SUSTAINABLE ENERGY AUTHORITY OF IRELAND

ENERGY IN IRELAND

2019 Report

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December 2019

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Sustainable Energy Authority of Ireland (SEAI)

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 funded by the Government of Ireland through the Department of Communications, Climate Action and Environment.

SEAI is the official source of energy data for Ireland. We develop and maintain comprehensive national and sectoral statistics for energy production, transformation and end-use. These data are a vital input in meeting international reporting obligations, for advising policymakers and informing investment decisions. SEAI's core statistics 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 all the organisations, agencies, energy suppliers and distributors that provided data and responded to questionnaires throughout the year.

Foreword


William Walsh

In 2019, the global movement to address the climate crisis gathered new momentum. This was best illustrated by the world-wide youth climate strike protest, with both young and old people taking to the streets of Dublin, Cork and other towns and villages across Ireland, calling for all of society to do more to reduce greenhouse gas emissions and tackle climate change.

This year's Energy in Ireland report shows how Ireland's energy system is evolving in response to the imperative to reduce greenhouse gas emissions on one hand and continued economic growth and demand for energy services on the other hand. Linked with increasing economic growth, Ireland's overall demand for energy continues to rise.

Despite the increase in energy demand, energy-related CO_2 emissions fell slightly, mainly due to a reduction in the amount of coal used for electricity generation, along with increased contributions from wind generation. The transition from fossil fuels to renewables to generate our electricity means that the amount of CO_2 released into the atmosphere for every unit of electricity used fell to a new low. It is now less than half what it was in the year 2000. This is an encouraging trend, but further acceleration of deployment is necessary to achieve the Government's target for electricity (70% from renewables by 2030).

Energy demand for heat and transport increased in 2018, leading to increased emissions from how we travel and heat our homes and businesses. We can all play a part in reducing energy use and emissions from these areas. There are a wide range of Government supports available via SEAI. These have already supported energy efficiency improvements in 420,000 homes. Given the trends evident in this report, however, it's clear that we need to continue to work together to encourage more uptake.

The Government's recently published *Climate Action Plan to Tackle Climate Breakdown* seeks to dramatically increase the rate of home retrofits, from around 25,000 per year to over 50,000. It also seeks to deepen the average intervention, to ensure homes are improved to a B2 Building Energy Rating (BER).

Ireland faces a significant challenge in the transport sector too. We need to encourage people to drive less, and to walk, cycle and take public transport as much as possible. Private cars will still remain part of the transport mix, but petrol and diesel cars will be phased out and substituted by electric vehicles, which are currently being encouraged and supported by Government grants.

Energy use for air travel reached an all-time high in 2018, surpassing the previous peak set during the Celtic Tiger era, and is now second only to private cars as a share of transport energy. This provides a pertinent example of the tug of war between the desire to reduce greenhouse gas emissions on the one hand and the increased energy demands of an improving economy on the other.

The data presented in this report highlights the progress we are making on the transition to sustainable energy, but also the scale of the challenge ahead. There are some encouraging signs, but the need to accelerate our transition away from fossil fuels is also clearly evident.

William Walsh

Chief Executive

Sustainable Energy Authority of Ireland

2018 Key Trends

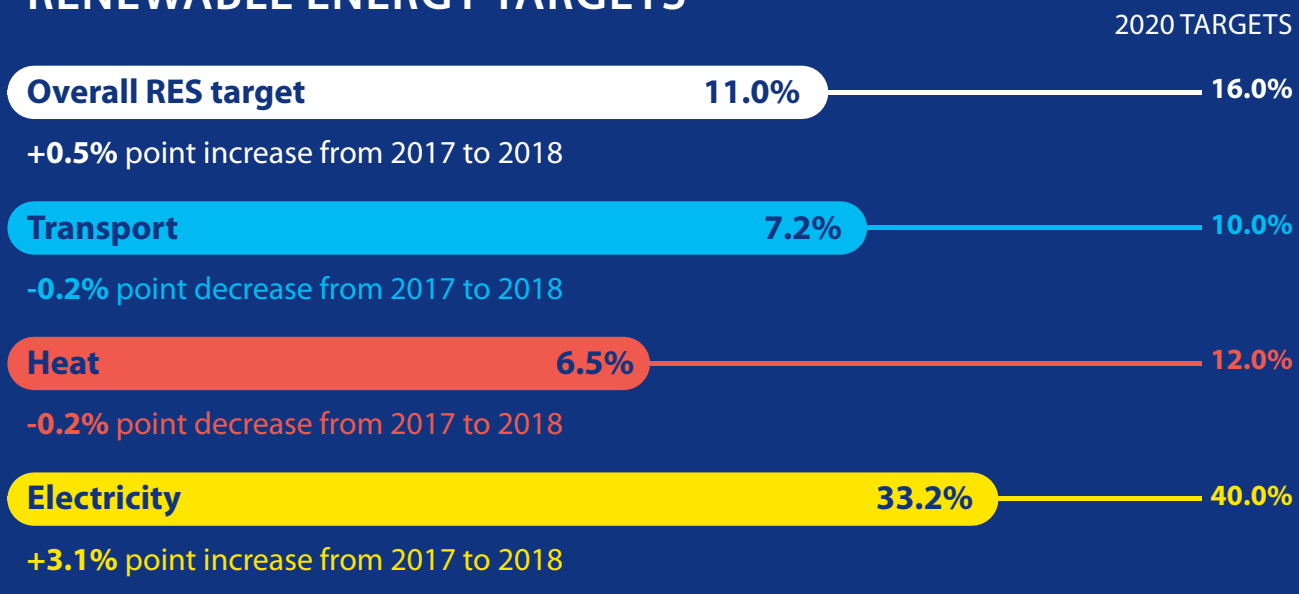
ECONOMIC GROWTH
(modified domestic demand)
+1.7%

OVERALL ENERGY USE
+1.6%

ENERGY-RELATED CO_2 EMISSIONS
-1.2%

	Energy use	Energy-related CO_2 Emissions
Residential	+6.8%	0.0%
Transport	+2.6%	+2.9%
Industry	+4.7%	-3.5%
Services	+6.4%	-3.6%

RENEWABLE ENERGY TARGETS



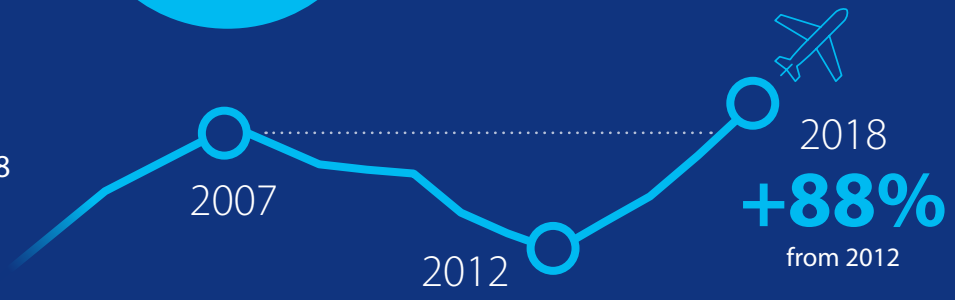
Note: Figures are all 2018 compared with 2017, unless otherwise stated.

Transport

LARGEST ENERGY USERS

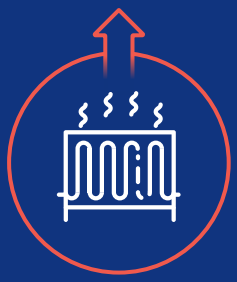
AIR TRAVEL

Energy use reached all time high in 2018



Heat

CO_2 emissions from energy use for heat increased by **6.4%**



Oil **+7%** | Gas **+7%** | Coal **+4%** | Peat **+4%**

Electricity

CO_2 INTENSITY OF ELECTRICITY

-14%

to a new low of **375 gCO_2/kWh**

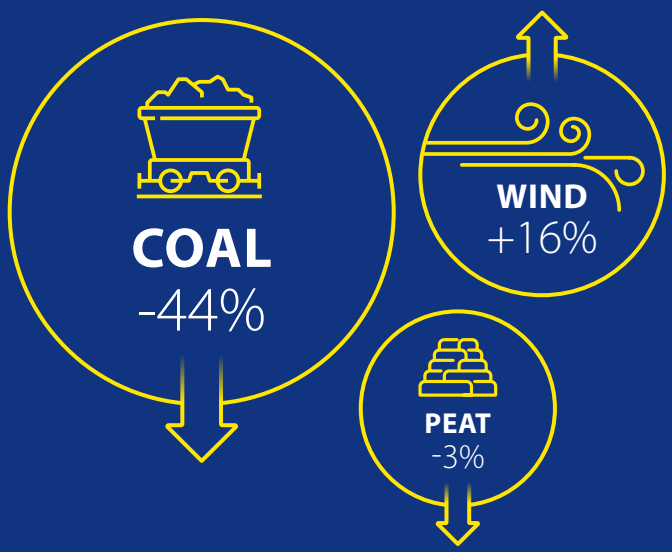
ELECTRICITY GENERATED

+2.9%

ENERGY USED FOR ELECTRICITY GENERATION

-4.0%

FUELS FOR ELECTRICITY GENERATION



Highlights 2018

Overview

- Final energy demand grew by 4.5% with increases in all sectors, while the economy grew by 1.7% as measured by modified domestic demand (MDD) or by 8.2% as measured by gross domestic product (GDP).
- Primary energy demand, which includes losses in electricity generation and other energy transformation sectors, increased by 1.6%.
- Demand for fossil fuels increased by 0.1% in 2018 and was 15% lower than in 2005.

Energy-related CO_2 emissions

- Energy-related CO_2 emissions fell by 1.2%, or 453 thousand tonnes of CO_2, and are now 19% below 2005 levels.
- CO_2 emissions from the combustion of fossil fuels accounted for 59% of Ireland's total greenhouse gas (GHG) emissions.
- Energy-related CO_2 emissions outside the EU Emissions Trading Scheme (ETS), known as non-ETS emissions, grew by 4.7%. This includes transport and heating in households, the commercial sector and small industry.

Renewable energy targets

- Renewables made up 11% of gross final consumption, relative to a 2020 target of 16%. This avoided 4.7 million tonnes of CO_2 emissions and €620 million of fossil fuel imports.
- The share of electricity generated from renewable sources increased by 3.1 percentage points in 2018, to 33.2%. The 2020 target is 40%.
- The share of energy used for transport from renewable sources decreased from 7.4% in 2017 to 7.2% in 2018. The 2020 target is 10%.
- The share of energy used for heat from renewable sources decreased from 6.7% in 2017 to 6.5% in 2018. The 2020 reduction target is 12%.

Transport

- Transport continues to dominate as the largest energy-consuming sector, with a 42% share of final consumption.
- Transport energy use increased by 2.6%.
- Energy used for air travel increased by 7.9% to a new all-time high, surpassing the previous peak set in 2007 for the first time.
- Aviation now accounts for 21% of the energy used for transport, is second only to private cars, and more than heavy and light goods vehicles combined.

Electricity

- The amount of electricity generated increased by 2.9%, but there was a 4.0% reduction in the fuels used for electricity generation, and a 12.6% reduction in the CO_2 emissions from electricity generation.
- This was due to a 44% reduction in coal use for electricity generation, which is much less efficient and more carbon intensive than gas or renewables.
- This large reduction in coal use was due to a technical fault at Ireland's only coal-fired electricity generation plant, Moneypoint.
- Wind generation accounted for 28.1% (normalised) of all electricity generated. It is the second largest source of electricity generation after natural gas.
- Renewable electricity generation accounted for 33.2% (normalised) of gross electricity consumption.
- The use of renewables in electricity generation in 2018 reduced CO_2 emissions by 4 Mt and avoided €430 million in fossil fuel imports.
- The carbon intensity of electricity fell from 437 gCO_2/kWh in 2017 to 375 gCO_2/kWh. This was mainly due to the reduction in coal use and increased wind generation.
- Without renewable energy the carbon intensity of electricity generation would have been over 500 gCO_2/kWh.

Heat

- Energy use for heat increased by 6.4% in 2018, when corrected for weather the increase was 5.3%.
- Direct energy use for heat in industry increased by 4.4% in 2018.
- Direct energy use for heat in households increased by 8.3% in 2018. Despite the notable severe weather in March caused by Storm Emma, on average the temperature was only slightly colder than the previous year. When corrected for weather the increase in energy for heat in households was 6.6%.
- Direct energy use for heat in services increased by 7.3% in 2018, or 5.4% when corrected for weather.

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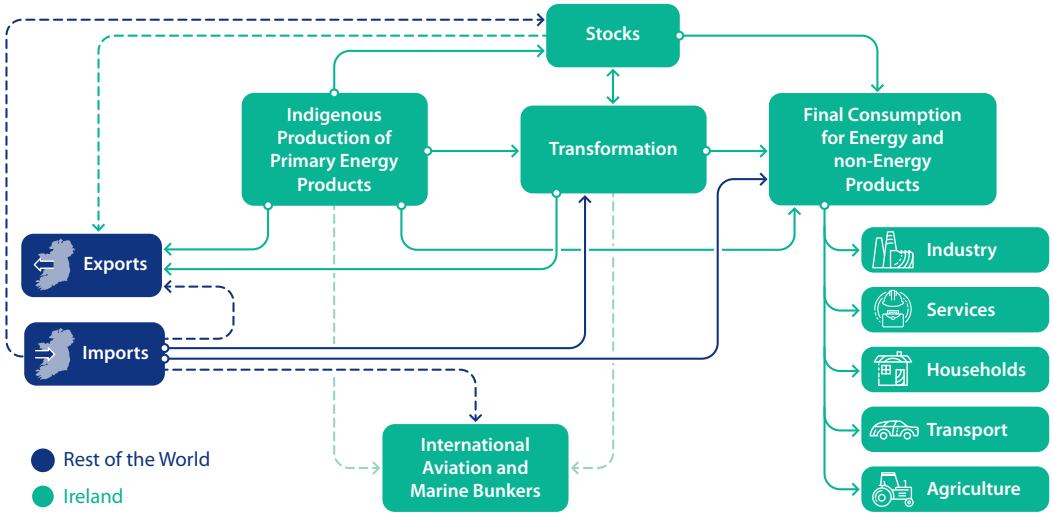
1 Introduction

This annual publication from SEAI presents national energy statistics on energy production and consumption in Ireland over the period 2005 – 2018. The report shows the trends in energy use and provides updates on Ireland's progress towards EU energy and climate targets. It also presents data and provides discussion on the underlying drivers of energy use in each sector.

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 and transformation through to final consumption in different sectors of the economy. These flows are illustrated in *Figure 1*. The energy balance is the starting point for the construction of various indicators of energy intensity, energy efficiency, and also of other areas of national interest such as energy-related greenhouse gas emissions.

Figure 1: Main energy flows in Ireland



The data in the energy balance are 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 these data to fulfil Ireland's energy statistics reporting obligations to Eurostat[1], under the EU Energy Statistics Regulation (EC 1099/2008), and to the International Energy Agency (IEA) through the completion of almost of two 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 period 2005 – 2018 are presented in this report.

A companion publication, *Energy Statistics – 2018 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. These publications are intended to 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 https://www.seai.ie/data-and-insights/.

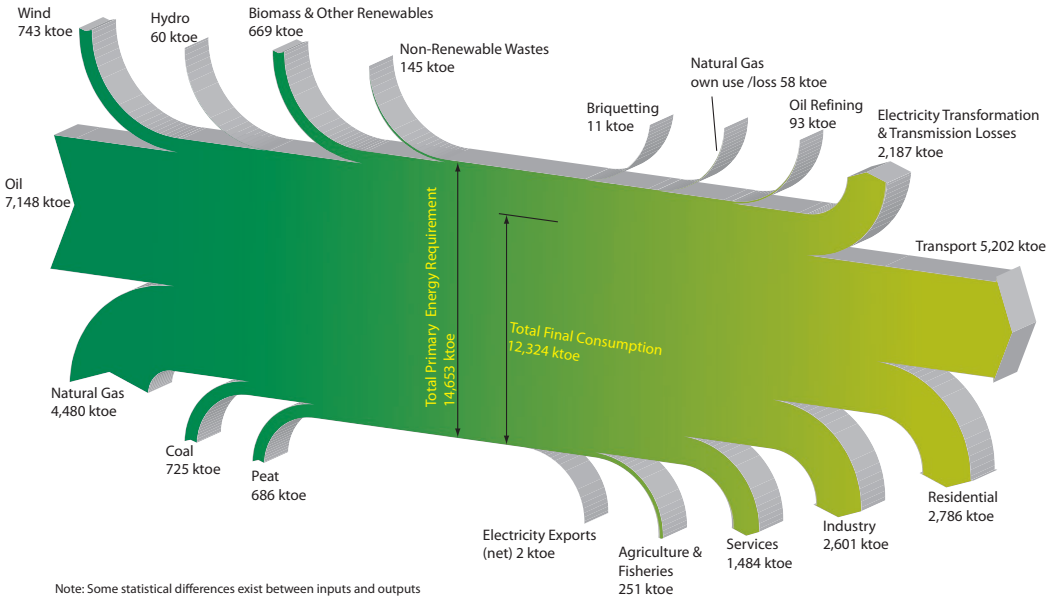
Feedback and comments on this report are welcome. Contact details are available on the back cover of this report.

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

1.1 Energy balance for 2018

Figure 2 shows the energy balance for Ireland in 2018 as a flow diagram. This is a simplified view of the energy flows shown in *Figure 1*. 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 2: Energy flow in Ireland 2018[2]



Fossil fuels used include oil, natural gas, coal and peat. In total they accounted for 13,039 ktoe (89%) of primary energy use in 2018. Oil dominated as a fuel, accounting for 7,148 ktoe, representing 49% of the total primary energy requirement. Renewables are disaggregated into wind, hydro and other renewables in *Figure 2,* and accounted for 10% of primary energy. Non-renewable wastes accounted for the remaining 1% of energy in 2018.

Transport continues to be the largest of the end-use sectors. It accounted for 5,202 ktoe in 2018, representing 42% of total final energy consumption.

Losses associated with the generation and transmission of electricity amounted to 15% of total primary energy requirement, or 2,187 ktoe, in 2018 (48% of the primary energy used for electricity generation). In 2005, losses associated with electricity generation represented 19% of the total primary energy requirement and 59% of the primary energy used for generation.

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

2 Final energy use

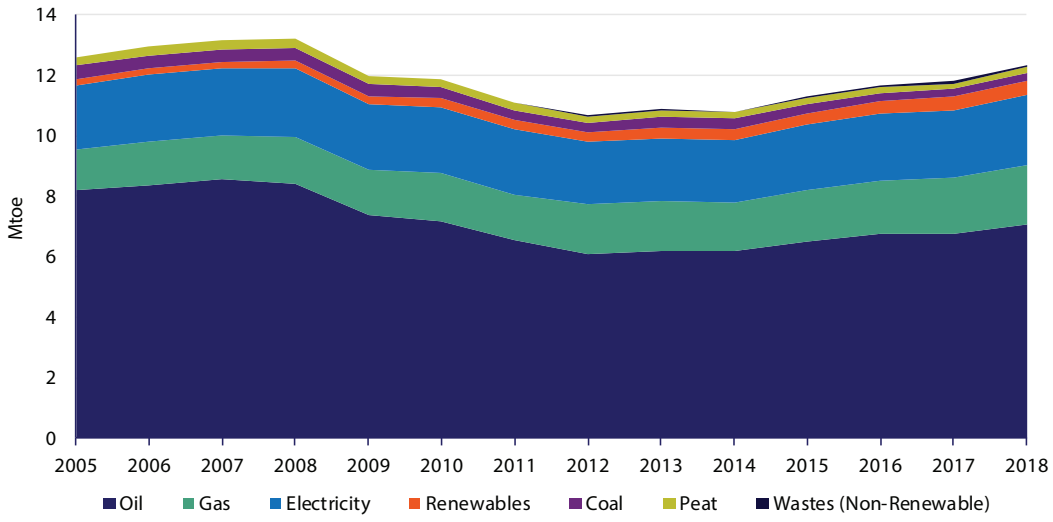
Final energy is the energy that is consumed directly by the end-user. It includes all the energy that is delivered for activities as diverse as manufacturing, transport of people and goods, and the day-to-day energy requirements of living such as heating and cooking. We look at the final energy split by fuel and sector, and we look in detail at the final energy used in heat, transport, and electricity.

Final energy does not include the energy consumed by the energy industry itself in the transformation sector or distribution losses. For example it includes the electricity used by end-users, but not the energy that was consumed to produce the electricity, such as coal, gas or wind. Similarly, it includes the energy in petrol and diesel used by end-users, but not the energy used to convert crude oil to petrol and diesel in a refinery. It is important to consider final energy as this is the energy use that end-users have direct control of.

2.1 Final energy by fuel

Figure 3 shows the split of final energy demand by fuel for the period 2005 – 2018.

Figure 3: Total final consumption by fuel



Source: SEAI

Total final energy consumption increased again in 2018, by 4.5% (4.0% weather corrected). After the economic crisis of 2008, total final consumption fell to a low of 10,671 ktoe in 2012, but it has increased in five of the six years since then. In 2018 it was 15% above the 2012 low point, but was 6.6% lower than the peak in 2008.

Looking at the split in final energy use by fuel type shown in *Figure 3*, oil has by far the largest share, accounting for 57% in 2018, significantly more than all other fuel types put together. This is as a result of the almost complete dependence on oil for transport and on the fact that transport makes up the largest share of final energy use.

The changes in the growth rates, quantities and respective shares of individual fuels in final consumption over the period are shown in *Table 1*.

For more details on absolute values associated with *Table 1* see the companion document Energy Statistics 1990 – 2018.

Oil has by far the largest share of final energy use at 57% in 2018, more than all other fuel types put together. Transport and home heating account for 86% of oil use.

Table 1: Growth rates, quantities and shares of final energy

	Overall Growth %	Average Annual Growth %					Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Fossil Fuels (Total)	-8.3	-0.7	-1.9	-1.5	2.8	4.8	10,324	9,471	81.9	76.9
Coal	-46.2	-4.7	-5.4	-3.2	-5.8	3.8	484	261	3.8	2.1
Peat	-27.9	-2.5	-1.5	-4.5	-0.7	4.4	274	197	2.2	1.6
Oil	-13.8	-1.1	-2.7	-2.0	2.9	4.3	8,196	7,065	65.0	57.3
Natural Gas	42.3	2.8	3.0	1.5	4.3	6.9	1,369	1,948	10.9	15.8
Renewables (Total)	146.4	7.2	10.5	5.2	5.1	1.0	188	464	1.5	3.8
Wastes (Non-Renewable)	-	-	-	38.8	7.6	-3.7	0	55	0.0	0.4
Combustible Fuels (Total)	-5.5	-0.4	-1.7	-1.2	2.9	4.5	10,507	9,932	83.3	80.6
Electricity	11.5	0.8	0.9	-0.3	2.7	4.4	2,094	2,334	16.6	18.9
Total	**-2.2**	**-0.2**	**-1.2**	**-1.0**	**2.9**	**4.5**	**12,606**	**12,324**		
Total (Weather Corrected)	**-3.2**	**-0.2**	**-2.2**	**-0.3**	**3.2**	**4.0**	**12,645**	**12,242**		

The most significant changes can be summarised as follows:

- Total final consumption was 12,324 ktoe in 2018, an increase of 4.5% on 2017. When corrected for weather[3], it increased by 4.0%.
- Final energy use of fossil fuels increased by 4.8%. Direct use of coal, peat, oil and natural gas all increased.
- Final energy consumption of electricity increased by 4.4% in 2018 to 2,334 ktoe (or 27,148 GWh). In 2018, electricity accounted for 18.9% of total final consumption.
- Final energy use of all renewable energy increased by 1.0% overall. Renewable energy use was up 8.0% and 3.5% in the residential and industry sectors respectively, but down 4.0% in transport. Renewables accounted for 3.8% of final energy use.[4]
- Final energy use of oil increased by 4.3% in 2018. This was driven by increased oil use in transport and households, which saw the final use of oil grow by 2.8% and 9.5% respectively. The share of oil in final energy consumption in 2018 was 57.3%.
- Final energy use of natural gas increased by 6.9% in 2018. It accounted for 15.8% of total final consumption. Gas use increased in most sectors in 2018, with increases in industry, services and households of 3.4%, 9.9% and 8.7% respectively.
- Final energy use of coal increased by 3.8% in 2018. It accounted for 2.1% of total final consumption. Coal use increased in industry (+3.1%) and households (+4.4%).
- Final energy use of peat increased by 4.4% in 2018. It accounted for 1.6% of total final consumption. Final use of peat was almost exclusively in the residential sector where all of the increase occurred in 2018.

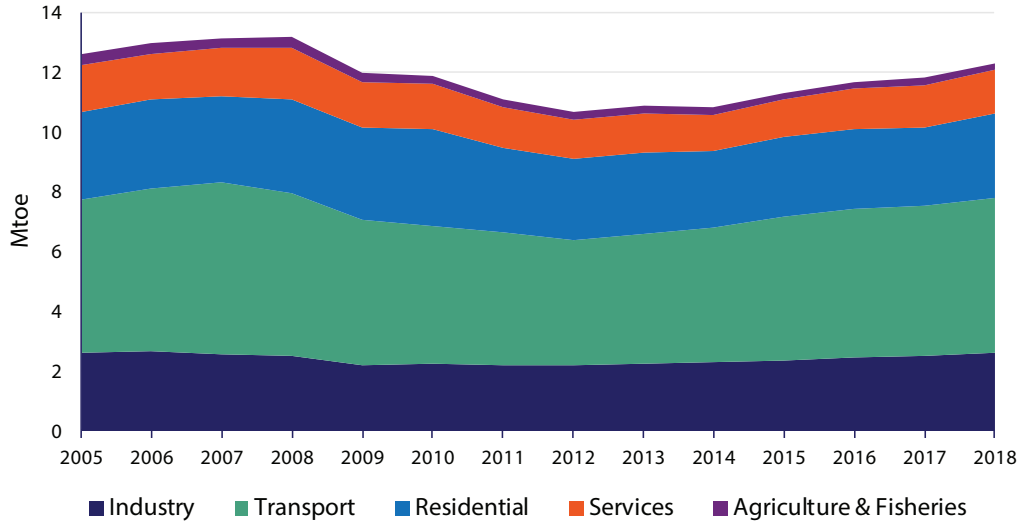
3 Weather correction is a method of smoothing out the variations in energy use for heating purposes resulting from annual changes in temperature. See *Glossary of terms* for more details.

4 Note that this does not include wind or hydro energy used for electricity production, as this is final energy.

2.2 Final energy by sector

Figure 4 shows final energy split by sector. Transport continues to dominate as the largest energy-consuming sector, with a share of 42% in 2018. The shares of the industry and residential sectors have decreased since the 1990s. In 2018, industry accounted for 21% of final energy use and the residential sector for 23%. The effect of the economic downturn is evident, in transport in particular, from 2008 to 2012.

Figure 4: Total final consumption by sector



Source: SEAI

Table 2: Growth rates, quantities and shares of final energy by sector

	Overall Growth %	Average Annual Growth %					Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Industry	-1.2	-0.1	-3.1	1.0	3.2	4.7	2,633	2,601	20.9	21.1
Transport	2.3	0.2	-2.0	0.8	2.8	2.6	5,084	5,202	40.3	42.2
Residential	-5.1	-0.4	2.1	-4.0	1.6	6.8	2,937	2,786	23.3	22.6
Services	-5.4	-0.4	-1.3	-2.7	5.0	6.4	1,569	1,484	12.4	12.0
Agriculture & Fisheries	-34.5	-3.2	-5.1	-5.6	4.4	6.3	383	251	3.0	2.0
Total	**-2.2**	**-0.2**	**-1.2**	**-1.0**	**2.9**	**4.5**	**12,606**	**12,324**		

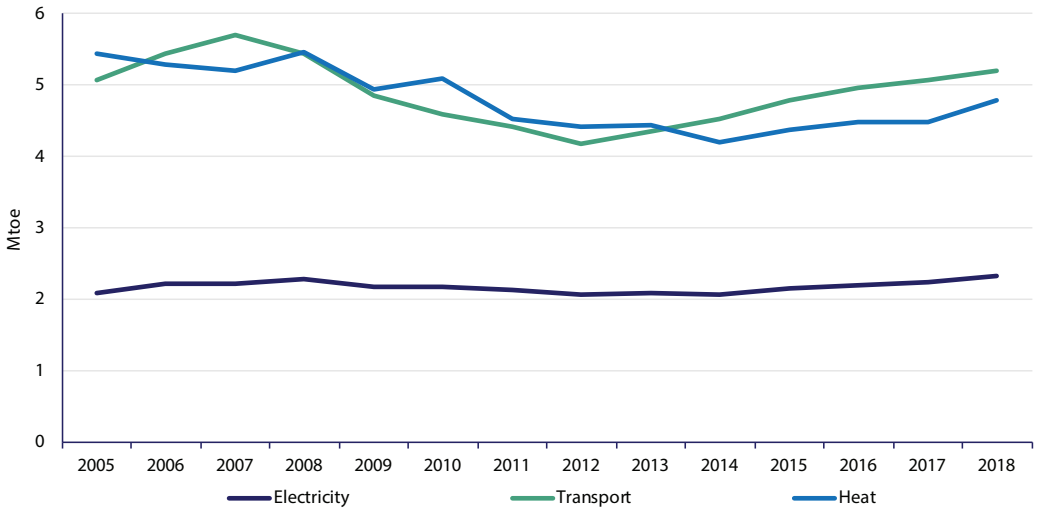
The changes in growth rates, quantities and shares are shown in *Table 2* and summarised as follows:

- Overall final energy consumption grew by 4.5% in 2018 – an increase of 533 ktoe to 12,324 ktoe – with all sectors showing growth.
- Final energy use in the residential sector increased by 178 ktoe, or 6.8%, in 2018 to 2,786 ktoe. Correcting for weather, residential energy use increased by 5.5%.
- There was a 6.4% increase (90 ktoe) in final energy use in the services sector in 2018 to 1,484 ktoe. Correcting for weather, the increase was 5.2%.
- In 2018, final energy use in industry grew by 4.7% – 117 ktoe in absolute terms – to 2,601 (or a 1.2% decrease in absolute terms) and its share of total final consumption remained steady at 21%.
- Energy use in transport grew in 2018 by 2.6%, to 5,202 ktoe, and an increase in absolute terms of 134 ktoe.
- The agricultural and fisheries sector's relative share fell from 3.0% in 2005 to 2.0% in 2018. Agriculture's energy consumption increased in 2018 by 6.3% (15 ktoe) to 251 ktoe.

2.3 Final energy by mode

Energy use can also be split into electricity, transport and heat. These three modes represent distinct energy services or markets. Where thermal or transport energy is provided by electricity (e.g. electric heaters or electric vehicles), this energy is counted under electricity, and not under thermal or transport. This means that there is no overlap and the modes can be added together to give total final energy use. *Figure 5* shows final energy split by mode.

Figure 5: Final energy in heat, transport and electricity



Source: SEAI

Table 3: Growth rates, quantities and shares of final energy in heat, transport and electricity

	Overall Growth %	Average Annual Growth %				Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Electricity	11.5	0.8	1.2	2.7	4.4	2,094	2,334	17	19
Transport	2.3	0.2	4.7	2.8	2.6	5,079	5,197	40	42
Heat	-12.0	-1.0	-0.4	3.0	6.4	5,433	4,778	43	39

Transport has had the largest share of final energy demand since 2014. In 2018, transport accounted for 42% of final energy, closely followed by heat at 39%. Electricity has the smallest share of final demand, accounting for 19% in 2018.

Transport energy decreased sharply after the economic crash in 2008, but returned to growth in 2013, and has increased every year since. For more details on energy use in transport see *Table 2.5* and *Table 7.2*.

Heat final energy use shows greater year to year fluctuations than transport or electricity. This is due to the effects of weather. For more on how weather affects heating energy see *Table 5.2*. When corrected for temperature variations, overall energy use for heat declined between 2008 and 2014, but increased between 2014 and 2018. This is due to the effects of the recession coupled with a period of record high oil prices between 2008 and 2014. With the recovery of the economy, and reduced oil prices after 2014, demand for heat increased. Final energy use for heat is discussed further in *Table 2.4*.

Electricity use increased steadily every year from 1990 to 2008, but following the recession it reduced by 9% between 2008 and 2012. Electricity use remained flat between 2012 and 2014, but from 2015 it returned to growth, and in 2018 electricity use surpassed the previous level to reach a new peak consumption. Electricity consumption as a share of total final consumption increased from 17% to 19% between 2005 and 2018. Electricity final energy use is discussed in *Table 2.6* and electricity generation is discussed in section *Table 4.1*

2.4 Heat

2.4.1 Heat final energy by sector

Figure 6 and *Table 4* show the trends for energy used for heat, split by sector. Energy use for heat increased by 6.4% in 2018 and, when corrected for weather, the increase was 5.3%.

Households are the single largest consumer of heat energy, larger than industry. This is partly because Ireland has very little energy intensive heavy industry, such as steel or car manufacturing. Direct energy use for heat in households increased by 8.3% in 2018.

Household heat energy demand is the most strongly affected by weather. Peak household heat energy demand occurred in 2010, which had periods of extremely cold weather. From 2010 to 2014 household energy demand decreased due to a combination of reduced disposable incomes during the recession, record high fuel prices, and energy efficiency improvements. Since 2014 this trend has reversed due to the recovering economy and a drop in fuel prices. When corrected for weather, the increase in energy use for heat in households in 2018 was 6.6%.

Industry use peaked in 2005, and fell sharply in 2009 following the economic crisis. Industry heat use increased after 2012. In 2018 was 19% above 2012, but still remained 16% below the 2005 peak.

Heat use in services peaked in 2008, reduced during the recession and began to increase again after 2014. In 2018 it was 22% higher than in 2014, but still 9% below the 2008 peak. Direct energy use for heat in services increased by 7.3% in 2018, or 5.4% when corrected for weather.

