ANNUAL REVIEW 2022

Acknowledgements

The Climate Change Advisory Council would like to acknowledge the contributions of:

- the Adaptation Committee of the Climate Change Advisory Council,
- the Secretariat of the Climate Change Advisory Council,
- the Environmental Protection Agency (EPA),
- Teagasc,
- the Sustainable Energy Authority of Ireland (SEAI),
- Met Éireann,
- Secretariat interns Therese Myslinski and Laura Marenco;

  in the preparation of the Annual Review 2022.

The Climate Change Advisory Council would also like to thank ALHAUS for their copyediting and proofreading of this document and Clever Cat Design for their design and typesetting of this Review.

Climate Change Advisory Council

The Climate Change Advisory Council is an independent advisory body tasked with assessing and advising on how Ireland can achieve the transition to a low-carbon, climate-resilient and environmentally sustainable economy.

The Climate Change Advisory Council was established on 18 January 2016 under the Climate Action and Low Carbon Development Act 2015.

Climate Change Advisory Council Members:

Marie Donnelly (Chair)
Dr Cara Augustenborg
Prof. Morgan Bazilian
Laura Burke (EPA)
Prof. Ottmar Edenhofer
Prof. John FitzGerald
Patricia King
Jillian Mahon
Eoin Moran (Met Éireann)
Andrew Murphy
Sinéad O'Brien
Prof. Frank O'Mara (Teagasc)
Julie Sinnamon
Prof. Peter Thorne

Climate Change Advisory Council – Adaptation Committee

At its meeting on 6 April 2016, the Climate Change Advisory Council established an Adaptation Committee to consider matters relating to climate change adaptation. The Council is required to have an adaptation committee under the Climate Action and Low Carbon Development (Amendment) Act 2021.

Adaptation Committee Members:

Prof. Peter Thorne (Chair, from February 2022)
Marie Donnelly (Chair, to February 2022)
Prof. John FitzGerald (to February 2022)
Mark Adamson
Laura Burke (EPA)
Dr Julie Clarke (from February 2022)
Prof. Robert Devoy
David Joyce (from February 2022)
Dr Ina Kelly
Keith Lambkin
Jillian Mahon (from February 2022)
Paddy Mahon
Prof. Conor Murphy
Sinéad O'Brien (from February 2022)
Prof. Frank O'Mara (Teagasc)
Roger Street

Contents

List of Acronyms used in this report

3-NOP	3-Nitrooxypropanol, a feed additive for ruminant animals
ACER	European Union Agency for the Cooperation of Energy Regulators
AFOLU	Agriculture, Forestry and Other Land Use
ARA	Adaptation Research Alliance
BECCS	Bioenergy with carbon capture and storage
BER	Building Energy Rating
BEV	Battery Electric Vehicle
bioCNG	Compressed Natural Gas from biogenic sources, e.g. biogas and biomethane
bioLPG	Liquefied petroleum gas refined from biogenic sources
BnM	Bord na Móna
CAP	Common Agricultural Policy
CARO	Climate Action Regional Office
CASA	Climate Adapatation and Strategic Assessment (CASA)
CCAC	Climate Change Advisory Council
CPPA	Corporate Power Purchase Agreement
CCS	Carbon Capture and Storage
CCU(S)	Carbon Capture, Utilisation (and Storage)
CEG	Clean Export Guarantee
CH_4	Methane
CMIP	Coupled Model Intercomparison Project
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
COP	Conference of Parties to the UNFCCC
CORDEX	Coordinated Regional climate Downscaling Experiment
CPO	Crude Palm Oil
CRU	Commission for Regulation of Utilities
CSO	Central Statistics Office of Ireland
DAFM	Department of Agriculture, Food and the Marine
DART	Dublin Area Rapid Transit
DECC	Department of Environment, Climate and Communications
DETE	Department for Enterprise, Trade and Employment
DHLGH	Department of Housing Local Government and Heritage

DoH	Department of Health
DOT	Department of Transport
DSU	Demand Side Unit
EEA	European Environment Agency
EI	Enterprise Ireland
EPA	Environmental Protection Agency
ESD	Effort Sharing Decision
ESR	Effort Sharing Regulation
ESRI	Economic and Social Research Institute
ETS	Emissions Trading System
EV	Electric Vehicle
EXEED	Excellence in Energy Efficiency Design
FAO	Food and Agriculture Organisation
F-gases	Man-made gases with greenhouse gas properties, includes HFCs, PFCs, SF_6 and NF_3
GCS	Generation Capacity Statement
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GNI*	Modified Gross National Income
GWP	Global Warming Potential
HGV	Heavy Goods Vehicles
HSE	Health Services Executive
I3E	The Ireland Environment, Energy and Economy model developed by ESRI
ICE	Internal Combustion Engine
ICHEC	Irish Centre for High-End Computing
IDA	Industrial Development Agency Ireland
IPCC	Intergovernmental Panel on Climate Change
LGV	Light Goods Vehicle
LNG	Liquified Natural Gas
LPG	Liquefied petroleum gas
LULUCF	Land Use, Land Use Change and Forestry
MAC	Maritime Area Consent
MACC	Marginal Abatement Cost Curve
MAP	Maritime Area Planning

MaREI	SFI Research Centre for Energy, Climate and Marine
N_2O	Nitrous Oxide
NACP	National Climate Action Plan
NAF	National Adaptation Framework
NDP	National Development Plan
NESC	National Economic and Social Council
NFS	National Farm Survey
NIR	National Inventory Report
NNFCC	National Non-Food Crops Centre, established by the UK government in 2003
NORA	National Oil Reserves Agency
NPF	National Planning Framework
NPWS	National Parks and Wildlife Service
OECD	Organisation for Economic Co-operation and Development
OPR	Office of the Planning Regulator
OPW	Office of Public Works
OSS	One Stop Shop
PHEV	Plug-in Hybrid Electric Vehicle
PSV	Public Service Vehicle
RED	Renewable Energy Directive
RESS	Renewable Electricity Support Scheme
RES-T	Renewable Energy Sources in Transport
SAP	Sectoral Adaptation Plan
SDG	Sustainable Development Goals
SEAI	Sustainable Energy Authority of Ireland
SEM	Single Electricity Market
SF_6	Sulphur hexafluoride, a potent F-gas
SME	Small and Medium-sized Enterprise
SNSP	System Non-Synchronous Penetration
Solar PV	Solar Photovoltaic technologies
SONI	Electricity Transmission System Operator for Northern Ireland
SuDS	Sustainable Urban Drainage Systems
SUV	Sports Utility Vehicle
TCRII	EPA funded research project Transboundary Climate Risks for Island of Ireland

TFEC	Total Final Energy Consumption
TPER	Total Primary Energy Requirement
TRANSLATE	Met Éireann led project to Standardise Future Climate Information for Ireland
UCD	University College Dublin
UCO	Used Cooking Oil
UNFCCC	United Nations Framework Convention on Climate Change
VRT	Vehicle Registration Tax
WAM	With Additional Measures
WEM	With Existing Measures
WGI	Working Group 1 of the IPCC, The Physical Science Basis
WGII	Working Group 2 of the IPCC, Impacts, Adaptation and Vulnerability
WGIII	Working Group 3 of the IPCC, Mitigation if Climate Change
WMO	World Meteorological Organization
WtE	Waste to Energy

Executive Summary

The mission of the Climate Change Advisory Council is to provide independent evidence-based advice and recommendations on policy to support Ireland's Just Transition to a biodiversity-rich, environmentally sustainable, climate-neutral and resilient society. It is also tasked with assessing the progress made towards this goal via an Annual Review.

This 2022 Annual Review considers the progress of Ireland's national climate goals in 2021 – the first year of the Carbon Budget 2021-2025 – and its structure reflects the delineation of the Carbon Budget 2021-2030 into sectoral ceilings. It updates our understanding of Ireland's resilience to climate change through climate change mitigation and adaptation actions and presents a review of progress in respect of national and EU targets at a national and sectoral level.

Since the publication of the Council's last Annual Review much has changed. The illegal and unprovoked invasion of Ukraine by Russia has triggered a global energy crisis, serious concerns for global food security and high levels of inflation with implications, particularly, for the poor. The crisis has highlighted the EU and Irish dependence on imported fossil fuels, along with exposure to volatile and high commodity prices, both of which can have implications for energy security. The Council expressed its concerns regarding the crisis to the Heads of Government by letter in April 2022[1] and further supports its position with the following recommendations:

Carbon budgets can be met, but require significant and early action consistent with a Just Transition

In April of this year the Houses of the Oireachtas formally adopted the Council's proposals for the first carbon budget programme covering the period 2021-2035. The carbon budgets for the first two periods allow for 295Mt CO_2 eq in the first period and 200Mt CO_2 eq in the second period.

The announcement of sectoral emissions targets for 2030 in July was a welcome milestone, but the targets announced do not provide all of the necessary clarity in terms of how the carbon budgets are allocated at a sectoral level, how the overall target of 51% reduction by 2030 will be met, or how the Land Use Sector will be included in meeting the targets. As presently expressed the quantified emissions reductions only amount to a reduction of 42% excluding the Land Use Sector and are therefore not consistent with the objective in the Climate Action and Low Carbon Development (Amendment) Act. Whilst these targets are a useful starting point the targets will need to be revised upwards and monitored closely in the light of experience.

The Climate Action Plan 2023, due later this year, will need to set out the precise actions and steps that will need to be followed in order to align with the ambition of the Carbon Budgets which were adopted by the Oireachtas in April. The EPA projections published in early June give the best early indicator of the likelihood that compliance will be achieved.

- Provisional national total emissions in 2021, the first year of the first carbon budget period, are estimated to have totalled 69.3Mt CO_2 eq, reflecting a reduction of 1.3% on emissions in the base year 2018. This accounts for about 23.5% of the emissions allowance for the first period and means that there will be a requirement for emissions to fall more quickly over the period 2022-2025 than originally anticipated if the first budget is to be met. Emissions reductions of 8.4% per annum will now be required.
- Current EPA projections to 2030 indicate that the first two carbon budget targets present a significant challenge based upon existing and planned measures, with estimated gaps to target of 40-55Mt CO_2 eq in the first carbon budget period and 77-127Mt CO_2 eq in the second period.[a]

a The lower figure in each range is based on the EPA 'With Additional Measures' (WAM) projection scenario whilst the higher figure is based on the EPA 'With Existing Measures' (WEM) projection scenario.

The following table shows a comparison between the EPA projections and the sectoral emissions targets for 2030.

Table ES. 1 Comparison between Sectoral Emissions Reduction Targets announced by the Government on 27 July 2022 and the EPA projections for emissions to 2030

Sector	2018	Sectoral Target Reductions	Sectoral Emissions Target 2030	WEM Emissions 2030	WAM Emissions 2030
	Mt CO_2 eq	Percentage relative to 2018		Mt CO_2 eq	
Electricity	*10.3*	75%	2.6	5.1	4.2
Transport	*12.2*	50%	6.1	10.3	7.4
Residential	*7.1*	40%	4.3	5.2	4
Commercial and Public Buildings	*1.5*	45%	0.8	1.3	1
Industry	*7.0*	35%	4.6	6	6.1
Other	*2.2*	50%	1.1	1.8	1.8
Agriculture	*23.1*	25%	17.3	22.8	17.8
Land Use, Land Use Change and Forestry	*6.9*	n/a	n/a	11.1	8.3
Total Emissions including LULUCF	**70.2**	**n/a**	**n/a**	**63.7**	**50.6**
Total Emissions excluding LULUCF	**63.4**	**42%**	**36.7**	**52.6**	**42.3**

In light of the still considerable (and as yet not fully explained) distance to target it is critical that planning of new measures and implementation of already announced actions across all sectors is advanced urgently if we are to close the substantial gap between ambition and action and meet our national and EU obligations.

A Just Transition must take account of the livelihoods impacted by the increasing pressure placed on carbon-intensive economic activities, as well as the need to ensure that poorer households do not bear the burden of policies to reduce emissions, and that the benefits of transition and Government support are shared equitably. Whilst the focus of the Just Transition Commissioner so far was on the Midlands, many broader actions already taken have helped to facilitate Ireland's Just Transition nationally. Focused policy which redistributes carbon tax receipts towards those in fuel poverty and actions that prioritise those same households for retrofit and energy efficiency upgrades can play an important role. The Just Transition Commissioner emphasised the core role of Regional and Spatial Economic Strategies, strategic partnerships and a focus on consultation and collaboration. NESC are also exploring the pathway for a Just Transition for rural communities and the Agriculture sector. Ultimately for the transition to be successful, these efforts need to cross all sectors and regions, both urban and rural, and further coordinated efforts must be made to proactively identify vulnerable communities and practical solutions.

Climate action must support households, communities and businesses through the energy crisis by reducing Irish society's reliance on fossil fuels

Fossil fuels are consumed across all of society and there are now specific sectoral emissions targets for 2030 in place for the Agriculture, Transport, Built Environment, Electricity and Enterprise sectors. Many mitigation policies have an impact on society and it is critical that our approach to identifying and implementing solutions is sensitive to the varying distribution of costs and benefits. Key recommendations from the Council on policy arising from those sectors where fossil fuel consumption is highest are:

Table ES. 2 Summary of Council advice regarding Climate Change and the current Energy Crisis

Sector	Advice
Transport	▶ The reduction in public transport fares in early 2022 was a welcome step. Public transport provision must be enhanced and the reduction in fares should be retained and extended with an assessment of the effectiveness of both measures in terms of supporting the vulnerable and reducing emissions. ▶ Electric Vehicle (EV) already have a lower lifetime cost to the owner than conventional vehicles for high kilometre drivers such as rural households, taxi drivers and commercial drivers. Furthermore, the overall emissions savings are greater when a high kilometre driver makes the switch to electric in comparison to a low kilometre driver. This should inform government policy in this area. The extension of government supported low cost finance initiatives for retrofit to include purchase of EVs offers a route to reduce costs for both the Government and consumers. ▶ Congestion charging is a proven measure for discouraging car use in urban areas where public transport options exist. Plans should be developed and adopted for its immediate implementation after the roll out of the BusConnects scheme. ▶ The Programme for Government commitment to phase out the sale of new petrol and diesel cars by 2030 should be incorporated into the NCAP2023. Vehicle registration tax (VRT) for all petrol and diesel cars needs to increase to encourage early progress towards this goal and to ensure a sustainable transport system. ▶ The road haulage sector needs to move towards sustainability. Existing direct and indirect fossil fuel subsidies for diesel consumption in the sector need to be phased out. Supports should be provided to the sector to transition to alternative fuels. ▶ The Council is concerned about the long-term sustainability of biofuels in the context of global biodiversity and climate crises and the current pressures facing the global food supply. The Council is also concerned about the reliability of the provenance of imported Used Cooking Oils as a biofuel feedstock and its long-term sustainability. The Council therefore recommends a pause to the increases in biofuel blending rate obligations pending further research into biofuels' sustainability in the context of the global biodiversity and climate crises.
Electricity	**Demand** ▶ A demand side strategy is urgently required to support adoption of demand side technologies and support reductions in emissions intensity in the sector, along with further measures to enable and incentivise demand side flexibility in industrial, commercial and residential demand. ▶ Accelerated installation of smart meters, while ensuring the provision of smart meter data to customers and incentivising greater uptake of tariffs to help move demand away from peak times, are crucial to saving customers money and delivering change in the patterns of electricity usage to support a lower carbon electricity system. ▶ The Council supports urgent efforts by Government to promote energy efficiency efforts to the maximum extent possible and supports SEAI's innovative programme of communications to inform consumers and businesses of actions they can take to reduce energy demand.
Electricity	**Supply** ▶ In the context of the climate and energy emergencies, developing our vast renewable resource must be considered as being in the overriding public interest. Targets for onshore wind and solar renewable electricity should be significantly increased, with faster roll out of these and the associated grid reinforcement. Strong political and policy support is needed at a national and local level for the rapid delivery of renewable energy projects. ▶ There are significant consequences to delays in the development of renewable generation capacity, in the form of increased CO_2 emissions and higher electricity prices. Planning and regulatory processes must be appropriately resourced to ensure that projects can progress to operation as early as possible, while ensuring that biodiversity is not negatively impacted.

Sector	Advice
Electricity	**Supply (continued)** ▶ Offshore wind will play a critical role in the low carbon transition and it is imperative that steps for planning, consenting and developing the grid for offshore wind progress at pace. ▶ The Council is concerned about the emissions impacts of the retention of existing fossil fuel generation in the upcoming review of security of energy supply of Ireland's natural gas and electricity systems being carried out by DECC. A clear strategy for limiting the use of high emissions fossil fuel generation (coal and oil) must be developed in the context of both our climate requirement and energy security needs. The Council also urges Government to ensure adherence to the planned closure dates for example of Moneypoint and Edenderry. ▶ The development of a roadmap and pathways for the electricity sector beyond 2030 should start now. This must include an ambitious and evidence-based strategy for the role of green hydrogen, including accounting for the greenhouse potential of fugitive emissions which is an emerging concern within the climate science community.
Built Environment	▶ Increased energy prices bring health risks for vulnerable households and therefore climate action in the coming months should focus on helping reduce their dependence on fossil fuels this Winter with an emphasis on measures that can be rapidly deployed; – Support for retrofit and zero carbon heating systems needs to be prioritised towards households in receipt of the fuel allowance and towards the worst performing buildings, including in particular those heated by coal and peat. – The target for the Local Authority Retrofit Programme should be significantly increased. – Relatively cheap and easy measures such as attic insulation, pumping wall cavities, draught proofing, other wall insulation, improving windows and doors and heating controls can move the worst performing houses up through the BER ratings, delivering significant energy cost savings and/or improvements in comfort. – Solar PV panels are another measure that can be quickly deployed and that would reduce households' exposure to energy prices and can also provide further benefits to the electricity system by reducing peak demand. They should be mandated on all new builds, residential, commercial and public, in line with prospective EU legislation. Planning exemptions on rooftop solar should be extended to include more building types and to increase allowed capacity ▶ Zero carbon district heating has the potential to supply up to 50% of residential heat demand across Ireland including urban and some suburban areas. Concrete plans for its deployment across urban areas in Ireland must be included in the NCAP2023. This should include a publication of heat demand maps for urban areas and an action plan for delivery of district heating in the highest demand areas. ▶ Heat pumps are a proven technology with the capacity to provide low carbon heating to rural homes. Barriers to rapid deployment need to be urgently addressed; including free provision of heat pump assessments irrespective of follow through, better communication of heat pump requirements and a rapid scaling up of appropriately skilled professionals and tradespeople. Achieving targets in the heat sector requires robust supply chains, especially skilled labour in the construction sector. ▶ A recent report by the Irish Green Building Council noted that there is also significant potential to increase the share of timber frame homes in Ireland's housing stock, including through Modern Methods of Construction. The Council calls for urgent consideration of measures that will increase the share of timber frame construction in new homes, public and commercial buildings to replace cement and steel. ▶ The BER performance of buildings should be included with the sales information on the property price register on-line to allow better tracking and awareness of the impact of BER ratings on property values.

Sector	Advice
Enterprise	▶ Immediate action is needed to define the details of planned implementation pathways including, for example, measures to achieve emissions savings from a decrease in embodied carbon in construction materials and Carbon Capture, Utilisation and Storage (CCUS). ▶ SEAI's recent National Heat Study found that most industrial heat demand can be decarbonised through technology changes or fuel switching to carbon neutral heating. Policies aimed at decarbonising heat demand for the manufacturing combustion sector need to be tailored to investment-decision timeframes for enterprises. ▶ Industrial processes emissions are forecast to increase, driven by increased activity in the cement production industry. In addition to fuel substitution, CO_2 emissions associated with cement production should be reduced by maximising clinker replacement, utilising efficient use of cement in construction and replacement with lower carbon construction materials. ▶ It will be important to support the strengthening of the revised provisions under the F-Gas regulation in order to ensure high global warming potential gases are further phased out given the higher projected F-gas emissions as a result of the projected uptake rates in heat pumps. ▶ The Council welcomes the Circular Economy, Waste Management (Amendment) and Minerals Development (Amendment) Bill 2022, which among other measures will provide for the inclusion of targets in respect of re-used and repaired products and materials in waste management plans. A broader focus on the importance of the circular economy in the waste sector and improvement of Ireland's circularity rate is required, given Ireland's low circularity rate of 1.6% compared to the EU average of 11.9%.

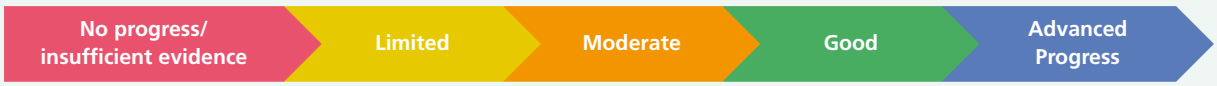
Given the relatively high share of national greenhouse gas emissions, it is also important to consider the Agriculture and Land Use Sectors. Amongst the measures a review of the 'Ag Climatise' – National Climate and Air Roadmap for the Agriculture Sector' is urgently required to realign the roadmap with the exigency and increased ambition for emissions reductions in the sector. This must provide a precise pathway and timeframe for speedy implementation of measures identified in Ag Climatise.

The Council recommends greater ambition in the rate and scale of deployment of land management mitigation measures. This includes urgent reform of the licensing and regulation of routine forestry activities, and acceleration of the rewetting and rehabilitation of the organic soil.

Increasing clarity regarding future impacts is emerging, but evidence of climate resilience across sectors is mixed

The Council's Adaptation Committee is now established on a legislative basis and its membership has been reviewed since the last Annual Review. Analysis of impacts of climate change on Ireland and internationally continues to develop and improve. Whilst the likely impacts on Ireland are becoming more evident, this is not matched by significant evidence of greater preparedness. Despite some progress at sectoral and local level, adaptation is still not adequately considered or represented in a range of policies or initiatives. This year's Annual Review considers for a second time, through its Scorecard analysis, progress across the 12 National Adaptation Framework (NAF) sectors, Local Government and the NAF itself. Engagement with this process by sectors is largely excellent but not universal. The Council again finds itself unable to give the highest score for adaptation progress to any sector and remains concerned about the understanding of adaptation and the capacity of all sectors to respond in a comprehensive manner. A summary of the outcome of the Scorecard analysis is presented in Table ES.3.

Table ES. 3 Adaptation scorecard summary (Source: CCAC and JBA Consulting analysis, see Chapter 9)



Sector (Department responsible)	Overall progress assessment
Agriculture, Forestry and Seafood (Department of Agriculture, Food and the Marine)	**Limited progress.**
Biodiversity (Department of Housing, Local Government and Heritage)	**No progress, insufficient evidence.**
Built and Archaeological Heritage (Department of Housing, Local Government and Heritage)	**Moderate progress.**
Transport infrastructure (Department of Transport)	**Moderate progress.**
Electricity and Gas Networks (Department of the Environment, Climate and Communications)	**Late submission/insufficient evidence.**
Communications Networks (Department of the Environment, Climate and Communications)	**Limited progress.**
Flood risk management (OPW)	**Good progress.**
Water Quality and Water Services Infrastructure (Department of Housing, Local Government and Heritage)	**Moderate progress.**
Health (Department of Health)	**Limited progress.**
Local Government (Local Authorities, CAROs)	**Good progress.**
National Adaptation Framework (Department of the Environment, Climate and Communications)	**Moderate progress.**

As set out in the Council's submission (July 2022) the review of the National Adaptation Framework by the Department should be more focused on adaptation action addressing priority risks while also preparing for the range of potential changes arising from remaining uncertainties in projections. The review should also look to strengthen resourcing and financing as enablers of adaptation actions. The Council has submitted its recommendations to the Department in respect of the review of the National Adaptation Framework, (see Chapter 10).[a] The key recommendations are:

- If considered in tandem with mitigation and sustainable development efforts, planned adaptation to climate change can present opportunities for innovative, inclusive and transformative climate resilient development. However, while the current National Adaptation Framework and sectoral and local adaptation plans and strategies, provide a solid foundation, overall, adaptation in Ireland has to date too often been marginal, incremental and process-based, and this is no longer sufficient.

a See Chapter 10 for the full text of the recommendations as submitted.

- A revised National Adaptation Framework must, therefore, provide for further integration with mitigation, sustainable development and disaster-risk reduction, all within the context of the National Climate Objective set in the Climate Act. All existing sectoral adaptation plans should then be revised and updated with additional plans required for sectors such as financial services, tourism and sport and the built environment. Coastal resilience also requires much more urgent attention.
- The NAF and plans under it should be informed by a regular national risk assessment and also clearly prioritise actions and investments. Decision makers at Government, department and national level must be better supported in their adaptation planning, so they can take account of the full range of potential changes projected. This includes the provision of adequate financial support for such activities on a sustained basis.
- To be effective, adaptation governance structures will also need to be revised and restructured to ensure cross-cutting issues that go across multiple sectors are addressed. More meaningful leadership and coordination across Government on climate adaptation action are required, but all of society has a role in ensuring our climate resilience.
- The Government must also urgently set forth and then monitor a set of national resilience indicators to measure our climate resilience and assess progress towards achieving climate resilient development.
- Finally, it is critical that an initial adaptation budget to 2030 be set, following an assessment of what is required to make Ireland resilient by 2050 and beyond. This budget must be determined in light of the social cost of climate change over at least the next 30 years, and must reflect the need to prioritise funding for adaptation to a significantly greater degree than is currently the case.

The Implementation Gap remains a cause for concern

The Annual Review 2021 raised the issue of the implementation gap whereby ambition on climate policy was not being matched by verifiable actions. Several issues regarding implementation continue to cause concern and are re-emphasised throughout this Annual Review 2022.

Table ES. 4 Causes for concern with respect to the Implementation Gap

Domain	Issue
Emissions Targets	▶ Ireland has failed to meet its 2020 EU target of a 20% reduction in greenhouse gas emissions and will have to use allowances purchased from other Member States to meet the shortfall. ▶ EPA emissions projections suggest that Ireland could meet its non-ETS EU targets of a 30% emission reduction by 2030 (compared to 2005), assuming full implementation of planned policies and measures and the use of the flexibilities available. New EU targets for 2030, which will further increase the level of ambition, are under negotiation in the context of the EU Fit for 55 Package. However, provisional non-ETS emissions in 2021 total 46.2Mt CO_2 eq, well in excess of the annual emissions allocation of 43.5Mt CO_2 eq. ▶ Achieving compliance with national and EU targets will require a significant acceleration in the planning of new measures and full and rapid implementation of already announced measures will be necessary to achieve these goals.

Domain	Issue
Delays to delivery	▶ Many of the measures in the 2021 Climate Action Plan have been delayed. Ireland is one of only four EU member states not to have submitted a Long-Term Climate Strategy. Other high impact measures, which have been delayed, include the development of a roadmap to promote higher use of low-carbon materials in construction and examining how and when fossil fuel heating systems can be phased out of public buildings ▶ Quarterly reporting of delivery by Government departments and agencies of the actions in National Climate Action Plans needs to be maintained and become more accessible and focused on those measures that make the most significant impact. These measures must then be afforded the highest possible priority by Government. Resourcing issues that are delaying action will need to be addressed. ▶ The upcoming Climate Action Plan should place increased focus on defining the details of planned implementation pathways and identification of further measures across all sectors. ▶ The quarterly report did provide some analysis of the main reasons for delay which are of substantial concern to the Council. It is clear that adequate resourcing is at the root of many of these issues and this will need to be addressed, where possible, in Budget 2023. ▶ The Council is also concerned that delays are being attributed to public consultation processes which can assist with public buy-in and the acceleration of implementation of measures, but should not become a bottleneck to implementation.

Conclusion

The recent IPCC reports highlight that projected adverse impacts and related losses and damages from climate change will continue to escalate with every increment of warming. This year's Annual Review shows that national greenhouse gas emissions fell in 2020 but bounced back in 2021 as the COVID-19 related restrictions were lifted. Emissions in 2020 were largely the same as the levels in 2011, and this lack of progress over the decade is no longer acceptable given our national and EU obligations. The carbon budget programme and the sectoral emissions ceilings bring a further level of clarity in terms of the responsibilities at Government level for achieving these targets. A greater level of urgency on achieving decarbonisation goals would clearly have benefits beyond the emissions reductions such as greater energy security. At the same time our path towards future climate resilience and adaptation requires a more comprehensive holistic approach and greater coordination across Government.

The Annual Review is intended to assist the Government in advancing climate action whilst dealing with a significant external crisis, deteriorating economic conditions, and growing public awareness of the scale of the challenge. The Government must ensure that actions taken now to address these crises tackle the cause of our exposure to these events and not just the symptoms. The lesson is clear: we need to take all actions to reduce demand for fossil fuels and decarbonise our energy supply while protecting the most vulnerable in our society. This transition is inevitable, has significant co-benefits for health, well-being and quality of life, and must not face any further delay.

1. Introduction

The Annual Review 2022 is the sixth annual review carried out by the Climate Change Advisory Council. Each year the Council reviews Ireland's performance during the immediately preceding year (in this case 2021) with regard to the achievement of the country's national climate aims through climate change adaptation and mitigation, and compliance with European Union (EU) and international obligations related to climate action.

This Annual Review of national progress is presented following the publication of the Intergovernmental Panel on Climate Change (IPCC)'s Working Groups II and III in spring of 2022, which update our understanding of issues in respect of climate change impacts, adaptation, vulnerability, and mitigation. These IPCC reports highlighted:

- the need for coordinated, inclusive, innovative and accelerated adaptation, and a strong message that projected adverse impacts and related losses and damages will continue to escalate with every increment of warming;
- that urgent action is required to achieve the Paris Agreement temperature goal of limiting global warming well below 2C and making efforts to limit warming to 1.5C above pre-industrial levels;
- that there is a narrowing window for action to reduce emissions and prepare our society for the impacts of a changing climate; and
- this requires enhanced prioritisation and accelerated implementation of current policies and enhanced ambition at a global level that is delivered at greater speed and scale.

Whilst the IPCC reports are global in nature, many of the messages have national implications. The Council is concerned that the necessary national actions are not taking place or being enabled at the speed and with the level of coordination across government and society that is required. Climate change is happening, and the recent extreme temperatures in India, across much of Europe and elsewhere have shown that every country is vulnerable to its impacts whilst needing to prepare for a world that is significantly less dependent on fossil fuels.

The Climate Action and Low Carbon Development (Amendment) Act 2021 ('the Climate Amendment Act')[2] sets out the legal framework for Ireland's transition to a climate resilient, biodiversity rich, environmentally sustainable and climate neutral economy by no later than 2050. This is called the **national climate objective** and replaces the national transition objective from the 2015 legislation.[a]

The amended Climate Act represents a substantial increase in ambition and a widening of the policy objective. The Act provides for a 2030 interim target (-51%), five-yearly carbon budgets, sectoral emissions ceilings, an annually updated Climate Action Plan and a Long-Term Climate Action Strategy.

From this year the Annual Review will assess progress in complying with the carbon budget and each sectoral emissions ceiling. As such the structure of the Review is somewhat realigned to take on a more sector-specific focus. While much of the analysis in this report considers progress in 2021, significant developments in 2022, such as the IPCC's WGII and WGIII Sixth Assessment Reports and the energy security crisis resulting

a The 2015 Act provided the statutory basis for the national transition objective laid out in the national policy position. The National Climate Policy Position established the national objective of achieving a competitive, low-carbon, climate-resilient and environmentally sustainable economy by 2050. It set out the level of greenhouse gas mitigation ambition needed and established the process to achieve the overall objective. The National Policy Position envisaged that policy development would be guided by a long-term vision based on: an aggregate reduction in carbon dioxide (CO_2) emissions of at least 80% (compared to the 1990 levels) by 2050 across the electricity generation, built environment and transport sectors, and an approach to carbon neutrality in the agriculture and land-use sector, including forestry, which does not compromise capacity for sustainable food production.

from Russia's illegal and unprovoked invasion of Ukraine, are also noted alongside up-to-date indicative values for key indicators for 2022.

The Annual Review 2022 reflects the requirements of Section 12 of the Climate Act and is organised into 11 chapters. The remainder of the report is structured as follows:

Chapter 2	contains a summary of Ireland's changing climate and future projections relevant to this subject.
Chapter 3	assesses the State's performance and compliance with its national and international obligations and targets for action on climate change.
Chapter 4	focuses on Agriculture, Forestry and other land.
Chapter 5	focuses on the Transport sector.
Chapter 6	focuses on the Electricity sector.
Chapter 7	focuses on the Built Environment sector.
Chapter 8	focuses on the Enterprise sector.
Chapter 9	reviews adaptation and Ireland's climate resilient transition in the existing National Adaptation Framework sectors.
Chapter 10	documents the Council's advice to Government in respect of the Review of the National Adaptation Framework.
Chapter 11	documents the activities and meetings of the Council and Adaptation Committee in 2021 in line with Section 12 of the Climate Act.

2. Our Changing Climate

Key messages

Observations

- Climate patterns are becoming increasingly unreliable and hard to predict. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have already occurred. The impacts of this are increasingly apparent: changes to temperature and rainfall, and increases in certain weather and climate extremes.
- The social, economic and environmental impacts of climate change are already being felt both around the globe and within Ireland.
- The key Irish climatic hazards and impacts are likely to be (i) the rise in temperatures, which will increase the number of heatwaves with the attendant risk of increasing frequency of droughts, (ii) altering precipitation patterns, which will increase flood risk, (iii) changes in the character of weather extremes such as storms, flooding, sea surges and flash floods, and (iv) sea-level rise leading to coastal inundation, and erosion.
- Ireland is experiencing different kinds of extreme weather events with increasing frequency and intensity. For example, Ireland was directly affected by three named storms in 2021(Darcy, Arwen and Barra), the second of which caused especially notable damage – flooding homes across the country, leaving 59,000 homes and businesses without power, and causing disruption to schools, colleges, transport and hospitals. These storms highlight how vulnerable our existing infrastructure can be to extreme weather events and underline the need to prepare for a changing climate.
- Irish modelling analysis indicates that risk of drought will continue to increase in the coming decades as dry periods in summer become ever more frequent and extreme, while heavy rainfall/precipitation events are also projected to increase substantially, particularly in autumn and winter.
- Research suggests that these changes also carry a significant risk for biodiversity in Ireland. Our changing climate will raise the level of stress experienced by organisms and reduce their capacity to survive, not least by inducing mismatches in the life cycles of species which depend on each other.
- As established by the Intergovernmental Panel on Climate Change (IPCC) Working Group II report, the window of opportunity to secure a liveable and sustainable future is closing, and we must act now.

2.1 Chapter introduction

This chapter presents a summary of the most recent developments in our understanding of our climate, how it is changing and how it is projected to change further. This is essential to understanding the urgency for both mitigation[a] and adaptation[b] action in both a global and Irish context.

2.1.1 Summary of recent developments and knowledge

Climate change is already impacting social, economic and environmental systems around the globe and within Ireland. Together, the IPCC WGI, WGII and WGIII Sixth Assessment Reports emphasise the need to decarbonise our economy and society through climate change mitigation while taking account of these impacts on our economy, society and environment through appropriate adaptation. They also show that even temporarily exceeding the 1.5°C Paris Agreement threshold will result in additional severe consequences compared to remaining below 1.5°C, some of which will be irreversible even if global warming is subsequently reduced. The IPCC reports' overarching message is that the cumulative scientific evidence is unequivocal: climate change is a threat to humans and all life on this planet. There is no more time for delay. The window of opportunity to secure a liveable and sustainable future is closing, and we must act now.

a Human interventions to reduce emissions or enhance the sinks of greenhouse gases.

b The process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities.

2.2 Latest scientific evidence for observed and projected climate change

2.2.1 Observed and projected climate changes

The IPCC's WGI Sixth Assessment Report confirms that evidence is overwhelming that the climate has changed since the pre-industrial era and that human activities are the principal cause of that change. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred, and these are unusual in the context of at least the past several thousand years.[a] The signs of this are increasingly apparent, with temperature changes and long-term changes in variables such as rainfall, while an increase in some weather and climate extremes have also now become apparent in many regions.[3] In its annual report on the State of the Global Climate, the World Meteorological Organization (WMO) reported that four key climate-change indicators broke records in 2021: greenhouse gas concentrations, sea level rise, ocean heat, and ocean acidification. It also reported that the past seven years have been the warmest consecutive years on record, with exceptional heatwaves breaking records across western North America and the Mediterranean over the summer of 2021, and that the world experienced a number of deadly and costly flooding events as well as extreme drought events.[4] The IPCC's WGII Sixth Assessment Report provides the stark analysis that this human-induced climate change has caused widespread adverse impacts and related losses and damage to nature and people. Even under the most ambitious mitigation policies, these will continue to get worse for many decades or, in the case of sea-level rise, many centuries to millennia. This will have social, economic and environmental implications that society will have no choice but to prepare for, and in which appropriate adaptation measures will be key.

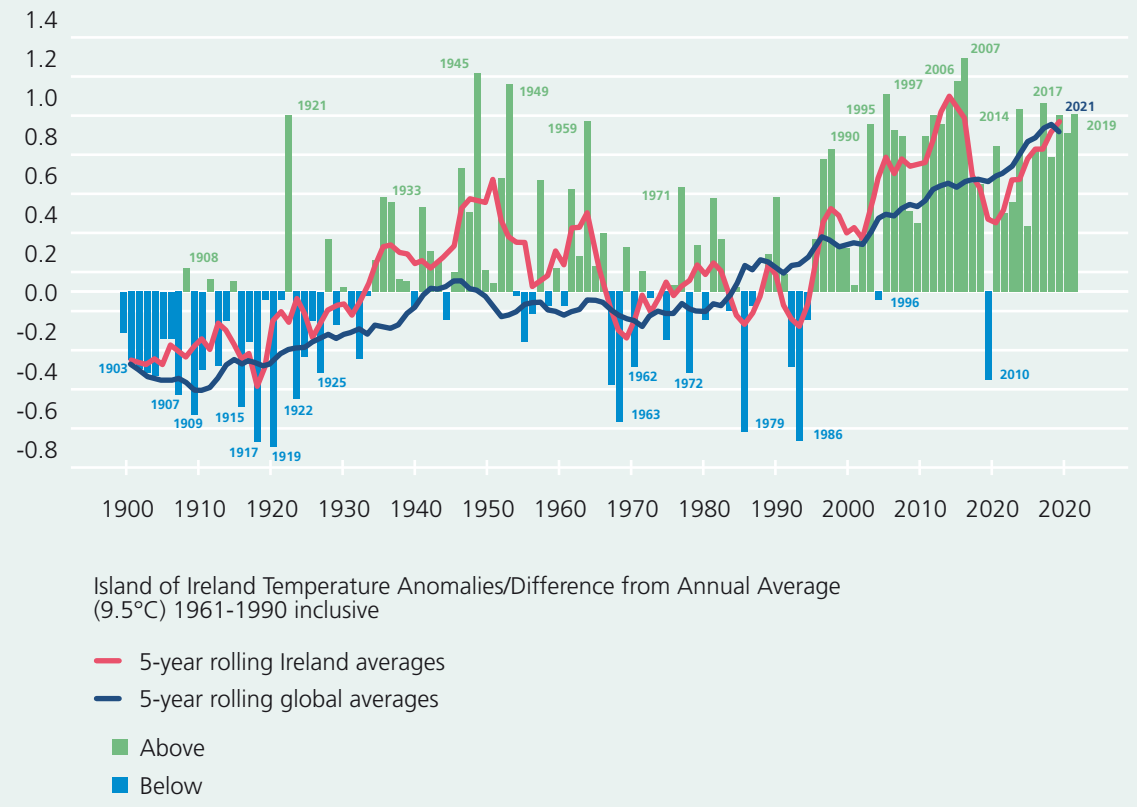
Many changes in the climate system, including reductions in Arctic sea ice, and increases in the frequency and intensity of hot extremes and heavy precipitation, become larger in direct relation to increasing global warming. Many other changes will be irreversible for centuries to millennia, especially changes in the ocean, ice sheets and global sea-level. Global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered by the IPCC. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide (CO_2) and other greenhouse gas emissions occur in the coming decades. Changes and associated impacts would be more widespread at 2°C compared to 1.5°C global warming and even more widespread and/or pronounced at a higher warming level.[3]

2.2.2 State of Ireland's climate in 2021

The year 2021 was the eleventh consecutive year with temperatures above Ireland's long-term average. While the first five months of 2021 were not particularly warm, Ireland experienced a variety of heat records between June and November, with at least 10 weather stations across the country recording heat wave conditions in July for several days, and Autumn 2021 earning the title of the warmest Autumn on record.[5] These increased temperatures are in line with the average temperature rise being experienced globally. Ireland was directly affected by three named storms in 2021, notably with two major storms towards the end of the year, Storm Arwen and Storm Barra, the latter of which caused especially notable damage, flooding homes across the country, leaving 59,000 homes and businesses without power, and causing disruption to schools, colleges, transport and hospitals.[6] The storms in 2021, and the storms experienced again in February 2022, highlight how vulnerable the existing Irish infrastructure can be to extreme weather events and underline the need to prepare for a changing climate. In particular, the adoption and implementation of effective adaptation measures across all sectors of human activity from, for example, water conservation, agriculture-horticulture, spatial and environmental planning to coastal zone living, is now critical.

a The cryosphere refers to those portions of the earth where water is in a solid form, usually snow or ice. Biosphere refers to those parts of the earth's surface and atmosphere occupied by living organisms. Atmosphere refers to the envelope of gases encircling the planet.

Figure 2.1, below, shows the annual air temperature anomalies for Ireland for the period 1900-2021 compared with the 1961-1990 average, confirming this warming trend. Recent research confirms that precipitation intensity has increased over the past century, especially in the east and southeast of the island, and that the contribution of heavy and extreme precipitation events to annual totals is also increasing, while there are no persistent trends in annual precipitation totals.[7]



Data from Malin Head, Co Donegal, Birr/Gurteen, Co Offaly/Tipperary, Phoenix Park, Co Dublin, Valentia Observatory, Co Kerry and Armagh Observatory, Co Armagh (Armagh data courtesy of Met Office, UK).

Global Temperature anomalies: HadCRUT5 Near-Global (Land+Sea), Climatic Research Unit, University of East Anglia, Wednesday 1 June 2022.

Figure 2.1 The annual air temperature anomalies for Ireland for the period 1900-2021 compared with the 1961-1990 average (Source: Met Éireann Annual Climate Statement for 2021)[5]

These trends accord with the pattern seen in the EPA, Met Éireann and Marine Institute's Status of Ireland's Climate 2020 report, which outlined how the annual average surface-air temperature in Ireland has increased by approximately 0.9°C over the last 120 years, with a rise in temperatures being observed in all seasons. Precipitation was 6% higher in the period 1989-2018 compared to the period 1961-1990, with the decade between 2006 and 2015 being the wettest on record, and the sea-level around Ireland has been rising by around 2-3mm per year since the early 1990s.[8] Across most of the country, river flows can be observed to be increasing, but in the last thirty years they have been decreasing in certain areas, suggesting an increase in potential drought conditions, especially in the east.[8] These changes in rainfall and sea-level rise are indicative of future flood risk (coastal, pluvial [rainfall] and fluvial [river]) across much of the country, while there is already some drought risk in the east of the country as well, meaning that changes in precipitation may result in increased pressure on water supply into the future. As water supplies in Ireland were originally built to cater for a smaller population, the vulnerability arising from intensifying drought conditions highlight the need for robust water resource management policies to ensure a safe and secure water supply in the future.[9]

Until recently, drought has been a 'forgotten hazard' in Ireland with few island-wide hydrological droughts occurring since the mid-1970s. This is reflected in national policy as Ireland's first National Drought Plan has yet to be drafted and no national scale drought-monitor or warning system has been established, despite climate forecasts showing Ireland has amongst the strongest trends to greater precipitation deficits in summer.[10]

2.2.3 Ireland's projected future climate

National climate modelling research conducted at the Irish Centre for High-End Computing (ICHEC) and Met Éireann involves assessing climate change on both a global and regional scale. National efforts can be augmented by the wealth of international climate modelling and, taken together, these simulations can inform us about potential climate futures. A measure of confidence in these national projections was provided by quantifying the uncertainty in the projections using a multi-model ensemble approach. The Irish climate-modelling analysis indicates that by mid-century (2041-2060) Irish temperatures are projected to increase by 1-1.6 °C compared with the 1981-2000 period[a], with the largest increases in the east of the country.[11] On summer days and winter nights, the average rise in temperatures may surpass 2°C. Ireland may experience approximately half the number of frost and ice days, while summer heatwaves will likely become more frequent, particularly in the south of the country. Dry periods in summer are also projected to become more frequent, while heavy rainfall/precipitation events are projected to increase substantially, particularly in autumn and winter. Projections also indicate that wind energy may decrease (≤2%) overall in future climate scenarios, storm tracks will change, and the growing season will lengthen. These results are confirmed and strengthened by similar outputs from earlier modelling studies. Of course, climate change projections, like all projections of the future, are subject to uncertainty, not least because the actions we do or do not take today and over the coming years will impact the state of the climate in the future. It is therefore critical to devise plans for a range of possible climate change scenarios and outcomes to ensure resilience.

2.2.4 Climate impacts for Ireland

The IPCC WGII report emphasises the need to implement climate adaptation measures as a priority to help society to build capacity to cope with the impacts of climate change. The timescale left for doing this is very short. Meanwhile under Project Ireland 2040[b], plans are being made for the likely increase of Ireland's population by another one million people by 2040, with the associated urban renewal, new housing, transport systems, water infrastructure, rural development, and more – all whilst transitioning to a climate-resilient, biodiversity-rich and climate neutral economy by no later than the end of the year 2050 (in line with the National Climate Objective).

The four key climate change risks identified for Europe by the IPCC in its WGII Sixth Assessment Report are (i) heat-related death and illness of humans and ecosystems, (ii) crop loss due to the combined effects of heat and droughts, (iii) water scarcity across sectors, and (iv) the effects of flooding on people, infrastructure and economies. Many of these risks apply also in Ireland as referenced already in Section 2.2.2.

In the area of biological impacts of climate change, significant shifts in the phenology (the study of seasonal events in the life cycle of living organisms) of plants and animals have already been observed. Recent EPA-funded research on phenology shows that increasingly significant mismatches are occurring in the life cycles of interdependent species due to climate change. Phenological mismatches pose a significant threat to biodiversity[12] and therefore to the health and sustainability of ecosystems and the ecosystem services they

a Under this work, in winter temperatures are projected to be 0.9-1.2°C higher in the south-west and 1.2-1.6°C higher in the north-east; in spring 0.9-1.0°C higher in the south-west and 1.0-1.3°C higher in the north-east; in summer 1.0-1.3°C higher in the north-west and 1.3-1.8°C higher in the south-east; and in autumn 1.3-1.6°C higher in the west and 1.5-1.9°C higher in the east.

b The National Planning Framework (2018) and the National Development Plan 2021-2030 combine to form Project Ireland 2040.

provide. The latest checklist of all protected and threatened species in Ireland, released in 2019, classified 77 species as critically endangered, 126 more as endangered, and many more as vulnerable.[13] Whilst the causes of threat to these species are not all from climate change, the role of climate will be increasingly to further raise the base level of stress for organisms and reduce their capacity to survive.

Biophysical impacts of climate change such as this translate into social and economic impacts. Economic impacts consist both of direct damage induced by, for example, extreme weather events, and the implications for the long-term productive capacity of the economy due to gradual changes in climatic conditions.

Climate change affects the long-term determinants of growth, i.e. the productivity of labour and capital and the dynamics of capital accumulation. Evidence shows that projected changes in the distribution of temperature and precipitation will shift the productivity in the agricultural, fishery and forestry sectors, reduce outdoor labour productivity, shift the energy demand and affect the energy supply, disrupt infrastructures such as transport, and can induce capital assets loss through fluvial floods and sea-level rise. Economists assess these impacts by evaluating climate induced change on Gross Domestic Product (GDP) in the medium to long term (2050 to 2100) relative to a counterfactual scenario in the absence of climate change.

As an example of how Ireland must consider climate change in our future development, guidelines published by the Department of Housing, Local Government and Heritage highlight the need for a multidisciplinary approach to surface-water management which incorporates Nature-based Solutions, particularly for urban areas, where the artificial drainage systems were designed for rainfall patterns that are more representative of the earlier years of the 20th century and where infrastructure was designed on the basis of historic data, rather than the changing patterns of rainfall of the present and into the future.[14]

A recent EU-funded project, titled CO-designing the Assessment of Climate CHange costs (COACCH)[15], evaluates the compounded impacts of climate change on EU GDP with country level disaggregation. It shows that the overall impacts of climate change are negative and will likely decrease Irish GDP from -0.1% to -1.2% by 2050. It should be noted that this assessment omits many expected impacts, such as health, and therefore is likely to be an underestimate of the impacts of climate change on Irish GDP. According to this analysis, most impacts come from losses in capital assets from fluvial flooding and climate-induced decreases in labour productivity. Also, the resulting range of impacts shows uncertainties underlying this type of assessment, which come from uncertainty in the future worldwide emission trajectories, regarding the strength of climate change biophysical effects, and in capturing the economic translation of biophysical impacts. Much remains to be done in a short timeframe to understand the different role of these uncertainties, as well as the distribution of the economic impacts across households and firms, and their interaction and interconnection and ultimate implications for society.

Most economic assessments omit non-market impacts of climate change such as on human health, biodiversity and ecosystem services. This is despite the IPCC's analysis providing further confirmation of the widespread damage to nature and people caused by human-induced climate change, which is already impacting people's health and livelihoods, the planet's biodiversity and its ability to recover.[16] Indeed, it stated that there is increasingly indisputable evidence that the rise in weather and climate extremes has already pushed some natural and human systems beyond their ability to adapt. Furthermore, current unsustainable development patterns are increasing exposure of ecosystems and people to climate hazards, rather than protecting them from such hazards. The projected adverse impacts of climate change and the related losses and damage will only continue to escalate with every increment of warming.[16]

3. Mitigation: national and international context

Key messages

Observations

- Latest EPA inventories indicate that due to emissions increases in 2021, greater percentage reductions in emissions than originally assessed in the Council's analysis for Carbon Budgets will be required over the period 2022-2025 to deliver the first carbon budget.
- Current projections highlight the risk of gaps to target of 40-55Mt CO_2 eq in the first carbon budget period and 77-127Mt CO_2 eq in the second carbon budget period. It is critical that National Climate Action Plan 2023 (NCAP 2023) addresses these gaps.
- It is clear there is a need for a significant acceleration of existing and planned actions and to identify, quantify, resource and implement significant further measures to put Ireland on track to remain within its carbon budgets.

Recommendations

- The announcement of sectoral emissions targets for 2030 is a welcome milestone but the targets announced do not provide all of the necessary clarity in terms of how the carbon budgets are allocated at a sectoral level, how the overall target of 51% reduction by 2030 will be met, or how the Land Use Sector will be included in meeting the targets. As presently expressed the quantified emissions reductions only amount to a reduction of 42% excluding the Land Use Sector and are therefore not consistent with the objective in the Climate Action and Low Carbon Development (Amendment) Act. Whilst these targets are a useful starting point, they will need to be revised upwards and monitored closely in the light of experience. The Climate Action Plan 2023, due later this year, will need to set out the precise actions and steps that must be followed in order to align with the ambition of the Carbon Budgets that were adopted by the Oireachtas in April.
- Many of the measures in the 2021 Climate Action Plan have been delayed. Quarterly reporting of delivery by Government departments and agencies of the actions in National Climate Action Plans needs to be maintained and become more accessible and focused on those measures that make the most significant impact. These measures must then be afforded the highest possible priority by Government. Resourcing issues that are delaying action will need to be addressed.
- The Council reaffirms its strong support for the Government's carbon tax plans, including the use of ringfenced revenue raised for the continuation and enhancement of retrofit supports, welfare transfers to protect the most vulnerable households and investment in sustainable agriculture.
- The EU is working on a very wide set of reforms through its EU Fit for 55 Package. The Irish position in the negotiations is understood to be broadly supportive of the package of measures, though transparency and timeliness in adopting positions is lacking. Given the level of reductions in emissions implied by the national climate objective, it is important that Ireland transparently and robustly supports this ambition whilst ensuring that important revenues for climate action are not jeopardised. Furthermore, the use of revenues from the EU ETS auctions, which has increased significantly in line with the higher ETS prices, should be transparent and focused on impactful climate measures.
- There is a need for further development of analysis around macroeconomic impacts of deep decarbonisation trajectories. Such analysis should also consider the potential for clearer and distinct budgeting for the resourcing of adaptation and mitigation measures.
- Recognising the need to increase both financial and skills resourcing for delivery of the national climate objective, the Council considers it critical that the objectives and resourcing of the state financing agencies as key enablers be definitively prioritised and aligned with the NCAP2023.
- It is vital that Government takes further action to ensure that the planning system is sufficiently resourced for and capable of responding to the challenges posed by deep and accelerated decarbonisation and resilience pathways.
- Given the importance of reducing fossil fuel use, it is imperative that analysis of fossil fuel subsidies is accelerated and that appropriate fiscal measures be incorporated into the 2023 and later fiscal budgets.

3.1 Chapter introduction

The policy landscape in which Ireland pursues its climate ambition is becoming ever more complex whilst the level of ambition has been ratcheted up. Carbon budgets proposed in advance of the last Annual Review were adopted by the Oireachtas in April. The extent of the ambition underpinning the Carbon Budget Programme should not be under-estimated and will require transformative change led by Government across all sectors and by all members of society. The sectoral emissions targets for 2030 announced by Government on July 28th represent an important first step in the distribution of the effort of achieving these demanding ceilings to the relevant sectors.

The EU is also demonstrating increased ambition, and this has differing consequences for various emissions sectors. Broadly speaking, the increased national ambition as expressed through the Low Carbon Climate Act is consistent with the increase in ambition at EU level in aggregate, although the EU set up is structurally quite different.[2],[17]

This chapter outlines the current situation as regards Ireland's national and EU targets, assesses some of the likely changes to the EU legal context arising from the EU Fit For 55 proposals and examines some other issues and measures that are national or cross-sectoral rather than sector specific.

3.2 Carbon budgets

In October 2021, the Council made its proposal to the Minister in respect of Ireland's first carbon budget programme. In line with the legislation, this proposal was the subject of review by the Joint Oireachtas Committee on Environment and Climate Action, public consultation and agreement by Government. Finally, in April of this year, the Oireachtas adopted the Council's proposal.[18] The budget programme means that Ireland's total emissions (excluding international aviation and maritime) must not exceed 295Mt CO_2 eq for the period 2021-2025, and 200Mt CO_2 eq for the period 2026-2030. A provisional ceiling of 153Mt CO_2 eq has been set for the period 2031-2035.

The sectoral emissions ceilings announced by Government on July 28th distribute the effort of achieving these demanding ceilings to the relevant sectors as illustrated in Table 3.1.[19] **This is a welcome milestone but the targets announced do not provide all of the necessary clarity in terms of how the carbon budgets are allocated at a sectoral level, how the overall target of 51% reduction by 2030 will be met, or how the Land Use Sector will be included in meeting the targets. As presently expressed the quantified emissions reductions only amount to a reduction of 42% excluding the Land Use Sector and are therefore not consistent with the objective in the Climate Action and Low Carbon Development (Amendment) Act. Whilst these targets are a useful starting point, the targets will need to be revised upwards and monitored closely in the light of experience. The Climate Action Plan 2023, due later this year, will need to set out the precise actions and steps that will need to be followed in order to align with the ambition of the Carbon Budgets, which were adopted by the Oireachtas in April.**

In line with the Amended Climate Act, the sectoral chapters that follow examine the extent of likely compliance with the ceilings and, where appropriate, propose additional or accelerated actions as necessary.

Table 3.1 Sectoral Emissions Targets for 2030[a]

Sector	2018	2021	Sectoral Target Reductions	Sectoral Emissions Target 2030	WEM Emissions 2030	WAM Emissions 2030	Distance to Target 2030 (WEM)	Distance to Target 2030 (WAM)
Electricity	10.3	10.0	75%	2.6	5.1	4.2	2.5	1.6
Transport	12.2	10.9	50%	6.1	10.3	7.4	4.3	1.3
Residential	7.1	7.0	40%	4.3	5.2	4.0	0.9	-0.2
Commercial and Public Buildings	1.5	1.5	45%	0.8	1.3	1.0	0.4	0.2
Industry	7.0	7.1	35%	4.6	6.0	6.1	1.5	1.5
Other	2.2	2.0	50%	1.1	1.8	1.8	0.7	0.7
Agriculture	23.1	23.1	25%	17.3	22.8	17.8	5.5	0.5
Land Use, Land Use Change and Forestry	6.9	7.8	n/a	n/a	11.1	8.3	n/a	n/a
Total Emissions including LULUCF	**70.2**	**69.3**	**63.7**	**50.6**	**n/a**	**n/a**	**n/a**	**n/a**
Total Emissions	**63.4**	**61.5**	**42%**	**36.7**	**52.6**	**42.3**	**15.8**	**5.6**

Preparatory work on the proposal for a second programme of carbon budgets has been initiated by the Council. This will be informed inter alia by the outputs of the Joint Oireachtas Committee report and an internal review that is ongoing. More detail on progress towards the next carbon budget programme will be provided in the Annual Review of 2023.

3.3 Emissions inventories, projections[b] and indicators

3.3.1 Inventories

Inventories of greenhouse gas emissions at a national level are finalised by the EPA approximately 16 months after the end of each reference year, with a full time series (from 1990 onwards) presented at that time. In recent years provisional data on inventories has become available in the year following the reference year.

Provisional data for 2021 was published on 21st July.[20] Figure 3.1 shows the split by sector of these emissions, including Land Use emissions for the period 1990-2021. Emissions (including Land Use) in 2021 increased by 5.5% due to a variety of factors, including significantly higher electricity generation using coal and oil, increased agricultural activity and a return to higher levels of transport emissions as Covid-19 restrictions were eased. Importantly, emissions were 1.3% lower than in 2018, the baseline year for carbon budgets and the legally mandated 51% reduction to be achieved by 2030.

a There may be minor differences in this table compared to the Government press release due to rounding.

b Emissions values are expressed using either AR4 or AR5 values as appropriate. For example in discussion on compliance with EU Targets for 2020, AR4 values are appropriate. When discussing projections for national and EU targets in 2030, AR5 values are appropriate. All future EPA publications of inventories or projections will use the GWP values from IPCC AR5.

There will need to be a significant drop in emissions over the remaining years of the first carbon budget period in order to ensure compliance. The rate of reduction in emissions required to return to a pathway that is consistent with the first carbon budget will be higher than that estimated in the Carbon Budget Technical Report.[17] The EPA noted in its publication that reductions of over 5Mt CO_2 eq (or 8.7%) per annum will be required. **The provisional 2021 emissions levels are NOT consistent with a pathway towards achieving the first carbon budget.**

Early indicator data for 2022 do not suggest any turnaround in this trend. In fact, the SEAI data suggest that there is strong growth across almost all of the main fossil fuels. Their 'Five Fuel' aggregate was growing at a moving annual total rate of 15% as of the end of April 2022.[21],[a] SEAI short-term statistics in regards to electricity suggest that whilst there are months during which the contribution of renewables is very high, reaching record levels in February of this year, that overall the contribution of fossil fuel generated electricity is still growing.[b] In summary, it seems likely at this point that carbon dioxide emissions from Energy will grow in 2022, whereas the carbon budgets demand the opposite.

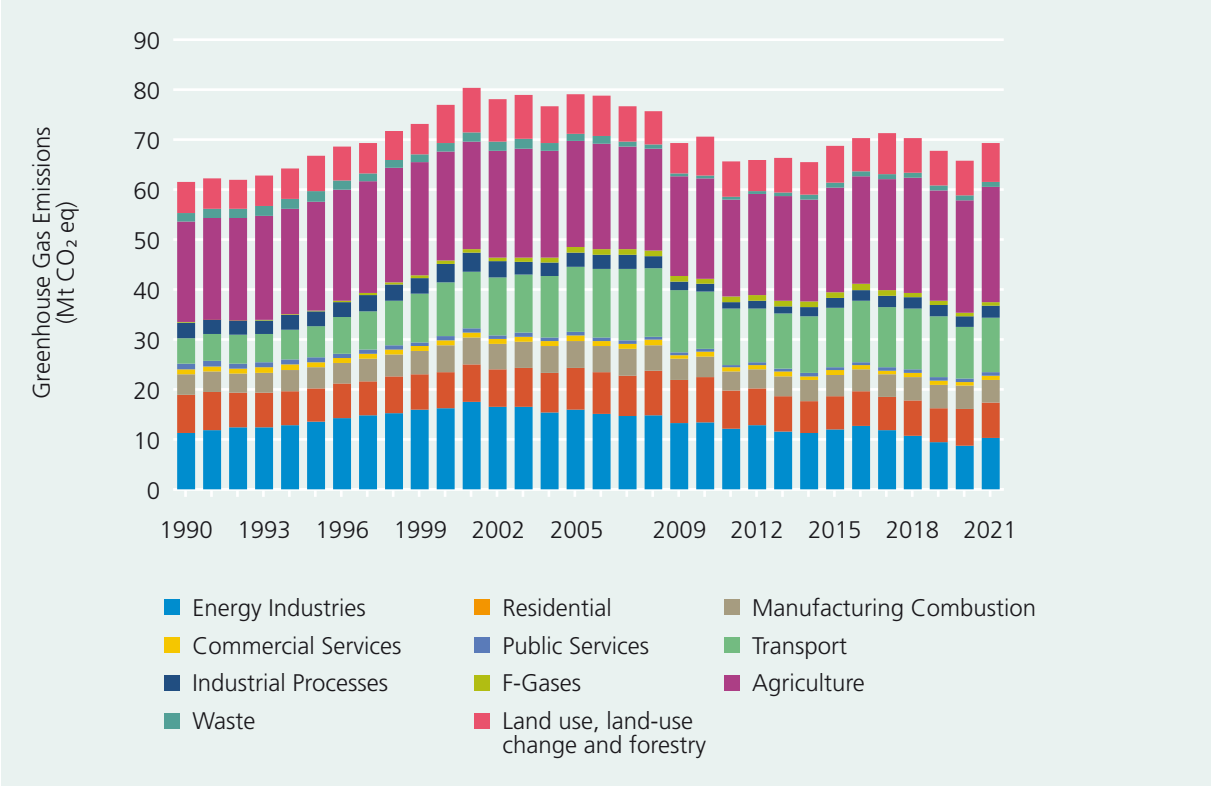


Figure 3.1 Emissions by sector between 1990 and 2021

a This comprises motor diesel, petrol, jet and non-jet fuel kerosene and heating and other gas oil.

b SEAI monthly statistics show that conventional thermal electricity is growing on a year to date basis of 6% – of which coal is growing by 11% and natural gas by 3%. Power generated by wind grew by 10% over the same period.

3.3.2 Projections

The EPA published the latest set of projections of greenhouse gas emissions on June 1st for the period 2021-2040. These include two policy scenarios based on the measures currently implemented and actions committed to by Government ('with existing measures'), and a projection based on the measures outlined in the latest Government plans at the time projections are compiled ('with additional measures').[a,b] At a nationally aggregated level these projections now assume a greater importance in light of the carbon budgets.

Box 3.1 Emissions projections scenarios

- What do 'With Existing Measures' and 'With Additional Measures' scenarios in emissions projections mean?
- The With Existing Measures (WEM) scenario assumes no additional policies and measures beyond those already in place by the end of the latest national GHG inventory year (2020) at the time of the projections compilation.
- The With Additional Measures (WAM) scenario assumes implementation of the WEM scenario in addition to, based on current progress, further implementation of planned government policies and measures adopted after the end of the latest inventory year. In the case of the latest projections (published in June 2022), this includes the implementation of Ireland's Climate Action Plan 2021. This Plan, published in November 2021, sets out a major programme of policies and measures aimed to help Ireland achieve its decarbonisation goals.

Figure 3.2 shows how the WEM and WAM scenarios project emissions to decline over the period to 2030. Relative to the 2018 base year, emissions in 2030 in the WEM scenario are projected to reflect a reduction of 9%, whilst the WAM scenario project a 28% reduction. **As the Climate Act requires a 51% reduction, it is evident that significant additional measures will be required.**

National Climate Action Plan 2021 (NCAP2021), upon which these projections are based, acknowledged a gap to target in the sectoral shares of the order of 4Mt CO_2 eq, whereas the projections envisage a larger gap, of the order of 9.3-10.7 $MtCO_2$ eq in the year 2030. This additional difference has a number of different causes, such as the insufficient information available to quantify the impact of some measures in the NCAP2021; or (where no specific measures were identified) the exclusion of savings arising from Carbon Capture and Storage (CCS) from the projections; discounting of emission savings from one or more sectors, e.g. embodied carbon in construction; and the regulatory environment in which emissions projections are estimated, which does not allow for the inclusion of some national measures (e.g. counting forward savings from LULUCF post 2030).[c] **It is critical that the National Climate Action Plan 2023 reconciles emissions projections and the national objective. There is a need for a significant acceleration of existing and planned actions and to identify, quantify and implement significant further measures to put Ireland on track to remain within its carbon budgets.**

a A cut-off date of the end of 2020 applies for inclusion in the WEM Scenario.

b This includes all policies and measures included in the WEM scenario, plus those included in government plans but not yet implemented.

c It should also be noted that there is no information currently available in relation to the design of this mechanism.

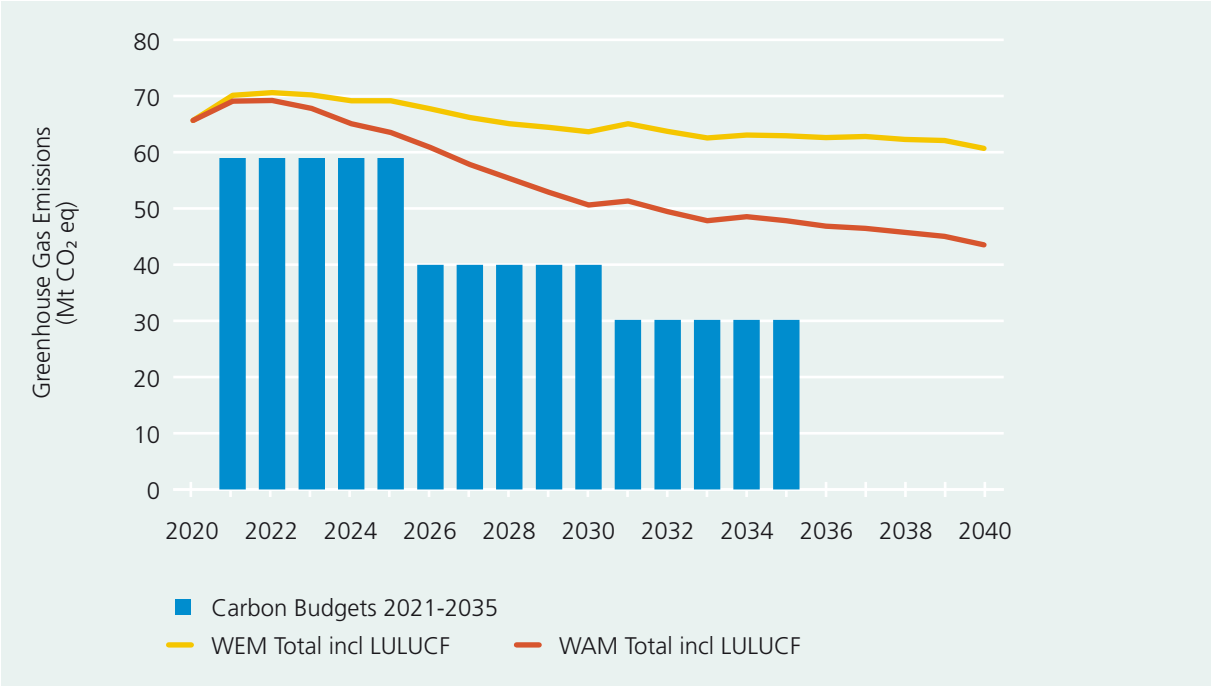


Figure 3.2 EPA Projections Total Emissions 2020-2040 and Carbon Budgets as proposed and adopted by the Oireachtas for periods 2021-2025, 2026-2030 and 2031-2035 (provisional)

3.3.3 Indicators

An evidence-based approach towards our national climate objective is important. The Council examined data reflecting progress in behavioural, technical, structural and infrastructural changes that are key. As in previous Annual Reviews, a range of indicators are presented. Indicators of a national or cross-sectoral nature are included in Table 3.2, but these need to be considered in tandem with the detailed sectoral reviews that follow in subsequent chapters.

