SUSTAINABLE ENERGY AUTHORITY OF IRELAND

RENEWABLE ENERGY IN IRELAND

2020 Update

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2020 Report

April 2020

SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Sustainable Energy Authority of Ireland

The 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 the Government, homeowners, businesses and communities to achieve this, through expertise, funding, educational programmes, policy advice, research and the development of new technologies. SEAI is funded by the Government of Ireland through the Department of Communications, Climate Action and Environment.

SEAI is the official source of energy data for Ireland. We develop and maintain comprehensive national and sectoral statistics for energy production, transformation and end-use. These data are a vital input in meeting international reporting obligations, advising policymakers and informing investment decisions. SEAI's core statistics functions are to:

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

Acknowledgements

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

2018 Highlights

Progress towards targets

- Overall renewable energy supply was 11% of gross final consumption. Ireland has a binding EU target of 16% by 2020.
- Ireland is not on track to meet 2020 renewable energy targets.
- Ireland had the second lowest progress to meeting the overall RES target of all EU Member States.
- The share of renewable transport energy (RES-T), including adjustments, was 7.2%. Ireland has a binding EU target of 10% by 2020.
- The share of renewable electricity (RES-E) was 33.2%. Ireland has a national target of 40% by 2020.
- The share of renewable heat (RES-H) was 6.5%. Ireland has a national target of 12% by 2020.

Benefits of renewable energy

- The use of renewable energy displaced fossil fuel use equivalent to 2 million tonnes of oil and avoided 4.9 million tonnes of CO_2 emissions. This was equivalent to 13% of total energy-related CO_2 emissions.
- 82% of CO_2 emissions avoided from the use of renewable energy were from electricity generation. Reducing the carbon intensity of electricity is critical for meeting Ireland's climate change objectives.

Renewable transport

- More than 98% of RES-T was from bioenergy, almost 88% was from biodiesel and 10% was from biogasoline.
- 82% of liquid biofuels used in transport were imported.
- 1% of renewable transport energy is from electricity. Most electricity used for transport is used by DART and Luas, but electricity for cars is growing rapidly as Ireland's fleet of electric vehicles grows quickly from a low base.
- Ireland was 13^{th} out of the EU-28 for RES-T.

Renewable heat

- The amount of renewable energy used for heat increased by 65% between 2005 and 2018, albeit from a low base.
- Renewable ambient energy captured by heat-pumps increased by 182% between 2010 and 2018. There has been a large increase in the use of air-source heat-pumps in the residential sector.
- Ireland had the second lowest share of renewable heat of all EU Member States.
- Ireland's poor performance in renewable heat is the biggest reason for us failing to achieve our overall renewable energy target.

Renewable electricity

- 66% of renewable energy in 2018 was renewable electricity.
- Renewable electricity forms the backbone of Ireland's strategy to achieve the overall renewable energy target for 2020.
- Wind generated 28% of all electricity in 2018, second only to natural gas.
- Ireland is a world leader at incorporating large amounts of wind-generated electricity onto the network.
- 358 MW of additional wind-generation capacity was installed in 2018.
- Other renewable electricity sources were: hydro 2.2%, bioenergy (biomass, biogas and landfill gas) 1.7%, renewable waste 1.1% and solar PV 0.1%.
- Ireland was 12^{th} out of the EU-28 for RES-E.

Renewable Energy in Ireland

Data from 2018

RENEWABLE ENERGY TARGETS

	2018	2020 TARGETS
Overall RES target	11.0%	16.0%
Transport	7.2%	10.0%
Heat	6.5%	12.0%
Electricity	33.2%	40.0%

0.5% point increase from 2017 to 2018 (Overall RES target)

0.2% point decrease from 2017 to 2018 (Transport)

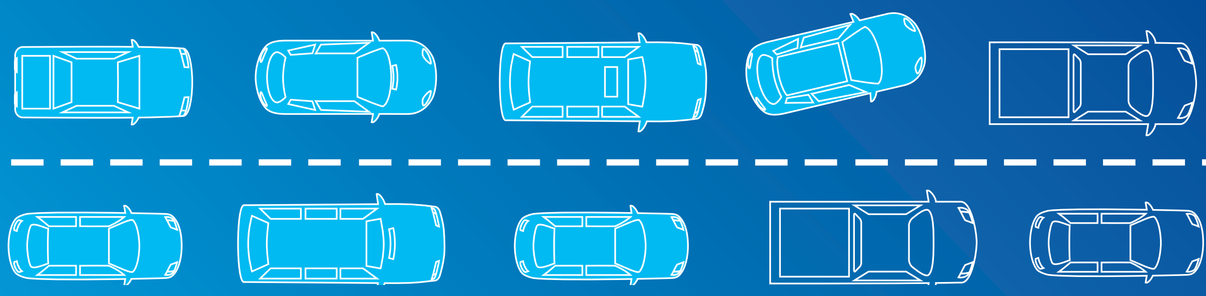
0.2% point decrease from 2017 to 2018 (Heat)

3.1% point increase from 2017 to 2018 (Electricity)

Ireland is not on track to meet 2020 renewable energy targets

4.9 $MtCO_2$

in avoided CO_2 emissions from renewable energy which is equivalent to removing 70% of private cars off the road



4 $MtCO_2$ **of this was avoided from renewable electricity**

To download the full report, visit **www.seai.ie/renewablereport**

TRANSPORT

RENEWABLES **3%**

FOSSIL FUELS **97%**

Climate Action Plan targets…

1 million
electric vehicles
on the road by 2030

No new diesel-only
public buses in our cities

Expand our network
of **cycle paths** and
park & ride facilities

P +

HEAT

RENEWABLES **6.5%**

FOSSIL FUELS **93.5%**

Ireland is
27th
out of the 28
EU countries for
renewable heat

Heat pumps
75%
renewable

Climate Action Plan targets…
600,000
heat pumps
installed by 2030

64% of renewable heat **is used in industry**

most of this is biomass

ELECTRICITY

RENEWABLES **33%**

FOSSIL FUELS **67%**

Ireland has the
2nd highest
share of wind-
generated electricity
in the EU at 28%

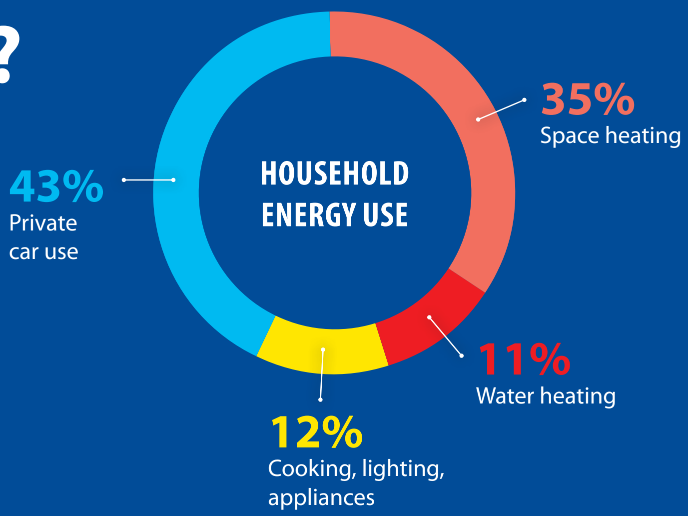
Climate Action Plan targets…

70%
of electricity from
renewables by 2030

Phase out
coal and peat
for electricity
generation

What can YOU do?

Reducing energy waste is key to reducing your impact. The less energy you use, the less energy that needs to be produced in the first place. **So efficiency first!**



A few changes can make a big difference:

Take climate action

If you think your community could benefit from getting involved in saving energy, find out about the **SEAI sustainable communities network**.

Walk, **cycle**, use **public transport** or **carpool** where possible.

Conversations with your family, friends and work colleagues can have a big impact. Help them make better energy decisions.

When replacing your car, **consider going electric**.

BER Building Energy Rating

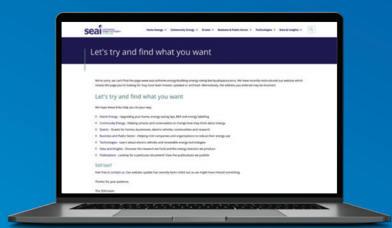
Get a **BER rating** for your home to understand what upgrades could be done to improve your energy rating.

Then consider renewable energy sources such as a **heatpump** or **solar panels**.

Insulate your home. This could include increased attic, wall and floor insulation.

To find out more how you can take climate action visit:

seai.ie/takeclimateaction



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1 Overall renewable energy

This section shows overall renewable energy use from 2005 to 2018. It examines Ireland's progress towards our 2020 renewable energy targets. It presents data on overall renewable energy use split by electricity, heat, and transport, and also by energy source.

1.1 Progress towards renewable energy targets

The Renewable Energy Directive (RED)[1] is the most important legislation influencing the growth of renewables in the European Union (EU) and Ireland.[2] The RED sets out two mandatory targets for renewable energy in Ireland to be met by 2020.

The first relates to overall renewable energy share (RES), and is commonly referred to as the overall RES target. For Ireland, the overall RES target is for at least 16% of gross final energy consumption (GFC)[3] to come from renewable sources in 2020.

The second mandatory target set by the RED relates to the renewable energy used for transport. This is commonly referred to as the RES-T target. The RES-T target is for at least 10% of energy consumed in road and rail transport to come from renewable sources.[4]

In addition to these EU mandatory targets, Ireland has two further national renewable energy targets for 2020 . These are for the electricity and heat sectors and are designed to help Ireland meet the overall RES target.

The renewable electricity target is commonly referred to as the RES-E target. The RES-E target is for 40% of gross electricity consumption to come from renewable sources in 2020.[5]

The renewable heat target is commonly referred to as the RES-H target. The RES-H target is for 12% of energy used for heating and cooling to come from renewable sources in 2020.

Table 1 shows progress towards the individual modal targets and towards the overall RES target for select years between 2000 and 2018.[6] The last column shows the targets for 2020.

Ireland is not on track to meet its 2020 renewable energy targets.

Table 1: Progress towards renewable energy targets[7], 2000 to 2018

Progress towards target %	2000	2005	2010	2015	2016	2017	2018	2020 target
RES-T (with weighting factors)	0.0	0.0	2.5%	5.9	5.2	7.4	7.2	10.0
RES-H	2.4	3.4	4.3	6.2	6.3	6.7	6.5	12.0
RES-E (normalised)	4.8	7.2	15.6	25.5	26.8	30.1	33.2	40.0
Overall RES	**1.9**	**2.8**	**5.7**	**9.1**	**9.2**	**10.5**	**11.0**	**16.0**

Source: SEAI

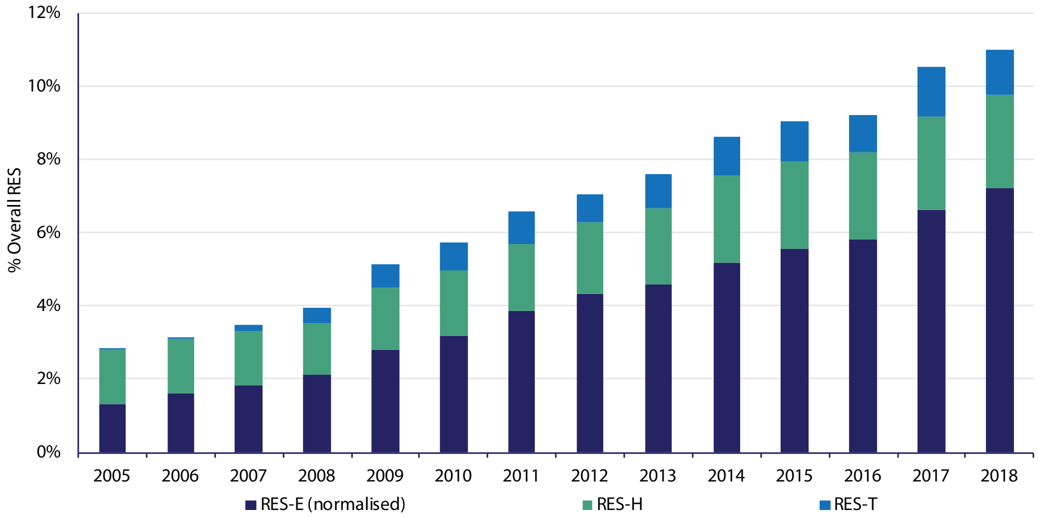
With two years remaining to reach the target, Ireland is not on track to meet any of its 2020 renewable energy targets. Projections of Ireland's renewable energy use in 2020 are covered by a separate SEAI report titled National Energy Projections to 2030.[8] The projections report discusses in more detail possible future trajectories for renewable energy, while this report focuses on the current levels of renewable energy use, presenting the most recent data for 2018 and the trend since 2000. Some provisional 2019 data is also presented.

Figure 1 shows the annual percentage of renewable energy as calculated for the overall RES target.[9] This is split into the three modes: electricity, transport and heat energy. *Table 2* provides further data on the quantities and growth rates of each of these modes. Renewable electricity has been responsible for most of the overall growth in renewable energy since 2000. It was the largest source of renewable energy in 2018, accounting for 66% of total renewable energy. Renewable transport continued to make the smallest contribution, at 13% of renewable energy.

66% of renewable energy in 2018 was renewable electricity.

7 Note that individual target percentages are not additive.

Figure 1: Renewable energy (normalised) by mode, 2000 to 2018



Source: SEAI

Table 2: Renewable energy (normalised) by mode, 2000 to 2018

	Quantity (ktoe)			Shares (%)			Growth (%)		Average annual growth rates (%)		
	2000	2010	2018	2000	2010	2018	'00-'18	'10-'18	'00-'10	'10-'18	2018
RES-H	118	218	310	54	31	23	163	42	6.4	4.5	3.6
RES-T	0	93	154	0	13	11	-	67	-	6.6	-4.0
RES-E	99	385	882	46	55	66	794	129	14.6	10.9	13.7
Overall RES	**216**	**696**	**1,346**	**-**	**-**	**-**	**522**	**93**	**12.4**	**8.6**	**8.9**

Source: SEAI

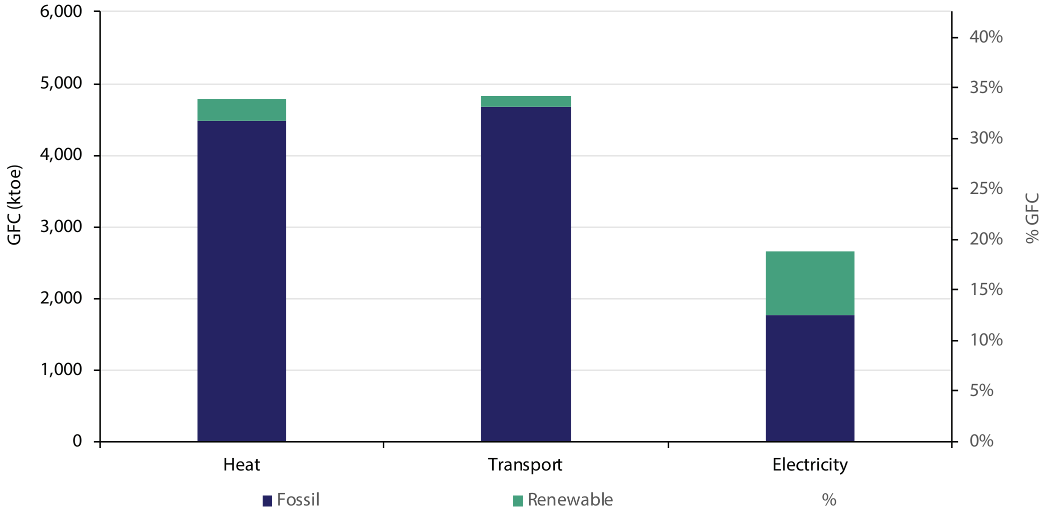
Figure 2 illustrates the total GFC in each mode according to the RED calculation, and the portion of each mode that comes from renewable sources. Significant progress has been made in increasing the share of renewable electricity, but electricity only accounted for 22% of GFC in 2018.

