ENERGY IN IRELAND

2022 Report

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Version 1.1

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

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

Acknowledgements

SEAI gratefully acknowledges the co-operation of all the organisations, agencies, energy suppliers and distributors that provide data and respond to its questionnaires throughout the year. This co-operation is especially appreciated in 2022, when many data providers have been asked to submit more data within shorter deadlines, as SEAI worked to collect energy details to inform Government policy and satisfy new emergency reporting brought about by the current energy crisis.

Foreword

As evident from the data and analysis in this report, our energy use and energy-related emissions have now fully rebounded following the lifting of Covid-related restrictions. Despite the upgrade of a further 40,000 homes, the addition of almost 40,000 EVs and a broad range of other actions including in the public sector and communities around Ireland over the last two years, our emissions are on an upward trajectory. As our economy recovers, and our population grows, it is more important than ever to deliver energy efficiency measures, while shifting this efficient demand to dependence on renewable energy sources.

In terms of policy, our legislative basis is stronger than ever before, including legally established, binding carbon budgets and sectoral emission ceilings. Annual Climate Action Plans detail increased Government ambition and actions across all sectors of the economy. According to recent EPA research, the vast majority of the Irish population is aware, engaged and even worried about the climate crisis. Yet we have not yet turned this sentiment into actions that reduce our overall greenhouse gas emissions. Our focus must now turn to finding ways to bridge this 'say' / 'do' gap.

Continued focus is needed from Government. An updated Climate Action Plan is expected in the weeks following the publication of this year's Energy in Ireland. It will need to be both ambitious, to turn our emission trends around to live within our carbon budgets, and supported across Government leadership to support society to make this unprecedented change.

I believe such a change is possible. At SEAI we remain positive and fully committed to supporting and driving climate action. We see significant promise in our over 700 Sustainable Energy Communities, driving action through around 35,000 members. We see huge potential for large infrastructure projects like offshore wind, solar and district heating – all of which will provide jobs, and represent a development of our energy systems that future generations could look back on as transformative. We believe more focus must be given to realising the potential from changes in our behaviours around energy use and the purchase of energy using technologies.

We need to concentrate our focus on the shift away from fossil fuels. It is of national, and global significance, requiring all sectors of society to respond and align. Given the increasing energy prices, and other cost-of-living challenges it is increasingly difficult for many consumers and businesses to take part in this transition. As Mike Ryan of the World Health Organisation said at a recent SEAI conference, we must find ways to support people with what's important to them, and in the process seek to meet climate aims. By way of example, supporting those on low income with home energy upgrades provides affordable warmth and improved health, and building walking and cycling tracks provides opportunities to enhance community health, wellbeing and amenity. At the same time, these actions save carbon and represent the just transition we need.

We don't have all the answers, but we are committed to driving and supporting action and we know it needs all hands on deck. We simply cannot achieve this without the public, Government, businesses, public sector and industry all acting together. At SEAI, we are also committed to discovering new ways to deliver and to support this national movement away from fossil fuels in our energy system. Ireland can be a leader, inspiring others to follow. We've done so before; we can do it again. We remain open and keen to work with anyone on their journey to quit fossil fuels.

William Walsh, CEO

2021 and 2022 Highlights

- Although Ireland has committed to reducing its CO_2 emissions by 4.8% per annum from 2021- 2025 under the first carbon budget, energy related emissions were instead up by 5.4% in 2021.
- Provisional data from monthly surveys indicate that energy related emissions will increase by a further 6% in 2022.
- A rebound in car use after the lifting of COVID-19 restrictions is a significant contributor to Ireland's increased emissions. Energy demand for transport rose by 7.1% from its significant suppression in 2020.
- Provisional data from monthly surveys indicate that energy demand for transport will rebound more fully in 2022 by up to 18%, returning us to roughly pre-COVID levels.
- The 35.5 $MtCO_2$ of energy-related CO_2 (including international aviation) accounts for over half of all GHG emissions in Ireland.
- Due to a low wind year for renewable generation in 2021, we used more coal and oil for electricity generation, which increased the carbon intensity of our electricity by 12.5%.
- The transport sector emitted 12.0 $MtCO_2$ in 2021 and accounted for 34% of Ireland's total energy emissions.
- Transport remained the most carbon intensive demand sector, with 95.5% of transport energy demand coming from fossil fuels in 2021.
- Private car use is by far the largest transport sub-sector accounting for 43% of all transport energy demand in 2021.
- The residential sector emitted 9.8 $MtCO_2$ in 2021, which was 27.5% of Ireland's total energy emissions.
- Oil remains the dominant source of residential energy demand in 2021, and accounted for 41% of all home energy use, followed by electricity at 25% and gas at 19%.
- Ireland's business activities consist of our industry sector, which emitted 6.2 $MtCO_2$ in 2021, and our commercial and public services sector, which emitted 6.3 $MtCO_2$.
- Together, the industry and services sectors accounted for 34.9% of Ireland's energy demand in 2021.
- The ICT sub-sector, which includes datacentres, accounted for 3.9% of Ireland's total energy demand, and 16.5% of its electricity demand in 2021.
- Energy demand in the ICT sub-sector increased by 17.9% in 2021.

From 2021, the first EU Renewable Energy Directive (REDI) was replaced by the second EU Renewable Energy Directive (REDII), which continues to promote the growth of renewable energy and set renewable energy share (RES) targets out to 2030. REDII introduces new sustainability and verification criteria for biomass fuels and puts counting caps on certain biofuels. These changes in criteria and caps modify how our RES results in 2021 are calculated compared to 2020, even where there is little to no change in the underlying renewable energy:

- Ireland's overall renewable energy share was 12.5% in 2021 under REDII
- Ireland's renewable energy share in electricity (RES-E) was 36.4% in 2021 under REDII
- Ireland's renewable energy share in heat (RES-H) was 5.2% in 2021 under REDII
- Ireland's renewable energy share in transport (RES-T) was 4.3% in 2021 under REDII

Contents

1 Energy review of 2021 and 2022

This 10-page review section outlines this year's most important energy trends, targets, policies and actions, including the most interesting and important energy trends over the last two years. We draw from both our definitive annual data analysis up to 2021 (sections 2 to 10) and our provisional monthly data for 2022 (section 11) to assess Ireland's current energy supply and demand.

In this year's review section, we look at:

1. Our 2021 and 2022 rebounds from COVID-19
2. Our carbon budgets and sectoral ceilings
3. Our 2030 renewable energy targets
4. The carbon intensity and fuel mix of electricity
5. Challenges to sustainability of energy demand
6. Ireland's energy security of supply

1.1 2021 and 2022 rebounds from COVID-19

COVID-19 had a significant impact on Irish society and economy, including loss of life, serious illness and strain on our health services. Looked at through an energy lens, we saw that travel restrictions strongly disrupted our transport energy demand. The closure of schools, universities and offices shifted energy demand to the residential sector as we spent more time at home, and the disruption of supply chains and consumer patterns reduced energy demand in many business sectors.

Figure 1: Annual changes in Ireland's energy demand (%)

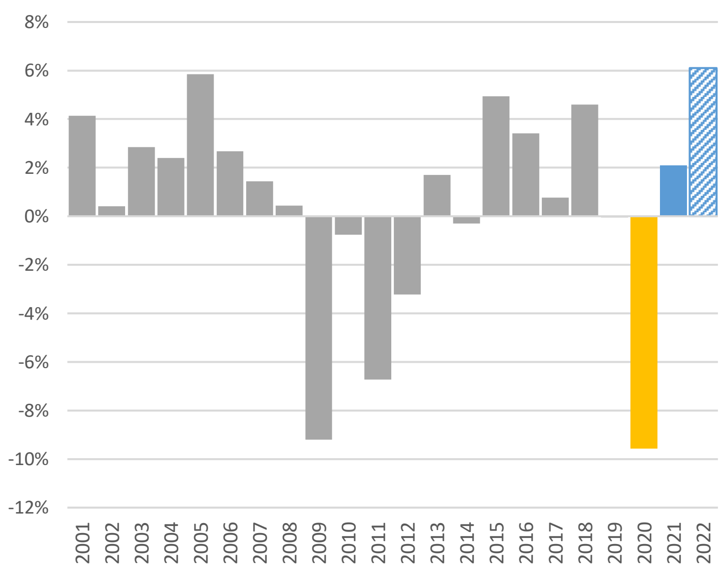
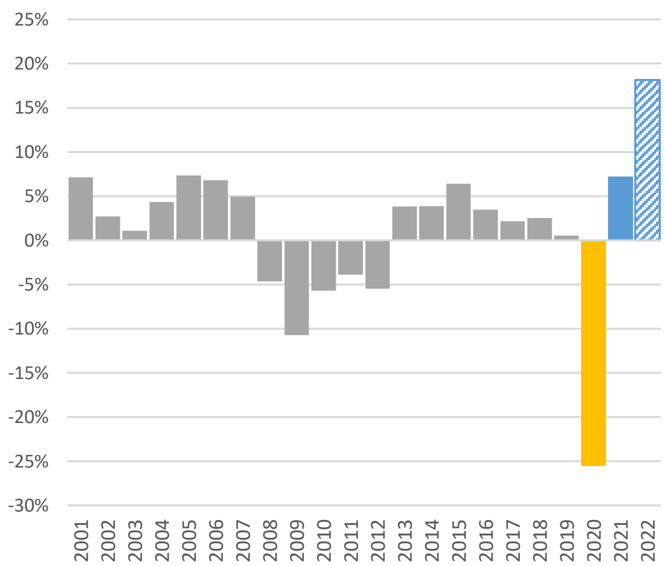


Figure 1 shows the year-on-year changes in Ireland's energy demand back to 2001. The sustained increases in energy demand from the 'boom' of the early-to-mid 2000s are clear, as are the demand drops during the recession that followed. The yellow bar shows the drop in energy demand in 2020, mainly due to COVID. While large, this drop is still comparable to the drop we experienced in 2009 during the height of the recession. This may surprise readers. We may feel or assume that the unprecedented social and economic changes from COVID had a greater impact on national energy demand than the data shows. Yet, what we have seen is that COVID acted to shift energy demand, as well as reduce it. Reductions in energy demand from the transport, commercial and public sectors were at least partially offset by increased demand from the residential sector, where people spent more of their time. The solid blue bar shows our energy demand increase in 2021, based on SEAI's definitive annual data, indicating a relatively modest rebound of +2.1%. The striped blue bar is our provisional estimate for energy demand increase in 2022, based on extrapolations of January to September's monthly data. This provisional estimate suggests a much stronger rebound in 2022 of +6% in energy demand, indicating that Ireland's energy demand has almost fully recovered to its pre-COVID 2019 levels. Of course, resuming an

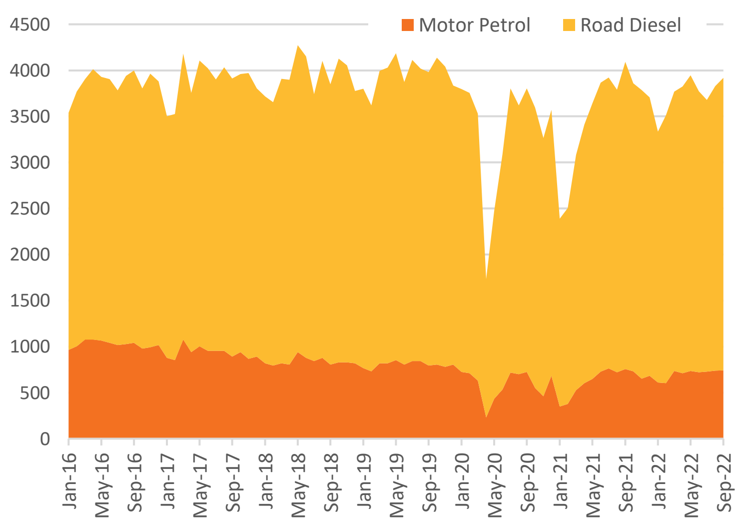
increasing trend is not what we want to see. While we may want to put COVID behind us, we need Ireland's energy demand to reduce as we pursue our 2030 Climate Action Plan targets.

Figure 2: Annual changes in transport energy (%)



The transport sector was the main driver of the energy demand reductions during COVID, and the rebounds we observe in 2021 and 2022 data show year-to-year changes in transport energy demand for the last two decades. The yellow bar in this plot highlights the unprecedented -26% drop in transport energy demand in 2020 due to travel restrictions, causing the subsequent reduced demand for diesel, petrol and jet kerosene, in that order. SEAI's definitive annual data shows a partial rebound of +7.2% in 2021's transport energy demand (solid blue bar). Our extrapolation of provisional monthly data for this year predicts an even stronger rebound of +18% in 2022 (striped blue bar). Given that the transport sector accounted for 36% of all energy demand in 2021, and is over 95% based on fossil fuels, these 2021 and 2022 rebounds imply significant rebounds in energy-related CO_2 emissions. We will look more at these emissions in the context of carbon budgets and sectoral emission ceilings in section 1.2.

Figure 3: Monthly deliveries of petrol and diesel (GWh)



But first, let us look at why the transport demand rebound seems to be so much stronger in 2022 than 2021. Plotting monthly data for petrol and diesel in *Figure* 3 shows just how hard and fast COVID travel restrictions hit the transport sector. Travel restrictions introduced considerable dips in the diesel and petrol demand profiles. There was a 50% demand reduction in April 2020 after the Government announced a national stay-at-home order on 27 March, and a 40% reduction in January 2021 after Ireland moved to full lockdown restrictions on 31 December 2020. This means that the calendar years of 2020 and 2021 both contained one 'dip' each, so the year-to-year change from 2020 to 2021 was comparing one strongly impacted year to another. It wasn't until 2022 that we have a full calendar year without a strong COVID feature, and that's where we see the strong +18% rebound mentioned above. We estimate COVID travel restrictions in 2020 and 2021 avoided 1 billion litres of fossil fuel on Irish roads, but observe that the sum of petrol and diesel deliveries has now returned to pre-COVID 2019 levels. To put that avoided 1 billion litres into perspective, we have already used over 3 billion litres of petrol and diesel in the first nine months of 2022 alone.

Our data shows rebounds in energy demand for both 2021 and 2022, but what does that mean for our energy-related CO_2 emissions? Simply put, our definitive annual data shows more emissions in 2021 than in 2020, and our provisional monthly data suggest we can expect more emissions in 2022 than in 2021.

Figure 4: Annual changes in energy-related CO_2 (%)

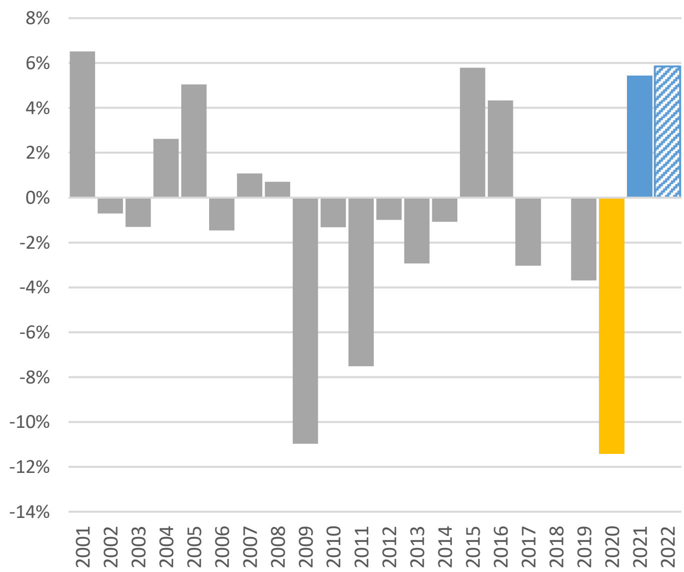


Figure 4 shows year-to-year changes in total energy-related emissions, including those from international aviation. The yellow bar shows the 2020 drop in energy-related emissions of -11.4%, driven largely by COVID travel restrictions, and the solid blue bar shows the +5.4% rebound in energy-related emissions in 2021, based on SEAI's definitive annual data. When we extrapolate our provisional monthly data for 2022, we find a similar rebound of just under +6% in energy emissions for 2022 (striped blue bar). The extra 1.8 $MtCO_2$ of energy-related emissions in 2021 were largely due to two factors. First, the partial rebound of the fossil fuel intensive transport sector; and second, the increased carbon intensity of Ireland's electricity in 2021. The increase in electricity emissions was due to heavier use of coal- and oil-fired electricity generators after disruptions to gas-fired generators, as well as reduced availability of renewable electricity due to a low wind year. In the following section, we explore energy-related emissions and their trends through the lens of our carbon budgets and sectoral emission ceilings.

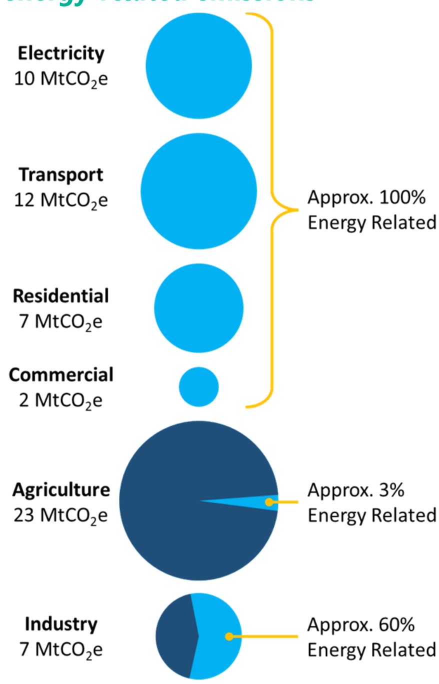
1.2 Carbon budgets and sectoral ceilings

Our carbon budget represents the total amount of emissions, measured in tonnes of CO_2 equivalent, that Ireland may emit in different periods. The Climate Action and Low Carbon Development Act commits Ireland to a legally binding target of a 51% reduction in emissions by 2030, compared to 2018 levels. The carbon budget programme comprises three successive five-year carbon budgets, also legally binding:

- **295 $MtCO_2e$** between 2021-2025
- **200 $MtCO_2e$** between 2026-2030
- **151 $MtCO_2e$** between 2031-2035

In total, these budgets commit us to an average overall reduction in emissions of -4.8% per annum from 2021 to 2025, and -8.3% per annum from 2026 to 2030. Sectoral ceilings published in July 2022 set out the maximum amount of greenhouse gas emissions that are permitted in different sectors of the economy during a carbon budget period. Combined, the carbon budgets and sectoral ceilings tell us when and where we need to make the emission reductions to remain on track for our 2030 target. *Figure* 5 shows the sector breakdown of Ireland's energy emissions in 2018, which was the baseline year for the carbon budgets, and identifies the energy-

Figure 5: Ireland's GHG emissions in 2018, by sector, and showing the energy-related emissions

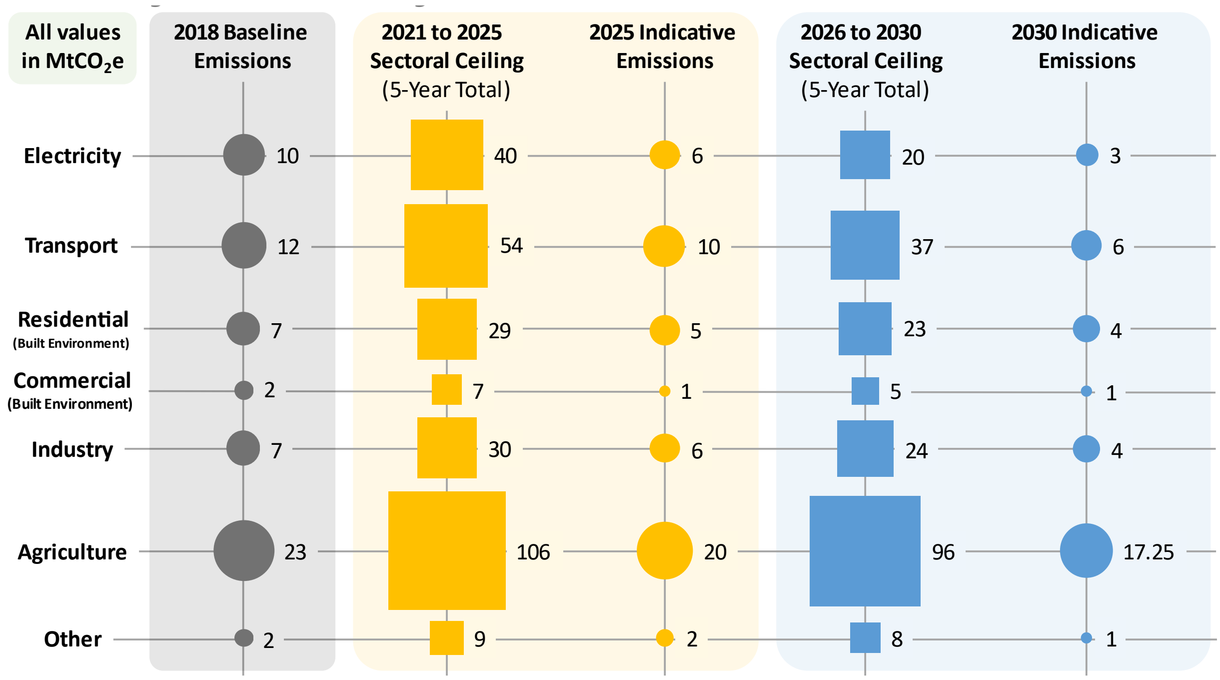


related component of these emissions. In 2021, Ireland's energy-related emissions, excluding international aviation (34.9 $MtCO_2$), accounted for 57% of Ireland's total greenhouse gas (GHG) emissions (61.8 $MtCO_2e$). This means SEAI's Energy Balance data are a critical input into the Environmental Protection Agency's (EPA) GHG inventory calculation for the formal calculation of emission results. Practically 100% of emissions from the electricity, transport, residential (buildings) and commercial (buildings) sectors are energy related; however, only about 3% of emissions from the agriculture sector are energy related. Most agriculture emissions are methane from livestock, and nitrous oxide from fertiliser and manure management. *Figure* 6 is a useful visual summary of the sectoral ceilings within the first two carbon budgets, spanning 2021–2025 and 2026–2030, which shows:

- The five-year total CO_2e emissions permitted by the different sectors in each budget period (**squares**)
- The annual 'indicative emissions' of each sector in the last year of a carbon budget (**circles**)

The 'indicative emission' value for a sector is a guide to the maximum annual emissions expected from that sector at the end of the budget period, but it is not a binding target. For example, the transport sector is permitted to emit a total of 54 $MtCO_2e$ in the five-year period between 2021 to 2025 and would be expected to have an annual emission of no more than 10 $MtCO_2e$ in the 2025 calendar year.

Figure 6: Carbon budgets and sectoral ceilings for 2021–2025 and 2026–2030



There are no specific yearly emission targets for each sector. However, we can obtain a very useful guideline trajectory for each sector, for each year, by 'solving' the five-year total (sectoral emission ceiling) and last-year-of-budget value (indicative emission) with a simple expression for year-on-year reductions. These trajectories are idealised paths to satisfying the sectoral emission ceilings. They assume that emission reductions start 'on track' in the first year, and are maintained each year, which has not been the case for all sectors. While not binding, these guideline trajectories help to convey the average pace necessary to remain consistent with the different sectoral emission ceilings, and add useful context to the annual emission results. As real data on emission reductions in the early years of a carbon budget become available, we should update the trajectories in subsequent years to show the new pace of change needed in later years to satisfy the sectoral emission ceilings.

Figure 7 shows the guideline trajectories of electricity's sectoral emission ceiling in the 2021-2025 (yellow) and 2026-2030 (blue) carbon budgets. The solid grey bar in 2021 is the CO_2 emitted from electricity generation, which we calculated from our definitive annual data. The striped grey bar in 2022 is the CO_2 emission from electricity generation extrapolated from provisional monthly data. The data shows that electricity emissions were 'on trajectory' in 2021 (10.3 $MtCO_2$), despite the greater dependence on coal- and oil-fired electricity generation. However, our provisional estimate for electricity emissions in 2022 (10.8 $MtCO_2$) is higher than the guideline trajectory (9.0 $MtCO_2e$). This is due to an increase in electricity demand for 2022, not all of which could be supplied through renewable electricity, and the significant pace of annual reductions (-12.6% down on each previous year) needed to satisfy electricity's sectoral emission ceiling. It is worth noting again that the guideline trajectories are not targets. They convey only the average pace compatible with satisfying the sectoral emission ceiling and the indicative emission of a sector in the last year of a carbon budget. The policies and strategies for reducing emissions in different sectors may be back-loaded to the end of the carbon budgets. However, any 'over emission' in the early years of a budget, as expected in 2022, must be 'caught up' in later years (i.e. via trajectory below the yellow bars), to satisfy the legally binding sectoral emission ceiling. The orange dotted line in *Figure 6* shows the revised guideline trajectory in 2023-2025 that will be necessary to compensate for the apparent 'over emission' of electricity in 2022, according to the baseline guideline trajectory.

Figure 7: Electricity emissions and guideline trajectories for sectoral emission ceiling in 2021-2025 and 2026-2030 carbon budgets

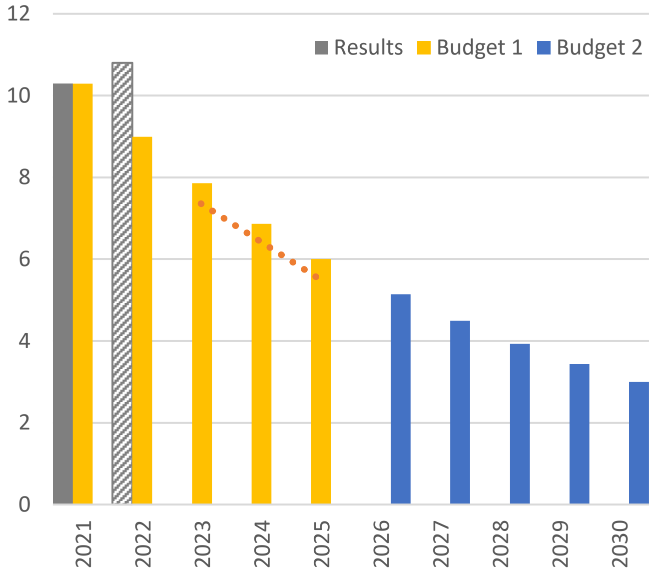
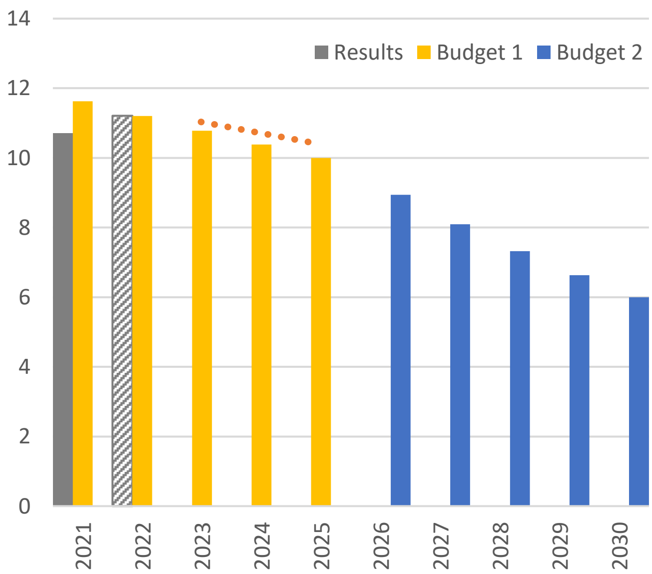


Figure 8 shows the guideline trajectories of transport's sectoral emission ceiling in the 2021-2025 (yellow) and 2026-2030 (blue) carbon budgets. Again, the solid grey bar in 2021 is the CO_2 emitted from transport demand (excluding emissions from international aviation and electricity use in transport), which we calculated from our definitive annual data. The striped grey bar in 2022 is the CO_2 emission extrapolated from provisional monthly data. Our transport emissions in 2021 (10.7 $MtCO_2$) were below the guideline trajectory of 11.6 $MtCO_2$, because the sector was still impacted by COVID, and our provisional estimate for transport emissions in 2022 (11.2 $MtCO_2$) matches the guideline trajectory of 11.2 $MtCO_2e$. In a sense, the continued impact of COVID on transport into 2021 has helped the sector 'bank' a 0.9 $MtCO_2$ under-emission that will make it easier to remain within its 54 $MtCO_2e$ sectoral emission ceiling to 2025.

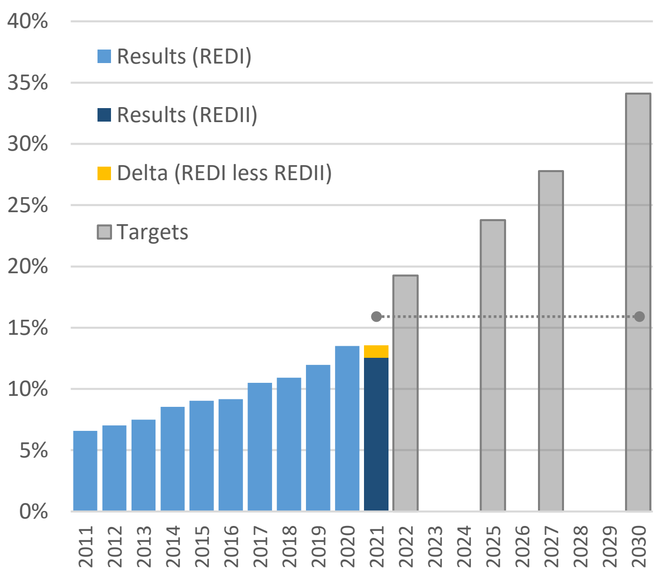
Figure 8: Transport emissions and guideline trajectories for sectoral emission ceilings in 2021-2025 and 2026-2030 carbon budgets



The orange dotted line in *Figure* 8 shows the upward revision in transport's guideline trajectory for 2023-2025 that would still satisfy its sectoral emission ceiling, given the lower-than-expected emissions in 2021. However, we will need significant emission reductions beyond the impacts of COVID to ensure transport emissions stay on track to 2025 and out to 2030. The average pace of emission reductions needed to satisfy the transport sectoral emission ceiling from 2021 to 2025 is -3.7% on each previous year, and -9.5% per year in the 2026-2030 budget. Further details on carbon budgets, sectoral ceilings, and guidelines trajectories are covered in section 8.1.2.

1.3 The 'RED Shift' and our 2030 energy targets

Figure 9: Overall renewable energy share (RES-Overall) under REDI and REDII with current EU targets out to 2030

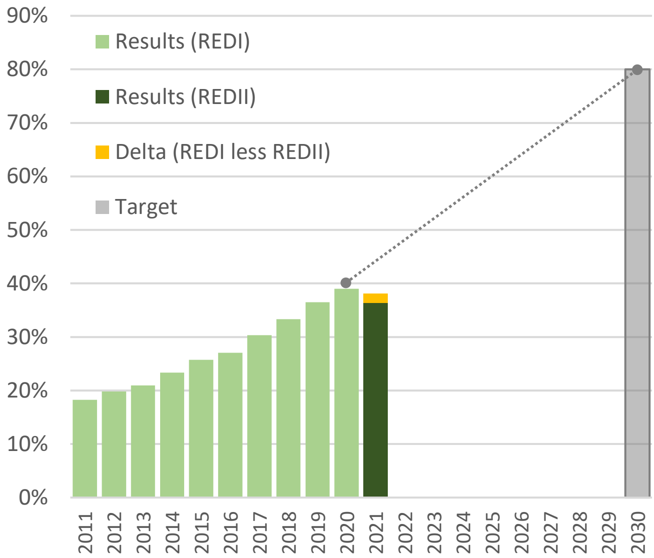


In order to reduce our emissions, Ireland needs to increase the renewable share of our electricity, heat and transport. Up until 2020, our renewable energy targets and results were set and calculated under the rules and methodologies of REDI – the EU's first Renewable Energy Directive. However, from 2021 onwards, our renewable results must be calculated under the REDII methodology. This updated Directive contains stricter requirements on the countability of biomass, biogas, and biofuels, as they relate to our renewable energy share (RES) results. Under REDII, biomass fuel consumed in installations above certain sizes, must fulfil various sustainability and GHG saving criteria to be counted towards national renewable energy targets. In July 2022, Irish legislation to transpose relevant elements of REDII into Irish law was published, and verification procedures for biomass are now being rolled out. In parallel, new sustainability and verification procedures are being rolled out for the EU's emission trading system (ETS). However, until these formal verification procedures are in place, some of Ireland's biomass is not countable towards the RES results. *Figure 9* shows our overall renewable energy share (RES-Overall) up to 2020 under REDI in light blue, and in 2021 under REDII in dark blue. Our RES-Overall result in 2020 was 13.6% under REDI, falling to 12.5% in 2021 under REDII. This single percentage point drop is primarily due to the changeover to the REDII methodology, and the stricter need for formal verification of biomass. If we had calculated our 2022 result under the 'old' REDI methodology, then we would have maintained a RES-Overall of 13.6%, as shown by the yellow 'delta' bar. *Figure* 9 also shows our RES-Overall targets out to 2030.

The profile of these targets is a little complicated. Every year, we should remain above the baseline of our 2020 target of 16% as indicated by a dashed line in *Figure* 9, but we also need to be on a trajectory to increase our RES-Overall to 34.1% by 2030, as set out in our current National Energy and Climate Plan (NECP). We will assess the trajectory to 2030 in the specific 'milestone years' of 2022, 2025 and 2027, each of which has an intermediate target that we need to achieve – these are indicated by the solid grey bars. It is possible that our 2030 RES-Overall target will be increased from 34.1% to around 45% under the RePowerEU plan, requiring us to proportionately revise-up the intermediate targets for 2022, 2025 and 2027.

Figure 10 shows Ireland's renewable energy share of electricity (RES-E) up to 2020 under REDI (in light green), and in 2021 under REDII (in dark green). Although there is no EU target for RES-E, Ireland had a national renewable electricity target of 40% in 2020, and aims to "increase the share of electricity demand generated from renewable sources to up to 80% where achievable and cost effective, without compromising security of electricity supply" under the current Climate Action Plan. In 2021, after many years of steady increases, our RES-E fell by 2.6 percentage points to 36.4%, under REDII. Over half of this drop was due to the shift to the REDII methodology and the exclusion of some biomass, highlighted by the yellow 'delta' bar. The remaining drop was due to reduced renewable electricity generation because of less wind in 2021.

Figure 10: RES in Electricity (RES-E) under REDI and REDII with Ireland's CAP target of 80% for reference

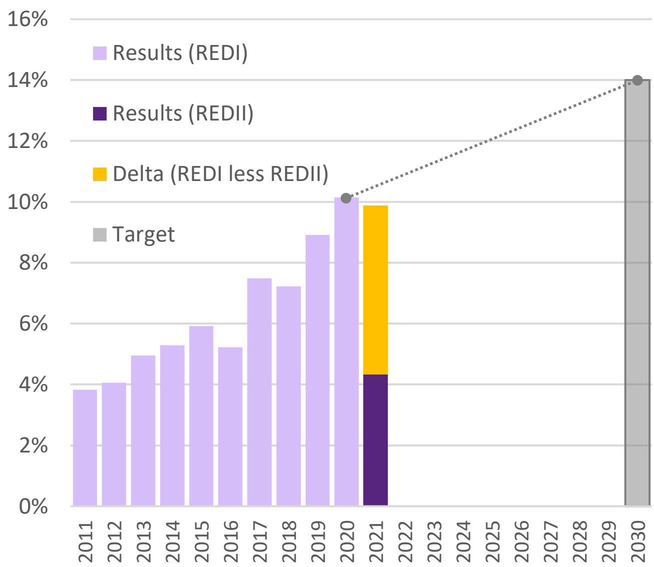


In July 2022, the Government committed additional resources for 5,500 MW of solar generation and 7,000 MW of off-shore wind generation by 2030 to support Ireland's need for greater renewable electricity capacity, and to further accelerate the reduction of overall economy-wide emissions. We look more at our electricity trends in 2021 and 2022 in the following section.

We can see the largest impact of shifting from the REDI to REDII methodology in our renewable energy share in transport (RES-T). The REDII methodology has strict caps on the countability of used cooking oil (UCO) and other waste animal fats like tallow, and these make up a substantial fraction of the biofuels blended into Irish road diesel and petrol. Under REDII, UCO and tallow for renewable transport can only make up 1.7% of gross final consumption in road and rail transport. Anything over this level goes uncounted.

Figure 11 shows Ireland's RES-T up to 2020 under REDI (in light purple) and in 2021 under REDII (in dark purple). Our RES-T in 2020 was 10.1% and fell to 4.3% in 2021, almost entirely due to the shift to the REDII methodology, as indicated by the yellow 'delta' bar. If our 2021 result was calculated under the 'old' REDI methodology, then our RES-T would be 9.9%. The caps on biofuels in RES-T are somewhat complicated and are explained more fully in section 8.2. REDII requires Ireland, along with all Member States, to set an obligation on fuel suppliers to ensure that the share of renewable energy within the final consumption of energy in transport is at least 14% by 2030, in accordance with an indicative trajectory set by the Member States.

Figure 11: RES-T under REDI and REDII with 2030 EU target



Another key energy target for 2030 comes from the EU's Energy Efficiency Directive. This is currently based on 'reference scenario' projections of energy use to 2030, based on the policies and measures that were in place and/or planned up to 2020. In June, the Energy Council of Ministers agreed a general approach to target a 9% reduction on 2030 energy use, relative to these reference scenarios. However, the REPowerEU proposal would act to strengthen this target to a 13% reduction, and the European Parliament is currently calling for a 14.5% reduction. Depending on the agreed final reduction target, the Energy Efficiency Directive will effectively mandate a reduction in Ireland's final energy demand of approximately 19-24%, relative to 2019 levels.

1.4 The carbon intensity and fuel mix of electricity

Electricity is the main vector of renewable energy into our homes, communities, and businesses. In 2021, electricity delivered 66% of all renewable energy demand in Ireland. Electricity on the grid is a mix of renewable electricity from wind and hydro generation, and non-renewable electricity from gas-, coal-, oil-, and peat-fired thermal plants. The carbon intensity of this electricity is a "quality factor" that tells us how many grams of CO_2 are emitted for every unit of electricity generated. The lower the carbon intensity the better. *Figure* 12 shows Ireland's carbon intensity from 2001 to 2021, with yellow line showing the EU average value. The long-term downward trend in Ireland has been driven by the combination of increased renewable generation, particularly wind, coupled with reduced oil-fired and then coal-fired electricity generation. In 2021, our carbon intensity was 348 gCO_2/kWh, up by 12.5% from 2020's historic low of 309 gCO_2/kWh. As mentioned previously, this increase was due to outages in our gas-fired electricity generators and a particularly poor year for wind generation in 2021, which forced us onto higher carbon intensity coal- and oil-fired electricity generators to compensate.

Figure 12: Carbon intensity of Irish electricity (gCO_2/kWh)

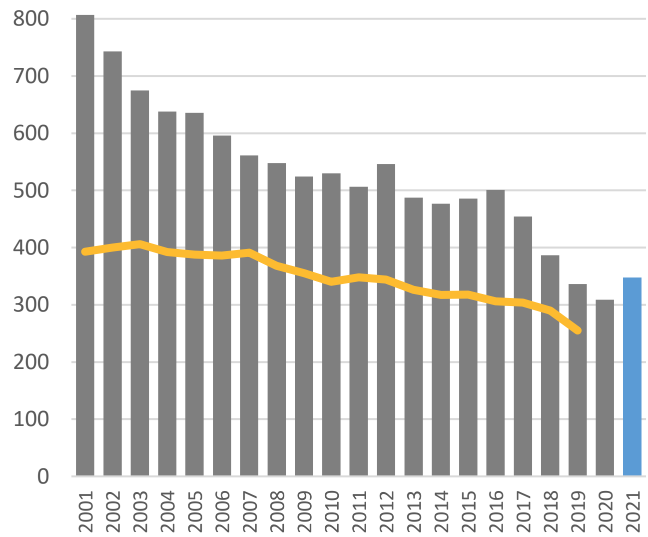


Figure 13 illustrates the shifts in fuel and energy inputs for electricity generation that led to 2021's increased carbon intensity. The largest inputs to electricity generation in both 2020 and 2021 are gas and renewables, but both dropped in 2021, by -8.8% and -12.6%, respectively. To compensate, the use of coal and oil as input fuels more than tripled. We also supplemented our indigenous electricity generation with 1600 GWh of net imports through the interconnects with Northern Ireland. Adding or maintaining fossil fuel inputs to our electricity generation, especially carbon intense fuels like coal and oil, is completely at odds with the sectoral emission ceilings for electricity in the 2021-2025 and 2026-2030 carbon budgets.

Figure 13: Fuel and energy Inputs to electricity generation (GWh)

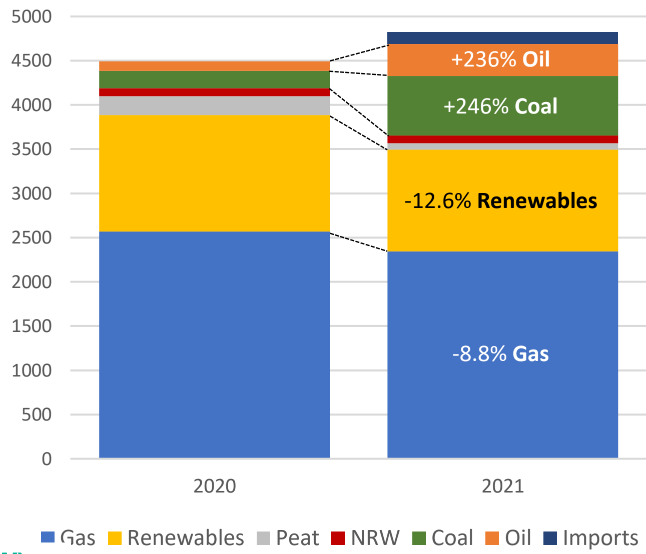
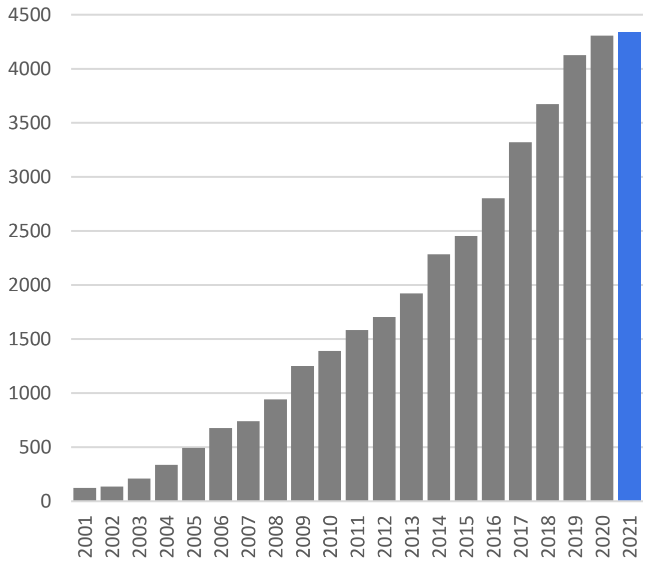


Figure 14: Ireland's installed wind capacity (MW)



Wind accounted for 84% of renewable electricity generated in 2021. As shown in *Figure 14*, Ireland had 4339 MW of installed wind capacity in 2021 (blue bar). Our wind capacity increased by an average of 12% (about 300 MW) each year from 2009 to 2019. However, this slowed in recent years to 180 MW of added capacity in 2020 and 32 MW in 2021, due to the profiling of renewable energy price support schemes. The last wind farm projects supported under the REFIT 2 scheme were scheduled for completion in 2019, and most of the 479 MW of wind energy projects awarded support under the first RESS auction are being constructed in 2022. So far in 2022, we have seen 78 MW of added wind capacity up to September. In parallel, the Government has committed additional resources for 5,500 MW of solar generation, and 7,000 MW offshore wind generation to support Ireland's 2030 targets.

1.5 Challenges to sustainability of energy demand

Between 2017 and 2021, over 45,000 new consumers were connected to our gas infrastructure. This amounts to around 4,000 GWh of new gas demand, or the equivalent to two full years of impact from the entirety of all Government energy efficiency policies. New gas connections lock users into a fossil fuel future, with a minimum expected average of 15 years. If Ireland is to stay within its legally binding carbon budgets, then many of these new gas connections will have to be undone. Ireland needs to eliminate fossil fuels as quickly as possible, and we need to favour solutions that are available today. District heating uses waste and renewable heat sources to provide space heating, and heat pumps for buildings and industrial processes are the perfect companion technology for district heating. These technologies are available right now and offer direct replacements to burning fossil fuels like oil and gas.

In July 2022, the Government released a statement on the role of data centres in Ireland's enterprise strategy, on the need to align the twin transitions of digitalisation and decarbonisation. The statement recognises the significant capacity constraints on the electricity system in the short-to-medium term and sets out principles to facilitate sustainable data centre development in line with Ireland's energy and enterprise policy objectives. SEAI data shows that the Information and Communication sub-sector accounted for 3.9% of energy demand in 2021. This determination includes the Central Statistics Office (CSO) figures showing that data centres accounted for 16% of Ireland's electricity demand in 2021. The electricity demand of data centres in 2021 was around 4000 GWh, equivalent to just over half the electricity demand of Ireland's residential sector - about 1 million homes.

Figure 15: Quarter to quarter increase in electricity demand from data centres as reported by the CSO

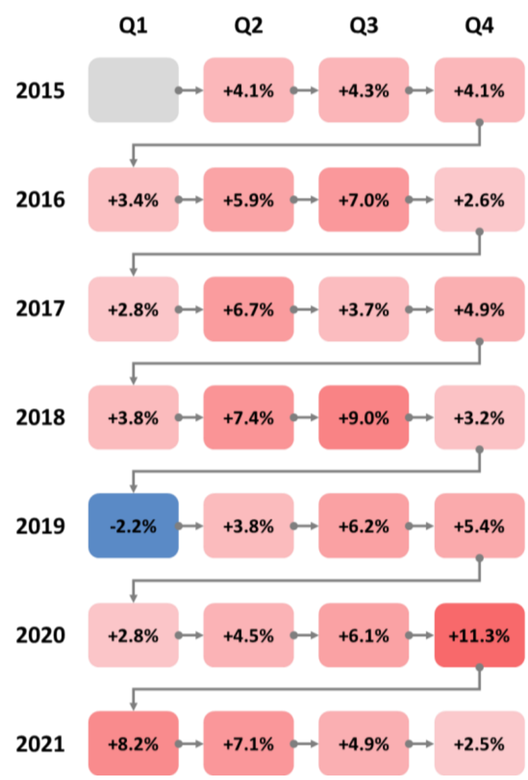


Figure 15 illustrates the quarter-to-quarter changes in data centre electricity demand from 2015 to 2021. Electricity demand of data centres increased in 27 of the 28 measured quarters. The average quarter-to-quarter increase was +4.9%, and the single-year increase from 2020 to 2021 was +32%. This marks out data centres as having the fastest growing energy demand of any commercial or industry sub-sector. The 'median scenario' forecast in Eirgrid's 2022 Capacity Statement suggests that data centres and other new large energy users will account for 28% of electricity demand by 2030. The same forecast indicates that essentially all new electricity demand over the next decade will come from data centres, electric vehicles (EVs), and heat-pumps. In these forecasts, it is important to recognise the difference between 'new added demand' for electricity from data centres, and the 'migration of existing demand' from fossil fuels to electricity, that is shifting petrol-or-diesel cars and gas-or-oil boilers to EVs and heat-pumps. The displacement of fossil-fuel demand in cars and homes over to increasingly renewable electricity acts to reduce our net energy-related emissions, whereas adding new electricity demand that is not 100% renewably sourced simply increases our energy emissions.

1.6 Ireland's energy security of supply

Ireland imports most of its energy. The breakdown of our 2021 primary energy across indigenous production, imports, and exports is illustrated in *Figure 16*. Oil and natural gas are by far our largest energy imports, but we also import significant quantities of coal, and some renewable energy, in the form of biomass, biodiesel and bioethanol. Our electricity interconnectors help us to balance the all-island grid loads, through near continuous importing and exporting of electricity to and from Northern Ireland. When averaged over the full year of 2021, we imported three times as much electricity as we exported.

Figure 16: Bubble plot summary of Ireland's energy supply in 2021 (GWh)

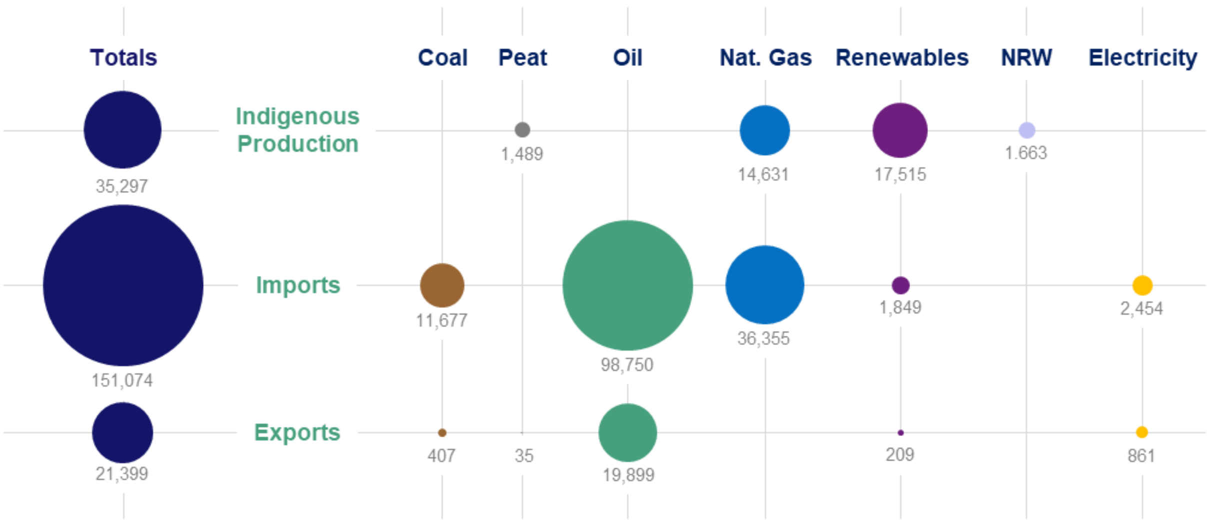


Figure 17 shows how the breakdown of Ireland's indigenous production of energy has changed over the years. The step-change increase in 2016 was due to the connection of the Corrib field to the gas grid. This more than doubled our indigenous energy production from a baseline of about 20,000 GWh during 2000–2015 to a maximum of 50,000 GWh in 2018. Even around this peak, indigenous production only accounted for about 34% of total energy supply. Since then, we have seen three trends – a decline in indigenous production from the Corrib gas field, a decline in using peat for energy, and an increase in indigenous renewable energy. 2021 was the first year since 2016, in which our indigenous production of energy from renewables (17,500 GWh) exceeded that of indigenous gas (14,600 GWh). As output from the Corrib gas field continues to decline, we will need to add more and more renewable energy capacity to maintain and then grow our indigenous supply of energy. Besides the commitments to 5.5 GW of solar and 7 GW of off-shore wind mentioned previously, the Government has committed resources for 2 GW of green hydrogen and up to 5.7 TWh of biomethane from agro-forestry and anaerobic digestion by 2030.

Figure 17: Breakdown of indigenous production of energy (GWh)

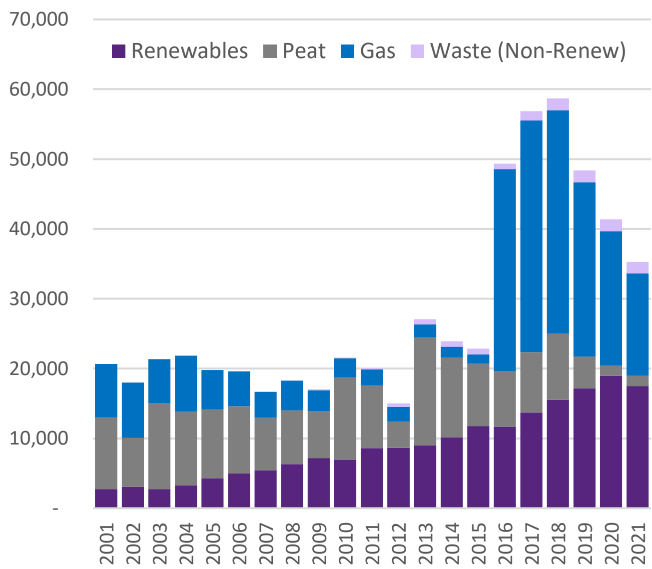
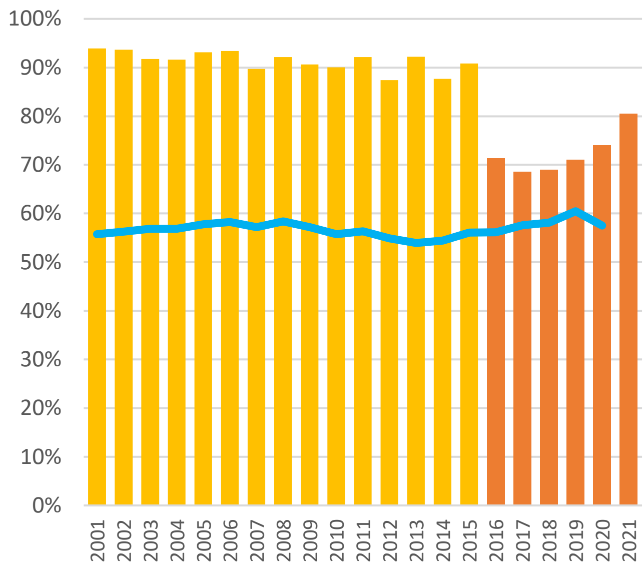


Figure 18: Ireland's import dependency of energy (%)



Increasing indigenous production helps improve the security of our energy supply. The ratio of net imports (i.e. imports less exports) to primary energy is a common measure of a country's import dependency. The higher this ratio, the more a country depends on the import of energy from outside its borders, and the more exposed that country is to international price shocks and supply shortages.

Figure 18 shows Ireland's import dependency from 2001 to 2021, with the blue line showing the European average. Prior to 2015, Ireland's import dependency was typically over 90%, but dropped to 71% in 2016 when the Corrib field was connected to the gas grid. Since 2018, Ireland's import dependency has been increasing steadily, as the output from the Corrib gas field reduces faster than we are adding new renewable sources. In 2021, our import dependency for energy was 80%, but how does this compare to international averages? In March 2022, Eurostat published import dependency data for all EU Member States. This showed that the EU imported 57.5% of the energy it consumes in 2020, with only 42.5% of its needs being met by its own production. All 27 EU Member States have been net importers of energy since 2013, and Malta, Cyprus and Luxembourg were almost entirely import dependent in 2020. Ireland ranked eight highest of the 27 Member States in terms of import dependency in 2020, the latest year in which full data are available. The Eurostat analysis also looked at import dependencies on Russia and showed that Ireland was the second least dependent of all Member States on Russian imports at just 3.2%.

A recent Government consultation carried out by the Department of the Environment, Climate and Communications (DECC) to review the security of energy supply of Ireland's electricity and gas systems concluded in October 2022. DECC invited feedback and evidence from all interested parties on the broad range of options that could be implemented to support Ireland's security of supply framework. The review considered potential risks to both our natural gas and electricity supplies, and examined a range of measures to mitigate these risks; including the need for additional capacity to import energy, reductions in energy use, increased energy storage, greater fuel diversification and more renewable gases - such as biomethane and hydrogen.

DECC identified the following 'shortlist' of mitigation options for both gas and electricity that could address potential security of supply gaps.

- **Strategic gas storage** – gas storage that would only operate during periods in which there is a material risk of demand disruptions in Ireland.
- **Strategic floating LNG** (liquefied natural gas) – a floating LNG facility that would only operate during periods of a material risk of demand disruption in Ireland.
- **Gas package** – a combination of strategic storage, renewable gas (biomethane injection and hydrogen) and demand-side response.
- **Additional electricity interconnection** – another 700 MW interconnector to France in addition to the Celtic Interconnector.
- **Additional pumped storage** – an additional 360 MW of pumped storage hydroelectricity capacity.
- **Biomass plant** – a 450 MW dedicated biomass plant.
- **Secondary fuel** – increased secondary fuel storage beyond the current five-day storage requirement.
- **Hydrogen plant conversion** – converting a combined cycle gas turbine (CCGT) to hydrogen.
- **Electricity package** – a combination of additional capacity of batteries and demand-side response.

It now remains for the Government to decide the best pathway forward in balancing the need for energy security against the imperative of living within our carbon budgets.

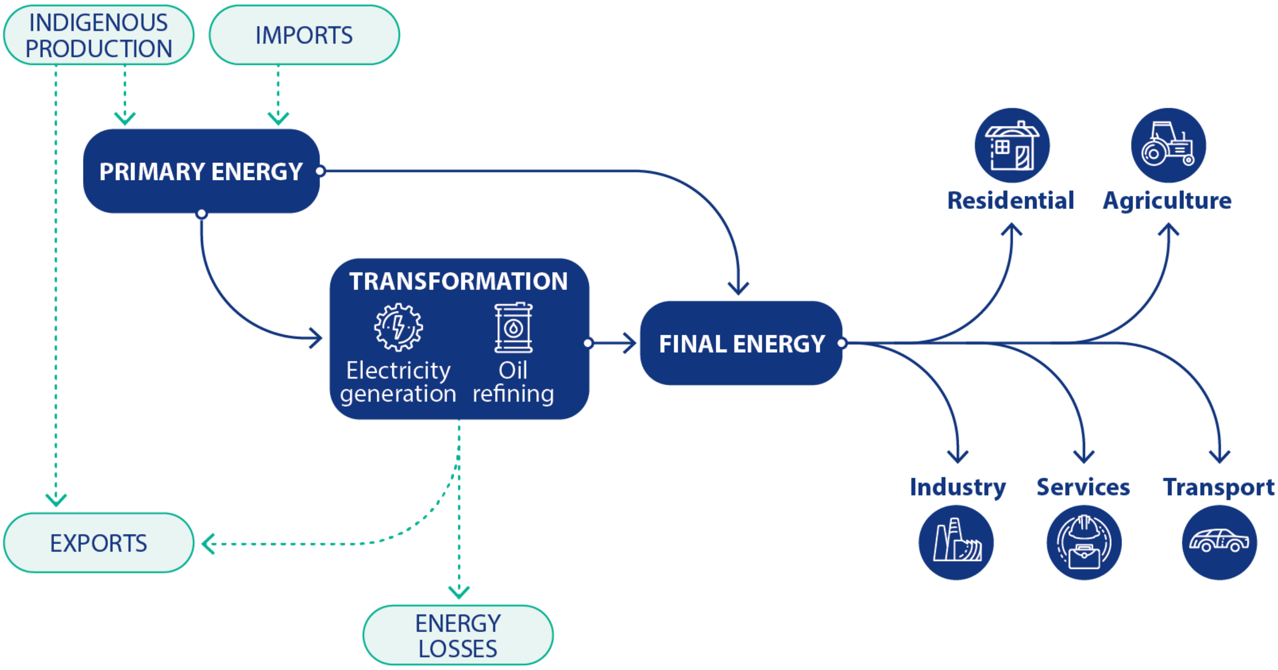
2 Definitive energy data from annual surveys

Following the formal establishment of the Energy Policy Statistical Support Unit (now called Energy Statistics Team, SEAI) in 2002, the Department of Communications, Marine and Natural Resources transferred the responsibility for the collection of data, to meet Ireland's reporting obligations in relation to energy statistics, to the new unit.

