SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Energy in Ireland 1990 – 2015

2016 Report

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Report prepared by
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Sustainable Energy Authority of Ireland

The Sustainable Energy Authority of Ireland's (SEAI) 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.

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 policymakers 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.

Acknowledgements

SEAI gratefully acknowledges the cooperation of the all the organisations, agencies, energy suppliers and distributors that provided data and responded to questionnaires throughout the year.

Foreword


Jim Gannon

At time of writing, the 2015 Paris Agreement has come into force, having met the double threshold of ratification by more than 55 countries, representing at least 55% of global emissions. A testament to how seriously the world and society now takes the threat of climate change is the fact that this took a fraction of the eight years required to get the Kyoto Protocol ratified.

This report provides both a milestone record of our progress in reducing and decarbonising our energy use, while also setting a baseline for future efforts. The deadline for our 2020 targets is approaching at pace, and we are now seeing a slow crystallisation of what our 2030 targets will look like.

In this year's report, there are very clear signals of the challenge ahead for Ireland. With strong economic growth in 2015, overall energy use increased by almost 5% and related emissions by almost 6%, the first time energy use grew to any great extent since 2010. So even though we have had some success in decoupling energy use from economic growth, it is apparent that further work is needed to achieve our evolving decarbonisation goals.

With regard to renewable energy, 2015 saw Ireland reach just over half way mark towards our 2020 renewable energy targets. Similar to our efforts on reducing energy demand, the next phase of decarbonising energy supply will be increasingly challenging. Through a range of approaches, a more widespread understanding of the need for renewables and support for their delivery must be achieved.

Collectively, we must maintain momentum in the electricity sector, and develop greater momentum in the heat and transport sectors. In a political and economic era of rapid change, success will only be achieved by countries which are agile and adaptable to change. As we build new platforms and mechanisms that will bring us to 2030, it is essential that we engage and activate the society who will need to accommodate a rate of change not previously seen.

SEAI is committed to the provision of robust and transparent data, such as that contained in this report, to ensure that the policy formation, decision-making and our energy transition are evidence-based.

Jim Gannon, Chief Executive, Sustainable Energy Authority of Ireland

Highlights

Highlights – the year 2015

- Energy use grew for the first time to any great extent since 2010. In 2015, overall energy use increased by 4.9%, with the economy growing strongly.
- Energy-related CO_2 emissions increased by 5.8% in 2015. When compared with 2005, energy-related CO_2 emissions have fallen by 19%.
- Energy-related emissions account for approximately 60% of Ireland's total greenhouse gas (GHG) emissions.
- Consumption of all fuels increased in 2015 with the exception of peat, biomass and non-renewable wastes.
- Ireland's energy import dependency increased to 88% in 2015 (from 85% in 2014). The cost of all energy imports to Ireland was approximately €4.6 billion, down from €5.7 billion in 2014 due mainly to falling oil and gas import prices.

Electricity

- Final consumption of electricity increased by 2.9% to 29 TWh with a 3.1% increase in the fuel inputs.
- Renewable electricity generation, consisting of wind, hydro, landfill gas, biomass and biogas, increased to 27.3% of gross electricity consumption in 2015.
- In 2015, wind generation accounted for 22.8% of the electricity generated and was the second largest source of electricity generation after natural gas.
- The use of renewables in electricity generation in 2015 reduced CO_2 emissions by 3.2 Mt and avoided €286 million in fossil fuel imports.
- The carbon intensity of electricity fell by 49% since 1990, to a low of 456 g CO_2/kWh in 2014. However, in 2015 it increased by 2.5%, to 468 g CO_2/kWh, primarily as a result of the 19.6% increase in coal used for generation.

Progress towards Targets

- The contribution of renewables to gross final consumption (GFC) was 9.1% in 2015, compared to a 2020 target of 16%. This avoided 3.9 million tonnes of CO_2 emissions and €426 million of fossil fuel imports.
- In 2015, with five years to go, Ireland was just over halfway towards each of the separate targets for contributions of renewable energy in electricity, transport and heat.
- The average emissions of new cars purchased in 2015 was 114.9 g CO_2/km, which is below the 2015 EU target for car manufacturers of 130 g CO_2/km.
- Energy-related CO_2 emissions in those sectors outside the EU Emissions Trading Scheme (ETS), which covers transport, heating in households, buildings and small industry, were 17% below 2005 levels in 2015 but increased by 5.3% in 2015. The target for non-ETS CO_2 emissions is to be 20% below 2005 levels by 2020.

Sectoral Highlights

- Transport continues to dominate as the largest energy consuming sector, with a share of 42% in 2015.
- Transport energy use increased by 5.9% in 2015, with air travel showing the strongest growth in energy use of the transport modes, with a 13% increase on 2014.
- More than three quarters (78%) of all new private cars purchased to date in 2016 were in the A label emissions band.
- In 2015 industry energy use increased by 4.8%, and was 10% lower than the peak in 2006. Between 1990 and 2015, industrial energy consumption increased by 39% while value added increased by 506%.
- Residential energy use increased by 5.2% in 2015 relative to 2014. When corrected for weather effects – 2015 was a colder year than 2014 – the increase in energy use was 3.5%.
- In 2015 the average household emitted 5.5 tonnes of CO_2 of which 61% came from direct fuel use in the home and the remainder from electricity use.
- Final energy use in the commercial and public services sector increased by 0.7% in 2015 – on a weather corrected basis it decreased by 1.1%.

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1 Introduction

This annual publication from the Sustainable Energy Authority of Ireland (SEAI) presents national energy statistics on energy production and consumption in Ireland over the period 1990 – 2015. Specifically, the report presents energy trends and underlying drivers as well as discussing sectoral energy consumption and how energy trends relate to Government and EU renewable energy targets.

Timely and reliable energy statistics underpin evidence-based decision making. To this end, this publication presents a comprehensive overview of energy supply and demand in Ireland in order to inform Government policy and the wider energy debate.

The information in the report is based on an energy balance for the country which shows the flow of energy from production, transformation and energy sector own use through to final consumption in different sectors of the economy. The energy balance is the starting point for the construction of various indicators of energy consumption (for example energy intensity, per capita etc.), of energy efficiency and also of other areas of national interest such as energy-related greenhouse gas (GHG) emissions.

The data in the energy balance is based on monthly and annual surveys received from approximately 300 organisations including energy producers, import/export companies and energy supply companies. In addition, SEAI uses this data to fulfil Ireland's energy statistics reporting obligations to Eurostat[1], under the EU Energy Statistics Regulation (1099/2008 EC), and to the International Energy Agency (IEA) through the completion of upwards of 100 hundred annual, quarterly, monthly and ad hoc questionnaires each year.

The energy balance develops continuously as new methods and methodologies become available. This ensures that the best information is available. The main changes related to the period 1990 – 2015 are presented in this report and are described later.

A companion publication, *Energy Statistics – 2016 Report*, is also available, presenting the background data for the analysis contained herein. Additionally, *Energy in Ireland Key Statistics* is available, which summarises Ireland's energy statistics in a concise pocket-sized booklet. It is intended that these publications serve as resources for policymakers, analysts and researchers with an interest in energy use in Ireland.

An energy data portal containing the background data that this report is based upon, together with energy forecast data, and an electronic version of this and other statistical reports, are available on SEAI's website at http://www.seai.ie/Energy-Data-Portal/.

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

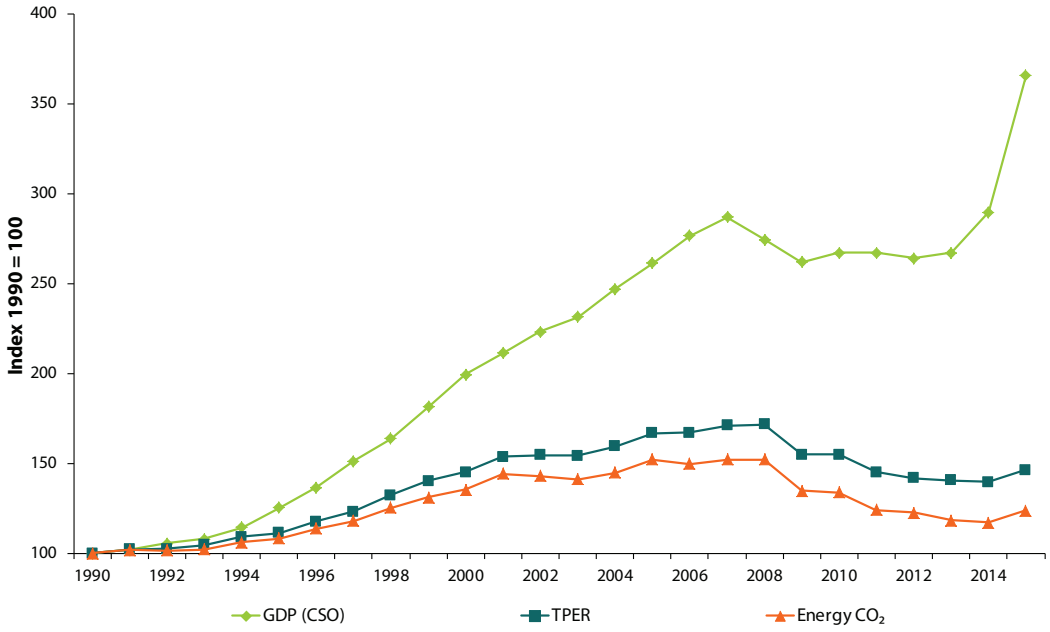
1 Eurostat is the statistical office of the European Union and is situated in Luxembourg.

2 Energy Trends

This section provides an overview of energy trends in Ireland, covering the period 1990 – 2015 with a particular focus on 2015. Ireland's total energy supply (gross energy consumption or total primary energy requirement [TPER]) 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 because of its importance as an energy service and the amount, and various sources, of energy consumed in its generation.

Energy supply depends on the demand for energy services (heating, transportation and electricity uses) and how that demand is delivered. Energy service demand in turn is driven primarily by economic activity and by the energy end-use technologies employed in undertaking the activity. *Figure 1* shows the historical trends for Gross Domestic Product (GDP), TPER and energy CO_2, each expressed as an index relative to 1990. Throughout the 1990s and early 2000s economic growth was particularly strong, especially from 1993 onwards. This resulted in GDP – a measure of economic growth – in 2007 being almost three times that of 1990. In 2008 the economy experienced a downturn that 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 partly due to weather conditions. In 2009, however, all sectors of the economy experienced reductions in energy use and related CO_2 emissions. 2011 to 2013 were mild years compared with 2010 and, notwithstanding the flat growth in GDP, there was a drop in energy demand across all sectors of the economy during these years. In 2015 GDP grew by 26.3%, much of this was attributed to the transfer into Ireland of assets by multinationals, which had little or no effect on energy use.

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



Source: Based on SEAI and CSO data.

Figure 1 shows the relative decoupling of TPER (also known as gross inland consumption[2]) from economic growth since 1992, in particular during 2002 – 2003, 2006 – 2008[3] and 2010 – 2015. 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[4] from

2 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.

3 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. Reduction in demand after 2007 was mainly due to reduced economic activity.

4 Energy-related CO_2 emissions shown here (2015 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.

energy use is also evident, particularly since 1993, and this is due to changes in the fuel mix and the efficiency of the power generation sector. Changes in the fuel mix of the final consuming sectors also contributed to this decoupling with, for example, the move away from high carbon fuels such as coal and peat in the residential sector to lower carbon fuels such as natural gas and, more recently, renewables.

Between 2010 and 2014, the economy grew by 8.4% while energy use has continued to fall, with a cumulative drop of 10% between 2010 and 2014. Some of the reduction in energy use can be accounted for by weather as it has generally been warmer since the very cold year that was experienced in 2010. Other reasons for the reduction can also be attributed to a large increase (83%) in wind generation, which reduced the primary energy requirements for electricity generation. There were also continued improvements in the energy performance of households arising from improved building regulations and SEAI's energy efficiency programmes. Also, in transport, 44% of the private cars on the road in 2015 are the more fuel efficient models purchased since 2008 when the Vehicle Registration and Road Taxes changed to be more favourable towards lower emission vehicles.

2015 saw the first significant increase in overall energy use since before the economic downturn in 2008, with TPER growing by 4.9%. This was linked to increased domestic economic activity as evidenced by the fact that final energy consumption in the industry and transport sectors, which are closely aligned with the economy, increased by 4.8% and 5.9% respectively.

Table 1 displays the growth rates for the economy (GDP), primary energy (TPER) and energy-related CO_2 emissions for the period 1990 – 2015. It highlights the high GDP growth rates compared with those for energy and CO_2 prior to 2008 and the increase in primary energy and energy-related CO_2 in 2015.

It is interesting to compare the trend over the ten year period 2005 – 2015 with that for the whole period, given the significance of 2005 with respect to the *EU Decision 406/2009/EC on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020.* Under the EU Decision, Ireland's GHG emissions in non-Emissions Trading Scheme (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 3.2*. Over the ten years, overall energy-related CO_2 emissions have fallen by 2% per annum on average, an aggregate decrease of 19%, while the economy is 40% larger than it was in 2005. In contrast, over the 25 year period since 1990, on average, energy-related CO_2 emissions grew by 0.9% per annum, while the economy grew by 5.3% per annum.

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

	Growth %	Average annual growth rates %				
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015
GDP	265.5	5.3	5.6	0.5	6.5	26.3
TPER	46.2	1.5	2.8	-1.5	-1.1	4.9
Energy CO_2	23.6	0.9	2.4	-2.5	-1.6	5.8
Energy CO_2 (excl. international aviation)	19.6	0.7	2.2	-2.6	-1.8	5.3

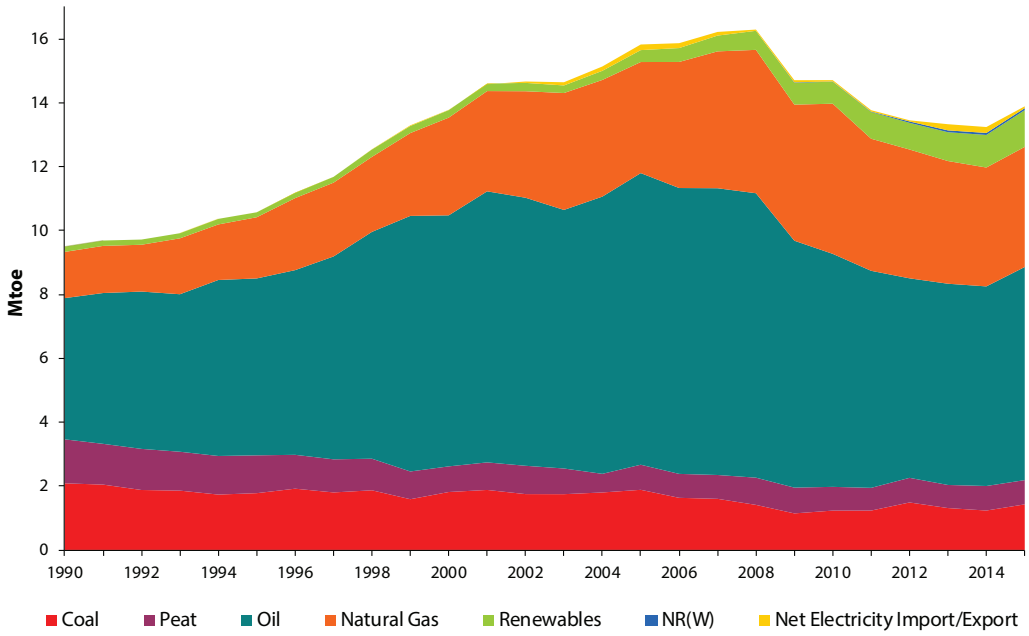
2.1 Energy Supply

Ireland's energy supply is discussed in terms of changes to the TPER, defined as the total amount of energy used in 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 – 2015, emphasising changes in the fuel mix. Primary energy consumption in Ireland in 2015 was 13,889 ktoe. Over the period 1990 – 2015 Ireland's annual TPER grew in absolute terms by 46% (1.5% per annum on average). In 2015 Ireland's primary energy requirement increased by 4.9% following decreases since 2010. Between 2005 and 2015 primary energy requirement fell by 12%.

5 GDP rates are calculated using constant market prices chain-linked annually and referenced to 2014.
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*[7]



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 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Fossil Fuels (Total)	35.2	1.2	2.4	-1.8	-2.0	5.4	9,330	12,618	98.2	90.9
Coal	-31.6	-1.5	0.7	-8.1	3.0	15.7	2,085	1,426	22.0	10.3
Peat	-44.9	-2.4	-0.4	-1.1	0.4	-1.2	1,377	759	14.5	5.5
Oil	50.9	1.7	3.0	-4.4	-1.8	6.8	4,422	6,672	46.6	48.0
Natural Gas	160.0	3.9	2.6	6.2	-4.4	1.0	1,446	3,761	15.2	27.1
Renewables (Total)	585.6	8.0	9.7	13.0	10.8	12.8	168	1,150	1.8	8.3
Hydro	15.7	0.6	-5.7	-1.0	6.1	13.8	60	69	0.6	0.5
Wind	-	-	35.4	20.4	18.5	27.9	0	565	-	4.1
Biomass	166.0	4.0	9.8	3.1	5.9	-7.7	105	281	1.1	2.0
Other Renewables	9852.4	20.2	8.9	33.7	5.0	10.5	2	235	0.0	1.7
Non-Renewable (Wastes)	-	-	-	-	48.6	-1.6	-	62	-	0.4
Electricity Imports (net)	-	-	83.6	-25.5	7.4	-68.7	-	58	-	0.4
Total	**46.2**	**1.5**	**2.8**	**-1.5**	**-1.1**	**4.9**	**9,497**	**13,889**		

The following are the main trends in national fuel share:

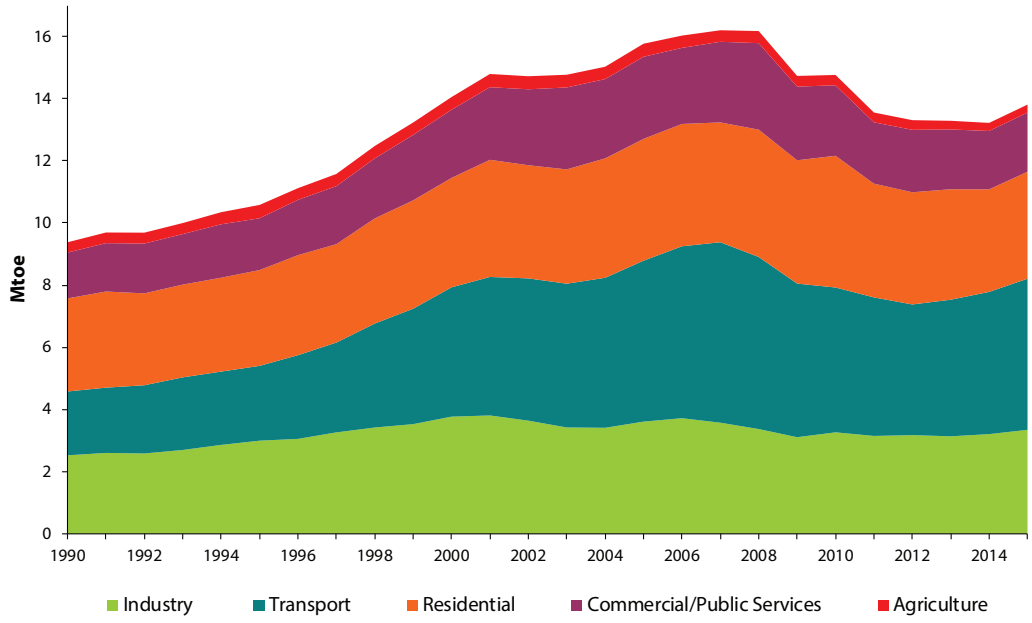
- Overall primary energy use grew by 4.9% in 2015. Consumption of all fuels increased in 2015 with the exception of peat, biomass and non-renewable wastes.
- Fossil fuels accounted for 91% of all energy used in Ireland in 2015, excluding the embodied fossil fuel content of imported electricity. Demand for fossil fuels increased by 5.4% in 2015 to 12,618 ktoe and has fallen 17% since 2005.
- Coal use increased by 16% and its share of TPER increased to 10.3% in 2015 up from 9.3% in 2014. Over the ten years 2005 – 2015, coal demand fell by 24% (2.7% per annum).
- Peat use fell by 1.2% and its share of overall energy use was 5.5% in 2015.
- Oil continues to be the dominant energy source and had a 48% share of TPER in 2015. The share of oil in overall energy use peaked in 1999 at 60%. Consumption of oil, in absolute terms, increased by 6.8% in 2015 to 6,672 ktoe. Over the ten years 2005 – 2015, oil demand fell by 27% (3.1% per annum).

7 'NR(W)' in the chart represents energy from Non-Renewable Wastes.

- Natural gas use increased in 2015 by 1.0% to 3,761 ktoe and its share of TPER was 27%. Over the period 2005 – 2015, natural gas use increased by 8.1% (0.8% per annum).
- Total renewable energy increased by 12.8% during 2015 to 1,150 ktoe. Hydro, wind and other renewables (biofuels, solar and geothermal) grew by 13.8%, 27.9% and 10.5% respectively although biomass use fell by 7.7%. The overall share of renewables in primary energy stood at 8.3% in 2015.
- Energy from non-renewable wastes decreased by 1.6% in 2015 to 62 ktoe and accounted for just 0.4% of primary energy.
- Electricity imports (net) fell by 69% to 58 ktoe in 2015. Electricity imports fell by 39% while exports grew by 53%, resulting in a decrease in net imports of 69%. Net electricity imports accounted for 0.4% of primary energy in 2015.

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 primary energy supply for each sector.

Figure 3 *Total Primary Energy Requirement by Sector*[8]



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 shows the growth rates of the different sectors in terms of TPER and also provides the percentage shares of TPER for 1990 and 2015. All sectors', except agriculture/fisheries, energy use grew in 2015, which can be directly attributed to the growth in the economy and, to a lesser extent, the weather. Energy use in the residential and services sectors is mainly for space heating and 2015 was a little colder than 2014.

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

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Industry	32.5	1.1	-0.9	-2.0	0.5	4.3	2,524	3,344	26.8	24.2
Transport	136.8	3.5	4.5	-2.1	0.9	6.3	2,054	4,863	21.8	35.2
Residential	14.9	0.6	2.2	1.6	-4.1	4.3	2,995	3,442	31.8	24.9
Services	29.2	1.0	3.8	-3.0	-3.4	1.5	1,476	1,906	15.7	13.8
Agriculture / Fisheries	-23.4	-1.1	1.0	-5.2	-5.1	-3.1	359	275	3.8	2.0

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

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

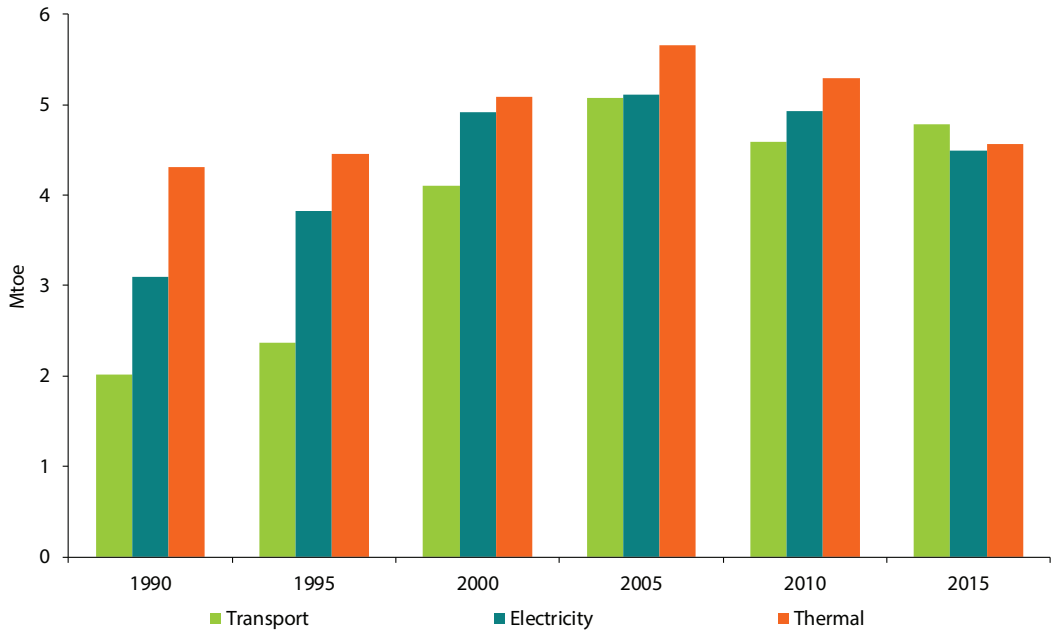
- Transport experienced an increase in primary energy use in 2015 of 6.3% to 4,863 ktoe. Transport primary energy use fell by 28% between 2007 and 2012 but has increased by 16% since then. Transport remains the largest energy consuming sector with a 35% share of primary energy in 2015.
- Industry primary energy increased by 4.3% in 2015 to 3,344 ktoe. Industry's share of primary energy was 24% in 2015.
- In 2015, primary energy use in households increased by 4.3% to 3,442 ktoe. 2015 was colder than 2014 with 3.3% more heating degree days. Residential share of primary energy was 25% in 2015.
- Use of primary energy in the commercial and public services sector increased by 1.5% in 2015 to 1,906 ktoe. Services' share of primary energy was 14% in 2015.
- 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 2015, primary energy in buildings accounted for 39% of primary energy supply. Overall, primary energy use in buildings had increased by 20% since 1990 (0.7% per annum) and in 2015 it grew by 3.3% to 5,348 ktoe.
- Agriculture/fisheries' primary energy use decreased by 3.1% in 2015 to 275 ktoe and accounted for 2% of primary energy.

2.2 Energy Use by Mode of Application

Energy use can be categorised by its mode of application: whether it is used for mobility (transport), power applications (electricity) or for thermal uses (space, water or process heating). These modes also represent three distinct energy markets. Where thermal or transport energy is provided by electricity (e.g. electric heaters and electric vehicles) this energy is considered under electricity, and not under thermal or transport, so that double counting is avoided.

In 1990 thermal uses for energy (4,315 ktoe) accounted for a significant proportion of all primary energy (46%), while electricity accounted for 33% (3,094 ktoe) and transport 21% (2,017 ktoe). This contrasts with the situation in 2015 when the transport share had risen to 35% (4,785 ktoe), the thermal share had fallen to 33% (4,562 ktoe) and the share of energy use for electricity generation fell to 32% (4,500 ktoe). The changes in mode shares are shown in *Figure 4*.

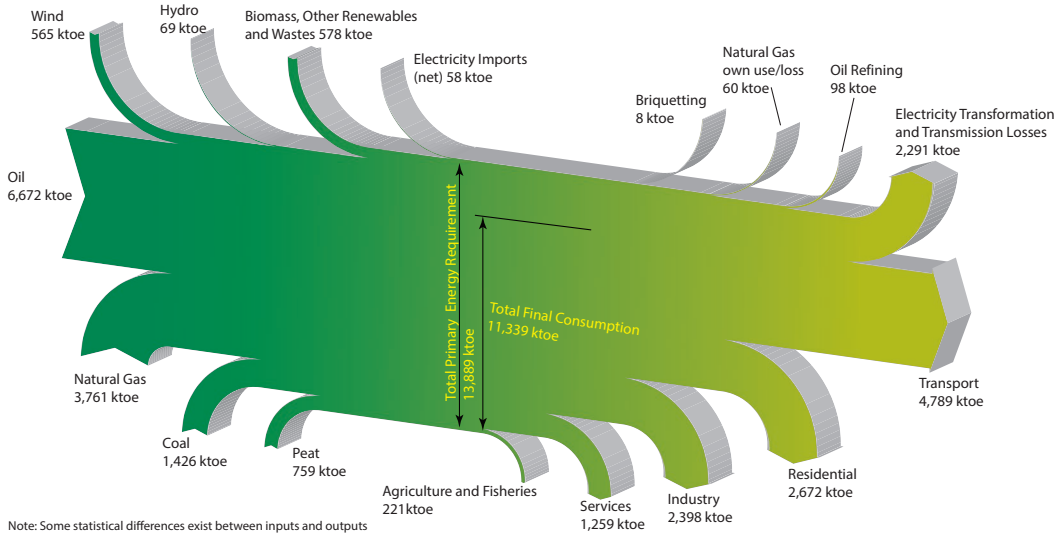
Figure 4 *Primary Energy by Mode of Application*



2.3 Energy Balance for 2015

Figure 5 shows the energy balance for Ireland in 2015 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 2015*[9]



Oil dominates as a fuel, accounting for 6,672 ktoe, representing 48% of the total requirement. Renewables are disaggregated into wind, hydro and other renewables in *Figure 5* and accounted for 8.3% of TPER.

Transport continues to be the largest of the end-use sectors, accounting for 4,789 ktoe, representing 42% of TFC (see *Section 2.4*) in 2015.

Losses associated with the generation and transmission of electricity amounted to 16% of TPER or 2,291 ktoe in 2015 (51% of the primary energy used for electricity generation). In 1990, losses associated with electricity generation represented 22% of TPER and 67% of the primary energy used for generation.

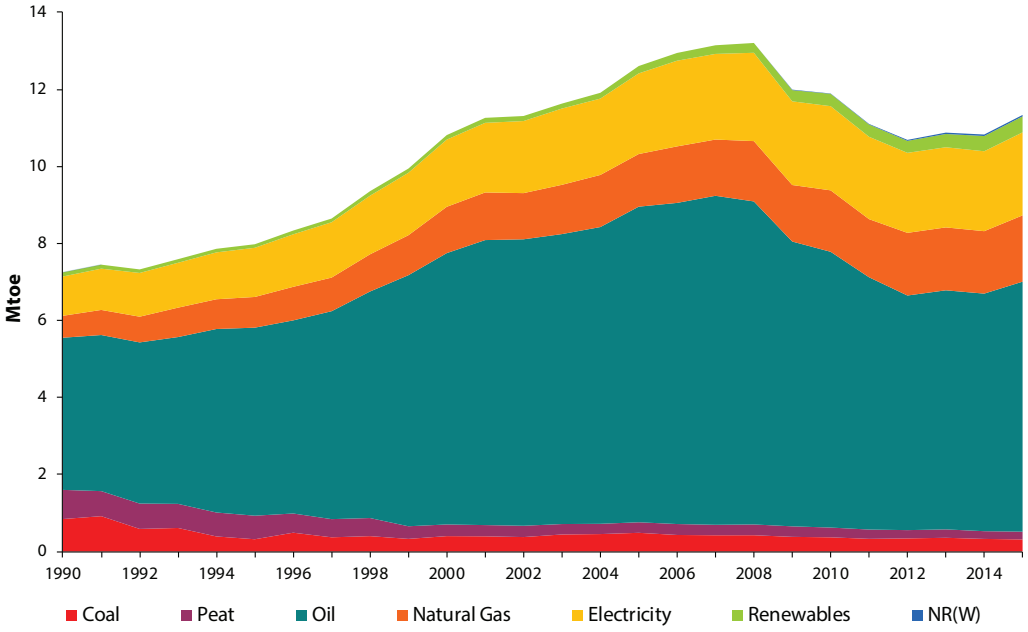
2.4 Energy Demand

Final energy demand is a measure of the energy that is delivered for use in activities as diverse as manufacturing, movement of people and goods, essential services and other day-to-day energy requirements of living; 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 and other fossil fuels into forms suitable for end-use consumers; electricity, patent fuels, etc. Transformation, processing or other losses entailed in delivery to final consumers are known as 'energy overheads'.

Figure 6 shows the shift in the pattern of final energy demand by fuel over the period 1990 – 2015.

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

Figure 6 *Total Final Consumption by Fuel*



Ireland's TFC in 2015 was 11,337 ktoe, an increase of 4.7% on 2014 and 56% above the 1990 level of 7,249 ktoe (representing growth of 1.8% per annum on average). When corrected for weather, final energy consumption increased in 2015 by 4.1%. Final consumption peaked in 2008 at 13,206 ktoe and has fallen by 14% since then. 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 more detail on absolute values associated with *Table 4* see the companion document *Energy Statistics 1990 – 2015*.

