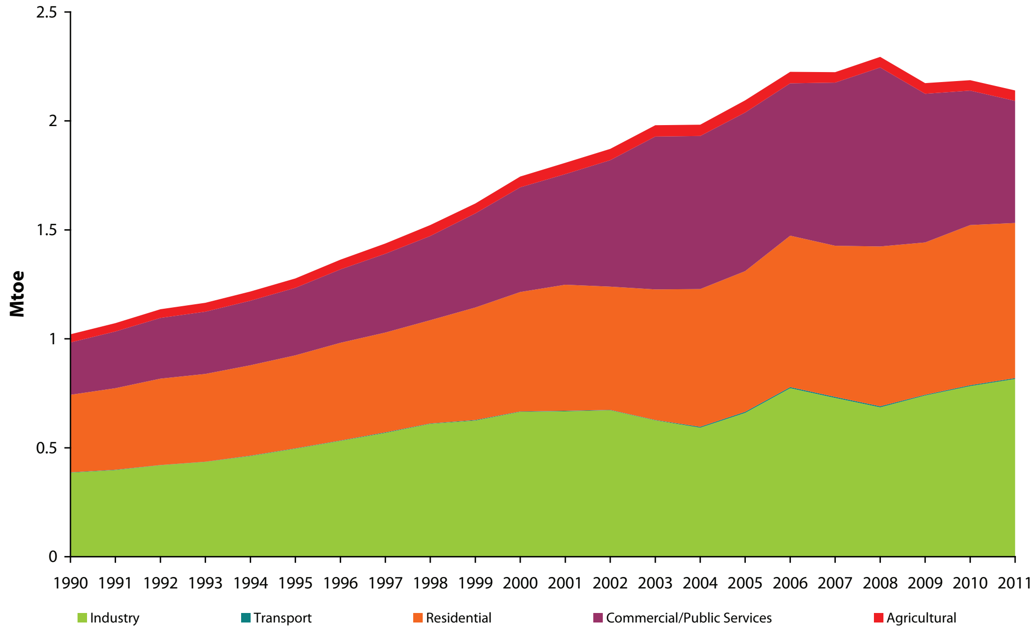
While renewables share of energy inputs to electricity generation was 11.5% in 2011 their share of gross electricity generated was 19.4%.

19 An alternative approach based on *primary energy equivalent* was developed in a separate report: SEAI (2012), *Renewable Energy in Ireland – 2011*. Available from www.seai.ie/statistics.

2.9 Electricity Demand

Figure 17 shows the final electricity consumption in each of the main sectors. The difference between fuel input (see *Figure 16*) and delivered electricity output (*Figure 17*) is accounted for by the transformation losses, totalling 2,097 ktoe in 2011 as shown in *Figure 12* and *Figure 13*. This size of the transformation loss is due to electricity in Ireland being predominantly generated from thermal generation (89% in 2011) 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 2.1 in 2011. Final consumption of electricity decreased by 2.2% in 2011 to 24,881 GWh with an 8.6% reduction in the fuel inputs to electricity generation.

Figure 17 *Final Consumption of Electricity by Sector*



Over the period 2005 – 2011, electricity demand increased by 0.4% per annum on average while the fuel inputs fell by 2.1% per annum.

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 in Dublin by the DART and reflects the arrival (testing and operation) of the Luas. In absolute terms electricity consumption in transport is small at 45 GWh (4 ktoe).

Industry was the only sector that experienced increased (by 4.2%) electricity demand during 2011, to 9,487 GWh (816 ktoe). All other sectors experienced decreased demand, with a 9.3% decrease in commercial and public services to 6,507 GWh (560 ktoe) and a 3% decrease in the residential sector to 8,283 GWh (712 ktoe). It is likely that the decrease in electricity demand in the residential and services sectors was due in some degree to the reduced use of supplementary electric heaters in 2011 with the return to mild weather compared with 2010.

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

	Growth %	Average annual growth rates %				Quantity (ktoe)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Industry	111.5	3.6	-0.1	3.5	4.2	386	816	37.8	38.1
Transport	183.6	5.1	17.8	-5.0	-0.4	1	4	0.1	0.2
Residential	100.0	3.4	3.3	2.6	-3.1	356	712	34.9	33.3
Commercial / Public	132.8	4.1	8.7	-3.2	-9.3	240	560	23.6	26.2
Agriculture	29.8	1.2	2.4	-2.8	0.0	37	48	3.6	2.2
Total	**109.6**	**3.6**	**3.7**	**0.9**	**-2.2**	**1,021**	**2,140**		

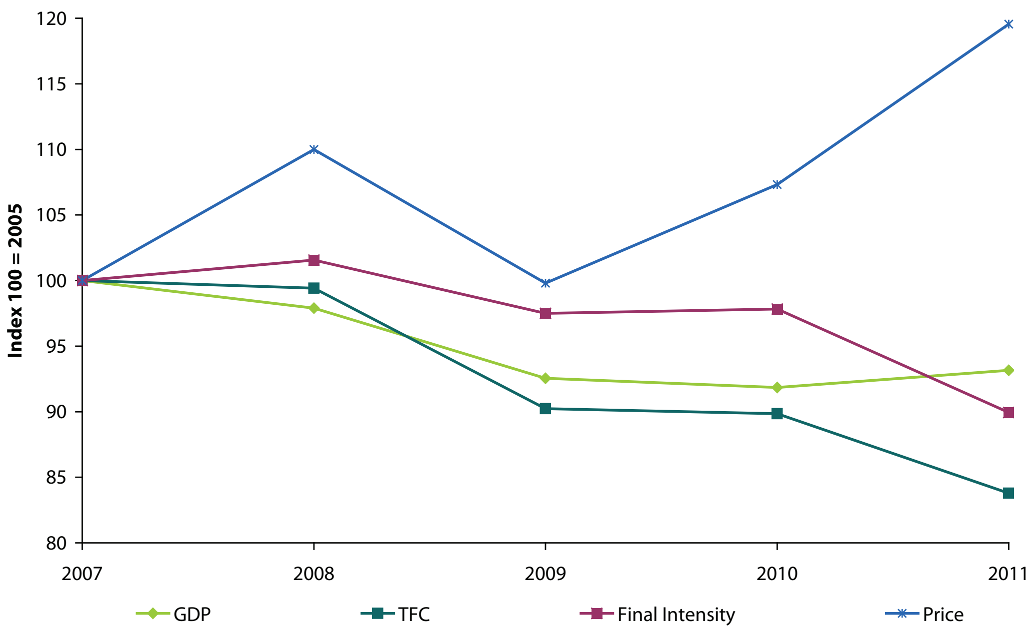
2.10 Energy and the Economic Downturn

In 2008 the economy in Ireland entered recession and gross domestic product (GDP) fell, approaching 2005 levels by 2010, before growth was observed again in 2011. *Figure 18* shows the trend in GDP in the period 2007 – 2011 as an index relative to 2007 levels. The impact of the recession on energy demand (TFC) is also clear in *Figure 18*. Between 2007 and 2011, the economy contracted by 6.8% while energy demand fell by 16%. The years 2009 and 2011 demonstrated the most significant reductions in energy demand relative to economic growth. In 2009 GDP contracted by 5.5% while TFC was reduced by 9.2%. In 2011 the economy grew by 1.4% and TFC fell by 6.7%.

Figure 18 also provides the trend in final energy intensity (TFC/GDP, i.e. the inverse of energy productivity) of the economy. In two of the years shown, i.e. 2008 and 2010, the energy intensity grew (by 1.6% and 0.4% respectively) while in all other years it decreased. These trends suggest that while the economic recession clearly affected energy use there were other factors at play, such as weather effects, improved energy efficiency, fuel mix changes and energy prices, all of which can have an impact on energy use and emissions.

Figure 18 also shows an overall energy index for Ireland calculated by the International Energy Agency (IEA). This index encompasses the spike in oil prices in 2008 and the collapse in 2009 and the continuing increase in oil and gas price in 2010 and 2011. High energy prices tend to dampen energy demand.

Figure 18 *Index of GDP, final energy demand, final energy intensity and energy price*



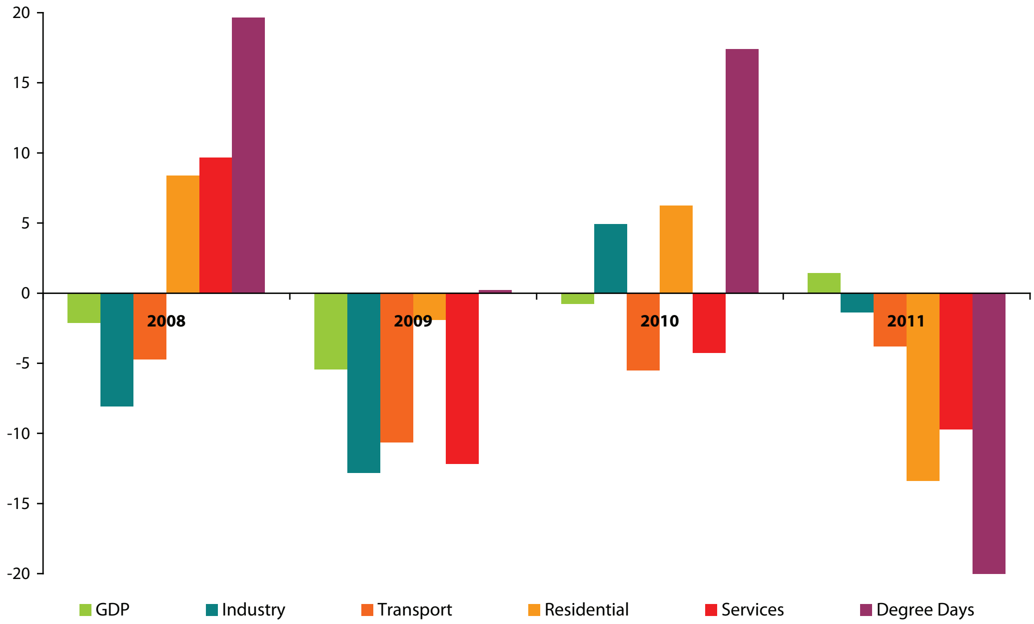
Source: SEAI, CSO and IEA

Figure 19 illustrates more clearly the separate effects that the economy and weather had on Ireland's energy demand since 2007. *Figure 19* shows the year on year percentage change in GDP, degree days (indicator of weather) and final energy consumption for industry, transport, residential and the services sector. While the recession impacts on energy demand in all sectors, the residential (in particular) and services sectors are also affected by weather, because the significant proportion of energy use in buildings is for space heating, which is clearly dependent on external temperatures. The two years 2008 and 2010 were cold, as indicated by the increase in degree days in those years. This would likely have contributed to an increase in energy demand in the residential sector for those years, despite the recession as indicated in *Figure 19*.

In 2011 by contrast, the weather was considerably milder than 2010 and energy use in the residential sector decreased by 13.4%. On a weather corrected basis, energy use per household fell by 16% since 2007.

The services sector is clearly also dependent on the weather as well as on economic activity. Energy demand in 2008 increased by 9.7% although output as measured by value added in the services sector increased by just 1.1%. In 2009, value added in the services sector contracted by 0.3% and energy demand decreased by 12.2% in this mild year. The year 2010 saw a similar contraction in economic activity, but energy demand dropped a lesser amount (4.3%) due in part to it being a relatively cold year.

Figure 19 *Annual changes in economic growth, weather and sectoral energy demand*



Source: SEAI, CSO and Met Eireann

Energy demand in industry and in transport appears to be less dependent on the weather according to *Figure 19*. Energy use in both these sectors fell in 2008 and 2009 as did economic activity. Transport demand has fallen in all four years, while energy demand in industry increased in 2010 by 4.9%. While the economy as a whole contracted in that year, industry economic activity grew by 4.8%. In 2011, industry energy TFC fell by 1.4%, despite the fact that industry output increased by 3.1%.

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 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

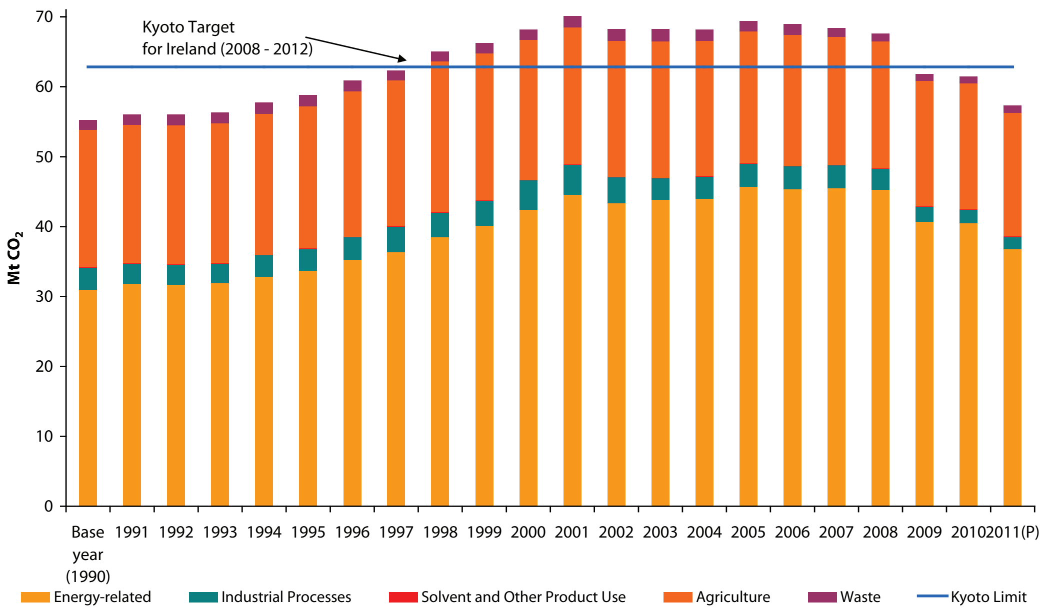
Ireland's target under the Kyoto Protocol, which is an international legally binding agreement to reduce GHG (greenhouse gas) emissions, is to limit the growth in annual emissions to 13% above 1990 levels in the period 2008 to 2012.

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 20 shows the trend in annual GHG emissions for the period 1990 – 2011. 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 20 *Greenhouse Gas Emissions by Source 1990 – 2011 (provisional)*[20]



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

20 *Figure 20* and *Figure 21* based on provisional data supplied by the EPA (November, 2011).

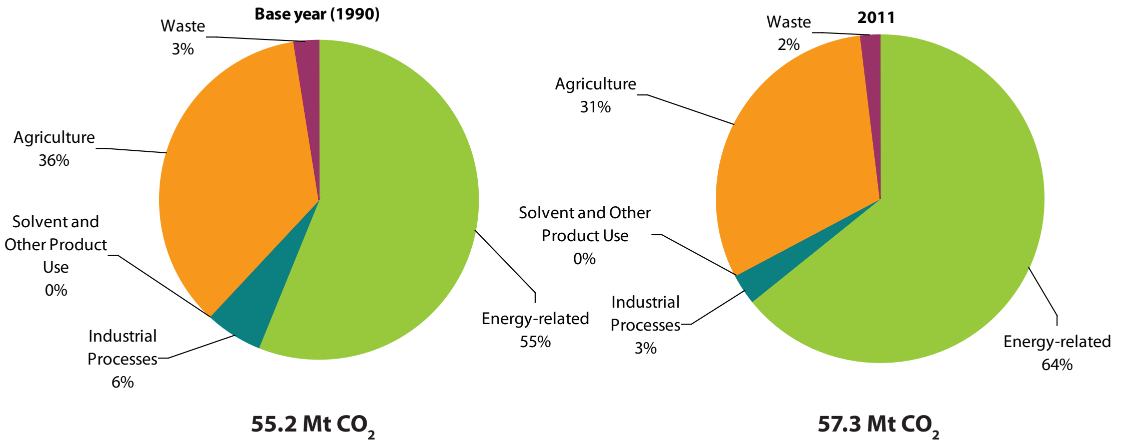
Figure 20 shows that Ireland's Kyoto target for the period 2008 – 2012 was first breached in 1998. By 2001, annual GHG emissions peaked at 27% above 1990 levels. It is also evident from *Figure 21* that the most significant area of growth is in energy-related emissions, in particular since 1995, although levelling off since 2001 and falling since 2009.

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 3.6% reduction on the peak 2001 emissions. Between 2008 and 2011 there was an acceleration in the rate of reduction in emissions due in large part to the economic downturn, with emissions falling by 15.2% between 2008 and 2011.

Provisional figures from the Environmental Protection Agency (EPA) show that total GHG emissions fell in 2011 by 6.7% to 57.34 million tonnes. As in 2010, most of the reduction in 2011 came from energy-related emissions, falling by 3.8 Mt CO_2eq. While the reduction in emissions brings Ireland below the Kyoto limit of 62.84 Mt CO_2eq, it is necessary to consider both the emissions-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 2011), that Ireland's distance to target is 1.77 Mt CO_2eq (cumulative of the four years) when the impact of forest sinks and the emissions-trading scheme are included.

Figure 21 shows the GHG emissions by source for 1990 and 2011, illustrating the increased role of energy as an emissions source.

Figure 21 *Greenhouse Gas Emissions by Source*



The share of GHG emissions arising from energy-related activities was 64% in 2011 compared with 55% in 1990. The share from agriculture dropped from 36% to 31% in the same period. It is interesting to note that for the EU as a whole, energy production and use represented 79% of GHG emissions in 1990[21]. The significant role of agriculture in the Irish economy underlies Ireland's variance from the EU average.

21 Eurostat (2011), *Energy, transport and environment indicators pocketbook*, http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-DK-11-001.

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

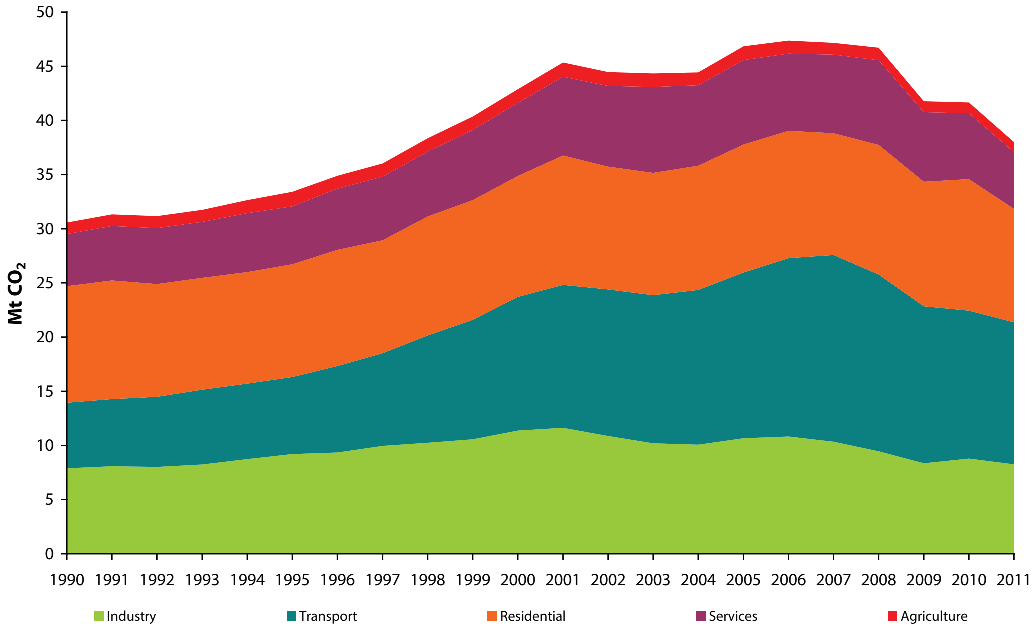


Figure 22 shows the sectoral breakdown of energy-related CO_2 emissions (which represent 96% of energy-related GHG emissions with the remaining 4% accounted for by energy-related nitrous oxide [N_2O] and methane [CH4]). Energy-related CO_2 emissions in 2011 were 25% higher than 1990 levels.

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

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

	Growth %	Average annual growth rates %				Quantity (kt)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Industry	4.5	0.2	-1.3	-3.8	-6.1	7,899	8,258	25.8	21.7
Transport	116.8	3.8	4.4	-2.3	-4.0	6,043	13,105	19.8	34.4
Residential	-2.7	-0.1	1.1	0.6	-13.8	10,764	10,479	35.2	27.5
Commercial / Public	8.7	0.4	2.9	-4.9	-13.9	4,817	5,234	15.8	13.8
Agriculture	-11.6	-0.6	0.1	-4.9	-6.4	1,046	924	3.4	2.4
Total	**24.5**	**1.0**	**1.8**	**-2.3**	**-8.8**	**30,569**	**38,061**		

The most significant area of growth overall since 1990 was in the transport sector, where CO_2 emissions in 2011 were 13.1 Mt, 117% higher than in 1990 (3.8% average annual growth rate). In 2007 they were 185% higher. Transport energy-related CO_2 emissions fell for the first time in 2008, by 5.3%. The reduction was greater in 2009 with a fall of 11.2% followed by smaller reductions of 5.9% in 2010 and 4% in 2011. Energy use in transport accounted for just over one third (34.6%) of energy-related CO_2 emissions in 2011. Transport is by far the largest CO_2 emitting sector – amounting to 1.6 times the energy-related CO_2 emissions of industry.

22 *Figure 22* 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.

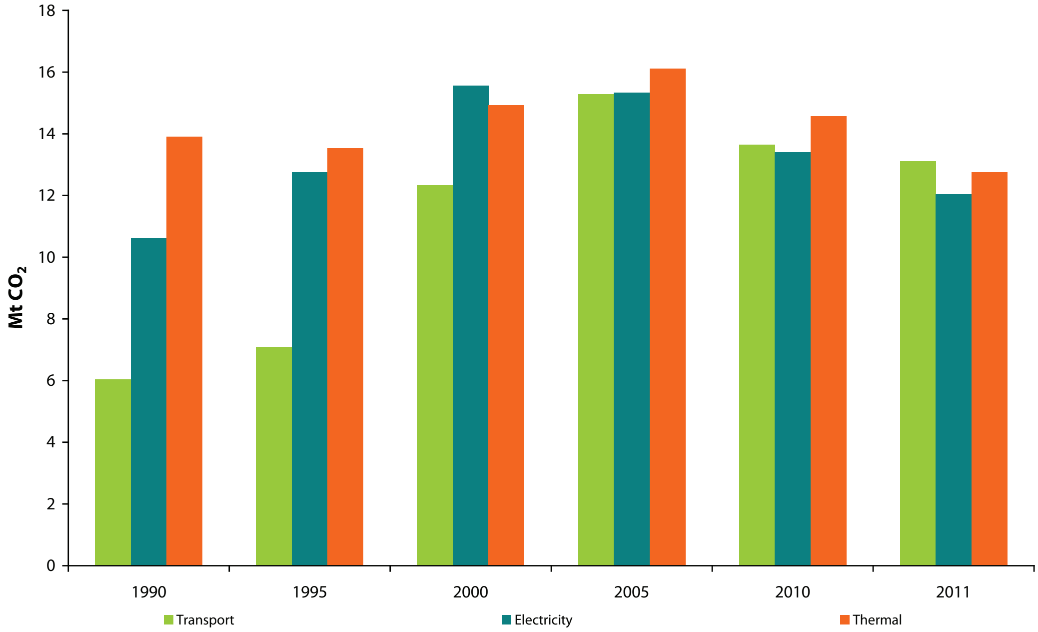
Energy-related CO_2 emissions also fell in industry in 2011, by 6.1% to 8.3 Mt. Under the emissions trading scheme only the emissions directly generated on site by industrial entities are taken into account. If upstream electricity emissions are omitted industry experienced a decrease in CO_2 emissions of 8.9% in 2011. This decrease in emissions was achieved in the context of a 3.1% increase in the economic output of industry.

The residential sector experienced a decrease of 14% in primary energy-related emissions during 2011 and services also experienced a decrease of 14% to 5.2 Mt. 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 fell by 6.4% in 2011 but the sector's share of these emissions is small at 2.4% (0.9 Mt). This is also small compared to other agriculture-related greenhouse gas emissions due primarily to livestock and also fertiliser use.

Figure 23 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 plus 2011. In 2011, the shares of energy-related CO_2 emissions from transport, electricity and thermal applications were 34.6%, 31.8% and 33.7% respectively.

Figure 23 *Energy-Related CO_2 Emissions by Mode of Energy Application*



The growth in emissions related to mobility (153% over the period to 2005) is again striking, although they have fallen since 2008 and in 2011 are back to pre 2001 levels (117% above 1990). Electricity was the dominant mode in terms of emissions from 1996 until 2002. Transport became the dominant mode between 2006 and 2009 and while thermal emissions made up 35% of all energy related emissions in 2010 due to the cold weather, in 2011 transport regained the position of the most dominant mode with 35% of all energy related emissions.

In 2011, energy-related emissions from electricity fell from the 2010 level by 10.2% to 12 Mt CO_2, compared to a decrease of 2.2% in final consumption of electricity. Factors affecting decreased emissions from electricity generation were increased wind and hydro generation. Overall, electricity generation emissions were 13% above 1990 levels.

Emissions from thermal energy applications fell by 12% in 2011 to 12.8 Mt and overall the thermal mode emissions were 8.2% below 1990 levels.

