Rialtas na hÉireann
Government of Ireland

Ireland's Long-term Strategy on Greenhouse Gas Emissions Reduction

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International and EU Context

Changes to the climate system as a result of human activity have already resulted in an observed global average temperature increase of more than 1^0C since pre-industrial times. Further increases in global average temperatures are projected to cause significant impacts in Ireland, and globally, especially in countries more exposed and less able than we are to withstand these impacts.

Climate change, as a trans-boundary challenge, can only be addressed through committed ambition and effective multilateral cooperation at the international level. The United Nations Framework Convention on Climate Change (UNFCCC), an international treaty that entered into force in 1994, provides the framework for addressing climate change. Two major subsidiary agreements under the UNFCCC are the Kyoto Protocol and the Paris Agreement, both designed to help stabilise greenhouse gas levels in the atmosphere. Ireland is a Party to these agreements and engages in negotiations under the UNFCCC through its membership of the EU.

International Context

The Intergovernmental Panel on Climate Change (IPCC), which is the United Nations body for assessing the science related to climate change, is currently in its Sixth Assessment cycle, during which the IPCC has produced Assessment reports from its three Working Groups, three Special Reports, and a refinement to a Methodology Report. The final Synthesis Report was published in March 2023, in advance of the 2023 Global Stocktake by the United Nations Framework Convention on Climate Change. The year 2023 is when countries will review progress towards the Paris Agreement goals, including the goal of keeping global warming to well below 2°C while pursuing efforts to limit it to 1.5°C.

The first Special Report, *Global Warming of 1.5°C*, published in 2018, highlighted the impending impacts of human influence on the climate system, such as melting glaciers and ice sheets causing sea level rise, coastal extreme events becoming more severe, and increases in ocean acidity; and outlined the potential destructive impact of 'tipping points' or feedback mechanisms within the climate systems that, if passed, could accelerate and

exacerbate the physical impact of climate change. The Special Report *Ocean and Cryosphere in a Changing Climate* and the Special Report *Climate Change and Land*, both published in 2019, confirm that this trend of increased heating, volatility and environmental/ecosystem degradation is observable in the world's oceans and terrestrial systems. The reports find that rapid reductions in anthropogenic GHG emissions across all sectors, following ambitious mitigation pathways, would reduce negative impacts of climate change.

The Assessment Report of Working Group I, *Climate Change 2021: The Physical Science Basis*, published in August 2021, provides the most up-to-date physical understanding of the climate system and climate change. It unequivocally confirms that human influence has warmed the atmosphere, ocean, and land, and that the scale of recent changes across the climate system as a whole and the present state of many aspects of the climate system are unprecedented over many centuries to many thousands of years.

The Assessment Report of Working Group II, *Climate Change 2022: Impacts, Adaptation and Vulnerability*, published in February 2022, assesses the impacts of climate change looking at ecosystems, biodiversity, and human communities and systems at the global and regional level. It finds that climate change has caused widespread adverse impacts and related losses and damages to nature and people, beyond natural climate variability and, further, that the impacts and risks of climate change are becoming increasingly complex and more difficult to manage.

The Assessment Report of Working Group III, *Climate Change 2022: Mitigation of Climate Change*, published in April 2022, underlines the urgency of reducing greenhouse gas emissions globally. The report states that, with current policies and commitments, the world is on track for an estimated 3°C increase in global temperatures by 2100. In order to limit global warming to 1.5°C, in line with the Paris Agreement target, global emissions must peak in 2025, must fall by 43% by 2030 and must reach net zero by 2050. The report emphasises that while the scale of action required cannot be underestimated the means and knowhow to limit warming already exist and sets out detailed mitigation pathways to achieve the necessary reduction across key sectors.

The IPCC reports highlight the importance of limiting global warming to 1.5°C to ensure that current and future generations can live sustainably on a stable and climate-resilient planet. The reports highlight the need for immediate global action to reduce emissions and to slow the impact of climate change to meet the Paris Agreement objectives of:

- Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognising that this would significantly reduce the risks and impacts of climate change

- Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production and that allows sustainable transformation and system transitions in energy, ecosystems and infrastructure

- Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development

The IPCC reports confirm the necessity for global emissions of CO_2 to reach net zero in this century in order to limit climate change to 1.5°C or 2°C and that they must reach net zero around mid-century to have a high probability of limiting global warming to 1.5°C.

The IPCC assessment reports also considered long-term trajectories for global emissions of nitrous oxide and methane and found that most scenarios which stay within global warming of 1.5°C require very significant reduction in emissions of these gases but that global emissions do not need to reach zero nor would it be feasible for them to do so.

The Conference of the Parties to the United Nations Framework Convention on Climate Change (COP) meets annually to take decisions to support the effective implementation of the Convention and the Paris Agreement. The overarching decision from the 26th meeting (COP26), the Glasgow Climate Pact, reaffirms the signatories commitment to the Paris Agreement goal of limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C and "stresses the urgency of enhancing ambition and action in relation to mitigation, adaptation and finance in this critical decade to address gaps between current efforts and pathways in pursuit of the ultimate objective of the Convention and its long-term global goal".

The Pact calls on all countries to present stronger national climate action plans in 2022, calls for a doubling of finance to support developing countries in adapting to the impacts of climate change and building resilience, and completes the Paris Agreement's rulebook as it relates to market mechanisms and non-market approaches and the transparent reporting of climate actions and support.

The Pact also includes a provision calling for a phase-down of coal power and a phase-out of "inefficient" fossil fuel subsidies – two key issues that had never been explicitly mentioned in

decisions of UN climate talks before, despite coal, oil and gas being the main drivers of global warming.

COP27, which took place in Egypt in November 2022, failed to advance further mitigation efforts to limit warming to 1.5°C, but delivered a historic decision to establish and operationalize a loss and damage fund, particularly for Parties most vulnerable to the climate crisis.

The Paris Agreement and the United Nations' Agenda 2030 Sustainable Development Goals recognise that the impacts of climate change will be felt by all, but that these impacts will be uneven. Vulnerable communities and people around the world – in particular women and girls – face devastating impacts to their livelihoods and greater challenges in adapting to the long-term effects of climate breakdown. Ireland recognises both the right and responsibility of all countries to pursue low-carbon, climate-resilient development, and is supporting initiatives – within the framework of both the Paris Agreement and the United Nations Sustainable Development Goals – to support developing countries in achieving these objectives. In light of this, our clear ambition is to continue to deliver a step-change in our emissions performance over the coming decade, so that we will not only meet our EU targets for 2030 but will also be well placed to meet our mid-century decarbonisation objectives.

Ireland's policy for international development, *A Better World*, recognises the threat that climate change presents to the achievement of the Sustainable Development Goals, and identifies climate action as a major priority. Our international climate finance is targeted at helping the poorest to adapt to climate impacts - in the sectors that most affect the poor and in the poorest countries. Ireland has committed to increasing our climate finance to at least €225 million per annum by 2025 to support these objectives. In July 2022, Ireland published its *International Climate Finance Roadmap* which illustrates Ireland's plans for scaling up its international climate financing to meet this target through public sources of finance. Levels of support will continue to be measured in Ireland's annual Climate Finance Report.

European Context

In its 2018 Communication *A Clean Planet for all*, the European Commission set out its vision for a climate-neutral EU and explored pathways that would enable the EU to achieve climate neutrality by mid-century in line with the Paris Agreement.

The European Green Deal, published in December 2019, sets out a low emissions growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource efficient and competitive economy, where there are no net emissions of greenhouse gases by 2050, where economic growth is decoupled from resource use and where no person and no place is left behind.[1]

The Green Deal sets out the EU's overall ambition on climate action as well as a policy and legislative programme for all key economic sectors in order to deliver on climate ambition, including energy, transport, agriculture, industry, buildings, and finance. The Green Deal also addresses wider environmental ambition, including in relation to the protection of biodiversity; action on chemicals; and policies addressing pollution to air, water and soils. The mainstreaming of sustainability within the European Union will be pursued through measures to support just transition, action on sustainable finance, strengthening non-financial reporting for companies, integration of the Sustainable Development Goals into the European Semester process, and strengthening relevant state aid guidelines.

The European Green Deal is underpinned by the European Climate Law, enacted in July 2020, which sets into legislation the objective of a climate-neutral EU by 2050 and a commitment to negative emissions thereafter. It also sets a binding intermediate Union target of a reduction of net greenhouse gas emissions (emissions after deduction of removals) by at least 55% by 2030 compared to 1990.

In July 2021, the Commission put forward the Fit for 55 package, a wide-ranging set of proposals to revise and update EU climate and energy legislation to ensure that EU policies are in line with the new EU objective established by the Climate Law. Additional Fit for 55 proposals were published in December 2021. Tripartite negotiations between representatives of the European Parliament, Council and Commission commenced in Q3 2022 with a view to reaching timely agreement on this ambitious package. This will help to accelerate Europe's decarbonisation and phase out our dependence on Russian gas, oil and coal imports.

[1] European Commission Communication, 'The European Green Deal,' COM (2019) 640, 11 December 2019

Security of Supply

As we transition to a climate neutral future, we must ensure the pathway to decarbonisation is underpinned by affordability and security in how we access and use energy in our everyday lives. Having a reliable source of energy is vital for consumers to have confidence in the transition.

Recent geopolitical events have had significant impacts for the European energy system, triggering a decision by the European Union to phase out its dependency on Russian gas, oil and coal imports.

In this context, the Department of Environment, Climate and Communications is preparing an Energy Security Package with recommendations for strengthening Ireland's energy security with a view to getting it adopted by Government in Q2 2023. The package will be based on five pillars: the review of the energy security of Ireland's electricity and gas networks, the independent review of the security of electricity supply (the McCarthy Report), the next steps for the National Energy Security Framework, oil security of supply and the Climate Action Plan. The purpose of the package is to bring different energy security work-streams together and ensure a coordinated policy response to energy security.

Ireland has set itself a target of reducing GHG emissions by 51% by 2030 and being climate neutral by 2050. As Ireland decarbonises its energy system as part of achieving these commitments, demand for electricity will increase and total demand for natural gas will decrease. The aim of the package is to ensure that the decarbonisation efforts are underpinned by security, and affordability, in how Ireland accesses and use its energy resources.

Ireland has identified a number of security of supply gaps both in the short- and the medium-term. In the short term, we need to address capacity shortfalls in the electricity system and ensure adequate conventional generation is in place to support the elevated levels of renewable electricity being generated.

The McCarthy Report highlighted the need for greater policy leadership and increased technical expertise within the Department and the need for action in relation to roles, responsibilities, and appropriate powers and, market structure and operation. The review of the energy security of Ireland's electricity and gas networks focused on the period out to 2030, but in the context of a sustainable transition to climate neutrality by 2050. The review considered the potential risks to Ireland's natural gas and electricity supplies and examined a

range of measures to mitigate these risks. Some of the mitigation options being considered include gas storage infrastructure, gas importation infrastructure (LNG), renewable gases, increased electricity interconnection, more batteries and increased secondary fuel storage. The review has underlined the importance of (i) completing the actions in the Climate Action Plan, (ii) greater demand side management, (iii) better annual forecasting for the electricity and gas systems and (iv) security of gas supply infrastructure, particularly in the context of electricity generation.

Ireland's 2050 Target

In line with Article 4 of the Paris Agreement and with Article 15 of the EU Regulation on the Governance of the Energy Union and Climate Action, this Strategy sets out Ireland's 2050 climate action targets and describes sector specific pathways to reaching these targets.[2]

Following a change of Government in 2020, there was a substantial increase in climate ambition set out in the 2020 Programme for Government, *Our Shared Future*, including new legislation providing for a 51% reduction in greenhouse gas emissions by 2030 and to achieve climate neutrality by no later than the end of 2050. It also set out a wide range of policies to achieve this target and affirmed the Government's commitment to place social justice at the heart of the transition to a low carbon economy.

While Ireland had prepared a draft of the Long-term Strategy on Greenhouse Gas Emissions Reduction in 2019, its submission to the European Commission was paused to ensure it aligned with new domestic climate ambition, including that which was set in Irish law in 2021 and that which is presented in Ireland's updated Climate Action Plan 2023.

Ireland's Climate Action and Low Carbon Development (Amendment) Act 2021, (the Climate Act), commenced on 7 September 2021. The Climate Act places on a statutory basis "the National Climate Objective"; that "*the State shall, so as to reduce the extent of further global warming, pursue and* ***achieve, by no later than the end of the year 2050, the transition to a climate resilient, biodiversity rich, environmentally sustainable and climate neutral economy****".* The Climate Act also provides for a 51% reduction in greenhouse gases by 2030 compared to 2018 levels, and puts in place a rigorous governance structure, including a system of carbon budgeting, sectoral emissions ceilings, a national adaptation

[2] (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018

framework, sectoral adaptation plans, and annually updated Climate Action Plans, to ensure that Ireland achieves its national, EU and international climate commitments in the near- and long-term.

Reaching climate neutrality will mean that Ireland will have no further negative impacts on the climate system by mid-century. This represents an extremely ambitious target for Ireland to meet over the next three decades, but one which is in line with the scale and severity of climate breakdown facing the international community and which underscores Ireland's commitment to showing leadership on climate action.

Public Consultation

A public consultation was held, in line with Regulation (EU) 2018/1999, to seek views from industry, stakeholders and members of the public as part of the development of Ireland's Long-term Strategy. Respondents were asked to consider 26 questions on key areas to be addressed in the Long-term Strategy around the potential decarbonisation pathway options available to Ireland to mid-century, including in relation to the energy system, sector specific considerations, and ensuring a Just Transition.

In total, 409 submissions were received from a wide range of stakeholders, including members of the public, commercial organisations and industry groups, public bodies, and NGOs. Of these responses, 279 were from members of the public, 60 were from commercial organisations and industry groups, 16 were from public bodies, 33 were from NGOs and the remaining 21 were from Colleges and Universities.

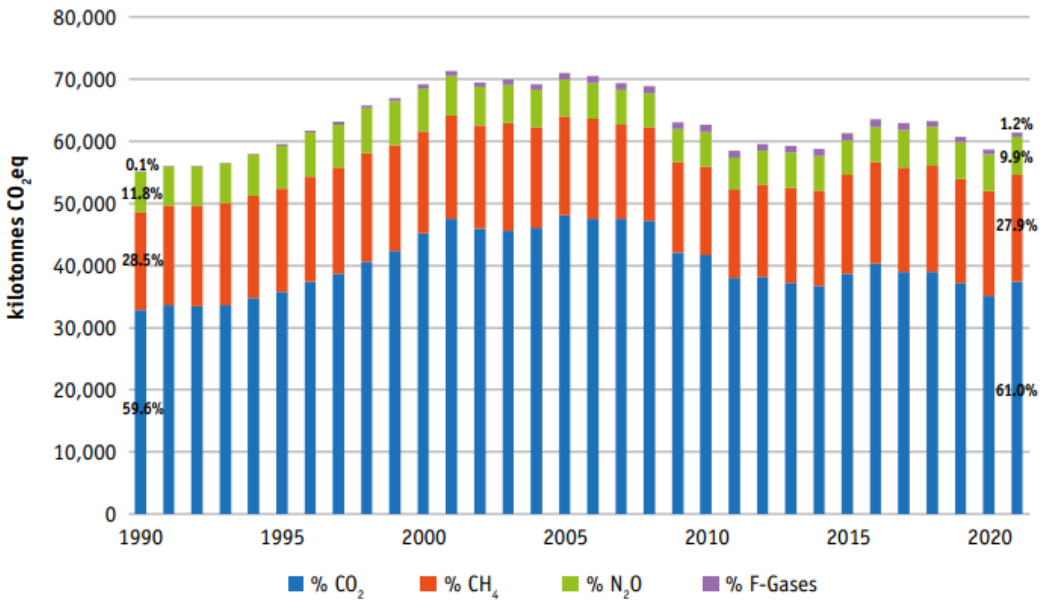
The submissions received through this consultation informed the development of this Long-term Strategy.

2. Policy to Date and Expected Impact of Planned Policies

Trends in Ireland's Emissions to Date

Ireland's greenhouse gas emissions have undergone considerable shift in the three decades since 1990.[3] According to the Environmental Protection Agency (EPA) inventory data, the rate of emissions reduction was modest up to 2008, with efforts to decarbonise constrained by strong economic activity. Since 2011, emissions have trended upwards again with an overall peak in emissions reported in 2018 – see Figure 2.1 below. The decline in emissions in 2020 was driven by the Covid-19 impact on transport and less peat used for electricity generation. This is seen to have been a temporary decline counter to projected future trends, as can be seen by the provisional 2021 emissions figures. Further transformative measures will be needed to meet national climate ambitions.

Figure 2.1 – Ireland's GHG Emissions Inventories by gas 1990-2021[4]

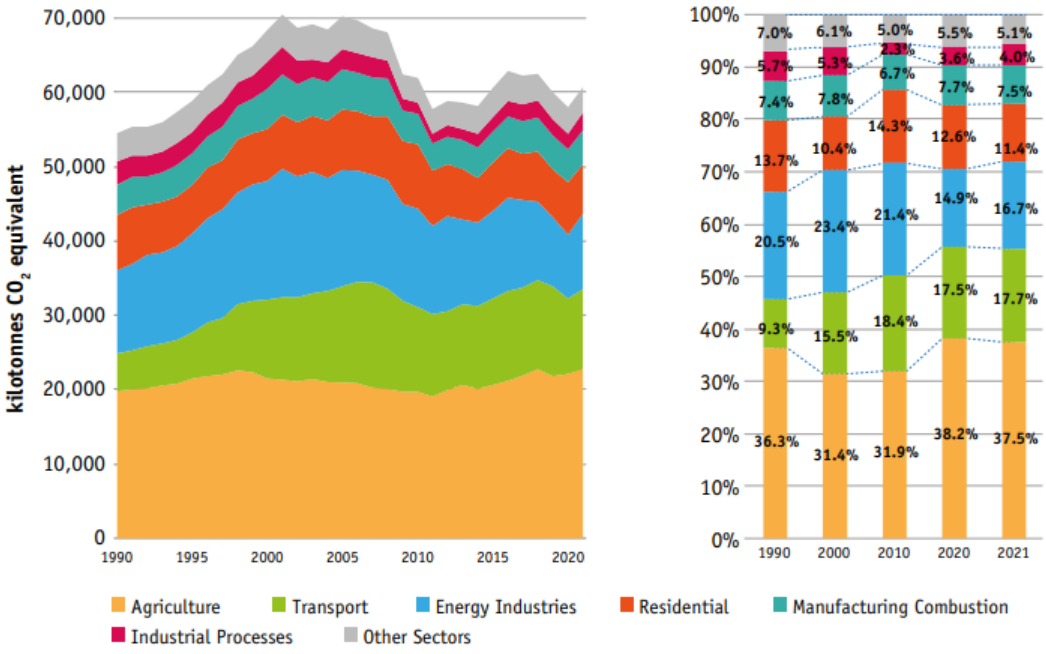


[3] Greenhouse gas emissions trends and inventories published by the EPA. See https://www.epa.ie/our-services/monitoring--assessment/climate-change/ghg/

[4] EPA (2022) Ireland's Provisional Greenhouse Gas Emissions 1990 – 2021 https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/EPA-Ireland's-Provisional-GHG-Emissions-1990-2021_July-2022v2.pdf

The profile of sectoral emissions has also changed since 1990. According to the EPA's Provisional Greenhouse Gas Emissions 1990-2021 Inventories report, Agriculture is the single largest contributor to the overall emissions at 37.5% of the total (excluding LULUCF). Transport and Energy Industries are the second and third largest contributors at 17.7% and 16.7% respectively. Residential and Manufacturing Combustion emissions account for 11.4% and 7.5% respectively. These five sectors accounted for 90.9% of national total emissions in 2021. The remainder is made up by the Industrial Processes sector at 4.0%, F-Gases at 1.2%, Commercial Services at 1.3%, Public Services at 1.1% and Waste at 1.5%. Figure 2.2 shows the trend in contributions from key sectors from 1990 to 2021, excluding LULUCF.

Figure 2.2 – EPA Trend profile of Ireland's greenhouse gas emissions for key sectors, 1990 to 2021[5]



[5] Ibid. Minor variances in figures due to rounding.

Ireland's National Climate Objective

Ireland's **National Climate Objective**, established in law by the Climate Action and Low Carbon Development (Amendment) Act 2021 (the Climate Act), is to achieve a **climate neutral economy by no later than the end of the year 2050**. The Climate Act also provides for an interim 51% reduction in emissions, relative to 2018 levels, by 2030 - in line with the European Climate Law and with the IPCC's 1.5°C pathways.