Figure 6: Final consumption of heat by sector

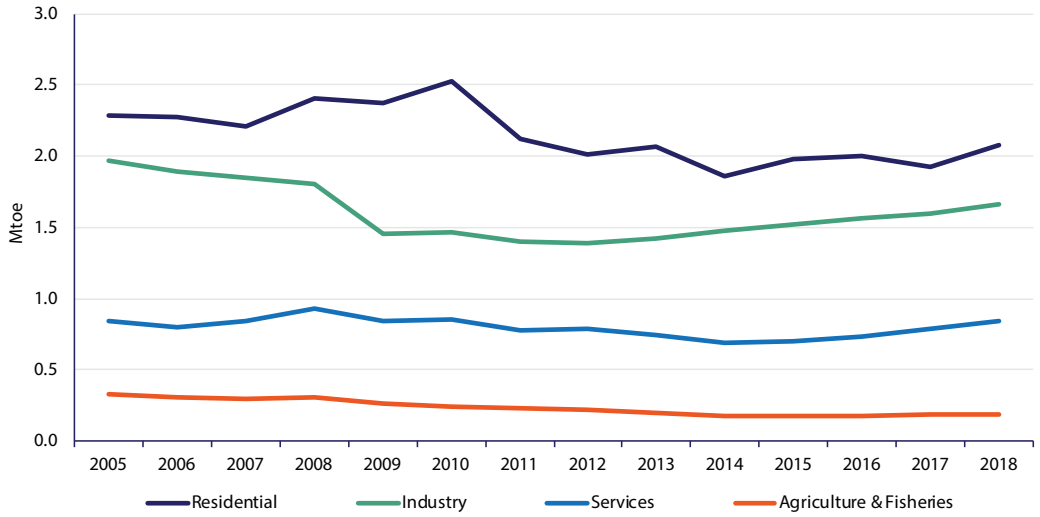


Table 4: Growth rates, quantities and shares of heat final energy by sector

	Overall Growth %	Average Annual Growth %				Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Residential	-9.1	-0.7	6.2	1.7	8.3	2,291	2,083	42	44
Industry	-15.6	-1.3	2.7	3.1	4.4	1,973	1,665	36	35
Services	0.2	0.0	2.0	6.3	7.3	841	843	15	18
Agriculture & Fisheries	-42.7	-4.2	-4.8	2.9	0.0	328	188	6	4
Total	**-12.0**	**-1.0**	**3.8**	**3.0**	**6.4**	**5,433**	**4,778**		

2.4.2 Heat final energy by fuel

The use of energy for heat was dominated by oil use from 1990 to 2010. Oil was still the most prominent fuel for heat energy in 2018 but its share has fallen, from almost 60% in 2005 to 42% in 2018. Gas use for heat has steadily increased since 1990. By 2005 it accounted for 25% of heat energy and increased to 40% by 2018 due to the expanding gas network and falling oil use.

There has been a shift from oil to gas for heat. In 2000, 59% of heat was from oil and 24% from gas whereas, in 2018, 42% of heat was from oil and 40% from gas.

Figure 7: Final consumption of heat by fuel

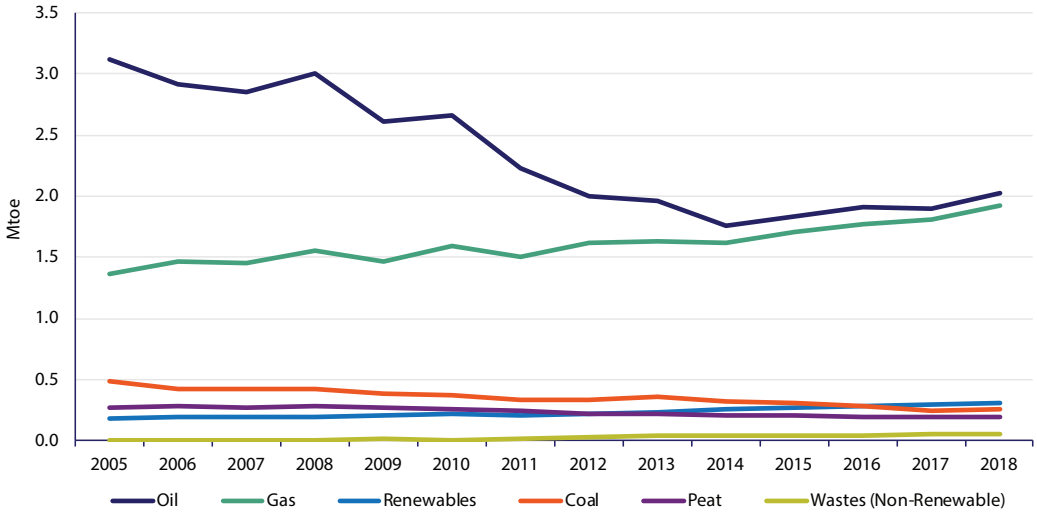
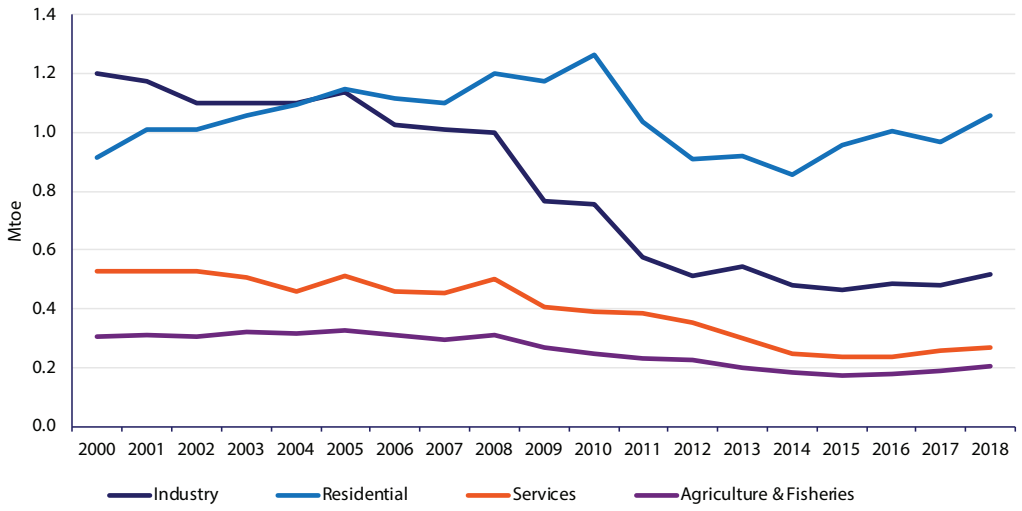


Table 5: Growth rates, quantities and shares of heat final energy by fuel

	Overall Growth %	Average Annual Growth %				Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Fossil Fuels	-15.9	-1.3	-2.5	2.9	6.7	5,246	4,414	97	92
Oil	-34.9	-3.3	-5.2	3.5	7.3	3,120	2,030	57	42
Gas	40.9	2.7	2.3	4.0	6.8	1,367	1,926	25	40
Coal	-46.2	-4.7	-4.3	-5.8	3.8	484	261	9	5
Peat	-27.9	-2.5	-3.0	-0.7	4.4	274	197	5	4
Renewables	65.4	3.9	3.8	4.5	3.6	187	310	3	6
Wastes (Non-Renewable)	-	-	-	7.6	-3.7	0	55	0	1
Total	**-12.0**	**-1.0**	**-2.2**	**3.0**	**6.4**	**5,433**	**4,778**		

Most of the drop in oil use for heat happened in industry, although it has reduced in all sectors. In industry, oil use in 2018 was 55% lower than in 2005. In households, oil use decreased 32% between 2010 and 2014, but increased by 24% between 2014 and 2018. Oil use in services also decreased, and in 2018 was 46% lower than in 2008. The economic recession from 2009 to 2012 and the record high oil prices experienced between 2011 and 2014 were significant factors during this time period.

Figure 8: Final consumption of oil for heat

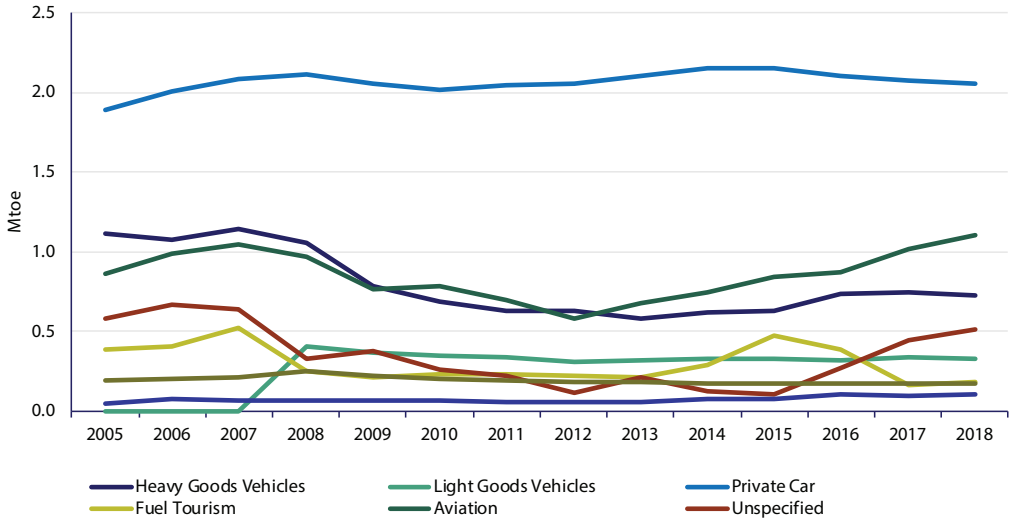


2.5 Transport

2.5.1 Transport final energy by mode

Figure 9 and *Table 6* show the trends for transport's energy use by mode. Private car energy use clearly dominates. Private car energy use declined following the economic crash during 2009 and 2010 but returned to growth soon after, in 2011. It grew year on year between 2011 and 2014, but reduced slightly each year between 2014 and 2018[5].

Figure 9: Transport energy demand by mode



Aviation energy use also reached a peak in 2007, and decreased sharply afterwards due to the recession. By 2012, aviation had reduced by 44% compared to 2007. Aviation energy use returned to growth in 2013 and since then it has recovered much more strongly than car or freight, increasing by 88% between 2012 and 2018. In 2018 aviation surpassed the previous 2007 peak for the first time, climbing 5.5% above it.

5 The reduction in our estimate of private car energy use was due to the estimated amount of kilometres driven by private cars levelling off and the estimated efficiency of the car stock improving. While this appears to be an encouraging trend, there is reason to be cautious due to some uncertainty in the estimate. While our estimates of the energy use of private cars, heavy goods vehicles and light goods vehicles have all decreased, the actual amount of fuel used has gone up, leading to an increase in the amount labelled as unspecified. We know that in real world driving the fuel consumption of cars is significantly worse than in standardised tests. There have been international studies carried out to try to quantify the difference, we use apply an on-road factor based on an estimate developed by the International Council for Clean Transportation. It may be the case however that the real word performance of cars in Ireland is actually worse still than that estimate. This is very difficult to quantify. Therefore we should be cautious in interpreting the current trend.

In 2018 aviation surpassed the previous 2007 peak for the first time, climbing 5.5% above it.

Table 6: Growth rates, quantities and shares of transport final energy demand by mode

	Overall Growth %	Average Annual Growth %					Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Heavy Goods Vehicle (HGV)	-34.7	-3.2	-9.2	-1.9	5.1	-3	1,112	727	22	14
Light Goods Vehicle (LGV)	-	-	-	-1.2	0.4	-2	-	332	-	6
Private Car	8.7	0.6	1.3	1.4	-1.6	-1	1,892	2,057	37	40
Public Passenger	-11.7	-1.0	0.9	-3.9	1.1	5	157	139	3	3
Rail	-4.5	-0.4	0.0	-2.1	2.0	1	40	38	1	1
Fuel Tourism	-52.4	-5.5	-10.0	15.7	-26.9	14	387	184	8	4
Navigation	68.8	4.1	5.4	2.1	5.5	11	50	84	1	2
Aviation	28.4	1.9	-1.7	1.5	9.2	8	859	1,103	17	21
Pipeline	922.6	19.6	-0.9	13.2	79.3	11	2	23	0	0
Unspecified	-12.1	-1.0	-14.9	-16.3	68.6	13	580	510	11	10
Total	**2.3**	**0.2**	**-2.0**	**0.8**	**2.8**	**3**	**5,079**	**5,197**		

Heavy goods vehicle (HGV) road freight energy use reduced by 49% between 2007 and 2013 as a result of reduced activity during the recession. The energy consumption of heavy goods vehicles increased by 29% between 2013 and 2017, but decreased by 2.6% in 2018. This was again due to changes in levels of activity, i.e. the amount of tonne-kilometres transported. In 2018 the amount of energy uses by heavy goods vehicles remained 35% below the 2005 level.

2.5.2 Transport final energy by fuel

Figure 10 and *Table 7* show the trends for transport's energy use by fuel type between 2000 and 2018, excluding electricity.

The biggest shift in the transport market has been from petrol to diesel. Diesel consumption increased by 30%, while petrol use fell by 55%. Diesel's overall market share grew from 47% in 2005 to 60% in 2018.

Transport energy use peaked in 2007, at 5,715 ktoe, and fell each year thereafter until 2013. As the economy started to expand again, transport energy use grew every year from 2013 to 2018, and in 2018 was 25% higher than in 2012. Energy consumption in transport was 2.3% higher in 2018 than in 2005, but remained 9% lower than the peak in 2007.

In 2018, overall energy use in transport increased by 2.6% compared with the previous year.

- Petrol use continued to fall in 2018, reducing by 9.2% to 821 ktoe. Petrol consumption is now 56% lower than the peak in 2007.
- Diesel consumption grew by 4.7% during 2018, to 3,095 ktoe. Diesel has by far the largest share of transport fuel use, accounting for 60% in 2018.
- Jet kerosene consumption increased by 7.9% in 2018, to 1,102 ktoe, accounting for 21% of transport's final energy use, the second largest fuel share after diesel.

Figure 10: Final consumption of transport by fuel

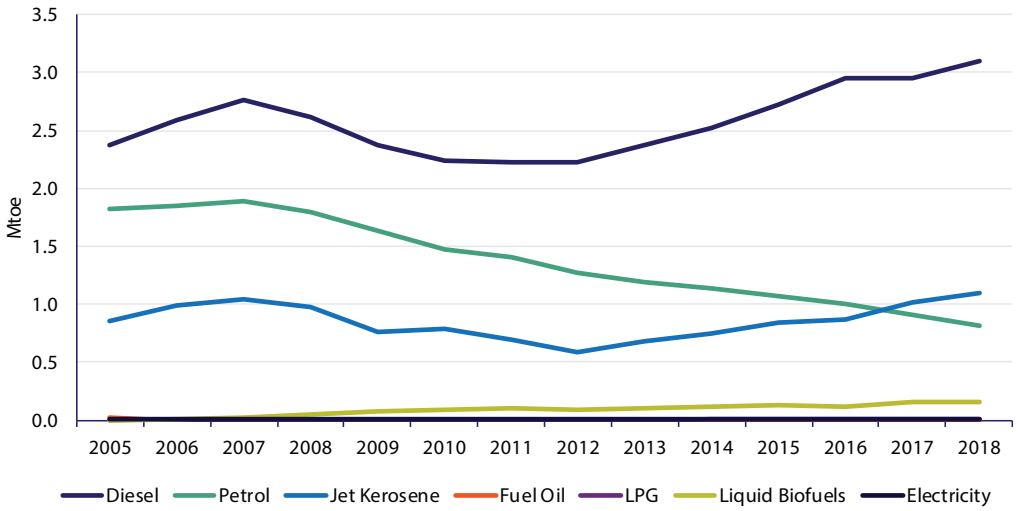


Table 7: Growth rates, quantities and shares of final consumption in transport

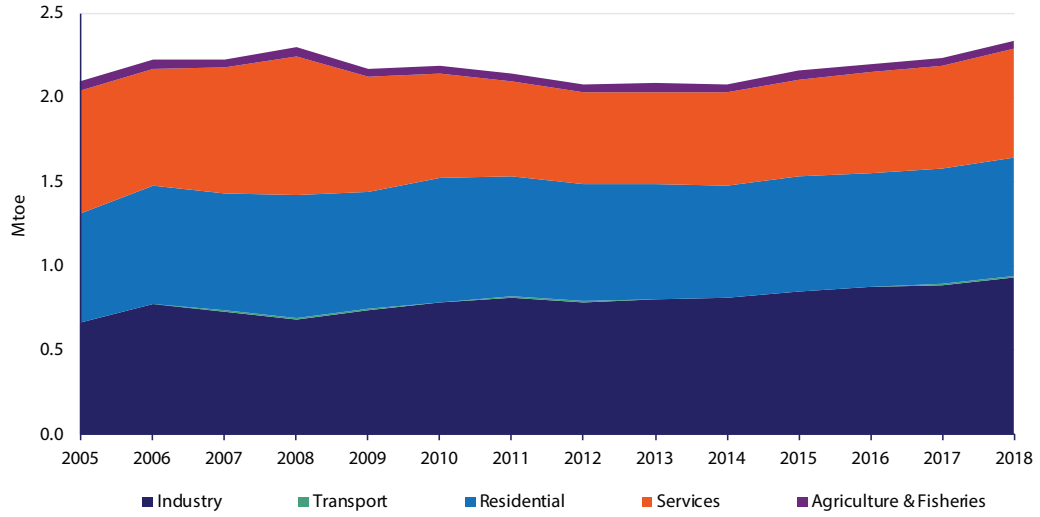
	Overall Growth %	Average Annual Growth %				Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Fossil Fuels (Total)	-0.7	-0.1	0.7	2.7	2.8	5,078	5,042	100.0	97.0
Total Oil	-1.1	-0.1	0.7	2.6	2.8	5,076	5,020	99.9	96.6
Petrol	-54.9	-5.9	-6.2	-8.6	-9.2	1,822	821	35.9	15.8
Diesel	30.1	2.0	4.1	4.3	4.7	2,378	3,095	46.8	59.5
Jet Kerosene	28.6	2.0	1.5	9.2	7.9	857	1,102	16.9	21.2
LPG	81.8	4.7	37.5	-9.9	-17.8	1	2	0.0	0.0
Natural Gas	923.9	19.6	13.3	79.1	11.5	2	22.56	0.0	0.4
Renewables	13945.1	46.3	6.7	6.4	-4.0	1	154	0.0	3.0
Combustible Fuels (Total)	2.3	0.2	0.8	2.8	2.6	5,079	5,197	100.0	100.0
Total	**2.3**	**0.2**	**0.8**	**2.8**	**2.6**	**5,084**	**5,202**		

2.6 Electricity

2.6.1 Electricity final energy by sector

Figure 11 shows the final electricity consumption in each of the main sectors. Final electricity demand peaked in 2008, at 2,294 ktoe before falling in the subsequent recession. It began to grow again in 2012 and in 2018 it surpassed the previous peak for the first time, reaching 1.8% higher than in 2008, at 2,334 ktoe (27,148 GWh). This was an increase of 4.4% on 2017.

Figure 11: Final consumption of electricity by sector



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

Table 8 shows changes in individual sector's electricity demand, and the impacts these changes have on the final consumption of electricity. Electricity demand grew in all sectors in 2018. In terms of shares of final electricity use, industry has the largest share at 40%, with the residential sector being the second largest at 30%. Transport experienced the largest growth in electricity at 16% (but from a very small base) to account for just 0.2% of the final share of electricity in 2018. Electricity use in transport includes that used by the Dublin Area Rapid Transit (DART) system and the Luas, and electric vehicles on the road. In absolute terms, electricity consumption in transport is small, at 60 GWh (5.2 ktoe), of which electric vehicles are estimated to account for approximately 12 GWh.

Table 8: Growth rates, quantities and shares of electricity final consumption

	Overall Growth %	Average Annual Growth %					Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Industry	41.9	2.7	3.5	1.6	3.4	5.3	660	936	31.5	40.1
Transport	2.6	0.2	-5.0	-0.8	11.4	16.2	5.1	5.2	0.2	0.2
Residential	8.8	0.7	2.6	-1.6	1.2	2.6	646	703	30.8	30.1
Services	-11.8	-1.0	-3.3	-1.2	3.4	5.3	728	642	34.8	27.5
Agriculture & Fisheries	-13.3	-1.1	-2.8	0.0	0.0	0.0	55	48	2.6	2.1
Total	**11.5**	**0.8**	**0.9**	**-0.3**	**2.7**	**4.4**	**2,094**	**2,334**		

3 Primary energy supply

Primary energy is the total amount of energy used, including all the energy that is consumed for energy transformation processes such as electricity generation and oil refining. We look at primary energy by fuel, sector and mode.

For energy that goes through a transformation process, such as electricity generation, the primary energy requirement depends on the efficiency of the transformation process, as well as the underlying demand for final energy.

3.1 Primary energy by fuel

Figure 12: Total primary energy requirement[6]

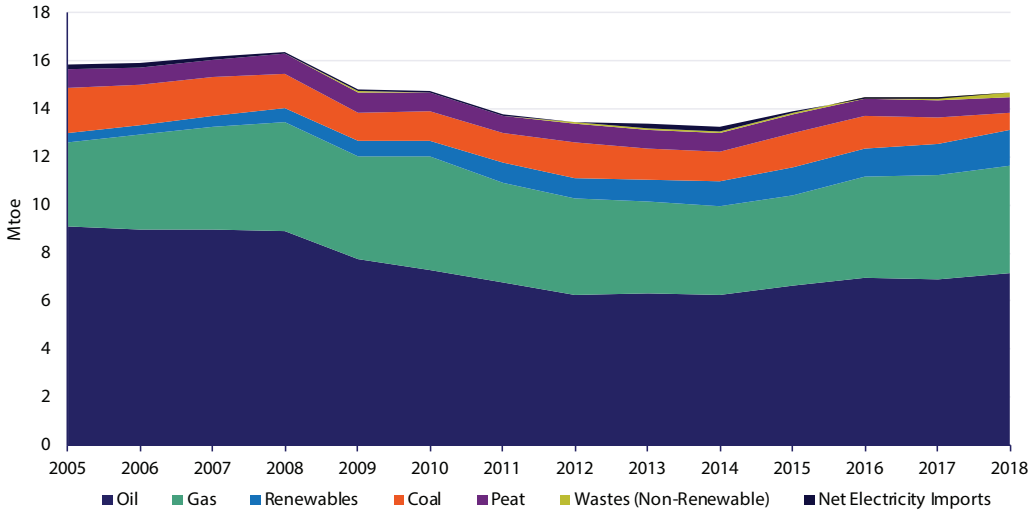


Figure 12 illustrates the trend in primary energy requirement over the period 2005 – 2018, emphasising changes in the fuel mix. Primary energy consumption in Ireland in 2018 was 14,653 ktoe, a 1.6% increase on the previous year. Over the period 2005 – 2018, Ireland's annual primary energy requirement fell in absolute terms by 7.6% (0.6% per annum on average).

The individual fuel growth rates, quantities and shares are shown in *Table 9*. Primary energy requirement peaked in 2008 and has fallen by 10.3% since then.

Table 9: Growth rates, quantities and shares of primary energy fuels

	Overall Growth %	Average Annual Growth %					Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Fossil Fuels (Total)	-14.8	-1.2	-1.8	-2.1	1.1	0.1	15,306	13,039	96.6	89.0
Coal	-61.5	-7.1	-8.1	3.0	-20.2	-34.1	1,882	725	11.9	4.9
Peat	-13.3	-1.1	-0.7	0.0	-3.6	-1.3	791	686	5.0	4.7
Oil	-21.7	-1.9	-4.4	-1.8	2.4	3.3	9,130	7,148	57.6	48.8
Natural Gas	27.9	1.9	6.1	-4.4	5.9	3.8	3,503	4,480	22.1	30.6
Renewables (Total)	297.2	11.2	12.9	10.9	9.0	10.2	370	1,471	2.3	10.0
Hydro	10.0	0.7	-1.0	6.1	-4.9	0.4	54	60	0.3	0.4
Wind	677.0	17.1	20.4	18.5	9.5	16.1	96	743	0.6	5.1
Biomass	127.1	6.5	3.1	6.2	12.9	11.0	180	410	1.1	2.8
Other Renewables	546.1	15.4	34.2	4.5	6.1	-2.8	40	259	0.3	1.8
Wastes (Non-Renewable)	-	-	-	51.7	28.3	28.4	-	145	-	1.0
Electricity Imports (net)	-101.4	-171.8	-25.5	7.4	-134.5	-95.9	176	-2	1.1	0.0
Total	**-7.6**	**-0.6**	**-1.5**	**-1.2**	**1.8**	**1.6**	**15,852**	**14,653**		

6 'Wastes (Non-Renewable)' in the graph represents energy from non-renewable wastes.

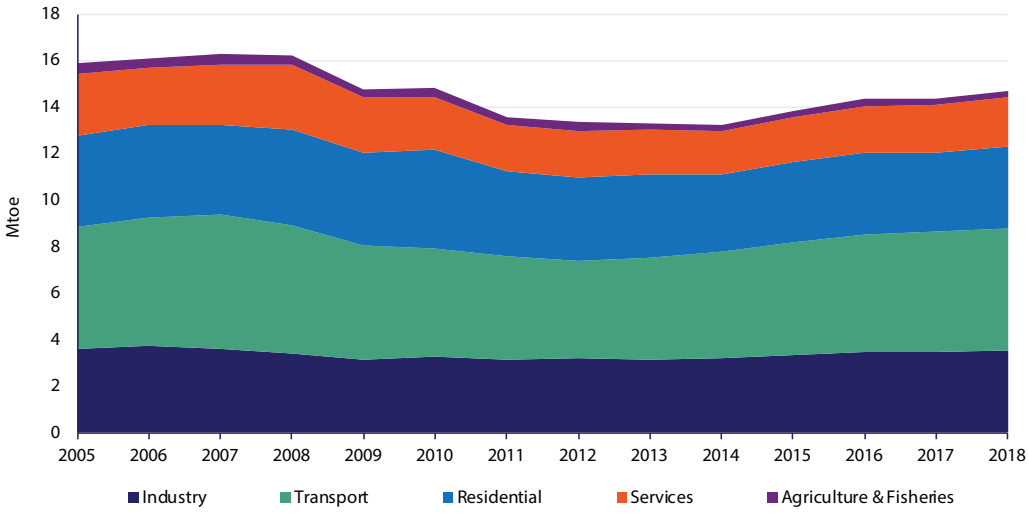
The following are the main trends in the national fuel share:

- Overall primary energy use grew by 1.6% in 2018.
- Fossil fuels accounted for 89% of all the energy used in Ireland in 2018. Demand for fossil fuels increased by 0.1% in 2018, to 13,039 ktoe, but was 15% lower than in 2005.
- Coal use decreased by 34% in 2018 and its share of total primary energy requirement fell to 4.9%, down from 10.3% in 2015. Since 2005, coal demand has fallen by 61% (7.1% per annum).
- Peat use fell by 1.3% in 2018 and its share of overall energy use was 4.7%.
- Oil continues to be the dominant energy source and maintained a 49% share of total primary energy requirement in 2018. The share of oil in overall energy use peaked in 1999 at 60%. Consumption of oil, in absolute terms, increased by 3.3% in 2018, to 7,148 ktoe, but compared with 2005, oil demand in 2018 was 22% lower.
- Natural gas use increased in 2018 by 3.8%, to 4,480 ktoe, and its share of total primary energy requirement increased to 31%. Natural gas use was 28% higher than in 2005.
- Total renewable energy increased by 10.2% during 2018, to 1,471 ktoe. Hydro and wind increased by 0.4% and 16% respectively. Biomass use increased by 11% in 2018, to 410 ktoe, and other renewables fell by 2.8%, to 259 ktoe. The overall share of renewables in primary energy stood at 10.0% in 2018, up from 9.3% in 2017.
- Energy from non-renewable wastes increased by 28% in 2018, to 145 ktoe, and accounted for 1% of primary energy.
- Ireland continued to be a net exporter of electricity in 2018, exporting just 2 ktoe, 96% less than in 2017.

3.2 Primary energy by sector

Figure 13 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 13: Total primary energy requirement by sector[7]



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

Table 10 shows the growth rates of the different sectors in terms of total primary energy requirement and also provides the percentage shares for 2005 and 2018.

Comparing *Table 10* to *Table 2*, we can see that the increases in primary energy for the industry, services and residential sectors were less than the increases in final energy. This is because there was a significant increase in the efficiency of electricity generation, and these sectors, which use significant amounts of electricity, benefited from this.

7 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 are included in the energy balance and presented in the transport section (*Table 7.2*).

Demand for fossil fuels increased by 0.1% in 2018, to 13,039 ktoe, and was 15% lower than in 2005.

Table 10: Growth rates, quantities and shares of primary energy by sector

	Overall Growth %	Average Annual Growth %					Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Industry	-3.1	-0.2	-2.1	0.3	2.0	1.0	3,634	3,523	22.9	24.0
Transport	1.8	0.1	-2.1	0.8	2.7	2.6	5,181	5,274	32.7	35.9
Residential	-11.2	-0.9	1.5	-4.1	0.6	2.9	3,928	3,488	24.8	23.7
Services	-20.1	-1.7	-3.0	-3.2	3.0	1.6	2,646	2,113	16.7	14.4
Agriculture & Fisheries	-36.2	-3.4	-5.2	-5.1	2.8	2.8	468	299	3.0	2.0

Changes in sectoral primary energy consumption presented in *Table 10* are as follows:

- In 2018, primary energy use in households grew by 2.9%, to 3,488 ktoe. The residential share of primary energy was 24% in 2018.
- Transport's primary energy use increased in 2018 by 2.6%, to 5,274 ktoe. Transport's primary energy use fell by 28% between 2007 and 2012, but has increased by 25% since then. Transport remains the largest energy-consuming sector, with a 36% share of primary energy in 2018.
- Use of primary energy in the commercial and public services sector increased by 1.6% in 2018, to 2,113 ktoe. Services' share of primary energy was 14% in 2018.
- Industry's primary energy use increased by 1.0% in 2018, to 3,523 ktoe. Industry's share of primary energy was 24% in 2018.
- 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 buildings. In 2018, primary energy in buildings accounted for 38% of primary energy supply. Overall, primary energy use in buildings has fallen by 15% since 2005 (1.2% per annum) and in 2018 it increased by 2.4%, to 5,601 ktoe.
- Agriculture and fisheries' primary energy use increased by 2.8%, in 2018 to 299 ktoe, and accounted for 2% of primary energy use.

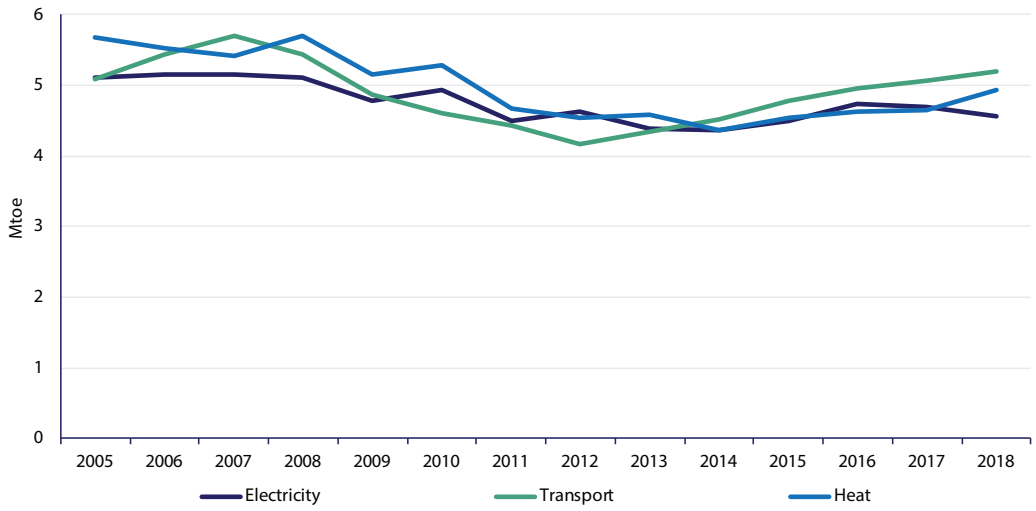
Sectoral energy-related CO_2 emissions are discussed in *Table 6.2*.

3.3 Primary energy by mode

Figure 14 shows primary energy split by heat, transport and electricity. Where thermal or transport energy is provided by electricity this energy is counted under electricity, and not under thermal or transport.

In primary energy terms, all three modes have a broadly similar share. Since 2014, transport has had the largest share, accounting for 35.4% of primary energy in 2018, followed by heat at 33.5% and electricity at 31.2%. Compared to *Figure 5*, electricity makes up a far higher share of primary energy than it does of final energy. This is because primary energy includes the large amount of energy that is lost as waste heat in the electricity generation process. For more information on electricity generation inputs, outputs and efficiency see *Table 4.1*.

Figure 14: Primary energy by mode of application



Source: SEAI

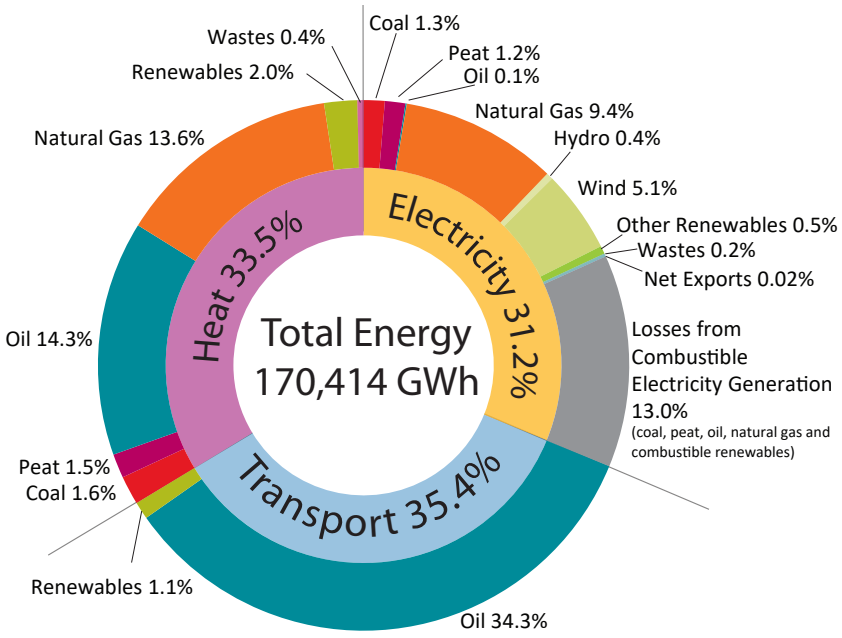
Figure 15 shows an alternative view of the 2018 energy balance. Total primary energy is shown as 170,414 GWh (14,653 ktoe) in the centre, and then the shares by mode in the next circle, and finally the shares of energy sources used in each of the modes in the outer circle. All of the percentages shown are of the total primary energy figure in the centre.

Taking transport as an example in *Figure 15*, it can be seen that transport accounted for 35.4% of overall primary energy. Oil use in transport, the bulk of transport energy use (96%), accounted for 34% of all primary energy use. Renewable energy use in transport accounted for just 1.1% of total primary energy requirement.

The energy use for heat purposes accounted for 31.2% of primary energy, and oil and gas make up the largest proportions of energy use for heat. Oil use for heat accounted for 14.3% of overall energy, natural gas 13.6%, followed by renewables at 2.0%, coal at 1.6%, peat at 1.5% and wastes at 0.4%.

Energy used to generate electricity accounted for 31.2% of all energy use in Ireland in 2018. A significant proportion of this is lost during the transformation process. Energy losses in electricity generation accounted for 13.0% of all energy use in Ireland in 2018. The figures in the outer circle show the proportions of the electricity generated by the different energy sources and their share of overall primary energy. The largest share of the electricity generated came from natural gas and represented 9.4% of primary energy use. This is followed by wind, which accounted for 28% of the electricity generated and 5.1% of primary energy. Coal generated electricity represented 1.3% of primary energy in 2018, and peat 1.2%.