Transport was the mode with the largest share of GFC[10], accounting for 39% of total GFC in 2018. Just 3.9% of this transport GFC was from renewable sources.[11]

Heat accounted for 39% of GFC and 6.5% of this was from renewable sources.

Transport had the largest share of energy consumption but the smallest share of renewable energy in 2018.

Figure 2: Renewable and fossil GFC by mode, 2018



Source: SEAI

Figure 3 and *Table 3* show the actual amount of renewable energy used each year, split by source.[12] Wind and hydro have not been normalised, so the actual variation in production from year to year can be seen.

Most of the growth in renewable energy has come from wind. Wind provided 55% of all renewable energy in 2018. Solid biomass and bioliquids were the next largest sources of growth. Bioenergy, including biomass, landfill gas, biogas and bioliquids, collectively accounted for 36% of renewable energy in 2018.

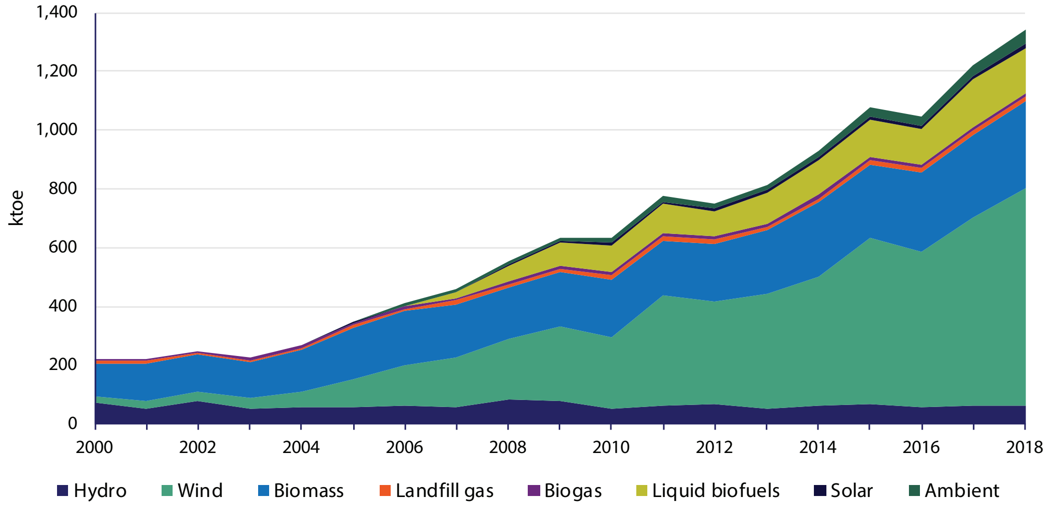
55% of all renewable energy in 2018 was from wind; 36% was from bioenergy.

Table 3: Renewable energy use by source, 2000 to 2018

	Quantity (ktoe)			Shares (%)			Growth (%)		Average annual growth rates (%)		
	2000	2010	2018	2000	2010	2018	'00-'18	'10-'18	'00-'10	'10-'18	2018
Biomass	113	196	299	52%	31%	22%	164%	52%	5.6%	5.4%	5.5%
Landfill gas	8	16	12	4%	2%	1%	46%	-24%	6.7%	-3.3%	-12.0%
Biogas	4	10	14	2%	2%	1%	217%	32%	9.1%	3.6%	0.3%
Liquid biofuels	0	93	154	0%	15%	12%	-	67%	-	6.6%	-4.0%
Total bioenergy	**126**	**315**	**479**	**57%**	**50%**	**36%**	**281%**	**52%**	**9.6%**	**5.4%**	**1.6%**
Hydro	73	52	60	33%	8%	4%	-18%	16%	-3.4%	1.9%	0.4%
Wind	21	242	743	10%	38%	55%	3441%	207%	27.7%	15.0%	16.1%
Solar	0	8	15	0%	1%	1%	-	99%	51.4%	9.0%	10.4%
Ambient	0	16	44	0%	2%	3%	-	163%	78.5%	13.8%	13.7%
Total	**220**	**631**	**1,341**	**100%**	**100%**	**100%**	**510%**	**112%**	**11.1%**	**9.9%**	**9.6%**

Source: SEAI

Figure 3: Renewable energy use, 2000 to 2018

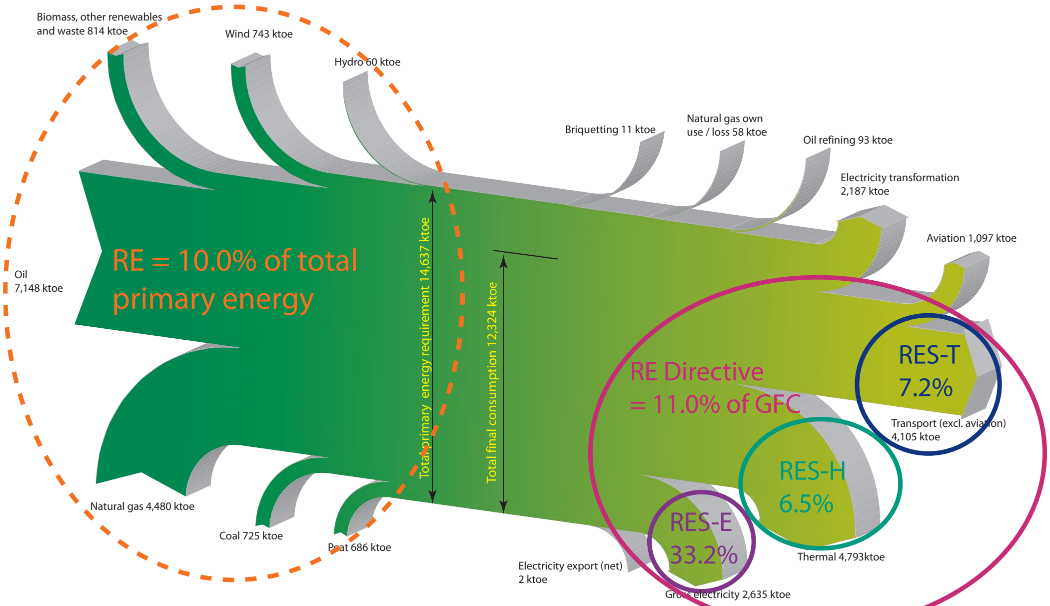


Source: SEAI

1.2 Renewables in the context of overall energy use

The Sankey diagram in *Figure 4* illustrates where the various renewable targets fit within overall energy use in Ireland and the progress towards those targets in 2018. Towards the left of *Figure 4* the overall contribution of renewable energy to total primary energy is shown at 10.0%. While there is no specific target for this measure it does help to illustrate the position of renewables in Ireland's overall energy usage. Towards the right of *Figure 4* the current percentages for renewables in transport, heat and electricity with respect to GFC are shown, as well as the percentage of overall renewables. The formulae set out in the RED to calculate these percentages are explained in Appendix 1. Each of the three modes is discussed in more detail in the sections *3*, *4* and *5*.

Figure 4: Renewable energy status in Ireland, 2018



Note: Some statistical differences exist between inputs and outputs.
RES-E Normalised wind and hydro.
RES-T adjusted to account for double certificates
GFC = Gross final consumption

Source: SEAI

2 Displacement of fossil fuels and CO_2 emissions

This section shows how the use of renewable energy displaces the use of fossil fuels. Renewable energy avoids CO_2 emissions, reduces Ireland's fossil fuel imports and improves energy security.

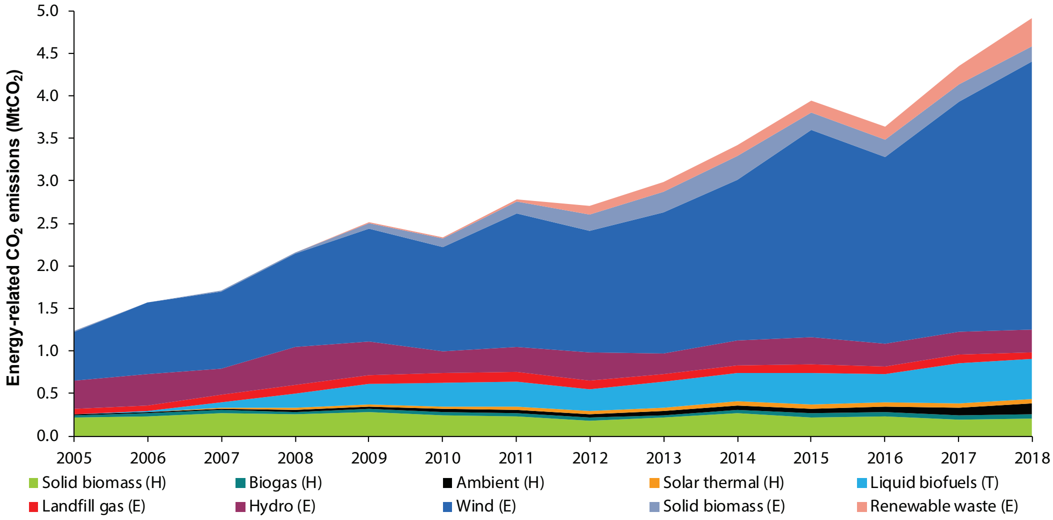
2.1 Avoided CO_2 emissions

Figure 5 shows the annual CO_2 emissions that were avoided from the use of renewable energy[13], across all sectors, from 2005 to 2018.

We estimate that renewable energy displaced 2.0 Mtoe of fossil fuel consumption and avoided 4.9 million tonnes of CO_2 ($MtCO_2$) in 2018. This was equivalent to 13% of total energy-related CO_2 emissions. We estimate that in 2018 wind energy displaced 1.3 Mtoe of fossil fuel and avoided 3.1 $MtCO_2$, or 64% of the total CO_2 avoided by renewables. 82% of the CO_2 emissions avoided by renewable energy was from renewable electricity.

Electricity generation is covered by the EU Emissions Trading System (ETS), therefore CO_2 emissions savings achieved in electricity generation do not count directly towards Ireland's EU targets to reduce greenhouse gas emissions outside of the ETS, which is termed the non-ETS sector. However, decarbonising the electricity system combined with increased electrification of heat and transport through the use of electric vehicles and heat pumps is an important part of the strategy for decarbonising the energy system as a whole. The use of renewable electricity ensures that switching to electric vehicles and heat pumps does not result in greater CO_2 emissions than the fossil fuel alternative. Electrification of heat and transport also reduces direct fossil fuel use in the non-ETS sector, thereby contributing to meeting the non-ETS greenhouse gas emissions reduction target.

Figure 5: Avoided CO_2 from renewable energy, 2005 to 2018



Source: SEAI

Renewable energy avoided 4.9 million tonnes of CO_2 emissions in 2018. 82% of this was in electricity generation. Reducing the carbon intensity of electricity is critical for meeting Ireland's climate change objectives.

The methodology used to calculate the fossil fuels displaced by renewable energy is described in Appendix 2. The main assumptions are as follows:

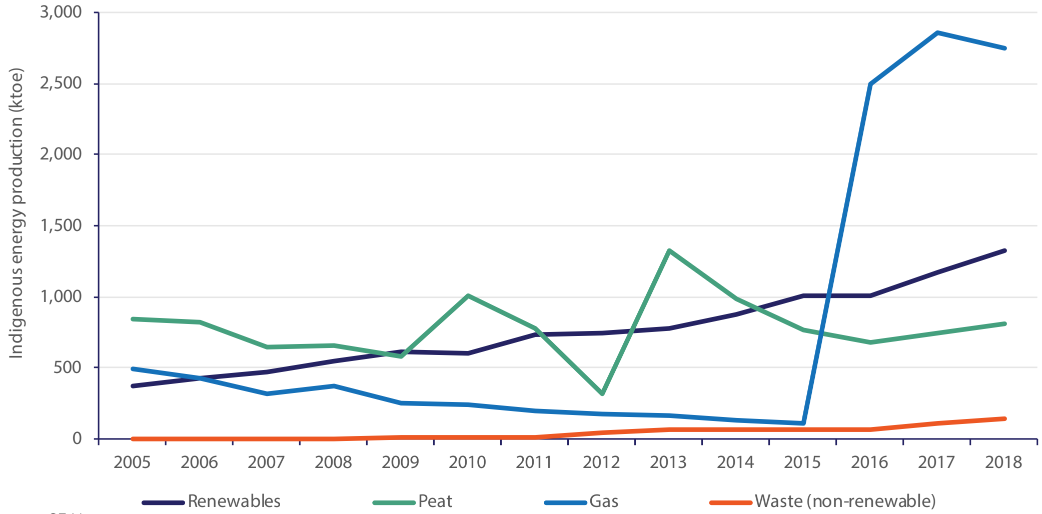
- Renewable hydro and wind electricity generation displace electricity production from natural gas, which is assumed to be the marginal fossil fuel generator. We further assume that wind-generation results in a 5% increase in the energy intensity of the remaining fossil fuel electricity generation mix, due to cycling and ramping effects.[14]
- Biomass used for electricity generation in combined heat and power plants (CHP) is assumed to displace electricity production from gas, as the marginal generator.
- Biomass used for heat generation in CHP is assumed to displace heat from oil-fired boilers.
- Biomass used for co-firing with peat was assumed to displace peat up until 2015, when Public Service Obligation support for peat ended. From 2016 electricity generated from burning biomass is assumed to displace electricity generated by natural gas.[15]
- Renewable heat energy is assumed to displace heat energy from oil-fired boilers. The exception is the use of solid biomass in the wood processing industry. In this case we assume that the biomass used does not displace fossil fuel, as biomass has traditionally been used for heat in this sector. This is significant because solid biomass used in the wood processing industry accounted for 58% of all renewable heat energy in 2017.
- Renewable liquid biofuels used for transport (biodiesel and biogasoline) displace diesel and petrol.
- For combustible renewables, such as solid biomass and liquid biofuels, we use the standard carbon dioxide accounting rules that are used to calculate Ireland's greenhouse gas emissions targets. Therefore, as long as a biofuel meets the minimum sustainability requirements set out in the RED, it is counted as zero carbon at the point of combustion.

2.2 Contribution to indigenous energy

Most of the renewable energy used in Ireland is produced or harnessed directly in Ireland. This indigenous energy does not need to be imported from other countries. The main exceptions are liquid biofuels, most of which are imported, along with some solid biomass. Increasing the deployment of indigenous renewable energy reduces the need for energy imports and improves energy security.

Figure 6 shows Ireland's indigenous energy production by source from 2005 to 2018. Historically, peat was the main indigenous energy source in Ireland. Peat production fluctuates significantly from year to year, partly due to the fact that the harvesting of peat can be adversely affected by poor weather and so peat tends to be stockpiled in years with good weather.