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

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Fossil Fuels (Total)	42.6	1.4	2.9	-1.9	-1.4	4.9	6,121	8,729	84.4	77.0
Coal	-62.9	-3.9	4.0	-5.4	-3.2	-4.2	843	312	11.6	2.8
Peat	-73.4	-5.2	-2.0	-1.5	-4.5	0.4	757	201	10.4	1.8
Oil	64.3	2.0	3.1	-2.7	-1.9	5.2	3,952	6,493	54.5	57.3
Natural Gas	202.2	4.5	2.6	3.1	1.5	6.2	570	1,722	7.9	15.2
Renewables	284.9	5.5	10.2	10.9	5.3	4.8	108	415	1.5	3.7
Non-Renewable (Wastes)	-	-	-	-	34.2	-3.4	0	37	0.0	0.3
Combustible Fuels (Total)	46.5	1.5	3.0	-1.6	-1.2	4.8	6,229	9,123	85.9	80.5
Electricity	111.2	3.0	3.7	0.9	-0.3	3.9	1,021	2,156	14.1	19.0
Total	**56.4**	**1.8**	**3.1**	**-1.2**	**-1.0**	**4.7**	**7,249**	**11,337**		
Total Climate Corrected	**51.7**	**1.7**	**3.3**	**-2.2**	**-0.2**	**4.1**	**7,393**	**11,213**		

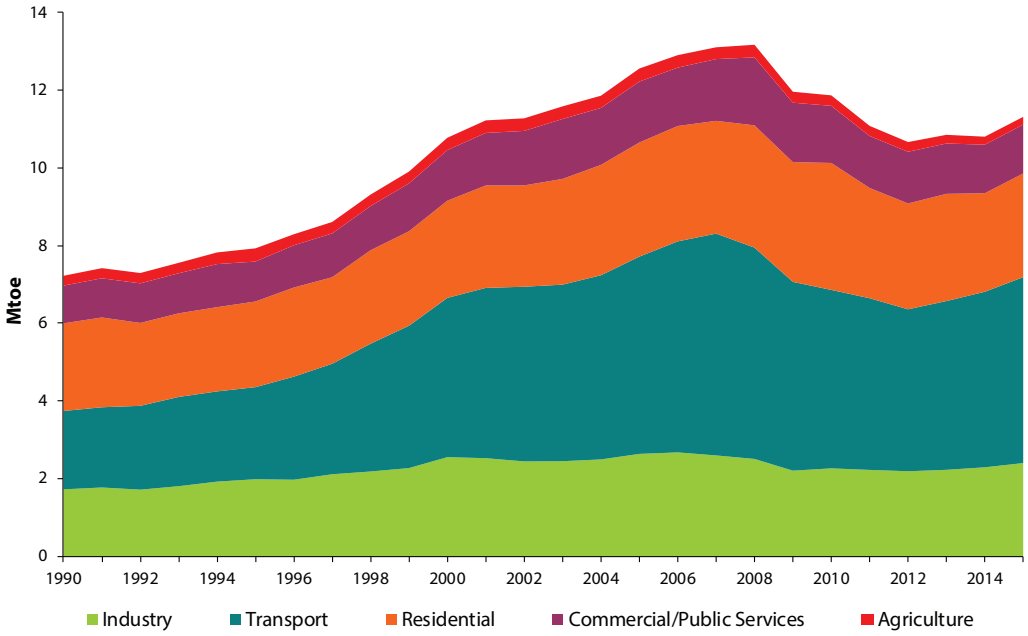
The most significant changes can be summarised as follows:

- Consumption of all fuels, with the exception of coal and non-renewable wastes, increased in final consumption in 2015. Natural gas experienced the largest increase in 2015 growing by 6.2% to 1,722 ktoe.
- Final consumption of oil increased by 5.2% in 2015 to 6,493 ktoe. This was driven by increased oil use in transport and households, which saw the final use of oil grow by 5.8% and 11.5% respectively while it fell in industry and services by 2.8%, and 3.2% respectively.
- In 2015 natural gas consumption increased by 6.2% to 1,722 ktoe. The share of gas in final consumption in 2015 was 15%.
- Final consumption of coal fell by 4.2% in 2015 to 312 ktoe. Its share of final use in 2015 was at 2.8%. Coal use in industry fell by 0.7% to 106 ktoe, while coal use in the residential sector fell by 5.8% to 206 ktoe. There was an extension to the Smoky Coal Ban in 2015.
- Final consumption of electricity in 2015 increased by 3.9% to 2,156 ktoe (or 25,069 GWh). In 2015, electricity accounted for 19% of final energy use.

- Final consumption of peat increased by 0.4% in 2015 to 201 ktoe. Peat accounted for 1.8% of final energy consumption in 2015.

Figure 7 also shows the sectoral trend in TFC over the period.

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 42% in 2015. The shares of the industry and residential sectors have decreased since 1990. In 2015 industry accounted for approximately one fifth of final energy use and the residential sector for a little under one quarter.

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

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Industry	39.4	1.3	0.7	-3.0	1.2	4.8	1,720	2,397	23.7	21.1
Transport	137.2	3.5	4.4	-2.0	0.8	5.9	2,019	4,789	27.8	42.2
Residential	18.3	0.7	3.3	2.2	-4.0	5.2	2,258	2,672	31.2	23.6
Commercial / Public	29.5	1.0	3.8	-1.3	-3.1	0.7	972	1,259	13.4	11.1
Agriculture / Fisheries	-21.3	-1.0	1.6	-5.1	-5.6	-3.8	280	221	3.9	1.9
Total	**56.4**	**1.8**	**3.1**	**-1.2**	**-1.0**	**4.7**	**7,249**	**11,337**		

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

- Overall final energy consumption grew by 4.7% in 2015 to 11,337 ktoe.
- Energy use in transport grew in 2015 by 5.9% to 4,789 ktoe but was 16% lower than in 2007.
- In 2015, final energy use in industry grew 4.8% to 2,397 ktoe. Over the 1990 – 2015 period, the average growth rate in final energy use in industry was 1.3% per annum (or 39% in absolute terms) and its share of TFC dropped from 24% to 21%.
- Final energy use in the residential sector increased by 5.2% in 2015 to 2,672 ktoe, partly due to the weather being colder compared with 2014. Correcting for weather[10], the increase in energy use was 3.5%.
- There was a 0.7% increase in final energy use in the commercial and public services sector in 2015 to 1,259 ktoe. Correcting for weather there was a decrease of 0.8%.
- The agricultural and fisheries sectors' relative share fell from 3.5% in 1990 to 1.9% in 2015. In absolute terms, agriculture energy consumption in 2015 fell by 3.8% to 221 ktoe.

10 See Glossary for description of Weather Correction.

2.5 Heating Degree Days

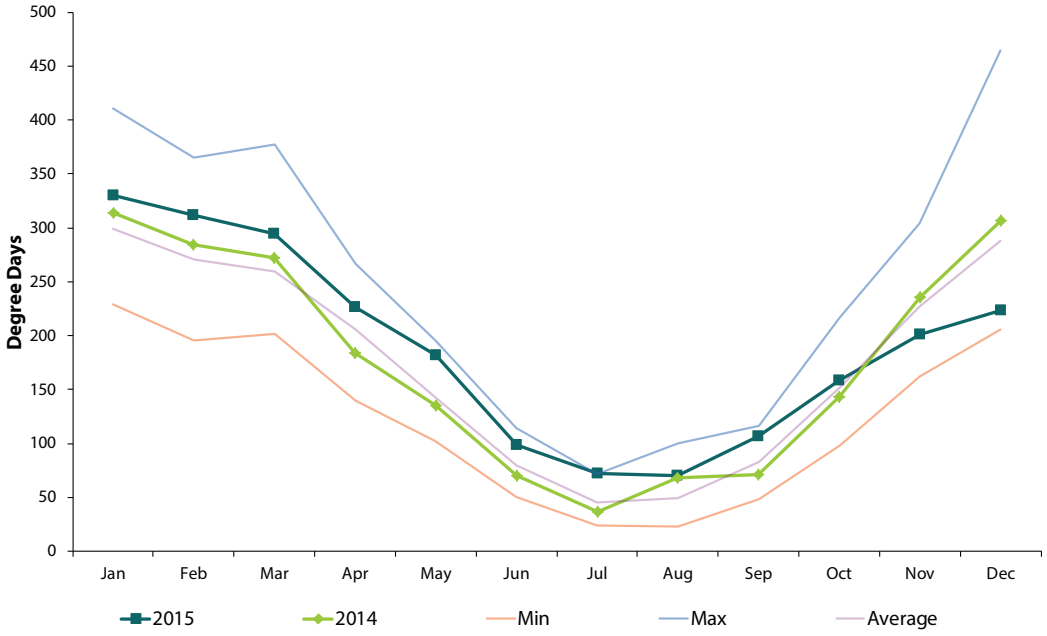
Weather variations from year to year can have a significant effect on the energy demand of a country, in particular on the portion of the energy demand associated with space heating. A method to measure the weather or climatic variation is through the use of 'degree days'.

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 the 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 Éireann 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 shows the heating degree days per month for 2015 and 2014.

Figure 8 *Heating Degree Day Trend 2015 versus 2014*



Source: Met Eireann and SEAI

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 each year. *Figure 8* shows that 2015 was an above average year in terms of heating requirement for the first half of the year and below average for the last two months. Compared with 2014 there were 3.3% more degree days (i.e. it was cooler) in 2015.

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 the GDP[11]. 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.

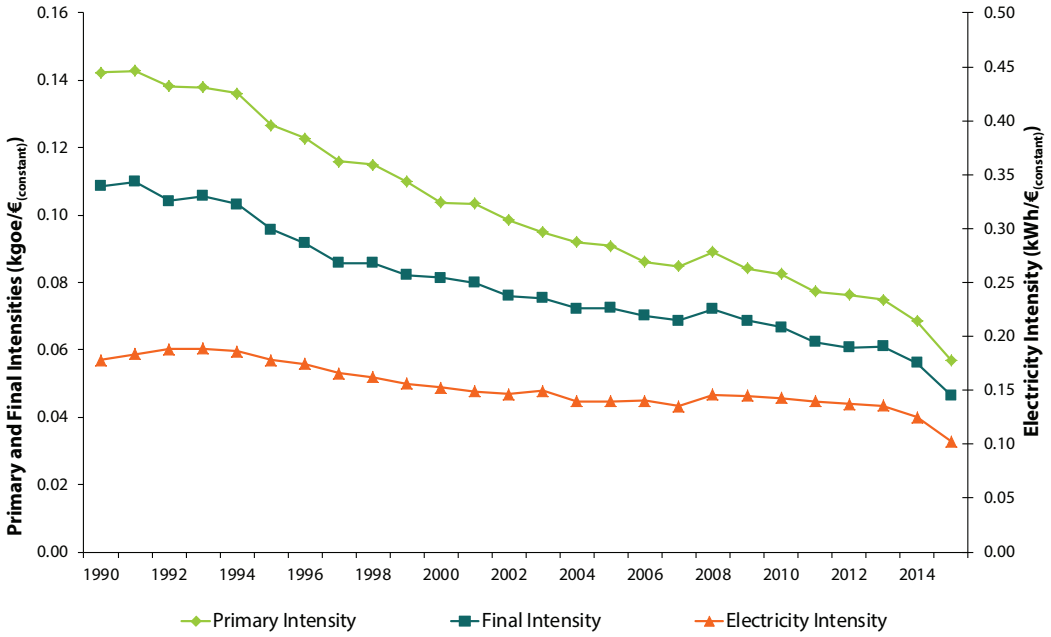
The intensity of primary and final energy and of electricity requirements has been falling (reflecting improving energy productivity) since 1990, as shown in *Figure 9*. The primary energy intensity of the economy fell by 39%

11 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 the 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.

between 1990 and 2007 (2.8% per annum). In 1990 it required 142 grammes of oil equivalent (goe) to produce one euro of GDP (in constant 2014 values) whereas in 2007 just 85 goe was required. Between 2007 and 2015 primary energy intensity fell by 33% (4.8% per annum) to 57 goe/€$_{2014}$ and was 60% lower than 1990.

Figure 9 shows the trend in both primary (TPER/GDP) and final (TFC/GDP) energy intensities (at constant 2014 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 after 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 19% whereas for final intensity the decrease was 15%.

Figure 9 *Primary, Final and Electricity Intensity*



Between 2010 and 2015, the primary and final intensity trends converged slightly with primary energy intensity falling at a slightly faster rate, 31%, compared with a 30% fall in final intensity.

There are many factors that contribute to how the trend in energy intensity evolves. These factors include: technological efficiency and the 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[12] sectors such as pharmaceuticals , electronics and services. Relative to traditional 'heavier' industries, such as car manufacturing and steel production, these growing sectors are not highly energy intensive. Examples of changes to the industry sector structure include the cessation of steel production in 2001, of fertiliser production in late 2002 and of sugar production in 2007.

Energy intensity will continue to show a decreasing trend if, as expected, the economy becomes increasingly 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.

The sharp fall in intensity in 2015 of 17% must be viewed in the context of the 26% increase in GDP as a result of the transfer of assets into Ireland. This should be viewed as an adjustment rather than a reduction in intensity as the increase in GDP had little or no effect on energy consumption. This is a good example of why energy intensity is not a good measure of energy efficiency progress.

The final electricity intensity of the economy has not been falling as fast as primary or final energy intensities. Over the period 1990 – 2007 the electricity intensity fell by 24%. This is attributed to the shift towards increased electricity consumption in energy end-use. While electricity consumption increased by 118% between 1990 and 2007 (4.7% average annual growth), final energy demand increased by 81% (3.6% annual growth). Electricity final intensity increased by 5.6% between 2007 and 2010, but fell by 28% between 2010 and 2015.

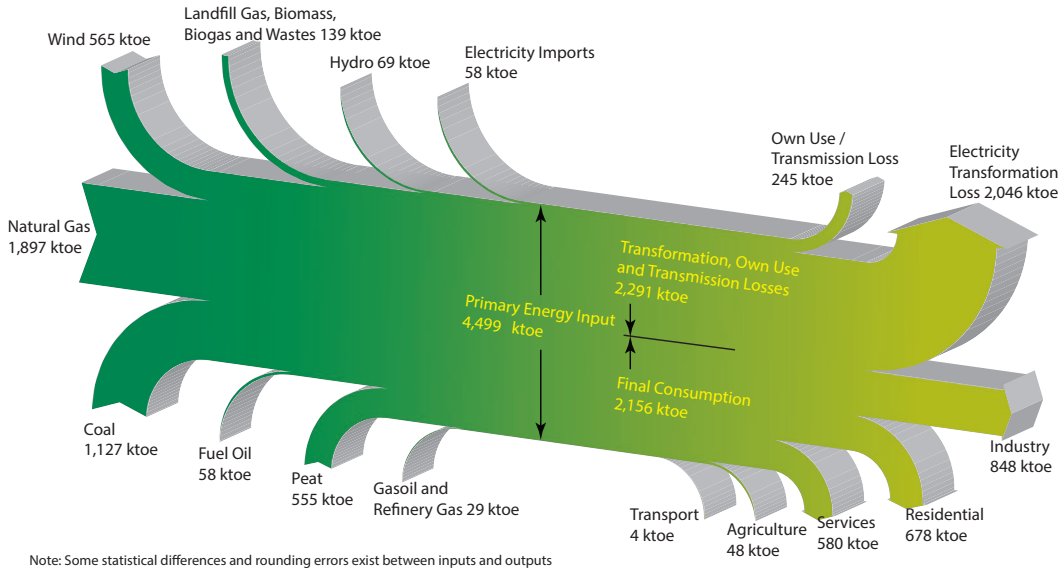
12 See Glossary.

2.7 Electricity Generation

Modern economies and societies are dependent on reliable and secure supplies of electricity. We have seen in *Figure 4* that the generation of electricity accounts for approximately one third of all energy use each year in Ireland. *Figure 10* shows the flow of energy in electricity generation[13]. Total energy inputs to electricity generation in 2015 amounted to 4,499 ktoe, 32% of TPER. The relative size of the useful final electricity consumption compared to the energy lost in transformation and transmission is striking. These losses represent 51% 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 2015, natural gas accounted for 42% (1,899 ktoe) of the fuel inputs to electricity generation.

In 2015 the share of renewables in the generation fuel mix grew to 16.7% compared with 14.5% in 2014. Overall the use of renewables in the electricity generation fuel mix increased by 18.8% in 2015 compared with 2014.

Figure 10 *Flow of Energy in Electricity Generation 2015*



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

Figure 11 shows a similar picture to *Figure 10* except that the electricity outputs are shown by fuel used to generate the electricity and as percentages, for the purposes of assessing against the various targets. Renewable generation consists of wind, hydro, landfill gas, biomass (including the renewable portion of wastes and a small amount of biodiesel) and other biogas and, in 2015, in total reached 7,857 GWh, accounting for more one quarter (27.3%) of gross electricity consumption compared with 22.9% in 2014.

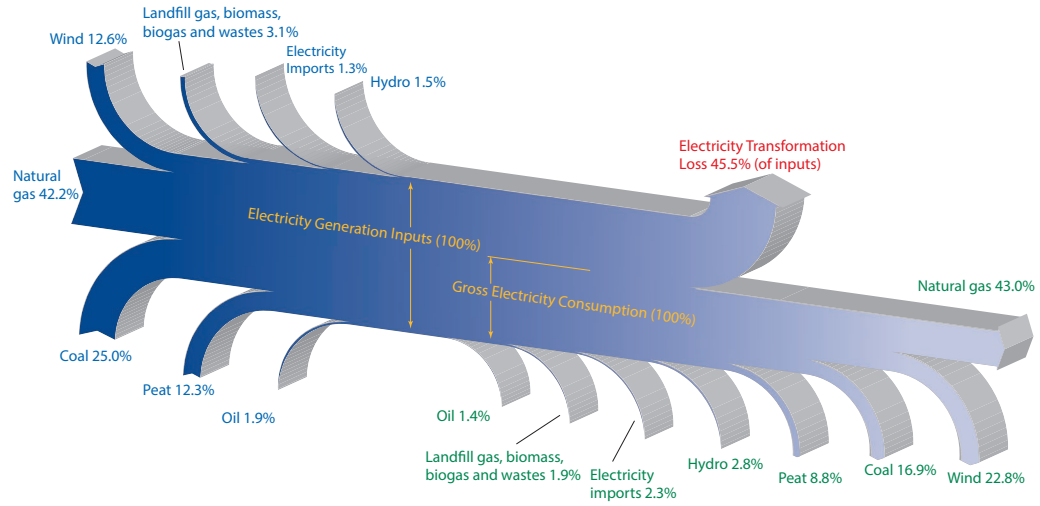
In calculating the contribution of hydropower and wind power for the purposes of Directive 2009/28/EC, the effects of climatic variation and capacity change are smoothed through the use of a normalisation rule[14]. Using normalised figures for wind and hydro, renewables also accounted for 25.3% of gross electricity consumption in 2015. The national target is to achieve at least a 40% share by 2020.

In 2015, wind generation accounted for 22.8% (21.1% normalised) of electricity generated and was again the second largest source of electricity generation after natural gas.

13 Electricity generation is covered by the ETS and as such is not covered by EU Decision 406/2009/EC. Therefore, a CO_2 impact comparison with 2005 is not considered in this section.

14 Article 5 and Annex II of Directive 2009/28/EC on the promotion of the use of energy from renewable sources.

Figure 11 *Flow of Energy in Electricity Generation 2015 – 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 = 27.3%
Renewables as % of gross electricity consumption (normalised) = 25.3%
CHP as % of total electricity generation = 7.5%

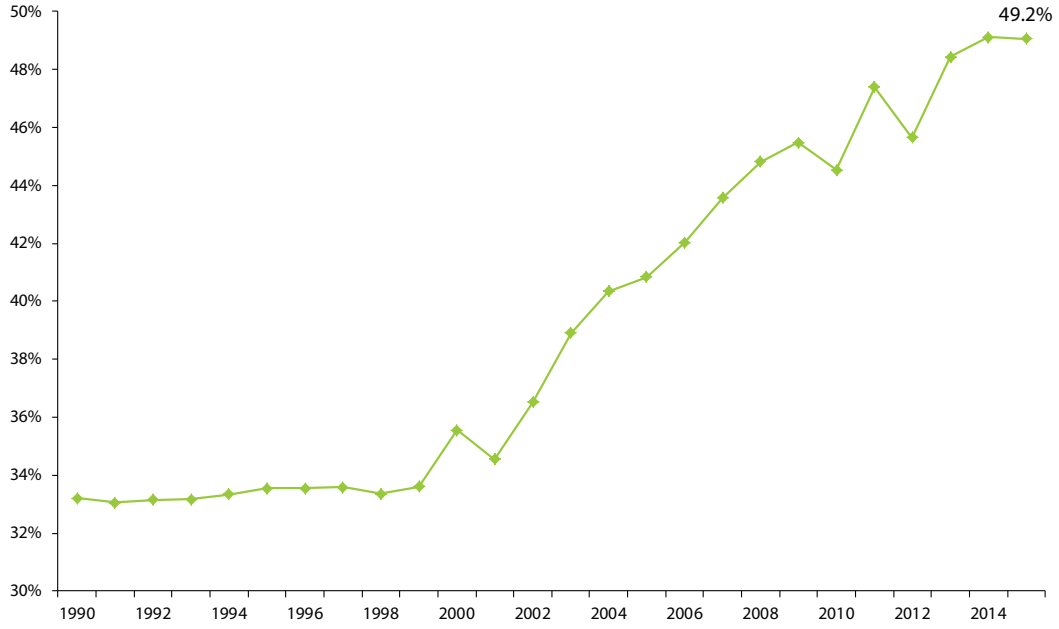
The efficiency of electricity supply shown in *Figure 12* is defined as final consumption of electricity divided by the fuel inputs required to generate this electricity and expressed as a percentage. The inputs include wind, hydro and imports which are direct electricity inputs and do not have the transformation losses associated with them that fossil fuels and combustible renewables do. 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. In 2015, the supply efficiency was 49% whereas the overall generating efficiency was 54%.

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 Combined Cycle Gas Turbine (CCGT) installations (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. In 2014 a new 460 MW CCGT generation plant operated by Endesa in Great Island commenced its commissioning phase and went into commercial operation in 2015 while a 240 MW heavy fuel oil generation plant, also at Great Island, was retired.

In 2011, with these new CCGT power plants fully operational and with the increased contribution from wind and hydro, efficiency increased to 47.3%. In 2012 the relatively high price of gas coupled with low prices for coal and CO_2 resulted in less gas and more coal being used in electricity generation. Peat generation, which is supported by the Public Service Obligation Levy also increased in 2012. Combined, these reduced efficiency to 45.6%. 2013 saw somewhat of a reversal of the trend evident in 2012 and, with increased imports, saw the efficiency of supply rise to 48.4% and then to 49.1% in 2014 and 2015.

Figure 12 *Efficiency of Electricity Supply*



The increase in renewable penetration from 2002 onwards was mainly from wind, which is variable by nature. This variability combined with general demand variability is primarily compensated for by varying gas generation output. The effect of this variation in demand on gas generation would have been expected to impact its overall generation efficiency. However, this is not borne out at the system level. *Figure 13* shows the system level gross efficiency of gas generation since 1990 together with the evolution of renewable penetration expressed as a percentage of gross final electricity consumption. This shows that gas generation efficiency has increased virtually continually since 2000, when it was around 40%, to 56% gross efficiency in 2015.

Figure 13 *Gas Generation Gross Efficiency and Renewable Generation Penetration*

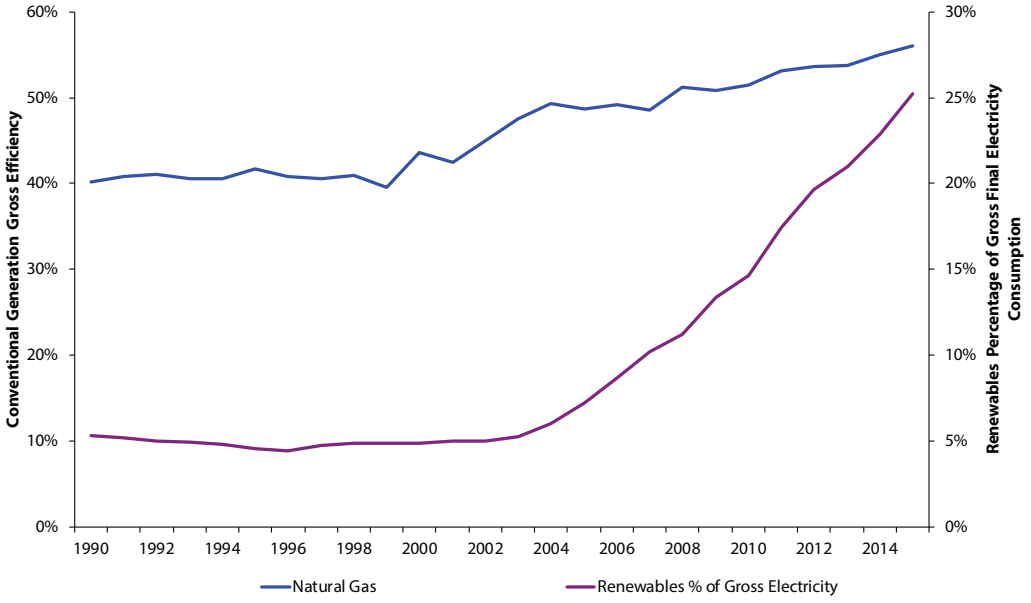
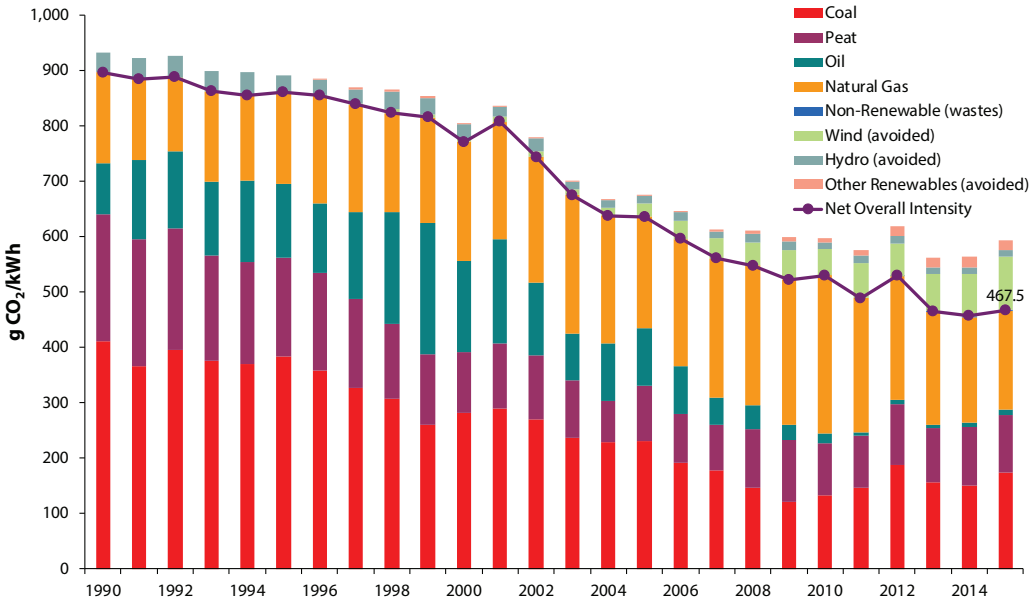


Figure 14 shows as stacked bars the shares of the various fuels contributing to the overall emissions intensity, as well as the reduction in intensity as a result of emissions avoided by renewable generation from wind, hydro and other renewables. It is important to note that this graph represents the shares of the fuels to the overall intensity and not the intensity of the generation by the individual fuels themselves. The net overall intensity is shown as a line graph in *Figure 14*.

Figure 14 *CO_2 Emissions per kWh of Electricity Supplied; with Contributions by Fuel*



Since 1990 the share of high carbon content fuels, such as coal and oil, 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 49%, from 896 g CO_2/kWh in 1990, to a low of 457 g CO_2/kWh in 2014. With reduced gas and wind, and increased peat and coal use the intensity had increased to 528 g CO_2/kWh in 2012 but by 2014 it had fallen back by 13.8%. The intensity increased by 2.5% to 467.5 g CO_2/kWh in 2015 due to increased coal generation and a reduction in net imports.

The reasons for the increase in carbon intensity of electricity in 2015 were a:

- 23% increase in coal used in generation, increasing the coal share in fuel inputs to 25%;
- 45% increase in oil used in generation albeit at a 1.9% share of fuel inputs;
- 3.7% reduction in natural gas generation (42% share of inputs);
- 69% decrease in net imports of electricity (1.3% share of inputs);
- 10.2% reduction in other renewable (biomass and landfill gas) inputs to electricity generation (2.6% share of inputs).

Countering these were a:

- 13.8% increase in hydro generation (1.5% share of inputs);
- 27.9% increase wind generation (12.6% share of inputs).

2.7.1 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 up to 60% of the input energy is lost with as little as 40% being transformed into electricity. 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[15] of CHP in Ireland at the end of 2015 was 342 megawatt electrical (MWe) (385 units[16]) – up from 339 MWe (366 units) in 2014 – an increase of 0.9%. Of the 385 units, only 281 were reported as being operational. The operational installed capacity increased by 1.5 MWe, to 312.5 MWe, in 2015 compared with 2014.

15 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.

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

Table 6 *Number of Units and Installed Capacity by Fuel 2015*

	No. of Units	Installed Capacity MWe	No. of Units %	Installed Capacity %
Natural Gas	340	315.7	88%	92%
Solid Fuels	2	5.2	1%	2%
Biomass	3	5.5	1%	2%
Oil Fuels	23	9.0	6%	3%
Biogas	17	6.4	4%	2%
Total	**385**	**342**	**100%**	**100%**

Source: SEAI

Natural gas was the fuel of choice for 316 MWe (340 units) in 2015. It is worth noting that there is one single 160 MWe gas plant which dominates. Oil products[17] made up the next most significant share with 9.0 MWe (23 units) and the remainder was biogas at 6.4 MWe (17 units), biomass at 5.5 MWe (3 units) and solid fuels at 5.2 MWe (2 units). CHP in Ireland is examined in more detail in a separate SEAI publication[18].

Figure 15 illustrates the contribution from CHP to Ireland's energy requirements in the period 1994 – 2015. Fuel inputs have increased by 186% (5.1% per annum) while the thermal and electrical outputs increased by 229% (5.8% per annum) and 725% (10.6% per annum) respectively over the period. This suggests that the overall stock of CHP installations has become more efficient over the period. In 2015 fuel input increased by 3.2% and thermal output increased by 4.3%, while electricity generated increased by 4.8%. The large increase in 2006 is accounted for by the Aughinish Alumina plant which came online in that year.

Figure 15 *CHP Fuel Input and Thermal/Electricity Output 1994 – 2015*

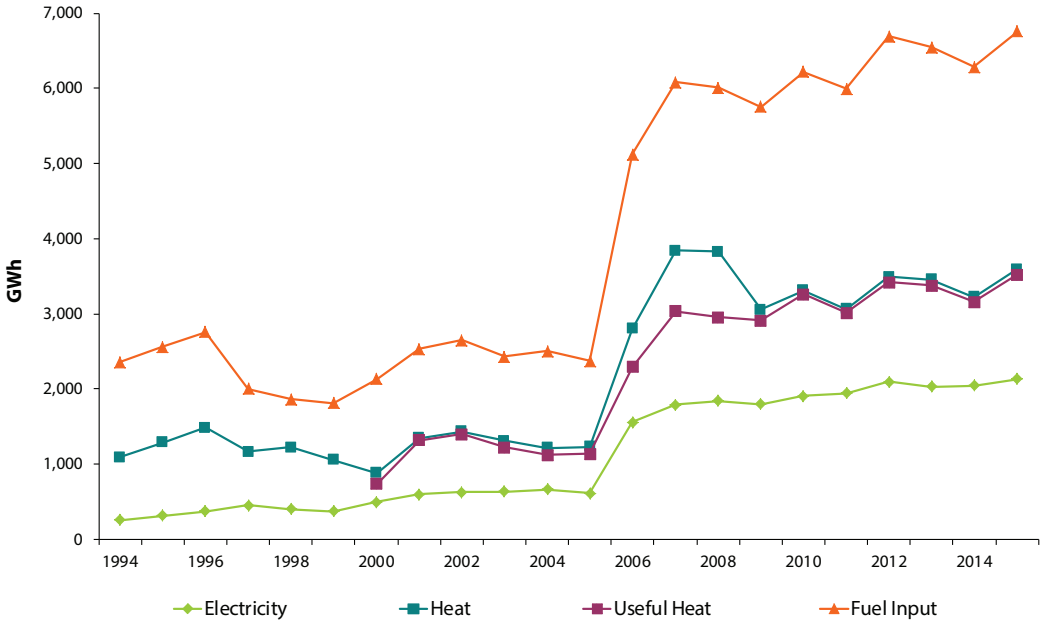


Figure 16 focuses on CHP generated electricity in Ireland as a proportion of gross electricity consumption (i.e. electricity generation plus net imports) in the period 1990 – 2015. In 2015, 7.5% of total electricity generation was generated in CHP installations compared with 7.4% in 2014. Some CHP units export electricity to the national grid. In 2015 there were 20 units exporting electricity to the grid. These units exported 1,417 GWh of electricity in 2015, an increase of 3.3% on 2014.

17 Oil products are comprised of LPG, heavy fuel oil, refinery gas and biodiesel.

18 Sustainable Energy Authority of Ireland (2016), *Combined Heat and Power in Ireland – 2016 Update*. Available from: www.seai.ie

Figure 16 *CHP Electricity as percentage of Total Electricity Generation 1990 – 2015*

2.7.2 Primary Fuel Inputs into Electricity Generation

The trends in the mix of primary fuels employed for electricity generation are shown in *Figure 17*. The shift from oil to gas since 2001 is evident, as is the growth of renewable generation since the early 2000s.

Figure 17 *Primary Fuel Mix for Electricity Generation*

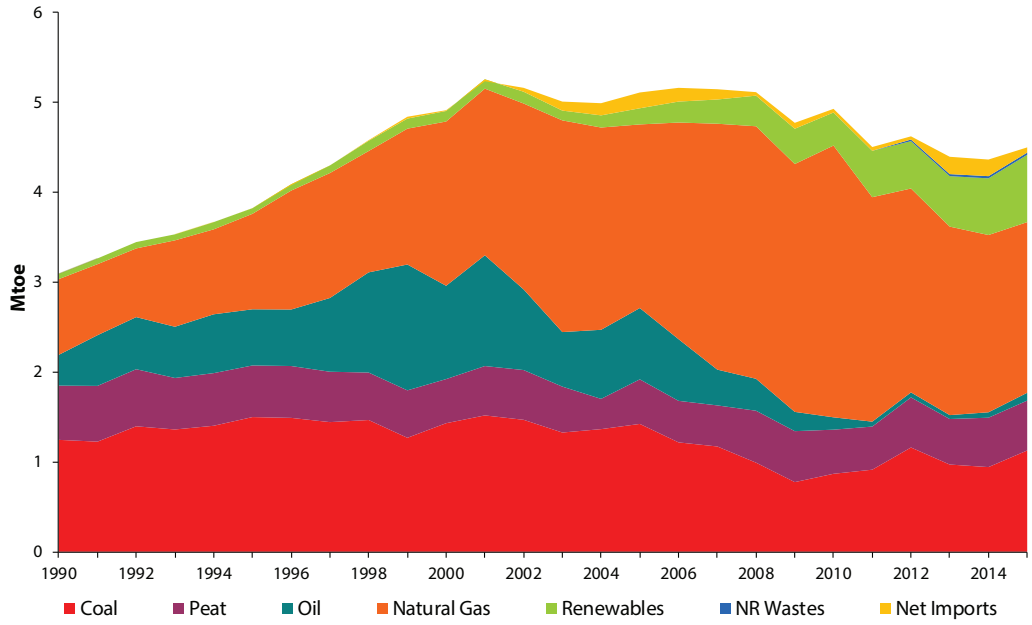


Table 7 shows the growth rates, quantities and shares of the primary fuel mix for electricity generation over the period 1990 – 2015.