The information in this report is largely based on Ireland's 2021 National Energy Balance and the preceding annual energy balances back to 2001. 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 simplified schematic for the energy balance flow is illustrated in *Figure* 19. 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 19: Main energy flows in Ireland



The energy balance is organised into three main parts, which are discussed in the following subsections:

- Primary energy – section 3
- Energy transformation – section 4
- Final energy use by sector– section 5

SEAI constructs the expanded energy balance for each fuel or energy product, such as gasoline, lignite, biomass and electricity. There are currently 34 fuels listed in the expanded balance. The number of fuels and energy products included in the balance has increased over the years as Ireland's energy mix has diversified. For analysis and presentation purposes, fuels can be combined into seven aggregated fuel or energy types:

- Coal
- Peat
- Oil

- Natural gas
- Renewables
- Non-renewable waste
- Electricity

In general, the data in this report is presented for aggregated energy types. Short versions of the energy balance in units of terajoules (TJ) and kilotonnes of oil equivalent (ktoe) are presented in *Table 1* and *Table 2*, respectively. A more detailed, expanded balance showing sub-fuel type data is available on the SEAI website at https://www.seai.ie/data-and-insights/seai-statistics/key-publications/national-energy-balance/.

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. Besides populating the energy balance, SEAI uses these surveys to fulfil Ireland's energy statistics reporting obligations to Eurostat (EU Energy Statistics Regulation (EC 1099/2008)) and the International Energy Agency (IEA).

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

To help policymakers, 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 introducing 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 within Ireland. 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.

Table 1: Short energy balance 2021 (TJ)

terajoule (TJ)	Coal	Peat	Oil	Natural Gas	Renew-ables	Non-Renew. Waste	Electricity	Total
Indigenous Production	-	5,347	-	52,677	63,053	5,979	-	127,056
Imports	42,028	-	355,488	130,861	6,658	-	8,824	543,860
Exports	1,477	109	71,625	-	733	-	3,108	77,053
Mar. Bunkers	-	-	7,192	-	-	-	-	7,192
Stock Change	-2,288	5,857	5,526	-	122	-	-	9,216
Primary Energy Supply (incl. non-energy)	**38,262**	**11,095**	**282,197**	**183,538**	**69,100**	**5,979**	**5,716**	**595,887**
Primary Energy Requirement (excl. non-energy)	**38,262**	**11,095**	**266,258**	**183,538**	69,100	5,979	**5,716**	**579,949**
Transformation Input	**28,168**	**5,416**	**146,043**	**99,455**	**9,966**	**3,722**	**2,239**	**295,009**
Public Thermal Power Plants	28,168	2,783	15,050	87,407	9,353	3,722	-	146,483
Combined Heat and Power Plants	-	208	19	10,671	613	-	-	11,512
Pumped Storage Consumption	-	-	-	-	-	-	1,856	1,856
Briquetting Plants	-	2,425	-	-	-	-	-	2,425
Oil Refineries & other energy sector	-	-	130,974	1,376	-	-	383	132,733
Transformation Output	**-**	**2,304**	**133,231**	**-**	**-**	**-**	**76,529**	**212,063**
Public Thermal Power Plants	-	-	-	-	-	-	68,066	68,066
Combined Heat and Power Plants	-	-	-	-	-	-	7,432	7,432
Pumped Storage Generation	-	-	-	-	-	-	1,031	1,031
Briquetting Plants	-	2,304	-	-	-	-	-	2,304
Oil Refineries	-	-	133,231	-	-	-	-	133,231
Exchanges and transfers	**1,017**	**-**	**-1,518**	**18**	**-38,250**	**-**	**38,233**	-502
Electricity	-	-	-	-	-38,233	-	38,233	-
Heat	-	-	-	-	-	-	-	-
Other	1,017	-	-1,518	18	-18	-	-	-502
Own Use and Distribution Losses	**-**	**438**	**4,187**	**2,295**	**-**	**-**	**11,721**	18,641
Available Final Energy Consumption	**11,110**	**7,544**	**263,680**	**81,806**	**20,884**	**2,257**	**106,517**	**493,798**
Non-Energy Consumption	**-**	**-**	**15,938**	**-**	**-**	**-**	**-**	**15,938**
Final Non-Energy Consumption	-	-	15,938	-	-	-	-	15,938
Total Final Energy Consumption	**11,523**	**7,534**	**250,244**	**81,680**	**21,052**	**2,257**	**106,410**	**480,700**
Industry	**3,742**	**-**	**13,775**	**42,021**	**8,286**	**2,257**	**22,337**	**92,419**
Non-Energy Mining	-	-	1,289	607	-	-	1,020	2,916
Food, Beverages and Tobacco	-	-	2,750	12,894	1,091	-	3,836	20,570
Textiles and Textile Products	-	-	91	505	-	-	134	731
Wood and Wood Products	-	-	110	379	5,133	-	924	6,546
Pulp, Paper, Publishing and Printing	-	-	28	270	-	-	253	552
Chemicals and Man-Made Fibres	-	-	662	5,220	-	-	3,370	9,252
Rubber and Plastic Products	-	-	149	497	-	-	843	1,489
Other Non-Metallic Mineral Products	3,742	-	6,406	1,412	2,062	2,257	2,594	18,474
Basic Metals and Fabricated Metal Products	-	-	169	16,820	-	-	2,423	19,411
Machinery and Equipment n.e.c	-	-	142	611	-	-	692	1,445
Electrical and Optical Equipment	-	-	100	839	-	-	3,788	4,727
Transport Equipment Manufacture	-	-	57	52	-	-	146	256
Other Manufacturing	-	-	422	1,778	-	-	1,944	4,143
Construction	-	-	1,401	138	-	-	369	1,908
Transport	**-**	**-**	**165,398**	**698**	**7,467**	**-**	**405**	**173,968**
Road Freight	-	-	31,430	65	1,815	-	-	33,310
Light Goods Vehicle	-	-	11,060	-	639	-	-	11,699
Road Private Car	-	-	71,282	-	3,610	-	228	75,120
Public Passenger Services	-	-	4,619	-	264	-	-	4,883
Rail	-	-	1,436	-	-	-	177	1,613
Domestic Aviation	-	-	120	-	-	-	-	120
International Aviation	-	-	18,576	-	-	-	-	18,576
Fuel Tourism	-	-	8,145	-	470	-	-	8,616
Navigation	-	-	5,050	-	-	-	-	5,050
Unspecified	-	-	13,679	634	668	-	-	14,981
Residential	**7,764**	**7,534**	**53,195**	**24,911**	**3,577**	**-**	**31,696**	**128,677**
Commercial/Public Services	**17**	**-**	**9,434**	**14,049**	**1,723**	**-**	**49,891**	**75,113**
Commercial Services	17	-	4,425	8,786	936	-	39,461	53,625
Public Services	0	-	5,008	5,263	786	-	10,430	21,487
Agricultural	-	-	7,645	-	-	-	2,082	9,726
Fisheries	-	-	797	-	-	-	-	797
Statistical Difference	-412	10	-2,502	126	-169	-	108	-2,840

Table 2: Short energy balance 2021 (ktoe)

kilotonnes of oil equivalent (ktoe)	Coal	Peat	Oil	Natural Gas	Renewables	Non-Renew. Waste	Electricity	Total
Indigenous Production	-	128	-	1,258	1,506	143	-	3,035
Imports	1,004	-	8,491	3,126	159	-	211	12,990
Exports	35	3	1,711	-	18	-	74	1,840
Mar. Bunkers	-	-	172	-	-	-	-	172
Stock Change	-55	140	132	-	3	-	-	220
Primary Energy Supply (incl. non-energy)	**914**	**265**	**6,740**	**4,384**	**1,650**	**143**	**137**	**14,233**
Primary Energy Requirement (excl. non-energy)	**914**	**265**	**6,359**	**4,384**	1,650	143	**137**	**13,852**
Transformation Input	**673**	**129**	**3,488**	**2,375**	**238**	**89**	**53**	**7,046**
Public Thermal Power Plants	673	66	359	2,088	223	89	-	3,499
Combined Heat and Power Plants	-	5	0	255	15	-	-	275
Pumped Storage Consumption	-	-	-	-	-	-	44	44
Briquetting Plants	-	58	-	-	-	-	-	58
Oil Refineries & other energy sector	-	-	3,128	33	-	-	9	3,170
Transformation Output	**-**	**55**	**3,182**	**-**	**-**	**-**	**1,828**	**5,065**
Public Thermal Power Plants	-	-	-	-	-	-	1,626	1,626
Combined Heat and Power Plants	-	-	-	-	-	-	178	178
Pumped Storage Generation	-	-	-	-	-	-	25	25
Briquetting Plants	-	55	-	-	-	-	-	55
Oil Refineries	-	-	3,182	-	-	-	-	3,182
Exchanges and transfers	**24**	**-**	**-36**	**0**	**-914**	**-**	**913**	-12
Electricity	-	-	-	-	-913	-	913	-
Heat	-	-	-	-	-	-	-	-
Other	24	-	-36	0	-0	-	-	-12
Own Use and Distribution Losses	**-**	**10**	**100**	**55**	**-**	**-**	**280**	445
Available Final Energy Consumption	**265**	**180**	**6,298**	**1,954**	**499**	**54**	**2,544**	**11,794**
Non-Energy Consumption	**-**	**-**	**381**	**-**	**-**	**-**	**-**	**381**
Final Non-Energy Consumption	-	-	381	-	-	-	-	381
Total Final Energy Consumption	**275**	**180**	**5,977**	**1,951**	**503**	**54**	**2,542**	**11,481**
Industry	**89**	**-**	**329**	**1,004**	**198**	**54**	**534**	**2,207**
Non-Energy Mining	-	-	31	14	-	-	24	70
Food, Beverages and Tobacco	-	-	66	308	26	-	92	491
Textiles and Textile Products	-	-	2	12	-	-	3	17
Wood and Wood Products	-	-	3	9	123	-	22	156
Pulp, Paper, Publishing and Printing	-	-	1	6	-	-	6	13
Chemicals and Man-Made Fibres	-	-	16	125	-	-	80	221
Rubber and Plastic Products	-	-	4	12	-	-	20	36
Other Non-Metallic Mineral Products	89	-	153	34	49	54	62	441
Basic Metals and Fabricated Metal Products	-	-	4	402	-	-	58	464
Machinery and Equipment n.e.c	-	-	3	15	-	-	17	35
Electrical and Optical Equipment	-	-	2	20	-	-	90	113
Transport Equipment Manufacture	-	-	1	1	-	-	3	6
Other Manufacturing	-	-	10	42	-	-	46	99
Construction	-	-	33	3	-	-	9	46
Transport	**-**	**-**	**3,950**	**17**	**178**	**-**	**10**	**4,155**
Road Freight	-	-	751	2	43	-	-	796
Light Goods Vehicle	-	-	264	-	15	-	-	279
Road Private Car	-	-	1,703	-	86	-	5	1,794
Public Passenger Services	-	-	110	-	6	-	-	117
Rail	-	-	34	-	-	-	4	39
Domestic Aviation	-	-	3	-	-	-	-	3
International Aviation	-	-	444	-	-	-	-	444
Fuel Tourism	-	-	195	-	11	-	-	206
Navigation	-	-	121	-	-	-	-	121
Unspecified	-	-	327	15	16	-	-	358
Residential	**185**	**180**	**1,271**	**595**	**85**	**-**	**757**	**3,073**
Commercial/Public Services	**0**	**-**	**225**	**336**	**41**	**-**	**1,192**	**1,794**
Commercial Services	0	-	106	210	22	-	943	1,281
Public Services	0	-	120	126	19	-	249	513
Agricultural	-	-	183	-	-	-	50	232
Fisheries	-	-	19	-	-	-	-	19
Statistical Difference	-10	0	-60	3	-4	-	3	-68

3 Primary energy

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.

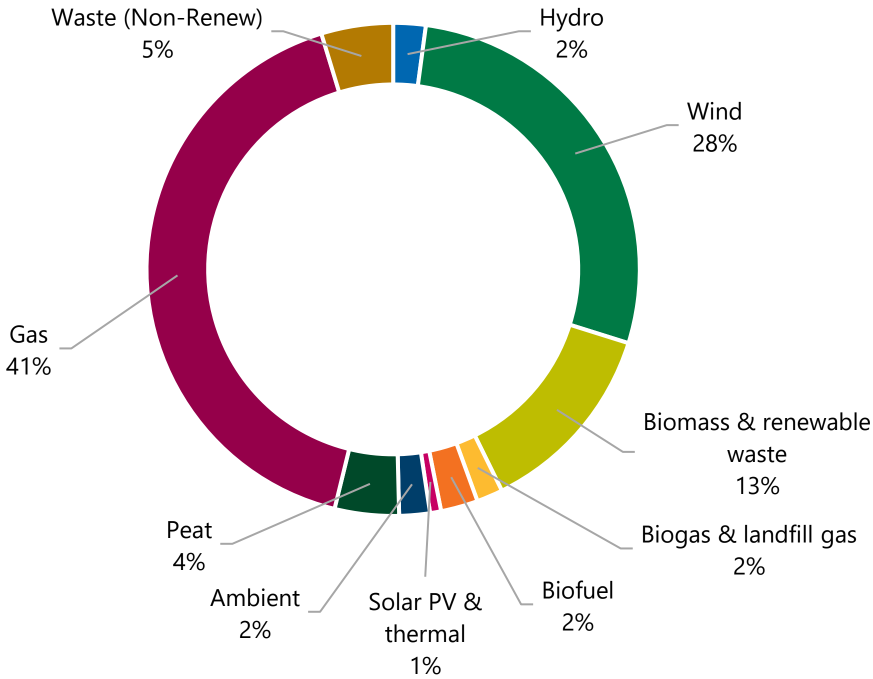
The primary energy supply depends on the final energy use, as well as the efficiencies of the various transformation processes needed to ensure that end-users receive final energy in the form that is needed. Just like final energy use, primary energy supply can be usefully analysed by fuel, sector and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

3.1 Primary energy production

Primary energy production refers to the production of energy products from natural sources within Ireland's national boundaries. Examples of production include extraction of peat, crude oil or natural gas from natural deposits; recovery of waste for energy purposes; electricity generation by wind, solar or hydro; thermal energy collection by solar thermal systems; and production of biomass or biogas.

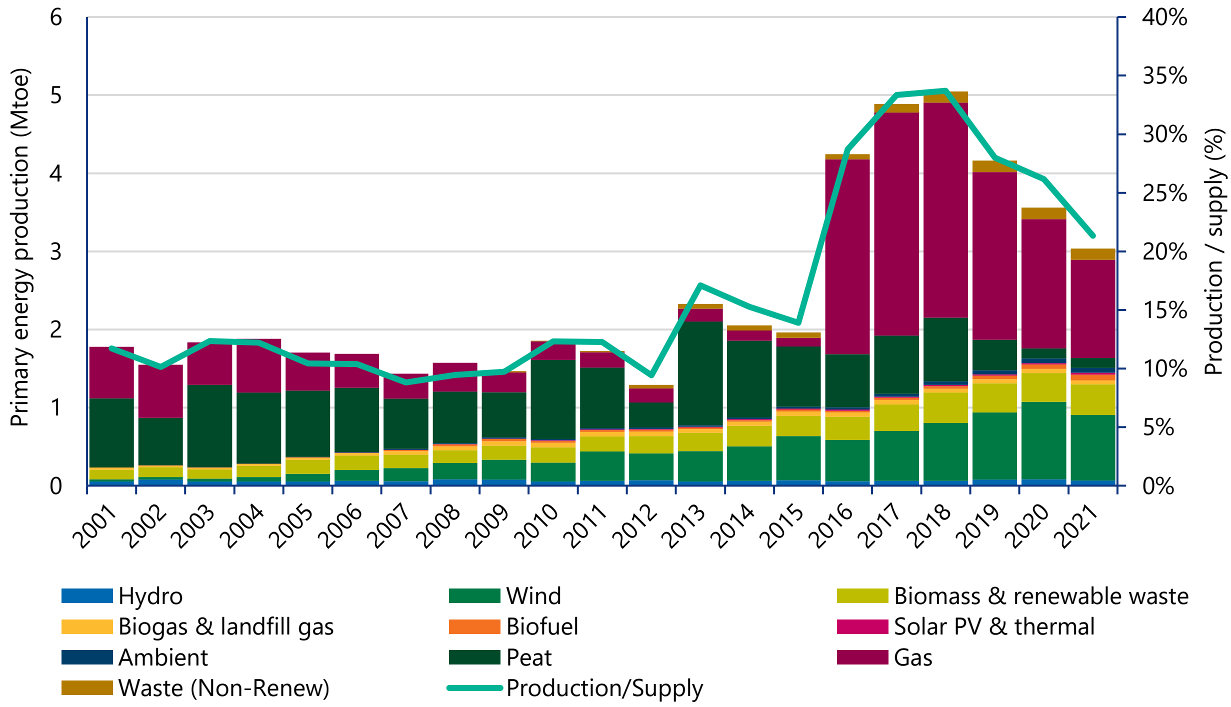
Figure 20 shows the latest split of Ireland's indigenous primary energy production by fuel type. *Figure 21* shows Ireland's annual primary energy production by fuel type and the ratio of primary energy production to supply.

Figure 20: 2021 primary energy production split by fuel type



Source: SEAI

Figure 21: Annual primary energy production by fuel type with production / supply ratio

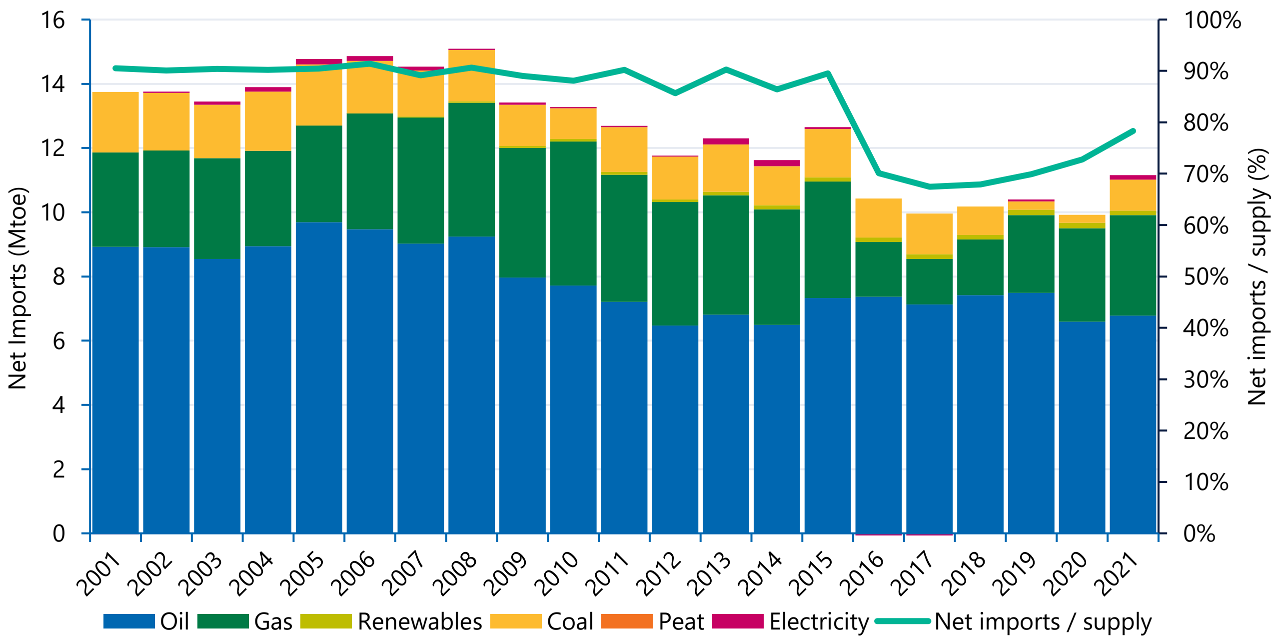


Source: SEAI

3.2 Primary energy imports and exports

Figure 22 shows Ireland's net energy imports by fuel type, along with the ratio of net imports to primary energy supply. Import dependency and energy security is discussed further in section1.6.

Figure 22: Annual net energy imports split by fuel type with ratio of net imports to supply



Source: SEAI

3.3 Primary energy supply and requirement

SEAI uses the following standard definition of primary energy supply for each fuel and energy type in the energy balance:

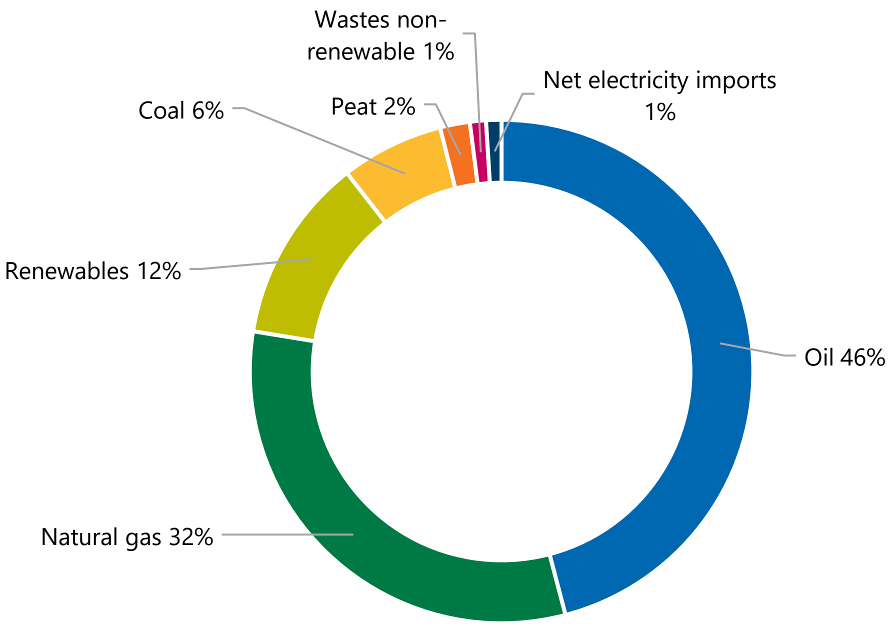
Primary energy supply = indigenous production + imports – exports – int. marine bunkers + stock change

Section 3.1 discusses production. Imports and exports refer to the quantities of each energy product that enters and exits Ireland. International marine bunkers refer to the fuel delivered at Ireland's ports to vessels that are engaged in international navigation; currently only fuel oil and gasoil are used for this purpose. Stock change is the change between opening and closing stock levels for a fuel held in Ireland during the year. A positive stock change indicates the net effect of the stock of a product being drawn down to enter the primary energy supply. A negative value indicates that the stock of the product has increased during the year. Stocks do not include reserves of fuels or products that are not yet extracted from natural deposits.

Another key measure of primary energy is primary energy requirement, defined as primary energy supply less non-energy use of the fuel or energy type. For most fuel types included in the energy balance, there are no significant non-energy uses, and their primary energy supply and requirement are equal. In Ireland, the exceptions to this are bitumen, lubricating oil and white spirits, and oil products not used for energy purposes. Renewables used for materials, such as wood for construction or peat for gardening are not tracked in the energy balance.

Figure 23 displays the split of fuels in Ireland's primary energy requirement for 2021.

Figure 23: 2021 primary energy requirement by fuel type



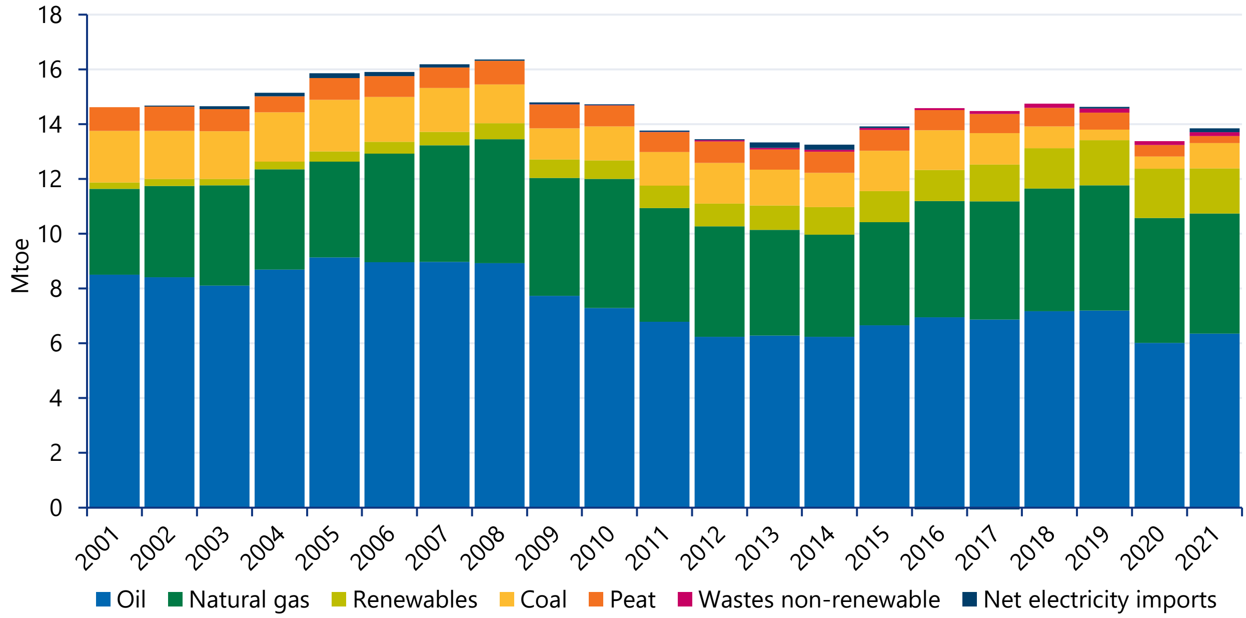
Source: SEAI

Figure 24 shows the trend in annual total primary energy requirement by energy type. *Table* 3 provides a detailed summary of the quantities and share of each energy type in Ireland's total primary energy requirement in comparison to previous years.

Total primary energy requirement peaked in 2008 before the economic downturn and reached a low in 2014 before growing to a relatively stable level from 2016 to 2019. This was the result of several competing factors. Increasing population and economic growth was countered by general efficiency improvements, and additionally, generation of 1 ktoe of electricity requires approximately 1 ktoe wind power, 2 ktoe of gas, or 3 ktoe of coal, peat or oil, so an increasing share of renewable generation, decreases primary energy demand for the energy sector. A significant contraction to TPER occurred in 2020 due to the impacts of the COVID-19 pandemic; this contraction was mostly confined to oil products, caused by a downturn in transport demand.

In absolute terms, Ireland's current total primary energy requirement is comparable to that from 20 and 10 years ago, despite intervening periods of significant growth and decline. Nevertheless, the mix of fuels and energy types in primary energy has evolved significantly during this time. The broad trend has been the growth of renewables and natural gas displacing oil, coal and peat. Despite the meaningful development of renewables, fossil fuels still dominate Ireland's primary energy supply.

Figure 24: Total primary energy requirement by fuel and energy type[1]



Source: SEAI

[1] 'Wastes (non-renewable)' in the graph represents energy from non-renewable wastes.

Table 3: Primary energy by fuel type compared with previous years

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Oil	6,359	45.9%	+347	+5.8%	-587	-8.4%	-426	-6.3%	-2,147	-25.2%
Gas	4,384	31.6%	-180	-4.0%	+133	+3.1%	+237	+5.7%	+1,245	+39.7%
Renewables	1,650	11.9%	-144	-8.0%	+515	+45.3%	+824	+99.7%	+1,417	+605.7%
Coal	914	6.6%	+466	+104.3%	-536	-37.0%	-310	-25.3%	-964	-51.3%
Peat	265	1.9%	-153	-36.5%	-469	-63.9%	-459	-63.4%	-598	-69.3%
Wastes non-renewable	143	1.0%	-4	-2.7%	+76	+114.3%	+129	+907.1%	+143	-
Net electricity imports	137	1.0%	+150	-	+198	-	+94	+223.9%	+158	-
Total	**13,852**	**100.0%**	**+482**	**+3.6%**	**-671**	**-4.6%**	**+89**	**+0.6%**	**-746**	**-5.1%**

Source: SEAI

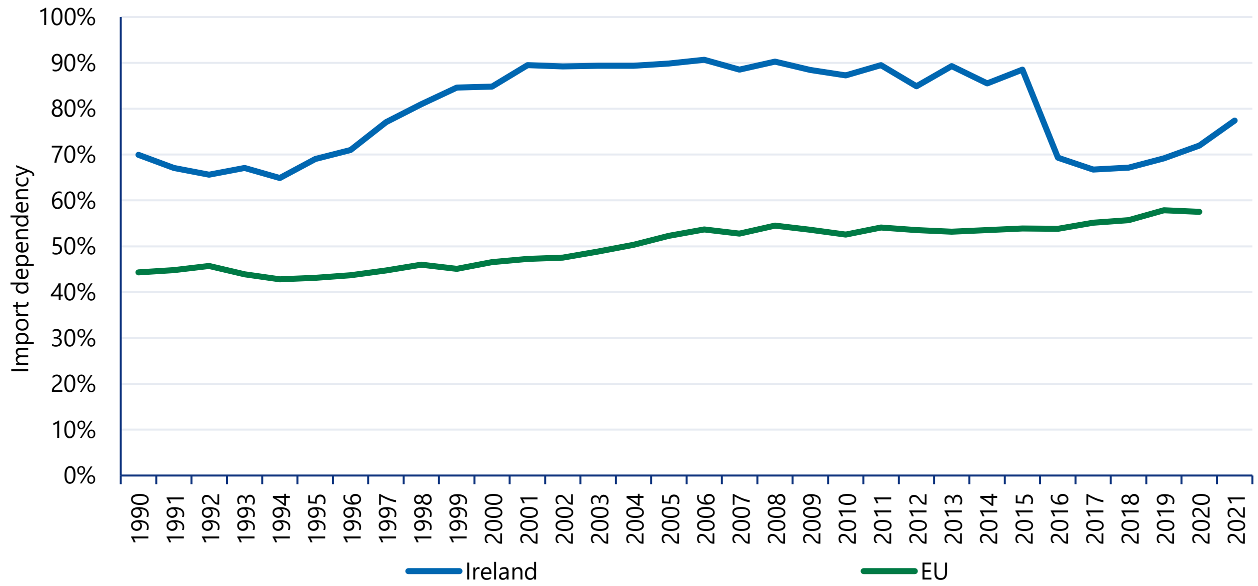
3.4 Energy security

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.

Figure 25 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 91% in 2006. In 2016, import dependency fell sharply following the opening of the Corrib gas field, but has been increasing again since, as the Corrib field production capacity declines.

Figure 25: Import dependency of Ireland and the EU



Source: SEAI and Eurostat

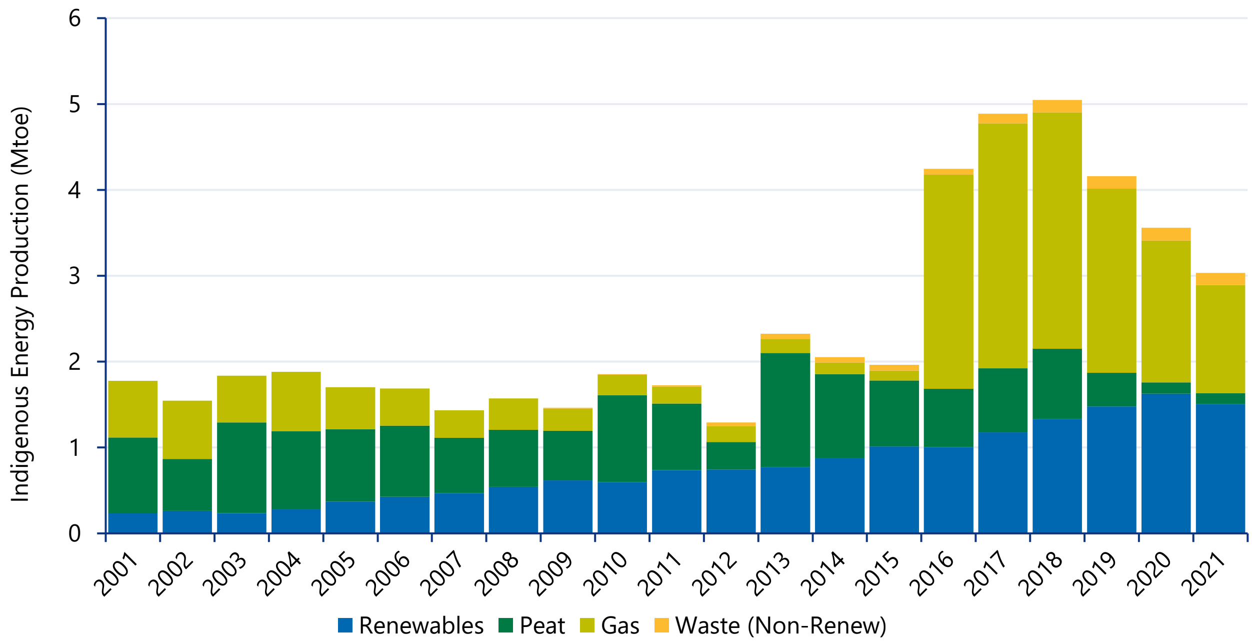
This trend reflects the fact that Ireland is not endowed with significant indigenous fossil fuel resources and has only in recent years begun to harness significant quantities of renewable resources and natural gas from the Corrib gas field.

Figure 26 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 when the highest natural gas production level ever was recorded for Ireland, due to the opening of the Corrib gas field. Production from the Corrib gas field has since declined, and this decline is expected to continue over the coming years.

Peat production was negligible in 2021. With Bord na Móna announcing a formal ending of peat harvesting on its lands in January 2021, industrial peat production of milled peat for energy purposes ceased in Ireland, and the only peat production was turf cutting to produce sod peat, almost exclusively for residential consumption. Existing stockpiles of milled peat were used to create peat briquettes.

Indigenous renewable energy production continues to increase, with most of this arising from wind energy. Total indigenous energy production in Ireland reached the highest level ever in 2018, of 5,048 ktoe, but has fallen since due to declining natural gas and peat production.

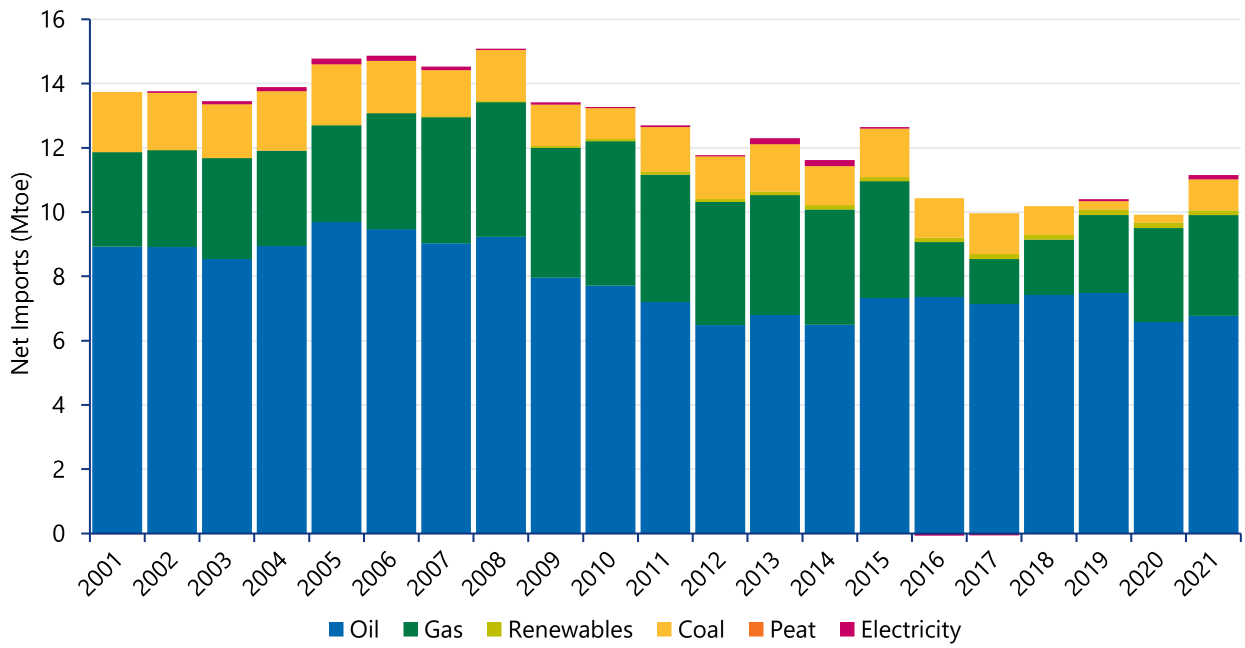
Figure 26: Indigenous primary energy production by fuel



Source: SEAI

Figure 27 shows the trend for net fuel imports (imports minus exports) over the period 2001 to 2021. The most striking feature is the dependence on oil, due largely to energy use in transport. Gas imports have been increasing in recent years due to declining indigenous production. Coal imports grew significantly in 2021 due to increased use in electricity generation.

Figure 27: Imported energy by fuel



Source: SEAI

4 Energy transformation

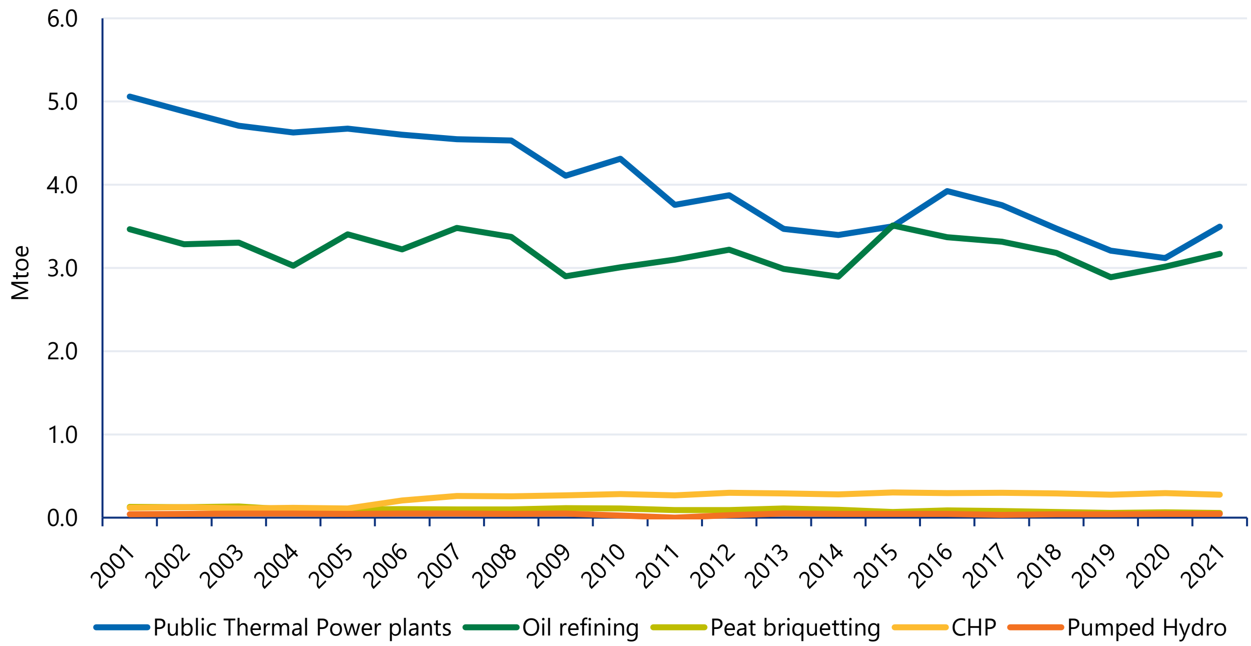
Energy transformation involves converting one fuel type or energy source into another, such as transforming crude oil into petrol and diesel in an oil refinery, or converting coal and gas into electricity in a thermal generation plant. Approximately half of all primary energy undergoes a transformation,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

Primary energy supply includes all inputs and losses in energy transformation processes, while final energy use only includes 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.

4.1 Overview of transformation

As shown in *Figure* 28, 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 approximately 3,250 ktoe per annum, while the transformation input of public thermal power plants for electricity generation has been trending downward over the long term as coal, oil and peat fired power are replaced by gas and renewables.

Figure 28: Primary energy inputs to transformation processes[2]



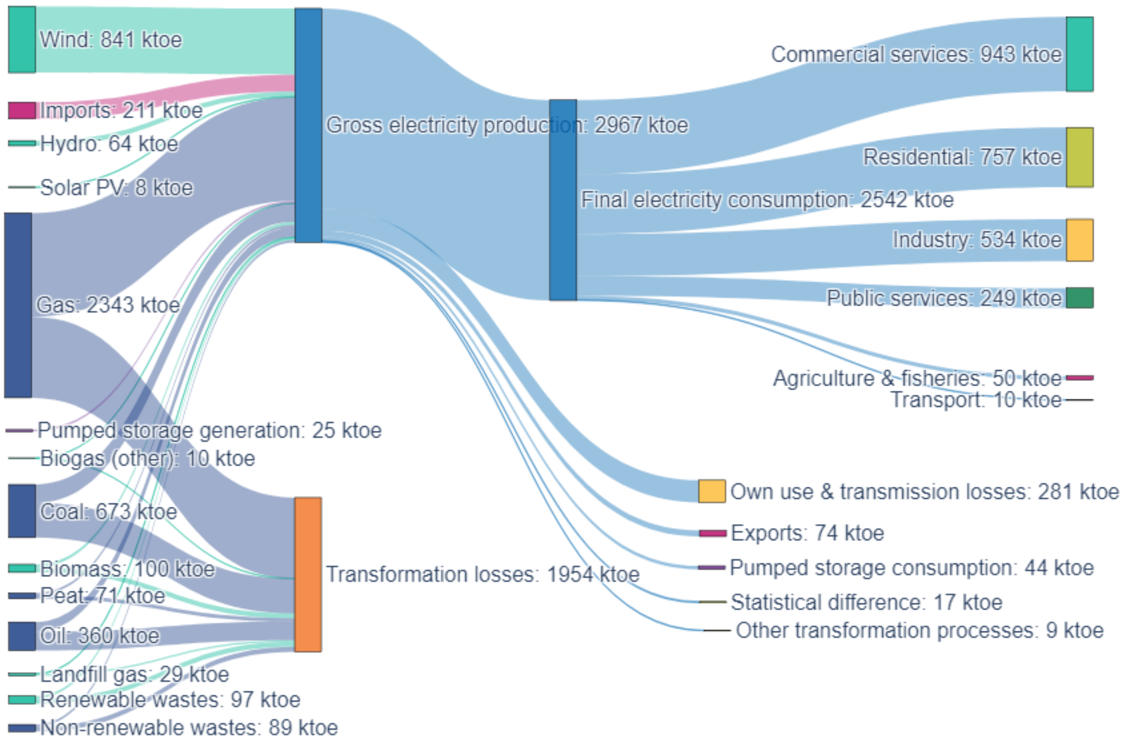
Source: SEAI

[2] In this graph, non-combustible renewables such as hydro, wind and solar are not included under electricity, as they do not involve a statistical energy transformation. However, these non-combustible sources of renewable electricity generation are presented in the following sub-sections in section 4.

4.2 Electricity generation

Modern economies and societies depend on reliable and secure supplies of electricity. Total energy inputs to electricity generation account for approximately one-third of Ireland's total primary energy supply. The Sankey diagram in *Figure* 29 shows the flow of energy from the inputs to electricity generation through to the final electricity used by the different sectors. As the diagram shows, a significant portion of the energy used to generate electricity is lost before the electricity reaches the end user, through a combination of transformation losses, own use of electricity by power plants, pumped hydro storage losses, and transmission and distribution losses.

Figure 29: Flow of energy in electricity generation and consumption



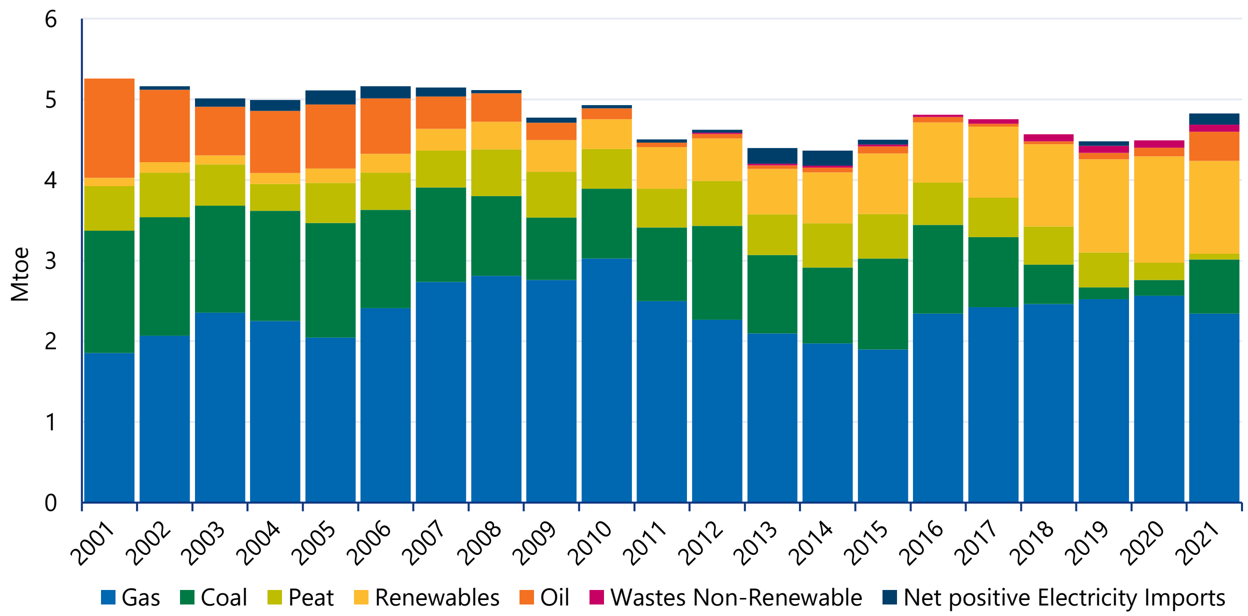
Source: SEAI

4.2.1 Primary fuel inputs into electricity generation

Figure 30 shows the trends in primary energy supply for electricity generation broken out by fuel type and energy source.

Note that non-combustible renewable sources accounted for a higher share of generated electricity than of primary energy supply for electricity generation. This is because the thermal generation of electricity from natural gas and coal has significant energy losses (*Figure* 29), while electricity generation from non-combustible renewable sources (wind, hydro and solar) is considered to be 100% efficient as this is the point at which the measurable energy enters the system.

Figure 30: Primary energy fuel mix for electricity generation



Source: SEAI

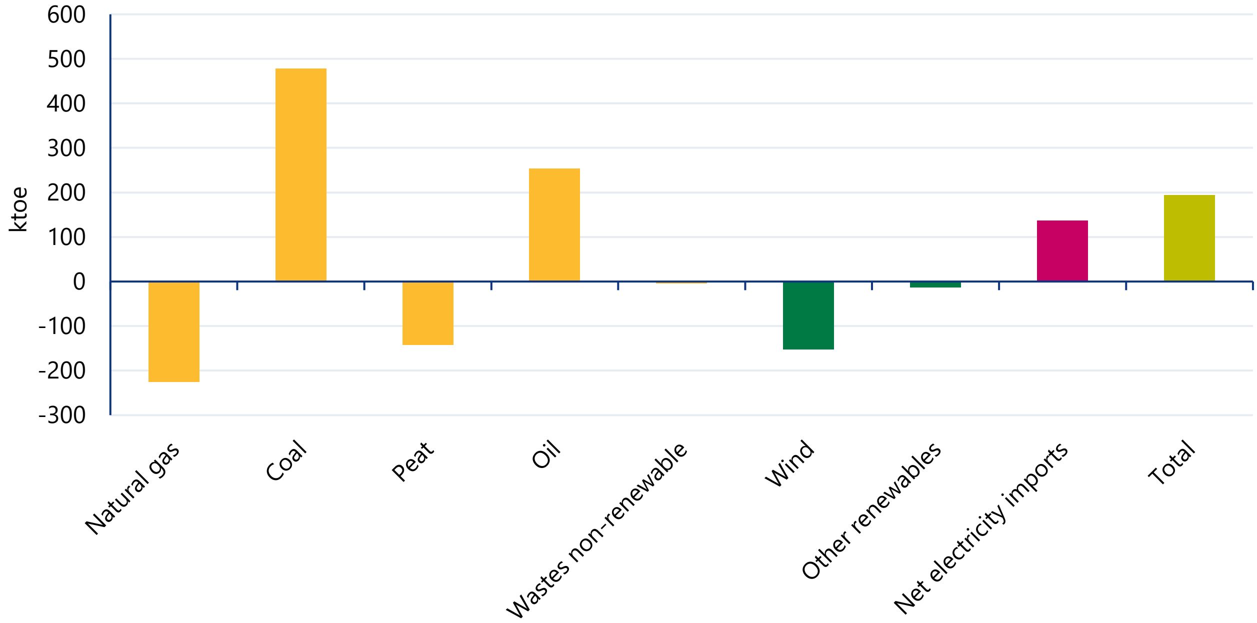
Table 4: Fuel mix in electricity generation (primary fuel inputs) compared with previous years

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Gas	2,343	48.6%	-225	-8.8%	+1	+0.0%	-156	-6.2%	+487	+26.3%
Coal	673	13.9%	+478	+245.5%	-430	-39.0%	-240	-26.3%	-844	-55.7%
Peat	71	1.5%	-142	-66.6%	-450	-86.3%	-409	-85.1%	-478	-87.0%
Oil	360	7.5%	+253	+235.9%	+292	+426.1%	+305	+557.2%	-872	-70.8%
Total fossil fuels	**3,447**	**71.5%**	**+364**	**+11.8%**	**-588**	**-14.6%**	**-500**	**-12.7%**	**-1,708**	**-33.1%**
Wastes non-renewable	89	1.8%	-4	-4.5%	+64	+256.4%	+89	-	+89	-
Wind	841	17.4%	-153	-15.4%	+312	+59.0%	+464	+123.2%	+812	+2,827%
Biomass	102	2.1%	+3	+3.6%	+14	+15.7%	+71	+233.2%	+102	-
Renewable wastes	97	2.0%	-4	-4.3%	+71	+274.6%	+97	-	+97	-
Hydro	64	1.3%	-16	-19.7%	+6	+10.0%	+4	+6.0%	+13	+25.7%
Other renewables	47	1.0%	+4	+8.9%	+0	+0.9%	-1	-1.9%	+23	+96.8%
Total renewables	**1,151**	**23.9%**	**-165**	**-12.6%**	**+403**	**+54.0%**	**+635**	**+123.1%**	**+1,047**	**+1007%**
Net positive electricity imports	137	2.8%	+137	-	+137	-	+94	+223.9%	+137	-
Total (excl. net exports)	**4,823**	**100.0%**	**+331**	**+7.4%**	**+16**	**+0.3%**	**+319**	**+7.1%**	**-435**	**-8.3%**

Source: SEAI

Table 4 provides a detailed summary of the quantities, shares and trends of fuel types and energy sources that go into electricity generation. *Figure* 31 shows the changes in primary supply for electricity generation in the last year, by fuel type and energy source.

Figure 31: Change in fuel inputs to electricity generation in 2021 compared with 2020

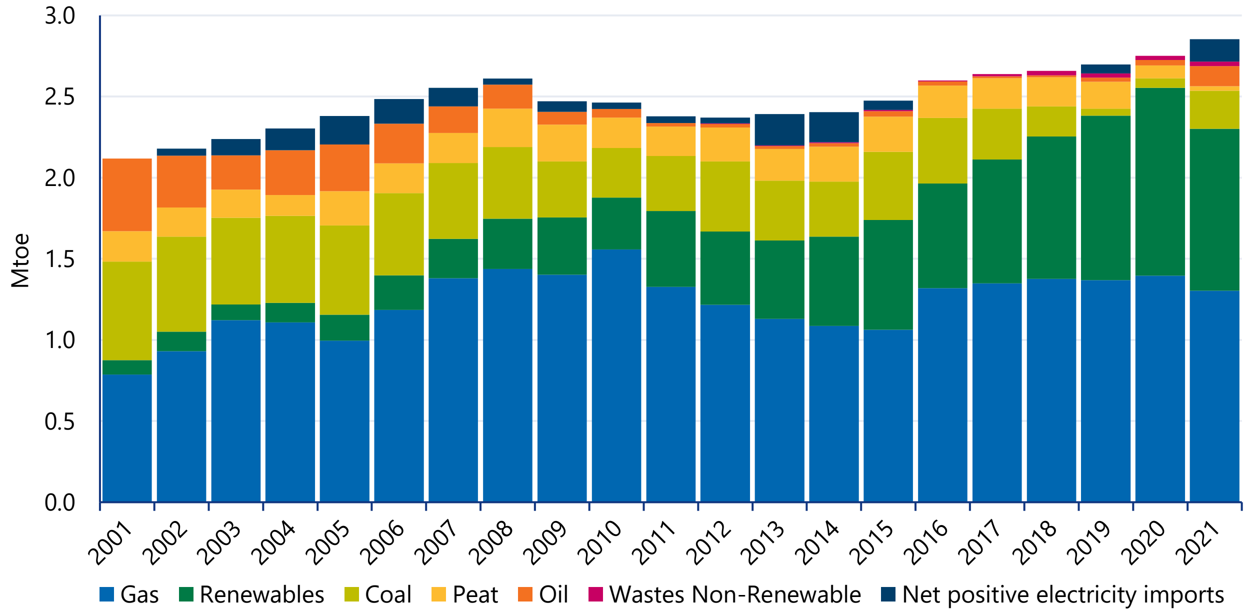


Source: SEAI

4.2.2 Electricity generated by fuel type

Figure 32 and *Table* 5 detail the generated electricity available for final consumption by end users, broken down by fuel type and energy source.

Figure 32: Electricity generated by fuel type



Source: SEAI

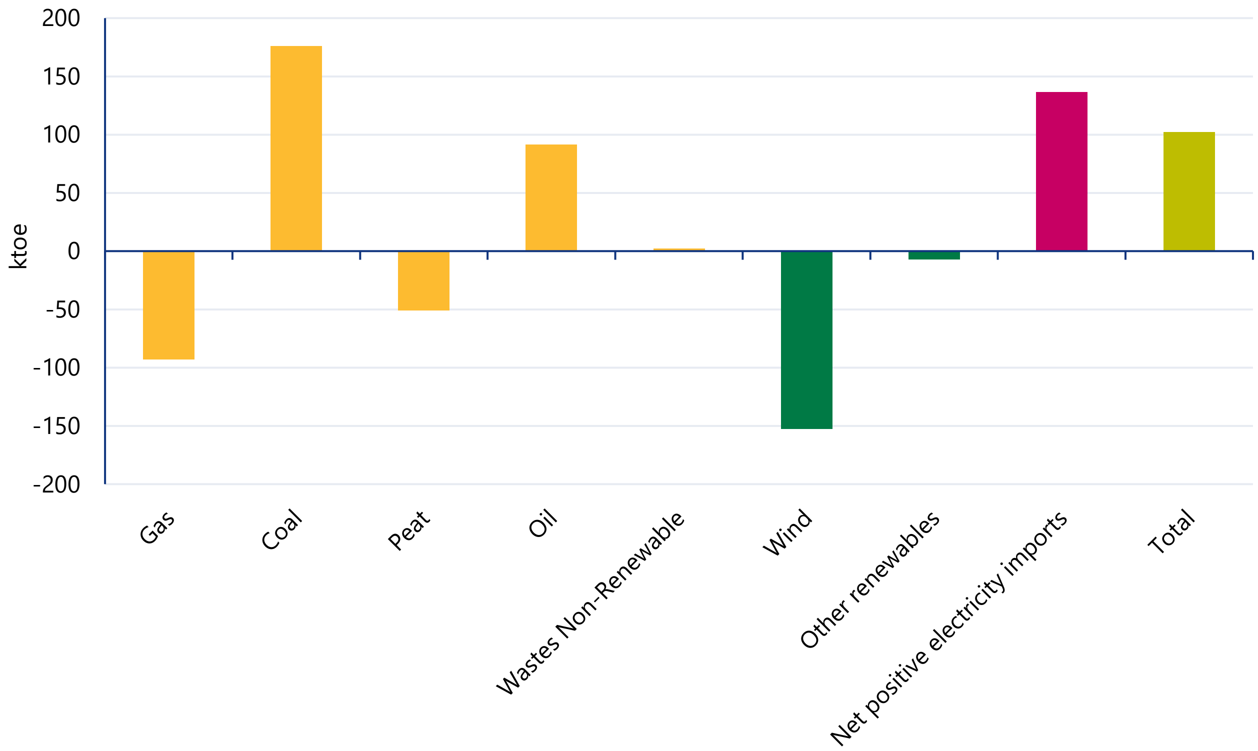
Table 5: Electricity generated by fuel type compared with previous years

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Gas	1,303	45.7%	-93	-6.7%	-15	-1.1%	-24	-1.8%	+517	+65.7%
Coal	234	8.2%	+176	+303.7%	-170	-42.1%	-106	-31.1%	-374	-61.5%
Peat	28	1.0%	-51	-64.6%	-171	-86.0%	-155	-84.7%	-161	-85.2%
Oil	125	4.4%	+91	+273.2%	+100	+396.6%	+105	+521.8%	-322	-72.1%
Total fossil fuels	**1,690**	**59.2%**	**+123**	**+7.9%**	**-257**	**-13.2%**	**-180**	**-9.6%**	**-340**	**-16.8%**
Wastes non-renewable	28	1.0%	+2	+7.6%	+21	+341.8%	+28	-	+28	-
Wind	841	29.5%	-153	-15.4%	+312	+59.0%	+464	+123.2%	+812	+2,827%
Biomass	40	1.4%	+4	+9.5%	+6	+19.0%	+29	+245.4%	+40	-
Renewable wastes	30	1.1%	+2	+7.9%	+24	+364.4%	+30	-	+30	-
Hydro	64	2.3%	-16	-19.7%	+6	+10.0%	+4	+6.0%	+13	+25.7%
Other renewables	23	0.8%	+3	+15.8%	+4	+24.1%	+6	+32.6%	+15	+173.9%
Total renewables	**999**	**35.0%**	**-159**	**-13.8%**	**+353**	**+54.6%**	**+532**	**+114.1%**	**+910**	**+1,031%**
Net positive electricity imports	137	4.8%	+137	-	+137	-	+94	+223.9%	+137	-
Total (excl. net exports)	**2,853**	**100.0%**	**+102**	**+3.7%**	**+254**	**+9.8%**	**+475**	**+20.0%**	**+735**	**+34.7%**

Source: SEAI

A comparison of *Figure* 30 and *Figure* 32 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 (5 Mtoe vs. 3 Mtoe) reflects the generation and transmission losses. The relative increase in share from renewable sources in *Figure* 32 (vs. *Figure* 30) is due to wind, hydro and solar generation being taken as 100% efficient.

