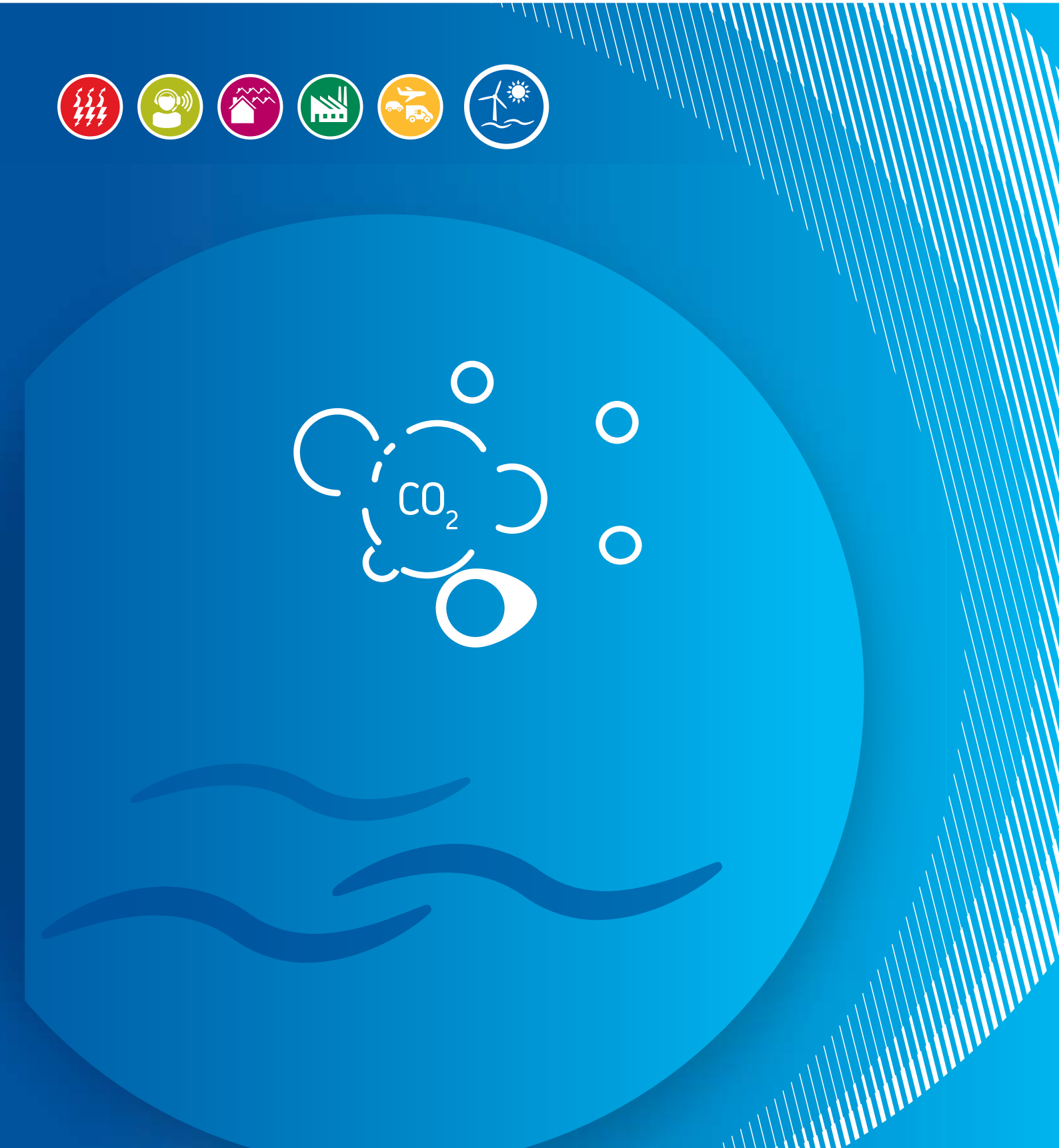
SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Energy-Related Emissions in Ireland

CO_2 Emissions from Fuel Combustion

2016 Report



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Report prepared by
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Energy Policy Statistical Support Unit

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Sustainable Energy Authority of Ireland

The Sustainable Energy Authority of Ireland's (SEAI) mission is to play a leading role in transforming Ireland into a society based on sustainable energy structures, technologies and practices. To fulfil this mission SEAI aims to provide well-timed and informed advice to Government, and delivering a range of programmes efficiently and effectively, while engaging and motivating a wide range of stakeholders, and showing continuing flexibility and innovation in all activities. SEAI's actions will help advance Ireland to the vanguard of the global green technology movement, so that Ireland is recognised as a pioneer in the move to decarbonised energy systems.

Energy Policy Statistical Support Unit (EPSSU)

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

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

Acknowledgements

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

Highlights (2005 – 2015)

- Over the period 2005 – 2015 energy-related CO_2 emissions decreased by 18.6% while the economy grew by 40%.
- Transport accounted for the largest share of energy-related CO_2 emissions, with a share of 37% in 2015, while the residential sector accounted for 25%, industry 22% and services 13%.

CO_2 Emissions from Fuel Use

Coal

- Overall CO_2 emissions from coal use decreased by 24% between 2005 and 2015. The majority of coal use is in electricity generation, which decreased by 45% over the period and was partly driven by the commencement of the EU Emissions Trading Scheme and the Large Combustion Plant Directive.
- The 16% drop in household use of coal was driven by extensions to the Smoky Coal Ban in 2011, 2013 and 2015 and fuel switching.
- Coal use also declined in industry by 51% over the period as the use of alternatives such as meat and bone meal and non-renewable wastes increased.

Peat

- Overall CO_2 emissions from peat use decreased by 3.9% between 2005 and 2015. This can be explained by the fact that peat use in households decreased over the period by 27%, offset by an increase of 10.4% in peat-fired electricity generation.

Oil

- CO_2 emissions from the combustion of oil are concentrated in the transport sector. Oil is also used in the residential, services and agricultural sectors.
- Overall, CO_2 emission associated with oil use decreased by 28% over the period. Much of the decrease occurred between 2007 and 2012 as the economy contracted and transport demand declined. Improvements in fuel efficiency and the lowering of the CO_2 intensity of new private cars resulting from the alignment of VRT and motor tax to CO_2 emissions also contributed to the reduction. More recently transport energy demand has increased as economic growth continues, with transport energy demand increasing by 5.7% in 2015.
- CO_2 emissions from oil use accounted for 30% of residential CO_2 emissions in 2015. This has decreased by 17% over the period, as the thermal efficiency of the housing stock has improved through higher building standards and energy efficiency gains from SEAI's grant schemes.
- In relation to industry, changes in the fuel mix over the period – for instance, from heavy fuel oil to natural gas in alumina production – has seen oil use in industry decline.

Natural Gas

- Natural gas is used for electricity generation (52%) and thermal applications in industry (21%), households (15%) and services (11%).
- Overall CO_2 emissions from natural gas use grew by 8.6% over the period to 9 Mt, this was driven by fuel switching (from oil to natural gas) in the industry and services sectors.
- Conversely, emissions of CO_2 from gas use in electricity generation fell by 6.4% to 4.5 Mt, this was driven by the use of higher efficiency combined cycle gas turbine (CCGT) plants and a greater use of wind energy.
- Emissions from natural gas use in the residential sector also fell over the period by 8.3% to 1.3 Mt, this was due to thermal efficiency improvements in the housing stock, including those from SEAI's energy efficiency retrofit programmes.

Sectoral Energy-Related CO_2 Emissions

Transport

- Between 2005 and 2015 energy-related CO_2 emissions in transport decreased by 7.9% to 14 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%, before rising again by 14% up to 2015.
- Over the period there has been a change in the fuel mix, particularly in relation to petrol and diesel. This was as a result of the change in the taxation regime for petrol and diesel cars.

Residential

- Energy-related CO_2 emissions from the residential sector fell by 19.3% over the period.
- The number of households in Ireland increased by 25% while the energy use in the sector fell by 9% (a 12.7% fall when corrected for weather effects) and emissions fell by 19.3%.
- This meant that the unit energy-related CO_2 emissions per household fell by 35% over the period, this was driven by a number of factors, such as more efficient new houses, improvements due to retrofitting, lower demand due to the high price of energy at times during the period, and the lowering of CO_2 intensity of electricity.

Industry

- Over the period overall energy-related CO_2 emissions in industry fell by 20% to 8.4 Mt.
- Electricity use in industry dominates energy-related CO_2 emissions in this sector, making up 55% of industry's total emissions in 2015.
- Some of the reduction in CO_2 emissions from industry occurred as a result of lower overall energy use in industry, which fell by 8.9%. In addition, there have been changes in the fuel mix of industry – for instance, from heavy fuel oil to natural gas in alumina production.

Services

- Over the period overall energy-related CO_2 emissions in services fell by 38% to 4.85 Mt.
- Electricity use in services dominates energy-related CO_2 emissions in this sector, making up 65% of the service sector's total emissions in 2015.
- Coal has ceased to be used to any extent in the services sector since 2008, with just three energy sources remaining, namely oil, natural gas and electricity. Over the period there has been significant fuel switching between oil and gas, with the share of emissions from oil in services falling from 20% to 15%, and that of gas increasing from 9.1% to 20%. This fuel switching, together with a 21% reduction in combustible fuel use in services over the period, has contributed to the 38% reduction in energy-related CO_2 emissions.

Avoided CO_2 Emissions from Renewables

- The CO_2 emissions avoided from renewable energy in electricity generation more than trebled over the period, reaching 3.2 Mt of CO_2 avoided in 2015.
- The intensity of CO_2 emissions in electricity generation has decreased by 26% over the period, from 635 gCO_2/kWh to 468 gCO_2/kWh, reflecting the increased generation from natural gas and renewable energy sources.
- CO_2 emissions avoided by the use of liquid biofuels in transport reached 264 kt in 2015.
- CO_2 emissions avoided through the use of renewable energy in heat grew by 56% over the period, from 261 kt to 408 kt. The largest share of avoided emissions was from the use of solid biomass at 218 kt in 2015, followed by geothermal energy (heat pumps) at 93 kt, and solar thermal at 55 kt.

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1 Introduction

Energy production and consumption accounted for 60% of Ireland's greenhouse gas (GHG) emissions in 2014 and is, therefore, an important source of emissions in Ireland. This report focuses on CO_2 emissions associated with energy use and details the trends and indicators of CO_2 emissions from fuel use and the activities driving the emissions. Many of the most cost-effective mitigation measures available in Ireland will come from reducing energy use across sectors such as transport and households, as well as increasing the uptake of renewable energy technologies. Therefore, understanding the trends and drivers for energy-related emissions is critical to making informed policy decisions. This report aims to provide that evidence by supplying insights into historical trends on energy-related emissions.

Emissions from energy use are driven by many factors. These range from economic activity, to weather conditions in a given year, to the efficiency of the technologies that use the energy. Ireland's economy grew rapidly during the Celtic Tiger years and subsequently contracted sharply between 2007 and 2010. This is reflected in the overall energy use in the country and the resulting emissions, particularly in the transport sector which is closely coupled with economic activity.

However, other factors were also important during the period 2005 – 2015, such as changes in technology and the fuel mix of electricity generation, improvements in our building stock and in our purchasing behaviour in relation to more fuel efficient and lower CO_2 emitting cars.

Weather affects those sectors that use energy mainly for space heating purposes. The residential and services sectors, collectively described as the 'built environment', show significant variation in energy use and emissions from year to year depending on the prevailing weather conditions. For example, 2010 was a particular case in point when there were unusually extended and very cold periods at both the beginning and end of the year. This resulted in a peak in energy use in the residential sector.

Energy-related 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 when used, whereas natural gas emits much less, and the use of some renewable energy sources emit zero carbon. Therefore, changes in the fuel mix over time can increase or reduce emissions.

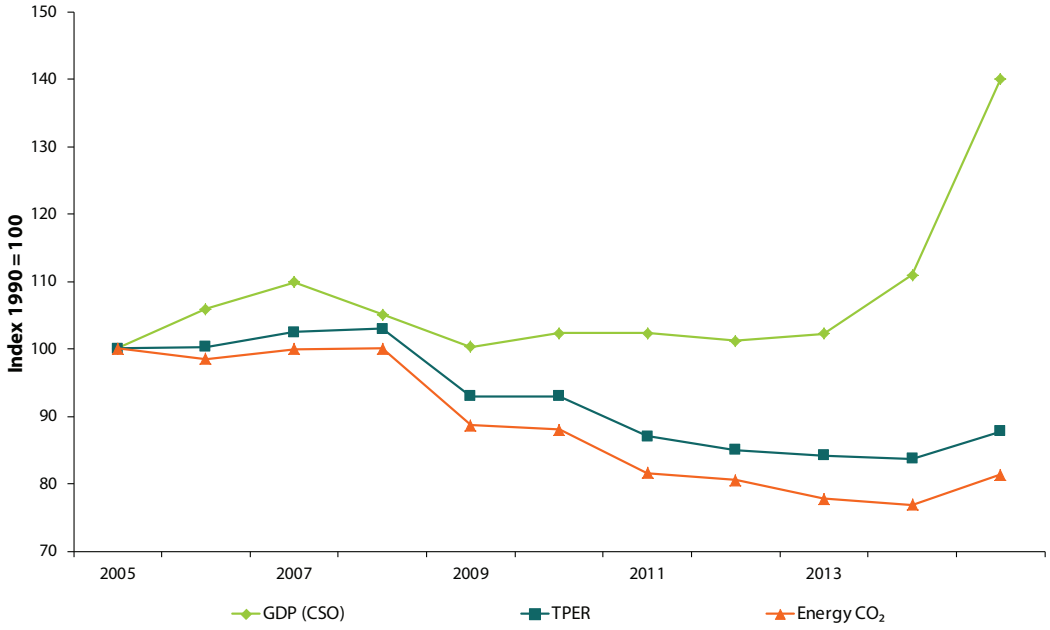
GHG emissions are usually presented in line with UNFCCC accounting rules and IPCC reporting guidelines, which often don't readily capture changes in fuel and the sectoral mix of energy use both upstream (e.g. emissions associated with the combustion of fossil fuels in electricity production that is subsequently used by consumers) and downstream (e.g. combustion of fossil fuels such as natural gas and coal). This report attempts to address this, providing more detail on where and from what source the emissions from energy are coming. Data presented are from 2005 to 2014, and include 2015 based on energy balance data frozen on 24 August 2016.