The 2030 and 2050 targets are to take account of all greenhouse gases included in the common reporting format tables submitted by the EPA to the United Nations under the UN reporting guidelines. In line with the Climate Act, Ireland's decarbonisation strategy will take account of the latest scientific advice and "the special economic and social role of agriculture", "including with regard to the distinct characteristics of biogenic methane". The Strategy is consistent with achieving net zero emissions for long-lived greenhouse gases (CO_2 and N_2O) and a significant reduction in methane emissions by 2050, thus establishing a climate neutral economy.

Ireland published an updated Climate Action Plan in 2021 and 2022, each with an accompanying Annex of Actions, to support decisive action to achieve the target of a 51% reduction in greenhouse gas emissions by 2030 and establish a pathway towards climate neutrality by no later than 2050. The 2021 Plan presented indicative ranges of emissions reductions for each sector of the economy by 2030 based on modelling and set out details of the planned policies, measures and actions to deliver these emissions reductions. The 2023 Plan presents the required policy pathways to achieving the sectoral emissions ceilings approved by the Government in July 2022.

Following publication of the Climate Action Plan in 2021, and in line with the process set out in the Climate Act, a carbon budget programme proposed by the Climate Change Advisory Council was approved by Government on 21 February 2022 and came into effect on 6 April 2022. A carbon budget determines the total amount of greenhouse gases that may be emitted in the State during a 5-year period, measured in tonnes of carbon dioxide equivalent. The programme comprises three successive carbon budgets for the periods 2021-2025, 2026-2030, and 2031-2035 (provisional). The average annual reduction proposed over the first five years is 4.8%; for the second period it is 8.3%; and for the final provisional period it is 3.5%. The first two carbon budgets in the programme provide for the 51% reduction in greenhouse gas emissions by 2030, relative to 2018 levels, while the the third is provisional and consistent with establishing a pathway to achieving climate neutrality by 2050.

Table 2.2: Ireland's legally binding carbon budget programme 2021 to 2035

	2021 – 2025 CB1	2026 – 2030 CB2	2031 – 2035 CB3 (Provisional)
	All Gases		
Carbon Budget (Mt CO2eq)	295	200	151
Annual Average Percentage Change in Emissions	-4.80%	-8.30%	-3.50%

The figures are consistent with emissions in 2018 of 68.3Mt CO_2eq reducing to 33.5Mt CO_2eq in 2030 thus allowing compliance with the 51% emissions reduction target.[6]

With Carbon Budgets set, Ireland established sectoral emissions ceilings, which were approved by Government on 28 July 2022 and apportion the economy-wide carbon budgets across the relevant sectors, determining what each sector may contribute in a given five-year period. The 2030 emissions ceilings are detailed in **Table 2.3** below. There are unallocated economy-wide savings of 5.25 MtCO_2eq. per annum for the second carbon budgetary period 2026-2030. This will require additional abatement measures to be identified ahead of the commencement of the second carbon budgetary period to ensure Ireland meets its 2030 emissions reduction target.

Moreover, finalising the ceiling for the Land-Use, Land-Use Change and Forestry (LULUCF) sector has been deferred for up to 18 months to allow for the completion of the Land-Use Review.

It is important to note that the technical classifications underpinning the EPA inventories and projections do not always align neatly with the configuration of Ministerial accountabilities and associated Departmental structures in Ireland. Thus, while a Ministerial accountability framework has been established for the sectors below, a review is to be undertaken by Q3 2023 to try to rectify such alignment issues.

[6] Based on AR5 accounting. Source: CCAC Carbon Budget Technical Report

Table 2.3 Sectoral emissions ceilings for 2030, relative to 2018

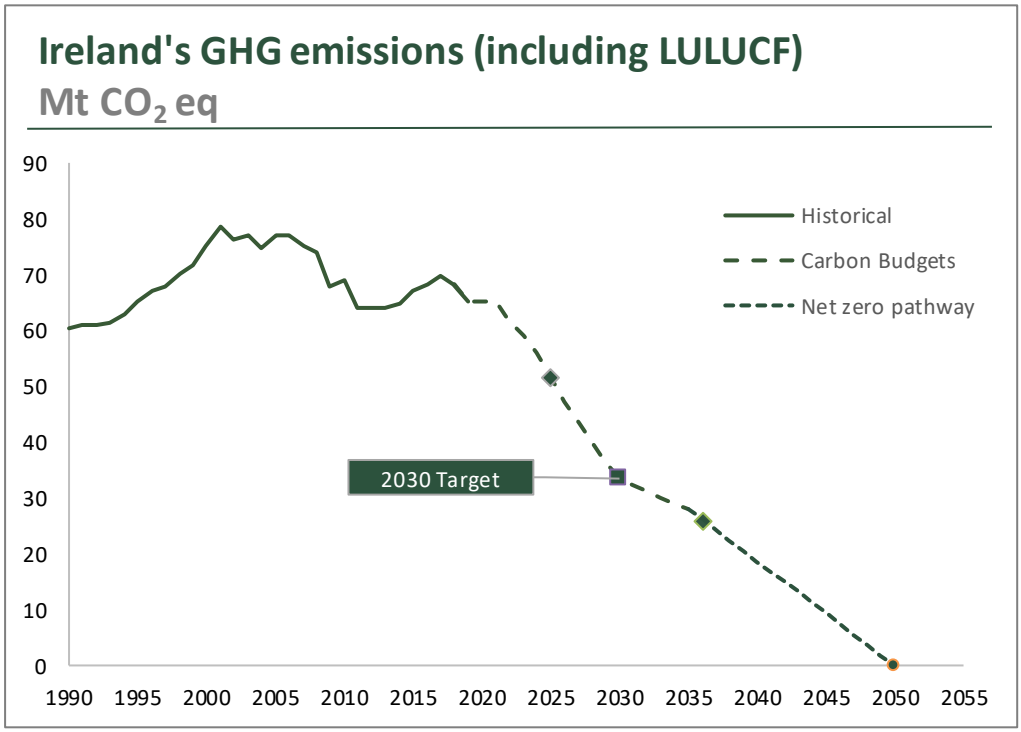
Sector	2018 emissions ($MtCO_2eq.$)	2030 target emissions ($MtCO_2eq.$)	% reduction relative to 2018
Electricity	10.5	3	75%
Transport	12	6	50%
Buildings (Commercial and Public)	2	1	45%
Buildings (Residential)	7	4	40%
Industry	7	4	35%
Agriculture	23	17.25	25%
LULUCF**	4.8	tbd	tbd
Other (F-Gases, Waste & Petroleum refining)	2	1	50%
Unallocated savings***	-	5.25	

* Figures for $MtCO_2eq$ for 2018 and 2030 have been rounded. This may lead to some discrepancies.
** Finalising the Sectoral Emissions Ceiling for the Land-Use, Land-Use Change and Forestry (LULUCF) sector will be determined following completion of a Land-Use Strategy, which is expected by Q1 2024.
*** The Sectoral Emissions Ceilings leave 5.25 $MtCO_2$ eq. in annual unallocated savings for the period 2026 to 2030 on an economy-wide basis pending the identification of additional abatement measures. There is both a policy and legal basis for this under the 2020 Programme for Government, subsequent climate action plans and the Climate Act 2021. The additional abatement measures must be identified ahead of the commencement of the second carbon budgetary period.

Climate Action Plan 2023 reflects the legally binding carbon budgets and sectoral emissions ceilings, and provides a roadmap of actions to ensure compliance. Government Ministers will be responsible for achieving the targets for their own sectoral area, with each Minister accounting for their performance towards sectoral targets and actions before an Oireachtas Committee each year.

Achieving climate neutrality in Ireland will mean that the country will have no further negative impacts on the climate system by mid-century. To reach this point, Ireland will have to achieve net zero emissions for long-lived greenhouse gases combined with a substantial reduction in methane emissions by 2050. Quick progress towards this objective, under the framework provided by the Climate Act, will allow Ireland to generate momentum around technological advancements and deployment and to prepare for increasingly challenging emissions reductions after 2030.

Figure 2.3 Ireland's required GHG emissions trajectory



3. Pathways to Climate Neutrality which Create the Least Burden and Offer the Most Opportunity for Ireland

Introduction

A key objective of this Strategy is to provide clarity on the sectoral adjustments that will be required to reach climate neutrality by 2050, to support policy stability and investment in the medium- and long-term.

By defining sector-specific targets and technology pathways to achieving them, this Strategy can increase the certainty of delivering our climate neutral target, in a manner which supports economic growth and development and ensures a just transition.

Ireland's climate action ambitions are underpinned by a robust framework that has a strong focus on implementation, including actions with specific timelines and steps needed to achieve each action, assigning clear lines of responsibility for delivery. Climate Action Plans, legally binding economy-wide carbon budgets, and sectoral emissions ceilings provide the roadmap for taking decisive action to halve Ireland's emissions by 2030 and set us on a pathway to reach climate neutrality by no later than 2050.

The exact pathways to achieving longer term sectoral targets will evolve over time, as some technologies mature and become more cost-effective in response to innovation and increased investment, or as new technologies emerge. We know with certainty, however, that reaching climate neutrality will require Ireland's carbon dioxide emissions from fossil fuel energy use in power generation, heating, industry, and transport to reduce to effectively zero. Though it is likely unavoidable that some emissions will remain from production in the agriculture sector, remaining greenhouse gases, will require balancing by sufficient levels of carbon dioxide removals to maintain an annual balance of emissions and removals from 2050 onwards.[7]

[7] In particular nitrous oxide emissions from the agriculture sector and process emissions in cement production.

Potential Pathway to Climate Neutrality

There are a range of measures which will allow Ireland to deliver the climate neutral target. However, given the timescale to 2050, there is uncertainty surrounding the availability and cost of certain technologies. Ireland's climate action framework, established by the Climate Action and Low Carbon Development (Amendment) Act 2021 (the Climate Act), allows for climate policy, including the allocation of carbon budgets, to evolve in line with developing scientific consensus and technology, subject to intense evaluation. The Climate Action Plan and Long-term Strategy will both be updated regularly in line with the latest scientific advice.

Notwithstanding this, the scale of the climate neutral challenge demands we make significant progress in the next decade, utilising all the policy tools that are currently at our disposal.

There is a high degree of certainty around many of the measures that will deliver the vast majority of required abatement. These are defined here as core and further measures:

- **Core:** technologies and measures that exist today and could deliver substantial emissions reduction. These are 'low-regret' measures that could be rolled-out immediately and at reasonable cost. These core technologies and measures are all included as part of the Climate Action Plan 2023.
- **Further**: technologies and measures that are more technically challenging, or are not yet available at scale in Ireland, but are nonetheless required to deliver the 51% target by 2030 and essential to achieve climate neutrality. These require further strategic evaluation to inform policy decisions in the coming years.

Delivering the final small percentage of emissions reductions to achieve climate neutrality will require alternative further measures around which there is a greater level of uncertainty:

- **Alternative-Further**: These are technologies which currently exist at research or pilot stage or have not reached commercial scale. These measures are required to deliver negative emissions and reach climate neutrality.

Given that these further measures are more challenging, a programme of work will need to be undertaken to refine the potential of these measures and to set relevant targets/ pathways.

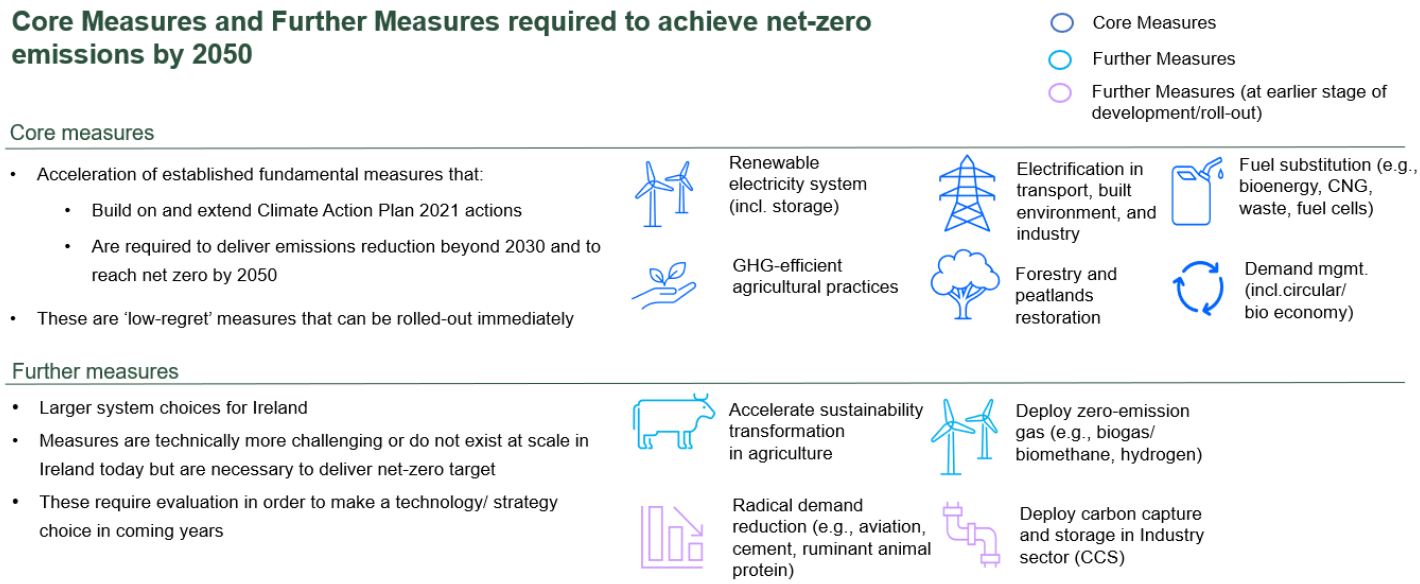
To prepare the ground for the post- 2030 period we will, over the next decade, continually assess progress of the impact of uptake of **abatement measures to be implemented under the Climate Action Plan**. We will also regularly update our analysis of the technical

abatement opportunities in each sector, refine measures which need more focus, and identify those which can potentially surpass targets. This will allow for rebalancing of efforts where necessary.

The key technologies and measures in this framework are described in **Figure 3.1**. For all categories, demand reduction, whether driven by regulation, pricing of emissions, behavioural changes or integration of circular economy approaches into specific sectors of the economy, will potentially have an important role to play, including in helping to reduce the overall cost burden of developing and deploying various technology-based solutions. By focusing on reducing consumption as a source of greenhouse gas emissions, application of circular economy principles also has the potential to contribute to emissions reductions in other countries through reducing Ireland's reliance on imports of consumer goods or raw materials.

The climate neutral pathway envisages that further measures will be required to offset any residual emissions by 2050. In this context further research will be undertaken to identify the technologies required to remove emissions across distinct sectors. This Strategy acknowledges that addressing the climate challenge will require the development of new technologies and innovative solutions to current and emerging issues. Further research will be undertaken on the technological innovation that will be required across a wide range of areas, including in the ongoing development of heat pump technology, in the development of carbon capture and storage, in sustainable farming systems and in the bioeconomy.

Figure 3.1: emissions reduction measures



Sector Abatement Ambition

Figure 3.2 summarises the sectoral technologies and measures, with indicative target levels, in the pathway required for Ireland to achieve climate neutrality. All of these will need to be implemented to deliver the sectoral emissions reductions required.

Figure 3.2: indicative pathway to climate neutrality by sector

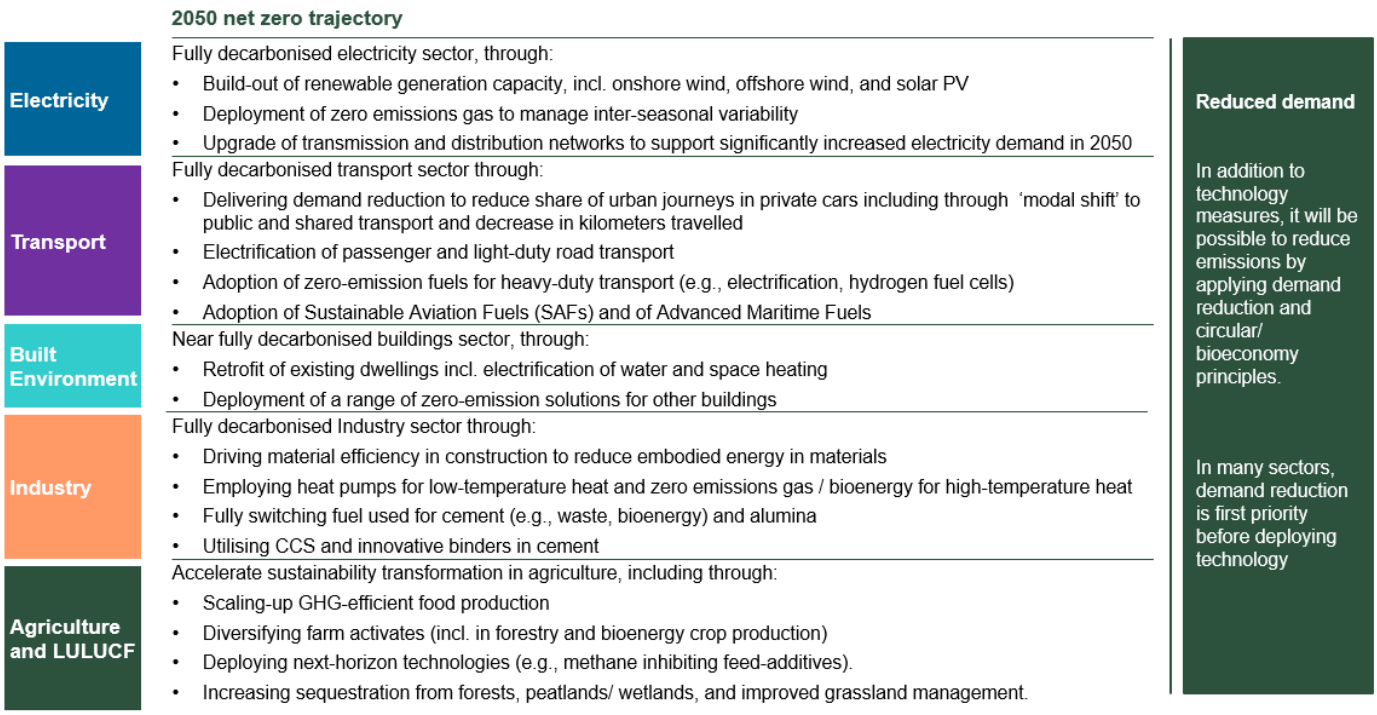


Figure 3.3 sets out an indicative timeline to 2050 for deployment of these measures. It will be essential that each sector implement relevant technologies and measures in sufficient time to realise necessary emissions reductions prior to 2050. This results in multiple implementation requirements over varying timeframes within and across different sectors and involving a wide range of stakeholders, which will need to be carefully planned and managed.

Figure 3.3: indicative pathway progress

	Estimated effort required by time horizon		
	2021-2025	**2026-2030**	**2031-2050**
Cross Sector	**Major ramp up of activity across all sectors, invest in infrastructure needed in decades to come**	**Maintain 2021-25 momentum**	**Achieve net-zero emissions through further decarbonization and offsetting**
Electricity	Build-out of renewable electricity generation: achieve ~50% renewable share of generation	Maintain 2021-25 momentum: achieve ~80% renewable generation	Achieve a zero emissions system by 2050
Transport	Significantly increase electric share of new vehicle registrations to by 2025 Roll out EV charging infrastructure	Deliver significant modal shift to active or public transport Convert 100% of new vehicle registrations to electric by 2030	Drive further demand reduction for vehicle kilometers travelled Transition to sustainable aviation and maritime fuels
Built Environment	Phase out installation of fossil fuel boilers Build capacity to retrofit homes Establish district heating networks to deliver up to 1.6TWh by 2025	Maintain momentum on retrofitting homes Maintain momentum on district heating networks, to deliver up to 2.7 TWh by 2030	Maintain momentum on retrofit rates
Industry	Roll out electric or other low-carbon heating solutions Further regulate F-gas emissions	Maintain momentum on low carbon heating solutions Drive reduction in embodied carbon in construction materials	Roll out CCS in hard to abate industry sectors Pursue deep electrification in heating
Agriculture and LULUCF	Increase uptake of GHG agricultural practices Diversify farm incomes Build capacity to plant forestry: plant 28kha by 2025 Rehabilitate 33kha of peatlands	Incorporate new technologies e.g., feed additives Diversify farm incomes Maintain 2021-25 momentum, increase pace to counter any missed targets early in the decade	Pursue deep decarbonization e.g., incorporating feed additives, driving demand shift, adopting tech. solutions Continue to deploy interventions across soil, peatlands, and forests to sequester carbon and help offset difficult to decarbonize sectors

Unallocated Savings

This plan recognises that it is not yet possible to identify all the emerging technologies or policies required to meet our full ambition. The pathway to climate neutrality outlined in this Strategy includes unallocated emissions abatement in the range of 5.20 $MtCO_2eq$. The manner in which these residual emissions are addressed will be determined in future iterations of the Long-term strategy (to be updated not less than once every five years), based on ongoing evaluation in line with evolving scientific consensus and technological developments.

