SUSTAINABLE ENERGY AUTHORITY OF IRELAND

ENERGY IN IRELAND 1990-2016

2017 Report

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December 2017

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Sustainable Energy Authority of Ireland

SEAI is Ireland's national energy authority investing in, and delivering, appropriate, effective and sustainable solutions to help Ireland's transition to a clean energy future. We work with Government, homeowners, businesses and communities to achieve this, through expertise, funding, educational programmes, policy advice, research and the development of new technologies. SEAI is part-financed by Ireland's EU Structural Funds Programme co-funded by the Irish Government and the European Union.

Energy Policy Statistical Support Unit (EPSSU)

SEAI has a lead role in developing and maintaining comprehensive national and sectoral statistics for energy production, transformation and end-use. This data is a vital input in meeting international reporting obligations, for advising 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

As the economy continued to recover in 2016, so too we have seen an increase in overall energy use in Ireland. There are encouraging trends, showing continued decoupling of economic growth and energy use. However, the pace of this divergence is too slow and is simply not sustainable.

A growing economy, powered by a low fossil fuel price, remains a significant barrier to the shift to a sustainable energy future. Encouraging decision makers to act is all the harder without the price signals to drive investment in sustainable energy technologies and practices. Despite this, the appetite for SEAI programmes continues to grow across the residential, community, SME and Industrial sectors. In 2018, SEAI will seek to invest a record amount of funding, supporting government action across research, development, innovation and programme delivery across all sectors of the economy. We will also explore how consumers and businesses react to more innovative incentives, policy interventions and a greater deployment of private sector finance in energy efficiency and decarbonisation. Our intention is to accelerate the transition to a lower carbon economy in the most cost-effective way possible. SEAI is facilitating the practical implementation of government policy through businesses, citizens and communities and this is an integral part of Ireland's drive to reach targets and transform how we live.

In 2016, renewable energy in Ireland helped avoid 3.9 million tonnes of CO_2 emission and reduced our national energy import bill by €342 million. When added to the significant savings homes and businesses can make through energy efficiency, the business case is undeniable. Renewable electricity capacity deployment was at the highest level ever in 2016 however, with most of it commissioned towards the end of the year, its full impact will only be felt in 2017.

One of the notable highlights from this year's report is the record level of energy sourced from Irish resources. This was driven by the start of natural gas production from the Corrib gas field. It is notable that the last time Ireland produced a comparable amount of its own energy was in 1995. In 2016, renewables accounted for 24% of Irish indigenous energy production.

The data provided in this report is a key strand in the SEAI evidence base that supports policy makers and researchers in Ireland. As the dialogue on climate change continues to gain momentum, it is now more important than ever that rational debate be based on robust statistical evidence from all emitting sectors. We have made progress but there is no doubt the future requires us to achieve much more. Accepting, understanding and using this evidence to inform the level of policy and behavioural change required will be essential

I encourage all readers to absorb the insights available in this data, and we welcome any contribution they might make in Ireland's transformation to a sustainable energy future.

Jim Gannon

Chief Executive

Sustainable Energy Authority of Ireland

Highlights

Highlights – the year 2016

- In 2016, overall energy use increased by 3.7%, while the economy grew by 5.1%.
- Energy-related CO_2 emissions increased by 3.6% in 2016 and were 16% below 2005 levels.
- Energy-related CO_2 emissions from the household, transport, services, industry and agricultural sectors account for approximately 60% of Ireland's total greenhouse gas (GHG) emissions.
- In 2016, the indigenous energy production in Ireland reached the highest level ever recorded at 4,246 ktoe. Natural gas production also reached the highest level ever, as a result of the Corrib gas field coming on stream.
- This reduced Ireland's energy import dependency from 88% in 2015 to 69% in 2016. As a result the energy import bill for Ireland fell from €4.6 billion in 2015 to €3.4 billion in 2016.

Progress towards Targets

- The contribution of renewables to gross final consumption (GFC) was 9.5% in 2016, compared to a 2020 target of 16%. This avoided 3.9 million tonnes of CO_2 emissions and €342 million of fossil fuel imports.
- The average emissions of new cars purchased in 2016 was 112.4 g CO_2/km. From 2020 onwards, EU Regulation 433/2014 sets a target of 95 g CO_2/km for the average emissions of the new car fleet.
- 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, increased by 3.4% in 2016.

Electricity

- Final consumption of electricity increased by 2% to 26 TWh with a 7% increase in the fuels used in electricity generation.
- Renewable electricity generation accounted for 27.2% (normalised) of gross electricity consumption in 2016. The use of renewables in electricity generation in 2016 reduced CO_2 emissions by 3.1 Mt and avoided €192 million in fossil fuel imports.
- 2016 saw the highest ever annual level of wind installations with approximately 400 MW being installed – approximately three quarters of this was deployed in the last 3 months of the year. This saw wind generation account for 22.3% (normalised) of the electricity generated in 2016 and was the second largest source of electricity generation after natural gas.
- In 2016 Ireland went from being a net importer of electricity to a net exporter. Previously, Ireland only exported electricity to any great extent in 1996 and 2001.
- For the second year running, the carbon intensity of electricity increased following significant reductions since 1990. In 2016 it increased to 483 g CO_2/kWh mainly as a result of a 23% increase in gas generation to compensate for lower wind (less windy than 2015) and hydro generation (lower rainfall) and a switch from net electricity imports to electricity exports to the UK[1].

Sectoral Highlights

- Final energy use increased in all sectors in 2016.
- Transport continues to dominate as the largest energy-consuming sector, with a share of 42% of final consumption in 2016.
- Transport energy use increased by 3.4% in 2016, with strong growth in road freight on foot of the expanding economy.
- More than three quarters of all new private cars purchased to date in 2017 were in the A label emissions band.
- In 2016 industry energy use increased by 3% driven by a 2.7% increase in output of industry as measured by value added.
- Residential energy use increased by 4.8% (weather corrected) in 2016 relative to 2015.
- 94% of new houses built between 2015 and 2017 were A rated.
- In 2016 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. This is down from 8.4 tonnes in 2005.
- Final energy use in the commercial and public services sector increased by 5% in 2016 – on a weather corrected basis the increase was 8.5%.

1 Contributing factors include capacity constraints and changes to the carbon floor price in the UK which pushed the east west interconnector (EWIC) up the merit order on the UK electricity grid.

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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 – 2016. Specifically, the report presents energy trends and underlying drivers as well as discussion on 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. As the dialogue on climate change continues to gain momentum, it is now more important than ever that rational debate is based on robust statistical evidence from all emitting sectors.

The information in the report is based on annual energy balances for the country that show 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 a hundred annual, quarterly, monthly and ad hoc questionnaires each year.

The energy balance develops continuously as data revisions and new methodologies become available. This ensures that the best information is available. The main changes related to the periods 1990 – 2016 and 2005 – 2016 are presented in this report and are described later.

A companion publication, *Energy Statistics – 2017 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, researchers and anyone 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/resources/energy-data/.

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 Supply and Use Trends

This section provides an overview of energy trends in Ireland, covering the periods 1990 – 2016 and 2005 – 2016 and with a particular focus on 2016. 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.

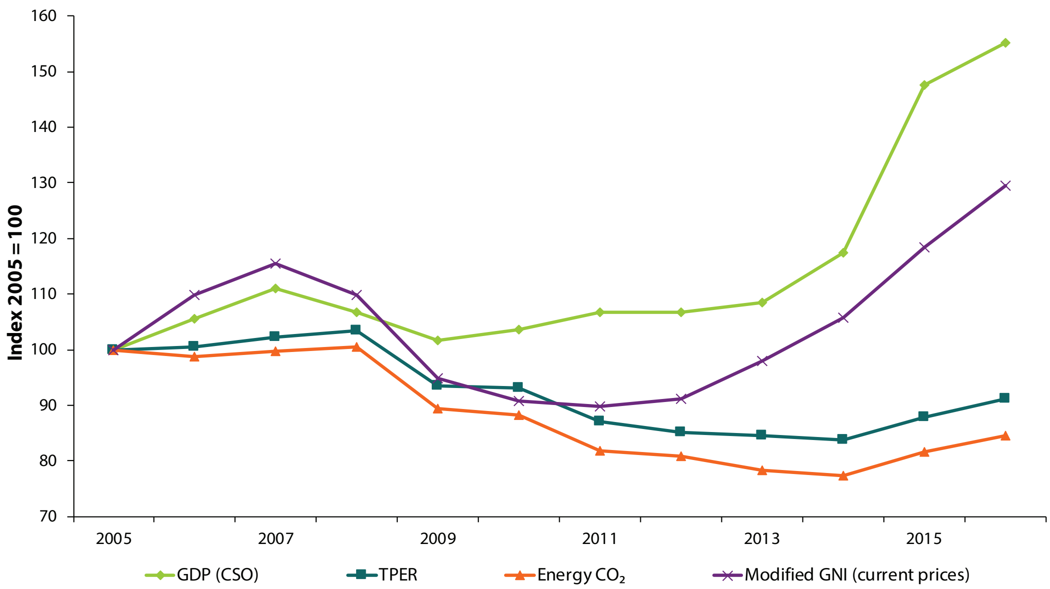
Energy supply depends on the demand for energy services (heating, transportation and electricity uses) and how that demand is satisfied. Energy service demand in turn is driven primarily by economic activity and by the energy end-use technologies employed in undertaking the activity. *Figure 1* shows the historical trends for Gross Domestic Product (GDP), Modified Gross National Income (GNI*)[2], TPER and energy CO_2, each expressed as an index relative to 2005. This captures the strong economic growth up to 2007, the economic downturn between 2008 and 2012 and the subsequent return to growth after 2013. Both GDP and GNI* are measures of economic growth. GDP is the traditional measure but in Ireland is strongly influenced by the activities of multinational companies particularly in the realms of aircraft leasing and intellectual property rights. GNI* was developed by the CSO in 2017 to be more reflective of Irish economic activity.

Energy-related CO_2 emissions have been growing since 2014.

In 2008 the economy experienced a downturn that deepened into 2009. Initially in 2008, 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, tracking the decline in the economy. 2011 to 2013 were mild years compared with 2010 and, notwithstanding the flat growth in GDP and return to growth in GNI* in 2013, 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. GNI* grew more modestly, but still significantly, by 11.9% in 2015. GDP growth in 2016 was 5.1% and GNI* grew by 9.4%.

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



Source: Based on SEAI and CSO data.

2 Modified Gross National Income (or GNI*) was introduced by the CSO in 2017 to assess the level of activity in the Irish economy excluding the effects of globalization that disproportionately affect the Irish economic results. GNI* is defined as GNI less the effects of the profits of re-domiciled companies and the depreciation of intellectual property products and aircraft leasing companies.

Figure 1 shows the relative decoupling of TPER (also known as gross inland consumption[3]) from economic growth up to 2007 and again from 2011 onwards. This is a result of changes in the structure of the economy and improvements in energy efficiency.

CO_2 emissions[4] grew a little slower than energy use in the period 2005 to 2011 due predominantly to decarbonisation of the electricity sector (see section *2.6*), however the trends remain relatively coupled since.

Between 2010 and 2014, the economy grew by 13% as measured by GDP (16.5% if measured by GNI*) while energy use 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 2010 was an exceptionally cold year. 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 also continued to be reductions in the energy intensity of households, due to a combination of improved energy efficiency and economic factors.

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. Overall energy use continued to grow in 2016 but at a more modest rate of 3.7%.

Table 1 displays the growth rates for the economy (GDP and Modified GNI), primary energy (TPER) and energy-related CO_2 emissions for the period 1990 – 2016. It is interesting to compare the trend over the eleven year period 2005 – 2016 with that for the whole period, given the significance of 2005 with respect to Ireland's 2020 greenhouse gas emissions target. 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*.

Between 2005 and 2016, overall energy-related CO_2 emissions have fallen by 1.5% per annum on average, an aggregate decrease of 16%, while the economy is 55% (4.1% per annum) larger as measured by GDP than it was in 2005 or 30% (2.4% per annum) larger if measured by GNI*. In contrast, over the 26 year period since 1990, on average, energy-related CO_2 emissions grew by 1% per annum, while the economy grew by 5.5% per annum. Since 2014 there has been a return to growth in energy-related CO_2 emissions as shown in *Figure 1*.

Table 1: GDP[5], Modified GNI, TPER and CO_2 Growth Rates[6]

	Growth %	Growth %	Average annual growth rates %		
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016
GDP	297.5	55.1	4.1	7.0	5.1
Modified GNI (current prices)	-	29.5	2.4	6.1	9.4
TPER	51.8	-8.8	-0.8	-0.4	3.7
Energy CO_2	28.1	-15.5	-1.5	-0.7	3.6
Energy CO_2 (excl. int'l aviation)	24.1	-16.6	-1.6	-0.9	3.7

Energy use is primarily driven by economic activity, but the relationship in Ireland is less straight forward than for other countries as significant portions of GDP or value added in Ireland is generated with very little consumption of energy. This was very well illustrated in 2015 when GDP grew by 26.3% as a result of the transfer into Ireland of intellectual property. Therefore, care must be taken when comparing macro-economic indicators such as energy intensity across countries.

Transport and industry have been more responsive to changes in economic activity while, in the short-term, residential and services energy use is heavily influenced by annual variations in weather and to some extent, energy price.

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

3 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.

4 Energy-related CO_2 emissions shown here 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.

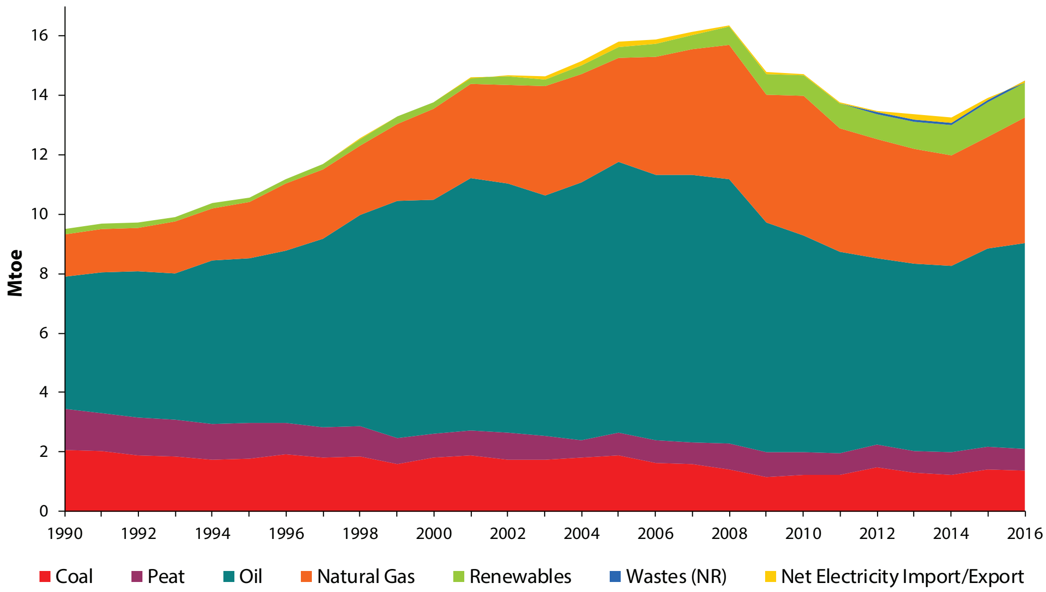
5 GDP rates are calculated using constant market prices chain-linked annually and referenced to 2015.

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

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 – 2016, emphasising changes in the fuel mix. Primary energy consumption in Ireland in 2016 was 14,413 ktoe, a 3.7% increase on the previous year. Over the period 1990 – 2016 Ireland's annual TPER grew in absolute terms by 52% (1.6% per annum on average). Between 2005 and 2016 primary energy requirement fell by 8.8%.

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 12% since then.

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

	Overall Growth %		Average annual growth %			Quantity (ktoe)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Fossil Fuels (Total)	42.0	-13.1	-1.3	-0.9	5.0	15,254	13,250	96.5	91.9
Coal	-34.1	-27.0	-2.8	1.8	-3.7	1,882	1,373	11.9	9.5
Peat	-46.7	-4.0	-0.4	-0.5	-4.3	765	734	4.8	5.1
Oil	56.3	-24.3	-2.5	-0.9	3.8	9,130	6,911	57.8	48.0
Natural Gas	192.6	21.7	1.8	-1.7	12.4	3,477	4,231	22.0	29.4
Renewables (Total)	590.5	210.2	10.8	9.1	0.3	373	1,158	2.4	8.0
Hydro	-2.3	7.9	0.7	2.2	-15.6	54	59	0.3	0.4
Wind	-	453.0	16.8	13.9	-6.5	96	529	0.6	3.7
Biomass	217.6	85.7	5.8	8.0	17.6	180	335	1.1	2.3
Other Renewables	9883.6	448.3	16.7	4.2	0.3	43	236	0.3	1.6
Wastes (Non-Renewable)	-	-	-	40.6	-3.8	-	66	-	0.5
Electricity Imports (net)	-	-	-	-	-	176	-61	1.1	-0.4
Total	**51.8**	**-8.8**	**-0.8**	**-0.4**	**3.7**	**15,803**	**14,413**		

The following are the main trends in national fuel share:

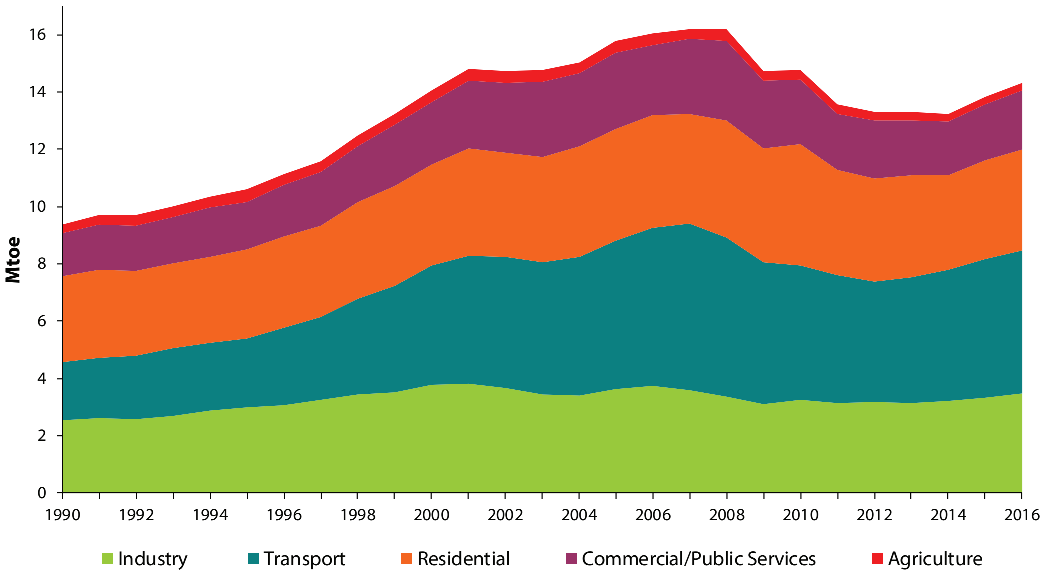
- Overall primary energy use grew by 3.7% in 2016.
- Fossil fuels accounted for 92% of all energy used in Ireland in 2016. Demand for fossil fuels increased by 5% in 2016 to 13,250 ktoe but was 13% lower than in 2005.
- Coal use decreased by 3.7% and its share of TPER fell to 9.5% in 2016 down from 10.3% in 2015. Since 2005, coal demand has fallen by 27% (2.8% per annum).

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

- Peat use fell by 4.3% and its share of overall energy use was 5.1% in 2016.
- Oil continues to be the dominant energy source and maintained a 48% share of TPER in 2016. The share of oil in overall energy use peaked in 1999 at 60%. Consumption of oil, in absolute terms, increased by 3.8% in 2016 to 6,911 ktoe but compared with 2005, oil demand in 2016 was 24% lower.
- Natural gas use increased in 2016 by 12.4% to 4,231 ktoe and its share of TPER increased to 29%. Natural gas use was 22% higher than in 2005.
- Total renewable energy increased slightly by 0.3% during 2016 to 1,158 ktoe. Hydro and wind decreased by 15.6% and 6.5% respectively as there was lower rainfall and less wind blowing in 2016 compared to 2015. Biomass use increased by 17.6% in 2016 to 335 ktoe and other renewables increased by 0.3% to 236 ktoe. The overall share of renewables in primary energy stood at 8% in 2016 down from 8.3% in 2015. Furthermore, approximately three quarters of the additional wind capacity deployed in 2016 was commissioned in the later half of that year.
- Energy from non-renewable wastes decreased by 3.8% in 2016 to 66 ktoe and accounted for just 0.5% of primary energy.
- Ireland was a net exporter of electricity in 2016 switching from net imports of 58 ktoe in 2015 to net exports of 61 ktoe in 2016 – a difference of 119 ktoe.

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.

> Demand for fossil fuels was 13% lower in 2016 compared to 2005, however, their use increased by 5% in 2016 to 13,250 ktoe.

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 2016. All sectors' energy use grew in 2016, which can be directly attributed to the growth in the economy. Energy use in the residential and services sectors is mainly for space heating and 2016 was a little warmer than 2015 but energy use increased nonetheless.

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.

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

	Overall Growth %		Average annual growth %			Quantity (ktoe)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Industry	37.3	-4.0	-0.4	1.0	4.6	3,626	3,480	22.9	24.3
Transport	143.7	-3.4	-0.3	1.2	3.0	5,179	5,005	32.7	34.9
Residential	17.3	-10.4	-1.0	-3.1	2.1	3,920	3,514	24.8	24.5
Services	39.8	-21.9	-2.2	-1.6	6.3	2,641	2,062	16.7	14.4
Agriculture / Fisheries	-21.0	-39.4	-4.4	-3.8	3.2	468	284	3.0	2.0

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

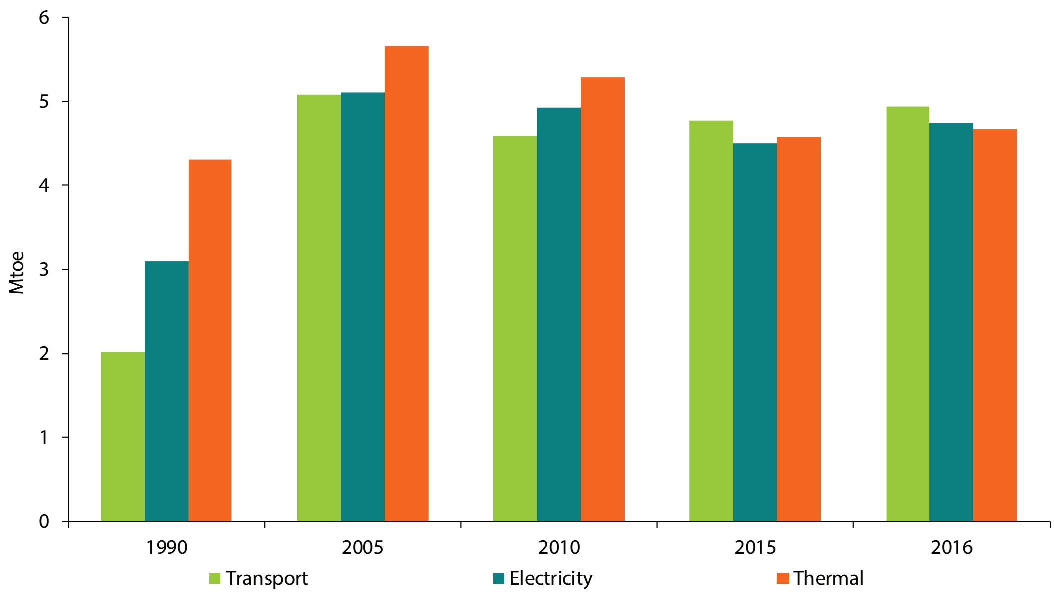
- Transport experienced an increase in primary energy use in 2016 of 3% to 5,005 ktoe. Transport primary energy use fell by 28% between 2007 and 2012 but has increased by 19% since then. Transport remains the largest energy consuming sector with a 35% share of primary energy in 2016.
- In 2016, primary energy use in households increased by 2.1% to 3,514 ktoe. 2016 was warmer than 2015 with 6.5% fewer heating degree days. Residential share of primary energy was 24% in 2016.
- Industry primary energy increased by 4.6% in 2016 to 3,480 ktoe. Industry's share of primary energy was 24% in 2016.
- Use of primary energy in the commercial and public services sector increased by 6.3% in 2016 to 2,062 ktoe. Services' share of primary energy was 14% in 2016.
- 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 2016, primary energy in buildings accounted for 39% of primary energy supply. Overall, primary energy use in buildings has fallen by 16% since 2005 (1.5% per annum) and in 2016 it grew by 3.6% to 5,577 ktoe.
- Agriculture/fisheries' primary energy use increased by 3.2% in 2016 to 284 ktoe and accounted for 2% of primary energy.

Sectoral energy-related CO_2 emissions are discussed in section *3.2*.

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.

Figure 4: Primary Energy by Mode of Application

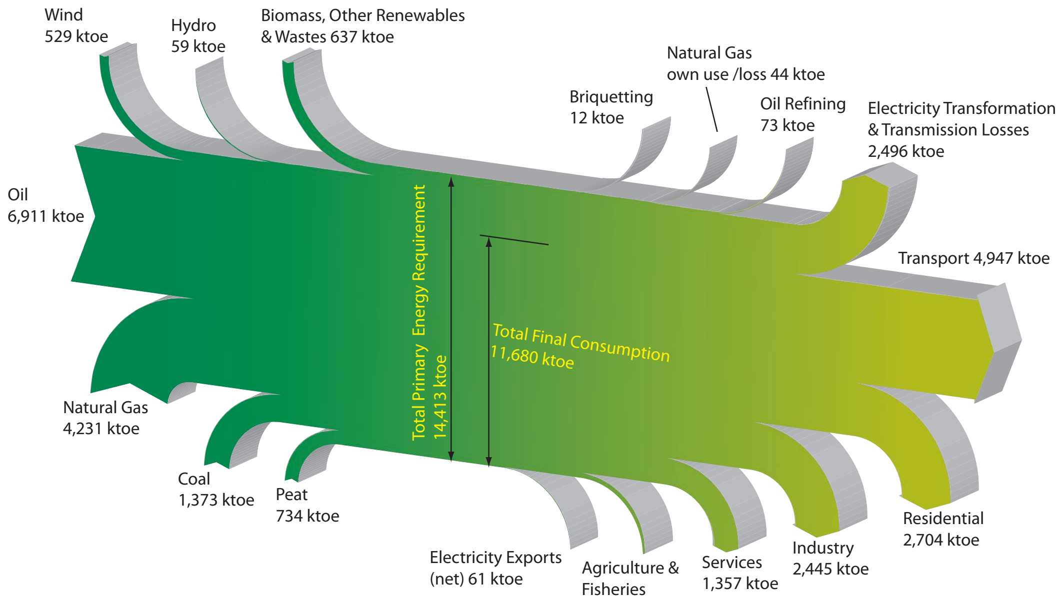


In 1990 thermal uses for energy (4,315 ktoe) accounted for a significant proportion of all primary energy (46%), while electricity accounted for 33% (3,094 ktoe) and transport 21% (2,017 ktoe). In 2005, thermal still had the highest share at 36% while transport and electricity were equal at 32% In 2016 the transport share had risen to 34% (4,943 ktoe), the thermal share had fallen to 32% (4,666 ktoe) and the share of energy use for electricity generation was 33% (4,571 ktoe). The changes in mode shares are shown in *Figure 4*.

2.3 Energy Balance for 2016

Figure 5 shows the energy balance for Ireland in 2016 as a flow diagram. This illustrates clearly the significance of each of the energy/fuel inputs, shown on the left, 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 2016[9]



Note: Some statistical differences exist between inputs and outputs

Oil dominates as a fuel, accounting for 6,911 ktoe, representing 48% of the total requirement. Renewables are disaggregated into wind, hydro and other renewables in *Figure 5* and accounted for 8.0% of TPER.

Transport continues to be the largest of the end-use sectors, accounting for 4,947 ktoe, representing 42% of TFC (see *Section 2.4*) in 2016.

Losses associated with the generation and transmission of electricity amounted to 17% of TPER or 2,496 ktoe in 2016 (52% 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.

Figure 6 shows an alternative view of the 2016 energy balance. In this the total primary energy is shown as 167,592 GWh (14,413 ktoe) in the centre and then the shares by mode in the next circle and finally the shares of energy sources used in each of the modes in the outer circle. All of the percentages shown are of the total primary energy figure in the centre.

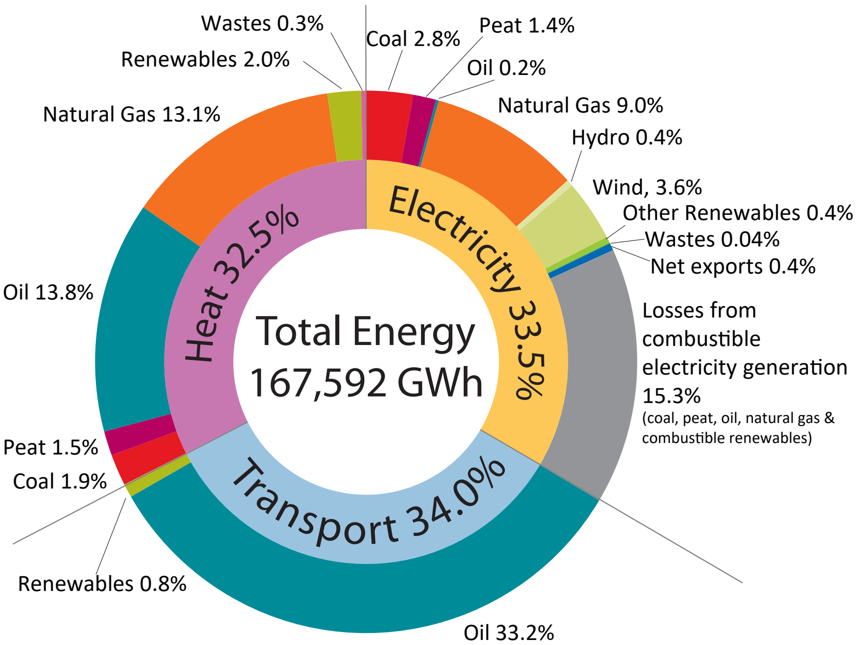
Taking transport as an example in *Figure 6*, it can easily be seen that transport accounted for 34% of overall primary energy and that oil use in transport, which accounts for the bulk of transport energy use (97%), accounts for 33% of primary energy use and renewable energy use in transport accounts for just 0.8%.

