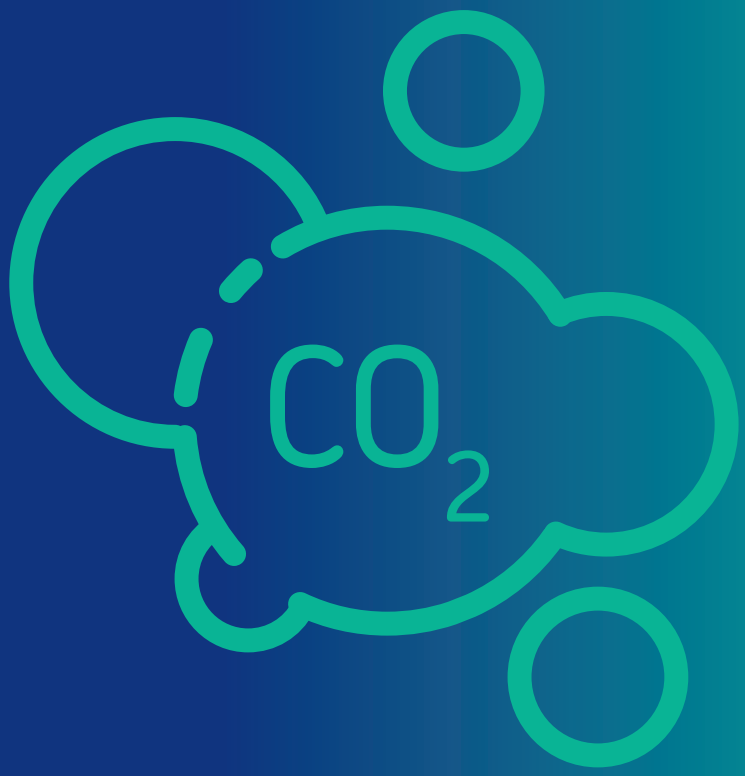
SUSTAINABLE ENERGY AUTHORITY OF IRELAND

ENERGY-RELATED CO_2 EMISSIONS IN IRELAND 2005-2016

2018 Report



Sustainable Energy Authority of Ireland

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

Energy Policy Statistical Support Unit (EPSSU)

SEAI has a lead role in developing and maintaining comprehensive national and sectoral statistics for energy production, transformation and end-use. This data is a vital input in meeting international reporting obligations, for advising policymakers and informing investment decisions. Based in Cork, EPSSU is SEAI's specialist statistics team. Its core functions are to:

- Collect, process and publish energy statistics to support policy analysis and development in line with national needs and international obligations;
- Conduct statistical and economic analyses of energy services sectors and sustainable energy options;
- Contribute to the development and promulgation of appropriate sustainability indicators.

Acknowledgements

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

ENERGY-RELATED CO_2 EMISSIONS IN IRELAND 2005 – 2016

CO_2 emissions from fuel combustion

May 2018

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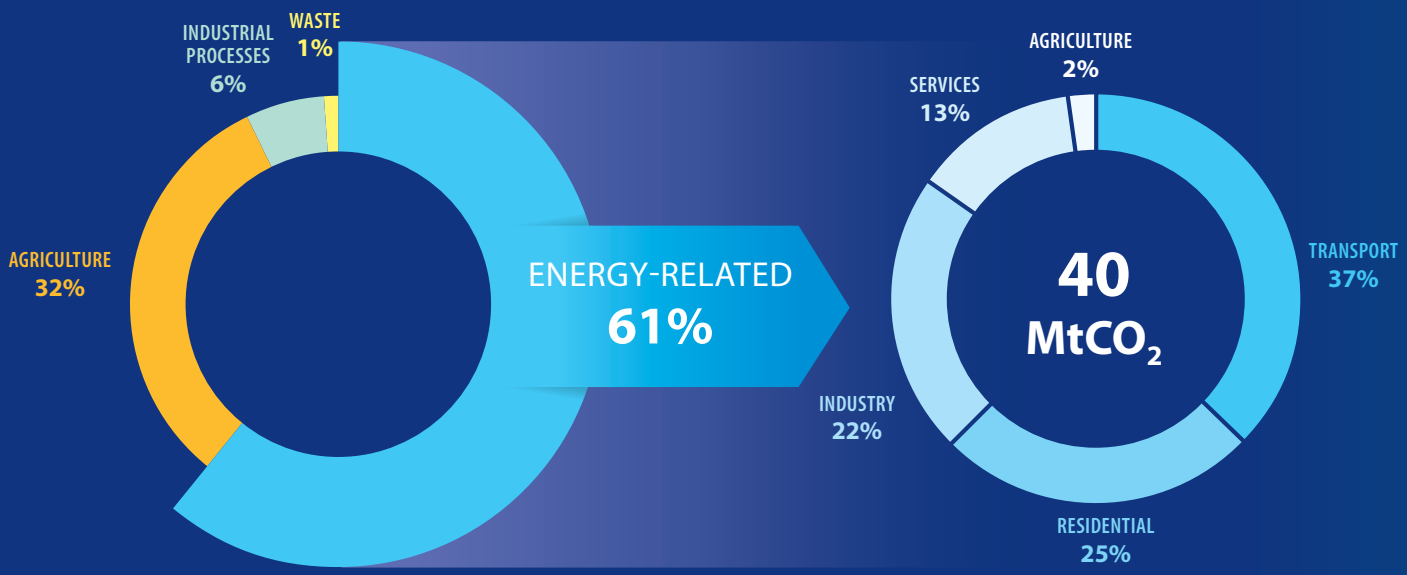
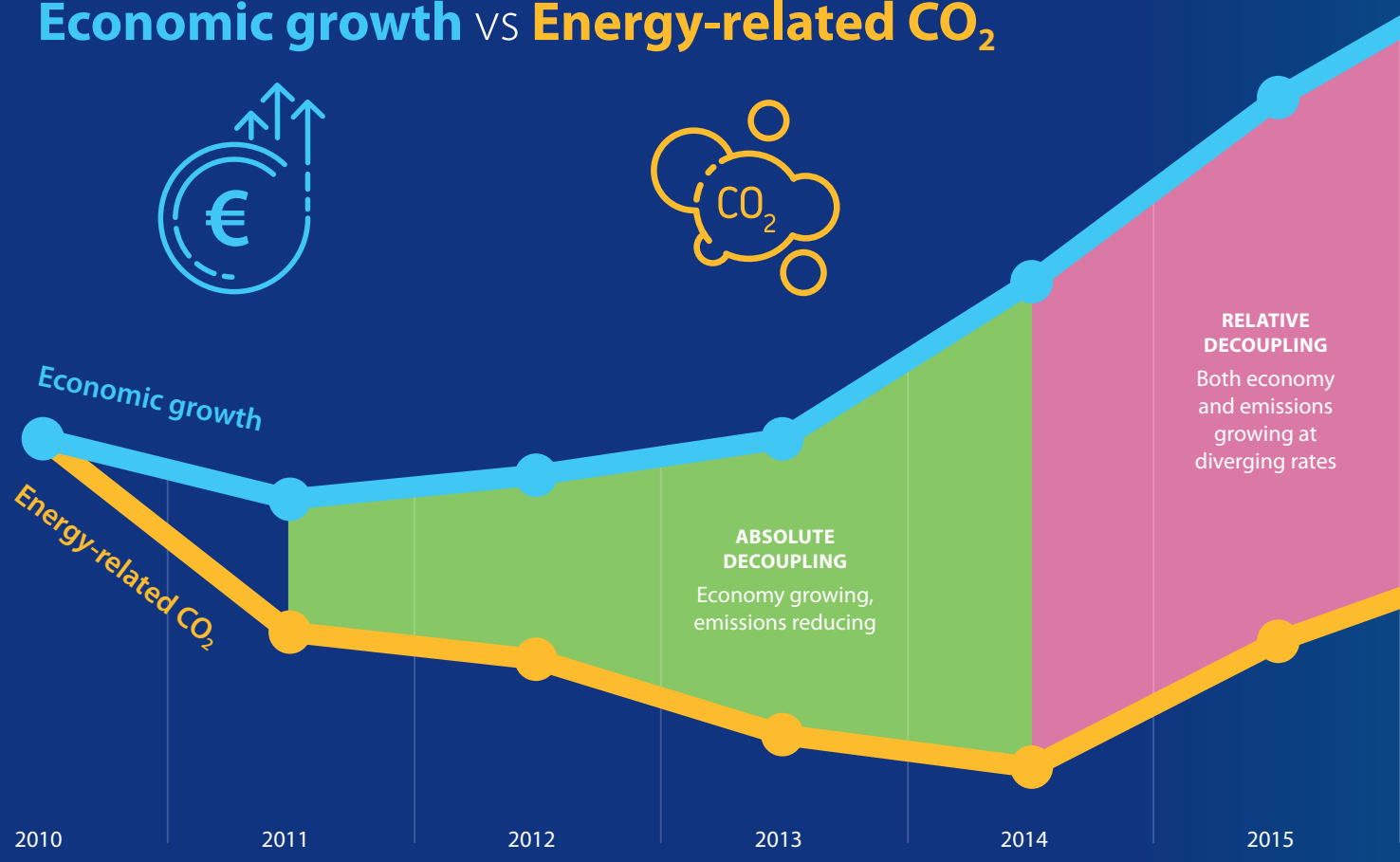
CO_2 Emissions from Energy Use in Ireland

Greenhouse gas emissions by source 2016



Energy-related CO_2 emissions by sector 2016

Economic growth vs Energy-related CO_2



In 2016, the CO_2 emissions intensity of Ireland's energy supply was

32% higher than the OECD European average

due to greater use of high-carbon fuels including

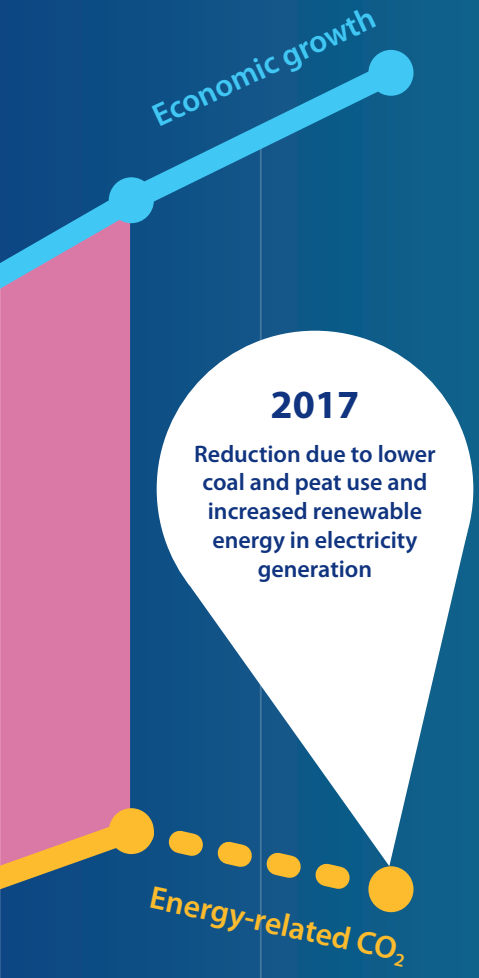
oil, coal and peat

Avoided CO_2 emissions from renewable energy in 2017 was

4.2 $MtCO_2$

which is **equivalent** to removing

70% of private cars off the road



What is driving Ireland's CO_2 emissions?

Increased emissions

- Economic growth
- Low energy prices
- Increased transport demand
- Use of peat and coal for electricity and heat production

Decreased emissions

- Increased renewables for electricity, heat and transport
- More efficient vehicles, including electric vehicles
- More efficient homes and businesses

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1 Introduction

Many of the most effective measures for reducing carbon dioxide (CO_2) emissions in Ireland are aimed at reducing energy use across sectors such as transport and households, as well as increasing the uptake of renewable energy technologies. Understanding the trends and drivers for energy-related emissions is critical to making informed policy decisions. This report provides that evidence by supplying insights into historical trends of energy-related emissions.

Energy consumption accounted for 61% of Ireland's greenhouse gas (GHG) emissions in 2016, with transport, residential and industry accounting for the highest shares.

1.1 What is Driving Ireland's CO_2 Emissions?

Ireland's economy grew rapidly during the Celtic Tiger years and subsequently contracted sharply between 2007 and 2010. Energy use and the resulting emissions also fell during this period, particularly in the transport sector, which is closely coupled with economic activity.

Between 2011 and 2014 Ireland's energy-related CO_2 emissions fell as the economy grew. This is called absolute decoupling – in other words, emissions declining in absolute terms as the economy grows. Some of the drivers included increased take-up of renewables energy technologies, coupled with higher efficiency vehicles, homes and businesses.

In 2015 and 2016, the economy continued to grow but emissions started to rise again, albeit at a slower rate than economic growth. This is called relative decoupling. Influential factors include economic growth, increased transport demand and low energy prices driving increased demand.

1.2 Ireland's Fuel Mix

Energy-related CO_2 emission levels are also affected by the choice of fuels and energy sources that are used. For instance, coal and peat emit high levels of CO_2 per unit of energy used, whereas natural gas emits much less, and the use of some renewable energy sources emits zero carbon. Therefore, changes in the fuel mix over time can increase or reduce emissions.

In 2015, the CO_2 emissions intensity of Ireland's energy supply was 32% higher than the OECD European average due to greater use of high-carbon fuels including coal, peat and oil.

Using renewable energy for heat, electricity and transport reduced emissions by 4.2 million tonnes CO_2 ($MtCO_2$). This equivalent to the CO_2 emissions of almost three quarters of private cars (1.4 million cars) on the road or equivalent to one fifth of agricultural emissions of greenhouse gases.

1.3 Methodological Note

This report provides data and analysis on CO_2 emissions from fuel use and other energy-related activities from 2005 to 2016. GHG emissions are usually presented in line with the United Nations Framework Convention on Climate Change (UNFCCC) accounting rules and the Intergovernmental Panel on Climate Change (IPCC) reporting guidelines. These often fail to capture changes in fuel and the sectoral mix of energy use both upstream (e.g. emissions associated with fossil fuel combustion in electricity generation) and downstream (e.g. combustion of fossil fuels by end-users, such as natural gas and coal used for heating). This report addresses this by providing more detail on the background of energy emissions.

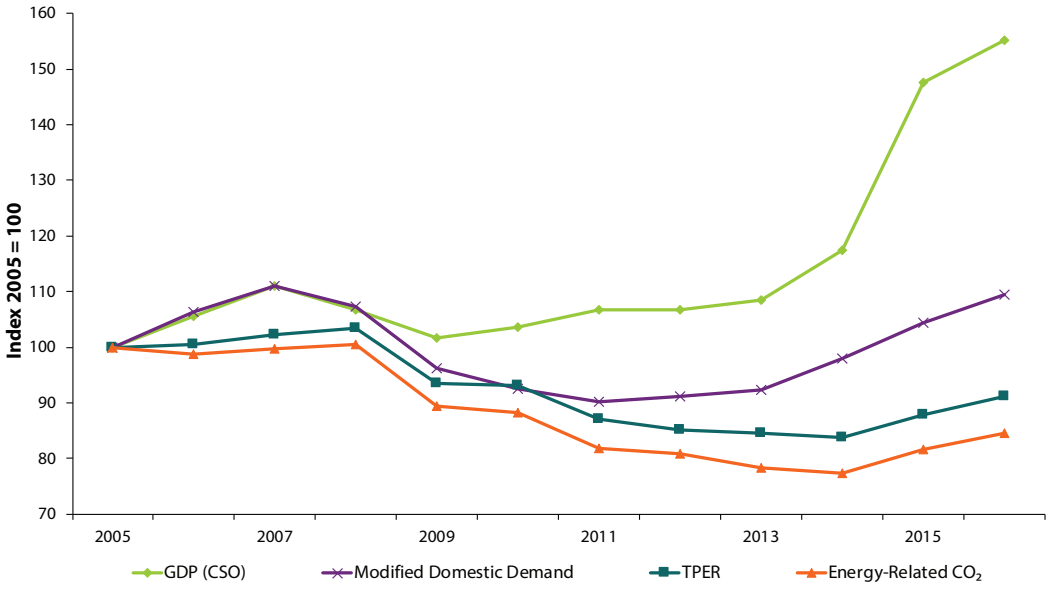
2 Economic Activity and Energy-Related CO_2 Emissions

Figure 1 shows the historical trends for Gross Domestic Product (GDP), Modified Domestic Demand[1], Total Primary Energy Requirement (TPER) and energy-related CO_2, each expressed as an index relative to 2005. This captures the strong economic growth up to 2007, the economic downturn between 2008 and 2012 and the subsequent return to growth after 2013. Both GDP and Modified Domestic Demand are measures of economic growth. GDP is the traditional measure, but in Ireland is strongly influenced by the activities of multinational companies, particularly in the realms of aircraft leasing and intellectual property rights. In 2017, the CSO developed the Modified Domestic Demand to better reflect Irish economic activity.