Some potential options to close the unallocated emissions savings gap include:

- **Increasing the ambition of existing measures**: the targets for specific measures set as part of this plan could be revisited to understand if a further increase in ambition for these is possible given evolution of technologies or behavioural shifts.
- **Development and implementation of targeted demand management measures:** these are measures which would encourage people to do less of certain emissions-intensive activities and/or switch to alternative options.
- **Emerging technologies:** these measures would require implementation of new and emerging technologies in Ireland. Further research on the operational and implementation feasibility of these technologies, as well as their emissions abatement potential needs to be conducted.

  The price per tonne of CO_2eq. is predicted to increase significantly out to 2050. As we move towards climate neutrality the very high residual carbon price of emissions will further incentivise rapid abatement and provide a more favourable economic environment for the uptake of these emerging technologies.

4. Costs, Benefits and Opportunities of Climate Neutrality for Ireland

Investment Needed

Investment to 2030

Reducing our greenhouse gas emissions by 51% by 2030 must influence both public and private investment choices over the next decade.

Modelling completed in support of Climate Action Plan 2021, which paves the way for achieving the 2030 target, indicates that delivery of the Plan could require a total investment of ~€125 billion, including ~€45 billion additional investment compared to a baseline of no climate action at all and a further ~€80 billion of reallocated funds (public and private) that could otherwise be invested in incumbent technologies. Annualising the total societal expenditure figure suggests that delivery of the Climate Action Plan 2021 could require a total of €14 billion per annum, on average, over the ten years 2021 to 2030.

It is not possible to predict exactly how the next decade will unfold. The pace of individual, technological, scientific, societal and economic change will not be precisely in line with our assumptions today. We will, therefore, update the Climate Action Plan annually in line with the Climate Action and Low Carbon Development (Amendment) Act 2021 and following consultation with key stakeholders. These updates will be informed by the latest analyses and by our performance against targets. The estimates for required investment will continue to be updated as the plan evolves over time.

The National Planning Framework and the National Development Plan 2021-2030 combine to form Project Ireland 2040. Project Ireland 2040 is the government's long-term overarching strategy to make Ireland a better country for all and to build a more resilient and sustainable future. The National Planning Framework sets the vision and strategy for the development of our country to 2040 and the National Development Plan provides the enabling investment to implement that strategy.

The revised National Development Plan, published in October 2021, will underpin public investment in climate action over the next decade. The National Development Plan sets out a ten-year capital expenditure framework that will support our transition to a low-carbon society over the period to 2030. The revised Plan incorporates an investment package of

€165 billion across all sectors of the economy. This will bring public investment to 5 per cent of modified GNI (GNI*), well above the recent EU average of 3 per cent of GDP. Extensive efforts have been made to ensure that the Plan will support the Government's climate ambitions. The investment it will support is necessary to meet our climate ambition, in areas such as renewable electricity generation, retrofit and public transport. The revised National Development Plan was, for the first time, informed by a climate and environmental assessment of the impact that each proposed measure was likely to have on seven specific climate and environmental outcomes:

- Climate mitigation
- Climate adaptation
- Water quality
- Air quality
- Waste and the circular economy
- Nature and biodiversity
- Just transition

The approach to this assessment will be refined further, based on international best practice, and supplements appraisal and evaluation under the Public Spending Code.

Ireland's National Recovery and Resilience Plan (NRRP) - prepared under the European Commission Recovery and Resilience Facility to mitigate the immense economic and social impacts of the coronavirus pandemic - prioritises a sustainable, equitable, green and digital recovery, in a manner that complements and supports the government's broader climate ambition. The National Recovery and Resilience Plan commits to investment of a total value of just under €1 billion, to be supported both by grants from the Recovery and Resilience Facility and national funds. The Plan aims to significantly reform and direct relevant funding towards decarbonising projects such as retrofitting, ecosystem resilience and regeneration, climate mitigation and adaptation, and green data systems. "Advancing the Green Transition" is the first of three priority components of the Plan; €518 million of funding is committed to investment in seven specific projects to advance the green transition.

The four Project Ireland 2040 funds, comprising the Climate Action Fund; Disruptive Technologies Innovation Fund; the Urban Regeneration and Development Fund; and the Rural Regeneration and Development Fund, will have a collective budget amounting to an estimated €4 billion to 2027. Each of the four funds will continue to promote investments for climate action within the scope of their mandates.

The Climate Action Fund will continue to fund initiatives that contribute to the achievement of Ireland's climate and energy targets in a cost-effective manner. It offers the potential for innovative interventions in these sectors which, in the absence of support from the fund, would not otherwise be developed. Seven projects spanning the electricity, heat, transport, and agriculture sectors, with both an urban and rural focus, were approved for funding of up to €77 million under the first call from this fund in 2018. By requiring a minimum contribution from each project, the fund's commitment will leverage a total investment of over €300 million. Another call for proposals under the Climate Action Fund is being planned.

It should be noted that reliance solely on Exchequer expenditure schemes is neither affordable nor adequate to the scale of the challenge to be addressed. Government recognises that climate action will require a targeted balance between Exchequer-supported expenditure, and taxation policies and regulation. Private investment will be needed to work alongside public funding to achieve our targets. In certain cases, taxation policy may have a stronger role to play in changing individual or business behaviour. In addition, the financial cost and resulting benefits will be evaluated in accordance with the Public Spending Code as policies are put in place to support the delivery of Ireland's climate targets.

Investment to 2050

Transitioning to a climate neutral economy and achieving the required level of emissions reduction is estimated to require a cumulative investment of €200 - €250 billion from 2030 to 2050.

Households and enterprises will be responsible for the vast majority of these investments and the extent of Government expenditure will depend on the nature of the policy choices to be taken to support the uptake of the technologies identified. To stimulate the required investment, the Government will, however, need to provide clear, long-term signals to provide the appropriate regulatory and policy framework, to ensure capital is directed to sustainable investments and to avoid the emergence of stranded assets. The implementation of the EU's sustainable finance framework is seen as an important part in unlocking financing for low carbon technologies. Finance initiatives to provide for climate and environmental projects are likely to be necessary in some areas of the economy and in particular as a means to unlock the benefits of energy efficiency.

Whilst the investment requirements are high, and short-run disruptions in certain sectors of the economy will be unavoidable, the transition to a climate neutral economy is projected to

be a core driver of economic development over the next three decades and will help to reduce the overall operating expenditure requirements of the economy, creating a net cost-benefit. Reaching climate neutrality is expected to have an overall net positive effect on the economy, through increased incremental investment, additional consumer spending, and reduced imports of fossil fuels. However, it is important that climate policy and investment, throughout this transition, is managed in a manner which supports Ireland's international competitiveness and protects economic growth.

Measures to Deliver Targets

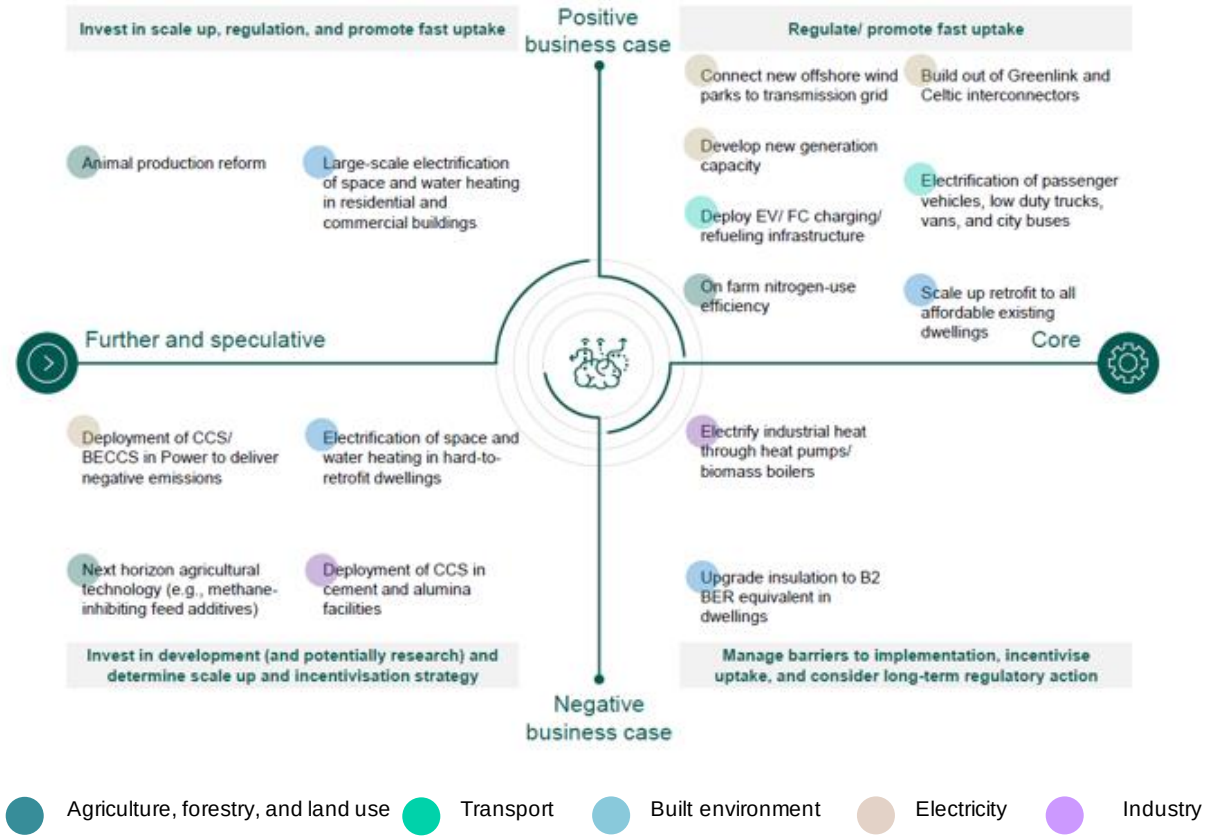
Progress in transforming Ireland's economy towards circular economy principles, as well as the extent to which behavioural changes will drive emissions reductions, also have the potential to reduce the need for additional investment. Potential reductions in health expenditure due to reduced air pollution in fossil fuel consumption, industrial processes, agriculture and waste are also expected to lead to savings in the economy.

A significant number of the technologies required to reach climate neutrality are expected to have positive business cases over the investment timeframe. These will require a combination of sustained investment and planning for clear regulation to promote deployment at scale.

Another group of technologies currently have a negative business case outlook. Irish industries and businesses that will need to install expensive low carbon technologies will face significant costs and challenges; it will be essential for the State to provide the necessary frameworks and assistance to support these enterprises and to ensure that they can remain competitive vis-à-vis their international competitors. For those technologies which are already proven, the challenge will be to carefully manage and address barriers to implementation through an appropriate mix of incentivising uptake and regulatory approaches. For further or speculative technologies, investment in research, development and deployment, including in cooperation with EU and international funding partners, will be required.

The different approaches required for core, further and speculative technologies and for those with positive and negative business cases are set out in **Figure 4.1** below.

Figure 4.1: technology business case map and policy implications



Socio-economic aspects

Achieving climate neutrality will require significant change across Ireland's economy, directly affecting citizens, communities, and businesses throughout the country. It will entail a significant shift, not only in the composition of employment in the economy, but also in employment structures and practices.

Some economic sectors may face a need to reduce employment, while others could require a larger workforce. The green economy, including the retrofitting sector, the circular economy, clean mobility, green and blue infrastructure, sustainable agriculture and the bio-economy will create new, local, high quality employment opportunities and will be a source of significant employment growth over the coming decades. This will have geographic, economic and capability-based implications for Ireland's workforce. At the same time, the ongoing transformation of the economy through information and communication technologies will help to facilitate the transition to a climate neutral economy.

The Climate Action Plan 2021 has identified the need to plan appropriately to ensure that those most affected by our transition to a low-carbon, climate resilient society are supported and equipped to contribute to this transition. It also recognises that the level of change required to decarbonise Ireland's economy cannot be avoided nor can the taxpayer compensate for all the actions which will have to be taken.

Through the overall framework provided by the Climate Act, we will consider on an ongoing basis, *inter alia*, the potential distributional effects of climate action and how they might impact a just transition, and what the policy implications may be to ensure meaningful and sustainable change.

Benefits of Action

Successfully transitioning to a decarbonised economy will not only have direct emissions abatement benefits, but will also facilitate further co-benefits within Ireland's economy, society and beyond

Enhanced economic opportunities: Given Ireland's legally binding climate ambition, enhanced climate action framework and the leadership that Ireland is seeking to continue to develop, there is a significant opportunity to tap into rapidly growing domestic and international markets for zero carbon, green economy services, driven also by big ongoing shifts in citizen and consumer expectations of enterprises.

For example, Ireland could reap economic benefits from the development and export of offshore wind and from the deployment of innovative business models in areas such as building retrofits. Ireland's economy will also stand to benefit from a reduction in expenditure on imported fossil fuels. In 2021, Ireland imported 77% of its energy supply, up from 72% in 2020[8]. This is particularly significant in the current environment, which has seen increasing market volatility and considerable inflation in the price of fossil fuels internationally.

Improved health outcomes: There will be direct positive impact to the health of citizens, through the facilitation of more active transport modes such as cycling and walking, and

[8] SEAI 2021 Interim National Energy Balance (National Energy Balance | Key Publications | SEAI).

reductions in harmful air emissions from transport and agriculture in particular, leading to a direct positive impact on the delivery and cost of health services in Ireland.

Enhanced living conditions: Fully decarbonising Ireland's housing stock will see more significant improvements in terms of housing comfort: not only will zero carbon homes reduce the risk of temperature related deaths, but it can also contribute to improved health outcomes through improved indoor air quality and reductions in moisture-related issues.

Risks of Inaction

In addition to the already predicted climate impacts for Ireland, outlined in detail in the chapter on Adaptation, Ireland faces further transition risks if action is not properly taken to fully decarbonise our economy by 2050:

Financial: Ireland could face rapidly increasing annual compliance costs if we do not take early action to meet our 2030 targets, which are set to increase as a result of more ambitious EU targets set out in the European Climate Law and the associated Fit for 55 package of proposals. Given the deeper annual emissions reductions for the 2030 to 2050 period, Ireland will need to act to avoid significant compliance-related costs, which could otherwise be used for productive investment within our economy to support citizens, communities and businesses in the transition to a climate neutral economy.

Technological: This Strategy sets out economy-wide pathways to transitioning to a climate neutral economy. These pathways comprise a mix of existing technologies; emerging technologies which do not yet exist at scale in Ireland; and speculative technologies which exist mostly at research/pilot stage or face significant challenges relating to their commercial viability. This Strategy should therefore be seen as a necessary framework to guide the prioritisation of investments in research development and deployment, and the development of appropriate policy and regulatory frameworks, to support both the wider deployment of emerging technologies and the maturation of speculative technologies, in the context of continual evolution in the feasibility and costs of decarbonisation technologies.

Market expectations and international reputation: Failure to take action towards achieving climate neutrality could lead to negative consequences for Ireland's economy overall and within specific sectors. Ireland's Foreign Direct Investment model and export-oriented economy relies heavily on our international reputation as an open, well-regulated

member of the European Union. As the international community takes increasingly ambitious action towards meeting the goals of the Paris Agreement, with the robustness of such ambitions increasingly expected to feature in trade and other international agreements, Ireland will need to be aligned with the most ambitious countries on climate action to ensure that its FDI model and export economy remains robust into the future.

5. Citizen Engagement, Community Leadership and Just Transition

Just Transition

Achieving climate neutrality by 2050 will require a transformational level of change across the economy and across society. While we must all act together towards this objective, it is clear that the costs of climate action will be felt more acutely by some than by others. Climate policy must seek to protect the most vulnerable and ensure that the costs, and benefits, of this transition are shared equitably.

. The Climate Act acknowledges '*the requirement for a just transition to a climate neutral economy which endeavours, in so far as is practicable, to— (i) maximise employment opportunities, and (ii) support persons and communities that may be negatively affected by the transition' and* the Climate Action Plan places a just transition at its core and provides the supporting policy framework.

Climate Action Plan 2023 re-affirms **four principles** that will guide our policy making and implementation over the coming years to ensure that we can effectively monitor and manage our transition and that our responses remain flexible so that we can respond to future transition challenges and target the areas in need of support:

1. An **integrated, structured, and evidence-based approach** to identify and plan our response to just transition requirements

2. People are **equipped with the right skills to be able to participate in and benefit from** the future climate neutral economy

3. The **costs are shared so that the impact is equitable** and existing inequalities are not exacerbated

4. **Social dialogue to ensure impacted citizens and communities are empowered and are core** to the transition process

All instruments, policies and regulations deployed in the delivery of our climate policy will need to align with these four principles, and ensure they are taken into account in their design and implementation.

A just transition requires a framework to structure how Ireland's economy and society will transition to a low carbon future. Important elements of this are already in place in Ireland. Strong climate governance and progressive policies contained in the Climate Action Plan are enabling Ireland to respond to the challenges and opportunities ahead. Ireland's National Dialogue on Climate Action (NDCA) has just transition at its core. The National Economic and Social Council will continue to provide strategic advice, research and analytical support for a just transition. We are continuing efforts to develop an enterprise education training system that is responsive, targeted and effective, and we are committed to ensuring that our carbon taxation policies are progressive by complementing future increases with targeted increases in social welfare and other initiatives to address fuel poverty.

Ireland is already demonstrating leadership in a just transition by explicitly recognising and aligning it with our climate policy framework the establishment of a range of financial supports for the Midlands region in its transition away from peat harvesting for power generation.

A just transition framework for Ireland in the long-term will be about ensuring that we effectively monitor and manage our transition through the structures and responses already in place and planned, that our responses remain flexible so that we can respond to future transition challenges, and that we target the areas in need of support.

Citizen Engagement

Given both the importance of achieving our 2050 targets and the level of transformation that will be required to do so, it is essential that we directly involve citizens and communities in contributing to climate action. Genuine and substantive citizen engagement is necessary to improve climate literacy, increase policy buy-in, and effect behavioural change. Citizens must be engaged with as members of the public, but also as active participants that can instigate positive behavioural change in their businesses, organisations, or places of employment.

The NDCA is the primary vehicle through which systematic and active engagement with stakeholders and the public across Ireland at local and national level will take place as we move forward.

The purpose of the NDCA is to create a comprehensive structure to support widespread public and stakeholder engagement on climate change, empower people across all of society to adopt more sustainable behaviours, and be a vehicle to facilitate public participation in national climate policy.

The NDCA aims to achieve three key objectives

1. Improve climate literacy by creating awareness and promoting understanding of climate change

2. Fund, support, and enable active engagement in climate action at a local and national level, conduct public consultations, and promote self-efficacy by empowering the public to adopt more sustainable behaviours

3. Capture insights from engagement activities and conduct social and behavioural research to measure behavioural change and provide an evidence base to inform the Climate Action Plan and sectoral climate policies

The vision, purpose and objectives above will be delivered through a systematic and cyclical process that runs, on an annual basis, in parallel with the annual review of the Climate Action Plan. This approach ensures that activities from inputs to outputs are linked, and that the impacts of these activities are measured as outcomes.

6. Carbon Pricing and Cross-cutting Policies

While the evaluation of different technologies, carried out in support of the development of this Strategy and of the Climate Action Plan, has provided a pathway to achieving a 51% reduction in greenhouse gas (GHG) emissions by 2030, the successful deployment of these technologies will require specific policies to remove barriers at the sectoral level. Government policies on taxation, expenditure, sustainable finance, spatial planning, and research and development provide an important enabling framework for individual, household, community, and company-level climate action. These policies also act as enablers for a wide range of other government policies and activities within individual sectors.