Given the policy focus on the non-emissions trading sectors[24], *Figure 24* 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 are 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 24 *Non Emissions Trading Energy-related CO_2 (non-ETS industry from 2005 onwards)*

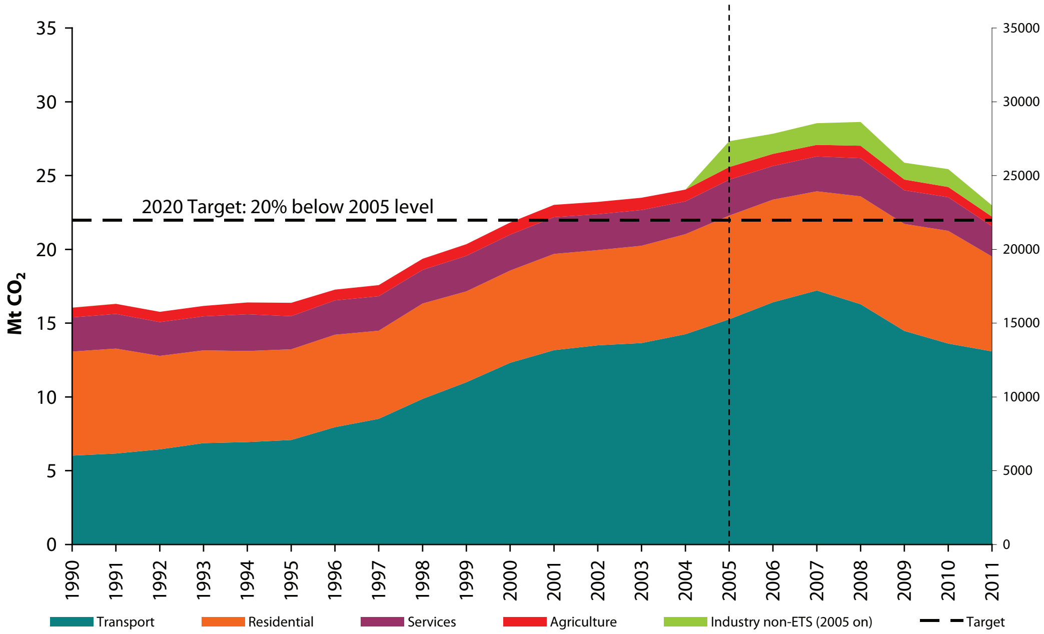


Table 9 *Growth Rates, Quantities and Shares of ETS and non-ETS Energy-Related CO_2 since 2005*

	Growth %	Average annual growth rates %		Shares %	
	2005 – 2011	'05 – '10	2011	2005	2011
ETS CO_2	-23.0	-3.6	-7.4	41.5	39.5
non-ETS CO_2	-16.1	-1.5	-9.7	58.5	60.5
Total Energy-Related CO_2	**-17.6**	**-2.3**	**-7.4**		

Non-ETS sectors (including non-ETS industry) energy-related CO_2 emissions decreased by 1.5% per annum between 2005 and 2010 with a further 9.7% fall in 2011. Non-ETS emissions are now 16% below 2005 levels. Under EU Decision 406/2009/EC there is a requirement on Ireland to achieve a 20% reduction in total non-ETS GHG emissions (including notably methane emissions from agriculture) on 2005 levels by 2020.

The emissions trading sector experienced a 23% fall in energy-related emissions since 2005 and emissions fell by 7.4% in 2011 compared with the previous year. The share of emissions covered in the emissions trading scheme in overall energy-related emissions stands at 39% in 2011.

3.1.2 Transboundary Gas Emissions

Emissions of sulphur dioxide (SO_2) and nitrogen oxides[25] (or NO_x) from energy use 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 2010 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 and continued to be so in 2010 with SO_2 levels being 16.1 kt or 38% below the target. The NO_x emissions exceeded the ceiling by 24 kt in 2009 but, while still exceeding the target, were reduced to 7.6 kt above the target in 2010.

Table 10 *SO_2 and NO_x Emissions and NEC Directive Ceilings for 2010*[26]

	1990 (kt)	2010 (kt)	2010 Ceiling (kt)	% above 2010 Ceiling
NO_x	129	72.6	65	11.7%
SO_2	183	25.9	42	-

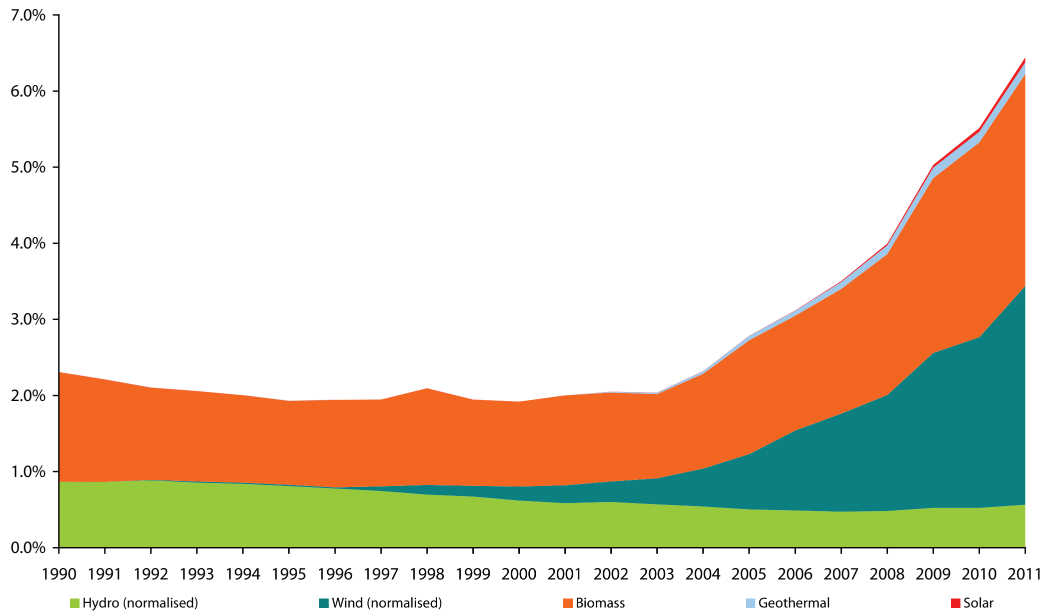
Source: EPA.

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 25* shows the contribution as per the Directive methodology from 1990 to 2011. The contribution from renewables in 1990 was 2.3%, rising to 6.4% in 2011[27]. 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 in order to smooth out variations in climate.

A more detailed discussion of renewable energy in Ireland can be found in SEAI's publication *Renewable Energy in Ireland*[28]. This section presents key graphs and updates where available from the Renewables report.

Figure 25 *Renewable Energy (%) Contribution to Gross Final Consumption (Directive 2009/28/EC)*



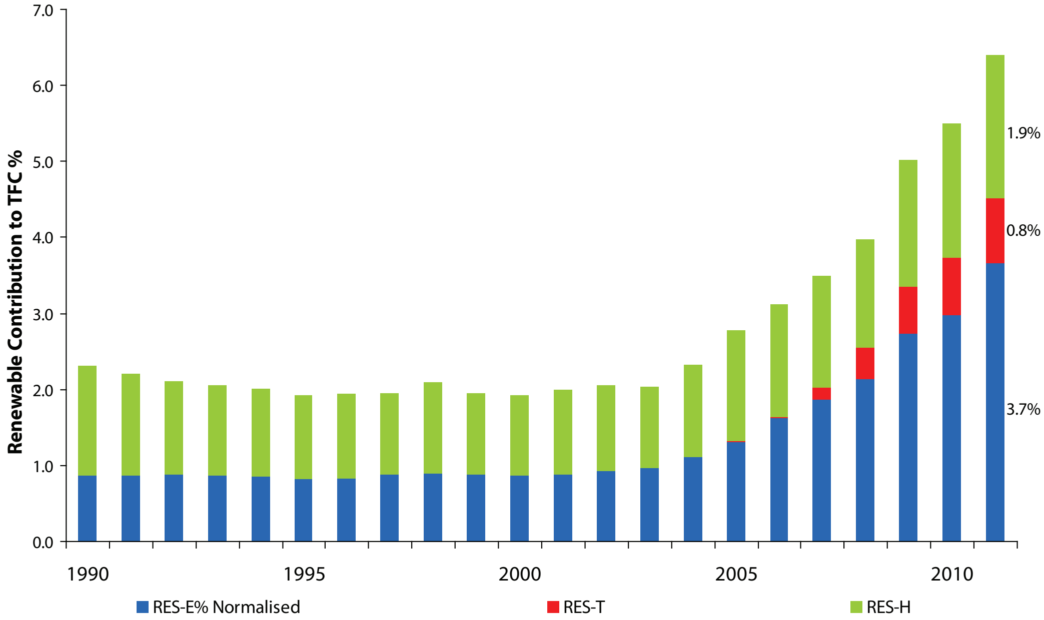
Source: SEAI.

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 26* shows the renewable energy percentage contribution to GFC by mode with RES-E normalised.

26 See http://www.epa.ie/downloads/pubs/air/airemissions/.
27 Calculated as per Directive 2009/28/EC.
28 Available from www.seai.ie/statistics.

3 Key Policy Issues

Figure 26 *Renewable Energy (%) Contribution to GFC by Mode*



Source: SEAI

The national target for electricity generation from renewable sources (RES-E) specified in the 2007 Government White Paper was 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[29] from 1990 – 2011 is shown in *Figure 27*. SEAI's *Energy Forecasts for Ireland to 2020*[30] 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.

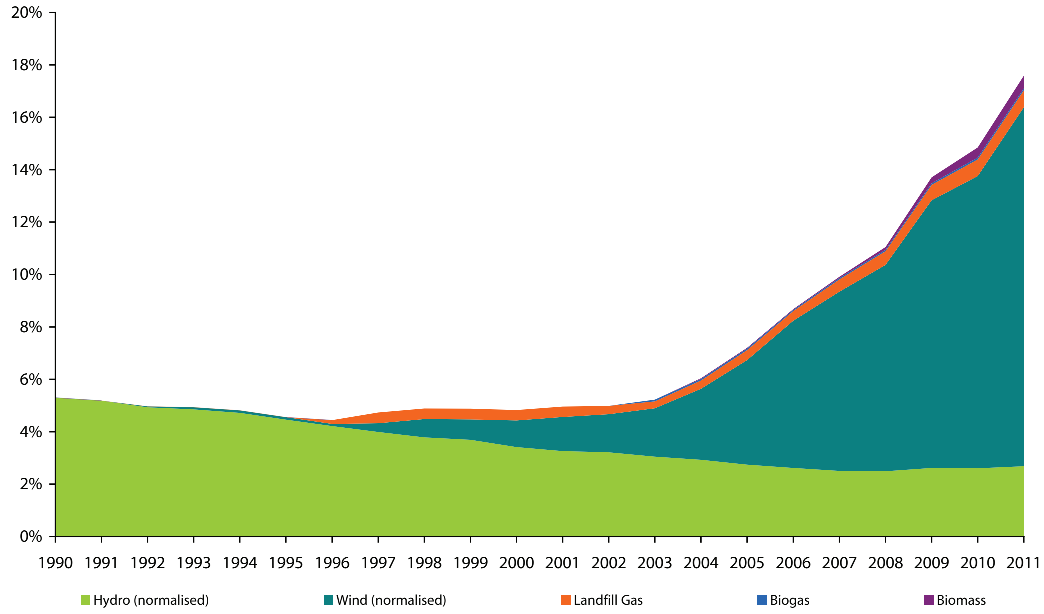
Historically, hydro was the largest contributor to renewable electricity in Ireland. While the contribution from hydro has declined in percentage terms, *Figure 27* shows how electricity production from wind energy has increased to the point that it accounted for 81% of the renewable electricity generated in 2011. Electricity generated from biomass accounted for 6% of renewable electricity in 2011. Biomass consists of contributions from solid biomass, landfill gas and waste water biogas. Wind, hydro and biomass-generated electricity in 2011, respectively, accounted for 15.6%, 2.5% and 1.2% of Ireland's gross electricity consumption.

The total contribution from renewable energy to gross electricity consumption in 2011 was 19.4% (compared with 12.9% in 2010 and 4.9% in 1990). Using normalised hydro and wind figures as specified in the Directive (2009/28/EC) the share in 2011 was 17.6%.

29 Defined as total electricity generated plus net imports.

30 http://www.seai.ie/Publications/Statistics_Publications/Energy_Modelling_Group/Energy_Forecasts_for_Ireland_to_2020-2010_report.pdf

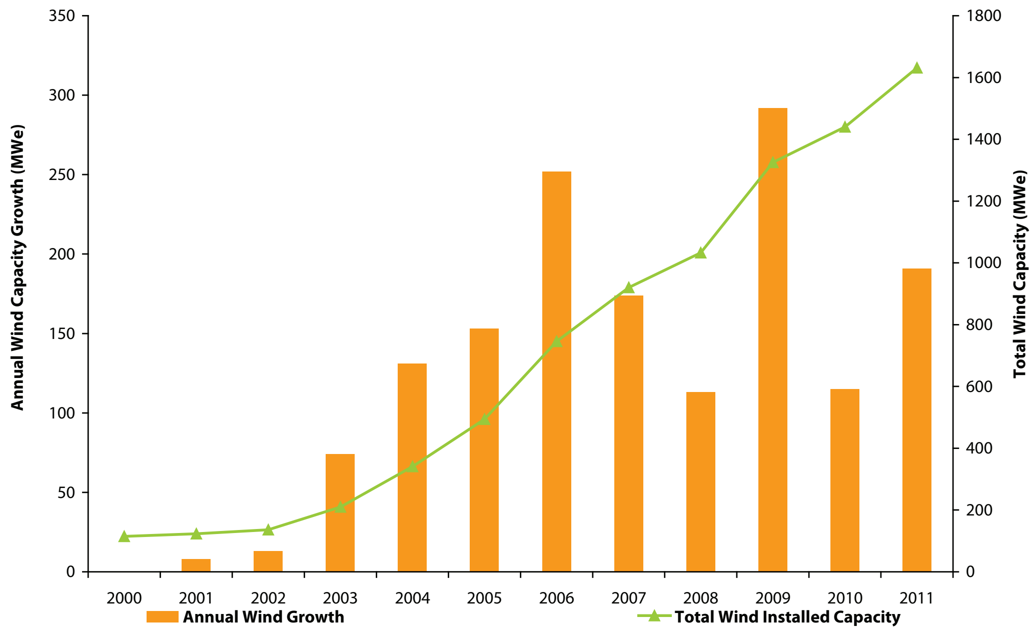
Figure 27 *Renewable Energy Contribution to Gross Electricity Consumption (RES-E normalised)*



The share of electricity from renewable energy has almost tripled between 1990 and 2011 – from 5.3% to 17.6%, an increase of over 12 percentage points over twenty years. In absolute terms there has almost been an eight fold increase (678% or 554% normalised) in the volume of renewable electricity generated. Most of this increase has taken place since 2000.

In 2011 displacement of fossil fuel for electricity generation by renewable energy is estimated by SEAI to have resulted in an avoidance of almost €300 million in natural gas imports. The savings on gas imports are based on estimating how much extra gas would have had to be imported had there been no wind generation in 2011. The estimates are based on the use of marginal generation fuel (more than 98% of which is gas generation), that would otherwise have been required to generate what would have been generated by wind.

Figure 28 *Installed Wind Generating Capacity 2000 - 2011*[31]



Source: Eirgrid

31 Installed Wind Report, Eirgrid, http://www.eirgrid.com/media/Connected%20TSO%20Wind%20Farms%2023rd%20July%202012.pdf and ESB Networks, http://www.esb.ie/esbnetworks/en/generator-connections/Connected-Contracted-Generators.jsp.

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 27* shows how electricity production from wind energy has increased. Wind energy in 2011 accounted for 15.6% of gross electricity consumption (9.7% in 2010).

Figure 28 shows the annual growth in installed wind generating capacity and overall cumulative capacity since 2000. By the end of 2011 the installed capacity of wind generation reached 1,631 MW. The peak recorded wind power output was 1,474 MW delivered on 26th November 2011[32]. *Figure 28* also shows the rate of growth in wind power in terms of installed capacity.

Based on data published on Eirgrid's and ESB Network's websites there are 95 MW of wind contracted for connection before the end of 2012 and a further 511 MW by the end of 2013. There are an additional 1,030 MW contracted and approximately 3,915 MW of live offers under the 'gate' process administered by the Commission for Energy Regulation (CER).

The output from wind and hydro generation is affected by the amount of the resource (wind and rainfall) in a particular year. It is also affected by the extent of outages of the plant for reasons such as faults, maintenance and curtailment. An indication of how these factors affect the output of wind and hydro can be obtained by examining the capacity factor (CF) for these generation types. The capacity factor (CF) is the ratio of average electricity produced to the theoretical maximum possible. For wind, it is the ratio of the actual electricity generated to the theoretical maximum possible for the installed capacity, as if that capacity was generating at a maximum for the full year.

The rate of capacity increase each year can significantly impact on the capacity factor in periods of large annual capacity increases. If significant capacity is added late in the year this would artificially reduce the capacity factor for the year. To mitigate this the wind capacity factors in *Table 11* are calculated using the average of the installed capacity in the year and the previous year.

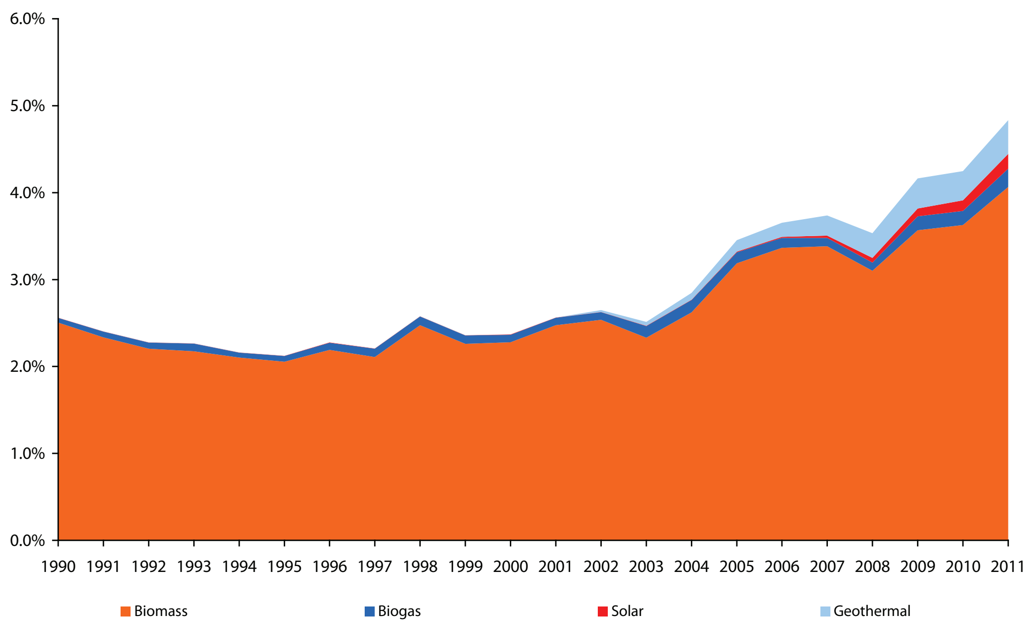
Table 11 *Annual Capacity Factor for Wind and Hydro Generation in Ireland 2000 - 2011*

Capacity Factor	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Wind	30%	32%	34%	30%	27%	30%	30%	28%	29%	29%	24%	33%
Hydro	41%	29%	43%	28%	30%	31%	35%	33%	47%	44%	29%	34%

Source: EirGrid and SEAI

The average countrywide wind capacity factor fell between 2006 and 2009 but remained around 30%. It fell to 24% in 2010 largely due to the lack of wind in 2010. The hydro capacity was also at its lowest level since 2003 due to the low level of rainfall in 2010. The wind capacity factor recovered to 33% in 2011 due to the increased wind resource. The hydro capacity factor recovered somewhat also.

Figure 29 *Renewable Energy Contribution to Thermal Energy (RES-H)*



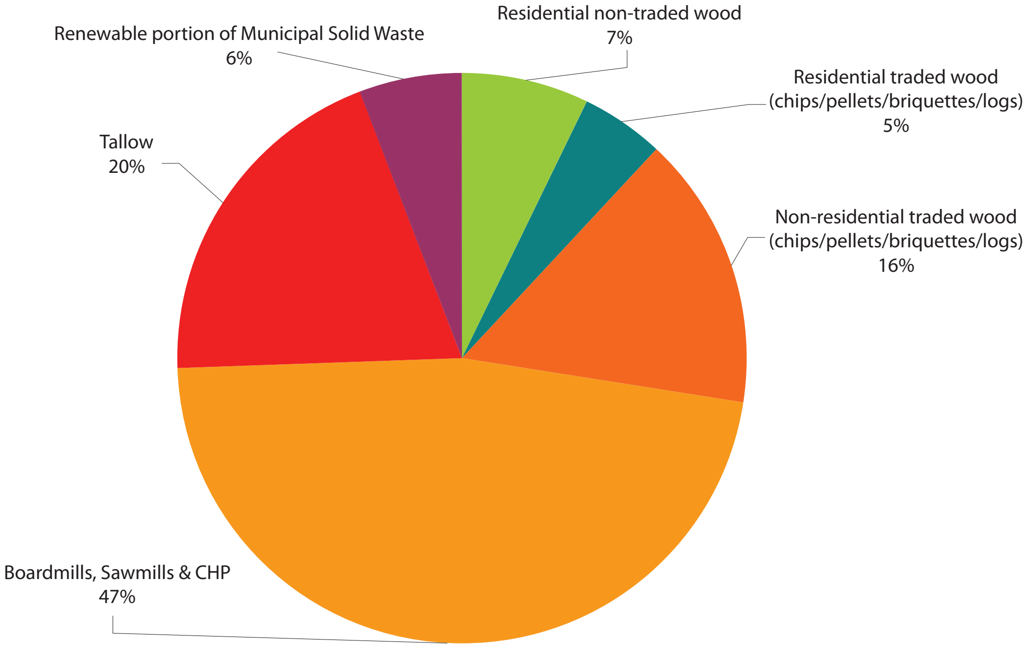
32 Wind generation data, Eirgrid, (http://www.eirgrid.com/operations/systemperformancedata/windgeneration/).

Figure 29 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 a doubling of biomass energy use from 108 ktoe in 1990 to 218 ktoe in 2011 (a growth of 102%). In 2011 renewable thermal energy decreased by 0.6% in absolute terms relative to 2010 and the renewable share of thermal energy stood at 4.8% in 2011. 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 2011 RES-H grew from 2.4 % to 4.8%. 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. Recent growth in renewable energy use in the residential and services sectors can be attributed to the support of grant schemes and revisions to building regulations requiring a share of the energy demand to come from renewable sources.

Solid biomass covers organic, non-fossil material of biological origin which may be used as fuel for heat production. It is primarily wood, wood wastes (firewood, wood chips, barks, sawdust, shavings, chips, black liquor[33] etc.), other solid wastes (straw, oat hulls, nut shells, tallow, meat and bone meal etc.) and the renewable portion of industrial and municipal wastes. Most of the solid biomass is used for thermal energy in the industrial sector where it is combusted directly for heat or used in CHP units; the rest is consumed in the residential and commercial sectors.

Figure 30 *Composition of Biomass Total Final Consumption in 2011*



Approximately half of all solid biomass is consumed in the wood and wood products industry sub-sector where wood wastes or wood residues of that sector are being combusted for heat. Similarly tallow, a by-product or output of the food sector, is combusted for heat in that sector. Tallow accounts for 20% of all solid biomass. A further 5.8% in 2011 of solid biomass is accounted for in the industry sub-sector of other non-metallic mineral products where the renewable portion of solid wastes is consumed by cement manufacturers.

Wood chips, pellets and briquettes make up approximately 20% of all solid biomass consumed in Ireland. The remaining 7% is an estimate of the non-traded wood logs which are being used in open fires or stoves. The non-traded wood is estimated in the absence of available data. Estimates of the non-trade wood consumption vary with different methodologies. However, as this non-traded wood is only a small part of the total solid biomass consumption, the relative variation in estimates is small relative to the overall total solid biomass consumption and for the calculation of RES-H.

The Renewable Energy Directive 2009/28/EC established a mandatory minimum 10% target for the contribution of renewable energy as a share of all petrol, diesel, biofuels and electricity consumed in road and rail transport energy by 2020. According to the Directive for this target a weighting of 2.5 is applied to the electricity from renewable energy sources consumed by electric road vehicles, where the contribution is calculated as the energy content of the input of electricity from renewable energy sources, measured two years before the year in question. Also

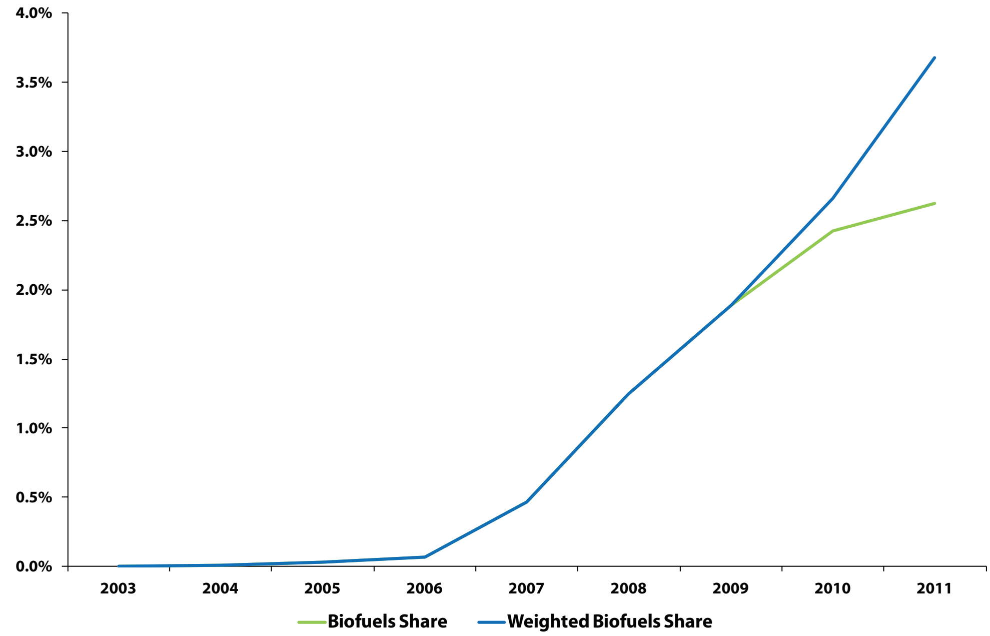
33 This is a recycled by-product formed during the pulping of wood in the paper-making industry.

supported through a weighting factor of 2 are second generation biofuels, and biofuels from waste; that is, biofuels that diversify the range of feedstocks used to become commercially viable should receive an extra weighting compared to first generation biofuels.

The White Paper on Energy 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[34]. The Minister for Energy issued a consultation paper[35] 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.

Figure 31 *Renewable Energy as a Proportion of (Petrol & Diesel) Transport (RES-T)*



In absolute terms, biofuels in transport increased from 1 ktoe in 2005 (0.03%) to 98 ktoe in 2011 (2.6% of transport energy). It is evident from *Figure 31* that the growth coincided with the introduction of tax relief support for biofuels, with slow growth from 2004 to 0.06% in 2006 followed by an increase to 1.2% in 2008, 1.5% in 2009 and 2.4% in 2010. The Mineral Oil Tax Relief scheme (MOTR II) ended in 2010 with the introduction of the biofuels obligation scheme. The figure for renewables in transport energy (RES-T) in 2011 was 2.6%, or 3.6% when the weightings for double certificates are applied in accordance with the Renewable Energy Directive.

