SUSTAINABLE
ENERGY AUTHORITY
OF IRELAND

ENERGY IN IRELAND

2021 Report

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December 2021

Sustainable Energy Authority of Ireland (SEAI)

SEAI is Ireland's national energy authority, investing in and delivering appropriate, effective and sustainable solutions to help Ireland's transition to a clean energy future. We work with Government, homeowners, businesses and communities to achieve this, through expertise, funding, educational programmes, policy advice, research and the development of new technologies. SEAI is funded by the Government of Ireland through the Department of the Environment, Climate and Communications.

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

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

Acknowledgements

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

Foreword

William Walsh

Despite a short reprieve, the global health crisis continues to impact our lives and our energy use. The easing of restrictions on our movement in the second half of 2020 led to a rebound in energy demand and associated emissions. This highlights, once again, the intrinsic link between our lifestyles and our use of fossil fuels.

During 2020 17,600 homes were upgraded for improved energy efficiency, 4,840 new electric vehicles entered our private car fleet, and 90 public building retrofits were delivered, among a plethora of other measures, with government investment of €121 million disbursed through programs that SEAI delivers, on behalf of Government. Yet emissions today are increasing back towards pre-pandemic levels, following the temporary decline in 2020. These facts demonstrate both a growing appetite in the market for action to decarbonise our energy system, and the persistent link between our economy, energy use and emissions. It's clear that the rate of deployment of sustainable energy technologies and behaviour change must vastly accelerate.

2020 was a landmark year for energy targets. We have been connected to the EU 2020 targets as our primary objective since they were first set over a decade ago. As illustrated in the pages of this report, we have had mixed success. We have performed strongly against our renewable electricity target and in doing so placed Ireland at the global forefront when it comes to integrating variable renewable energy on our electricity system. We achieved renewable transport target, primarily by blending of petrol and diesel with sustainable biofuels. However, we fell well short of our renewable heat, energy efficiency and emissions related targets. This fact cannot be overlooked, and we must reflect and react in real time to the lessons learned from this failure.

Since learning of this shortfall Government has taken significant steps to address the gap. We now have some of the most demanding decarbonisation targets globally, with the necessity to halve emissions by 2030 and reach net-zero by 2050 now enshrined in Irish law. This will soon be accompanied by sectoral carbon budgets that will serve to further illustrate the need for a drastic acceleration of action. The consequence of slow reaction will be further failure in 2030. With increased budget commitments, a revised Climate Action Plan, and increased focus across all media via a coordinated national movement, I believe achieving the 2030 targets is entirely possible. But they will only be achieved with sustained commitment to action delivered on an emergency footing. There is no precedent from the past that illustrates how quickly we must act. We continue to pull together around the health pandemic, we must do the same around the climate crisis.

At SEAI we continue to work with Government to deliver innovative programmes for all energy users to drive their energy transition. We are coordinating research and analysis to inform the next wave of policy initiatives and supports for society to work together to get this done. I truly believe that as Ireland prioritises this challenge, we will have policy learnings to share and new business models to export globally, as all countries move to tackle the climate crisis. Maya Angelou once said, "You may encounter many defeats, but you must not be defeated". We now need to apply that same logic to the existential challenge posed by the climate crisis. It's time to make sure we leave future generations with a planet on which they can thrive. Our actions now will define our legacy.

William Walsh

Chief Executive

Sustainable Energy Authority of Ireland

Highlights 2020*

Overview

- The public health measures taken to combat the COVID-19 pandemic had far-reaching impacts on all aspects of society during 2020, including on our energy use and resulting CO_2 emissions.
- Total energy consumption fell by 8.7% against a backdrop of a 4.2% contraction of the economy.
- Practically all of the reduction in energy use occurred in the transport sector because of reduced mobility during the COVID-19 pandemic.
- Oil use decreased by 16.5% - the largest annual reduction observed to date - largely due to reduced transport energy use.

Energy-related CO_2 emissions

- Energy-related CO_2 emissions from the combustion of fossil fuels accounted for 57% of Ireland's total greenhouse gas emissions.
- When international aviation is included, energy related CO_2 emissions fell by 11.4%. (4.3 million tonnes of CO_2)
- Almost half of the observed CO_2 reductions are due to the drop in international aviation, with a 78% reduction in passenger numbers and a 65% reduction in flight numbers.
- Energy related CO_2 emissions excluding international aviation decreased by 6.3% (2.1 million tonnes). This is less than the amount that will need to be achieved on average every year from 2021 to 2030 to meet our long-term decarbonisation goals.

Renewable energy targets

- Ireland did not meet its EU 2020 overall renewable energy target. The overall share of renewable energy was 13.5%, compared to the target of 16%.
- Ireland succeeded against its EU 2020 renewable energy target for transport (10.2% vs. 10%), and just missed its renewable energy target for electricity (39.1% vs. 40%).
- Ireland achieved just half its 2020 renewable energy target for heating and cooling (6.3% vs. 12%).
- Energy from renewable sources grew by 8.9% in 2020.

*Note: All percentage changes are 2020 compared to 2019, unless otherwise stated.

Transport

- There were significant restrictions on personal mobility during 2020 which had direct effects on transport energy use, especially on international aviation and private cars.
- Total transport energy use was down by over a quarter (-26%).
- The largest reduction in transport energy use was the two-thirds drop in jet kerosene use for aviation (64.3%).
- Consumption of road diesel and petrol were down 13.6% and 25.9%, respectively.

Electricity

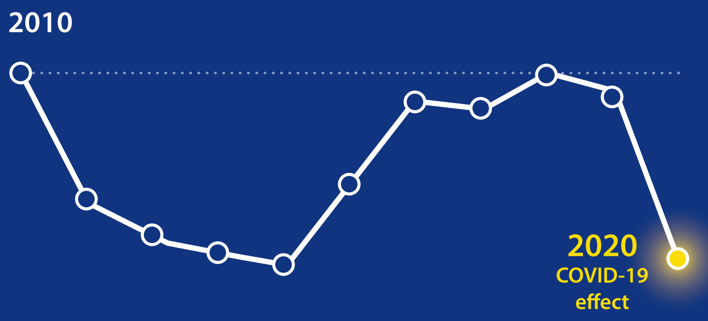
- Peat used for electricity generation fell by 51%.
- 42% of all electricity generated in 2020 came from renewable sources.
- 86% of all renewable electricity came from wind, with the remaining 14% evenly split across hydroelectricity and bioenergy sources.
- Ireland had a total installed wind capacity of 4.3 GW at the end of 2020 - an increase of 180 MW on 2019.
- There has been a strong reduction in the CO_2 intensity of electricity generation, especially after 2016, with intensity falling below 300 gCO_2/kWh for the first time in 2020. It is now less than half of its 2005 value.

Heat

- Energy used for heat increased by 3.2% in 2020.
- This was mostly due to an 7.4% increase in oil use for heat. In contrast gas use for heat declined by 0.6%.
- Energy related CO_2 emissions from heating increased by 2.6% or 0.4 million tonnes.
- CO_2 emissions from residential heating increased by 9.1% or 0.6 million tonnes and the sector was responsible for 53% of CO_2 emissions from heating.

2020 Key Figures

The public health measures taken to combat the COVID-19 pandemic had far-reaching impacts on all aspects of society during 2020, including on our energy use and resulting CO_2 emissions. Total energy use was down substantially on previous years, with most of the reduction occurring in transport.



Total energy consumption

-8.7%

Energy-related CO_2 emissions*

-11.4%

*including international aviation

	Energy use	Energy-related CO_2 Emissions
Residential	+8.4%	+6.2%
Transport	-26.0%	-26.5%
Business	-1.7%	-5.7%

Renewable energy targets

	2020	2020 TARGETS	
Overall RES target	13.5%	16.0%	✗
Renewable Heat	6.3%	12.0%	✗
Renewable Transport	10.2%	10.0%	✓
Renewable Electricity	39.1%	40.0%	✗

Note: Figures are all 2020 compared with 2019, unless otherwise stated.

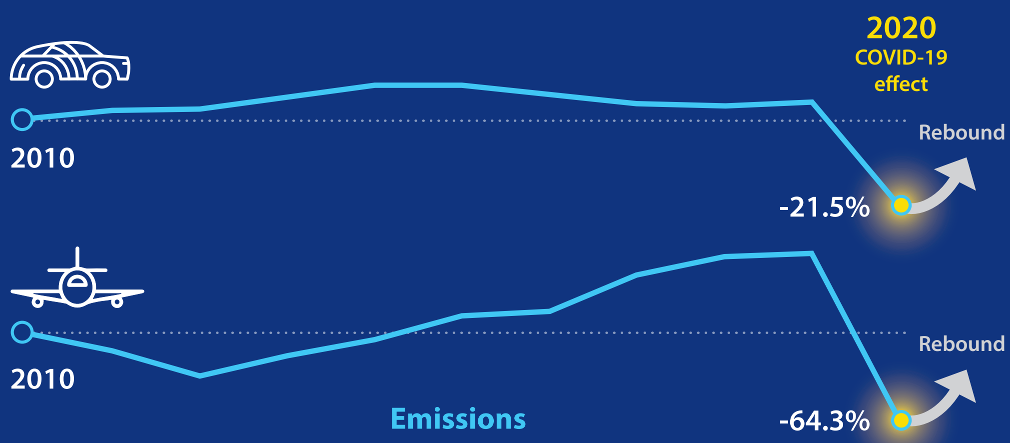
Heat 13.5 $MtCO_2$

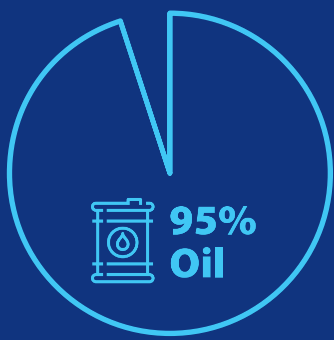
Emissions **+2.6%**

The increase was mainly in oil products...

...caused by low oil prices in 2020

Transport 11.2 $MtCO_2$





Electricity 8.4 $MtCO_2$

Electricity generated **+2.0%**

CO_2 intensity of electricity **-7.6%**

Peat used -50.8%

Wind energy +15.3%

Shares of electricity generated by fuel

Gas 51%

Wind 36%

Coal & peat 5%

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1 Introduction

This annual publication from SEAI presents national energy statistics on energy use in Ireland from 2005 to 2020. It details trends in energy production and consumption and provides updates on Ireland's progress towards EU energy and climate targets. The report presents data and insights into the underlying drivers of energy use in different consumption sectors (transport, industry, services, residential and agriculture).

Timely and reliable energy statistics are needed to inform evidence-based decision-making. This publication presents a comprehensive overview of energy supply and demand in Ireland to inform Government policy and wider conversations on the future of Ireland's energy transition. As the pace and intensity of climate change discussions build, it is crucial that debate is informed by accessible, robust, and transparent statistical evidence from all emitting sectors.

1.1 Energy in 2020

COVID-19 and related public health measures had a significant impact on Irish society and economy in 2020. Clearly its most immediate and damaging impact was the appalling loss of life and serious illness, and the resultant strain on our health services.

Looked at through an energy lens, national and international travel restrictions caused a step-change in the transport sector, supply-chain disruptions changed energy consumption patterns in the industry sector, and the closure of schools and universities affected public services.

While these changes in energy use resulted in real and significant reductions in CO_2 emissions (energy related CO_2 emissions were down 11.4% in 2020), it is important to understand that much of the change was driven by the temporary public health measures taken in response to the COVID-19 pandemic and are not representative of long-term trends towards a sustainable energy transition.

In the two sub-sections below, we work to separate and summarise those changes in 2020 energy use that were driven by COVID-19 impacts that are likely to rebound without additional effort, and those that were due to long-term changes that extend through the COVID-19 impacted periods. Section 1.2 provides preliminary energy data from 2021 that already shows the rebound of certain energy sources to pre-COVID-19 levels, particularly petrol and diesel.

2020 was also a landmark reporting year for renewable energy targets, which are definitively captured in this report. Ireland achieved its EU transport target (RES-T) and came very close on the national renewable electricity target (RES-E). However, we did not reach our overall 2020 renewable energy target, and we fell far short of our renewable heating and cooling target (RES-H). Missing these 2020 RES-targets highlights the need to accelerate the deployment of energy efficiency and renewable energy technologies, and to increase sustainable energy practices across all sectors.

Government has recognised this and responded by increasing the ambition in the recently updated Climate Action Plan. The updated 2021 Climate Action Plan includes an enhanced suite of actions to achieve the targets contained within the Climate Action and Low Carbon Development (Amendment) Act 2021. These actions will seek to ensure we stay within our carbon budgets and achieve our economy-wide targets of 51% emissions reduction by 2030 and net-zero emissions by 2050.

1.1.1 COVID-19 impacts on 2020 energy data

Ireland's first COVID-19 related lockdown was announced in mid-March 2020, so the majority of 2020 energy consumption occurred during COVID-19 impacted periods. Public health measures directly changed energy consumption patterns through travel restrictions, work-from-home directives and recommendations, the closure of public services like schools and universities, and of private business, particularly in the hospitality sector. As a result, Ireland experienced a step-change in the consumption of energy in 2020, with final energy consumption down by 9.6% on the previous year. To put that one-year drop in context, the long-term trend in final energy consumption since 2014 (the last year final energy consumption was so low) had been a net growth of 14.3%.

Practically all of the 9.6% drop in total final energy use occurred in the transport sector which saw a 26% drop in final energy use. International aviation (-64%) and private car (-21%) were the sub-sectors most affected by COVID-19 related travel restrictions.

Ireland's transport sector remains dominated by oil, so this reduction in transport energy significantly contributed to the overall 11.4% reduction in energy-related CO_2 emissions in 2020. However, as discussed in Section 1.2 below, early data for 2021 shows that the easing of COVID-19 restrictions has led to deliveries of petrol and diesel returning to pre-pandemic levels.

In contrast to the transport sector, the use of energy for heat and electricity was largely unaffected by COVID-19. There was an increase in residential oil use, likely due in part to increased time spent at home due to COVID-19 restrictions. This highlights the importance of efficient and renewable heating sources, and the quality of home insulation, as work-from-home and hybrid-models of employment become more established.

It is a startling fact that energy related CO_2 emissions fell by less in 2020 than will be required every year between 2021 and 2030, on average, if we are to meet our 2030 targets for reducing greenhouse gas emissions. Understanding the impact of COVID-19 on energy use and associated CO_2 emissions in the context of its wider impacts on society and the economy, highlights the magnitude of the change needed to address the climate challenge. To meet this challenge, we need nothing short of a sustained societal movement that ultimately ends the use of fossil fuels.

1.1.2 Non-COVID energy trends in 2020

Although COVID-19 caused several step-changes in energy use for 2020, it is still possible to identify longer-term drivers and trends in the supply and demand of energy in Ireland. For example, the fraction of fossil fuels in the primary energy fuel mix continued to decline marginally, in line with established trends. In 2020, 86% of Ireland's primary energy came from fossil fuels (oil, gas, coal, or peat), down from 88% in 2019 (and 97% in 2005). In parallel, 2020 saw another modest increase in renewable sources, with 13.3% of primary energy supply coming from renewables (up from 11.2% in 2019), mainly attributable to increased wind generation capacity (up by 180 MW in 2020).

The fuel mix for electricity generation continued to trend in favour of renewable sources, and reduced dependence on fossil fuels. In 2020, 69% of energy used to generate electricity came from fossil fuels, down from 71% in 2019 (and down from 93% in 2005). Electricity generation from peat halved in 2020, due to closures at two of the three peat burning power plants. 42.1% of the electricity generated in 2020 was from renewable sources, up from 37.6% in 2019 (and up from 6.8% in 2005). The reduced dependence on fossil fuels and increase in renewable generation resulted in continued improvement to the CO2 intensity of electricity generation. In 2020, the CO_2 intensity of electricity fell below 300 gCO_2/kWh for the first time, less than half of its 2005 value.

In 2020, there were small increases in the use of oil and coal for electricity generation, a trend that appears to accelerate in 2021.

1.1.3 2020 Energy flow from primary supply to final use

Figure 1 is a Sankey diagram that shows the flow of energy from primary supply on left side (broken out by fuel) to final consumption on the right side (broken out by sector). The flow also captures the transformation and transmission losses, largely due to electricity generation. Ireland's total primary energy supply requirement in 2020 was 13,350 ktoe, which enabled for a total final energy consumption by end user of 11,246 ktoe.

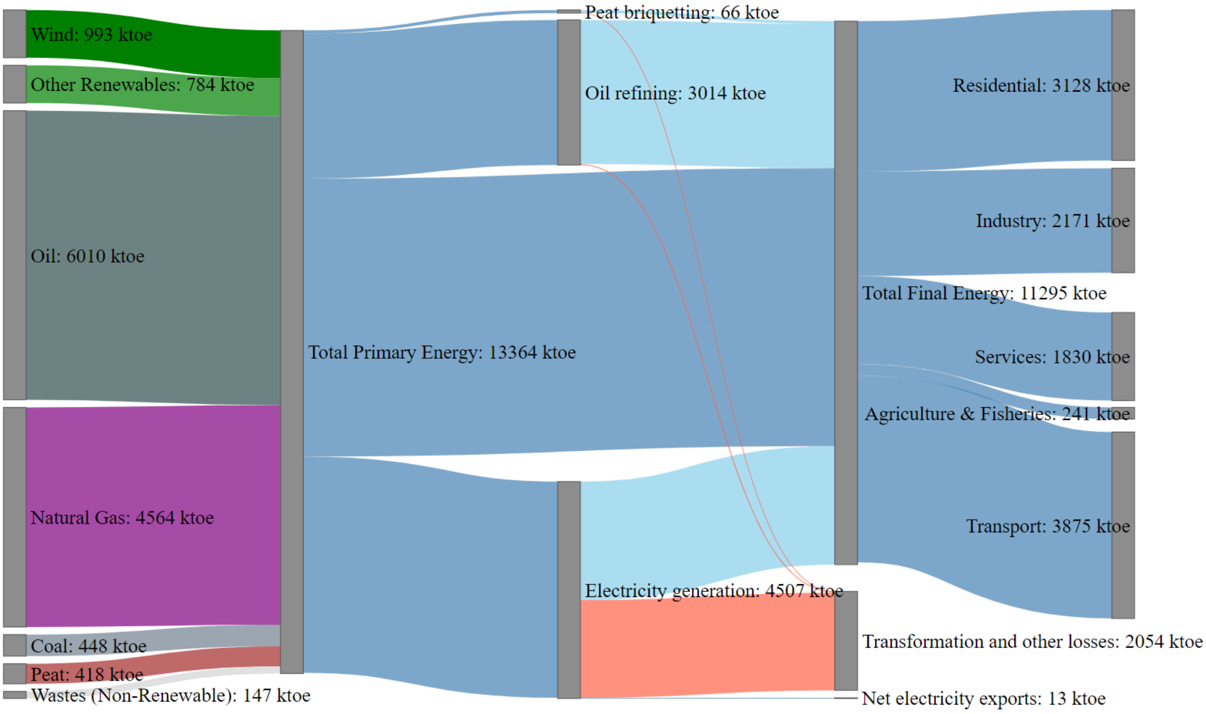
The unit of ktoe (kilo-tonne oil equivalent) is generally used in this report, and in the energy balances, to align to standardised Eurostat and IEA reporting practices.

In 2020, fossil fuels (oil, natural gas, coal, and peat) accounted for 86% (11,439 ktoe) of Ireland's total primary supply of energy. Oil alone accounted for 45% (6,010 ktoe) of all primary energy supply, making it by far the single largest energy source. Renewable energy sources accounted for 13% (1,778 ktoe) of Ireland's primary energy in 2020. Non-renewable wastes and electricity imports accounted for the remaining 1% of primary energy supply.

In 2020, energy losses associated with the generation and transmission of electricity were 2,028 ktoe, equivalent to 45% of the primary energy supply used to generate that electricity. These losses are the single largest source of difference between the total primary supply of energy, and the final energy available to end-users for direct consumption. Over the last 15 years, these losses have decreased from 59% to 45%, due to more efficient fuels and the adoption of new technologies, phasing out older and less efficient thermal generators.

The transport sector remains Ireland's largest end-user of energy. In 2020 it accounted for 34% (3,875 ktoe) of total final energy consumption. This was down considerably from 42% (5,235 ktoe) in 2019, due to the impact of public health measures that limited national and international travel.

Figure 1: Energy flow in Ireland 2020[1]



Source: SEAI

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

1.2 Early indications from 2021

The main part of this report focuses on the latest statistics on annual energy use from the 2020 National Energy Balance. The annual National Energy Balance is the most comprehensive and robust account of national energy use. It tracks all fuel use and provides detailed information on how energy is used in each sector.

SEAI also collects monthly data for a smaller selection of fuels. This data is more limited in scope than the National Energy Balance, as it only covers a selection of fuels and only shows total fuel use (it does not provide data on energy use in each sector and subsector). This data is provisional and subject to revision from energy suppliers. However this monthly data is more timely than the annual data and can be used to give early indications of emerging trends in the current year. This is particularly relevant for 2021 due to the ongoing effects of the COVID-19 pandemic.

This section examines the monthly data for 2020 and 2021, and gives us an early picture of how energy use has responded to the easing of COVID-19 restrictions during 2021.

1.2.1 Oil products

In 2020, the restrictions put in place in response to the COVID-19 pandemic had the greatest impact on oil use, especially in transport. The latest data available on oil supply is up to September 2021, as shown in *Figure 2*. This shows data for five different oil products. It shows the trend for 2020 and 2021 and for comparison also shows the trend for 2019 and the range observed between 2015 and 2019. The data shown is for 'Gross Inland Deliveries', which is essentially the amount of oil product coming into the Irish energy system, either from the refinery or directly imported. Unlike electricity or gas supplied from the grid, oil products can be easily stored from one month to the next, so the trend shown does not correspond exactly to total oil used in each month.

Petrol (road)

The vast majority of petrol is used for private cars. Annual petrol use has decreased every year since 2006, and is expected to continue to decrease year on year due to the switch from petrol to diesel new cars seen from 2008 onwards. This explains why the monthly totals for 2019 were the lowest observed in the period 2015 to 2019. The impact of public health measures to combat COVID-19 had a clear impact in 2020, particularly during periods of Level 5 restrictions in April and November 2020 and January 2021. The impact of the COVID-19 measures persisted until summer 2021, but by June 2021 petrol use had recovered to business-as-usual levels. The fact that petrol use from June to September 2021 was lower than observed in 2019 is in keeping with the longer-term trend of steadily reducing petrol use, rather than the exceptionally low levels seen as a result of COVID-19 restrictions.

Diesel (road)

Diesel is used for the majority of road transport, including heavy goods vehicles, light goods vehicles and private cars. In contrast to petrol, annual diesel use increased every year between 2012 and 2019, leading to the monthly totals for 2019 being among the highest observed in the period 2015 to 2019. There was a sharp reduction in April 2020 when the COVID-19 pandemic first hit, but consumption recovered to near normal levels by July 2020. There was another sharp reduction during the Level 5 restrictions in Jan 2021, but by June it had returned to business-as-usual levels and in September 2021 it reached the highest monthly total since our records begin in 2008.

Heating (gasoil and kerosene)

There are two oil products that are commonly referred to as "heating oil" in Ireland, marked gasoil and kerosene, shown together in *Figure 2*. Annual heating oil use has been on an increasing trend since 2014, but is also affected by significant cold weather events from year to year. Looking at the monthly data, there is strong seasonal variation, as would be expected. There was a dramatic spike in Gross Inland Deliveries of heating oil in March 2020. This does not imply that this much oil was actually used in that month, just that it was supplied to the market. It was likely stored and used throughout the remainder of that year. This spike is likely related to the sudden collapse of global oil prices seen in March and April 2020 following the onset of the COVID-19 pandemic. In 2021, heating oil use has returned to business-as-usual levels, and over the first nine months has seen higher consumption than any year since 2010, with the exception of 2020.

Jet kerosene

Jet kerosene is used for aviation. Annual jet kerosene use has been increasing strongly year-on-year since 2012, leading to the monthly totals for 2019 being among the highest observed in the period 2015 to 2019. However aviation was the sector hardest hit by the COVID-19 travel restrictions, and in 2020 passenger numbers were down 78% on 2019 levels, flight numbers were down 65% and aviation energy use was down 64%. The impact of the pandemic on aviation energy use persisted well into 2021, with aviation energy use for the first nine months of 2021 68% below the same period of 2019, despite increasing energy use from May to September.

Overall

If we exclude jet kerosene, then total Gross Inland Deliveries of petrol, diesel, marked gasoil and kerosene for September 2021 were greater than in September 2019 and have essentially returned to business-as-usual levels.

Figure 2: Monthly gross inland deliveries of selected oil products

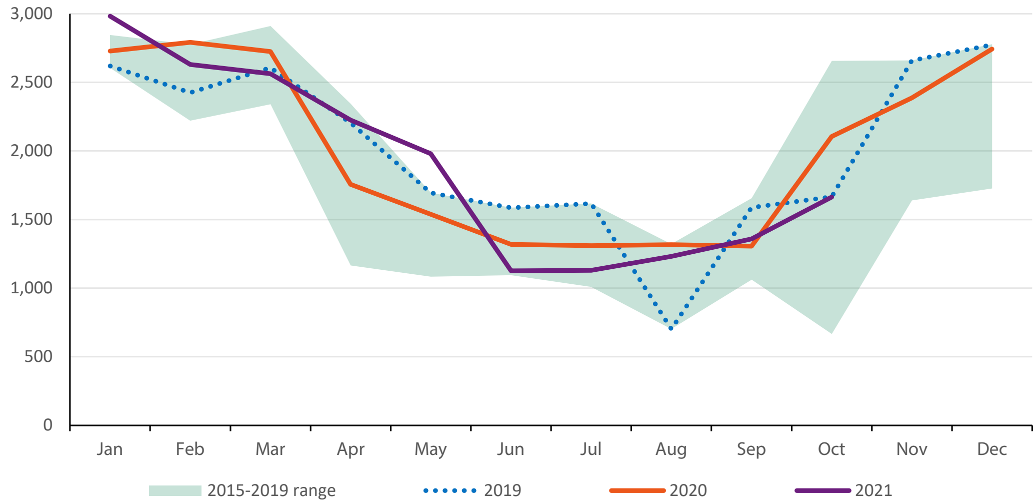
Source: SEAI

1.2.2 Gas supply

Between 2015 and 2019 about 55% of all gas was used for electricity generation. Electricity use was largely unaffected by the COVID-19 pandemic, as discussed in *Section 1.2.3*. The amount of gas used for electricity generation is largely influenced by seasonal variations in wind generation, by commodity and carbon prices, and by outages at gas generating plants, or outages in other dispatchable electricity generating plants.

Figure 3 shows monthly gas supply excluding gas delivered to electricity generating plants, to examine the impact of COVID-19 restrictions on the potion of gas not used for electricity generation. This gas is almost all used for heat. There is a strong seasonal effect, as would be expected. Gas supply was not noticeably affected by the COVID-19 restrictions, with monthly supply in both 2020 and 2021 broadly within the range of normal values seen over the previous five years. Gas supply (excluding electricity) for the first ten months of 2021 shows no change from 2020.

Figure 3: Monthly gas supply excluding gas used for electricity generation



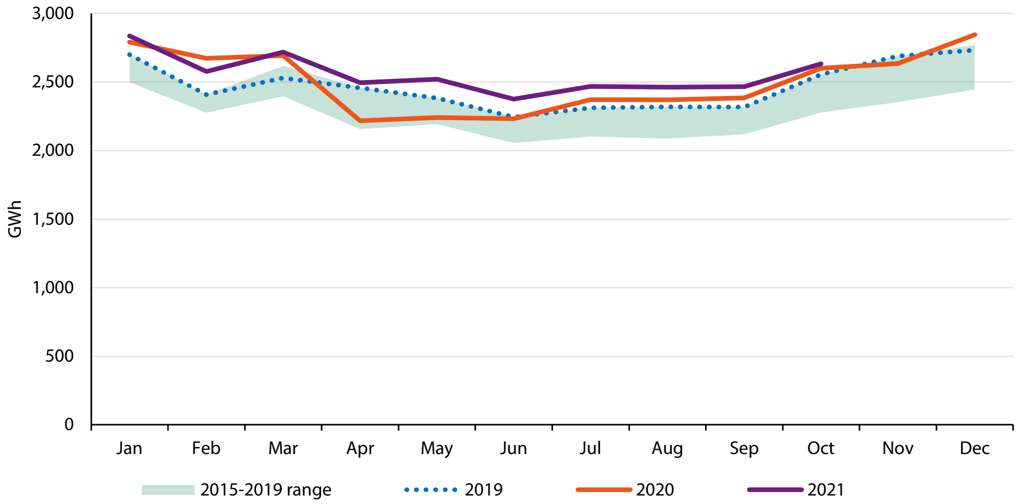
Source: SEAI

1.2.3 Electricity use

Figure 4 shows monthly data for electricity generated, less pumped-hydro losses. Annual electricity use has been increasing year-on-year since 2015, leading to the monthly totals for 2019 being among the highest observed from 2015 to 2019.

Electricity generated reduced slightly in April 2020 when COVID-19 restrictions were first introduced, but returned to business-as-usual levels by June 2020, and remained unaffected by further COVID-19 restrictions thereafter. For 2021, electricity use has returned to the same steady growth that has been seen since 2015, with the monthly total electricity generated for the first ten months of 2021 the highest ever recorded. For the first ten months of the year, total electricity generated was up 4% on the same period in 2020.

Figure 4: Monthly electricity generated



Source: SEAI

Electricity fuel mix

Figure 5 shows electricity generated by wind, gas, coal and net imports. 2021 has so far been a "low wind" year, with electricity generated from wind during the first ten months of the year down 18% on the same period in 2020. Wind generation is highly seasonal, with high levels of generation over the winter months, so the annual total may recover somewhat over November and December.

For the first ten months of 2021 electricity generated from gas was also down by 7% compared to the same period in 2020, with a number of gas powered electricity generation stations being offline due to technical faults for much of the year.

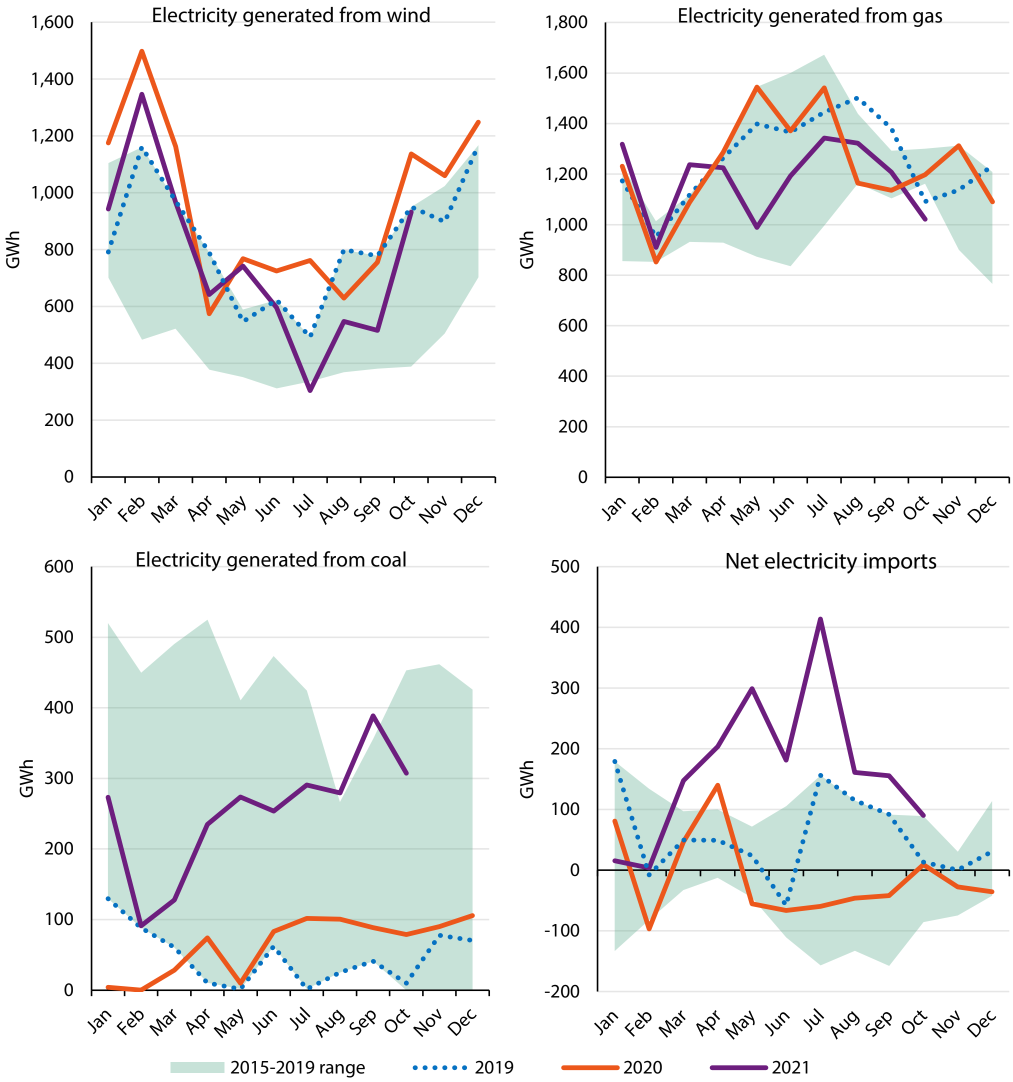
The shortfall in wind and gas generated electricity has been made up by a combination of large increases in both generation from coal and electricity imports from the UK.

Annual electricity generated from coal fell by 86% between 2015 and 2020, but for the first ten months of 2021 it was back to 2017 levels, up 343% on the same period in 2020.

Ireland was a net exporter of electricity in 2020 but it returned to high levels of imports in 2021. For the first ten months of 2021 net electricity imports were 1,672 GWh, the highest since 2014.

Because of the reduction in electricity generated by wind and gas and the increase in the use of coal, the CO_2 emissions from electricity generation for the first ten months of 2021 were 18% higher than in the same period in 2020.

Figure 5: Monthly electricity generated by source



Source: SEAI

1.3 Future energy and climate targets

As mentioned previously, Ireland had mixed success in reaching its 2020 renewable energy share targets – it achieved its transport target, but fell short of its overall target, far short of its heating target, and just missed its electricity target. At a national level, Government has recognised and responded with increased ambition in the 2021 Climate Action Plan (CAP-21), while the Climate Change Advisory Council (CCAC) has recommended 5-year carbon budgets aligned to bring carbon emission targets down by 51% by 2030. At an international level, new targets for 2030 are being put in place by Europe, with technical details and reporting obligations being agreed. Future Energy in Ireland reports will include these targets to add context to annual results.

1.3.1 National energy targets beyond 2020

Ireland's CAP-21 provides a plan to achieve a 51% reduction in overall greenhouse gas emissions by 2030, and set us on a path to reach net-zero emissions by no later than 2050. CAP-21 aims to increase renewable electricity by increasing wind and solar energy up to 80% by 2030, and to reduce emissions from electricity by 62% (81% from 2018 levels). It also aims for a complete phase-out of coal and peat-fired electricity generation, and the roll-out up to 2.7 TWh of district heating for homes and buildings. In the transport sector, CAP-21 aims to increase the number of EVs on the road to 1 million by 2030, while expanding the public transport fleet with 1,500 electric buses in the same period.

The CCAC recently published proposed carbon budgets out to 2030. The Oireachtas is tasked with reviewing and approving the overall economy-wide carbon budgets, and the Government will then divide the overall carbon budgets into sectoral emissions ceilings. The first two 5-year carbon budgets equate to a total reduction of 51% emissions over the period to 2030. The average year-on-year reductions in the first budget are set at just under 4.8% (to end of 2025), and the reductions in the second budget are set at 8.3% (2026 to 2030). The emission limits for 2021-2025 are 295 $MtCO_2$ equivalent, and a 200 $MtCO_2$ limit for 2026-2030. The recommended provisional carbon budget for 2031-2035 is 151 $MtCO_2$.

1.3.2 International energy targets beyond 2020

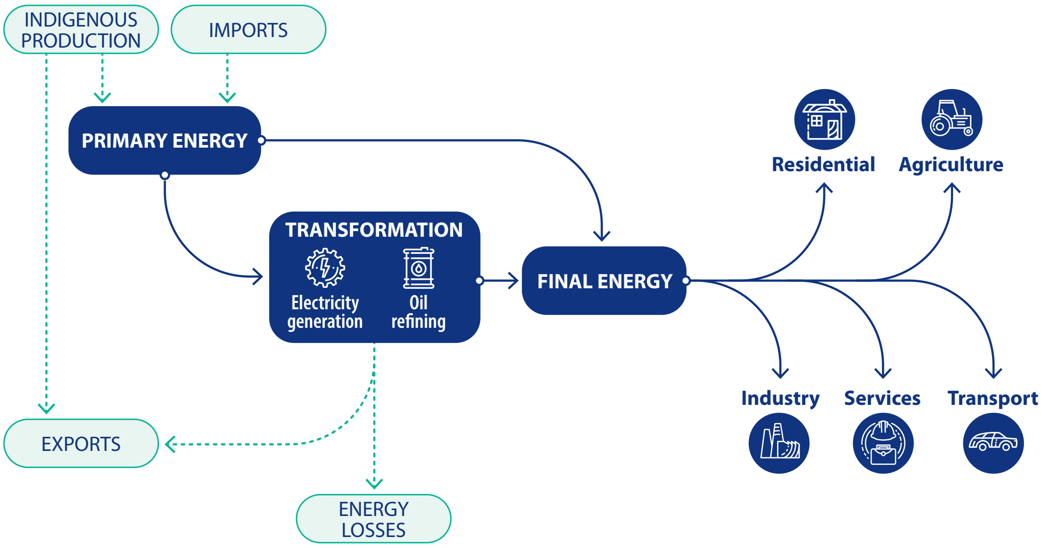
Through the European Green Deal, the European Commission adopted a set of proposals to make the EU's climate, energy, transport and taxation policies fit for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. The European Green Deal proposes ambitious targets for reducing the CO2 emissions of new cars and vans, including a 55% reduction in emissions from cars by 2030, a 50% reduction in emissions from vans by 2030, and no emissions from new cars by 2035. The Commission also proposes to increase the binding target of renewable sources in the EU's energy mix to 40%, and increasing energy efficiency targets to achieve an overall reduction of 36-39% for final and primary energy consumption by 2030.

At the COP26 summit, Ireland committed to phasing out oil and gas production, as part of the he Beyond Oil and Gas Alliance. Through the Climate Act 2021, there is no longer a legal basis for granting new licences for oil and gas exploration.

1.4 National Energy Balance

The information in this report is largely based on Ireland's 2020 national energy balance, and preceding energy balances back to 2005. These energy balances quantify the flow and transformation of energy sources from primary supply to final consumption, and profile that consumption across different sectors of the economy. A schematic for the energy balance flow is illustrated in *Figure 6*. National energy balances are the definitive sources for constructing other normalised national energy indicators, such as energy intensity, energy efficiency, and energy-related greenhouse gas emissions.