Figure 6: Indigenous energy production by source, 1990 to 2018



Source: SEAI

Production of natural gas from the Kinsale gas field began in the late 1970s, peaked in 1995, and declined sharply from then on. In 2016, gas from the Corrib gas field was first brought on stream, and gas regained its position as the largest source of indigenous energy. Production from the Corrib gas field peaked in 2017 and is expected to taper off significantly over the next couple of years.[16]

Indigenous renewable energy has grown steadily since the 1990s. By 2015 it had surpassed peat and accounted for over half of all indigenous energy that year, but was overtaken by gas from the Corrib gas field in 2016.

In 2015 renewable energy was Ireland's largest source of indigenous energy production, before being surpassed by natural gas from the Corrib gas field in 2016.

3 Renewable energy in transport

This section shows Ireland's progress towards the renewable transport target and gives information on the sources of renewable transport energy.

Transport has by far the highest fossil fuel dependency, lowest degree of electrification and lowest share of renewable energy compared with the other major economic sectors (residential, industry, services), or compared with the other modes (heat, electricity). In 2018, 97% of transport energy was from oil-based products. Transport is also the sector with the largest energy demand, accounting for 42% of final energy demand in 2018 or 40% of GFC as per the RED.[17]

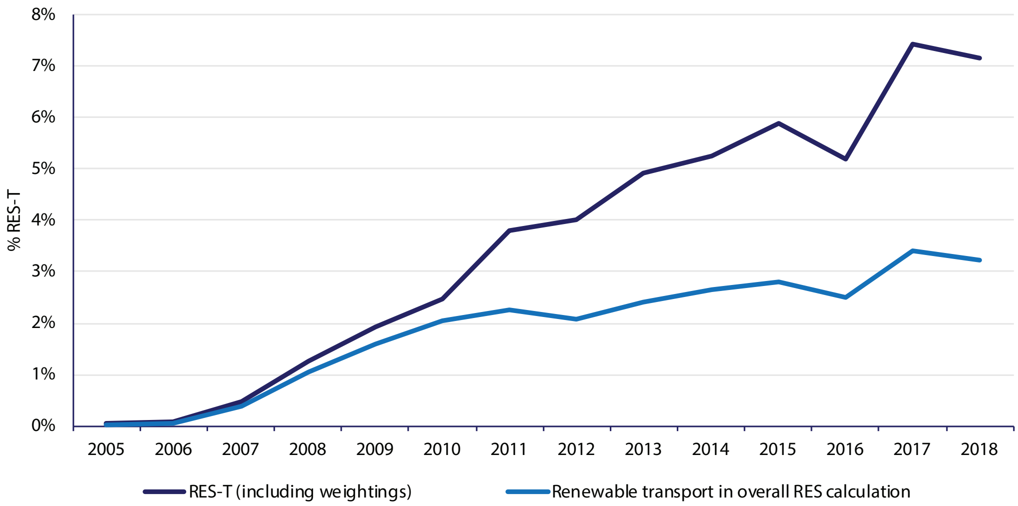
3.1 Progress towards renewable transport target

The RED established a mandatory minimum target of 10% for the share of all petrol, diesel, biofuels and electricity consumed in road and rail transport to come from renewable energy by 2020. The RED also specifies a number of weightings or multipliers that can be applied to certain fuels. The weightings help to incentivise these fuels, and also make it easier to meet the RES-T target. A weighting factor of 2 is applied to advanced biofuels and biofuels from waste. A weighting of 2.5 is applied to electricity from renewable energy sources consumed by electric rail transport, and a weighting of 5 is applied to electricity from renewable sources consumed by electric cars. The share of electricity that comes from renewable sources in a particular year is taken to be the share that was measured two years before the year in question.

Figure 7 and *Table 4* show the progress towards the RES-T target, with and without the weightings applied. In 2018 RES-T stood at 7.2%, compared to the 2020 target of 10%.

RES-T was 7.2% in 2018; the 2020 target is 10%.

Figure 7: Progress towards renewable transport energy target, 2005 to 2018



Source: SEAI

Table 4: Progress towards renewable transport target, 2005 to 2018

Share of renewable transport	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018
RES-T with weightings	0.0%	2.5%	3.8%	4.0%	4.9%	5.2%	5.9%	5.2%	7.4%	7.2%
Renewable transport in overall RES calculation	0.0%	2.0%	2.3%	2.1%	2.4%	2.7%	2.8%	2.5%	3.4%	3.2%

Source: SEAI

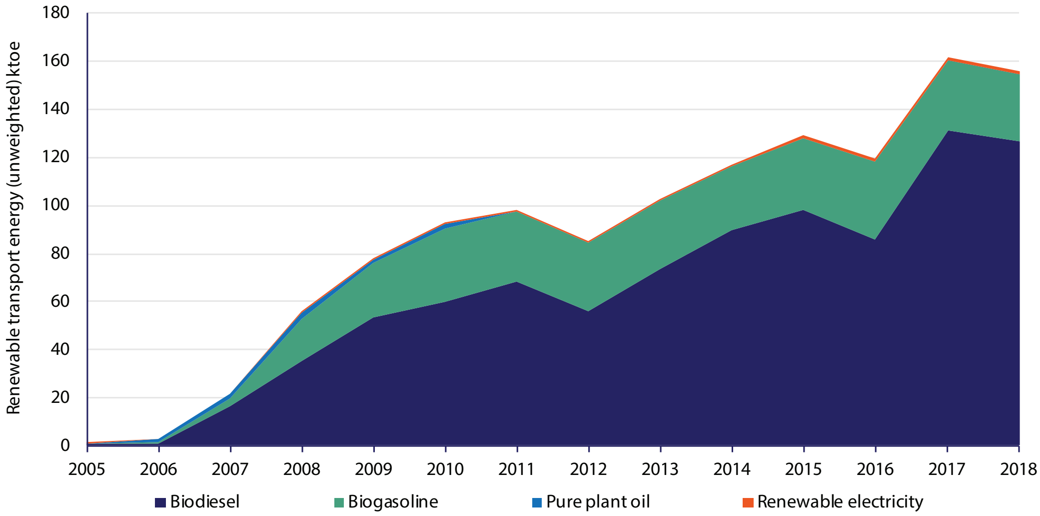
These weightings only apply to the RES-T target, not to the transport contribution to the overall RES target. Another difference is that aviation is not included in the denominator for the RES-T target, but it is for the overall RES target. *Figure*

7 and *Table 4* also show the share of renewable transport from the perspective of the overall RES target, which was just 3.2% in 2018. Most of the difference between the two is due to the double weighting for advanced biofuels. The significant gap between the RES-T share and the share of renewable transport energy from the perspective of the overall RES target has contributed to the poor progress towards the overall RES target.

To understand the year-to-year variations in RES-T, we must look in more detail at policies in place for the different fuel types. *Figure 8* and *Table 5* show renewable transport energy in absolute energy terms without weightings applied. 98% of renewable transport energy was from biofuels in 2018, 88% was from biodiesel and 10% was from biogasoline. The remainder was from renewable electricity. There were noticeable drops in biofuel use in 2012, 2016 and 2018; these are explained in Section *3.2*.

98% of RES-T in 2018 was from bioenergy, and 88% was from biodiesel.

Figure 8: Renewable transport energy (without weightings), 2005 to 2018



Source: SEAI

Table 5: Renewable transport energy (without weightings) by source, 2010 to 2018

	Quantity (ktoe)			Shares (%)			Growth (%)		Average annual growth rates (%)		
	2010	2015	2018	2010	2015	2018	'10-'18	'15-'18	'10-'15	'15-'18	2018
Biodiesel	60	98	127	65	76	82	111	29	10.3	8.9	-3
Biogasoline	30	30	27	32	23	18	-10	-9	-0.2	-3.0	-8
Pure plant oil	2	0	0	2	0	0	-100	-	-100.0	-	-
Renewable electricity	0	1	1	0	1	1	230	75	13.5	20.4	22
Total renewable transport	**93**	**129**	**156**	**100**	**100**	**100**	**67**	**21**	**6.7**	**6.5**	**-4**

Source: SEAI

Table 6 shows the equivalent amounts of renewable energy with the weightings applied. With weightings, biodiesel made up almost 88% of the contribution towards RES-T in 2018.

Table 6: Renewable transport energy (with weightings) by source, 2010 to 2018

	Quantity (ktoe)			Shares %			Growth %		Average annual growth rates %		
	2010	2015	2018	2010	2015	2018	'10-'15	'15-'18	'10-'15	'15-'18	2018
Biodiesel	60	196	254	64	86	88	322	30	26.6	9.1	-3
Biogasoline	30	30	30	32	13	10	-1	0	-0.2	0.1	1
Pure plant oil	2	0	0	2	0	0	-100	-	-100.0	-	-
Renewable electricity	1	2	5	1	1	1	389	144	14.9	34.6	59
Total renewable transport (weighted)	**94**	**228**	**289**	**100**	**100**	**100**	**209**	**27**	**19.4**	**8.3**	**-2**
RES-T (%)	**2.5%**	**5.9%**	**7.2%**								

Source: SEAI

3.2 Biofuels

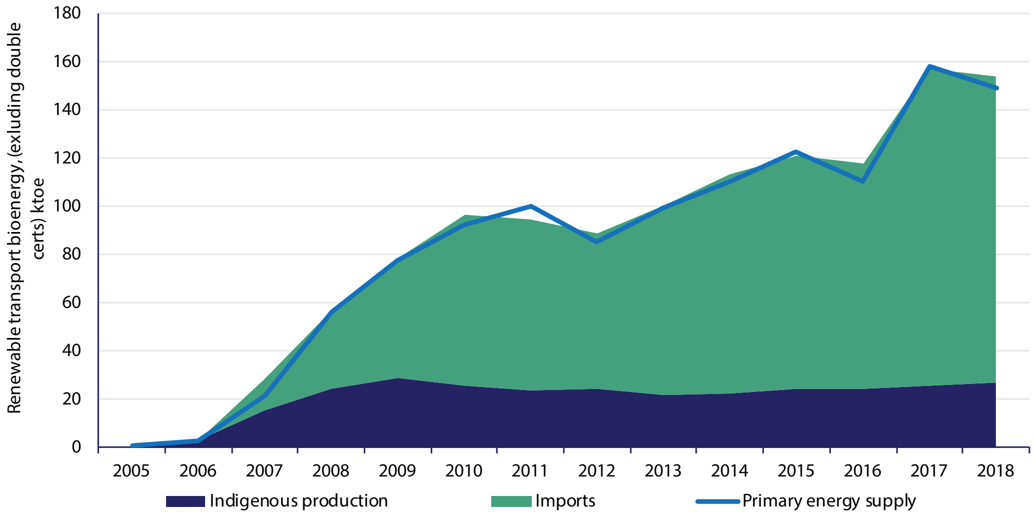
Since 2010, suppliers of oil products as road transport fuels in Ireland are required to blend biofuels with the fossil fuel they sell. This scheme is known as the Biofuels Obligation Scheme and is administered by the National Oil Reserves Agency.[18] Fuel suppliers are granted certificates for each litre of biofuel blended that meets the minimum sustainability requirements laid out in the RED and in the indirect land-use change Directive.[19] First-generation biofuels that meet the sustainability requirements are awarded one certificate per litre. Two certificates are supplied for each litre of advanced biofuels and biofuels from waste, in line with the weightings specified in the RED. Virtually all biodiesel used in Ireland has qualified for double certificates since 2012, with 100% qualifying since 2016, as shown in *Table 7*. No biogasoline qualified for double certificates before 2017, but in 2017 a small amount, just over 1%, did. In 2018 the share of biogasoline qualified for double certificates jumped to 18%. SEAI uses the National Oil Reserves Agency data for the amounts of biofuels used in Ireland.

Table 7: Proportion of liquid biofuels used in transport with double certificates, 2011 to 2018

	2011	2012	2013	2014	2015	2016	2017	2018
Biogasoline	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%	17.8%
Biodiesel	58.0%	98.7%	99.6%	85.9%	99.1%	100.0%	100.0%	100.0%

Source: National Oil Reserves Agency

Figure 9: Biofuels production, imports and usage, 2005 to 2018



Source: SEAI

The obligation was set at 4.167% in volume terms in 2010, 6.383% from 2013 and 8.696% from 2017. This meant that in 2017, each supplier had to submit eight certificates for every 92 litres of fossil fuel sold. The obligation increased further to 11.111% in January 2019 and to 12.360% in January 2020.[20] There was a noticeable drop in the use of biofuels in 2018 and 2016. This was as a result of a feature of the scheme which allows participants to carry forward certificates from one year to the next. There was also a drop in the use of biofuels in 2012. The amount of biodiesel which was eligible for double certification increased from 58% in 2011 to 99% in that year. This substantially reduced the actual amount of biodiesel required to be placed on the market in order to satisfy the biofuel obligation.

100% of biodiesel since 2016 qualified for double certificates.

Figure 9 shows the amount of liquid biofuels used in transport that are imported and produced indigenously.[21] Indigenous liquid biofuel production has remained relatively constant since 2008, at between 20 and 30 ktoe per annum. This is in spite of increasing demand for liquid biofuels due to the Biofuels Obligation Scheme. All indigenous liquid biofuel used in transport has been in the form of biodiesel since 2009. 18% of biodiesel supply in 2018 was from indigenous production and with 82% imported.

3.3 Renewable electricity in transport

The traditional users of electricity for transport in Ireland have been urban rail services, first the DART and from 2004 onwards the Luas, as shown in *Figure 10*.

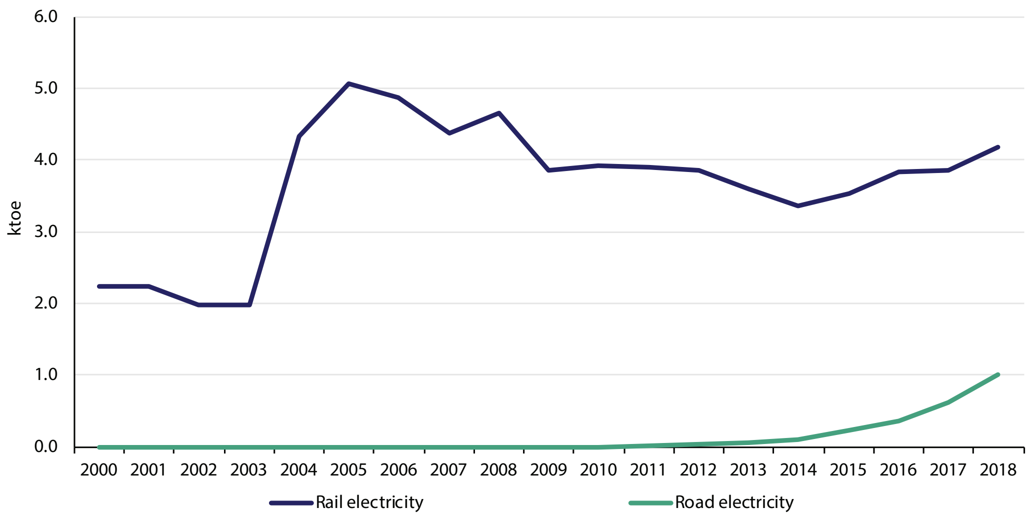
The numbers of electric vehicles, and their electricity use, remains small, but is growing fast. In 2018 there were 4,528 electric vehicles licensed, up from 2,718 in 2017. By the end of 2019 there were 8,473 electric vehicles licensed, and a further 6,305 plug-in hybrid vehicles.