In 2008 the economy experienced a downturn that deepened into 2009. In 2008, industry and transport experienced reductions in energy use while there was continuing energy growth in the residential and services sectors, partly due to weather conditions. In 2009, however, there were reductions in energy use and related CO_2 emissions across all sectors, in accordance with the overall economic decline. There was a further drop in energy demand across all sectors of the economy during the subsequent years, with a dramatic drop in energy demand in 2011 to 2013 compared with 2010. Despite the flat growth in GDP and return to growth in Modified Domestic Demand in 2013, energy demand and energy-related CO_2 emissions remained lower than 2005 levels.

In 2015, GDP grew by 26.3%. Much of this growth was attributed to the transfer of assets into Ireland by multinationals, which had little or no effect on energy use. Modified Domestic Demand grew more modestly, but still significantly, by 6.6% in 2015. GDP growth in 2016 was 5.1% and Modified Domestic Demand grew by 4.8%.

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



Source: Based on SEAI and CSO data.

Figure 1 shows the relative decoupling of TPER (also known as gross inland consumption[2]) from economic growth up to 2007 and again from 2011 onwards. This is a result of changes in the structure of the economy and improvements in energy efficiency.

1 Modified Total Domestic Demand was introduced by the CSO in 2017 to assess the level of activity in the Irish economy excluding the effects of globalization that disproportionately affect the results. Modified Total Domestic Demand is defined as Total Domestic Demand less the effects of the trade in aircraft by aircraft leasing companies and the imports of intellectual property.

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

CO_2 emissions[3] generally fell more than energy use in the period 2005 – 2014. This was predominantly due to the decarbonisation of the electricity sector, however the trends have remained relatively similar since then.

Between 2010 and 2014, the economy grew by 13% as measured by GDP (6% if measured by Modified Domestic Demand), while energy use continued to fall, with a cumulative drop of 10% between 2010 and 2014. Some of the reduction in energy use can be attributed to the weather, as it was generally warmer after 2010. Another factor is the large increase (83%) in wind generation, which reduced the primary energy requirements for electricity generation. There were also continued reductions in the energy intensity of households, due to a combination of improved energy efficiency and economic factors.

The first significant increase in overall energy use since before the economic downturn in 2008 was seen in 2015, with TPER growing by 4.9%. This was linked to increased domestic economic activity. Final energy consumption in the industry and transport sectors, which are closely aligned with the economy, increased by 4.8% and 5.9% respectively. Overall energy use continued to grow in 2016, but at the more modest rate of 3.7%.

Table 1 displays the growth rates for the economy (GDP and Modified Domestic Demand), primary energy (TPER) and energy-related CO_2 emissions for the period 1990 – 2016.

Table 1: GDP[4], Modified Domestic Demand, TPER and CO_2 Growth Rates[5]

	Growth %	Average annual growth rates %			
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016
GDP	55.1	4.1	0.7	7.3	5.1
Modified Domestic Demand	9.5	0.8	-1.6	2.5	4.8
TPER	-8.8	-0.8	-1.4	-1.1	3.7
Energy CO_2	-15.5	-1.5	-2.5	-1.6	3.6
Energy CO_2 (excl. international aviation)	-16.6	-1.6	-2.5	-1.8	3.7

Source: Based on SEAI and CSO data.

Figure 2 shows emissions by mode of energy use. The emissions are allocated according to whether the energy used is for transport, electricity, or thermal energy. These modes also represent the distinct energy markets. In 2016, the shares of energy-related CO_2 emissions from transport, electricity and thermal applications were 37.1%, 32.0% and 30.9% respectively.

Figure 2: Energy-Related CO_2 Emissions by Mode of Energy Application

Source: SEAI

3 The energy-related CO_2 emissions shown here cover all energy-related CO_2 emissions associated with TPER, including emissions associated with international air transport. These are usually excluded from the national Greenhouse Gas (GHG) emissions inventory in accordance with the reporting procedures of the UNFCCC guidelines.

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

5 Throughout the report where annual growth rates cover multiple years they always refer to *average annual growth rates*.

Energy-related CO_2 emissions fell in all modes after 2005. The largest reduction was observed in heat (25% decrease) followed by electricity (18% decrease) and transport (4.3% decrease). Transport CO_2 emissions decreased by 19% between 2005 and 2012, but have been increasing each year since then: they were 19% higher in 2016 than in 2012.

Table 2: Energy-Related CO_2 Emissions by Mode of Application

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Transport	-4.3	-0.4	-2.4	0.7	3.9	15,256	14,597	32.7	37.1
Electricity	-17.8	-1.8	-2.6	-2.4	6.0	15,325	12,601	32.8	32.0
Heat	-24.6	-2.5	-2.1	-3.8	1.7	16,104	12,137	34.5	30.9
Total	**-15.5**	**-1.5**	**-2.5**	**-1.6**	**3.6**	**47,352**	**40,007**		

Source: SEAI

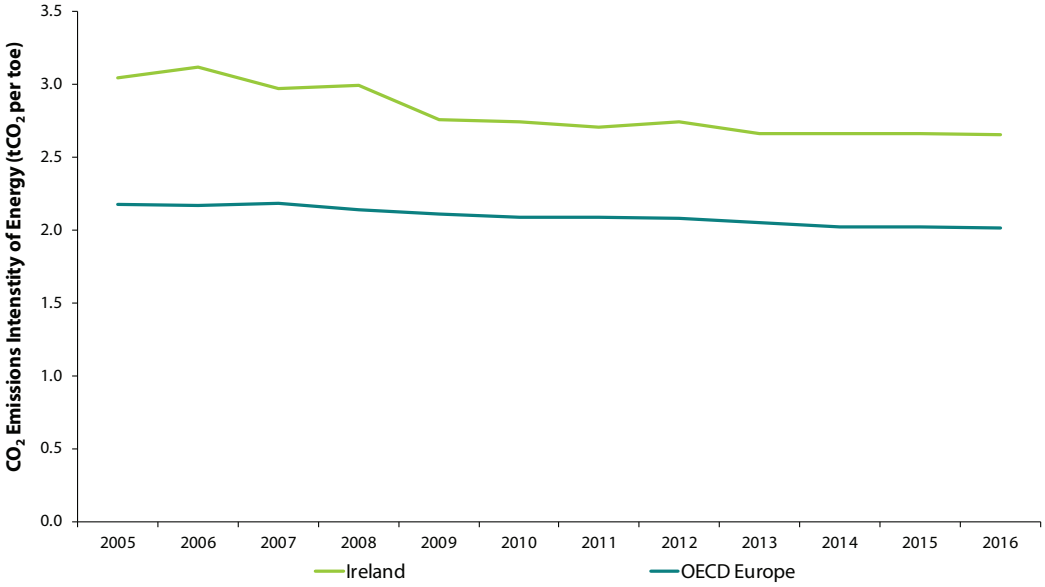
Emissions grew in all modes in 2016 compared with 2015, with transport, electricity and heat CO_2 emissions growing by 3.9%, 6.0% and 1.7% respectively.

3 Energy-Related CO_2 Emissions Indicators

3.1 Energy-related CO_2 Emissions Intensity of Overall Energy Use

Figure 3 shows the CO_2 emissions intensity of overall energy use in Ireland in terms of tonnes of CO_2 (tCO_2) per tonne of oil equivalent (toe) of total primary energy supply (TPES), and provides a comparison with the average in OECD Europe[6]. Over the period 2005 – 2016 the emissions intensity in Ireland in terms of overall energy use fell by 13.3% to 2.65 tCO_2/toe having peaked in 2006 at 3.12 tCO_2/toe. Over the same period the intensity in OECD Europe fell by 7.5% to 2.01 tCO_2/toe.

Figure 3: Energy-Related CO_2 Emissions Intensity of Primary Energy Use — Ireland and OECD Europe



Source: International Energy Agency

The CO_2 emissions intensity of primary energy use (i.e. energy supply) for Ireland was higher than OECD Europe over the whole period, peaking at 42% above in 2006 and falling to 32% above in 2016. There are a number of reasons for this. Some countries in Europe have a considerably higher share of renewable energy in their energy mix. For example, hydro contributes a significant share to Norway and Austria's energy mix. In addition, the prevalence of nuclear energy in many European countries (e.g. France) is another reason for the lower emissions intensity relative to Ireland, as is the widespread use of district heating in many Nordic countries.

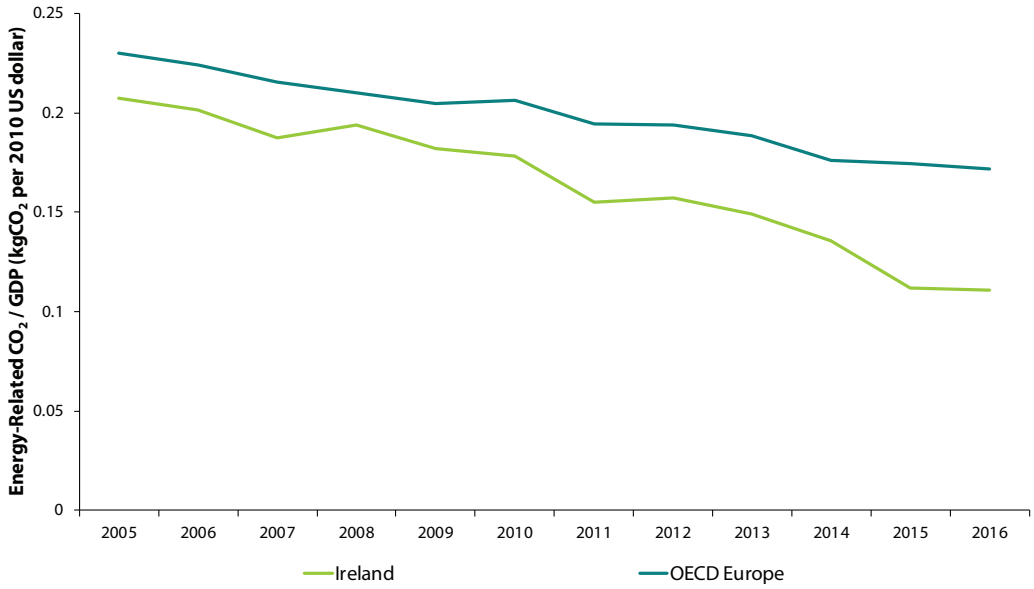
3.2 Energy-related CO_2 Emissions Intensity of Economic Growth

Figure 4 shows the energy-related CO_2 intensity of the economy in Ireland compared with the average in OECD Europe. At the start of the period, in 2005, 0.21 tCO_2 were emitted in Ireland to generate one dollar of GDP (in 2010 value), which was 10% below the level emitted in Europe. The emissions intensity in Ireland fell at a faster rate than in Europe over the period. This metric enables a cross country comparison of the evolution of emissions intensity. However, it must be noted that changes in GDP can be influenced by activities that have no bearing on energy use or related emissions.

Between 2005 and 2016 the energy-related CO_2 emissions intensity of the economy in Ireland fell by 46% (5.5% per annum) to 0.11 t/€GDP and was 35% lower than the average intensity in OECD Europe in 2016. This could be explained by the increasing efficiency of electricity generation, improvements in the energy performance of the built environment and the higher fuel economy of private cars. Structural changes in the economy, such as the increasing importance of high value added, low energy consuming (less energy intensive) sectors (ICT and pharma-chem for example) and the closure of some energy intensive industries, such as steel, fertilizer and sugar production, would also have contributed to the lowering of energy-related emissions intensity.

6 OECD Europe comprises all European members of the OECD (not necessarily EU members). In 2016 these were Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Figure 4: Energy-Related CO_2 Emissions Intensity of the Economy — Ireland and OECD Europe

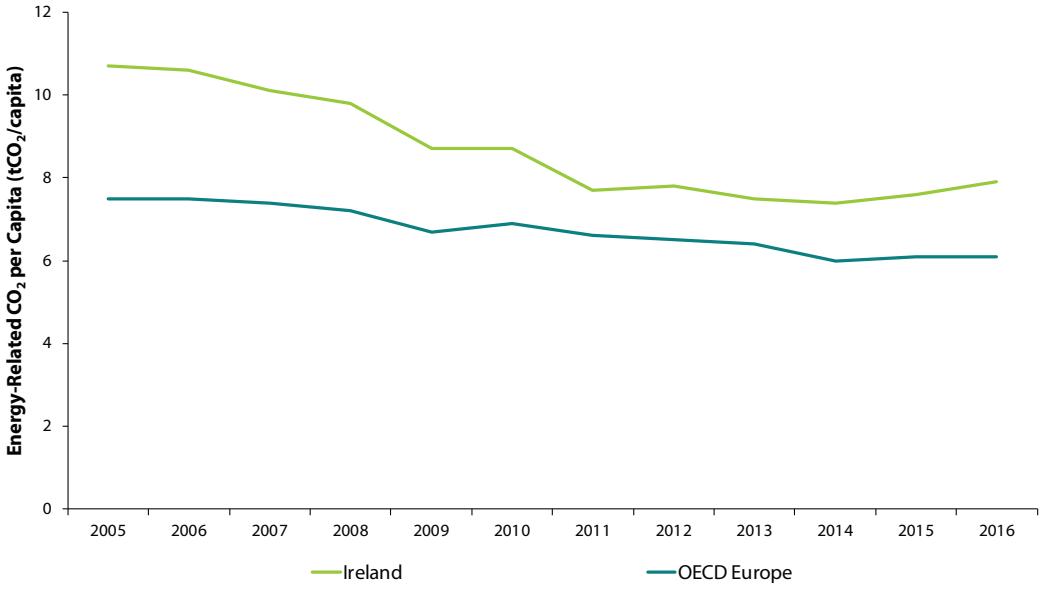


Source: International Energy Agency

3.3 Energy-related CO_2 Emissions Intensity per Capita

Figure 5 shows the level of energy-related CO_2 emissions per capita in Ireland in comparison with the average in OECD Europe. Energy-related CO_2 emissions per capita were above the European average after 1990 and peaked in 2001 at 48% above. Since then the intensity has fallen, and in 2016 it was 30% above the OECD Europe average. Between 2005 and 2016, Irish energy-related CO_2 emissions per capita fell by 26%, from 10.7 tonnes per capita in 2005 to 7.3 tonnes in 2014, but increased to 7.9 tonnes in 2016. Over the same period emissions per capita in Europe fell by 19%, from 7.5 tonnes to 6.1 tonnes.