The sectoral pathways outlined in this Strategy point to a number of cross-sectoral challenges which will need to be addressed over the coming decade through the Climate Action Plan:

Provide certainty on transition to decarbonised technologies: citizens, communities and businesses need time to prepare and plan for necessary transition to low-carbon alternatives. Decisions to regulate certain technologies out of everyday use, e.g., in relation to fossil fuel boilers, can have significant impacts on markets and on household or enterprise investment behaviour. Clear signalling of policy direction, including just transition principles, with sufficient lead-in times for any changes will therefore be essential.

Environmental Taxation and Carbon Pricing: taxation policy can play a central role in incentivising the behavioural change necessary to reduce our GHG emissions and to support additional environmental benefits. Ireland has had a broadly-based carbon tax in place since 2010, with legislation in place to increase the annual rate until at least 2030. Carbon tax income supports Government programmes, such as the National Residential Retrofit Plan, that play a vital part in the decarbonisation of society. We are committed to further developing a taxation framework, which plays its full part in incentivising, along with other available policy levers, the necessary actions to reduce our emissions.

Align the financial system to decarbonisation ambition: achieving climate neutrality implies a very significant transition for all actors in Ireland's economy. It is critical that the financial system supports this transition by moving investment away from emissions-intensive assets (and avoiding infrastructure lock-in) and by providing the finance needed to adopt the zero-emissions technologies of the future. There are several important ways that

the government can facilitate this transition. In January 2022, the ECB launched its Supervisory Climate Risk Stress test to assess how prepared banks are for dealing with financial and economic shocks stemming from climate risk. The Corporate Sustainability Reporting Directive and Sustainable Financial Disclosures Regulation will create a set of rules that will bring sustainability reporting on a par with financial reporting. Consequently, drafts of EU Sustainability Reporting Standards have been prepared that will set out how organisations can report on climate-related matters in a consistent fashion. The EU is continuing to develop a taxonomy for sustainable activities, that will provide a classification framework through which economic activities can be considered environmentally sustainability. The aim of the taxonomy is to provide certainty for investors, protect investors from greenwashing, help organisations to plan for the decarbonisation transition and shift investments to where they are most sustainable. The immediate task for the Government of Ireland is to identify the mechanisms which can be used to ensure Ireland's financial system is supported in the required transition.

Put sustainability and climate action at the centre of Planning policy: the National Planning Framework (NPF) promotes the growth and development of sustainable communities. Its objectives include supporting the compact urban growth, greater efficiency of land management and the reuse of brownfield sites in serviced areas.

Develop an integrated approach to land use which facilitates achieving climate neutrality: the imperatives of further developing a sustainable model of agricultural production, maximising the carbon sink capacity of our land use, developing our bioenergy and wider bioeconomy production supply chain, and enhancing our environmental protection and biodiversity will require a more systematic consideration of Ireland's overall land use and to ensure that these imperatives can be achieved in a complementary manner. This will require:

- further detailed research to improve our understanding of LULUCF sink profile and potential over the coming decades and to define emissions reductions measures and targets to 2050 accordingly
- defining national land requirements for bioenergy production, and consider what market mechanisms may be required to support the development of a bioenergy supply chain to support full decarbonisation of the electricity and industry sectors, including infrastructure

creation, supply ramp-up and demand creation, with the need for operational financial support and incentives

- defining a roadmap of agricultural activities in line with climate, environmental and market demands, including capturing the opportunities from market growth in the bioeconomy as well as physical changes in Ireland's climate, and realigning incentives and support mechanisms to bring about the required shifts in agricultural outputs
- ensuring that land use policies are full aligned with adaptation requirements and building Ireland's resilience to climate change
- ensuring Ireland's land use facilitates improved biodiversity through e.g., re-wetting of peatlands and re-wilding of specified habitats to promote enhanced biodiversity

Ireland has committed to completing a Land-use Review, including examining the implications of recent significant developments in our scientific knowledge of the sector's emissions for the economy-wide carbon budgets. This is expected to be completed by Q1 2024.

Develop a strategy for negative emissions technologies: to provide for the development of a coherent policy and legislative framework for the introduction of such technologies, including carbon capture and storage and direct air capture, in Ireland.

Define the future of the gas grid: zero-emissions gas will be required in a climate neutral pathway for mid-century. Decisions on the future configuration of the grid will be needed in the next number of years. This will inform investment in research and development, infrastructure requirements (e.g., hydrogen readiness), and the future of the grid, including at regional, county and urban levels.

In order for a coherent national approach to the development and supply of zero-emission and renewable gases on a cross-sectoral basis, there will need to be measures taken to ensure an economic, steady, resilient, and reliable supply. Key measures to develop a renewable gas industry over the next decade are captured across various sectoral chapters of the Climate Action Plan.

Develop a strategy on the bioeconomy: building on the existing National Policy Statement on the Bioeconomy, we will need to take further steps to facilitate innovation in order to identify the primary circular and bio-economy opportunities for Ireland to develop leadership capabilities (e.g., generation of innovative business models).

Ensure national research and innovation funding supports achievement of our climate neutral objective: sustained significant investment in research, development and innovation in Ireland, and in cooperation with EU and international research programmes, will be required over the coming decades. Research prioritisation exercises within and across sectors will need to include assessments of where Ireland is best placed to be an innovator and leader within these research, development and innovation efforts.

We are committed to introducing a transformational programme of research and development, to ensure that Ireland is at the cutting edge of scientific and technological innovation in order to meet our climate change and inter-related environment targets, spanning GHG emission mitigation; climate adaptation; water and air quality; the circular economy and waste; and nature and biodiversity. This will include developments in areas such as climate science; biodiversity science; geoscience; energy system decarbonisation; transport system transition and technologies; the bioeconomy; carbon sequestration and utilisation (including nature-based solutions); natural capital and ecosystem services; green hydrogen; marine research (including marine renewable energy, floating offshore wind turbines); and in agriculture, to improve breeding programmes; feed additives to reduce biogenic methane; agroforestry; paludiculture; nutrient management; smart and data-driven agriculture. It will equally be important to develop social, psychological and behavioural science research, to understand how to motivate more sustainable outcomes in resource utilisation, conservation, and policy buy-in.

The government launched 'Impact 2030: Ireland's Research and Innovation Strategy' in May 2022. The strategy puts research and innovation at the heart of addressing Ireland's social, economic and environmental challenges. It will ensure that the best scientific evidence and advice is available to underpin government policy and support the implementation of climate action, and to ensure that Ireland's research and innovation infrastructure progressively builds capacity and capability to support the fundamental transition that Ireland's economy will undergo over the coming decades.

7. Pathways to Climate Neutrality by Sector

7.1 Electricity

State of Play

In 2021, electricity accounted for 14.4% of Ireland's greenhouse gas (GHG) emissions. A reliable and secure supply of electricity is an essential component of a modern economy, and electricity demand is projected to increase considerably as we transition to a climate neutral economy. The carbon intensity of Ireland's electricity has reduced in the last decades from 636g CO_2 eq. per kWh in 2005 to 296g CO_2 eq. per kWh in 2020[9], largely due to a shift away from oil and coal generation and increased renewable energy. In 2021, approximately 52% of our electricity came from fossil fuel generation (gas, peat and coal).

While the current geopolitical impacts on fuel pricing poses challenges to reducing the amount of coal being used, Ireland will continue its efforts to decarbonise the electricity sector by taking advantage of its significant renewable energy resources in a way that is competitive*, cost-effective and ensures the security of our electricity supply. By doing this, we will also decrease our dependence on imported fossil fuels. As Ireland decarbonises its energy system, demand for electricity will increase and total demand for natural gas will decrease. Ireland must ensure that its decarbonisation efforts are underpinned by security, and affordability, in how we access and use our energy resources. Ireland is taking a number of steps to ensure the security of its energy system and these steps is described in more detail in Chapter 1.*

Ireland has been very successful to date in deploying renewable electricity, with 36.4 % of electricity deployed from renewable sources in 2021, with the majority of this though onshore wind generation. To date, growth in renewable energy has been supported by public policies and consumer pressure, but a shifting economic environment will likely pave the way for future success. The costs of renewable energy technologies have steadily declined globally, reflecting reductions in capital costs, increased competition as the sector has matured and improvements in scale and technology continue.

[9] SEAI: Data and Insights

However, this trend has reversed in recent years, as commodity prices and input costs have risen significantly since the beginning of 2021. The reversal of the long-term trend of decreasing costs is reflected in the higher prices of wind turbines and solar PV modules as manufacturers pass through increased equipment costs. The IEA estimated that the overall investment costs of new utility-scale PV and onshore wind plants were between 15% to 25% higher in 2022, than two years earlier. While significant in absolute terms, the increase in renewables costs have not hampered their competitiveness as prices of fossil fuels and electricity have risen at a much higher rate over the same period.[10] Ultimately, it is forecast that new-build renewables will outcompete even existing fossil fuel generation in most countries before 2030.

Accelerating the deployment of wind and solar power is a central pillar of long-term decarbonisation of the electricity system which aligns with Ireland's EU commitment's and support for the RePowerEU Plan. Deployment of renewable electricity presents challenges, as production is variable, and electricity is not easily stored as energy in a liquid or gaseous form. Therefore, Ireland will focus on a variety of actions set out in the Climate Action Plan to increase the flexibility of Ireland's electricity system. Electricity will be a key enabler in decarbonising other sectors of our economy, primarily through the increased electrification of the transport and built environment sectors.

To reach Ireland's climate neutral target, the power sector will need to deliver its own reduction in emissions and support the decarbonisation of multiple other sectors and end-uses. The electrification of transport, built environment, and certain industry uses is expected to double electricity demand by 2050, which makes it extremely challenging to continue to deliver increasing rates of renewable penetration.

Pathway to 2030

National Energy and Climate Plan

In accordance with the Governance of the Energy Union and Climate Action Regulation, Ireland submitted its draft National Energy and Climate Plan (NECP) 2021-2030to the European Commission in 2018. As Ireland was due to submit its final NECP, there was a

[10] IEA. (2022) *Renewable Energy Market Update Outlook for 2022 and 2023*.

change in Government with a more ambitious Programme for Government, and higher targets for greenhouse gas emissions. To facilitate the ongoing analysis at EU level, Ireland's submitted an updated NECP in 2020 with the caveat that it would need further revision to reflect the new ambitious targets committed to by Government. The NECP submitted took into account, *inter alia*, all planned policies and measures that were identified up to the end of 2019, which were projected to collectively deliver a 30% reduction by 2030 in non-ETS greenhouse gas emissions (from 2005 levels).

Under the new Programme for Government and the subsequent Climate Act 2021, Ireland is now committed to achieving a 51% reduction in greenhouse gas emissions by 2030 (relative to 2018 levels). Updated NECP's are due in draft form by 30 June 2023 with final versions due by 30 June 2024. Ireland will be preparing an updated NECP that reflects this higher commitment.

Sectoral Emissions Ceiling and Climate Action Plan 2023

Under the sectoral emissions ceilings agreed by the Government on 28 July 2022, the electricity sector has been set a binding carbon budget of 60 $MtCO_2$ eq. over the period from 2021 to 2030, which corresponds with a 75% reduction in greenhouse gas emissions by 2030, relative to the baseline year of 2018.[11]

Climate Action Plan 2023 provides an integrated energy strategy for achieving the ambitious emissions reductions required under the Sectoral Emissions Ceiling for Electricity. The central element of the current Plan is to deliver 80% renewable electricity generation by 2030. This will involve a dramatic reduction in fossil fuel generation, increasing renewable electricity, reinforcing the electricity grid (including greater interconnection to allow electricity to flow between Ireland and other European Countries) and putting systems in place to manage intermittent sources of power, especially from wind.

For fossil fuel generation, the Plan will complete the phase-out of coal and peat fired electricity generation. The plan recognises that it is essential that the burden borne by this transition is seen to be fair and includes a programme of measures to support a just transition.

[11]

Achieving a renewable electricity target of 80% will entail large-scale investment, including in the installation and maintenance of generation assets, and associated infrastructure and services, as well as in the development of supply chains and port infrastructure.

A key component of the Plan will be the continued roll out of regular competitive auctions for onshore and offshore renewables under the Renewable Electricity Support Scheme (RESS) to deliver our targets and ensure a steady supply pipeline of projects and efficient use of the network. The RESS invites renewable electricity projects to bid for capacity and receive a guaranteed price for the electricity they generate. It also includes community participation elements. Climate Action Plan 2023 commits to delivering at least 500 MW of renewables through local community-based projects and to supporting the deployment of at least 1000MW of new micro-generation and small scale-generation.

Further, a new Offshore Renewable Energy Development Plan (OREDP II) will be completed to quantify the offshore renewable energy potential in Ireland's maritime area. The OREDP II will also provide an evidence base for the assessment of areas suitable for deployment of offshore renewable energy.

The management of electricity demand will be a central part of our approach to achieving emissions reductions. Similarly, unlocking the flexibility of large electricity demand users will be a key challenge as the electricity system is decarbonised. Energy demand, including data centres, will be expected to operate within sectoral emissions ceilings and further signals will be required to locate demand where existing or future electricity grid is available and close to renewable energy generation. Research and development in energy storage and flexibility (such as a science challenge to industry) will be required to put Ireland on a pathway to net zero-carbon data centres.

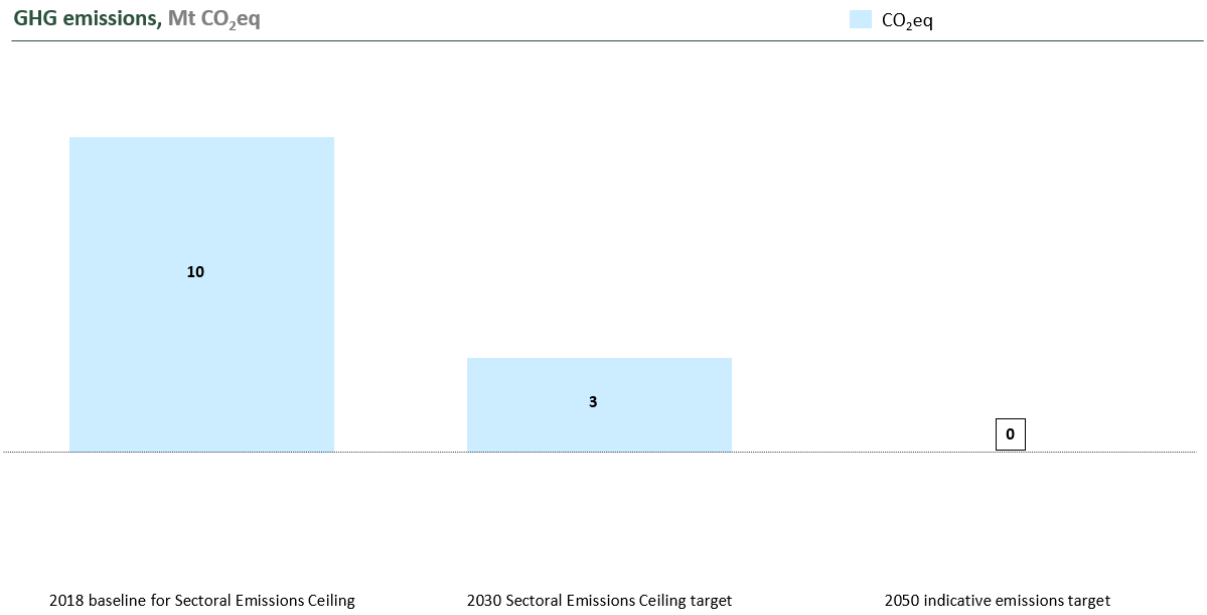
A reliable, resilient, and flexible electricity network will facilitate customer-centric solutions for citizens to become active participants in the energy system. The National Smart Metering Programme will replace over 2.4 million electricity meters by end of 2024 and smart meter customers are now able to avail of new Time of Use tariffs and smart services being made available from electricity suppliers. This, in addition to the development of green electricity tariffs to incentivise the use of electricity at times of high wind and solar generation, will be a key measure to deliver on demand innovation and will continue to play an increasingly more important role in enabling consumers to participate in the energy transition to a decarbonised system.

Pathway to Climate Neutrality by 2050

Meeting Ireland's 2050 climate neutrality target will require full decarbonisation of the power sector. In order to achieve this, Ireland will need to achieve near zero emissions from 2035.

Over the course of the next decade, Ireland's enormous potential for offshore wind will start to be realised, setting the country on a long-term trajectory for a net zero electricity system and allowing Ireland to supply renewable energy to, and offset emissions in, other European countries.

Figure 7.1.1: Annual emissions from electricity to 2050

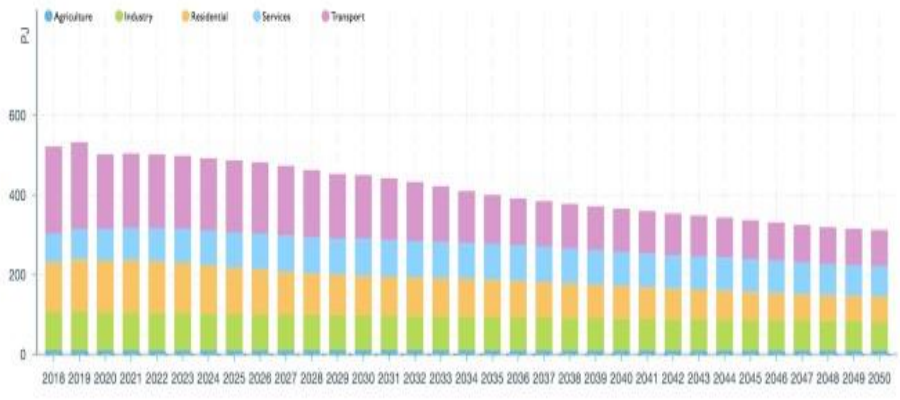


Emissions intensity of GDP

In order to reach net zero, emissions intensity must decline. The most exposed sectors will be those with high emissions intensity in their own operations; those whose products, in turn, emit while being used; or those that have high emissions embedded in their supply chains. From analysis conducted in 2019, Ireland's climate neutral pathway implies a decline in

emissions intensity by approximately 96%, from ~ 170 kgCO_2/thousand USD in 2017 to ~ 8-10 kgCO_2/thousand USD by 2050. [12]

Indicative final energy demand per sector consistent with 2030 and 2050 decarbonisation targets



This graph provides an indicative breakdown of Final Energy Demand by sector for a modelled emissions reduction pathway consistent with Irelands 2030 and 2050 targets, but not directly aligned to the recently approved sectoral emissions ceilings.

In this pathway emissions from Agriculture are reduced by 25% by 2030 (relative to 2018 levels) and emissions from energy and industry by 65% over the same period.

This pathway reflects a Low Energy Demand (LED) scenario, wherein the energy sector is modelled to meet the CAP2021 objectives through structural changes in energy service demands[1]. Broadly, this encompasses densification of settlement patterns, very significant investment in public transport and walking and cycling transport, and de - materialisation of the economy, which enables large-scale modal shifts in transport, lower heat demand in buildings and lower demands for materials such as cement.

Source: University College Cork (UCC) Times Ireland Model (TIM): https://tim-carbon-budgets-2021.netlify.app/about
1. A full outline of assumptions for the LED scenario can be found at: https://tim-carbon-budgets-2021.netlify.app/scenarios/low-energy-demand

Emission Reduction Measures and Milestones to 2050

The core measures necessary to deliver a net zero emissions electricity sector are to deliver significantly higher renewable power capacity mostly through onshore wind, offshore wind, and solar PV. To achieve the required increase in renewable electricity capacity, installation rates of wind and solar power will need to significantly accelerate. We will also need to ensure the timely modernisation and expansion of the power grid in a cost-effective way through the involvement of developers, network operators, communities and other stakeholders. This in turn requires resources and new technologies to manage the intermittency on the grid and ensure our energy supply is stable and secure.

Further measures will aim to deliver a range of flexible technologies and practices that could enable the grid to function with high levels of intermittent sources of power.

[12] McKinsey Global Institute; MACC analysis

- **Power storage:** development of a variety of long duration storage technologies to capture of energy from intermittent sources (e.g., wind/ solar) for use at a later time – with particular focus on batteries and the storage of renewable power as gas (e.g., green Hydrogen)
- **Power-to-gas:** conversion of electrical power into renewable gases that can later be distributed on an as-needed basis, enabling the balance of supply from intermittent sources and demand

Climate Action Plan 2023 sets a number of major milestones including to deliver total installed capacity of at least 5 GW of offshore wind capacity and 9 GW of onshore wind and 8GW of solar capacity by 2030. Delivering the Climate Action Plan requires upgrade and expansion of the electricity grid infrastructure to accommodate increased renewable generation as well as increased electrification of energy use (particularly in transport and built environment sectors).

