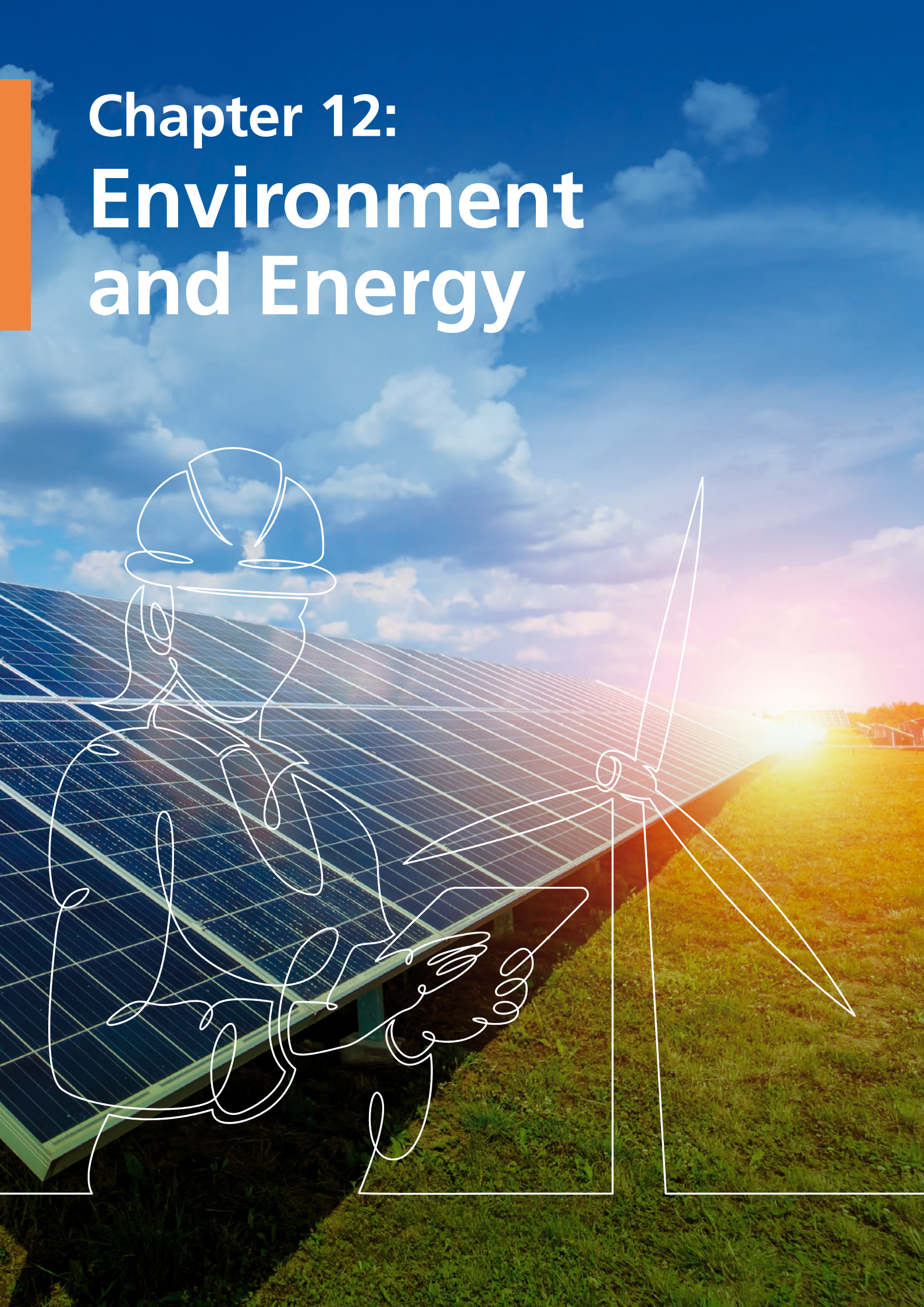
Chapter 12:
Environment and Energy



Environment and Energy

1. Introduction

Our health, environment and climate are significantly affected by how we source, manage and use energy in Ireland to meet our growing demands for heating, mobility and electricity. Access to reliable energy supplies and energy-powered technologies has improved our quality of life and has been a key enabler of economic and social development in Ireland. A century has passed since legislation was introduced that drove the construction of Ireland's first large-scale hydro power plant at Ardnacrusha, which in turn led to the development of our electricity grid system, enabling widespread access to electricity and the multiple benefits this brought.

Population growth, economic growth and rising standards of living over the past 50 years have all contributed to increasing Ireland's demands for heating, transport and electricity. We have primarily met these growing demands by using more coal and peat initially, then oil (petrol, diesel and kerosene), followed by natural gas and more recently wind power.

As a consequence of meeting these growing demands primarily with oil, natural gas, coal and peat, our energy system is highly dependent on fossil fuels. Ireland has made some progress in transforming the electricity system through the deployment of wind farms, with renewable energy currently providing more than 40% of electricity used. However, electricity represents only one-fifth of Ireland's energy use, and our transport and heating systems remain heavily reliant on fossil fuel systems, with lock-ins that need to be addressed.

In addition to growing electricity from wind and solar sources, some progress has been made in Ireland's heating and transport energy systems due to policy changes relating to new buildings through building regulations, upgrading existing buildings through retrofitting, biofuel blending in transport and increased sales of electric vehicles.

Ireland's energy supply and demand is currently undergoing accelerated changes driven by increased climate policy ambitions and by economic and geopolitical trends. The policy responses that followed Russia's invasion of Ukraine and the resulting increases in energy prices highlighted our dependency on imported fossil fuels and the need to improve our energy security. This further emphasised the urgency of accelerating the transition away from fossil fuels in Ireland and towards using cleaner and more renewable energy sources to support decarbonisation, protect against volatile energy prices and secure Ireland's future energy supply.

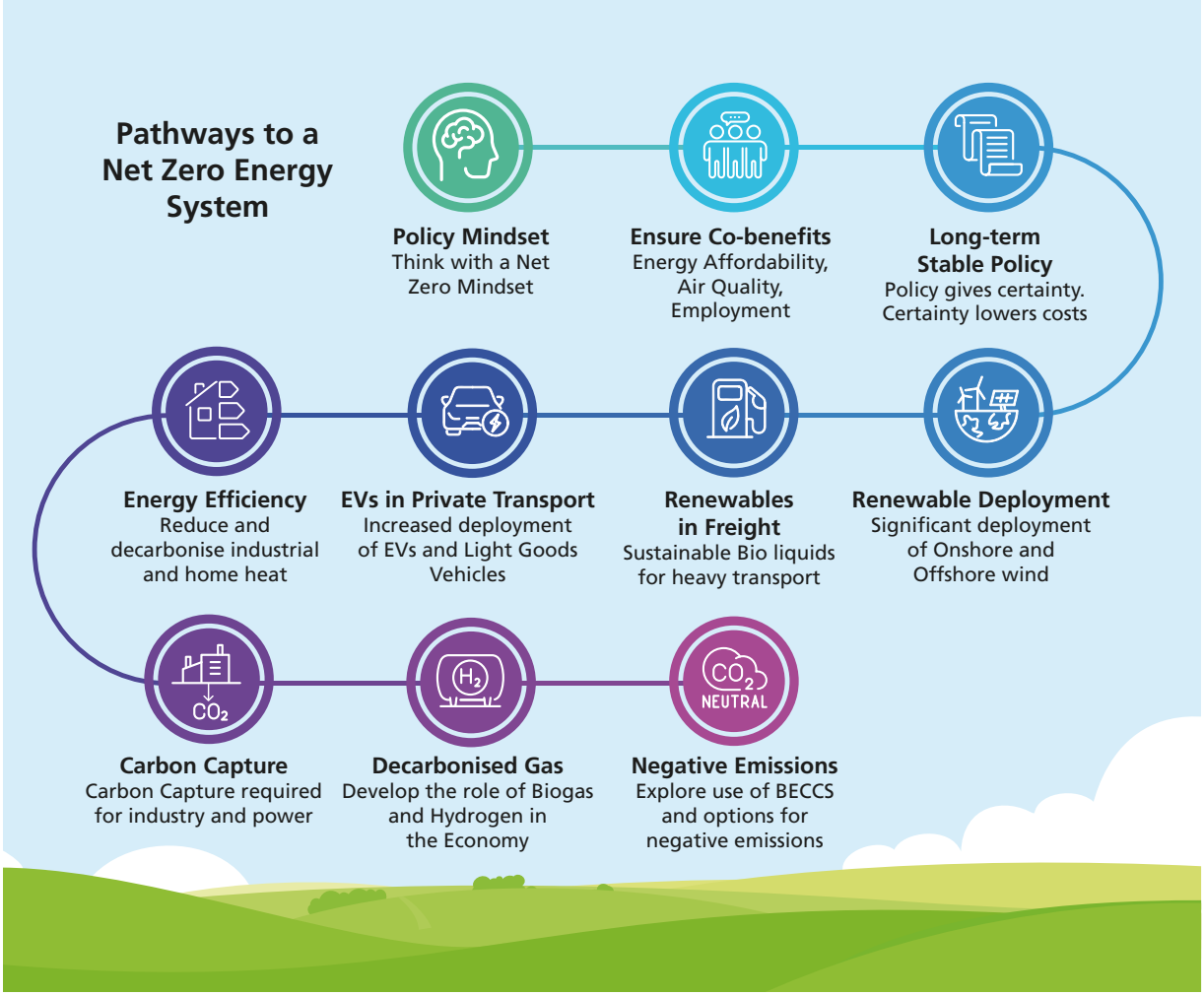
Demands for energy are also changing, and Ireland is experiencing strong growth in electricity demand, in particular through the development of the digital economy. Therefore the transition requires not only technological changes but also systemic changes across society and the economy – changes that challenge approaches to growth and consumption. This transformation of our energy systems also needs to enable a just transition for all members of society.

Looking ahead, the changes that are needed in Ireland's energy system are becoming increasingly clear. Volume 2 of Ireland's Climate Change Assessment (ICCA), *Achieving Climate Neutrality by 2050* (McGookin *et al.*, 2023), highlights that well-established 'no-regret options' can significantly move Ireland's energy decarbonisation forward and need to be implemented now. These include demand reduction (e.g. through energy efficiency and reduced consumption), electrification (e.g. electric vehicles and heat pumps), deployment of market-ready renewables (e.g. wind and solar power) and low-carbon heating options (e.g. district heating).