Table 12 *Biofuels Growth in ktoe and as a Proportion of Road and Rail Transport Energy 2002 - 2011*

Fuel	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Petrol (ktoe)	1,689	1,687	1,732	1,820	1,884	1,920	1,907	1,744	1,552	1,425
Diesel (ktoe)	1,956	2,018	2,176	2,329	2,509	2,695	2,673	2,493	2,238	2,248
Biofuels (ktoe)	0	0	0	1.1	2.6	21.5	55.4	64.0	92.5	98.0
Petrol plus Diesel	3,645	3,705	3,907	4,149	4,394	4,614	4,581	4,237	3,791	3,673
Biofuel Penetration	***0%***	***0%***	***0%***	***0.03%***	***0.06%***	***0.5%***	***1.2%***	***1.5%***	***2.4%***	***2.6%***
Weighted biofuels (ktoe)	0	0	0	1	3	21	55	77	102	137
Weighted biofuels share	***0.0%***	***0.0%***	***0.0%***	***0.0%***	***0.1%***	***0.5%***	***1.2%***	***1.8%***	***2.6%***	***3.6%***

Source: SEAI

3.1.4 Progress towards Renewable Energy Targets

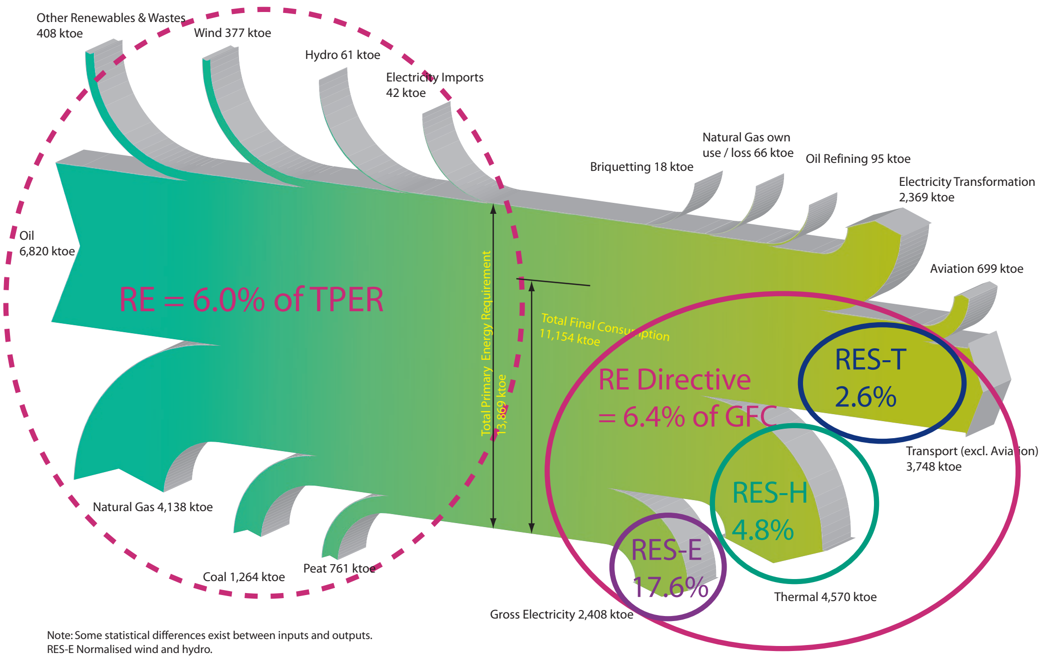
Figure 32 illustrates where the various renewable targets fit within overall energy use in Ireland and the position with regard to progress towards those targets in 2011. Towards the right of the figure the transport, heat and electricity

34 In line with the European target set in Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport.

35 DCENR (2008), *Public Consultation on the Biofuels Obligation Scheme, September 2008.* Available from www.dcenr.ie

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 13*).

Figure 32 *Progress to Targets 2011*



Note: Some statistical differences exist between inputs and outputs.
RES-E Normalised wind and hydro.

Towards the left of *Figure 32* the overall contribution of renewable energy to total primary energy requirement (TPER) is shown at 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 13 *Renewable Energy Progress to Targets*[36]

% of each target	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2010	2020
RES-E (normalised)	5.3	4.6	4.8	7.2	8.7	9.9	11.1	13.7	14.8	17.6	15	40
RES-T	0.0	0.0	0.0	0.0	0.1	0.5	1.2	1.9	2.4	2.6	3	10
RES-H	2.6	2.1	2.4	3.4	3.7	3.7	3.5	4.2	4.3	4.8	5	12
Directive (2009/29/EC)	**2.3**	**1.9**	**1.9**	**2.8**	**3.1**	**3.5**	**4.0**	**5.0**	**5.5**	**6.4**		**16**

Source: SEAI

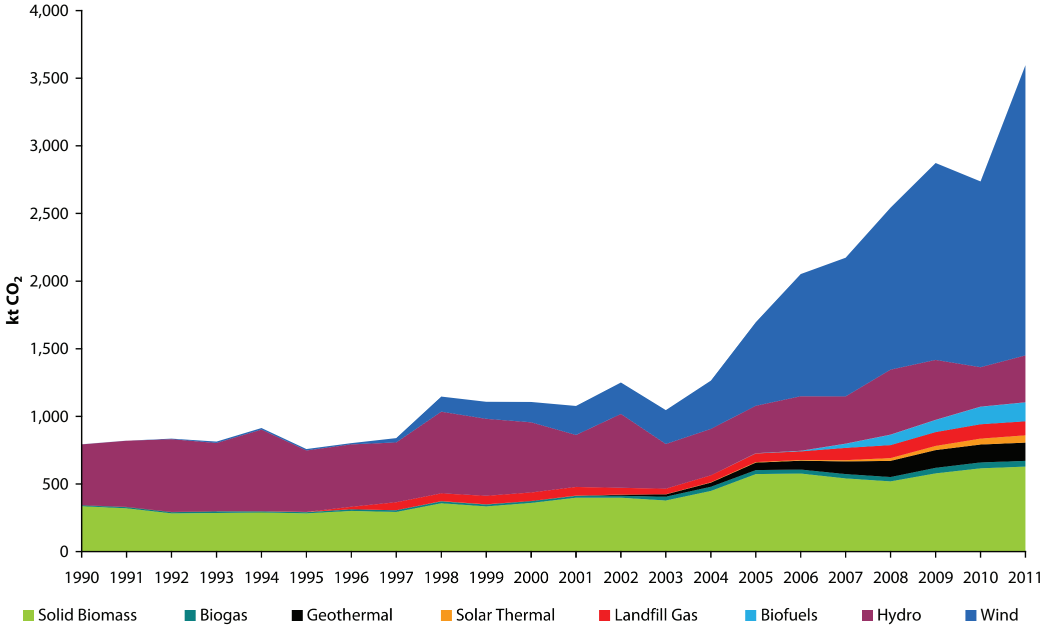
Table 13 tabulates progress towards the individual national modal targets and to the overall Directive target for the period 1990 – 2011. Here the percentages in each row (RES-E, RES-T and RES-H) relate to the specific modal targets and the percentages in the final row relate to the overall target using 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 33 shows the trend in avoided CO_2 emissions from renewable energy for the period 1990 – 2011. See *Renewable Energy in Ireland* for details on the methodology used to calculate the avoided emissions. The estimated amount of CO_2 avoided from renewable energy increased by 348% (7.8% per annum on average) over the period 1990 to 2011, reaching 3,554 kt CO_2 as illustrated in *Figure 33*. The emissions avoided from wind were most significant again in 2011, at 2,107 kt CO_2, followed by solid biomass at 629 kt CO_2 and hydro at 340 kt CO_2.

36 Note: Individual target percentages are not additive.

Figure 33 *Avoided CO_2 from Renewable Energy 1990 to 2011*



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 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[37] of CHP in Ireland at the end of 2011 was 326 MWe (262 units[38]) – up from 307 MWe (227 units) in 2010, an increase of 6.2%. Of the 262 units 189 of them were reported as being operational. The operational installed capacity increased by 22 MWe, to 304 MWe, in 2011 compared with 2010.

Table 14 *Number of Units and Installed Capacity by Fuel 2011*

	No. of Units	Installed Capacity MWe	No. of Units %	Installed Capacity %
Natural Gas	236	301	90	85
Solid Fuels	2	5.2	1	3
Biomass	3	5.4	1	3
Oil Fuels	9	8.4	3	5
Biogas	12	5.5	5	3
Total	**262**	**326**	**100**	**100**

Source: SEAI

Natural gas was the fuel of choice for 301 MWe (236 units) in 2011. It is worth noting that there is one single 160 MWe gas plant which dominates. Oil products[39] made up the next most significant share with 8.4 MWe (9 units) and the remainder being biomass at 5.4 MWe (2 units), solid fuels 5.2 MWe (2 units) and biogas 5.5 MWe (12 units). CHP in Ireland is examined in more detail in a separate SEAI publication[40].

37 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.
38 Note that units are distinct from CHP plants or schemes and that there may be more than one CHP unit at a site.
39 Oil products are comprised of LPG and heavy fuel oil and refinery gas.
40 Sustainable Energy Authority of Ireland (2012), Combined Heat and Power in Ireland: Trends and Issues - 2012 Update. Available from: www.seai.ie

Figure 34 illustrates the contribution from CHP to Ireland's energy requirements in the period 1994 – 2011. Fuel inputs have increased by 156% (6% per annum) while the thermal and electrical outputs increased by 182% (6.3% per annum) and 654% (13% per annum) respectively over the period. This suggests that the overall stock of CHP installations has become more efficient over the period. In 2011 fuel input decreased by 3.3%, thermal output decreased by 8% while electricity increased by 1.6%. The large increase in 2006 is accounted for by the Aughinish Alumina plant which came online in that year.

Figure 34 *CHP Fuel Input and Thermal/Electricity Output 1994 – 2011*

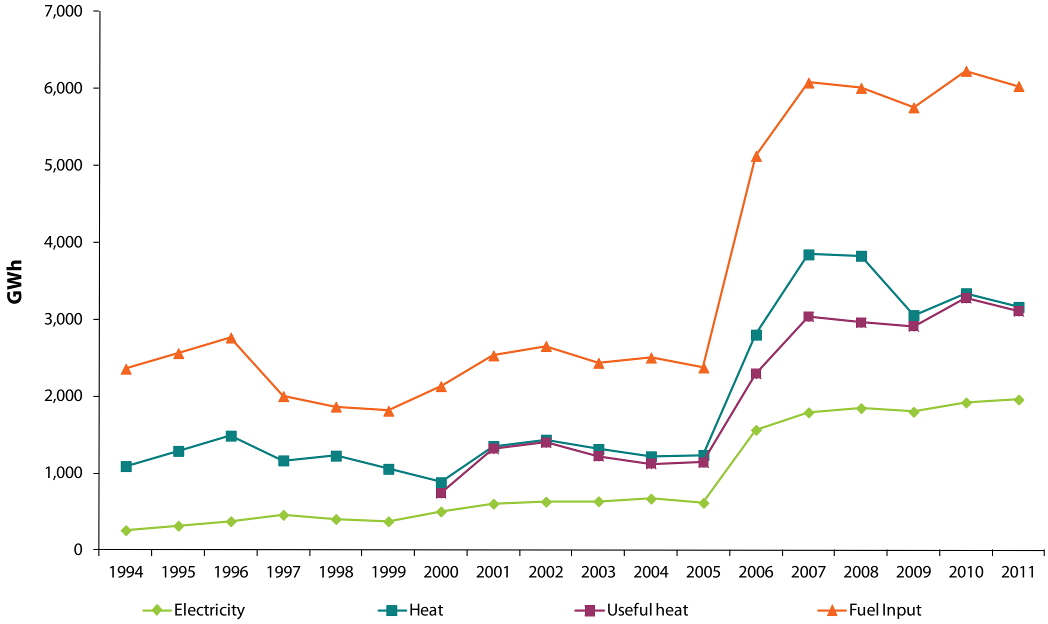
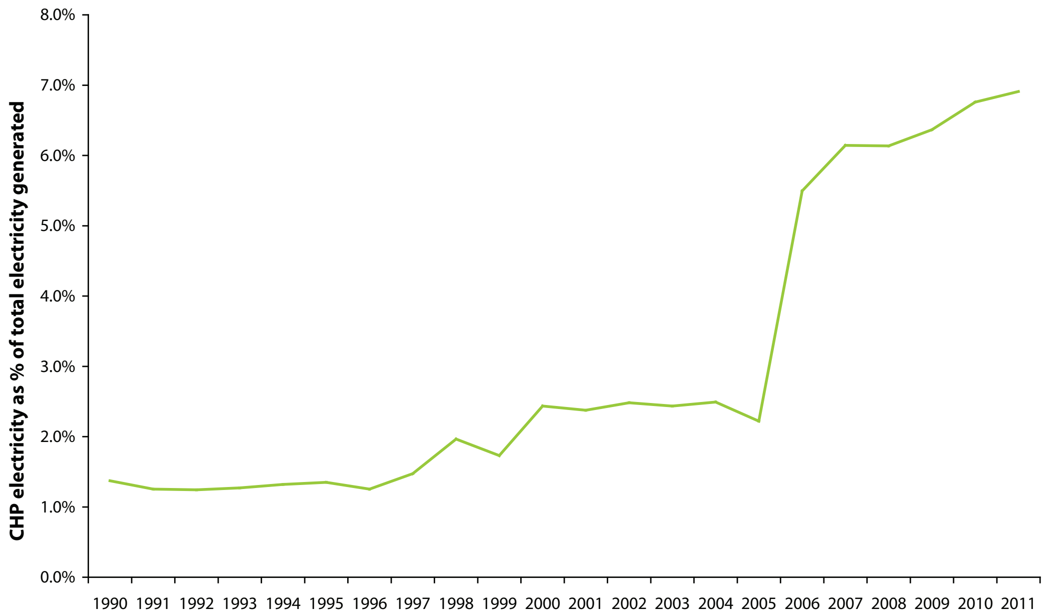


Figure 35 focuses on CHP generated electricity in Ireland as a proportion of gross electricity consumption (i.e. electricity generation plus net imports) in the period 1990 to 2011. In 2011, 7% of total electricity generation was generated in CHP installations compared with 6.8% in 2010. Some CHP units export electricity to the national grid. In 2011 there were 17 units exporting electricity to the grid. These units exported 1,343 GWh of electricity in 2011, a decrease of 1% on 2010.

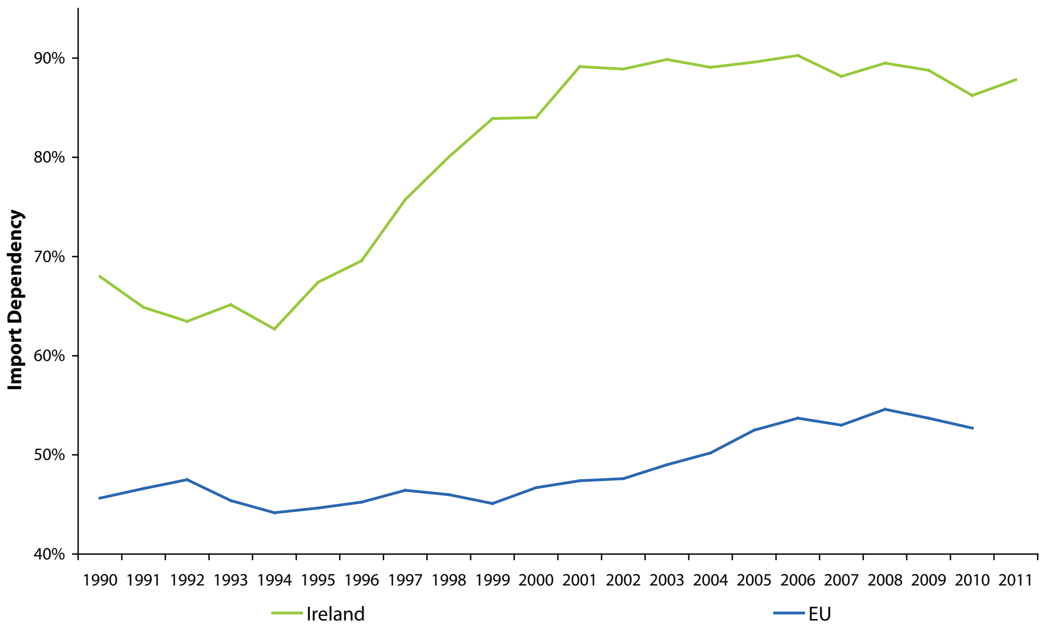
Figure 35 *CHP Electricity as percentage of Total Electricity Generation 1990 – 2011*



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[41]. *Figure 36* illustrates the trend in import dependency since 1990, comparing it with that for the EU as a whole.

Figure 36 *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 77% of TPER in 2011, compared with 50% in the early 1990s. Ireland's overall import dependency reached 90% in 2006 but has decreased to 88% in 2011.

This trend reflects the fact that Ireland is not endowed with significant indigenous fossil fuel resources and has only in recent years begun to harness significant quantities of renewable resources. *Figure 37* 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 85% over the period since 1990 to 285 ktoe and peat by 46% to 760 ktoe. Renewable energy in contrast increased by 343% to 742 ktoe. Indigenous production peaked in 1995 at 4,105 ktoe and there has been a 48% reduction since then to 1,801 ktoe.

The share of total indigenous fuels contribution from native gas was 16% in 2011, compared with 54% in 1990. The share of peat increased from 41% in 1990 to 42% in 2011 but in absolute terms peat production declined by 46%. Renewable energy accounted for 41% of indigenous produced fuels in 2011.

Although peat production fell in 2011 by 23%, peat consumption fell by just 3.8%, with significant stock changes accounting for this difference.

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.

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

Figure 37 *Indigenous Energy by Fuel*[42]

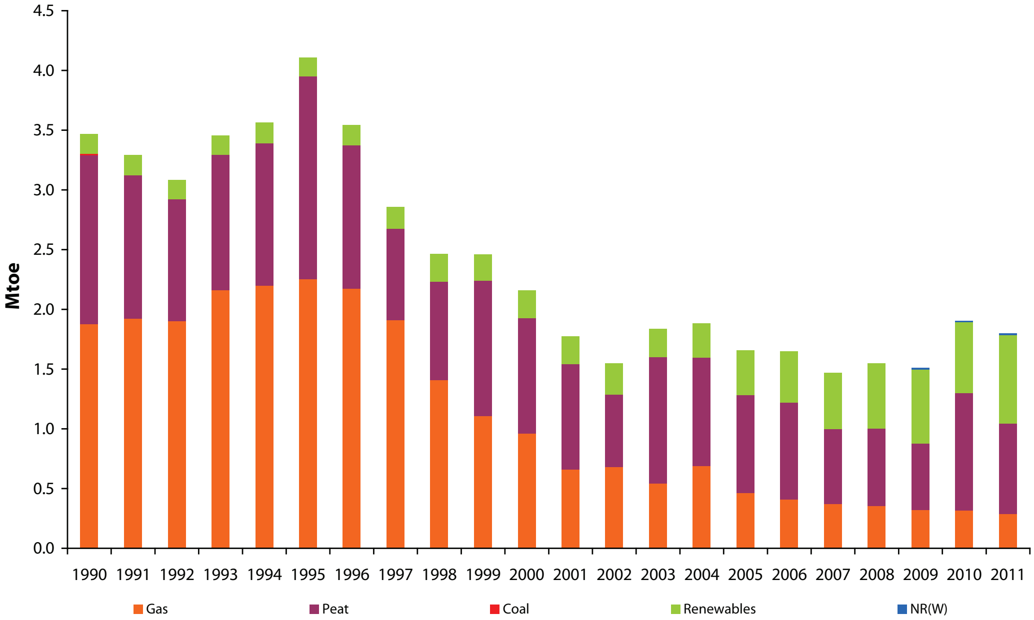
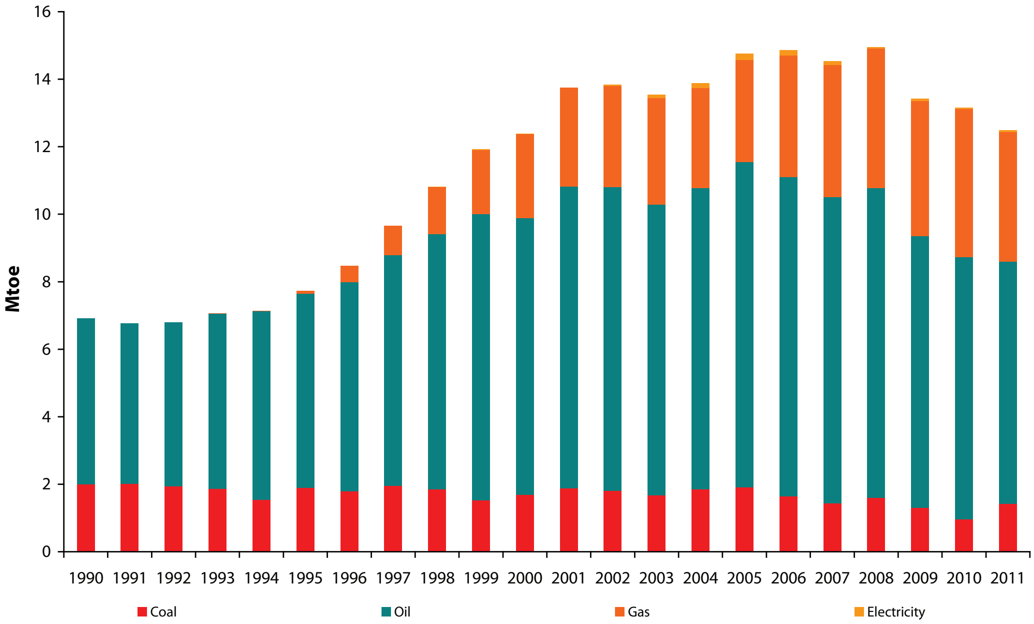


Figure 38 shows the trend for net fuel imports (imports minus exports) over the period 1990 – 2011. The growing dependence on oil due largely to increase in energy use in transport is the most striking feature. There was an 117% increase in total net imports up to 2008, with a 87% increase in net imports of oil. Net imports have fallen since and are now 82% above 1990 levels, with oil imports 46% 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 increased by 47% in 2011 relative to a low level. In 2011, oil, gas and coal accounted for 57%, 31% and 11% of net imports respectively.

Figure 38 *Imported Energy by Fuel*



42 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. Ireland has a high import dependence for oil and gas and is essentially a price taker on these commodities. The EU has introduced competition into the electricity and gas markets through the liberalisation process in order to reduce energy costs to final consumers.

The change in global oil prices have shown dramatic fluctuations in recent years. This has particular effect in Ireland due to our high dependence on oil. In addition there is the knock-on impact that oil prices have on other energy prices, in particular natural gas and as a consequence electricity prices. Average oil prices rose steadily during the second half of 2010 and peaked at $127/barrel at the start of May 2011. During the second half of 2011 the average price of crude oil was $111/barrel. This compares with an average price in 2008 of $97/barrel and €80/barrel in 2010. SEAI estimates that in 2011 the cost of all energy imports to Ireland was approximately €6 billion.

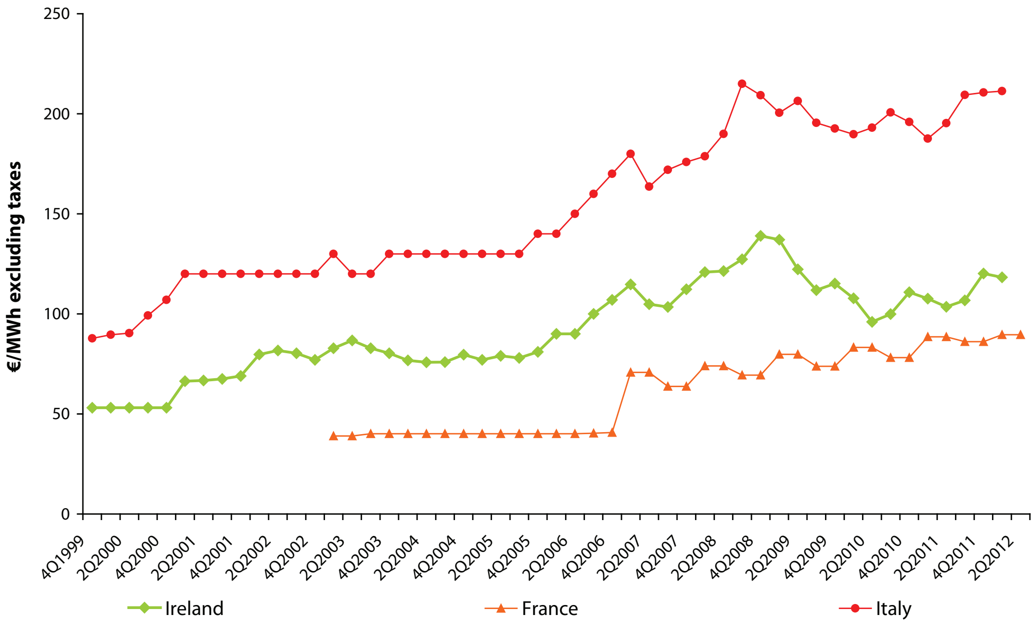
Since 2007, energy prices[43] in Ireland increased by 20% in real terms, compared with an average rise of 15% in OECD Europe over the same period. In 2011, overall energy prices in Ireland were 11% higher than in 2010, compared with an increase of 6% in OECD Europe. These price trends reflect Ireland's heavy dependence on imported oil and gas as these were the main drivers of global energy prices over this period.

SEAI publishes biannual reports titled *Understanding Electricity and Gas Prices in Ireland*[44] based on the methodology for the revised EU Gas & Electricity Price Transparency Directive[45] which came into effect on the 1st January 2008. The reports focus specifically on gas and electricity prices and are a useful reference on cost-competitiveness.

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 first quarter of 2012. Prices shown are in current (nominal) money[46]. 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 1st quarter 2012) 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.

3.3.1 Energy Prices in Industry

Figure 39 *Electricity Prices to Industry*



Source: Energy Prices & Taxes © OECD/IEA, 2012.

43 International Energy Agency,2012, *Energy Prices and Taxes - 3rd Quarter 2012*, www.iea.org/w/bookshop/add.aspx?id=606

44 Sustainable Energy Ireland (various dates), *Understanding Electricity and Gas Prices in Ireland*, www.seai.ie.

45 http://europa.eu/legislation_summaries/energy/internal_energy_market/l27002_en.htm

46 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.