To assess progress, it is important to understand whether practices and technology deployment are changing or whether we are experiencing continued lock-in of high-carbon technologies and practices. Table 3.2 thus presents an extended illustrative list of national indicators to give a broader perspective on the state of transition across the sectors in Ireland. Measuring progress goes beyond historical comparisons of emissions against previous performance. Incremental improvements are no longer sufficient.

Given the adoption of the carbon budget programme, the second, third and fourth indicators below (all of which are new) will gain in importance over the passage of time. The first of these new indicators shows what percentage of the 295Mt CO_2 eq in the first budget period is used up by the estimated emissions in 2021. In an ideal world this would be less than 20% but more realistically, it will need to begin to fall rapidly from the current provisional value of 23.5% over the period 2022-2025. The second and third of these new indicators combine historic and projected figures (using the WEM and WAM scenarios) to estimate what percentage of the carbon budget is projected to be used over each budget period of the first carbon budget programme. Whilst these are ideally less than 100% for each budget period, to the extent that they exceed 100% and how this changes over time will inform how well the overall targets are being met and the potential for under/over compliance with these targets.[a] Comparisons between the values for WEM and WAM will help to explain the degree to which compliance with these targets is predicated on policies and measures that were not already in place and fully funded.

a Section 6.D of the Act as amended details how surplus or excess greenhouse gas emissions should be treated at the end of each carbon budget period.

Short-term indicators also give a sense of the likely trend in emissions over the most recent calendar year. For example, the SEAI Five Fuels aggregate shows year-on-year moving annual aggregate growth of 15% to end April 2022. Quarterly National Accounts data, particularly for components such as consumption and investment, give an early perspective on the impact of the Ukraine crisis on overall economic activity. Indications are that the export-oriented sector continues to perform strongly, whilst consumption and investment are rather static. Whilst GDP increased by 10.8% in Q1 2022, modified final domestic demand (which is a better measure of activity) decreased slightly by 1%.[22] Meanwhile, the Consumer Price Index reveals movements in prices of relevance. The annual rate of inflation for 'Electricity, Gas and other fuels' was 56.7% at the end of May 2022 whilst 'Fuels and lubricants for personal transport equipment' had increased by 33.4%. Early estimates from Census 2022 indicate that Ireland's population has now reached 5.12m persons, having grown at an average rate of 1.2% per annum since Census 2016.[23] In conclusion, early indications suggest that, despite the sizeable upwards trends in fossil fuel prices, emissions are not on a downwards path in 2022.

Table 3.2 Emissions indicators between 2014 and 2035 (inventories and projections)

Indicator	UNIT	2014	2015	2016	2017	2018	2019	2020	2021	2021-2025	2026-2030	2031-2035
National GHG Emissions as % Emissions Ceiling CB period to date	%								23.5%			
National GHG Emissions above/below Carton Budget Projected (WEM)	%									18%	64%	110%
National GHG Emissions above/below Carton Budget Projected (WAM)	%									13%	39%	62%
GHG Intensity (GHG/GNI*)	*$ktCO_2$ eq per €m*	0.36	0.39	0.38	0.37	0.34	0.32	0.33	0.30			
GHG per capita	*tCO_2 eq per capita*	14.09	14.66	14.82	14.88	14.46	13.76	13.20	13.83			
CO_2 Intensity (CO_2/GNI*)	*$ktCO_2$ per €m*	0.23	0.25	0.25	0.24	0.22	0.21	0.21	0.19			
CO_2 per capita	*tCO_2 eq per capita*	9.11	9.59	9.69	9.60	9.23	8.78	8.25	8.88			
Total Primary Energy Requirement	*MWh*	154,109	161,878	168,891	168,286	171,368	169,972	155,261				
Renewables share of TPER	%	7.6%	8.2%	7.8%	9.2%	10.0%	11.2%	13.3%				

Indicator	UNIT	2014	2015	2016	2017	2018	2019	2020	2021	2021-2025	2026-2030	2031-2035
Total Final Energy Consumpion	*MWh*	126,511	132,756	137,292	138,339	144,700	144,631	130,791				
Renewables share of TFEC	%	3.5%	3.5%	3.4%	3.9%	3.7%	3.9%	4.3%				
Rate of Change of Energy Prices	%	-1.5	-8.1	-6.1	3.9	7.1	1.1	-5	12.3			
Development – Number of Dwellings in Five Cities	%	26%	25%	35%	36%	35%	29%	29%	32%			
Development – Apartments as a % of Total New Dwellings	%	14%	9%	12%	15%	13%	17%	19%	25%			
Development – once off dwellings as a % of Total New Dwellings	%	54%	45%	37%	30%	26%	24%	24%	23%			

3.4 EU Targets

3.4.1 EU Fit for 55 Package

The EU Fit for 55 package, which aims to increase the level of ambition at EU level for the period to 2030 (in a manner consistent with the long-term 2050 climate neutrality goal currently being negotiated), incorporates many legislative areas that will have an impact on EU and Irish emissions over the coming years. The headline targets include a reduction in EU ETS emissions by 61% (relative to 2005) by 2030 and a reduction in emissions covered by the Effort Sharing Regulation of 40% relative to 2005 by 2030 EU-wide. The target for Irish emissions in that sector is a reduction of 42%. In addition, it is proposed that Ireland would take on a target of reducing net LULUCF emissions to 3.7Mt in the years 2026-2030. These targets are relatively consistent with the reductions in emissions that should arise from Ireland's new national targets, although the EU targets allow for more flexibility between sectors.

More specifically in respect of the EU ETS proposals, there are several ancillary changes that go beyond ratcheting up the headline targets that are achieved, in the main, by increasing the annual linear reduction factor from 2.2% to 4.2%. These include the following:

- a Carbon Border Adjustment Mechanism that will penalise imports of carbon intensive products (such as cement, aluminium, iron and steel and fertilisers) from outside the EU unless they emanate from a country with broadly equivalent carbon pricing;
- the expansion of the ETS from 2026 onwards to include emissions from Buildings and Transport, whereby these additional sectors would be included in the scheme requiring fuel distributors to participate in the scheme;

- a Social Climate Fund to act as a redistribution mechanism of the auction revenues coming from the additional sectors (i.e. Building and Transport);
- the phasing out of free allowances for aviation operators, who must account for emissions in relation to intra-EU flights in the scheme, and inclusion, for the first time, of emissions from maritime activity; and,
- the simplification of the Market Stability Reserve, which was an instrument designed to reduce the numbers of excess allowances in circulation (thus supporting the price).

Several regulations and revisions to existing EU directives are also being proposed to support the increased ambition and help to drive emissions down across a range of sectors. These include:

- revision of the Renewable Energy Directive and Energy Efficiency Directive raising Member State targets;
- revision of the Energy Taxation Directive with a view to aligning the tax treatment of fuels with energy and environmental objectives;
- regulation of the CO_2 Standards for Passenger Cars and Commercial Vehicles which aim to ensure that all new vehicles sold in the EU by 2035 are zero-emissions;
- regulation on alternative fuels infrastructure which seeks to ensure the availability of the necessary infrastructure across the EU to facilitate a quicker transition to cleaner vehicles;
- the ReFuelEU Initiative which will oblige energy suppliers to blend increasing volumes of sustainable aviation fuels in kerosene taken on board in EU airports; and,
- the FuelEU Maritime Initiative which will stimulate the uptake of sustainable maritime fuels and zero emissions technologies by setting a limit on the greenhouse gas emissions content of fuels taken on board by ships arriving at, staying in, or departing from EU ports
- The Energy Performance of Buildings Directive to improve the energy efficiency of new and existing buildings

Negotiations of the Package have now reached the stage of trialogue discussions[a] and a number of new initiatives have been initiated, primarily but not only as a result of the energy crisis brought upon by the illegal invasion by Russia of Ukraine. These include inter alia[b]:

- New transport proposals target greater efficiency and more sustainable travel
- Commission proposals to remove, recycle and sustainably store carbon
- Proposal of a new EU framework to decarbonise gas markets, promote hydrogen and reduce methane emissions
- REPowerEU plan: affordable, secure and sustainable energy for Europe

The REPowerEU plan includes diversification of energy supplies and accelerated rollout of renewable energy to replace fossil fuels. The Plan also aims to support coordinated planning and financing of cross-border and national infrastructure through the Recovery and Resilience Facility, as well as the roll-out of the EU Solar Strategy which aims to make the installation of rooftop solar panels compulsory for all residential buildings by 2029, tackle skills shortages, and support solar panel manufacturing.

a The stage where the Council, Parliament and Commission come to an agreement on the legislative proposals

b For further information on elements of the Green Deal visit A European Green Deal | European Commission (europa.eu)

The Irish position in the negotiations is understood to be broadly supportive of the package of measures, though transparency and timeliness in adopting positions is lacking. Given the level of reductions in emissions implied by national climate objectives, it is important that Ireland transparently and robustly supports this ambition whilst ensuring that important revenues for climate action are not jeopardised. Furthermore, the use of revenues from the EU ETS auctions, which has increased significantly in line with the higher ETS prices, should be transparent and focused on impactful climate measures. This would allow governments to hypothecate the revenues from the expanded ETS to protect the vulnerable and invest in tackling climate change – as with the carbon tax. This is very important in gaining and maintaining acceptability by the wider public of the resulting price increases.

3.4.2 EU ETS

The ETS is a pan-EU carbon pricing system aimed at reducing greenhouse gas emissions in line with EU targets. Ireland does not have a national target in respect of ETS emissions; rather it is subject to the overall package of reductions, free allocation rules and other elements of the current ETS package which are agreed at EU level. As shown in Figure 3.3, Ireland's ETS emissions from stationary sources increased by 15% in 2021 relative to 2020, representing a deviation from the long-term trend where emissions have fallen steadily in this sector over the period since the inception of the scheme. This reflects both the increase in economic activity in general in 2021 arising from the gradual resumption of normal economic activities post-Covid19 restrictions, but also relates to an increase in emissions from electricity arising from a change in the fuel mix. This later issue is explained by reduced generation from wind and from the increase in the use of coal generation arising from the unavailability of some gas fired plants during 2021 (see sections on Electricity and Enterprise for more detailed analysis). The return to higher emissions levels reinforces the need for a wider package of measures than the ETS to drive down emissions in the two relevant sectors. Whilst the reforms mentioned in the previous section are broadly welcome, they will not be sufficient in their own right to drive emissions to the levels envisaged by the Carbon Budgets and Sectoral Emissions Ceilings.

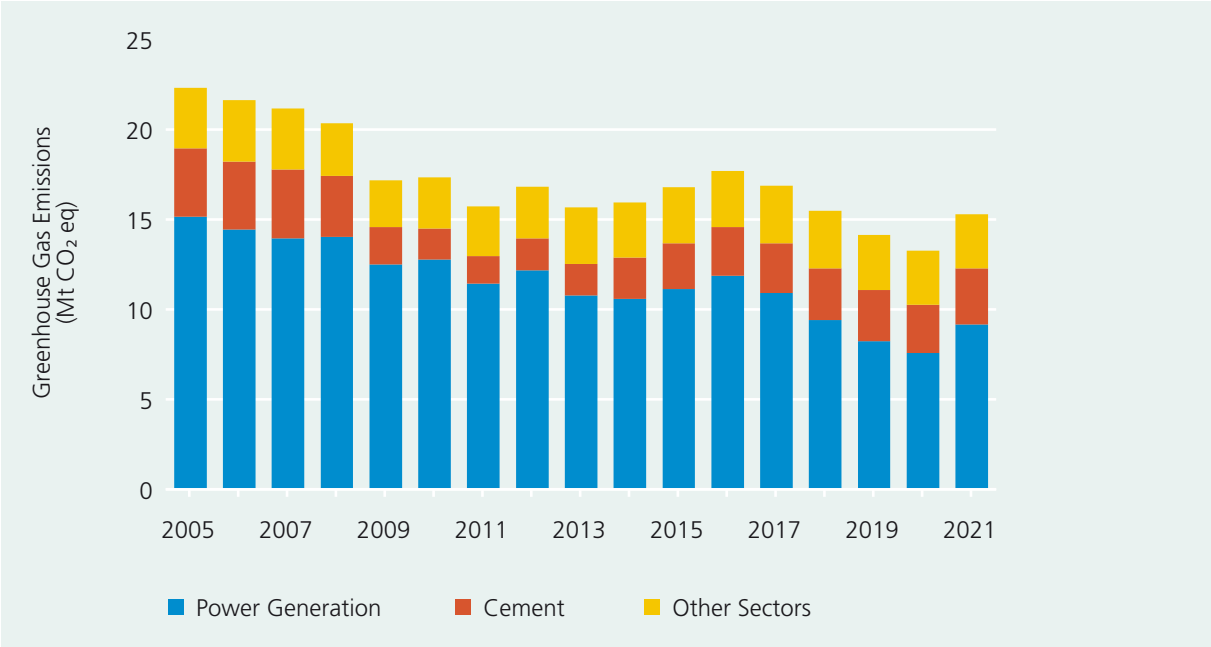


Figure 3.3 Emissions from power generation, cement and other industries from 2005 to 2021 (Mt CO_2 eq)

3.4.3 Effort Sharing Decision

Under the Effort Sharing Decision, EU Member States had binding annual greenhouse gas emission targets for 2013-2020 for those sectors of the economy that fall outside the scope of the EU Emissions Trading System (EU ETS). These sectors, including transport, buildings, agriculture, non-ETS industry and waste, account for almost 60% of total domestic EU emissions.

Inventories finalised by the EPA this April illustrate the final situation in relation to compliance with the Effort Sharing Decision which covered the period 2013-2020. Ireland's headline target was to reduce emissions by 20% relative to 2005 by 2020. Targets for the intermediary years 2013-2019 were calculated using a starting level related to average emissions between 2008 and 2010 and Member States were allowed to use a variety of international credits, banking and borrowing, as well as trading between Member States to demonstrate compliance with the Decision. In Ireland's case, a variety of these flexibilities were required.

Figure 3.4 illustrates how total emissions developed over the years relating to the Decision. Over-compliance in early years of the Decision was soon replaced by much larger deficits. For the period 2013-2020, the total allocation was exceeded by 12Mt CO_2e. As mentioned in previous Annual Reviews, Ireland will have to use carbon credits purchased from other Member States in order to meet the legislative requirement. Using purchased carbon credits to demonstrate compliance with these targets deepens carbon lock-in, forgoes the benefits of transition and imposes a cost on the exchequer, and thereby ultimately on all citizens. In light of Ireland's significantly increased level of climate ambition, this approach will no longer be acceptable.

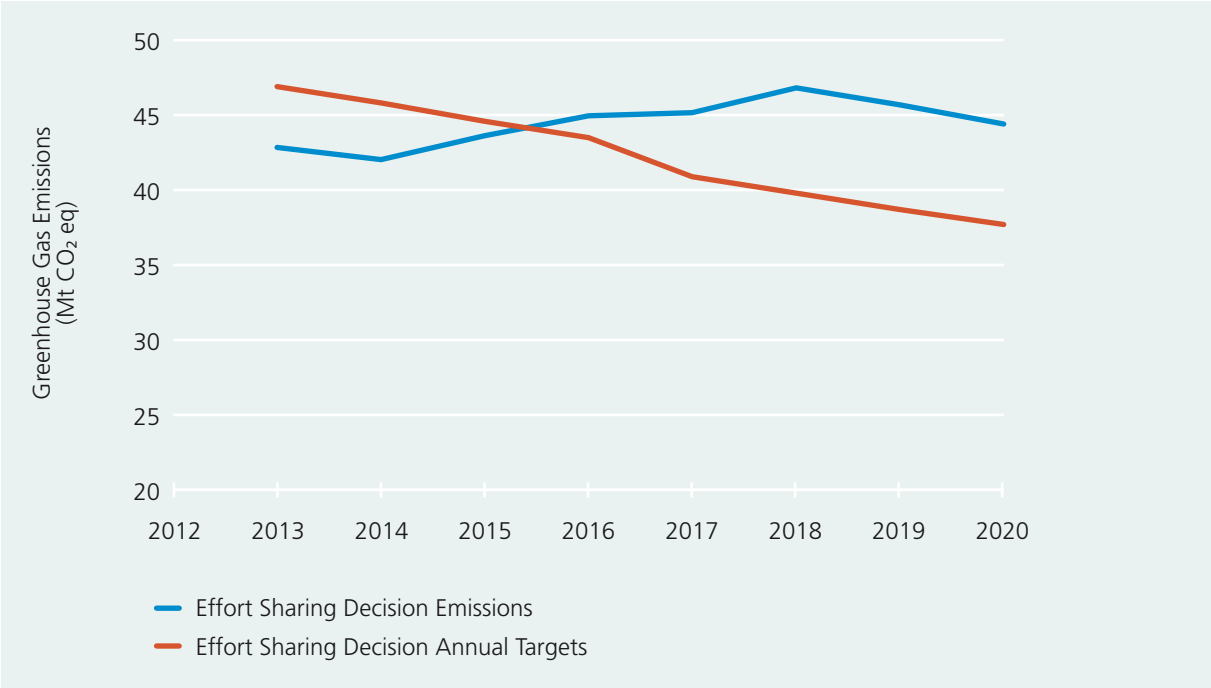


Figure 3.4 Effort Sharing Decision Emissions and Annual Targets 2013-2020 (EPA)

3.4.4 Effort Sharing Regulation

The Effort Sharing Regulation (which replaces the Effort Sharing Decision) covers the period from 2021 to 2030. The regulation sets down an annual limit for the amount of greenhouse gases (same scope as Effort Sharing Decision with some very minor adjustments) in the relevant sectors alongside various accounting rules that can be applied to demonstrate compliance with these targets.

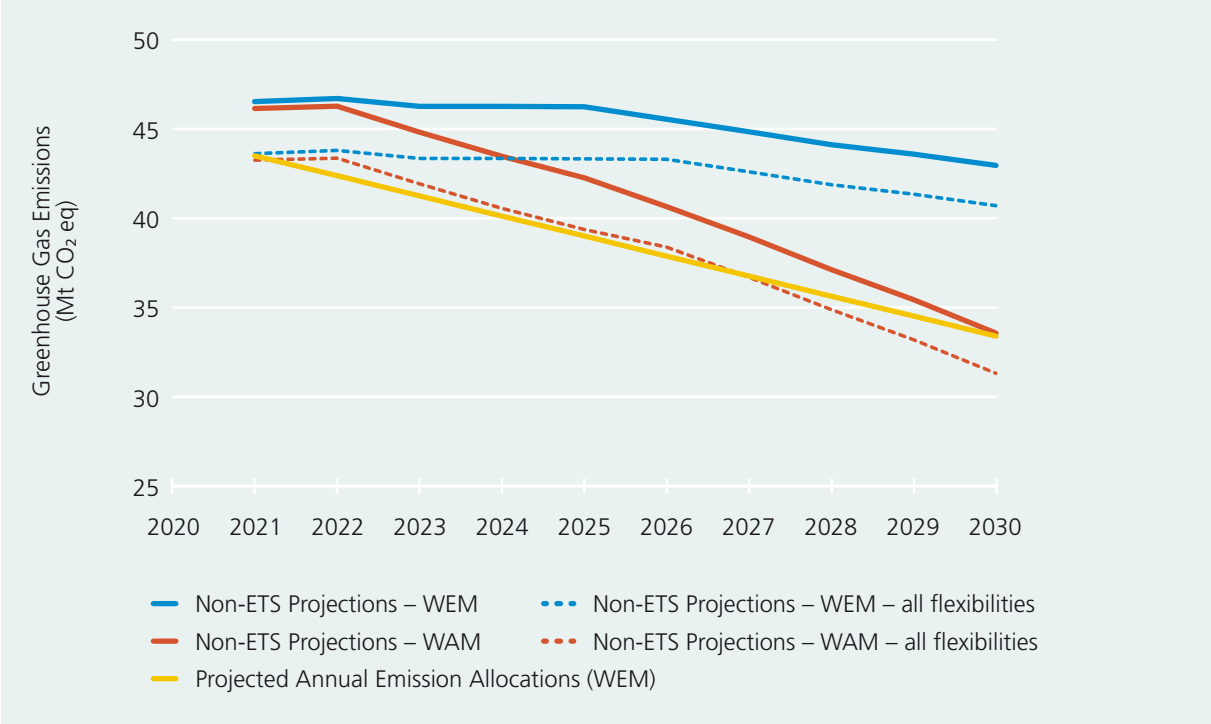


Figure 3.5 WEM and WAM Projections of non ETS emissions 2021-2030 (EPA) adjusted for inclusion of ESR Flexibilities

The recently published EPA projections represent the best available source of information for assessing whether Ireland would meet its Effort Sharing Regulation targets. Figure 3.5 illustrates the overall picture. Existing measures are clearly not sufficient to achieve compliance with the ESR targets, even if combined with the two flexibilities of the regulation. A deficit of just under 50Mt CO_2 eq arises in such a circumstance, which would need to be closed by use of other allowable flexibilities within the Regulation (such as purchases of allocation units from other member states). If the plans and policies in the With Additional Measures scenario are fully implemented and both flexibilities are fully utilised, then Ireland would be projected to have a small surplus of 1.5Mt CO_2 eq for the period as a whole.

This surplus only arises where the LULUCF units are delivered to the levels anticipated in the projections, which are now significantly lower than previously anticipated, primarily because of lower than required forestry planting rates. The LULUCF flexibility is now projected to deliver only 6.7Mt CO_2 eq, whereas the regulation caps Ireland's use of the flexibility at 26.8Mt CO_2 eq. Secondly, it should be noted that the ETS flexibility does not come without a cost. Should current market prices be maintained over the decade then ETS auction revenues foregone would be of the order of €1.6bn.[a] It is clear that analysis that addresses the potential costs of compliance[b] with these EU targets needs to be renewed and updated on an annual basis by the Department of Expenditure and Reform in order to ensure that public discourse on the relevant options is well informed and evidence-based.

Finally, as mentioned earlier, the current indications are that the EU Fit for 55 Package will lead to a higher headline level of ambition (up from a 30% reduction to a 42% reduction relative to 2005, albeit with some changes to the way the baseline emissions are calculated) with potentially reduced access to the LULUCF

a Median EU ETS Auction price from 01/01-23/05 was €82.09 (Source EEX Markets)

b This analysis has historically only focused on the costs of compliance. There is a strong case to be made that any such analysis of costs should also consider the benefits arising to Ireland in achieving compliance, albeit that this would require a significantly more complex analysis.

flexibility. **The legislative ambition set out in the Act would be broadly compliant with this higher EU Fit for 55 ambition, provided the significant implementation, funding and planning gaps are closed and all policies and measures are fully implemented urgently.**

3.5 Analysis

3.5.1 Ukraine crisis

Energy prices have grown significantly in the last year, arising predominantly from the illegal invasion of Ukraine by Russia. As illustrated in Table 3.2 the weighted average price growth of energy in 2021 amounted to just over 12%, while by the end of May 2022 this indicator showed growth of 57% year-on-year (including electricity price inflation running at 41%, gas price inflation just over 57%, home heating oil increasing at 102.5% and solid fuels at 26%).[24] Motor fuels were also increasing in price. Petrol is 26% higher in price, whilst diesel has increased in price by 42%. As the indicator in Table 3.2 illustrates, such changes may unwind over time. Another aspect of this that is important to consider is the impact of the price growth on different household types. Recently the CSO reported that the following household types spend more than the average amount of their income on electricity gas and other fuels:

- Households with lower gross household income
- Households that either own their home outright or rent from a local authority
- Rural households
- Households where the household reference person is aged 65 or over
- Households of one adult or one adult with children

It is important that there remains a focus on targeted support to move away from fossil fuel dependence particularly for the many households (particularly those on fixed or lower incomes) that have a lower capacity to deal with the current price volatility.[25]

3.5.2 Carbon tax

Table 3.3 below illustrates the impact of the carbon tax increases on prices that are minor relative to the impact of the commodity price changes arising from the current crisis. For example, recent petrol prices of the order of €2.10 per litre would imply that the cost of a 60-litre fill has increased by approximately €33 per tank, whilst the carbon tax increase contributed about €1.28 per tank.

Table 3.3 Price Impact of Carbon Tax Changes Budget 2022

	Unit of Measure	Carbon Tax at €33.50 per tonne (cents)	Carbon Tax at €41 per tonne (cents)
Petrol	*Litre*	9.5	11.7
Diesel	*Litre*	11.0	13.5
Kerosene	*Litre*	9.6	11.8
Coal	*Kg*	10.0	12.3
Peat Briquettes	*Kg*	7.0	8.6
Natural Gas	*kWh*	0.7	0.8

A price on carbon via the carbon tax, which is partially and explicitly set aside for climate action, raises important revenues to support climate action across the whole of society.[a] Total yield from the carbon tax amounted to €431m in 2019 and €494m in 2020. The Department of Finance estimated that yield would increase by €108m in 2022 and €147m in 2023 based on the increase in the rates in Budget 2022.[26] The Programme for Government 2020 included a commitment that the revenue use would be the subject of legislation.[27] All additional carbon tax revenues are allocated towards:

- ensuring that the increases in the carbon tax are progressive through targeted social welfare and other initiatives to prevent fuel poverty and ensure a just transition,
- funding a socially progressive national retrofitting programme targeting all homes but with a particular emphasis on the Midlands region and on social and low-income tenancies,
- allocating funding to a new Agri-Climate Rural Environment Scheme (ACRES) programme to encourage and incentivise farmers to farm in a greener and more sustainable way.

The Programme for Government estimated that the total yield over the period to 2030 would amount to €9.5bn, of which €3bn would be focused on targeted measures, €5bn would be focused on the retrofitting programme and the €1.5bn would be focused on the Agri-Climate Rural Environment Scheme. The certainty of the carbon tax increments is key to informing investment decisions and meeting decarbonisation targets. The most recent IPCC Working Group III report reaffirms the effectiveness of economic instruments such as the carbon tax as part of a suite of measures to reduce emissions.

The Council reaffirms its strong support for the Government's carbon tax plans, including the use of revenue raised for the continuation and enhancement of retrofit supports, welfare transfers to protect the most vulnerable households and investment in sustainable agriculture.

3.5.3 Governance and cross sectoral activities

In June 2022 the Council conducted a sectoral dialogue with the Department of An Taoiseach, Department of Public Expenditure and Reform, the Department of Finance and Department of Environment Climate and Communications. The increasing prevalence of Climate Action Divisions and Units in key Government Departments is a welcome development. It will be important that this increased focus on climate action is maintained and further developed to ensure a holistic cross cutting approach, and that central departments play an increasingly visible role in coordinating and driving implementation of climate actions.

Last year's Annual Review included an analysis of the reporting regime for Climate Action Plan 2019. This highlighted the fact that many actions contained in the plan were subject to delay. An ongoing feature of the reporting that causes difficulty is the lack of transparency around prioritisation at national and sectoral level of different actions and measures from the perspective of achieving the national objectives. Necessarily, some actions are directly and very specifically relevant to either the mitigation or adaptation objectives whereas others are only rather tangentially relevant. Since the publication of the Annual Review, reporting resumed with the publication of a combined volume for actions in Q4 2021 and Q1 2022 and a single volume for Q2 2022 published at the end of July.[28],[29] **The Council has noted the change of the Terms of Reference of the Climate Action Delivery Board and recommend that regular quarterly reporting be maintained, with focused analysis on the most important 20% of actions in order to maximise the impact that such a body can have on the acceleration of delivery.[30]**

a The first €20 per tonne is not explicitly set-aside (hypothecated) for climate action. The agreement to set aside carbon revenues only applies to those revenues beyond the first €20 per tonne.

Many of the measures in the 2021 Climate Action Plan have been delayed. It is reported that only 45% of the actions slated for delivery in Q2 2022 were delivered on time and that the overall delivery rate for all actions since the launch of the plan is 71%.[a] The recent Quarterly Progress reporting is welcome for providing more focus on those measures that are critical for delivery. The reporting does, however, disappointingly identify that many high-impact measures are not being delivered on time, and does not distinguish between high impact and other measures when reporting on overall delivery rates. Timely delivery of measures, particularly those identified as high-impact measures, is essential if Ireland is to meet national targets. **For example, there are continued delays with the finalisation of a Long-Term Climate Strategy. Ireland is one of only four EU Member States yet to submit its long-term strategy under the relevant EU Regulation.** Other high impact measures that have been delayed include the development of a roadmap to promote higher use of low carbon materials in construction and examining how and when fossil fuel heating systems can be phased out of public buildings. These gaps and others continue to be a cause of concern to the Council. The quarterly reports do provide some analysis of the main reasons for delay, presented below in Box 3.2. It is clear that adequate resourcing, in respect of both finance and skills, are at the root of many of these issues and will need to be addressed, where possible, in Budget 2023. The Council is concerned that many delays are being attributed to public consultation processes that can assist with public buy-in and the acceleration of implementation of measures, but should not be used as a reason to delay taking action.

Box 3.2 Reasons for delays in implementation

The main reasons cited by Departments for delayed implementation were outlined in the Q2022 quarterly report and presented in terms of order of impact. The top three reasons are estimated to account for 50% of the delays, and the next three account for 30% of the delays encountered:

- **consultation efforts**, including both the need for stakeholder consultation for inclusive policy-making (including for Strategic Environmental Assessments) and the subsequent analysis of submissions that prove to be unexpectedly voluminous, complex or lengthy,
- **capacity and capability constraints**, including delays arising from civil service reliance on external expertise, competing work priorities (particularly in energy and housing) and difficulties in recruitment and resourcing, and/or
- **desires for alignment** with other policies, programmes and funds related to climate action for reasons of increasing measure effectiveness, efficiency or impact,
- **time required for the legislative process**, including the time taken to complete drafting, secure legal advice and/or in the passage of legislation through the Houses of the Oireachtas,
- **complexity and technical aspects** of climate action delivery, including measures awaiting further evidence bases, physical/infrastructure issues and the engagement required to develop implementable solutions, and/or
- **administrative delays** in obtaining approvals and clearance for measures, including from a wide array of stakeholders from internal steering groups right up to final Government approval.

Evaluation of expenditure

The cross-sectoral chapter of NCAP2021 includes commitments to further develop the area of green budgeting. Green budgeting is the use of the fiscal (financial) budgetary system itself to promote and achieve improved environmental outcomes. The plan identifies transparency and effectiveness as two key principles to drive developments in this area.

A high-level subjective assessment of the impact of 128 measures included in the National Development Plan (NDP) was carried out against seven criteria (climate mitigation, climate adaptation, water quality, air quality, waste and circular economy, nature and biodiversity and Just Transition) which found that some 16% of measures were found to have a net unfavourable impact. While this analysis is certainly welcome,

a For example if an action was due for delivery in Q1 2022 but delivered in Q2 2022 this is included in this calculation.

it needs to be more objective with defined metrics and needs to be broadened to other areas of planning. Despite this relatively positive presentation of the impact of the NDP, other research by University College Dublin has pointed towards the risks that embodied emissions may increase over the decade ahead arising from the impact of development plans, including NDP and Housing for All.[31]

NCAP2021 included a welcome commitment to further embed the cost of emissions into ex ante evaluation of long-term policy proposals. This included work led by the Department of Public Expenditure and Reform with the Organisation for Economic Co-operation and Development (OECD), funded by the EU Commission through DG REFORM's Technical Support Instrument, on progressing a new model for assessing the emissions impact of infrastructure investment. This is to ensure that the full range of potential consequences for this type of investment are captured and valued appropriately. Secondly, the OECD is examining how Government should consider and appraise investments that may be vulnerable to the impacts of climate change. This work can inform and be informed by the Council's work with the ESRI on the Costs of Impacts of Climate Change. Further commitments in this area also propose to incorporate a methodology for assessing climate-related risks into the Public Spending Code and also to review the compatibility of the Public Spending Code with the National Climate Objective.

The Council considers that delivering the output of these analyses and implementing the changes arising is both essential and urgent, particularly given the very significant levels of public and private investment that will be required over the coming years and the significant cross-system analytical burden associated with this.

Fossil fuel subsidies

It is also important to analyse the impact of tax expenditures that incentivise fossil fuel consumption. The Glasgow Climate Pact included the commitment to accelerate 'the phase-out of inefficient fossil fuel subsidies'.[32] The CSO estimates that such subsidies amounted to approximately €2.2bn in 2020 but €2.8bn in 2019. The main cause of the reduction relates to the significant reduction in aviation activity arising from the Covid-19 public health crisis. Working Group III of the IPCC Sixth Assessment Report concluded that 'removing fossil fuel subsidies would reduce emissions, improve public revenue and macroeconomic performance, and yield other environmental and sustainable development benefits'. The Council notes that the Department of Finance is due to review the cost and impact of these subsidies in 2023 and propose a roadmap away from these subsidies in 2024. **Given the importance of reducing fossil fuel use, it is imperative that this analysis is accelerated and that appropriate fiscal measures be incorporated into the 2023 and later fiscal budgets, whilst avoiding the creation of new fossil fuel subsidies.** It will be critical that the analysis provides a pathway from these subsidies that pays equal attention to the issue of impacts as well as costs.

3.5.4 Macroeconomic impacts of climate change

The scale of investment required to achieve the Paris Agreement objectives will be very significant. Increasing investment on such a scale will have knock-on implications for the diversion of investment from other areas, and on consumption, taxation policy, interest rates, competitiveness and output over the longer term. On the other hand, these investments will also lead to a number of local and broader benefits, such as reduced energy bills, protecting biodiversity and human health, and the wide range of benefits and opportunities that would accrue from reduced warming. Furthermore, the avoided long-term impacts arising from meaningful global action would represent a long-term saving to Ireland. The Climate Action and Low Carbon Development Act mandates both the Council in terms of their responsibilities in respect of the proposal of Carbon Budget programmes and the Government in terms of plan-making and considering actions for inclusion in Climate Action Plans to take account of 'the need to maximise employment, the attractiveness of the State for investment and the long-term competitiveness of the economy'. These criteria are very difficult to fully consider in the absence of a detailed modelling framework.

Some of the macro-economic implications of the Carbon Budgets were explored in an exploratory paper by Professor Fitzgerald (which built on a paper by Pisani-Ferri), but there is a need to build greater capacity in this area across Government.[33],[34] Definitive prioritisation of key actions within the National Climate Action plan 2021 for both the medium and long-term is essential. Such a definition of strategic prioritisation would provide clarity to key government bodies on the level of resourcing, risk appetite and public and private financing required to deliver transformative change.

Furthermore, the Irish Fiscal Advisory Council noted in its most recent Budgetary Assessment that 'detail on economic and budgetary impact remains lacking' in reference to the significant levels of expenditure required to meet the national objectives in this area.[35] They also cautioned that short-term measures taken to reduce the impact of the war on Ukraine 'could conflict with medium-term goals in transitioning from fossil fuels' This sentiment is of particular concern when considering, in tandem, the goal to reduce fossil fuel subsidies.

Finally, it is of note that the Central Bank has begun to consider the implications of climate change mitigation and impacts on its functions. A signed article published recently examined the economic implications of the risks associated with continuing climate change and abrupt mitigatory actions, reviewed how these risks could affect the transmission of monetary policy through conventional channels, and discussed how the Central Bank's analytical framework needs to adapt. The author suggests that a suite-of-models approach offers the most practical and effective way of addressing these issues.[36] It should be noted that the approach identified goes much further than those required by the Council or for sectoral consideration but recognises there is considerable scope for further development in this area. Private Capital will be critical to delivering the scale of investment required to support Ireland's Climate ambition. The role of the Central Bank in providing direction and regulation of climate financing from the private sector will be essential to ensuring international best practice and EU and International regulation.

There is a need for a coordinated body of work to be conducted on the most relevant economic models within Ireland in order to ensure that the macro-economic implications of deep decarbonisation pathways can be explored and explained in greater detail. Furthermore, recognising the need to increase both financial and skills resourcing for delivery of the national climate objective, the Council considers it critical that the objectives and resourcing of the state financing agencies as key enablers be definitively prioritised and aligned with the NCAP2023.

3.5.5 The role of planning in delivering the National Climate Objective

In proposing its Carbon Budget, the Council stressed that the carbon budget programme for the decade requires immediate action and investment in the first period to deliver the accelerated reductions in the second carbon budget period that are required to meet the 2030 target of a 51% reduction relative to 2018. Many of the changes required now will only have a real impact on emissions in the second carbon budget period. More recently, the IPCC has reminded us that there is a narrowing window of opportunity for action.

The ambition of the National Climate Objective and the implications of the carbon budget have not yet been fully mapped into planning policy and practice and the hierarchy of planning policies needs to be better aligned to meet mitigation and adaptation goals. The planning system is central to dealing with both the legacy of unsustainable, carbon intensive, development and delivering the strategically critical infrastructure required to meet our climate targets, all at a time of significant population growth.

The National Planning Framework (NPF) targets 50% of the population growth of one million persons by 2040 to take place within our five major cities and therefore a significant increase in the numbers of apartments as a share of total developments. Over 2019-2021, 30% of housing completions were in the five

city areas, albeit that lead indicators of completions suggest an upward movement in this trend. Over the same period, apartments as a share of total housing completions has increased from 17% to 25%. Similarly, lead indicators are positive in respect of the potential for growth of this share over time. Apartments tend to have a positive impact on emissions as the increased density leads to reduced travel demand and benefits also accrue in terms of reduced embedded emissions from construction and reduced and/or more efficient heating demand. Whilst once-off dwellings as a share of total fell from 54% to 23% since 2014, there is still a steady volume of these completions in the region of 5000 per annum. A significant reduction in this pattern will be necessary to avoid further embedding long-term car dependency in rural areas. Preliminary Census 2022 results point to significant population growth in the counties surrounding Dublin. The population of Meath increased by 12.9% while Kildare's population increased by 11% and Wicklow by 9.2%. At the same time Dublin's population grew by 7.7%.[23] Further efforts will be required to ensure that Ireland's population growth is distributed in a sustainable manner and in line with the objectives of the National Planning Framework.

A range of factors are behind the significant increase in the number of new applications for judicial reviews in the planning area in recent years, not least the increasing complexity of national and EU environmental law. This can be a significant brake on the infrastructure required to decarbonise the country, and as well as legislative and procedural reform (while still ensuring access to environmental justice). Further public engagement on planning, environmental and climate issues and professional capacity building is essential. The Council acknowledges the resource and capacity constraints facing local authorities and the Climate Action Regional Offices (CAROs) given their importance in delivering mitigation and adaptation. However, more fundamentally, we need a sense of national solidarity built around a vision for a low carbon, climate-resilient future that engages with all society, communities, and individuals. **It is vital that Government takes further action to ensure that the planning system is sufficiently resourced and capable of responding to the challenges posed by deep and accelerated decarbonisation and resilience pathways.**

3.5.6 Biodiversity

Ireland's obligations in matters of biodiversity protection are mandated by Ireland's own Wildlife (Amendment) Act 2000, National Biodiversity Action Plan, Climate Action and Low Carbon Development (Amendment) Bill 2021, and Biodiversity Climate Change Sectoral Adaptation Plan, as well as the UN Sustainable Development Goals, UN Convention on Biodiversity and the seven EU pieces of legislation protecting biodiversity (Birds Directive, Habitats Directive, Water Framework Directive, Marine Strategy Framework Directive, Biodiversity Strategy, and Environmental Impact Assessment and Strategic Environmental Impact Assessment Directives). All of these are designed to protect and restore Ireland's, Europe's and the world's ecosystems, for the benefit of people and the planet. Despite this, as referenced in earlier chapters, there are a number of worrying trends evident across both species and habitats.

3.5.7 Just Transition

'Just Transition' and 'climate justice' are both cited in the Climate Action and Low Carbon Development (Amendment) Act 2021.[37] Just Transition is noted in the Paris Agreement and can also be related to the overall agenda of the UN SDGs. The 2021 Climate Action Plan commits to delivering a just transition, recognising that the economic and behavioural burden of achieving the transition to a climate neutral economy must be as fairly distributed as possible.[38] The focus of the Just Transition Commissioner, whose mandate expired in December 2021, was on the Midlands, to assist workers as peat extraction ceased, and peat-fired power stations closed. The Commissioner's final progress report was published in April 2022, in which he described the trials and successes of retrofitting homes in the Midlands, to enable households to become independent of peat, reskilling and upskilling the workforce, attracting investment to the region and creating new enterprises, improving the transport infrastructure, and implementing peatland rehabilitation

projects.[39] Instituting a statutory Just Transition Commission is included within the 2021 Climate Action Plan to deliver a more integrated approach that embeds Just Transition principles into climate actions and policies.[39],[38] The approval of policy on the establishment of a Just Transition Commission is due by the end of Q2 2022 (which was noted as delayed per most recent Quarterly update), and the approval of the General Scheme of legislation to establish a Just Transition Commission is due by Q4 2022.[38]

A Just Transition must take account of the livelihoods impacted by the increasing pressure placed on carbon-intensive economic activities, as well as the need to ensure that poorer households do not bear the burden of policies to reduce emissions, and that the benefits of transition and Government supports are shared equitably. Whilst the focus of the Just Transition Commissioner was on a particular regional issue, many broader actions already taken do help to facilitate Ireland's Just Transition nationally. Focused policy that redistributes carbon tax receipts towards those in fuel poverty and actions that prioritise those same households for retrofit and energy efficiency upgrades play an important role. The Just Transition Commissioner emphasised the core role of Regional and Spatial Economic Strategies, strategic partnerships and a focus on consultation and collaboration.[40],[41] A public consultation on a draft of Ireland's Territorial Just Transition Plan was launched in December 2021, to discuss how the Government proposes to invest EU Just Transition funding (up to €84.5 million over the period to 2027, to be complemented with Exchequer resources), although the plan's focus appears to remain predominantly upon the wider Midlands region.[42] Further national efforts must be made to proactively identify vulnerable communities and solutions.

4. Sectoral progress – Agriculture, Forest and Other Land Use (AFOLU)

Key messages

Observations

- There is a high risk of a global food crisis in the coming year. The war in Ukraine has exacerbated the risk of a global food crisis, which is emerging due to extreme climate events in several major food producing regions, including Europe. Ireland, in cooperation with the EU, should review how we contribute to addressing food security nationally, at EU level and globally, addressing both availability and affordability.
- Agriculture and Land Use in Ireland are not, as yet, on a sustainable low-carbon path. Significant action is required for a transition that supports low-emissions agriculture and land use, sustainable rural development, and a reversal in the decline in water quality status and biodiversity.
- Approximately 23.1Mt CO_2 eq greenhouse gas emissions occurred within agriculture in 2021, that is 33% of total national emissions, while an additional 7.8Mt CO_2 eq (11% of total emissions) arose from land use. Emissions from agriculture are 15% higher than in 1990, while emissions from land use are 25% higher. There is significant uncertainty in the estimation of emissions and removals from land use. Research is ongoing to address this uncertainty, which will provide greater understanding and insight in the coming years.
- Projections from the EPA suggest, under the 'with additional measures' scenario, emissions from agriculture will decrease to 17.8Mt CO_2 eq by 2030. The Government has set a target of 25% emissions reduction by 2030, or 17.3Mt CO_2 eq. Emissions from land use are projected to increase to 8.3Mt CO_2 eq by 2030, due to the interaction between low afforestation rates over the last decade and the higher rates of harvesting in coming years as a large cohort of existing forest stands to reach maturity.
- To avoid any necessity for actions to reduce emissions which could impact food production, it is imperative that the full suite of proven mitigation measures are deployed rapidly and at the most ambitious scale, with additional research required to identify further measures.

Recommendations

- A Just Transition requires strong community engagement and confidence that the transition will deliver a vibrant rural economy. Addressing climate change through deployment of technologies and diversification of activities should be enabled through design, resourcing and implementation of policies. These need to present viable and attractive options for farmers and support rural communities.
- A review of the 'Ag Climatise' – National Climate and Air Roadmap for the Agriculture Sector' is urgently required to realign the roadmap with the growing demand for and increased ambition for emissions reductions in the sector. This must provide a precise pathway and timeframe for speedy implementation of measures identified in Ag Climatise.
- Significant and immediate reductions in both methane and nitrous oxide emissions are required. Mitigation potential of a range technologies have been robustly demonstrated and many are available on the market. However, protected urea fertilisers, for example, represent only an estimated 5% of nitrogen fertilisers sold in 2021. The Council recommends an acceleration in the rate of deployment of proven mitigation options. This will require use of a diverse range of policy instruments, including targeted incentives under the Common Agricultural Policy, regulation and enforcement, market mechanisms, communications and advisory services.
- There is a critical need to accelerate research and assessment of new and emerging technologies and farming practices, such as the feed additive 3-NOP. This requires an ambitious programme of applied research, stakeholder engagement, support and guidance for implementation which establishes an effective pipeline from 'theory to practice' as exemplified in the Teagasc Signpost programme and the IFA-led Smart Farming initiatives.
- The Council is very concerned about the continued increase in emissions within the dairy sector. The Interim Report of the Food Vision Dairy Policy Group has identified several practical measures which have the potential to reduce emissions. Co-design of effective policy instruments will ensure sectoral acceptance and deployment at the scale necessary for significant impact on emissions.
- Some of the actions included in the NCAP2021 would reduce activity at farm level while maintaining economic and environmental sustainability. For example, an expansion of organic farming may lead to lower stocking rates but maintain or enhance farm income, whilst delivering co-benefits for biodiversity, water and air quality. It is important that the full impact of these measures is recognised in the policy design, and that farmers are appropriately compensated for the mitigation and other public goods delivered.

- The rewetting and/or restoration of peatlands, degraded due to peat extraction, can deliver cost-effective emissions reduction in the near term. Changes in land management can also reduce emissions from grasslands on drained organic soils. Removals can also be enhanced on mineral soils through management interventions. The appropriate land management options will be determined by the specific site conditions and accurate quantification of the existing soil carbon. Partial rewetting can deliver mitigation, and any uncertainties or barriers to its implementation need to be removed. The Council recommends greater ambition in the rate and scale of deployment of these land management options.
- Afforestation needs to be perceived and rewarded as an attractive option for farmers. Urgent reform of the licensing and regulation of routine forestry activities is necessary. The Council calls for the Forestry Policy Group, by the end of 2022, to identify initiatives to revitalise the forest sector, to deliver detailed policy design, and the pathway and timeframes for implementation.

4.1 Chapter introduction

In this section, Agriculture, Forestry and Other Land Use (AFOLU) are considered together. Combined, activities within these sectors account for the largest source of emissions in Ireland. Approximately 33.3% of total national in 2021 occurred within agriculture, while an additional 11.2% arose from land use. In July 2022, the government agreed to a target of 25% emissions reduction by 2030, relative to 2018, for the agriculture sector. The government did not agree a target for the Land Use sector.

Emissions from the agriculture sector are dominated by sources of methane and nitrous oxide, with livestock farming and the use of nitrogen fertiliser to grow fodder for animals the dominant activities driving emissions. The profile and size of the cattle herd is important as dairy animals have a higher emissions profile than non-dairy animals. Although a relatively small source of emissions within the agriculture sector, the sheep flock delivered important emissions reduction in the period to 2005 but has seen expansion in recent years.

Much of Ireland's food production is exported, which limits the extent to which domestic action on consumption can influence emissions within the sector. As such primary production within agriculture is largely driven by international market forces, including input costs and output prices. In addition, farm enterprises also avail of farm support and environmental schemes implemented under the EU Common Agricultural Policy.

Agricultural emissions can be mitigated by changes in production systems and efficiency, and new technologies, as set out in the Teagasc MACC.[43] To date, there has been more success in developing technologies or system change to reduce nitrous oxide emissions (e.g. reducing nitrogen fertiliser use through the use of clover or multi species swards, or changing fertiliser type to lower emitting products) than with methane emissions. Research is active in this area and supporting farmers to adopt mitigation measures on a widespread scale is also an imperative.

There is high risk of a global food crisis in the coming year. The war in Ukraine has exacerbated the risk of a global food crisis which is emerging due to a series of extreme climate events, including heatwaves, droughts and flooding, in several major food producing regions including Europe. The potential for such events in future will rise with further climate change necessitating a reconsideration of food security of supply issues from national to global scales.

The Food and Agriculture Organisation (FAO) notes in its flagship annual report 'The State of Food Security and Nutrition in the World' for 2022, that *'the intensification of the major drivers behind recent food insecurity and malnutrition trends (i.e. conflict, climate extremes and economic shocks) combined with the high cost of nutritious foods and growing inequalities will continue to challenge food security and nutrition. This will be the case until agrifood systems are transformed, become more resilient and are delivering lower cost nutritious foods and affordable healthy diets for all, sustainably and inclusively'*. The most recent

data from FAO shows the global food price index in real terms at levels not seen since the oil crisis in the 1970s.[44] The World Bank July 2022 update on Food Security also highlighted that *'the global food crisis has been partially made worse by the growing number of food trade restrictions put in place by countries with a goal of increasing domestic supply and reducing prices.'*[45] Similar analysis on disruptions to the global food system has been published by the FAO's Agricultural Market Information System.[46] Ireland is not food insecure, nor experiencing the dramatic food price inflation observed in more vulnerable countries.[47] Nevertheless, Ireland, in cooperation with the EU, should review how we take action to contribute to food security nationally, at EU level and globally, addressing both availability and affordability.

There is an intimate connection between agriculture and land use. Land use can either emit greenhouse gases or sequester them. For example, the drainage of peatland or organic agricultural soils can lead to emissions of CO_2 from the soil; while appropriate management of forest and agricultural land can enhance the removal of CO_2 from the atmosphere to biomass and soils. Land use is a major source of emissions in Ireland with agricultural grasslands and croplands representing 70% of the land area in Ireland. The dominant source of carbon dioxide emissions is the continual drainage of organic soils and peatlands for various purposes, including grassland (for grazing and fodder), peat extraction and forest. Changes to the management of grassland and cropland on both mineral and organic soils can contribute to the reduction of carbon loss, and the enhanced removal of carbon dioxide from the atmosphere while also delivering co-benefits to biodiversity and water quality.

Rewetting and water table management on organic soils have been demonstrated, nationally and internationally, to be key cost-effective mitigation options which can reduce or eliminate carbon dioxide emissions.[48],[49],[50],[51] Peatlands have complex hydrology[a] which leads to significant uncertainty both in site characterisation and assessment of the likely impact of changes in management on the greenhouse gas emissions. The uncertainty relates to the assessment of the historic and current management practices on drained organic soils and the associated rate of carbon emissions. However, it is certain that the ongoing drainage of organic soils causes carbon losses and management options such as rewetting and restoration will reduce net emissions. Implementation of these management options will be based on specific site assessment and will require public and private investment in advisory and operational services.[52]

Forest lands, if located appropriately, can remove carbon dioxide from the atmosphere. The national forest estate had expanded over several decades with high rates of afforestation seen up to the late 1990s. However, a significant proportion of this historic afforestation occurred on organic soils, and it may be necessary to consider whether it is appropriate for these areas to remain under forest going forward. Large areas of forests are approaching harvesting age, which, coupled with low rates of afforestation in more recent years, will see a large increase in carbon losses from the sector.

Engagement with farming communities to enable appropriate diversification of land use and land management practices is critical for the success of mitigation measures, most of which are implemented at farm scale and require intimate, site-specific knowledge.

A Council sectoral dialogue was held with the Department of Agriculture, Food and the Marine (DAFM) on 8 June 2022 during which the DAFM presented their analysis of the challenge up to 2030. Significant action will be required to deliver a transition that supports low emissions agriculture and land use, reversal of water quality degradation and biodiversity loss, and achieve sustainable rural development.

a The properties, distribution, and circulation of water on and below the earth's surface.

4.2 Inventories and projections

4.2.1 Agriculture inventory

Provisional estimates for the Agriculture sector for 2021 indicate emissions increased by 3.0% in 2021 relative to 2020, which followed a 1.2% increase in 2020. This continues a general trend of increasing emissions since 2011. Agriculture Emissions in 2021 were 15% higher than in 1990. Agriculture emissions in 2021 were 0.1% higher than in 2018.

Detailed activity data underlying the national inventory report, covering the period 1990-2020, provides useful insight into the drivers of emissions. Figure 4.1 shows the activities under which greenhouse gas emissions associated with agriculture are reported, Figure 4.2 breaks down methane emissions from enteric fermentation into animal type and shows an increase in emissions due to expansion of the dairy sector. As seen in Figure 4.3, the reduction in emissions in 2019 was largely due to a decrease in activity in the non-dairy cattle herd, which offset an increase in emissions from the dairy cow numbers. A further modest decrease in the non-dairy cattle sector in 2020 was not sufficient to offset the increase in emissions from the dairy sector coupled with an increase in activity from the sheep sector.[a]

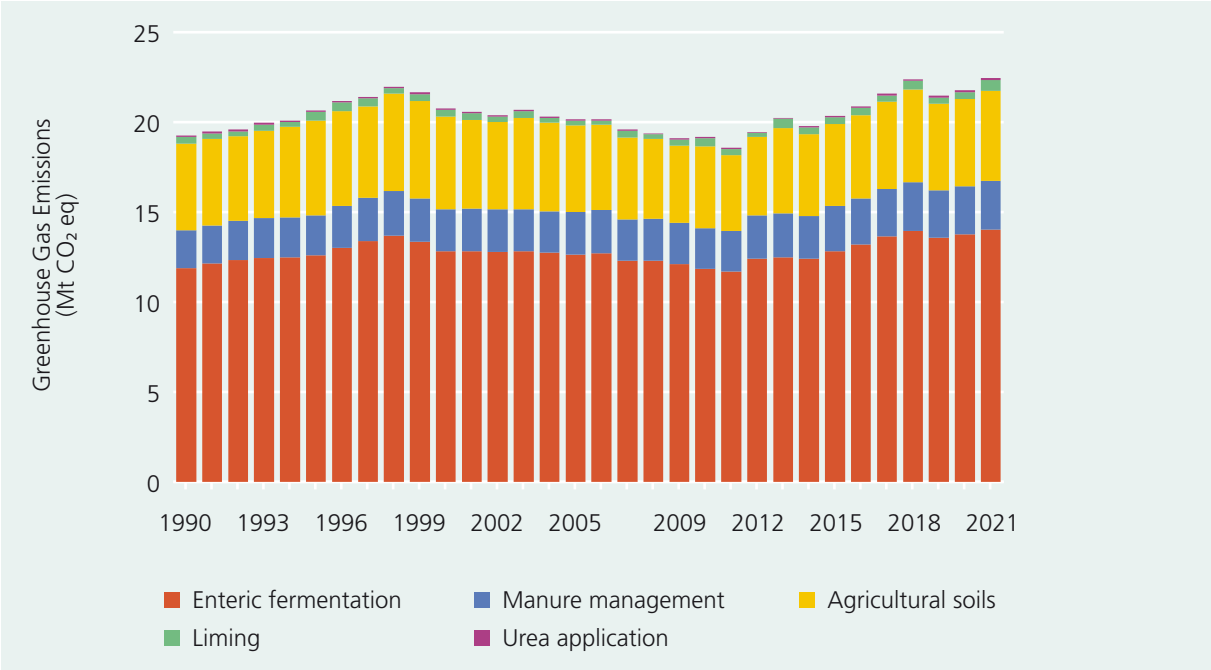


Figure 4.1 Provisional estimates for emissions across agriculture 1990-2021 (Source EPA 2022)[20]

a Emissions associated with Agriculture and Land Use have the highest levels of uncertainty in the National Inventory Report estimates of emissions, with a combined uncertainty of approximately 47% in total AFOLU emissions. The uncertainty in Agriculture is approximately 33%, and 94% uncertainty in the LULUCF estimates.

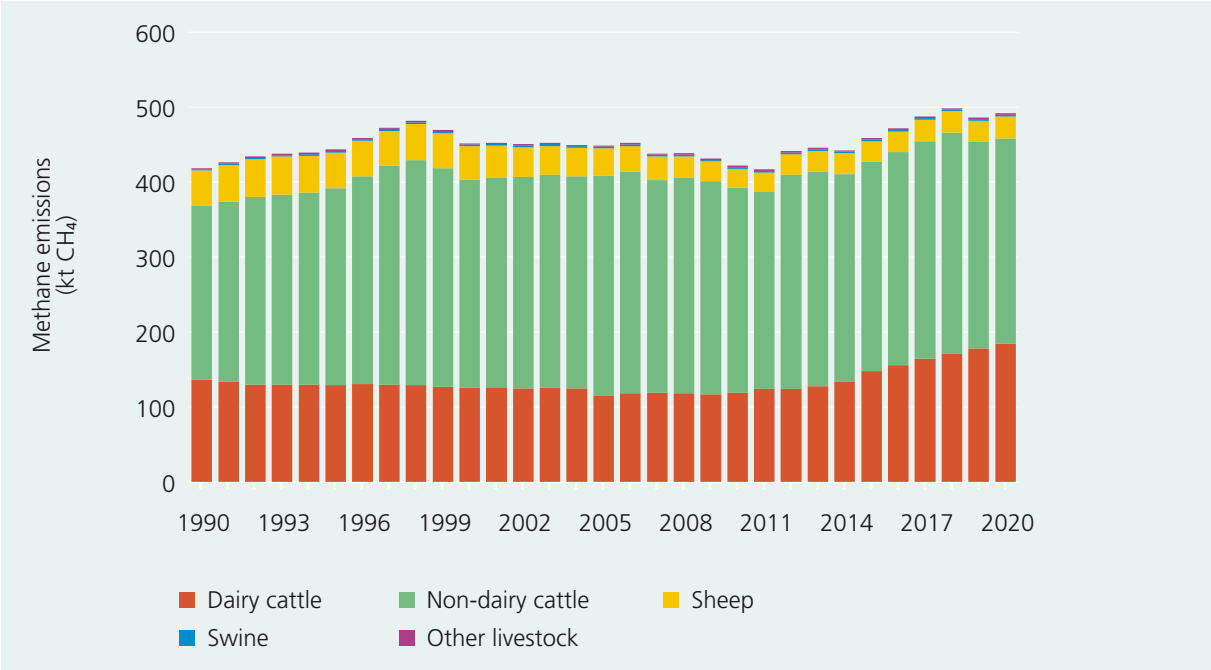


Figure 4.2 Methane emissions from ruminant livestock (enteric fermentation) 1990-2020 (Source: Extract from EPA Inventory submission to UNFCCC, Common Reporting Format, 2022)[53]

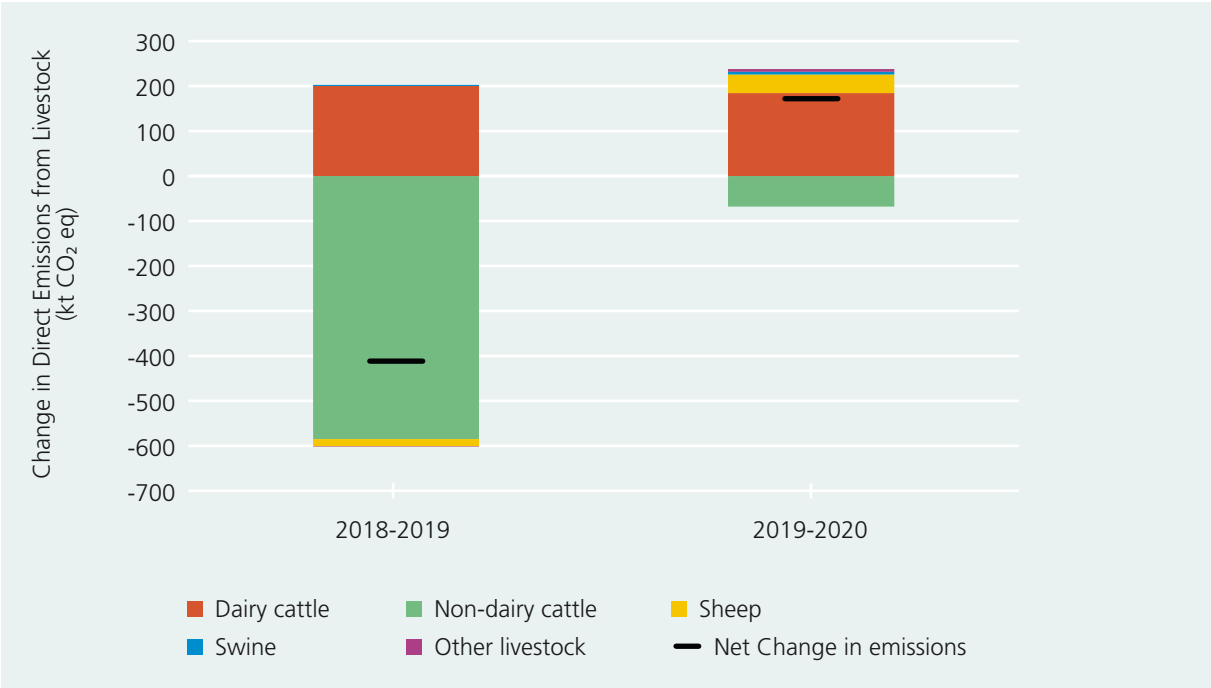


Figure 4.3 Annual change in estimated emissions from different livestock types (Source: Extract from EPA Inventory submission to UNFCCC, Common Reporting Format, 2022)[53]

4.2.2 Agriculture projections

The EPA has prepared emissions projections for the Agriculture sector which explore the 'With Existing Measures' (WEM) and a 'With Additional Measures' (WAM) scenarios (see Box 3.1). The projections report also included analysis of the sensitivity sector with the external drivers. The WAM scenario assumes the impact of ***full*** implementation of the measures and policies under the *Climate Action Plan 2021*) including;

- to improve the carbon efficiency of production,
- reduction in nitrogen use,
- and the adoption of a suite of technical measures which reduce absolute emissions as outlined in the Teagasc MACC.[43]

However, the EPA report highlights that it does not have information on the planned implementation pathway for 'with additional measures' scenario for the reduction of methane, and warns that more information on planning and implementation will be required for these measures to continue to inform projections analysis.

The Government has set a target of 25% emissions reduction by 2030, or 17.3Mt CO_2 eq. WEM and WAM policies and measures are projected to reduce emissions to approximately 22.8 Mt CO_2 eq and 17.8Mt CO_2 eq respectively in 2030, between 5.5Mt CO_2 eq and 0.5Mt CO_2 eq above the emissions target. **To achieve the sectoral emissions reduction target and remain within the Carbon Budget, further measures and policies will be urgently required.**

Figure 4.4 shows the projected total emissions from agriculture. To estimate projected potential emissions, the EPA takes into account policy targets and related trends in market activity and policies introduced to reduce emissions. Underlying assumptions of external drivers modelled using the Teagasc FAPRI-Ireland projections cause an increase in dairy cattle, sheep, pig and poultry, alongside a decline in non-dairy cattle, as shown in Figure 4.5, and in tillage. This reflects the expectation that milk production will continue to be profitable, with some opportunities for expansion, while beef and tillage provide lower economic return. In other words, the market is forecast to drive ongoing change in the profile of the national herd, with an increase in dairy numbers partly offset by a decrease in non-dairy animals. However, as seen in the WEM scenario, this market-led decrease in cattle numbers is insufficient to result in a significant decrease in emissions. The projections in the WAM scenario assume delivery of the 2021 Climate Action Plan measures. These would decrease agricultural emissions by 22% by 2030 compared to 2018.