According to the ICCA report, however, there remains uncertainty regarding the full scale and mix of specific future technologies to help bring the sector to net zero emissions. Alternatives such as bioenergy, other renewables and hydrogen will be needed in sectors not currently suited to electrification, such as heavy transport and industry, and to balance a grid based on variable renewable electricity technologies. These require further investigation.

The ICCA report also highlights that renewables open up opportunities in the green economy, including for coastal communities and farmers, and that distributed energy enables homeowners to be producers of energy, lowering energy bills. The energy transition requires consideration of issues beyond technical aspects, including environmental, societal, economic and governance dimensions. The ICCA report identifies the need for an enhanced regulatory and planning framework to accelerate the deployment of renewables, realise co-benefits and manage trade-offs, competition and impacts on other land uses, including biodiversity, food production and carbon sequestration. In summary, the pathways to achieving a net zero energy system involve many elements (Figure 12.1)

Figure 12.1 Pathways to a net zero energy system



BECCS, bioenergy with carbon capture and storage

Source: Adapted from McGookin *et al.*, 2023

2. Energy, health and the environment

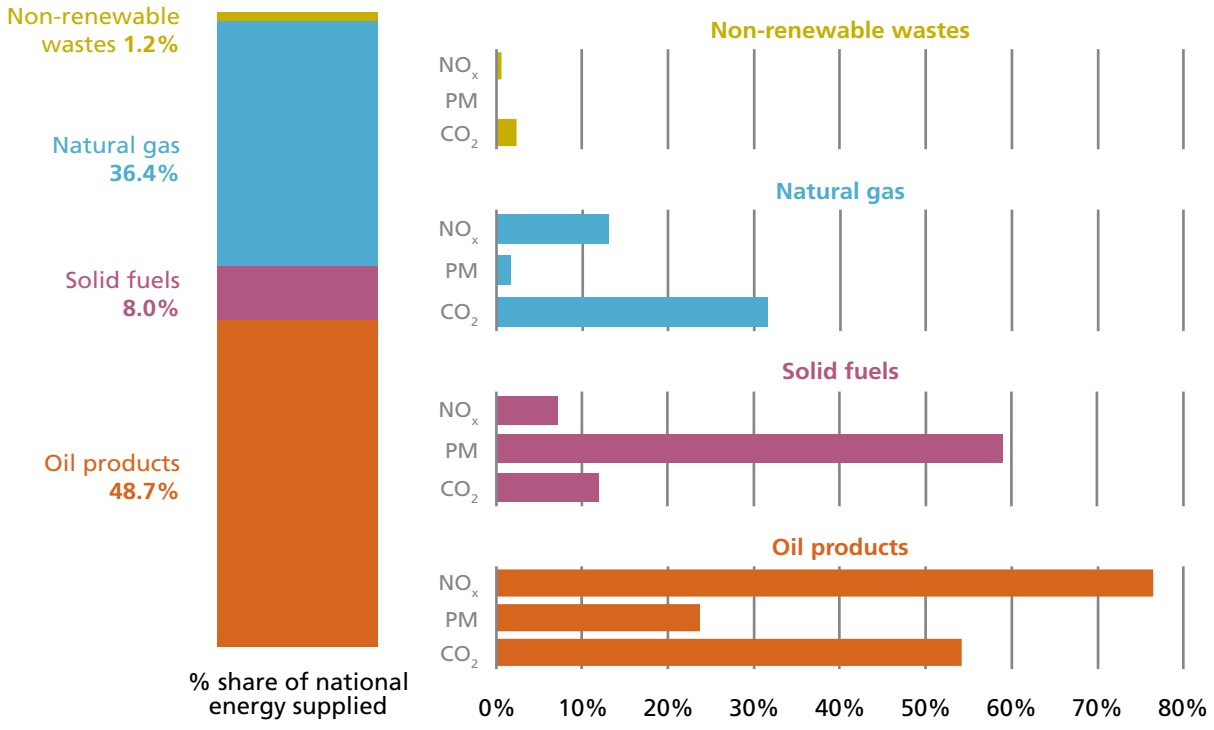
The generation of useful energy for mobility, heating and electricity through the combustion of coal, oil products, natural gas and peat (i.e. fossil fuels) releases polluting by-products that have significant adverse impacts on human health, the climate and our environment.

Fossil fuel use is a significant source of key air pollutants and greenhouse gases (GHGs). The main impacts of combustion of fossil fuels include:

- the emission of GHGs
- the direct production of reactive gases such as nitrogen oxides, sulphur dioxide and particulates, including black carbon
- the production of secondary pollutant gases and particulates such as ozone, ammonium nitrate and ammonium sulphate, and condensed compounds such as organic carbons
- the release of heavy metals such as mercury and the formation of persistent organic pollutants such as polycyclic aromatic hydrocarbons, which build up in ecosystems and food chains.

The relative impact on air quality and climate change depends on the fossil fuel used and its quality. The combustion of solid fuels such as coal and peat has the largest impacts, and gas combustion has the lowest impacts, with the combustion of liquid fuels typically having intermediate impacts (Figure 12.2). The combustion of biofuels can also result in significant air pollutant emissions that vary with fuel type and combustion systems used. Sustainably produced fuels such as wood, biogas and ethanol have less of an impact on the climate system but may have an impact on air quality.

Figure 12.2 Energy use in 2022 and relative emissions of carbon dioxide, particulate matter and nitrogen oxides



Sources: EPA, 2024a,b

Addressing the range of impacts caused by energy use while maintaining and enhancing our health and wellbeing is a central element in a series of United Nations conventions and global policies as well as key European Union (EU) and national policies (EC, 2020; DECC, 2024a). The approach taken can be summarised as follows:

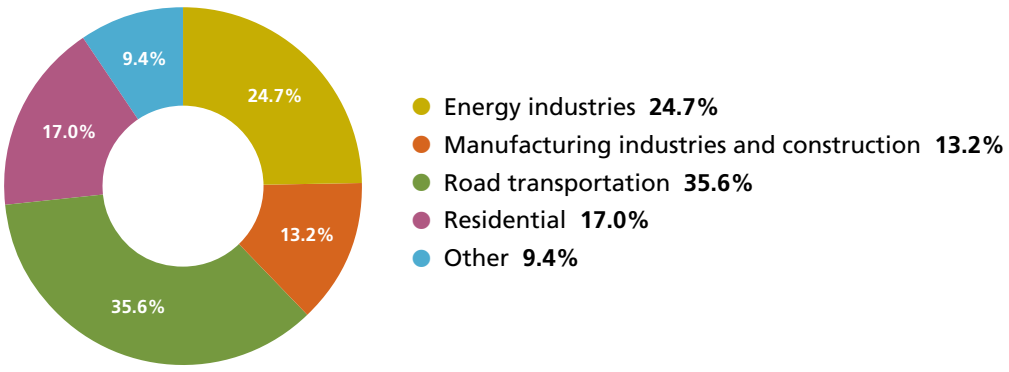
- Reduce energy use and loss through increased energy efficiency and demand reduction.
- Reduce emissions through mitigation technologies such as removing certain contaminants, such as sulphur, and carbon capture and storage.
- Switch to clean and sustainable energy solutions from non-combustion sources such as hydropower, wind or solar energy and the use of green hydrogen. These do not give rise to combustion-related impacts, but there is a need to be cognisant of their social and environmental impacts, as they do impact land use.

These issues are explored in more detail later in this chapter and in Chapter 2, Air; Chapter 4, Climate; Chapter 5, Land; Chapter 11, Transport; and Chapter 13, Industry.

3. Sources of and trends in Ireland's key energy-related greenhouse gas emissions

Ireland's national energy-related GHG emissions accounted for 50% of Ireland's total GHG emissions (including from land use, land use change and forestry) in 2023. Emissions in 2023 were 6.8% lower than in 2022, driven by reduced emissions from electricity generation and residential sources; however, faster annual reductions will be needed to stay within carbon budgets and sectoral ceilings (EPA, 2024). Ireland's energy-related GHG emissions in 2023 were 15% lower than 2018 levels. Emissions from electricity generation in Ireland decreased by 22.1% in 2023 due to the increased importation of electricity from the UK through electricity interconnectors, together with an increase in the share of renewable electricity generation to 40.7%. Transport sector emissions (excluding international aviation and navigation) grew by 0.3% in 2023 having previously increased by 6% in both 2022 and 2021. Emissions from residential buildings decreased by 7% in 2023, hitting a historical low for the second consecutive year. Carbon dioxide emissions from the manufacturing combustion sector decreased by 4.6%, from commercial services by 2.5%, and from public services by 2.7% in 2023, associated with reductions in fossil fuel use within these sectors (Figure 12.3).

Figure 12.3 Profile of Ireland's energy-related greenhouse gas emissions by sector



Source: EPA, 2024c

4. Key energy demand drivers

Focusing on trends over time, the drivers of energy demand vary across the energy consuming sectors, but economic growth and population growth are key pressures that are difficult to decouple fully from energy demand growth. Energy prices and weather also have a key impact on our demands for energy. Given our current high dependency on imported fossil fuels, we are very exposed to fuel price variations, which in turn are influenced by geopolitical events, as has been very evident in the past few years.

Ireland's climate mitigation policy has a strong supply-side focus on increasing the deployment of renewable electricity together with a focus on electrifying as much energy end use as possible. The most prominent example of the latter is the roll-out of electric vehicles and heat pumps, with the goal of switching transport and heating away from fossil fuel combustion technologies towards renewable electricity-powered technologies.

However, it is essential to have a complementary focus on energy demand reduction and energy efficiency measures, which can bring additional emission reductions and also cost savings and improved energy affordability. Understanding the demand drivers for electricity, transport fuels and home heating fuels is essential to inform policy choices. These drivers are briefly explored here and also in Chapter 11.

Electricity demand

Ireland's electricity demand doubled over the period 1990-2020. EirGrid projects that this demand will further increase substantially by 2030, based on an increasing demand for electricity from high-demand users, including pharmaceutical plants, high-tech manufacturing and data centres, and the increasing use of electricity for transport and heating (EirGrid, 2024).

Data published by the Central Statistics Office (CSO) on metered electricity consumption indicate that there was a 2.5% increase in electricity demand in 2023 relative to 2022, largely driven by a 20% growth in electricity consumption by data centres. Data centres accounted for 21% of metered electricity consumption in 2023, which exceeded the electricity use of urban households (18%) and rural households (10%).

Residential heating fuel demand

The GHG emissions inventory limits residential emissions to those associated with domestic heating and cooking using solid, liquid or gaseous fossil fuels. The upstream emissions associated with residential electricity usage are recorded in the energy industries sector.