As set out in CAP 23, a long-term electricity system development strategy to achieve our 2050 objective may require the following potential policies and opportunities:

- A policy to require future dispatchable generation to be zero carbon gas ready;
- The continued delivery of required levels of variable renewable electricity generation and supporting infrastructure as we electrify buildings, industry and transport;
- Zero carbon demand growth supported by an industrial spatial strategy to locate new industrial development with renewable generation opportunities;
- The continued delivery of demand flexibility, to incentivise demand when low carbon variable renewable electricity is available;
- Further policies to incentivise the construction of short and long duration storage to provide for smoothing of electricity supply and demand between times of high variable renewable production and low variable renewable production;
- Policies to ensure that zero carbon gases, like hydrogen, are utilised in the electricity sector to provide zero carbon dispatchable electricity at sufficient scale;
- Policies to support the development of inter seasonal storage of hydrogen;
- Development of further interconnectors with other European markets;
- Industrial spatial strategy to locate new industrial development with renewable generation opportunities.

Required by all sectors

The pathway outlined above will require market mechanisms that support intermittent energy sources, as well as provision of capacity and effective market signals to produce a reliable demand-side response. Furthermore, the streamlining of licensing, permitting and planning for infrastructure and providing clarity in terms of timing and administrative requirements will underpin the transition required by all sectors.

Zero-emissions gas will also be required in a climate neutral pathway in order to support the intermittency of wind and solar generation.

7.2 Industry

State of Play

As Ireland and the world aim for a climate neutral economy by 2050, the transition to low carbon has become a defining force for business. Building sustainable, low-carbon, businesses is becoming increasingly imperative, not only from a social and environmental perspective, but also from a market-competitive and financial one. Business models which are sustainable and focused on decarbonisation are crucial to long-term resilience. Equally, companies and sectors that fail to decarbonise will become increasingly uncompetitive. This has the potential to have far reaching negative impacts for the economy, including locking us into a redundant fossil-fuel based economic model. As a small open economy, we need the enterprise sector to be resilient and competitive in international markets.

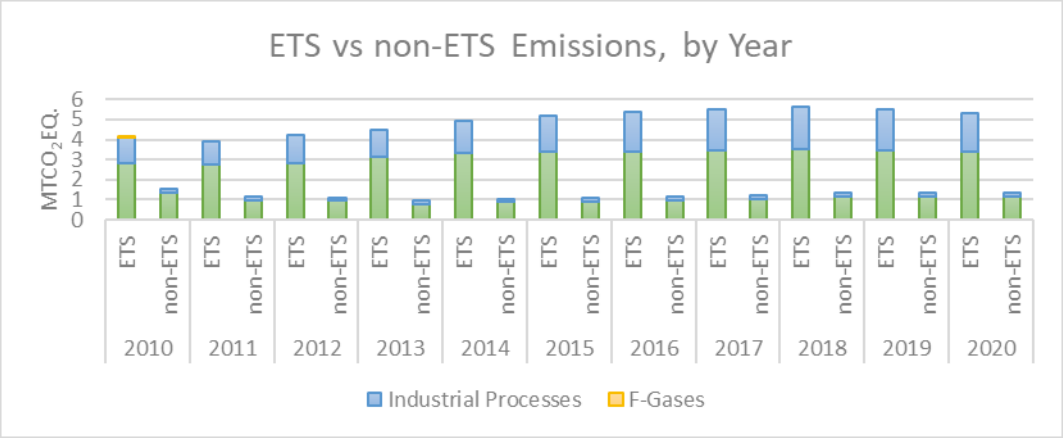
Industry will play a pivotal role in reducing our emissions by 51% by 2030, and in Ireland becoming a climate neutral and resilient economy by no later than the end of 2050. It influences the way scarce resources are managed along supply chains, from raw materials to the consumption of final products and the disposal of waste. It constructs and uses a large share of our building stock and manages significant transport flows. However, emissions from industry in the greenhouse gas inventory include only those associated with industry/production processes, i.e., manufacturing combustion, industrial processes and F-gases.

According to the Environmental Protection Agency (EPA), in 2021, industry was responsible for 10.2% of Ireland's greenhouse gas emissions, emitting ~7.1 Mt CO_2eq..The sector accounts for a smaller share of total emissions relative to other EU countries. The majority of emissions come from manufacturing, food and beverages processing, alumina production, and cement. Industry emissions are highly correlated with economic activity; emissions from the sector increased steadily between 2012 and 2018 as the recovery of the Irish economy accelerated, but remain significantly below the levels of the early 2000s. Swift implementation of Climate Action Plan measures will be important to ensure that any progress already made can be maintained and that the performance of the sector can be decoupled from greenhouse gas emissions.

A significant share of the emissions in this sector fall under the EU-wide Emissions Trading System (EU ETS). Installations which fall within the EU ETS must purchase a permit for the greenhouse gases they emit. The availability of permits reduces year on-year in order to meet an EU target of 43% emissions reduction by 2030, relative to 2005 levels.

The EU “Fit for 55” package proposes that emissions from the current EU ETS sectors (including the extension to maritime transport) be reduced by 61% by 2030, relative to 2005 levels. If agreed, this would represent an increase of 18 percentage points compared to the current -43% contribution from the EU ETS to the EU’s climate target. For enterprise to contribute to our climate objectives, and particularly for the Irish ETS sector to meet the proposed new EU ETS target, a dramatic turnaround is required from the sector’s recent trend of a 48% increase in EU ETS emissions between 2011 and 2021.

Table 7.2.1 ETS/Non-ETS emissions 2010 – 2020



Emissions from industry that fall outside the EU ETS are highly diverse, with a large proportion arising from Small and Medium Enterprises (SMEs), including those working with industrial gases (also known as fluorinated or F-Gases). These are gases with high global warming potential, which are used in refrigeration, air conditioning and semiconductor manufacturing. According to a Central Statistics Office publication in July 2022, the population of enterprises in Ireland was 278,862 in 2020, with SMEs accounting for 99.8% of the total.[13]

Pathway to 2030

Sectoral Emissions Ceiling and Climate Action Plan 2023

Under the sectoral emissions ceilings agreed by the Government on 28 July 2022, the industry sector has been set a binding carbon budget of 54 $MtCO_2$ eq. over the period from

[13] Business Demography 2020 - CSO - Central Statistics Office

2021 to 2030, which corresponds with a 35% reduction in greenhouse gas emissions by 2030, relative to the baseline year of 2018.[14]

Climate Action Plan 2021, which was prepared ahead of agreeing sectoral emissions ceilings, provides a pathway to emissions reductions for the sector (including F-gases) in the range of 29% to 41% by 2030, relative to 2018, and despite increasing production. This was further updated Climate Action Plan 2023, to align with the agreed sectoral emissions ceiling for the sector, and to update the roadmap of actions where necessary to ensure compliance.

Key measures in the Climate Action Plan 2023 include increasing the share of carbon neutral heating in total fuel demand, phasing out high-GWP F-gases, reducing embodied carbon in construction, measures to reduce energy demand reduction in industry and increasing the use of zero emission gas.

The Climate Action Plan also tasks several of the State Agencies, such as the SEAI, IDA, EI and others, with supporting industry in the transition to 2030.

In parallel to implementing the Climate Action Plan, Ireland will continue to work proactively with our EU partners, including considering the further reforms proposed under the "Fit for 55" package or supplementary measures, to ensure that the EU ETS can effectively deliver reductions in greenhouse gas emissions, while addressing the challenges faced by sectors most exposed to international competition. A strong price signal, as part of a reformed EU ETS, including progressively more restrictive rules on how many allowances will be available within the EU ETS, is expected to drive decarbonisation over the coming decade by increasing the cost to firms in the EU ETS of doing nothing to reduce their emissions.

Industry sectors outside the EU ETS will be incentivised by the general carbon price trajectory set by Government in successive budgets which is now set at €48.50 per tCO_2 and is legally required to reach €100 per tCO_2 by 2030 but will also be exposed to carbon price movements within the EU ETS in circumstances where such prices can be passed on by EU ETS sectors. As we progressively decarbonise our economy, policy must prevent a large

[14] the technical classifications underpinning the EPA inventories and projections do not always align neatly with the configuration of Ministerial accountabilities and associated Departmental structures. Here enterprise covers emissions primarily from manufacturing combustion and industrial processes. A review will be carried out to address any alignment issues.

gap emerging between carbon pricing in the EU ETS and non-EU ETS sectors to ensure an ongoing strong signalling effect for decarbonisation.

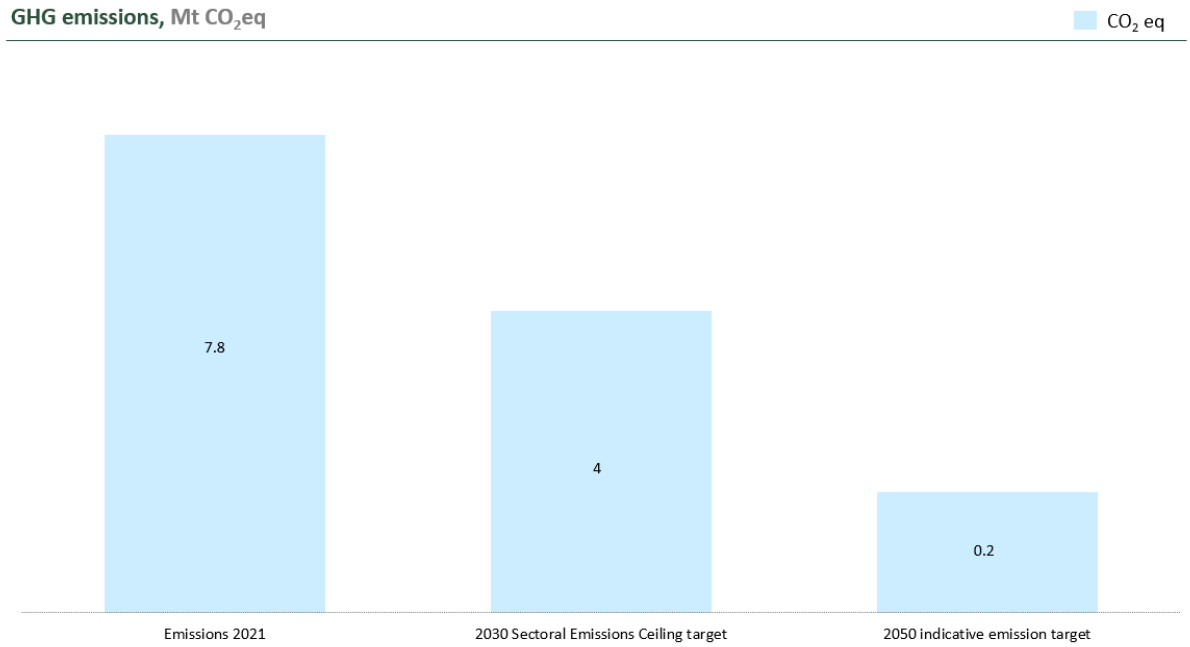
Detailed estimated trajectories for energy demand[15] up to 2030 is included in Ireland's National Energy and Climate Plan (NECP) 2021-2030, submitted to the European Commission in accordance with the Governance of the Energy Union and Climate Action Regulation. However, Ireland will be preparing an updated NECP to reflect the increased climate ambition committed to under the Programme for Government and Climate Act 2021, which is due in draft form by 30 June 2023.

Pathway to Climate Neutrality by 2050

Full decarbonisation of the industry sector poses significant challenges. There is no known way to deliver complete decarbonisation in some industry sub-sectors, such as cement. This means that the sector will need to reduce emissions as much as possible and use negative emissions to offset these remaining emissions. Delivering this pathway will require integrated action amongst industrial players, the power sector and Government.

[15] As set out under regulation (EU) 2018/1999 Annex IV subsection 2.4.2

Figure 7.2.1: Annual emissions from enterprise to 2050



Emission Reduction Measures and Milestones to 2050

The 2030 target is a steppingstone towards the ambition of achieving climate neutrality, with a relatively clear trajectory for the sector to 2050. Achieving a fully decarbonised industry sector will require; driving material efficiency in construction to reduce embodied energy in materials; employing heat pumps for low-temperature heat and zero emissions gas/ bioenergy for high-temperature heat; fully switching fuel used for cement (e.g., waste, bioenergy) and alumina, and; utilising CCS and innovative binders in cement.

Core measures to support decarbonisation are fuel substitution including alternative fuels in cement and lime, electrification of low-temperature industrial processes, and increased solid biomass use.

Further and alternative measures in industry could include zero-emissions gas (e.g., biogas/ bio-methane) and Carbon Capture and Storage (CCS) and CO_2 injection into concrete to promote calcification and rapid cure. These are particularly important for the cement and alumina sectors.

At a sectoral level, decarbonisation of cement production may require a suite of abatement levers including CCS and low-energy carbonate binders. By 2050, the cement industry could source 100% of its energy needs from waste, although this would require a secure supply of

energy-dense waste in significant volumes. Alternative opportunities may be able to offer emission reductions, such as low-energy carbonate binders, energy efficiency improvements and clinker / feedstock substitution. Each of these options presents different challenges, although the abatement cost through CCS is expected to fall as technology improves.

Climate Action Plan 2023 commits to the establishment of a framework for analysis of the potential for CCS deployment for Ireland including assessment of the environmental, technical, and financial factors and including feasibility in electricity and cement sectors.

In other industries including the food sector, the most likely decarbonisation path is to electrify low/ mid-temperature heat and to use zero-emissions gas and/ or bioenergy for high-temperature heat. As discussed above, an important short-term priority will be to define the future of zero-emissions gas, given its particular importance for high temperature heat production.

F-gases

As the enterprise sector transitions to electrification and the use of Heat Pump technologies become more prevalent, this will lead to a subsequent increase in the level of emissions from F-gases as heat pump technologies require F-gases to transfer heat and cool air from one section to another. Novel technologies will be required to phase out F-gas emissions from use in heat pumps to see a reduction in F-gas emissions as Ireland electrifies the residential, commercial, and industrial sectors.

7.3 Built Environment

State of Play

The built environment covers residential, commercial and public sector buildings and includes homes, workplaces, schools and hospitals, with 1.8 million permanently occupied dwellings in Ireland, according to the latest available census data, (a number which is expected to grow to 2.5 million by 2050) and about 136,000 non-residential buildings. The built environment sector was responsible for 8.5MtCO_2eq. of greenhouse gas emissions in 2021, which accounted for 12.3% of Ireland's overall emissions for the year. The main emissions in this sector arise from the use of fossil fuel for space and water heating, as the majority of the other end-uses (e.g., lighting, appliances) are already fully electrified.

Since 2005, Ireland has experienced some success in reducing the share of national emissions from this sector, reducing from 13% of total emissions in 2005 to 12.3% in 2021. This was achieved despite a large increase in our building stock over the same period. Notwithstanding these reductions, Ireland's emissions from buildings remain above the EU average. This is because our heating systems are largely reliant on fossil fuels, including oil fired boilers and solid fuels such as peat and coal.

Reducing our emissions in this sector means both reducing the energy demand through energy efficiency and decarbonising energy that we do use. Improving the energy efficiency of our buildings will not only reduce emissions, but also reduce our dependence on imported fossil fuels and improve our living standards, by providing buildings which are more comfortable, healthier, safer and less costly to heat. A high level of building standards will help ensure that the energy needs of new buildings are very low. For existing buildings, energy efficiency means improving the fabric of our buildings.

Pathway to 2030

Sectoral Emissions Ceiling and Climate Action Plan 2023

Under the sectoral emissions ceilings agreed by the Government on 28 July 2022, the Built Environment sector has been set a binding carbon budget of 64 MtCO_2 eq. over the period

from 2021 to 2030, which corresponds with a 44% reduction in greenhouse gas emissions by 2030, relative to the baseline year of 2018.[16]

Climate Action Plan 2023, published in December 2022, sets out the policies, measures and actions that will be necessary to achieve the required emissions reduction. Subsequent plans, which will be published annually, will develop these actions further.

To meet the required level of emissions reduction, by 2030 Ireland must significantly reduce the use of fossil fuels (coal, natural gas, oil, and peat) to heat our buildings and support an ambitious expansion in retrofit activity to underpin this reduction. This direction of travel is being further driven and supported by EU policy under the Energy Efficiency Directive, Renewable Energy Directive, the Energy Performance of Buildings Directive and REPowerEU.

Key measures for 2030 set out in CAP 2023 include: the effective phase out of the use of fossil fuels for space and water heating in all new buildings and developing the roadmap for the phase out of fossil fuels in existing buildings; the completion of the equivalent of 500,000 residential retrofits, including the installation of 400,000 heat pumps, to achieve a B2 BER/cost optimal; supporting public and commercial buildings to deliver savings of 735 Kt CO2, and; the delivery of up to 2.7 TWh of district heating. Further, the Plan commits to progressively strengthen the Building Regulations for all types of buildings, including to implement legislative changes at EU level; promote the use of lower carbon alternatives in construction, and; promote behavioural change in how households use energy.

Pathway to Climate Neutrality by 2050

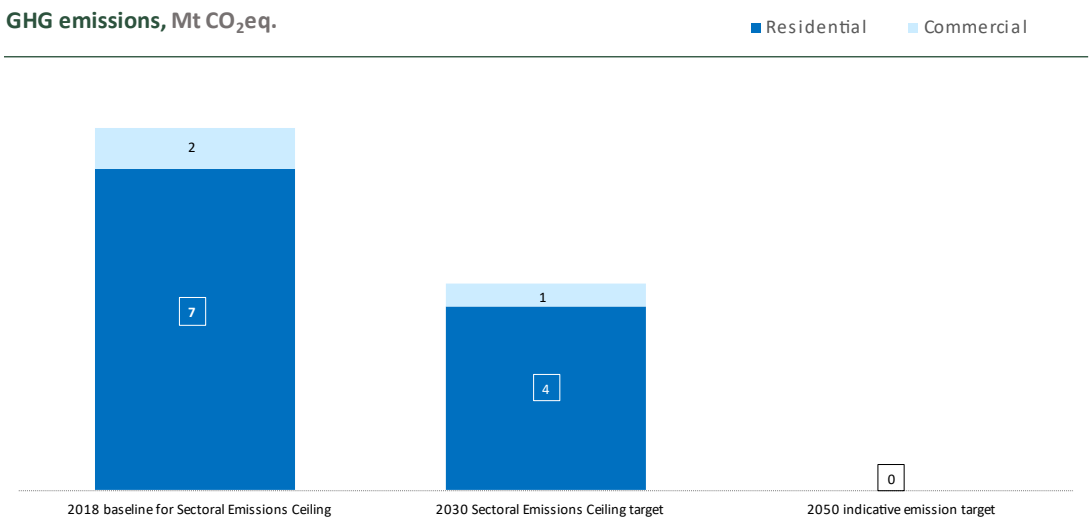
In order to meet an economy-wide target of climate neutrality by 2050, Ireland will need to decarbonise its built environment. The pathway to decarbonisation will include the continuation and expansion of the measures from the Climate Action Plan, including the retrofit of existing housing stock and electrification of heat across residential, commercial, and public buildings. All buildings will need to switch to technologies such as heat pumps or

[16] the technical classifications underpinning the EPA inventories and projections do not always align neatly with the configuration of Ministerial accountabilities and associated Departmental structures. Here built environment covers emissions primarily from residential, commercial and public sector buildings. A review will be carried out to address any alignment issues.

district heating by 2050, meaning that the gas grid will no longer supply existing homes and commercial premises.

This approach would see the sectors emissions drop to about 2.5-3 $MtCO_2eq.$ in 2040, before reaching zero in 2050.

Figure 7.3.1: Annual Emissions from Built Environment (residential and commercial[17]) to 2050



Emission Reduction Measures and Milestones to 2050

Key components of a net zero pathway in the built environment will be compact urban growth, zero energy new buildings, fabric first (retrofit) and zero emissions heating.

- **Compact urban growth:** Urban planning and compact urban growth are critical to reducing heating demand and travel distances. Densely populated areas could also facilitate the introduction of district heating networks.
- **Zero Emission new buildings:** Zero Emission Buildings (ZEB) principles will be incorporated in the design of new buildings to ensure sustainability of the growing building stock.

[17] "Commercial" includes emissions from public buildings, as per the Government decision of July 2022.

- **Fabric-first:** Retrofitting existing buildings will ensure that emissions reduction is achieved in a cost-effective and energy efficient way, while also providing significant co-benefits in terms of thermal comfort and improved health for dwellers.
- **Zero emissions heating:** Electrification and the deployment of district heating will ensure that our buildings are heated using zero emissions sources.