Figure 6: Main energy flows in Ireland



The data in the national energy balances are informed by survey responses received from approximately 300 organisations, including energy producers, import/export companies and energy supply companies. In addition to populating the energy balance, these surveys are used by SEAI to fulfil Ireland's energy statistics reporting obligations to Eurostat[2] (EU Energy Statistics Regulation (EC 1099/2008)) and the International Energy Agency.

To ensure that the best possible information is always available to Government and other users, SEAI employs a policy of continuous improvement with regard to historic energy balances updating these with data revisions and new methodologies as they become available.

To help policy makers, analysts, researchers, and the public better understand Ireland's energy data, SEAI is expanding its use of data visualisations and interactive dashboards. This work started with the introduction of an energy data portal in 2019 linked to the national energy balances, and is now being expanded to include new interactive graphics and dashboards that allow users to explore monthly updates on energy delivery, quarterly updates on energy and fuel costs, and geographical analysis, comparing Ireland to other EU countries, and zooming down to the local authority level. Please visit SEAI's website at https://www.seai.ie/data-and-insights/ for developments.

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

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

2 Final energy use

The term final energy describes the energy that is directly consumed by an end-user. It covers energy delivered for manufacturing, transport of goods and people, and the day-to-day energy requirements of living, such as heating and cooking. SEAI analyses final energy consumption by fuel, by sector, and by "mode" (heat, transport, and electricity).

Final energy use excludes energy lost in the transformation or transmission of primary energy supply, because this energy is not available to the end-user. Multiple primary energy sources may be aggregated and transformed into a single final energy for an end-user. For example, when an end-user consumes electricity (as final energy), that electricity actually originated from a blend of wind, natural gas, etc. (i.e. primary energy sources). Similarly, final energy use covers the energy in petrol and diesel consumed by end-users, but not the energy that was needed to convert crude oil into that petrol and diesel in a refinery.

Final energy use is important, because individuals and businesses have direct control over how they decide to consume it - petrol vs. diesel vs. electric vehicles for surface transport, gas vs. oil vs. heat-pumps for heating, etc.

2.1 Final energy use by fuel and source

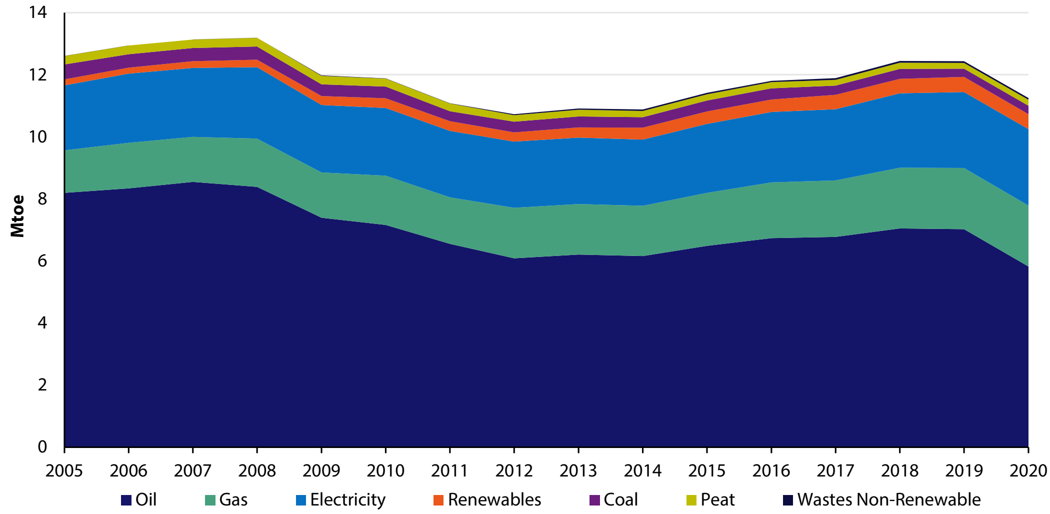
Total final energy demand fell by 9.6% in 2020 compared to 2019 levels (12,436 ktoe to 11,246 ktoe). After a correction that accounts for the heating of buildings in cold weather, the normalised final energy drop was 9.2%. This reduction was almost exclusively due to reduced consumption of oil, which fell by 17% (from 7022 ktoe to 5,825 ktoe) in 2020, due to the impact of the COVID-19 pandemic and related public health measures on the transport sector.

Figure 3 breaks-out final energy use by fuel from 2005 to 2020. Oil remains the largest energy single source for final consumption, accounting for 52% of final energy use in 2020, despite public health measures that restricted national and international travel. Ireland is almost completely dependent on oil for the servicing of its transport sector, and that sector is Ireland's largest end-user of energy.

Fossil fuels account for 73% of final energy use in 2020. This was down by 12.7% compared to 2019 levels, with the reductions coming from oil and natural gas use. While the use of coal and peat for final energy increased slightly in 2020, their combined share remains low at 4% of final energy use.

In the last 15 years, from 2005 to 2020, the final consumption of oil, coal, and peat have all fallen in the range of 30-40%, while the final consumption of natural gas has increased by 43%. Since 2005, Ireland has reduced its overall final use of fossil fuels by 20%.

Figure 3: Total final consumption by fuel



Source: SEAI

Table 1 provides numerical details on the absolute values, relative shares, and percentage changes in the final consumption of different energy sources of the data in *Figure 3*.

Oil accounts for 52% of final energy use in 2020, with transport and home heating accounting for 86% of this.

Final energy consumption of electricity increased by 0.8% in 2020 to 2,464 ktoe (28.7 TWh). Electricity accounted for 22% of total final consumption of energy by end-users in Ireland, up from 20% in 2019.

Final use of renewable energy decreased by 1.6% in 2020 compared to 2019 (490 ktoe to 482 ktoe)[3]. However, this should be viewed in the context of an overall reduction in final energy consumption of 9.6%. The share of renewable energy in final consumption actually increased from 3.9% to 4.3% from 2019 to 2020. Direct final consumption of renewable energy by end-users increased by 156% since 2005.

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Oil	5,825	52%	8,196	65%	-1,197	-17.0%	-10.1%	-2.1%	-28.9%	-2.3%
Gas	1,960	17%	1,369	11%	-13	-0.7%	14.3%	2.7%	43.2%	2.4%
Coal	272	2%	484	4%	6	2.2%	-23.1%	-5.1%	-43.9%	-3.8%
Peat	189	2%	274	2%	6	3.2%	-6.0%	-1.2%	-30.9%	-2.4%
Fossil fuels	**8,247**	**73%**	**10,324**	**82%**	**-1,198**	**-12.7%**	**-5.8%**	**-1.2%**	**-20.1%**	**-1.5%**
Wastes Non-Renewable	54	0%	0	0%	-3	-5.4%	21.9%	4.0%	-	-
Electricity	2,464	22%	2,094	17%	19	0.8%	11.1%	2.1%	17.6%	1.1%
Renewables	482	4%	188	1%	-8	-1.6%	20.2%	3.7%	156.0%	6.5%
Total	**11,246**	**100%**	**12,606**	**100%**	**-1,190**	**-9.6%**	**-1.5%**	**-0.3%**	**-10.8%**	**-0.8%**

Source: SEAI

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

2.2 Final energy use by sector

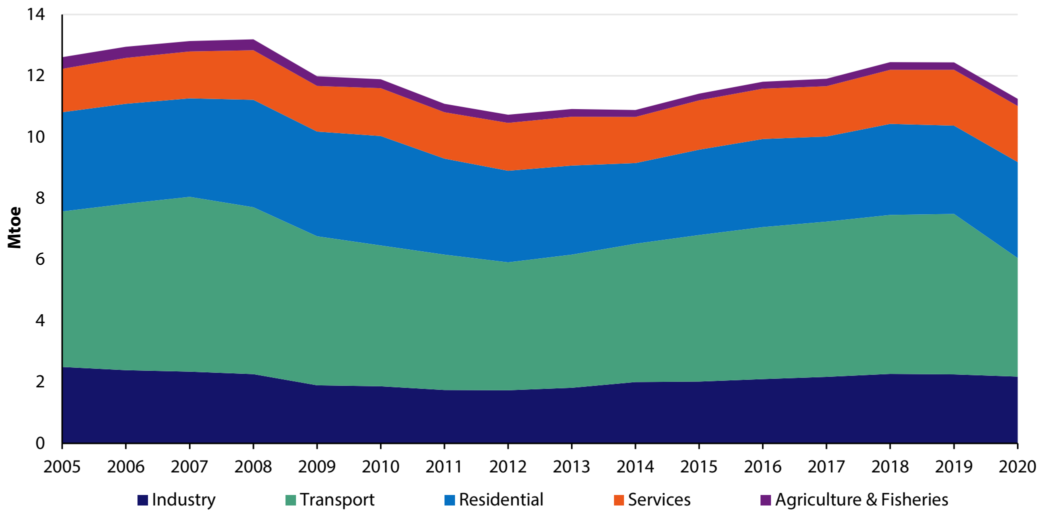
Figure 7 shows final energy demand from 2005 to 2020 broken-out by sector. The broad reduction in final energy use across all sectors from 2008 to 2012 is attributed to the international economic downturn, with the industry, transport and services sectors returning to growth after 2012, and growth in the residential sector delayed until 2014.

The reduction in 2020 final energy use was almost entirely limited to the transport sector, which fell by 26%. Final energy use in transport (3,875 ktoe) was the lowest since 1999. Prior to 2020, final energy demand for transport had risen every year since 2012.

Despite the significant reduction in 2020, transport remained the sector with greatest final energy use, accounting for 34% of final energy in 2020. The residential sector was the next largest sector with a share of 28%, followed by industry and services with 19% and 16%, respectively.

Table 2 provides absolute values, relative shares, and percentage changes in the final energy use by sector.

Figure 7: Total final consumption by sector



Source: SEAI

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Industry	2,171	19%	2,486	20%	-80	-3.5%	8.1%	1.6%	-12.7%	-0.9%
Transport	3,875	34%	5,084	40%	-1,359	-26.0%	-19.0%	-4.1%	-23.8%	-1.8%
Residential	3,128	28%	3,238	26%	244	8.4%	12.1%	2.3%	-3.4%	-0.2%
Services	1,830	16%	1,415	11%	11	0.6%	13.7%	2.6%	29.4%	1.7%
Agriculture & Fisheries	241	2%	383	3%	-5	-2.1%	9.0%	1.7%	-37.2%	-3.1%
Total	**11,246**	**100%**	**12,606**	**100%**	**-1,190**	**-9.6%**	**-1.5%**	**-0.3%**	**-10.8%**	**-0.8%**

Ireland's final energy use fell by 9.6% in 2020, largely due to the impact of COVID-19, with almost all of the reduction localised to the transport sector.

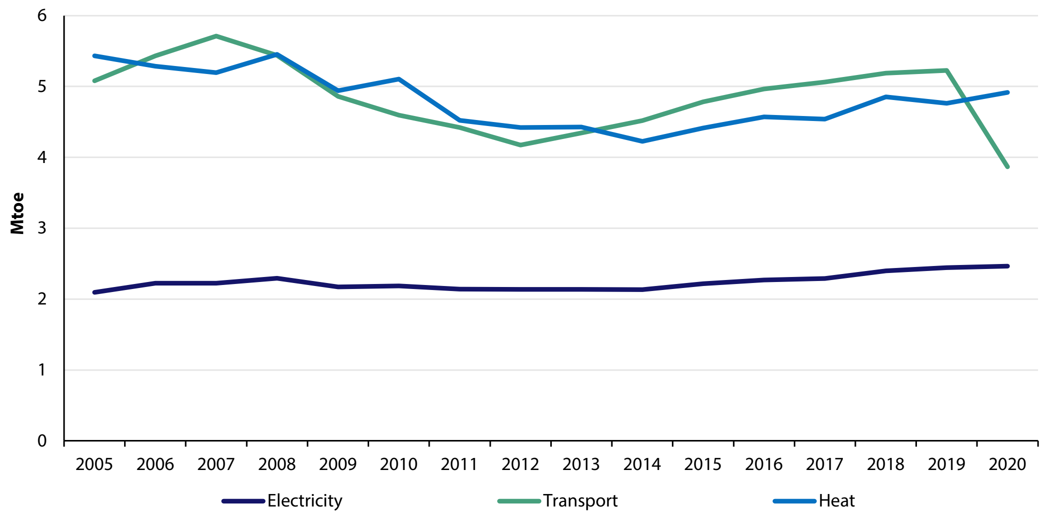
2.3 Final energy use by mode

It is useful to split final energy use into the three modes of electricity, transport, and heat. These represent distinct energy services and markets, and also map onto national and European renewable energy targets. To avoid double-counting across modes, any heat and transport energy provided by electricity (e.g. electric heaters and electric vehicles) is counted into the electricity mode only, not the heat or transport modes. This ensures that summing across the three modes gives a consistent total final energy use.

Figure 8 shows final energy use from 2005 to 2020 through the lens of the three energy modes. The transport and heat modes historically account for approximately 40% of final energy use each, with the electricity mode accounting for the remaining 20%. The electricity mode has been relatively constant, increasing by just 17.6% over the last 15 years (from 2094 ktoe to 2464 ktoe). The heat mode shows the greatest year-to-year fluctuations, due to its sensitivity to weather effects. *Section 5.2* provides more detail on weather effects on heating energy.

It is clear from *Figure 8* that the electricity and heat modes have been largely unaffected by the 9.6% reduction in 2020's final energy use, with practically all of the drop in final energy use localised to the transport mode.

Figure 8: Final energy in heat, transport and electricity



Source: SEAI

As detailed in Table 3, the heat mode accounted for 44% of final energy in 2020, followed by transport (34%), and electricity (22%). 2020 was the first year since 2013 that the transport mode was not the largest consumer of final energy.

Given the step-change in transport observed in 2020, care must be taken in the interpretation of the values in Table 3. For example, the table correctly identifies that the overall change in the transport mode from 2005 to 2020 is -23.9%, but it must be noted that practically all of this reduction arose in the single calendar year of 2020, as shown in *Figure 8*. It is important to use all information available to distinguish between long-term trends and short-term effects. Therefore this drop is not indicative of a long-term sustainable trend. It is important to use context to distinguish between short-term effects and long-term trends.

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Electricity	2,464	22%	2,094	17%	19	0.8%	11.1%	2.1%	17.6%	1.1%
Transport	3,868	34%	5,079	40%	-1,360	-26.0%	-19.1%	-4.2%	-23.9%	-1.8%
Heat	4,914	44%	5,433	43%	151	3.2%	11.3%	2.2%	-9.5%	-0.7%
Total	**11,246**	**100%**	**12,606**	**100%**	**-1,190**	**-9.6%**	**-1.5%**	**-0.3%**	**-10.8%**	**-0.8%**

2.4 Final energy use in heat mode

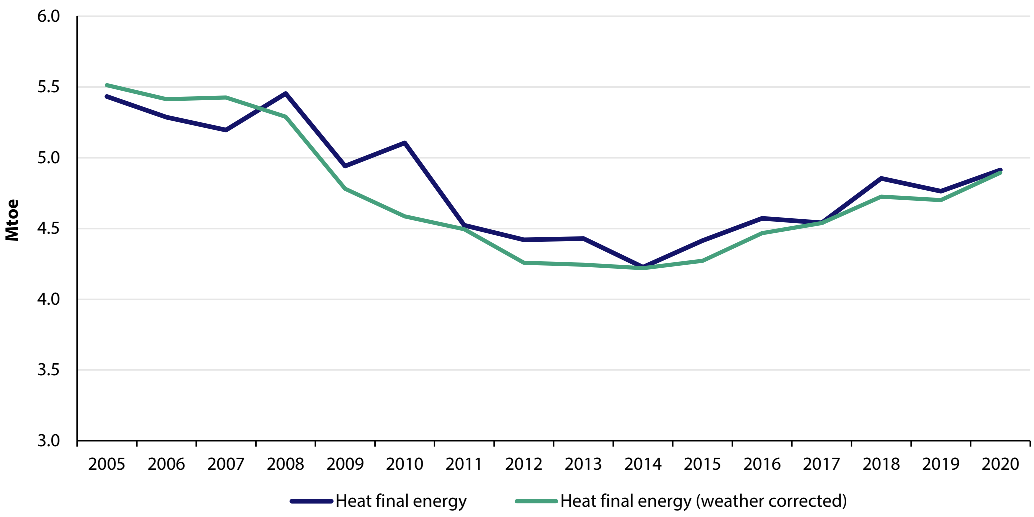
Figure 9 shows final energy use in the heat mode from 2005 and 2020 with and without a weather correction. SEAI uses the concept of degree-days for weather normalisation across warmer and colder years, which is the established standard recommended by Eurostat. Further details are provided in *Section 5.2*.

Weather corrected heat demand reached a broad minimum in the period of 2012 to 2015 (averaging 4250 ktoe), likely due to a combination of impacts from the economic recession, a period of record high oil prices, and efficiency improvements in the heating and insulation of buildings. Since 2015, reduced international oil prices coupled with the recovery of the Irish economy have acted to increase heat demand.

After a brief slow-down in 2019, the upward trend in heat demand continued in 2020, with an increase of 4.1% (from 4,701 ktoe to 4,894 ktoe). A sectoral breakdown of heat demand in the following section helps identify the origin of this increase.

Weather corrected final energy demand for heat increased by 4.1% in 2020.

Figure 9: Final energy use for heat, actual and weather corrected



Source: SEAI

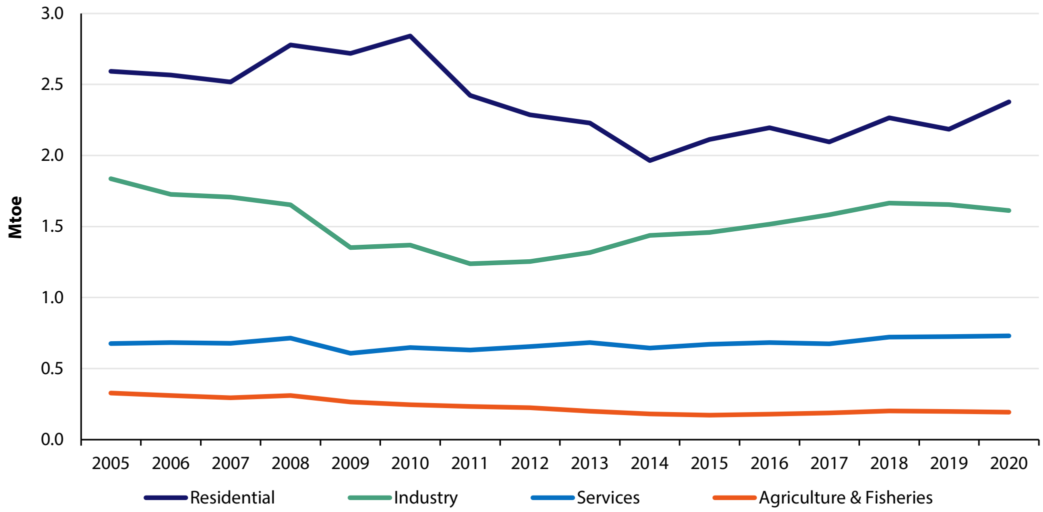
2.4.1 Final energy use in heat mode by sector

As shown in *Figure 10* and detailed in *Table 4* the residential sector (48%) is largest end-user of final energy in the heat mode, followed by industry (33%), services (15%), and agricultural & fisheries (4%) sectors.

Final energy for heating in households increased by 8.8% in 2020. Household demand for heat is strongly affected by weather, as evidenced by the historic peak in 2008, a year that had periods of extremely cold weather. When corrected for weather, final energy use for heat in 2020 households increased by 9.7%.

Final use of energy for heat in industry dropped by 2.5% in 2020, the first substantive reduction since 2012.

Figure 10: Final consumption of heat by sector



Source: SEAI

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Residential	2,377	48%	2,592	48%	192	8.8%	12.5%	2.4%	-8.3%	-0.6%
Industry	1,613	33%	1,836	34%	-41	-2.5%	10.6%	2.0%	-12.2%	-0.9%
Services	731	15%	676	12%	5	0.8%	8.9%	1.7%	8.0%	0.5%
Agriculture & Fisheries	194	4%	328	6%	-5	-2.6%	12.2%	2.3%	-40.9%	-3.4%
Total	**4,914**	**100%**	**5,433**	**100%**	**151**	**3.2%**	**11.3%**	**2.2%**	**-9.5%**	**-0.7%**

2.4.2 Final energy use in heat mode by fuel and source

Table 5 and *Figure 11* detail the fuels and energy sources in the final energy heat mode. In 2020, oil (44%) remained the largest fuel-type for the delivery of heat, followed closely by natural gas (40%). The gap between oil and natural gas for final energy heat closed substantially between 2005 and 2015, with oil use decreasing and natural gas increasing. This was driven by Ireland's expanding gas network and an industrial transition from oil to gas. Since 2015, both oil and natural gas have been approximately equal sources of final energy for the heat mode, with oil always slightly leading. 2020 saw an increase in oil use for heat (+7.4%) and a small decrease in natural gas for heat (-0.6%).

Coal and peat combined made up 10% of Ireland's final energy demand in the heat mode. The relative use of coal and peat increased slightly by 2-3% in 2020, compared to 2019 shares.

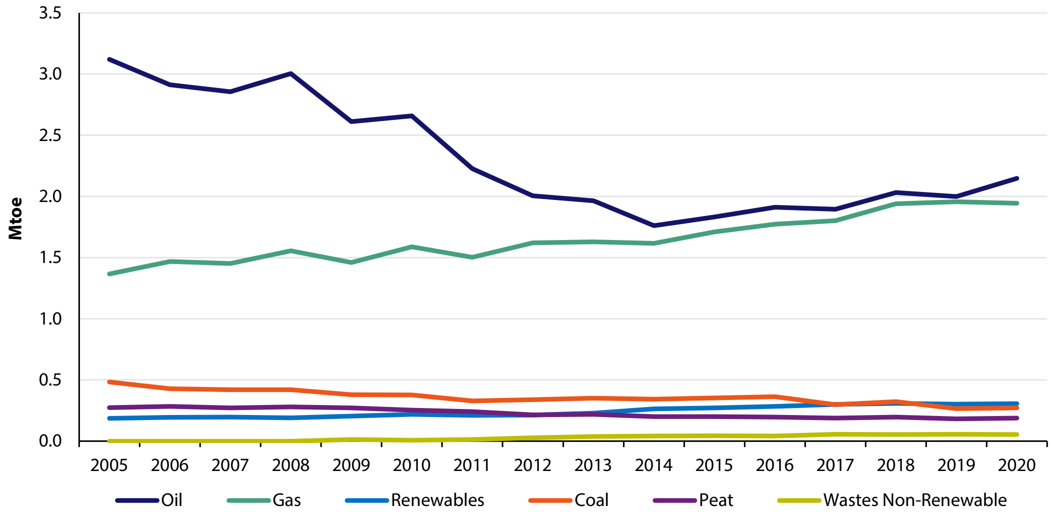
Renewable energy made up 6% of final energy demand in the heat mode, increasing by 1.9% from 2019 (307 ktoe to 302 ktoe).

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Oil	2,148	44%	3,120	57%	148	7.4%	17.2%	3.2%	-31.2%	-2.5%
Gas	1,945	40%	1,367	25%	-11	-0.6%	13.6%	2.6%	42.3%	2.4%
Renewables	307	6%	187	3%	6	1.9%	12.7%	2.4%	64.2%	3.4%
Coal	272	6%	484	9%	6	2.2%	-23.1%	-5.1%	-43.9%	-3.8%
Peat	189	4%	274	5%	6	3.2%	-6.0%	-1.2%	-30.9%	-2.4%
Wastes Non-Renewable	54	1%	0	0%	-3	-5.4%	21.9%	4.0%	-	-
Total	**4,914**	**100%**	**5,433**	**100%**	**151**	**3.2%**	**11.3%**	**2.2%**	**-9.5%**	**-0.7%**

The last two decades have seen Ireland shift from an oil dominance in the heat mode to near parity between oil and gas for heat supply.

Figure 11: Final consumption of heat by fuel

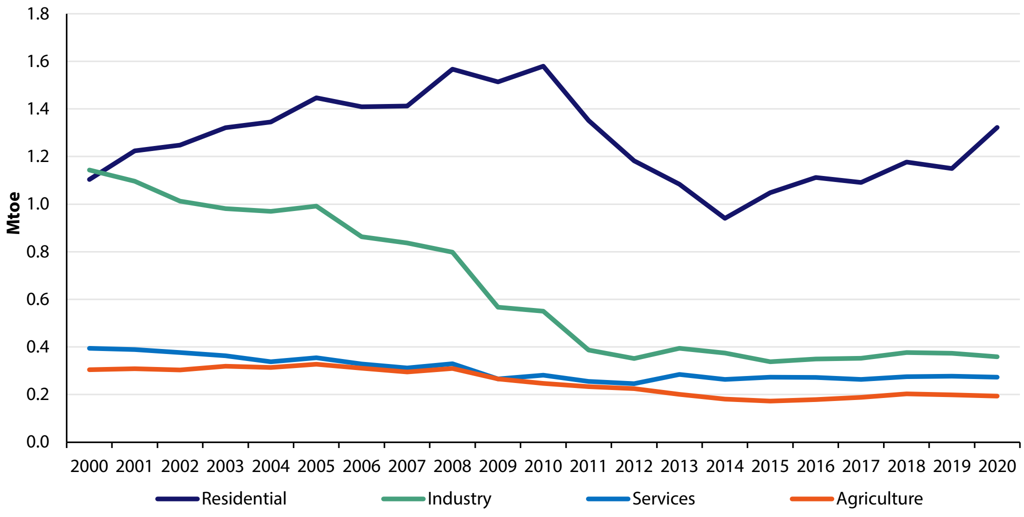


Source: SEAI

Figure 12 profiles oil use for final energy in the heat mode by sector. The largest and most consistent reduction in oil use for heat has come from the industry sector, with the agriculture and services sectors also seeing smaller reductions.

While oil consumption for heat in the residential sector fell by 40% from 2010 to 2014, due to a period of record high oil prices, it has since trended upwards, reaching 1322 ktoe in 2020, its highest value since 2011.

Figure 12: Final consumption of oil for heat



Source: SEAI

2.5 Final energy use in transport mode

2.5.1 Final energy use in the transport mode by sub-sector

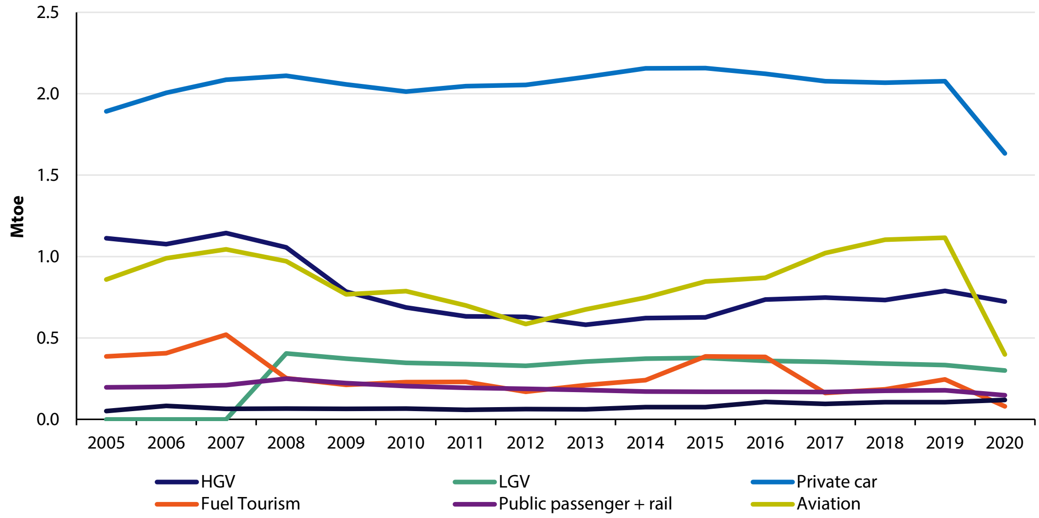
Figure 13 and *Table 6* show the trends and details of final energy use in the transport mode broken-out by sub-sector. Overall, final energy use in the transport mode dropped by 26% in 2020 (a reduction of 1,360 ktoe from 2019). All surface transport sub-sectors experienced a reduction: HGVs, light goods vehicles (LGVs), private cars, public passenger (buses, taxis, and coaches), rail, and fuel tourism.

In 2020, private car energy use remained the transport sub-sector with greatest energy use (42% of all transport). Energy use in private cars has been relatively constant for the last decade at an average of 2,100 ktoe, but this changed in 2020, when energy use for private cars dropped by 21.4% to 1,634 ktoe. This reduction is mostly due to the impact of public health measures on limiting travel during the pandemic, and resulted in the lowest energy use in private cars for almost 20 years (1,642 ktoe in 2001).

From 2013 to 2019, the second largest transport sub-sector was aviation, reaching a historic peak (1,116 ktoe) in 2019 just prior to the COVID-19 pandemic. Final energy use in the aviation sub-sector fell by 64.1% in 2020 (to 398 ktoe), taking it below the HGV sub-sector demand for the first time since 2012.

Fuel tourism (the purchasing of motor fuel in one country with lower costs, for consumption in another region) also reduced substantially in 2020, falling by 67.2% (from 245 ktoe to 80 ktoe). This is again likely due to the impact of public health measures on limiting regional and international travel during the pandemic.

Figure 13: Transport energy demand by mode



Source: SEAI

In 2020, energy use in private cars fell by 21.4%, while energy use in the aviation sector fell by 64.3%, largely due to public health travel restrictions.

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Heavy Goods Vehicles	724	19%	1,112	22%	-65	-8.2%	15.6%	2.9%	-34.9%	-2.8%
Light Goods Vehicles	301	8%	0	0%	-33	-9.8%	-20.3%	-4.4%	-	-
Private Car	1,634	42%	1,891	37%	-444	-21.4%	-24.3%	-5.4%	-13.6%	-1.0%
Public Passenger	117	3%	157	3%	-21	-15.3%	-11.9%	-2.5%	-25.4%	-1.9%
Rail	32	1%	40	1%	-8	-20.3%	-11.4%	-2.4%	-20.3%	-1.5%
Fuel Tourism	80	2%	387	8%	-165	-67.2%	-79.2%	-27.0%	-79.2%	-9.9%
Navigation	104	3%	50	1%	15	16.4%	45.5%	7.8%	109.2%	5.0%
Aviation	398	10%	859	17%	-718	-64.3%	-53.0%	-14.0%	-53.6%	-5.0%
Pipeline	15	0%	2	0%	-2	-10.8%	287.9%	31.1%	588.7%	13.7%
Unspecified	461	12%	581	11%	80	21.1%	224.2%	26.5%	-20.6%	-1.5%
Total	**3,867**	**100%**	**5,079**	**100%**	**-1,360**	**-26.0%**	**-19.1%**	**-4.2%**	**-23.9%**	**-1.8%**

Source: SEAI

2.5.2 Final energy use in transport mode by fuel and source

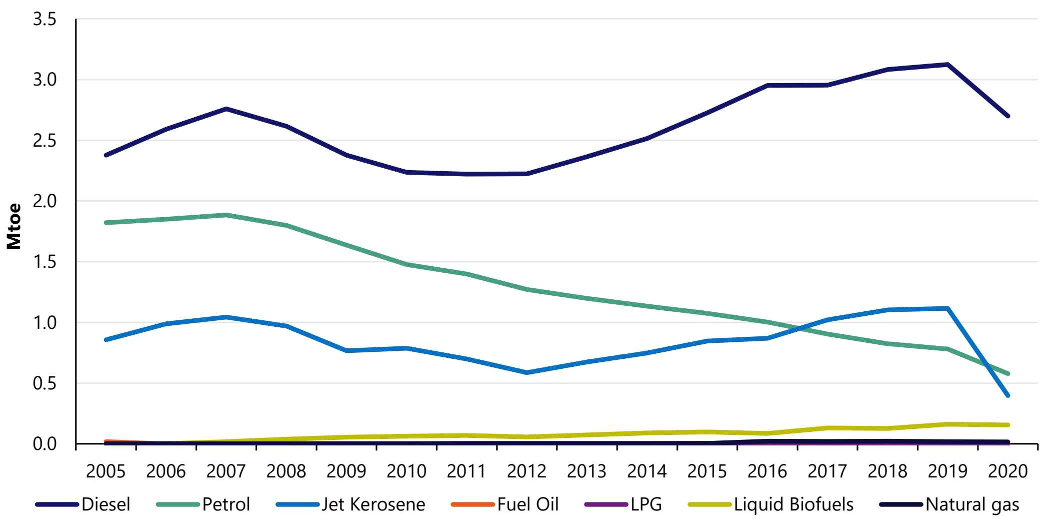
Figure 14 and *Table 7* show the final energy use in the transport mode broken-out by fuel type. To avoid double-counting across the transport and electricity modes, energy provided by electricity (e.g. electric vehicles) are counted into the electricity mode only, and so are excluded from this transport analysis.

In 2020, every single fuel-type in the transport mode saw a reduction against its 2019 values, with an overall reduction in final energy use of 26.0% in transport. Diesel remained by the largest fuel-type with a share of 70%, followed by petrol (15%) and jet kerosene (10%). Most of the reduction in transport fuel use in 2020 was in diesel and jet kerosene, which fell by 13.6% and 64.3% respectively.

One significant long-term trend is the year-on-year reduction in petrol use since 2007, which continued into 2020. This has been mostly driven by a sustained switch from petrol to diesel vehicles.

Liquid biofuels accounted for 4% of final energy demand in the transport mode in 2020. Although they saw a small drop from 2019 levels (162 ktoe to 155 ktoe), their use in transport has approximately tripled since 2012 (56 ktoe) as a long-term trend.

Figure 14: Final consumption of transport by fuel



Source: SEAI

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

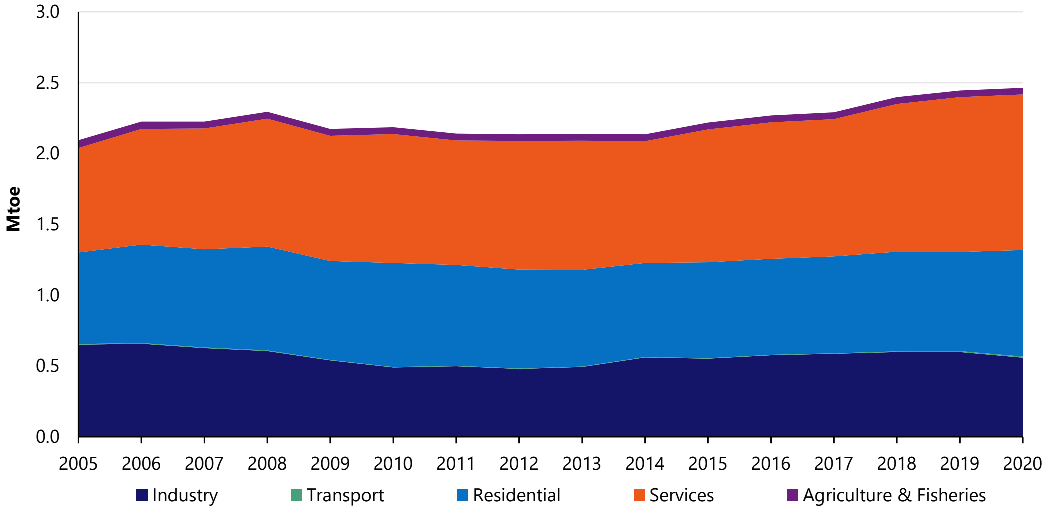
	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Diesel	2,700	70%	2,378	47%	-424	-13.6%	-1.0%	-0.2%	13.5%	0.8%
Petrol	578	15%	1,822	36%	-202	-25.9%	-46.2%	-11.7%	-68.3%	-7.4%
Jet Kerosene	398	10%	857	17%	-718	-64.3%	-53.0%	-14.0%	-53.6%	-5.0%
Fuel Oil	0	0%	18	0%	0	-	-	-	-100.0%	-100.0%
LPG	1	0%	1	0%	-1	-48.5%	-66.9%	-19.8%	-17.7%	-1.3%
Liquid Biofuels	155	4%	1	0%	-7	-4.2%	57.8%	9.5%	14127.0%	39.2%
Natural gas	16	0%	2	0%	-2	-9.5%	301.6%	32.1%	615.4%	14.0%
Total	**3,867**	**100%**	**5,079**	**100%**	**-1,360**	**-26.0%**	**-19.1%**	**-4.2%**	**-23.9%**	**-1.8%**

2.6 Final energy use in electricity mode

2.6.1 Final energy use in electricity mode by sector

Figure 15 shows the trends and break-out of final energy consumption in the electricity mode across main sectors. 2020 was a historic peak in final energy demand for electricity, reaching 2464 ktoe (28.7 TWh). This is up slightly (0.8%) on electricity consumption in 2019. The largest sectoral consumers of electricity in 2020 were services with a 45% share, followed by residential (31%), and industry (23%), with the remaining 2% in agriculture & fisheries and transport.

Figure 15: Final consumption of electricity by sector



Source: SEAI

2020 was a record high year for electricity use.

Table 8 details the quantities, shares, and trends in final energy use of the electricity mode. Overall, electricity use increased slightly in 2020 by 0.8%, with the residential sector experiencing a relative increase of 7.4%, and the industry sector a relative decrease of 6.5%. This may be partly correlated to COVID-19 impacts, with a significant fraction of the population spending more time at home, and industry supply-chains disrupted. Services, the largest sectoral consumer of electricity, saw only a small increase of 0.5%.

The transport sector experienced the largest relative growth in electricity use in 2020 at 12.1%, but accounts for just 0.3% of the overall share of electricity use. Electricity use in transport includes the Dublin Area Rapid Transit (DART) rail system, the Luas light rail system, and electric vehicles on the road.