Energy use for heat purposes accounted for 32% of primary energy and oil and gas make up the largest proportions of energy use for heat. Oil use for heat accounted for 13.8% of overall energy, natural gas 13.1% followed by renewables at 2.0%, coal 1.9%, peat 1.5% and wastes at 0.3%.

Energy used to generated electricity accounted for 34% of all energy use in Ireland in 2016. A significant proportion of it, accounting for 15.3% of all energy use, is lost in the transformation process from combustible fuels to electricity. The figures in the outer circle show the proportions of electricity generated by the different energy sources and their share of overall primary energy. The largest share of electricity generated comes from natural gas and represents 9% of primary energy use. This is followed by wind which accounted for one fifth of electricity generated and 3.6% of primary energy. Coal generated electricity represented 2.8% of primary energy in 2016, peat 1.4% and oil just 0.2%.

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

Figure 6: Energy Balance by Mode and Fuel



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/manufactured fuels, etc. These transformation, processing or other losses entailed in delivery to final consumers are known as 'energy overheads' are not included in the TFC figures.

Figure 7: Total Final Consumption by Fuel

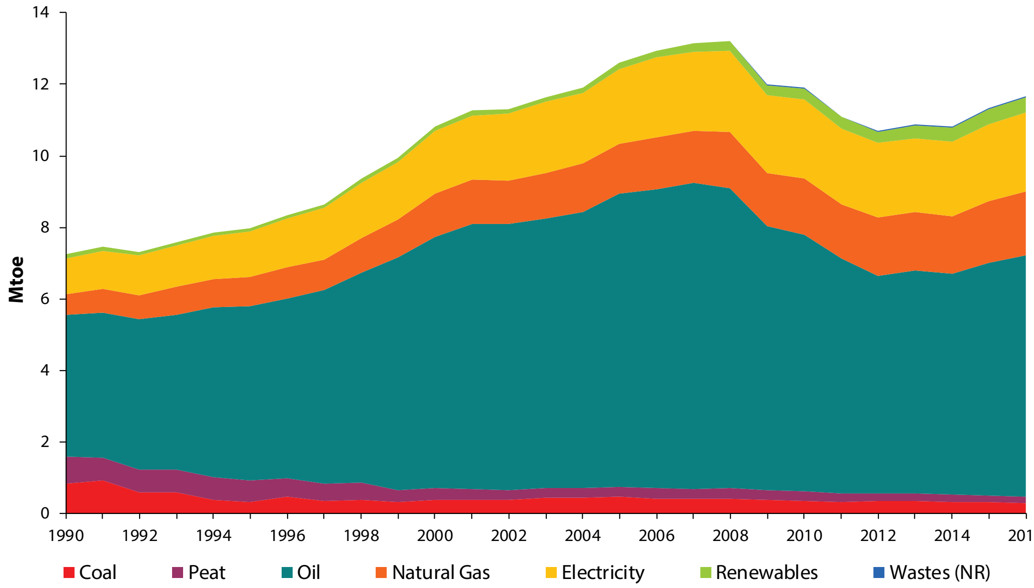


Figure 7 shows the shift in the pattern of final energy demand by fuel over the period 1990 – 2016.

Ireland's TFC in 2016 was 11,680 ktoe, an increase of 3% on 2015 and 61% above the 1990 level of 7,249 ktoe (1.9% per annum on average) but 7.4% below 2005 levels. When corrected for weather[10], final energy consumption increased in 2016 by 4.2%. Final consumption peaked in 2008 at 13,206 ktoe and has fallen by 12% 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 – 2016.

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

	Overall Growth %		Average annual growth %			Quantity (ktoe)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Fossil Fuels (Total)	47.2	-12.7	-1.2	-0.7	3.3	10,322	9,013	81.9	77.2
Coal	-65.7	-40.3	-4.6	-3.9	-7.5	484	289	3.8	2.5
Peat	-73.9	-27.8	-2.9	-4.1	-1.8	274	198	2.2	1.7
Oil	70.6	-17.8	-1.8	-1.0	3.9	8,196	6,740	65.0	57.7
Natural Gas	213.6	30.7	2.5	1.9	3.7	1,367	1,786	10.8	15.3
Renewables	294.9	122.6	7.5	4.8	1.5	191	426	1.5	3.6
Wastes (Non-Renewable)	-	-	-	30.2	-5.2	0	42	0.0	0.4
Combustible Fuels (Total)	51.1	-10.4	-1.0	-0.5	3.1	10,505	9,412	83.3	80.6
Electricity	115.5	5.0	0.4	0.1	2.0	2,094	2,199	16.6	18.8
Total	**61.1**	**-7.4**	**-0.7**	**-0.3**	**3.0**	**12,607**	**11,680**		
Total Weather Corrected	**57.2**	**-8.1**	**-0.8**	**0.4**	**4.2**	**12,646**	**11,618**		

The most significant changes can be summarised as follows:

- Consumption of all fuels, with the exception of coal, peat and non-renewable wastes, increased in final consumption in 2016. Oil and natural gas experienced the largest increases in 2016.
- Final consumption of oil increased by 3.9% in 2016 to 6,740 ktoe. This was driven by increased oil use in all sectors but particularly in households and transport, which saw the final use of oil grow by 5.1% and 3.8% respectively while industry and services' oil use increased by 4.3%, and 1.5% respectively. The share of oil in final consumption in 2016 was 58%.
- In 2016 natural gas consumption increased by 3.7% to 1,786 ktoe. The share of gas in final consumption in 2016 was 15%.
- Final consumption of coal fell by 7.5% in 2016 to 289 ktoe. Its share of final use in 2016 was at 2.5%. Coal use in industry increased by 3.7% to 106 ktoe but fell in the residential sector fell by 13.3% to 179 ktoe. There was an extension to the Smoky Coal Ban[11] in 2015.
- Final consumption of electricity in 2016 increased by 2% to 2,199 ktoe (or 25,574 GWh). In 2016, electricity accounted for 19% of final energy use.
- Final consumption of peat fell by 1.8% in 2016 to 198 ktoe. Peat accounted for 1.7% of final energy consumption in 2016.

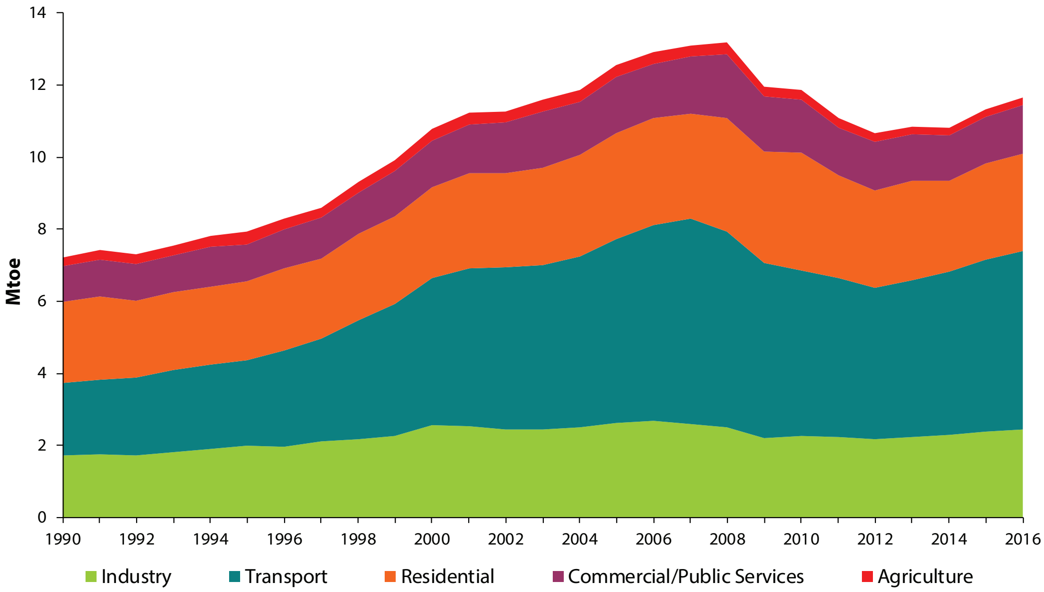
Figure 8 also shows the sectoral trend in TFC over the period.

Consumption of all fuels, with the exception of coal, peat and non-renewable wastes, increased in final consumption in 2016. Oil and natural gas experienced the largest increases in 2016.

10 Weather correction is a method of smoothing out the variations in energy use for heating purposes resulting from annual changes in weather patterns. See section *2.8 Energy, Weather and the Economy*.

11 http://www.dccae.gov.ie/en-ie/environment/topics/air-quality/smoky-coal-ban/Pages/default.aspx

Figure 8: Total Final Energy Consumption by Sector



The effect of the economic downturn is evident from 2008 to 2012. It is also evident from *Figure 8* 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 2016. The shares of the industry and residential sectors have decreased since 1990. In 2016 industry accounted for approximately one fifth of final energy use and the residential sector for under one quarter.

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

	Overall Growth %		Average annual growth %			Quantity (ktoe)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Industry	42.2	-7.1	-0.7	1.3	3.0	2,633	2,445	20.9	20.9
Transport	145.1	-2.7	-0.2	1.2	3.4	5,082	4,947	40.3	42.4
Residential	19.7	-8.0	-0.8	-3.1	1.2	2,940	2,704	23.3	23.2
Commercial / Public	39.6	-13.5	-1.3	-1.3	5.0	1,569	1,357	12.4	11.6
Agriculture / Fisheries	-19.2	-40.8	-4.7	-4.3	2.7	383	226	3.0	1.9
Total	**61.1**	**-7.4**	**-0.7**	**-0.3**	**3.0**	**12,607**	**11,680**		

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

- Overall final energy consumption grew by 3.0% in 2016 to 11,680 ktoe with all sectors showing growth.
- Energy use in transport grew in 2016 by 3.4% to 4,947 ktoe but was 13% lower than before the economic downturn in 2007.
- In 2016, final energy use in industry grew 3.0% to 2,445 ktoe. Over the 2005 – 2016 period, the average growth rate in final energy use in industry was -0.7% per annum (or 7.1% fall in absolute terms) and its share of TFC remained steady at 21%.
- Final energy use in the residential sector increased by 1.2% in 2016 to 2,704 ktoe. Correcting for weather[12], the increase in energy use was 4.8%.
- There was a 5.0% increase in final energy use in the commercial and public services sector in 2016 to 1,357 ktoe. Correcting for weather there was an increase of 8.5%.
- The agricultural and fisheries sectors' relative share fell from 3.5% in 1990 to 1.9% in 2016. Agriculture energy consumption increased in 2016 by 2.7% to 226 ktoe.

12 See Glossary for description of Weather Correction.

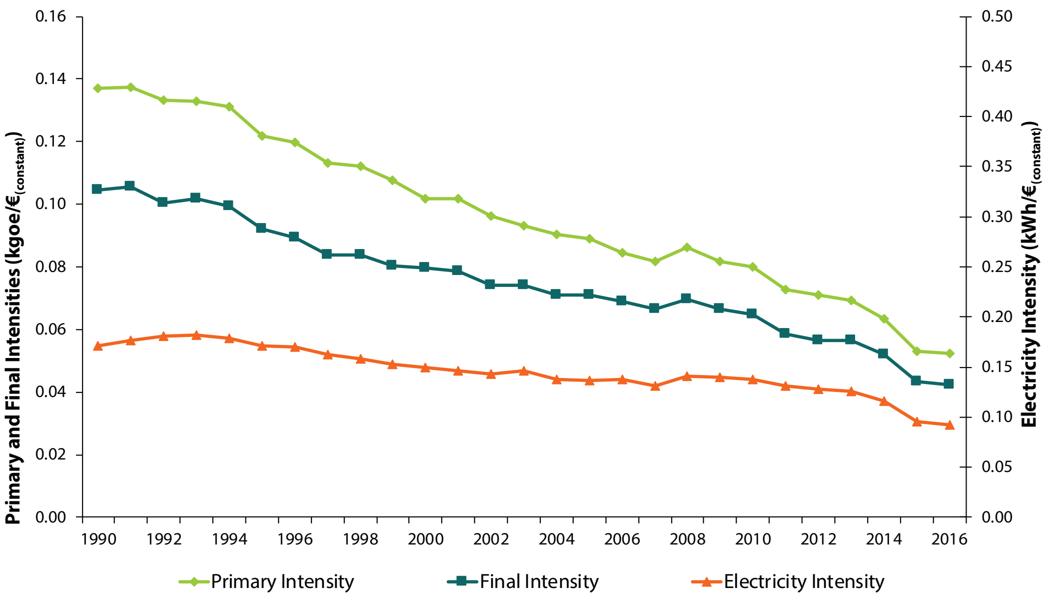
2.5 Energy Intensities

Energy intensity is defined as the amount of energy required to produce some functional output. In the case of the economy, the measure of output is generally taken to be the GDP[13]. 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 40% between 1990 and 2007 (3% per annum). In 1990 it required 137 grammes of oil equivalent (goe) to produce one euro of GDP (in constant 2015 values) whereas in 2007 just 82 goe was required. Between 2007 and 2016 primary energy intensity fell by 36% (4.8% per annum) to 52 goe/$€_{2014}$ and was 62% lower than 1990.

Figure 9 shows the trend in both primary (TPER/GDP) and final (TFC/GDP) energy intensities (at constant 2015 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 20% whereas for final intensity the decrease was 15%.

Figure 9: Primary, Final and Electricity Intensity



Between 2010 and 2016, the primary and final intensity trends converged slightly with primary energy intensity falling at a slightly faster rate, 34%, compared with a 33% 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 to thirty years. The structure of the economy has shifted in the direction of the high value-added[14] 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 16% 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

13 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. The CSO introduced Modified Gross National Income (GNI*) in 2017 to better reflect the level of activity in the Irish economy.

14 See Glossary.

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.

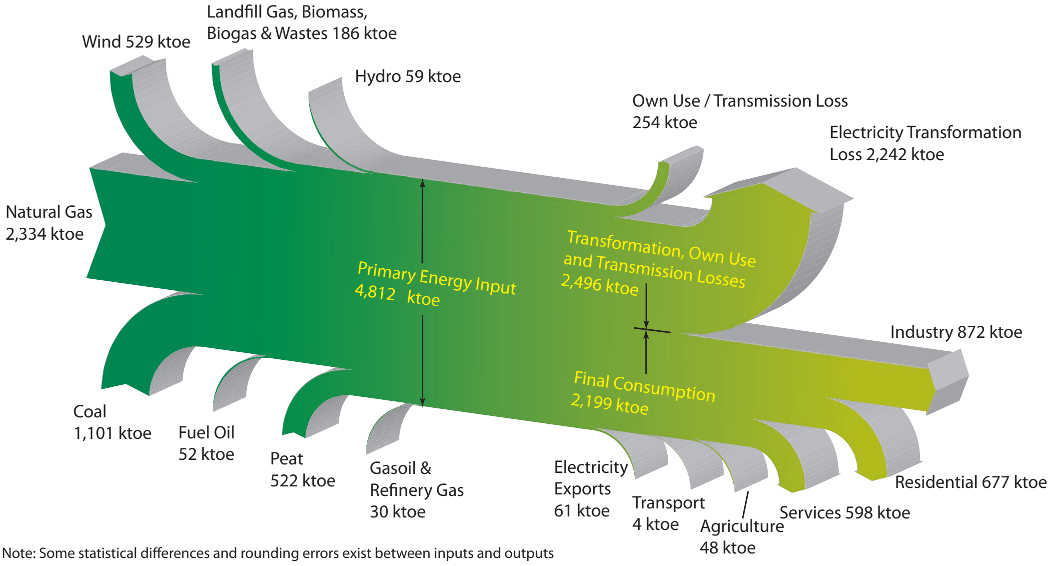
The final electricity intensity of the economy has not been falling as fast as primary or final energy intensities. Over the period 1990 – 2007 the electricity intensity fell by 23%. This is attributed to the shift towards increased electricity consumption in energy end-use. While electricity consumption 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 5.4% between 2007 and 2010, but fell by 33% between 2010 and 2016.

2.6 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[15]. Total energy inputs to electricity generation in 2016 amounted to 4,812 ktoe, 33% 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 52% 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 2016, natural gas accounted for 48% (2,334 ktoe) of the fuel inputs to electricity generation – a 23% increase compared with the previous year.

In 2016 the share of renewables in the generation fuel mix fell to 15.6% compared with 16.7% in 2015 due in the main to lower wind resource in 2016. Overall the use of renewables in the electricity generation fuel mix fell by 0.1% in 2016 compared with 2015.

Figure 10: Flow of Energy in Electricity Generation 2016



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. In 2016, electricity generated from renewable sources amounted to 7,516 GWh, accounting for over one quarter (25.6%) of gross electricity consumption compared with 27.3% in 2015.

In 2016, 4,812 ktoe of energy was used to generate electricity, 6.9% more than in 2015 and 8.5% less than peak levels in 2001.

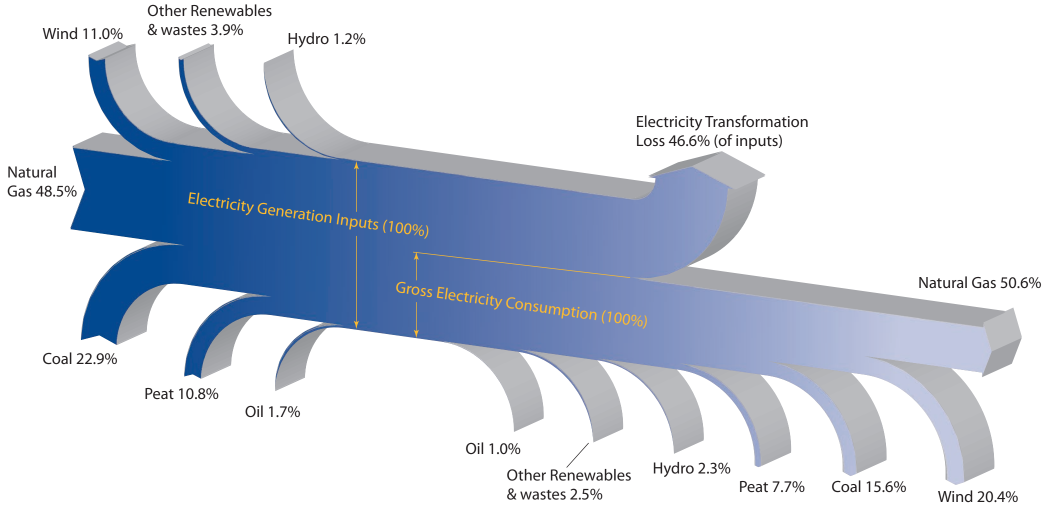
In calculating the contribution of hydropower and wind power for the purposes of Directive 2009/28/EC on the promotion

15 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.

of the use of energy from renewable sources, the effects of weather variation and capacity change are smoothed through the use of a normalisation rule[16]. Using normalised figures for wind and hydro, renewables accounted for 27.2% of gross electricity consumption in 2016. The national target is to achieve at least a 40% share by 2020.

In 2016, wind generation accounted for 20.4% (22.3% normalised) of electricity generated and was again the second largest source of electricity generation after natural gas.

Figure 11: Flow of Energy in Electricity Generation 2016 – 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 = 25.6%
Renewables as % of gross electricity consumption (normalised) = 27.2%
CHP as % of total electricity generation = 7.1%

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 imported electricity 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 2016, the supply efficiency was 47% whereas the overall generating efficiency was 54%.

In 2016, wind generation accounted for 20.4% (22.3% normalised) of electricity generated and was again the second largest source of electricity generation after natural gas.

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

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

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

In 2016, lower hydro and wind resources and increased electricity exports saw electricity generated from gas increase by 23%.

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.

In 2016 lower hydro and wind resources combined with increased electricity exports saw electricity generated from gas increase by 23%. The effect of the increase in gas generation offsetting the non-combustible sources of hydro, wind and imports saw the efficiency of supply drop to 47.5%.

Figure 12: Efficiency of Electricity Supply

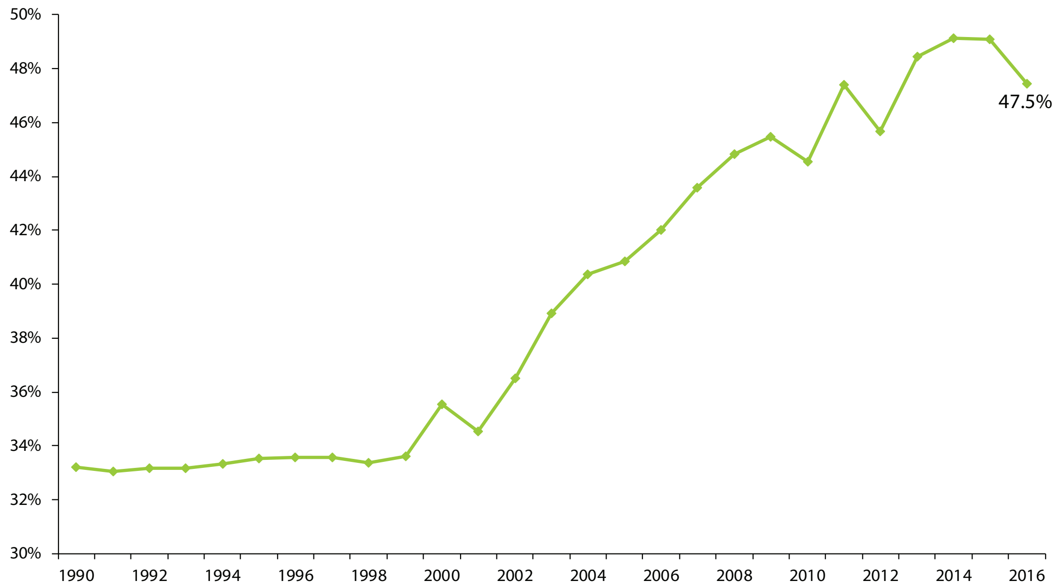


Figure 13: CO_2 Emissions per kWh of Electricity Supplied; with Contributions by Fuel

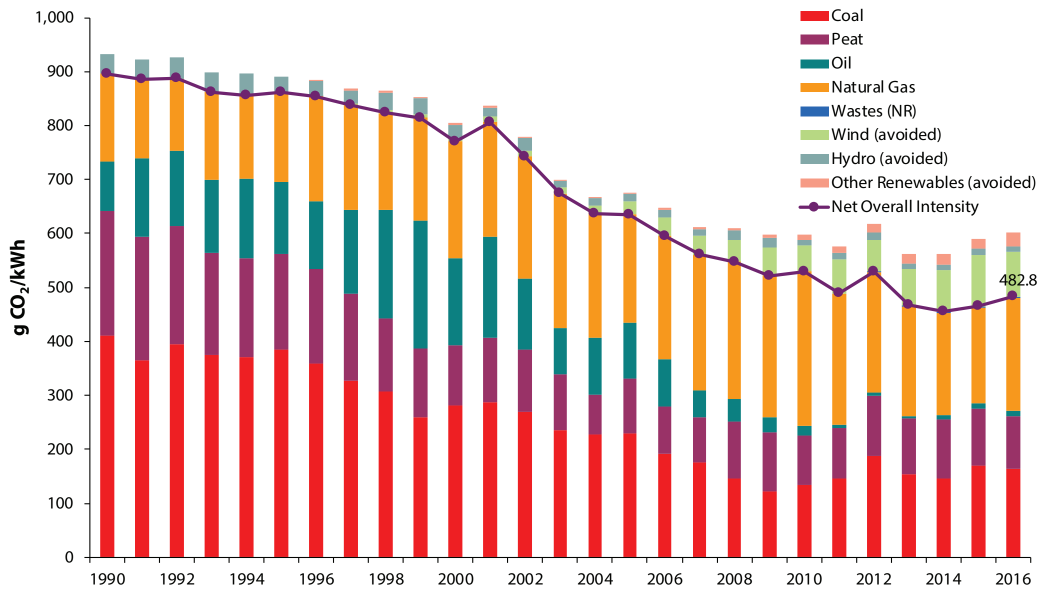


Figure 13 shows as stacked bars the shares of the various fuels contributing to the overall emissions intensity, as well as the reduction in intensity as a result of emissions avoided by renewable generation from wind, hydro and other renewables. It is important to note that this graph represents the 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 13*.

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 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. It increased further in 2016 to 483 g CO_2/kWh.

The reasons for the increase in carbon intensity of electricity in 2016 were:

- 23% increase in gas used in generation, increasing the gas share in fuel inputs to 48%;
- 15.6% decrease in hydro generation (1.2% share of inputs);
- 6.5% decrease wind generation (11% share of inputs).
- switch from net imports of electricity to net exports;

Countering these were a:

- 40.4% increase in biomass use in generation (3.3% share of inputs);
- 2.3% reduction in coal use in generation (23% share of inputs);
- 5.8% reduction in peat use in generation (11% share of inputs);
- 5.6% reduction in oil use in generation (1.7% share of inputs)

2.6.1 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[17] of CHP in Ireland at the end of 2016 was 343 megawatt electrical (MWe) (404 units[18]) – up from 342 MWe (385 units) in 2015. Of the 404 units, only 290 were reported as being operational. The operational installed capacity increased by 3.7 MWe, to 316.2 MWe, in 2016 compared with 2015.

Table 6: Number of Units and Installed Capacity by Fuel 2016

	No. of Units	Installed Capacity MWe	No. of Units %	Installed Capacity %
Natural Gas	356	314.8	88%	92%
Solid Fuels	2	5.2	0%	2%
Biomass	3	5.5	1%	2%
Oil Fuels	23	9.0	6%	3%
Biogas	20	9.0	5%	3%
Total	**404**	**343**	**100%**	**100%**

Source: SEAI

Natural gas was the fuel of choice for 315 MWe (356 units) in 2016. It is worth noting that there is one single 160 MWe gas plant which dominates. Oil products[19] and biogas made up the next most significant shares with 9.0 MWe each (23 and 20 units respectively) and the remainder was 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[20].

17 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.

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

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

20 Sustainable Energy Authority of Ireland (2017), *Combined Heat and Power in Ireland – 2017 Update*. Available from: www.seai.ie

Figure 14 illustrates the contribution from CHP to Ireland's energy requirements in the period 1994 – 2016. Fuel inputs have increased by 175% (4.7% per annum) while the thermal and electrical outputs increased by 201% (5.1% per annum) and 712% (10.0% per annum) respectively over the period. In 2016 fuel input decreased by 3.7% and thermal output decreased by 7.2%, while electricity generated fell by 1.6%. The large increase in 2006 is accounted for by the Aughinish Alumina plant which came online in that year.

Figure 14: CHP Fuel Input and Thermal/Electricity Output 1994 – 2016

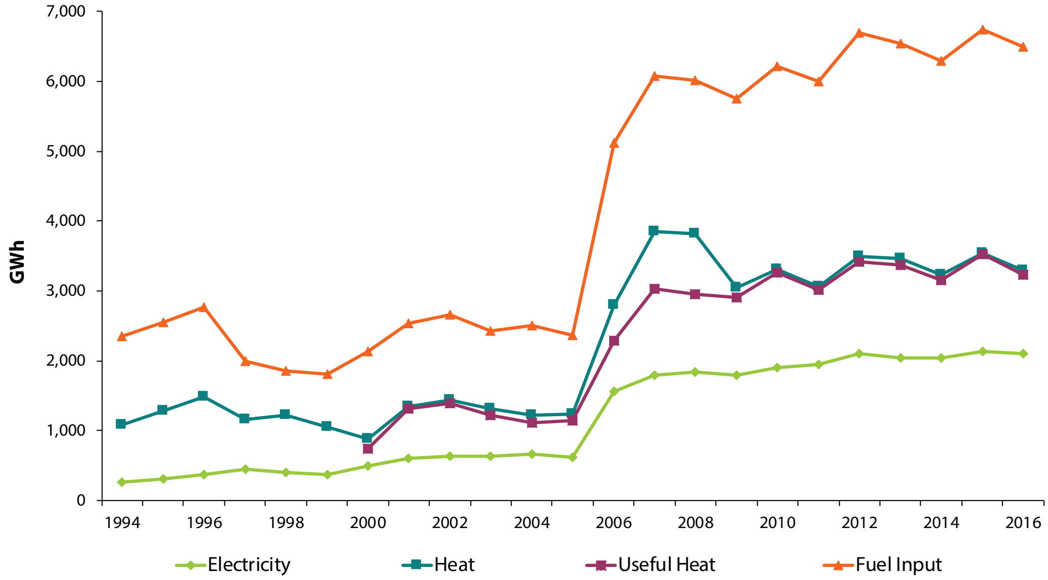
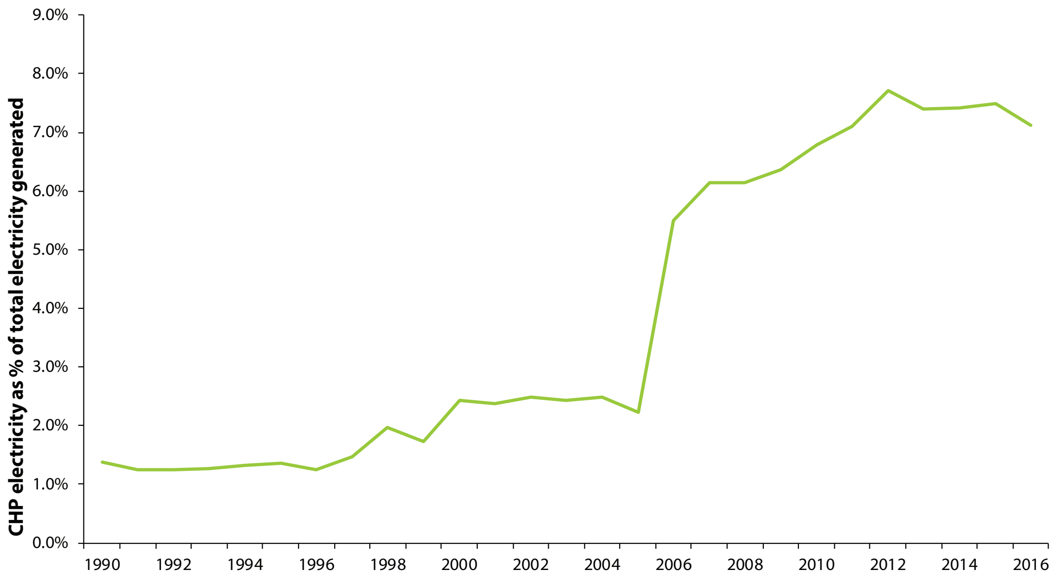


Figure 15 focuses on CHP generated electricity in Ireland as a proportion of gross electricity consumption (i.e. electricity generation plus net imports) in the period 1990 – 2016. In 2016, 7.1% of total electricity generation was generated in CHP installations compared with 7.5% in 2015. Some CHP units export electricity to the national grid. In 2016 there were 16 units exporting electricity to the grid. These units exported 1,375 GWh of electricity in 2016, an decrease of 3.0% on 2015.