Figure 33: Change in electricity generation by source in 2021 compared with 2020



Source: SEAI

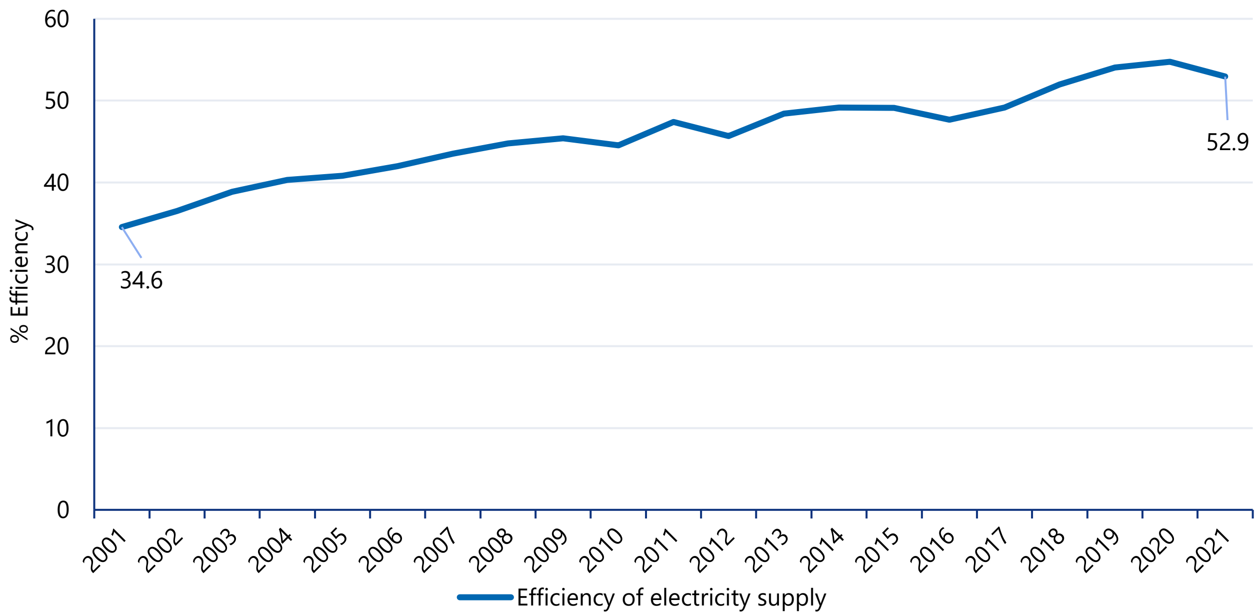
4.2.3 Efficiency of electricity supply

Figure 34 shows trends in the efficiency of Ireland's electricity supply. Efficiency of electricity supply is defined as the ratio of final energy use of electricity and the primary energy supply for the generation of that electricity.[3]

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 efficiency therefore increases as the share of non-combustible renewable sources, and as more efficient fuels and technologies are employed in thermal generation plants.

The efficiency of Ireland's electricity supply has generally improved over the last two decades, due to introducing higher efficiency natural gas plants, the closure of or reduction in utilisation of older oil-, coal-, and peat-fired stations, as well as increased direct generation from renewable sources.

Figure 34: Efficiency of electricity supply



Source: SEAI

4.2.4 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. 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, despite higher capital outlay, CHP can be an economical means of improving the efficiency of energy use and reducing emissions. *Table* 6 contains the number of CHP units and installed electrical capacity (MWe), broken down by fuel for 2021 and 2020.

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[3] Electricity supply efficiency calculations include energy consumed by electricity generating plants themselves as well as transmission and distribution losses. Electricity generation efficiency ignores these losses, hence generation efficiency is higher than supply efficiency.

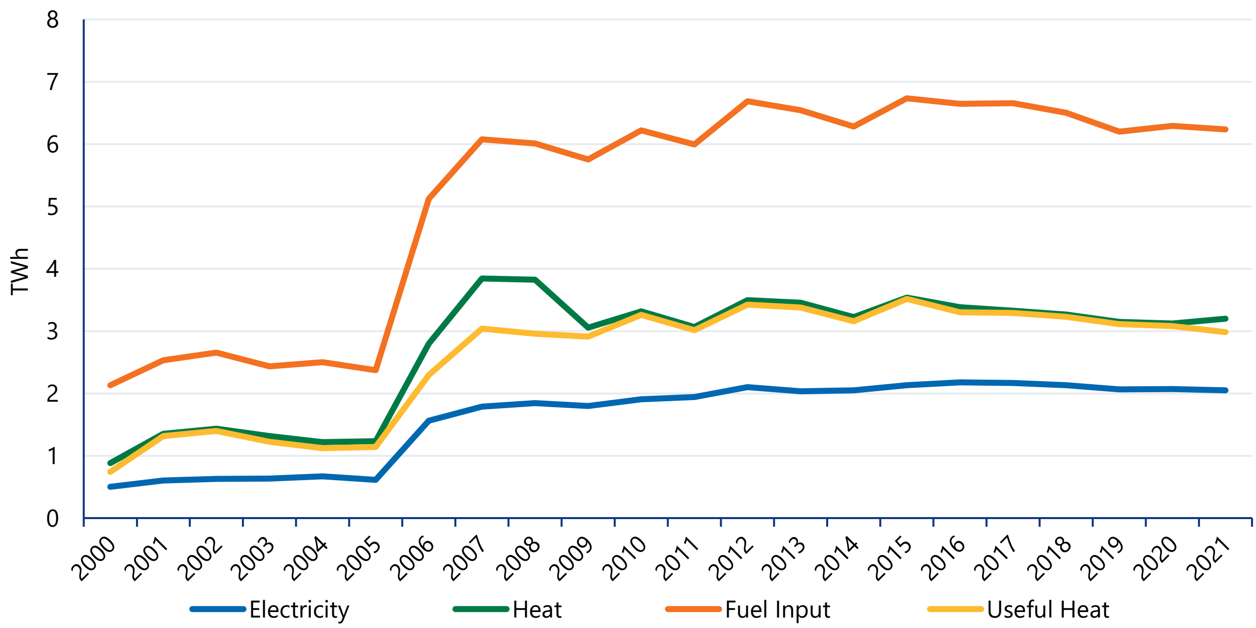
Table 6: Number of operational units and installed capacity by fuel, 2021

	2021				2020	
	No. of Units	Installed Capacity (MWe)	No. of Units %	Installed Capacity %	No. of Units	Installed Capacity (MWe)
Natural gas	277	304	87%	93%	283	301
Solid fuels	1	3	0%	1%	1	3
Biomass	3	7	1%	2%	3	7
Oil fuels	20	1	6%	0%	20	1
Biogas	18	12	6%	4%	20	12
Total	**319**	**326**	**100%**	**100%**	**327**	**323**

Source: SEAI

Figure 35 illustrates the contribution from CHP to Ireland's energy requirements in the period 2000 to 2021. The step-change increase observed in 2006 is due to the Aughinish Alumina CHP plant coming online.

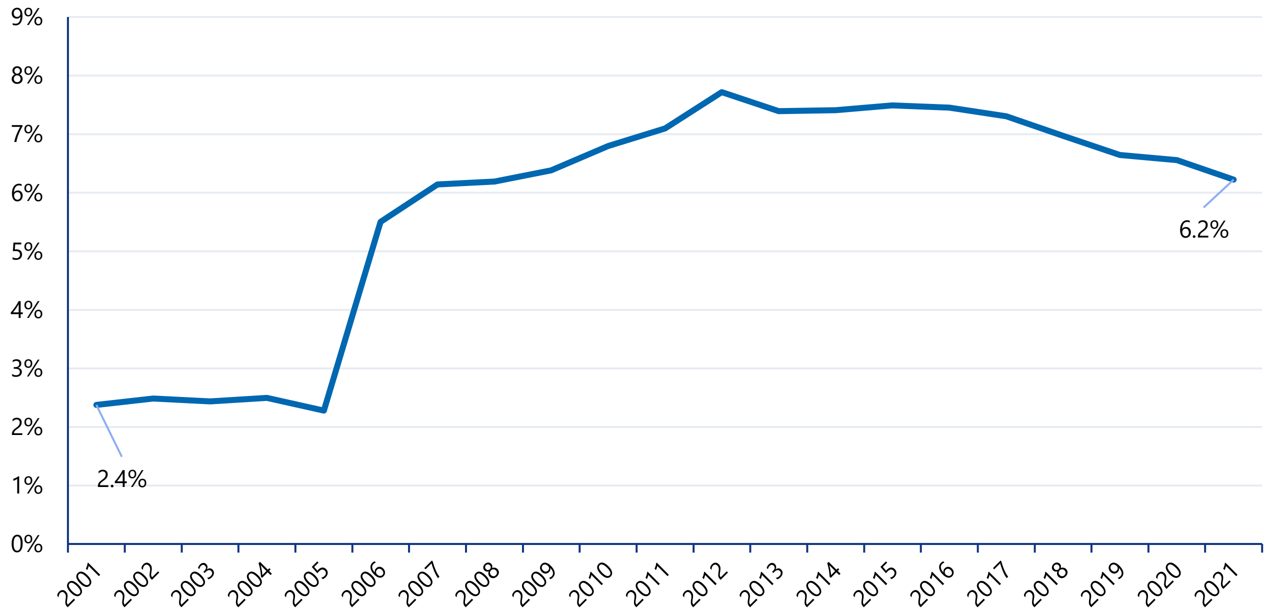
Figure 35: CHP fuel input and thermal/electricity output



Source: SEAI

Figure 36 focuses on CHP generated electricity in Ireland as a proportion of gross electricity consumption (that is electricity generation plus net imports) in the period 2001 to 2021. *Table* 7 provides data on the number of CHP units that exported electricity to the grid in the last two years and the total quantity of electricity exported.

Figure 36: CHP electricity as percentage of total electricity generation



Source: SEAI

Table 7: Electricity exported to the grid from CHP

	2021	2020
No. of CHP units exporting to grid	15	13
Electricity exported to grid (GWh)	1,317	1,378

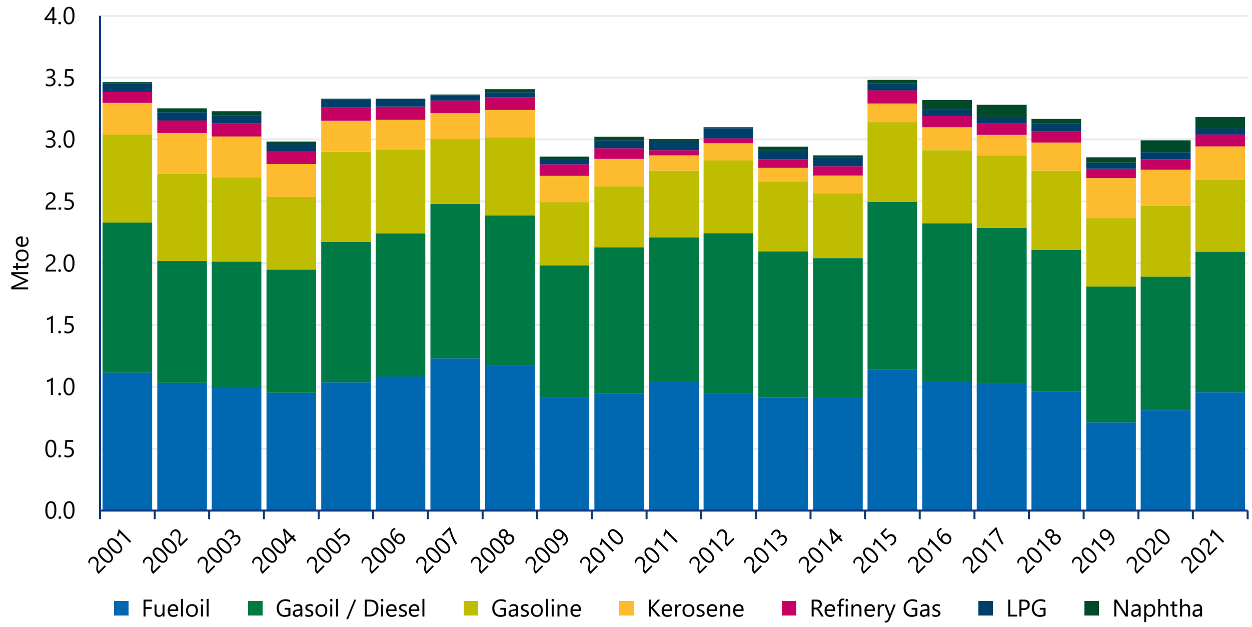
Source: SEAI

4.3 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 kerosene, etc). *Figure* 37 shows the outputs from oil refining, the main ones being fuel oil, diesel (gasoil) and petrol (gasoline).

Due to the highly international nature of the oil market, refinery outputs are not heavily influenced by local demand in the Irish market, but on the configuration and capabilities of the refinery. A significant portion of the refinery's output is exported directly, while the majority of oil products used for final energy in Ireland are imported as finished products. Nonetheless, the refinery is an important piece of infrastructure regarding energy security.

Figure 37: Outputs from oil refining



Source: SEAI

4.4 Other transformation processes

Several other energy transformation processes operate in the Irish energy sector, though all are very small compared to electricity generation, CHP and oil refining.

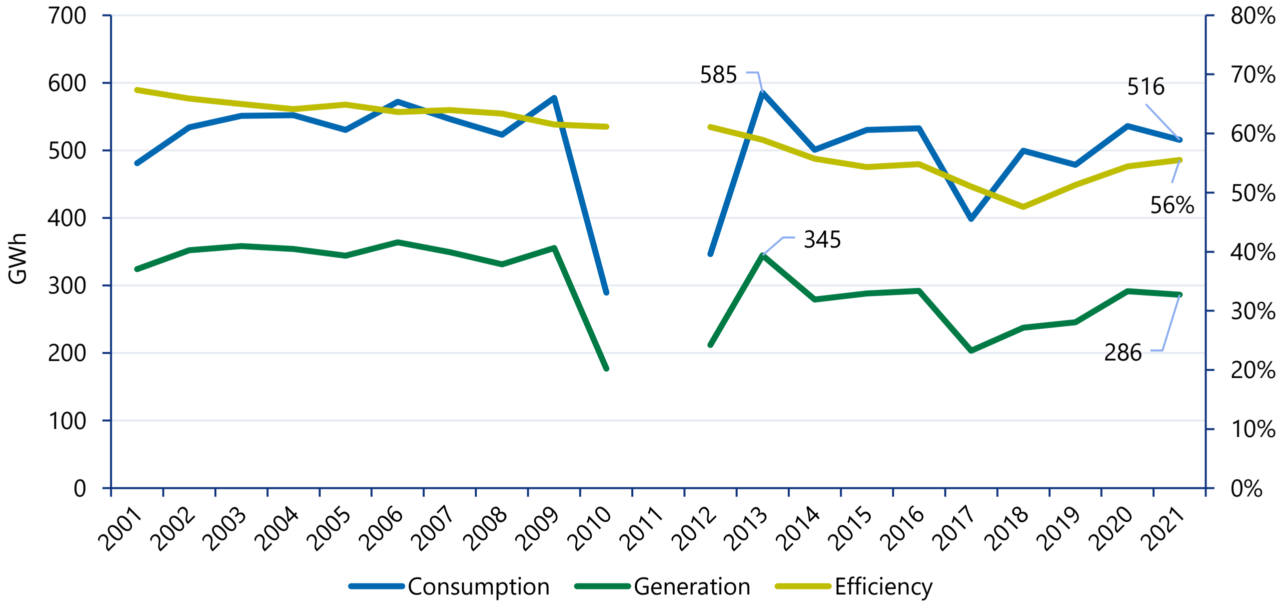
4.4.1 Pumped hydroelectric storage

Pumped hydroelectricity storage is the process of using electricity to pump water to an uphill reservoir, and later releasing the water from the reservoir 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 hydroelectric station in Ireland at Turlough Hill in Wicklow, with a total capacity of 292 MW. It can operate for roughly 6 hours at maximum generating capacity.

The electricity generated from pumped hydro storage is not considered hydroelectricity for statistical purposes 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.

Figure 38 shows the annual consumption and generation of electricity, along with associated overall efficiency, at Turlough Hill. The facility underwent significant overhaul work from 2010 to 2012, producing no electricity in 2011. 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.

Figure 38: Pumped hydroelectric storage (Turlough Hill)

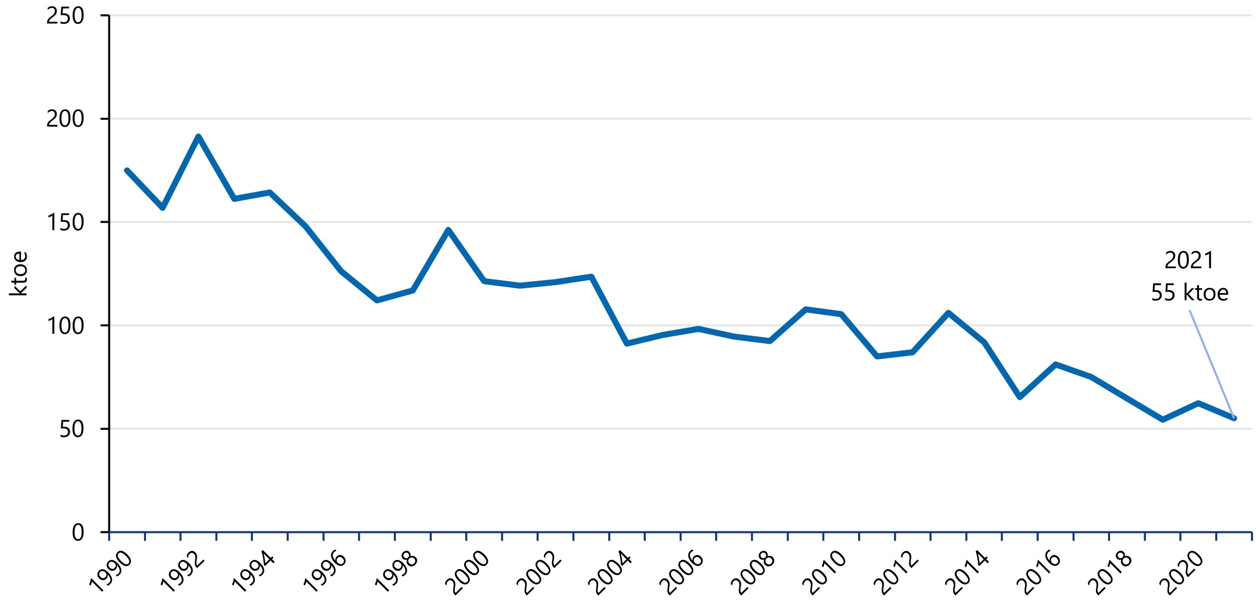


Source: SEAI

4.4.2 Peat briquetting

Peat briquetting converts milled peat into briquettes for residential use. Peat briquette production has been reducing since the early 1990s, as shown in *Figure* 39.

Figure 39: Annual production of peat briquettes



Source: SEAI and Bord na Móna

5 Final energy

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 and by sector.

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 type 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., (that is, 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.

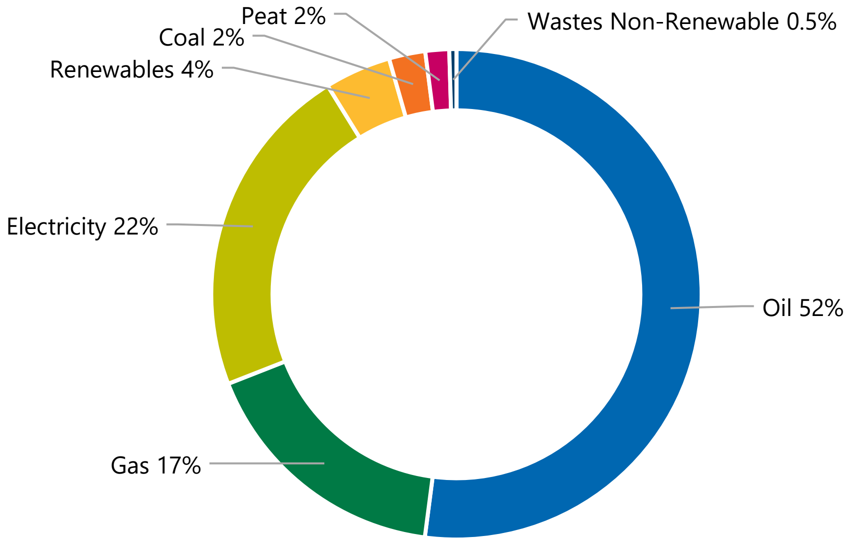
5.1 Final energy use by fuel

In evaluating final energy use in Ireland, SEAI collects data on each fuel, or energy type, from various sources:

- Aggregated electricity consumption data collected by the meter registration system operator (MRSO, a function within ESB Networks).
- Aggregated gas consumption data collected by Gas Networks Ireland.
- Oil supply data reported to the DECC for the payment of the National Oil Reserves Agency (NORA) levy.
- Biofuel data collected by NORA for the Biofuel Obligation Scheme.
- Fuel consumption data reported by permit holders to the EPA under EU Emissions Trading System (ETS).
- Aggregated carbon tax receipts published by the CSO.
- SEAI surveys of solid fuel suppliers.
- SEAI surveys of biomass/wood suppliers.
- Other data requests made by SEAI.
- SEAI data on the number and size of heat pumps and solar thermal collectors in dwellings.

Figure 40 shows the current percentage breakdown of Ireland's final energy use by energy type. Oil products account for more than half of Ireland's final energy use, followed by electricity, gas, renewables, coal and peat, in that order. Ireland is almost completely dependent on oil for the servicing of its transport sector, and that sector is Ireland's largest end use of energy. Electricity from renewable sources (for example wind, solar, renewable waste) is included in the 'electricity' energy type for final energy use, not 'renewables'. The 'renewables' energy type in final energy comprises the combustion of biomass and biogas for heat, the combustion of biofuels in transport, solar thermal and ambient heat (via heat pumps). Similarly, consumption of oil, gas coal and peat reported here is direct consumption of these fuels and excludes fuels consumed for generation of electricity, non-energy use, and those converted into other fuels that were discussed in section 4.

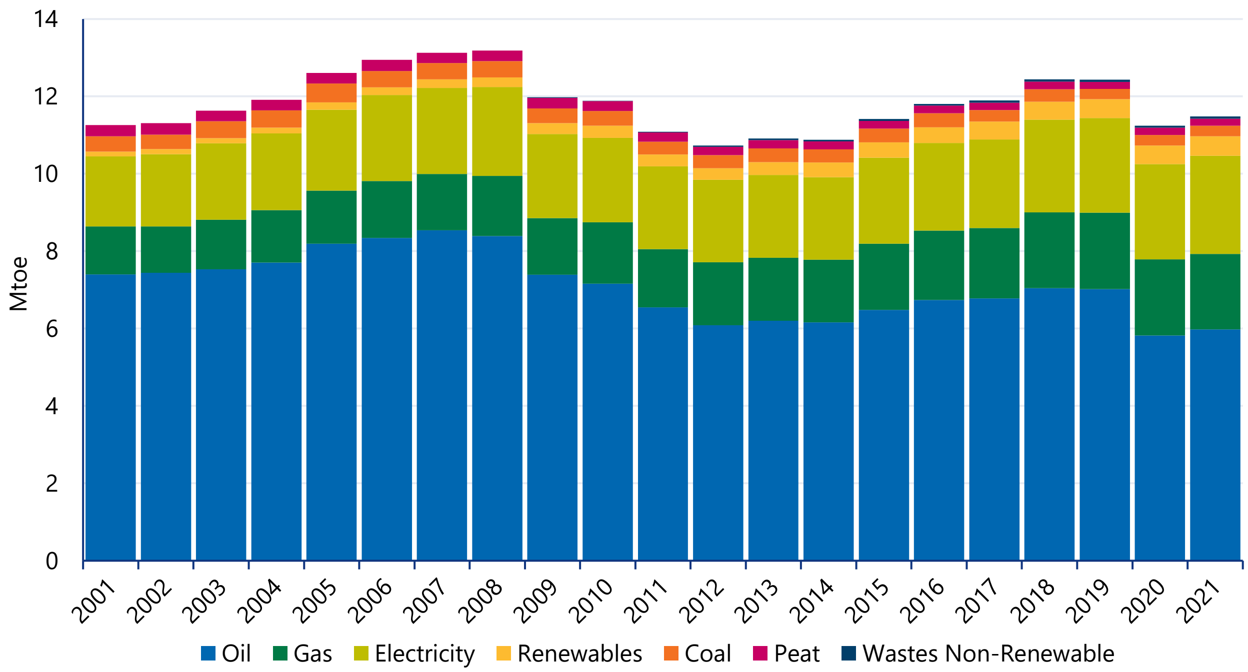
Figure 40: Ireland's total final energy use by energy type 2021



Source: SEAI

Figure 41 shows the annual trends in final energy use by energy type for the most recent 21-year period. *Table* 8 provides numerical details on the absolute values, relative shares, and percentage changes in the final energy use by energy type shown in *Figure* 41. Although Ireland remains heavily reliant on oil, its consumption has decreased, in absolute and percentage terms, over the period presented. Decreases were precipitated by two events: the economic downturn from 2008 to 2012 and the COVID-19 impact in 2020 and 2021. Outside of these events, oil consumption has increased each year. Other general trends over the period shown have been decreases in the consumption of coal and peat, and increases in the consumption of gas, electricity and renewables.

Figure 41: Total final consumption by fuel type



Source: SEAI

Table 8: Final energy by fuel compared with previous years

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Oil	5,977	52.1%	+152	+2.6%	-759	-11.3%	-570	-8.7%	-1,425	-19.3%
Gas	1,951	17.0%	-9	-0.5%	+157	+8.8%	+445	+29.6%	+714	+57.7%
Coal	275	2.4%	+4	+1.4%	-89	-24.4%	-53	-16.2%	-118	-30.0%
Peat	180	1.6%	-9	-5.0%	-18	-9.0%	-62	-25.5%	-112	-38.4%
Fossil fuels	**8,383**	**73.0%**	**+137**	**+1.7%**	**-709**	**-7.8%**	**-240**	**-2.8%**	**-941**	**-10.1%**
Wastes non-renewable	54	0.5%	+0	+0.6%	+12	+29.3%	+40	+280.2%	+54	-
Electricity	2,542	22.1%	+79	+3.2%	+273	+12.0%	+402	+18.8%	+733	+40.6%
Renewables	503	4.4%	+20	+4.1%	+100	+24.7%	+195	+63.2%	+373	+287.2%
Total	**11,481**	**100%**	**+235**	**+2.1%**	**-323**	**-2.7%**	**+397**	**+3.6%**	**+220**	**+1.9%**

Source: SEAI

5.2 Final energy use by sector

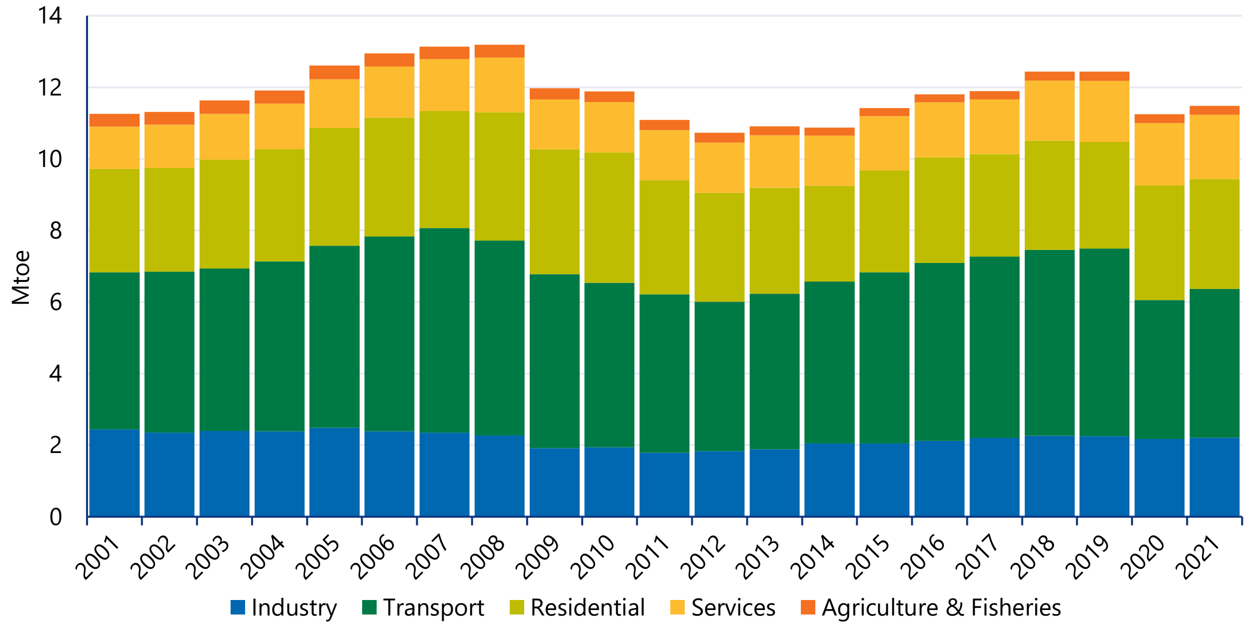
In calculating the final energy use by sector, SEAI uses the data on final energy use of each fuel type as described in section 5.1 and apportions it to each sector using data from, among other things:

- CSO's most recent annual Business Energy Use Survey.
- SEAI solid fuel and biomass/wood supplier surveys indicating sales to industry, commercial and residential sectors.
- Aggregated metered electricity consumption in each sector.
- Aggregated metered gas consumption in each sector.
- SEAI's Public Sector Monitoring and Reporting Programme.

Figure 42 shows the annual final energy demand 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 mostly due to the COVID-19 restrictions and was almost entirely limited to the transport sector. Prior to 2020, final energy demand for transport had risen every year since 2012 as activity growth outstripped efficiency improvements. Transport remains the sector with greatest final energy use, followed in order by the residential sector, industry and services.

Figure 42: Annual total final consumption by sector



Source: SEAI

Table 9 provides absolute values, relative shares, and percentage changes in the final energy use by sector.

Table 9: Final energy by sector compared with previous years

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Industry	2,207	19.2%	+36	+1.7%	+87	+4.1%	+418	+23.4%	-235	-9.6%
Transport	4,155	36.2%	+275	+7.1%	-814	-16.4%	-271	-6.1%	-232	-5.3%
Residential	3,073	26.8%	-131	-4.1%	+125	+4.2%	-119	-3.7%	+179	+6.2%
Services	1,794	15.6%	+54	+3.1%	+254	+16.5%	+398	+28.5%	+616	+52.3%
Agriculture & fisheries	251	2.2%	+1	+0.2%	+25	+11.0%	-30	-10.5%	-109	-30.2%
Total	**11,481**	**100%**	**+235**	**+2.1%**	**-323**	**-2.7%**	**+397**	**+3.6%**	**+220**	**+1.9%**

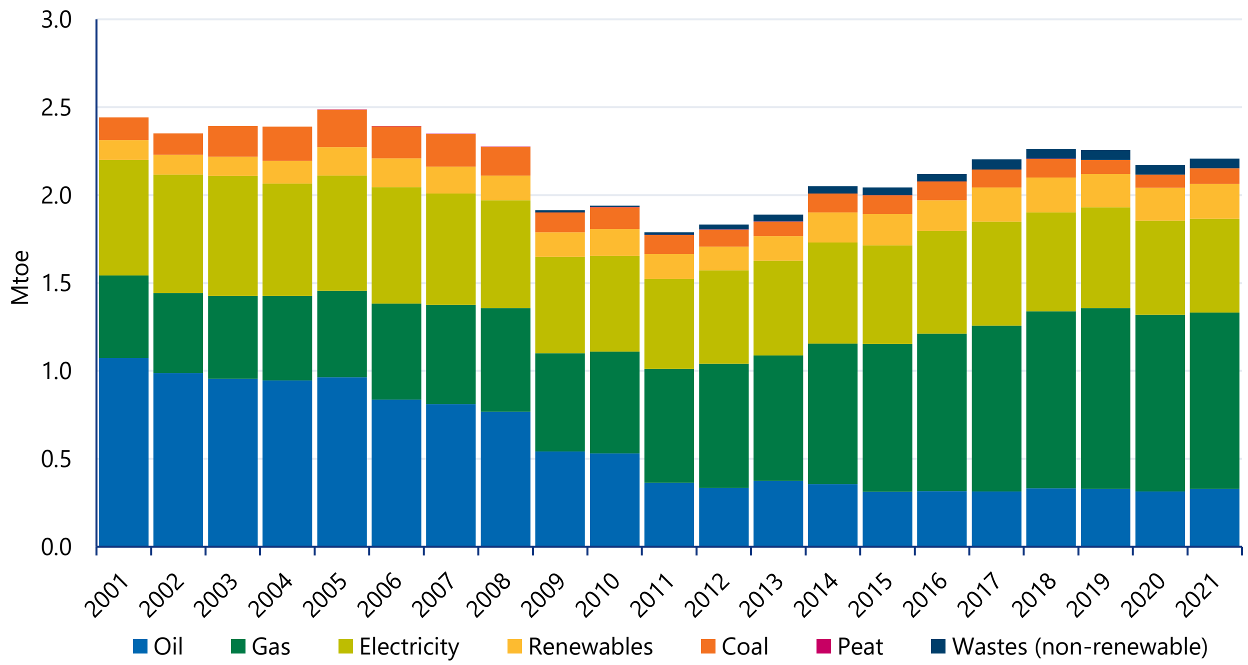
Source: SEAI

5.2.1 Final use in industry

In determining the sectoral breakdown of energy consumption, SEAI uses a blend of data sources, including the BEUS from the CSO. In May 2022, the CSO published the latest version of the BEUS, which is based on energy use in 2019. SEAI uses this most recent BEUS release in estimating the breakdown of 2021 energy consumption across the industry sector. For more details, see Revisions to Ireland's National Energy Balance from 1990 to 2018 (SEAI, 2020) following incorporation of new survey data on business energy use, available from www.seai.ie/NationalEnergyBalance/.

Figure 43 shows that natural gas, wastes and renewables have all increased their shares of industrial energy use over the period, while the shares of oil and coal have decreased. The share of electricity has declined slightly faster than overall energy consumption within the industry sector. The increase evident in renewables, is mainly due to the use of biomass in the wood-processing industry, the use of tallow in the rendering industry, and the use of the renewable portion of wastes in cement manufacturing.

Figure 43: Industry final energy use by fuel



Source: SEAI

Table 10 shows the growth rates, quantities and relative shares of energy used in industry by fuel.

Table 10: Growth rates, quantities and shares of final consumption in industry by fuel

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Oil	329	14.9%	+15	+4.6%	+12	+3.8%	-35	-9.5%	-745	-69.4%
Gas	1,004	45.5%	-2	-0.2%	+108	+12.1%	+356	+55.0%	+534	+113.7%
Coal	89	4.0%	+13	+17.5%	-17	-16.1%	-20	-18.1%	-40	-30.8%
Peat	0	0.0%	0	-	-1	-100.0%	-0	-100.0%	0	-
Total fossil fuels	**1,422**	**64.4%**	**+26**	**+1.9%**	**+103**	**+7.8%**	**+301**	**+26.8%**	**-251**	**-15.0%**
Renewables	198	9.0%	+10	+5.6%	+22	+12.5%	+56	+39.2%	+85	+74.7%
Electricity	534	24.2%	-0	-0.0%	-50	-8.6%	+22	+4.2%	-123	-18.7%
Wastes (non-renewable)	54	2.4%	+0	+0.6%	+12	+29.3%	+40	+280.2%	+54	-
Total	**2,207**	**100.0%**	**+36**	**+1.7%**	**+87**	**+4.1%**	**+418**	**+23.4%**	**-235**	**-9.6%**

Source: SEAI

There was also significant fuel switching from coal and oil to natural gas during this period. 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.

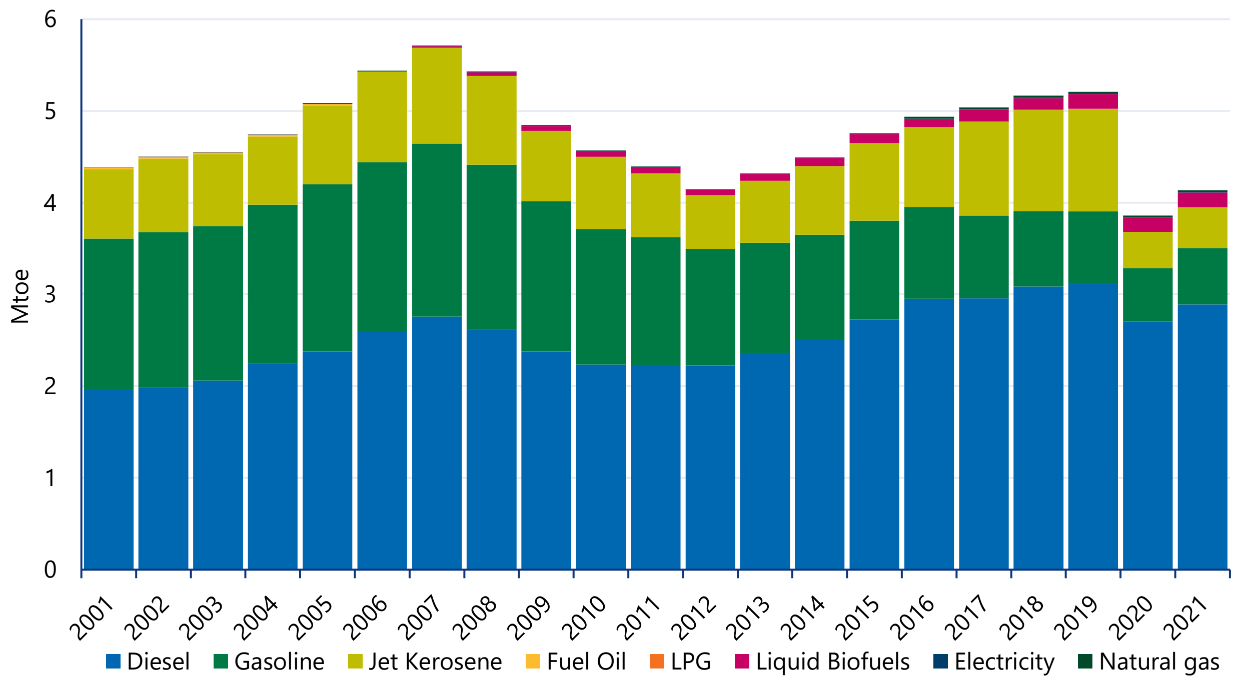
5.2.2 Final use in transport

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; petrol and liquefied petroleum gas (LPG) are almost exclusively used for road transport; and diesel consumption is used for road transport, domestic water navigation, and rail. *Figure* 44 and *Table* 11 show the trends in transport's final energy use, split by fuel type between 2001 and 2021. Blended fuels (fossil fuels and biofuels) are reported separately as their renewable and non-renewable constituent components, despite being consumed as blended products.

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. Renewables made up a very small share of transport energy use in 2021. Electricity also remains a small share of transport energy use, which is split between electric rail (Dublin Area Rapid Transit (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.

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

Figure 44: Transport final energy use by fuel



Source: SEAI. This graph is based on data of fuel sales in Ireland, rather than fuels consumed in Ireland, so will include international trucking. Marine bunkers for international shipping are excluded.

Table 11: Growth rates, quantities and shares of final consumption in transport

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Diesel	2,891	69.6%	+185	+6.8%	-61	-2.1%	+669	+30.1%	+935	+47.8%
Gasoline	613	14.7%	+34	+5.9%	-390	-38.9%	-787	-56.2%	-1,039	-62.9%
Jet kerosene	446	10.7%	+48	+12.0%	-423	-48.7%	-254	-36.3%	-309	-41.0%
Fuel oil	0	0.0%	0	-	0	-	0	-	-20	-100.0%
LPG	1	0.0%	+0	+1.3%	-1	-54.3%	+1	+111.9%	-0	-25.7%
Total oil	**3,950**	**95.1%**	**+267**	**+7.3%**	**-875**	**-18.1%**	**-370**	**-8.6%**	**-434**	**-9.9%**
Natural gas	17	0.4%	+1	+5.8%	-5	-21.6%	+13	+359.2%	+17	-
Total fossil fuels	**3,967**	**95.5%**	**+268**	**+7.3%**	**-879**	**-18.1%**	**-357**	**-8.3%**	**-417**	**-9.5%**
Liquid biofuels	158	3.8%	+3	+1.9%	+72	+84.3%	+89	+129.9%	+158	-
Electricity	10	0.2%	+3	+38.6%	+5	+129.4%	+6	+146.5%	+7	+332.2%
Total	**4,155**	**100.0%**	**+275**	**+7.1%**	**-814**	**-16.4%**	**-271**	**-6.1%**	**-232**	**-5.3%**

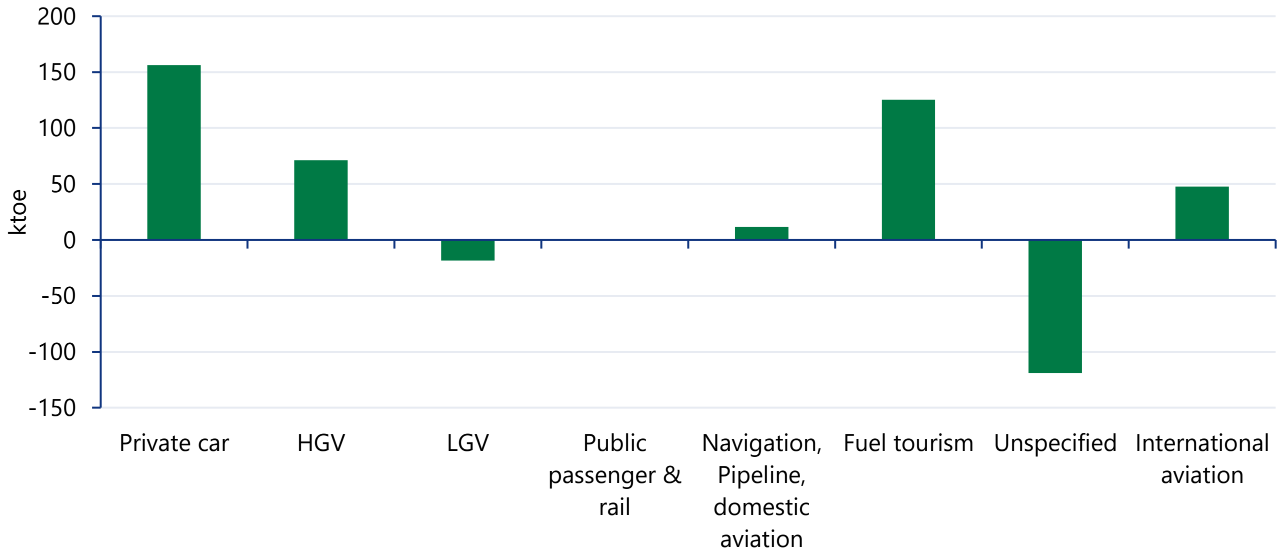
Source: SEAI

The change in transport energy use by sub-sector is shown in *Figure* 45 and detailed in *Table* 12. *Table* 13 shows the corresponding data for energy-related CO_2 emissions.

COVID-19 caused significant restrictions on personal mobility during 2020 and 2021, which had direct effects on transport energy use, especially on international aviation and private cars.

The National Energy Balance includes the energy use of international aviation. However, the CO_2 emissions from international aviation are not included in the National Greenhouse Gas Inventory prepared by the EPA, 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.

Figure 45: Change in transport energy use in 2021 by sub-sector



Source: SEAI

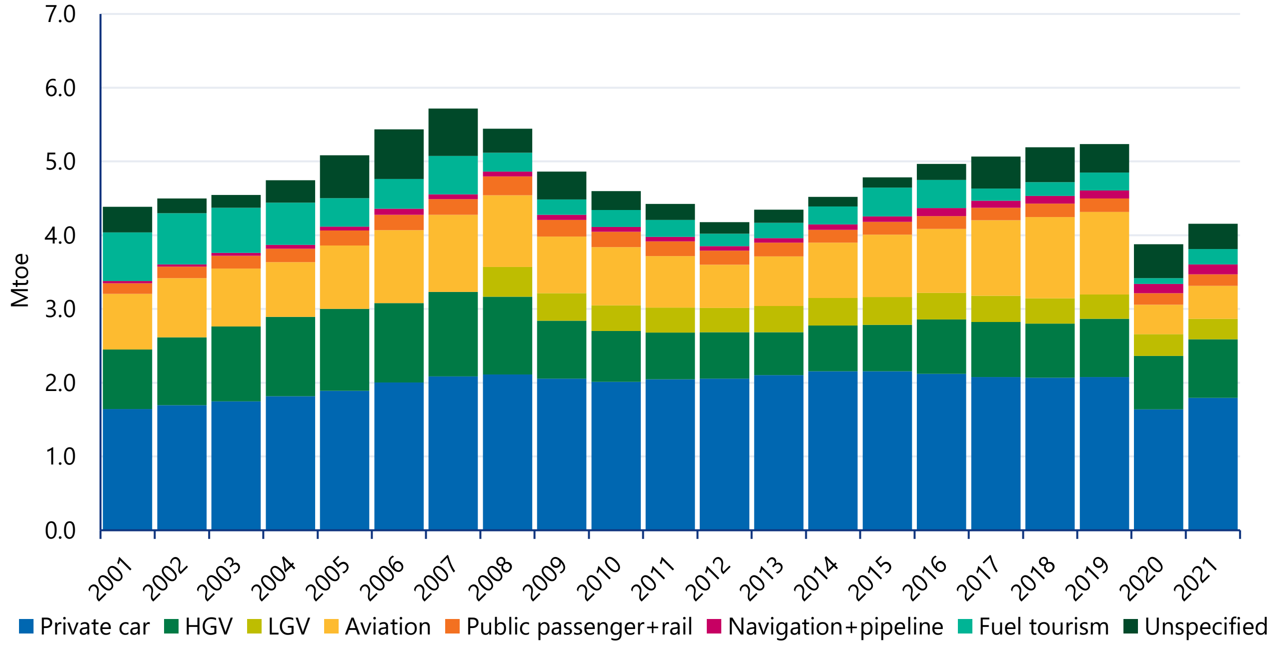
Figure 46 shows the trend for energy use of transport by sub-sector over the period. Transport has been the sector most responsive to changes in economic growth. Transport energy use and CO_2 emissions peaked in 2007 before falling sharply during the recession. It returned to growth in 2013, but by 2021, total transport energy use was still below the 2007 peak. The energy use of light goods vehicles (LGV) is estimated from 2008 onwards. Prior to 2008, the energy use of this sub-sector was included in the 'unspecified' category.

Private car energy use clearly dominates and accounted for over 40% of transport energy use in 2021. Private car energy use declined briefly during the recession in 2009 and 2010 but returned to growth in 2011. It peaked in 2015 and remained relatively flat until 2019, before the sharp drop in 2020.

Aviation energy use is notable in that it usually makes up a large share of transport energy use in Ireland, particularly since 2000, but can be severely affected by external factors, such as recessions or the COVID-19 pandemic. Aviation energy use fell by 44% between 2007 and 2012 during the recession. It returned to strong growth after 2012, reaching an all-time-high in 2019, 6.8% above the previous 2007 peak, before the dramatic fall in 2020.

Heavy goods vehicles (HGV) energy use also saw a large reduction during the recession, falling by 49% between 2007 and 2013. It has increased since, but remains below the 2007 peak. These changes are due to changes in the amount of goods transported, as discussed further in section 10.3.4.

Figure 46: Transport energy demand by sub-sector



Source: SEAI

Table 12: Growth rates, quantities and shares of transport final energy demand by sub-sector

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Private car	1,794	43.2%	+156	+9.5%	-328	-15.4%	-253	-12.3%	+152	+9.3%
HGV	796	19.1%	+71	+9.8%	+60	+8.2%	+163	+25.8%	-12	-1.5%
LGV	279	6.7%	-18	-6.2%	-80	-22.3%	-60	-17.7%	+279	-
Aviation	447	10.7%	+48	+12.0%	-423	-48.6%	-254	-36.2%	-310	-41.0%
Public passenger & rail	155	3.7%	+1	+0.4%	-18	-10.6%	-43	-21.6%	+11	+7.4%
Navigation & pipeline	136	3.3%	+11	+9.1%	+29	+26.6%	+76	+127.6%	+107	+371.6%
Fuel tourism	206	5.0%	+125	+155.6%	-178	-46.4%	-24	-10.6%	-453	-68.8%
Unspecified	343	8.2%	-119	-25.8%	+125	+57.3%	+123	+56.2%	-6	-1.7%
Total	**4,155**	**100.0%**	**+275**	**+7.1%**	**-814**	**-16.4%**	**-271**	**-6.1%**	**-232**	**-5.3%**

Source: SEAI

Table 13: Growth rates, quantities and shares of transport CO_2 emissions by sub-sector

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity ($ktCO_2$)	Share (%)	($ktCO_2$)	(%)	($ktCO_2$)	(%)	($ktCO_2$)	(%)	($ktCO_2$)	(%)
Private car	5,178	48.1%	+465	+9.9%	-1,020	-16.5%	-780	-13.1%	+325	+6.7%
HGV	2,307	21.5%	+211	+10.1%	+117	+5.3%	+427	+22.7%	-171	-6.9%
LGV	811	7.5%	-51	-5.9%	-260	-24.3%	-199	-19.7%	+811	-
Domestic aviation	9	0.1%	+1	+9.1%	-8	-48.8%	-16	-65.1%	-60	-87.6%
Public passenger	338	3.1%	-5	-1.5%	-56	-14.3%	-116	-25.5%	+38	+12.8%
Rail	137	1.3%	+9	+6.7%	-4	-2.7%	-14	-9.5%	-19	-12.1%
Navigation	370	3.4%	+35	+10.4%	+106	+40.4%	+198	+115.3%	+282	+319.0%
Pipeline	0	0.0%	0	-	0	-	0	-	0	-
Fuel tourism	597	5.6%	+364	+156.3%	-546	-47.8%	-86	-12.6%	-1,396	-70.0%
Unspecified	986	9.2%	-343	-25.8%	+357	+56.8%	+349	+54.9%	-71	-6.7%
Total (excl. international aviation)	**10,754**	**100.0%**	**+686**	**+6.8%**	**-1,336**	**-11.0%**	**-217**	**-2.0%**	**-239**	**-2.2%**
International aviation	1,326		+142	+12.0%	-1,255	-48.6%	-742	-35.9%	-867	-39.5%
Total (incl. international aviation)	**12,080**		**+828**	**+7.4%**	**-2,591**	**-17.7%**	**-960**	**-7.4%**	**-1,107**	**-8.4%**

Source: SEAI

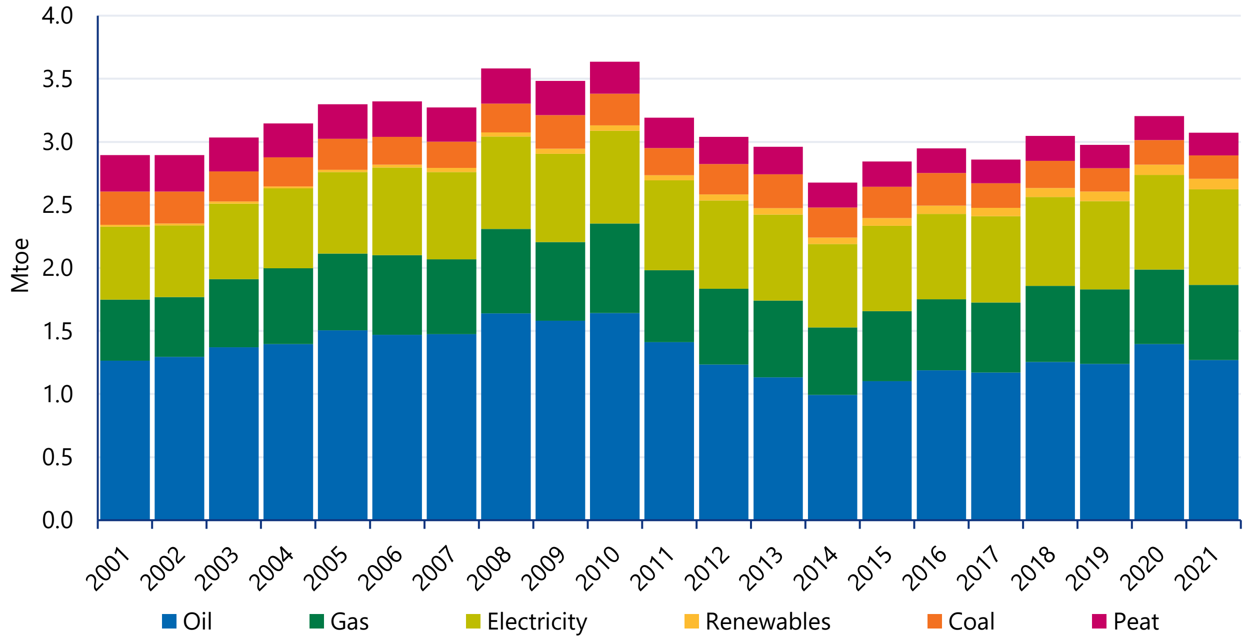
5.2.3 Final use in residential

Figure 47 shows the mix of fuels consumed in the residential sector between 2005 and 2021. 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. Electricity was the second largest source of energy in the sector in 2021, with natural gas having the third largest share. Use of renewables for final energy directly in households has grown each year since 2016. *Table* 14 shows the growth rates, quantities and shares.

It is notable that electricity consumption over the period was at its highest in 2021.

Figure 47: Residential final energy use by fuel



Source: SEAI

Table 14: Growth rates, quantities and shares of final consumption in the residential sector

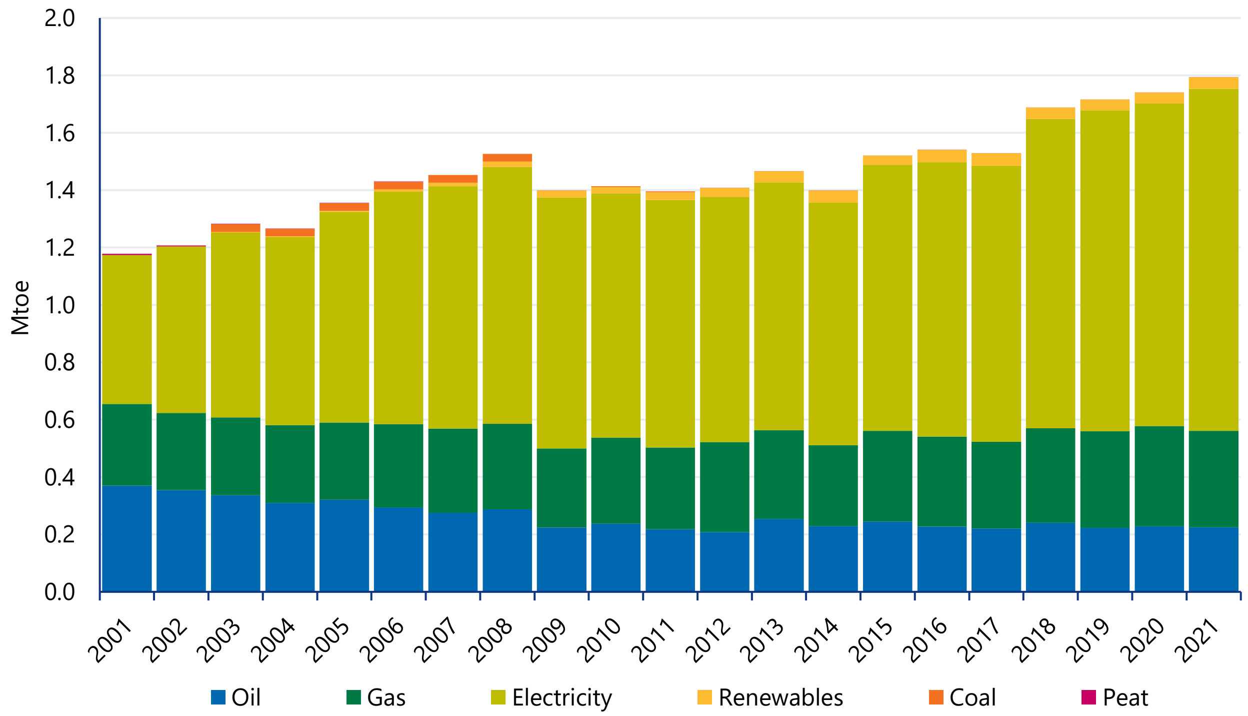
	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Oil	1,271	41.3%	-127	-9.1%	+82	+6.9%	-141	-10.0%	+5	+0.4%
Gas	595	19.4%	+5	+0.9%	+32	+5.7%	+26	+4.5%	+113	+23.5%
Coal	185	6.0%	-10	-4.9%	-72	-27.8%	-30	-13.9%	-78	-29.7%
Peat	180	5.9%	-9	-5.0%	-17	-8.6%	-61	-25.4%	-108	-37.4%
Fossil Fuels	**2,231**	**72.6%**	**-140**	**-5.9%**	**+26**	**+1.2%**	**-207**	**-8.5%**	**-68**	**-3.0%**
Biomass	27	0.9%	+1	+3.9%	-7	-21.5%	+5	+21.2%	+11	+64.4%
Solar thermal	14	0.5%	-0	-0.4%	+2	+16.1%	+5	+62.9%	+14	-
Ambient	45	1.5%	+2	+3.8%	+25	+123%	+34	+305%	+45	-
Renewables	**85**	**2.8%**	**+3**	**+3.1%**	**+19**	**+28.8%**	**+44**	**+104%**	**+69**	**+416%**
Electricity	757	24.6%	+7	+0.9%	+80	+11.8%	+45	+6.3%	+178	+30.8%
Total	**3,073**	**100%**	**-131**	**-4.1%**	**+125**	**+4.2%**	**-119**	**-3.7%**	**+179**	**+6.2%**

Source: SEAI

5.2.4 Final use in services

In determining the sectoral breakdown of commercial and public service energy use, SEAI uses a blend of data sources, including the BEUS from the CSO. In May 2022, the CSO published the latest version of the BEUS, which is based on energy use in 2019. SEAI uses this most recent BEUS release in estimating the 2021 energy consumption across the commercial and public service sectors.