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Industry	558	23%	650	31%	-39	-6.5%	1.5%	0.3%	-14.1%	-1.0%
Transport	8	0%	5	0%	1	12.1%	101.7%	15.1%	50.2%	2.7%
Residential	751	31%	646	31%	52	7.4%	10.9%	2.1%	16.3%	1.0%
Services	1,100	45%	738	35%	5	0.5%	17.2%	3.2%	49.0%	2.7%
Agriculture & Fisheries	47	2%	55	3%	0	0.0%	-2.5%	-0.5%	-15.4%	-1.1%
Total	**2,464**	**100%**	**2,094**	**100%**	**19**	**0.8%**	**11.1%**	**2.1%**	**17.6%**	**1.1%**

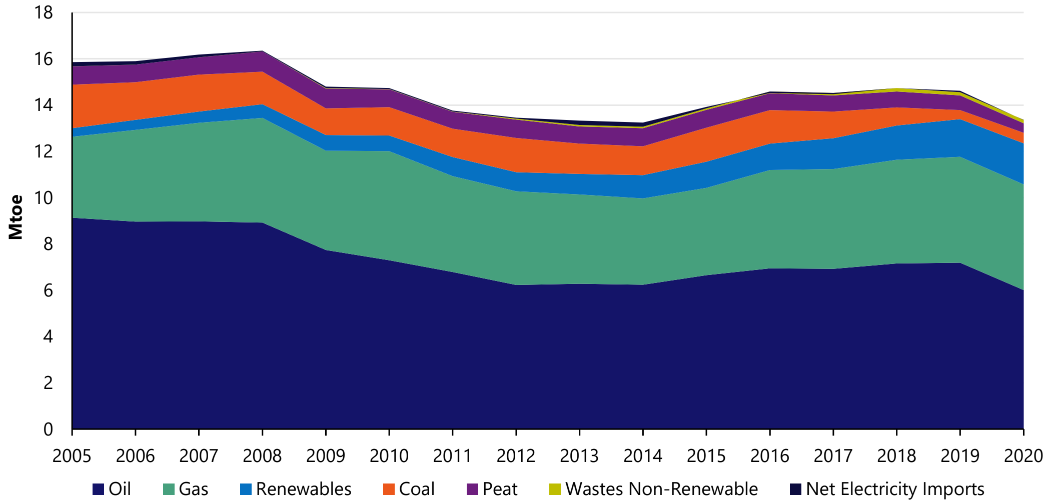
3 Primary energy supply

Primary energy is the total amount of energy that is required to satisfy the down-stream final energy use of end-users. It describes the initial energy sources that are transformed, transmitted, and distributed, before that energy is made available to end-users for final consumption. Primary energy therefore describes the energy inputs of processes like electricity generation and crude oil refining, rather than the consumption of that electricity or refined oil products.

The primary energy supply depends on the final energy use, as well as the efficiencies of the various transformation processes needed to ensure that end-users receive final energy in the form that is needed. Just like final energy use, primary energy supply can be usefully analysed by fuel, sector, and mode.

3.1 Primary energy supply by fuel and source

Figure 16: Total primary energy requirement[4]



Source: SEAI

Figure 16 illustrates trends in primary energy supply broken-out by fuel. Primary energy supply in 2020 was 13,350 ktoe (down 8.7% from 2019). The three largest primary sources for Ireland's energy in 2020 were oil (45%), gas (34%), and renewables (13%).

Oil continues to be the dominant energy source, almost as large as natural gas and renewable energy combined. In total, fossil fuels (oil, gas, coal, and peat) accounted for 86% (11,439 ktoe) of Ireland's primary energy supply in 2020.

Ireland's use of oil for primary supply fell by 16.5% in 2020 (7,194 ktoe to 6010 ktoe), but remained practically constant for natural gas (4,571 ktoe to 4,564 ktoe). The year-on-year consumption of coal increased by 15.6% (387 ktoe to 448 ktoe), but fell by 33.6% for peat (629 ktoe to 418 ktoe).

Renewable energy for primary supply was 1,778 ktoe in 2020, up from 1,633 ktoe in 2019. The share of renewable energy in Ireland's primary supply has increased from 2.3% to 13.3% since 2005, just under a factor of 6 increase.

The following sections of this report provide further sector and mode break-outs to add more insights.

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

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

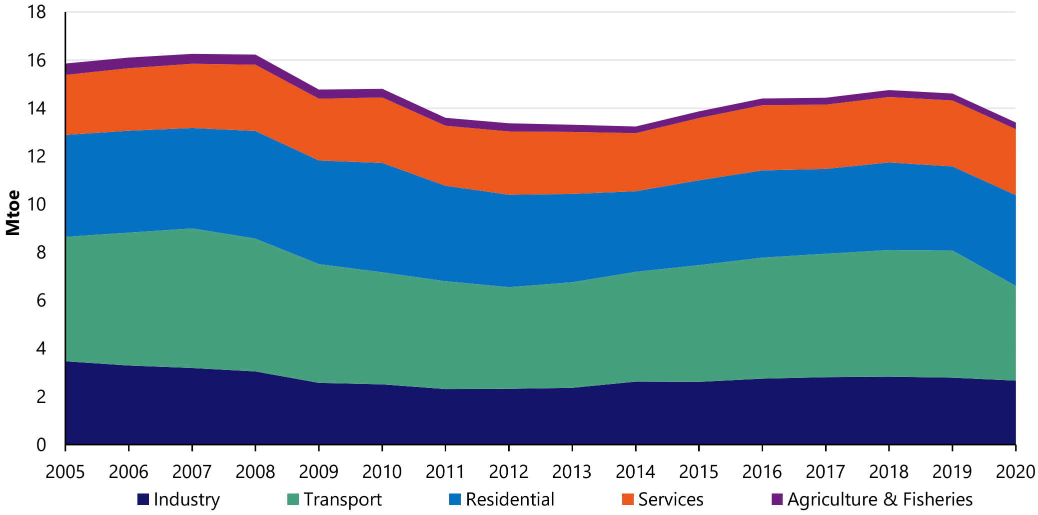
	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Oil	6,010	45%	9,134	58%	-1,185	-16.5%	-9.7%	-2.0%	-34.2%	-2.8%
Gas	4,564	34%	3,503	22%	-7	-0.2%	21.1%	3.9%	30.3%	1.8%
Renewables	1,778	13%	370	2%	145	8.9%	56.3%	9.3%	379.9%	11.0%
Coal	448	3%	1,882	12%	60	15.6%	-69.5%	-21.1%	-76.2%	-9.1%
Peat	418	3%	791	5%	-212	-33.6%	-45.5%	-11.4%	-47.2%	-4.2%
Wastes Non-Renewable	147	1%	0	0%	1	1.0%	113.3%	16.4%	-	-
Net Electricity Imports	-13	0%	176	1%	-68	-123.6%	-122.6%	-174.2%	-107.4%	-184.1%
Total	**13,350**	**100%**	**15,857**	**100%**	**-1,265**	**-8.7%**	**-4.1%**	**-0.8%**	**-15.8%**	**-1.1%**

Demand for fossil fuels fell by 10.5% in 2020, largely driven by reduced oil consumption in the transport sector, due to public health travel restrictions.

3.2 Primary energy supply by sector

Figure 17 shows how Ireland's primary energy supply ultimately services the energy needs of different sectors of the economy. Where primary energy is used directly by end-users in a particular sector then allocation is straightforward, for example, the use of natural gas in the residential sector. Where fuels undergo a transformation process before final use by an end-user then the full primary energy required to satisfy that final use is allocated to the sector. For example, for the electricity used in the residential sector, the fuels used to generate that electricity (gas, wind, coal, peat and oil, etc) are allocated to the residential sector.

Figure 17: Total primary energy requirement by sector[5]



Source: SEAI

Table 10 details the quantities, shares, and trends of primary energy supply across economic sectors. The total primary supply of 13,350 ktoe in 2020 was split across the transport (30%), residential (28%), services (21%), industry (20%), and agriculture & fisheries (2%) sectors. The total primary supply of energy in Ireland fell by 8.7% in 2020 compared to 2019 (14,615 ktoe to 13,350 ktoe).

In 2020, transport had the largest share of primary energy, despite a 25.6% reduction against 2019 levels (5,298 ktoe to 3,941 ktoe). Primary energy to the residential sector increased by 8.1% in 2020 (3,499 ktoe to 3,782 ktoe), but fell by 4.4% for industry (2,783 ktoe to 2,662 ktoe).

Sectoral energy-related CO_2 emissions are discussed in *Section 6.1*.

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Industry	2,662	20%	3,470	22%	-121	-4.4%	1.9%	0.4%	-23.3%	-1.8%
Transport	3,941	30%	5,181	33%	-1,357	-25.6%	-19.0%	-4.1%	-23.9%	-1.8%
Residential	3,782	28%	4,234	27%	283	8.1%	7.2%	1.4%	-10.7%	-0.8%
Services	2,741	21%	2,503	16%	-2	-0.1%	5.8%	1.1%	9.5%	0.6%
Agriculture & Fisheries	282	2%	468	3%	-5	-1.8%	3.3%	0.7%	-39.9%	-3.3%
Total	**13,350**	**100%**	**15,857**	**100%**	**-1,265**	**-8.7%**	**-4.1%**	**-0.8%**	**-15.8%**	**-1.1%**

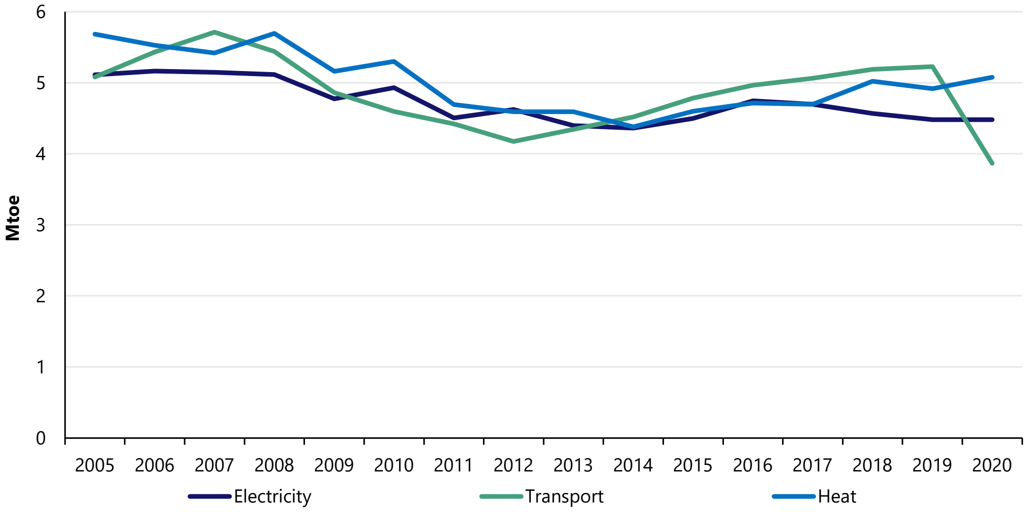
5 International air transport kerosene is included in the transport sector in these graphs. Later graphs showing CO_2 emissions by sector omit international air transport energy emissions following UN Intergovernmental Panel on Climate Change (IPCC) guidelines.

3.3 Primary energy supply by mode

Figure 18 shows primary energy supply through the lens of the heat, transport and electricity modes. To avoid double-counting, heat and transport energy provided by electricity (e.g. electric heaters and electric vehicles) is counted into the electricity mode only, not the heat or transport modes.

All three modes have a broadly similar share in primary energy. In 2020 the split was heat (5,078 ktoe), electricity (4,481 ktoe), and transport (3,868 ktoe) This differs from the mode split of final energy use, where the electricity mode is approximately half that of heat and transport. This is due to the fact that a significant amount of energy is lost in the thermal generation of electricity, and never reaches end-users for final consumption. Therefore the primary supply electricity mode is always substantially higher than the final use electricity mode. For more information on electricity generation inputs, outputs and efficiency see *Section 4.1.*

Figure 18: Primary energy by mode of application



Source: SEAI

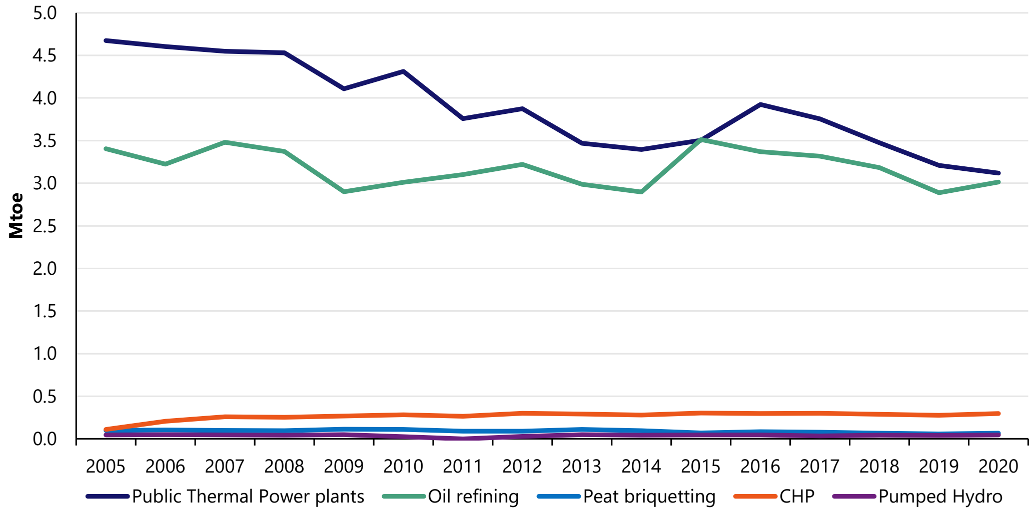
4 Electricity generation and other energy transformations

Energy transformation involves converting one fuel-type or energy source into another, e.g. transforming crude oil into petrol and diesel in an oil refinery, or converting coal and gas into electricity in a thermal generation plant. Approximately half of all primary energy undergoes a transformation before it reaches an end-user for final consumption.

Primary energy supply considers all inputs and losses in energy transformation processes, while final energy use only considers the outputs from those transformation processes. Transformation outputs are less than the primary supply inputs due to the energy required to make the transformations, and losses from those processes.

As shown in *Figure 19*, the two most significant energy transformation processes in Ireland are electricity generation, and oil refining. Oil refining has had a relatively constant long-term average input of 3,250 ktoe, while the transformation input of public thermal power plants for electricity generation has been trending down in the long-term (4,675 ktoe in 2005 to 3,119 ktoe in 2020).

Figure 19: Primary energy inputs to transformation processes[6]



Source: SEAI

4.1 Electricity generation

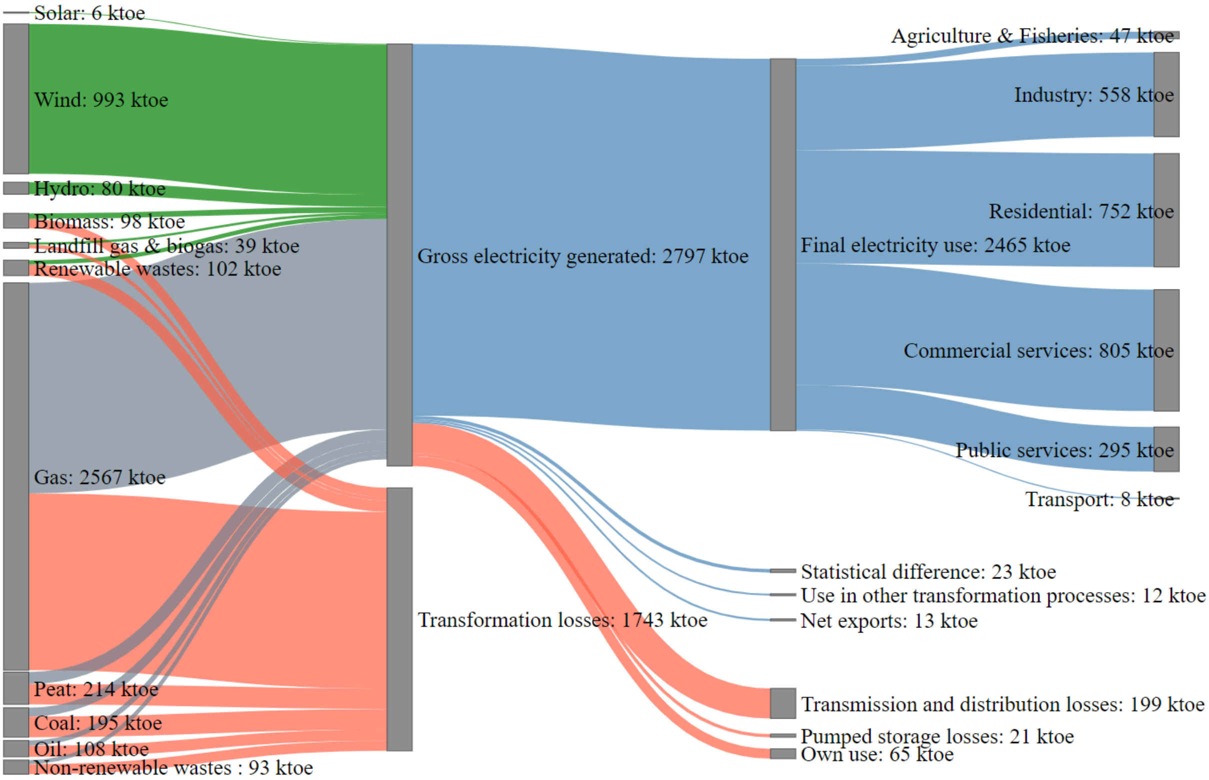
Modern economies and societies depend on reliable and secure supplies of electricity. Total energy inputs to 2020 electricity generation were 4,494 ktoe, 33.6% of Ireland's total primary energy supply. *Figure 20* is a Sankey diagram that shows the flow of energy from the inputs to electricity generation to the final electricity used by the different sectors.

Despite steady improvements in the efficiency of the electricity generation system, 45.1% of all energy used to generate electricity in 2020 was lost before the electricity reached the final end-user, through a combination of transformation losses, own-use of electricity by power plants, pumped hydro storage losses and transmission losses. Of the primary energy used to generate electricity (4,494 ktoe) only 2,464 ktoe is available for final consumption as electricity.

The growing contribution from renewables (hydro, wind, landfill gas and biomass) is also notable. In 2020, wind generation accounted for 36.1% of all electricity generated in Ireland. It was again the second largest source of generated electricity after natural gas. Hydro generation provided 2.9% of all generated electricity, the same as that generated by peat.

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

Figure 20: Flow of energy in electricity generation



Source: SEAI

4.1.1 Primary fuel inputs into electricity generation

Figure 21 shows the trends in primary energy supply for electricity generation broken-out by fuel-type and energy source.

In 2005, 93% of energy for electricity generation came from fossil fuels, in 2020, that share has fallen to 69%. Conversely, the share of renewable energy for electricity generation has increased from 3.5% to 29.3% in the same period (a factor of over 8).

A significant recent trend was the reduction in coal use for electricity generation, falling from 1,126 ktoe in 2015 to 148 ktoe in 2019. However, 2020 saw a slight reversal of this trend with coal for electricity generation rising to 195 ktoe. Similarly, the use of oil for electricity generation is increasing, rising from 35 ktoe in 2018 to 107 ktoe in 2020.

The use of peat for electricity generation fell sharply in 2020, from 434 ktoe to 214 ktoe, just over a 50% reduction.

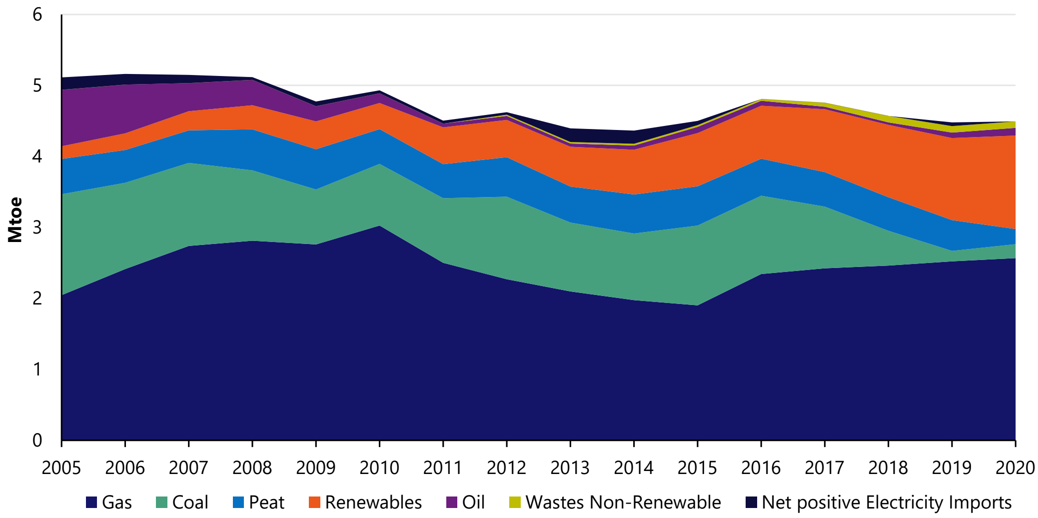
Natural gas remains the largest fuel source for electricity generation and has been relatively stable at an average of 2,450 ktoe (or just over half the primary supply for electricity) since 2016. In 2020 natural gas accounted for 57.1% of primary energy for electricity generation, with very little change from 2019 (2,521 ktoe to 2,567 ktoe).

Strong consistent growth in renewable electricity generation since the early 2000's is also evident. Renewable electricity more than doubled (631 ktoe to 1,318 ktoe) since 2014 and now accounted for a 29.3% share of the primary energy used for electricity generation.

Note that while renewable sources accounted for 29.3% of the primary energy supply for electricity generation in 2020, they contributed 41.2% of all electricity generated. This is because the thermal generation of electricity from natural gas and coal has significant losses, while electricity generation from non-combustible renewable sources (wind, hydro and solar) is considered to be 100% efficient.

The use of peat for electricity generation fell by half in 2020.

Figure 21: Primary fuel mix for electricity generation



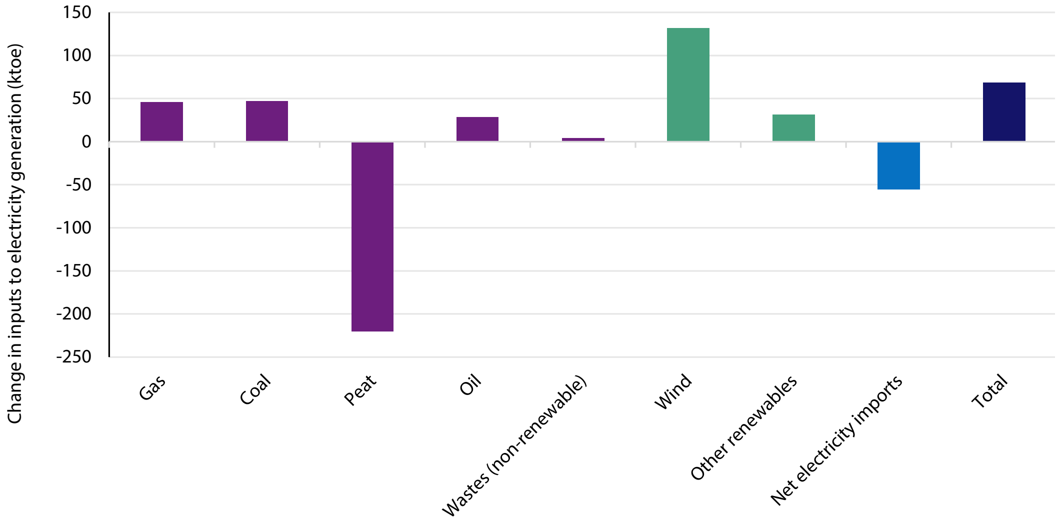
Source: SEAI

Table 11 provides a detailed summary of the quantities, shares and trends of fuel-types and energy sources that go into electricity generation, and *Figure 22* shows the "swing" in primary supply for electricity generation between 2020 and 2019, broken-out by fuel-type and energy-source. The largest swings were the reduction in peat (221 ktoe) for electricity generation and the increase in wind (132 ktoe) generation.

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Gas	2,567	57%	2,044	40%	46	1.8%	35.2%	6.2%	25.6%	1.5%
Coal	195	4%	1,422	28%	47	31.7%	-82.7%	-29.6%	-86.3%	-12.4%
Peat	214	5%	496	10%	-221	-50.8%	-61.4%	-17.3%	-56.9%	-5.5%
Oil	107	2%	794	16%	29	36.6%	24.3%	4.4%	-86.5%	-12.5%
Total Fossil Fuels	3,083	69%	4,756	93%	-99	-3.1%	-15.9%	-3.4%	-35.2%	-2.8%
Wastes Non-Renewable	93	2%	0	0%	4	5.1%	275.4%	30.3%	-	-
Wind	993	22%	96	2%	132	15.3%	75.7%	11.9%	938.7%	16.9%
Biomass	98	2%	2	0%	21	27.4%	128.8%	18.0%	3912.7%	27.9%
Renewable Wastes	102	2%	0	0%	5	5.4%	293.5%	31.5%	-	-
Hydro	80	2%	54	1%	4	5.2%	15.6%	2.9%	47.7%	2.6%
Other renew-ables	45	1%	27	1%	1	3.3%	-4.6%	-0.9%	63.3%	3.3%
Renewables	1,318	29%	180	4%	163	14.1%	75.7%	11.9%	633.3%	14.2%
Net positive Electricity Imports	0	0%	176	3%	-55	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%
Total (exlc. net imports)	**4,494**	**100%**	**5,112**	**100%**	**13**	**0.3%**	**-0.1%**	**0.0%**	**-12.1%**	**-0.9%**

Figure 22: Change in fuel inputs to electricity generation in 2020 compared with 2019

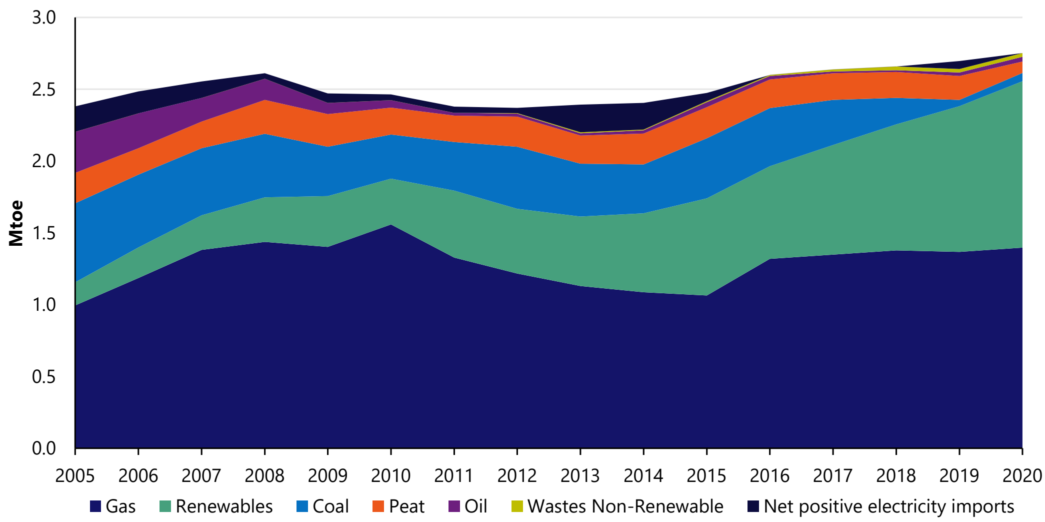


Source: SEAI

4.1.2 Electricity generated by fuel type

Figure 23 and *Table 12* detail the generated electricity available for final consumption by end-users, broken-out by fuel-type and energy-source.

Figure 23: Electricity generated by fuel type



Source: SEAI

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Gas	1,396	51%	995	42%	28	2.1%	31.3%	5.6%	40.3%	2.3%
Coal	58	2%	549	23%	14	33.1%	-86.2%	-32.7%	-89.5%	-13.9%
Peat	79	3%	211	9%	-87	-52.3%	-63.5%	-18.3%	-62.5%	-6.3%
Oil	33	1%	287	12%	9	37.8%	-4.3%	-0.9%	-88.3%	-13.3%
Total Fossil Fuels	**1,567**	**57%**	**2,043**	**86%**	**-35**	**-2.2%**	**-9.7%**	**-2.0%**	**-23.3%**	**-1.8%**
Wastes Non-Renewable	26	1%	0	0%	0	1.4%	303.6%	32.2%	-	-
Wind	993	36%	96	4%	132	15.3%	75.7%	11.9%	938.7%	16.9%
Biomass	37	1%	1	0%	7	24.1%	118.5%	16.9%	5347.1%	30.5%
Renewable wastes	28	1%	0	0%	0	1.8%	323.1%	33.4%	-	-
Hydro	80	3%	54	2%	4	5.2%	15.6%	2.9%	47.7%	2.6%
Other renew-ables	21	1%	11	0%	1	7.2%	16.1%	3.0%	97.6%	4.6%
Total Renew-ables	**1,159**	**42%**	**161**	**7%**	**145**	**14.3%**	**71.5%**	**11.4%**	**619.5%**	**14.1%**
Net positive electricity imports	0	0%	176	7%	-55	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%
Total (exlc. net imports)	**2,752**	**100%**	**2,380**	**100%**	**55**	**2.0%**	**11.2%**	**2.1%**	**15.6%**	**1.0%**

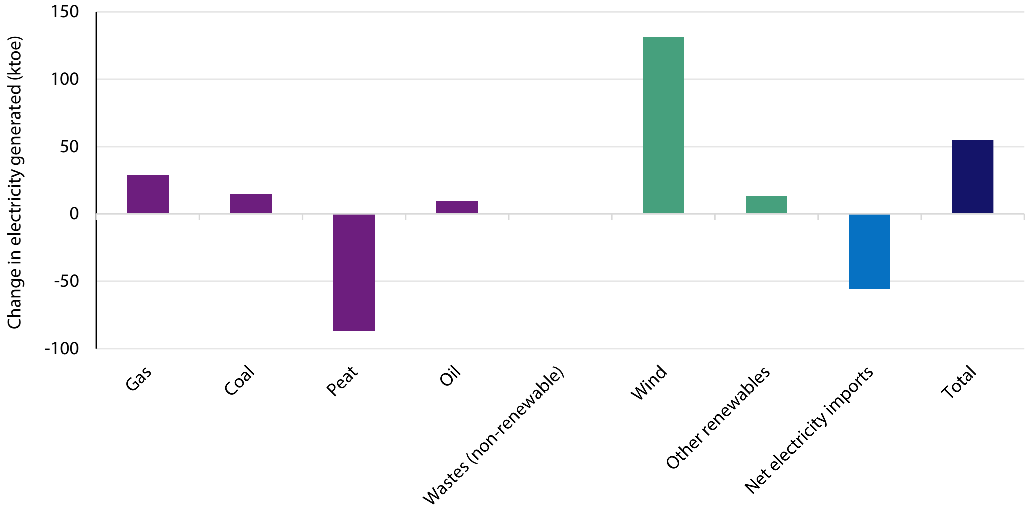
A comparison of *Figure 21* and *Figure 23,* is equivalent to a comparison of the primary energy supply for electricity and final energy use of electricity. The difference in scale between the two figures (6 Mtoe vs. 3 Mtoe) gives a sense of the generation and transmission losses. The relative increase in share from renewable sources in *Figure 23* is due to wind, hydro, and solar generation being taken as 100% efficient.

The share of electricity generated by renewable sources was 42.1% in 2020, up from 37.6% in 2019. Normalising for wind and hydro as per EU Directive 2009/28/EC the share of electricity generated from renewable sources in 2020 was 39.1%.

In 2020, renewable sources accounted for 42.1% of the generated electricity for end users in Ireland.

As shown in *Figure 24*, the most significant changes in 2020 were reductions in generated electricity from peat, and increases in generated electricity from wind. 2020 also saw Ireland return to a zero net importer of electricity. Electricity generated from gas, coal, and oil all increased in 2020.

Figure 24: Change in electricity generation by source in 2020 compared with 2019



Source: SEAI

4.1.3 Efficiency of electricity supply

Trends in the efficiency of Ireland's electricity supply are shown in *Figure 25*. Efficiency of electricity supply is defined as the ratio of final energy use of electricity and primary energy supply for the generation of electricity[7].

The overall efficiency is determined by the weighted average of electricity generation from non-combustible renewable sources, such as wind, hydro, and solar (taken to be 100% efficient), and electricity from combustible sources, such as gas, coal, and biomass (which have transformation losses). The efficiency of electricity supply therefore increases as the share of non-combustible renewable sources (e.g. wind, hydro, and solar) increases, and as more efficient fuels and technologies are employed in thermal generation plants.

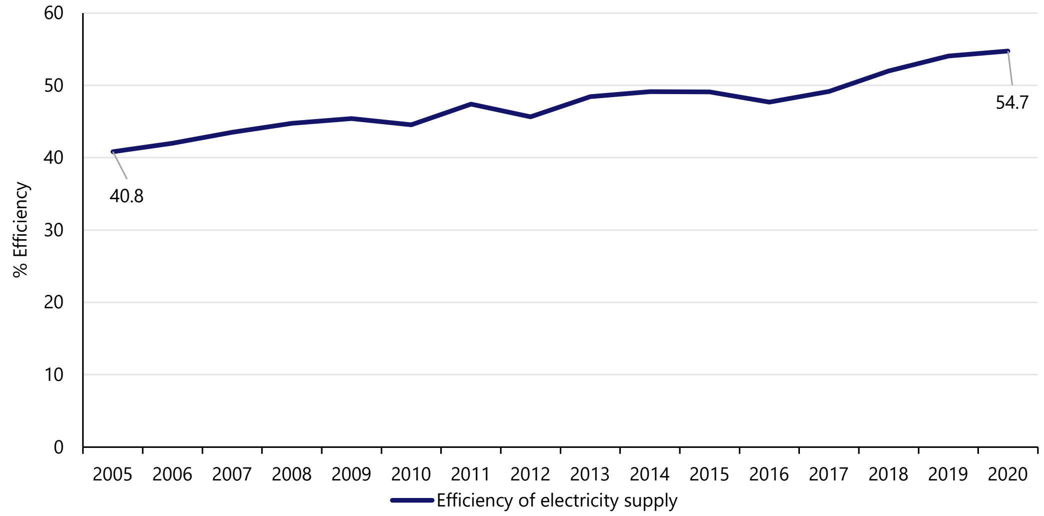
Ireland has significant electricity generation losses due to the predominance of thermal generation. In 2020, thermal generation plants required a primary energy supply of 3,176 ktoe to generate 1,592 ktoe of electricity for final use, meaning that they operated at an average national efficiency of just 50.1%.

In 2020, the overall efficiency of Ireland's electricity supply was 54.7%. On average, it takes 1000 kWh of primary energy supply to generate 547 kWh of electricity final consumption by end-users (with the other 453 kWh unavailable for end-use).

The efficiency of Ireland's electricity supply has been improving over the last decades, due to the introduction of higher efficiency natural gas plants, the closure of older peat-fired stations, and increased direct generation from renewable sources.

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

Figure 25: Efficiency of electricity supply

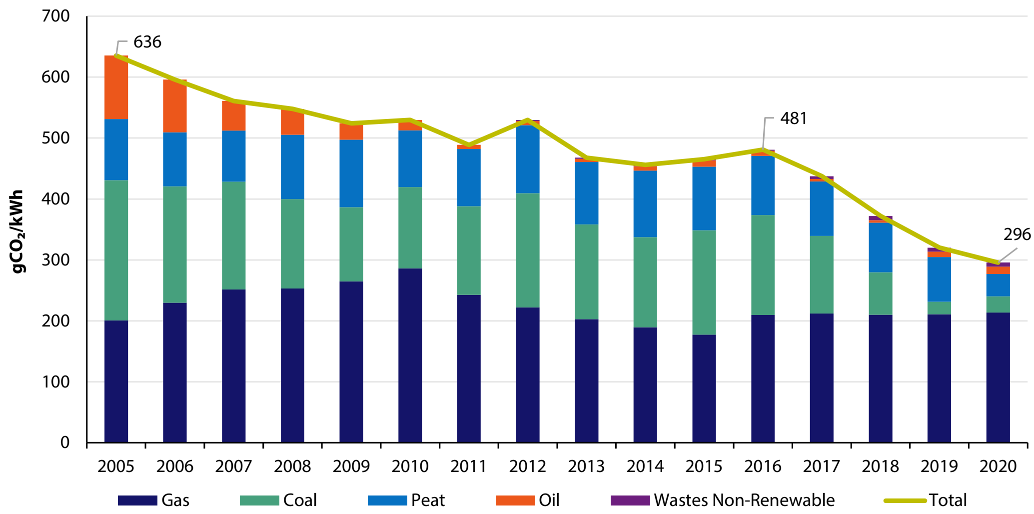


Source: SEAI

4.1.4 Carbon intensity of electricity supply

Figure 26 shows the CO_2 emission intensity of Ireland's electricity generation, which is measured in gCO_2/kWh. The stacked bars show the share of CO_2 emissions by fuel for each kWh of electricity generated in Ireland. It is important to note that the stacked bars in the graph represent the contributions of different fuels to the overall CO_2 intensity of Ireland's electricity generation, not the CO_2 intensity of the individual fuels themselves.

Figure 26: CO_2 emissions per kWh of electricity supplied, with contributions by fuel



Source: SEAI

The CO_2 intensity of electricity generation fell to 296 gCO_2/kWh in 2020, which is a historic low for Ireland. For perspective, this is 39% lower than in 2016 (481 gCO_2/kWh) and 53% lower than in 2005 (636 gCO_2/kWh). The dramatic improvements in CO_2 emission intensity are due to reductions in the use of coal for electricity generation, and increased generation from zero-carbon renewable sources.

Over the longer term, there has been a shift away from coal and oil, two of the fuels with the highest CO_2 intensity. These fuels have been replaced by a combination of high efficiency gas combined cycle gas turbine (CCGT) generation, and zero carbon renewables. Imported electricity is also considered as zero carbon from Ireland's perspective as emissions are counted in the jurisdiction in which they are emitted.

The reduction in the carbon intensity of electricity generation in 2020 can largely be attributed to the 51% reduction peat used for electricity generation, and the 15% increase in wind generation. Countering these positive trends in carbon intensity were 33% and 38% relative increases in electricity generation from coal and oil, respectively.

4.1.5 Combined heat and power generation

Combined heat and power (CHP) is the simultaneous generation of usable heat and electricity in a single process. In conventional electricity generation much of the input energy is lost as waste heat. Typically, up to 60% of the input energy is lost, with 40% transformed into electricity. The efficiency of a CHP plant can be 20-25% higher than the combined efficiency of heat-only boilers and conventional power stations. Also, if embedded in the network close to the point of electrical consumption, CHP can avoid some of the transmission losses incurred by centralised generation. In the right circumstances CHP can be an economical means of improving the efficiency of energy use, and achieving environmental targets for emissions reduction.

The installed capacity[8] of CHP in Ireland at the end of 2020 was 365 MWe (464 units[9]), up very slightly from 362 MWe (456 units) in 2019 (see *Table 13*). Of these 464 units, only 327 were reported as being operational. The operational installed capacity increased by 8.0 MWe to 327 MWe in 2020.

