
CLIMATE CHANGE ADVISORY COUNCIL
Annual Review 2020

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Climate Change Advisory Council
McCumiskey House
Richview, Clonskeagh Road, Dublin 14, D14 YR62
Phone: 01 2680180
Email: info@climatecouncil.ie
www.climatecouncil.ie

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Image credits

Main Image: Clonwhelan Bog, part of the Bord na Móna Raised Bog Restoration Programme, *Image courtesy of Bord na Móna.*

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National Dialogue on Climate Action Regional Gathering Tralee *image courtesy of M.CO*

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:
Prof. John FitzGerald (Chair)
Prof. Alan Barrett (ESRI)
Prof. Gerry Boyle (Teagasc)
Laura Burke (EPA)
Prof. Peter Clinch
Prof. Frank Convery
Dr. Joseph Curtin
Prof. Anna Davies
Prof. Ottmar Edenhofer
Prof. Alan Matthews
William Walsh (SEAI)

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.

Adaptation Committee Members:
Prof. John FitzGerald (Chair)
Mark Adamson
Prof. Gerry Boyle (Teagasc)
Laura Burke (EPA)
Prof. Robert Devoy
Ciarán Hayes
Dr. Ina Kelly
Eoin Moran
Prof. Conor Murphy
Roger Street
William Walsh (SEAI)

From Planning to Action

Executive Summary

The Climate Change Advisory Council is an independent advisory body tasked with reviewing national climate policy, progress on the achievement of the national transition objective and progress towards international targets in a cost-effective manner. As set out in the Climate Action and Low Carbon Development Act 2015, a key task of the Council is to conduct an annual review of progress made over the previous year in reducing greenhouse gas emissions and furthering the transition to a low-carbon, climate-resilient and sustainable economy and society by 2050. This is the Climate Change Advisory Council's fourth Annual Review of progress on transition.

The imperative for climate action remains, despite the understandable immediate focus on Covid-19. Ireland is already seeing the negative impacts of climate change and, regardless of the future success of national or global mitigation measures, adaptation to climate change is essential because of the effects of continuing global emissions.

Climate Resilience

Climate change is happening, and recent extreme events, such as Storms Ellen and Francis in August 2020 have shown that we are vulnerable to its impacts. 2019 was the ninth consecutive year with temperatures in Ireland above normal. The winter of 2018/2019 was the warmest winter on record in Ireland (119 years).

The need to prepare for climate change impacts and to reduce and manage climate change risks through a combination of mitigation and adaptation responses, remains under-recognised in wider Government policy. To better prepare for future climate extremes and limit their impact we need to move from adaptation planning to adaptation action by implementing the priorities of existing sectoral adaptation plans and local adaptation strategies although gaps including in the financial system still exist.

The decisions of policymakers, households, businesses and investors must evolve in recognition of the changes in the frequency and intensity of weather extremes and in changes in average conditions into the future. However, those most at risk from climate change may also be among the most vulnerable in society, without the capacity to prepare or make the necessary investments. Local authorities must integrate climate action into their existing functions with adequate resourcing to deliver on this role. The role of spatial planning in ensuring development does not occur in inappropriate locations also remains essential.

Mitigation, Transition and the National Policy Position

Ireland will not meet its 2020 targets and will require huge efforts to meet its existing 2030 targets, notwithstanding progress made in the development of the Climate Action Plan. Still more challenges could emerge from new targets or obligations arising out of the proposed EU Climate Law and the ambition contained in the Programme for Government. The Council emphasises the need to increase implementation and delivery, not only to meet EU targets but also to put Ireland on track to meet our 2050 ambitions of achieving net-zero emissions.

National emissions reduced by 0.1% from 2017 to 2018 largely due to progress in the Electricity sector. Other sectors have not delivered emissions reductions on the scale required.

The most recent Environmental Protection Agency projections of greenhouse gas emissions consider actions contained within the Climate Action Plan. The projections demonstrate that Ireland will only meet its existing emissions reduction targets with a full and successful implementation of all measures in the Plan. There is no room for complacency. It is noted that additional measures within the recent Programme for Government are not included.

The Council believes there is a need to consider the implementation of additional measures as a contingency for under performance of the measures within the Climate Action Plan and for increased ambition under a new EU Climate Law.

Key Council Recommendations

Just Transition

All climate action policies, including those directed at household level, must be consistent with a Just Transition and maximise economic and social opportunities. The costs of decarbonisation must be fairly distributed across the population, ensuring that those on lower incomes are not disadvantaged. Financial incentives are not the only motivator for climate action. Central to developing policies for Just Transition is continual public participation. This may be challenging, but it is essential. A dialogue of blame for emissions is not an appropriate approach and does not foster cooperation. Recognising the valuable role that communities, organisations and groups can play in tackling climate change challenges is a good platform for action.

Public Participation

Without citizen engagement, public acceptance of ambitious climate action diminishes. There needs to be a more coherent and focused approach to public participation in terms of both mitigation and adaptation. Engaging the public and communities in relation to climate action should be an on-going process not a once off. Effort must also be made to reach beyond existing climate networks. Engagement with stakeholders and appropriate communication are important to build ownership and support for climate action. Although there was progress in early development of a national dialogue, the impact has been somewhat limited and local in scope. A more strategic approach to public engagement with a focus on awareness, participation and activation is required.

Adaptation

Successful adaptation is a key part of Ireland's transition to a low-carbon, climate-resilient economy and society. Government must bring more coherence to how the different adaptation plans and strategies are prioritised and funded, how the costs of extreme weather are assessed, how our cities are resourced to prepare and how they learn from the experiences of others. Furthermore, communities, businesses and households will need to take individual action to adapt to climate change.

Carbon Tax

The Council recommends the carbon tax be raised to €35 per tonne of carbon dioxide equivalent in Budget 2021, rising to €100 per tonne by 2030. This accelerated increase reflects the fall in fossil fuel prices over the last year, which would otherwise lead to an increase in emissions. The carbon tax is an effective instrument in delivering long term emissions reductions. Negative impacts on the poorest households can and should be offset by effective use of the carbon tax revenue. The Council welcomes the increase in the carbon tax and earmarking of the associated revenue for climate action in Budget 2020 and the commitment to further incremental increases towards €100 per tonne by 2030 in the Programme for Government.

Innovation and Research

Continued funding for research and innovation is crucial to ensure that we have available and can appropriately deploy the technologies, tools and measures to help us reduce our emissions, enhance our carbon sinks and manage the impacts of climate change. Maintaining alignment with EU strategy, for example in green hydrogen (hydrogen produced from renewable sources), and farm to fork, is likely to enable access to EU funding to pilot or trial climate solutions at an appropriate scale.

Transport

The targets set out in the Climate Action Plan will be challenging and their achievement will depend on effective implementation of the measures in the Plan. Additional measures will be essential if new Government and EU ambitions are to be realised. The Council recommends development of a suite of additional measures to provide contingency options if progress falters. The costs of over performing will be very small relative to the costs of underperforming.

To reduce emissions in the long-term and achieve 2050 goals, attention must be paid to the appropriate location of residential and commercial development. Our dispersed settlement pattern and a lack of coordinated transport and land use planning in the past has resulted in many people living remote from frequent public transport, creating conditions of forced car ownership and high usage. Better planning at local and regional level can support walking and cycling and improve access to public transport.

Rapid uptake of Electric Vehicles is a central component for emissions reductions within Transport by 2030. The Council is concerned that the current approach could impose a relatively high burden on the Exchequer, and it depends on favourable developments in the car market. Council recommends that targeted subsidies be combined with other policy instruments, including disincentives for conventional vehicle ownership and use.

Incentives for electric vehicles need to be better targeted. Council recommends that incentives for electric vehicles should be refocused towards those with high usage including commercial and public service providers, and small and medium size enterprises. Similarly focussing fiscal support on rural communities, where high usage and alternative means of transport are not available, will deliver more cost effective reduction in emissions.

Investment in public transport modes, and associated infrastructure and networks, will be essential if we are to reach net zero emissions by 2050. The BusConnects programme is a critical component of this investment. The beneficial effects of the investment in public transport on reducing emissions can be enhanced by related investment in active transport modes.

Agriculture and Land

Absolute emissions of greenhouse gases in Agriculture and Land Use have increased relative to 2005. Even with the policies and measures envisaged under the Climate Action Plan, projections for the sector to 2040 show limited progress towards emissions reduction.

Council has recommended setting a separate target for biogenic methane emissions consistent with the objective of carbon neutrality and Ireland's contribution to achieving the global objectives of the Paris Agreement.

The Council recommends that CAP income support payments should better support and encourage farmers to reduce emissions, including through reducing animal numbers and/or using their land more profitably, while providing additional positive environmental outcomes.

Specific policy innovation to encourage and enable higher rates of afforestation and improved management of high carbon soils, including peatlands are required. The Council recommends that the role of farmers in the management of carbon stocks be acknowledged and that farmers should be incentivised to adopt measurable and verifiable practices that sequester carbon.

Council recommends positive, constructive engagement with the EU Farm to Fork Strategy initiative. In particular, to help achieve both greenhouse gas emissions reduction and other environmental benefits such as improved water quality, the Government should introduce measures to significantly reduce nitrogen use by 2030.

Additional resources should be allocated to support necessary investment in innovation, research and knowledge transfer to enable the long-term climate sustainability and resilience of Irish agriculture and land use.

Built Environment

Policy must first focus on eliminating the most carbon intensive fuels from space and water heating, followed by phasing out oil. The cost and number of buildings requiring deep retrofit means that government supports must be prioritised to vulnerable households and then to households where emissions are highest. Private households will benefit in comfort and energy savings from retrofit and will be incentivised by an increased carbon tax. Current plans to scale up retrofitting investment in ways which will facilitate household participation reflect the need to take account of the behavioural obstacles to transforming the built environment. Addressing capital constraints including through innovative funding options will be crucial.

Electricity and Industry

Decarbonising energy supplies is crucial to achieving net zero emissions by 2050. This is already apparent with electric vehicles and electric heat systems. Progress needs to be maintained in the Electricity sector and more focus is required to develop a strategic approach to zero carbon fuels. The role of offshore wind could be very important. There has been limited progress in industry with no long-term plan in place. A strengthened EU Emissions Trading System, including a carbon price floor, could deliver the transition needed.

Contents

1. Introduction

Each year the Climate Change Advisory Council is charged with reviewing Ireland's performance regarding the achievement of the national transition objective and compliance with European Union (EU) and international obligations related to climate action. The Annual Review 2020 is the fourth annual review carried out by the Council.

In line with the requirements of the Climate Action and Low Carbon Development Act 2015, the Annual Review documents Ireland's progress in the previous year in achieving reductions in greenhouse gas emissions and in furthering the transition to a low-carbon, climate-resilient and environmentally sustainable economy by the end of 2050 through climate change mitigation and adaptation.

The Council notes the ambitious mitigation targets contained in the recently published Programme for Government and the potential for further ambitious legislated targets under the EU Green Deal. The Council, as part of its Annual Review, is mandated to assess progress towards existing Government policy and legislated targets based on the most recent greenhouse gas emissions inventory and projections. For now, developments such as these have been noted where appropriate.

The Annual Review 2020 is organised differently to previously Annual Reviews. This year, Part A presents the Council's findings, advice and recommendations while Part B presents the evidence gathered as part of the review. The chapters in Part B are arranged as follows:

Chapter 1 provides an introduction to Part B.

Chapter 2 presents a summary of the 2018 national greenhouse gas emissions inventory and projections and draws attention to changes that occurred between 2017 and 2018.

Chapter 3 describes Ireland's progress made in furthering transition to date.

Chapter 4 describes the progress of sectors in the low-carbon transition and policies and measures towards further mitigation.

Chapter 5 outlines Ireland's progress towards a climate-resilient Ireland, including with a focus on adaptation issues in Ireland's five cities.

Chapter 6 provides perspectives and a narrative on mitigation in the Agriculture and Land Use sectors.

Chapter 7, the Special Focus Chapter, looks at the Transport sector, given its significance for Ireland.

Chapter 8 documents the activities of the Council in 2019.

Part A

Introduction

Part A of the Annual Review presents the recommendations and advice of the Council. Each recommendation is shown in italics, immediately followed by an outline of the rationale based on evidence and analysis with references presented in Part B.

Climate change is happening and, as recent extreme events have shown, we are vulnerable to its impacts. 2019 was the ninth consecutive year with temperatures in Ireland above normal, and winter 2018/2019 was the warmest on record (119 years). Covid-19 has had enormous impact on Ireland in 2020, causing a devastating loss of life and upending our ways of living, working and socialising. This consideration was to the forefront of Council deliberations for this, the last Annual Review of the Council's first term.

- *Council emphasises that the environmental imperative for climate action remains despite the understandable immediate focus on Covid-19.*

While the Covid-19 response is a Government priority, we cannot lose sight of the imperative to address climate change through decarbonising our economy and society (mitigation) and preparing Ireland for the ongoing and future impacts of climate change (adaptation). We must learn lessons from the pandemic, both positive and negative. Following this period of personal and societal change, we may have a singular opportunity to shift gears in our response to climate change. Climate action, both mitigation and adaptation, must be fully integrated across Government plans, policies and programmes to help accelerate economic recovery and enhance social equity while increasing resilience within our communities.

- *With limited resources, the policy focus must be on cost-effective, socially sustainable and environmentally compatible decarbonisation and climate resilience to 2050, taking account of the potential social, environmental and economic co-benefits.*

Challenges in addressing climate change may be heightened as economic conditions worsen. Covid-19 has seen a massive fall off in Government revenue along with huge expenditure increases to support those recently unemployed as a result of the measures taken to respond to the pandemic. As Government attention shifts to stimulating economic activity, investment must still demonstrate value for money. The available research shows that major investment in tackling climate change should figure prominently in future Government investment plans.

Government must also demonstrate the consistency of all components of its Covid-19 stimulus with the low-carbon transition. A green Covid-19 recovery is not only possible but essential. As the Government moves to stimulate expenditure, efforts should be taken to support low carbon transition and climate resilience, including investment by householders in energy efficiency.

- *Council recommends that Government policy and, in particular, future iterations of the Climate Action Plan better reflect the importance and urgency of adaptation as a core component of climate action. Clarity is required on the interaction and reporting between national, sectoral and local governance structures, including the mainstreaming of adaptation and the role of the Climate Action Delivery Board in adaptation.*

Due to the effects of historic and continuing global greenhouse gas emissions, climate change will continue for many decades (and in the case of sea-level rise, many centuries), with major social,

economic and environmental implications. Therefore, societies need to adapt to the unavoidable impacts of ongoing and future climate change. Despite this, the need for adaptation to be a core component of climate action and inextricably linked with mitigation remains under-recognised in Government policy. For example, decision makers require a deeper understanding of what projected changes in climate and adaptation needs might mean for achieving our mitigation goals in areas such as the Built Environment and Energy sectors. Ambitious mitigation that reduces the scale and speed of climate change remains the best form of adaptation. However, even with the most ambitious mitigation trajectory, adaptation actions will be required as we face unavoidable climate impacts.

Successful adaptation is a key part of Ireland's transition to a low-carbon, climate-resilient economy and society. We need to move from adaptation planning to adaptation action by implementing existing sectoral plans and local strategies. For this, it is essential that government brings more coherence to how the different plans and strategies are prioritised and funded, how the costs of extreme weather are assessed, how our cities and towns are resourced, and how they learn from the experience of other jurisdictions. In addition, communities, businesses and households will need to take individual action to adapt to climate change. Gaps in adaptation planning still exist, including in the financial system. Research continues to point to adverse future impacts on Ireland of climate change. The Irish population recognised and responded to the need to 'flatten the curve' to reduce the impacts of Covid-19. We need to promote a similar understanding to support flattening the climate change curve.

- *The Council welcomes the level of ambition for mitigation shown in the Programme for Government, but more ambition and delivery is required for adaptation.*

While Ireland is a small country, no country is exempt in the efforts to combat climate change. We have the potential to 'punch above our weight' in the global effort if we can develop and demonstrate climate solutions, especially in sectors where Ireland has particular advantage and special concern, for example Agriculture and Land Use; Rural Development; Offshore Renewable Resources; and the Hydrogen Economy.

2020 Programme for Government

The Programme for Government was published in June 2020. Estimates of the emissions reduction associated with each measure or the cost were not provided. Therefore, the Council can only provide a preliminary commentary on the programme here.

The Programme for Government commits to an average 7% per annum reduction in overall greenhouse gas emissions from 2021 to 2030 (a 51% reduction over the decade) and to achieving net zero emissions by 2050. The Council welcomes the ambition contained in the Programme for Government. This ambition needs to be captured in official plans and policy and communicated to the wider public and the European Union. This ambition can deliver real benefits for Ireland, but the efforts required to deliver it should not be underestimated. The Council welcomes plans for a new Climate Action Bill. Statutory carbon budgets will be an important tool for government to manage the low-carbon transition.

Monitoring the impacts and outcomes of policies and measures will be important to meet targets and manage the low-carbon climate-resilient transition. The Council looks forward to government providing additional analysis on costs and effectiveness in the course of the development of policies and measures. On this basis the Council can fulfil its mandate to provide advice and recommendations to government on progress.

Adaptation receives little attention in the Programme for Government despite the challenges already faced by Ireland to deal with extreme weather events. Adaptation planning needs to move beyond the confines of traditional flood defence spending to encompass approaches to community resilience and ecosystem-based approaches to adaptation.

Plans presented for passenger transport are very ambitious, with significant focus on modal shift to public transport, walking and cycling. While such measures will make an important contribution to the long-term low-carbon transition, their contribution to 2030 targets is not clear. Plans for addressing emissions in the Freight sector are lacking and urgently need development.

Plans presented for retrofitting residential buildings are ambitious but do not substantially go beyond the existing Climate Action Plan, and therefore their contribution to increased ambition is unclear.

The Programme for Government recognises the need for development of measures to address emissions in the Industry sector. The effectiveness of the emissions trading system (ETS) in delivering emissions reductions needs to be considered. The commitment to supporting development of new energy technologies such as offshore wind and green hydrogen will be important to Ireland's long-term transition.

The Council notes diverse objectives for the Agriculture sector that may be hard to resolve. It will not be sufficient to improve the carbon efficiency of Irish agriculture. Absolute emissions must reduce to reach 2030 and 2050 targets.

Delivery of the 51% emissions reduction by 2030 will be challenging and will require consistent focus across the economy and society. It is not yet clear in the Programme for Government where the additional emissions reductions required to achieve this target will come from. Progress will not be even across sectors and activities. Many of the necessary actions and investments will take time to deliver emissions reductions, but early implementation will be crucial. The whole population – young and old, rich and poor, urban and rural – must be engaged in the effort. After Covid-19 this is our ongoing societal challenge.

Legislative strengthening needs to be accompanied by action and delivery.

Ireland now needs to focus on implementation to achieve the low-carbon transition. In addition to the Climate Action Plan, the National Development Plan and the National Planning Framework also address climate change. These will require concerted effort and resources to deliver the anticipated outcomes. A monitoring and tracking framework to ensure cost-effective delivery, promised in the Climate Action Plan, will be critical. The Climate Action Delivery Board has been tasked with ensuring implementation of the Climate Action Plan. The Board published its first progress report in October 2019. The Council urges that the Government maintain the schedule of regular quarterly progress reports on implementation of the Plan.

Adaptation

Ireland's climate is already changing, and extreme events, such as Storms Ellen and Francis in August 2020, highlight the vulnerability of Irish society to climate change. The decisions of policymakers, households, businesses and investors must evolve in recognition of the changes in the frequency and intensity of extremes and in changes in average conditions into the future.

Though climate change projections, like all projections, are subject to uncertainty, the latest high-resolution regional climate modelling projections for Ireland are in broad agreement with previous research. Heatwave events are expected to increase by mid-century and the number of frost and ice days is projected to decrease. Mid-century precipitation is expected to be more variable, with substantial projected increases in both dry periods and heavy precipitation events. Changes in wind speeds, storm tracks and sea level will also occur.

Ireland must build on its adaptation planning with action. In parallel, efforts must be made to fill gaps in planning for key areas. Council advises that reporting and prioritisation in the implementation of the sectoral and local plans must be improved. This should be supported by a robust system of indicators.