Figure 48: Commercial and public services final energy use by fuel



Source: SEAI

Figure 48 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. Electricity is used in buildings for heating, air conditioning, water heating, lighting, lifts and escalators, automatic doors, and ICT. Electricity in services is also used for public lighting, off-road electric vehicles, and water and sanitation services.

Electricity use in services is driven by the changing structure of this sector and the general increase in 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* 15.

Table 15: Growth rates, quantities and shares of final consumption in the commercial and public services sector

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Oil	225	12.6%	-3	-1.2%	-2	-0.7%	+7	+3.4%	-144	-39.0%
Gas	336	18.7%	-14	-3.9%	+21	+6.8%	+50	+17.7%	+50	+17.7%
Coal	0	0.0%	0	+0.0%	-0	-39.6%	-3	-89.5%	+0	-
Peat	0	0.0%	0	-	0	-	0	-	-4	-100.0%
Total fossil fuels	**561**	**31.3%**	**-16**	**-2.8%**	**+19**	**+3.6%**	**+54**	**+10.7%**	**-98**	**-14.9%**
Renewables	41	2.3%	+3	+7.3%	-1	-3.0%	+15	+55.9%	+41	+86045%
Electricity	1,192	66.4%	+68	+6.0%	+236	+24.7%	+329	+38.1%	+673	+129.7%
Total	**1,794**	**100.0%**	**+54**	**+3.1%**	**+254**	**+16.5%**	**+398**	**+28.5%**	**+616**	**+52.3%**

Source: SEAI

6 Energy modes

6.1 Introduction to modes

It is useful to split energy supply or 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 (for example electric heaters and electric vehicles (EVs)) is counted in the electricity mode only, not the heat or transport modes. This ensures that summing across the three modes gives a consistent total energy use.

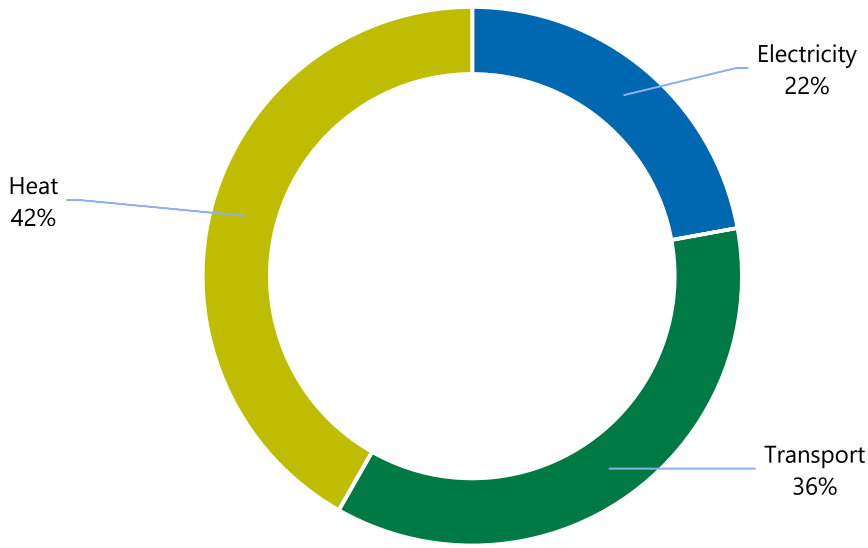
6.2 Final energy use by mode

Figure 49 shows the current split in final energy use between electricity, transport and heat.

Figure 50 shows the historical trend of the three modes in terms of final energy use. *Table* 16 shows the quantities and shares of final energy use in each mode and changes relative to previous years.

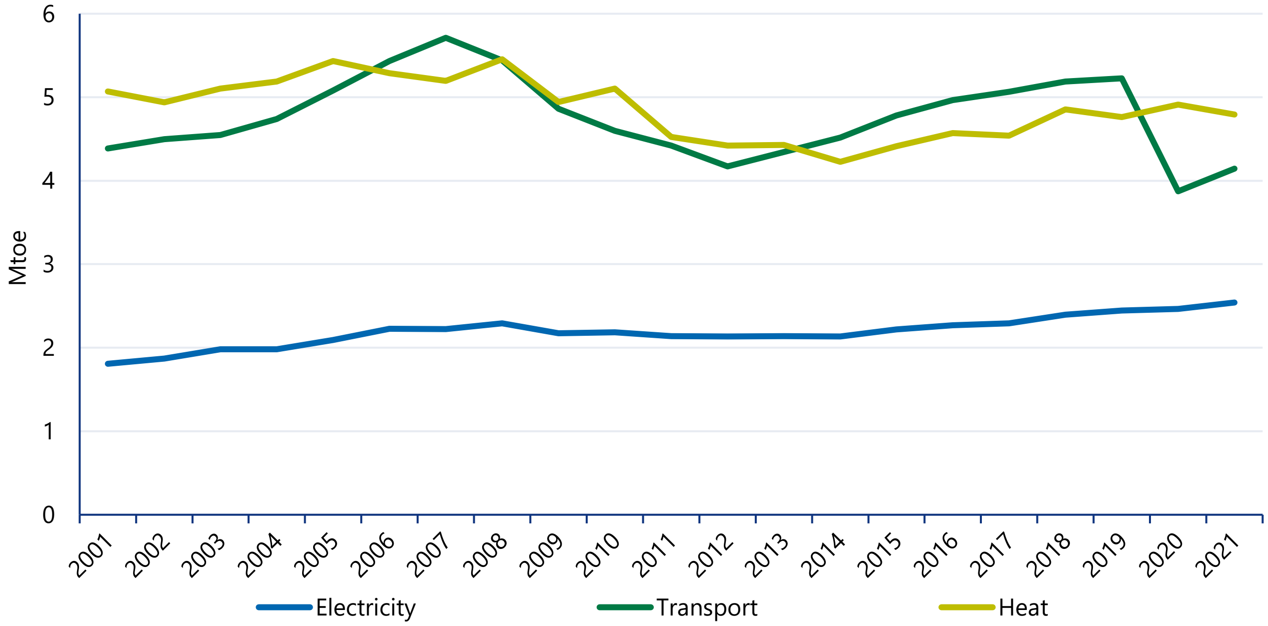
The transport and heat modes historically account for approximately 40% of final energy use each, with the electricity mode accounting for the remaining 20%. However, electricity consumption has increased steadily over this 21-year period at a faster rate than total energy consumption. The heat mode tends to show the greatest year-to-year fluctuations, due to its sensitivity to weather effects. Section 9.2 provides more detail on weather effects on heating energy. Final energy use in transport decreased during the 2008-2012 recession, and again during the COVID-19 restrictions in 2020 and early 2021. Outside of these events, final energy use in the transport mode has increased each year.

Figure 49: Current split of final energy by mode of application



Source: SEAI

Figure 50: Final energy in electricity, transport and heat



Source: SEAI

Table 16: Final energy in electricity, transport and heat compared with previous years

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Electricity	2,542	22.1%	+79	+3.2%	+273	+12.0%	+402	+18.8%	+733	+40.6%
Transport	4,145	36.1%	+272	+7.0%	-819	-16.5%	-277	-6.3%	-239	-5.4%
Heat	4,794	41.8%	-116	-2.4%	+223	+4.9%	+271	+6.0%	-275	-5.4%
Total	**11,481**	**100%**	**+235**	**+2.1%**	**-323**	**-2.7%**	**+397**	**+3.6%**	**+220**	**+1.9%**

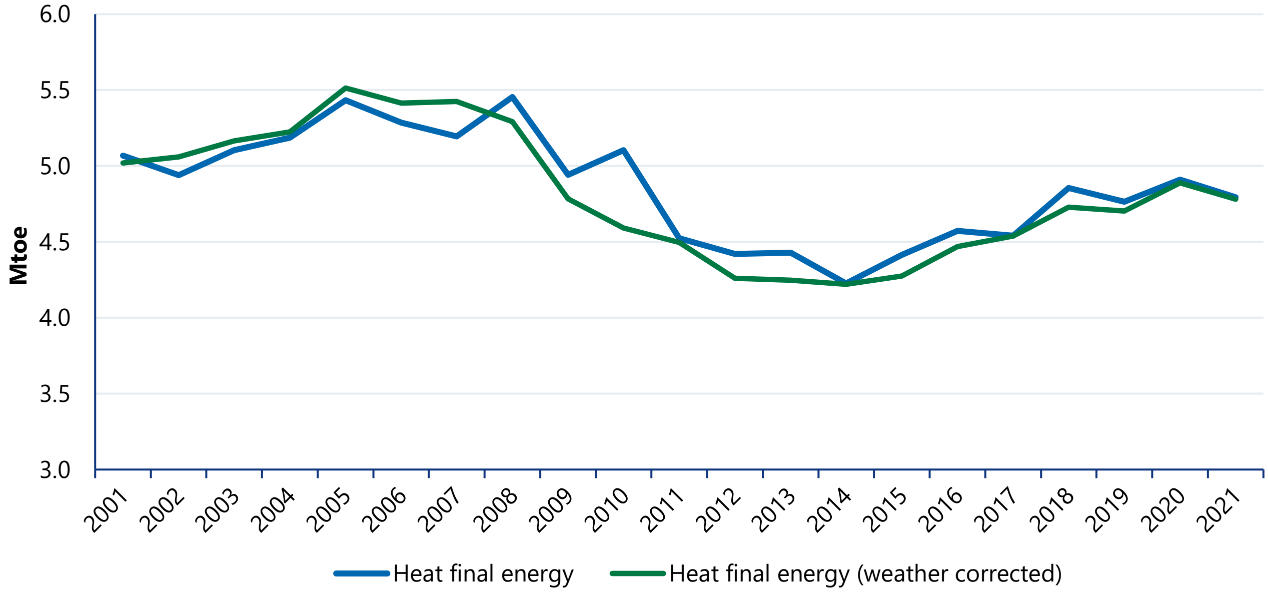
Source: SEAI

6.3 Heat mode

Figure 51 shows the historical final energy use in the heat mode 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 9.2.

Weather-corrected heat demand reached a broad minimum in the period of 2012 to 2015 (averaging 4,250 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.

Figure 51: Final energy use for heat, actual and weather corrected



Source: SEAI

6.3.1 Final energy use in heat mode by sector

As shown in *Figure* 52 and detailed in *Table* 17, the residential sector is the largest end user of final energy in the heat mode, followed by industry, services, and agricultural and fisheries sectors.

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.

Figure 52: Final consumption of heat by sector

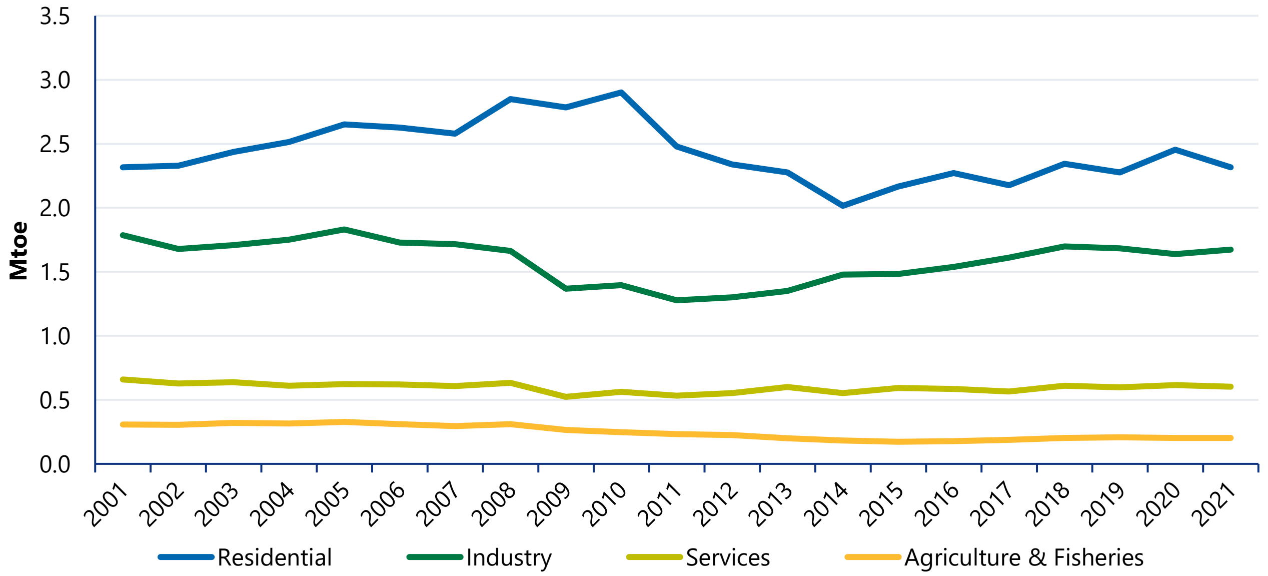


Table 17: Final energy in heat by sector compared with previous years

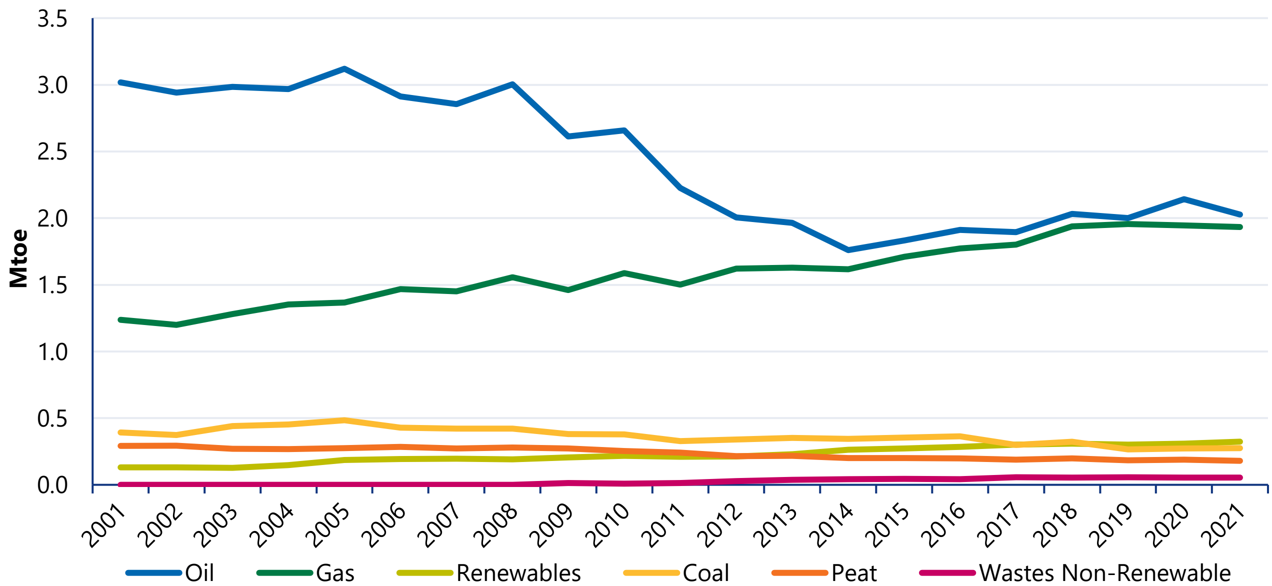
	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Residential	2,316	48.3%	-138	-5.6%	+45	+2.0%	-163	-6.6%	+1	+0.0%
Industry	1,674	34.9%	+37	+2.2%	+137	+8.9%	+396	+31.0%	-112	-6.3%
Services	602	12.6%	-14	-2.2%	+18	+3.1%	+69	+13.0%	-57	-8.6%
Agriculture & fisheries	202	4.2%	-1	-0.6%	+23	+12.9%	-31	-13.4%	-107	-34.6%
Total	**4,794**	**100.0%**	**-116**	**-2.4%**	**+223**	**+4.9%**	**+271**	**+6.0%**	**-275**	**-5.4%**

6.3.2 Final energy use in heat mode by fuel and source

Figure 53 and *Table* 18 detail the fuels and energy sources in the final energy heat mode. Oil remains the largest fuel type for the delivery of heat, followed closely by natural gas. 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. 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.

Coal and peat combined make up just less than 10% of Ireland's final energy demand in the heat mode. These are followed by renewables and non-renewable waste.

Figure 53: Final consumption of heat by fuel



Source: SEAI

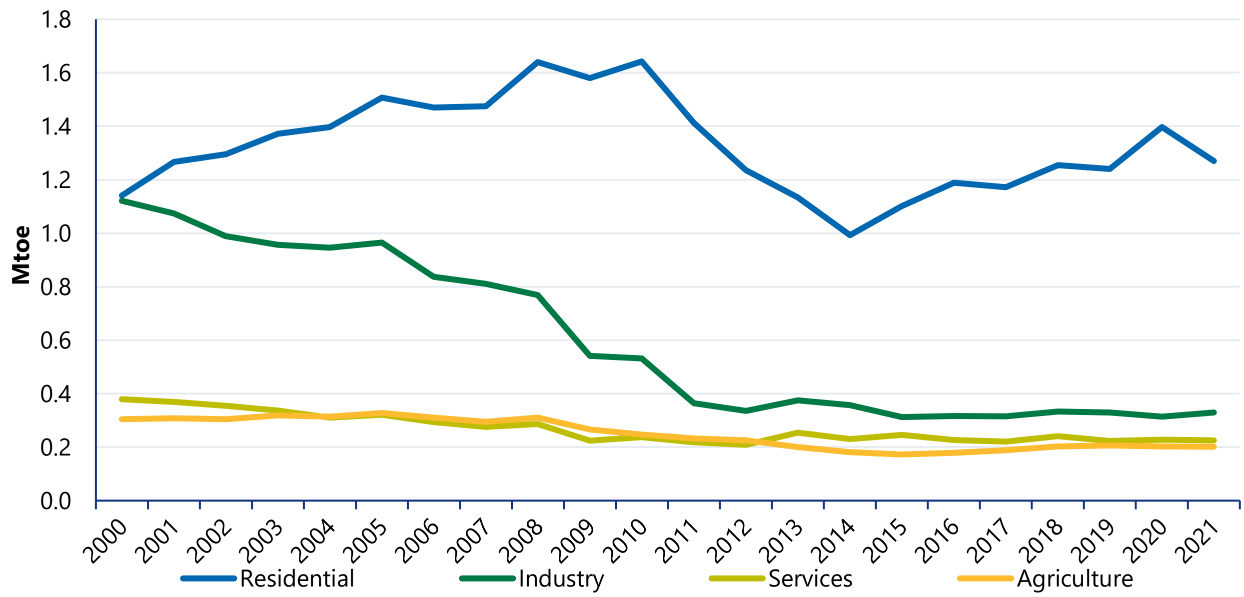
Table 18: Final energy in heat by fuel compared with previous years

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Oil	2,027	42.3%	-116	-5.4%	+116	+6.1%	-200	-9.0%	-991	-32.8%
Gas	1,934	40.3%	-10	-0.5%	+162	+9.1%	+432	+28.8%	+697	+56.4%
Renewables	324	6.8%	+16	+5.1%	+40	+14.0%	+114	+54.3%	+195	+149.8%
Coal	275	5.7%	+4	+1.4%	-89	-24.4%	-53	-16.2%	-118	-30.0%
Peat	180	3.8%	-9	-5.0%	-18	-9.0%	-62	-25.5%	-112	-38.4%
Wastes non-renewable	54	1.1%	+0	+0.6%	+12	+29.3%	+40	+280.2%	+54	-
Total	**4,794**	**100%**	**-116**	**-2.4%**	**+223**	**+4.9%**	**+271**	**+6.0%**	**-275**	**-5.4%**

Figure 54 profiles oil use for final energy in the heat mode broken down 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.

Oil consumption for heat in the residential sector fell by 40% from 2010 to 2014, during a period of record high oil prices, before trending upwards in the second half of the decade.

Figure 54: Final consumption of oil for heat by sector



6.4 Transport mode

6.4.1 Final energy use in transport mode by sub-sector

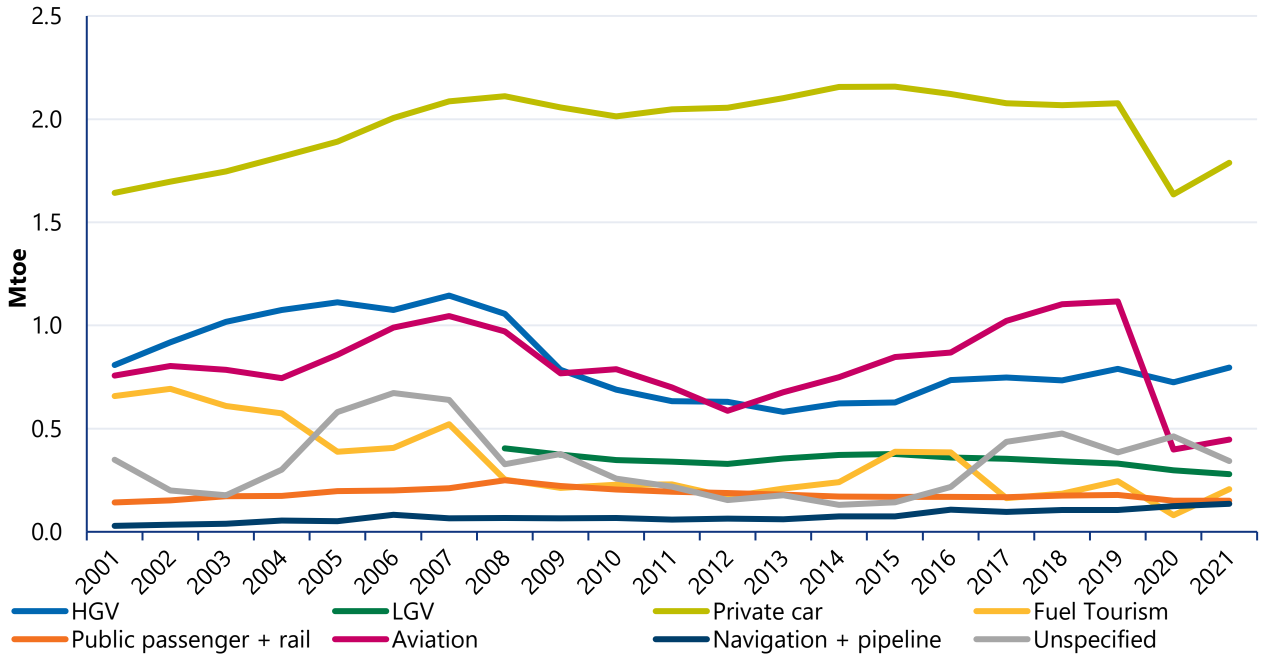
Figure 55 and *Table* 19 show the trends and details of final energy use in the transport mode by sub-sector.

Private car energy use remains the transport sub-sector with the greatest energy use. Energy use in private cars had been relatively constant for a decade at an average of 2,100 ktoe, but this changed in 2020, when energy use for private cars dropped by 21%. This reduction was 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.

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

The unspecified quantity in *Figure* 55 and *Table* 19 relates to measured consumption of transport fuels that cannot be definitively attributed to one of the road transport sub-sectors, and is composed entirely of petrol, road diesel and respective blended biofuels.

Figure 55: Transport energy demand by sub-sector



Source: SEAI

Table 19: Final energy in transport by sub-sector compared with previous years

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
HGV	796	19.2%	+71	+9.8%	+60	+8.2%	+163	+25.8%	-12	-1.5%
LGV	279	6.7%	-18	-6.2%	-80	-22.3%	-60	-17.7%	+279	-
Private car	1,789	43.2%	+154	+9.4%	-333	-15.7%	-258	-12.6%	+147	+8.9%
Public passenger	117	2.8%	-2	-1.8%	-17	-12.4%	-37	-24.2%	+18	+18.4%
Rail	34	0.8%	+3	+8.1%	-2	-5.9%	-6	-14.6%	-9	-21.7%
Fuel tourism	206	5.0%	+125	+155.6%	-178	-46.4%	-24	-10.6%	-453	-68.8%
Navigation	121	2.9%	+11	+10.4%	+35	+40.4%	+65	+115.3%	+92	+319.0%
Aviation	447	10.8%	+48	+12.0%	-423	-48.6%	-254	-36.2%	-310	-41.0%
Pipeline	15	0.4%	-0	-0.2%	-6	-28.8%	+12	+316.8%	+15	-
Unspecified	343	8.3%	-119	-25.8%	+125	+57.3%	+123	+56.2%	-6	-1.7%
Total	**4,145**	**100.0%**	**+272**	**+7.0%**	**-819**	**-16.5%**	**-277**	**-6.3%**	**-239**	**-5.4%**

6.4.2 Final energy use in transport mode by fuel and source

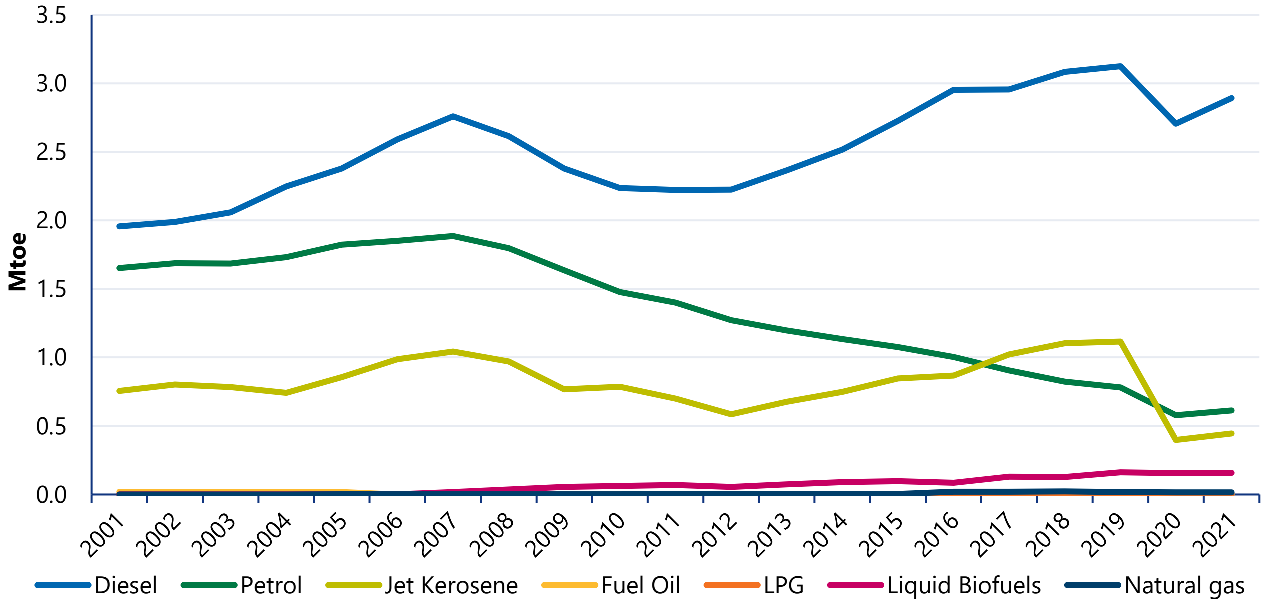
Figure 56 and *Table* 20 show the final energy use in the transport mode by fuel type. To avoid double counting across the transport and electricity modes, energy provided by electricity (e.g. EVs) are counted in the electricity mode only, and so are excluded from this transport analysis.

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% 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 56: Final energy in transport by fuel



Source: SEAI

Table 20: Final energy in transport by fuel compared with previous years

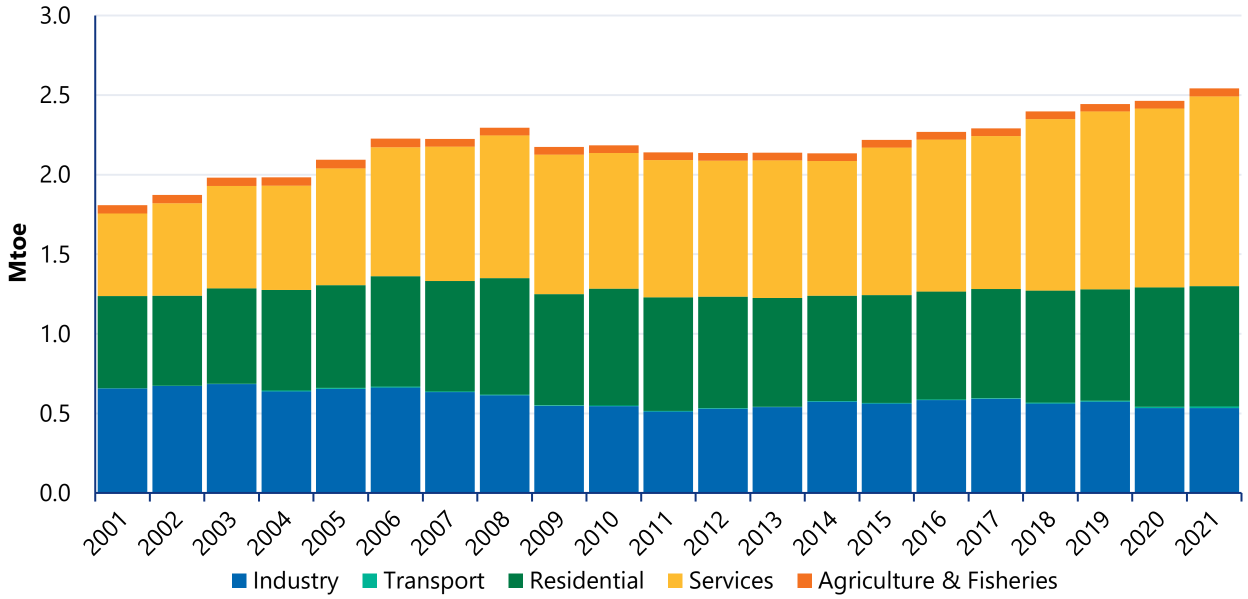
	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Diesel	2,891	70.1%	+185	+6.8%	-61	-2.1%	+669	+30.1%	+935	+47.8%
Petrol	613	14.9%	+34	+5.9%	-390	-38.9%	-787	-56.2%	-1,039	-62.9%
Jet kerosene	446	10.8%	+48	+12.0%	-423	-48.7%	-254	-36.3%	-309	-41.0%
Fuel oil	0	0.0%	0	-	0	-	0	-	-20	-100.0%
LPG	1	0.0%	+0	+1.3%	-1	-54.3%	+1	+111.9%	-0	-25.7%
Liquid biofuels	158	3.8%	+3	+1.9%	+72	+84.3%	+89	+129.9%	+158	-
Natural gas	17	0.4%	+1	+5.8%	-5	-21.6%	+13	+359.2%	+17	-
Total	**4,125**	**100.0%**	**+271**	**+7.0%**	**-807**	**-16.4%**	**-268**	**-6.1%**	**-259**	**-5.9%**

6.5 Electricity mode

6.5.1 Final energy use in electricity mode by sector

Figure 57 shows the trends and breakdown of final energy consumption in the electricity mode across the main sectors. 2021 was a record high for final energy demand for electricity. In order of largest to smallest, the sectoral consumers are services, residential, industry, agriculture and fisheries, and transport (barely visible in *Figure* 57).

Figure 57: Final consumption of electricity by sector



Source: SEAI

Table 21 details the quantities, shares and trends in final energy use of the electricity mode. Overall, the last 10 years have seen a significant increase in demand in services, a modest increase in residential and industry, and a small increase in agriculture and fisheries. The percentage growth in using electricity in transport over the last 10- and 20-year period is significant, but the absolute quantity of electricity used in transport is remains small. Electricity use in transport includes the DART rail system, the Luas light rail system and EVs on the road.

Table 21: Final energy in electricity by sector compared with previous years

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Industry	534	21.0%	-0	-0.0%	-50	-8.6%	+22	+4.2%	-123	-18.7%
Transport	10	0.4%	+3	+38.6%	+5	+129.4%	+6	+146.5%	+7	+332.2%
Residential	757	29.8%	+7	+0.9%	+80	+11.8%	+45	+6.3%	+178	+30.8%
Services	1,192	46.9%	+68	+6.0%	+236	+24.7%	+329	+38.1%	+673	+129.7%
Agriculture & fisheries	50	2.0%	+2	+3.5%	+2	+3.6%	+2	+3.6%	-2	-4.4%
Total	**2,542**	**100.0%**	**+79**	**+3.2%**	**+273**	**+12.0%**	**+402**	**+18.8%**	**+733**	**+40.6%**

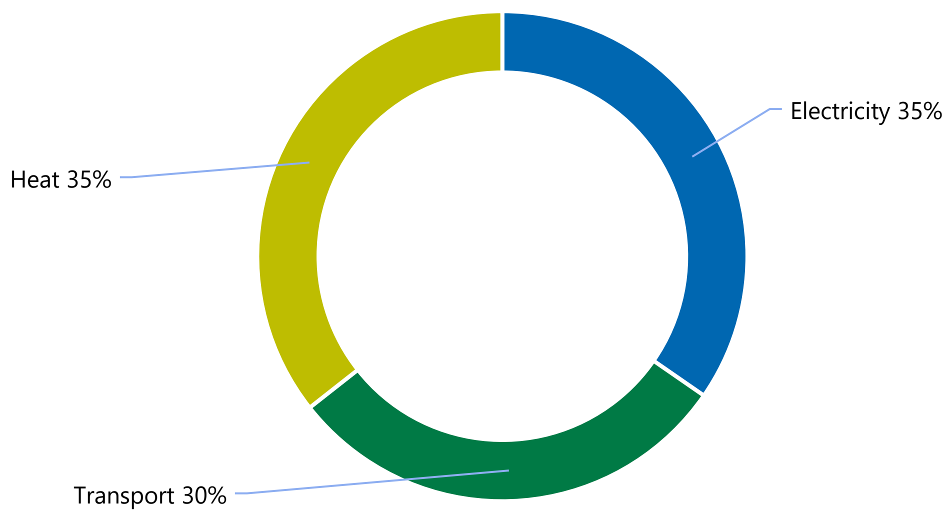
6.6 Primary energy requirement by mode

Figure 58 shows the primary energy supply through the lens of the electricity, transport and heat modes. To avoid double counting, heat and transport energy provided by electricity is counted in the electricity mode only.

Figure 59 shows the historical trend in primary energy by mode. All three modes have a broadly similar share in primary energy. This differs from the mode split of final energy use (see section 6.2) where the electricity mode is approximately half that of heat and transport. This is because 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 0.

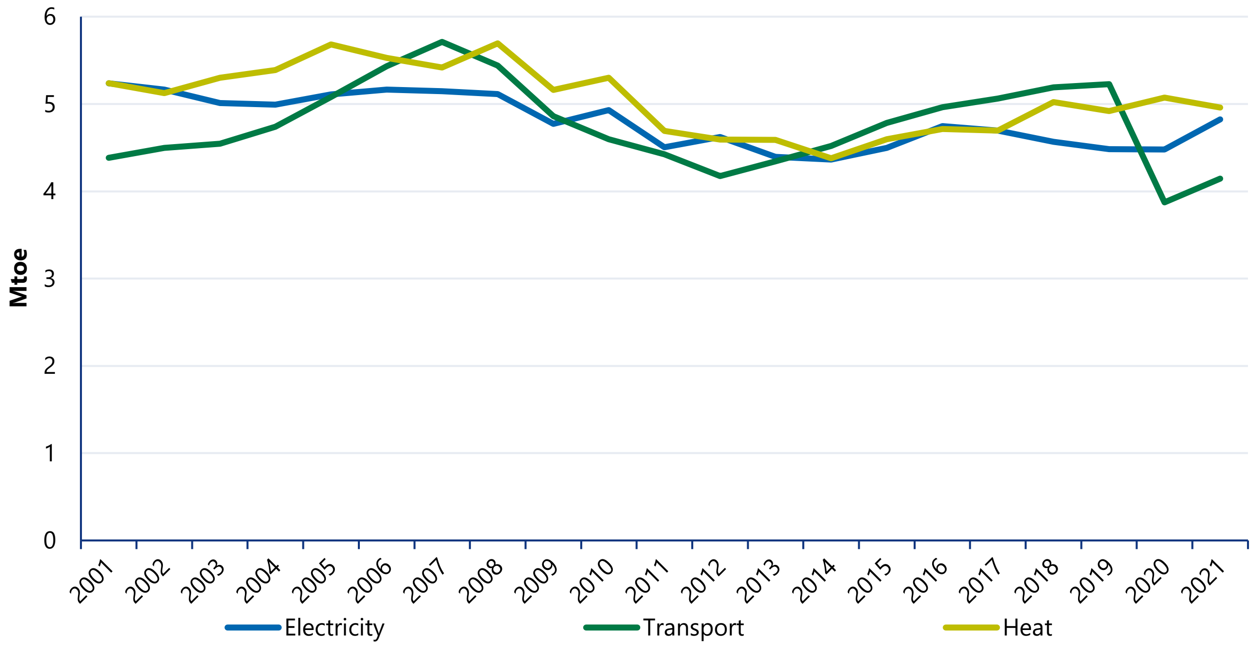
All three of the modes decreased during the economic downturn from 2008 to 2012. Transport grew to become the largest of the three modes from 2014 to 2019, before shrinking to become the smallest in 2020 due to the impact of the COVD-19 travel restrictions.

Figure 58: Current split of primary energy by mode of application



Source: SEAI

Figure 59: Primary energy by mode of application



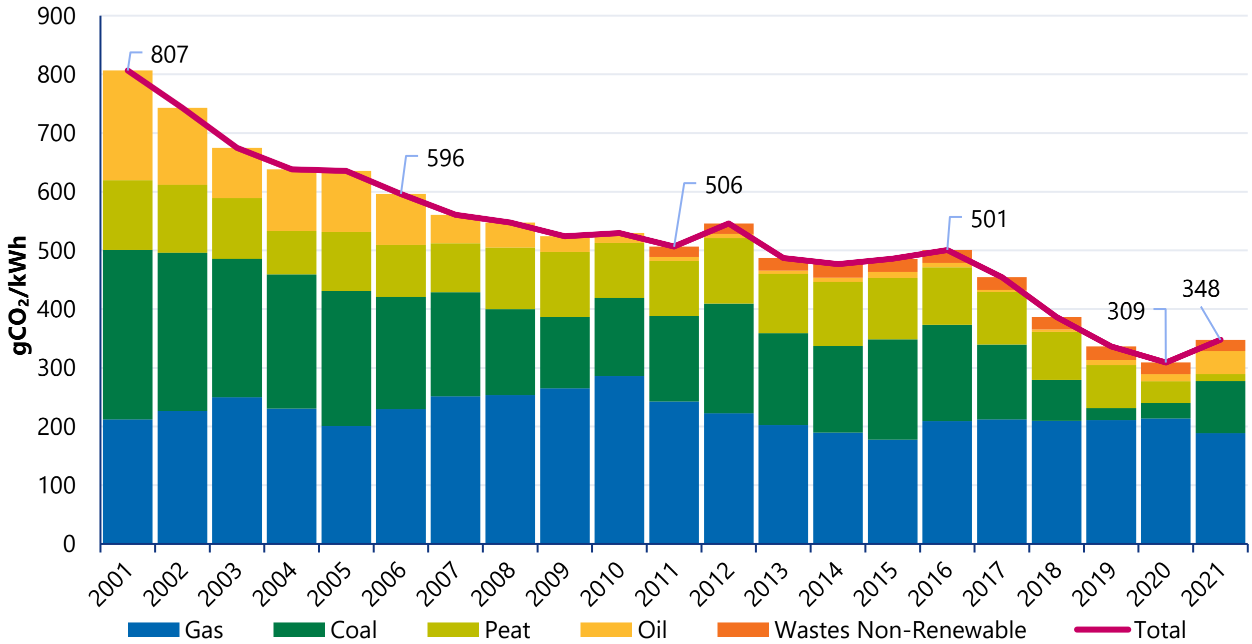
Source: SEAI

7 Energy-related CO_2 emissions

7.1 Carbon intensity of electricity supply

Figure 60 shows the CO_2 emission intensity of Ireland's electricity supply, which is measured in gCO_2/kWh. The stacked bars show the share of CO_2 emissions by fuel for each kWh of electricity supplied 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 supply, not the CO_2 intensity of the individual fuels themselves.

Figure 60: CO_2 emissions per kWh of electricity supplied, with contribution by fuel



Source: SEAI

The CO_2 intensity of electricity generation fell to a historic low in 2020, before increasing slightly in 2021 due to an increase in emissions from coal and, to a lesser extent, oil. The dramatic overall improvements in annual CO_2 emission intensity, as seen in *Figure* 60, are due to reductions in using 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.

7.2 Energy-related CO_2 emissions by sector

Figure 61, *Figure* 62 and *Table* 22 show the most recent and historical 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. It 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 reached a low point in 2020 before increasing slightly in 2021. Transport (excluding international aviation) provides the largest share of energy-related CO_2 emissions, followed by electricity generation, the residential sector, industry, services, international aviation, agriculture and fisheries, and other, in that order.

Figure 61: Current share of energy-related CO_2 emissions by sector

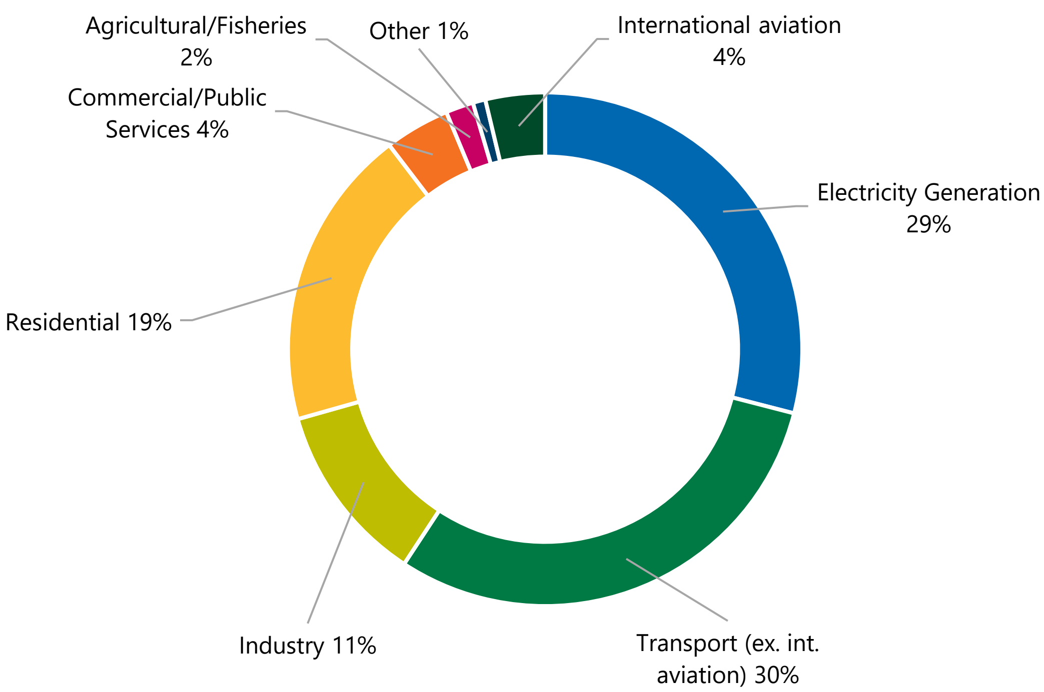
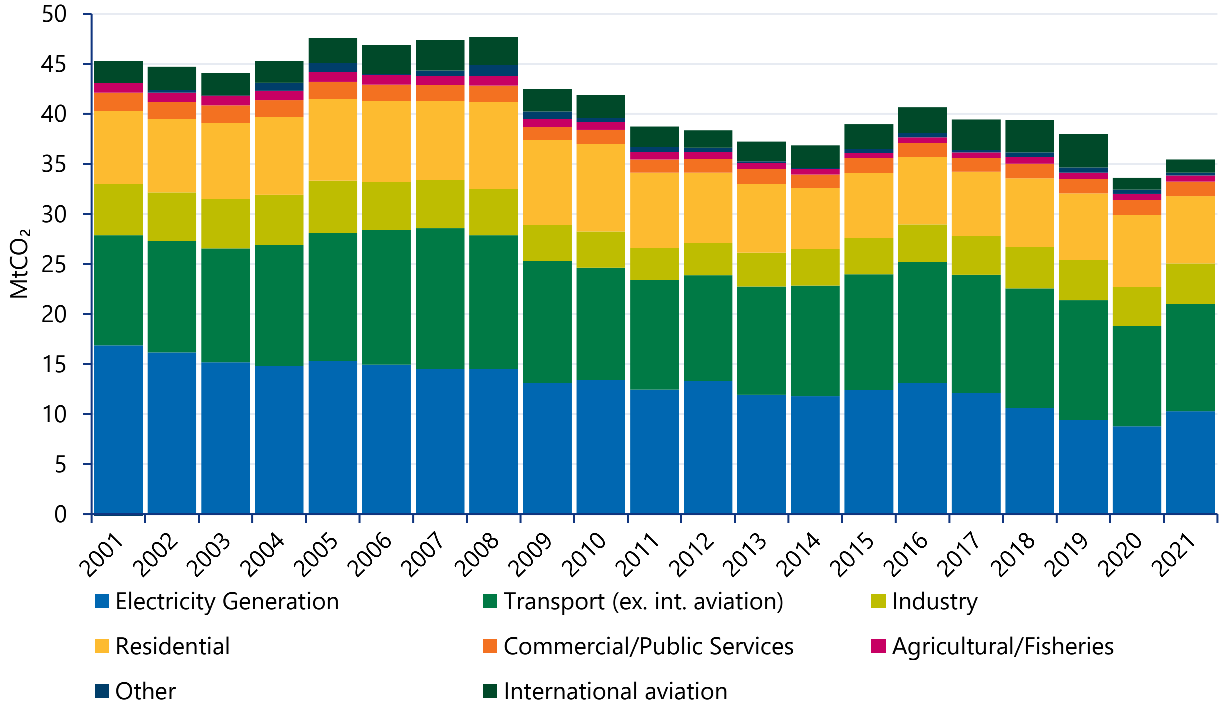


Figure 62: Energy-related annual CO_2 emissions by sector[4]



[4] Emissions for agriculture, as with all sectors, shown in the chart and tables are for energy-related emissions only.

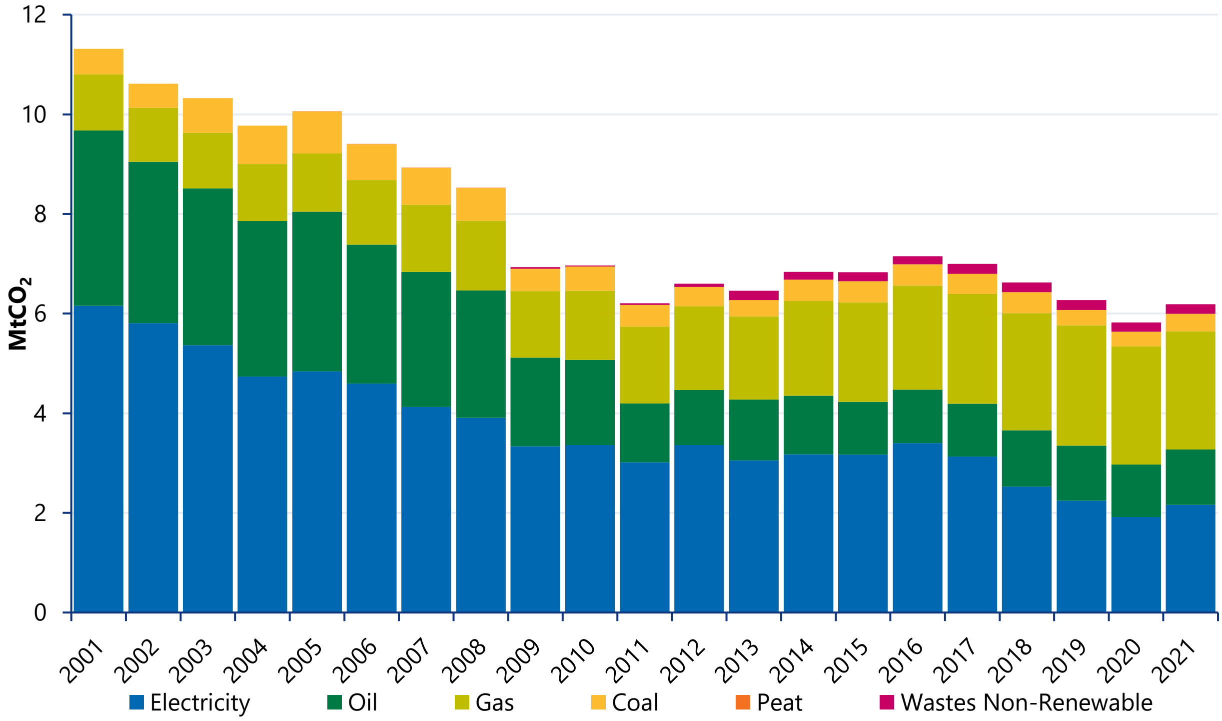
Table 22: Primary energy-related CO_2 by sector compared with previous years

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity ($ktCO_2$)	Share (%)	(kCO_2)	(%)	($ktCO_2$)	(%)	($ktCO_2$)	(%)	($ktCO_2$)	(%)
Electricity generation	10,289	29.0%	+1,518	+17.3%	-2,830	-21.6%	-2,177	-17.5%	-6,594	-39.1%
Transport (ex. int. aviation)	10,715	30.2%	+672	+6.7%	-1,350	-11.2%	-233	-2.1%	-258	-2.3%
Industry	4,032	11.4%	+127	+3.3%	+278	+7.4%	+842	+26.4%	-1,123	-21.8%
Residential	6,744	19.0%	-435	-6.1%	-20	-0.3%	-773	-10.3%	-559	-7.6%
Commercial / Public services	1,451	4.1%	-40	-2.7%	+45	+3.2%	+119	+8.9%	-367	-20.2%
Agricultural & fisheries	619	1.7%	-3	-0.6%	+71	+12.9%	-96	-13.4%	-327	-34.6%
Other	280	0.8%	-153	-35.3%	-142	-33.6%	-232	-45.2%	+536	-
Total excl. international aviation	**34,130**	**96.3%**	**+1,686**	**+5.2%**	**-3,947**	**-10.4%**	**-2,550**	**-7.0%**	**-8,691**	**-20.3%**
International aviation	1,326	3.7%	+142	+12.0%	-1,255	-48.6%	-742	-35.9%	-867	-39.5%
Total incl. international aviation	**35,456**	**100.0%**	**+1,829**	**+5.4%**	**-5,202**	**-12.8%**	**-3,293**	**-8.5%**	**-9,558**	**-21.2%**

7.2.1 Industry emissions

Approximately 60% of greenhouse gas emissions from industry are energy related. 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* 63 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 63: Industry energy-related CO_2 emissions by fuel



Source: SEAI

Table 23 shows the growth rates, quantities and relative shares of energy-related CO_2 emissions in industry.

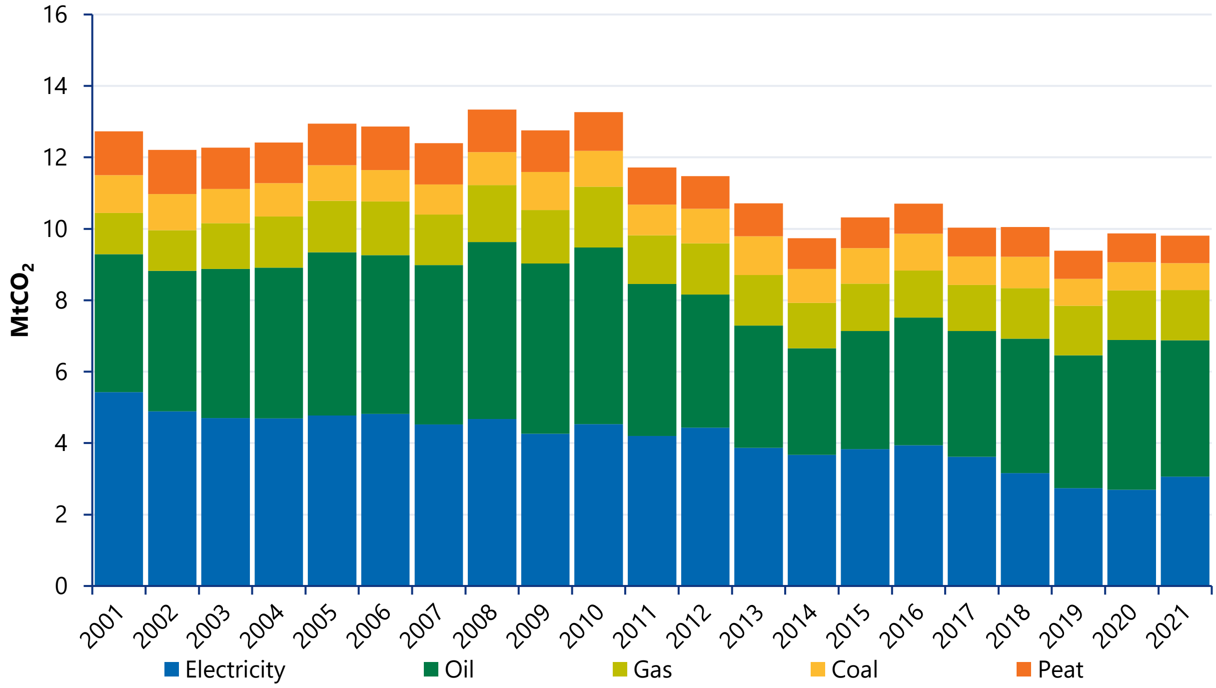
Table 23: Growth rates, quantities and shares of energy-related CO_2 emissions in industry

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity ($ktCO_2$)	Share (%)	($ktCO_2$)	(%)	($ktCO_2$)	(%)	($ktCO_2$)	(%)	($ktCO_2$)	(%)
Kerosene	18	0.3%	-2	-11.8%	+0	+0.3%	+1	+8.7%	-128	-87.6%
Fuel oil	68	1.1%	-25	-26.9%	-42	-38.2%	-472	-87.4%	-1,748	-96.3%
LPG	155	2.5%	+14	+9.8%	+11	+7.7%	+69	+80.0%	+11	+7.7%
Gasoil	305	4.9%	-2	-0.5%	+33	+12.0%	+34	+12.6%	-257	-45.7%
Petroleum coke	567	9.2%	+75	+15.2%	+39	+7.5%	+303	+114.7%	-281	-33.1%
Total oil	**1,113**	**18.0%**	**+59**	**+5.6%**	**+41**	**+3.8%**	**-65**	**-5.5%**	**-2,405**	**-68.4%**
Gas	2,368	38.3%	+3	+0.1%	+275	+13.1%	+821	+53.1%	+1,243	+110.6%
Coal	354	5.7%	+53	+17.5%	-68	-16.1%	-78	-18.1%	-158	-30.8%
Peat	0	0.0%	0	-	-4	-100.0%	-2	-100.0%	0	-
Total fossil fuels	**3,836**	**62.0%**	**+115**	**+3.1%**	**+244**	**+6.8%**	**+676**	**+21.4%**	**-1,320**	**-25.6%**
Electricity	2,158	34.9%	+240	+12.5%	-1,240	-36.5%	-857	-28.4%	-3,999	-65.0%
Wastes (non-renewable)	196	3.2%	+12	+6.5%	+34	+21.2%	+166	+557.0%	+196	-
Total	**6,190**	**100.0%**	**+367**	**+6.3%**	**-962**	**-13.4%**	**-15**	**-0.2%**	**-5,122**	**-45.3%**

7.2.2 Residential emissions

Figure 64 shows energy-related CO_2 emissions from the residential sector, including upstream electricity emissions. There was a reduction in energy-related CO_2 emissions between 2010 and 2014, but a return to growth in 2015, 2016, 2018 and again in 2020.

Figure 64: Residential energy-related CO_2 by fuel



Source: SEAI. Energy-related emissions detailed are not corrected for weather.