Table 13: Number of units and installed capacity by fuel, 2020

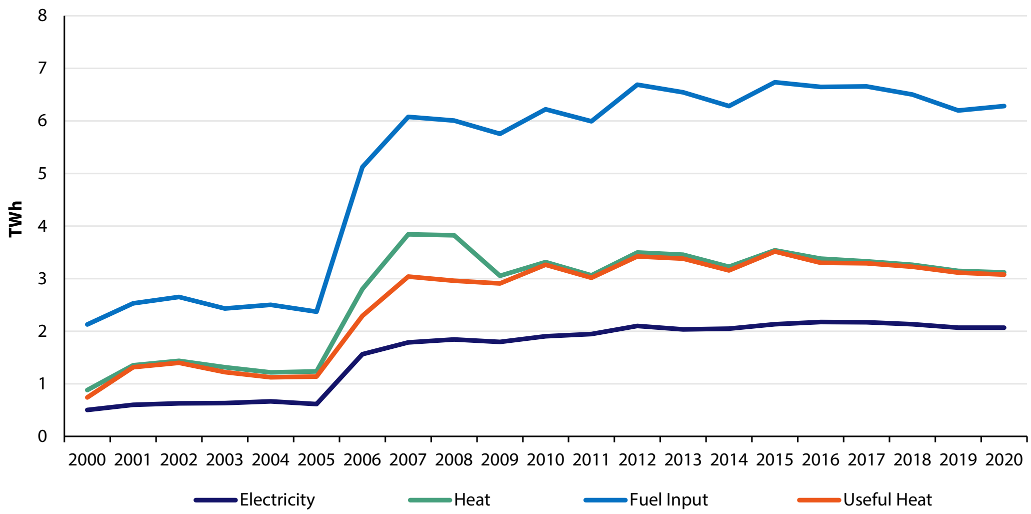
	No. of Units	Installed Capacity (MWe)	No. of Units %	Installed Capacity %
Natural Gas	410	332.0	88.4	90.9
Solid Fuels	2	5.2	0.4	1.4
Biomass	4	6.7	0.9	1.8
Oil Fuels	24	8.9	5.2	2.4
Biogas	24	12.3	5.2	3.4
Total	**464**	**365**	**100**	**100**

Source: SEAI

Natural gas was the fuel of choice for 332 MWe (410 units) in 2020, with a single gas plant accounting for 160 MWe. Biogas and oil products[10] made up the next most significant shares with 12.3 MWe and 8.9 MWe, respectively (24 units each). The remainder was biomass at 6.7 MWe (4 units) and solid fuels at 5.2 MWe (2 units). CHP in Ireland is examined in more detail in a separate SEAI publication[11].

Figure 27 illustrates the contribution from CHP to Ireland's energy requirements in the period 2000 to 2020. Fuel inputs increased by 195% over this period while the thermal and electrical outputs increased by 315% and 312% respectively. In 2020, fuel input increased by 1.3%, electricity generated increased by 0.1% and thermal output decreased by 0.8%. The step-change increase observed in 2006 is due to the Aughinish Alumina CHP plant coming online.

Figure 27: CHP fuel input and thermal/electricity output



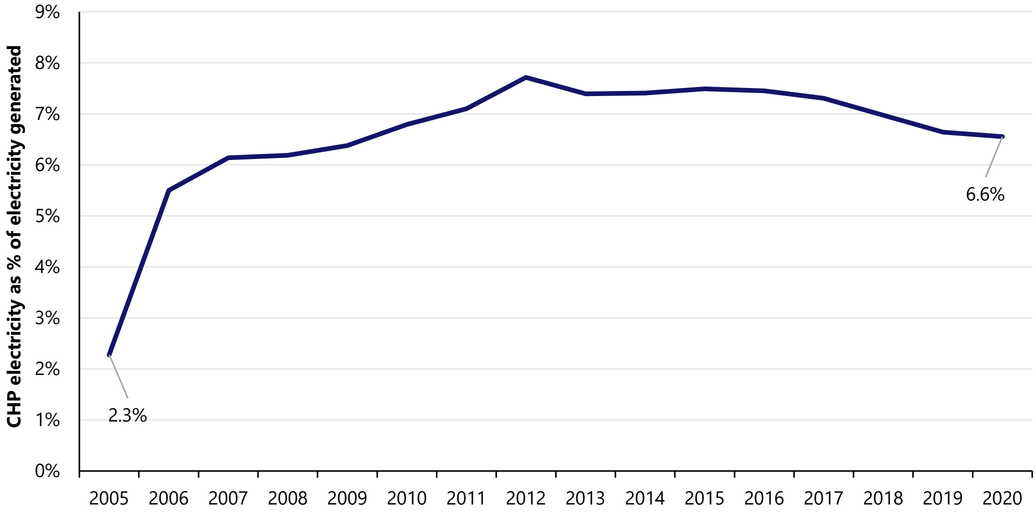
Source: SEAI

Figure 28 focuses on CHP generated electricity in Ireland as a proportion of gross electricity consumption (i.e. electricity generation plus net imports) in the period 2005 to 2020. In 2020, 6.6% of total electricity generation was generated in

8 Megawatt electrical or MWe is the unit by which the installed electricity generating capacity or size of a CHP plant is quantified, representing the maximum electrical power output of the plant.
9 Note that units are distinct from CHP plants or schemes and that there may be more than one CHP unit at a site
10 Oil products are comprised of LPG, heavy fuel oil, refinery gas and biodiesel.
11 SEAI (2020), *Combined Heat and Power in Ireland – 2020 Update*. Available from: https://www.seai.ie/publications/

CHP installations, the same as 2019. Some CHP units export electricity to the national grid. In 2020, there were 15 units exporting electricity to the grid. These units exported 1,378 GWh of electricity in 2020, an increase of 3.1% on 2019.

Figure 28: CHP electricity as percentage of total electricity generation



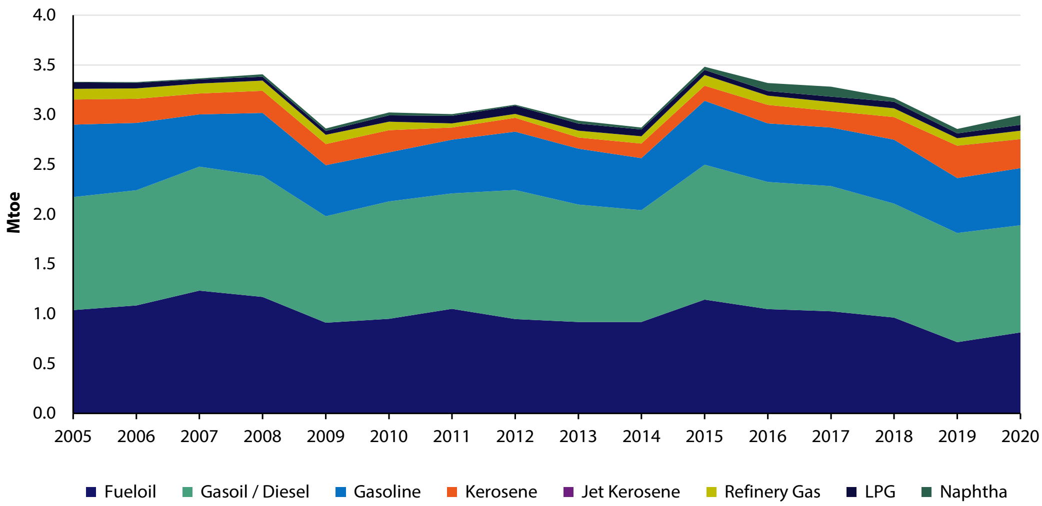
Source: SEAI

4.2 Oil refining

Ireland has one oil refinery at Whitegate in Cork that is currently operated by Irving Oil. Whereas electricity generation has a variety of fuel inputs and just one output (electricity), oil refining has one major fuel input (crude oil), but multiple fuel outputs (petrol, diesel and jet kerosene, etc). *Figure 29* shows the outputs from oil refining from 2005 to 2020. Fuel oil, diesel (gasoil) and petrol (gasoline) are the main outputs.

Due to the highly international nature of the oil market, refinery outputs are not heavily influenced by local demand in the Irish market. Much of the Irish refinery output is exported directly, and the majority of oil products used for final energy in Ireland are imported in the form of finished products, not produced in the Irish refinery. Nonetheless the refinery is an important piece of infrastructure, with regard to energy security.

Figure 29: Outputs from oil refining



Source: SEAI

4.3 Other transformation processes

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

Pumped hydro electricity storage

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

The electricity generated from pumped hydro storage is not considered hydro-electricity and is not counted as renewable energy. Pumped storage facilities act to store electricity previously generated by other sources. Although it is not a renewable source, pumped hydro storage is useful for integrating and smoothing variable non-synchronous renewable electricity sources, such as wind, onto the electricity system.

Use of Turlough Hill peaked in 2013 when there was 50 ktoe or 585 GWh of electricity input, and 30 ktoe or 345 GWh of output. In 2020, this had reduced to 46 ktoe (536 GWh) of inputs and 25 ktoe (292 GWh) of output. The overall efficiency of Turlough Hill has fallen from the 1990s (over 70%) to 54% in 2020.

Peat briquetting

Peat briquetting converts milled peat into briquettes for residential use. Peat briquette production has been reducing since the early 1990s. In 2020, 62 ktoe of peat briquettes were produced, approximately 50% below the early 2000s.

5 Drivers of energy demand

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

5.1 Energy, economy and emissions

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

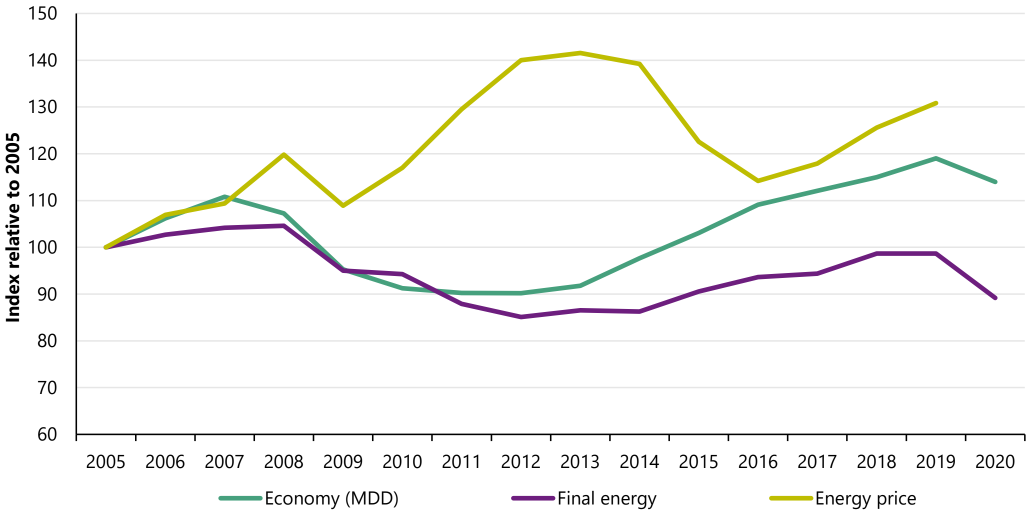
The relationship between economic activity and energy demand is less straightforward in Ireland than it is for most other countries. Gross Domestic Product (GDP) is the most widely accepted measure of economic activity internationally, but Ireland's GDP is strongly influenced by the revenue and profits reported by multinational companies. Some economic activity of these companies results in large amounts of value added[12], but results in little energy consumption. This was illustrated clearly in 2015, when Irish GDP increased suddenly by 25% from 2014, due to the transfer of intellectual property from multinational companies. Care must be taken when comparing macro-economic indicators, such as energy per unit GDP, across countries.

The Central Statistics Office (CSO) have developed alternative indicators to GDP, that more accurately reflect the level of economic activity in the domestic economy, and to remove the distorting effects of globalisation. Modified domestic demand[13] was first published in the Quarterly National Accounts[14] results for Q1-2017 and excluded trade by aircraft leasing companies, exports and imports of R&D services, and exports and imports of R&D-related IP products. For comparison, Ireland's modified domestic demand grew by 5.3% from 2014 to 2015, compared to 25% for GDP.

Figure 30 shows the historical trends for modified domestic demand, energy prices and final energy, each expressed as an index relative to 2005. This figure illustrates changes in economic growth between 2005 and 2020, and shows the effect of the economic downturn between 2008 and 2012 (and the subsequent return to growth after 2013).

Table 14 gives the growth rates for the economy (GDP and modified domestic demand), primary energy, final energy and energy-related CO_2 emissions for the period 2005 to 2020. The starting year of 2005 is chosen to align to Ireland's 2020 greenhouse gas emissions target. Transport and industry have been responsive to economic activity, while energy use in the residential and services sectors are more driven by short-term annual variations in weather and energy prices.

Figure 30: Index of modified domestic demand, final energy demand and energy price



Source: Based on SEAI and CSO data

12 See *Glossary of terms*.

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

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

Table 14: GDP[15], modified domestic demand, final energy, primary energy, and energy-related CO_2 growth rates[16]

	Overall change (%)			Annual average change (%)			
	2019-2020	2015-2020	2005-2020	2015-2020	2010-2015	2005-2010	2005-2020
Economy (GDP)	5.9%	34.6%	91.1%	6.1%	6.8%	0.4%	4.4%
Economy (MDD)	-4.2%	10.6%	14.0%	2.0%	2.5%	-1.8%	0.9%
Final energy	-9.6%	-1.5%	-10.8%	-0.3%	-0.8%	-1.2%	-0.8%
Primary energy	-8.7%	-4.1%	-15.8%	-0.8%	-1.1%	-1.5%	-1.1%
Energy related CO_2	-11.4%	-14.5%	-30.3%	-3.1%	-1.5%	-2.5%	-2.4%

Source: CSO and SEAI

In 2009, tracking the decline in economic activity, all sectors experienced reductions in energy use and related emissions. This was somewhat balanced in 2010 by an exceptionally cold year that saw record high energy use for heat in the residential sector. Although modified domestic demand was relatively constant in 2012, energy demand continued to fall (mostly in the transport and residential sectors) largely due to record high energy prices, including a sustained period with oil prices of over $100 per barrel. Strong growth of modified domestic demand returned 2014, with increases in energy demand and energy-related CO_2 emissions following after a one year lag, following the easing of energy prices. Final energy demand increased every year from 2014 to 2018, and fell slightly (-0.6%) in 2019, despite a 2019 growth in modified domestic demand of 3.2%. Most of the reduction in final energy demand in 2019 can be explained by reduced heat demand due to a warm year. When weather-corrected, final energy use in 2019 increased by 0.5%.

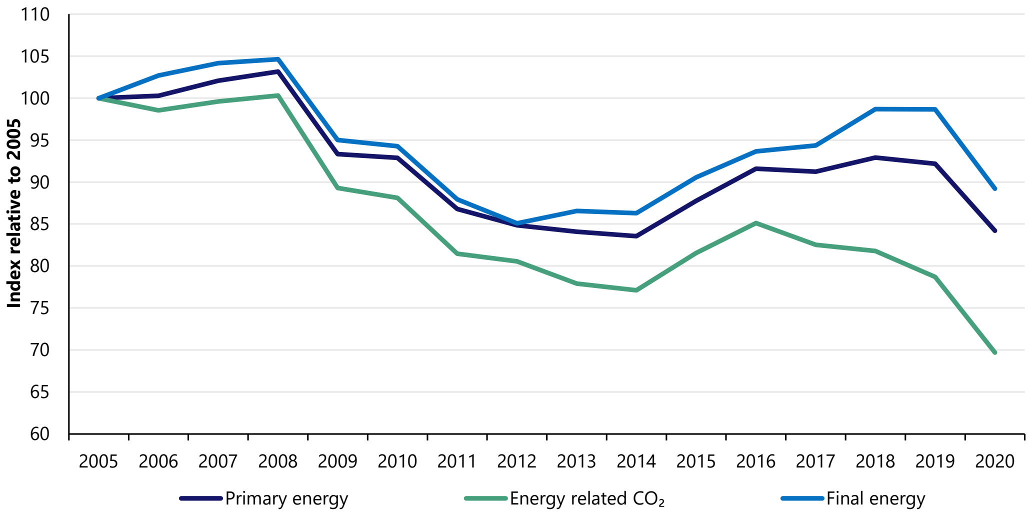
In 2020, final energy use fell by 9.6% and energy-related CO_2 emissions fell by 11.4%. Modified domestic demand fell by 4.2%, due largely to the impact of COVID-19 on economic activity (while GDP increased by 5.9%).

> Final energy use in 2020 fell by 9.6% and energy-related CO2 emissions fell by 11.4%, due largely to the impact of COVID-19 on economic activity.

Figure 31 shows the relationship between final energy demand, primary energy use and energy-related CO_2 emissions, expressed as an index relative to 2005. The difference between the trends in final energy use and primary energy supply arises from improvements in the efficiency of energy transformations, particularly electricity generation.

The overall efficiency of electricity generation has gone from 33% in the early 1990s, to 41% in 2005, to 54.7% in 2020. These improvements are driven by the introduction of higher efficiency CCGT gas generators, reductions in inefficient coal generation, and the increased supply of wind generated electricity (considered 100% efficient).

Figure 31: Index of final energy, primary energy and energy-related CO_2

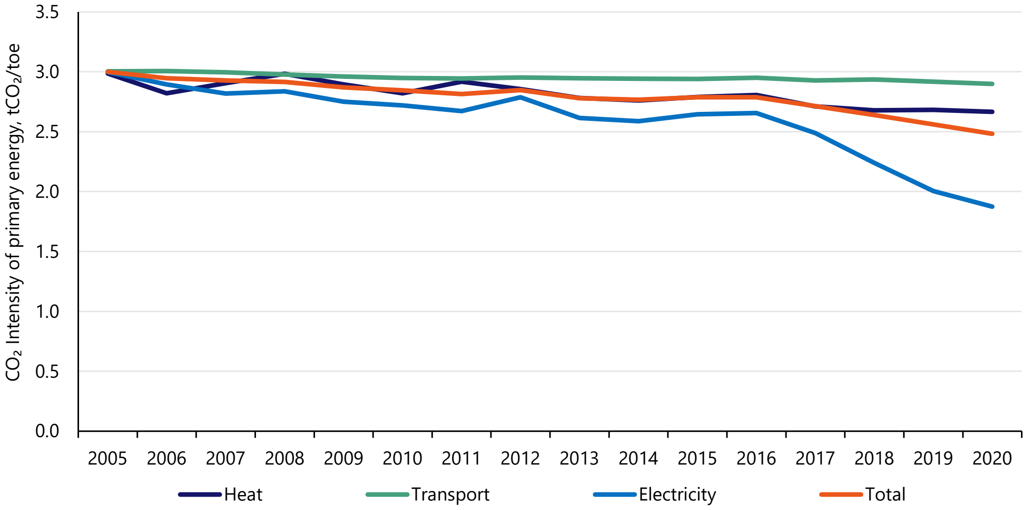


Source: SEAI

15 GDP and Modified Domestic Demand rates are for constant market prices chain-linked annually and referenced to 2019.
16 Throughout the report, where annual growth rates are across multiple years they always refer to *average annual growth rates*.

The difference between the trends for energy-related CO_2[17] and primary energy in *Figure 31* are due to changes in the CO_2 intensity of the fuel mix used across all sectors. Changes in the CO_2 intensity of Ireland's fuel mix is examined in more detail in *Figure 32*, which shows the CO_2 intensity per unit of primary energy in each of the heat, transport and electricity sectors.

Figure 32: CO_2 intensity of primary energy by mode



Source: SEAI

Electricity has seen the greatest reduction in CO_2 intensity, especially since 2016. This is due to the 86.2% reduction in high CO_2 intensity coal generation, and the 71.5% increase in zero carbon renewable generation between 2015 and 2020.

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

There has been little reduction in the carbon intensity of transport energy, as it remains almost entirely dependent on oil products. There has been an increase in the use of renewable liquid biofuels in transport, but these still only accounted for 4% of transport primary energy use in 2020, so the reduction in carbon intensity has been small.

5.2 Energy and the weather

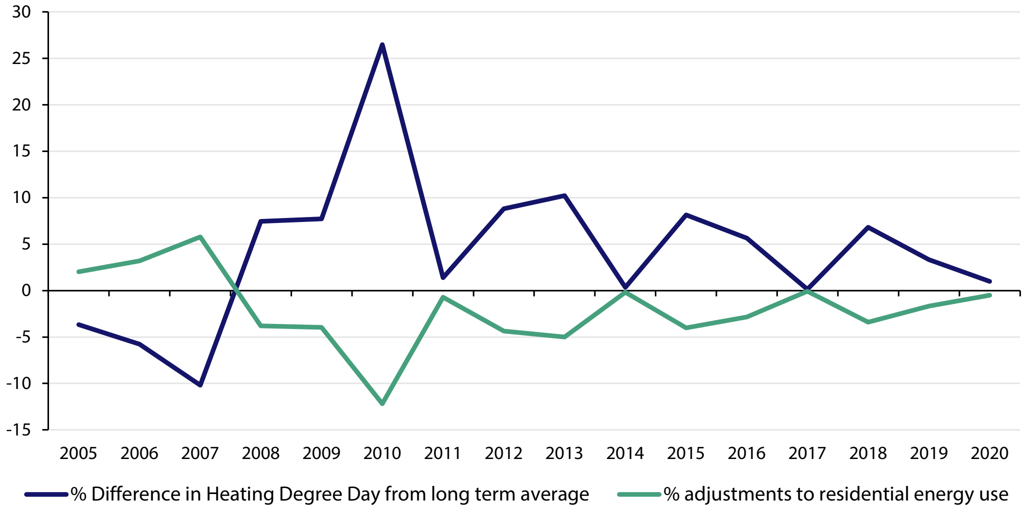
Weather variations from year to year can have a significant effect on the energy demand of a country, in particular on the portion of the energy demand associated with space heating. A method to measure the weather, or climatic variation, is the use of 'degree days'.

Degree days are the measure or index used to take account of the severity of the weather when looking at energy use in terms of heating (or cooling) load on a building. A degree day is a measure of how cold (or warm) it is outside, relative to a day on which little or no heating (or cooling) would be required. It is thus a measure of the cumulative temperature deficit (or surplus) of the outdoor temperature relative to a neutral target temperature (base temperature) at which no heating or cooling would be required. The larger the number of heating degree days, the colder the weather. If, for example, the outdoor temperature for a particular day is 10 degrees lower on average than the base temperature (15.5 degrees), this would contribute 10 degree days to the annual or monthly total. The typical heating season in Ireland is October to May.

Met Éireann calculates degree day data for each of its synoptic weather stations. SEAI calculates a population weighted average of these data to arrive at a meaningful degree day average for Ireland that is related to the heating energy demand of the country.

17 Energy-related CO_2 emissions shown here cover all energy-related CO_2 emissions associated with total primary energy requirement, including emissions associated with international air transport. These are usually excluded from the national greenhouse gas emissions inventory in accordance with the reporting procedures of the UN Framework Convention on Climate Change (UNFCCC) guidelines.

Figure 33: Deviation from average heating degree days and resulting weather adjustment



Source: Met Eireann and SEAI

Figure 33 shows the percentage deviation in the number of heating degree days from the long-term average between 2005 and 2020. 2010 was the coldest year recorded over that period and 2007 was the warmest. The portion of each fuel that is assumed to be used for heating is adjusted by multiplying it by the ratio of the long-term average number of degree days to the number of degree days in the given year. This adjustment yields a lower normalised energy consumption in cold years, and yields a higher normalised consumption in mild years. Typically, the weather adjustment is within plus or minus 6% of the actual energy consumption. The largest correction over the period was for 2010, an exceptionally cold year, where the weather-corrected energy consumption was 12% less than the actual energy consumption.

5.3 Economic energy intensities

Energy intensity is defined as the amount of energy required to produce a functional output. In the case of the economy, the measure of output is generally taken to be the GDP[18]. As mentioned in Section 5.1, modified domestic demand is a more meaningful indicator of economic in activity in Ireland, but GDP is still the standard international metric, therefore, here we present energy intensity in terms of GDP. We use GDP measured in constant prices to remove the influence of inflation.

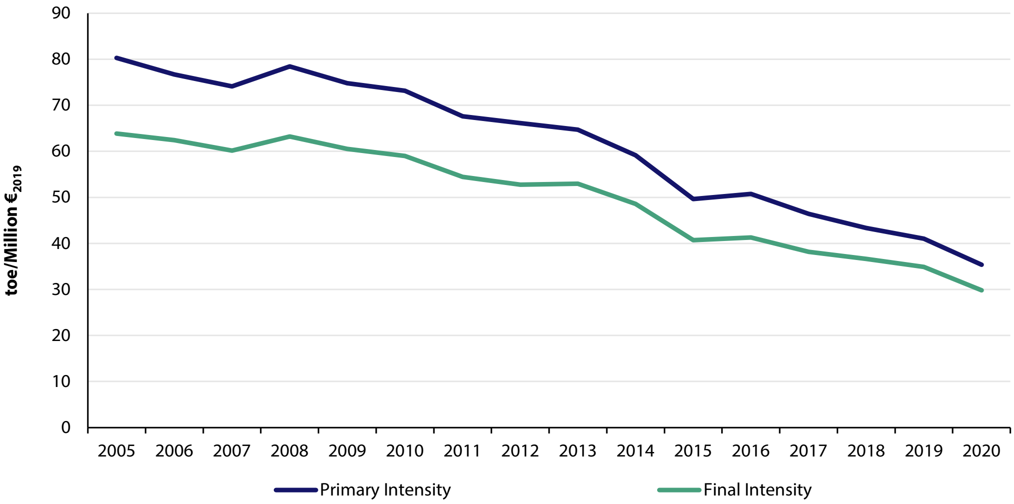
Figure 34 shows the trend in both primary energy intensity (primary energy divided by GDP) and final energy intensity (final energy consumption divided by GDP) (at constant 2019 prices). The difference between these two trends reflects the amount of energy lost in the transformation of primary energy into final energy, mostly for electricity generation.

The primary and final energy intensity of the economy has fallen since 2005, with the exception of 2008. In 2005, 80 grammes of oil equivalent (goe) produced 1 euro of GDP (in constant 2019 values), whereas in 2007 just 74 goe was required. Between 2005 and 2020 primary energy intensity of the economy fell by 56% (3.7% per annum) to 35 goe/$€_{2019}$. This can be attributed to a combination of increased energy efficiency and increases in GDP.

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

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

Figure 34: Primary, final and electricity intensities



Source: SEAI

There are many factors that contribute to how trends in energy intensity of the economy evolve. These factors include: technological efficiency and the fuel mix, particularly in relation to electricity generation; economies of scale in manufacturing; and, not least, the structure of the economy. The structure of the economy, in Ireland, has changed considerably over the past 20 to 30 years. It has shifted in the direction of the high value added sectors, such as pharmaceuticals , electronics and services. Relative to traditional 'heavier' industries, such as car manufacturing and steel production, these growing sectors are not highly energy intensive. Examples of changes to the structure of the industry sector include the cessation of steel production in 2001, of fertiliser production in late 2002, and of sugar production in 2007.

The energy intensity of the economy will continue to decrease if, as expected, the economy becomes increasingly dominated by high value added, low energy-consuming sectors. This results in a more productive economy from an energy perspective but does not necessarily mean that the actual processes used are more energy efficient, or that less energy is being used overall in the economy.

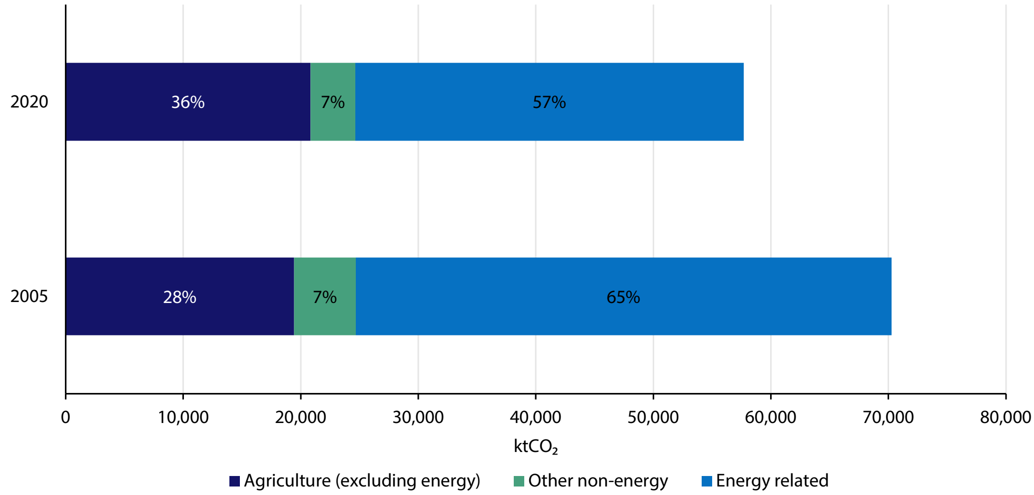
6 Policy perspectives

This section examines areas that are a focus of national and international energy policy, including Ireland's progress towards our EU 2020 targets for renewable energy and greenhouse gas emissions, and also the issues of energy security and cost competitiveness.

6.1 Greenhouse gas emissions

Figure 35 shows greenhouse gas emissions by source for 2005 and provisional figures for 2020 (excluding land use and land use change), as reported by the Environmental Protection Agency (EPA). The share of greenhouse gas emissions from energy use has fallen from 65% (45.6 Mt) in 2005 to 57% (33.1 Mt) in 2020. Ireland is unusual within the EU in having such a large share of greenhouse gas emissions from agriculture. For the EU as a whole in 2019 11% of greenhouse gas emissions were from agriculture, compared to 34% in Ireland. 98% of the energy related greenhouse gas emissions are from CO_2, with the remainder from other by products of combustion such as Nitrous Oxide (NOX) emissions.

Figure 35: Total greenhouse gas emissions by source (excluding international aviation)



Source: EPA

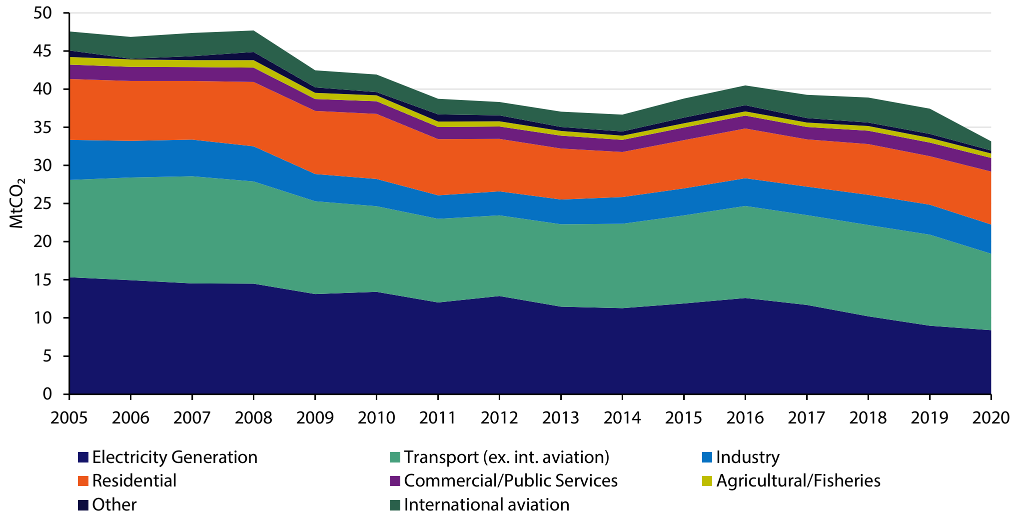
6.1.1 Energy related CO_2 emissions by sector

Figure 36 and *Table 15* show energy related CO_2 emissions split by sector. In this case the emissions from electricity generation are shown separately from the emissions from direct fossil fuel use in the end use sectors. This aligns more closely with the breakdown used by the EPA and internationally for reporting greenhouse gas emissions. International aviation is also shown separately. International aviation is included in the national energy balance (in line with international practice) and so is included in the figures for transport energy use in this report. However it is not included in the national greenhouse gas inventory (in line with international practice), and is also not included in Ireland's national greenhouse gas emissions reduction targets for 2030 and 2050.

Excluding international aviation, energy related CO_2 emissions were 29% lower in 2020 than in 2005. Transport (excluding international aviation) was responsible for the largest share of energy-related CO_2 emissions in 2020 at 31%, even after the dramatic reduction in transport energy reduction as a result of COVID-19 travel restrictions. Electricity generation was the next largest sector at 26%, followed by the residential sector at 22% and industry at 12%.

Transport was responsible for the largest share of energy-related CO_2 emissions in 2020 (31% excluding international aviation), despite the reduction in transport energy use due to COVID-19 travel restrictions.

Figure 36: Energy-related CO_2 emissions by sector[19]



Source: SEAI

Table 15: Growth rates, quantities and shares of primary energy-related CO_2 by sector

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity ($ktCO_2$)	Share (%)	Quantity ($ktCO_2$)	Share (%)	Absolute change ($ktCO_2$)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Electricity Generation	8,398	26%	15,325	34%	-582	-6.5%	-29.4%	-6.7%	-45.2%	-3.9%
Transport (ex. int. aviation)	10,026	31%	12,775	28%	-1,910	-16.0%	-13.2%	-2.8%	-21.5%	-1.6%
Industry	3,810	12%	5,248	12%	-106	-2.7%	7.7%	1.5%	-27.4%	-2.1%
Residential	6,949	22%	7,991	18%	577	9.1%	9.9%	1.9%	-13.0%	-0.9%
Commercial/ Public Services	1,789	6%	1,859	4%	9	0.5%	6.8%	1.3%	-3.8%	-0.3%
Agricultural/ Fisheries	594	2%	1,005	2%	-16	-2.6%	12.2%	2.3%	-40.9%	-3.4%
Other	395	1%	866	2%	-120	-23.3%	-47.8%	-12.2%	-54.3%	-5.1%
Total excl international aviation	**31,962**	**100%**	**45,068**	**100%**	**-2,148**	**-6.3%**	**-11.9%**	**-2.5%**	**-29.1%**	**-2.3%**
International aviation	1,184		2,487		-2,135	-64.3%	-53.0%	-14.0%	-52.4%	-4.8%
Total incl international aviation	**33,145**		**47,555**		**-4,283**	**-11.4%**	**-14.5%**	**-3.1%**	**-30.3%**	**-2.4%**

Source: SEAI

6.1.2 Energy related CO_2 emissions by mode

Figure 37 shows energy related CO_2 emissions, but divided into the three modes of transport, heat and electricity. This groups the emissions from industry, residential, commercial services, public services, agriculture and fisheries shown in *Figure 36* and *Table 15* together as heat. The emissions for transport including and excluding international aviation are shown for reference.

Energy-related CO_2 emissions in all three modes declined after 2007 during the recession, but transport returned to growth after 2012 with heat and electricity returning to growth after 2014.

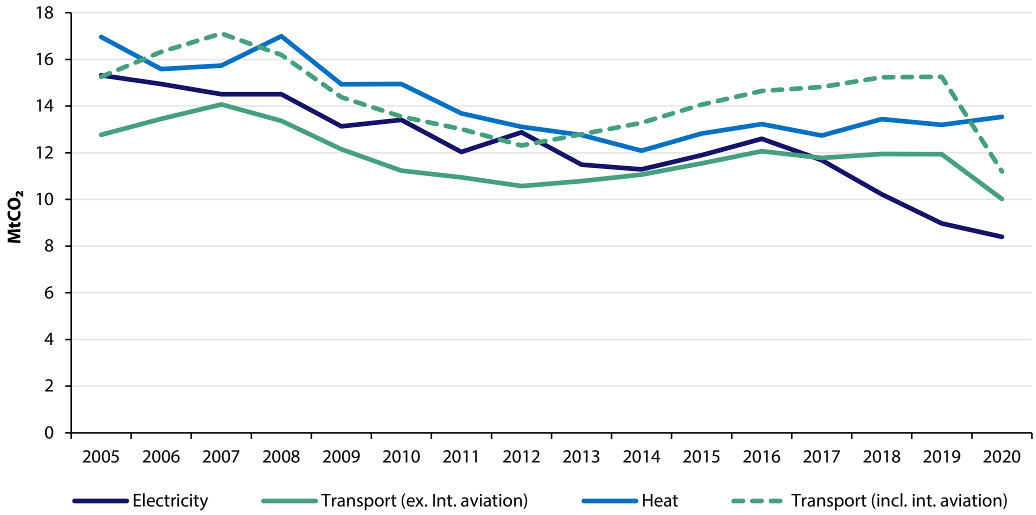
From 2016 there was a dramatic reduction in CO_2 emissions from electricity generation, due to the reduction in coal and peat (the most carbon intensive fossil fuels) and an increase in electricity from renewable, zero-carbon sources.

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

CO_2 emissions from electricity generation in 2020 were 45% lower than in 2005 and 33% below 2016. Between 2016 and 2019 the success seen in decarbonising electricity generation was not repeated in either heat or transport (excluding international aviation), where emissions remained flat.

In 2020 there was a dramatic reduction in CO_2 emissions from transport due to travel restrictions imposed during the COVID-19 pandemic. CO_2 emissions from transport (excluding international aviation) fell by 16.0%. The emissions from international aviation fell by a massive 64.3%, and if these are included the CO_2 emissions from transport fell by 26.5%. In contrast CO_2 emissions from heat increased by 2.6% during 2020, due mostly to a 9.1% increase in emissions from households, due in part to more time spent at home during COVID-19 restrictions. The CO_2 emissions from electricity also reduced in 2020, but this was unrelated to the effects of the COVID-19 pandemic, as the amount of electricity used actually increased slightly by 0.8%. The reduction was due mostly to a 51% drop in peat used for electricity generation, and an increase in wind generation.

Figure 37: Energy-related CO_2 emissions by heat, transport and electricity



Source: SEAI

6.1.3 EU 2020 greenhouse gas emissions reductions targets

The EU 2020 Climate and Energy Package[20] set a target for the EU as a whole to achieve a 20% greenhouse gas emissions reduction by 2020. The greenhouse gas emissions reductions targets are split across two categories. The first category covers large scale carbon emitters, typically large industrial sites or electricity generation stations, but also including some bodies in the services sector and international aviation. These bodies are dealt with at EU level under the EU Emissions Trading System (ETS). The second category covers all greenhouse gas emissions not covered by the ETS, known as the non-ETS sector. Achieving greenhouse gas emissions reductions in the non-ETS sector is the responsibility of national governments. The Effort Sharing Decision (2009/406/EC) set a mandatory target for Ireland to reduce non-ETS emissions to 20% below 2005 levels by 2020.

In 2005 68% of Ireland's total greenhouse gas emissions and 56% of energy related greenhouse gas emissions were within the non-ETS sector. In 2020 77% of Ireland's total greenhouse gas emissions and 66% of energy related greenhouse gas emissions were within the non-ETS sector.

The non-ETS sector includes the majority of greenhouse gas emissions in the residential, transport and services sectors. It also includes most non-energy related emissions, notably from agriculture. In 2005, energy related emissions made up 54% of non-ETS emissions, with agriculture making up another 41%, and the remainder from sources such as waste and industrial processes. In 2020 the share from energy had fallen to 49% and agriculture had risen to 47%, with 4% from other sources..