Figure 5: Energy-Related CO_2 Emissions per Capita — Ireland and OECD Europe



Source: International Energy Agency

4 CO_2 Emissions from Fuel Use

This section presents CO_2 emissions arising from the combustion of different fuel types across all sectors of the economy i.e. electricity generation, transport, residential, services, and industry. Only the CO_2 emissions from the combustion of fuels for energy use is included (which represent 96% of energy-related GHG emissions, with the remaining 4% accounted for by energy-related nitrous oxide [N_2O] and methane [CH_4]).

CO_2 emissions from fuel combustion accounted for approximately 61% of all GHG emissions in Ireland in 2016[7]. Compared with 2005, these were 15.5% lower. *Table 3* and *Figure 6* show the level of energy-related CO_2 emissions from each individual fuel source since 2005. CO_2 emissions from all fuels fell between 2005 and 2016 with the exception of natural gas, which saw CO_2 emissions increase by almost 20%. The CO_2 emissions associated with coal and oil fell by 27% and 25% respectively. Emissions from peat also decreased over the period by 3.1%.

Oil accounted for the largest share of emissions in 2016, at 52%, followed by natural gas at 25%, coal at 14% and peat at 8.8%.

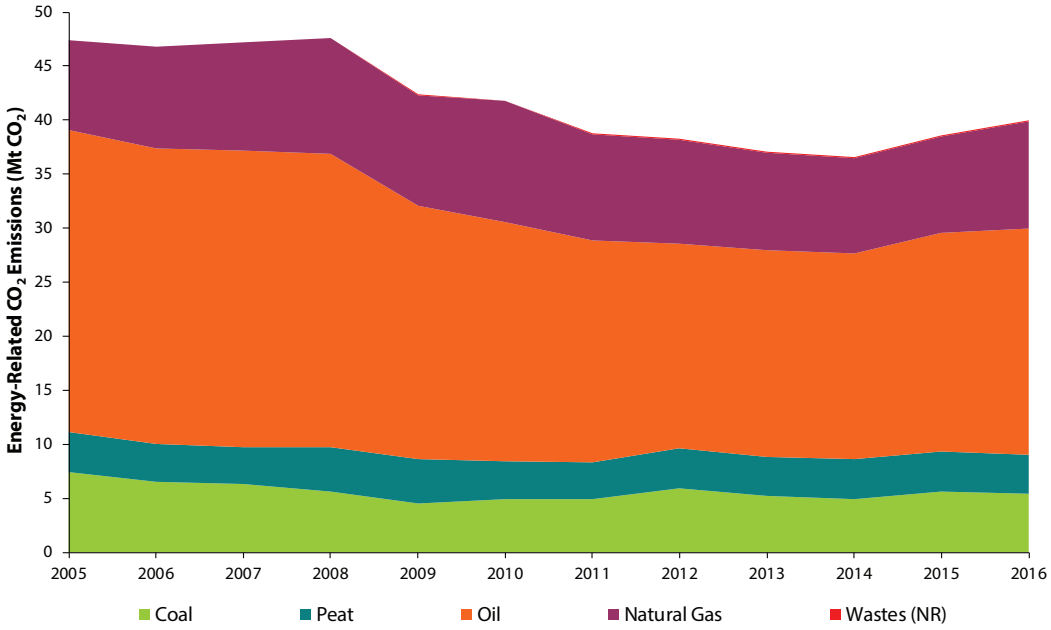
In 2016, 47% of energy-related CO_2 emissions were in the Emissions Trading Scheme (ETS).

Table 3: Energy-Related CO_2 Emissions by Fuel[8]

	Growth %	Average annual growth rates %				Quantity ($ktCO_2$)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Coal	-27.0	-2.8	-8.1	3.0	-3.7	7,463	5,449	15.8	13.6
Peat	-3.1	-0.3	-0.4	0.4	-2.9	3,637	3,526	7.7	8.8
Oil	-25.0	-2.6	-4.6	-1.8	3.8	27,982	20,998	59.1	52.5
Natural Gas	19.7	1.6	6.3	-4.4	10.4	8,270	9,896	17.5	24.7
Non-Renewable Waste	-	-	-	54.1	-3.8	0	140	0.0	0.3
Total	**-15.5**	**-1.5**	**-2.5**	**-1.6**	**3.6**	**47,352**	**40,007**		

Source: SEAI

Figure 6: CO_2 Emissions from Fuel Use



Source: SEAI

7 Provisional 2016 emissions data from the EPA.

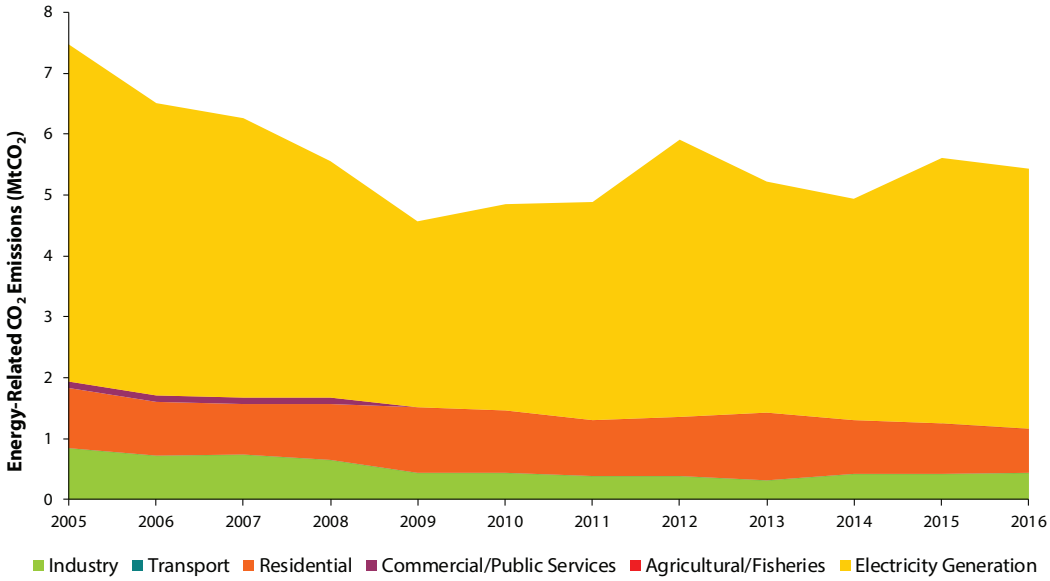
8 Note that there are some differences in the estimations of emissions when calculated by top-down overall fuel use and bottom-up sectoral use. This is due to statistical differences in the energy balance between the top-down and bottom-up allocation of energy supply and consumption. The differences were in the order of less than 1% for coal, approximately 1.5% for peat and oil, and 3.7% for natural gas in 2015.

4.1 CO_2 Emissions from Coal

Coal use for energy in Ireland is concentrated in electricity generation, and accounted for 79% of the coal CO_2 emissions in 2016, up from 74% in 2005. The residential sector was the next largest source of CO_2 emissions from coal, accounting for 13%, followed by industry, which was responsible for 8%. *Figure 7* and *Table 4* show the trend in CO_2 emissions from coal use between 2005 and 2016.

In 2016, approximately 85% of CO_2 emissions from coal were in the ETS.

Figure 7: CO_2 Emissions from Coal Use



Source: SEAI

Overall CO_2 emissions from coal use fell by 27% (2.8% per annum), from 7.5 Mt in 2005 to 5.4 Mt in 2016. The sharpest fall was between 2005 and 2009 (see *Figure 7*), when emissions fell by 39% (11.6% per annum) to a low of 4.6 Mt. The majority of the reduction in CO_2 emissions between 2005 and 2009 was in electricity generation, which saw coal CO_2 emissions fall by 45% to a low of 3 Mt, or a drop of 2.5 Mt in absolute terms. This was driven by, amongst other things, the commencement of the EU ETS in 2005 and the Large Combustion Plant Directive emissions limits. CO_2 emissions from coal use in electricity generation have recovered somewhat since 2009, to 4.3 Mt in 2016, which is 23% lower than in 2005.

Table 4: Energy-Related CO_2 Emissions from Coal

	Growth %	Average annual growth rates %				Quantity ($ktCO_2$)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Industry	-48.0	-5.8	-11.8	-1.2	3.7	838	436	11.2	8.0
Transport	-	-	-	-	-	0	0	0.0	0.0
Residential	-27.1	-2.8	0.6	-4.0	-13.2	989	721	13.2	13.3
Services	-100.0	-100.0	-100.0	-	-	106	0	1.4	0.0
Agriculture	-	-	-	-	-	0	0	0.0	0.0
Electricity Generation	-22.8	-2.3	-9.4	5.2	-1.8	5,547	4,280	74.1	78.7

Source: SEAI

CO_2 emissions from coal use in the residential sector fell by 27% over the period 2005 – 2016 and accounted for 13.3% of the CO_2 emissions associated with coal in 2016. The reduction in coal use in households was partly driven by extensions to the Smoky Coal Ban in 2011, 2013 and 2015.

CO_2 emissions from coal use in industry accounted for 8% of coal emissions in 2016, and fell by 48% during the period 2005 – 2016. Coal use in industry is limited to a small number of sectors — mainly cement manufacturing and, to a lesser extent, food processing. Some of the reduction in coal combustion in industry, and particularly in cement manufacturing, is driven by the increased use of renewable alternatives, such as meat and bone meal (MBM), the renewable portions of tyre-derived fuels, and municipal waste. Some non-renewable sources also contributed to the reduction in coal use, such as non-renewable wastes and petroleum coke.

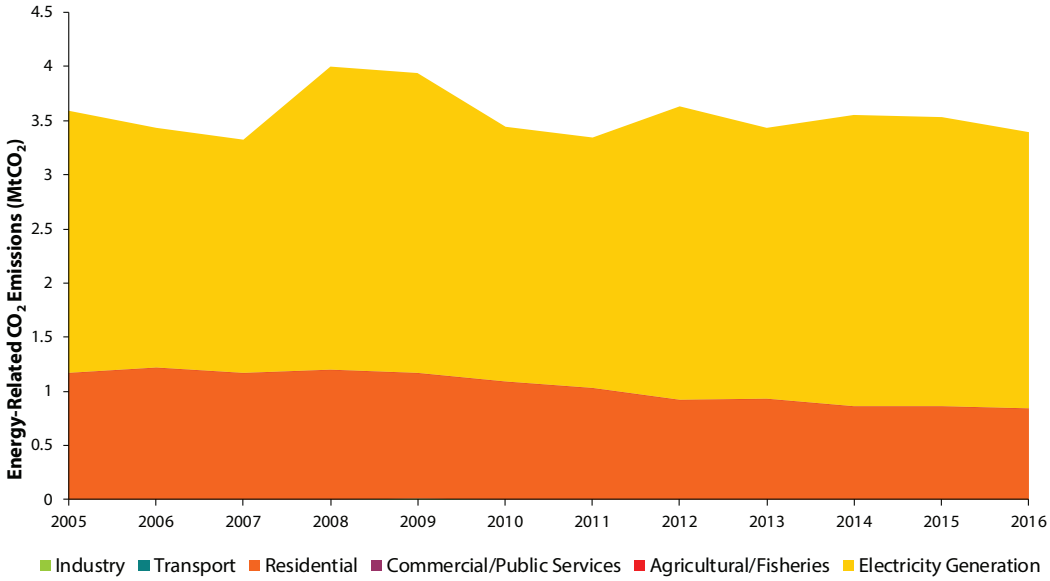
CO_2 emissions from coal use in services fell from 106 kt in 2005 to zero in 2009.

4.2 CO_2 Emissions from Peat

In Ireland, peat fuel is, like coal, used mainly for electricity generation. In 2005, electricity generation accounted for 67% of peat CO_2 emissions, and this increased to 75% in 2016. The residential sector was the next largest source of CO_2 emissions from peat, at 25%. Industry accounts for just 0.1%, or 4 kt, in absolute terms. *Figure 8* and *Table 5* show the trend in CO_2 emissions from peat use between 2005 and 2016.

In 2016, approximately 74% of CO_2 emissions from peat were in the ETS.

Figure 8: CO_2 Emissions from Peat Use



Source: SEAI

Table 5: Energy-Related CO_2 Emissions from Peat

	Growth %	Average annual growth rates %				Quantity ($ktCO_2$)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Industry	126.2	7.7	3.3	12.7	5.7	2	4	0.1	0.1
Transport	-	-	-	-	-	0	0	0.0	0.0
Residential	-28.0	-2.9	-1.5	-4.6	-1.8	1,170	842	32.6	24.8
Services	-100.0	-100.0	-100.0	-	-	2	0	0.1	0.0
Agriculture	-	-	-	-	-	0	0	0.0	0.0
Electricity Generation	5.4	0.5	-0.5	2.5	-4.5	2,419	2,549	67.3	75.1

Source: SEAI

Overall CO_2 emissions from peat use fell by 5.5% (0.5% per annum) between 2005 and 2016, to 3.4 Mt. This can be explained by the fact that there was a 28% reduction in peat use in the residential sector, to 0.8 Mt. However, this was offset somewhat by CO_2 emissions from peat use in electricity generation increasing by 5.4%, to 2.5 Mt, between 2005 and 2016.

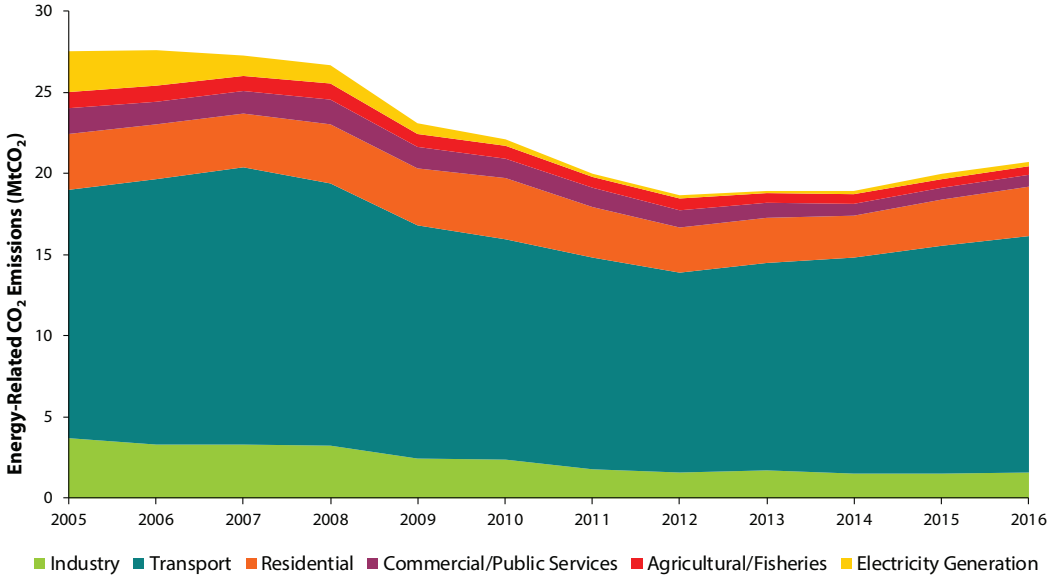
4.3 CO_2 Emissions from Oil

Oil is used primarily in the transport sector, which accounted for 70% of the CO_2 emissions from oil use in 2016. The residential sector is the next largest source of CO_2 emissions from oil, at 14.5%, followed by industry at 7.5%. Services accounted for 3.6% of oil emissions, and agriculture for 2.6%. The share of oil emissions from electricity generation has declined over time to just 1.2%, from a peak of 18% in 1999.