Ireland must now build on its adaptation planning efforts with adaptation action. Ireland's first National Adaptation Framework (NAF) was published on 19 January 2018. It identifies twelve key sectors under the remit of seven Government Ministers where sectoral adaptation plans are to be prepared. These sectoral adaptation plans – which together contain over 180 actions – were launched in October 2019 and have a five-year lifespan in line with the NAF, which is also to be reviewed at least every five years. In 2019 local authorities also adopted five-year climate adaptation strategies. The implementation of the sectoral adaptation plans, local adaptation strategies and the NAF will be closely monitored in future Annual Reviews.

The Council has previously highlighted that the sectors identified in the NAF do not cover some important areas, for example no sectoral adaptation plans are in place for housing and planning, emergency management, the financial sector, tourism and sport. The current sectors also do not fully address all aspects of coastal change and sea level rise that may be expected due to climate change. The Council notes that there has been some progress in planning effectively for sea level rise and coastal erosion with the establishment of an interdepartmental group on coastal change.

- *Further work should be undertaken by the Department of Finance and by the Central Bank on the impacts of climate change on the financial system. 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. Further work by the Department of Finance and the Central Bank is required to ensure that such impacts are understood. This will be complex and will involve the assessment of multiple climate scenarios and transition pathways over several decades. The financial sector in Ireland, including the insurance industry, must understand, assess and communicate its climate-related risks in a coordinated way. As these conditions are developing internationally, the financial sector in Ireland will need to evolve and innovate to address and finance the transitions needed for a climate-resilient low-carbon economy.

- *Local authorities must integrate climate action into their existing functions with adequate resourcing to deliver on this role. The role of spatial planning in ensuring development does not occur in inappropriate locations remains essential.*

  With their involvement in the natural and built environment and in managing climate risks and vulnerabilities, local authorities have a key role in delivering effective climate action at both the national and local levels. They also deliver services to the public either directly or in partnership with Government Departments, such as housing, planning, water, environment, waste, transport, parks, enterprise and community development; each of which offers an opportunity for climate action. Local authorities must integrate climate action into their existing functions with adequate resourcing to deliver on this role.

- *Coordination between emergency planning and climate change adaptation planning should be increased. More coherence across government is required in assessing the costs of severe weather and ensuring that the economic loss, costs and damage are captured. This is relevant to both emergency management and adaptation.*

  Recent reports from the National Directorate for Fire and Emergency Management and the Local Government Management Association highlight the links between emergency preparedness and adaptation, the direct and indirect costs of extreme weather events, and the additional demands that climate change will place on local authorities. The Council considers that more needs to be done to promote coordination between emergency planning and climate change adaptation planning. This is discussed further in Section 5.6 in of Part B.

- *An assessment of the prioritised investment needs of adaptation for Ireland should be developed, establishing what is required to make Ireland resilient by 2050 and beyond based on deeper quantitative risk-based analysis. The assessment must capture the social, environmental and economic co-benefits of planned, integrated adaptation as well as the synergies with mitigation.*

  Climate adaptation can be expensive, but inaction will be likely to cost more. The NAF anticipates that sectors will reflect their key priorities within the annual budgetary and estimates processes. This will lead to fragmentation, lack of synergies and complementarities or even conflicts, when coherence in resourcing our adaptation transition is required. Instead 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, based on the commitments contained in sectoral and local plans and strategies. Such an assessment should consider the funding that is required to adapt to climate change and how it should be prioritised.

Coherent proposals that quantify the cost of implementing grey (e.g. engineering solutions), green (e.g. making use of nature) and soft (e.g. regulatory change) adaptation measures in Irish cities and towns to 2050 are required as part of this. Also, the costs related to the unavoidable damage associated with climate change should be identified. This assessment can be informed by the Guiding Principles for Adaptation as outlined in the NAF, which states that adaptation actions must be prioritised according to criteria such as efficiency, cost-effectiveness, risk and urgency, and Just Transition. Some of the best forms of adaptation may necessitate little or no additional (direct) costs, mainly requiring consideration of adaptation needs when making other investments.

Globally, cities are increasingly recognised as a key level of government in responding to climate change. The National Planning Framework anticipates that the population of Irish cities will increase by 50% in the coming years. Critical socioeconomic infrastructure is present in our cities. Their overall resilience depends not only on their own adaptation planning but on the sectoral adaptation strategies prepared by key Government Departments. That is why Section 5.12 of Part B of this year's Annual Review particularly considers the adaptation issues facing Dublin, Cork, Limerick, Galway and Waterford. Lessons from international and European city networks show that building urban resilience will require a long-term vision, innovation in institutions and governance, consideration of equity issues, and mutual learning – in particular with regard to implementation. This may also be relevant for Irish towns that are vulnerable due to their location, design and development pressures.

The Council advises that coordinated government action, support and leadership is essential for climate resilience. However, individuals also have personal responsibility to take steps to protect themselves and their property against changing climate risks.

Government will need to support individuals, households and communities to protect themselves and their property, bearing in mind that some of the most vulnerable may have the least capacity to respond. Local and national government will have an increased responsibility to show leadership, build local capacity and engage in dialogue with communities on the long-term responses available and the decisions that will be required.

Climate change is creating new challenges for both governments and citizens with regard to their rights, obligations and responsibilities, while also placing a burden on the voluntary sector. So far, the emphasis has been on the role of governments; however, these efforts alone are not sufficient to reduce and cope with the impacts of climate change.

Indeed, the NAF argues that most adaptation actions will be taken by individuals, households and businesses, as they adjust independently to their experiences or perceptions of climate risk. They will need to be supported in doing so. If individual households are expected to take action, the role of national and local government in ensuring that development does not occur in inappropriate locations and in addressing legacy issues through spatial planning will be key.

While adaptation by individuals and households can be highly effective in reducing the impact of climate-related hazards, many people are not yet engaging in adaptive behaviour, or are taking

insufficient measures. Adaptation actions by households may be relatively simple and cost-effective (for example, changing behaviour during a heatwave, flood proofing the interior of at-risk houses or choosing permeable surfaces in our gardens). However, those most at risk are often also those who are already the most vulnerable in society, without the capacity to make such investments.

Further consideration should be given to how insurance can provide a financial incentive for high-risk households and communities themselves to take action to prevent flooding losses and increase property-level flood resilience, but it is also crucial that supports are provided for the most vulnerable in society.

Households that do not implement even basic adaptation measures may increase the strain on emergency responders during extreme events. The public's response to national leadership regarding the Covid-19 pandemic may present lessons in this regard. This is discussed further in Section 5.9 of Part B.

Mitigation

Ireland will not meet its 2020 targets and will require huge efforts to meet its EU 2030 targets, notwithstanding progress made in the development of the Climate Action Plan and the ambition contained in the Programme for Government. The Council emphasises that Ireland needs to increase its mitigation efforts in implementation and delivery, not only to meet legislated EU targets but also to set in train the actions required to meet our 2050 ambitions.

National emissions decreased in 2018, due largely to progress in the Electricity sector, but had increased consistently from 2013 to 2017. Other sectors are not delivering emissions reductions at a scale required to meet existing targets, or to respond to any potential EU or unilateral national agreement to increase ambition. Projections show that we can meet our legislated EU 2030 targets but there is absolutely no room for complacency. All measures in the Climate Action Plan will have to be fully implemented to meet our EU targets. See Chapters 2 and 3 in Part B for a more detailed discussion of these issues.

- *The Council recommends that the National Mitigation Plan be updated to include the actions contained in the Climate Action Plan as well as further contingency measures to give confidence in meeting Ireland's legislated EU targets to 2030 and the long-term national transition objective.*

In recent years, the Government has devoted considerable resources to development and enhancement of plans to meet climate mitigation targets. Legislative strengthening could underpin the delivery of results. Capturing the Climate Action Plan within a statutory instrument, currently the National Mitigation Plan, would build confidence. The Council welcomes the proposal to amend and strengthen the existing Climate Action and Low Carbon Development Act (2015).

The Climate Action Plan has no contingency plans if any single measure does not deliver the planned emissions reductions. Underperformance of any measure would mean missing legislated targets. Furthermore, the projections indicate that beyond 2030 there will continue to be drivers within the economy that have the potential to increase emissions in the absence of new long-term policies. Additional policies and measures are required to give more certainty in meeting legislated EU targets. New policies and measures identified in the Programme for Government

could be developed and captured in official plans to meet this purpose. See Section 2.3 and Chapter 3 of Part B for more detailed discussion of these issues.

- *Council recommends an increased carbon tax in Budget 2021 to €35 per tonne, with sustained increases, reaching €100 per tonne by 2030 to counteract the negative impacts of low fuel prices.*

Carbon pricing remains a key pillar in the climate response. The Council welcomed the increase in the carbon tax announced in Budget 2020 and earmarking of the associated revenue for climate action. A greater increase in the carbon tax is required in Budget 2021 to offset the negative impacts on emissions of fuel price decreases arising from the Covid-19 pandemic. The Council welcomes the Programme for Government commitment to further incremental increases in the carbon tax towards €100 per tonne by 2030, which will be important to reduce emissions and to raise funds to support climate action and reduce the negative impacts on vulnerable groups. It would also incentivise more action by the private sector. Other mechanisms that deliver an effective carbon price could contribute to meeting mitigation objectives, e.g. carbon price floor and fuel excise duties. With constrained Exchequer resources, continued support for potentially harmful fossil fuel subsidies is untenable. The Council recommends the rapid phasing out of such subsidies. See Section 3.5.5 of Part B for more detailed discussion of these issues.

- *Council recommends the Government adopt an all-sectors, all greenhouse gases approach to define carbon neutrality for strategic planning and policy development, consistent with best available science and taking due regard of international and EU commitments*

Ireland lacks a framework that sets out a shared understanding of zero-carbon or climate neutrality goals to guide us towards the 2050 objective of net zero emissions. This needs to be established at an EU level but Ireland could usefully inform the debate. The long-term strategy must be consistent with meeting EU targets and requirements.

A definition of carbon neutrality would enable long-term strategic planning in the Agriculture and Land Use sector. Agreeing a definition is a priority to support strategic development of the sector consistent with long-term goals. National policy considers neutrality in the context of Agriculture and Land Use; however, the EU Green Deal and proposed EU Climate Law expands this to all sectors and all greenhouse gases. Definition of neutrality should consider this policy context. The following criteria should be considered in developing a definition of climate and/or carbon neutrality:

- There is a need for complete and rapid transition away from fossil fuel use in all sectors of the economy.
- Residual and unavoidable emissions of long-lived greenhouse gases, with an atmospheric lifetime of greater than approximately 10 years, must be balanced by an equivalent removal. These gases include carbon dioxide and nitrous oxide.
- The removal of carbon dioxide, seen as a necessary part of the long-term solution, needs to be robust and verifiable.
- Removals based on land use and land management are important but necessarily limited.

- The rate of emissions of short-lived greenhouse gases, including methane, with lifetimes of less than 10 years, needs to stabilise at a much lower level than today, and consistent with the findings of the Intergovernmental Panel on Climate Change (IPCC) Special Report on 1.5°C of warming.

Based on these criteria, and until a formal definition is adopted at national or international level, the Council will use the following working definition of carbon neutrality:

> Carbon neutrality is achieved when the net sum of emissions and removals of greenhouse gases associated with all activities within the economy makes no further additional physical impact on global warming.

This definition can be modified to consider carbon neutrality in the narrower context of Agriculture and Land Use, as framed from the current national policy position. However, other sectors are anticipated to need removals to balance unavoidable residual emissions in the context of a net zero emissions target by 2050.

- *Council recommends setting a separate target for biogenic methane emissions consistent with the objective of carbon neutrality and Ireland's contribution to achieving the global objectives of the Paris Agreement.*[i]

The Council has previously noted that in scenarios assessed by the IPCC that successfully limit the increase in global temperature to 1.5°C, it is essential that emissions of CO_2 are reduced to net zero by 2050. Also, in most 1.5 and 2°C scenarios, net removals are required after 2050. However, it is neither necessary nor feasible to reduce methane emissions to zero. The Council recommended in a letter in 2019 that the Government should set separate targets for long-lived greenhouse gases and fossil methane (where net emissions must be reduced to or below zero by 2050 at the latest) and biogenic methane (where net emissions need to be significantly reduced, but not necessarily to zero. This approach has been adopted by New Zealand in setting its climate targets.

Setting a separate target for reduced emissions of biogenic methane is not a trivial task. It involves questions of climate science, but also value judgements regarding the role of historical emissions, development pathways for the rural economy and information on the relative economic cost of reducing emissions in different economic sectors. The dominant sources of biogenic methane in Ireland are in the Agriculture and Land Use sector, largely livestock, with a smaller contribution from the Waste sector. The target for biogenic methane emissions should be consistent with the objective of carbon neutrality and Ireland's contribution to achieving the global objectives of the Paris Agreement.

The Council recognises that Ireland remains bound by its legal commitments under EU legislation to achieve a certain target reduction in emissions based on aggregating all gases according to their Global Warming Potential evaluated over a 100 year period, particularly in the period to 2030. In the context of increased EU and national ambition for 2030, how to address biogenic methane will need to be considered.

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i Biogenic methane emissions arise from biological processes. Anthropogenic sources of biogenic methane in Ireland are primarily agricultural activities and to a lesser extent the management of landfill. As well as including biogenic methane, anthropogenic sources of methane include fossil methane due to fugitive emissions from fossil fuel extraction, distribution and use.

The Council recommends that the Government should support efforts to ensure consistency between reporting and accounting rules and the objectives of the Paris Agreement and to engage constructively in the negotiations on the proposed revision of the EU's 2030 effort-sharing targets. In the longer run, the Government should seek to engage with its EU partners on the validity of a separate target for biogenic methane. This will be important in defining the objective for 2050, the pathways to net-zero emissions and climate neutrality. It must be based on the IPCC advice in its forthcoming Sixth Assessment Report. See Section 4.2 and Chapter 6 of Part B.

- *Decarbonised energy is crucial to achieving our 2050 goals. Progress is being made in the Electricity sector, though continued efforts will be required. The Council recommends that policies and planning are urgently required to develop zero-carbon fuels supply systems in Ireland.*

Decarbonisation of Ireland's energy systems is critical to support the decarbonisation effort in other sectors, notably Transport and Heat. Anticipated emissions savings and eventual decarbonisation from technologies, such as electric vehicles and heat pumps, rely on decarbonising the electricity supply. Progress is being made but continued efforts are required to reach 2050 goals of net zero emissions. Not all energy services can be supplied by electricity and therefore consideration and planning are urgently required for development of zero-carbon fuels including biomethane and green hydrogen. See Section 3.5.3 of Part B.

- *There is a critical need to assess the negative emissions potential within the Irish economy including the potential for enhanced removals associated with the Agriculture and Land Use sector and emerging technologies.*

The IPCC has indicated that negative emissions will be necessary globally towards 2050 to stay consistent with the goals of the Paris Agreement. This is also true on the national scale. This requires long-term planning and preparation now, due to physical constraints in domestic negative emissions potential. Research has considered the potential for negative emissions technologies in Ireland however, further analysis, assessment and stakeholder engagement is required to consolidate a shared understanding of what this amount may be. The principle that there is a limit to the deployment of negative emissions within the economy is fundamental and critical to development of a national strategy for transition to a low-carbon economy in the period to 2050 and beyond. See Sections 3.5.5 and 4.2.2 and Chapter 6 of Part B.

- *Efforts must continue on citizen engagement as a continuous process to support delivery of ambitious targets.*

Without citizen engagement and Just Transition, public acceptance of ambitious climate action diminishes. Although there has been progress in the early development of a national dialogue, the impact has been somewhat limited and local in scope. Effort must also be made to reach beyond existing climate networks. There needs to be a more coherent and focused approach to public participation in terms of both mitigation and adaptation.

- *The Council recommends that the Government develop greater monitoring and assessment capacity in order to track outcomes and understand cost-effectiveness of different policies and measures.*

It is encouraging to see that learnings from previous experience have resulted in the incorporation of monitoring into policies and measures. For example, the next phase of the Agricultural Catchments Programme (Teagasc) and the work under the Retrofit Programme (Sustainable Energy Authority of Ireland – SEAI) will include monitoring of the effectiveness of measures, and the outcome of the monitoring is a key indicator in the Climate Action Plan. The publication of new indicators on costs and effectiveness provided in the Revised Estimates in 2020 is an important step towards transparent management of the impact and outcomes from carbon taxation revenue allocation and may enable revision of measures to increase the cost-effectiveness of the disbursement of these revenues. This approach to monitoring can be applied more broadly and will help inform evidence-based policymaking. More of the Government's analysis and evidence base needs to be routinely published. The Council looks forward to agreeing a Memorandum of Understanding with Government Departments for the sharing of analytical resources and evidence.

Transport

Emissions in transport remain strongly coupled with economic activity. Targets for electric vehicles will be very difficult and expensive for Government to achieve. We need to better understand the balance of costs and benefits for the individuals and households who buy and use electric cars as well as for society. While it will be essential if we are to meet our 2050 goal, major investment in public transport may not deliver emissions savings required in the period to 2030. However, without such investment in the current decade our 2050 goal will be unachievable. Thus we need additional options to achieve emissions reductions in the current decade, particularly in the areas of freight and rural transport. Constraints on green field development, demand management options including through spatial planning, road or congestion pricing, and potential new work practices are important.

It is noted that overall the sector would also benefit from an agreed set of criteria and modelling tools to estimate the costs of climate change and severe weather to transport operators and infrastructure providers. Indirect costs such as revenue lost due to disruption of economic activity should also be captured. This would enable more cost-effective planning and implementation of adaptation measures. See Section 4.1 and Chapter 7 of Part B.

- *To reduce emissions in the long-term and achieve 2050 goals, attention must be paid to the appropriate location of residential and commercial development. Better planning at local and regional level can support walking and cycling and improved access to public transport.*

A well-regulated and coherent planning system is required to guide sustainable settlement. Ireland has a low-density, dispersed population structure. Our dispersed settlement pattern and a lack of coordinated transport and land use planning in the past has resulted in many people living remote from frequent public transport, creating conditions of forced car ownership and encouraging high levels of multiple car ownership with high usage within households.

While we cannot move current settlement patterns, the trend of increased urbanization observed over recent years may reduce the numbers living in isolated locations. Effective planning and strict regulation can ensure this urbanisation occurs in a sustainable manner. More concentrated settlement patterns better facilitate sustainable transport links.

Development must address existing spatial and infrastructural 'lock-in', while also preventing further lock-in. Development and infrastructure planning, through the National Planning Framework and the National Development Plan, should support a transition to high-density spatial planning integrated with low-carbon active and public transport.

- *Council recommends that disincentives for the purchase and use of conventional vehicles be incorporated into policies and measures to reduce transport emissions.*

The Climate Action Plan sets an objective of at least 935,000 electric vehicles in Ireland by 2030. This is very challenging, requiring close to 100% of all new and imported used cars beyond 2025 to be electric. Using current policy instruments, this is likely to be achievable only at significant cost to the Exchequer. However, over the lifetime of the vehicles themselves, the Climate Action Plan estimates that owners will incur lower costs compared to internal combustion engine (ICE) vehicles. Owners benefit from lower operational costs while society benefits from improved air quality.

Current incentives towards the purchase of electric vehicles are quite generous and have contributed to increased sales in recent years. Premature removal of incentives, without replacement by alternative policy instruments such as taxation, will have significant adverse impact on the rate of electric vehicle adoption. However, consideration should be given to a gradual reduction in the level of incentive, especially as the relative price of electric vehicles continues to decrease and consumer choice improves. By the end of the decade, the take-up of electric vehicles should be driven by normal market forces supplemented by appropriate taxation measures.

The cost of Irish electric vehicle policy to the Exchequer is considerable. Government should explore more cost-effective supports tailored to addressing the market failure. If owners benefit throughout the lifetime of ownership, as the Climate Action Plan suggests, it is capital constraints that limit adoption. Low-cost loans, taking advantage of the low cost of government borrowing, should replace subsidies if this is the case.

Regulation could favour the purchase of electric cars over the purchase of ICE vehicles. One option might be to ban the sale of ICE cars after 2030. Clear and unequivocal policy signals in advance with regard to the timing of such regulation could hasten the take-up of electric vehicles.

- *Refocus incentives for electric vehicles to communities and individuals with high usage and experiencing forced car ownership, particularly in rural areas.*

Access to transport and forced car ownership are emerging concerns, particularly in areas with limited access to public transport infrastructures and for people with unusual needs that necessitate private transport for individuals and households. Rural communities, households and individuals will continue to experience challenges in accessing adequate public transport and will primarily rely on private transport. With climate change impacts into the future, those in rural areas may also face proportionately greater costs due to the disruption caused by severe weather, needing to divert and travel greater distances or extending commuting/journey times.