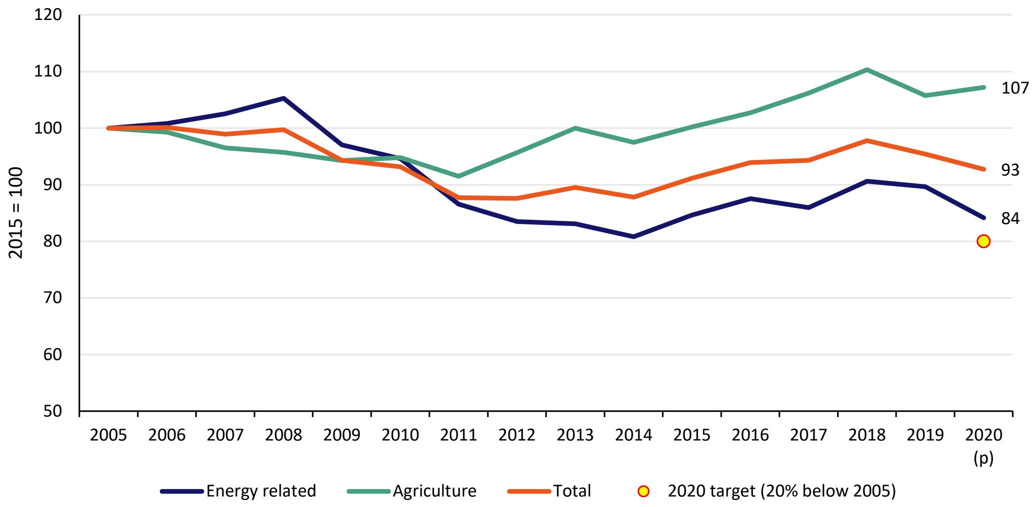
Figure 38 shows the trend in non-ETS emissions relative to 2005 for all non-ETS emissions, and also separately for energy related non-ETS emissions and agriculture non-ETS emissions. The data is from the EPA and is provisional for 2020. The provisional data for 2020 shows that overall non-ETS greenhouse gas emissions in 2020 were 7% below 2005 levels, compared to the target of 20% below. This was helped by the drop in transport emissions in 2020 as result of the public health measures to combat the COVID-19 pandemic. Though despite this drop in transport emissions energy related non-ETS emissions were only 16% below 2005 levels. Non-ETS emissions from agriculture were 7% higher than 2005 levels.

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

Energy related non-ETS emissions dipped to 19% below 2005 levels in 2014 during the recession, but had rebounded to 10% below 2005 levels by 2019.

Non-ETS energy-related emissions decreased by 6.1% in 2020, due to reduced energy use for transport during the COVID-19 pandemic.

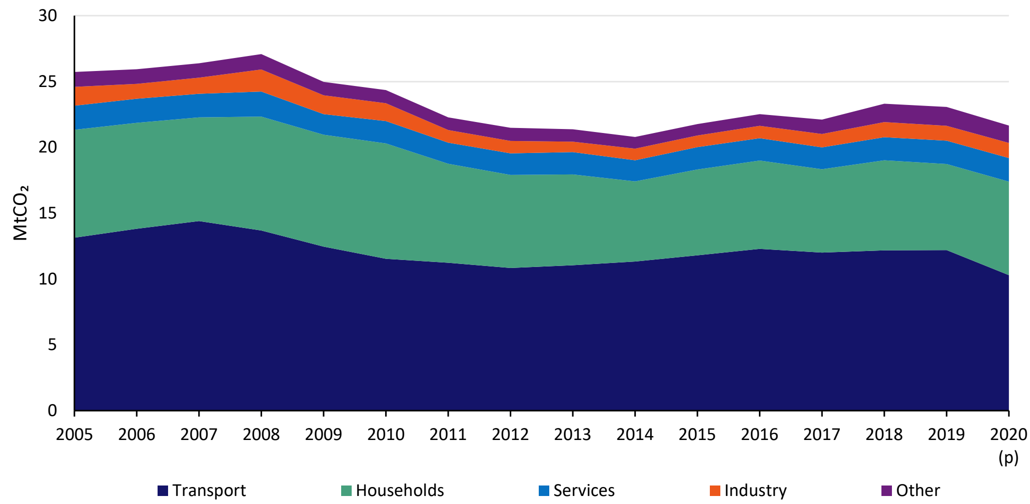
Figure 38: Index of non-ETS greenhouse gas emissions relative to 2005



Source: EPA

Figure 39 shows the trend in non-ETS energy-related CO_2 emissions split by sector[21]. Transport and households typically account for about 80% of energy related non-ETS emissions. In 2019 transport accounted for 53% and households for 28%. In 2020, due to the effects of the COVID-19 pandemic, transport accounted for 47% and households for 33%.

Figure 39: Energy-related non-ETS greenhouse gas emissions

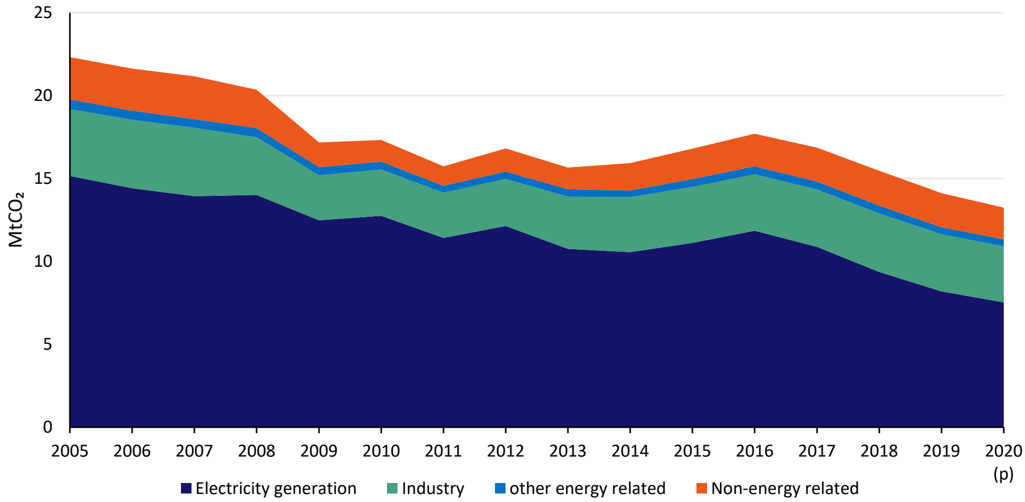


Source: EPA

21 This excludes emissions associated with electricity use by these sectors as these emissions are included in the EU ETS. It also excludes international aviation, and the activity of bodies in the industry and services sectors that are within the ETS.

Figure 40 shows the trend in emissions from fossil fuel combustion from those installations included in the EU ETS in Ireland after 2005. ETS greenhouse gas emissions in 2020 were 41% below 2005 levels. Most of the ETS emissions in Ireland are from electricity generation, and this is also where most of the reduction in greenhouse gas emissions has occurred. In 2020 ETS emissions from electricity generation were down by 50% compared to 2005, while ETS emissions from all other sectors were down by 20%.

Figure 40: EU ETS greenhouse gas emissions in Ireland (excluding international aviation)



Source: EPA

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity ($ktCO_2$)	Share (%)	Quantity ($ktCO_2$)	Share (%)	Absolute change ($ktCO_2$)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Energy related ETS	11,402	20%	19,843	28%	-720	-5.9%	-24.0%	-5.4%	-42.5%	-3.6%
Non-energy related ETS	1,907	3%	2,555	4%	-151	-7.3%	4.2%	0.8%	-25.3%	-1.9%
Total ETS	**13,310**	**23%**	**22,398**	**32%**	**-870**	**-6.1%**	**-21.0%**	**-4.6%**	**-40.6%**	**-3.4%**
Energy related non-ETS	21,655	38%	25,729	37%	-1,411	-6.1%	-0.6%	-0.1%	-15.8%	-1.1%
Non-energy related non-ETS	22,734	39%	22,139	32%	138	0.6%	4.1%	0.8%	2.7%	0.2%
Total non-ETS	**44,389**	**77%**	**47,868**	**68%**	**-1,273**	**-2.8%**	**1.8%**	**0.4%**	**-7.3%**	**-0.5%**
Total	**57,699**	**100%**	**70,266**	**100%**	**-2,143**	**-3.6%**	**-4.6%**	**-0.9%**	**-17.9%**	**-1.3%**

Source: SEAI

Emissions trading is a 'cap and trade' scheme where an EU-wide limit or cap is set for participating installations. The cap is reduced over time so that total emissions fall. Within that limit 'allowances' for emissions are auctioned or allocated for free (outside the power generation sector). Individual installations must report their CO_2 emissions each year and surrender sufficient allowances to cover their emissions. If their available allowances are exceeded, an installation must purchase more. If an installation has succeeded in reducing its emissions, it can sell its leftover allowances. The system is designed to bring about reductions in emissions at the lowest possible overall cost. The EPA is responsible for the implementation of the EU ETS in Ireland, and administers the accounts on Ireland’s domain in the Union Registry.

6.2 Progress towards renewable energy targets

The first Renewable Energy Directive (RED)[22] has been the most important legislation[23] influencing the growth of renewable energy in the European Union (EU) and Ireland over the past decade. The RED set 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 was for at least 16% of gross final energy consumption (GFC)[24] to come from renewable sources in 2020. The actual overall renewable energy share in 2020 was 13.5%, meaning that Ireland did not meet this target. The shortfall to target was equivalent to 3.3 TWh of renewable energy.

Ireland did not meet its overall 2020 renewable energy target.

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 was for at least 10% of energy consumed in road and rail transport to come from renewable sources[25]. The actual RES-T achieved in 2020 was 10.2%, meaning that Ireland did meet this target.

In addition to these EU mandatory targets, Ireland had two further national renewable energy targets for 2020. These were for the electricity and heat sectors and were 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 was for 40% of gross electricity consumption to come from renewable sources in 2020[26]. The actual RES-E achieved in 2020 was 39.1%, falling just short of the national target. Nevertheless the development of renewable electricity has been a major success in Ireland since 2005 and forms the backbone of our renewable energy use.

The renewable heat target is commonly referred to as the RES-H target. The RES-H target was for 12% of energy used for heating and cooling to come from renewable sources in 2020. The actual RES-H achieved in 2020 was 6.3%, falling well short of the national target. This poor progress in RES-H was the main reason for failing to meet the overall RES target.

Table 17 shows the final results for the individual national modal targets and for the overall RED target for 2020. It also shows the progress at a selection of previous years for reference.

Table 17: Renewable energy targets[27]

	Progress Towards Targets								Target
Target	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2020**
RES-E (normalised)	7.2%	15.6%	25.7%	27.1%	30.3%	33.3%	36.5%	39.1%	40%
RES-T (weighted)	0%	2.5%	5.9%	5.2%	7.5%	7.2%	8.9%	10.2%	10%
RES-H	3.4%	4.3%	6.2%	6.2%	6.6%	6.4%	6.3%	6.3%	12%
Overall RES	**2.8%**	**5.7%**	**9.0%**	**9.2%**	**10.5%**	**10.9%**	**12.0%**	**13.5%**	**16%**

Source: SEAI

Figure 41 illustrates the total GFC in each mode according to the RED calculation, and the portion of each mode that comes from renewable sources. This gives important context to the separate transport, heat and electricity targets. Although electricity had the highest share of renewable energy in 2020, electricity only made up 24% of GFC. The heat mode made up the largest share of GFC at 43% in 2020. Transport[28] accounted for 33% of total GFC in 2020. Just 4.6% of this transport GFC was from renewable sources.[29]

22 Directive 2009/28/EC on the promotion of the use of energy from renewable sources. Available from: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009L0028

23 Statutory Instrument (SI) 147 gives effect to the RED in Irish law.

24 Total primary energy requirement is a measure of all energy inputs, including energy that is lost during transformation before it is used by the final customer. Total final consumption (TFC) is a measure of the energy used by final customers only, i.e. excluding the losses from transformation. Gross final consumption of energy is an alternative to TFC and is the denominator used by the EU to track progress towards the targets in the RED.

25 Weighting factors specified in the RED for electricity and advanced biofuels are used in the calculation of the RES-T target. However, these weightings do not apply to the transport contribution to the overall RES target.

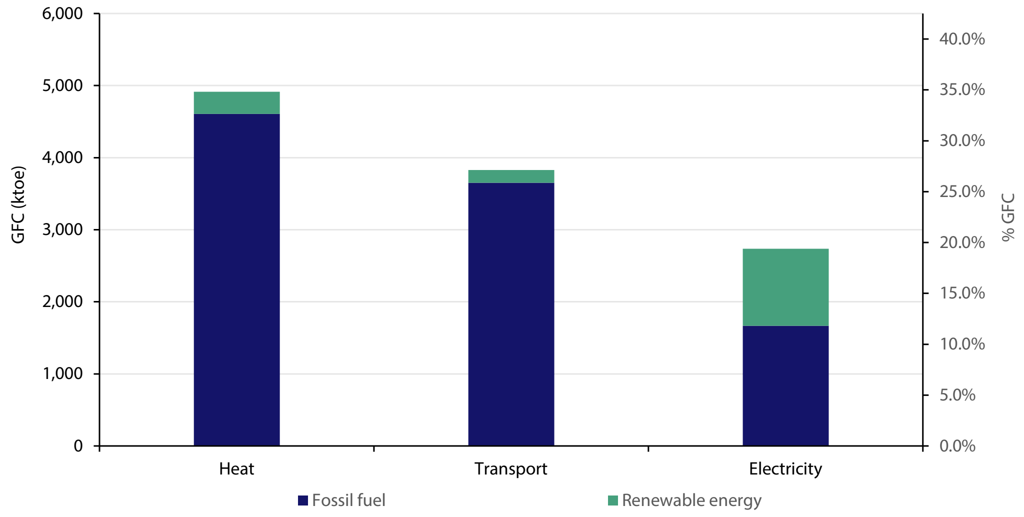
26 For the calculation of RES-E, the energy produced from hydro and wind is normalised to even out the effects of high or low wind or rainfall.

27 Note that individual target percentages are not additive. RES-T includes double certificates for advanced biofuels.

28 This graph shows the quantity of GFC for each mode according to the calculation of the denominator for the overall RES target. According to this methodology: aviation is limited to 6.18% of Total Final Consumption; marine bunkers are excluded; and calorific values for gasoline and diesel as specified in the Directive are applied (these are different to those used in the national energy balance).

29 The RES-T share was 10.2% in 2020. There are two main differences between the calculation of the RES-T target and the overall RES target. Firstly, the RES-T calculation includes the use of multipliers or weighting factors specified in the RED for electricity and advanced biofuels in the numerator, but not the overall RES calculation. Secondly, the RES-T calculation does not include any aviation in the denominator, but the overall RES calculation includes aviation, limited to 6.18% of Total Final Consumption.

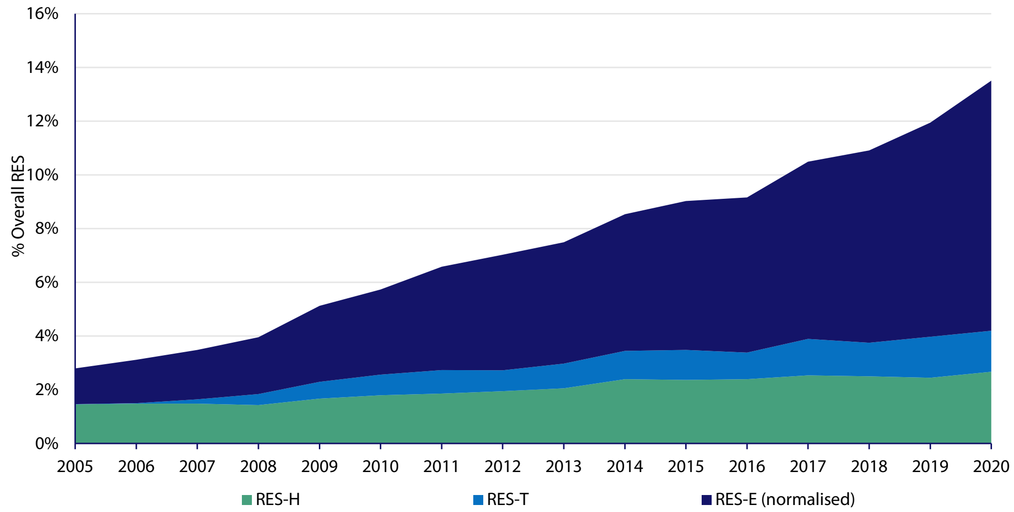
Figure 41: Renewable and fossil gross final energy consumption by mode



Source: SEAI

Figure 42 shows the contribution of renewable heat, transport and electricity to the overall RES target.[30] Renewable electricity has been responsible for most of the overall growth in renewable energy since 2005. In 2020 it accounted for 69% of total renewable energy. Renewable transport continued to make the smallest contribution, at 11.2% of renewable energy.

Figure 42: Renewable energy (normalised) by mode



Source: SEAI

Figure 43 and *Table 18* show the amount of renewable energy used each year, split by source.[31] Most of the growth in renewable energy has come from wind. Wind provided 59% of all renewable energy in 2020. Solid biomass and bioliquids were the next largest sources of growth. Bioenergy, including solid biomass, renewable wastes, landfill gas, biogas and bioliquids, collectively accounted for 32% of renewable energy in 2020.

A more detailed discussion of renewable energy in Ireland can be found in SEAI's publication *Renewable Energy in Ireland*[32].

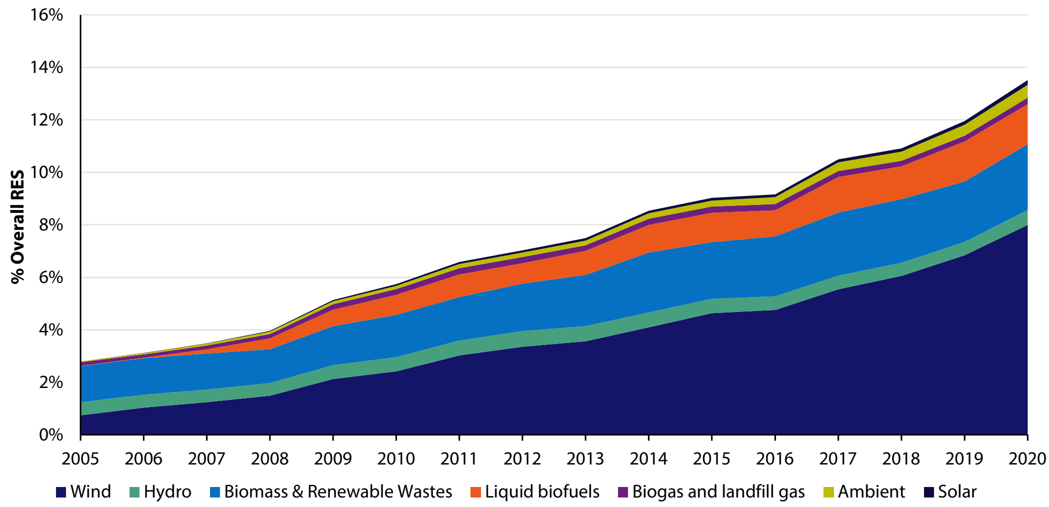
30 Wind and hydro energy are normalised; weighting factors for renewable transport energy are not applied.

31 Ambient energy is the energy that heat pumps use to provide useful heat. It typically comes from 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.

32 Available from http://www.seai.ie/

Wind accounted for 59% of the contribution towards Ireland's renewable energy target in 2020, with bioenergy accounting for another 32%.

Figure 43: Renewable energy contribution to Gross Final Consumption by source (normalised)



Source: SEAI

Table 18: Renewable energy contribution to Gross Final Consumption use by source (normalised)

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Biomass & Renewable Wastes	288	19%	176	49%	5	1.8%	15.7%	3.0%	64%	3.3%
Liquid biofuels	174	11%	1	0%	-14	-7.2%	36.2%	6.4%	15789%	40.2%
Biogas and landfill gas	28	2%	17	5%	2	8.5%	7.2%	1.4%	63%	3.3%
Total bioenergy	**491**	**32%**	**195**	**54%**	**-6**	**-1.3%**	**21.6%**	**4.0%**	**152%**	**6.4%**
Wind	918	59%	95	26%	75	8.9%	72.3%	11.5%	870%	16.4%
Hydro	65	4%	65	18%	2	2.6%	5.0%	1.0%	0%	0.0%
Ambient	57	4%	4	1%	5	9.7%	111.5%	16.2%	1247%	18.9%
Solar	20	1%	0	0%	2	14.3%	66.9%	10.8%	4150%	28.4%
Total Renewable	**1,551**	**100%**	**360**	**100%**	**78**	**5.3%**	**49.5%**	**8.4%**	**331%**	**10.2%**

Source: SEAI

6.2.1 Transport energy from renewable sources (RES-T)

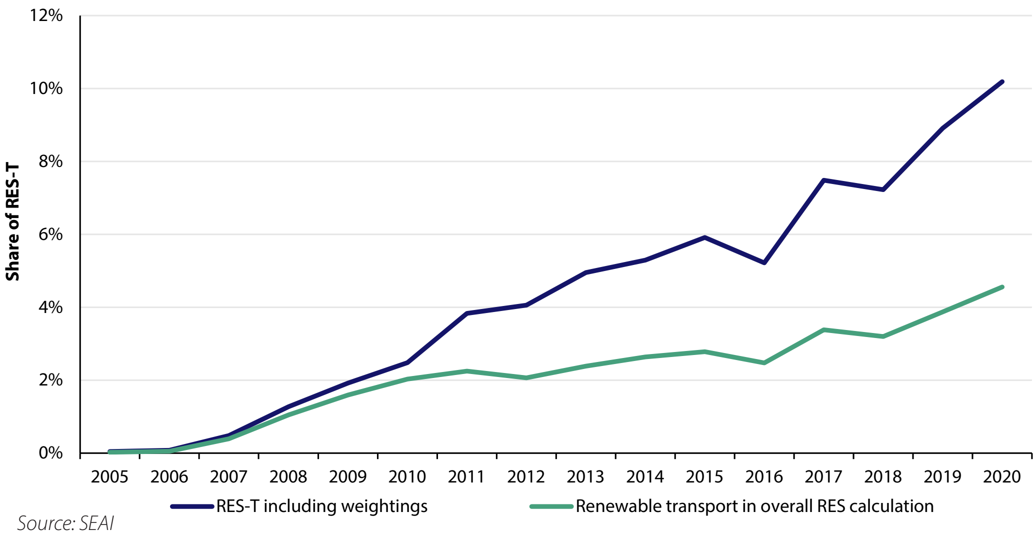
The RED established a mandatory minimum target of 10% for the share of all petrol, diesel, biofuels and electricity consumed in road and rail transport to come from renewable energy by 2020 (RES-T). Ireland exceeded this target, reaching 10.2% RES-T in 2020, up from 8.9% in 2019. *Figure 44* shows the progress for renewable transport energy, in terms of the RES-T target and also in terms of the contribution of transport to the overall RES target.

The RED specifies a number of weightings or multipliers that can be applied to certain fuels for the calculation of RES-T. These 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. In 2020, all of the biodiesel and approximately 51% of the bioethanol used for road transport were eligible for double certificates[33].

Ireland met our 2020 target for renewable energy share in transport (RES-T).

There are some important differences between how the share of renewable transport energy is calculated for the RES-T target and for the overall RES target. The weightings for advanced biofuels and electricity only apply to the RES-T target, not 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 44* shows the share of renewable transport from the perspective of the overall RES target, which was just 4.6% in 2020. 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 failure to meet the overall RES target.

Figure 44: Progress towards renewable transport energy target



Source: SEAI

Figure 45 and *Table 19* show renewable transport energy in absolute energy terms without weightings applied. 99% of renewable transport energy was from biofuels in 2020, 88% was from biodiesel and 11% was from biogasoline. The remainder was from renewable electricity used in both electric rail and electric cars. There was a noticeable drop in biofuel use in 2020. This was due to the overall reduction in road transport energy use due to COVID-19 restrictions. Biogasoline has also been reducing in since 2016, due to the long term trend of reducing overall petrol use.

In 2010, a Biofuel Obligation Scheme[34] was established which required fuel suppliers to include, on average, 4% biofuel by volume (equivalent to approximately 3% in energy terms) in their annual sales. The Biofuel Obligation Scheme is a certificate-based scheme that grants one certificate for each litre of biofuel placed on the market in Ireland; two certificates are granted to biofuel that is produced from wastes and residues. Oil companies are required to apply to the National Oil Reserves Agency for certificates and to demonstrate that the quantities of biofuel for which they are claiming certificates are accurate. Since the introduction of the Sustainability Regulations (SI 33 of 2012), companies are also required to

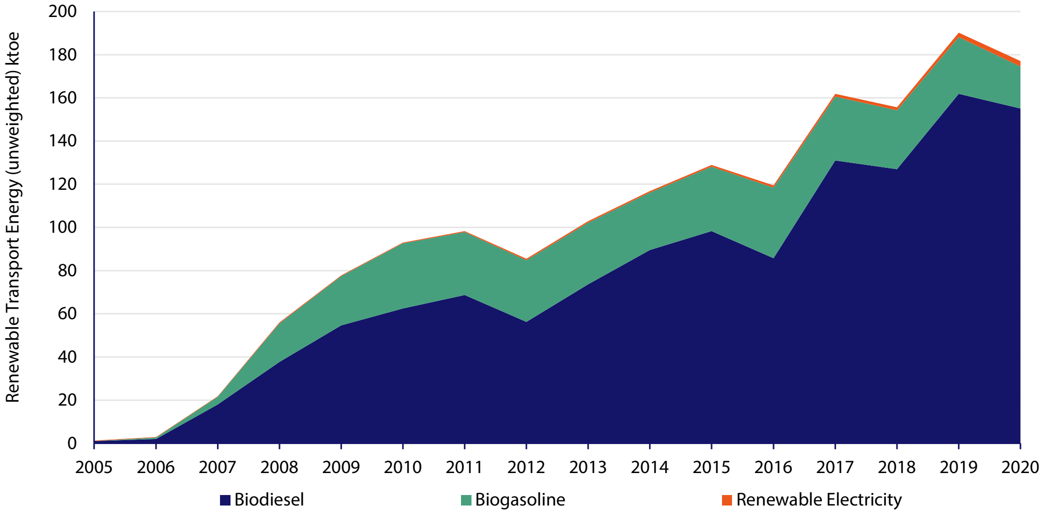
33 https://www.nora.ie/_fileupload/457-21X0088%20-%20BOS%20Annual%20Report%20for%202020%20for%20publication.pdf
34 See NORA website for more information, https://www.nora.ie/biofuels-obligation-scheme.141.html

demonstrate that the biofuel being placed on the market is sustainable, fulfilling the requirements of the RED. Biofuel that is not deemed to be sustainable will not be awarded certificates and cannot be counted towards the biofuel obligation.

The obligation was increased to 6% in 2013, to 8% in 2017, to 10% in January 2019, and 11%[35] in January 2020.

In 2015, new rules[36] came into force that amended the legislation on biofuels – specifically Directive 2009/29/EC and Directive 2009/30/EC – to reduce the risk of indirect land use change and to prepare the transition towards advanced biofuels.

Figure 45: Renewable energy for transport by source (without weightings)



Source: SEAI

Table 19: Renewable energy for transport by source (without weightings)

	2020		2005		2019-2020		2015-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)
Biodiesel	155	87.6%	1	80.0%	-7	-4.2%	57.8%	9.5%
Biogasoline	19	11.0%	0	0.6%	-7	-25.8%	-34.9%	-8.2%
Renewable electricity rail	1	0.8%	0	19.4%	0	2.2%	86.8%	13.3%
Renewable electricity private car	1	0.7%	0	0.0%	0	63.1%	2178.1%	86.9%
Total	**177**	**100.0%**	**1**	**100.0%**	**-13**	**-6.9%**	**37.3%**	**6.5%**

Source: SEAI

35 the legislative requirement was 12.359%, i.e. for every 89 litres of fossil fuel that was placed on the road transport market, an obligated party must have 11 certificates

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

6.2.2 Electricity from renewable energy sources (RES-E)

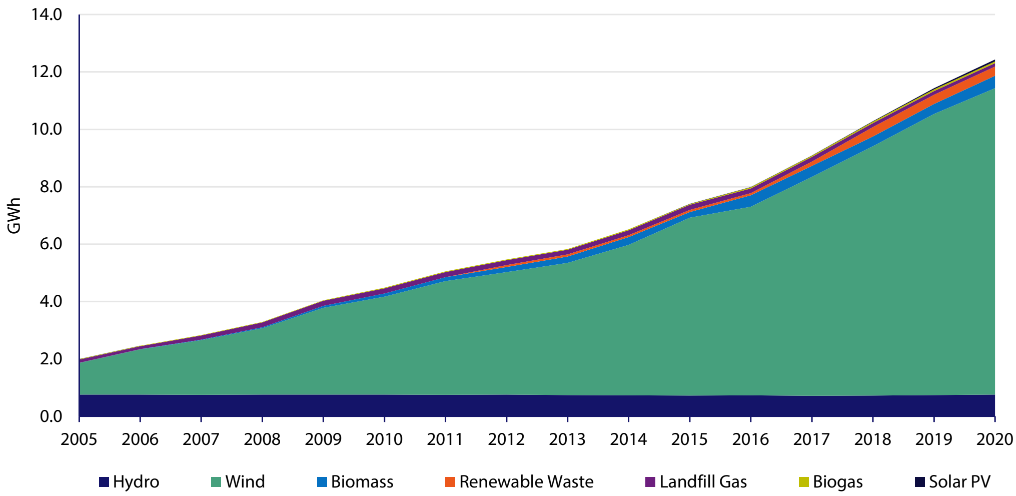
Ireland had no mandatory target for RES-E for 2020, but RES-E formed the backbone of Ireland's strategy to achieve the overall 16% renewable energy target for 2020, and we set an ambitious national target of 40%. We fell just short of this target, achieving 39.1% RES-E in 2020, but despite this, electricity 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.

The share of electricity from renewable energy increased fivefold between 2005 and 2020 and there was a sevenfold increase in the volume of renewable electricity generated.

Table 20 and *Figure 46* show how electricity production from wind energy increased to the point where it accounted for 86% of the renewable electricity generated in 2020.

Wind energy accounted for 86% of the renewable electricity in 2020.

Figure 46: Renewable energy contribution to gross electricity consumption (RES-E normalised)



Source: SEAI

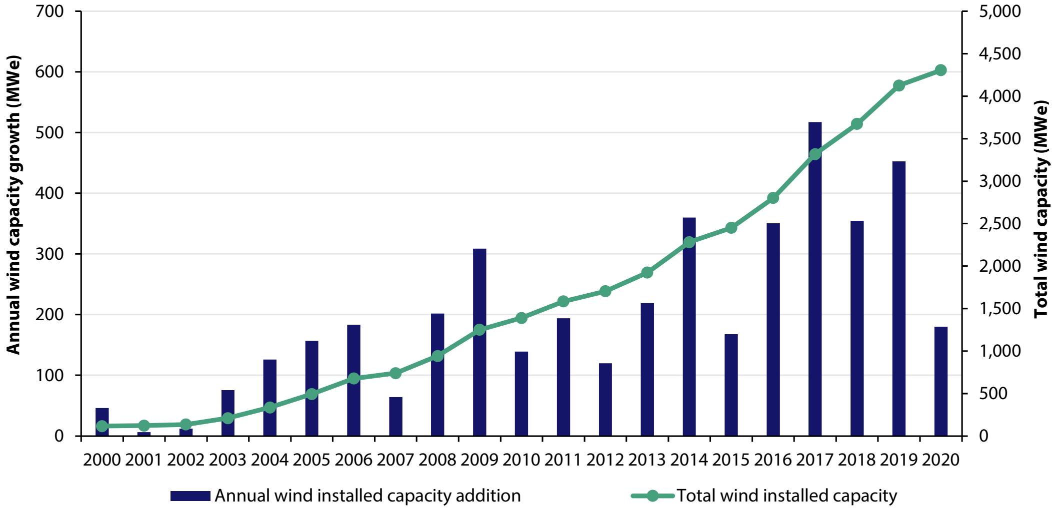
Table 20: Renewable energy contribution to gross electricity consumption (RES-E normalised)

	2020		2005		2019-2020		2015-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)
Hydro	761	6%	760	38%	20	2.6%	5.0%	1.0%
Wind	10,675	86%	1,101	55%	875	8.9%	72.3%	11.5%
Biomass	430	3%	8	0%	84	24.1%	118.5%	16.9%
Renewable Waste	326	3%	0	0%	6	1.8%	323.1%	33.4%
Landfill Gas	117	1%	106	5%	-13	-10.2%	-33.3%	-7.8%
Biogas	61	0%	16	1%	6	10.4%	106.6%	15.6%
Solar PV	64	1%	0	0%	24	59.1%	1673.8%	77.7%
Total	**12,434**	**100%**	**1,991**	**100%**	**1,000**	**8.7%**	**68.0%**	**10.9%**

Source: SEAI

Figure 47 shows the annual growth in installed wind generation capacity and overall cumulative capacity since 2000[37]. By the end of 2020, the installed capacity of wind generation reached 4,307 MW, with 180 MW of new capacity installed over the year. The peak recorded wind power output was 3,591 MW, delivered on 11 February 2021[38].

Figure 47: Installed wind generating capacity



Source: EirGrid

EirGrid and ESB Networks note that as of the third quarter of 2021 there are 1,706 MW of additional wind generation planned, either with connection contracts in place or applications for connection underway. Historically, there has been a maximum of just over 500 MW installed in any one year and on average the installation rate between 2015 and 2020 was 337 MW.

The output from wind and hydro generation is affected by the amount of the resource (wind and rainfall) in a particular year. It is also affected by the extent of outages of the plant for reasons such as faults, maintenance and curtailment. An indication of how these factors affect the output of wind and hydro can be obtained by examining the capacity factors for these generation types. The capacity factor is the ratio of average electricity produced to the theoretical maximum possible if the installed capacity was generating at a maximum for a full year.

The rates of capacity increase each year can have a significant impact on the capacity factor in periods of large annual capacity increases. If significant capacity is added late in the year, this artificially reduces the capacity factor for the year. To mitigate this, the wind capacity factors in *Table 21* are calculated using the average of the installed capacity in any given year and the previous year.

Table 21: Annual capacity factor for wind and hydro generation in Ireland

Capacity Factor %	2005	2010	2015	2016	2017	2018	2019	2020
Wind	30.6%	24.3%	31.7%	26.7%	27.8%	28.2%	29.3%	31.3%
Hydro	30.8%	28.9%	38.8%	32.8%	33.3%	33.4%	42.7%	44.9%

Source: EirGrid and SEAI

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

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

6.2.3 Heat from renewable energy sources (RES-H)

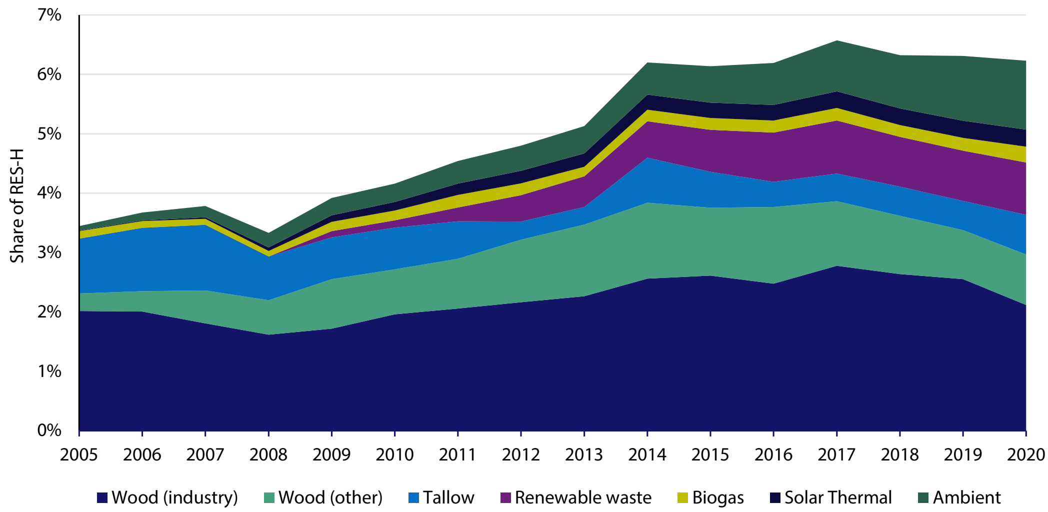
Although there is no mandatory target for RES-H set in the RED, Ireland set a national target of 12% RES-H by 2020 to help deliver the overall mandatory target of 16% renewable energy. We fell well short of achieving this target, reaching just 6.3% RES-H in 2020.

> In 2020, the RES-H result was 6.3% (the same as in 2014) which fell far short of its 12% target for 2020.

Figure 48 shows the contribution from renewable energy to heat or thermal energy uses as a share of overall heat use. RES-H grew from 3.4 % in 2005 to a peak of 6.6% in 2017. In 2018 it fell to 6.3% and remained at this level in 2019 and 2020.

Between 2008 and 2014 there was a reduction in overall amount of energy used for heat, which contributed positively towards the RES-H target, as the share of renewable heat is measured against a smaller total. During this period the quantity of renewable heat energy increased by 38% but the share of renewable heat energy increased by 81%. This trend reversed after 2014, when the total energy used for heat began increasing again following the return to economic growth and a reduction in international oil prices. Between 2014 and 2020 the quantity of renewable heat increased by 16%, but so did the overall amount of energy used for heat, meaning that the share of renewable heat remained virtually unchanged.

Figure 48: Renewable energy contribution to thermal energy (RES-H)



Source: SEAI

Renewable heat energy is dominated by the use of solid biomass and renewable wastes in industry 59%. The use of ambient energy (ground-source and air-source) has grown more than ten-fold between 2005 and 2020 and is now a significant source of renewable heat energy, accounting for approximately 19% of renewable heat energy in 2020.

Recent growth in renewable energy use for heat has been due to increased use of renewable wastes in industry and increased use of heat pumps delivering ambient energy in the residential and services sectors. The latter is mostly due to revisions to building regulations for new dwellings and also the support of grant schemes.

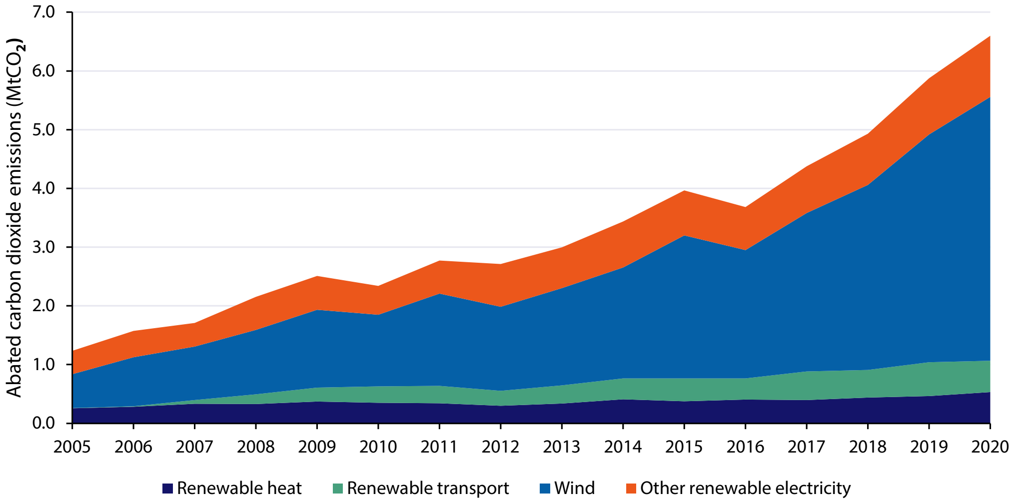
6.2.4 CO_2 displacement and avoided fuel imports

The use of renewable energy displaces the use of fossil fuels thereby avoiding CO_2 emissions and reducing the amount of fossil fuels we need to import. We estimate the amount of CO_2 avoided and fossil fuel imports displaced using the primary energy equivalent approach. This estimates the quantity of fossil fuels that would have been required to replace renewable energy use. The estimates for electricity are based on the use of marginal generation fuel that would otherwise have been required to produce the electricity. We also include a factor to account for the effects of increased ramping and cycling of fossil fuel generators, based on previous detailed electricity dispatch modelling[39,40].