At 20.7 Mt, CO_2 emissions from oil use were 25% lower overall in 2016, than in 2005. CO_2 emissions from oil use fell to a low of 18.9 Mt in 2014, but increased by 5.6% in 2015 and by another 3.8% in 2016. This was driven primarily by increased oil use in transport, with oil-related emissions growing by 5.7% and 3.9% in 2015 and 2016 respectively, reaching 14.6 Mt by the end of the period. To a lesser extent, the residential sector contributed to the growth in oil use between 2014 and 2016, increasing in aggregate by 9.8% to 3.0 Mt.

In 2016, approximately 20% of CO_2 emissions from oil use were in the ETS (international aviation accounting for 16% points).

Figure 9: CO_2 Emissions from Oil Use



Source: SEAI

Table 6: Energy-Related CO_2 Emissions from Oil

	Growth %	Average annual growth rates %				Quantity ($ktCO_2$)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Industry	-58.0	-7.6	-8.5	-8.9	4.4	3,706	1,556	13.5	7.5
Transport	-4.3	-0.4	-2.4	0.7	3.9	15,256	14,597	55.4	70.5
Residential	-13.2	-1.3	1.8	-5.5	5.1	3,467	3,008	12.6	14.5
Services	-51.8	-6.4	-5.1	-9.2	1.5	1,567	756	5.7	3.6
Agriculture	-45.5	-5.4	-5.5	-6.9	3.4	1,005	548	3.7	2.6
Electricity Generation	-90.0	-18.9	-29.7	-8.9	-7.2	2,513	251	9.1	1.2

Source: SEAI

The largest share of emissions from oil use is in the transport sector where, in 2016, 98% of energy use in the sector was petroleum related. CO_2 emissions from oil use in transport fell by 4.3% between 2005 and 2016, to 14.6 Mt. Much of the decrease in emissions associated with oil use in the transport sector occurred between 2007 and 2012 due not only to economic recession, but also to improved fuel efficiency, and the use of bioethanol and biodiesel fuel blends since 2005. Improvements in fuel efficiency resulted in a 32% decline in the CO_2 intensity of new private cars between 2007 and 2016.

CO_2 emissions from oil use fell in the residential sector as well, dropping from 3.5 Mt to 3.0 Mt between 2005 and 2016, a decrease of 13%. The residential sector's share of CO_2 emissions from oil use grew from 13% to 15% over the same period. The decline in emissions related to oil use in the residential sector is underpinned by improvements to the thermal efficiency of the housing stock, as a result of higher building standards for new builds and energy efficiency gains from SEAI's energy efficiency programmes. In addition, high oil prices in 2008 and between 2011 and 2015 would have contributed to reduced demand. Emissions from oil use in the residential sector increased by 5.1% in 2016 compared with 2015.

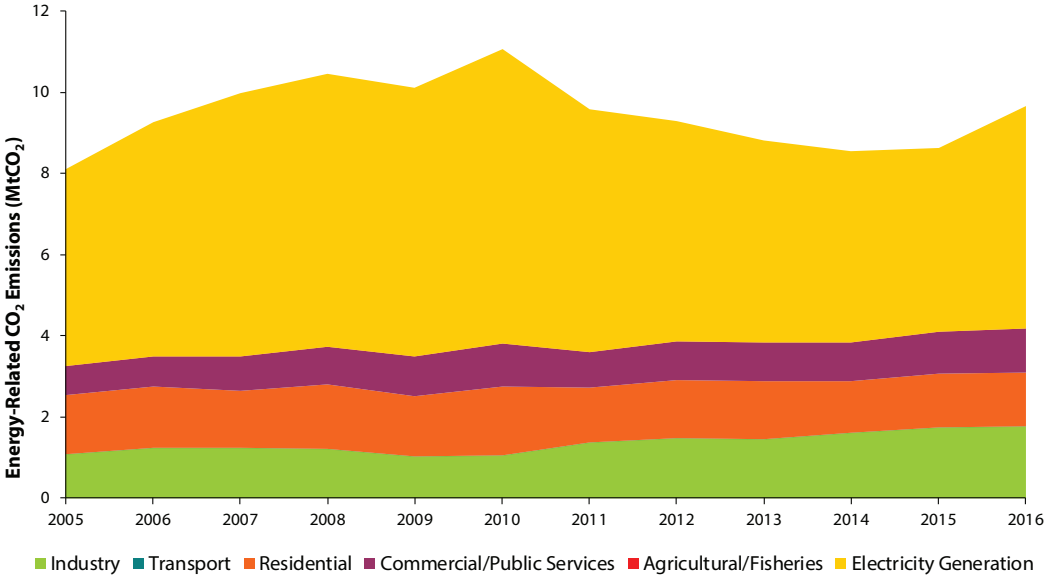
Oil-related CO_2 emissions from all other sectors fell over the period, with oil use in electricity generation decreasing the most. The decommissioning of oil generation at Poolbeg and Great Island resulted in a 90% drop, from 2.5 Mt in 2005 to 0.3 Mt in 2016. Oil-related CO_2 emissions fell in industry, services and agriculture by 58%, 52% and 46% respectively.

4.4 CO_2 Emissions from Natural Gas

Natural gas is used mainly for electricity generation and thermal applications in industry, services and households. In 2016, 57% of CO_2 emissions from the use of natural gas were due to electricity generation, down from 60% in 2005. Less than one fifth (18%) was accounted for by industry, 14% by households and 11% by services. A negligible amount of natural gas, in the form of compressed natural gas (CNG), is used in transport.

In 2016, approximately 73% of CO_2 emissions from natural gas were in the ETS.

Figure 10: CO_2 Emissions from Natural Gas Use



Source: SEAI

Overall, CO_2 emissions from natural gas use grew by 19% between 2005 and 2016, to 9.6 Mt. This was driven by an increase in natural gas use in the industry and services sectors, where associated emissions increased by 62% and 52% respectively over the period. Emissions from natural gas use grew by 11.7% in 2016 when compared with 2015, mostly due to increased gas use in electricity generation.

Table 7: Energy-Related CO_2 Emissions from Gas

	Growth %	Average annual growth rates %				Quantity ($ktCO_2$)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Industry	62.4	4.5	-0.6	11.4	-2.5	1,098	1,783	13.6	18.5
Transport	-	-	-	-	-0.8	0	0	0.0	0.0
Residential	-8.8	-0.8	3.3	-4.9	-0.5	1,443	1,317	17.8	13.6
Services	51.8	3.9	8.2	-2.0	13.3	710	1,077	8.8	11.2
Agriculture	-	-	-	-	-	0	0	0.0	0.0
Electricity Generation	12.9	1.1	8.4	-8.9	20.7	4,846	5,471	59.8	56.7

Source: SEAI

Emissions of CO_2 from gas use in electricity generation fell by 6.4% between 2005 and 2015, to 4.5 Mt, and increased by 20.7% in 2016, to 5.5 Mt, 12.9% higher than in 2005. The decrease up to 2015 was driven by increases in the efficiency of gas generation as a result of a number of CCGT plant being commissioned, and also by the displacement of gas generation by wind. Gas generation is generally the marginal generation plant on the electricity system, therefore when wind generation increases gas-fired electricity generation declines. However, in 2016, lower wind availability and a switch from net imports of electricity to net exports to the UK, due to carbon tax increases there, resulted in an increase in the use of gas for electricity generation in Ireland, and a 20.7% increase in emissions.

Emissions from natural gas use in the residential sector fell by 8.8% between 2005 and 2016, to 1.3 Mt, due to improvements in the thermal efficiency of the housing stock, energy efficiency gains from SEAI's energy efficiency programmes and high gas prices during some of the period.

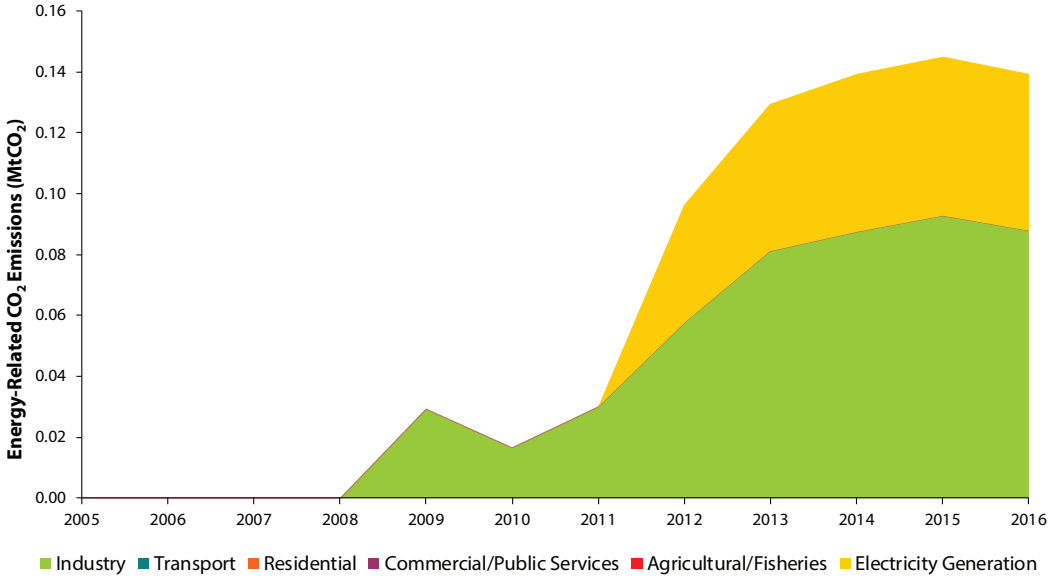
4.5 CO_2 Emissions from Non-Renewable Wastes

Energy from non-renewable wastes is only used in electricity generation and industry. Until mid 2017 there was only one municipal waste-to-energy plant in Ireland. The facility, operated by Indaver, is based in Duleek, Co. Meath and became operational in 2011. It manages 200,000 tonnes of residual waste per annum and has a capacity of 22 MW. In 2016, 70 GWh of electricity was produced from waste incineration, and emitted an estimated 52 kt CO_2.

In 2017, the Covanta operated waste-energy plant in Ringsend went into operation. It has a capacity of 60 MW.

In industry the use of non-renewable waste is concentrated in the cement industry and consists of MBM, and the non-renewable portions of municipal waste and tyre-derived fuels. Emissions from this source amounted to 88 kt CO_2 in 2016.

Figure 11: CO_2 Emissions from Non-Renewable Wastes Use



Source: SEAI

Table 8: Energy-Related CO_2 Emissions from Non-Renewable Wastes

	Growth %	Average annual growth rates %				Quantity ($ktCO_2$)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Industry	-	-	-	40.9	-5.2	-	88	-	63.0
Transport	-	-	-	-	-	-	0	-	0.0
Residential	-	-	-	-	-	-	0	-	0.0
Services	-	-	-	-	-	-	0	-	0.0
Agriculture	-	-	-	-	-	-	0	-	0.0
Electricity Generation	-	-	-	-	-1.3	-	52	-	37.0

Source: SEAI

5 Sectoral Energy-Related CO_2 Emissions

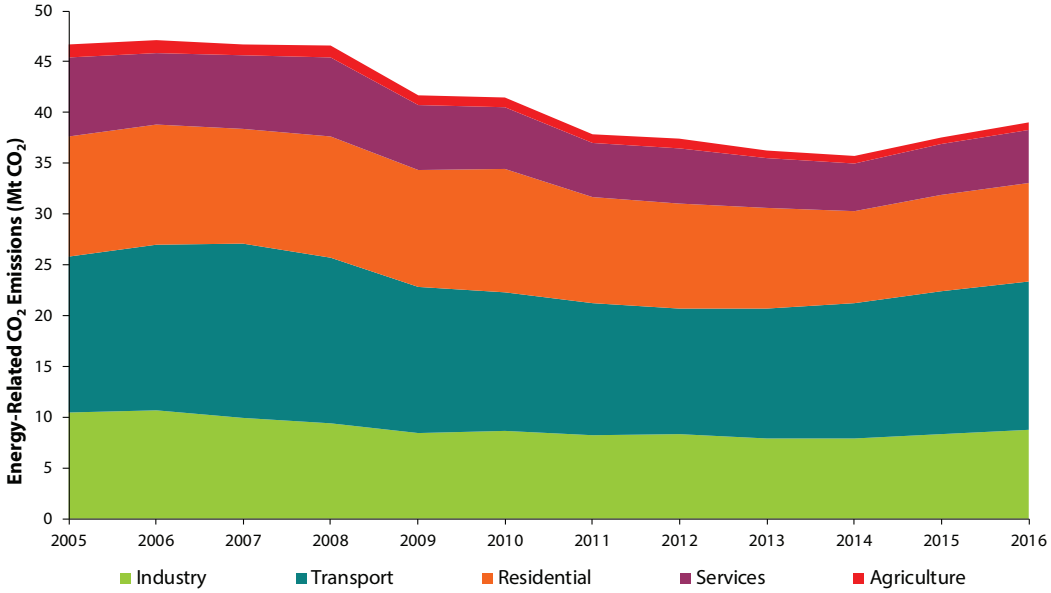
The sectoral energy-related CO_2 emissions presented in this section are based on the sectoral disaggregation contained in the energy balance, with the upstream emissions from electricity generation and other energy transformations allocated to the economic sectors where that electricity is used. This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

The data presented in *Section 5.1* reflects the CO_2 emissions resulting from the final demand for all forms of energy, including electricity and heat, within each sector and gives a view of the total emissions associated with energy demand. *Section 5.2* and *Section 5.3* present the data on the emissions from electricity generation and heat specifically.

Figure 12 and *Table 9* show the sectoral breakdown of energy-related CO_2 emissions (which represent 96% of energy-related GHG emissions, with the remaining 4% accounted for by energy-related nitrous oxide [N_2O] and methane [CH_4]).

5.1 Sectoral Energy-Related CO_2 Emissions

Figure 12: Energy-Related CO_2 Emissions by Sector



Source: SEAI

Energy-related CO_2 emissions in 2016 were 15.5% lower than 2005 levels.

As shown in *Table 9,* transport accounted for the largest share of energy-related CO_2 emissions, with a share of 37% in 2016, up from 33% in 2005. The residential sector accounted for the second largest share in that year, at 25%, followed by industry at 22% and services at 13%. Energy-related CO_2 emissions in agriculture and fisheries accounted for just 2.1%.