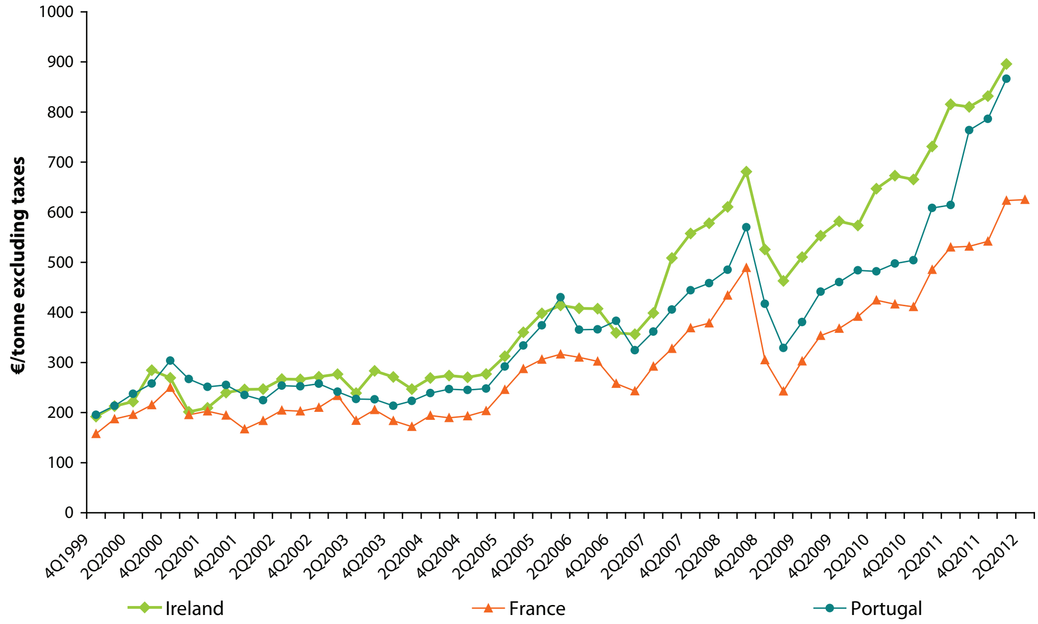
Table 15 *Electricity Price to Industry Increase since 2005*

Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
1st qtr 2012 (nominal)	165	142	149	106	143	224	167	194	**148**	151	99	118	130	159	178	176
1st qtr 2012 (real)	135	121	112	89	111	193	148	141	**147**	128	78	91	110	131	154	132

Source: Energy Prices & Taxes © OECD/IEA, 2012.

Electricity prices to Irish industry have increased by 47% in real terms between 2005 and early 2012. Based on this data for these countries, France experienced the highest increase since 2005 with a 93% increase in real terms between 2005 and 2012. 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, Luxembourg and the Netherlands each have 64% and Italy has 58% of electricity generated by gas and oil.

Figure 40 *Fuel Oil Prices to Industry*



Source: Energy Prices & Taxes © OECD/IEA, 2012.

Table 16 *Oil Price to Industry Increase since 2005*

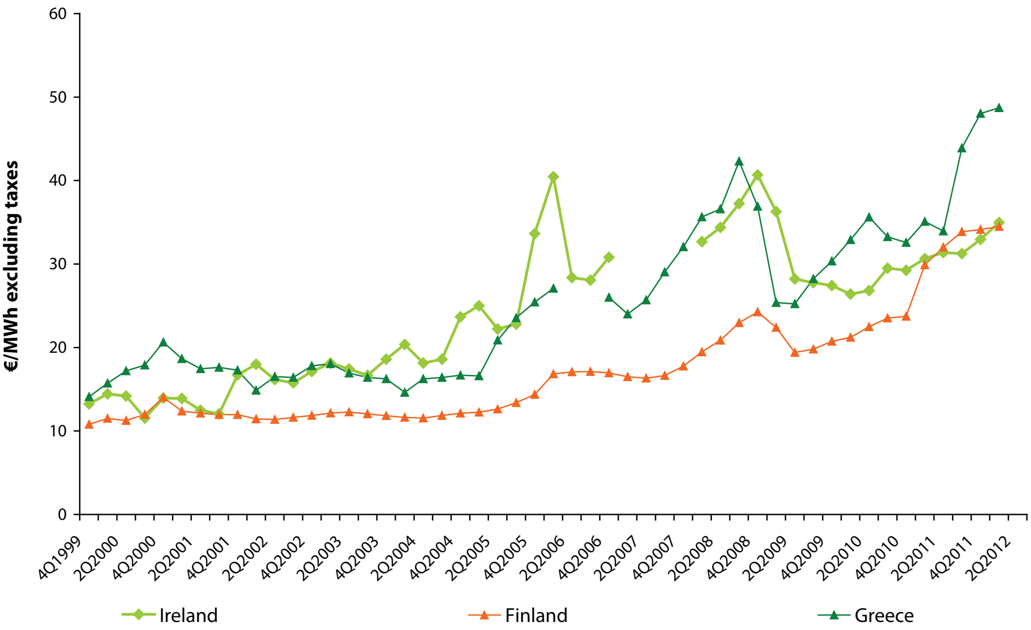
Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
1st qtr 2012 (nominal)	150	123	149	147	166	141	143	166	**157**	153	149	131	156	151	146	159
1st qtr 2012 (real)	122	103	112	122	128	120	126	118	**155**	128	116	100	131	122	126	118

Source: Energy Prices & Taxes © OECD/IEA, 2012.

Oil prices to industry in Ireland were 55% higher in real terms in early 2012 than in the year 2005. This was the largest increase in real terms of the EU-15 countries. The average increase in oil price in Europe was 22%.

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 peaked at $127/barrel at the start of May. During the second half of 2011 the average price of crude oil was $111/barrel. In May 2012 prices peaked again at $128/barrel. During the first half of 2012 the average price of Brent Crude was $113/barrel.

Figure 41 *Natural Gas Prices to Industry*[47]



Source: Energy Prices & Taxes © OECD/IEA, 2012.

Table 17 *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
1st qtr 2012 (nominal)	160	139	109	-	262	167	149	225	**135**	141	145	153	164	185	-	169
1st qtr 2012 (real)	132	118	82	..	203	144	132	163	**134**	120	115	118	139	153	-	127

Source: Energy Prices & Taxes © OECD/IEA, 2012

With reference to *Figure 41*, natural gas prices to Irish industry have been increasing since 2nd quarter 2010. In the first quarter of 2012 gas prices to industry were 34% above 2005 levels in real terms.

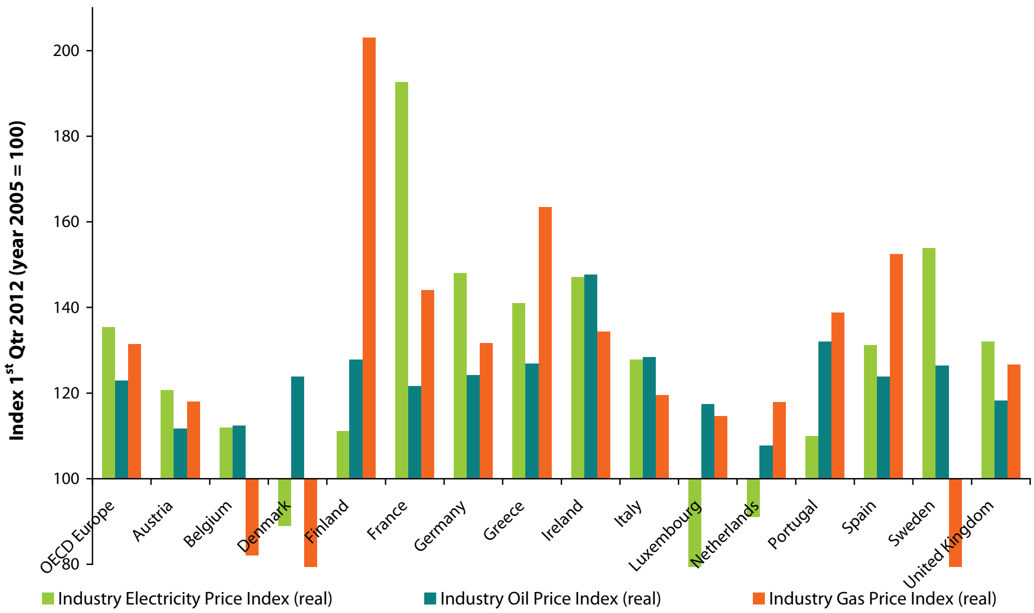
Figure 41 also shows the dramatic increase in gas prices to industry during 2008, the subsequent fall from the start of 2009 and the steady rise since early 2010, mirroring changes in global energy prices.

Figure 42 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 price to Irish industry between 2005 and 2012 increased by 46% compared with 26% for OECD Europe. This should be considered in the context of the weighting of energy in the cost base of Irish industry[48].

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

48 See Sustainable Energy Ireland (2007), *Energy in Industry 2007 Report*, available from www.seai.ie. This report found that 94% of industrial enterprises in Ireland spent less than 4% of their overall costs on energy. These enterprises also accounted for 93% of industrial gross value added.

Figure 42 *Real Energy Price Change to Industry since 2005 in EU-15 (index)*



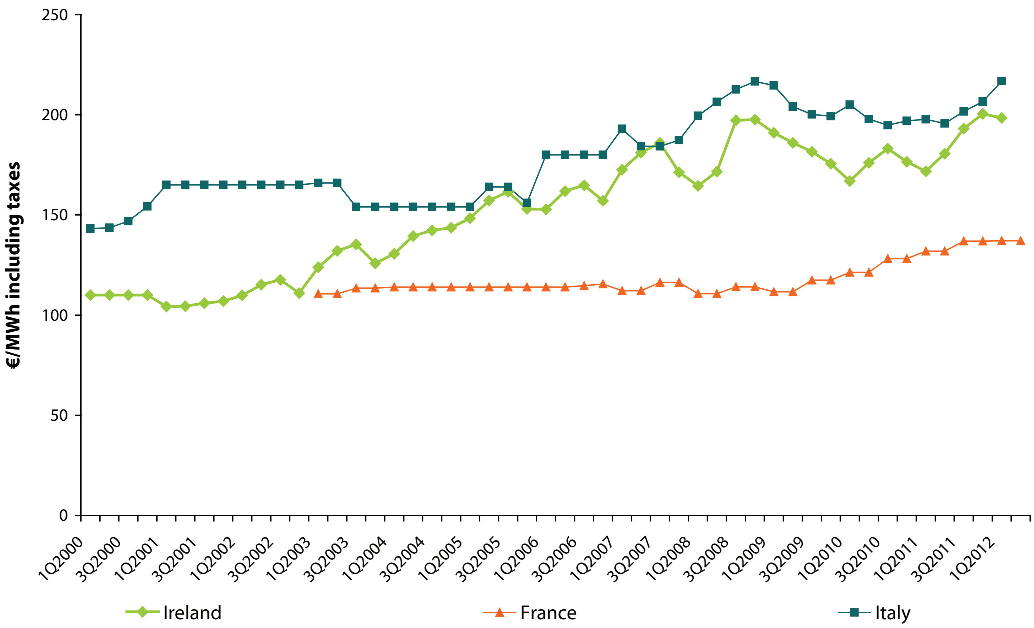
Source: Energy Prices & Taxes © OECD/IEA, 2012.

Since 2007, energy prices for industry in Ireland increased by 24% real terms. In OECD Europe the increase was lower at 16%. This reflects Ireland's dependence on oil and gas as these were the main drivers of global energy prices over this period.

2011 was also a period of increasing global oil and gas prices. This is reflected in overall energy prices to industry in Ireland being 15% higher than 2010. In OECD Europe the increase was 6%.

3.3.2 Household Energy Prices

Figure 43 *Household Electricity Prices*



Source: Energy Prices & Taxes © OECD/IEA, 2012.

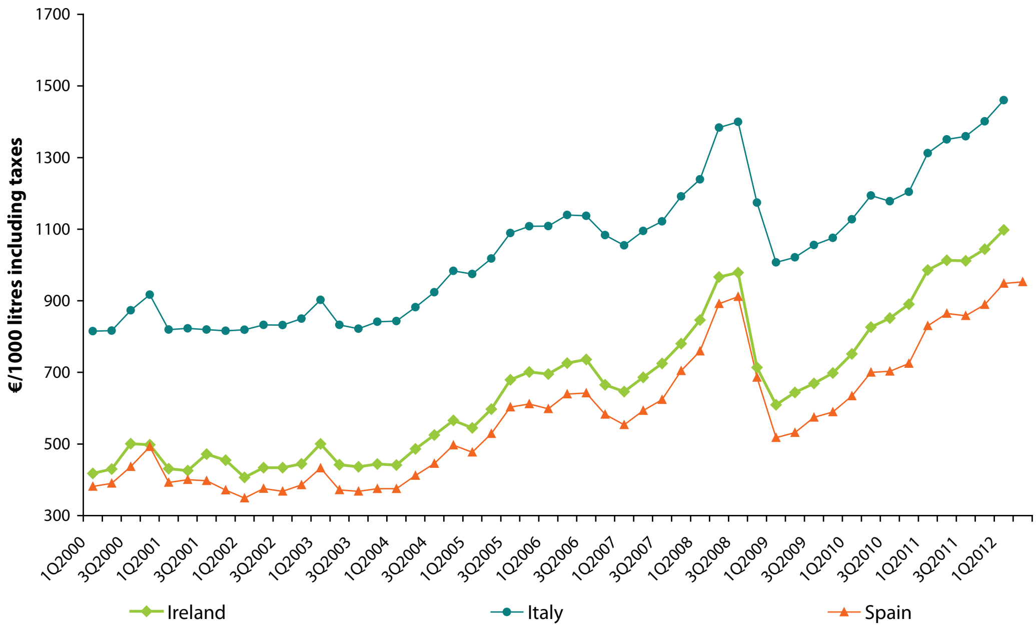
Table 18 *Electricity Price to Households Increase since 2005*

Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
1st qtr 2012 (nominal)	144	139	130	128	159	120	148	156	**124**	136	109	97	136	172	143	165
1st qtr 2012 (real)	122	121	111	110	137	108	132	128	**111**	118	93	87	118	148	128	133

Source: Energy Prices & Taxes © OECD/IEA, 2012.

Electricity prices to Irish householders increased by 11% in real terms since 2005. In Luxembourg and the Netherlands the price of electricity is lower in 2012 than in 2005 but in Spain it is 48% higher.

Figure 44 *Household Heating Oil Prices*



Source: Energy Prices & Taxes © OECD/IEA, 2012.

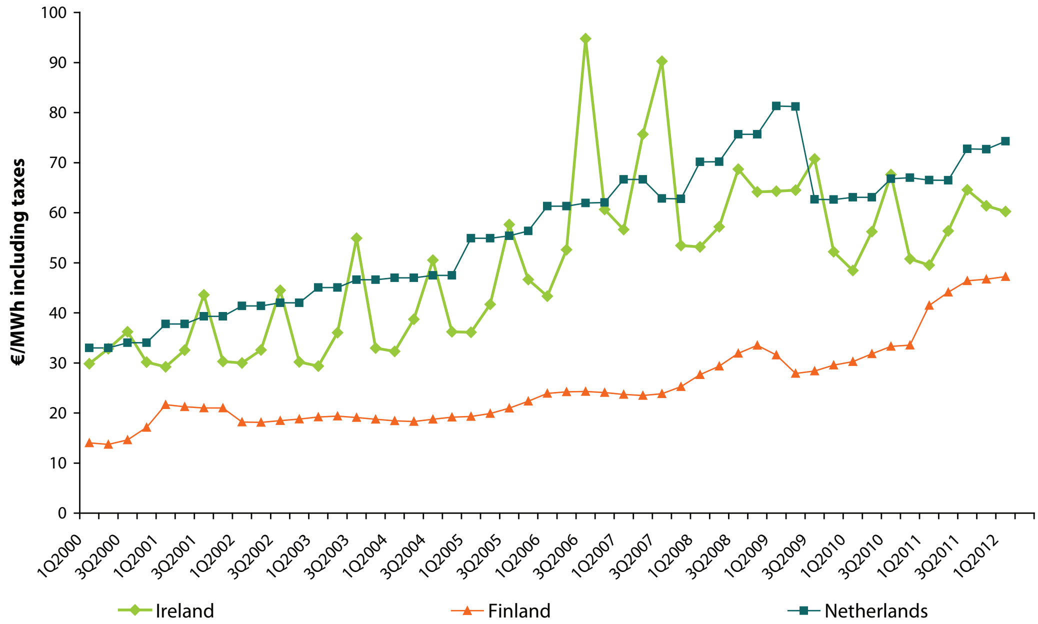
Table 19 *Oil Price to Households Increase since 2005*

Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
1st qtr 2012 (nominal)	151	151	154	143	147	147	147	196	**160**	148	146	131	146	155	139	160
1st qtr 2012 (real)	128	131	131	122	126	131	130	157	**143**	127	123	116	126	130	124	127

Source: Energy Prices & Taxes © OECD/IEA, 2012.

Heating oil prices to Irish householders increased in real terms by 43% since 2005, the second largest amongst the EU-15 countries. Greece had the largest increase at 57%. On average in Europe the price of oil to households increased by 28% in real terms.

Figure 45 *Household Natural Gas Prices*



Source: Energy Prices & Taxes © OECD/IEA, 2012.

Note that the peaks shown in the Irish gas price in *Figure 45* 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.

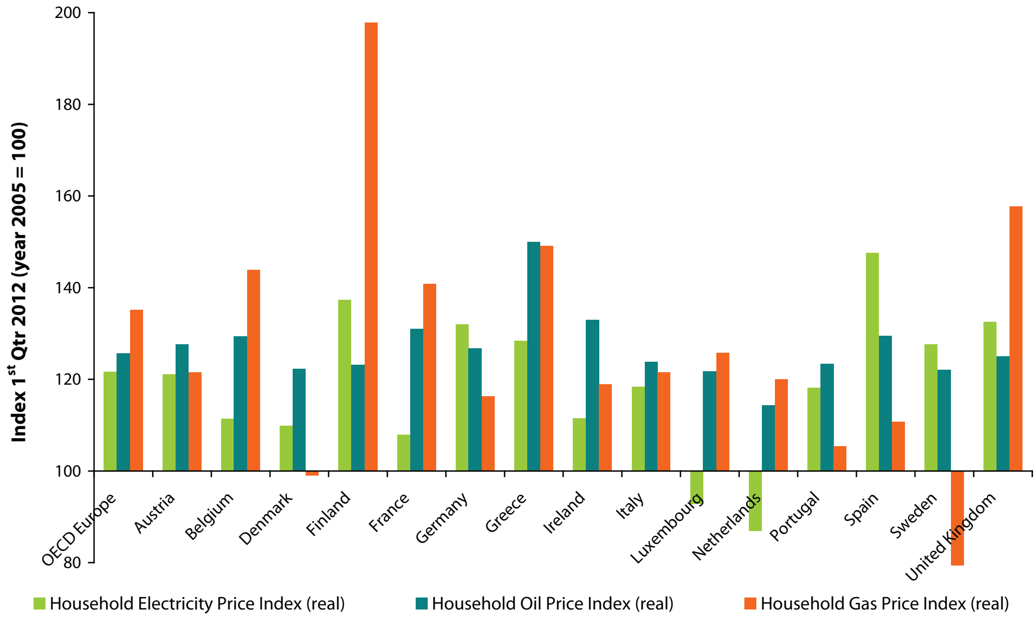
Table 20 *Natural Gas Price to Households Increase since 2005*

Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
1st qtr 2012 (nominal)	162	139	169	115	229	157	130	181	**132**	140	147	134	122	129	..	197
1st qtr 2012 (real)	135	122	144	99	198	141	116	149	**119**	121	126	120	105	111	..	158

Source: Energy Prices & Taxes © OECD/IEA, 2012.

In early 2012, gas prices to householders in Ireland were 19% above 2005 levels in real terms. Prices in OECD Europe as a whole were 35% above and the UK 58% above 2005 levels.

Figure 46 *Real Energy Price Change to Households since 2005 in EU-15 (index)*



Source: Energy Prices & Taxes © OECD/IEA, 2012.

Figure 46 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 price to Irish households increased by 24% between 2005 and the first quarter of 2012; similar to the OECD Europe increase of 25% over the same period.

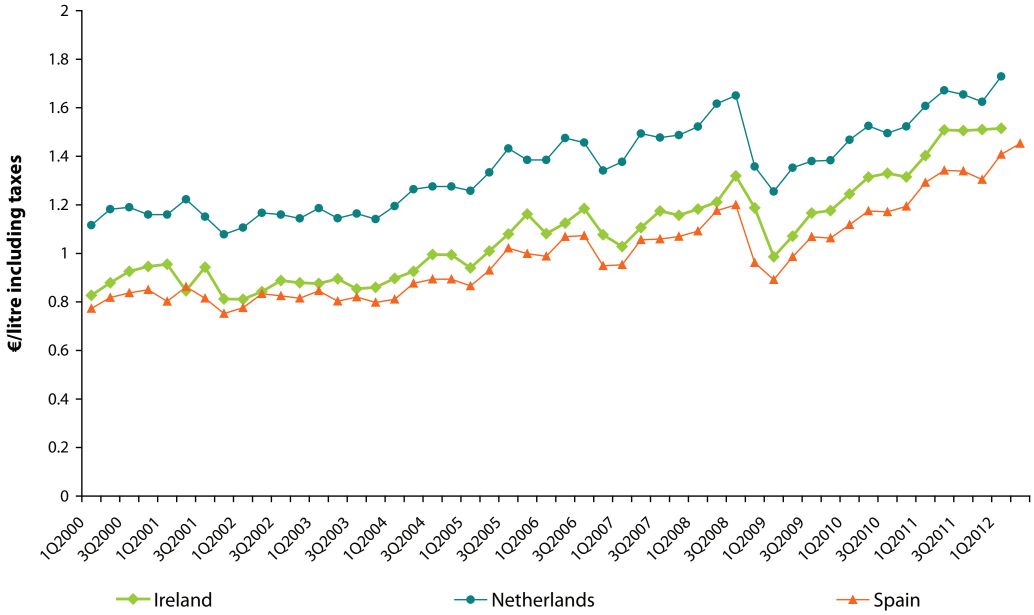
Since 2007, energy prices for households in Ireland increased by 17% in real terms. In OECD Europe the increase was lower at 13%. This reflects Ireland's dependence on oil and gas as these were the main drivers of global energy prices over this period.

2011 was also a period of increasing global oil and gas prices. This is reflected in overall energy prices to households in Ireland being 8% higher than 2010. In OECD Europe the increase was 6%.

3.3.3 Transport Energy Prices

Petrol and diesel prices shown here are inclusive of both excise and VAT and the carbon tax which was introduced on December 9th 2009 on motoring fuels.

Figure 47 *Retail Unleaded Petrol Prices (95 RON[49])*



Source: Energy Prices & Taxes © OECD/IEA, 2012.

Table 21 *Petrol Price Increase since 2005*

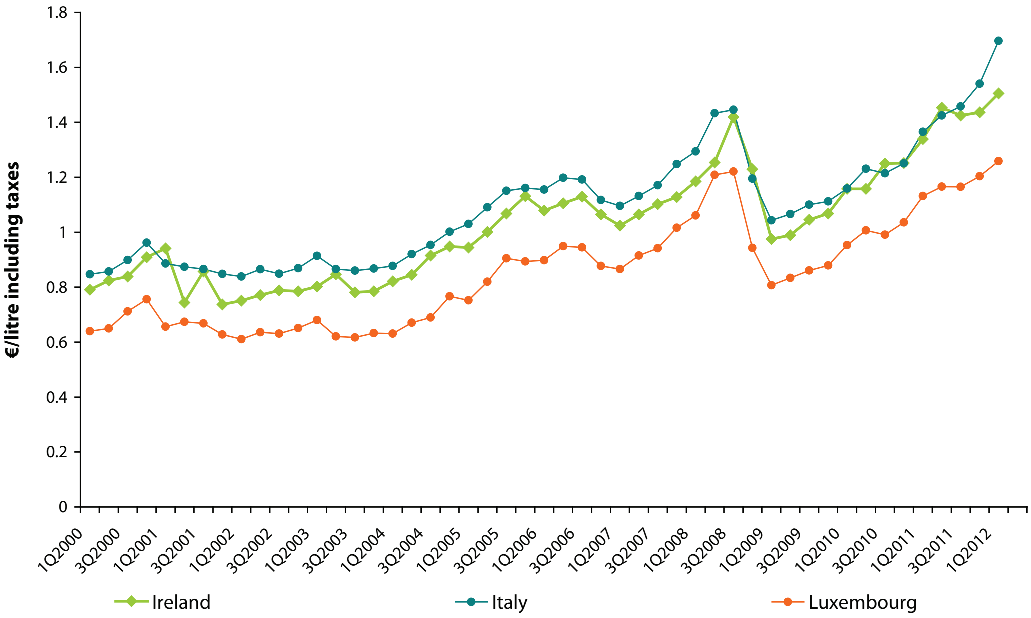
Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
1st qtr 2012 (nominal)	143	138	133	139	134	137	134	196	**146**	143	136	128	142	147	136	156
1st qtr 2012 (real)	122	121	113	120	116	123	119	161	**131**	124	116	114	123	126	122	125

Source: Energy Prices & Taxes © OECD/IEA, 2012.

Figure 47 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 1st quarter of 2012 were 31% above the level in 2005 in real terms. Petrol prices have been increasing since the 1st quarter of 2009 and have increased by 54% since then.

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

Figure 48 *Retail Road Diesel Prices*



Source: Energy Prices & Taxes © OECD/IEA, 2012.

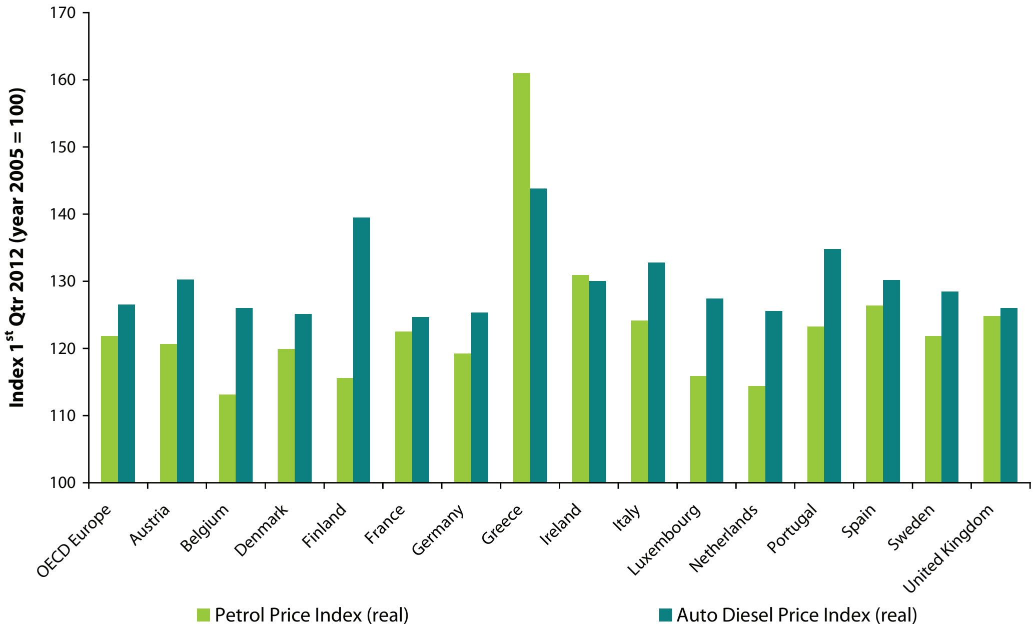
Table 22 *Auto Diesel Price Increase since 2005*

Index 2005 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
1st qtr 2012 (nominal)	150	149	148	145	161	139	141	175	**145**	153	149	140	155	152	144	157
1st qtr 2012 (real)	127	130	126	125	139	125	125	144	**130**	133	127	126	135	130	128	126

Source: Energy Prices & Taxes © OECD/IEA, 2012.