SEAI receives data on the electricity use of the DART and Luas from Irish Rail and Transdev. SEAI estimates the energy consumption of electric vehicles based on their numbers, an estimate of the annual km driven per electric vehicle based on data from the NCT database, and an estimate of the average energy consumption per km of electric vehicles.[22]

Rail transport consumed 48.7 GWh (4.3 ktoe) of electricity in 2018 and SEAI estimate that electric vehicles consumed 11.8 GWh (1.1 ktoe). Only the renewable portion of electricity (as measured two years before the year in question) used in rail and road counts towards the RES-T. In 2018 this was 1.4 ktoe for electric rail and 0.3 ktoe from electric vehicles.[23]

Most electricity used for transport is by DART and LUAS, but electric vehicles are growing quickly from a low base.

Figure 10: Electricity used in transport, 2000 to 2018



Source: SEAI

4 Renewable energy in heat

This section presents the latest data on the share of renewable heat energy, the sectors where it is used and the energy sources used.

In the context of renewable energy, the terms 'heat energy' and 'thermal energy' are often used interchangeably and they refer to energy used for heating and cooling. Examples include energy used for space and water heating in homes and businesses, cooking, air conditioning, high-temperature process heat in industry, etc.

Thermal/heat energy is the second largest of the three modes of energy. It accounted for 38% of the final energy demand in 2018. The residential sector has the largest demand for heat energy, accounting for 42% of final heat energy in 2018, followed by industry, which accounted for 34%. Heat energy was once dominated by oil, accounting for 60% in 2000, followed by gas at 24%. Since 2005, oil use has fallen and gas has continued to increase so that in 2018, oil accounted for 43% and gas accounted for 40%.

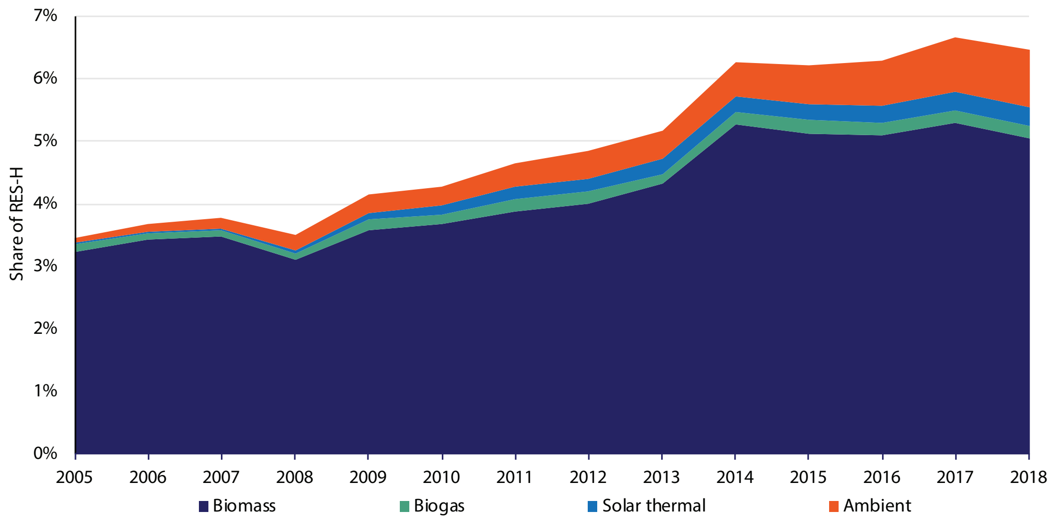
4.1 Progress towards renewable heat target

Although there is no mandatory target for RES-H set in the RED, Ireland has set a target of 12% RES-H to help deliver the overall mandatory target of 16% renewable energy by 2020. *Figure 11* and *Table 8* show the trend for RES-H[24] between 2005 and 2018, divided by source. Unlike RES-T, the calculation of RES-H excludes renewable electricity used for heating and cooling.

Renewable heat energy is dominated by solid biomass use (78%), in particular in industry. The use of ambient energy (ground-source and air-source) has grown ten-fold between 2005 and 2018 and is now a significant source of renewable heat energy, accounting for approximately 14% of renewable heat energy in 2018.

RES-H was 6.5% in 2018; the target for 2020 is 12%.

Figure 11: Percentage RES-H by source, 2005 to 2018



Source: SEAI

RES-H as a share of total heat energy doubled between 2005 and 2017, increasing from 3.4% to 6.7%. Even though the share doubled, the actual amount of renewable heat energy used only increased by two thirds. The difference was due to the reduction in overall heat energy demand between 2005 and 2017. This highlights that greater energy efficiency in buildings helps Ireland to meet the national renewable heat target and the binding overall renewable energy target, as well as our energy efficiency target and our greenhouse gas emissions targets. In 2018 this trend reversed and RES-H reduced to 6.5%, even though the amount of renewable heat energy used increased. This was because the total amount of fossil energy used for heat increased by more than the amount of renewable energy did.

Table 8: Renewable heat energy by source, 2005 to 2018

	Quantity (ktoe)			Shares (%)			Growth (%)		Average annual growth rates (%)		
	2005	2010	2018	2005	2010	2018	'05-'18	'10-'18	'05-'10	'10-'18	2018
Biomass	176	187	242	94	86	78	38	30	1.2	3.3	1.9
Biogas	7	8	10	4	4	3	41	17	3.9	2.0	0.4
Solar thermal	0	7	14	0	3	4	-	81	74.7	7.7	7.1
Ambient	4	16	44	2	7	14	944	182	29.9	13.8	13.7
Total renewable heat	**187**	**218**	**310**	**100**	**100**	**100**	**65**	**42**	**3.1**	**4.5**	**3.6**
RES-H (%)	**3.4%**	**4.3%**	**6.5%**	-	-	-	-	-	-	-	-

Source: SEAI

Figure 12 and *Table 9* show renewable heat energy by sector and industrial sub-sector. In 2018, most renewable heat energy was still used in industry; between 2005 and 2018, most of the growth was in the residential and commercial sectors, along with cement production (non-metallic minerals sector).

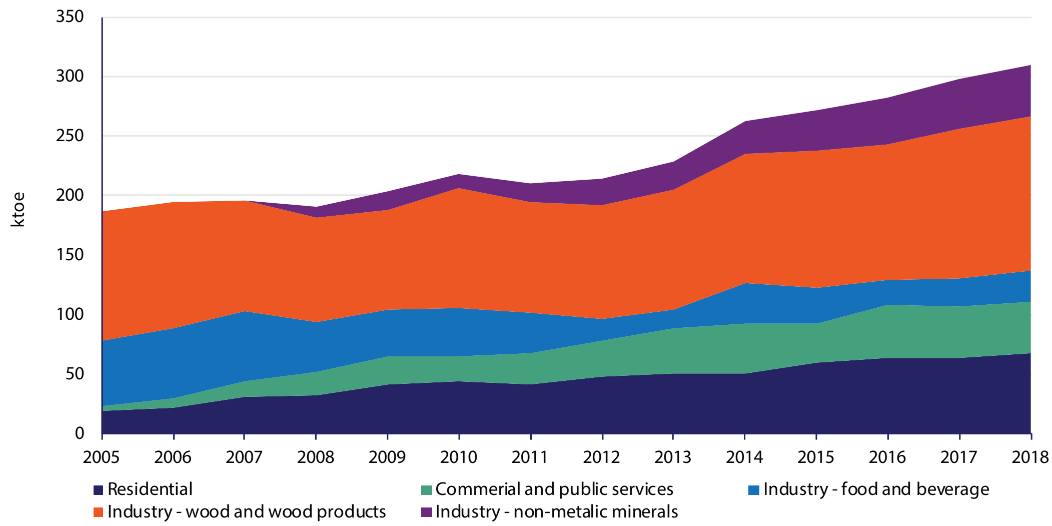
Renewable heat use in the residential sector declined by more than half between 1990 and 2005 due to decreased use of wood in open fires, but increased by 246% between 2005 and 2018.[25] This increase has been due to increased use of wood, including wood chips and wood pellets; solar thermal for water heating; and, increasingly, ambient energy from heat pumps.

Renewable heat increased by a factor of 7 in the services sector between 2005 and 2018. This growth occurred mostly in biomass and ambient energy from heat pumps.[26]

> Increased use of renewables in households was the largest contributor to renewable thermal energy growth between 2005 and 2018.

In industry, most renewable heat energy is in the form of wood waste used in board and saw mills. The food processing industry mostly uses tallow, but this declined by 52% between 2005 and 2018. A significant new source of renewable heat energy that has emerged since 2005 is the use of renewable waste in cement manufacture.

Figure 12: Renewable heat energy by sector, 2005 to 2018



Source: SEAI

Table 9: Renewable heat energy by source, 2005 to 2018

	Quantity (ktoe)			Shares (%)			Growth (%)		Average annual growth rates (%)		
	2005	2010	2018	2005	2010	2018	'05-'18	'10-'18	'05-'10	'10-'18	2018
Industry - food and beverage	54	40	26	29	19	8	-52	-35	-5.7	-5.3	12.7
Industry - wood and wood products	109	100	129	58	46	42	18	30	-1.8	3.3	2.6
Industry - non-metallic minerals	0	12	43	0	5	14	-	265	-	17.6	1.1
Industry total	**163**	**152**	**198**	**87**	**70**	**64**	**21**	**30**	**-1.4**	**3.3**	**3.5**
Residential	20	44	68	11	20	22	246	54	17.6	5.5	8.0
Commercial and public services	4	21	43	2	10	14	965	101	39.6	9.1	-2.0
Total	**187**	**218**	**310**	**100**	**100**	**100**	**65**	**42**	**3.1**	**4.5**	**3.6**

Source: SEAI

4.2 Solid biomass and renewable waste

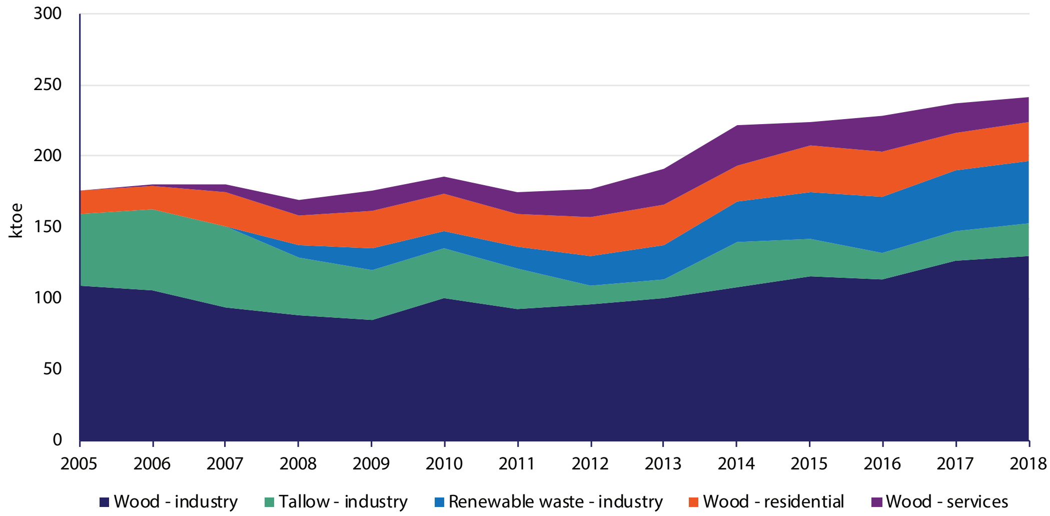
Solid biomass, including renewable waste, is the largest fuel category in renewable heat. Solid biomass covers organic, non-fossil material of biological origin that may be used as fuel for heat production. It includes wood (firewood, wood chips, wood pellets), wood waste (barks, sawdust, shavings, chips, black liquor,[27] etc.), other solid waste (straw, oat hulls, nut shells, tallow, meat and bone meal, etc.) and the renewable portion of industrial and municipal waste.

Most of the solid biomass used in Ireland is for heat energy purposes, where higher efficiencies, relative to electricity generation, make the best use of this valuable resource.

Data on wood and wood waste is based on surveys of wood suppliers, data on tallow is provided by the Department of Agriculture, Food and the Marine, and data on other industrial energy use, including renewable waste, is sourced from the Environmental Protection Agency (EPA) ETS database.

The breakdown of solid biomass by type and sector is shown in *Figure 13* and *Table 10*. Most of the growth since 2005 has been from the use of renewable waste in industry.

Figure 13: Solid biomass used for heat by sector, 2005 to 2018



Source: SEAI

Table 10: Solid biomass used for heat by sector, 2005 to 2018

	Quantity (ktoe)			Shares (%)			Growth (%)		Average annual growth rates (%)		
	2005	2010	2018	2005	2010	2018	'05-'18	'10-'18	'05-'10	'10-'18	2018
Wood - industry	109	100	129	62	54	53	18	30	-1.8	3.3	2.6
Tallow - industry	50	36	24	29	19	10	-52	-33	-6.5	-5.0	13.7
Renewable waste - industry	0	12	43	0	6	18	-	265	-	17.6	1.1
Wood - residential	16	27	28	9	14	12	75	4	10.9	0.5	3.7
Wood - services	0	12	18	0	6	7	-	51	133.7	5.2	-14.1
Total	**176**	**186**	**242**	**100**	**100**	**100**	**38**	**30**	**1.2**	**3.3**	**1.9**

Source: SEAI

4.3 Biogas

Biogas is produced from the anaerobic digestion of sewage, animal slurries and waste in abattoirs, breweries and other agri-food industries. Biogas can be used directly in boilers to provide heat only, in CHP units to provide both heat and electricity, or can be upgraded to biomethane.

Data on biogas use is obtained from surveys of industry including Irish Water for waste-water treatment plants.

In 2017, 10 ktoe of biogas was used for heat, 2 ktoe was used in industry in the agri-food sector and 8 ktoe was used in the public-service sector in waste-water treatment plants.

4.4 Ambient energy from heat pumps

Ambient energy is the energy that heat pumps use to provide useful heat. Heat pumps typically use freely available but low-grade energy from the outside environment: from air, water, or ground. Ambient energy from the ground is often referred to as geothermal energy but for international energy statistics is more correctly known as ground-source ambient energy.[28] The use of ambient energy from the air, or air-source energy, has increased rapidly since 2012. In 2017, the Heat Pump Association of Ireland estimated that over 90% of all heat pumps sold in Ireland were air-source heat pumps.

There has been a large increase in the use of air-source heat pumps in the residential sector.

Heat pumps require energy to 'pump' the ambient energy from the cooler external environment into the warmer internal environment to provide useful heat. For heat pumps to be effective they need to deliver more energy as useful heat than they themselves consume. The ratio of the energy output from a heat pump to its energy consumption is known as the coefficient of performance (COP). If the COP is 3, then for every 1 unit of energy the heat pump uses, it delivers 3 units of energy as useful heat.

Not all of the energy that is output from a heat pump is considered as renewable ambient energy. To calculate the renewable portion, the final energy demand of the heat pump itself is subtracted from the total output of the heat pump. In the above example of a heat pump with a COP of 3, for every 3 units of heat delivered by the heat pump, 2 units are counted as renewable ambient energy. The COP would typically range from 2.5 to 5.6.