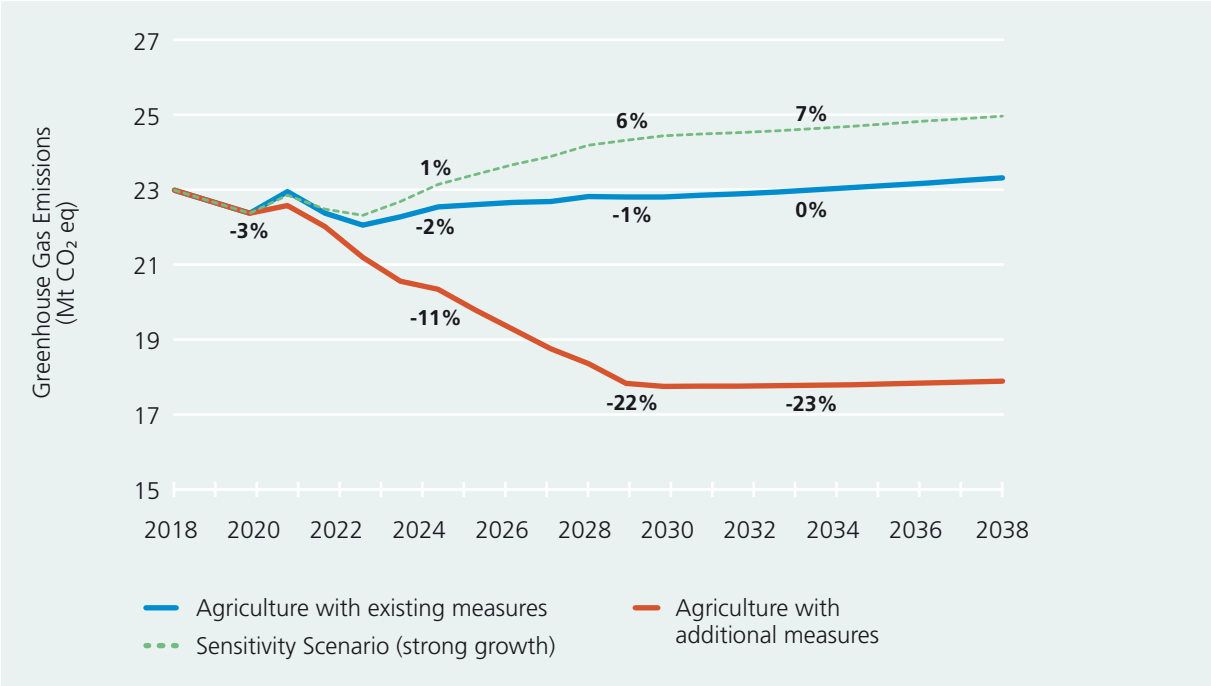


Figure 4.4 Projections of emissions from agriculture (Mt CO_2 eq) under 'with existing measures' and 'with additional measures' based on NCAP2021 and a strong growth sensitivity analysis relative to the 'with existing measures' projection. (Source: EPA, Provisional Inventory and Projections, 2022)[54]

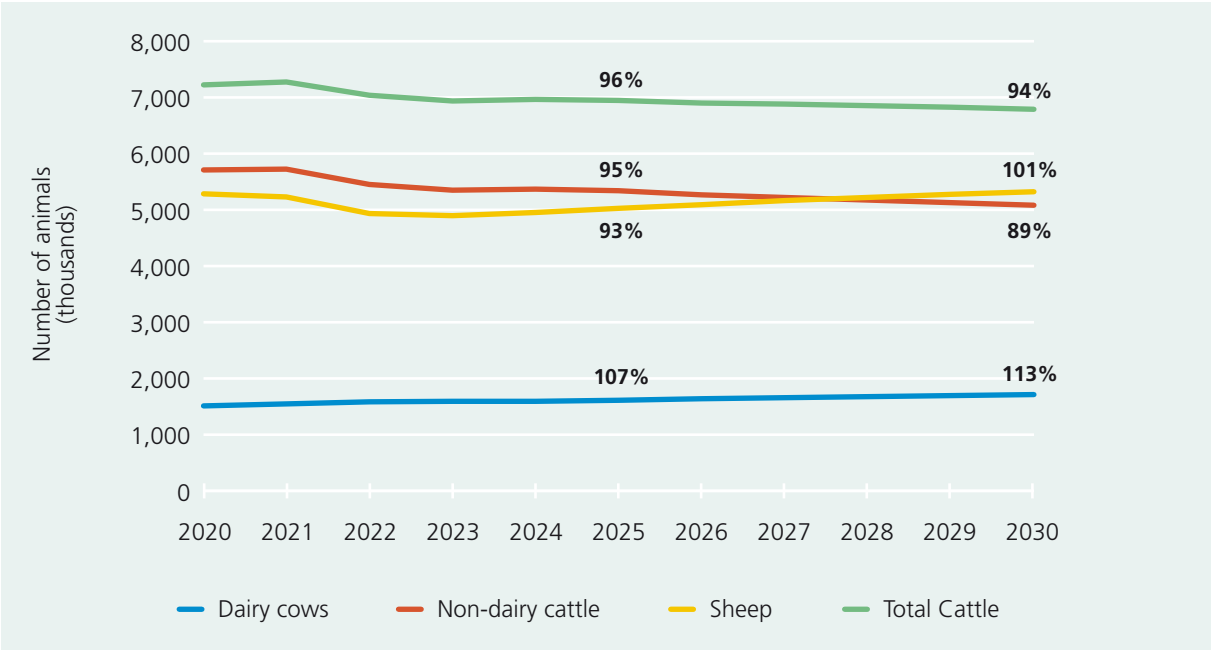


Figure 4.5 Projected animal numbers from FAPRI-Ireland modelling of assumed market conditions and sector response. Percentage values are projected in the number of animals relative to 2020. Source EPA, 2022 submission of national projections of anthropogenic greenhouse gas emissions pursuant to Governance Regulation Art.18 (1)(b)/Implementing Regulation Art.38[a]

a https://reportnet.europa.eu/public/dataflow/113

The EPA report has included a discussion of a sensitivity analysis performed for the agriculture activity forecast (see Figure 4.4) to improve understanding of the range of plausible outcomes from the sector associated with the external drivers increasing the risk of an increase in emissions. The sensitivity analysis scenario considers high growth within the sector, including a 10% increase in farm gate milk prices compared to the 'with existing measures' scenario and an increase in the allocation of budget from the Common Agricultural Policy to additional coupled support for the suckler herd.

The sensitivity analysis indicates an increase in total cattle numbers and a related increase in use of nitrogen fertiliser. A separate key insight from the sensitivity analysis is the need for policy coherence across the sector ensuring the interactions between farming activities are cumulative. For example, the additional support for the suckler herd changes the dynamic and relative profitability of sheep over beef and discourages diversification. Similarly, the high dairy prices further incentivises conversion from tillage to dairy, again reducing the diversity and increasing concentration risk in farming activity in the economy. In addition, **it is critical to consider how supports are consistent with environmental objectives and the risk of high market prices stimulating higher levels of emissions in Ireland.**

Table 4.1 shows a preliminary analysis of the projected cumulative emissions associated with agricultural activities over the first three carbon budget periods for the sector. The Government has agreed on a sectoral emissions reduction target of 25% by 2030. It is anticipated that the NCAP2023 will provide more details on the pathway of emissions reductions and consistency with carbon budgets.

Table 4.1 Projected agriculture cumulative emissions over the carbon budget periods from CB1-2021-2025; CB2-2026-2030; and CB3-2031-2035

	CB1	CB2	CB3
Agriculture Total WEM	112 Mt CO_2 eq	114 Mt CO_2 eq	114 Mt CO_2 eq
Agriculture Total WAM	107 Mt CO_2 eq	94 Mt CO_2 eq	88 Mt CO_2 eq

4.2.3 Land Use inventory

Ireland is one of just three EU member states which reports a significant net source of emissions from land use, the others being the Netherlands and Denmark. The common features are a high proportion of drained organic soils and low forest cover. Ireland's net emissions from Land Use were 7.8Mt CO_2 eq in 2021, an increase of 11.9% relative to 2020. The increase in emissions is largely due to a significant decrease in the rate of carbon removals from forest land activity. Land Use Emissions in 2021 were 25% higher than in 1990, and 13% higher than in 2018. Figure 4.6 shows the times series of estimated emissions and removals from Land Use from 1990 to 2021. There can be important interannual variation in emissions and removals within individual land uses often associated with specific events, including uncontrolled fire, making the historical trend across the sector as a whole, difficult to assess.

There has been a significant revision to the methodology and country-specific emission factors applied to soil carbon emissions and removals on afforested lands, based on improved understanding of the underlying processes and advanced observations of carbon fluxes from these soils. This reduces uncertainty in the inventory. However, given the complex, biological nature of the processes involved, uncertainty remains high. This has led to the estimate of carbon removals associated with forest land being revised downwards through the entire time series. Further refinements and revisions to the inventory for the LULUCF sector are expected over the coming years.

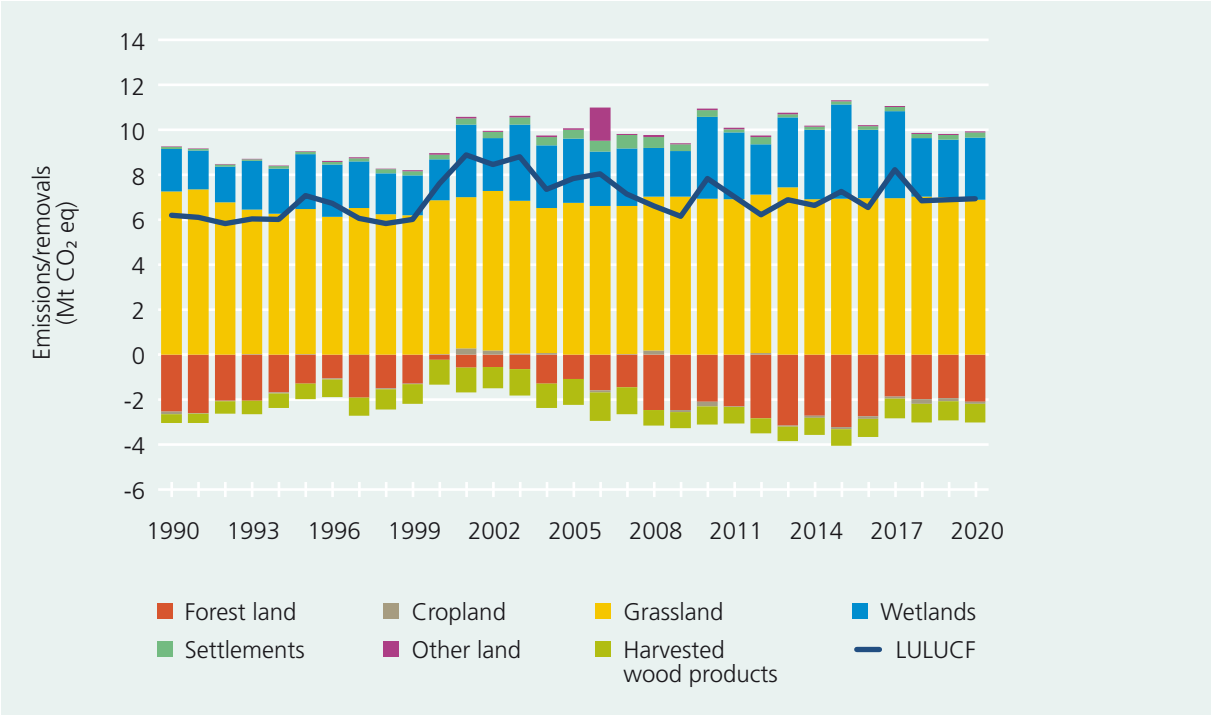


Figure 4.6 Provisional estimate of Land Use, Land Use Change and Forestry emissions and removal 1990-2021 (Source EPA 2022)[20]

4.2.4 Land Use Projections

Figure 4.7 shows the projections for emissions and removals within the Land Use sector published in 2022. As with the inventory estimates, the projections have been updated to include the revised modelling and emissions factors for forest soils, and project an imminent transition of forest land from sink to source of emissions. As noted in the discussion of the inventory, there is considerable uncertainty in the estimate of emissions associated with changes in land use and land use management. There is ongoing research and development funded by DAFM, EPA, BnM and others, to improve our understanding and reduce this uncertainty. It is expected that the findings of this research will be incorporated into the inventory and projections analysis as they emerge and pass peer review. Notwithstanding the uncertainty as to the exact impact of changes in land use and management on emissions and removals, there already is convincing evidence that actions including rehabilitation, rewetting, partial rewetting through water table management, afforestation and agroforestry will reduce emissions and enhance sequestration, when implemented appropriately.

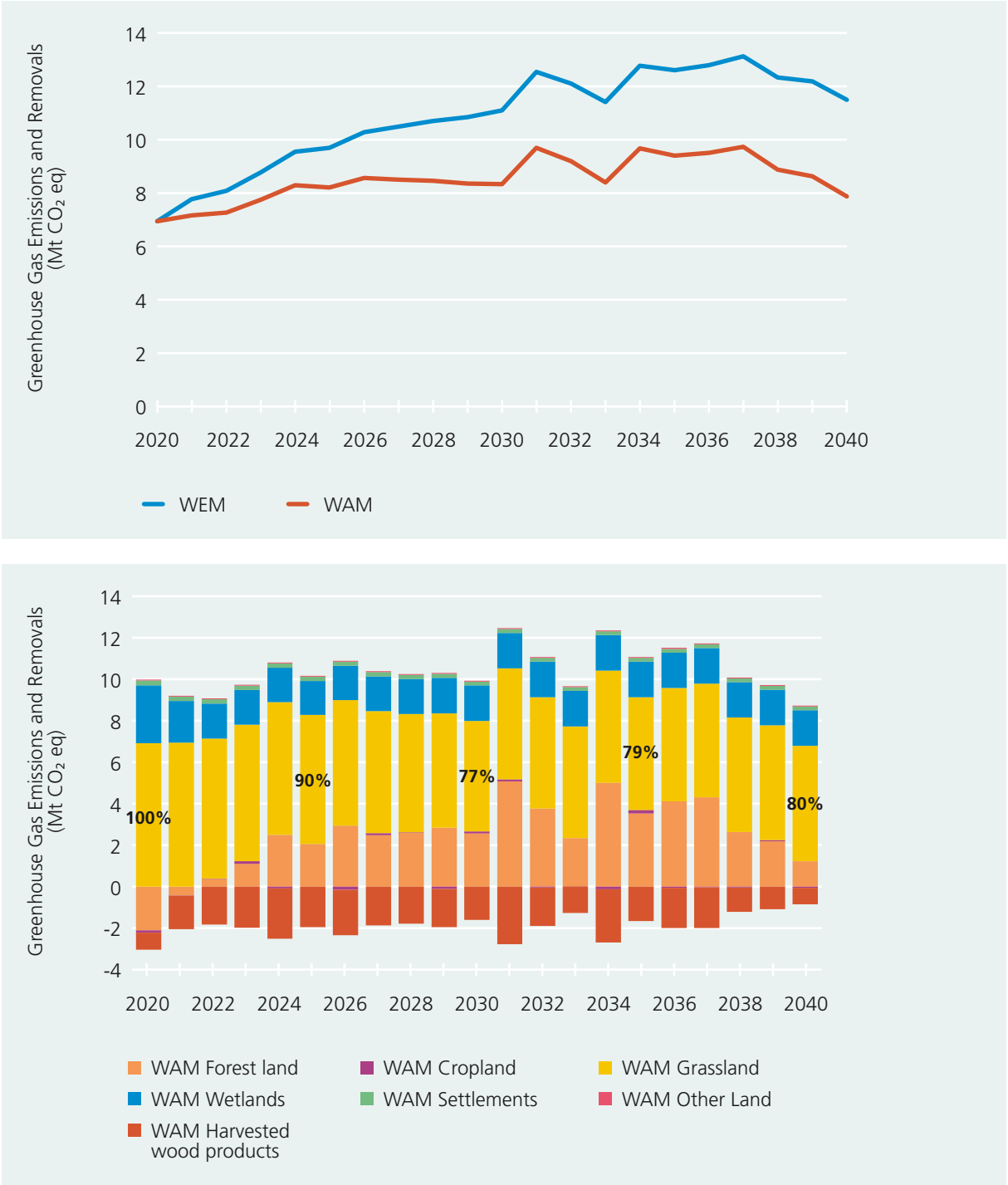


Figure 4.7 Top panel: Projections of emissions and removals associated with land use, land use change and Forestry with existing measures and with additional measures scenarios., Bottom panel: breakdown of emissions and removals for each land use category and harvested wood productions from the with additional measures projection. (Source EPA, 2022)[54]

Table 4.2 shows the projected cumulative emissions associated with Land Use activities over the first three carbon budget periods. The analysis clearly demonstrates the positive potential impact of additional mitigation measures identified in the NCAP2021. The recent announcement of sectoral emissions reduction targets did not include a target for the Land Use.

Table 4.2 Projected Land Use cumulative emissions over the carbon budget periods from CB1-2021-2025; CB2-2026-2030; and CB3-2031-2035

	CB1	CB2	CB3 provisional
LULUCF Total WEM	44 Mt CO_2 eq	53 Mt CO_2 eq	61 Mt CO_2 eq
LULUCF Total WAM	39 Mt CO_2 eq	42 Mt CO_2 eq	46 Mt CO_2 eq

4.3 Indicators

The trends in emissions in the Agriculture and Land Use sector overall are not promising. Although the reduction in non-dairy cow numbers continued, there has been a more rapid increase in dairy cow numbers, and a trend towards an increase in sheep numbers has continued into 2021. Coupled with an increase in fertiliser use, these are strong indicators of how the underlying drivers of emissions within the sector increased in 2021 as reflected in the provisional inventory published by the EPA. As regards land use, the sharp decline in afforestation rates seen in recent years appears to have continued. Reporting of indicator data on the other measures proposed for land use needs to be developed.

While perhaps premature to assess the implementation of the measures identified in the NCAP2021, where data exists it is useful to consider recent values for these indicators to establish underlining trends and establish baseline values for future assessment, see Tables 4.3 and 4.4. The indicators in these tables attempt to track the progress and potential impact of the various measures and actions within agriculture described in the NCAP2019 and NCAP2021. Many of the actions to be implemented aim to improve the greenhouse gas efficiency of production in dairy, beef and tillage sectors. The Teagasc National Farm Survey and Sustainability Reports provides insight for these indicators, which indicate modest improvement in efficiency in recent years, however, it is expected that it will take an extended period for efficiency measures to deploy across the sector and the full impact to emerge from the analysis.

The draft Common Agriculture Policy Strategic Plan, 2023-2027, proposal seeks 'to underpin the sustainable development of Ireland's farming and food sector by supporting viable farm incomes and enhancing competitiveness, by strengthening the socio-economic fabric of rural areas, and by contributing to the achievement of environmental and climate objectives at national and EU levels.'

This includes proposals to adopt mitigation measures under the Good Agriculture and Environment Condition provisions – Pillar I Eco-schemes and Pillar II Interventions. This is an effective approach to ensure engagement and implementation of measures at farm scale. The Council encourages further research, design and development of additional provisions as forward planning for the next periodic review of the Common Agricultural Policy for the period 2028 onwards.

Broader environmental indicators related to implementation of measures to maintain and enhance biodiversity and water and air quality may also be useful in the assessment of transition of the Agriculture and Land Use sector towards low carbon, climate resilience status. Many of these measures will be implemented through the Common Agriculture Policy. Climate positive outcomes may derive from actions whose primary focus is to address other environmental concerns. Measures to improve nitrogen use efficiency are a prime example of this. Primarily aimed at reducing nitrogen losses to water and air, lower nitrogen use will also reduce nitrous oxide emissions. Similarly, measures to enhance biodiversity within hedgerows and other farm habitats, for example, as supported under the Common Agricultural Policy, can increase on farm carbon sequestration and storage. However, regular, detailed reporting of implementation and outcome of measures needs development.

Table 4.3 Agricultural indicators 2014-2021

Name	Unit	2015	2016	2017	2018	2019	2020	2021
Sectoral emissions	*Mt CO_2 eq*	20.9	21.5	22.2	23.1	22.1	22.4	23.1
Emissions relative to 2018	*%*				100.0%	95.7%	97.0%	100.0%
Sectoral emissions CH_4	*kt CH_4*	526	541	559	572	557	564	575
Sectoral emissions N_2O	*kt N-N_2O*	19.6	19.8	20.9	22.1	20.8	20.9	21.6
Dairy Cows (June)	*Thousands*	1,296	1,398	1,433	1,481	1,505	1,568	1,605
Other cows (June)	*Thousands*	1,076	1,104	1,081	1,048	1,000	983	940
Other cattle (June)	*Thousands*	4,592	4,720	4,850	4,820	4,704	4,764	4,814
Total cattle (June)	*Thousands*	6,964	7,221	7,364	7,349	7,209	7,315	7,359
Total sheep (June)	*Thousands*	5,139	5,179	5,197	5,109	5,146	5,520	5,609
Milk deliveries	*million litres*	6,989	7,464	7,933	8,112	8,485	8,296	8,759
Nitrogen fertiliser use	*kt N*	331	339	369	408	367	380	399
Protected urea fertiliser % of total Nitrogen fertiliser sales	*%*	0.0%	0.1%	0.5%	0.8%	3.4%	5.3%	5.1%
Dairy production efficiency	*kg CO_2 eq per kg FPCM*	1.03	1.06	1.08	1.11	1.03	1.04	
Dairy nitrogen use efficiency	*%*	25.0	24.0	24.4	21.5	24.4	25.6	
Dairy N balance	*Excess kg N inputs over outputs per hectare*	155.9	164.8	171.9	200.7	178.7	172.6	
Dairy use of protected urea	*% of farms* *Top* *Middle* *Bottom*						8% 4% 2%	

Name	Unit	2015	2016	2017	2018	2019	2020	2021
Beef production efficiency	*kg CO_2 eq per kg beef*	11.2	10.8	11.0	11.5	11.0	10.5	
Beef nitrogen use efficiency	*%*	22.6	23.2	24.2	20.8	22.3	23.0	
Beef N balance	*Excess kg N inputs over outputs per hectare*	53.6	63.2	65.2	70.9	65.4	58.4	
Beef use of protected urea	*% of farms* *Top* *Middle* *Bottom*						4% 0% 0%	
Milk recording %	*% of farms* *Top* *Middle* *Bottom*						59% 44% 23%	
Tillage nitrogen use efficiency	*%*	68.1	67.9	69.8	57.1	68.7	62.6	
Tillage nitrogen balance	*Excess kg N inputs over outputs per hectare*	70.9	79.3	81.7	93.6	83.7	74.8	
Dairy profitability (gross margin)	*€ per hectare*	1,710	1,457	2,111	1,728	1,793	1,906	
Dairy economic viability	*% of farms*	75	69	85	73	74	79	85
Beef profitability (gross margin)	*€ per hectare*	463	507	533	483	497	510	
Beef economic viability	*% of farms*	24%	23%	25%	18%	18%	17%	16%
Tillage profitability (gross margin)	*€ per hectare*	757	671	817	904	921	756	
Economic viability	*% of farms*	62%	60%	74%	62%	59%	65%	72%

Table 4.4 Summary of actions in the National Climate Action Plan

NCAP Action	NCAP target	2020	2021	Implementation
Governance, Policy design and Common Agriculture Policy (Action 325, 331, 333, 358)				CAP 2023-2027 at final stages of negotiation with EU Commission
Reduce fertiliser use (Action 304, 305, 306, 342)	350,000 by 2028 325,000 by 2030	379,159 t	399,126 t	Good Agricultural Practice Regulations (SI 113 of 2022) came into effect on 11 March 2022. Signpost Programme
Protected urea fertiliser (Action 307, 342)	65% replacement of CAN	5.3%	5.1%	Signpost programme Nutrient Management Planning Online tool
Sward management (Action 308, 324, 346)	No target			Funding under CAP
Dairy Sector, Milk recording % (Action 309,314)	90%	23%-59%		Signpost programme, Dairy sector engagement
Beef Sector (Action 310, 311, 314, 343)				Funding under CAP
Average finishing age (Action 315)	24 mths	~26mths	~26mths	Implementation through engagement industry and advisory services
Improved animal feeding (Action 312, 313, 323, 324)	Not quantified	–		Good Agricultural Practice Regulations (SI 113 of 2022) came into effect on 11 March 2022. Sets constraints on crude protein in concentrate feed
Nitrogen use efficiency and Low emissions slurry spreading (Action 359, 360)	90%	36% (51% dairy, 18% other cattle)		Regulation, Signpost Programme, advisory services, CAP incentives.
Organic farming (Action 316, 317)	350,000ha	~74,000ha		Advisory services, trade organisations. Exemplar farms included in the Signpost programme
Cross-sector energy and bioecnomy (Action 318, 319, 320, 341, 347, 353, 361, 363)	1.6TWh yr-1	–		Leverage EU Capital investment Scheme. research institutions and industry, pilot facilities at farm level.
Research, modelling, analysis and assessment (Action 303, 310, 323, 326, 327, 328, 330, 344, 352,353, 354, 355)				National and international research programmes, national modelling capacity
Knowledge Transfer and Advisory Services (Action 321, 329, 345, 346, 348, 349, 350, 351, 354, 355, 356, 357, 359, 362)				Advisory services, industry, online tools, exemplar farms, case studies, etc.
Adaptation (Action 334, 335, 336, 337, 338, 339, 340, 351, 352,)				Implementation under the National Adaptation Framework

Table 4.5 outlines indicators to assess progress in transition, which provide insight into the implementation and impact of policies and measures across the various land uses. Table 4.6 classifies actions in the National Climate Action Plan 2021 under broad headings and the instruments proposed for their implementation. However, these indicators need to be further developed. **The renewed focus on outcome-based payments in the Common Agricultural Policy is welcome in this regard, and it is to be expected that reporting on outcomes will inform future assessment of climate action in this sector.**

Table 4.5 LULUCF indicators 2014-2021

Name	Unit	2015	2016	2017	2018	2019	2020	2021 (provisional)
Sectoral emissions	*Mt CO_2 eq*	7.3	6.5	8.3	6.9	6.9	6.9	7.8
Forestry cover	*kha*	758	764	769	773	777	779	
Forestry cover	*%*	10.7%	10.7%	10.8%	10.9%	10.9%	11.0%	
Drained organic soils	*kha*	884	887	879	872	872	870	
Grasslands management (mineral)	*kha*	3,885	3,882	3,879	3,877	3,876	3,874	
Grasslands management (organic)	*kha*	349	346	344	342	340	339	
Peatlands management (extraction)	*kha*	90	92	85	76	75	74	
Afforestation rates	*ha*	6,293	6,500	5,536	4,025	3,550	2,434	2,016

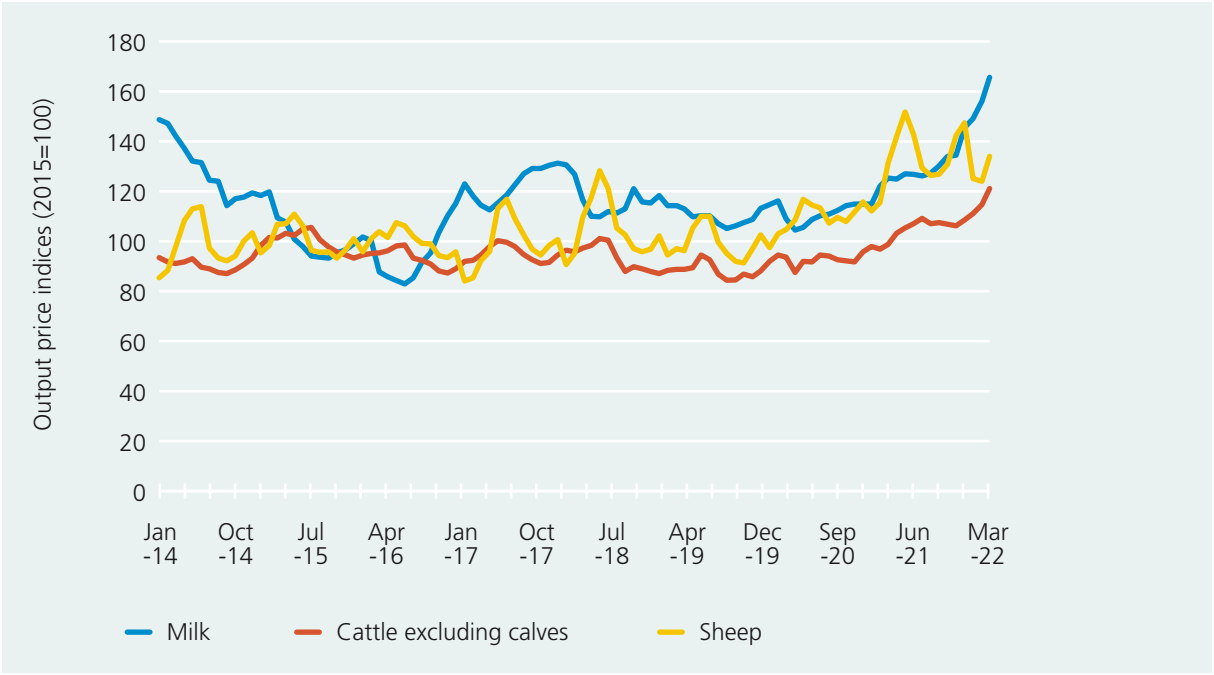
Table 4.6 Classification of actions in the National Climate Action Plan 2021 under land use categories

Potential additional indicators required to monitor implementation of measures		NCAP 2021 2030 Target
Management of organic soils and peatlands	Rehabilitation of degraded peatland Improved management of Forest on organic soils	65,000ha No Target specified
Grasslands management	Rewetting, water table management of grassland Agroforestry Hedgerows (establishment and removal) Multispecies sward	80,000ha No Target specified No Target specified 450,000ha
Tillage	Cover crop Straw incorporation	50,000ha 10%

4.4 Analysis

4.4.1 Agriculture

Strong market forces are driving activity within the Agriculture and broader food production sector. The preliminary results of the National Farm Survey reflect this positive economic outlook, with an increase in the proportion of viable farms across all farm types. Figure 4.8 shows trends in output and input price indices impacting activity within the agricultural sector. Current agriculture output prices are relatively high, though with interannual volatility. Input costs are also at historically high levels, particularly fertiliser prices. The producer-led response to the market drivers has led to higher production levels in the more profitable sectors of agriculture, tempered by input cost inflation. In 2021, the higher output prices appeared to allow the sector to absorb higher input costs, resulting in higher production and higher overall emissions. The early indicators suggest the drivers for increased production, particularly for the dairy sector, have continued into 2022, although heavily dampened by higher input prices.



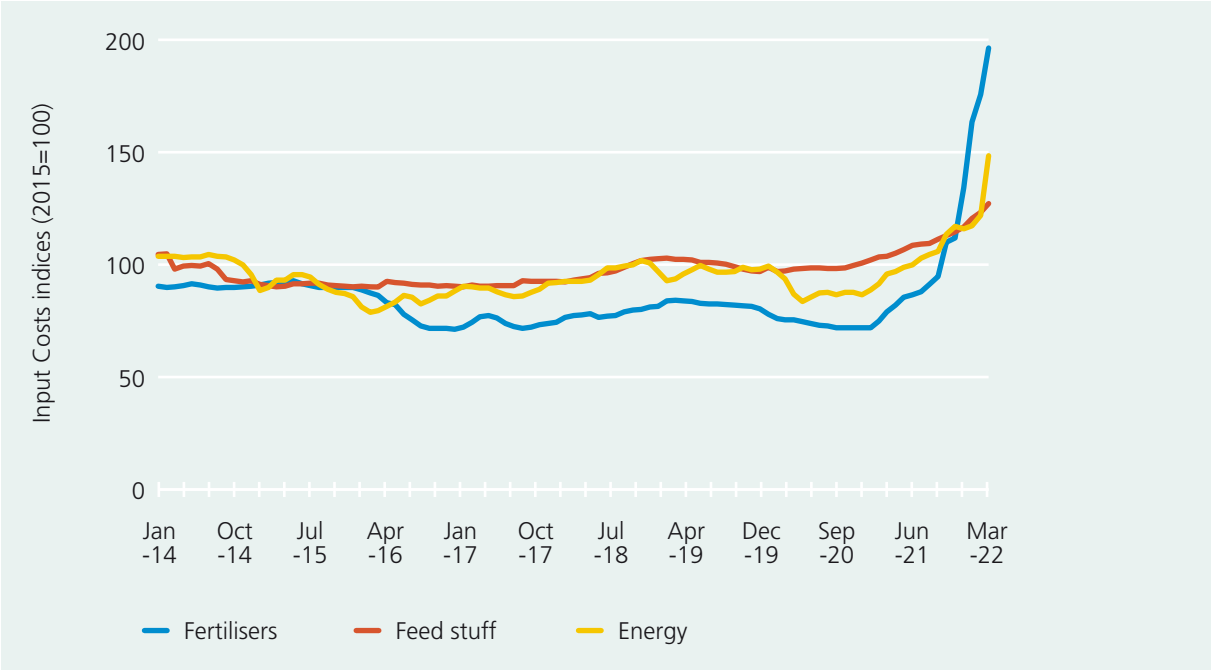


Figure 4.8: Input and Output price indices within Agriculture Top panel: Output price indices. Bottom Panel: Input price indices (Source: CSO)

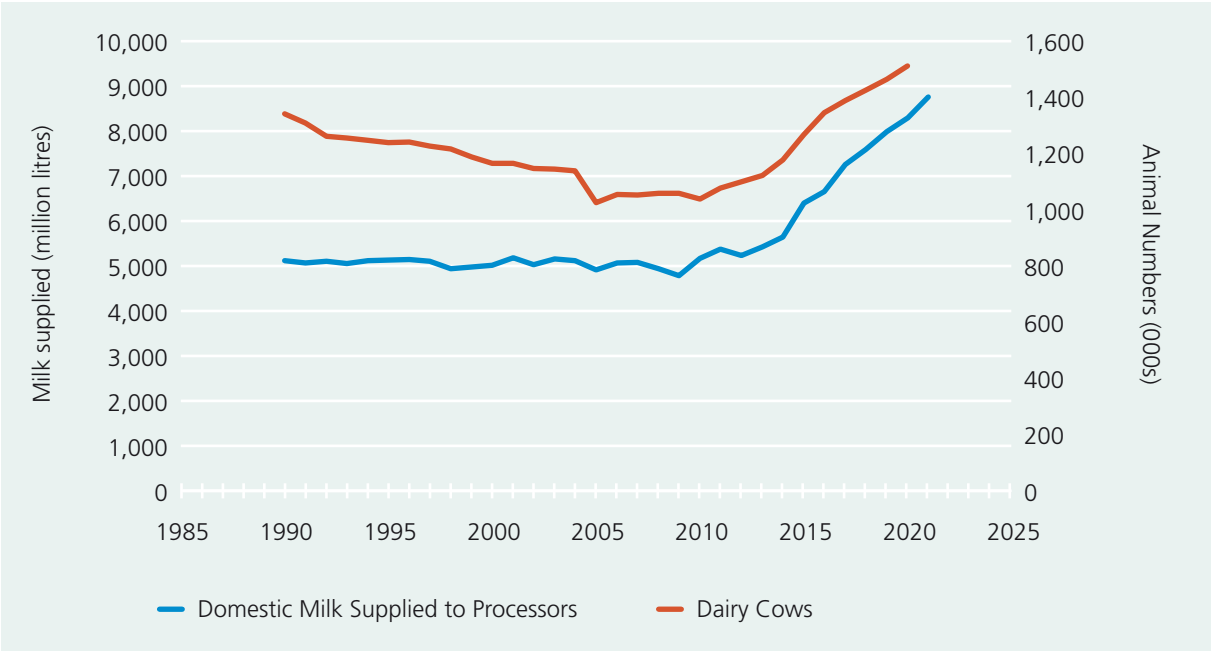


Figure 4.9 Milk deliveries to processors, Dairy cow numbers. Estimated milk yield per animal (excluding on farm consumption) (Source: CSO)

In the period leading up to, and following, the removal of the milk quota in 2015 there has been a major expansion of the dairy herd, see **Figure 4.9**. Over the same period, the suckler herd has decreased, see Figure 4.10, reflecting some restructuring where suckler animals have been replaced by dairy animals, which have higher greenhouse emissions per animal. The expansion of the dairy herd has outpaced the decline in the beef suckler herd, and overall the national cattle herd has increased slightly. **The Council has repeatedly noted that agriculture is not on a sustainable path, and gains in production efficiency alone are not enough to address the need for reduction in total emissions. Additional policy instruments need to be explored to create a meaningful counter-balance to the strong market drivers pushing an expansion of production, especially in the dairy sector.**

Preliminary figures on the income performance of Irish farms have been published for 2022 by Teagasc.[55] Dairy and tillage farms continue to report substantially higher average income levels than beef and sheep farms. The differences in income partially relate to differences in farm size, with dairy and tillage farms typically being larger than beef and sheep farms. However, even when farm size is taken account of, the profit margin on dairy and tillage farms tends to be considerably higher than on beef and sheep farms. The profitability at farm scale influences resources available to implement mitigation measures and the need to design the appropriate incentives, controls and regulations to encourage engagement.

In its Annual Review 2020, the Council highlighted ongoing research which explored cost-negative mitigation opportunities through diversification of land use related to afforestation and agroforestry, based on the approach developed by Duffy et al., 2020.[56] Despite recent movement in output prices, the analysis remains valid, particularly for vulnerable farm enterprises.[55]

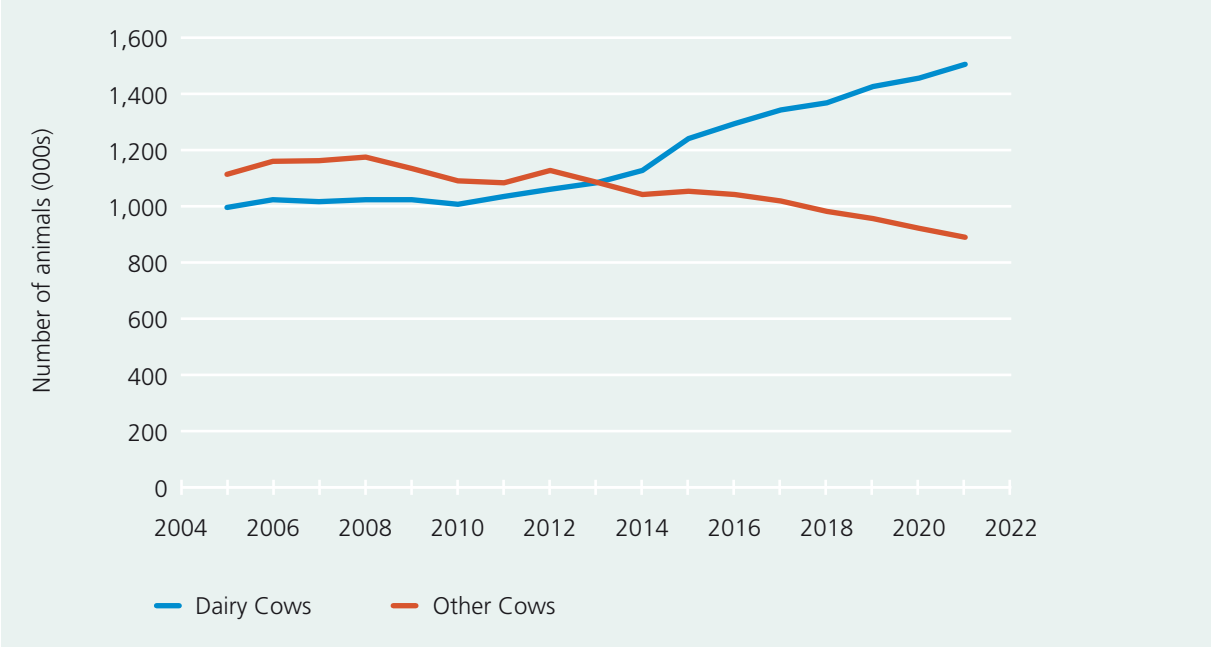


Figure 4.10 Trends in numbers of dairy and non-dairy cows (June) in the period from 2006 to 2021 (Source: CSO Livestock Table AAA09)[a]

a https://data.cso.ie/table/AAA09

The Council has noted that the Food Vision 2030 strategy launched in 2021 adopts the Ag Climatise Roadmap as the basis for sectoral development and articulates a target to reduce methane emissions by at least 10% relative to 2018, and that the Roadmap commits to the adjustment of this target subsequent to the agreement of specific sectoral targets as allowed for under the Climate Act[2]. **The Council is concerned that a 10% reduction in methane emissions may not be consistent with objectives of the Paris Agreement**, as evidenced by analysis present in the Carbon Budgets Technical Report (2021)[57].

A review of the Ag Climatise Roadmap is required to realign the roadmap with the urgency and increased ambition for emissions reductions in the NCAP 2023 when published. The Government must provide the pathway and timeframe for speedy implementation of measures identified in Ag Climatise.

The ambition of Ag Climatise Roadmap, published in December 2020, was to 'develop a climate-neutral food system compatible with the Paris temperature goals, whereby the climate impact of biogenic methane is reduced to zero and remaining agricultural emissions are balanced through land use and a significant contribution to renewable energy' by 2050. The Ag Climatise Roadmap was developed on the basis of the original ambition for emissions reductions agriculture in the National Climate Action Plan 2019. Both understanding of the urgency for emissions reduction and climate policy have advanced since 2019. The Ag Climatise Roadmap set out a roadmap to reduce absolute emissions. In seeking transition, key areas noted for action by Council include:

- Nitrous oxide emissions must be substantially reduced,
- The need to manage livestock numbers within biophysical boundaries,
- Efforts must be intensified to find ways to reduce methane emissions at scale,
- Policy should focus more on nature-based carbon removals, and
- Long-term land-use strategy is required.

Measures to reduce nitrous oxide emissions can be most effectively targeted at farm types with relatively high nitrogen usage, including the dairy and tillage sector.

The Council notes that measures which seek to stabilise emissions of methane and improve nitrogen use efficiency (resulting in reduced nitrous oxide emissions) envisaged in the 2020 strategy have not been adopted to date at a rate sufficient to counter the impact of increased production and a general intensification of agricultural practice in many regions.

The sectoral emissions ceilings for the agriculture sector are challenging. A review of the 'Ag Climatise – National Climate & Air Roadmap for the Agriculture Sector' is required to meet this challenge.

Most recently, the Food Vision Dairy Group, established to develop and implement a Plan to stabilise and then reduce emissions associated with the dairy sector, produced an interim report. An important measure identified by the interim report is a 100% replacement rate of CAN with Protected Urea by the end of 2025 for grass-based dairy production systems. The use of protected urea has the potential to reduce emissions of nitrous oxide, though supply chain issues may have limited uptake. There is promising uptake within the dairy sector, though heavily skewed to the higher performing enterprises. Uptake on beef farms is limited to only top performing enterprises.

The Council reiterates its observations on the EU 'Farm to Fork Strategy'[58], and a variety of prominent national and international assessments, which have identified the need to ensure agriculture, food production and food consumption policies are coherent, consistent and aligned with broader environmental, climate and health objectives. Practices to reduce emissions have evolved to recognise the need to apply an integrated

systems approach to food and agriculture, to work for consumers, producers, climate and the environment.[9],[59],[60],[61],[62] **The revised Common Agricultural Policy (CAP) can be used as an instrument of change, with sustainable management of natural resources and climate action representing one of the three main objectives of the new CAP.** Also, enhancing research, and providing advisory support for farmers, and farmer-driven partnerships, can enhance practice. The Council notes the launch in 2021 of the Teagasc-led Signpost programme, which is a collaborative partnership of farmers, industry and State agencies, working together for climate action at farm level, ensuring an effective pipeline from 'theory to practice' and the demonstration and rapid deployment of proven mitigation options at farm scale. This is also relevant to afforestation in the Land Use sector.

The Signpost programme also supports the Smart Farming initiative led by the Irish Farmers' Association, in conjunction with the Environmental Protection Agency, which complements Bord Bia's Origin Green, but has a broader environmental scope. In its 2020 report, the Smart Farming programme estimated a 9% average potential greenhouse gas emissions reduction on participating farms, with an average of €5,602 cost savings. Realising and verifying these potential emissions reductions through robust data analysis and monitoring are required. Data on the uptake of these practices and real-world impact on carbon stocks are needed to ensure they are reflected in national reporting of emissions and removals.

The Council is encouraged by the recent findings of the European Food Safety Authority with regard to safety and efficacy of the feed additive 3-nitrooxypropanol (3-NOP)[63] in reducing methane emissions from dairy animals. 3-NOP is also subject to ongoing research by Teagasc, specifically looking at ways in which to deploy 3-NOP and other potentially beneficial feed additives to the diet of ruminants in the context of pasture-based farm systems. It is important that any time-lag between research, certification and deployment is kept to a minimum, while respecting the necessary processes of evaluation, certification and validation required of all new technologies. This involves early engagement and communication with both industry and farmers with respect to emerging technologies and other solutions.

As indicated, there exist a number of technological solutions that are ready for adoption, such as clover, MSS, and protected urea, as set out in the MACC, which can, when deployed effectively, realise significant emissions reductions by 2030. However, additional technological solutions to reduce emissions are required, and are the subject of intense research. It is unclear at this stage if both existing and emerging solutions will be effective, low cost, and acceptable to the public, and whether these will emerge on the market in time to contribute to achieving emissions reduction targets. However, if these solutions are not effective, the alternative actions available to the sector to reduce emissions will involve reduction in production. The situation regarding nitrogen emission in the Netherlands is an extreme example of the steps which the Government can be forced to take to address serious environmental degradation.[64]

The Intergovernmental Panel on Climate Change (IPCC) noted the mitigation potential,[65] and improved health outcomes of balanced diets featuring plant-based foods and animal-sourced food produced in resilient, sustainable and low-GHG emission systems and reduced food waste.[66] A similar finding emerged from the EU dietary change scenarios of 'A Clean Planet for All' report. Researchers in Teagasc participating in the SuHeGuide project, which examines synergies between healthy and sustainable diets[a], offer an example of national-level study, that can complement international research on synergies across public health and sustainability policy. The social dimension also increases in prominence when it is recognised that policies to reduce emissions may have social implications, which need to be addressed for a Just Transition.

a SuHeGuide: Food based dietary guidelines for sustainable and healthy lifestyles.

4.4.2 Land Use

The NCAP2021 contains several measures to reduce emissions and enhance removals associated with land use change, land use management and forestry. The actions will see changes in land use across the country. Some will be subtle but important, others will have significant visual and environmental impact.

There has been major investment by the EPA in research to improve the resolution of analysis of land use and land management practices. This research is complemented by the recent Teagasc initiative to establish the National Agricultural Soil Carbon Observatory in 2021, to get more accurate measurements of emissions and removals from mineral and agricultural organic soils. The expectation is that findings from this research will be integrated into inventory and projections methodologies in the coming years.

Forest land: Ireland is not achieving national ambition for afforestation. Harvest volumes are projected to increase, as a large cohort of the national forest reaches maturity. **The land use sector requires urgent actions if the potential to reduce emissions and for negative emissions are to be achieved in the coming decades.**

Generous incentives have been provided for afforestation, but uptake is not sufficient, highlighting that other market, regulatory, social, and cultural barriers need to be addressed. Afforestation needs to be perceived and rewarded as an attractive option for farmers which does not appear to be the case in recent years, as evidenced in Figure 4.11. The recent announcement by Coillte to expand their forest holding by 100,000 hectares by 2050, while welcome, will not fully address the identified need for increased afforestation to meet the national forest cover target of 18% by 2050. Nevertheless, there is merit in an acceleration of the afforestation through Coillte and other bodies to achieve targeted national rates of afforestation to address the overriding public need. In the interim, policy must adjust to allow the private sector to restructure itself to deliver on medium- and long-term objectives, and re-establish supply chains, including tree nursery capacity, to support an expanded afforestation programme. The Carbon Budgets Technical Report includes scenario-based analysis which highlights the importance of an immediate increase in the rate of afforestation in order to ensure that the annual rate of carbon sequestration and storage can contribute to the balance of residual greenhouse gas emissions and match the ambition of the carbon budgets. There has been insufficient analysis and communication of the likely impact of this major expansion of forest cover in Ireland, especially given that the historic pattern of large-scale afforestation on peatland is unsustainable, and therefore afforestation will compete with agriculture for land. As noted in previous Council Annual Reviews, for many farm enterprises, diversification of some of their holdings to forestry is an attractive economic option.

Urgent reform of the licensing and regulation of routine forestry activities is necessary. The Council looks forward to findings of the Forest Policy Group tasked with identifying initiatives to revitalise the forest sector. State afforestation through Coillte should also be revitalised, with a renewed mandate to deliver for commercial and public good objectives. **The Council urges the forest policy group to be innovative in its consideration of options for reform of the regulatory and licensing structures governing forestry in Ireland, particularly with regard to streamlining administrative, planning and approval processes, without compromising environmental integrity.** As in other areas of planning, additional resources are likely to be required to process the increased volume of activity, in respect to afforestation and harvesting, arising from the ambition for the forest sector to contribute to mitigation articulated in the NCAP2021.

Barriers to the use of advanced timber products within construction at planning and regulatory levels hamper innovation and growth in the forestry sector. Ireland can learn from international experience and best practices to address these barriers. Urgency is required in addressing these issues to both maximise the storage potential of the carbon sequestered to our commercial forests as the sector prepares to harvest maturing plantations, and to reduce the embedded emissions in materials used in construction.

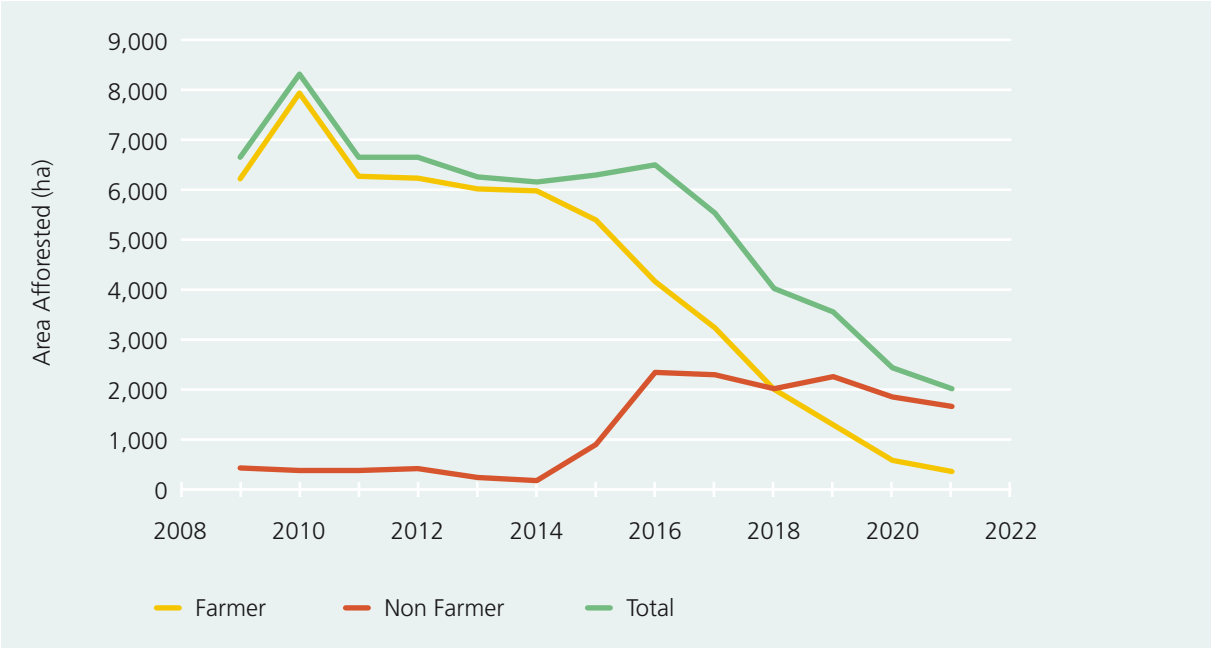


Figure 4.11 Annual afforestation rates 2008-2021 (Source: CSO Afforestation Area 2021, Online ISSN: 2811-5597)

Grassland: Grasslands are the dominant land use in Ireland, managed primarily to provide grazing and fodder for livestock. The grasslands category is also the largest source of emissions of carbon dioxide due to the drainage of approximately 300,000 hectares of organic soils (generally reclaimed peatlands). The NCAP2021 sets out the ambition to support improved water table management and rewetting on 80,000ha of these lands. This would deliver up to 2Mt CO_2 eq emissions reduction per annum by 2030. Improved management of grasslands on mineral soils, coupled with incentives for farmers to convert to organic farming practices, where appropriate, provide additional options for enhanced carbon uptake at farm scale.[67] The same study noted adoption of these land management options will have the additional beneficial impact of reducing animal stocking rates and associated emissions. The study struck a note of caution as regards the potential for carbon leakage if consumer demand for high emissions intensive products remained high.

There is significant uncertainty as to the emissions profile of many of these drained organic soils, which benefited from reclamation initiatives in earlier decades, but whose current status is not well documented. The EPA land use mapping project will be important in identifying and characterising these lands, and the Teagasc National Agricultural Soil Carbon Observatory will be important in measuring the emissions from these lands. This research will result in the emissions profile of these grasslands likely being represented more accurately in the inventory analysis in the coming years.

Wetlands: Ireland has a significant area of wetlands, including peatlands. The protection and improved management of all types of wetland habitats is of critical importance from biodiversity, water quality and climate resilience perspectives. However, there is a necessary focus required on degraded peatlands drained for the purpose of peat extraction and their ongoing carbon dioxide emissions. The drainage of peatlands leads to the continual oxidation of the organic carbon stored in the peat due to its exposure to air. For as long as the peat is drained, carbon dioxide is emitted to the atmosphere. Rewetting, rehabilitation and restoration are effective management options to avoid these emissions. The peatlands owned and managed by Bord na Mona (BnM) are the most familiar cohort of drainage peatlands for extraction for electricity generation and horticultural use. BnM have committed to the cessation of peat extraction and committed

resources to a programme of rewetting, rehabilitation, restoration and alternative, low carbon after-use as appropriate. Implementation of this programme is a prominent part of the emissions reduction projected in the 'with additional measures' scenario informed by the NCAP 2021, delivering up to 2Mt CO_2 eq emissions reduction per annum by 2030.

There is limited information on the area and present condition of peatlands impacted by the historic and current exercise of turbary rights. Although the use of sod peat has declined sharply in recent decades, there remains a significant cohort of households which rely on peat for home heating. The EPA land use mapping project will be important in identifying and characterising these lands, and the emissions profile of these lands is likely to be represented more accurately in the inventory analysis in the coming years.

Cropland: Croplands account for a relatively small area of agricultural land use in Ireland, approximately 300,000 hectares under crops per year, with a similar area under temporary grassland within crop rotations. Underlying market trends have resulted in a reduction in tillage in Ireland, pulling more land into dairy production.[68] This raises a number of concerns: the further expansion of dairy and associated increase in emissions; possibility of the contraction of the tillage sector, thereby reducing the diversity of the rural economy and reducing the potential for circular economy synergies between agricultural sectors (straw, slurry); security of feed and food supplies as domestic demand increases but domestic production decreases; and uncertainty with respect to the provenance and environmental sustainability of international supply chains impacting on the life cycle assessment and production efficiency of food in Ireland. Other perspectives may also be argued, as there may be opportunity for expansion of cereal production in response to the high demand from the dairy sector. However, this would be in competition with imported cereal from producers with lower labour and other input costs. In response to food security issues emerging from the war in Ukraine, the Government has created new incentives for additional tillage in 2022. While some expansion of tillage in Ireland may be sustainable, it is worth noting that the conversion of permanent grassland to tillage could lead to significant carbon losses from the soils.

Afforestation and the adoption of rewetting and water table management on organic soils under grasslands has the additional potential to reduce direct emissions of methane and nitrous oxide by reducing the national herd displaced from those lands. A similar potential exists with the expansion of organic farming and other incentives which lower stocking rates on participating farms. It is important that this additional potential for emissions reduction is recognised as it represents a significant opportunity cost to farmers who may decide to intensify production on other areas of the farm to compensate.

While important for emissions management at a farm level, it is important not to overstate the contribution of this aspect of afforestation to mitigation targets in the short- to medium-term. The potential reduction in the number of animals is proportional to the rate of afforestation. If we assume Ireland achieves an afforestation rate of 8kha to 2030, and these lands had an average stocking rate of 1.3 animals per hectare, the reduction in national herd would be of the order of 90k animals, and emissions reductions of approximately 0.15 Mt CO_2 eq per year by 2030, or less than 1% reduction in total emissions from agriculture.[a]

Innovation in agriculture policy must be matched by innovation in land use policy and planning. The Programme for Government: Our Shared Future, 2020, committed to undertake a national land use review, including farmland, forests, and peatlands, so that optimal land use options inform all relevant government decisions. It is important that opportunities for diversification of land use are exploited, including high nature value and carbon farming, land sharing and sparing, agroforestry and afforestation.[69]

a Approximately 1.5 tCO_2 eq per animals per year based on implied emission factors for non-dairy cattle from the National Inventory Report.

4.4.3 Biodiversity

Agriculture is the dominant land use in Ireland, and therefore agricultural practices can have the greatest impact on biodiversity. Many of the management options which would favour biodiversity would also have important positive impacts for climate change adaptation and mitigation. Historically, the agricultural sector has focused on increasing productivity and yield, and resulted in pressure on local habitats and species. As Gorman et al. (2021) noted, 'agricultural land use, with associated habitat destruction and nutrient leaching, is currently the most prevalent threat to habitats, species and freshwater quality in Ireland.'[70] Low-intensity farming systems are critical to nature conservation and protection, while large-scale input-intensive systems can cause major environmental problems in agricultural landscapes and ecosystems.[71] The agricultural sector must now move towards more sustainable, eco-friendly production practices, with the inclusion of multiple actors and stakeholder engagement, innovation and technology, knowledge sharing and effective support systems and networks. The Council is encouraged by the DAFM's advisory initiatives which seek to leverage peer to peer learning to encourage implementation of sustainable land management and farming practices, developing on the successful approach long established within Teagasc.

Livestock farming can put pressure on biodiversity. For example, the pasture management that is typical of Irish dairy systems requires high nitrogen fertiliser use, tends towards low diversity swards, and this negatively impacts biodiversity. As the CCAC's Carbon Budgets Technical Report (2021)[17] outlined, changes in land management, including drainage and hedgerow removal, to facilitate the expansion or intensification of livestock farming may be detrimental to biodiversity and should be avoided.

Biodiversity protection must be incorporated into our agricultural frameworks through strategic policy instruments. The Common Agricultural Policy 2023-2027 includes biodiversity protection as part of its sixth objective, with the aim 'to contribute to halting and reversing biodiversity loss, enhance ecosystem services and preserve habitats and landscapes'.[72] Ireland's resulting CAP Strategic Plan 2023-2027[73] proposes a number of interventions aiming to further this objective, such as the Eco-Scheme and Agri-Environment Climate Measure. The Council supports these initiatives, which would be key steps in integrating biodiversity into the Irish agricultural sector.

A high proportion of Ireland forest land is in private ownership, and this is largely within the farming community. Hence, current ambition for afforestation and agroforestry will require strong engagement from the farming community. The management of existing forest, afforestation and agroforestry, when properly planned and managed, with the right trees in the right place, will mitigate against wildfire and poor water quality and can be highly cost-effective.[70] Making good on Ireland's high potential for agroforestry could also provide a valuable ecological network delivering on services such as carbon sequestration and storage, shelter for livestock and pollutant remediation and wildlife corridors, however, there are important knowledge gaps which need to be addressed to quantify the impacts of agroforestry.[70],[74] It is important that agroforestry is appropriately classified and recognised as an agricultural land management measure to meet climate and environment objectives, and is not classified as removing lands from agriculture under the terms and conditional of the Common Agricultural Policy.

Peatland restoration and rehabilitation offers huge benefits in biodiversity conservation, as well as flood protection and carbon storage. On former peat extraction sites, the highest possible level of ambition for restoration and rehabilitation of ecosystem function should be incentivised. On drained organic soils under agricultural use there may be fewer options for restoration of peatland ecosystem function. Nevertheless, where opportunities for rewetting and water table management are identified, high nature value conditions can be maintained and enhanced, with ongoing low intensity pasture management.

Through the introduction of Nature-based Solutions, there could even be a high potential for the agricultural sector to transition from being a driver of environmental impact to an 'environmental solution provider'.[75] Nature-based Solutions, when properly implemented, can enhance nature and biodiversity, while also increasing agricultural production and resilience, benefiting grazing management and mitigating climate change.[76] There are several Nature-based Solutions the agricultural sector can adopt that specifically benefit biodiversity, including grazing optimisation, reduced fertiliser use, use of cover crops in fallow periods, and planting legumes in pastures.[75] Planting trees on agricultural land also increases habitat value. However, when investing in Nature-based Solutions, a nuanced understanding of the specific constraints different farmers face must be applied.[75]

The potential for bioenergy and biofuel crops to contribute to emissions mitigation must be consistent with the protection of biodiversity.[70] Some negative impacts could be potentially mitigated by incorporating the protection of important biodiversity landscape features, such as hedgerows, ponds, and buffer strips, into plans to expand the development of bioenergy in Ireland.[77] Further research is needed to understand how the development of bioenergy through different land use changes could impact local biodiversity.

4.4.4 Just Transition

The agricultural sector is one of Ireland's largest sectors in terms of its economic contribution and employment rates. The sector faces both challenges and opportunities as Ireland undergoes a transition into a climate resilient, low-carbon economy. A Just Transition requires strong community engagement and confidence that the transition will deliver a vibrant rural economy. NESC has been requested by the Government in the NCAP2021 to undertake research and engage on how to support a climate Just Transition in agriculture, reporting in March 2023.

Engagement with stakeholders will be important to ensure that the farming community benefits from the necessary changes in land use, including a focus on jobs and training, for new opportunities in sustainability innovations. Alternative income sources for farmers can include employment within the forestry and agroforestry sector, employment within emerging rewetting and restoration sectors, expanding bioenergy and small-scale generation sectors based in rural communities, as well as opportunities arising from local residential and SME retrofit activities.

Analysis included in the annual National Farm Survey and Farm Sustainability Reports identifies a significant cohort of farm enterprises which operate with very low economic viability, particularly within the beef sector. It is important that interventions achieve necessary co-benefits for climate, environment, economy and social cohesion. A Just Transition in the agricultural sector should not only consider decarbonising and prioritising sustainability in production levels and sustainable intensification, but also the use of an integrated, holistic approach that balances the economic, social, and environmental objectives relevant to food, agriculture, and public health.[78],[79],[80],[81]

A Just Transition within the agricultural sector requires that the needs of farming communities are served while also mitigating and adapting to climate change, ensuring food security, expanding opportunities for diversification, including forestry, biomass and bioenergy within the rural economy, supporting gender equity and reducing poverty and inequality. These need to present viable and attractive options for farmers and support rural communities. Social dialogue and early long-term engagement with all relevant stakeholders will be vital to create a fair and Just Transition plan.[82] The development and investment in programmes to build knowledge, and (re)skill and (re)train on sustainable practices will be necessary, uptake of plant-based farming could be encouraged, and livestock farmers must be helped financially to transition away from carbon intensive practices.[83],[84]

The Council is encouraged by the Teagasc-led Signpost programme, launched in 2021, which is a €17 million multi-annual collaborative partnership of farmers, industry and State agencies, working together for climate action at farm level. However, further ambition and urgent action is required if Ireland is to achieve its climate goals and obligations to reach net zero by 2050 with Just Transition at its centre.

The transition of the Land Use from a carbon source to a more sustainable one envisages key actions such as a rapid increase in afforestation, improved management of existing forest areas, and the rehabilitation and restoration of peatlands. There is a need to incorporate a Just Transition framework into policies relevant to the sector to ensure a smooth and fair transformation that would offer both social and environmental benefits, through dialogue with those who will be most affected by the transition. Adequate support should also be put in place for those who are willing to manage their land more sustainably. For example, the new Forestry Strategy and Programme, to be launched in 2023, should provide agri-environmental schemes to encourage farmers to establish and maintain forests on their land.

It is important to think ahead when it comes to the displacement of jobs, to prepare and support adequate and sustainable social protection for job losses and displacement. Individuals and communities who are at risk of loss of employment or livelihoods in the future need to be identified now in order to allow for timely preparatory plans to be designed. It is important to choose emissions reductions plans that also promote sustainable development and that drive environmental sustainability, jobs and decent work, social inclusion, and poverty eradication.[85] Many lessons in this field can be learnt from the work of the Just Transition Commission in the Midlands.

5. Sectoral progress – Transport

Key messages

Observations

- Increased fuel costs are impacting households and businesses, particularly isolated households without access to effective public transport services.
- Emissions from the domestic Transport sector increased from 2020 to 2021 but still did not reach levels seen before the Covid-19 pandemic. However recent traffic count data suggest activity is returning to previous levels.
- Emissions from freight were less impacted by Covid-19 and traffic counts for HGV movements in 2022 are ahead of levels in the same months for 2019-2021.
- Some measures to reduce transport emissions can protect households from rising fuel prices and support improved wellbeing.

Recommendations

- The reduction in public transport fares in early 2022 was a welcome step. Public transport provision must be enhanced and the reduction in fares should be retained and extended with an assessment of the effectiveness of both measures in terms of supporting the vulnerable and reducing emissions.
- Electric Vehicles (EV) already have a lower lifetime cost to the owner than conventional vehicles for high kilometre drivers such as drivers in rural households, taxi drivers and commercial drivers. Furthermore, the overall emissions savings are greater when a high kilometre driver makes the switch to electric in comparison to a low kilometre driver. This should inform government policy in this area. The extension of government-supported low cost finance initiatives for retrofit to include purchase of EVs offers a route to reduce costs for both the Government and consumers.
- Congestion charging is a proven measure for discouraging car use in urban areas where public transport options exist. Plans should be developed and adopted for its immediate implementation after the roll out of the BusConnects scheme.
- The Programme for Government commitment to phase out the sale of new petrol and diesel cars by 2030 should be incorporated into the NCAP2023. Vehicle registration tax (VRT) for all petrol and diesel cars needs to increase to encourage early progress towards this goal and to ensure a sustainable transport system.
- The road haulage sector needs to move towards sustainability. Existing direct and indirect fossil fuel subsidies for diesel consumption in the sector need to be phased out. Supports should be provided to the sector to transition to alternative fuels.
- The Council is concerned about the long-term sustainability of biofuels in the context of global biodiversity and climate crises and the current pressures facing the global food supply. The Council is also concerned about the reliability of the provenance of imported Used Cooking Oils as a biofuel feedstock and its long-term sustainability. The Council therefore recommends a pause to the increases in biofuel blending rate obligations pending further research into biofuel sustainability in the context of the global biodiversity and climate crises.
- Emissions from international aviation and maritime sectors are increasing. To date, measures to address emissions from aviation and shipping have been pursued primarily at European and international level but emissions continue to grow. The Council recommends that such measures are complemented at national level, in particular by developing the supply of alternative fuels to these sectors. Such measures should be clearly identified in the revised NCAP2023.

5.1 Chapter introduction

The transport sector represents the second largest source of greenhouse gas emissions in Ireland. The Sectoral Emissions Ceilings set a target for a 50% emissions reduction in the domestic transport sector from 2018 levels by 2030. This equates to a target emissions level of approximately 6Mt CO_2 eq in 2030.

A very productive sectoral dialogue was held with the Department of Transport on 21 April 2022 during which the Department presented their comprehensive analysis of the challenge up to 2030, set out interim targets to 2025, identified specific actions with their emission reduction impact, and reported on 74 headline actions for the transport sector in NCAP2021 (with 165 sub-actions due for delivery over Q4 2021 to Q4 2025). A special focus was placed on the 10 'most impactful' actions, including five actions in the areas of sustainable mobility/demand management; two in electrification; one in alternative fuels/biofuels; and two in system-wide actions. Timely implementation of these was stressed, along with the on-going research necessary to identify further measures to close the 'gap to target' that was identified in the NCAP2021.

NOTE: The transport sector covers both freight and passenger transport and includes road transportation, rail transport, and domestic aviation and navigation. International aviation and maritime emissions are not currently covered by legislated national targets under the EU or domestic legislation and so are not typically included in transport sector emissions statistics. Intra-EU aviation emissions are covered by the EU Emissions Trading System. Proposals under the ReFuelEU Aviation Initiative would cover international aviation beyond. International aviation and maritime emissions are usually reported as a separate 'bunker fuels' or international transport sector. However, international aviation and maritime can be considered part of 'economy-wide' targets or obligations as mandated under the Paris Agreement. The UK's sixth carbon budget, running from 2033 to 2037, for the first time includes aviation and maritime emissions,[86] while the French Climate Council has recommended the inclusion of international aviation and maritime emissions in French national targets[87]. Therefore, in this chapter we provide data and analysis of these emissions in relation to Ireland in a dedicated section below.

5.2 Inventories and projections

Emissions from the domestic transport sector were 10.9Mt CO_2 eq in 2021, an increase of 6.1% on 2020, but still 10% less than in 2019.[a] Figure 5.1 illustrates how the reduction in emissions relative to 2019 was due primarily to a reduction in emissions from private transport. Private cars accounted for 77.7% of the total number of licensed vehicles and 75.3% of the total distance travelled in 2019.