Figure 48 shows that diesel prices in Ireland are in the upper range for the euro-zone countries. Diesel prices in Ireland increased by 30% in real terms since 2005 which is above the 27% average increase for OECD Europe countries. Again diesel prices have been increasing since the 1st quarter of 2009 and are 54% higher than then.

Figure 49 *Real Energy Price Change in Transport since 2005 in EU-15 (index)*



Source: Energy Prices & Taxes © OECD/IEA, 2012.

Figure 49 summarises the data presented in *Table 21* and *Table 22*. While no overall index is provided for transport, *Figure 49* indicates that Ireland has experienced the second largest increase in petrol price and sixth largest for diesel price 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 grew by 60% to a high of 2,752 ktoe over the period 1990 – 2006 and has been falling since then with the exception of an increase in 2010. In 2011 industry energy use fell by 1.4%, back to 31% above 1990 levels (2,257 ktoe), similar to the 1999 consumption level. Energy use in 2011 was 2,257 ktoe, 18% lower than the peak in 2006.

Over the period only electricity, natural gas and renewables have increased their share and since 2009 non-renewable wastes have been used as an energy source in industry. The share of electricity has risen from 22% to 36%, natural gas from 21% to 28% and renewables from 3.7% to 6.6%. 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 50 *Industry Final Energy Use by Fuel*

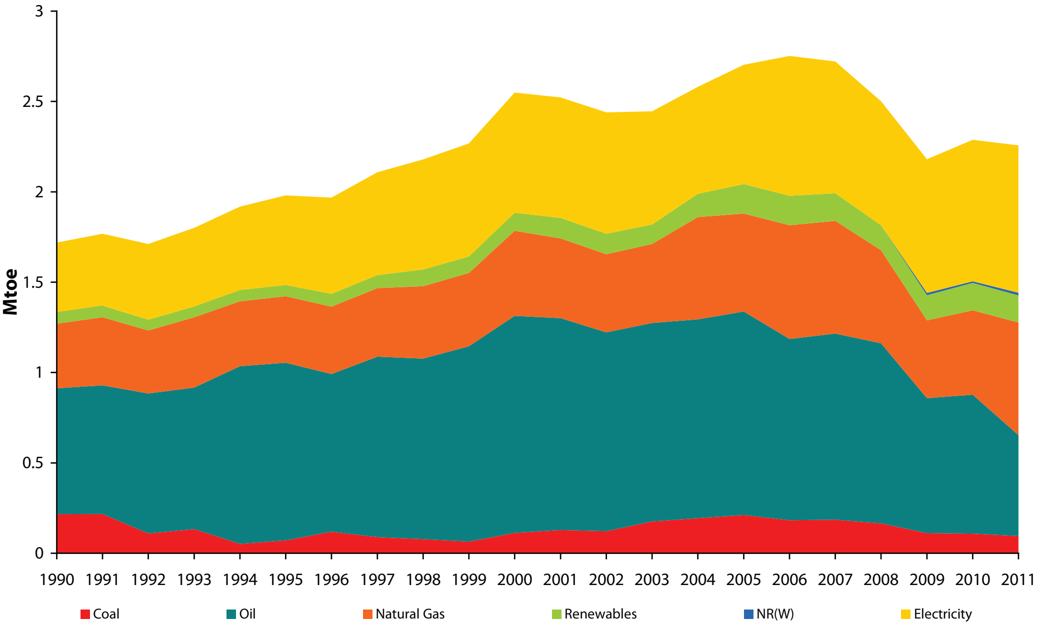


Table 243 tabulates the growth rates, quantities and relative shares of energy in industry.

Table 23 *Growth Rates, Quantities and Shares of Final Consumption in Industry*

	Growth %	Average annual growth rates %				Quantity (ktoe)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Fossil Fuels (Total)	0.5	0.0	1.1	-6.5	-5.0	1,271	1,277	73.9	56.6
Coal	-55.9	-3.8	13.4	-12.6	-11.9	216	95	12.6	4.2
Oil	-19.9	-1.1	-1.3	-7.3	-27.4	696	558	40.5	24.7
Gas	74.1	2.7	2.9	-3.0	33.6	358	624	20.8	27.6
Renewables	137.5	4.2	10.3	-1.4	-1.8	63	150	3.7	6.6
Non-Renewable (Wastes)	-	-	-	-	65.8	-	14	0.0	0.6
Combustible Fuels (Total)	8.0	0.4	1.6	-5.9	-4.2	1,334	1,441	77.6	63.9
Electricity	111.5	3.6	-0.1	3.5	4.2	386	816	22.4	36.1
Total	**31.2**	**1.3**	**1.2**	**-3.3**	**-1.4**	**1,720**	**2,257**		

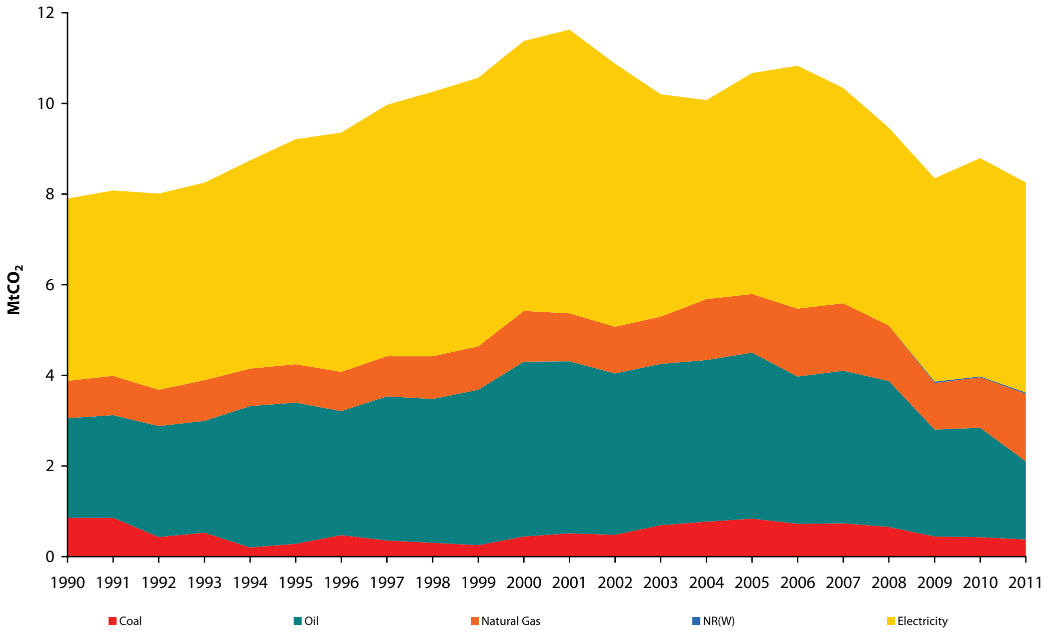
In 2011, coal, oil and renewables consumption fell in industry. Oil consumption experienced the largest reduction, falling by 27% to 558 ktoe. Coal consumption fell by 12% to 95 ktoe and renewables, mostly biomass, by 1.8% to 150 ktoe. Gas consumption increased by 34% in 2011 to 624 ktoe and electricity consumption grew by 4.2% to 816 ktoe.

Electricity is the most dominant energy source in industry, accounting for 36% of final energy use. Oil accounts for approximately one quarter of final energy use in industry and gas has a slightly higher share of almost 28%.

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 2011 electricity represented 56% of energy used in industry, when calculated on a primary energy basis, compared to 36% on a final energy basis.

Figure 51 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 51 *Industry Energy-Related CO_2 Emissions by Fuel*



As detailed in *Table 24*, industrial energy-related CO_2 emissions fell by 6.1% in 2011 to 8.3 Mt CO_2. Electricity consumption was responsible for 56% of industry's energy related emissions in 2011. Electricity is indirectly responsible for almost half of CO_2 emissions in industry, more than all the other fuels used by industry combined.

Table 24 tabulates the growth rates, quantities and relative shares of energy related CO_2 emissions in industry.

Table 24 *Growth Rates, Quantities and Shares of Energy-related CO_2 Emissions in Industry*

	Growth %	Average annual growth rates %				Quantity (kt)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Coal	-55.9	-3.8	13.4	-12.6	-11.9	856	378	10.8	4.6
Oil Total	-21.5	-1.1	-1.0	-8.0	-28.5	2,199	1,725	27.8	20.9
Kerosene	425.4	8.2	6.8	-2.0	-21.0	50	265	0.6	3.2
Fuel Oil	-59.5	-4.2	-6.8	-8.0	-45.2	1,341	543	17.0	6.6
LPG	60.8	2.3	3.6	-0.1	-3.3	165	265	2.1	3.2
Gas Oil	1.4	0.1	0.8	-4.3	-5.9	454	461	5.7	5.6
Petroleum Coke	3.7	0.2	7.5	-18.7	-40.3	185	191	2.3	2.3
Natural Gas	80.7	2.9	2.8	-2.9	33.5	824	1,490	10.4	18.0
Non-Renewable (Wastes)	-	-	-	-	79.0	-	30	0.0	0.4
Total Combustible Fuels	-6.6	-0.3	1.3	-7.3	-8.9	3,879	3,623	49.1	43.9
Electricity	15.3	0.7	-3.9	-0.2	-3.8	4,020	4,635	50.9	56.1
Overall Total	**4.5**	**0.2**	**-1.3**	**-3.8**	**-6.1**	**7,899**	**8,258**		

If upstream electricity-related emissions are omitted then there was an 8.9% decrease in CO_2 emissions from combustible fuels used on-site in industry in 2011. This is a direct result of the 5% decrease in fossil fuel use in industry (detailed in *Table 23*) while at the same time there was a 3.1% increase in the output of industry as measured by value added[50].

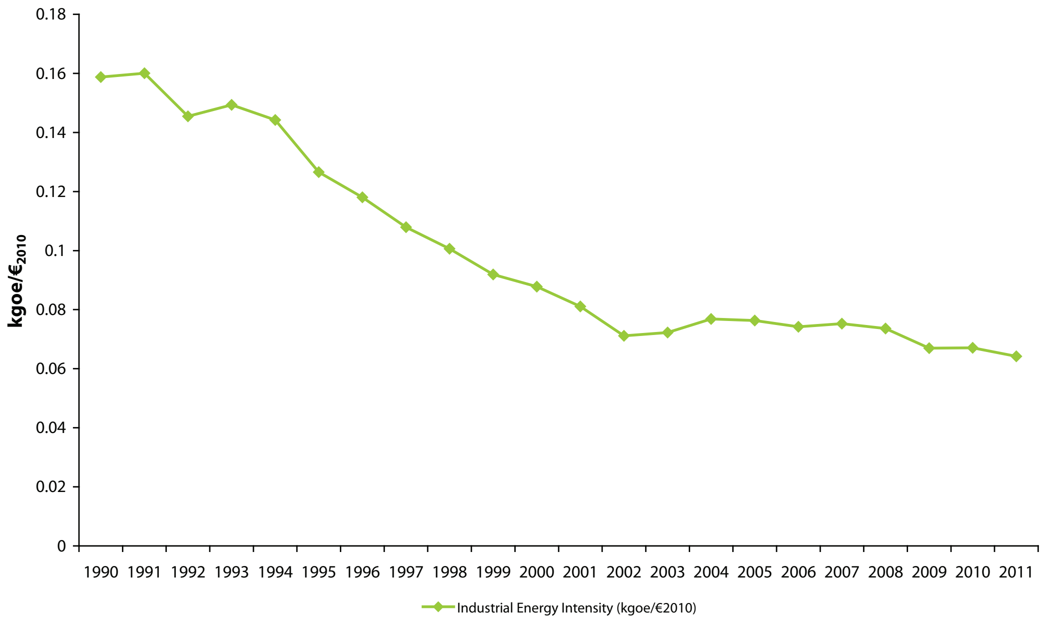
50 CSO (2012) *National Income and Expenditure - Annual Results for 2011*, www.cso.ie.

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 52* shows the industrial energy intensity between 1990 and 2011 in kilograms of oil equivalent per euro of industrial value added (in 2010 values) (kgoe/€$_{2010}$). Over the period, industrial energy consumption increased by 31.2% while value added increased by 225% resulting in a reduction in intensity of 60%. In other words to generate a euro of value added in 2011, 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 3.1% in 2011 compared with the 1.4% increase in the economy overall. Energy use in industry fell by 1.4% resulting in a 4.3% increase in energy productivity in industry.

Figure 52 *Industry Energy Intensity*



As mentioned in section *2.6*, energy intensity in this form is a limited indicator and variation may be the result of many factors such as structural changes, fuel mix, volume and other changes. To eliminate the effects of structural changes an index of energy intensity at constant structure [51] is also shown, in *Figure 53*.

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 53* is the trend in energy intensity in industry. Over the period 1995 to 2011, the intensity of industry fell by 54.8% (4.8% per annum). Between 1995 and 2002 there was an improvement of 35% (6% per annum) before deteriorating between 2002 and 2005 by over 5.3% (2.7% per annum). Since 2005, there has been an overall improvement in the industry energy intensity of 27% (7.7% per annum).

The light green line represents the evolution of industrial energy intensity had the structure of industry not changed over time. If the structural change in industry had not occurred, the intensity would have improved by 15% (2.4% per annum) between 1995 and 2002 before deteriorating between 2002 and 2005 by 3.5% (1.3% per annum). There was a return to an energy efficiency improvement in the notional intensity at constant structure between 2005 and 2008 of 5.2% (2% per annum) before the impact of the economic downturn in 2008 which led to a deterioration in the notional efficiency of industry at constant structure of 17% (6.4% per annum) between 2008 and 2011.

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 53*.

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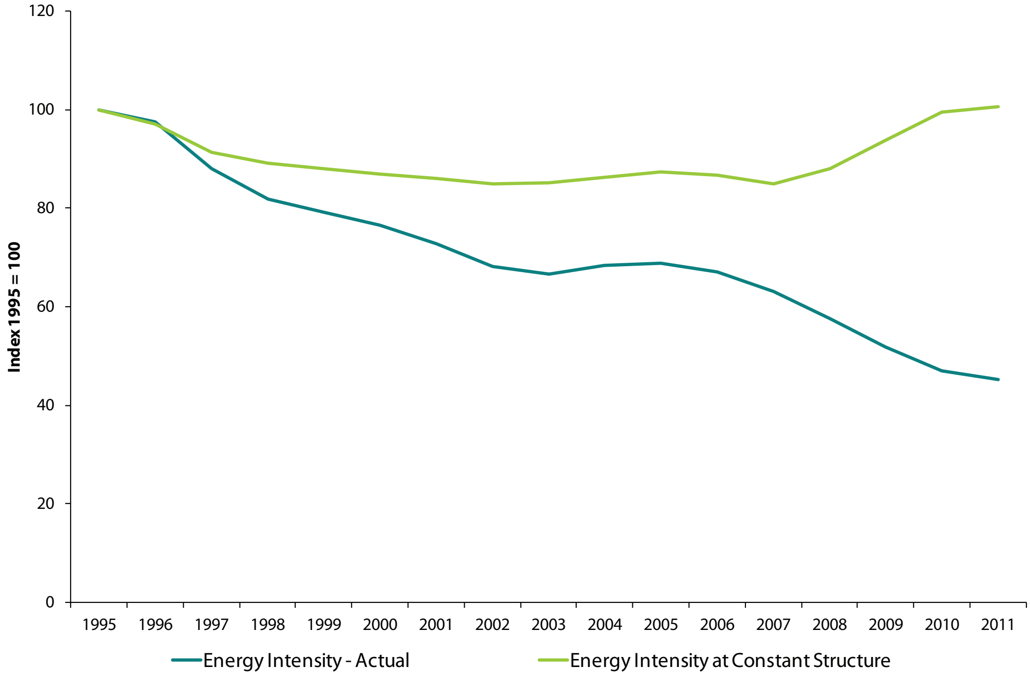
51 This section draws on methodology developed under the ODYSSEE project. See Bosseboeuf D. et al, 1999, *Energy Efficiency Indicators – The European Experience* and Bosseboeuf D. et al, 2005, *Energy Efficiency Monitoring in the EU-15*, both published by ADEME and the European Commission. http://www.odyssee-indicators.org/

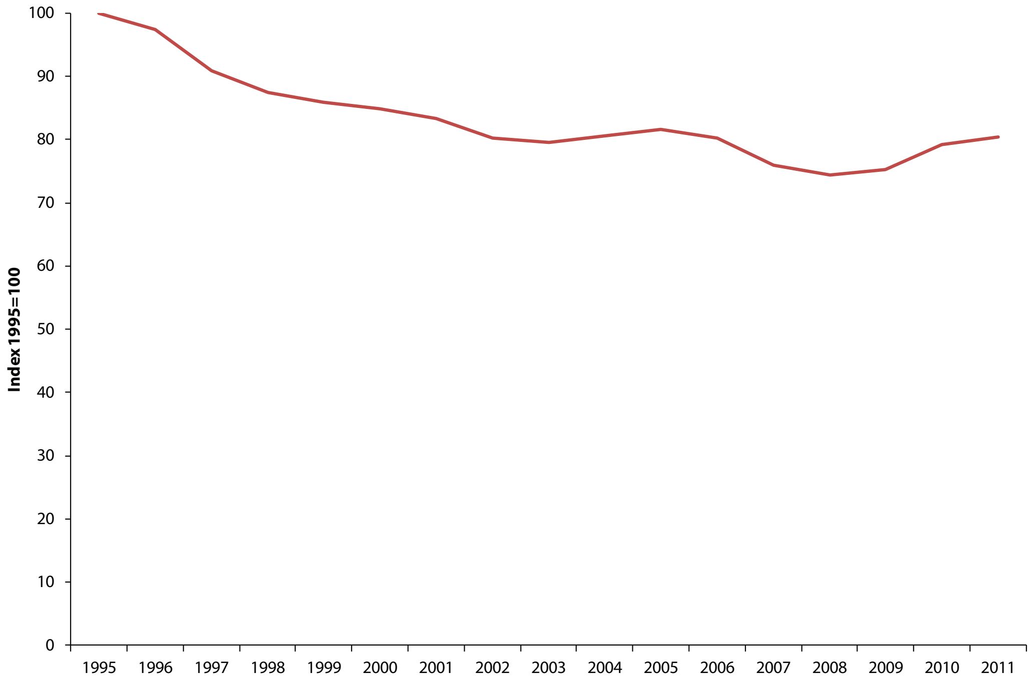
Figure 53 *Index of Energy Intensity of Industry 1995 - 2011*



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 2011, shown in *Figure 54*. Again here, as with intensity, a downward trend signifies improvement, this time in efficiency. The index decreased from 100 in 1995 to 80.5 in 2011, indicating a 20% (1.3% per annum) improvement in energy efficiency over the period.

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 54 *Industry ODEX 1995 - 2011*

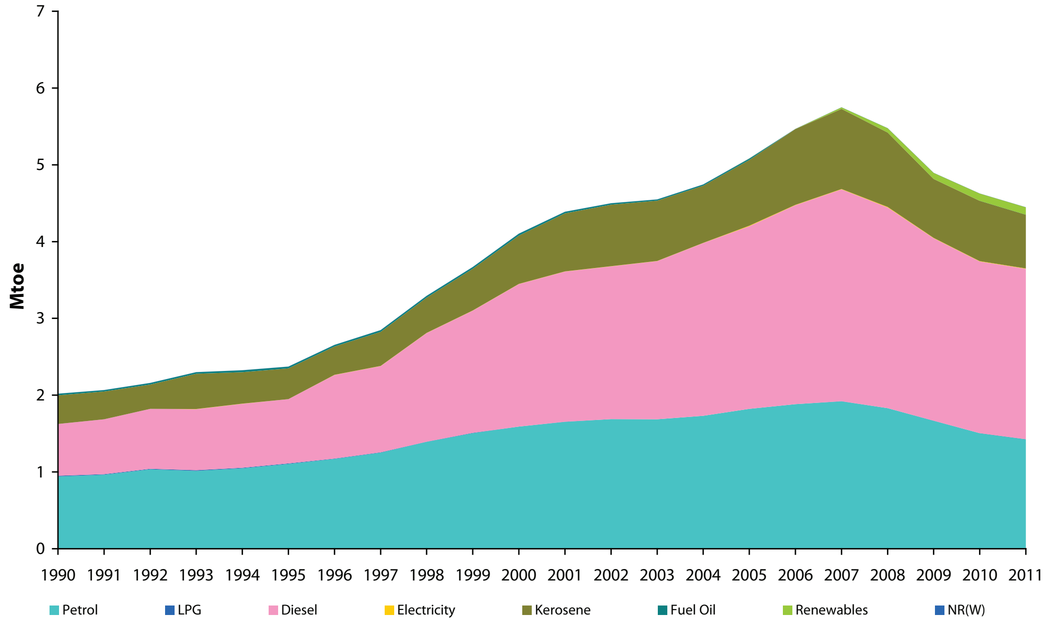


There is a significant difference between the estimated energy-efficiency improvement calculated using the ODEX methodology (20%) and using energy intensity at constant structure, which indicates an overall deterioration in energy efficiency of 0.6% over the period 1995 to 2011. This issue is currently 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

Transport energy use peaked in 2007 at 5,749 ktoe and has been falling since. In 2011 transport energy use fell by 3.8% to 4,448 ktoe. Transport energy use has fallen 23% since the peak in 2007, bringing it back to 2002 levels.

Figure 55 *Transport Final Energy Use by Fuel*[52]



The growth rates for the different transport fuels over the period are shown in *Table 25*. Overall energy use in transport fell in 2011 by 3.8%. Renewables, in the form of biofuels, and LPG were the only fuels to experience growth with an increase of 5.5% for biofuels to 98 ktoe and 6.8% for LPG although absolute consumption of auto LPG is very small (0.5 ktoe). Of the oil based fuels, jet kerosene consumption experienced the largest decrease, falling by 11% to 699 ktoe. Kerosene in transport is exclusively used for aviation. Petrol consumption fell by 5.3% to 1,425 ktoe while diesel consumption remained relatively stable with a fall of just 0.6% to 2,221 ktoe. Diesel consumption grew by 229% between 1990 and 2011 and now accounts for half of all transport energy consumption.

Table 25 *Growth Rates, Quantities and Shares of Final Consumption in Transport*

	Growth %	Average annual growth rates %				Quantity (ktoe)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Fossil Fuels (Total)	115.4	3.7	4.4	-2.3	-4.0	2,017	4,346	99.9	97.7
Total Oil	115.4	3.7	4.4	-2.3	-4.0	2,017	4,346	99.9	97.7
Petrol	51.2	2.0	2.8	-3.8	-5.3	942	1,425	46.7	32.0
Diesel	229.4	5.8	5.1	-1.2	-0.6	674	2,221	33.4	49.9
Kerosene	87.0	3.0	6.4	-1.7	-11.1	374	699	18.5	15.7
LPG	-92.1	-11.4	-14.1	-12.8	6.8	7	1	0.3	0.0
Renewables	-	-	-	142.8	5.5	-	98	0.0	2.2
Combustible Fuels (Total)	120.3	3.8	4.4	-1.9	-3.8	2,017	4,444	99.9	99.9
Electricity	183.6	5.1	17.8	-5.0	-0.4	1	4	0.1	0.1
Total	**120.3**	**3.8**	**4.4**	**-1.9**	**-3.8**	**2,019**	**4,448**		

The growth rates, quantities and shares of the energy-related CO_2 emissions from the different transport fuels are given in *Table 26*. Transport experienced for the fourth year in a row a decrease in primary energy-related CO_2 emissions, which fell by 4% in 2011 following a 5.9% reduction in 2010. Emissions from aviation fell by 11% in 2011.

52 This is based on data of fuel sales in Ireland rather than fuels consumed in Ireland. 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 56*.

Table 26 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions in Transport*

	Growth %	Average annual growth rates %				Quantity (kt)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Total Oil Products	117.0	3.8	4.4	-2.2	-4.0	6,029	13,083	99.8	99.8
Petrol	51.2	2.0	2.8	-3.8	-5.3	2,761	4,174	45.7	31.8
Diesel	229.4	5.8	5.1	-1.2	-0.6	2,070	6,817	34.2	52.0
Kerosene	87.0	3.0	6.4	-1.7	-11.1	1,118	2,090	18.5	16.0
LPG	-92.1	-11.4	-14.1	-12.8	6.8	19	1	0.3	0.0
Electricity	54.6	2.1	13.3	-8.4	-8.0	14	22	0.2	0.2
Total	**116.8**	**3.8**	**4.4**	**-2.3**	**-4.0**	**6,043**	**13,105**		

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*[53] 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 56* and detailed in *Table 27*, updated with 2011 data. The aviation category recorded the largest fall in demand in 2011, decreasing by 11% to 700 ktoe followed by road freight falling by 8.7% to 657 ktoe. Indeed, with the exception of rail, all modes experienced reduced demand in 2011.