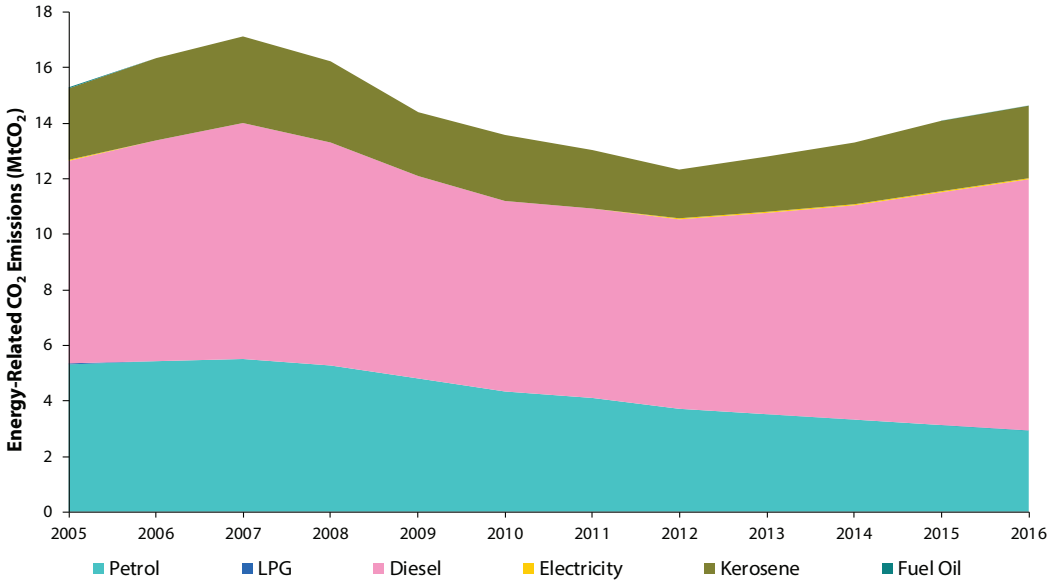
Table 9: Energy-Related CO_2 Emissions by Sector

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Industry	-16.7	-1.6	-3.7	-0.9	5.2	10,519	8,765	22.5	22.4
Transport	-4.4	-0.4	-2.4	0.7	3.9	15,293	14,620	32.7	37.4
Residential	-18.2	-1.8	0.5	-4.7	1.6	11,843	9,690	25.3	24.8
Services	-33.2	-3.6	-4.8	-4.1	5.7	7,764	5,189	16.6	13.3
Agriculture/Fisheries	-42.2	-4.9	-5.7	-5.6	3.8	1,414	817	3.0	2.1

Source: SEAI

5.1.1 Transport Energy-Related CO_2 Emissions

Figure 13: Transport Energy-Related CO_2 Emissions



Source: SEAI

Energy-related CO_2 emissions in transport were almost entirely produced by the use of petroleum products (98% in 2016) and were concentrated on the use of petrol, diesel and kerosene. Kerosene is exclusively used for air transport and petrol is mainly used in cars. Diesel, which accounted for approximately 62% of transport emissions in 2016, is used across multiple modes of transport, such as cars, light and heavy goods transport on roads, rail and water transport.

Table 10: Energy-Related CO_2 Emissions in Transport

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Total Oil Products	-4.3	-0.4	-2.4	0.7	3.9	15,256	14,597	99.8	99.8
Petrol	-45.0	-5.3	-4.1	-6.2	-6.7	5,337	2,937	34.9	20.1
Diesel	24.1	2.0	-1.2	4.1	8.2	7,299	9,057	47.7	61.9
Jet Kerosene	1.3	0.1	-1.7	1.5	2.6	2,562	2,595	16.8	17.8
LPG	150.2	8.7	-12.8	37.5	0.7	3	7	0.0	0.0
Electricity	-37.3	-4.2	-8.4	-3.5	16.1	37	23	0.2	0.2
Total	**-4.4**	**-0.4**	**-2.4**	**0.7**	**3.9**	**15,293**	**14,620**		

Source: SEAI

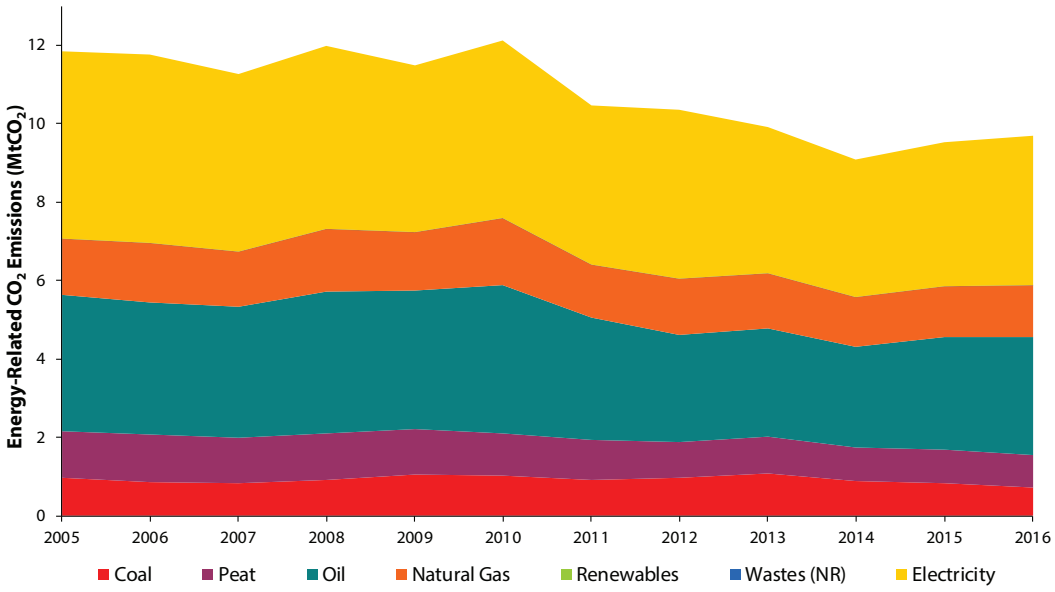
In 2016, the transport emissions were 14,620 kt, which represented 37% of the total energy-related CO_2 emissions. Over the period 2005 – 2016, energy-related CO_2 emissions in transport decreased by 4.4% (0.4% per annum), to 14.6 Mt. Emissions peaked in 2007 at 17.1 Mt and fell rapidly during the economic downturn, to 12.3 Mt in 2012, a fall of 28%. Between 2012 and 2016 emissions increased again by 19%.

Over the period there was a change in the fuel mix, particularly in relation to petrol and diesel. This resulted from changes to the taxation regime; motor tax for private cars was no longer calculated on engine size, but on CO_2 emissions. In 2005, petrol accounted for 35% of transport CO_2 emissions and this fell to 20% in 2016. In absolute terms, petrol CO_2 emissions fell by 45% over the period, to 2.9 Mt. Similarly, diesel accounted for 48% of the emissions in 2005, a figure which rose to 62% in 2016. In absolute terms, diesel CO_2 emissions increased by 24%, to 9.1 Mt.

5.1.2 Household Energy-Related CO_2 Emissions

In 2016, residential sector energy-related CO_2 emissions (including upstream electricity emissions) were 9,690 kt CO_2, representing 25% of the total energy-related CO_2 emissions. The residential sector total was the second largest in terms of CO_2 emissions after transport (37%). Excluding upstream electricity emissions, direct CO_2 emissions from the household sector were 5.9 Mt, and were 0.3% higher in 2016 compared with 2015.

Figure 14: Household Energy-Related CO_2 Emissions



Source: SEAI

Over the period 2005 – 2016, energy-related CO_2 emissions[9] from the residential sector fell by 18.2% (1.8% on average per annum). If upstream emissions associated with electricity use are excluded, the CO_2 emissions from direct fossil fuel use in the residential sector fell by 20% between 2005 and 2016, while the number of households increased by 24%.

Energy-related CO_2 emissions in the residential sector peaked in 2010 at 12.1 Mt. This was one of the coldest years in recent times with prolonged cold periods at both the beginning and end of the year.

Table 11: Energy-Related CO_2 Emissions in the Residential Sector

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Coal	-27.1	-2.8	0.6	-4.0	-13.2	989	721	8.4	7.4
Peat	-28.0	-2.9	-1.5	-4.6	-1.8	1,170	842	9.9	8.7
Briquettes	-23.4	-2.4	-0.5	-3.7	-5.1	374	286	3.2	3.0
Oil	-13.2	-1.3	1.8	-5.5	5.1	3,467	3,008	29.3	31.0
Gas	-8.8	-0.8	3.3	-4.9	-0.5	1,443	1,317	12.2	13.6
Combustible Fuels (Total)	-16.7	-1.6	1.4	-5.0	0.3	7,069	5,889	59.7	60.8
Electricity	-20.4	-2.0	-1.1	-4.1	3.7	4,773	3,801	40.3	39.2
Total	**-18.2**	**-1.8**	**0.5**	**-4.7**	**1.6**	**11,843**	**9,690**		

Source: SEAI

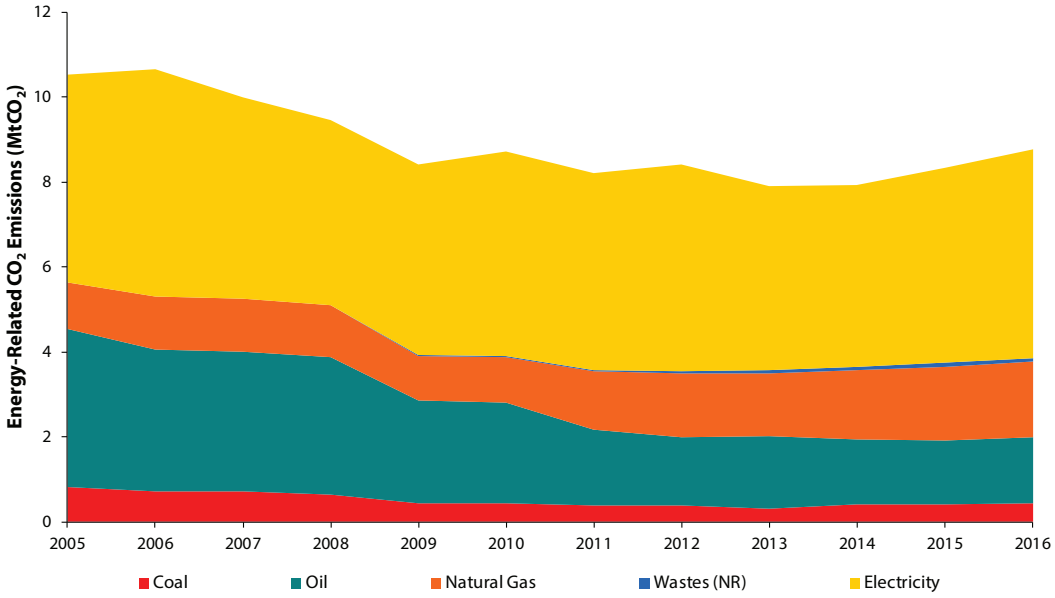
Between 2005 and 2016 the number of households in Ireland increased by 24% while the energy use in the sector fell by 8% (10.8% when corrected for weather effects) and emissions fell by 18%. This meant that the unit energy-related CO_2 emissions per household fell by 34% over the period. This was driven by a number of factors, such as more efficient new houses, improvements due to retrofitting, and some reductions were due to the high price of energy at times during those years. Overall CO_2 emissions per household decreased to 5.5 tCO_2/household. Some of the reduction is also accounted for by the lower CO_2 intensity of electricity. Per-household emissions from upstream electricity fell by 36% over the period, to 2.2 tCO_2/household. Direct use of fossil fuels in households fell by 33% over the period, to 3.3 tCO_2/household.

5.1.3 Industry Energy-Related CO_2 Emissions

Figure 15 shows the primary energy-related CO_2 emissions in industry, including the upstream emissions associated with electricity consumption. Over the period 2005 – 2016, overall energy-related CO_2 emissions in industry fell by 17% (1.6% per annum), to 8.8 Mt. Industry CO_2 emissions peaked in 2001 at 11.6 Mt.

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

Figure 15: Industry Energy-Related CO_2 Emissions



Source: SEAI

Industrial activity, as measured by gross value added (GVA) of industry, increased by 142% between 2005 and 2016. There was a large increase in GVA in 2015 caused by a number of one-off factors, such as the transfer of assets into Ireland and what are known as 'reverse takeovers'. This increase in GVA incurred no additional energy consumption.

Table 12: Energy-Related CO_2 Emissions in Industry

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Coal	-48.0	-5.8	-11.8	-1.2	3.6	838	436	8.0	5.0
Oil Total	-58.0	-7.6	-8.5	-8.9	4.4	3,706	1,556	35.2	17.8
Kerosene	-27.2	-2.8	-2.0	-5.2	5.2	372	271	3.5	3.1
Fuel Oil	-92.7	-21.2	-8.0	-33.4	-15.4	1,502	110	14.3	1.3
LPG	10.0	0.9	-0.1	0.6	7.1	275	302	2.6	3.4
Gas Oil	-43.3	-5.0	-4.6	-7.3	5.0	609	345	5.8	3.9
Petroleum Coke	-44.1	-5.2	-21.3	11.5	7.1	944	528	9.0	6.0
Natural Gas	62.4	4.5	-0.6	11.4	-2.5	1,098	1,783	10.4	20.3
Non-Renewable (Wastes)	-	-	-	40.9	-5.2	-	88	0.0	1.0
Total Combustible Fuels	-31.5	-3.4	-7.1	-0.3	0.8	5,644	3,867	53.6	44.1
Electricity	0.4	0.0	-0.2	-1.0	7.0	4,876	4,897	46.4	55.9
Overall Total	**-16.7**	**-1.6**	**-3.7**	**-0.7**	**4.2**	**10,519**	**8,765**		

Source: SEAI

As detailed in *Table 12*, upstream emissions from electricity consumption account for 56% of industrial energy-related CO_2 emissions — more than all the other fuels used by industry combined.

If upstream electricity-related emissions are omitted then there was a 31% decrease in CO_2 emissions from combustible fuels used on-site in industry between 2005 and 2016. Some of the reduction is as a result of lower overall energy use in industry, which fell by 7.1%. Changes in the fuel mix also contributed to lowering emissions. In 2005, oil accounted for 35% of the emissions and this dropped to 18% in 2016. Of the oil products, heavy fuel oil has the highest emission factor.

In 2005, heavy fuel oil accounted for 14% of industry's CO_2 emissions (41% of industry's oil emissions) but this fell to just 1.3% in 2016. This was as a result of fuel switching in alumina production, from the direct use of heavy fuel to a more efficient use of natural gas in combined heat and power production.

Natural gas, a lower emissions fuel, increased its share in industry energy-related CO_2 emissions from 10% to 20% over the period. The renewable energy share of final energy consumption also grew slightly, accounting for 7.1% of industry demand in 2016, compared with 6.2% in 2005.

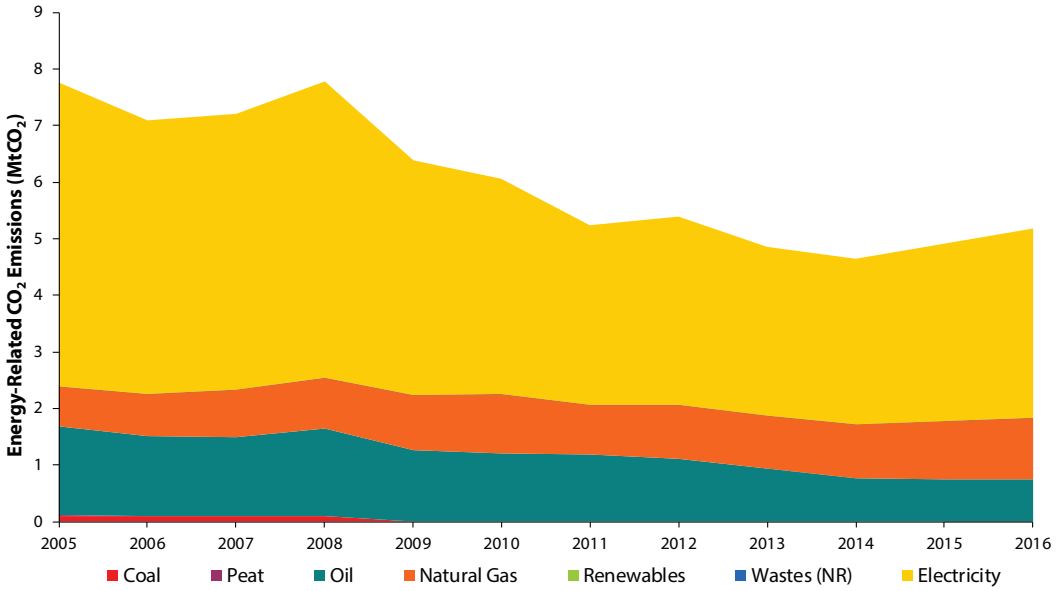
5.1.4 Services Energy-Related CO_2 Emissions

Figure 16 shows the primary energy-related CO_2 emissions of the services sector, including the upstream emissions

associated with electricity consumption. CO_2 emissions from direct fossil fuel combustion in the services sector decreased by 23% between 2005 and 2016, and the emissions associated with electricity consumption fell by 38%. This was driven by both a 20% reduction in electricity demand in services and a reduction in the emissions intensity of electricity generation. During this period, employment in services increased by 14% and the value added generated in services increased by 49%[10].