In addition to supporting access to services and Just Transition, the focus of incentives towards these users may be more cost-effective as they typically have higher car usage and therefore higher emissions when driving conventional cars.

- *Developments in the car market, especially used car imports, should be monitored to inform effective policy*

A lack of consumer choice in the range and volume of electric vehicle models currently on the market, especially in the most popular market segments, is a major constraint on sales, notwithstanding generous incentives. There is also concern that the high proportion of used cars imported into the Irish market, largely from the UK, leaves the ambition for uptake of electric vehicles susceptible to developments in other markets. Policy should address evolving trends in the car market, including potentially negative influence of used car imports.

- *Refocus and reinforce incentives for electric vehicles to commercial and public service suppliers including small and medium-size enterprises.*

Light-duty commercial and service vehicles, such as trade and delivery vehicles, are demonstrated to have the highest potential per vehicle for emissions reduction through a switch to electric vehicles. Their intensive use increases the savings in reduced fuel and maintenance costs. Therefore, only a relatively short time is needed to recoup the additional purchase cost of zero-emissions vehicles. The high visibility of commercial and service vehicles can engender public interest and acceptance, leading to a potentially quicker uptake by the general public and reducing the need for high-cost interventions.

Heavy-duty, long-haul road freight presents particular challenges for decarbonisation. Road transport is likely to remain the dominant mode for heavy goods in Ireland. While Ireland will be a technology taker in many aspects of decarbonisation of freight transport, recent research concludes that significant emissions reduction can be achieved through development of a suite of interlocking and consistent policy instruments. These include fuel economy regulations, carbon taxes on transport fuels, road pricing, widespread data-sharing and collaboration across the supply chain as enabled by digital technologies, and sustained investment in research, development and deployment of ultra-low- and zero-carbon fuels and associated infrastructure. It is also essential that the infrastructure required to decarbonise the sector is climate-resilient. Road haulage currently receives favourable treatment under the excise tax rebate scheme. This is an environmentally damaging subsidy and needs to be addressed.

- *Council recommends that investment in low-carbon public transport and associated infrastructure and networks be maintained and deepened to support long-term transition. Programmes including BusConnects need to be delivered.*

Climate action within public transport faces two challenges. First is the deployment of low-carbon technologies within bus and rail fleets. Ireland will largely be a technology taker in this regard; however, as within freight, policy and investment options can enable more rapid transformation within public transport. Also, continual review of public procurement criteria can provide appropriate signals to purchasing managers to enable deployment of low-carbon options. A robust green public procurement policy could support technology uptake.

The second challenge is to encourage higher usage of public transport across all journey types. Public transport competes directly with the private car. At present, public transport is often seen

as less attractive in terms of direct cost, perceived convenience or comfort. Greater innovation is required to address this disparity on all three fronts. Greater investment in modern fleet capacity may address comfort and convenience. However, the key aspect of comfort and convenience that must be addressed is reducing journey times so that public transport competes better with journey times by private car. The BusConnects programme has the potential to deliver considerable improvements to service levels and convenience and should be implemented as rapidly as possible.

- *Council recommends supports to maintain high levels of home working in sectors and occupations where it is feasible. However, further research is required.*

Home working has long been proposed as a potential measure to reduce emissions in both private and public sectors. Arguably the most visible action in the national response to the Covid-19 crisis has been the forced widespread experiment in homeworking. Full advantage should be taken of this learning experience. The benefits and trade-offs of homeworking within the public and private sectors need to be understood in terms of energy use, transport, productivity, physical and mental health, standard of living and quality of life. However, the unique circumstances of the Covid-19 crisis may make evaluation of some of these more challenging.

Other observed impacts of the Covid-19 restrictions have been the significant shifts in consumer behaviour. These include increased use of online shopping and home delivery services, and households making less frequent trips to supermarkets but making larger purchases. These changes in behaviour can have implications for transport emissions due to lower demand for private journeys or greater use of light-duty delivery vehicles which can play a role in the transition to electric vehicles. However, there may also be changes in the volume of household waste, impacting emissions from the Waste sector.

- *The implicit fossil fuel subsidy to the Aviation sector should be discontinued through Ireland supporting proposals at EU level for a tax on aviation.*

More attention needs to be paid to emissions outside of road transport. Emissions from aviation are not taxed directly. While flights within the EU are included in the ETS, the free allowances awarded to aviation greatly reduce its impact. In addition, airline tickets are not subject to value added tax. The Central Statistics Office (CSO) calculated that the exemption of aviation fuel from excise amounted to an indirect environmentally harmful subsidy of up to €494 million in 2016. This is untenable. Ireland needs to support EU efforts to control emissions in aviation to prevent a return to the trend of increasing emissions.

Agriculture and Land Use

Absolute emissions of greenhouse gases in Agriculture and Land Use have increased relative to 2005. The sector – including livestock systems – is heavily impacted by the weather and therefore faces risks with more variable weather and extreme events due to climate change. Policies across Agriculture and Land Use need to be developed in consultation with the farming community and other interests to determine how the measures will be most effective and will provide co-benefits to the rural community.

The sector faces considerable immediate challenges from Brexit and longer-term challenges where consumers attach higher value to environmental integrity and local sourcing of high-value foods and where reform of EU agriculture, food and land-use policies is increasingly designed

to meet sustainability criteria. There is the potential for considerable risk for Irish agri-food exports in premium markets if emissions continue unabated. The Council encourages Bord Bia to further strengthen the scope and ambition of Origin Green so that it remains a leader among national sustainability schemes. In this context, the Council stresses the importance of being able to demonstrate the positive impact of changes at farm level, and to reflect these in reporting and in marketing. This will require low-cost, accurate and robust systems of measurement and assessment of greenhouse gas fluxes at farm level so that each farmer will know their emissions profile, supported by analysis in the annual Sustainability Report published by Teagasc.

The separation of policies and targets for the Agriculture and Land Use sectors respectively is not conducive to coherent policy development or cost-effective transition. The current reporting structures create an artificial disconnect between how land is managed and the goods and services it provides. This disconnect tends to filter through to policymaking structures, leading to potentially sub-optimum policy design. The Council notes that the Scottish Government has modified its domestic reporting of inventory emissions to avoid this disconnect by explicitly referring to trends in agriculture and related land-use emissions in a unified way. This could be replicated in Ireland.

The Council recommends that the Government take every opportunity to raise the need for reform of the EU climate framework. The negotiations for revision of the EU's 2030 climate targets foreseen as part of the EU Green Deal and the proposed EU Climate Law provide an opportunity to better integrate net emissions reduction from agriculture and land use in EU climate policy.

A number of mitigation options identified by Teagasc, particularly those that relate to reducing nitrous oxide emissions, can deliver very important co-benefits in the national effort to comply with the EU Nitrates, National Emissions Ceilings and Water Framework Directives. The Common Agricultural Policy could be a powerful tool to deliver changes in farming practices and land-use management. The next phase of the Common Agricultural Policy will provide greater flexibility to Member States to design the incentives, measures and implementation at a national level more appropriate to their needs. This offers a great opportunity to use EU farm payments to achieve national climate goals. Other sources of EU funding could offer complementary assistance. For example, Ireland has previously attracted funding under the Horizon and LIFE programmes for environmental projects.

- *The Council recommends that Government develop additional mitigation measures within Agriculture and Land Use as a contingency for under-performance of existing measures or a need for greater ambition.*

The Climate Action Plan sets out measures that have the potential to make a significant contribution to meeting emissions reduction targets to 2030. However, additional measures need to be considered as a contingency against under-performance of those measures or in case of a potential increase in ambition arising from negotiations on 2030 climate reduction targets under the EU Green Deal and the Programme for Government. This need for contingency measures has been noted generally regarding the Climate Action Plan, but it is particularly important in the context of Agriculture and Land Use, noting specific challenges in implementation of mitigation measures across the sector e.g. the uptake of alternative fertilisers, accounting for carbon emissions and removals associated with land management. This will require innovation in policy development and design to ensure rapid implementation and deployment of solutions.

- *The Council proposes that the Government adopt a strategic approach to Land Use, to balance the diverse demands for ecosystem services, informed by high-resolution mapping of activities and their impact.*

There is a need for a rural development strategy that recognises the diverse environmental, economic and socially sustainable activities that can thrive and support local communities and the national economy. The production of food will remain the dominant use of land in Ireland, but greater innovation and diversification of land use is required within food production, energy supply, raw materials, eco-tourism and other social and environmental ecosystem services, such as biodiversity. Current planning and policy developments are fragmented between competing sectors and activities, leading to confusion and uncertainty for investors and other stakeholders.

The Council welcomes the commitment in the Programme for Government to a national land-use review "including farmland, forests, and peatlands, so that optimal land use options inform all relevant government decisions". The necessary next step from this review will be the development of a strategic approach to land use that seeks to incentivise and align the resource needs of low-carbon transition with sustainable land management.

- *The Council recommends that the role of farmers in the management of carbon stocks be acknowledged and that farmers be incentivised to adopt measurable and verifiable practices that sequester carbon. Specific policy innovation to encourage and enable higher rates of afforestation and improved management of high-carbon soils, including peatlands, is required.*

Low afforestation rates are undermining sectoral mitigation targets. The current focus on commercial afforestation including long-term legal commitment to replanting has created barriers to engagement. Approaches that integrate woodland and agro-forestry more sympathetically into the agricultural landscape should be promoted.

Similarly, the management of national peatlands and grasslands continues to be a significant source of emissions. The rewetting of drained peatlands is one of the most cost-effective measures supported by carbon tax revenue. This should be expanded. Policy innovation will be required to improve land management while maintaining public acceptance. It should be noted that due to a lack of drainage maintenance, a potentially large area of farmed peatlands may have already reverted to a wet status. There is anecdotal evidence for this but research is required to determine the extent of this phenomenon. There is an urgent need to improve our understanding of soil carbon fluxes in agricultural soils and to be able to capture changes in emissions and removals in the national inventory.

Opportunities exist for many co-benefits from rewetting peatlands and afforestation if effectively implemented, including eco-tourism, biodiversity, soil, water and air quality and local amenity value. The sector has the potential to play a central role in the possible development of green infrastructure initiatives and in protecting biodiversity, mitigating ammonia emissions and supporting resilience in other sectors. Monitoring systems and indicators to quantify these co-benefits will be important to allow assessment of policy measures and to illustrate their societal value.

Teagasc is leading on the development of the Signpost Demonstration Farm programme with the objective of encouraging farmers to adopt mitigation measures. This initiative will establish

a network of farms on a national basis that will demonstrate options towards the achievement of carbon neutrality. The Signpost programme includes the establishment of the National Soil Carbon Observatory designed to measure and monitor carbon sequestration, which can provide additional activity data to inform and refine the national inventory.

Options that could be considered to improve the impact of farming practices on carbon stocks include:

- Mandate measures for improved carbon management, as appropriate, including water table management, and the establishment of woodland areas on all farm enterprises that receive derogation under the Nitrates Regulation.
- Implement appropriate carbon management measures at farm level within the mandated criteria for enhanced conditionality for receipt of basic farm payments.
- Enhance incentives for additional implementation of appropriate carbon management measures at farm level under agri-environmental schemes.

- *The Council recommends that CAP income support payments should better support and encourage farmers to reduce emissions, including through reducing animal numbers and/or using their land more profitably, while providing additional positive environmental outcomes.*

The structure and size of the national cattle herd is a fundamental driver of agricultural emissions. Improvements in production efficiency will not be enough to meet mitigation targets. There is a need to consider the long-term trajectory for the livestock sector. The current approach, as seen in the Food Harvest and Food Wise strategies, strongly favours existing enterprises and practices and tends to consider only short-term market opportunities and policy interventions. There is also a need to consider additional demand and opportunities for ecosystem services, including raw materials, biodiversity, and water and air quality.

Low profitability of the cattle sector and its dependence on Common Agricultural Policy payments provides an opportunity to both raise incomes on these farms and reduce emissions by redesigning payments to encourage more sustainable agriculture and land use practices. This approach would achieve a reduction in animal numbers and, along with the adoption of alternative land uses, has the potential to maintain and enhance farm incomes and achieve wider rural economic and environmental sustainability. Farm payments should be tied to the achievement of environmental objectives, allowing farmers to choose alternative production systems that could enhance their incomes while simultaneously furthering environmental goals.

In general, farm support schemes should avoid eligibility criteria that constrain farmers to maintain the number of animals at a level that is above the minimum necessary for consistency with Good Agricultural and Environmental Condition. In shaping the next stage of the CAP, Ireland needs to target the measurable delivery of absolute emissions reductions and carbon sequestration.

The Council reiterates its view that total cattle numbers currently exceed a sustainable level, notwithstanding important local and regional variations in both economic and environmental sustainability. The sustainable level of numbers is not static and may increase in line with technological innovations, such as dietary methane inhibitors, that decrease the environmental

and climate footprint of animal numbers. It may also decrease as a result of lower carrying capacity due to, for example, climate impacts and increased vulnerability.

The Council believes that the essential income support for low-income farm households should be consistent with the green transition and emissions reduction ambitions. Continued support for the beef sector requires stronger conditionality to encourage structural changes and changes in practices and land use that would enhance the environmental and economic resilience of these farm households and address the underlying causes of income insecurity in the sector.

Measures to address environmental issues such as water quality, air quality and biodiversity deployed at farm scale will often have the additional potential to reduce greenhouse gas emissions, both directly and indirectly. Of particular relevance are measures that constrain livestock stocking rates or improve management of carbon stocks at farm level. For example, constraints on nitrogen use, developed under Nutrient Management Plans (Teagasc), may indirectly reduce the number of animals on the land. Greenhouse gas emissions will therefore benefit, directly from a reduction in potential nitrous oxide emissions from fertiliser application and also from reductions in methane, nitrous oxide and ammonia emissions associated with the animals themselves and manure management. It is important that these opportunities for management of herd size at sustainable levels at farm scale are recognised in policy development and regulation.

Council recommends positive, constructive engagement with the EU Farm to Fork Strategy initiative. In particular, to help achieve both greenhouse gas emissions reduction and other environmental benefits, such as improved water quality, the Government should introduce measures to significantly reduce nitrogen use by 2030.

The proposed EU Farm to Fork Strategy is at the heart of the Green Deal. It addresses the challenges of sustainable food systems. A shift to a sustainable food system can bring environmental, health and social benefits and offer economic gains. The increasing recurrence of droughts, floods, forest fires and new pests is a constant reminder that our food system is under threat and must become more sustainable and resilient. The Council recommends that the targets proposed under the EU Farm to Fork Strategy be reflected in Ireland's national approach to the Common Agricultural Policy Strategic Plan as it is developed. Environmental policy incentives and regulations should be designed to ensure the optimum outcomes in terms of multiple co-benefits, for example the simultaneous reduction of emissions of nitrous oxide and ammonia through improved management of chemical nitrogen fertiliser.

Since publication of the Farm to Fork Strategy, the Commission has indicated that a minimum mandatory percentage share of Common Agricultural Policy Pillar 1 direct payments should be allocated to eco-schemes. The Council stresses that eco-schemes, properly designed, can be a vital additional instrument in the next Common Agricultural Policy to incentivise greenhouse gas mitigation and sequestration activities through precision agriculture, agro-ecology (including organic farming), carbon farming and agro-forestry. In addition, as additional state funding is provided to enhance support, for example, for the management of peatlands, this could further enhance rural incomes. The Council therefore supports a mandatory minimum allocation of funds for environmental purposes under Pillar 1 and urges that eco-schemes should play a prominent role in Ireland's Common Agricultural Policy Strategic Plan.

The EU "Farm to Fork Strategy" has identified an excess of nutrients (especially nitrogen and phosphorus) as a major source of environmental pollution and climate impacts. At an EU level, it proposes to reduce nutrient losses by at least 50% by 2030, while ensuring that there is no deterioration in soil fertility. The proposal recommends a target to reduce chemical nitrogen, while also limiting organic nitrogen loading through the stricter mandates under the Nitrates Directive. Recent trends indicate the area farmed under derogation has increased by 34% from 2014 to 2018, while a significant additional cohort of 5,000 farmers are operating above derogation stocking rate limits, but are exporting slurry to comply with loading limits.

Ireland will submit its next Nitrates Action Programme next year. The Council recommends that the synergies with climate action be fully considered in the design of this Programme.

The Council recommends that the government should pro-actively engage with and support the objectives of the Farm to Food Strategy. However, detailed analysis is required to determine appropriate national targets under these proposals and to identify the appropriate suite of cost-effective measures through which they can be achieved.

The Council recommends that additional resources be allocated to support necessary investment into research and knowledge transfer to enable the long-term climate sustainability of Irish agriculture.

Ambitious targets will require considerable research and advisory support for farmers. The Council welcomes the ongoing efforts by Teagasc to develop low cost, accurate and robust systems of measurement and assessment of greenhouse gas fluxes at farm level so that each farmer would know their emissions profile

Research and innovation to expand the range of technically feasible mitigation options available to farmers is required, as well as to facilitate and incentivise carbon sequestration efforts. The Council emphasises the key importance of developing techniques to reduce methane emissions from grazing livestock.

In addition, and as noted in the Department of Agriculture, Food and the Marine's Agriculture, Forest and Seafood Climate Change Sectoral Adaptation Plan, the sector – including livestock systems – is heavily impacted by the weather and therefore faces risks with more variable weather and extreme events due to climate change. Further research is required to support effective adaptation in the sector.

Progress will require a lot of learning by doing, with farmers encouraged to proactively engage in finding new and better ways to become champions for nature conservation and climate stewardship, and the enabling of new entrants who can bring new and potentially radical ideas to the table.

The Council also sees the need to use Common Agricultural Policy funds to greatly increase knowledge transfer activities, advisory services, and support for farmer-driven partnerships dedicated to enhanced resilience to climate change and the reduction of agricultural and land use net emissions.

Built Environment

The Built Environment sector includes three subsectors: residential, commercial and public buildings whose direct emissions are primarily due to fuel used for space and water heating. While there has been progress in reducing emissions in this sector since 1990, emissions increased from 2017 to 2018 due to low fuel costs, demonstrating the significant further efforts required to get this sector on track to meet the 2030 and 2050 goals.

See Section 4.5 of Part B for more in-depth analysis of the sector.

- *Council recommends a targeted approach in the short term to achieve the greatest emissions reductions for a given investment:*

  1. *Focus government support for retrofit on vulnerable households and the worst performing buildings.*
  2. *End reliance on coal and peat for heating; facilitate and/or support households in switching from coal and peat to low-carbon and efficient heating systems. This will frequently require deep retrofit of the building fabric.*
  3. *Ban the use of oil within new builds as soon as possible and rapidly phase out oil central heating systems in all buildings, with a ban on sale of oil burners and domestic oil tanks by 2030.*
  4. *Target the roll-out of heat pumps at homes currently heated by coal, peat or oil. This will often have to be associated with an energy efficiency retrofit.*

Recently introduced building standards will ensure that new builds are substantially decarbonised by their high level of energy efficiency and use of micro-renewables. However, a significant challenge remains in addressing emissions in the existing stock of buildings: many houses have poor energy ratings and the vast majority depend on fossil fuels for space and water heating.

An analysis of the deep retrofit pilot programme carried out by SEAI observed an average cost of €54,000 per house. Other estimates, e.g. from the Tipperary Energy Agency, while lower at €30,000, still put the task of retrofitting the housing stock beyond the capacity of the Exchequer to deliver. The cost of retrofit may not be affordable for many households who have limited savings and/or lack access to capital. Even for households that have the resources, deep retrofit may be perceived as too disruptive: it usually requires moving out of one's home for some weeks and significant engagement in project management with multiple professionals and tradesmen to see the task through from beginning to end. We need to learn the lessons from behavioural research that doing the right thing needs to be straightforward for widespread uptake.

Retrofitting the existing building stock represents a great challenge. The SEAI provided grants for approximately 1500 deep retrofits in 2019. To achieve the targets laid out in the Climate Action Plan and the Programme for Government 2020, the retrofit of upwards of 50,000 homes every year from 2023 to 2030 is required. The capacity of the construction sector to achieve this goal will be stretched while it is also delivering increased new homes promised in the Programme for Government. The construction industry must be encouraged and supported to increase its capacity.

Where resources are limited it will be important to prioritise actions by targeting buildings where most benefits and emissions reductions can be achieved. Clearly the energy ratings of the worst-

performing dwellings must improve. This would bring many benefits, not only through energy cost savings and emissions reductions but also through improvements to health from warmer, drier homes. This will be incentivised through the rising carbon tax, but low-income households will need additional support.