Figure 49 shows the trend in avoided CO_2 emissions from renewable energy for the period 2005 to 2020. The estimated amount of CO_2 avoided through the use of renewable energy reached 6.6 Mt CO_2 in 2020, with 4.5 Mt CO_2 avoided by wind energy.

Decarbonising the electricity system combined with increased electrification of heat and transport through the use of electric vehicles (EV) and heat pumps is an important part of the strategy for decarbonising the energy system as a whole. The use of renewable electricity ensures that switching to EVs and heat pumps does not result in greater CO_2 emissions than the fossil fuel alternative. Electrification of heat and transport reduces direct fossil fuel use in the non-ETS sector, thereby contributing to meeting the non-ETS greenhouse gas emissions reduction target[41].

Figure 49: Avoided CO_2 from renewable energy



Source: SEAI

39 See SEAI reports Quantifying Ireland's Fuel and CO_2 Emissions Savings from Renewable Electricity in 2012 and Renewable Energy in Ireland 2012 for further details on the methodologies used to calculate the avoided emissions.

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

41 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 (non-ETS).

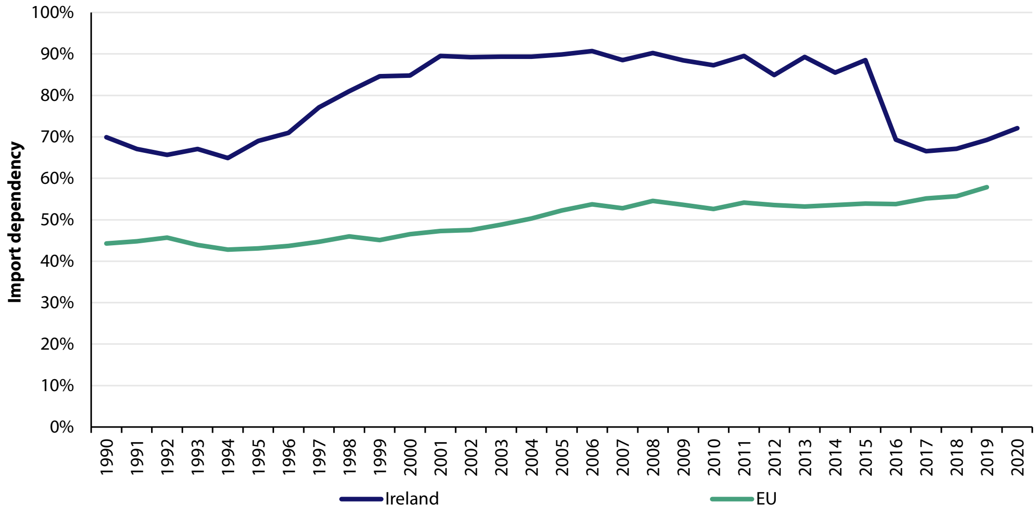
6.3 Energy security

Energy security, in its simplest terms, means having uninterrupted access to reliable, affordable supplies of energy. Secure supplies of energy are essential for our economy and for maintaining safe and comfortable living conditions.

Energy import dependency is one of the simplest and most widely used indicators of a country's energy security, with indigenous energy sources generally considered to be more secure than imported energy. While the overall import dependency figure provides a useful context, a deeper understanding of energy security requires more detailed information on individual energy sources. This includes the countries from where each fuel is sourced, global market conditions, transportation and other infrastructure requirements. It also requires analysis of the current trends in energy use, and of the significant changes that will occur in energy use both nationally and globally over the coming years. Energy security is considered in more detail in a separate SEAI publication[42].

Figure 50 illustrates the trend in import dependency since 1990, comparing it with that for the EU as a whole, and shows the dramatic change in Ireland's import dependency in 2016 resulting from the start of natural gas production from the Corrib gas field. Indigenous production accounted for 32% of Ireland's energy requirements in 1990. From the mid-1990s import dependency grew significantly due to the increase in energy use, together with the decline in indigenous natural gas production at Kinsale since 1995, and decreasing peat production. Ireland's overall import dependency reached 90% in 2006. It varied between 85% and 90% until 2016 when it fell sharply following the opening of the Corrib gas field. It fell to a low of 66% in 2017, but has been increasing since. In 2020 import dependency was 72%.

Figure 50: Import dependency of Ireland and the EU



Source: SEAI and Eurostat

This trend reflects the fact that Ireland is not endowed with significant indigenous fossil fuel resources and has only in recent years begun to harness significant quantities of renewable resources and more recently natural gas from the Corrib gas field.

Before the Corrib gas field started production in 2016, Ireland's import dependency varied between 85% and 90% - it fell to 67% in 2017 but has increased to 72% in 2020.

Figure 51 shows the indigenous energy fuel mix for Ireland over the period. Indigenous production of natural gas decreased by 95% from the previous peak in 1995 to a low of 113 ktoe in 2015. It increased dramatically in 2016 and rose again in 2017, to 2,854 ktoe. This was the highest natural gas production level ever recorded in Ireland. Production from the Corrib gas field has already begun to decline and in 2020 it was 1,654 ktoe, 42% below the 2017 peak. It is expected to continue this decline over the coming years[43].

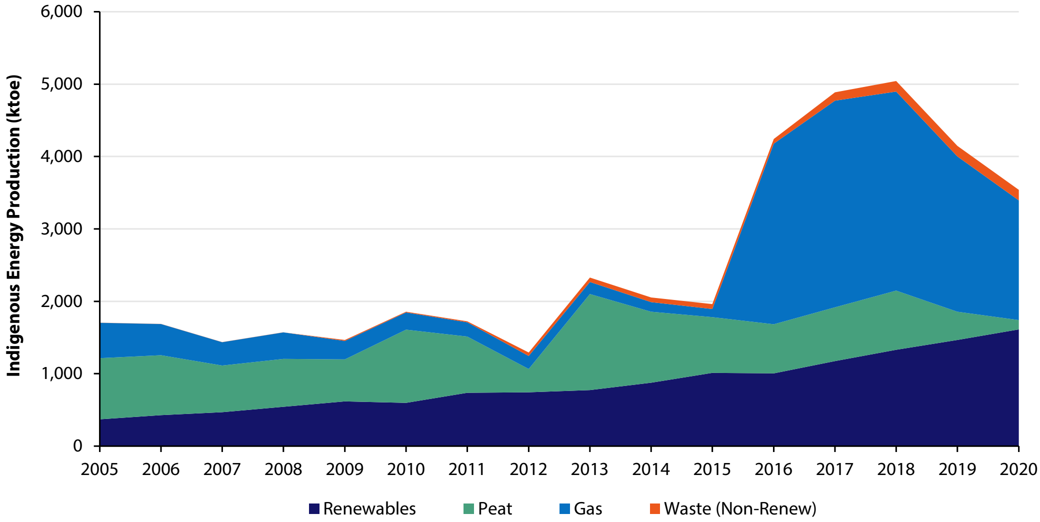
42 SEAI (2020), *Energy Security in Ireland*, https://www.seai.ie/publications/Energy-Security-in-Ireland-2020-.pdf

43 For more information see the latest Gas Networks Ireland Network Development Plan, available at www.gasnetworks.ie/corporate/gas-regulation/regulatory-publications/GNI-2020-Network-Development-Plan.pdf

Peat production was down 67% in 2020 on the previous year with Bord na Móna announcing a formal ending of peat harvesting on its lands in January 2021. Indigenous renewable energy production increased by 335% between 2005 and 2020, to 1,612 ktoe. Most of this is from wind energy.

Total indigenous energy production in Ireland reached the highest level ever in 2018 of 5,044 ktoe, but declined to 3,541 ktoe in 2020 due to declining natural gas and peat production.

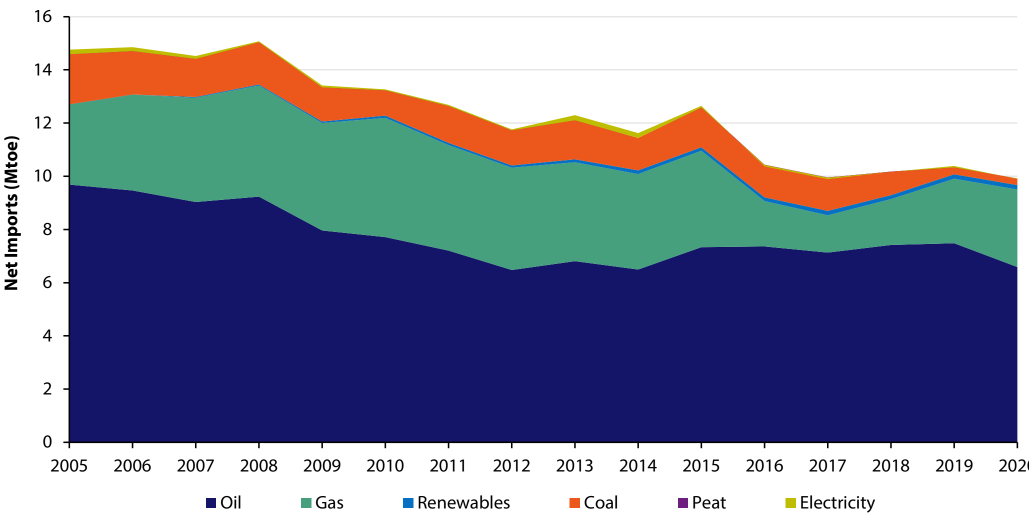
Figure 51: Indigenous energy by fuel



Source: SEAI

Figure 52 shows the trend for net fuel imports (imports minus exports) over the period 2005 to 2020. The most striking feature is the dependence on oil, due largely to energy use in transport. Oil, which includes crude oil and oil products such as diesel and petrol, accounted for 67% of all energy imports in 2020, and was down 12% on the previous year. Gas imports increased by 20% in 2020 due to declining indigenous production, and accounted for 29% of energy imports. Coal imports fell by 5% and accounted for 2.5% of net imports. Renewable energy imports were up 1% in 2020 and accounted for 1.7% of total energy imports. Ireland was a net exporter of electricity in 2020 with net exports of 13 ktoe of electricity in 2020. Total net energy imports decreased by 5% in 2020 and were 34% lower than in the peak in 2008.

Figure 52: Imported energy by fuel



Source: SEAI

6.4 Cost competitiveness

Energy use is an important part of economic activity and therefore the price paid for energy is a determining factor in the competitiveness of the economy. Ireland has a high import dependence on oil and gas and is essentially a price-taker on these commodities. The EU has introduced competition into the electricity and gas markets through the liberalisation process in order to reduce energy costs to final consumers.

Between 2015 and 2020, energy prices[44] in Ireland increased by 4.6% in real terms, compared with an average decrease of 4.3% in OECD (Organisation for Economic Co-operation and Development) Europe, and a 11.6% decrease in the United States over the same period based on data from the IEA. In 2020, overall energy prices in Ireland were 0.6% lower than in 2019, compared with a decrease of 6.1% in OECD Europe and a 10.4% decrease in the US.

The price of natural gas at the UK National Balancing Point[45] was, on average, 30% lower in 2020 compared with 2019. Up to mid-November 2021, the price was, on average, 289% higher than in 2020.

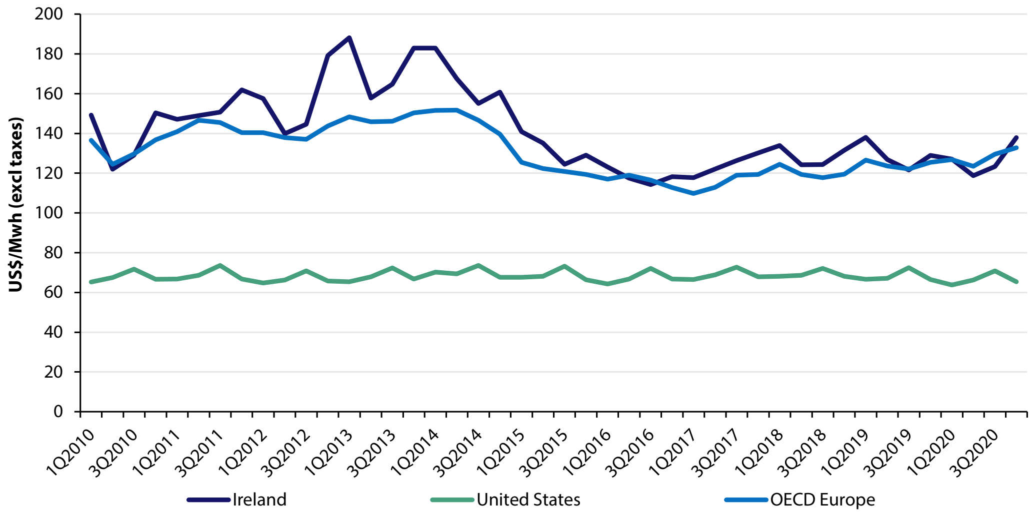
SEAI publishes biannual reports titled *Electricity and Gas Prices in Ireland*[46] based on data collected under EU legislation on the transparency of gas and electricity prices, which came into effect in January 2008. These reports focus specifically on gas and electricity prices using data published by Eurostat, and are a useful reference on cost-competitiveness and cover both business and households.

This section focuses on business energy prices. It presents comparisons of the cost of energy in various forms in Ireland and compares prices in OECD Europe and the US. The source of the data presented here is the IEA's Energy Prices and Taxes. This data source was chosen because it is produced quarterly and data is shown for the fourth quarter of 2020. Prices shown are in US dollars and are in current (nominal) money[47]. Relative price increases since 2015, however, are tabulated for EU-15 countries and the US in index format in both nominal and real terms.

6.4.1 Energy prices to industry

Table 22 shows that electricity prices to Irish industry increased by 33% in real terms between 2015 and 2020. It has been increasing in recent years and was 7% higher in Q4 2020 than in Q4 2019 The fuel mix for electricity generation is one factor that has a key bearing on the variation in the price of electricity. In the EU, Ireland has a high overall dependency for electricity generation on fossil fuels, at 60%, behind Greece at 66%, the Netherlands at 74% and Poland at 82%. Ireland also has a high dependency on gas generation, at 51%.

Figure 53: Electricity prices to industry



Source: Energy Prices and Taxes © OECD/IEA, 2021

44 IEA, Energy Prices and Taxes.

45 National Grid UK, www.nationalgrid.com/uk/gas-transmission/balancing/day-commodity-market-ocm

46 SEAI (various dates), Electricity and Gas Prices in Ireland.

47 Nominal and real values: Nominal value refers to the current value expressed in money terms in a given year, whereas real value adjusts nominal value to remove the effects of price changes and inflation, to give the constant value over time indexed to a reference year.

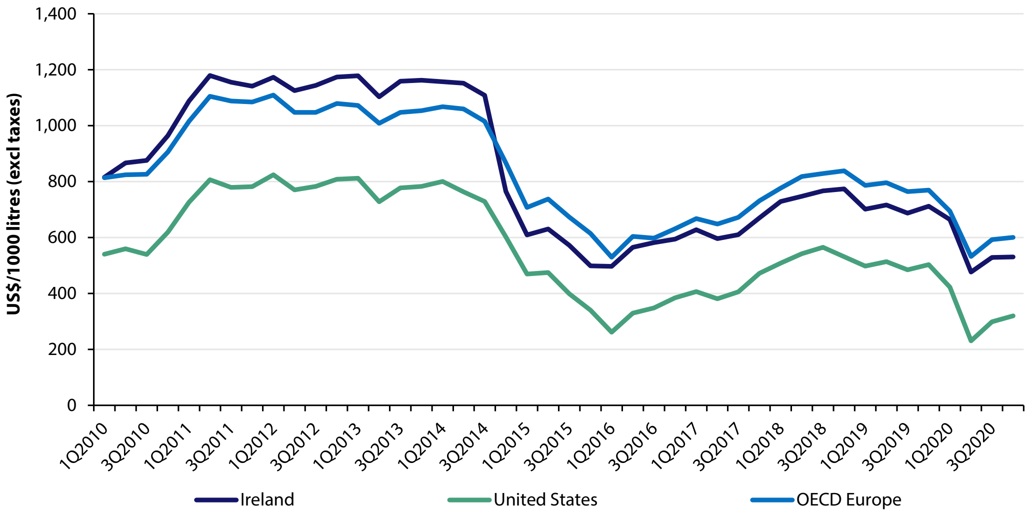
Table 22: Electricity price to industry change since 2015

Index 2015 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom	United States
4th qtr 2020 (nominal)	121	106	107	97	106	102	117	100	**97**	92	122	123	97	91	119	133	95
4th qtr 2020 (real)	105	103	99	94	105	101	112	106	**117**	91	121	121	96	89	110	123	90

Source: Energy Prices and Taxes © OECD/IEA, 2021

Table 23 shows that oil prices to industry in Ireland were 13% higher in real terms in Q4 2020 than in 2015. The average oil price in Europe remained stable and fell by 14% in the US. Crude oil prices averaged around $42/barrel in 2020, falling as low as $9 in April during the early stages of the global COVID-19 pandemic, compared with $64/barrel on average in 2019.

Figure 54: Oil prices to industry



Source: Energy Prices and Taxes © OECD/IEA, 2021

Table 23: Oil prices to industry change since 2015

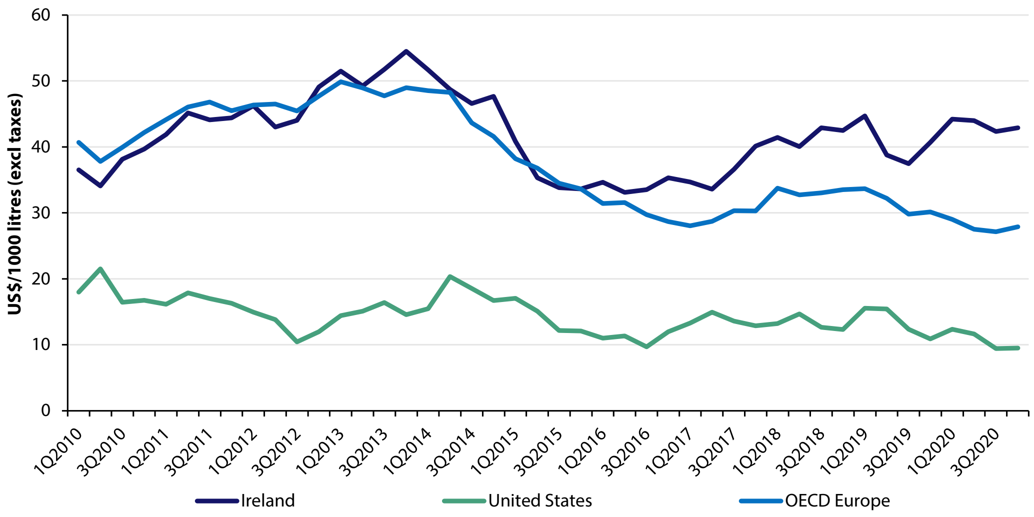
Index 2015 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom	United States
4th qtr 2020 (nominal)	103	94	110	95	96	105	93	97	**94**	91	93	97	103	92	105	102	90
4th qtr 2020 (real)	93	91	102	92	95	105	89	102	**113**	89	92	96	102	91	97	94	86

Source: Energy Prices and Taxes © OECD/IEA, 2021

Crude oil prices averaged approximately $42 per barrel in 2020, down from $64 per barrel in 2019, due to COVID-19 impacts on global demand

As can be seen in *Figure 55*, natural gas prices to Irish industry increased from the second quarter of 2010 until the end of 2013. Prices had been relatively stable from the middle of 2015 until the middle of 2017 when they started to rise again. In the fourth quarter of 2020 the price of gas to industry in Ireland was 34% above 2015 levels in real terms. *Figure 55* also shows the gap between gas prices in Europe and the US.

Figure 55: Natural gas prices to industry



Source: Energy Prices and Taxes © OECD/IEA, 2021

Table 24: Natural gas prices to industry change since 2015

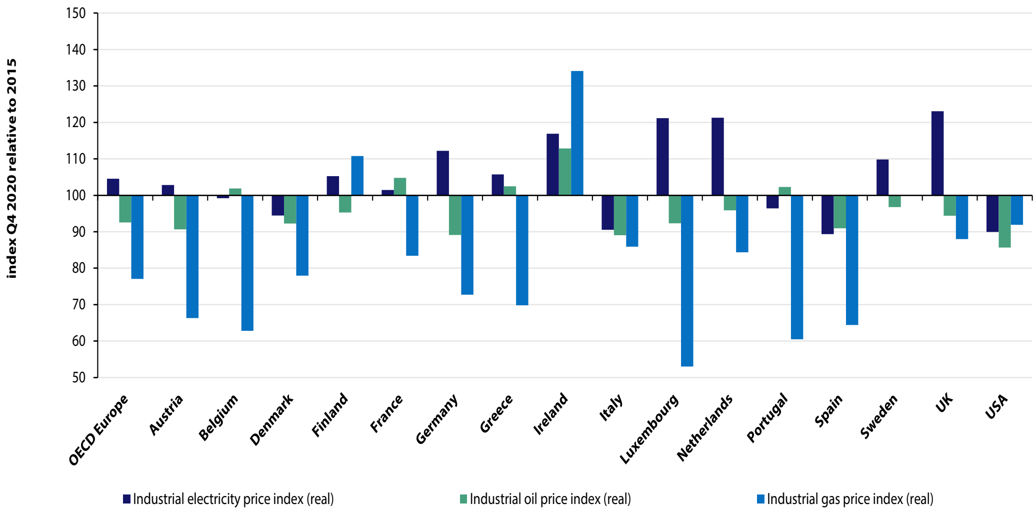
Index 2015 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom	United States
4th qtr 2020 (nominal)	89	69	68	80	111	84	76	66	**111**	88	54	86	61	65	0	95	97
4th qtr 2020 (real)	77	66	63	78	111	83	73	70	**134**	86	53	84	60	64	0	88	92

Source: Energy Prices and Taxes © OECD/IEA, 2021

The average price of natural gas at the UK National Balancing Point was 30% lower in 2020 than in 2019.

Figure 56 summarises the data presented in *Table 22*, *Table 23* and *Table 24*. The IEA publishes an overall energy price index (real) for industry, which shows that the overall energy price to Irish industry between 2015 and the fourth quarter of 2020 increased by 7%, compared with a decrease of 9% for OECD Europe and a 7% decrease in the US.

Figure 56: Real energy price changes to industry since 2015 (index)



Source: Energy Prices and Taxes © OECD/IEA, 2021

In 2020, energy prices for industry in Ireland increased by 1.6% in real terms compared with 2019. In OECD Europe, there was a decrease was 6.2%, while in the US energy prices decreased by 12%.

The year 2020 saw global oil price falling, from around $64/barrel on average in 2019 to $41/barrel on average in 2020. Natural gas prices at the UK Balancing Point were, on average, 30% lower in 2020 compared with 2019.

The overall energy price to Irish industry between 2015 and the Q2 2021 increased by 10%, compared with a decrease of 3.7% for OECD Europe and a 10% decrease in the US.

7 Sectoral trends and indicators

This section explores in more detail the changes in energy use in each of the main sectors: industry, transport, residential, and services[48].

7.1 Industry

Trends in 2020

While the overall economic activity of Ireland increased in terms of GDP (+5.9%) and decreased in terms of MDD (-4.2%) in 2020, the economic activity of industry increased by 20% in terms of GDP. The final use of energy in the industry sector fell by 3.5% (to 2.2 Mtoe) in 2020. The main trends in final energy use in industry were:

- Natural gas consumption in industry decreased by 1.8% in 2020, to 937 ktoe, and accounted for 43% of industry's final energy demand.
- Electricity consumption in industry decreased by 6.5%, to 558 ktoe, and accounted for 26% of final energy consumption in industry.
- Oil use fell by 4.0%, to 359 ktoe, and accounted for 16.5% of industry's energy use.
- Renewable energy use in industry fell by 1.4%, to 187 ktoe, in 2020 and accounted for 8.6% of industry's energy use.
- Coal use fell by 3.9%, to 76 ktoe, and accounted for 3.5% of the energy share of industry.
- The use of non-renewable wastes in industry increased by 5.4% in 2010, to 54 ktoe, and accounted for 2.5% of energy use in industry.

In determining the sectoral breakdown of energy consumption, SEAI uses a blend of data sources, including the business energy use survey (BEUS) from the CSO. In May 2021, the CSO published the latest version of the BEUS, which is based on energy use in 2018. SEAI uses this most recent BEUS release in estimating the breakdown of 2020 energy consumption across the industry sector. For more details, see SEAI's 2020 publication, *Revisions to Ireland's National Energy Balance from 1990 to 2018 following incorporation of new survey data on business energy use*, available from www.seai.ie/NationalEnergyBalance/.

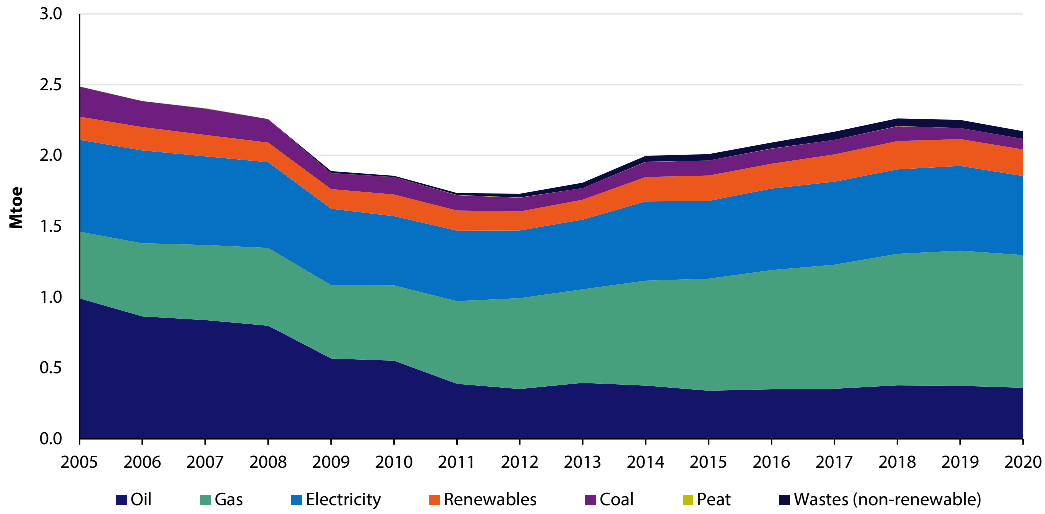
Trends from 2005 to 2020

Final energy use in industry was 12.7% lower in 2020 than in 2005. Between 2005 and 2012, there was an 30% fall in industrial final energy use. Between 2012 and 2020 energy use in industry increased by 25%. In 2020, it decreased by 3.5% and was 12.7% below 2005 levels.

Figure 57 shows that over the period 2005 to 2020 natural gas, wastes and renewables have all increased their shares of industrial energy use, while the shares of oil and coal have decreased. The share of electricity has remained at 26%. Since 2009, non-renewable wastes have been used in industry, and in 2020 accounted for 2.5% of industry's energy use. The share of natural gas has risen from 19% to 43% and renewables from 6.6% to 8.6% (see *Table 25*). The increase in renewables is mainly due to the use of biomass in the wood-processing industry, the use of tallow in the rendering industry and the use of the renewable portion of wastes in cement manufacturing.

48 In 2020, SEAI revised the National Energy Balances to incorporate new improved data from the CSO Business Energy Use Survey (BEUS). This new data source provides a basis for the breakdown of energy use in the commercial services, public services and industrial sectors, at a level of detail not previously possible. SEAI prepared a special report that explains the background to the BEUS, describes the new data that is available, how this compares to previous estimates, how the National Energy Balance has been revised to incorporate the new data, and gives a detailed comparison of the before and after estimates of energy use by fuel and by sector. That report, *Revisions to Ireland's National Energy Balance from 1990 to 2018 following incorporation of new survey data on business energy use*, is available from the SEAI website at www.seai.ie/NationalEnergyBalance/.

Figure 57: Industry final energy use by fuel



Source: SEAI

Table 25 shows the growth rates, quantities and relative shares of energy used in industry by fuel.

Table 25: Growth rates, quantities and shares of final consumption in industry

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Oil	359	17%	991	40%	-15	-4.0%	6.1%	1.2%	-63.8%	-6.6%
Gas	937	43%	470	19%	-17	-1.8%	18.5%	3.5%	99.6%	4.7%
Coal	76	4%	212	9%	-3	-3.9%	-28.1%	-6.4%	-64.1%	-6.6%
Peat	0	0%	0	0%	0	-	-100.0%	-100.0%	-100.0%	-100.0%
Total Fossil Fuels	**1,372**	**63%**	**1,673**	**67%**	**-35**	**-2.5%**	**11.0%**	**2.1%**	**-18.0%**	**-1.3%**
Renewables	187	9%	163	7%	-3	-1.4%	4.6%	0.9%	14.7%	0.9%
Electricity	558	26%	650	26%	-39	-6.5%	1.5%	0.3%	-14.1%	-1.0%
Wastes (Non-Renewable)	54	2%	0	0%	-3	-5.4%	21.9%	4.0%	-	-
Total	**2,171**	**100%**	**2,486**	**100%**	**-80**	**-3.5%**	**8.1%**	**1.6%**	**-12.7%**	**-0.9%**

Source: SEAI

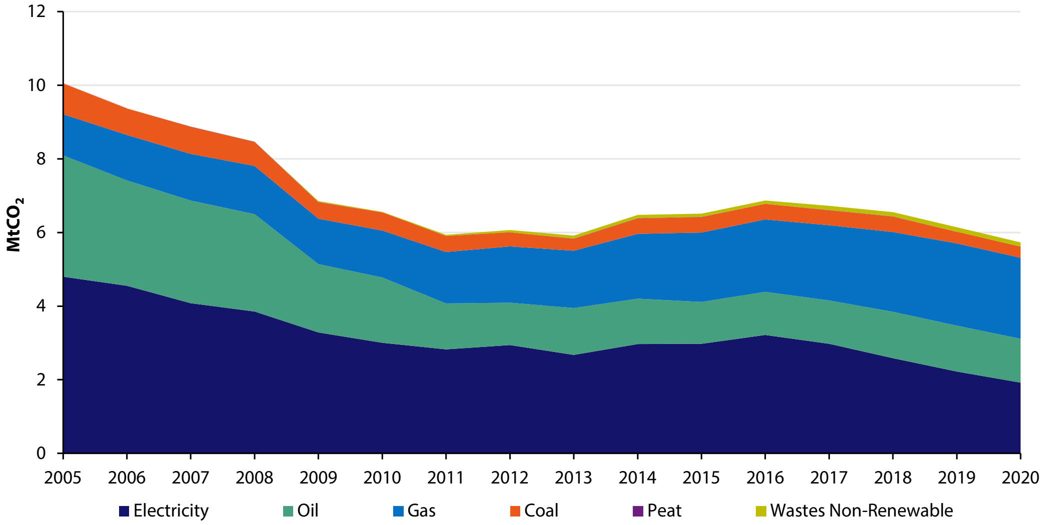
Direct use of all fossil fuels accounted for 63% of energy use in industry in 2020 and fell by 2.5%. Over the period 2005 to 2020, use of fossil fuels in industry fell by 18%.

There was also significant fuel switching from coal and oil to natural gas during this period. Between 2005 and 2020, coal and oil consumption in industry both fell by 64%, while natural gas use increased by 100%. Because gas is less carbon intensive than oil or coal, this fuel switching, along with increased use of renewable energy, has resulted in lower average emissions per unit of energy used in industry during this period.

Energy-related CO_2 emissions – including emissions associated with electricity

In order to determine industry's total energy-related CO_2 emissions, it is necessary to include estimations of upstream emissions for the electricity consumed by industry. *Figure 58* shows the primary energy-related CO_2 emissions from industry, detailing the on-site CO_2 emissions associated with direct fuel use and the upstream emissions associated with electricity consumption.

Figure 58: Industry energy-related CO_2 emissions by fuel



Source: SEAI

Table 26 shows the growth rates, quantities and relative shares of energy-related CO_2 emissions in industry.

As detailed in *Table 26*, industrial energy-related CO_2 emissions fell by 6.7% in 2020, to 5.7 $MtCO_2$. Electricity consumption was responsible for 34% of industry's energy-related CO_2 emissions in 2020.

Table 26: Growth rates, quantities and shares of energy-related CO_2 emissions in industry

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Kerosene	25	0%	104	1%	0	1.0%	-4.4%	-0.9%	-76.0%	-9.1%
Fueloil	93	2%	1,502	15%	-1	-0.8%	-28.4%	-6.5%	-93.8%	-16.9%
LPG	135	2%	128	1%	-13	-8.5%	21.8%	4.0%	6.0%	0.4%
Gasoil	445	8%	610	6%	4	1.0%	18.3%	3.4%	-27.0%	-2.1%
Petroleum Coke	492	9%	944	9%	-44	-8.2%	-0.1%	0.0%	-47.9%	-4.2%
Total Oil	**1,190**	**21%**	**3,291**	**33%**	**-53**	**-4.3%**	**4.8%**	**0.9%**	**-63.8%**	**-6.6%**
Gas	2,205	38%	1,117	11%	-34	-1.5%	17.0%	3.2%	97.5%	4.6%
Coal	301	5%	838	8%	-12	-3.9%	-28.2%	-6.4%	-64.1%	-6.6%
Peat	0	0%	2	0%	0	-	-100.0%	-100.0%	-100.0%	-100.0%
Total Fossil Fuels	**3,697**	**65%**	**5,248**	**52%**	**-99**	**-2.6%**	**7.3%**	**1.4%**	**-29.6%**	**-2.3%**
Electricity	1,920	34%	4,802	48%	-304	-13.7%	-35.5%	-8.4%	-60.0%	-5.9%
Wastes (Non-Renewable)	113	2%	0	0%	-6	-5.4%	21.9%	4.0%	-	-
Total	**5,730**	**100%**	**10,049**	**100%**	**-409**	**-6.7%**	**-12.0%**	**-2.5%**	**-43.0%**	**-3.7%**

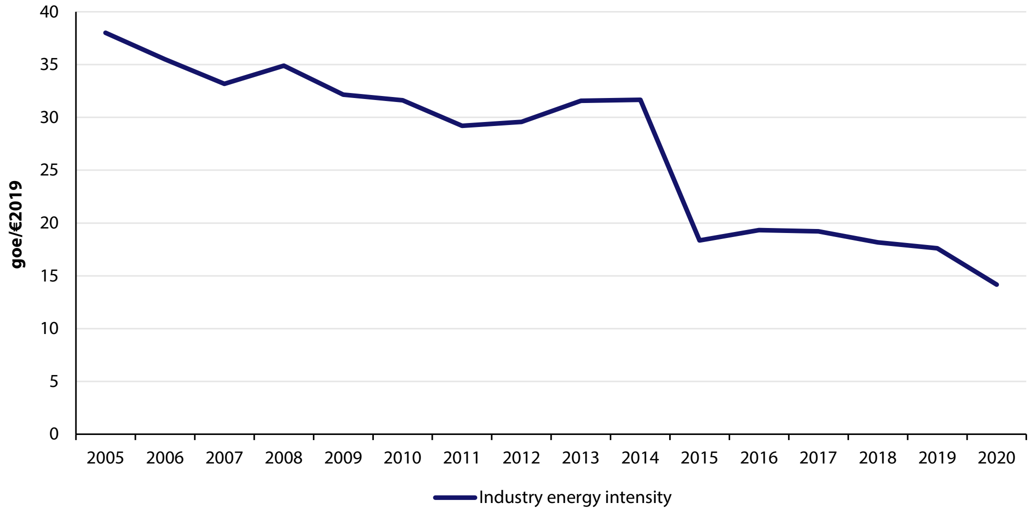
Energy-related CO_2 emissions – excluding emissions associated with electricity

If upstream electricity-related emissions are omitted, then there was a 2.7% fall in CO_2 emissions from combustible fuels used on-site in industry in 2020. This is as a result of changes in the volume and fuel mix used in industry, with decreased oil (-4.0%), coal (-3.9%) and natural gas (+1.8%).

7.1.1 Industry energy intensity

Industrial energy intensity is the amount of energy required to produce a unit of value added, measured in constant money values. *Figure 59* shows the industrial energy intensity between 2005 and 2020 expressed in kilograms of oil equivalent per euro of industrial value added at 2019 money value (kgoe/$€_{2019}$). Over the period, industrial energy consumption fell by 12.7%, while value added increased by 134%, resulting in a reduction in intensity of 63%. In other words, to generate a euro of value added in 2020, it took approximately half of the amount of energy it took in 2005.

Figure 59: Industry energy intensity



Source: SEAI

Value-added output from industry was 74% higher in 2015 compared with 2014. The large increase in gross value added in 2015 is explained by a number of one-off factors, such as the transfer of assets into Ireland, and what are known as reverse takeovers. This increase in gross value added incurred no additional energy consumption.

The step change in industry energy intensity in 2015 illustrates the fact that energy intensity is not a good indicator of energy efficiency, as variations may be the result of many factors, such as structural changes, or changes to the fuel mix or activity.

7.2 Transport

7.2.1 Transport energy demand by sub-sector

Trends in 2020

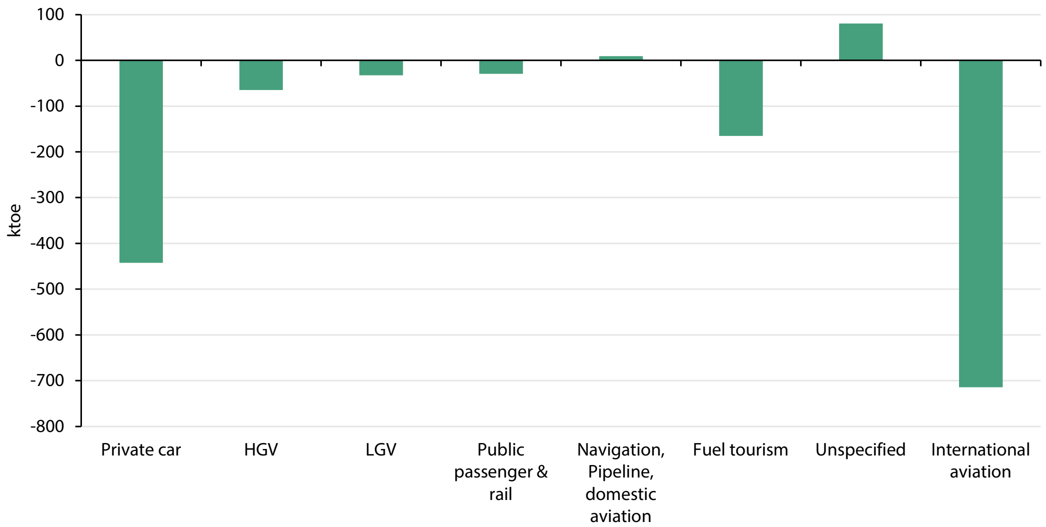
The change in transport energy use by subsector in 2020 is shown in *Figure 60* and detailed in *Table 27*. The corresponding data for energy related CO_2 emissions is also shown in *Table 28*.