Table 24: Growth rates, quantities and shares of energy-related CO_2 emissions in the residential sector

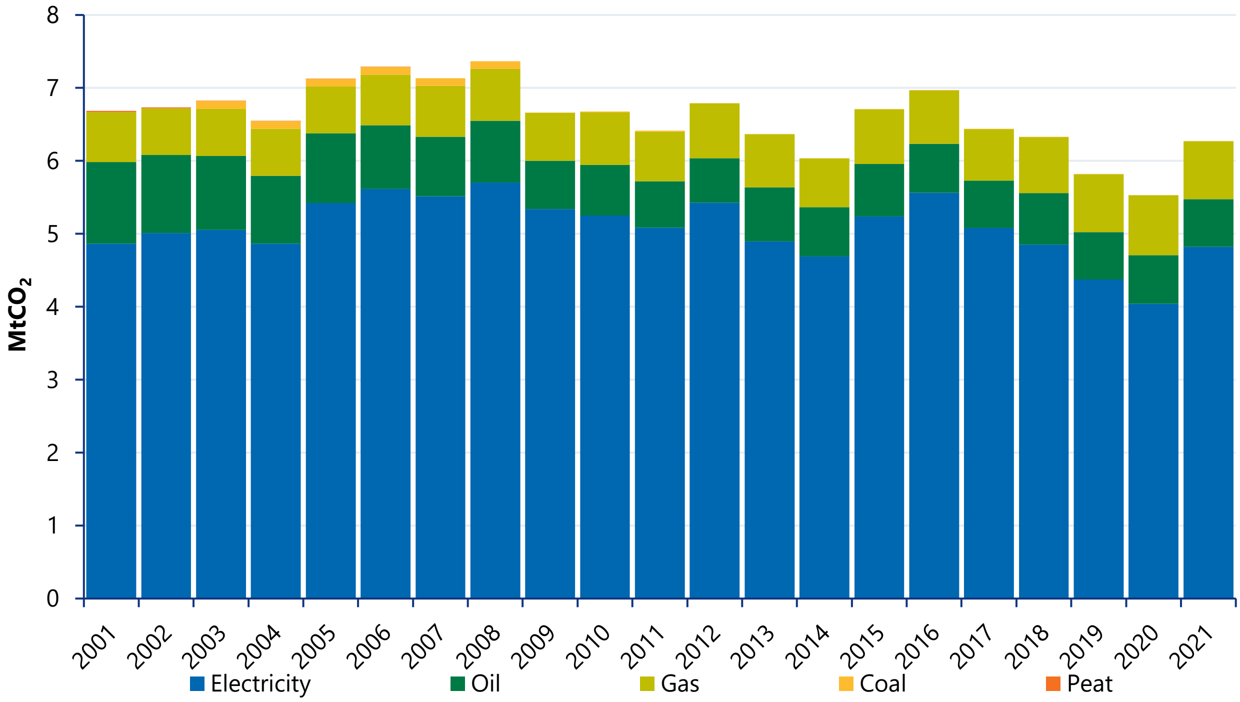
	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity ($ktCO_2$)	Share (%)	($ktCO_2$)	(%)	($ktCO_2$)	(%)	($ktCO_2$)	(%)	($ktCO_2$)	(%)
Oil	3,816	38.9%	-376	-9.0%	+247	+6.9%	-443	-10.4%	-44	-1.1%
Gas	1,404	14.3%	+17	+1.2%	+87	+6.6%	+44	+3.3%	+250	+21.7%
Coal	752	7.7%	-36	-4.6%	-284	-27.4%	-112	-13.0%	-308	-29.1%
Peat	772	7.9%	-39	-4.8%	-70	-8.3%	-261	-25.3%	-456	-37.1%
Total fossil fuels	**6,744**	**68.8%**	**-435**	**-6.1%**	**-20**	**-0.3%**	**-773**	**-10.3%**	**-559**	**-7.6%**
Electricity	3,062	31.2%	+366	+13.6%	-881	-22.3%	-1,134	-27.0%	-2,366	-43.6%
Total	**9,806**	**100.0%**	**-69**	**-0.7%**	**-901**	**-8.4%**	**-1,907**	**-16.3%**	**-2,924**	**-23.0%**

Source: SEAI

7.2.3 Commercial and public services emissions

Figure 63 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.

Figure 65: Commercial and public services sector CO_2 emissions by fuel



Source: SEAI

Table 25: Growth rates, quantities and shares of CO_2 emissions in commercial and public services

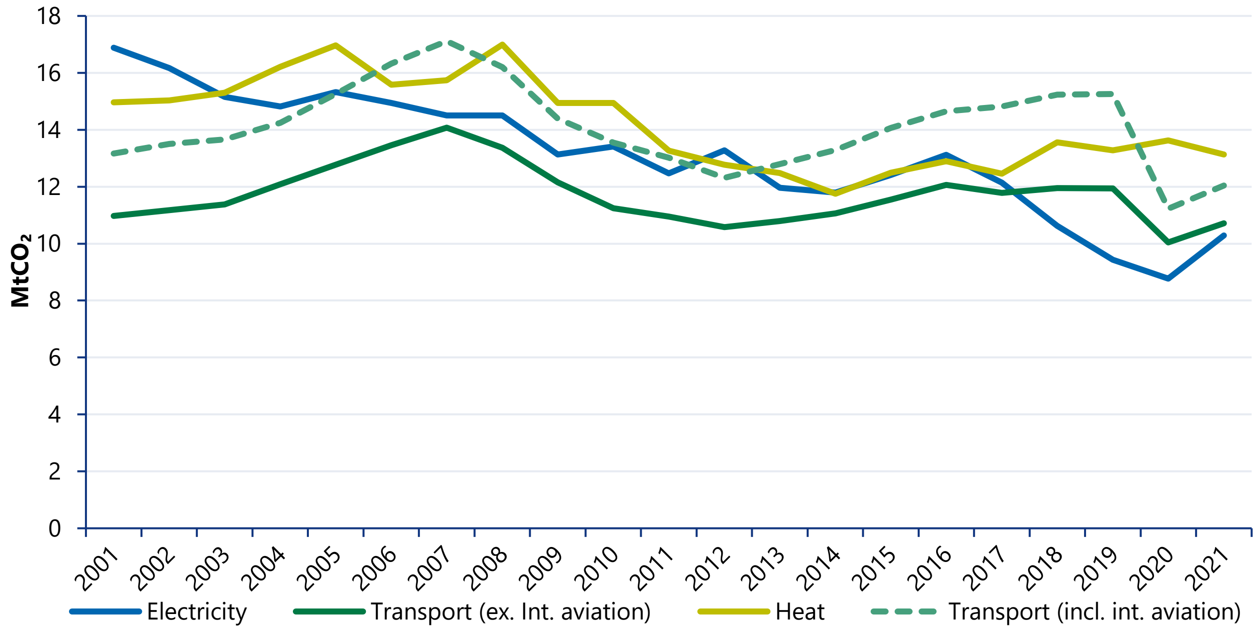
	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity ($ktCO_2$)	Share (%)	($ktCO_2$)	(%)	($ktCO_2$)	(%)	($ktCO_2$)	(%)	($ktCO_2$)	(%)
Oil	658	10.5%	-10	-1.5%	-11	-1.6%	+21	+3.4%	-459	-41.1%
Gas	792	12.6%	-30	-3.6%	+57	+7.8%	+111	+16.3%	+109	+16.0%
Coal	2	0.0%	0	+0.0%	-1	-39.6%	-14	-89.5%	+2	-
Peat	0	0.0%	0	-	0	-	0	-	-18	-100.0%
Total fossil fuels	**1,451**	**23.1%**	**-40**	**-2.7%**	**+45**	**+3.2%**	**+119**	**+8.9%**	**-367**	**-20.2%**
Electricity	4,819	76.9%	+780	+19.3%	-746	-13.4%	-264	-5.2%	-48	-1.0%
Total	**6,270**	**100.0%**	**+740**	**+13.4%**	**-700**	**-10.0%**	**-145**	**-2.3%**	**-414**	**-6.2%**

Source: SEAI

7.3 Energy-related CO_2 emissions by mode

Figure 66 shows energy-related CO_2 emissions, but divided into the three modes of electricity, transport and heat. This aggregates the emissions from industry, residential, commercial services, public services, and agriculture and fisheries shown in *Figure* 61, *Figure* 62 and *Table* 22 together as heat. The emissions for transport, including and excluding international aviation, are shown for reference.

Figure 66: Energy-related CO_2 emissions by electricity, transport and heat



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.

CO_2 emissions from electricity generation reached a minimum in 2020, before increasing again in 2021. 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, with emissions from international aviation alone dropping 64.3%. Emissions from transport subsequently increased in 2021 as travel restrictions eased. In contrast, CO_2 emissions from heat increased slightly during 2020, due in part to more time spent at home during COVID-19 restrictions, before decreasing again in 2021. Annual emissions of CO_2 from electricity reached a minimum in 2020 before increasing in 2021.

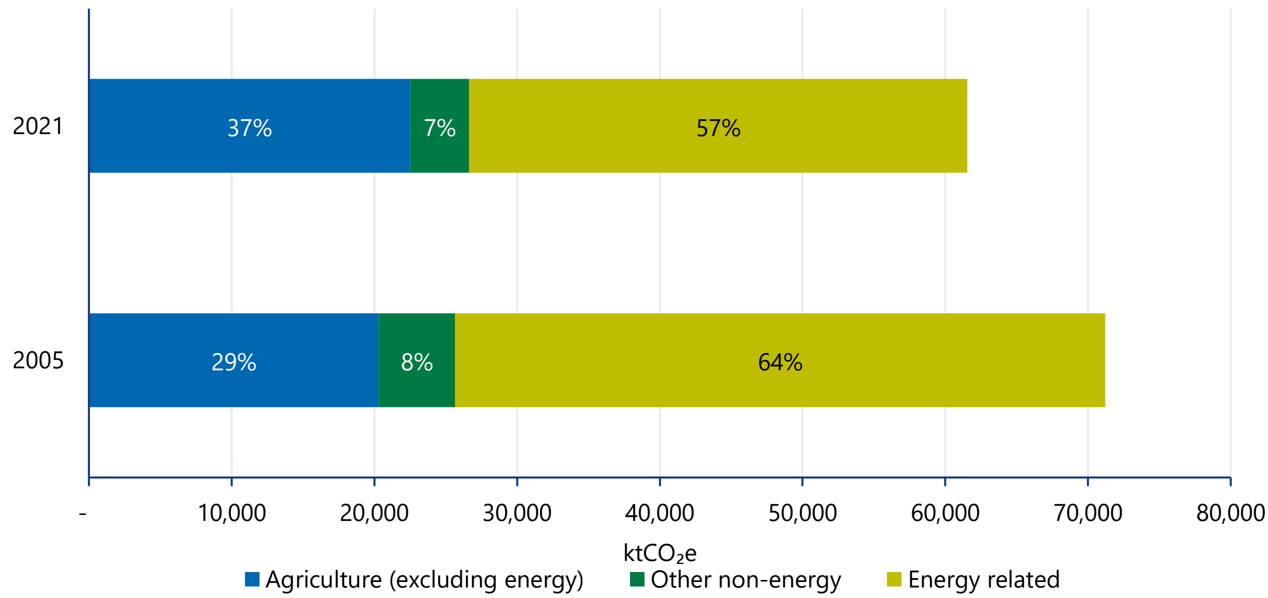
8 Energy targets and policy

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

8.1 Greenhouse gas emissions

Figure 67 shows greenhouse gas emissions by source for 2005 and provisional figures for 2021 (excluding land use and land use change), as reported by the EPA. The share of greenhouse gas emissions from energy use has fallen in both percentage and absolute quantity since 2005. 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, 12% of greenhouse gas emissions were from agriculture, compared to 34% in Ireland. Almost all (98%) of the energy-related greenhouse gas emissions are from CO_2, with the rest from other by-products of combustion such as nitrous oxide (N_2O) emissions.

Figure 67: Total greenhouse gas emissions by source (excluding international aviation)



Source: EPA

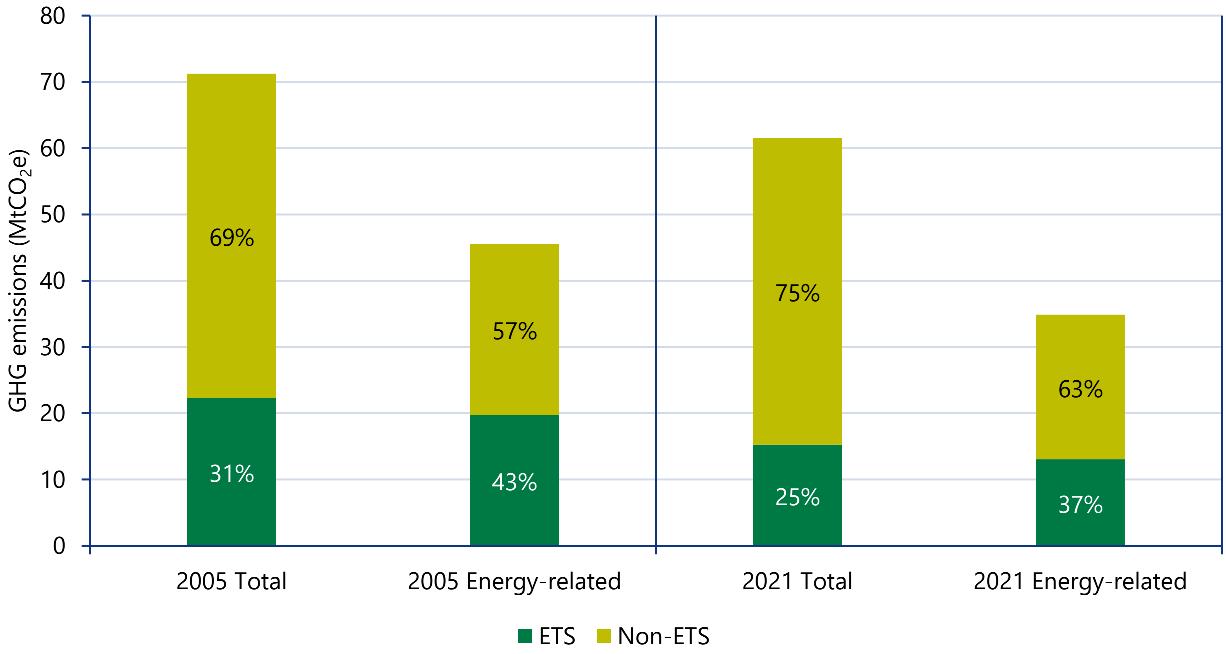
8.1.1 Greenhouse gas emissions reductions targets

The EU 2030 climate and energy framework sets a target for the EU as a whole to achieve a 55% greenhouse gas emissions reduction by 2030 compared to 1990. 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 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 EU Effort

Sharing Regulation[5] and implementing decision[6] set national annual emission allocations relative to the baseline year 2005, from a 9% reduction in 2021 to a 30% reduction in 2030.

Figure 68 compares Ireland's total and energy emissions, split between ETS and non-ETS sectors, for the baseline year (2005) and 2021.

Figure 68: Energy-related and total GHG emissions in the ETS and non-ETS sectors for 2005 and 2021



Source: EPA and SEAI

The non-ETS sector includes most greenhouse gas emissions in the residential, transport and services sectors. It also includes most non-energy-related emissions, notably from agriculture.

Figure 69 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 are from the EPA and are provisional for 2021.

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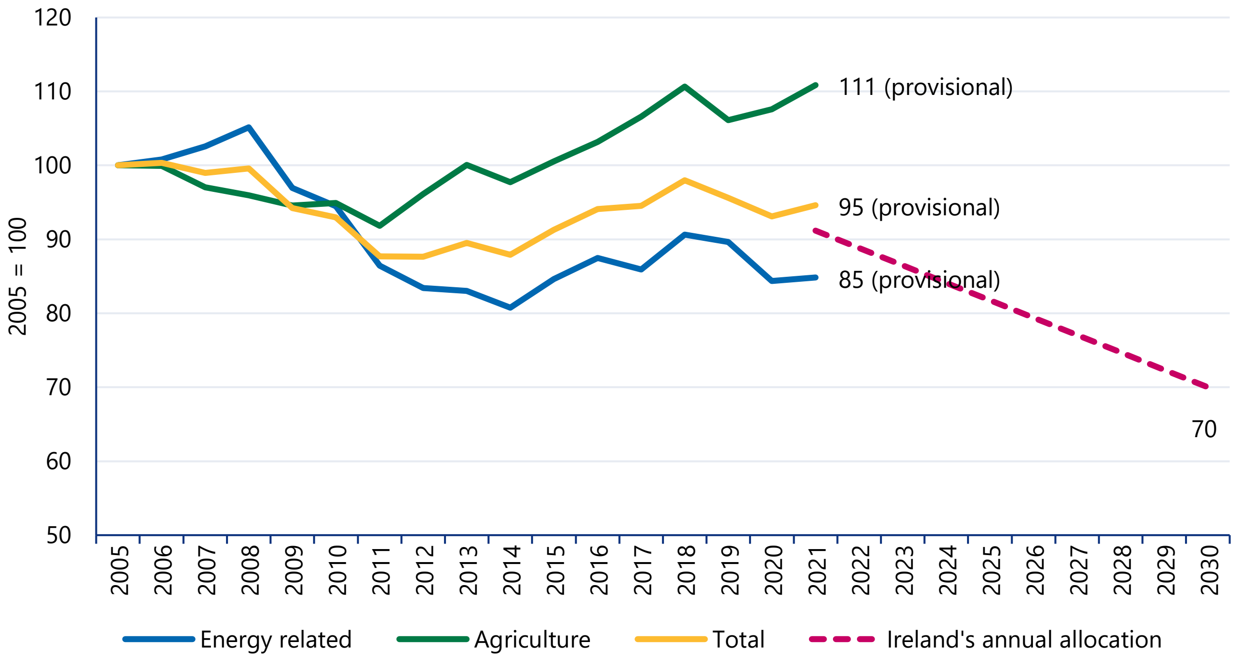
[5] Regulation (EU) 2018/842 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement. Available from: https://eur-lex.europa.eu/eli/reg/2018/842.
[6] Commission Implementing Decision (EU) 2020/2126 on setting out the annual emission allocations of the Member States for the period from 2021 to 2030 pursuant to Regulation (EU) 2018/842 of the European Parliament and of the Council. Available from: https://eur-lex.europa.eu/eli/dec_impl/2020/2126/oj

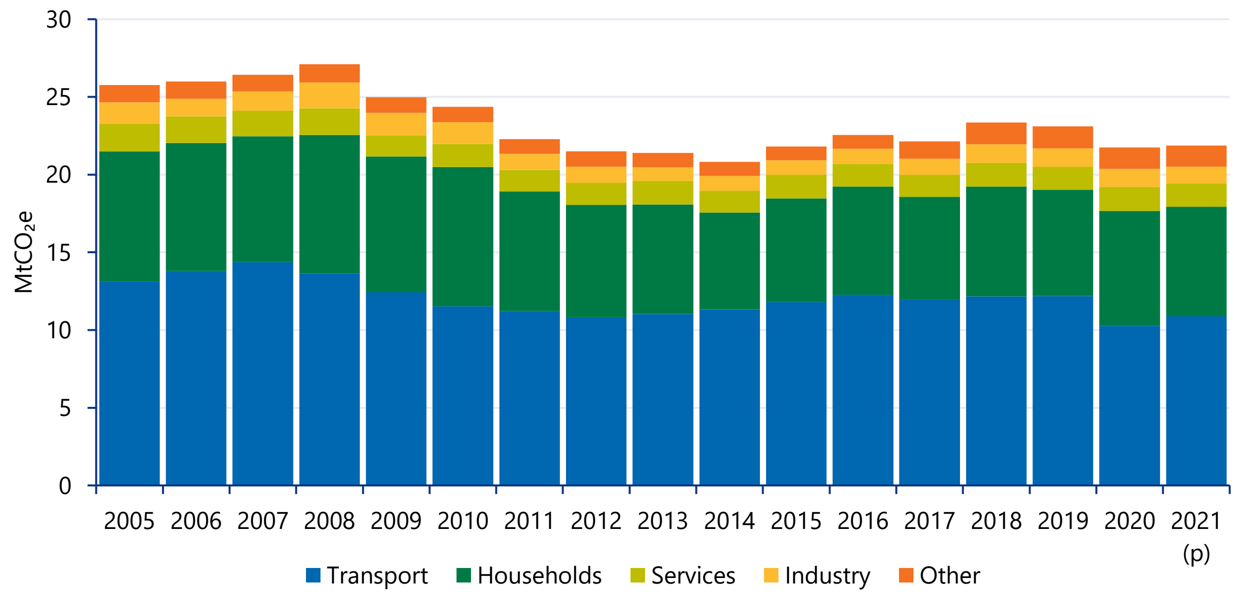
Figure 69: Index of non-ETS greenhouse gas emissions relative to 2005



Source: data from EPA

Figure 70 shows the trend in non-ETS energy-related greenhouse gas emissions split by sector.[7] Transport and households typically account for about 80% of energy-related non-ETS emissions.

Figure 70: Energy-related non-ETS greenhouse gas emissions



[7] This excludes emissions associated with electricity use by these sectors – emissions from electricity generation are included in the EU ETS. It also excludes international aviation and the activity of organisation in the industry and services sectors that are within the ETS.

Figure 71 shows the trend in emissions from fossil fuel combustion from those installations included in the EU ETS in Ireland after 2005. 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.

Figure 71: EU ETS greenhouse gas emissions in Ireland (excluding international aviation)

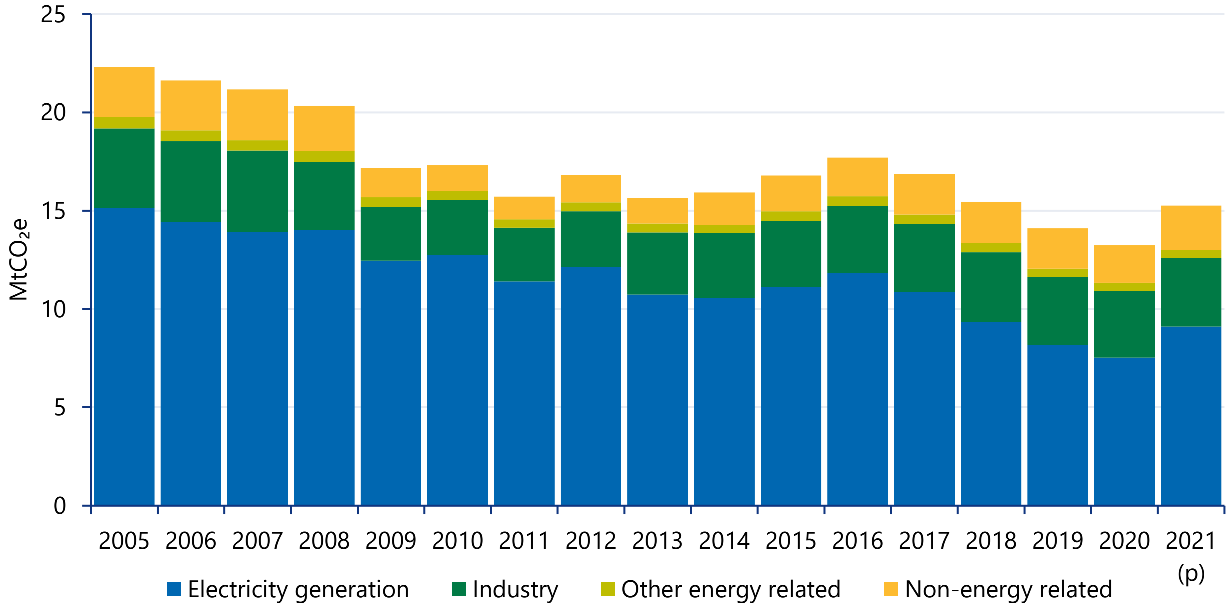


Table 26: Energy-related GHG emissions, ETS and non-ETS, compared with previous years

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		16-year change (2005–2021)	
	Quantity ($ktCO_2e$)	Share (%)	($ktCO_2e$)	(%)	($ktCO_2e$)	(%)	($ktCO_2e$)	(%)	($ktCO_2e$)	(%)
Energy-related ETS	13,024	21.2%	+1,673	+14.7%	-2,731	-17.3%	-1,538	-10.6%	-6,754	-34.1%
Non-energy related ETS	2,257	3.7%	+350	+18.3%	+289	+14.7%	+1,090	+93.4%	-298	-11.7%
Total ETS	**15,281**	**24.8%**	**+2,023**	**+15.3%**	**-2,443**	**-13.8%**	**-448**	**-2.8%**	**-7,052**	**-31.6%**
Energy-related non-ETS	21,862	35.5%	+116	+0.5%	-690	-3.1%	-423	-1.9%	-3,912	-15.2%
Non-energy related non-ETS	24,385	39.6%	+623	+2.6%	+944	+4.0%	+3,811	+18.5%	+1,284	+5.6%
Total non-ETS	**46,247**	**75.2%**	**+739**	**+1.6%**	**+254**	**+0.6%**	**+3,388**	**+7.9%**	**-2,628**	**-5.4%**
Total	**61,528**	**100.0%**	**+2,762**	**+4.7%**	**-2,189**	**-3.4%**	**+2,940**	**+5.0%**	**-9,680**	**-13.6%**

ETS is a 'cap and trade' system 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 and depending on the nature of the installation). Individual operators must report the greenhouse gas emissions from their installations each year and surrender sufficient allowances to cover their emissions. If an operator exceeds its available allowances, it must purchase more. If an operator has reduced 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 implementing the EU ETS in Ireland and administering the accounts on Ireland's domain in the Union Registry.

8.1.2 Carbon budgets and sectoral emission ceilings

Our carbon budget represents the total amount of emissions, measured in tonnes of CO_2 equivalent, that Ireland may emit in different periods. The Climate Action and Low Carbon Development Act commits Ireland to a legally binding target of a 51% reduction in emissions by 2030, compared to 2018 levels. The carbon budget programme comprises three successive five-year carbon budgets, also legally binding:

- **295 MtCO_2e** between 2021-2025
- **200 MtCO_2e** between 2026-2030
- **151 MtCO_2e** between 2031-2035

In total, these budgets commit us to an average overall reduction in emissions of -4.8% per annum from 2021 to 2025, and -8.3% per annum from 2026 to 2030. Sectoral ceilings published in July 2022 set out the maximum amount of greenhouse gas emissions that are permitted in different sectors of the economy during a carbon budget period. Combined, the carbon budgets and sectoral ceilings tell us when and where we need to make the emission reductions to remain on track for our 2030 target.

In 2021, Ireland's energy-related emissions, excluding international aviation (34.9 MtCO_2), accounted for 57% of Ireland's total greenhouse gas (GHG) emissions (61.8 MtCO_2e). This means SEAI's Energy Balance data are a critical input into the Environmental Protection Agency's (EPA) GHG inventory calculation for the formal calculation of emission results. Practically 100% of emissions from the electricity, transport, residential (buildings) and commercial (buildings) sectors are energy related; however, only about 3% of emissions from the agriculture sector are energy related. Most agriculture emissions are methane from livestock, and nitrous oxide from fertiliser and manure management.

Figure 72 summarises the sectoral ceilings within the first two carbon budgets, spanning 2021–2025 and 2026–2030. The five-year total CO_2e emissions permitted by the different sectors in each budget period (squares), and the annual 'indicative emissions' of each sector in the last year of a carbon budget (circles). The 'indicative emission' value for a sector is a guide to the maximum annual emissions expected from that sector at the end of the budget period, but it is not a binding target. For example, the transport sector is permitted to emit a total of 54 MtCO_2e in the five-year period between 2021 to 2025 and should have an annual emission of 10 MtCO_2e in the 2025 calendar year.

There are no specific yearly emission targets for each sector. However, we can get a very useful guideline trajectory for each sector, for each year, by 'solving' the five-year total (sectoral emission ceiling) and last-year-of-budget value (indicative emission) with a simple expression for year-on-year reductions. These trajectories are idealised paths to satisfying the sectoral emission ceilings. They assume that emission reductions start 'on track' in the first year, and are maintained each year, which has not been the case for all sectors. While not binding, these guideline trajectories help to convey the average pace necessary to remain consistent with the different sectoral emission ceilings and add useful context to the annual emission results. As real data on emission reductions in the early years of a carbon budget become available, we should update the trajectories in subsequent years to show the new pace of change needed in later years to satisfy the sectoral emission ceilings.

Figure 72: Sectoral ceilings first two carbon budgets, spanning 2021–2025 and 2026–2030

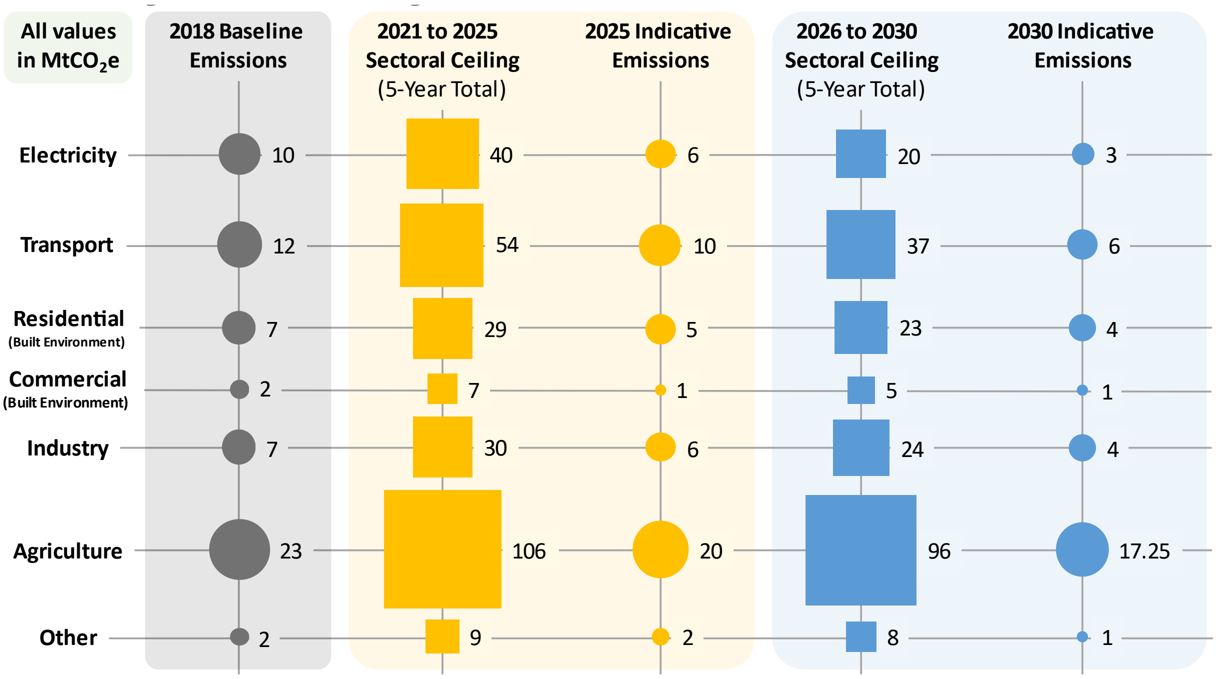


Figure 73 shows the guideline trajectories of electricity's sectoral emission ceiling in the 2021-2025 (yellow) and 2026-2030 (blue) carbon budgets. The solid grey bar in 2021 is the CO_2 emitted from electricity generation, which we calculated from our definitive annual data. The data shows that electricity emissions were 'on trajectory' in 2021 (10.3 $MtCO_2$), despite the greater dependence on coal- and oil-fired electricity generation. It is worth noting again that the guideline trajectories are not targets. They convey only the average pace compatible with satisfying the sectoral emission ceiling and the indicative emission of a sector in the last year of a carbon budget. The policies and strategies for reducing emissions in different sectors may be back-loaded to the end of the carbon budgets. However, any 'over emission' in the early years of a budget, as expected in 2022, must be 'caught up' in later years (i.e. via trajectory below the yellow bars), to satisfy the legally binding sectoral emission ceiling.

Figure 73: Sectoral emissions for Electricity (MtCO2)

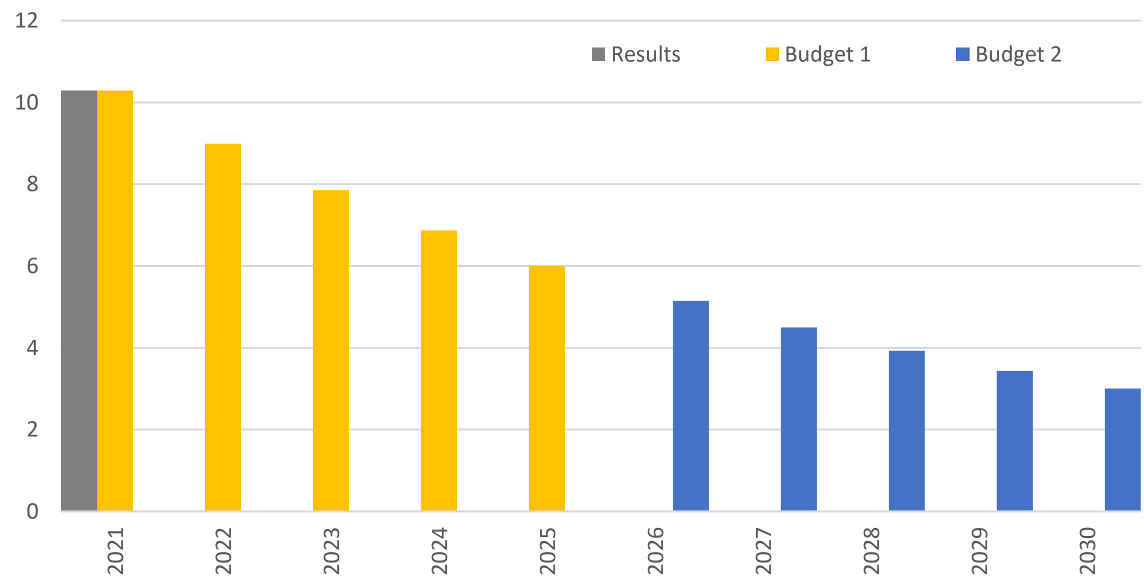
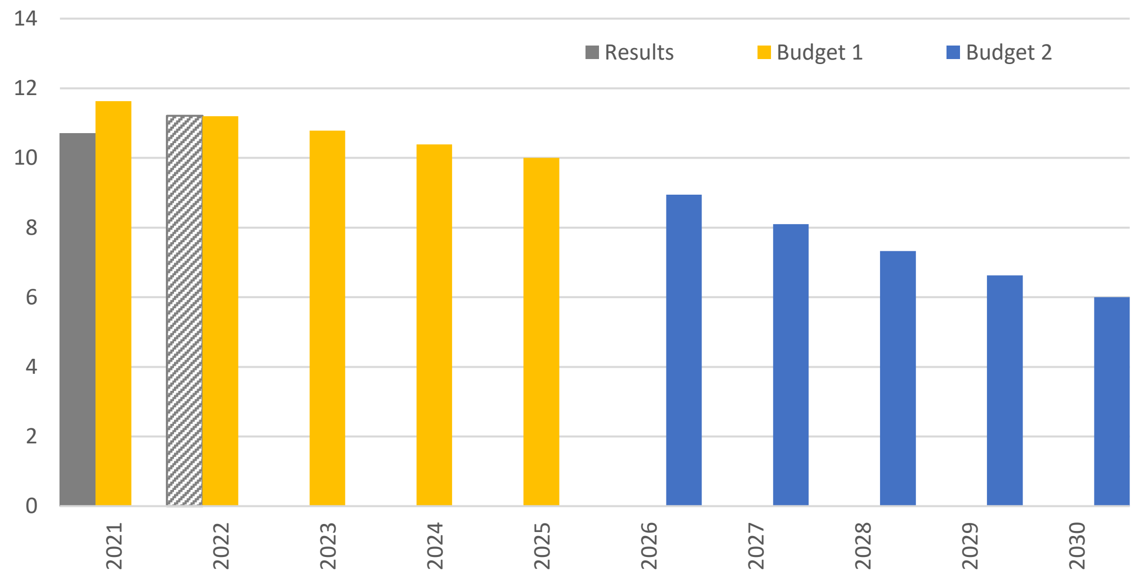


Figure 8 shows the guideline trajectories of transport's sectoral emission ceiling in the 2021-2025 (yellow) and 2026-2030 (blue) carbon budgets. The solid grey bar in 2021 is the CO_2 emitted from transport demand (excluding emissions from international aviation and electricity use in transport). Transport emissions in 2021 (10.7 $MtCO_2$) were below the guideline trajectory of 11.6 $MtCO_2$, because the sector was still impacted by COVID. In a sense, the continued impact of COVID on transport into 2021 has helped the sector 'bank' a 0.9 $MtCO_2$ under-emission that will make it easier to remain within its 54 $MtCO_2e$ sectoral emission ceiling to 2025. However, we will need significant emission reductions beyond the impacts of COVID to ensure transport emissions stay on track to 2025 and out to 2030. The average pace of emission reductions needed to satisfy the transport sectoral emission ceiling from 2021 to 2025 is -3.7% on each previous year, and -9.5% per year in the 2026-2030 budget.

Figure 74: Sectoral emissions for Electricity (MtCO2)



8.2 Renewable energy targets

8.2.1 Renewable Energy Directive and targets

The first Renewable Energy Directive (RED)[8] was the most important legislation influencing the growth of renewable energy in the EU and Ireland for the decade ending in 2020. From 2021, RED was replaced by the second Renewable Energy Directive (REDII),[9] which continues to promote the growth of renewable energy out to 2030. RED set out two mandatory targets for renewable energy in Ireland to be met by 2020, while REDII sets new targets and criteria to be met by Ireland in 2030 and the interim.

The first target 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)[10] to come from renewable sources in 2020. Ireland's actual overall RES in 2020 was 13.5%, meaning that Ireland

[8] 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

[9] Directive (EU) 2018/2001 on the promotion of the use of energy from renewable resources (recast). Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32018L2001

[10] 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, that is 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.

was obligated to acquire statistical transfers of 3.3 TWh of renewable energy from other Member States to compensate for this shortfall.

REDII introduced a binding EU-wide target for overall RES of 32% in 2030 and requires Member States to set their national contributions to the EU-wide target. As per the National Energy and Climate Plant (NECP) 2021-2030,[11] Ireland's overall RES target is 34.1% in 2030.

The second mandatory target set by the RED related to the renewable energy share in transport sector.[12] This is commonly referred to as the RES-T target. The 2020 RES-T target was for at least 10% of energy consumed in road and rail transport to come from renewable sources. The actual RES-T achieved in 2020 was 10.2%, meaning that Ireland did meet this target. REDII sets a new RES-T target of 14% by 2030.

Besides 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 The actual RES-E achieved in 2020 was 39.1%, falling just short of the national target. Nevertheless, the development of renewable electricity was a major success in Ireland since 2005. Ireland's NECP 2021-2030 includes a planned RES-E of 70% in 2030, which will ensure that renewable electricity continues to form the backbone of our renewable energy use for the coming decade and beyond. Ireland's Climate Action Plan 2021 (CAP 21) includes a target to increase the share of electricity generated from renewable sources "up to 80% where achievable and cost effective, without compromising security of electricity supply."[13]

The renewable heat target is commonly referred to as the RES-H target. For 2020, the RES-H target was for 12% of energy used for heating and cooling to come from renewable sources. The actual RES-H achieved in 2020 was 6.3%, falling well short of the national target. The lack of progress in RES-H was the main reason for failing to meet the overall RES target in 2020. The NECP 2021 shows a planned RES-H of 24% in 2030. Although REDII does not specify a target for RES-H, the directive requires Ireland to "endeavour to increase" the RES-H by an indicative 1.1 percentage points as an annual average calculated for the periods 2021–2025 and 2026–2030.

As part of the European Green Deal and REPowerEU, the EU's plan to become independent of Russian fossil fuel, the European Parliament adopted the text of a proposed amendment[14] to REDII in September 2022. The proposal includes various new measures to promote the uptake of renewable energy and increases the EU-wide RES target to 45% in 2030. It also includes a new target for the increase in renewable energy share in the industry sector and the changing the basis of the transport sector target from renewable energy share to a reduction in greenhouse gas intensity.

8.2.2 Biomass sustainability

Besides specifying new EU and national renewable energy targets, REDII also introduced new sustainability and verification criteria for biomass fuels (solid and gaseous) from the beginning of 2021. Introducing these

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[11] Ireland's National Energy and Climate Plan 2021-2030. Available from: https://www.gov.ie/en/publication/0015c-irelands-national-energy-climate-plan-2021-2030/?adlt=strict

[12] In the context of RED and REDII, consumption in the transport sector relates only to energy in road and rail; however, renewable energy consumed in aviation and marine can contribute towards the RES-T.

[13] Climate Action Plan 2021. Available from: https://www.gov.ie/en/publication/6223e-climate-action-plan-2021/

[14] Document P9_TA(2022)0317, Amendments adopted by the European Parliament on 14 September 2022 on the proposal for a directive of the European Parliament and of the Council amending Directive EU) 2018/2001 (COM(2021)0557 - C9-0329/2021 - 2021/0218(COD)). Available from: EUR-Lex - P9_TA(2022)0317 - EN - EUR-Lex (europa.eu)

criteria has led to circumstances where a significant portion of the biomass fuel consumed in Ireland in 2021 cannot be included in the national renewable shares, specifically the overall RES, RES-E and RES-H.

From the beginning of 2021, biomass fuel consumed in installations, above certain sizes, must fulfil various sustainability[15] and greenhouse gas saving criteria to be counted towards national renewable energy targets, or be eligible for financial supports. In addition, the biomass fuel must be subject to a verification procedure requiring economic operators to demonstrate that the sustainability and greenhouse gas saving criteria, as laid out in the directive, have been fulfilled. Verification must require economic operators to, among other things, maintain sustainability records of all consignments of biomass, applying a mass balance, and arrange for independent auditing of all information submitted to the competent authority.

Legislation[16] was introduced in July 2022 to transpose the biomass sustainability and verification requirements of REDII into Irish law. While a verification procedure is currently being developed for operators of biomass installations, no verification system was in place during 2021. Consequently, any biomass consumed during 2021 that was required to meet the sustainability criteria and undergo verification cannot be included in the overall RES, RES-E and RES-H. In total this amounts to approximately 8% of Ireland’s 2021 renewable energy that cannot be counted towards the RES.

Only biomass fuel consumed in an installation with a rated thermal output above one of the following thresholds is required to meet the sustainability criteria:

- Equal to or exceeding 20 MW for solid biomass fuels; or
- Equal to or exceeding 2 MW for gaseous biomass fuels.

Biomass fuels consumed in smaller installations are not required to meet the sustainability and verification criteria to be counted towards the renewable energy targets. Biomass, such as wood, consumed in the residential sector and in many smaller commercial/industrial boilers can be included the RES.

Where biomass fuel cannot be included in the RES calculations, due to the absence of verification, it still contributed to decarbonisation by displacing fossil fuel and reducing greenhouse gas emissions under EU ETS and Ireland’s national emissions allocations.

8.2.3 Overall renewable energy share

Table 27 shows the RES for the individual modes, and overall, for 2021. It also shows the progress at a selection of previous years for reference.

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[15] ‘Sustainability’, in the context of biomass under REDII, relates to: soil monitoring and management; protection of land with high biodiversity; protection of land with high carbon stock; protection of peatland; sustainable forest production; and land-use, land-use change and forestry (LULUCF).

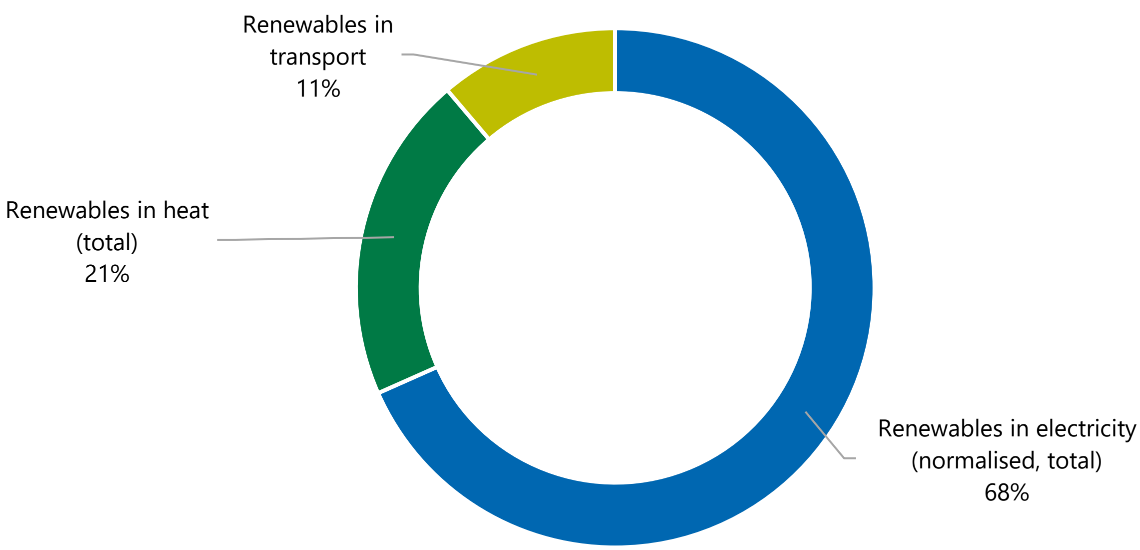
[16] SI No. 350 of 2022 European Union (Renewable Energy) Regulations (2) 2022. Available from: https://www.irishstatutebook.ie/eli/2022/si/350/

Table 27: Ireland's progress towards overall renewable energy share (RES) target

	2016	2017	2018	2019	2020	2021	2030 Target
RES-E (normalised)	27.1%	30.3%	33.3%	36.5%	39.0%	36.4%	70%[17]
RES-T (weighted)	5.2%	7.5%	7.2%	8.9%	10.1%	4.3%	14%
RES-H	6.2%	6.6%	6.4%	6.3%	6.3%	5.2%	24%[17]
Overall RES	**9.2%**	**10.5%**	**10.9%**	**12.0%**	**13.5%**	**12.5%**	**34.1%**

Figure 75 shows the current split of renewable energy between the three modes. *Figure* 76 shows the contribution of renewable electricity, heat and transport to the overall RES target. Renewable electricity makes the largest contribution to the overall RES and has been responsible for most of the overall growth in renewable energy since 2005. The figure also shows the share of heat and electricity generated by biomass that was not verified as sustainable in the context of REDII and, consequently, could not be included in Ireland's 2021 RES (see section 8.2.2 for further details).

Figure 75: Current share of renewable energy (overall RES) by mode



[17] These are the planned RES-E and RES-H set out in Ireland's National Energy and Climate Plan (NECP) 2021-2030.

Figure 76: Renewable energy share (overall RES) with contribution by mode

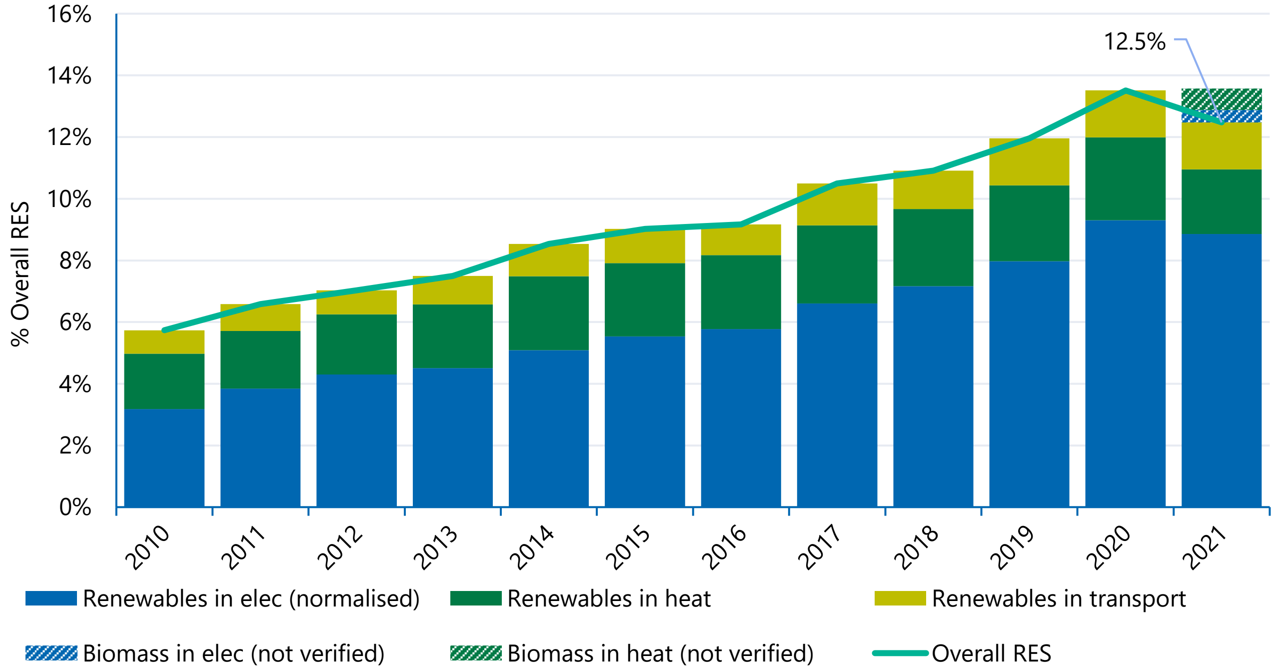


Figure 77 shows the overall RES from 2010 to 2021 along with Ireland's current 2030 target of 34.1%. The figure also includes the projected trajectory set out in Ireland's NECP, the indicative trajectory as per EU legislation[18] and the proposed EU-wide target included in the most recent draft EU legislation[19] (for comparison only).

The proposed, amended EU-wide trajectory starts at the value of 22% in 2020 and rises to a target of 45% in 2030. If this new target is adopted by the EU as part of an amendment to REDII, it is likely that Ireland's 2030 RES target will increase to close to 45%.

[18] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action. Available from: http://data.europa.eu/eli/reg/2018/1999/oj

[19] The most recent text of the proposed amendment to the Renewable Energy Directive, adopted by the European Parliament on 14 September 2022, requires the EU-wide renewable energy share to be at least 45% by 2030.

Figure 77: Renewable energy share (overall RES) and trajectories to 2030 targets

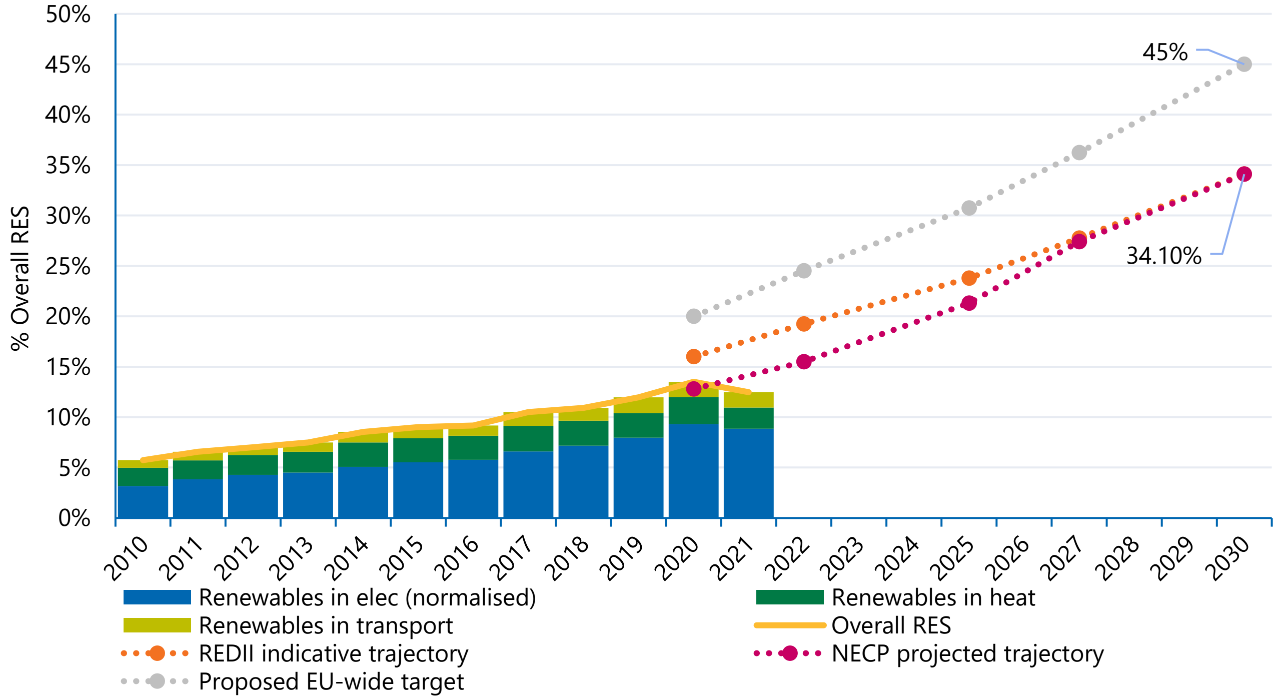


Figure 78 illustrates the total GFC in each mode according to the REDII calculation, and the portion of each mode that comes from renewable sources. This gives important context to the separate heat, transport and electricity targets. Although electricity has the highest share of renewable energy, it is the smallest of the modes in terms of GFC. The heat mode makes up the largest share of GFC, follow by transport, which has the smallest renewable share.

Figure 78: Renewable and fossil gross final energy consumption by mode

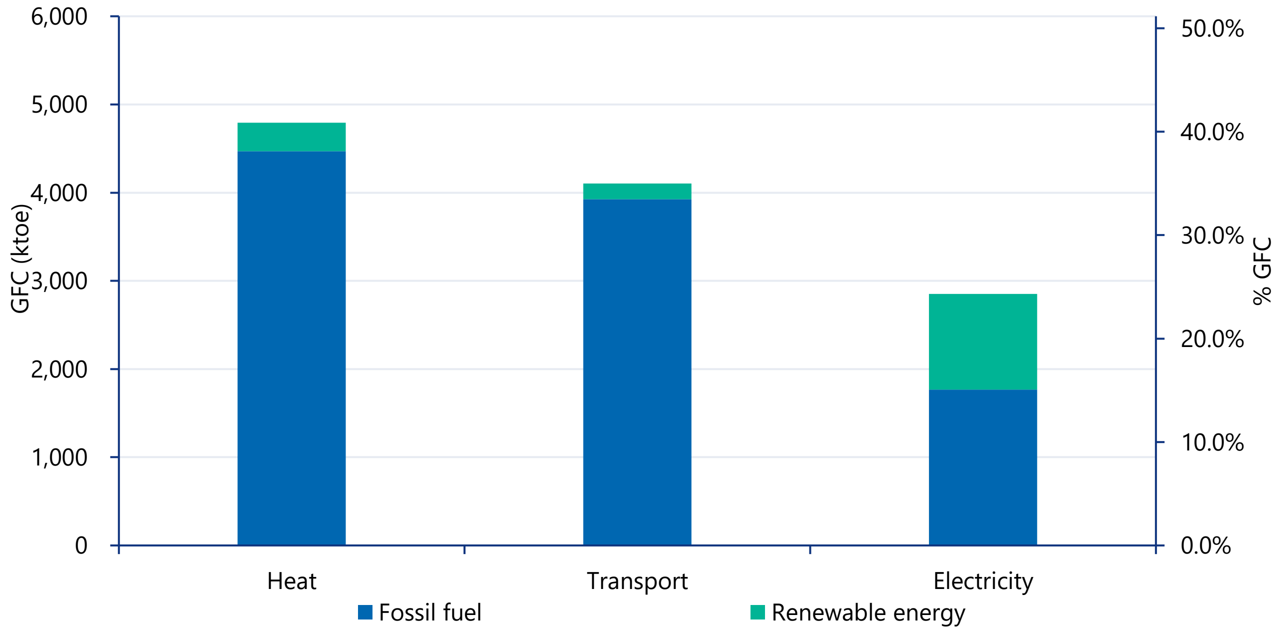


Figure 79 and *Table* 28 show the share and quantity of renewable energy used each year, split by source. Most of the growth in renewable energy has come from wind. Wind provides more than half of all renewable energy. Solid biomass and bioliquids were the next largest sources of growth. Bioenergy, including solid biomass, renewable wastes, landfill gas, biogas and bioliquids, collectively accounted for approximately one-third of Ireland's renewable energy.

Figure 79 also shows the share of biomass and biogas that was not verified as sustainable in the context of REDII and, consequently, could not be included in Ireland's 2021 RES, see section 8.2.2 for further details. This amounts to 117 ktoe of the biomass & renewable waste quantity and 10 ktoe of the biogas & landfill gas quantity in Table 28.

Figure 79: Renewable energy share of gross final consumption by source

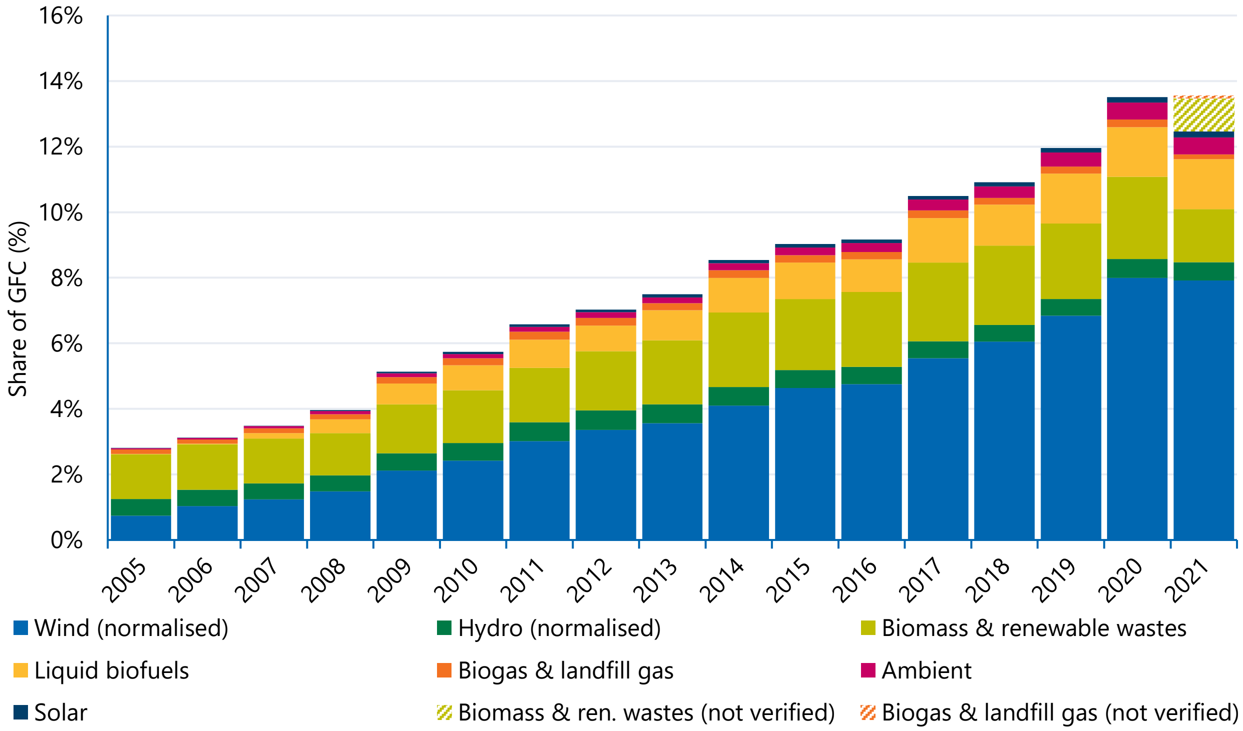


Table 28: Renewable energy contribution to gross final consumption by source

	2021		1-year change 2020–2021		5-year change 2016–2021		10-year change 2011–2021		20-year change 2001–2021	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Biomass & renewable wastes	308	19.4%	+20	+6.9%	+37	+13.5%	+121	+64.9%	+183	+145.6%
Liquid biofuels	178	11.2%	+4	+2.2%	+60	+50.5%	+81	+82.4%	+178	-
Biogas and landfill gas	27	1.7%	+1	+2.6%	+0	+0.3%	+1	+2.3%	+15	+115.6%
Total bioenergy	**514**	**32.3%**	**+24**	**+5.0%**	**+96**	**+23.1%**	**+202**	**+65.1%**	**+375**	**+272%**
Wind (normalised)	928	58.4%	+10	+1.1%	+363	+64.2%	+588	+172.6%	+901	+3,298%
Hydro (normalised)	66	4.1%	+0	+0.1%	+3	+4.3%	+1	+1.3%	-3	-4.2%
Ambient[20]	61	3.8%	+2	+2.8%	+29	+88.4%	+44	+252.7%	+61	-
Solar	22	1.4%	+3	+13.6%	+9	+74.5%	+13	+152.7%	+22	-
Total renewable	**1,590**	**100%**	**+39**	**+2.5%**	**+500**	**+45.9%**	**+848**	**+114%**	**+1,356**	**+580%**

Source: SEAI

8.2.4 Transport energy from renewable sources (RES-T)

REDI established a mandatory minimum target for the share of renewable energy sources in transport (RES-T) by 2020: 10% of all petrol, diesel, biofuels and electricity consumed in road and rail transport. Ireland exceeded this target reaching 10.2% RES-T in 2020. REDII requires Ireland, along with all Member States, to set an obligation on fuel suppliers to ensure that the share of renewable energy within the final consumption of energy in transport is at least 14% by 2030.