These measures will require continued investment to ensure the electricity grid infrastructure is ready to accommodate the transition, by upgrading and enhancing the network to enable it to support electrification of energy used in our buildings. In taking these measures, the principles within our just transition framework will guide policy decisions to support vulnerable households, and to help ensure that every group makes an appropriate and fair level of effort in the transition.

Further research and development in the decarbonisation of the built environment will be required to unlock potential emission reductions, particularly in the areas of low-cost retrofits, high temperature heat-pumps, and district heating.

The first set of milestones and decisions are:

- **Reach target scale of annual building retrofits**
  Continuing to scale up deployment of retrofit for existing dwellings with poor energy performance coupled with the roll-out of heat pumps as established under the Climate Action Plan. This will require the active support and stimulation of both demand for and supply of retrofits. For the residential sector, the National Retrofit Plan sets out Ireland's approach to meeting our retrofit targets. The Plan was guided by a number of key principles including:
    - fairness – ensuring fairness to all and supporting a just transition
    - universality – covering all housing types and consumer segments/income deciles
    - customer-centric – designing customer centric solutions to reduce the costs and hassle, making the process easier for those investing in retrofit

- **District Heating**
  SEAI's National Heat Study has identified that district heating could provide as much as 50% of building heat demand in Ireland. The Government will need to make a number of decisions relating to supports for the rollout of district heating in Ireland; the development of a regulatory framework to protect consumers and suppliers; the manner in which

national, regional and local planning frameworks encourage and facilitate the development of district heating; and financing mechanisms to support the delivery of district heating projects.

Government will develop a regulatory framework for geothermal energy and a strategy for the development of the geothermal energy sector, including as a source of heat district heating schemes. The sector will also be developed to provide a renewable source of energy for cooling buildings across all sectors, for heat storage and electricity generation.

- **Planning for the phase-out of fossil fuel heating systems**

  Ending the installation of fossil fuel heating systems in existing buildings will be a key step in our transition to zero emissions heating in our building stock. A roadmap will be developed to support this transition, setting out the required policy and regulatory instruments, to promote greater electrification of domestic heating and to accelerate the phase out of fossil fuels for heating. We will continue to drive the development of the supply chain to support the achievement of our heat pump targets so that the technology will become the default solution for householders in choosing a new heating system in the coming years.

7.4 Transport

State of Play

The transport sector includes road transport, domestic aviation and navigation, and railways. The sector has a critical role to play in national decarbonisation policy, given that it accounts for approximately 15.7% of Ireland's greenhouse gas emissions. Road transportation accounts for 94% of those emissions and gives rise to a range of air pollutants that can potentially impact both human health and the environment.

The population of Ireland is expected to reach 5.7 million by 2040 from a current estimate of 5.1 million in 2022. In parallel, over the next two decades there are projections of both employment and economic growth that may stimulate greater transport activity and demand. Without systemic and transformative changes in travel patterns, modal share, and technology, a growth in current transport activity and demand will further diminish our national competitiveness, quality of life, and decarbonisation goals.

The main challenges facing decarbonisation of the sector are:

- The universal nature of transport, i.e., that it impacts everyone in society
- In the absence of suitable alternatives to the car at a national level, a cultural mindset has been embedded over decades whereby only car ownership is associated with perceptions of freedom and convenience – this is partly a result of our settlement patterns and previous policy-making
- Communicating the significant benefits of decarbonisation – those that extend beyond carbon emission abatement – to a wide variety of societal cohorts
- How to decouple travel demand from economic growth
- How to address transport poverty while achieving decarbonisation of the sector
- Addressing the significant lead-in times associated with the delivery of major transport infrastructure and rollout of additional public transport services as attractive and compelling alternatives to private car use
- The complex nature of instituting effective governance and oversight across the range of policies and structures relevant to decarbonising the transport sector.
- The competing objectives, impacts and costs of decarbonisation as each of the other sectors strive to reduce emissions

There is an increasing pressure for the transportation sector to decarbonise, with an increased focus on the high emissions associated with some modes of transport. Public attitudes are continuing to shift in favour of living and working locally, there is increasing pressure to deliver public transport and active mobility options and business is also paying more attention to the environmental impact of their logistics within their wider supply chains.

Emissions from international aviation and from shipping remain outside national emissions targets for EU Member States and are not covered by the Paris Agreement.

Action on Non-Road Transport Activities

As a small open economy on the periphery of Europe, the aviation and maritime sectors are critical for the movement of our goods and people. Action is being taken at EU and international levels to address emissions from these sectors, including through market-based measures such as the EU ETS and sustainable fuel mandating initiatives (through ReFuel EU Aviation, Fuel EU Maritime, and the Alternative Fuel Infrastructure Regulation, which will all include binding targets once adopted).

Continued international collaboration through the International Maritime Organization and the International Civil Aviation Organization, will be key to achieving greater sustainability and preserving a level playing field in these global sectors. Ireland will support appropriate actions taken at EU and global levels to reduce emissions from the aviation and maritime sectors. Transport emissions peaked at 14.4 MtCO2eq. in 2007, falling during the economic recession to 10.9 MtCO2eq. in 2012. As the economic recovery took hold, the sector's emissions began to rise once more, illustrating a continued relationship between transport emissions and economic activity in Ireland that must be addressed. Ongoing development and implementation of the Climate Action Plan offers a pathway towards a low-emitting and sustainable transport sector. However, it is clear that to deliver an economy-wide 51% GHG emission reduction by 2030, the level of ambition and supporting actions must be based on a systematic and transformative approach to the sector. According to the Environmental Protection Agency (EPA), emissions from the Transport sector fell to 10.3 $MtCO_2eq.$ in 2020 before rebounding to 10.91 $MtCO_2eq$ in 2021 as Covid-19 restrictions were eased. Though the sector is not yet projected at a risk of failure in its ability to comply with its carbon budget, the need to substantially accelerate the implementation of Climate Action Plan measures is clear.

Pathway to 2030

Over the next decade, transportation must undergo an unprecedented transition in order to decarbonise. Key drivers for mitigation in this decade will focus on demand reduction, a shift away from the car to more sustainable modes (walking, cycling, public transport) and the continuing electrification of transport fleets.

Demand reduction coupled with sustainable and shared mobility will be delivered over time by progressing integrated transport and spatial planning as well as the necessary infrastructure and services to support a shift from car use to sustainable and accessible mobility, both at the national level and in co-operation with local authorities.

Notwithstanding the current geopolitical challenges, including global supply chain and resource scarcity, it is anticipated that battery electric passenger cars and light trucks could reach cost-parity with petrol and diesel vehicles mid-way this decade. While there has previously been a high level of uncertainty as to the likely technological pathway for decarbonising the HGV sector, there have been recent public commitments by major manufacturers (OEMs) regarding their intention to increase the availability and supply of e-trucks to the market by mid-decade. Together with the expected requirements that will be set out under the forthcoming AFIR under the EU's 'Fit for 55' legislative package that will obligate member states to provide a sufficiently dense electric charging point and alternative fuel network, it is expected that a transition to battery electric vehicles for this sector will be possible in the near future. While the sector will continue to rely mainly on diesel in the interim, there will be an increasing use of biofuels and other low emission technologies going forward.

Sectoral Emissions Ceiling and Climate Action Plan 2023

Under the sectoral emissions ceilings agreed by the Government on 28 July 2022, the Transport sector has been set a binding carbon budget of 91 $MtCO_2$ eq. over the period from 2021 to 2030, which corresponds with a 50% reduction in greenhouse gas emissions by 2030, relative to the baseline year of 2018.[18]

[18] The technical classifications underpinning the EPA inventories and projections do not always align neatly with the configuration of Ministerial accountabilities and associated Departmental structures. A review will be carried out to address any alignment issues.

Climate Action Plan 2023 will provide a pathway to 50% emissions reductions for the sector by 2030 (relative to 2018). Primary measures to deliver decarbonisation to 2030 include measures to reduce and curtail aspects of road transport demand, a strong shift to sustainable travel modes and the electrification of vehicle fleets. The challenge is not so much in setting the pathway to transport decarbonisation, but rather in delivering the requisite policy supports, investment, infrastructure and information, so that the behavioural and technological changes are understandable, easy, plausible and attractive for citizens, and that the necessary rates of change can be delivered in a just and fair manner. Nonetheless, delivery of the transport measures will be extremely challenging, as it involves significant changes to long-ingrained personal and social behaviours in the majority of the population. While a pathway has been identified, the practical delivery and success of the measures to achieve the emissions reductions targets will be difficult.

As well as continuing the technology improvements previously committed to, demand reduction with modal shift will play an important role in the development of a more sustainable transport system over the next decade. Government investment in public transport, cycling and walking infrastructure, along-side the provision of increased public transport services and shared mobility options, will help to reduce reliance on private cars and address congestion in our cities. This investment contributes to a 50% increase in daily active travel journeys and a 130% increase in daily public transport journeys by 2030.

Travel demand is expected to grow to 2030 due to population growth; thus, corrective measures will be necessary and the policy focus must be to ensure transport demand is reduced and that we are well positioned to pursue a more widespread modal shift in order to reduce the share of private car journeys arising from the public investments that we will make over the next decade.

Supporting National Plans

The Climate Action Plan2023 will support and build on several key national policy plans that are driving the necessary changes in the transport sector, including Project Ireland 2040, the National Planning Framework, Housing for all, the National Remote Work Strategy, the National Adaptation Framework, Our Rural Future - Rural Development Policy 2021-2025, and the Sustainable Mobility Policy. Other plans that will be published shortly include the national EV Charging Infrastructure Strategy and the Road Haulage Strategy 2022-2031. Finally, Climate Action Plan 2023 commits to delivering a new National Demand Management Strategy by end 2023.

Pathway to Climate Neutrality by 2050

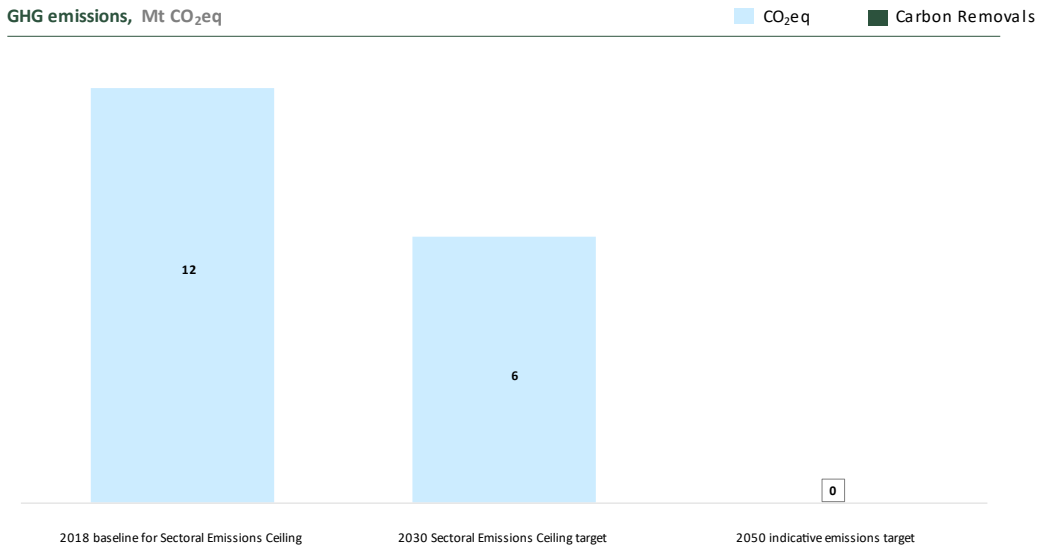
Our vision is that Ireland's transport sector will be carbon neutral by 2050. This will require coordinated action of Government, State transport agencies, Local Authorities, individuals and business, and needs to progress in tandem with technological and regulatory developments within the EU.

To achieve our emissions abatement ambition for both 2030 and for 2050, and to reduce the negative externalities associated with high levels of car dependency (both ICE and EV), transformative behavioural and systemic changes will be required in relation to reducing our demand for travel and changing how our residual travel needs are met. To achieve these changes, CAP23 identifies co-operation between the Department of Housing, Local Government and Heritage, and with the Local Authorities, as crucial for integrating climate action and transport considerations into the spatial planning system, placemaking and accessibility.

Achieving climate neutrality will require continued and significant electrification of passenger cars and commercial vehicles, including for heavy duty vehicles by 2050. It will also require deployment of alternative fuels, particularly for heavy duty and long-haul vehicles, acknowledging that the precise mix of technologies and fuels for this sector is uncertain at this point. Many of these measures are expected to be cost-beneficial before 2030 but will require adequate infrastructure to be in place for businesses and private individuals to fully take advantage of zero-emission technologies.

Radical shifts in the organisation of different modes of our transport system, driven by digitalisation, automation data sharing and interoperable standards, will take place over the next three decades. Effective regulation will be needed to ensure that technological developments maximise decarbonisation within the sector, by facilitating smart traffic management, shared mobility options, modal shift and demand management, which in turn will reduce congestion and increase occupancy rates in transport fleets, both public and private.

Figure 7.4.1: Annual Emissions from Transport to 2050



Emission Reduction Measures and Milestones to 2050

As set out below, the core technology-based measures to achieve a fully decarbonised transport system by 2050 will be the electrification of passenger cars light trucks and buses and, with a longer time lag, HGVs. This reflects the technology readiness and cost-effectiveness for these segments as well as their share of Ireland's overall transport emissions. All passenger cars could be electrified by the early 2040s, driven by economic competitiveness of battery electric vehicle (BEV) cars, and the anticipated EU wide ban of new fossil fuel-powered car sales from 2035 onwards (through the CO2 standards for cars and vans regulation). The process of electrifying the light truck and bus fleet will accelerate throughout the 2020s and early 2030s driven by light electric trucks potentially reaching cost-competitiveness before 2030. Legacy fossil fuel trucks could be substantially phased out by early 2040s in an economically optimal pathway. It will be important to put in place suitable policy and regulatory structures to support this transition and to account for potential downsides associated with the electrification of the national vehicle fleet, including for example, increased demand for batteries and cost, affordability and sustainable supply issues.

Further technology measures that will contribute to full decarbonisation of Ireland's transport system will be deployment of alternative zero carbon fuels in heavy duty and long-distance freight transport alongside electrification and the development of electrification and other zero carbon fuel alternatives for domestic aviation, navigation and railways. Synthetic or eFuels rely upon hydrogen production and additional renewable electricity, therefore in the shorter-term a contributing technology will be biofuels, in particular advanced biofuels from a wider range of waste feedstocks.

The implementation of Ireland National Planning Framework - and notably the National Strategic Objectives for Compact Growth and Sustainable Mobility - will also provide an essential underpinning to a decarbonised transport sector by 2050 by promoting high density residential development with greater urban densities, helping to reduce commuting travel distances and promoting a higher modal share for public transport and for active travel. Transport-led development will be critical to delivering the level of systemic transformation required in reversing Ireland's high level of car dependency. Widespread development of the 15-minute neighbourhood concept in major cities and urbans centres will be a key factor.

Modal shift will play a key role in decarbonisation by 2050. Our **cities** will be leaders in transport innovation due to the predominance of short-distance journeys, existing availability of public transport alternatives, air quality considerations and due to the requirement to provide for greater urban density in residential development, to ensure improved proximity to services and more viable public transport, and consequently a reduced demand for private car ownership. This will lead to large improvements in the quality of urban living in the coming decades.

Mobility in **rural areas** will see significant changes over the decades, driven by investment to provide greater accessibility of public transport alternatives to private cars as well as by digitalisation. The implementation of the National Broadband Plan, and the establishment of remote working hubs, will underpin a significant shift in commuting patterns away from journeys between rural and urban areas for employment purposes.

For **passenger cars,** an environment fostering the replacement of ICE cars after 2030 will be supported by various EV policy pathways relating to vehicles and charging infrastructure. In line with the EU regulations on alternatively fuelled infrastructure, this pathway will require significant ramping up in public charging sites (including fast motorway chargers) along with continued reliance on private / home charging by 2050. Sufficient space and an adequate grid connection should be available in the cities and along the motorways to install the public chargers. Charging policy must be designed to complement the transformation of cities to

public transport and active modes and to facilitate bi-directional EV charging to facilitate the development of commercial grid balancing services.

Heavy-duty freight and long-distance vehicles could begin to convert to zero emissions from mid-decade and throughout 2030s and 2040s. A key milestone for this segment will be the choice of technology between fossil-free hydrogen and battery electric vehicles, with a conversion pathway that will need to be compatible with that of the rest of Europe. Decisions will need to be made this decade, to enable sufficient time to develop adequate refuelling infrastructure. An appropriate regulatory framework will be developed to enable production, transportation, and storage of ammonia and green hydrogen

International aviation and shipping

As global industries, the contribution of **international aviation and shipping** to meeting the goals of the Paris Agreement requires a global response. The aviation industry has committed to achieve a 50% reduction of emissions by 2050 when compared to 2005 levels.

The International Civil Aviation Organization (ICAO), of which Ireland is a member, has developed a four pillar approach to deliver on this emissions reduction objective , focused on: market-based measures; operational improvements; sustainable aviation fuels, and; aircraft technology.

In tandem with the ICAO basket of measures, the main Irish airlines have also introduced voluntary initiatives and long-term sustainability targets, with Aer Lingus, (as part of IAG) committed to reach net zero CO_2 emissions by 2050 and Ryanair having recently announced its decarbonisation strategy – Pathway to Net Zero outlining its similar goal of net zero emissions by 2050.

Shipping accounts for approximately 2.5% of global greenhouse gas emissions. Under a business-as-usual scenario and if other sectors of the economy reduce emissions to keep the global temperature increase below 2 degrees Celsius, shipping could represent some 10% of global GHG emissions by 2050. The 2018 International Maritime Organisation (IMO) strategy on the reduction of greenhouse gas emissions from ships has the objective of reducing emissions by 50% by 2050 compared to 2008 while pursuing efforts to achieve full decarbonisation as soon as possible in this century.

The IMO strategy envisages the adoption of measures and incentives to encourage further development and use of low and zero carbon fuels in shipping, including a combination of bioenergy and renewable fuels, hydrogen and its derivatives. Research and development of

these alternatives fuels will require international collaboration requiring significant investments over the coming decades and Ireland will actively contribute to this agenda, including through a supportive research infrastructure where relevant.

The initial IMO strategy envisaged that a revised strategy would be adopted in 2023.

7.5 Agriculture, Forestry and Land Use

State of Play

Agriculture

The agri-food sector is one of Ireland's largest industries. Agriculture makes an important contribution to Ireland's society and economy. In 2021, it accounted for almost 7% of modified gross national income; 10% of exports in value terms; approximately 170,400 jobs representing 7.1% of total employment; and €15.4 billion of exports.

The historical and economic importance of agriculture relative to other industries means that the sector is the single largest contributor to overall emissions, at 33.4% in 2021, representing one third of Ireland's total greenhouse gas emissions (GHGs). Our carbon intensity per head of population in the sector, at 4.6 $MtCO_2eq.$, is substantially higher than the EU average reflecting the significant role that the agricultural sector plays in Ireland's economic make-up and the lack of heavy industry in Ireland's economic profile. While Ireland is currently an efficient producer of both milk and beef, relative to other EU member states and international competitors, Ireland's key agricultural outputs are nevertheless products with a high carbon footprint.

The Climate Act 2021 requires that Irish climate policy take account of 'special economic and social role of agriculture including with regard to the distinct characteristics of biogenic methane' It is clear, however, as laid out in Climate Action Plan 2023, that the high proportion of national emissions represented by agriculture means that for Ireland to meet its overall emissions reduction targets, along with all other sectors, the agriculture sector must make a positive contribution to combating climate change and supporting the transition to a climate resilient, biodiversity rich and climate neutral economy and society no later than 2050.Additionally, as other sectors decarbonise, the share of the agriculture contribution to the national emissions profile will increase.

Land use, Land use change, and Forestry (LULUCF)

Provisional data[19] for 2021 indicate that LULUCF in Ireland was responsible for 7.8 $MtCO_2eq$, an 11.2% share of overall GHG emissions. Across the EU-27 since 1990, the LULUCF sector has been a net sink of greenhouse gas (GHG) emissions, primarily due to extensive forest cover. In contrast, the Irish LULUCF sector has been a net source of GHG emissions in all years from 1990 to 2021. This is largely due to carbon emissions from Grasslands and Wetlands. Forests and Harvested Wood Products (HWP) have been a significant carbon sink since 1990. However, this sink is in decline. Forest cover in Ireland represents 11.6% of the total land area in comparison to the EU average of 38%. Since the foundation of the State, forest cover in Ireland has grown significantly from 1.4% of the land area to current levels but is still below the national target of 18%. Grassland and Wetlands in Ireland are considerable sources of emissions as a result of the drainage of organic soils. The land-use category Cropland fluctuates between being a small net sink in some years and a small source of emissions in others. However, all of these categories have the potential to be managed as net sinks for GHGs in the longer term.