The key drivers of residential emissions are therefore the number of households, which is related to both population growth and economic growth, the emissions performance of the energy systems in these households, weather and energy prices.

It is particularly notable that, despite the almost doubling of the number of households (from 1 million in 1990 to 1.9 million in 2023), emissions from the sector in 2023 are slightly below 1990 levels. This was achieved by improved insulation and energy efficiency, coupled with switching from carbon-intensive solid fuels to liquid and gaseous fuels over the period.

Changes over time to building regulations mean that newer homes have a much-improved energy performance and are heated using electricity and heat pumps. The continued growth in the number of households is therefore not anticipated to result in increased residential emissions in the future.

Transport fuel demand

Transport GHG emissions have seen the greatest growth in energy-related emissions, having increased by 134% from 1990 to 2023 (EPA, 2024c). This growth can be directly linked to the increased number of passenger car and freight transport activity over that time frame, which is coupled to economic growth.

Increasing the share of electric vehicles in the car fleet and growing the use of biofuels have a key role in decoupling transport demand growth from emissions growth in the future. There is also a need to pursue complementary measures that address an overdependence on private car usage for congestion, environmental, health and wellbeing reasons. These include increasing public transport use and more trips undertaken by walking and cycling, i.e. active travel. This is explored in greater detail in Chapter 11.

5. EU and national energy policy

There are significant policy and legislative drivers at EU and national levels that are accelerating Ireland's energy transition. These will both enhance energy security and help deliver on climate commitments.

EU energy policy

The European Green Deal and associated European Climate Law (Regulation (EU) 2021/1119) are key overarching elements of EU policy that are driving changes in energy policy in Ireland and across the EU. The European Climate Law provides a legislative framework for Member States to achieve an overall reduction in GHG emissions of at least 55% by 2030, compared with 1990 levels. This ambition builds on progress to date in reducing emissions whereby, according to Eurostat, net GHG emissions reduced by 31% in the EU between 1990 and 2022.

There are many elements of the European Climate Law that impact directly on Ireland's energy sector. The EU targets for GHG emission reduction are allocated separately to sectors that participate in the EU Emissions Trading System (ETS) (electricity generation, large industry and intra-EU aviation) and sectors outside the scheme, i.e. the non-ETS sectors (heat, transport and agriculture).

Directive (EU) 2023/959 targets a 62% EU-wide reduction in ETS emissions by 2030 relative to 2005 levels. The ETS establishes a 'cap-and-trade' market that results in a carbon price for emissions associated with fossil fuel-generated electricity and for heavy users of fossil fuels.

Regulation (EU) 2023/857 sets binding annual non-ETS GHG emission reductions for each Member State from 2021 to 2030 that collectively will deliver a 40% reduction in EU-wide non-ETS GHG emissions by 2030 relative to 2005 levels. Ireland's target under this EU Effort Sharing Regulation is to achieve a 42% reduction in non-ETS GHG emissions by 2030.

At EU level, the Governance of the Energy Union and Climate Action Regulation ((EU) 2018/1999) also requires Ireland to prepare a National Energy and Climate Plan (NECP) and a Long-term Strategy on Greenhouse Gas Emissions Reductions. The NECP[1] describes the actions Ireland needs to take to decarbonise its energy sector in line with EU targets to 2030. Ireland's NECP draws on the Climate Action Plan 2024 (CAP24), which is Ireland's policy to reduce sectoral emissions and achieve its 2030 climate targets (DECC, 2024a). Ireland's Long-term Strategy on Greenhouse Gas Emissions Reductions[2] sets out Ireland's 2050 climate action targets and describes sector-specific pathways to reaching those targets. In addition to meeting the specifications of Article 15 of the EU Regulation on the Governance of the Energy Union and Climate Action, this long-term strategy is also in line with Article 4 of the Paris Agreement.

In addition to climate mitigation policies, there is a large set of energy sector-specific policies and measures encompassing renewable energy, energy efficiency, energy security and energy markets. The EU's ambition for renewable energy has grown in recent years, driven by the leadership position taken by the EU globally on climate action. In addition, the EU's dependence on imported fossil fuels came into sharp focus during the energy crisis following Russia's invasion of Ukraine. This prompted a specific EU policy response (REPowerEU plan[3]) that refocused attention on maritime transport accelerating renewable energy deployment.

The EU Renewable Energy Directive (2023/2413) establishes an overall EU target for the renewable energy share of overall energy use of at least 42.5% by 2030. The EU achieved its 20% renewable energy target in 2020 agreed under the original EU Renewable Energy Directive (2009/28/EC) (EC, 2024). Ireland's 2020 target under this directive was to achieve a renewables share of 16% of gross final energy consumption by 2020. In 2020, Ireland achieved a 13.5% renewable share of energy use and purchased 'statistical transfers' costing €50 million to address the shortfall of 3500 GWh of renewable energy. Ireland's target for 2030 is 43%, as set out in the National Energy and Climate Plan 2021-2030. It is important to note that this target is 43% of gross final energy consumption, that is, including heating and transport in addition to electricity.

1 www.gov.ie/en/publication/a856a-national-energy-and-climate-plan-necp-2021-2030/#:~:text=The%20NECP%20will%20act%20to,of%20Climate%20Action%20Plan%202024. (accessed 9 September 2024).

2 www.gov.ie/en/publication/e4e81-long-term-strategy-on-greenhouse-gas-emissions-reductions/ (accessed 9 September 2024).

3 eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A230%3AFIN&qid=1653033742483 (accessed 9 September 2024).

This target is expected to increase, given that the EU 2030 target has increased from 32% to 42.5%. In addition, Ireland must retain the baseline (of 16%, i.e. the 2020 target) and meet interim trajectory points in 2022, 2025 and 2027 (20.9%, 27.6% and 33.6%, respectively). In 2023, Ireland achieved a 14% renewable share, falling significantly short of the agreed targets (SEAI, 2024a).

The EU Energy Efficiency Directive (2023/1791) compels Member States to collectively ensure a 11.7% reduction in energy consumption by 2030, compared with the projections of the EU reference scenario 2020 (EC, 2021a,b). This establishes an effective cap on EU energy use of 8874 TWh by 2030. The indicative target for Ireland is a 2030 final energy demand of 115 TWh. This is approximately 18% below Ireland's energy demand in 2022. This is very challenging in the context of Ireland's projected economic and population growth in the period to 2030. Based on Sustainable Energy Authority of Ireland (SEAI) projections of energy demand, Ireland's energy use is projected to exceed the indicative cap by between 19% and 31% in 2030.

National policy

In addition to meeting targets agreed at EU level, Ireland has established a strong legislative and policy framework in recent years that is impacting energy supply and demand trends. The Climate Action and Low Carbon Development (Amendment) Act 2021 provides for an ambitious 51% reduction in GHG emissions by 2030, compared with 2018 levels. To achieve this aim, legally binding carbon budgets and sectoral emissions ceilings have been put in place across all sectors, including the key energy sectors of electricity, transport, industry and buildings. These issues are explored in more detail in Chapter 4.

The electricity sector has made significant achievements in terms of emission reductions over the past 20 years relative to other sectors and was allocated an ambitious sectoral emissions ceiling of 40 megatonnes of carbon dioxide equivalent (Mt CO_2 eq) in the period 2021-2025. By 2023, electricity had expended 68% of the sectoral ceiling, a higher share than any other sector. There was a significant 21.6% reduction in emissions in 2023, however. As a result, emissions will need to reduce by 10% per annum in 2024 and 2025 to stay within the ceiling.

The greatest progress towards sectoral emissions ceilings for energy-related emissions has been observed in energy in buildings – both residential and commercial and public buildings. Emissions released in the period 2021-2023 accounted for 62% of the 29 Mt CO_2 eq sectoral emissions ceiling for the residential sector and 61% of the 7 Mt CO_2 eq for the commercial and public buildings sector. Residential sector emissions could increase slightly in the period 2024-2025 and still remain within the sectoral emissions ceiling.

In addition to improving energy efficiency by switching to lower carbon fuels, electrification will play a key role in the decarbonisation of transport and heating (in both buildings and industry). Electrification transfers emissions from transport and heating to electricity, increasing the challenge in meeting the electricity sectoral emissions ceiling. This points to the need for unprecedented deployment rates of renewable energy and grid infrastructure, requiring urgent action by all relevant stakeholders. Environmental Protection Agency (EPA) GHG emission projections indicate that current planned measures will fall short of achieving the sectoral emissions ceiling goals (EPA, 2024d).

CAP24 outlines goals for heating, transport and renewable energy, focusing on solar and onshore and offshore wind generation. It also identifies further areas for development in the second half of the decade, including the role of hydrogen, in line with the National Hydrogen Strategy 'the role of interconnector capacity in increasing low-carbon power supply through deeper integration of cross-border electricity markets; building out low-carbon flexibility opportunities such as long-duration energy storage; and deploying sustainable biofuels, in line with EU regulations, in hard-to-abate transport sectors such as domestic aviation and maritime.

6. Ireland's energy supply

Ireland's energy supply, generally referred to as total primary energy requirement (TPER), is the amount of energy used in Ireland each year. This includes the energy requirements for the conversion of primary energy sources into energy used by the final consumer, for example electricity generation, oil refining and peat briquetting.