Most heat pumps are run on electricity, though some run on natural gas. For electric heat pumps, it is the final energy of the electricity input to the heat pump that is subtracted from the total heat pump output to get the ambient portion, as per the RED methodology.[29]

The amount of ambient energy used in Ireland is based on an estimate of the total number of heat pumps. This is based on a Heat Pump Association estimate of annual sales of heat pumps. For the commercial sector the heat total heat output is based on an assumed typical capacity and COP for each unit installed. For the residential sector, the estimate of heat output per unit was revised downwards in 2018 based on data from the BER database. This resulted in a revision of the estimated renewable ambient energy use from 2002 to 2018.

SEAI estimates that 44 ktoe of renewable ambient energy was used in 2018 in Ireland. This was an increase of 182% on the amount in 2010 and made up 14% of all renewable heat energy in 2018.

4.5 Solar thermal

Solar energy can be captured by solar photovoltaic (solar PV) panels to produce electricity or solar thermal panels to produce hot water. Solar PV contributes to the RES-E target and solar thermal contributes to the RES-H target.

The amount of solar thermal energy used in Ireland is estimated based on an estimate of the surface area of panels installed each year, combined with an assumed annual energy production per square metre. The amount of solar thermal panels installed each year is based on data from SEAI-administered grant schemes and from the BER database.

SEAI estimates that 14 ktoe of thermal energy from solar thermal panels was produced in Ireland in 2018, all in the residential sector. This made up 4% of all renewable heat energy.

5 Renewable energy in electricity

Electricity generation has been the most successful of the three modes for the development of energy from renewable sources. Renewable energy sources are now the second largest source of electricity after natural gas. Ireland has no mandatory target for RES-E for 2020 but has set an ambitious national target of 40%. RES-E forms the backbone of Ireland's strategy to achieve the overall 16% renewable energy target for 2020.

Wind energy is the main source of renewable electricity generated in Ireland. Electricity generated from wind is variable and non-synchronous.[30] Incorporating such a large share of wind energy on the Irish electricity network has required the Irish grid operator, EirGrid, to become a world leader in this area through the DS3 programme.

5.1 Progress towards renewable electricity target

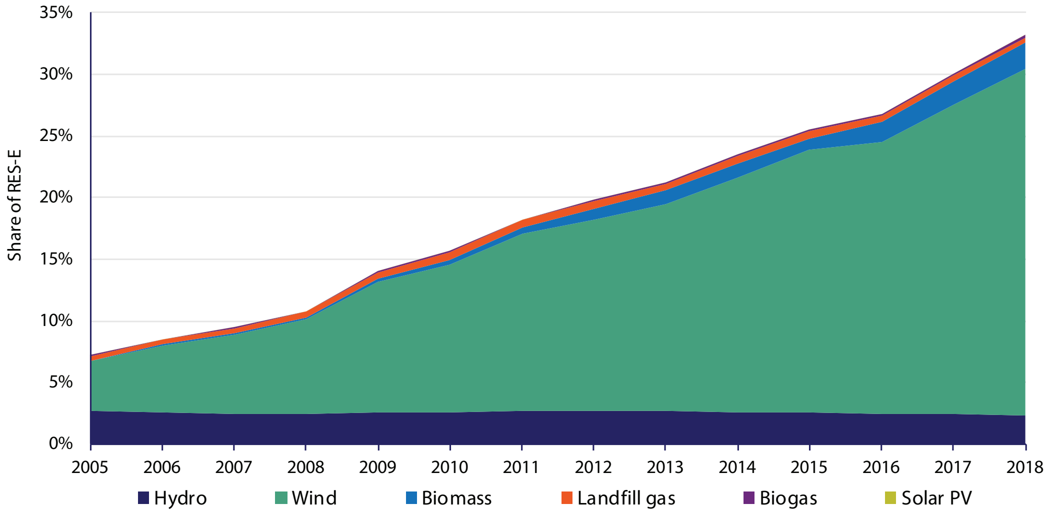
Normalised renewable electricity production by source is shown in *Figure 14* and *Table 11*.

Normalisation is used to smooth out the natural variation in wind speeds and rainfall from year to year. Wind normalisation also adjusts for the effect of large increases in installed capacity midway through a year. Normalisation is discussed more in sections *5.2.3* and *5.3.2*.

RES-E was 33.2% in 2018, up from 30.1% in 2017. The target for 2020 is 40%.

The relatively large share of renewables in electricity generation contrasts with that in heat and transport, reaching 33.2% in 2018. Renewable electricity has been dominated by the growth in wind energy since the early 2000s. Wind accounted for 85% of normalised renewable electricity in 2018. Bioenergy moved to be the second largest source of renewable electricity in 2018 at 8%, followed by hydro at 7%. There was large percentage growth (54%) in energy from solar PV in 2018 but from a very low base and accounted for 0.2% of renewable electricity.

Figure 14: Normalised share of RES-E by source, 2005 to 2018



Source: SEAI

Table 11: Normalised renewable electricity by source, 2005 to 2018

	Quantity (ktoe)			Shares (%)			Growth (%)		Average annual growth rates (%)		
	2005	2010	2018	2005	2010	2018	'05-'18	'10-'18	'05-'10	'10-'18	2018
Hydro	65	65	62	38	17	7	-5	-4	-0.2	-0.5	1.0
Wind	95	293	746	55	76	85	688	154	25.4	12.4	14.7
Biomass and renewable Waste	1	9	57	0	2	6	8262	502	69.3	25.1	24.0
Landfill gas	9	16	12	5	4	1	31	-24	11.4	-3.3	-12.0
Biogas	1	2	4	1	1	0	181	100	7.0	9.1	-0.1
Solar PV	0	0	1	0	0	0	-	3399	-	56.0	54.2
Total renewable electricity	**171**	**385**	**882**	**100**	**100**	**100**	**415**	**129**	**17.6**	**10.9**	**13.7**
RES-E (%)	**7%**	**16%**	**33%**								

Source: SEAI

5.2 Wind energy

Total electrical output from wind in 2018, not normalised, was 8,640[31] GWh. This was an increase of 16% on 2017. Wind generated 28% of gross electrical consumption in 2018, second only to natural gas.

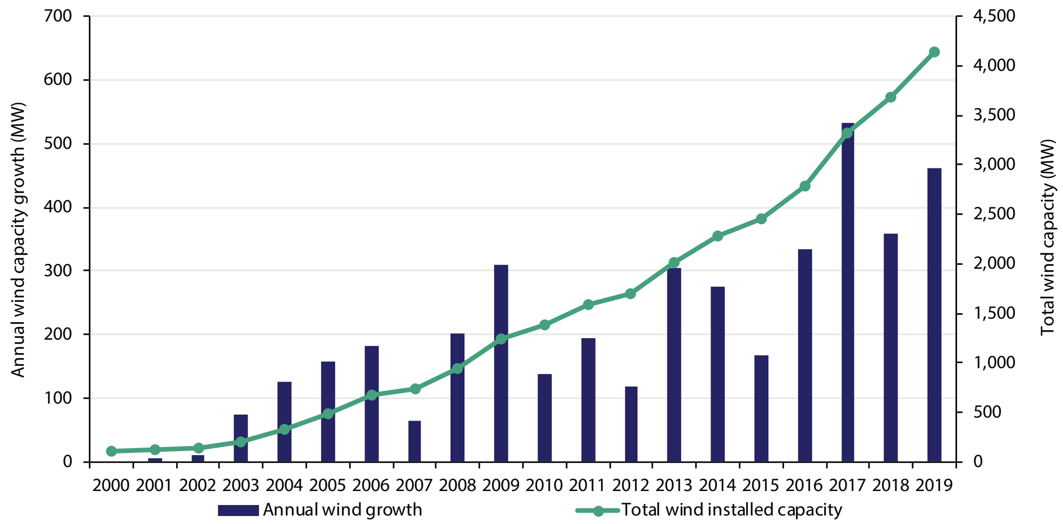
Wind generated 28% of all electricity in 2018, second only to natural gas.

5.2.1 Installed wind capacity

Figure 15 and *Table 12* show the annual growth in installed wind-generation capacity and overall cumulative capacity since 2000. During 2018, 358 MW of wind capacity was installed. The average annual installed capacity between 2008 and 2017 was 258 MW. An additional 461 MW was installed in 2019 bringing the total installed wind capacity to 4,137 MW.

By the end of 2018, the installed capacity of wind-generation reached 3,676 MW. The peak recorded wind-power output in 2018 was 3,058 MW, delivered on 12 December. It represented 69% of the instantaneous system demand at that point. At the time of writing, the historic peak recorded wind-power output[32] was 3,337 MW, delivered at 18:45am on 21 February 2020, at which time wind accounted for 73% of the instantaneous system demand.

Figure 15: Installed wind-generation capacity, 2000 to 2019



Source: EirGrid

Table 12: Installed wind-generation capacity, 2005 to 2019

MW installed wind capacity	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Annual increase in installed wind capacity	157	139	194	120	304	275	168	335	532	358	461
Total installed wind capacity	493	1,390	1,585	1,704	2,008	2,283	2,451	2,786	3,318	3,676	4,137
Two-year average installed wind capacity	415	1,321	1,488	1,644	1,856	2,146	2,367	2,619	3,052	3,497	3,907

Source: EirGrid

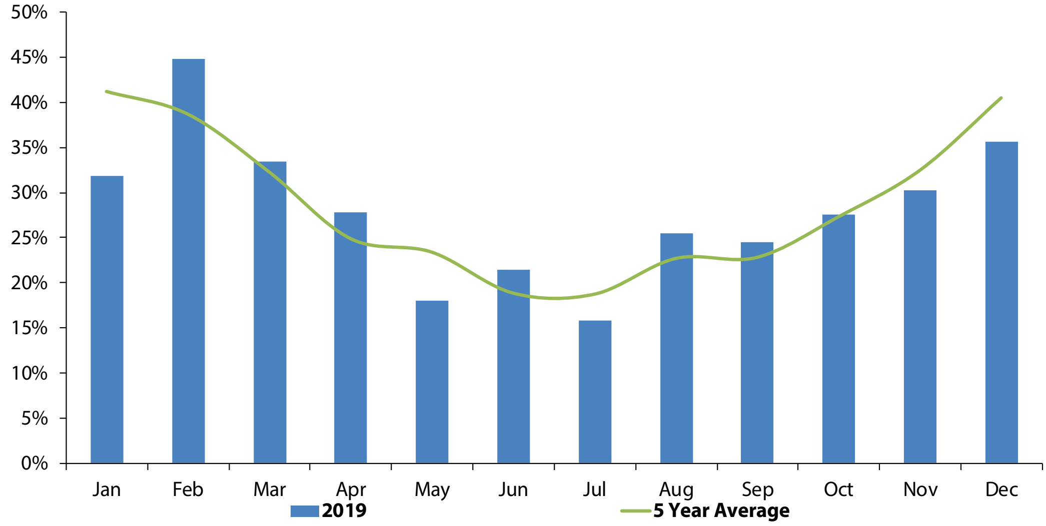
461 MW of wind-generation capacity was installed in 2018.

Successfully integrating these levels of non-synchronous generation is unprecedented and presents significant challenges for the real-time operation of the network. In response to these challenges EirGrid began a multi-year programme, 'Delivering a Secure, Sustainable Electricity System', known as DS3. The aim of the DS3 programme is to enable the operation of the electricity system in a secure manner while achieving the 2020 renewable electricity targets.[33]

5.2.2 Capacity factors

The capacity factor of wind-power is the ratio of average delivered power over a particular time period to the theoretical maximum power. It can be computed for a single turbine, a wind farm or at the national level. It can be calculated across a range of time frames, from days to months to years. *Figure 16* shows the capacity factors for each month in 2019 compared to the long-term average profile. Average wind-generation capacity factors are higher in the winter months and lower in the summer months. February was the windiest month in 2019.

Figure 16: Monthly wind-generation capacity factors, 2019



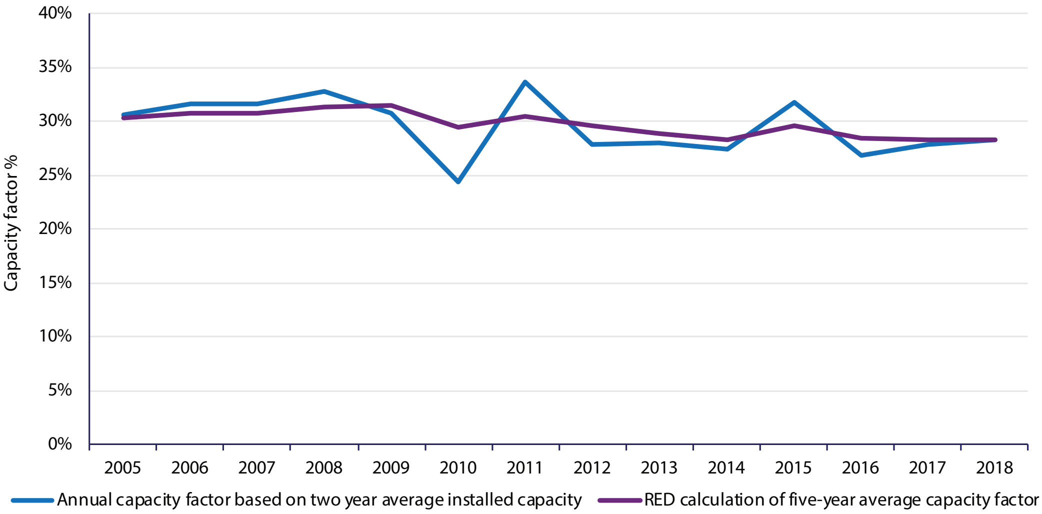
Source: EirGrid & SEAI

At the national level, the profile of newly installed capacity over the course of the year can significantly impact on the annual average capacity factor. If a significant amount of capacity is installed in the last months of the year then the capacity factor for the year will appear low, as this additional capacity will only have generated electricity for a small fraction of the year. For this reason, the RED specifies that the two-year average installed capacity is used, as shown in *Table 12*.

The capacity factor also varies from year to year depending on how windy each year was. For example 2010 was an exceptionally calm year with low wind speeds resulting in a low capacity factor. The annual average capacity factor for wind-power in Ireland from 2005 to 2018 based on two year average installed capacity is shown in *Figure 17* and *Table 13*.

The 5 year average wind-generation capacity factor for 2018 was 28.3%.