The primary fuel requirement for electricity generation grew by 71% from 3,062 ktoe in 1990 to a high of 5,237 ktoe in 2001. Between 2001 and 2014 the requirement reduced by 17%, while the final consumption of electricity increased by 15%. In 2015, 4,500 ktoe of energy was used to generate electricity, 3.1% more than in 2014 and 14% less than peak levels in 2001.

The fuel inputs to electricity generation were one third (32%) of the TPER in 2015. Electricity consumption as a share of TFC increased from 14% to 19% between 1990 and 2015.

Table 7 *Growth Rates, Quantities and Shares of Electricity Generation Fuel Mix (primary fuel inputs)*

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Fossil Fuels (Total)	20.9	0.8	-0.1	-1.0	-4.1	4.0	3,034	3,667	98.1	81.5
Coal	-9.5	-0.4	-0.1	-9.4	5.4	19.6	1,245	1,127	40.2	25.0
Peat	-8.2	-0.3	0.2	-0.2	2.4	0.8	604	554	19.5	12.3
Oil (Total)	-74.5	-5.3	-5.2	-29.6	-8.7	44.7	343	87	11.1	1.9
Fuel Oil	-82.6	-6.8	-6.4	-32.1	-10.9	22.4	334	58	10.8	1.3
Gas Oil and Refinery Gas	162.7	3.9	18.6	-17.4	-6.2	152.5	7	19	0.2	0.4
Gas	125.3	3.3	2.3	8.2	-8.9	-3.7	843	1,899	27.2	42.2
Renewables (Total)	1150.3	10.6	8.9	15.4	15.3	18.8	60	749	1.9	16.7
Hydro	15.7	0.6	-5.7	-1.0	6.1	13.8	60	69	1.9	1.5
Wind	-	-	35.4	20.4	18.5	27.9	-	565	-	12.6
Other Renewables	-	-	4.8	20.1	9.1	-10.2	-	115	-	2.6
Non-Renewable (Wastes)	-	-	-	-	-	1.2	-	25	-	0.6
Combustible Fuels (Total)	25.5	0.9	-0.1	-0.8	-3.7	3.5	3,034	3,807	98.1	84.6
Electricity Imports (net)	-	-	83.6	-25.5	7.4	-68.7	-	58	-	1.3
Total	**45.4**	**1.5**	**0.8**	**-0.7**	**-1.8**	**3.1**	**3,094**	**4,500**		

The main trends are:

- Overall fuel inputs into electricity generation increased by 3.1% in 2015, to 4,500 ktoe, while final consumption of electricity increased by 3.9%, to 2,156 ktoe (or 25,070 GWh).
- The overall share of fossil fuels used in electricity generation was 82% in 2015 (3,667 ktoe), down from 98% throughout the 1990s. The share of fossil fuels averaged 94% between 2000 and 2010 and started to dip below 90% from 2011 onwards due to the increasing penetration of renewable generation.
- Natural gas remains the dominant fuel in electricity generation but its share fell from a peak of 61% in 2010 to 42% in 2015. Natural gas use in electricity generation was 1,899 ktoe in 2015, 3.7% lower than in 2014.
- Fuel oil had a share in electricity generation of 11% in 1990; this rose to 28% in 1999 but in 2015 was minimal at 1.3%. Consumption of fuel oil in electricity generation in 2015 was 58 ktoe.
- In 2015 consumption of coal for electricity generation increased by 19.6% to 1,127 ktoe. The share of coal used in electricity generation reduced from 40% in 1990 to 25% in 2015. Coal use was at its lowest in 2009 at 775 ktoe but increased by 50%, to 1,160 ktoe, in 2012.
- Peat consumption in electricity generation increased by 0.8%, to 554 ktoe, in 2015 and accounted for 12.3% of the fuel inputs to electricity generation.
- In 2015 there was an 18.8% increase in renewables' contribution to the electricity fuel mix due to the increased contribution from hydro, wind and biomass. Wind contribution to electricity generation grew by 27.9% in 2015, hydro grew by 13.8% and other renewables, in the form of landfill gas, biogas, renewable wastes, decreased by 10.2%. Solar photovoltaic is included in other renewables. The renewable energy share in fuel used for electricity generation was 16.7% in 2015.
- The use of energy from waste as a fuel source for electricity generation increased by 1.2% in 2015 to 25 ktoe and accounted for 0.6% of all fuel inputs.
- Net electricity imports fell by 69% in 2015 to 58 ktoe. This is the net result of a 39% decrease in electricity imports and a 53% increase in electricity exports in 2015.

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 Electricity in Ireland 2015*). It is therefore more common to see the share of hydro and wind reported as a percentage of gross electricity generated. Electricity generated from hydro accounted for 2.8% (2.5% normalised) of the total and wind accounted for 22.8% (21.1% normalised) in 2015.

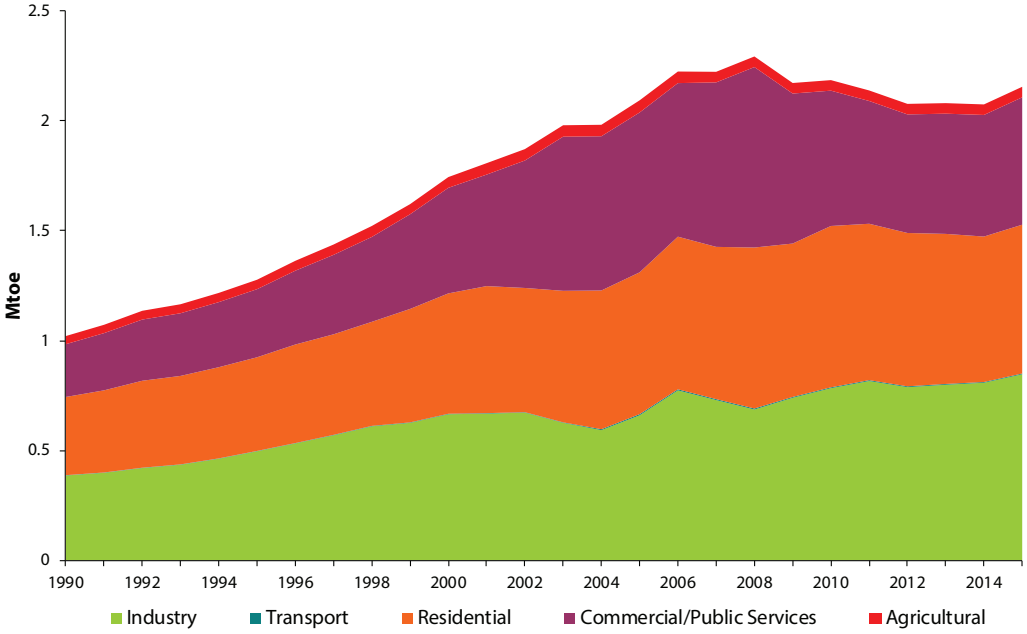
Overall, the share of electricity generated by renewables was 27.3% in 2015, up from 22.9% in 2014, while the renewables share of energy inputs to electricity generation was 16.7%. Normalising for wind and hydro as per Directive 2009/28/EC the share of electricity generated from renewables in 2015 was also 25.3%.

19 An alternative approach based on *primary energy equivalent* was developed in a separate report: SEAI (2014), *Renewable Energy in Ireland – 2012*. Available from http://www.seai.ie/Publications/Statistics_Publications/Renewable_Energy_in_Ireland/

2.8 Electricity Demand

Figure 18 shows the final electricity consumption in each of the main sectors. The difference between fuel input (see *Figure 17*) and delivered electricity output (*Figure 18*) is accounted for by the transformation losses, totalling 2,046 ktoe in 2015, as shown in *Figure 10* and *Figure 11*. This size of the transformation loss is due to electricity in Ireland being predominantly generated thermally (72% in 2015) and therefore primary energy requirement has always been significantly higher than final electricity consumption. This ratio of primary to final[20] energy in electricity consumption fell from 3.0 in 1990 to 2.1 in 2015. Final consumption of electricity increased by 3.9% in 2015 to 25,070 GWh compared to a 3.1% increase in the fuel inputs to electricity generation.

Figure 18 *Final Consumption of Electricity by Sector*



Final electricity demand peaked in 2008 at 2,294 ktoe and has fallen 6.0% since to 2,156 ktoe.

Table 8 shows changes in individual sectors' electricity demand and the impact on final consumption of electricity. The electricity use in transport includes that used in Dublin by the DART and the Luas. In absolute terms electricity consumption in transport is small at 41 GWh (4 ktoe). This figure doesn't take electric vehicles on the road into account yet as the numbers are currently not significant.

Electricity demand grew in all sectors in 2015 with industry and the services sectors both experiencing growth in electricity demand of 4.8%, to 847 ktoe and 580 ktoe respectively. The residential sector's electricity use increased by 2.3%, to 678 ktoe, in 2015.

In terms of shares of final electricity use, industry has the largest share at 39% with the residential sector being the second largest at 31%.

Table 8 *Growth Rates, Quantities and Shares of Electricity Final Consumption*

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Industry	119.5	3.2	-0.1	3.5	1.6	4.8	386	847	37.8	39.3
Transport	156.5	3.8	17.8	-5.0	-2.1	5.1	1	4	0.1	0.2
Residential	90.3	2.6	3.3	2.6	-1.6	2.3	356	678	34.9	31.4
Commercial / Public	141.4	3.6	8.7	-3.3	-1.2	4.8	240	580	23.6	26.9
Agriculture	29.8	1.0	2.4	-2.8	0.0	0.0	37	48	3.6	2.2
Total	**111.2**	**3.0**	**3.7**	**0.9**	**-0.3**	**3.9**	**1,021**	**2,156**		

20 On a net calorific value basis.

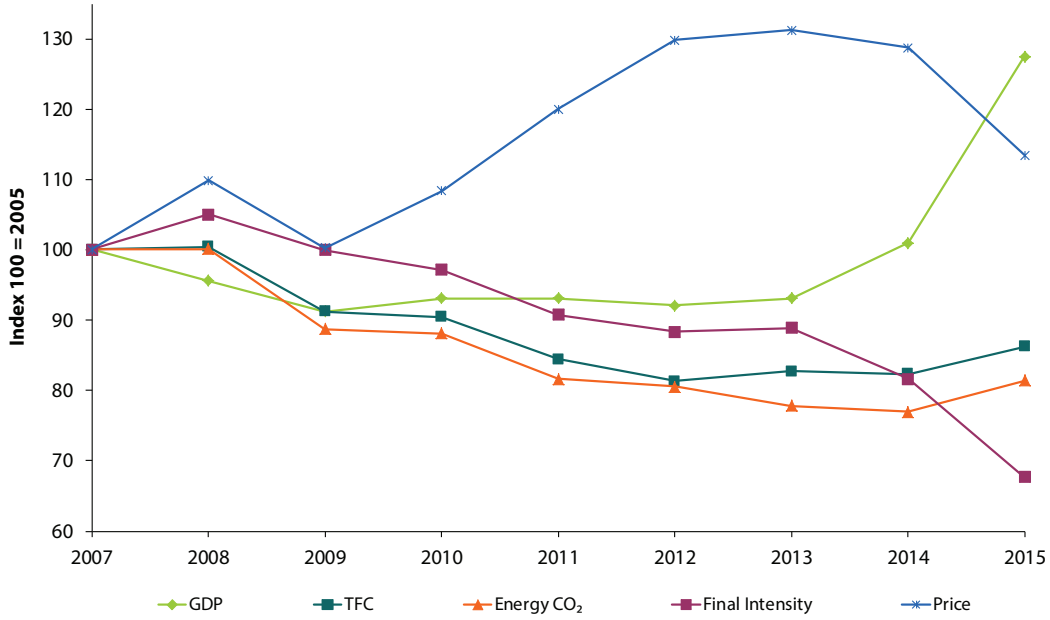
2.9 Energy, Weather and the Economic Downturn

In 2008 the economy in Ireland entered a recession and GDP fell, it approached 2005 levels by 2010 before growth was observed again in 2011. *Figure 19* shows the trend in GDP in the period 2007 – 2015 as an index relative to 2007 levels. The impact of the recession on energy demand (TFC) is also clear in *Figure 19*. Between 2007 and 2009, the economy contracted by 7.7% but by 2015 it had recovered to be 27% above the 2007 level. However, overall energy use has fallen since 2008 and in 2015 was 15% lower than 2008.

Figure 19 also provides the trend in final energy intensity (TFC/GDP, the inverse of energy productivity) of the economy. In two of the years shown, 2008 and 2013, the energy intensity grew (by 2.7% 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, changes in energy efficiency, fuel mix changes and energy prices, all of which can have an impact on energy use and emissions.

Figure 19 also shows an overall energy-price index for Ireland calculated by the IEA. This index encompasses the spike in the price of oil in 2008 and its collapse in 2009, the continuing increase in oil and gas prices from 2010 to 2013 and the price drop in 2014 and 2015. High energy prices tend to dampen energy demand and vice versa.

Figure 19 *Index of GDP, Final Energy Demand, Final Energy Intensity and Energy Price*



Source: SEAI, CSO and IEA

Figure 20 illustrates more clearly the separate effects that the economy and weather have had on Ireland's energy demand since 2010. *Figure 20* shows the year-on-year percentage change in GDP, degree days (indicator of weather) and final energy consumption for the industry, transport, residential and services sectors.

While the recession had an impact on energy demand in all sectors, the residential (in particular) and services sectors were also affected by weather, because the significant proportion of energy use in buildings is for space heating, which is clearly dependent on external temperatures. 2010 was a cold year, as indicated by the increase in degree days, and this contributed to an increase in energy demand in the residential sector for that year, despite the recession, as indicated in *Figure 20*.

In 2011 by contrast, the weather was considerably milder than 2010 and energy use in the residential sector decreased by 13.1%. Final energy use continued to fall in 2012, rose in 2013 by 1.3%, fell again in 2014 by 8.1%, but increased by 5.2% in 2015. On a weather corrected basis, energy use per household has fallen by 17% since 2010. Changes in the energy demand per household are discussed in *Section 4.3.1*.

Figure 20 *Annual Changes in Economic Growth, Weather and Sectoral Energy Demand*

Source: SEAI, CSO and Met Éireann

The services sector is clearly also dependent on the weather as well as on economic activity. The year 2010 saw a 0.2% contraction in services' economic activity, but energy demand dropped a greater amount (3.8%) even though it was a relatively cold year. Services' energy consumption increased by 0.7% in 2015, while the economic output of services grew over the two-year period by 6.5%.

Energy demand in industry and in transport is less dependent on the weather as is illustrated in *Figure 20*. Energy use in both these sectors fell in 2008 and 2009 as did economic activity. Transport demand fell in the four years up to 2012, while energy demand in industry increased in 2010 by 3.8%. While the economy as a whole contracted in that year, industry economic activity grew by 4%.

2015 is characterised by strong economic growth, colder-than-normal weather and increases in the final consumption in all sectors. All sectors experienced growth in energy use in 2015 broadly in line with the increase in economic activity and the weather.

3 Key Policy Issues

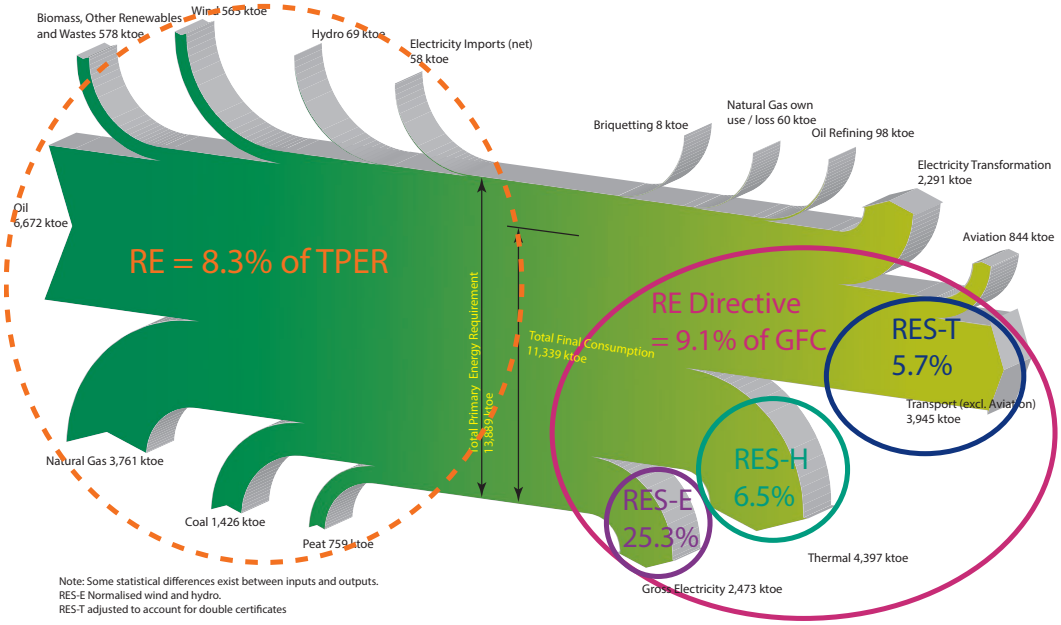
The energy trends discussed in *Section 2* are analysed to assess performance with regard to Government policies and targets. This section focuses those detailed in the EU Directives related to renewable energy, energy efficiency, GHG and transboundary emissions.

3.1 Progress towards Renewable Energy Targets

The target for Ireland in the Directive 2009/28/EC is a 16% share of renewable energy in GFC by 2020. The Directive requires each Member State to adopt a national renewable energy action plan (NREAP) to set out Member States' national targets for the share of energy from renewable sources consumed in transport, electricity and heating in 2020 that will ensure delivery of the overall renewable energy target. These sectoral targets are RES-E (electricity), RES-T (transport) and RES-H (heat) respectively.

The contribution from renewables in 1990 was 2.3%, rising to 9.1%[21] of GFC[22] in 2015. *Figure 21* illustrates where the various renewable targets fit within overall energy use in Ireland and the position with regard to progress towards those targets in 2015. Towards the right of the figure the 2015 contribution percentages of renewables are shown relative to the respective amount of final energy that they refer to. Also shown is how these relate to the Directive's target (see also *Table 9*).

Figure 21 *Progress to Targets 2015*



Towards the left of *Figure 21* the overall contribution of renewable energy to TPER is shown at 8.3%. 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 9 shows progress towards the individual national modal targets and to the overall Directive target for the period 1990 – 2015. 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 Directive 2009/28/EC.

21 Calculated as per Directive 2009/28/EC.

22 GFC in the Directive is different from TFC as conventionally defined in the energy balance. See *Glossary of Terms on page 76*. Hydro and wind electricity generation are normalised as per the Directive in order to smooth out variations in climate.

Table 9 *Renewable Energy Progress to Targets*[23]

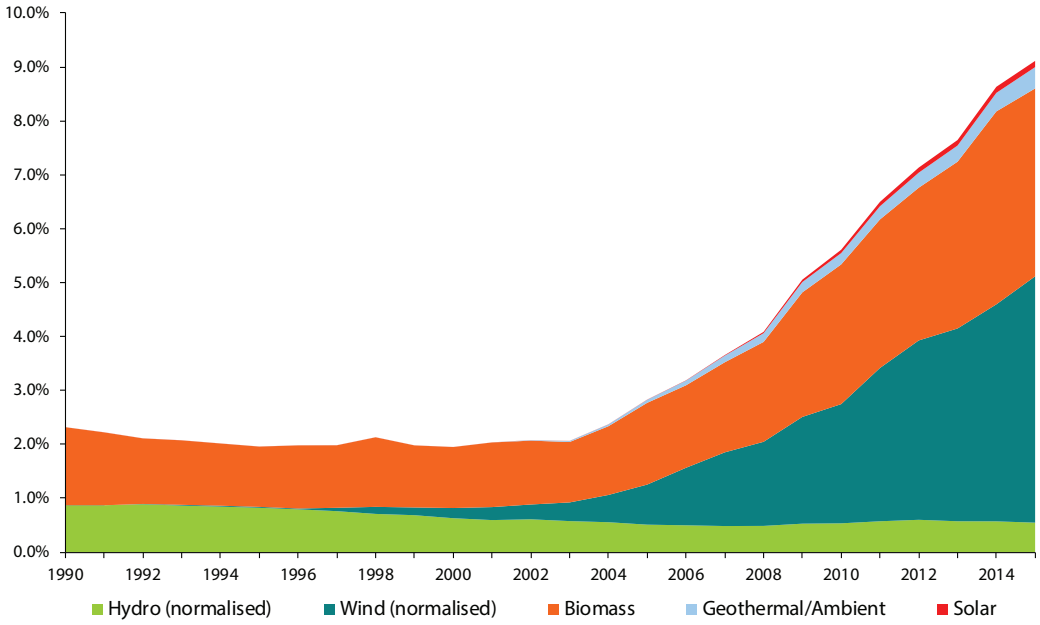
	Progress towards targets								Target
% of each target	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2020**
RES-E (normalised)	4.8	7.2	14.6	17.4	19.7	21.0	22.9	25.3	40
RES-T	0	0	2.4	3.7	3.9	4.8	5.1	5.7	10
RES-H	2.4	3.5	4.5	4.9	5.1	5.5	6.6	6.5	12
Directive (2009/29/EC)	**2.0**	**2.8**	**5.6**	**6.5**	**7.1**	**7.6**	**8.6**	**9.1**	**16**

Source: SEAI

RES-E increased by 2.4 percentage points in 2015, to 25.3% towards the 40% 2020 target. RES-T also increased during 2015, to 5.7% towards the 10% 2020 target. However, RES-H fell back 0.1 percentage point, to 6.5% towards the 12% 2020 target.

Figure 22 shows the contribution as per the Directive methodology from 1990 to 2015 while *Figure 23* shows the renewable energy percentage contributions to GFC by mode with RES-E normalised.

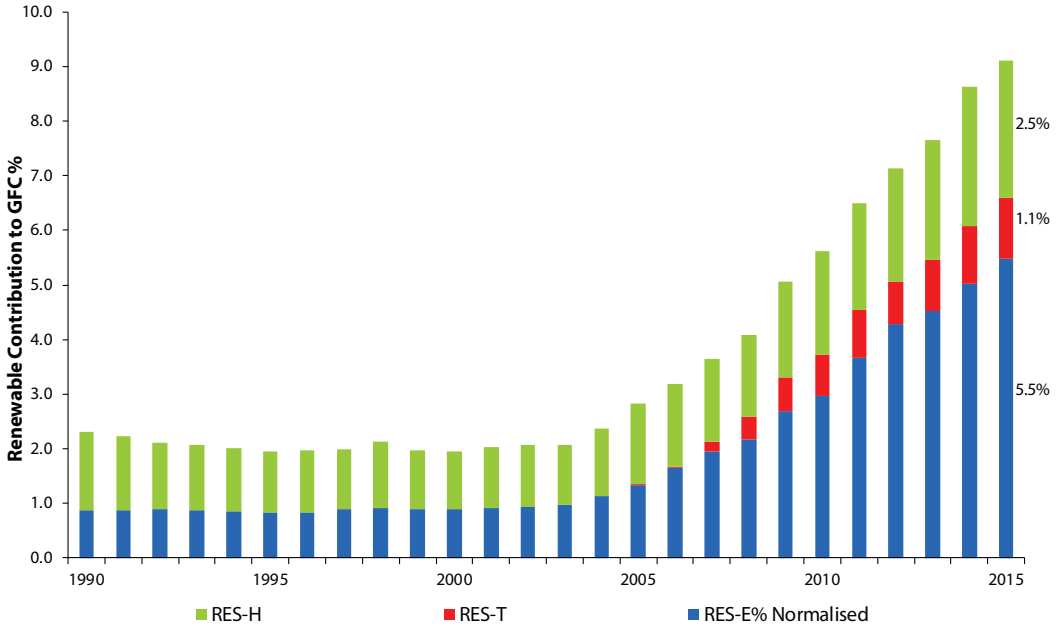
Figure 22 *Renewable Energy (%) Contribution to Gross Final Consumption (Directive 2009/28/EC)*



Source: SEAI

23 Note: Individual target percentages are not additive.

Figure 23 *Renewable Energy (%) Contribution to GFC by Mode*



Source: SEAI

A more detailed discussion of renewable energy in Ireland can be found in SEAI's publication *Renewable Energy in Ireland*[24]. This section presents key graphs and updates where available from the renewables report.

3.1.2.1 Electricity from Renewable Energy Sources (RES-E)

Ireland's NREAP specified a target of 40% electricity consumption from renewable sources by 2020. The total contribution from renewable energy to gross electricity consumption in 2015 was 27.3% (compared with 22.9% in 2014 and 4.9% in 1990). Using normalised hydro and wind figures as specified in EU Directive 2009/28/EC the share in 2015 was 25.3%.

The share of electricity from renewable energy has increased fivefold between 1990 and 2015 – from 4.9% to 25.3% – an increase of over 20 percentage points over 25 years. In absolute terms there has been an elevenfold increase in the volume of renewable electricity generated. Most of this increase has taken place since 2000 and the vast majority has been from wind energy.

Table 10 and *Figure 24* shows how electricity production from wind energy has increased to the point that it accounted for 84% of the renewable electricity generated in 2015. Electricity generated from biomass accounted for 6% of renewable electricity in 2015. Biomass consists of contributions from solid biomass, landfill gas, the renewable portion of waste and other biogas. Wind, hydro and bioenergy-generated electricity in 2015, respectively, accounted for 21.1%, 2.5% and 1.7% of Ireland's gross electricity consumption.

Table 10 *Renewable Energy Contribution to Gross Electricity Consumption (RES-E normalised)*

Renewable Electricity %	1990	2000	2005	2010	2011	2012	2013	2014	2015
Hydro (normalised)	5.3	3.4	2.7	2.6	2.7	2.8	2.7	2.6	2.5
Wind (normalised)	0	1.0	4.0	10.9	13.5	15.3	16.6	18.4	21.1
Biomass	0	0	0	0.4	0.5	0.9	1.1	1.2	1.0
Landfill Gas	0	0.4	0.4	0.6	0.6	0.6	0.6	0.6	0.6
Biogas	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Solar PV	0	0	0	0	0	0	0	0	0.01
Overall	**5.3**	**4.8**	**7.2**	**14.6**	**17.4**	**19.7**	**21.0**	**22.9**	**25.3**

24 Available from http://www.seai.ie/energy-data-portal/

Figure 24 *Renewable Energy Contribution to Gross Electricity Consumption (RES-E normalised)*

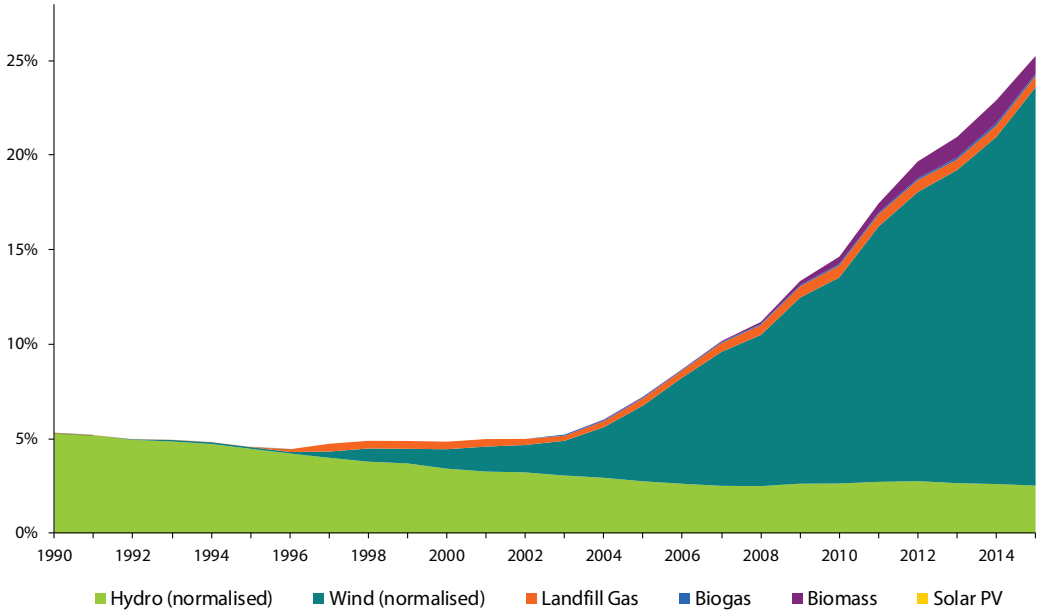
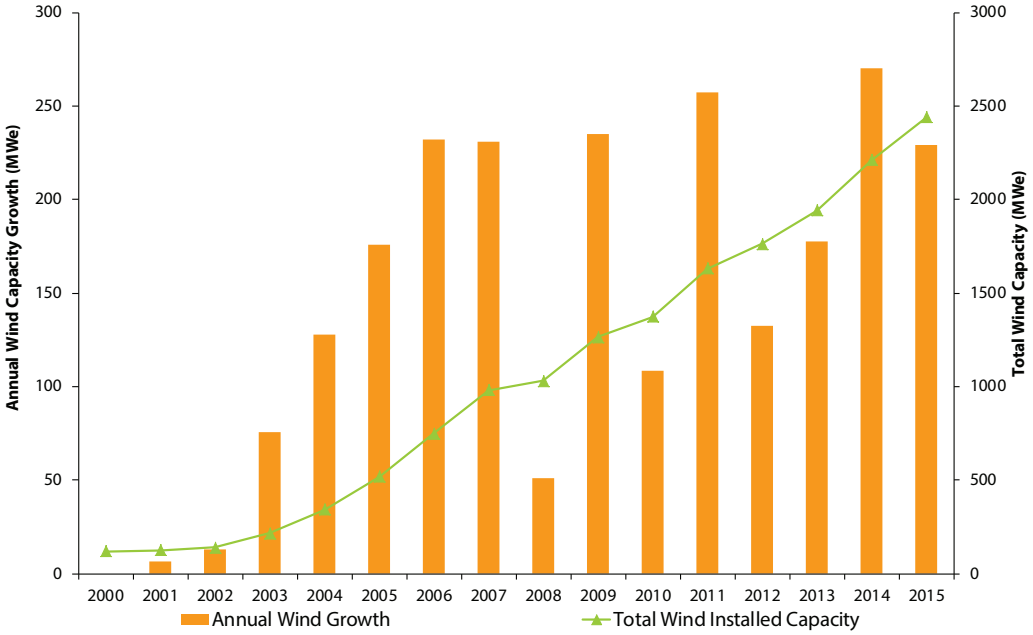


Figure 25 shows the annual growth in installed wind generating capacity and overall cumulative capacity since 2000. By the end of 2015 the installed capacity of wind generation reached 2,440 MW. The peak recorded wind power output was 2,132 MW, delivered on 28 January 2016[25].

Based on data published on EirGrid's and ESB Network's websites (September 2016) there are 445 MW of wind generation contracted for connection before the end of 2016 and a further 1,357 MW by the end of 2017.

Figure 25 *Installed Wind Generating Capacity 2000 – 2015*[26]



Source: EirGrid

25 Wind generation data, EirGrid, http://smartgriddashboard.eirgrid.com/#roi/wind

26 *Installed Wind Report*, EirGrid, http://www.eirgridgroup.com/site-files/library/EirGrid/ConnectedTSOWind-Farms18thSept2015.pdf and ESB Networks, http://www.esb.ie/esbnetworks/en/generator-connections/Connected-Contracted-Generators.jsp

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 for these generation types. The capacity factor 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 were generating at a maximum for the full year.

The rate of capacity increase each year can have a significant 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 any given year and the previous year.

Table 11 *Annual Capacity Factor for Wind and Hydro Generation in Ireland 2000, 2005, 2010 – 2015*

Capacity Factor	2000	2005	2010	2011	2012	2013	2014	2015
Wind	30%	30%	24%	33%	27%	28%	28%	32%
Hydro	41%	31%	29%	34%	39%	29%	34%	39%

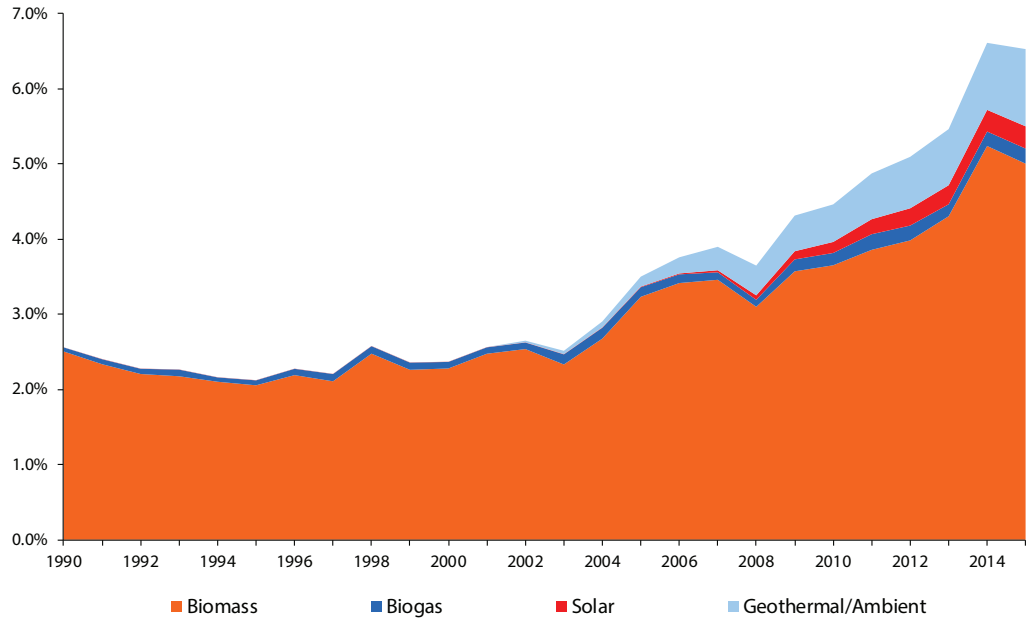
Source: EirGrid and SEAI

The average countrywide wind capacity factor fell between 2006 and 2009 but averaged around 29%. It was 24% in 2010 largely due it being a low wind year compared with historic average levels. The hydro capacity was also at its lowest level since 2003 due to the low level of rainfall in 2010. The wind capacity factor was 32% in 2015 and the hydro capacity factor was 39%.