It should be noted that renewable energy consumed in any mode of transport contributes towards the RES-T, but that only energy consumed in *road & rail* is counted in the denominator:

$$\text{RES\_T} = \frac{\text{Final consumption of renewable energy in all transport}}{\text{Final consumption of energy in road \& rail}}$$

The only fossil fuels counted in the denominator are petrol, diesel and natural gas; the relatively small quantity of fossil LPG consumed in road transport is not included in RES-T denominator, but is included in the overall RES.

REDII, as with REDI before it, specifies several weightings or multipliers that are applied to certain fuels or energy for the calculation of RES-T. These weightings help to incentivise the use of advanced biofuels and

[20] 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: air, water or ground. It can also come from waste energy streams such as exhaust gases or waste water.

biofuels from wastes over crop-based fuels, generally promoting those with lower life-cycle greenhouse gas intensities. Table 29 sets out the current multipliers under REDII and how they have changed from those used for REDI. More than 85% of the biofuel used in Ireland is produced from feedstocks listed in Annex IX of REDII, including used cooking oil (UCO) and tallow (category 1 & 2), and consequently count twice towards the RES-T target.

These multipliers do not apply to the overall RES. Prior to the transition to REDII, there was a significant difference between the RES-T value and the share of renewable energy in transport, as a component of the overall RES.

Table 29: Change in multipliers used in the calculation of RES-T

	REDI	REDII
Biofuels from Annex IX feedstocks	2× (numerator only)	2× (numerator & denominator)
Renewable electricity in road	5× (numerator only)	4 × (numerator & denominator)
Renewable electricity in rail	2.5 × (numerator & denominator)	1.5 × (numerator & denominator)
Aviation & maritime fuels (excl. fuels from food & feed crops)	-	1.2 × (numerator)

In addition to the change in multipliers used in the RES-T calculation, REDII also includes three limits on biomass fuels produced from certain feedstocks, see Table 30. These limits are defined as percentages of energy consumed in transport. Although two of these limits can technically apply to bioliquids or biomass fuels consumed outside of the transport sector, they are currently only relevant to fuels used in the transport sector.

The first limit relates to the share of used cooking oil (UCO) and animal fat (tallow) category 1 & 2 and is the most consequential change to the calculation of Ireland's RES-T arising from the transition to REDII. UCO and tallow (cat. 1 & 2) accounted for 4.3% of final energy consumption in transport in 2021; under REDII, this biofuel is limited to 1.7% of transport energy for the purposes of RES-T. In 2021, approximately 53% of the biofuel consumed in Ireland (before application of multipliers) cannot be counted towards RES-T due to this limit.

The second limit relates to fuels produced from food and feed crops (e.g. bioethanol from maize, biodiesel from sunflower). Biofuels from food and feed crops only constituted 0.3% of final consumption of energy in transport in 2021, well below the limit of 2%.

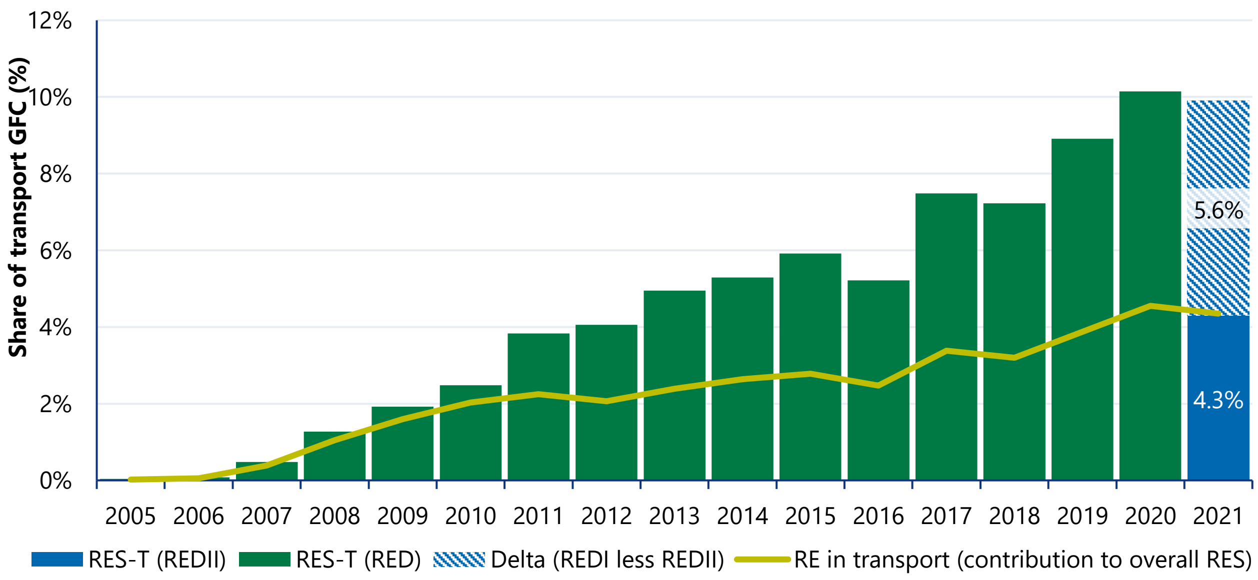
The third limit applies to biofuels (in addition to bioliquids and biomass fuels) produced from crops with a 'high indirect land-use change risk' (high ILUC risk), specifically fuels produced from palm oil. The limit is based on the share of high ILUC risk biofuels in Ireland in 2019, i.e. 0.05%. The share in 2021 was 0.09%; consequently, a relatively small quantity of biofuel from palm oil (1.4 ktoe) could not be counted towards RES-T or RES.

Table 30: Limits on biofuels from certain feedstocks

Feedstocks	Fuel type	Scope	Limit	2021 share
Used cooking oil (UCO) and animal fat (tallow cat. 1 & 2)	• Biofuels • Biogas	RES-T only	1.7% of transport energy	**4.3%**
Food and feed crops	• Biofuels • Bioliquids • Biomass fuels in transport	Overall RES & RES-T	2% of transport energy	0.3%
High ILUC-risk food & feed crops	• Biofuels • Bioliquids • Biomass fuels	Overall RES & RES-T	0.05% of transport energy	**0.09%**

Figure 80 shows the annual RES-T from 2005 to present and the share of renewable energy in transport, as it contributes to the overall RES. The RES-T decreased from 10.2% in 2020 to 4.3% in 2021 – 5.6 percentage points of the decrease is due to the change in calculation methodology between REDI and REDII. The share of renewable energy in transport, without multipliers and as a component of overall RES, decreased somewhat from 4.6% to 4.3%. Despite including the multipliers and limits set out above, the 2021 RES-T result is practically equal to the share of renewable energy in transport, at 4.3%.

Figure 80: Renewable energy share of gross final consumption in transport



In 2010, a Biofuel Obligation Scheme[21] 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

[21] See National Oil Reserves Agency's (NORA) website for more details: https://www.nora.ie/

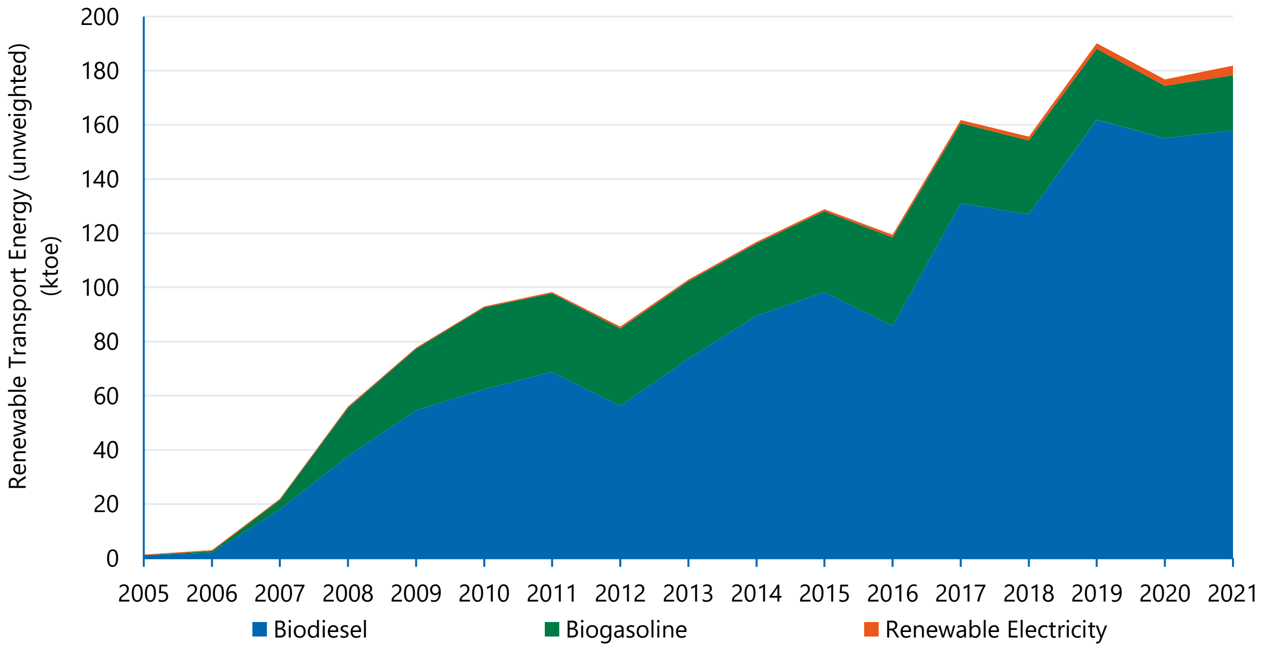
the market in Ireland; two certificates are granted to biofuel that is produced from wastes and residues. Oil companies are required to apply to NORA for certificates and to demonstrate that the quantities of biofuel for which they are claiming certificates are accurate. Since the Sustainability Regulations (SI 33 of 2012) were introduced, companies are also required to 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 subsequently increased, on a volume basis, to:

- 6% in 2013;
- 8% in 2017;
- 10% in 2019;
- 11% in 2020; and
- 13% in 2022.

At the time of writing the Department for Energy, Climate and Communications is completing a consultation process for proposed legislation to change the biofuel obligation from a volume-based-rate to an energy-based one and to increase the obligation to 16.985% (by energy) from January 2023.

Figure 81 and Table 31 show the renewable energy used in transport in absolute terms, without multipliers or limits applied. Biofuels provide almost all of the renewable energy in transport, more than 98% in 2021. While renewable electricity in private cars still constitutes a small share of the total, it has seen significant percentage growth in the last 5 years.

Figure 81: Renewable energy in transport by source (without multipliers)



Source: data from SEAI and NORA

Table 31: Renewable energy for transport by source (without multipliers)

	2021		1-year change 2020 to 2021		5-year change 2016 to 2021		10-year change 2011 to 2021		15-year change 2001 to 2021	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Biodiesel	158.0	86.9%	+3.0	+1.9%	+72.3	+84.3%	+89.3	+129.9%	+156.0	+7,733%
Biogasoline	20.3	11.2%	+0.9	+4.6%	-12.4	-38.0%	-8.8	-30.1%	+19.7	+3,052%
Renewable elec rail	1.5	0.8%	+0.2	+11.6%	+0.6	+72.4%	+1.0	+183.5%	+1.2	+427%
Renewable elec Private car	2.0	1.1%	+1.0	+110.5%	+1.9	2,144%	+2.0	-	+2.0	-
Total	**181.9**	**100.0%**	**+5.0**	**+2.9%**	**+62.4**	**+52.2%**	**+83.5**	**+84.9%**	**+178.9**	**+6,055%**

Source: SEAI and NORA

8.2.5 Electricity from renewable energy sources (RES-E)

Ireland has no mandatory national target for RES-E for 2030, nor was there one for 2020, but RES-E forms the backbone of Ireland's strategy to achieve the overall renewable energy target for 2030. Ireland's National Energy and Climate Plant (NECP 2021-2030) includes a planned RES-E of 70% in 2030, while Ireland's Climate Action Plan 2021 (CAP 21) includes a target to increase the share of electricity generated from renewable sources "up to 80% where achievable and cost effective, without compromising security of electricity supply."[22]

The Government set an ambitious national target for RES-E of 40% for 2020. Ireland 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 (when aggregated) is 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 annual quantity of renewable electricity generated.

Figure 82 and Table 32 show renewable energy share in electricity (RES-E) by source. RES-E decreased from 39.1% in 2020 to 36.4% in 2021.

Approximately 568 GWh of electricity was generated by biomass fuel (i.e. biomass, landfill gas and biogas) that, under REDII, must be verified as sustainable in order to be counted towards RES-E and overall RES in 2021, see section 8.2.2 for further details. The absence of verification for this biomass fuel accounts for 1.7 percentage point decrease in RES-E for 2021.

It should also be noted that although the quantity of (normalised) renewable electricity increased by 1.8%, this was more than offset by a 4.2% increase in gross final consumption of electricity.

[22] Climate Action Plan 2021. Available from: https://www.gov.ie/en/publication/6223e-climate-action-plan-2021/

Figure 82: Renewable energy share of gross final consumption in electricity (RES-E normalised)

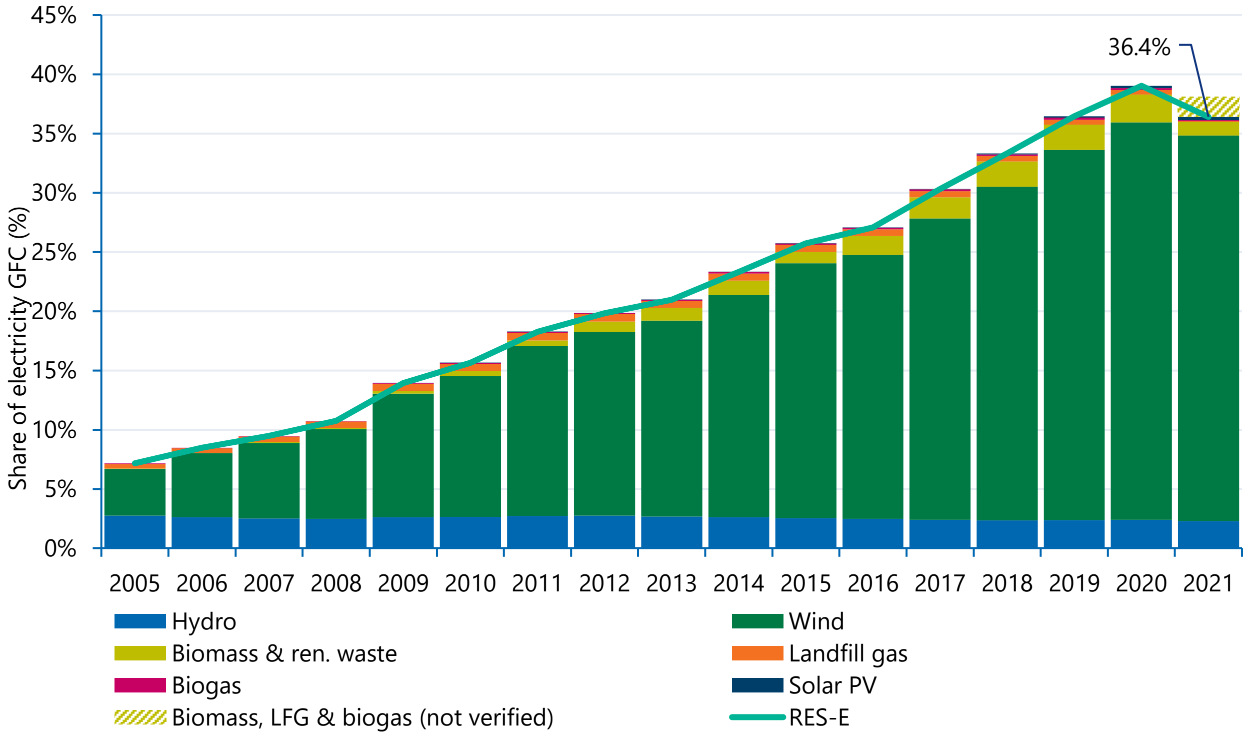
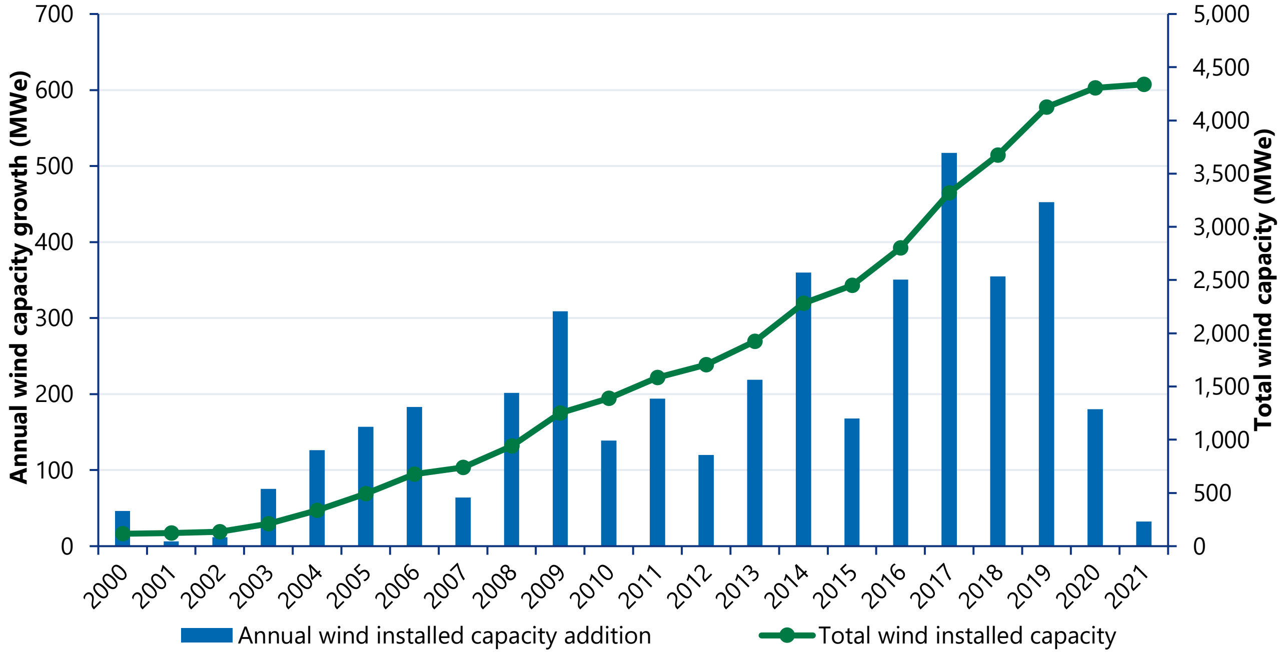


Table 32: Renewable energy contribution to gross electricity consumption (normalised)

	2021		1-year change 2020 to 2021		5-year change 2016 to 2021		10-year change 2011 to 2021		20-year change 2001 to 2021	
	Quantity (GWh)	Share (%)	(GWh)	(%)	(GWh)	(%)	(GWh)	(%)	(GWh)	(%)
Hydro	762	6.0%	+1	+0.1%	+31	+4.3%	+10	+1.3%	-34	-4.2%
Wind	10,795	85.4%	+118	+1.1%	+4,222	+64.2%	+6,835	+172.6%	+10,477	+3,298%
Biomass	471	3.7%	+41	+9.5%	+75	+19.0%	+334	+245.4%	+471	-
Renewable Waste	352	2.8%	+26	+7.9%	+276	+364.4%	+352	-	+352	-
Landfill Gas	119	0.9%	+2	+1.4%	-45	-27.5%	-60	-33.4%	+22	+22.4%
Biogas	54	0.4%	+3	+6.5%	+10	+22.3%	+33	+152.4%	+54	-
Solar PV	93	0.7%	+31	+50.5%	+87	+1,423%	+92	+17,056 %	+93	-
Total normalised renewable	**12,645**	**100%**	**+221**	**+1.8%**	**+4,656**	**+58.3%**	**+7,597**	**+150%**	**+11,435**	**+945%**

Figure 83 shows the annual growth in installed wind generation capacity and overall cumulative capacity since 2000[23]. *Table* 33 shows the capacity figures for 2021, along with the peak wind power generated and the most recent figures for planned (i.e. contracted) wind generation. 2021 saw the lowest annual capacity addition since 2002.

Figure 83: Installed wind generating capacity



Source: EirGrid

Table 33: Wind capacity and generation

	MW
Wind capacity at end of 2021	4,339
Wind capacity added in 2021	32.3
Additional planned wind capacity (contracted)[24]	1,924

Source: EirGrid and ESB Networks

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.

[23] Reports on connected wind generators from Eirgrid, https://www.eirgridgroup.com/customer-and-industry/general-customer-information/connected-and-contracted-generators/, and ESB Networks, https://www.esbnetworks.ie/new-connections/generator-connections-group/generator-statistics

[24] Reports on contracted wind available from Eirgrid (7 July 2022), https://www.eirgridgroup.com/customer-and-industry/general-customer-information/connected-and-contracted-generators/, and ESB Networks (11 October 2022), https://www.esbnetworks.ie/new-connections/generator-connections-group/generator-statistics

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* 34 are calculated using the average of the installed capacity in any given year and the previous year.

Table 34: Annual capacity factor for wind and hydro generation

Capacity factor	2005	2010	2015	2016	2017	2018	2019	2020	2021
Wind	30.6%	24.3%	31.7%	26.7%	27.8%	28.2%	29.3%	31.3%	25.8%
Hydro	30.8%	28.9%	38.9%	32.8%	33.3%	33.4%	42.7%	44.9%	36.1%

Source: EirGrid and SEAI

8.2.6 Heat from renewable energy sources (RES-H)

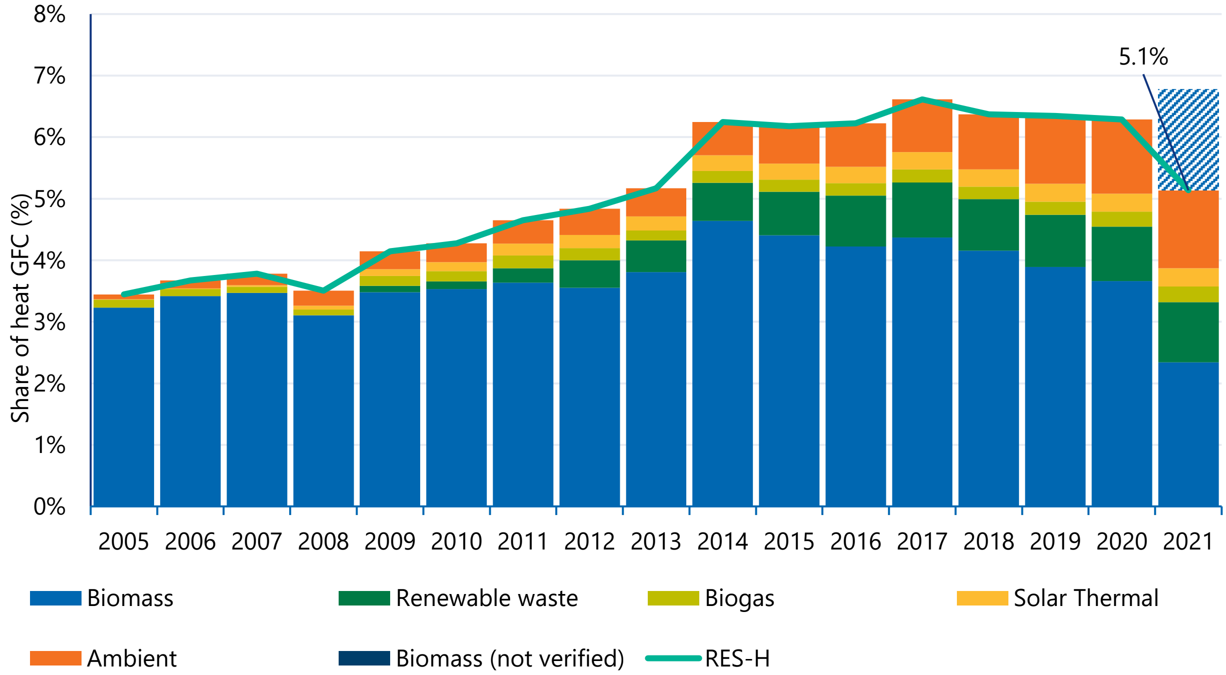
Although there is no mandatory target for RES-H set in REDII, Ireland's NECP 2021-2030 sets out a planned RES-T of 24% by 2020 to help deliver the overall mandatory target of 34.1% renewable energy. Under REDII, Ireland, along with all other Member States, must endeavour to increase the share of renewable energy in heating and cooling by an indicative 1.1 percentage points as an annual average calculated for the periods 2021 to 2025 and 2026 to 2030.

Figure 84 shows the contribution from renewable energy to heat or thermal energy uses as a share of overall heat use. RES-H fell from 6.3% in 2020 to 5.2% in 2021; this decrease can be attributed to the transition from REDI to REDII and the introduction of new sustainability and verification criteria for biomass fuels.

In 2021, approximately 79 ktoe of heat was generated by biomass fuel (i.e. solid biomass and biogas) that, under REDII, must be verified as sustainable in order to be counted towards RES-H and overall RES in 2021, see section 8.2.2 for further details. The absence of verification for this biomass fuel accounts for a decrease of 1.6 percentage points in the RES-H for 2021.

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 84: Renewable energy share in heat (RES-H)



Renewable heat energy is dominated by the use of solid biomass and renewable wastes in industry. Using ambient energy (via ground-source and air-source heat pumps) 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 2021.

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.

8.2.7 CO_2 displacement and avoided fuel imports

Using 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[25][26].

Figure 85 shows the trend in annual avoided CO_2 emissions from renewable energy from 2005 to present. The estimated amount of CO_2 avoided through the use of renewable energy reached a peak in 2020 before decreasing slightly to 6.2 Mt CO_2 in 2021, with 4.0 Mt CO_2 avoided by wind energy.

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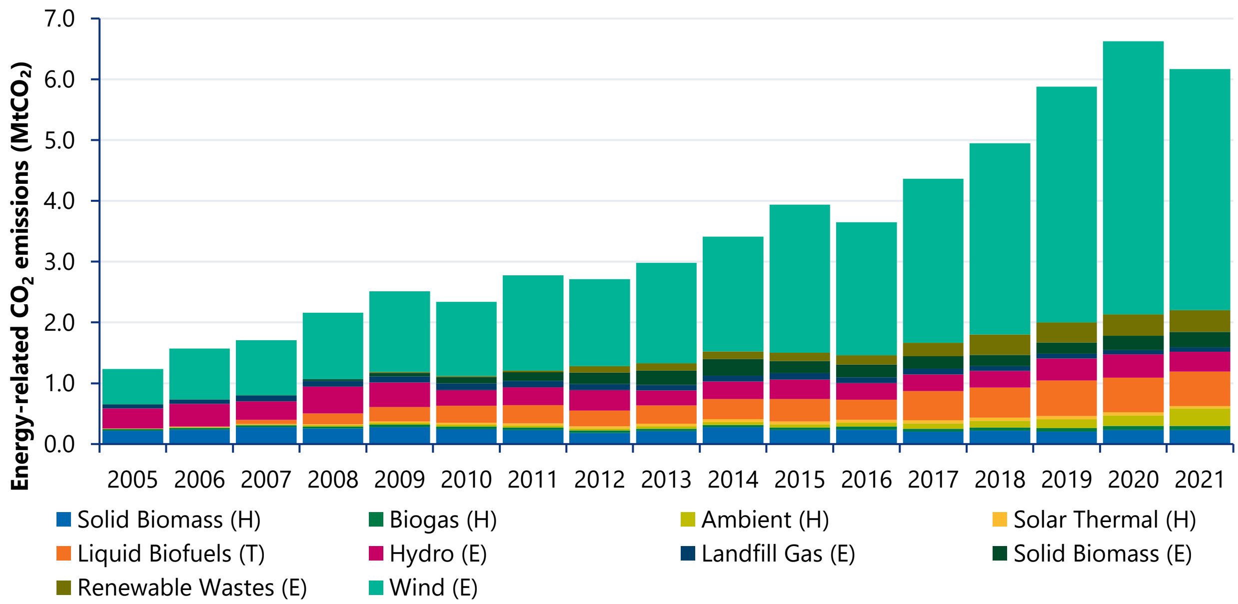
[25] See SEAI reports Quantifying Ireland's Fuel and CO2 Emissions Savings from Renewable Electricity in 2012 and Renewable Energy in Ireland 2012 for further details on the methodologies used to calculate the avoided emissions.

[26] Holttinen, Hannele, et al (2014), *Estimating the reduction of generating system CO2 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

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 results in less 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[27], see section 8.1.

Figure 85: Avoided CO_2 from renewable energy



8.3 Energy prices to industry

Energy use is an important part of economic activity and therefore the price paid for energy is a determining factor in the economy's competitiveness. 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.

SEAI publishes biannual reports titled Electricity and Gas Prices in Ireland[28] based on data collected under EU legislation[29] 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 International Energy Agency's (IEA) Energy Prices and Taxes[30]. This data source was chosen because it is produced quarterly and contains data to the end of 2021. Prices shown are in US dollars and are in current

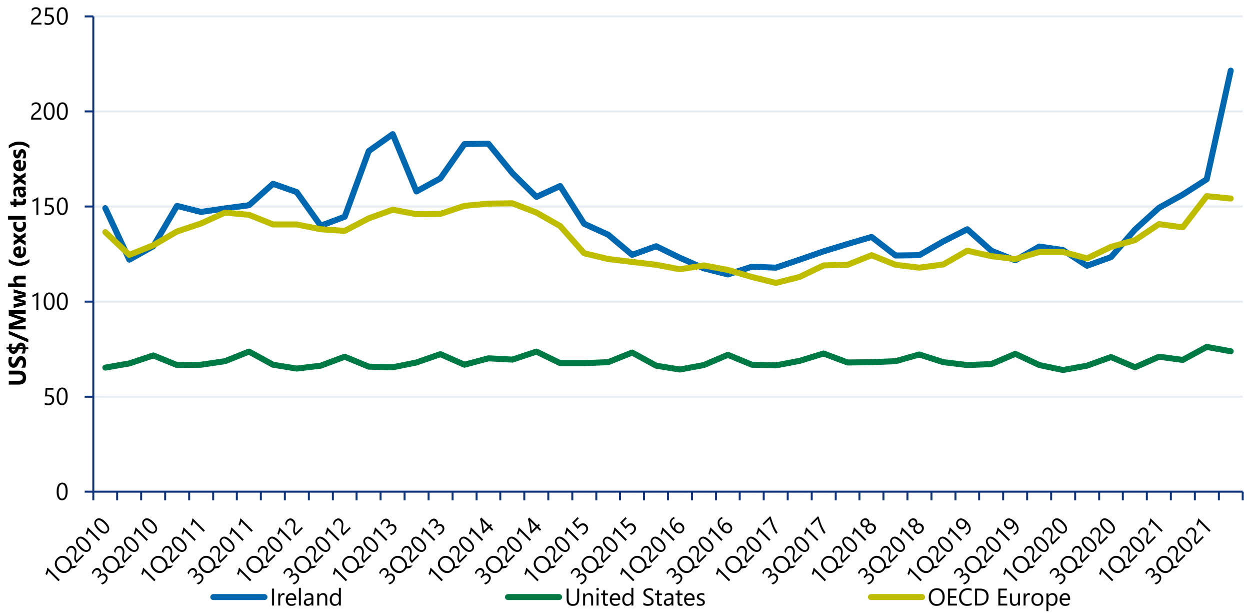
[27] Electricity generation is covered by the EU emissions trading system (ETS), therefore CO_2 emissions savings achieved in electricity generation do not count directly towards Ireland's EU targets to reduce greenhouse gas emissions outside of the ETS (non-ETS)
[28] SEAI, *Electricity & Gas Prices* biannual reports. Available from: https://www.seai.ie/data-and-insights/seai-statistics/key-publications/national-energy-balance/
[29] Council Directive 90/377/EEC concerning a Community procedure to improve the transparency of gas and electricity prices charged to industrial end-users. Available from: https://eur-lex.europa.eu/eli/dir/1990/377/oj
[30] IEA, *OECD Energy Prices and Taxes Quarterly*. Available from: https://www.iea.org/data-and-statistics/data-sets

(nominal) money. Relative price increases since 2015, however, are tabulated for EU countries and the US in index format in both nominal and real terms.

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.

Figure 86 shows that electricity prices to Irish industry have been increasing in recent years, with a steep increase from Q1 2021. The fuel mix for electricity generation is one factor that has a key bearing on the variation in the price of electricity. Compared to the EU, Ireland has a high overall dependency for electricity generation on fossil fuels including gas generation.

Figure 86: Electricity prices to industry



Source: Energy Prices and Taxes ©OECD/IEA, 2022

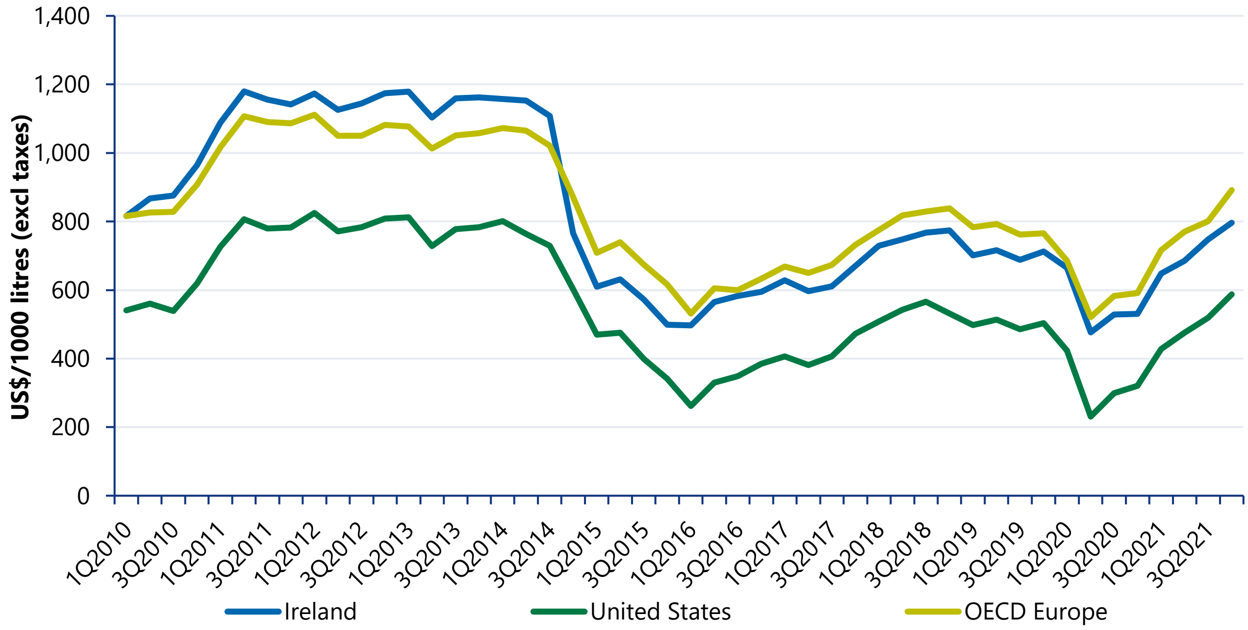
Table 35: Electricity price to industry change since 2015

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 2021 (nominal)	160	130	128	153	124	110	126	179	162	111	166	158	103	126	133	158	107
4th qtr 2021 (real)	117	112	98	140	103	99	109	162	194	97	130	129	90	107	106	133	88

Source: Energy Prices and Taxes ©OECD/IEA, 2022

Table 36 shows that oil prices to industry in Ireland were 53% higher in real terms in Q4 2021 than in 2015. The average oil price in Europe and the US also increased. Crude oil prices averaged around $71/barrel in 2021, compared with $42/barrel on average in 2020.

Figure 87: Oil prices to industry



Source: Energy Prices and Taxes ©OECD/IEA, 2022

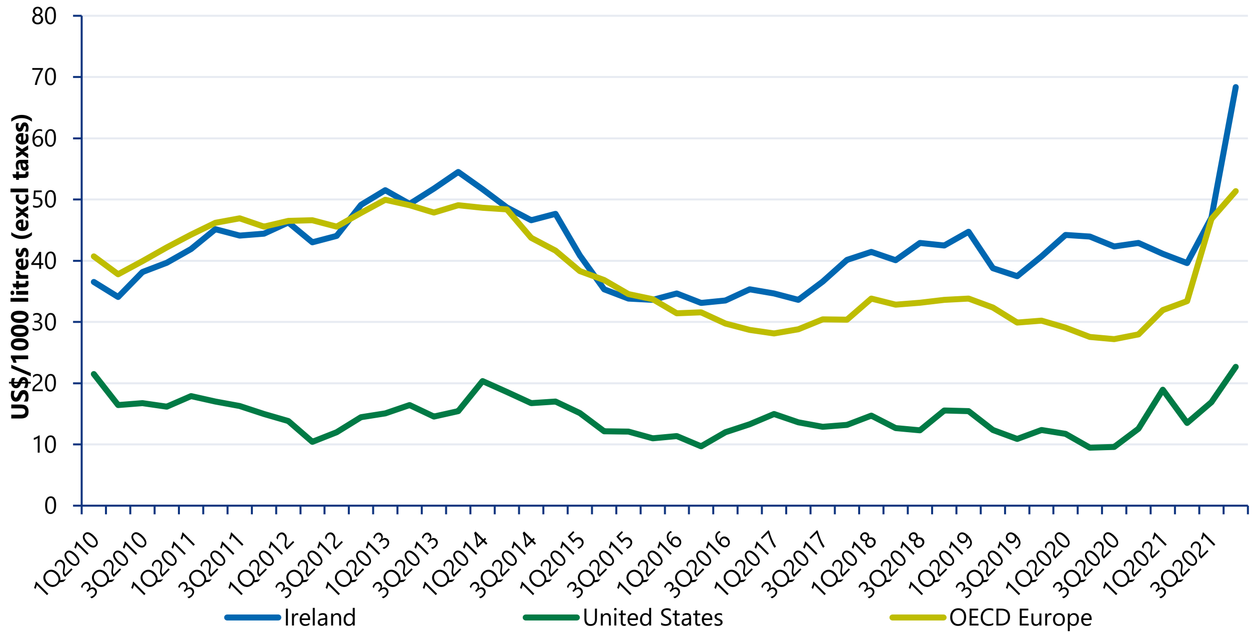
Table 36: Oil prices to industry change since 2015

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 2021 (nominal)	140	156	134	125	130	134	132	128	128	114	135	132	128	133	130	128	136
4th qtr 2021 (real)	108	135	102	115	108	121	115	116	153	100	105	108	112	113	104	109	111

Source: Energy Prices and Taxes ©OECD/IEA, 2022

As *Figure* 88 shows, 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 rose again. In the fourth quarter of 2021, the price of gas to industry in Ireland was 121% above 2015 levels in real terms. *Figure* 88 also shows the gap between gas prices in Europe and the US.

Figure 88: Natural gas prices to industry



Source: Energy Prices and Taxes ©OECD/IEA, 2022

Table 37: Natural gas prices to industry change since 2015

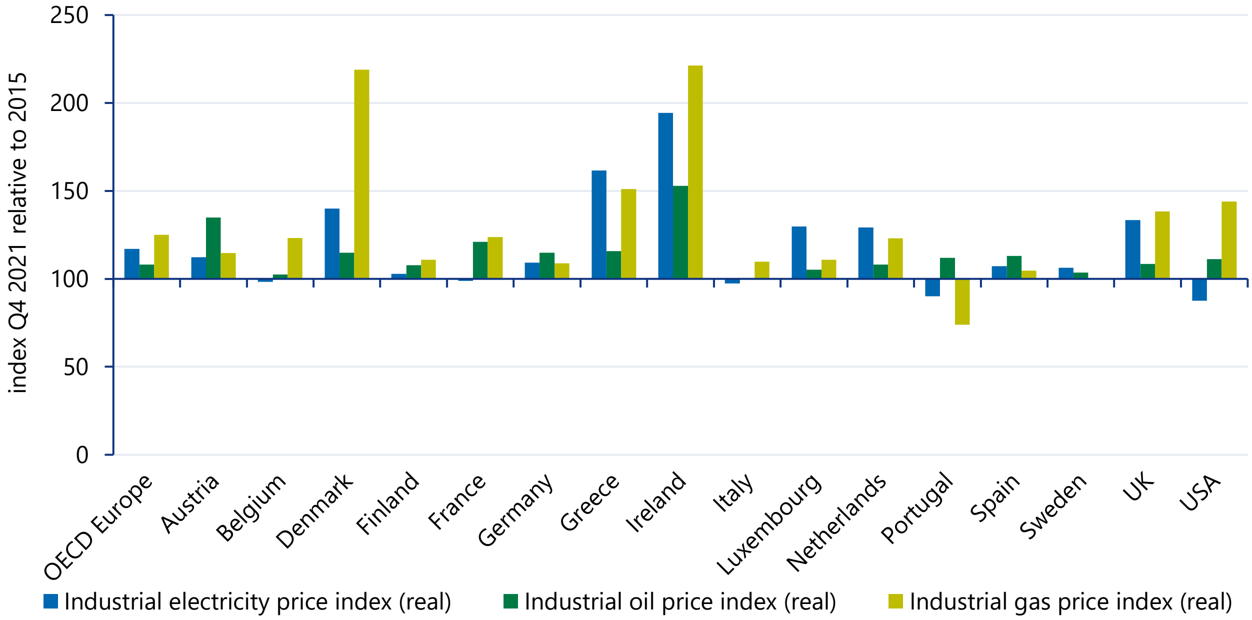
Index 2015 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom	United States
4th qtr 2021 (nominal)	174	132	161	239	133	138	125	168	185	125	142	150	85	123	0	163	176
4th qtr 2021 (real)	125	115	123	219	111	124	109	151	221	110	111	123	74	105	0	138	144

Source: Energy Prices and Taxes ©OECD/IEA, 2022

The average price of natural gas at the UK National Balancing Point was 374% higher in 2021 than in 2020.

Figure 89 summarises the data presented in *Table* 35, *Table* 36 and *Table* 37. 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 2021 increased for all fuels.

Figure 89: Real energy price changes to industry since 2015 (index)



Source: Energy Prices and Taxes ©OECD/IEA, 2022

9 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 2001.

9.1 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 (see Appendix 4), 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 CSO has 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[31](MDD) was first published in the Quarterly National Accounts[32] 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 90 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 and shows the effect of the economic downturn between 2008 and 2012 (and the subsequent return to growth after 2013).

Table 38 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. Transport and industry have responded to economic activity, while energy use in the residential and services sectors is more driven by short-term annual variations in weather and energy prices.

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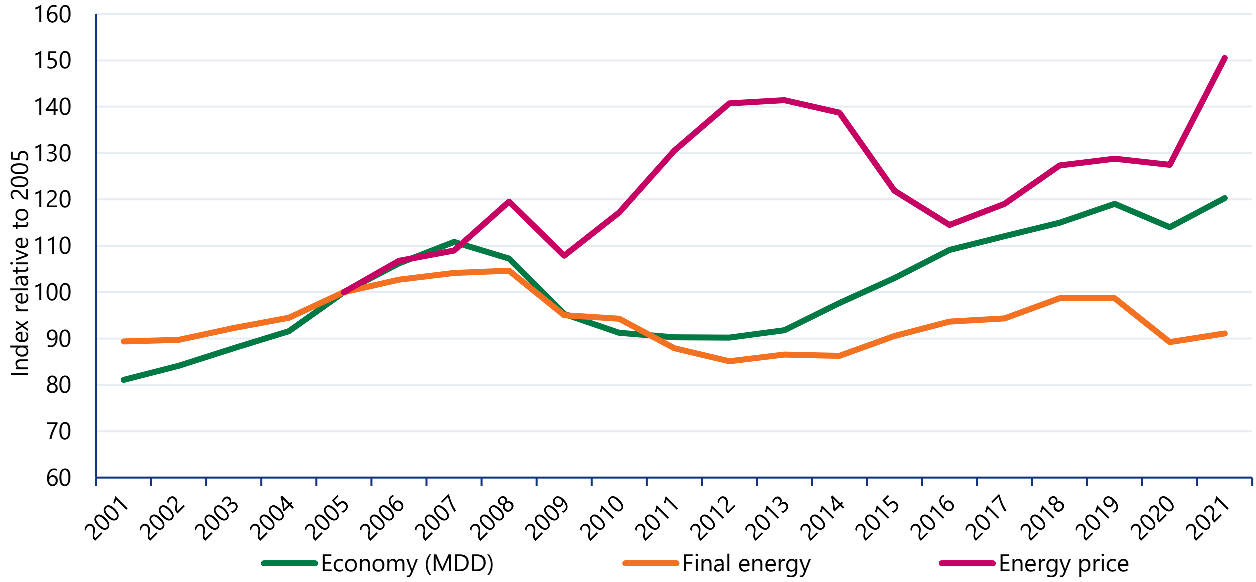
[31] Previous editions of this report presented another economic indicator, modified gross national income (GNI*), as an alternative to GDP. For more information on the differences between GDP, GNI* and modified domestic demand refer to the CSO.
[32] CSO, *Quarterly National Accounts*. Available from: https://www.cso.ie/en/statistics/nationalaccounts/quarterlynationalaccounts/

Figure 90: Index of modified domestic demand, final energy demand and energy price



Source: SEAI and CSO

Table 38: GDP, MDD, final energy, primary energy and energy-related CO_2 growth rates

	1-year change (2020–2021)	5-year change (2016–2021)	10-year change (2011–2021)	20-year change (2001–2021)
Economy (GDP)	+13.6%	+50.4%	+109.7%	+165.4%
Economy (MDD)	+5.5%	+10.3%	+33.3%	+48.4%
Final energy	+2.1%	-2.7%	+3.6%	+1.9%
Primary energy	+3.6%	-4.6%	+0.6%	-5.1%
Energy-related CO_2	+5.4%	-12.8%	-8.5%	-21.2%

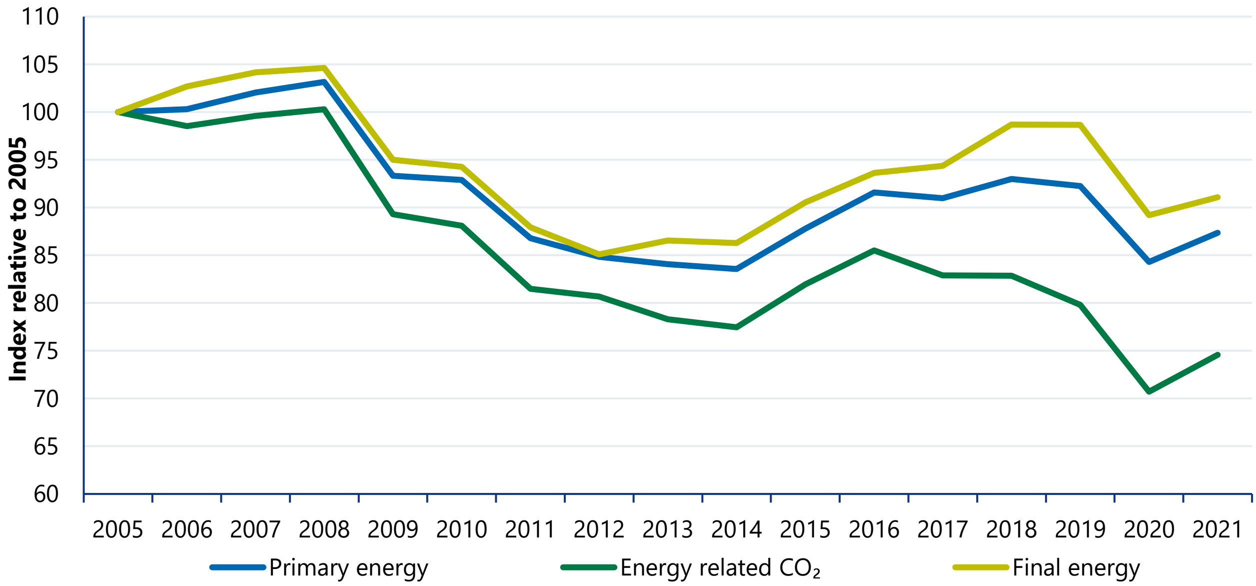
Source: CSO and SEAI

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 in 2014, with increases in energy demand and energy-related CO_2 emissions following after a one-year lag, following the easing of energy prices. In 2020, final energy use, energy-related CO_2 emissions and modified domestic demand fell, due largely to the impact of COVID-19 on economic activity (while GDP increased by 5.9%). All indicators returned to growth in 2021.

Figure 91 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 increased over the period. These improvements are driven by introducing higher efficiency CCGT gas generators, reductions in inefficient coal generation, and the increased supply of wind-generated electricity (considered 100% efficient).

Figure 91: Index of final energy, primary energy and energy-related CO_2



9.2 Energy and the weather

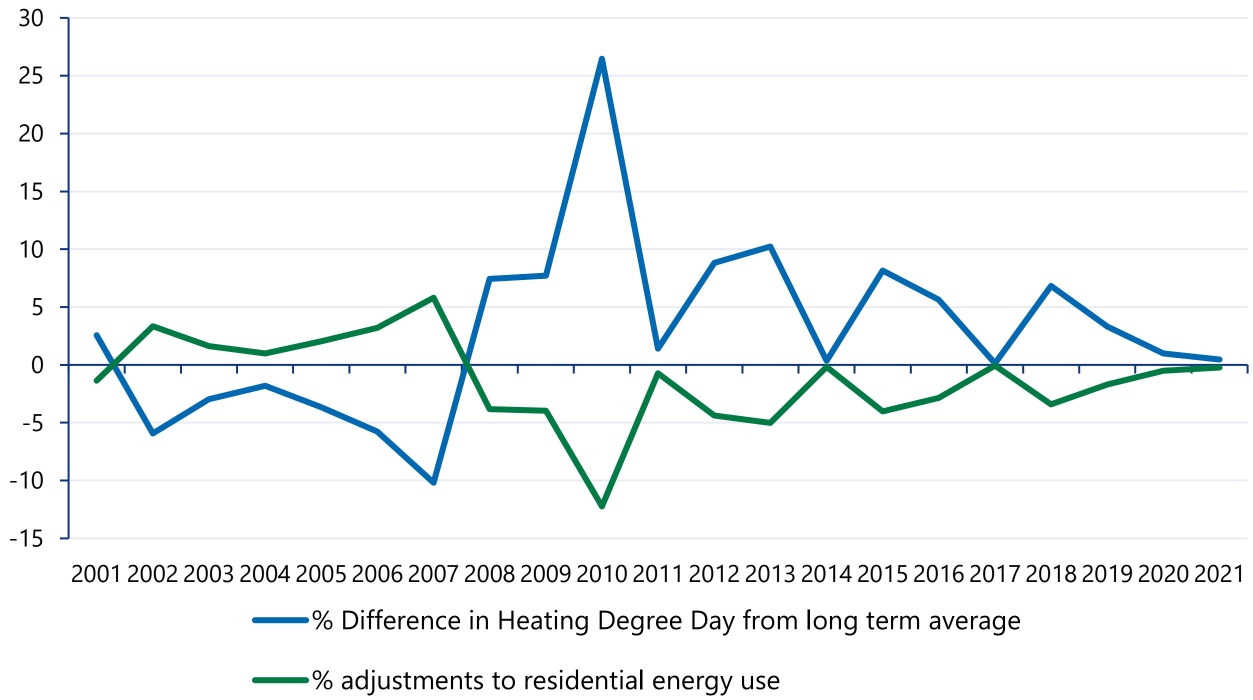
Weather variations from year to year can have a significant effect on the energy demand of a country, in particular on the portion of the energy demand associated with space heating. A method to measure the weather, or climatic variation, is the use of 'degree days'.

Degree days are the measure or index used to consider 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.

Figure 92 shows the percentage deviation in the number of heating degree days from the long-term average between 2001 and 2021. Over that period, 2010 was the coldest year recorded and 2007 was the warmest. The portion of each fuel 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 ±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.

Figure 92: Deviation from average heating degree days and resulting weather adjustment



Source: Met Eireann and SEAI

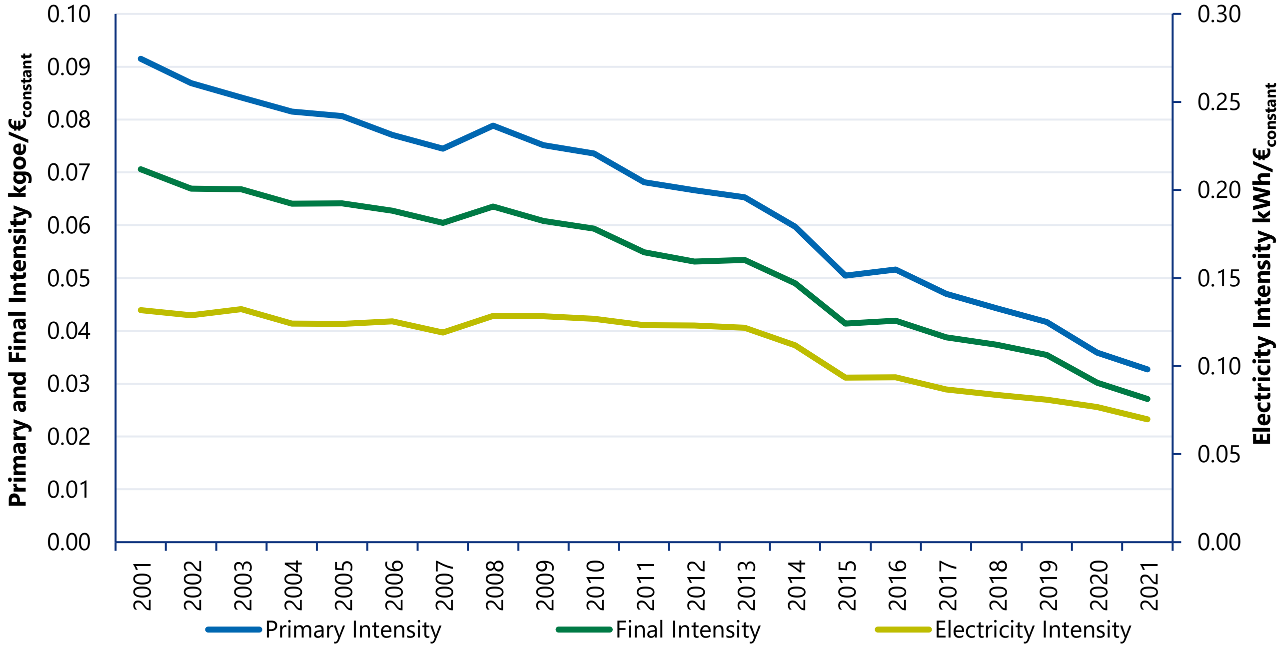
9.3 Economic energy intensities

Energy intensity is defined as the amount of energy required to produce a functional output. For the economy, the measure of output is generally taken to be the GDP. As mentioned in section 5.1, modified domestic demand is a more meaningful indicator of economic 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 93 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 2020 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 generally fallen since 2001, except in 2008 and 2016, which 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 resulted from transferring 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.

Figure 93: 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 toward 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.

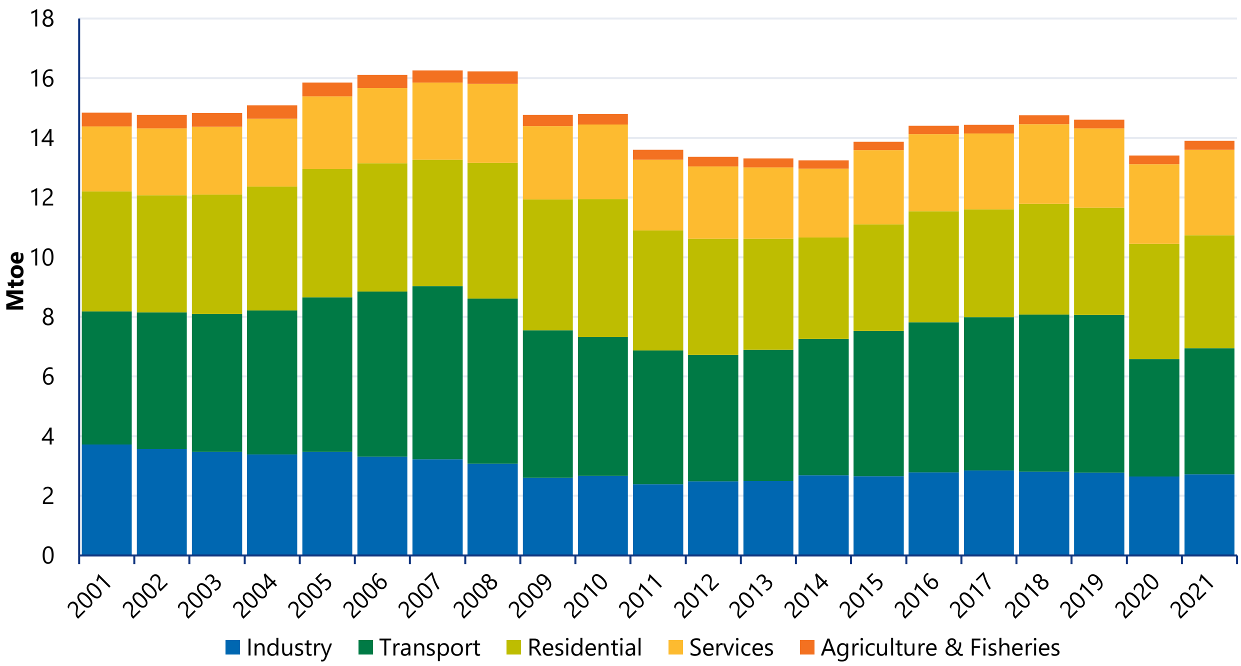
10 Further sectoral analysis

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

10.1 Primary energy requirement by sector

Figure 94 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 94: Total primary energy requirement by sector



Source: SEAI

Table 39 details the quantities, shares and trends of primary energy supply across economic sectors. The total primary supply is split across the transport, residential, services, industry, and agriculture and fisheries sectors. Sectoral energy-related CO_2 emissions are presented in section 7.2.