Figure 15: Primary energy by mode and fuel



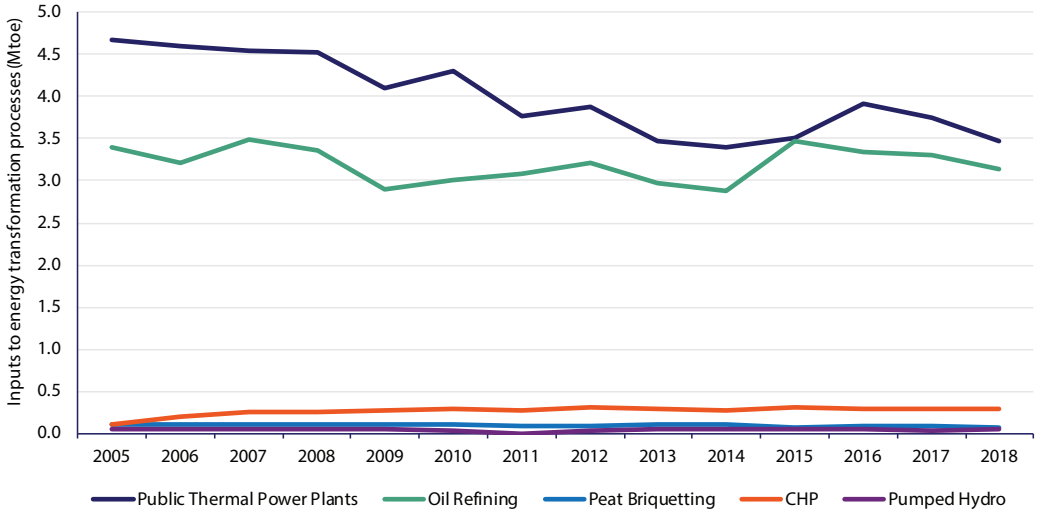
4 Electricity generation and other transformation processes

Transformation is the process of converting energy from one type of fuel to another, such as transforming crude oil into petrol and diesel, or converting coal and gas into electricity. Around half of all primary energy in Ireland is put through a transformation process before the energy reaches the final end-user.

Primary energy considers all the inputs to the energy transformation sector, while final energy only considers the outputs from energy transformation. The outputs are less than the inputs due to the energy required to make the transformation and losses from the process.

The two most significant energy transformation processes are electricity generation and oil refining, as shown in *Figure 16*.

Figure 16: Primary energy inputs to transformation processes[8]



Source: SEAI

4.1 Electricity generation

Modern economies and societies are dependent on reliable and secure supplies of electricity. We have seen in *Figure 14* that the generation of electricity accounts for one third of all energy use each year in Ireland. *Figure 17* shows the flow of energy in electricity generation[9]. Total energy inputs to electricity generation in 2018 amounted to 4,564 ktoe, 31% of total primary energy requirement. The relative size of the useful final electricity consumption compared with the energy lost in transformation and transmission is striking. These losses represent 48% 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 2018, natural gas accounted for 54% (2,461 ktoe) of the fuel inputs for electricity generation – a 1.5% increase compared with the previous year.

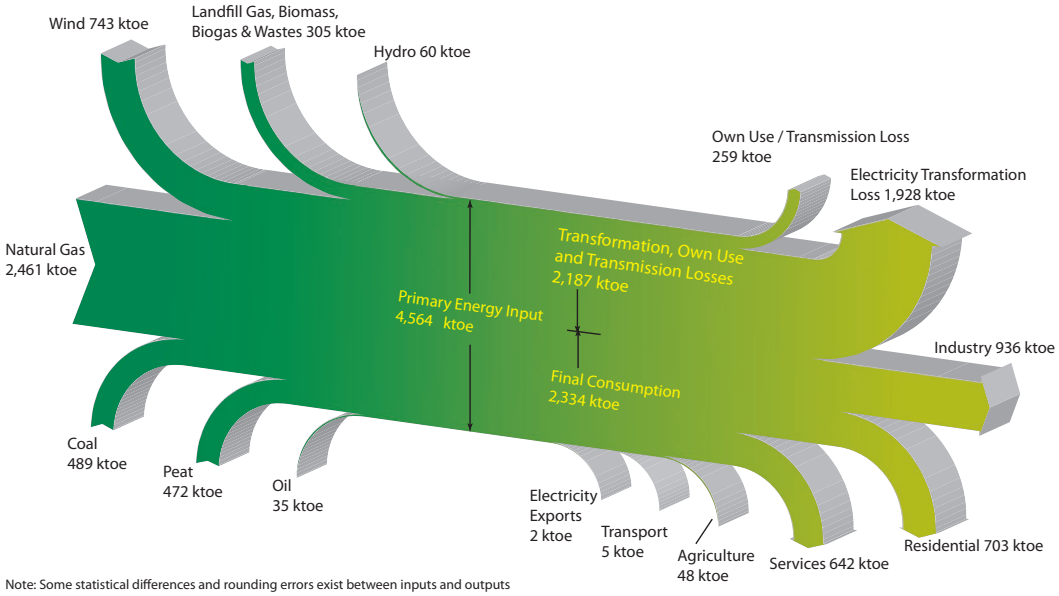
In 2018, the share of renewables in the generation fuel mix increased to 22.3%, compared with 18.6% in 2017 due, mainly, to increased wind generation. Overall, the use of renewables in the electricity generation fuel mix increased by 15% in 2018 (relative to 2017).

Total energy inputs to electricity generation in 2018 amounted to 4,564 ktoe, 4% less than in 2017 and 11% less than in 2005.

8 In this graph, non-combustable renewables such as hydro, wind and solar are not included under electricity, as technically they do not involve energy transformation. However in the following section on electricity generation non-combustible renewables are included.

9 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.

Figure 17: Flow of energy in electricity generation, 2018



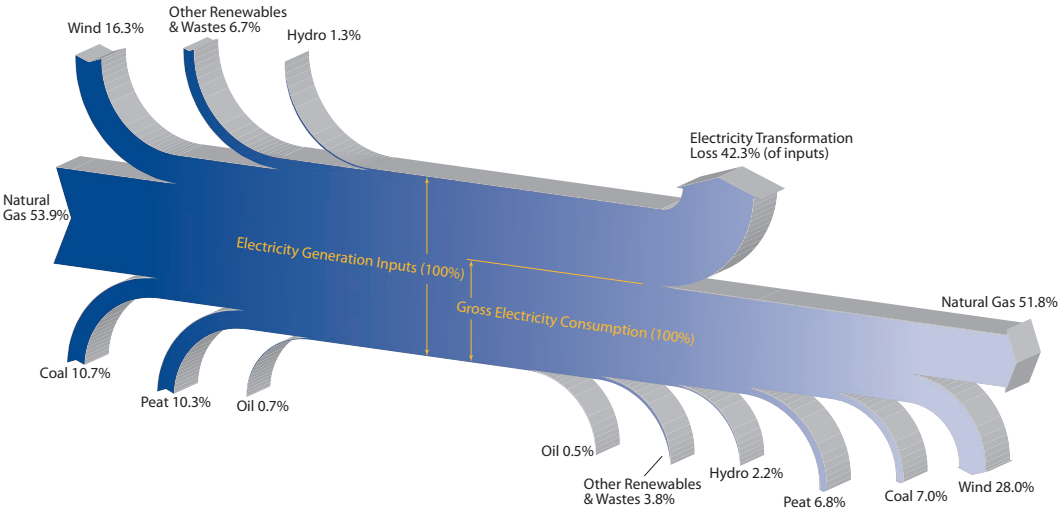
Note: Some statistical differences and rounding errors exist between inputs and outputs

Figure 18 shows a similar picture to *Figure 17* except that the electricity outputs are represented by the fuel used to generate the electricity and as percentages, for the purposes of comparing them against the various targets. Renewable generation consists of wind, hydro, landfill gas, biomass (including the renewable portion of wastes) and other biogases. In 2018, electricity generated from renewable sources amounted to 10,195 GWh, accounting for 33.0% of gross electricity consumption (compared with 29.6% in 2017).

In calculating the contribution of hydro and wind power for the purposes of Ireland's 2020 renewable targets as specified by the Renewable Energy Directive[10], the effects of weather variation and capacity change are smoothed through the use of a normalisation rule[11]. Using normalised figures for wind and hydro, renewables accounted for 33.2% of gross electricity consumption in 2018, compared with 30.1% in 2017. The national target is to achieve at least a 40% share by 2020.

In 2018, wind generation accounted for 28% (28.1% normalised) of the electricity generated. It was again the second largest source of electricity generation after natural gas, and generated more than twice that of coal and peat combined.

Figure 18: Flow of energy in electricity generation, 2018 – 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 percentage of gross electricity consumption = 33.0%
Renewables as percentage of gross electricity consumption (normalised) = 33.2%
CHP as percentage of total electricity generation = 7.0%

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

4.1.1 Primary fuel inputs into electricity generation

The trends in the mix of primary fuels employed for electricity generation are shown in *Figure 19*. The shift from oil to gas since 2001 is evident, as is the growth of renewable generation since the early 2000s.

In the past two years coal use in electricity generation has more than halved.

Figure 19: Primary fuel mix for electricity generation

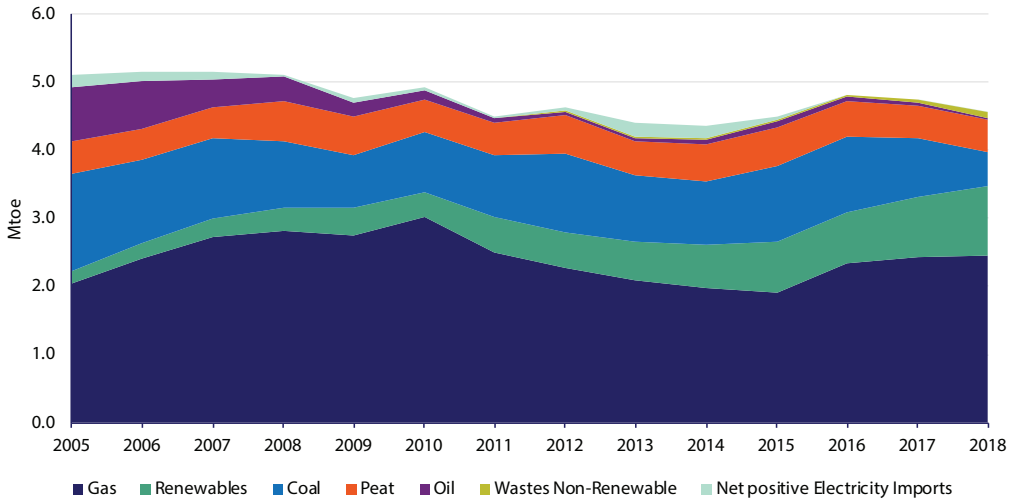


Table 11 shows the growth rates, quantities and shares of the primary fuel mix for electricity generation over the period 2005 – 2018.

The primary fuel requirement for electricity generation grew 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 2018, 4,564 ktoe of energy was used to generate electricity, 4% less than in 2017 and 13% less than peak levels in 2001. The fall in inputs to electricity generation in 2018 is against the backdrop of a 2.9% increase in the amount of electricity generated and a 4.4% increase in indigenous demand. The difference between generation and demand is because of a reduction in net exports to the UK.

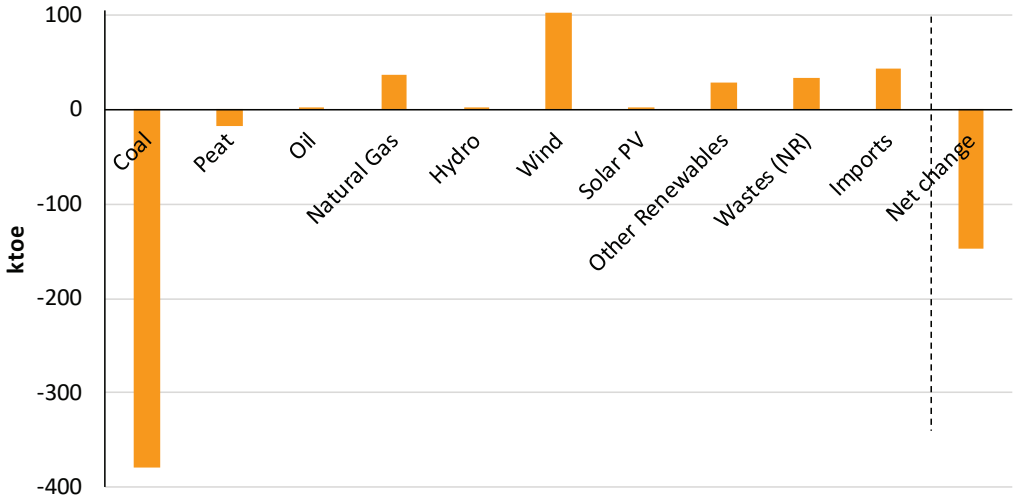
The fuel inputs to electricity generation were less than one third (31%) of the total primary energy requirement in 2018.

Table 11: Growth rates, quantities and shares of electricity generation fuel mix (primary fuel inputs)

	Overall Growth %	Average Annual Growth %					Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Fossil Fuels (Total)	-27.3	-2.4	-1.0	-4.1	-2.0	-9.4	4,756	3,456	93.0	75.7
Coal	-65.6	-7.9	-9.4	5.4	-24.3	-43.7	1,422	489	27.8	10.7
Peat	-4.9	-0.4	-0.2	2.4	-5.2	-3.3	496	472	9.7	10.3
Oil	-95.6	-21.4	-29.6	-8.9	-26.1	2.3	794	35	15.5	0.8
Natural Gas	20.4	1.4	8.2	-8.9	9.0	1.5	2,044	2,461	40.0	53.9
Renewables (Total)	466.2	14.3	15.4	15.3	10.7	15.0	180	1,017	3.5	22.3
Hydro	10.0	0.7	-1.0	6.1	-4.9	0.4	54	60	1.1	1.3
Wind	677.0	17.1	20.4	18.5	9.5	16.1	96	743	1.9	16.3
Other Renewables	620.7	16.4	20.1	9.2	23.0	16.1	30	215	0.6	4.7
Wastes (Non-Renewable)	-	-	-	-	54.1	60.9	-	91	-	2.0
Combustible Fuels Total	-21.4	-1.8	-0.8	-3.7	-0.4	-7.3	4,786	3,760	93.6	82.4
Electricity Imports (net)	-	-	-25.5	7.4	-	-	176	-	3.4	-
Total	**-10.7**	**-0.9**	**-0.7**	**-1.8**	**0.5**	**-4.0**	**5,112**	**4,564**		

Figure 20 shows the differences, by fuel, of the inputs for electricity generation between 2017 and 2018, along with the net overall change.

Figure 20: Change in fuel inputs to electricity generation in 2018 compared with 2017



The main trends are:

- Overall energy inputs to electricity generation decreased by 4% (190 ktoe) in 2018, to 4,564 ktoe (53,079 GWh), while the amount of electricity generated increased by 2.9%, to 2,654 ktoe (30,868 GWh). Net imports decreased by 56 ktoe.
- The overall share of fossil fuels used in electricity generation was 76% in 2018 (3,456 ktoe), down from 93% in 2005 and down on the 2017 figure of 80%.
- In 2018, consumption of coal for electricity generation fell by 44% (379 ktoe), to 489 ktoe, and accounted for 11% of the energy used in electricity generation. 7% of the electricity generated was from coal in 2018. In the past two years coal use in electricity generation more than halved (-56%), a reduction of 613 ktoe.
- Natural gas' share of the energy used in electricity was 54% in 2018, up from 51% the previous year. Natural gas use in electricity generation increased by 1.5% (37 ktoe) in 2018, to 2,461 ktoe, and generated 52% of electricity.
- Oil's share of the energy used in electricity generation was 0.8% in 2018, an increased of 2.3% (0.8 ktoe) to 35 ktoe and generated 0.5% of electricity.
- Peat consumption in electricity generation fell by 3.3% (17 ktoe), to 472 ktoe, in 2018 and accounted for 10.3% of the fuel mix. Some 6.8% of the electricity generated in 2018 was from peat.
- Overall, renewables' contribution to the electricity fuel mix increased by 15% (133 ktoe) in 2018, and accounted for 22% of the fuel mix and 33% of the electricity generated. Wind and hydro's contribution to electricity generation increased by 16% (103 ktoe) and 0.4% (0.2 ktoe), respectively, in 2018. The use of other renewables in electricity generation increased by 16% (30 ktoe) to 215 ktoe, with the increase coming mainly from the co-firing of biomass in peat stations and the renewable portion of waste in waste-to-energy plants.
- The use of energy from waste as a fuel source for electricity generation increased by 61% in 2018, to 91 ktoe, and accounted for 2% of all fuel inputs and 1% of the electricity generated.
- Electricity imports increased by 45% (505 ktoe) while exports fell by 8.1% (146 ktoe), resulting in net imports of electricity increasing by 651 ktoe.

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[12] (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 2.2% (2.3% normalised) and wind accounted for 28.0% (28.1% normalised) of the total in 2018.

12 An alternative approach based on *primary energy equivalent* was developed in a separate report: SEAI (2019), *Renewable Energy in Ireland 2019 Report*. Available from https://www.seai.ie/publications/Renewable-Energy-in-Ireland-2019.pdf

4.1.2 Electricity generated by fuel type

Figure 21 and *Table 12* show the growth rates, quantities and shares of the electricity generated by fuel over the period 2005 – 2018.

Figure 21: Electricity generated by fuel type

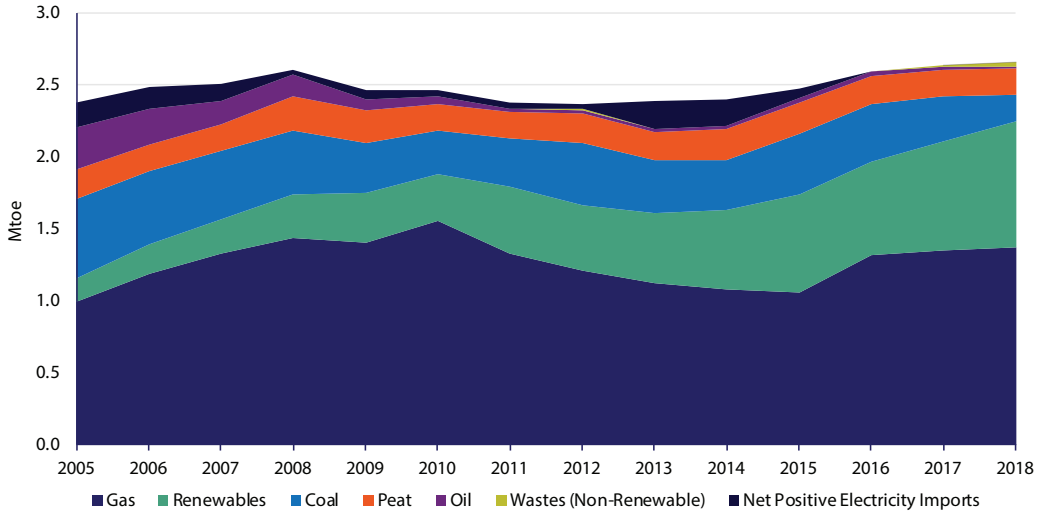


Table 12: Growth rates, quantities and shares of electricity generated by fuel

	Overall Growth %	Average Annual Growth %					Quantity (GWh)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Coal	-66.3	-8.0	-11.1	6.5	-23.9	-41.0	6,389	2,152	23.1	7.0
Peat	-14.5	-1.2	-2.3	2.9	-5.9	-3.2	2,450	2,095	8.9	6.8
Oil	-95.8	-21.7	-29.0	-7.6	-30.0	-1.7	3,340	139	12.1	0.5
Natural Gas	38.4	2.5	9.4	-7.3	9.0	2.1	11,574	16,014	41.8	51.8
Renewables (Total)	444.2	13.9	14.8	16.1	9.0	14.8	1,873	10,195	6.8	33.0
Hydro	10.0	0.7	-1.0	6.1	-4.9	0.4	631	694	2.3	2.2
Wind	677.0	17.1	20.4	18.5	9.5	16.1	1,112	8,640	4.0	28.0
Solar	-	-	-	48.2	69.7	54.2	-	17	-	0.05
Other Renewables	548.0	15.5	19.3	8.8	20.8	14.8	130	844	0.5	2.7
Wastes (Non-Renewable)	-	-	-	-	59.7	89.3	-	302	-	1.0
Electricity Imports (net)	-	-	-25.5	7.4	-	-	2,044	-	7.4	-
Total	**11.7**	**0.9**	**0.7**	**0.1**	**2.4**	**0.7**	**27,671**	**30,896**		

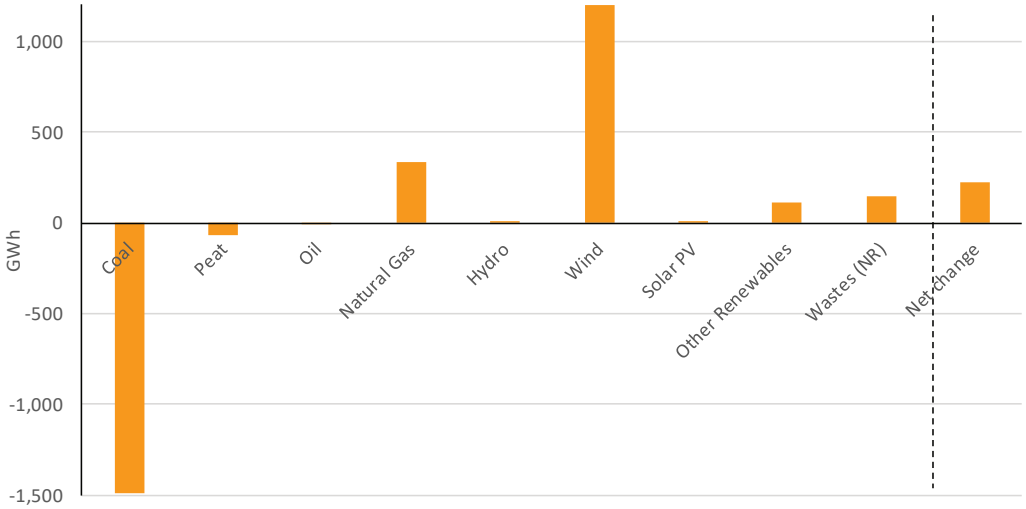
The share of electricity generated by renewables was 33.0% in 2018, up from 29.6% in 2017. Normalising for wind and hydro as per EU Directive 2009/28/EC the share of electricity generated from renewables in 2018 was 33.2%.

Renewable energy makes up a significantly larger share of the electricity generated than it does of the inputs to electricity generation. This is because a large part of the combustible fossil fuel energy that is used for electricity generation is lost as waste heat, as is the case for combustible renewable sources such as biomass. However the large majority of renewable electricity sources, including wind hydro and solar, are considered 100% efficient, in that electricity is produced directly, so the primary energy is equal to the final energy.

In 2018, wind generation accounted for 28% (28.1% normalised) of the electricity generated and was again the second largest source of electricity generation after natural gas.

In 2018, the most significant change was that coal generation was offline for almost 3 months. As shown in *Figure 22*, this resulted in 1,493 GWh less being generated from coal. There was another reduction in generation from peat and oil of 72 GWh. These shortfalls were made up from the other sources, with wind being the most significant (contributing 1,196 GWh), gas (334 GWh), wastes (142 GWh) and other renewables and hydro (111 GWh). A reduction in exports and an increase in imports contributed another 651 GWh.

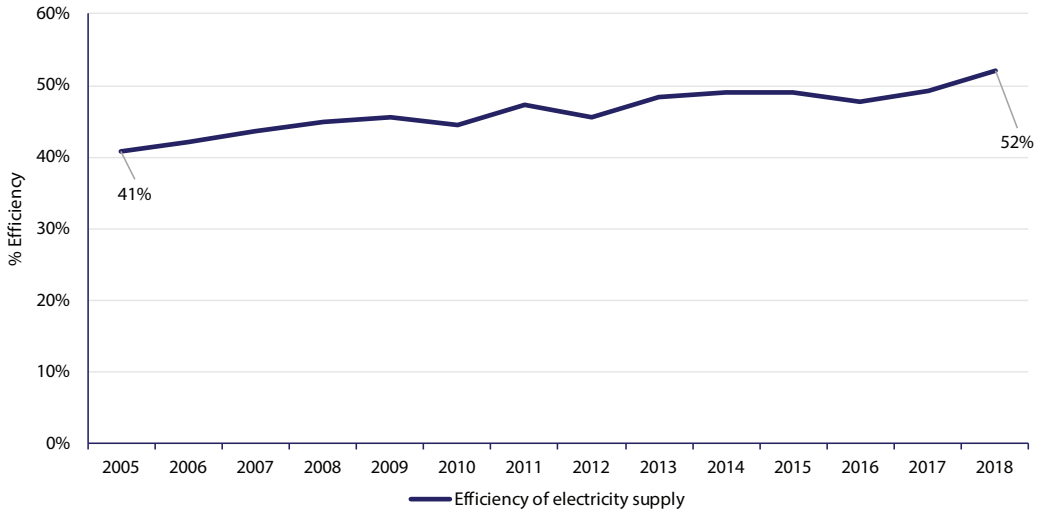
Figure 22: Change in electricity generation by source in 2018 compared with 2017



4.1.3 Efficiency of electricity supply

The efficiency of electricity supply, shown in *Figure 23*, is defined as the final consumption of electricity divided by the fuel inputs required to generate this electricity, and it is expressed as a percentage[13]. The inputs include combustible fuels such as gas, coal and biomass, that incur transformation losses, and non-combustible sources such as wind, hydro and solar, which are direct renewable inputs and so do not have transformation losses.

Figure 23: Efficiency of electricity supply



In 2018, the supply efficiency was 52%. Or put another way, 48% of all energy used to generate electricity are lost before it reached the final customer. The size of this loss is due to electricity in Ireland being predominantly generated thermally (82% of the energy used to generate electricity and 70% of the electricity generated in 2018). This ratio of primary to final[14] energy in electricity consumption fell from 3.0 in 1990 to 1.9 in 2018.

13 Electricity supply efficiency includes energy consumed by electricity generating plants themselves and also transmission and distribution losses. Electricity generation efficiency ignores these losses, hence generation efficiency is higher than supply efficiency. In 2018, the generation efficiency was 58%.

14 On a net calorific value basis.

From the mid-1990s onwards the efficiency of the electricity generation began to increase due to the introduction of higher efficiency natural gas plant[15], the increase in production from renewable sources, the closure of old peat-fired stations, and an increase in electricity imports.

4.1.4 Carbon intensity of electricity supply

Figure 24: CO_2 emissions per kWh of electricity supplied, with contributions by fuel

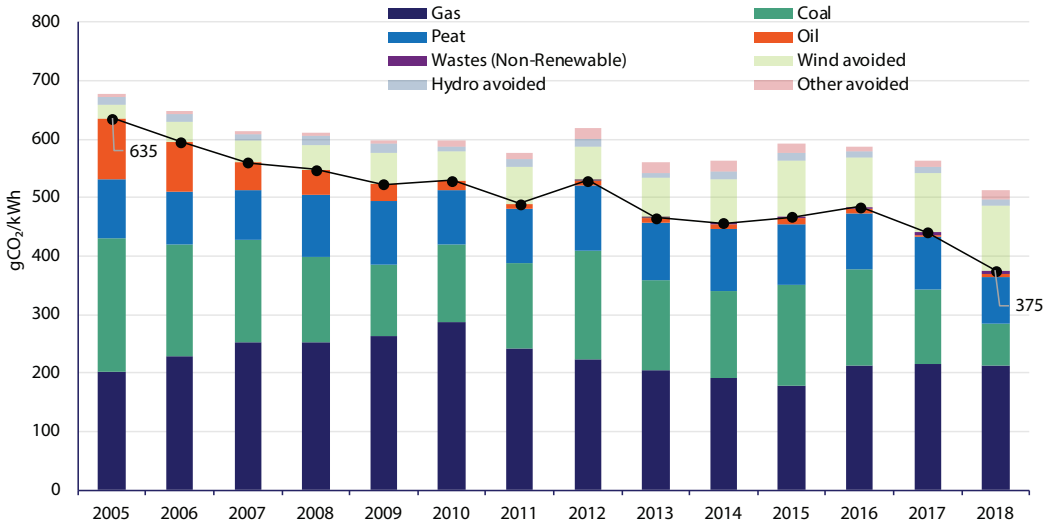


Figure 24 shows, as stacked bars, the shares of the various fuels contributing to the overall emissions intensity of electricity, as well as the reduction in intensity as a result of emissions avoided by renewable generation from wind, hydro and other renewables. It is important to note that this graph represents the contributions 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 24*.

Since 2005, the share of high carbon content fuels, such as coal and oil, has generally been reducing, and there has been a corresponding rise in the relatively lower carbon natural gas, and zero carbon renewables. Imported electricity is also considered as 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 gCO_2/kWh in 1990 to a low of 455 gCO_2/kWh in 2014. The intensity increased to 465 gCO_2/kWh in 2015 due to increased coal generation and a reduction in net imports. It increased further in 2016, to 480 gCO_2/kWh as a result of lower wind and hydro resources. Better wind and hydro resources in 2017, coupled with increased wind capacity, saw the intensity of electricity fall to 437 gCO_2/kWh. Similarly in 2018, with the addtional effect of coal generation being offline for approximately 3 months, the emissions intensity fell below 400 gCO_2/kWh for the first time, to a new low of 375 gCO_2/kWh.

With coal generation offline for approximately 3 months the emissions intensity fell below 400 gCO_2/kWh for the first time, to a new low of 375 gCO_2/kWh.

The reasons for the reduction in the carbon intensity of electricity in 2018 were:

- 44% reduction in coal use in generation (11% share of inputs);
- 16% increase in wind generation (16% share of inputs);
- 16% increase in bioenergy use in generation (4.7% share of inputs);
- 3.3% reduction in peat use in generation (10.3% share of inputs);
- 0.4% increase in hydro generation (1.3% share of inputs);
- 95% reduction in net exports of electricity.

15 The following high efficiency CCGT gas electricity generation plant have been opened in Ireland in recent years: Tynagh (384 MW) in 2006; Huntstown 2 (401 MW) in 2007; Whitegate (445 MW) and Aghada (435 MW) in 2010; Great Island (460 MW) in 2015.

Countering these were a:

- 1.5% increase in gas used in generation, increasing the gas share in fuel inputs to 54%;
- 61% increase in the use of non-renewable wastes (2% share of inputs);
- 2.3% increase in oil use in generation (0.8% share of inputs).

4.1.5 Combined heat and power generation

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 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[16] of CHP in Ireland at the end of 2018 was 354 MWe (438 units[17]) – up from 348 MWe (419 units) in 2017 (see *Table 13*). Of the 438 units, only 315 were reported as being operational. The operational installed capacity increased by 0.5 MWe, to 319.2 MWe[18], in 2018 compared with 2017.

Table 13: Number of units and installed capacity by fuel, 2018

	No. of Units	Installed Capacity (MWe)	No. of Units %	Installed Capacity %
Natural Gas	378	325.4	88	92
Solid Fuels	2	5.2	0	1
Biomass	3	5.5	1	2
Oil Fuels	23	8.7	5	2
Biogas	23	9.5	5	3
Total	**438**	**354**	**100**	**100**

Source: SEAI

Natural gas was the fuel of choice for 325 MWe (387 units) in 2018. It is worth noting that there is one single 160 MWe gas plant that dominates. Oil products[19] and biogas made up the next most significant shares with 9.0 MWe and 9.5 MWe, respectively (21 and 23 units), 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].

Figure 25 illustrates the contribution from CHP to Ireland's energy requirements in the period 2000 – 2018. Fuel inputs increased by 205% (6.4% per annum) while the thermal and electrical outputs increased by 272% (7.6% per annum) and 325% (8.4% per annum), respectively, over the period. In 2018 fuel input fell by 2.3% and thermal output decreased by 1.3%, while the electricity generated fell by 1.8%. The large increase in 2006 is accounted for by the Aughinish Alumina plant which came online in that year.

16 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.
17 Note that units are distinct from CHP plants or schemes and that there may be more than one CHP unit at a site
18 Revised since the 2017 CHP update.
19 Oil products are comprised of LPG, heavy fuel oil, refinery gas and biodiesel.
20 SEAI (2018), *Combined Heat and Power in Ireland – 2018 Update.* Available from: https://www.seai.ie/publications/CHP-Update-2018.pdf

Figure 25: CHP fuel input and thermal/electricity output, 2000 – 2018

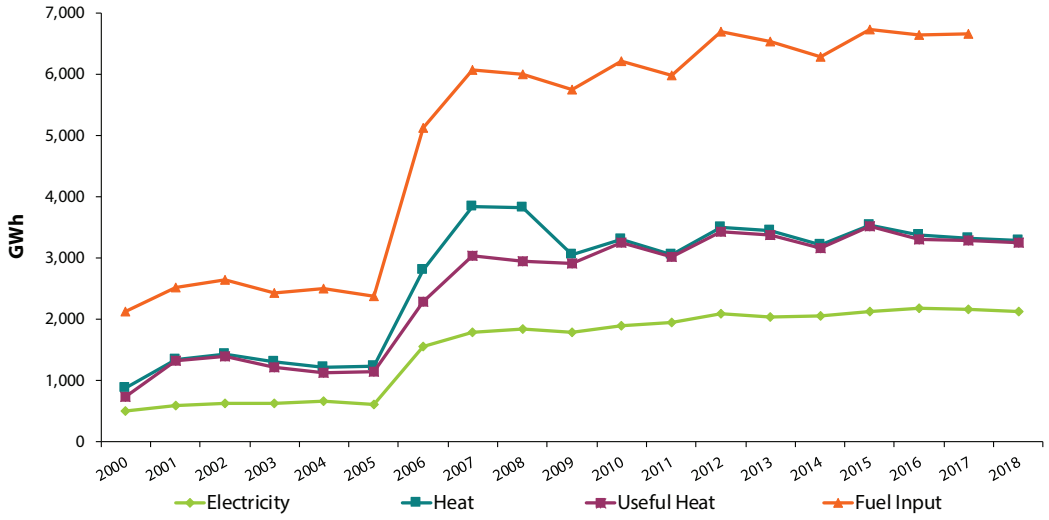
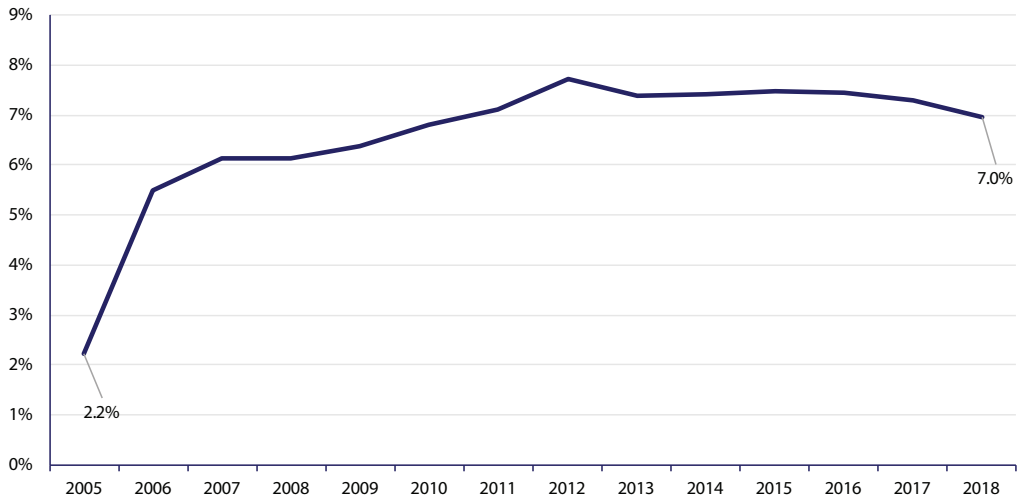


Figure 26 focuses on CHP-generated electricity in Ireland as a proportion of gross electricity consumption (i.e. electricity generation plus net imports) in the period 2005 – 2018. In 2018, 7.0% of total electricity generation was generated in CHP installations compared with 7.3% in 2017. Some CHP units export electricity to the national grid. In 2018, there were 17 units exporting electricity to the grid. These units exported 1,395 GWh of electricity in 2018, an increase of 0.8% on 2017.