Figure 15: CHP Electricity as percentage of Total Electricity Generation 1990 – 2016



2.6.2 Primary Fuel Inputs into Electricity Generation

The trends in the mix of primary fuels employed for electricity generation are shown in *Figure 16*. The shift from oil to gas since 2001 is evident, as is the growth of renewable generation since the early 2000s.

Figure 16: Primary Fuel Mix for Electricity Generation

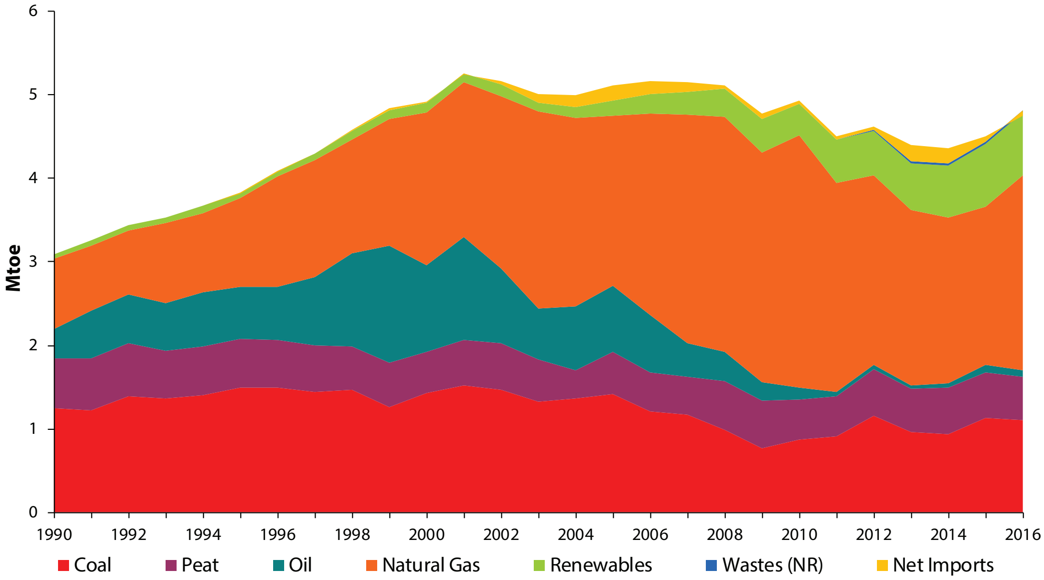


Table 7 shows the growth rates, quantities and shares of the primary fuel mix for electricity generation over the period 1990 – 2016.

The primary fuel requirement for electricity generation grew by 56% from 3,094 ktoe in 1990 to a high of 5,258 ktoe in 2001. Between 2001 and 2014 the requirement reduced by 17%, while the final consumption of electricity increased by 15%. In 2016, 4,812 ktoe of energy was used to generate electricity, 6.9% more than in 2015 and 8.5% less than peak levels in 2001. The increase in inputs to electricity generation in 2016 is against the backdrop of a 4.7% increase in electricity generated and a 2% increase in indigenous demand – the difference between generation and demand being accounted for by net exports to the UK.

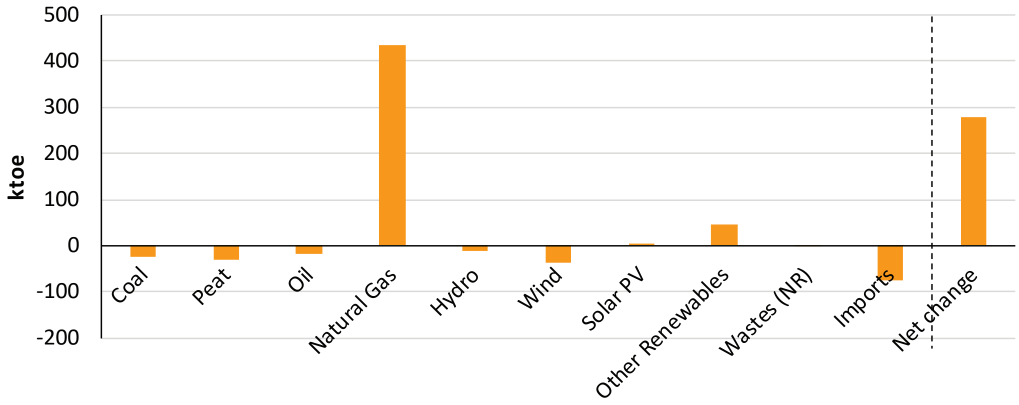
The fuel inputs to electricity generation were one third (33%) of the TPER in 2016. Electricity consumption as a share of TFC increased from 14% to 19% between 1990 and 2016.

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

	Overall Growth %		Average annual growth %			Quantity (ktoe)		Shares %	
	1990 – 2016	2005 – 2016	‘05 – ‘16	‘10 – ‘16	2016	2005	2016	2005	2016
Fossil Fuels (Total)	33.1	-15.1	-1.5	-1.9	10.2	4,756	4,039	93.0	83.9
Coal	-11.6	-22.6	-2.3	4.1	-2.3	1,422	1,101	27.8	22.9
Peat	-13.5	5.2	0.5	1.0	-5.8	496	522	9.7	10.8
Oil	-76.0	-89.6	-18.6	-8.2	-4.6	794	82	15.5	1.7
Gas	176.9	14.2	1.2	-4.2	22.9	2,044	2,334	40.0	48.5
Renewables (Total)	1148.7	316.5	13.8	12.6	-0.1	180	748	3.5	15.6
Hydro	-2.3	7.9	0.7	2.2	-15.6	54	59	1.1	1.2
Wind	-	453.0	16.8	13.9	-6.5	96	529	1.9	11.0
Other Renewables	-	440.9	16.6	24.4	40.4	30	161	0.6	3.3
Wastes (Non-Renewable)	-	-	-	-	-1.3	-	24	-	0.5
Combustible Fuels (Total)	39.2	-11.7	-1.1	-1.4	11.0	4,786	4,224	93.6	87.8
Electricity Imports (net)	-	-	-	-	-	176	-	3.4	-
Total	**55.5**	**-5.9**	**-0.5**	**-0.4**	**7.0**	**5,112**	**4,812**		

Figure 17 shows the change in 2016, by fuel, compared with 2015 of the inputs into electricity generation along with the net overall change.

Figure 17: Change in Fuel inputs to Electricity Generation in 2016 compared with 2015



The main trends are:

- Overall fuel inputs into electricity generation increased by 7.0% in 2016 to 4,812 ktoe (55,963 GWh), while electricity generated increased by 4.7% to 2,590 ktoe (30,125 GWh) and final consumption of electricity increased by 2%, to 2,199 ktoe (or 25,578 GWh).
- The overall share of fossil fuels used in electricity generation was 84% in 2016 (4,039 ktoe), down from 93% in 2005 but up on the 2015 figure of 82%.
- Natural gas share of energy used in electricity was 48% in 2016 up from 42% the previous year. Natural gas use in electricity generation increased by 23% (434 ktoe) in 2016 to 2,334 ktoe and generated 52% of electricity.
- Oil share of energy in electricity generation was 1.7% in 2016 and its use fell by 4.6% (18 ktoe) to 82 ktoe and generated 1% of electricity
- In 2016 consumption of coal for electricity generation fell by 2.3% (26 ktoe) to 1,101 ktoe and accounted for 23% of the energy used in electricity generation. 16% of electricity generated was from coal in 2016.
- Peat consumption in electricity generation fell by 5.8% (32 ktoe), to 522 ktoe, in 2016 and accounted for 10.8% of the fuel mix. 7.9% of electricity generated in 2016 was from peat.
- Overall renewables' contribution to the electricity fuel mix decreased by 0.1% (45 ktoe) in 2016 and accounted for 15.6% of the fuel mix and 26% of the electricity generated. Wind and hydro contribution to electricity generation fell by 6.5% (37 ktoe) and 15.6% (11 ktoe) respectively in 2016, due to lower wind and hydro resource last year. Countering this there was a 40% (45 ktoe) increase in other renewables used in electricity generation mainly from the co-firing of biomass in the peat stations.
- The use of energy from waste as a fuel source for electricity generation decreased by 1.3% in 2016 to 24 ktoe and accounted for 0.5% of all fuel inputs.
- There was a switch from net imports of electricity to net exports in 2016 with 61 ktoe being exported. This switch from net electricity imports in 2015 to net exports in 2016 is thought to be due to a number of factors. The carbon floor price in the UK caused significant reduction in coal generation there and pushed the east west interconnector (EWIC) up the merit order on the UK electricity grid. Other capacity constraints in the UK occurred due to damage to a sub-sea interconnector to France in late 2016 and the outages of a number of French nuclear plants for inspection reduced the availability of imports into the UK from there.

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[21] (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 2.3% (2.4% normalised) of the total and wind accounted for 20.9% (22.3% normalised) in 2016.

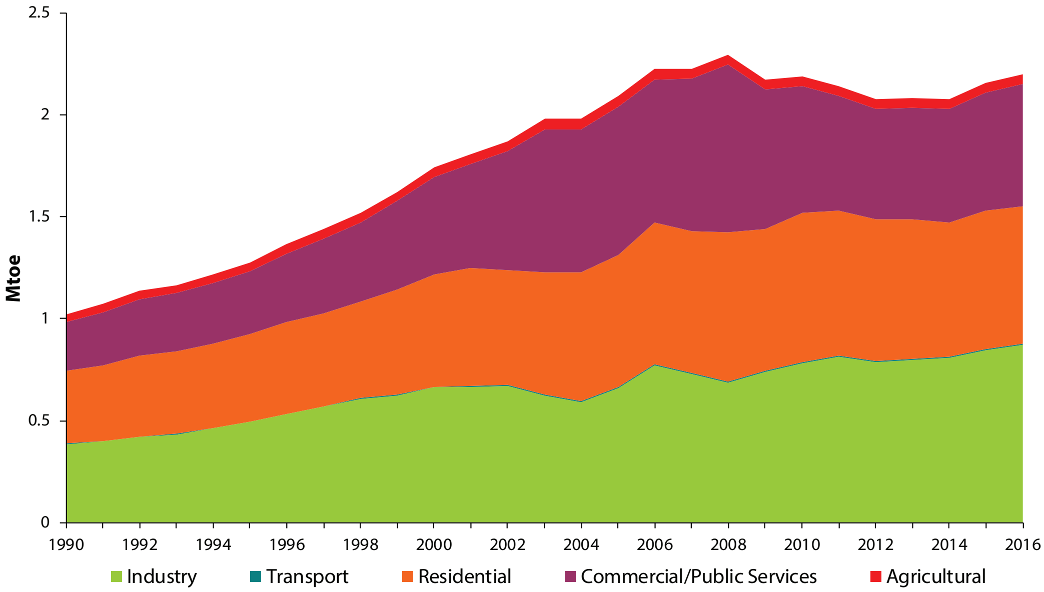
Overall, the share of electricity generated by renewables was 25.6% in 2016, down from 27.3% in 2015, while the renewables share of energy inputs to electricity generation was 15.6%. Normalising for wind and hydro as per Directive 2009/28/EC the share of electricity generated from renewables in 2016 was 27.2%.

21 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/

2.7 Electricity Demand

Figure 18 shows the final electricity consumption in each of the main sectors. The difference between fuel input (see *Figure 16*) and delivered electricity output (*Figure 18*) is accounted for by the transformation losses, totalling 2,242 ktoe in 2016, and electricity net exports (61 ktoe) as shown in *Figure 10* and *Figure 11*. The size of the transformation loss is due to electricity in Ireland being predominantly generated thermally (77% in 2016) and therefore primary energy requirement has always been significantly higher than final electricity consumption. This ratio of primary to final[22] energy in electricity consumption fell from 3.0 in 1990 to 2.1 in 2016. Final consumption of electricity grew by 2% in 2016 to 25,574 GWh compared to a 6.9% 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 was 4.1% lower than that in 2016 at 2,199 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 by the DART and the Luas in Dublin, and electric vehicles on the road. In absolute terms electricity consumption in transport is small at 49 GWh (4 ktoe) of which electric vehicles are estimated to account for approximately 4 GWh.

Industry has the largest share of final electricity use at 40%.

Electricity demand grew in all sectors in 2016 except in the residential sector where it fell by 0.1%. Transport experienced the largest growth in electricity at 11.8% but from a very small base to account for just 0.2% of the final share of electricity in 2016.

In terms of shares of final electricity use, industry has the largest share at 40% with the residential sector being the second largest at 31%.

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

	Overall Growth %		Average annual growth %			Quantity (ktoe)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Industry	126.2	32.2	2.6	1.8	3.0	660	872	31.5	39.7
Transport	203.7	-17.5	-1.7	1.1	11.8	5	4	0.2	0.2
Residential	90.1	4.8	0.4	-1.4	-0.1	646	677	30.8	30.8
Commercial / Public	148.7	-17.9	-1.8	-0.5	3.0	728	598	34.8	27.2
Agriculture	29.8	-13.3	-1.3	0.0	0.0	55	48	2.6	2.2
Total	**115.5**	**5.0**	**0.4**	**0.1**	**2.0**	**2,094**	**2,199**		

22 On a net calorific value basis.

2.8 Energy, Weather and the Economy

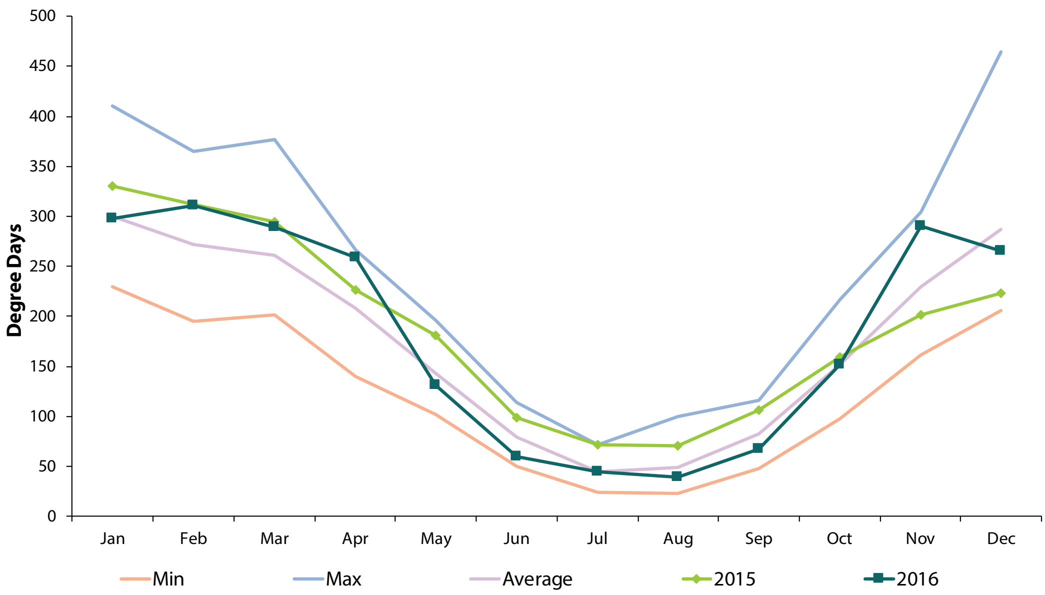
Weather variations from year to year can have a significant effect on the energy demand of a country, in particular on the portion of the energy demand associated with space heating. A method to measure the weather or climatic variation is through the use of 'degree days'.

Degree days are 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 on average 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 19 shows the heating degree days per month for 2016 and 2015.

Figure 19: Heating Degree Day Trend 2016 versus 2015



Source: Met Eireann and SEAI

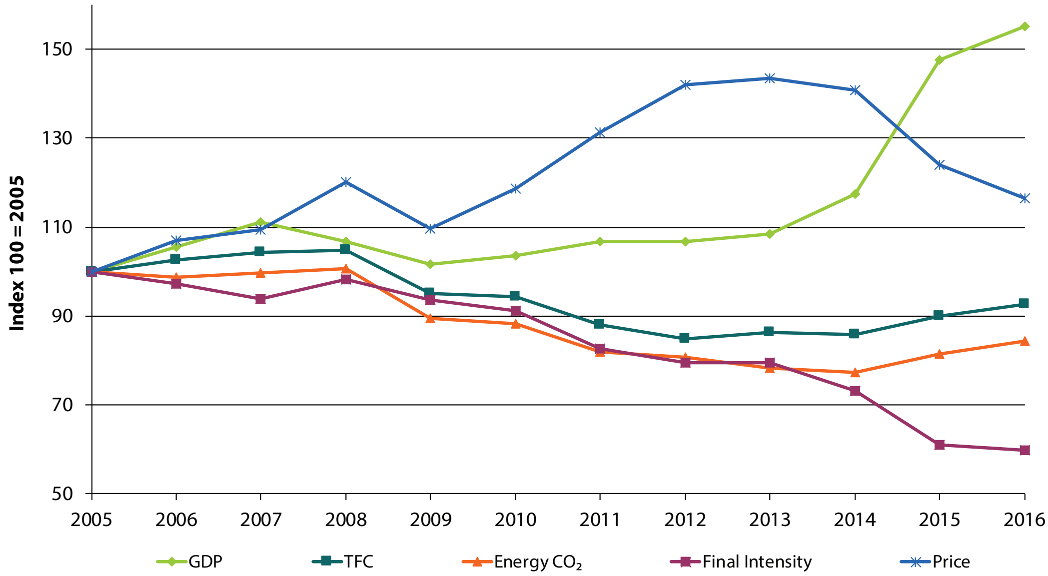
The graphs show the minimum, maximum and average degree days for each month for the last 30 years together with the monthly degree days for each year. *Figure 19* shows that 2016 was an above average year in terms of heating requirement between February and May and again in November. The rest of the year was more or less average. Compared with 2015 there were 6.5% less heating degree days (i.e. it was warmer) in 2016.

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 20* shows the trend in GDP in the period 2005 – 2016 as an index relative to 2005 levels. The impact of the recession on energy demand (TFC) is also clear in *Figure 20.* Between 2007 and 2009, the economy contracted by 8% but by 2016 it had recovered to be 40% above the 2007 level. However, overall energy use has fallen since 2008 and in 2016 was still 12% lower than 2008.

Figure 20 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 4.6% and 0.1% 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 20 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 up to 2016. High energy prices tend to dampen energy demand and vice versa.

Figure 20: Index of GDP, Final Energy Demand, Final Energy Intensity and Energy Price

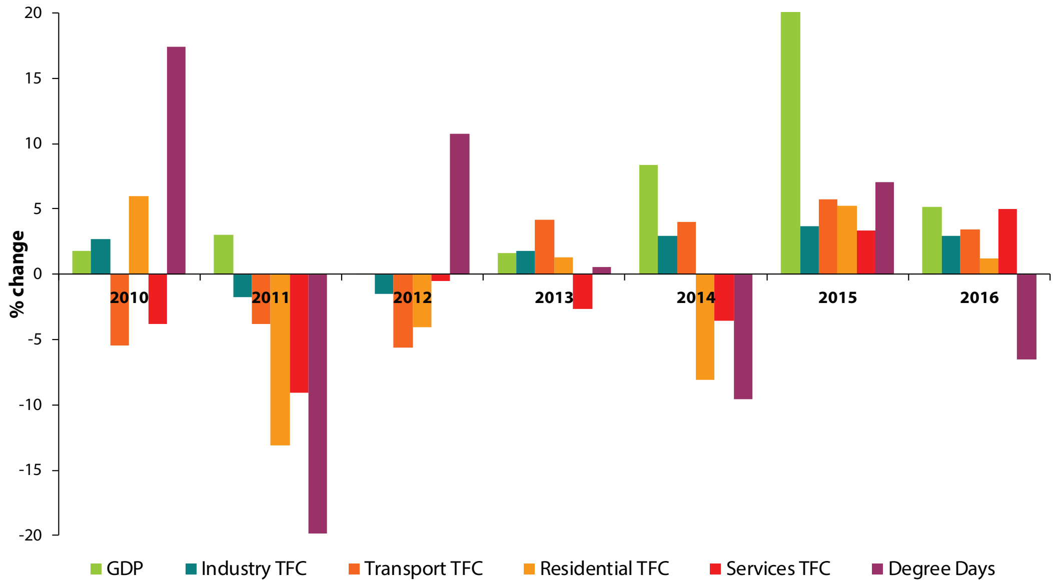


Source: SEAI, CSO and IEA

Figure 21 illustrates more clearly the separate effects that the economy and weather have had on Ireland's energy demand since 2010. *Figure 21* 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 21*.

Figure 21: Annual Changes in Economic Growth, Weather and Sectoral Energy Demand



Source: SEAI, CSO and Met Éireann

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. In 2016 the number of degree days was lower than 2015 but residential and services still increased. Changes in the energy demand per household are discussed in *Section 4.3.1*.

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. Economic activity in services increased by 6.3% in 2016 which might account for why final energy use increased by 7.8% while 2016 was milder than 2015.

Energy demand in industry and in transport is less dependent on the weather as is illustrated in *Figure 21*. 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 by 23% but has increased by 19% since and in 2016 was back at 2009 levels. Energy demand in industry fell between 2007 and 2009 and again in 2011 and 2012 resulting in demand being 20% lower but the economic activity of industry increased by 7.3% over the same period. Between 2012 and 2016 economic activity increased by 107% while energy use increased by 12%.

2016 was characterised by reasonably strong economic growth, slightly colder-than-normal weather and increases in the final consumption in all sectors. All sectors experienced growth in energy use in 2016 broadly in line with the increase in economic activity and the weather except for the residential sector which saw a 4.8% weather corrected increase in energy demand.

2016 was characterised by reasonably strong economic growth and slightly colder-than-normal weather. All sectors experienced growth in energy use in 2016.

3 Policy Perspectives

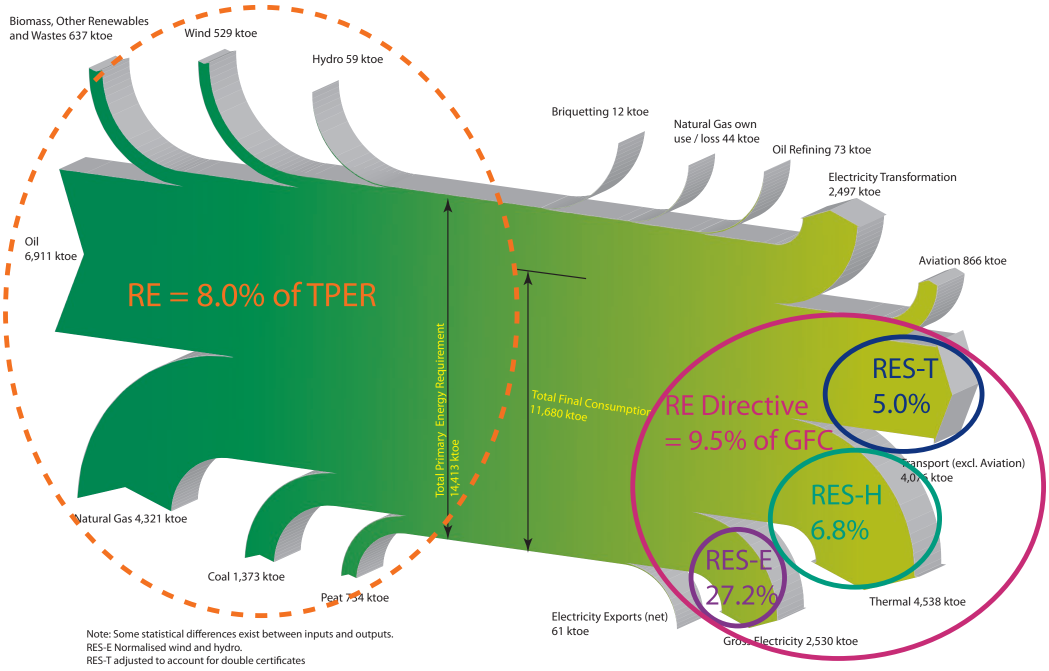
The energy trends discussed in *Section 2* are analysed to assess performance with regard to Government policies and targets. This section focuses on those detailed in the EU Directives related to renewable energy, GHG and transboundary emissions.

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 referred to as RES-E (electricity), RES-T (transport) and RES-H (heat).

The contribution from renewables in 1990 was 2.3%, rising to 9.5%[23] of GFC[24] in 2016. *Figure 22* illustrates where the various renewable targets fit within overall energy use in Ireland and the progress towards those targets in 2016. Towards the right of the figure the 2016 percentages of renewables are shown relative to the amount of final energy that they refer to. Also shown is how these relate to the Directive's target (see also *Table 9*).

Figure 22: Progress to Targets 2016



Towards the left of *Figure 22* the overall contribution of renewable energy to TPER is shown at 8.0%. 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 2000 – 2016. 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.

23 Calculated as per Directive 2009/28/EC.

24 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 weather.

Table 9: Renewable Energy Progress to Targets[25]

% of each target	2000	2005	2010	2011	2012	2013	2014	2015	2016	Target 2020
			Progress towards targets							
RES-E (normalised)	4.8	7.2	14.6	17.4	19.7	21.0	22.9	25.3	27.2	40
RES-T	0	0	2.4	3.7	3.9	4.8	5.1	5.7	5.0	10
RES-H	2.4	3.5	4.5	4.9	5.1	5.5	6.6	6.6	6.8	12
Directive (2009/29/EC)	**2.0**	**2.8**	**5.6**	**6.5**	**7.1**	**7.6**	**8.6**	**9.1**	**9.5**	**16**

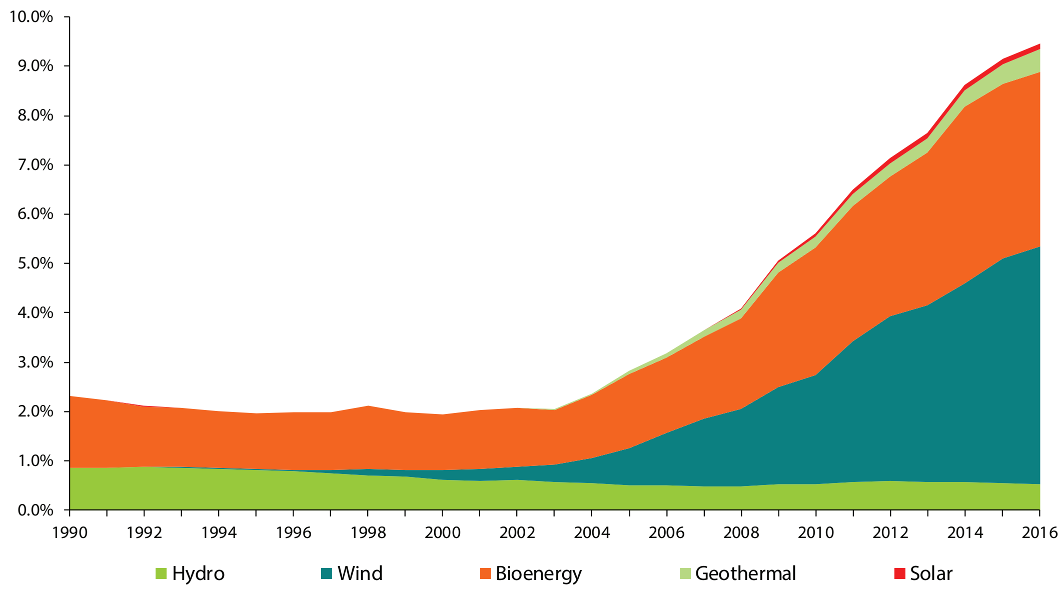
Source: SEAI

RES-E increased by 1.9 percentage points in 2016, to 27.2% towards the 40% 2020 target. RES-T fell back during 2016, to 5.0% towards the 10% 2020 target from 5.7% in 2015 (see section *3.1.2.3*). RES-H increased by 0.2 percentage points to 6.8% towards the 12% 2020 target.

Bioenergy accounted for 39% of the contribution towards the Renewable Energy Directive target.

Figure 23 shows the contribution as per the Directive methodology from 1990 to 2016 while *Figure 24* shows the renewable energy percentage contributions to GFC by mode with RES-E normalised.