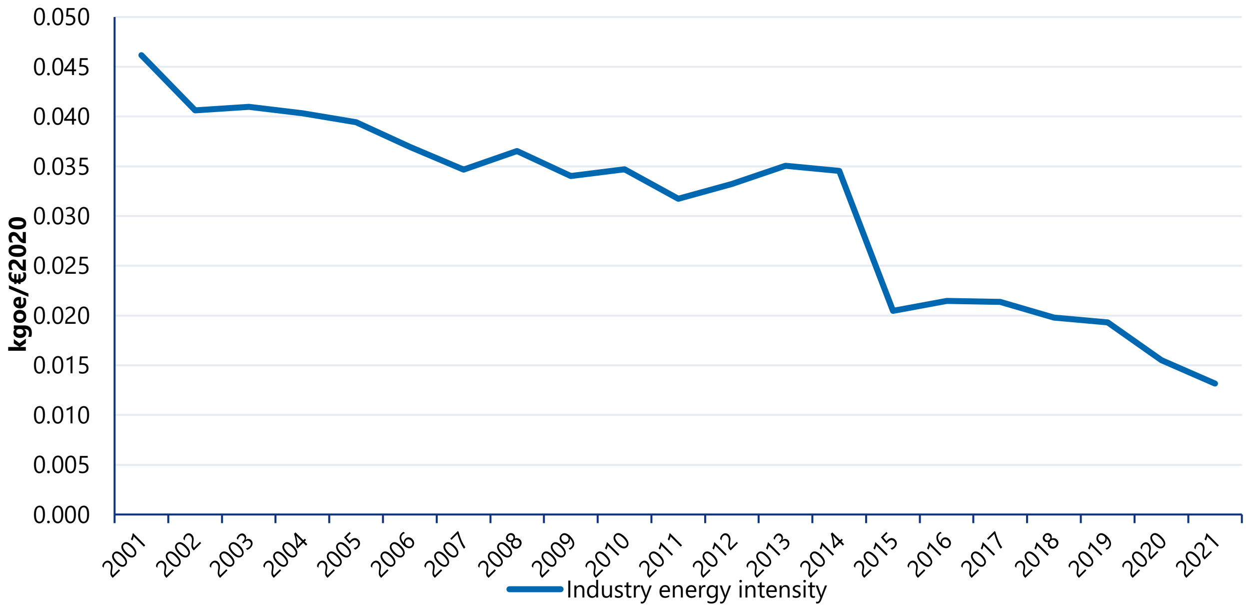
Table 39: Primary energy by sector compared with previous years

	2021		1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity (ktoe)	Share (%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)	(ktoe)	(%)
Industry	2,719	19.6%	+76	+2.9%	-67	-2.4%	+326	+13.6%	-1,002	-26.9%
Transport	4,230	30.5%	+285	+7.2%	-801	-15.9%	-252	-5.6%	-226	-5.1%
Residential	3,788	27.3%	-69	-1.8%	+70	+1.9%	-238	-5.9%	-241	-6.0%
Services	2,868	20.7%	+200	+7.5%	+276	+10.6%	+502	+21.2%	+690	+31.7%
Agriculture & fisheries	299	2.2%	+6	+2.0%	+18	+6.4%	-38	-11.2%	-165	-35.5%
Total	**13,852**	**100.0%**	**+482**	**+3.6%**	**-671**	**-4.6%**	**+89**	**+0.6%**	**-746**	**-5.1%**

10.2 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* 95 shows the industrial energy intensity over the period expressed in kilograms of oil equivalent per euro of industrial value added at 2020 money value (kgoe/€2020). Over the period, industrial energy consumption fell, while value added increased, resulting in a reduction in intensity.

Figure 95: 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 several one-off factors, such as transferring 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 result from many factors, such as structural changes, or changes to the fuel mix or activity.

10.3 Transport

10.3.1 Private car activity

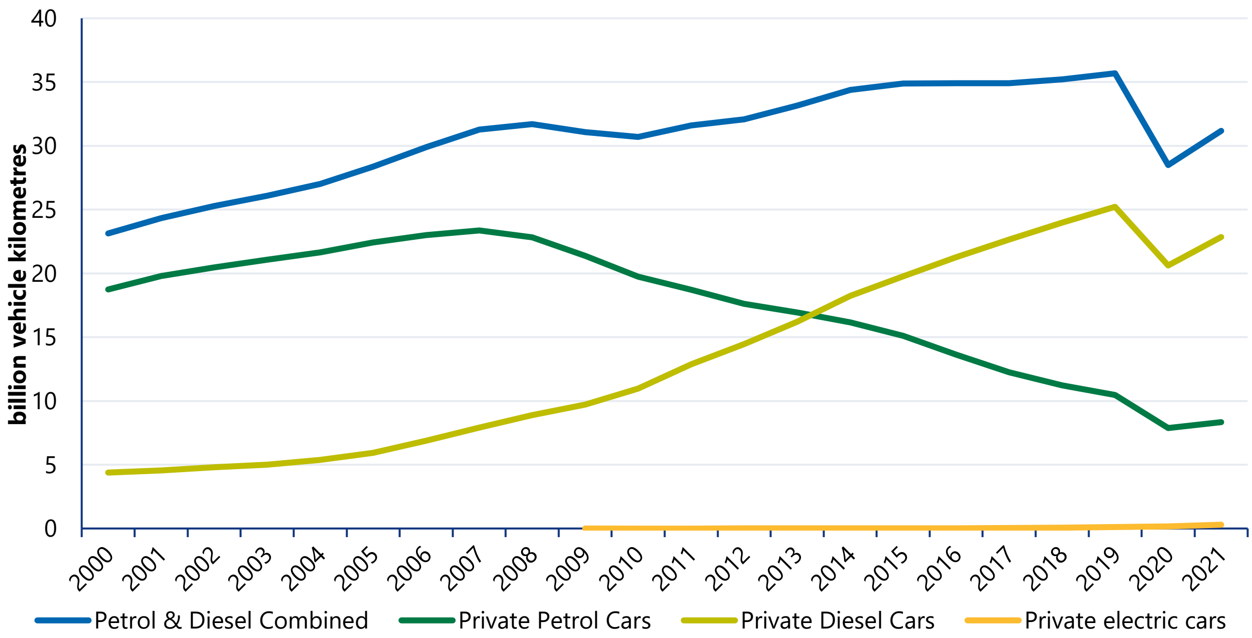
Figure 96 shows the total kilometres driven by petrol, diesel and electric private cars in Ireland each year. This is based on an analysis of NCT data for all years, except 2020 and 2021. The NCT methodology assumes that the kilometres driven between the last two dates in a car which has had an NCT are 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 and 2021. We estimated the reduction in activity of the average petrol car in these years from the observed drop in petrol use. We then assumed that the average diesel car's activities were reduced by the same proportion as the average petrol car.

The total number of vehicle-kilometres travelled declined following the economic crash (during 2009 and 2010) but returned to growth soon after in 2011. Total vehicle-kilometres continued to grow until the dramatic fall in 2020 due to travel restrictions during COVID-19.

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.

Annual vehicle-kilometres for electric vehicles (EVs) have been estimated since 2009 and have grown every year since.

Figure 96: Petrol, diesel and electric private car total annual vehicle-kilometres



Source: Based on NCT Data

10.3.2 CO_2 intensity of new private cars

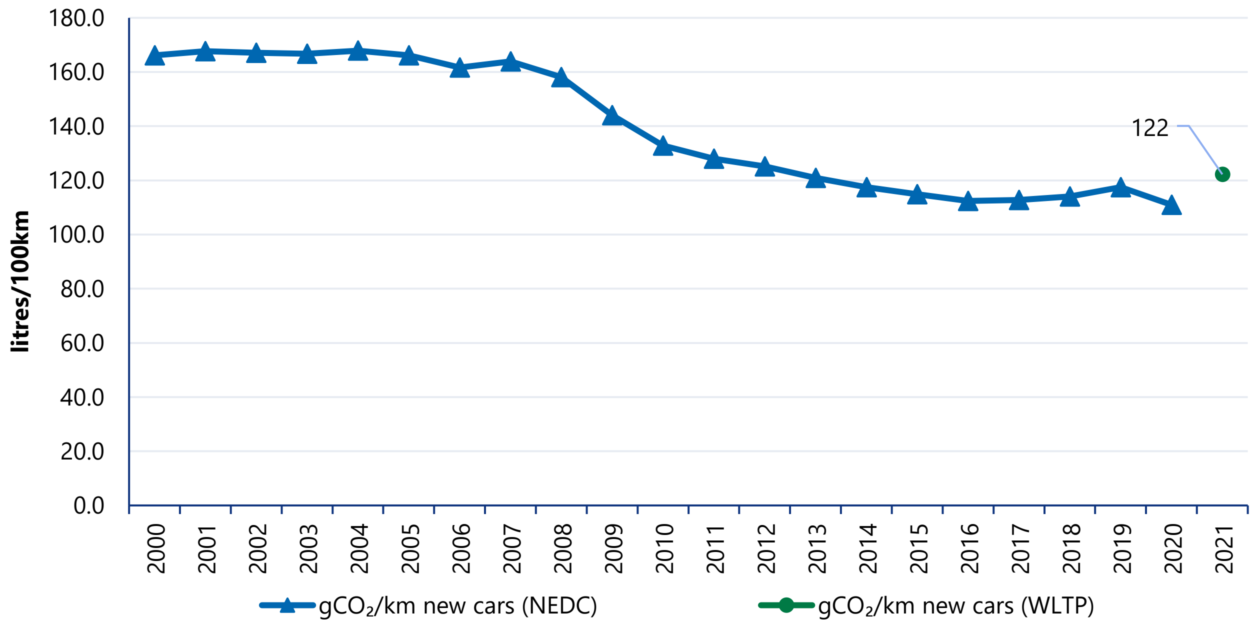
Figure 64 shows the change in the weighted average specific CO_2 emissions of new cars licensed for the first time (excluding battery EVs) over the period, according to standardised testing procedures. This does not include imported second-hand cars.

The standardised testing procedures are known to underestimate the fuel use and CO_2 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.

The data up to 2020 is based on the results of a standardised laboratory test procedure called the New European Driving Cycle (NEDC). From January 2021, a new test methodology called the Worldwide Harmonised Light Vehicle Test Procedure (WLTP) came into force for all new cars to better reflect real-world driving profiles.

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.

Figure 97: Specific CO_2 emissions of new cars, excluding battery electric vehicles

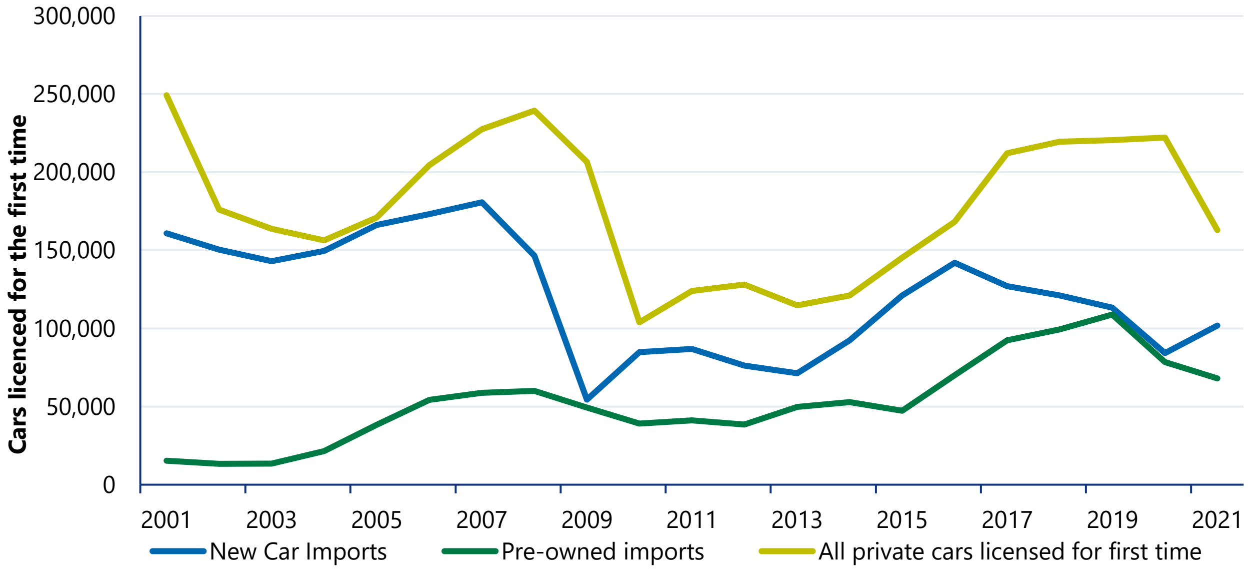


Source: Dept. Transport, Vehicle Registration Unit data.

10.3.3 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* 98. 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 until 2019 and has fallen since then. This is important as the profile of pre-owned imports tends to differ to that of new car imports.

Figure 98: Share of private cars licensed for the first time that are new or pre-owned imports

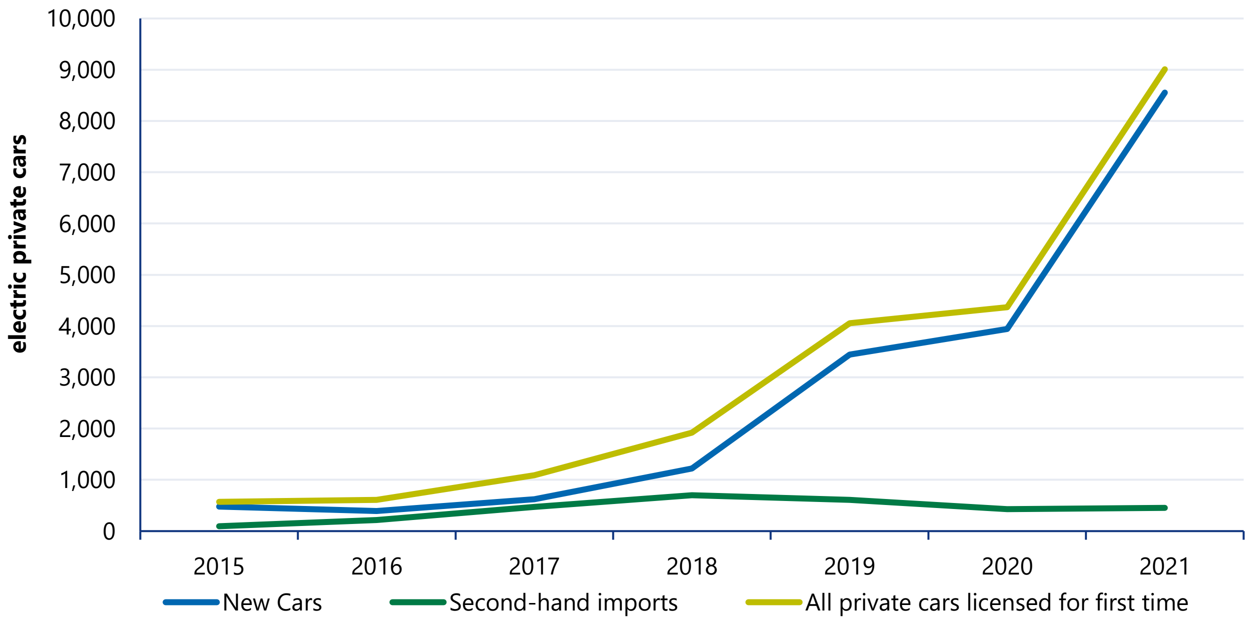


Source: CSO and Dept. Transport, Vehicle Registration Unit

Figure 99 and *Table* 40 show the share of private cars added to the Irish car stock each year that are EVs, split into new imports, pre-owned imports and all new cars licensed for the first time.

This is showing strong growth but still from a low base. With over 90% of all vehicles licensed for the first time in 2021 having an internal combustion engine, and given that the typical lifespan of a car is around 15 years, it will be well into the next decade before there is a significant phasing out of cars with internal combustion engines.

Figure 99: Private cars licensed for the first time that are electric vehicles



Source: CSO and Dept. Transport, Vehicle Registration Unit.

Table 40: Share of private cars licensed for the first time that are electric

	2015	2016	2017	2018	2019	2020	2021
New car imports	0.4%	0.3%	0.5%	1.0%	3.0%	4.7%	8.4%
Pre-owned imports	0.2%	0.3%	0.5%	0.7%	0.6%	0.5%	0.7%
All private cars licensed for the first time	**0.3%**	**0.3%**	**0.5%**	**0.9%**	**1.8%**	**2.7%**	**5.3%**

10.3.4 Heavy goods vehicle activity

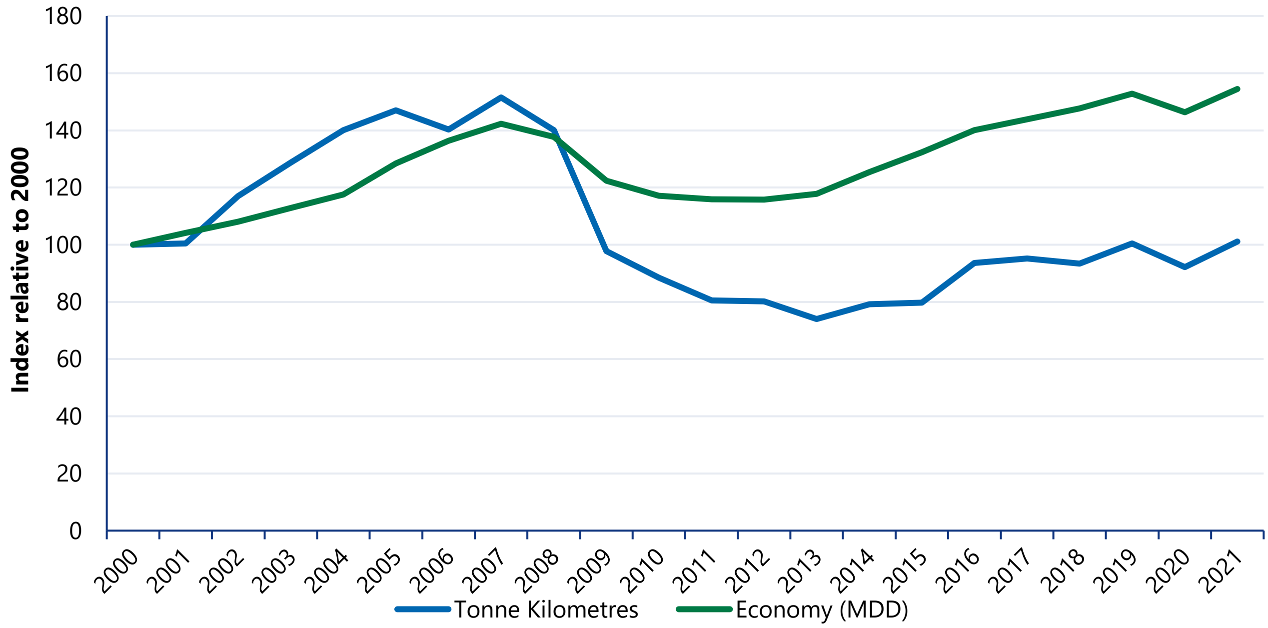
The main metric used to measure activity in the road freight sector is tonne-kilometres, which is the total weight of material transported multiplied by the distance over which it is transported. *Figure* 100 and *Table* 41 present data on road freight tonne-kilometres, along with data on economic growth as measured by modified domestic demand. In *Figure* 100, the data are presented as an index with respect to 2000. The data are taken from the CSO's Road Freight Transport Survey[33], 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 HGVs 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-kilometres still fell in 2020. This was nearly twice the reduction seen in total economic activity, as measured by modified domestic demand. HGV activity returned to growth in 2021.

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 2021 it was still below the 2007 level.

[33] CSO, *Road Freight Transport Survey*. Available from: https://www.cso.ie/en/methods/transport/roadfreighttransportsurvey/

Figure 100: Road freight activity



Source: CSO

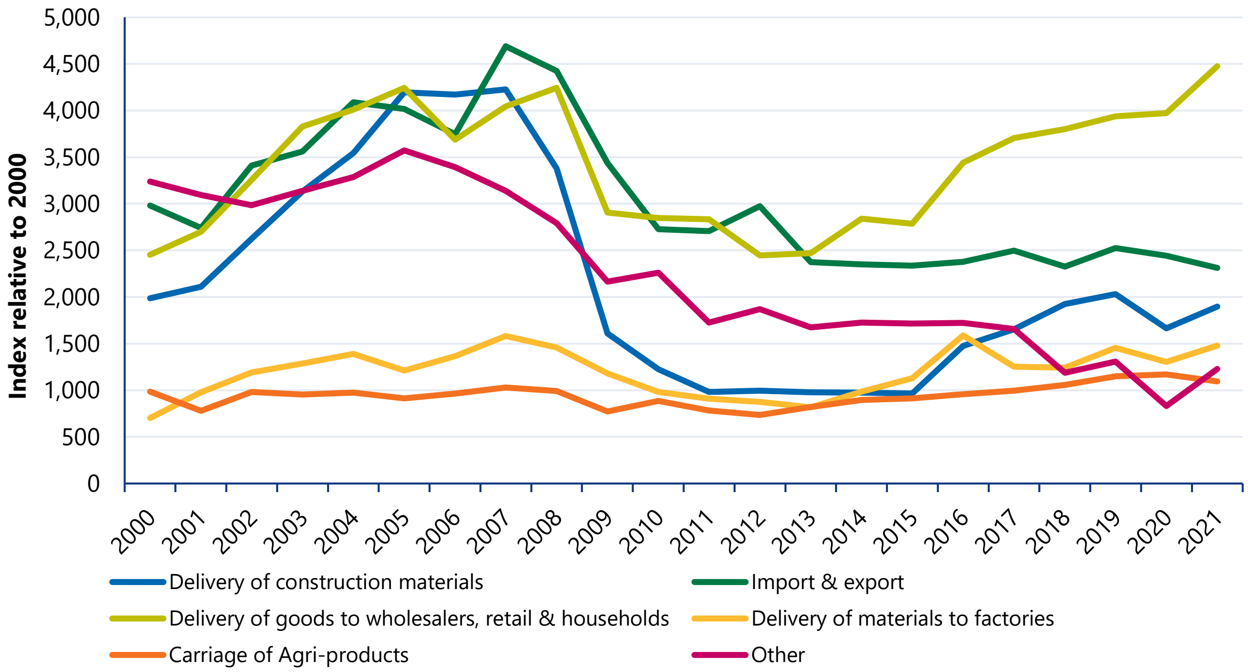
Table 41: Road freight activity

	2021	1-year change (2020–2021)		5-year change (2016–2021)		10-year change (2011–2021)		20-year change (2001–2021)	
	Quantity	Quantity	(%)	Quantity	(%)	Quantity	(%)	Quantity	(%)
Mega tonne-kilometres	12,485	+1,102	+9.7%	+921	+8.0%	+2,544	+25.6%	+80	+0.6%
Modified domestic demand (billion € 2020)	191,790	+10,025	+5.5%	+17,859	+10.3%	+47,924	+33.3%	+62,514	+48.4%

Source: CSO

The CSO also provides data on HGV activity, classed by main type of work done. *Figure* 101 shows the trends for tonne-kilometres in each category between 2000 and 2021.

Figure 101: 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 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 during this period. The next biggest contributor to the fall of transport activity was 'Import and export'. Between 2007 and 2013 it reduced by 49% and accounted for 24% of the total reduction.

Despite the recovery of the economy between 2012 and 2019, the HGV activity in most categories did not recover to 2007 levels. By 2019, 'Delivery of construction materials' remained 52% below 2007, 'Import and 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 and 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', 'Delivery of construction materials' and 'Delivery of materials to factories'. These all returned to growth in 2021 and 'Delivery of goods to wholesalers, retail and households' exceeded its 2008 peak.

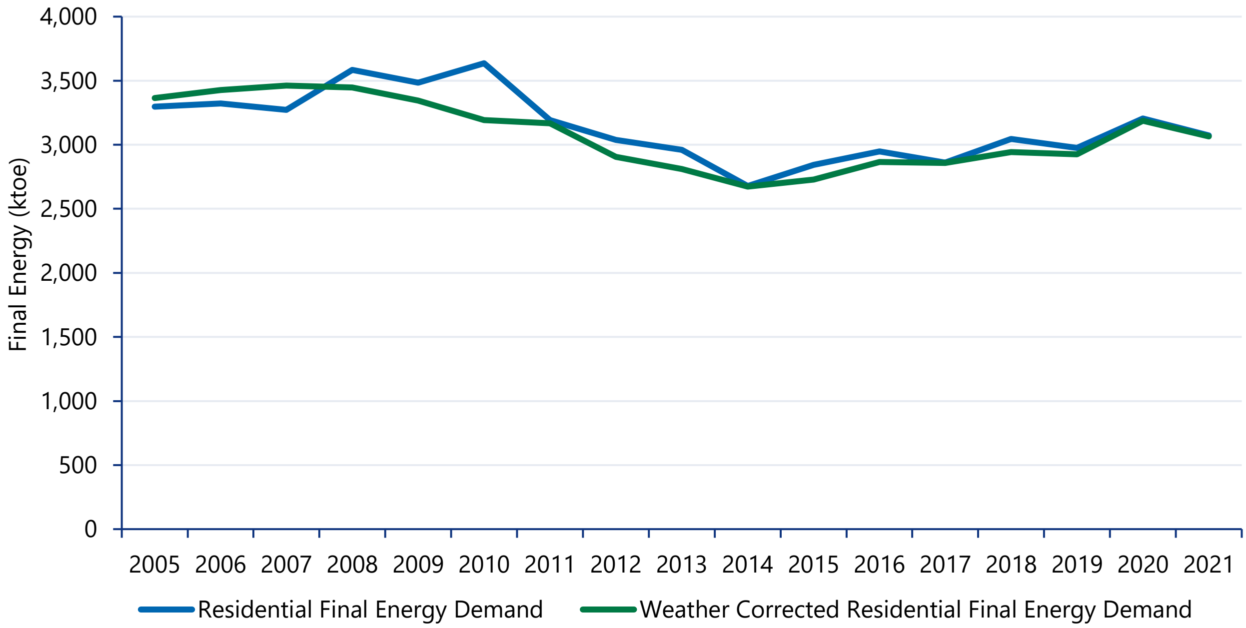
10.4 Residential

10.4.1 Weather correction

Figure 102 shows the trend for the residential sector's final energy consumption between 2005 and 2021, 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).

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 102: Residential final energy

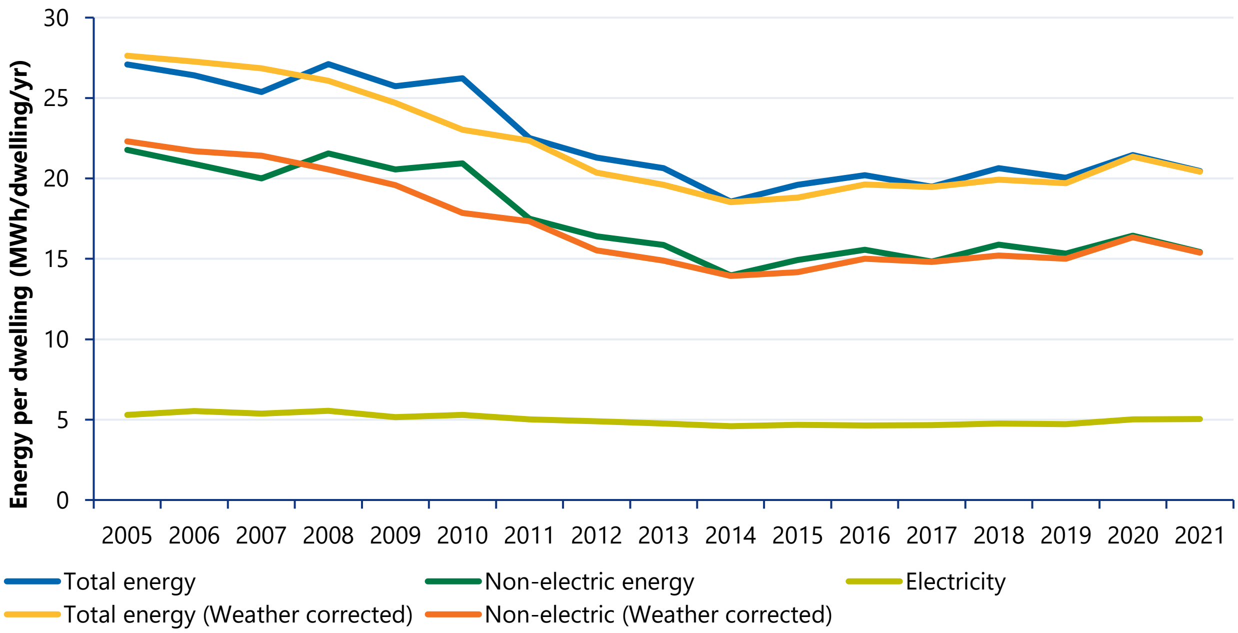


Source: SEAI

10.4.2 Energy consumption per dwelling

Figure 103 shows the trend in final energy consumption per dwelling with and without weather correction.

Figure 103: Energy per dwelling (permanently occupied)



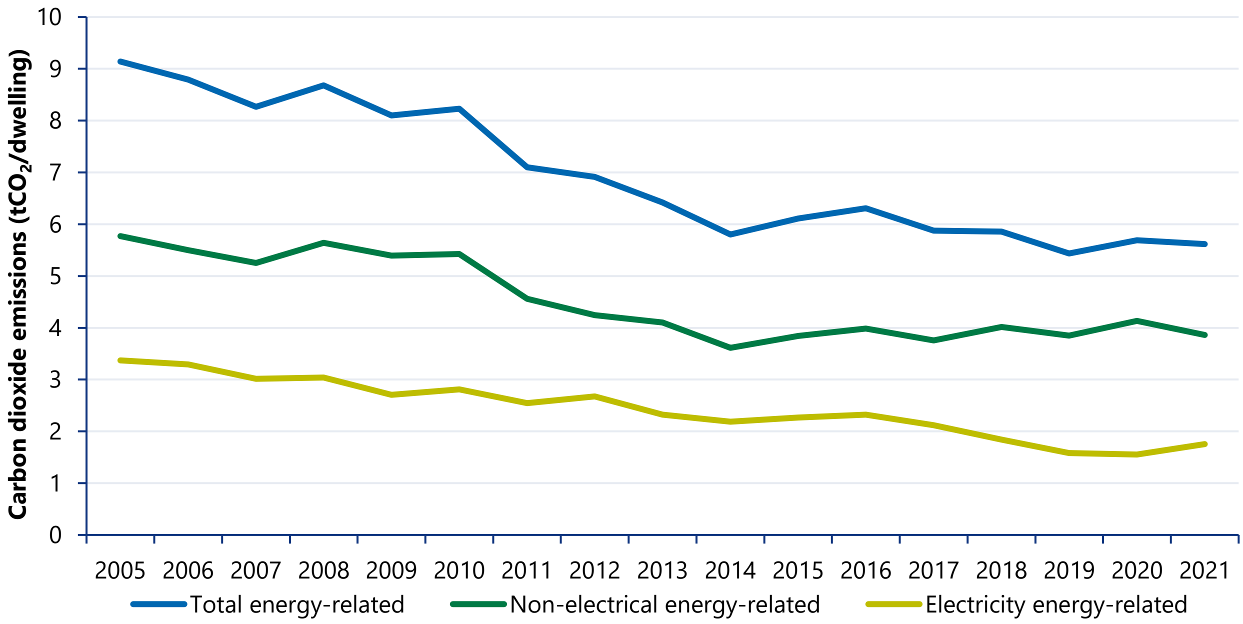
Source: Based on SEAI, CSO and Met Éireann data.

Table 42: Growth rates and quantities of energy consumption and CO_2 emissions per dwelling

Energy per dwelling	2021		1-year change (2020-2021)		5-year change (2016-2021)		10-year change (2011-2021)		20-year change (2001-2021)	
	Quantity (kWh/ dwelling)	Share (%)	(kWh/ dwelling)	(%)	(kWh/ dwelling)	(%)	(kWh/ dwelling)	(%)	(kWh/ dwelling)	(%)
Non-electric fuel use	15,430	75.4%	-1,008	-6.1%	-133	-0.9%	-2,054	-11.7%	-6,078	-28.3%
Electricity	5,043	24.6%	+18	+0.4%	+405	+8.7%	+20	+0.4%	-331	-6.2%
Total energy	20,473	100.0%	-990	-4.6%	+272	+1.3%	-2,034	-9.0%	-6,409	-23.8%
Energy per dwelling (weather corrected)	**2021**		**1-year change (2020–2021)**		**5-year change (2016–2021)**		**10-year change (2011–2021)**		**20-year change (2001–2021)**	
	Quantity (kWh/ dwelling)	**Share (%)**	**(kWh/ dwelling)**	**(%)**	**(kWh/ dwelling)**	**(%)**	**(kWh/ dwelling)**	**(%)**	**(kWh/ dwelling)**	**(%)**
Total energy	20,424	100.0%	-928	-4.3%	+800	+4.1%	-1,919	-8.6%	-6,092	-23.0%
Non-electric fuel use	15,383	75.3%	-948	-5.8%	+372	+2.5%	-1,944	-11.2%	-5,772	-27.3%
Electricity	5,040	24.7%	+20	+0.4%	+428	+9.3%	+25	+0.5%	-320	-6.0%
Energy-related CO_2 emissions per dwelling	**2021**		**1-year change (2020–2021)**		**5-year change (2016–2021)**		**10-year change (2011–2021)**		**20-year change (2001–2021)**	
	Quantity (tCO_2/ dwelling)	**Share (%)**	**(tCO_2/ dwelling)**	**(%)**	**(tCO_2/ dwelling)**	**(%)**	**(tCO_2/ dwelling)**	**(%)**	**(tCO_2/ dwelling)**	**(%)**
Total energy	5.62	100.0%	-0.07	-1.2%	-0.69	-10.9%	-1.48	-20.9%	-4.55	-44.8%
Non-electric fuel use	3.86	68.8%	-0.27	-6.6%	-0.12	-3.1%	-0.69	-15.2%	-1.97	-33.8%
Electricity	1.75	31.2%	+0.20	+12.9%	-0.57	-24.5%	-0.79	-31.1%	-2.58	-59.5%

Source: SEAI

Figure 104: Unit energy-related CO_2 emissions per dwelling



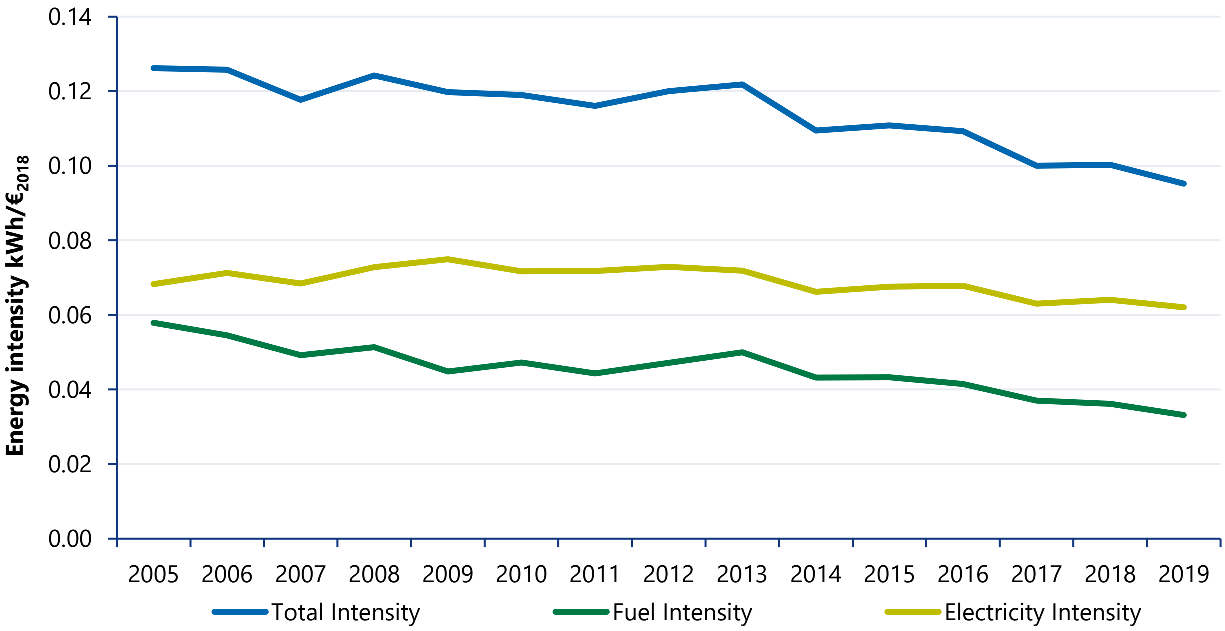
Source: SEAI

10.5 Commercial and public services

10.5.1 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* 105, this intensity is flatter than that of industry.

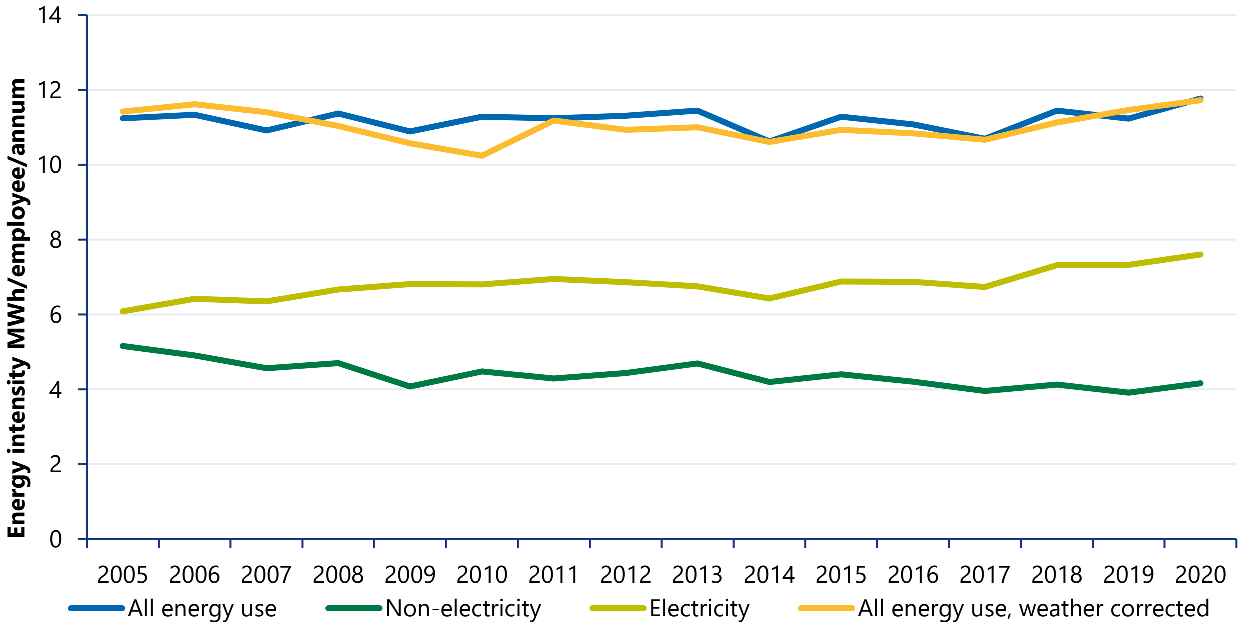
Figure 105: Energy intensity of the commercial and public services sector



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 106: 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. *Figure* 106 shows electricity per employee has been increasing since 2017.

Table 43: Growth rates and quantities of energy per employee in commercial and public services

Energy per employee in commercial and public services	2021		1-year change (2020-2021)		5-year change (2016-2021)		10-year change (2011-2021)		20-year change (2001-2021)	
	Quantity (kWh/ employee)	Share (%)	(kWh/ employee)	(%)	(kWh/ employee)	(%)	(kWh/ employee)	(%)	(kWh/ employee)	(%)
Non-electric energy use	3,829	33.6%	-337	-8.1%	-375	-8.9%	-464	-10.8%	-2,567	-40.1%
Electricity	7,575	66.4%	-29	-0.4%	+699	+10.2%	+627	+9.0%	+2,541	+50.5%
Total energy	**11,404**	**100.0%**	**-366**	**-3.1%**	**+324**	**+2.9%**	**+162**	**+1.4%**	**-26**	**-0.2%**
Energy per employee in commercial and public services (weather corrected)	**2021**		**1-year change (2020-2021)**		**5-year change (2016-2021)**		**10-year change (2011-2021)**		**20-year change (2001-2021)**	
	Quantity (kWh/ employee)	**Share (%)**	**(kWh/ employee)**	**(%)**	**(kWh/ employee)**	**(%)**	**(kWh/ employee)**	**(%)**	**(kWh/ employee)**	**(%)**
Non-electric energy use	4,046	33.5%	-91	-2.2%	+2	+0.1%	-206	-4.8%	-2,237	-35.6%
Electricity	8,044	66.5%	+456	+6.0%	+1,245	+18.3%	+1,115	+16.1%	+3,036	+60.6%
Total energy	**12,090**	**100.0%**	**+365**	**+3.1%**	**+1,247**	**+11.5%**	**+909**	**+8.1%**	**+799**	**+7.1%**

Source: SEAI

10.5.2 Public sector developments

The public sector comprises approximately 4,000 separate public bodies, about 3,650 of which are individual schools. The other 350 comprise, among other things, 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 (for example, a small rural school or a five-person agency) to very large (for example, the Health Service Executive or An Garda Síochána). The vast majority of energy is consumed by the 100 largest organisations.

Public services energy consumption comprises two main classes of energy consumer:

- **Public sector buildings** (offices, hospitals, clinics, nursing homes, schools, prisons, barracks, Garda stations, etc.), which primarily consume electricity, natural gas and oil-based fuels in addition to smaller amounts of renewable and solid fuels.
- **Public sector utilities**, which primarily consume electricity, such as wastewater treatment plants, water treatment facilities, pumping stations and street lighting (~400,000 units).

In addition, the energy consumed by public bodies also includes some consumption counted in the transport sector in the National Energy Balance, such as 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.

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 regarding their 'exemplary role' for energy efficiency. The NEEAP set a 33% efficiency target for the sector by 2020.

Since 1 January 2011, public sector bodies have been required to report to the Government annually on their energy use and the actions they have taken to reduce consumption. SEAI and the DECC have developed an energy monitoring and reporting system 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 November 2021, SEAI published the Annual Report 2021 on Public Sector Energy Efficiency Performance.[34] It noted that 349 public sector bodies and 3,670 schools completed reports on energy and these represented 99% of total public sector energy consumption. The total energy consumption in 2020 of these bodies was 9,160 GWh (primary energy), which comprised 4,163 GWh of electricity, 3,036 GWh of thermal energy and 1,961 GWh of transport energy. This cost the State €597 million in 2020. The report also noted that these bodies have achieved annual primary energy savings of 4,576 GWh, or a 34% improvement on business as usual, yielding a cost saving of €298 million. The public sector therefore exceeded the target of 33% energy efficiency improvement by 2020.

The 2021 Climate Action Plan set a more ambitious targets for the public sector of 50% energy efficiency improvement and a 51% absolute emissions reduction by 2030.

[34] https://www.seai.ie/publications/Public-Sector-Annual-Report-2021.pdf

11 Provisional energy data from monthly surveys

Besides its definitive annual reporting, SEAI collects and publishes provisional monthly energy data on electricity generation, gas supply and oil deliveries. The coverage of this monthly data is not as comprehensive as annual data; for example, the monthly electricity data only covers electricity exported to the grid from generator stations, and so does not include industry auto-producers or residential solar PV generation. Nor is it possible to carry out the same level of double checks and cross-agency reconciliation on monthly data as applied to definitive annual records. However, monthly data brings valuable timeliness to national energy reporting, and allows us to examine seasonal variations that are otherwise 'washed out' in annual totals. Simply put, both definitive annual reporting and provisional monthly reporting bring different advantages to energy reporting and are complementary, provided their differences are understood and acknowledged. In this section, we present provisional monthly data for electricity, gas and oil up to and including 2022, to examine medium-term trends and explore seasonal effects.

11.1 Monthly electricity data to 2022

11.1.1 Seasonality in monthly electricity generated

Figure 107 shows monthly electricity generation exported to the grid over the last several years, split by electricity generated from renewable sources and non-renewable sources. While the seasonality of both total electricity generation and electricity generation from renewable sources is somewhat apparent in this 'raw' monthly data, it can be made much clearer through cross-year averaging, as shown in subsequent figures.

Figure 107: Monthly electricity generation – January 2015 to September 2022

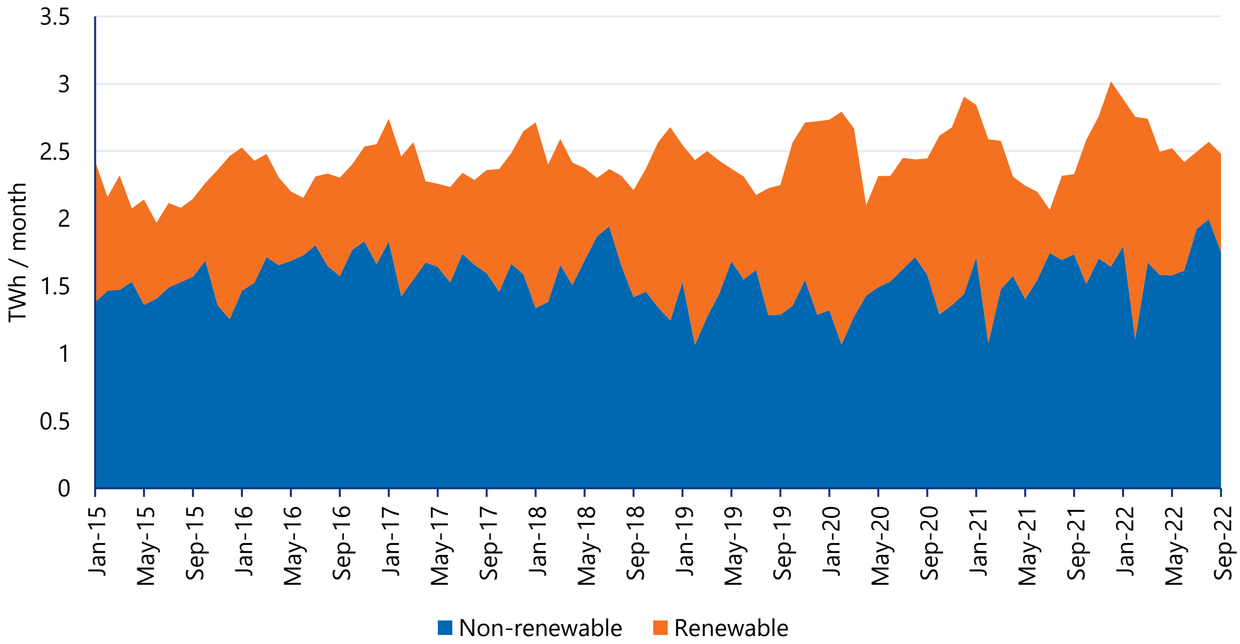


Figure 108 shows the renewable electricity generation to the grid by calendar month, where each month's value is the average of that month's electricity generation over the previous 5-6 years. For example, the January value is the average of January 2015, January 2016, etc., to January 2022. It shows a pronounced seasonal variation approximating a sine wave oscillating around an average value of approximately 0.9 TWh. It has a maximum of approximately 1.2 TWh from December to February, and a minimum of approximately 0.6 TWh from June to August. The seasonal variation of renewable electricity generation is therefore

approximately ±33% the annual average. This variation is largely driven by the strong seasonality of wind generation, which makes up a considerable fraction of our renewable electricity generation (see below for more details). Fortunately, the seasonality of our renewable electricity generation matches the seasonality of our demand – the wind generally blows hardest in the winter months, and this is when energy demand for light and heat is highest.

Figure 108: Average renewable electricity generated – January 2015 to September 2022

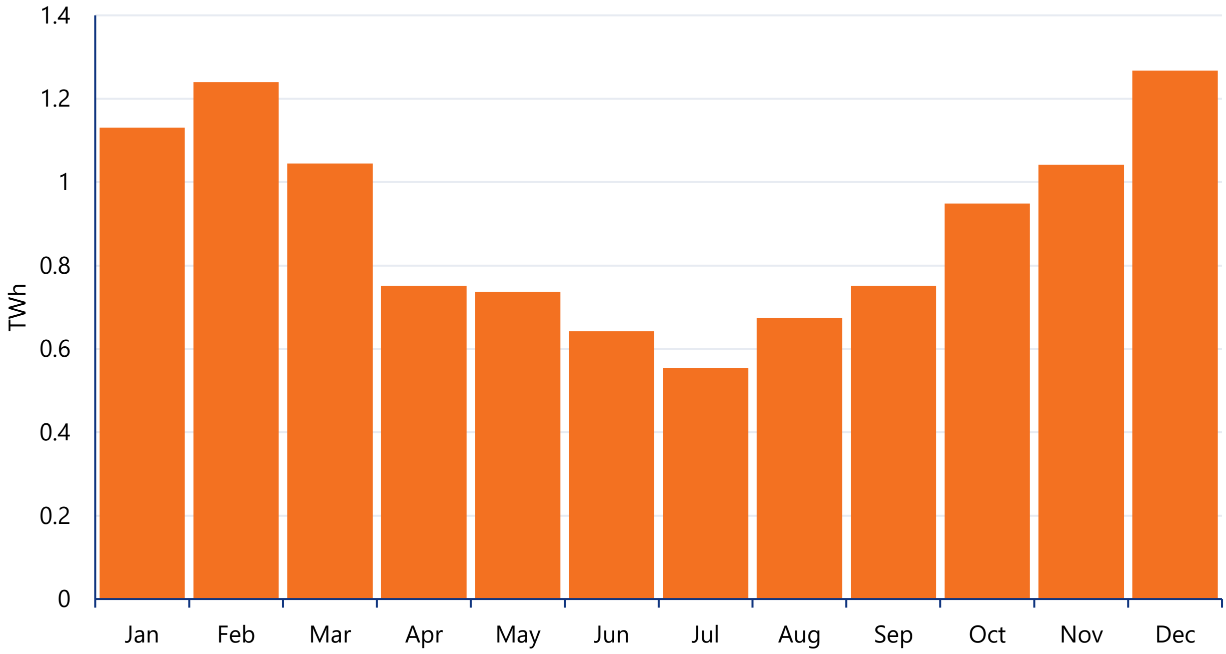
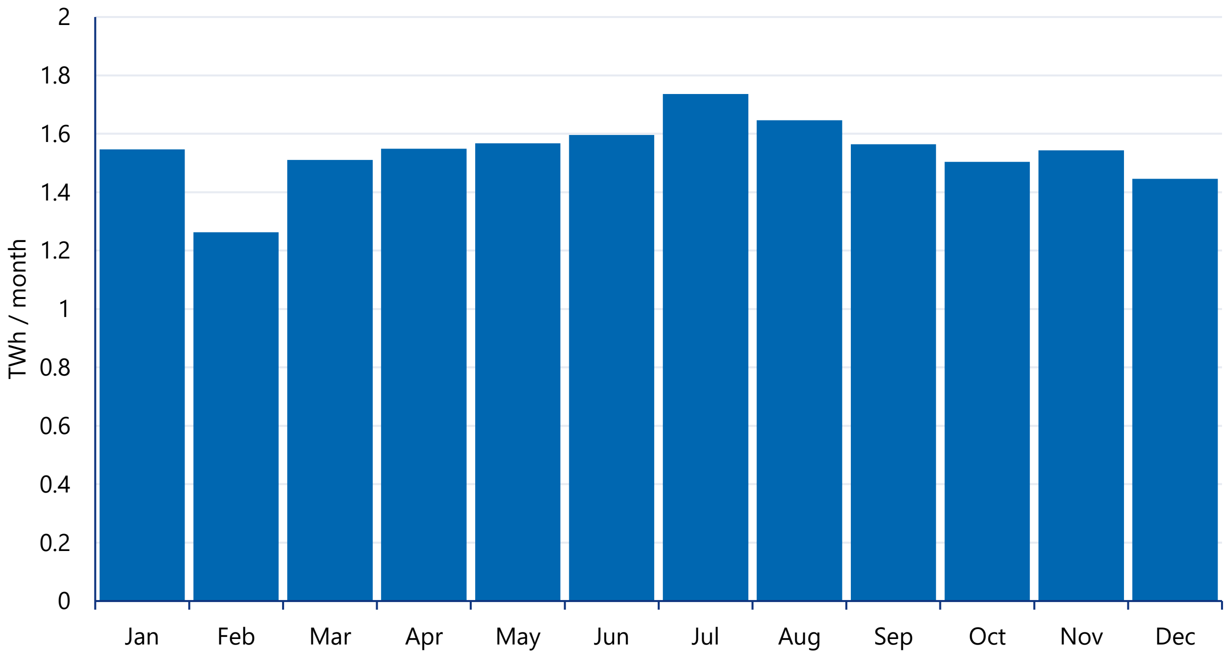


Figure 109 shows the non-renewable electricity generation to the grid by month, where each month's value is the average value of that month's electricity generation over the previous 5-6 years, as explained above. It is relatively flat at approximately 1.5 TWh per month, but shows higher non-renewable electricity generation in the summer months, and lower non-renewable electricity generation in the winter months. Non-renewable electricity generation is anti-correlated to renewable generation – when renewable generation is high, non-renewable electricity is low, and vice versa. This is most clearly illustrated by comparing the average values of February and July in *Figure 108* and *Figure 109*, where the particularly high and low renewable generation values match particularly low and high renewable generation values.

Figure 109: Average non-renewable electricity generated – January 2015 to September 2022



11.1.2 Monthly electricity generated in 2022

Figure 110 shows total electricity generation to the grid by month in 2022, compared to the last 2 years, and the maximum-to-minimum envelope back to 2015. For almost every month, the total monthly electricity generation in 2022 defines the maximum level of the historic envelope. This has generally been the case every year, because an increasing fraction of Ireland's energy demand is satisfied through electricity. In every month to date in 2022, the total electricity generation to the grid has exceeded the corresponding month in 2021.

Figure 110: Monthly electricity generated – 2022 to previous years

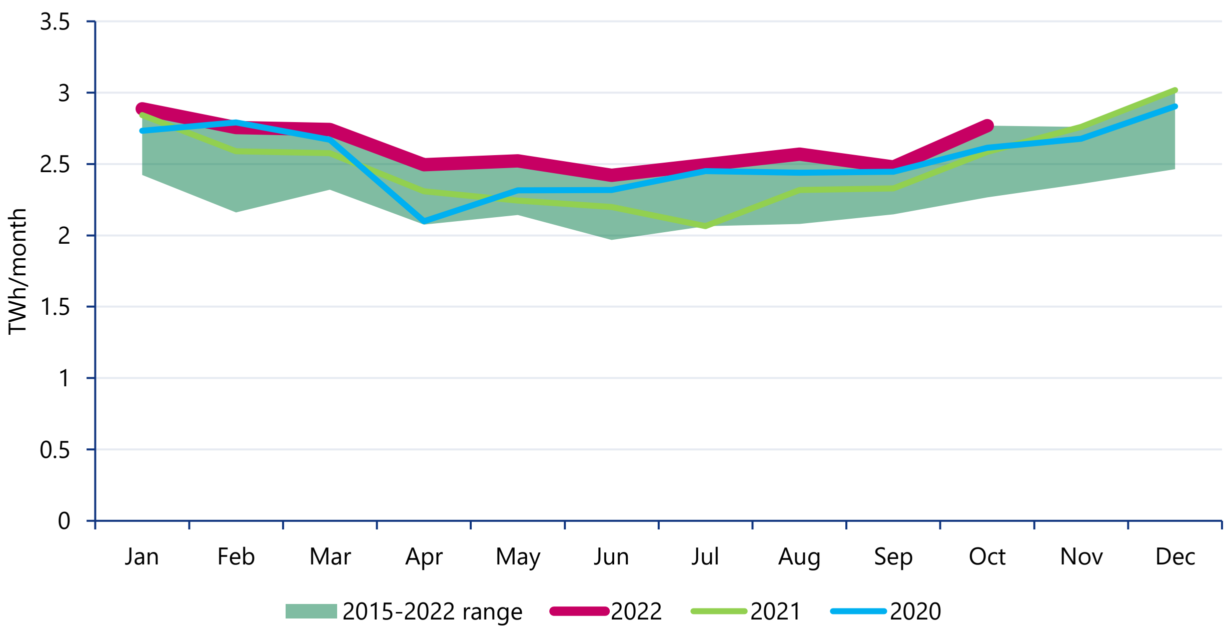


Figure 111 shows the monthly electricity generation to the grid to date in 2022, broken down by input fuel or energy type. Note that this figure shows the electricity generated due to each fuel/energy input, rather than the quantity of fuel/energy needed to generate that electricity. The seasonal variations in electricity generated from wind and gas are visible, with wind accounting for 55% of grid exported electricity in February 2022.