Figure 26: CHP electricity as percentage of total electricity generation, 2005 – 2018



Source: SEAI

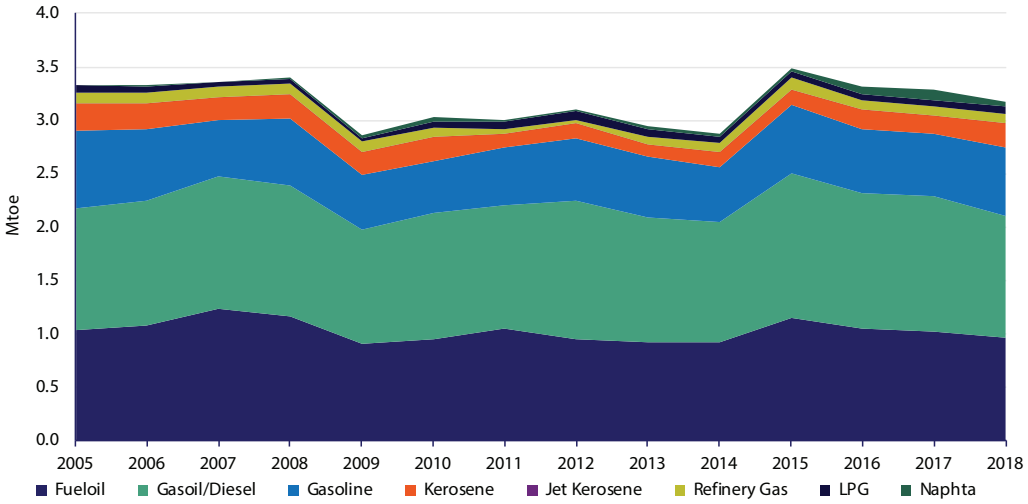
4.2 Oil refining

Ireland has one oil refinery, located at Whitegate, Co. Cork, which is currently operated by Irving Oil. Whereas electricity generation has a variety of fuel inputs and just one output, electricity, oil refining has one major fuel input, crude oil, and multiple fuel outputs, such as petrol, diesel and jet kerosene. *Figure 27* shows the outputs from oil refining from 2005 to 2018. Heavy fuel oil, diesel and petrol (gasoline) are the main outputs.

The outputs of the refinery are not heavily influenced by the demand in the Irish market, due to the highly international nature of the oil market. Much of the output of the refinery is exported directly, and the majority of oil products used for final energy in Ireland is imported directly in the form of finished products, rather than being produced in the refinery.

Nonetheless the refinery is an important piece of infrastructure from the point of view of energy security.

Figure 27: Outputs from oil refining



Source: SEAI

4.3 Other transformation processes

There are a number of other transformation processes in operation in the Irish energy sector, though they are all very small in comparison to electricity generation, oil refining, and CHP.

Pumped hydro electricity storage

Pumped hydro electricity storage is the process of using electricity to pump water to an uphill reservoir, and later releasing the water from the reservoir back down through a turbine to generate electricity. In this way the pumped storage facility acts like a battery to store relatively large amounts of electricity. There is one pumped hydro station in Ireland, at Turlough Hill, Co. Wicklow, with a total capacity of 292 MW.

The electricity generated from pumped hydro storage is not considered hydro-electricity and is not counted as renewable, as the pumped storage facility merely stores electricity that has previously been generated by another source. Although it is not a renewable source, pumped hydro storage has attributes which are beneficial for integrating variable non-synchronous renewable electricity sources, such as wind, onto the electricity system.

Use of Turlough Hill peaked in 2013 when there was, 50 ktoe, or 585 GWh of electricity inputs and 30 ktoe, or 345 GWh, of outputs. In 2018, this had reduced to 43 ktoe (499 GWh) of inputs and 20 ktoe (238 GWh) of outputs. The overall efficiency of Turlough hill fell since the 1990s, when it was over 70%, to 48% in 2018.

Peat briquetting

Peat briquetting converts milled peat into briquettes for residential use. Peat briquette production has been reducing since the early 1990s. In 2018, 65 ktoe of peat briquettes were produced, almost 50% less than in the early 2000s.

5 Drivers of energy demand

This section takes a high level view of the trends in the economy, weather, energy use, and energy-related CO_2 emissions since 2005.

5.1 Energy, economy and emissions

Energy supply depends on the demand for energy services (heating, transportation and electricity) and how that demand is satisfied. Energy service demand is driven primarily by economic activity and by the energy end-use technologies employed in undertaking such activity.

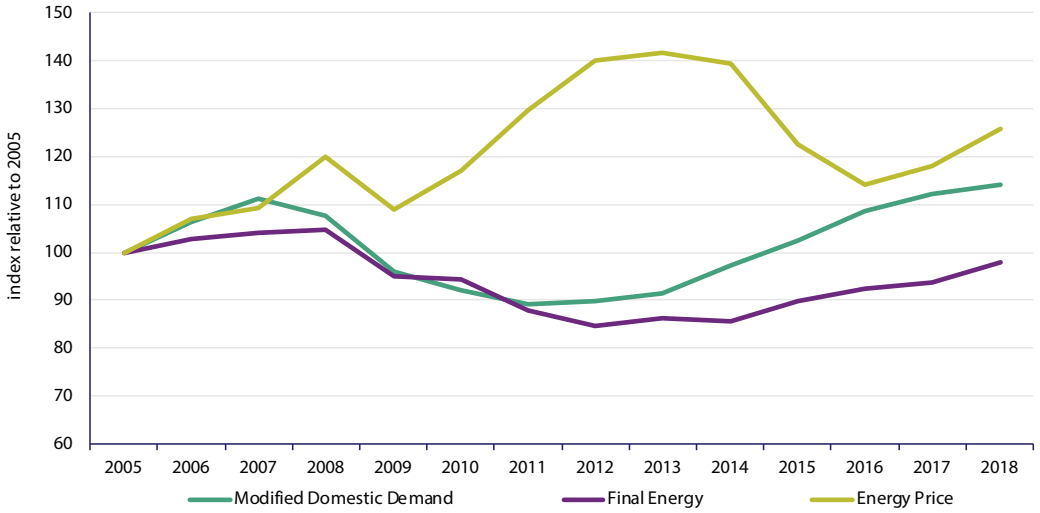
The relationship between economic activity and energy demand is less straightforward in Ireland than it is for most other countries. GDP is the most widely accepted measure of economic activity, but in Ireland GDP is strongly influenced by the activities of multinational companies. Some of the activities of these companies result in large amounts of value added[21], but very little consumption of energy. This was very well illustrated in 2015 when GDP grew by 25% as a result of the transfer into Ireland of intellectual property. Therefore, care must be taken when comparing macro-economic indicators, such as energy per unit GDP, across countries.

The Central Statistics Office (CSO) have developed new indicators of economic activity as alternatives to GDP, to more accurately reflect the level of activity in the domestic economy, and to remove the distorting effects of globalisation. Modified domestic demand[22] was first published in the Quarterly National Accounts[23] results for Quarter 1 2017 and excluded trade by aircraft leasing companies and exports and imports of R&D services and of R&D-related IP products (effectively, all trade in R&D-related intangibles). In contrast to GDP, modified domestic demand grew by 5.3% in 2015.

Figure 28 shows the historical trends for modified domestic demand, energy prices and final energy, each expressed as an index relative to 2005. This captures the changes in economic growth between 2005 and 2018, showing the economic downturn between 2008 and 2012 and the subsequent return to growth after 2013.

Table 14 displays the growth rates for the economy (GDP and modified domestic demand), primary energy, final energy and energy-related CO_2 emissions for the period 2005 to 2018. 2005 is chosen because of its significance with respect to Ireland's 2020 greenhouse gas emissions target.

Figure 28: Index of modified domestic demand, final energy demand and energy price



Source: Based on SEAI and CSO data

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21 See *Glossary of terms*.

22 Previous editions of this report presented another economic indicator, modified gross national income (GNI*), as an alternative to GDP. For more information on the differences between GDP, GNI* and modified domestic demand refer to the CSO.

23 CSO Quarterly National Accounts https://www.cso.ie/en/statistics/nationalaccounts/quarterlynationalaccounts/

Table 14: GDP[24], modified domestic demand, final energy, primary energy, and energy-related CO_2 growth rates[25]

	Growth %	Average annual growth rates %				
	2005 – 2018	2005 – '18	2005 – '10	2010 – '15	2015 – '18	2018
GDP	71.6	4.2	0.4	6.7	6.6	8.2
Modified Domestic Demand	14.2	1.0	-1.7	2.2	3.7	1.7
Final Energy	-2.2	-0.2	-1.2	-1.0	2.9	4.5
Primary Energy	-7.6	-0.6	-1.5	-1.2	1.8	1.6
Energy-Related CO_2	-18.8	-1.6	-2.5	-1.6	0.0	-1.2

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 energy prices.

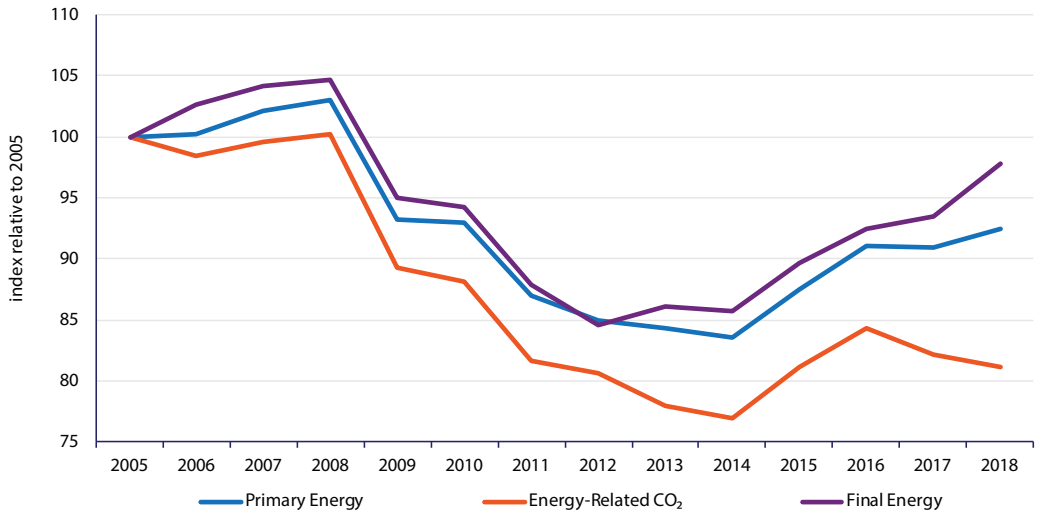
In 2009 all sectors of the economy experienced reductions in energy use and related emissions, tracking the decline in the economy. 2010 was an exceptionally cold year and saw record high energy use for heat in the residential sector, which resulted in energy demand staying flat despite the reduction in economic activity.

Modified domestic demand held flat in 2012 but energy demand continued to fall, mostly in the transport and residential sectors, partially due to record high energy prices, including a sustained period with oil prices of over $100 per barrel. Modified domestic demand returned to strong growth in 2014. Energy demand and energy-related CO_2 emissions followed after a one year lag, returning to growth in 2015, following the easing of energy prices. Final energy demand has increased every year since 2014. In 2018 final energy demand grew by 4.5%, compared to growth in modified domestic demand of 1.7%. Final energy demand increased across all sectors in 2018, with the strongest growth in residential and services (6.8% and 6.4% respectively).

Final energy use continues to track economic growth, and has grown every year since 2014.

Figure 29 shows the relationship between final energy demand, primary energy use and energy-related CO_2 emissions, expressed as an index relative to 2005. The difference between the trends in final energy demand and primary energy supply is due to changes in the efficiency of the energy transformation sector, particularly in electricity supply. Electricity supply has gone from an overall efficiency as low as 33% in the early 1990s, to 41% in 2005, and to 52% in 2018. This is due to the introduction of higher efficiency CCGT generators and the large amounts of wind generated electricity now on the grid, which is considered 100% efficient.

Figure 29: Index of final energy, primary energy and energy-related CO_2

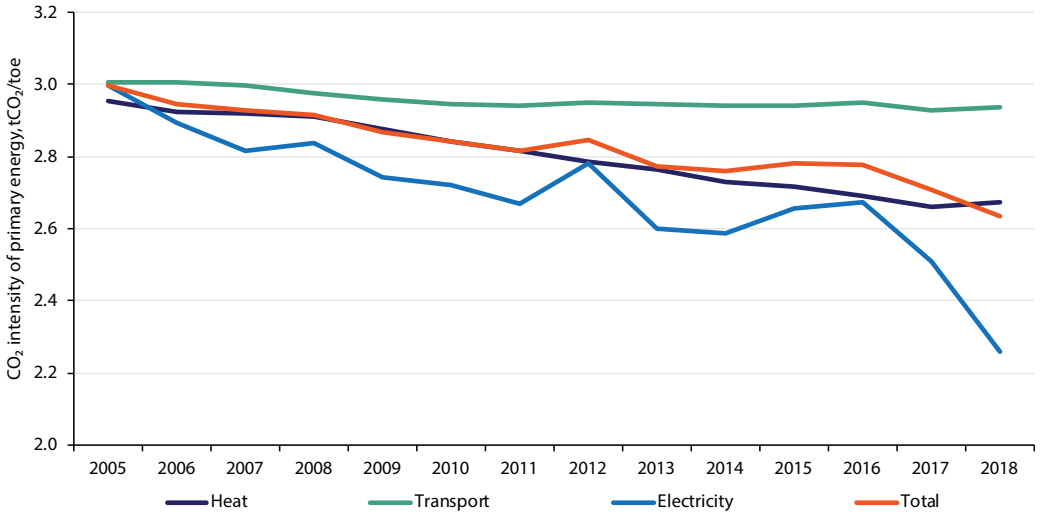


24 GDP rates are calculated using constant market prices chain-linked annually and referenced to 2017.

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

The difference between the trends for energy-related CO_2[26] and primary energy in *Figure 29* is due to changes in the CO_2 intensity of the fuel mix used across all sectors. Changes in the CO_2 intensity of Ireland's fuel mix is examined in more detail in *Figure 30*, which shows the CO_2 intensity per unit of primary energy in each of the heat, transport and electricity sectors.

Figure 30: CO_2 intensity of primary energy by mode



Electricity has seen the greatest reduction in CO_2 intensity, due to the increased share of high efficiency gas and renewable generation. The particularly noticeable drop in CO_2 intensity in 2017 and 2018, which can also be seen in *Figure 29,* is due to a reduction in the amount of coal used for electricity generation.

There has also been a reduction in carbon intensity in heat. This has been due to the switch away from fuels with higher CO_2 intensity, for instance the shift from oil to gas in industry, and a continuing reduction in coal and peat use in the residential sector. There has also been an increase in renewable energy use.

There has been little reduction in the carbon intensity of transport energy, as it remains almost entirely dependent on oil products. There has been an increase in the use of renewable liquid biofuels in transport, but these still only accounted for 3% of transport primary energy use in 2018, so the reduction in carbon intensity has been small.

5.2 Energy and the weather

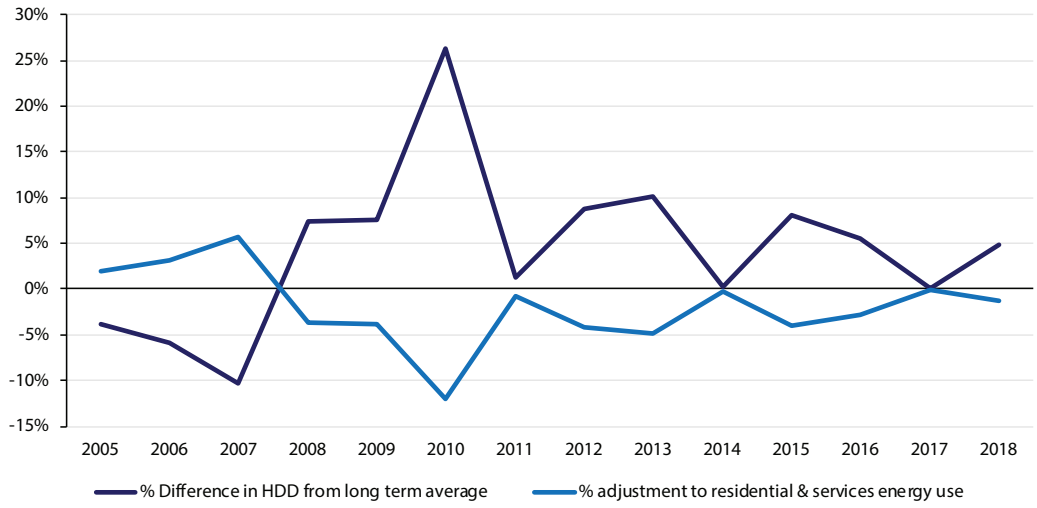
Weather variations from year to year can have a significant effect on the energy demand of a country, in particular on the portion of the energy demand associated with space heating. A method to measure the weather, or climatic variation, is the use of 'degree days'.

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 a measure 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. The larger the number of heating degree days, the colder the weather. 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. The typical heating season in Ireland is October to May.

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.

26 Energy-related CO_2 emissions shown here cover all energy-related CO_2 emissions associated with total primary energy requirement, 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.

Figure 31: Deviation from average heating degree days and resulting weather adjustment



Source: Met Eireann and SEAI

Figure 31 shows the percentage deviation in the number of heating degree days from the long-term average between 2005 and 2018. 2010 was the coldest year recorded over that period and 2007 was the warmest. The portion of each fuel that is assumed to be used for heating is adjusted by multiplying it by the ratio of the long-term average number of degree days to the number of degree days in the given year. This adjustment yields a lower normalised energy consumption in cold years, and yields a higher normalised consumption in mild years. Typically, the weather adjustment is within plus or minus 6% of the actual energy consumption. The largest correction over the period was for 2010, an exceptionally cold year, where the weather-corrected energy consumption was 12% less than the actual energy consumption.

5.3 Energy intensities

Energy intensity is defined as the amount of energy required to produce a functional output. In the case of the economy, the measure of output is generally taken to be the GDP[27]. 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.

Figure 32 shows the trend in both primary (primary energy divided by GDP) and final (final energy consumption divided by GDP) energy intensities (at constant 2017 prices). The difference between these two trends reflects the amount of energy required in the transformation of primary energy into final energy – primarily used for electricity generation.

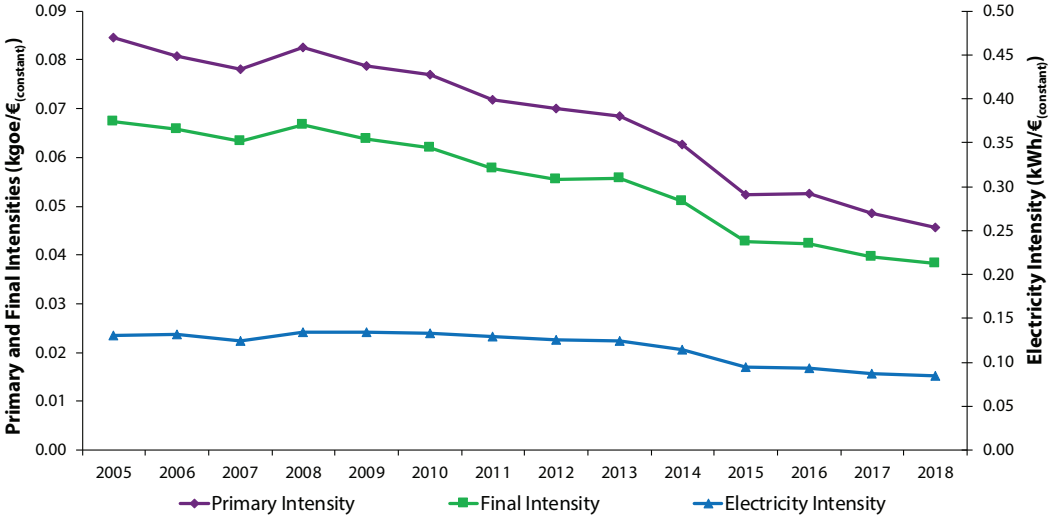
The intensity of primary and final energy, and of electricity requirements, has been falling (reflecting improving energy productivity) since 2005, with the exception of 2008, as shown in *Figure 32*. In 2005, it required 85 grammes of oil equivalent (goe) to produce 1 euro of GDP (in constant 2017 values), whereas in 2007 just 78 goe was required. Between 2005 and 2018 primary energy intensity fell by 46% (4.6% per annum) to 46 goe/$€_{2017}$.

Between 2010 and 2018, the primary and final intensity trends converged slightly, with primary energy intensity falling at a slightly faster rate, 41% (6.3% per annum), compared with a 38% (5.8% per annum) fall in final intensity. This was due to increased efficiency in electricity generation.

The sharp fall in intensity in 2015 of 16% must be viewed in the context of the 25% increase in GDP (the result of the transfer of assets into Ireland). This should be viewed as an adjustment rather than a reduction in intensity, as the increase in GDP had little or no effect on energy consumption. This is a good example of why energy intensity is not a good measure of energy efficiency progress.

27 It can be argued that in Ireland's case, an alternative to GDP such as Modified Domestic Demand should be used to address the impacts of the activities of multinationals. The practice internationally is to use GDP, so for comparison purposes we have followed this convention. Care must be taken in interpreting any indicators based on GDP for Ireland..

Figure 32: Primary, final and electricity intensities



The final electricity intensity of the economy has not been falling as fast as primary or final energy intensities. Over the period 2005 – 2018, electricity intensity fell by 35% (3.3% per annum). This is attributed to the shift towards increased electricity consumption in energy end-use. Final electricity intensity increased by 6.5% between 2007 and 2010, but fell by 36% between 2010 and 2018.

There are many factors that contribute to how trends in energy intensity evolve. 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. The structure of the economy, in Ireland, has changed considerably over the past 20 to 30 years. It has shifted in the direction of the high value added 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 structure of the industry sector 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.

6 Policy perspectives

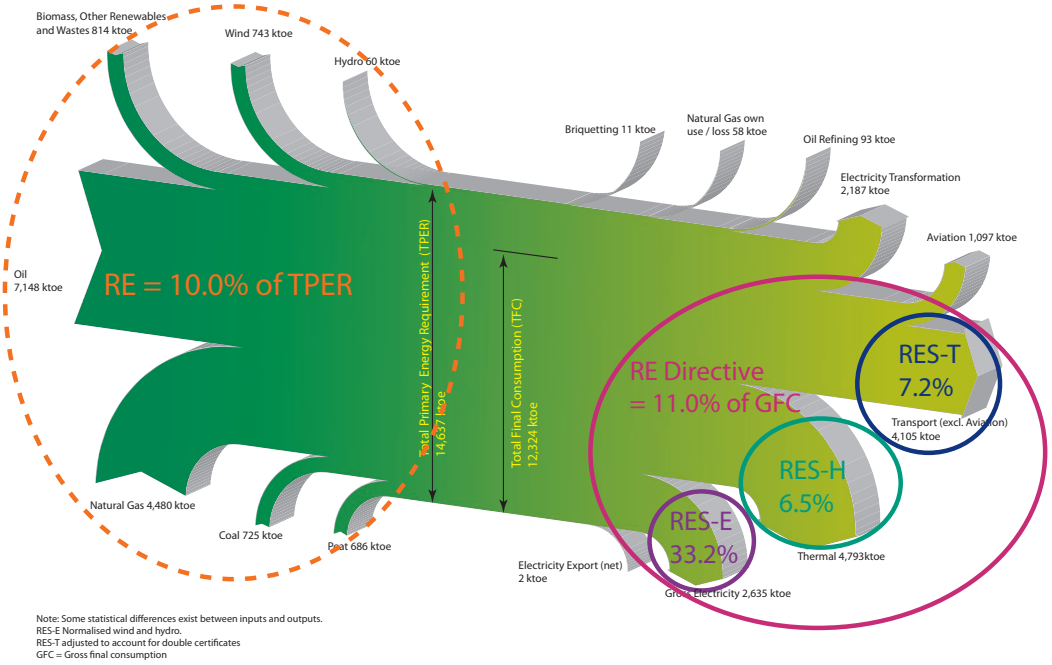
The energy trends discussed in *Table 2* and *Table 3* are analysed to assess performance with regard to Government policies and targets. This section focuses on the targets detailed in the EU Directives related to renewable energy, greenhouse gases, and transboundary emissions.

6.1 Progress towards renewable energy targets

The target for Ireland in the EU Renewable Energy Directive[28] is a 16% share of renewable energy in gross final consumption by 2020. The Directive requires each Member State to adopt a national renewable energy action plan (NREAP) to set out 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 Renewable Energy Share (RES) targets: RES-E (electricity), RES-T (transport) and RES-H (heat).

The contribution from renewables to gross final consumption[29] in 2005 was 2.8%, rising to 11.0%[30] in 2018. *Figure 33* illustrates where the various renewable targets fit within overall energy use in Ireland and the progress towards those targets in 2018. Towards the right of the figure, the 2018 percentages of renewables are shown relative to the amount of final energy to which they refer. Also shown is how these relate to the Directive's targets (see also *Table 15*).

Figure 33: Progress to targets, 2018



Towards the left of *Figure 33*, the overall contribution of renewable energy to total primary energy requirement is shown at 10.0%. While there is no specific target for this figure, it does help to illustrate the position of renewables in the overall energy use in Ireland.

Table 15 shows the progress towards the individual national modal targets and towards the overall Directive target for the period 2005 – 2018. Here, the percentages in each row (RES-E, RES-T and RES-H) relate to the specific modal targets, while the percentages in the final row relate to the overall target, using the definition in EU Directive 2009/28/EC.

28 EU Directive 2009/28/EC: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=en.
29 See *Glossary of terms*.
30 Calculated as per Directive 2009/28/EC.

Table 15: Renewable energy progress to targets[31]

	Progress Towards Targets %									Target %
Target	**2005**	**2010**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2020**
RES-E (normalised)	7.2	15.6	19.8	21.3	23.5	25.5	26.8	30.1	33.2	40
RES-T	0	2.5	4.0	4.9	5.2	5.9	5.2	7.4	7.2	10
RES-H	3.4	4.3	4.8	5.2	6.3	6.2	6.3	6.7	6.5	12
Overall RES	**2.8**	**5.7**	**7.1**	**7.6**	**8.6**	**9.1**	**9.2**	**10.5**	**11.0**	**16**

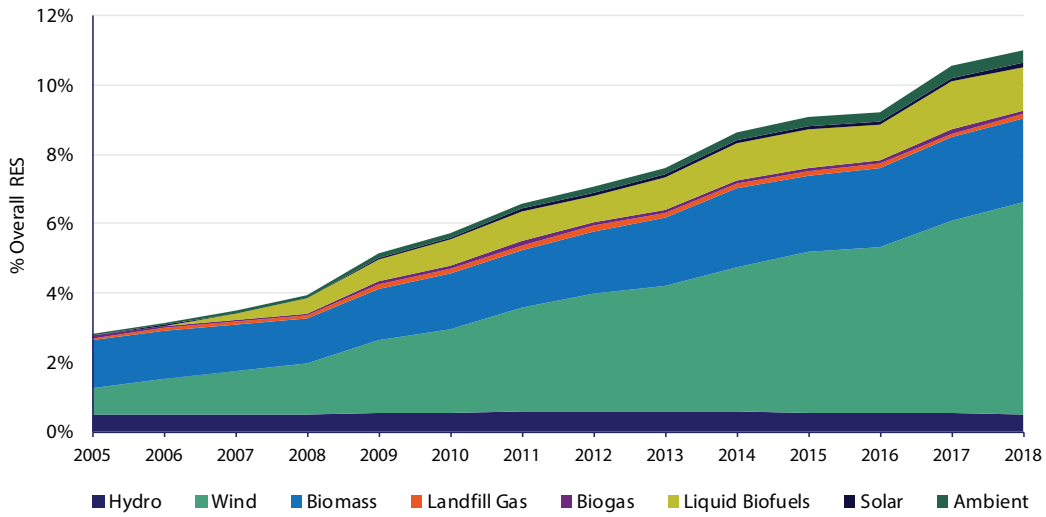
Source: SEAI

RES-E increased by 3.1 percentage points in 2018, to 33.2% (towards the 40% 2020 target). RES-T fell back in 2018, to 7.2% (towards the 10% 2020 target) from 7.4% in 2017 (see Section *6.1.3*). RES-H fell by 0.2 percentage points in 2018, to 6.5% (towards the 12% 2020 target).

Wind accounted for 55% of the contribution towards the Directive target.

Figure 34 shows the contribution, as per the Directive methodology, from 2005 to 2018 while *Figure 35* shows the renewable energy percentage contributions to gross final consumption by mode.

Figure 34: Renewable energy (%) contribution to gross final consumption (Directive 2009/28/EC)



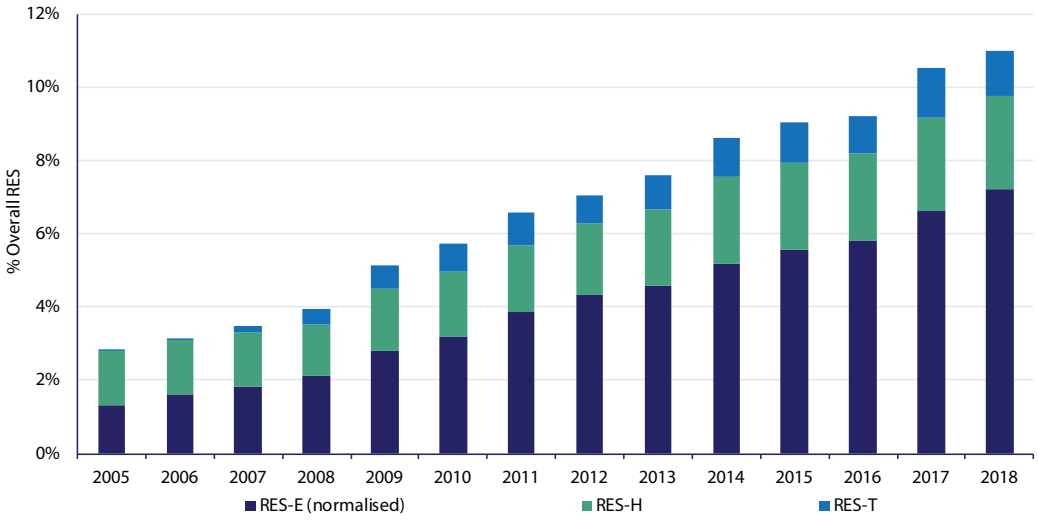
Source: SEAI

Wind accounted for 55% of the contribution towards the Directive target. Bioenergy accounted for 36% of the contribution, which consists of biomass at 22 percentage points, liquid biofuels at 12 percentage points and biogas at 1.9 percentage points. The remaining contribution came from hydro and ambient energy at 4.5% and 3.3% respectively, and solar at 1.1%.

Bioenergy accounted for 36% of the contribution towards the overall Directive target.

31 Note that individual target percentages are not additive. RES-T includes double certificates for advanced biofuels. The table contains some revisions compared with the last edition of Energy in Ireland – 2017 Report.

Figure 35: Renewable energy (%) contribution to gross final consumption by mode[32]



Source: SEAI

A more detailed discussion of renewable energy in Ireland can be found in SEAI's publication *Renewable Energy in Ireland*[33]. This section presents key graphs and updates where available from the renewables report.

6.1.1 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 2018 was 33.2% normalised (compared with 30.1% in 2017).

The share of electricity from renewable energy increased almost fivefold between 2005 and 2018 – from 7.2% to 33.2% – an increase of 23 percentage points over 13 years. In absolute terms, there has been a fivefold increase in the volume of renewable electricity generated, from 1,873 GWh in 2005 to 10,195 GWh in 2018.

Table 16 and *Figure 36* show how electricity production from wind energy increased to the point where it accounted for 84% of the renewable electricity generated in 2018. Electricity generated from biomass accounted for 8.3% of renewable electricity in 2018. Biomass consists of contributions from solid biomass, landfill gas, the renewable portion of waste and other biogases.

Wind energy accounted for 85% of the renewable electricity in 2018.

Wind, hydro and bioenergy generated electricity respectively, accounted for 28.1%, 2.3% and 2.7% of Ireland's gross electricity consumption in 2018. Solar photovoltaic (PV) accounted for 0.05%.