3.1.2.2 Heat from Renewable Energy Sources (RES-H)

Ireland's NREAP specified a target of 12% renewable heat by 2020. *Figure 26* 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 and regulations for renewable systems in residential dwellings, has led to renewable energy use more than doubling, from 108 ktoe in 1990 to 287 ktoe in 2015 (a growth of 166%). In 2015 renewable thermal energy increased by 2.5% in absolute terms relative to 2014. However, as overall thermal energy consumption increased at a faster rate than renewable heat in 2015, the renewable share of thermal energy fell by 0.1 percentage points to 6.5% in 2015.

Figure 26 *Renewable Energy Contribution to Thermal Energy (RES-H)*

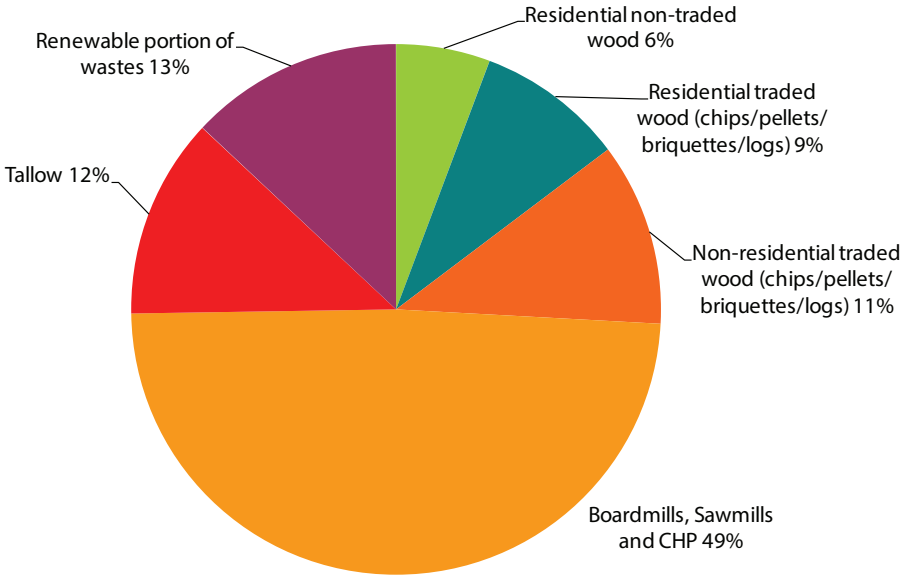


Following a decline in the contribution from renewable energy to thermal energy in the early 1990s (from 2.6% in 1990 to 2.1% in 1995), RES-H grew between 2000 and 2014, from 2.4 % to 6.6%, but it fell back to 6.5% in 2015. This growth, dominated by solid biomass[27], is mostly due to the increased use of wood waste as an energy source

27 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 [a recycled by-product formed during the pulping of wood in the paper-making industry] etc.), other solid wastes (straw, oat hulls, nut shells, tallow, meat and bone meal, etc.) and the renewable portion of industrial and municipal wastes.

in the wood products and food sub-sectors of industry. In addition, 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 in new dwellings to come from renewable sources.

Figure 27 *Composition of Biomass used for Heat in TFC in 2015*



Source: SEAI

Figure 27 shows the composition of biomass in TFC in 2015. Approximately half (49%) 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 and is also being refined for use as a biofuel in transport. Tallow accounts for 12% of all solid biomass. A further 13% in 2015 of solid biomass is consumed in the cement industry in the form of the renewable portion of solid wastes.

Wood chips, pellets and briquettes make up approximately 20% of all the solid biomass consumed in Ireland. The remaining 6% is an estimate of the non-traded wood logs which are being used in open fires or stoves in households. The non-traded wood consumption is estimated in the absence of available data and varies with different methodologies. However, as this non-traded wood is only a small part of the total solid biomass consumption, the variation in estimates is small relative to the overall total solid biomass consumption used for the calculation of RES-H.

3.1.2.3 Transport Energy from Renewable Sources (RES-T)

Directive 2009/28/EC established a mandatory minimum 10% target for the contribution of renewable energy in the final consumption of energy in transport 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 share of electricity from renewable energy sources as measured two years before the year in question. Also 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, receive an extra weighting compared with first generation biofuels. These weighting factors are used for the calculation of RES-T only and do not apply when calculating the transport contribution to the overall RES share.

In 2015 new rules[28] came into force which amend the current legislation on biofuels – specifically Directive 2009/29/EC and Directive 2009/30/EC – to reduce the risk of indirect land use change and to prepare the transition towards advanced biofuels. The amendment:

- limits the share of biofuels from crops grown on agricultural land that can be counted towards the 2020 renewable energy targets to 7%;
- sets an indicative 0.5% target for advanced biofuels as a reference for national targets, which will be set by EU countries in 2017;
- harmonises the list of feedstocks for biofuels across the EU whose contribution would count double towards the 2020 target of 10% for renewable energy in transport;

28 http://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/land-use-change

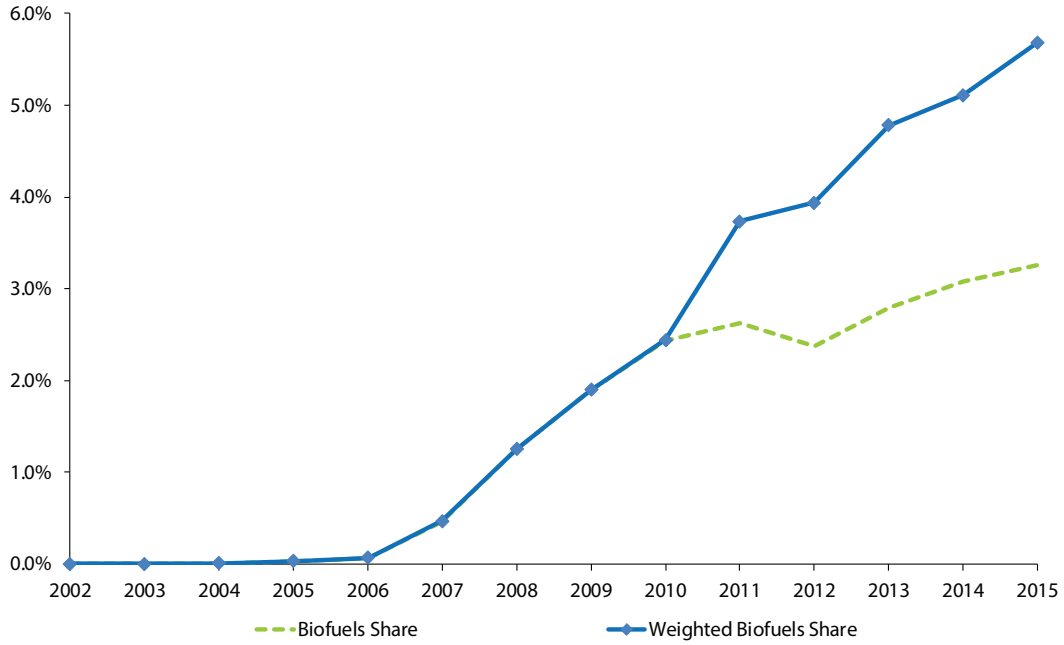
- requires that biofuels produced in new installations emit at least 60% fewer GHGs than fossil fuels;
- introduces stronger incentives for the use of renewable electricity in transport (by counting it at an increased rate towards the 2020 target of 10% for renewable energy use in transport);
- includes a number of additional reporting obligations for the fuel providers, EU countries and the European Commission.

The figure for renewables in transport energy (RES-T) in 2015 was 3.3%, or 5.7% when the weightings for double certificates are applied in accordance with the Directive.

In order to provide incentives to achieve the 2020 target, the Mineral Oil Tax Relief Scheme was introduced in 2005. In 2010 a biofuel obligation scheme was established which required fuel suppliers and consumers to include, on average, 4% biofuel by volume (equivalent to approximately 3% in energy terms) in their annual sales. The biofuel obligation scheme is a certificate based scheme which grants one certificate for each litre of biofuel placed on the market in Ireland; two certificates are granted to biofuel which is produced from wastes and residues. Oil companies and consumers are required to apply to the National Oil Reserves Agency (NORA) for certificates and demonstrate that the quantities of biofuel for which they are claiming certificates are accurate. Since the introduction of the Sustainability Regulations (SI 33 of 2012) in 2012, the companies are also required to demonstrate that the biofuel that is being placed on the market is sustainable. Biofuel that is not deemed to be sustainable will not be awarded certificates and cannot be counted towards the biofuel obligation.

The obligation was increased to 6% in January 2013. It is expected to increase to 8.695% in 2017[29] and increase further over time in order to meet Ireland's target of 10% renewable energy in the transport sector by 2020[30].

Figure 28 *Renewable Energy as a Proportion of (Petrol and 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). The quantity fell in 2012 to 85 ktoe mainly as a result of the majority of biodiesel qualifying for double certificates, thereby allowing the obligation to be met with certificates but causing the actual volume of biofuel to fall. Actual volumes increased again after 2013 to reach 128 ktoe (3.3% of transport energy) in 2015. In 2015, 99% of the biodiesel used for road transport was eligible for double certificates, up from 86% in 2014.

It is evident from *Figure 28* 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 ended in 2010 with the introduction of the Biofuels Obligation Scheme. The figure for renewables in transport energy (RES-T) in 2015 was 5.7% when the weightings for double certificates are applied in accordance with the Directive.

29 Draft Order regarding Biofuel Obligation Rate Increase, http://www.dccae.gov.ie/energy/en-ie/Pages/Consultation/Biofuels-Obligations-Increase.aspx
30 *The Biofuels Obligation Scheme, Annual Report 2015* http://www.nora.ie/_fileupload/457-X0159%20-%20BOS%20Annual%20Report%20for%202015.pdf

Table 12 *Biofuels Growth in ktoe and as a Proportion of Road and Rail Transport Energy 2005, 2010 – 2015*

Fuel	2005	2010	2011	2012	2013	2014	2015
Petrol (ktoe)	1,822	1,478	1,399	1,272	1,197	1,134	1,075
Diesel (ktoe)	2,378	2,236	2,221	2,224	2,368	2,519	2,733
Biofuels (ktoe)	1.1	92.6	97.8	84.9	102.2	116.2	128.1
Petrol plus Diesel	4,200	3,713	3,621	3,497	3,566	3,652	3,808
Biofuel Penetration	***0.0%***	***2.4%***	***2.6%***	***2.4%***	***2.8%***	***3.1%***	***3.3%***
Weighted biofuels (ktoe)	1	93	138	140	176	193	226
Weighted biofuels share	***0.0%***	***2.4%***	***3.7%***	***3.9%***	***4.8%***	***5.1%***	***5.7%***

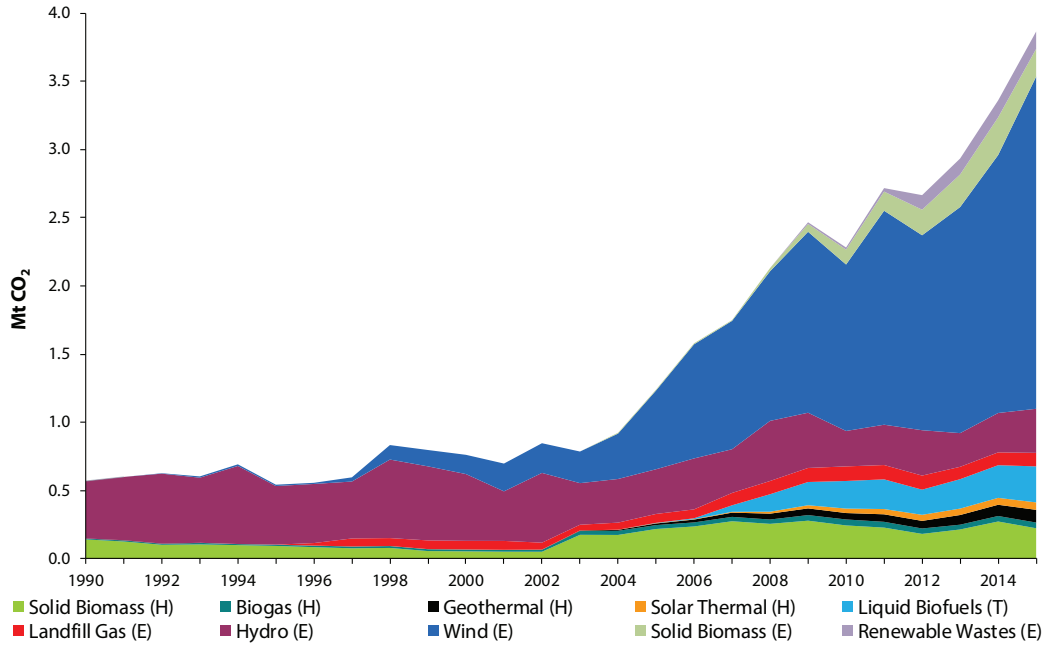
3.1.1 CO_2 Displacement and Avoided Fuel Imports

The avoided carbon emissions and displacement of fossil fuel imports by renewable energy generation are estimated using the Primary Energy Equivalent approach. The results obtained using this methodology have been further refined, using the results of a more detailed dispatch model of the operation of the entire all-island electricity system in the year 2012, so that the effects of ramping and cycling of fossil fuel plants are accounted for[31,32].

Figure 29 shows the trend in avoided CO_2 emissions from renewable energy for the period 1990 – 2015. The estimated amount of CO_2 avoided from renewable energy increased by 578% over the period 1990 – 2015, reaching 3,866 kt CO_2 as illustrated in *Figure 29*. The emissions avoided from wind were most significant again in 2015, at 2,436 kt CO_2, followed by solid biomass at 427 kt CO_2, hydro at 323 kt CO_2 and liquid biofuels used in transport at 264 kt CO_2.

In relation to the displacement of fossil fuels by renewable energy, it is estimated that in 2015 approximately €286 million in fossil fuel imports were avoided, of which €233 million was avoided by wind generation. The displacement of fuel imports is calculated by estimating how much extra fossil fuel would have had to be imported had there been no renewable generation in 2015. The estimates are based on the use of marginal generation fuel that would otherwise have been required to produce what had been generated by renewable energy.

Figure 29 *Avoided CO_2 from Renewable Energy 1990 – 2015*



3.2 Greenhouse Gas Emissions Targets

In 2008, the EU agreed a Climate Energy Package that included a target to reduce greenhouse gas (GHG) 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:

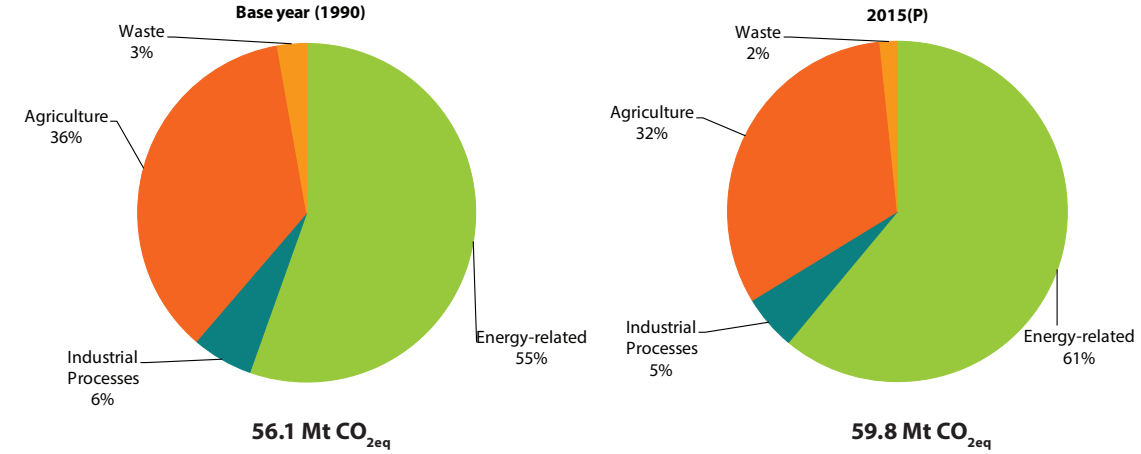
31 See SEAI reports *Quantifying Ireland's Fuel and CO_2 Emissions Savings from Renewable Electricity in 2012* and *Renewable Energy in Ireland 2012* for further details on the methodologies used to calculate the avoided emissions.

32 Holttinen, Hannele, et al (2014), 'Estimating the Reduction of Generating System CO_2 Emissions Resulting from Significant Wind Energy Penetration.' *3th International Workshop on Large-Scale Integration of Wind Power into Power Systems as well as on Transmission Networks for Offshore Wind Power Plants, Berlin*. Vol. 10. No. 2.1.

- 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 30 shows GHG emissions by source for 1990 and provisional figures for 2015 as reported by the Environmental Protection Agency (EPA).

Figure 30 *Greenhouse Gas Emissions by Source*



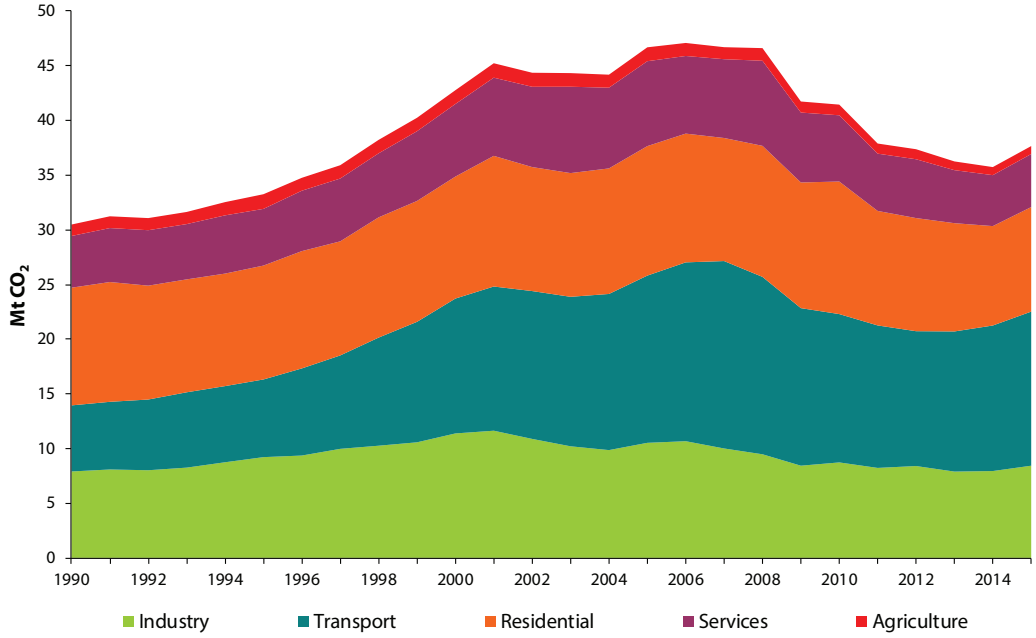
Source: Based on EPA data

It is evident from *Figure 30* that energy-related emissions contributed a higher share towards total national emissions in 2015 compared with 1990. The share of GHG emissions arising from energy-related activities was 61% in 2015 compared with 55% in 1990. The share from agriculture dropped from 36% to 32% 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. The significant role of agriculture in the Irish economy underlies Ireland's variance from the EU average.

The sectoral energy-related CO_2 emissions presented in *Figure 31* and *Table 13* are based on the economic sectoral disaggregation contained in the energy balance, with the upstream emissions from electricity generation and other energy transformations allocated to the economic sectors where that electricity is used. This differs from the way in which national GHG emissions inventories are reported by the EPA, where the 'energy sectors' (for example, electricity generation and oil refining) are reported separately according to UNFCCC and IPCC reporting guidelines.

Figure 31 and *Table 13* 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 [CH_4]). Energy-related CO_2 emissions in 2015 were 24% higher than 1990 levels. Between 2005 and 2015 energy-related CO_2 emissions fell by 18.6%.

Figure 31 *Energy-Related CO_2 Emissions by Sector*[33,34]



As shown in *Table 13* transport accounted for the largest share of energy-related CO_2 emissions, with a share of 37% in 2015, up from 33% in 2005. The residential sector accounted for the second largest share in 2015, at 25%, followed by industry at 22% and services at 13%. Energy-related CO_2 emissions in agriculture and fisheries accounted for just 2.1%.

Table 13 *Growth Rates, Quantities and Shares of Primary Energy-Related CO_2 by Sector*

	Growth %	Average annual growth rates %					Quantity (kt)		Shares %	
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Industry	6.7	0.3	-1.6	-3.7	-0.7	6.2	7,899	8,428	25.8	22.3
Transport	133.2	3.4	4.4	-2.4	0.8	5.9	6,043	14,092	19.8	37.4
Residential	-11.2	-0.5	1.2	0.5	-4.6	5.1	10,764	9,560	35.2	25.3
Commercial / Public	2.6	0.1	3.2	-4.8	-4.3	4.1	4,730	4,852	15.5	12.9
Agriculture and Fisheries	-30.2	-1.4	0.6	-5.7	-5.5	-2.6	1,133	791	3.7	2.1

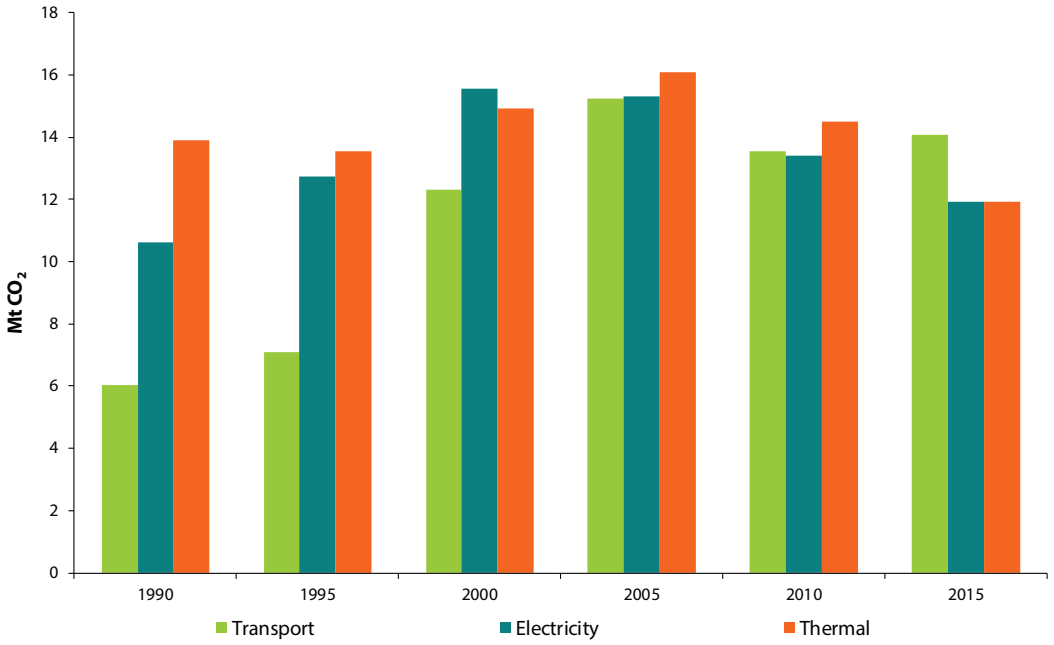
A more detailed discussion can be found in SEAI's publication, called *Energy-Related Emissions in Ireland*.

Figure 32 and *Table 14* illustrate the variations in emissions by mode of energy use. Here the emissions are allocated according to whether the energy used is for: transport; electricity; or thermal energy. These modes also represent distinct energy markets. The graph presents the emissions at five-yearly intervals up to 2015. In 2015, the shares of energy-related CO_2 emissions from transport, electricity and thermal applications were 37.1%, 31.5% and 31.4% respectively.

33 *Figure 31* and *Table 13* 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 UNFCCC guidelines and are also excluded here.

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

Figure 32 *Energy-Related CO_2 Emissions by Mode of Energy Application*



Energy-related CO_2 emissions fell in all modes after 2005, by 19% overall, to 38 Mt. The fastest rates of decline were observed in heat (26% decrease) followed by electricity (22% decrease) and transport (7.8% decrease).

Table 14 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions by Mode of Application*

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Transport	-7.8	-0.8	-2.4	0.8	5.9	15,256	14,073	32.7	37.1
Electricity	-22.0	-2.5	-2.6	-2.3	5.8	15,325	11,947	32.8	31.5
Heat	-25.9	-3.0	-2.1	-3.9	3.6	16,104	11,926	34.5	31.4
Total	**-18.7**	**-2.1**	**-2.3**	**-1.8**	**5.1**	**46,684**	**37,946**		

Source: SEAI

Given the policy focus on the non-ETS[35] sectors, *Table 15* and *Figure 33* show 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.

Table 15 *Growth Rates, Quantities and Shares of ETS and non-ETS Energy-Related CO_2 since 2005*

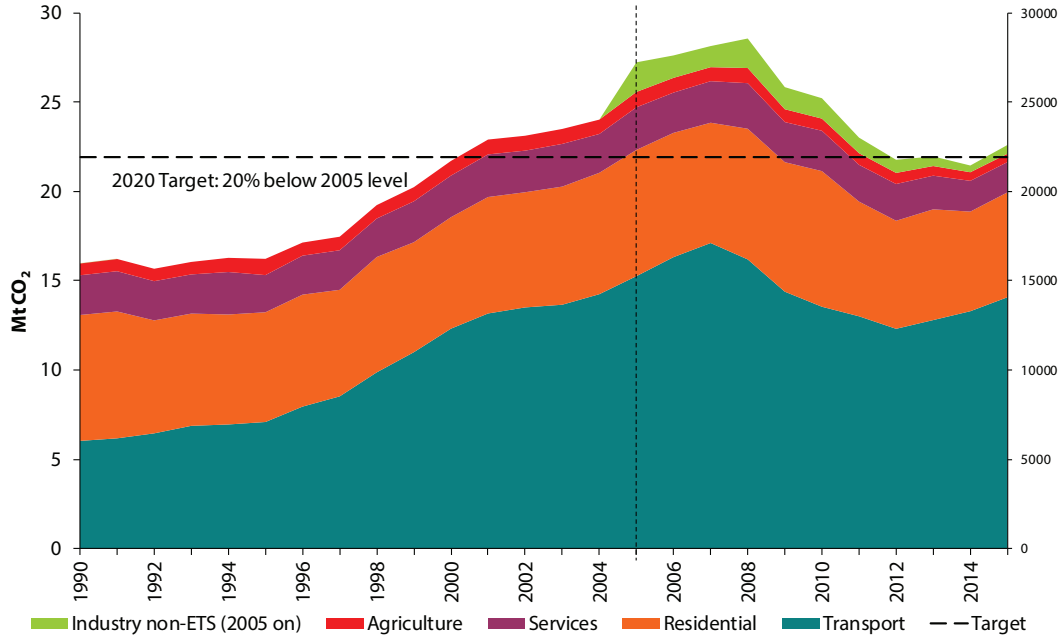
	Growth %	Average annual growth rates %			Shares %	
	2005 – 2015	'05 – '10	'10 – '15	2015	2005	2015
ETS CO_2	-23.8	-3.6	-1.7	5.1	41.7	39.4
non-ETS CO_2	-16.4	-1.5	-2.0	5.5	58.3	60.6
Total Energy-Related CO_2	**-18.6**	**-2.5**	**-1.6**	**5.8**		

Table 15 shows non-ETS sectors' (including non-ETS industry) energy-related CO_2 emissions decreased by 1.5% per annum between 2005 and 2010, and 2% per annum between 2010 and 2015, with emissions increasing by 5.5% in 2015. Non-ETS energy-related CO_2 emissions are now 16% below 2005 levels. Under EU Decision 406/2009/EC there is a requirement for 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 has experienced a 24% fall in energy-related emissions since 2005 and emissions increased by 5.1% in 2015 compared with the previous year. The share of emissions covered in the ETS in overall energy-related emissions stands at 39% in 2015.

35 EU Decision 406/2009/EC.

Figure 33 *Non Emissions Trading Energy-Related CO_2 (non-ETS industry from 2005 onwards)*[36]



3.2.1 Transboundary Gas Emissions

Emissions of sulphur dioxide (SO_2) and nitrogen oxides[37] (NO_x) from energy use are associated with acid rain, smog and other environmental issues (including acidification and eutrophication) that are commonly described as air quality issues. Under Article 4.1 of Directive 2001/81/EC, Member States must limit their annual national emissions of the pollutants sulphur dioxide (SO_2), nitrogen oxides (NO_x), ammonia (NH_3) and volatile organic compounds (VOC). *Table 16* shows the emission levels for SO_2 and NO_x in 2014 as well as the 2010 ceiling limit set in the Directive.

Table 16 *SO_2 and NO_x Emissions and NEC Directive Ceilings for 2010*[38]

	1990 (kt)	2014 (kt)	2010 Ceiling (kt)	% above 2010 Ceiling
NO_x	140	74.7	65	14.9%
SO_2	183	19.3	42	-

Source: EPA

SO_2 levels in Ireland fell by 89% between 1990 and 2014. Emissions from power generation fell by 94% over the period as a result of the installation of abatement equipment and the switch from oil to natural gas. Reductions in the order of 81% in SO_2 emissions in the residential and services sectors and an 90% reduction in industry were achieved over the period through the use of low sulphur coal and a switch to natural gas from oil.

NO_x emissions contribute to the acidification of soils and surface waters, tropospheric ozone formation and nitrogen saturation in terrestrial ecosystems. Power generation plants and motor vehicles are the principal sources of NO_x, through high-temperature combustion. NO_x emissions in Ireland decreased by 48% between 1990 and 2014 and have decreased by 38 kt, or 34% since 2008. The latest estimate is 74.7 kt in 2014, which is a decrease of 1.2% on the previous year. In 2014, NO_x emissions were 14.9% above the 2010 ceiling.

The transport sector, which mainly consists of road transport, is the principal source of NO_x emissions, contributing approximately 57% of the total in 2014. The industrial and power generation sectors are the other main sources of NO_x emissions, with contributions of 14% and 10% respectively in 2014. The remainder of NO_x emissions emanate from the residential/commercial and the agricultural sectors, which together produced around 10% of the total in 2014.

36 The 2020 target of 20% below 2005 levels refers to total GHG emissions and not just energy-related CO_2 emissions. While there's no specific target for energy-related CO_2, the datum of 20% below 2005 levels is shown here for illustrative purposes.

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

38 See http://www.epa.ie/downloads/pubs/air/airemissions/

3.3 Energy Security

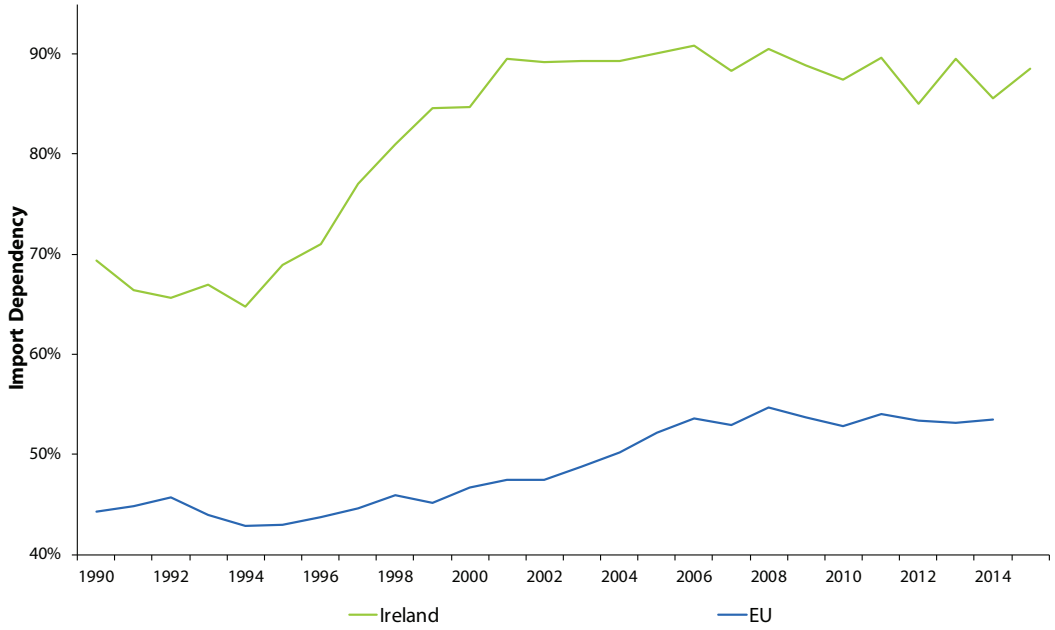
Energy security relates to import dependency, fuel diversity and the capacity and integrity of the supply and distribution infrastructure. Ireland's energy security is closely linked to EU security of supply, but import dependency is examined here for Ireland in its own right. Energy security is treated in more detail in a separate SEAI publication[39]. *Figure 34* illustrates the trend in import dependency since 1990, comparing it with that for the EU as a whole.

Indigenous 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 2015, compared with 50% in the early 1990s. Ireland's overall import dependency reached 90% in 2006. It has varied between 85% and 90% since then, and was at 88% in 2015. It is estimated that in 2015 the cost of all energy imports to Ireland was approximately €4.6 billion, down from €5.7 billion in 2014, due mainly to falling oil and, to a lesser extent, gas import prices.

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 35* 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 94% over the period since 1990, to 107 ktoe. Renewable energy in contrast increased by 511% to 1,026 ktoe. Indigenous production of all energy peaked in 1995 at 4,105 ktoe and there has been a 52% reduction since then to 1,957 ktoe.

Peat production was depressed in 2012 due to the very wet summer of that year. Production was down 59% in 2012 compared with 2011. In contrast, the summer of 2013 provided very good harvesting conditions for peat and as a result production was 310% above 2012 levels, at 1,292 ktoe, with a considerable amount of the production going to building up stock levels. Production in 2015 was down 22% on 2014 at 762 ktoe.

Figure 34 *Import Dependency of Ireland and EU*



Source: SEAI and Eurostat

The share of the total indigenous fuels contribution from native gas was 5.5% in 2015, compared with 54% in 1990. The share of peat went from 41% in 1990 to 39% in 2015 but in absolute terms peat production fell by 46%. Renewable energy accounted for 52% of indigenously produced energy in 2015.