We need to first eliminate the most carbon-intensive fuels from our homes. Use of these fuels also has the biggest adverse impact on health and local air quality. Priority should be given to switching homes away from peat and coal in open-fires and central heating systems, towards cleaner, more efficient alternatives. This would also help reduce energy poverty.

The next priority is to phase out the use of oil for heating in all buildings. SEAI has identified that a significant number of oil-heated homes are heat-pump ready. Other oil-heated homes would need some level of retrofit to improve heat retention before a heat pump could provide an efficient alternative. Incentives will help to deliver change in some households but may not be enough to achieve a transition across the entire housing stock. To achieve 2050 targets, more substantial change is required and our efforts towards 2030 should be consistent with a cost-effective pathway to 2050.

To achieve the ambitious national targets by 2050, research shows that the Built Environment sector must decarbonise to near zero. Fossil fuels currently dominate the supply of energy for space and water heating in Irish buildings. While electrification of heating will be a cost-effective option in many instances, other zero-carbon energy sources could also provide a low-cost option for decarbonisation. Natural gas is the most carbon-efficient of the fossil fuels and does not result in the significant pollution and adverse air quality impacts of coal and peat. The gas grid has the potential to deliver zero-carbon energy in the long term, particularly where there is significant deployment of biomethane or green hydrogen. The Council therefore does not consider the deep retrofit or fuel switching of dwellings connected to the gas grid a priority for government in the short-term, except where they are occupied by vulnerable households experiencing energy poverty. The possibility of more rapid progress in reducing emissions in these households through the use of biomethane or green hydrogen should be researched and piloted.

- *To achieve the ramp-up rates in transition implied in the Climate Action Plan, Council recommends that supports to individuals to enable them take their own action will be required, alongside an increased carbon tax:*
  - *a portal for access to independent information on retrofit*
  - *free and supported training on energy efficiency for tradesmen and construction and architecture professionals integrated with their professional qualification programmes*
  - *aggregation approaches to reduce the average cost of retrofits and 'one-stop shops' to make it easier for individuals to take action*
  - *aligned planning rules*
  - *innovative financial products and loan facilities*
  - *appropriate consideration of the potential for overheating in a changing climate.*

In 2019 the Government established a retrofit taskforce to develop approaches for achieving deep retrofit of the existing building stock to a Building Energy Rating (BER) of B or its carbon efficiency

equivalent. The Council welcomes this initiative and looks forward to its outcomes. The Council recommends that the role of an increased carbon tax to incentivise energy efficiency measures by households be included in the work of the taskforce.

- *Council advises that high rates of retrofit cannot be achieved without unlocking low-cost capital for households and SMEs.*

Retrofits embody a large upfront cost and long-lived benefits. A high carbon tax reduces the payback period and makes the long-lived benefits more salient. However, capital constraints may still limit the ability of householders to make the required investment. Few households will have the savings necessary to finance a deep retrofit out of pocket. Currently, the only other alternative to self-finance a retrofit is to take out a loan from a retail bank or credit union, where high interest rates will add to the costs. Access to such loans is constrained where assessments of ability to repay do not take account of expected savings due to energy efficiency. Without access to finance, the vast majority of households will not be able to invest in deep retrofit.

Interest rates outside the retail banking sector are at an all-time low and should provide an opportunity for households to invest in energy efficiency at a low cost, if the right instruments are made available. Pay-as-you-save and other financing models, perhaps delivered through utilities or non-traditional actors, could help to overcome barriers to achieving retrofit goals. EU funding should also be explored to support aggregated approaches.

Electricity

Full decarbonisation of the Electricity sector will be required by 2050 to support ambitious mitigation across the sectors. Eirgrid's commitment to 70% renewable generation on the transmission network by 2030 is an important next step, which is challenging but achievable. While the share of renewable electricity generation, particularly wind, is increasing, the pace of decarbonisation of the sector needs to accelerate.

Considering the projections for the impacts of climate change on Ireland, it is evident that greater consideration needs to be given to climate-proofing Ireland's energy supply and security to 2050 and beyond. The models indicate that wind speeds and solar radiation will change, such that wind and solar energy output from installations may be reduced in future. These long-term, gradual changes need to be accounted for in energy policy to ensure that our electricity supply is adapted and resilient to future impacts.

- *Council recommends accelerated closure of Moneypoint and cessation of peat-fired generation.*

Decarbonisation of electricity generation is a critical component of the transition to a low-carbon future. While progress has been made, much more is needed to meet ambitious national targets to 2030 and 2050. The Climate Action Plan reiterated the government commitment to end the burning of coal at Moneypoint by 2025 and to transition away from peat for electricity generation by 2028. In fact, the transition from peat will happen much sooner as the ESB has announced that it will end electricity generation at its West Offaly and Lough Ree power stations by the end of 2020, while Bord na Móna has committed to transition its electricity generation to 100% renewable sources by 2024. Electricity generation from coal has decreased in recent years due to sustained periods when Moneypoint was offline. The reasons are unclear but maintenance, fuel costs and carbon prices are thought to have played a role. Its reduced operating hours

contributed to significant reductions in greenhouse gas emissions in the sector and to a decrease in the carbon intensity of electricity generation. Ireland urgently needs to establish an Electricity sector that does not rely on the dirtiest fossil fuels. A clear policy is needed to transition fully away from coal generation before 2025.

- *Council recommends a carbon price floor to support renewable energy, transition away from fossil fuels and reduce the need for subsidies in the sector.*

A carbon floor price would support the continued displacement of the existing coal and peat generating capacity by low- and zero-carbon options. It remains to be seen whether the reforms to the EU ETS, including the market stability reserve, will deliver the increased carbon price signal required to drive down emissions from electricity generation. It is promising that the recent carbon price on the ETS has largely remained above €20 since August 2018. The spread of Covid-19 has caused more volatility in the market, with the price of carbon dropping briefly almost to €15 and then rising to over €30. Despite this high peak, volatility and uncertainty will continue to undermine investment in substantial decarbonisation. An appropriate carbon floor price could reduce the need for ongoing support of renewables via the Public Service Obligation levy.

- *Council recommends investment in infrastructure to support high renewable energy penetration.*
  - *It is essential that a decarbonised Energy sector is also resilient to the impacts of climate change, particularly given the potential for cascading effects.*
  - *Public acceptance is important and needs to be nurtured.*

Investment in renewables must be accompanied by (1) diversification of energy sources, (2) greater interconnection to international energy networks, (3) electricity storage, and (4) the roll-out and exploitation of the full benefits of smart meters. Complementing the investment in renewables in this manner will increase capacity to electrify heat and transport in the future.

Investment in the distribution and transmission networks will be important to enable deep decarbonisation of electricity generation. Interconnection is essential to both Ireland and the EU in reducing emissions and guaranteeing that Irish and European citizens have access to energy that is generated from clean sources and whose supply is reliable. The Celtic Interconnector is welcome but may not be sufficient.

Public acceptance of large infrastructure development is important and needs to be nurtured. The Renewable Energy Support Scheme (RESS) provides supports for the development of renewables and to ensure that people and communities living adjacent to proposed installations are consulted and involved in the process. This is a crucially important action in the successful deployment of renewable energy infrastructure.

Continued adaptation planning and resilience building is also essential. The National Directorate for Fire and Emergency Management's 'Review Report on Severe Weather Events 2017–2018' shows that a loss of power supply has cascading impacts into other sectors, affecting communications networks and water treatment and supply during extreme weather events, for example.

- *Council recommends that policy should allow and create space for emerging alternative decarbonisation technologies to compete and contribute to the national objectives. This would include policy to facilitate commercial development of offshore windfarms as a crucial element in the long-term decarbonisation of energy supplies in Ireland.*
  - *Advancing the Marine Planning and Development Bill is a priority.*

Offshore wind has the potential to contribute significantly to reaching high levels of low-cost renewable penetration and could support plans for power-to-gas green hydrogen systems. A general scheme of the Marine Planning and Development Management (MPDM) Bill was approved by Government in December 2019; the Programme for Government commits to draft, publish and enact this legislation within nine months. This will be crucial to the development of the offshore wind resource. The commitment in the Programme for Government to conduct an auction under the RESS for offshore wind in 2021 could do much to encourage the development of this industry in Ireland. The Council welcomes the recent announcement of the provisional results of the RESS 2020 auction.[i]

Recent analysis from the ESRI urges that policy initiatives should take a technology-neutral approach to decarbonisation of electricity generation and cautions against an overly prescriptive policy for renewables within electricity generation. A technology-neutral approach would avoid policy bias against alternative, cost-effective mitigation options, particularly in the context of deep decarbonisation and growing electricity demand, for example biomethane coupled with carbon capture and storage. Council recommends that policy should allow and create space for emerging alternative decarbonisation technologies to compete and contribute to the national objectives.

While we pursue development of market-ready technologies, support for research, development and demonstration of technologies that may be crucial to full decarbonisation in the longer term, such as bioenergy with carbon capture and storage (BECCS), ocean energy or green hydrogen, should not be neglected.

- *Council recommends that support be continued for micro-generation schemes to underpin public support for and engagement in climate action.*

Plans are currently under development by the SEAI to increase individual and community engagement through distributed micro-generation of electricity. While micro-generation is not anticipated to contribute a large proportion of supply overall, this is a step in the right direction in terms of effectively engaging with communities on these issues. All these activities are crucial in increasing the pace of installation of renewables. Lessons from SEAI's sustainable energy communities and micro-generation support schemes indicate that communities and energy users who actively participate in energy projects use less energy and take steps to change their behaviour. They also demonstrate awareness of the importance of adapting their lifestyles to be resilient to climate change. Continued support for micro-generation schemes can underpin public support for and engagement in climate action. The RESS is a welcome step to supporting the uptake of micro-generation projects by communities.

i https://www.gov.ie/en/press-release/9627f-minister-ryan-announces-the-provisional-results-of-the-first-renewable-electricity-support-scheme-ress-auction/

Industry

Emissions in this sector remain strongly coupled to economic activity. The ETS has delivered emissions reductions and should do more, but SMEs operating outside the ETS need more help and incentives to reduce emissions.

- *Council recommends that Ireland develop a comprehensive strategy for decarbonisation of the sector for both the ETS and non-ETS actors.*
  - *Increased support to SMEs to reduce their emissions.*
  - *A carbon price floor to reduce emissions in larger industry sectors.*
  - *Decarbonising energy sources and use of hydrogen should be explored as potentially providing cost-effective means to substantially reduce emissions in this sector in the longer term.*

Projections of Industry emissions for activities covered by the ETS indicate a gradual increase in emissions to 2030, and for the rate of increase to accelerate in the period to 2040. The projections reveal that additional measures identified in the Climate Action Plan do not contribute to emissions reduction in industry activities covered by the ETS.

For non-ETS activities, although projections show a 27% emissions reduction in the period to 2030 relative to 2005, thereafter other drivers in the economy lead to an increase in emissions in the period to 2040 to levels only 15% below the 2005 baseline.

Ireland lacks a comprehensive, long-term low-carbon transition strategy for the Industry sector. Ireland relies heavily on the ETS to provide the incentive for Industry to innovate and adopt low-carbon technologies. However, there is little evidence that the trading system will provide this incentive in the medium term, especially given the high level of insulation from the carbon price within the ETS afforded to the main actors in the sector through the provision of free allowances.

Industry actors operating outside the ETS may respond well to additional measures identified in the Climate Action Plan. However, in the longer term, underlying drivers within the economy will lead to the sector losing ground.

Innovation in the Industry sector is required, especially in identifying technologies and energy sources to displace fossil fuels and raw materials and to displace carbon-intensive resources. The recent EU initiative on renewable hydrogen may be a useful source of funding for innovation in this sector.

Zero-Carbon Fuels

- *Council recommends that Government develop a roadmap for decarbonised fuels in Ireland with a cross-sectoral remit.*

The same focus that was given to planning for renewable energy penetration in the Electricity sector needs to be given to decarbonisation of the gas grid. Stakeholders are acting in a policy vacuum, while a pilot project on green hydrogen transport has already begun in Northern Ireland. Cross-sectoral engagement of stakeholders and government support will be required to develop and implement a robust strategy.

- *Investment in pilot projects in Ireland for the use of renewable hydrogen for transport, heat, electricity generation and industrial purposes should be encouraged.*

  Zero carbon fuels, if cost-effective, could be a key component of Ireland's pathway to 2050. Hydrogen produced with renewable electricity has the potential to be a large-scale source of zero-carbon energy across the Transport, Built Environment, Industry and Electricity sectors if production costs drop as anticipated

  Cost-effectiveness can only be achieved with strategic planning and early action to explore and pilot options. Our renewable energy and bioenergy resources coupled with a modern gas network mean that Ireland is well placed to take leadership in Europe on this issue. The hydrogen strategy released by the European Commission in July 2020 suggests that EU funding may be available for what is seen as a strategic priority. Government needs to support applied research and piloting of options for Ireland and to give serious consideration to their place in supporting decarbonisation across sectors.

- *Council recommends that in the short term biomethane needs support, including through development of infrastructure and markets, to enable it to play a role as a transition zero-carbon fuel.*

  Biomethane, though limited by the availability of bioresources, can also be a zero-carbon fuel and could assist in the transition. Biomethane production using anaerobic digestion can take advantage of current low-value waste streams (municipal and animal) and higher value biomass resources (including grass). Teagasc expects to commission a biomethane demonstration plant at Grange, Co. Meath using grass silage at the main feedstock. Additional research and innovation is required to assess the costs within more diverse, realistic business models and real-world scenarios of the development of a significant biomethane supply system.

Innovation and Research

Ireland, like other countries, faces many challenges in the long-term decarbonisation towards 2050 and management of the increasing impacts of climate change. Continued funding for research and innovation is crucial to ensure that we have available and can appropriately deploy the technologies, tools and systems to help us reach our goals.

- *Council recommends that provision of climate impact and adaptation information resources needs to be further developed.*

  The Council welcomes the progress made by the Climate Research Coordination Group on its strategic goals and delivery of programme of work. The addition of five new members indicates wider collaboration of climate-related research to assist in the growth of knowledge on the impacts of and response to climate change in Ireland. However, the provision of climate impact and adaptation information resources, such as Climate Ireland, needs to be further developed, consolidated and supported with appropriate funding, governance and technical advisory structures.

- *Council recommends that private sector investment in climate research is required to ensure Ireland remains competitive within the EU.*

It will be important for the private sector in Ireland to increase its proportion of investment in research and development of climate change mitigation technologies (CCMTs) to remain competitive in this area within the EU.

Ireland must foster the development of an ecosystem of innovation, both privately and publicly, to ensure that we remain at the forefront of knowledge and technologies that can disrupt climate change and prepare us for its impacts. It must also engage with its European partners in the forthcoming Horizon Europe programme, engage with the Green Deal process and work with existing structures and processes that are working in the various areas of climate services and solutions including Joint Programming Initiative on Climate (JPI Climate) and Climate Knowledge and Information Community (Climate KIC).

Just Transition

Transitioning to a low-carbon, climate-resilient and environmentally sustainable economy will present many challenges. A key challenge will be ensuring that the transition is fair for all: that the benefits are shared while those negatively affected (communities, workers or consumers) are supported. Imposing solutions without consultation or building trust may exacerbate problems within communities and result in failures on essential climate policies. Just Transition involves designing and implementing policies that respond to the multidimensional impacts of climate change in a transparent and open way that maximises the economic and social opportunities presented by the transition and is fair for all.

Given this, Just Transition requires a broadly based approach:

- understanding that climate change and the transition will impact individuals and communities in a range of ways
- understanding and reflecting the different capacities, needs and hopes of individuals and communities in policy design
- sharing the challenges and opportunities of climate action equitably so that inequalities are not created or exacerbated.

The development of policy requires early and sustained processes whereby policymakers collaborate with stakeholders to design and implement policies.

Section 3.6 of Part B presents a more in-depth discussion of Just Transition issues.

- *Council recommends that it is necessary to ensure that all climate action policies, including at household level, align with a Just Transition and maximise economic and social opportunities.*

Climate policy needs to be designed with consideration of the distributional impacts for both households and employment. There will be opportunities for employment in new sectors that arise in renewable energy, retrofitting and the circular economy. However, there will also be costs, and the costs of decarbonisation must be fairly distributed across the population, ensuring that those on lower incomes are not disadvantaged. The low-carbon transition will affect those working in the fossil fuel sector, who will face uncertainty and, if their skills are non-transferable,

the prospect of unemployment. However, it will also result in changes in activities across other sectors, such as agriculture and transport, as well as at household level.

- *Council recommends that the Government continue to actively engage communities to respond to climate change and ensure that climate policy is developed in a transparent and open way.*

Central to developing policies for Just Transition is continual public participation. This may be challenging, but it is essential. Active efforts by policymakers to engage individuals and communities to understand their own particular challenges, hopes and concerns will uncover any issues that have yet to be addressed. Continuous dialogue with the public also builds trust and gives ownership of the responses to climate change.

If the equitable distribution of the benefits and responsibility for climate action is to be achieved, the process of developing policy must be inclusive. The process will involve social dialogue and it will need to be deliberative. Policymakers will need to consider when and how they engage individuals and communities, and whom to engage, in the process of developing viable policies.

Financial incentives are not the only motivator for climate action. Engagement with stakeholders and appropriate communication are important to build ownership and support for climate action. A dialogue of blame for emissions is not an appropriate approach and would not foster cooperation. Recognising the valuable role that communities and groups can play in tackling climate change challenges is a good platform for action.

- *Council recommends that mitigation measures need to be better targeted for more equitable outcomes with greater impact.*

Responding to climate change needs to be equitable. Varying incomes, savings levels and capacities of households and sectors need to be taken into account in designing mitigation and adaptation climate action policies and measures that may present costs or bestow benefits. Where grants are going to households with higher levels of disposable income, for example for home retrofits or electric vehicles, the added value of this support may be unclear. It would be better if those households were persuaded to invest for other reasons, such as health and comfort benefits or prestige. Such grants, tied to a capital investment, may benefit wealthier households, while others, such as those in the rental sector, may have limited disposable income and limited control of their home environment. Therefore, different measures will be required to reach them. A more refined approach to provision of grants and other measures, targeting groups where the greatest impact will be achieved, can be more cost-effective and, at the same time, contribute to a more Just Transition.

Part B: Technical Review

1. Introduction

This year, Part A presents the Council's findings, advice and recommendations while Part B presents the evidence gathered as part of the review. Following this introduction, the chapters in Part B are arranged as follows:

Chapter 2	presents a summary of the 2018 national greenhouse gas emissions inventory and projections and draws attention to changes that occurred between 2017 and 2018.
Chapter 3	describes Ireland's progress made in furthering transition to date.
Chapter 4	describes the progress of sectors in the low-carbon transition and policies and measures towards further mitigation.
Chapter 5	outlines Ireland's progress towards a climate-resilient Ireland, including with a focus on adaptation issues in Ireland's five cities.
Chapter 6	provides perspectives and a narrative on mitigation in the agriculture and land use sectors.
Chapter 7,	the Special Focus Chapter, looks at the Transport sector, given its significance for Ireland.
Chapter 8	documents the activities of the Council in 2019.

2. A summary of the National Greenhouse Gas Emissions Inventory and projections

The Climate Action and Low Carbon Development Act 2015[1] tasked the Council, as part of its Annual Review, to provide a summary of the national greenhouse gas emissions inventory. This inventory of greenhouse gas emissions and sinks in 2018, as published in 2020 by the Environmental Protection Agency (EPA), the national competent authority, is provided below. It is the quantitative basis for the Council's review of progress in achieving reductions in greenhouse gas emissions.

2.1 Ireland's greenhouse gas emissions inventory

The annual greenhouse gas emissions inventory is central to the development of national climate change mitigation policy. It reflects the effectiveness of measures taken to achieve policy goals. Each year the EPA prepares and publishes Ireland's official greenhouse gas emissions inventory.[2] The inventory is reported to the EU and the United Nations Framework Convention on Climate Change (UNFCCC) and is subject to in-depth international review. The current inventory provides data from 1990 to 2018, was submitted to the UNFCCC on 15 April 2020.