Private transport fell in response to Covid-19 restrictions introduced in March 2020.

a Section 3.2.4.1.3 of the National Inventory Report considers uncertainties and time-series consistency considerations in relation to Energy Industries. There is low uncertainty in the estimates of CO_2 emissions for the energy sector overall which is the major source category in Ireland and for which the input data and methodologies are most reliable.

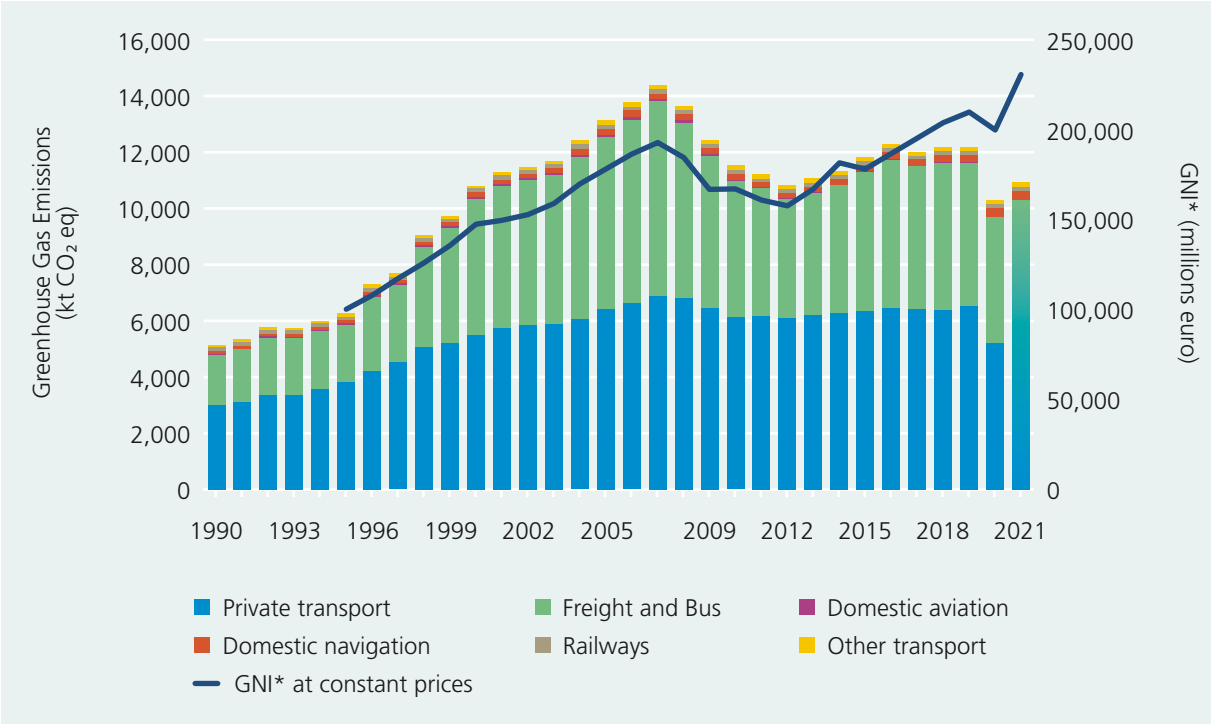


Figure 5.1 Transport emissions by mode and GNI* at constant prices. Data for 2021 emissions are provisional (Source: EPA 2022, CSO 2022)

The projections for future transport emissions are calculated on a different basis to the inventory with no division between public and private or passenger and freight transport. Rather, the projections are split according to road/rail/aviation or navigation. The projections figures are thus dominated by road transport which represents more than 90% of kms travelled. Other modes of transport represent a much smaller share of emissions at just 6% of all domestic transport emissions in 2020. The projections for those modes are consequently based on more simple assumptions with little change projected up to 2030 under the WAM or WEM scenarios, a small increase in emissions from rail, offset by decreases in 'other transport'. Other transport covers emissions from the pipeline transport of gas.

The EPA has prepared a 'With Additional Measures' (WAM) scenario (see box 3.1) including;

- 944,600 Electric Vehicles, including battery and plug in electric hybrids and electric delivery vans on the road by 2030,
- Biofuel Obligation reaching 10% for petrol and 20% for diesel in 2030,
- the impact of transport infrastructure projects such as the DART Expansion and BusConnects programmes and extension of Smarter Travel measures to promote greater sustainable mobility, with particular emphasis on schools, colleges and workplaces.

These WAM policies and measures are projected to reduce emissions to approximately 7.4Mt CO_2 eq in 2030, leaving a gap of 1.4Mt to the Sectoral Emissions Ceilings target for 2030. As identified by the Department of Transport, further measures and policies will be required to meet a 50% reduction (see Figure 5.2).

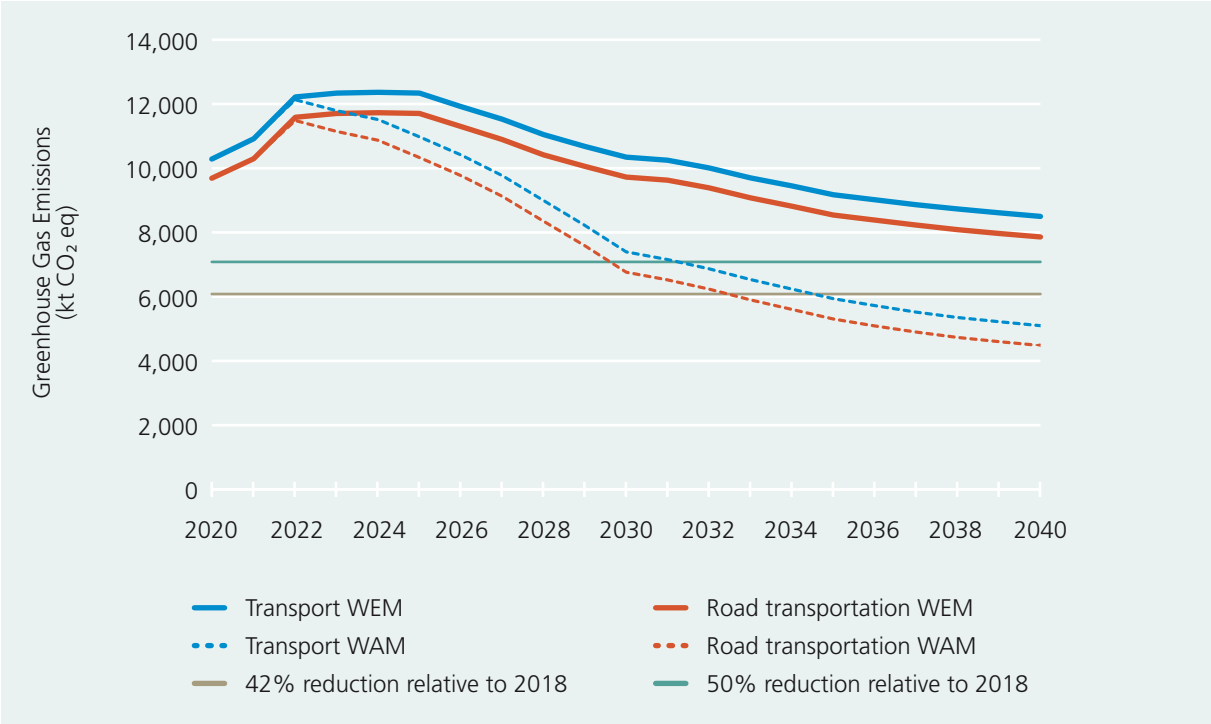


Figure 5.2 Transport and road transport emissions projections Mt CO_2 eq (Source: EPA 2022)

Table 5.1 shows a preliminary analysis of the projected cumulative emissions associated with Transport over the first three carbon budget periods for the sector. The Government has agreed on a sectoral emissions reduction target of 50% by 2030. It is anticipated that the NCAP2023 will provide more detail on the pathway of emissions reductions and consistency with carbon budgets.

Table 5.1 Projected Transport cumulative emissions over the carbon budget periods from CB1-2021-2025; CB2-2026-2030; and CB3-2031-2035

	CB1	CB2	CB3
Transport Total WEM	60.2Mt CO_2 eq	55.5Mt CO_2 eq	48.6Mt CO_2 eq
Transport Total WAM	57.3Mt CO_2 eq	44.8Mt CO_2 eq	32.7Mt CO_2 eq

5.3 Indicators

Whilst the EPA National Emissions Inventory represents the latest official available data on emissions, we can use more recent indicators to inform a more up-to-date picture on trends in the transport sector. The NCAP2021 sets out six enabling targets to reduce emissions from the transport sector to a range of 6-7Mt CO_2 eq by 2030 (see box 5.1).

To meet the required level of emissions reduction by 2030 we will:

- provide for an additional 500,000 daily public transport and active travel journeys,
- develop the required infrastructural, regulatory, engagement, planning, innovation and financial supports for improved system, travel, vehicle and demand efficiencies,
- increase the fleet of EVs and low-emitting vehicles (LEVs) on the road to 945,000, comprising:
  - 845,000 electric passenger cars
  - 95,000 electric cars
  - 3,500 low-emitting trucks
  - 1,500 electric buses
  - an expanded electrified rail network
- raise the blend proportion of biofuels to B20 in diesel and E10 in petrol,
- reduce ICE kilometres by c. 10% compared to present day levels,
- undertake a programme of work that will review progress and further refine measures to deliver the additional c. 0.9Mt CO_2 reduction by 2030 in a fair and equitable manner.

Box 5.1 2030 Transport targets, NCAP2021 (Source: DECC 2021)[38]

A set of indicators has been developed by the Council to help track progress against these targets and provide an evidence-based view of progress in the sector. This is listed in Table 5.2 along with some additional indicators of progress in the sector.

- **Traffic count data**, available up to end of April 2022, suggests that car traffic levels are rebounding from the lows of Covid-19 restrictions and are close to pre-Covid levels of 2019 (see Figure 5.3 illustrating regional traffic counts).

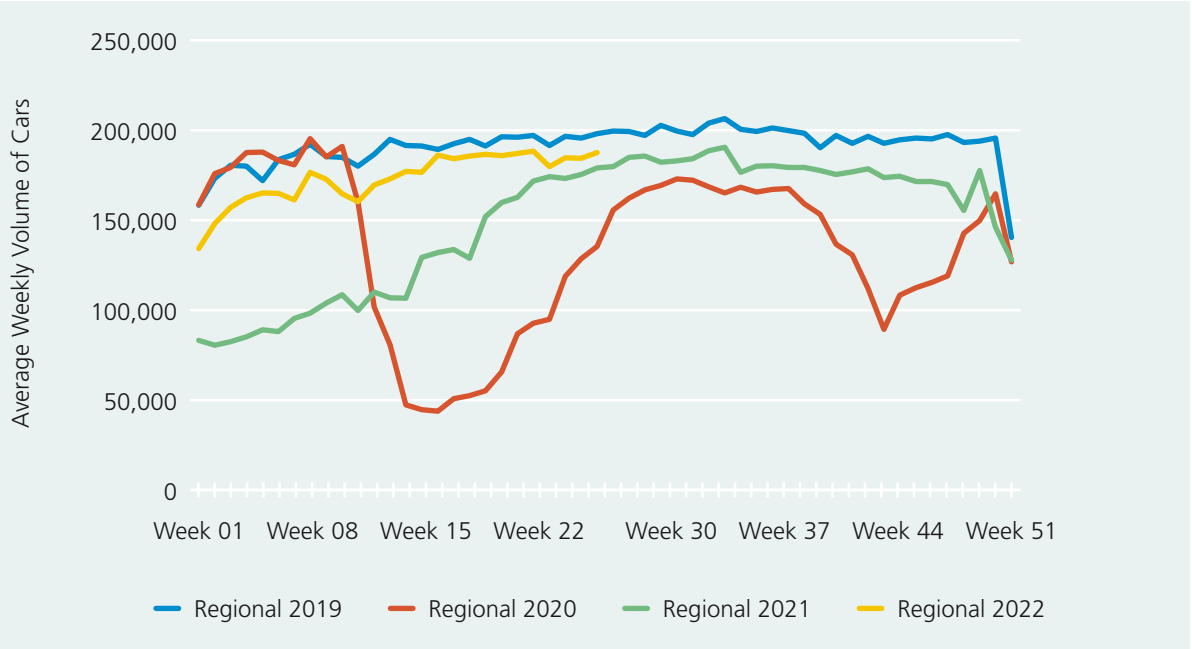


Figure 5.3 Regional Average weekly volume of cars across the year (Source: CSO 2022)[88]

- **Freight activity** was not impacted by Covid-19 in the same way as passenger transport. The latest traffic count data for heavy goods vehicles show activity above pre-Covid levels. If this trend continues through 2022, emissions from heavy goods vehicles movement in 2022 would exceed pre-Covid levels.

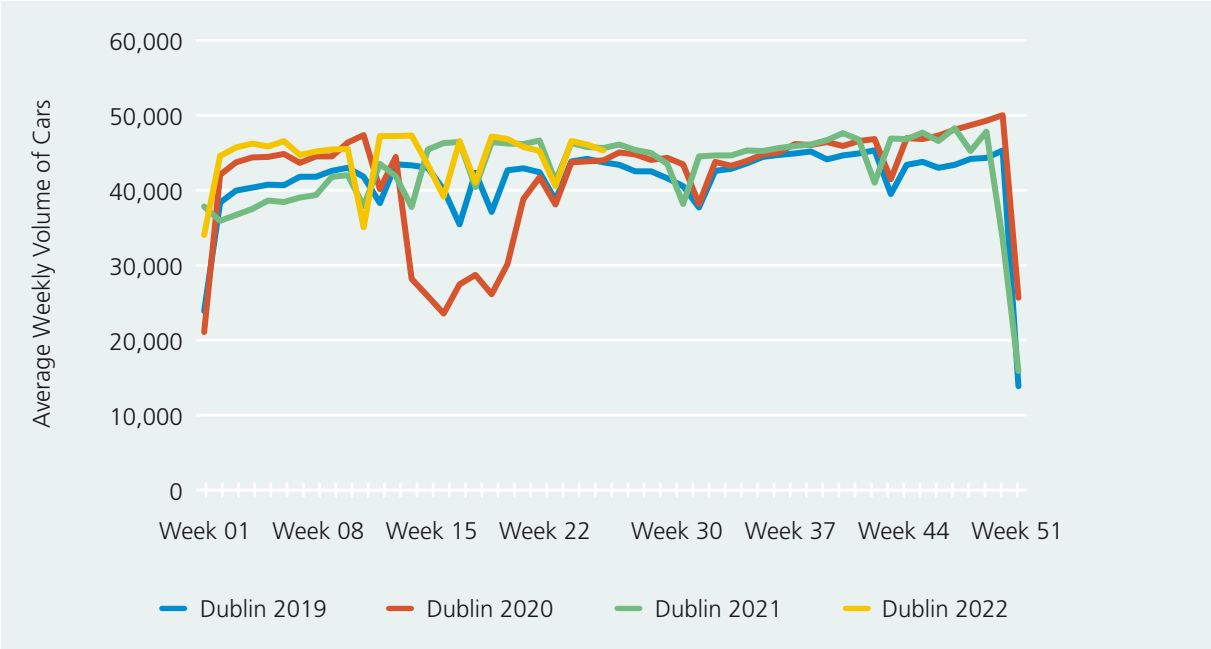


Figure 5.4 Average weekly volume of heavy goods vehicles in Dublin across the year (Source: CSO 2022)[89]

- More recent data on **new car licensing** in 2022 suggest a good start has been made on EV purchase targets, with the hybrid and electric category outselling petrol and diesel cars respectively (see Figure 5.5), but much more will be needed to meet the ambitious targets in place.

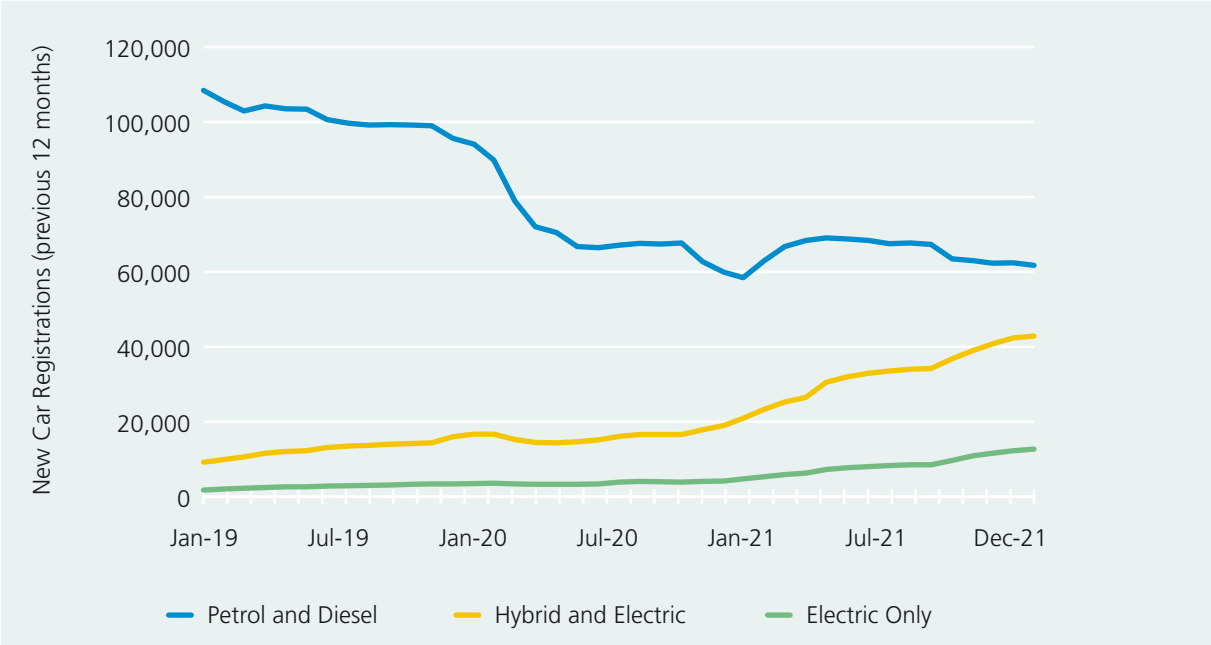


Figure 5.5 New private cars licensed – rolling annual total 2018 to date (Source: CSO 2022)

Table 5.2 Transport indicators

Name	Unit	2015	2016	2017	2018	2019	2020	2021
Sectoral Emissions	*Mt CO_2 eq*	11.81	12.29	12.01	12.19	12.20	10.29	10.91
Emissions relative to 2018	%				100%	100%	84%	89%
Renewable Energy Sources in Transport (RES-T) weighted	%	5.9%	5.2%	7.5%	7.2%	8.9%	10.2%	
Distance by private car	*Millions km*	35,020	36,623	37,181	35,975	35,453	26,102	
Distance by private car per capita	*Km*	7,470	7,727	7,758	7,407	7,204	5,244	
Distance by goods vehicles	*Millions km*	7,021	7,410	7,785	7,891	8,023	7,283	
Distance by PSVs	*Millions km*	1,167	1,194	1,219	1,228	1,240	823	
New Private Car Fuel type BEV share in all new cars	%	0.4%	0.3%	0.5%	1.0%	3.0%	4.7%	8.4%
New Goods Vehicles BEV share in all new goods vehicles	%	0.06%	0.04%	0.15%	0.31%	1.25%	2.31%	3.88%
Electric Buses energy use as % of total	%						5.9%	
Electrified Rail energy use as % of total	%						11%	
Journeys by Public Transport							1.7m weekly (june)	2.45m weekly (june)

5.4 International aviation and maritime sector

Emissions from the international aviation and maritime sector fell very significantly in 2020 due to Covid-19 restrictions impacting activity levels (primarily in the aviation sector), falling by 56% overall from 3.8Mt CO_2 eq in 2019 to 1.7Mt CO_2 eq in 2020, as illustrated in Figure 5.6.[a] Emissions from the international maritime sector increased by almost 10% in the same time period. The driver for the increase in maritime sector emissions is unclear; it could be a response to reduced service levels in aviation in response to Covid-19 or it could be a response to Brexit as more routes between Ireland and the continent were opened or another factor. Therefore, it is unclear at this point whether the increase will be maintained.

a Data for international bunker fuels were not included in the EPA's publication 'Provisional greenhouse gas emissions 1990-2021' so the EPA's official inventory data for 2020 were used here.

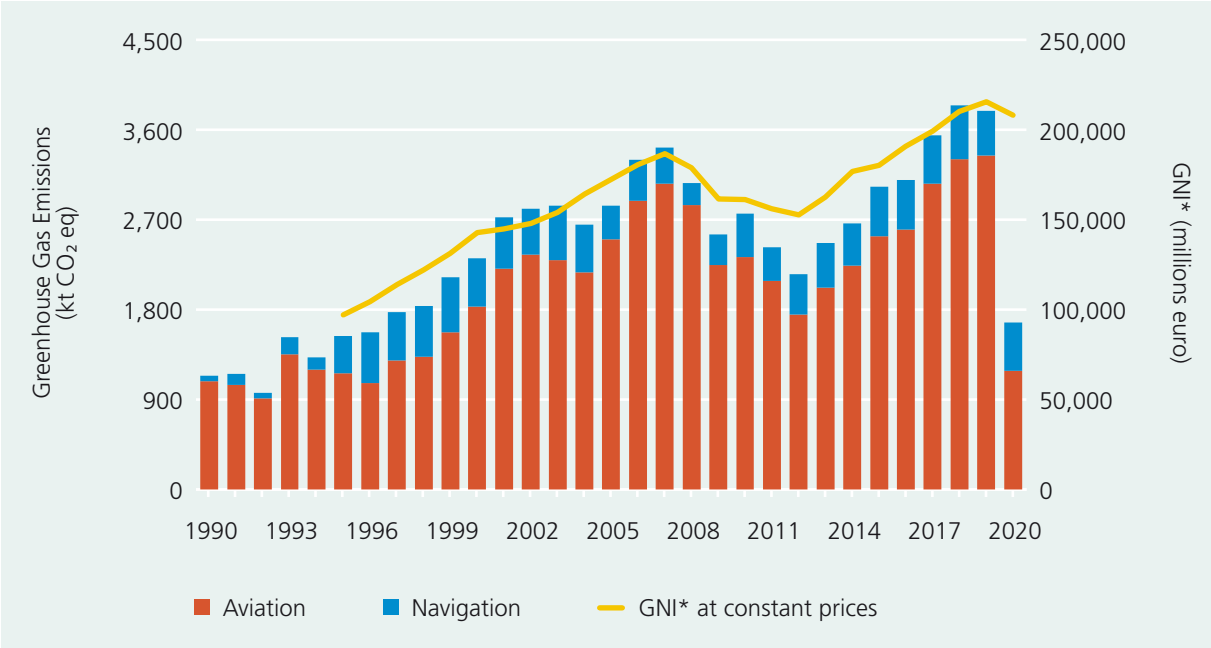


Figure 5.6 International bunker fuels (Sources: EPA 2021, CSO 2022)

With respect to aviation, recent CSO data shows that 'the number of passengers in Dublin airport in April 2022 was more than 19 times higher than in April 2021, but only 85% of the level seen in the same month in 2019 (before Covid-19).' Given the time lag between the easing of restrictions and passengers managing to book travel plans etc., it is very possible that the rebound will continue over 2022 and further close the gap with pre-Covid activity levels.

Both Figures 5.1 and 5.6 illustrate the strong influence of overall economic activity, represented here by Modified Gross National Income (GNI*) at constant prices, on transport emissions.

Emissions from international bunker fuels are increasing due to rebound from Covid-19 restrictions and increased freight activity. These emissions are covered by EU and international processes. Strategies to reduce emissions in this sector normally rely on increasing efficiencies and fuel switching. Addressing growth in aviation emissions may include demand management or behavioural change measures at national, EU or international level.

5.5 Biodiversity

Transport impacts biodiversity directly through air and noise pollution, but also indirectly through the large quantity of materials, as well as intensive water use, on which it relies for the construction, operation and maintenance of transport assets.[90] The use of biofuels in transport also has implications for biodiversity, particularly where crops are specifically grown for biofuel. This can lead to expansion of agricultural land and intensification placing pressure on and reducing the space for habitats. Building new roads and other transport infrastructure can also lead to habitat loss, as well as habitat fragmentation, and can increase human access to previously undisturbed areas. Simultaneously, the transport sector benefits from ecosystem services, such as flood and landslide mitigation. It is therefore vital that the transport sector implement careful management of its assets, consider the introduction of green tunnels and bridges where roads divide habitats and separate animal populations, and redouble its efforts to decarbonise in order to reduce pollution.[91] The connectivity provided by the road network can also provide wildlife habitats and corridors by protection and enhancement of hedgerows and green verges on roads and motorways. This chimes with some preliminary recommendations made by the OECD regarding rethinking the use of roadspace to break systemic car dependency, enhance active travel and improve well-being.

5.6 Just Transition

Significant efforts will be required to achieve a Just Transition in terms of transport. As the carbon tax increases in line with the Finance Act (partly in an effort to incentivise the population away from using their petrol and diesel fuelled cars) the households who cannot afford Electric Vehicles and who have the fewest alternative local public transport connections will suffer disproportionately.[92] Efforts to expand public transport networks, improve the quality of cycle lanes and footpaths, increase EV charging stations and increase the viability of EV adoption (to a wider range of households) must be accelerated.[93] Thought must also be given to retraining and upskilling the motor vehicle parts and maintenance workforce, the demand for which will decrease significantly as the EV uptake increases, due to EVs' simpler design, fewer parts, lack of requirement for oil changes and fewer maintenance needs. Retraining and upskilling should redirect the workforce towards the jobs that would be created as the public transport network expands, such as bus maintenance and driving, or those that would be created in the context of charging stations and bus depots construction.

5.7 Analysis

The target for transport is ambitious, requiring an early and fundamental shift in transport systems in Ireland. The NCAP2021 was not able to identify sufficient measures to achieve its then designated 2030 target of minus 42-50% by 2030. Following the setting of the 50% sectoral emissions reduction target in July, the sector must identify further measures to reach its target.

The strategy for achieving the required emissions reductions in the NCAP2021 is clearly centred around achieving EV targets of 945,000 vehicles in Ireland by 2030. The main measure to support this is the subsidy for EV purchase. This has been found to be an expensive policy, though high mitigation costs are often a feature in the deployment of new low carbon technologies.[94],[95] However, to date, uptake has been strongest in urban areas where usage, measured by annual kilometres per year, is lowest and where the case for private car ownership is often weaker relative to rural areas.[96] Greater emission reductions would be achieved were EV deployment to be better targeted at high kilometre users such as rural households, taxi drivers and commercial drivers. Such targeting should be a priority for the recently established Zero Emissions Vehicles Ireland office, through measures such as reforms to the subsidies offered, more targeted deployment of charging infrastructure and information campaigns to address issues related to range anxiety. Electric vehicles are an important decarbonisation strategy for those individuals and households with little if any access to appropriate public transport. Electric vehicles already have a lower lifetime cost for high kilometre drivers due to the significant savings on fuel and maintenance. Access to low cost finance for electric vehicles would facilitate the transition by further reducing the total cost of ownership.

The EV targets in the NCAP2021 will be very challenging to achieve, with different studies noting the difficulties in achieving the EV targets and the associated emissions savings[94],[95] Therefore, increasing the EV sales targets is not a realistic option to close the gap to transport emission reduction targets. More prioritisation and resources are needed on the other measures identified in the NCAP2021 as well as identifying further measures.

The target for an additional 500,000 daily public transport and active travel journeys and the target to reduce ICE kilometres by about 10% compared to present day levels should be seen as complementary. Once a consumer or business makes the investment to buy a private car, its low trip cost and convenience make it difficult for active travel, shared services and public transport to compete on a per-trip basis (where such options are even available).[97],[94] Therefore, the extent of public transport provision and the level of fares and fare structures are extremely important. The recent reduction in public transport fares was welcome. However, it did not extend to privately operated services and public transport costs still exceed those in other European countries.[98] The data need to be examined to understand the impact of the recent

reduction in Irish public transport fares on public transport use. Additional reduction in fares needs to be considered as a potential further contribution to supporting vulnerable individuals through high energy prices and to reduce emissions.

Progressively, but *only* where other modes are already or become available, private car ownership and use needs to become practically and financially less attractive in Ireland. Experiences from London and Stockholm have shown the effectiveness of congestion charges to reduce car use in cities where public transport options are available and where road or street space has been reallocated appropriately. In London, one of the stated aims of the congestion charge was reallocating road space to public transport.[99] Stockholm and London combine their congestion charge and low-emission zone schemes with prioritising space for social interaction, active travel, and public transport.[100],[101],[95] Public transport services in Irish cities are expected to improve with the roll out of BusConnects. **The Council recommends that congestion charging be introduced to the five cities after the implementation of BusConnects as the charging system would be feasible and fair at that point.**

Comfort and safety levels for pedestrians and cyclists need to improve to increase uptake of these measures over private car use. A 2019 survey of the Dublin Metropolitan Area conducted for the National Transport Authority found that 75% of the respondents would like to see more government spending on cycling, 71% on public transport, 61% on walking, while just 34% of the sample would like to see more spending being devoted to car-related infrastructure. Furthermore, 84% of respondents to the same survey were in favour of investment in physically separated cycling infrastructure even if this would mean less space for other road traffic.[102] This suggests a greater level of public support for active travel than is commonly assumed. More investment in cycling and walking infrastructure, including redesigning and reorganising street and road space, will be important to support the low carbon transition.[94],[95]

Sports utility vehicles (SUVs) accounted for half of new car registrations in Ireland in 2021, up from 24% in 2015.[103] While some of these are electric vehicles, they are not the most resource-efficient car type. Motor vehicles and their batteries need to be part of the circular economy strategy and targets. This includes maintaining a focus on vehicle energy efficiency, while also increasing awareness of the embodied emissions in vehicles. France considers vehicle weight as one component in vehicle registration taxes to reflect embodied emissions and efficiencies.[104] This needs to be done sensitively to differentiate between ICE and EVs because an EV is generally heavier than a comparable ICE vehicle due to the weight of the batteries. **The Council advises that the Vehicle Registration Tax (VRT) needs to be recalibrated to progressively and increasingly disincentivise the purchase of any new vehicle with an internal combustion engine and to promote resource and energy efficient vehicles.**

Freight activity levels were not impacted to the same extent as passenger transport by the Covid-19 crisis. Activity levels in 2022 are ahead of 2019 levels up to end of June. Freight activity is intrinsically tied to economic activity and so the desire normally is not to reduce freight transport activity but rather to improve its energy and carbon efficiency. Innovation has occurred in urban areas in Ireland, with low or zero carbon solutions applied for 'last-mile' deliveries, such as cargo bikes or electric vehicles.[105] In 2020, Dublin became the first city in the world with a zero carbon postal delivery service.[106] **However, this innovation is not evident in rural areas or for the 'last 50 miles' freight trips. More focus needs to be given to addressing these challenges.**

Road transport is the dominant mode of freight within Ireland. At the end of 2020, there were a total of 377,890 commercial goods vehicles taxed in Ireland, including heavy goods vehicles (HGVs) and light goods vehicles (LGVs). Electric vehicles already offer a solution for LGVs. There is no consensus yet as to which technology or group of technologies offer the solution to reducing emissions from HGV freight, though there are serious questions over the life-cycle sustainability of LNG and CNG as transition fuels.[107] Battery

technology for economic freight electric vehicles is advancing,[108],[109] with loaded vehicle ranges up to 350km already available. Trips under 150km made up about 45% of tonne kilometres in Ireland, demonstrating the early potential for battery vehicles to play a role beyond just the 'last mile' and light goods deliveries. Green hydrogen[a] also has potential in freight, while biofuels represent an existing mitigation strategy in transport but with some important issues open to question, as discussed below. Logistics management changes need to be examined for their potential such as: consolidation of deliveries, including in rural areas; reduced empty vehicle kilometres; a movement away from the prevalence of 'next day delivery' commitments; and 'Just in Time' logistics models. Dublin City Council is one of two 'living labs' for a Horizon 2020 EU research project examining how to improve the operation of urban logistics while reducing emissions, including the role of innovations like shared urban logistics hubs.[110] A ten-year road haulage strategy is expected from Government in mid-2022. This strategy should promote efficiency in freight and explore and support new approaches to logistics, as well identifying and supporting the most appropriate technologies in the freight sector now and over the next decade. Ireland should support measures at EU level to improve vehicle efficiency and to advance quickly on zero emission technology. The advantages of roll-on/roll-off (Ro-Ro) freight import and export need to be re-examined against those of load-on/load-off (Lo-Lo) in the context of targets for accelerated decarbonisation and the new Brexit realities. Ro-Ro freight, where heavy goods vehicles drive onto ships and drive off, is the dominant mode for Irish imports and exports. It was particularly advantageous pre Brexit where the 'land-bridge' of driving freight through the UK on the way to mainland Europe was seen as a lower cost route. Lo-Lo, where containers are lifted by crane from portside onto ships and then lifted back on to lorries (or trains) at the other end of the journey has been found in some contexts to be more carbon-efficient.[111] It could also facilitate greater use of zero or low carbon modes such as battery electric HGVs that would not yet have the capacity for intra-EU journeys.

Fossil fuel subsidies in Ireland, including both direct and indirect subsidies, have been identified both by the EU and by the CSO.[112],[113] The CSO identified €590.3 million in indirect subsidies to the consumption of the diesel through exemptions from and rebates on taxes, with road haulage a significant beneficiary. These indirect subsidies represent a counter signal to greenhouse gas mitigation efforts. The NCAP2021 includes an action for the Department of Finance: 'Develop roadmap for review and transition away from fossil fuel tax subsidies in transport sector'. This roadmap is due for adoption in early 2024. With the significant ambition implied by the target for 51% emissions reduction on 2018 levels by 2030 and the recently legislated carbon budgets, phasing out fossil fuel subsidies has increased in urgency. **The Council recommends that planning for phasing out fossil fuel subsidies, in particular in the road haulage sector, is accelerated with supports for transition to zero emissions vehicles provided to hauliers.**

Biofuels have been relied on to date to deliver the bulk of greenhouse gas emissions reductions in transport in Ireland through the biofuel obligation scheme. The current obligation rate (June 2022) requires 14.942% of motor fuels placed on the Irish market to be produced from certified renewable sources. The Department of Transport estimates that in 2021, 246m litres of liquid biofuel and 618 Nm3 of gaseous biofuel were placed on the market with calculated carbon savings of 623kt (a year of reduced fuel use due to Covid-19 restrictions). In 2021 approximately 18% of biofuel feedstock originated from Ireland. Approximately 64% of all the biofuel placed on the market in Ireland was produced from used cooking oil (UCO) sourced from 58 different countries (China being the largest source). Biofuels derived from waste products qualify for two certificates per litre (double weighting) as they are presumed to have lower environmental impact. UCO is classified as a waste product. According to the National Oil Reserve Authority's (NORA) 2021 report, practically all the biodiesel placed on the market was eligible for two BOS Certs per litre on account of it being produced from a waste or residue (this has been the case since 2016). All the bioCNG placed on

a Hydrogen is a fuel. Green hydrogen is produced from purified water with an electrolyser powered by renewable electricity. Grey hydrogen is generated from methane or natural gas and produces some CO_2 emissions. When the CO_2 emissions from the production of grey hydrogen are captured, the hydrogen can be classified as blue. See chapter X on Electricity for more about green hydrogen.

the market was also eligible for double-weighting. Approximately 66% of the bioethanol and 25% of the bioLPG placed on the market was double-weighted.[114]

The NCAP2021 commits to raising the blend proportion of biofuels to at least B20 (biodiesel) in diesel and E10 (ethanol) in petrol by 2030. This target is anticipated by the Department of Transport to see an emissions abatement saving of 1.1Mt CO_2 eq by 2030. Advocates for biofuels see them having an important role in delivering mitigation in 'hard to abate' sectors, such as heavy freight, marine and aviation, prior to the large-scale commercial deployment of zero emissions technologies.[115] It is also seen by some as a low hanging fruit or easy measure to achieve emissions reductions in car passenger transport. However, questions remain over the sustainability of biofuel feedstocks and their life-cycle carbon emissions when direct and indirect land use impacts are taken into account. Competition between biofuels and food for land has become an increasingly important issue in the context of increasing risks of a global food crisis due to climatic events in global food exporters and the invasion of the Ukraine (see chapter 4), leading to calls for limits to the production of biofuels. The double-weighting for certification under the biofuels obligation scheme granted to biofuels from waste stocks is an attempt to place greater value on more sustainable sources; however, this may be leading to perverse incentives. Analysis suggests that there are few concerns regarding the traceability and sustainability of the UCO (used cooking oil), particularly generated outside the EU. Its limited supply means that imports are used to meet higher targets. In China, UCO has been priced higher than crude palm oil (CPO) since mid-2018. Analysis by the National Non-Food Crops Centre (NNFCC) in the UK suggests that 'the higher value of UCO and a lack of stringent traceability controls on the CPOs and points of origin in China could give rise to fraudulent activity'.[116] In the long run, at a global level it would be most efficient if regional waste feedstocks were used to assist regional decarbonisation efforts. Due to these environmental concerns and the limited supply of sustainable waste biofuels in the EU, the **Council recommends a pause to the increases in biofuel blending rate obligations, pending further research into biofuels' sustainability in the context of the global biodiversity and climate crises.**

Wide deployment of improved and reliable charging infrastructure will be crucial to support transport targets. Plans for such infrastructure currently focus on car and Light Goods Vehicle (LGV) use. However, in line with reducing dependency on private car travel as discussed above, and with efforts to decarbonise 'last 50 mile' freight trips, it is crucial that EV charging infrastructure plans also give sufficient priority to facilities for goods vehicles, buses and shared transport modes and hubs.

International bunker fuels are a mobile source of emissions, where the economic activity (of fuel purchases) can readily move across international boundaries, therefore it is important, where possible, to coordinate measures with other countries internationally. To date, measures to address emissions from aviation and shipping have been pursued primarily at European and international level – yet emissions continue to grow. **The Council recommends that such measures are complemented at national level, in particular by developing the supply of alternative fuels to these sectors. Such measures should be clearly identified in the revised NCAP.**

6. Sectoral progress – Electricity

Key messages

Observations

- The renewable energy share of electricity generation fell to 35% in 2021, compared to 42% in 2020, while the use of coal and fuel oil for electricity generation more than tripled. Continuation of this trend threatens to negatively impact achievement of National targets. Emissions in the sector increased by 17.6% in 2021, with an increase in the emissions intensity of power generation by 11.9%. This is a very concerning reversal of emissions reductions in the electricity sector in previous years.
- The rapidly evolving geopolitical context has highlighted our dependence on imported fossil fuels, along with the societal and economic exposure to volatile and high prices, with implications for electricity security of supply.
- Urgent implementation of the measures identified in NCAP2021 and identification of further new measures will be required to meet National emissions reduction targets in the electricity sector. This is critically important given the reliance of other sectors on successful decarbonisation of this sector.

Recommendations

Demand

- A demand side strategy is urgently required to support adoption of demand side technologies and support reductions in emissions intensity in the sector, along with further measures to enable and incentivise demand side flexibility in industrial, commercial and residential demand.
- Accelerated installation of smart meters, while ensuring the provision of smart meter data to customers and incentivising greater uptake of tariffs to help move demand away from peak times, are crucial to saving customers' money and delivering change in the patterns of electricity usage to support a lower carbon electricity system.
- The Council supports urgent efforts by the Government to promote energy efficiency efforts to the maximum extent possible and supports SEAI's innovative programme of communications to inform consumers and businesses of actions they can take to reduce energy demand.

Supply

- In the context of the climate and energy emergencies, developing our vast renewable resource must be considered as being in the overriding public interest. Targets for onshore wind and solar renewable electricity should be significantly increased, with faster roll-out of these and the associated grid reinforcement. Strong political and policy support is needed at a national and local level for the rapid delivery of renewable energy projects.
- There are significant consequences to delays in the development of renewable generation capacity, in the form of increased CO_2 emissions and higher electricity prices. Planning and regulatory processes must be appropriately resourced to ensure that projects can progress to operation as early as possible, while ensuring that biodiversity is not negatively impacted.
- Offshore wind will play a critical role in the low-carbon transition and it is imperative that steps for planning, consenting and developing the grid for offshore wind progress at pace.
- The Council is concerned about the emissions impact of the retention of existing fossil fuel generation in the upcoming review of security of energy supply of Ireland's natural gas and electricity systems being carried out by the Department of the Environment, Climate and Communications (DECC). A clear strategy for limiting the use of high emissions fossil fuel generation (coal and oil) must be developed in the context of both our climate requirement and energy security needs. The Council also urges the Government to ensure adherence to the planned closure dates, for example, of Moneypoint and Edenderry.
- The development of a roadmap and pathways for the electricity sector beyond 2030 should start now. This must include an ambitious and evidence-based strategy for the role of green hydrogen, including accounting for the greenhouse potential of fugitive emissions, which is an emerging concern within the climate science community.

6.1 Chapter introduction

The Energy Industries sector, as defined in the National Inventory Report (NIR), is the third largest sector by emissions in Ireland, but has also been the most successful at reducing emissions in recent years. This sector is often referred to as 'electricity', as virtually all emissions are associated with power generation, with relatively small quantities from other categories, such as oil refining. The long-term downward trend in energy emissions has been driven by significant reductions in coal and peat power generation, improving efficiency, increased zero carbon power from wind, and a shift to natural gas generation, which is less carbon intensive than other fossil fuels. In 2021, however, emissions in this sector increased.

The rapidly evolving geopolitical context has highlighted our dependence on imported fossil fuels, along with the societal and economic exposure to volatile and high prices, with implications for electricity security of supply. The high number of System Alerts in 2021 indicated that the margin between electricity demand and supply was tight. The link between these issues and greenhouse gas emissions have led to additional challenges for this sector.

NCAP2021 set a target for 62-81% emissions reduction in the Energy Industries sector from 2018 levels by 2030. This equates to a target emissions level of approximately 2-4Mt CO_2 eq in 2030. Many other sectors are reliant on the successful decarbonisation of the electricity sector in order to meet their own emissions reduction targets, as frequently the solution in other sectors is electrification of currently fossil-fuel based activities, and this implies that total electricity demand will increase substantially from present levels. In July 2022, the government agreed to a target of 75% emissions reduction by 2030, relative to 2018, for the Electricity sector[a].

A sectoral dialogue was held with the Department of the Environment, Climate and Communications (DECC) and relevant agencies on 10 March 2022 during which DECC presented their analysis of the challenges facing the sector. The headline target for 2030 is increasing renewable electricity to up to 80%, encompassing up to 8 GW onshore wind capacity, at least 5 GW offshore wind capacity and between 1.5 and 2.5 GW solar PV capacity supported by a range of actions.[b] These include delivery of three new interconnectors (to Northern Ireland, Great Britain, and France), expanding and reinforcing the grid, circa 2 GW of new flexible gas-fired power stations, the complete phase-out of coal and peat-fired electricity generation, and increasing flexible system demand to 20-30% by 2030. At least 500 MW of new renewables will be delivered through local community-based projects, subject to competition as appropriate.

6.2 Inventories

Combustion of fossil fuels drives significant amounts of CO_2 emissions in this sector with only small amounts of CH_4 and N_2O associated with fuel combustion. Almost all emissions in this sector are accounted for under the EU Emissions Trading Scheme (ETS) with CO_2 estimates reported under the scheme for each installation and the corresponding fuel use used to estimate CH_4 and N_2O emissions.[c]

In 2020, Energy Industries emissions were 8.7Mt CO_2 eq, a decrease of 7.4% compared to 2019, which is attributable to a 51% decrease in peat used in electricity generation.[53] Renewables accounted for 42.1% of electricity generated in the year and the emissions intensity of power generation decreased to 296g CO_2/kWh. **In 2021, however, due to increased carbon intensity of Ireland's electricity production,**

a Excluding Petroleum Refining.

b Note that the Government announced additional targets in July 2022 of 5.5 GW of solar, 7 GW offshore wind, an additional 2 GW of green hydrogen and up to 5.7 TWh of biomethane.

c Section 3.2.4.1.3 of the National Inventory Report considers uncertainties and time-series consistency considerations in relation to Energy Industries. There is low uncertainty in the estimates of CO_2 emissions for the energy sector overall, which is the major source category in Ireland and for which the input data and methodologies are most reliable.

emissions in this sector increased by 17.6% to 10.272Mt CO_2 eq with an emissions intensity of power generation of 331g CO_2/kWh. Influencing factors were increased electricity demand, less wind and hydro power availability and use of older plants, including a coal fired plant due to extended outages at gas fired plants.[117] Older plants, including the coal-fired plant at Moneypoint, were used to ensure that power was available.

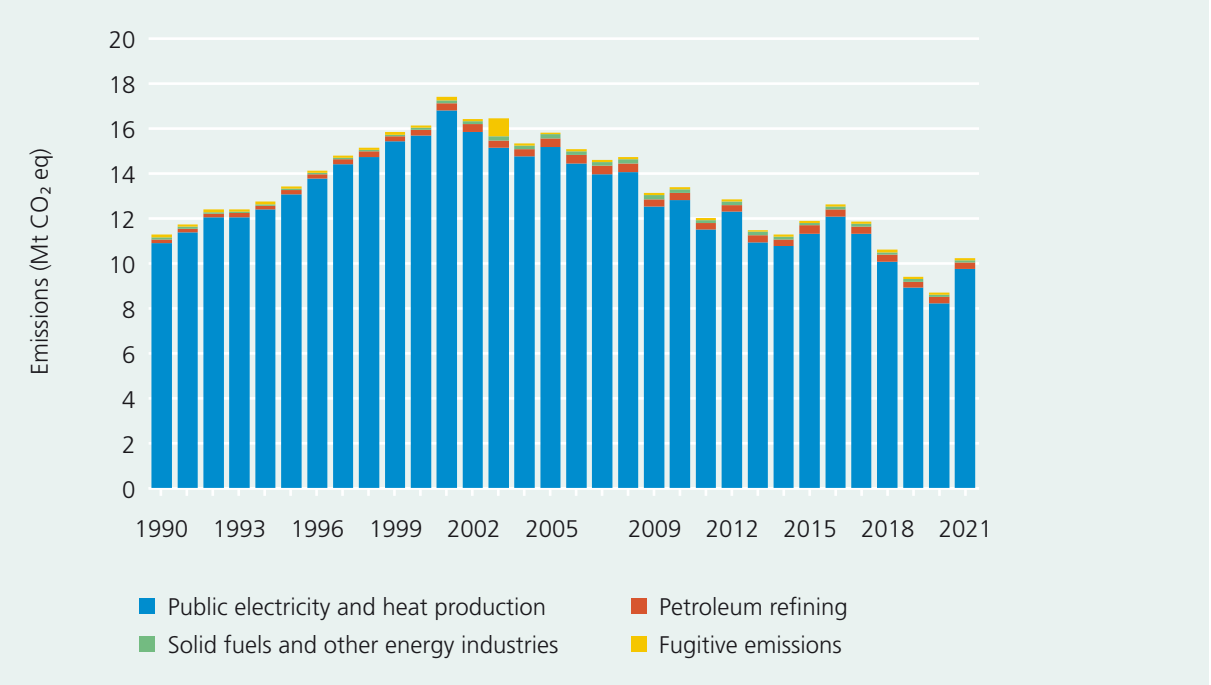


Figure 6.1 Trend in Energy Industries Emissions between 1990-2021 (Source: EPA Provisional Inventory, 2022)

6.3 Indicators

Whilst the EPA National Emissions Inventory represents the latest official available data on emissions, we can use more recent indicators to inform a more up-to-date picture on trends in the electricity sector. NCAP2021 sets out eight enabling targets to reduce emissions from the electricity sector to a range of 2-4Mt CO_2 eq by 2030. A set of indicators have been developed by the Council to track progress against these targets and provide an evidence-based view of progress in the sector, in addition to the information presented in this chapter on emissions and projections in 2021 from the EPA inventory.

Table 6.1 Indicators of transition in the electricity sector (Source: EPA, SEAI, EirGrid, SEMO)

Name	Unit	2014	2015	2016	2017	2018	2019	2020	2021
Final Electricity Consumption	*GWh*	24,795	25,807	26,365	26,644	27,865	28,435	28,621	28,746*
Emissions from peat and coal fired electricity generation	*Mt CO_2*	6.4	7.0	6.8	5.8	4.2	2.6	1.8	4.8*
CO_2 intensity of electricity	*gCO_2/kWh*	456	465	481	437	372	320	296	333
% renewable gross electricity consumption	%	22.9%	27.3%	25.5%	29.6%	33.1%	37.6%	42.3%	34.9%

Name	Unit	2014	2015	2016	2017	2018	2019	2020	2021
Sectoral Emissions	*Mt CO_2 eq*	11.3	12.0	12.7	11.9	10.6	9.4	8.7	10.3
Share of coal as a % of demand	%	14.2%	16.9%	15.9%	12.2%	7.0%	1.6%	2.1%	8.2%
Share of peat as a % of demand	%	8.9%	8.8%	7.9%	7.2%	6.8%	6.1%	2.9%	1.0%
Share of oil as a % of demand	%	0.9%	1.4%	1.0%	0.5%	0.5%	0.9%	1.2%	4.4%
Closure dates for Peat, Coal and Oil-fired Stations	*Year*								Edenderry planning permission expires end 2023, Tarbert 2023, Moneypoint end 2025
ETS Emissions (Power Generation)	*Mt CO_2 eq*	10.56	11.11	11.85	10.87	9.36	8.19	7.53	9.11
Residential electricity consumption	*GWh*	7,711	7,885	7,874	7,955	8,176	8,129	8,734	8,740*
Industry electricity consumption	*GWh*	6,501	6,385	6,676	6,792	6,931	6,955	6,478	6,489*
Onshore Wind Capacity	*MW*	2,266	2,447	2,795	3,312	3,667	4,120	4,323	4,332
Offshore Wind Capacity	*MW*								25
Solar PV Capacity	*MW*								261
Zero emission Gas Capacity	*MW*								0
Transmission Grid Connections	*MW Wind Installed Capacities*	201.35	106	218.7	220.25	182.95	158	132.3	9.3
Distribution Grid Connections	*MW Wind Installed Capacities*	141.79	74.85	128.79	297.26	171.82	294.61	71.25	0
Interconnection capacity & progress	*MW*								1000
DSU Capacity	*MW*								540
Storage Capacity (pumped hydro)	*MW*								292
Successful community projects in RESS auctions	*MW*								204
Wind Curtailment %	%	2.9%	3.3%	1.4%	2.6%	3.3%	3.1%	5.3%	2.8%
Wind Constraints %	%	1.5%	1.8%	1.4%	1.0%	1.7%	3.8%	6.1%	4.5%
SNSP Limit	%	50%	50%	55%	60%	65%	65%	65%	70%

Name	Unit	2014	2015	2016	2017	2018	2019	2020	2021
Minimum number of large thermal generating units	*Number*								8
Progress on smart meter installation	*Number of cumulative installations*							250,000	620,000
Uptake of Time of Use Tariffs	*Cumulative number of customers on tariffs*							n/A	55,034
Progress on RESS auctions	*Number of auctions*							RESS 1	No Auctions

* Based on SEAI projections.

Due to changes in the overall fuel mix, the emissions intensity of electricity generation has declined over time and in 2020 was 296g CO_2/kWh, compared to 455g CO_2/kWh in 2014. 2020 was the first time this fell below 300g CO_2/kWh.[118] The EPA's provisional Greenhouse Gas Emissions indicate that this has increased to 331g CO_2/kWh in 2021.[20] According to SEAI's latest Energy in Ireland report, for 2021, electricity use returned to the same steady growth that has been seen since 2015.[119]

In terms of early indicators in 2022, between January and June the percentage of demand met by wind averaged 36% (this indicator varies on a monthly basis and throughout the year)[a]. In Q1 of 2022, overall dispatch down of wind was 8.2% (comprised of 3.7% constraints and 4.5% curtailments), compared to 9.7% in Q1 of 2021[b]. In Q2 of 2022 overall dispatch down was 8.6%. 8.2% of generation was met by coal between January and May 2022, compared to 7.6% for the same period in 2021; 3.1% of generation was met by oil between January and May 2022 compared to 1.3% for the same period in 2021[c].

6.4 Projections

The 2021 EPA 'With Existing Measures' (WEM) scenario[d] for Energy Industries projects annual emissions to decrease from 8.7 to 5.4Mt CO_2 by 2030.[54] The WEM scenario assumes that the proportion of renewable energy generation increases to approximately 70% of electricity consumption by 2030, with one peat plant (co-firing with 30% biomass) continuing to operate until planning permission expires in 2023. The Moneypoint power station is assumed to operate in the market up to the end of 2025, at which point it will no longer generate electricity from coal. It is also assumed that the roll-out of approximately 2.25 million smart meters will be completed by 2024.[120]

The EPA 'With Additional Measures' (WAM) scenario assumes that by 2030 renewable energy generation will increase to approximately 80% of electricity consumption, based on expansion in wind energy and other renewables. The same assumptions as for the WEM scenario are used for closure dates of high emissions generation. It is assumed that the Greenlink 500MW interconnector to the UK will be available from 2025 and the Celtic 700MW interconnector to France from 2027, with 2 GW of storage in place by 2030.

a This is based on EirGrid's System and Renewable Summary Report which can be found here; https://www.eirgridgroup.com/how-the-grid-works/renewables/

b This is based on EirGrid's Renewable Dispatch-Down reports which can be found here; https://www.eirgridgroup.com/how-the-grid-works/renewables/

c This is based on SEAI's monthly energy data which can be found here; https://www.seai.ie/data-and-insights/seai-statistics/monthly-energy-data/electricity/

d The *With Existing Measures* (WEM) scenario forecasts Ireland's emissions including all national policies and measures implemented by the end of 2020.

Under the WAM scenario, emissions from the energy industries sector are projected to decrease by 48.9% from 8.7 to 4.5Mt CO_2 eq over the period 2020 to 2030.[54] These scenarios compare to a target within the NCAP2021 to reduce electricity sector emissions to between 2-4Mt CO_2 eq by 2030. Under the WEM scenario, only a 49% reduction is achieved by 2030, while under the WAM scenario a 58.1% reduction is achieved. **This indicates that under the current WAM scenario the electricity sector will not meet its sectoral ceiling and further new measures will be required under NCAP2023 to meet emissions reduction targets in the Electricity sector. This is critically important given the reliance of other sectors on successful decarbonisation of this sector.**

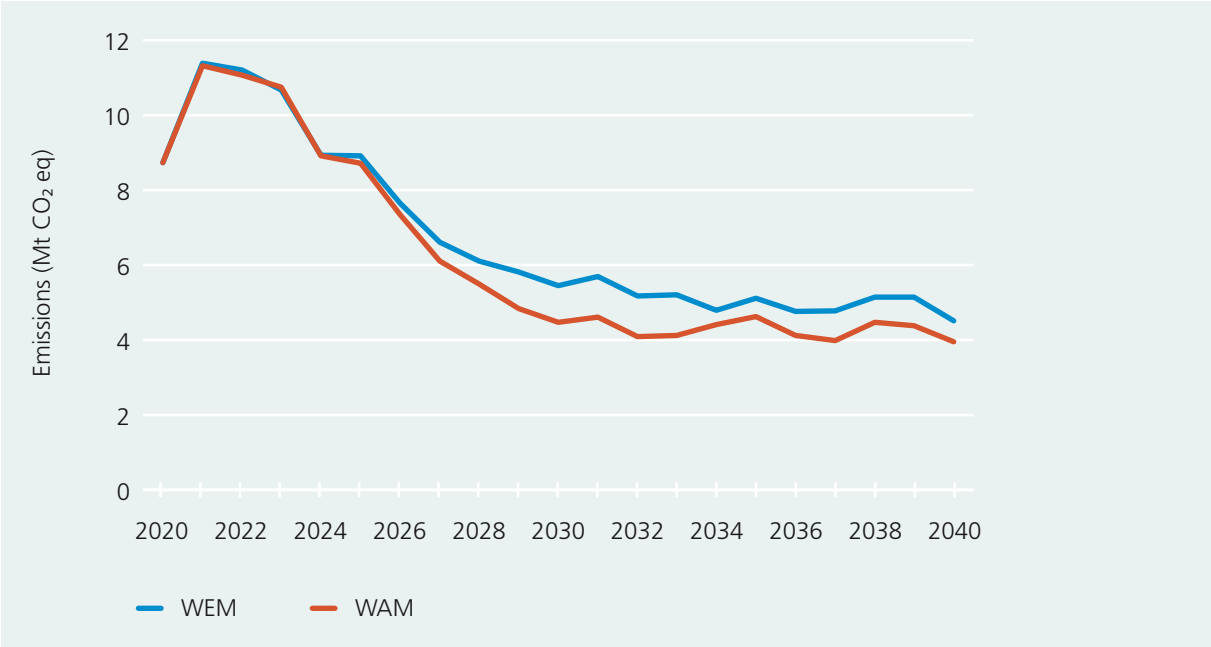


Figure 6.2 Greenhouse Gas Emissions Projections from the Energy Industries Sector under the With Existing Measures (WEM) and With Additional Measures (WAM) scenario between 2020 and 2040 (Source: EPA, 2022)

Table 6.2 shows a preliminary analysis of the projected cumulative emissions associated with Electricity[a] over the first three carbon budget periods for the sector. The government has agreed a sectoral emissions reduction target of 75% by 2030 or 2.6Mt CO_2 eq for Electricity[b]. WEM and WAM policies and measures are projected to reduce emissions to approximately 5.1Mt CO_2 eq and 4.2Mt CO_2 eq respectively in 2030, which is between 2.5Mt CO_2 eq and 1.6Mt CO_2 eq above the 75% emissions reduction target. It is anticipated that the NCAP2023 will provide more detail on the pathway of emissions reductions and consistency with carbon budgets. **To achieve the sectoral ceiling and remain within the Carbon Budget, further measures and policies will be urgently required.**

a Excluding Petroleum Refining

b Excluding Petroleum Refining

Table 6.2 Projected Electricity cumulative emissions over the carbon budget periods from CB1-2021-2025; CB2-2026-2030; and CB3-2031-2035 (excluding Petroleum Refining)

	CB1	CB2	CB3
Electricity Total WEM	49.7 Mt CO_2 eq	31.1 Mt CO_2 eq	24.4 Mt CO_2 eq
Electricity Total WAM	49.3 Mt CO_2 eq	26.7 Mt CO_2 eq	20.3 Mt CO_2 eq

6.5 Analysis

The technical challenges facing Ireland in moving to 80% renewable electricity on an island system with limited interconnection are unprecedented and will require significant infrastructural and renewable generation investment, development of demand side measures, energy storage, further development of system services and timely implementation of the broader actions identified in the NCAP2021. Recent global energy price increases, geopolitical events impacting on security of supply across Europe, and the link between these issues and greenhouse gas emissions have also led to additional challenges facing this sector.

To date, emissions reduction in this sector has been driven by a reduction in use of coal and peat for electricity generation and strong consistent growth in renewable electricity generation since the early 2000s, contributing 42% of all electricity generated in 2020[a,][119]. This sector made significant progress in emissions reduction up to 2021 when this trend was reversed. In 2021, the renewable energy share of electricity generation fell to 35%.[121] The use of coal and oil for electricity generation tripled in 2021, also driven by extended closures of some gas generators and increased demand.[20] As set out in the EPA's Provisional Greenhouse Gas Emissions report, the effect of current geopolitical impact on fuel pricing could result in a continued increase in the amount of coal being used, which could impact on achievement of the first carbon budget.[20]

6.5.1 Developments in 2021 and early 2022

Across 2021 and 2022, significant progress has been made in the electricity sector across several measures identified in NCAP2021.

A significant milestone was met with the enactment of the Maritime Area Planning (MAP) Act 2021, providing for the establishment of the Maritime Area Regulatory Authority, a marine planning regime for the development of offshore renewable energy and an interim process for assessment of the first batch of Maritime Area Consent (MAC) applications from a set of seven qualified Offshore Renewable Energy (ORE) projects.[122]

An indicative forward schedule of RESS auctions (for renewable energy under the Irish Government's Renewable Energy Support Scheme) over a three-year period was published by DECC in 2021 along with indicative auction volumes and dates, providing a signal for the renewable energy pipeline.[123] In May 2022, the provisional results of the second RESS auction were published, with a significant increase in the volume of support of 1,948 MW compared to 1,276 MW in RESS 1, comprising a significant number of solar electricity projects. The prices bid by participants in the RESS 2 auction have increased since RESS 1, reflecting issues such as the strain on international supply chains and prices. The first Offshore-RESS auction, initially due to take place in 2021 according to the Programme for Government, has been delayed until late 2022. **It is imperative that auctions take place with sufficient volumes to ensure the targets for delivery of offshore wind and other renewables can be reached as early as possible.**

a Normalising for wind and hydro as per EU Directive 2009/28/EC the share of electricity generated from renewable sources in 2020 was 39.1%.

Another important milestone was reached in April 2022 with the successful completion of a trial to run the electricity grid on 75% variable renewable generation at any point in time, an increase from the previous cap of 70%.[124] The continued improvement of this system non-synchronous penetration (SNSP) limit[a] and other system limits within this decade will be critical to supporting a decarbonised electricity system.

Most of the ETS emissions in Ireland are from electricity generation. In 2020 ETS emissions from electricity generation were down by 50% compared to 2005, while ETS emissions from all other sectors were down by 20%.[119] In 2021 ETS emissions from the electricity generation sector increased by 21%.[117] A revision of the EU ETS is currently underway to align the ETS Directive with the increased GHG emissions reduction targets set in the European Climate Law[125]. There has been a significant increase in the ETS price between 2020 and 2022, which may contribute to driving further innovation and emissions reduction in the sector if coupled with appropriate policy and regulation.

6.5.2 Electricity demand

The 2021 EirGrid and SONI Generation Capacity Statement (GCS)[b] found that demand will grow significantly in the next decade, driven by strong economic growth, an increase in industrial demand, particularly from data centres and to a lesser extent from electrification of transport and heat.[126]

The forecasted growth in electricity demand between 2021 and 2030 is between 17% in EirGrid's low-demand scenario and 43% in the high-demand scenario. The 2021 GCS forecast a significant increase in demand driven by data centres and other large energy users, with an estimated 27% of total system demand by 2030.[126] Changes in the uptake of EV charging, electrical heating and demand for large industrial users will also alter the profile of demand throughout the day and seasonally. Projected increases in electricity demand in this decade risk outpacing mitigation measures, demonstrating the need to focus effort on demand-side flexibility and management.

The Council supports urgent efforts by the Government to promote energy efficiency efforts to the maximum extent possible and supports SEAI's innovative programme of communications to inform consumers and businesses on actions they can take to reduce energy demand.

A demand side strategy, as set out in NCAP2021, is also urgently required to support adoption of demand side technologies and support reductions in emissions intensity in the sector, along with further measures to enable and incentivise demand side flexibility in industrial, commercial and residential demand. The Council considers that this strategy should also take into account the emissions impact of demand side response, for example, where on-site fossil fuel generation is used.

a SNSP is a measure of the non-synchronous generation on the system at an instant in time. It is the ratio of the real-time MW contribution from non-synchronous generation and net interconnector imports to demand plus net interconnector exports.

b Each year, EirGrid and SONI, the Transmission System Operators for Ireland and Northern Ireland, publish an All Island Generation Capacity Statement (GCS) which provides a future looking assessment of generation adequacy in Ireland and Northern Ireland. The GCS considers the total electricity requirement based on the winter peak, historic demand, economic forecasts and large energy users. It then considers available generation to meet demand including conventional units, the capacity of renewable energy, auction contracts for conventional and renewable energy and the impact of forced and scheduled outages. On the basis of these factors, the GCS considers the gap between supply and demand or generation adequacy.

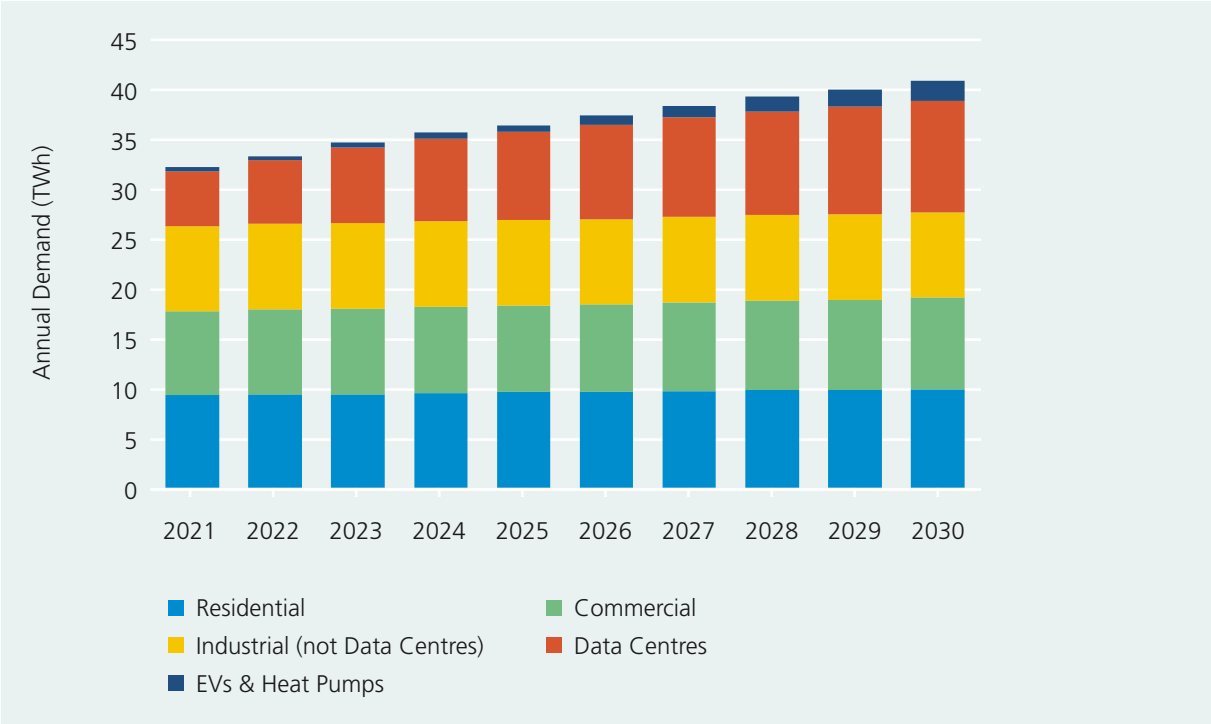


Figure 6.3 Breakdown of demand forecast by sectors under the Median Demand scenario for Ireland 2021-2030 (Source: EirGrid and SONI GCS 2021)

Demand response at a domestic level could also contribute to improved energy efficiency and security of supply, which could be enhanced through the National Smart Metering Programme and the shift of demand from peak times. As of June 2022, the National Smart Metering Programme has installed over 800,000 smart meters, with over 79,000 of those customers having moved on to Time-of-Use Tariffs. **Accelerated installation of smart meters, while ensuring the provision of smart meter data to customers and incentivising greater uptake of tariffs to help move demand away from peak times are crucial to saving customers money and delivering change in the patterns of electricity usage to support a lower carbon electricity system.**

Microgeneration provides an accessible opportunity for household energy production and overall demand reduction, shielding households from volatile energy prices, and such small-scale renewable energy infrastructure can be installed relatively quickly. The review of the current planning exemptions relating to solar panels was recently completed with a consultation on revised regulations launched in June as part of the Strategic Environmental Assessment process[a]. **It will be important to finalise this process as soon as possible to support households, schools, communities and other non-domestic microgeneration.**

From 2022, micro and small-scale generators can receive a payment from their electricity supplier (the Clean Export Guarantee or CEG) for all excess renewable electricity they export to the grid, reflecting the market value of electricity. The CEG became available upon the transposition of Article 21 of the Renewable Energy Directive (RED II) into Irish law on 15 February 2022.[127] It is available to both new and existing micro- and small-scale generators that fulfil the eligibility criteria set out in the Commission for Regulation of Utilities' (CRU) decision on the enabling framework for microgeneration.[128] In addition, the Microgeneration Support Scheme was approved in December 2021 providing grants via the SEAI for installing equipment

a The draft regulations have been reviewed under the Strategic Environmental Assessment (SEA) Directive and it has been determined that they are likely to have significant effects on the environment, necessitating the undertaking of a full SEA on the draft proposals.

for both domestic and non-domestic applicants and a fixed export tariff for non-domestic applicants over a 15-year period.