Figure 17: Annual wind capacity factors, 2005 to 2019



Source: EirGrid & SEAI

Table 13: Wind-generation capacity factors, 2005 to 2019

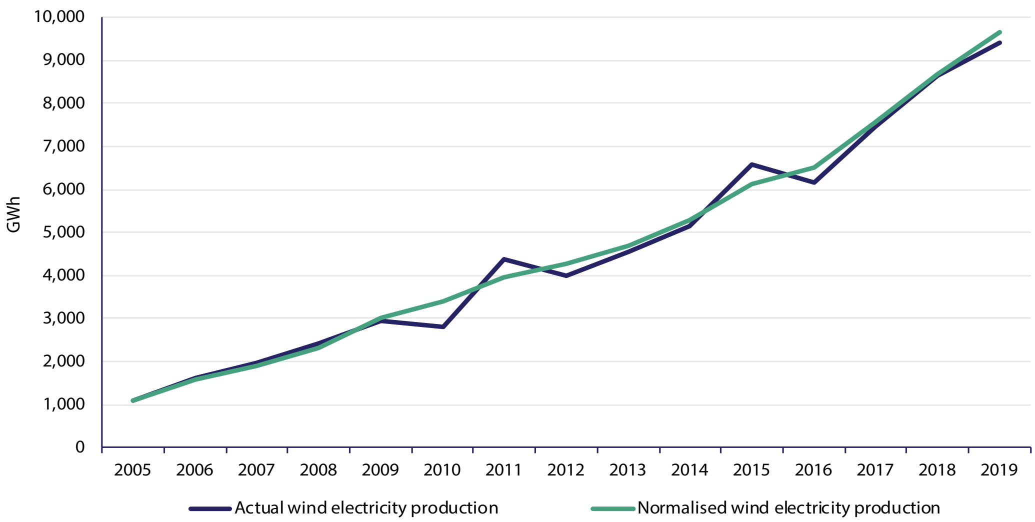
	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Annual wind capacity factor based on two-year average installed capacity %	30.6	24.3	33.6	27.8	27.9	27.3	31.7	26.8	27.8	28.2	27.5
Five-year average wind capacity factor based on RED %	30.3	29.5	30.4	29.6	28.8	28.2	29.6	28.4	28.3	28.3	28.3

Source: EirGrid

5.2.3 Normalisation of wind energy

The RED allows for the effects of high- or low-wind years to be smoothed out by using an average capacity over five years. This is called normalisation. The average installed capacity over the previous two years and the average capacity factor over the previous five years are used in the calculation. Appendix 1 provides a detailed description of the methodology. *Figure 17* and *Table 13* show the five-year average capacity factor as per the RED methodology. *Figure 18* shows the actual and normalised annual wind-powered electricity generation from 2005 to 2018.

Figure 18: Normalised wind-powered electricity generation, 2005 to 2019



Source: SEAI and EirGrid

5.3 Hydro energy

5.3.1 Installed hydro capacity

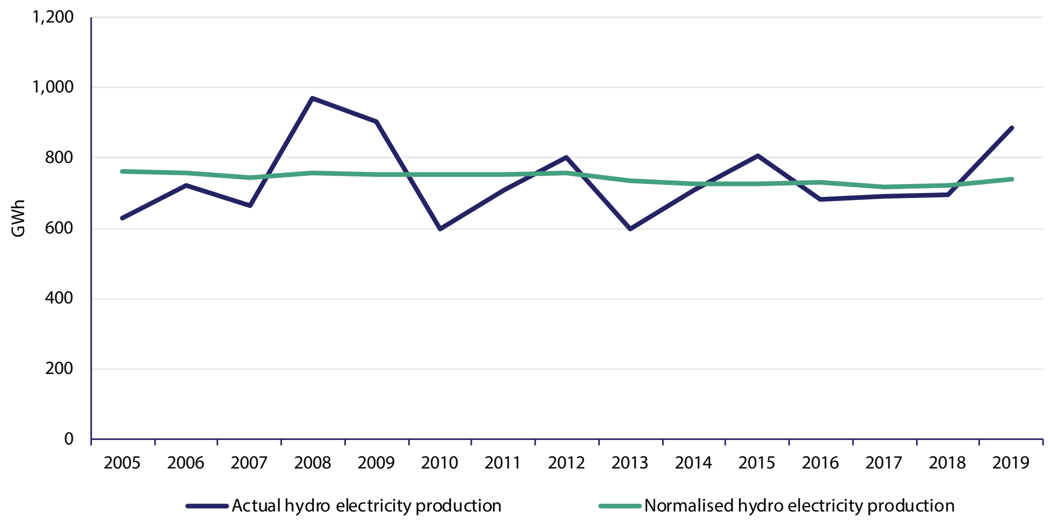
There are 15 hydroelectric[34] generators connected to the electricity transmission system, 14 of which have a maximum export capacity of more than 4 MW. The total hydro connected to the transmission system is 212 MW. There are a further 59[35] hydroelectric generators connected to the electricity distribution system, with a total installed capacity of 26 MW.

5.3.2 Normalisation of hydro energy

The normalisation rule for hydro uses the average capacity factor of the previous 15 years and the installed capacity of the reporting year to calculate the normalised hydro contribution towards the renewable energy targets. *Figure 19* shows the actual and normalised data from 2000 to 2018.

In 2018 hydropower generated 694 GWh of electricity (2.2% of gross electricity). Normalised hydro electricity generation was 724 GWh (2.3% of gross electricity).

Figure 19: Normalised hydro-powered electricity generation, 2000 to 2019



Source: SEAI and EirGrid

5.3.3 Pumped hydro storage

Electricity produced by pumped storage from water that has previously been pumped uphill is not classified as being from a renewable energy source and is not included in either the numerator or the denominator of the RES-E or overall RES calculations. There is one pumped hydro station in Ireland, at Turlough Hill, with a total capacity of 292 MW. As all of the electricity produced from this station is from water that has previously been pumped uphill, it is not classed as renewable. Although it is not a renewable electricity source, pumped hydro storage has attributes which are beneficial for integrating variable non-synchronous electricity generation onto the electricity system.

5.4 Solid biomass

Solid biomass covers organic, non-fossil material of biological origin which may be used as fuel. It is primarily wood, wood waste (firewood, wood chips, barks, sawdust, shavings, chips, black liquor, etc.)[36] and other solid waste (straw, oat hulls, nut shells, tallow, meat and bone meal).

In electricity generation, biomass is primarily used in co-firing with peat, with a small amount also used in combined heat and power plants.

Edenderry Power Station is the only peat-fired power station that co-fires with biomass. In 2018, 321 GWh of electricity was produced from the biomass, or 37% of the electricity generated from Edenderry Power Station over the year.

In 2018, 13 GWh of electricity was produced from biomass combined heat and power plants.

5.5 Renewable waste

There are currently two municipal waste-to-energy plants in Ireland, in Meath and Dublin, with capacities of 17 MW and 60 MW, respectively.

Part of the municipal solid waste used by these plants is biodegradable and is considered to be renewable biomass.[37] When this is combusted, the heat and electricity produced is considered renewable. For each facility, if the renewable portion of the municipal solid waste is not known, then a default value of 50% is used. In 2018, 302 GWh of electricity was produced from the combustion of renewable waste. This was an 89% increase on the previous year.

5.6 Landfill gas

Landfill gas is regarded as a renewable or sustainable energy source for the purposes of meeting targets set down under EU renewable energy targets. Landfill gas in Ireland is only used for electricity generation or is flared directly to the atmosphere. In 2018, 128 GWh of electricity was produced from landfill gas, representing 0.3% of the gross electricity generated. Electricity generated from landfill gas peaked in 2010 at 182 GWh. It is expected that this resource will gradually decline over time as the organic material in the existing landfills fully decomposes.

5.7 Biogas

Biogas is produced by the anaerobic digestion of biological materials such as animal slurries, agri-food waste, and sewage sludges. Once biogas is produced, it can be burned in a boiler to produce heat, used in CHP plants to produce heat and electricity, or upgraded further to biomethane. In 2018, a total of 44 GWh of electricity was generated from biogas CHP in industry and waste-water treatment plants.

Sewage sludge produced in the waste-water treatment plants can be anaerobically digested to produce biogas. This biogas is used on-site in the waste-water treatment plants in CHP units to provide heat and electricity for the plants' own use. In 2018, approximately 31 GWh of electricity was produced from sewage sludge gas.

Biogas is also produced from the anaerobic digestion of animal slurries, waste in abattoirs, breweries, and other agri-food industries. In 2018, approximately 14 GWh of electricity was generated from biogas CHP in industry.

5.8 Solar photovoltaic

Solar PV panels can be installed in residential, commercial or industrial settings, or as a stand-alone electricity-generating plant feeding electricity directly to the national grid. We estimate that there were 24.2 MW of installed solar PV capacity in Ireland in 2018: 17.7 MW in the residential sector and 6.5 MW in the commercial/industrial sector.

In the residential sector, solar PV is mostly installed on new homes to meet the requirements of the building regulations for use of energy from renewable sources. SEAI estimates the installed capacity of solar PV on new dwellings based on the BER database. A single electricity supplier, Electric Ireland, voluntarily offered a domestic microgeneration rate[38] of €0.09 per kWh for micro-generation exported to the grid, including domestic solar PV. This rate will continue to be paid to existing participants until the end of 2020, but the scheme has been closed to new entrants since the end of 2014.

SEAI estimates the installed capacity of solar PV in the commercial/industrial sector using data from SEAI grant programmes such as Better Energy Communities and from regional energy agencies such as the Tipperary energy agency, and on a continuous basis based on public announcements by businesses and suppliers.

In 2018, we estimate that 16.7 GWh of electricity was generated from solar PV, representing 0.1% of renewable electricity or 0.04% of electricity GFC.

In spite of its small contribution in 2018, solar PV is already growing rapidly. As of mid-2018 there were 245 MW of installed capacity contracted for connection to the transmission grid and by the end of 2019 this had increased to 706 MW.[39] There is also likely to be continuing growth in the residential sector due to the renewables requirement in the building regulations for new dwellings and also due to the introduction of a capital grant for domestic solar PV in existing dwellings.[40]

6 EU comparison

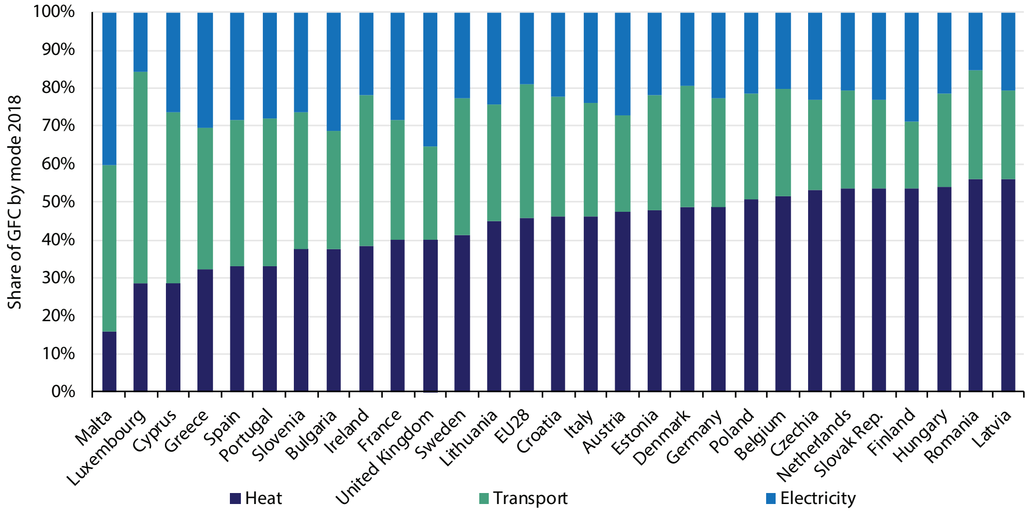
This section provides a comparison of the progress Ireland has made towards its 2020 renewable energy targets with that of other EU Member States.

Eurostat has developed a harmonised approach to calculating and reporting renewable energy shares across the EU. This is done using the SHARES[41] tool. Eurostat publishes the results for each member state annually. Here, we examine the latest available data for 2018.

6.1 Gross final consumption in EU by heat, transport and electricity

Figure 20 shows final energy use in each of the EU-28, the 28 EU Member States, split by heat transport and electricity. In 22 out of the EU-28 heat is the largest end use. Ireland moved into this category in 2018 with heat increasing to slightly more than transport. In 24 of the EU-28 electricity is the smallest of the three end uses. For every Member State except Malta, heat is a larger end use than electricity; for most Member States, the share of heat is twice as big as the share of electricity. This context is important when looking at the contribution of renewable energy in each of the modes to overall renewable energy supply for each EU Member State.

Figure 20: Gross final consumption in EU by heat, transport and electricity, 2018



Source: Eurostat

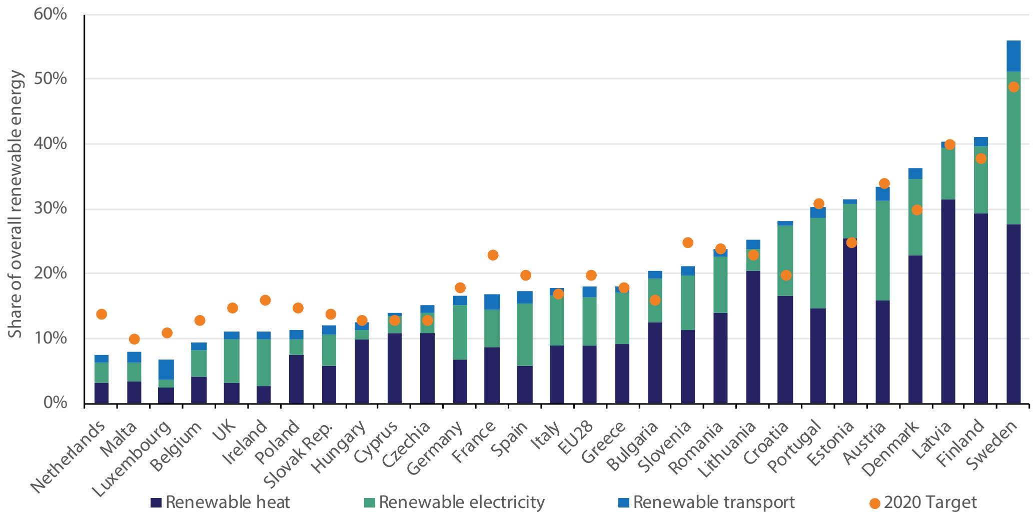
6.2 Overall RES

Figure 21 shows the share of overall renewable energy for each Member State split by the contribution from each mode. Ireland was 23rd out of the EU-28 for overall RES in 2018 on 11.1%, compared to the EU-28 average of 18%. There is a broadly similar pattern across most Member States. Although transport is a major final end use (typically the second largest after heat), renewable transport is small and contributes little to overall renewable energy share. The heat and electricity sectors have achieved higher shares of renewable energy. RES-H contributed the largest share of overall RES in 22 of the EU-28 in 2018. For almost all Member States, the share of RES-H is the most important factor influencing the share of overall renewable energy.

Ireland was 23rd out of the EU-28 for overall renewable energy share in 2018.

Each Member State has its own target for overall renewable energy share in 2020, shown in *Figure 21* by the orange markers. The overall EU-28 target is for 20% overall RES in 2020. These 2020 targets were set in 2007. Each Member State was set a target based on its existing share of renewable energy. Wealthier Member States were also given more ambitious targets. Ireland's 2020 target is for 16% overall RES.

Figure 21: Overall renewable energy share in 2018 for EU Member States



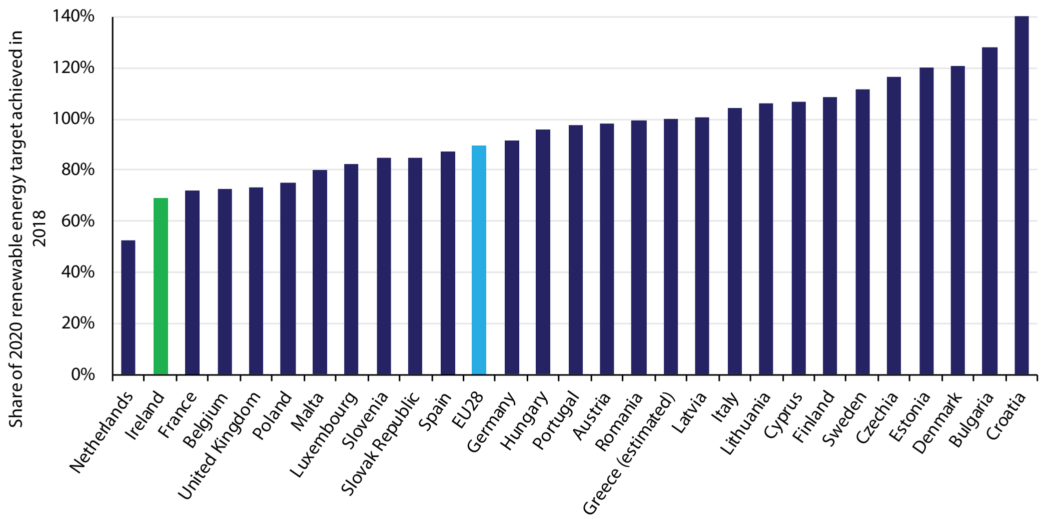
Source: Eurostat

For most of the EU-28, RES-H contributes the largest share to overall renewable energy supply.