In 2018, total emissions of greenhouse gases in Ireland were 60.9 million tonnes of carbon dioxide equivalent (Mt CO_2eq), excluding those associated with land use, land use change and forestry. This was a marginal decrease of 0.01 Mt CO_2eq compared to 2017. This follows a decrease of 0.5 Mt CO_2eq in 2017 compared to 2016.[2]

Increases in greenhouse gas emissions were recorded in the Residential (0.46 Mt CO_2eq, 7.9%), Agriculture (0.38 Mt CO_2eq, 1.9%), Transport (0.2 Mt CO_2eq, 1.6%), Manufacturing Combustion (0.18 Mt CO_2eq, 3.9%), Public services (0.07 Mt CO_2eq, 2.9%), Commercial sectors (0.06 Mt CO_2eq, 5,3%), and Industrial Processes (0.05 Mt CO_2eq, 2.0%) sectors in 2018 relative to 2017.

Decreases in greenhouse gas emissions were recorded in the Energy Generation (–1.7 Mt CO_2eq, –10.7%), F-gases (–0.16 Mt CO_2eq, –11.9%) and Waste (–0.03 Mt CO_2eq, –3,2%) sectors in 2018 relative to 2017.

When emissions from land use, land-use change and forestry are included, total emissions are reported to have decreased by 1.1 Mt CO_2eq, from 66.3 Mt CO_2eq to 65.2 Mt CO_2eq between 2017 and 2018.

In 2017, the national inventory identified an exceptional spike in emissions associated with wildfires across various land uses, with emissions of 1.9 Mt CO_2eq. If repeated, this could impact on Ireland's ability to access flexibilities allowed under the EU Energy and Climate Package to 2030. In 2018, the occurrence of fires across the country returned to a more typical level, with reported emissions of 0.4 Mt CO_2eq. This variability in biomass burning accounts for most of the reported decrease in 2018 of total greenhouse gas emissions including land use, land use change and forestry.

In the period since 2005, reductions in emissions were observed of the order of 8.8 Mt CO_2eq (–12.6%) have been observed. These were due, in large part, to the downturn in Ireland's economy over the period 2009 to 2011 (see Figure 2.1). Ireland's emissions have a high proportion of non-CO_2 greenhouse gases (36.3%) is a direct reflection of the importance of agriculture within the economy.

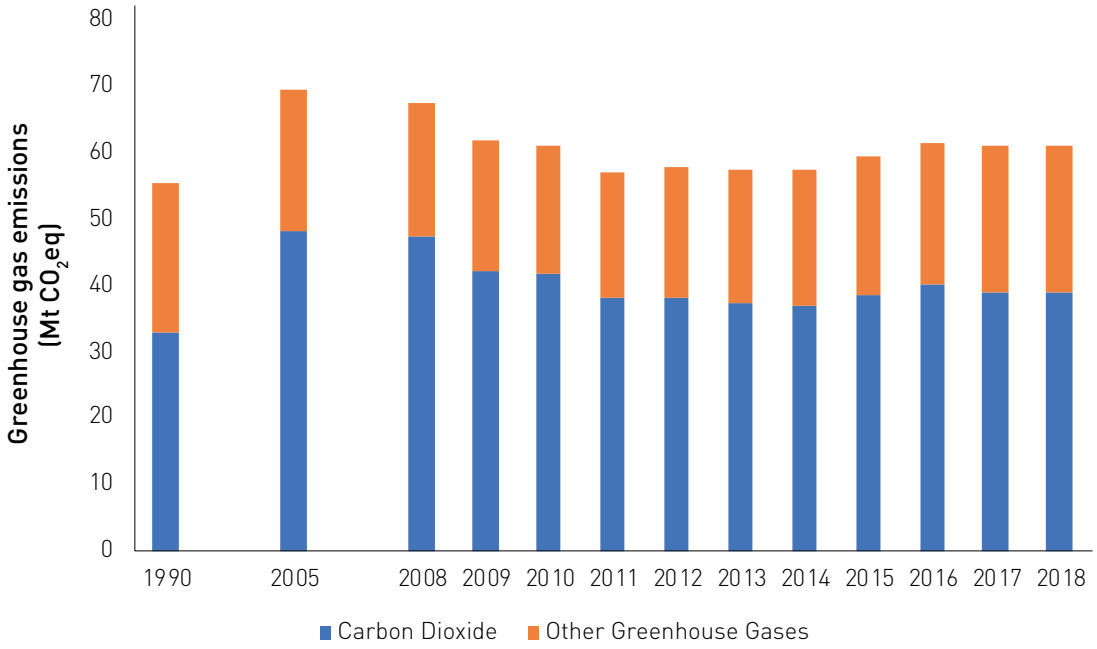


Figure 2.1: Greenhouse gas emissions, excluding land use, land-use change and forestry, for base years 1990 (National Policy Position[3]) and 2005 (EU 2020 targets) and the period 2008 to 2018 showing carbon dioxide and other greenhouse gases. **Data sources:** *EPA (2020) National Emissions Inventory.*[2]

2.1.1 Sectoral greenhouse gas emissions

The EPA provides an analysis of inventory data broken down into ten economic sectors. Emissions and removals from Land Use, Land-Use Change and Forestry are excluded from this breakdown, as the sector is not part of national emissions for reporting purposes under the targets for 2020. A summary of greenhouse gas emissions from these sectors in 2018 is given in Table 2.1. Changes in sectoral greenhouse gas emissions and how each sector contributed to the overall decrease in 2018 are shown in Figure 2.2.

Increases in greenhouse gas emissions are evident in several sectors, illustrated in Figure 2.3, with the largest absolute increase in Residential at 0.46 Mt CO_2eq, and an increase from Agriculture of 0.38 Mt CO_2eq. Transport saw an increase of 0.2 Mt CO_2eq; the Commercial and Public services an increase of 0.13 Mt CO_2eq and Manufacturing Combustion an increase of 0.18 Mt CO_2eq. Industrial Processes reported a modest increase in emissions of 0.05 Mt CO_2eq. There were decreases in emissions in the Energy Industries of -1.3 Mt CO_2eq and in F-gases of -0.16 Mt CO_2eq. Waste emissions also decreased marginally.

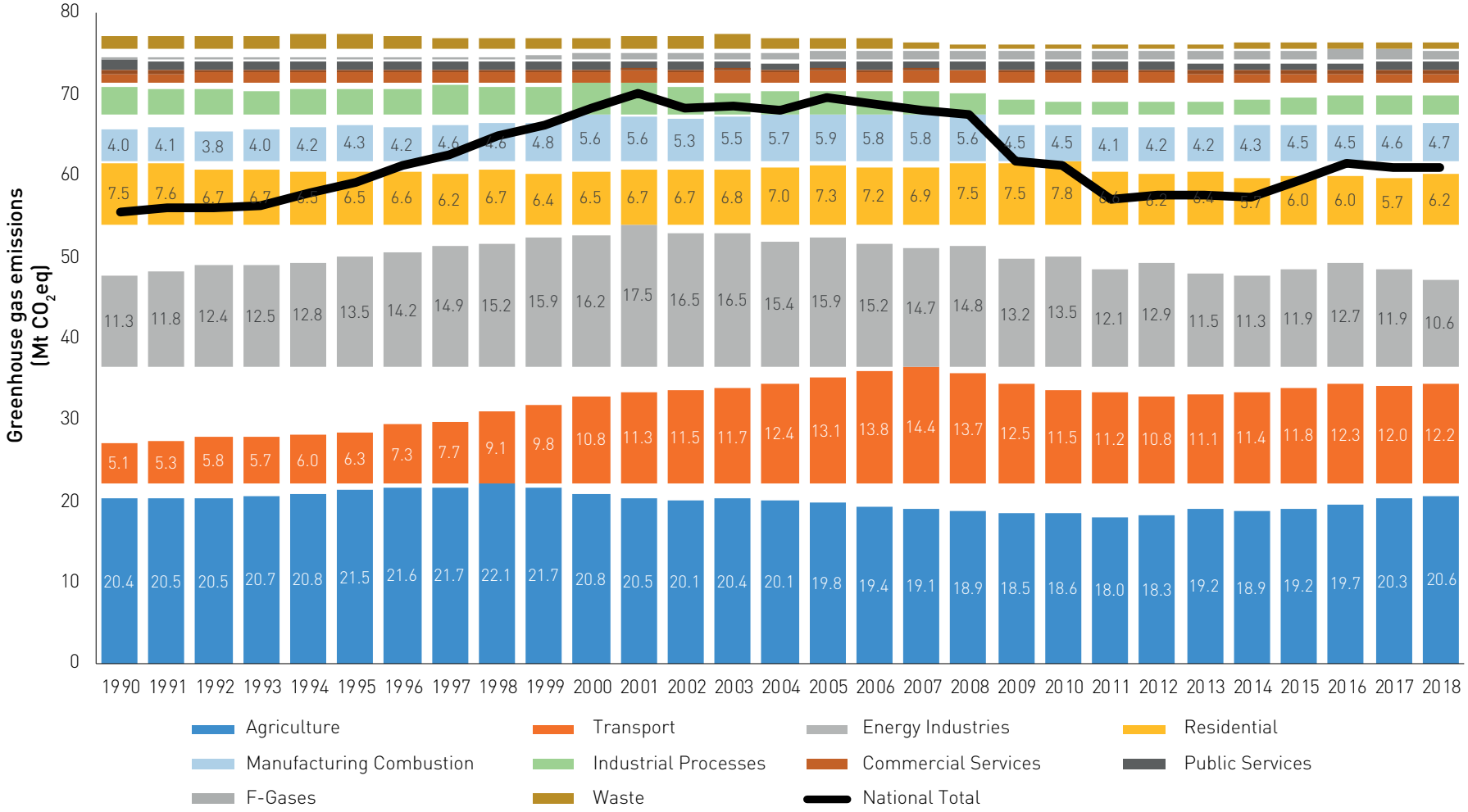


Figure 2.2: Greenhouse gas emissions for economic sectors from 1990 to 2018. F-gases refers to fluorinated greenhouse gases.
Data source: *EPA (2020) National Emissions Inventory.*[2]

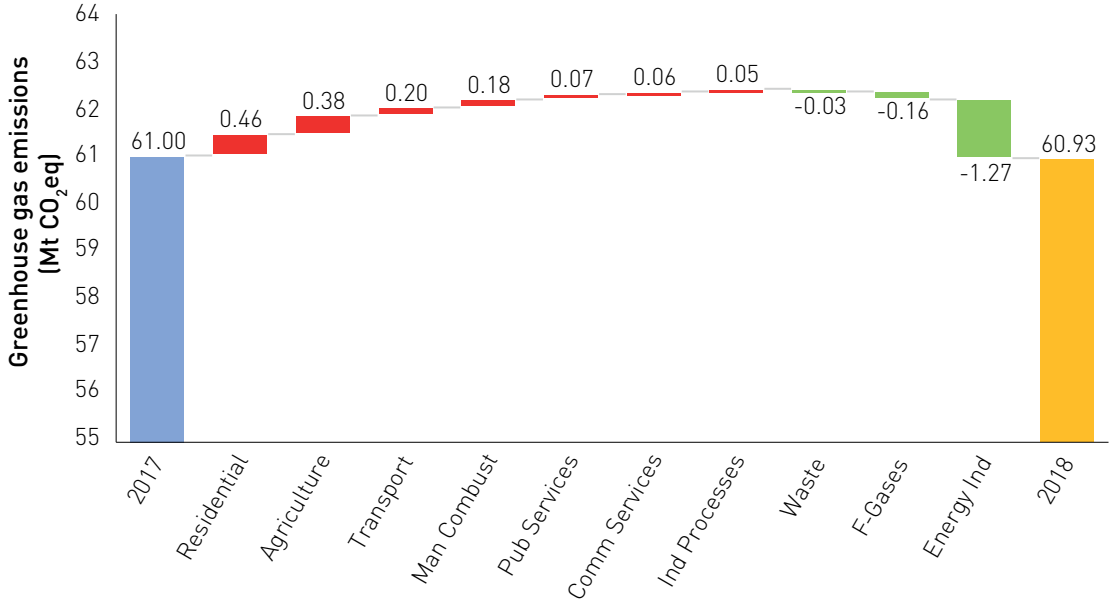


Figure 2.3: Contribution of sectors to change in emissions from 2017 to 2018. **Data source:** *EPA (2020) National Emissions Inventory.*[2]

Taking a slightly longer-term view, over the five-year period from 2014 to 2018 total emissions have increased by 3.6Mt CO_2eq. As seen in Figure 2.4 only Energy Industries recorded a significant decrease in emissions over this period.

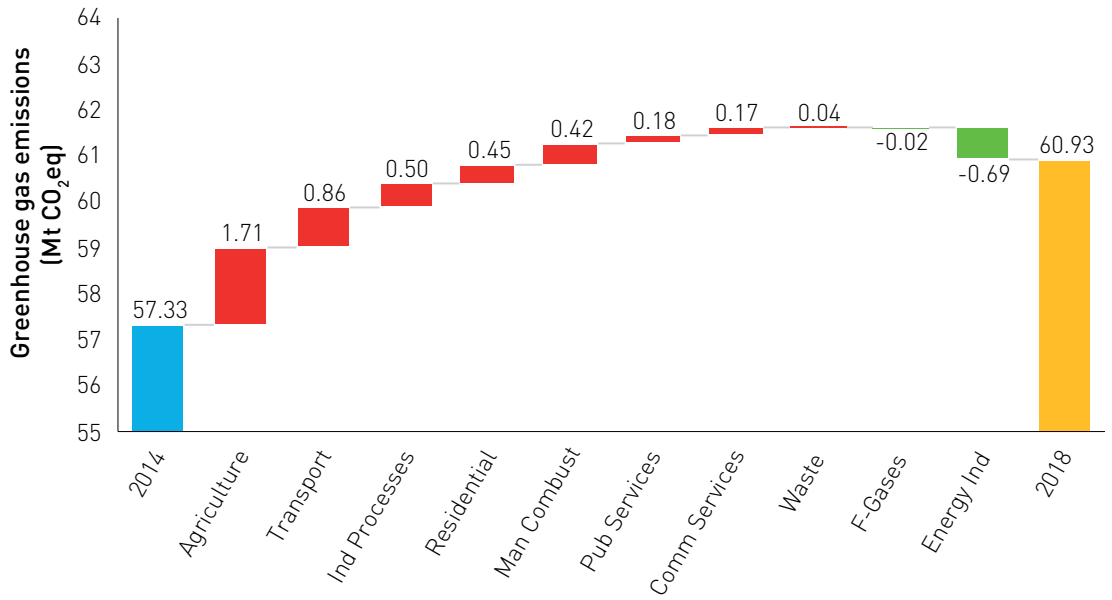


Figure 2.4: Contribution of sectors to change in greenhouse gas emissions in the period from 2014 to 2018. **Data source:** *EPA (2020) National Emissions Inventory.*[2]

In the period from 2005 to 2018, there has been a total decrease in emissions of -8.8 Mt CO_2eq, shown in Figure 2.5 most of which has been due to reduction in the Energy sector. In this period, Agriculture was the only sector where emissions have increased in absolute terms. However, emissions reductions in the other sectors were modest.

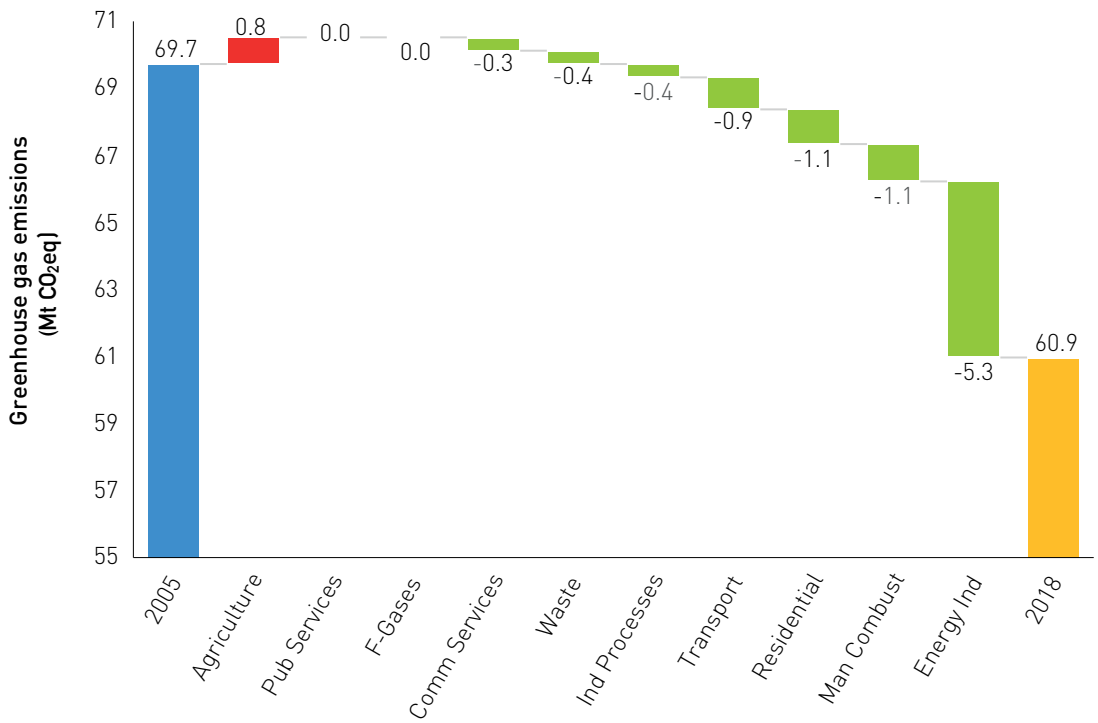


Figure 2.5: Contribution of sectors to change in emissions between 2005 and 2018. **Data source:** *EPA (2020) National Emissions Inventory.*[2]

Main greenhouse gases by sector

It is useful to consider a breakdown of the sources of emissions of the three main greenhouse gases across sectors.

Carbon dioxide, CO_2

Carbon dioxide emissions from sectors largely reflect their demand for energy, and more particularly fossil fuels. It is notable that Transport has overtaken Energy Industries as the largest source of CO_2 emissions, shown in Figure 2.6. This reflects the very significant increase in transport emissions since 1990. Since 2000, energy generation has seen characterised by an increase in renewables and natural gas and a shift away from coal and peat generation.

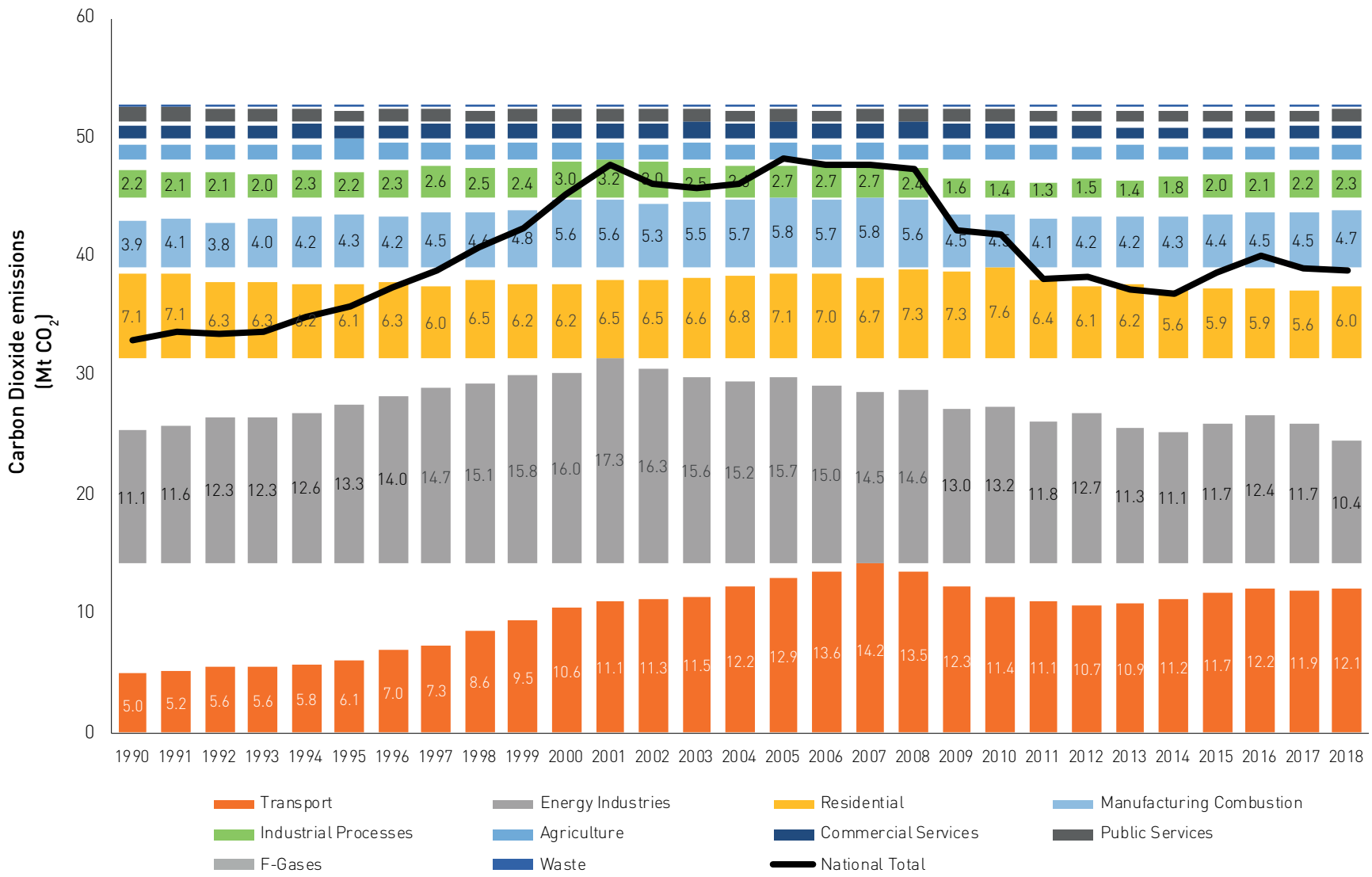


Figure 2.6: Sectoral breakdown of trends of carbon dioxide emissions. **Data source:** *EPA (2020) National Emissions Inventory.*[2]

Methane, CH_4

Methane emissions in Ireland are largely due to biological processes in the Agriculture and Waste sectors. The dominance of agriculture means significant progress can only be made with policy development in this sector aimed at reducing emissions, shown in Figure 2.7. Fossil fuel extraction and distribution activities can be important sources in other countries but make only limited contribution to methane emissions in Ireland. The Energy Industry's emissions of methane in 2003 illustrate a risk with respect to natural gas, where a specific incident caused a spike in emissions. Fortunately, as the data show, such events have been uncommon.