There were significant restrictions on personal mobility during 2020 which had direct effects on transport energy use, especially on international aviation and private cars. Overall transport energy use[49] was down by 26.% .

The largest reduction in energy use in was in international aviation, which was down by 64%. This caused a drop in the CO_2 emissions from international aviation of 2.1 $MtCO_2$. This was a result of a 78% reduction in passenger numbers and a 65% reduction in flight numbers.

The other large reduction in energy use in transport was in private cars, which was down by 21% in 2020, resulting in a drop in CO_2 emissions of 1.3 $MtCO_2$. The energy use of heavy goods vehicles and light goods vehicles were affected less by the COVID-19 restrictions than aviation or private cars and were down by 8.2% and 9.8% respectively.

Figure 60: Change in transport energy use in 2020 by sub-sector



Source: SEAI

Trends in 2005 to 2020

Figure 61[50] shows the trend for energy use of transport by sub-sector from 2005 to 2020. Transport has been the sector most responsive to changes in economic growth. Transport energy use and CO_2 emissions peaked in 2007 before falling sharply during the recession. It returned to growth in 2013 but by 2019 total transport energy use was still 8.5% below the 2007 peak, mostly due to heavy goods vehicles remaining 31% below 2007 levels.

Private car energy use clearly dominates and accounted for 42% of transport energy use in 2020. Private car energy use declined briefly during the recession in 2009 and 2010 but returned to growth in 2011. It peaked in 2015 but remained relatively flat up until 2019, before the sharp drop in 2020. The levelling off of private car energy demand between 2015 and 2019 was due to a combination of the amount of kilometres driven levelling off and the efficiency of the car stock improving.

Aviation energy use is notable in that it usually makes up a large share of transport energy use in Ireland (21% in 2019) but can be severely affected by external factors such as recessions or the COVID-19 pandemic. Aviation energy use fell by

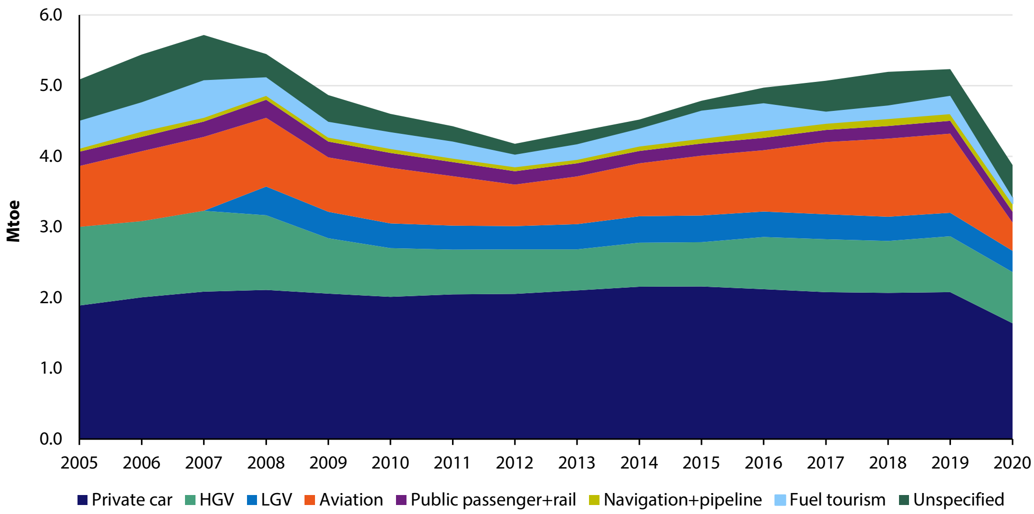
49 The energy use of international aviation is included in the National Energy Balance in line with international reporting requirements. However the CO_2 emissions from energy use by international aviation are not included in the National Greenhouse Gas Inventory prepared by the EPA, again in line with international reporting requirements. Care must be taken to be clear whether or not international aviation is included when discussing or comparing figures for energy use and energy related CO_2 emissions for transport. In this report we have included international aviation when discussing transport energy use, to align with the National Energy Balance. When discussing energy related CO_2 emissions from transport we show the CO_2 emissions from international aviation separately.

50 The energy use of 'light goods vehicle' is estimated from 2008 onwards. Prior to 2008 the energy use of this sub-sector was included in the 'unspecified' category.

44% between 2007 and 2012 during the recession. It returned to strong growth after 2012, increasing by 90% between 2012 and 2019, when it reached an all-time-high, 6.8% above the previous 2007 peak, before the dramatic 64% fall in 2020.

HGV energy use also saw large reduction during the recession, falling by 49% between 2007 and 2013. It increased by 36% between 2013 and 2019, but still remained 31% below the 2007 peak. These changes are due to changes in amount of goods transported, as discussed further in section *7.2.6*.

Figure 61: Transport energy demand by subsector



Source: SEAI

Table 27: Growth rates, quantities and shares of transport final energy demand by sub-sector

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Private car	1,637	42%	1,891	37%	-443	-21.3%	-24.1%	-5.4%	-13.5%	-1.0%
HGV	725	19%	1,112	22%	-65	-8.2%	15.7%	3.0%	-34.8%	-2.8%
LGV	301	8%	0	0%	-33	-9.8%	-20.3%	-4.4%	-	-
Domestic aviation	2	0%	27	1%	-4	-59.7%	-53.3%	-14.1%	-90.9%	-14.8%
International aviation	396	10%	832	16%	-714	-64.3%	-53.0%	-14.0%	-52.4%	-4.8%
Public passenger	117	3%	157	3%	-21	-15.3%	-11.9%	-2.5%	-25.4%	-1.9%
Rail	36	1%	45	1%	-8	-19.0%	-8.8%	-1.8%	-20.1%	-1.5%
Navigation	104	3%	50	1%	15	16.4%	45.5%	7.8%	109.2%	5.0%
Gas pipeline	15	0%	2	0%	15	-	-	-	588.7%	13.7%
Fuel tourism	80	2%	387	8%	80	-	-	-	-79.2%	-9.9%
Unspecified	461	12%	581	11%	461	-	-	-	-20.6%	-1.5%
Total	**3,875**	**100%**	**5,084**	**100%**	**-1,359**	**-26.0%**	**-19.0%**	**-4.1%**	**-23.8%**	**-1.8%**

Source: SEAI

Table 28: Growth rates, quantities and shares of transport CO_2 emissions by sub-sector

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity ($ktCO_2$)	Share (%)	Quantity ($ktCO_2$)	Share (%)	Absolute change ($ktCO_2$)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Private car	4,792	47.7%	5,594	43.7%	-1,309	-21.5%	-24.5%	-5.5%	-14%	-1.0%
HGV	2,096	20.9%	3,411	26.6%	-201	-8.8%	13.2%	2.5%	-39%	-3.2%
LGV	871	8.7%	0	0.0%	-101	-10.4%	-22.0%	-4.9%	-	-
Domestic Aviation	7	0.1%	80	0.6%	-11	-59.8%	-53.4%	-14.2%	-91%	-14.8%
Public passenger	346	3.4%	478	3.7%	-64	-15.6%	-12.9%	-2.7%	-27%	-2.1%
Rail	128	1.3%	160	1.2%	-27	-17.5%	-5.9%	-1.2%	-20%	-1.5%
Navigation	319	3.2%	153	1.2%	45	16.4%	45.5%	7.8%	109%	5.0%
Gas pipeline	0	0.0%	0	0.0%	0	-	-	-	-	-
Fuel tourism	233	2.3%	1,178	9.2%	-481	-67.4%	-79.6%	-27.3%	-80%	-10.2%
Unspecified	1,328	13.2%	1,755	13.7%	231	21.0%	222.8%	26.4%	-24%	-1.8%
Total (excl. international aviation)	**10,052**	**100.0%**	**12,812**	**100.0%**	**-1,909**	**-16.0%**	**-13.1%**	**-2.8%**	**-22%**	**-1.6%**
International aviation	1,184		2,487		-2,135	-64.3%	-53.0%	-14.0%	-52%	-4.8%
Total (incl. international aviation)	**11,236**		**15,299**		**-4,044**	**-26.5%**	**-20.2%**	**-4.4%**	**-27%**	**-2.0%**

Source: SEAI

7.2.2 Transport energy by fuel

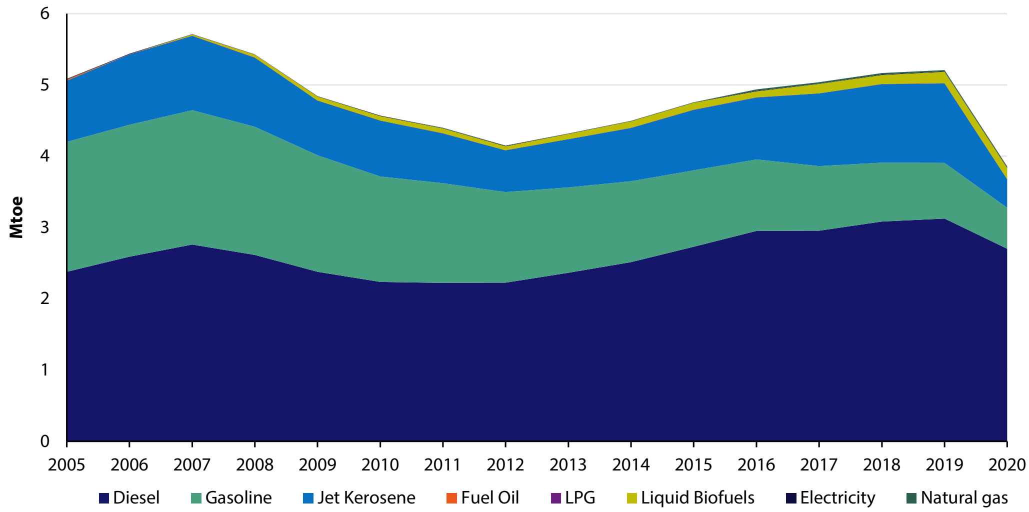
Fuel consumption in transport is often closely aligned to the mode of transport used: jet kerosene is used for air transport, fuel oil for shipping and petrol and LPG are almost exclusively used for road transport. Diesel consumption is used for road transport, navigation and rail. *Figure 62* and *Table 29* show the trends in transport's final energy use split by fuel type between 2005 and 2019.

The most important point to note is that transport remains almost completely dependent on fossil fuels, particularly oil products. This lack of fuel diversity is unique amongst the energy using sectors. Renewable made up just 4.5% of transport energy use in 2020, up from 3.6% in 2019. Electricity remains a very small share of transport energy use, just 0.2% in 2020. This is now about evenly split between electric rail (DART and Luas) and electric private cars. This has meant that there has been very little decarbonisation of the transport fuel mix to date, with transport CO_2 emissions remaining tightly coupled to energy use. In 2019 transport CO_2 emissions were the same as they had been in 2005.

There was a clear shift from petrol to diesel over the time period, due to the switch to diesel private cars that was accelerated by the changes to the private car tax system from 2008 onwards.

Transport energy use remains dominated by fossil fuels, which accounted for over 95% of transport energy use in 2020.

Figure 62: Transport final energy use by fuel[51]



Source: SEAI

Table 29: Growth rates, quantities and shares of final consumption in transport

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Diesel	2,700	69.7%	2,378	46.8%	-424	-13.6%	-1.0%	-0.2%	13.5%	0.8%
Gasoline	578	14.9%	1,822	35.8%	-202	-25.9%	-46.2%	-11.7%	-68.3%	-7.4%
Jet Kerosene	398	10.3%	857	16.9%	-718	-64.3%	-53.0%	-14.0%	-53.6%	-5.0%
Fuel Oil	0	0.0%	18	0.3%	0	-	-	-	-100.0%	-100.0%
LPG	1	0.0%	1	0.0%	-1	-48.5%	-66.9%	-19.8%	-17.7%	-1.3%
Total Oil	**3,677**	**94.9%**	**5,076**	**99.8%**	**-1,345**	**-26.8%**	**-20.9%**	**-4.6%**	**-27.6%**	**-2.1%**
Natural gas	16	0.4%	2	0.0%	-2	-9.5%	301.6%	32.1%	615.4%	14.0%
Total Fossil Fuels	**3,693**	**95.3%**	**5,078**	**99.9%**	**-1,347**	**-26.7%**	**-20.7%**	**-4.5%**	**-27.3%**	**-2.1%**
Liquid Biofuels	174	4.5%	1	0.0%	-14	-7.2%	36.2%	6.4%	15789.3%	40.2%
Electricity	8	0.2%	5	0.1%	1	12.1%	101.7%	15.1%	50.2%	2.7%
Total	**3,875**	**100.0%**	**5,084**	**100.0%**	**-1,359**	**-26.0%**	**-19.0%**	**-4.1%**	**-23.8%**	**-1.8%**

Source: SEAI

7.2.3 Private car activity

Figure 63 shows the total kilometres driven by petrol and diesel private cars in Ireland each year from 2000 to 2020[52]. The total number of vehicle-kilometres travelled declined following the economic crash (during 2009 and 2010) but returned to growth soon after, in 2011. Between 2011 and 2015 total vehicle-kilometres increased by 13.6%, or 2.6% per annum. Between 2015 and 2019 this growth levelled off. In 2020, total kilometres travelled by petrol and diesel private cars decreased by 20%.

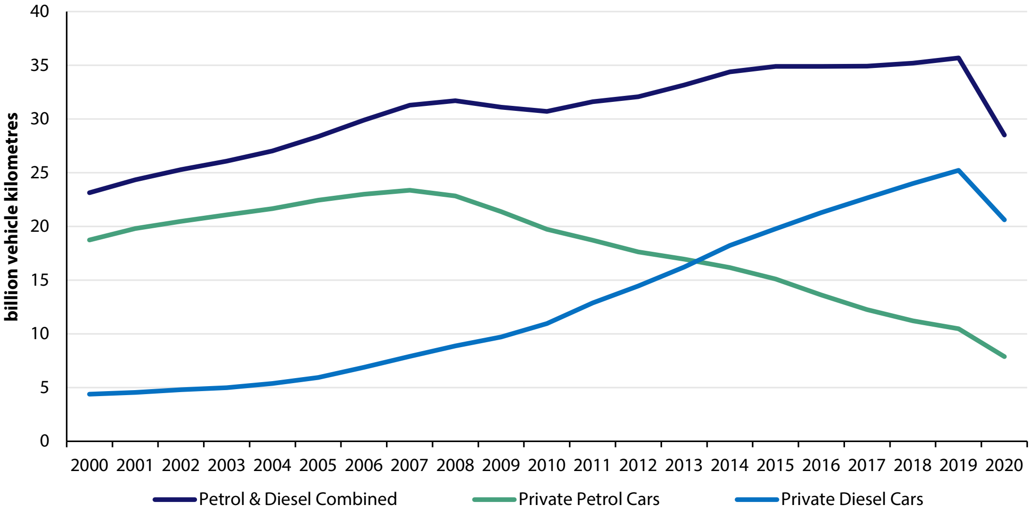
There was a clear shift from petrol to diesel cars in this period. This was already underway prior to the changes in motor taxation in 2008 but accelerated sharply after that. Overall travel by petrol cars reduced by 55% between the peak in 2007 and 2019. Travel by diesel cars increased by 219% over the same period. In 2007, 75% of total private car mileage was fuelled by petrol and 25% by diesel. In 2020, petrol accounted for 28% and diesel for 72%.

51 This is based on data of fuel sales in Ireland rather than fuels consumed in Ireland. .

52 This is based on an analysis of NCT data for all years except 2020. The NCT methodology assumes that the kilometres driven between the last two dates that a car has had an NCT are split evenly across that time periods, which can be 4, 2 or 1 years. In normal times this is a reasonable assumption but if there is a sudden change the activity pattern, as was experienced during COVID-19 travel restrictions, then this method no longer gives good results. Therefore, we developed an alternative approach for 2020. We estimated the reduction in activity of the average petrol car in 2020 from the observed drop in petrol use. We then assumed that the activity of the average diesel car was reduced by the same proportion as the average petrol car.

We estimate that electric vehicles travelled 127 million km in 2019, and 154 million km in 2020, just 0.5% of the combined activity of petrol and diesel vehicles.

Figure 63: Petrol and diesel private car total annual vehicle-kilometres



Source: Based on NCT Data

7.2.4 CO_2 intensity of new private cars

*Figure 64 s*hows the change in the weighted average specific CO_2 emissions[53] of new cars, excluding battery electric vehicles,[54] between 2005 and 2020, according to standardised testing procedures[55].

The standardised testing procedures are known to underestimate the fuel use and CO2 emissions of cars, compared to typical real world driving conditions. The difference between the test emissions and the emissions produced in real-world driving conditions is referred to as the on-road factor, or the performance gap. A number of reports by the International Council on Clean Transportation highlighted that the performance gap between test results and real world driving increased dramatically after 2008, and that the real-world fuel consumption and carbon emissions of new vehicles are increasingly higher than the reported values under standardised testing procedures[56,].

Since 2008, the combined effect of the EU legislation obligating manufacturers to reduce average fleet emissions and the changes to the Irish taxation system for private cars has been to shift new car purchases from higher to lower CO_2 emissions bands, and to reduce the average specific CO_2 emissions of new cars. After 2016 this trend reversed and the weighted average specific CO_2 emissions increased, due in part to the increasing popularity of larger SUV style cars. In 2020 the specific CO_2 emissions decreased by 6% to 111.0 gCO_2/km, due to a higher share of plug-in-hybrid and petrol-electric vehicles.

More recent studies have also raised concerns over the potential for very large performance gaps between the test results and the real world operation of plug-in-hybrid vehicles in particular[57]. This is an important caveat when considering the data shown in *Figure 64.*

53 Fuel consumption and CO_2 emissions data were sourced from the Vehicle Certification Agency. The database can be downloaded at http://www.dft.gov.uk/vca/fcb/new-car-fuel-consump.asp

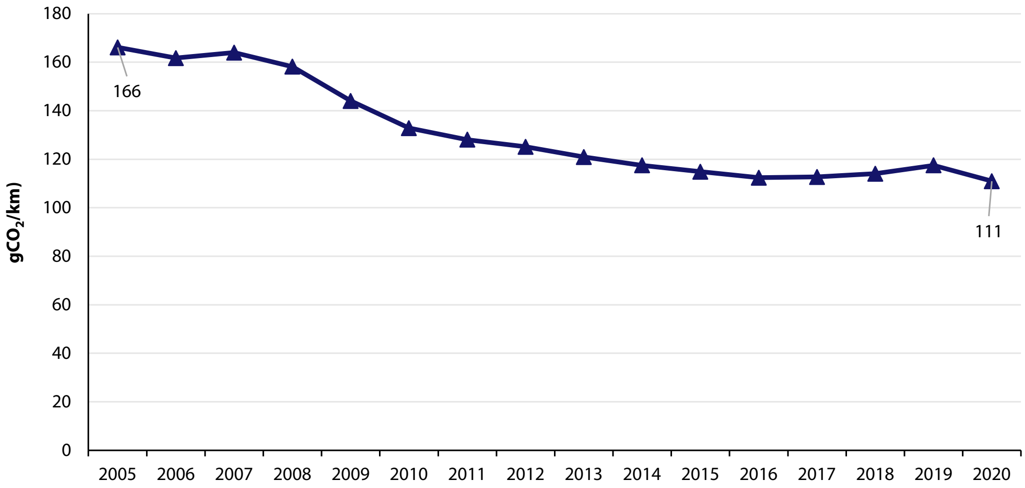
54 New private cars licensed for the first time. This does not include imported second-hand cars. It only includes brand new cars.

55 The data shown here is all based on the results of a standardised laboratory test procedure called the New European Driving Cycle (NEDC). From September 2018, a new test methodology called the Worldwide Harmonised Light Vehicle Test Procedure (WLTP) came into force for all new cars. This new test is intended to better reflect real-world driving profiles..

56 For more information see www.theicct.org.

57 For more information see https://www.transportenvironment.org/discover/plug-hybrids-europe-heading-new-dieselgate/

Figure 64: Specific CO_2 emissions of new cars, excluding battery electric vehicles

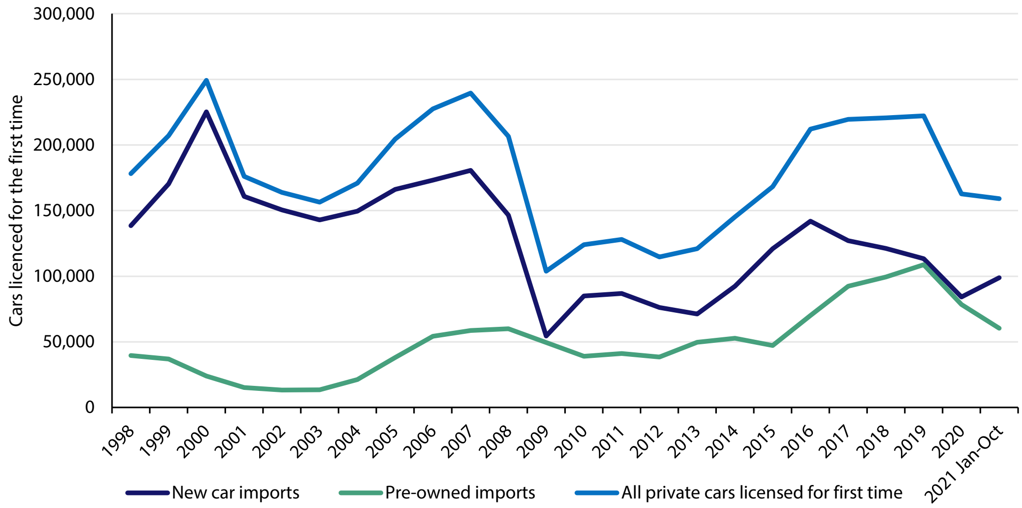


Source: Dept. Transport, Vehicle Registration Unit data

7.2.5 Penetration of zero emissions vehicles

There are two sources of cars for the Irish market: brand new imports and pre-owned imports, shown in *Figure 65*. The importance of the pre-owned imports market varies over time, but in the lead up to the UK leaving the EU its share increased and in 2019 and 2020 it accounted for just under half of all cars licenced for the first time. This is important as the profile of pre-owned imports tends to different to that of new car imports.

Figure 65: Share of private cars licenced for the first time that are new or pre-owned imports

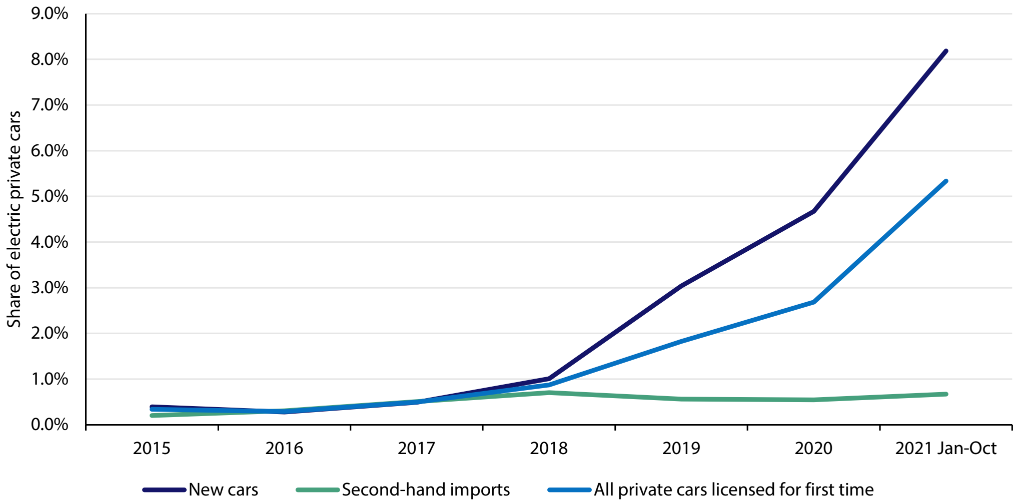


Source: CSO & Dept. Transport, Vehicle Registration Unit

Figure 66 and *Table 30* show the share of private cars added to the Irish car stock each year that are electric vehicles, split into new imports, pre-owned imports and all new cars licenced for the first time. For the first ten months of 2021 over 8% of all new car imports were electric, but only 0.7% of pre-owned imports were, resulting in 5.3% of all private cars licenced for the first time in Ireland being electric.

This is showing strong growth but still from a low base, with only 0.6% of the total vehicle stock electric at the end of 2020. With 95% of all vehicles licenced for the first time in the first ten months of 2021 having an internal combustion engine, and given that the typical life-span of a car is around fifteen years, it will be well into the next decade before there is a significant phasing out of cars with internal combustion engines.

Figure 66: Share of private cars licenced for the first time that are electric vehicles



Source: CSO & Dept. Transport, Vehicle Registration Unit

Table 30: Share of private cars licenced for the first time that are electric

Share of private cars licenced for the first time that are electric	2015	2016	2017	2018	2019	2020	2021 Jan-Oct
New car imports	0.4%	0.3%	0.5%	1.0%	3.0%	4.7%	8.2%
Pre-owned imports	0.2%	0.3%	0.5%	0.7%	0.6%	0.5%	0.7%
All private cars licensed for first time	0.3%	0.3%	0.5%	0.9%	1.8%	2.7%	5.3%

Source: CSO & Dept. Transport, Vehicle Registration Unit

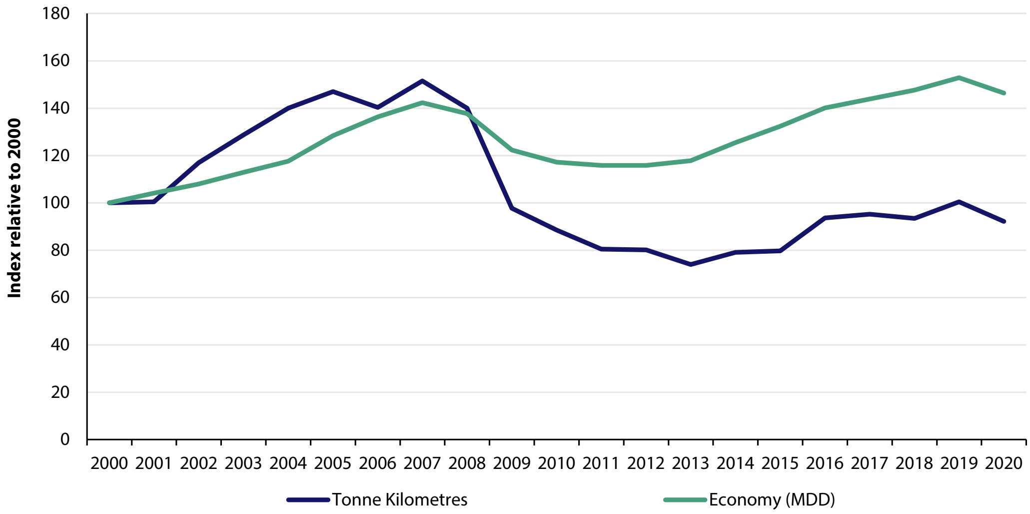
7.2.6 Heavy goods vehicle activity

The main metric used to measure activity in the road freight sector is tonne-kilometres, which is the total weight of material transported multiplied by the distance over which it is transported. *Figure 67* and *Table 31* present data on road freight tonne-kilometres, along with data on economic growth as measured by modified domestic demand. In *Figure 67* the data is presented as an index with respect to 2000. The data are taken from the CSO's Road Freight Transport Survey, which considers, for example, vehicles taxed as goods vehicles, those weighing over two tonnes unladen and those which are actually used as goods vehicles, rather than for service-type work. We estimate the energy use of heavy goods vehicles based on the activity, as measured by tonne-kilometres, and the energy consumption per tonne-kilometre, based on the EU average.

Although HGV activity was less affected by COVID-19 travel restrictions than private cars or aviation, the amount of tonne-km still fell by 8.2% in 2020. This was nearly twice the reduction seen total economic activity, as measured by modified domestic demand.

HGVs were responsible for the largest share of the decrease in transport sector energy demand between 2007 and 2013. This was primarily the result of reduced activity in the sector, which contracted more sharply than economic growth after the economic crisis of 2008. By 2013 HGV activity was down 51% compared to the peak in 2007. It returned to growth from 2014 but by 2019 it remained 34% below the 2007 level, and fell to 39% below the 2007 level in 2020.

Figure 67: Road freight activity



Source: CSO

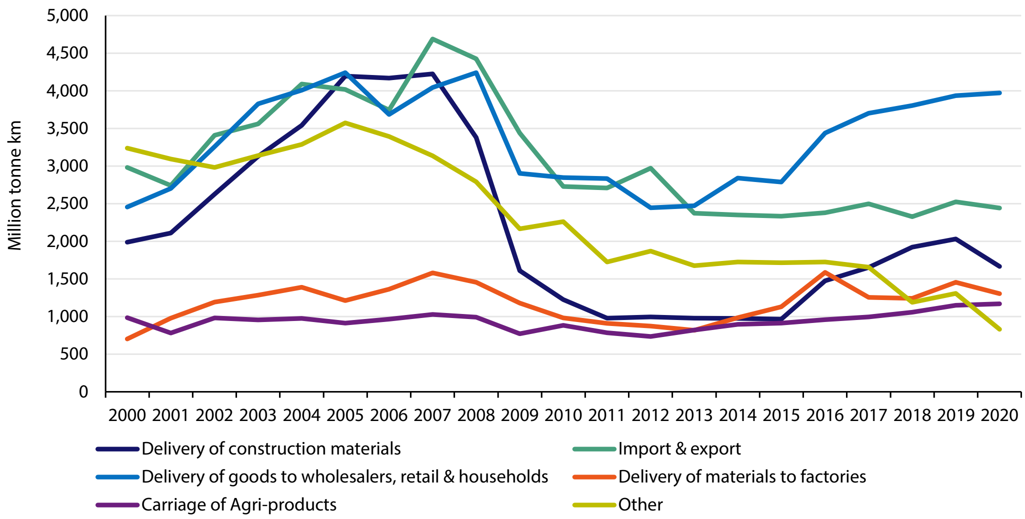
Table 31: Road freight activity

	2020	2005	2019-2020	2015-2020		2005-2020	
	Quantity	Quantity	Overall change (%)	Overall change (%)	Annual average change (%)	Overall change (%)	Annual average change (%)
Mega tonne-Kilometres	11,383	18,152	-8.2%	15.6%	2.9%	-37.3%	-3.1%
Modified Domestic Demand (billion € 2019)	182	159	-4.2%	10.6%	2.0%	14.0%	0.9%

Source: CSO

The CSO also provides data on heavy goods vehicle activity, classed by main type of work done. The trends for tonne-kilometres in each category between 2000 and 2020 are shown in *Figure 68*.

Figure 68: Road freight activity by main type of work done



Source: CSO

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

Despite the recovery of the economy between 2012 and 2019, the heavy goods vehicle activity in most categories did not recover to 2007 levels. By 2019 'Delivery of construction materials' remained 52% below 2007, 'Import & export' was 46% below and 'Other' was 58% below.

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

During 2020, the biggest reductions in activity were seen in 'Other' (down by 37% or 478 Mtkm), 'Delivery of construction materials' (down by 18% or 367 Mtkm) and 'Delivery of materials to factories' (down 10% or 151 Mtkm).

7.3 Residential

Trends in 2020

Residential energy use grew by 8.4% in 2020 compared to 2019. On average, the weather was warmer in 2020 (2.2% fewer degree days). When corrections for weather effects[58] are taken into account, energy use in the residential sector was 9.7% higher in 2020 than in 2019 (see *Table 32*).

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

- Overall direct fossil fuel use in households grew by 8.8%, to 2,296 ktoe, in 2020 and accounted for 73% of household energy use.
- Oil consumption in households grew by 15% in 2020, to 1,322 ktoe. Oil's share of household energy accounted for 42% in 2020.
- Electricity consumption grew by 7.4% in 2020, to 751 ktoe (8,734 GWh), and its share of residential final consumption was 24%.
- Natural gas use fell by 0.3% in 2020, to 590 ktoe, and accounted for 19% of residential energy use.
- Direct renewables use in households increased in 2020 by 8.0%, to 81 ktoe, and its share increased to 2.6%.
- Coal use in households grew in 2020 by 4.8%, to 195 ktoe, and had a 6.2% share of the residential sector's energy use.
- Peat use also grew by 3.2% in 2020 and peat briquette use grew by 10%. Total peat consumption was 189 ktoe in 2020. The peat and briquette share in household energy was 6.1% in 2020.

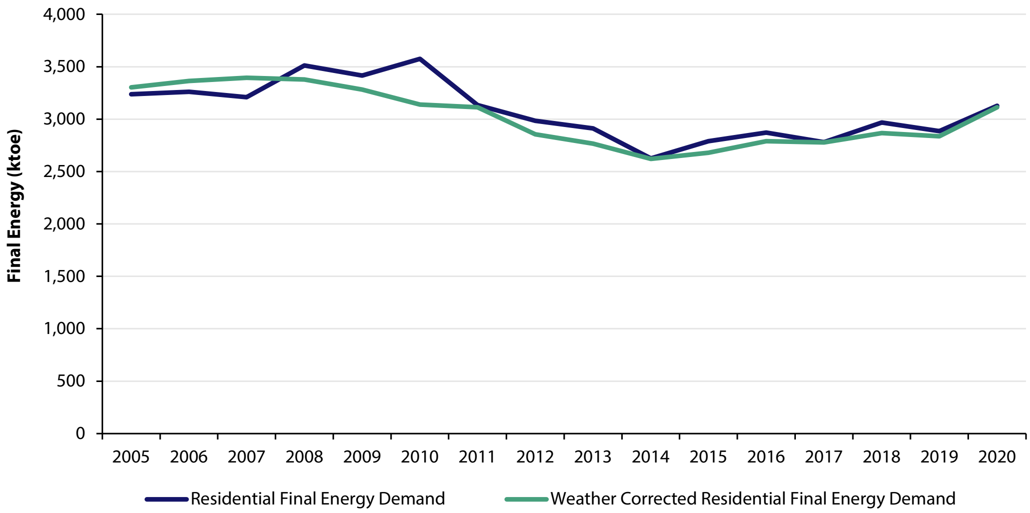
Weather-corrected energy use in the residential sector grew by 9.7% in 2020 compared to 2019.

Trends from 2005 to 2020

Figure 69 shows the trend for residential sector final energy consumption between 2005 and 2020, with and without weather correction. Weather correction yields a lower normalised energy consumption in cold years (e.g. 2010), and yields a higher normalised consumption in mild years (e.g. 2007). Accounting for weather variations, residential energy demand decreased every year between 2007 and 2014 but increased between 2015 and 2018. Residential final energy use in 2020 was 3,128 ktoe, 3.4% below the level recorded in 2005. Correcting for weather variations, 2020 residential final energy use was 5.8% below 2005.

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

Figure 69: Residential final energy



Source: SEAI

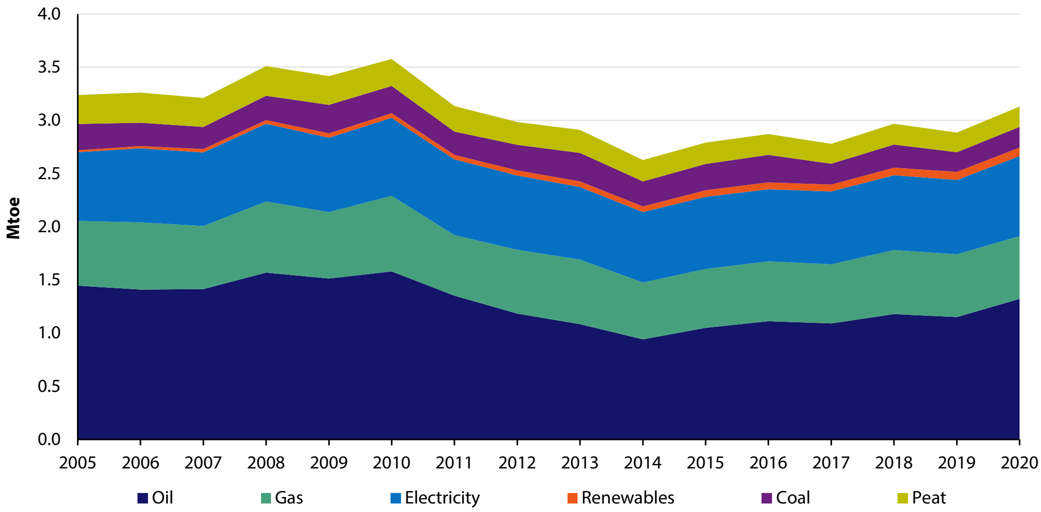
Figure 70 shows the mix of fuels consumed in the residential sector between 2005 and 2020. The fuel shares were relatively stable, with a gradual increase in the share of electricity, gas and of renewables and a continuing though gradual decline in coal, peat and oil use.

Oil remains the dominant fuel in the residential sector, though its share reduced slightly, from 45% in 2005, to 42% in 2020. Electricity was the second largest source of energy in the sector in 2020, at 24%, with natural gas having the next largest share at 19%. The renewables share of final energy used directly in households in 2020 was 2.6%. The growth rates, quantities and shares are shown in *Table 32*.

Looking at the period 2007 to 2014, overall residential energy use declined by 18%, or 584 ktoe. The majority of the reduction was from oil, which fell by 33%, or 472 ktoe, followed by gas, which fell by 9.7%, or 57 ktoe. Some reasons for this may be: the higher oil price, and the greater increase in price of oil compared to gas, in the period 2010 to 2015; the potentially greater opportunities for fuel switching to peat and non-traded wood in rural areas, where the majority of oil-fired dwellings are located.

It is also notable that total electricity consumption peaked in 2020, 2.2% higher, or 17 ktoe, than the previous peak in 2010.