2 Economy and Energy CO_2 Emissions

Figure 1 shows the trend, as an index, of economic output as measured by gross domestic product (GDP), overall energy use as total primary energy requirement (TPER) and the associated energy-related CO_2 emissions. Over the period 2005 – 2015 overall energy-related CO_2 emissions (excluding aviation) decreased by 18.6% (2.0% per annum on average), or by 19.7% if international aviation is excluded. Over the same period the economy grew in aggregate by 40%.

The economy grew between 2005 and 2007 by approximately 10% while energy use grew by 2.5% and energy-related CO_2 emissions fell by 0.1%. This divergence in growth between the economy and both energy and emissions was due to a number of factors. Economic growth was underpinned by activities that were not very energy intensive while, at the same time, changes were happening in the way energy was supplied. For instance, two new high efficiency electricity generation combined cycle gas turbine (CCGT) plants started operation, in Tynagh in 2006 and in Huntstown in 2007. There was also a 32% increase in the use of renewable energy between 2005 and 2007, mainly in electricity generation, which had the effect of lowering both the primary energy requirement of electricity generation and the associated emissions.

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



Source: Based on SEAI and CSO data.

In 2008 when the economy entered recession, GDP fell by 2.6% compared with 2007, while primary energy use grew by 0.7% and energy-related CO_2 emissions grew by 0.1%. In 2009, the downturn in the economy deepened with GDP falling by 6.4% and energy and related CO_2 emissions falling by 9.7% and 11.3% respectively. The downturn particularly affected construction related sectors and the reduction in output from sectors such as cement manufacture had a significant effect in reducing energy use. Transport energy also reduced sharply at the start of the recession with lower activity in transporting goods and private car use resulting in a reduction of 10.7% in transport energy use in 2009 compared with 2008. With energy use falling at a faster rate than GDP and emissions falling faster than energy use, there continued to be a degree of decoupling of energy use from economic activity and emissions from energy use over this period.

In 2010 the rate of decline of the economy slowed to 0.3%, while overall energy use remained the same and emissions fell by 0.8%. There followed a particularly cold year in 2010, with prolonged cold spells at both the start and end of the year resulting in increased energy use for space heating in buildings.

Between 2010 and 2013 the economy was flat, with very little growth. The economy grew by just 0.1% over this period while energy use fell by 9.4% and energy-related emissions fell by 11.7%. One of the reasons for the reduction in energy use was the commissioning of a further two CCGT electricity plants in Cork (Whitegate and Aghada) in 2011. Other reasons for the reduction can also be attributed to a large increase (83%) in wind generation, which reduced the primary energy requirements for electricity generation. There were also continued improvements in the energy performance of households arising from changes to the building regulations and SEAI's retrofit grant schemes. In

transport 44% of the private cars on the road in 2015 comprised the more fuel efficient models purchased since 2008 when the vehicle registration and road taxes changed to align with lower emission vehicles.

Economic growth returned in 2014 and 2015, with the economy growing by 8.5% and 26.3% respectively in those years. Energy use continued to fall in 2014 reducing by 0.7%, with emissions reducing by 1.1%. The exceptional growth in GDP in 2015 is associated with a one-off transfer of assets into Ireland and a number of tax inversions which saw the siting of intellectual property rights in Ireland. These types of activities do not result in increased energy use however and energy use grew in 2015 by 4.9%, with energy-related CO_2 emissions growing at a higher rate of 5.8%. The rate of increase in energy use is probably close to the real growth in the economy if the above issues were excluded, and the higher rate of increase in emissions was primarily due to a 20% increase in the use of coal in electricity generation resulting from low coal and carbon prices.

Table 1 displays the growth rates for GDP, TPER and energy-related CO_2 emissions for the period 2005 – 2015. It highlights the growth in GDP compared with the reductions in energy and associated CO_2 emissions over the period.

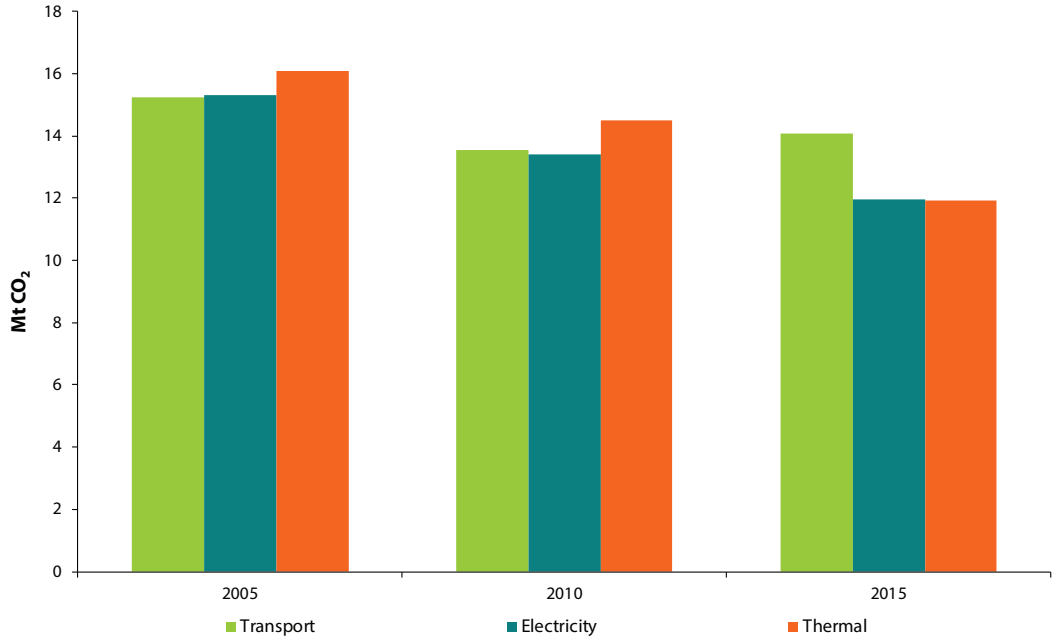
Table 1 *GDP[1], TPER and CO_2 Growth Rates[2]*

	Growth %	Average annual growth rates %			
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015
GDP	40.1	3.4	0.5	6.5	26.3
TPER	-12.2	-1.3	-1.5	-1.1	4.9
Energy CO_2	-18.6	-2.0	-2.5	-1.6	5.8
Energy CO_2 (excl. international aviation)	-19.7	-2.2	-2.6	-1.8	5.3

Source: Based on SEAI and CSO data.

Figure 2 illustrates the variations in 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. The graph presents the emissions at five-yearly intervals up to 2015. In 2015, the shares of energy-related CO_2 emissions from transport, electricity and thermal applications were 37.1%, 31.5% and 31.4% respectively.

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



Source: SEAI

Energy-related CO_2 emissions fell in all modes after 2005, by 19% overall, to 38 Mt. The fastest rates of decline were observed in heat (26% decrease) followed by electricity (22% decrease) and transport (7.8% decrease). The share of emissions by mode was almost equal at around one third each in 2005 whereas in 2015 transport accounted for the highest share, at 37%, followed by electricity and heat, at 31.5% and 31.4% respectively.

1 GDP rates are calculated using constant market prices chain-linked annually and referenced to 2013.
2 Throughout the report where annual growth rates are across multiple years they always refer to *average annual growth rates*.

Table 2 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions by Mode of Application*

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

Source: SEAI

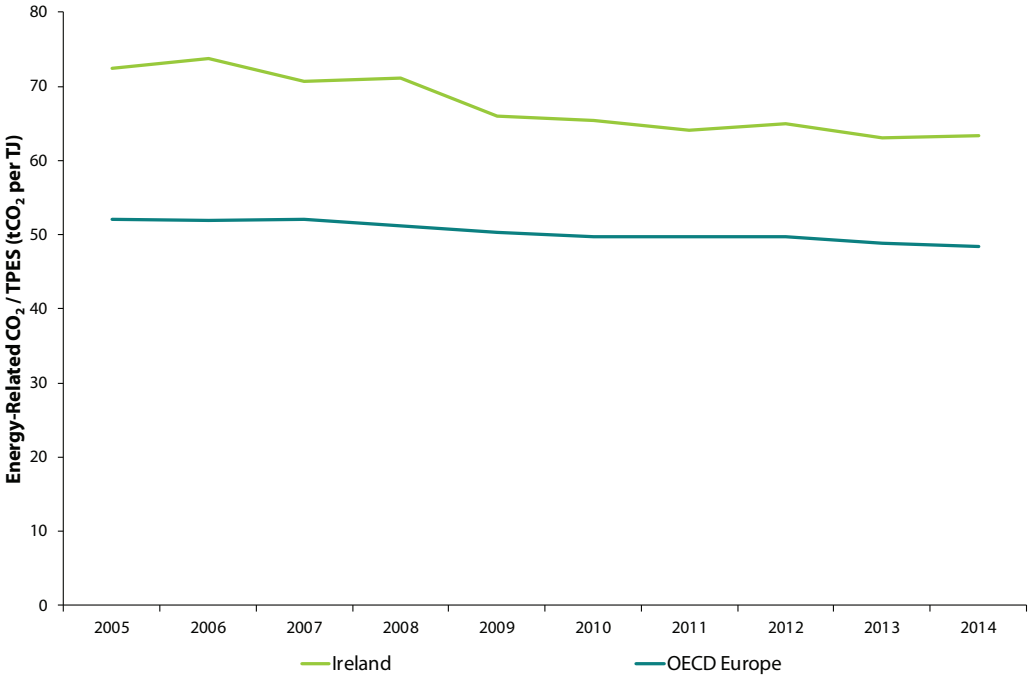
Emissions grew in all modes in 2015 compared with 2014, with transport, electricity and heat CO_2 emissions growing by 5.9%, 5.8% and 3.6% respectively.

3 Energy CO_2 Emissions Indicators

3.1 CO_2 Energy-related 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 terra joule (TJ) of total primary energy supply (TPES), and provides a comparison with the average in the OECD Europe[3]. Over the period 2005 – 2015 the emissions intensity in Ireland in terms of overall energy use fell by 12.6% to 63.3 tCO_2/TJ having peaked in 2006 at 73.8 tCO_2/TJ. Over the same period the intensity in OECD Europe fell by 7.1% to 48.4 tCO_2/TJ.

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) was higher than OECD Europe over the whole period, peaking at 42% above in 2006 and falling to 31% above in 2015. 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, and also the widespread use of district heating in many Nordic countries.

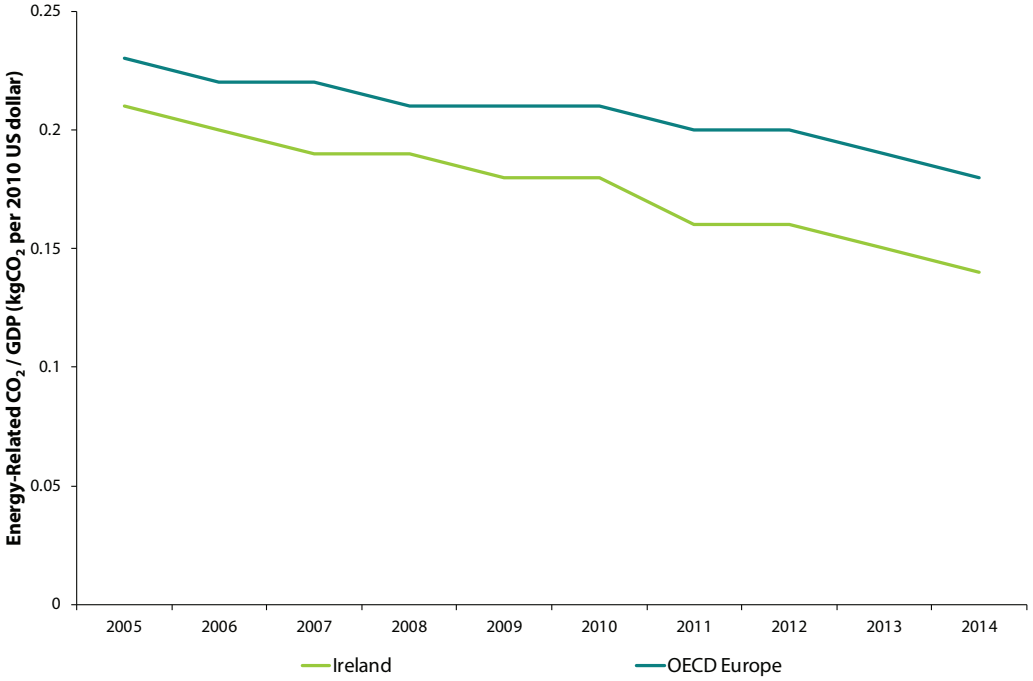
3.2 CO_2 Energy-related Emissions Intensity of Economic Growth

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 tonnes of CO_2 were emitted in Ireland to generate one dollar of GDP (in 2010 value), which was 9.1% below the level emitted in Europe. The emissions intensity in Ireland fell at a faster rate than in Europe over the period.

Between 2005 and 2014 the CO_2 emissions intensity of the economy in Ireland fell by 62% (1.4% per annum) to 0.14 tonnes per dollar and was 22% lower than the average intensity in OECD Europe in 2014. This decrease in intensity can be explained by a decline in the energy intensity of the Irish economy over the period. After 1990 energy intensity in Ireland fell by 54% as energy intensive industries such as steel manufacturing and sugar production ceased. Increasing generation efficiency in electricity production and a move away from solid fuel open fires in households have also contributed.