Figure 111: Monthly electricity generation by source in 2022

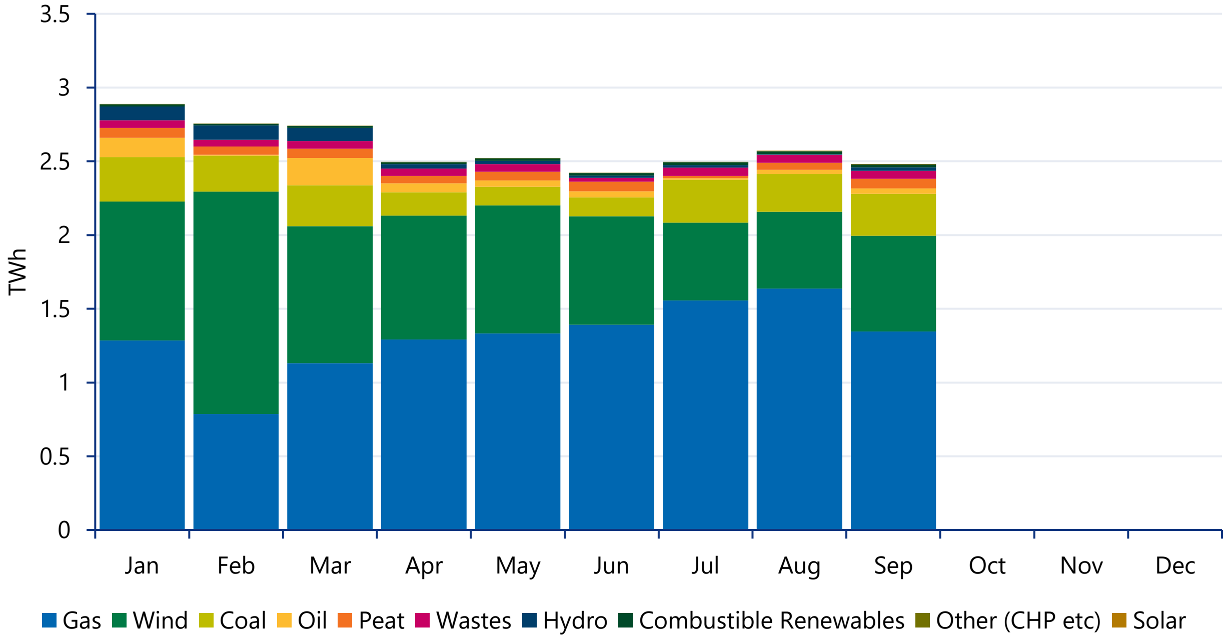
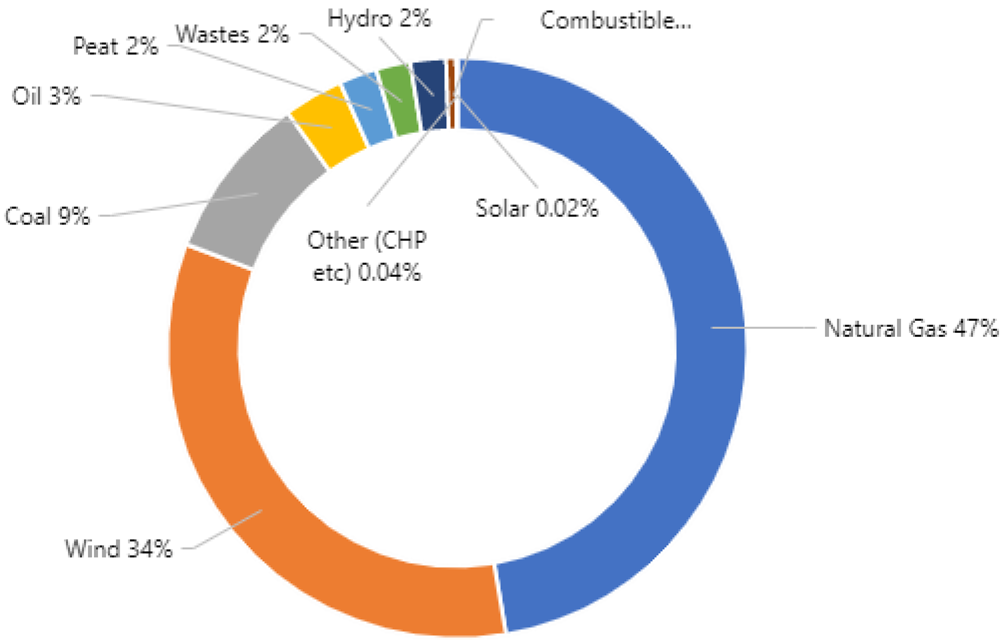


Figure 112 shows the breakdown of the generated electricity by input fuel or energy type, averaged over the last 12 calendar months, e.g. from September 2021 to September 2022. This 12-month approach is more appropriate than simply averaging over the year-to-date, because electricity generation from October to December has higher seasonal renewable contributions. In the last 12-months, the proportion of electricity generation to the grid was:

- Gas 47%
- Wind 34%
- Coal 9%
- Oil 3%

Figure 112: Sources of electricity generation – 12-month rolling average to September 2022



11.1.3 Spotlight on coal and oil in electricity generation

Figure 113 shows the monthly electricity generation arising from the combustion of coal. From late-2018 to mid-2020, coal was substantially removed from the fuel mix of grid electricity, but it has since returned, and recently accounted for approximately 10% of monthly electricity generation. The increase in electricity generation from coal is largely a substitution effect, arising from the temporary shutdown of gas-powered electricity generation plants, including the *Bord Gáis* Whitegate power station and one unit of the *Energia* Huntstown plants. The shift from gas-powered generation to coal-powered generation increases the carbon intensity of our electricity because coal generates more CO_2 than gas for the same amount of electricity.

Figure 113: Monthly electricity generated from coal

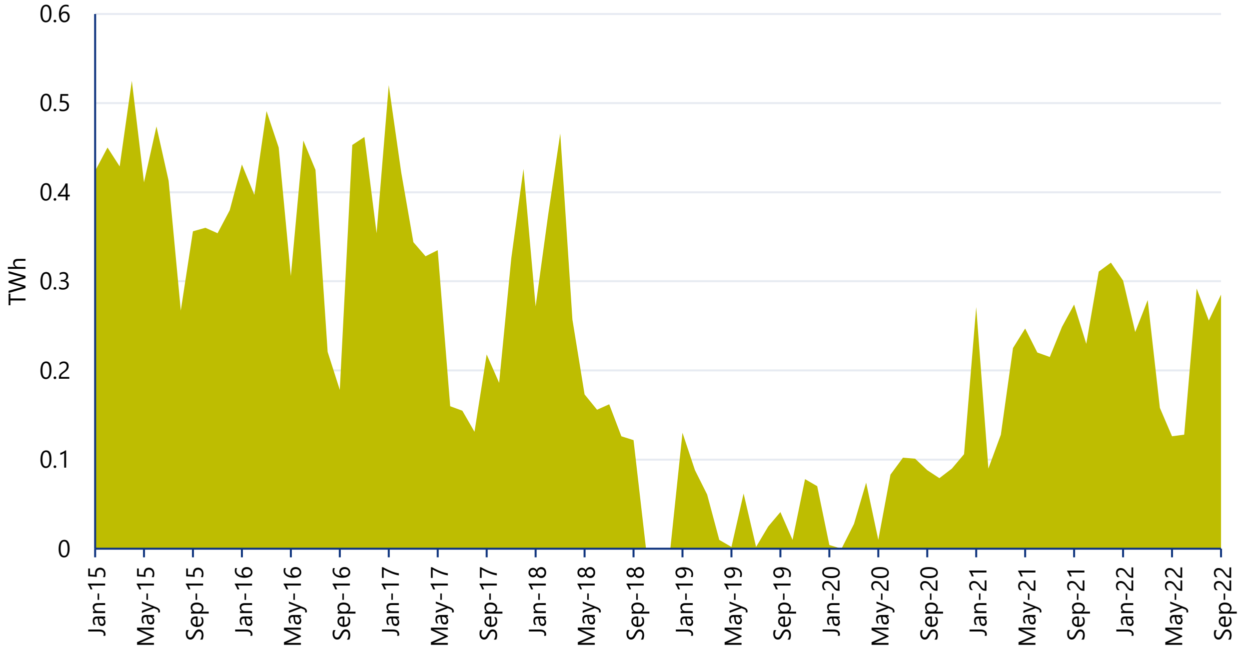
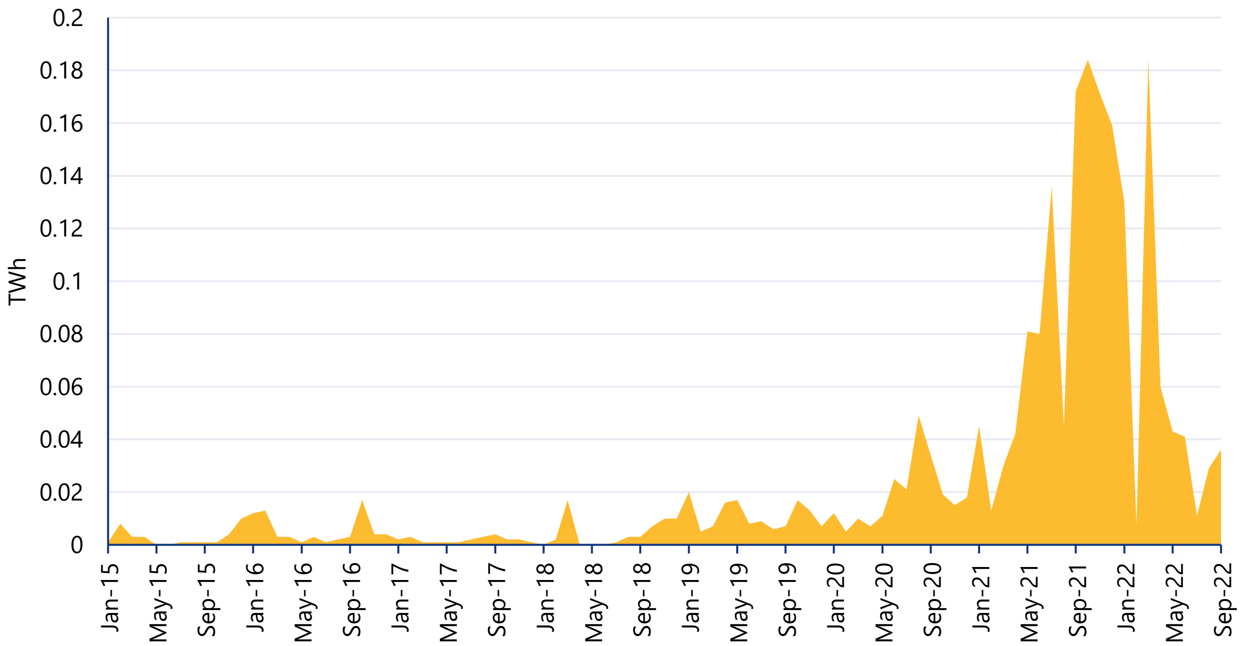


Figure 114 shows the monthly electricity generation arising from the combustion of oil products. For the last decade, oil has generally been used as a secondary or priming fuel for electricity generation by other fuel types. However, from mid-2021, electricity generation from oil increased significantly, peaking at almost 0.2 TWh per month in September 2021. Again, this was largely a substitution effect arising from the temporary shutdown of gas-powered electricity generation plants, requiring the use of older and more carbon-intensive generation plants to make up the shortfall in required grid capacity. This recent increase in electricity generation from oil products appears to have been short-lived, with average monthly values in late-2022 falling to approximately 0.02 TWh.

Figure 114: Monthly electricity generated from oil



11.2 Gas

11.2.1 Seasonality in monthly gas supply

Figure 115 shows the monthly supply of grid over the last few years, split into imported gas and indigenous gas supply. The large step-change increase in indigenous production in January 2016 is due to the connection of the Corrib gas field to the national gas grid. Indigenous production peaked in 2017 and has slowly been decreasing since then, which is the natural life cycle of a gas field. The sharp drops in indigenous production in September 2017 and July 2021 correspond to periods of maintenance at the Corrib gas field or its connection to the grid. In these periods of low indigenous production, the gas interconnectors between Ireland and Scotland stepped-up delivery of imports to satisfy demand. The monthly supply of gas to the grid can be 'spikey' because a substantial fraction of total gas supply is used for electricity generation that backs our intermittent wind generation. In periods of low wind, gas supply to gas-fired electricity plants needs to increase, and vice versa.

Figure 116 shows the total gas supply to the grid by month, where each month's value is the average value of that month's gas supply over the previous 5-6 years. For example, the January value is the average of total gas supply to the grid from January 2022, January 2021, January 2020, etc., back to January 2015. While certain sectors have pronounced seasonal variations, particularly the residential sector's gas demand for space heating, the overall seasonal variation in total gas supply is relatively small. Market-shifts act to flatten the profile of monthly gas supply across the year. In winter months, gas supply to the residential sector is higher for heating, but gas supply to electricity generation is lower (because wind generation has a seasonal peak). Conversely, in summer months, gas supply to the residential sector is lower, but gas supply to electricity generation is higher (because wind generation has a seasonal low).

Figure 115: Monthly gas supply trends

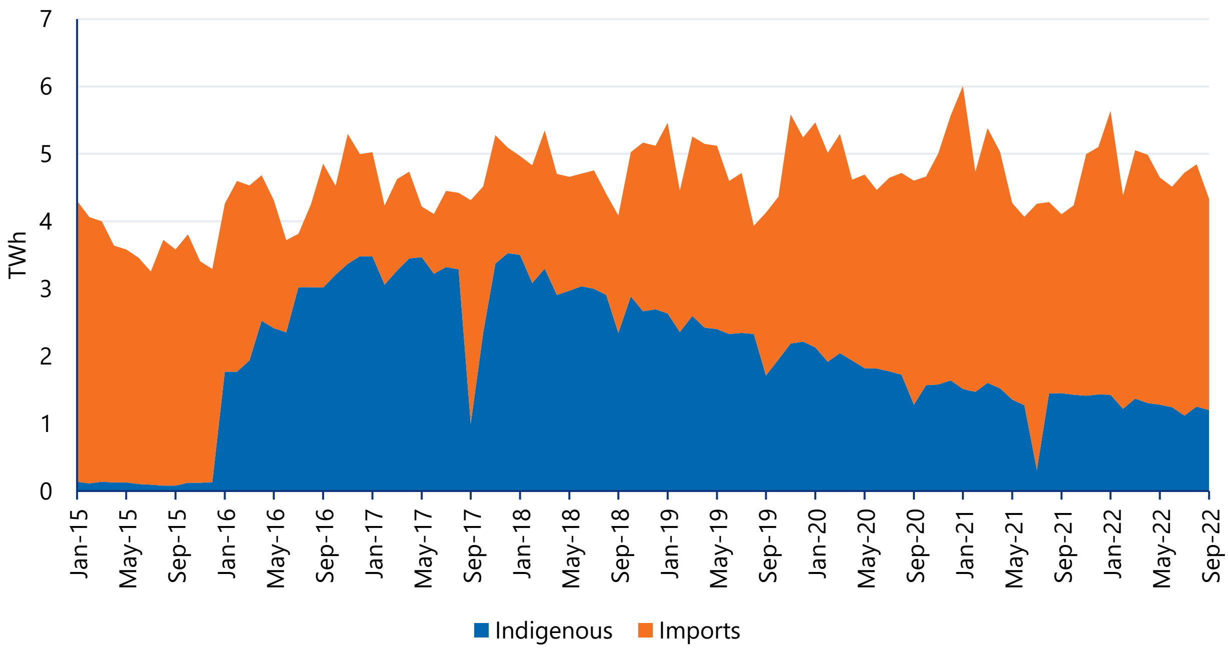
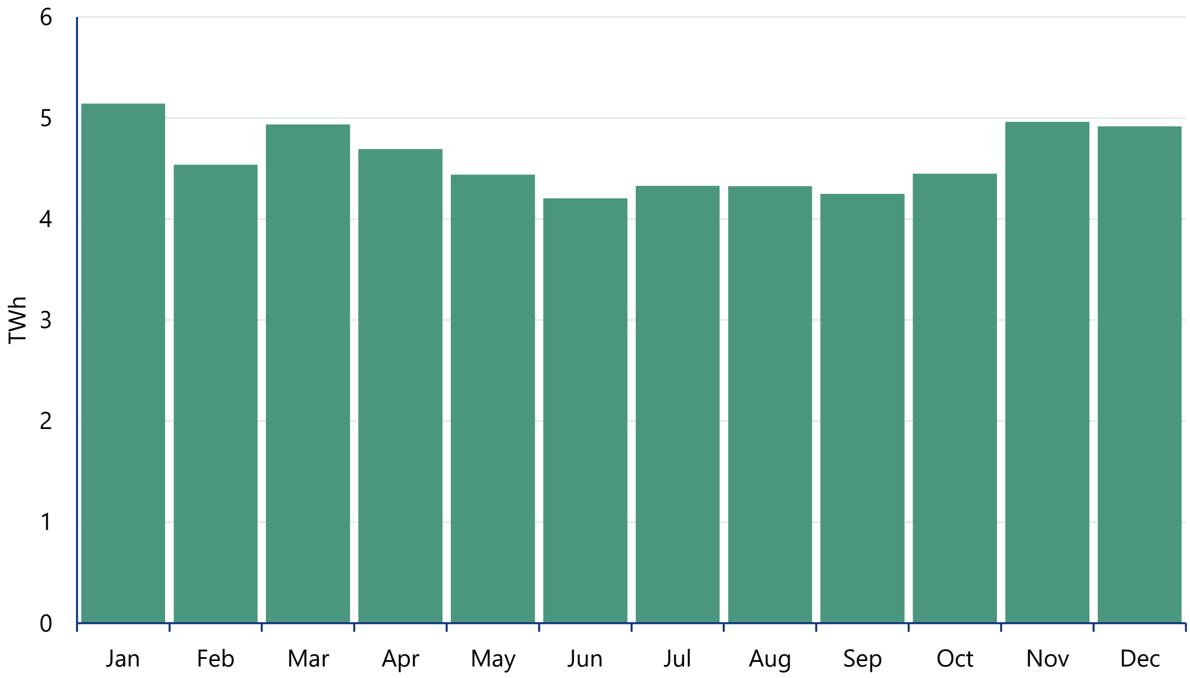


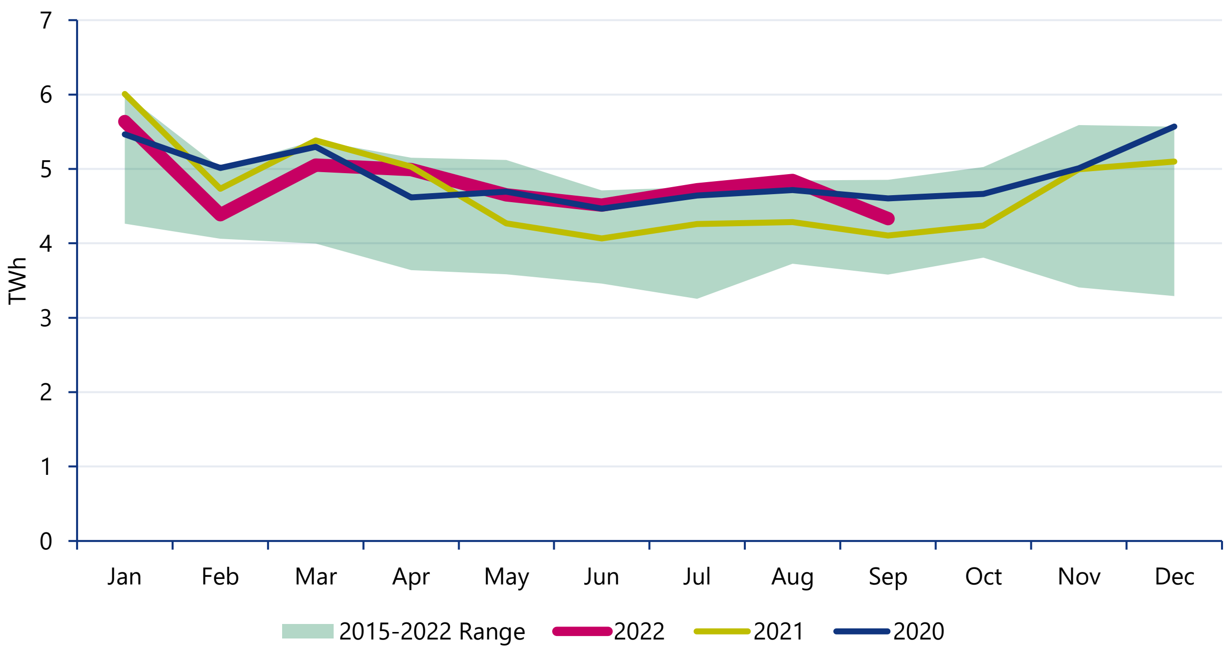
Figure 116: Average monthly gas supply – 2015 to 2022



11.2.2 Monthly gas supply in 2022

Figure 117 shows the overall monthly gas supply in 2022 compared to the previous two calendar years, and in the context of the maximum and minimum monthly supplies back to 2015. Overall gas supply in 2022 was typical – with monthly supply in Q1-2022 lower than that of 2021 and 2020 but increasing above 2020 and 2021 levels in the second half of the year. Outages in gas-fired electricity generation plants in 2021, resulted in lower monthly gas supplies during the summer months, compared to 2022 and 2020.

Figure 117: Monthly gas supply – 2022 compared to previous years



As currently collected, the monthly gas supply data shown in *Figure 118* is broken down only into indigenous gas and imported gas. In general, indigenous supply is constant and demand supply of imported gas is adjusted to match demand patterns, especially those arising from gas-fired electricity generation plants stepping-up and -down to back renewable generation of electricity.

Figure 119 shows the breakdown of monthly gas supply data in 2022 by indigenous gas and imported gas, averaged over the last 12 calendar months, i.e. from September 2021 to September 2022. This approach is more appropriate than simply averaging over the year-to-date to September 2022, because electricity generation from October to December has higher seasonal renewable contributions. In the last 12-months, the proportion of electricity generation to the grid was:

- Imported gas 74%
- Indigenous gas 26%

Figure 118: 2022 monthly gas supply

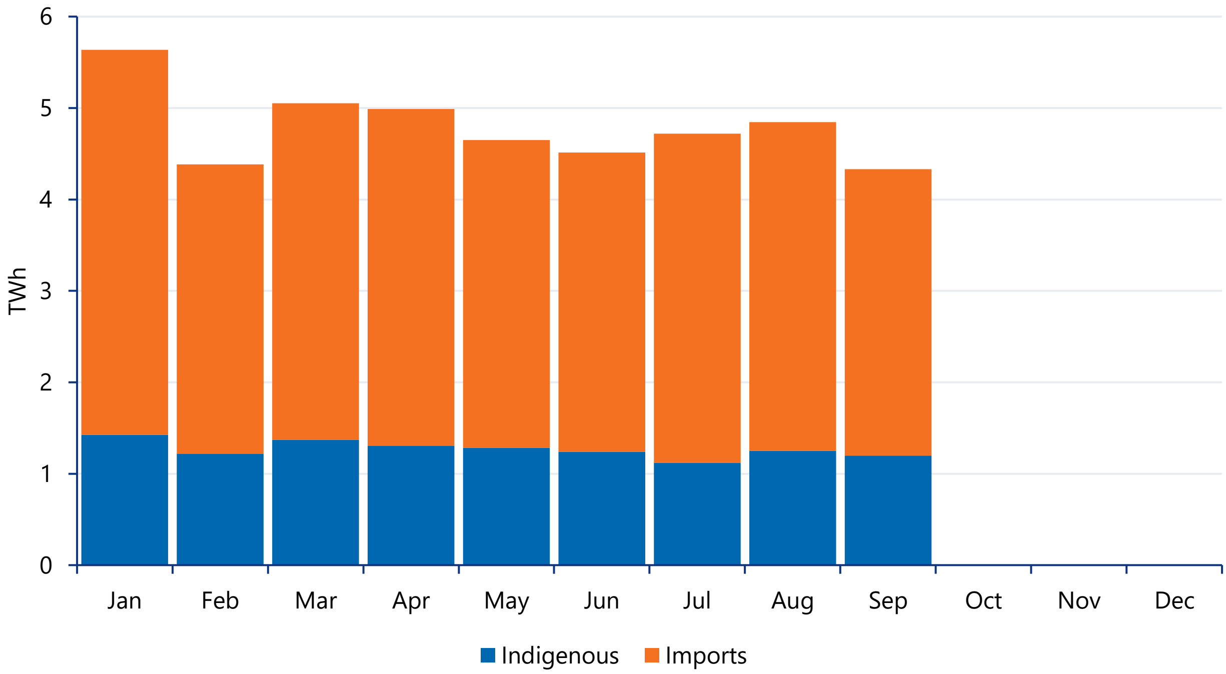
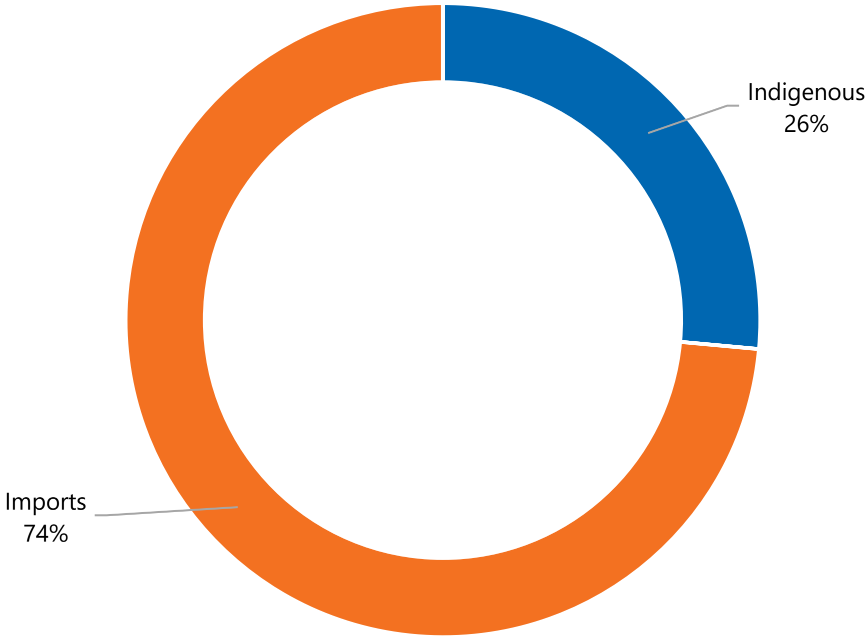


Figure 119: Source of gas supply – 12-month rolling average to September 2022



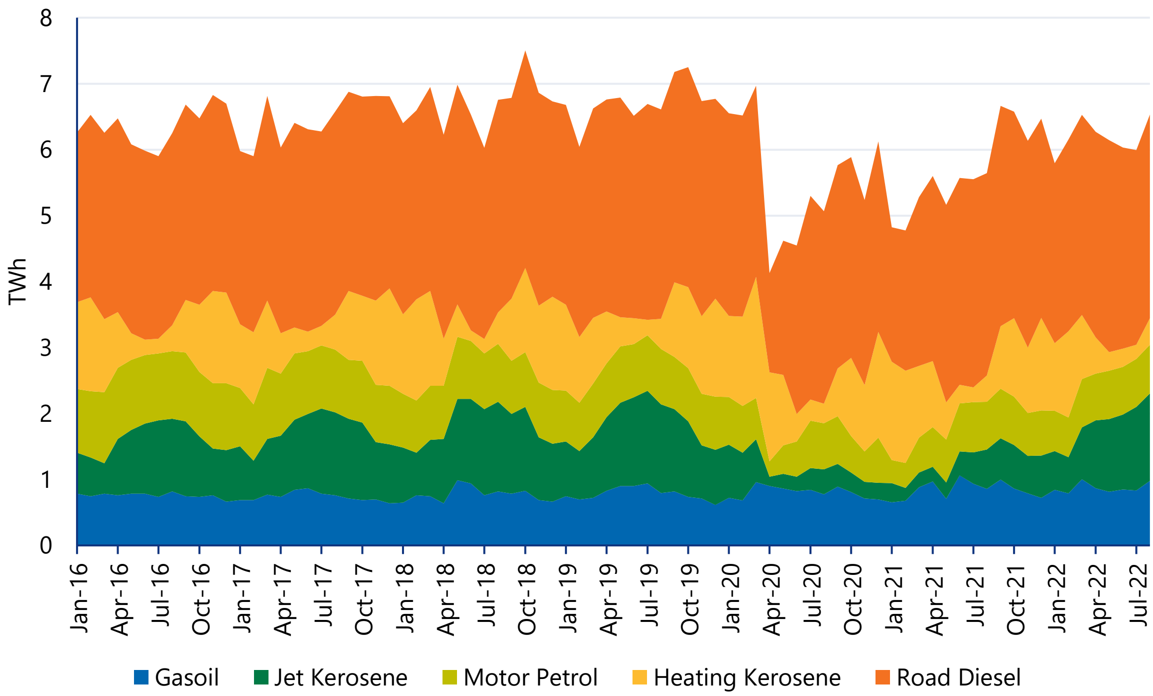
11.3 Oil

Monthly oil supply is captured in terms of gross inland deliveries (GIDs), or "The observed delivery of finished petroleum products from primary sources (e.g. refineries, blending plants etc.) to the inland market". GID is the quantity of oil-products flowing through the market from production to delivery, now ready sale or consumption:
Gross Inland Delivery = Primary product receipts + Refinery gross output + Recycled products - Refinery fuel + Imports - Exports - International marine bunkers + Interproduct transfers - Products transferred - Stocks changes

11.3.1 Seasonality and COVID impacts in monthly oil deliveries

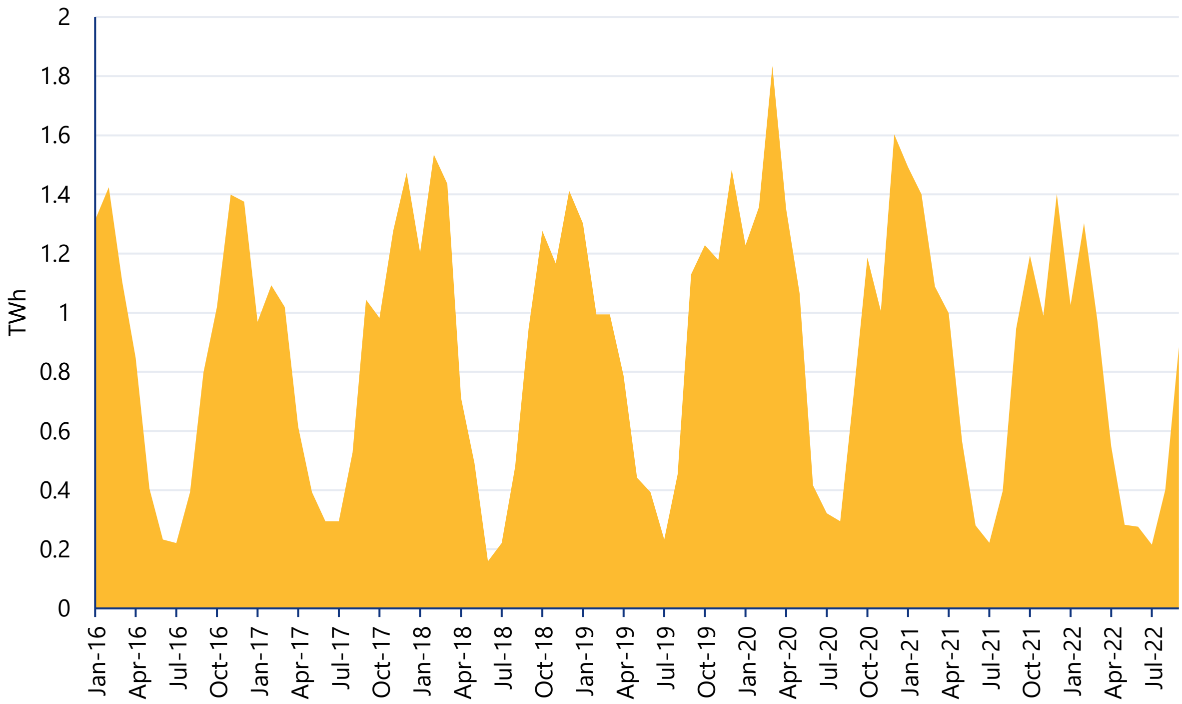
Figure 120 shows the sum of monthly oil deliveries from Road Diesel, Motor Petrol, Heating Kerosene, Jet Kerosene, and Gasoil from January 2016 to September 2022. *Figure 121* to *Figure 124* breakout the monthly delivery of different oil products to better show their seasonal variation, and any impacts from COVID. The monthly delivery of heating kerosene has a strong seasonal pattern with demand peaking in the height of winter and falling to about 20% of peak values in the summer months. Deliveries of heating kerosene were largely unaffected by COVID. Deliveries of jet kerosene show peaks in summer months and in the Christmas / New Years months, due to the high volume of flights to and from Ireland for holidays and tourism. In April 2020, delivery of jet kerosene fell to just 10% of its peak value in 2019, as COVID travel restrictions were rolled out.

Figure 120: Oil supply trends



Monthly deliveries of motor petrol show a gradual but noticeable decline from January 2016 to January 2020, before being disrupted by COVID impacts, leading to significant dips in April 2020 after the Government announced a national stay-at-home order on 27 March, and in January 2021 after Ireland moved to full lockdown restrictions on 31 December 2020.

Figure 121: Trend in heating kerosene



A smaller dip around and after Christmas 2021 was likely due to travel hesitancy after the COVID-Omicron surge. Monthly deliveries of road diesel show the same sharp COVID features as motor petrol. However, in contrast to motor petrol, road diesel shows a gradual but noticeable increase from January 2016 to January 2020.

Figure 122: Trend in jet kerosene

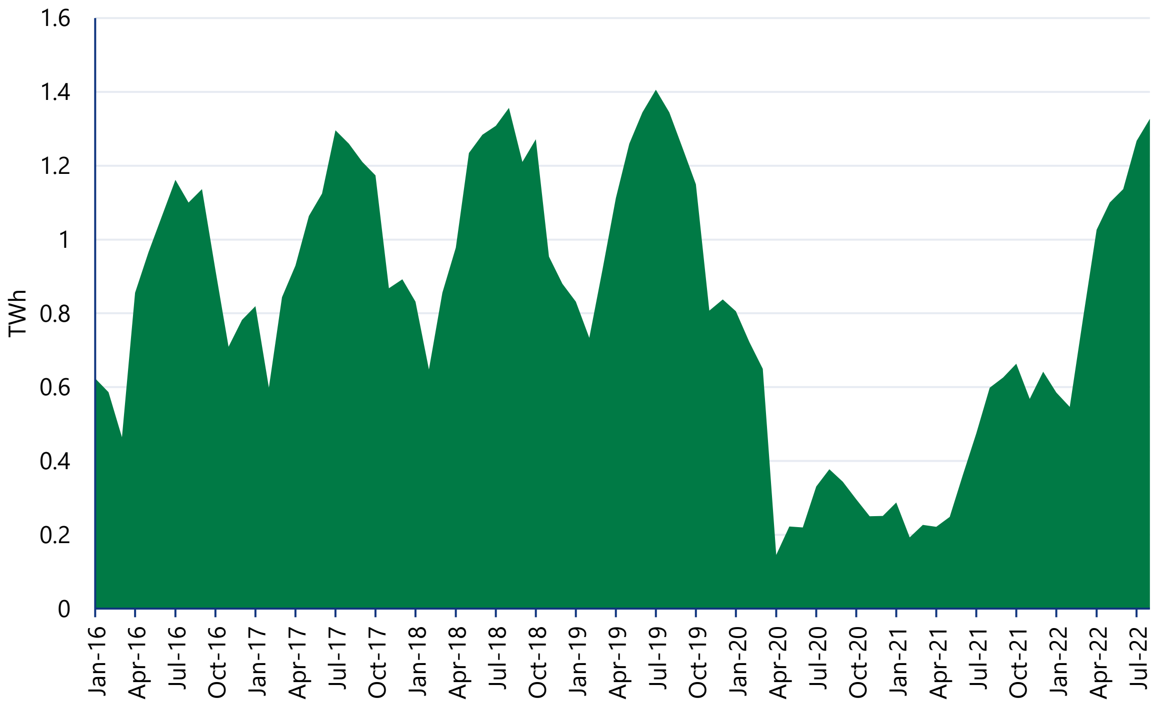


Figure 123: Trend in motor petrol

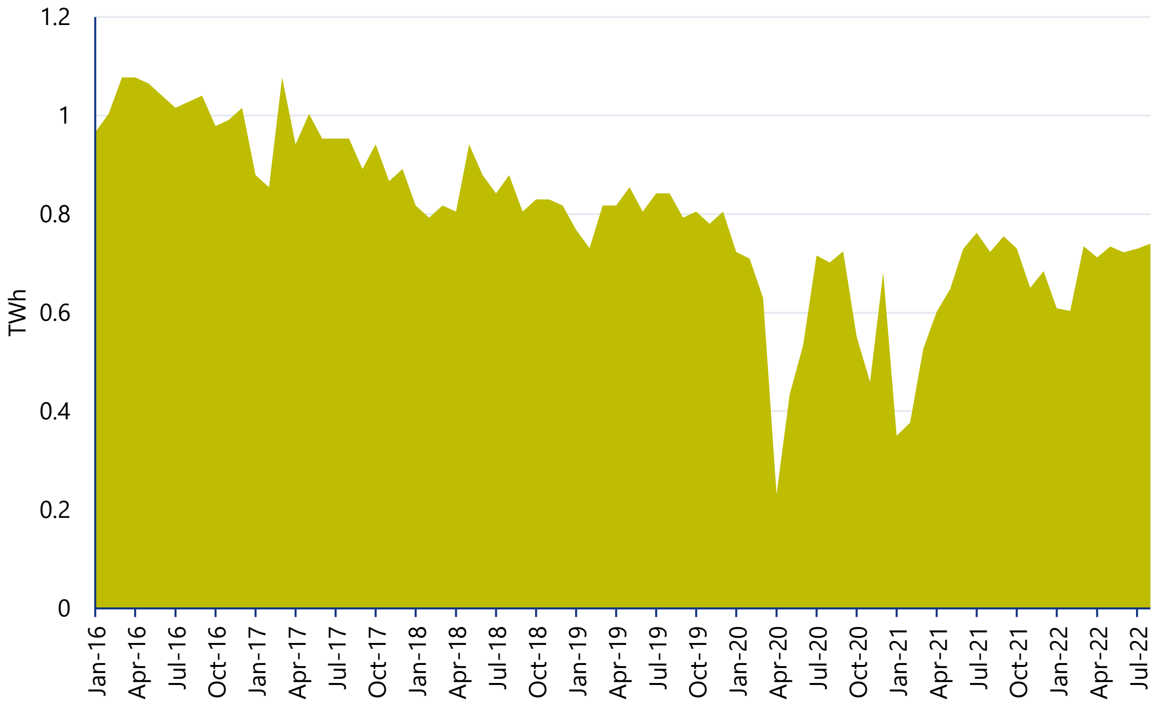
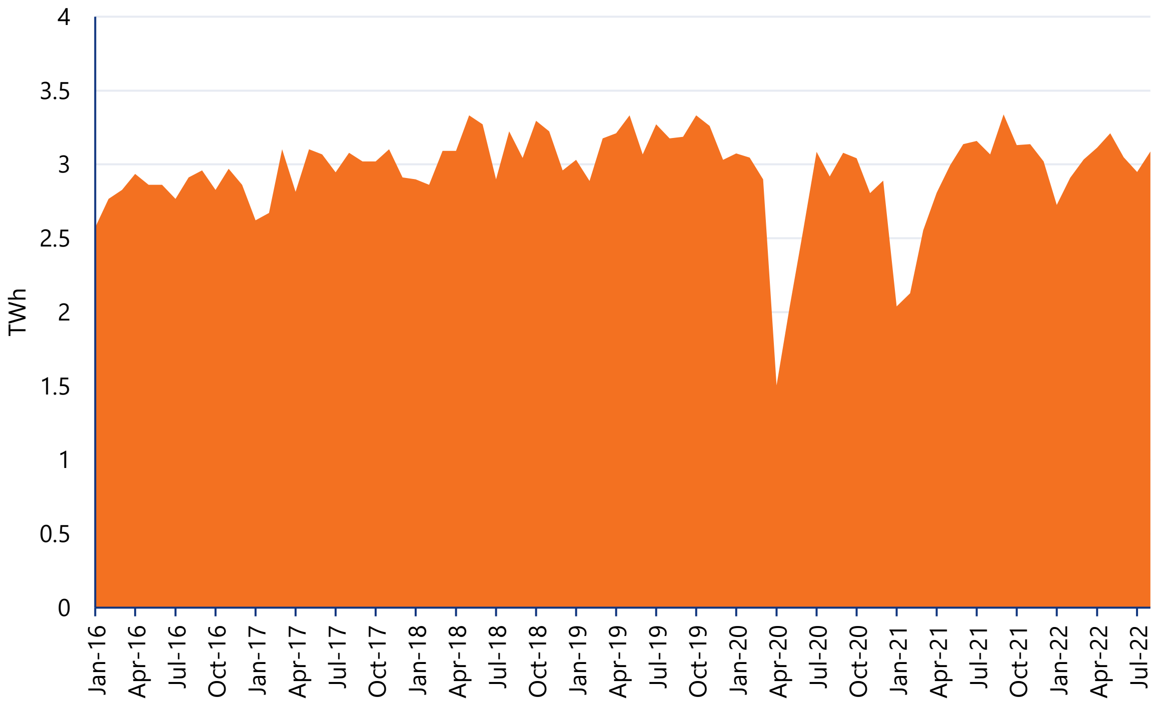


Figure 124: Trend in road diesel



11.3.2 Monthly oil supplies in 2022

Figure 125 shows 2022 total monthly oil supply compared to the previous two calendar years, and in the context of the maximum and minimum monthly supplies back to 2016. Most minimum values in this period were set during COVID impacts in 2020. For every month in 2022, total oil deliveries were higher than in 2021, showing that the COVID rebound in oil demand is still ongoing.

Figure 125: Monthly oil supply – 2022 compared to previous years

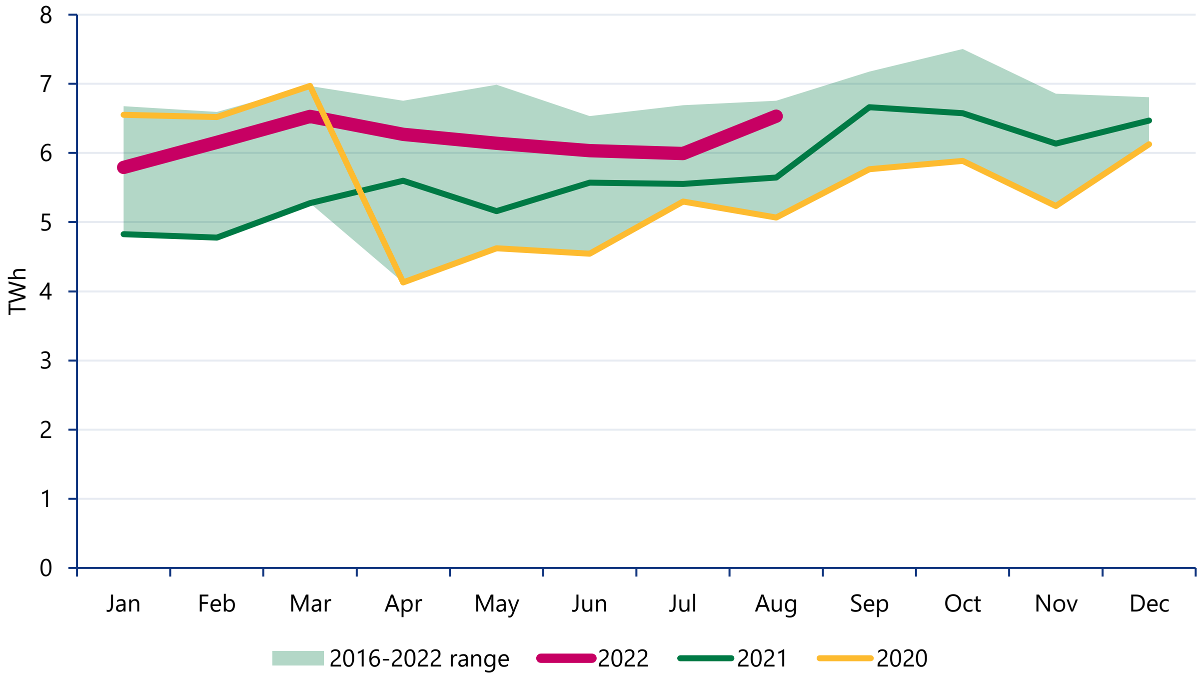


Figure 126 shows the breakdown of monthly oil deliveries by type in 2022 to date. The seasonal variations in heating kerosene and jet kerosene are visible, and tend to compensate for each other in the total oil deliveries, i.e. deliveries of jet kerosene are highest in summer, when deliveries of heating kerosene are lowest.

Figure 127 shows the percentage breakdown of average monthly oil deliveries by type to date in 2022:

- Road Diesel 49%
- Jet Kerosene 16%
- Gasoil 14%
- Motor Petrol 11%
- Heating Kerosene 10%

Figure 126: Monthly oil product supply – 2022 to date

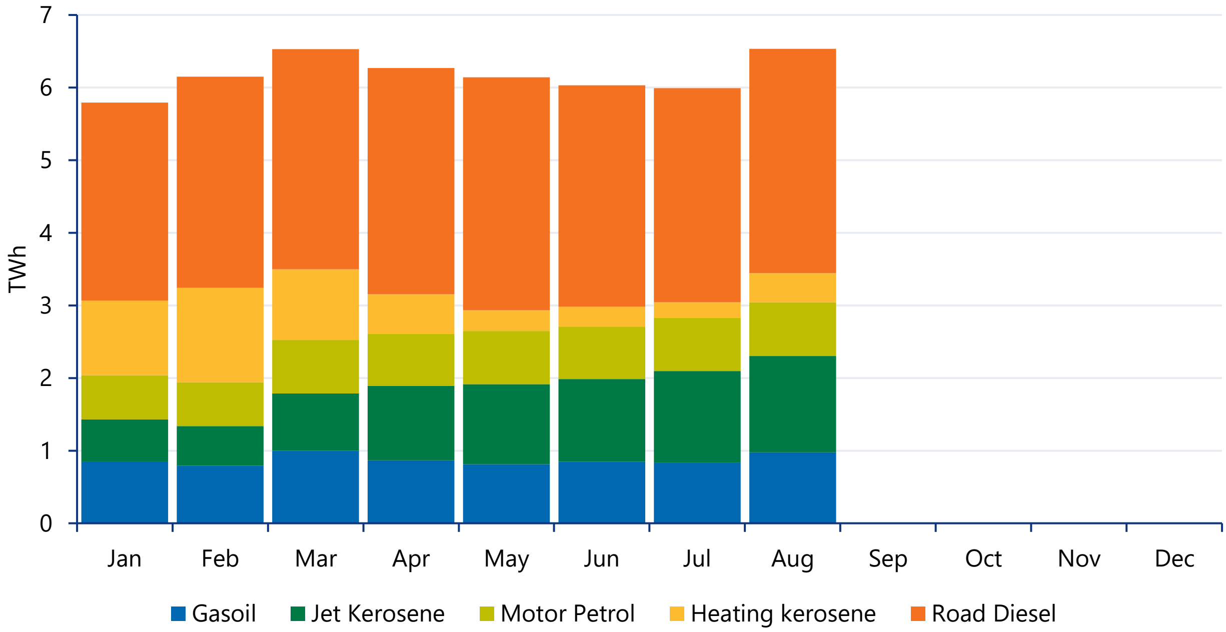
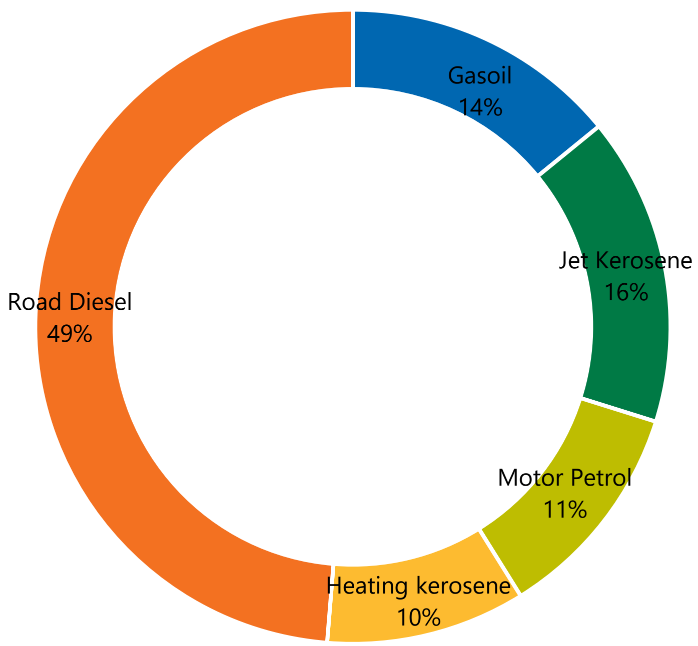


Figure 127: Breakdown of oil product supply – 2022 to date



Appendix 1: List of figures

Appendix 2: List of tables

Appendix 3: Glossary of abbreviations

Abbreviation	Explanation
BEUS	Business Energy Use Survey
CAP	Climate action plan
CCGT	Combined cycle gas turbine
CHP	Combined heat and power
CO_2	Carbon dioxide
CSO	Central Statistics Office
DART	Dublin Area Rapid Transit
DECC	Department of the Environment, Climate and Communications
EPA	Environmental Protection Agency
ETS	EU Emission Trading Scheme
EV	Electric vehicle
GCV	Gross calorific value
GDP	Gross domestic product
GFC	Gross final consumption (of energy)
GHG	Greenhouse gas
GNI*	Modified gross national income
GNP	Gross national product
goe	Gramme of oil equivalent
GWh	Gigawatt hours
HGV	Heavy goods vehicle
ICT	Information and communications technology
IEA	International Energy Agency
IP	Intellectual property
IPCC	Intergovernmental Panel on Climate Change
ktoe	Kilotonne of oil equivalent
LNG	Liquefied natural gas
NCT	National Car Testing service
NCV	Net calorific value
NECP	National Energy and Climate Plan
NEDC	New European Driving Cycle

Abbreviation	Explanation
NEEAP	National energy efficiency action plan
NORA	National Oil Reserves Agency
NREAP	National renewable energy action plan
OECD	Organization for Economic Co-operation and Development
PV	Photovoltaic
R&D	Research and development
RED	Renewable Energy Directive
REDI	First Renewable Energy Directive
REDII	Recast Renewable Energy Directive
RES	Renewable energy share
RES-E	Renewable energy share in electricity
RES-H	Renewable energy share in heat
RES-T	Renewable energy share in transport
SEAI	Sustainable Energy Authority of Ireland
TFC	Total final energy consumption
TJ	Terajoule
TPER	Total primary energy requirement
UCO	Used cooking oil
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile organic compounds
WLTP	Worldwide Harmonised Light Vehicle Test

Appendix 4: Glossary of terms

Biomass: Directive (EU) 2018/2001 defines biomass as the biodegradable fraction of products, waste and residues from biological origin from agriculture, including vegetal and animal substances, from forestry and related industries, including fisheries and aquaculture, as well as the biodegradable fraction of waste, including industrial and municipal waste of biological origin.

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 – kilotonnes of CO_2 (103 tonnes) and MtCO_2 – megatonnes of CO_2 (106 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.

Combined heat and power (CHP) plants: 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 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 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 GDP 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 (GFC): 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 (such as 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.

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.

Appendix 5: Energy units and conversion factors

Energy conversion factors

To: / From:	toe / *Multiply by*	MWh	GJ
toe	1	11.63	41.868
MWh	0.08598	1	3.6
GJ	0.02388	0.2778	1

Energy units

Joule (J): Joule is the international (SI) 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 (NCV) of 41.868 GJ. A related unit is the kilogram of oil equivalent (kgoe), where 1 kgoe = 10^{-3} toe.

Decimal prefixes

deca (da)	101	deci (d)	10^{-1}
hecto (h)	102	centi (c)	10^{-2}
kilo (k)	103	milli (m)	10^{-3}
mega (M)	106	micro (•)	10^{-6}
giga (G)	109	nano (n)	10^{-9}
tera (T)	1012	pico (p)	10^{-12}
peta (P)	1015	femto (f)	10^{-15}
exa (E)	1018	atto (a)	10^{-18}

Calorific values

Fuel	NCV toe/t	NCV 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
LPG	1.1263	47,156
Petroleum Coke	0.7663	32,084

	Conversion Factor	Conversion Factor
Electricity	86 toe/GWh	3.6 TJ/GWh

Emission factors

Liquid Fuels	t CO_2/TJ (NCV)	g CO_2/kWh (NCV)
Motor Spirit (Gasoline)	70.0	251.9
Jet Kerosene	71.4	257.0
Other Kerosene	71.4	257.0
Gas/Diesel Oil	73.3	263.9
Residual Oil	76.0	273.6
LPG	63.7	229.3
Naphtha	73.3	264.0
Petroleum Coke (2021)	94.1	338.7
Solid Fuels and Derivatives		
Coal	94.6	340. 6
Milled Peat (2021)	119.6	430.5
Sod Peat	104.0	374.4
Peat Briquettes	98.9	355.9
Gas		
Natural Gas (2021)	56.6	202.9
Electricity		
Electricity (2021)	96.60	347.8

Appendix 6: Data sources

SEAI gratefully acknowledges the co-operation of all the organisations, agencies, energy suppliers and distributors that provide data and respond to its questionnaires throughout the year:

- 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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Appendix 8: Energy statistics revisions

Some changes, revisions and corrections to the historic energy balance data were implemented during 2021. The most significant of these are listed below:

Data Flows
Total Final Energy Consumption

- Sectoral split revised to align with the latest data from the 2019 CSO Business Energy Use Survey (BEUS), including historic revisions. Please see full methodological changes from the CSO at https://www.cso.ie/en/methods/surveybackgroundnotes/businessenergyuse/

CO_2 Emissions

- CO_2 emission factor for non-renewable waste updated from 2009

Appendix 9: Electricity and gas price tables

SEAI collects and analyses electricity and gas prices every 6-months, in line with EU Regulation 2016/1952. SEAI calculates the **effective unit price** of energy (the revenue collected for energy delivered, divided by the total quantity of energy delivered) across **different consumption bands**, and then calculate the weighted average price, based on the market-share of each consumption band. Using data available from Eurostat, SEAI ranks the effective unit price paid by Irish consumers, compared to their European counterparts.

The tables below update the effective electricity and gas energy prices paid by residential and business consumers in Ireland for January – June 2022. The tables breakdown the effective unit price of energy in each band, the changes in that price over the last 12- and 24-months, Ireland's EU ranking of the price in that band, and the market share of each band.

Note: Domestic electricity customers, including pay as you go customers, received an account credit of €200 between April and June 2022. This rebate is included in the Residential Electricity Prices for S12022. Please see our 2021 report which provides more detail on this price collection. A full 2022 report will be published in 2023.

Figure 128: Residential Electricity Prices – January to June 2022 (includes €200 account credit)

Household electricity prices (all taxes included)	c/kWh S1 2022	Change in 12 months	Change in 24 months	Ranking EU	Band Share of Market
Band DA Consumption < 1,000 kWh	33.9	-28.9%	0.5%	16	2.7%
Band DB 1,000 kWh < Consumption < 2,500 kWh	31.4	-6.2%	7.8%	7	9.7%
Band DC 2,500 kWh < Consumption < 5,000 kWh	27.4	7.3%	13.5%	7	35.4%
Band DD 5,000 kWh < Consumption < 15,000 kWh	24.9	16.4%	19.2%	9	44.4%
Band DE Consumption > 15,000 kWh	22.4	25.1%	23.7%	10	7.9%
Weighted Average	**26.5**	**10.4%**	**14.6%**		

Figure 129: Residential Gas Prices – January to June 2022

Household gas prices (all taxes included)	c/kWh S1 2022	Change in 12 months	Change in 24 months	Ranking EU	Band Share of Market
Band D1 Consumption < 20 GJ	9.5	36.0%	26.4%	16	4.7%
Band D2 20 GJ < Consumption < 200 GJ	8.5	36.6%	26.6%	12	93.1%
Band D3 Consumption > 200 GJ	7.9	37.9%	29.1%	11	2.2%
Weighted Average	**8.5**	**36.4%**	**26.5%**		

Figure 130: Business Electricity Prices – January to June 2022

Business electricity prices (ex VAT)	c/kWh S1 2022	Change in 12 months	Change in 24 months	Ranking EU	Band Share of Market
Band IA Consumption < 20 MWh	30.2	20.1%	37.5%	5	6.9%
Band IB 20 MWh < Consumption < 500 MWh	23.5	29.6%	41.1%	5	25.6%
Band IC 500 MWh < Consumption < 2,000 MWh	21.8	43.9%	63.9%	5	10.1%
Band ID 2,000 MWh < Consumption < 20,000 MWh	19.4	59.6%	90.5%	6	20.5%
Band IE 20,000 MWh < Consumption < 70,000 MWh	18.8	72.6%	101.5%	6	8.9%
Band IF 70,000 MWh < Consumption < 150,000 MWh	20.1	85.4%	137.1%	4	5.1%
Band IG > 150,000 MWh	23.1	119.1%	193.4%	2	23.0%
Weighted Average (Band IA to IF)	**22.0**	**43.9%**	**63.9%**		

Figure 131: Business Gas Prices – January to June 2022

Business gas prices (ex VAT)	c/kWh S1 2022	Change in 12 months	Change in 24 months	Ranking EU	Band Share of Market
Band I1 Consumption < 1,000 GJ	7.6	76.2%	54.8%	15	13.7%
Band I2 1,000 GJ < Consumption < 10,000 GJ	7.3	87.9%	97.0%	15	20.1%
Band I3 10,000 GJ < Consumption < 100,000 GJ	6.7	102.7%	138.8%	17	20.6%
Band I4 100,000 GJ < Consumption < 1,000,000 GJ	5.4	102.3%	141.4%	24	34.5%
Band I5 1,000,000 GJ < Consumption < 4,000,000 GJ	7.3	201.6%	361.0%	9	11.1%
Weighted Average (Band I1 to I4)	**6.5**	**99.3%**	**113.8%**		

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