Figure 23: Renewable Energy (%) Contribution to Gross Final Consumption (Directive 2009/28/EC)

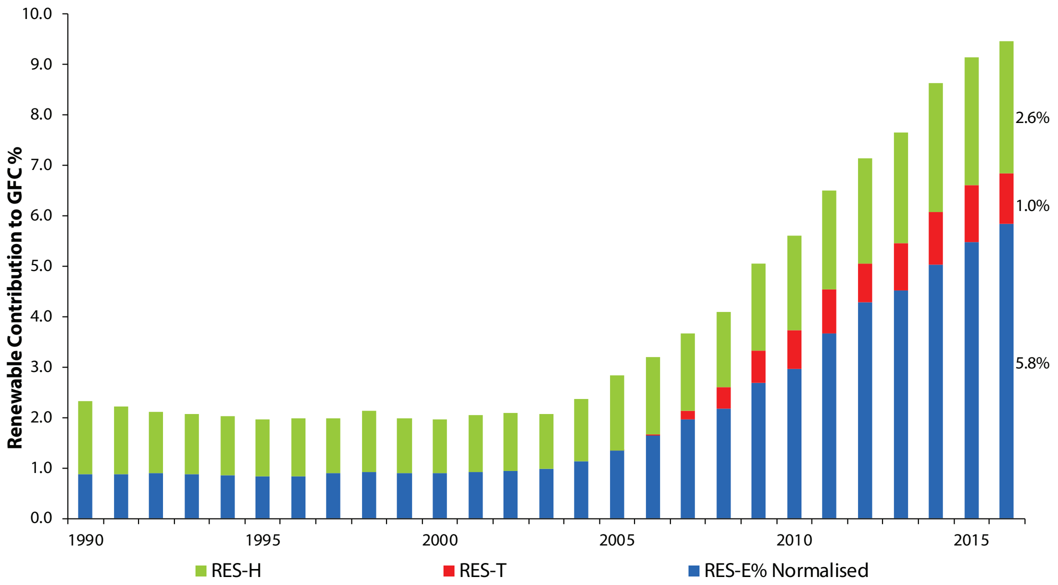


Source: SEAI

Wind accounted for 49% of the contribution towards the Directive target. Bioenergy accounted for 39% of the contribution which consists of biomass at 25% points, liquid biofuels at 11% points and biogas at 2.6% points. The remaining contribution came from hydro and geothermal both at 5% each and solar at 1.3%.

25 Note: Individual target percentages are not additive. RES-T includes double certificates for advanced biofuels.

Figure 24: Renewable Energy (%) Contribution to GFC by Mode[26]



Source: SEAI

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

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 2016 was 27.2% normalised (compared with 25.3% in 2015).

The share of electricity from renewable energy has increased fivefold between 1990 and 2016 – from 5.3% to 27.2% – an increase of over 22 percentage points over 26 years. In absolute terms there has been an elevenfold increase in the volume of renewable electricity generated from 697 GWh in 1990 to 7,516 GWh in 2016. Most of this increase has taken place since 2000 and the vast majority has been from wind energy.

Table 10 and *Figure 25* shows how electricity production from wind energy has increased to the point that it accounted for 84% of the renewable electricity generated in 2015. 2016 was less windy than 2015 and electricity generated from wind fell by 6.5% but still accounted for 82% of renewable electricity. Electricity generated from biomass accounted for 9% of renewable electricity in 2016. Biomass consists of contributions from solid biomass, landfill gas, the renewable portion of waste and other biogas.

Wind, hydro and bioenergy-generated electricity in 2016, respectively, accounted for 22.3%, 2.5% and 2.3% of Ireland's gross electricity consumption. Solar photovoltaic accounted for 0.01%.

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

Renewable Electricity %	1990	2000	2005	2010	2011	2012	2013	2014	2015	2016
Hydro (normalised)	5.3	3.4	2.7	2.6	2.7	2.8	2.7	2.6	2.5	2.5
Wind (normalised)	0	1.0	4.0	10.9	13.5	15.3	16.6	18.4	21.1	22.3
Biomass	0	0	0	0.4	0.5	0.9	1.1	1.2	1.0	1.6
Landfill Gas	0	0.4	0.4	0.6	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	0.1
Solar PV	0	0	0	0	0	0	0	0	0.01	0.01
Overall	**5.3**	**4.8**	**7.2**	**14.6**	**17.4**	**19.7**	**21.0**	**22.9**	**25.3**	**27.2**

26 RES-T double certification for advanced biofuels are not included in the overall RES target.
27 Available from http://www.seai.ie/

Figure 25: Renewable Energy Contribution to Gross Electricity Consumption (RES-E normalised)

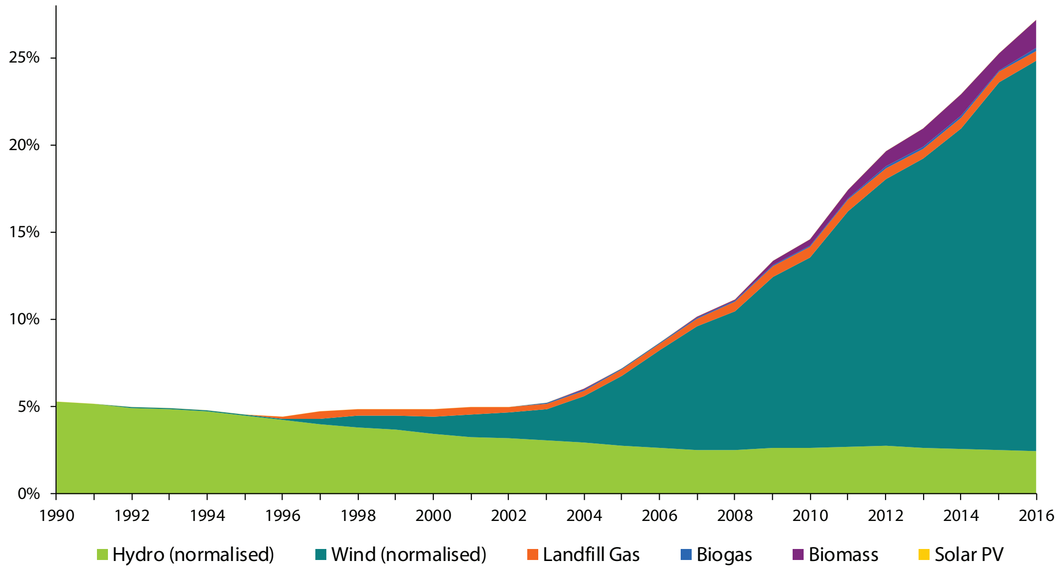
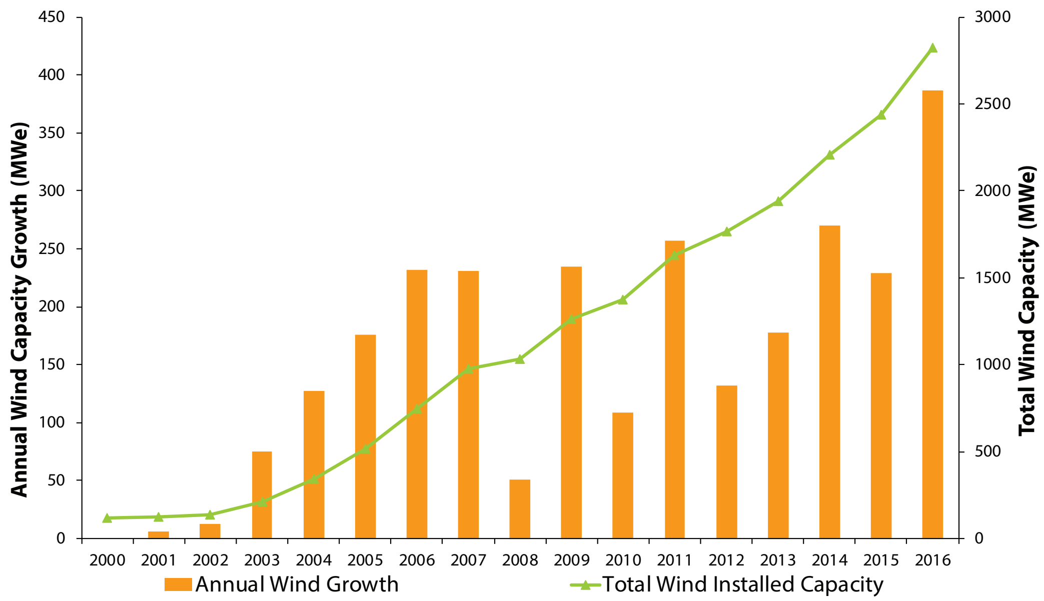


Figure 26 shows the annual growth in installed wind generating capacity and overall cumulative capacity since 2000. By the end of 2016 the installed capacity of wind generation reached 2,827 MW. The peak recorded wind power output was 2,444 MW, delivered on 17 February 2017[28] at 17:00hr and represented 66% of demand at that time. The highest level of wind installations happened in 2016 with approximately 400 MW being installed – most of this was deployed in the last quarter of the year.

Based on data published on EirGrid's and ESB Network's websites (September 2017) there are 1,119 MW of wind generation contracted for connection before the end of 2017 and a further 1,458 MW by the end of 2018. Historically, there has been a maximum of just under 400 MW installed in any one year since 2005 and on average the installation rate has been 200 MW.

Figure 26: Installed Wind Generating Capacity 2000 – 2016[29]



Source: EirGrid

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

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

29 *Installed Wind Report*, EirGrid, http://www.eirgridgroup.com/customer-and-industry/general-customer-information/connected-and-contracted-generators/ and ESB Networks, http://www.esb.ie/esbnetworks/en/generator-connections/Connected-Contracted-Generators.jsp

for these generation types. The capacity factor is the ratio of average electricity produced to the theoretical maximum possible if the installed capacity was 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 – 2016

Capacity Factor	2000	2005	2010	2011	2012	2013	2014	2015	2016
Wind	29%	30%	24%	33%	27%	28%	28%	32%	27%
Hydro	41%	31%	29%	34%	39%	29%	34%	39%	33%

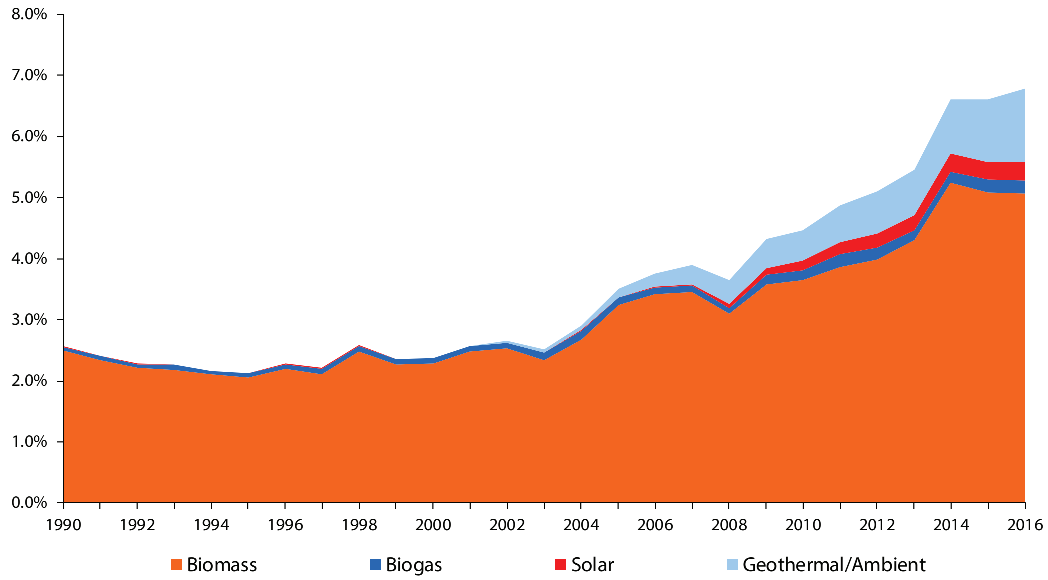
Source: EirGrid and SEAI

The average countrywide wind capacity factor fell between 2006 and 2009 but averaged around 28%. 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 dropped to 27% in 2016 and the hydro capacity factor to 33% due mainly to lower wind and rainfall level.

3.1.2.2 Heat from Renewable Energy Sources (RES-H)

Ireland's NREAP specified a target of 12% renewable heat by 2020. *Figure 27* 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 rising from 190 ktoe in 2005 to 308 ktoe in 2016 (a growth of 62%). In 2016 renewable thermal energy increased by 5.7% in absolute terms relative to 2015. The renewable share of thermal energy increased by 0.2 percentage points to 6.8% in 2016.

Figure 27: Renewable Energy Contribution to Thermal Energy (RES-H)



Following a decline in the contribution from renewables 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%, and held steady at 6.6% in 2015 before increasing again in 2016 to 6.8%. This growth, dominated by solid biomass[30], is mostly due to the increased use of wood waste as an energy source 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.

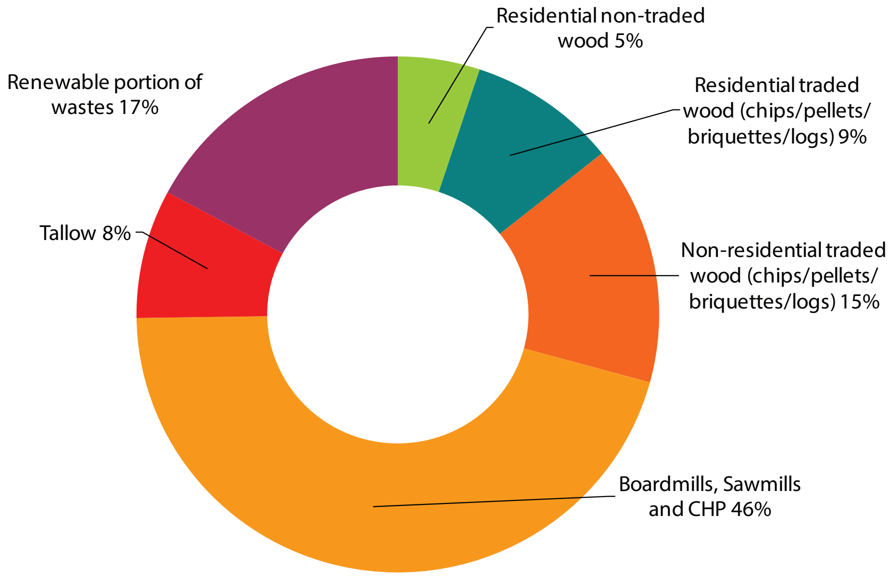
Figure 28 shows the composition of biomass in TFC in 2016. 46% of all solid biomass is consumed in the wood and wood products industry sub-sector, where wood wastes or wood residues of that sector are being combusted for heat. Similarly

30 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.

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 8% of all solid biomass. A further 17% in 2016 of solid biomass is used for heat in the cement industry in the form of the renewable portion of solid wastes.

Wood chips, pellets and briquettes make up 24% of all the solid biomass consumed in Ireland. The remaining 5% 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.

Figure 28: Composition of Biomass used for Heat in TFC in 2016



Source: SEAI

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 5 is applied to the electricity from renewable energy sources consumed by electric road vehicles and a weighting of 2.5 electricity from renewable energy sources consumed by rail transport, 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 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 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, fulfiling the requirements of Directive 2009/28/EC. 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 2013 and to 8% in 2017[31] and will increase further over time in order to help meet Ireland's target of 10% renewable energy in the transport sector by 2020[32].

31 S.I. No. 225/2016 - National Oil Reserves Agency Act 2007 (Biofuel Obligation Rate) Order 2016 http://www.irishstatutebook.ie/eli/2016/si/225/made/en/print#

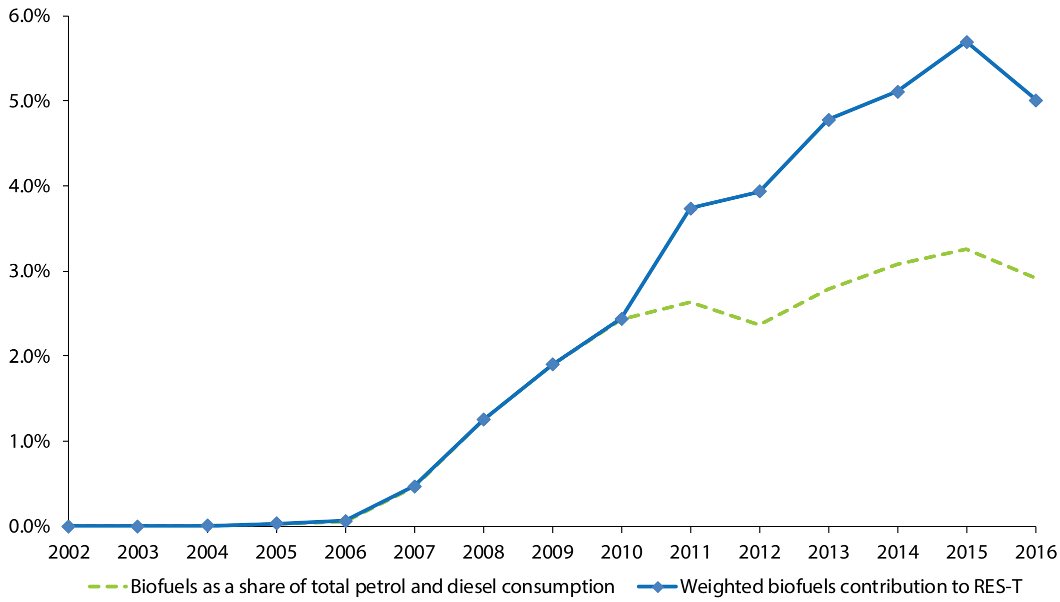
32 *The Biofuels Obligation Scheme, Annual Report 2016* http://www.nora.ie/_fileupload/457-X0174%20-%20BOS%20Annual%20Report%202016.pdf

In 2015 new rules[33] came into force which amend the 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%;
- proposed a specific sub-target of at least 0.5% for advanced biofuels in road and rail energy from 2021 rising to 3.6% in 2030[34];
- 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;
- 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. The renewable portion of electricity consumed by rail transport carries a 2.5 multiplier. For the calculation of the electricity from renewable energy sources consumed by electric road vehicles, that consumption is considered to be five times the energy content of the input of electricity from renewable energy sources;
- 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 2016 was 3.0%, or 5.0% when the weightings for biofuels and renewable electricity are applied in accordance with the Directive. These are down on the respective 2015 figures of 3.3% and 5.7% as a result of carry forward of certificates to meet the biofuel obligation in 2016 from previous years. 20% of the required certificates for 2016 were carried forward from 2014 and 2015 as allowed for under the Biofuel Obligation Scheme[35].

Figure 29: 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 129 ktoe (3.3% of transport energy) in 2015 but fell to 119 ktoe in 2016 (3.0% of transport energy). In 2016, all of the biodiesel used for road transport was eligible for double certificates, up from 86% in 2014.

33 http://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/land-use-change
34 COM(2016) 767 final/2 http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52016PC0767R(01)&from=EN
35 http://www.nora.ie/regulationslegislation/biofuels-obligation-scheme.152.html

Table 12: Biofuels Growth in ktoe and as a Proportion of Road and Rail Transport Energy 2005, 2010 – 2016

Fuel	2005	2010	2011	2012	2013	2014	2015	2016
Petrol (ktoe)	1,822	1,478	1,399	1,272	1,197	1,134	1,075	1,003
Diesel (ktoe)	2,378	2,236	2,221	2,224	2,368	2,519	2,733	2,951
Biofuels (ktoe)	1.1	92.6	97.8	84.9	102.2	116.2	128.1	117.9
Petrol plus Diesel	4,200	3,713	3,621	3,497	3,566	3,652	3,808	3,954
Biofuel Penetration	***0.0%***	***2.4%***	***2.6%***	***2.4%***	***2.8%***	***3.1%***	***3.3%***	***3.0%***
Weighted biofuels (ktoe)	1	93	138	141	176	194	226	206
Weighted biofuels share	***0.0%***	***2.4%***	***3.7%***	***3.9%***	***4.8%***	***5.1%***	***5.7%***	***5.0%***

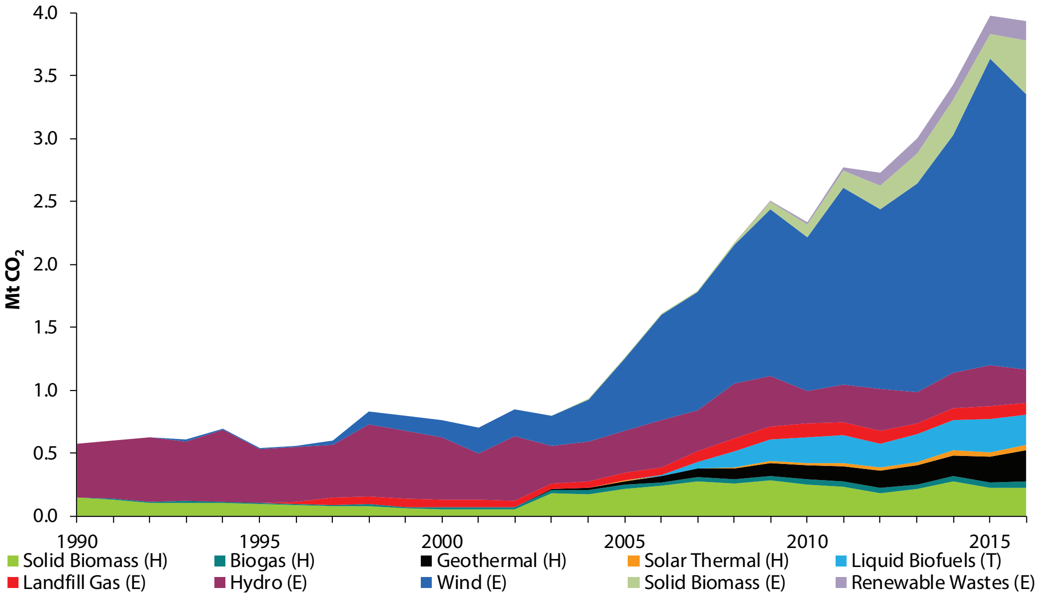
3.1.1 CO_2 Displacement and Avoided Fuel Imports

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[36,37].

Figure 30 shows the trend in avoided CO_2 emissions from renewable energy for the period 1990 – 2016. The estimated amount of CO_2 avoided from renewable energy increased by 216% over the period 2005 – 2015, reaching 3,971 kt CO_2 in 2015 as illustrated in *Figure 30* but fell to 3,932 kt CO_2 in 2016. The emissions avoided from wind were most significant again in 2016, at 2,188 kt CO_2, followed by solid biomass at 647 kt CO_2, hydro at 269 kt CO_2 and liquid biofuels used in transport at 238 kt CO_2.

In relation to the displacement of fossil fuels by renewable energy, it is estimated that in 2016 approximately €342 million in fossil fuel imports were avoided, of which €155 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 2016. 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 30: Avoided CO_2 from Renewable Energy 1990 – 2016



Approximately €342 million in fossil fuel imports were avoided by renewables in 2016.

36 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.

37 Holttinen, Hannele, et al (2014), *'Estimating the Reduction of Generating System CO_2 Emissions Resulting from Significant Wind Energy Penetration.'* 3thInternational 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.

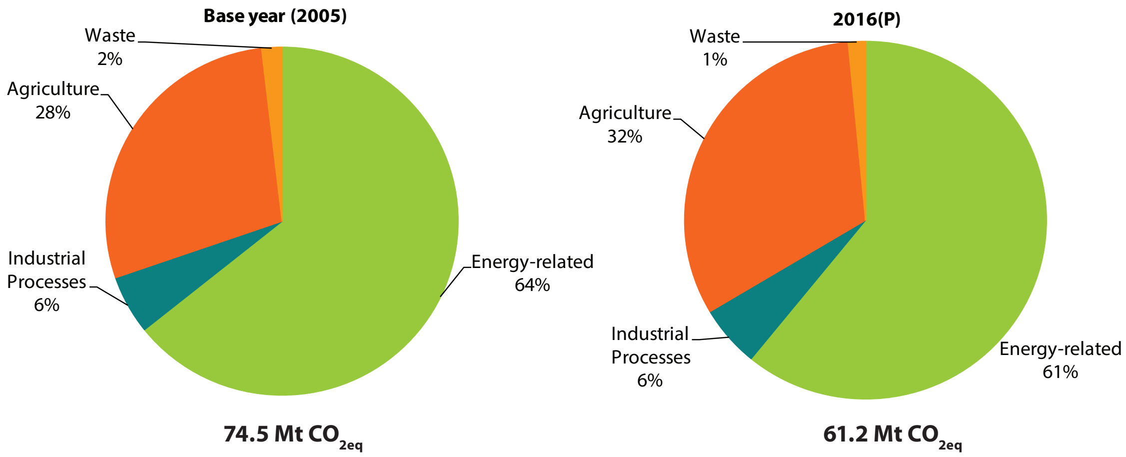
3.2 Greenhouse Gas Emissions Targets

In 2008, the EU agreed a Climate and 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:

- 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 31 shows GHG emissions by source for 2005 and provisional figures for 2016 as reported by the Environmental Protection Agency (EPA).

Figure 31: Greenhouse Gas Emissions by Source



Source: Based on EPA data

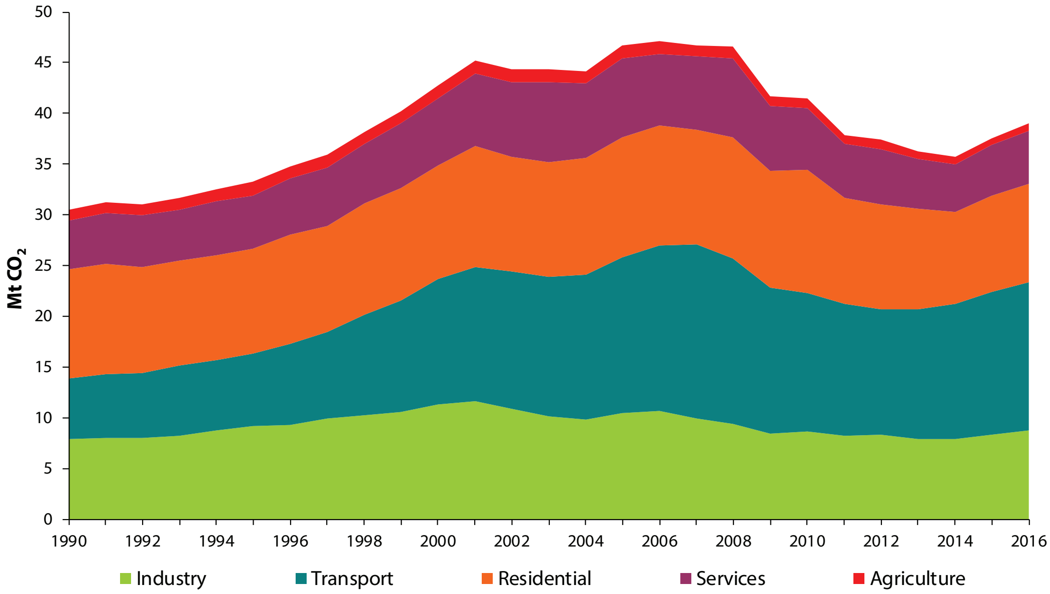
Figure 31 shows that the share of energy-related emissions in total greenhouse gas emissions have fallen since 2005. The share of GHG emissions arising from energy-related activities was 61% (37.2 Mt) in 2016 compared with 64% (44.6 Mt) in 2005. The share from agriculture increased from 28% to 32% in the same period although in absolute term it fell slightly from 19.7 Mt to 19.6 Mt.. 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 share of GHG emissions arising from energy-related activities was 61% (37.2 Mt) in 2016 compared with 64% (44.6 Mt) in 2005.
>
> Energy-related GHG emissions increased by 3.6% in 2016.

The sectoral energy-related CO_2 emissions presented in *Figure 32* 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.

The sectoral breakdown of energy-related CO_2 emissions shown represents 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 2016 were 28% higher than 1990 levels but 15.5% lower than in 2005.

Figure 32: Energy-Related CO_2 Emissions by Sector[38,39]



As shown in *Table 13* transport accounted for the largest share of energy-related CO_2 emissions, with a share of 37% in 2016, 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

	Overall Growth %		Average annual growth %			Quantity (kt)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Industry	11.0	-16.7	-1.6	0.1	5.2	10,519	8,765	22.5	22.4
Transport	141.9	-4.4	-0.4	1.3	3.9	15,293	14,620	32.7	37.4
Residential	-10.0	-18.2	-1.8	-3.7	1.6	11,843	9,690	25.3	24.8
Commercial / Public	9.7	-33.2	-3.6	-2.5	5.7	7,764	5,189	16.6	13.3
Agriculture and Fisheries	-27.8	-42.2	-4.9	-4.1	3.8	1,414	817	3.0	2.1

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

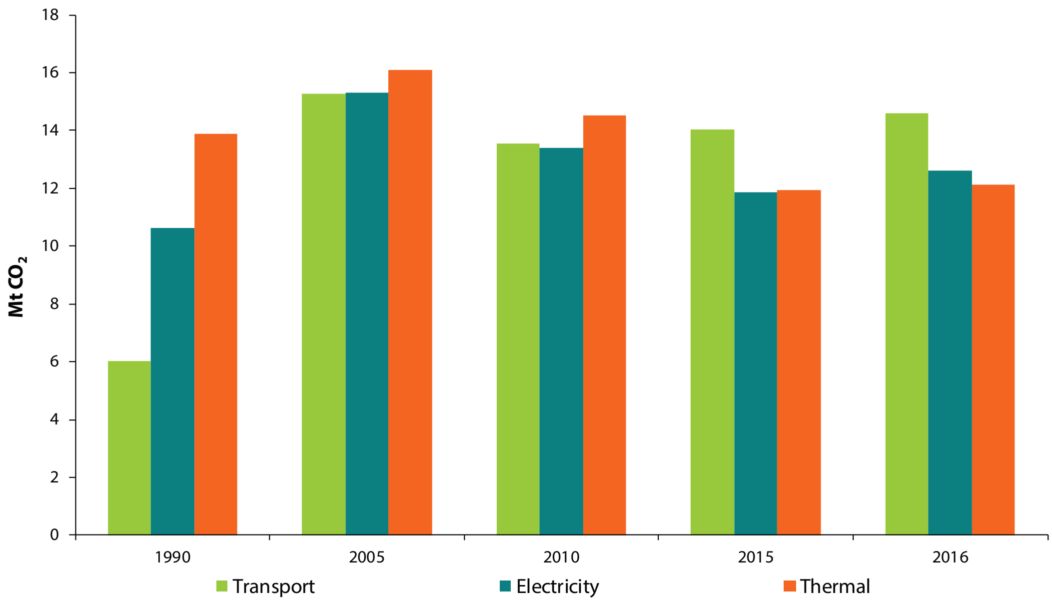
Figure 33 and *Table 14* illustrate the variations in emissions by mode of energy use. Here the emissions are allocated according to whether the energy used is for: transport; electricity; or thermal energy. These modes also represent distinct energy markets. The graph presents the emissions in the years 1990, 2005, 2010, 2015 and 2016. In 2016, the shares of energy-related CO_2 emissions from transport, electricity and thermal applications were 37.1%, 32.0% and 30.8% respectively.