3 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*

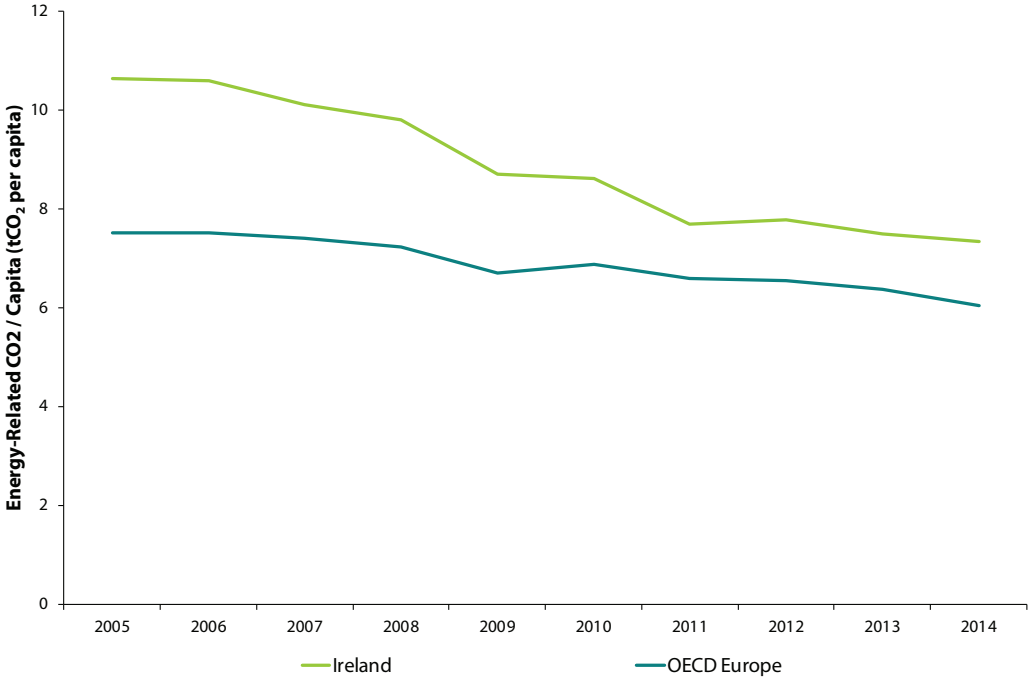


Source: International Energy Agency

3.3 CO_2 Energy-related 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 over the whole period but peaked in 2001 at 48% above. The intensity has fallen since, and in 2014 was 21% above the OECD Europe average. Between 2005 and 2014, Irish energy-related CO_2 emissions per capita fell by 31%, from 10.6 tonnes per capita in 2005 to 7.3 tonnes in 2014. Over the same period emissions per capita in Europe fell by 20%, 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, and presents CO_2 emissions only from the combustion of fuels for energy use.

CO_2 emissions from fuel combustion fell by 18.6% between 2005 and 2015 (*Table 3*) and accounted for approximately 60% of all GHG emissions in Ireland in 2014[4]. *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 2015 with the exception of natural gas, which saw CO_2 emissions increase by 8.3%. The CO_2 emissions associated with oil and coal fell by 28% and 24% respectively. Emissions from peat also decreased over the period by 3.9%.

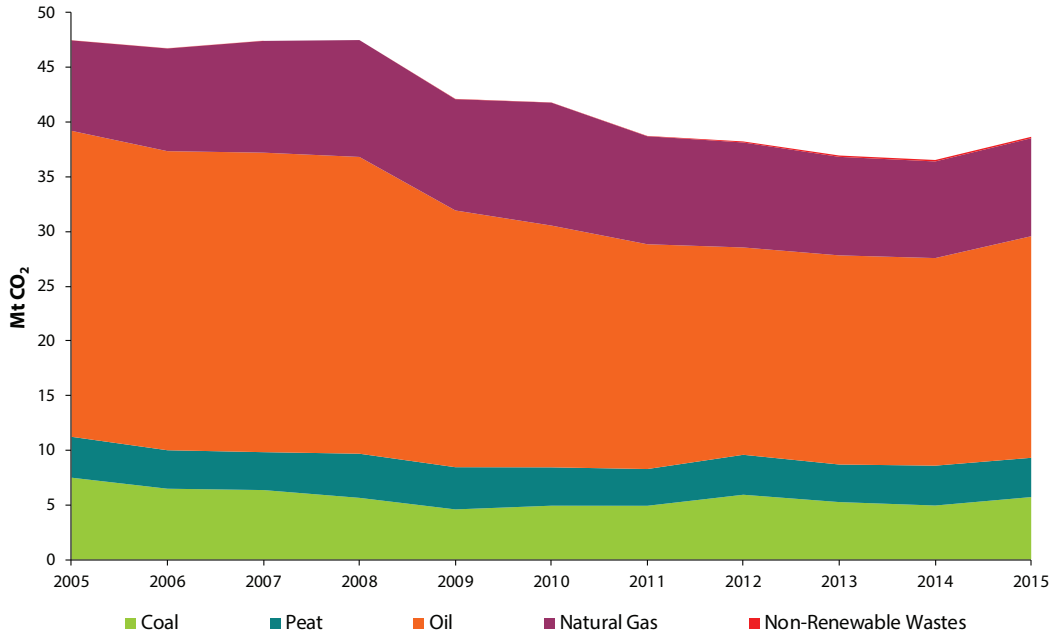
Oil accounted for the largest share of emissions in 2015, at 52%, followed by natural gas at 23%, coal at 15% and peat at 9.3%.

Table 3 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions by Fuel*[5]

	Growth %	Average annual growth rates %				Quantity ($ktCO_2$)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Coal	-24.2	-2.7	-8.1	3.0	15.6	7,463	5,658	15.7	14.7
Peat	-3.9	-0.4	-1.3	0.5	-1.5	3,738	3,591	7.9	9.3
Oil	-27.6	-3.2	-4.6	-1.7	6.7	27,982	20,265	59.0	52.5
Natural Gas	8.3	0.8	6.3	-4.4	1.4	8,270	8,961	17.4	23.2
Non-Renewable Waste	-	-	-	50.9	-1.6	0	131	0.0	0.3
Total	**-18.6**	**-2.0**	**-2.5**	**-1.6**	**5.8**	**47,453**	**38,606**		

Source: SEAI

Figure 6 *CO_2 Emissions from Fuel Use*



Source: SEAI

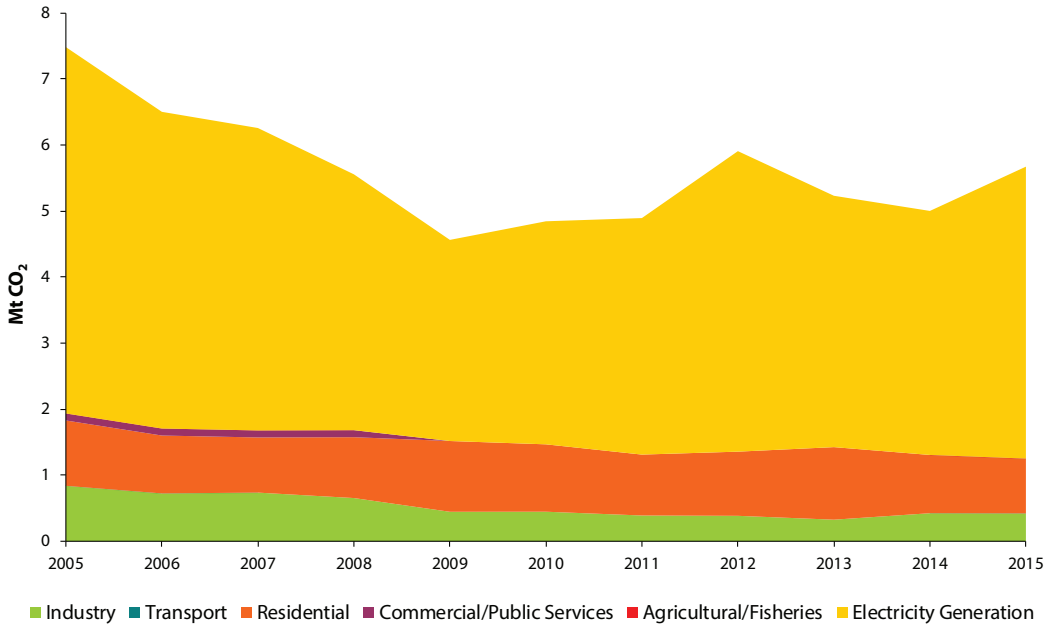
4.1 CO_2 Emissions from Coal

Coal use for energy in Ireland is concentrated in electricity generation, and accounted for 78% of the coal CO_2 emissions in 2015, up from 74% in 2005. The residential sector has the second highest share of emissions associated with coal combustion, at just under 15%, and industry accounts for 7.4%. *Figure 7* and *Table 4* show the trend in CO_2 emissions from coal use between 2005 and 2015.

4 At the time of writing data was only available for all GHG emissions up until 2014 from the EPA.

5 Note that there are some differences in the estimations of emissions when calculated by top-down overall fuel use and botton-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.

Figure 7 *CO_2 Emissions from Coal Use*



Source: SEAI

Overall CO_2 emissions from coal use have fallen by 24% (2.7% per annum), from 7.5 Mt in 2005 to 5.7 Mt in 2015. 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 CO_2 emissions reduction 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 Emissions Trading Scheme (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 4.4 Mt in 2015, still 20% lower than in 2005.

Table 4 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions from Coal*

	Growth %	Average annual growth rates %				Quantity ($ktCO_2$)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Industry	-49.8	-6.7	-11.8	-1.2	-0.7	838	421	11.2	7.4
Transport	-	-	-	-	-	0	0	0.0	0.0
Residential	-16.1	-1.7	0.6	-4.0	-5.8	989	831	13.2	14.6
Services	-100.0	-100.0	-100.0	-	-	106	0	1.4	0.0
Agriculture	-	-	-	-	-	0	0	0.0	0.0
Electricity Generation	-20.3	-2.2	-9.4	5.5	19.6	5,547	4,420	74.1	77.9

Source: SEAI

CO_2 emissions from coal use in the residential sector fell by 16% over the period 2005 – 2015 and accounted for 14.6% of coal associated CO_2 emissions in 2015. Reductions in coal use in households was partly driven by extensions to the Smoky Coal Ban in 2011, 2013 and 2015.

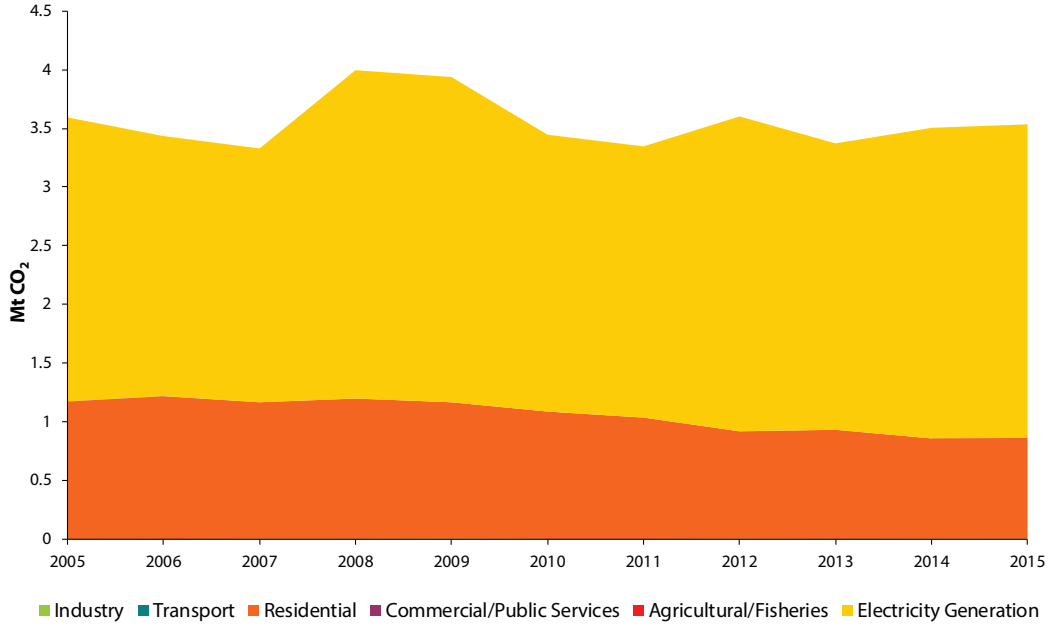
CO_2 emissions from coal use in industry accounted for 7.4% of coal emissions in 2015, and fell by 51% during the period 2005 – 2015. Coal use in industry is limited to a small number of sectors – mainly cement manufacture and to a lesser extent food processing. Some of the reduction in coal combustion in industry, and particularly in cement manufacturing, is driven by the increased use of renewable alternatives, such as meat and bone meal, the renewable portions of tyre-derived fuels and municipal waste.

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

Peat use for energy in Ireland, like coal, is concentrated in electricity generation, and accounted for 76% of peat CO_2 emissions in 2015, up from 67% in 2005. The residential sector has the second highest peat associated CO_2 emissions, at 24%, and industry accounts 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 2015.