Developments that are likely to affect this trend include the commencement of supply from the Corrib Gas Field in January 2016 and the targets for increasing the deployment of renewable energy.

39 Sustainable Energy Authority of Ireland (2015), *Energy Security in Ireland*, www.seai.ie

Figure 35 *Indigenous Energy by Fuel*[40]

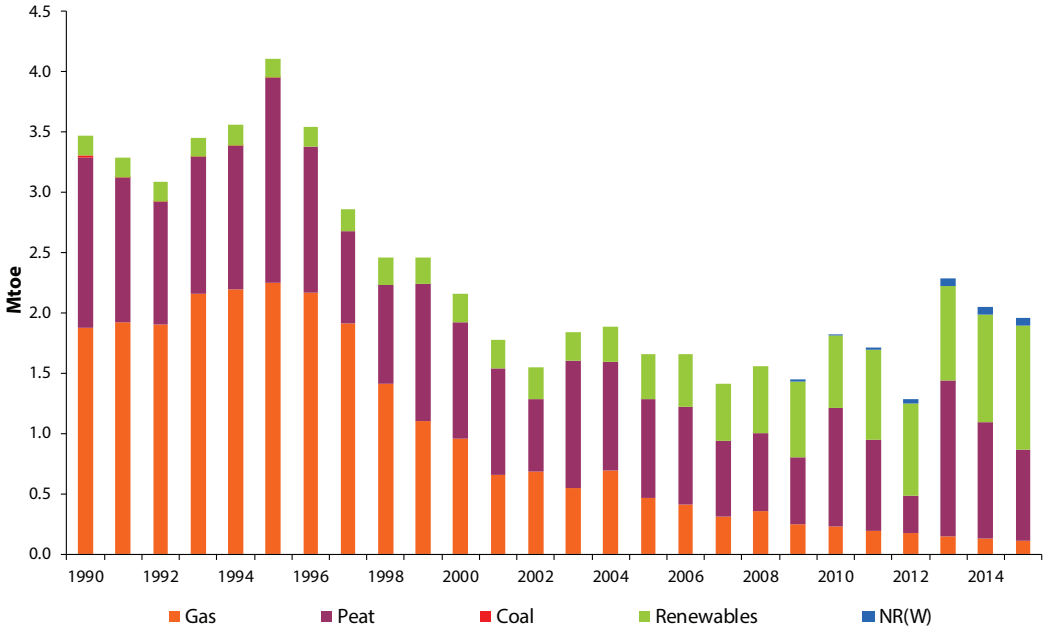


Figure 36 shows the trend for net fuel imports (imports minus exports) over the period 1990 – 2015. The growing dependence on oil due largely to an increase in energy use in transport is the most striking feature up until 2008 and the subsequent fall off in oil imports is a result of the economic downturn. There was a 117% increase in total net imports from 1990 to 2008, with an 87% increase in net imports of oil. Between 2008 and 2015 net imports have fallen by 16% with oil imports falling 20%. In 2015 net imports increased by 8.6% and were 83% above 1990 levels while oil imports were up 49%.

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. In 2015, oil, gas and coal accounted for 58%, 29% and 12% of net imports respectively.

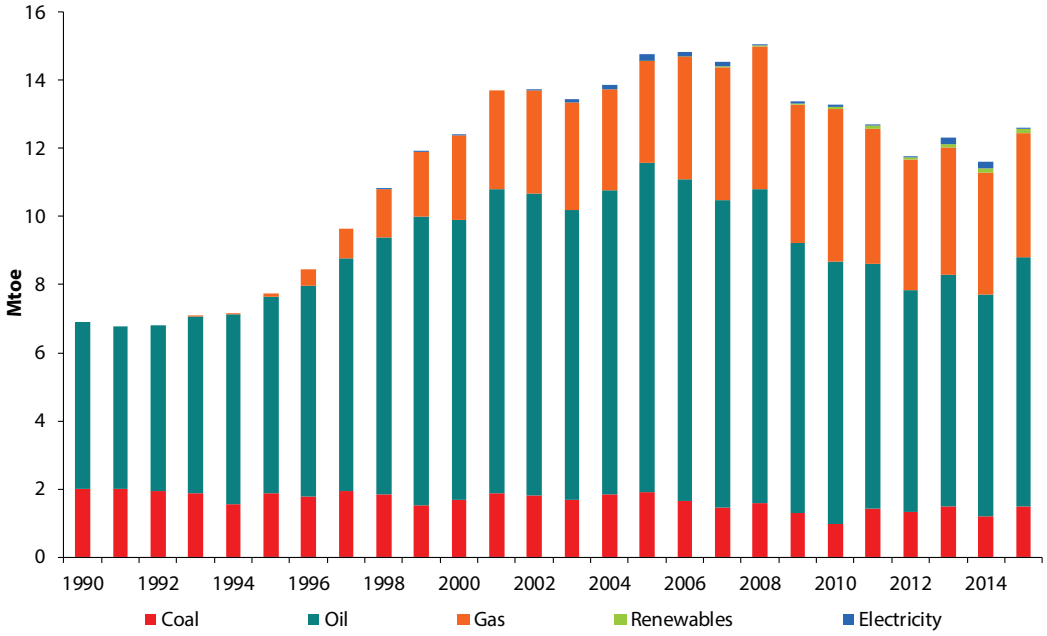
Other contributions to the increase in import dependency in 2015 were:

- Coal imports were up 22% to 1,469 ktoe;
- Oil imports were up 13% to 7,343 ktoe;
- Natural gas imports were up 1.1% to 3,629 ktoe.

Countering this was a 69% fall in net electricity imports, to 58 ktoe and a 6.4% fall in renewable energy imports (biomass and biofuels), to 124 ktoe.

40 NR(W) is non-renewable energy from wastes.

Figure 36 *Imported Energy by Fuel*



3.4 Cost Competitiveness

Energy use is an important part of economic activity and therefore the price paid for energy is a determining factor in the competitiveness of the economy. Ireland has a high import dependence on 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.

Since 2010, energy prices[41] in Ireland have increased by 4.7% in real terms, compared with an average fall of 0.1% in OECD Europe and a 14% fall in the US over the same period based on data from the IEA. In 2015, overall energy prices in Ireland were 14% lower than in 2014, compared with a fall of 7.3% in OECD Europe and a 20% drop in the US. 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.

Crude oil prices during the first half of 2015 were around $58/barrel and fell further during the second half to $47/barrel. For the year as a whole the price averaged $52 and in January 2016 it fell briefly to €26/barrel, its lowest level in decades.

The price of natural gas at the UK Balancing Point was on average 22% lower in 2014 compared with 2013 and fell a further 5.2% in 2015.

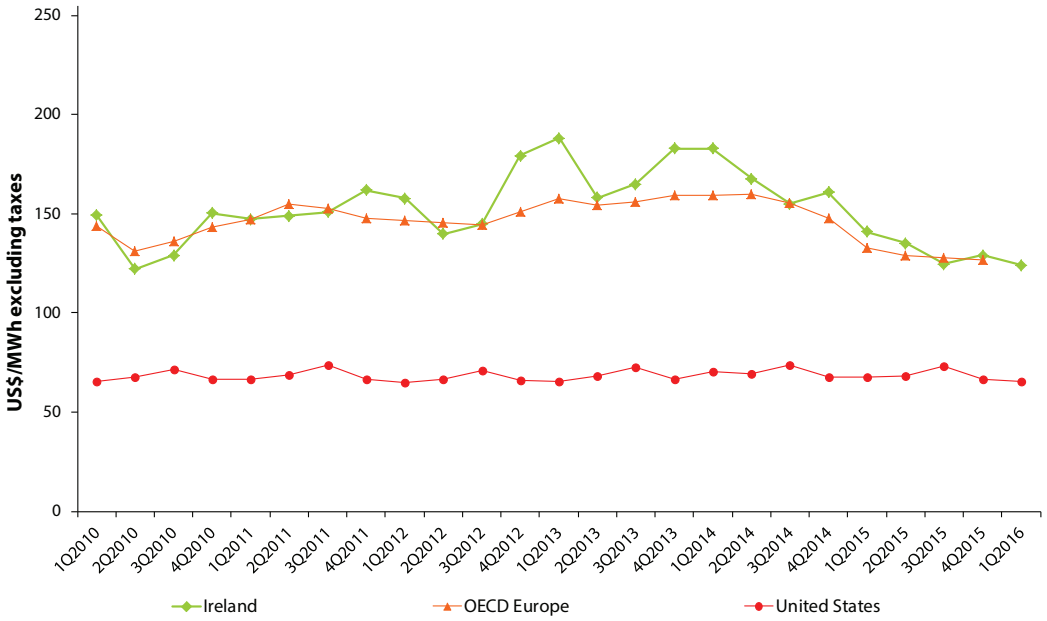
SEAI publishes biannual reports titled *Understanding Electricity and Gas Prices in Ireland*[42] based on the methodology for the revised EU Directive on the transparency of gas and electricity prices[43], which came into effect on the 1 January 2008. These reports focus specifically on gas and electricity prices using data published by Eurostat and are a useful reference on cost-competitiveness.

This section presents comparisons of the cost of energy in various forms in Ireland and compares prices in OECD Europe and the US. The source of the data presented here is the IEA's *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 2016. Prices shown are US dollars and are in current (nominal) money[44]. Relative price increases since 2010, however, are tabulated for EU-15 countries and the US in index format in both nominal and real terms.

41 International Energy Agency, 2016, *Energy Prices and Taxes - 2nd Quarter 2016*, http://www.iea.org/bookshop/
42 Sustainable Energy Authority of Ireland (various dates), *Understanding Electricity and Gas Prices in Ireland*, www.seai.ie
43 http://europa.eu/legislation_summaries/energy/internal_energy_market/l27002_en.htm
44 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.

3.4.1 Energy Prices in Industry

Figure 37 *Electricity Prices to Industry*



Source: Energy Prices and Taxes © OECD/IEA, 2016

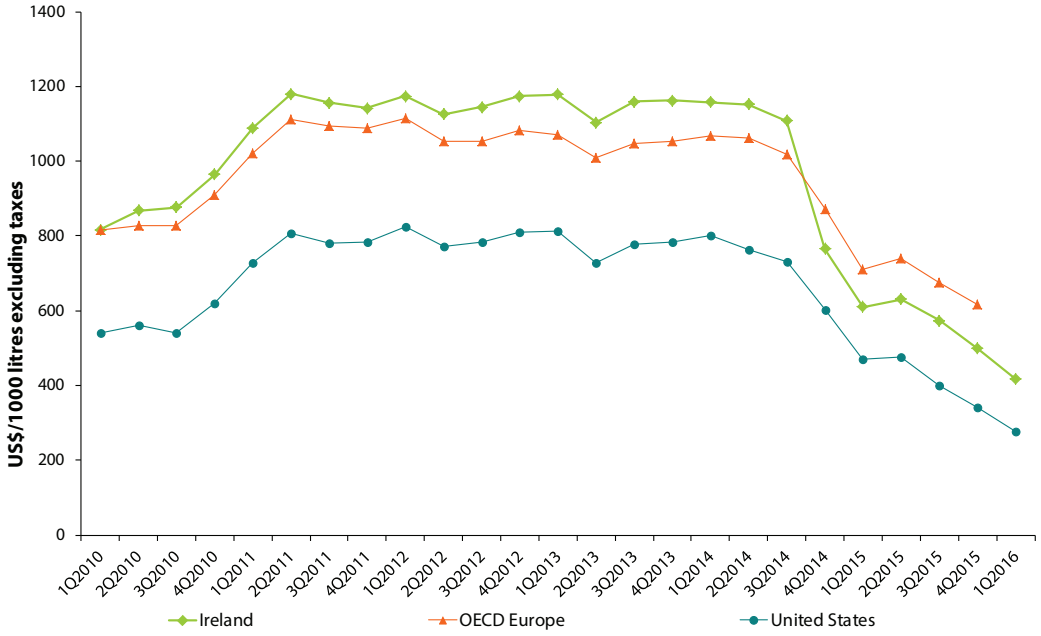
Table 17 *Electricity Price to Industry Increase since 2010*

Index 2010 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom	United States
1st qtr 2016 (nominal)	110	89	101	90	103	121	121	102	**109**	119	72	85	123	101	70	117	96
1st qtr 2016 (real)	105	87	107	84	100	121	118	113	**103**	117	71	89	126	99	71	114	94

Source: Energy Prices and Taxes © OECD/IEA, 2016

Table 17 shows that electricity prices to Irish industry increased by 3% in real terms between 2010 and early 2016. The fuel mix for electricity generation is one factor that has a key bearing on the variation in the price of electricity. In the EU, Ireland has a high overall dependency for electricity generation on fossil fuels at 68%, behind the Netherlands at 80%, Cyprus at 92% and Malta at 98%. Ireland also has a high dependency on oil and gas generation at 50%. Apart from Malta and Cyprus, only the Netherlands, at 52% , has higher gas and oil generation dependency than Ireland.

Figure 38 *Oil Prices to Industry*



Source: Energy Prices and Taxes © OECD/IEA, 2016

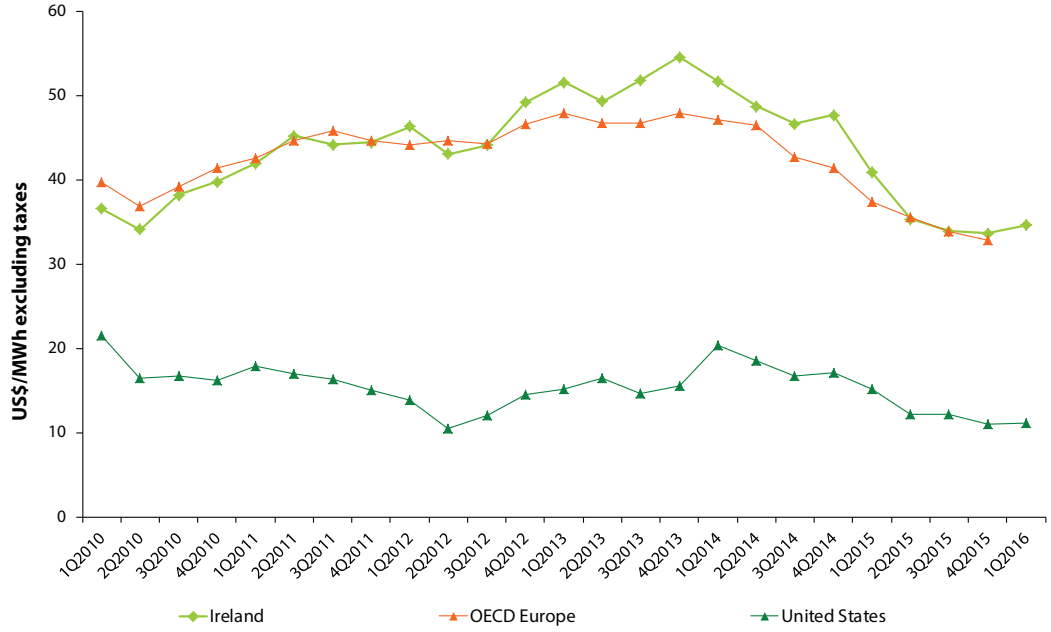
Table 18 *Oil Price to Industry Increase since 2010*

Index 2010 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom	United States
1st qtr 2016 (nominal)	88	69	91	90	97	90	79	79	**86**	98	86	90	92	84	99	83	67
1st qtr 2016 (real)	85	67	96	84	94	90	77	87	**82**	96	85	94	94	83	101	81	66

Source: Energy Prices and Taxes © OECD/IEA, 2016

Table 18 shows that oil prices to industry in Ireland were 18% lower in real terms in early 2016 than in the year 2010. The average decrease in oil price in Europe was 15% and 34% in the US.

Figure 39 *Natural Gas Prices to Industry*[45]



Source: Energy Prices and Taxes © OECD/IEA, 2015

Table 19 *Natural Gas Price to Industry Increase since 2010*

Index 2010 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom	United States
1st qtr 2016 (nominal)	106	171	98		125	108	84	82	**112**	109	117	97	123	100		107	62
1st qtr 2016 (real)	100	167	104		121	108	82	90	**107**	107	116	101	126	99		105	61

Source: Energy Prices and Taxes © OECD/IEA, 2015

With reference to *Figure 39*, natural gas prices to Irish industry increased from the second quarter 2010 until the end of 2013. In general, the price has been falling since then. In the first quarter of 2016 the price of gas to industry in Ireland was 7% above 2010 levels in real terms.

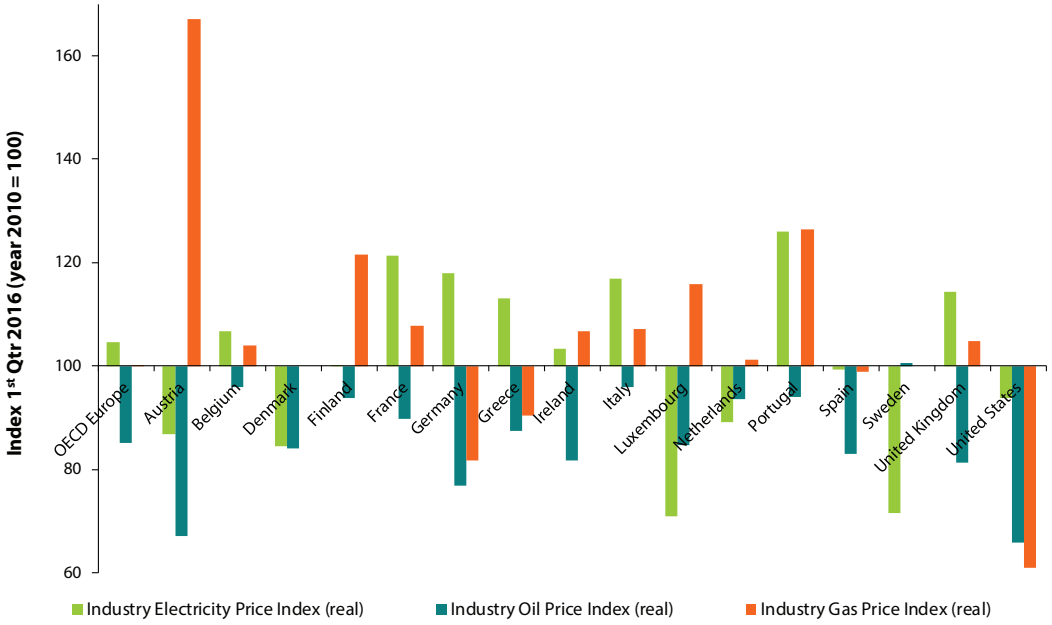
Figure 39 shows the gap between gas prices in Europe and the US.

Figure 40 summarises the data presented in *Tables 17, 18* and *19*. The IEA publishes an overall energy price index (real) for industry which shows that the overall energy price to Irish industry between 2010 and early 2016 fell by 11%, compared with a fall of 8.4% for OECD Europe and 27% for the US. This should be considered in the context of the weighting of energy in the cost base of Irish industry[46].

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

46 Sustainable Energy Authority of 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 40 *Real Energy Price Change to Industry since 2010 in EU-15 (index)*



Source: Energy Prices and Taxes © OECD/IEA, 2016

Between 2010 and 2015, energy prices for industry in Ireland decreased by 0.5% in real terms. In OECD Europe the decrease was 1.2% while in the US energy prices fell by 15% over the same period.

2015 was also a period of falling global oil and gas prices. This is reflected in overall energy prices to industry in Ireland being 20% lower than 2014. In OECD Europe prices fell by 8.1% and by 21% in the US.

4 Sectoral Indicators

This section explores the changes in energy trends that are taking place at a sectoral level to help in understanding the general patterns of energy use and to assist in assessing the likely impacts of policies and measures on achieving particular targets.

4.1 Industry

Trend in 2015

In 2015, energy use in industry was 2.4 Mtoe and was 4.8% higher than in 2014. The economic activity of industry increased in 2015 by 98%, however the bulk of this increase is related to one-off factors such as the transfer into Ireland of assets, such as intellectual property rights, which inflated the value added of certain industry sectors. This would have had little or no effect on the energy demand of industry and therefore the recorded increase in energy use probably reflects the true economic growth of industry in 2015.

In 2015 consumption of all fuel experienced growth except coal, oil and non-renewable wastes. Oil use fell by 2.8% and accounted for just under one fifth of industry's energy use. Coal use fell by 0.7% following a 30% increase in 2014, although it still only accounted for 4.4% of the energy share of industry. Non-renewable wastes account for 1.6% of industry's energy use and fell by 3.4% in 2015.

Natural gas had the highest rate of growth in industry in 2015, with a 12% increase, and accounted for 32% of industry's final energy demand. Renewable energy use in industry grew by 1.7% in 2015 and accounted for 7.3% of industry's energy use. Electricity consumption increased by 4.8% to 847 ktoe and accounted for 35% of industry's energy use.

Trends 1990 – 2015

Final energy use in industry grew by 55% to a high of 2,672 ktoe over the period 1990 – 2006. Between 2006 and 2009 there was an 18% fall in industrial final energy use. Following a small increase in 2010 of 2.8%, consumption in industry fell until 2012. After 2012, energy use in industry increased by 9.6%. In 2015 it increased by 4.8% to 2,397 ktoe.

Figure 41 shows that over the period 1990 – 2015 only electricity, natural gas and renewables have increased their share. Since 2009 non-renewable wastes have been used in industry, but in 2015 accounted for just 1.6% of industry's energy use. The share of electricity has risen from 22% to 35%, natural gas from 21% to 32% and renewables from 3.7% to 7.3%. The increase in renewables is mainly due to the use of biomass in the wood processing industry, the use of tallow in the rendering industry and the use of the renewable portion of wastes in cement manufacturing.

Figure 41 *Industry Final Energy Use by Fuel*

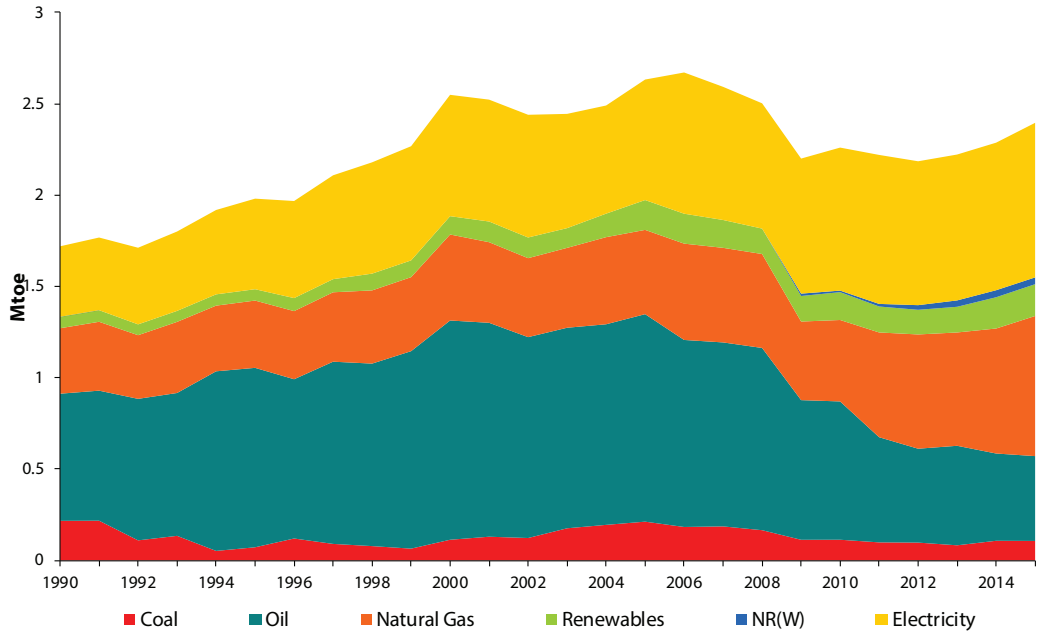


Table 20 shows the growth rates, quantities and relative shares of energy in industry.

Table 20 *Growth Rates, Quantities and Shares of Final Consumption in Industry*

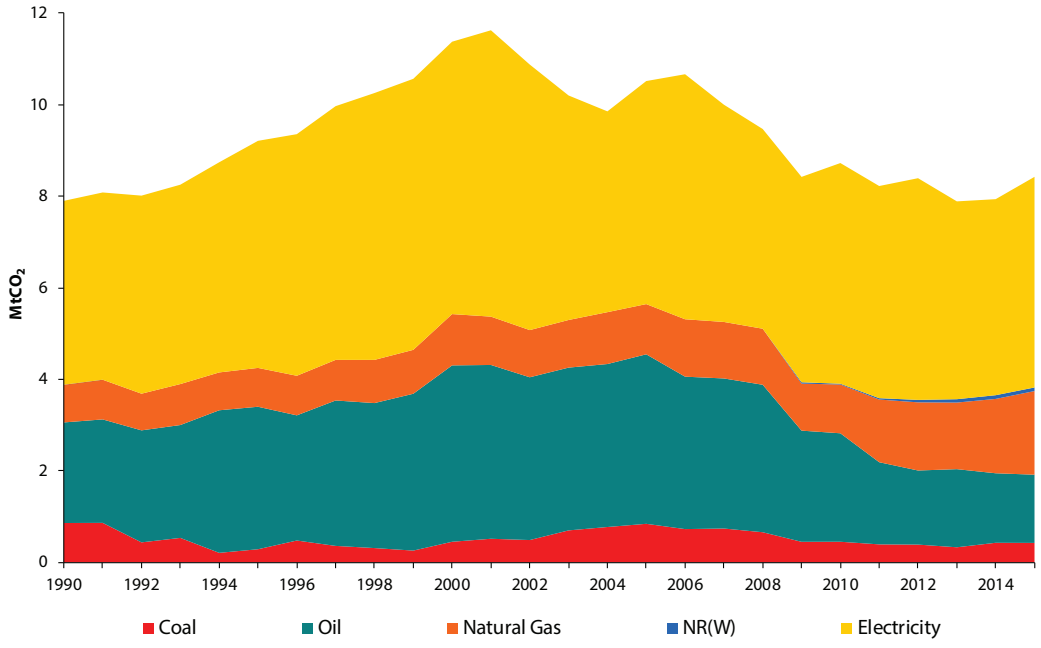
	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Fossil Fuels (Total)	5.3	0.2	0.3	-6.2	0.3	5.4	1,271	1,339	73.9	55.9
Coal	-50.9	-2.8	13.4	-11.8	-1.2	-0.7	216	106	12.6	4.4
Oil	-33.3	-1.6	-1.1	-7.8	-9.3	-2.8	696	464	40.5	19.4
Gas	114.1	3.1	-0.4	-0.7	11.5	12.1	358	767	20.8	32.0
Renewables	176.2	4.1	10.3	-1.4	2.7	1.7	63	174	3.7	7.3
Non-Renewable (Wastes)	-	-	-	-	34.2	-3.4	-	37	0.0	1.6
Combustible Fuels (Total)	16.2	0.6	0.9	-5.6	1.0	4.8	1,334	1,550	77.6	64.7
Electricity	119.5	3.2	-0.1	3.5	1.6	4.8	386	847	22.4	35.3
Total	**39.4**	**1.3**	**0.7**	**-3.0**	**1.2**	**4.8**	**1,720**	**2,397**		

Direct use of fossil fuels accounted for 56% of energy use in industry in 2015 and grew by 5.4% in 2015 or 5.3% over the period 1990 – 2015. So, while coal and oil consumption in industry has fallen over the period by 51% and 33% respectively overall fossil fuel use has grown due to the 114% increase in natural gas use. This change in fuel mix resulted in lower emissions from fuel use in industry.

Energy-related CO_2 Emissions – including emissions associated with electricity

In order to determine industry's total energy-related CO_2 emissions it is necessary to include estimations of upstream emissions for electricity consumed by industry. *Figure 42* 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 42 *Industry Energy-Related CO_2 Emissions by Fuel*



As detailed in *Table 21*, industrial energy-related CO_2 emissions increased by 6.1% in 2015 to 8.4 Mt CO_2. Electricity consumption was responsible for 55% of industry's energy-related emissions in 2015. Electricity is indirectly responsible for more than half of CO_2 emissions in industry.

Table 21 shows the growth rates, quantities and relative shares of energy-related CO_2 emissions in industry.

Table 21 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions in Industry*

	Growth %	Average annual growth rates %					Quantity (kt)		Shares %	
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Coal	-50.8	-2.8	13.4	-11.8	-1.2	-0.6	856	421	10.8	5.0
Oil Total	-32.2	-1.5	-0.8	-8.5	-8.9	-1.9	2,198	1,491	27.8	17.7
Kerosene	409.6	6.7	6.8	-2.0	-5.2	15.8	50	257	0.6	3.1
Fuel Oil	-90.3	-8.9	-6.8	-8.0	-33.4	-45.5	1,341	130	17.0	1.5
LPG	71.3	2.2	3.6	-0.1	0.6	1.5	165	282	2.1	3.3
Gas Oil	-27.5	-1.3	0.8	-4.6	-7.3	-3.7	454	329	5.7	3.9
Petroleum Coke	166.7	4.0	8.4	-21.3	11.5	12.0	185	493	2.3	5.8
Natural Gas	121.8	3.2	-0.4	-0.6	11.4	12.5	824	1,828	10.4	21.7
Non-Renewable (Wastes)	-	-	-	-	36.2	-3.4	-	78	0.0	0.9
Total Combustible Fuels	-1.4	-0.1	0.8	-7.1	-0.4	4.6	3,879	3,823	49.1	45.4
Electricity	14.5	0.5	-3.9	-0.2	-0.9	7.4	4,020	4,602	50.9	54.6
Overall Total	**6.7**	**0.3**	**-1.6**	**-3.7**	**-0.7**	**6.1**	**7,899**	**8,425**		

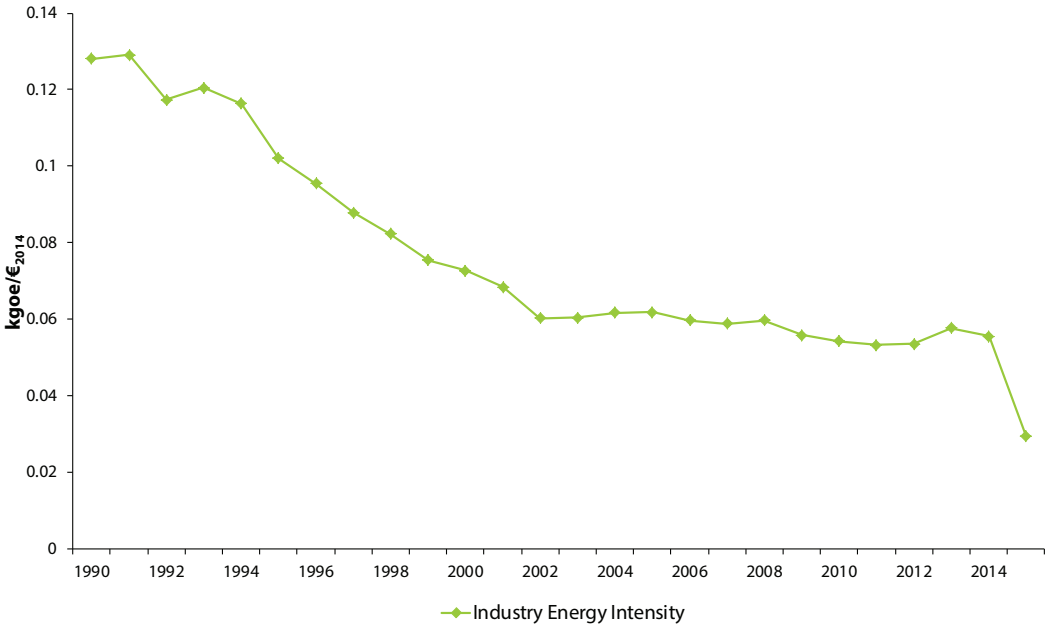
Energy-related CO_2 Emissions – excluding emissions associated with electricity

If upstream electricity-related emissions are omitted then there was a 4.6% increase in CO_2 emissions from combustible fuels used on site in industry in 2015. This is as a result of changes in the volume and fuel mix used in industry, with increased gas, kerosene and petroleum coke (+12.5%, +15.8% and +12% respectively), countered by reduced fuel oil (-45.5%), gas oil (-3.7%) and increased renewables (+1.7%).

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 43* shows the industrial energy intensity between 1990 and 2015 expressed in kilograms of oil equivalent per euro of industrial value added (kgoe/€$_{2014}$) at 2014 money value. Over the period, industrial energy consumption increased by 39% while value added increased by 5.6%, resulting in a reduction in intensity of 77%. In other words to generate a euro of value added in 2015, it took less than a quarter 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.

Figure 43 *Industry Energy Intensity*



Value-added output from industry grew by 98% in 2015 relative to 2014. The large increase in Gross Value Added (GVA) in 2015 (98%) is explained by a number of one-off factors such as the transfer of assets into Ireland and what are known as reverse takeovers. This increase in GVA incurred no additional energy consumption.

Energy intensity in this form is not a good indicator of energy efficiency and variation may be the result of many factors such as structural changes, fuel mix, volume and other changes.