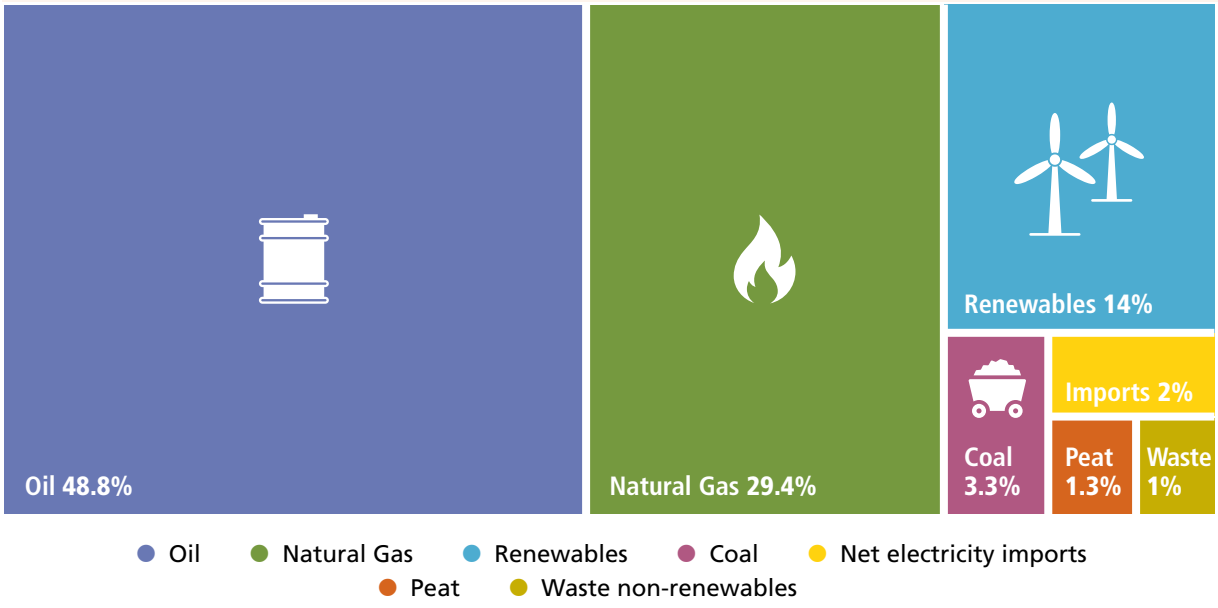
In 2023, Ireland's TPER fell 1.7% to 164 TWh of energy compared with 2022, with 82.8% of energy supply coming from fossil fuels (SEAI, 2024b). This is the lowest level of TPER in over 20 years, with the exception of 2020, when COVID-19-related travel restrictions significantly reduced demand for petrol, diesel and jet kerosene. The year 2023 also saw record use of renewable energy in Ireland at 14% of TPER. The fuel breakdown of TPER for 2023 is presented in Figure 12.4.

Over three-quarters of Ireland's energy came from oil and gas in 2023, with 48.8% of energy from oil used for heating and transport, with small amounts also used for electricity generation. Ireland used 35.5% less

coal, 19.2% less peat and 7.2% less natural gas than in 2022, while there was an increase of 9.5% (+2.0 TWh) in energy from renewables and of 11.6% (+0.2 TWh) in energy from non-renewable waste. In addition, there was a substantial and unprecedented 1200% (+3.0 TWh) increase in net imports of electricity (SEAI, 2024c).

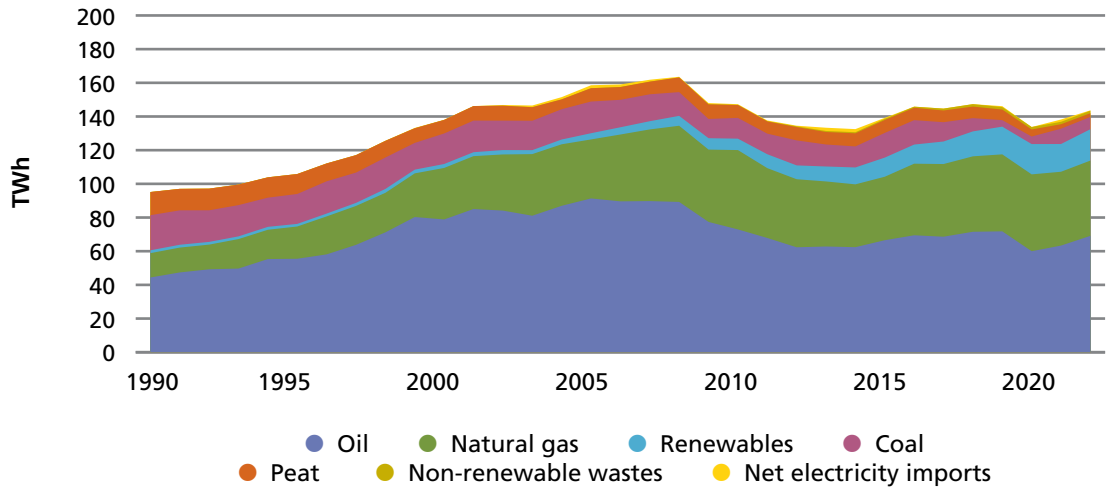
The trends in TPER in Ireland over the period 1990-2023 are presented in Figure 12.5. (SEAI, 2024a). The continued dominance of oil in Ireland's energy supply mix is evident, as is the growth in dependence on natural gas in particular over the past 25 years. The reduction in the use of solid fuels (coal and peat) is also apparent in Figure 12.5, along with the steady growth in renewable energy.

Figure 12.4 Breakdown by fuel of Ireland's total primary energy requirement in 2023



Source: Adapted from SEAI (2024b)

Figure 12.5 Total primary energy requirement in Ireland, 1990-2023



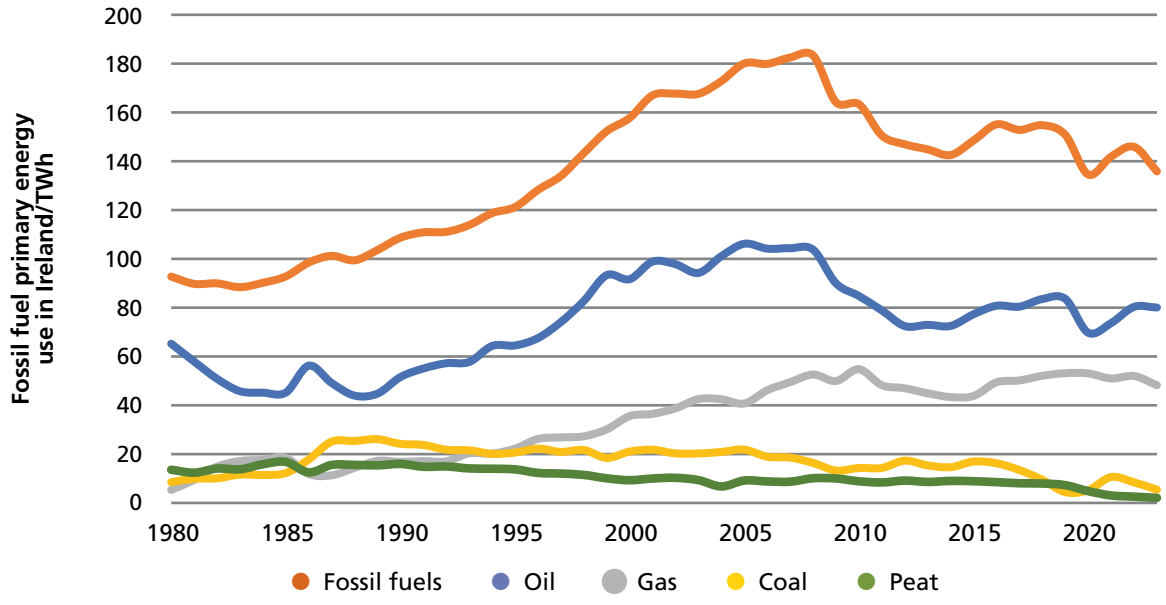
Source: SEAI, 2024a

According to the International Energy Agency all fossil fuel usage is anticipated to peak globally before 2030 (IEA, 2023). This marks a significant development, signalling the beginning of the end of the fossil fuel era. The data for Ireland on fossil fuel usage indicate that the peak in overall fossil fuel usage (at 183 TWh) took place in 2008, as shown in Figure 12.6.

Ireland's strong economic growth in recent decades, in particular in the late 1990s and early 2000s, prompted an increased demand for energy, which was met primarily by growth in oil and gas usage, driving fossil fuel usage to its peak in 2008. This growth sometimes masked the underlying fuel switching and energy efficiency gains that were introduced in the period from 2000, along with the growth in renewable energy in the past 15 years in particular. The economic downturn between 2007 and 2013 saw overall energy supply reducing and, as Ireland's economy recovered, fuel switching, energy efficiency and renewables have combined to dampen fossil fuel growth since then, as is evident in Figure 12.6.

Focusing on individual fuels, coal and peat both reached their peak contribution to Ireland's energy supply during the 1980s, first peat in 1985 and then coal in 1989. Since then both fuels have been in decline, more rapidly as a fuel for home heating and more recently as a fuel for electricity generation. Oil has accounted for more than half of Ireland's total fossil fuel usage since 1992. Oil demand was highest in 2005 at 106 TWh and then plateaued before dropping after 2008 during the economic recession. Natural gas usage grew steadily over the 20-year period between 1990 and 2010 and appears to have peaked in 2010. Natural gas use may increase in the short term until more renewables are brought on to the grid in the remainder of the 2020s and the next decade. The report *Energy Security in Ireland to 2030* sets out that natural gas will play a greater role in electricity generation during the transition to a renewables-led system, particularly to support the grid in times of low renewable output (DECC, 2023a).

Figure 12.6 Fossil fuel use in Ireland, 1980-2023



Source: Based on data from the Economic and Social Research Institute and SEAI

From 2013 to 2022, oil and natural gas use increased by 6.6% and 10.8%, respectively, due to the demands from transport (oil) and electricity generation (gas), while the use of more carbon-intensive fuels, coal and peat, declined by 44% and 27%, respectively (SEAI, 2024d).

Ireland continues to source most of its energy from fossil fuels, however. In addition, most of Ireland's energy is imported: in 2023, Ireland's energy import dependency was 78.4%, importing 77.5% of its natural gas and 100% of its oil and coal requirements.