Figure 8 *CO_2 Emissions from Peat Use*



Source: SEAI

Table 5 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions from Peat*

	Growth %	Average annual growth rates %				Quantity ($ktCO_2$)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Industry	113.8	7.9	3.3	12.7	18.5	2	4	0.1	0.1
Transport	-	-	-	-	-	0	0	0.0	0.0
Residential	-26.7	-3.1	-1.5	-4.6	0.3	1,170	858	32.6	24.3
Services	-100.0	-100.0	-100.0	-	-	2	0	0.1	0.0
Agriculture	-	-	-	-	-	0	0	0.0	0.0
Electricity Generation	10.4	1.0	-0.5	2.5	1.0	2,419	2,672	67.3	75.6

Source: SEAI

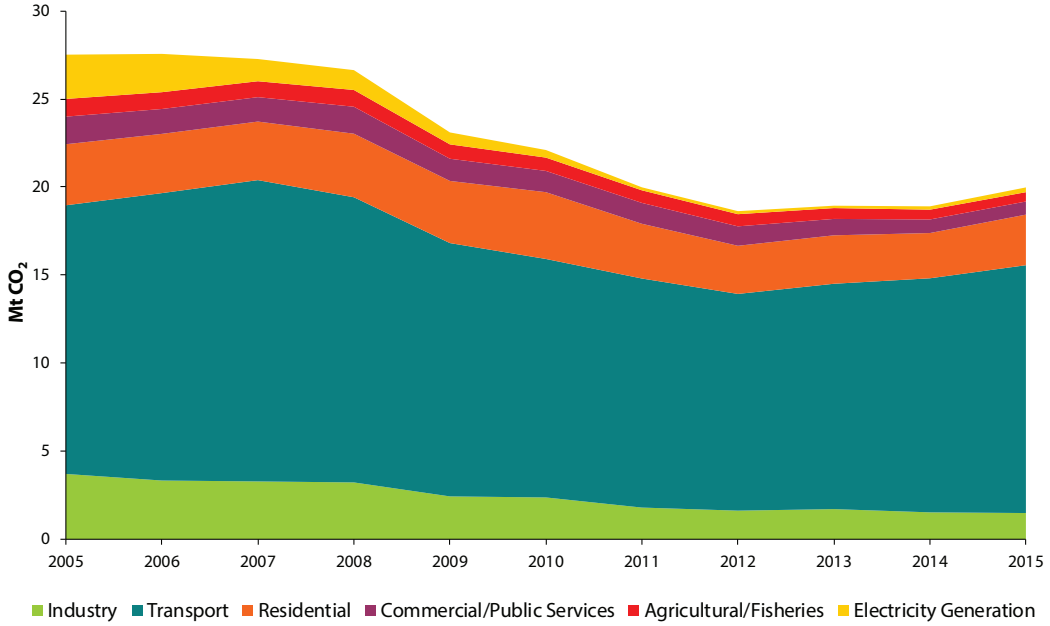
Overall CO_2 emissions from peat use have fallen by 3.9% (0.4% per annum) between 2005 and 2015, to 3.6 Mt. This can be explained by the fact that CO_2 emissions from peat use in electricity generation increased by 10.4%, to 2.7 Mt, between 2005 and 2015, and its share increased from 67% to 76%, while CO_2 emissions from peat use in the residential sector fell by 27% between 2005 and 2015.

4.3 CO_2 Emissions from Oil

Energy-related CO_2 emissions from oil use are spread across all sectors but are concentrated in the transport sector where they accounted for 70% of oil-related CO_2 emissions in 2015. The residential sector is the next largest at 14.3%, and then industry at 7.5%. Emissions from oil in services and agriculture were 3.7% and 2.7% respectively in 2015 and oil emissions in electricity generation have declined over time to just 1.4%, from a peak of 18% in 1999.

Overall CO_2 emissions from oil use decreased by 28% (3.2% per annum), to 3.4 Mt, between 2005 and 2015. However CO_2 emissions from oil increased by 5.7% in 2015 when compared with 2014.

Figure 9 *CO_2 Emissions from Oil Use*



Source: SEAI

Table 6 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions from Oil*

	Growth %	Average annual growth rates %				Quantity ($ktCO_2$)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Industry	-59.8	-8.7	-8.5	-8.9	-1.9	3,706	1,491	13.5	7.5
Transport	-7.8	-0.8	-2.4	0.8	5.9	15,256	14,073	55.4	70.5
Residential	-17.4	-1.9	1.8	-5.5	11.4	3,467	2,863	12.6	14.3
Services	-52.5	-7.2	-5.1	-9.2	-3.2	1,567	745	5.7	3.7
Agriculture	-47.3	-6.2	-5.5	-6.9	-4.8	1,005	530	3.7	2.7
Electricity Generation	-89.3	-20.0	-29.7	-8.9	43.5	2,513	270	9.1	1.4

Source: SEAI

The largest share of emissions from oil use is in the transport sector where, in 2015, 97% of energy use in the sector was petroleum related. CO_2 emissions from oil use in transport fell by 7.8% between 2005 and 2015, to 14.1 Mt. Much of the decrease in emissions associated with oil use in the transport sector occurred between 2007 and 2012 due to the economic recession. In addition, some of the reduction can also be attributed to improvements in fuel efficiency and the lowering of the CO_2 intensity of new private cars (the average CO_2 emissions of new private cars has declined by 31% since 2007). The use of bioethanol and biodiesel blended with petrol and diesel respectively have also contributed to the reduction since 2005.

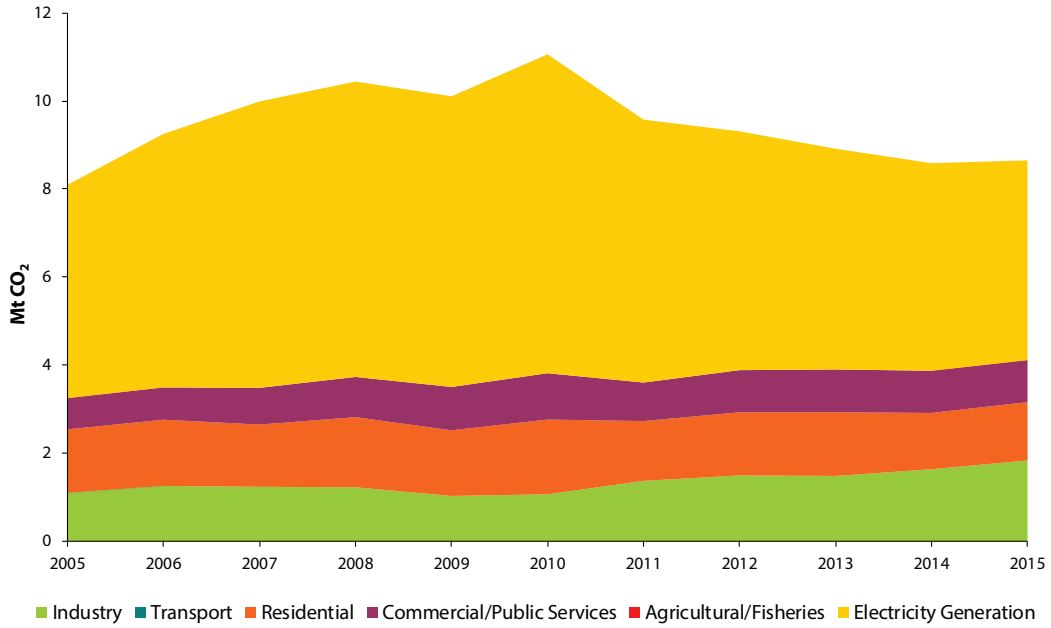
CO_2 emissions from oil use also fell in the residential sector, going from 3.5 Mt to 2.9 Mt between 2005 and 2015, a decrease of 17%. Its share grew from 13% to 14% over the same period. The decline in emissions related to oil use in the residential sector is underpinned by improvements to the thermal 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, a small degree of fuel switching saw the share of oil use in households fall from making up 39% to 36% of the residential sector energy use.

CO_2 emissions from all other sectors fell over the period with oil use in electricity generation decreasing the most from 2.5 Mt in 2005 to 0.3 Mt in 2015, a drop of 89%. CO_2 emissions fell in industry, services and agriculture by 60%, 52% and 47% 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 2015, 52% of CO_2 emissions from the use of natural gas occurred in electricity generation, down from 60% in 2005. A little over one fifth (21%) was accounted for by industry, 15% by households in the residential sector, and 11% in services. To date, a negligible amount of natural gas, in the form of compressed natural gas (CNG), is used in transport.

Figure 10 *CO_2 Emissions from Natural Gas Use*



Source: SEAI

Overall CO_2 emissions from natural gas use grew by 8.6% between 2005 and 2015, to 9 Mt. This was driven by an increase in natural gas use in the industry and services sectors, where associated emissions increased by 67% and 35% respectively over the period. Emissions grew by 1% in 2015 when compared with 2014.

Table 7 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions from Gas*

	Growth %	Average annual growth rates %				Quantity ($ktCO_2$)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Industry	66.8	5.2	-0.6	11.4	12.6	1,098	1,831	13.6	21.2
Transport	-	-	-	-	-45.1	0	0	0.0	0.0
Residential	-8.3	-0.9	3.3	-4.9	4.0	1,443	1,323	17.8	15.3
Services	34.1	3.0	8.2	-2.0	-0.1	710	952	8.8	11.0
Agriculture	-	-	-	-	-	0	0	0.0	0.0
Electricity Generation	-6.4	-0.7	8.4	-8.9	-3.8	4,846	4,535	59.8	52.5

Source: SEAI

Emissions of CO_2 from gas use in electricity generation fell by 6.4% between 2005 and 2015, to 4.5 Mt. This decrease was driven by increases in the efficiency of gas generation as a result of commissioning a number of CCGT plants 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.

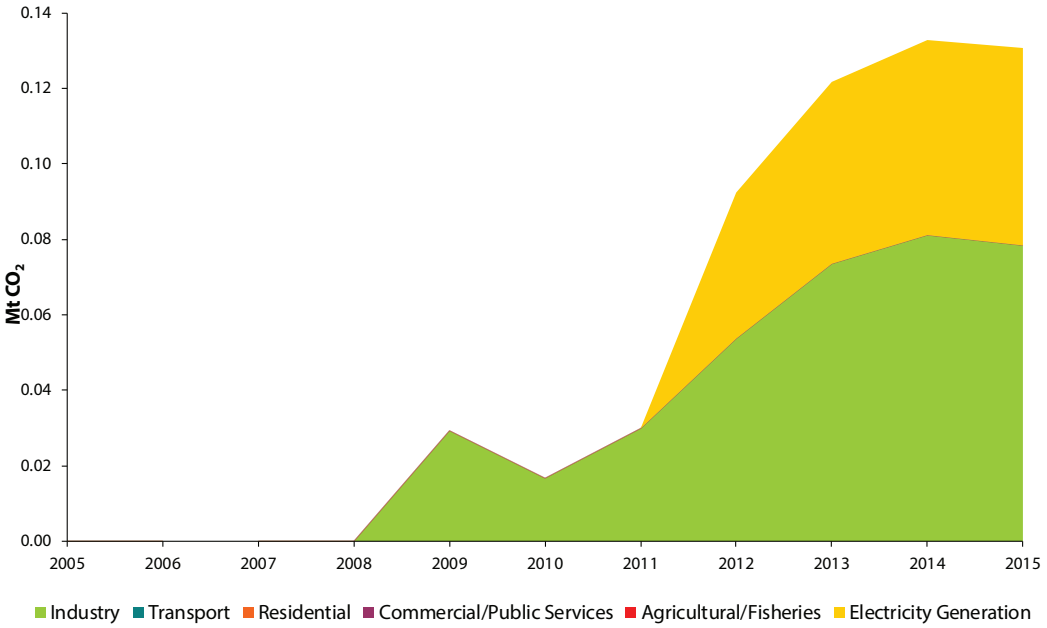
Emissions from natural gas use in the residential sector fell by 8.3% between 2005 and 2015, to 1.3 Mt, due to improvements in the thermal efficiency of the housing stock and energy efficiency gains from SEAI's energy efficiency programmes.

4.5 CO_2 Emissions from Non-Renewable Wastes

Energy from non-renewable wastes is only used in electricity generation and industry. There is currently 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 2015, 151 GWh of electricity was produced from waste incineration and emitted an estimated 52 kt CO_2.

In industry non-renewable waste use is concentrated in the cement industry and consists of meat and bonemeal and the non-renewable portions of municipal waste and tyre-derived fuels. Emissions from this source in 2015 amounted to 78 kt CO_2.

Figure 11 *CO_2 Emissions from Non-Renewable Wastes Use*



Source: SEAI

Table 8 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions from Non-Renewable Wastes*

	Growth %	Average annual growth rates %				Quantity ($ktCO_2$)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Industry	-	-	-	36.2	-3.4	-	78	-	60.0
Transport	-	-	-	-	-	-	0	-	0.0
Residential	-	-	-	-	-	-	0	-	0.0
Services	-	-	-	-	-	-	0	-	0.0
Agriculture	-	-	-	-	-	-	0	-	0.0
Electricity Generation	-	-	-	-	1.2	-	52	-	40.0

Source: SEAI

5 Sectoral Energy-Related CO_2 Emissions

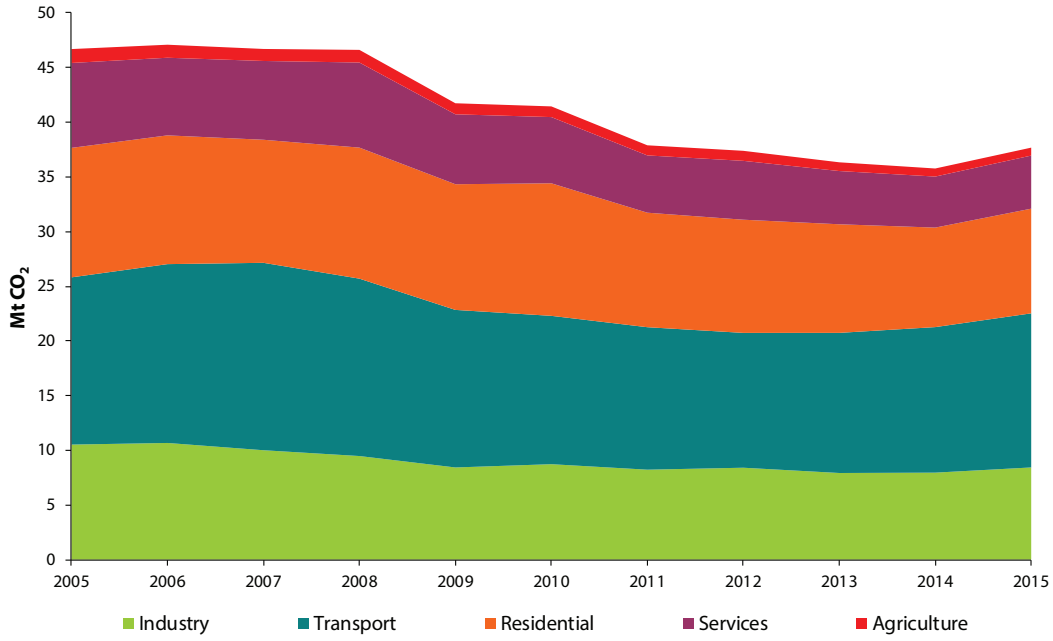
The sectoral energy-related CO_2 emissions presented in this section are based on the economic sectoral disaggregation contained in the energy balance, with the upstream emissions from electricity generation and other energy transformations allocated to the economic sectors where that electricity is used. This differs from the way in which national GHG emissions inventories are reported by the 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 2015 were 18.6% 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 2015, up from 33% in 2005. The residential sector accounted for the second largest share in 2015, at 25%, followed by industry at 22% and services at 13%. Energy-related CO_2 emissions in agriculture/fisheries accounted for just 2.1%.