Table 27 *Growth Rates, Quantities and Shares of Transport Final Energy Demand by Mode, 1990 – 2011*

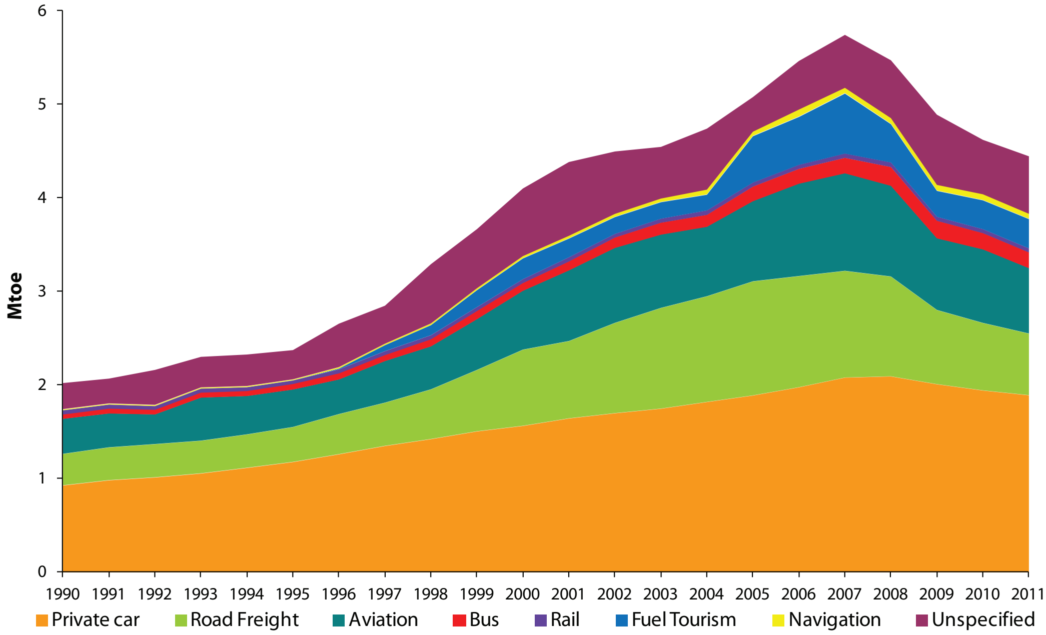
	Growth %	Average annual growth rates %				Quantity (ktoe)		Shares %	
Mode	1990 - '11	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Road Freight	96.7	3.3	8.4	-9.8	-8.7	334	657	16.6	14.8
Private car	104.0	3.5	3.9	0.0	-2.6	926	1,890	45.9	42.5
Public Passenger (road)	226.8	5.8	12.8	1.4	-2.8	52	171	2.6	3.9
Rail	-1.6	-0.1	1.1	-0.3	1.0	45	44	2.2	1.0
Aviation	86.8	3.0	6.4	-3.3	-11.1	375	700	18.6	15.7
Fuel Tourism	-	-	17.5	-7.4	1.5	0	313	0.0	7.0
Navigation	673.0	10.2	16.0	2.0	-13.2	7	56	0.4	1.3
Unspecified	120.8	3.8	-12.5	8.8	5.6	279	616	14	13.9
Total	**120.3**	**3.8**	**4.4**	**-2.2**	**-3.8**	**2,019**	**4,448**		

Combined petrol and diesel fuel tourism is also included in *Figure 56*. Only fuel tourism out of the Republic of Ireland (ROI) is included in this graph (i.e. fuel which is purchased in ROI but consumed elsewhere). Before 1995 the trend was negative, meaning fuel was purchased outside and consumed within the State.

In *Table 27 'Road Freight'* refers to heavy goods vehicles and the data are derived from the CSO's road freight survey of vehicles over 2 tonnes unladen weight. Some preliminary analysis has been carried out by SEAI on data from the annual Department of Transport test of commercial vehicles, looking at the mileage of light goods vehicles (LGV) in order to estimate the energy consumption of LGVs. Indications from this work are that these vehicles account for most of the fuel use in the '*Unspecified*' category in the table. SEAI will publish the results of this analysis in a future report.

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

Figure 56 *Transport Energy Demand by Mode 1990 - 2011*



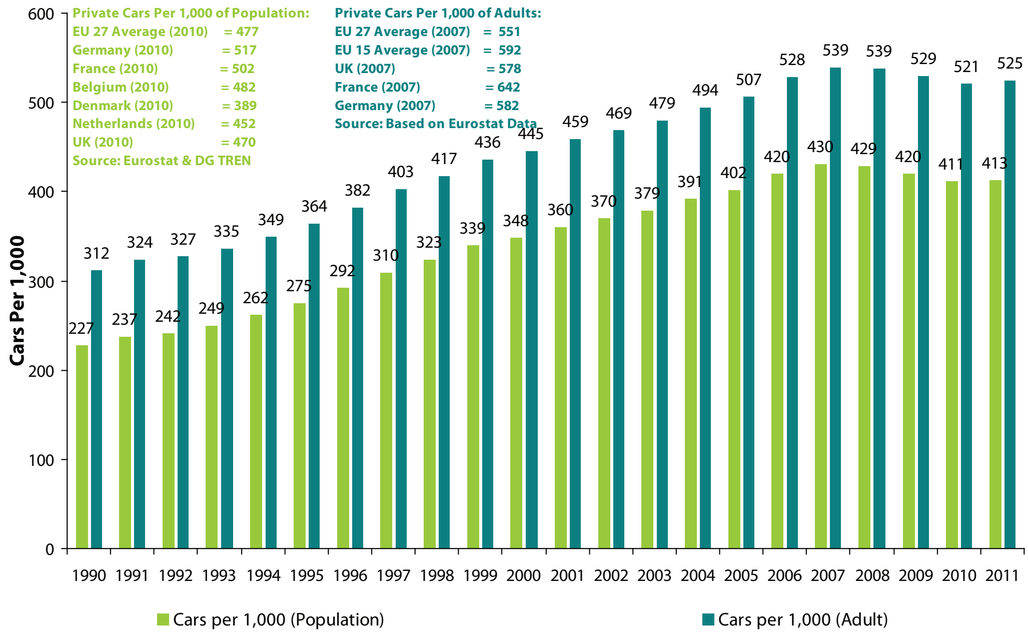
Energy use in transport was 4,448 ktoe in the year 2011, a fall of 3.8% on 2010. Road transport accounted for 61% of this (75% if unspecified is included). SEAI estimates that private car transport was responsible for 1,890 ktoe of energy use in 2011. This represents 69% of road transport energy use and 42% of all transport energy use. *Figure 56* 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[54] 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. Numbers increased in 2011 to 2,425,387 vehicles, an increase of 0.4%. Of these there were 1.9 million private cars or 78% of the total. Private car numbers increased by 0.8% in 2011 following a cumulative 2.6% reduction in 2009 and 2010. The car density in 2011 (as shown in *Figure 57*) was 525 cars per 1000 adults, up slightly on the 2010 figure of 521. This is compared to an EU-27 average of 551 and a UK average of 578 (both in 2007).

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

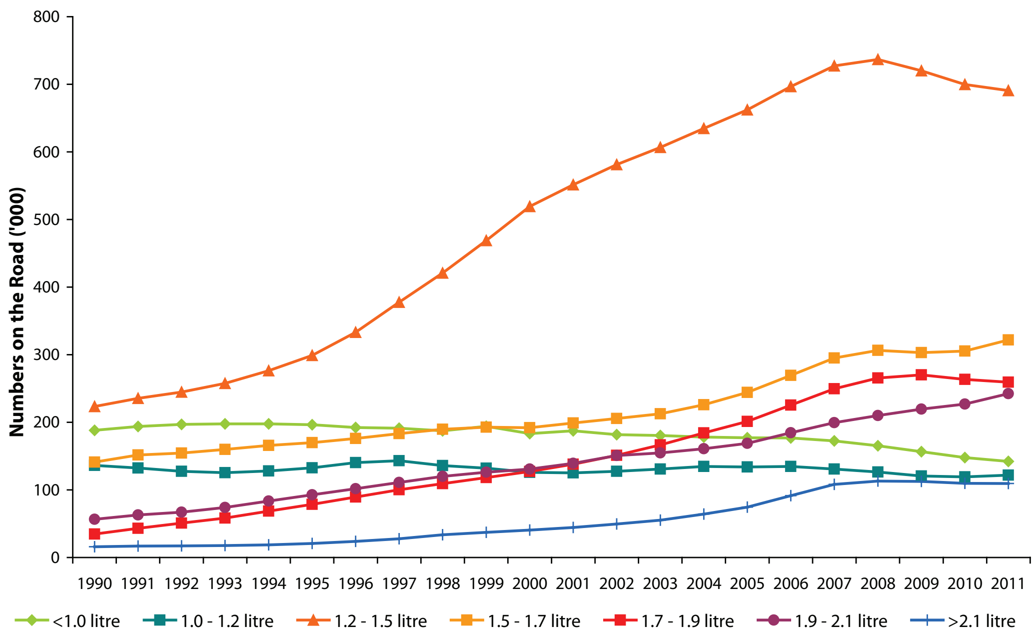
Figure 57 *Private Cars per 1000 of Population*



Source: Based on Vehicle Registration Unit and CSO data.

Figure 58 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 and 2011, only the 1.9 – 2.1 litre and the 1.5 – 1.7 litre categories increased in numbers, growing by 6.8% and 5.3% respectively in 2011. The 1.0 – 1.2 litre category started to grow again in 2011, by 2.1%.

Figure 58 *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 2011. This was over twice the share of the second most popular class, the 1.5 to 1.7 litre band, which accounted for 17% 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 7.5% in 2011.

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 19% in 2011. Indeed, cars with engines greater than 1.7 litres have increased their share from 13.5% in 1990 to 32% in 2011.

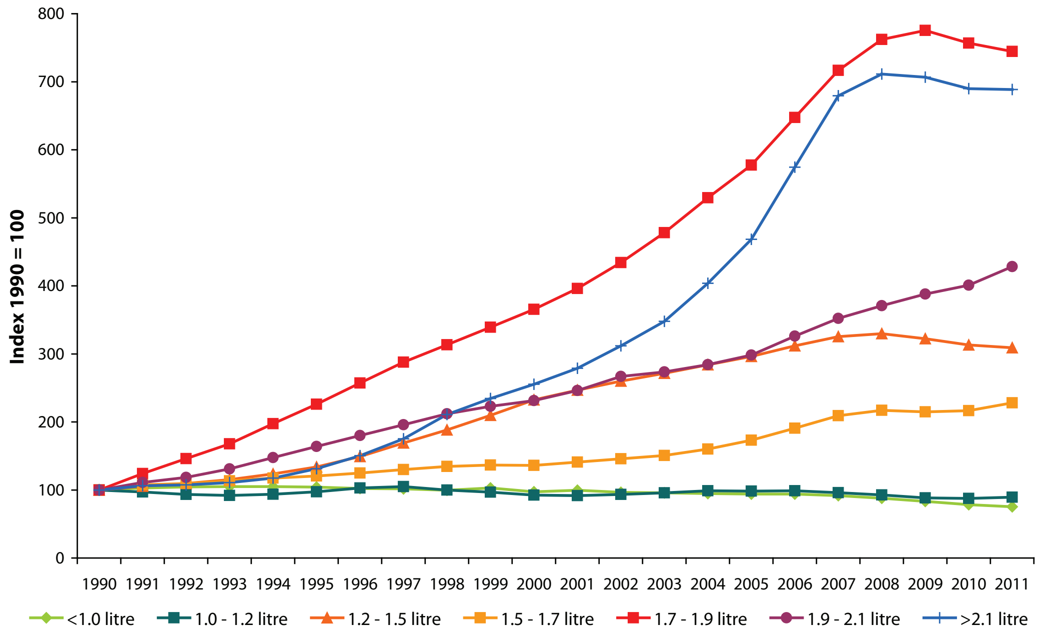
Table 28 *Growth Rates, Quantities & Shares of Private Cars by Engine Size Band 1990 to 2011*

	Growth %	Average annual growth rates %				Quantity (numbers)		Shares %	
CC Bands	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
<1.0 litre	-24.5	-1.3	-0.7	-3.0	-3.9	188,238	142,031	23.6	7.5
1.0 - 1.2 litre	-10.6	-0.5	1.2	-1.9	2.1	136,327	121,900	17.1	6.5
1.2 - 1.5 litre	209.2	5.5	5.0	0.9	-1.3	223,435	690,807	28.1	36.6
1.5 - 1.7 litre	128.1	4.0	4.9	3.8	5.3	141,072	321,817	17.7	17.0
1.7 - 1.9 litre	644.5	10.0	9.6	4.6	-1.6	34,829	259,302	4.4	13.7
1.9 - 2.1 litre	328.2	7.2	5.2	5.0	6.8	56,594	242,351	7.1	12.8
>2.1 litre	588.8	9.6	12.9	6.7	-0.2	15,913	109,602	2.0	5.8
Total	**137.0**	**4.2**	**4.7**	**2.0**	**0.8**	**796,408**	**1,887,810**		

Source: Based on Dept. of Transport Data.

Figure 59 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 engine sizes of 1.5 – 1.7 litre and 1.9 – 2.1 litre have shown increasing numbers continuously since 1990. The classes 1.2 – 1.5, 1.7 – 1.9 and the greater than 2.1 litre have levelled off or decreased since 2008.

Figure 59 *Change in Car Engine Size (Index)*



Source: Based on Vehicle Registration Unit data.

Four engine size bands (less than 1.0 litre, 1.2 – 1.5, 1.7 – 1.9 and greater than 2.1 litre) continued to decline in numbers in 2011, falling by 3.9%, 1.3%, 1.6% and 0.2% respectively. The other bands (1.0 – 1.2, 1.5 – 1.7 and 1.9 – 2.1 litre) increased their numbers in 2011 by 2.1%, 5.3% and 6.8% respectively. 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 645% since 1990 and those in the greater than 2.1 litre range grew by 589%.

4.2.3 CO_2 based Vehicle Registration and Road Tax Bands

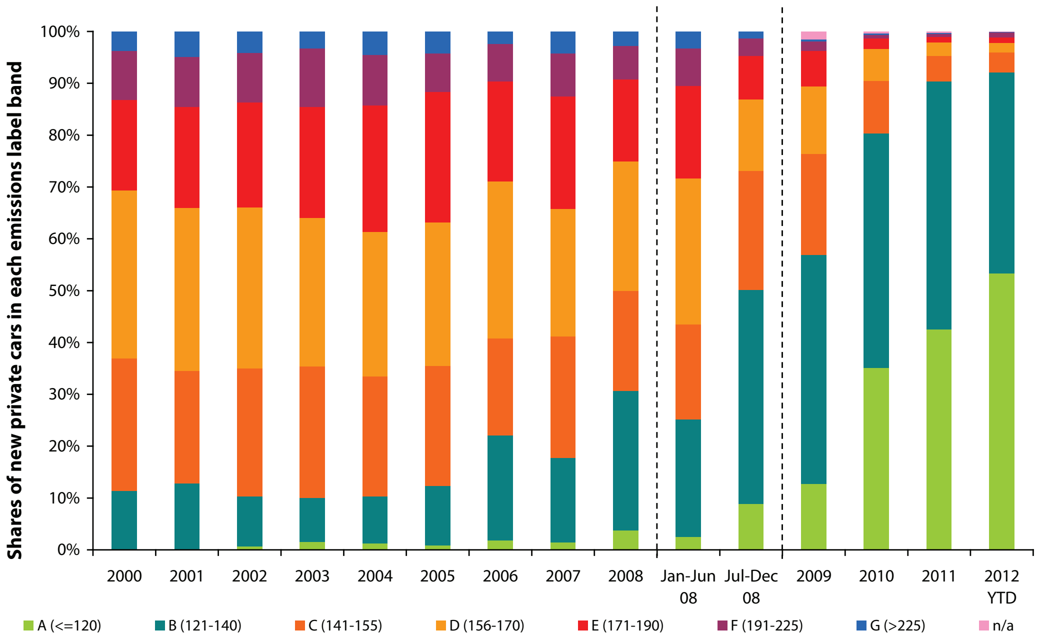
A new system of assessing private cars for Vehicle Registration Tax (VRT) and annual motor tax (AMT) came into effect from July 2008. This was signalled in the December 2007 Budget. The system moved away from assessing vehicles based on engine size to one that is based solely on the CO_2 emissions per kilometre. Seven tax bands are used for the assessment with the bands corresponding to the EU labelling system. The bands are shown in *Table 29*.

Table 29 *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 60 *Shares of New Private Cars in each Emission Band 2000 – 2011 (+2012 to July)*



Source: Based on Vehicle Registration Unit data.

Figure 60 shows the shares of new-car sales[55] between 2000 and July 2012 classified by emissions label band. The year 2008 is shown split between before and after the taxation changes. Between 2000 and 2005 the share of label bands A, B and 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 the 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 90% A or B and 95% A, B or C. In the year to date to July 2012 the shares of A or B was 92% and A, B or C 96%.

Table 30 tabulates the data shown in *Figure 60*. The largest increase in share was in the A label band, rising from just 1.5% in 2007 to 53% or more than half the new private cars sold in the year to July 2012. The share of high emitting cars in label bands E, F and G only amounted to 2.1% of new cars sold during 2012 (up to July), just 1,356 out of a total of 65,100 new cars.

55 Licensed as private cars.

Table 30 *Shares of New Private Cars in each Emissions Band, 2000, 2005 – 2011 (+2012 to July)*

CO_2 band	2000	2005	2006	2007	2008	Jan - Jun 2008	July - Dec 2008	2009	2010	2011	2012 to July
A	0.0%	0.9%	1.8%	1.5%	3.8%	2.4%	8.8%	12.7%	35.1%	42.5%	53.3%
B	11.3%	11.4%	20.3%	16.3%	26.8%	22.8%	41.3%	44.1%	45.2%	47.8%	38.8%
C	25.6%	23.2%	18.8%	23.4%	19.3%	18.3%	22.9%	19.5%	10.1%	5.0%	3.9%
D	32.4%	27.6%	30.2%	24.7%	25.0%	28.1%	13.8%	13.1%	6.2%	2.6%	1.8%
E	17.5%	25.1%	19.3%	21.6%	15.9%	17.9%	8.5%	6.8%	2.0%	1.0%	1.0%
F	9.5%	7.5%	7.2%	8.4%	6.4%	7.3%	3.3%	1.8%	0.6%	0.6%	1.0%
G	3.7%	4.2%	2.3%	4.2%	2.8%	3.2%	1.3%	0.4%	0.3%	0.2%	0.1%

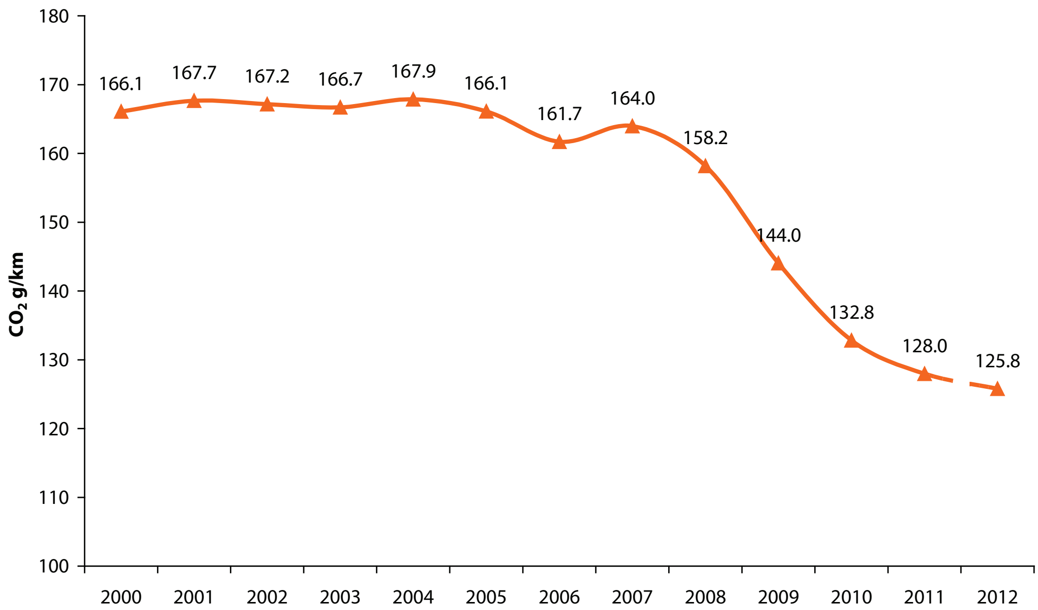
Source: Based on Vehicle Registration Unit data.

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 (8.7% reduction). The overall weighted average for 2008 was 158 g CO_2/km, a 3.5% reduction on 2007.

Figure 61 shows the change in the weighted average specific CO_2 emissions of new cars between 2000 and 2011 with an estimate for 2012. 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 144 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 2011 the average emissions were 128 CO_2 g/km or 22% below the level prior to the taxation change.

Figure 61 *Specific CO_2 Emissions of New Cars, 2000 – 2011 (2012 estimated)*



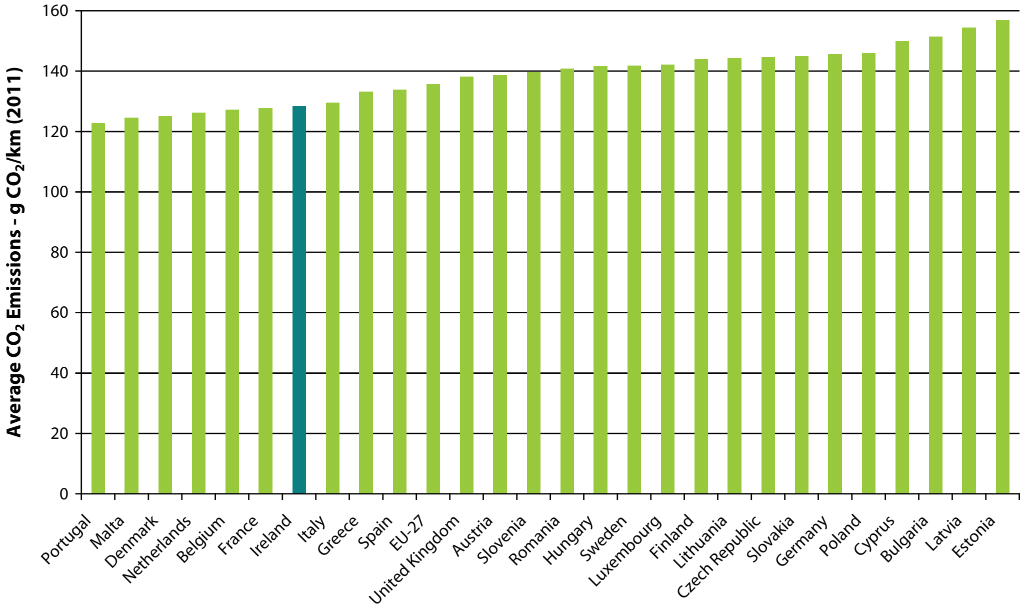
Source: Based on Vehicle Registration Unit & VCA data.

In label terms and with reference to *Figure 61*, 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 increased the shares of A and B labelled cars being sold and this resulted in the average new private car in 2010 to 2012 being a B label. The average specific CO_2 emissions of new cars were 128 CO_2 g/km in 2011 and an estimated 125.8 CO_2 g/km in 2012 (B label).

In 2011, 21.3% of the stock of private cars were purchased in 2008 or later.

Figure 62 *Specific CO_2 Emissions of New Cars: International Comparison – 2011*[56]



Source: European Environment Agency.

Figure 62 shows the position of Ireland in relation to its EU partners in terms of new car emissions. In 2011, the average CO_2 emissions from new cars in Ireland were 5.4% below the EU average and ranked seventh lowest out of the 27 countries. The EU Directive (443/2009) has set a target for all passenger cars to have average emissions below 130 g CO_2/km by 2015.

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 59* 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[57], which measures the overall efficiency of new cars entering the fleet.

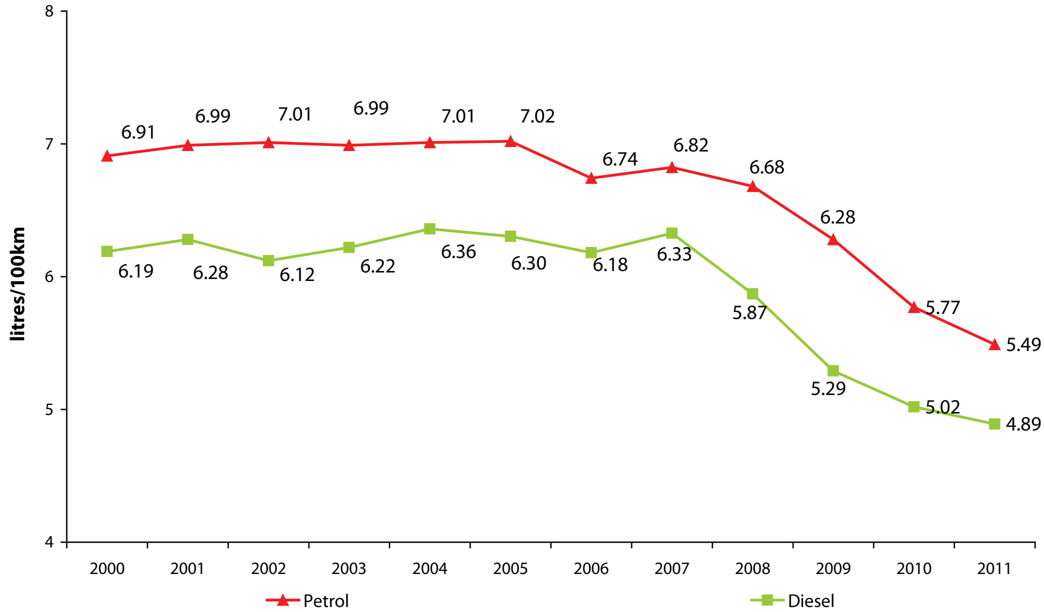
All new cars have fuel consumption figures (measured under test conditions) quoted for urban, extra-urban and combined driving. It is possible to arrive at an average test efficiency figure for new cars entering the national fleet weighted by the sales figures for each individual model.

The weighted average of the fuel consumption of new cars first registered in the years 2000 – 2011 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.

56 European Environment Agency, 2012, *Monitoring CO_2 emissions from new passenger cars in the EU: summary data for 2011*, http://www.eea.europa.eu/publications/monitoring-co2-emissions-from-new.

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

Figure 63 *Weighted Average Specific Fuel Consumption of New Cars 2000 – 2011*



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 5.49 litres/100km (-19%) in 2011, helped by the change in taxation.

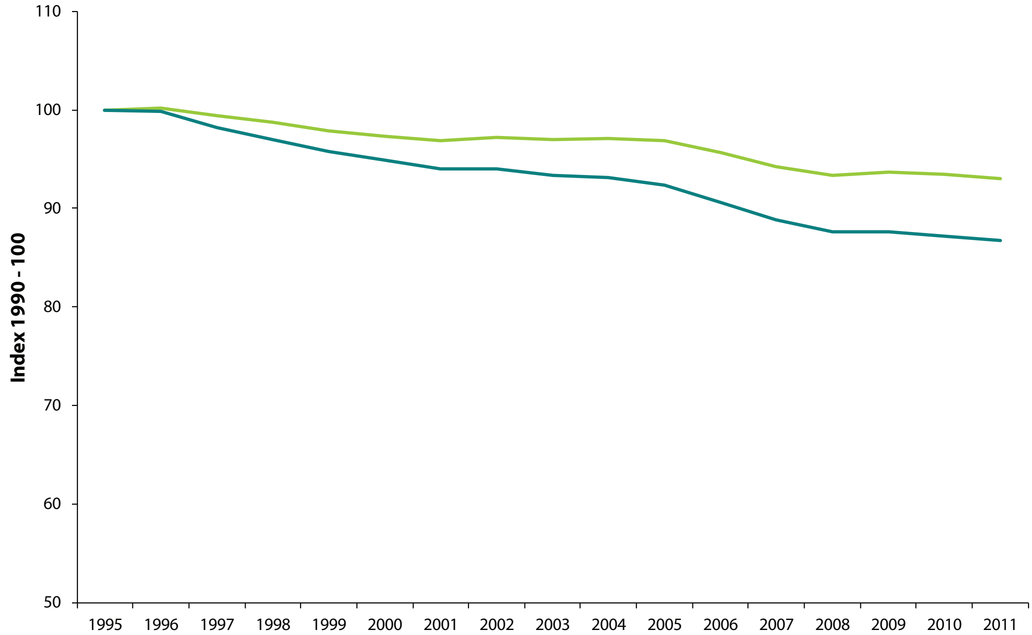
For diesel cars the average fuel efficiency improved slightly over the period 2000 - 2006 by 0.2% to 6.18 litres/100km. As with petrol cars, diesel private car specific fuel consumption has been falling since 2007. In 2008 the taxation change had more of an effect on new diesel cars; the average fuel efficiency fell to 5.87 litres/100km, an improvement of 7.3%, and there was a further improvement each year with the consumption falling to 4.89 litres/100km in 2011 – 23% below the pre-taxation change of 6.33 litre/100km in 2007.