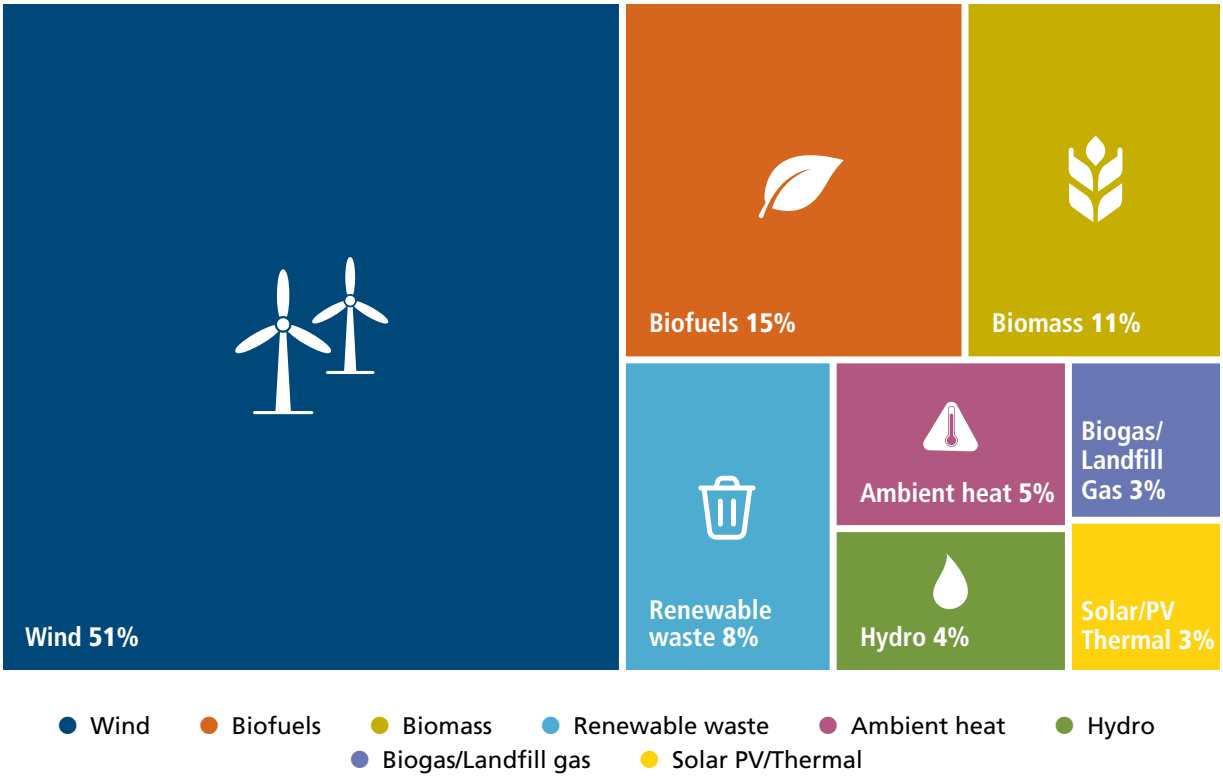
Natural gas from the Kinsale gas field contributed significantly to Ireland's indigenous energy supply in the 1990s. After a lull in indigenous natural gas supply during the early 2000s, production at the Corrib gas field has helped to reduce Ireland's energy import dependency to below 70% since 2015. As this gas field has depleted, Ireland's energy import dependency has grown again.

The use of peat as a fuel for electricity generation ended in 2023, when planning permission expired for the last remaining plant, and coal-fired generation at the Moneypoint power plant is due to end in 2025. To ensure security of electricity supply, while new generation capacity is constructed the Moneypoint power plant will transition from coal- to oil-fired electricity generation.

The contribution of renewable energy to Ireland's energy supply increased over tenfold from 2 TWh in 1990 to 23.0 TWh in 2023, providing 14% of total energy supply and more than half of all indigenous energy in Ireland (SEAI, 2024d). Wind accounted for just over half (50.8%) of Ireland's renewable energy, followed by biodiesel , biomass and renewable wastes. In 2023, heat pumps installed in homes and businesses across the country harnessed renewable ambient heat in the air that, in energy terms, exceeded the renewable energy produced from hydroelectricity.

Figure 12.7 illustrates Ireland's renewable energy contribution to TPER in 2023 and emphasises the dominance of wind and bioenergy in Ireland's renewable energy mix.

Figure 12.7 Contribution of renewables to Ireland's total primary energy requirement, 2023



Source: SEAI, 2024b

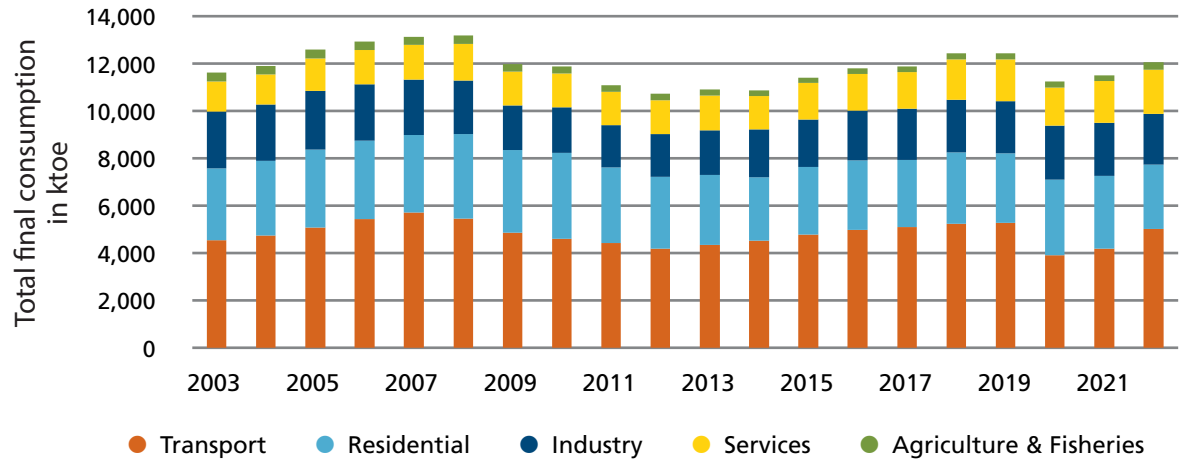
7. Total final energy consumption

Some of Ireland's primary energy is transformed into different forms of useful energy using a range of processes (e.g. electricity generation and oil refining) before being used by final energy users. Much of the energy (46% in 2022) used to generate electricity is 'lost' as waste heat in thermal power plants during generation and as distribution losses in the electricity grid.

For this reason, the 164 TWh of total primary energy in 2023 became 141 TWh of total final consumption (TFC) of energy, which represents the total energy delivered to final users. TFC in Ireland grew by 1%, despite TPER reducing by 1.7%, pointing to an efficiency increase in the overall energy system.

Over the past 20 years, Ireland's TFC peaked in 2008, as shown in Figure 12.8. Energy demand subsequently reduced during the economic recession and then increased in all sectors but remains below 2008 levels.

Figure 12.8 Total final energy consumption in Ireland by sector, 2003-2022



Source: SEAI, 2023

The transport sector dominates TFC in Ireland, accounting for a 41.3% share in 2022. Heating is also significant, accounting for 36.5% of TFC, comprising space and water heating in homes and in commercial and public buildings, in addition to thermal energy for manufacturing in industry. According to SEAI's national heat study (SEAI, 2022), heat demand is expected to rise over the next 20 years, and the deployment of energy efficiency measures in all sectors is not projected to sufficiently offset the impact of economic and population growth. New buildings also drive the growth in heat demand in the services sector. In the industry sector, heat demand grows in line with projections of increased economic activity.

8. Electricity generation

Ireland has seen significant changes in electricity generation over the past 20 years, and significant changes are expected over the next 20 years. This expectation is due in part to our significant wind and solar energy resources and also to the potential role of electrification in decarbonising heating and transport, which currently remain locked into fossil fuel systems.

Ireland's electricity demand was almost 34,000 GWh in 2022, accounting for 22% of TFC, while combustion of oil and gas accounted for 70% of TFC. The share of electricity in TFC is projected to increase with the increase in the number of electric vehicles and heat pumps, displacing the use of oil and gas for transport and heating.

Electricity demand is also growing in response to economic and population growth. Electricity use in the information and communication technologies sector has increased in particular in recent years, due to the increase in the number of data centres in Ireland. Electricity demand overall increased by 3% per annum on average over the 5-year period to 2022. Of this increase in demand, 23% per annum is due to the ICT sector, which currently accounts for over 20% of total demand.

There have been significant changes in Ireland's electricity fuel mix over the period from 2015 to 2023. Electricity demand increased in this 8-year period by 22%, but the fossil fuels combusted to generate this electricity reduced by 23%, demonstrating the higher efficiency of low-carbon electricity generation. There has been a reduction in solid fuel usage (coal and peat) for electricity generation and an increase in electricity generation from renewables and efficient natural gas plants.

In 2023, 40.7% of Ireland's gross electricity supply (which is the sum of indigenous generation and net imports) was renewable (SEAI, 2024b). The year 2023 saw new records for wind generation in Ireland, which was 4.1% higher than in 2022, setting a new annual record of 11.7 TWh. It was also the first year that Ireland produced more energy from wind than it extracted from its natural gas reserves (10.9 TWh) (SEAI, 2024b).

The impact of these changes on Ireland's electricity generation mix is also demonstrated over a longer period by the substantial reduction in the CO_2 intensity of electricity in Ireland, down from 896 g CO_2/kWh in 1990 to 255 g CO_2/kWh in 2023 (SEAI, 2023; EPA, 2024c).

9. Looking ahead

Decarbonisation of electricity generation has been a key measure in successive climate action plans, with the end of peat's use as a fuel for electricity generation in 2023 and the use of coal at Moneypoint to be phased out at the end of 2025. Significant growth in renewable energy is required to meet Ireland's future demands for electricity, requiring a transformation of power system operation to achieve the flexibility required to incorporate the growth in renewables while maintaining power system security. Table 12.1 summarises some of Ireland's renewable generation and system flexibility ambitions over the next ten years.

Wind energy

Ireland currently has 4.6 GW of installed wind generation capacity (over 99% of which is onshore) (SEAI, 2023). Ireland's CAP24 targets a 50% renewable energy share of electricity generation by 2025 and an 80% share by 2030 (DECC, 2024a). This will require increasing onshore wind capacity to 6 GW in 2025 and to 9 GW in 2030 and an offshore wind capacity of 5 GW by 2030.

Table 12.1 Some key metrics to deliver reduced emissions from electricity generation

THEME	ACCELERATE RENEWABLE ENERGY GENERATION	ACCELERATE FLEXIBILITY
2025 KPIs	■ 50% renewable electricity share of demand ■ 6 GW onshore wind capacity ■ Up to 5 GW solar photovoltaic capacity	■ Maximum level of renewables at any one time on the grid: 85% ■ Minimise surplus generation ■ Required long-term storage (4 hours plus) in place
2030 KPIs	■ 80% renewable electricity share of demand ■ 9 GW onshore wind capacity and at least 5 GW offshore wind capacity ■ 8 GW solar photovoltaic capacity	■ Maximum level of renewables at any one time on the grid: 95-100% ■ Minimise surplus generation ■ Required long-term storage (4 hours plus) in place ■ At least 2 GW of new flexible gas-fired generation ■ Zero emission gas-fired generation from biomethane and hydrogen commencing by 2030
2031-2035 measures	■ Decarbonisation roadmap for net zero power system ■ Green hydrogen production via 2 GW offshore wind	■ Required additional duration storage technologies in place ■ Increased zero emission gas-fired generation to enable a net zero power system

KPI, key performance indicator

Source: DECC, 2023b

The development of offshore renewable energy is hence a critical element of meeting climate action plan targets. CAP24 sets the objective of developing 5 GW of installed offshore renewable energy by 2030, with a further 2 GW of non-grid connected capacity to be in development by 2030, rising to 37 GW by 2050, with floating technology playing a role. The first Offshore Renewable Electricity Support Scheme auction (ORESS-1) was held in June 2023. There were four successful applicants with an average support price of €86/MWh for approximately 20 years, with three projects planned for the east coast and one for the west coast of Ireland. The successful projects ranged in size from 0.45 GW to 1.3 GW, with a combined installed capacity of just over 3 GW. ORESS-2 is due to launch in 2024, aiming to address the shortfall in offshore wind capacity and delivering the targeted 5 GW of grid-connected offshore wind by 2030 and the further 2 GW of non-grid wind power for green hydrogen production.