The European Commission recently published an EU Solar Strategy which aims to double solar PV capacity by 2025, with a phased-in legal obligation to install solar panels on new public and commercial buildings, and new residential buildings and certain existing public and Commercial buildings by 2027.[129]

Ireland saw an increase in electricity consumption in 2021, a key driver being the growth in electricity use by data centres.[130] The CSO recently published a dataset showing an increase in the percentage of metered electricity consumed by data centres from 5% in 2015 to 14% in 2021.[130] The large number of data centre applications to date, combined with the scale of energy demand, is a challenge, with data centres disproportionately contributing to predicted rapid demand growth. **Growing energy demand, including from data centres, will make additional abatement measures significantly more challenging. The upcoming Climate Action Plan should place increased focus on demand side flexibility and management, in addition to development of renewable generation capacity.**

Corporate Power Purchase Agreements (CPPAs) between corporate energy consumers have the potential to increase the amount of renewable electricity produced in Ireland, where they result in additional renewable capacity, and a recent roadmap published by DECC notes the role CPPAs can play in decarbonising the electricity sector.[131] One of the policy priorities highlighted in the roadmap relates to the issue of the allocation of costs associated with CPPA-funded projects, including network reinforcement and congestion, which may lead to increased costs for other electricity consumers. In order to mitigate this and other issues highlighted in the roadmap, temporal and spatial matching of such renewable electricity generation and corporate demand should be maximised.

Given the role of Data Centres in driving electricity consumption in 2021, the recently published Government statement of the role of Data Centres in Ireland's Enterprise Strategy (27 July 2022), will be considered by the Council to assess alignment with revised renewable electricity targets and sectoral emissions ceilings.[132] In the interim, the Council welcomes the criteria introduced to assess connection applications for data centres based on their location, ability to provide on-site generation or storage and ability to reduce consumption when requested, but urges an assessment of emissions impacts in monitoring implementation of these measures.[a] The Council also notes and supports the proposals under the revised Energy Efficiency Directive to require monitoring and reporting of sustainability criteria and energy use by data centres.[b] The Council notes with interest the recent announcement[133] that Microsoft data centres will act as a dispatchable energy source during times of high demand from their on-site storage and welcomes such creative solutions more generally being sought.

6.5.3 Electricity supply

Ireland has been successful in deployment of onshore wind to date, which reduced the emission intensity of electricity up to 2021, when this increased as set out in Section 6.2. To respond to the current energy crisis with increasing and volatile costs of fossil fuels and risks to security of supply, as well as the demanding emissions reductions required under our climate targets, wind and solar resources will need to be harnessed to a greater and faster extent than previously considered.

a In July 2021, the CRU published a consultation paper which stated that a significant contributory factor to electricity security of supply risks is the large increase in electricity demand presented by the growth of the data centre industry. The CRU decision in relation to Data Centre grid connection processing in November 2021 issued directions to the System Operators (EirGrid and ESBN) setting out criteria that they would be required to consider in assessing data centre connection applications. These criteria include the location of the applicant, their ability to bring on-site dispatchable generation or storage and their ability to provide flexibility in their demand.

b https://ec.europa.eu/info/news/commission-proposes-new-energy-efficiency-directive-2021-jul-14_en

NCAP2021 has identified renewable volumes of up to 8 GW onshore wind, at least 5 GW offshore wind and between 1.5 and 2.5 GW solar PV.[a] Whilst progress has been made with a new marine planning system and consenting regime to support the development of offshore renewable energy, offshore wind generators are complex infrastructure projects and planning applications, including environmental assessment and public consultation, will take time. In addition, competition for and constraints within international supply chains may cause unavoidable delays. **As a contingency therefore, targets for onshore wind and solar renewable electricity should be significantly increased, with faster roll-out of these and associated grid reinforcement.**

In RePowerEU, the plan to rapidly reduce dependence on Russian fossil fuels and accelerate the green transition, the European Commission has urged Member States to ensure that *'the planning, construction and operation of plants for the production of energy from renewable sources, their connection to the grid and the related grid itself are considered as being in the overriding public interest and in the interest of public safety and qualify for the most favourable procedure available in their planning and permitting procedures.'*[134] **Energy independence for Irish customers has significant benefits for both the climate and energy security. Therefore, the Government needs to proactively communicate the opportunities and benefits of greater energy independence via further renewable development. Strong political and policy support is needed at a national and local level for the rapid delivery of renewable energy projects.**

The high number of System Alerts in 2021 indicated that the margin between electricity demand and supply was tight. This was driven by factors such as an ageing fleet of conventional generators, which experienced high outage rates, delays in essential maintenance due to the pandemic, lower than average levels of wind and high demand.[135] These issues fed into an increase in emissions in the sector in 2021, despite success in reducing emissions in previous years. In November 2021, the Government issued a policy statement on security of electricity supply, which stated that it is appropriate to retain existing coal, heavy fuel oil and biomass fired generation until new capacity is developed in order to ensure security of electricity supply.[136] A further review is currently being carried out by DECC on the security of energy supply of Ireland's natural gas and electricity systems. **It will be important to ensure that the technical analysis supporting this review accounts for the emissions impact and sustainability of options being considered, in addition to the impact of the actions set out in the National Energy Security Framework published in April 2022.**[137]

As the penetration of renewable generation (primarily wind and solar) increases in order to reduce dependency on more carbon intensive fuels, the electricity system will require increased flexibility through interconnection, storage, new system services, demand response and low carbon generation. It will also be important to focus on residual sources of fossil fuel generation from an emissions perspective as coal and oil, for example, are two of the fuels with the highest CO_2 intensity. In 2021 coal generated 11% of electricity but was responsible for 30% of emissions in the sector.[138] **There will be a need to assess the efficiency and carbon intensity of remaining conventional generation. A clear strategy for high emissions fossil fuel generation must be developed to limit its use in the context of our climate requirement and energy security needs, and the Council urges closure dates for high emissions generators to be adhered to.**[138]

a Note that the Government announced additional targets in July 2022 of 5.5 GW of solar, 7 GW offshore wind, an additional 2 GW of green hydrogen and up to 5.7 TWh of biomethane.

NCAP2021 notes that there will be a need for approximately 5 GW of conventional generation capacity in 2030, including 2 GW of new flexible gas capacity. The 2021 Generation Capacity Statement (GCS) identified a potential capacity shortfall of 260 MW for the capacity year 2022-2023, rising to 1,050 MW in 2023-2024 and 1,850 MW in 2024-2025, driven by growth in electricity demand, closure of older fossil fuel generation and failure to deliver new capacity through the Capacity Auctions.[a]

The CRU indicated in its 2021 Security of Electricity Supply programme of actions that as a significant proportion of the replacement capacity contracted to be delivered for the year 2023/24 will not be delivered, the extension of operation of up to 1,200 MW of older, higher emissions generators will be explored until new capacity is delivered to replace them.[139] In an update published in June 2022, it was noted that 450 MW of additional emergency temporary generation will be required for the 2023-2024 period, while EirGrid has already taken steps to secure 200 MW of emergency generation in 2022.[139],[140] The 2021 GCS noted that failure to deliver new capacity presents significant challenges. This will have a direct impact on emissions if older, less efficient generators are required to run for longer periods due to capacity shortfalls.[141]

The role of gas (fossil or renewable) in electricity generation and alternative fuels for dispatchable generation and storage out to 2050 remains to be determined. This uncertainty has implications for investment decisions and infrastructure development.[142] **It will be important to develop a roadmap and pathways for the electricity sector beyond 2030. As part of this, the urgent development of an ambitious and evidence-based strategy for the role of green hydrogen is required, and it is crucial that a Hydrogen Strategy, which is targeted for publication in line with the updated Climate Action Plan later this year, is not delayed.** At the same time, it is important to understand the greenhouse potential of fugitive hydrogen emissions, which is rapidly emerging as an area of concern given their substantial greenhouse potential over decadal timescales[143]. The Council welcomes the recently published Consultation on developing a hydrogen strategy for Ireland. Green hydrogen, if deployed properly, could provide long-term, high-capacity energy storage and dispatchable generation with minimal additional climate impact. As demonstrated in a recent study published by the Council, hydrogen is likely to become cost-effective for electricity storage post 2030. As the drivers of cost reduction related to hydrogen deployment are capital and electricity costs, supporting the reduction of electricity costs is a no-regrets policy.[144]

The EU Agency for the Cooperation of Energy Regulators (ACER) recently concluded a review of the EU Wholesale Electricity Market Design in the context of the significant changes needed to deliver the clean energy transition and impacts of the current energy crisis on electricity prices. The review notes that, *'The market design will need to facilitate a massive rollout of low-carbon generation, and in particular, renewable generation characterised by high upfront investment costs, while ensuring that flexible resources complement intermittent renewable production where and when needed.'*[145] In terms of recommendations, the report states that significant and diverse flexible resources (including generation, storage, demand and grid infrastructure) will be required to optimise the value of growing shares of intermittent generation and address increased volatility. A key focus will need to be the provision of long-term flexibility for times when demand is high or when renewable generation is low.[145] The European Commission intends to launch an impact assessment process on possible adjustments to the electricity market design, which the Council supports. The existing State Aid approval for the SEM Capacity Market also expires in 2027, which may lead to an opportunity to evolve the Capacity Market in line with mitigation targets as the Single Electricity Market (SEM) incorporates a growing share of renewables.

a The Capacity Market is designed to help ensure that the generation capacity in Ireland and Northern Ireland (including Storage, Demand Side Units and Interconnector capacity) is sufficient to meet demand, through competitive auctions.

6.5.4 Renewables and infrastructure development

Globally, there is very significant mitigation potential in the energy sector from wind and solar energy in particular, at a cost of less than $20 per tonne abated and with the potential for deployment leading to net cost savings.[146] EirGrid's grid development strategy, 'Shaping Our Electricity Future' identified a range of actions and projects that need to be delivered to support the development of infrastructure, enabling technologies and systems to support onshore renewables and accommodate offshore wind energy.[147] Implementation of these actions, along with further actions to accommodate the higher renewable ambition since the strategy was published, will require strong political and public support. **To support renewable energy development as an overriding public interest, consideration should be given to enhancing the mandate, funding and risk appetite of state financing agencies to support delivery on this strategic climate agenda.**

It will also be important to progress actions under the NCAP2021 to utilise the existing grid as efficiently as possible in order to address renewable constraints. **Ensuring a supportive spatial planning framework for both onshore and offshore renewable electricity generation development is critical. National and local political support is essential to support the timely development of grid infrastructure.**

The European Commission has recently called on Member States to ensure that investments in renewable energy and related grid infrastructure are considered as being in the public interest and require the most favourable planning and permitting procedures available. In its REPowerEU communication, the European Commission notes that administrative procedures have been identified as one of the key obstacles for investments in renewables and related infrastructure.[134]

The European Commission's RePower EU plan[a] proposes that in the medium-term, new EU legislation and recommendations will be developed for faster permitting of renewables in designated 'go-to areas' where renewable generation is not expected to have significant environmental impacts.[b] **The Council welcomes the European Commission Recommendation[148] to tackle slow and complex permitting for major renewable projects, and a targeted amendment to the Renewable Energy Directive[149] to recognise renewable energy as an overriding public interest. This should be supported at a national level.**

In terms of planning at the local level, a study carried out by the OPR and MaREI in 2021 outlined how local authority development plans have the potential to play a significant role in supporting wider efforts to increase renewable energy generation capacity.[150] The study noted, however, that current local authority's renewable energy strategies are focused on onshore wind energy, neglecting offshore wind, solar PV and other options. Very few of the development plans reviewed had assessed current demand or supply or identified the planned MW installs of renewable energy for the period of the plan or for 2030. **In general, this will be an important area in the next year given the recent amendments to Directive (EU) 2018/2001 under the RePower EU plan requiring Member States to identify the land and sea areas for the installation of renewable generation, accounting for energy demand and relevant grid infrastructure.**

a See: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en

b See Articles 15b and 15c here: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A222%3AFIN&qid=1653033811900

As set out in a recent paper by the Economic and Social Research Institute (ESRI), there are some regulatory hurdles for the development of renewable energy projects in Ireland, depending on the nature of the project. Planning permission, a grid connection, and authorisation to construct a plant/generate electricity are required by most projects. The majority of projects will also seek financial support under the Renewable Electricity Support Scheme (RESS). A foreshore licence or lease is also required for projects based in marine waters.[151] Table 6.3 as presented in the paper provides an overview of the process.

Table 6.3 Regulatory hurdles for renewable energy projects. Source: ESRI Working Paper

Authorisation	Public Body	Authorisation Cycle	Decision Timeframe
Planning Permission	Local Authority/ An Bord Pleanála	Continuous	18 weeks
Grid Connection	EirGrid/ESB Networks	Yearly (September)	12-15 months
Licence to Generate/ Authorisation to Construct	Commission for Regulation of Utilities (CRU)	Continuous	12-16 months
Renewable Electricity Support Scheme (RESS)	Department of Environment, Climate and Communications	Yearly (March)	3 months
Foreshore Licence/Lease	Department of Housing, Local Government and Heritage	Continuous	18 weeks

The ESRI study found that the design and timelines for these regulatory processes can impact on when projects are delivered, with demonstrable consequences from delays in the form of increased CO_2 emissions and higher electricity prices.

Electricity systems powered predominantly by renewables are becoming increasingly viable and the costs of these technologies have become competitive with fossil fuel alternatives, as highlighted in the recent IPCC WG III report.[146] Given the cumulative nature of emissions, increasing the renewable share of electricity generation as early as possible will assist in adhering to a finite carbon emissions budget.[151] **The Council supports the ESRI study's recommendation for a review of the overall regulatory process and, in particular, the interface between processes to reduce the timelines for development of renewable generation capacity.** The Council has already stressed the importance of ensuring that the planning system is appropriately resourced to ensure that projects can progress to energisation by 2030 at the latest with appropriate supporting infrastructure.

In the context of the targets for 5 GW offshore wind, 8 GW onshore wind and 1.5-2.5 GW of solar by 2030, to date there has been a maximum of just over 500 MW installed in any one year and on average the rate of installation between 2015 and 2020 was 337 MW.[142] Figure 6.4 shows a decrease in the total installed capacity in 2021 compared to previous years, potentially reflecting the gap between renewable support schemes.

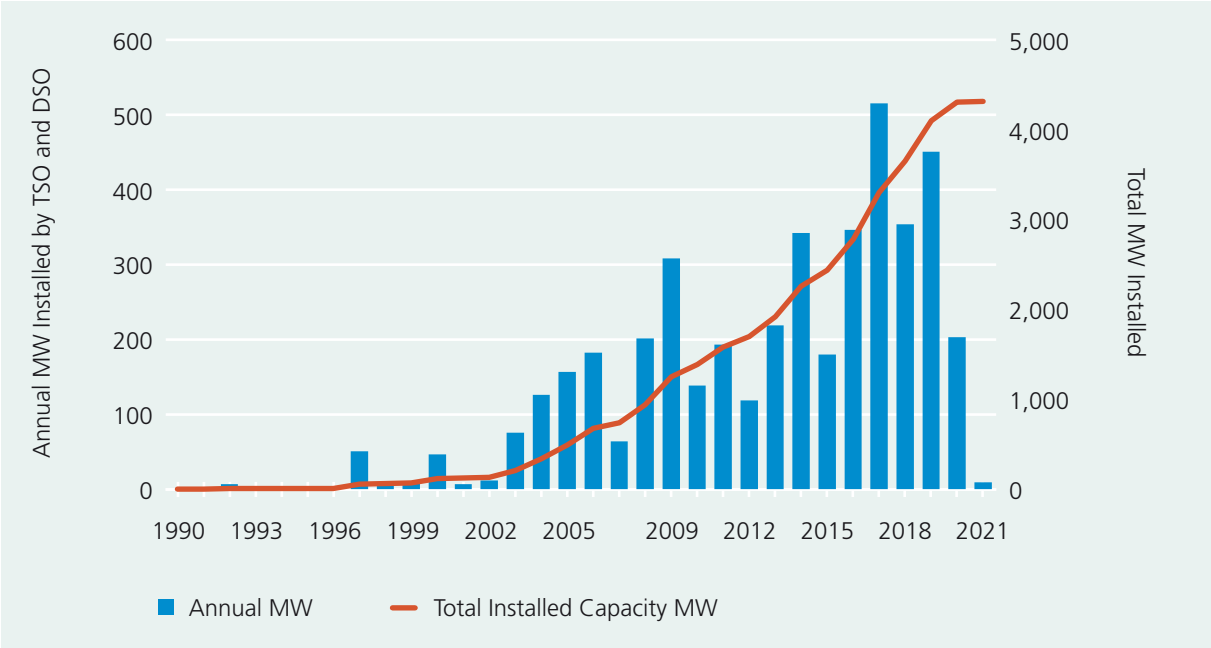


Figure 6.4 Annual Wind Installed Capacities by TSO and DSO and total MW installed between 1990 and 2021 (Source: EirGrid and ESBN)

6.5.5 Biodiversity

Offshore wind, onshore wind and solar photovoltaics can all be associated with both positive and negative impacts to biodiversity, depending on site location and management.[70] Offshore wind can be designed with biodiversity in mind, thereby providing habitats and protection for marine wildlife and, if located strategically, can shelter marine areas from bottom trawling and dredging.

For onshore wind, it is especially important to avoid placement of wind farms on vulnerable peatland areas or areas that are important for sensitive species. However, areas surrounding wind turbines can be rehabilitated into natural habitats and/or managed for biodiversity and ecosystems service provision. They could also be located on farmland as farmers could continue to use around 95% of the land to plant crops or graze livestock near the turbines.[70]

For solar photovoltaics farms, there are opportunities to create functional space beneath and between solar panels to support ecosystem services such as pollination. It is critical that all renewable energy projects are sited appropriately, and that action-based monitoring is employed across all measures.[70]

6.5.6 Just Transition

A Just Transition must ensure the pressure on lower income households facing energy poverty is dealt with before there is any risk of their situation being worsened by the transition.[152]

Small-scale renewable energy infrastructure such as solar can be installed relatively quickly and provides an opportunity for household energy production and demand reduction, in addition to energy efficiency measures. SEAI's free home energy upgrade service was amended in February 2022 to target the worst performing properties for energy upgrades, with half of the €8 billion allocated under the National Development Plan to home energy upgrades ring-fenced for support for vulnerable and energy poor households.[153] This approach is supported by recent research carried out by ESRI, which has found that low-income households identified as fuel poor have the smallest level of demand response due to higher energy prices, demonstrating the importance of combining income support with improvements in energy efficiency for such households.[154]

7. Sectoral progress – Built Environment

Key messages

Observations

- Emissions in this sector decreased in 2021 from 2020, but have not returned to the lower 2019 levels.
- Energy efficiency is improving and the roll-out of low-carbon heat options has begun, but not at a fast enough rate to achieve objectives.

Recommendations

- Increased energy prices bring health risks for vulnerable households and, therefore, climate action in the coming months should focus on helping to reduce their dependence on fossil fuels this winter, with an emphasis on measures that can be rapidly deployed:
  - Support for retrofit and zero carbon heating systems needs to be prioritised towards households in receipt of the fuel allowance and towards the worst performing buildings, including, in particular, those heated by coal and peat.
  - The target for the Local Authority Retrofit Programme should be significantly increased.
  - Relatively cheap and easy measures such as attic insulation, pumping wall cavities, draught proofing, other wall insulation, improving windows and doors and heating controls can move the worst performing houses up through the BER ratings, delivering significant energy cost savings and/or improvements in comfort.
  - Solar PV panels are another measure that can be quickly deployed and that would reduce households' exposure to energy prices and can also provide further benefits to the electricity system by reducing peak demand. They should be mandated on all new builds, residential, commercial and public, in line with prospective EU legislation. Planning exemptions on rooftop solar should be extended to include more building types and to increase allowed capacity.
- Zero carbon district heating has the potential to supply up to 50% of residential heat demand across Ireland, including urban and some suburban areas. Concrete plans for its deployment across urban areas in Ireland must be included in the NCAP2023. This should include a publication of heat demand maps for urban areas and an action plan for delivery of district heating in the highest demand areas.
- Heat pumps are a proven technology with the capacity to provide low carbon heating to rural homes. Barriers to rapid deployment need to be urgently addressed, including free provision of heat pump assessments irrespective of follow-through, better communication of heat pump requirements and a rapid scaling-up of appropriately skilled professionals and tradespeople. Achieving targets in the heat sector requires robust supply chains, especially skilled labour in the construction sector.
- A recent report by the Irish Green Building Council noted that there is also significant potential to increase the share of timber frame homes in Ireland's housing stock, including through Modern Methods of Construction. The Council calls for urgent consideration of measures that will increase the share of timber frame construction in new homes, public and commercial buildings to replace cement and steel.
- The BER performance of buildings should be included with the sales information on the property price register online to allow better tracking and awareness of the impact of BER ratings on property values.

7.1 Chapter introduction

The Built Environment sector includes residential, commercial and public buildings with emissions primarily due to fossil fuels used for space and water heating. Consumption of electricity is not included in this category. Within these parameters, the Built Environment is not one of the largest sources of emissions. Nevertheless, emission reductions in this sector are important to contribute to national emissions reductions targets and have well established technological solutions that can bring well-being benefits and, over time, save money.

The Sectoral Emissions Ceilings set a target to reduce emissions in the Residential Built Environment sector by 40% from 2018 levels by 2030, with emissions of 4Mt CO_2 eq in 2030. Commercial and public buildings together were set a target under the Sectoral Emissions Ceilings to reach 1Mt CO_2 eq in 2030, representing a reduction of 45% from 2018 levels.

7.2 Inventories and projections

Emissions from the Built Environment sector were 8.5Mt CO_2 eq in 2021, a decrease of almost 5% from emissions in 2020, which measured at about 8.9Mt CO_2 eq.[a] Figure 7.1 illustrates how this decrease in emissions was due primarily to a decrease in emissions in the residential sector, probably due to reduced time spent at home after the lifting of Covid restrictions. However, emissions have not yet returned to the lower 2019 levels.

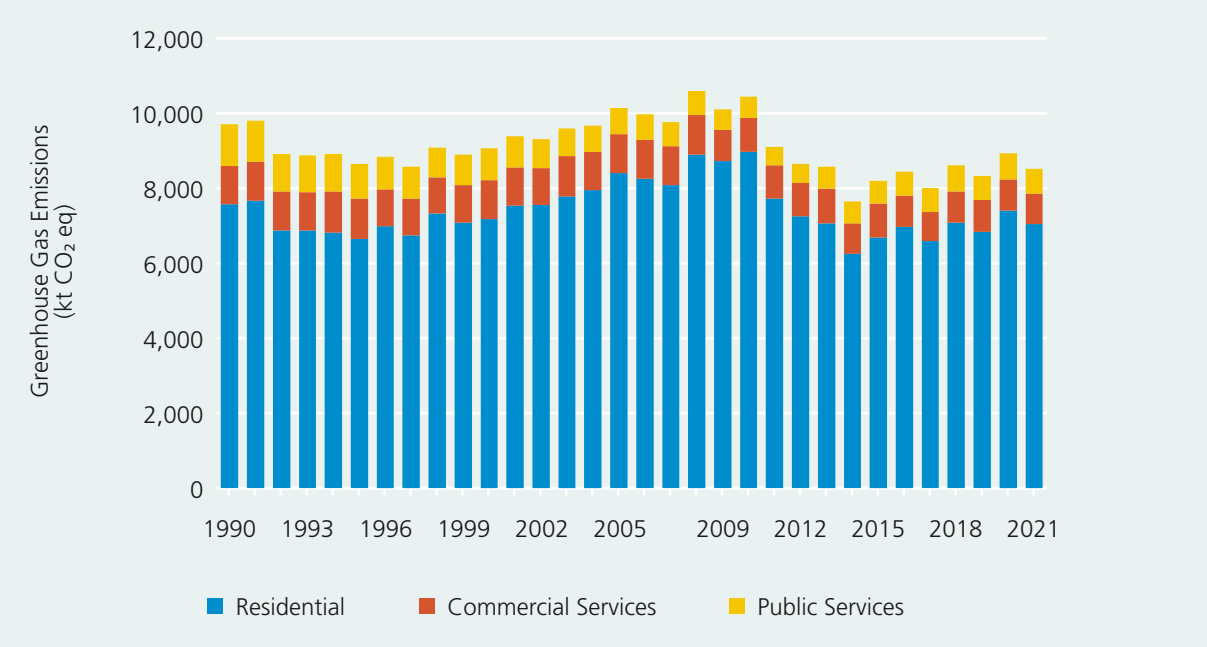


Figure 7.1 Built environment preliminary emissions inventory Mt CO_2 eq 1990-2021 (Source: EPA Provisional Inventory 2022)

The EPA has prepared a 'With Additional Measures' (WAM) scenario (see box 3.1) including:

- Installation of 680,000 heat pumps by 2030,
- A ban on oil boilers in new residential buildings from 2022 and gas boilers from 2025,
- District heating reaching 2.7 TWh of heat by 2030,
- Energy Efficiency programmes involving upgrades to homes, and retrofits to achieve at least a BER 'B2' rating,
- A total of 1,600 GWh of biomethane use across heat and transport sectors by 2030,
- Implementation of a range of energy efficiency programmes, including the retrofit of public building stock with a focus on decarbonisation and the Energy Performance Contract scheme.

Full implementation of policies and measures under the NCAP 2021 would bring emissions in both residential buildings and commercial and public buildings to the targeted emissions level under the sectoral emissions ceilings, with a value of approximately 4Mt CO_2 eq and 1Mt CO_2 eq in 2030 respectively (Figure 7.2).

a Section 3.2.4.1.3 of the National Inventory Report considers uncertainties and time-series consistency considerations in relation to Energy Industries. There is low uncertainty in the estimates of CO_2 emissions for the energy sector overall, which is the major source category in Ireland and for which the input data and methodologies are most reliable.

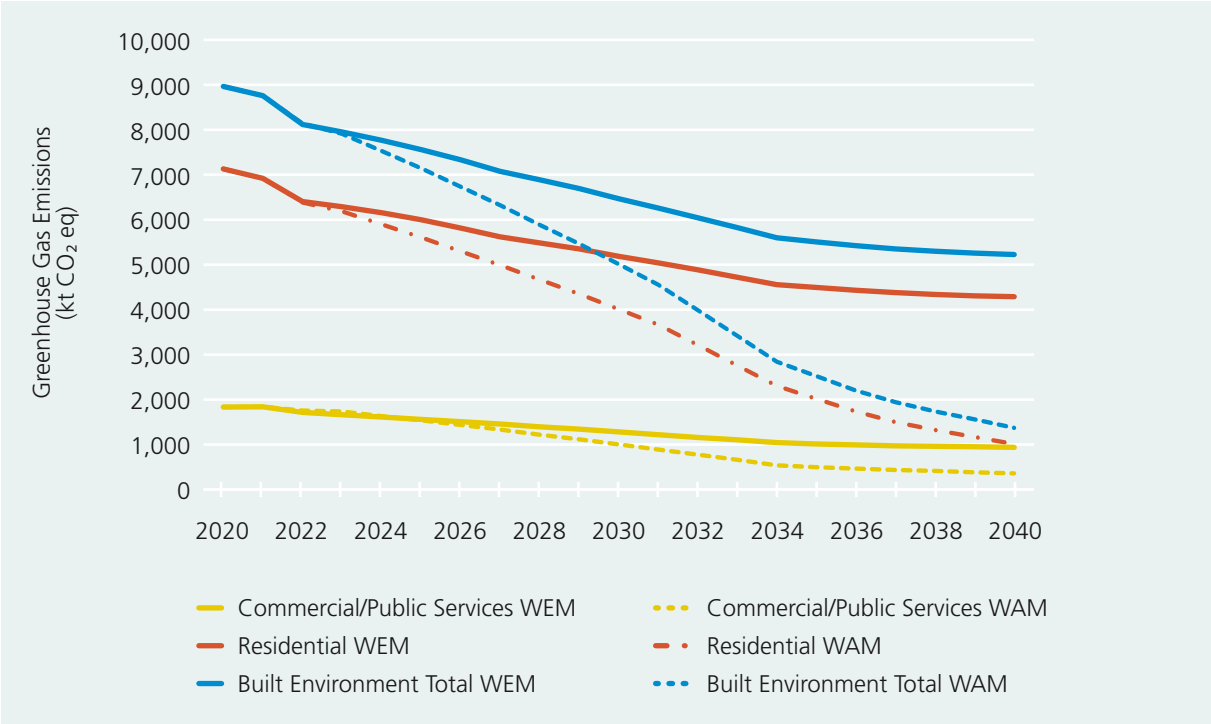


Figure 7.2 Projected emissions Mt CO_2 eq Built Environment 2015-2040 (Source: EPA 2022)[54]

Table 7.1 shows a preliminary analysis of the projected cumulative emissions associated with Built Environment over the first three carbon budget periods for the sector. The Government has agreed a sectoral emissions reduction target of between 40% and 45% by 2030. It is anticipated that the NCAP2023 will provide more detail on the pathway of emissions reductions and consistency with carbon budgets.

Table 7.1 Projected Built Environment cumulative emissions over the carbon budget periods from CB1-2021-2025; CB2-2026-2030; and CB3-2031-2035

	CB1	CB2	CB3
Built Environment Total WEM	39.0 Mt CO_2 eq	35.6 Mt CO_2 eq	37.7 Mt CO_2 eq
Built Environment Total WAM	37.1 Mt CO_2 eq	28.1 Mt CO_2 eq	26.0 Mt CO_2 eq

7.3 Indicators

The EPA National Emissions Inventory represents the latest official available data on emissions. However, we can use more recent indicators to inform a more up-to-date picture on trends in the Built Environment sector. The BER data set provides a good insight into recent developments in the housing stock, providing insights into the main heat energy sources employed in residential buildings (see Table 7.2), though it is not a fully representative sample. The CSO's own analysis of national data suggests that the BER dataset is better performing than the overall building stock.[155] Indicators are not yet available in all areas to track progress towards targets set in the NCAP 2021 (see Table 7.3).

Table 7.2 Current indicators for Buildings 2015-2021

Name	Units	2015	2016	2017	2018	2019	2020	2021
Built Environment Emissions	*Mt CO_2*	8.2	8.4	8	8.6	8.3	8.9	8.5
Emissions relative to 2018					100.0%	96.5%	103.5%	98.8%
Renewable Heat	%	6.20%	6.30%	6.60%	6.30%	6.30%	6.30%	
% residential energy from solid fuel (coal and peat, SEAI)	%	16%	15.80%	13.80%	13.90%	12.80%	12.30%	
Residence completions without fossil heating of space or water*	%						58%	79%
Existing (BER) homes without fossil heating								191,780
% A and B BER rated domestic dwellings	%	12%	13%	14%	15%	16%	23%	
% A and B BER rated commercial buildings	%	14%	13.80%	13.60%	13.20%	13.60%	14.20%	
Existing comm buildings without fossil heating*								37,748 (61.9%)
% Energy Efficiency Gains in Public Bodies (includes heating and electricity)	%	21%	20%	24%	27%	29%	34.10%	
Energy Consumption of Public Bodies* GWh (includes heating and electricity)	*GWh*	9,343	9,375	10,248	10,178	9,898	9,160	
District Heating Capacity/ Supply								<1% all heat

* The Part L building regulation, which sets out the requirements in relation to the conservation of fuel and energy in buildings, was updated in 2019 to include the Energy Performance in Buildings Directive (EPBD) requirement for Nearly Zero Energy Buildings. The impact of this change in regualtion is increasingly being seen in the rapidly improving performance of new constructions.

Table 7.3 Potential future indicators for Buildings

Name	CAP target
New commercial buildings without fossil heating	100%
LA housing retrofit to below B2	Not quantified
LA housing retrofit to min B2	36,500
Private housing retrofit to min B2	463,500
Private housing retrofit below B2	Not quantified
Heat pumps installed (cumulative since 2019)	600,000 in Residential
Low carbon build – embedded carbon	Not quantified

The SEAI provides a detailed breakdown of energy sources used by the different sectors within the Built Environment. The most polluting fuels, coal and peat, have been eliminated in both the commercial and public sectors for over a decade, see Figure 7.3 and 7.4. However, they are still a significant source for the residential sector, see Figure 7.5, and their use is predominantly associated with poorer households, rural households and older occupants.[17] Connections to and use of natural gas and electricity networks dominate the energy supply for the commercial and public sectors, showing potential for future decarbonisation. In

the residential sector, oil is the largest source of energy. Renewable sources still represent a very small proportion of the overall energy use in the Built Environment. However, the share of renewables in overall energy consumption may under-represent the role played by renewable heat sources in heating homes. Renewables are typically found in more energy efficient buildings where the amount of renewable energy consumed would typically be lower for the same heat service provision. In 2021, almost one in five new builds relied on gas or oil for space heating. This number is falling. In 2022 up to March, just 8% of new builds relied on gas or oil for space heating. While this is a significant improvement, it is important the NCAP21 target to eliminate fossil fuels in new builds is met with urgency.

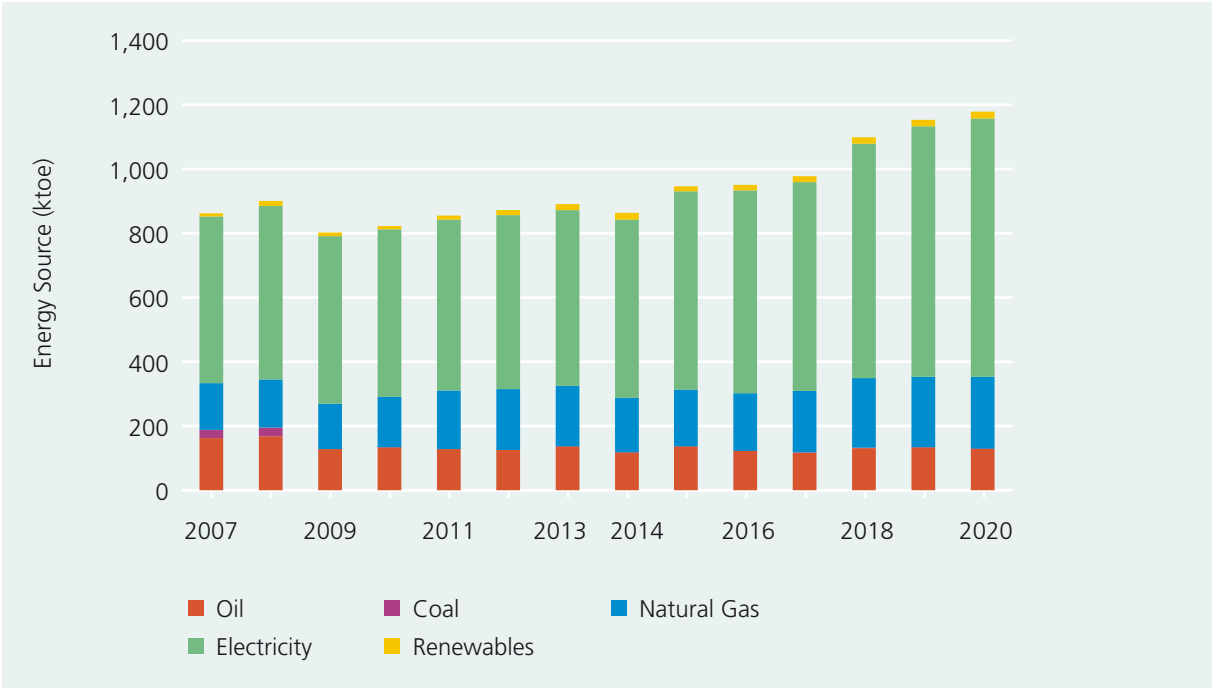


Figure 7.3 Commercial sector energy sources Ktoe (Source: SEAI 2021)[121]

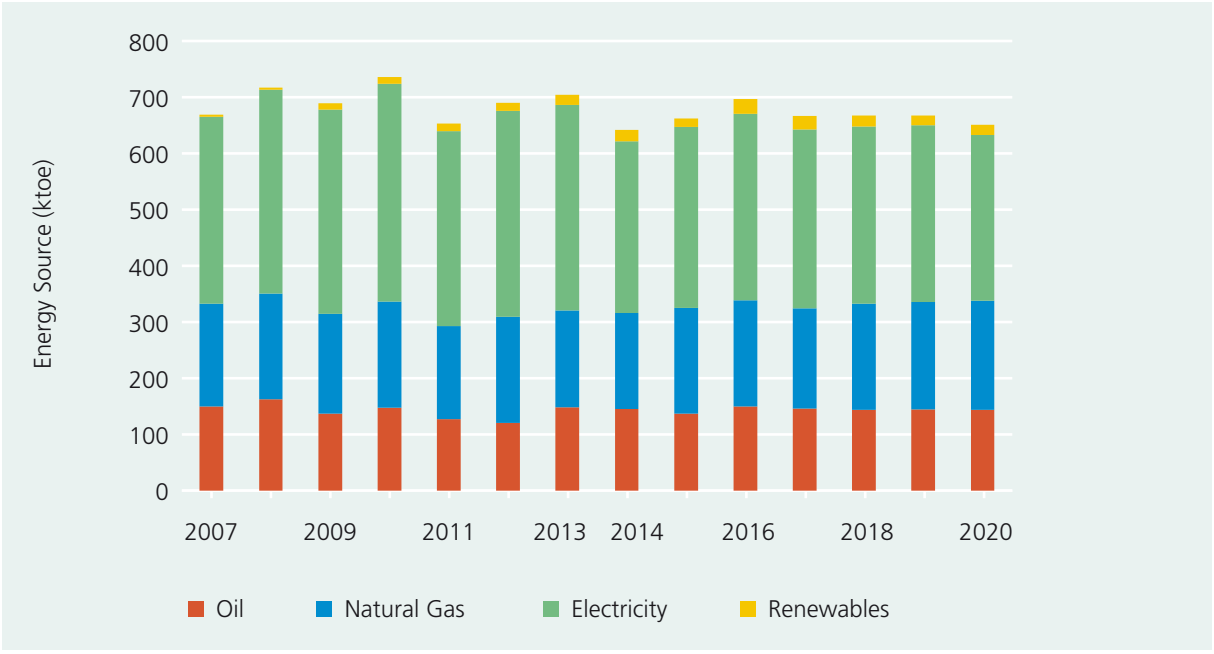


Figure 7.4 Public sector energy sources Ktoe (Source: SEAI 2021)[121]

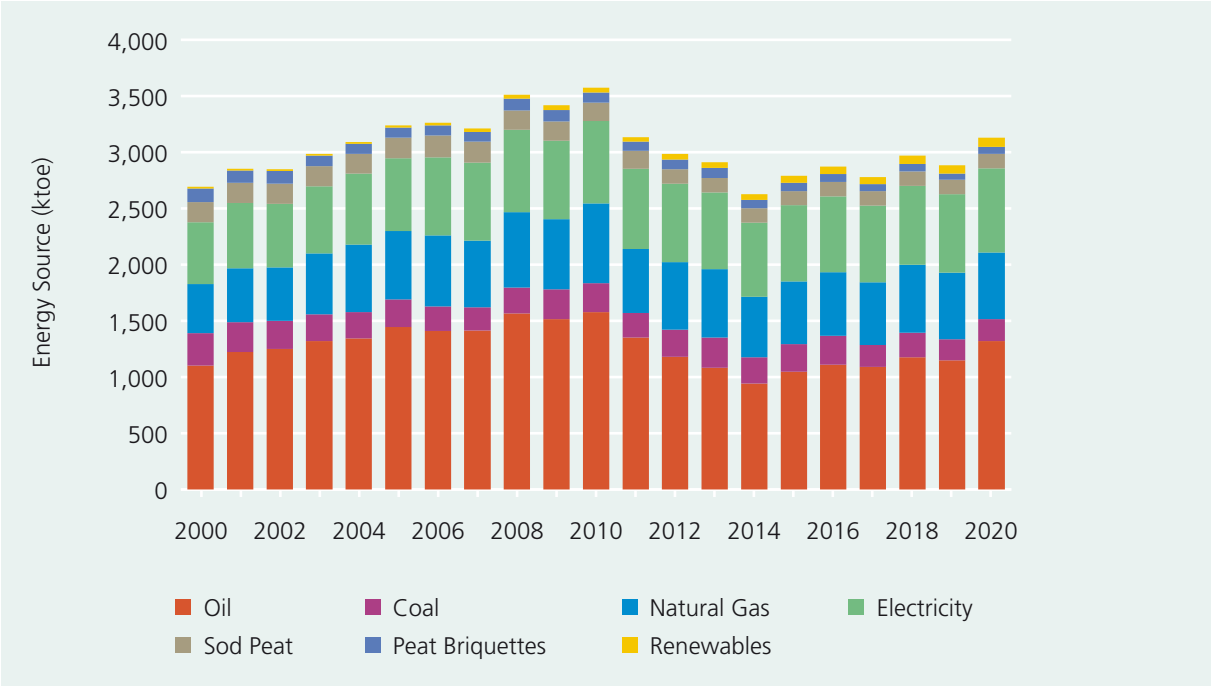


Figure 7.5 Residential energy sources Ktoe (Source: SEAI 2021)[121]

7.4 Biodiversity

The Built Environment also has the potential to integrate biodiversity considerations into development projects in a truly significant way, by accommodating spaces for biodiversity within its planning process and by protecting and conserving existing green spaces.[156],[157] Considerate planning decisions will be needed to protect biodiversity into the future, as will choosing the most appropriate site locations to avoid negatively impacting vulnerable habitats. Nature-based solutions can also provide biodiversity-promoting options for this sector, such as sustainable drainage systems, green roofs, rivers, urban trees and community green spaces.[70]

The sector's potential to contribute to the protection of biodiversity also includes its role in the minimising of negative ecological impacts from renewable energy methods such as solar PV, which can be nearly entirely avoided by incorporating solar panels into existing infrastructure such as buildings, car parks, residential houses, or any other land that has already been degraded and/or developed by humans.

7.5 Just Transition

Following Russia's illegal and unprovoked invasion of Ukraine and the consequent increases in fuel and electricity costs, winter 2022 is expected to present great difficulties for many families to heat their homes and to pay their electricity bills. According to SEAI data, the price of home heating oil (Kerosene) increased by over 100% in the 12 months to May 2022, with increases of 35% and 25% for coal and gas respectively (see section 3.5.1).[158] Supporting families in a substantive way to switch to renewable energy sources and to improve the insulation fabric of their home in the short term is an urgent priority. Measures like district heating or deep retrofit require infrastructure or complex installation supported by skilled professionals, which can be difficult to achieve in the short term. Installation of solar panels, attic insulation and pumping wall cavities are all measures that can usually be installed quickly in a home with only a quick assessment necessary to determine suitability.

Addressing emissions in the Built Environment is bound up with a Just Transition because a healthy home environment is crucial to well-being. In its 2021 Technical Report on Carbon Budgets, the Council found that solid fuel use for primary home heating is predominantly associated with poorer households, rural households and older occupants.[17] Solid fuel use for home heating significantly impacts indoor air quality as well as air quality in the local environment. It is also less efficient at delivering heat. If solid fuel use is phased out without providing these vulnerable households with alternative, cleaner, low carbon heating, the health risk of living in underheated homes is high, as evidenced by the phenomenon of excess winter mortality.[159] The Technical Report on Carbon Budgets further outlined how poor building stock exacerbates (or perhaps in some cases is the direct cause of) respiratory and some cardiac conditions due to cold, damp, draughts, and mould. Fossil fuel heating further compounds the problem because of carbon dioxide, carbon monoxide gases, and particulates (smoke and soot), decreasing the indoor air quality.[160] These impacts are usually felt most by the poorest and most vulnerable sections of society. Addressing the building fabric and developing alternative heating systems, particularly for vulnerable households, will be of utmost importance. The ReHeat report, commissioned by the Council, outlined the difficulties in addressing poor quality heat and building stock among the disadvantaged, noting that most grants and other support are directed at homeowners, or welfare recipients.[161] There are concerns about missing the rental households who don't qualify for welfare but might nevertheless experience energy poverty, particularly given recent inflation in rental and energy prices. Targeted support for these rental households will be crucial in the budget. To encourage decarbonisation in the rental sector, it is essential that tailored initiatives recognising the split incentive barrier to energy efficiency that exists for landlord and tenant are developed and resourced.

The NCAP 2021 commits to extending the Local Authority Retrofit Programme to retrofit 36,500 local authority homes to B2 or cost optimal standard with a heat pump by 2030. Synergies and cost savings can be achieved by retrofitting houses in the same street or estate together, while the accelerated activity of the public sector can bring more confidence to retrofit suppliers, supporting the expansion of capacity in the medium- to long-term.

A Just Transition framework plays a key role in the transformation of the Built Environment sector as it not only involves a change in technologies and architecture, but also behaviour, lifestyle, and culture which have significant impacts on building energy consumption. Retraining and reskilling will be required for those currently employed within the built environment, and the Council believes that the development and implementation of plans to develop the scale of relevant skills need to be accelerated immediately both nationally and regionally. Under the Apprenticeship Action Plan, a target was set for 10,000 new apprentices every year by 2025. In 2021, over 8,600 were registered.[162] Achieving increased apprenticeship registrations and completions will be critical to delivering on climate targets.

7.6 Analysis

With increasing cost of fossil fuels, and the high dependency on fossil fuels to heat Irish homes, urgent action is required to safeguard a warm and healthy environment in winter 2022. The two main strategies for reducing emissions in this sector are energy efficiency and fuel switching. Behaviour change without a change in efficiency or energy source has limited potential to reduce emissions because for health and comfort there will always be a demand for space and water heating. In 2020, the Council funded work by researchers in Trinity College Dublin and University College Dublin to analyse the potential for emissions reductions in heat in the residential sector, the ReHeat project.[161] The final report of this project informed the Council's considerations below and is available on the Council website.

Table 7.4 demonstrates the previously calculated savings that could be made by improving building fabric and changing heat source. Relatively cheap and easy measures, such as attic insulation, pumping wall cavities, draught proofing, other wall insulation, improving windows and doors and heating controls, can move the worst performing houses up through the categories, delivering energy cost savings and/or

improvements in comfort. **Rapid deployment of these measures must be a priority in the coming months to assist the most at-risk households to cope with energy cost pressures over winter.** Solar panels are another measure that can be quickly deployed and that would reduce households' exposure to energy prices. The imminent application of mandated minimum prices to householders for exports to the grid will increase the returns on investment by households. The RePowerEU plan proposes rapid expansion of rooftop solar to support decarbonisation and the switch away from fossil fuels. **Consideration should be given to the potential for even greater support and accelerated deployment of attic insulation, cavity wall insulation and solar panels measures for those on social welfare and those on lower incomes to reduce the impact of the energy crisis on these households.** Provision of updated figures, based on the latest energy price trends, should be made available as a matter of priority to assist households in their decision making. This could be accompanied by up-to-date simple 'pay back' calculators for different retrofit and technology options.

Table 7.4 SEAI Indicative annual CO_2 emissions and running costs for different rating bands for space and water heating (Source: SEAI 2021). Note that this table is based on pre-2020 energy prices and consequently the current cost gap between the best and worst performing houses is wider, meaning that potential energy cost savings are greater.

Rating	2 Bed Apartment		3 Bed Semi-D		4 Bed Semi-D		Detached House		Large House	
	Area (m^2)	75	Area (m^2)	100	Area (m^2)	150	Area (m^2)	200	Area (m^2)	300
	Tonnes CO_2	Cost (€)	Tonnes CO_2	Cost (€)	Tonnes CO_2	Cost (€)	Tonnes CO_2	Cost (€)	Tonnes CO_2	Cost (€)
A1	0.4	€140	0.5	€190	0.8	€280	1.1	€400	1.6	€600
A2	0.8	€280	1.1	€.380	1.6	€560	2.2	€800	3.2	€1,100
A3	1	€350	1.4	€470	2	€700	2.7	€900	4.1	€1,400
B1	1.3	€440	1.7	€590	2.5	€900	3.4	€1,200	5	€1,800
B2	1.6	€570	2.2	€800	3.3	€1,100	4.3	€1,500	6.5	€2,300
B3	2	€700	2.7	€900	4	€1,400	5.3	€1,900	8	€2,800,
C1	2.4	€800	3.1	€1,100	4.7	€1,600	6.3	€2,200	9.4	€3,300
C2	2.8	€1,000	3.7	€1,300	5.5	€1,900	7.4	€2,600	11	€3,900
C3	3.2	€1,100	4.2	€1,500	6.3	€2,200	8.4	€2,900	12.7	€4,400
D1	3.7	€1,300	5	€1,700	7.5	€2,600	10	€3,500	14.9	€5,200
D2	4.4	€1,500	5.8	€2,000	8.8	€3,100	11.7	€4,100	17.5	€6,100
E1	S	€1.800	6.7	€2,300	10.1	€3,500	13.4	€4,700	20.1	€7,000
E2	5.7	€2,000	7.6	€2,600	11.4	€4,000	15.1	€5,300	22.7	€7,900
F	6.8	€2,400	9.1	€3,200	13.6	€4,700	18.2	€6,300	27.2	€9,500
G	8.5	€3,000	11.3	€4,000	17	€5,900	22.7	€7,900	34	€11,900

As a next step, by improving insulation levels and air tightness, these homes could be made ready for a shift from direct fossil fuel use to electric heat pumps. Some homes are already ready and could switch from a fossil fuel boiler to a heat pump now. The Government has ambitious targets for deployment of both heat pumps and district heating. Both are proven alternatives with great potential to deliver emissions reductions in rural and urban areas respectively.

The 2016 Census identified 5% of households (over 80,000) as relying on peat to heat their homes, this could be as much as 6% of homes if homes identified simply as having no central heating are included. The concentrations are much higher in the midlands with Offaly recording 38%. Peat-reliant households are not captured very well in the BER data, probably because the BER data indicates that peat is concentrated in older homes and, as the CSO found when comparing the 2011 and 2016 census, a change of occupants (often a sale which would trigger a BER) was linked with a switch away from using solid fuels.[163]

This data does not capture homes that may use peat as a secondary or even tertiary heat source. As discussed in section 10.5, solid fuel use for primary home heating is predominantly associated with poorer households, rural households and older occupants. It has implications for health and its harvesting has implications for biodiversity and carbon sequestration. **Households that currently rely on turf-cutting to heat their homes should receive accelerated and additional support to improve their homes' energy efficiency and to switch away from peat to low carbon options.** This will improve health outcomes and support protection of peatlands.

Support for retrofit and zero carbon heating systems needs to be prioritised towards households in receipt of the fuel allowance and towards the worst performing buildings, including, in particular, those heated by coal and peat. The target for the Local Authority Retrofit Programme should be doubled to deliver approximately 70,000 retrofits by 2030. This would underpin climate justice by ensuring that support for retrofit goes to social housing, the most vulnerable and energy poor households in both urban and rural communities. It would have significant health benefits through improved living environments in homes and improved air quality.

The built environment transition is largely paid for privately, with Government support prioritised to vulnerable households and then to households where emissions are highest. To support households and small businesses to invest in their homes and premises, access to low-cost finance will be crucial. **The recent announcement of low-cost Government-supported finance to consumers and small landlords for retrofit and zero carbon heating systems is welcomed but now needs to be accelerated in delivery and made broadly available, while giving consideration to the greatest impact in delivery of decarbonisation given the market challenges.** Policies need to be further developed to address the challenge of driving the rental sector to engage in upgrades, where there may be less incentive for landlords to improve properties. While measures are typically targeted at homeowners, the rental sector is significant and retrofitting policies, arising from the 'Housing For All' strategy, need to be ambitious and successfully delivered for a Just Transition.

Significant actions in the NCAP 2021 support deployment of heat pumps in residential buildings through delivery of 'One Stop Shops' (OSSs) for easier access to grants and project management services via the SEAI website, and increased grants for heat pumps. Eligibility for a heat pump grant notably includes an assessment of whether the residence is 'heat pump ready' with a heat loss indicator (HLI) at or below 2W/m^2. Homeowners are required to procure a 'heat pump technical assessment', which will calculate the HLI and recommend any works that may be required to bring the HLI to the required level. Although a grant is available from SEAI towards the assessment, the grant is only released to those who follow through on accessing the heat pump grant. With a technical assessment costing anywhere around €650 to €1000, this already acts as a barrier to accessing the heat pump grant, given the uncertainty regarding the assessment result and the cost of any potentially required works. Better communication to the public on the types of homes likely to qualify for a heat pump grant without fabric upgrades would reduce uncertainty and therefore should increase the uptake. Out of the approximately two million residential building stock, about 1 million have a BER certificate and of those approximately 210,000 are currently heated by oil and have a BER rating from C3 up to B3. A further approximately 1,000 homes have a rating from C3 up to B3 and are currently heated by multi-solid fuel. These should be early candidates for deployment of heat pumps,

as many of these homes may be 'heat pump ready' or the level of retrofit required may be smaller. **The technical assessment grant should be offered irrespective of heat pump take-up, as this could increase take-up of retrofit options and heat pumps.**

It is important that heat pumps are not installed in poorly insulated homes, or at inappropriate sizes for individual homes as the cost savings of a heat pump only materialise when the system operates efficiently.

SEAI's National Heat Study: Low Carbon Heating and Technologies found that heat pumps are technically suitable in 78% of existing residential buildings and in 66% and 47% of existing commercial and public buildings respectively, even without energy efficiency improvements. This estimate takes a less stringent approach to assessing suitability compared to the current grant eligibility requirements based on the Heat Loss Indicator. While air-source heat pumps rely on electricity, which is not yet zero carbon on the grid, they provide significant carbon savings in their own right and will deliver even more savings as the electricity sector decarbonises. They are particularly useful for standalone dwellings in rural locations with limited low carbon alternatives, and potential capacity for microgeneration.

As 25% of the current dwelling stock was constructed in 2001 to 2010 and since the average life expectancy for a heating system of this period is 15-20 years, a large share of properties built during the construction boom of the early 2000's will need heating system replacements in the coming decade. This highlights the importance of policies which will influence heating technology choices in the coming years. The success of recent grant increases and the launch of the OSS by the SEAI has highlighted the issue of capacity constraints in the sector (see Section 10.6 on Just Transition). This is an issue across Europe, as the demand for building upgrades and low carbon solutions accelerates.

The SEAI's National Heat Study: District Heating and Cooling report found that low carbon district heating, predominantly from biomass boilers and air source heat pumps, has the potential to supply up to 50% of residential heat demand across Ireland, including urban and some suburban areas. District heating infrastructure can have a large impact and cost-effectively make use of heat that is currently wasted, particularly in areas of concentrated heat demand. Right now, power stations and data centres produce large amounts of waste heat suitable for heat networks. Biomass boilers and air source heat pumps are also economical sources of energy for district heating. **The Climate Action Plan 2021 contains many preparatory actions with regard to district heating but little regarding 'on the ground' delivery.** Homes heated by gas can be switched to a heat network supply in a matter of hours. Deploying heat network infrastructure is the biggest challenge in district heating and this is where **Government support will be critical in terms of governance and support for infrastructural development for district heating**.

Action in the residential sector can be supported and catalysed by leadership from the public sector. Delivering early progress on the public sector targets will be crucial. The NCAP2021 recognises that as a large purchaser of goods and services, the public sector can influence suppliers into offering greener products through its procurement practices. Decarbonised public buildings can also play a key exemplar role, demonstrating to and familiarising the public with modern energy solutions. In this regard, public buildings would be particularly suitable as fulcrum or anchor customers for district heating systems.[161]

Achieving targets in the heat sector requires robust supply chains, especially skilled labour in the construction sector. Support for deep retrofit across the housing stock could increase competition for limited resources. A focus on retrofitting the lowest rated housing and social housing would minimise resource competition between retrofitting and the construction of new homes, while delivering maximum social benefits. The timing of roll-out of new heating technologies and related policies should factor in carbon budget constraints as well as costs and uptake readiness.

The technological solutions exist to make significant savings in emissions in the residential sector by 2030. Government resources and supply chains have some constraints, therefore effective targeting of the right technologies to different households and businesses will achieve the most benefit not just for climate action but for health, well-being and the environment.

The Built Environment also has the opportunity to contribute to emissions reductions outside the sector by consideration of the embedded carbon and sustainability of the building process and materials. The construction industry, being a very resource-intensive industry, is a major contributor to biodiversity loss. [156] How we source materials and build infrastructure requires a shift in thinking to more eco-friendly methods. Reusing, repairing/retrofitting and recycling buildings and materials help reduce the need for new construction and material extractions and, therefore, limits the negative impacts on biodiversity. Reuse of derelict buildings in urban spaces can contribute to urban regeneration, improved streetscapes, well-being and sustainable densification of population, and would support transport objectives. While no reliable numbers yet exist for derelict buildings, in 2021 over 90,000 vacant dwellings were identified across the state.

There is also an opportunity to use eco-friendly materials during the construction process. Timber frame construction represented less than 25% of new homes constructed in Ireland.[164] Approximately 80% of new buildings in Scotland are timber frame. Expansion of timber frame construction in Ireland could provide a strong domestic market for domestically produced timber, providing further commercial incentive for investment in afforestation as committed to in the NCAP2021. Coillte estimates that annual timber production in Ireland would be sufficient to build 44,000 homes. Green concrete is an emerging sustainable and cost-effective material to use in construction.[165] Other examples of eco-friendly building materials are eco-bricks, hemp[166] (hempcrete) and bamboo[167]. However, local authorities can be reluctant to approve planning permission for constructions such as high-rise timber frame or unusual building materials as they lack the resources to assess whether and how they satisfy fire safety and other building regulations. **The Department of Housing and Local Government should clarify the building regulations, amend where necessary and provide guidance to Councils on alternative building materials and their appropriate use in construction.**

8. Sectoral progress – Enterprise and Waste

Key messages

Observations

- Emissions from manufacturing combustion and industrial processes increased by 0.9% and 16.8% respectively in 2021. Current projections suggest that significant further measures will need to be identified in order to meet emissions reduction targets for manufacturing combustion and industrial processes, while the Waste sector is projected to slightly exceed its 2030 emissions reduction target.
- Several key measures under the Enterprise sector in NCAP2021 lack details of a planned implementation pathway and, as a result, have not been included in the EPA projections.
- Both the Waste and F-gases sectors have demonstrated how some discrete sectors and gases can be more amenable to policy and regulatory change that push shifts in practices and technologies towards emission reductions. Emissions from the waste sector decreased by 4.5% in 2021, while F-Gas emissions decreased by 0.2%.

Recommendations

- Immediate action is needed to define the details of planned implementation pathways, including, for example, measures to achieve emissions savings from a decrease in embodied carbon in construction materials and Carbon Capture, Utilisation and Storage (CCUS).
- SEAI's recent National Heat Study found that most industrial heat demand can be decarbonised through technology changes or fuel switching to carbon neutral heating. Policies aimed at decarbonising heat demand for the manufacturing combustion sector need to be tailored to investment-decision timeframes for enterprises.
- Industrial processes emissions are forecasted to increase, driven by increased activity in the cement production industry. In addition to fuel substitution, CO_2 emissions associated with cement production should be reduced by maximising clinker replacement, utilising efficient use of cement in construction and replacement with lower carbon construction materials.
- It will be important to support the strengthening of the revised provisions under the F-Gas Regulation in order to ensure high global warming potential gases are further phased out, given the higher projected F-gas emissions as a result of the projected uptake rates in heat pumps.
- The Council welcomes the Circular Economy, Waste Management (Amendment) and Minerals Development (Amendment) Bill 2022, which among other measures will provide for the inclusion of targets in respect of re-used and repaired products and materials in waste management plans. A broader focus on the importance of the circular economy in the waste sector and improvement of Ireland's circularity rate is required, given Ireland's low circularity rate of 1.6% compared to the EU average of 11.9%.

8.1 Chapter introduction

NCAP2021 set a target for 40% emissions reduction in the enterprise sector[a] from 2018 levels by 2030. This equates to a target emissions level of approximately 5Mt CO_2 eq in 2030. NCAP2021 also set a target for 15.4% emissions reduction in the waste sector from 2018 levels by 2030, which equates to a target emissions level of approximately 0.77Mt CO_2 eq in 2030. In July 2022, the government agreed to a target of 35% emissions reduction by 2030, relative to 2018, for Industry[b].

a Including Manufacturing combustion, Industrial processes, and F-gases.

b Including Manufacturing Combustion and Industrial Processes

A sectoral dialogue was held with the Department of Enterprise, Trade and Employment and relevant agencies on 16 May 2022, during which the Department presented their analysis of the challenges facing the enterprise sector. NCAP2021 set out four core measures that will deliver emissions reduction of approximately 1.7Mt CO_2 eq in 2030 in order to meet the required level of emissions reductions. These include the accelerated uptake of carbon neutral heating in Industry; the phase-out of high-GWP F-gasses; a 10% decrease in embodied carbon in construction materials; and the electrification of high-temperature heat generation. Further measures include a 10-60% decrease in embodied carbon in construction materials and the deployment of Carbon Capture and Storage (CCS) at two out of four cement/lime plants.

This chapter includes four separate sectors (some of) which are covered by the EU ETS and reported on as part of the national greenhouse gas inventory. These are mainly associated with production processes and include manufacturing combustion; industrial processes; Fluorinated gases; and the waste sector.

The biggest share of enterprise emissions comes from a small number of large companies in the manufacturing sector (comprising 64 installations), mostly in alumina, food processing, beverages and cement, which are included in the EU ETS.[38] Emissions in the sectors outside of the EU ETS arise mainly from Small to Medium-sized Enterprises (SMEs).[38] There is significant crossover between industrial emissions and building and transport emissions, with a low level of renewables penetration in heating in the building sector and high dependence on fossil fuels for transport. Emissions in relation to buildings and transport are considered further in Chapters 7 and 5.

Manufacturing Combustion: Manufacturing combustion involves emissions from the burning of fossil fuels as part of production processes, usually for heat, water and industrial spaces. This includes combustion of fuels for heating, steam generation and powering machinery in industry.

Industrial Processes: Emissions in this area are mainly associated with production processes (such as the chemical reactions that occur during the manufacturing process). Industrial process emissions represent a lower share of Ireland's total emissions than the EU average, as many industrial processes within the chemical sector and metal production common to many other developed countries have never been an important part of the Irish economy.[53] Cement production is a key source of CO_2 emissions within this category.

Fluorinated Gases: Fluorinated gases or F-gases are synthetic greenhouse gases found in a diverse range of products and industrial processes. There is no production of F-gases in Ireland, however these substances (HFCs, PFCs, SF_6 and NF_3) are used in a number of industries.[53]

Waste: The waste sector includes emissions from solid waste disposal sites, which are a source of CH_4. Emissions from this source include both historical unmanaged and managed solid waste disposal sites. This sector also includes treatment of wastewater and sewage, composting of household organic waste, open burning of waste and anaerobic digestion at biogas facilities for recovery of biomass and some waste incineration. All solid waste incineration in Ireland is for electricity production and therefore is accounted for in the Energy Industries inventory category.

8.2 Inventories

The total emissions in each sector between 2014 and 2021 are set out in Table 8.1, with an overview of each individual sector provided below.[53]

Table 8.1 Enterprise and Waste Sector Emissions between 2014-2021 (Source: EPA)

1990-2020 Mt CO_2 eq	2014	2015	2016	2017	2018	2019	2020	2021
Manufacturing Combustion	4.3	4.3	4.4	4.5	4.7	4.6	4.6	4.6
Industrial Processes	1.8	2.0	2.2	2.2	2.3	2.3	2.1	2.5
Waste	1.0	1.0	1.1	1.0	1.0	1.0	1.0	0.9
F-Gases	1.2	1.2	1.3	1.2	0.9	0.9	0.7	0.7
Total (Mt CO_2 equivalent)	8.2	8.5	8.8	8.9	8.9	8.7	8.4	8.7

8.2.1 Manufacturing combustion

Emissions in the manufacturing combustion sector represented 4.59Mt CO_2 eq 2021, accounting for 7.5% of total emissions.[a] They increased by 0.9% (0.04Mt CO_2 eq) in 2021 compared to 2020. Emissions from manufacturing combustion peaked in 2005 and declined during the recession to a minimum in 2011, but have been on an upward trend with minor reductions in 2019 and 2020 as shown in Figure 8.1.

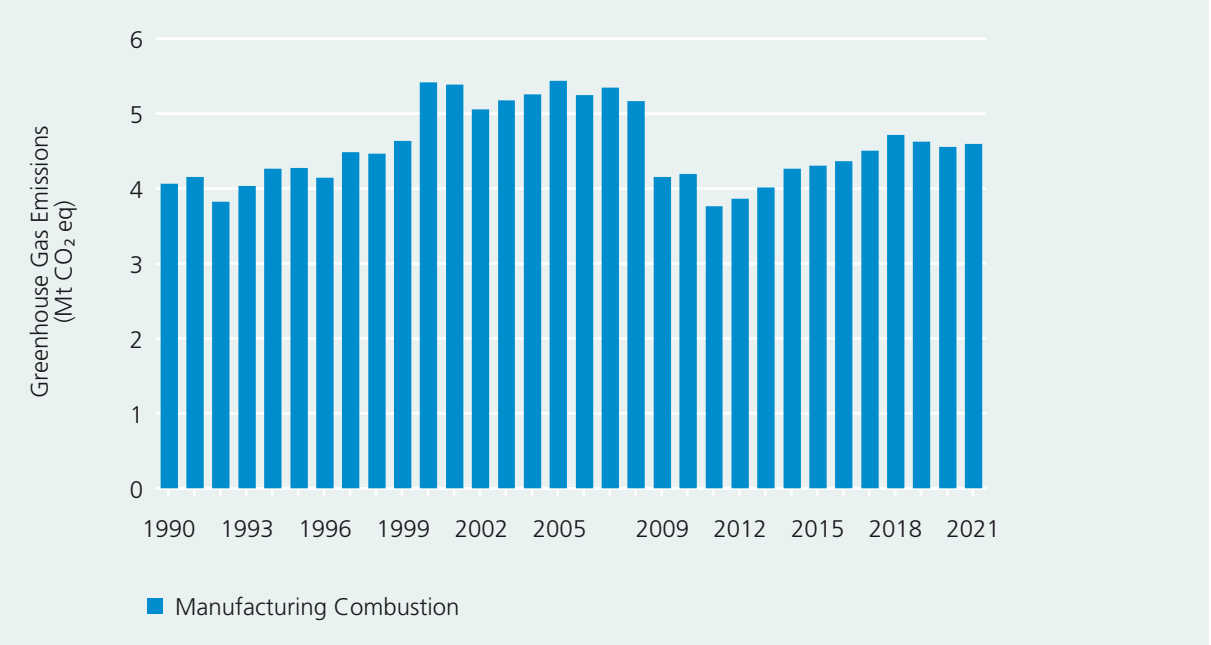


Figure 8.1 Trend in Manufacturing Combustion Emissions 1990-2021 (Source: EPA)

a Slightly higher uncertainty levels are used in the NIR for energy activity data in sub-categories under 1.A.2 Manufacturing Industries and Construction and 1.A.4 Other Sectors, where the end use of fuels is not as well quantified in the top-down methods used.