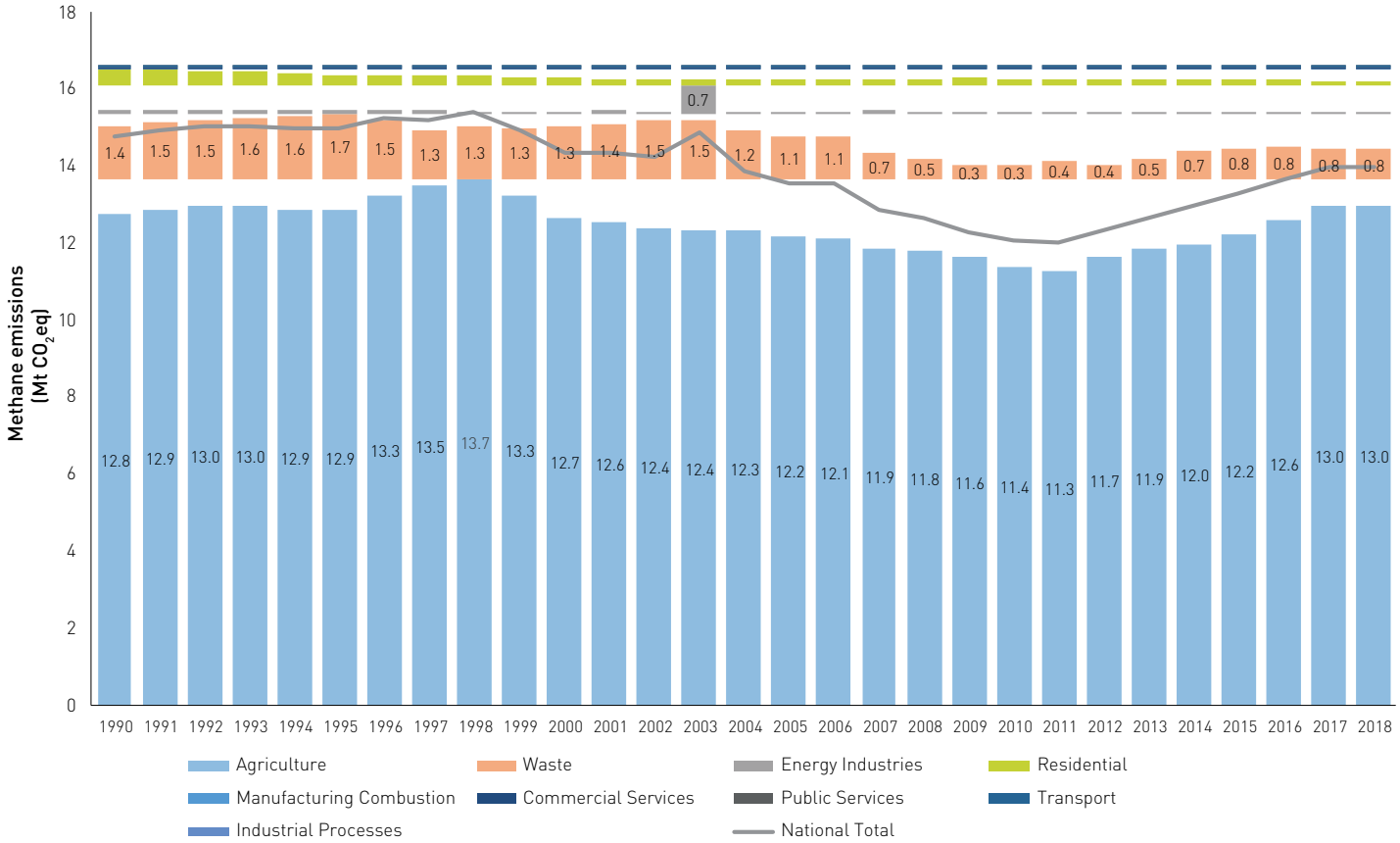


Figure 2.7: Sectoral breakdown of trends of methane emissions. **Data source:** *EPA (2020) National Emissions Inventory.*[2]

Nitrous oxide, N_2O

Nitrous oxide emissions in Ireland are also concentrated within the Agriculture sector, shown in Figure 2.8. Following the closure of specific industries in the late 1990s and early 2000s, agricultural sources presently account for 96% of N_2O emissions nationally. As with methane, significant progress on N_2O emissions can be made with policy development within this sector.

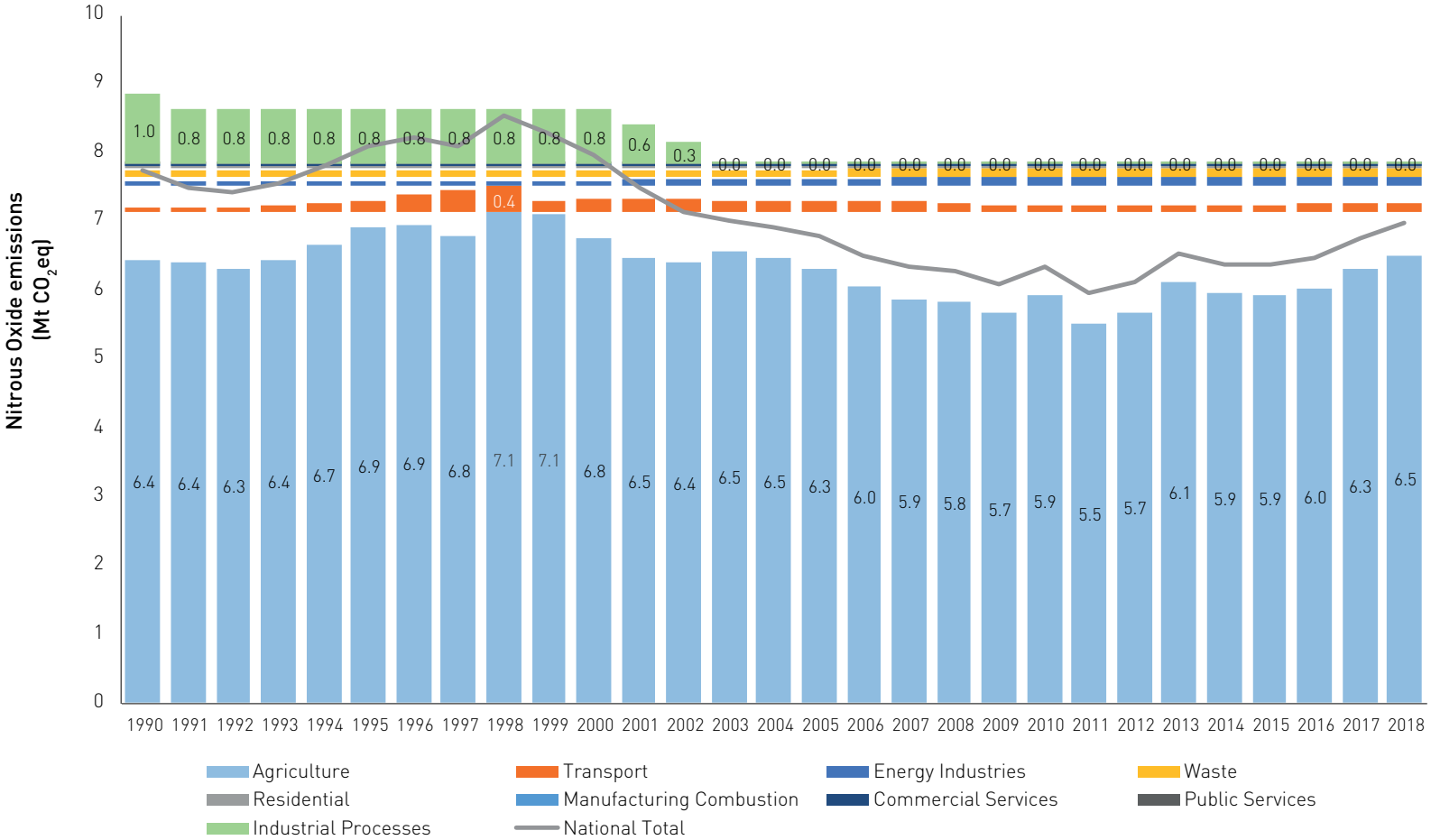


Figure 2.8: Sectoral breakdown of trends of nitrous oxide emissions. **Data source:** *EPA (2020) National Emissions Inventory.*[2]

Table 2.1: Greenhouse gas emissions for base years 1990 (National Policy Position[3]) and 2005 (EU 2020 targets), and for 2014 to 2018, broken down by sector and detailing the change in emissions in 2018 relative to 1990, 2005 and 2017. **Red text highlights an increase in emissions**. *Data source: EPA (2020) National Inventory Report.*[2]

Sector (% of total greenhouse gas emissions in 2018)	Greenhouse gas emissions inventory							Change in 2018 relative to 1990		Change in 2018 relative to 2005		Change in 2018 relative to 2017		Key drivers from 2017 to 2018 from EPA Inventory (2020)
	1990	2005	2014	2015	2016	2017	2018							
	Mt CO_2eq							Mt CO_2eq	%	Mt CO_2eq	%	Mt CO_2eq	%	
Agriculture (33.9%)	20.4	19.8	18.9	19.2	19.7	20.3	20.6	**0.23**	**1.1%**	**0.80**	**4.1%**	**0.38**	**1.9%**	Increased dairy production
Transport (20.1%)	5.1	13.1	11.4	11.8	12.3	12.0	12.2	**7.08**	**137.5%**	–0.92	–7.0%	**0.20**	**1.6%**	Continued growth in the economy, Increase in fuel tourism
Energy Industries (17.4%)	11.3	15.9	11.3	11.9	12.7	11.9	10.6	–0.70	–6.2%	–5.27	–33.1%	–1.27	–10.7%	Decrease in coal generation
Residential (10.2%)	7.5	7.3	5.7	6.0	6.0	5.7	6.2	–1.33	–17.6%	–1.07	–14.8%	**0.46**	**7.9%**	Relatively cold January-April period.
Manufacturing Combustion (7.8%)	4.0	5.9	4.3	4.5	4.5	4.6	4.7	**0.78**	**19.7%**	–1.13	–19.2%	**0.18**	**3.9%**	Continued growth in the economy
Industrial Processes (3.8%)	3.3	2.8	1.8	2.0	2.2	2.3	2.3	–0.96	–29.3%	–0.45	–16.2%	**0.05**	**2.0%**	Continued growth in the economy
F-Gases (2.0%)	0.0	1.2	1.2	1.2	1.3	1.4	1.2	**1.16**	**3347.3%**	–0.01	–0.8%	–0.16	–11.9%	Decrease in use of a number of HFC species
Waste (1.5%)	1.6	1.3	0.9	0.9	0.9	0.9	0.9	–0.66	–42.6%	–0.40	–31.1%	–0.03	–3.2%	Continuing steady decrease in landfill emissions
Commercial Services (1.9%)	1.1	1.5	1.0	1.0	1.0	1.1	1.1	**0.05**	**4.2%**	–0.35	–23.5%	**0.06**	**5.3%**	Space heating requirement response to cold start to year
Public Services (1.6%)	1.2	1.0	0.8	0.8	0.8	0.9	1.0	–0.18	–15.6%	**0.03**	**2.9%**	**0.07**	**8.2%**	Space heating requirement response to cold start to year
Total Emissions	**55.5**	**69.7**	**57.3**	**59.4**	**61.5**	**61.0**	**60.9**	**5.47**	**9.9%**	**–8.77**	**–12.6%**	**–0.07**	**–0.1%**	

2.1.2 Analysing the macroeconomic drivers of greenhouse gas emissions

Understanding the drivers of greenhouse gas emissions aids management and mitigation. The Fifth Assessment Report of the IPCC has listed the drivers as being economic growth, the energy intensity of economic output, population and the carbon intensity of electricity, heat and transport.[4] Figure 2.9 shows the trend of each driver relative to changes in Irish economic output. Each driver will now be discussed in turn.

The link between economic growth and emissions is declining but remains strong. As well as developments in Modified Gross National Income (GNI*) emissions are affected by a range of other factors. Looking further, a number of important trends may be identified. Some sectors have experienced a continued correlation with economic growth, albeit with a shift in the magnitude of this effect. This is observed with respect to commercial, public and industrial services. Further econometric analysis is required to deepen our understanding here.

Residential emissions decline through the period while GNI* grows. This suggests that the added wealth has not been translating into emissions in the home. A decline in the emissions intensity may be attributable to many factors, with further evidence required to understand why this is the case.

Some sectors, such as Agriculture and Residential, present little or no correlation with economic growth. This suggests that the relationship between emissions in these sectors and economic growth is more complex, being influenced by regulation and individual consumption/production decisions. In the Energy Industries sector the relationship of emissions to economic activity trends is currently dominated by large shifts in technology and relative energy prices.

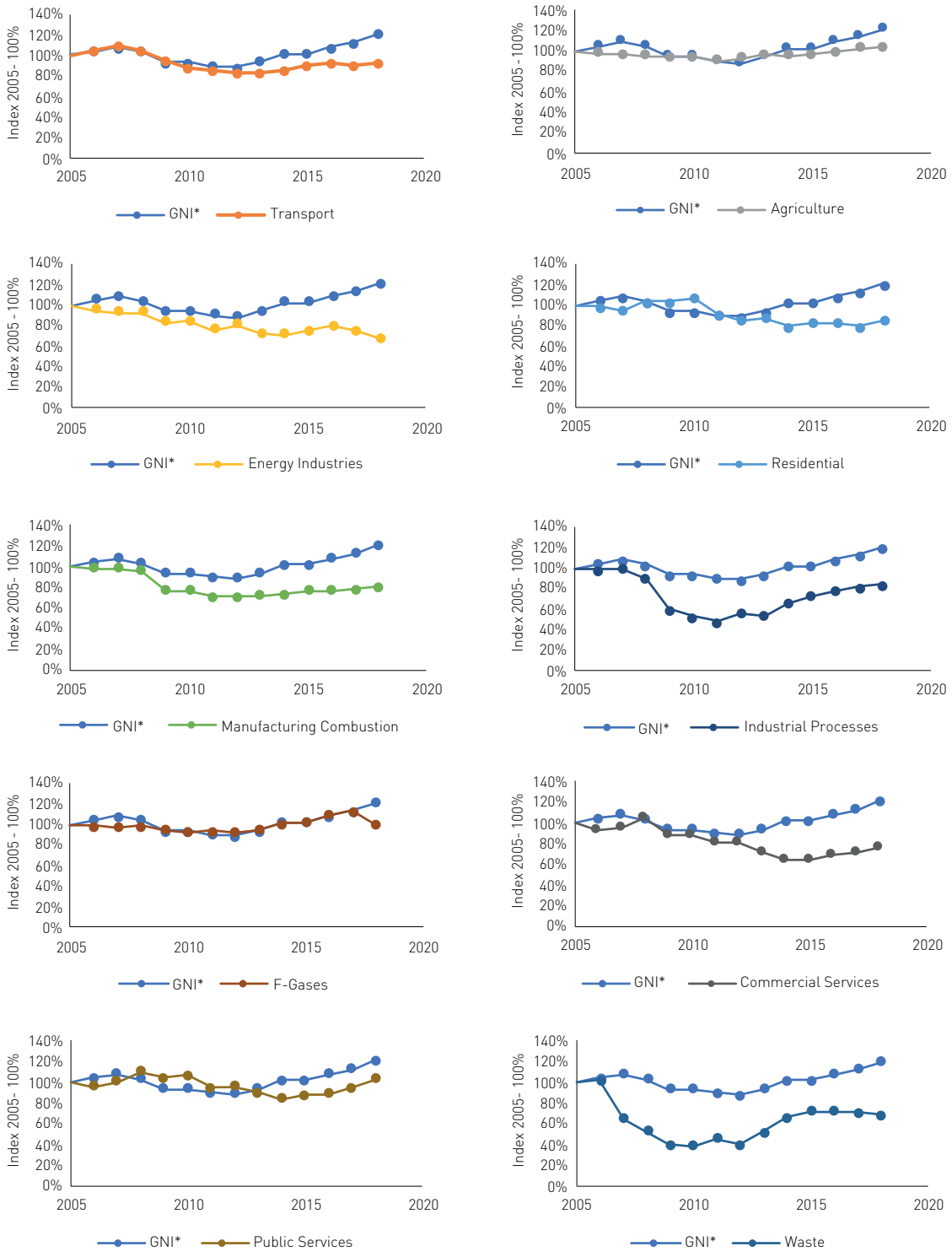


Figure 2.9: Modified Gross National Income (GNI*) at constant prices and greenhouse gas emissions by sector. **Data source:** *EPA (2020) National Emissions Inventory 2020*[2], *CSO (2020) National Accounts.*[5]

The emissions intensity of electricity and agriculture is very important in determining the trend in Irish greenhouse gas emissions. Ireland is a service-led economy with less heavy manufacturing than European counterparts. Agriculture is also an important source of emissions. With respect to electricity, Ireland has traditionally been reliant on imported fossil fuels. Where low-carbon fossil fuels (gas), and subsequently renewable energies, have been employed there has been great progress in emissions reduction and in reducing the emissions intensity of economic growth.[i] This is reflected in the Figure 2.9, where the Energy industry displays a downward trend of emissions intensity despite recent economic growth. The continued decarbonisation of Ireland's Electricity sector is of fundamental importance for achieving climate action targets as this is the foundation of decarbonisation in many sectors.

As long as fossil fuels are employed as energy sources in the economy, energy intensity or energy consumption levels will be an important factor in driving greenhouse gas emissions in Ireland. Final energy use decreased from 2005 to 2018 by about 2%, even as the economy grew.[6] This decrease reflects energy efficiency gains and some structural shifts. When compared internationally, energy intensity is seen to reflect the structure of an economy and, in particular, the share of heavy industry and manufacturing in economic output.

Population growth has not been a major driver of emissions. Though population steadily increased from 4.1 million in 2005 to an estimated 4.8 million in 2018, total greenhouse gas emissions decreased. The potential impact of population increase was overcome by decreasing per capita emissions. More progress is needed in reducing per capita emissions in Ireland which remain above the EU average.[7] This will be especially important as the Irish population is expected to increase significantly by 2050, with projections ranging from 5.6 to 6.7 million in 2050 based on different scenarios.[8]

i Ireland's overall use of fossil fuels in final energy use has decreased from an 82% share in 2005 to a 77% share in 2018. The share of gas within fossil fuel use increased in the same period leading to considerable emissions reductions.