Transport accounted for the largest share of energy-related CO_2 emissions, with a share of 37% in 2016, up from 33% in 2005.

38 *Figure 32* 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.

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

Figure 33: 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 39 Mt. The fastest rates of decline were observed in heat (25% decrease) followed by electricity (18% decrease) and transport (4.3% decrease).

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

	Growth %	Average annual growth %			Quantity (kt CO_2)		Shares %	
	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Transport	-4.3	-0.4	1.3	3.9	15,256	14,597	32.7	37.1
Electricity	-17.8	-1.8	-1.0	6.1	15,325	12,601	32.8	32.0
Heat	-24.6	-2.5	-2.9	1.7	16,104	12,137	34.5	30.9
Total	**-15.7**	**-1.5**	**-0.9**	**3.9**	**46,684**	**39,335**		

Source: SEAI

Given the binding target at the national level is the non-ETS[40] sectors, *Table 15 and Figure 34* show the trend in non-ETS energy-related CO_2 emissions for the transport, residential, services and agriculture[41] sectors since 1990, non-ETS industry from 2005 onwards and non-ETS transport since 2012. 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 – 2016	'05 – '16	'10 – '16	2016	2005	2016
ETS CO_2	-17.0	-1.7	-0.3	4.3	47.0	46.8
non-ETS CO_2	-16.1	-1.6	-1.6	3.4	53.0	53.2
Total Energy-Related CO_2	**-15.5**	**-1.5**	**-0.7**	**3.6**		

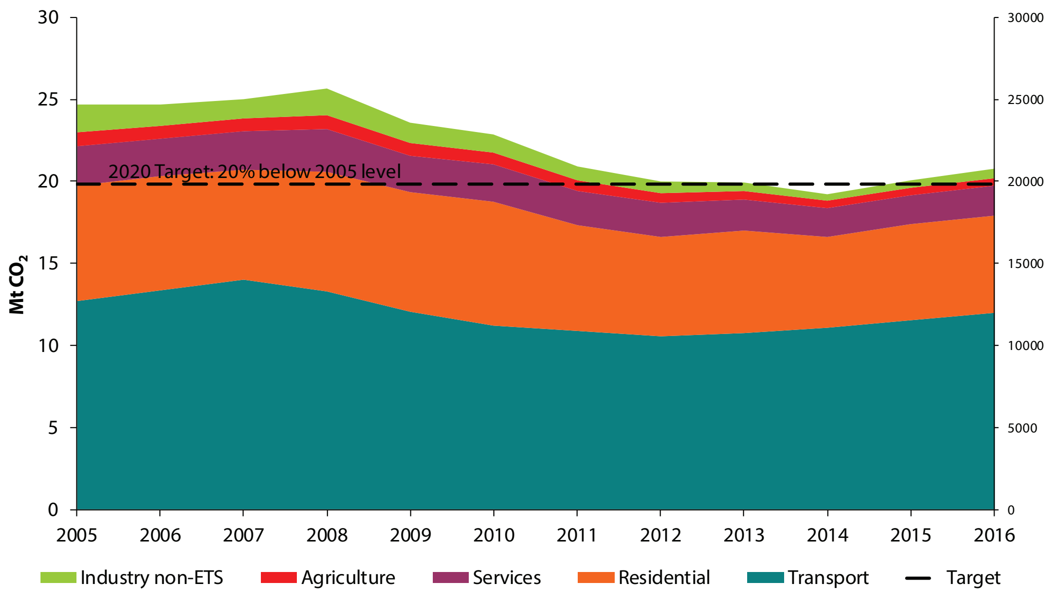
Table 15 shows non-ETS sectors' (including non-ETS industry) energy-related CO_2 emissions decreased by 1.6% per annum between 2005 and 2010, and 2.6% per annum between 2010 and 2015, with emissions increasing by 4.3% in 2015 and by 3.4% in 2016. Non-ETS energy-related CO_2 emissions were 16% below 2005 levels in 2016. 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 17% fall in energy-related emissions since 2005 and emissions increased by 4.3% in 2016 compared with the previous year. The share of emissions covered in the ETS in overall energy-related emissions stands at 53% in 2016.

40 EU Decision 406/2009/EC.

41 Agricultural energy use only.

Figure 34: Non Emissions Trading Energy-Related CO_2 (non-ETS industry and transport from 2005 onwards)[42]



3.2.1 Transboundary Gas Emissions

Emissions of sulphur dioxide (SO_2) and nitrogen oxides[43] (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 2015 as well as the 2010 ceiling limit set in the Directive.

Table 16: SO_2 and NO_x Emissions and National Emissions Ceiling Directive limits for 2010[44]

	1990 (kt)	2015 (kt)	2010 Ceiling (kt)	% above 2010 Ceiling
NO_X	140	73.5	65	13%
SO_2	183	17.6	42	-

Source: EPA

SO_2 levels in Ireland fell by 90% between 1990 and 2015. Emissions from power generation fell by 95% 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 82% in SO_2 emissions in the residential and services sectors and a 93% 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 2015 and have decreased by 40 kt, or 35% since 2008. The latest estimate is 73.5 kt in 2015, which is a decrease of 1.0% on the previous year. In 2015, NO_x emissions were 13% above the 2010 ceiling.

The transport sector, which mainly consists of road transport, is the principal source of NO_x emissions, contributing approximately 54% of the total in 2015. The industrial and power generation sectors are the other main sources of NO_x emissions, with contributions of 15% and 13% respectively in 2015. The remainder of NO_x emissions emanate from the residential/commercial and the agricultural sectors, which together produced around 18% of the total in 2015.

42 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.
43 Collective term for nitric oxide (NO) and nitrogen dioxide (NO_2)
44 See http://www.epa.ie/downloads/pubs/air/airemissions/

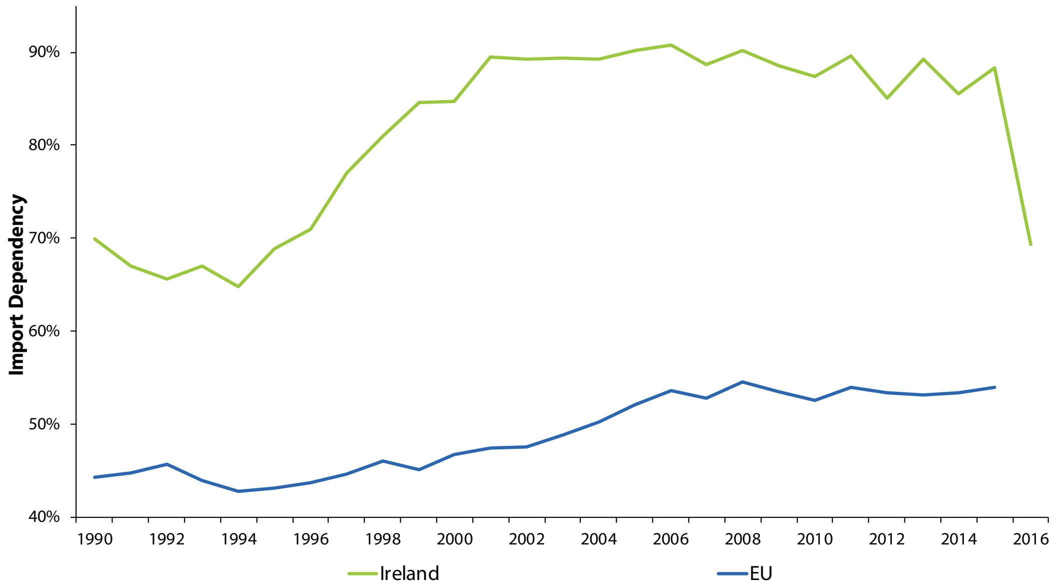
3.3 Energy Security

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[45]. *Figure 35* illustrates the trend in import dependency since 1990, comparing it with that for the EU as a whole and shows the dramatic change in Ireland's import dependency in 2016 resulting from the start of natural gas production from the Corrib gas field.

Dramatic change in Ireland's import dependency in 2016 resulting from the start of natural gas production from the Corrib gas field.

Indigenous production accounted for 32% of Ireland's energy requirements in 1990. However, since the mid-1990s import dependency had 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. Ireland's overall import dependency reached 90% in 2006. It varied between 85% and 90% until 2016 when it fell to 69%. It is estimated that in 2015 the cost of all energy imports to Ireland was approximately €4.6 billion, this fell to €3.4 billion in 2016 due mainly to reduced gas imports.

Figure 35: Import Dependency of Ireland and EU



Source: SEAI and Eurostat

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 and more recently natural gas from the Corrib field. *Figure 36* shows the indigenous energy fuel mix for Ireland over the period. The reduction in indigenous supply of natural gas (until 2016) is clearly evident from the graph as is the switch away from peat. Production of indigenous gas decreased by 94% over the period between 1990 and 2015 to 106 ktoe but then increased dramatically in 2016 to 2,473 ktoe. This is the highest natural gas production level ever recorded in Ireland. This high level of production from the Corrib field is expected to taper off significantly in the next couple of years[46].

Indigenous renewable energy production increased by 176% between 2005 and 2015 to 1,030 ktoe but fell slightly to 1,028 ktoe in 2016. This was due to reduced wind and hydro levels but balanced by an increase in biomass and geothermal.

Indigenous production of all energy in Ireland reached the highest level ever with a new peak in 2016 of 4,246 ktoe, up from the previous peak in 1995 at 4,105 ktoe.

Peat production was down since 2013 following a bumper production during that summer which provided very good harvesting conditions for peat. In 2016 peat production was down 11.7% to 679 ktoe compared with the previous year.

45 Sustainable Energy Authority of Ireland (2015), *Energy Security in Ireland*, www.seai.ie
46 https://www.gasnetworks.ie/corporate/company/our-network/GNI_NetworkDevPlan_2016.pdf

Figure 36: Indigenous Energy by Fuel[47]

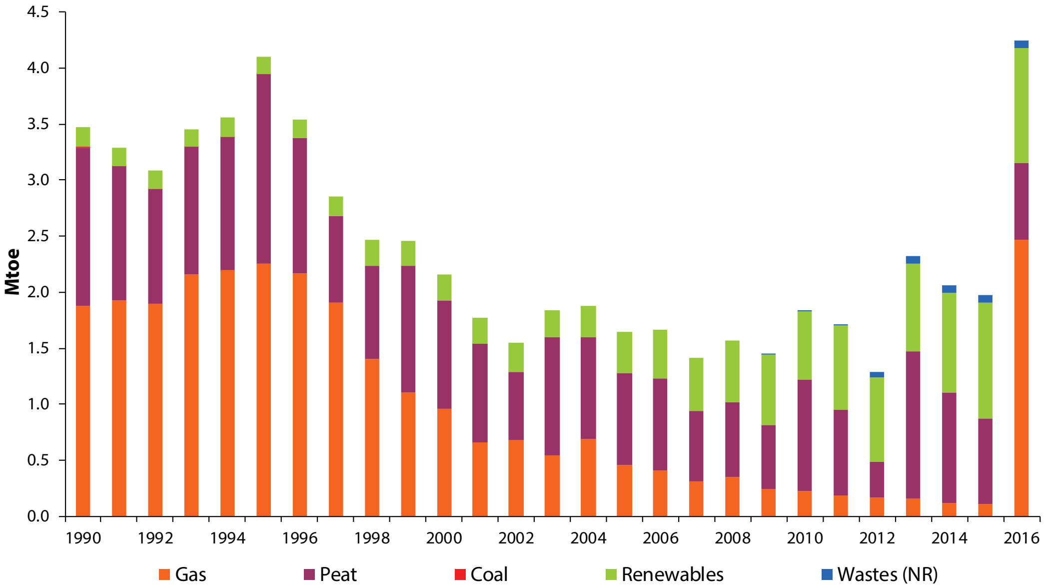


Figure 37 shows the trend for net fuel imports (imports minus exports) over the period 1990 – 2016. The growing dependence on oil, due largely to an increase in energy use in transport, is the most striking feature up until 2008. There was a 113% increase in total net imports from 1990 to 2008, with an 81% increase in net imports of oil. Between 2008 and 2016 net imports have fallen by 32% with oil imports falling 20%. In 2016 net imports fell by 18% and were 45% above 1990 levels while oil imports were also up 45% on 1990 levels.

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 1990s. The fall in gas imports in 2016 is due to new indigenous production from the Corrib gas field.

Coal imports have remained stable over the period, reflecting the base load operation of Moneypoint electricity generating plant. In 2016, oil, gas and coal accounted for 72%, 17% and 11% of net imports respectively.

Contributions to the decrease in import dependency in 2016 were:

- Natural gas imports were down 53% to 1,704 ktoe;
- Coal imports were down 22% to 1,155 ktoe;

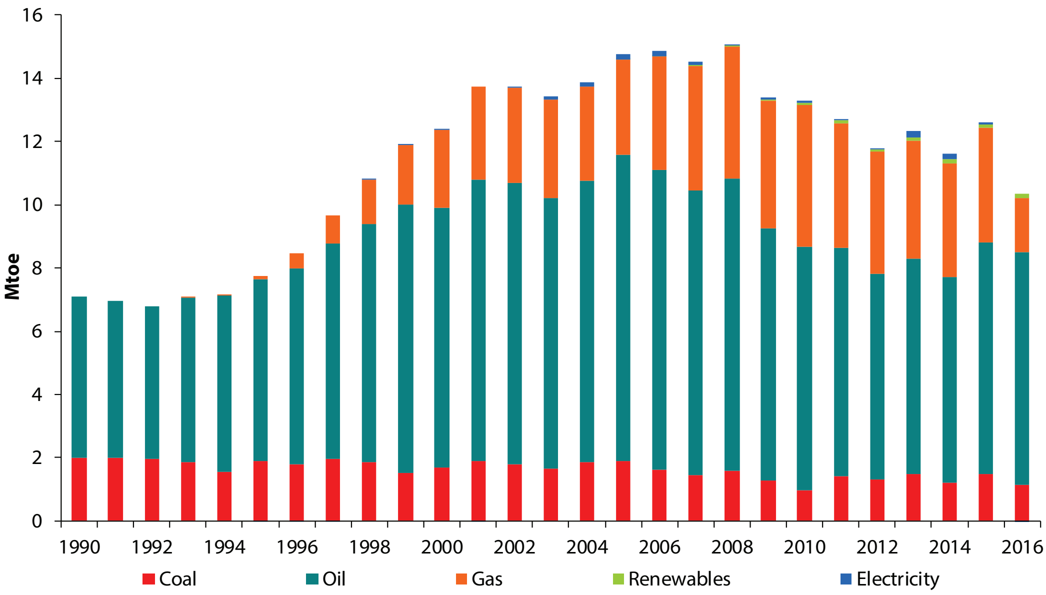
Countering these were;

- Net oil imports were up 0.5% to 7,367 ktoe;
- An 11.8% increase in renewable energy imports (biomass and biofuels) to 139 ktoe.

Indigenous production of all energy in Ireland reached the highest level ever with a new peak in 2016 of 4,246 ktoe, up from the previous peak in 1995 at 4,105 ktoe.

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

Figure 37: 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[48] in Ireland have fallen by 1.8% in real terms, compared with an average fall of 4.1% in OECD Europe and a 17% fall in the US over the same period based on data from the IEA. In 2016, overall energy prices in Ireland were 6.5% lower than in 2015, compared with a fall of 9.8% in OECD Europe and a 7.3% 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 averaged around \$44/barrel in 2016 compared to \$52/barrel on average in 2015. Up to mid-October 2017 the average crude oil price returned to \$52/barrel[49].

The price of natural gas at the UK Balancing Point[50] was on average 30% lower in 2016 compared with 2015.

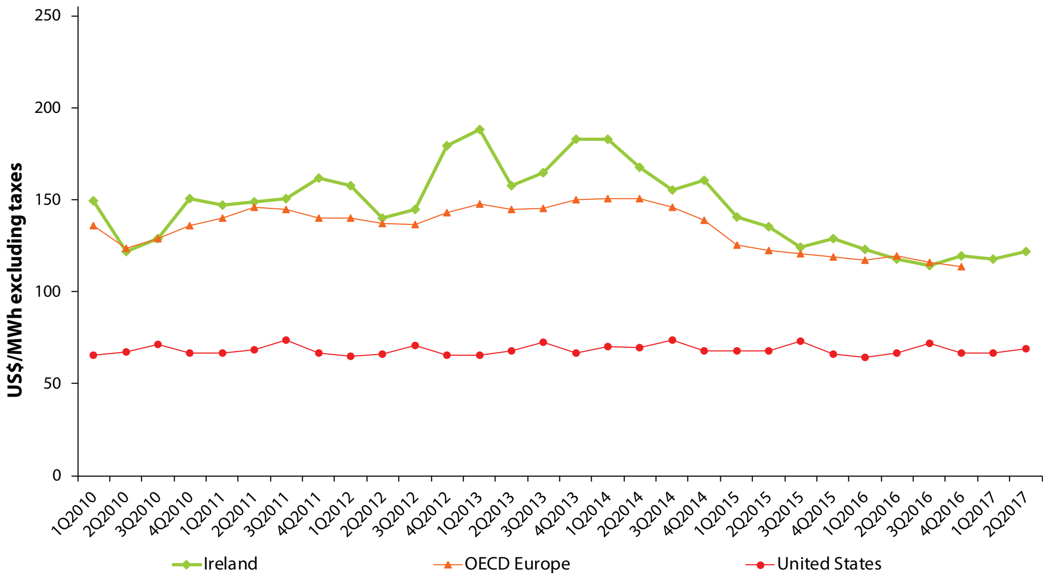
SEAI publishes biannual reports titled *Understanding Electricity and Gas Prices in Ireland*[51] based on the methodology for the revised EU Directive on the transparency of gas and electricity prices[52], which came into effect in January 2008. These reports focus specifically on gas and electricity prices using data published by Eurostat and are a useful reference on cost-competitiveness and cover both business and households.

This section focuses on business energy price. It 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 second quarter of 2017. Prices shown are US dollars and are in current (nominal) money[53]. Relative price increases since 2010, however, are tabulated for EU-15 countries and the US in index format in both nominal and real terms.

48 International Energy Agency, 2017, *Energy Prices and Taxes - 2nd Quarter 2017*, http://www.iea.org/bookshop/
49 US Energy Information Administration http://www.eia.gov
50 National Grid UK https://www.nationalgrid.com/uk/gas/market-operations-and-data/transmission-operational-data
51 Sustainable Energy Authority of Ireland (various dates), *Understanding Electricity and Gas Prices in Ireland*, www.seai.ie
52 http://europa.eu/legislation_summaries/energy/internal_energy_market/l27002_en.htm
53 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 38: Electricity Prices to Industry



Source: Energy Prices and Taxes © OECD/IEA, 2017

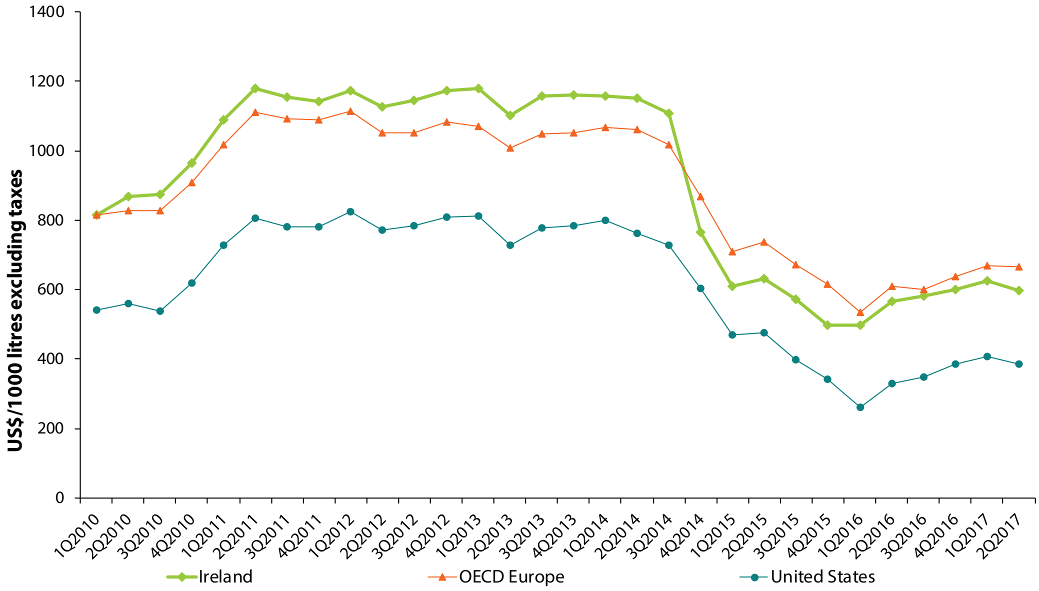
Table 17: Electricity Price to Industry Increase since 2010

Index 2010 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom	United States
2nd qtr 2017 (nominal)	111	75	113	92	95	119	124	102	**107**	115	69	90	125	98	77	126	102
2nd qtr 2017 (real)	100	70	106	84	89	115	117	105	**101**	109	66	86	124	92	74	115	95

Source: Energy Prices and Taxes © OECD/IEA, 2017

Table 17 shows that electricity prices to Irish industry increased by 1% in real terms between 2010 and 2017. 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 62%, behind Greece at 71%, Netherlands at 79% and Poland at 84%. Ireland also has a high dependency on oil and gas generation at 45%.

Figure 39: Oil Prices to Industry



Source: Energy Prices and Taxes © OECD/IEA, 2017

Table 18: Oil Price to Industry Increase since 2010

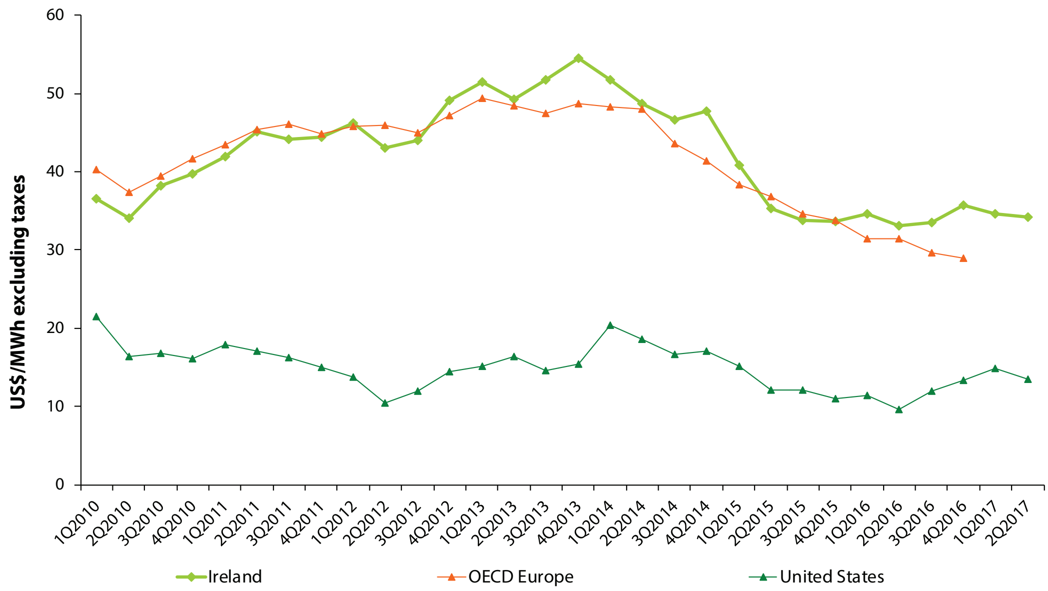
Index 2010 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom	United States
2nd qtr 2017 (nominal)	104	91	109	100	111	105	94	98	**100**	111	96	102	105	97	111	97	84
2nd qtr 2017 (real)	95	85	102	92	104	102	89	101	**94**	105	91	97	104	91	107	88	78

Source: Energy Prices and Taxes © OECD/IEA, 2017

Table 18 shows that oil prices to industry in Ireland were 6% lower in real terms in 2017 than in the year 2010. The average decrease in oil price in Europe was 5% and 22% in the US.

Crude oil prices averaged around $44/barrel in 2016 compared to $52/barrel on average in 2015. Up to mid-October 2017 the average crude oil price returned to $52/barrel.

Figure 40: Natural Gas Prices to Industry[54]



Source: Energy Prices and Taxes © OECD/IEA, 2017

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
2nd qtr 2017 (nominal)	98	138	103	83	150	98	78	80	**111**	97	90	93	93	95		101	76
2nd qtr 2017 (real)	87	130	97		141	95	74	82	**105**	92	86	89	92	89		92	71

Source: Energy Prices and Taxes © OECD/IEA, 2017

With reference to *Figure 40*, natural gas prices to Irish industry increased from the second quarter 2010 until the end of 2013. Price has been relatively stable since the middle of 2015. In the second quarter of 2017 the price of gas to industry in Ireland was 5% above 2010 levels in real terms. *Figure 40* also shows the gap between gas prices in Europe and the US.

Figure 41 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 2017 increased by 0.6%, compared with a fall of 2.5% for OECD Europe and 15% for the US. This should be considered in the context of the weighting of energy in the cost base of Irish industry[55].

The price of natural gas at the UK Balancing Point was on average 30% lower in 2016 compared with 2015.

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

55 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 41: Real Energy Price Change to Industry since 2010 in EU-15 (index)

Source: Energy Prices and Taxes © OECD/IEA, 2017

Between 2010 and 2017, energy prices for industry in Ireland decreased by 0.5% in real terms. In OECD Europe the decrease was 2.5% while in the US energy prices fell by 15% over the same period.

2016 was also a period of stable global oil and gas prices with oil price averaging around $43/barrel. That said, overall energy prices to industry in Ireland were 8% lower than 2015. In OECD Europe prices fell by 5% and by 9% in the US.

Overall energy price to Irish industry between 2010 and 2017 increased by 0.6%, compared with a fall of 2.5% for OECD Europe and 15% for the US.

4 Sectoral Trends and Indicators

This section explores the changes in energy trends that are taking place at a sectoral level. These 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

Trends in 2016

In 2016, energy use in industry was 2.4 Mtoe and was 3.0% higher than in 2015. The economic activity of industry increased in 2016 by 2.7%. The main trends in energy use in industry were:

- In 2016 consumption of coal, oil, gas and electricity increased.
- Oil use increased by 4.3% to 484 ktoe and accounted for approximately one fifth (19.8%) of industry's energy use.
- Coal use increased by 3.7% to 110 ktoe and accounted for 4.5% of the energy share of industry.
- Natural gas consumption in industry increased by 3.9% in 2016 to 762 ktoe and accounted for 31% of industry's final energy demand.
- Electricity consumption in industry increased by 3% to 872 ktoe and accounted for 36% of final energy consumption in industry.
- Renewable energy use in industry fell by 2.9% in 2016 and accounted for 7.1% of industry's energy use.
- The use of wastes (non-renewable) in industry also decreased in 2016, falling by 5.2% to 42 ktoe but only accounted for 1.7% of energy use in industry.

Trends 2005 – 2016

Final energy use in industry grew by 42% to 2,445 ktoe over the period 2005 – 2016. 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 11.7%. In 2016 it increased by 1.6%.

Figure 42 shows that over the period 1990 – 2016 only electricity, natural gas and renewables have increased their share. Since 2009 non-renewable wastes have been used in industry, but in 2016 accounted for just 1.7% of industry's energy use. The share of electricity has risen from 22% to 36%, natural gas from 21% to 31% and renewables from 3.7% to 7.1% (see *Table 20*). 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 42: Industry Final Energy Use by Fuel

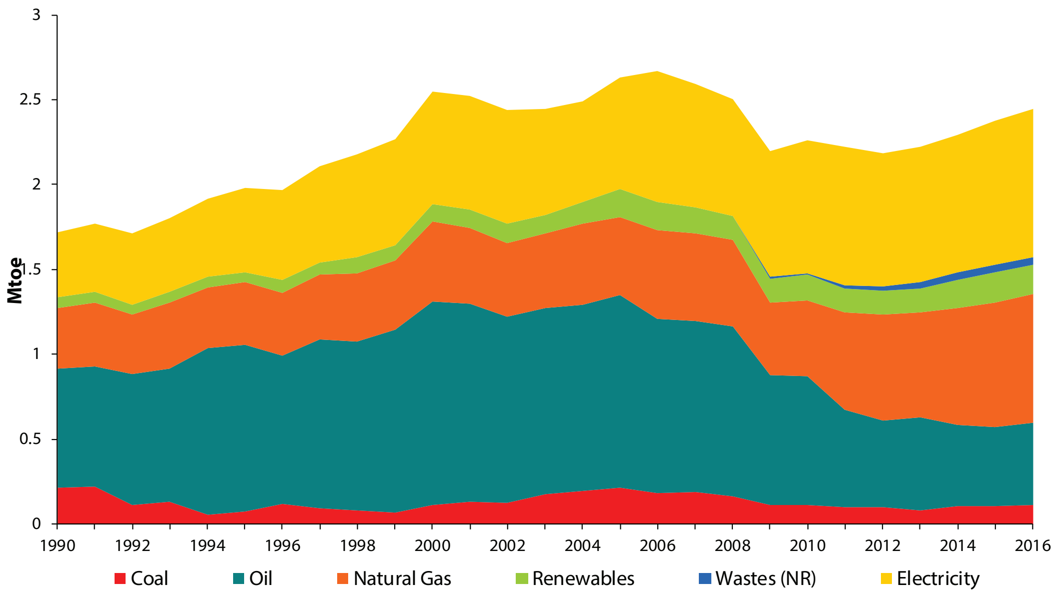


Table 20 shows the growth rates, quantities and relative shares of energy in industry.