Ireland's Offshore Wind Industrial Strategy ('Powering Prosperity') is focused on action in 2024 and 2025. It sets out how it will build on the 2030 targets and includes an interim target for 2040 of 20 GW capacity (DETE, 2024). It sets out that achieving the 2050 target of 37 GW of generation capacity would enable the production of green hydrogen and other fuels, the development of a hydrogen industry, the decarbonisation of industrial heat and the export of electricity, and ensure energy security through interconnection.

The National Marine Planning Framework was adopted by the government in May 2021. This framework applies to Ireland's maritime area, outlining objectives and marine planning policies for each marine activity. A key objective of the framework is to ensure that future developments in Ireland's maritime area take place in a sustainable and strategic way, with consideration of environmental protection. The framework commits the government to using sub-national forward spatial planning through the establishment of designated maritime area plans (DMAPs). The Minister for the Environment, Climate and Communications has been designated as the competent authority to prepare DMAPs for the development of offshore renewable energy. Ireland's first offshore renewable energy designated maritime area will be situated off the south coast (See Chapter 9).

Solar energy

CAP24 sets a solar capacity target of 5 GW in 2025 and 8 GW in 2030. Ireland's solar photovoltaic electricity generation capacity reached close to 1 GW by the end of 2023, and solar energy accounted for 1.9% of gross electricity supply (SEAI, 2024b). Utility-scale grid-connected solar farms accounted for 64% of solar photovoltaic generation, with 36% coming from rooftop solar panels. Generation from solar farms increased 24-fold compared with the previous year, due to multiple sites being connected to the national grid in 2023. In parallel, electricity generation from rooftop solar panels increased by 74% in 2023.

Energy storage

Electricity storage systems aim to ensure security of supply in the electricity network by storing excess renewable generation and managing peak demand. The government's Electricity Storage Policy Framework for Ireland 2024 sets out the role of electricity storage in meeting Ireland's 2030 climate goals and addresses the deployment of storage up to 2040 (DECC, 2024b). The policy framework refers in the main to electricity storage systems developed to provide grid-supporting services. According to the policy framework, electricity storage systems with a capacity of over 1 GW are in place, and this capacity is expected to grow substantially in the coming years.

Biomass

Biomass accounted for 56% (i.e. 125 million tonnes of oil equivalent or 1453 TWh) of gross final renewable energy consumption in the EU in 2021 (this share was 63% in 2005) (EEA, 2023). This is much greater than in Ireland, as outlined in Figure 12.7, where biomass accounts for 33% of Ireland's renewable energy. Biomass here includes bioenergy in the form of solid biomass, liquid biofuels and renewable wastes.

Biomass used for energy generation is considered to be carbon neutral because plants and trees can regrow and sequester CO_2 from the atmosphere. However, the process of regrowth can take several decades, and the use of biomass in energy via combustion releases significant amounts of CO_2 and other pollutants into the atmosphere over the short term. The production, harvesting and transport of biomass for combustion can impact biodiversity, the condition of ecosystems and their capacity to sequester CO_2 from the atmosphere. Therefore, the use of biomass needs to be balanced with other ecosystem conservation needs.

Energy efficiency and electrification of buildings

In addition to significant ambitions for renewable energy supply, Ireland has many policies and measures in place to upgrade the energy performance of buildings and to switch their energy supply from fossil fuel boilers to electric heat pumps.

Houses currently built in Ireland tend to have a high standard of energy performance and are mostly heated by heat pumps following changes to building regulations in 2005. Almost half (48%) of Ireland's existing dwellings, however, have a relatively low building energy rating of 'D' or lower on a scale of A-G, indicating significant ongoing energy costs for these households. CAP24 has a target of upgrading 120,000 dwellings to a rating of 'B2' by 2025 and the installation of 45,000 heat pumps. The targets for 2030 are to retrofit 500,000 dwellings and install 400,000 heat pumps. The National Retrofit Plan sets out how the government intends to deliver on the climate action plan targets (DECC, 2022).

There is progress, according to SEAI, including 47,953 home upgrades delivered in the year 2023 – 17,600 to a B2 level (SEAI, 2024e). To achieve the desired delivery trajectory and meet the 2030 target, SEAI has projected that 185,000 home energy upgrades should be delivered between 2019 and 2025. Of these, over 83,000 should be upgrades to a B2/cost-optimal level. According to SEAI, when the carbon savings from the non-B2 upgrades are included, this will be equivalent to the CAP24 target of 120,000 B2 upgrades over the period. To deliver on the National Retrofit Plan objective, SEAI said it would need to deliver on average 75,000 B2-equivalent home upgrades per year from 2026 to 2030 to achieve the overall target of 500,000 by 2030 (SEAI, 2024e).

Heat pumps are gaining in popularity as the default heating system for new builds, and 3750 heat pump installations were supported by SEAI in 2023. While the number of heat pumps supported in 2023 was up 65% on the 2022 figure, SEAI stated that this number will need to dramatically increase in the coming years to achieve the 45,000 target by 2025 (SEAI, 2024e).

The 2022 Heat Study by SEAI noted that capital costs are a barrier to installing heat pumps in the residential sector, and additional policy support is needed to drive uptake (SEAI, 2022). The SEAI report also highlighted that the biggest challenges in achieving the 2025 and 2030 targets is the availability of sufficient skilled workers and construction sector inflation (SEAI, 2024e). In addition to retrofitting and heat pumps, the SEAI Heat Study also highlights the untapped potential in Ireland of district heating, which has the distinct advantage of being able to use renewable energy supplies to meet heating requirements (Topic Box 12.1).

In the context of the rising energy prices, driven by international geopolitics, that have significantly affected oil, gas and electricity prices over the past 3 years, researchers at the Economic and Social Research Institute estimated that 29% of Irish households were in energy poverty (Barrett *et al.*, 2022). Retrofitting the homes of those experiencing energy poverty is crucial for a just transition.

Topic Box 12.1 District heating

District heating has the potential to play an important role in improving energy efficiency and reducing emissions in Ireland. District heating networks can use various renewable technologies to help decarbonise the heat sector. Currently, district heating accounts for a very small share of the Irish heating sector, estimated to be significantly less than 1%, representing one of the lowest shares in Europe (SEAI, 2022). The large-scale deployment of heat networks (district heating) and the use of bioenergy can make significant contributions to reducing CO_2 emissions. Heat extracted from purpose-built combined heat and power generation and waste heat are the cheapest energy sources for heat networks. Heat pumps and biomass are also widely used to meet heat supply needs in the modelling where combined heat and power is not available. SEAI recommends that opportunities for extracting heat from power stations, recovering waste heat from industrial sites, and feeding heat from geothermal sources and low-grade heat from data centres into district heating schemes should also be encouraged. This would need policy, planning and regulatory support to be provided.

The revised EU Renewable Energy Directive strengthens the promotion of district heating in EU Member States. This will be transposed into Irish law by 11 October 2025.

Electricity interconnection

Increased interconnection and storage help balance electricity supply and demand between countries and provides a valuable back-up power supply for when electricity systems have reduced capacity. Electricity interconnection is playing an increasing role in Ireland's energy system as the system becomes decarbonised and fossil fuel generation is replaced by large-scale variable-supply renewables. Interconnectors act as energy highways and allow energy import and export. As we increase our share of renewable electricity generation, interconnectors will allow us not only to import electricity when we have insufficient indigenous generation available but also to export electricity when we generate more than we require to meet our domestic energy demands.

Ireland's net import of electricity across interconnectors increased 12-fold up to 3.3 TWh in 2023 and set a new annual record. This step change in interconnector behaviour is set to increase into the near future. Ireland's interconnection capacity currently stands at 500 MW in a single connection to the UK. Facilitated by the National Policy Statement on Interconnection 2018,[4] capacity is set to more than treble by 2026 to 1700 MW, including a return of direct interconnection between Ireland and the EU via the Celtic Interconnector (DECC, 2023c).

Energy efficiency and electrification of transport

The current dependence of transport systems in Ireland on liquid fossil fuels is unsustainable and is completely misaligned with the goal of transitioning to a climate-neutral economy. A range of zero- and low-emission transport technologies now exists, primarily electrification but also liquid and gaseous biofuels and the emerging prospects of electrofuels (hydrogen, green methanol, etc.), in particular for harder to electrify transport modes such as aviation and maritime shipping.

Technology end-of-pipe solutions alone do not address systemic and structural issues, however. An integrated approach to mobility and settlement planning that embraces the avoid-shift-improve approach and encourages opportunities for active modes of travel and public transport can have multiple gains, including for overall energy use in transport and for health and the environment.

For a detailed discussion of the energy use and environmental impact of the transport sector in Ireland, along with future plans for the sector, please refer to Chapter 11.

Renewable fuels

While electrification is expected to meet many energy needs in the future, some hard-to-decarbonise sectors will require access to fuels or stored energy that can meet their demands, including for some industrial and transport applications. Progress is being made with developing these low- and zero-carbon energy supplies.

Liquid biofuels. Ireland set new records for biofuel blending in road petrol and road diesel in 2023. The annualised average biofuel blend in road diesel was 8.4% in 2023, up from 6.5% in 2022, and the average biofuel blend in road petrol was 4.2% in 2023, up from 3.2% in 2022. The increased blending of biofuel into road diesel reduced the energy demand of fossil petrochemical diesel by 2.0% in 2023 (SEAI, 2024a).

Ireland's energy requirements for biodiesel, bioethanol and biomass are satisfied through a combination of indigenous production and international imports. In 2023, Ireland's import dependencies on biodiesel and bioethanol were 68.4% and 78.8%, respectively, while its import dependency on biomass was 16.1% (SEAI, 2024b).

In 2023, biofuels saved 0.81 million tonnes of CO_2 emissions from transport. Since 2005, there have been cumulative biofuel emissions savings of 6.4 million tonnes of CO_2, making biofuels one of the more important mitigation measures to date for reducing transport-related emissions (EPA, 2024c).