Ireland will need to reverse this trend if it is to achieve its national climate targets. The pathways for Ireland to achieve climate neutrality will require the LULUCF sector to be developed into a net carbon sink in advance of 2050.

Pathway to 2030

Agriculture: Sectoral Emissions Ceiling and Climate Action Plan 2021

According to the Environmental Protection Agency (EPA), in 2021 agriculture emissions were 23 $MtCO_2eq$ (note that this does not include the LULUCF sector), The most significant drivers for emissions in 2021 were increased use of synthetic nitrogen fertiliser use and higher dairy cow numbers with an increase in milk production.

[19] EPA (2022) Ireland's Provisional Greenhouse Gas Emissions 1990-2021 https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-provisional-greenhouse-gas-emissions-1990-2021.php. Provisional data for the LULUCF sector are based on projections and are subject to revision when final data are submitted to the EU and UN in 2023.

Under the sectoral emissions ceilings agreed by the Government on 28 July 2022, the Agriculture sector has been set a binding carbon budget of 202 $MtCO_2$ eq. over the period from 2021 to 2030, which corresponds with a 25% reduction in greenhouse gas emissions by 2030, relative to the baseline year of 2018.[20]

Full implementation of the Climate Action Plan 2023 will deliver an emissions reduction from 23 Mt CO_2eq. in 2018 to 17.25 Mt CO_2eq. in 2030, in line with a 25% reduction. This will be further updated under the next annual Climate Action Plan, due to be published by the end of 2022, to align with the agreed sectoral emissions ceiling for the sector, and to update the roadmap of actions where necessary to ensure compliance.

Key measures included in the Climate Action Plan 2023 to reduce on-farm emissions include a significant reduction in nitrous oxide emissions by changing farm management practices in relation to nutrient use improved GHG efficiencies from breeding, feed modification and earlier finishing age for cattle, an increase in the proportion of organic farming, and with the waste sector providing feedstocks for the production of indigenous sustainably produced biomethane.

Additional measures required to achieve the 2030 target include enabling a carbon farming framework and exploring the potential for methane reducing feed additives for pasture-based solutions and by incentivising diversification across the sector. The Government is undertaking a comprehensive national Land Use Review, covering farmland, forests and peatlands, with the aim of ensuring that policy decisions are suitably informed by optimal land use strategies. The Government will also carry out diversification reviews for income and land use for farmers, including areas such biomethane and energy production, agro-forestry and woodland creation.

The Common Agricultural Policy Strategic Plan (CSP) for 2023 – 2027 will be an important delivery mechanism to achieve our climate ambition. The environmental and climate ambition within the CSP will be aligned to the Common Agricultural Policy's new 'green architecture'. This will operate across both pillars of Common Agricultural Policy expenditure to achieve a coherent overall approach. While the CSP has a key role to play in driving the

[20] the technical classifications underpinning the EPA inventories and projections do not always align neatly with the configuration of Ministerial accountabilities and associated Departmental structures. A review will be carried out to address any alignment issues.

decarbonisation of the Agriculture sector, a whole-of-government, and whole-of-industry, approach will be needed [alongside the CSP] to achieve our overall climate objectives.

Land use, Land use change, and Forestry (LULUCF)

Ireland's LULUCF sector is currently a net source of emissions, and emissions reductions for this sector are set to become increasingly challenging, as the age profile of the forest stock matures and harvesting levels increase in line with projected forecasts. When considered alongside comparable EU Member States, there is a significant challenge over the medium- to longer-term in managing and reducing LULUCF emissions in Ireland unlike other sectors, a sectoral emissions ceiling (SEC) for the Land Use, Land Use Change and Forestry (LULUCF) sector has not been set, and is to be settled in parallel with the second phase of the Land Use Review.We must establish a pathway for our LULUCF sector to become a long-term sustainable net sink, making a positive contribution to combating climate change, and supporting our transition to a climate neutral economy and society by no later than 2050. The objective is to bring this sector in line with the with the burden sharing goals of the EU, minimising emissions and optimising GHG sequestration opportunities, while balancing environmental, social, and economic considerations across several sectors. Achieving this will yield significant ecosystem services and biodiversity benefits.

Key measures, for reducing emissions from LULUCF, included in the Climate Action Plan 2023 include increasing our annual afforestation rate and the promotion of forest management initiatives to increase carbon sinks and stores, increase the area of afforestation by 68,000 hectares, reducing the management intensity of 80,000 hectares of grassland on drained organic soils, improving our management for carbon sequestration of at least 450,000 hectares of grasslands on mineral soils, increasing the inclusion of cover crops in tillage to at least 50,000 hectares, increasing the incorporation of straw to 55,000 hectares of tillage (cereal) area, And rehabilitating 77,600 hectares of peatlands across numerous landowners and projects.

Pathway to Climate Neutrality by 2050

Meeting Ireland's 2050 climate neutral target will require agriculture to drive towards the total elimination of carbon dioxide and nitrous oxide emissions and significant reductions in biogenic methane emissions. It will not be possible to completely eliminate emissions of carbon dioxide and nitrous oxide in the Sector; it will be necessary to offset any remaining emissions through negative emissions.

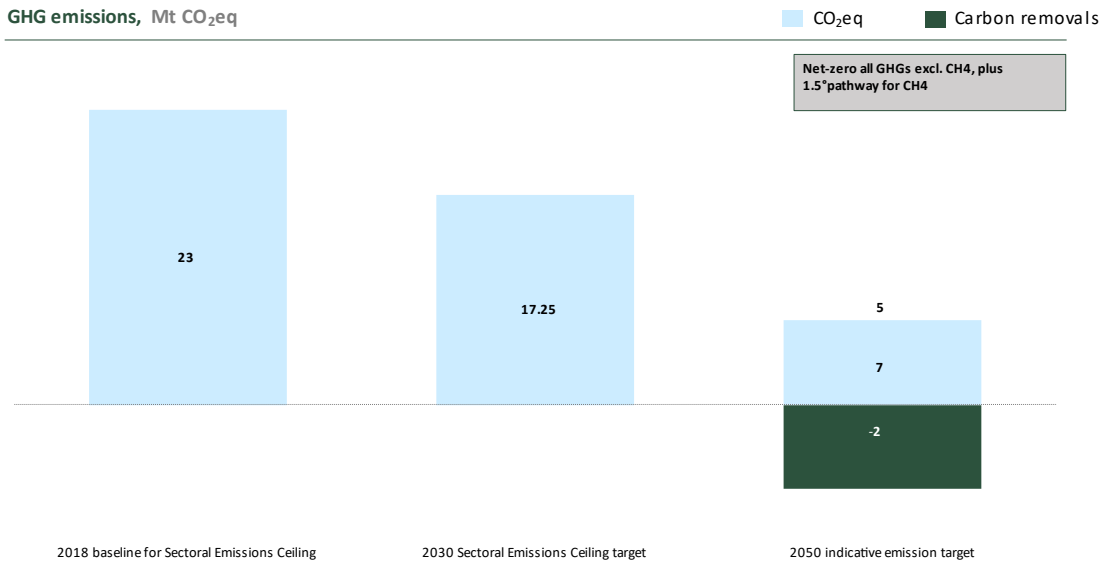
Realising this pathway for the agriculture sector in a socially and economically viable way is challenging, but achievable. We need to accelerate sustainability transformation in agriculture, including through the scaling-up of GHG-efficient food production, diversifying farm activates (including in forestry and bioenergy crop production), deploying next-horizon technologies (e.g., methane vaccines), and increasing sequestration from forests, peatlands/ wetlands, and improved grassland management. Supporting the unique capacity of the agriculture and forestry sectors to remove CO_2 from the atmosphere will be a key component of this multi-pronged approach for the sector. The benefits of delivering this transformation are manifold, not least maintaining Irish agri-food exports "green" reputation and supporting carbon offsets in other sectors.

While reducing emissions will bring challenges there will also be opportunities for farmers and their communities, including diversification of farm-based incomes, as well as delivery of further benefits in biodiversity, water and air quality.

Support for farmers and rural communities will be required in the transition to lower-emissions farming activities. This investment will need to deliver active management of a transition of agricultural activities to establish sufficient and sustained education, knowledge transfer, and behavioural shift interventions.

The crucial role played by the sector in limiting the impact of climate change will require sustained, integrated action and support over a number of decades, with Government, industry, research, science and consumers all having a role to play in reducing emissions from agriculture. Through the Climate Action Plan and the Ag-Climatise Strategy, we are rolling out an approach to stakeholder engagement with the sector which recognises the multi-faceted challenges facing the sector as well as the contribution that the sector will need to be empowered to make to achieve our climate objectives. Over the long-term, we will continue to build on our engagement with farmers and with the broader sector to help deliver our climate neutral goal.

Figure 7.5.1: Emissions reductions to 2050



Emission Reduction Measures and Milestones to 2050

To maintain Ireland's leadership in production-efficiency, and meet the 2050 emissions reduction targets for the sector, we will need to build on the developments in GHG efficient practices, technology and farm income diversity committed to under the Climate Action Plan, and pursue deep decarbonization, for example, through incorporating feed additives, driving demand shift, adopting new technological solutions. In addition, we will continue work to enhance sink potential of various land uses in Ireland, including meeting our objective to achieve 18% forest cover in Ireland by 2050, while minimising emissions from other land under agricultural production and from non-agricultural wetlands. At 14 - 18% forest cover, forestry and Harvested Wood Products could deliver a sink of ~5.0 Mt CO_2eq. in 2050.

Further technologies will emerge over the coming decades that may provide additional abatement opportunities as they mature and come to market, including multiple nascent technologies which are not currently available/ available at scale, but which show promising emissions reduction potential, such as feed additives, vaccines and direct methane capture. Further research and development will be necessary to understand how some of these

technologies might be successfully applied to grass-based agricultural systems such as Ireland's.

Engagement with farmers and the wider agriculture sector in delivering Ireland's climate neutral target will be necessary. This will include supporting the sector to further develop land-based economic opportunities that will enable Ireland to meet its 2050 objectives, e.g., through the development of the bioenergy crop supply chain and through afforestation.

The measures required are closely interconnected and will require the development of a strategic approach to land use alongside, and as part of, a long-term shift to low emissions agricultural production.

Significant investment in **research and development,** including technology and infrastructure to unlock potential emissions reductions will be necessary to ensure we can deliver both core and further measures. This will mean supporting the development of new abatement technologies including bringing them to market with a particular focus on applicability to outdoor grass-fed systems.

We will also need to define and scale up our strategy to incentivise the **uptake of technologies** such as methane-inhibiting vaccines, feed additives, as they come to market so that we can deliver ongoing emissions abatement from new technologies from 2030 onwards. This will require continued investment to ensure farmers can properly adopt the new technologies as they emerge. We expect that innovation through digitalisation and smart technologies will play an increasingly important role in the deployment of new technologies at farm level and will underpin precision agriculture techniques such as optimal application of fertiliser and plant protection products.

We will aim to provide global leadership on research into low emissions agriculture and will continue to develop our **international research partnerships** on agriculture and land-use, including through the UNFCCC, FAO and OECD to coordinate the development of practical mitigation technologies for the sector. We will also pursue an EU-wide approach to future targets for agriculture emissions which takes account of both the relative carbon efficiency

grass-based agricultural systems and the evolving science and metrics on the measurement and accounting of non-CO_2 gases.[21]

We recognise that our existing policy commitment to support on-going **afforestation** rates to meet our mid-century target of 18% forest cover is extremely challenging and we will need to regularly review our approach to the promotion of afforestation to ensure we remain on track. Meeting this target will be essential to maintaining, and building up over time, the carbon sequestration capacity of our national forest estate which, in turn, will contribute to the annual negative emissions budget that will be required to offset remaining emissions from 2050 onwards.

We will continue to refine our technical assessment of **LULUCF** as both sources and sinks of emissions access all land use categories and to define appropriate targets/measures accordingly, including promotion of nature-based solutions where the carbon sink benefit of such approaches can be verified and where this is appropriate to local ecosystems. This will also require investment in our capacities to analyse land use activities with detailed granularity, including through satellite observations.

Building on this, we will undertake a land use review to ensure optimal land functionality to deliver climate and wider environmental benefits, while meeting market demands for food, bioenergy and wider bio-economy needs.

Marine

Significant developments are currently under way in the planning and consenting regime for the Marine Environment to support our ambitions for decarbonising our energy sector through the development of offshore renewable energy. Alongside this, work is being undertaken to designate further marine Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) in the Marine Environment and to allow for the designation and management of Marine Protected Areas. This will allow the development of offshore

[21] The point about the international/EU accounting treatment of methane is possibly a point for chapter two in the discussion on how we've defined our targets.

renewable energy to progress at pace alongside the conservation, protection and recovery of marine biodiversity.

There have been a number of very significant developments over recent years, which demonstrate Ireland’s commitment to the sustainable development of our maritime area. The National Marine Planning Framework (NMPF) provides for long-term forward planning for Ireland's maritime area and will enhance the effective management of marine activities and more sustainable use of our marine resources.

The Maritime Area Planning (MAP) Act 2021, as amended, provides the legal underpinning to an entirely new marine planning system, which will balance harnessing our huge offshore wind potential with protecting our rich and unique marine environment. Enactment of the MAP Act has delivered a new legislative basis, allowing, for the first time, for the regulation of Ireland’s maritime area usage outside the 12 nautical mile coastal zone. The comprehensive and coherent marine planning regime in the MAP Act provides clarity to developers on the offshore wind consenting system for developments in our maritime area. Removing barriers in the permitting and consenting process, while ensuring a more facilitative and supportive planning framework, is essential to achieving our green transition as quickly as possible.

Marineplan.ie has been developed to assist decision makers in making evidence-based decisions with a graphical representation of relevant activities in the marine space.

8. The Circular and Bioeconomy

Technological developments alone will not get Ireland to achieve climate neutrality, it will be important for us change our patterns of consumption and to greatly reduce the amount of waste we produce as an economy. Driving demand reduction, through developing the circular economy and bioeconomy, could decrease the cost of achieving climate neutrality and deliver additional economic value.

The circular economy offers an alternative to today's linear ('take-make-waste') model of production and consumption, in which we extract great quantities of natural resources to make things that we may use only once before throwing them away. In the circular economy, resources are kept in use for as long as possible, the maximum value is extracted from them while in use, before residual resources are then recovered and regenerated into new products and materials at the end of each lifecycle. The circular economy is, therefore, an inherently regenerative system, which minimises or avoids the emissions and other negative environmental impacts associated, by replacing a linear lifespan with a closed loop for materials.

The bioeconomy is a component of the circular economy and relates to the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, and bio-energy. It cuts across a range of sectors, including agriculture, the marine, forestry, water and waste management, energy, as well as biopharmaceuticals.

The Government's vision for the bioeconomy, as set out in the National Policy Statement on the Bioeconomy, is to grow Ireland's ambition to be a global leader for the bioeconomy through a coordinated approach that harnesses Ireland's natural resources and competitive advantage, and that fully exploits the opportunities available while monitoring and avoiding unintended consequences.

The bio-economy is based on four principles which combine to achieve emissions reduction while creating value; demand reduction; design out waste and pollution; keep products and materials in use, and; regenerate natural systems.

The four guiding principles underlying the bioeconomy, are the:

Sustainability Principle - Environmental sustainability is an integral, core principle of the bioeconomy and products developed must be sustainable.

Cascading Principle - whereby higher value applications are preferentially derived from biological resources which will allow us to derive the maximum value from our bioresources.

Precautionary Principle - is a risk management approach to prevent policies or actions causing harm to the public or the environment.

Food First Principle - gives priority to food and nutrition security by improving the availability of and access to a safe and healthy food supply for citizens.

A circular and bio-economy maximises the value and benefits from a limited set of resources, and reduces demand for new materials through replacing the 'end-of-life' concept with restoration and recycling, and aiming for the elimination of waste through the superior design of materials, products, systems, and business models. Circular and bioeconomy initiatives are an additional source of CO2 emissions abatement in the most challenging sectors. Further, the associated demand reduction for imported goods will help decrease emissions more globally and the new green economy will save money and create new jobs.

Achieving this circular transition will require significant levels of innovation in relation to the design of both production and business models.

State of Play

The Circularity rate indicates the share of material which is recovered and fed back into an economy. Ireland currently has a circularity rate of 1.6%, some way behind the EU average of 12.8%. Improving this rate will yield savings not only in tonnes of materials wasted, but also in carbon emitted.

In 2018, Waste accounted for 1.5% of Ireland's total greenhouse gas emissions - approximately 0.91 MtCO2eq. This figure accounts for emissions from waste treatment that are reported under the waste sector (predominantly methane emissions as a result of disposal to landfill). The gains in reducing material use, and substituting virgin material with recycled material, will be credited back up the supply chain. Minimising waste generation, and improving segregation, reuse and recycling, will lead to less emissions associated with waste transport and treatment.

Waste emissions per head are lower in Ireland compared to the EU average. Emissions have fallen since 2005, but not as much as in other Member States or compared to the EU average. Ireland has made significant progress in managing waste streams, particularly in

improving recycling rates and diversion from landfill. Ambitious targets have been adopted for 2030.

Pathway to 2030

Ireland's short-/medium-term waste and circular economy strategy is outlined in Climate Action Plan 2023, Whole of Government Circular Economy Strategy 2022-2023 and Waste Action Plan for a Circular Economy (2020 – 2025). The Circular Economy and Miscellaneous Provisions Act 2022 placed the Circular Economy Strategy on a statutory footing, making the ongoing development of circular economy policy a legal requirement of Government.

The circular economy strategy commits to support and implement measures that significantly reduce Ireland's circularity gap, in both absolute terms and in comparison, with other EU Member States, so that Ireland's rate is **above the EU average by 2030**; such measures to address facets of sustainable production and consumption most impactful in an Irish context.

The Sector Emission Ceiling for 'Other', which includes Waste, commits to a 25% reduction in greenhouse gas emissions by 2025, and a 50% reduction by 2030 relative to 2018 levels.

Additionally, the Plan commits to recycling 70% of packaging by 2030, recycling 55% of plastic waste by 2030, reducing food waste by 50% by 2030, provide for 90% collection of plastic drinks containers by 2029, and further to ensure all plastic packaging is reusable or recyclable by 2030.

Pathway to Climate Neutrality by 2050

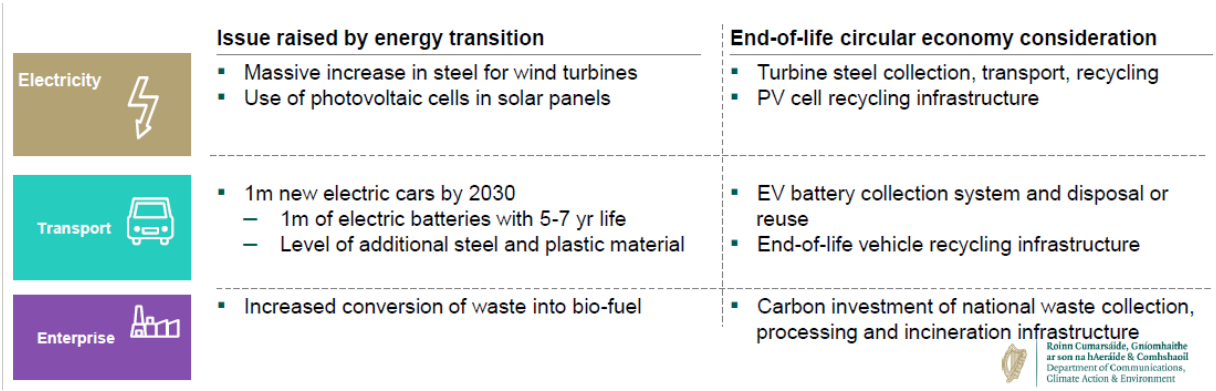
Achieving additional abatement can become increasingly challenging and increasingly costly meaning that a developed circular and bio-economy can play a significant role in supporting the transition to climate neutrality from 2030. The circular economy is projected to create 700,000 additional jobs across Europe and provide a EUR 1.8 trillion annual benefit.