2.2 Summary of projected greenhouse gas emissions

The Climate Action and Low Carbon Development Act 2015 tasked the Council as part of its Annual Review to provide a summary of the most recent projections of greenhouse gas emissions. Ireland's future greenhouse gas emissions as projected by the EPA are provided below. These projections are based on policies and measures in place for the period 2019 to 2040 and use the mandated template for reporting to the EU under the Monitoring Mechanism Regulation. (Regulation (EU) No 525/2013.[9]

2.2.1 Ireland's greenhouse gas emissions projections

Every year, the EPA releases greenhouse gas emissions projections for Ireland. In accordance with reporting requirements, these projections are submitted to the EU every second year, as part of the Monitoring Mechanism Regulation, and to the United Nations Framework Convention on Climate Change (UNFCCC) every four years. As with the greenhouse gas inventory, the projections are subject to in-depth international review. The current set of projections was published on 8 July 2020.

The projections data represent the potential emissions based on two scenarios for the period 2019 to 2040, known officially as the 'with existing measures' (WEM) and 'with additional measures' (WAM) scenarios. The WEM scenario only considers policies and measures that were already in place by the end of 2018. The WAM scenario also considers the implementation of planned policies and measures from 2019, including renewable and energy efficiency measures as described in the National Energy Efficiency Action Plan, the National Renewable Energy Action Plan, the National Energy and Climate Plan and the Climate Action Plan 2019. It is worth noting that the projections do not include any immediate or, long term impact of the Covid-19 crisis.

The output of the WEM scenario identifies a significant shortfall in achieving Ireland's Effort Sharing Decision 2020 emissions reduction target, with only a 2% to 4% reduction in greenhouse gas emissions relative to 2005, compared to the target of 20%. The WEM scenario also projects a shortfall in achieving Ireland's Effort Sharing Regulation emissions reduction target for 2030, with only a 6% reduction relative to 2005, compared to the target of 30%.

The EPA's 2020 report of projections states 'Ireland's non-ETS emissions are projected to be 6% and 29% below 2005 levels in 2030 under the With Existing Measures and With Additional Measures scenarios, respectively. With the use of a Land-Use, Land-Use Change and Forestry (LULUCF) flexibility, as provided for under EU legislation, emissions are projected to be 12% and 34% below 2005 levels in 2030'.[10] This would allow compliance with the 2030 target.

Greenhouse gas emissions projections are prepared using data from several key sources. The energy forecast is provided by the Sustainable Energy Authority of Ireland (SEAI). This information was prepared with the Economic and Social Research Institute (ESRI) and University College Cork (UCC). The ESRI uses macroeconomic projections produced by the I3E, (Ireland Environment Energy Economy) model.[11] Projections of global economic activity are based on the National Institute Global Econometric Model (NiGEM) from the National Institute of Economic and Social Research in the UK.[12] Agricultural forecasts are provided by Teagasc. These include data on animal numbers, crop areas and fertiliser use.

For the 2020 emissions projections, fuel price data (that are used as input for the ESRI I3E model) were sourced from the UK Department for Business, Energy and Industrial Strategy

(BEIS) 2018 publication.[13] These are significantly lower than the fuel prices used to produce the energy demand projections that underpinned the 2019 emissions projections, which were based on the 2016 EU reference scenario fuel prices. It is difficult to accurately forecast oil and energy prices over long timescales. The projected emissions reductions based on these assumptions are sensitive to real-world volatility in pricing. Indeed, the current coronavirus crisis and recent tensions between oil-producing countries have driven oil prices to their lowest levels in about twenty years. The Government, in the development of the National Energy and Climate Action Plan, has adopted the more conservative projection of a lower fuel price consistent with the BEIS analysis.

2.2.2 Future sectoral greenhouse gas emissions

The breakdown of projections by sector provides insight into areas where existing and additional measures are envisaged to have significant impact on emissions.

The WAM scenario projects some significant emissions reduction in the period from 2018 to 2030 achieved within the Transport, Energy Industries, Residential and Agriculture sectors. Combined, these sectors realise 14.1 Mt CO_2eq per year emissions reduction relative to 2018. The Commercial and Public Services sector, F-Gases and Waste combined contribute a further 1.5 Mt CO_2eq emissions reductions. In the same period, the combined Industrial Processes and Manufacturing sectors are projected to increase emissions by 1.2 Mt CO_2eq. While the Climate Action Plan articulates effective policies and measures in key sectors, there is clearly a gap with respect to the Industrial Processes and Manufacturing sectors. The recently agreed Programme for Government sets out a national target of 51% emissions reduction by 2030 relative to 2018.[14] The level of increased ambition implied by the Programme for Government is clear from Figure 2.10.

When the projections are considered out to the period 2030 – 2040, as shown in Figure 2.11, overall emissions are projected to increase, with some worrying trends emerging across a number of sectors. The Industrial Processes and Manufacturing sectors continue to increase emissions. However, perhaps of even greater concern is that the Energy Industries and Agriculture sectors are projected to lose ground, with only the Transport sector projected to continue to decrease emissions. It is perhaps obvious, but worth stating, that the lack of measures out to 2040 is not yet a critical issue of itself, however the projections to 2040 show that the external drivers of emissions in the wider economy remain, and strategic medium- to long-term sectoral planning is required to counter these pressures. Figure 2.12 shows the projected emissions across all sectors for 'with existing measures' and 'with additional measures' scenarios.

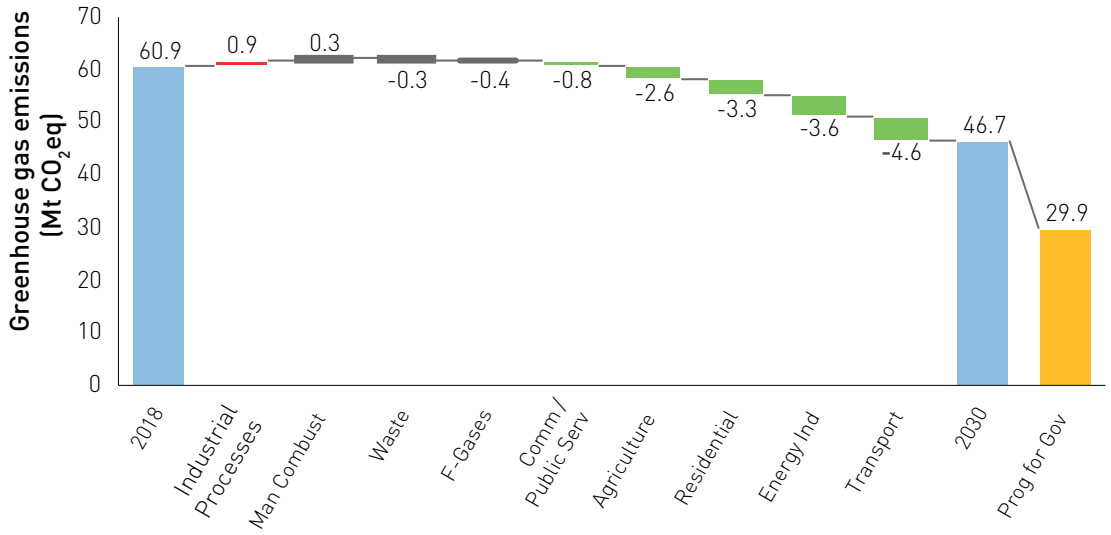


Figure 2.10: *Schematic of target under the Programme for Government and projected changes in greenhouse gas emissions across sectors in the period from 2018 to 2030 based on "with additional measures" scenario.* **Data source:** *EPA (2020) National Emissions Inventory*[2] *EPA Projections 2020, Programme for Government June 2020.*[14]

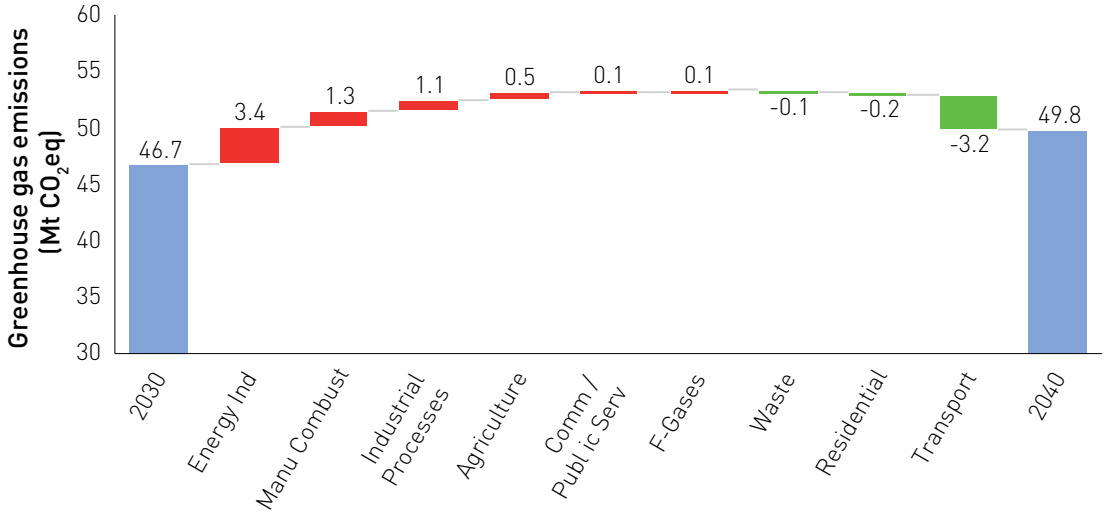


Figure 2.11: Projected changes in greenhouse gas emissions across sectors in the period from 2030 to 2040 based on "with additional measures" scenario. **Data source:** *EPA (2020) National Emissions Inventory.*[2]

Table 2.2: Projections of total greenhouse gas emissions by sector from 2019 to 2020, 2030, 2040 under the 'with additional measures' scenario. Red text highlights an increase in emissions. **Data sources:** *EPA (2020) National Emissions Inventory*[2] *and Ireland's Greenhouse Gas Emissions Projections 2019–2040.*[10]

Sector	Greenhouse gas emission inventory			Greenhouse gas emission projections for 'with additional measures'									Key assumptions as identified in Ireland's Greenhouse Gas Emissions Projections 2018 to 2040*
	1990	2005	2018	2020	2030	2040	Change in 2020 relative to 2018		Change in 2030 relative to 2018		Change in 2040 relative to 2018		
	Mt CO_2eq (% of total)			Mt CO_2eq (% of total)			Absolute Mt CO_2eq	%	Absolute Mt CO_2eq	%	Absolute Mt CO_2eq	%	
Agriculture	20.4 (36.8%)	19.8 (28.4%)	20.6 (33.9%)	20.4 (32.6%)	18.1 (38.7%)	18.6 (37.4%)	–0.2	–1.2%	–2.6	–12.4%	–2.0	–9.8%	Implementation of Climate Action Plan to 2030, Countered by sector response to underlying growth in market demand
Transport	5.1 (9.3%)	13.1 (18.9%)	12.2 (20.1%)	12.4 (19.8%)	7.6 (16.3%)	4.4 (8.9%)	0.2	1.3%	–4.6	–37.8%	–7.8	–63.9%	Rapid uptake of EVs,
Energy Industries	11.3 (20.4%)	15.9 (22.8%)	10.6 (17.4%)	11.7 (18.7%)	7.0 (15.0%)	10.5 (21.0%)	1.1	10.3%	–3.6	–34.1%	–0.2	–1.7%	70% renewables on the grid by 2030, increased energy demand to 2040 met with mixed energy portfolio including fossil fuels.
Residential	7.5 (13.6%)	7.3 (10.4%)	6.2 (10.2%)	6.2 (9.8%)	2.9 (6.3%)	2.7 (5.5%)	–0.0	–0.4%	–3.3	–52.7%	–3.5	–55.7%	Progress in retrofit and new build to 2030, stagnation to 2040.
Manufacturing Combustion	4.0 (7.1%)	5.9 (8.4%)	4.7 (7.8%)	5.5 (8.8%)	5.1 (10.8%)	6.4 (12.8%)	0.7	15.6%	0.3	6.5%	1.6	34.3%	Limited impact of climate policy on trends in the sector
Industrial Processes	3.3 (5.9%)	2.8 (4.0%)	2.3 (3.8%)	2.5 (3.9%)	3.3 (7.0%)	4.4 (8.8%)	0.1	5.9%	0.9	40.5%	2.0	88.3%	Limited impact of climate policy on trends in the sector
F-Gases	0.0 (0.1%)	1.2 (1.7%)	1.2 (2.0%)	1.1 (1.7%)	0.8 (1.8%)	0.9 (1.8%)	–0.1	–8.6%	–0.4	–31.3%	–0.3	–26.4%	Gradual reduction in use of F-gases,
Waste	1.6 (2.8%)	1.3 (1.9%)	0.9 (1.5%)	0.8 (1.3%)	0.6 (1.3%)	0.5 (1.0%)	–0.1	–8.5%	–0.3	–33.6%	–0.4	–43.8%	Continued trend to divert biological wastes from landfill, improved management of sites.
Commercial / Public Services	2.2 (4.0%)	2.4 (3.5%)	2.1 (3.5%)	2.1 (3.4%)	1.3 (2.9%)	1.5 (3.0%)	0.0	0.7%	–0.8	–36.3%	–0.6	–29.9%	Progress under CAP to 2030, but stagnation to 2040
National Total	**55.5**	**69.7**	**60.9**	**62.6**	**46.7**	**49.8**	1.7	2.8%	**–14.3**	**–23.4%**	**–11.1**	**–18.3%**	

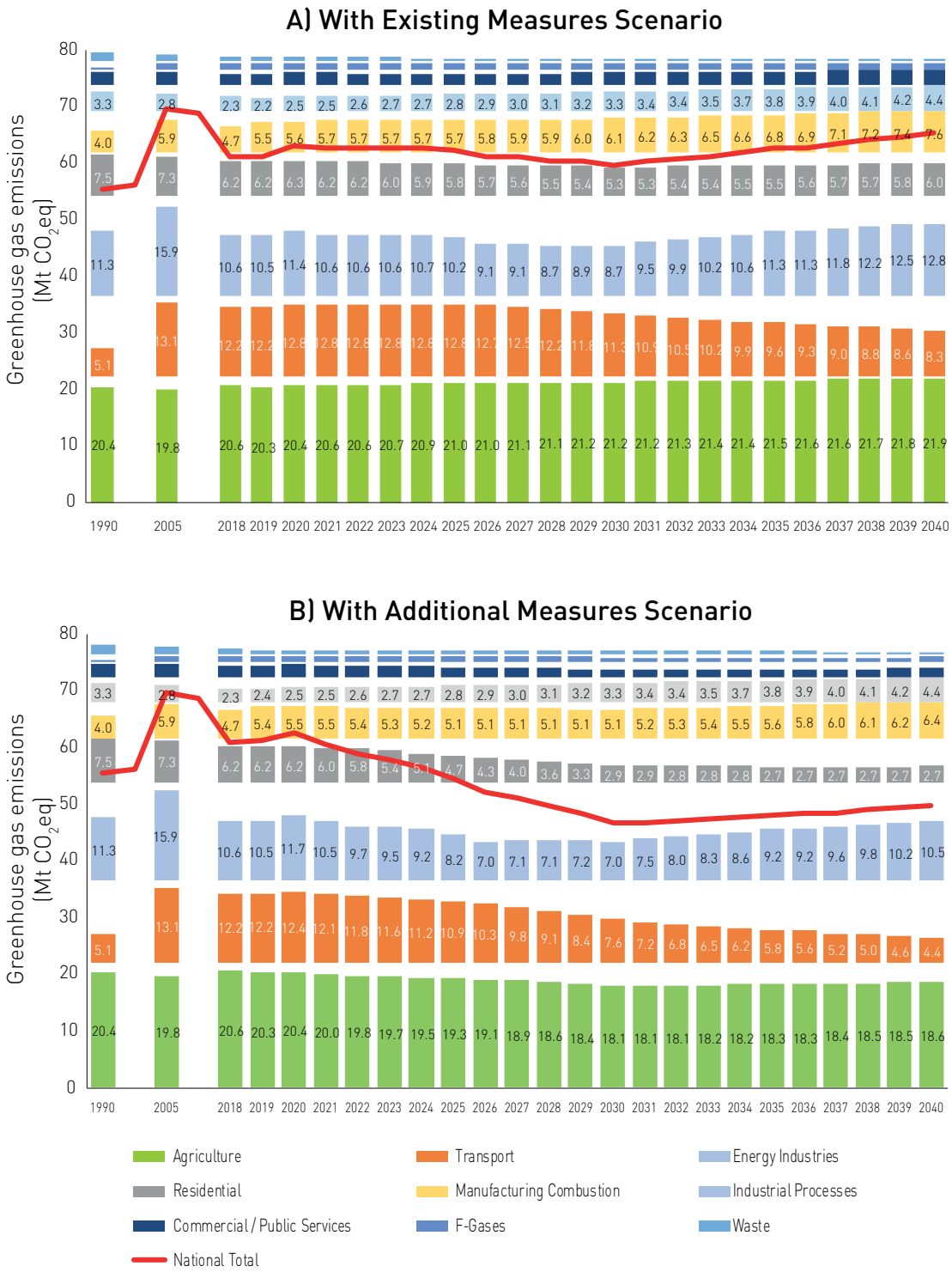


Figure 2.12: Greenhouse gas emissions for (a) With Existing Measures and (b) With Additional Measures scenarios, base years 1990 (National Policy Position) and 2005 (EU 2020 targets), 2018 data and projections to 2020, 2030 and 2040, broken down by sector in units. **Data source:** *EPA (2020) National Emissions Inventory*[2] *and Ireland's Greenhouse Gas Emissions Projections 2019–2040.*[10]

2.2.3 Conclusions on inventories and projections

Though emissions of greenhouse gases fell slightly from 2017 to 2018, emissions increased over the five-year period from 2014 to 2018. This indicates that existing policies and measures failed to deliver meaningful low-carbon transition within the economy.

Projections indicate that although Ireland will not achieve its emissions reduction targets for 2020, the suite of new measures envisaged in the Climate Action Plan 2019, if fully implemented, will allow Ireland to achieve the emission reduction targets for 2030. There is no contingency for underperformance of key measures.

Projections for the period 2031 – 2040 illustrate the need for additional policies and measures to counter underlying drivers within the economy which will be required to build on the effects of implementing of the Climate Action Plan.

2.3 Performance against existing obligations of the State

The Climate Action and Low Carbon Development Act 2015[1] tasked the Council, as part of its Annual Review, to provide advice and recommendations in relation to compliance with the state's existing obligations under EU law or international agreements. Ireland's performance in reducing greenhouse gas emissions is considered below.

2.3.1 EU legislated targets to 2020 and 2030

Governance of emissions is shared between the EU and the Member States. The EU governs greenhouse gas emissions centrally through the Emissions Trading System while emissions outside the Emissions Trading System are governed by each respective Member State in its own territory. The European Commission manages the Emissions Trading System and has key responsibility for ensuring that activities within the system succeed in reducing the emissions across Europe. The Irish Government has primary responsibility for achieving the targets in the non-Emissions Trading System sector.

Under the Emissions Trading System, the EU aims to reduce emissions from large industrial and institutional facilities, including electricity generation.[15] The Emissions Trading System covers 45% of the EU's greenhouse gas emissions and aims to reduce these emissions to 20% below 2005 levels by 2020 and to further reduce these emissions by 43% below 2005 levels by 2030. In Ireland, in 2018 the Emissions Trading System covered 26%, or 15.5 Mt CO_2eq, of total greenhouse gas emissions. The Effort Sharing Decision and the subsequent Effort Sharing Regulation cover emissions that are not addressed in the Emissions Trading System.[16,17]

Effort Sharing Decision 2020

The Climate and Energy Package 2020 is a collection of directives and decisions to ensure that the EU meets its climate and energy targets for the year 2020.[18] The package has three key objectives: (1) to cut greenhouse gas emissions by 20% relative to 1990; (2) to produce 20% of EU energy from renewables; and (3) to improve energy efficiency by 20% by 2020. Each Member State has binding targets for reducing emissions in the non-ETS sector between 2013 and 2020. Ireland's target for non-ETS emissions was a reduction of 20% on 2005 levels by 2020. The extent of Ireland's compliance with the 2020 target and the Effort Sharing Decision will become apparent in 2022 when the official greenhouse gas inventory of 2020 emissions is submitted to the EU. A final legal determination of compliance will be made in 2023.