Figure 70: Residential final energy use by fuel



Source: SEAI

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Oil	1,322	42%	1,447	45%	172	15.0%	26.2%	4.8%	-8.6%	-0.6%
Gas	590	19%	607	19%	-2	-0.3%	6.2%	1.2%	-2.8%	-0.2%
Coal	195	6%	246	8%	9	4.8%	-21.1%	-4.6%	-20.7%	-1.5%
Peat	189	6%	273	8%	6	3.2%	-5.6%	-1.1%	-30.7%	-2.4%
Total Fossil Fuels	**2,296**	**73%**	**2,573**	**79%**	**186**	**8.8%**	**12.0%**	**2.3%**	**-10.7%**	**-0.8%**
Biomass	26	1%	16	0%	1	2.2%	-22.9%	-5.1%	63.1%	3.3%
Solar thermal	14	0%	0	0%	0	3.0%	23.7%	4.4%	2924.0%	25.5%
Ambient	41	1%	3	0%	5	14.1%	142.5%	19.4%	1118.4%	18.1%
Total Renew-ables	**81**	**3%**	**20**	**1%**	**6**	**8.0%**	**30.7%**	**5.5%**	**308.8%**	**9.8%**
Electricity	751	24%	646	20%	52	7.4%	10.9%	2.1%	16.3%	1.0%
Total	**3,128**	**100%**	**3,238**	**100%**	**244**	**8.4%**	**12.1%**	**2.3%**	**-3.4%**	**-0.2%**
Total (weather corrected)	**3,112**		**3,304**		**276**	**9.7%**	**16.2%**	**3.0%**	**-5.8%**	**-0.4%**

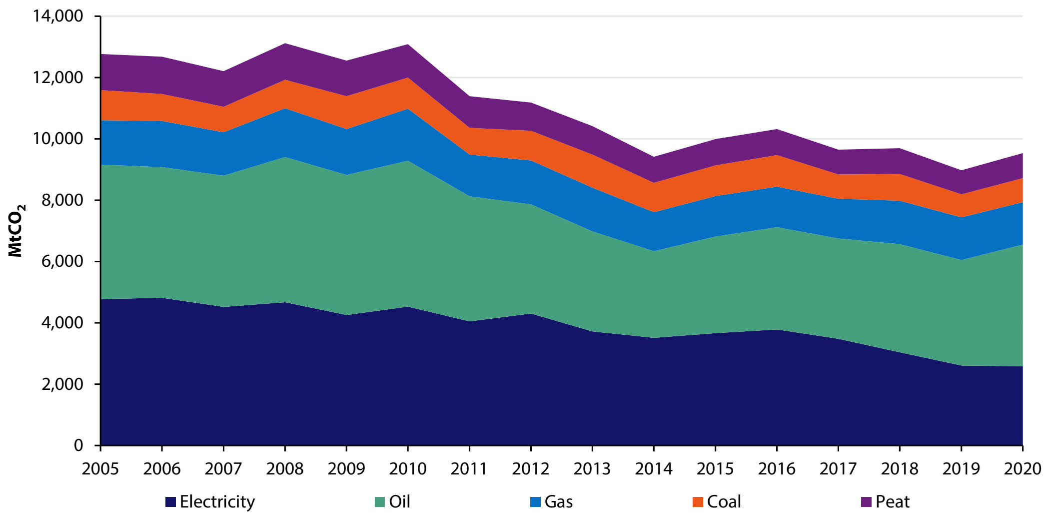
Source: SEAI

Energy-related CO_2 emissions – including emissions associated with electricity

Energy-related CO_2 emissions from the residential sector are shown in *Figure 71*. There was a reduction in energy-related CO_2 emissions between 2010 and 2014, but there was a return to growth in 2015, 2016, 2018 and again in 2020. In 2020 residential sector energy-related CO_2 emissions (including upstream electricity emissions) grew by 6.2%, to 9,535 kt CO_2. This was due to an increase of fossil fuel use in the residential sector in 2020.

Energy-related CO_2 emissions[59] from the residential sector in 2020 were 25% below 2005 levels. In 2020 the residential sector accounted for 29% of the total energy-related CO_2 emissions, the second largest source after transport, which accounted for 34%.

Figure 71: Residential energy-related CO_2 by fuel



Source: SEAI

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

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Oil	3,963	42%	4,389	34%	518	15.0%	25.9%	4.7%	-9.7%	-0.7%
Gas	1,387	15%	1,443	11%	0	0.0%	4.9%	1.0%	-3.9%	-0.3%
Coal	788	8%	989	8%	35	4.7%	-20.8%	-4.6%	-20.4%	-1.5%
Peat	811	9%	1,170	9%	24	3.1%	-5.4%	-1.1%	-30.6%	-2.4%
Total Fossil Fuels	**6,949**	**73%**	**7,991**	**63%**	**577**	**9.1%**	**9.9%**	**1.9%**	**-13.0%**	**-0.9%**
Electricity	2,585	27%	4,775	37%	-20	-0.8%	-29.5%	-6.8%	-45.9%	-4.0%
Total	**9,535**	**100%**	**12,765**	**100%**	**557**	**6.2%**	**-4.6%**	**-0.9%**	**-25.3%**	**-1.9%**

Source: SEAI

Energy-related CO_2 emissions – excluding emissions associated with electricity

If the upstream emissions associated with electricity use are excluded, the CO_2 emissions from direct fossil fuel use in the residential sector in 2020 were 13% lower than in 2005. This was achieved through a combination of a less carbon-intensive fuel mix and a reduction in overall energy use post-2010. Excluding upstream electricity emissions, direct CO_2 emissions from the household sector were 6,949 kt, and were 9.1% higher in 2020 compared with 2019 (see *Table 33*).

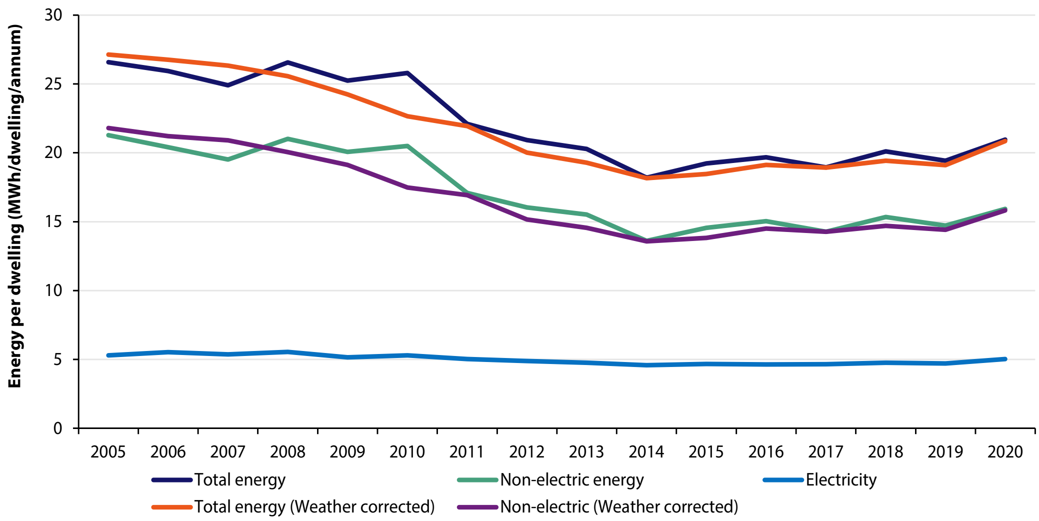
Average dwelling energy use

In 2020, the average dwelling consumed a total of 20,205 kWh of energy, 7.8% higher than in 2019. This comprised 15,352 kWh (76%) of direct fuels and 4,853 kWh (24%) of electricity.

> In 2020, the average dwelling consumed a total of 20,205 kWh of energy; 76% of this was direct fuel use and the remainder electricity.

Figure 72 shows the trend in final energy consumption per dwelling with and without weather correction. Weather corrected final energy use per dwelling reduced by 34% between 2005 and 2014, before returning to gradual growth since. Weather-corrected final energy consumption per dwelling grew by 9.1% in 2020, and is 24% below 2005 levels. Most of the reduction was in non-electric fuel use, which was 28% below 2005 levels in 2020, with electricity down 8.5% over the same period.

Figure 72: Energy per dwelling (permanently occupied)



Source: Based on SEAI, CSO and Met Éireann data

Table 34: Growth rates and quantities of energy consumption and CO_2 emissions per dwelling

	2020		2005		2019-2020	2015-2020		2005-2020	
Energy per dwelling	**Quantity (kWh/ dwelling)**	**Share (%)**	**Quantity (kWh/ dwelling)**	**Share (%)**	**Overall change (%)**	**Overall change (%)**	**Average annual change (%)**	**Overall change (%)**	**Average annual change (%)**
Total Energy	20,955	100%	26,585	100%	7.8%	9.0%	1.7%	-21.2%	-1.6%
Non-electric fuel use	15,922	76%	21,282	80%	8.2%	9.4%	1.8%	-25.2%	-1.9%
Electricity	5,034	24%	5,303	20%	6.8%	7.8%	1.5%	-5.1%	-0.3%
Energy per dwelling (weather corrected)	**Quantity (kWh/ dwelling)**	**Share (%)**	**Quantity (kWh/ dwelling)**	**Share (%)**	**Overall change (%)**	**Overall change (%)**	**Average annual change (%)**	**Overall change (%)**	**Average annual change (%)**
Total Energy	20,847	100%	27,124	100%	9.1%	13.0%	2.5%	-23.1%	-1.7%
Non-electric fuel use	15,819	76%	21,801	80%	9.8%	14.4%	2.7%	-27.4%	-2.1%
Electricity	5,028	24%	5,323	20%	7.1%	8.6%	1.7%	-5.5%	-0.4%
Energy-related CO_2 emissions per dwelling	**Quantity (tCO_2/ dwelling)**	**Share (%)**	**Quantity (tCO_2/ dwelling)**	**Share (%)**	**Overall change (%)**	**Overall change (%)**	**Average annual change (%)**	**Overall change (%)**	**Average annual change (%)**
Total Energy	5.49	100%	9.01	100%	5.6%	-7.2%	-1.5%	-39.1%	-3.2%
Non-electric fuel use	4.00	73%	5.64	63%	8.4%	6.9%	1.3%	-29.0%	-2.3%
Electricity	1.49	27%	3.37	37%	-1.3%	-31.5%	-7.3%	-55.8%	-5.3%

Source: SEAI

Energy-related CO_2 emissions per dwelling

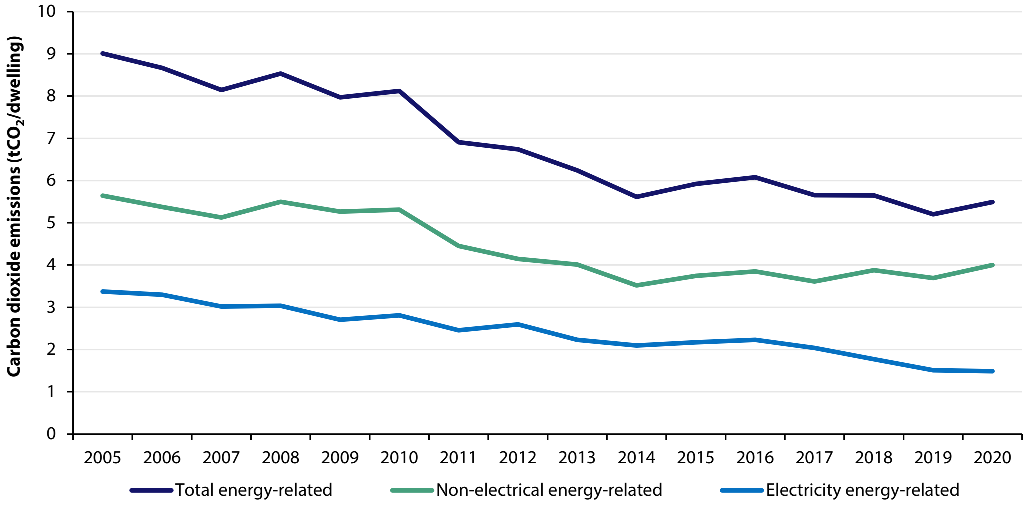
The emissions of energy-related CO_2 per dwelling fell by 39% over the period 2005 to 2020, while energy use per dwelling fell by 21% (see *Table 34* and *Figure 73)*. In 2020, the average dwelling was responsible for emitting 5.5 tonnes of energy-related CO_2. A total of 4.0 tonnes of CO_2 (73%) came from non-electric fuel use in the home and the remainder indirectly from electricity use.

Energy-related CO_2 emissions per dwelling for non-electric fuel use fell by 29% between 2005 and 2020, primarily as a result of reduced energy consumption per dwelling. CO_2 emissions from electricity use reduced by 56% in the same time period due to a combination of reduced electricity use and the reduced carbon intensity of the electricity grid.

Emissions from total energy use per dwelling grew by 5.6% in 2020, due to increased fossil fuel consumption during the COVID-19 lockdowns. Emissions from non-electric fuel use grew by 8.4% in 2020.

In 2020, the average dwelling was responsible for emitting 5.6 tonnes of energy-related CO_2. This was 39% less than in 2005.

Figure 73: Unit energy-related CO_2 emissions per dwelling



Source: SEAI

7.4 Commercial and public services

Trends in 2020

Commercial and public services' energy use increased by 0.6% in 2020. As 2020 was warmer than 2019 (2.2% fewer degree days), when corrections for weather effects are taken into account, energy use in services increased by 4.7% (see *Table 35*). This is against the backdrop of the economic activity of services, as measured by value added, decreasing by 3.2%.

The key trends in 2020 were as follows:

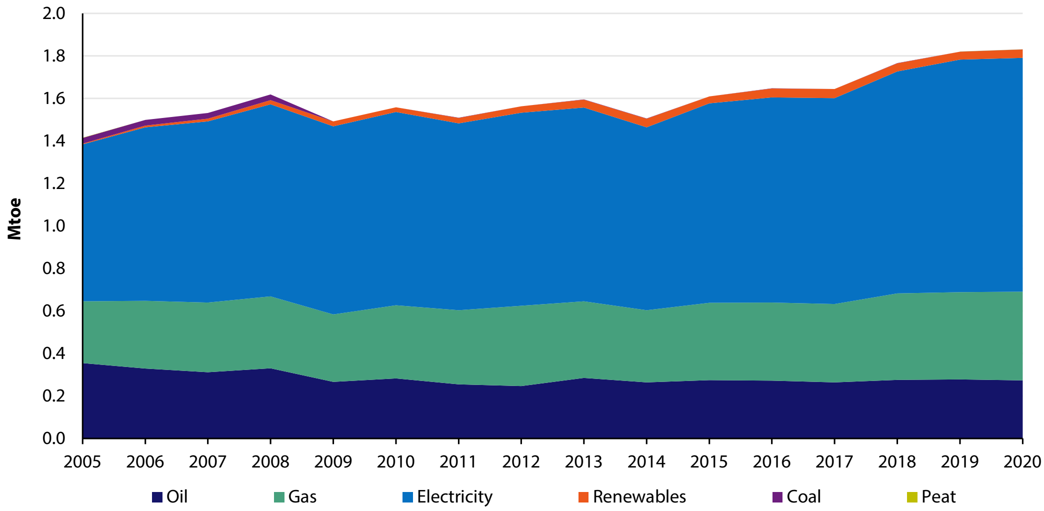
- Final energy use in services grew by 0.6% in 2020, to 1,830 ktoe; however when corrected for weather effects the increase was 1.5%.
- Oil, gas and electricity make up 98% of the energy consumed in the services sector. The contributions from coal and peat are negligible.
- Electricity consumption in services increased by 0.5%, to 1,100 ktoe, and accounted for 60% of final energy consumption in services in 2020.
- Oil consumption decreased by 1.5%, to 273 ktoe. The share of oil in the sector's final consumption was 15%.
- Natural gas consumption increased by 1.7%, to 417 ktoe, and its share of the sector's final consumption was 23%.
- Overall direct fossil fuel use in services increased by 0.4%, to 691 ktoe.
- Renewable energy use in services grew by 6.8%, to 39 ktoe, in 2020. The share of renewables in services' final energy consumption was 2.1%.

In determining the sectoral breakdown of commercial and public service energy use, SEAI uses a blend of data sources, including the business energy use survey (BEUS) from the CSO. In May 2021, the CSO published the latest version of the BEUS, which is based on energy use in 2018. SEAI uses this most recent BEUS release in estimating the 2020 energy consumption across the commercial and public service sectors.

Trends from 2005 to 2020

Final energy use in the commercial and public services sector increased by 29% (1.7% per annum) between 2005 and 2020, to 1,830 ktoe. The increase was 27% if weather-corrected energy use is considered. During this period, the value added generated by the sector grew by 61%, while the numbers employed increased by 23%.

Figure 74: Commercial and public services final energy use by fuel



Source: SEAI

Figure 74 shows the changes in the fuel mix in the services sector over the period. The range of fuels used in this sector is small – essentially oil, gas and electricity. Oil and gas are used predominantly for space heating, but also for water heating, cooking and, in some sub-sectors, laundry. Gas consumption has increased by 44% since 2005, to 417 ktoe. Electricity is used in buildings for heating, air conditioning, water heating, lighting, and information and communications technology (ICT). Electricity in services is also used for public lighting and water and sanitation services.

Electricity consumption in services increased by 49% (2.7% per annum) between 2005 and 2020, to 1,100 ktoe (12,790 GWh), and had a higher share, at 60%, than any other individual source in services (up from 52% in 2005). Electricity use in services is driven by the changing structure of this sector and the general increase in the use of ICT, electric heating and air conditioning. Data centres are also included under commercial services.

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

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Oil	273	15%	355	25%	-4	-1.5%	0.0%	0.0%	-22.9%	-1.7%
Gas	417	23%	290	21%	7	1.7%	14.3%	2.7%	43.7%	2.4%
Coal	1	0%	27	2%	0	0.0%	50.1%	8.5%	-98.1%	-23.2%
Peat	0	0%	0	0%	0	-	-	-	-100.0%	-100.0%
Total Fossil Fuels	**691**	**38%**	**672**	**48%**	**3**	**0.4%**	**8.2%**	**1.6%**	**2.8%**	**0.2%**
Renewables	39	2%	4	0%	2	6.8%	23.1%	4.2%	874.0%	16.4%
Electricity	1,100	60%	738	52%	5	0.5%	17.2%	3.2%	49.0%	2.7%
Total	**1,830**	**100%**	**1,415**	**100%**	**11**	**0.6%**	**13.7%**	**2.6%**	**29.4%**	**1.7%**
Total (weather corrected)	**1,823**		**1,438**		**27**	**1.5%**	**17.0%**	**3.2%**	**26.8%**	**1.6%**

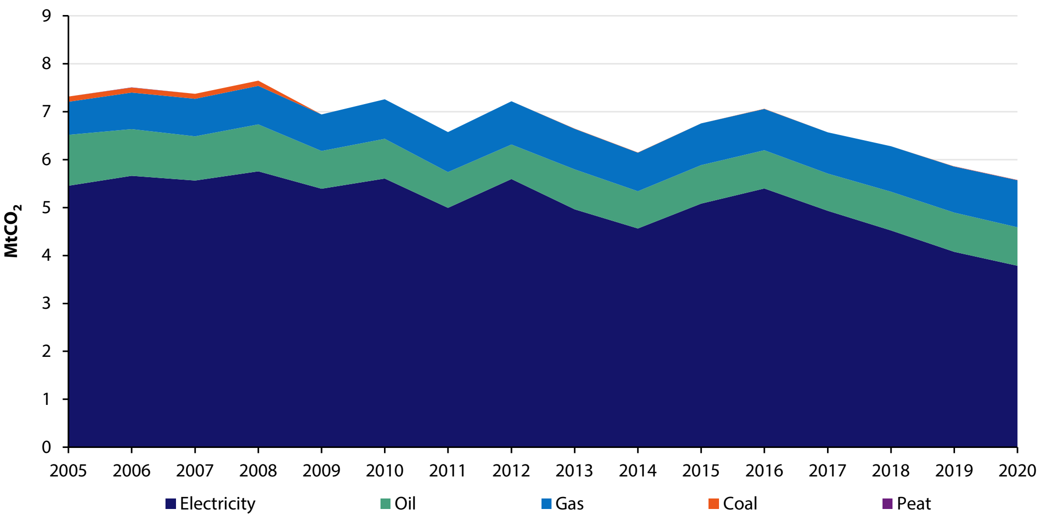
Source: SEAI

Energy-related CO_2 emissions – including emissions associated with electricity

Figure 75 shows the primary energy-related CO_2 emissions of the services sector, distinguishing between the on-site CO_2 emissions associated with direct fuel use and the upstream emissions associated with electricity consumption. Emissions from non-electrical energy fell by 3.8% over the period and the emissions associated with electricity consumption fell by 31%. In 2020, non-electricity emissions in services increased by 0.5% and electricity-associated emissions fell by 7.2%. Overall energy-related CO_2 emissions in this sector fell by 4.9% in 2020, to 5.6 $MtCO_2$.

In the services sector, the share of emissions associated with electricity demand in 2020 was 68%, compared to 75% in 2005 (see *Table 36*).

Figure 75: Commercial and public services sector CO_2 emissions by fuel



Source: SEAI

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

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Oil	806	14%	1,061	14%	-10	-1.3%	0.1%	0.0%	-24.0%	-1.8%
Gas	982	18%	691	9%	19	2.0%	12.8%	2.4%	42.1%	2.4%
Coal	2	0%	106	1%	0	0.0%	50.1%	8.5%	-98.1%	-23.3%
Peat	0	0%	2	0%	0	-	-	-	-100.0%	-100.0%
Total Fossil Fuels	**1,789**	**32%**	**1,859**	**25%**	**9**	**0.5%**	**6.8%**	**1.3%**	**-3.8%**	**-0.3%**
Electricity	3,784	68%	5,457	75%	-294	-7.2%	-25.5%	-5.7%	-30.7%	-2.4%
Total	**5,573**	**100%**	**7,316**	**100%**	**-285**	**-4.9%**	**-17.5%**	**-3.8%**	**-23.8%**	**-1.8%**

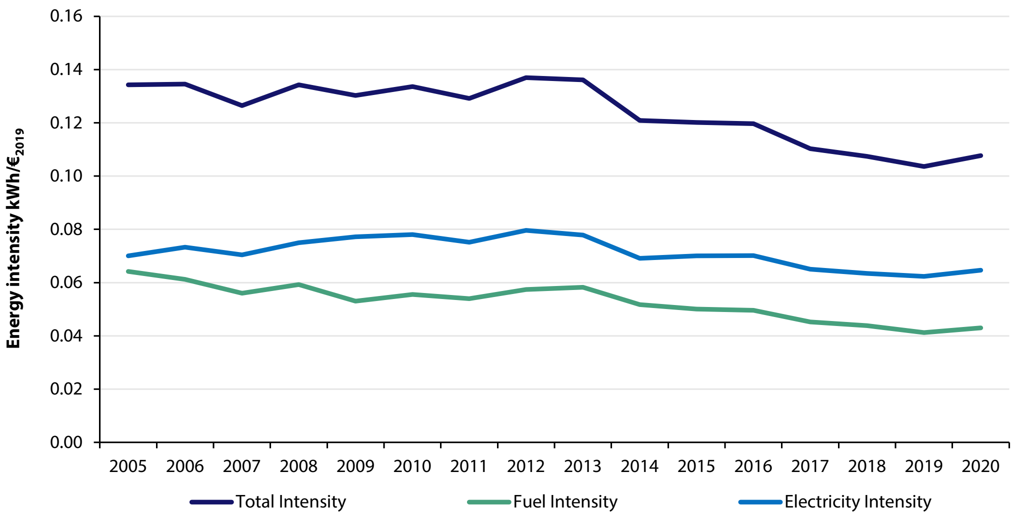
Source: SEAI

7.4.1 Energy intensity of the commercial and public services sector

The energy intensity of the services sector is generally measured in relation to the value added generated by services activities. As shown in *Figure 76*, this intensity is flatter than that of industry. The overall energy intensity of the services sector was 20% lower in 2020 than it was in 2005, principally because of the rapid growth in the value added in the sector. There has been a general downward trend in services' energy intensity since 2005. Energy intensity in services grew by 4% in 2020.

Electricity intensity had been falling since 2005, with the exception of 2008. However, in 2020, electricity intensity increased by 3.8% compared with 2019 and was 8% below the 2005 level.

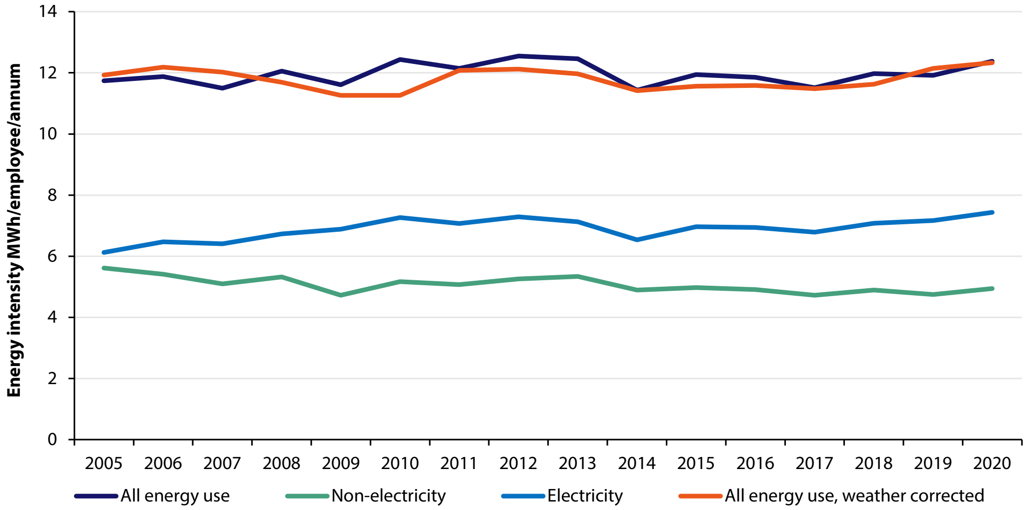
Figure 76: Energy intensity of the commercial and public services sector



Source: SEAI

Two other indicators in this sector are energy use per unit of floor area and per employee. The consumption of oil and gas is mainly for space-heating purposes and is likely to be more related to the floor area heated, rather than to the number of people occupying a building at a given time. Due to an absence of data on floor area in the services sector, it is not currently possible to calculate the consumption per unit of floor area.

Figure 77: Energy per employee in the commercial and public services sector



Source: SEAI

Electricity use per employee is used as an indicator of energy use in the services sector because, usually, there is a correlation between electricity use and the number of employees. In *Figure 77,* it can be seen that electricity per employee has been increasing since 2017, growing by 3.8% in 2020.

Non-electric energy use per employee grew by 4.1% in 2020, and stood at 17% below 2005 levels. If corrections are made for the effects of weather, then non-electric energy use per employee increased by 2.4% in 2020 when compared with 2019 (see *Table 37*).

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

	2020		2005		2019-2020	2015-2020		2005-2020	
Energy per employee in commercial and public services	Quantity (kWh/ dwelling)	Share (%)	Quantity (kWh/ dwelling)	Share (%)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Total Energy	12,380	100%	11,737	100%	3.9%	3.7%	0.7%	5.5%	0.4%
Non-electric energy use	4,941	40%	5,612	48%	4.1%	-0.7%	-0.1%	-11.9%	-0.8%
Electricity	7,439	60%	6,126	52%	3.8%	6.8%	1.3%	21.4%	1.3%
Energy per employee in commercial and public services (weather corrected)									
Total Energy	12,330	100%	11,930	100%	1.5%	6.6%	1.3%	3.4%	0.2%
Non-electric energy use	4,907	40%	5,759	48%	2.4%	4.2%	0.8%	-14.8%	-1.1%
Electricity	7,423	60%	6,171	52%	0.9%	8.3%	1.6%	20.3%	1.2%

Source: SEAI

7.4.2 Public sector developments

The public sector consists of approximately 4,400 separate public bodies, about 4,000 of which are individual schools. The other 400 comprise, inter alia, Government departments, non-commercial State bodies, State-owned companies and local authorities. Each 'public body' is a stand-alone organisation and can range in size from very small (e.g. a small rural school or a five-person agency) to very large (e.g the Health Service Executive or An Garda Síochána). The vast majority of energy is consumed by the 100 largest organisations.

Public services[60] energy consumption comprises two main classes of energy consumer:

- Public sector buildings (offices, hospitals, clinics, nursing homes, schools, prisons, barracks, Garda stations, etc.), which primarily consume electricity, natural gas and oil-based fuels in addition to smaller amounts of renewable and solid fuels;

60 In addition, the energy consumed by public bodies also includes some consumption counted in the transport sector in the National Energy Balance, e.g. public transport fleets (rail, bus, etc.) as well as other transport fleets operated by public bodies; for example, ambulances, local authority vehicles, Garda fleet, Defence Forces' vehicles, etc.

- Public sector utilities, which primarily consume electricity, for example wastewater treatment plants, water treatment facilities, pumping stations, and street lighting (~400,000 units).

The Fourth National Energy Efficiency Action Plan (NEEAP) and the European Union (Energy Efficiency) Regulations 2014 (SI 426 of 2014) set out several obligations on public bodies with respect to their 'exemplary role' for energy efficiency. The NEEAP sets a 33% efficiency target for the sector by 2020. This is equivalent to 279 ktoe (4,581 GWh based on 2018 data).

Since 1 January 2011, public sector bodies have been required to report to Government annually on their energy use and the actions they have taken to reduce consumption. SEAI and the Department of the Environment, Climate and Communications have developed an energy monitoring and reporting system[61] to satisfy the reporting requirements of both SI 426 of 2014 and the NEEAP. Since 2013, all public sector organisations have been obliged to use this system to report their annual energy consumption to SEAI. The system includes a national public sector energy database, which includes all public sector electricity and natural gas meter numbers. Over time, the monitoring and reporting system will build a comprehensive bottom-up picture of energy consumption in the sector through the population of the national public sector energy database.

In February 2021 SEAI published the *Annual Report 2020 on Public Sector Energy Efficiency Performance*[62]. It noted that 349 public sector bodies and 3,669 schools completed reports on energy and these represented 98% of total public sector energy consumption. The total energy consumption in 2019 of these bodies was 9,898 GWh (primary energy), which consisted of 4,658 GWh of electricity, 3,097 GWh of thermal energy and 2,143 GWh of transport energy. This cost the State €699 million in 2019. The report also noted that these bodies have achieved annual primary energy savings of 4,064 GWh, or a 29% improvement on business as usual, yielding a cost saving of €287 million. The public sector has a target of 33% energy efficiency improvement by 2020.

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

62 Available from https://www.seai.ie/business-and-public-sector/public-sector/monitoring-and-reporting/public-sector-results/

8 Energy statistics revisions and corrections

Some changes, revisions and corrections to the historic energy balance data were implemented during 2020. The most significant of these are listed below:

Energy Sources

Coal

- Residential estimates and corresponding imports were revised to align with data from the Revenue Solid Fuel Carbon Tax excise data.
- Transformation Input revised to align with updated data from the Emissions Trading Scheme.

Solar Photovoltaic

- Solar PV estimates revised to align with data from the Building Energy Rating database.

Ambient Heat

- Ambient Heat is now estimated based on data from the Building Energy Rating database.

Oil

- Some data points were revised to reflect updated information from data suppliers.

Data Flows

Total Final Energy Consumption

- Sectoral split revised to align with the latest data from the CSO Business Energy Use Survey.

Glossary of abbreviations

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

Glossary of terms

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

Carbon intensity (gCO_2/kWh): This is the amount of CO_2 that will be released per kWh of energy of a given fuel. For most fossil fuels the value of this is almost constant, but in the case of electricity it will depend on the fuel mix used to generate the electricity and also on the efficiency of the technology employed.

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

Combined heat and power (CHP) plants: Combined heat and power (CHP) refers to plants which are designed to produce both heat and electricity, for own use only or third-party owned and selling electricity and heat on site as well as exporting electricity to the grid.

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

Gross and net calorific value (GCV and NCV): The gross calorific value (GCV) gives the maximum theoretical heat release during combustion, including the heat of condensation of the water vapour produced during combustion. This water is produced by the combustion of the hydrogen in the fuel, or in some cases from the evaporation of water already present in the fuel. The net calorific value (NCV) excludes this heat of condensation because it cannot be recovered in conventional boilers. For natural gas, the difference between GCV and NCV is about 10%, for oil it is approximately 5%.

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

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

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

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

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

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

Nominal and real values: Nominal value refers to the current value expressed in money terms in a given year, whereas real value adjusts nominal value to remove effects of price changes and inflation to give the constant value over time indexed to a reference year.

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

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

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

Wastes (non-renewable): The non-renewable portion of wastes used as an energy source.

Energy conversion factors

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

Energy units

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

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

tonne of oil equivalent (toe): This is a conventional standardised unit of energy. One tonne of oil equivalent is defined as having a net calorific value of 41.868 GJ. A related unit is the kilogram of oil equivalent (kgoe), where 1 kgoe = 10^{-3} toe.

Decimal prefixes

deca (da)	10^{1}	deci (d)	10^{-1}
hecto (h)	10^{2}	centi (c)	10^{-2}
kilo (k)	10^{3}	milli (m)	10^{-3}
mega (M)	10^{6}	micro (µ)	10^{-6}
giga (G)	10^{9}	nano (n)	10^{-9}
tera (T)	10^{12}	pico (p)	10^{-12}
peta (P)	10^{15}	femto (f)	10^{-15}
exa (E)	10^{18}	atto (a)	10^{-18}

Calorific values

Fuel	Net Calorific Value toe/t	Net Calorific Value MJ/t
Crude Oil	1.0226	42,814
Gasoline (Petrol)	1.0650	44,589
Kerosene	1.0556	44,196
Jet Kerosene	1.0533	44,100
Gasoil/Diesel	1.0344	43,308
Residual Fuel Oil (Heavy Oil)	0.9849	41,236
Milled Peat	0.1860	7,787
Sod Peat	0.3130	13,105
Peat Briquettes	0.4430	18,548
Coal	0.6650	27,842
Liquefied Petroleum Gas (LPG)	1.1263	47,156
Petroleum Coke	0.7663	32,084
	Conversion Factor	**Conversion Factor**
Electricity	86 toe/GWh	3.6 TJ/GWh

Emission factors

	t CO_2/TJ (NCV)	g CO_2/kWh (NCV)
Liquid Fuels		
Motor Spirit (Gasoline)	70.0	251.9
Jet Kerosene	71.4	257.0
Other Kerosene	71.4	257.0
Gas/Diesel Oil	73.3	263.9
Residual Oil	76.0	273.6
LPG	63.7	229.3
Naphtha	73.3	264.0
Petroleum Coke (2020)	93.7	337.5
Solid Fuels and Derivatives		
Coal	94.6	340. 6
Milled Peat (2020)	116.1	418.1
Sod Peat	104.0	374.4
Peat Briquettes	98.9	355.9
Gas		
Natural Gas (2020)	56.2	202.2
Electricity		
Electricity (2020)	82.2	295.8

Sources

Applus+ (National Car Test)

Central Statistics Office

Department of the Environment, Climate and Communications

Department of Housing, Local Government, and Heritage

Department of Transport

EirGrid

Environmental Protection Agency

ESB Networks

European Commission DG TREN

EU-funded ODYSSEE Project

Eurostat

Gas Networks Ireland

International Energy Agency

Met Éireann

National Grid UK

Revenue Commissioners

Road Safety Authority (Vehicle Registration Unit)

US Energy Information Administration

Vehicle Certification Agency UK

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Energy balance 2020

kilotonnes of oil equivalent (ktoe)	Coal	Peat	Oil	Natural Gas	Renewables	Non-Renew/Waste	Electricity	Total
Indigenous Production	0	128	0	1,654	1,612	147		3,541
Imports	257	0	8,333	2,910	188		151	11,839
Exports	8	6	1,746	0	17		165	1,940
Mar. Bunkers	0	0	155		0			155
Stock Change	198	296	-193	0	-6			294
Primary Energy Supply (incl. non-energy)	**448**	**418**	**6,239**	**4,564**	**1,778**	**147**	**-13**	**13,580**
Primary Energy Requirement (excl. non-energy)	**448**	**418**	**6,010**	**4,564**	**1,778**	**147**	**-13**	**13,350**
Transformation Input	**195**	**279**	**3,066**	**2,611**	**239**	**93**	**58**	**6,541**
Public Thermal Power Plants	195	209	107	2,291	225	93		3,119
Combined Heat and Power Plants	0	5	0	277	14			296
Pumped Storage Consumption							46	46
Briquetting Plants	0	66	0		0			66
Oil Refineries and other energy sector	0	0	2,959	43	0		12	3,014
Transformation Output	**0**	**62**	**2,993**	**0**	**0**	**0**	**1,697**	**4,752**
Public Thermal Power Plants	0	0	0		0		1,492	1,492
Combined Heat and Power Plants	0	0	0		0		179	179
Pumped Storage Generation							25	25
Briquetting Plants		62	0		0			62
Oil Refineries		0	2,993		0			2,993
Exchanges and Transfers	**24**	**0**	**-48**	**0**	**-1,079**	**0**	**1,079**	**-24**
Electricity					-1,079		1,079	0
Heat								0
Other	24		-48	0	-0			-24
Own Use and Distribution Losses	**0**	**9**	**94**	**61**	**0**		**264**	**428**
Available Final Energy Consumption	**276**	**191**	**6,025**	**1,893**	**460**	**54**	**2,441**	**11,339**
Non-Energy Consumption	**0**	**0**	**230**	**0**	**0**	**0**	**0**	**230**
Final Non-Energy Consumption	0	0	230	0	0			230
Total Final Energy Consumption	**272**	**189**	**5,825**	**1,960**	**482**	**54**	**2,464**	**11,246**
Industry	**76**	**0**	**359**	**937**	**187**	**54**	**558**	**2,171**
Non-Energy Mining	0	0	21	12	0		15	48
Food, Beverages and Tobacco	0	0	64	285	39		127	515
Textiles and Textile Products	0	0	3	2	0		2	7
Wood and Wood Products	0	0	3	3	104		20	130
Pulp, Paper, Publishing and Printing	0	0	1	7	0		10	18
Chemicals and Man-Made Fibres	0	0	15	134	0		92	241
Rubber and Plastic Products	0	0	4	3	0		25	32
Other Non-Metallic Mineral Products	76	0	167	26	45	54	55	423
Basic Metals and Fabricated Metal Products	0	0	9	383	0		43	435
Machinery and Equipment n.e.c.	0	0	5	7	0		16	29
Electrical and Optical Equipment	0	0	3	19	0		72	94
Transport Equipment Manufacture	0	0	2	0	0		3	5
Other Manufacturing	0	0	14	39	0		55	108
Construction	0	0	48	18	0		22	88
Transport	**0**	**0**	**3,677**	**16**	**174**	**0**	**8**	**3,875**
Road Freight	0	0	683	1	41			725
Light Goods Vehicles	0	0	284		17			301
Road Private Car	0	0	1,552		81		3	1,637
Public Passenger Services	0	0	111		7			117
Rail	0	0	32		0		4	36
Domestic Aviation	0	0	2		0			2
International Aviation	0	0	396		0			396
Fuel Tourism	0	0	76		5			80
Navigation	0	0	104		0			104
Unspecified	0	0	438	15	23			476
Residential	**195**	**189**	**1,322**	**590**	**81**		**751**	**3,128**
Commercial/Public Services	**1**	**0**	**273**	**417**	**39**	**0**	**1,100**	**1,830**
Commercial Services	1	0	129	223	22	0	805	1,179
Public Services	0	0	144	194	18		295	651
Agricultural	**0**	**0**	**175**	**0**	**0**		**47**	**222**
Fisheries	**0**	**0**	**18**		**0**			**18**
Statistical Difference	5	2	-30	-68	-22	0	-23	-136

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

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