Figure 22 examines the progress each Member State had made towards meeting its 2020 target in 2018. The progress in 2018 is expressed as a percentage of the 2020 target; if the 2020 target was already fully achieved in 2018, the progress towards target would be 100%; if the Member State was only half-way towards the 2020 target, the progress would be 50%. Ireland was 27th out of the EU28 in 2018, having reached 69% of the 2020 target, compared to the average for the EU28 of 90%. Twelve Member States had already reached or surpassed their 2020 targets by 2018.

Ireland was 27th out of the EU-28 for progress towards the overall renewable energy 2020 targets in 2018.

Figure 22: Percentage of 2020 renewable energy target achieved in 2018 for EU Member States



Source: Eurostat

6.3 Renewable heat

Figure 23 shows data on renewable heat use split into direct energy use, district heating and ambient energy from heat pumps. In 2018, Ireland was 27th out of the EU-28 for renewable heat, at 6.5%. The EU average was 19.7% and Sweden had the highest share at 65.4% RES-H.

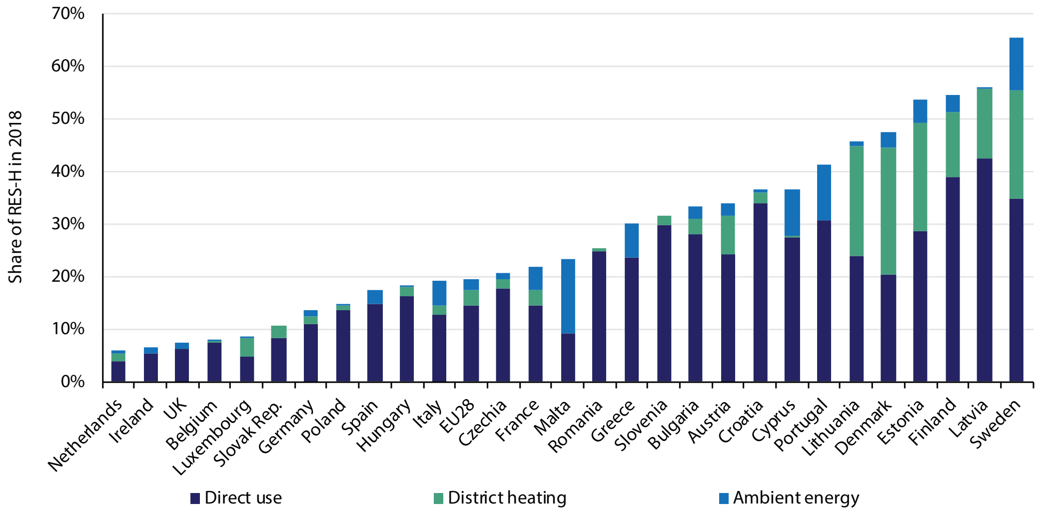
> Ireland was 27th out of the EU-28 for renewable heat in 2018. Ireland's poor performance in renewable heat is the biggest reason for us failing to achieve our overall renewable energy target.

The Member States with the highest levels of RES-H are the Baltic countries, which use significant amounts of renewable heat through district heating networks. The Member State with the lowest levels of RES-H are the northwestern countries, which have high annual heat demands but did not develop significant district heating networks and are reliant on direct fossil fuel use for heat. Despite the lack of past experience of district heating in Ireland, there are significant opportunities for the development of new district heating networks in specific areas that have high heat demand, in particular utilising waste heat.[42]

Some Member States with warmer climates, such as Portugal, have achieved high percentage shares of renewable heating and cooling, but this must be viewed in the context of their overall lower heat demand and the prevalence of traditional wood burning for residential heat.

Ireland's low share of RES-H is the biggest reason for our poor progress towards our overall renewable energy target.

Figure 23: Renewable heat share in 2018 for EU Member States



Source: Eurostat

6.4 Renewable electricity

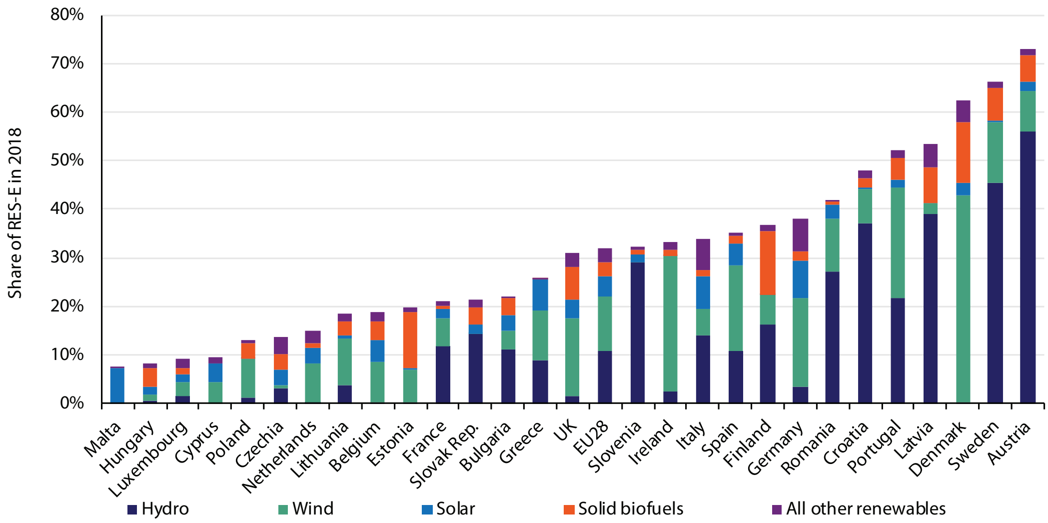
Figure 24 shows the share of electricity from renewable sources for each Member State. In 2018, Ireland was 12th out of the EU-28 at 33.2%, above the EU-28 average of 32.1%.[43]

The Member States with the highest share of RES-E tend to have a high share of hydro energy, for example Austria and Sweden. Electricity that is generated from pumped-hydro plants from water that has previously been pumped uphill does not count as renewable hydroelectricity. However, having pumped-hydro capacity on the electricity grid makes it easier to accommodate significant amounts of variable renewables such as wind. This is the case in Portugal, for example, which had a high share of hydro and the third highest share of wind (22.6%). It is also easier to incorporate large amounts of variable renewables if a Member State has extensive interconnection with neighbouring countries. This is the case for Denmark, which had the highest share of wind energy in 2018 at 42.8%.

Ireland was 12th out of the EU-28 for renewable electricity in 2018. The top performing countries tend to have large hydropower resources.

Ireland had the second highest share of wind-generated electricity in 2018 at 28.1%. In Ireland's case, this was achieved without the benefits of significant amounts of pumped-hydro storage or interconnection and required the Irish electricity grid operator EirGrid to become a world leader in incorporating large amounts of variable non-synchronous generation onto an isolated electricity grid.

Figure 24: Renewable electricity share in 2018 for EU Member States



Source: Eurostat

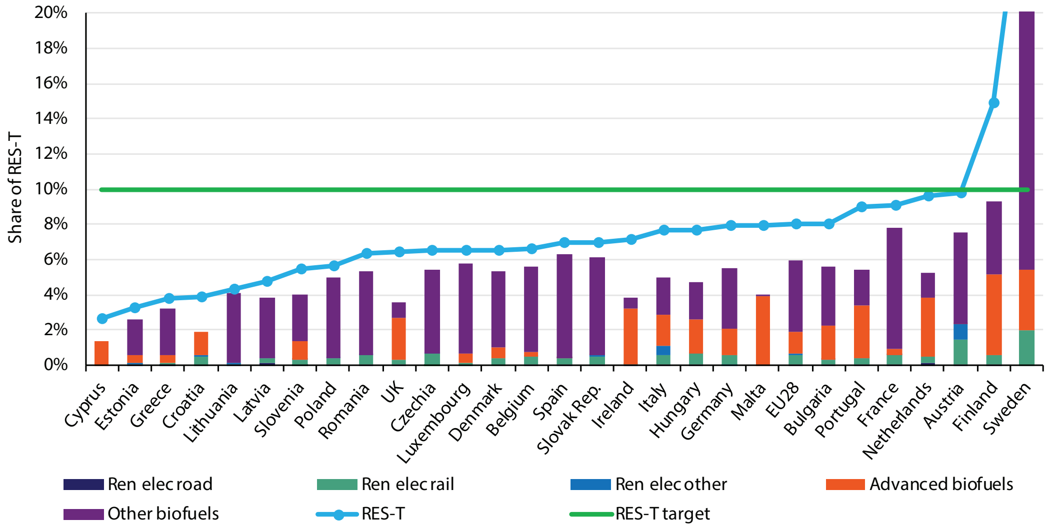
6.5 Renewable transport

In the heat and transport sectors, some Member States have natural advantages over others in adopting renewable energy technologies, for example pre-existing district heating networks or large hydroelectricity resources. In comparison, the transport sector is largely a level playing-field for all. This is reflected in the broadly similar progress made by the majority of Member States, with 15 of the EU-28 achieving between 5.0% and 8.0% RES-T in 2018. In 2018, Ireland was 13th out of the EU-28 for RES-T.

Figure 25 shows the progress of each Member State in 2018 towards the RES-T target. The columns for each country show the amount of each source of renewable energy used without any multipliers applied. The blue line shows the percentage of RES-T achieved when multipliers are taken into account. The green line shows the 2020 target of 10% RES-T for all Member States. For most, the majority of renewable transport energy use comes from first-generation biofuels, which do not qualify for multiple weightings, such as bioethanol from energy crops.

Ireland was 13th out of the EU-28 for renewable transport in 2018.

Figure 25: Renewable transport share in 2018 for EU Member States



Source: Eurostat

The obvious outlier is Sweden, which has managed to achieve 23.2% of renewable energy in road and rail transport not including multipliers, or almost 29.7% RES-T including multipliers.

According to the Swedish Bioenergy Association (Svebio),[44] this is largely due to the use of the so-called 'drop-in' biofuel, hydrotreated vegetable oil. Conventional biofuels are not chemically identical to the fossil fuel equivalents, and can only be blended up to certain ratios without causing technical difficulties when used in engines designed for fossil fuels. In contrast drop-in biofuels are chemically identical to fossil diesel and so can be blended at any rate or used directly in pure form. Pure hydrotreated vegetable oil, referred to as HVO100, was introduced to the Swedish market in 2015 and is now used widely for commercial vehicles, helped by attractive tax exemptions.[45]

Glossary of abbreviations

Abbreviation	Explanation
CHP	Combined Heat and Power
CO_2	Carbon dioxide
COP	Coefficient of performance - usually of heat pump
ETS	EU Emissions Trading Scheme
EU-28	28 Member States of the European Union
GFC	Gross final energy consumption
ktoe	kilo-tonne of oil equivalent
PV	Solar photovoltaic
RED	Renewable Energy Directive
RES	Renewable energy share
RES-E	Renewable energy share in electricity
RES-H	Renewable energy share in heat
RES-T	Renewable energy share in transport
TFC	Total final consumption
toe	tonne of oil equivalent

Glossary of terms

Air-source energy: Heat energy contained in the air, even at low temperatures. Heat pumps can use this low grade energy as a renewable source useful heat.

Ambient energy: The energy that heat pumps use to provide useful heat. It typically comes from use freely available but low-grade energy from the outside environment: from air, water, or ground. It can also come from waste energy streams such as exhaust gases or waste water.

Biodiesel: Biofuel that can be blended with fossil diesel. Includes biodiesel, biodimethylether (DME), Fischer-Tropsch diesel, cold-pressed bio-oil and all other liquid biofuels which are added to or blended with or used straight as transport diesel.

Biofuels: Generally refers to liquid fuels derived from biomass crops or by-products that are suitable for use in vehicle engines or heating systems. They can be considered as potential replacements or extenders for mineral fuels such as diesel or petrol. Liquid biofuels are typically categorised by the fossil fuels that they can be blended with or can replace. The two most common categories of liquid biofuel are biodiesel and biogasoline.

Bioenergy: An umbrella term for energy produced from any biological material including solid biomass, biogas, liquid biofuels and landfill gas.

Biogas: A gas composed principally of methane and carbon dioxide produced by the anaerobic digestion of organic materials. Common feedstocks for the production of biogas through anaerobic digestion include sewage sludge, animal slurries, agri-food waste and crops.

Biogasoline: Biofuel that can be blended with fossil gasoline (petrol). Includes bioethanol, biomethanol, bio-ethyl-ter-butyl ether (bioETBE), bio-methyl-tertio-butyl-ether (bioMTBE), and all other liquid biofuels which are added to or blended with or used straight as transport gasoline.

Biomass: Generally refers to solid organic material that can be used for energy. See Solid Biomass

Carbon dioxide (CO_2): A compound of carbon and oxygen formed when carbon is burned. Carbon dioxide is one of the main greenhouse gases. Units used in this report are t CO_2 (tonnes of CO_2), kt CO_2 (kilo-tonnes of CO_2 {10^3 tonnes}) and MtCO_2 (mega-tonnes of CO_2 {10^6 tonnes}).

Combined heat and power: Combined heat and power (CHP) refers to plants which are designed to produce both heat and electricity. CHP plants may generate for their own use only (auto-producer), may export electricity to the grid, or may also export heat via a district heating network.

Drop-in biofuel: Biofuels that are chemically identical to their fossil fuel equivalent and so can be blended at any rate or used directly in pure form in engines designed to run fossil fuel without modification. In contrast most biofuel are not chemically identical to the fossil fuel equivalents, and can only be blended up to certain ratios without causing technical difficulties with engines designed to run on fossil fuels.

Geothermal energy: Energy originating from the earth's core, for example from high-temperature geothermal vents. The term 'geothermal energy' can sometimes be used to refer low-temperature heat energy in the ground that is used by heatpumps, but this is more correctly referred to as to ground-source energy.

Ground-source energy: Low temperature heat energy contained in the ground. Heatpumps can use this low grade energy as a renewable source useful heat.

Gross final consumption (GFC): The Renewable Energy Directive (2009/28/EC) defines gross final consumption of energy as the energy commodities delivered for energy purposes to manufacturing 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.

Heat pump: A heat pump is a device that moves heat from one location (the source) to another (the sink). Heat pumps are used for space heating and cooling, as well as water heating. Geothermal heat pumps operate on the fact that the earth beneath the surface remains at a constant temperature throughout the year, and that the ground acts as a heat source in winter and a heat sink in summer. They can be used in both residential and commercial or institutional buildings. Other heat pump types are available, such as air- and water-source. These operate on the same principle indoors but the method of collecting heat is different for each type.