In 2016 non-electricity emissions increased by 3.3% and the electricity-associated emissions in services increased by 7.0%. Overall, energy-related CO_2 emissions in this sector increased by 5.7% in 2016 to 5.2 Mt CO_2. Energy-related CO_2 emissions in services peaked in 2003 at 7.9 Mt, and have fallen by 34% since then.

Figure 16: Services Energy-Related CO_2 Emissions



Source: SEAI

There is a smaller range of energy sources used in the service sector, than in industry or households. The sector now relies on oil, natural gas and electricity, and hasn't used coal since 2008. Over the period 2005 – 2016, there was a significant move from oil to gas in the fuel mix used in the sector, with the share of emissions from oil falling from 20% to 15%, and that of gas increasing from 9.1% to 21%. This factor, together with a 12% reduction in combustible fuel use in services contributed to a 23% reduction in CO_2 emissions from fuel use.

Table 13: Energy-Related CO_2 Emissions in the Services Sector

	Growth %	Average annual growth rates %				Quantity (kt)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Coal	-100.0	-100.0	-100.0	-	-	106	-	1.4	0.0
Oil	-51.8	-6.4	-5.1	-9.2	1.5	1,567	756	20.2	14.6
Gas	51.8	3.9	8.2	-2.0	13.3	710	1,077	9.1	20.8
Electricity	-37.6	-4.2	-6.7	-3.7	7.0	5,379	3,356	69.3	64.7
Total	**-33.2**	**-3.6**	**-4.8**	**-4.4**	**7.4**	**7,764**	**5,189**		

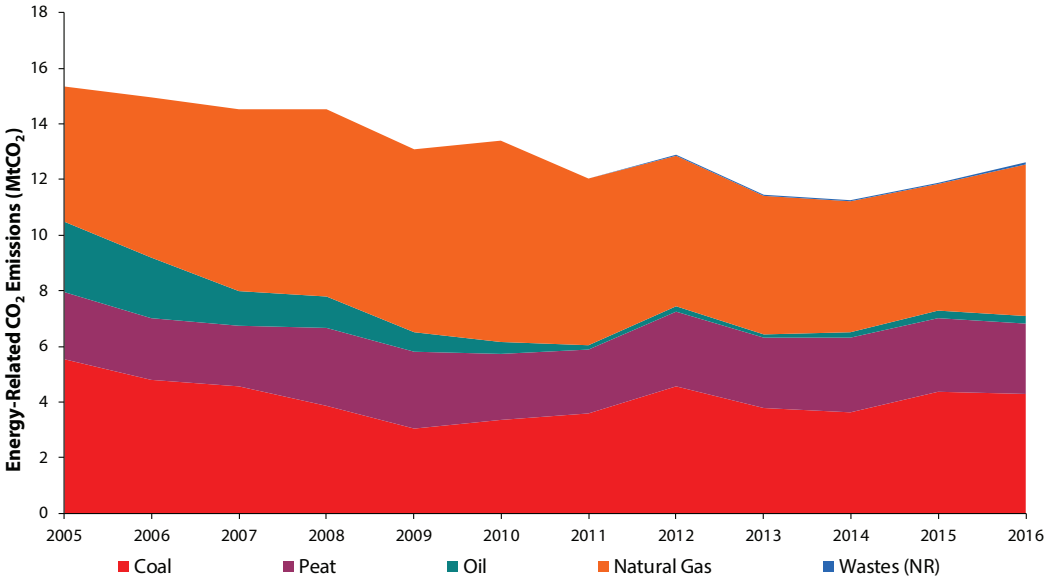
Source: SEAI

10 See http://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?Maintable=QNQ40&Planguage=0 and http://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?maintable=N1604&PLanguage=0

5.2 Energy-Related CO_2 Emissions from Electricity Generation

Figure 17 shows the trend in emissions from fuel combustion in electricity generation over the period 2005 – 2016, which saw CO_2 emissions from fuels used in electricity generation fall by 18%, to 12.6 Mt. *Table 14* shows the growth rates, quantities and shares of emissions from fuel combustion in electricity generation. Emissions from gas-generated electricity grew by 12.9%, while emissions from all other fuel sources fell. Gas accounted for 32% of the sector's emissions in 2005, and this rose to 43% by 2016.

Figure 17: Electricity Generation CO_2 Emissions by Fuel



Source: SEAI

CO_2 emissions from natural gas use in electricity generation fell by 6.4% over the period 2005 – 2015, but due to a 21% increase in gas emissions in electricity generation in 2016, emissions were 13% higher in 2016 than in 2005.

The share of emissions from coal-generated electricity remained relatively stable over the period, decreasing only very slightly from 36.2% to 34%, but in absolute terms coal emissions fell by 23%, to 4.3 Mt.

Emissions from coal, peat and oil fell in 2016 compared with 2015, by 1.8%, 4.5% and 6.9% respectively while natural gas emissions increased by 20.7%.

Table 14: Energy-Related CO_2 Emissions in Electricity Generation

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Fossil Fuels (Total)	-18.1	-1.8	-2.6	-2.5	6.1	15,325	12,550	100.0	99.6
Coal	-22.8	-2.3	-9.4	5.2	-1.8	5,547	4,280	36.2	34.0
Peat	5.4	0.5	-0.5	2.5	-4.5	2,419	2,549	15.8	20.2
Oil (Total)	-90.1	-18.9	-29.8	-9.0	-6.9	2,513	250	16.4	2.0
Fuel Oil	-92.7	-21.2	-32.1	-10.9	-9.9	2,283	166	14.9	1.3
Gas Oil and Refinery Gas	-83.9	-15.3	-17.4	-6.2	-42.6	208	33	1.4	0.3
Gas	12.9	1.1	8.4	-8.9	20.7	4,846	5,471	31.6	43.4
Non-Renewable (Wastes)	-	-	-	-	-1.3	-	52	-	0.4
Total	**-17.8**	**-1.8**	**-2.6**	**-2.4**	**6.0**	**15,325**	**12,601**		

Source: SEAI

While a combined 23% of electricity generated in Ireland in 2016 was from coal and peat as shown in *Figure 18*, their use in electricity generation accounted for 54% of electricity emissions as shown in *Table 14*. Natural gas generated 51% of the electricity used and this accounted for 43% of electricity-related emissions.

Figure 18: Flow of Energy in Electricity Generation 2016 — Input and Output Shares by Fuel

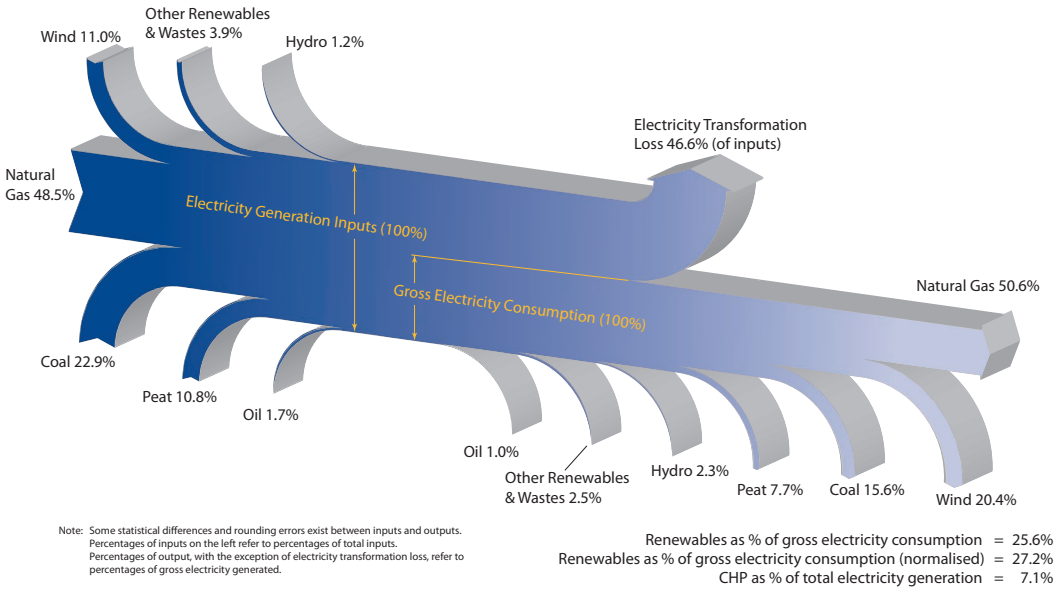
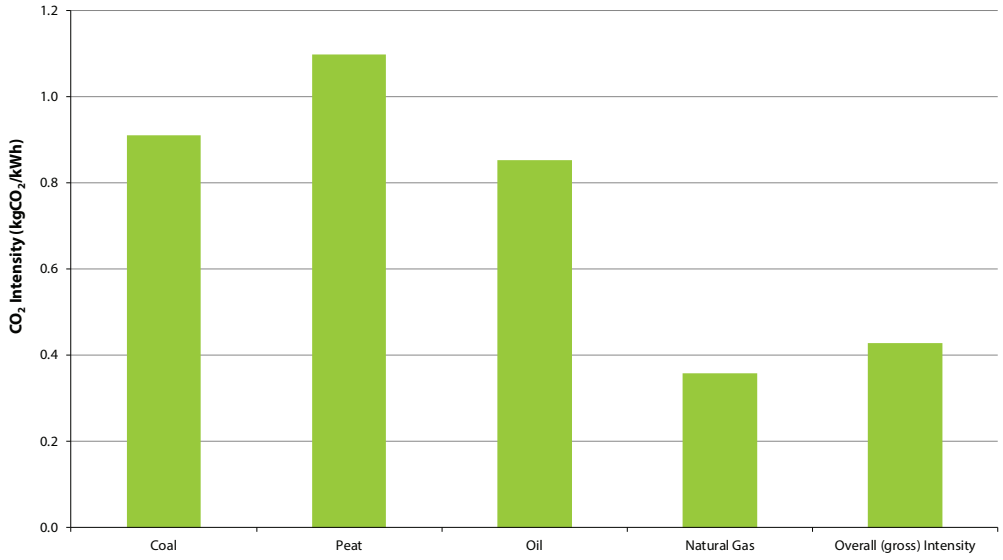


Figure 19 shows the relative emissions intensity of electricity generation from different fuels in 2016. Emissions from peat are the highest, at 1,098 gCO_2/kWh, followed by coal at 911 gCO_2/kWh. Electricity generated from oil was 854 gCO_2/kWh but oil generation only made up 1% of the electricity generated in 2016. The emissions intensity of natural gas generation was 359 gCO_2/kWh in 2016 and the overall figure (on a gross basis) was 428 gCO_2/kWh.

Figure 19: Gross Emissions Intensity of Electricity Generation by Fuel in 2016



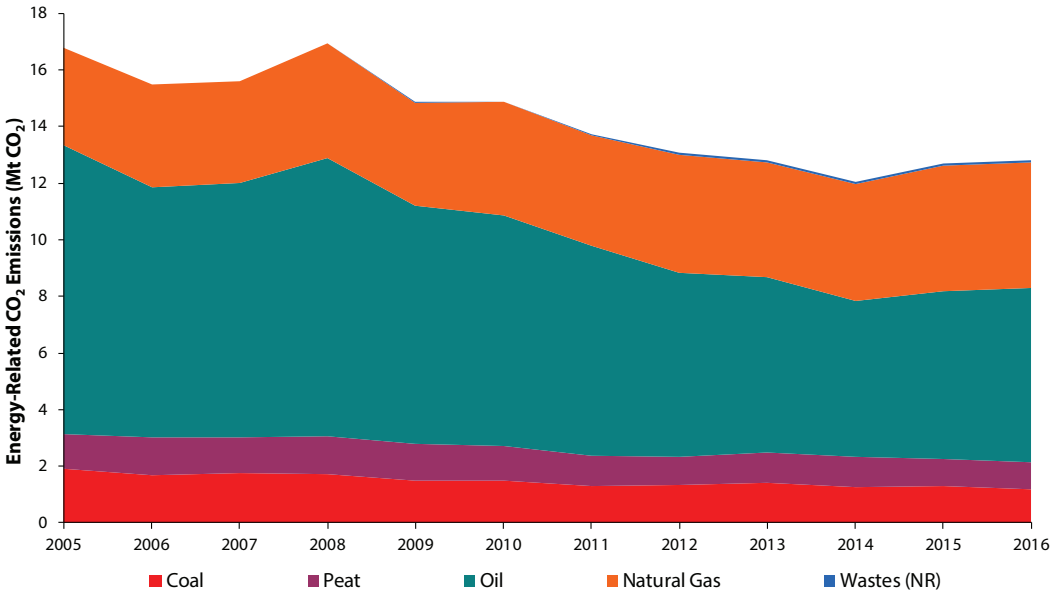
Source: SEAI

5.3 Energy-Related CO_2 Emissions from Heat

The heat sector consists of all energy used for heating purposes, such as space and water heating in households, commercial buildings and industry, and process heating in industry and cooking. It is essentially the non-transport and non-electricity[11] final energy use.

Figure 20 shows the trend in energy-related CO_2 emissions from heat demand between 2005 and 2016. The largest share of energy-related CO_2 emissions from heat in 2016 was from oil, at 48%, and the second largest was from natural gas at 35%.

Figure 20: Heat CO_2 Emissions by Fuel



Source: SEAI

CO_2 emissions from the use of fossil fuels for heat fell by 24% between 2005 and 2016, from 16.7 Mt to 12.8 Mt. Overall, energy-related CO_2 emissions from heat grew by 1% in 2016.

Emissions from coal, peat and oil fell by 39%, 20% and 40% respectively while emissions from natural gas grew by 29% to 4.4 Mt.

Table 15: Energy-Related CO_2 Emissions in Heat

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Coal	-39.0	-4.4	-4.7	-2.9	-10.0	1,917	1,169	11.4	9.1
Peat	-19.8	-2.0	-0.2	-4.4	1.6	1,218	977	7.3	7.6
Oil	-39.8	-4.5	-4.4	-6.2	4.2	10,213	6,151	60.9	48.0
Natural Gas	29.2	2.4	3.2	2.1	-0.2	3,424	4,425	20.4	34.5
Wastes	-	-	-	40.9	-5.2	0	88	0.0	0.7
Total	**-23.6**	**-2.4**	**-2.4**	**-3.1**	**1.0**	**16,771**	**12,810**		

Source: SEAI

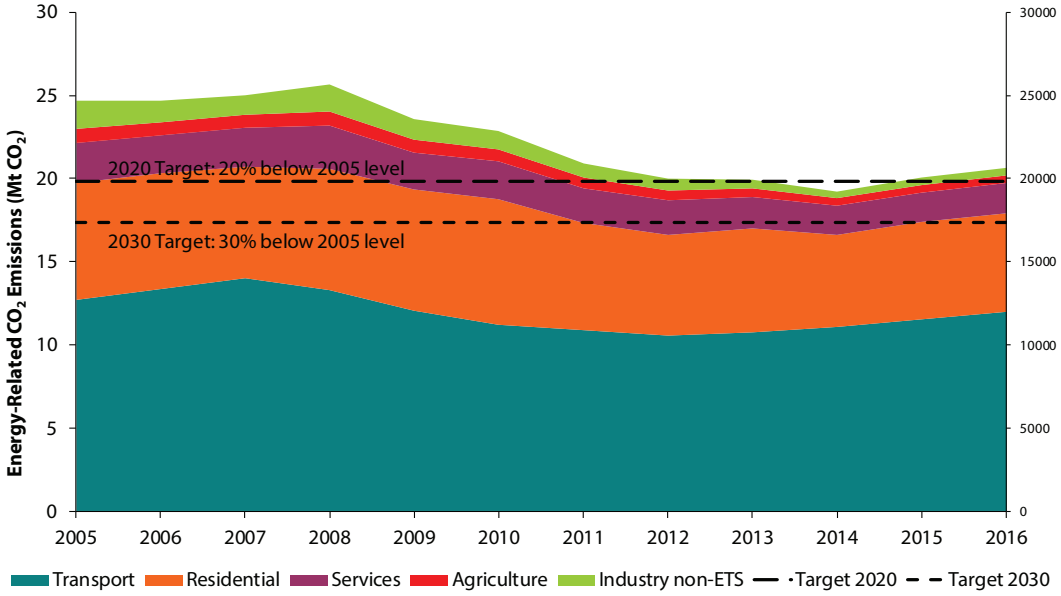
11 Where electricity is used for heat, the emissions are included under electricity generation and not heat.