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 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.

4.2.5 Transport Sector Energy Efficiency

Two ODEX indicators examine efficiency for the transport sector as a whole in *Figure 64*. Note that air transport is not included as per the Energy Services Directive 2006/32/EC.

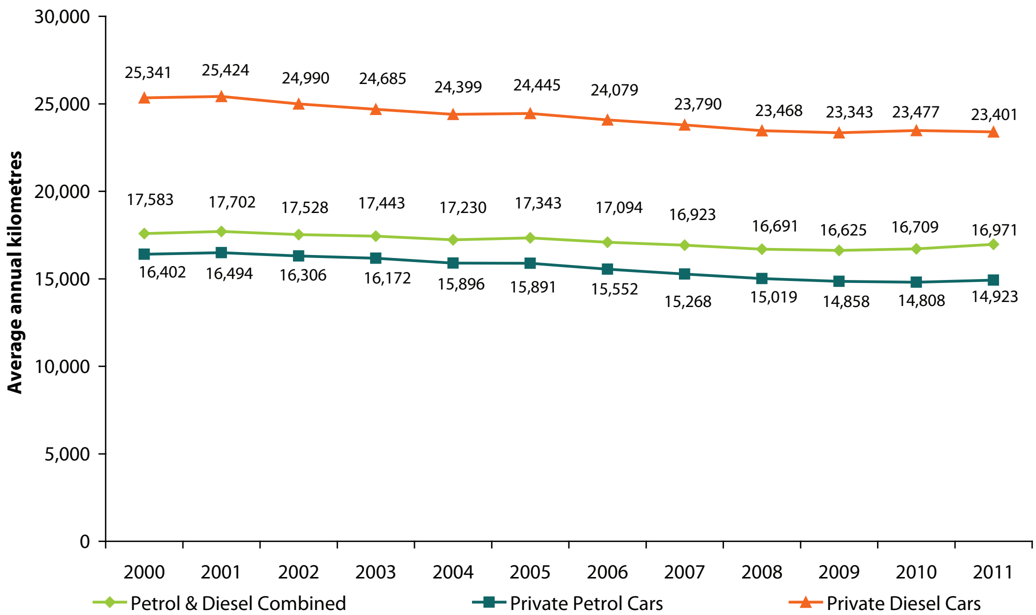
Figure 64 *Transport ODEX 1995 - 2011*



The transport observed ODEX fell by 7%[58] (0.5% per annum) over the period 1995 – 2011 while the technical ODEX decreased by 13.3% (0.9% per annum).

4.2.6 Private Car Average Annual Mileage

Figure 65 *Private Car Average Annual Mileage 2000 – 2011*



Source: Based on NCT Data

SEAI's report *Energy in Transport - 2007 Report*[59] first profiled private car average annual mileage. Refining and updating of the results took place since and the revised figures are presented here. These are based on the analysis of 10.5 million National Car Test (NCT) results.

58 7% improvement in transport sector energy efficiency
59 Sustainable Energy Ireland (2007), *Energy in Transport – 2007 Report*, www.seai.ie/statistics.

Figure 65 presents the results of the NCT analysis for the period 2000 – 2011. The combined average mileage for petrol and diesel cars in 2011 was 16,971 kilometres (10,454 miles). Diesel cars had an average mileage of 23,401 km (14,541 miles) with the average for petrol being 14,923 km (9,273 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.

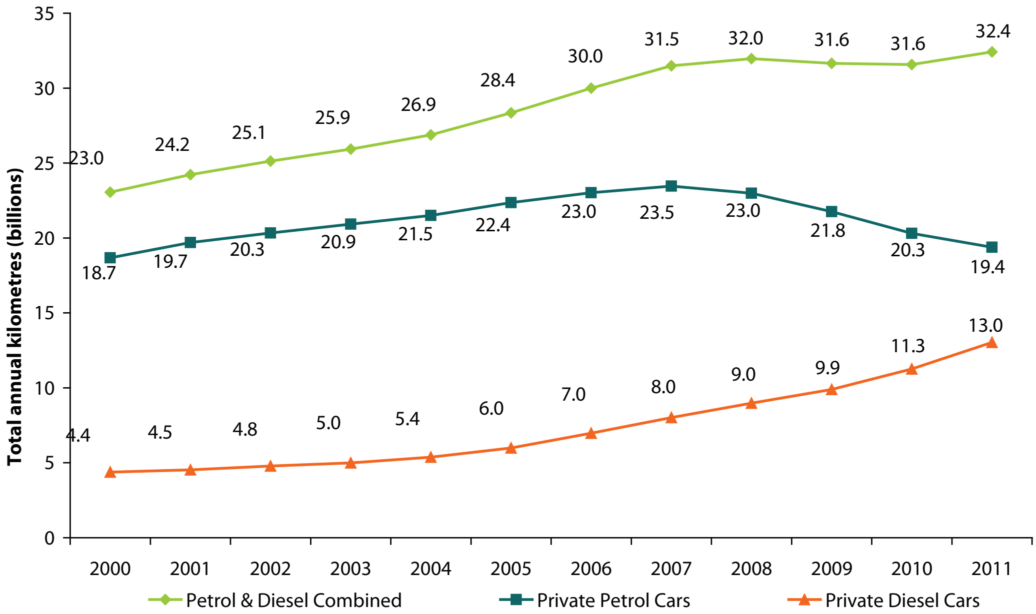
Overall average annual mileage per private car increased by 1.6% in 2011 compared to 2010. Petrol car mileage increased by 0.8% and diesel car mileage decreased by 0.3%.

Average mileage for all private cars has fallen by 3.5% (0.3% per annum on average) over the period 2000 to 2011. Petrol car annual mileage fell by 9% (0.9% per annum) while diesel car average mileage fell by 7.7% (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 41% over the period 2000 to 2011 (see *Figure 66*). Total mileage by petrol cars increased by 3.7% and diesel cars by 195%.

Figure 66 *Total Private Car Annual Mileage 2000 – 2011*



Source: Based on NCT Data

Figure 66 shows overall travel in petrol cars has been falling since 2007, a 17% reduction, while travel by diesel cars continued to rise. Indeed the rate of increase of overall travel by diesel cars increased after 2007 to 13% per annum compared with 9% per annum between 2000 and 2007. 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.[60]

In 2000, 81% of total mileage was fuelled by petrol and 19% by diesel. In 2011, petrol accounted for 60% and diesel for 40%.

60 A note of caution, as the mileages are based on NCT tests and new cars are only first tested when they are four years old there is an inherent lag in the recording of the changing mileage patterns in this data.

4.3 Residential

Residential final energy use grew by 26% (1.1% per annum) over the period 1990 – 2011 to a figure of 2,836 ktoe in real terms. Corrected for weather the growth was 19%. During this time the number of households[61] in the State increased by 64% from approximately 1.0 million to 1.65 million[62]. Residential energy use decreased by 13% during 2011. 2011 was significantly milder than 2010 in terms of degree days (20% less degree days[63]). When corrections for weather effects[64] are taken into account there was a decrease of 2.2% in energy use (see *Table 31*).

Figure 67 *Residential Final Energy Use by Fuel*

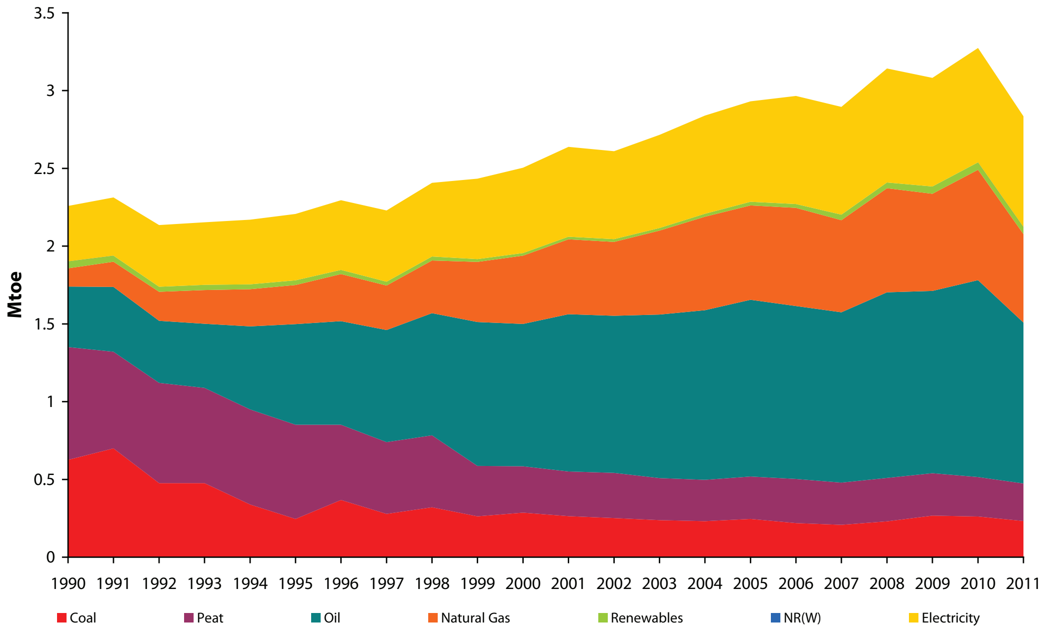


Figure 67 shows significant changes in the mix of fuels that have been consumed in the residential sector over the period. This can largely be explained by the move away from the use of open fires and solid fuel fired back-boiler heating systems that were popular in the 1970s and 1980s. New houses built in the 1990s predominantly had oil or gas-fired central heating, or in some cases electric storage heating, and there has also been a trend since the late 1980's 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, July 2008 and December 2011, all which had the effect of significantly strengthening the insulation, heating system and overall energy performance requirements of the new housing stock.

The increase in electricity usage in households may in part 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 67*, oil has become the dominant fuel in the residential sector, more than doubling its share from 17% in 1990 to 39% in 2010 but falling back to 36% in 2011. Electricity is the second most dominant energy form in the sector at a little over 25%. Natural gas usage increased by a factor of almost six over the period to become the third fuel of choice at 20% share. The renewables share of energy used in households in 2011 was 1.6%.

The growth rates, quantities and shares are tabulated in *Table 31*. All forms of energy used in households experienced reductions in consumption in 2011.

61 Defined as the number of private households in permanent housing units.

62 Based on Central Statistics Office (2012), *Census 2011 Profile 4 The Roof over our Heads.*

63 See Glossary for definition of 'degree days'.

64 Annual variations in weather affect the space heating requirements of occupied buildings. Weather correction involves adjusting the energy used for space heating by benchmarking the weather in a particular year with that of a long-term average measured in terms of number of degree days.

Table 31 *Growth Rates, Quantities and Shares of Final Consumption in Residential Sector*

	Growth %	Average annual growth rates %				Quantity (ktoe)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Fossil Fuels (Total)	11.9	0.5	3.1	1.9	-16.6	1,857	2,078	82.2	73.3
Coal	-62.9	-4.6	-3.0	1.2	-11.1	626	232	27.7	8.2
Peat	-66.7	-5.1	-1.8	-1.5	-4.8	725	241	32.1	8.5
Briquettes	-49.3	-3.2	-5.5	-0.5	-10.8	155	79	6.9	2.8
Oil	165.8	4.8	4.4	2.2	-18.3	389	1,035	17.2	36.5
Gas	385.5	7.8	6.7	3.2	-19.8	117	569	5.2	20.1
Renewables	2.3	0.1	5.6	16.4	-5.6	45	46	2.0	1.6
Combustible Fuels (Total)	10.4	0.5	3.1	2.0	-16.6	1,902	2,100	84.2	74.1
Electricity	100.0	3.4	3.3	2.6	-3.1	356	712	15.8	25.1
Total	**25.6**	**1.1**	**3.2**	**2.2**	**-13.4**	**2,258**	**2,836**		
Total Climate Corrected	**18.6**	**0.8**	**3.8**	**-0.7**	**-2.2**	**2,378**	**2,819**		

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

- As the weather in 2011 was significantly milder than 2010 there was a reduction in the demand for all fuel types.
- Direct renewables usage in households decreased by 5.6% in 2011 to 46 ktoe and its share dropped from 2% to 1.6% since 1990. The reduction in the 1990's is associated with a shift from open fires to central heating systems. There has been an increase in renewables in the last decade, with the availability of wood pellet/chip boilers and stoves.
- Oil usage increased by 166% over the period 1990 – 2011 to 1,035 ktoe and its share in the residential sector grew from 17% to 36%. There was an 18% drop in oil consumption in households in 2011.
- Electricity consumption decreased by 3.1% in 2011 to 712 ktoe (8,283 GWh) and its share of residential final consumption now stands at 25%.
- Natural gas usage fell by 20% in 2011 to 569 ktoe.
- Coal usage decreased by 11% in 2011 to 232 ktoe.
- Sod peat usage fell by 4.8% in 2011 and peat briquette usage decreased by 10.8% Total peat consumption was 241 ktoe in 2011.
- Overall fossil fuel use in households fell by 17% to 2,078 ktoe in 2011.

In 2011 residential sector energy-related CO_2 emissions were 10,479 kt CO_2 representing 27% of the total (energy-related). The residential sector total was the second largest after transport (34%).

Over the period 1990 to 2011 energy-related CO_2 emissions from the residential sector decreased by 2.7% (0.1% on average per annum) while those in transport, services, and industry rose, respectively, by 117% (3.8% per annum), 8.7% (0.4% per annum), and 4.5% (0.2% per annum). If upstream emissions associated with electricity use are excluded, the CO_2 emissions from direct fossil fuel use in the residential sector fell by 8.8% compared with 1990.

The residential sector is specifically examined in more detail with respect to energy-related CO_2 emissions in *Figure 68* and the relatively constant or flat overall trend can be seen. While final energy use in the sector increased by 26% over the period, its energy-related CO_2 emissions fell by 2.7%, illustrating the effect of the changing fuel mix on energy related emissions.

Figure 68 *Residential Energy-related CO_2 by Fuel*

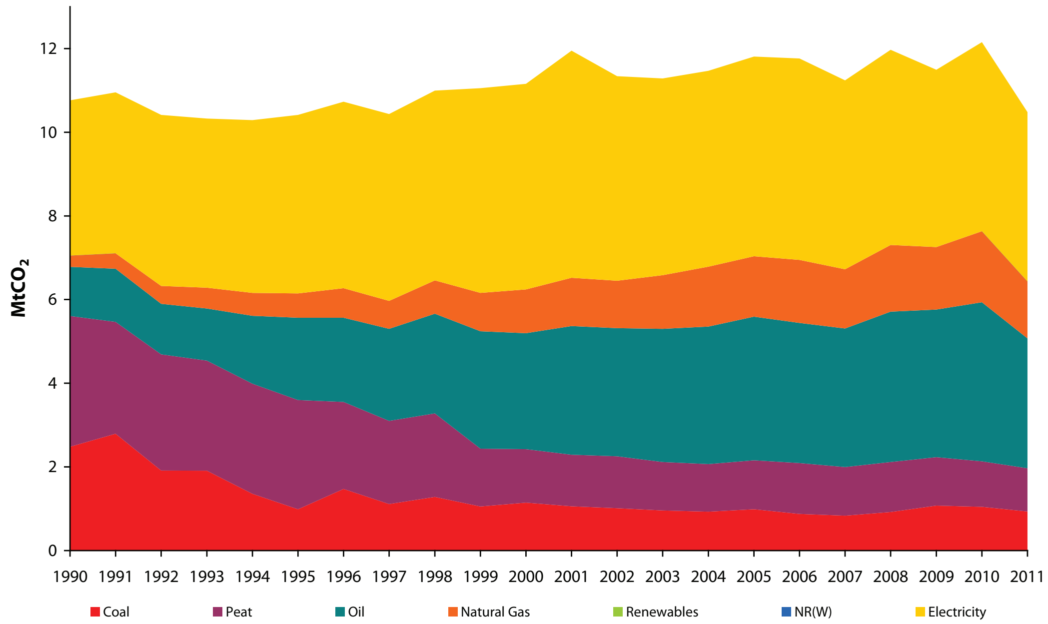


Table 32 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions in Residential Sector*

	Growth %	Average annual growth rates %				Quantity (kt)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Coal	-62.4	-4.6	-2.9	1.1	-11.0	2,484	933	23.1	8.9
Peat	-66.9	-5.1	-1.7	-1.5	-4.7	3,123	1,034	29.0	9.9
Briquettes	-49.3	-3.2	-5.5	-0.5	-10.8	642	325	6.0	3.1
Oil	164.3	4.7	4.3	2.1	-18.3	1,175	3,106	10.9	29.6
Gas	403.9	8.0	6.7	3.3	-19.9	270	1,359	2.5	13.0
Renewables	-	-	-	-	-	-	-	0.0	0.0
Combustible Fuels (Total)	-8.8	-0.4	2.4	1.6	-15.7	7,052	6,432	65.5	61.4
Electricity	9.0	0.4	-0.6	-1.1	-10.5	3,713	4,047	34.5	38.6
Total	**-2.7**	**-0.1**	**1.1**	**0.6**	**-13.8**	**10,764**	**10,479**		

4.3.1 Unit Consumption of the Residential Sector

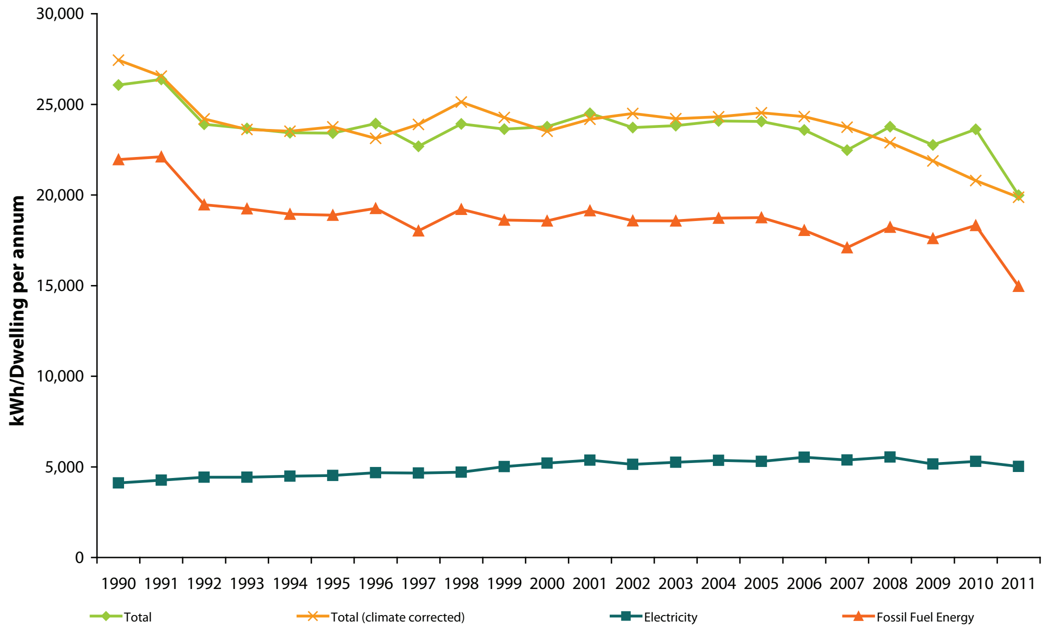
The unit consumption of the residential sector is typically defined in terms of the unit consumption of energy or the energy consumed per dwelling. *Figure 69* shows the trend in unit consumption per dwelling, which decreased by 23% during the period 1990 – 2011.

While overall unit energy use per dwelling has decreased by 23% since 1990, *Figure 69* also shows an increasing trend in electricity consumption per dwelling. This has increased by 22% 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 contrast, fossil fuel consumption per dwelling has decreased by 32% over the period.

In 2011 the "average" dwelling consumed a total of 19,875 kWh of energy based on climate corrected data, 4.4% below the 2010 level. This was comprised of 14,858 kWh (75%) in the form of direct fossil fuels and the remainder (5,016 kWh) as electricity.

Figure 69 also shows overall unit energy use per dwelling, corrected for climate variations. Looking at this and in conjunction with *Table 35*, it can be seen that the decrease in climate corrected energy use per dwelling over the period was 28% while the uncorrected energy use decrease was 23%. 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 Homes Scheme.

Figure 69 *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 33* and *Figure 70*. Larger houses have higher space-heat requirements and they also have proportionally greater surface area and therefore higher heat losses. *Table 33* shows that the fastest rate of growth in the floor area of new houses and flats occurred in the 2005 – 2011 period.

Table 33 *Growth Rates in Residential Floor Areas per New Dwelling*[65]

	Growth %	Average annual growth rates %					
	1990 – 2011	1990 – '11	1990 – '95	1995 – '00	2000 – '05	2005 – '10	2011
New Houses	46.2	1.8	-0.1	2.0	0.9	5.1	-0.7
New Flats	60.9	2.3	0.3	3.1	0.5	3.1	13.6

Average floor areas of new houses grew from 130 square metres in 1990 to 190 square metres in 2011 (an increase of 46%). 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 decreased by 0.7% in 2011. Average floor areas of new flats showed a stronger growth over the period from 64 square metres to 103 square metres (61%). The average floor area of flats increased by 14% in 2011.

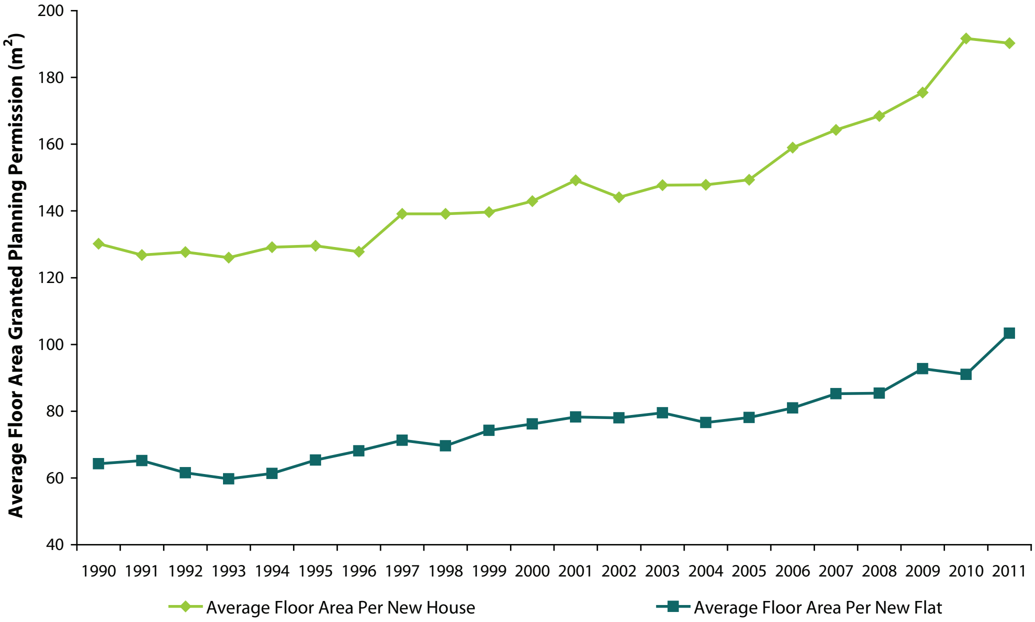
The ratio of new houses to new flats built in 1990 was approximately 25 to 1 whereas in 2011 it was approximately 6.8 to 1.

The 2006 Census[66] notes that in 1991, 6.5% of the housing stock consisted of apartments or flats whereas in 2011 the share was 10%.

65 Note that the figures used in *Table 33* and *Figure 70* 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.

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

Figure 70 *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[67] 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[68]. 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 71*. *Table 34* summarises the growth rates during the period. Over the period 1990 to 2011 the estimated average floor area of the stock of dwellings increased from 100 square metres in 1990 to 119 square metres in 2011.

Table 34 *Growth in Average Floor Area – Housing Stock*

	Growth %	Average annual growth rates %					
	1990 – 2011	1990 – '11	1990 – '95	1995– '00	2000 – '05	2005 – '10	2011
Average Floor Area	19.3	0.8	0.3	1.1	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 2011. 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. In 2011, the average floor area of non-estate houses granted permission was 249 square metres compared to 135 square metres for houses in estates and 103 square metres for flats[69].

In 2007, 52% of the number of units granted planning permission were estate dwellings, 22% non-estate and 26% were apartments. In 2011 these ratios were 42%, 36% and 22% respectively. This explains why there is an increase in the average floor area in 2011 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.

67 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.