8.2.2 Industrial processes

Industrial processes accounted for 4% of greenhouse gas emissions in 2021, representing 2.46Mt CO_2 eq.[a] Emissions in the industrial processes sector increased by 16.8% in 2021 following a 7.1% decrease in 2020. The decrease in 2020 was due to a reduction in cement production, with most cement plants having extended closures in 2020 due to Covid-19, shown in Figure 8.2. Emissions increased significantly in 2021 as cement production increased.

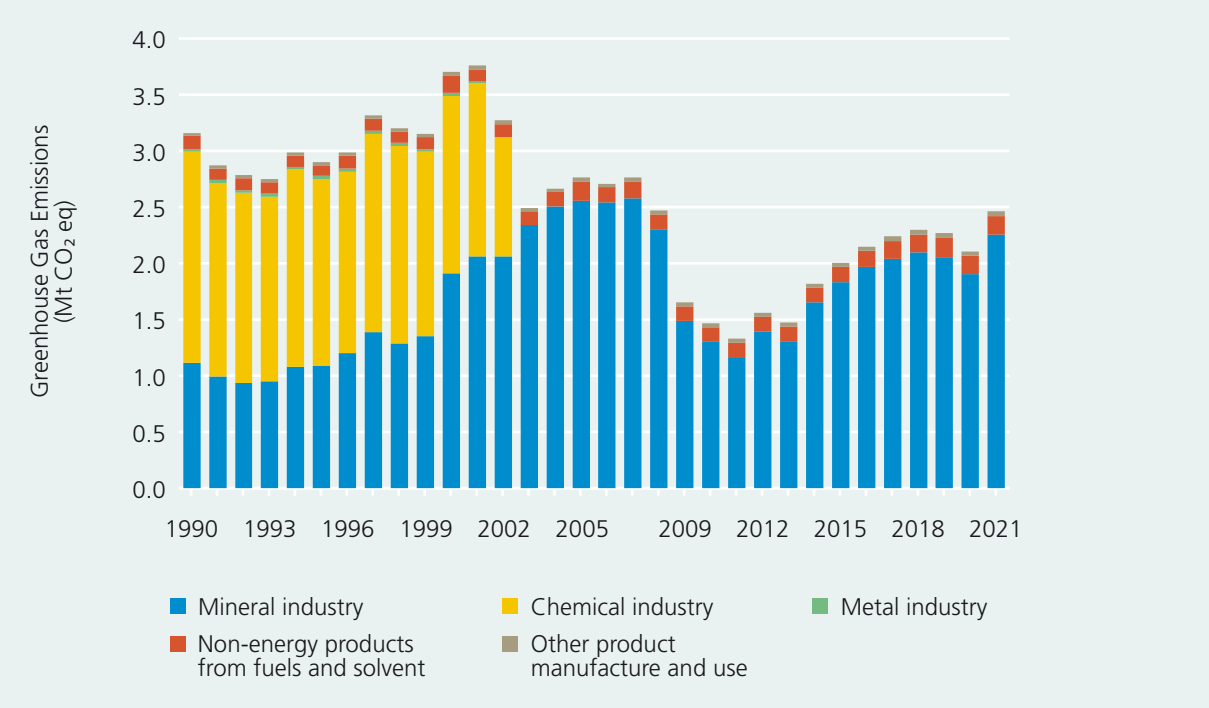


Figure 8.2 Trend in Industrial Process Emissions 1990-2021 (Source: EPA)

8.2.3 Fluorinated gases

Fluorinated gases or F-gases accounted for 1.2% of overall emissions in 2021, representing 0.74Mt CO_2 eq.[b] Combined emissions of HFCs, PFCs, SF_6 and NF_3 have generally increased year-on-year since 1990, reflecting increased use of hydrofluorocarbons or HFCs across a range of applications (e.g. often as replacements in applications where the use of CFC and HCFCs is no longer permitted under the Montreal Protocol).[c] The Kigali Amendment to the Montreal Protocol adds HFCs to the list of controlled substances with a timeline for their gradual reduction. Recent decreases in F-gas emissions have been driven by a reduction in refrigeration and air conditioning emissions through a phasing out of gases with high GWPs under the F-Gas Regulation (EU) No. 517/2014. This is shown in Figure 8.3.

a Low activity data uncertainties are justified in respect of CO_2 emissions sources in 2.A Industrial Processes, for which bottom-up data are applied in most cases and the major sources of emissions are covered by ETS.

b The impact of HFC, PFC, SF6 and NF3 on inventory uncertainty in the year 2020 was negligible (0.56 per cent) because they account for only 1.4 per cent of total emissions.

c The Montreal Protocol on Substances that Deplete the Ozone Layer is the landmark multilateral environmental agreement that regulates the production and consumption of nearly 100 man-made chemicals referred to as ozone depleting substances (ODS). https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol

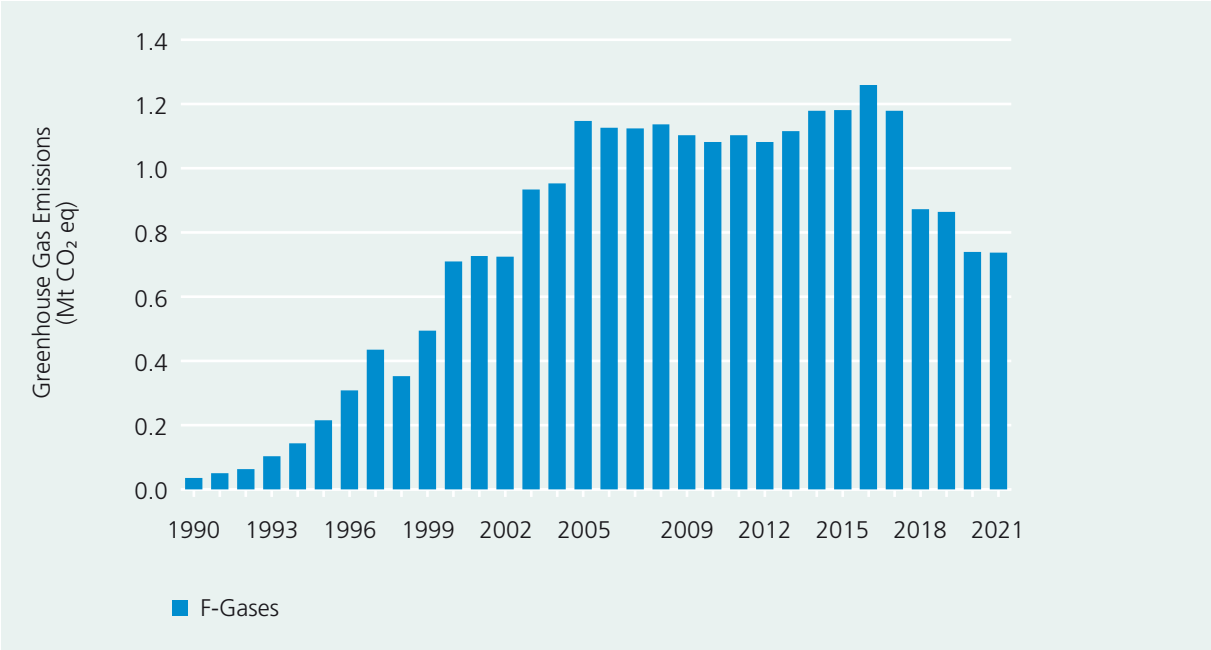


Figure 8.3 Trend in F-Gas Emissions 1990-2021 (Source: EPA)

8.2.4 Waste

Emissions in the waste sector accounted for 1.5% of overall emissions in 2021, representing 0.94 Mt CO_2 eq and decreased by 4.5% in 2021. Emissions from the waste sector are dominated by the methane that arises from organic waste deposited in landfills.

Emissions reductions in this area have been driven by decreased quantities of municipal solid wastes (MSW) disposed of at landfills, which are now are combusted in Waste to Energy (WtE) plants[a] and a decrease in the proportion of organic materials (food and garden waste) in MSW, as well as a diversion of paper products from landfills. Improved management of landfill greenhouse gases has also helped to avoid fugitive emissions. Emissions reductions were also likely a result of policy changes such as the Landfill Directive (Directive 1999/31/EC on the landfill of waste), and license requirements for landfills, which saw a gradual decline in the number of active landfills since the 1990s. The trend in waste emissions between 1990-2021 is shown in Figure 8.4.

a Ireland's first waste to energy municipal solid waste (MSW) incinerator commenced operation in 2011 and its second commenced in 2017 and emissions from these new plants have been reported under public electricity and heat production.

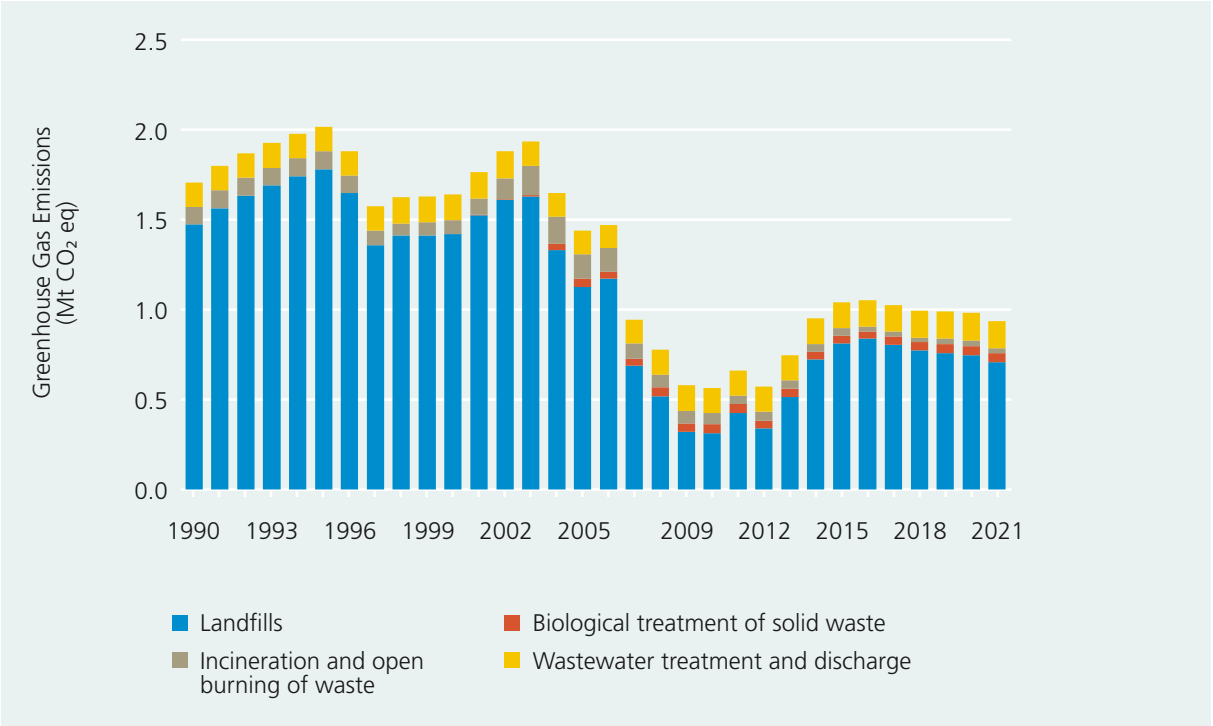


Figure 8.4 Trend in Waste Emissions 1990-2021 (Source: EPA)

8.3 Indicators

NCAP2021 set out a number of measures to reduce Ireland's enterprise emissions by 40%, from 7.9 Mt CO_2 eq in 2018 to ~5 Mt CO_2 eq in 2030. The aim of the indicators in Table 8.2 below is to present an evidenced-based view of progress in the enterprise sector on achievement of the overall transition objective, in addition to the EPA inventories and projections presented in this chapter.

Table 8.2 Indicators of transition in the Enterprise sector between 2014 and 2021 (Source: EPA, CSO, SEAI)

Name	Unit	2014	2015	2016	2017	2018	2019	2020	2021
Sectoral Emissions (from Manufacturing Combustion, Industrial Processes and F-Gases)	*Mt CO_2 equivalent*	7.3	7.5	7.8	7.9	7.9	7.8	7.4	7.8
Emissions relative to 2018	%					100.0%	98.4%	93.8%	98.8%
ETS Emissions (excluding Energy Industries)	*Mt CO_2 equivalent*	5.0	5.2	5.4	5.5	5.6	5.5	5.3	5.7
F-Gas Emissions	*Mt CO_2 equivalent*	1.2	1.2	1.3	1.2	0.9	0.9	0.7	0.7
% electricity in industry energy consumption	%	28%	27%	27%	27%	26%	27%	26%	26%
% renewables in industry energy consumption	%	9%	9%	8%	9%	9%	8%	9%	9%

Name	Unit	2014	2015	2016	2017	2018	2019	2020	2021
Industrial Production Index (Manufacturing Industries)	*Base Year 2015 = 100*		100	104.8	102.2	97.9	104	117.2	139.4
Industrial Production Index (Other non-metallic mineral products)	*Base Year 2015 = 100*		100	109.7	109.2	111.1	122.1	124.5	159.8
CO_2 emissions from Manufacture of other non-metallic mineral products	*Mt CO_2*	2.8	3.1	3.2	3.3	3.5	3.4	3.3	
Air emissions intensity of Manufacture of other non-metallic mineral products	*Kilograms of CO_2 equivalent per euro*	4.36	5.46	4.07	3.94	4.12	3.7	3.93	

In addition to the indicators in Table 8.2, the EPA released its preliminary analysis of greenhouse gas emissions in 2021 for the EU ETS in April 2022. Emissions in the ETS sector from 2005 to 2021, excluding those associated with energy industries, are shown in Figure 8.5.

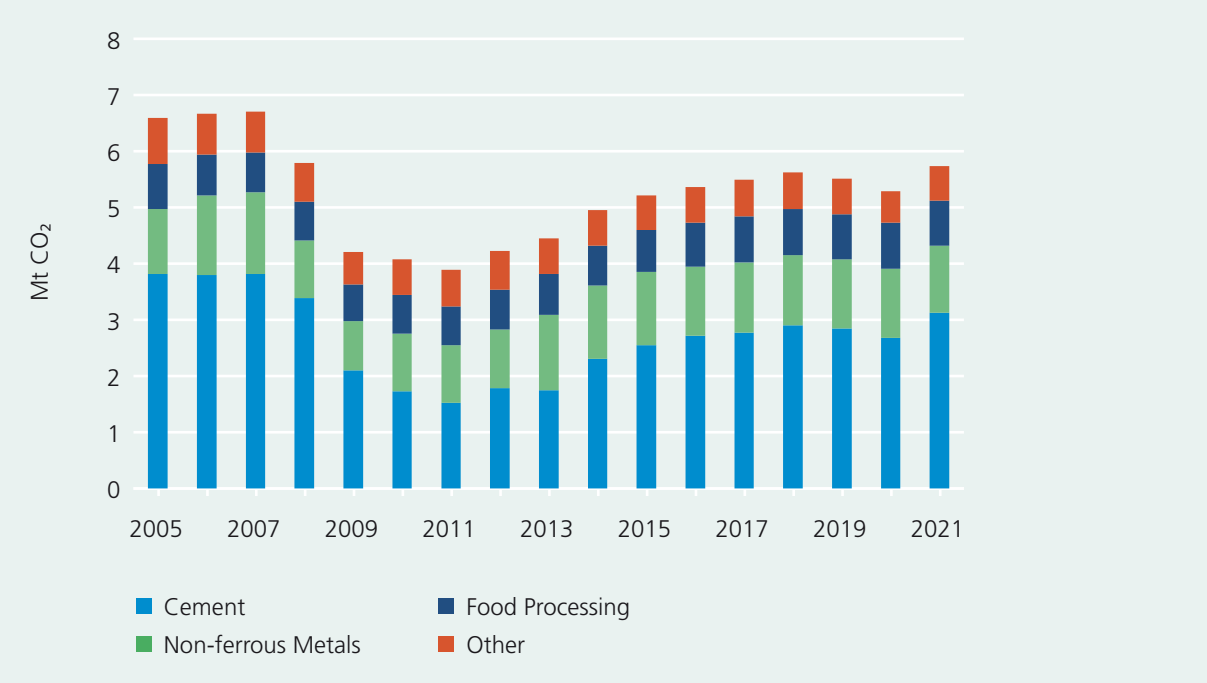


Figure 8.5 Trend in EU ETS Emissions (excluding power generation) 2005-2021 (Source: EPA)

Emissions in this area are correlated with economic activity and in the first three months of 2022, the seasonally adjusted Industrial Production Index for manufacturing industries ranged between 133.6-138 and for non-metallic mineral products between 167.1-168.7.

NCAP2021 includes a target of emissions reduction in the waste sector from 0.91Mt CO_2 eq in 2018 to 0.77Mt CO_2 eq in 2030, but also includes broader targets in relation to the circular economy, bioeconomy and waste, which are reflected in the indicators in Table 8.3.

Table 8.3 Indicators of transition in the waste and circular economy sector (Source: EPA, CSO, Eurostat)

Name	Unit	2014	2015	2016	2017	2018	2019	2020	2021
Sectoral Emissions (from waste)	*Mt CO_2 eq*	0.95	1.04	1.05	1.03	0.99	0.99	0.98	0.94
Emissions relative to 2018						100.0%	99.8%	98.8%	94.3%
Circularity rate (share of material which is recovered in the economy)*	%	2%	1.90%	1.70%	1.70%	1.60%	1.60%	1.80%	
Biodegradable municipal waste to landfill (<427,000 CAP target)	*Tonnes*	276,000	278,000	390,000	307,000	190,000	145,000	104,000	109,000
% Municipal Waste Disposal (10% CAP target)	%	20%	Data gap	26%	23%	14%	15%		
% Recycling of Municipal Waste (65% CAP target)	%	40%	Data gap	41%	40%	38%	37%		
% Recycling of Packaging Waste (70% CAP target)	%	68%	68%	67%	66%	64%	62%		

* The circularity rate is defined as the ratio of the circular use of materials to the overall material use. The overall material use is measured by summing up the aggregate domestic material consumption (DMC) and the circular use of materials. DMC is defined in economy-wide material flow accounts. The circular use of materials is approximated by the amount of waste recycled in domestic recovery plants minus imported waste destined for recovery plus exported waste destined for recovery abroad. See; https://ec.europa.eu/eurostat/web/products-datasets/-/cei_srm030.

8.4 Projections

NCAP2021 aims for a 29-41% reduction in emissions in the Manufacturing Combustion and Industrial Process sectors by 2030 compared to 2018. **However, under the WAM scenario (see box 3.1) only a 12.8% reduction is forecast across both sectors. Further measures will need to be identified in these sectors in order to progress emissions reduction targets.**

While there is no explicit target in the Climate Action Plan associated with F-gases, the EPA's projections indicate that the waste sector will exceed the emissions reduction target in the 2021 Climate Action Plan of a 15.4% reduction with an estimated 16.7% reduction by 2030.[54]

Table 8.4 shows a preliminary analysis of the projected cumulative emissions associated with Industry[a] over the first three carbon budget periods for the sector. The Government has agreed a sectoral emissions reduction target of 35% by 2030 or 4.6Mt CO_2 eq for Industry[b]. WEM and WAM policies and measures are projected to reduce emissions to approximately 6.0Mt CO_2 eq and 6.1Mt CO_2 eq respectively in 2030, which is between 1.5Mt CO_2 eq above the 35% emissions reduction target. It is anticipated that the NCAP2023 will provide more detail on the pathway of emissions reductions and consistency with carbon budgets. **To achieve the sectoral ceiling and remain within the Carbon Budget, further measures and policies will be urgently required.**

a Including Manufacturing Combustion and Industrial Processes

b Including Manufacturing Combustion and Industrial Processes

Table 8.4 Projected Industry cumulative emissions over the carbon budget periods from CB1-2021-2025; CB2-2026-2030; and CB3-2031-2035 (including Manufacturing Combustion and Industrial Processes)

	CB1	CB2	CB3
Industry Total WEM	33.5 Mt CO_2 eq	31.0 Mt CO_2 eq	30.2 Mt CO_2 eq
Industry Total WAM	33.5 Mt CO_2 eq	31.2 Mt CO_2 eq	30.3 Mt CO_2 eq

8.4.1 Manufacturing combustion

Under the WEM scenario, which assumes implementation of the SEAI Large Industry Programme, Accelerated Capital Allowances programme and the Excellence in Energy Efficiency Design (EXEED) programme, emissions from manufacturing combustion are projected to reduce by 19.3% between 2020 and 2030 from 4.5 to 3.7Mt CO_2 eq. Under the WAM scenario emissions are also projected to decrease to 3.7Mt CO_2 based on the assumption of further roll out of energy efficiency programmes (Figure 8.6). The impact of currently planned additional measures is only felt in this sector in the 2030s.

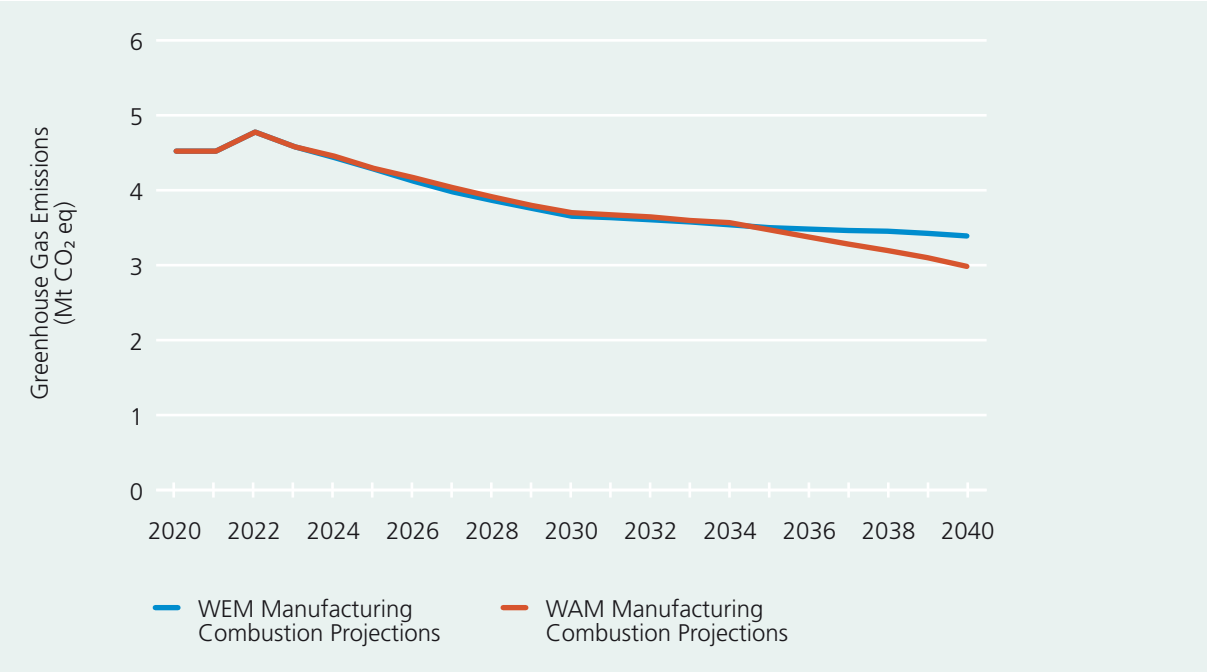


Figure 8.6 Manufacturing Combustion Projected emissions between 2020-2040 (Source: EPA)

8.4.2 Industrial processes

Emissions from Industrial processes are projected to increase by 13% between 2020 and 2030 under the WEM scenario from 2.1 to 2.4Mt CO_2 eq, with no WAM scenario available for the sector. This is based on growth forecasts from the cement industry, with the majority of emissions in the sector coming from the cement and lime industries. **It should be noted that the latest EPA projections do not include measures from the Climate Action Plan aimed at achieving emissions savings from a decrease in embodied carbon in construction materials and emissions reductions associated with Carbon Capture and Storage, as the plans currently lack the level of detail necessary to give confidence.**

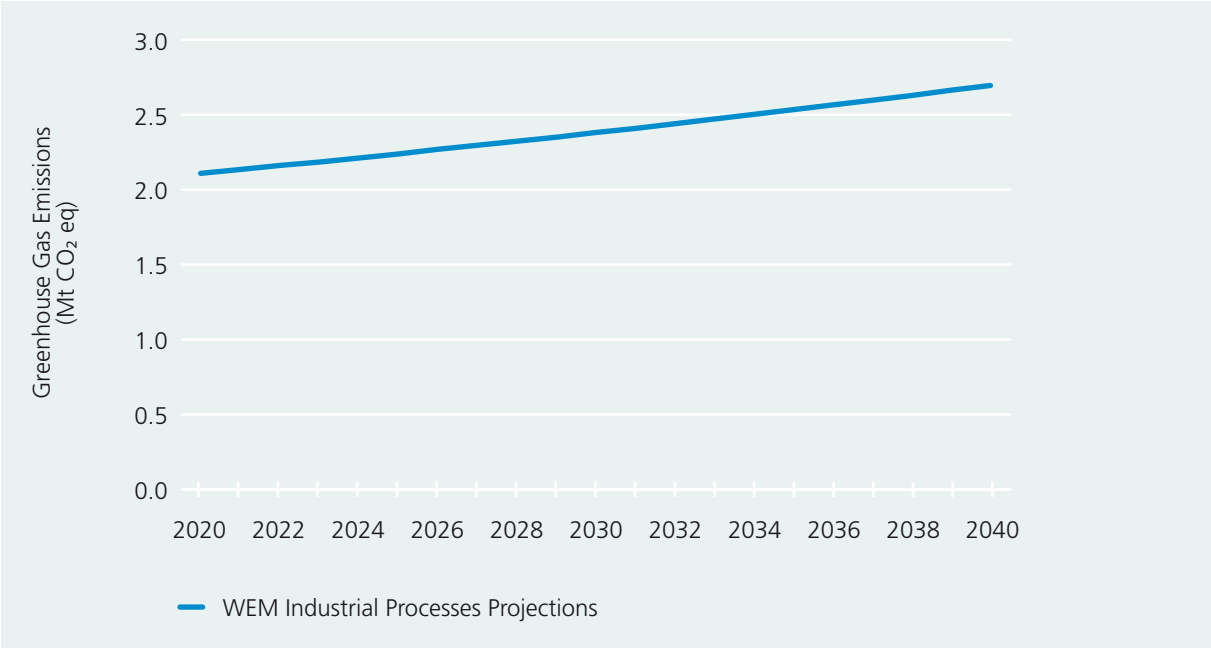


Figure 8.7 Industrial Processes Projected emissions between 2020-2040 (Source: EPA)

8.4.3 Fluorinated gases

F-gases are projected to decrease by 11.5% by 2030 in the WEM scenario (from 0.74 to 0.65Mt CO_2 eq) due to the move away from mobile air-conditioning systems in vehicles that contain F-gases with a high GWP. In comparison, emissions are projected to reduce by only 8.8% by 2030 (from 0.7 to 0.67Mt CO_2 eq) in the WAM scenario, due to a greater uptake of heat pumps in this scenario which contain F-gases. This is coupled with a switch to a lower Global Warming Potential gas (R-32 refrigerant, also known as difluoromethane) in air conditioning units and heat pumps over the projected period (Figure 8.8). Clearly, work is still required to find viable alternatives to F-gases in some applications that will be required to meet emissions reductions in other sectors.

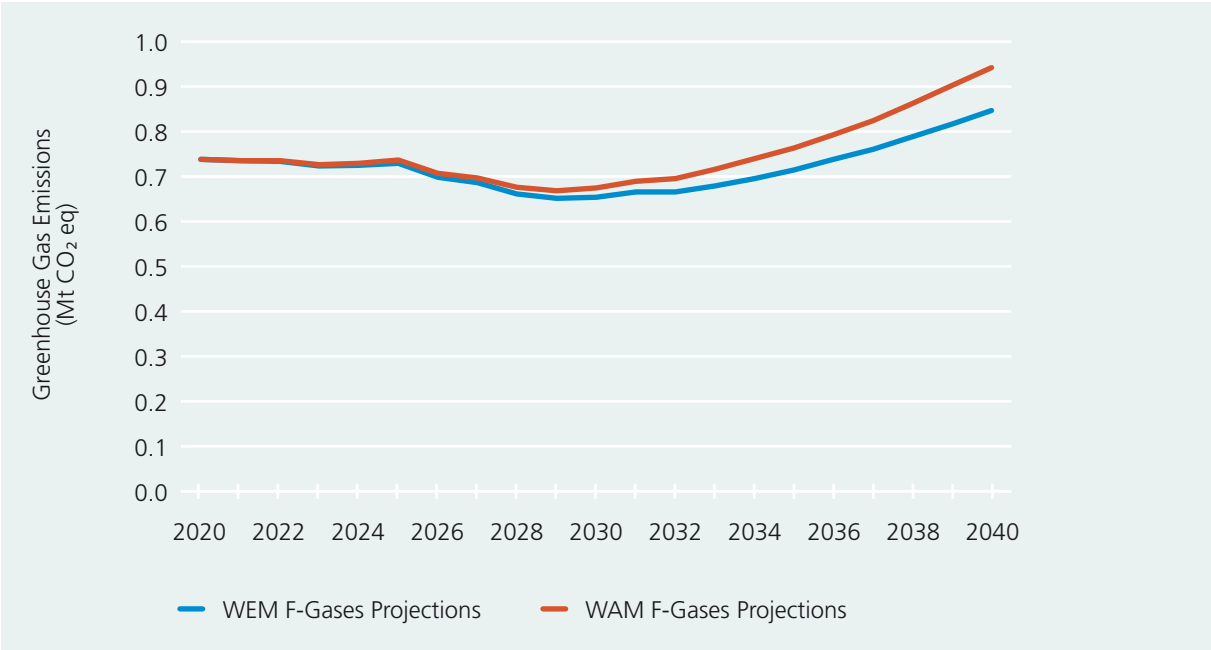


Figure 8.8 F-Gases Projected emissions between 2020-2040 (Source: EPA)

8.4.4 Waste

Waste sector emissions are projected to decrease by 15.7% between 2020 and 2030 to 0.8Mt CO_2 eq. Emissions are primarily attributable to methane emissions from landfill, which reduce over the projected period, and the age of the waste already there. It is assumed that the amount of landfill gas flared and utilised for energy production is 57% in 2020 and decreases to 46% in 2030 (Figure 8.9). No additional measures are currently planned in this sector.

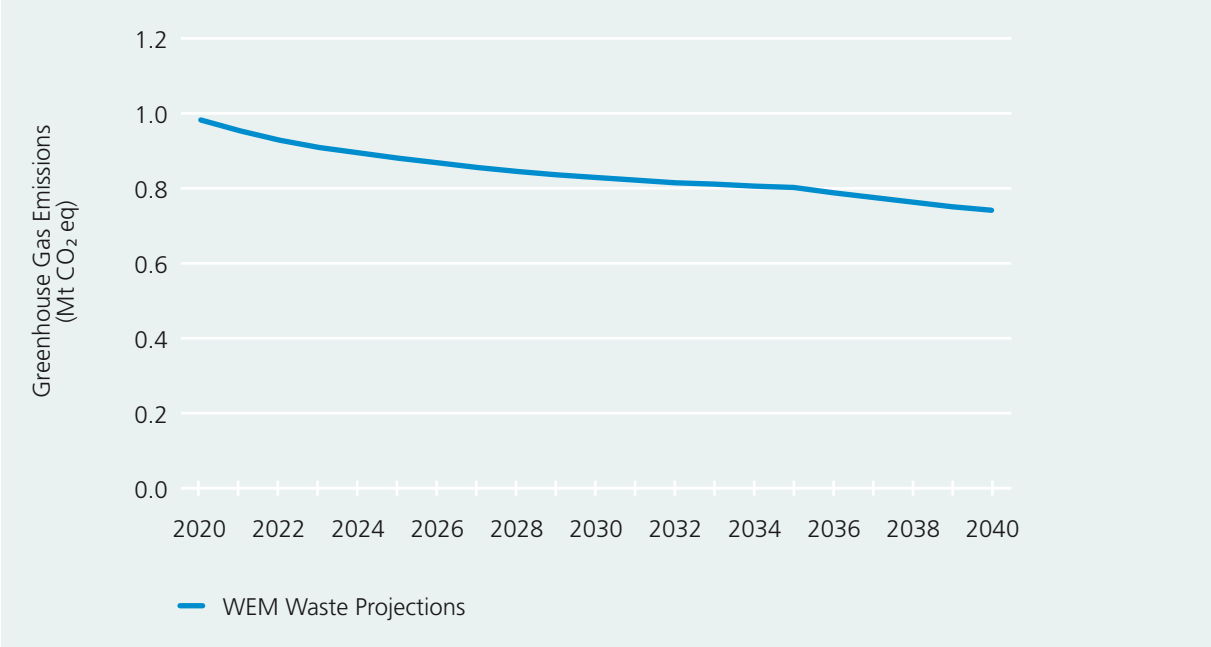


Figure 8.9 Waste Projected emissions between 2020-2040 (Source: EPA)

8.5 Analysis

The sectors considered in this chapter have an important role in supply chain emissions, processing and consumption of final products and waste disposal. The overall enterprise sector also uses a large share of building stock and manages significant transport flows. It will be important to understand the sources and alternatives to emissions in the enterprise sector as Ireland progresses towards climate neutrality.

The 2021 Climate Action Plan identified the need for the enterprise sector to improve the energy efficiency of its processes, buildings and transport and replace fossil fuels with renewables.[38] It also identified the need for improvement in the way resources are used in supply chains to reduce emissions and conform to circular economy principles. Emissions across the sectors in this chapter are highly diverse, with a large proportion arising from Small to Medium-sized Enterprises.

Achievement of sustained emissions reductions will require enterprises to implement significant investment programmes to improve energy efficiency of buildings, processes and transport. Appropriate policies will be required to ensure that the necessary scale of investments are made to deliver the targeted emission reductions across the enterprise sector in Ireland in the immediate term.

A number of measures under the enterprise sector in the Climate Action Plan lack details of a planned implementation pathway or approach to measure progress, notably embodied carbon reduction and Carbon Capture, Utilisation and Storage (CCUS). Immediate action is needed to define the details of planned implementation pathways for these measures and to identify further measures to meet emissions reduction targets in the enterprise sector.

8.5.1 Emissions Trading System

105 major industrial and institutional sites were required to report their emissions for 2021 by 31 March 2022 under the EU Emissions Trading System (ETS). In 2021, greenhouse gas emissions from industrial companies covered by the EU ETS increased by approximately 7%, with cement industry emissions increasing by 17%.[117] Emissions from 'pharmachem' industries also increased by 3%. The variation in ETS emissions demonstrates that sector-specific solutions are required.

The EU Reference Scenario Emissions Trading Scheme carbon prices project a linear increase in the price of carbon from €25 per tonne in 2020 to €30 per tonne in 2030.[168] Due to the recent growth in the ETS price, these projections have been surpassed. In SEAI's latest energy projections, the ETS price is projected to linearly increase from an average price of €45 per tonne in 2021 to €100 euro per tonne by 2030.[a]

8.5.2 National policy & support schemes for businesses

A number of State entities in Ireland are involved in the provision of supports and funding to businesses to support decarbonisation, including DETE, Enterprise Ireland[b], Local Enterprise Offices[c] and SEAI[d]. Additionally, state financing agencies such as ISIF and SBCI are involved in financing initiatives identifying areas of market failure or private financing gaps to deliver climate policy initiatives (ISIF providing equity to climate-related investments in Ireland and SBCI delivering the SME Energy Efficiency Loan Scheme). These initiatives have been identified in the Climate Action Plan 2021 as measures to deliver against targets set out in the enterprise sector.

As part of the National Recovery and Resilience Plan submitted to the European Commission in 2021, reforms and direct funding towards decarbonisation projects in the enterprise sector were included (based on supports for SMEs and exporters to address their emissions and investment in carbon measurement and abatement technologies for manufacturing companies).[169] This includes a €55m fund to incentivise the installation of Energy Metering and Monitoring Control Systems and increase the uptake of carbon neutral low/medium temperature heating in the manufacturing industry. The mechanism to provide funding is via two components, expected to launch in mid-2022[e].

In December 2021, DETE and DECC launched a government website for SMEs to receive an estimate of their carbon footprint with an action plan to reduce it, based on estimates of energy, travel, material and water emissions for the business, calculated on the basis of provision of information in each of these areas (for example, energy, water and waste bills and usage information).[170]

8.5.3 Manufacturing combustion

A significant proportion of emissions in the enterprise sector arise from fossil fuel use in combustion processes and in 2020 this sector was responsible for 7.7% of Ireland's total greenhouse gas emissions.[171] Emissions in this sector are forecast to reduce only slightly to 6.9% of total emissions by 2030.

---

a See SEAI Energy Data Portal: https://www.seai.ie/data-and-insights/seai-statistics/energy-data/

b Enterprise Ireland offers a Climate Action Voucher to client companies to access technical or advisory support in relation to resource efficiency, renewable energy potential and other areas. Other funding supports include the GreenStart and GreenPlus programmes and the Climate Enterprise Action Fund.

c Local Enterprise Offices offer the Green for Micro programme for small businesses, which provides free advice and technical support on resource efficiency, carbon footprints and implementation of an environmental management system. These initiatives, along with the IDA's Go Green Offer, aim to encourage companies to incorporate sustainable practices into their businesses.

d SEAI offers a number of resources and grant supports for small, medium and large businesses, including vouchers for SMEs towards the cost of energy audits and online learning tools. Grants are provided for example for purchase of electric commercial vehicles, for projects following the EXEED Certified standard for Excellence in Energy Efficient Design and for installation of renewable heat.

e The Carbon Reduction Fund, targeting enterprises in the manufacturing sector, focuses on carbon reducing technologies at a plant level with monitoring and tracking systems. The Climate Enterprise Action Fund, which aims to identify emissions abatement opportunities, projects and research and development for early stage decarbonisation. This is administered by Enterprise Ireland with supports for different businesses to identify projects leading to reduced emissions and greater resource efficiency and development of decarbonisation plans.

A study commissioned by DETE in 2019 demonstrated that gas is a predominant fuel in the Food & Drink, Chemicals and Electrical equipment sectors, while oil use is high in the Cement & Lime and Food & Drink Sectors.[172]

SEAI's National Heat Study found that most of industrial heat demand in Ireland could be decarbonised through technology changes or fuel switching.[173] According to the study, over 50% of industrial heat demand in Ireland could be decarbonised via electrification of industrial heating processes. Table 8.5, from SEAI's report, demonstrates the technical potential for low carbon fuels in the Irish industry sector. The study recommended acceleration of competitive options for heat in the commercial and industrial sectors. **The Council recommends that the insights and recommended actions identified in SEAI's National Heat Study are included in the next Climate Action Plan in the Enterprise sector.**

Table 8.5 Technical potential (GWh) for low carbon fuels in the Irish industry sector for each technology type (Source: SEAI)

Technology Type	Biomass	Biomethane	Electricity	Heat Pump (High temper-ature)	Heat Pump (Medium temperature)	Hydrogen	Mixed Fuel	Bio and non-bio waste	Total heat demand (GWh)
Boiler	6,499	4,656	6,499	532	1,031	5,875			6,499
CHP	3,498	3,275				3,390			3,498
Cement/ lime/kiln/ calciner						276 (lime only)	3,079	982	3,079
Furnace		2,025				2,136			2,136
Dryer		338	1,509			1,294		31	1,509
Oven		488	631			538			631
Kiln (other)		20	133			67			133
Heat demand potential served by each fuel	9,997	10,802	8,772	532	1,031	13,524	3,079	1,013	17,486

The IPCC[174] has highlighted electrification as a key decarbonisation option for industry but has also highlighted the lack of research in this area to evaluate feasibility. A study by Madeddu et al. (2020) analysed energy use in 11 industrial sectors across the EU and found that 78% of energy demand in industry is electrifiable with already established technologies.[175]

The IPCC AR6 WGIII summary for policy-makers stated that; *'Net-zero CO_2 emissions from the industrial sector are challenging but possible. Reducing industry emissions will entail coordinated action throughout value chains to promote all mitigation options, including demand management, energy and materials efficiency, circular material flows, as well as abatement technologies and transformational changes in production processes. Progressing towards net zero GHG emissions from industry will be enabled by the adoption of new production processes using low and zero GHG electricity, hydrogen, fuels, and carbon management.'*[146]

Policies aimed at decarbonising industrial heat demand through technology changes or fuel switching need to be tailored to investment-decision timeframes for enterprises. Information

needs to be provided to enterprises on the most appropriate technologies to decarbonise industrial processes, for example, via electrification, hydrogen, biomethane and sustainable biomass fuels.

8.5.4 Industrial processes

For Industrial processes, projection scenarios envisage an increase in activity leading to an increase in emissions, dominated by the cement production industry.

Cement is identified as a 'hard-to-decarbonise' sector due to the significant emissions associated with the cement production process. Research into concretes using constituents outside of current standards needs to be supported, with standards reformed urgently if required.[176]

There are currently four cement production plants in Ireland.[53] According to a recent report by the Green Construction Board, there is significant variation in how concrete is used and specified and it is possible to reduce the carbon intensity of concrete through better specification and construction practices.[176] The report recommends that clear guidance should be provided on how to specify, design and use lower-carbon concrete and its use should be optimised within efficient design processes. The report also states that carbon sequestration and capture should be developed with, not instead of, other carbon-saving approaches, which should be an area of focus within the next Climate Action Plan.

A 2021 report by the Irish Green Building Council noted that the Climate Action Plan proposes reducing the carbon intensity of cement by substitution of fuel, but also noted the greater carbon emissions resulting from the chemical process of converting limestone to clinker.[177] The report recommends that CO_2 emissions associated with the cement production process should be reduced by maximising clinker replacement and investigating alternative technologies, with the use of cement and concrete rationalised in overall building design. The report also noted that there is significant potential to increase the share of timber frame in Ireland's housing stock. The IEA has similarly recommended greater focus on reducing the clinker to cement ratio through blended cements and clinker replacements, as the amount used is directly proportional to the CO_2 emissions generated in cement manufacturing.[178]

In terms of fuel associated with cement production, SEAI's National Heat Study found that as cement and lime kilns require very high temperatures, they require fuels with a high carbon content and typically use coal, coke and heavy fuel oils.[173] The IEA has noted that while it is at a considerably earlier stage of development than CCS, electrification of cement production could also help reduce emissions. Greater uptake of alternative, sustainably sourced fuels should also be facilitated.

In addition to fuel substitution and advanced planning for CCS, CO_2 emissions associated with the cement production process should be reduced by maximising clinker replacement, utilising efficient use of cement in construction or replacement with lower carbon construction materials and investigating alternative technologies.

8.5.5 Carbon Capture, Utilisation and Storage

SEAI's recent study on Carbon Capture, Utilisation and Storage (CCUS) found that CCUS is an important decarbonisation technology option for industrial sectors with process emissions that cannot be entirely abated, such as the cement and lime sectors in Ireland, in the energy from waste sectors and in large-scale power generation.[173]

The study recommended that advanced planning in relation to the role of CCUS and BECCS (Bioenergy with Carbon Capture and Storage) in Ireland is needed, particularly around the clustering of sites and infrastructure in order to support deployment and support CO_2 transport options and storage sites. A range of potential next steps are considered in the report, and it will be important to ensure that an appropriate governance framework is put in place in order to progress this area further. This framework should include consideration of long-term investment by the state through its investment fund to ensure ongoing development of these long-term developmental needs.

As set out in SEAI's Heat study, advanced planning on the role of CCUS as well as BECCS in Ireland is required in order to support its deployment for industrial processes emissions that cannot be abated by low-carbon fuel switching as soon as possible. However, it should also be noted that CCUS doesn't reduce overall heat demand, which will also need to be addressed through efficiencies and clinker replacement.

8.5.6 Fluorinated gases

Avoidance of F-gas emissions will be important for achieving climate objectives due to their high global warming potentials (GWP) and, in many cases, very long atmospheric lifetimes.[179]

The European Commission is currently reviewing the F-Gas Regulation (EU 517/2014)[180] in light of its implementation to date, the European Green Deal, European Climate Law and international obligations. As part of this process, an evaluation of the effectiveness of the current Regulation was carried out by the Commission, which found that it had been mostly effective in meeting its objectives, although there are challenges such as the continued use of some high GWP F-gases in sectors where this could be avoided.[179] The main objectives of the amendments to the Regulation are to raise ambitions in line with the Green Deal, achieve full alignment with the Montreal Protocol and improve implementation and enforcement.

The Climate Action Plan also notes a commitment to bring forward additional measures to reduce F-gas emissions by 80% by 2030 compared to 2014. **It will be important to support the strengthening of the revised provisions under the F-Gas Regulation in order to ensure high GWP gases are further phased out.**

8.5.7 Waste and circular economy

The Climate Action Plan 2021 states that Ireland's success in diverting waste from landfill has been underpinned by increases in the levy for waste disposal to landfill and requirements under the Landfill Directive.

The waste sector is significantly affected by increased rates of material consumption, and data from the EPA demonstrate that while there have been improvements in recycling and composting rates, this has not been enough to offset overall increases in waste generation in Ireland, which consistently fail to decouple from economic growth. Development and implementation of further strategies aimed at waste prevention is required.

The 2021 Climate Action Plan recognises that a shift to a circular economy is required, in addition to absolute reductions in waste sector emissions through the national inventory, noting that Ireland has a circularity rate of 1.6% (the % share of material that is recovered and fed back into the economy) compared to the EU average of 11.9%. A broader focus on the importance of the circular economy and improvement of Ireland's circularity rate is required. The Council welcomes the Circular Economy, Waste Management (Amendment) and Minerals Development (Amendment) Bill 2022, which will provide for the inclusion of targets in respect of re-used and repaired products and materials in waste management plans, along with other measures.

Ireland's Waste Action Plan for a Circular Economy, published in 2020, sets a roadmap for the transition to a circular economy with a number of targets to reduce waste and improve recycling rates and is aligned to the EU Waste Directives.[181] The Whole of Government Circular Economy Strategy 2022-2023 'Living More, Using Less' was published in December 2021 and aims to set a course for all sectors to transition toward circularity.[182] A report published by the EPA in 2021 noted that Ireland needs timely implementation of the policy measures identified in the Waste Action Plan.[183] It found that packaging waste in Ireland increased by 11% in 2019 with an increase in plastic packaging going for incineration with energy recovery – something that has a negative impact on CO_2 emissions. For example, in 2019, the treatment of 129,670 tonnes of plastic at municipal incinerators led to the emission of 350,100 tonnes of CO_2. The EPA issued a number of

recommendations for Government and industry, for example: to strengthen measures to minimise the amount of single use packaging used, identify packaging that can be replaced with reusable alternatives and support increased use of recycled materials in packaging, including the possible introduction of a levy on virgin plastic.

The Council welcomes the European Commission's upcoming early warning assessment related to the 2025 targets for municipal and packaging waste, which will assess Ireland's likelihood of meeting 2023 and 2025 EU waste targets and is due to be published in September.

8.5.8 Biodiversity

Integrating biodiversity considerations within the enterprise sector can take various forms and the Convention on Biological Diversity (2018) outlines several potential approaches: reducing raw material/resource needs by recycling, product eco-design (e.g. shifting to less polluting or harmful components), and industrial ecology circular economy initiatives.[184] Other key approaches/tools include environmental management systems, environmental and social impact assessments, life-cycle impact assessments, and environmental management accounting reporting. The World Business Council for Sustainable Development developed 'Vision 2050: Time to Transform', which maps how systems can transform, lays out a new framework to guide business action in the decade ahead and includes consideration of biodiversity.[185]

Businesses have the potential to help reverse biodiversity loss in several ways, including choosing suppliers and materials that manage biodiversity effectively, and supporting wildlife within the business's landholding. Negative impacts on biodiversity can be reduced and even avoided through early identification and careful planning. In Ireland, the 'Biodiversity Framework for Business' was developed with the support of experts in Trinity College Dublin's Botany Department and the National Biodiversity Data Centre. It functions as a thinking tool for companies to get them started in supporting biodiversity.[186] Natural Capital Ireland is currently developing the 'Business for Biodiversity' website that aims to be a platform for businesses in every sector and size and help to understand their impacts and dependencies on nature, and to take action to mitigate and identify risks for a more nature-positive economy for Ireland.[187]

8.5.9 Just Transition

Just Transition is a key framework to incorporate into enterprise policies as it aims to reduce emissions, while also increasing productivity in a way that retains and improves employment, maximises positive effects for workers and local communities, and allows companies to grasp commercial opportunities of the low-carbon transition.[188] Consideration will also be needed of the profile of Irish enterprise, particularly indigenous SMEs not directly supported by any of the State agency mandates in terms of the impact climate transition will have on their viability.

The green economy (including the retrofitting and renewable energy sector, the circular economy, clean mobility, green and blue infrastructure, sustainable agriculture and the bioeconomy) will create high quality employment opportunities that are expected to be a source of significant employment growth over the coming decades. Both EI and the IDA support clients to expand their sustainability capability and create new roles in sustainable supply chain management, procurement, environmental and energy management, analytics, green finance, and circular economy enablement. The SEAI also offers a range of training and supports around energy management and standards. There is potential for Ireland to build up its green skills capability, but this will require significant upskilling and reskilling investment to update existing jobs-skills profiles.

It is crucial that preparatory work is conducted to identify the potential negative implications of the transition and ensure that support and services are available to those most vulnerable. For example, the manufacturing sector has the biggest share of emissions and must transition to more sustainable practices and/or materials. [37]

9. Reviewing adaptation progress in Ireland

Key messages

Observations

- A review of adaptation progress across 12 sectors in Ireland showed that, across all of them, the most adaptation progress in the past 12 months was seen within risk, prioritisation and adaptive capacity. However, there was an overall lack of detail with regards to risk-monitoring progress.
- Overall, no sector received the highest score in this year's scorecard. However, it should be noted that good progress has been demonstrated by the Flood Risk Management and Local Government sectors. Conversely, it is very disappointing that the Electricity and Gas Networks and Biodiversity sectors were unable to engage fully with the process within the time constraints.
- Governance, coordination, and cross-cutting issues were generally the weakest areas across all sectors. However, high-level evidence of improved systematic coordination and governance structure was provided by most sectors.

Recommendations

- A good example of progress in adaptation governance, coordination, and cross cutting issues has been demonstrated by the Transport sector and should be matched across other key sectors.
- The 2022 Adaptation Scorecard assessment found clear issues with lack of capacity and capability across sectors that need to be addressed:
  - There is clear national ambition for climate adaptation, but it needs to be increased to match the ambition for mitigation.
  - It is imperative that adaptation considerations permeate decision making and inform the policy that will impact Ireland's ability to cope with the long-term future climate.
  - More and better actions need to be identified to manage cross-cutting issues and the associated socio-economic, environmental and biodiversity risks and opportunities across sectors.
  - Resourcing remains a common constraint across many sectors. Sufficient staff need to be provided to ensure consistency, coordination and implementation of adaptation actions. There is some evidence of planned policy changes to facilitate mainstreaming, but these need to be more proactive than reactive.
- Although generally there was evidence that risks were being addressed, the Council recommends implementing a process for prioritisation of risks in policy, resourcing and a process to support enhanced action.

9.1 Chapter introduction

To move towards climate resilient development, Ireland needs to identify actions on adaptation, measure progress on the implementation of adaptation policy and inform the development of future policies. Under the 2015 Climate Act, Ireland's first statutory National Adaptation Framework (NAF) was prepared and published in 2018. This framework mandates 12 priority sectors and local authorities to assess climate change risks, mainstream adaptation considerations into policy and implement resilience actions. An Adaptation Scorecard was adopted in the 2021 Annual Review to measure the progress of sectoral and local adaptation plans against the NAF, and to monitor implementation of the NAF itself.[79]

For 2022, this Adaptation Scorecard has been reviewed and revised, taking into consideration the most relevant metrics for Ireland, allowing progress in implementing adaptation policy and increasing resilience to be measured in 2022 and subsequent years. The scorecard will continue to be the template through which the Council will communicate its assessment and critique of adaptation progress in its annual reviews.

The Climate Change Advisory Council commissioned JBA Consulting to support the Council and its Adaptation Committee in the design, delivery, analysis, and finalisation of the 2022 Adaptation Scorecard. The 2022 revision of the 2021 adaptation scorecard process aims to build upon the progress monitoring currently undertaken to develop a thorough understanding of sectoral progress on climate change adaptation. Engagement with those sectors that did not contribute to the 2021 assessment and addressing any gaps from last year's process was a key focus for the 2022 revision. It is important to note that the 2022

Adaptation Scorecard represents adaptation progress across the various sectors for 2022 only and does not consider adaptation progress in previous years.

The scorecard presented in Table 9.1 below is based on the detailed response to a questionnaire sent out to each sector (available in Appendix A of the JBA Consulting report on the Council website). This questionnaire was built on the 2021 questionnaire and maintained the same three main criteria.

The final assessment was based on the degree to which the Council was satisfied progress had been made with respect to the following three adaptation criteria:

- **Risk, prioritisation and adaptive capacity** – where sectors are identifying, prioritising and monitoring risks, are addressing knowledge gaps and building adaptive capacity.
- **Resourcing and mainstreaming** – where sectors are taking future climate into account in decision making and are ensuring that adaptation is being mainstreamed and appropriately resourced.
- **Governance, coordination and cross-cutting issues** – where sectors are ensuring good coherence with other policies and systemic coordination is in place, both within the sector and across other sectors.

The questionnaire was sent to lead authorities for priority sectors, Local Government and the NAF to provide an update on adaptation progress over the past year. An assessment framework was used to grade responses. This framework was consistent with the approach taken in 2021. Once the questionnaire had been distributed to sectors, an optional opportunity to meet with the assessors was provided for each sector to discuss their response and the scorecard process more generally.

Once scores were allocated for each of the three adaptation criteria, an overall score was determined for each sector. It is important to note that the assessment applies to progress made over the previous 12 months. Actions completed before this timeframe, for which no further progress was noted in 2021-2022, were therefore not considered during the scoring process. The assessment was based on the information provided within the scorecard response and the limited interactions that followed with sectors.

The Biodiversity sector did not provide a response to the questionnaire (and the submission from the Electricity and Gas Networks was received too late for formal inclusion) but both were offered the opportunity to engage through virtual meetings. The Biodiversity sector had a discussion with the assessors to review adaptation progress within the last year. Despite the discussion proving useful in providing an overview of adaptation progress, to ensure consistency across the assessment, a full scorecard assessment for the biodiversity sector was not created based on this discussion. The Electricity and Gas Networks sector did not take up this opportunity. A discussion was also held with the Transport sector.

9.2 Summary of results by sector

Following the detailed review of sector responses against assessment criteria, progress categories were allocated for the three adaptation criteria for each sector, as shown in Table 9.1. An overall score was also determined for each sector, giving a high-level overview of adaptation progress in Ireland for 2022.

Table 9.1 Adaptation scorecard summary

Sector (Departments responsible)	Risk, prioritisation & adaptive capacity	Resourcing & mainstreaming	Governance, coordination & cross cutting issues	Overall progress assessment
Agriculture, Forestry and Seafood *(DAFM)*	**Moderate.**	**Limited.**	**Limited.**	**Limited.** There seems to be a greater level of understanding and action on carbon mitigation than on adaptation. The sectors would benefit from integrating adaptation and mitigation policies, actions, and resources. There are several high-level actions outlined in the CAP. Full advantage should be taken of the opportunity to translate actions in the plan into credible policies that support mainstreaming adaptation.
Biodiversity *(DHLGH)*	**No progress/ insufficient evidence.**	**No progress/ insufficient evidence.**	**No progress/ insufficient evidence.**	**No progress/insufficient evidence.** Last year the Council found that the biodiversity sector had made limited progress, highlighting that a wide range of adaptation challenges face this key, deeply interdependent sector and that further coordinated actions are essential. The absence of a completed consultation template this year means that limited information is available and, considering this, a score of 'No progress/insufficient evidence' has been assigned. This is particularly concerning given the need to integrate adaptation, mitigation and biodiversity action to achieve the National Climate Objective.
Built and Archaeological Heritage *(DHLGH)*	**Good.**	**Moderate.**	**Moderate.**	**Moderate.** Key constraints, including staffing capacity and engagement, are identified and actions are in place to overcome these challenges. There is clear ambition for adaptation, although further development of cross sectoral links and deeper consideration of associated socio-economic and environmental (including biodiversity) risks and opportunities and actions to manage these could enable a more integrated adaptation response to be taken.

Sector (Departments responsible)	Risk, prioritisation & adaptive capacity	Resourcing & mainstreaming	Governance, coordination & cross cutting issues	Overall progress assessment
Transport infrastructure *(DoT)*	**Good.**	**Moderate.**	**Moderate.**	**Moderate.** The sector has built on the engagement with other critical infrastructure sectors outlined last year, but momentum needs to be maintained to ensure adaptive capacity is continuing to increase. There is some concern this could get lost due to the challenges outlined in the response. Enabling strengthened and continued coordination should be the focus of this sector over the next year to ensure adaptation is mainstreamed across all sub-sectors. Future climate change is being incorporated and mainstreamed to some degree, but this could be expanded moving forward. Regular meetings to assess gaps allows for a more constant monitoring of risk but it is essential this is maintained. It is recognised that the availability and use of consistent climate data across sectors and overcoming the issue of confidential assets would aid with addressing and mainstreaming future climate risks, including effective coordination of adaptation policies and their implementation.
Electricity and Gas Networks *(DECC)*	**Late submission.**	**Late submission.**	**Late submission.**	**Late submission.** Last year the Council found that this sector had made limited progress. This is a concern particularly given the potential climate vulnerability arising from the electrification of the power systems, personal transport, heat, etc., as part of decarbonisation (in addition to cascading effects for other sectors). Though actions are underway to enhance the resilience of national distribution infrastructure, the Council had not received sufficient information to show how these were coherent with the priorities of the statutory sectoral plan in place under the NAF at the time of finalisation of this scorecard. Findings arising from the late submission to the scorecard process are discussed below.

Sector (Departments responsible)	Risk, prioritisation & adaptive capacity	Resourcing & mainstreaming	Governance, coordination & cross cutting issues	Overall progress assessment
Communications Networks *(DECC)*	**Moderate.**	**Limited.**	**Limited.**	**Limited.** This sector recognises in its strategy and goals the importance of adaptation (framed as network security and resilience), however there is limited evidence that this has been translated into credible policy decisions. There is limited evidence that long-term decisions are accounting for the future climate or evidence of mainstreaming, systematic coordination, and coherence with other policies. This sector is still at the stage of building capacity and identifying risks and vulnerabilities.
Flood risk management *(OPW)*	**Good.**	**Good.**	**Moderate.**	**Good.** Progress has been made on including and valuing nature-based solutions in catchment management and social benefits in some economic appraisal of Flood Relief Schemes. However, it is likely that this will need to be scaled up to meet future challenges. Also, the current economic appraisal framework does not factor in the net economic benefits of adaptation and the near-term rising cost of raw materials is seen as a barrier to implementation. The policy change to include the damages associated with future flood risk (Sectoral Adaptation Plan [SAP] Action 2D) included in the economic appraisal will help to mainstream the inclusion of adaptation measures as part of the design process. There seems to be a potential opportunity to integrate this approach into the methodology that is currently being developed to include the damages associated with future flood risk in economic appraisals. This sector would benefit from a review of policies that influence long-term decisions to account for future climate damages and to consider wider socioeconomic and environmental (including biodiversity) risks and opportunities and to mainstream these through changes in economic appraisals and other policy amendments.

Sector (Departments responsible)	Risk, prioritisation & adaptive capacity	Resourcing & mainstreaming	Governance, coordination & cross cutting issues	Overall progress assessment
Water Quality and Water Services Infrastructure *(DHLGH)*	**Moderate.**	**Limited.**	**Moderate.**	**Moderate.** Good evidence of awareness of knowledge gaps and associated socio-economic and environmental risks and opportunities is provided. Further development or evidence of leadership buy-in would benefit the sector and is paramount due to the likely intensive impacts of climate change upon this sector and those highly dependent on water resources. Effectively outlining the human and financial resources used to build capacity would benefit tracking how this translates into built capacity. Momentum on building adaptive capacity within the sectors of water quality and water services must be maintained in order to effectively build resilience in such a vulnerable sector. Overall progress of building adaptive capacity is noted as moderate.
Health *(DoH)*	**Limited.**	**Limited.**	**Limited.**	**Limited.** The unprecedented challenge which the COVID-19 pandemic has brought to the health sector since the beginning of 2020 has impacted climate adaptation and resulted in limited progress. Climate change adaptation and action will require great progress within the health sector due to the interconnected nature of climate, health and implications for well-being, and the likelihood for the climate crisis to lead to a health crisis. Ultimately, climate action is also health action. Developing this would also lead to improvements in the consideration of the associated socio-economic and environmental risks and opportunities.

Sector (Departments responsible)	Risk, prioritisation & adaptive capacity	Resourcing & mainstreaming	Governance, coordination & cross cutting issues	Overall progress assessment
Local Government *(Local Authorities, CAROs)*	**Good.**	**Moderate.**	**Good.**	**Good.** Building upon last year's scorecard assessment, the integration of mitigation with adaptation demonstrates good progress. The climate action training programme appears to be successful and should increase mainstreaming in the future. Obtaining sufficient resources appears to be a priority of the CAROs over the near future, which should reduce challenges to implementation. Further detail of how knowledge gaps are being addressed would provide some benefit. This sector would benefit from further consideration and coordination of the associated socio-economic and environmental (including biodiversity) risks and opportunities and actions to manage these. The key challenge remains the resourcing of dedicated staff to ensure consistency, coordination and implementation. The realised desire noted for closer working with national agencies on risk assessments, adaptation policies and tools for use by local authorities is essential to enabling progress on adaptation by the local authorities and national agencies.
National Adaptation Framework *(DECC)*	**Moderate.**	**Moderate.**	**Moderate.**	**Moderate.** There are clear advances towards achieving adaptation actions and addressing knowledge gaps with several ongoing research projects, although there remains a lack of capacity in specific areas such as risk assessment. Increasing provision of financial and staff resourcing for adaptation is evident which should be expanded to all areas and sectors. Continued development, testing and implementation of national adaptation indicators will enable improved monitoring. More work is also needed in standardising risk and adaptation assessments to facilitate prioritisation for adaptation, particularly where there are interdependencies.

The assessment shows that most sectors have demonstrated moderate (four sectors) or limited (three sectors) progress towards adaptation in the past year. Two sectors provided insufficient evidence and therefore demonstrated no progress. Two further sectors showed good progress towards adaptation, but no sectors achieved advanced progress, indicating that there is scope for improvement for every sector in Ireland.

The 'risk, prioritisation and adaptive capacity' category showed the strongest progress overall, with least progress demonstrated within the 'governance, coordination and cross-cutting issues' category.

The Council and the Adaptation Committee welcome the late submission to the scorecard process from Electricity and Gas Networks, but regret that it was submitted several weeks too late for formal inclusion. It will, however, provide critical input to the workshop that the Adaptation Committee will be holding in 2023 on the topic of the resilience of critical infrastructure. The report resulting from this workshop will provide a much more substantive assessment of the sector (amongst others). The submission indicates that good progress within the sector has been made in the areas of 'risk, prioritisation and adaptive capacity', but there has been limited progress within 'resourcing and mainstreaming' and 'governance, coordination and cross-cutting issues'.

9.3 Analysis

9.3.1 Risk, prioritisation and adaptive capacity

Across all sectors, the most progress was seen within risk, prioritisation and adaptive capacity. Actions for addressing knowledge gaps are in place for most sectors, although some research areas remain under-represented, for example further work to standardise risk and adaptation assessments nationally would help to facilitate prioritisation for adaptation. Knowledge sharing between sectors could also be improved. Although research advances are apparent, overall there is a clear need for improved translation and dissemination to ensure research outputs are available to feed into policy. Evidence of effective interfaces between research and end user needs varies between sectors but is generally limited. National upgrades to the Climate Ireland platform show some efforts to increase user access are under way, but further improvement in this area across all sectors has scope to make a significant impact towards increasing adaptive capacity and maximising research value.

The 2022 Adaptation Scorecard assessments found overall limited evidence on how adaptation considerations have permeated decision-making or informed credible policy decisions, which account for the future climate in the long-term. Details around the use of prioritisation were also lacking. Although there was generally evidence that risks were being addressed, implementing a process for prioritisation of risks would enable improved action. Prioritisation of research by the NAF based on user needs and capacities across different sectors should also be considered. The assessment highlighted an overall lack of detail with regard to risk-monitoring processes, although some sectors did provide high level information: for example, the Communications sector uses the e-licensing incident reporting portal for monitoring and building knowledge of risks. National monitoring at the sectoral level is undertaken by the Adaptation Steering Group, but would be better enabled by implementation of a national indicator set.

There is clear national ambition for climate adaptation, but in several sectors there is a greater level of understanding and action on mitigation than on adaptation. For example, within the Agriculture, Forestry and Seafood sectors there are several plans, programmes, and strategies where adaptation is mentioned as an add-on rather than fully integrated or central to the initiatives. The assessment has highlighted that these sectors would benefit from better integrating adaptation and mitigation policies, actions, and resources.

9.3.2 Resourcing and mainstreaming

Resourcing remains a key constraint across many sectors. The COVID-19 pandemic has acted as a barrier for achieving policy goals and has restricted progress, most notably for the Health and Communications sectors. The pulling of resources initially allocated to address the climate crisis towards addressing other crises appears to remain a challenge across all sectors, as well as within Local Government. There is evidence to show clear actions are under way to address this, but sufficient staff to ensure consistency, coordination and implementation of adaptation actions is not currently in place. Examples of positive progress include

additional staff in the Flood Risk Management sector being appointed in the Climate Adapatation and Strategic Assessment (CASA) team, and the Built and Archaeological Heritage sector planning to appoint external support to assist in coordinating, facilitating, and tracking progress of adaptation plan actions. Training programmes have also contributed to improved resourcing, and 13,000 local authority staff received training on adaptation, including flood risk and spatial planning in 2021. The climate action training programme should increase mainstreaming in the future, particularly for the Flood Risk Management sector, but will require scaling up to meet future challenges and a broader scope to enable greater cross-sector integration. Despite training programmes, there is also limited evidence to show how national agencies and local authorities are working closely to enable effective adaptation.