6 ETS and non-ETS Energy-Related CO_2 Emissions

The EU 2020 Climate and Energy Package[12] set a target for the EU as a whole to achieve 20% GHG emissions reduction by 2020. The GHG emissions reductions targets are split across two categories. The first category covers large scale carbon emitters in industry, electricity generation and aviation. These bodies are dealt with at EU level under the EU ETS. The second category covers all GHG emissions not covered by the ETS, known as the non-ETS sector. This includes the majority of GHG emissions in the residential, transport and agricultural sectors. Achieving GHG emissions reductions in the non-ETS sector is the responsibility of national governments. The Effort Sharing Decision (2009/406/EC) set a mandatory target for Ireland to reduce non-ETS emissions by 20% below 2005 levels by 2020.

Figure 21 shows the trend in energy-related CO_2 emissions for the transport, residential, services and agricultural sectors, and non-ETS industry from 2005 onwards. This excludes emissions associated with electricity use by these sectors as these emissions are included in the EU ETS.

Figure 21: Non-Emissions Trading Energy-Related CO_2



Source: SEAI

Non-ETS energy-related CO_2 emissions fell by 16% between 2005 and 2016, from 25 Mt to 21 Mt. In 2016, CO_2 emissions in this sector increased by 3.4% compared with the previous year, due to increases in the transport and residential sectors and the portion of industry outside the ETS. The non-ETS sector as a whole has a target to reduce GHG emissions by 20% below 2005 levels by 2020, and 30% by 2030. The CO_2 emissions dipped below the 2020 target in 2014, but increased to 4.8% above the target in 2016.

Table 16: Energy-Related CO_2 Emissions, ETS and non-ETS

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
ETS CO_2	-17.0	-1.7	-3.3	-1.2	4.3	22,022	18,274	47.0	46.8
non-ETS CO_2	-16.1	-1.6	-1.6	-2.6	3.4	24,812	20,807	53.0	53.2
Total CO_2	**-15.5**	**-1.5**	**-2.5**	**-1.6**	**3.6**	**47,352**	**40,007**		

Source: SEAI

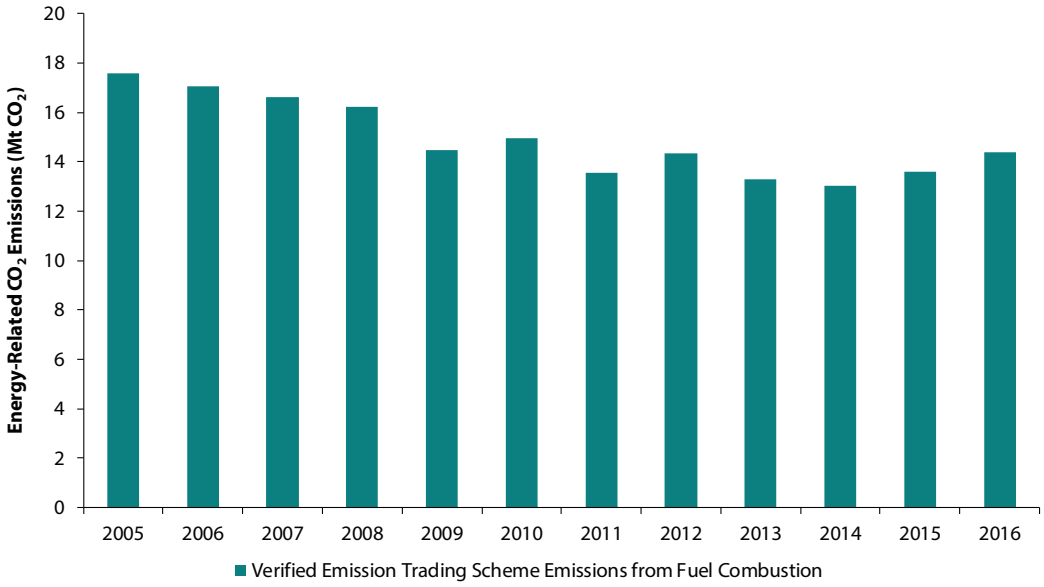
Figure 22 shows the trend in emissions from fuel combustion from those installations included in the EU ETS in Ireland since 2005. CO_2 emissions in the ETS fell by 17% (1.7% per annum) between 2005 and 2016, from 22 Mt to 18 Mt. In 2016, emissions increased by 4.3% compared with the previous year. According to the EPA[13] emissions of GHGs (CO_2 and other GHGs from energy and process emissions) from Irish companies in the EU ETS in 2016 increased by 5.4% overall compared to 2015. The increase can be broken down as follows:

12 See https://ec.europa.eu/clima/policies/strategies/2020_en

13 EPA press release; Greenhouse gas emissions from Irish companies in the EU ETS increased in 2016, http://www.epa.ie/newsandevents/news/pressreleases2017/name,61975,en.html

- There was an overall national increase of 6.6% in energy-related emissions in the power generation sector. This was largely due to a rise in the use of natural gas for electricity generation in 2016, which resulted in a 21% increase in emissions from natural gas generation.
- Cement industry emissions increased by 6.8% and the food and drink sector increased by 5.6%.
- Aviation emissions increased by 23%. This was mainly due to increased traffic but there were also some changes in the attribution of flights to Ireland that had previously been reported to another country in the scheme. Aviation emissions have been included in the scheme since 2012.

Figure 22: Emissions Trading Scheme Emissions from Fuel Combustion — Ireland



Source: European Environment Agency based on EPA data

Emissions trading is a 'cap and trade' scheme where an EU wide limit or cap is set for participating installations. The cap is reduced over time so that total emissions fall. Within that limit 'allowances' for emissions are auctioned or allocated for free (outside the power generation sector). Individual installations must report their CO_2 emissions each year and surrender sufficient allowances to cover their emissions. If their available allowances are exceeded, an installation must purchase more. If an installation has succeeded in reducing its emissions, it can sell its leftover allowances. The system is designed to bring about reductions in emissions at least cost. This system is expected to play an increasingly important role in assisting European industry in implementing the type of reductions envisaged in the EU Commission's target (at least an overall 20% reduction of GHG emissions in the EU by 2020).

The EPA is the competent authority for the implementation of the EU ETS in Ireland, and administers the accounts on Ireland's domain in the Union Registry. Currently there are 100 stationary installations with open accounts and two more are due to open accounts this year. Fifteen aviation operators are also currently included in the scheme, including six large Irish-registered commercial airlines. In view of the much-anticipated International Civil Aviation Organisation (ICAO) agreement last year on a global Market Based Mechanism to address emissions from international aviation, aircraft operators were only required to report and surrender in relation to emissions from flights within the EEA for 2016. An EU Commission proposal to continue this reduced coverage until there is sufficient clarity about the nature and content of the legal instruments adopted by the ICAO for the implementation of the global Market Based Mechanism is currently being debated in the European Parliament and the EU Council.

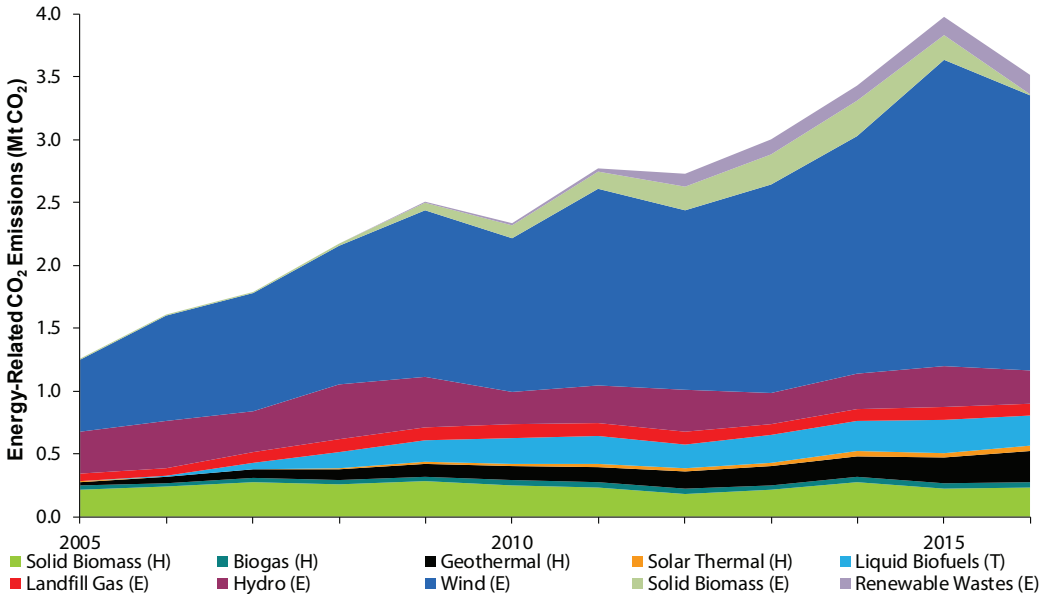
ICAO Assembly Resolution A39-3 decided to implement a global Market Based Mechanism in the form of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to address any annual increase in total CO_2 emissions from international civil aviation (i.e. civil aviation flights that depart in one country and arrive in another) above 2020 levels, taking into account special circumstances and respective capabilities.

7 Avoided CO_2 Emissions from Renewable Energy

The use of renewable energy is seen as an important tool for reducing GHG emissions and improving energy security by displacing the use of fossil fuels and energy imports. This section presents the current estimates of overall avoided emissions through the use of renewable energy in electricity generation, transport and heat markets.

The avoided carbon emissions and the displacement of fossil fuel imports by renewable energy generation are estimated using the Primary Energy Equivalent approach. The results obtained using this methodology have been further refined, using the results of a more detailed dispatch model of the operation of the entire all-island electricity system in the year 2012, so that the effects of ramping and cycling of fossil fuel plants are accounted for[14,15].

Figure 23: Avoided CO_2 Emissions from Renewable Energy



Source: SEAI

Figure 23 shows the trend in avoided CO_2 emissions from renewable energy for the period 2005 – 2016. The estimated amount of CO_2 avoided from renewable energy increased by 180% over the period 2005 – 2015, reaching 3,971 kt CO_2 in 2015 (as illustrated in *Figure 23*) but fell to 3,516 kt CO_2 in 2016.

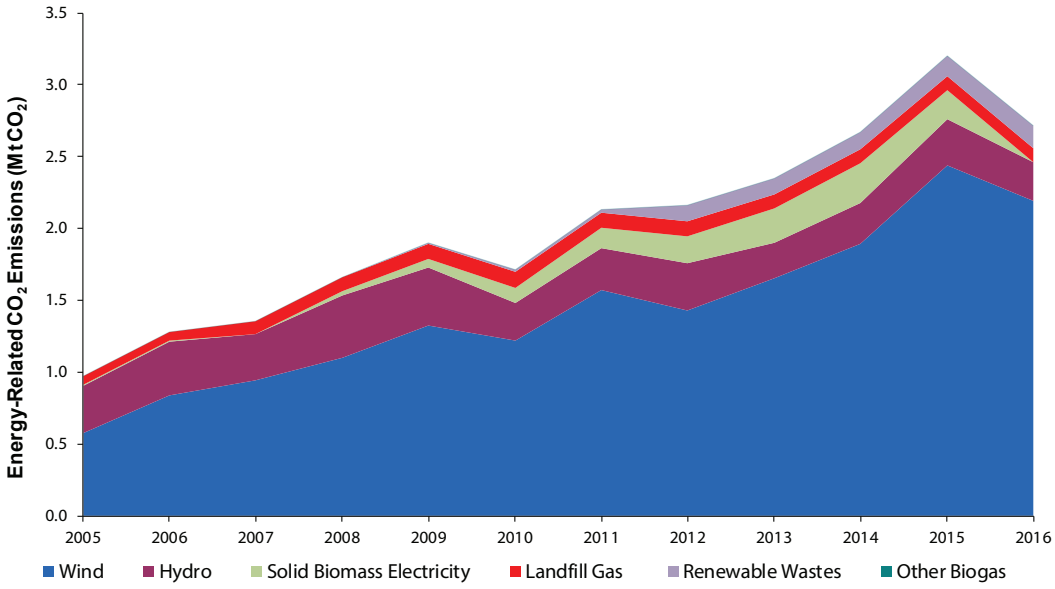
7.1 Avoided CO_2 Emissions from Electricity Generation

Figure 24 shows the trend in avoided CO_2 emissions from renewable energy for the period 2005 – 2016. The estimated amount of CO_2 avoided from renewable energy use in electricity generation increased by 178%, reaching 3,199 kt CO_2 in 2015, as illustrated in *Figure 24* and *Table 17*. However, they fell to 2,712 kt CO_2 in 2016, primarily as a result of less wind that year. Wind accounted for the highest share of avoided emissions that year, however, at 2,188 kt CO_2, followed by hydro at 269 kt CO_2, and renewable wastes at 154 kt CO_2.

14 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.

15 Holttinen, Hannele, et al (2014), *Estimating the Reduction of Generating System CO_2 Emissions Resulting from Significant Wind Energy Penetration.* 13th International Workshop on Large-Scale Integration of Wind Power into Power Systems as well as on Transmission Networks for Offshore Wind Power Plants, Berlin, Vol. 10, No. 2.1.

Figure 24: Avoided CO_2 Emissions from Renewable Energy in Electricity Generation



Source: SEAI

When the co-firing of biomass with peat commenced in Edenderry, there was an increase from 2008 levels of avoided emissions from biomass-generated electricity. Electricity generating from peat at Edenderry was covered by a Public Service Obligation (PSO) until the end of 2015, which meant that it had a 'must run' status. During the period when peat generation was supported by the PSO, co-firing of biomass with peat directly resulted in avoidance of emissions from peat generation. Since 2016, however, electricity generation from peat is no longer supported by the PSO. Instead, co-firing of biomass with peat at Edenderry is supported under REFIT 3. Without the REFIT from co-firing with biomass, electricity generation from peat would fall down the merit order and be replaced by gas generation (applying the operating margin approach[16], as for other renewables). The emissions from electricity generated from gas are lower than from electricity generated by peat co-fired with biomass at the proposed rates of co-firing. Therefore, co-firing biomass with peat no longer avoided carbon emissions after 2015. A small amount of emissions are still avoided from the use of biomass in CHP, as shown in *Figure 24*.