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

69 CSO (2012), *Planning Permissions – Quarter 1 2012*. Available at www.cso.ie.

Figure 71 *Average Floor Area of the Housing Stock 1990 – 2011*

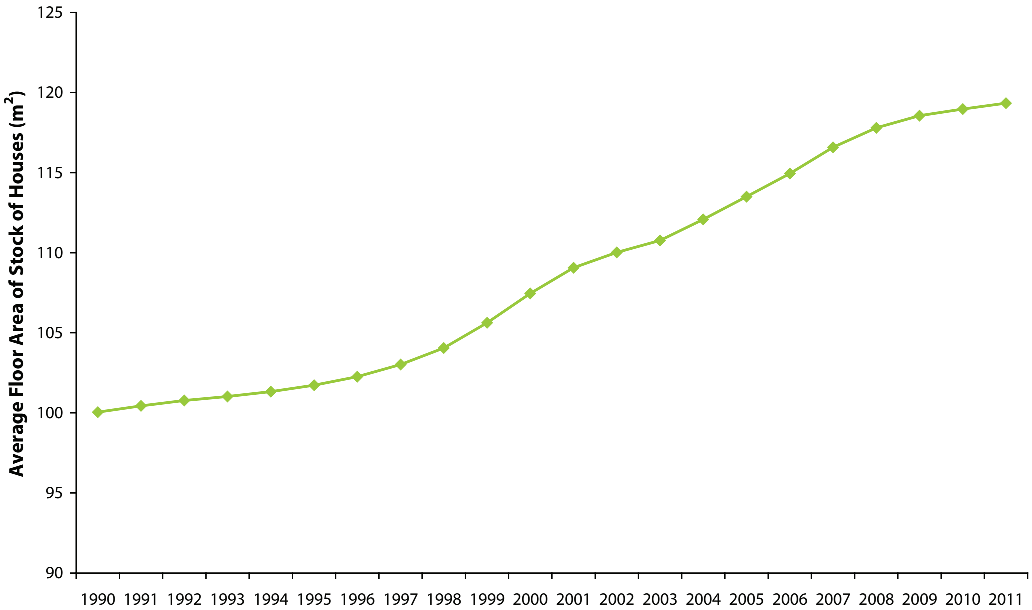


Table 35 *Growth Rates and Quantities of Residential Unit Energy Consumption and Unit CO_2 Emissions*

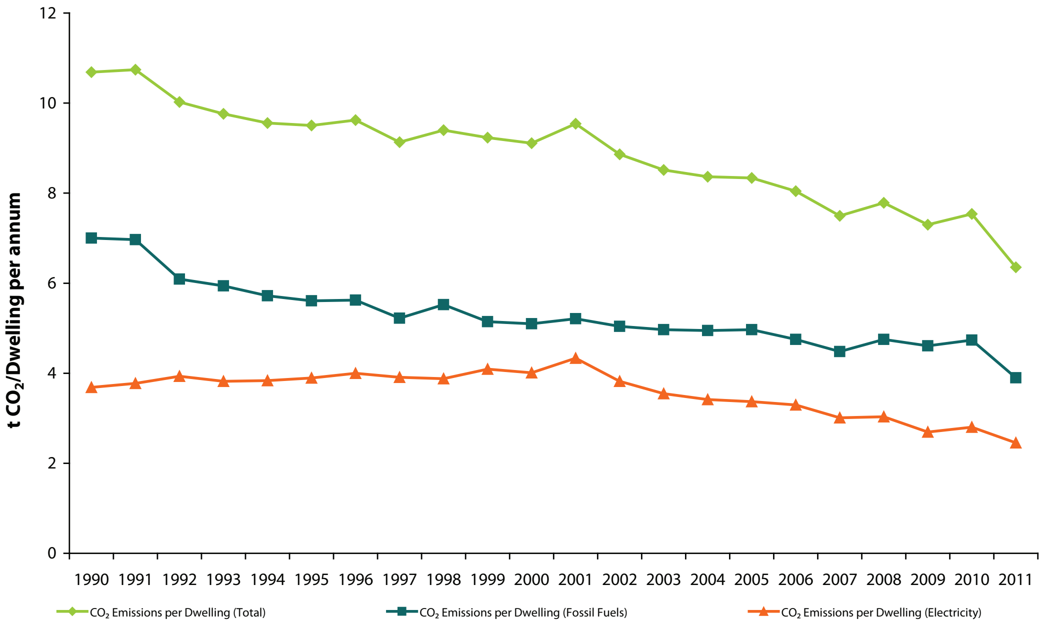
	Growth %	Average annual growth rates %				Quantity (kWh)	
Unit Energy Consumption	**1990 – 2011**	**'90 – '11**	**'00 – '05**	**'05 – '10**	**2011**	**1990**	**2011**
Total Energy	-23.3	-1.3	0.2	-0.4	-15.4	26,068	19,992
Fossil Fuel Energy	-31.8	-1.8	0.2	-0.5	-18.3	21,956	14,971
Electrical Energy	22.1	1.0	0.4	0.0	-5.3	4,112	5,022
Unit Energy Consumption Climate Corrected						**Quantity (kWh)**	
Total Energy Climate Corrected	-27.6	-1.5	0.9	-3.3	-4.4	27,443	19,875
Fossil Fuel Energy Climate Corrected	-36.2	-2.1	1.0	-4.0	-4.9	23,295	14,858
Electrical Energy Climate Corrected	20.9	0.9	0.5	-0.6	-2.9	4,148	5,016
Unit Energy-Related CO_2 Emissions						**Quantity (t)**	
Total Energy CO_2	-40.5	-2.4	-1.8	-2.0	-15.7	10.7	6.4
Fossil Fuel CO_2	-44.3	-2.7	-0.5	-1.0	-17.6	7.0	3.9
Electricity CO_2	-33.4	-1.9	-3.4	-3.6	-12.5	3.7	2.5

Examining *Table 35* and *Figure 72* over the period 1990 to 2011, the emissions of energy-related CO_2 per dwelling fell by 40% while the reduction for unit energy use was 23%. The unit fossil fuel CO_2 emission levels fell by 44% 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 5.8% and 3.8% respectively. Total unit energy-related CO_2 emissions in 2011 fell by 16%. This was as a result of 2011 being much milder than 2010. Climate corrected, the unit energy consumption per household was 4.4% lower in 2011 than in 2010 compared with an uncorrected 15% decrease.

Emissions associated with the use of electricity per dwelling fell by 33% over the period, despite the 22% 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 2011 the "average" dwelling was responsible for emitting approximately 6.4 tonnes of energy-related CO_2. A total of 3.9 tonnes CO_2 (61%) came from direct fuel use and the remainder indirectly from electricity use. Overall emissions per dwelling have fallen by 41% since 1990 and 24% since 2005.

Figure 72 *Unit Energy-Related CO_2 Emissions per Dwelling*

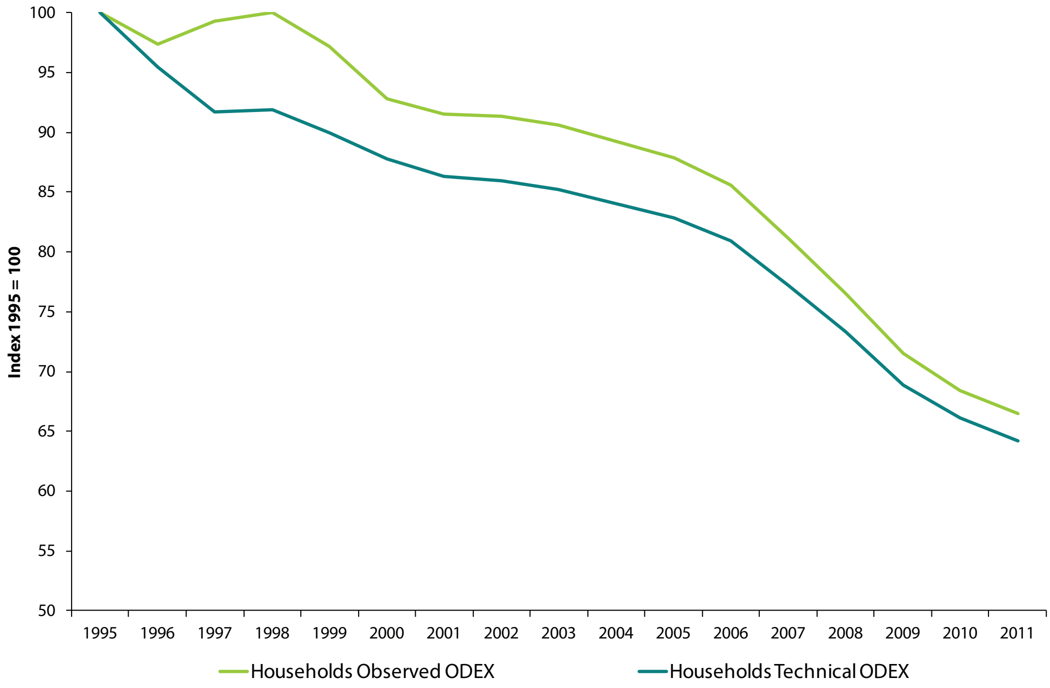


4.3.2 Residential Sector Energy Efficiency

Two ODEX indicators are shown in *Figure 73* 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 34% over the period (2.5% 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 36% (2.7% 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 73 *Household ODEX 1995 - 2011*



4.4 Commercial and Public Services

Final energy use in the commercial and public services sector grew by 33% (1.4% per annum) over the period 1990 – 2011 to a figure of 1,333 ktoe. Growth was 26% if climate corrected energy use is considered. During this period the value added generated by the sector grew by 141% while the numbers employed increased by 115%.

Figure 74 *Commercial and Public Services Final Energy Use by Fuel*

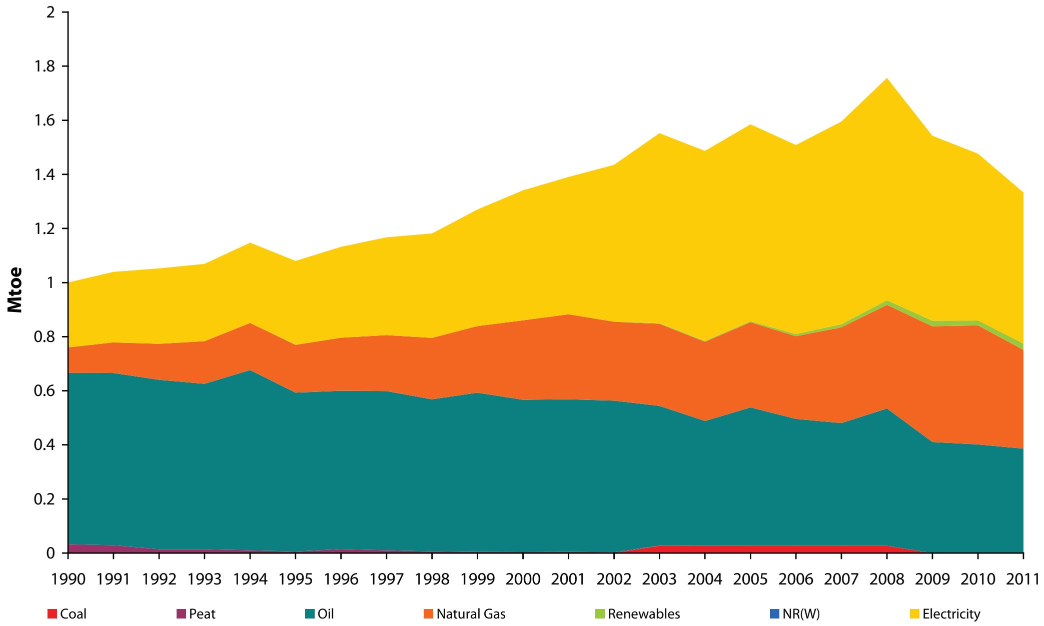


Figure 74 shows the changes in the fuel mix in the services sector over the period. One interesting feature is the small range of fuels utilised in this sector – essentially oil, gas and electricity accounting for 98% of the energy use. Oil and gas are used predominantly for space-heating purposes but also for water heating, cooking and, in some subsectors, laundry. Gas consumption increased by 288% since 1990 to 365 ktoe although this was from a low base.

Electricity consumption in services increased by 133% (4.1% per annum) between 1990 and 2011 to 560 ktoe (6,507 GWh) and has a higher share at 42% 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, quantities and shares are tabulated in *Table 36*.

Table 36 *Growth Rates, Quantities and Shares of Final Consumption in the Commercial & Public Services Sector*

	Growth %	Average annual growth rates %				Quantity (ktoe)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Fossil Fuels (Total)	-1.2	-0.1	-0.2	-0.3	-10.7	760	751	76.0	56.3
Coal	-	-	-	-	-	1	-	0.1	0.0
Oil	-39.0	-2.3	-1.9	-4.7	-3.8	634	386	63.3	29.0
Natural Gas	288.1	6.7	1.4	6.9	-17.1	94	365	9.4	27.4
Renewables	46662.1	34.0	143.3	34.8	23.3	0	22	0.0	1.7
Combustible Fuels (Total)	1.4	0.1	-0.1	0.0	-10.1	760	771	76.0	57.8
Electricity	132.8	4.1	8.7	-3.2	-9.3	240	560	24.0	42.0
Total	**33.2**	**1.4**	**3.4**	**-1.4**	**-9.7**	**1,001**	**1,333**		
Total Climate Corrected	**25.6**	**1.1**	**4.0**	**-4.1**	**1.1**	**1,055**	**1,325**		

The key trends are as follows:

- Final energy use grew by 33% over the period 1990 – 2011 (1.4% per annum). The increase was 26% when corrected for climate. Overall energy use in this sector fell by 9.7% in 2011, or increased by 1.1% on a climate corrected basis.
- Oil, gas and electricity make up 98% 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 133% over the period 1990 – 2011 and its share went from 24% to 42%. Electricity consumption in services decreased by 9.3% in 2011 to 560 ktoe.
- Oil consumption decreased by 3.8% in 2011 to 386 ktoe. The share of oil in final consumption of the sector fell from almost 64% in 1990 to 29% in 2011.
- Natural gas consumption fell by 17% in 2010 to 365 ktoe. Its share has grown from 9.4% in 1990 to 27% in 2011.
- Overall fossil fuel use in services decreased by 10.7% in 2011.
- Renewable energy use in services increased by 23% in 2011. The share of renewables in services was 1.7% in 2011.

Figure 75 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 fell by 11.1% over the period and the emissions associated with electricity consumption increased by 27%. In 2011 the non-electricity emissions decreased by 10% and the electricity associated emissions in services fell by 16%. Overall energy-related CO_2 emissions in this sector decreased by 14% in 2011 to 5.2 Mt CO_2 – down from 6.1 Mt CO_2 in 2010.

In the services sector, the share of emissions associated with electricity demand in 2011 was 61% 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 75 *Commercial and Public Services Sector CO_2 Emissions by Fuel*

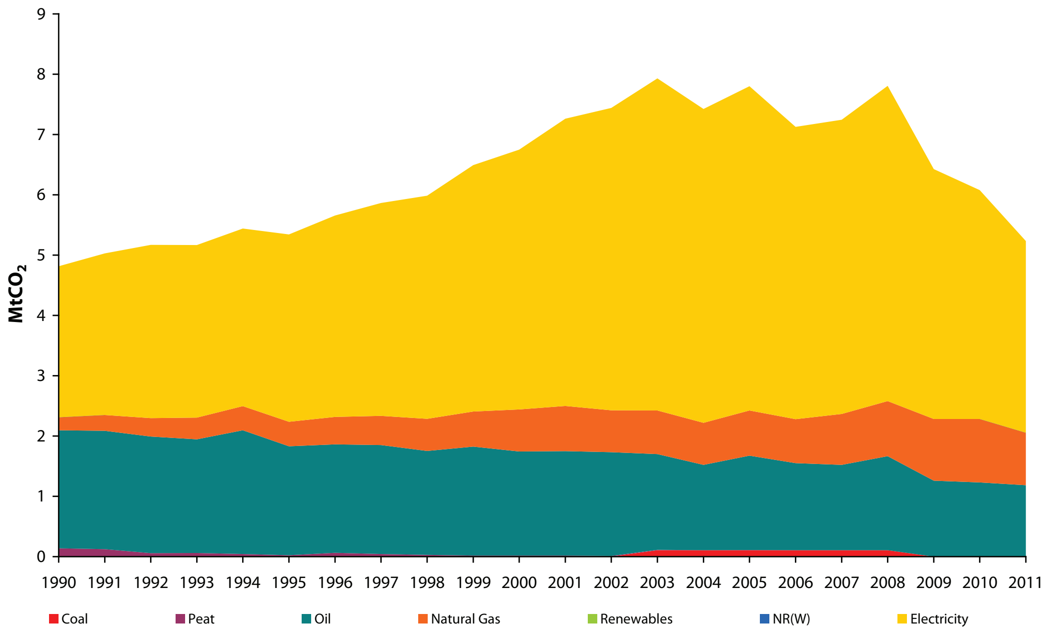


Table 37 *Growth Rates, Quantities and Shares of CO_2 Emissions in Commercial/Public Services*

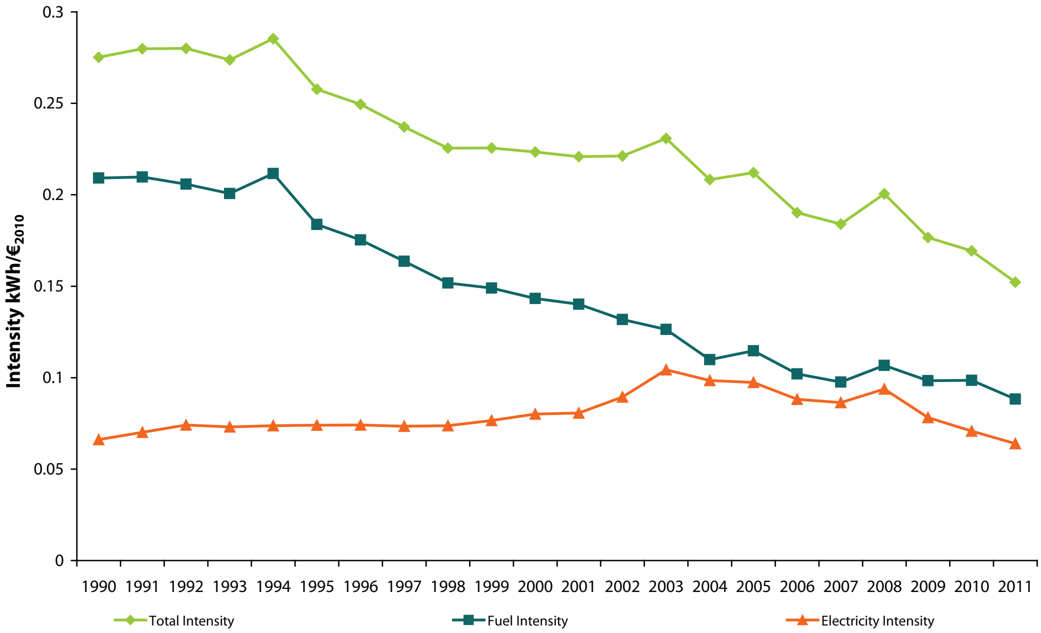
	Growth %	Average annual growth rates %				Quantity (kt)		Shares %	
	1990 – 2011	'90 – '11	'00 – '05	'05 – '10	2011	1990	2011	1990	2011
Combustible Fuels	-11.1	-0.6	-0.1	-1.2	-10.0	2,311	2,054	48.0	39.2
Electricity	26.9	1.1	4.5	-6.7	-16.2	2,505	3,179	52.0	60.8
Total	**8.7**	**0.4**	**2.9**	**-4.9**	**-13.9**	**4,817**	**5,234**		

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 76*, 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 45% lower in 2011 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. Energy intensity in services fell by 10% in 2011.

Electricity intensity increased by 58% up to 2003 and has been falling since with the exception of 2008. In 2011 electricity intensity fell 39% below the peak in 2003 and 3.4% below the 1990 level.

Figure 76 *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 77* it can be seen that unit consumption of electricity was rising steadily since 1990. By 2003 it was 58% higher than in 1990 but by 2011 it had fallen back to 8.1% above 1990 levels. Electricity use per employee decreased by 8.2% in 2011.

Fuel consumption per employee also decreased in 2011, by 8.9% and stood at 53% below 1990 levels. If corrections are made for the effects of climate then the fuel consumption per employee actually increased by 7.1% in 2011 when compared with 2010.

Figure 77 *Unit Consumption of Energy & Electricity per Employee in the Services Sector*

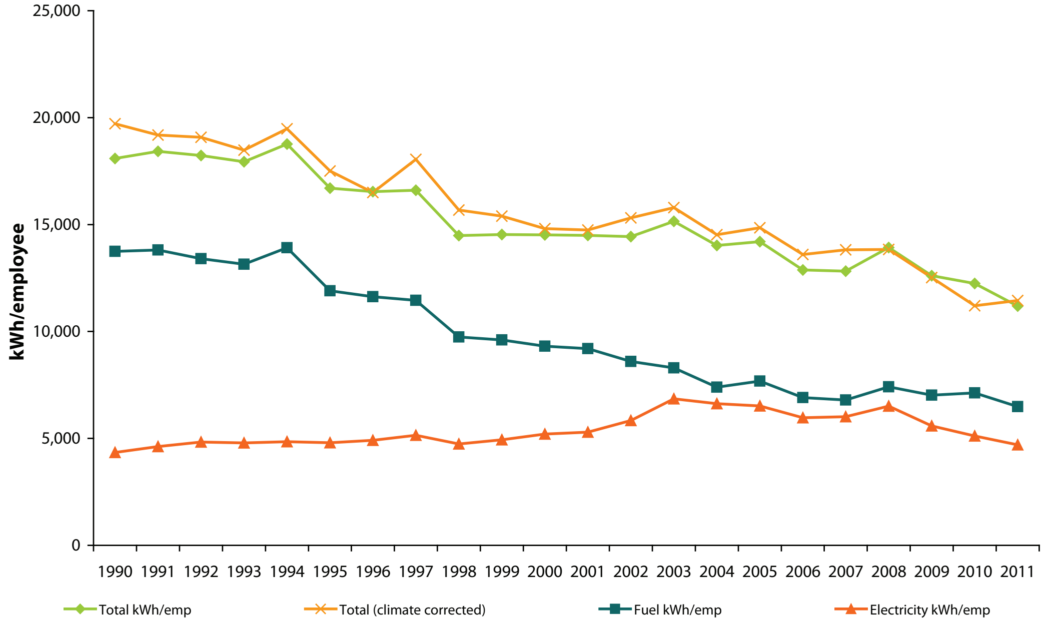


Table 38 *Growth Rates and Quantities of Unit Consumption per Employee in Commercial/Public Services*

	Growth %	Average annual growth rates %				Quantity (kWh)	
	1990 – 2011	1990 – '11	2000 – '05	2005 – '10	2011	1990	2011
Total kWh/employee	-38.2	-2.3	-0.4	-2.9	-8.6	18,094	11,189
Fuel kWh/employee	-52.8	-3.5	-3.8	-1.5	-8.9	13,747	6,491
Electricity kWh/employee	8.1	0.4	4.6	-4.7	-8.2	4,347	4,698
Climate Corrected (cc)							
Total kWh/employee (cc)	-41.7	-2.5	0.1	-5.5	2.3	19,079	11,126
Fuel kWh/employee (cc)	-56.1	-3.8	-3.0	-5.3	7.1	14,654	6,439
Electricity kWh/employee (cc)	5.9	0.3	4.9	-5.9	-3.5	4,425	4,687

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.

Weather Correction: Annual variations in weather affect the space heating requirements of occupied buildings. Weather 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

From:	To: toe	MWh	GJ
	Multiply by		
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		
(2011)	135.7	488.6

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

ESB Networks

European Commission DG TREN

EU-funded SAVE II ODYSSEE Project

Eurostat

International Energy Agency

Met Éireann

Revenue Commissioners

Vehicle Registration Unit

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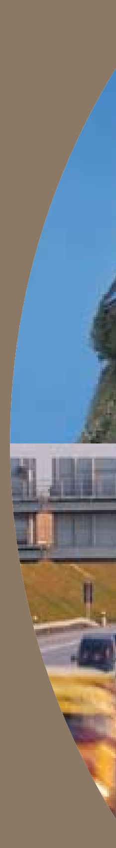
Energy Balance 2011

kilo tonnes of oil equivalent (ktoe)	Coal	Peat	Oil	Natural Gas	Renewables	Non-Renew/Waste	Electricity	Total
Indigenous Production	0	760	0	285	742	14		1,801
Imports	1,423	0	8,776	3,853	84		63	14,198
Exports	8	9	1,602	0	1		21	1,641
Mar. Bunkers	0	0	108		0			108
Stock Change	-152	10	35	1	5			-100
Primary Energy Supply (incl non-energy)	**1,264**	**761**	**7,101**	**4,138**	**831**	**14**	**42**	**14,151**
Primary Energy Requirement (excl. non-energy)	**1,264**	**761**	**6,820**	**4,138**	831	14	**42**	**13,869**
Transformation Input	**913**	**576**	**3,044**	**2,506**	**79**	**0**	**19**	**7,136**
Public Thermal Power Plants	913	473	48	2,254	71			3,759
Combined Heat and Power Plants	0	7	7	246	8			267
Pumped Storage Consumption							0	0
Briquetting Plants	0	96	0		0			96
Oil Refineries & other energy sector	0	0	2,990	6	0		18	3,014
Transformation Output	**0**	**85**	**3,015**	**0**	**29**	**0**	**1,900**	**5,029**
Public Thermal Power Plants	0	0	0		26		1,730	1,756
Combined Heat and Power Plants - Electricity	0	0	0		3		169	173
Combined Heat and Power Plants - Heat					0			0
Pumped Storage Generation							0	0
Briquetting Plants		85	0		0			85
Oil Refineries		0	3,015		0			3,015
Exchanges and Transfers	**19**	**0**	**-19**	**0**	**-467**	**0**	**467**	**0**
Electricity					-467		467	0
Heat								0
Other	19		-19		0			0
Own Use and Distribution Losses	**0**	**18**	**95**	**66**	**0**		**272**	**451**
Available Final Energy Consumption	**370**	**252**	**6,958**	**1,566**	**315**	**14**	**2,118**	**11,593**
Non-Energy Consumption	**0**	**0**	**281**	**0**	**0**	**0**	**0**	**281**
Final non-Energy Consumption	0	0	281	0	0			281
Total Final Energy Consumption	**328**	**241**	**6,558**	**1,558**	**315**	**14**	**2,140**	**11,154**
Industry	**95**	**0**	**558**	**624**	**150**	**14**	**816**	**2,257**
Non-energy Mining	0	0	58	12	0		59	130
Food, beverages and tobacco	16	0	130	110	41		174	470
Textiles and textile products	0	0	3	1	0		10	14
Wood and wood products	0	0	3	2	93		35	133
Pulp, paper, publishing and printing	0	0	3	4	0		19	26
Chemicals & man-made fibres	0	0	28	68	0		148	244
Rubber and plastic products	0	0	9	5	0		36	50
Other non-metallic mineral products	80	0	89	18	16	14	52	268
Basic metals & fabricated metal products	0	0	152	262	0		64	478
Machinery and equipment n.e.c.	0	0	6	6	0		21	32
Electrical and optical equipment	0	0	37	129	0		101	266
Transport equipment manufacture	0	0	4	2	0		17	23
Other manufacturing	0	0	35	7	0		79	121
Transport	**0**	**0**	**4,346**	**0**	**98**	**0**	**4**	**4,448**
Road Freight	0	0	637		20			657
Road Private Car	0	0	1,843		46			1,890
Public Passenger Services	0	0	167		5			171
Rail	0	0	40		0		4	44
Domestic Aviation	0	0	6		0			6
International Aviation	0	0	694		0			694
Fuel Tourism	0	0	305		8			313
Navigation	0	0	56		0			56
Unspecified	0	0	599		18			616
Residential	**232**	**241**	**1,035**	**569**	**46**		**712**	**2,836**
Commercial/Public Services	**0**	**0**	**386**	**365**	**22**	**0**	**560**	**1,333**
Commercial Services	0	0	250	160	18		401	829
Public Services	0	0	136	205	4		158	504
Agricultural	**0**	**0**	**212**	**0**	**0**		**48**	**260**
Fisheries	**0**	**0**	**20**		**0**			**20**
Statistical Difference	42	10	119	8	-1	0	-22	157

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.



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