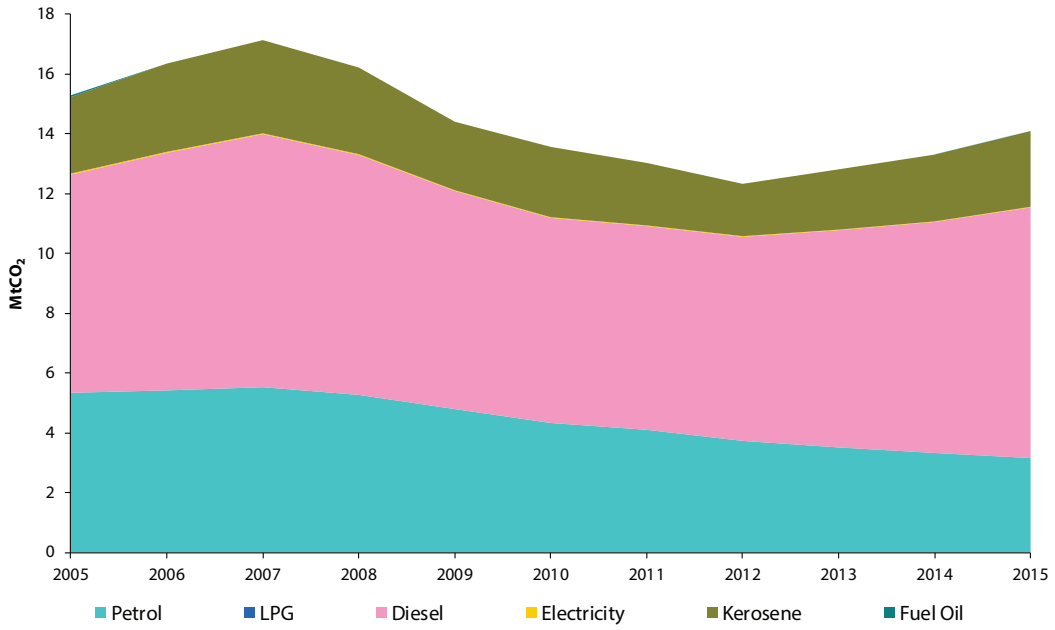
Table 9 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions by Sector*

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Industry	-19.9	-2.2	-3.7	-0.7	6.2	10,519	8,430	22.5	22.3
Transport	-7.9	-0.8	-2.4	0.8	5.9	15,293	14,092	32.7	37.4
Residential	-19.3	-2.1	0.5	-4.6	5.2	11,843	9,561	25.3	25.3
Services	-37.5	-4.6	-4.8	-4.3	4.2	7,764	4,853	16.6	12.9
Agriculture/Fisheries	-44.1	-5.6	-5.7	-5.5	-2.6	1,414	791	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 arose almost wholly from the use of petroleum products (97% in 2015) 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 60% of transport emissions in 2015, is used across multiple modes of transport, such as cars, light and heavy goods transport on roads, rail and water transport.

Table 10 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions in Transport*

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Total Oil Products	-7.8	-0.8	-2.4	0.8	5.9	15,256	14,073	99.8	99.9
Petrol	-41.0	-5.1	-4.1	-6.2	-5.2	5,337	3,148	34.9	22.3
Diesel	14.9	1.4	-1.2	4.1	8.5	7,299	8,388	47.7	59.5
Jet Kerosene	-1.2	-0.1	-1.7	1.5	13.2	2,562	2,530	16.8	18.0
LPG	148.4	9.5	-12.8	37.5	20.0	3	7	0.0	0.0
Electricity	-48.7	-6.5	-8.4	-4.5	7.8	37	19	0.2	0.1
Total	**-7.9**	**-0.8**	**-2.4**	**0.8**	**5.9**	**15,293**	**14,092**		

Source: SEAI

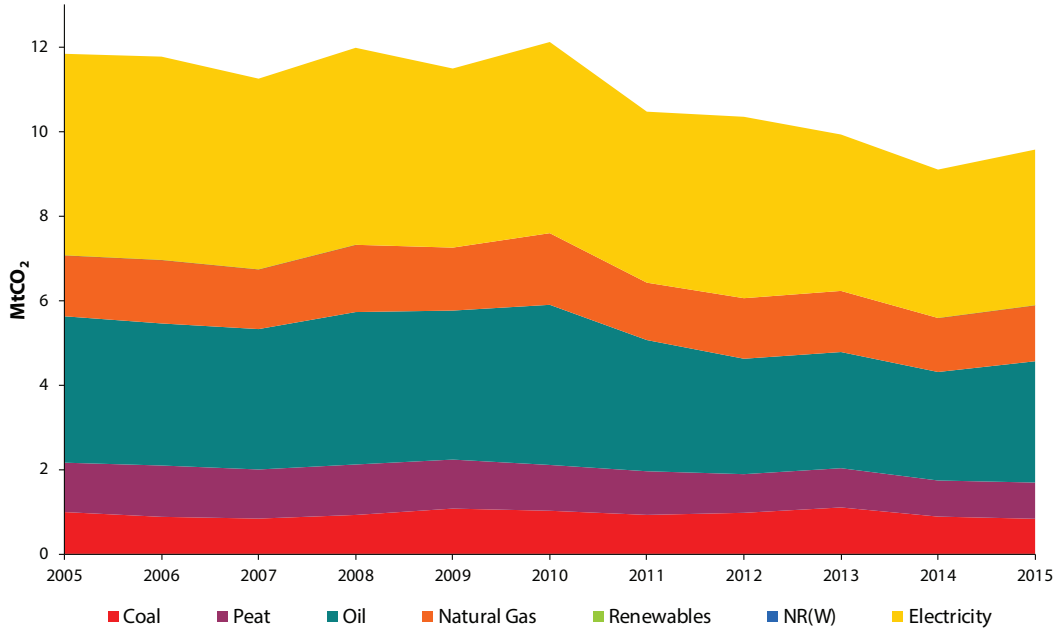
In 2015 the transport energy-related CO_2 emissions were 14,092 kt, which represented 37% of the total energy-related CO_2 emissions. Over the period 2005 – 2015 energy-related CO_2 emissions in transport decreased by 7.9% (0.8% per annum) to 14 Mt. Emissions peaked in 2007 at 17.1 Mt and fell rapidly during the economic downturn, to 12.3 Mt in 2012, a fall of 28%. Between 2012 and 2015 emissions increased again by 14%.

Over the period there was a change in the fuel mix, particularly in relation to petrol and diesel. This was as a result of the change in the taxation regime for private cars, from being based on engine size to being based on CO_2 emissions. In 2005, petrol accounted for 35% of transport CO_2 emissions and this fell to 22% in 2015. In absolute terms, petrol CO_2 emissions fell by 41% over the period to 3.1 Mt. Similarly, diesel accounted for 48% of the emissions in 2005, which rose to 60% in 2015 and, in absolute terms, diesel CO_2 emissions increased by 15% to 8.4 Mt.

5.1.2 Household Energy-Related CO_2 Emissions

In 2015 residential sector energy-related CO_2 emissions (including upstream electricity emissions) were 9,561 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 5.3% higher in 2015 compared with 2014.

Figure 14 *Household Energy-Related CO_2 Emissions*



Source: SEAI

Over the period 2005 – 2015 energy-related CO_2 emissions[6] from the residential sector fell by 19.3% (2.1% 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 16.9% compared with 2005, while over the same period the number of households increased by 25%.

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

Table 11 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions in the Residential Sector*

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Coal	-16.1	-1.7	0.6	-4.0	-5.8	989	831	8.4	8.7
Peat	-26.7	-3.1	-1.5	-4.6	0.3	1,170	858	9.9	9.0
Briquettes	-19.3	-2.1	-0.5	-3.7	0.9	374	302	3.2	3.2
Oil	-17.4	-1.9	1.8	-5.5	11.4	3,467	2,863	29.3	29.9
Gas	-8.3	-0.9	3.3	-4.9	4.0	1,443	1,323	12.2	13.8
Combustible Fuels (Total)	-16.9	-1.8	1.4	-5.0	5.3	7,069	5,874	59.7	61.4
Electricity	-22.8	-2.5	-1.1	-4.0	4.9	4,773	3,687	40.3	38.5
Total	**-19.3**	**-2.1**	**0.5**	**-4.6**	**5.2**	**11,843**	**9,561**		

Source: SEAI

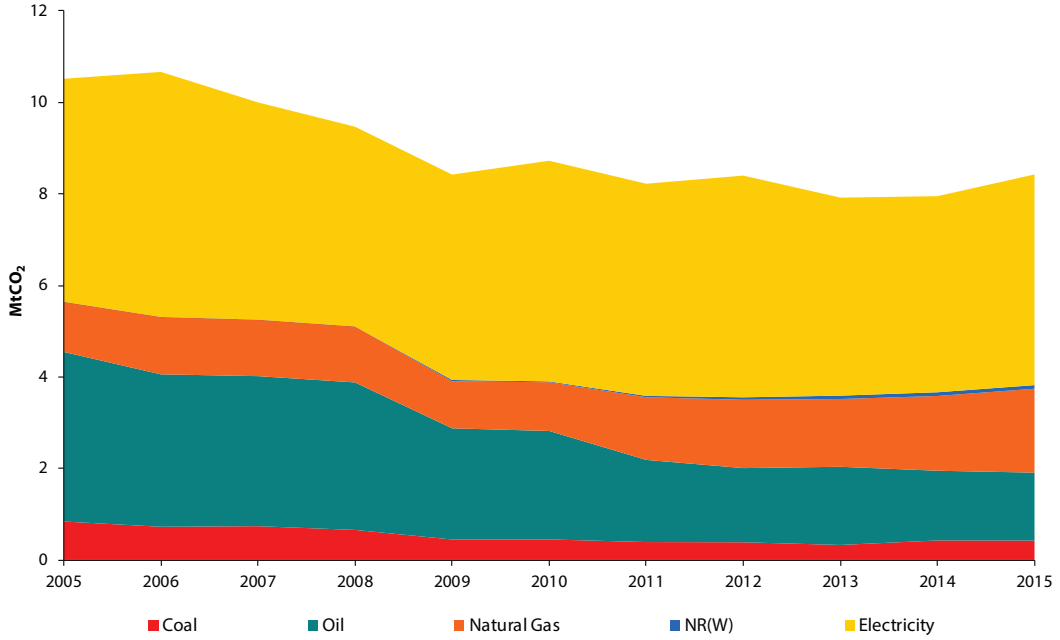
Between 2005 and 2015 the number of households in Ireland increased by 25% while the energy use in the sector fell by 9% (12.7% fall when corrected for weather effects) and emissions fell by 16.7%. This meant that the unit energy-related CO_2 emissions per household fell by 35% over the period, this 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 the period. Overall unit CO_2 emissions decreased to 5.1 tCO_2/household. Some of the reduction is also accounted for by the lowering of the CO_2 intensity of electricity. Unit emissions from upstream electricity emissions fell by 38% over the period, to 2.1 tCO_2/household. Unit emissions from the direct use of fossil fuels in households fell by 33% over the period, to 3.4 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 – 2015 overall energy-related CO_2 emissions in industry fell by 20% (2.2% per annum) to 8.4 Mt. Industry CO_2 emissions peaked in 2001 at 11.6 Mt.

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

Figure 15 *Industry Energy-Related CO_2 Emissions*



Source: SEAI

Economic activity, as measured by gross value added (GVA) of industry, fell by 3% between 2005 and 2014 but increased by 91% if the period is extended to 2015. The large increase in GVA in 2015 (98%) is explained by a number of one-off factors such as the transfer of assets into Ireland and what are known as reverse takeovers. This increase in GVA incurred no additional energy consumption.

Table 12 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions in Industry*

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Coal	-49.8	-6.7	-11.8	-1.2	-0.6	838	421	8.0	5.0
Oil Total	-59.8	-8.7	-8.5	-8.9	-1.9	3,706	1,491	35.2	17.7
Kerosene	-30.9	-3.6	-2.0	-5.2	15.8	372	257	3.5	3.1
Fuel Oil	-91.3	-21.7	-8.0	-33.4	-45.5	1,502	130	14.3	1.5
LPG	2.7	0.3	-0.1	0.6	1.5	275	282	2.6	3.3
Gas Oil	-46.0	-6.0	-4.6	-7.3	-3.7	609	329	5.8	3.9
Petroleum Coke	-47.8	-6.3	-21.3	11.5	12.0	944	493	9.0	5.8
Natural Gas	66.8	5.2	-0.6	11.4	12.6	1,098	1,831	10.4	21.7
Non-Renewable (Wastes)	-	-	-	36.2	-3.4	-	78	0.0	0.9
Total Combustible Fuels	-32.2	-3.8	-7.1	-0.4	4.7	5,644	3,825	53.6	45.4
Electricity	-5.6	-0.6	-0.2	-0.9	7.5	4,876	4,605	46.4	54.6
Overall Total	**-19.9**	**-2.2**	**-3.7**	**-0.7**	**6.2**	**10,519**	**8,430**		

Source: SEAI

As detailed in *Table 12*, industrial energy-related CO_2 emissions associated with electricity consumption were responsible for 55% of industry's energy-related emissions in 2015. Electricity is indirectly responsible for more than half of CO_2 emissions in industry, more than all the other fuels used by industry combined.