Biomethane. Biogas is produced as the main product of the anaerobic digestion of biological feedstocks, including food waste, sewage sludge and agricultural feedstocks. Biogas typically comprises 60% methane and 40% carbon dioxide. When biogas is upgraded to greater than 97% purity methane, it is termed biomethane.

CAP24 has ambitious targets of producing 1 TWh of biomethane by 2025 and 5.7 TWh by 2030 from anaerobic digestion of agricultural feedstocks to replace the fossil methane in the natural gas network. This target is a little over 10% of the current use of fossil fuels; however, it is expected to rise to over 50% of Irish usage by the mid-2030s as Ireland shifts the economy away from gas in favour of electrification. Achieving the biomethane targets will require very significant investment and scaling up from the current biomethane production level. A recent Gas Networks Ireland report identified the potential for 14.8 TWh of biomethane from over 170 prospective producers (Gas Networks Ireland, 2023).

4 www.gov.ie/en/publication/3e988-national-policy-statement-on-electricity-interconnection/ (accessed 9 September 2024).

A National Biomethane Strategy was published in June 2024 setting out a vision for an agri-led biomethane industry that promotes the use of the gas in Ireland's future energy system. According to the strategy, the increase in biomethane production needed to achieve the CAP24 targets will be facilitated by increasing the number of anaerobic digestion plants in Ireland to 200 by 2030. In Ireland there are currently two operational biomethane facilities that can inject methane into the national grid and 43 facilities that produce biogas. These new anaerobic digestion plants will require authorisation from the EPA when using waste feedstocks.

To be classified as a zero-carbon-rated fuel, biomethane must satisfy the Renewable Energy Directive's life cycle sustainability criteria. A national biomethane charter is planned, which will include all of the issues covered by the Renewable Energy Directive, as well as land use, water quality, biodiversity, fertiliser use and carbon sequestration to the extent that they are not addressed under the Renewable Energy Directive.

It is estimated that, to meet the biomethane production targets, over 20% of all winter cattle slurry produced in Ireland would be required to facilitate a balanced feedstock for the anaerobic digestion plants. The National Biomethane Strategy assumes an equal mix of grass foliage and slurry in the feedstock and estimates that, at national level, a total land area of 120,000 hectares would be needed to produce the silage to feed the anaerobic digester biomethane plants required to reach the 5.7 TWh target. The strategy will seek to avoid potential competition with other critical uses of land, including food production and biodiversity protection, and ensure that the industry contributes to nature and water quality recovery. The strategy highlights that anaerobic digestate can be used to replace chemical fertilisers, reducing the need for these in agriculture.

Hydrogen. The National Hydrogen Strategy was published by the Department of the Environment, Climate and Communications in 2023. The strategy sets out the strategic vision for the role that hydrogen will play in Ireland's energy system and the short-term actions that need to be delivered to enable the development of the hydrogen sector in Ireland. The rationale for the strategy is to develop a solution for hard-to-decarbonise sectors with an indigenous zero-carbon renewable fuel that enhances our energy security while also presenting some potential export opportunities.

The strategy envisages hydrogen supporting dispatchable flexible electricity as a long-duration store of renewable energy in decarbonising industrial processes and as a transport fuel in sectors such as heavy goods transport, maritime transport and aviation. Prior to 2030, it is envisaged that hydrogen will be produced from grid-connected electrolysis from surplus renewables. A 2 GW target for the production of renewable hydrogen from offshore wind has been set for 2030.

10. Subsidies and taxes

Taxation, operating in conjunction with other measures, provides the government with an important climate action policy lever. Fiscal measures such as price signalling and the gradual removal of fossil fuel subsidies support the move away from heavily polluting fossil fuels and towards more sustainably fuelled transport, heat and industry. A range of policies, including demand management, is needed to meet the necessary reductions and underpin the transition to a low-emission and ultimately net zero economy.

Fossil fuel subsidies

The International Energy Agency's World Energy Outlook 2022 (International Energy Agency, 2022) highlights that recent direct fossil fuel subsidies and below-market energy prices reduce or remove incentives for energy efficiency and disproportionally benefit wealthier households and businesses, and are a burden on public finances.

The EU and its Member States have a long-standing commitment to phasing out potentially environmentally harmful subsidies, including fossil fuel subsidies. Such subsidies include tax exemptions/reductions for specific goods or groups. The CSO provides an analysis of fossil fuel subsidies in Ireland (CSO, 2023), including direct and indirect subsidies. These direct subsidies include those provided for fossil fuel exploration, production and consumption, with a significant focus on lower income households and groups (Table 12.2). The CSO estimates direct fossil fuel subsidies at €300 million per annum for 2017-2021, on average. Additional direct subsidies were introduced following Russia's invasion of Ukraine in February 2022, as fossil fuel prices soared, including direct electricity payments to households, reduced VAT on electricity and natural gas, and decreases in excise rates on road petrol and diesel. Higher fossil fuel prices have the hardest impact on poor people. These recent subsidies were not targeted to any income group and apply to all householders and fuel users. It is important to ensure that climate policies and fuel taxation measures are targeted to the most vulnerable, helping to achieve a just transition.

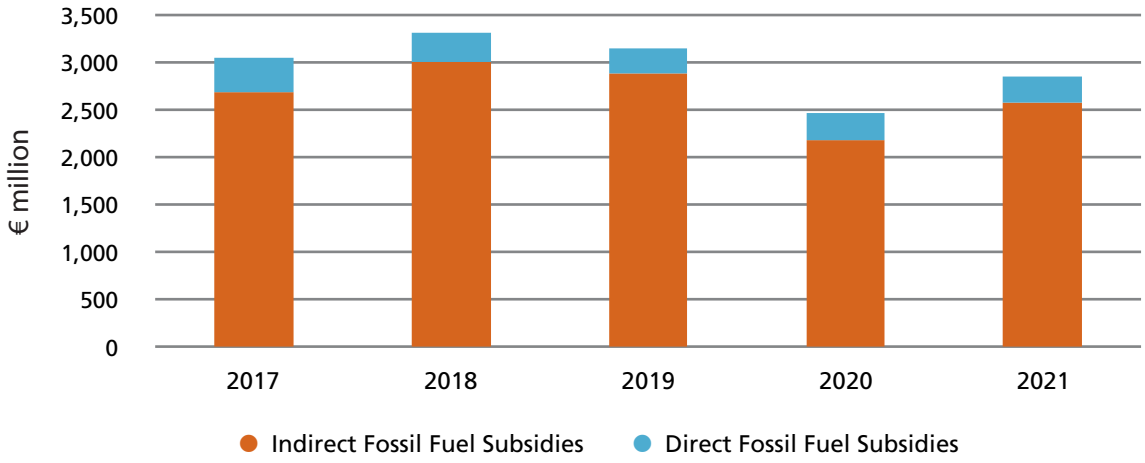
Table 12.2 Direct fossil fuel subsidies, 2017-2021

DIRECT FOSSIL FUEL SUBSIDIES	2017	2018	2019	2020	2021
Total	**357.8**	**309.6**	**268.7**	**290.6**	**284.8**
Fossil Fuel Production					
Petroleum exploration and production promotion and support scheme	2.1	1.2	1.4	2.1	0.9
Science Foundation Ireland fossil fuel R&D funding	1.3	1.3	0.8	0.2	0.0
Fossil Fuel Consumption					
PSO levy: electricity generation from peat	117.8	65.5	25.5	31.4	7.7
PSO levy: security of supply	–	–	–	–	–
Electricity allowance	110.2	108.6	105.7	104.9	115.7
Gas allowance	20.6	19.3	21.2	20.9	22.1
Fuel allowance	90.5	96.1	96.0	116.2	126.3
Other supplements (including heating)	5.8	7.7	7.7	4.9	4.1
Fuel grant for disabled drivers /passengers	9.5	10.0	10.5	10.0	8.1

– Scheme not in operation or no relevant payments made

Source: CSO, 2023

Figure 12.9 Direct and indirect fossil fuel subsidies, 2017-2021



Source: CSO, 2023

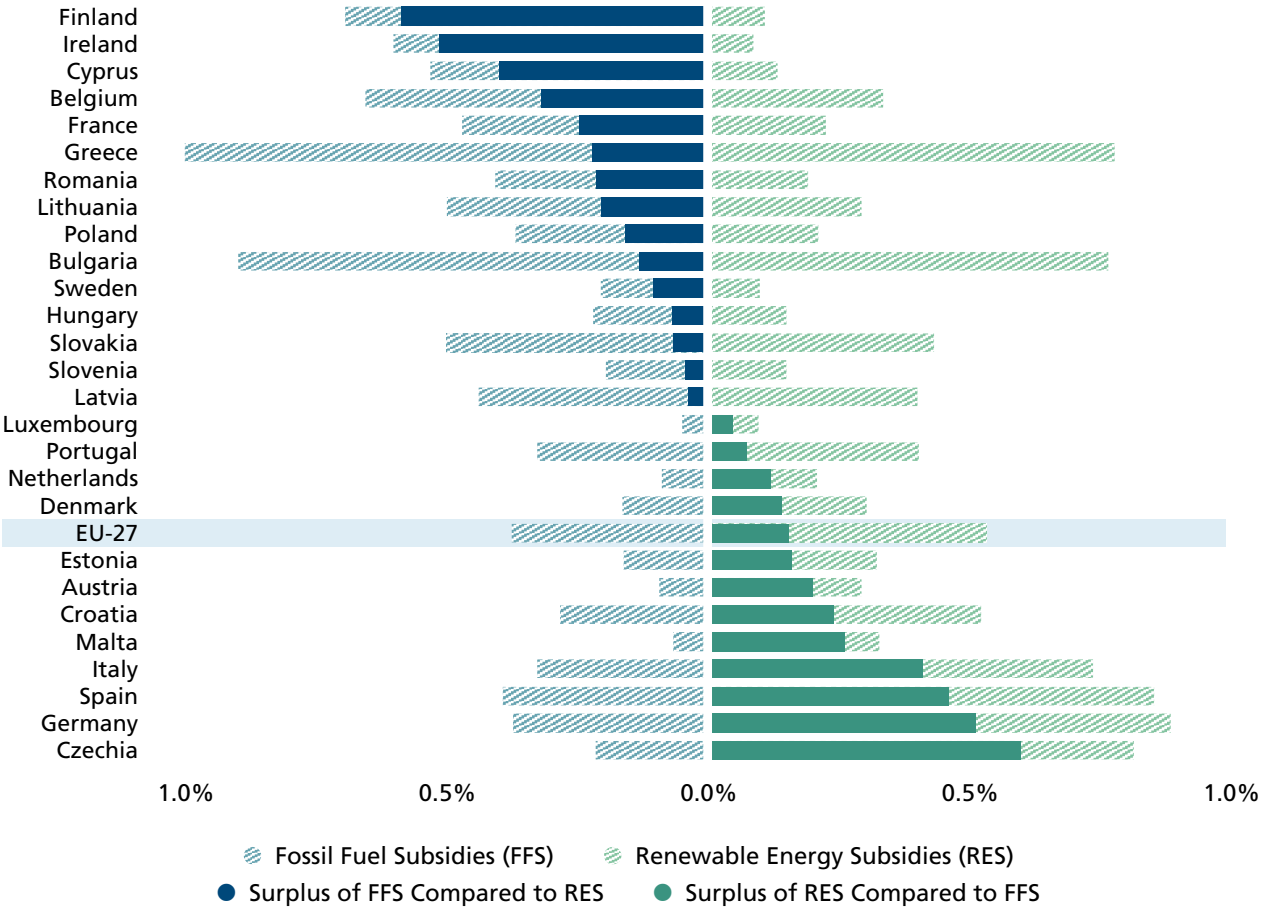
The CSO also estimates indirect fossil fuel subsidies amount, on average, to €2.5 billion per annum, including exemptions on excise and VAT for aviation fuels, tax differentials on marked gas oil and road diesel, VAT rebates for road diesel and lower VAT on energy products. The total indirect and direct fossil fuel subsidies for 2017-2021 are presented in Figure 12.9, which shows COVID-19 impacts resulting in lower subsidies in 2020.