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

	Overall Growth %		Average annual growth %			Quantity (ktoe)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Fossil Fuels (Total)	6.9	-25.0	-2.6	0.5	4.0	1,810	1,358	68.7	55.5
Coal	-49.0	-48.0	-5.8	-0.4	3.7	212	110	8.0	4.5
Oil	-30.4	-57.4	-7.5	-7.2	4.3	1,136	484	43.2	19.8
Gas	112.7	65.2	4.7	9.3	3.9	462	762	17.5	31.2
Renewables	175.1	6.1	0.5	2.2	-2.9	163	173	6.2	7.1
Wastes (Non-Renewable)	-	-	-	30.2	-5.2	-	42	0.0	1.7
Combustible Fuels (Total)	17.9	-20.3	-2.0	1.0	2.9	1,973	1,573	74.9	64.3
Electricity	126.2	32.2	2.6	1.8	3.0	660	872	25.1	35.7
Total	**42.2**	**-7.1**	**-0.7**	**1.3**	**3.0**	**2,633**	**2,445**		

Direct use of fossil fuels accounted for 56% of energy use in industry in 2016 and grew by 4.0% in 2016 or 6.9% over the period 1990 – 2016. So, while coal and oil consumption in industry has fallen over the period by 49% and 30% respectively overall fossil fuel use has grown due to the 113% increase in natural gas use. This change in fuel mix resulted in lower emissions from fuel use in industry.

Energy use in industry was 3% higher in 2016 than in 2015 while the economic activity of industry increased by 2.7%.

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 43* 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 43: Industry Energy-Related CO_2 Emissions by Fuel

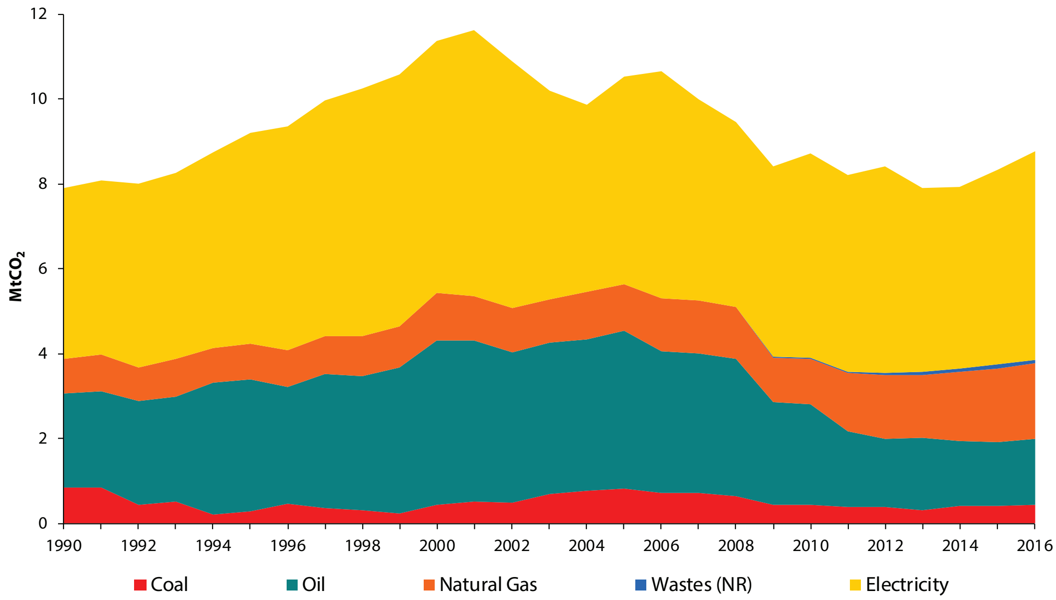


Table 21 shows the growth rates, quantities and relative shares of energy-related CO_2 emissions in industry.

As detailed in *Table 21*, industrial energy-related CO_2 emissions increased by 5.2% in 2016 to 8.8 Mt CO_2. Electricity consumption was responsible for 56% of industry's energy-related emissions in 2016.

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

	Overall Growth %		Average annual growth %			Quantity (kt)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Coal	-49.0	-48.0	-5.8	-0.4	3.6	838	436	8.0	5.0
Oil Total	-29.2	-58.0	-7.6	-6.8	4.4	3,706	1,556	35.2	17.8
Kerosene	436.3	-27.2	-2.8	-3.5	5.2	372	271	3.5	3.1
Fuel Oil	-91.8	-92.7	-21.2	-30.7	-15.4	1,502	110	14.3	1.3
LPG	83.5	10.0	0.9	1.7	7.1	275	302	2.6	3.4
Gas Oil	-23.9	-43.3	-5.0	-5.4	5.0	609	345	5.8	3.9
Petroleum Coke	185.7	-44.1	-5.2	10.8	7.1	944	528	9.0	6.0
Natural Gas	116.3	62.4	4.5	8.9	1.9	1,098	1,783	10.4	20.3
Wastes (Non-Renewable)	-	-	-	31.9	-5.2	-	88	0.0	1.0
Total Combustible Fuels	-0.3	-31.5	-3.4	-0.2	2.9	5,644	3,867	53.6	44.1
Electricity	21.8	0.4	0.0	0.2	7.0	4,876	4,897	46.4	55.9
Overall Total	**11.0**	**-16.7**	**-1.6**	**0.1**	**5.2**	**10,519**	**8,765**		

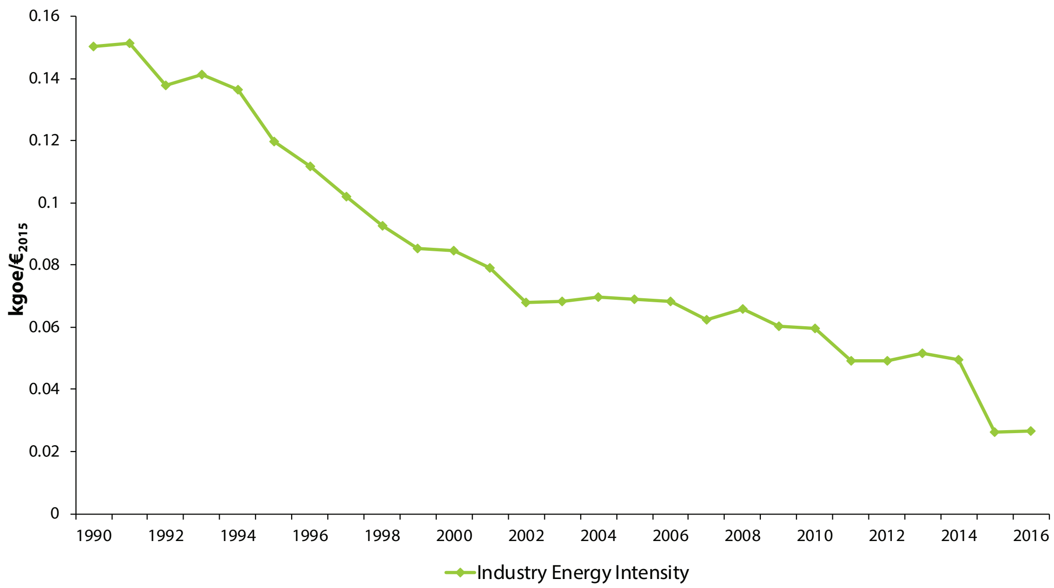
Energy-related CO_2 Emissions – excluding emissions associated with electricity

If upstream electricity-related emissions are omitted then there was a 2.9% increase in CO_2 emissions from combustible fuels used on site in industry in 2016. This is as a result of changes in the volume and fuel mix used in industry, with increased coal (+3.7%), kerosene (+5.2%), LPG (+7.1%), gasoil (+5.0%), petroleum coke (+7.2%) and natural gas (+1.9%) countered by reduced fuel oil (-15.4%) and wastes (-5.2%).

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 44* shows the industrial energy intensity between 1990 and 2016 expressed in kilograms of oil equivalent per euro of industrial value added (kgoe/$€_{2015}$) at 2015 money value. Over the period, industrial energy consumption increased by 42% while value added increased by 707%, resulting in a reduction in intensity of 82%. In other words to generate a euro of value added in 2016, it took less than one fifth of the amount of energy it took in 1990.

Figure 44: Industry Energy Intensity



Value-added output from industry grew by 94% in 2015 relative to 2014. The large increase in Gross Value Added (GVA) in 2015 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

Trends in 2016

In 2016, overall energy use in transport increased by 3.4% compared with the previous year.

- Petrol and biofuels both experienced reductions in 2016, with petrol reducing by 6.7% to 1,003 ktoe and biofuels by 8% to 118 ktoe. Petrol consumption is now back at levels last seen in 1991/'92.
- Diesel consumption grew by 8.2% during 2016, to 2,951 ktoe, and was the most dominant fuel used, accounting for 60% of all energy use in transport.

Trends 2005 – 2016

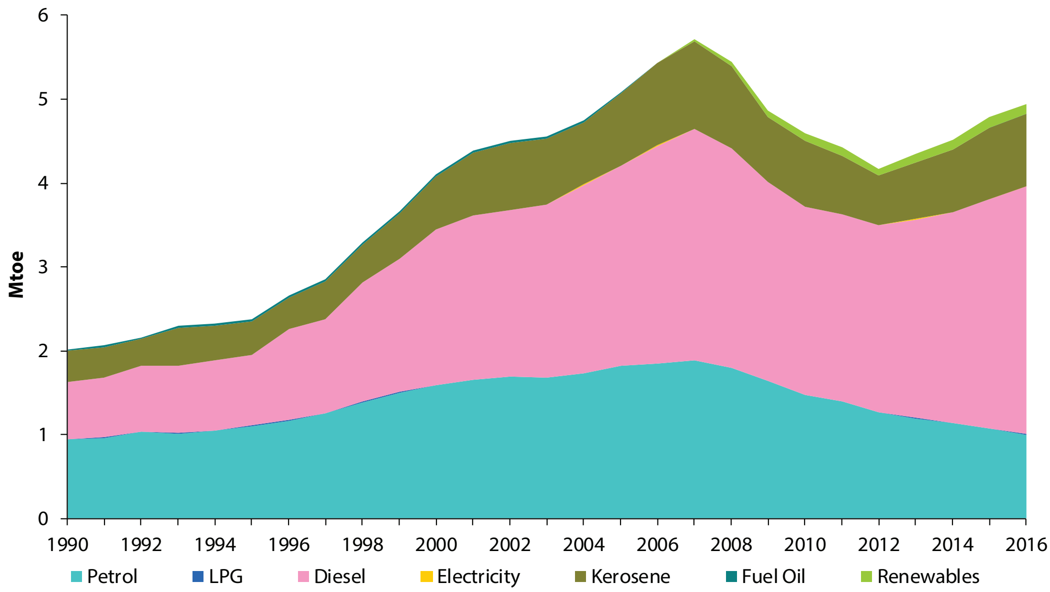
Over the period 1990 – 2016, the biggest shift in the transport market has been from petrol to diesel. While consumption of both fuels increased, consumption of diesel increased by 338% while petrol is now just 6.4% higher than in 1990. Diesel's overall market share grew from 33% in 1990, to 47% in 2005 and up to 60% in 2016.

> As the economy started to expand again transport energy use has grown every year since 2013 and in 2016 was 19% higher than in 2012.

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 has grown every year since 2013 and in 2016 was 19% higher than in 2012. Energy consumption in transport was 2.7% lower in 2016 than in 2005.

As shown in *Figure 45* transport energy in 2016 was 13% below the peak in 2007.

Figure 45: Transport Final Energy Use by Fuel[56]



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

56 This is based on data of fuel sales in Ireland rather than fuels consumed in Ireland. The effect of cross border trade (fuel tourism) 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

	Overall Growth %		Average annual growth %			Quantity (ktoe)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Fossil Fuels (Total)	139.2	-4.9	-0.5	1.2	3.8	5,076	4,825	99.9	97.5
Total Oil	139.2	-4.9	-0.5	1.2	3.8	5,076	4,825	99.9	97.5
Petrol	6.4	-45.0	-5.3	-6.3	-6.7	1,822	1,003	35.8	20.3
Diesel	337.6	24.1	2.0	4.7	8.2	2,378	2,951	46.8	59.7
Jet Kerosene	132.2	1.3	0.1	1.7	2.6	857	868	16.9	17.6
LPG	-63.3	150.2	8.7	30.6	0.7	1	3	0.0	0.1
Natural Gas	-	-	-	-	1.0	-	0.01	0.0	0.000
Renewables	-	-	53.0	4.1	-8.0	1	118	0.0	2.4
Combustible Fuels (Total)	145.0	-2.6	-0.2	1.2	3.4	5,077	4,943	99.9	99.9
Electricity	203.7	-17.5	-1.7	1.1	11.8	5	4	0.1	0.1
Total	**145.1**	**-2.7**	**-0.2**	**1.2**	**3.4**	**5,082**	**4,947**		

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 the 2007 peak 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 2016, by 3.9% to 14.6 $MtCO_2$ and were 142% above 1990 levels but 4.4% below 2005.

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

	Growth %		Average annual growth %			Quantity (kt)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Total Oil Products	142.1	-4.3	-0.4	1.3	3.9	15,256	14,597	99.8	99.8
Petrol	6.4	-45.0	-5.3	-6.3	-6.7	5,337	2,937	34.9	20.1
Diesel	337.6	24.1	2.0	4.7	8.2	7,299	9,057	47.7	61.9
Jet Kerosene	132.2	1.3	0.1	1.7	2.6	2,562	2,595	16.8	17.8
LPG	-63.3	150.2	8.7	30.6	0.7	3	7	0.0	0.0
Electricity	63.6	-37.3	-4.2	-0.5	16.1	37	23	0.2	0.2
Total	**141.9**	**-4.4**	**-0.4**	**1.3**	**3.9**	**15,293**	**14,620**		

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*[57] 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 46* and detailed in *Table 24*. In 2014, a new category of Light Goods Vehicle (LGV) was added. This has been made possible on the basis of the analysis of the fuel efficiency of LGVs and an 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 2016

Energy consumption by heavy goods vehicles (HGVs) increased by 17.4% in 2016 while conversely consumption by LGVs fell by 3.7%. Overall energy use by goods vehicles in total increased by 10.1% in 2016.

Private car energy consumption fell by 1.3% in 2016 to 2,146 ktoe and accounted for 43% of transport energy use. Petrol consumption by private cars fell by 12.2% in 2016 to 833 ktoe while diesel consumption increased by 8.1% to 1,245 ktoe and biofuels fell by 7.5% to 64 ktoe.

Aviation energy consumption grew by 2.6% in 2016 to 869 ktoe.

57 Sustainable Energy Authority of Ireland (2014), *Energy in Transport – 2014 Report*, https://www.seai.ie/resources/publications/

Table 24: Growth Rates, Quantities and Shares of Transport Final Energy Demand by Mode, 1990 – 2016

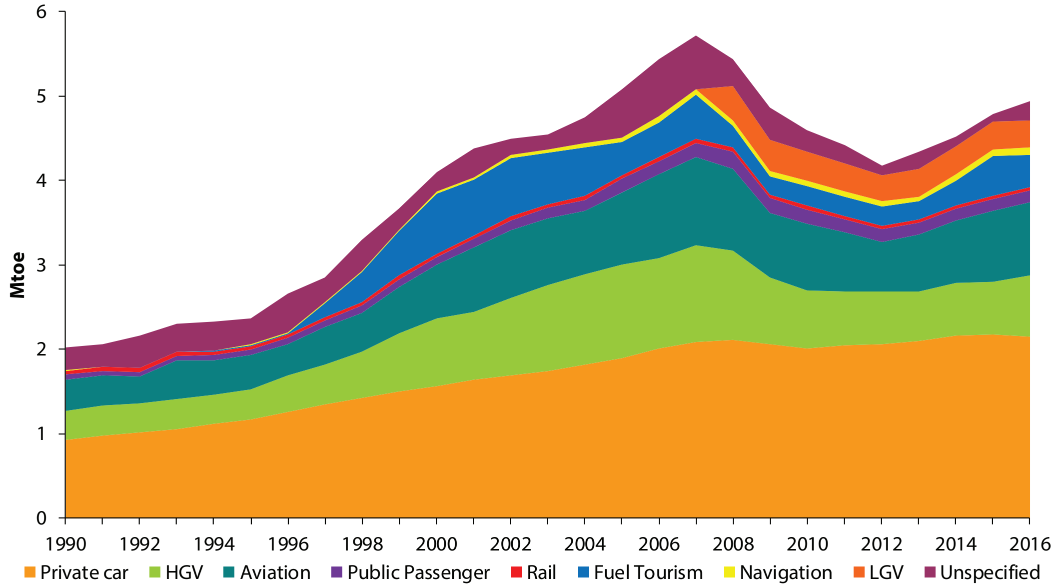
	Overall Growth %		Average annual growth %			Quantity (ktoe)		Shares %	
Mode	**1990 - '16**	**2005 - '16**	**'05 – '16**	**'10 – '16**	**2016**	**2005**	**2016**	**2005**	**2016**
Road Freight	112.5	-33.9	-3.7	1.1	17.4	1,112	735	21.9	14.9
Light Goods Vehicle (LGV)	-	-	-	-1.5	-3.7	-	318	-	6.4
Private Car	131.7	13.4	1.2	1.0	-1.3	1,893	2,146	37.2	43.4
Public Passenger (road)	156.4	-14.6	-1.4	-3.2	-0.5	157	135	3.1	2.7
Rail	-10.0	-10.2	-1.0	-1.3	2.5	45	40	0.9	0.8
Aviation	131.8	1.2	0.1	1.6	2.6	859	869	16.9	17.6
Fuel Tourism	-	-0.9	-0.1	9.0	-18.8	387	384	7.6	7.8
Navigation	1086.6	72.8	5.1	4.9	20.2	50	86	1.0	1.7
Unspecified	-12.4	-59.6	-7.9	-1.5	173.1	580	234	11	4.7
Total	**145.1**	**-2.7**	**-0.2**	**1.2**	**3.5**	**5,082**	**4,947**		

Road transport accounted for 67% of transport TFC in 2016 (80% if unspecified and fuel tourism are included as road transport). Private car use accounted for almost two thirds (64%) of road transport with goods vehicles accounting for almost another third (32%) and public passenger services the rest (4%).

Aviation was responsible for 18% of transport TFC in 2016 and rail transport just under 1%. Public passenger (road) consumption decreased by 0.5% in 2016.

Combined petrol and diesel fuel tourism is also included in *Figure 46*. 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 46: Transport Energy Demand by Mode 1990 – 2016



Trends 2005 – 2016

Figure 46 clearly shows the growth in transport energy consumption prior to the economic downturn after 2007, the fall in consumption during the recession and the recovery in energy consumption growth from 2013 onwards as the economy starts to grow again.

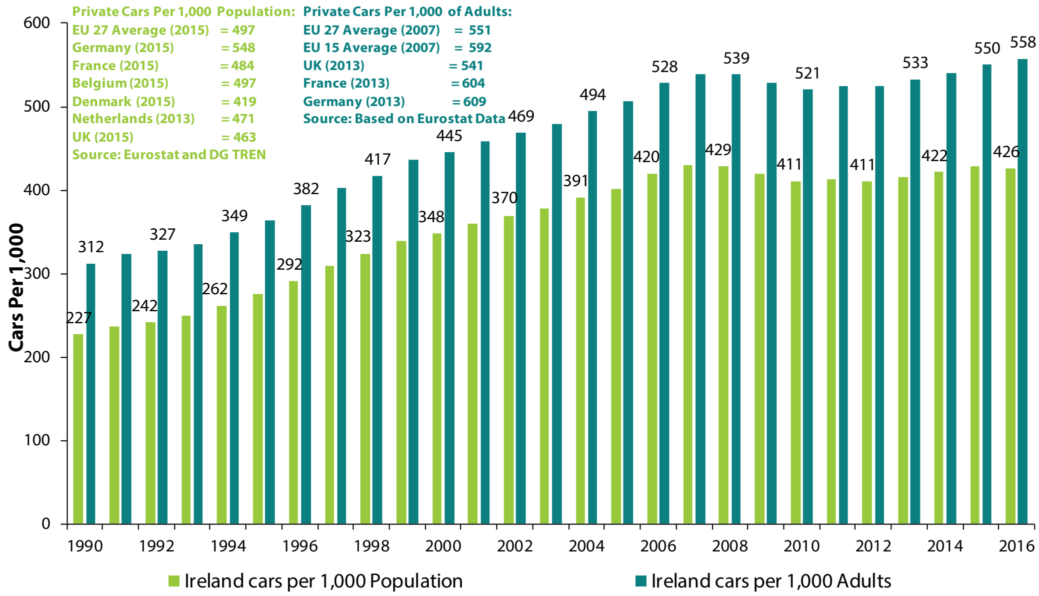
HGV road freight in particular has been affected by both the economic boom and the recession, experiencing both the greatest increase in the period 1990 – 2007 (231%, from 346 to 1,145 ktoe) and the greatest contraction in the period 2007 – 2013 (49%, from 1,145 to 621 ktoe). The energy consumption of HGVs increased by 27% between 2013 and 2016 and in 2016 HGV energy consumption increased by 17.4% to 735 ktoe but was still 34% below the 2005 level.

Over the period, private car energy consumption increased by 132% to 2,146 ktoe and accounted for 43% of transport energy in 2016. Aviation energy use increased by 132% over the period to 869 ktoe and accounts for 17.6% of transport energy.

4.2.2 Private Car Transport

In 2015, the number of vehicles on Irish roads was 2.6 million (2,624,958), 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 2016 the number of licensed private cars on the road increased by 2.1% to a new peak of 2,026,977, exceeding the 2008 numbers by 5.4%.

Figure 47: Private Cars per 1,000 of Population



Source: Based on Vehicle Registration Unit and CSO data

The car density in 2016 (as shown in *Figure 47*) was 426 cars per 1,000 of population, down slightly on the 2015 figure of 428. This is compared to an EU-27 average of 497 in 2015 and a UK average of 463 also in 2015.

4.2.3 CO_2 Emissions of New Private Cars

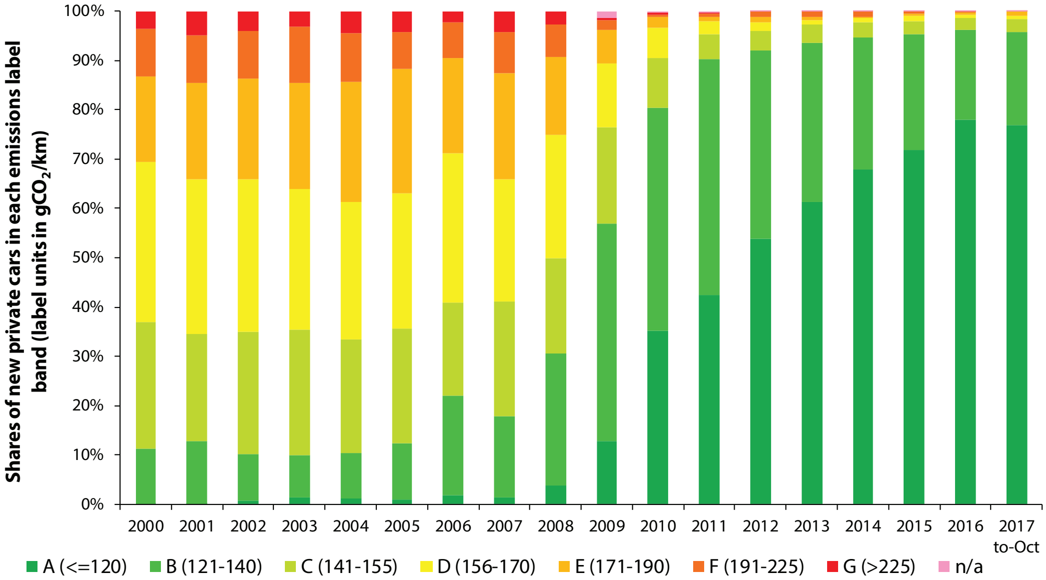
All new cars have associated fuel consumption and CO_2 emissions figures measured under test conditions and are licensed according to CO_2 emissions bands. *Figure 48* and *Table 25* show the shares of new car sales[58] between 2000 and October 2017 classified by emissions label band. The combined effect 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. Between 2000 and 2005 the share of cars in the A label band (i.e. <120 g CO_2/km) was on average less than 1%. In 2016, 78% of new cars purchased in Ireland were in the A category.

In 2016 the share of A and B label band cars was 96.2% and for the first ten months of 2017 it was down slightly to 95.7%. While the share of B label cars continued to increase in 2017 the share of A label cars fell slightly (see *Table 25*).

> The share of private cars in the A label emissions band rose from just 1.5% in 2007 to 78% of the new private cars sold in 2016.

58 Licensed as private cars.

Figure 48: Shares of New Private Cars in each Emissions Band 2000 – 2016 (+2017 to October)



Source: Based on Vehicle Registration Unit data

The largest increase in share was in the A label band, which rose from just 1.5% in 2007 to 78% of the new private cars sold in 2016. Data for 2017 (up to October) show that this trend has abated a little with vehicles in the A label band making up 76.8% 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 less than 1% of new cars sold during 2016 and the first ten months of 2017, in the latter case just 1,035 cars out of a total of 124,850.

Table 25: Shares of New Private Cars in each Emissions Band, 2000, 2005, 2010 – 2016 (+2017 to October)

CO_2 band	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017 to October
A	0.0%	0.9%	35.1%	42.5%	53.8%	61.3%	67.8%	71.8%	78.0%	76.8%
B	11.3%	11.4%	45.2%	47.8%	38.2%	32.2%	26.8%	23.5%	18.2%	18.9%
C	25.6%	23.2%	10.1%	5.0%	4.0%	3.7%	3.0%	2.6%	2.5%	2.7%
D	32.4%	27.6%	6.2%	2.6%	1.9%	0.9%	0.8%	1.0%	0.6%	0.7%
E	17.5%	25.1%	2.0%	1.0%	1.0%	0.8%	0.4%	0.6%	0.5%	0.7%
F	9.5%	7.5%	0.6%	0.6%	1.0%	1.0%	0.9%	0.4%	0.3%	0.1%
G	3.7%	4.2%	0.3%	0.2%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%

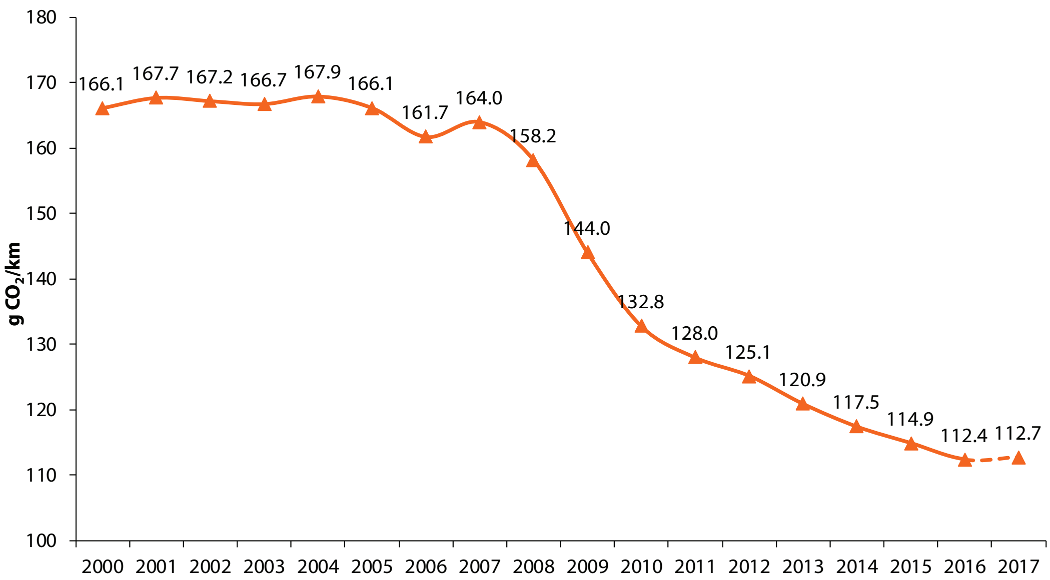
Source: Based on Vehicle Registration Unit data

Figure 49 shows the change in the weighted average specific CO_2 emissions of new cars between 2000 and 2016, with an estimate for 2017. Through the combined effects of the taxation change introduced in July 2008 and the obligation on manufacturers to reduce overall fleet emissions, the average emissions of the new car fleet has fallen, reaching 112.4 g CO_2/km in 2016 which is within band A4. This was 32% below the level in 2007. It is estimated that the average emissions of new cars purchased in 2017 has increased slightly to 112.7 g CO_2/km.

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[59].

59 For more information see www.theicct.org.

Figure 49: Specific CO_2 Emissions of New Cars, 2000 – 2016 (2017 estimated)

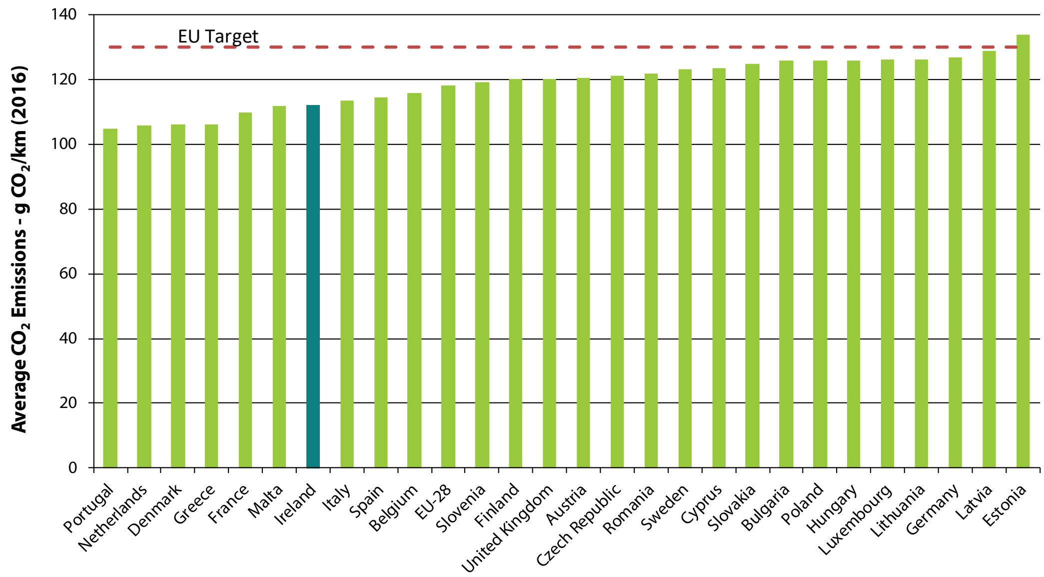


Source: Based on Vehicle Registration Unit and VCA data

Figure 50 shows the position of Ireland in relation to other EU Member States in terms of new car emissions. In 2016, the average CO_2 emissions from new cars in Ireland were 5.2% below the EU average and ranked seventh lowest out of the 28 countries. EU Regulation 443/2009/EC set a target for all passenger cars to have average emissions below 130 g CO_2/km by 2015. All EU member states were below this in 2016 with the exception of Estonia at 133.9 g CO_2/km.