If upstream electricity-related emissions are omitted then there was a 32% decrease in CO_2 emissions from combustible fuels used on-site in industry between 2005 and 2015. Some of the reduction is as a result of lower overall energy use in industry, which fell by 8.9% over the period. In addition, there have been changes in the fuel mix used for industry over the period. In 2005, oil accounted for 35% of the emissions and this dropped to 18% in 2015. 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 1.5% in 2015. This was as a result of fuel switching in alumina production from the direct use of heavy fuel to an indirect and more efficient use of natural gas in combined heat and power production.

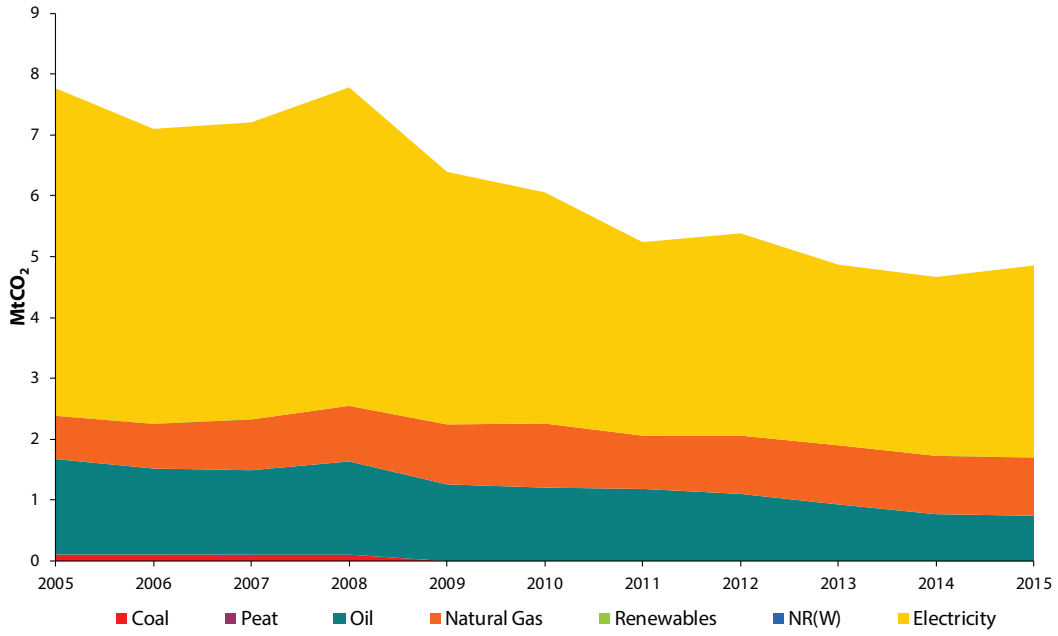
Natural gas, a lower emissions fuel, increased its share in industry energy-related CO_2 emissions from 10% to 22% over the period. The renewable energy share of final energy consumption also grew slightly, accounting for 7.3% of industry demand in 2015 compared with 6.2% in 2005.

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. Overall, CO_2 emissions from fuel combustion in the services sector decreased by 29% between 2005 and 2015. In addition, the emissions associated with electricity consumption fell by 41%, this was driven by both a 20% reduction in electricity demand in services over the period and a reduction in the emissions intensity of electricity generation. During this period, employment in services increased by 12% and the value added generated in services increased by 32%[7].

In 2015 non-electricity emissions decreased by 1.7% and the electricity associated emissions in services increased by 7.5%. Overall energy-related CO_2 emissions in this sector increased by 4.1% in 2015 to 4.9 Mt CO_2. Energy-related CO_2 emissions in services peaked in 2003 at 7.9 Mt, and have fallen by 39% since then.

Figure 16 *Services Energy-Related CO_2 Emissions*



Source: SEAI

In the services sector, the range of energy sources is smaller than in industry or households. Coal has ceased to be used to any extent since 2008 with just three energy sources remaining, namely oil, natural gas and electricity. Over the period 2005 – 2015 there has been significant fuel switching between oil and gas with the share of emissions from oil in the services fuel mix falling from 20% to 15%, and that of gas increasing from 9.1% to 20%. This fuel switching, together with a 21% reduction in combustible fuel use in services over the period, has contributed to the 29% reduction in CO_2 emissions from fuel use.

Table 13 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions in the Services Sector*

	Growth %	Average annual growth rates %				Quantity (kt)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Coal	-100.0	-100.0	-100.0	-	-	106	-	1.4	0.0
Oil	-52.5	-7.2	-5.1	-9.2	-3.3	1,567	745	20.2	15.3
Gas	34.1	3.0	8.2	-2.0	-0.1	710	952	9.1	19.6
Electricity	-41.3	-5.2	-6.7	-3.6	7.5	5,379	3,156	69.3	65.0
Total	**-37.5**	**-4.6**	**-4.8**	**-4.3**	**4.1**	**7,764**	**4,853**		

Source: SEAI

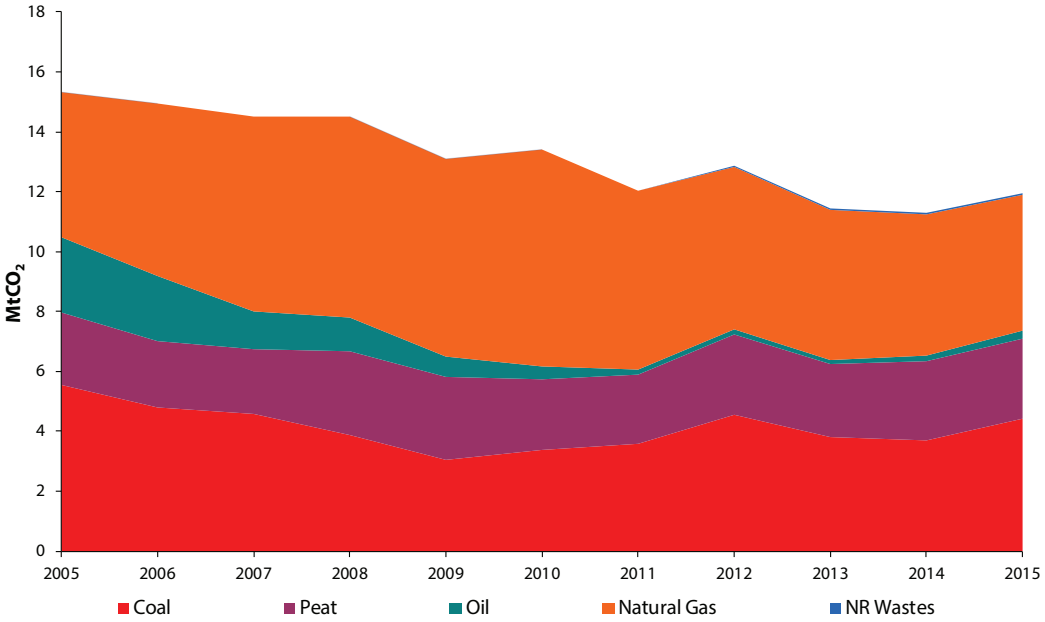
5.2 Energy-Related CO_2 Emissions from Electricity Generation

Figure 17 shows the trend in emissions from fuel combustion in electricity generation over the period 2005 – 2015, which saw CO_2 emissions from fuels used in electricity generation fall by 22% to 12 Mt. *Table 14* shows the growth

7 See http://www.cso.ie/px/pxeirestat/Database/eirestat/Quarterly%20National%20Household%20Survey%20Main%20Results/Quarterly%20National%20Household%20Survey%20Main%20Results_statbank.asp?SP=Quarterly National Household Survey Main Results&Planguage=0

rates, quantities and shares of emissions from fuel combustion in electricity generation. Emissions have fallen from all fuel sources with the exception of peat, which grew by 10.4% over the period and its share in emissions grew from 15% to 22%.

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, but its share grew from 32% in 2005 to 38% in 2015. The share of emissions from coal in electricity generation remained relatively stable over the period, increasing only very slightly from 36.2% to 37% but in absolute terms coal emissions fell by 20% over the period, to 4.4 Mt.

Emissions from coal, peat and oil grew in 2015 compared with 2014, by 19.6%, 1% and 44% respectively while natural gas emissions fell by 3.8%.

Table 14 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions in Electricity Generation*

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Fossil Fuels (Total)	-22.4	-2.5	-2.6	-2.4	5.8	15,325	11,895	100.0	99.6
Coal	-20.3	-2.2	-9.4	5.5	19.6	5,547	4,420	36.2	37.0
Peat	10.4	1.0	-0.5	2.5	1.0	2,419	2,672	15.8	22.4
Oil (Total)	-89.3	-20.0	-29.8	-9.0	43.7	2,513	268	16.4	2.2
Fuel Oil	-91.9	-22.2	-32.1	-10.9	22.4	2,283	185	14.9	1.5
Gas Oil and Refinery Gas	-72.0	-11.9	-17.4	-6.2	152.5	208	58	1.4	0.5
Gas	-6.4	-0.7	8.4	-8.9	-3.8	4,846	4,535	31.6	38.0
Non-Renewable (Wastes)	-	-	-	-	1.2	-	52	-	0.4
Total	**-22.0**	**-2.5**	**-2.6**	**-2.3**	**5.8**	**15,325**	**11,947**		

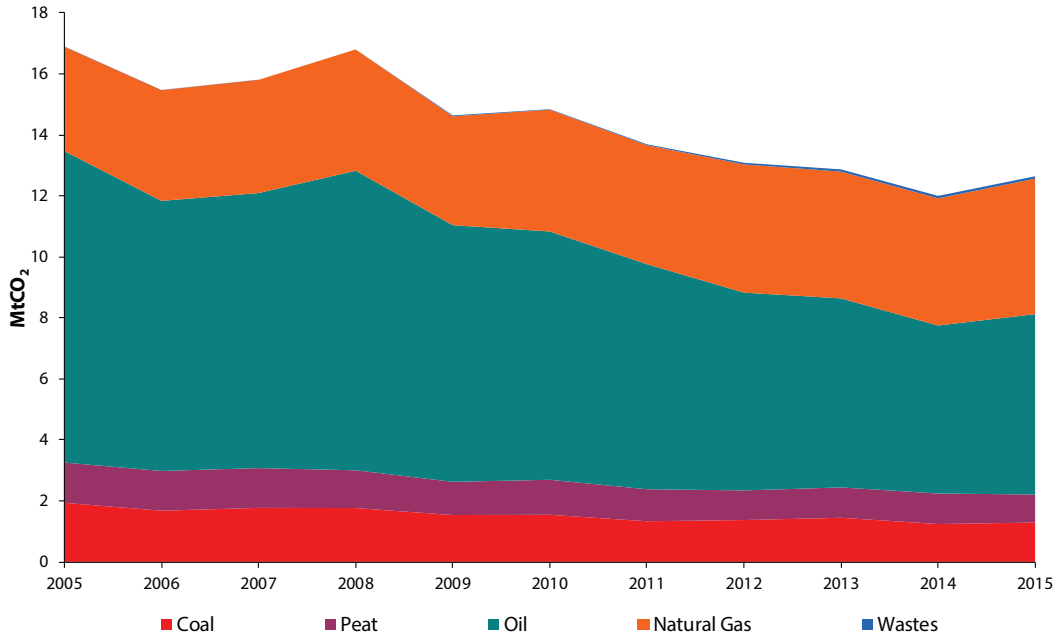
Source: SEAI

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, process heating in industry and cooking. It is essentially the non-transport and non-electricity final energy use.

Figure 18 shows the trend in energy-related CO_2 emissions from heat demand between 2005 and 2015. The largest share of energy-related CO_2 emissions from heat were from oil, at 47%, in 2015 and the second largest was from natural gas. In 2005 the share of emissions from gas was 20%, up from just 9.5% in 1990. The share of emissions from coal and peat were 11.5% and 7.8% respectively in 2005 but have fallen slightly to 10.2% and 7.3% respectively in 2015 as a result of lower usage of these fuels in the residential sector.

Figure 18 *Heat CO_2 Emissions by Fuel*



Source: SEAI

CO_2 emissions from the use of fossil fuels for heat fell by 25% between 2005 and 2015, from 16.9 Mt to 12.6 Mt. Overall energy-related CO_2 emissions from heat grew by 5.7% in 2015.

Over the period, emissions from coal, peat and oil fell by 33%, 30% and 42% respectively while emissions from natural gas grew by 29% to 4.4 Mt.

Table 15 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions in Heat*

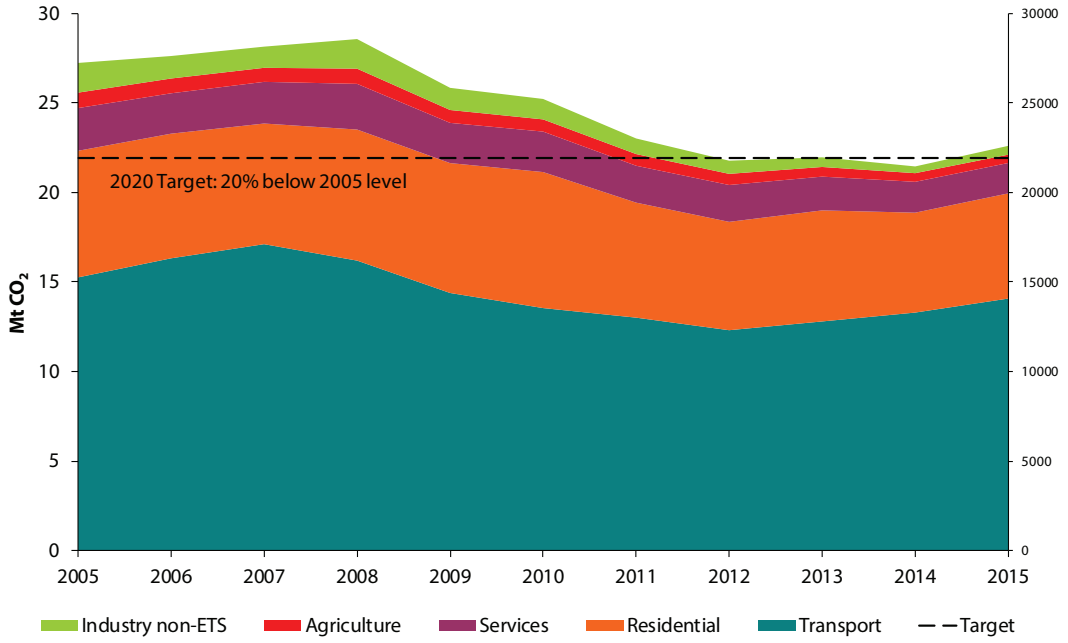
	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Coal	-33.5	-4.0	-4.4	-3.5	3.9	1,936	1,288	11.5	10.2
Peat	-30.3	-3.5	-2.7	-4.4	-8.1	1,319	919	7.8	7.3
Oil	-42.0	-5.3	-4.4	-6.2	7.6	10,213	5,923	60.5	46.9
Natural Gas	29.2	2.6	3.1	2.1	7.3	3,425	4,426	20.3	35.0
Wastes	-	-	-	36.2	-3.4	0	78	0.0	0.6
Total	**-25.2**	**-2.9**	**-2.5**	**-3.2**	**5.7**	**16,892**	**12,635**		

Source: SEAI

6 ETS/non-ETS Energy-Related CO_2 Emissions

Given the policy focus on the non-ETS[8], *Figure 19* 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 usage by these sectors as these emissions are included in the EU ETS.