Table 16: Renewable energy contribution to gross electricity consumption (RES-E normalised)

Renewable Electricity %	2005	2010	2012	2013	2014	2015	2016	2017	2018
Hydro (normalised)	2.7	2.6	2.8	2.7	2.6	2.5	2.5	2.4	2.3
Wind (normalised)	4.0	11.9	15.5	16.9	19.0	21.3	22.0	25.2	28.1
Biomass	0	0.4	0.9	1.1	1.2	1.0	1.6	1.8	2.1
Landfill Gas	0.4	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5
Biogas	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Solar PV	0	0	0	0	0	0.01	0.02	0.04	0.05
Overall	**7.2**	**15.6**	**19.8**	**21.3**	**23.5**	**25.5**	**26.8**	**30.1**	**33.2**

32 RES-T double certification for advanced biofuels is not included in the overall RES target.
33 Available from http://www.seai.ie/

Figure 36: Renewable energy contribution to gross electricity consumption (RES-E normalised)

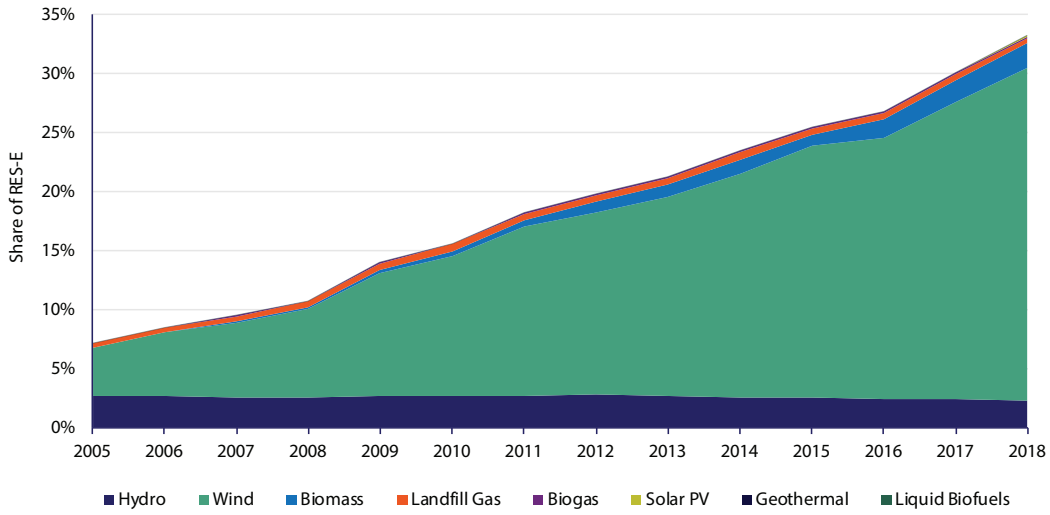
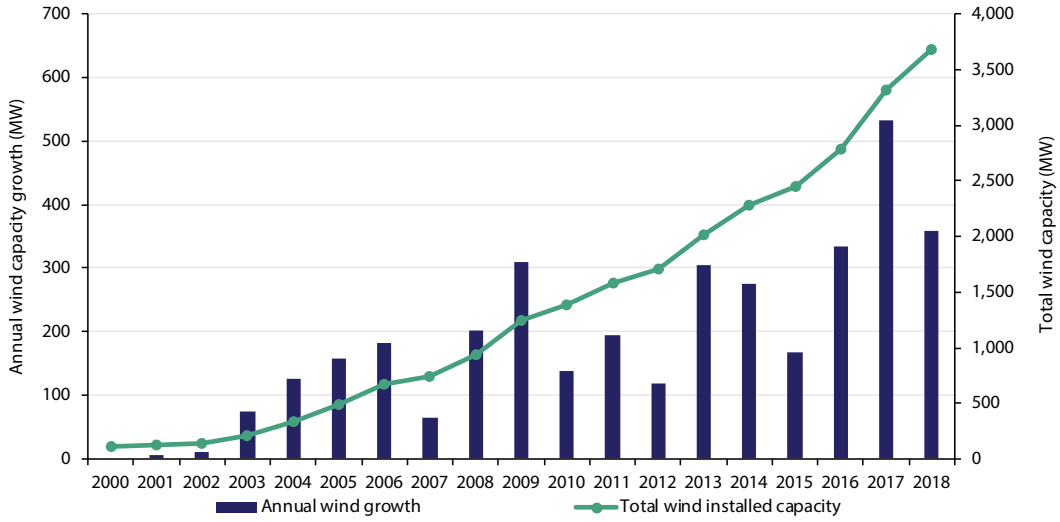


Figure 37 shows the annual growth in installed wind generation capacity and overall cumulative capacity since 2000. By the end of 2018, the installed capacity of wind generation reached 3,676 MW. The peak recorded wind power output was 3,058 MW, delivered on 12 December 2018[34] at 20:15 hr (it represented 69% of demand at that time). During 2018, 358 MW of wind capacity was installed.

EirGrid and ESB Networks note that as of 2019 there is 1,873 MW of additional wind generation planned, either with connection contracts in place or applications for connection underway. Historically, there has been a maximum of just over 500 MW installed in any one year since 2005 and on average the installation rate has been 200 MW.

Figure 37: Installed wind generating capacity, 2000 – 2018[35]



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 factors 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 a full year.

The rates 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 artificially reduces the capacity factor for the year.

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

35 *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

To mitigate this, the wind capacity factors in *Table 17* are calculated using the average of the installed capacity in any given year and the previous year.

Table 17: Annual capacity factor for wind and hydro generation in Ireland – 2005, 2010, 2012 to 2018

Capacity Factor	2005	2010	2012	2013	2014	2015	2016	2017	2018
Wind	30%	23.7%	27.7%	28.5%	27.5%	31.7%	27.4%	28.2%	28.2%
Hydro	31%	29%	39%	29%	34%	39%	33%	33%	33%

Source: EirGrid and SEAI

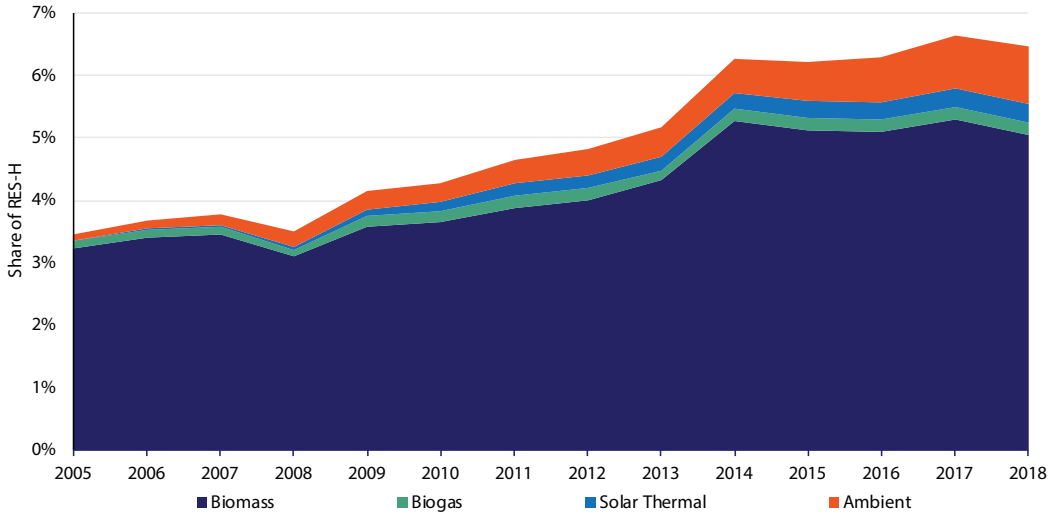
The average countrywide wind capacity factor was 30% in 2005 but fell to 24% in 2010 largely due to it being a low wind year compared with historic average levels. The hydro capacity was also at its lowest level since 2003 due to the low level of rainfall in 2010. The wind capacity factor increased to 28% in 2017 and maintained that level in 2018. The hydro capacity factor has remained steady at 33%.

6.1.2 Heat from renewable energy sources (RES-H)

Ireland's NREAP specified a target of 12% renewable heat by 2020. *Figure 38* shows the contribution from renewable energy to heat or thermal energy uses as a share of overall heat use.

RES-H grew from 3.4 % in 2005 to 6.3% in 2014. It fell in 2015 to 6.2% and increased again in 2016 and 2017 to 6.7%. In 2018 it fell again to 6.5%. The absolute amount of renewable heat energy used increased in 2018, but the share of renewable heat reduced because the use of fossil fuels increased at a faster rate than renewables did in that year. Overall between 2005 and 2018, the amount of fossil fuels used for heat has reduced significantly, which contributed positively towards the RES-H target, as the share of renewable heat is measured against a smaller total.

Figure 38: Renewable energy contribution to thermal energy (RES-H)



The growth since 2000 has been dominated by solid biomass[36], 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.

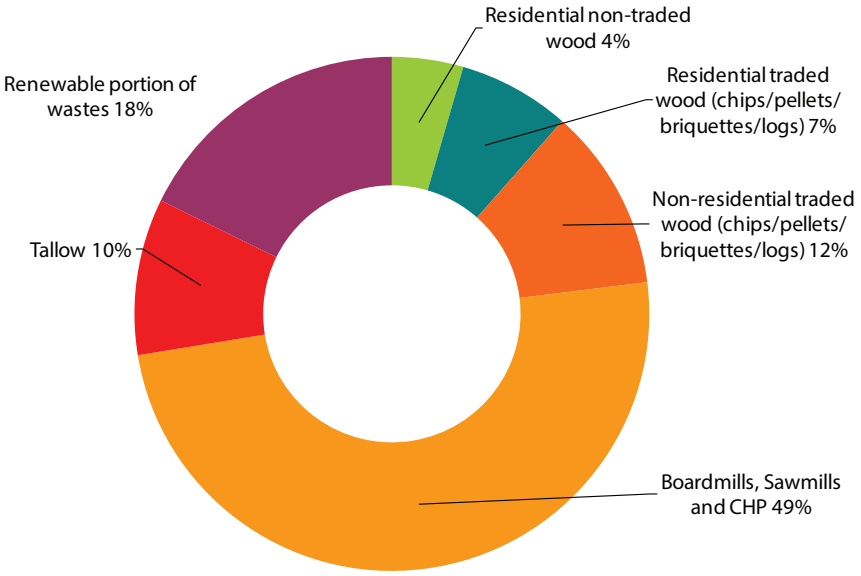
Figure 39 shows the composition of biomass in total final consumption in 2018. Forty-nine per cent of all solid biomass is consumed in the wood and wood products industry sub-sector, where wood wastes or wood residues from that sector are being combusted for heat. Similarly tallow, a by-product or output of the food sector, is combusted for heat in that sector and is also being refined for use as a biofuel in transport. Tallow accounts for 10% of all solid biomass. In 2018, a further 18% of solid biomass was used for heat in the cement industry in the form of the renewable portion of solid wastes.

Wood chips, pellets and briquettes make up 12% of all the solid biomass consumed in Ireland. The remaining 4% is an estimate of the non-traded wood logs that are used in open fires or stoves in households. Non-traded wood consumption is estimated in the absence of available data and varies with different methodologies. However, as it is only a small part of

36 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.

the total solid biomass consumption, the variation in estimates is small relative to the overall solid biomass consumption total used for the calculation of RES-H.

Figure 39: Composition of biomass used for heat in total final consumption, in 2018



Source: SEAI

6.1.3 Transport energy from renewable sources (RES-T)

The 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 is applied to 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. 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 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 that grants one certificate for each litre of biofuel placed on the market in Ireland; two certificates are granted to biofuel that is produced from wastes and residues. Oil companies are required to apply to the National Oil Reserves Agency for certificates and to 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), companies are also required to demonstrate that the biofuel being placed on the market is sustainable, fulfilling 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, to 8% in 2017[37], and to 10% in January 2019[38].

In 2015, new rules[39] came into force that amended 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%.
- Proposes 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[40].

37 SI 225 of 2016 - National Oil Reserves Agency Act 2007 (Biofuel Obligation Rate) Order 2016 http://www.irishstatutebook.ie/eli/2016/si/225/made/en/print#

38 SI 198 of 2018, National Oil Reserves Agency Act 2007 (Biofuel Obligation Rate) Order 2018 http://www.nora.ie/_fileupload/SI198%20of%202018%20Rate%20Increase%2010%20percent.pdf

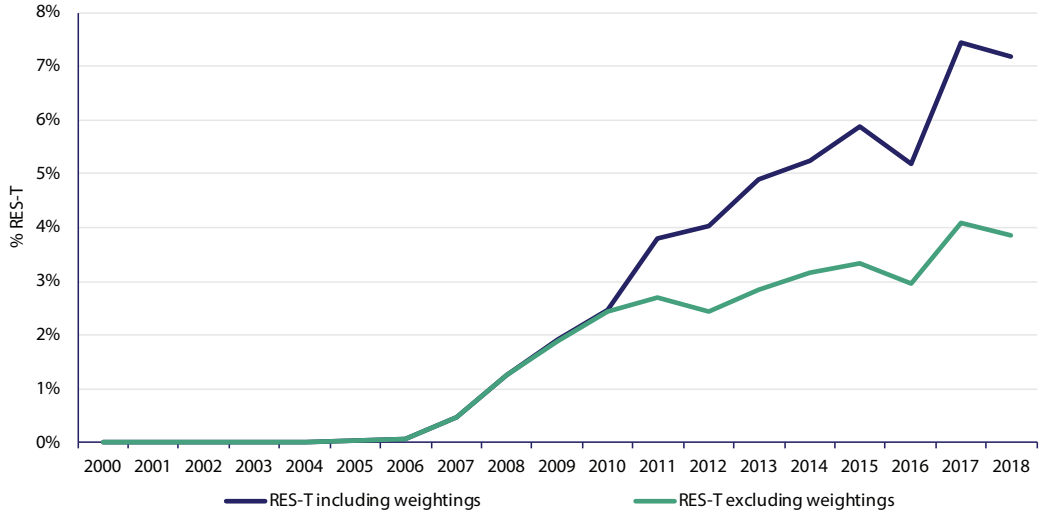
39 https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/overview

40 COM (2016) 767 final/2 http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52016PC0767R(01)&from=EN

- Harmonises the list of feedstocks for biofuels whose contribution would count as double towards the 2020 target of 10% for renewable energy in transport, across the EU.
- 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 multiplier of 2.5. 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 RES-T in 2018 was 3.9%, or 7.2% when the weightings for biofuels and renewable electricity are applied in accordance with the Directive (see *Figure 40*). These are a reduction on the respective 2017 figures of 4.1% and 7.4%. Sixteen per cent of the required certificates for 2018 were carried forward from 2016 and 2017, as allowed under the Biofuels Obligation Scheme[41].

Figure 40: Renewable energy as a proportion of (road and rail) 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) (see *Table 18*). The quantity fell in 2012, to 85 ktoe, mainly as a result of the majority of biodiesel qualifying for double certificates, thereby allowing the obligation to be met with certificates but causing the actual volume of biofuel to fall. Actual volumes increased again after 2013, to reach 128 ktoe (3.3% of transport energy) in 2015, but fell to 119 ktoe in 2016 (3.0% of transport energy), before increasing again in 2017, by 36%, to 161 ktoe. The volume fell again in 2018, to 156 ktoe. In 2018, all of the biodiesel and approximately 10% of the bioethanol used for road transport were eligible for double certificates[42].

Table 18: Biofuels growth and as a proportion of road and rail transport energy – 2005, 2010, and 2012 to 2018

Fuel	2005	2010	2012	2013	2014	2015	2016	2017	2018
Petrol (ktoe)[43]	1,822	1,478	1,227	1,155	1,093	1,036	967	872	792
Diesel (ktoe)[44]	2,378	2,236	2,209	2,351	2,501	2,708	2,930	2,934	3,072
Biofuels (ktoe)	1.1	92.6	85.5	102.9	116.9	128.9	119.5	161.8	155.6
Renewable Electricity		0.4	0.6	0.7	0.7	0.8	1.0	1.1	1.4
Petrol plus Diesel	4,200	3,713	3,436	3,506	3,594	3,744	3,897	3,806	3,865
Biofuel Penetration	***0.0%***	***2.4%***	***2.4%***	***2.8%***	***3.1%***	***3.3%***	***3.0%***	***4.1%***	***3.9%***
Weighted Renewables (ktoe)	1	94	142	177	195	228	208	295	288
Weighted Renewables Share	***0.0%***	***2.5%***	***4.0%***	***4.9%***	***5.2%***	***5.9%***	***5.2%***	***7.4%***	***7.2%***

41 http://www.nora.ie/regulationslegislation/biofuels-obligation-scheme.152.html
42 http://www.nora.ie/_fileupload/457-18X0074%20-%20BOS%20Annual%20Report%20for%202017.pdf
43 Using Renewable Directive calorific value.
44 Using Renewable Directive calorific value.

Renewable energy share in transport (RES-T) in 2018 was 7.2% when the weightings for biofuels and renewable electricity are applied.

6.1.4 CO_2 displacement and avoided fuel imports

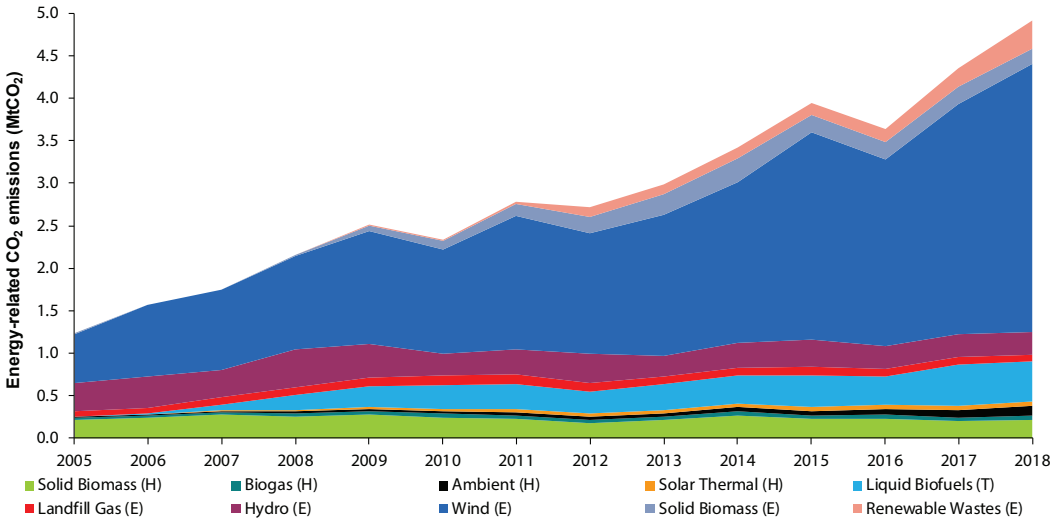
The use of renewables avoids CO_2 emissions and displaces the use of fossil fuels that would otherwise need to be imported. We estimate the amount of CO_2 avoided and fossil fuel imports displaced using the primary energy equivalent approach. This estimates the quantity of fossil fuels that would have been required to replace renewable energy use. The estimates for electricity are based on the use of marginal generation fuel that would otherwise have been required to produce the electricity. 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[45,46].

Figure 41 shows the trend in avoided CO_2 emissions from renewable energy for the period 2005 – 2018. The estimated amount of CO_2 avoided through the use of renewable energy increased by 298% over the period 2005 – 2018, reaching 4,920 kt CO_2 in 2018. Wind energy avoided majority of emissions, at 3,149 kt CO_2 in 2018, followed by bioenergy at 1,328 kt CO_2, hydro at 273 kt CO_2, ambient heat at 116 kt CO_2 and solar at 53 kt CO_2.

Electricity generation is covered by the EU emissions trading system (ETS), therefore CO2 emissions savings achieved in electricity generation do not count directly towards Ireland's EU targets to reduce greenhouse gas (GHG) emissions outside of the ETS (non-ETS). However, decarbonising the electricity system combined with increased electrification of heat and transport through the use of electric vehicles (EV) and heat pumps is an important part of the strategy for decarbonising the energy system as a whole. The use of renewable electricity at current levels helps ensure that switching to EVs and heat pumps does not result in greater CO2 emissions than the fossil fuel alternative. Electrification of heat and transport also reduces direct fossil fuel use in the non-ETS sector, thereby contributing to meeting the non-ETS GHG emissions reduction target.

In relation to the displacement of fossil fuels by renewable energy, it is estimated that in 2018 approximately €623 million in fossil fuel imports were avoided, of which €432 million was avoided by wind generation.

Figure 41: Avoided CO_2 from renewable energy, 2005 – 2018



In 2018, approximately €623 million in fossil fuel imports were avoided by the use of renewables, of which €432 million was avoided by wind.

45 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.

46 Holttinen, Hannele, et al (2014), *Estimating the reduction of generating system CO_2 emissions resulting from significant wind energy penetration* 13h International Workshop on Large-Scale Integration of Wind Power into Power Systems as well as on Transmission Networks for Offshore Wind Power Plants. Berlin: Energynautics.

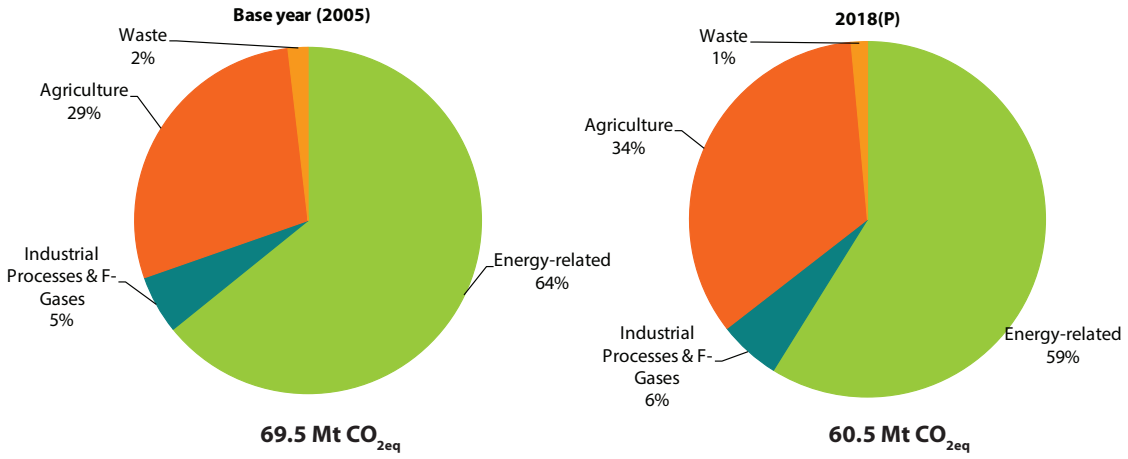
6.2 Greenhouse gas emissions targets

In 2008, the EU agreed a climate and energy package that included a target to reduce 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 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 42 shows GHG emissions by source for 2005 and provisional figures for 2018, as reported by the Environmental Protection Agency (EPA).

Figure 42: Greenhouse gas emissions by source



Source: Based on EPA data

Figure 42 shows that the share of energy-related emissions of the total GHG emissions has fallen since 2005. The share of GHG emissions arising from energy-related activities was 59% (35.6 Mt) in 2018, compared with 64% (44.6 Mt) in 2005. The share from agriculture increased from 29% to 34% in the same period, from 19.8 Mt to 20.6 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.

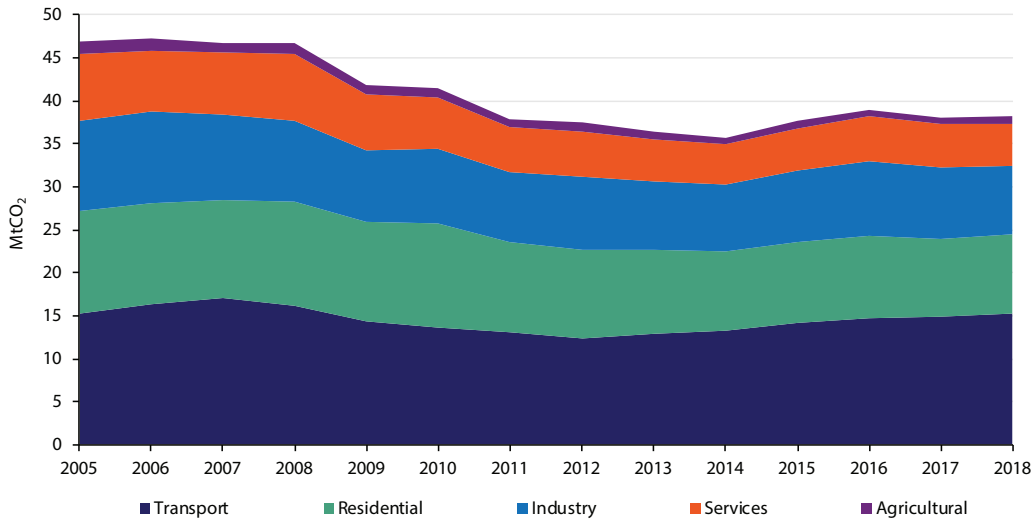
The sectoral energy-related CO_2 emissions presented in *Figure 43* and *Table 19* are based on the economic sectoral disaggregation contained in the energy balance, with the upstream emissions from electricity generation and other energy transformations allocated to the economic sectors where that electricity 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 UN IPCC reporting guidelines.

The share of GHG emissions arising from energy-related activities was 59% (35.6 Mt) in 2018, compared with 64% (44.6 Mt) in 2005.

Energy-related GHG emissions fell by 1.2% in 2018.

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 2018 were 18% higher than 1990 levels but 20% lower than in 2005.

Figure 43: Energy-related CO_2 emissions by sector[47,48]



As shown in *Table 19,* transport accounted for the largest share of energy-related CO_2 emissions, with a share of 40% in 2018, up from 33% in 2005. The residential sector accounted for the second largest share in 2018, at 24%, followed by industry at 21% and services at 13%. Energy-related CO_2 emissions in agriculture and fisheries accounted for just 2.2%.

Table 19: Growth rates, quantities and shares of primary energy-related CO_2 by sector

	Overall Growth %	Average Annual Growth %					Quantity (kt CO_2)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Industry	-22.8	-2.0	-3.7	-0.9	-0.9	-3.5	10,519	8,118	22.5	21.3
Transport	-0.1	0.0	-2.4	0.7	2.8	2.9	15,299	15,277	32.7	40.0
Residential	-23.0	-2.0	0.5	-4.6	-1.6	0.0	11,843	9,114	25.3	23.9
Services	-37.4	-3.5	-4.9	-4.1	-0.3	-3.6	7,764	4,860	16.6	12.7
Agriculture & Fisheries	-41.2	-4.0	-5.7	-5.6	1.7	1.2	1,414	831	3.0	2.2

A more detailed discussion can be found in SEAI's publication *Energy-Related CO_2 Emissions in Ireland*.

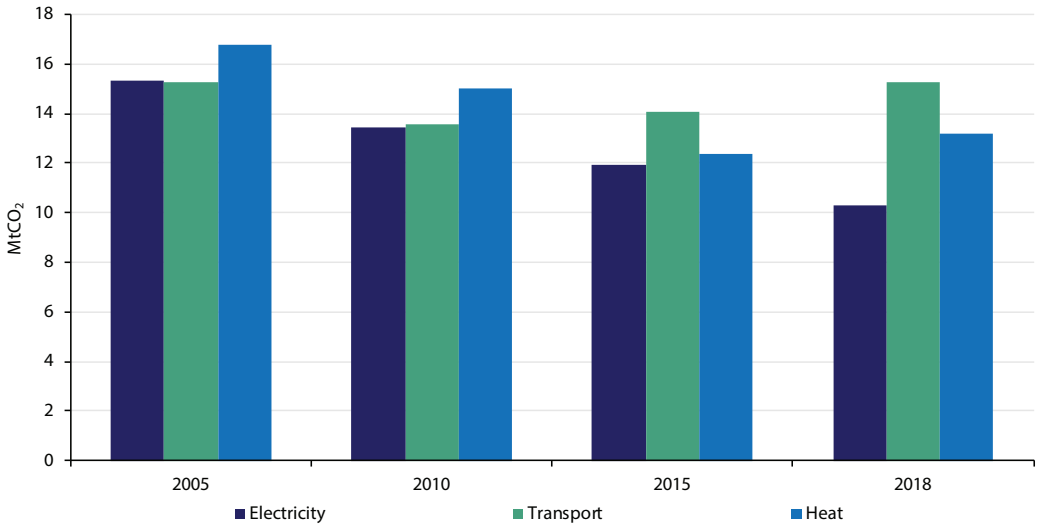
Figure 44 and *Table 20* illustrate the variations in emissions by mode of energy use. Here the emissions are allocated according to whether the energy used is for transport, electricity, or thermal energy. These modes also represent distinct energy markets. The graph presents the emissions in the years 2005, 2010, 2015 and 2018. In 2018, the shares of energy-related CO_2 emissions from transport, electricity and thermal applications were 39.4%, 26.6% and 34.0% respectively.

Transport accounted for the largest share of energy-related CO_2 emissions, with a share of 40% in 2018, up from 33% in 2005.

47 *Figure 43* and *Table 19* are based on SEAI estimates and use a different methodology to that used by the EPA for compiling the national inventory. International air transport emissions are excluded from the national GHG emissions inventory in accordance with the reporting procedures established by the UNFCCC guidelines.

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

Figure 44: Energy-related CO_2 emissions by mode of energy application



Energy-related CO_2 emissions fell in all modes after 2005, by 19% overall, to 38.7 Mt. The fastest rates of decline were observed in electricity (33% decrease), followed by heat (22% decrease). Transport returning to 2005 levels in 2018, with a fall of just 0.05%. In 2018, emissions fell by 12.6% in electricity but increased by 6.9% in heat and by 2.9% in transport.

Table 20: Growth rates, quantities and shares of energy-related CO_2 emissions by mode of application

	Overall Growth %	Average Annual Growth %					Quantity (kt CO_2)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Transport	-0.05	0.0	-2.4	0.7	2.7	2.9	15,261	15,254	32.7	39.8
Electricity	-32.8	-3.0	-2.6	-2.3	-4.8	-12.6	15,325	10,303	32.8	26.9
Heat	-20.7	-1.8	-2.1	-3.9	2.4	6.9	16,104	12,763	34.5	33.3
Total	**-17.9**	**-1.5**	**-2.4**	**-1.8**	**0.4**	**-0.6**	**46,690**	**38,320**		

Source: SEAI

Given that the binding target at the national level is for the non-ETS[49] sectors, *Table 21 and Figure 45* show the trends in non-ETS energy-related CO_2 emissions for the transport, residential, services and agriculture[50] sectors since 2005, non-ETS industry from 2005 onwards and non-ETS transport since 2012. This excludes emissions associated with electricity use by these sectors as these emissions are included in the ETS.

Table 21: Growth rates, quantities and shares of ETS and non-ETS energy-related CO_2 since 2005

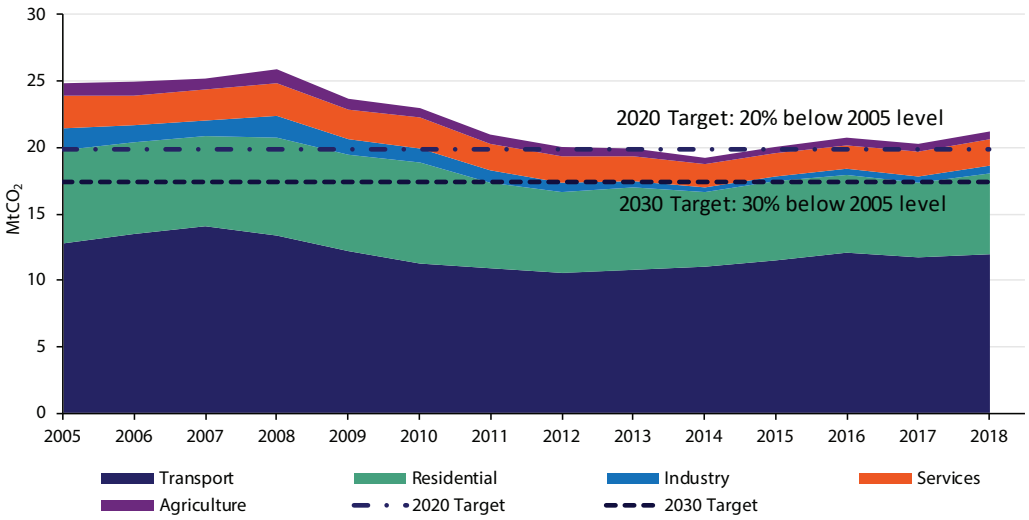
	Overall Growth %	Average Annual Growth %					Quantity (kt CO_2)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
ETS CO_2	-23.1	-2.0	-3.4	-1.1	-1.2	-5.5	22,033	16,953	47.0	44.4
Non-ETS CO_2	-14.3	-1.2	-1.6	-2.6	1.9	4.7	24,805	21,248	53.0	55.6
Total Energy-Related CO_2	**-18.8**	**-1.6**	**-2.5**	**-1.6**	**0.0**	**-1.2**	**47,543**	**38,599**		

Table 21 shows that non-ETS sectors' (including non-ETS industry) energy-related CO_2 emissions decreased by 1.6% per annum between 2005 and 2010, and by 2.6% per annum between 2010 and 2015, with emissions increasing by 1.9% per annum between 2015 and 2018. Non-ETS energy-related CO_2 emissions were 14% below 2005 levels in 2018. 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) from 2005 levels by 2020.

The emissions trading sector has experienced a 23% fall in energy-related emissions since 2005, and emissions fell by 5.5% in 2018 compared with the previous year. The share of emissions covered in the ETS in overall energy-related emissions stood at 44% in 2018.

49 EU Decision 406/2009/EC.
50 Agricultural energy use only.

Figure 45: Non-emissions trading energy-related CO_2[51]



6.2.1 Transboundary gas emissions

Emissions of sulphur dioxide (SO_2) and nitrogen oxides[52] (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 22* shows the emission levels for SO_2 and NO_x in 2017 as well as the 2010 ceiling limit set in the Directive.

Table 22: SO_2 and NO_x emissions and Directive 2001/81/EC limits for 2010[53]

	1990 (kt)	2017 (kt)	2010 Ceiling (kt)	% Above 2010 Ceiling
NO_x	140	108.3	65	67
SO_2	183	13.2	42	-

Source: EPA

SO_2 levels in Ireland fell by 93% between 1990 and 2018. Emissions from power generation fell by 96% 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 84% in SO_2 emissions in the residential and services sectors and a 92% 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. Nitrous Oxide is also a potent greenhouse gas. Power generation plants and motor vehicles are the principal sources of NO_x, through high-temperature combustion. NO_x emissions in Ireland decreased by 38% between 1990 and 2017 and have decreased by 36 kt, or 25%, since 2008. The latest estimate is 108.3 kt for 2018, which is an increase of 0.9% on the previous year. In 2017, NO_x emissions were 67% above the 2010 ceiling.

Ireland has applied an adjustment to NO_x emission inventories, as allowed under Article 5(1) of EU Directive 2016/2284 in accordance with Part 4 of Annex IV, as Ireland is non-compliant with national emission reduction commitments as a result of applying improved emission inventory methods updated in accordance with scientific knowledge. Ireland exceeded the emission ceiling in 2010 and has been compliant with the NO_x emission ceiling since 2011.

The transport sector, which mainly consists of road transport, is the principal source of NO_x emissions, contributing approximately 41% of the total in 2017. The industrial and power generation sectors are the other main sources of NO_x emissions, with contributions of 9.5% and 7.5% respectively in 2016. The remainder of NO_x emissions emanate from the residential/commercial and the agricultural sectors, which together produced around 11.1% of the total in 2017.

51 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.

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

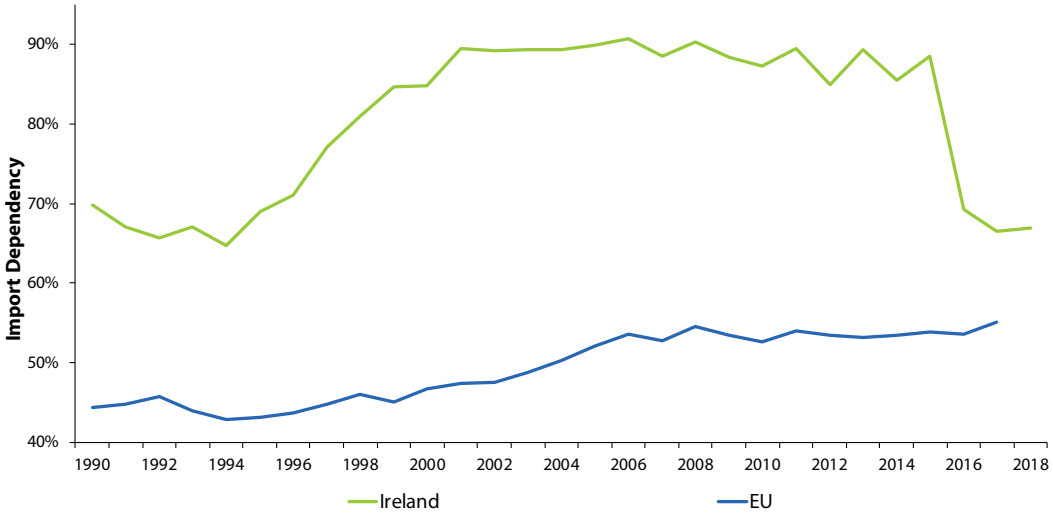
53 See http://www.epa.ie/pubs/reports/air/airemissions/

6.3 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 the 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[54]. *Figure 46* 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.