From 2020, EU Regulation 333/2014 sets a target of 95 g CO_2/km for the average emissions of the new car fleet.

Figure 50: Specific CO_2 Emissions of New Cars: International Comparison – 2016[60]



Source: European Environment Agency

In 2016, 53% of the stock of private cars had been purchased in 2008 or later.

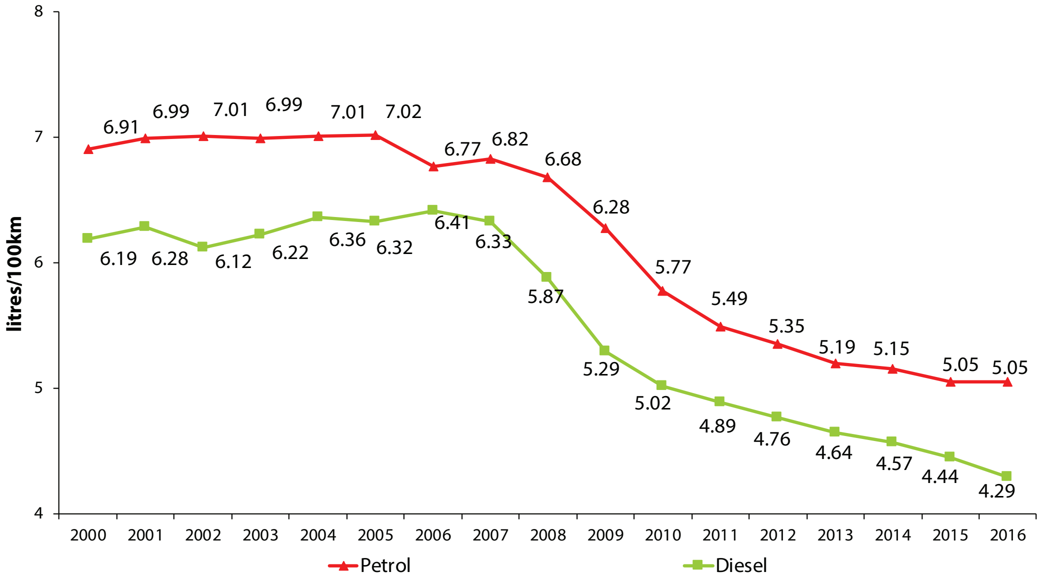
60 European Environment Agency (2014), *Monitoring CO_2 emissions from passenger cars and vans in 2013*, http://www.eea.europa.eu//publications/monitoring-co2-emissions-from-passenger

4.2.4 Energy Efficiency of New Private Cars

All new cars have associated fuel consumption figures[61] (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 – 2016 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 51* .

Figure 51: Weighted Average Test Specific Fuel Consumption of New Cars 2000 – 2016



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 33% improvement in the average fuel efficiency of new diesel cars, to 4.29 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*[62] 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 5.4% (0.3% per annum on average) over the period 2000 – 2016. Petrol car annual mileage fell by 20% (1.4% per annum) while diesel car average mileage fell by 11.7% (0.8% 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. Also the fall in the average diesel mileage reflects the growing share of diesel cars many of which are replacing lower annual mileage petrol cars.

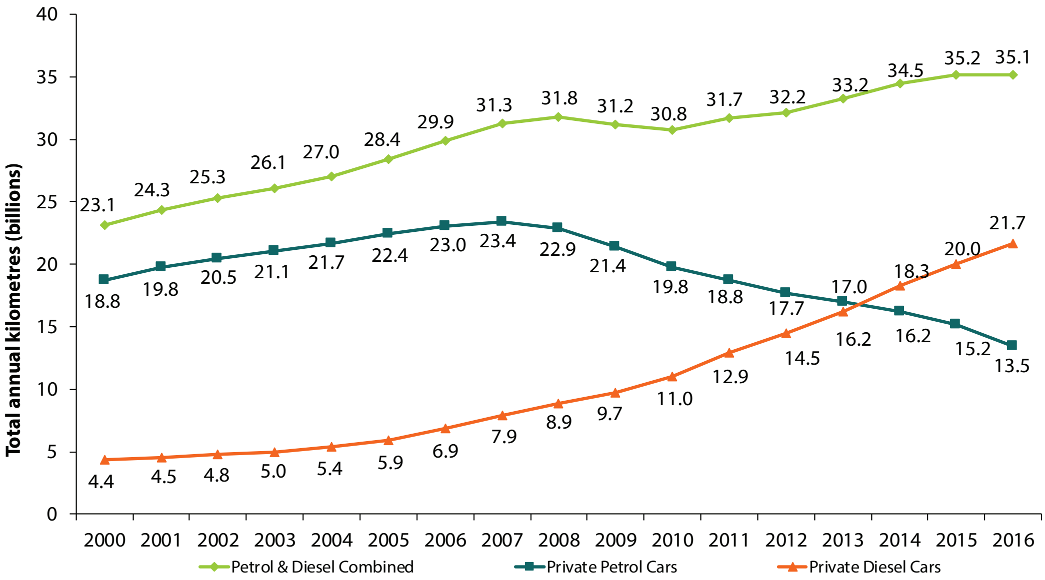
Figure 52 shows the total kilometres driven by private cars in Ireland each year from 2000 to 2016, based on an analysis of NCT data. Overall, the total number of kilometres travelled has increased which in turn has led to increased private car fuel consumption, as detailed in *Section 4.2.1*. Total mileage by all private cars increased by 52% over the period 2000 – 2016. Total mileage of private cars fell slightly (-0.1%) in 2016 compared with 2015.

61 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

62 Sustainable Energy Ireland (2014), *Energy in Transport – 2014 Report*, https://www.seai.ie/resources/publications/ for latest transport report

Overall travel in petrol cars has been falling since 2007, reducing by 42% between 2007 and 2016, while travel by diesel cars increased by 174% 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 2016, petrol accounted for 38% and diesel for 62%. Between 2000 and 2016 the total mileage by petrol cars fell by 28% while total mileage for diesel cars increased by 394%. 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.[63]

Figure 52: Total Private Car Annual Mileage 2000 – 2016



Source: Based on NCT Data

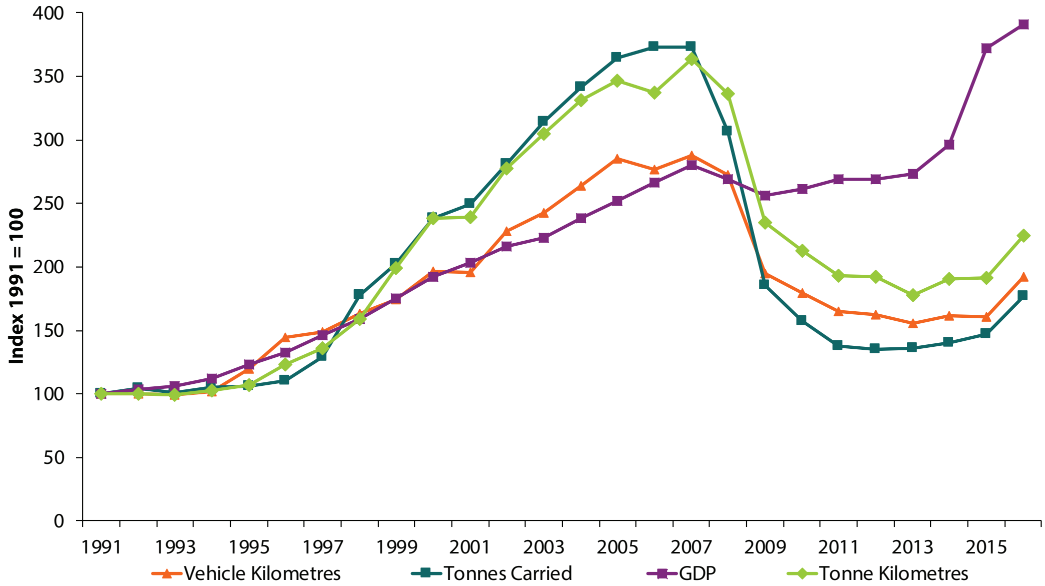
4.2.6 Heavy Goods Vehicle Activity

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 – 2013. 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 53* 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 2016 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.

> Since 2006 there has been a 33% improvement in the average fuel efficiency of new diesel cars, to 4.29 litres/100 km and a 25% improvement in petrol cars, to 5.05 litres/100km.

63 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 53: Road Freight Activity 1991 – 2016



Source: CSO

Table 26: Road Freight Activity 1991 – 2016

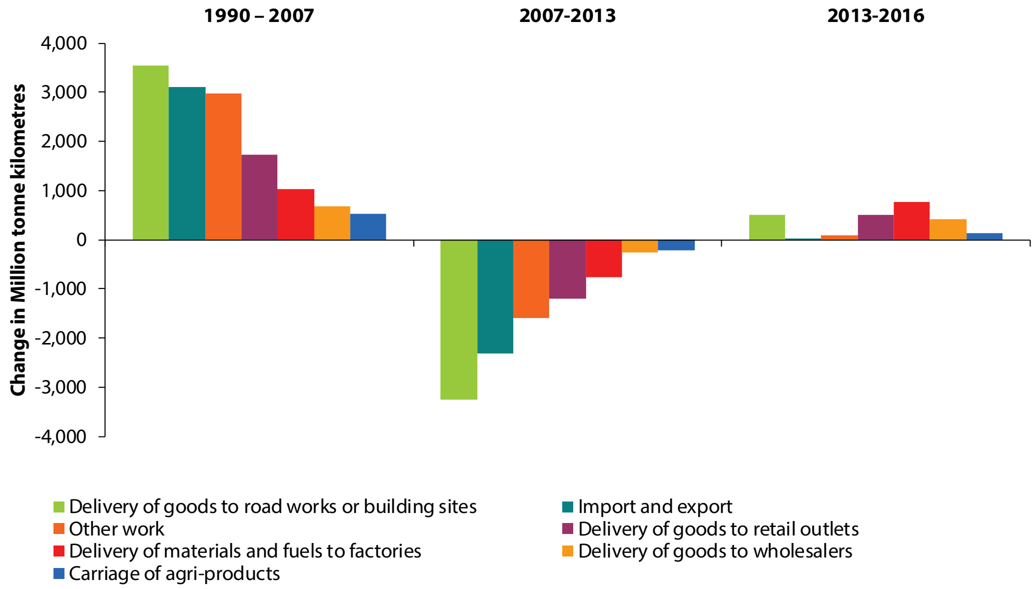
	Growth %	Average annual growth rates %				Quantity		
	'91 – '16	'00 – '05	'05 –'10	'10 – '15	2016	1991	2007	2016
Mega-Tonne Kilometres	125.1	7.8	-9.3	-2.1	17.5	5,138	18,707	11,564
Kilo-Tonnes Carried	76.8	8.8	-15.5	-1.3	20.0	80,137	299,307	141,669
Mega-Vehicle Kilometres	92.1	7.7	-8.8	-2.2	19.7	811	2,332	1,558
GDP (million € @2014 prices)	291.1	5.6	0.7	7.3	5.1	70,446	197,261	208,700

Source: CSO

Between 2007 and 2009 GDP fell, but has since returned to growth. In 2016, the overall tonnes carried grew by 20% to 142 Mt and were 53% below 2007 levels. Tonne-kilometres were 38% lower in 2016 than in 2007 and vehicle kilometres travelled were 33% 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 could be repeated following 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 – 2016. 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 the increase in activity between 1990 and 2007, the contraction from 2007 to 2013, and the recent return to growth from 2013 to 2016, these data are shown in *Figure 54*.

Figure 54: Absolute Change in Road Freight Activity by Main Type of Work Done 1990 – 2016



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 (3,248 Mtkm) and the largest percentage decrease (77%) between 2007 and 2013. 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 2016 (7,144 Mtkm) it was responsible for 39%, 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 2013 accounted for 2,315 Mtkm (24%) of the total reduction.

In the recent period 2013 to 2016 the largest source of growth in road freight has been in 'Delivery of materials and fuels to factories' which has grown by 770 Mt-km, fully recovering the activity lost in the period 2007 to 2013. There has been almost no increase in the 'Import and export' and 'Other work' categories despite sharp reductions in the previous period. 'Import and export' was the category with the largest share of activity throughout the period 2007 to 2016 but it remains 49% below 2007 levels, and is approximately at the level seen in 1999. Delivery of goods to road works or building sites increased by 51% from a low base between 2013 and 2016 but remains 65% below 2007 levels, also at the level seen in 1999. As activity in the economy in general and in the construction sector increases there is the potential for significant further growth in the freight activity of these categories.

4.3 Residential

Trends in 2016

Residential energy use increased by 1.2% in 2016 relative to 2015. 2016 was milder than 2015 in terms of degree days (6.5% fewer degree days[64]). When corrections for weather effects[65] are taken into account the increase in energy use was 4.8% in 2016 relative to 2015 (see *Table 27*).

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

- Overall direct fossil fuel use in households increased by 1.4% to 1,944 ktoe in 2016 and accounted for 72% of household energy use.
- Oil consumption in households increased by 5.1% in 2016, to 1,005 ktoe. The price of oil fell internationally by 47% in 2015 and the price to Irish households fell in the region of 20% at the same time and remained below 2015 levels throughout 2016. Oil's share of household energy stood at 37% in 2016.
- Electricity consumption fell by 0.1% in 2016 to 677 ktoe (7,873 GWh) and its share of residential final consumption was 25%.
- Natural gas usage increased by 1.4% in 2016 to 563 ktoe and accounted for 21% of residential energy use.
- Direct renewables usage in households increased in 2016, growing by 8.8% to 83 ktoe, and its share increased to 3.1%.
- Coal use in households fell in 2016 by 13.3% to 179 ktoe and a 6.6% share of the residential sector energy use.
- Peat usage decreased by 1.9% in 2016 and peat briquette usage fell by 5.1%. Total peat consumption was 197 ktoe in 2016. The peat and briquette share in household energy was 7.3% in 2016.

Weather corrected energy use in the residential sector increased by 4.8% in 2016 relative to 2015.

Trends 2005 – 2016

Figure 55 shows the trend for residential sector final energy consumption between 1990 and 2016, with and without weather correction. Weather correction yields a lower normalised energy consumption in cold years, (for example 2010), and yields a higher normalised consumption in mild years, (for example 2007). Accounting for weather variations, residential energy demand decreased every year between 2007 and 2012 but grew in both 2015 and 2016. Residential final energy use in 2016 was 2,704 ktoe 8.0% below that in 2005. Correcting for weather variations 2016 residential final energy use was 10.8% below 2005.

The main driver for increased residential energy consumption is the increase in total floor area of the housing stock, given that space heating is the dominant end use within the sector. Total floor area of all occupied dwellings increased by 103% between 1990 and 2016, as shown in *Figure 56*. This was as a result of the total number of dwellings increasing by 74% and the average floor area per dwellings increasing by 17%. The increasing number of dwellings is in turn driven by population growth, which increased by 35% between 1990 and 2016, and a reduction in the average number of people per dwelling. The number of people per dwelling fell from 3.3 in 1991 to 2.7 in 2011 but actually increased marginally between 2011 and 2016 due to the housing crisis. By international standards the average household size in Ireland remains very high, second only in the EU28 to Croatia. The EU countries with the lowest persons per household were Sweden on 1.9 and Germany and Denmark both on 2.0[66].

The rate of growth in floor area reduced between 2011 and 2016, due to the collapse of the housing market post 2008, but overall both the number of dwellings and the floor area continued to grow. In spite of this continued increase in total floor area total residential final energy, adjusted for weather, decreased by 18% between 2007 and 2014 (annual average decrease of 2.8%). This was as a result of significant reductions in energy intensity of dwellings in the period, which is discussed in more detail in Section *4.3.1*.

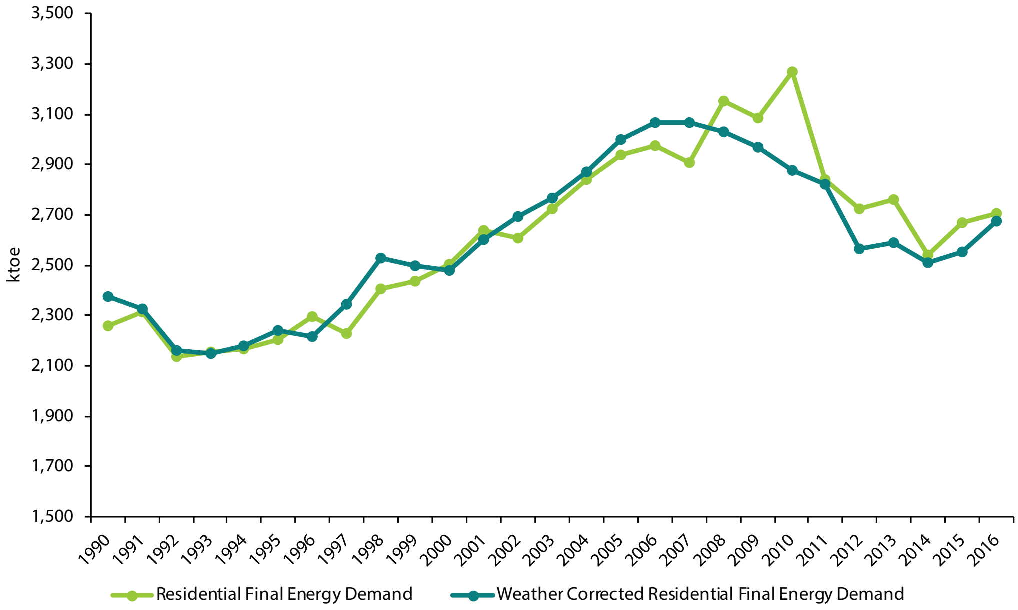
Between 2014 and 2016 residential final energy demand, adjusted for weather variation, increased by 6.5% (annual average growth of 3.2%).

64 See Glossary for definition of 'degree days'.

65 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.

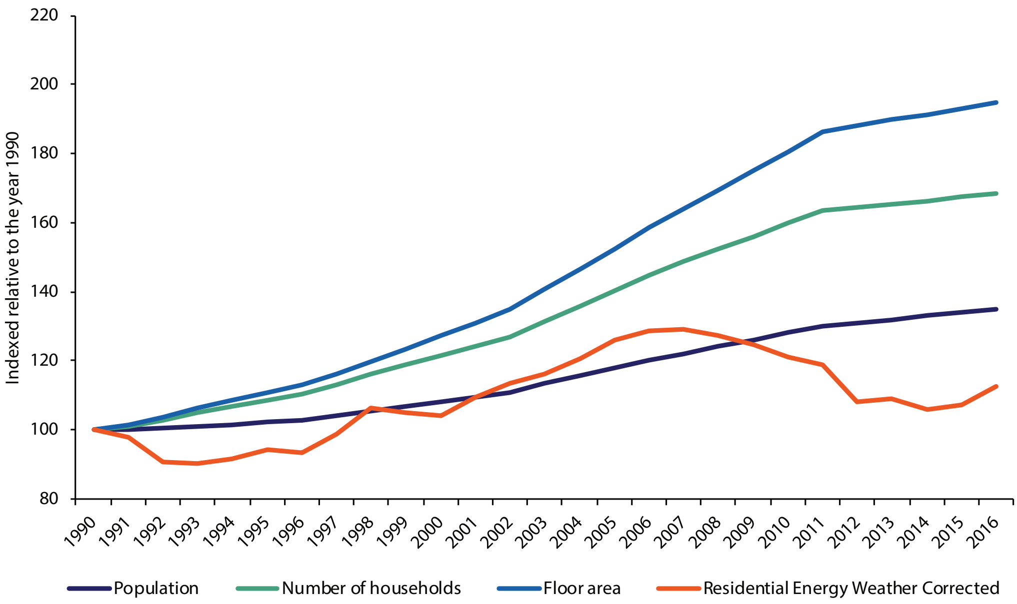
66 Eurostat Household composition statistics; http://ec.europa.eu/eurostat/statistics-explained/index.php/Household_composition_statistics

Figure 55: Residential Final Energy Use by Fuel



Source: SEAI

Figure 56: Population, Number of dwellings, total floor area and residential final energy demand, indexed to 1990



Source: SEAI and CSO

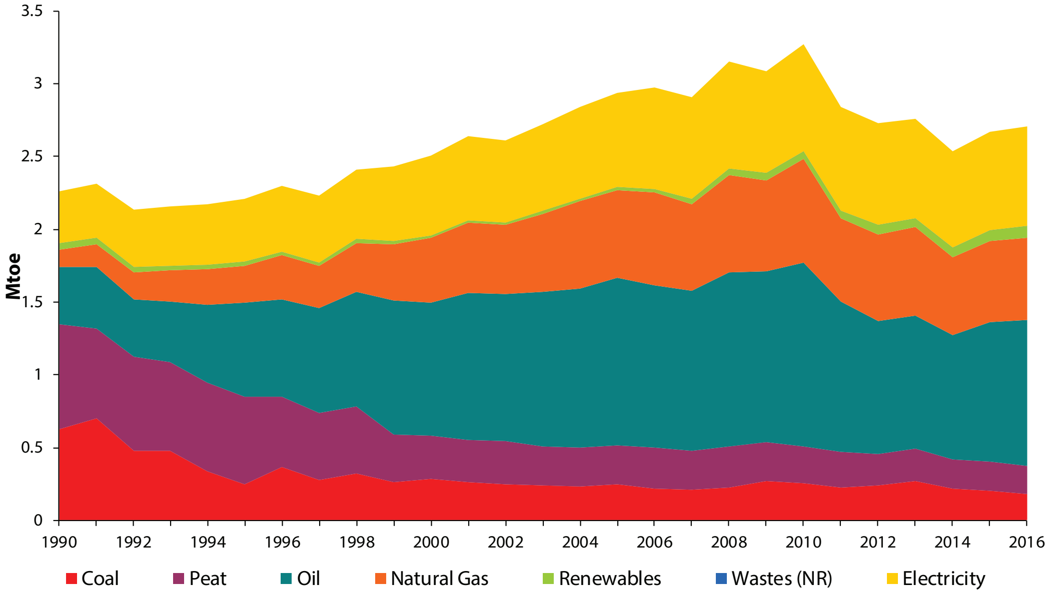
Figure 57 shows significant changes in the mix of fuels consumed in the residential sector over the period. In the early part of the period, between 1990 and 2000, there was a clear switch away from solid fuels such as coal and peat, which would traditionally have been burned in open fires, and towards oil and gas, typically used in central heating systems. In the latter part of the period from 2005 to 2016 the fuel shares have been more stable, with a gradual increase in the share of electricity and of gas and a continuing though gradual decline in coal and peat use.

Oil remains the dominant fuel in the residential sector, though its share reduced slightly from 39% in 2005 to 37% in 2016. Electricity was the second most dominant energy form in the sector in 2016 at 25%, with natural gas having the next largest share at 21%. The renewables share of final energy used directly in households in 2016 was 3.1%. The growth rates, quantities and shares are shown in *Table 27.*

Looking at the period 2007 to 2014, overall weather corrected residential energy use declined by 18% or 556 ktoe. The majority of the reduction was from oil which fell by 28% or 334 ktoe, followed by gas which fell by 17% or 106 ktoe. Some reasons for this may be: the higher oil price and the greater increase in oil price, relative to gas, in the period 2010 to 2015; potentially there are greater opportunity for fuel switching to peat and non-traded wood in rural areas, where the majority of oil fired dwellings are located.

It is also notable that total electricity consumption peaked in 2008 and has reduced slightly to 2016, having more than doubled between 1990 and 2016 and in spite of the continued growth in population and number of dwellings.

Figure 57: Residential Final Energy Use by Fuel



Source: SEAI

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

	Overall Growth %		Average annual growth %			Quantity (ktoe)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Fossil Fuels (Total)	4.6	-14.4	-1.4	-4.0	1.4	2,271	1,944	77.3	71.9
Coal	-71.4	-27.3	-2.9	-5.7	-13.3	246	179	8.4	6.6
Peat	-72.8	-27.9	-2.9	-4.1	-1.9	273	197	9.3	7.3
Briquettes	-55.4	-23.4	-2.4	-3.9	-5.1	90	69	3.1	2.6
Oil	158.1	-12.2	-1.2	-3.7	5.1	1,145	1,005	39.0	37.2
Gas	380.1	-7.2	-0.7	-3.8	1.4	607	563	20.6	20.8
Renewables	86.1	266.0	12.5	7.4	8.8	23	83	0.8	3.1
Combustible Fuels (Total)	3.9	-13.6	-1.3	-3.9	1.3	2,287	1,976	77.8	73.1
Electricity	90.1	4.8	0.4	-1.4	-0.1	646	677	22.0	25.0
Total	**19.7**	**-8.0**	**-0.8**	**-3.1**	**1.2**	**2,940**	**2,704**		
Total Weather Corrected	**12.5**	**-10.8**	**-1.0**	**-1.2**	**4.8**	**2,998**	**2,675**		

Source: SEAI

Energy-related CO_2 Emissions – including emissions associated with electricity

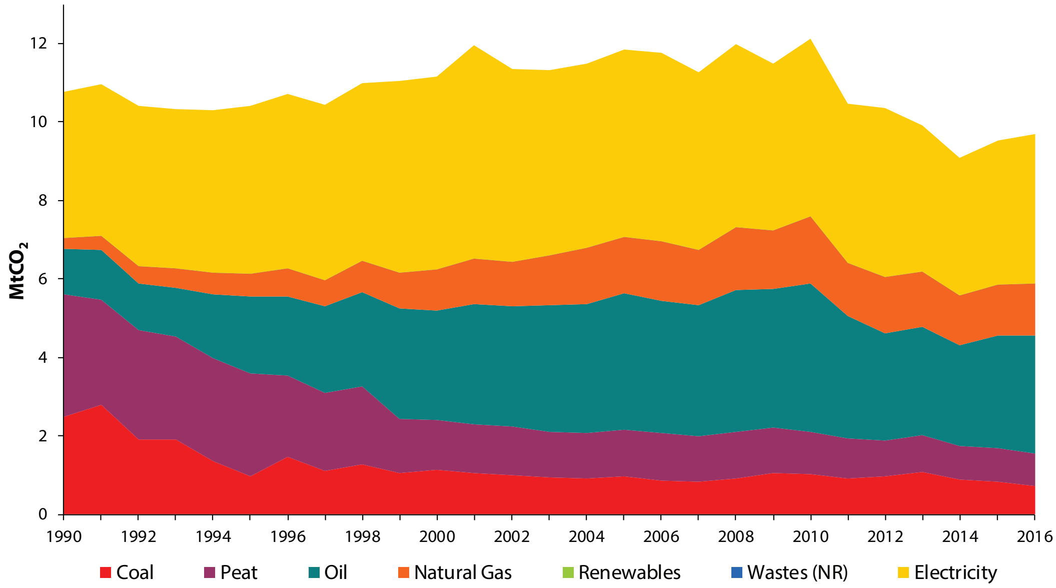
The residential sector is examined in more detail with respect to energy-related CO_2 emissions in *Figure 58*. In order to determine total energy-related CO_2 emissions from the residential sector, it is necessary to view electricity on a primary energy basis, i.e. the fuels required to generate the electricity consumed by households.

There was a reduction in energy related CO_2 emissions between 2010 and 2014, but there was a return to growth in CO_2 emissions in 2015 and again in 2016. Over the period 1990 – 2016 energy-related CO_2 emissions[67] from the residential sector fell by 10% while those in transport, industry and services rose, respectively, by 142%, 11%, and 9.7%. In 2016 residential sector energy-related CO_2 emissions (including upstream electricity emissions) were 9,690 kt CO_2, representing

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

24% 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%.

Figure 58: Residential Energy-Related CO_2 by Fuel



Source: SEAI

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

	Overall Growth %		Average annual growth %			Quantity (kt CO_2)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Coal	-71.0	-27.1	-2.8	-5.6	-13.2	989	721	8.4	7.4
Peat	-73.0	-28.0	-2.9	-4.1	-1.8	1,170	842	9.9	8.7
Briquettes	-55.4	-23.4	-2.4	-3.9	-5.1	374	286	3.2	3.0
Oil	156.0	-13.2	-1.3	-3.8	5.1	3,467	3,008	29.3	31.0
Gas	388.2	-8.8	-0.8	-4.1	-0.5	1,443	1,317	12.2	13.6
Renewables	-	-	-	-	-	-	-	0.0	0.0
Combustible Fuels (Total)	-16.5	-16.7	-1.6	-4.2	0.3	7,069	5,889	59.7	60.8
Electricity	2.4	-20.4	-2.0	-2.9	3.7	4,773	3,801	40.3	39.2
Total	**-10.0**	**-18.2**	**-1.8**	**-3.7**	**1.6**	**11,843**	**9,690**		

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 in 2016 were 16.5% lower than in 1990 and 16.7% lower than in 2005. This was achieved through a combination of less carbon intensive fuel mix and a reduction in overall energy usage post 2010. Excluding upstream electricity emissions, direct CO_2 emissions from the household sector were 5,889 kt and were 0.3% higher in 2016 compared with 2015.

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. In 2016 the average dwelling consumed a total of 17,691 kWh of energy based on weather corrected data, 4.2% above the 2015 level. This comprised 13,223 kWh (75%) of direct fuels and 4,468 kWh (25%) of electricity.

> In 2016 the average dwelling consumed a total of 17,691 kWh of energy. 75% of this was direct fuels and the remainder electricity.

Figure 59 shows the trend in final energy consumption per dwelling with and without weather correction. Looking at this in conjunction with *Table 29*, it can be seen that final energy use per dwelling remained relatively constant between 2000 and 2005 but reduced significantly between 2005 and 2014 before returning to growth in 2015 and 2016. Weather corrected total final energy consumption per dwelling fell by 28% over the period 2005 to 2016, but increased by 4.2% in 2016. Between 2007 and 2014 final energy use of electricity per dwelling, weather corrected, reduced by 19%, having increased by 30% between 1990 and 2007.