Figure 19 *Non-Emissions Trading Energy-Related CO_2*



Source: SEAI

Non-ETS energy-related CO_2 emissions fell by 16% between 2005 and 2015, from 27 Mt to 23 Mt. In 2015 CO_2 emissions in this sector increased by 5.3% when compared with the previous year due to increases in the transport and residential sectors and the portion of industry outside of ETS. The non-ETS sector has a target for GHG emissions to be 20% below 2005 levels by 2020. In this sector the CO_2 emissions presented here dipped below this target in 2012 and 2014 but increased in 2015 to 3.5% above.

Table 16 *Growth Rates, Quantities and Shares of Energy-Related CO_2 Emissions ETS and non-ETS*

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
ETS CO_2	-22.7	-2.5	-3.6	-1.5	5.4	19,460	15,051	41.6	39.9
non-ETS CO_2	-17.2	-1.9	-1.6	-2.2	5.3	27,374	22,664	58.4	60.1
Total CO_2	**-18.6**	**-2.0**	**-2.5**	**-1.6**	**5.8**	**47,453**	**38,606**		

Source: SEAI

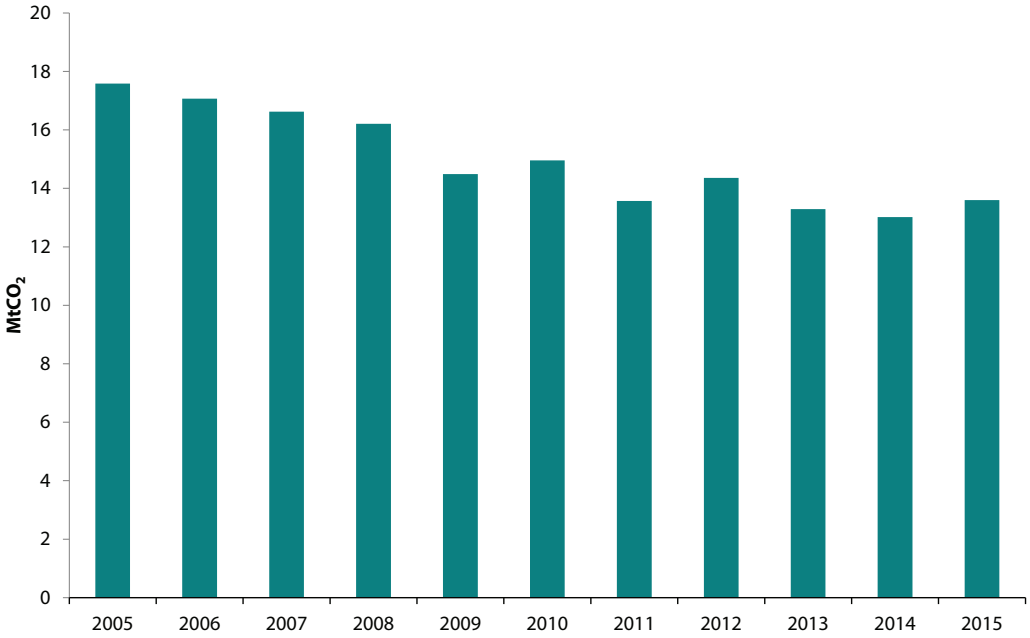
Figure 20 shows the trend in emissions from fuel combustion from those installations included in the EU ETS in Ireland since 2005. CO_2 emissions in the ETS fell by 24% (2.7% per annum) between 2005 and 2015, from 20 Mt to 15 Mt. In 2015 emissions increased by 5.1% when compared with the previous year. According to the EPA[9] emissions of GHGs (CO_2 and other GHGs from energy and process emissions) from Irish companies in the EU ETS in 2015 increased by 5.5% overall compared to 2014. The increase was due to:

- Emissions from the power generation sector increased by 5.3%. The greater use of the coal-fired plant at Moneypoint for electricity generation in 2015 (an increase of 20% in emissions) was the main factor in the overall national increase in power generation emissions.
- Cement industry emissions increased by 10.8%.
- Aviation emissions increased by 11%. In the aviation sector growth was 11%, due to growth in business across the EEA of flights by Irish-registered carriers. Aviation emissions have been included in the scheme since 2012.

8 EU Decision 406/2009/EC.

9 EPA press release; GHG emissions from Ireland's ETS sector increased in 2015, http://www.epa.ie/newsandevents/news/pressreleases2016/name,59180,en.html

Figure 20 *Emissions Trading Scheme Emissions from Fuel Combustion – Ireland*



Source: European Environment Agency based on EPA data

7 Avoided CO_2 Emissions from Renewable Energy

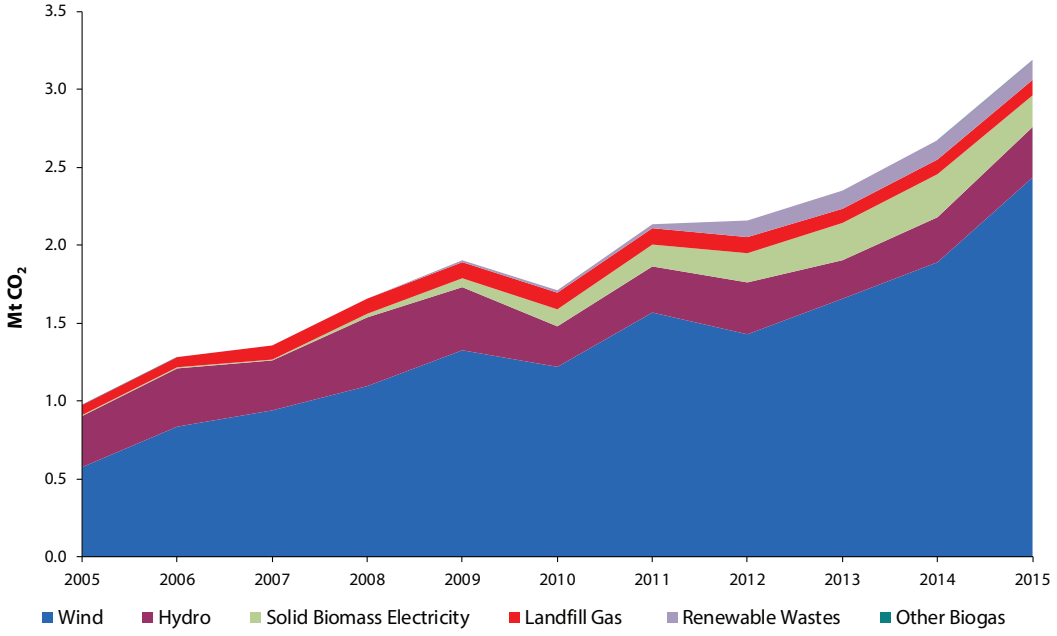
The use of renewable energy is seen as an important tool in terms of reducing GHG emissions and improving energy security by displacing the use of fossil fuels and energy imports. This section presents the current estimates of avoided emissions through the use of renewable energies in electricity generation,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

7.1 Avoided CO_2 Emissions from Electricity Generation

The avoided carbon emissions and displacement of fossil fuel imports by renewable energy generation are estimated using the Primary Energy Equivalent approach. The results obtained using this methodology have been further refined, using the results of a more detailed dispatch model of the operation of the entire all-island electricity system in the year 2012, so that the effects of ramping and cycling of fossil fuel plants are accounted for[10].

Figure 21 shows the trend in avoided CO_2 emissions from renewable energy for the period 2005 – 2015. The estimated amount of CO_2 avoided from renewable energy use in electricity generation increased by 226% over the period 2005 – 2015, reaching 3,188 kt CO_2 as illustrated in *Figure 21* and *Table 17*. The emissions avoided from wind were most significant again in 2015, at 2,436 kt CO_2, followed by hydro at 323 kt CO_2, and solid biomass at 203 kt CO_2.

Figure 21 *Avoided CO_2 Emissions from Renewable Energy in Electricity Generation*



Source: SEAI

In relation to the displacement of fossil fuels by renewable energy, it is estimated that in 2014 approximately €255 million in fossil fuel imports were avoided, of which €200 million was avoided by wind generation. The displacement of fuel imports is calculated by estimating how much extra fossil fuel would have had to be imported had there been no renewable generation in 2014. 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.

10 See the 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.

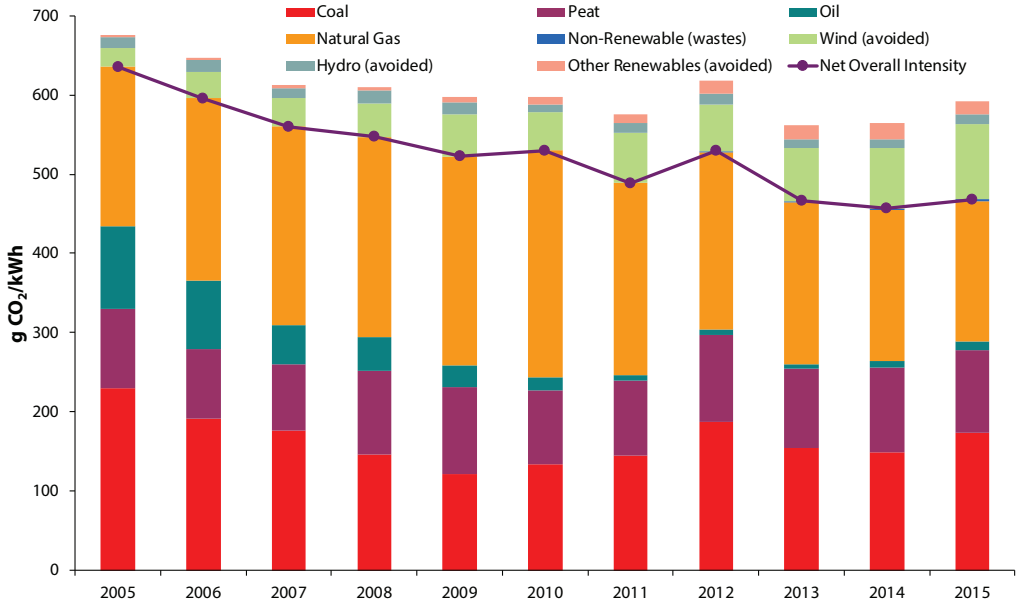
Table 17 *Growth Rates, Quantities and Shares of Avoided CO_2 Emissions from Renewable Energy in Electricity Generation*

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Wind	321.9	11.1	16.2	14.8	28.8	577	2,436	59.1	76.4
Hydro	-1.5	-2.8	-4.5	4.4	11.9	328	323	33.6	10.1
Solid Biomass Electricity	52.4	3.4	10.4	-1.5	5.4	65	99	6.7	3.1
Landfill Gas	3087.6	43.7	76.5	13.2	-26.4	6	203	0.7	6.4
Other Biogas	-	-	-	-	-	-	-	-	-
Renewable Wastes	-	-	-	52.5	2.3	-	127	-	4.0
Total	**226.5**	**9.2**	**11.9**	**13.2**	**19.2**	**976**	**3,188**		

Source: SEAI

Figure 22 shows the CO_2 emissions intensity of electricity supplied between 2005 and 2015. The intensity in 2005 was 635.4 g CO_2/kWh and this fell to a low of 456.1 g CO_2/kWh in 2014.

Figure 22 *Electricity CO_2 Intensity*



Source: SEAI

Figure 22 show, as stacked bars, the shares of the various fuels contributing to the overall emissions intensity as well as the reduction in intensity as a result of emissions avoided by renewable generation from wind, hydro and other renewables. It is important to note that this graph represents the shares of the fuels in relation 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 22*.

Table 18 *Emission Sources Contributing to Electricity CO_2 Intensity*

CO_2 Intensity (gCO_2/kWh)	2005	2010	2011	2012	2013	2014	2015
Coal	230.0	133.4	145.5	187.1	155.0	149.3	173.0
Peat	100.3	93.2	93.9	110.3	99.4	106.9	104.3
Oil	104.2	17.0	6.9	7.0	5.4	7.5	10.5
Gas	200.9	286.2	242.6	223.0	203.8	190.3	177.6
Wind (avoided)	-23.9	-48.2	-63.7	-58.7	-67.5	-76.4	-95.3
Hydro (avoided)	-13.6	-10.3	-12.0	-13.7	-10.1	-11.7	-12.6
Other Renewables (avoided)	-3.0	-9.1	-11.0	-16.3	-18.2	-20.0	-16.8
Non-Renewable (Wastes)	0	0.0	0.0	1.6	2.0	2.1	2.0
Net Overall Intensity	**635.4**	**529.8**	**488.9**	**529.0**	**465.5**	**456.1**	**467.5**

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 g CO_2/kWh in 1990, to a new low of 456 g CO_2/kWh in 2014. Increased coal and peat use and lower net imports in 2015 saw the intensity increase to 468 g CO_2/kWh.

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

- 19.6% increase in coal used in generation;
- 1.0% increase in peat used in generation;
- 44.7% increase in oil used in generation (albeit to a share of just 1.9% of fuel inputs);
- 69% reduction in net electricity imports;
- 1.2% increase in non-renewable wastes use for electricity generation.