The establishment of four CAROs with a commitment of funding of €10 million from DECC over five years provides evidence of improved financial resourcing for adaptation. Although the CAROs have undertaken engagement and communication actions, there is still the need to further expand resourcing of adaptation with all areas and sectors. Increased funding allocation for adaptation within some sectors was also apparent, for example within the Built and Archaeological Heritage sector there have been significant budget increases awarded and the roll-out of heritage scheme grants for adaptation and resilience actions. Further improvements to financial resourcing could be achieved through increased cross-sector funding arrangements.

The assessment found some evidence of planned policy changes to facilitate mainstreaming, for example, the Flood Risk Management sector includes the damages associated with future flood risk within economic appraisals to mainstream inclusion of adaptation measures as part of design. However, there is still a need for mainstreaming efforts to be broadened and to be more proactive rather than reactive across the board. Individual sectors also demonstrate some action towards mainstreaming. For example, the Department of Transport demonstrates mainstreaming through the development of guidance documents to help with day-to-day activities in integrating climate adaptation.

Sectoral actions could be strengthened through better interactions and more collaborative working with local authorities and other sectors, although some sectoral evidence of coherence with other policies was identified. For example, for the Built and Archaeological Heritage sector, climate change priorities have been embedded into the new cross-government national heritage plan, Heritage Ireland 2030. However, the inclusion of adaptation within policy needs to be scaled up to achieve mainstreaming more broadly.

9.3.3 Governance, coordination and cross-cutting issues

The assessment found that governance, coordination, and cross-cutting issues was the weakest area generally across all sectors, although high-level evidence of improved systematic coordination and governance structures was provided by the majority of sectors, particularly through the establishment of working and steering groups. For example, the Transport sector has re-established the external Transport Adaptation Stakeholders Working Group and Core Adaptation Team to increase coordination capacity. Similarly, the Health sector has established the Climate Change Oversight Group and is planning the establishment of a Climate Change Unit in the Health Service Executive (HSE). However, there was limited evidence to demonstrate tangible progress made by these groups and further work is needed to understand their effectiveness. Alongside this, strengthening leadership buy-in across sectors would help drive adaptation ambition and govern actions. There was a general lack of comment on cross-cutting issues and the associated socio-economic and environmental (including biodiversity) risks and opportunities across sectors and actions to manage these. The assessment also highlighted a need for greater cross-sectoral efforts, particularly with regard to research inputs and knowledge sharing, although there is some evidence that building cross-sectoral adaptation is occurring, such as via the climate action governance structures. For the Transport sector, cross-cutting themes have been considered via the use of cross-divisional working groups known as Horizontal Working Groups and coordination with other departments, bodies and sectors including

tourism, freight, and maritime. Expansion of this multi-sector working approach should be taken forward and applied by other sectors to drive collaborative adaptation action. Closer working between national agencies and local authorities on risk assessments, adaptation policies and tools will also be essential to enable progress on adaptation nationally.

9.3.4 Conclusion

The scorecard exercise has now been carried out for a second time and proves to be a very useful tool for gathering information on adaptation actions. The level of engagement with the tool is generally good but still very fragmented. Despite giving a clear indication that this process would be annual, some sectors were not in a position to respond to the questionnaire this year. This raises questions about the levels of resources available to the key sectors to monitor, develop and improve on adaptation preparedness in their areas. This is a recurring theme of the Annual Review: the need for sufficient resources to be applied in areas where the risks of inaction or delay are very high. More generally, the very small number of areas where progress is good or advanced is worrying. The Council acknowledges the good progress being made at a sectoral level in Flood Risk Management and by Local Government. Considering the criteria, whilst the area of risk prioritisation and adaptive capacity shows some reasonable progress across different sectors, resourcing and mainstreaming, and governance, coordination and cross-cutting issues remain problems. Given the scale of the economic risks facing Ireland, arising from climate change impacts and vulnerabilities deficiencies in these areas, this is an issue that needs to be addressed urgently.

10. The Council and its Adaptation Committee's input to the review of the National Adaptation Framework

This chapter includes the recommendations from the Council's submission to the review process of Ireland's National Adaptation Framework sent to the Minister on 19 July 2022.

Key messages

Observations

- Implementation of sufficient adaptation measures to negate climate-related risks is imperative to ensure the health and well-being of Ireland's citizens, healthy and flourishing ecosystems, and resilient infrastructure and services, upon which we depend.
- Existing vulnerabilities (e.g. to flooding, water shortages or power outages) may be amplified, and new ones (e.g. overheating in our buildings) may arise as climate change evolves.
- If considered in tandem with mitigation and sustainable development efforts, planned adaptation to climate change can present opportunities for innovative, inclusive and transformative climate resilient development. However, while the current National Adaptation Framework, and sectoral and local adaptation plans and strategies, provide a solid foundation, overall, adaptation to date in Ireland has too often been marginal, incremental and process-based, and this is no longer sufficient.

Recommendations

- A revised National Adaptation Framework must therefore provide for further integration with mitigation, sustainable development and disaster risk reduction, all within the context of the National Climate Objective set in the Climate Act. All existing sectoral adaptation plans should then be revised and updated with additional plans required for sectors such as financial services, tourism and sport and the built environment. Coastal resilience also requires much more urgent attention.
- The NAF and plans under it should be informed by a regular national risk assessment, and they should also clearly prioritise actions and investments. Decision makers at Government, department and national level must be better supported in their adaptation planning, so they can take account of the full range of potential changes projected. This includes the provision of adequate financial support for such activities on a sustained basis.
- To be effective adaptation governance structures will also need to be revised and restructured to ensure cross-cutting issues that go across multiple sectors are addressed. More meaningful leadership and coordination across Government on climate adaptation action is required, but all of society has a role in ensuring our climate resilience.
- The Government must also urgently set forth and then monitor a set of national resilience indicators to measure our climate resilience and assess progress towards achieving climate resilient development.
- Finally, it is critical that an initial adaptation budget to 2030 be set, following an assessment of what is required to make Ireland resilient by 2050 and beyond. This budget must be determined in light of the social cost of climate change over at least the next 30 years and must reflect the need to prioritise funding for adaptation to a significantly greater degree than is currently the case.

10.1 Chapter introduction

Our climate is already changing, with evidence of higher temperatures, higher rainfall and rising sea levels, while the ocean is becoming warmer and more acidic. It is imperative that we decarbonise our economy and society to limit climate change through mitigation while taking account of the unavoidable impacts of climate change on Ireland's economy, society and environment through commitment to appropriate adaptation and developing our climate resilience. Building on the assessment of progress in key sectors in the Adaptation Scorecard, this chapter discusses Ireland's progress in adapting to its changing climate by reviewing the 2018 National Adaptation Framework (NAF) and giving advice and recommendations on what future climate policy must do to further our climate resilience.

Under Section 5(1)(b) of the Climate Act the Minister 'shall review a national adaptation framework approved by the Government. not less than once in every period of five years' and 'may, having regard to that review and the requirements of adaptation in relation to the effects of climate change, make and submit to the Government for approval a national adaptation framework'. Action 455 of the Climate Action Plan 2021 relates to the review of the NAF, committing to launching a public consultation on the existing NAF in Q1 2022 and 'Report to Minister results of Review Process' in Q3 2022. This public consultation was delayed to Q2 2022 and was launched on 25 May.

In January 2022 the Council sent a signpost document to the Department of the Environment, Climate and Communications in response to an initial NAF review of a stakeholder consultation document received in December 2021. This signpost document aimed to highlight relevant key advice and recommendations from previous Council's reports and letters. The letter accompanying the signpost document indicated that the Council intends giving further advice and recommendations with respect to the next NAF in its 2022 Annual Review, and these are presented in this chapter (which should be read in conjunction with the signpost document). The Council may also decide to comment on any future public consultation on any draft NAF.[a]

The Council and its Adaptation Committee considers that a revised National Adaptation Framework is required, and this chapter presents 34 recommendations for the next NAF based on the experience of the first round of statutory adaptation plan-making and developments in knowledge.

The stepwise presentation of advice below is in line with the adaptation policy cycle, the advice of previous Annual Reviews and the structure of the Department's public consultation. It builds on, inter alia:

- Ongoing developments in research and science, including the IPCC's Sixth Assessment Report,
- Previous Council advice and recommendations, including the Council's 2019 review of plan making and the adaptation scorecard process,
- The results of Small Scale Studies commissioned by the Council and Adaptation Committee,
- The report of the 2021 Adaptation Committee coastal workshop.

10.2 Priorities for future NAFs and key principles for adaptation

The IPCC's WGII Sixth Assessment Report shows that, given the evidence of observed impacts, projected risks, levels and trends in vulnerability, and adaptation limits, climate resilient development action is more urgent than previously thought. The report showed that climate change poses risks to health and well-being, ecosystems, infrastructure, livelihoods and food, and that as these multiple risks interact, they will generate new sources of vulnerability. However, considered and inclusive adaptation can generate multiple benefits such as productivity, innovation, health and well-being, food security, livelihoods and biodiversity, as well as the reduction of risks and damage. On the other hand, adaptation that is poorly planned, reactive and not mindful of the needs of those affected can result in negative outcomes for individuals and communities.[189],[190]

a Under Section 11(1) of the Climate Act the functions of the Advisory Council 'shall be to advise and make recommendations to' the Minister in relation to the 'preparation of a national adaptation framework'. The Minister is required to publish a public consultation draft before submitting a national adaptation framework to Government for approval. In November 2017 the Advisory Council submitted a letter of advice to the Minister based on the consultation draft of the first statutory NAF to fulfil this section. This followed an August 2016 letter on a pre-consultation on the NAF. Furthermore, within three months of the laying of a NAF before the Oireachtas the Government shall request that identified Ministers prepare a sectoral adaptation plan within a specified period – this period was 18 months for the first round of sectoral adaptation plans (Section 6(1)). A Minister preparing a Sectoral Adaptation Plan shall 'in the preparation of such plan' inter alia consult with the Advisory Council (Section 6(3)). Under Section 11(1) the Advisory Council shall advise and make recommendations to Ministers in relation to 'the making by him or her of a sectoral adaptation plan' and the Government in relation to the approval of a sectoral adaptation plan. The Council did this through letters reviewing draft sectoral adaptation plans in 2019. Under Section 11(1) the Advisory Council shall advise and make recommendations to the Government in relation to the approval of a national adaptation framework or a sectoral adaptation plan. No specific advice to the Government was sought in 2018 or 2019 in this regard.

The core principle of effective adaptation is to shift from incremental and reactive actions towards a transformative and systemic approach.[16] Incremental adaptation does not fundamentally transform the system and can be high-cost, inefficient, and prove insufficient or even maladaptive. For example, in the face of a heatwave, incremental adaptation suggests the installation of cooling systems. A transformative adaptation relies on a systemic approach towards a more resilient and sustainable society. For instance, truly transformative adaptation to heatwaves involves changing thermal and ventilation standards in buildings, adapting spatial planning policies, as well as changing cultural habits (such as working hours, or norms such as typical work attire). Implementing such a framework implies a cross-sectoral, integrated response. The IPCC's WGII Sixth Assessment Report emphasised the necessity of coordinated, inclusive, innovative and accelerated transformative – rather than incremental – adaptation. It makes clear that political commitment and follow-through across all levels of government are necessary to accelerate the implementation of adaptation actions.

However, as the Council emphasised in its 2021 Annual Review, Irish climate policy has to date given inadequate consideration to adaptation issues and the potential for their integration with mitigation solutions, which could alleviate risks and enable effective climate resilient development. The IPCC confirms that monitoring and evaluation of adaptation is critical to track progress and enable effective adaptation. Again, the Government has not set national resilience indicators to measure our climate resilience or progress towards achieving it.

The sectoral adaptation plans and local adaptation strategies, prepared under Ireland's first statutory National Adaptation Framework (2018), provide a foundation for our adaptation planning and climate resilience. Adaptation is a continuous learning and improvement process, and the lessons from the preparation, implementation and evaluation of the NAF and subsequent plans and strategies can ensure Ireland continues to move from adaptation planning and process-based, incremental efforts to more transformative adaptation action.

Incremental, sector-specific responses are no longer sufficient. Ireland, along with the rest of the world, must prepare for the long-term risks of a changing climate by integrating considerations for all interlinked sectors and taking a systemic approach to risk assessment and resulting actions, while also protecting and enhancing biodiversity and ecosystems. Successful adaptation to climate change requires far more meaningful leadership and coordination across Government and its agencies than heretofore, but must also make sure to involve local communities from the outset of the planning process, and to integrate funding, provision of information, and other socio-economic planning supports to involve those communities. A central message for Irish policy makers from the IPCC report must be that reinvigorated action towards climate change adaptation is now critical.

Recommendation 1

A revised National Adaptation Framework is required. The nine guiding principles for adaptation planning in the 2018 NAF should be further developed as follows:

- Firstly, they should reflect the impetus for transformational, rather than incremental adaptation. · Secondly, a tenth guiding principle, just resilience, should be added.
- Thirdly, the 'monitoring progress' principle should be updated to explicitly consider effectiveness and outcomes for those affected.
- Fourthly, the importance of ecosystem-based adaptations should be included as a principle and overall they should reflect the integrated ambition of the National Climate Objective.
- Finally, that the guiding principles be given more attention, so that the next NAF expands on these and that future sectoral and local plans and strategies must demonstrate how they have been taken into account.

Recommendation 2

The next NAF should provide greater clarity for the relationship between mitigation and adaptation, but also their relationship with sustainable development and Disaster Risk Reduction.

10.3 Preparing the ground for adaptation

10.3.1 Approaches to decision-making

Even with scientific advances, uncertainty will remain inherent to the adaptation decision-making process and should be considered by both knowledge providers and decision-makers. This is key given that significant decisions and investments across society, sectors, local, regional and national government must be resilient to uncertain climate impacts. To achieve this requires an adaptive management approach that maximises flexibility and phasing options in response to uncertain climate risks and evolving socio-economic priorities in an open-ended and iterative way.[191]

Recommendation 3

In their adaptation planning all levels of Government should map options, appropriately consider uncertainties, identify trade-offs and trigger points, and develop and apply robust climate resilient development pathways in decision-making under uncertainty to a much greater extent than they have done to date, supported by a revised NAF.

10.3.2 How to maximise/address weaknesses of the sectoral approach

As noted in Chapter 3, the sectoral approach has potential benefits and risks. Both the EU Adaptation Strategy and IPCC WGII report confirm the need for a systemic approach to adaptation and resilience. However, the Council is aware of examples of cross-sectoral incoherence (likely compounded by the shared deadline for completed plans where differing capacities and approval processes caused practical difficulties with limited time to share early drafts, etc.[192]) and where departments are not proactively ensuring the actions and priorities of their adaptation plans, and synergies and complementarities with others are not being considered, implemented and monitored.

The IPCC emphasises the risks to coastal settlements and infrastructure caused by sea-level rise and the cascading impacts of coastal flooding, to which Ireland is particularly vulnerable, and for the long-term risks which Ireland is not planning for to the same extent as some other European countries. Coastal adaptation will be of vital importance to Ireland due to the large (and growing) percentage of the Irish population living on and near the coast, the high cultural and heritage value, and the range of Irish infrastructure vulnerable to sea-level rise, coastal flooding and erosion. The vulnerability of Ireland's many coastal settlements and its coastal infrastructure to storms will be exacerbated both by sea-level rise and the cascading impacts associated with it.[193] Sea-level rise will compromise coastal livelihoods and ecosystems.[16],[194]

Indeed, the OPW's 2019 Flood Risk Management Climate Adaptation Plan shows that the cost of coastal flood damage in Limerick City and Environs for a one in 200-year event would rise from €83 million to over €1 billion under sea-level rise of 1 metre. A total of 1.9 million people in Ireland live within 5km of the coast, representing 40% of the population, while 40,000 people live less than 100m from the coast.

Adapting our coastal areas, including our islands, will require more than coordinating the actions of different sectors.[195],[196] Ireland has no integrated and holistic national coastal management policy. While many other policies have implications for coastal areas, the implementation of climate change adaptation policy affecting coastal areas is not coherent. Furthermore, the principles for coherence advocated in higher-level

policies can become lost in local strategies and plans. It has been found that climate considerations for planning coastal infrastructure in Ireland also prioritise mitigation over adaptation. We require flexibility in our approach to coastal adaptation, so that we may respond effectively to future developments.

Though some topics may not fit neatly into sectoral bounds, with implications for all sectors and all levels of decision-making (e.g. health, biodiversity), this does not diminish the responsibilities of the Minister responsible for the plan for such a sector to consider what actions they can put in place to increase Ireland's climate resilience, while underlining the need for coordination and cross sectoral cooperation in plan implementation and preparation.

Recommendation 4

Coordination, reporting and prioritisation in the preparation and implementation of the sectoral plans and in mainstreaming adaptation measures across all sectors must significantly improve under the next iteration of the NAF.

While there have been both achievements and challenges in the preparation and implementation of the nine sectoral adaptation plans addressing the 12 priority sectors identified in the 2018 NAF, gaps in our sectoral adaptation planning remain.

The role of spatial planning in ensuring development does not occur in inappropriate locations remains essential. There remains substantial scope to further enhance and promote adaptation within the forward-planning process, and it is still not clear how climate risks and action are going to be reflected in development-management decisions, driving, for example, the adoption of appropriate water-management actions such as Sustainable Urban Drainage Systems (SuDS) and wider catchment-based approaches.

The financial sector in Ireland must understand, assess and communicate its climate-related risks in a coordinated way. Climate change will have significant implications for the financial system in areas such as insurance, mortgages and investment funds. The existing adaptation deficit and increasing severity and/or frequency of climate and weather-related events can damage property and infrastructure, impact on agricultural output and lead to loss of life, while also impacting on productivity. These are in addition to the transition risks, including the risk of stranded assets. Other areas which have a significant dependence on weather and climate, such as tourism and sport, also do not have a sectoral adaptation plan.

Recommendation 5

Under the next NAF all existing sectoral adaptation plans should be revised and updated. Utilising the Climate Amendment Act's provision for joint sectoral plans where required, statutory sectoral adaptation plans should also be developed for the following: financial services, tourism and sport, and the built environment. A coastal management plan for Ireland is also required which considers adaptation along with other coastal pressures.

Recommendation 6

The thematic approach (Natural and Cultural Capital, Critical Infrastructure, Water Resource and Flood Risk Management, Public Health) should be retained but expanded. This may be a way to facilitate joint plans and also encourage cooperation on specific cross-cutting issues such as coastal change.

10.3.3 Governance, coordination and coherence issues

When updating or developing sectoral adaptation plans there is a need to balance urgency with cross-sectoral and vertical coherence and coordination.

The chapter on implementation and governance in the 2018 NAF now appears to be largely obsolete. A range of actors and mechanisms presented (e.g. regional adaptation strategies, the Citizens' Assembly, High Level Climate Action Steering Group) either were not fully developed or are no longer in place. It must be ensured that the structures to oversee the development of the next NAF are fit for purpose. The Council's Annual Review 2021 noted the need for a strategy to address any data and knowledge gaps necessary for the preparation and implementation of the next NAF, and it must be ensured this is in place. Given the complexity of implementing adaptation, there is also likely a role for experimental governance approaches.

Recommendation 7

Existing adaptation governance structures should be revised to ensure a revised NAF, and sectoral adaptation plans under it, are developed as quickly as possible while ensuring cross-cutting issues are adequately addressed. This was not the case in the first round of sectoral and local plans and strategies. Similarly, how adaptation is considered in national climate governance structures is not sufficient. Existing structures should be more effectively leveraged rather than setting up new ones to try to ensure adaptation is adequately considered across wider policy.

Recommendation 8

A statement is required at the beginning of the next NAF and sectoral adaptation plans demonstrating how the Climate Act, NAF and its guiding principles for adaptation, advice, and guidelines (as appropriate) have been considered.

Recommendation 9

More meaningful leadership and coordination across Government on climate adaptation action is required. Instigation of focal points for adaptation in each public body working together could help to address this.

10.3.4 Role of adaptation in national policy

The IPCC's WGII Sixth Assessment report makes clear that political commitment and follow-through across all levels of government are necessary to accelerate the implementation of adaptation actions. However, as the Council emphasised in its 2021 Annual Review, Irish climate policy has not placed a sufficient emphasis on adaptation and has shown inadequate consideration of adaptation issues and limited integration and recognition of the potential for win-win solutions. So far, adaptation has been fragmented and dominated by incremental, sector-specific responses.

The Council has not seen evidence of the development of a distinct vision for adaptation in climate action policy. A strategic vision for adaptation/resilience in sectors has not been present. This is despite the IPCC highlighting that there is a 'rapidly narrowing window of opportunity to enable climate resilient development'.[16]

Recommendation 10

A distinct vision of Ireland's climate resilience, expanding on that in the current NAF, and the resourcing needs for its achievement are required, alongside a better understanding of the societal and economic implications of not addressing current and future vulnerabilities.

Recommendation 11

The discussion of how adaptation planning integrates with Project Ireland 2040 and also the delivery of the Sustainable Development Goals must be significantly more developed in the next iteration of the NAF.

10.3.5 Identifying key research priorities/knowledge gaps that should be addressed

Access to relevant and usable data and research remains an issue, but it cannot be a barrier to 'no regrets' adaptation action. It is also a concern that, despite considerable research investment, adaptation skill sets and capacities are still seen as being in short supply. The Council's Annual Review 2021 noted the need for a strategy to address any data and knowledge gaps necessary for the preparation and implementation of the next NAF, but it is not clear if this is in place.

To ensure that the full range of possible outcomes are accounted for, it will be critical that adaptation decisions are made in the light of the full range of potential future climate outcomes projected by the full multi-model ensemble and socio-economic projections, including a comprehensive accounting for both scenario and model uncertainty. It is key that practitioners get relevant training in how to use and account for such uncertainties and that the Climate Ireland platform be evolved to include the full range of possible projected outcomes arising from the CMIP and CORDEX ensembles and guidance on how to use these to inform risk assessments and resulting decisions and their implementation. The TRANSLATE project offers the potential for improved tools in this regard for users. It is important to provide understanding of, and provide guidance on, the full range of scenarios available. and how different projections and scenarios should be used to enhance the robustness of decision-making in different decision contexts. Robustness and resilience of the decisions we make will be contingent on the diversity of the information we use to make those decisions.

The Council notes that delivery of the Climate Ireland information platform is within the remit of the EPA as of 2021, with an external technical advisory group in place to support its work, and that work is underway to redevelop the platform to meet current and future user needs.

Recommendation 12

In the 2018 NAF, significant space was given to outlining climate observations and projections for Ireland. Given the rapid developments in climate and adaptation science, it is recommended that in the next NAF a shorter section be provided to give policy makers and the public the necessary context while directing them to platforms – such as Climate Ireland – databases and supports where they can access up-to-date information in an interactive way. Decision-makers must be supported to get on with the business of adaptation within their area of policy expertise by being provided with knowledge, information and data suitable for their needs.

Recommendation 13

For the next NAF, and in keeping with the Met Éireann TRANSLATE project, a set of climate change storylines for Ireland, including low likelihood, high-impact scenarios (High++), with cross-sector relevance should be developed for testing adaptation actions and communicating key risks to diverse audiences.

Recommendation 14

It is important to note that projections of future climate are not perfect and are subject to varying levels of uncertainty. Use of high resolution modelling needs to be accompanied by sufficient levels of expert guidance, advice and interpretation to ensure due regard is given to such uncertainties, which are evident in the range of all models available. Decisions should consider the potential for warming of 2°C and beyond, taking account of the need for resilience to the full range of potential changes projected.

Recommendation 15

Climate research must more closely consider the requirements of decision makers, with long-term planning and capacity building needed to deliver the necessary knowledge and innovations regarding adaptation and resilience. In addition to TRANSLATE there is also a need for continued, long-term coordinated efforts at a national level on the interface between science and policy and aligning outputs to end-user needs, particularly in light of the differing capacities and resources available to sectors and local authorities.

10.3.6 Priorities from the European Adaptation Strategy

'Forging a climate-resilient Europe – The new EU Strategy on Adaptation to Climate Change', published in February 2021, will shape the next iteration of the NAF, and the action to 'stimulate cooperation regionally and across borders and enhance the guidelines on national adaptation strategies in cooperation with the Member States' will have implications for how adaptation on an all-island basis is considered. How the strategy's focus on more and better climate-related risk and losses of data to avoid 'climate blind' decisions and policies, and dialogue with insurers is applied in Ireland will be key. Also, how the Commission's ambitions for nature-based adaptation interact with the 'biodiversity rich' and 'environmentally sustainable' components of the National Climate Objective set out under the amended climate legislation should be clear in the next NAF. Furthermore, the relationship between sectors, the CAROs and the Covenant of Mayors should be explicit in the NAF, reflecting the European Strategy's focus on local adaptation.

Recommendation 16

The EU Adaptation Strategy will likely significantly inform the next NAF and while our policies must align with it, given the context-specific nature of adaptation a 'wait and see' approach is not necessarily appropriate for long-standing priorities which require urgent progress. Ireland should continue to learn from the adaptation experiences of other countries, including in the developing world, particularly in the areas of locally led adaptation, coastal adaptation, innovation, monitoring and evaluation, and climate and gender justice in adaptation.

10.3.7 Lessons from other jurisdictions and from Ireland's adaptation finance

Other countries have adopted an approach similar to that followed in Ireland. For instance, France's adaptation plans are developed separately by the different ministries, and thus organised by sector. However, there the assessment of climate risks varies across ministries, making the identification of adaptation options unequal across sectors. Furthermore, the methods used for cost-benefit assessments differ across sectors. Thus, France's High Council for Climate Change also recommends the development of an integrated approach, which can identify synergies and conflicts across sectors and systematically integrate adaptation to climate change into policies at national and territorial level.[197] Sweden also has disaggregated its adaptation plan at the sectoral level, and the Ministry of the Environment and Energy coordinates the work on adaptation. However, the plan as of 2018, and currently in revision, lacks local implementation. Recent legislative changes, which require municipalities to take further actions on adaptation, should allow greater responsibilities and detailed planning to implement adaptation locally. In addition to a national adaptation plan coordinated by the Ministry of Agriculture and Forestry, Finland has developed decentralised adaptation plans, where, at a local level, most municipalities have adopted a climate strategy concerning both mitigation and adaptation. Adaptation options are usually selected using expert judgement and participatory processes. The relevant ministries are then responsible for providing funding to increase climate resilience in their administrative branches.

Through a more systemic approach, the UK builds an adaptation plan with clear objectives to reduce risks (exposure and vulnerability), with specific actions, as well as a monitoring plan to link the actions and the outcomes.[198] The Netherlands have adopted an integrated approach, by gathering several institutional bodies and stakeholders to build an adaptation programme concerning some key impacts. This ongoing programme, titled Delta, is structured around flood risk management (e.g. improving dykes, maintaining

the coast through sand replenishment, and more room for rivers), freshwater supply (e.g. securing a sufficient supply of fresh water) and spatial adaptation (e.g. redesigning the Netherlands to cope with natural extremes). This programme involves regional water authorities, local authorities, stakeholders such as industries and transport infrastructure institutions.[199]

The IPCC finds that though adaptation is happening across Europe, it is not implemented at the scale, depth and speed needed to avoid the risks, with forward-looking adaptation planning required to avoid path-dependencies, maladaptation, and ensure timely action. Systemic barriers to adaptation include limited resources, lack of private sector and citizens engagement, insufficient mobilisation of finance, lack of political leadership, and a low sense of urgency. Adaptation policy must avoid creating competition and trade-offs between limited water and land resources and also with mitigation options and socioeconomic development, but examples of transformative adaptation often remain policy experiments and prove challenging to upscale. Human and knowledge resources are also central to successful, proactive adaptation, but institutional and behavioural lock-in that prevents systemic change and hampers the transition to climate resilience must be addressed. Closing the adaptation gap requires moving beyond short-term planning and ensuring timely and adequate implementation.[16] Systemic and cascading risks are often recognised in policy, but most conventional risk assessment methods that inform adaptation planning are ill-equipped to deal with these effects.[200]

Adaptation and adaptation finance were given significant attention at COP26 in Glasgow, as were the limits to adaptation and the topic of Loss and Damage. Eighty countries submitted either Adaptation Communications or National Adaptation Plans by the time COP26 began, and a global commitment was made to double climate finance by 2025. The Adaptation Research Alliance (ARA) was formally launched, and, by committing €5 million, Ireland was one of the first funders of the Santiago Network on Loss and Damage, which was formally established at COP26. Significant financial contributions, far surpassing previous collective mobilisations, were pledged to a number of other causes, including the UNFCCC Adaptation Fund, the Least Developed Countries Fund, the Least Developed Countries Initiative for Effective Adaptation and Resilience, and the Champions Group on Adaptation Finance.

The majority of Ireland's climate finance to the developing world goes towards adaptation,[201] which suggests the potential for Ireland to learn from the projects that it finances. Research into internationally funded adaptation interventions shows that many such projects end up inadvertently reinforcing, redistributing or creating new sources of vulnerability through a variety of mechanisms, and that the most foolproof way of avoiding such maladaptation is for adaptation practitioners to engage more meaningfully with the local populations the interventions are designed to help, so as to harness their expertise and understanding of the specific environmental and political context being dealt with[202],[203]. Irish adaptation policy may therefore learn important lessons from these projects in the fields of locally led and context-specific adaptation, but it may also have lessons to learn in the areas of coastal adaptation, innovative adaptation, monitoring and evaluation, and climate and gender justice.

10.3.8 Identifying vulnerable people and places, just resilience and participative adaptation

The impacts of climate change will not be equally distributed, neither geographically nor socially. How people are affected by climate change impacts, and what ability they have to deal with those impacts, is largely dependent on their social and economic situation.[204] The EU Green Deal and the revised EU Adaptation Strategy both highlight the importance of achieving resilience in a just and fair way in order for adaptation benefits to be shared equitably. The EU Adaptation Strategy also elaborates the concept of 'just resilience', which highlights the need for greater awareness of social vulnerability to climate change, and the conditions which prevent members of society from benefiting from adaptation measures to the same extent as others (such as being priced out of a housing area due to the gentrification caused by the implementation of green, attractive Nature-based Adaptation).

In a further example, low-income groups are less likely to have adequate home insurance, or renters may have less influence on timely building repairs. Therefore, households with different characteristics living in the same area and in similar dwellings may have different levels of exposure and variable capacity to act. The role of mapping socioeconomic vulnerability will be essential here. Critical in evaluating the potential impacts and exposure to risk is to understand social vulnerability related to individual and household characteristics, including income, age, social networks, physical ability, etc. These same characteristics also impact an individual or household's capacity to adapt.[205] The UK's Climate Change Committee have also recently published a report highlighting the implications of a Just Transition for climate change adaptation.[206]

Transposing the concept of just resilience to an Irish context, effective adaptation policy must not only target regions and sectors with high risks of climate impacts, but must also prioritise households and sectors with low resilience to impacts. Societally and economically, vulnerable households lack the capacity to absorb climate change impacts. Furthermore, households will also face unequal challenges in the face of a transition to a net zero economy. There are likely to be interconnections between economic, climate and transition impacts resulting in households and sectors facing immense difficulties in overcoming the multitude of these impacts.

Frameworks to understand these impacts in the Irish context, to identify vulnerable populations, and to inform policy decisions are scarce. In March 2022, Dublin City University researchers published a report outlining the barriers to poorer and vulnerable communities being involved in decisions regarding the environment and climate change in Ireland, and the need for greater resourcing of community engagement and access to environmental justice.[207] The report also highlights the fact that no national study has ever been conducted in Ireland correlating data on environmental quality with spatial representation of disadvantage and marginalisation, and that this lack of information is a significant inhibitor of our understanding regarding the overlap between environmental impacts and social inequalities.

An ESRI research project funded by the EPA will further study the vulnerabilities of Irish households arising from their economic standing and the low carbon transition and how they interconnect with climate impacts.[208] Using spatial microsimulation modelling, it aims at identifying regions and socio-economic groups most at risk to climate impacts, and in particular to fluvial and coastal flooding. This will be done by matching spatially referenced measures of multidimensional deprivation data with flood maps. Then, applying a macroeconomic model (I3E) representative of the functioning of the Irish economy and its low-carbon transition, the project will consider sectors most at risk of being climate affected and what policy measures may be required for those working in vulnerable sectors to achieve just resilience. Specifically, Nature-based Solutions can be a source of resilience and wellbeing. The project will review and assess their potential by simulating the effects of adaptation interventions.

Recommendation 17

Socioeconomic vulnerability and just resilience have not been adequately considered in national, sectoral and local policy to date and must be a key focus of future national adaptation policy and planning.

A key message, stressed in the IPCC WGII Sixth Assessment Report, but also across international adaptation research, is the importance of local participation during adaptation planning and implementation. Adaptation aligned with local knowledge and cultural values proves far more effective, while maladaptation often arises from implementation of adaptation measures without local buy-in. Inclusive governance and co-production of knowledge are required in order to reduce vulnerabilities and climate risks through policies and interventions designed to address context-specific inequities such as disability, ethnicity, gender, age, income and location[16],[209]. Such approaches would ensure meaningful participation of the most vulnerable groups, and provide them with access to the resources they need to adapt, which is something being

called for by Irish coastal communities experiencing coastal change, such as the Maharees Conservation Association, which calls for deeper integration of funding and other socio-economic planning provisions between Government and coastal communities to support them. It has also been argued that such funding should allow space for creativity, such that the adaptation actions taken should be prescribed by stakeholders on the ground.[209]

Recommendation 18

Lessons from local action and the importance of participative adaptation planning and action should underpin the next NAF to a far greater extent than the previous NAF.

Recommendation 19

Research into spatial socioeconomic vulnerability to climate change in an Irish context must be considered in future adaptation policy development and planning from the outset. Such research should include an investigation into the variability of risk perception and behavioural responses to vulnerabilities. Greater use of public consultations during the process of developing adaptation strategies, greater collaboration between adaptation policy decision-makers and social policy decision-makers, in order to visualise the full breadth of climate-social feedback loops and achieve just resilience are needed. These should also continue efforts towards achieving gender equality, and to address gender mainstreaming within adaptation.

10.4 Assessing climate change risks and vulnerabilities

Recommendation 20

In the preparation and communication of adaptation planning, clarity should be provided on the assessment of risk, exposure, vulnerability, resilience and adaptive capacity, and the decision-making framework under which options are considered. This should include criteria for prioritisation, implementation, monitoring and evaluation. These would bring forward consideration of the types of options to develop and the need for a robust and credible portfolio of measures.

Recommendation 21

A regular national climate risk assessment by the Government, which considers cross sectoral risks, should inform future National Adaptation Frameworks and any plans and strategies prepared under them.

10.4.1 Socioeconomic dimensions/non-climate pressures and avoiding maladaptation

As discussed in the IPCC AR6 WGII report, avoiding maladaptation must be a key concern of policy. Maladaptation can arise when just considering climate change not socioeconomic factors and vulnerability and not taking a systemic perspective when considering risks and required responses. Maladaptation can be infrastructural, institutional or behavioural and it can shift vulnerability, 'rebound' vulnerability (increasing current or future vulnerability) or erode sustainable development through increasing emissions for example or having impacts for biodiversity, water and catchment resilience. Avoiding it requires a strong understanding of what drives vulnerability to climate change.[210]

Recommendation 22

It is important when undertaking a risk assessment and identifying and implementing adaptation actions to also consider pressures in addition to climate change (e.g. demographic, societal change stressors such as urbanisation, as well as environmental legislative frameworks such as the Water Framework Directive) and how climate change compares and relates to these pressures both positively and negatively.

Recommendation 23

It is important that adaptation actions and planning do not happen in a vacuum and that other pressures are also taken into account, recognising that climate action can be synergistic or complementary but also conflicting. This may be useful in the identification of adaptation options whereby 'win-win' measures can be pursued.

10.4.2 Transboundary issues

Climate change impacts are nationally and internationally interconnected through the integration of markets. Geographically distant regions and different economic sectors interact on international markets for goods or resources. Also, economic integration within global value chains potentially makes separated regions or sectors vulnerable to outside risks, such as the price shocks resulting from the Ukraine crisis. This will even be more the case as biophysical impacts of climate change intensify.[16] Simply put, climate change will impact various sectors, changing prices across both the Irish and global economy, these price changes will also impact production costs of seemingly climate resilient sectors.

Some evidence underlines that these market interdependencies can play a buffering role in climate risks.[211],[212] Indeed, economic integration can facilitate the substitution between different products, or streamline the reallocation of inputs from one sector to another. In other words, if an input becomes unavailable due to climate change, other inputs can be sourced from the market, or if jobs become vulnerable in a sector due to climate change impacts, economic integration can facilitate a transition of that labour and its expertise to another sector. However, this buffering capacity needs to be weighed against the associated adjustment and transition costs. Furthermore, the capacity of the market to buffer impacts will depend on their available resource capacity, which in turn will be affected by the costs to economic sectors of the transition to a low carbon economy. There will be a need for resources to both adapt to climate change and to mitigate emissions, and they will need to compete for sectors' resource availability. Specific macroeconomic tools for assessing the impacts of climate change can account for these interdependencies within the economy but often ignore or minimise the adjustment and transaction costs.

The EPA-funded Transboundary Climate Risks for Island of Ireland (TCRII) project is taking a risk-based approach to explore the key cross-border, trans-boundary and international impacts of climate change for the Island of Ireland. It will consider how trans-boundary climate risks can flow through shared ecosystems and resources (through biophysical connections), trade links (through the flow of goods and services, such as commodities like wheat, rice or coffee), financial interdependencies (such as the flow of capital and other assets), and people (through migration or forced displacement).[213] These risks can be managed through a variety of management responses that can be categorised into three main approaches: (1) management at source; (2) management along the risk pathway; and (3) management at point of impact.[214],[213],[215],[216] In practice, the best way to manage trans-boundary climate risks is through a combination of all three approaches. The project is identifying trans boundary synergies that can be developed in terms of information and policy solutions to build the resilience of mutually significant sectors that face similar challenges and opportunities.[217]

10.5 Identifying and assessing adaptation options

10.5.1 Financial and economic considerations

Recent European Environment Agency (EEA) research has shown that total economic losses from climate and weather-related events across the 32 EEA member countries between 1980 and 2020 amounted to the equivalent of €450-520 billion today, and that only one quarter to a third of these losses were insured. The same research also estimated that climate and weather-related fatalities during the same period amounted to between 85,000 and 145,000 deaths. For Ireland, the economic losses were estimated to be between €2,968,000,000 and €4,600,000,000, with between 62 and 71 fatalities caused by weather and climate-related extreme events in the period.[218] According to a recent study conducted by the Central Bank of Ireland, the extreme weather-related economic losses for this period were close to 2.3% of Irish GNI*.[219] The EEA report stressed that while 60% of economic losses were caused by only 3% of events, it remains important to record smaller-scale events in order to fully evaluate the impacts of climate change on society, the economy and the environment and thereby better inform adaptation action. Indeed, the new EU Adaptation Strategy calls for better and more standardised climate-related risk and loss data across Member States in order to develop the best possible database from which to make climate risk assessments.[218]

The current NAF lays out the economic basis for adaptation, with cost-effectiveness amongst the criteria for prioritising adaptation options (alongside efficiency, risk and urgency and distributional impacts). Internationally, it is recognised that establishing benchmarking costs as well as the relative economic benefits of different adaptation options are far from straightforward tasks.[191] The current approach to adaptation in Ireland anticipates that sectors will reflect their key priorities within the annual budgetary and estimates processes. This sector-focused approach will lead to fragmentation, lack of synergies and complementarities or even conflicts, when coherence to resourcing our adaptation transition is required. Instead, there is a need for an assessment of the prioritised investment needs of adaptation for Ireland, quantifying what is required to make the country resilient by 2050 and beyond, based on integrated consideration of the commitments contained in sectoral and local plans and strategies. The assessment should consider the monies that will be required to adapt to climate change, consideration of the costs of inaction, and also the costs related to the damage associated with climate change that cannot be prevented. This will require delineating what constitutes 'adaptation', as distinct from other forms of investment/spending that also bring adaptation benefits.

The cost-effectiveness of all adaptation actions needs to be monitored. This requires the availability of quantitative data on adaptation. There is a lack of data, especially from the private sector, which are critical to assess the outcomes from adaptation action and their effectiveness. Simply identifying actions for adaptation is not enough; we must be able to assess the contributions of every action in reaching an adaptation objective and our long-term resilience. Ultimately, monitoring aims at distinguishing year-to-year variability from long-term trends, and to attribute the changes in impacts to different drivers – for example, whether the driver is a change in hazard or the result of adaptation actions. Developing metrics of adaptation with long time series can partly address this challenge. For instance, regarding the adaptation to climate change of the agricultural sector, we know little about soil quality. Also, the exposure of flood risks can be evaluated by assessing indicators on the number, types and location of infrastructure in areas that are exposed to flooding, and by collecting data on whether properties have or do not have flood insurances.

Recommendation 24

The discussion on capital investment requirements and the evaluation of public expenditure in the next NAF must be significantly more detailed, indicating workflows for proportionate and transparent economic appraisal of adaptation options that can be applied to project- and sector-level actions.

Recommendation 25

Data sharing for adaptation monitoring (including climate related risk and losses data) must be advanced and should be driven by the Department of the Environment, Climate and Communications, with the input of other departments and agencies including in particular the CSO.

10.5.2 Prioritisation

Early action on adaptation may be a priority where there is an identified need to: (1) address an existing vulnerability with respect to present climate variability and changes, while adapting to build future climate resilience; (2) intervene early to embed adaptation in near-term decisions with long lifetimes, thereby reducing the risk of 'lock-in'; (3) fast-track early adaptive management actions for decisions with long lead times or requiring transformative change; or (4) build adaptive capacity and provision of data, knowledge and tools to support adaptation decision-making and implementation today and in the future. However, the urgency of action should be assessed in a systematic and consistent way.[191] To select the most cost-effective transformative actions, actions must be specific, with measurable outcomes, a detailed timescale and clear ownership of the actions. Greater clarity is required regarding the decision framework that should be used to determine adaptation priorities and how ownership for adaptation actions is to be assigned in areas where there are multiple actors, fragmentation of responsibilities, and potentially conflicting objectives. Economic appraisal of investments should also capture ecosystem goods and services. It is also important to consider no-regret actions (that is to say, relevant adaptation actions whatever the climate scenario) and socioeconomic dynamics. Nature-based Adaptation is amongst these: restoring ecosystems can limit natural risks, provide food security, and water security. Also, no-regret actions can also encompass those actions generating co-benefits on mitigation, health, or biodiversity.

Recommendation 26

The next NAF should strengthen the criteria and processes for urgency scoring of adaptation options and this should be extended within and across sectoral plans to establish clear national priorities for adaptation action in Ireland.

10.6 Implementation

10.6.1 Resourcing

As discussed above, resourcing is inherently linked to prioritisation. The 2018 NAF anticipated that sectors would reflect their key priorities within the annual budgetary and estimates processes. However, this approach leads to fragmentation, lack of synergies and complementarities or even conflicts, when coherence in resourcing our adaptation transition is required.

Enabling community financing structures may assist with a more holistic approach to financing and engagement on adaptation, delivering funding and encouraging 'buy-in' to long-term adaptation projects in key sectors and regions.

However, funding alone will not guarantee our resilience. In the 2021 Adaptation Scorecard, the Council gave slightly more weight to sectors demonstrating progress in addressing prioritised risks and vulnerabilities, building adaptive capacity and putting in place good governance and coordination structures, noting that adaptation actions may be well resourced but to be effective, they must be coherent with other policies and sectors and address key, prioritised risks.

Recommendation 27

There is a need for an assessment of the prioritised investment needs of adaptation, quantifying what is required to make Ireland resilient by 2050 and beyond. Such an assessment should consider the funding that is required to adapt to climate change and how it should be prioritised. This should include setting an initial adaptation budget to 2030. The budget itself should be determined in light of the social cost of climate change over at least the next 30 years. Such budgetary planning must begin now as projects may have to begin in the short- or medium-term if they take a long time to mature or require significant investment, e.g. coastal protection or national long-term water supply projects. In this, the role of the Department of Public Expenditure and Reform will be key.

10.6.2 Mainstreaming

The IPCC WGII Sixth Assessment Report stated clearly that adaptation must come to underpin almost every aspect of national policy. The world is already experiencing the impacts of climate change and those impacts are guaranteed to be felt more keenly into the future. Every aspect of national policy must therefore take the need to adapt to climate change into consideration and evolve accordingly. However, prioritising mainstreaming alone risks a focus on incremental, rather than transformative, adaptation.[16] Adaptation and mitigation must be better integrated, so that they may address both the impacts and the causes of climate change, and they must be delivered at a greater speed and scale.

To ensure that adaptation is adequately integrated into national decision-making, further clarity is required on the interaction and reporting between national, sectoral and local governance structures, including the role of the Climate Action Delivery Board. This oversight should ensure that adaptation is mainstreamed into policy-making, planning and implementation. Adaptation should be directly considered when policies and investments are being prepared and evaluated to ensure they promote, and do not act as barriers to, adaptation.

Recommendation 28

Further detail should be given as to the efforts needed to facilitate mainstreaming of adaptation into policy and practice, with examples of effective mainstreaming provided. The 2018 NAF provides a discussion of the importance of mainstreaming but less detail on how it is to be achieved in practice. Given the experience of the first round of statutory adaptation planning, significant detail can be provided here. Overall, overarching governance, roles and responsibilities of adaptation must be clearer.

10.6.3 Non-Governmental adaptation, including households and businesses

Individuals are already experiencing the impacts of climate change and as climate disruption deepens, this exposure to risk will become more heightened.[205] For individual businesses, organisations, or the public, it is extremely challenging to build awareness and take adaptation actions at a scale that is effective and efficient, and that accounts for social costs and benefits, without centralised support and direction where needed.

To be effective, adaptation requires action that is multi-scalar and multi-actor. However, given the focus on the role of Government and state action in adaptation, there has been less attention given to the potential role of individuals, households and local communities in adapting to climate change risks, thus neglecting the need for a 'whole-of-society' approach to adaptation to complement a 'whole-of-Government' response.[220],[205]

Some impacts will be experienced 'in-place', at the scale of everyday life and home, leading to household and individual exposure to health, security and wellbeing impacts, property damage, and disruption to essential infrastructure and the services they provide.[221] In line with above recommendations on including the voice of those affected in adaptation planning, to avoid maladaptation, decisions must be sensitive to how place is valued. Other impacts will result from wider national and global challenges; for example, as climate change disrupts national and global supply chains, food production and energy security, with potential cost of living implications.[205] There has been progress in addressing flood related risks to property at a scheme scale and in Local Government, but less progress in implementing the health and infrastructural adaptation plans. Overall, the Council is not satisfied that national and local policy has sufficiently considered these risks or enabled, prepared and supported households, individuals and communities to take action to address such vulnerabilities. Taken in the absence of strong Government policy, direction and support, adaptation actions by individuals and households have the potential for reinforcing pre-existing socio-spatial inequalities or risking maladaptation or the displacement of risks onto others.[205]

Many coastal communities are witnessing a need for coastal adaptation and having to handle the situation on their own. They are finding that education, signage, fencing off areas and a variety of Nature-based approaches can achieve real results. However, the burden of taking such actions should not fall exclusively upon the shoulders of these communities. The role of local communities in decision-making and managing the coastline has potential. This requires deeper integration of funding and other socio-economic planning supports between Government and coastal communities in Ireland, for the development of sustainable coastal economies and infrastructures under the impacts of future climate changes.

The 'Climate Change Adaptation: Risks and Opportunities for Irish Businesses' EPA-funded study, published in February 2022, found that most Irish businesses have limited awareness of the need for or the roles they could play in climate adaptation, despite the risks climate change poses to certain production processes, the reliability of supply chains and the interdependencies between businesses, customers and enabling sectors. Large businesses, particularly in chemical and pharmaceutical manufacturing, and financial services and energy sectors, were found to be the most advanced at incorporating climate-related risks into their long-term business strategies, while food and beverage manufacturing and the hospitality and tourism sectors were found to be the least advanced, despite being the most vulnerable to risks related to extreme weather events.[222]

Recommendation 29

Enabling household and community level adaptation must be addressed in the next NAF; however, this cannot just involve the individualisation of risk away from the state towards the individual or community as this may lead to uneven outcomes, displaced risk and maladaptation or retrenching pre-existing socioeconomic outcomes. Adaptation actions led at this level must be legitimate, effective, robust and lead to just outcomes that support clear, effective and just national adaptation objectives. It is imperative that the social contract (i.e. the expectations of the state from its citizens) around adaptation and climate risks is negotiated in a clear, transparent, inclusive and just way.[223]

Recommendation 30

Adaptation must be integrated further into existing and future climate action communications and campaigns (which currently mainly target mitigation), while making use of new insights about place attachment, memorable extremes, and storylines to personalise climate risks and adaptation opportunities for diverse audiences.

Recommendation 31

Reinvigorated focus will be required to draw the private sectors' attention to the risks of not adapting to the changing climate, and the opportunities provided by forward-thinking and factoring climate-related risks and effective actions all along businesses' supply chains into their long-term strategies. The next NAF should also set a clear strategy for coordinating and incentivising private sector adaptation as well as the community financing of adaptation investment.

10.7 Monitoring and evaluating adaptation and resilience

10.7.1 How to integrate with the National Transition Objective, including links with mitigation and biodiversity considerations

Mitigation and adaptation must be more closely integrated in policy and practice. It is clear that, as stated in the 277 EPA report on Irish Climate Futures, 'too often mitigation and adaptation are treated as independent strategies; in reality, even if we could somehow stop all greenhouse gas emissions right now, some degree of impact on Ireland's society, economy and environment will still result from historical emissions. Additionally, as the IPCC WGI and WGII reports make clear, even at 1.5°C and 2°C warming, potentially severe impacts will still be felt. Therefore, it is critical that society adapts to future impacts of climate change'.[224]

In May 2019 the Dáil declared a climate and biodiversity emergency. Although public awareness of biodiversity loss and change has increased and cross-sectoral engagement in biodiversity action has improved in recent years, the status of biodiversity in protected areas, seas and the wider countryside is in poor condition and continues to decline. This is primarily due to causes such as land-use change, intensive agriculture, overharvesting and pollution, and threatens the provision of critical services such as flood mitigation, clean drinking water, as well as pollination, which underpin current and future economic activity in agriculture, forestry and tourism, and ensure basic quality of life.[70] The concept of resilience and its value to Ireland and its people should be further articulated in the next NAF and a clear conceptualisation must be at the centre of local and sectoral plans and meeting the national climate objective. Greater emphasis must also be placed on nature-based approaches to adaptation, which integrate mitigation and adaptation considerations, while also benefiting biodiversity, within the next NAF, but also within the National Development Plan, the Climate Action Plan and the National Biodiversity Action Plan, all of which need to be more aligned.[209]

As emphasised in both the IPCC's WGII Sixth Assessment Report and the EU's Adaptation Strategy, Nature-based Adaptation provides an opportunity to adapt to climate change, mitigate against climate change, and protect biodiversity simultaneously.[16],[225] Options such as peatland restoration, afforestation in strategic locations, and green urban planning can act as adaptation measures to help with flood mitigation, soil erosion and the urban heat island effect, as mitigation measures by removing carbon from the atmosphere, and as biodiversity protections by providing new habitats.[70]

Recommendation 32

An integrated, multidisciplinary, long-term systemic approach, within public policy-making, towards integrating adaptation and mitigation as a means of combating climate change and building resilience is essential. This also includes just resilience and just transition and wellbeing. Resilience indicators will be essential to demonstrating progress and identifying gaps and priorities towards meeting the new National Climate Objective.

Recommendation 33

The next NAF must explain how the NAF, sectoral adaptation plans and local climate plans work together to deliver the National Climate Objective. Inherent to this, the next NAF should adopt a more outcome-based approach, where the NAF itself and sectoral and other plans under it are outcomes-focused.

10.7.2 Evaluation of adaptation actions

It is rare that adaptation interventions have singular impacts that can be easily evaluated using one metric (risk reduction may be coupled with changes in aesthetic value or access to green space), and, with an increasing focus on transformative adaptation, it is likely that there will be multifaceted direct and indirect consequences of different adaptation interventions. Whilst traditionally success of adaptation projects has been judged on reduction of risk (e.g. reduced likelihood of flooding) and cost-effectiveness of interventions, increasingly it is recognised that the impacts of adaptation strategies are much further reaching.[16] Adaptation decision-making has implications for how people see themselves,[226] for health outcomes[227] and can result in reinforcement or redistribution of a range of vulnerabilities.[202]

Taking a broader approach to monitoring and evaluating success can allow a more holistic understanding of how adaptations impact populations and how they can be harnessed to pursue sustainable and transformative adaptation strategies. This reframing of success will require a broader set of indicators for evaluation processes. Metrics that can capture the fairness of process and distribution of outcomes of adaptation will help to clarify exactly who benefits, and who may suffer as the result of climate adaptation interventions. A project on Healthy Adaptations at Maynooth University and funded by the Wellcome Trust is working with policy-makers and communities in Ireland, Ghana and the UK to identify health and wellbeing metrics for adaptation planning (www.healthyadaptations.org), and the metrics emerging from the project reflect issues such as community identity, place attachment and wellbeing.

10.7.3 Indicators

The 2018 NAF indicated that a 'priority for Ireland will be to take forward a project to develop a range of adaptation indicators which will enable Ireland to monitor progress in preparing for the long-term effects of climate change'. The Council has regularly indicated the urgent need for adaptation indicators and regrets that they are still not in place, despite progress on an indicators pilot under the Climate Action Plan 2021.

The Council also notes recommendations within the literature that indicators of 'restorative' action be included (i.e. action that includes heritage protection and restoration), alongside indicators of progress towards furthering community participation.[209]

Recommendation 34

Adaptation indicators must be set out in the next NAF. Indicators should be provided on socio-economic vulnerabilities, such as the location, condition, and performance of critical infrastructure, or for health and social care delivery and linking with wellbeing and social justice that are critical to the achievement of the SDGs. Sector specific indicators that do not consider cross cutting risks, synergies and co-dependencies will be a missed opportunity, e.g. progress in one sector could be increasing vulnerability in another. Above all, there is scope for more indicators describing resilience and effectiveness of adaptation actions for and across key sectors such as agriculture, biodiversity, health, the built environment, and infrastructure.

11. Activities of the Council

As required under Section 12(f) of the Climate Action and Low Carbon Development Act 2015 (as amended), the activities of the Council in 2021 are listed here.

Date	Organisation	Subject	Council/Committee/ Secretariat Attendees
13.01.2021	Northern Ireland Department of Agriculture, Environment and Rural Affairs	Climate Change Advisory Council's approach to methane emissions from agriculture	Prof. John FitzGerald
14.01.2021	Climate Change Advisory Council	Climate Change Advisory Council Meeting	Prof. John FitzGerald, Prof. Alan Barrett (ESRI), Prof. Gerry Boyle (Teagasc), Laura Burke (EPA), Prof. Peter Clinch, Prof. Frank Convery, Prof. Anna Davies, Prof. Ottmar Edenhofer, Prof. Alan Matthews, William Walsh (SEAI), Climate Secretariat
05.02.2021	Department of the Taoiseach	Shared Island Dialogue: The Environment and Climate – addressing shared challenges on the island	Prof. John FitzGerald
05.02.2021	Advisor to the Minister for Environment, Climate and Communications	Transition of Climate Change Advisory Council	Climate Secretariat
10.02.2021	SEAI	SEAI Schools Programme	Marie Donnelly
23.02.2021	Department of Environment, Climate and Communications	CCAC – Decarbonisation measures to close the gap between CAP19 and PfG targets	Climate Secretariat
25.02.2021	Royal Irish Academy	RIA Conference 25 February 2021 – Achieving Ireland's Climate Action Ambitions	Prof. John FitzGerald and Marie Donnelly
26.02.2021	European Climate Foundation	EU Level Climate Advisory Body	Marie Donnelly
04.03.2021	Department of the Environment, Climate and Communications	Climate Action Plan 2021	Marie Donnelly and Climate Secretariat
05.03.2021	Climate Change Advisory Council	Climate Change Advisory Council Meeting	Marie Donnelly, Prof. Alan Barrett (ESRI), Prof. Gerry Boyle (Teagasc), Laura Burke (EPA), Prof. John FitzGerald, Prof. Peter Thorne, William Walsh (SEAI), Climate Secretariat
08.03.2021	Women in Energy	Women in Energy: International Women's Day Event	Marie Donnelly

Date	Organisation	Subject	Council/Committee/ Secretariat Attendees
11.03.2021	British Irish Chamber of Commerce	Building a Pathway to Net Zero	Marie Donnelly
11.03.2021	Teagasc	Presentation on the latest research	Marie Donnelly and Climate Secretariat
23.03.2024	Irish Green Building Council	National Leadership Forum on Whole Life Carbon in construction	Marie Donnelly
23.03.2021	Climate Change Advisory Council	Informal meeting on the Ad-hoc Committee on Carbon Budgeting	Marie Donnelly, Prof. John Fitzgerald, Prof. Peter Thorne, Climate Secretariat
25.03.2021	OECD	Moderation of OECD Clean Energy Finance and Investment Review of Indonesia	Climate Secretariat
01.04.2021	Department of Environment, Climate and Communications	Capacity to support carbon budget work	Marie Donnelly and Climate Secretariat
06.04.2021	Climate Change Advisory Council	Informal meeting on the Ad-hoc Committee on Carbon Budgeting	Marie Donnelly, Prof. John Fitzgerald, Prof. Peter Thorne and Climate Secretariat
15.04.2021	Climate Change Advisory Council	Climate Change Advisory Council Meeting	Marie Donnelly, Prof. Alan Barrett (ESRI), Prof. Gerry Boyle (Teagasc), Laura Burke (EPA), Prof. Ottmar Edenhofer, Prof. John FitzGerald, Andrew Murphy, Julie Sinnamon, Prof. Peter Thorne, William Walsh (SEAI), Eoin Moran (Met Éireann), Climate Secretariat
17.04.2021	Young Fine Gael	Young Fine Gael National Conference 2021: Lessons for a Post-COVID Ireland	Marie Donnelly
19.04.2021	Brian Coyne, TCD	ReHeat Workshop on decarbonising residential energy use	Members of the Council, Secretariat and other attendees
20.04.2021	Law Society of Ireland	Recorded talk on 'Sustainable planning for a resilient built environment' for MOOC on Environmental Law and Climate Change	Climate Secretariat
21.04.2021	Society of Chartered Surveyors Ireland, Engineers Ireland, IPI, RIAI and ACEI	Building Collaboration for Climate Action: Circular Economy	Marie Donnelly

Date	Organisation	Subject	Council/Committee/ Secretariat Attendees
22.04.2021	Climate Change Advisory Council	Adaptation Committee Meeting	Marie Donnelly, Mark Adamson (OPW), Prof. Gerry Boyle (Teagasc), Laura Burke (EPA), Prof. Robert Devoy, Prof. John FitzGerald, Dr Ina Kelly (HSE), Keith Lambkin (Met Éireann), Prof. Conor Murphy (NUIM), Roger Street (UO),William Walsh (SEAI), Climate Secretariat
27.04.2021	Climate Change Advisory Council	Carbon Budget Committee Meeting	Marie Donnelly, Patricia King, Prof. Peter Thorne, Julie Sinnamon, Prof. John Fitzgerald, Andrew Murphy, Eoin Moran (Met Éireann), George Hussey (DHLGH), Prof. Alan Matthews, Aoife Parker-Hedderman (DECC), Prof. Hannah Daly (UCC), Keith Lambkin (Met Éireann), Prof. Lisa Ryan (UCD), Stephen Treacy (EPA), Paul Price (DCU), Andrew Smith (UCC), Trevor Donnellan (Teagasc), Kevin Hanrahan (Teagasc), Bill Callanan (DAFM), Dr. David Styles (UL), Colm Duffy (NUIG) and Climate Secretariat
28.04.2021	IERC – International Energy Research Centre	Re-imagining the role of the energy market in the transition to Net Zero	Marie Donnelly
29.04.2021	Irish Climate Summit	Climate governance and the Climate Change Advisory Council	Marie Donnelly
30.04.2021	Climate Change Advisory Council	Carbon Budget Committee Meeting	Marie Donnelly, Patricia King, Prof. Peter Thorne, Julie Sinnamon, Prof. John Fitzgerald, Andrew Murphy, Eoin Moran (Met Éireann), George Hussey (DHLGH), Prof. Alan Matthews, Aoife Parker-Hedderman (DECC), Prof. Hannah Daly (UCC), Keith Lambkin (Met Éireann), Prof. Lisa Ryan (UCD), Stephen Treacy (EPA), Paul Price (DCU), Andrew Smith (UCC), Trevor Donnellan (Teagasc), Kevin Hanrahan (Teagasc), Bill Callanan (DAFM), Dr. David Styles (UL) and Climate Secretariat
05.05.2021	Department of the Environment, Climate and Communications	Meeting of National Adaptation Steering Committee	Climate Secretariat
05.05.2021	UCD	ReHEAT Workshop on Policies and Behaviours	Council, Committee and others
06.05.2021	IBEC	CEO's roundtable	Marie Donnelly

Date	Organisation	Subject	Council/Committee/ Secretariat Attendees
07.05.2021	IFA	Draft Climate Action and Low Carbon Development (Amendment) Bill 2021	Marie Donnelly
11.05.2021	TII	Climate change and transport infrastructure	Marie Donnelly
12.05.2021	Eirgrid	Civil Society Forum	Marie Donnelly
13.05.2021	Climate Change Advisory Council	Climate Change Advisory Council Meeting	Marie Donnelly, Prof. Alan Barrett (ESRI), Prof. Gerry Boyle (Teagasc), Laura Burke (EPA), Prof. John FitzGerald, Andrew Murphy, Julie Sinnamon, Prof. Peter Thorne, William Walsh (SEAI), Eoin Moran (Met Éireann), Dr Cara Augustenborg, Sinéad O'Brien, Climate Secretariat
17.05.2021	Climate Change Advisory Council	Carbon Budget Committee Meeting	Marie Donnelly, Prof. John Fitzgerald, Patricia King, Julie Sinnamon, Andrew Murphy, Dr Cara Augustenborg, Bill Callanan (DAFM), Prof. Gerry Boyle (Teagasc), Prof. Alan Matthews, Prof. Peter Thorne, Prof. Brian Ó Gallachoir (UCC), Prof. Hannah Daly (UCC), Keith Lambkin (Met Éireann), Aoife Parker-Hedderman (DECC), Kevin Hanrahan (Teagasc), Prof. Lisa Ryan (UCD), Stephen Treacy (EPA), Trevor Donnellan (Teagasc), Dr David Styles (UL), George Hussey (DHLGH), Prof. Morgan Bazilian, Sinead O'Brien, Climate Secretariat
18-19.05.2021	International Climate Advisory Councils	Climate Advisory Councils – International Dialogue	Marie Donnelly, Prof. Peter Thorne and Climate Secretariat
20.05.2021	CCMA/CARO	Economic Opportunities from Climate Action project	Marie Donnelly
20.05.2021	Marine Institute	Marine Institute's Oceans of Learning: Panel discussion on the future of the oceans and climate change	Marie Donnelly
21.05.2021	Irish Planning Institute	Chairing members' workshop on planning and climate change	Climate Secretariat
24.05.2021	Ecocem	Ecocem, the future of low carbon construction and the impact of carbon budgeting	Marie Donnelly

Date	Organisation	Subject	Council/Committee/ Secretariat Attendees
24.05.2021	Climate Change Advisory Council	Carbon Budget Committee Meeting	Marie Donnelly, Prof. John Fitzgerald, Julie Sinnamon, Prof. Gerry Boyle (Teagasc), Patricia King, Andrew Murphy, Prof. Peter Thorne, Dr Cara Augustenborg, Eoin Moran (Met Éireann), Prof. Morgan Bazilian, Sinead O'Brien, Bill Callanan (DAFM), Kevin Hanrahan (Teagasc), Trevor Donnellan (Teagasc), Jim Scheer (SEAI), Prof. Lisa Ryan (UCD), Prof. Brian Ó Gallachóir (UCC), Prof. Alan Matthews, Prof. Hannah Daly (UCC), Andrew Smith (UCC), Dr. David Styles (UL), Keith Lambkin (Met Éireann), Stephen Treacy (EPA), Prof. Aoife Ahern (UCD), Aoife Parker-Hedderman (DECC), Brian Carroll (DECC), Peter Mannion (McKinsey), Climate Secretariat
26.05.2021	Association of Chief Executives of State Agencies (ACESA)	Breakfast briefing: Climate Change	Marie Donnelly
26.05.2021	ACEI	ACEI: Sustainability and addressing climate change	Marie Donnelly
31.05.2021	Greenlink	Greenlink Interconnector	Marie Donnelly
31.05.2021	PwC	Sustainability and decarbonisation roundtable	Marie Donnelly
04.06.2021	OECD	Work package to assist the Climate Change Advisory Council	Climate Secretariat
10.06.2021	Business in the Community	Business in the Community Low Carbon Pledge report launch	Marie Donnelly
10.06.2021	Royal Dublin Society	RDS Vision 2030	Marie Donnelly
11.06.2021	Department of Agriculture, Food and the Marine	Meeting with Minister McConalogue	Marie Donnelly and Prof. Gerry Boyle (Teagasc)
11.06.2021	Law Society of Ireland	MOOC online Q&A	Climate Secretariat