Previous modelling suggested that developing the circular economy could lead to a 5% - 10% reduction in CO_2 emissions relative to 2030, an approximate 3.2 Mt CO_2 reduction in emissions included in the national inventory. However, the 2021 Climate Act and Climate Action Plan mandate an acceleration in the level of emissions reductions to be achieved in this decade and as a result, require a corresponding front-loading of the implementation of

abatement measures - including circular economy, bioeconomy and waste-reduction measures. This means that emissions reductions will differ to that previously modelled, with greater abatement in the period to 2030 and slightly less abatement in the period from 2030 to 2050. In any case, it is clear that the circular and bioeconomy provides significant emissions reductions potential as we strive for climate neutrality by 2050.

Outside of Ireland, there is also potential emissions abatement that could be achieved due to reduced demand for imports.

The circular economy strategy must consider the longer term, end-of-life materials to be dealt with as part of the shift to zero-emissions. The figure below outlines a number of these areas where the transition to zero emission energy has consequences that the design of a circular economy must take into account and address.



9. Adaptation to Climate Change

Climate Change Impacts

International context

The IPCC Working Group II contribution to the Sixth Assessment Report, finalized in February 2022, assesses the impacts of climate change, looking at ecosystems, biodiversity, and human communities at global and regional levels. It also reviews vulnerabilities and the capacities and limits of the natural world and human societies to adapt to climate change.

The report finds that climate change, and the related increase in the frequency and intensity of extreme weather events, has caused widespread adverse impacts and related losses and damages to nature and to people. Further it finds that the impacts and risks of climate change are becoming more complex and increasingly difficult to manage. Interaction between multiple climatic and non-climatic risks will result in compounding overall risk and risks cascading across sectors and regions. The report highlights the urgency of immediate and far-reaching climate action, finding that near-term actions that limit global warming to close to 1.5°C would substantially reduce projected losses and damages related to climate change in human systems and ecosystems, compared to higher warming levels, but cannot eliminate them all.

The report also finds that climate change risks and impacts can be reduced, within limits, if humans and nature adapt to the changing conditions. The scale and scope of actions to reduce climate risks (adaptation) have increased worldwide. Individuals and households along with communities, businesses, religious groups and social movements are adapting to climate change already.

However, the Working Group II Report identifies large gaps between ongoing efforts, and the level of adaptation ambition needed to cope with current levels of warming, with the scale of the challenge varying in different regions. The report also highlights that the effectiveness of available adaptation options decreases with every increment of warming. Successful adaptation requires urgent, more ambitious and accelerated action and, at the same time, rapid and deep cuts in greenhouse gas emissions. The quicker and further emissions fall, the more scope there is for people and nature to adapt.

EU Context

Forging a climate-resilient Europe – the EU Strategy on Adaptation to Climate Change, was published in February 2021 in recognition of adaptation as a crucial component of the long-term global response to climate change. The strategy identifies that the frequency and severity of climate and weather extremes across the EU is increasing. This has caused a surge in the frequency and severity of disasters over the last two decades. The strategy aims to increase and accelerate the EU's efforts to protect nature, people and livelihoods against the unavoidable impacts of climate change. Building on the work already carried out as a result of the 2013 EU Adaptation Strategy, the new Strategy outlines a long-term vision of creating a climate resilient EU by 2050 by making adaptation smarter, more systemic and swifter, and by stepping up international action. Irish adaptation policy will continue the process of aligning, where possible, with EU climate adaptation policy and priorities and also utilise developments in EU adaptation policy, including the EU Climate Risk Assessment, EU Climate Adaptation Indicators and the EU Climate Adaptation Mission to increase climate resilience at national level.

Irish Context

Observations show that Ireland's climate is changing at a scale and rate of change consistent with regional and global trends. The most immediate risks to Ireland are predominantly those associated with changes in extremes, such as floods, precipitation and storms.

Climate change is expected to have diverse and wide-ranging impacts on Ireland's environment, society and economic development, including on managed and natural ecosystems, water resources, agriculture and food security, human health, and coastal zones. The most immediate risks to Ireland which can be influenced by climate change are predominantly those associated with changes in extremes, including floods, droughts and storms. For Ireland, climate change impacts are projected to increase in the coming decades and could include the following:

- sea level rise;
- more intense storms and rainfall events;
- increased likelihood and magnitude of river and coastal flooding;
- water shortages in summer;
- increased risk of new pests and diseases;
- adverse impacts on water quality; and

- changes in distribution and phenology (the timing of lifecycle events) of plant and animal species on land and in the oceans.

In 2021, the second *The Status of Ireland's Climate* report, commissioned by GCOS Ireland, funded by the EPA, the Marine Institute and Met Éireann and taking new data, analyses, and knowledge into account, was published.. This report provides an updated picture of developing trends in Ireland's climate and also how Ireland is being impacted by climate change. Trends in temperature and precipitation records as well as those relating to sea level measurements and ecosystem decline are a cause for concern:

Temperature: Average temperatures have increased by 0.9°C since 1900, with a rise in temperatures being observed in all seasons. This compares with a global average temperature estimated to be 1.1°C above pre-industrial levels. The number of warm spell days has increased slightly over the last 60 years, with very little change in cold spell duration. This is in line with what has been observed in many regions of the world

Precipitation: Average annual national rainfall has increased by approximately 6% in the period 1989-2018, compared to the period 1961-1990; the largest increases are observed over the west of the country.

Sea level rise: Satellite observations indicate that the sea level around Ireland has risen by approximately 2–3mm per year since the early 1990s, and analysis of sea level data from Dublin Bay show a rise of approximately 1.7mm per year since 1938, consistent with global average rates

Sea surface temperature: The average sea surface temperature measured at Malin Head was 0.47°C higher over the last 10 years compared with the period 1981–2010.

Climate Change Impacts Towards 2050

While uncertainty remains regarding the impacts of changing climate towards 2050, trends in temperature, precipitation, and sea level rise are expected to continue, with impacts affecting the whole of Irish society and the economy:

Temperature: Projections indicate an increase in average temperatures across all seasons (1–1.6°C). The number of warm days is expected to increase and heat waves are expected to occur more

frequently. Incidences of cold stress are likely to decrease while incidences of heat stress will increase. The duration of the growing season will increase, starting earlier and extending later.

Precipitation: Precipitation is expected to become more variable, with substantial projected increases in the occurrence of both dry periods and heavy precipitation events. Significant reductions are expected in average annual, spring and summer rainfall. The increased occurrence of dry spells will result in increased pressure on water supply. Projections indicate a substantial increase in the frequency of heavy precipitation events in winter and autumn (approx. 21% - 31%), which will result in increased fluvial and pluvial flood risk.

Wind speed: Projections indicate an overall decrease in wind speed and an increase in extreme wind speeds, particularly during winter. Increases in extreme wind speeds may impact on wind turbines and the continuity of power supply.

Sea level rise: Sea levels will continue to rise for all coastal areas, by up to 0.84 m by 2100. The south of Ireland will likely feel the impacts of these rises first. 80% of the damage associated with sea level rise for Ireland is expected by 2050. There will be a significant increase in areas at risk of coastal inundation and erosion, and increased risk to coastal aquifers and water supply.

Sea surface temperature: Sea surface temperatures are projected to continue warming. Projected changes for the Irish Sea indicate a warming for all seasons with the highest warming in Autumn and the lowest in Spring, however, projected changes remain uncertain. This will result in a change in distribution of fish species, with implications for fisheries and aquaculture industries.

Climate data and Information

Improved information and more detailed and reliable climate projections are required to understand the impacts of climate change and to build resilience towards 2050.

Climate projections work in Ireland date back to 2003 when Met Éireann established a project called the Community Climate Change Consortium for Ireland (C4I) and applied regional climate models (RCMs), structurally very similar to the models used for numerical weather prediction (NWP), to simulate the future climate of Ireland at high spatial resolution for the first time. Since then, more climate projections for Ireland have been produced.

For example, Met Éireann is a core member of the "EC-Earth" international climate modelling consortium working with leading experts from 12 European countries to develop Global Climate Models (GCMs) and run state-of-the-art climate projections. A large ensemble of global EC-Earth atmosphere-ocean simulations has recently been completed as part of the IPCC's 6th Coupled Model Inter-comparison Project (CMIP6) which informed

the latest IPCC AR6 report. These simulations consist of 5 historical (1850-2014) and 20 future scenario simulations (2015-2100) covering the full range of IPCC scenarios.

A range of atmosphere-only RCMs (such as HCLIM, WRF and COSMO) and coupled atmosphere-ocean RCMs (such as COAWST) are currently being employed by Met Éireann and ICHEC to downscale EC-Earth's CMIP6 outputs to domains over the North Atlantic and Ireland. This work is co-funded by the EPA, the Marine Institute and Met Éireann and once completed, will be used to update the current set of high-resolution 21st century climate projections for Ireland.

This work will be crucial in updating our current understanding of the observed and future impacts of climate change in Ireland. Research will also be required to better understand the implications of climate change on areas such as health risks, and how best to build resilience.

Another requirement is access to information presented in an accessible form by policy makers, particularly those producing sectoral or local adaptation plans or required to account for climate risks. The provision of accurate and authoritative information and expertise is a crucial element in ensuring that Government, Local Authorities, communities and the private sector can plan ahead and respond effectively to the challenges of climate change.

Met Éireann will soon be introducing a national standard set of climate projections as part of the TRANSLATE project and establishing, with its partners, a National Framework for Climate Services (NFCS) to coordinate the provision of climate services in Ireland in support of climate action decision making.

Ireland's Climate Information Platform, *Climate Ireland*, was developed on a phased basis under the EPA Research Programme as a "one-stop shop" of information, data and knowledge to support those preparing for, and adapting to, the consequences of climate change. The platform provides a central source of climate data for Ireland, combining authoritative information from a variety of sources such as Met Éireann, OPW, EPA, the European Environmental Agency and the Intergovernmental Panel on Climate Change (IPCC) to assist a variety of stakeholders in planning ahead for the likely impacts of climate change. Climate Ireland was designed and developed by the Centre for Marine and Renewable Energy (MaREI) at University College Cork (UCC) and the Irish Centre for High End Computer (ICHEC) at the National University of Ireland, Galway and as part of the EPA-funded project *A Climate Information Platform for Ireland* (ICIP).

Climate Action Plan 2021 and its successor Climate Action Plan 2023 implement measures to deliver Climate Ireland as the national platform for data, information and decision supports on climate impacts and adaptation. It is important that security of the resource in the long-term is ensured, to allow for the broader and more in-depth planning required towards 2050.

National Adaptation Policy

Ireland's first statutory National Adaptation Framework (NAF, 2018)[22] represents Ireland's primary national policy response to the challenges posed by the impacts of climate change. The NAF was prepared under the Climate Action and Low Carbon Development Act 2015. It sets out the national strategy for the application of adaptation measures in different sectors and by Local Authorities in their administrative areas in order to reduce the vulnerability of the State to the negative effects of climate change and to avail of any positive impacts that may occur.

The NAF identifies 12 key sectors requiring sectoral adaptation plans. These plans were approved by Government and published in October 2019. The sectoral adaptation plans are grouped under four themes as set out in the following table.

Table 9.1 Sectoral Adaptation Plans

Theme	Sector Level	Lead Department for Sectoral Adaptation Plans
Natural and Cultural Capital	Seafood	Department of Agriculture, Food and the Marine
	Agriculture	
	Forestry	
	Biodiversity	Department of Housing, Local Government and Heritage
	Built and Archaeological Heritage	
Critical Infrastructure	Transport Infrastructure	Department of Transport
	Electricity and Gas Networks	Department of the Environment, Climate and Communications
	Communications Networks	
	Flood Risk Management	Office of Public Works

[22] DCCAE/National Adaptation Framework

Water Resource and Flood Risk Management	Water Quality	Department of Housing, Local Government and Heritage
	Water Services Infrastructure	
Public Health	Health	Department of Health

The plans were developed in line with the *Sectoral Planning Guidelines for Climate Change Adaptation*, which were published in 2018, ensuring that a consistent and coherent process was followed across all sectors in their development. The plans describe and assess the extent of the risks presented by climate change to the sector, and present contingency plans to address these risks and build climate resilience. They include actions to mainstream adaptation into policy and administration, as well as actions to improve cooperation and coherence across other sectors and with the Local Government sector. All the sectoral adaptation plans have been published on www.gov.ie. National adaptation measures are also included in annual Climate Action Plans.

National Adaptation Framework

The NAF clearly identifies the critical role to be played by local authorities in building climate resilience. In 2019, Local Adaptation Strategies were developed by all 31 local authorities in Ireland in line with Government guidance. Four, government-funded, local authority Climate Action Regional Offices (CAROs) supported the preparation of the strategies, driving climate action at local authority level and ensuring consistency in the development of each strategy. Building on their success, the CAROs now provide enhanced support to Local Authorities covering mitigation and citizen engagement along with adaptation. They will also have a key role in the development of the adaptation requirements of Local Authority Climate Action Plans which are now required to be prepared under climate legislation every five years. A long term strategic vision for climate adaptation in Ireland

Recognising that the process of adapting to climate change is iterative and long term, Ireland's National Adaptation Framework considers a set of guiding strategic principles which will inform adaptation planning at sectoral, regional, local and individual levels in Ireland. The following principles summarise the main success factors for adaptation contained within international research aim to inform the approach to be taken in preparing sectoral planning in Ireland;

- Ownership: A clear commitment at senior levels within relevant organisations to pursuing adaptation from the outset. In the longer term, sufficient personnel and financial resources for adaptation must be made available.

- Vulnerability based assessment: Each sector and region will begin their adaptation planning with a clear understanding of sensitivities and vulnerabilities to current and future climate change.
- Openness and knowledge transfer: Sharing best practises in adaptation, improving data collection of adaptation relevant information as well as the communication of this information are all essential for adaptation processes. Scientific information must be presented in a way that is understandable, consistent and meets the requirements of the specific target audience.
- Foster cooperation: A working partnership with relevant and affected stakeholders throughout the entire adaptation process is an important prerequisite for successful adaptation. The objectives and the areas of responsibility of the participants must be clearly determined and communicated.
- Account for uncertainty: Uncertainties are an inherent part of all projections of climate change and its impacts. They will never be fully eliminated but adaptation measures will be required nonetheless. A precautionary approach to adaptation should be adopted. Appropriately, accounting for uncertainty can improve adaptation decisions by making them more robust in the face of uncertainties.
- Climate Scenarios: When prioritising climate change impacts at regional and local levels, both past weather events and scenarios of possible future climatic and socio-economic changes should be analysed. In order to understand the uncertainty in the potential impacts of climate change, a range of scenarios should always be drawn upon for the estimation of climate trends
- Identify a wide range of adaptation options: A comprehensive range of adaptation options should be considered at the outset (green, grey and soft). The available options should be described in as much detail as is reasonably possible in terms of their objectives and direct and indirect effects.
- Prioritise adaptation actions: It will not be practical to undertake all adaptation options identified. Implementation of adaptation actions must be prioritised according to relevant criteria such as efficiency, cost-effectiveness, risk and urgency and ensuring a just transition. The local authority and sectoral adaptation guidelines discuss how to both prioritise climate risks at the appropriate scales and, following this, how identified adaptation options should be prioritised for implementation. Monitoring progress: It will be necessary to establish appropriate monitoring mechanisms and indicators so as to ensure the effectiveness of sector specific adaptation responses.

Such mechanisms will also ensure efficient use of resources while allowing flexibility to how plans are implemented.

In addition to these high-level guiding principles Ireland will also implement adaptation policies in line with the additional principles below which have gained in prominence since the publication of the NAF in 2018

Considering adaptation in parallel with sustainable development

The NAF recognises the international policy context relevant to Ireland's climate action commitments including the EU Adaptation Strategy, Sendai Framework for Disaster Risk Reduction 2015-2030, and the Sustainable Development Goals (SDGs), particularly SDG 13: Climate Action. Equally, climate adaptation is fully considered within Ireland's SDG Implementation Plan. Ireland will continue to ensure alignment between its adaptation policies and the SDGs.

Aligning Climate Adaptation and Mitigation

The Paris Agreement includes a long-term adaptation goal alongside the goal for mitigation. This connection makes it clear that, if mitigation activities succeed in limiting the rise in global temperature, less adaptation will be needed to deal with the consequences of climate change. Accordingly, the NAF had regard to on-going mitigation actions to limit temperature increases, recognising that this would significantly reduce the risks and impacts of climate change.

Mitigation actions also have the potential to deliver adaptation co-benefits (rewetting of peatlands, rewilding, vegetation coverage, sustainable planning policies etc). It is equally important that mitigation policies minimise maladaptation and that they account for a changing climate (ie in building standards, planning policy etc). Future iterations of adaptation policy will give greater consideration to how adaptation policy can best support mitigation policy and maximise co-benefits while minimising maladaptation.

More emphasis on 'transformational' adaptation as a complement to 'incremental' adaptation

Transformational adaptation, according to the IPCC[23] "seeks to change the fundamental attributes of systems in response to actual or expected climate and its effects, often at a scale and ambition greater than incremental activities. Scheduled reviews of climate change

[23] IPCC 2014 AR5, Chapter 14: https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap14_FINAL.pdf

adaptation policy in Ireland, including the review of the National Adaptation Framework in 2022, will provide opportunities to examine the need to more towards transformational adaptation measures as adaptation policy in Ireland is implemented over time and as the scale of the impacts of climate change become clearer.

Public consultation and engagement

The NDCA facilitates the changing of perceptions around climate change, including adaptation. Public consultation and public engagement will remain a central part of adaptation policy in Ireland.

Just Transition

The Climate Action Plan commits to delivering a just transition, recognising the significant level of change required and that the burden must be as fairly distributed as possible. De-carbonising the economy presents significant challenges but also brings important opportunities to respond and create learning on how best to deliver a just transition. Work to date on implementing a just transition has largely focused on mitigation. The concept of just resilience has emerged at international level but has yet to be clearly defined. It is likely to emerge as an important issue in adaptation policy in the future. Irish adaptation policy will examine the just transition in the context of adaptation and to see how adaptation policy can assist in bringing greater clarity to this concept.

Continuous Review and Updating of National Adaptation Policy Towards 2050

In Ireland national adaptation planning centres on the implementation of National Adaptation Frameworks and Sectoral Adaptation Plans (which are required to be reviewed regularly in line with the requirements of the Climate Act). Monitoring, review, and evaluation are important aspects of such iterative adaptation planning. Ireland continues to provide detailed reports on climate adaptation to the European Commission in line with requirements of the Regulation on the Governance of the Energy Union and Climate Action. The review of National Adaptation Frameworks and Sectoral Adaptation Plans at allows the latest science and assessment of climate change impacts to be considered, and adaptation policy and planning can be refocussed accordingly. Adaptation policy in Ireland is also subject to review and comment by the independent Climate Change Advisory Council (CCAC).

The current NAF underwent a statutory review in 2022 resulting in a number of recommendations being made to the Minister. The key recommendation, approved by the Minister, is to commence drafting a new National Adaptation Framework in 2023 to

supersede the current NAF. Revised national Guidelines on developing Sectoral Adaptation Plans will also be progressed in parallel. The sectoral adaptation plans outlined under section 9.2 represent the first stage in an iterative process of developing, refining, and integrating approaches to develop sectoral resilience to the impacts of climate change and will be reviewed following the approval of the next NAF.

Cross-sectoral challenges still exist, and solutions to developing climate resilience will be further assessed bilaterally and via the National Adaptation Steering Committee as plans are implemented and further developed. By 2050, the NAF, Sectoral Adaptation Plans, and Local Adaptation Strategies will all be in their 7th iteration, allowing considerable review and adjustment to ensure the development of resilience across society and the economy.

In addition to refinement of plans in further iterations, it is expected that sectoral planning will have been broadened to additional sectors and cover additional priorities by 2050. Adaptation planning and actions will have been mainstreamed across policy development in all relevant sectors. It is envisaged that this mainstreaming process will ensure that in future climate change impacts will be taken into consideration strategically across housing and planning, emergency management, and the financial sector which are not currently required to develop sectoral adaptation plans.

Prioritisation will also be addressed in further iterations of the plans and strategies, and the development of a national climate change risk assessment will be progressed. Adaptation planning guidelines will be revised and updated over time, using learnings from the recent cycle of planning, and allowing flexibility for the different requirements of diverse sectors.

Finally, Ireland is committed to supporting the implementation of the EU Strategy on Adaptation to Climate Change which, in time, will provide further guidance on many aspects of Climate Adaptation, including risk prevention and preparedness, which will be taken into account in future adaptation planning in Ireland.