4.2 Transport

Trend in 2015

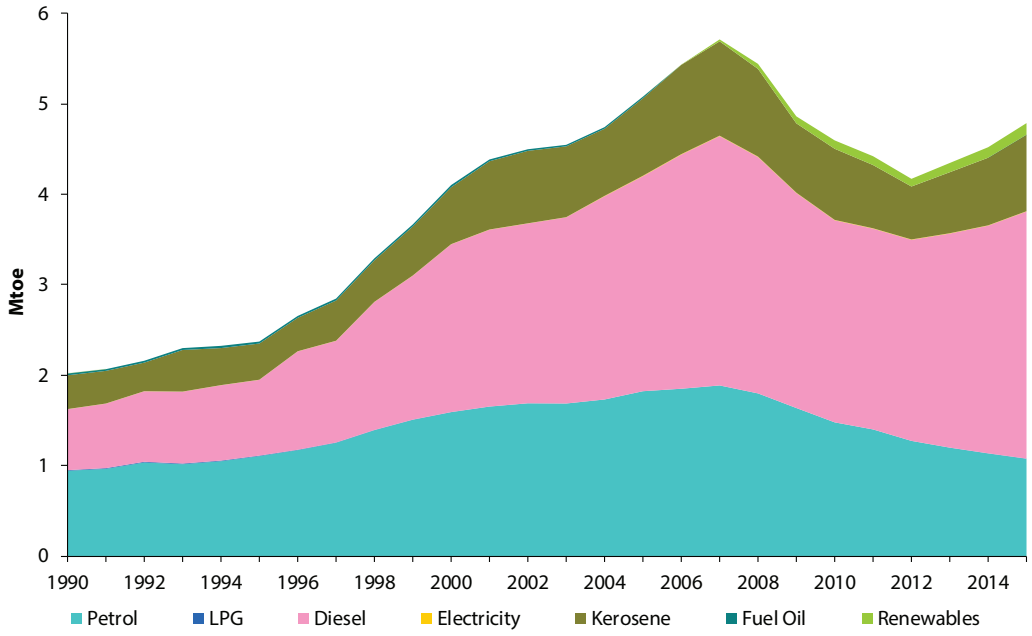
In 2015, overall energy use in transport increased by 5.9%. Historically transport energy growth tracked economic growth so it is likely that real growth in economic activity in Ireland was close to this figure. Petrol was the only fuel of significance to experience falling use in 2015, reducing by 5.2% to 1,075 ktoe. Liquefied Petroleum Gas (LPG) experienced the largest growth in 2015, growing by 20% (but from a very small base) and reaching just 3 ktoe. Renewables in the form of biofuels also had strong growth, increasing by 10.3% to 128 ktoe. Diesel consumption grew by 5.8% during 2015, to 2,733 ktoe, and was the most dominant fuel used, accounting for 57% of all energy use in transport.

Trends 1990 – 2015

Over the period 1990 – 2015, the biggest shift in the transport market has been from petrol to diesel. While consumption of both fuels increased, consumption of diesel increased by 305% compared with just a 14% increase for petrol. Diesel's overall market share grew from 33% in 1990 to 57% in 2015.

Transport energy use peaked in 2007 at 5,715 ktoe and fell each year thereafter until 2013. As the economy started to expand again transport energy use grew in 2013, 2014 and 2015, by 4.2%, 4.0% and 5.9% respectively, to 4,789 ktoe. As shown in *Figure 44* transport energy in 2015 was 16% below the peak in 2007, or back to 2004 levels.

Figure 44 *Transport Final Energy Use by Fuel*[47]



The growth rates for the different transport fuels over the period are shown in *Table 22*.

47 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 (2014),* presents estimates of fuel tourism and these are shown in *Figure 58* in the transport report.

Table 22 *Growth Rates, Quantities and Shares of Final Consumption in Transport*

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Fossil Fuels (Total)	130.8	3.4	4.4	-2.4	0.7	5.8	2,017	4,657	99.9	97.3
Total Oil	130.8	3.4	4.4	-2.4	0.7	5.8	2,017	4,657	99.9	97.3
Petrol	14.0	0.5	2.8	-4.1	-6.2	-5.2	942	1,075	46.7	22.4
Diesel	305.3	5.8	5.1	-1.2	4.1	8.5	674	2,733	33.4	57.1
Jet Kerosene	126.4	3.3	6.4	-1.7	1.5	13.2	374	846	18.5	17.7
LPG	-63.6	-4.0	-14.1	-12.8	37.5	20.0	7	3	0.3	0.1
Natural Gas	-	-	-	-	-	-45.3	-	0.01	0.0	0.000
Renewables	-	-	-	142.8	6.7	10.3	-	128	0.0	2.7
Combustible Fuels (Total)	137.2	3.5	4.4	-2.0	0.8	5.9	2,017	4,785	99.9	99.9
Electricity	156.5	3.8	17.8	-5.0	-2.1	5.1	1	4	0.1	0.1
Total	**137.2**	**3.5**	**4.4**	**-2.0**	**0.8**	**5.9**	**2,019**	**4,789**		

Energy-related CO_2 Emissions

The growth rates and shares of the energy-related CO_2 emissions from the different transport fuels, which are shown in *Table 23*, closely match the changes in transport fuel consumption. Between 2007 and 2012, the primary energy-related CO_2 emissions fell by 28%. Transport emissions began to rise again in 2013 for the first time since 2007, increasing by 3.9%. Emissions increased in 2015, by 5.9% to 14.1 $MtCO_2$.

Table 23 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions in Transport*

	Growth %	Average annual growth rates %					Quantity (kt)		Shares %	
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Total Oil Products	133.4	3.4	4.4	-2.4	0.8	5.9	6,029	14,073	99.8	99.9
Petrol	14.0	0.5	2.8	-4.1	-6.2	-5.2	2,761	3,148	45.7	22.3
Diesel	305.3	5.8	5.1	-1.2	4.1	8.5	2,070	8,388	34.2	59.5
Jet Kerosene	126.4	3.3	6.4	-1.7	1.5	13.2	1,118	2,530	18.5	18.0
LPG	-63.6	-4.0	-14.1	-12.8	37.5	20.0	19	7	0.3	0.0
Electricity	33.8	1.2	13.3	-8.4	-4.5	7.7	14	19	0.2	0.1
Total	**133.2**	**3.4**	**4.4**	**-2.4**	**0.8**	**5.9**	**6,043**	**14,092**		

4.2.1 Transport Energy Demand by Mode

Fuel consumption in transport is closely aligned to the mode of transport used: jet kerosene is used for air transport, fuel oil for shipping and electricity is currently consumed mostly by the Dublin Area Rapid Transport (DART) system and, since 2004, by Luas. LPG is almost exclusively used for road transport, as is petrol. The bulk of petrol consumption for road transport is assumed to be for private car use although there are a significant number of petrol-driven taxis in operation and practically all motorcycles use petrol. Diesel consumption is used for road transport, navigation and rail.

SEAI's report *Energy in Transport*[48] presents an estimation of the energy use in transport by different modes. The contribution from each mode of transport to energy demand is shown in *Figure 45* and detailed in *Table 24*. In 2014, a new category of Light Goods Vehicle (LGV) was added. This was been made possible from the analysis of the fuel efficiency of LGVs and the assessment of annual mileage estimated from the Commercial Vehicle Roadworthiness Test data from the Road Safety Authority (RSA). Energy use identified under the LGV category was previously included in the Unspecified category.

Trend in 2015

Energy consumption by heavy goods vehicles (HGVs) increased by 0.7% in 2015 while conversely consumption by LGVs fell by 5.1%. Overall energy use by goods vehicles in total fell by 1.2% in 2015.

Private car energy consumption fell by 0.8% in 2015 to 2,078 ktoe and accounted for 43% of transport energy use. Petrol consumption by private cars fell by 9% in 2015 while diesel consumption increased by 7% and biofuels by 7.7%.

Aviation experienced the highest growth in energy use with a 13% increase in 2015.

48 Sustainable Energy Authority of Ireland (2014), *Energy in Transport – 2014 Report*, http://www.seai.ie/energy-data-portal/

Table 24 *Growth Rates, Quantities and Shares of Transport Final Energy Demand by Mode, 1990 – 2015*

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
Mode	**1990 - '15**	**'90 – '15**	**'00 – '05**	**'05 – '10**	**'10 – '15**	**2015**	**1990**	**2015**	**1990**	**2015**
Road Freight	80.8	2.4	6.6	-9.2	-1.9	0.7	346	625	17.1	13.1
Light Goods Vehicle (LGV)	-	-	-	-	-3.7	-5.1	-	300	-	6.3
Private Car	124.4	3.3	3.9	1.2	0.7	-0.8	926	2,078	45.9	43.4
Public Passenger (road)	160.6	3.9	12.8	0.8	-3.6	-1.9	52	137	2.6	2.9
Rail	-12.1	-0.5	1.2	-0.6	-2.1	2.2	45	39	2.2	0.8
Aviation	126.0	3.3	6.4	-1.7	1.5	13.1	375	847	18.6	17.7
Fuel Tourism	-	-	-11.6	-10.0	15.7	61.1	0	473	0.0	9.9
Navigation	887.5	9.6	16.0	5.4	2.1	-1.4	7	71	0.4	1.5
Unspecified	-18.8	-0.8	20.1	-15.4	-2.8	9.7	267	217	13	4.5
Total	**137.2**	**3.5**	**4.4**	**-2.0**	**0.8**	**5.9**	**2,019**	**4,789**		

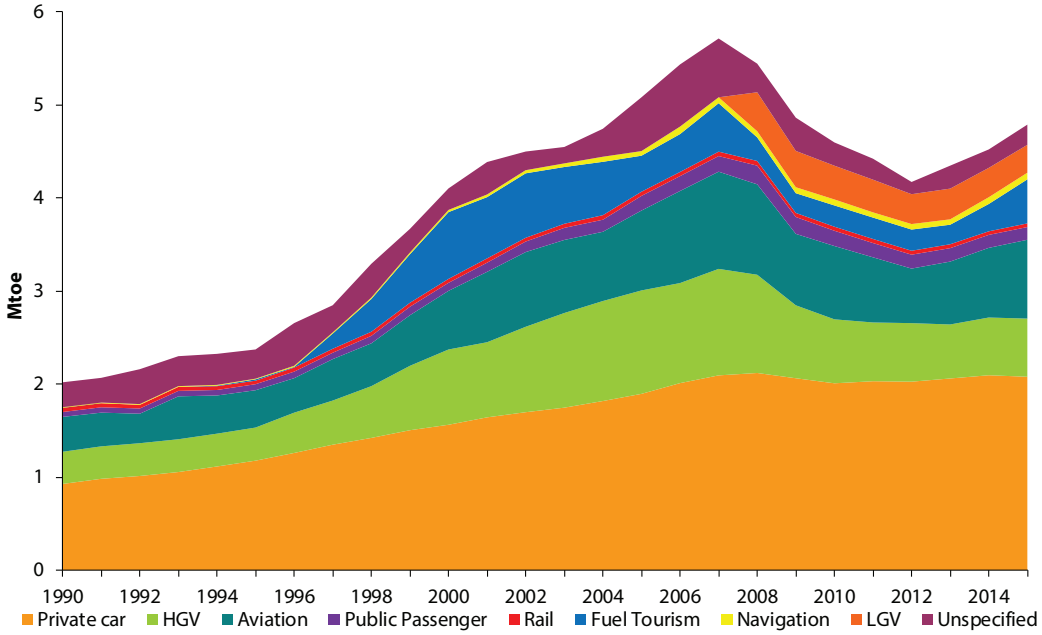
Road transport accounted for 66% of transport TFC in 2015 (80% if unspecified and fuel tourism are included as road transport). Private car use accounted for two thirds (66%) of road transport with goods vehicles accounting for almost another third (30%) and public passenger services the rest (4%).

Aviation was responsible for 18% of transport TFC in 2015 and rail transport just under 1%.

Energy use by private cars, accounting for 43% of transport energy, fell by 0.8% and public passenger (road) consumption decreased by 1.9% in 2015.

Combined petrol and diesel fuel tourism is also included in *Figure 45*. 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.

Figure 45 *Transport Energy Demand by Mode 1990 – 2015*



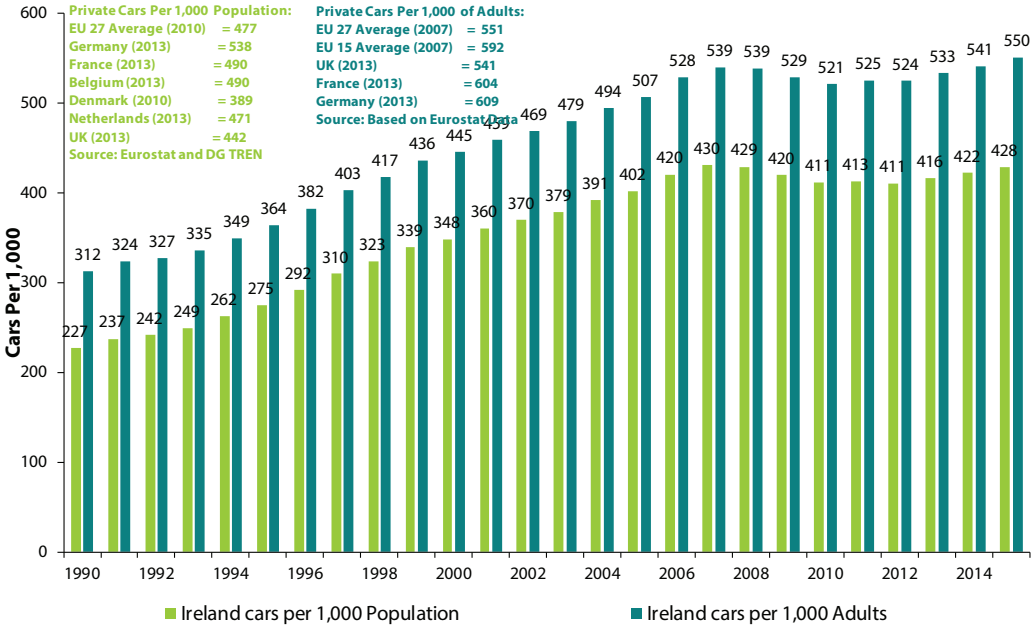
Trends 1990 – 2015

Looking at *Figure 45* there is a clear divide to be seen in consumption trends pre- and post-2007, due in large part to the economic downturn that began in 2008. HGV road freight in particular has been affected by both the economic boom and the recession, experiencing both the greatest increase in the period 1990 – 2007 (231%, from 346 to 1,145 ktoe) and the greatest contraction in the period 2007 – 2015 (45%, from 1,145 to 625 ktoe). The energy consumption of HGVs increased by 7.7% in 2015 while LGV energy consumption fell by 9.3%.

4.2.2 Private Car Transport

In 2015, the number of vehicles on Irish roads was 2.6 million (2,570,294), of which 77% were private cars. The number of private cars peaked in 2008 at 1,923,471 and numbers fell in three of the following five years. In 2015 the number of licensed private cars on the road increased by 2.1% to a new peak of 1,985,130, exceeding the 2008 numbers by 3.2%.

Figure 46 *Private Cars per 1,000 of Population*



Source: Based on Vehicle Registration Unit and CSO data

The car density in 2015 (as shown in *Figure 46*) was 428 cars per 1,000 of population, up slightly on the 2014 figure of 422. This is compared to an EU-27 average of 477 in 2010 and a UK average of 442 in 2013.

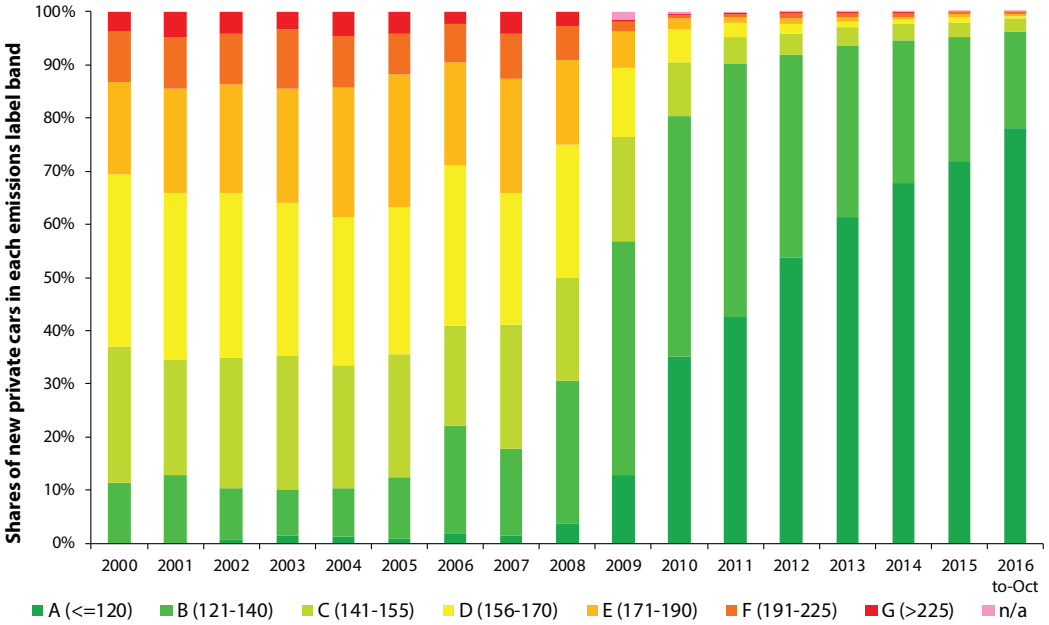
4.2.3 CO_2 Emissions of New Private Cars

Figure 47 and *Table 25* show the shares of new car sales[49] between 2000 and September 2016 classified by emissions label band. Between 2000 and 2005 the share of label bands A and B was on average 11%. For the first half of 2008, before the new taxes came into effect, the share of these two bands was 25%. Upon introduction the taxes had an immediate effect: for the second half of 2008 the share of the A and B bands rose to 50%. Conversely, the combined share of bands E, F and G fell from 28% in early 2008 to 13% in the second half of 2008, just after the change.

This was a significant shift in purchasing patterns towards lower-emissions vehicles in such a short time period, though it was tempered by the fact that the motor industry experienced a severe downturn during 2008/2009. Notwithstanding the reduction in the number of vehicles sold, the combined effect of the EU legislation obligating manufacturers to reduce average fleet emissions and the changes to the Irish taxation system for private cars has been to continue to steadily drive down the average new car fleet emissions year on year since 2008. In 2010 a further incentive towards the purchase of A and B band vehicles came in the form of a government scrappage scheme which applied if a car of 10 years or older was being scrapped and the new car being purchased was in emissions band A or B. This scheme ran until June 2011 but with reduced relief from January 2011.

49 Licensed as private cars.

Figure 47 *Shares of New Private Cars in each Emissions Band 2000 – 2015 (+2016 to October)*



Source: Based on Vehicle Registration Unit data

In 2015 the share of A and B label band cars was 95.3% and for the first ten months of 2016 it was 96.2%. The largest increase in share was in the A label band, which rose from just 1.5% in 2007 to 71.8% of the new private cars sold in 2015. Data for 2016 (up to October) show that this trend has continued with vehicles in the A label band making up 78% or more than three quarters of all new registrations. The share of high emitting cars in label bands E, F and G only amounted to 1% of new cars sold during 2015 and to 0.8% of new cars for the first ten months of 2016, in the latter case just 1,062 cars out of a total of 140,100.

Table 25 *Shares of New Private Cars in each Emissions Band, 2000, 2005, 2010 – 2015 (+2016 to October)*

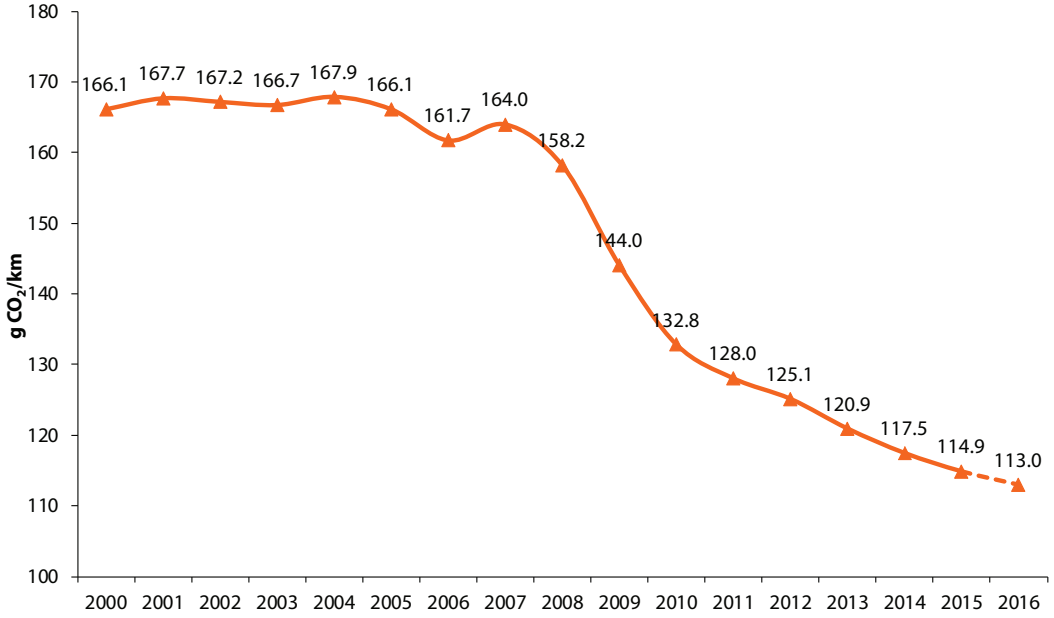
CO_2 band	2000	2005	2010	2011	2012	2013	2014	2015	2016 to Oct
A	0.0%	0.9%	35.1%	42.5%	53.8%	61.3%	67.8%	71.8%	78.1%
B	11.3%	11.4%	45.2%	47.8%	38.2%	32.2%	26.8%	23.5%	18.1%
C	25.6%	23.2%	10.1%	5.0%	4.0%	3.7%	3.0%	2.6%	2.5%
D	32.4%	27.6%	6.2%	2.6%	1.9%	0.9%	0.8%	1.0%	0.6%
E	17.5%	25.1%	2.0%	1.0%	1.0%	0.8%	0.4%	0.6%	0.5%
F	9.5%	7.5%	0.6%	0.6%	1.0%	1.0%	0.9%	0.4%	0.3%
G	3.7%	4.2%	0.3%	0.2%	0.1%	0.1%	0.1%	0.0%	0.0%

Source: Based on Vehicle Registration Unit data

All new cars have associated fuel consumption and CO_2 emissions figures measured under test conditions. *Figure 48* shows the change in the weighted average specific CO_2 emissions of new cars between 2000 and 2015, with an estimate for 2016. Between 2000 and 2007 the average CO_2 emissions for all cars was approximately 166 g CO_2/km which is within band D. Following the change to CO_2 taxation in July 2008 the weighted average emissions went from 161 g CO_2/km, for the first six months of 2008, to 147 g CO_2/km for the second half of the year (8.7% reduction).

Through the combined effects of the taxation change and the obligation on manufacturers to reduce overall fleet emissions, the average emissions of the new car fleet continued to drop, reaching 114.9 g CO_2/km in 2015 which is within band A4. This was 31% below the level in 2007. It is estimated that the average emissions of new cars purchased in 2016 is 113 g CO_2/km, which also falls within the A4 band.

Figure 48 *Specific CO_2 Emissions of New Cars, 2000 – 2015 (2016 estimated)*



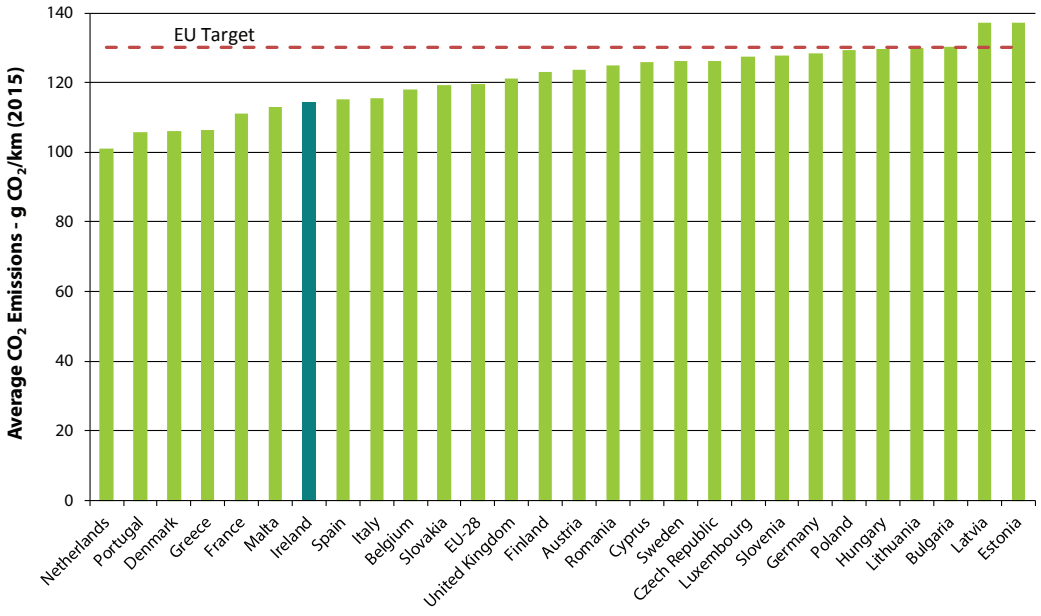
Source: Based on Vehicle Registration Unit and VCA data

Data presented in this report on the carbon emissions ratings of new cars are based on the results of a standardised laboratory test procedure based on the New European Driving Cycle (NEDC). The difference between the test emissions and the emissions actually produced in real world driving conditions is referred to as the on-road factor. A number of recent reports by the International Council on Clean Transportation (ICCT) have highlighted data from a number of sources which suggest that the on-road factor has increased dramatically in recent years and that the real world fuel consumption and carbon emissions of new vehicles is now significantly greater than the reported test values[50].

Figure 49 shows the position of Ireland in relation to its EU partners in terms of new car emissions. In 2015, the average CO_2 emissions from new cars in Ireland were 4.5% below the EU average and ranked seventh lowest out of the 28 countries. EU Regulation 443/2009/EC has set a target for all passenger cars to have average emissions below 130 g CO_2/km by 2015. Ireland is one of 10 EU countries already below the target.

50 For more information see www.theicct.org.

Figure 49 *Specific CO_2 Emissions of New Cars: International Comparison – 2015*[51]



Source: European Environment Agency

In 2015, 44% of the stock of private cars had been purchased in 2008 or later. This means that a significant portion of the stock of cars on the road is more efficient than the older cohort.

4.2.4 Energy Efficiency of New Private Cars

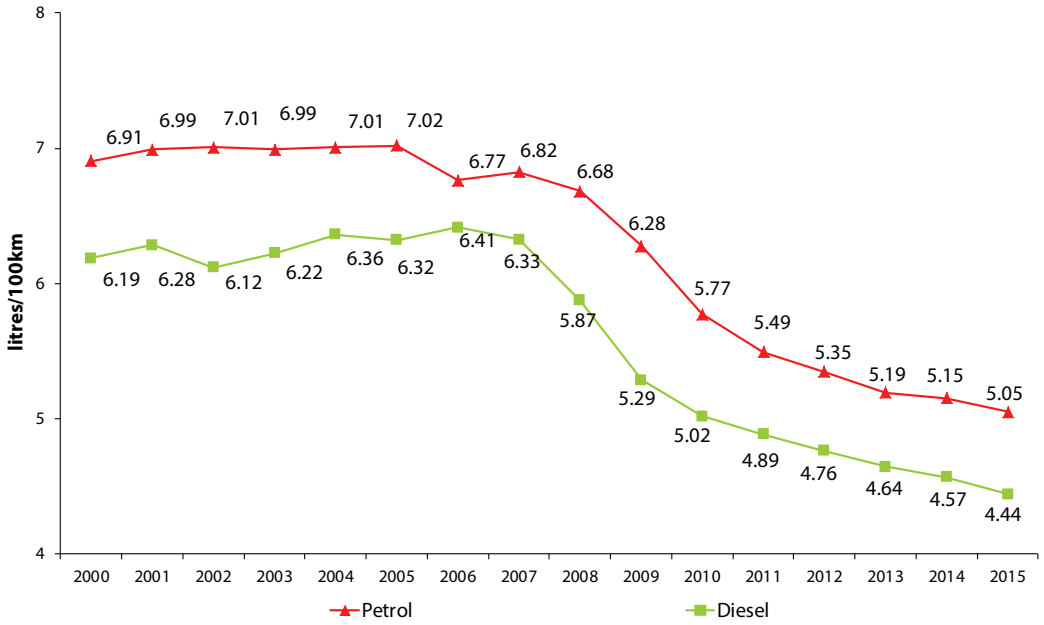
All new cars have associated fuel consumption figures[52] (measured under test conditions), quoted for urban, extra-urban and combined driving. SEAI calculates a weighted average specific fuel consumption figure for new cars entering the national fleet by weighting the test values by the sales figures for each individual model.

The weighted average of the fuel consumption of new cars first registered in the years 2000 – 2015 was calculated using an extract from the Vehicle Registration Unit's national database, and data on the fuel consumption of individual models. The results of this analysis are shown in *Figure 50*.

51 European Environment Agency (2014), *Monitoring CO_2 emissions from passenger cars and vans in 2013*, http://www.eea.europa.eu//publications/monitoring-co2-emissions-from-passenger

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

Figure 50 *Weighted Average Test Specific Fuel Consumption of New Cars 2000 – 2015*



Source: Based on Vehicle Registration Unit and VCA data

Before 2008, for new petrol cars, the lowest average fuel efficiency was recorded in 2006 (6.77 litres/100km). Since 2006 there has been a 25% improvement in the fuel efficiency of new petrol cars, to 5.05 litres/100 km. For new diesel cars, the average fuel efficiency in 2006 was 6.41 litres/100km. Since 2006 there has been a 31% improvement in the average fuel efficiency of new diesel cars, to 4.44 litres/100 km.

Generally, until 2005 the decrease in fuel efficiency suggests that the purchasing trend towards large cars over the period outweighed any of the efficiency benefits of engine improvements. This changed during 2008 following the introduction of policy measures aimed at improving the CO_2 emissions of new cars. Since CO_2 emissions are very closely linked to fuel efficiency, such policy measures have had a direct and corresponding effect on fuel efficiency.

4.2.5 Private Car Average Annual Mileage

SEAI's report *Energy in Transport – 2007 Report*[53] first profiled private car average annual mileage. A refining and updating of the results has since taken place and the revised figures are presented here. These are based on the analysis of National Car Test (NCT) results.

Average mileage for all private cars decreased by 4.3% (0.3% per annum on average) over the period 2000 – 2015. Petrol car annual mileage fell by 17% (1.2% per annum) while diesel car average mileage fell by 8.0% (0.6% per annum). 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.

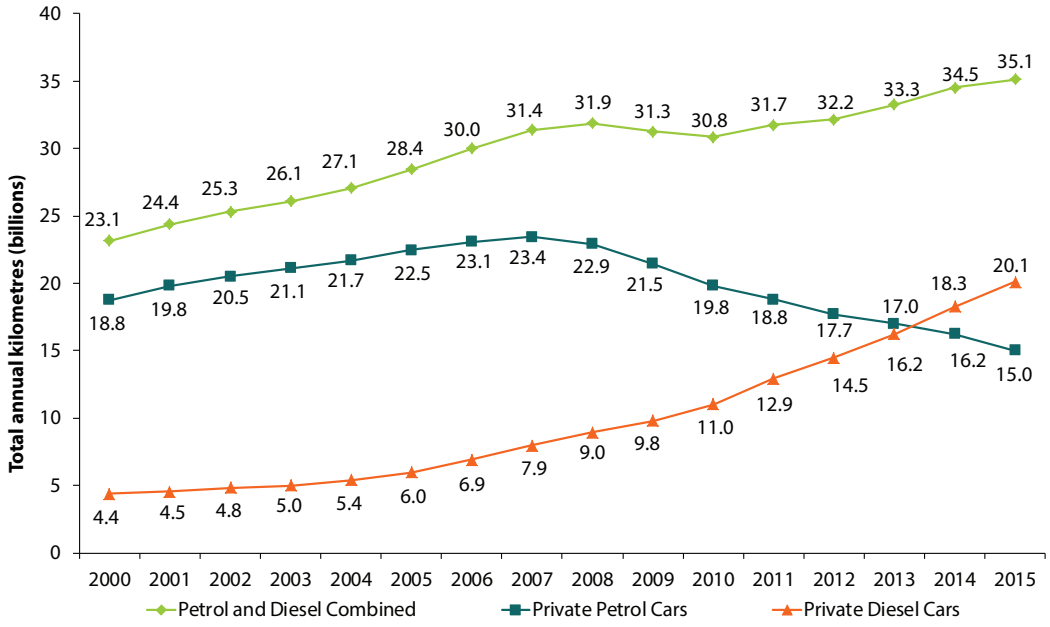
Figure 51 shows the total kilometres driven by private cars in Ireland each year from 2000 to 2015, based on an analysis of NCT data. Overall, the total number of kilometres travelled has increased which in turn has led to increased private car fuel consumption, as detailed in *Section 4.2.1*. Total mileage by all private cars increased by 52% over the period 2000 – 2015.

Overall travel in petrol cars has been falling since 2007, reducing by 36% between 2007 and 2015, while travel by diesel cars increased by 153% over the same period. Indeed the rate of increase of overall travel by diesel cars increased after 2007 to 12% per annum, compared with 9% per annum between 2000 and 2007. In 2000, 81% of total private car mileage was fuelled by petrol and 19% by diesel. In 2015, petrol accounted for 43% and diesel for 57%. Between 2000 and 2015 the total mileage by petrol cars fell by 20% while total mileage for diesel cars increased by 358%. This reduction in travel by petrol vehicles and increase in travel by diesel vehicles is due to the changing ownership patterns since the changes in the VRT and Annual Road Tax were introduced in 2008.[54]

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

54 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 average mileage patterns in this data.