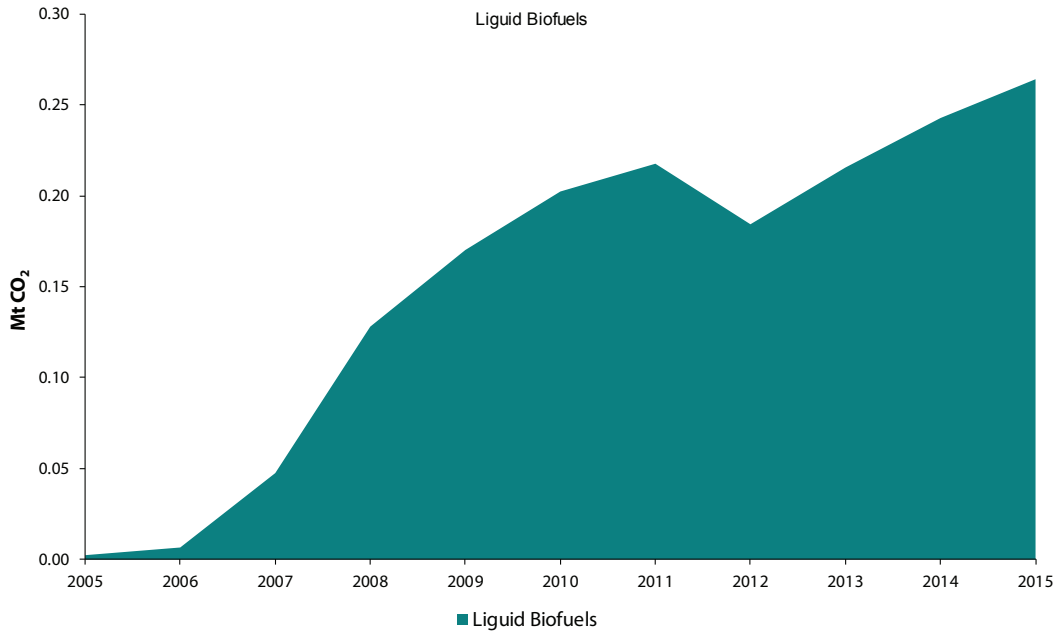
Countering these were a:

- 27.9% increase in wind generation;
- 13.8% increase in hydro generation;
- 3.7% reduction in gas use for electricity generation.

7.2 Avoided CO_2 Emissions in Transport

The avoided CO_2 emissions associated with biofuels usage in transport are calculated on the basis of an assumed 100% displacement of emissions from conventional fuels. The emissions from biofuels production are accounted for in this analysis in accordance with the UNFCCC reporting guidelines. Thus the CO_2 avoided from bioethanol in transport is equated with CO_2 emissions that would have arisen from the petrol consumption displaced, and CO_2 avoided from biodiesel and pure plant oil is determined from the diesel consumption displaced.

Figure 23 *Avoided CO_2 Emissions from Renewable Energy in Transport*



Source: SEAI

The use of biofuels in transport only started to any extent from 2005 onwards. 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 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 and consumers are required to apply to the National Oil Reserves Agency (NORA) for certificates and demonstrate that the quantities of biofuel for which they are claiming certificates are accurate. Since the introduction of the Sustainability Regulations (SI 33 of 2012), the companies are also required to demonstrate

that the biofuel that is being placed on the market is sustainable. Biofuel that is not deemed to be sustainable will not be awarded certificates and cannot be counted towards the biofuel obligation. The obligation was increased to 6% in 2013 and the Department of Communications, Climate Action and Environment conducted a consultation between October 2015 and March 2016 on increasing the obligation rate from 7 to 8% in 2017. The proposed rate is 8.695% from 1 January 2017, with a final decision expected in October 2016.

Table 19 *Growth Rates and Quantities of Avoided CO_2 Emissions from Renewable Energy in Transport*

	Growth %	Average annual growth rates %				Quantity (kt CO_2)	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015
Liquid Biofuels	10,807	56.7	142.3	5.5	8.8	2.4	264

Source: SEAI

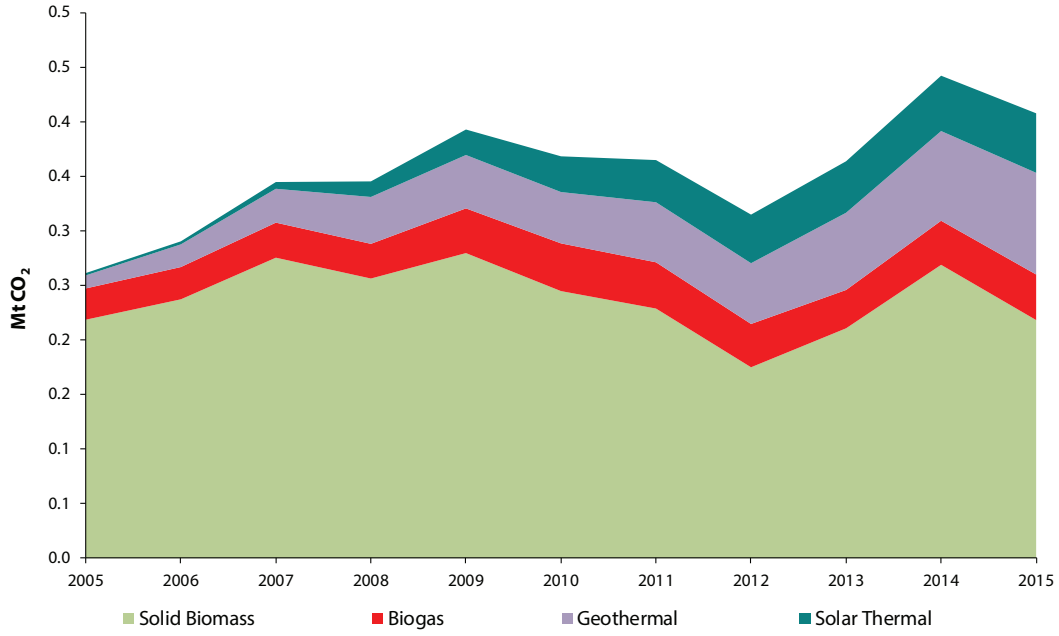
Emissions avoided by the use of liquid biofuels in transport have grown from approximately 2 kt in 2005 to 264 kt in 2015. Between 2010 and 2015, emissions avoided grew by 5.5% per annum on average, and in 2015 grew by 8.8%.

7.3 Avoided CO_2 Emissions in Heat

It is assumed that the thermal energy from renewable energy (solid biomass, biogas, geothermal, solar, biogas 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 24 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 50% between 2005 and 2015, while the associated CO_2 emissions from heat fell by 25% over the period.

Figure 24 *Avoided CO_2 Emissions from Renewable Energy in Heat*



Source: SEAI

Table 20 *Growth Rates, Quantities and Shares of Avoided CO_2 Emissions from Renewable Energy in Heat*

	Growth %	Average annual growth rates %				Quantity (kt CO_2)		Shares %	
	2005 – 2015	'05 – '15	'05 – '10	'10 – '15	2015	2005	2015	2005	2015
Solid Biomass	-0.2	-0.4	2.3	-2.3	-18.8	219	218	83.6	53.5
Biogas	45.8	2.1	8.8	-0.9	3.4	29	42	11.0	10.2
Geothermal	679.7	19.5	31.5	14.7	13.3	12	93	4.6	22.8
Solar Thermal	2,447.2	36.2	72.5	10.7	7.5	2	55	0.8	13.4
Total	**56.0**	**3.4**	**7.1**	**2.1**	**-7.8**	**261**	**408**		

Source: SEAI

Overall emissions avoided through the use of renewable energy in heat grew by 56% between 2005 and 2015, from 261 kt to 408 kt. The largest share of avoided emissions from the use of solid biomass was 218 kt in 2015. The use of geothermal energy (heat pumps) accounted for 23% of the avoided emission in 2015, at 93 kt, while solar thermal avoided 55 kt (13% 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.

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

Combined Heat and Power Plants: Combined heat and power (CHP) 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.

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

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

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

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

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

Nominal and Real Values: Nominal value refers to the current value expressed in monetary 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 (TFC): This is the energy used by the final consuming sectors of industry, transport, residential, agriculture and services. It excludes the energy sector: electricity generation, oil refining, etc.

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

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

Energy Conversion Factors

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

Energy Units

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

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

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

	t CO_2/TJ (NCV)	g CO_2/kWh (NCV)
Liquid Fuels		
Motor Spirit (Gasoline)	70.0	251.9
Jet Kerosene	71.4	257.0
Other Kerosene	71.4	257.0
Gas/Diesel Oil	73.3	263.9
Residual Oil	76.0	273.6
LPG	63.7	229.3
Naphta	73.3	264.0
Petroleum Coke	92.9	334.5
Solid Fuels and Derivatives		
Coal	94.6	340. 6
Milled Peat	116.7	420.0
Sod Peat	104.0	374.4
Peat Briquettes	98.9	355.9
Gas		
Natural Gas	56.9	204.7
Electricity		
(2015)	129.9	467.5

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EirGrid

Environmental Protection Agency

ESB Networks

European Commission DG TREN

Eurostat

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Energy Balance 2015

kilo tonnes of oil equivalent (ktoe)	Coal	Peat	Oil	Natural Gas	Renewables	Non-Renew/Waste	Electricity	Total
Indigenous Production	-	762	-	107	1,025	62	-	1,957
Imports	1,481	-	9,120	3,629	124	-	151	14,505
Exports	11	7	1,777	-	0	-	93	1,889
Mar. Bunkers	-	-	160	-	-	-	-	160
Stock Change	-43	5	-303	24	1	-	-	-317
Primary Energy Supply (incl. non-energy)	**1,426**	**759**	**6,880**	**3,761**	**1,150**	**62**	**58**	**14,096**
Primary Energy Requirement (excl. non-energy)	**1,426**	**759**	**6,672**	**3,761**	1,150	62	**58**	**13,889**
Transformation Input	**1,127**	**640**	**3,502**	**1,943**	**115**	**25**	**57**	**7,407**
Public Thermal Power Plants	1,127	547	77	1,620	107	25	-	3,503
Combined Heat and Power Plants	-	8	10	279	8	-	-	305
Pumped Storage Consumption	-	-	-	-	-	-	46	46
Briquetting Plants	-	85	-	-	-	-	-	85
Oil Refineries and other energy sector	-	-	3,415	43	-	-	11	3,469
Transformation Output	**-**	**65**	**3,481**	**-**	**41**	**6**	**1,807**	**5,400**
Public Thermal Power Plants	-	-	-	-	37	6	1,596	1,596
Combined Heat and Power Plants – Electricity	-	-	-	-	4	-	186	186
Combined Heat and Power Plants – Heat	-	-	-	-	-	-	-	-
Pumped Storage Generation	-	-	-	-	-	-	25	25
Briquetting Plants	-	65	-	-	-	-	-	65
Oil Refineries	-	-	3,481	-	-	-	-	3,481
Exchanges and Transfers	**15**	**-**	**-18**	**-**	**-634**	**-**	**634**	**-3**
Electricity	-	-	-	-	-634	-	634	-
Heat	-	-	-	-	-	-	-	-
Other	15	-	-18	-	-	-	-	-3
Own Use and Distribution Losses	**-**	**8**	**98**	**60**	**-**	**-**	**245**	**411**
Available Final Energy Consumption	**314**	**177**	**6,744**	**1,758**	**401**	**37**	**2,197**	**11,629**
Non-Energy Consumption	**-**	**-**	**208**	**-**	**-**	**-**	**-**	**208**
Final non-Energy Consumption	-	-	208	-	-	-	-	208
Total Final Energy Consumption	**312**	**201**	**6,493**	**1,722**	**415**	**37**	**2,156**	**11,337**
Industry	**106**	**1**	**464**	**767**	**174**	**37**	**847**	**2,397**
Non-energy mining	-	-	30	12	-	-	61	102
Food, beverages and tobacco	22	1	127	105	30	-	180	465
Textiles and textile products	-	-	2	1	-	-	11	14
Wood and wood products	0	-	2	2	115	-	36	156
Pulp, paper, publishing and printing	0	-	3	3	-	-	20	26
Chemicals and man-made fibres	-	-	27	65	-	-	154	245
Rubber and plastic products	-	-	9	4	-	-	37	50
Other non-metallic mineral products	84	-	171	17	29	37	54	391
Basic metals and fabricated metal products	-	-	11	422	-	-	67	500
Machinery and equipment n.e.c.	-	-	5	5	-	-	22	32
Electrical and optical equipment	0	-	38	123	-	-	105	266
Transport equipment manufacture	-	-	4	2	-	-	18	24
Other manufacturing	0	-	36	6	-	-	82	125
Transport	**-**	**-**	**4,657**	**0**	**128**	**-**	**4**	**4,789**
Road Freight	-	-	603	-	23	-	-	625
Light Goods Vehicles (LGV)	-	-	289	0	11	-	-	300
Road Private Car	-	-	2,012	-	66	-	-	2,078
Public Passenger Services	-	-	132	-	5	-	-	137
Rail	-	-	36	-	-	-	4	39
Domestic Aviation	-	-	3	-	-	-	-	3
International Aviation	-	-	844	-	-	-	-	844
Fuel Tourism	-	-	456	-	17	-	-	473
Navigation	-	-	71	-	-	-	-	71
Unspecified	-	-	210	-	7	-	-	217
Residential	**206**	**201**	**956**	**555**	**76**	**-**	**678**	**2,672**
Commercial/Public Services	**-**	**-**	**243**	**399**	**36**	**-**	**580**	**1,259**
Commercial Services	-	-	156	175	31	-	416	777
Public Services	-	-	87	224	5	-	164	481
Agricultural	**-**	**-**	**152**	**-**	**-**	**-**	**48**	**200**
Fisheries	**-**	**-**	**21**	**-**	**-**	**-**	**-**	**21**
Statistical Difference	2	-24	43	36	-14	-	41	84

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

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