Date	Organisation	Subject	Council/Committee/ Secretariat Attendees
14.06.2021	Climate Change Advisory Council	Carbon Budget Committee Meeting	Marie Donnelly, Prof. John Fitzgerald, Julie Sinnamon, Prof. Gerry Boyle (Teagasc), Patricia King, Andrew Murphy, Eoin Moran (Met Éireann), Laura Burke (EPA), Prof Peter Thorne, Dr Cara Augustenborg, Bill Callanan (DAFM), Kevin Hanrahan (Teagasc), Trevor Donnellan (Teagasc), Jim Scheer (SEAI), Prof. Lisa Ryan (UCD), Prof. Brian Ó Gallachóir (UCC), Prof. Alan Matthews, Prof. Hannah Daly (UCC), Andrew Smith (UCC), Dr. David Styles (UL), Keith Lambkin (Met Éireann), Stephen Treacy (EPA), Prof. Aoife Ahern (UCD), George Hussey (DHLGH), Climate Secretariat
15.06.2021	Climate Ireland/EPA	Local Authority Climate Action Plan Guidelines Project Advisory Group	Climate Secretariat
16.06.2021	EUFORES – European Forum for Renewable Energy Sources	EUFORES Webinar on Renewable Energy and Energy Efficiency with the Parliament of Ireland	Marie Donnelly
18.06.2021	Climate Change Advisory Council	Climate Change Advisory Council Meeting	Marie Donnelly, Prof. Gerry Boyle (Teagasc), Laura Burke (EPA), Prof. John FitzGerald, Patricia King, Andrew Murphy, Julie Sinnamon, Prof. Peter Thorne, William Walsh (SEAI), Eoin Moran (Met Éireann), Dr Cara Augustenborg, Sinéad O'Brien, Climate Secretariat
21.06.2021	Climate Change Advisory Council	Carbon Budget Committee Meeting	Marie Donnelly, Prof. John Fitzgerald, Julie Sinnamon, Prof. Gerry Boyle (Teagasc), Patricia King, Andrew Murphy, Laura Burke (EPA), Peter Thorne, Eoin Moran (Met Éireann), Bill Callanan (DAFM), Kevin Hanrahan (Teagasc), Trevor Donnellan (Teagasc), Jim Scheer (SEAI), Prof. Lisa Ryan (UCD), Prof. Brian Ó Gallachóir, Prof. Alan Matthews, Prof. Hannah Daly (UCC), Andrew Smith (UCC), Keith Lambkin (Met Éireann), Stephen Treacy (EPA), Climate Secretariat
22.06.2021	Embassy of the Kingdom of the Netherlands	Climate Change Advisory Council	Marie Donnelly and Climate Secretariat
22.06.2021	ECCA	ECCA Adaptation Conference Closing Plenary	Climate Secretariat

Date	Organisation	Subject	Council/Committee/ Secretariat Attendees
22.06.2021	Department of the Environment, Climate and Communications	Draft Climate Action and Low Carbon Development (Amendment) Bill 2021	Brian Carroll (DECC), Marie Donnelly and Climate Secretariat
23.06.2021	Energy Storage Ireland Conference	Path to 2030 and a net zero carbon economy by 2050 with particular focus on the role of technologies such as energy storage in achieving our climate action ambitions	Marie Donnelly
23.06.2021	EPA	EPA Climate Conference	Marie Donnelly
25.06.2021	Climate Change Advisory Council	Adaptation Committee Meeting	Marie Donnelly, Roger Street (UO),Prof. Robert Devoy, Keith Lambkin (Met Éireann), Prof. John FitzGerald, Mark Adamson (OPW), Prof. Prof. Conor Murphy (NUIM), Dr Ina Kelly (HSE), Prof. Gerry Boyle (Teagasc), William Walsh (SEAI), Paddy Mahon (CCMA), Climate Secretariat
28.06.2021	Climate Change Advisory Council	Carbon Budget Committee Meeting	Marie Donnelly, Prof. John Fitzgerald, Patricia King, Prof. Gerry Boyle (Teagasc), Julie Sinnamon, Andrew Murphy, Dr Cara Augustenborg, Prof Peter Thorne, Eoin Moran (Met Éireann), Bill Callanan (DAFM), Prof. Alan Matthews, Dr. David Styles (UL), Prof. Hannah Daly (UCC), George Hussey (DHLGH), Kevin Hanrahan (Teagasc), Prof. Lisa Ryan (UCD), Prof. Brian Ó Gallachoir (UCC), Andrew Smith (UCC), Stephen Treacy (EPA), Trevor Donnellan (Teagasc), William Beausang (DFHERIS), Trudy Duffy (DFHERIS), Andrew Brownlee (SOLAS), Climate Secretariat
28-29.06.2021	Government of Ireland	National Economic Forum	Marie Donnelly
01.07.2021	Northern Ireland Assembly	Oral Evidence on Climate Change Bill for Northern Ireland	Prof. Peter Thorne
02.07.2021	Ecologic Institute	How can advisory bodies effectively support climate policy?	Prof. John FitzGerald

Date	Organisation	Subject	Council/Committee/ Secretariat Attendees
05.07.2021	Climate Change Advisory Council	Carbon Budget Committee Meeting	Marie Donnelly, Prof. John Fitzgerald, Julie Sinnamon, Andrew Murphy, Patricia King, Prof. Gerry Boyle (Teagasc), Eoin Moran (Met Éireann), Dr Cara Augustenborg, Prof. Hannah Daly (UCC), Andrew Smith (UCC), Prof. Lisa Ryan (UCD), Prof. Brian Ó Gallachóir (UCC), Stephen Treacy (EPA), Trevor Donnellan (Teagasc), Prof. Aoife Ahern (UCD), Bill Callanan (DAFM), Prof. Peter Thorne, Dr. David Styles (UL), Aoife Parker-Hedderman (DECC), George Hussey (DHLGH), Climate Secretariat
06.07.2021	An Taisce	Green Schools Summer Course	Marie Donnelly
06.07.2021	Climate Ireland/EPA	Local Authority Climate Action Plan Guidelines Project Advisory Group	Climate Secretariat
07.07.2021	National Transport Authority	Meeting between Chair of Council and NTA CEO	Marie Donnelly
12.07.2021	Climate Change Advisory Council	Climate Change Advisory Council Meeting	Marie Donnelly, Prof. Gerry Boyle (Teagasc), Laura Burke (EPA), Prof. John FitzGerald, Patricia King, Andrew Murphy, Julie Sinnamon, Prof. Peter Thorne, William Walsh (SEAI), Climate Secretariat
12.07.2021	ISIF IC	ISIF/NTMA	Marie Donnelly
15.07.2021	Met Éireann	Coordinating the Provision of Climate Services in Ireland	Climate Secretariat
22.07.2021	Climate Change Advisory Council	Climate Change Advisory Council Meeting	Marie Donnelly, Prof. Gerry Boyle (Teagasc), Laura Burke (EPA), Prof. John FitzGerald, Patricia King, Andrew Murphy, Julie Sinnamon, Prof. Peter Thorne, Eoin Moran (Met Éireann), Dr Cara Augustenborg, Sinéad O'Brien, Climate Secretariat
27.07.2021	UK Committee on Climate Change	Meeting with adaptation analyst in the UK CCC Secretariat	Climate Secretariat
29.07.2021	International Climate Advisory Councils	Climate Advisory Councils – International Dialogue	Marie Donnelly
29.07.2021	Eirgrid	The role of offshore wind in a future vision for the transformation of the Irish economy and society	Marie Donnelly

Date	Organisation	Subject	Council/Committee/ Secretariat Attendees
29.07.2021	Codling Wind Park	Codling Wind Park project introduction	Marie Donnelly
04.08.2021	Eirgrid	The role of offshore wind in a future vision for the transformation of the Irish economy and society	Prof. John FitzGerald
05.08.2021	ESRI	Carbon Budgets	Climate Secretariat
10.08.2021	Department of the Environment, Climate and Communications	Information Exchange on Climate Regulation	Brian Carroll (DECC), Marie Donnelly, Council members and Climate Secretariat
17.08.2021	Climate Ireland/EPA	Local Authority Climate Action Plan Guidelines Project Advisory Group	Climate Secretariat
24.08.2021	Minister for the Environment, Climate and Communications	Climate Change Advisory Council	Climate Secretariat
02.09.2021	Climate Change Advisory Council	Climate Change Advisory Council Meeting	Marie Donnelly, Prof. Gerry Boyle (Teagasc), Laura Burke (EPA), Prof. John FitzGerald, Patricia King, Andrew Murphy, Prof. Peter Thorne, William Walsh (SEAI), Eoin Moran (Met Éireann), Dr Cara Augustenborg, Sinéad O'Brien, Prof. Frank O'Mara (Teagasc), Prof. Morgan Bazilian, Climate Secretariat
03.09.2021	American Chamber of Commerce and US Embassy	The Journey to COP26	Marie Donnelly
05.09.2021	European Youth Parliament (EYP) Ireland	Digital Energy Roundtable as part of EYP's international effort to empower youth active citizenship	Marie Donnelly
09.09.2021	Climate Change Advisory Council	Carbon Budget Committee Meeting	Marie Donnelly, Prof. John Fitzgerald, Patricia King, Prof. Gerry Boyle (Teagasc), Eoin Moran (Met Éireann), Dr Cara Augustenborg, Prof. Frank O'Mara (Teagasc), Prof. Hannah Daly (UCC), Andrew Smith (UCC), Prof. Lisa Ryan (UCD), Prof. Brian Ó Gallachoir (UCC), Stephen Treacy (EPA), Trevor Donnellan (Teagasc), Prof. Aoife Ahern (UCD), Bill Callanan (DAFM), Prof. Peter Thorne, Dr. David Styles (UL), Prof. Frank O'Mara (Teagasc), Kevin Hanrahan (Teagasc), Keith Lambkin (Met Éireann), Jim Scheer (SEAI), Prof. Alan Matthews, Paul Price (DCU), Climate Secretariat

Date	Organisation	Subject	Council/Committee/ Secretariat Attendees
15.09.2021	Teagasc/Ornua	Moorepark Dairy Open Day – 'The Future of Irish Dairy'	Marie Donnelly
15.09.2021	Climate Change Advisory Council	Adaptation Committee Workshop: Coastal Adaptation	Members of the Adaptation Committee, Secretariat and other attendees
20.09.2021	Mazars	SEAI strategy – external stakeholder engagement	Marie Donnelly
21.09.2021	Salesforce	Salesforce panel discussion and general discussion	Marie Donnelly
22.09.2021	Climate Change Advisory Council	Climate Change Advisory Council Meeting, Carbon Budgets	Marie Donnelly, Laura Burke (EPA), Prof. John FitzGerald, Patricia King, Andrew Murphy, Prof. Peter Thorne, William Walsh (SEAI), Eoin Moran; Dr. Cara Augustenborg, Prof. Frank O'Mara, Julie Sinnamon, Prof. Alan Matthews; Prof. Brian Ó Gallachóir (UCC); Dr. Hannah Daly; Trevor Donnellan (Teagasc); Stephen Treacy (EPA); Bill Callanan (DAFM); Climate Secretariat
28-29.09.2021	International Climate Advisory Councils	International Climate Advisory Councils Event	Marie Donnelly and Climate Secretariat
28.09.2021	DPER	The Climate Action Act – the traditional Budget versus the Carbon Budget	Marie Donnelly
06.10.2021	Salesforce Ireland	Panel discussion: Why Irish leaders need to embed Sustainability in their corporate strategy	Marie Donnelly
12-13.10.2021	CCMA/CARO	Economic Opportunities from Climate Action project	Marie Donnelly
13.10.2021	Ernst and Young	Entrepreneur of the Year event – Presentation on Climate Change	Dr Cara Augustenborg
14.10.2021	Climate Change Advisory Council	Climate Change Advisory Council Meeting	Marie Donnelly, Laura Burke (EPA), Prof. John FitzGerald, Patricia King, Andrew Murphy, Prof. Peter Thorne, Eoin Moran (Met Éireann), Dr Cara Augustenborg, Prof. Frank O'Mara (Teagasc), Julie Sinnamon, Prof. Morgan Bazilian, Sinéad O'Brien, Prof. Ottmar Edenhofer, Jillian Mahon, Climate Secretariat
21.10.2021	Statistical and Social Inquiry Society of Ireland	Sustainable Development: A Thirty-Year Perspective.	Marie Donnelly

Date	Organisation	Subject	Council/Committee/ Secretariat Attendees
25.10.2021	Climate Change Advisory Council	Climate Change Advisory Council Meeting	Marie Donnelly, Laura Burke (EPA), Prof. John FitzGerald, Patricia King, Andrew Murphy, Prof. Peter Thorne, William Walsh (SEAI), Eoin Moran (Met Éireann), Dr Cara Augustenborg, Prof. Frank O'Mara (Teagasc), Julie Sinnamon, Jillian Mahon, Sinead O'Brien, Climate Secretariat
26.10.2021	IIEA (Brussels)	'Net Zero – how do we get there – and pay for it?' webinar	Marie Donnelly
28.10.2021	DCU Centre for Climate and Society and Dublin Climate Action Regional Office	Are the media doing their job on climate change? Online public event	Dr Cara Augustenborg
05.11.2021	Oireachtas TV Debate	Oireachtas TV Debates – Interview with Chair of CCAC	Marie Donnelly
09.11.2021	Eirgrid/DECC	COP Side event – Government, Energy Sector and Civil Society working together to accelerate decarbonisation (Eirgrid/ DECC)	Marie Donnelly
11.11.2021	EPSRC-SFI Energy Resilience in the Built Environment Centre for Doctoral Training (ERBE CDT)	Keynote address: EPSRC-SFI Energy Resilience in the Built Environment Centre for Doctoral Training (ERBE CDT) Colloquium	Marie Donnelly
01-12.11.2021	COP26	COP26	Marie Donnelly and Climate Secretariat
12.11.2021	EPSRC-SFI Energy Resilience in the Built Environment Centre for Doctoral Training (ERBE CDT)	Keynote address: EPSRC-SFI Energy Resilience in the Built Environment Centre for Doctoral Training (ERBE CDT) Colloquium	Marie Donnelly
17.11.2021	European Commission	European Commission Post COP26 event	Marie Donnelly
18.11.2021	Climate Change Advisory Council	Climate Change Advisory Council Meeting	Marie Donnelly, Laura Burke (EPA), Prof. John FitzGerald, Patricia King, Andrew Murphy, Prof. Peter Thorne, Eoin Moran (Met Éireann), Dr Cara Augustenborg, Julie Sinnamon, Prof. Morgan Bazilian, Sinead O'Brien, Jillian Mahon, William Walsh (SEAI), Prof. Frank O'Mara (Teagasc), Prof. Ottmar Edenhofer, Climate Secretariat

Date	Organisation	Subject	Council/Committee/ Secretariat Attendees
25.11.2021	SEAI	SEAI National Energy Research and Policy Conference – Keynote presentation pre-recording	Marie Donnelly
07.11.2021	Bord Bia Conference	Carbon Budgets	Marie Donnelly
25.11.2021	Climate Change Advisory Council Adaptation Committee	Climate Change Advisory Council Adaptation Committee meeting	Marie Donnelly, Mark Adamson (OPW), Prof. Frank O'Mara (Teagasc), Prof. Robert Devoy, Paddy Mahon (CCMA), Dr Ina Kelly (HSE), Keith Lambkin (Met Éireann), Prof. Prof. Conor Murphy (NUIM), Climate Secretariat
02.12.2021	EEA	National climate change advisory bodies in Europe – virtual discussion	Marie Donnelly and Climate Secretariat
08.12.2021	Joint Oireachtas Committee	Carbon Budgets	Marie Donnelly

Endnotes

[1] Climate Change Advisory Council (2022). Letter to Taoiseach Micheál Martin, Tánaiste Leo Varadkar and Minister Eamon Ryan regarding energy security and climate action. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/documents/news/CCAC%20Letter%20to%20Government.pdf

[2] Climate Action and Low Carbon Development (Amendment) Act 2021. Available at: https://www.irishstatutebook.ie/eli/2021/act/32/enacted/en/print.html

[3] IPCC (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

[4] World Meteorological Organization (2022). State of the Global Climate 2021. Available at: https://library.wmo.int/doc_num.php?explnum_id=11178

[5] Met Éireann (2022). Weather and Climate Review 2021. Available at: https://www.met.ie/weather-climate-review-2021-2

[6] The Irish Times (2021). Storm Barra: Homes flooded, 'damaging' wind and 59,000 without power. Available at: https://www.irishtimes.com/news/ireland/irish-news/storm-barra-homes-flooded-damaging-wind-and-59-000-without-power-1.4749015

[7] Ryan, C.; Curley, M.; Walsh, S.; Murphy, C. (2021). Long-term trends in extreme precipitation indices in Ireland. International Journal of Climatology. Available at: https://rmets.onlinelibrary.wiley.com/doi/pdfdirect/10.1002/joc.7475?casa_token=MPDuPuKDcGsAAAAA:7tuuF7nQzWpqXRIT8nHcma2ACrMW-gWry513cTwQ3JAh5GZkJUGHLk3bFlRhMuI50UZJvMe1C3TKvF0G

[8] Cámaro García, W.C.A.; Dwyer, N. (2021). Research 386: The Status of Ireland's Climate, 2020. EPA. Available at: https://www.epa.ie/publications/research/climate-change/research-386-the-status-of-irelands-climate-2020.php

[9] EPA (2020). *Ireland's Environment – An Integrated Assessment*. Available at: from https://epawebapp.epa.ie/ebooks/soe2020/330/. Available at: Project MUSE - Reconstruction of hydrological drought in Irish catchments (1850-2015) (jhu.edu)

[10] Noone, S., and Murphy, C. (2020). Reconstruction of hydrological drought in Irish catchments (1850-2015)

[11] Nolan, P.; Flanagan, J. (2020). Research 339: High-resolution Climate Projections for Ireland – A Multi-model Ensemble Approach. EPA. Available at: https://www.epa.ie/publications/research/climate-change/research-339-high-resolution-climate-projections-for-ireland-.php

[12] Wingler, A.; Cawkwell, F.; Holloway, P.; Misra, G.; de la Torre Cerro, R.; Sweeney, C. (2022). EPA Research Report 404: PhenoClimate: Impact of Climate Change on Phenology in Ireland. Available at: https://www.epa.ie/publications/research/epa-research-2030-reports/research-404-phenoclimate-impact-of-climate-change-on-phenology-in-ireland.php

[13] Nelson, B.; Cummins, S.; Fay, L.; Jeffrey, R.; Kelly, S.; Kingston, N.; Lockhart, N.; Marnell, F.; Tierney, D.; Wyse Jackson, M. (2019). Checklist of protected and threatened species in Ireland. National Parks and Wildlife Services. Available at: https://www.npws.ie/sites/default/files/publications/pdf/IWM%20116%20Checklists%20Protected%20and%20Threatened%20Species%202019.pdf

[14] Department of Housing, Local Government and Heritage (2022). Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas: Water Sensitive Urban Design Best Practice Interim Guidance Document. Available at: https://www.gov.ie/en/publication/10d7c-nature-based-solutions-to-the-management-of-rainwater-and-surface-water-runoff-in-urban-areas-best-practice-interim-guidance-document/

[15] COACCH Consortium (2022). CO-designing the Assessment of Climate CHange costs. Available at: https://www.coacch.eu.

[16] Bednar-Friedl, B., R. Biesbroek, D.N. Schmidt, P. Alexander, K.Y. Børsheim, J. Carnicer, E. Georgopoulou, M. Haasnoot, G. Le Cozannet, P. Lionello, O. Lipka, C. Möllmann, V. Muccione, T. Mustonen, D. Piepenburg, and L. Whitmarsh (2022) Europe. In: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press.

[17] Climate Change Advisory Council (2021). Carbon Budgets Technical Report. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/Technical%20report%20on%20carbon%20budgets%2025.10.2021.pdf

[18] Joint Oireachtas Committee on Environment and Climate Action (2022). Report on the proposed Carbon Budgets. Available at: https://data.oireachtas.ie/ie/oireachtas/committee/dail/33/joint_committee_on_environment_and_climate_action/reports/2022/2022-02-07_report-on-the-proposed-carbon-budgets_en.pdf

[19] Department of the Taoiseach (2022). Government announces Sectoral Emissions Ceilings – setting Ireland on a pathway to turn the tide on climate change. Available at: gov.ie - Government announces Sectoral Emissions Ceilings – setting Ireland on a pathway to turn the tide on climate change (www.gov.ie)

[20] EPA (2022). Ireland's Provisional Greenhouse Gas Emissions. Available at EPA-Ireland's-Provisional-GHG-Emissions-1990-2021_July-2022v2.pdf

[21] SEAI (2022). Oil Monthly Energy Data for Ireland. Available at: https://www.seai.ie/data-and-insights/seai-statistics/monthly-energy-data/oil/

[22] Central Statistics Office (2022). Quarterly National Accounts Quarter 1 2022 Provisional. Available at: https://www.cso.ie/en/releasesandpublications/ep/p-na/quarterlynationalaccountsquarter12022provisional/headlineeconomicresults/

[23] Central Statistics Office (2022). Census of Population 2022 – Preliminary Results. Available at: Census of Population 2022 - Preliminary Results - CSO - Central Statistics Office

[24] Central Statistics Office (2022). Consumer Price Index. Available at: https://www.cso.ie/en/releasesandpublications/er/cpi/consumerpriceindexmay2022/

[25] Central Statistics Office (2022). Estimated inflation by household characteristics March 2022. Available at: https://www.cso.ie/en/releasesandpublications/frp/frp-eihc/estimatedinflationbyhouseholdcharacteristicsmarch2022/

[26] Department of Finance (2021). Climate Action and Tax Paper Tax Strategy Group – 21/09. Available at: https://assets.gov.ie/198270/61142180-955c-458e-a7fb-695768ddd8e4.pdf

[27] Department of Taoiseach (2020). Programme for Government: Our Shared Future. Available at: https://assets.gov.ie/130911/fe93e24e-dfe0-40ff-9934-def2b44b7b52.pdf

[28] Department of Taoiseach (2022). Climate Action Plan 2021 Progress Report Q4 2021 and Q1 2022. Available at: https://assets.gov.ie/226639/c32c135d-4df3-41a6-9c05-342b01aa0da0.pdf

[29] Department of An Taoiseach (2022). Climate Action Plan 2021 Progress Report Q2 2022. Available at: https://assets.gov.ie/230837/29bcf9bd-cf90-486e-a164-306256655da3.pdf

[30] Houses of the Oireachtas (2022). Cabinet Committees: Dáil Éireann Debate – Wednesday 11 May 2022 Parliamentary Questions (33rd Dáil). Available at: https://www.oireachtas.ie/en/debates/question/2022-05-11/19/#pq_19

[31] The *Building in a Climate Emergency (BIACE)* Research Lab, UCD School of Architecture, Planning and Environmental Policy, for the Irish Green Building Council. Draft Report available at: 22 WLC-IGBC Build Green Now P1 and P2_SW Edit

[32] United Nations Framework Convention on Climate Change (2022). Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on its second session, held in Glasgow from 31 October to 12 November 2021. Available at: https://unfccc.int/sites/default/files/resource/cma2021_10_add1_adv.pdf

[33] Fitzgerald, J. (2021). The Macroeconomic Implications of Carbon Budgets for Ireland. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/documents/cbcbackgroundpapers/MacroEconomicImplications_JF_210914.pdf

[34] Pisani-Ferry, J. (PIIE) (2021). Climate policy is macroeconomic policy, and the implications will be significant. Available at: https://www.piie.com/publications/policy-briefs/climate-policy-macroeconomic-policy-and-implications-will-be-significant

[35] Fiscal Council (2022). Budgetary Assessment: Significant spending pressures to arise in the coming years. Available at: https://www.fiscalcouncil.ie/wp-content/uploads/2022/05/FAR-May-2022-Section-2-Budgetary-Assessment.pdf

[36] McInerney, N. (2022). The Macroeconomic Implications of Climate Change for Central Banks. Available at: https://www.centralbank.ie/docs/default-source/publications/quarterly-bulletins/quarterly-bulletin-signed-articles/macroeconomic-implications-of-climate-change-for-central-banks.pdf?sfvrsn=7

[37] Climate Action and Low Carbon Development (Amendment) Act 2021. Available at: https://www.irishstatutebook.ie/eli/2021/act/32/enacted/en/html

[38] Government of Ireland (2021). Climate Action Plan 2021. Available at: https://www.gov.ie/en/publication/6223e-climate-action-plan-2021/

[39] Mulvey, K. (2022). Just Transition Fourth and Final Progress Report. Available at: https://www.gov.ie/en/publication/e0e7e-climate-action-plan-to-tackle-climate-breakdown-just-transition/

[40] Mulvey, K. (2020). Just Transition Second Progress Report – September 2020. Available at: https://assets.gov.ie/98708/41af24f7-e165-4501-ad86-49a21a180f61.pdf

[41] Mulvey, K. (2020). Just Transition Third Progress Report – December 2020. Available at: https://assets.gov.ie/140425/c9b0f66d-3fc5-4941-b0c7-b7760aa9de1c.pdf

[42] Department of the Environment, Climate and Communications (2021). Minister announces launch of public consultation on Ireland's Territorial Just Transition Plan. Available at: https://www.gov.ie/en/press-release/81d6f-minister-announces-launch-of-public-consultation-on-irelands-territorial-just-transition-plan/

[43] Lanigan, G., Buckley, C., Donnellan, T., Richards, K., Forrestal, P. and Krol, D. (2019) Gaseous Emissions – A Marginal Abatement Cost Curve. Teagasc.

[44] https://www.fao.org/worldfoodsituation/foodpricesindex/en/

[45] World Bank, July 2022, Food Security Update: https://www.worldbank.org/en/topic/agriculture/brief/food-security-update. Accessed July 2022.

[46] Agricultural Market Information System, Jun 2022, The global food security consequences of the war in Ukraine, http://www.amis-outlook.org/news/detail/en/c/1155743/

[47] FAO, IFAD, UNICEF, WFP and WHO. 2022. The State of Food Security and Nutrition in the World 2022. Repurposing food and agricultural policies to make healthy diets more affordable. Rome, FAO. https://doi.org/10.4060/cc0639en

[48] The Economist, 2022, Peatland Rewetting: Reversing the environmental impacts of peatland drainage, on-line article https://carbonremoval.economist.com/peatland-rewetting/ Accessed July 2022

[49] Florence Renou-Wilson, Tom Bolger, Craig Bullock, Frank Convery, Jim Curry, Shane Ward, David Wilson and Christoph Müller, BOGLAND: Sustainable Management of Peatlands in Ireland, STRIVE Report Series No.75, 2011.

[50] Okumah, M., Walker, C., Martin-Ortega, J., Ferré, M., Glenk, K. and Novo, P. (2019) How much does peatland restoration cost? Insights from the UK. University of Leeds – SRUC Report.

[51] Günther, A., Barthelmes, A., Huth, V. et al. (2020) Prompt rewetting of drained peatlands reduces climate warming despite methane emissions. Nat Commun 11, 1644. https://doi.org/10.1038/s41467-020-15499-z

[52] Bord Na Mona, 2022, Restoring raised bogs for a greener future, on-line article, https://www.bordnamona.ie/peatlands/peatland-restoration/. Accessed July 2022.

[53] Duffy, P., et al. (2022) National Inventory Report, 2022.Environmental Protection Agency, Available for download at https://unfccc.int/ghg-inventories-annex-i-parties/2022

[54] EPA, Ireland's Greenhouse Gas Emissions Projections 2021-2040, 2002 Available online at: https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/EPA-Ireland's-GHG-Projections-Report-2021-2040v4.pdf

[55] Dillion, E, Donnellan, T., Moran, B., and Lennon, J., 2022, National Farm Survey 2021 Preliminary Results, Teagasc, on-line presentation https://www.teagasc.ie/publications/2022/teagasc-national-farm-survey-2021-preliminary-results.php. Accessed: August 2022

[56] Duffy, C., O'Donoghue, C., Ryan, M., Styles, D. and Spillane, C. (2020) Afforestation: Replacing livestock emissions with carbon sequestration. *Journal of Environmental Management*, 264, Article 110523.

[57] Climate Change Advisory Council (2021). Carbon Budgets Technical Report. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/Technical%20report%20on%20carbon%20budgets%2025.10.2021.pdf

[58] COM (European Commission) (2020). Communication from the Commission to the European Parliament, the Council, The European Economic and Social Committee and the Committee of the Regions: A Farm to Fork Strategy for a fair, healthy and environmentally friendly food system. COM(2020) 381 final. Available at: https://ec.europa.eu/info/sites/info/files/communication-annex-farm-fork-green-deal_en.pdf

[59] European Environment Agency (2019). The European Environment – State and Outlook 2020: Knowledge for Transition to a Sustainable Europe. Available at: https://www.eea.europa.eu/publications/soer-2020

[60] European Environment Agency (2017). Food in a green light: a systems approach to sustainable food. EEA Report No 16/2017.

[61] Committee on Climate Change (2020). Reducing UK emissions Progress Report to Parliament. Available at: https://www.theccc.org.uk/wp-content/uploads/2020/06/Reducing-UK-emissions-Progress-Report-to-Parliament-Committee-on-Cli.._-002-1.pdf

[62] IPCC (2018). Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

[63] EFSA FEEDAP Panel (EFSA Panel on Additives and Products or Substances used in Animal Feed), Bampidis, V., Azimonti, G., Bastos, M.L., Christensen, H., Dusemund, B., Fašmon Durjava, M., Kouba, M., López-Alonso, M., López Puente, S., Marcon, F., Mayo, B., Pechová, A., Petkova, M., Ramos, F., Sanz, Y., Villa, R.E., Woutersen, R., Aquilina, G., Bories, G., Brantom, P.G., Gropp, J., Svensson, K., Tosti, L., Anguita, M., Galobart, J., Manini, P., Tarrès-Call, J. and Pizzo, F. (2021) Scientific Opinion on the safety and efficacy of a feed additive consisting of 3-nitrooxypropanol (Bovaer® 10) for ruminants for milk production and reproduction (DSM Nutritional Products Ltd). EFSA Journal 2021;19(11):6905, 35 pp. https://doi.org/10.2903/j.efsa.2021.6905

[64] Coggin, C., 2022, The Dutch Nitorgen Crisis, FAIRR, on-line article https://www.fairr.org/article/the-dutch-nitrogen-crisis/. Access July 2022.

[65] IPCC (2019). Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.

[66] COM (European Commission) (2018). In-depth analysis in support on the COM(2018) 773: A Clean Planet for all – A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy. Available at: https://knowledge4policy.ec.europa.eu/publication/depth-analysis-support-com2018-773-clean-planet-all-european-strategic-long-term-vision_en

[67] Smith, L.G., Kirk, G.J.D., Jones, P.J. et al. The greenhouse gas impacts of converting food production in England and Wales to organic methods. Nat Commun 10, 4641 (2019). https://doi.org/10.1038/s41467-019-12622-7

[68] Wallace, M., Economic Impact Assessment of the Tillage Sector in Ireland, July 2020, School of Agriculture and Food Science, University College Dublin. Published by: Tillage Industry Ireland. http://tillageindustryireland.ie/wp-content/uploads/2020/07/Economic-Impact-Assessment-of-the-Tillage-Sector-in-Ireland.pdf

[69] Houses of Parliament, POSTnote Number 418 September 2012 Balancing Nature and Agriculture, London, Sept. 2012, https://post.parliament.uk/research-briefings/post-pn-418/

[70] Gorman et al. (2021). Small Scale Study of the Impacts of Climate Change Mitigation Measures on Biodiversity. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/documents/cbcbackgroundpapers/Gorman_etal_CCAC_Biodiversity.pdf

[71] Reidsma et al. (2006). Impacts of land-use change on biodiversity: An assessment of agricultural biodiversity in the European Union. Available at: https://doi.org/10.1016/j.agee.2005.11.026

[72] EU Commission (2022). Key Policy Objectives of the new CAP. Available at: https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/new-cap-2023-27/key-policy-objectives-new-cap_en

[73] Department of Agriculture, Food and Marine (2022). The CAP Strategic Plan 2023-2027. Available at: https://www.gov.ie/en/publication/76026-common-agricultural-policy-cap-post-2020/

[74] Boinot, S., Barkaoui, K., Mézière, D. et al. Research on agroforestry systems and biodiversity conservation: what can we conclude so far and what should we improve? BMC Ecol Evo 22, 24 (2022). https://doi.org/10.1186/s12862-022-01977-z

[75] Hallstein, E., and Iseman, T. (2021) Nature-based solutions in agriculture – Project design for securing investment. Virginia. FAO and The Nature Conservancy. Available at: https://doi.org/10.4060/cb3144en

[76] Hallstein, E., and Iseman, T. (2021) ibid. & Best, M. and Hochstrasser, T. (2022). Detecting and avoiding impasse mechanisms for nature-based approaches to climate change adaptation in Ireland. Working Paper No. 10. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/publications/Working%20Paper%20No.%2010%20Nature-based%20Adaptation%20impasses%20in%20Ireland.pdf

[77] SEAI (2022). Sustainable Bioenergy for Heat. Available at: https://www.seai.ie/publications/Sustainable-Bioenergy-for-Heat.pdf

[78] https://www.hse.ie/eng/services/list/5/publichealth/publichealthdepts/env/

[79] Climate Change Advisory Council (2021). Annual Review 2021. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/publications/CCAC_AnnualReview_2021.pdf

[80] Melissa R. Marselle, et al, Pathways linking biodiversity to human health: A conceptual framework, Environment International, Volume 150, 2021, 106420, ISSN 0160-4120, https://doi.org/10.1016/j.envint.2021.106420

[81] OECD (2021), Making Better Policies for Food Systems, OECD Publishing, Paris, https://doi.org/10.1787/ddfba4de-en.

[82] Baldock, D. and Buckwell, A. (2021) Just Transition in the EU agriculture and land use sector, Institute for European Environmental Policy. Available at: https://ieep.eu/uploads/articles/attachments/8d472ed3-cc73-428c-b9cd-da67e1e229c2/Just%20transition%20in%20the%20EU%20agriculture%20land%20use%20sector%20-%20IEEP%20(2022).pdf?v=63809716825

[83] Driscoll, L. (2021) Supporting a Just Transition for Agriculture. *Stray Dog Institute*. Available at: https://straydoginstitute.org/just-transition/#:~:text=The%20idea%20of%20a%20just%20transition%20in%20agriculture,fair%20use%20of%20human%2C%20financial%2C%20and%20environmental%20resources

[84] Anderson, T. and Kwizera, S. (2020) Principles for Just Transitions in extractives and ag. *Actionaid*. Available at: https://actionaid.org/sites/default/files/publications/Principles%20for%20Just%20Transitions%20in%20Extractives%20%26%20Agriculture.pdf

[85] Just Transition Centre (2018). Just Transition: A Business Guide. Available at: https://bteam.org/assets/reports/Just-Transition-A-Business-Guide.pdf#:~:text=At%20the%20company%20level%2C%20a%20just%20transition%20is,new%20job%20creation%2C%20social%20inclusion%20and%20community%20renewal

[86] Gov.uk (2021). 'UK enshrines new target in law to slash emissions by 78% by 2035' 21 April 2021. Available at: https://www.gov.uk/government/news/uk-enshrines-new-target-in-law-to-slash-emissions-by-78-by-2035#:~:text=change%20and%20energy-,UK%20enshrines%20new%20target%20in%20law,emissions%20by%2078%25%20by%202035&text=The%20UK's%20sixth%20Carbon%20Budget,to%20net%20zero%20by%202050

[87] Haut Conseil pour le Climat (2021). 'COP26: IMPLICATIONS ET OPPORTUNITÉS POUR LA POLITIQUE CLIMATIQUE DE LA FRANCE' 16 December 2021. Available at: https://www.hautconseilclimat.fr/actualites/cop26-implications-et-opportunites-pour-la-politique-climatique-de-la-france/

[88] Central Statistics Office (2022). THA21 Average weekly volume of cars for selected traffic count sites. Available at: https://data.cso.ie/table/THA21

[89] Central Statistics Office (2022). THA22 Average weekly volume of heavy goods vehicles for selected traffic count sites. Available at: https://data.cso.ie/table/THA22

[90] Santos, S.; Grilo, C.; Shilling, F.; Bhardwaj, M.; Papp, C.R. (2022). Ecological Solutions for Linear Infrastructure Networks: The key to green infrastructure development. *Nature Conservation*. Available at: https://natureconservation.pensoft.net/article/81795/element/4/432//

[91] European Environment Agency (2016). Transport and ecosystems. Available at: https://www.eea.europa.eu/signals/signals-2016/articles/transport-and-ecosystems

[92] McKinsey (2021). Socioeconomic implications of a net zero transition. Paper produced for the Climate Change Advisory Council. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/Socioeconomic%20implications%20of%20a%20net%20zero%20transition.pdf

[93] European Commission (2016). A European Strategy for Low-Emission Mobility. Available at: https://www.eea.europa.eu/policy-documents/a-european-strategy-for-low

[94] Caulfield, B., Carroll, P., Ahern, A. (2020). 'Transitioning to low carbon and sustainable mobility', Working Paper No.8 September 2020, Climate Change Advisory Council https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/publications/Working%20Paper%20No.%208.pdf

[95] OECD (2022 forthcoming). Transforming transport for netzero: towards Irish transport systems that work for people and the planet. Draft copy, accessed July 2022, subject to review. Publication forthcoming October 2022 to be available at www.climatecouncil.ie and www.oecd.org

[96] Caulfield, B., Furszyfer, D., Stefaniec, A. et al (2022). 'Measuring the equity impacts of government subsidies for electric vehicles' Energy 248 (2022) 123588 http://www.tara.tcd.ie/bitstream/handle/2262/98192/Caulfield%20et%20al%202022.pdf?sequence=1

[97] Mattioli et al. (2020). The political economy of car dependence: A systems of provision approach. *Energy Research & Social Science*, 66. Available at: https://doi.org/10.1016/j.erss.2020.101486

[98] Numbeo Online (2023). Europe: Prices by City of Monthly Pass (Regular Price) (transportation). Available at: https://www.numbeo.com/cost-of-living/region_prices_by_city?itemId=20&region=150 Accessed 28/07/2022.

[99] Leape, Jonathan, (2006). 'The London Congestion Charge.' Journal of Economic Perspectives, 20 (4): 157-176. DOI: 10.1257/jep.20.4.157

[100] Transport for London Online (2022). Encouraging cycling and walking. Available at: https://tfl.gov.uk/corporate/about-tfl/how-we-work/planning-for-the-future/encouraging-cycling-and-walking 21/07/2022

[101] City of Stockholm (2012). Urban Mobility Strategy. www.stockholm.se/trafikkontoret Available in English at: https://international.stockholm.se/globalassets/ovriga-bilder-och-filer/urban-mobility-strategy.pdf

[102] NTA and Sustrans (2020). Bike Life – Dublin Metropolitan Area. Dublin: NTA. Bike Life 2019 Dublin Metropolitan Area - National Transport

[103] Society of the Irish Motor Industry (2022). Motorstats – New Online Vehicle Statistics System. Available at: https://www.simi.ie/en/motorstats

[104] France24 Online (2022). SUVs targeted in new French 'weight tax'. 15/10/2020 Available at https://www.france24.com/en/live-news/20201015-suvs-targeted-in-new-french-weight-tax accessed on 21/07/2022

[105] Zhang, S.x & Kanellos, N.V. (2021). Urban Logistics and Decarbonisation; presentation given to Haulage Strategy Webinar on 16 June 2021. Available at: https://assets.gov.ie/137783/df9de114-cb28-4645-81da-14d595781760.pdf

[106] An Post (2020). 'Dublin becomes first Capital City globally with zero emissions postal delivery' 07 February 2020. Available at: https://www.anpost.com/Media-Centre/News/Dublin-becomes-first-Capital-City-globally-with-ze

[107] Department for Transport (2018). The Road to Zero: Next steps towards cleaner road transport and delivering our Industrial Strategy. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf

[108] Rees, T. (2022). 'Volvo electric lorry will travel 600 miles on a single charge' 29 May 2022. Telegraph. Available at: https://www.telegraph.co.uk/business/2022/05/29/volvo-electric-lorry-will-travel-600-miles-single-charge/

[109] Fleet (2022). Scania launches electric truck solutions for regional transport. Available at: https://fleet.ie/scania-launches-electric-truck-solutions-for-regional-transport/

[110] Senator Project (2022). Available at: https://www.senatorproject.eu/

[111] Econostrum [Online] (2022). LoLo or Ro-Ro: A Strategic Choice. Available at: https://en.econostrum.info/LoLo-or-Ro-Ro-A-Strategic-choice_a320.html Accessed on 28/07/2022

[112] European Commission, Directorate-General for Energy, Lee, L., Rademaekers, K., Bovy, P., et al., (2021). Study on energy subsidies and other government interventions in the European Union : final report, Publications Office, 2021, https://data.europa.eu/doi/10.2833/513628

[113] CSO (2021). Fossil Fuel Subsidies 2020. Online. Available at: https://www.cso.ie/en/releasesandpublications/ep/p-ffes/fossilfuelsubsidies2020/

[114] The National Oil Reserves Agency (2022). The Biofuels Obligation Scheme Annual Report 2021. Available at: https://www.nora.ie/_fileupload/457-22X0084%20-%20BOS%20Annual%20Report%202021%20for%20publication.pdf

[115] Department for Transport [UK] (2021). Consultation on when to phase out the sale of new, non-zero emissions heavy goods vehicles. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1009791/consultation-on-when-to-phase-out-the-sale-of-new-non-zero-emission-heavy-good-vehicles.pdf Accessed on 28/07/2022.

[116] NNFCC (2019). Implications of Imported Used Cooking Oil (UCO) as a Biodiesel Feedstock. Available at: https://www.nnfcc.co.uk/files/mydocs/UCO%20Report.pdf

[117] EPA Press Release (2022). Ireland's power generation and industrial emissions increase by 15 percent in 2021. Available at: https://www.epa.ie/news-releases/news-releases-2022/irelands-power-generation-and-industrial-emissions-increase-by-15-percent-in-2021.php

[118] SEAI (2021). Interim Energy Balance. Available at: https://www.seai.ie/data-and-insights/seai-statistics/key-publications/national-energy-balance/#comp00006023933e000000bbbe3751

[119] SEAI (2021). Energy in Ireland 2021 Report. Available at: https://www.seai.ie/publications/Energy-in-Ireland-2021_Final.pdf

[120] EPA (2021). Ireland's Greenhouse Gas Emissions Projections 2020-2040. Available at: https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-greenhouse-gas-emissions-projections-2020-2040.php

[121] SEAI (2021). Interim Energy Balance. Available at: https://www.seai.ie/data-and-insights/seai-statistics/key-publications/national-energy-balance/

[122] Department of the Environment, Climate and Communications Press Release (2022). Ireland moves a step closer to energy independence. Available at: https://www.gov.ie/en/press-release/f4c68-ireland-moves-a-step-closer-to-energy-independence/

[123] Department of the Environment, Climate and Communications (2021). Renewable Electricity Support Scheme – Schedule of Future Auctions. Available at: https://www.gov.ie/en/publication/8b63a-renewable-electricity-support-scheme-schedule-of-future-auctions/

[124] EirGrid (2022). Electricity Grid to Run on 75% Variable Renewable Generation Following Successful Trial. Available at: https://www.eirgridgroup.com/newsroom/electricity-grid-to-run-o/index.xml

[125] See: https://ec.europa.eu/clima/eu-action/european-green-deal/european-climate-law_en

[126] EirGrid and SONI (2021). All-Island Generation Capacity Statement. Available at: http://www.eirgridgroup.com/site-files/library/EirGrid/208281-All-Island-Generation-Capacity-Statement-LR13A.pdf

[127] Department of the Environment, Climate and Communications (2021) Micro-generation Support Scheme (MSS). Available at: https://www.gov.ie/en/publication/b1fbe-micro-generation/

[128] Commission for Regulation of Utilities (2022). Remuneration of Renewables Self-consumers for exported electricity. Available at: https://www.cru.ie/document_group/remuneration-of-renewables-self-consumers-exported-electricity/

[129] European Commission (2022). EU Solar Energy Strategy. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A221%3AFIN&qid=1653034500503

[130] CSO (2022). Data Centres Metered Electricity Consumption 2021. Available at: https://www.cso.ie/en/releasesandpublications/ep/p-dcmec/datacentresmeteredelectricityconsumption2021/

[131] DECC (2022) Renewable Electricity Corporate Power Purchase Agreements Roadmap. Available at: https://www.gov.ie/en/publication/a0d2e-renewable-electricity-corporate-power-purchase-agreements-roadmap/

[132] DETE (2022) Government Statement on the Role of Data Centres in Ireland's Enterprise Strategy. Available at: https://enterprise.gov.ie/en/publications/government-statement-on-role-of-data-centres-in-enterprise-strategy.html

[133] Cohen, P. (2022) Microsoft's Dublin, Ireland data center to put power back on the grid. *Enterprise IoT Insights*. Available at: https://enterpriseiotinsights.com/20220712/energy/microsofts-dublin-ireland-data-center-to-put-power-back-on-the-grid

[134] European Commission Press Release (2022). REPowerEU: Joint European action for more affordable, secure and sustainable energy. Available at: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1511

[135] EirGrid and SONI (2021). Winter Outlook 2021/22. Available at: https://www.eirgridgroup.com/site-files/library/EirGrid/Winter-Outlook-2021-2022.pdf

[136] Department of the Environment, Climate and Communications (2021). Policy Statement on Security of Electricity Supply. Available at: https://www.gov.ie/en/publication/a4757-policy-statement-on-security-of-electricity-supply/

[137] Department of the Environment, Climate and Communications (2022). National Energy Security Framework. Available at: https://www.gov.ie/en/publication/ea9e4-national-energy-security-framework/

[138] MaREI (2022). Climate Action in Ireland is not following Climate Ambition. Available at: https://www.marei.ie/climate-action-in-ireland-is-not-following-climate-ambition/

[139] Commission for Regulation of Utilities (2021). Security of Electricity Supply – Programme of Actions. Available at: https://www.cru.ie/document_group/security-of-electricity-supply-programme-of-actions/

[140] See; https://www.gov.ie/en/consultation/d1177-notice-of-application-to-an-bord-pleanala-by-the-minister-for-the-environment-climate-and-communications/

[141] EirGrid and SONI (2021). All-Island Generation Capacity Statement 2021-2030. Available at: http://www.eirgridgroup.com/site-files/library/EirGrid/208281-All-Island-Generation-Capacity-Statement-LR13A.pdf

[142] SEAI (2020). Energy Security in Ireland 2020 Report. Available at: https://www.seai.ie/publications/Energy-Security-in-Ireland-2020-.pdf

[143] Department for Business, Energy & Industrial Strategy (2022) Policy Paper: Atmospheric implications of increased hydrogen use. Available at: https://www.gov.uk/government/publications/atmospheric-implications-of-increased-hydrogen-use

[144] Designing policy for sustainable technology (2022) Niall Farrell. Economic and Social Research Institute Trinity College Dublin Queen's Management School, Queen's University Belfast. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/publications/FINAL%20SSS%20Hydrogen%20Paper%20-%20Niall%20Farrell%20-%2019.07.2022.pdf

[145] ACER (2022). ACER's Preliminary Assessment of Europe's High Energy Prices and the Current Wholesale Electricity Market Design. Available at; https://www.acer.europa.eu/sites/default/files/documents/Publications/ACER%26%23039%3Bs%20Final%20Assessment%20of%20the%20EU%20Wholesale%20Electricity%20Market%20Design.pdf

[146] IPCC (2022) AR6 Working Group III Report, Summary for Policymakers, SPM7. Available at: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_SPM.pdf

[147] EirGrid (2021). Shaping Our Electricity Future Roadmap. Available at: https://www.eirgridgroup.com/site-files/library/EirGrid/Shaping_Our_Electricity_Future_Roadmap.pdf

[148] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=PI_COM%3AC%282022%293219&qid=1653033569832

[149] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A222%3AFIN&qid=1653033811900

[150] MaREI and OPR (2022). Climate Action and the Local Authority Development Plan. Available at: https://www.marei.ie/local-authority-plans-could-make-contribution-to-climate-change/

[151] ESRI Working Paper (2022). The impact of planning and regulatory delays for major energy infrastructure, ESRI Working Paper. Available at: https://www.esri.ie/publications/the-impact-of-planning-and-regulatory-delays-for-major-energy-infrastructure

[152] Social Justice Ireland (2021). Energy Poverty and a Just Transition. Available at: https://www.socialjustice.ie/content/policy-issues/energy-poverty-and-just-transition

[153] House of the Oireachtas (2022). Mr William Walsh CEO, Sustainable Energy Authority of Ireland Opening address to the Joint Committee on Environment and Climate Action. Available at: https://data.oireachtas.ie/ie/oireachtas/committee/dail/33/joint_committee_on_environment_and_climate_action/submissions/2022/2022-04-05_opening-statement-william-walsh-ceo-sustainable-energy-authority-of-ireland-seai_en.pdf

[154] ESRI Research Bulletin (2022). Are fuel poverty metrics fit for purpose? Evidence from Ireland. Available at: https://www.esri.ie/publications/are-fuel-poverty-metrics-fit-for-purpose-evidence-from-ireland

[155] CSO (2022). Domestic Building Energy Ratings, Quarter 1, 2022. Available at: https://www.cso.ie/en/releasesandpublications/er/dber/domesticbuildingenergyratingsquarter12022/

[156] Alex Opoku (2019). Biodiversity and the built environment: Implications for the Sustainable Development Goals (SDGs). *Resources, Conservation and Recycling*. 141, pp. 1-7. Available at: https://doi.org/10.1016/j.resconrec.2018.10.011

[157] Stafford, R., Chamberlain, B., Clavey, L., Gillingham, P.K., McKain, S., Morecroft, M.D., Morrison-Bell, C. and Watts, O. (Eds.) (2021) Nature-based Solutions for Climate Change in the UK: A Report by the British Ecological Society. London, UK. Available at: https://www.britishecologicalsociety.org/policy/nature-based-solutions/

[158] SEAI (2022) Online: Prices 6th June 2022; https://www.seai.ie/data-and-insights/seai-statistics/key-statistics/prices/#comp00005cb739ab0000000838246e

[159] Clinch, J.P. and Healy J.D. (2000). Housing standards and excess winter mortality. *Journal of Epidemiology & Community Health*, 54(9), 719-720. Available at: https://jech.bmj.com/content/54/9/719

[160] IERC (2021). Creating Shared Value for all: The multiple benefits of a retrofit renovation wave in Ireland. International Energy Research Centre (IERC), Ireland. Available at: http://www.ierc.ie/wpcontent/uploads/2021/04/IERC-Retrofit-Co-Benefits-Paper_Final_Digital.pdf

[161] Coyne, B., Petrov, I., Ryan, L., Denny, E. (2021); 'ReHeat: Review of the Irish Heat Sector – Policies, Technologies, and Best Practice'; https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/publications/Working%20Paper%20No.%209%20ReHeat.pdf

[162] Gov.ie (2022) Online: 'Record number of people register as apprentices – Minister Harris' 24th January 2022; https://www.gov.ie/en/press-release/8fe8d-record-number-of-people-register-as-apprentices-minister-harris/#:~:text=Minister%20for%20Further%20and%20Higher,8%2C607%20new%20registrations%20in%202021.

[163] CSO (2017); Census 2016 Main Results; Online https://www.cso.ie/en/releasesandpublications/ep/p-copep/thecensusofpopulationfromanenvironmentperspective2011and2016/mainresults/

[164] Coillte (2021). '90% of Irish Adults Don't know the Irish Forestry Industry Can Supply Enough Wood to Build Over 44,000 New Irish Homes Per Annum'. 21 September 2021. Available at: https://www.coillte.ie/90-of-irish-adults-dont-know-the-irish-forestry-industry-can-supply-enough-wood-to-build-over-44000-new-irish-homes-per-annum/

[165] Garg, C. and Jain, A. (2014) Green Concrete: Efficient & Eco-Friendly Construction Materials. IMPACT: International Journal of Research in Engineering & Technology. 2(2), pp. 259-262. Available at: https://oaji.net/articles/2014/489-1393938775.pdf

[166] Hemp Cooperative Ireland (2022) 7 Pillars of Hemp: Sustainable Construction. Available at: https://hempcooperativeireland.com/7-pillars-of-hemp/sustainable-construction/

[167] The International Bamboo and Rattan Organisation (INBAR) is an intergovernmental development organisation that promotes environmentally sustainable development using bamboo and rattan. INBAR attended COP 26 in Glasgow to promote sustainable bamboo construction. Further information on INBAR can be found at: https://www.inbar.int/ and their presentation at COP 26 can be found at: https://www.inbar.int/inbar-at-cop-26/

[168] European Commission, Directorate-General for Climate Action, Directorate-General for Energy, Directorate-General for Mobility and Transport, De Vita, A., Capros, P., Paroussos, L., et al., EU reference scenario 2020: energy, transport and GHG emissions: trends to 2050, Publications Office, 2021, https://data.europa.eu/doi/10.2833/35750

[169] Department of Public Expenditure and Reform (2021). Ireland's National Recovery and Resilience Plan 2021. Available at: https://www.gov.ie/en/publication/d4939-national-recovery-and-resilience-plan-2021/

[170] Climate Toolkit 4 Business (2022). Available at: https://www.climatetoolkit4business.gov.ie/

[171] EPA (2022). Manufacturing & Industry. Available at: https://www.epa.ie/our-services/monitoring--assessment/climate-change/ghg/manufacturing-and-industry/

[172] Toward Zero Carbon (2019). Analysis of CO_2 Emissions in the Enterprise Sector. Available at: https://tzc.ie/co2-emission-enterprise-sector/

[173] SEAI (2022). National Heat Study – Low Carbon Heating and Cooling Technologies: Options, Costs, Performance, and Suitability. Available at: https://www.seai.ie/publications/Low-Carbon-Heating-and-Cooling-Technologies.pdf

[174] IPCC (2022). Strengthening and Implementing the Global Response. In Global Warming of 1.5°C: IPCC Special Report on Impacts of Global Warming of 1.5°C above Pre-industrial Levels in Context of Strengthening Response to Climate Change, Sustainable Development, and Efforts to Eradicate Poverty (pp. 313-444). Cambridge: Cambridge University Press. doi:10.1017/9781009157940.006. Available at: https://www.cambridge.org/core/books/global-warming-of-15c/strengthening-and-implementing-the-global-response/51C0BCDC8572D2705245720919BF03F5

[175] Maddedu et al. (2021). The CO_2 reduction potential for the European industry via direct electrification of heat supply (power-to-heat). *Environmental Research Letters*. Available at: https://iopscience.iop.org/article/10.1088/1748-9326/abbd02

[176] ICE (2022). Low Carbon Concrete Routemap. Available at: https://www.ice.org.uk/knowledge-and-resources/briefing-sheet/low-carbon-concrete-routemap

[177] Irish Green Building Council (2021). Net Zero Whole Life Carbon Roadmap for the Built Environment in Ireland, Preliminary Recommendations: Vision for 2050. Available at: https://www.igbc.ie/wp-content/uploads/2021/11/IGBC-PRELIMINARY-RECOMMENDATIONS-REPORT-11-11-2021.pdf

[178] International Energy Agency (2021) Tracking Report, Cement. Available at: https://www.iea.org/reports/cement

[179] European Commission (2021). Evaluation and impact assessment for amending Regulation (EU) No 517/2014 on fluorinated greenhouse gases. Available at: https://ec.europa.eu/clima/system/files/2021-05/20210506_briefing_en.pdf

[180] European Commission (2022). EU legislation to control F-gases. Available at: https://ec.europa.eu/clima/eu-action/fluorinated-greenhouse-gases/eu-legislation-control-f-gases_en

[181] Department of the Environment, Climate and Communications (2020). Waste Action Plan for a Circular Economy. Available at: https://www.gov.ie/en/publication/4221c-waste-action-plan-for-a-circular-economy/

[182] Department of the Environment, Climate and Communications (2021). Whole of Government Circular Economy Strategy 2022-2023 'Living More, Using Less. Available at: https://www.gov.ie/en/publication/b542d-whole-of-government-circular-economy-strategy-2022-2023-living-more-using-less/

[183] EPA (2021). Factsheet on Packaging Waste in Ireland in 2019. Available at: https://www.epa.ie/publications/monitoring--assessment/waste/national-waste-statistics/Packaging-Waste-Ireland-2019.pdf

[184] Convention on Biological Diversity (2018). Biodiversity Mainstreaming in the Manufacturing and Processing Sector. Available at: https://www.cbd.int/doc/c/b23c/f96f/93d4a6e1f9d48a55f9e287a4/sbi-02-04-add4-en.pdf#:~:text=Impacts%20on%20biodiversity%20vary%20across%20manufacturing%20industries%2C%20and,cturing%20companies%20generate%20both%20direct%20%28e.g.%2C%20factory%20location

[185] WBCSD (2022). Vision 2050 Infographic. Available at: https://www.wbcsd.org/download/file/12184 and WBCSD (2022). Vision 2050: Time to Transform. Available at: https://www.wbcsd.org/Overview/About-us/Vision-2050-Time-to-Transform

[186] Hamilton, H., Reynolds, N. and McMahon, C. (2019). Business in the Community Ireland's Biodiversity Handbook for Business. BITCI, Dublin, Ireland. Available at: https://www.bitc.ie/wp-content/uploads/2019/02/Biodiversity-for-Business.pdf

[187] Business for Biodiversity (2022). Available at: https://www.businessforbiodiversity.ie/

[188] Just Transition Centre (2018). Just Transition: A Business Guide. Available at: https://bteam.org/assets/reports/Just-Transition-A-Business-Guide.pdf#:~:text=At%20the%20company%20level%2C%20a%20just%20transition%20is,new%20job%20creation%2C%20social%20inclusion%20and%20community%20renewal

[189] Phillips, C., Murphy, C. (2021) Solastalgia, place attachment and disruption: insights from a coastal community on the front line. Available at: https://link.springer.com/article/10.1007/s10113-021-01778-y

[190] Clarke, D., Murphy, C., Lorenzoni, I. (2018) Place attachment, disruption and transformative adaptation. Available at: https://www.sciencedirect.com/science/article/pii/S0272494417301834

[191] Wilby, R. (2022) Well informed adaptation decision making under uncertainty. Paper for the Climate Change Advisory Council. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/publications/Working%20Paper%20No.%2012%20Decision%20making%20under%20uncertainty.pdf

[192] Climate Change Advisory Council (2019) Progress towards a Climate-Resilient Ireland: Review of Statutory Sectoral Adaptation Plan Making 2018-2019. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/publications/Climate%20Change%20Advisory%20Council%20Review%20of%20Sectoral%20Adaptation%20Plan%20Making%202018%202019.pdf

[193] Devoy, R.J.N. (2022) Sea-Level Rise: Causes, Impacts and Scenarios for Change. Available at: https://www.sciencedirect.com/science/article/pii/B978012396483000008X

[194] Devoy, R.J.N., Cummins, V., Brunt, B., Bartlett, D.,Kandrot, S. (2021) The Coastal Atlas of Ireland. Cork University Press.

[195] Pasimeni, M. R., Valente, D., Zurlini, G., Petrosillo, I. (2019) The interplay between urban mitigation and adaptation strategies to face climate change in two European countries. Environmental Science & Policy. pp. 20-27. Available at: https://www.sciencedirect.com/science/article/abs/pii/S1462901118311274?via%3Dihub

[196] Smith, G., LeTissier, M., O'Hagan, A.M., Farrell, E.J. (2022) Policy Coherence for Climate Change Adaptation at the Land-Sea Interface in Ireland. Planning Practice & Research. pp. 173-188. Available at: https://www.tandfonline.com/doi/abs/10.1080/02697459.2021.1991657

[197] Haut Conseil pour le Climat (2021). Renforcer l'attenuation, Engager l'Adaptation. Available at: https://www.hautconseilclimat.fr/publications/rapport-annuel-2021-renforcer-lattenuation-engager-ladaptation/

[198] UK Climate Change Committee (2019). Progress in preparing for climate change – 2019 Progress Report to Parliament. Available at: https://www.theccc.org.uk/publication/progress-in-preparing-for-climate-change-2019-progress-report-to-parliament

[199] Climate Change Advisory Council (2021). Building resilience and capacities for Ireland's coastal future. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/documents/Coastal%20Reflection%20and%20Learning%20Workshop%20Report%202021.pdf

[200] Adger, W. N., I. Brown and S. Surminski (2018). Advances in risk assessment for climate change adaptation policy. 13 Philosophical Transactions of the Royal Society a-Mathematical Physical and Engineering Sciences, 376(2121), doi:10.1098/rsta.2018.0106.

[201] Department of Foreign Affairs (2020). Ireland's Climate and Environmental Finance Report 2019. Available at: https://www.irishaid.ie/media/irishaid/publications/21-008-Climate-Finance-Report_Final---digitial.pdf

[202] Eriksen, S.; Schipper, E.L.F.; Scoville-Simonds, M.; Vincent, K.; Adam, H.N.; Brooks, N.; Harding, B.; Lenaerts, L.; Liverman, D.; Mills-Novoa, M.; Mosberg, M. (2021). Adaptation interventions and their effect on vulnerability in developing countries: Help, hindrance or irrelevance? Available at: https://www.sciencedirect.com/science/article/pii/S0305750X20305118?via%3Dihub

[203] Soanes, M., Shakya, C., Barrett, S., Steinbach, D., Nisi, N.,; Smith, B., Murdoch, J. (2021) Follow the money: tracking Least Developed Countries' adaptation finance to the local level. Available at: https://pubs.iied.org/20326iied

[204] Breil, M., Zandersen, M., Pishmisheva, P., Pedersen, A.B., Romanovska, L., Coninx, I., Rogger, M., Johnson, K. (2021) 'Leaving No One Behind' in Climate Resilience Policy and Practice in Europe Overview of Knowledge and Practice for Just Resilience. EEA Research. Available at: https://www.eionet.europa.eu/etcs/etc-cca/products/etc-cca-reports/tp_2-2021

[205] Scott, M., O'Neill, E. (2022) Opportunities for individual, household and community level climate change adaptation in Ireland. Paper for the Climate Change Advisory Council. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/publications/Working%20Paper%20No.%2011%20Household%20adaptation.pdf

[206] UK Climate Change Committee (2022). The Just Transition and climate change adaptation. Available at: https://www.theccc.org.uk/wp-content/uploads/2022/03/CCC-The-just-transition-and-climate-change-adaptation.pdf

[207] O'Neill, S., Gleeson, C., Torney, D.; Mercier, S., Daly, C., Wall, R. (2022), Environmental Justice in Ireland: Key dimensions of environmental and climate injustice experienced by vulnerable and marginalised communities. Irish Research Council. Available at: https://communitylawandmediation.ie/environmental-justice-in-ireland/

[208] Farrell, N., De Bruin, K. (2019) Just Resilience and Adaptation in Ireland: Sectors and Regions. ESRI. Available at: https://www.esri.ie/current-research/just-resilience-and-adaptation-in-ireland-sectors-and-regions

[209] Best, M.,; Hochstrasser, T. (2022) Detecting and avoiding impasse mechanisms for nature-based approaches to climate change adaptation in Ireland. Paper for the Climate Change Advisory Council. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/publications/Working%20Paper%20No.%2010%20Nature-based%20Adaptation%20impasses%20in%20Ireland.pdf

[210] Schipper, L. (2020) Maladaptation: When Adaptation to Climate Change Goes Very Wrong, One Earth, 3(4), pp. 409-414.

[211] Costinot, A., Donaldson, D., Smith, C. (2016) Evolving comparative advantage and the impact of climate change in agricultural markets: Evidence from 1.7 million fields around the world. Journal of Political Economy. Available at: https://www.journals.uchicago.edu/doi/abs/10.1086/684719

[212] Anderson, S.E., Anderson, T.L., Hill, A.C., Kahn, M.E., Kunreuther, H., Libecap, G.D., Mantripragada, H., Mérel, P. Plantinga, A.J. Kerry Smith, V. (2019) The critical role of markets in climate change adaptation. Climate Change Economics. Available at: https://www.worldscientific.com/doi/abs/10.1142/S2010007819500039

[213] Benzie, M., Carter. T.R., Carlsen, H., Taylor, R. (2019) Cross-border climate change impacts: implications for the European Union. Regional Environmental Change. Available at: https://link.springer.com/article/10.1007/s10113-018-1436-1

[214] Adams, K.; Harris, K.; Klein, R.J.T.; Lager, F.; Benzie, M. (2020). Climate-Resilient Trade and Production: The Transboundary Effects of Climate Change and Their Implications for EU Member States. Adaptation Without Borders Policy Brief. SEI, ODI, IDDRI. Available at: https://www.sei.org/publications/climateresilient-trade-production-transboundary-eu/

[215] Levermann, A. (2014). Climate economics: make Supply chains climate smart. Nature. Available at: https://www.nature.com/articles/506027a

[216] Carter, T.R.; Benzie, M.; Campiglio, E.; Carlsen, H.; Fronzek, S.; Hildén, M.; Reyer, C.P.; West, C. (2021). A conceptual framework for cross-border impacts of climate change. Global Environmental Change. Available at: https://www.sciencedirect.com/science/article/pii/S0959378021000868

[217] Anderson, S.E.; Anderson, T.L.; Hill, A.C.; Kahn, M.E.; Kunreuther, H.; Libecap, G.D.; Mantripragada, H.; Mérel, P.; Plantinga, A.J.; Kerry Smith, V. (2019). The critical role of markets in climate change adaptation. Climate Change Economics. Available at: https://www.worldscientific.com/doi/abs/10.1142/S2010007819500039

[218] European Environment Agency (2022). Economic losses and fatalities from weather- and climate-related events in Europe. Available at: https://www.eea.europa.eu/publications/economic-losses-and-fatalities-from

[219] Niall McInerney (2022). The Macroeconomic Implications of Climate Change for Central Banks. Central Bank of Ireland. Available at: https://www.centralbank.ie/docs/default-source/publications/quarterly-bulletins/quarterly-bulletin-signed-articles/macroeconomic-implications-of-climate-change-for-central-banks.pdf?sfvrsn=7

[220] CCAC (2020). Annual Review 2020. Available at: https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/publications/CCAC_AnnualReview2020FINAL.pdf

[221] Matthews, T.; Mullan, D.; Wilby, R.L.; Broderick, C.; Murphy, C. (2016). Past and future climate change in the context of memorable seasonal extremes. Climate Risk Management. Available at: https://www.sciencedirect.com/science/article/pii/S221209631600005X

[222] Deignan, K.; O'Hora, A.; Delargy, O.; Heuston, L.; Morrow, C. (2022). Climate Change Adaptation: Risks and Opportunities for Irish Businesses. EPA Research. Available at: https://www.epa.ie/publications/research/epa-research-2030-reports/Research_Report_402.pdf

[223] Adger, W.N.; Quinn, T.; Lorenzoni, I.; Murphy, C.; Sweeney, J. (2013). Changing social contracts in climate-change adaptation. Nature Climate Change. Available at: https://www.nature.com/articles/nclimate1751

[224] Murphy, C.; Broderick, C.; Matthews, T.; Noone, S.; Ryan, C. (2019). Irish Climate Futures: Data for Decision-making. EPA Report 277. Available at: https://www.epa.ie/publications/research/climate-change/research-277-irish-climate-futures-data-for-decision-making.php

[225] European Commission (2021). Forging a climate-resilient Europe – the new EU Strategy on Adaptation to Climate Change. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:82:FIN

[226] Barnett, J.; Graham, S.; Quinn, T.; Adger, W.N.; Butler, C. (2021). Three ways social identity shapes climate change adaptation. *Environmental Research Letters*. Available at: https://iopscience.iop.org/article/10.1088/1748-9326/ac36f7/meta

[227] Dannenberg, A.L.; Frumkin, H.; Hess, J.J.; Ebi, K.L. (2019). Managed retreat as a strategy for climate change adaptation in small communities: public health implications. *Climatic Change*. Available at: https://link.springer.com/article/10.1007/s10584-019-02382-0

Submitted to the Minister for the Environment, Climate and Communications on 31st August 2022

Climate Change Advisory Council
McCumiskey House
Richview
Clonskeagh Road
Dublin 14
D14 YR62

Tel: 01 2680180
Email: info@climatecouncil.ie

www.climatecouncil.ie

ISBN: 978-1-80009-065-1