Figure 51 *Total Private Car Annual Mileage 2000 – 2015*

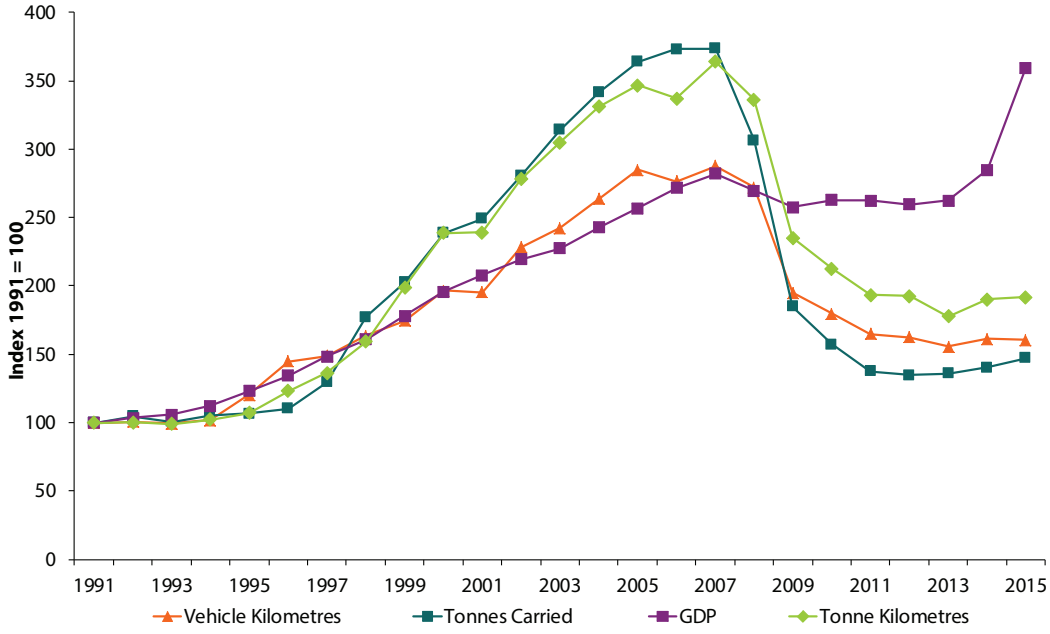


Source: Based on NCT Data

4.2.6 Heavy Goods Vehicle Activity

As discussed in *Section 4.2.1* HGV freight transport was responsible for the largest share of the decrease in transport sector energy demand in the period 2007 – 2015. This was primarily the result of reduced activity in the sector. Three metrics which measure activity in the road freight sector are tonne-kilometres, vehicle kilometres and tonnes carried. *Figure 52* and *Table 26* present data on these three metrics, along with GDP as an index with respect to 1991. The data are taken from the CSO's *Road Freight Survey* for 1991 to 2015 which considers vehicles taxed as goods vehicles, weighing over two tonnes unladen and those which are actually used as goods vehicles, rather than for service type work, for example.

Figure 52 *Road Freight Activity 1991 – 2015*



Source: CSO

Table 26 *Road Freight Activity 1991 – 2015*

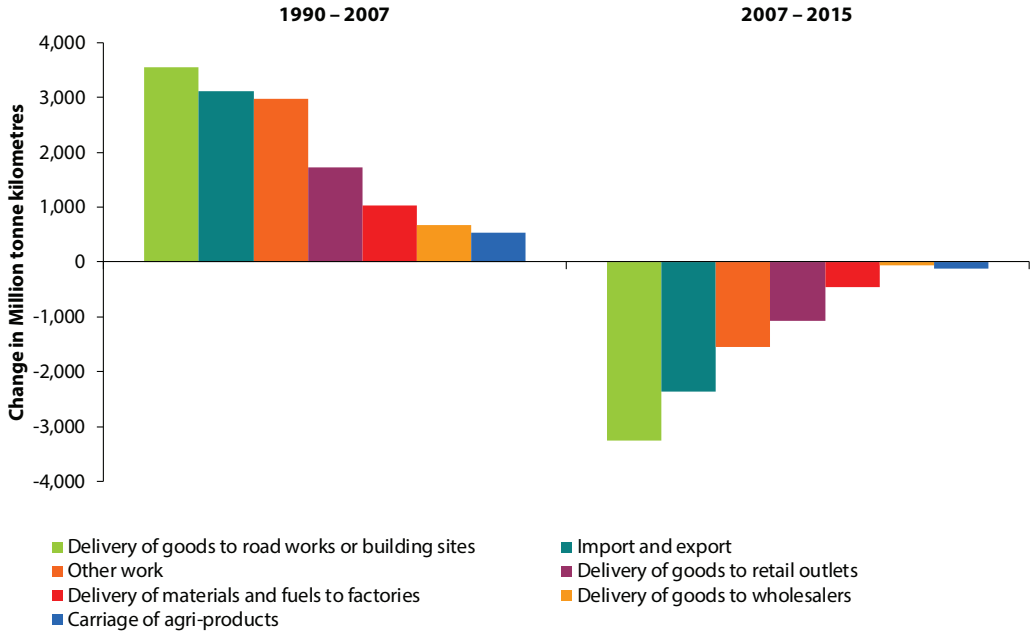
	Growth %	Average annual growth rates %				Quantity		
	'91 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1991	2007	2015
Mega-Tonne Kilometres	91.6	7.8	-9.3	-2.1	0.7	5,138	18,707	9,844
Kilo-Tonnes Carried	47.3	8.8	-15.5	-1.3	4.9	80,137	299,307	118,059
Mega-Vehicle Kilometres	60.5	7.7	-8.8	-2.2	-0.4	811	2,332	1,302
GDP (million € @2014 prices)	259.6	5.6	0.5	6.5	26.3	67,824	191,362	243,914

Source: CSO

Between 2007 and 2009 GDP fell, but has since returned to growth and in 2014 was 1.6% above 2007 levels. This increased to 260% above in 2015 as a result of the inflated GDP figures associated with multinational asset transfers. In 2015, the overall tonnes carried grew by 0.7% to 8,844 Mt and were 61% below 2007 levels. Tonne-kilometres were 47% lower in 2015 than in 2007 and vehicle kilometres travelled were 44% below. Again it should be noted that all three transport metrics contracted more sharply than GDP after the economic crisis of 2008.

It is important to understand why freight has been so responsive to economic drivers in the past so as to be able to estimate how it will respond to potential future economic trends, particularly whether the dramatic rise in tonne-kilometres transported and the corresponding increase in energy demand experienced in the period 1990 – 2007 is likely to be repeated should there be a return to significant economic growth. To do this it is useful to analyse in more detail which sectors of the economy contributed to the changes in tonne-kilometres transported in the period 1990 – 2015. The CSO provides data on HGV activity classed by main the type of work done. To highlight which categories contributed most in absolute terms to both the increase in activity between 1990 and 2007 and the contraction from 2007 to 2015, these data are shown in *Figure 53*.

Figure 53 *Absolute Change in Road Freight Activity by Main Type of Work Done 1990 – 2015*



Source: CSO

The category 'Delivery of goods to road works or building sites' experienced the largest absolute increase (3,545 Mtkm) and the second largest percentage increase (521%) between 1990 and 2007 and subsequently experienced both the largest absolute decrease (3,261 Mtkm) and the largest percentage decrease (77%) between 2007 and 2015. Of the total increase in freight transport activity from 1990 to 2007 (13,578 Mtkm) 'Delivery of goods to road works and building sites' was responsible for 26%, the highest share, while of the total reduction in activity from 2007 to 2015 (8,864 Mtkm) it was responsible for 37%, again the largest share.

The next biggest contributor to both the rise and fall of transport activity was 'Import and export' which between 1990 and 2007 accounted for 3,104 Mtkm (23%) of the total increase, and between 2007 and 2015 accounted for 2,354 Mtkm (27%) of the total reduction.

4.3 Residential

Trend in 2015

Residential energy use increased by 5.2% in 2015 relative to 2014. 2015 was colder than 2014 in terms of degree days (3.3% more degree days[55]). When corrections for weather effects[56] are taken into account the increase in energy use was 3.5% in 2015 relative to 2014 (see *Table 27*).

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

- 2015 was colder than 2014, which saw energy use increase by 5.2%. Allowing for weather corrections the increase in energy use was 3.5%.
- Coal was the only fuel to experience a decrease in usage in 2015, falling by 5.8% to 206 ktoe to a 7.7% share of the residential sector energy use.
- Direct renewables usage in households increased in 2015, growing by 18% to 76 ktoe, and its share increased to 2.9%.
- Oil consumption in households increased by 11.5% in 2015, to 956 ktoe. The price of oil fell internationally by 47% in 2015 compared with 2014 and the price to Irish households fell in the region of 20% at the same time.
- Electricity consumption increased by 2.3% in 2015 to 678 ktoe (7,883 GWh) and its share of residential final consumption was 25%.
- Natural gas usage increased by 3.6% in 2015 to 555 ktoe and accounted for 21% of residential energy use.
- Peat usage increased by 0.3% in 2015 and peat briquette usage increased by 0.9%. Total peat consumption was 201 ktoe in 2015. The peat and briquette share in household energy was 10.2% in 2015.
- Overall direct fossil fuel use in households increased by 5.9% to 1,918 ktoe in 2015 and accounted for 72% of household energy use.

Trends 1990 – 2015

Residential final energy use grew by 18.3% (0.4% per annum) over the period 1990 – 2015 to a figure of 2,672 ktoe in absolute terms. Corrected for weather the growth was 10%. During this time the number of households[57] in the State increased by 74% from approximately 1.0 million to 1.75 million[58].

Oil is the dominant fuel in the residential sector, as can be seen from *Figure 54*, and more than doubled its share from 17% in 1990 to 39% in 2010, although it fell back to 36% in 2015. Electricity is the second most dominant energy form in the sector at 25%. Natural gas is the third fuel of choice, at a 21% share. The renewables share of final energy used directly in households in 2015 was 2.9%. The growth rates, quantities and shares are shown in *Table 27*.

Figure 54 shows significant changes in the mix of fuels consumed in the residential sector over the period. The changes in the fuel mix 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 1980s to convert existing back-boiler systems to either oil or gas. Lately there's a trend to install closed solid fuel stoves to replace open fireplaces which has the double effect of improving efficiency and reducing heat loss from draughts.

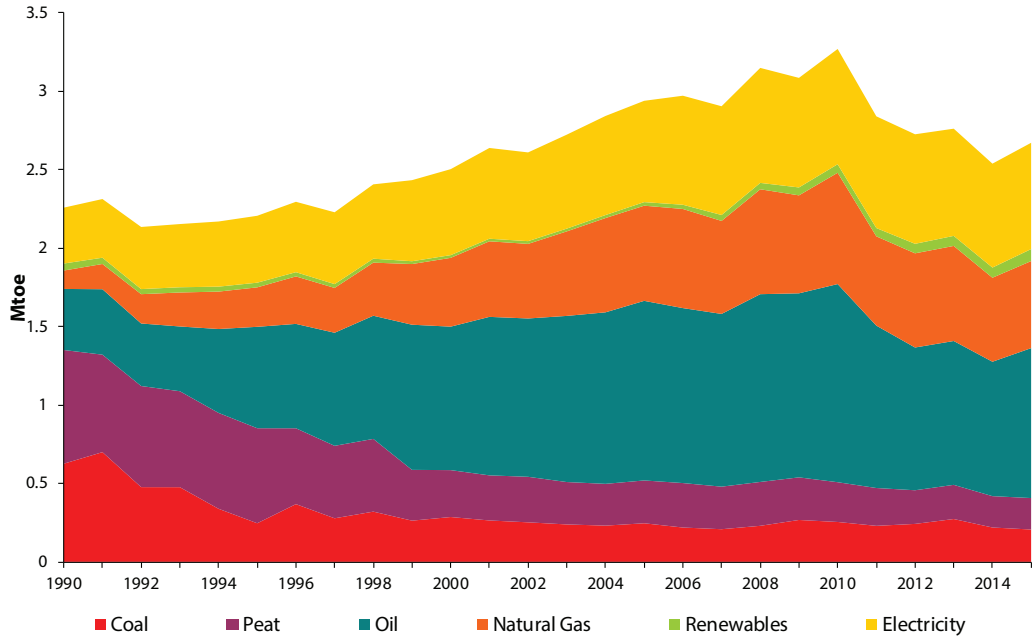
55 See Glossary for definition of 'degree days'.

56 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. It is assumed that 65% of fuels and 10% of electricity use in households is used for space heating.

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

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

Figure 54 *Residential Final Energy Use by Fuel*



Central heating systems are generally more energy efficient than individual room heating appliances, so for a given level 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.

The revisions of building regulations also had an impact on residential final energy use. Revisions were introduced in 1992, 2002, 2007, 2008 and 2011, all of which had the effect of significantly improving 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 domestic appliances: washing machines, driers, dishwashers, microwave ovens, computers, televisions, games consoles, etc.

Table 27 *Growth Rates, Quantities and Shares of Final Consumption in Residential Sector*

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Fossil Fuels (Total)	3.3	0.1	3.2	1.8	-5.0	5.9	1,857	1,918	82.2	71.8
Coal	-67.0	-4.3	-3.0	0.7	-4.1	-5.8	626	206	27.7	7.7
Peat	-72.3	-5.0	-1.8	-1.5	-4.6	0.3	725	201	32.1	7.5
Briquettes	-53.0	-3.0	-5.5	-0.5	-3.7	0.9	155	73	6.9	2.7
Oil	145.5	3.7	4.6	2.0	-5.4	11.5	389	956	17.2	35.8
Gas	373.4	6.4	6.7	3.2	-4.8	3.6	117	555	5.2	20.8
Renewables	71.0	2.2	5.6	19.0	7.1	18.0	45	76	2.0	2.9
Combustible Fuels (Total)	2.5	0.1	3.2	1.9	-4.9	6.1	1,902	1,950	84.2	73.0
Electricity	90.3	2.6	3.3	2.6	-1.6	2.3	356	678	15.8	25.4
Total	**18.3**	**0.7**	**3.3**	**2.2**	**-4.0**	**5.2**	**2,258**	**2,672**		
Total Climate Corrected	**9.4**	**0.4**	**3.9**	**-0.8**	**-2.0**	**3.5**	**2,378**	**2,600**		

Energy-related CO_2 Emissions – including emissions associated with electricity

In order to determine total energy-related CO_2 emissions from the residential sector, it is necessary to view electricity on a primary energy basis, i.e. the fuels required to generate the electricity consumed by households. Over the period 1990 – 2015 energy-related CO_2 emissions[59] from the residential sector fell by 11.2% (0.5% on average per annum) while those in transport, industry and services rose, respectively, by 133% (3.4% per annum), 6.7% (0.3% per annum) and 2.5% (0.1% per annum). In 2015 residential sector energy-related CO_2 emissions (including upstream electricity emissions) were 9,558 kt CO_2, representing 25% of the total energy-related CO_2 emissions. The residential sector total was the second largest source of CO_2 emissions after transport, which accounts for 37%.

59 Energy-related emissions detailed are not corrected for weather.

Energy-related CO_2 Emissions – excluding emissions associated with electricity

If upstream emissions associated with electricity use are excluded, the CO_2 emissions from direct fossil fuel use in the residential sector fell by 0.8% compared with 1990, while over the same period the number of households increased by 74%. This was achieved by a combination of lower emitting fuel mix and improved thermal efficiency of the housing stock. Excluding upstream electricity emissions, direct CO_2 emissions from the household sector were 5,874 kt and were 5.3% higher in 2015 compared with 2014.

The residential sector is examined in more detail with respect to energy-related CO_2 emissions in *Figure 55*: a relatively constant or flat overall trend can be seen until 2010, which becomes a reducing trend after that year.

Figure 55 *Residential Energy-Related CO_2 by Fuel*

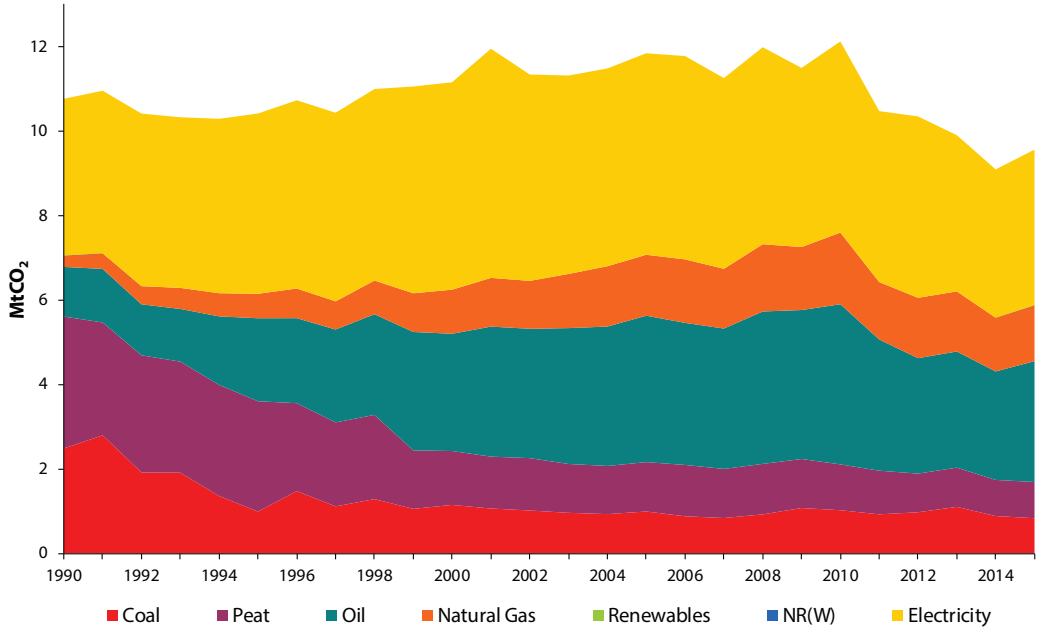


Table 28 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions in Residential Sector*

	Growth %	Average annual growth rates %					Quantity (kt CO_2)		Shares %	
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Coal	-66.6	-4.3	-2.9	0.6	-4.0	-5.8	2,483	831	23.1	8.7
Peat	-72.5	-5.0	-1.7	-1.5	-4.6	0.3	3,123	858	29.0	9.0
Briquettes	-53.0	-3.0	-5.5	-0.5	-3.7	0.9	642	302	6.0	3.2
Oil	143.6	3.6	4.5	1.8	-5.5	11.4	1,175	2,863	10.9	29.9
Gas	390.4	6.6	6.7	3.3	-4.9	4.0	270	1,323	2.5	13.8
Renewables	-	-	-	-	-	-	-	-	0.0	0.0
Combustible Fuels (Total)	-16.7	-0.7	2.5	1.4	-5.0	5.3	7,052	5,874	65.5	61.5
Electricity	-0.8	0.0	-0.6	-1.1	-4.0	4.8	3,713	3,684	34.5	38.5
Total	**-11.2**	**-0.5**	**1.2**	**0.5**	**-4.6**	**5.1**	**10,764**	**9,558**		

4.3.1 Unit Consumption of the Residential Sector

The unit consumption of the residential sector is typically defined in terms of the energy consumed per dwelling. *Figure 56* shows the trend in unit consumption per dwelling, which decreased by 32% during the period 1990 – 2015.

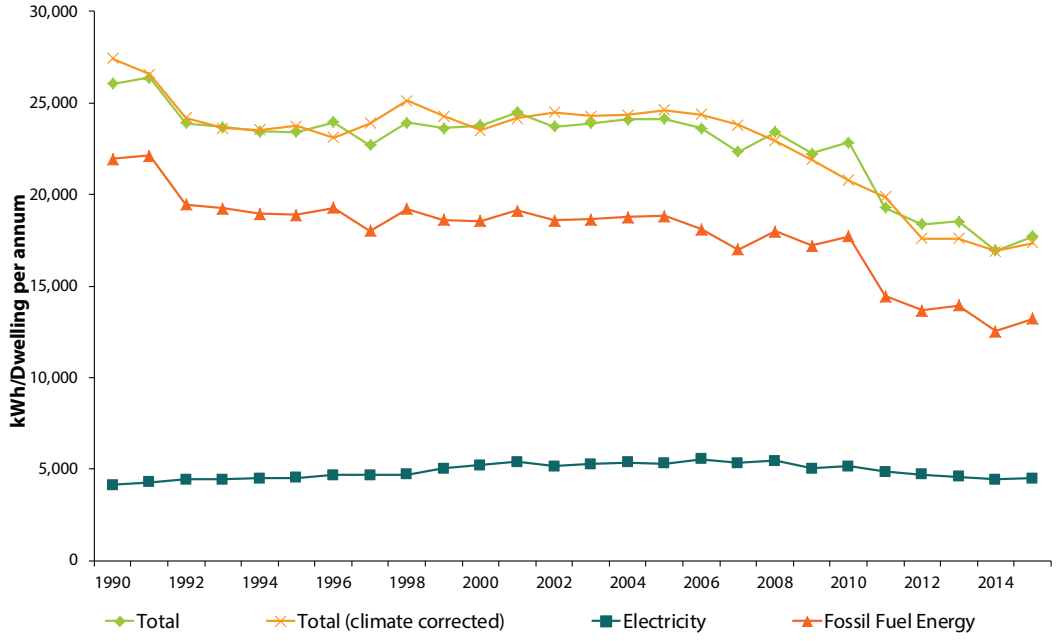
While overall unit energy use per dwelling has decreased by 32% since 1990, *Figure 56* also shows an increasing trend in electricity consumption per dwelling. This has increased by 9.3% since 1990. The increasing penetration of household electrical appliances such as washing machines, dishwashers, clothes driers, computers, multiple televisions and set top boxes as well as convenience appliances is believed to have contributed to this increase. In contrast, fossil fuel consumption per dwelling has decreased by 40% over the period.

In 2015 the average dwelling consumed a total of 17,241 kWh of energy based on climate corrected data, 2.9% above the 2014 level. This comprised 12,772 kWh (74%) of direct fuels and 4,470 kWh (26%) of electricity.

Figure 56 also shows overall unit energy use per dwelling, corrected for climate variations. Looking at this in conjunction with *Table 31*, it can be seen that the decrease in climate corrected energy use per dwelling over the period was 37% while the uncorrected energy use decrease was 32%. Most of the improvement in climate corrected per unit use occurred during the early 1990s and again from 2006 onwards. There are a number of influential factors potentially driving this significant reduction. These include:

- Improvements to Part L of the Building Regulations governing conservation of energy in mandating more efficient new dwellings and, since 2008, mandating the installation of renewable energy technologies in new dwellings;
- Various government schemes to support and incentivise the retrofit of existing dwellings with energy saving measures such as wall and roof insulation, including SEAI's Better Energy Homes scheme, the Warmer Homes scheme, the Home Energy Savings Scheme and Better Energy Communities;
- The economic crisis resulted in behavioural changes aimed at reducing energy costs and heating bills. Reduced income together with rising energy costs is likely to have resulted in increased fuel poverty.

Figure 56 *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, in terms of unit energy use per dwelling, may be the trend towards larger houses as shown in *Table 29* and *Figure 57*. *Table 29* shows that the fastest rate of growth in the floor area of new houses and flats occurred in the 2005 – 2010 period while *Figure 57* shows the floor areas of new houses and new flats.

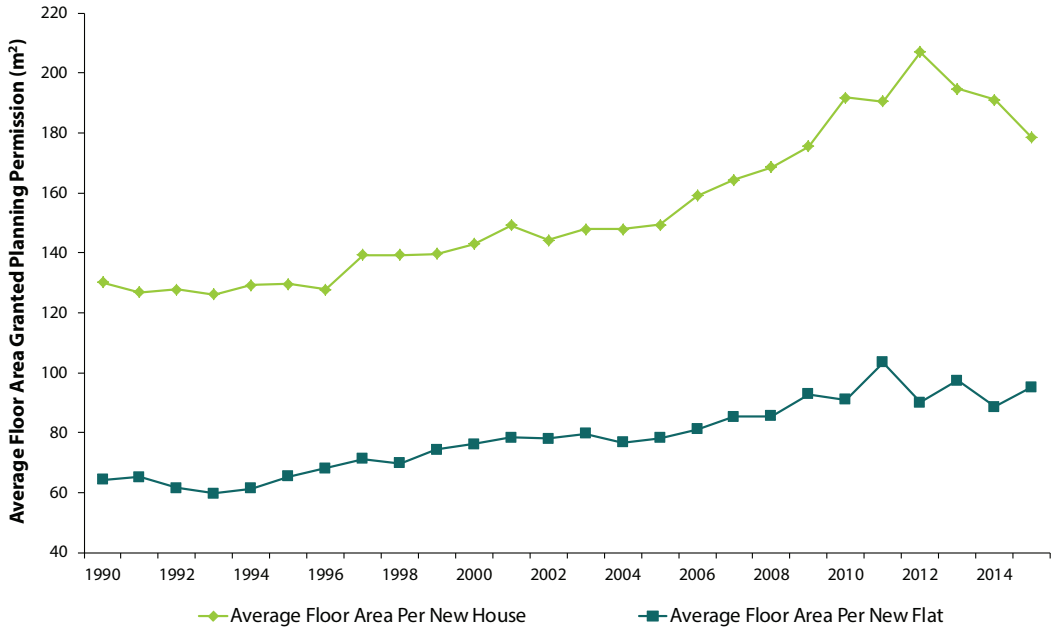
Table 29 *Growth Rates in Residential Floor Areas per New Dwelling*[60]

	Growth %	Average annual growth rates %						
	1990 – 2015	1990 – '15	1990 – '95	1995 – '00	2000 – '05	2005 – '10	2010 – '15	2015
New Houses	37.1	1.3	-0.1	2.0	0.9	5.1	-1.4	-6.6
New Flats	48.0	1.6	0.3	3.1	0.5	3.1	-0.7	7.4

The evidence suggests that there has been a trend towards larger dwellings (although estate house 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 due to their greater wall surface area and therefore higher heat loss. This has been offset somewhat by the increasing insulation standards, heating controls, efficient boilers etc., 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.

60 Note that the figures used in *Table 29* and *Figure 57* 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.

Figure 57 *Floor Areas of New Houses and New Flats*



Source: CSO

While the data above only refer to new dwellings it is also possible to estimate the trend in the stock[61] as a whole using the CSO dataset and a model of the stock of dwellings derived using, inter alia, data from Department of Housing, Planning, Community and Local Government (DHPCLG) studies in the mid-1990s[62]. Data from this model is updated incrementally, using planning permission data and estimates of the number of permanently occupied dwellings. The results are presented in *Figure 58*. *Table 30* summarises the growth rates during the period. Over the period 1990 – 2015 the estimated average floor area of the stock of dwellings types increased from 98 square metres in 1990 to 114 square metres in 2015.

Table 30 *Growth in Average Floor Area – Housing Stock*

	Growth %	Average annual growth rates %						
	1990 – 2015	1990 – '15	1990 – '95	1995– '00	2000 – '05	2005 – '10	2010 – '15	2015
Average Floor Area	15.9	0.6	0.3	0.6	0.7	0.9	0.5	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 2015. 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 2015, the average floor area of non-estate houses granted permission was 243 square metres, compared to 143 square metres for houses in estates and 95 square metres for flats[63].

In 2007, 51% of the number of house completions were scheme houses, 25% individual houses and 24% were apartments. In 2015 these ratios were 39%, 48% and 13% respectively[64].

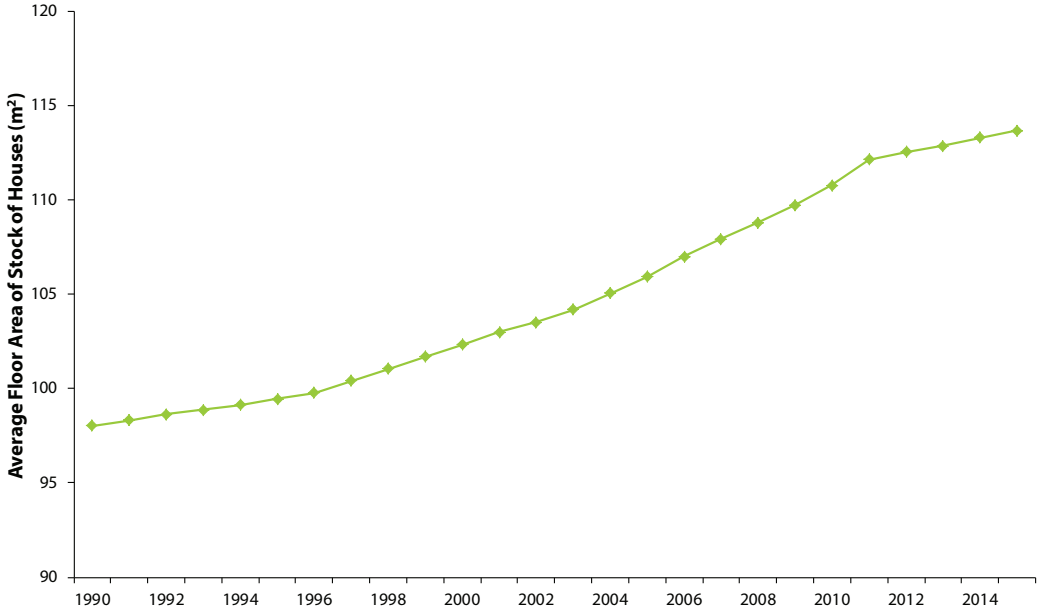
61 This section draws on data first presented in a separate SEAI report entitled *Energy Consumption and CO_2 Emissions in the Residential Sector 1990 to 2004.* The report is available at www.seai.ie. Methodology was revised for this publication.

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

63 CSO (2015), *Planning Permissions – Quarter 2 2015*. Available at www.cso.ie

64 Completions by type annually, http://www.housing.gov.ie/housing/statistics/house-building-and-private-rented/construction-activity-completions

Figure 58 *Average Floor Area of the Housing Stock 1990 – 2015*



Energy-related CO_2 Emissions per Dwelling

The emissions of energy-related CO_2 per dwelling fell by 49% over the period 1990 – 2015 while the reduction for unit energy use was 32% – see *Table 31* and *Figure 59*. In 2015 the average dwelling was responsible for emitting 5.5 tonnes of energy-related CO_2. A total of 3.3 tonnes CO_2 (61%) came from direct fuel use in the home and the remainder indirectly from electricity use.

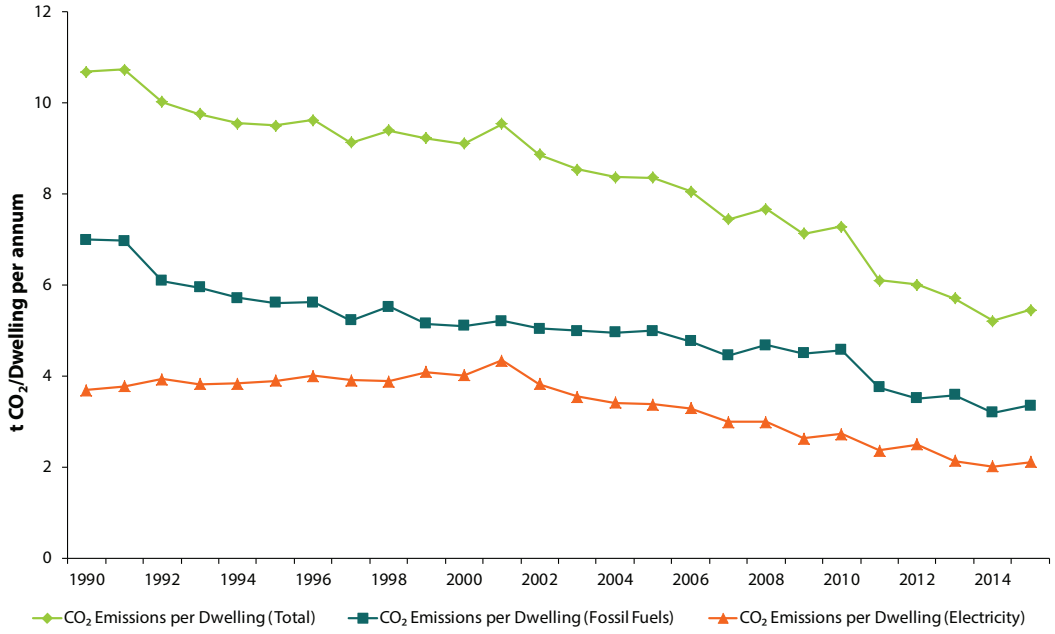
The unit fuel CO_2 emission levels (excluding electricity) fell by 52% over the period as a result of consumers switching away from coal and peat to lower CO_2 emitting fuels such as gas, oil and renewables. However, the downward trend was reversed in 2008, 2010 and 2013 when the energy use per household increased by 6.6%, 3.7% and 2% respectively. Emissions from direct fuel use in households increased by 4.7% in 2015 as a result of increased peat, oil and gas consumption.

Table 31 *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 – 2015**	**'90 – '15**	**'00 – '05**	**'05 – '10**	**'10 – '15**	**2015**	**1990**	**2015**
Total Energy	-32.0	-1.5	0.3	-1.1	-5.0	4.7	26,068	17,718
Fuel Energy	-39.8	-2.0	0.3	-1.2	-5.7	5.7	21,956	13,224
Electrical Energy	9.3	0.4	0.4	-0.6	-2.6	1.7	4,112	4,494
Unit Energy Consumption Climate Corrected							**Quantity (kWh)**	
Total Energy Climate Corrected	-37.2	-1.8	0.9	-3.3	-3.7	2.9	27,443	17,241
Fuel Energy Climate Corrected	-45.2	-2.4	1.0	-4.1	-3.9	3.4	23,295	12,772
Electrical Energy Climate Corrected	7.7	0.3	0.5	-0.6	-2.8	1.4	4,148	4,470
Unit Energy-Related CO_2 Emissions							**Quantity (t)**	
Total Energy CO_2	-49.0	-2.7	-1.7	-2.7	-5.6	4.5	10.7	5.5
Fuel CO_2	-52.2	-2.9	-0.4	-1.8	-6.0	4.7	7.0	3.3
Electricity CO_2	-43.0	-2.2	-3.4	-4.2	-5.0	4.3	3.7	2.1

Emissions associated with the use of electricity per dwelling fell by 43% over the period, despite the 9.3% increase in electricity consumption per dwelling. This is as a result of the reduced carbon intensity of electricity generation. This is particularly the case since 2002 when high-efficiency CCGT plants were brought online and because of the growing contribution of renewables in electricity generation.

Figure 59 *Unit Energy-Related CO_2 Emissions per Dwelling*



4.4 Commercial and Public Services

Trend in 2015

The commercial and public services energy use increased by 0.7% in 2015 relative to 2014. As 2015 was colder than 2014 (3.3% more degree days), when corrections for weather effects are taken into account energy use in services fell by 0.8% in 2015. This is against the backdrop of the economic activity of services, as measured by value added, increasing by 6.5%.

The key trends in 2015 are as follows:

- Final energy use in services grew by 0.7% in 2015 to 1,259 ktoe, however it fell by 0.8% when corrected for weather effects.
- Oil, gas and electricity make up 97% of the energy consumed in the services sector. The contributions from coal and peat are negligible.
- Electricity consumption in services increased by 4.8% to 580 ktoe.
- Oil consumption fell by 3.2%, to 243 ktoe. The share of oil in the sector's final consumption was 19%.
- Natural gas consumption decreased by 0.5%, to 399 ktoe and its share of the sector's final consumption was 32%.
- Overall fossil fuel use in services fell by 1.6%, to 643 ktoe.
- Renewable energy use in services decreased by 17.4%, to 36 ktoe. The share of renewables in services' final energy consumption was 2.9% .