Renewable energy subsidies

A recent European Court of Auditors report assessed how energy taxes, carbon pricing and energy subsidies fit with EU climate objectives (European Court of Auditors, 2022). Energy taxation can support climate efforts, but current tax levels do not reflect the extent to which different energy sources pollute. Renewable energy subsidies almost quadrupled over the period 2008-2019, while fossil fuels subsidies remained stable.

Fossil fuel subsidies represent an obstacle to reaching climate goals because they hinder the green energy transition. Overall, across the EU, renewable energy subsidies are higher than fossil fuel subsidies, but Ireland is among 15 Member States that allocate more fossil fuel subsidies than renewable energy ones (Figure 12.10) (European Court of Auditors, 2022).

Figure 12.10 Level of fossil fuel subsidies compared with renewable energy subsidies



Source: European Court of Auditors, 2022; reproduced under the terms of the Creative Commons CC BY 4.0 licence (creativecommons.org/licenses/by/4.0/)

Energy taxes and carbon pricing

The importance of carbon pricing in reducing GHG emissions has been recognised across the world, with both taxation and 'cap-and-trade' pricing schemes in operation in many countries and regions, including in the EU and Ireland. Evidence of the impact of taxing energy use on reducing energy consumption has been widely published over many years (Labandeira *et al.*, 2017). While direct energy taxation (e.g. taxes on transport or heating fuels) has been in place in Ireland for many years, a carbon tax was introduced in December 2009 directly related to CO_2 emissions, and has remained in place since then, growing steadily over time.

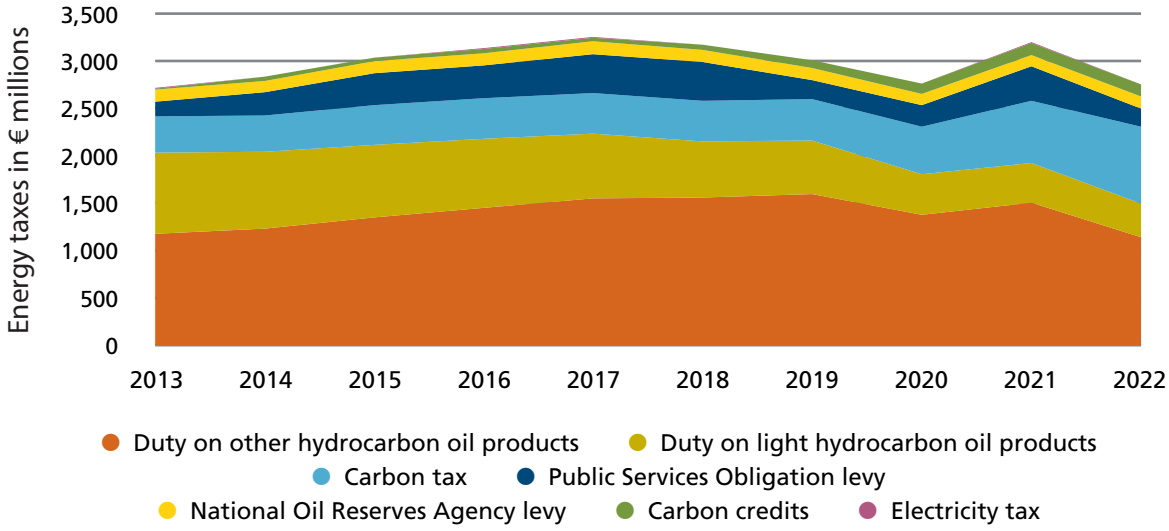
Since 2010, an excise duty, in the form of the Natural Gas Carbon Tax, has been applied to supplies of natural gas. Mineral Oil Tax (MOT) is an excise duty that applies to liquid fuels released for consumption in Ireland for motor or heating purposes.[5] The MOT rates were amended in 2010 to introduce a carbon component in addition to the pre-existing non-carbon component. A carbon tax was introduced for solid fuels in 2013 in the form of the Solid Fuel Carbon Tax, which is applied to coal, peat briquettes, milled peat and other peat supplied in Ireland.

The rates applied to the Natural Gas Carbon Tax, Solid Fuel Carbon Tax and the MOT carbon component are proportionate to the amount of CO_2 emitted when the fuel is combusted and are based on charging an amount per tonne of CO_2 emissions.

5 www.revenue.ie/en/companies-and-charities/excise-and-licences/excise-duty-rates/mineral-oil-tax.aspx (accessed 9 September 2024).

Legislation was introduced in 2020 setting a 10-year trajectory of carbon tax increases to bring the charge per tonne of CO_2 emissions to €100 by 2030. While carbon tax has continued to increase, reaching €807 million in 2022, energy taxes have reduced overall since 2017, with reductions in duty on light hydrocarbon products and other hydrocarbon products (Figure 12.11). A phased reversal of these cuts has taken place in 2023 and 2024.

Figure 12.11 Energy taxes, 2013-2022



Source: CSO, 2023

11. Conclusions

Meeting Ireland's statutory obligations to remain within carbon budgets to 2030 and achieve climate neutrality by 2050 requires significant and unprecedented changes to the energy system.

Large-scale and immediate GHG emission reductions are needed across the whole energy system (electricity, heat and transport). The ICCA report highlights that well-established 'no-regret options' can move Ireland's energy decarbonisation significantly forward and must be implemented now. These include demand reduction, electrification, deployment of market-ready renewables and low-carbon heating options (e.g. district heating).

Ireland's heating and transport systems remain heavily dependent on fossil fuels, and rapid transformational change is needed in how we heat our homes, deliver our goods and services and transport people and goods.

Localised environmental issues relating to air quality are integrally linked with the combustion of fossil fuels for home heating and transport. Progressing heating and transport systems towards using zero-carbon fuels will have a significant beneficial impact on air quality.

Retrofitting homes and other buildings is key to reducing emissions and brings multiple other benefits relating to air quality and health. Electrification of home heating through the replacement of solid and liquid fuels with heat pumps is also key to reducing building energy-related emissions. Retrofitting the homes of those experiencing energy poverty should be a priority, as it is crucial for a just transition.

Renewable electricity generation is projected to reach up to 80% of electricity generation at the end of the decade as a result of a projected rapid expansion in wind energy and solar power. Continuing this substantial progress is a critical element in Ireland achieving net zero.

Renewable fuels such as solid, liquid and gaseous forms of bioenergy and hydrogen will be needed in sectors not currently suited to electrification, such as heavy goods transport and some sectors of industry and to balance an electricity grid based on variable renewable electricity technologies.

A net zero energy system can bring multiple benefits, including improved energy security and significantly reduced import of fossil fuels into Ireland to meet our energy needs, from over 80% today (SEAI, 2024d) to less than 5% in the future, and societal co-benefits, including improved human health and air quality.

To ensure grid stability and security of supply, the system will also require other options, such as increased interconnection, demand flexibility, storage and zero-emission back-up generation.

The ICCA report highlights that renewable energy not only reduces emissions but also opens up opportunities in the green economy, including for coastal communities and farmers, and distributed energy enables homeowners to be producers of energy, lowering energy bills.

The energy transition requires consideration of issues beyond technical aspects, including environmental, societal, economic and governance dimensions. In this context, the ICCA report identifies the need for an enhanced regulatory and planning framework to accelerate the deployment of renewables, realise co-benefits and manage trade-offs, competition and impacts on other land uses, including biodiversity, food production and carbon sequestration.

Effective frameworks for investment in Ireland's energy transition are needed, and significant redirection of fossil fuel subsidies can contribute to this process.

SEAI has highlighted the challenge of establishing a sufficient supply of competent providers to meet the needs of the National Retrofit Plan. Similar challenges have also been highlighted in the renewables industry. Addressing these gaps in national capability will be critical to achieving the transformational changes needed to progress to net zero.

Key chapter messages

1. Established technologies, such as wind energy, solar photovoltaics and bioenergy, will be key in meeting short-term emission reduction targets (i.e. 2030), whereas significant growth in offshore wind infrastructure is expected to be the key essential element of future energy systems. Enhanced regulatory and planning frameworks, and support schemes, are required to accelerate the deployment of renewables, realise co-benefits and manage trade-offs.

2. Growing demand for electricity is an anticipated by-product of the expected electrification of the heat and transport sectors. However, additional and rapidly increasing electricity demand growth from large energy users is putting pressure on energy systems.

3. World class infrastructure takes significant time and investment from conception to implementation. The time horizon for achieving national and EU commitments is getting ever shorter. Planning in the broadest sense needs to be fast tracked to achieve the ambitious national renewable energy targets.

4. Substantial challenges remain for high-intensity hard-to-decarbonise sectors, e.g. high temperature users, and the development of low or zero carbon fuels to meet these applications are needed. Negative emissions technologies and solutions will also be required to deliver a climate-neutral Ireland.

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