Regarding the displacement of fossil fuels by renewable energy, it is estimated that in 2016 approximately €192 million in fossil fuel imports were avoided, €155 million of which is attributed to wind generation. The displacement of fuel imports is calculated by estimating how much extra fossil fuel would have been imported if there had been no renewable generation in 2016. The estimates are based on the use of marginal generation fuel that would otherwise have been required to produce what had been generated by renewable energy.

Table 17: Avoided CO_2 Emissions from Renewable Energy in Electricity Generation

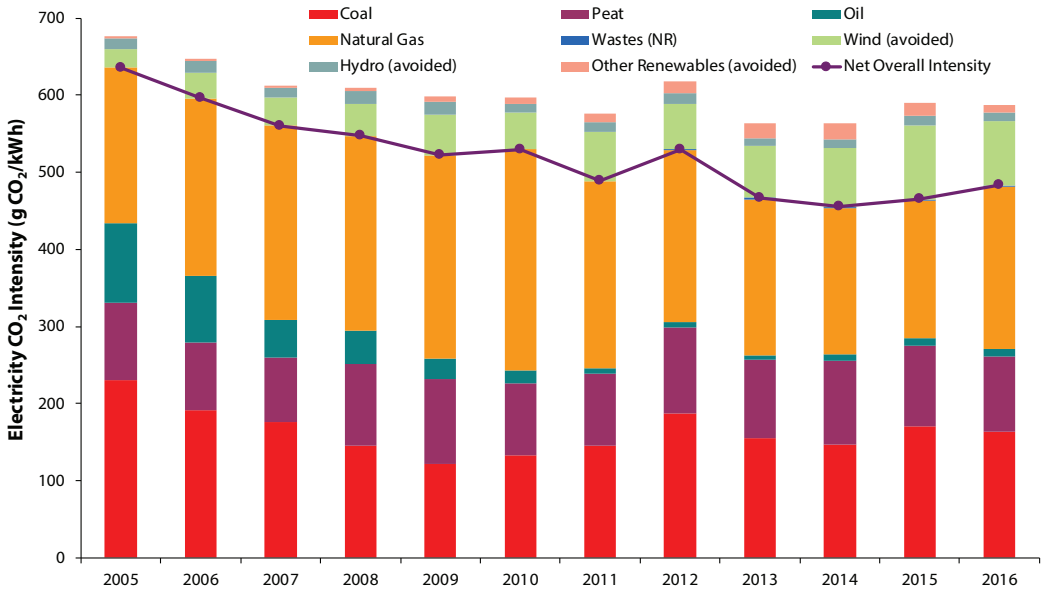
	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Wind	279.2	12.9	16.2	14.8	-10.2	577	2,188	59.1	80.7
Hydro	-17.8	-1.8	-4.5	4.4	-16.5	328	269	33.6	9.9
Landfill Gas	43.7	3.4	10.4	-1.5	-5.7	65	93	6.7	3.4
Solid Biomass Electricity	9.7	0.8	76.5	13.2	-96.6	6	7	0.7	0.3
Other Biogas	-	-	-	-	-	-	-	-	-
Renewable Wastes	-	-	-	55.0	11.7	-	154	-	5.7
Total	**177.8**	**9.7**	**11.9**	**13.3**	**-15.2**	**976**	**2,712**		

Source: SEAI

Figure 25 shows the CO_2 emissions intensity of electricity supplied between 2005 and 2016. The intensity in 2005 was 635.4 gCO_2/kWh and this fell to a low of 454.9 gCO_2/kWh in 2014. Intensity increased in both 2015 and 2016 to 464.9 gCO_2/kWh and 482.8 gCO_2/kWh respectively. The stacked bars in *Figure 25* shows the shares of the various fuels contributing to the overall emissions intensity, as well as the reduction in intensity as a result of emissions avoided by renewable generation. It is important to note that this graph represents the shares of the fuels in relation to the overall intensity, rather than the generation by the individual fuels themselves. The net overall intensity is shown as a line graph in *Figure 25*.

16 See Appendix 1 in Renewable Energy in Ireland 2012 - February 2014 Report

Figure 25: Electricity CO_2 Intensity



Source: SEAI

Table 18: Emission Sources Contributing to Electricity CO_2 Intensity

CO_2 Intensity (gCO_2/kWh)	2005	2010	2011	2012	2013	2014	2015	2016
Coal	230.0	133.4	145.5	187.3	154.7	146.8	170.6	164.0
Peat	100.3	93.2	93.9	111.4	102.0	109.0	104.4	97.7
Oil	104.2	17.0	6.9	7.0	5.4	7.5	10.4	9.6
Gas	200.9	286.2	242.6	222.4	203.0	189.5	177.5	209.6
Non-Renewable (Wastes)	0	0.0	0.0	1.6	2.0	2.1	2.0	2.0
Net Overall Intensity	**635.4**	**529.8**	**488.9**	**529.7**	**467.1**	**454.9**	**464.9**	**482.8**
Wind (avoided)	23.9	48.2	63.7	58.7	67.5	76.4	95.3	83.8
Hydro (avoided)	13.6	10.3	12.0	13.7	10.1	11.7	12.6	10.3
Other Renewables (avoided)	3.0	9.1	11.0	16.3	18.2	20.0	17.2	9.7

Source: SEAI

Since 1990 the share of high carbon content fuels, such as coal and oil, has been reducing, with a corresponding rise in (the relatively lower carbon) natural gas, and zero carbon renewables. Imported electricity is also considered zero carbon from Ireland's perspective under UNFCCC and IPCC reporting guidelines 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 456 gCO_2/kWh in 2014. Increased coal and peat use and lower net imports in 2015 saw the intensity increase to 465 gCO_2/kWh and a rise in natural gas use in 2016 increased the intensity to 483 gCO_2/kWh.

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

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

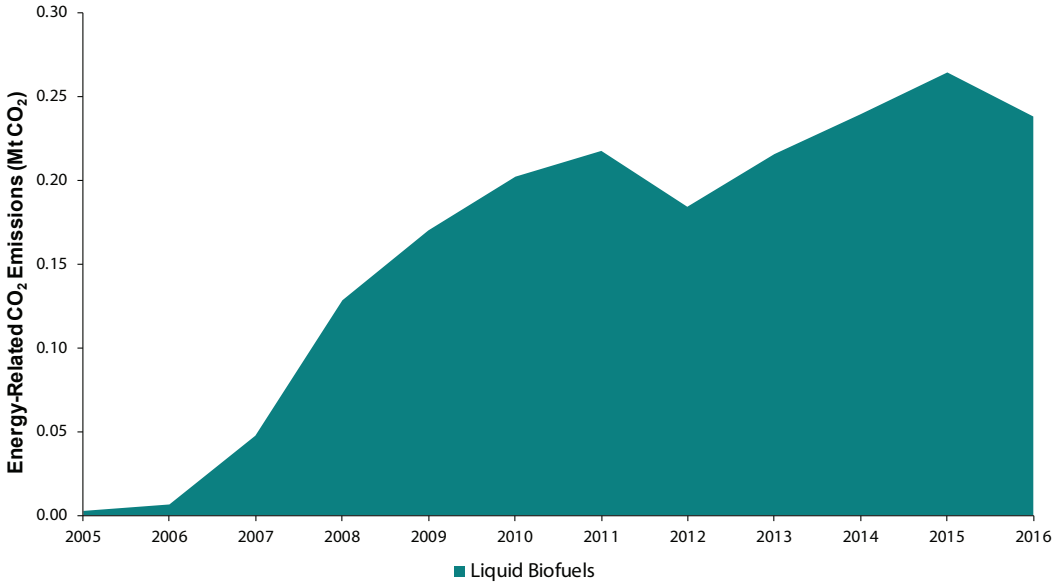
Countering these were a:

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

7.2 Avoided CO_2 Emissions in Transport

The avoided CO_2 emissions associated with biofuels are accounted for in this analysis according to the UNFCCC reporting guidelines. Thus the CO_2 avoided from bioethanol in transport is equated with CO_2 emissions that would have arisen from petrol consumption, and CO_2 avoided from biodiesel and pure plant oil is determined from the diesel consumption displaced.

Figure 26: Avoided CO_2 Emissions from Renewable Energy in Transport



Source: SEAI

The use of biofuels in transport only began in 2005. 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. In order to provide incentives to achieve the 2020 target, a Mineral Oil Tax Relief Scheme was introduced in 2005. In 2010 a Biofuel Obligation Scheme was established that required fuel suppliers and consumers to include, on average, 4% biofuel by volume (equivalent to approximately 3% in energy terms) in their annual sales. The biofuel obligation scheme is certificate based, and 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 and consumers are required to apply to the National Oil Reserves Agency (NORA) and demonstrate that the quantities of biofuel for which they are claiming certificates are accurate. Since the introduction of the Sustainability Regulations (SI 33 of 2012), the companies are also required to show that the biofuel placed on the market is sustainable. Biofuel that is not deemed to be sustainable will not be awarded certificates and cannot be counted towards the biofuel obligation. The obligation was increased to 6% by volume in 2013 and 8% from 1 January 2017.

Table 19: Avoided CO_2 Emissions from Renewable Energy in Transport

	Growth %	Average annual growth rates %				Quantity (kt CO_2)	
	2005 – 2016	'05 – '16	'05 – '10	'10 – '15	2016	2005	2016
Liquid Biofuels	9,735.4	51.8	142.3	5.5	-9.8	2.4	238

Source: SEAI

Emissions avoided by the use of liquid biofuels in transport grew from approximately 2 kt in 2005 to 264 kt in 2015, but fell back to 238 kt in 2016. Between 2010 and 2015, emissions avoided grew by 5.5% per annum on average, and in 2016 fell by 9.8%.

The use of biofuels in transport was down in 2016 compared with 2015 as a result of certificates being carried forward from previous years to meet 2016 obligations. Of the required certificates for 2016, 20% were carried forward from 2014 and 2015 (as allowed for under the Biofuel Obligation Scheme).

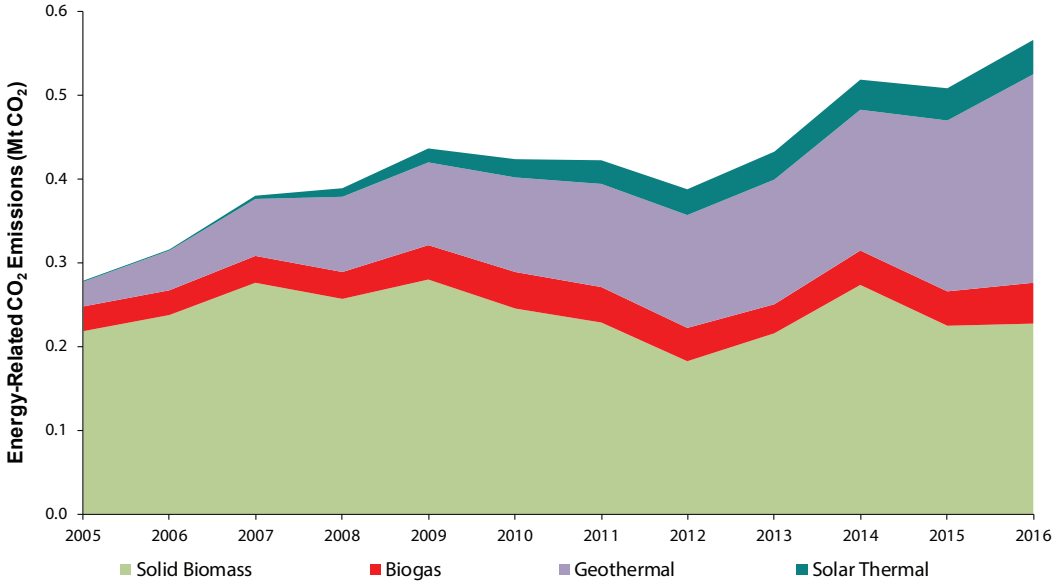
7.3 Avoided CO_2 Emissions in Heat

It is assumed that the thermal energy from renewable energy (solid biomass, biogas, geothermal, solar and renewable waste) displaces thermal energy from oil-fired boilers. The CO_2 avoided from thermal renewable energy is equated with

the CO_2 emissions that would have arisen from this oil consumption.

Figure 27 shows the estimated avoided emissions in the heat sector through the use of renewable energy sources. The use of renewables for thermal applications increased by 52% between 2005 and 2016, while the associated CO_2 emissions from heat fell by 24%.

Figure 27: Avoided CO_2 Emissions from Renewable Energy in Heat



Source: SEAI

Table 20: Avoided CO_2 Emissions from Renewable Energy in Heat

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2016	'05 – '15	'05 – '10	'10 – '15	2016	2005	2016	2005	2016
Solid Biomass	4.1	0.4	2.3	-1.8	1.5	219	228	78.4	40.2
Biogas	70.6	5.0	8.8	-0.9	17.0	29	49	10.3	8.6
Geothermal	725.3	21.2	30.2	12.6	21.7	30	248	10.8	43.8
Solar Thermal	2,945.7	36.4	74.8	11.7	7.1	1	42	0.5	7.4
Total	**103.1**	**6.7**	**8.7**	**3.7**	**11.3**	**279**	**566**		

Source: SEAI

Overall emissions avoided through the use of renewable energy in heat grew by 103% between 2005 and 2016, from 279 kt to 566 kt. The largest share of avoided emissions from the use of solid biomass was 228 kt in 2016. The use of geothermal and ambient energy (heat pumps) accounted for 44% of the avoided emissions in 2016, at 248 kt, while solar thermal avoided 42 kt (7.4% share).

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 (GHGs). Units used in this report are t CO_2 — tonnes of CO_2, kt CO_2 — kilo-tonnes of CO_2 (10^3 tonnes) and Mt CO_2 — mega-tonnes of CO_2 (10^6 tonnes).

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

Emissions Trading Scheme (ETS): The 2009 Emissions Trading Directive established a cap and trade system for GHG emissions associated with large industry and electricity generation installations across the EU. The EU ETS includes some 11,000 installations (101 currently in operation in Ireland of which 75 are industrial installations), with an installed capacity of more than 30MW. It covers about 45% of EU emissions, but only just over 25% of total emissions in Ireland.

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

Energy Intensity: The amount of energy used per unit of activity. Examples of activity used in this report are gross domestic product (GDP), value added, number of households, employees, etc. Where possible, the monetary values used are in constant prices.

Greenhouse Gas Emissions (GHG): Greenhouse gases trap heat from the sun and warm the surface of the Earth. The main greenhouse gases are carbon dioxide, methane, nitrous oxide and fluorinated gases.

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

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

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

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

Heating Degree Days: 'Degree days' is the measure or index used to take account of the severity of the weather when looking at energy use in terms of heating (or cooling) 'load' on a building. A degree day is an expression of how cold (or warm) it is outside, relative to a day on which little or no heating (or cooling) would be required. It is thus a measure of cumulative temperature deficit (or surplus) of the outdoor temperature relative to a neutral target temperature (base temperature) at which no heating or cooling would be required.

Total Final Consumption (TFC): This is the energy used by the final consuming sectors of industry, transport, residential, agriculture and services. It excludes the energy sector: electricity generation, oil refining, etc.

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

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

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.

Energy Conversion Factors

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

Energy Units

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

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

tonne of oil equivalent (toe): This is a conventional standardised unit of energy and is defined on the basis of a tonne of oil having a net calorific value of 41,686 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
Naphta	73.3	264.0
Petroleum Coke	92.9	334.5
Solid Fuels and Derivatives		
Coal	94.6	340. 6
Milled Peat	116.7	420.0
Sod Peat	104.0	374.4
Peat Briquettes	98.9	355.9
Gas		
Natural Gas	56.9	204.7
Electricity		
(2016)	133.7	482.8

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Energy Balance 2016

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

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

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