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 fell further, to 66%, in 2017, but increased to 67% in 2018. 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. It has since increased, to €5 billion in 2018.

Figure 46: Import dependency of Ireland and the 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 gas field. *Figure 47* shows the indigenous energy fuel mix for Ireland over the period. Production of indigenous gas decreased by 94% over the period 1990 – 2015, to 106 ktoe but then increased dramatically in 2016, to 2,493 ktoe. It increased again in 2017, to 2,854 ktoe. This is the highest natural gas production level ever recorded in Ireland. This high level of production from the Corrib gas field is expected to taper off significantly in the next couple of years[55] and this indeed appears to have started in 2018, with a small reduction in production (to 2,752 ktoe).

Peat production was down since 2013, following a bumper production during that summer that provided very good harvesting conditions. In 2018 peat production was up 3.4%, to 816 ktoe, compared with the previous year.

Indigenous renewable energy production increased by 258% between 2005 and 2018, to 1,326 ktoe.

The indigenous production of all energy in Ireland reached the highest level ever with a new peak in 2018 of 5,040 ktoe, up from the previous peak in 2017 of 4,884 ktoe.

Ireland's import dependency varied between 85% and 90% until 2016 when Corrib gas field started production, and it fell to 69%. It fell further, to 66%, in 2017 but increased to 67% in 2018.

54 SEAI (2015), *Energy Security in Ireland*, www.seai.ie
55 https://www.gasnetworks.ie/corporate/company/our-network/GNI_NetworkDevPlan_2016.pdf

Figure 47: Indigenous energy by fuel

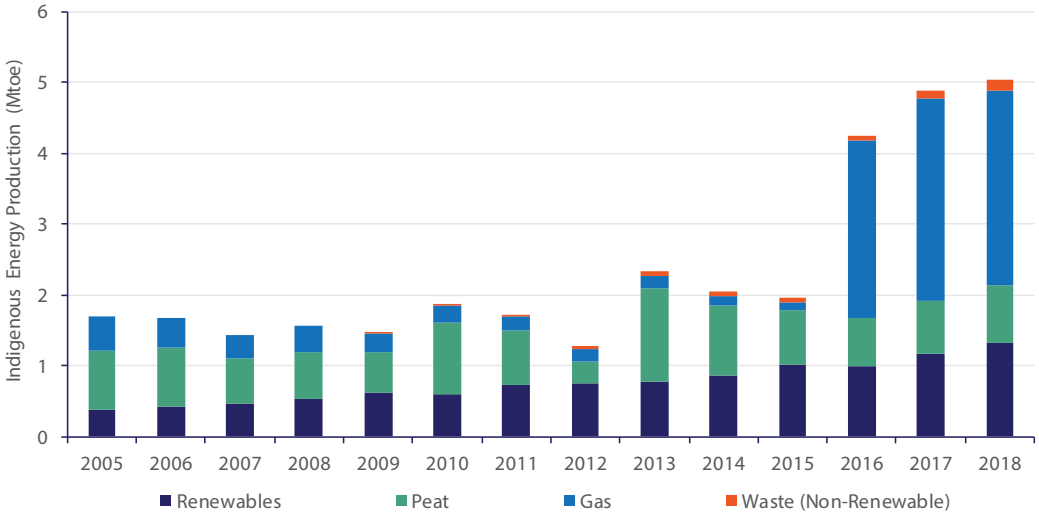


Figure 48 shows the trend for net fuel imports (imports minus exports) over the period 2005 – 2018. The dependence on oil, due largely to energy use in transport, is the most striking feature up until 2008. Between 2008 and 2018, net imports fell by 33%, with oil imports falling 20%. In 2018, net imports increased by 2.3% but were still 32% below 2005 levels, while oil imports were 24% below 2005. Gas imports increased by 23% in 2018 to compensate for lower indigenous output and the closure of the Inch storage facility.

Coal imports fell by 31% in 2018 as a result of the reduced operation of Moneypoint electricity generating plant. In 2018, oil, gas and coal accounted for 73%, 17% and 8% of net imports, respectively.

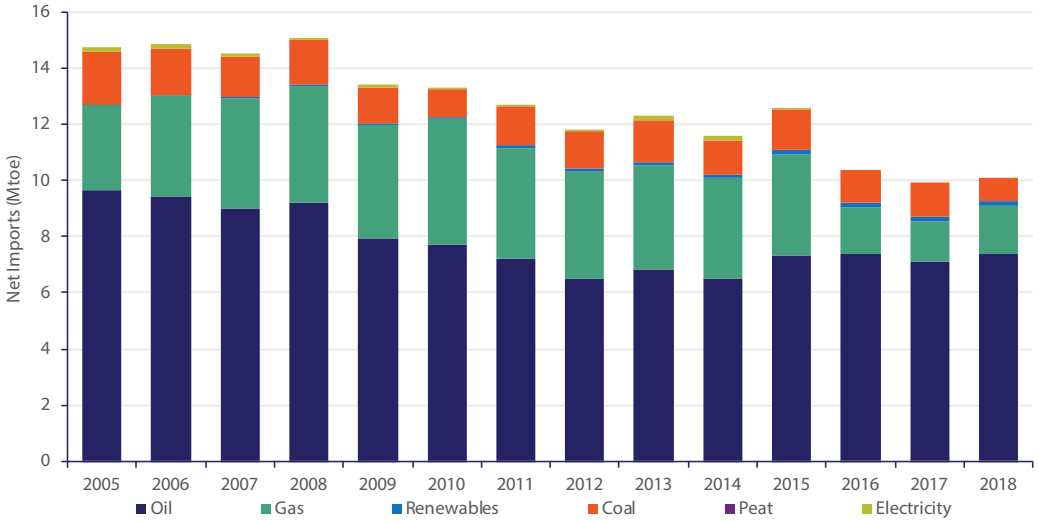
Contributions to the increase in import dependency in 2018 were:

- Natural gas imports, were up 23% to 1,728 ktoe;
- Net oil imports, were up 3.6% to 7,382 ktoe.

Countering these were:

- Coal imports were, down 32% to 830 ktoe;
- A 11.4% decrease in renewable energy imports (biomass and biofuels) to 141 ktoe;
- Net electricity exports, were down 96% to 2 ktoe.

Figure 48: Imported energy by fuel



6.4 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 2015, energy prices[56] in Ireland have increased by 2.5% in real terms, compared with an average increase of 0.6% in OECD (Organisation for Economic Co-operation and Development) Europe, and a 7.9% increase in the United States over the same period based on data from the IEA. In 2018, overall energy prices in Ireland were 2% higher than in 2017, compared with an increase of 4% in OECD Europe and a 7% increase in the US.

Crude oil prices averaged around $71/barrel in 2018, compared with $54/barrel on average in 2017. Up to mid-October 2019, the average price for Brent crude oil was $64/barrel[57].

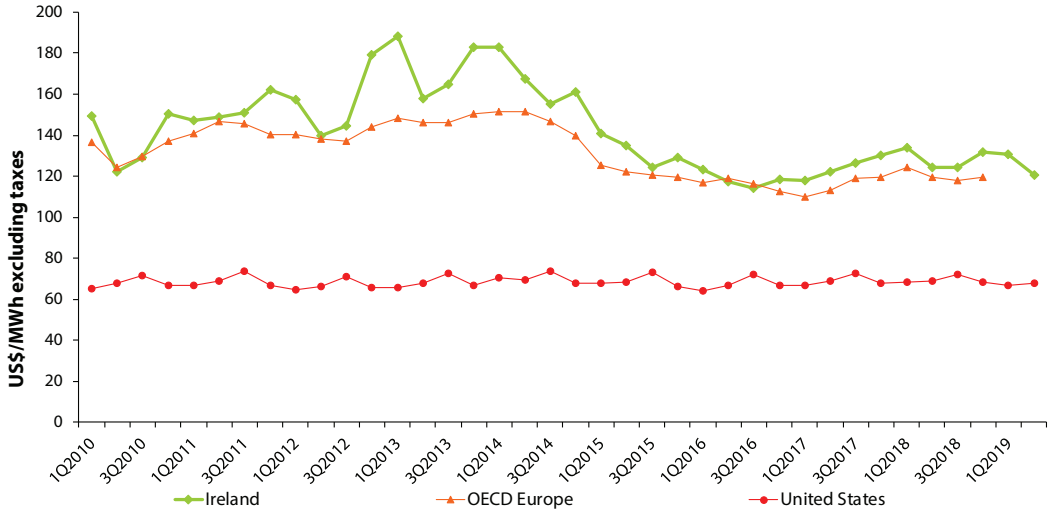
The price of natural gas at the UK National Balancing Point[58] was, on average, 34% higher in 2018 compared with 2017.

SEAI publishes biannual reports titled *Electricity and Gas Prices in Ireland*[59] based on data collected under EU legislation on the transparency of gas and electricity prices, 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 prices. 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 2019. Prices shown are in US dollars and are in current (nominal) money[60]. Relative price increases since 2015, however, are tabulated for EU-15 countries and the US in index format in both nominal and real terms.

6.4.1 Energy prices in industry

Figure 49: Electricity prices to industry



Source: Energy Prices and Taxes © OECD/IEA, 2018

56 IEA, Energy Prices and Taxes.
57 US Energy Information Administration http://www.eia.gov
58 National Grid UK https://www.nationalgrid.com/uk/gas/market-operations-and-data/transmission-operational-data
59 SEAI (various dates), Electricity and Gas Prices in Ireland.
60 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 the effects of price changes and inflation, to give the constant value over time indexed to a reference year.

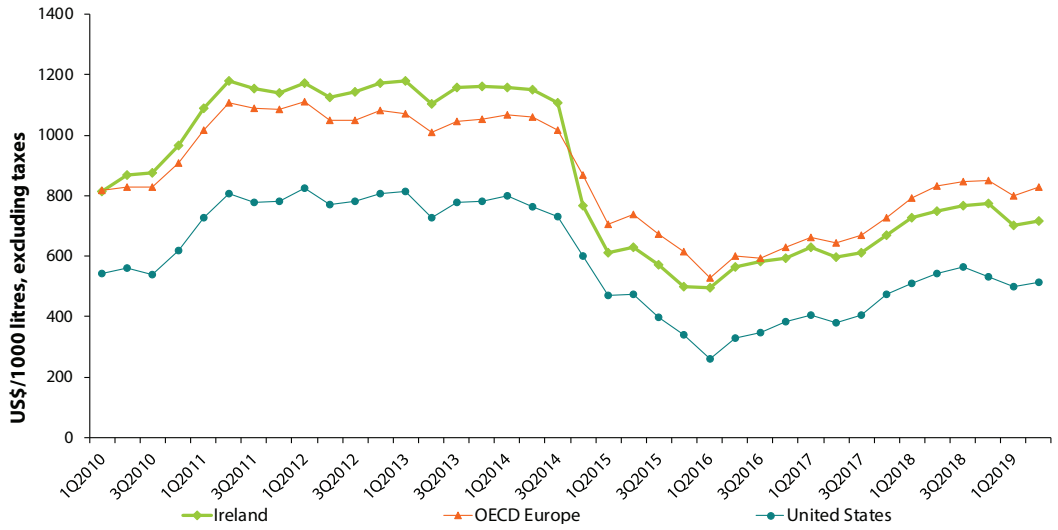
Table 23: Electricity price to industry increase since 2015

Index 2015 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom	United States
2nd qtr 2019 (nominal)	111	97	105	87	97	93	94	98	**90**	85	109	100	100	96	131	130	98
2nd qtr 2019 (real)	97	92	93	85	93	90	90	94	**95**	82	101	93	96	92	116	117	92

Source: Energy Prices and Taxes © OECD/IEA, 2018

Table 23 shows that electricity prices to Irish industry fell by 5% in real terms between 2015 and 2018. 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 70%, behind Greece at 75%, the Netherlands at 78% and Poland at 84%. Ireland also has a high dependency on gas generation, at 51%.

Figure 50: Oil prices to industry



Source: Energy Prices and Taxes © OECD/IEA, 2018

Table 24: Oil prices to industry increases since 2015

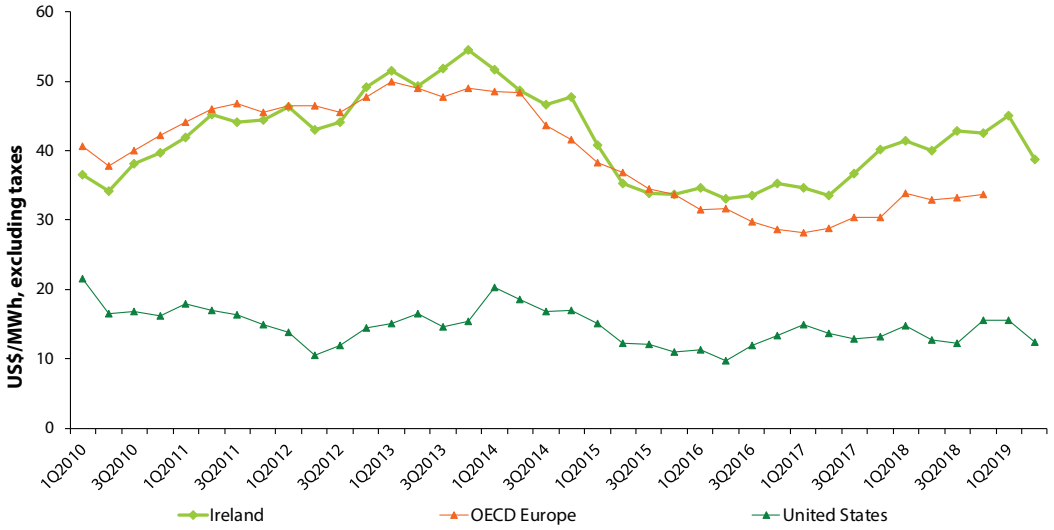
Index 2015 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom	United States
2nd qtr 2019 (nominal)	119	108	125	112	111	127	111	119	**108**	108	109	111	116	111	120	117	116
2nd qtr 2019 (real)	107	103	112	109	106	123	105	114	**113**	104	101	103	111	106	106	105	108

Source: Energy Prices and Taxes © OECD/IEA, 2018

Table 24 shows that oil prices to industry in Ireland were 13% higher in real terms in 2018 than in 2015. The average increase in oil price in Europe was 7%, and 8% in the US.

Crude oil prices averaged around $71/barrel in 2018, compared with $54/barrel on average in 2017. Up to mid-October 2019, the average price for Brent crude oil was $64/barrel.

Figure 51: Natural gas prices to industry



Source: Energy Prices and Taxes © OECD/IEA, 2018

Table 25: Natural gas prices to industry increases since 2015

Index 2015 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom	United States
2nd qtr 2019 (nominal)	100	88	94	95	121	101	86	95	**107**	84	74	95	71	90		95	95
2nd qtr 2019 (real)	87	84	83	92	116	98	81	91	**112**	81	69	88	68	85		85	89

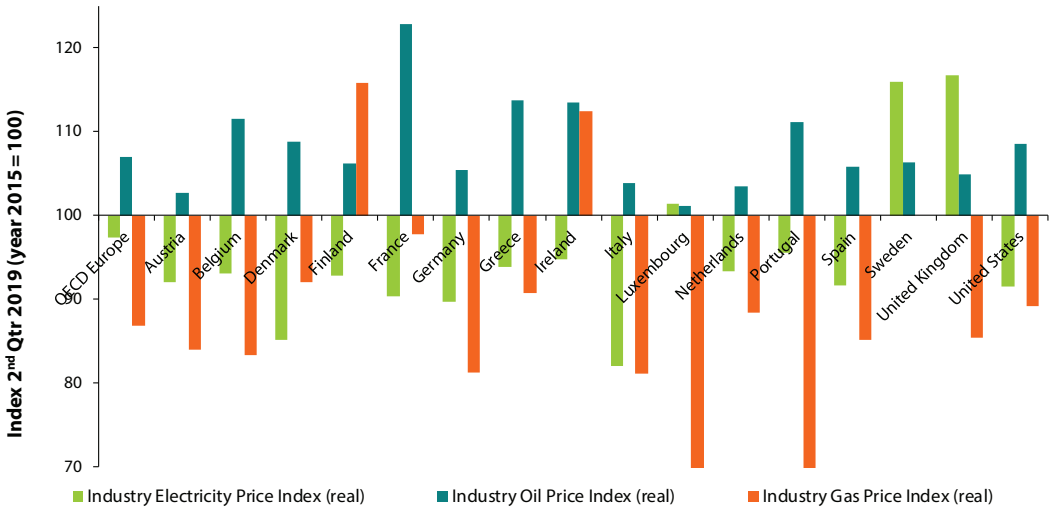
Source: Energy Prices and Taxes © OECD/IEA, 2018

As can be seen in *Figure 51*, natural gas prices to Irish industry increased from the second quarter of 2010 until the end of 2013. Prices had been relatively stable from the middle of 2015 until the middle of 2017 when they started to rise again. In the second quarter of 2019 the price of gas to industry in Ireland was 12% above 2015 levels in real terms. *Figure 51* also shows the gap between gas prices in Europe and the US.

The price of natural gas at the UK National Balancing Point was, on average, 34% higher in 2018 compared with 2017.

Figure 52 summarises the data presented in *Table 23*, *24* and *25*. The IEA publishes an overall energy price index (real) for industry, which shows that the overall energy price to Irish industry between 2015 and 2018 increased by 4.7%, compared with an increase of 0.7% for OECD Europe and a 5% increase in the US.

Figure 52: Real energy price changes to industry since 2015 in EU-15 (index)



Source: Energy Prices and Taxes © OECD/IEA, 2018

In 2018, energy prices for industry in Ireland decreased by 8.6% in real terms compared with 2017. In OECD Europe, the increase was 4.7%, while in the US energy prices increased by 7.2%.

The year 2018 saw global oil price increasing, from around $54/barrel on average in 2017 to $71/barrel on average in 2018. Natural gas prices at the UK Balancing Point were, on average, 34% higher in 2018 compared with 2017.

The overall energy price to Irish industry between 2015 and 2018 increased by 4.7%, compared with an increase of 0.7% for OECD Europe and a 5% increase in the US.

7 Sectoral trends and indicators

This section explores in more detail the changes in energy use in each of the main sectors: residential, industy, transport, and services.

7.1 Industry

Trends in 2018

The economic activity of industry increased in 2018 by 9.6%, and final energy use grew by 4.7% compared with the previous year, to 2.6 Mtoe. The main trends in final energy use in industry were:

- In 2018, the consumption of all fuels increased with the exception of non-renewable wastes.
- Oil use increased by 7.4%, to 516 ktoe, and accounted for one-fifth (19.8%) of industry's energy use.
- Natural gas consumption in industry increased by 3.4% in 2018, to 790 ktoe, and accounted for 30% of industry's final energy demand.
- Renewable energy use in industry increased by 3.5%, to 198 ktoe, in 2018 and accounted for 7.6% of industry's energy use.
- Electricity consumption in industry increased by 5.3%, to 936 ktoe, and accounted for 36% of final energy consumption in industry.
- Coal use increased by 3.1%, to 105 ktoe, and accounted for 4.1% of the energy share of industry.
- The use of non-renewable wastes in industry fell by 3.7% in 2018, to 55 ktoe, and accounted for 2.1% of energy use in industry.

Trends in 2005 – 2018

Final energy use in industry was 1.2% lower in 2018 than in 2005. 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. Between 2012 and 2018 energy use in industry increased by 19%. In 2018, it increased by 4.7%.

Figure 53 shows that over the period 2005 – 2018 only electricity, natural gas, wastes and renewables have increased their shares. Since 2009, non-renewable wastes have been used in industry, and in 2018 accounted for 2.1% of industry's energy use. The share of electricity has risen from 25% to 36%, natural gas from 18% to 30% and renewables from 6.2% to 7.6% (see *Table 26*). 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 53: Industry final energy use by fuel

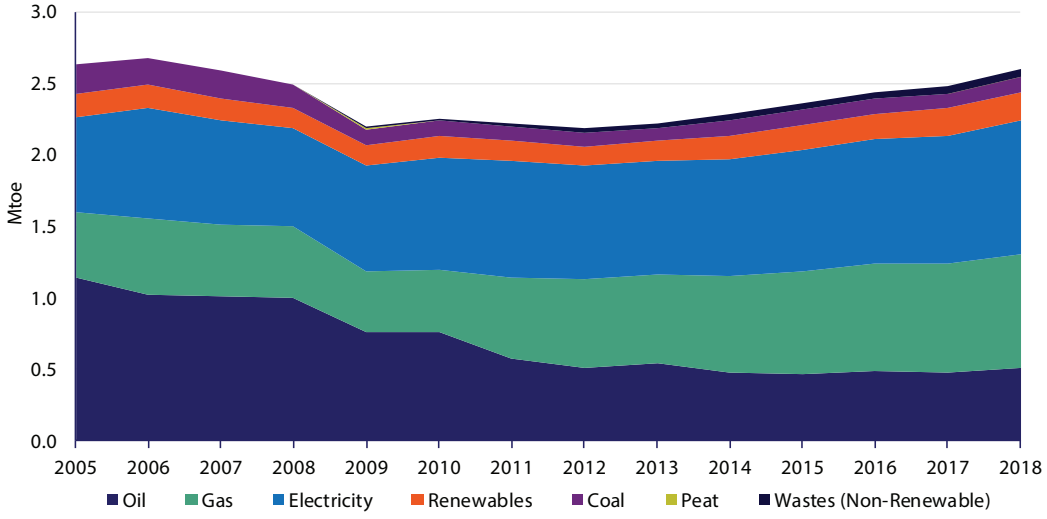


Table 26 shows the growth rates, quantities and relative shares of energy in industry.

Table 26: Growth rates, quantities and shares of final consumption in industry

	Overall Growth %	Average Annual Growth %					Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Fossil Fuels (Total)	-22.0	-1.9	-6.3	-0.2	2.9	4.8	1,810	1,412	68.7	54.3
Coal	-50.2	-5.2	-11.8	-1.2	-0.1	3.1	212	105	8.0	4.1
Oil	-54.6	-5.9	-7.8	-9.3	3.5	7.4	1,136	516	43.2	19.8
Gas	71.1	4.2	-1.1	10.6	3.0	3.4	462	790	17.5	30.4
Renewables	21.4	1.5	-1.4	3.2	3.6	3.5	163	198	6.2	7.6
Wastes (Non-Renewable)	-	-	-	38.8	7.6	-3.7	-	55	0.0	2.1
Combustible Fuels (Total)	-15.6	-1.3	-5.7	0.6	3.1	4.4	1,973	1,665	74.9	64.0
Electricity	41.9	2.7	3.5	1.6	3.4	5.3	660	936	25.1	36.0
Total	**-1.2**	**-0.1**	**-3.1**	**1.0**	**3.2**	**4.7**	**2,633**	**2,601**		

Direct use of all fossil fuels accounted for 54% of energy use in industry in 2018 and grew by 4.8% in that year. Over the period 2005 – 2018, use of fossil fuels in industry fell by 22%. So, while coal and oil consumption in industry fell over the period by 50% and 55% respectively, overall fossil fuel did not fall at the same rate because of increased natural gas use (+71%). These changes in the fuel mix resulted in lower emissions from fuel use in industry during this period.

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 the electricity consumed by industry. *Figure 54* shows the primary energy-related CO_2 emissions from industry, detailing the on-site CO_2 emissions associated with direct fuel use and the upstream emissions associated with electricity consumption.

Figure 54: Industry energy-related CO_2 emissions by fuel

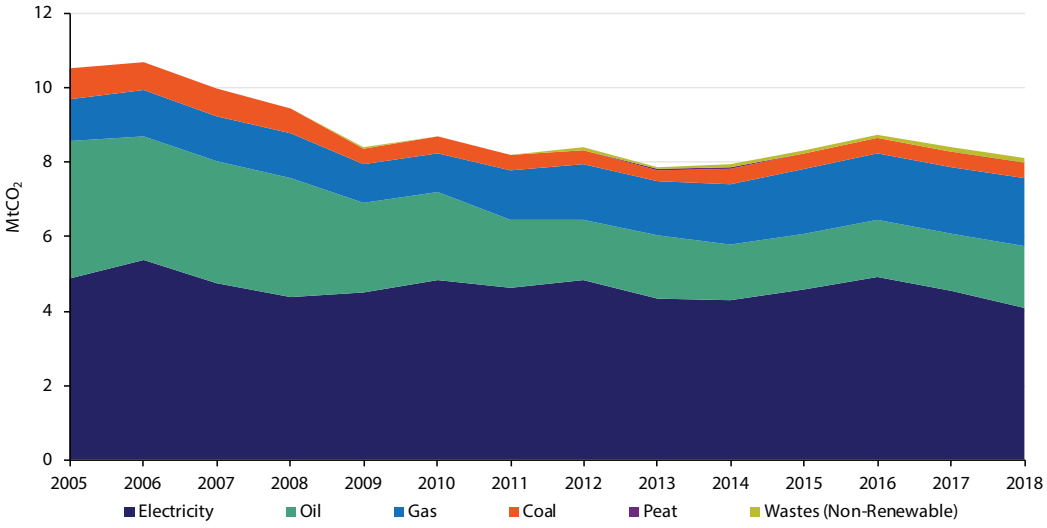


Table 27 shows the growth rates, quantities and relative shares of energy-related CO_2 emissions in industry.

As detailed in *Table 27*, industrial energy-related CO_2 emissions fell by 3.5% in 2018, to 8.1 $MtCO_2$. Electricity consumption was responsible for 50% of industry's energy-related CO_2 emissions in 2018.

The economic activity of industry increased in 2018, by 9.6%, and energy use grew by 4.7% compared with the previous year, to 2.6 Mtoe.

Table 27: Growth rates, quantities and shares of energy-related CO_2 emissions in industry

	Overall Growth %	Average Annual Growth %					Quantity (kt CO_2)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Coal	-50.2	-5.2	-11.8	-1.2	-0.2	3.1	838	418	8.0	5.1
Oil Total	-55.4	-6.0	-8.5	-8.9	3.5	7.3	3,706	1,651	35.2	20.3
Kerosene	-24.0	-2.1	-2.0	-5.2	3.2	10.2	372	283	3.5	3.5
Fuel Oil	-93.8	-19.2	-8.0	-33.4	-10.5	-2.3	1,502	93	14.3	1.1
LPG	22.7	1.6	-0.1	0.6	6.1	9.0	275	337	2.6	4.2
Gas Oil	-37.5	-3.6	-4.6	-7.3	5.0	6.3	609	381	5.8	4.7
Petroleum Coke	-41.0	-4.0	-21.3	11.5	4.2	7.2	944	557	9.0	6.9
Natural Gas	68.1	4.1	-1.0	10.5	2.3	3.5	1,098	1,845	10.4	22.7
Wastes (Non-Renewable)	-	-	-	40.9	7.6	-3.7	-	115	0.0	1.4
Total Combustible Fuels	-28.5	-2.6	-7.2	-0.8	2.6	4.8	5,644	4,033	53.6	49.7
Electricity	-16.2	-1.4	-0.2	-0.9	-3.9	-10.4	4,876	4,085	46.4	50.3
Total	**-22.8**	**-2.0**	**-3.7**	**-0.9**	**-0.9**	**-3.5**	**10,519**	**8,118**		

Energy-related CO_2 emissions – excluding emissions associated with electricity

If upstream electricity-related emissions are omitted, then there was a 4.8% increase in CO_2 emissions from combustible fuels used on-site in industry in 2018. This is as a result of changes in the volume and fuel mix used in industry, with increased oil (+7.3%), coal (+3.1%) and natural gas (+3.5%) countered by increased renewables (+3.5%).

7.1.1 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 55* shows the industrial energy intensity between 2005 and 2018 expressed in kilograms of oil equivalent per euro of industrial value added at 2017 money value (kgoe/$€_{2017}$). Over the period, industrial energy consumption fell by 1.2%, while value added increased by 146%, resulting in a reduction in intensity of 60%. In other words, to generate a euro of value added in 2018, it took less than half of the amount of energy it took in 2005.

Figure 55: Industry energy intensity

Value-added output from industry was 92% higher in 2015 compared with 2014. The large increase in gross value added 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 gross value added incurred no additional energy consumption.

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

7.2 Transport

Trends in 2018

In 2018, overall energy use in transport increased by 2.6% compared with the previous year.

- Petrol use continued to fall in 2018, reducing by 9.2% to 821 ktoe. Petrol consumption is now 56% lower than the peak in 2007 and accounts for 16% of transport energy use.
- Diesel consumption grew by 4.7% during 2018, to 3,095 ktoe. Diesel has by far the largest share of transport fuel use, accounting for 60% in 2018.
- Jet kerosene consumption increased by 7.9% in 2018, to 1,102 ktoe, accounting for 21% of transport's final energy use, the second largest fuel share after diesel.

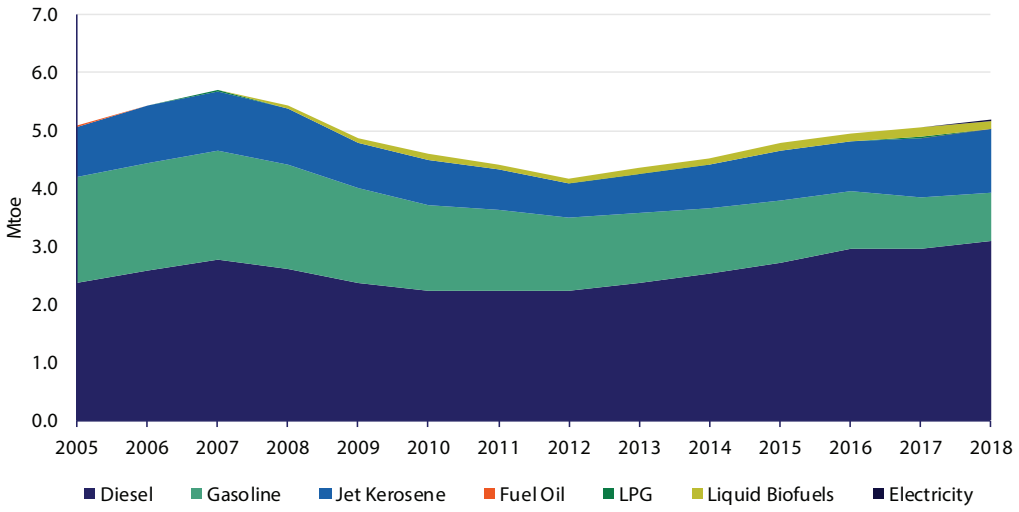
Trends in 2005 – 2018

Figure 56 and *Table 28* show the trends in transport's final energy use split by fuel type between 2005 and 2018. Over the period 2005 – 2018, the biggest shift in the transport market was from petrol to diesel. While consumption of diesel increased by 30%, petrol use fell by 55%. Diesel's overall market share grew from 47% in 2005 to 60% in 2018.

Transport's energy use peaked in 2007, at 5,715 ktoe, and fell each year thereafter, until 2013. As the economy started to expand again, transport's energy use grew. It expanded every year after 2013, and in 2018 it was 25% higher than in 2012. Energy consumption in transport was 2.3% higher in 2018 than in 2005, but remained 9% lower than the peak in 2007.

As the economy started to expand again, transport energy use grew. It expanded every year after 2013, and in 2018 it was 25% higher than in 2012.

Figure 56: Transport final energy use by fuel[61]



Jet kerosene use increased by 7.9% in 2018 and is now greater than petrol use, which declined by 9.2%.

61 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 *Energy in Transport 2014 Report*, presents estimates of fuel tourism which are shown in *Figure 58* in the transport report.

Table 28: Growth rates, quantities and shares of final consumption in transport

	Overall Growth %	Average Annual Growth %				Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Fossil Fuels (Total)	-0.7	-0.1	0.7	2.7	2.8	5,078	5,042	99.9	96.9
Total Oil	-1.1	-0.1	0.7	2.6	2.8	5,076	5,020	99.8	96.5
Petrol	-54.9	-5.9	-6.2	-8.6	-9.2	1,822	821	35.8	15.8
Diesel	30.1	2.0	4.1	4.3	4.7	2,378	3,095	46.8	59.5
Jet Kerosene	28.6	2.0	1.5	9.2	7.9	857	1,102	16.9	21.2
LPG	81.8	4.7	37.5	-9.9	-17.8	1	2	0.0	0.0
Natural Gas	923.9	19.6	13.3	79.1	11.5	2	22.56	0.0	0.4
Renewables	13945.1	46.3	6.7	6.4	-4.0	1	154	0.0	3.0
Combustible Fuels (Total)	2.3	0.2	0.8	2.8	2.6	5,079	5,197	99.9	99.9
Electricity	2.6	0.2	-0.8	11.4	16.2	5	5	0.1	0.1
Total	**2.3**	**0.2**	**0.8**	**2.8**	**2.6**	**5,084**	**5,202**	100.0	100.0

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 29*, closely match the changes in transport fuel consumption. Between the 2007 peak and 2012, 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 2018, by 2.9%, to 15.3 $MtCO_2$, just 0.1% below the 2005 level.

Table 29: Growth rates, quantities and shares of energy-related CO_2 emissions in transport

	Overall Growth %	Average Annual Growth %				Quantity (kt CO_2)		Shares %	
	2005 – 2018	'05 – '18	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Total Oil Products	-0.4	0.0	0.7	2.7	2.9	15,256	15,202	99.7	99.5
Petrol	-54.9	-5.9	-6.2	-8.6	-9.2	5,337	2,406	34.9	15.8
Diesel	30.1	2.0	4.1	4.3	4.7	7,299	9,496	47.7	62.2
Jet Kerosene	28.6	2.0	1.5	9.2	7.9	2,562	3,294	16.7	21.6
LPG	81.8	4.7	37.5	-9.9	-17.8	3	5	0.0	0.0
Natural Gas	906.9	19.4	13.2	78.0	11.5	5	53	0.0	0.3
Electricity	-39.1	-3.7	-3.4	3.9	0.3	37	23	0.2	0.1
Total	**-0.1**	**0.0**	**0.7**	**2.8**	**2.9**	**15,299**	**15,277**	100.0	100.0

7.2.1 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 DART system and, since 2004, by the Luas, but increasingly now by electric vehicles on the road. 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.

The contribution from each mode of transport to energy demand is detailed in *Table 30*. In 2014, a new category of 'light goods vehicle') was added. Energy use identified under this category was previously included in the 'unspecified' category.