Plausible reasons for the decrease direct fuel use in households between 2007 and 2014 include:

- reduced household incomes and expenditure;
- increased energy prices;
- increased thermal efficiency of newly built dwellings – 94% of new houses built between 2015 and 2017 were A rated[68];
- retrofitting of existing dwellings with energy efficiency measures;
- fuel switching from traded energy such as oil and gas to un-traded energy such as wood and sod peat which are not well accounted for in the national statistics.

Potential reasons for the reduction in electricity use per dwelling between 2007 and 2014 reversing the earlier long-term trend of increased electricity usage could include:

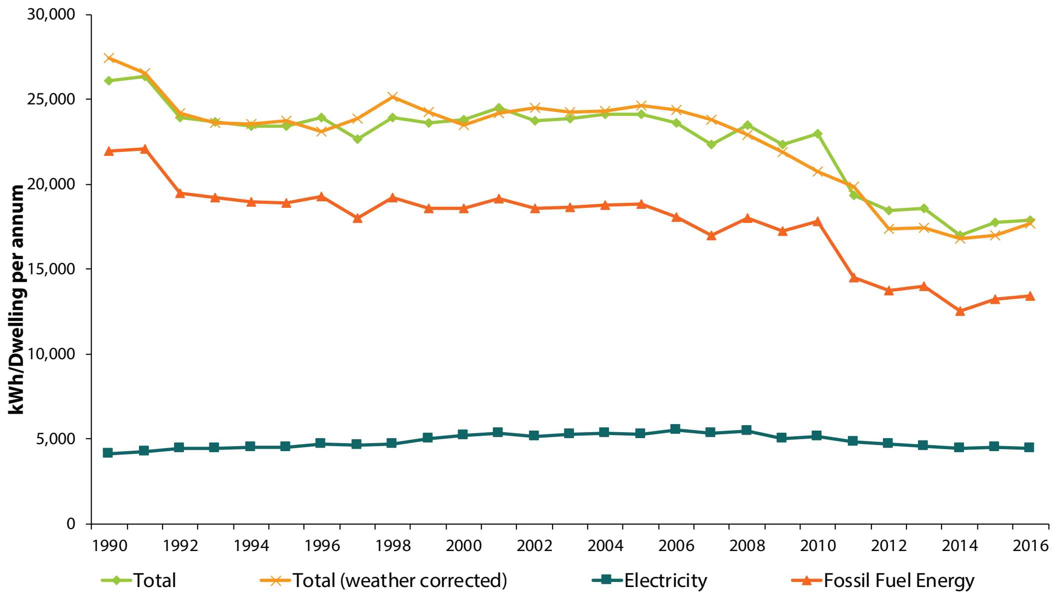
- reduced household incomes and expenditure;
- increased electricity prices;
- more efficient appliances;
- reduced usage of appliances;
- reduced demand for space and water heating due to greater thermal efficiency of the stock or due to fuel switching from electricity to fossil fuels for space and water heating.

Plausible reasons for the increase in residential energy use per dwelling in 2015 and 2016 include:

- increasing household incomes and expenditure;
- reduced energy price, particularly the price of oil;
- Fuel switching from non-traded energy such as wood and peat to traded energy such as oil.

More data and research is required to better understand the underlying drivers behind the recent increase in residential energy use and to allow better prediction of the future trend.

Figure 59: Unit Consumption of Energy per Dwelling (permanently occupied)



Source: Based on SEAI, CSO and Met Éireann data

68 CSO, 2017, *Domestic Building Energy Ratings - Q3 2017*, http://www.cso.ie/en/releasesandpublications/er/dber/domesticbuildingenergyratingsquarter32017/

Table 29: Growth Rates and Quantities of Residential Unit Energy Consumption and Unit CO_2 Emissions

Unit Energy Consumption	Overall Growth % 1990 – 2016	Overall Growth % 2005 – 2016	Average annual growth % '05 – '16	Average annual growth % '10 – '16	Average annual growth % 2016	Quantity (kWh/dwelling) 2005	Quantity (kWh/dwelling) 2016
Total Energy	-31.4	-25.9	-2.7	-4.1	0.6	24,129	17,883
Fuel Energy	-38.9	-28.8	-3.0	-4.6	1.0	18,827	13,405
Electrical Energy	8.9	-15.6	-1.5	-2.3	-0.7	5,302	4,478
Unit Energy Consumption Weather Corrected						**Quantity (kWh/dwelling)**	
Total Energy Weather Corrected	-35.5	-28.1	-3.0	-2.6	4.2	24,608	17,691
Fuel Energy Weather Corrected	-43.2	-31.4	-3.4	-2.7	5.6	19,286	13,223
Electrical Energy Weather Corrected	7.7	-16.0	-1.6	-2.4	0.0	5,322	4,468
Unit Energy-Related CO_2 Emissions						**Quantity (tCO2/dwelling)**	
Total Energy CO_2	-48.4	-34.1	-3.7	-4.6	1.0	8.4	5.5
Fuel CO_2	-52.2	-32.9	-3.6	-5.1	-0.3	5.0	3.3
Electricity CO_2	-41.3	-35.8	-4.0	-3.8	3.1	3.4	2.2

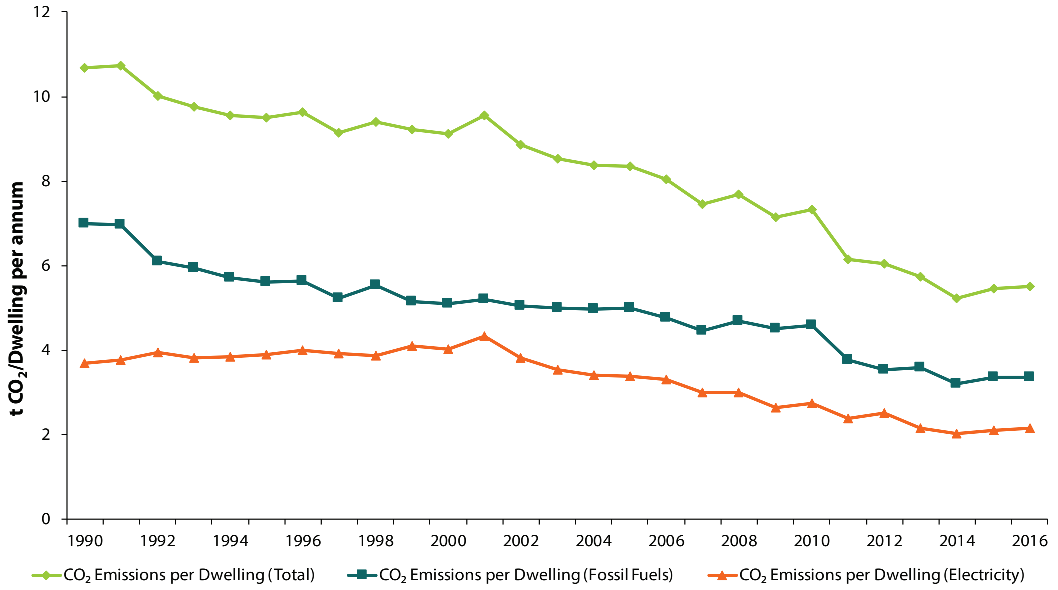
Energy-related CO_2 Emissions per Dwelling

The emissions of energy-related CO_2 per dwelling fell by 34% over the period 2005 – 2016 while the reduction for unit energy use was 26% – see *Table 29* and *Figure 60*. In 2016 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.

Energy related CO_2 emissions per dwelling for direct non-electric fuel use fell by 33% between 2005 and 2016, primarily as a result of reduced energy consumption per dwelling. CO_2 emissions from electricity use reduced by 36% in the same time period due to a combination of reduced electricity use and reduced carbon intensity of the electricity grid. The carbon intensity of grid electricity has improved since 2002 when high-efficiency CCGT plants were brought online and because of the growing contribution of renewables in electricity generation.

Emissions from energy use in households increased by 1% in 2016, mainly as a result of increased CO_2 intensity of electricity supplied and also increased oil consumption.

Figure 60: Unit Energy-Related CO_2 Emissions per Dwelling



Source: SEAI

In 2016 the average dwelling emitted 5.5 t of energy-related CO_2.

4.4 Commercial and Public Services

Trends in 2016

The commercial and public services energy use increased by 5.0% in 2016 relative to 2015. As 2016 was milder than 2015 (6.5% fewer degree days), when corrections for weather effects are taken into account energy use in services increased by 8.5% in 2016. This is against the backdrop of the economic activity of services, as measured by value added, increasing by 6.3%.

The key trends in 2016 are as follows:

- Final energy use in services grew by 5.0% in 2016 to 1,357 ktoe, however when corrected for weather effects the increase was 8.5%.
- Oil, gas and electricity make up 96% of the energy consumed in the services sector. The contributions from coal and peat are negligible.
- Electricity consumption in services increased by 3% to 598 ktoe and accounted for 44% of final energy consumption in services in 2016.
- Oil consumption increased by 1.5%, to 247 ktoe. The share of oil in the sector's final consumption was 18%.
- Natural gas consumption increased by 6.5%, to 461 ktoe and its share of the sector's final consumption was 34%.
- Overall fossil fuel use in services increased by 4.7%, to 708 ktoe.
- Renewable energy use in services increased by 41.6%, to 51 ktoe from increased use of biomass, heat pumps and biogas. The share of renewables in services' final energy consumption was 3.8%.

Trends 2005 – 2016

Final energy use in the commercial and public services sector fell by 13% (1.3% per annum) over the period 2005 – 2016, to a figure of 1,357 ktoe. The decrease was 16% if weather corrected energy use is considered. During this period the value added generated by the sector grew by 49% while the numbers employed increased by 14%.

Figure 61: Commercial and Public Services Final Energy Use by Fuel

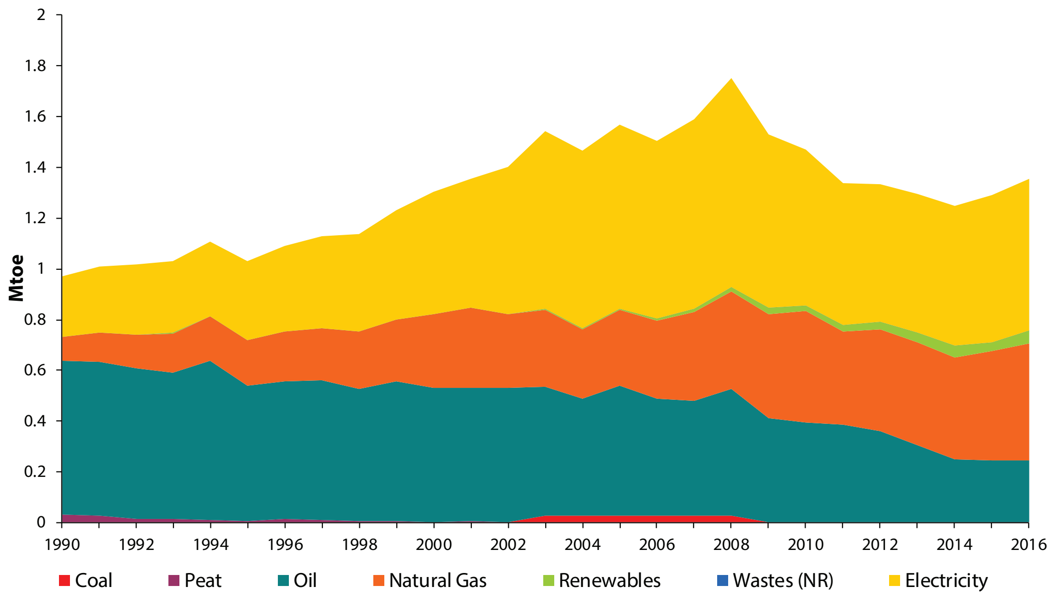


Figure 61 shows the changes in the fuel mix in the services sector over the period. The range of fuels used in this sector is small – essentially oil, gas and electricity. Oil and gas are used predominantly for space heating, but also for water heating, cooking and, in some sub-sectors, laundry. Gas consumption increased by 390% since 1990, to 461 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 149% (3.6% per annum) between 1990 and 2016, to 598 ktoe (6,951 GWh) and has a higher share at 44% 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), electric heating and air conditioning.

Growth rates, quantities and shares are shown in *Table 30*.

Table 30: Growth Rates, Quantities and Shares of Final Consumption in the Commercial and Public Services Sector

	Overall Growth %		Average annual growth %			Quantity (ktoe)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Fossil Fuels (Total)	-3.3	-15.5	-1.5	-2.7	4.7	837	708	53.4	52.2
Coal	-		-	-	-	27	-	1.7	0.0
Oil	-59.2	-51.7	-6.4	-7.5	1.5	511	247	32.6	18.2
Natural Gas	390.2	54.3	4.0	0.8	6.5	299	461	19.0	34.0
Renewables	-	1171.3	26.0	15.7	41.6	4	51	0.3	3.8
Combustible Fuels (Total)	1.2	-11.8	-1.1	-2.3	6.2	840	741	53.6	54.6
Electricity	148.7	-17.9	-1.8	-0.5	3.0	728	598	46.4	44.1
Total	**39.6**	**-13.5**	**-1.3**	**-1.3**	**5.0**	**1,569**	**1,357**		
Total Weather Corrected	**31.1**	**-15.9**	**-1.6**	**0.5**	**8.5**	**1,597**	**1,343**		

Energy-related CO_2 Emissions – including emissions associated with electricity

Figure 62 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 17.6% over the period and the emissions associated with electricity consumption increased by 34%. In 2016 the non-electricity emissions increased by 3.3% and the electricity associated emissions in services increased by 7%. Overall energy-related CO_2 emissions in this sector increased by 5.7% in 2016 to 5.2 Mt CO_2.

In the services sector, the share of emissions associated with electricity demand in 2016 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 62: Commercial and Public Services Sector CO_2 Emissions by Fuel

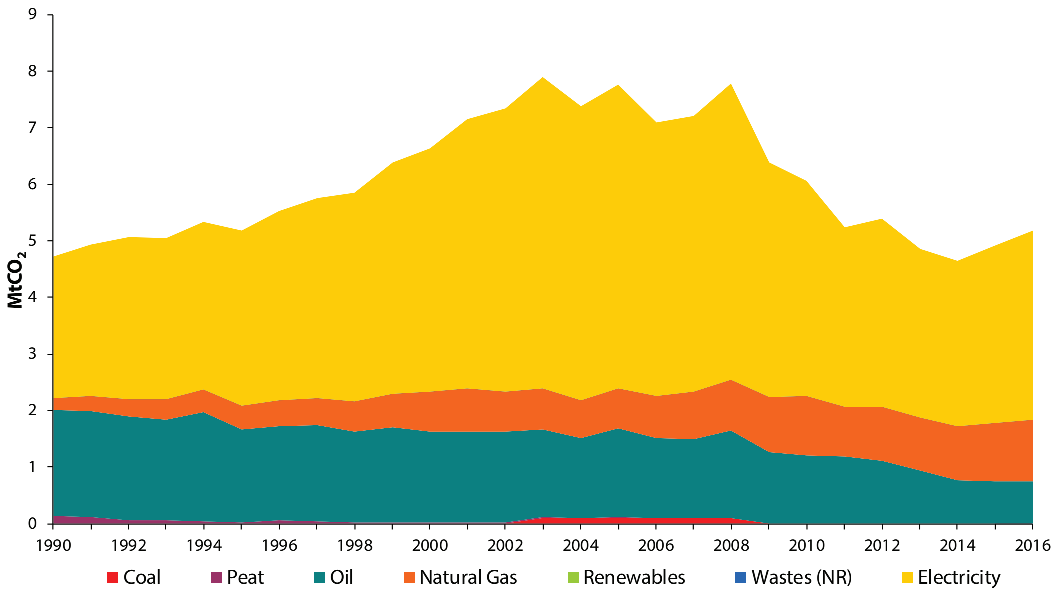


Table 31: Growth Rates, Quantities and Shares of CO_2 Emissions in Commercial and Public Services

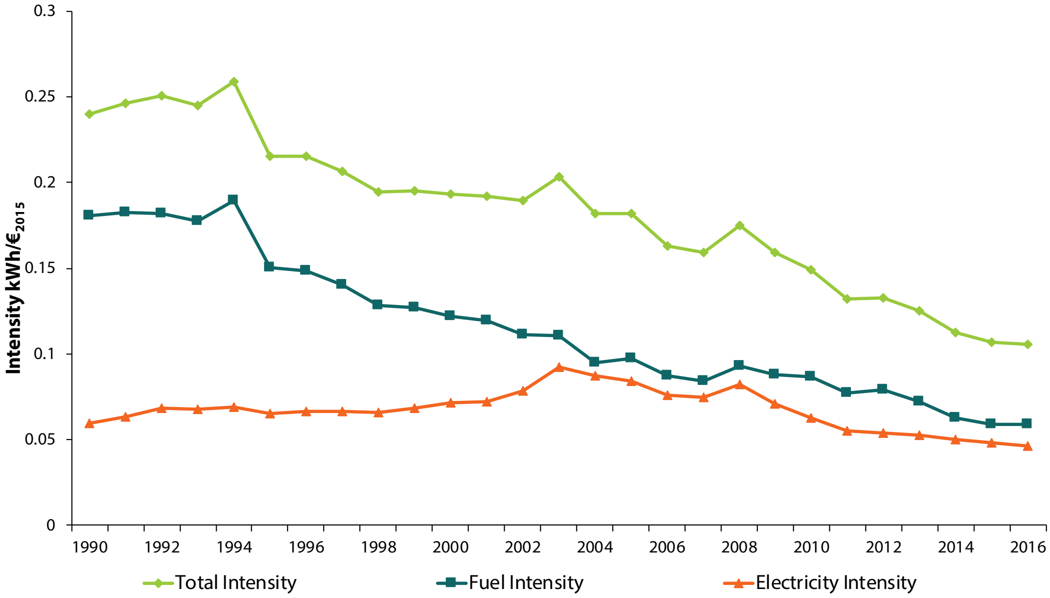
	Overall Growth %		Average annual growth %			Quantity (kt)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Combustible Fuels	-17.6	-23.1	-2.4	-3.4	3.3	2,385	1,833	30.7	35.3
Electricity	34.0	-37.6	-4.2	-2.0	7.0	5,379	3,356	69.3	64.7
Total	**9.7**	**-33.2**	**-3.6**	**-2.5**	**5.7**	**7,764**	**5,189**		

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 63*, this intensity is 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 2016 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 1.2% in 2016.

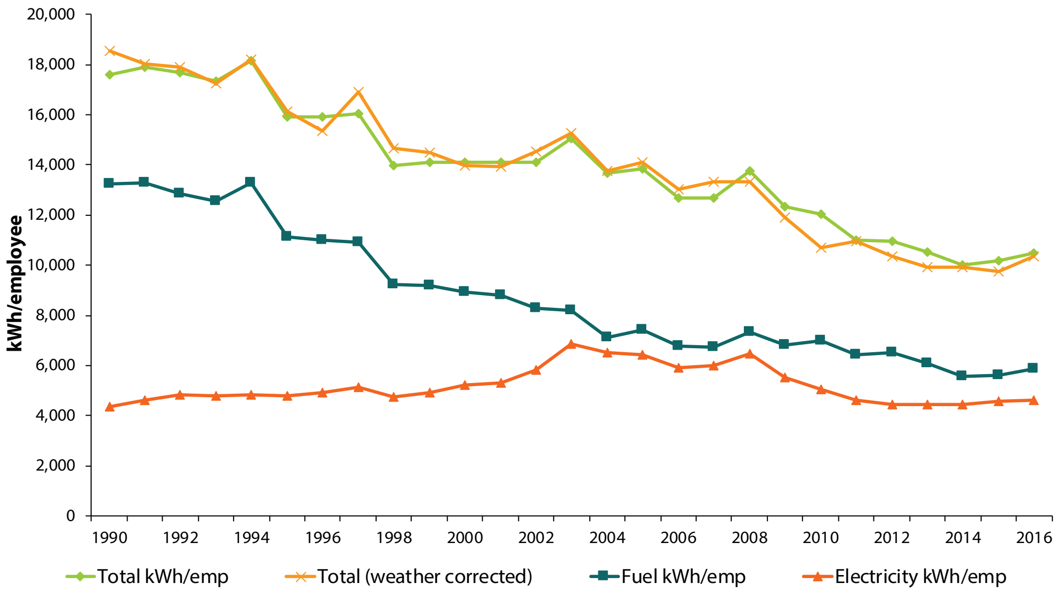
Electricity intensity increased by 59% up to 2003 and has been falling since then, with the exception of 2008. In 2016 electricity intensity decreased by 3% compared with 2015, was 50% below the peak in 2003 and 21% below the 1990 level.

Figure 63: Energy Intensity of Commercial and Public Services Sector



Two other indicators 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 64: 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 64* it can be seen that unit consumption of electricity rose steadily after 1990. By 2003 it was 58% higher than in 1990 but by 2016 it had fallen back to 6.1% above 1990 levels. Electricity use per employee increased by 0.8% in 2016.

Fuel consumption per employee increased by 4.3% in 2016, and stood at 56% below 1990 levels. If corrections are made for the effects of weather then the fuel consumption per employee increased by 9.4% in 2016 when compared with 2015.

Table 32: Growth Rates and Quantities of Unit Consumption per Employee in Commercial and Public Services

	Overall Growth %		Average annual growth %			Quantity (kWh)	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016
Total kWh/employee	-40.4	-24.5	-2.5	-2.3	2.7	13,861	10,470
Fuel kWh/employee	-55.7	-21.2	-2.1	-2.9	4.3	7,430	5,857
Electricity kWh/employee	6.1	-28.3	-3.0	-1.5	0.8	6,430	4,613
Weather Corrected (wc)							
Total kWh/employee (wc)	-44.1	-26.5	-2.8	-0.5	6.1	14,104	10,365
Fuel kWh/employee (wc)	-59.1	-24.3	-2.5	-0.4	9.4	7,626	5,771
Electricity kWh/employee (wc)	3.8	-29.1	-3.1	-0.7	2.2	6,478	4,594

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 statistical 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. Other studies have also been conducted in the areas of commercial building stock characterisation and consumer attitudes to investment energy efficiency in the sector[69].

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 100 largest organisations.

Public services[70] 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 Fourth 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[71] 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

69 SEAI (2015), *Extensive survey of the commercial buildings stock in the Republic of Ireland – Insights Paper*, https://www.seai.ie/resources/publications/Extensive-Survey-of-Commercial-Buildings-Stock-in-the-Republic-of-Ireland.pdf
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70 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.

71 Additional information on this system is available from https://www.seai.ie/energy-in-business/public-sector/

build a comprehensive bottom-up picture of energy consumption in the sector through the population of the national public sector energy database.

In 2017 SEAI published the *Annual Report 2016 on Public Sector Energy Efficiency Performance*[72]. It noted that 337 public sector bodies and 1,792 schools completed reports on energy and these represented 96% of total public sector energy consumption. The total energy consumption in 2015 of these bodies was 9,343 GWh (primary energy), which consisted of 5,027 GWh of electricity, 2,322 GWh of thermal energy and 1,993 GWh of transport energy. This cost the state €588 million in 2015. The report also noted that these bodies have achieved annual primary energy savings of 2,442 GWh or a 21% improvement on business as usual, yielding a cost saving of €154 million. The public sector has a target of 33% energy efficiency improvement by 2020.

Public sector bodies have achieved annual primary energy savings of 2,442 GWh or a 21% improvement on business as usual, yielding a cost saving of €154 million. The public sector has a target of 33% energy efficiency improvement by 2020.

72 Available from https://www.seai.ie/resources/publications/Annual-Report-2016-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 2017. The most significant of these were:

Milled Peat

2005 – 2016

- Corrected error where the input to briquette plants was double-counted.

Gasoline

2005 – 2016

- On road factor used for estimating gasoline (petrol) consumption of private cars was modified to reflect the widening gap between test values and real world consumption. This had a knock-on effect on the unspecified figures.

2015

- Imports were revised to align with figures published in international data.

Gasoil / Diesel / DERV

2007 – 2016

- On road factor used for estimating gasoline (petrol) consumption of private cars was modified to reflect the widening gap between test values and real world consumption. This had a knock-on effect on the unspecified figures.

2008 – 2016

- Methodology for estimating light goods vehicle (LGV) consumption was revised. This also had a knock-on effect on the unspecified figures.

2015

- Imports were revised to align with figures published in international data.

Bitumen

1990 – 1991

- Revised to align with figures published in international data.

2015

- Imports and exports revised to align with CSO data.

White Spirit

2015

- Imports and exports revised to align with CSO data.

Lubricants

1990 – 1991

- Revised to align with international data.

2015

- Imports and exports revised to align with CSO data.

Natural Gas

2007 onwards

- Production and stock levels revised from 2007 onwards based corrected data provided by the data suppliers.

2015

- Revision of split of gas consumption in 2015 between industry and services based on better classification of consumers by GNI.

Liquid Biofuels

2005 – 2016

- Transport sub-sector split revised to align with revisions to gasoline and diesel.

Non-Renewable Waste

2012 – 2016

- Liquid recovered fuel included based on Emissions Trading Scheme data.

Electricity

2011 – 2016

- Estimated electric vehicle consumption added to the Energy Balance for the first time.

Energy balance data analysed in this report were frozen on 29 September 2017. 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 (https://www.seai.ie/resources/seai-statistics/energy-data/). 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 CSO Databank. 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.

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, 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.

Wastes - Non-Renewable [Wastes (NR)]: The non-renewable portion of wastes used as an energy source.

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		
(2016)	133.7	482.8

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

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EU-funded ODYSSEE Project

Eurostat

Gas Networks Ireland

International Energy Agency

Met Éireann

Revenue Commissioners

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Energy Balance 2016

kilo tonnes of oil equivalent (ktoe)	Coal	Peat	Oil	Natural Gas	Renewables	Non-Renew/Waste	Electricity	Total
Indigenous Production	0	679	0	2,473	1,028	66		4,246
Imports	1,155	0	9,009	1,704	139		75	12,082
Exports	9	5	1,643	0	0		136	1,793
Mar. Bunkers	0	0	160		0			160
Stock Change	228	59	-34	54	-8			299
Primary Energy Supply (incl. non-energy)	**1,373**	**734**	**7,173**	**4,231**	**1,158**	**66**	**-61**	**14,675**
Primary Energy Requirement (excl. non-energy)	**1,373**	**734**	**6,911**	**4,231**	1,158	66	**-61**	**14,413**
Transformation Input	**1,101**	**607**	**3,354**	**2,388**	**161**	**24**	**56**	**7,691**
Public Thermal Power Plants	1,101	513	63	2,068	152	24		3,922
Combined Heat and Power Plants	0	9	19	265	9			303
Pumped Storage Consumption							46	46
Briquetting Plants	0	85	0		0			85
Oil Refineries and other energy sector	0	0	3,272	54	0		10	3,336
Transformation Output	**0**	**81**	**3,319**	**0**	**59**	**6**	**2,028**	**5,493**
Public Thermal Power Plants	0	0	0		53	6	1,823	1,823
Combined Heat and Power Plants – Electricity	0	0	0		5		180	180
Combined Heat and Power Plants – Heat					0			0
Pumped Storage Generation							25	25
Briquetting Plants		81	0		0			81
Oil Refineries		0	3,319		0			3,319
Exchanges and Transfers	**12**	**0**	**-15**	**0**	**-588**	**0**	**588**	**-3**
Electricity					-588		588	0
Heat								0
Other	12		-15		0			-3
Own Use and Distribution Losses	**0**	**12**	**73**	**44**	**0**		**254**	**383**
Available Final Energy Consumption	**284**	**196**	**7,049**	**1,800**	**410**	**42**	**2,245**	**12,025**
Non-Energy Consumption	**0**	**0**	**262**	**0**	**0**	**0**	**0**	**262**
Final non-Energy Consumption	0	0	262	0	0			262
Total Final Energy Consumption	**289**	**198**	**6,740**	**1,786**	**426**	**42**	**2,199**	**11,680**
Industry	**110**	**1**	**484**	**762**	**173**	**42**	**872**	**2,445**
Non-energy mining	0	0	31	12	0		63	106
Food, beverages and tobacco	21	1	131	105	21		186	464
Textiles and textile products	0	0	2	1	0		11	15
Wood and wood products	0	0	2	2	113		37	155
Pulp, paper, publishing and printing	0	0	3	3	0		20	27
Chemicals and man-made fibres	0	0	27	65	0		159	251
Rubber and plastic products	0	0	9	4	0		38	52
Other non-metallic mineral products	89	0	182	17	39	42	56	425
Basic metals and fabricated metal products	0	0	8	417	0		68	493
Machinery and equipment n.e.c.	0	0	5	5	0		22	33
Electrical and optical equipment	0	0	41	123	0		108	272
Transport equipment manufacture	0	0	5	2	0		18	25
Other manufacturing	0	0	37	6	0		85	129
Transport	**0**	**0**	**4,825**	**0**	**118**	**0**	**4**	**4,947**
Road Freight	0	0	713		22			735
Light Goods Vehicles (LGV)			309	0	9			318
Road Private Car	0	0	2,082		64		0	2,147
Public Passenger Services	0	0	131		4			135
Rail	0	0	36		0		4	40
Domestic Aviation	0	0	4		0			4
International Aviation	0	0	866		0			866
Fuel Tourism	0	0	372		11			384
Navigation	0	0	86		0			86
Unspecified	0	0	227		7			234
Residential	**179**	**197**	**1,005**	**563**	**83**		**677**	**2,704**
Commercial/Public Services	**0**	**0**	**247**	**461**	**51**	**0**	**598**	**1,357**
Commercial Services	0	0	158	202	44		429	833
Public Services	0	0	89	259	7		169	524
Agricultural	**0**	**0**	**159**	**0**	**0**		**48**	**207**
Fisheries	**0**	**0**	**19**		**0**			**19**
Statistical Difference	-5	-1	47	14	-16	0	45	83

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

SUSTAINABLE ENERGY AUTHORITY OF IRELAND

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

t +353 1 808 2100
f +353 21 240 7987
e epssu@seai.ie
w www.seai.ie

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

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

@seai_ie

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