Hydrotreated Vegetable Oil: This a drop-in biofuel that can be used as a direct substitute for fossil diesel.

Gross electricity 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.

Hydropower: Potential and kinetic energy of water converted into electricity in hydroelectric plants. Pumped storage is treated separately in the national energy balance. The Renewable Energy Directive 2009/28/EC states that electricity produced in pumped storage units from water that has previously been pumped uphill should not be considered to be electricity produced from renewable energy sources.

Kilowatt hour (kWh): The conventional unit of energy whereby electricity is measured and charged for commercially. Related units are megawatt hour (MWh) and gigawatt hour (GWh) which are one thousand and one million kWhs respectively.

Landfill gas: A gas composed principally of methane and carbon dioxide produced by anaerobic digestion of landfill waste.

Photovoltaic energy (PV): Energy from solar electric panels. Solar radiation is exploited for electricity generation by photovoltaic cells which convert the solar radiation into DC current.

Refuse derived fuels (RDF): Fuels produced from waste through a number of different processes such as mechanical separation, blending and compressing to increase the fuel value of the waste. Such waste derived fuels can be comprised of paper, plastic and other combustible waste and can be combusted in a waste-to-energy plant, cement kiln or industrial furnace.

RES-E: Renewable energy share of electricity.

RES-H : Renewable energy share of heat/thermal energy.

RES-T: Renewable energy share of road and rail transport energy.

Solar PV: See photovoltaic energy

Solid biomass: Covers organic, non-fossil material of biological origin which may be used as fuel for heat production or electricity generation. It comprises: (a) charcoal, covering the solid residue of the destructive distillation and pyrolysis of wood and other vegetal material and (b) wood, wood waste and other solid waste, covering purpose-grown energy crops (poplar, willow etc.), a multitude of woody materials generated by an industrial process (wood/paper industry in particular) or provided directly by forestry and agriculture (firewood, wood chips, bark, sawdust, shavings, chips, black liquor etc.) as well as (c) waste such as tallow, straw, rice husks, nut shells, poultry litter, crushed grape dregs etc. Combustion is the preferred technology for these solid waste. The quantity of fuel used is reported on a net calorific value basis.

Tallow: The fatty tissue or suet of animals.

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.

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

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

Wind energy: Kinetic energy of wind exploited for electricity generation in wind turbines.

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Appendix 1: Methodology for calculating renewable energy shares

Renewable Energy Directive 2009/28/EC

Ireland's binding target under the RED is for renewable sources to account for 16% of GFC, in 2020. There are differing methodologies for the calculation of the overall share of energy from renewables and the individual share of renewables by each mode of energy application, namely heat, transport and electricity (termed RES-H, RES-T and RES-E respectively). These individual targets have separate denominators and in some cases weighting factors; therefore, the individual target percentages cannot be simply added together to get the overall share of renewables.

The main difference arises in transport energy consumption. In the overall RES target all transport energy is included, including aviation and marine, whereas the RES-T target relates only to road and rail energy use (i.e. land transport). There are also weighting factors used in the RES-T calculation for some individual renewable sources (namely biofuels from waste, second generation biofuels and renewable generated electricity powering electric vehicles and rail) but in the calculation of the overall renewable energy target weighting factors are not applied.

Gross final consumption

The RED defines GFC as the energy commodities delivered for energy purposes to manufacturing 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. The renewable energy contribution includes electricity generation, transport energy and thermal energy from renewable sources. This builds on the definition for GFC of electricity used in Directive 2001/77/EC (to track progress in renewable generated electricity) and adds gross final consumption of heat and transport.

- GFC = TFC (Transport) + GFC (Electricity) + GFC (Heat)

In the case of electricity for example, the difference between TFC and GFC is that TFC equates to all electricity demand used by customers, whereas GFC includes the transmission and distribution losses and the in-house use of electricity by electricity generators.

Overall renewables target

In order to facilitate international comparisons of renewable energy, it is necessary to set transparent and unambiguous rules for calculating the share of energy from renewable sources and for defining those sources across all countries. In the RED, the renewable energy share is calculated from the gross final consumption of energy. No weighting factors are applied to renewable energy sources for the calculation of the overall renewable energy share. There is a legally binding European target for Ireland to achieve a 16% share of energy from renewable energy sources in gross final consumption of energy by 2020, specified in Annex 1 of the RED.

Numerator: The numerator here is the sum of the individual renewable sources.

- Electricity – This is the total renewable electricity generation, with the contribution from wind and hydro normalised to account for climatic variation and in the case of wind to smooth the effect of large annual increases in the installed capacity.
- Heat – This is the total renewable energy used for heat purposes, excluding renewable generated electricity that is used for heating to avoid double counting.
- Transport – This is the total renewable energy used for transport, excluding renewable generated electricity that is used for transport to avoid double counting.

Denominator: The denominator is the gross final consumption adjusted so that aviation is limited to 6.18% of gross final consumption (as prescribed in Article 5.6 of the RED).

Renewable electricity (RES-E)

Ireland's 2020 national target for renewable electricity is 40% of gross electricity consumption, but there is no specified mandatory EU RES-E target for 2020.

Numerator: The total renewable electricity for RES-E calculation is the same as the amount calculated for the overall target, i.e. the sum of the individual renewable electricity sources. No multiplication factors are applied in the calculation of the renewable electricity target, but the wind and hydro portions of renewable electricity are normalised for weather variations when reporting progress towards international renewable energy targets.

Denominator: The denominator here is the gross electricity consumption, which is defined as gross electricity generated plus net imports. No account is taken of the renewable content of imports.

It is important to note that the gross electricity generated is different to (greater than) both the final electricity consumption and the total electricity requirement, the latter of which is often quoted by EirGrid, the transmission system operator. Gross electricity includes electricity used within power stations and also transmission system and distribution system losses, whereas the total electricity requirement is the gross electricity requirement minus the in-house load of power plants.

Normalisation

In calculating the contribution of hydro and wind energy for the purpose of the overall 16% target for renewable energy in Ireland by 2020 in the RED, the effects of climatic variation are smoothed through use of normalisation rules. The normalisation rules are specified in Annex II of the RED and different rules apply for hydro and for wind.

The normalised renewable hydro contribution is calculated as the installed capacity of the latest year for hydro multiplied by the sum of electricity generated, divided by the installed capacity for the last 15 years for hydro energy, as shown in *Equation 1*, where:

- N is the reference year;
- $Q_{N(Norm)}$ is the normalised electricity generated by all hydropower plants in year N for reporting towards the RED;
- Q_i is the actual quantity of electricity generated in year i by all hydropower plants measured in GWh, excluding production from pumped storage units, using water that has previously been pumped uphill; and
- C_i is the total installed capacity of all hydropower plants, net of pumped storage, at the end of year i measured in MW.

Equation 1 *Hydro normalisation equation*

$$Q_{N(norm)} = \frac{C_N \times \left[\sum_{i=N-14}^{N} \frac{Q_i}{C_i}\right]}{15}$$

Source: European Commission

The normalised wind electricity contribution is calculated as the average installed capacity of the latest two years, multiplied by the sum of electricity generated, divided by the average year-end installed capacity over the last five years, as shown in *Equation 2*, where:

- N is the reference year;
- $Q_{N(Norm)}$ is the normalised electricity generated by all wind-power plants in year N for reporting towards the RED;
- Q_i is the actual quantity of electricity generated in year i by all wind-power plants measured in GWh;
- C_i is the total installed capacity of wind-power plants at the end of year i measured in MW; and
- n is 4 or the number of years preceding year N for which capacity and production data are available, whichever is the lower.

Equation 2 *Wind normalisation equation*

$$Q_{N(norm)} = \frac{C_N + C_{N-1}}{2} \times \frac{\sum_{i=N-n}^{N} Q_i}{\sum_{j=N-n}^{N} \left(\frac{C_j + C_{j-1}}{2}\right)}$$

Source: European Commission

Renewable heat (RES-H)

In order to meet the 2020 national RES target, renewable thermal energy (RES-H) is required to be around 12% in 2020, but there is not a specified mandatory RES-H target for 2020 in the RED.

Numerator: Total renewable heat for the RES-H target is the same as that for the overall target, i.e. the total renewables used for heat purposes. With regard to geothermal energy, the renewable energy contribution is taken to be the total heat produced by the heat pump less the final energy of the electricity input, i.e. the renewable portion of the heat produced. It is assumed that the coefficient of performance of all heat pumps is 3.5. In the case of direct electric heating, the share of renewable electricity used for heating is not included as it would lead to double counting.

Denominator: In the absence of district heating, thermal GFC is equal to thermal TFC. Hence, thermal GFC is calculated as TFC minus TFC (electricity) minus TFC (transport less electricity used in transport) i.e. the heat demand is calculated as a remainder when electricity and transport demands are subtracted from the overall final consumption.

Renewable transport (RES-T)

There is a mandatory obligation for all Member States to meet the 10% RES-T target by 2020 as well as achieving the overall RES target specified for each Member State.

Numerator: Total renewables for RES-T is the sum of:

- first-generation biofuels used for road or rail
- plus second-generation biofuels or biofuels from waste used for road and rail transport multiplied by a weighting factor of 2[46]
- plus the renewable portion of electricity used for road vehicles multiplied by a weighting factor of 5
- plus the renewable portion of electricity used for rail multiplied by a weighting factor of 2.5.

These weighting factors are used for the calculation of RES-T only and do not apply when calculating the transport contribution to the overall RES share.

The RED attaches an important condition to biofuels: that they must come from sustainable sources. Sustainable sources as defined by Article 17 of the RED are as follows.

- The greenhouse gas emission savings from the use of biofuels and bioliquids shall be at least 35%, in accordance with the methodology prescribed in the RED. This percentage increases to 50% from 2017 and (for new biofuel plants that start production from 1 January 2017) 60% from 2018.
- Biofuels and bioliquids shall not be made from raw material obtained from land with high biodiversity value.
- Biofuels and bioliquids shall not be made from raw material obtained from land with high carbon stock.

Agricultural raw materials cultivated in the EU and used for the production of biofuels and bioliquids shall be obtained in accordance with the requirements and standards set out in the provisions referred to under the heading 'Environment' in part A and in point 9 of Annex II to Council Regulation (EC) No 73/2009.

Denominator: The denominator here is the sum of petrol, diesel, biofuels and electricity used for road and rail transport. The multiplication factor for renewable electricity in rail is included in the denominator, but the multiplication factors for advanced biofuels and renewable electricity used for road transport are not included. Consumption of aviation (kerosene and/or biofuels) and marine transport are not included in the denominator.

Co-operating mechanisms and short-term statistical transfers

If a country is unable to meet the target with indigenous renewable energy sources, there are mechanisms outlined in the RED that could assist in meeting the EU target.[47] There are three main cooperation mechanisms.

- Statistical transfers, where Member States agree to attribute renewable energy produced in one state to another in their statistical accounting for target compliance. There is no specific plant or physical energy involved.
- Joint projects, where the renewable energy from a particular project is shared between the parties, with or without a physical flow of the energy produced. Under Article 9 of the RED joint projects with physical flows can also be arranged with third countries.
- Joint support schemes, where Member States co-finance their new renewable energy production independent of location (within their territories).

Appendix 2: Displacement of fossil fuels by renewable energy

SEAI estimates the amount of fossil fuel use that is avoided through the use of renewable energy, and the resulting reduction in CO_2 emissions. To do this, we are required to make a number of assumptions about which fossil fuels are displaced by each renewable energy source.

Renewable heat and transport

Renewable transport is the most straightforward. We assume that biodiesel and biogasoline replace conventional diesel and petrol respectively.

Renewable thermal energy is assumed to displace thermal energy from oil-fired boilers. The exception is the use of solid biomass in the wood processing industry. In this case we assume that the biomass used does not displace fossil fuel, as biomass has traditionally been used for heat in this sector. This is significant because solid biomass used in the wood processing industry accounted for 58% of all renewable thermal energy in 2017. Biomass used for heat generation in CHP is assumed to displace heat from oil-fired boilers.

Renewable electricity

Variable renewable generators

For renewable electricity, there are a number of considerations. The first is what type of fossil fuel electricity generation is being displaced by renewables. Previously, we assumed that each kWh of electricity generated from non-combustible renewable generation displaced a kWh of electricity from across the entire fossil fuel plant mix. The methodology used now draws on approaches that have been developed for use in baselining studies in credit-based emissions-trading systems.[48,49] Variable renewable energy generators primarily displace electricity from the last fossil fuel plant dispatched to meet electricity demand, also known as the marginal generator. In Ireland these are mostly gas generators.

A further consideration is the interaction between variable renewable electricity generation and both fossil fuel generation and cross-border trade. The simple approach of assuming that a unit of electricity from renewables displaces a unit of electricity from fossil fuel generators cannot account for these complex interactions. To accurately account for these interactions a full dispatch model of the Irish electricity system is required.

SEAI conducted such an analysis for a single year (2012) using a detailed dispatch model. This work is presented in the SEAI report Quantifying Ireland's Fuel and CO_2 Emissions Savings from Renewable Electricity in 2012, which was published in May 2014.[50,51] The advantage of such a model is that it is capable of comprehensively accounting for the extensive range of dynamic factors that influence the interaction of renewable plant and fossil fuel generators and which affect the savings attributed to renewable generation, such as ramping and cycling effects, contingency reserve, network constraints, cross-border electricity trade, etc.

The disadvantage of dispatch models is that because of the level of detail involved, they are labour-intensive to build, update and maintain. For this reason, it is not practical to routinely use a dispatch model to estimate the annual avoided fossil fuel usage and carbon emissions from renewable energy. Instead, the results of the single-year analysis using the dispatch model have been used to inform and refine the results of the simplified approach, in particular by enabling the emissions resulting from ramping and cycling of fossil fuel plants in response to renewable electricity generation to be estimated and accounted for. There are clear limitations in this analysis but it does provide useful indicative results.

On this basis we assume that renewable hydro and wind electricity generation displaces electricity production from natural gas, which is assumed to be the marginal fossil fuel generator. We further assume that wind-generation results in a 5% increase in the energy intensity of the remaining fossil fuel electricity generation mix, due to increased cycling and ramping effects.

Renewable combined heat and power

Biomass used for electricity generation in combined heat and power is assumed to displace electricity production from gas, as the marginal generator.

Biomass co-firing with peat

Biomass used for co-firing with peat was assumed to displace peat up until 2015. From 2016 onwards biomass used for electricity generation is assumed to displace natural gas.

Up until 2015 burning peat for electricity generation was supported directly by the Public Service Obligation. In this case, where biomass was co-fired with peat, it was assumed to be directly displacing peat, as if the biomass had not been used, the support was in place to burn peat instead.

Since 2016, electricity generation from peat is no longer supported by the Public Service Obligation. Instead, burning of biomass at Edenderry is directly supported under REFIT 3. In this case, if the biomass was not used, it would not be replaced with peat. Instead it would be replaced by the marginal generation plant which is assumed to be gas.

Bioenergy carbon dioxide accounting

For combustible renewables, such as solid biomass and liquid biofuels used for heat, transport or electricity, we use the standard carbon dioxide accounting rules that are used to calculate Ireland's greenhouse gas emissions targets.[52] Therefore as long as a biofuel meets the minimum sustainability requirements set out in the RED it is counted as zero carbon at the point of combustion.

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