Trends in 2018

Overall energy use in transport increased by 2.6% in 2018. This was despite a fall in the energy consumption of heavy goods vehicles (-2.6%), light goods vehicles (-2.2%) and private cars (-1.0%). The increase came mostly from aviation (+7.9%), along with fuel tourism (+13.6%) and unspecified[62] fuel use (+13.5%).

62 Unspecified transport energy is the difference between the total energy used for transport and the energy that we estimate is used by each of the other modes, e.g. heavy goods vehicles, private cars, fuel tourism, etc. Changes in unspecified energy are due to variations between our estimates of energy use in these modes and the total transport energy use. This is unavoidable to a certain extent. When the amount of unspecified fuel increases, in reality this is an increase in one or more of the other modes of transport, that our estimates have not fully accounted for.

Table 30: Growth rates, quantities and shares of transport final energy demand by mode

	Overall Growth %	Average Annual Growth %					Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Heavy Goods Vehicle	-34.7	-3.2	-9.2	-1.9	5.1	-2.6	1,112	727	21.9	14.0
Light Goods Vehicle	-	-	-	-1.2	0.4	-2.2	-	332	-	6.4
Private Car	8.8	0.7	1.3	1.4	-1.6	-1.0	1,892	2,058	37.2	39.6
Bus & Taxi	-11.7	-1.0	0.9	-3.9	1.1	4.8	157	139	3.1	2.7
Rail	-5.9	-0.5	-0.6	-2.1	2.4	1.7	45	42	0.9	0.8
Aviation	28.4	1.9	-1.7	1.5	9.2	7.9	859	1,103	16.9	21.2
Fuel Tourism	-52.4	-5.5	-10.0	15.7	-26.9	13.6	387	184	7.6	3.5
Navigation	68.8	4.1	5.4	2.1	5.5	10.6	50	84	1.0	1.6
Pipeline	**922.6**	**19.6**	**-0.9**	**13.2**	**79.3**	**11.5**	**2**	**23**	**0.0**	**0.4**
Unspecified	-12.1	-1.0	-14.9	-16.3	68.6	13.5	580	510	11.4	9.8
Total	**2.3**	**0.2**	**-2.0**	**0.8**	**2.8**	**2.6**	**5,084**	**5,202**	100.0	100.0

Private car energy consumption accounted for just under 40% of transport energy use in 2018. Petrol consumption by private cars fell by 10.5% in 2018, to 665 ktoe, and diesel consumption increased by 5.0%, to 1,312 ktoe, and biofuels use decreased by 4.7% to 78 ktoe.

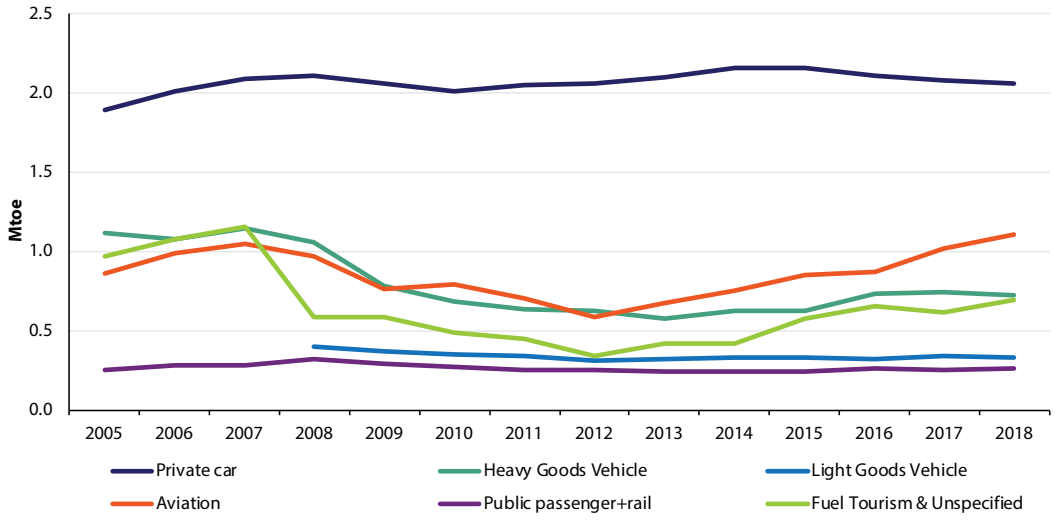
Road transport accounted for 63% of transport's total final consumption in 2018, or 76% if unspecified and fuel tourism are included as road transport. Private car use accounted for almost two thirds (63%) of road transport, with goods vehicles accounting for almost another one third (33%), and public passenger services the rest (4%).

Aviation was responsible for 21% of transport's total final consumption in 2018. In contrast, public passenger (road), which includes buses and taxis, was 2.7% and rail just 0.8%.

Trends in 2005 to 2018

Figure 57 shows the trend for energy use of transport by mode. Private car energy use clearly dominates. Private car energy use declined following the economic crash during 2009 and 2010 but returned to growth soon after in 2011. It grew year on year between 2011 and 2014, but reduced slightly each year between 2014 and 2018. This is due to amount of kilometres driven by private cars levelling off and the efficiency of the car stock improving.

Figure 57: Transport energy demand by mode, 2005 – 2018



Heavy goods vehicles road freight energy use reduced by a massive 49% between 2007 and 2013 as a result of reduced activity during the recession. The energy consumption of heavy goods vehicles increased by 29% between 2013 and 2017, but decreased by 2.6% in 2018. This is again due to changes in levels of activity, i.e. the amount of tonne-kilometres transported. In 2018 the amount of energy used by heavy goods vehicles remained 35% below the 2005 level.

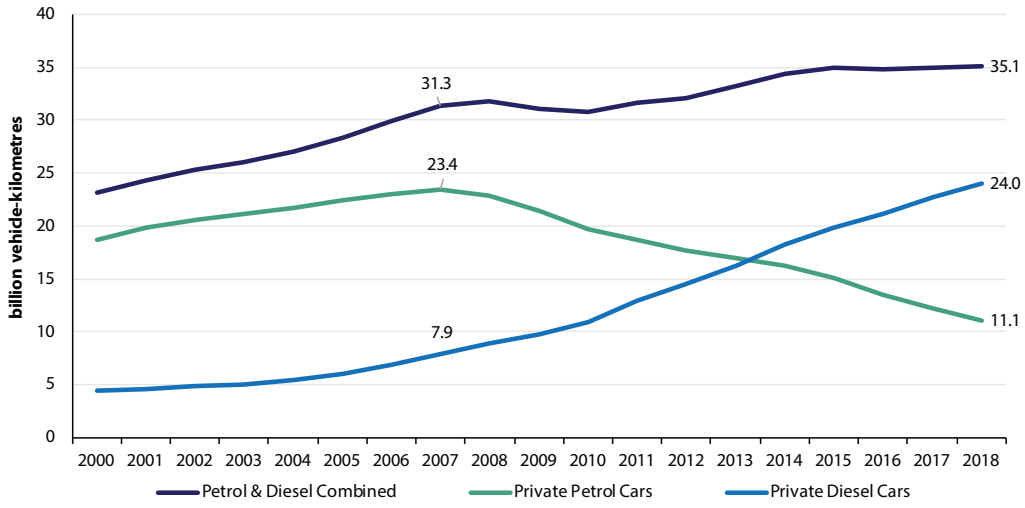
Aviation energy use also reached a peak in 2007, and decreased sharply afterwards due to the recession. By 2012, aviation had reduced by 44% compared to 2007. Aviation energy use returned to growth in 2013 and since then it has recovered much more strongly than car or freight, increasing by 88% between 2012 and 2018. In 2018 aviation surpassed the previous 2007 peak for the first time, climbing 6% above the level of energy use in 2007.

7.2.2 Private car transport

Figure 58 shows the total kilometres driven by private cars in Ireland each year from 2000 to 2018, based on an analysis of NCT data[63]. The total number of kilometres travelled declined following the economic crash (during 2009 and 2010) but returned to growth soon after, in 2011. Between 2011 and 2015 total vehicle-kilometres increased by 13.6%, or 2.6% per annum. Between 2015 and 2018 this growth levelled off. In 2018, total kilometres travelled by private cars increased by just 0.6%, or 0.2% per annum.

There was a clear shift from petrol to diesel cars in this period. This was already underway prior to the changes in motor taxation in 2008 but accelerated sharply after that. Overall travel by petrol cars reduced by 53% between the peak in 2007 and 2018. Travel by diesel cars increased by 204% over the same period. In 2007, 75% of total private car mileage was fuelled by petrol and 25% by diesel. In 2017, petrol accounted for 32% and diesel for 68%.

Figure 58: Total private car annual vehicle-kilometres, 2000 – 2018



Source: Based on NCT Data

7.2.3 CO_2 intensity of new private cars

Figure 59 shows the shares of new car sales[64] between 2005 and 2018, classified by emissions label band, and includes an estimate for 2019 based on sales to date. *Figure 60* shows the change in the weighted average specific CO_2 emissions of new cars between 2005 and 2018, with an estimate for 2019.

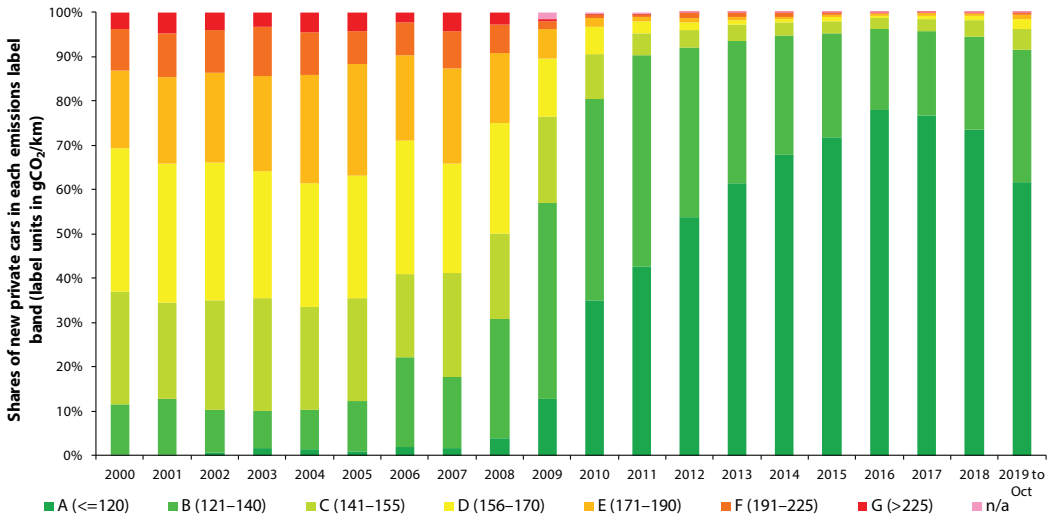
Since 2008, the combined effect of the EU legislation obligating manufacturers to reduce average fleet emissions and the changes to the Irish taxation system for private cars has been to shift new car purchases from higher to lower CO_2 emissions bands, as seen in *Figure 59*, and to reduce the average specific CO_2 emissions of new cars, as seen in *Figure 60*.

By 2016, 78% of new cars purchased were in the A category, and the average specific CO_2 emissions of new cars fell to 112.4 gCO_2/km. This trend has reversed since 2016. In 2018, the share of A-rated cars dropped to 74% and the specific CO_2 emissions increased to 114.0 gCO_2/km. Figures for 2019 (up until the end of August) show the share of A-rated vehicles dropping to 62% and the specific CO_2 emissions increasing to 117.5 gCO_2/km. This increasing market share of SUVs is likely to be a contributing factor.

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.

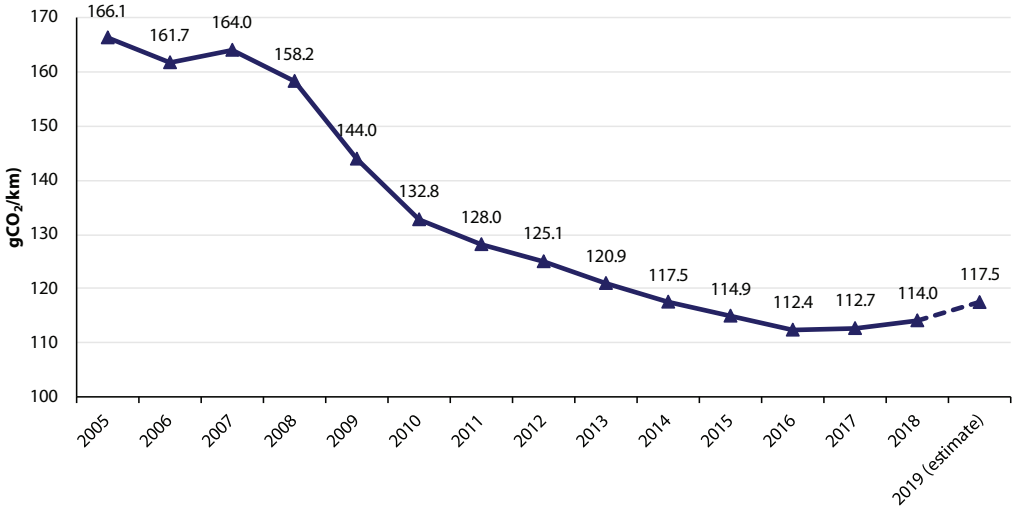
64 New private cars licensed for the first time. This does not include imported second-hand cars. It only includes brand new cars.

Figure 59: Shares of new private cars in each emissions band, 2000 –2018 (2019 to date)



Source: Dept. Transport Tourism and Sport, Vehicle Registration Unit

Figure 60: Specific CO_2 emissions of new cars, 2000 – 2018 (2019 estimated)



Source: Dept. Transport Tourism and Sport, Vehicle Registration Unit and VCA data

Data on the carbon emissions ratings of new cars prior to September 2018 was based on the results of a standardised laboratory test procedure called 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 reports by the International Council on Clean Transportation highlighted that the on-road factor increased dramatically after 2008, and that the real-world fuel consumption and carbon emissions of new vehicles is increasingly higher than the reported test values under the NEDC proceedure[65].

From September 2018, a new test methodology called the Worldwide Harmonised Light Vehicle Test Procedure (WLTP) came into force for all new cars. This new test is expected to better reflect real-world driving profiles. For new vehicles tested and sold across the EU in 2018, the European Environment Agency reports that the WLTP emissions factors were, on average, 20% higher than the NEDC emissions factors for the same vehicles. This change in the testing procedure is not responsible for the increase in specific CO_2 emissions of new cars seen in 2018 and 2019 in *Figure 60* as the data here is all based on the NEDC.

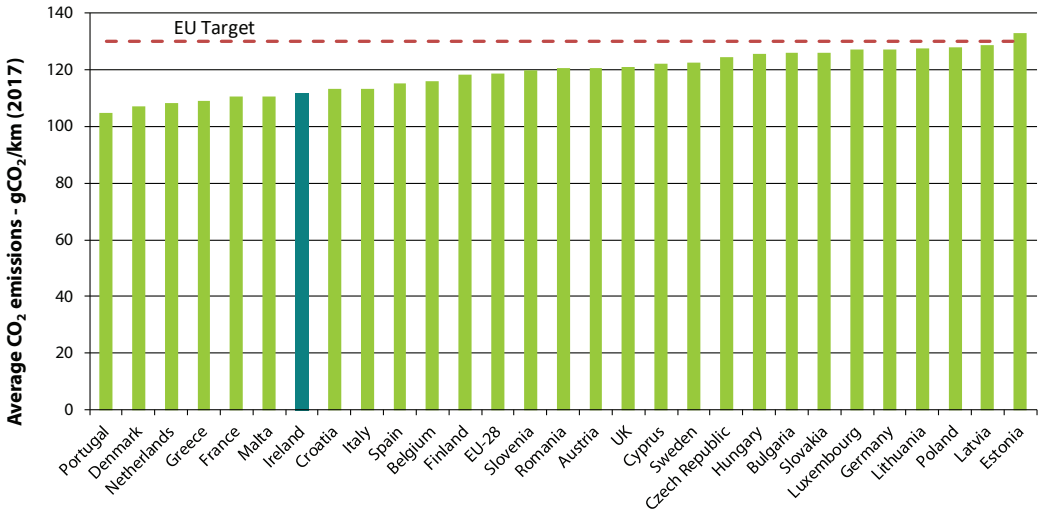
65 For more information see www.theicct.org.

The share of private cars in the A-label emissions band has fallen each year since 2016, and the average specific CO_2 emissions of new cars has increased.

Figure 61 shows the position of Ireland in relation to other EU Member States in terms of new car emissions. In 2017, the average CO_2 emissions from new cars in Ireland were 5.8% 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 gCO_2/km by 2015. All EU Member States were below this in 2016, with the exception of Estonia at 132.8 gCO_2/km.

From 2020, EU Regulation 333/2014 sets a target of 95 gCO_2/km for the average emissions of the new car fleet.

Figure 61: Specific CO_2 emissions of new cars – international comparison, 2017[66]



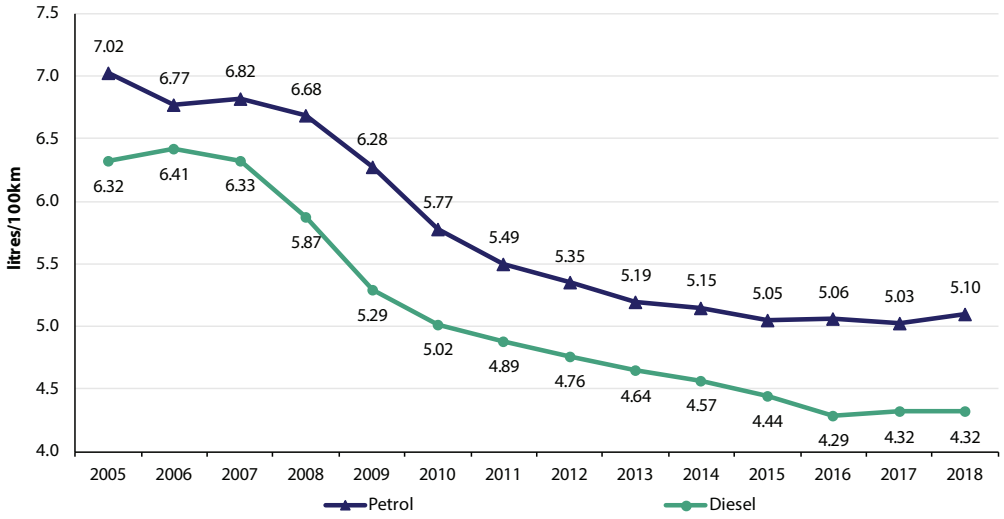
Source: European Environment Agency

66 European Environment Agency (2017), *Monitoring CO_2 emissions from passenger cars and vans in 2016*, https://www.eea.europa.eu//publications/monitoring-co2-emissions-from-new-2

7.2.4 Energy efficiency of new private cars

The average specific fuel consumption of new cars in Ireland from 2005 to 2018 is shown in *Figure 62* [67,68,69]. The specific fuel consumption of new cars is based on the same standardised test procedures as the specific CO_2 emissions of new cars, discussed in *Table 7.2.3*.

Figure 62: Weighted average test specific fuel consumption of new cars, 2005 – 2018



Source: Based on Vehicle Registration Unit and VCA data

In 2018 the fuel efficiency of the average new petrol car was 5.10 litres/100 km. This was 25% lower than in 2008 but 1% higher than the previous year. In 2018 the average new diesel car was 32% more fuel efficient than in 2008, and level with the previous year. As discussed in *Table 7.2.3,* when the test procedure switches from the NEDC to the WLTP, it is expected that this will to result in an increase in the measured specific fuel consumption of new cars.

Since 2008, there has been a 32% improvement in the average fuel efficiency of new diesel cars as measured by the NEDC test procedure.

7.2.5 Heavy goods vehicle activity

Heavy goods vehicle 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 that measure activity in the road freight sector are tonne-kilometres, vehicle kilometres and tonnes carried. *Figure 63* and *Table 31* present data on these three metrics, along with modified domestic demand as an index with respect to 2000. The data are taken from the CSO's Road Freight Transport Survey, which considers, for example, vehicles taxed as goods vehicles, those weighing over 2 tonnes unladen and those which are actually used as goods vehicles, rather than for service-type work. Tonne-kilometres is the activity metric used to estimate the energy use of heavy goods vehicles.

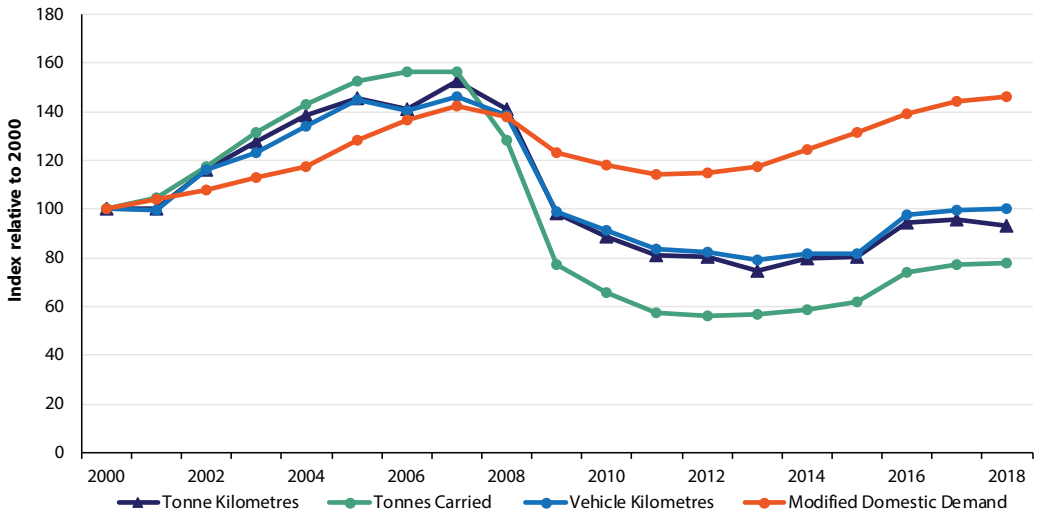
In 2018 there were 2.7% fewer tonne-kilometres travelled than in 2017, and 39% fewer than the peak in 2007. Tonnes carried and vehicle-kilometres were up by 1.4% and 0.2% respectively in 2018, but both of these metrics also remained well below the 2007 peak. All three transport metrics contracted more sharply than economic growth after the economic crisis of 2008.

67 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

68 New private cars licensed for the first time. This does not include imported second-hand cars. It only includes brand new cars.

69 The figures regarding litres/100km for petrol and diesel are not directly comparable as petrol and diesel have different energy content (calorific values).

Figure 63: Road freight activity, 2000 – 2018



Source: CSO

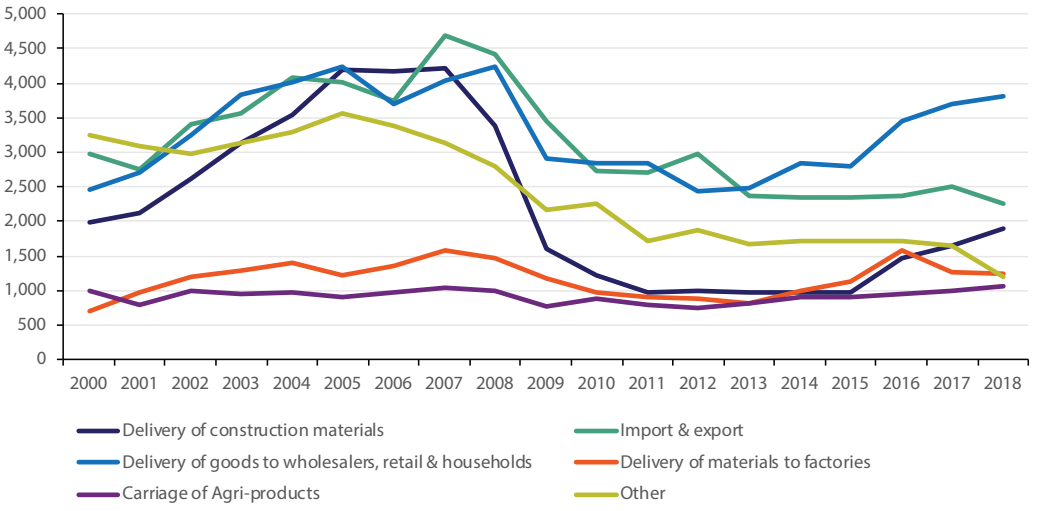
Table 31: Road freight activity, 2000 – 2018

	Growth %	Average Annual Growth %					Quantity		
	'00 – '18	'00 – '05	'05 – '10	'10 – '15	'15 – '18	2018	2000	2007	2018
Mega Tonne-Kilometres	-4.1	7.8	-9.3	-2.1	5.2	-2.7	12,263	18,707	11,445
Kilo-Tonnes Carried	-23.0	8.8	-15.5	-1.3	8.1	1.4	191,264	299,307	149,235
Mega Vehicle-Kilometres	-0.2	7.7	-8.8	-2.2	7.0	0.2	1,595	2,332	1,595
Modified Domestic Demand (million € 2017)	46.5	5.1	-1.7	2.2	3.7	1.7	120,240	171,335	176,178

Source: CSO

The CSO provides data on heavy goods vehicle activity, classed by main type of work done. The trends for tonne-kilometres in each category between 2000 and the peak in 2007, the contraction from 2007 to the low point in 2013, and the period 2013 – 2018 are shown in *Figure 64*.

Figure 64: Road freight activity by main type of work done, 2000 – 2018



Source: CSO

Between 2007 and 2013, the category 'Delivery of construction materials' experienced both the largest absolute decrease (3,248 Mtkm) and the largest percentage decrease (77%). It was responsible for the largest share, 34%, of the total reduction in activity from 2007 to 2013. This corresponds to the collapse of activity in the construction sector in this time period. The next biggest contributor to the fall of transport activity was 'Import & export'. Between 2007 and 2013 it reduced by 49%, and accounted for 2,315 Mtkm (24%) of the total reduction.

Despite the recovery of the economy between 2012 and 2018, the heavy goods vehicle activity in most categories has not recovered to 2007 levels. In 2018 'Delivery of construction materials' remained 55% below 2007, 'Import & export' was 52% below and 'Other' was 62% below.

For 'Delivery of construction materials', this is to be expected, as despite the recovery in the economy, activity in both new house construction and motorway construction is well below 2007 levels, and may never reach the exceptional output of those years again. For 'Import & export' and 'Other' it is not as clear why these remain so far below 2007 levels, or if they are ever likely to reach those levels again.

Despite the recovery of the economy between 2012 and 2018, heavy goods vehicle activity has not recovered to 2007 levels. It is not clear if it will return to those levels again

7.3 Residential

Trends in 2018

Residential energy use increased by 6.8% in 2018 compared to 2017. Despite the notable severe weather in March caused by Storm Emma, on average the temperature in 2018 was only slightly colder than the previous year (4.9% more degree days). When corrections for weather effects[70] are taken into account, energy use in the residential sector was still 5.5% higher in 2018 compared to 2017 (see *Table 32*).

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

- Overall direct fossil fuel use in households increased by 8.3%, to 2,015 ktoe, in 2018 and accounted for 72% of household energy use.
- Oil consumption in households increased by 9.5% in 2018, to 1,059 ktoe. Oil's share of household energy stood at 38% in 2018.
- Electricity consumption increased by 2.6% in 2018, to 703 ktoe (8,175 GWh), and its share of residential final consumption was 25%.
- Natural gas use increased by 8.7% in 2018, to 604 ktoe, and accounted for 22% of residential energy use.
- Direct renewables use in households increased in 2018 by 8%, to 68 ktoe, and its share stood at 2.5%.
- Coal use in households increased in 2018 by 4.4%, to 155 ktoe, and a 5.6% share of the residential sector's energy use.
- Peat use also increased by 4.4% in 2018 and peat briquette use by 13.5%. Total peat consumption was 197 ktoe in 2018. The peat and briquette share in household energy was 7.1% in 2018.

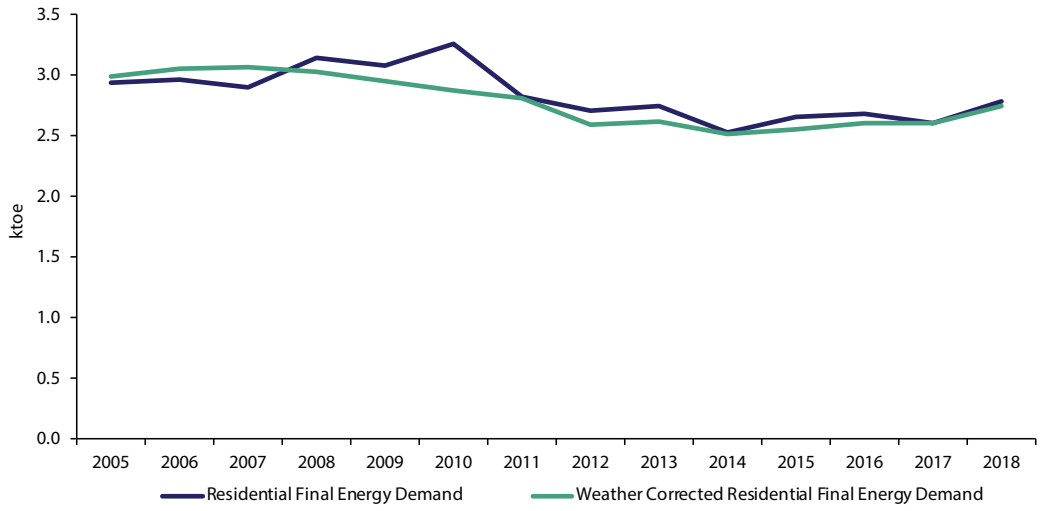
Weather-corrected energy use in the residential sector increased by 5.5% in 2018 compared to 2017.

Trends in 2005 – 2018

Figure 65 shows the trend for residential sector final energy consumption between 2005 and 2018, with and without weather correction. Weather correction yields a lower normalised energy consumption in cold years (e.g. 2010), and yields a higher normalised consumption in mild years (e.g. 2007). Accounting for weather variations, residential energy demand decreased every year between 2007 and 2012 but increased between 2015 and 2018. Residential final energy use in 2018 was 2,786 ktoe, 5.1% below the level recorded in 2005. Correcting for weather variations, 2018 residential final energy use was also 8.2% below 2005.

70 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 numbers of degree days.

Figure 65: Residential final energy



Source: SEAI

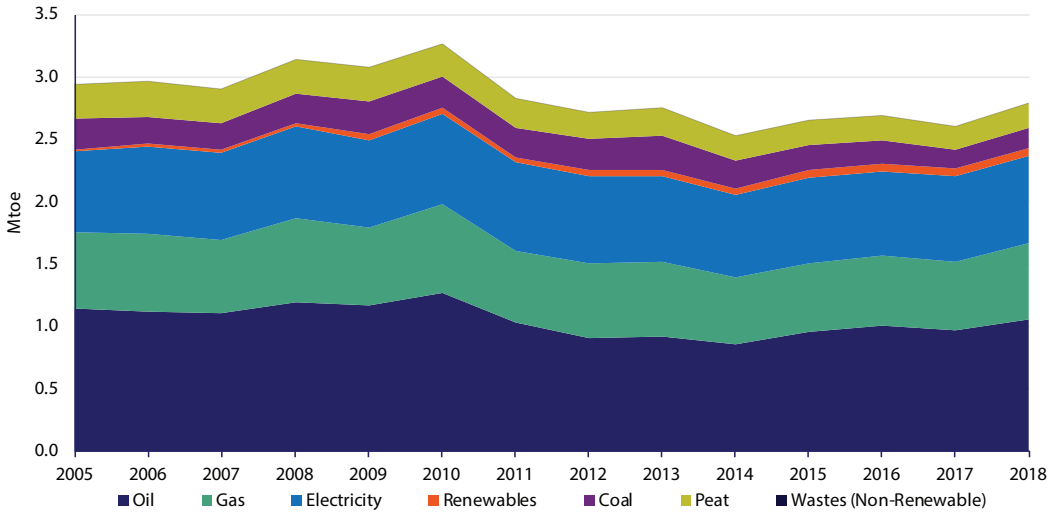
Figure 66 shows the mix of fuels consumed in the residential sector over the period. Between 2005 and 2018, the fuel shares were more stable, with a gradual increase in the share of electricity and of gas and a continuing though gradual decline in coal, peat and oil use.

Oil remains the dominant fuel in the residential sector, though its share reduced slightly, from 39% in 2005, to 38% in 2018. Electricity was the second largest source of energy in the sector in 2018, at 25%, with natural gas having the next largest share at 22%. The renewables share of final energy used directly in households in 2018 was 2.5%. The growth rates, quantities and shares are shown in *Table 32*.

Looking at the period 2007 – 2014, overall weather-corrected residential energy use declined by 18%, or 542 ktoe. The majority of the reduction was from oil, which fell by 28%, or 324 ktoe, followed by gas, which fell by 16%, or 100 ktoe. Some reasons for this may be: the higher oil price, and the greater increase in price of oil compared to gas, in the period 2010 – 2015; the potentially greater opportunities 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 2010 and has fallen by 2.1% since then.

Figure 66: Residential final energy use by fuel



Source: SEAI

Table 32: Growth rates, quantities and shares of final consumption in the residential sector

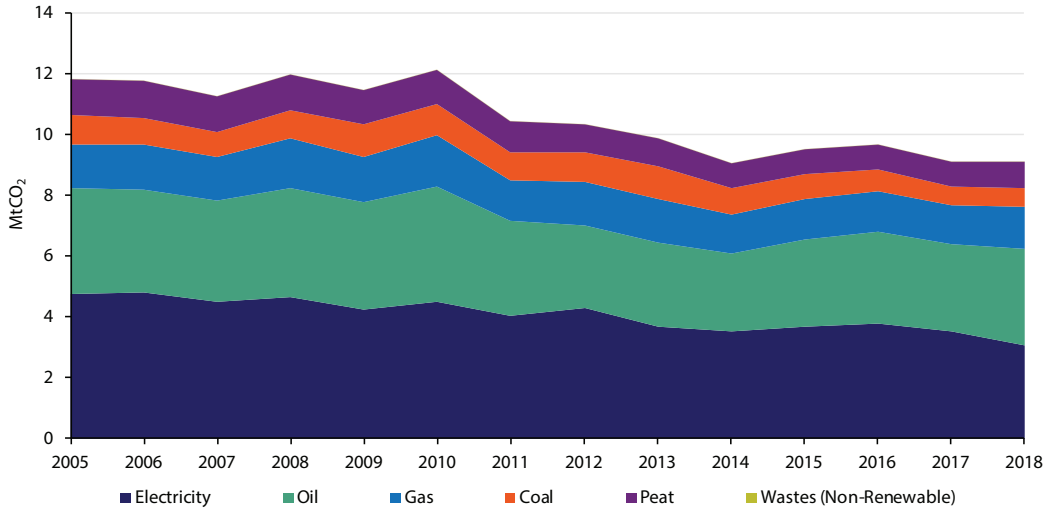
	Overall Growth %	Average Annual Growth %					Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Fossil Fuels (Total)	-11.3	-0.9	1.8	-5.0	1.7	8.3	2,271	2,015	77.3	72.3
Coal	-36.9	-3.5	0.7	-4.1	-9.0	4.4	246	155	8.4	5.6
Peat	-28.0	-2.5	-1.5	-4.6	-0.7	4.4	273	197	9.3	7.1
Briquettes	-23.8	-2.1	-0.5	-3.7	-1.9	13.5	90	69	3.1	2.5
Oil	-7.5	-0.6	2.0	-5.4	3.5	9.5	1,145	1,059	39.0	38.0
Gas	-0.4	0.0	3.2	-4.8	2.9	8.7	607	604	20.7	21.7
Renewables	246.1	10.0	17.6	6.4	4.2	8.0	20	68	0.7	2.5
Combustible Fuels (Total)	-10.7	-0.9	1.9	-4.9	1.6	8.3	2,287	2,043	77.9	73.3
Electricity	8.8	0.7	2.6	-1.6	1.2	2.6	646	703	22.0	25.2
Total	**-5.1**	**-0.4**	**2.1**	**-4.0**	**1.6**	**6.8**	**2,937**	**2,786**	**22.0**	**25.2**
Total (Weather Corrected)	**-8.2**	**-0.7**	**-0.8**	**-2.3**	**2.5**	**5.5**	**2,995**	**2,749**		

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 67*. 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 2016. Over the period 2005 – 2018, energy-related CO_2 emissions[71] from the residential sector fell by 23%. In 2018 residential sector energy-related CO_2 emissions (including upstream electricity emissions) grew by just 0.04%, to 9,114 kt CO_2. This flat growth in CO2 emissions, despite strong growth in energy use, is due to the reduced carbon intensity of electricity. In 2018 the residential sector accounted for 24% of the total energy-related CO_2 emissions, the second largest source after transport, which accounted for 38%.