Trends 1990 – 2015

Final energy use in the commercial and public services sector grew by 29% (1% per annum) over the period 1990 – 2015, to a figure of 1,259 ktoe. Growth was 20% if weather corrected energy use is considered. During this period the value added generated by the sector grew by 170% while the numbers employed increased by 129%.

Figure 60 *Commercial and Public Services Final Energy Use by Fuel*

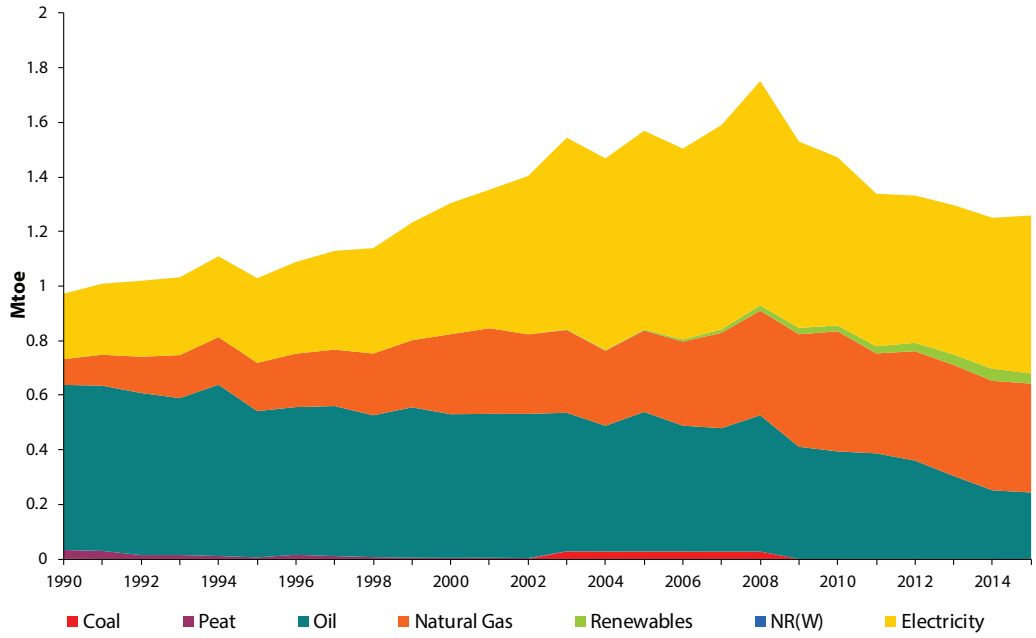


Figure 60 shows the changes in the fuel mix in the services sector over the period. The range of fuels used in this sector is small – essentially oil, gas and electricity. Oil and gas are used predominantly for space heating, but also for water heating, cooking and, in some sub-sectors, laundry. Gas consumption increased by 325% since 1990, to 399 ktoe, although this was from a low base. Electricity is used in buildings for heating, air conditioning, water heating, lighting, information and communication technologies. Electricity in services is also used for public lighting and water and sanitation services.

Electricity consumption in services increased by 141% (3.56% per annum) between 1990 and 2015, to 580 ktoe

(6,746 GWh) and has a higher share at 46% than any other individual fuel in services, up from 25% 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 shown in *Table 32*.

Table 32 *Growth Rates, Quantities and Shares of Final Consumption in the Commercial and Public Services Sector*

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Fossil Fuels (Total)	-12.2	-0.5	0.3	-0.1	-5.1	-1.6	732	643	75.3	51.0
Coal	-	-	-	-	-	-	1	-	0.1	0.0
Oil	-59.8	-3.6	-0.6	-5.1	-9.2	-3.2	605	243	62.3	19.3
Natural Gas	324.8	6.0	0.4	8.1	-1.9	-0.5	94	399	9.7	31.7
Renewables	-	-	142.8	39.6	11.1	-17.4	0	36	0.0	2.9
Combustible Fuels (Total)	-9.2	-0.4	0.4	0.2	-4.8	-3.1	732	665	75.3	52.8
Electricity	141.4	3.6	8.7	-3.3	-1.2	4.8	240	580	24.7	46.1
Total	**29.5**	**1.0**	**3.8**	**-1.3**	**-3.1**	**0.7**	**972**	**1,259**		
Total Climate Corrected	**19.8**	**0.7**	**4.3**	**-3.9**	**-1.2**	**-0.8**	**1,025**	**1,228**		

Energy-related CO_2 Emissions – including emissions associated with electricity

Figure 61 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 24% over the period and the emissions associated with electricity consumption increased by 26%. In 2015 the non-electricity emissions decreased by 1.5% and the electricity associated emissions in services increased by 7.4%. Overall energy-related CO_2 emissions in this sector increased by 4.1% in 2015 to 4.8 Mt CO_2.

In the services sector, the share of emissions associated with electricity demand in 2015 was 65%. In 1990 the split between electricity and thermal fuels (oil and gas) emissions was closer to half and half (53% electricity and 47% fuels).

Figure 61 *Commercial and Public Services Sector CO_2 Emissions by Fuel*

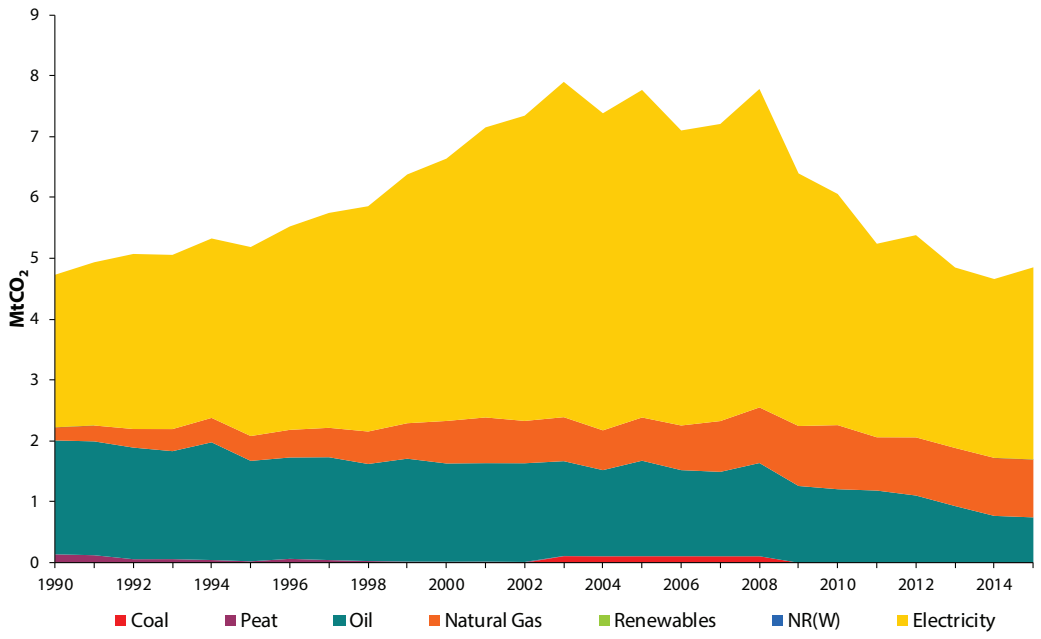


Table 33 *Growth Rates, Quantities and Shares of CO_2 Emissions in Commercial and Public Services*

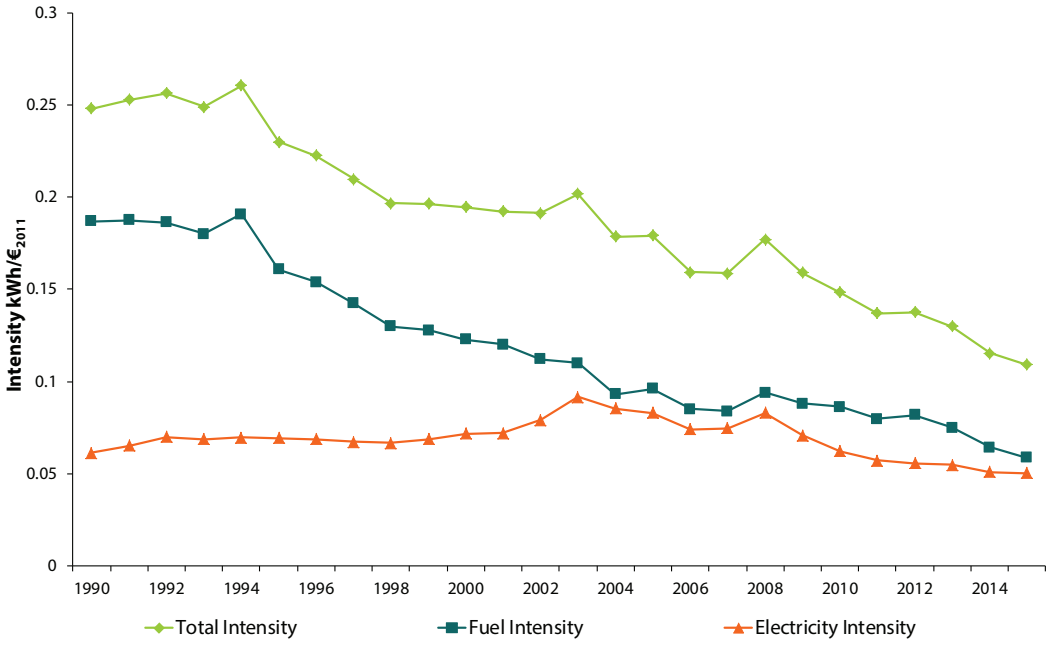
	Growth %	Average annual growth rates %					Quantity (kt)		Shares %	
	1990 – 2015	'90 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015	1990	2015
Combustible Fuels	-23.8	-1.1	0.5	-1.1	-5.6	-1.5	2,225	1,696	47.0	35.0
Electricity	25.9	0.9	4.5	-6.7	-3.6	7.4	2,505	3,154	53.0	65.0
Total	**2.5**	**0.1**	**3.2**	**-4.8**	**-4.3**	**4.1**	**4,730**	**4,850**		

4.4.1 Energy Intensity of the Commercial and Public 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 62*, this intensity is much flatter than that of industry, although it has been showing a declining trend since 1994. The overall energy intensity of the services sector was 56% lower in 2015 than it was in 1990, principally because of the rapid growth in the value added in the sector. There was a general downward trend in services' energy intensity since the early 1990s with the exceptions in some years mostly due to colder weather. Energy intensity in services fell by 5.5% in 2015.

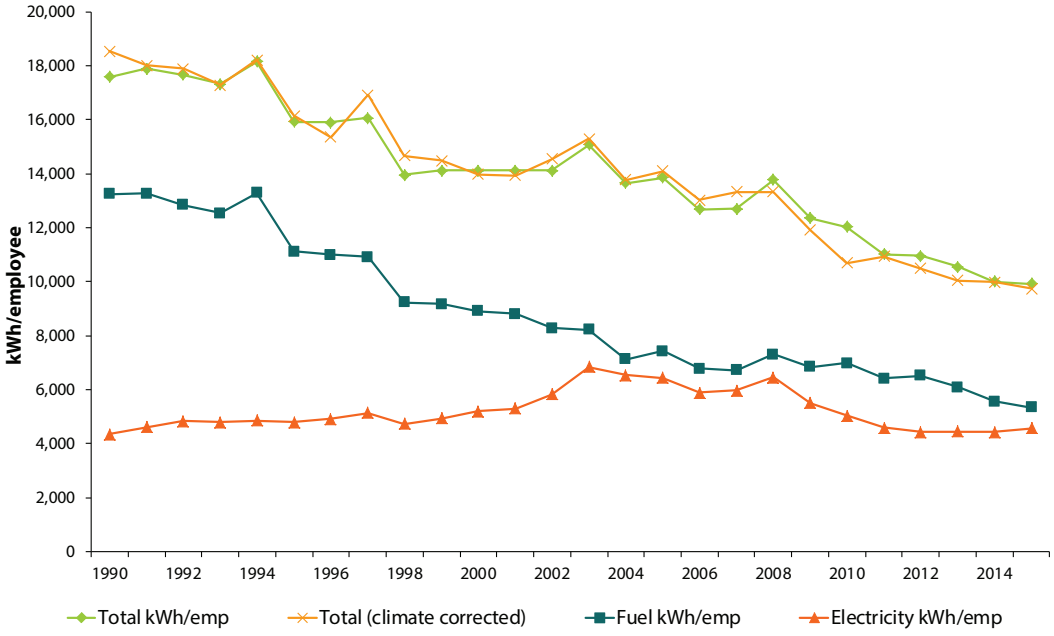
Electricity intensity increased by 59% up to 2003 and has been falling since then, with the exception of 2008. In 2015 electricity intensity decreased by 1.7% compared with 2014, was 45% below the peak in 2003 and 18% below the 1990 level.

Figure 62 *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 space 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.

Figure 63 *Unit Consumption of Energy and Electricity per Employee in the Commercial and Public Services Sector*



Unit consumption of electricity per employee is used as an indicator of energy use in the services sector because, in the main, there is a correlation between electricity use and the number of employees. In *Figure 63* it can be seen that unit consumption of electricity rose steadily after 1990. By 2003 it was 58% higher than in 1990 but by 2015 it had fallen back to 5.3% above 1990 levels. Electricity use per employee increased by 3.3% in 2015.

Fuel consumption per employee fell by 3.9% in 2015, and stood at 60% below 1990 levels. If corrections are made for the effects of weather then the fuel consumption per employee decreased by 6.1% in 2015 when compared with 2014.

Table 34 *Growth Rates and Quantities of Unit Consumption per Employee in Commercial and Public Services*

	Growth %	Average annual growth rates %					Quantity (kWh)	
	1990 – 2015	1990 – '15	'00 – '05	'05 – '10	'10 – '15	2015	1990	2015
Total kWh/employee	-43.5	-2.3	-0.4	-2.8	-3.8	-0.7	17,582	9,928
Fuel kWh/employee	-59.6	-3.6	-3.6	-1.2	-5.2	-3.9	13,235	5,353
Electricity kWh/employee	5.3	0.2	4.3	-4.8	-1.9	3.3	4,347	4,575
Climate Corrected (cc)								
Total kWh/employee (cc)	-47.8	-2.6	0.2	-5.4	-1.9	-2.2	18,533	9,682
Fuel kWh/employee (cc)	-63.5	-3.9	-2.8	-5.0	-2.7	-6.1	14,108	5,156
Electricity kWh/employee (cc)	2.3	0.1	4.6	-5.9	-1.1	2.6	4,425	4,526

As a result of the heterogeneous nature of the services sector it is difficult to assess the amount of energy that is consumed. 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 sector is affected by uncertainties in all other sectors. As a result, there is only limited information available to policymakers with which to formulate and target energy efficiency policies and measures for the sector.

Work is ongoing, however, to address this situation and new data will become available in the near future from a joint CSO/SEAI Business Energy Use Survey (BEUS) and the Public Sector Energy Programme, which will enable a deeper analysis of service sector energy use.

4.4.2 Public Sector Developments

The public sector consists of approximately 4,400 separate public bodies, of which about 4,000 are individual schools. The other 400 comprise, inter alia, government departments, non-commercial state bodies, state-owned companies and local authorities. Each 'public body' is a stand-alone organisation and can range in size from very small (e.g. a small rural school or a five-person agency) to very large (the HSE, An Garda Síochána). The vast majority of energy is consumed by the approximately 100 largest organisations.

Public services[65] energy consumption comprises two main classes of energy consumer:

- Public sector buildings (offices, hospitals, clinics, nursing homes, schools, prisons, barracks, Garda stations, etc.), which primarily consume electricity, natural gas and oil-based fuels in addition to smaller amounts of renewable and solid fuels;
- Public sector utilities, which primarily consume electricity, e.g. waste water treatment plants, water treatment facilities, pumping stations, street lighting (~400,000 units).

The Third National Energy Efficiency Action Plan (NEEAP) and the European Union (Energy Efficiency) Regulations (SI 426 of 2014) set out several obligations on public bodies with respect to their 'exemplary role' for energy efficiency. The NEEAP sets a 33% efficiency target for the sector by 2020, equivalent to 279 ktoe.

Since 1 January 2011, public sector bodies have been required to report to Government annually on their energy usage and the actions they have taken to reduce consumption. SEAI and the Department of Communications, Climate Action and Environment (DCCAE) have developed an energy monitoring and reporting system[66] to satisfy the reporting requirements of both SI 426 of 2014 and the NEEAP. Since 2013, all public sector organisations have been obliged to use this system to report their annual energy consumption to SEAI. The system includes a national public sector energy database, which includes all public sector electricity and natural gas meter numbers. Over time, the monitoring and reporting system will build a comprehensive bottom-up picture of energy consumption in the sector through the population of the national public sector energy database.

In 2015 SEAI published the *Annual Report 2015 on Public Sector Energy Efficiency Performance*[67]. It noted that 281 public sector bodies and 977 schools completed reports on energy and these represented 87% of total public sector energy consumption. The total energy consumption in 2014 of these bodies was 9,106 GWh (primary energy), which consisted of 4,972 GWh of electricity, 2,203 GWh of thermal energy and 1,931 GWh of transport energy. The report also noted that these bodies had achieved annual primary energy savings of 1,840 GWh or a 17% improvement on business as usual, yielding a cost saving of €121 million. The public sector has a target of 33% energy efficiency improvement by 2020.

65 In addition, the energy consumed by public bodies also includes some consumption counted in the transport sector in the National Energy Balance, e.g. public transport fleets (rail, bus, etc.) as well as other transport fleets operated by public bodies; e.g. ambulances, local authority vehicles, Garda fleet, Defence Forces' vehicles, etc.

66 Additional information on this system is available from www.seai.ie/Your_Business/Public_Sector/Reporting/

67 Available from http://www.seai.ie/Publications/Your_Business_Publications/Public_Sector/Annual-Report-2015-on-Public-Sector-Energy-Efficiency-Performance.pdf

5 Energy Statistics Revisions and Corrections

Some changes, revisions and corrections to the historic energy balance data were implemented during 2016. The most significant of these were:

Bituminous Coal

1996 – 2006

- Exports now shown for bituminous coal as per international data.

2007 – 2015

- Exports included as part of net imports in imports row as per international data.

2012 – 2015

- Figures for TFC were revised to reflect most up-to-date data.

Gasoline

2005 – 2014

- Figures for private car and public passenger services revised based on updated methodology. This has had a knock-on effect on the unspecified sub-sector.

2005 – 2014

- Figures for fuel tourism have been revised to reflect the latest data from the Department of the Environment, Community and Local Government. This has also a knock-on effect on the unspecified sub-sector.

Fuel Oil

1990 – 2014

- The split between commercial and public services sectors was revised due to error in formula.

2014

- The figures for TFC were revised to reflect most up-to-date data.

Gasoil / Diesel / DERV

2014

- The figures for primary energy supply and TFC were revised to reflect most up-to-date data.

2007 – 2014

- Figures for road private car and public passenger services were revised based on updated methodology. This has had a knock-on effect on the unspecified sub-sector.

2008 – 2014

- Figures for light goods vehicles on the road were revised based on updated methodology. This has had a knock-on effect on the unspecified sub-sector.

1994 – 2015

- Figures for fuel tourism were revised to reflect the latest data from the Department of the Environment, Community and Local Government. This has also had a knock-on effect on the unspecified sub-sector.

Petroleum Coke

2014

- Figures for primary energy supply and TFC were revised to reflect most up-to-date data.

Bitumen

2012 – 2014

- Figures for primary energy supply were revised to reflect most up-to-date data.

White Spirit

2012 – 2014

- Figures for primary energy supply were revised to reflect most up-to-date data.

Natural Gas

1990 – 2014

- The split between commercial and public services was revised due to error in formula.

2014

- Figures for primary energy supply and TFC were revised to reflect most up-to-date data.

Landfill Gas

2013 – 2015

- Figures for primary energy supply were revised to reflect most up-to-date data.

Liquid Biofuels

2005 – 2014

- Figures for transport sub-sector split revised to align with revisions to gasoline and diesel.

Solar

2014

- Solar PV figures were revised to reflect most up-to-date data.

Electricity

2010 – 2014

- Revised Transformation Output to calculate gross electricity output using a net-to-gross conversion factor by fuel based on monthly electricity generator data. Previously the same default factor was used for all combustible fuels. This has had a knock-on effect on own use and distribution losses.

1990 – 2014

- Split between Commercial and Public Services revised due to error in formula.

Weather Correction

2012 – 2015

- Population weighting of degree days was updated with preliminary data from the 2016 Census.

Energy balance data analysed in this report were frozen on 24 August 2016. Balance data are updated whenever more accurate information is known. To obtain the most up-to-date balance figures, visit the statistics publications section of SEAI's website (www.seai.ie/Energy-Data-Portal/Energy%20Data%20Publications/). A new Data Portal on this website links to interactive energy statistics, forecasts and other data developed by SEAI.

An energy data service is also available at http://www.cso.ie/px/pxeirestat/pssn/sei/homepagefiles/sei_statbank.asp. This service is hosted by the Central Statistics Office with data provided by SEAI.

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 (10^3 tonnes) and Mt CO_2 – mega-tonnes of CO_2 (10^6 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 and 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 and 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 (GDP): The gross domestic product (GDP) represents the total output of the economy over a period.

Gross Final Consumption (GFC): Directive 2008/28/EC defines Gross Final Consumption (GFC) of energy as the energy commodities delivered for energy purposes to 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: electricity generation, oil refining, etc.

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

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

Energy Conversion Factors

To:	**toe**	**MWh**	**GJ**
From:	*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		
(2015)	126.8	467.5

Sources

Applus+ (National Car Test)

Central Statistics Office

Department of Communications, Climate Action and Environment

Department of Housing, Planning, Community and Local Government

Department of Transport

EirGrid

Environmental Protection Agency

ESB Networks

European Commission DG TREN

EU-funded ODYSSEE Project

Eurostat

Gas Networks Ireland

International Energy Agency

Met Éireann

Revenue Commissioners

Vehicle Registration Unit

References

ADEME, European Commission (2005), *Energy Efficiency Monitoring in the EU-15*, Paris: ADEME.

Bosseboeuf D. et al (2005), *Energy Efficiency Monitoring in the EU-15*, Paris: ADEME. Available from: www.ODYSSEE-indicators.org

Bosseboeuf D., Lapillonne Dr B., Eichhammer W. and Landwehr M. (1999), *Energy Efficiency Indicators – The European Experience*, Paris: ADEME.

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

Central Statistics Office (2007), *Census 2006 Volume 6 – Housing*, http://www.cso.ie/en/census/census2006reports/census2006volume6-housing/

Central Statistics Office (2012), *Census 2011 Profile 4 The Roof over our Heads – Housing in Ireland*, http://www.cso.ie/en/census/census2011reports/census2011preliminaryreport/

Central Statistics Office (2015), *Planning Permissions Quarter 2 2015*, http://www.cso.ie/en/releasesandpublications/er/pp/planningpermissionsquarter22015/

Central Statistics Office (2015), *National Income and Expenditure – Annual Results for 2014*, http://www.cso.ie/en/releasesandpublications/er/nie/nationalincomeandexpenditureannualresults2014/

Commission of the European Communities (1997), *A Community Strategy to Promote Combined Heat and Power and to Dismantle Barriers to its Development*, http://europa.eu.int/comm/energy/demand/legislation/heat_power_en.htm

Commission of the European Communities (1997), *COM(97)599 Energy for the Future: Renewable Sources of Energy – White Paper for a Community Strategy and Action Plan*, http://europa.eu/documents/comm/white_papers/pdf/com97_599_en.pdf

Commission of the European Communities (1998), *COM(98)353 Climate Change – Towards an EU Post-Kyoto Strategy*, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:51998DC0353&from=EN

Department of Communications, Energy and Natural Resources and Sustainable Energy Authority of Ireland (2006), *Bioenergy in Ireland*, http://www.seai.ie/

Department of Communications, Energy and Natural Resources (2007), *Energy White Paper 2007 – Delivering a Sustainable Energy Future for Ireland*, http://www.dcmnr.gov.ie/NR/rdonlyres/54C78A1E-4E96-4E28-A77A-3226220DF2FC/27356/EnergyWhitePaper12March2007.pdf

Department of Communications, Energy and Natural Resources (2011), *Biofuel Obligation Scheme*, http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/Biofuels/

Di Cosmo V. and Malaguzzi Valeri L. (October 2014), *ESRI Working Paper No. 493 – The Effect of Wind on Electricity CO_2 Emissions: The Case of Ireland*, Dublin: ESRI.

Duffy P., Hanley E., Hyde B., O'Brien P., Ponzi J., Cotter E., and Black K. (2014), *Ireland National Inventory Report 2014*, http://coe.epa.ie/ghg/nirdownloads.php

EirGrid (2016), *All Island Generation Capacity Statement 2016 – 2025*, http://www.eirgridgroup.com/site-files/library/EirGrid/Generation_Capacity_Statement_20162025_FINAL.pdf

European Environment Agency (2014), *Monitoring CO_2 emissions from passenger cars and vans in 2013*, http://www.eea.europa.eu//publications/monitoring-co2-emissions-from-passenger

European Union (2003), Directive 2003/30/EC of the European Parliament and of the Council on the promotion of the use of biofuels or other renewable fuels for transport, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:123:0042:0046:EN:PDF

European Union (2003), Directive 2003/87/EC of the European Parliament and of the Council establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003L0087&from=EN

European Union (2004), Directive 2004/8/EC of the European Parliament and of the Council on the promotion of cogeneration based on useful heat demand in the internal energy market and amending Directive 92/42/EEC, http://europa.eu.int/eur-lex/pri/en/oj/dat/2004/l_052/l_05220040221en00500060.pdf

European Union (2006), Directive 2006/32/EC energy end-use efficiency and energy services, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:114:0064:0064:EN:PDF

European Union (2007), Decision 2007/394/EC methodology to be applied for the collection of gas and electricity prices charged to industrial end-users, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:148:0011:0016:EN:PDF

European Union (2009), Decision No 406/2009/EC on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF

European Union (2009), Directive 2009/28/EC on the promotion of the use of energy from renewable sources, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF

Eurostat (2015), *Energy, transport and environment indicators – 2014 Edition*, http://ec.europa.eu/eurostat/web/products-pocketbooks/-/KS-DK-14-001

International Energy Agency (2015), *Energy Balances of OECD Countries 2015 Edition*, Paris: IEA.

ICF Consulting and Byrne Ó Cléirigh (2004), *Determining the share of national greenhouse gas emissions for emissions trading in Ireland*, Dublin: Department of Environment, Heritage and Local Government http://www.environ.ie/en/Environment/Atmosphere/PublicationsDocuments/FileDownLoad,1290,en.pdf

National Oil Reserves Agency (2011), *Energy (Biofuel Obligation and Miscellaneous Provisions) Act 2010*, http://www.nora.ie/regulationslegislation/biofuels-obligation-scheme.152.html

OECD / IEA / Eurostat (2005 edition), *Energy Statistics Manual*, Paris: OECD/International Energy Agency.

O'Rourke, Kevin (2005), *Model of the Housing Stock*. Personal Communication with Energy Policy Statistical Support Unit.

Sustainable Energy Authority of Ireland (2005), *Profiling Energy and CO_2 Emissions in the Services Sector*, http://www.seai.ie/statistics

Sustainable Energy Authority of Ireland (2007), *Energy in Industry – 2007 Report*, http://www.seai.ie/statistics

Sustainable Energy Authority of Ireland (2009), *Energy Efficiency in Ireland – 2009 Report*, www.seai.ie/statistics

Sustainable Energy Authority of Ireland (2011), *Energy Forecasts for Ireland for 2020 – 2011 Report*, http://www.seai.ie/Publications/Statistics_Publications/Energy_Forecasts_for_Ireland/Energy_Forecasts_for_Ireland_for_2020_-2011_Report.pdf

Sustainable Energy Authority of Ireland (2011), *Energy Security in Ireland – A Statistical Overview*, http://www.seai.ie/Publications/Statistics_Publications/Energy_Security_in_Ireland/

Sustainable Energy Authority of Ireland (2013), *Energy in the Residential Sector*, http://www.seai.ie/statistics

Sustainable Energy Authority of Ireland (2014), Combined Heat and Power in Ireland – 2014 Update, http://www.seai.ie/Publications/Statistics_Publications/CHP-in-Ireland/

Sustainable Energy Authority of Ireland (2014), *Energy in Transport – 2014 Report*, http://www.seai.ie/statistics

Sustainable Energy Authority of Ireland (2015), *Annual Report 2015 on Public Sector Energy Efficiency Performance*, http://www.seai.ie/Publications/Your_Business_Publications/Public_Sector/Annual-Report-2015-on-Public-Sector-Energy-Efficiency-Performance.pdf

Sustainable Energy Authority of Ireland (2016), *Renewable Electricity in Ireland 2015*, http://www.seai.ie/Publications/Statistics_Publications/Renewable_Energy_in_Ireland/Renewable-Electricity-in-Ireland-2015.pdf

Sustainable Energy Authority of Ireland (2016), *Understanding Electricity & Gas Prices in Ireland – 2nd Semester (July – December) 2015*, http://www.seai.ie/Publications/Statistics_Publications/Electricity_and_Gas_Prices/Price-Directive-2nd-Semester-2015.pdf

UNFCCC (2003), *Caring for Climate – A guide to the climate change convention and the Kyoto Protocol*, http://unfccc.int/resource/docs/publications/caring_en.pdf

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

Energy Balance 2015

kilo tonnes of oil equivalent (ktoe)	Coal	Peat	Oil	Natural Gas	Renewables	Non-Renew/Waste	Electricity	Total
Indigenous Production	-	762	-	107	1,026	62	-	1,957
Imports	1,481	-	9,120	3,629	124	-	151	14,505
Exports	11	7	1,777	-	0	-	93	1,889
Mar. Bunkers	-	-	160	-	-	-	-	160
Stock Change	-43	5	-303	24	1	-	-	-317
Primary Energy Supply (incl. non-energy)	**1,426**	**759**	**6,880**	**3,761**	**1,150**	**62**	**58**	**14,096**
Primary Energy Requirement (excl. non-energy)	**1,426**	**759**	**6,672**	**3,761**	1,150	62	**58**	**13,889**
Transformation Input	**1,127**	**639**	**3,502**	**1,943**	**115**	**25**	**56**	**7,406**
Public Thermal Power Plants	1,127	547	77	1,620	107	25	-	3,503
Combined Heat and Power Plants	-	7	10	279	8	-	-	304
Pumped Storage Consumption	-	-	-	-	-	-	46	46
Briquetting Plants	-	85	-	-	-	-	-	85
Oil Refineries and other energy sector	-	-	3,415	43	-	-	11	3,469
Transformation Output	**-**	**65**	**3,481**	**-**	**41**	**6**	**1,806**	**5,400**
Public Thermal Power Plants	-	-	-	-	37	6	1,596	1,596
Combined Heat and Power Plants – Electricity	-	-	-	-	4	-	185	185
Combined Heat and Power Plants – Heat	-	-	-	-	-	-	-	-
Pumped Storage Generation	-	-	-	-	-	-	25	25
Briquetting Plants	-	65	-	-	-	-	-	65
Oil Refineries	-	-	3,481	-	-	-	-	3,481
Exchanges and Transfers	**15**	**-**	**-18**	**-**	**-635**	**-**	**635**	**-3**
Electricity	-	-	-	-	-635	-	635	-
Heat	-	-	-	-	-	-	-	-
Other	15	-	-18	-	-	-	-	-3
Own Use and Distribution Losses	**-**	**9**	**98**	**60**	**-**	**-**	**245**	**412**
Available Final Energy Consumption	**314**	**177**	**6,744**	**1,758**	**401**	**37**	**2,197**	**11,629**
Non-Energy Consumption	**-**	**-**	**208**	**-**	**-**	**-**	**-**	**208**
Final non-Energy Consumption	-	-	208	-	-	-	-	208
Total Final Energy Consumption	**312**	**201**	**6,493**	**1,722**	**415**	**37**	**2,156**	**11,337**
Industry	**106**	**1**	**464**	**767**	**174**	**37**	**847**	**2,397**
Non-energy mining	-	-	30	12	-	-	61	102
Food, beverages and tobacco	22	1	127	105	30	-	180	465
Textiles and textile products	-	-	2	1	-	-	11	14
Wood and wood products	0	-	2	2	115	-	36	156
Pulp, paper, publishing and printing	0	-	3	3	-	-	20	26
Chemicals and man-made fibres	-	-	27	65	-	-	154	245
Rubber and plastic products	-	-	9	4	-	-	37	50
Other non-metallic mineral products	84	-	171	17	29	37	54	391
Basic metals and fabricated metal products	-	-	11	422	-	-	67	500
Machinery and equipment n.e.c.	-	-	5	5	-	-	22	32
Electrical and optical equipment	0	-	38	123	-	-	105	266
Transport equipment manufacture	-	-	4	2	-	-	18	24
Other manufacturing	0	-	36	6	-	-	82	125
Transport	**-**	**-**	**4,657**	**0**	**128**	**-**	**4**	**4,789**
Road Freight	-	-	603	-	23	-	-	625
Light Goods Vehicles (LGV)	-	-	289	0	11	-	-	300
Road Private Car	-	-	2,012	-	66	-	-	2,078
Public Passenger Services	-	-	132	-	5	-	-	137
Rail	-	-	36	-	-	-	4	39
Domestic Aviation	-	-	3	-	-	-	-	3
International Aviation	-	-	844	-	-	-	-	844
Fuel Tourism	-	-	456	-	17	-	-	473
Navigation	-	-	71	-	-	-	-	71
Unspecified	-	-	210	-	7	-	-	217
Residential	**206**	**201**	**956**	**555**	**76**	**-**	**678**	**2,672**
Commercial/Public Services	**-**	**-**	**243**	**399**	**36**	**-**	**580**	**1,259**
Commercial Services	-	-	156	175	31	-	416	777
Public Services	-	-	87	224	5	-	164	481
Agricultural	**-**	**-**	**152**	**-**	**-**	**-**	**48**	**200**
Fisheries	**-**	**-**	**21**	**-**	**-**	**-**	**-**	**21**
Statistical Difference	2	-24	43	36	-14	-	41	84

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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