Figure 67: Residential energy-related CO_2 by fuel



Source: SEAI

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

Table 33: Growth rates, quantities and shares of energy-related CO_2 emissions in the residential sector

	Overall Growth %	Average Annual Growth %					Quantity (kt CO_2)		Shares %	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Coal	-36.6	-3.4	0.6	-4.0	-8.9	4.3	989	628	8.4	6.9
Peat	-28.1	-2.5	-1.5	-4.6	-0.7	4.2	1,170	841	9.9	9.2
Briquettes	-23.8	-2.1	-0.5	-3.7	-1.9	13.5	374	285	3.2	3.1
Oil	-8.6	-0.7	1.8	-5.5	3.4	9.5	3,467	3,168	29.3	34.8
Gas	-2.2	-0.2	3.3	-4.9	2.2	8.9	1,443	1,411	12.2	15.5
Renewables	-	-	-	-	-	-	-	-	0.0	0.0
Combustible Fuels (Total)	-14.5	-1.2	1.4	-5.0	1.0	8.0	7,069	6,047	59.7	66.4
Electricity	-35.8	-3.3	-1.1	-4.0	-5.9	-12.7	4,773	3,067	40.3	33.6
Total	**-23.0**	**-2.0**	**0.5**	**-4.6**	**-1.6**	**0.04**	**11,843**	**9,114**		

Energy-related CO_2 emissions – excluding emissions associated with electricity

If the upstream emissions associated with electricity use are excluded, the CO_2 emissions from direct fossil fuel use in the residential sector in 2018 were 14% lower than in 2005. This was achieved through a combination of a less carbon-intensive fuel mix and a reduction in overall energy use post-2010. Excluding upstream electricity emissions, direct CO_2 emissions from the household sector were 6,047 kt, and were 8% higher in 2018 compared with 2017 (see *Table 33*).

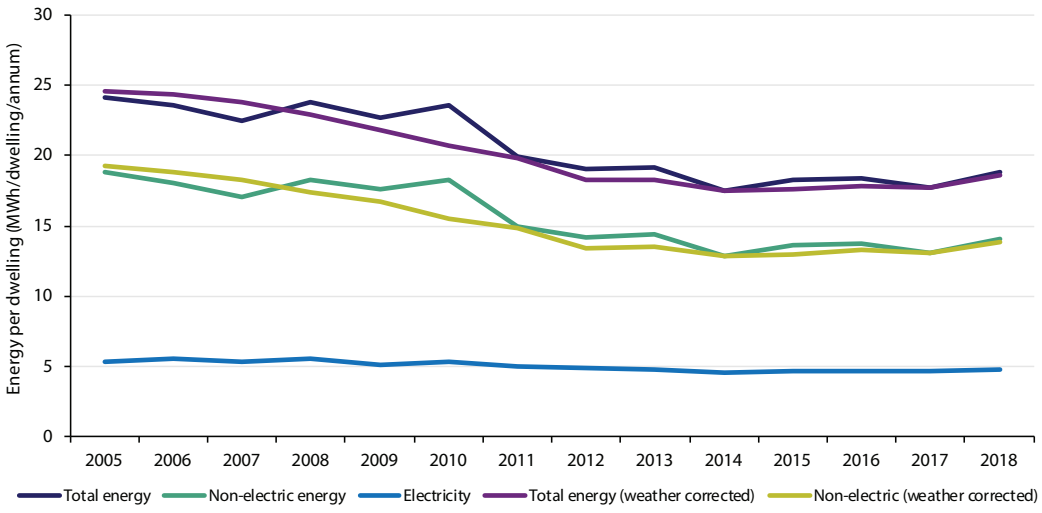
7.3.1 Unit consumption of the residential sector

In 2018, the average dwelling consumed a total of 18,208 kWh of energy based on weather-corrected data, 6.2% higher than in 2017. This comprised 13,614 kWh (75%) of direct fuels and 4,594 kWh (25%) of electricity.

In 2018, the average dwelling consumed a total of 18,208 kWh of energy; 75% of this was direct fuels and the remainder electricity.

Figure 68 shows the trend in final energy consumption per dwelling with and without weather correction. Looking at this in conjunction with *Table 34*, it can be seen that final energy use per dwelling reduced significantly between 2005 and 2014, before returning to growth in 2015 and 2016, falling in 2017, and growing again in 2018. Weather-corrected total final energy consumption per dwelling had been consistent for the last three years, and is still 27% below 2005 levels. Between 2007 and 2018, the final energy use of electricity per dwelling, weather corrected, reduced by 14%.

Figure 68: Unit consumption of energy per dwelling (permanently occupied)



Source: Based on SEAI, CSO and Met Éireann data

Table 34: Growth rates and quantities of residential unit energy consumption and unit CO_2 emissions

	Overall Growth %	Average Annual Growth %					Quantity (kWh/dwelling)	
Unit Energy Consumption	**2005 – 2018**	**'05 – '18**	**'05 – '10**	**'10 – '15**	**'15 – '18**	**2018**	**2005**	**2018**
Total Energy	-24.5	-2.1	-1.0	-5.0	1.0	6.2	24,105	18,208
Fuel Energy	-27.6	-2.5	-1.2	-5.8	1.1	7.7	18,802	13,614
Electrical Energy	-13.4	-1.1	-0.6	-2.7	0.6	2.0	5,302	4,594
Unit Energy Consumption (Weather Corrected)							**Quantity (kWh/dwelling)**	
Total Energy	-26.9	-2.4	-3.4	-3.9	1.9	4.9	24,583	17,967
Fuel Energy	-30.5	-2.8	-4.2	-4.3	2.3	6.0	19,261	13,385
Electrical Energy	-13.9	-1.1	-0.6	-2.8	0.8	1.8	5,322	4,582
Unit Energy-Related CO_2 Emissions							**Quantity (tCO_2/dwelling)**	
Total Energy	-38.8	-3.7	-2.6	-5.7	-2.1	-0.3	8.4	5.1
Fuel	-31.9	-2.9	-1.7	-6.0	0.4	7.4	5.0	3.4
Electricity	-49.0	-5.0	-4.1	-5.2	-6.4	-12.6	3.4	1.7

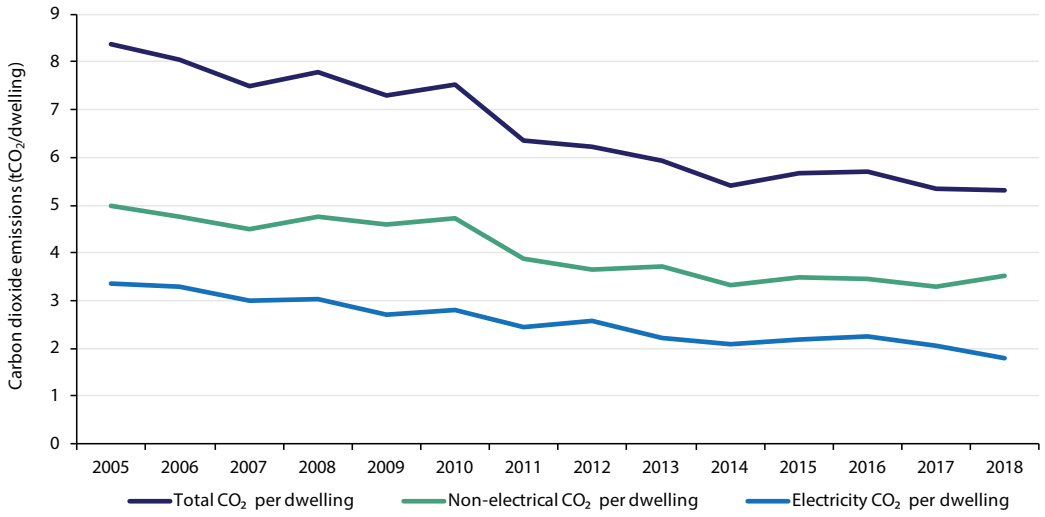
Energy-related CO_2 emissions per dwelling

The emissions of energy-related CO_2 per dwelling fell by 39% over the period 2005 – 2018, while the reduction for unit energy use was 24% (see *Table 34* and *Figure 69*). In 2018, the average dwelling was responsible for emitting 5.1 tonnes of energy-related CO_2. A total of 3.4 tonnes of CO_2 (66%) 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 32% between 2005 and 2018, primarily as a result of reduced energy consumption per dwelling. CO_2 emissions from electricity use reduced by 49% in the same time period due to a combination of reduced electricity use and the 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 the contribution of renewables in electricity generation began to grow.

Emissions from energy use in households increased by just 0.04% in 2018, the increase kept low as a result of the decreased CO_2 intensity of the electricity supplied and countered by increased fossil fuel consumption. Emissions from direct fuel use increased by 8% in 2018.

Figure 69: Unit energy-related CO_2 emissions per dwelling



Source: SEAI

In 2018, the average dwelling emitted 5.1 tonnes of energy-related CO_2.

7.4 Commercial and public services

Trends in 2018

Commercial and public services' energy use increased by 6.4% in 2018 compared to 2017. As 2018 was colder than 2017 (4.9% more degree days), when corrections for weather effects are taken into account, energy use in services increased by 5.2% (see *Table 35*). This is against the backdrop of the economic activity of services, as measured by value added, increasing by 7.3%.

The key trends in 2018 were as follows:

- Final energy use in services grew by 6.4% in 2018, to 1,484 ktoe; however when corrected for weather effects the increase was 5.2%.
- Oil, gas and electricity make up 97% of the energy consumed in the services sector. The contributions from coal and peat are negligible.
- Electricity consumption in services increased by 5.3%, to 642 ktoe, and accounted for 43% of final energy consumption in services in 2018.
- Oil consumption increased by 4.0%, to 268 ktoe. The share of oil in the sector's final consumption was 18%.
- Natural gas consumption increased by 9.9%, to 532 ktoe, and its share of the sector's final consumption was 36%.
- Overall direct fossil fuel use in services increased by 7.8%, to 800 ktoe.
- Renewable energy use in services fell by 2%, to 43 ktoe, in 2018. The share of renewables in services' final energy consumption was 2.9%.

Trends in 2005 – 2018

Final energy use in the commercial and public services sector fell by 5.4% (0.4% per annum) over the period 2005 – 2018, to a figure of 1,484 ktoe. The decrease was 8.2% if weather-corrected energy use is considered. During this period, the value added generated by the sector grew by 55%, while the numbers employed increased by 23%.

Figure 70: Commercial and public services final energy use by fuel

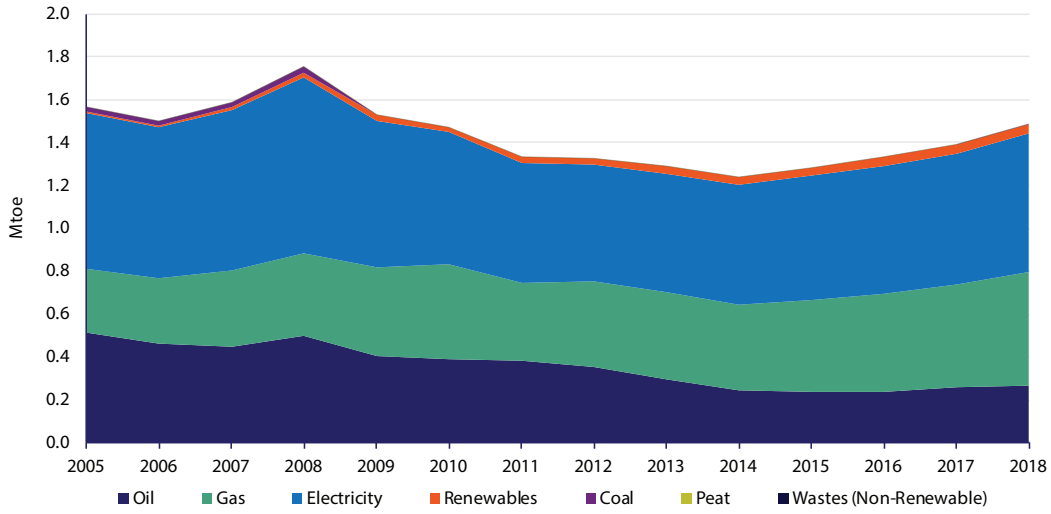


Figure 70 shows the changes in the fuel mix in the services sector over the period. The range of fuels used in this sector is small – essentially oil, gas and electricity. Oil and gas are used predominantly for space heating, but also for water heating, cooking and, in some sub-sectors, laundry. Gas consumption has increased by 78% since 2005, to 532 ktoe. Electricity is used in buildings for heating, air conditioning, water heating, lighting, and information and communications technology (ICT). Electricity in services is also used for public lighting and water and sanitation services.

Electricity consumption in services fell by 12% (1.0% per annum) between 2005 and 2018, to 642 ktoe (7,464 GWh), and had a higher share, at 43%, than any other individual source in services (down from 46% in 2005). Electricity use in services is driven by the changing structure of this sector and the general increase in the use of ICT, electric heating and air conditioning.

Growth rates, quantities and shares are shown in *Table 35*.

Table 35: Growth rates, quantities and shares of final consumption in the commercial and public services sector

	Overall Growth %	Average Annual Growth %					Quantity (ktoe)		Shares %	
	2005 – 2018	'05 – '17	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Fossil Fuels (Total)	-4.5	-0.4	-0.1	-4.2	6.1	7.8	837	800	53.4	53.9
Coal	-	-	-	-	-	-	27	-	1.7	-
Oil	-47.7	-4.9	-5.2	-9.6	4.2	4.0	511	268	32.6	18.0
Natural Gas	78.2	4.5	8.1	-0.4	7.2	9.9	299	532	19.0	35.8
Renewables	964.6	20.0	39.6	8.7	9.7	-2.0	4	43	0.3	2.9
Combustible Fuels (Total)	-1.8	-0.1	0.2	-4.0	6.1	7.2	840	825	53.6	55.6
Electricity	-11.8	-1.0	-3.3	-1.2	3.4	5.3	728	642	46.4	43.2
Total	**-5.4**	**-0.4**	**-1.3**	**-2.7**	**5.0**	**6.4**	**1,569**	**1,484**		
Total (Weather Corrected)	**-8.2**	**-0.7**	**-4.0**	**-1.1**	**5.9**	**5.2**	**1,597**	**1,466**		

Energy-related CO_2 emissions – including emissions associated with electricity

Figure 71 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 14% over the period and the emissions associated with electricity consumption fell by 48%. In 2018, non-electricity emissions in services increased by 7.5% and electricity-associated emissions fell by 10.4%. Overall energy-related CO_2 emissions in this sector fell by 3.6% in 2018, to just under 4.9 $MtCO_2$.

In the services sector, the share of emissions associated with electricity demand in 2018 was 58%. In 2005, the split between electricity and thermal fuels (oil and gas) emissions was 69% electricity and 31% fuels (see *Table 36*).

Figure 71: Commercial and public services sector CO_2 emissions by fuel

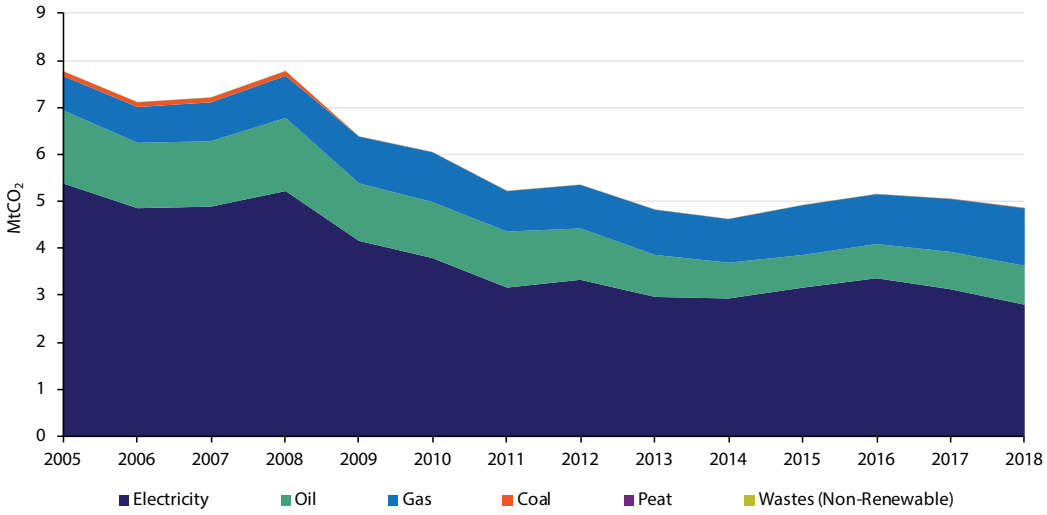


Table 36: Growth rates, quantities and shares of CO_2 emissions in commercial and public services

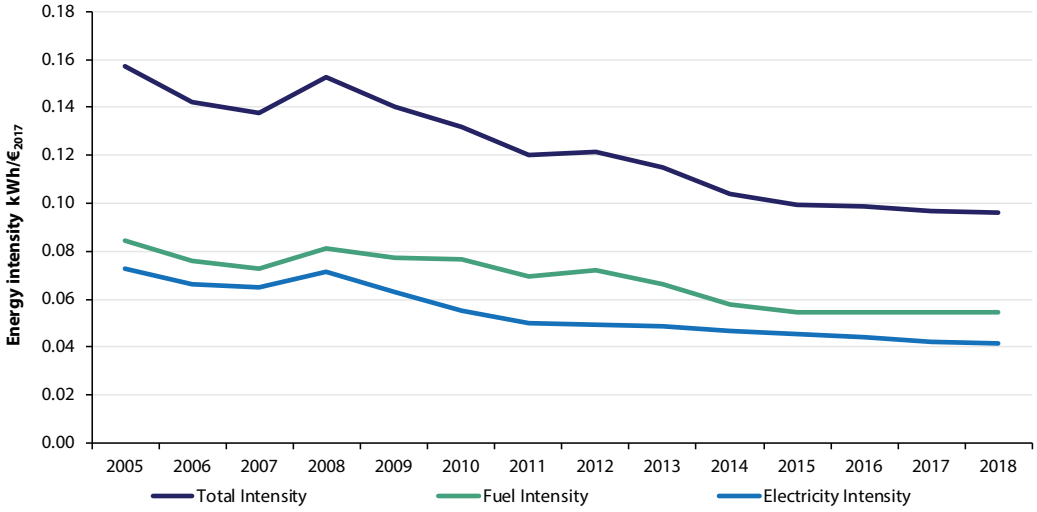
	Overall Growth %	Average Annual Growth %					Quantity (kt CO_2)		Shares %	
	2005 – 2018	'05 – '17	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018	2005	2018
Combustible Fuels	-13.6	-1.1	-1.2	-4.9	5.5	7.5	2,385	2,060	30.7	42.4
Electricity	-48.0	-4.9	-6.7	-3.6	-3.9	-10.4	5,379	2,800	69.3	57.6
Total	**-37.4**	**-3.5**	**-4.9**	**-4.1**	**-0.3**	**-3.6**	**7,764**	**4,860**		

7.4.1 Energy intensity of the commercial and public services sector

The energy intensity of the services sector is generally measured in relation to the value added generated by services activities. As shown in *Figure 72*, this intensity is flatter than that of industry. The overall energy intensity of the services sector was 39% lower in 2018 than it was in 2005, principally because of the rapid growth in the value added in the sector. There has been a general downward trend in services' energy intensity since 2005. Energy intensity in services fell by 0.8% in 2018.

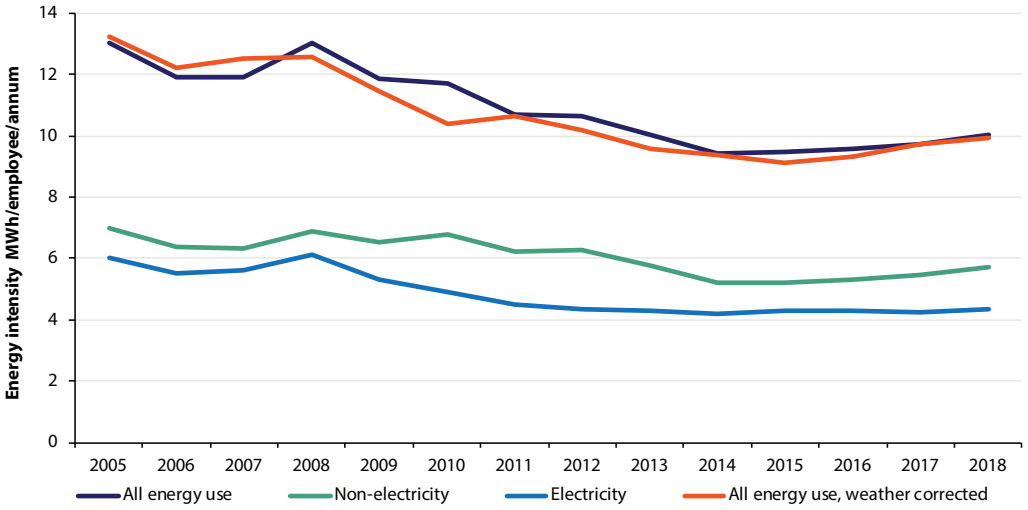
Electricity intensity has been falling since 2005, with the exception of 2008. In 2018, electricity intensity decreased by 1.8% compared with 2017 and was 43% below the 2005 level.

Figure 72: Energy intensity of the 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 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 73: 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, usually, there is a correlation between electricity use and the number of employees. In *Figure 73,* it can be seen that unit consumption of electricity fell between 2008 and 2011 but has been relatively stable since then. Electricity use per employee increased by 1.9% in 2018.

Fuel consumption per employee increased by 3% in 2018, and stood at 23% below 2005 levels. If corrections are made for the effects of weather, then the fuel consumption per employee increased by 2.1% in 2018 when compared with 2017 (see *Table 37*).

Table 37: Growth rates and quantities of unit consumption per employee in commercial and public services

	Overall Growth %	Average Annual Growth %					Quantity (kWh)	
	2005 – 2018	'05 – '18	'05 – '10	'10 – '15	'15 – '18	2018	2005	2018
Total kWh/employee	-22.9	-2.0	-2.1	-4.1	1.9	3.0	13,020	10,040
Fuel kWh/employee	-18.3	-1.5	-0.6	-5.2	3.1	3.9	6,980	5,699
Electricity kWh/employee	-28.1	-2.5	-4.1	-2.6	0.3	1.9	6,040	4,341
Weather Corrected								
Total kWh/employee	-25.2	-2.2	-4.7	-2.5	2.7	1.8	13,248	9,914
Fuel kWh/employee	-21.9	-1.9	-4.4	-3.0	4.4	2.1	7,163	5,596
Electricity kWh/employee	-29.0	-2.6	-5.2	-1.9	0.7	1.4	6,085	4,318

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 related 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 is becoming available from a joint CSO/SEAI Business Energy Use Survey 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[72].

7.4.2 Public sector developments

The public sector consists of approximately 4,400 separate public bodies, about 4,000 of which 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 (e.g the Health Service Executive or An Garda Síochána). The vast majority of energy is consumed by the 100 largest organisations.

Public services[73] 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, for example wastewater treatment plants, water treatment facilities, pumping stations, and street lighting (~400,000 units).

The Fourth National Energy Efficiency Action Plan (NEEAP) and the European Union (Energy Efficiency) Regulations 2014 (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. This is equivalent to 279 ktoe (4,446 GWh based on 2017 data).

Since 1 January 2011, public sector bodies have been required to report to Government annually on their energy use and the actions they have taken to reduce consumption. SEAI and the Department of Communications, Climate Action and Environment have developed an energy monitoring and reporting system[74] to satisfy the reporting requirements of both SI 426 of 2014 and the NEEAP. Since 2013, all public sector organisations have been obliged to use this system to report their annual energy consumption to SEAI. The system includes a national public sector energy database, which includes all public sector electricity and natural gas meter numbers. Over time, the monitoring and reporting system will build a comprehensive bottom-up picture of energy consumption in the sector through the population of the national public sector energy database.

72 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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73 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; for example, ambulances, local authority vehicles, Garda fleet, Defence Forces' vehicles, etc.

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

In 2018 SEAI published the *Annual Report 2018 on Public Sector Energy Efficiency Performance*[75]. It noted that 331 public sector bodies and 2,279 schools completed reports on energy and these represented 96% of total public sector energy consumption. The total energy consumption in 2017 of these bodies was 10,248 GWh (primary energy), which consisted of 5,073 GWh of electricity, 3,086 GWh of thermal energy and 2,090 GWh of transport energy. This cost the State €608 million in 2017. The report also noted that these bodies have achieved annual primary energy savings of 3,223 GWh, or a 24% improvement on business as usual, yielding a cost saving of €191 million. The public sector has a target of 33% energy efficiency improvement by 2020.

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75 Available from https://www.seai.ie/resources/publications/2017_Annual_Report_on_Public_Sector_Energy_Efficiency_Performance.pdf

8 Energy statistics revisions and corrections

Some changes, revisions and corrections to the historic energy balance data were implemented during 2019. The most significant of these are listed below:

Crude Oil

2017

- Supply revised to reflect international data

Gasoline

2017

- Supply revised to reflect international data

2005– 2018

- Transport modal split revised to reflect the most up-to-date data available

Kerosene

2017

- Supply revised to reflect international data

Jet Kerosene

1990 – 2018

- Split between domestic and international aviation revised to reflect Eurocontrol bottom-up estimates provided by the EPA

Fuel Oil

2015 – 2018

- Fuel oil consumption revised according to ETS data

2017 – 2018

- Supply revised to reflect international data

LPG

2017

- Supply revised to reflect international data

Gasoil / diesel / DERV

2017

- Supply revised to reflect international data

2007 – 2018

- Transport modal split revised to reflect the most up-to-date data available

Natural gas

2017

- Amount consumed in oil refineries & other energy sectors revised

Biomass & renewable waste

2017

- Industry data revised to reflect the most up-to-date ETS

Liquid biofuel

2005 – 2018

- Transport modal split revised to reflect the most up-to-date data available.

Landfill gas

2017

- Revised to reflect the most up-to-date data

Solar thermal

2011 – 2018

- Methodology to assess the extent of the contribution of solar thermal was updated based on revisions to the estimates of the numbers of new dwelling completions

Ambient heat / heat pumps

2017

- Revised to reflect the most up-to-date data

Non-renewable waste

2016 – 2017

- Industry data revised to reflect the most up-to-date ETS

Electricity

2017

- Revised to reflect the most up-to-date data

CO_2 Emissions

- CO_2 emission factors revised based on updated carbon factors

The energy balance data analysed in this report were frozen on 21 October 2019. Balance data are updated whenever more accurate information is available. 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 CSO, with data provided by SEAI.

Glossary of abbreviations

Abbreviation	Explanation
CCGT	Combined cycle gas turbine
CHP	Combined heat and power
CO_2	Carbon dioxide
CSO	Central Statistics Office
EPA	Environmental Protection Agency
ETS	EU Emission Trading Scheme
EU-15	The first 15 Member States of the European Union
GDP	Gross domestic product
GHG	Greenhouse gas
GNI*	Modified gross national income
GNP	Gross national product
goe	gramme of oil equivalent
ICT	Information and communications technology
IEA	International Energy Agency
IP	Intellectual property
IPCC	Intergovernmental Panel on Climate Change
ktoe	kilo tonne of oil equivalent
NCT	National Car Testing service
NEDC	New European Driving Cycle
NEEAP	National energy efficiency action plan
NREAP	National renewable energy action plan
OECD	Organization for Economic Co-operation and Development
PV	Photovoltaic
R&D	Research and development
RES	Renewable energy share
RES-E	Renewable energy share in electricity
RES-H	Renewable energy share in heat
RES-T	Renewable energy share in transport
SEAI	Sustainable Energy Authority of Ireland
TFC	Total final energy consumption
TPER	Total primary energy requirement
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile organic compounds
WLTP	Worldwide Harmonised Light Vehicle Test

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 (gCO_2/kWh): This is the amount of CO_2 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 (CHP) 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 and 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 represents the total output of the economy over a period.

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.

Gross final consumption: Directive 2008/28/EC defines gross final consumption 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 inland energy consumption: Sometimes abbreviated as gross inland consumption, is the total energy demand of a country or region. It represents the quantity of energy necessary to satisfy inland consumption of the geographical entity under consideration.

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 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.

Modified gross national income (GNI*): 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 globalisation 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.

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.

Total final consumption: 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: 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): The non-renewable portion of wastes used as an energy source.

Energy conversion factors

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

Energy units

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

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

tonne of oil equivalent (toe): This is a conventional standardised unit of energy and is defined on the basis of a tonne of oil having a net calorific value of 41,868 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

Liquid Fuels	t CO_2/TJ (NCV)	g CO_2/kWh (NCV)
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
Naphtha	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		
(2018)	104.2	375.2

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Applus+ (National Car Test)

Central Statistics Office

Department of Communications, Climate Action and Environment

Department of Housing, Planning, and Local Government

Department of Transport

EirGrid

Environmental Protection Agency

ESB Networks

European Commission DG TREN

EU-funded ODYSSEE Project

Eurostat

Gas Networks Ireland

International Energy Agency

Met Éireann

Revenue Commissioners

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Energy balance 2018

kilo tonnes of oil equivalent (ktoe)	Coal	Peat	Oil	Natural Gas	Renewables	Non-Renew/Waste	Electricity	Total
Indigenous Production	0	816	0	2,752	1,326	145		5,040
Imports	845	0	9,099	1,728	150		139	11,962
Exports	15	7	1,717		9		142	1,891
Mar. Bunkers	0	0	162					162
Stock Change	-106	-123	160	0	4			-64
Primary Energy Supply (incl. non-energy)	**725**	**686**	**7,380**	**4,480**	**1,471**	**145**	**-2**	**14,885**
Primary Energy Requirement (excl. non-energy)	**725**	**686**	**7,148**	**4,480**	1,471	145	**-2**	**14,653**
Transformation Input	**489**	**540**	**3,127**	**2,501**	**213**	**91**	**54**	**7,015**
Public Thermal Power Plants	489	467	34	2,188	204	91		3,472
Combined Heat and Power Plants	0	5	1	273	9			287
Pumped Storage Consumption							43	43
Briquetting Plants	0	68	0		0			68
Oil Refineries and other energy sector	0	0	3,092	41	0		11	3,144
Transformation Output	**0**	**65**	**3,167**	**0**	**73**	**26**	**1,873**	**5,203**
Public Thermal Power Plants	0	0	0		68	26	1,668	1,668
Combined Heat and Power Plants – Electricity	0	0	0		5		185	185
Combined Heat and Power Plants – Heat					0			0
Pumped Storage Generation							20	20
Briquetting Plants		65	0		0			65
Oil Refineries		0	3,167		0			3,167
Exchanges and Transfers	**22**	**0**	**-24**	**0**	**-804**	**0**	**804**	**-2**
Electricity					-804		804	0
Heat								0
Other	22		-24		0			-2
Own Use and Distribution Losses	**0**	**11**	**93**	**58**	**0**		**259**	**421**
Available Final Energy Consumption	**258**	**199**	**7,303**	**1,921**	**454**	**55**	**2,362**	**12,551**
Non-Energy Consumption	**0**	**0**	**232**	**0**	**0**	**0**	**0**	**232**
Final Non-Energy Consumption	0	0	232	0	0			232
Total Final Energy Consumption	**261**	**197**	**7,065**	**1,948**	**464**	**55**	**2,334**	**12,324**
Industry	**105**	**1**	**516**	**790**	**198**	**55**	**936**	**2,601**
Non-Energy Mining			34	13	0		67	114
Food, Beverages and Tobacco	19	1	136	111	26		201	494
Textiles and Textile Products			3	1	0		12	16
Wood and Wood Products			3	2	129		40	175
Pulp, Paper, Publishing and Printing			3	4	0		22	29
Chemicals and Man-Made Fibres			28	69	0		171	268
Rubber and Plastic Products			10	5	0		41	56
Other Non-Metallic Mineral Products	87		193	18	43	55	60	456
Basic Metals and Fabricated Metal Products			10	422	0		71	503
Machinery and Equipment n.e.c.			6	6	0		24	35
Electrical and Optical Equipment			46	131	0		116	292
Transport Equipment Manufacture			5	2	0		20	27
Other Manufacturing			40	7	0		91	138
Transport	**0**	**0**	**5,020**	**23**	**154**	**0**	**5**	**5,202**
Road Freight			697		30			727
Light Goods Vehicles			318	0	14			332
Road Private Car			1,979		78		1	2,058
Public Passenger Services			134		6			139
Rail			38		0		4	42
Domestic Aviation			6		0			6
International Aviation			1,097		0			1,097
Fuel Tourism			177		8			184
Navigation			84		0			84
Unspecified			490	23	20			533
Residential	**155**	**197**	**1,059**	**604**	**68**		**703**	**2,786**
Commercial/Public Services	**0**	**0**	**268**	**532**	**43**	**0**	**642**	**1,484**
Commercial Services	0	0	177	233	35		460	905
Public Services	0	0	91	299	8		182	579
Agricultural	**0**	**0**	**175**	**0**	**0**		**48**	**223**
Fisheries	**0**	**0**	**27**		**0**			**27**
Statistical Difference	-3	2	6	-27	-10	0	27	-5

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 https://www.seai.ie/data-and-insights/seai-statistics/key-publications/national-energy-balance/

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