Between 2017 and 2018, total emissions, excluding land use, land-use change and forestry, saw a net decrease of 0.07 Mt CO_2eq. The Effort Sharing Decision sectors saw an increase of 3.0% or 1.3 Mt CO_2eq (see Figure 2.13). In Ireland, in 2018 the greater part (74%, or 45.0 Mt CO_2eq) of emissions is covered by the Effort Sharing Decision.

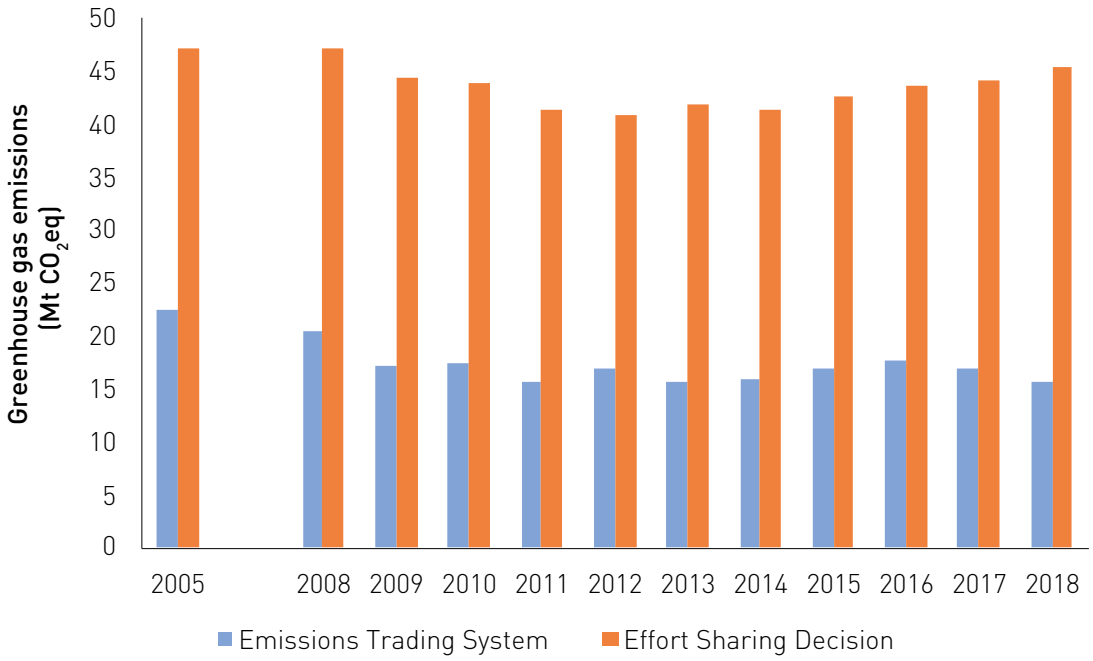


Figure 2.13: Greenhouse gas emissions for the Emissions Trading System and the Effort Sharing Decision over the period 2008 to 2018 and in the base year 2005 of EU climate and energy 2020 target.
Data source: *EPA (2020) National Emissions Inventory.*[2]

Under the EU Effort Sharing Decision, Ireland has both annual targets and a cumulative target for reductions in greenhouse gas emissions from 2013 to 2020. Emissions in 2018 were above the annual limits under the EU Effort Sharing Decision for the third year in a row. Ireland's annual limit for 2018 was 39.8 Mt CO_2eq. This limit was exceeded by 5.6 million tonnes. In 2017 and 2016, Ireland exceeded that target by 0.3 and 2.9 million tonnes respectively. However, emissions in the years 2013, 2014 and 2015 were below the annual targets. Therefore, although Ireland failed to meet annual targets for 2016, 2017 and 2018, there remains approximately 1.6 Mt CO_2eq in savings to contribute to the cumulative target to 2020.

Figure 2.14 shows the most recent reported emissions from 2005 to 2018. Figure 2.14 also shows these compliance values, which for the years 2013 to 2015 are slightly higher than revised estimates of emissions, whereas, for 2016 and 2017 the compliance values submitted are slightly lower than revised emissions estimates. Progress towards targets is based on the annual compliance submissions.

Projections for both 'with existing measures' and 'with additional measures' scenarios indicate that emissions will continue to exceed the annual targets from 2018 onwards (see Figure 2.14 and Table 2.1). Over the period 2013 to 2020, greenhouse gas emissions are projected to exceed annual limits by a cumulative total of between 13.4 and 12.6 Mt CO_2eq. This takes into consideration emissions savings accrued from 2013 to 2015. These projections indicate that, despite existing and planned additional policies and measures, greenhouse gas emissions continue to increase, suggesting that our cumulative emission reduction targets will be missed by a substantial margin.

To achieve compliance, Ireland will need to enter bilateral trading arrangements with other Member States. This is further discussed under 'Use of Flexibilities' below.

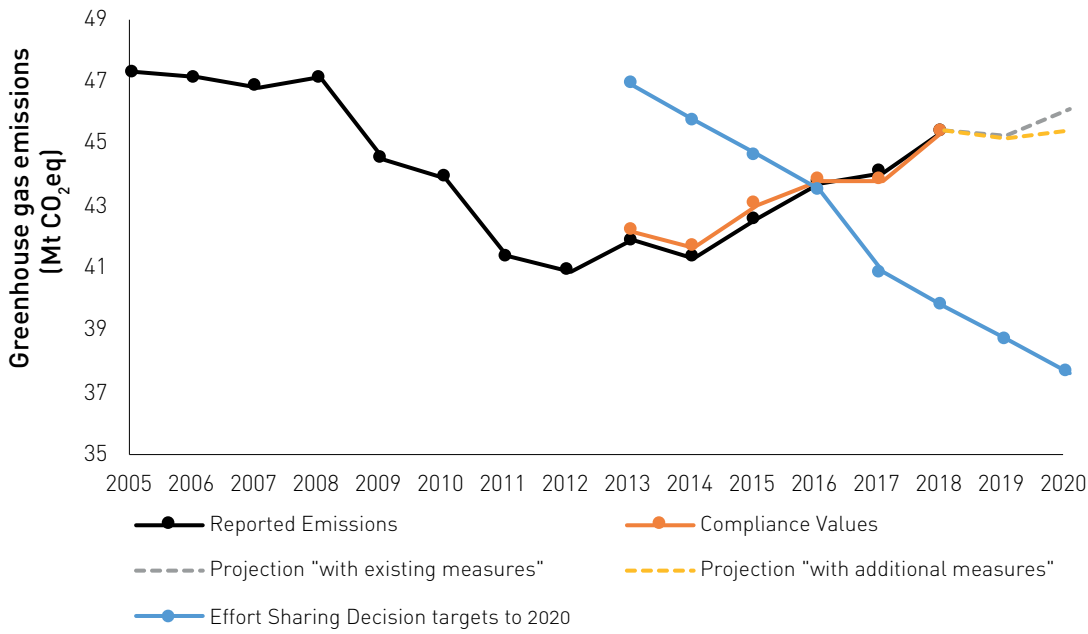


Figure 2.14: Ireland's greenhouse gas emissions from 2005 to 2018. Emissions estimates submitted in previous compliance years, 2013–2017. Annual targets under the Effort Sharing Decision for the period 2013 to 2020, without use of flexibilities, and emissions projections for 'with existing measures' and 'with additional measures' are presented. **Data sources:** *EPA (2020) National Emissions Inventory*[2] *and Ireland's Greenhouse Gas Emissions Projections 2019–2040.*[10]

Table 2.3: Summary of emissions under the Effort Sharing Decision, emissions to 2018, projections to 2020 and estimate of distance to target. Historical and projected greenhouse gas emissions, covered under the EU Effort Sharing Decision targets, relative to annual totals and total cumulative emissions targets. Red text highlights exceedance of annual targets. **Data sources:** *EPA (2020) National Emissions Inventory*[2] *and Ireland's Greenhouse Gas Emissions Projections 2019–20409 and European Commission Decision (EU) 2017/1471 2017.*[19]

Year	Limits Mt CO_2eq	Emissions Mt CO_2eq		Distance to target Mt CO_2eq	
Historical		**Actual**		**Actual**	
2013	46.9	42.2		4.7	
2014	45.8	41.7		4.1	
2015	44.6	43.0		1.6	
2016	43.5	43.8		–0.3	
2017	40.9	43.8		–2.9	
2018*	39.8	45.4		–5.6	
Cumulative (2013–2016)	261.5	259.9		1.6	
Projections		**With existing measures**	With additional measures	**With existing measures**	With additional measures
2019	38.7	45.2	45.2	–6.5	–6.5
2020	37.7	46.1	45.4	–8.5	–7.7
Projected (2018–2020)	76.4	91.3	90.6	–15.0	–14.2
Total	**337.9**	**351.3**	**350.5**	**–13.4**	**–12.6**

Values for 2018 have been submitted to EU Commission and are under review.
Numbers may not sum exactly due to rounding

Effort Sharing Regulation 2030

The Effort Sharing Regulation, the successor to the Effort Sharing Decision, is part of the suite of EU climate policies and regulations under the Climate and Energy Framework.[17, 20] It was adopted on 14 May 2018. The objective of the Effort Sharing Regulation is to reduce EU-wide emissions in the non-Emissions Trading System sector by 30% by 2030 relative to 2005 levels. It sets annual national limits on Member States' emissions of greenhouse gases in the non-Emissions Trading System sector for the period 2021 to 2030. The agreed national target for Ireland is to reduce emissions by 30% by 2030, relative to 2005 levels (see Figure 2.15 and Table 2.2).

As with the Effort Sharing Decision, emissions savings accrued in one year can be carried over to meet annual limits in subsequent years. Member States can transfer or buy annual emission allocations (AEAs) to and from other Member States

In addition to the existing flexibilities, the proposed Effort Sharing Regulation offers two new flexibilities. The first is a one-off flexibility that allows Member States to achieve their targets using Emissions Trading System allowances that would otherwise be auctioned. Ireland has access to a total of 18.8 Mt CO_2eq through this flexibility. However, the Government has indicated in the National Mitigation Plan and the Climate Action Plan that it intends to use this provision only *in extremis*.[21,22] The second flexibility acknowledges the difficulty of achieving emissions reductions in agriculture and allows the use of removals accumulated within the Land-Use, Land-

Use Change and Forestry (LULUCF) sector to achieve the target. Ireland has negotiated access to a total of 26.8 Mt CO_2eq through this flexibility. The annual limits for Ireland, excluding impact of these flexibilities, are presented in Figure 2.15. The "with additional measures" projection converges on the Effort Sharing Regulation targets; however, emissions remain higher than the annual targets throughout the decade. The cumulative exceedance is 17.9 Mt CO_2eq. Therefore, Ireland will need access to the LULUCF flexibility to achieve compliance with Effort Sharing Regulation targets.

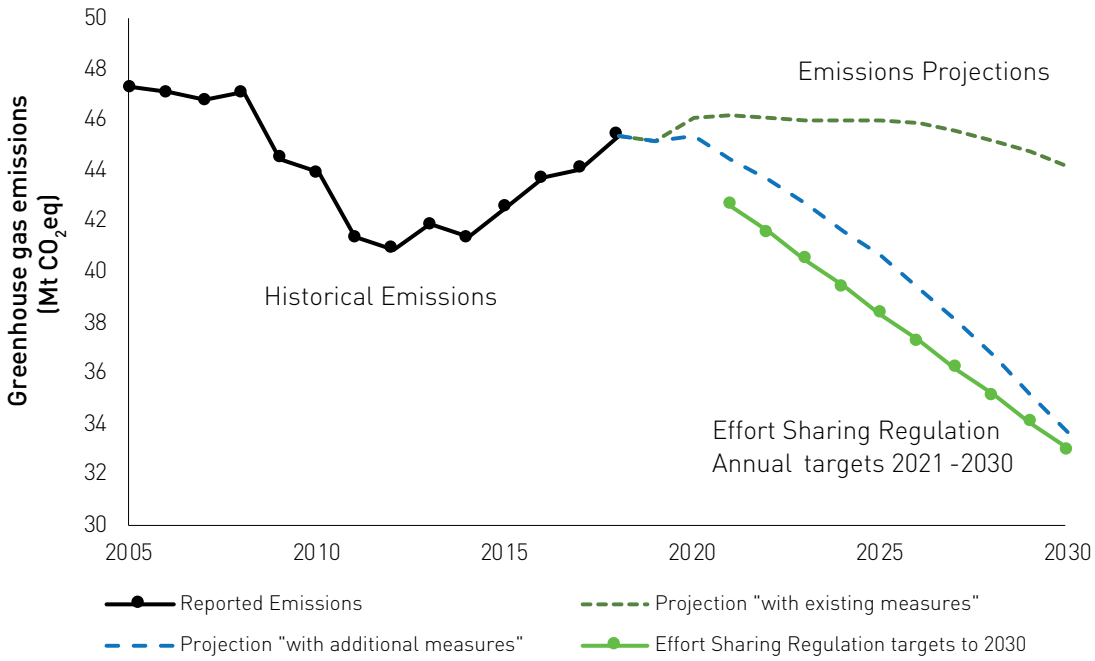


Figure 2.15: Ireland's greenhouse gas emissions from 2005 to 2018. Annual targets as included under the Effort Sharing Regulation17 for the period 2021 to 2030 and emissions projections for 'with existing measures' and 'with additional measures' are presented. **Data sources:** *EPA (2020) National Emissions Inventory*[2] *and Ireland's Greenhouse Gas Emissions Projections 2019–2040.*[10]

Use of flexibilities

2020 Effort Sharing Decision flexibilities

Ireland may use the purchase of emission allowances to comply with its EU Effort Sharing Decision targets to 2020.

The European Environment Agency has indicated that based on current progress, only Ireland and Malta would require access to the flexible mechanism to remain compliant with 2020 targets under the Effort Sharing Decision.[23] Malta has been balancing its surplus emissions by Annual Emissions Allocations (AEA) purchases from Bulgaria; the details of this transaction are not in the public domain.

In November 2019, the Minister for Communications, Climate Action and Environment requested the National Treasury Management Agency (NTMA) to reactivate its carbon credit purchasing programme, the Carbon Fund, to assist Ireland in meeting its obligations under the EU Effort Sharing Decision. Subsequently the Carbon Fund made its first purchase since 2009 of 400,576 credits, bringing the total number of credits held in the fund to 6,045,431 at the end of 2019.[24]

Purchase of compliance does not avoid the costs of emissions reductions but rather delays the cost to the post-2030 period, when even deeper emissions reductions are required. It also increases the challenge of achieving our national transition objective for 2050. The Council has previously expressed concern over Ireland's fiscal exposure to requirements for the purchasing of compliance with EU climate targets.[25] This use of public funds produces no notable local benefits or national investment in the low-carbon transition.

2030 Effort Sharing Regulation flexibilities

If Ireland is successful in implementation of the measures under the Climate Action Plan, it is unlikely that there will be a need to purchase allowances to comply with the Effort Sharing Regulation targets to 2030. In the case of the EU Effort Sharing Regulation, there are three flexibility mechanisms: (1) the option to trade EU emissions allowances with other Member States; (2) the option to transfer EU emissions allowances from the EU Emissions Trading System; and (3) the option to use EU emissions allowances associated with LULUCF. As noted above, Ireland has access to a total flexibility from the Emissions Trading System, amounting to 18.8 Mt CO_2eq, and the LULUCF flexibility, amounting to 26.8 Mt CO_2eq. As the ETS allowances could otherwise be auctioned, if they are used to offset under-performance in reducing emissions within the Effort Sharing Regulation sectors, the use of the ETS flexibility would be likely to involve significant Exchequer cost depending on carbon price within the ETS when the allowances are cancelled.

If Ireland needs to use these flexibilities in order to comply with its EU targets, its primary focus should be on allowances associated with LULUCF. These allowances, achieved predominantly through afforestation and the management of degraded peatlands, augment removals through the existing terrestrial carbon sink and have tangible environmental benefits where the afforestation is carried out and managed in an environmentally sustainable manner.

The use of the LULUCF flexibility is consistent with the longer term national transition objective of an approach to carbon neutrality in Agriculture and Land Use.

The secondary focus should be on the other flexibilities mentioned above (1 and 2). If options 1 and 2 are considered, the concerns that the Council has previously expressed regarding the use of public funds to purchase compliance will also need to be considered. This is less of a concern in relation to complying with targets through land-use measures, whereby environmental benefits in Ireland could be achieved.

Table 2.4: Projected greenhouse gas emissions, covered under the EU Effort Sharing Regulation targets, relative to annual totals and total cumulative emissions targets. **Data sources:** *Greenhouse Gas Emissions Projections 2019– 2040*[10] *and European Commission Decision 2017.*[19]

Year	Projected limits Mt CO_2eq	Emissions Mt CO_2eq		Distance to target Mt CO_2eq	
	With existing measures	With existing measures	With additional measures	With existing measures	With additional measures
2021	42.7	46.2	44.5	3.5	1.9
2022	41.6	46.2	43.7	4.6	2.1
2023	40.5	46.1	42.7	5.6	2.2
2024	39.4	46.0	41.6	6.6	2.2
2025	38.4	46.0	40.7	7.6	2.4
2026	37.3	45.9	39.4	8.6	2.1
2027	36.2	45.6	38.1	9.4	1.9
2028	35.2	45.2	36.7	10.1	1.5
2029	34.1	44.8	35.2	10.7	1.1
2030	33.0	44.2	33.7	11.2	0.6
Total	**378.3**	**456.0**	**396.2**	**77.7**	**17.9**
LULUCF flexibility	—	—	—	–26.8	–26.8
ETS flexibility	—	—	—	–18.8	–18.8
Net exceedance with LULUCF flexibility	—	—	—	**50.9**	**–8.9**
Net exceedance with LULUCF + ETS Flexibility	—	—	—	**32.1**	**–27.7**

ETS, Emissions Trading System; LULUCF, land use, land-use change and forestry.

2.3.2 International agreements

Ireland is a party to the United Nations Framework Convention on Climate Change and has ratified both the Kyoto Protocol and the Paris Agreement under the Convention. The Kyoto Protocol, agreed in 1997, sets legally binding emission limitation and reduction targets based on levels of greenhouse gas emissions in 1990. As a Member State of the EU, Ireland participates in meeting the EU emission reduction targets. There are two distinct commitment periods, from 2008 to 2012 and from 2013 to 2020. The EU met its 2012 binding greenhouse gas emissions reduction target and is on track to meet its binding greenhouse gas emissions reduction targets to 2020. Therefore, Ireland would be considered compliant with Kyoto Protocol commitments.

The Paris Agreement was adopted in 2015 and entered into force in 2016. It requires countries to submit nationally determined contributions, which, for developed countries, include emissions reduction targets to 2025 or 2030. As a Member State of the EU, Ireland's contribution to the Paris Agreement is captured in the EU's nationally determined contribution. The EU contribution to the Paris Agreement reflects the EU-wide ambition and targets as set out in Section 2.3.1. Ireland's compliance with the emissions reductions commitments of the Paris Agreement depends on the overall EU compliance.

2.3.3 National Policy Position

Ireland's national transition objective, as defined in the Climate Action and Low Carbon Development Act 2015, is to transition to a low-carbon, climate-resilient and environmentally sustainable economy by 2050. The National Policy Position[4] further defines the objective. In terms of mitigation, it has two components; the first aims to reduce emissions of carbon dioxide in three key sectors – Electricity Generation, the Built Environment and Transport – by 80% by 2050 relative to 1990 levels; the second is related to Agriculture, Land Use and Forestry. It identifies 'an approach to carbon neutrality' without compromising sustainable food production as its primary objective.

The National Policy Position brings focus to carbon dioxide emissions from fossil fuel sources. This recognises the importance of reducing carbon dioxide emissions that will continue to warm the planet long into the future. The targets under the National Policy Position are not legally binding. However, the National Policy Position was articulated in 2014, and international understanding of the long-term mitigation challenge has evolved. National policy will likely need revision in order to maintain consistency with developments such as the EU Green Deal, the recent Programme for Government and scientific assessment emerging from the IPCC.[26,14,27,28]

Emissions of carbon dioxide

In 2018, total greenhouse gas emissions decreased by 0.2%, or 0.14 Mt CO_2eq, relative to 2017, while emissions of carbon dioxide decreased by 0.6%, or 0.22 Mt CO_2eq. Although emissions of carbon dioxide peaked at 48 Mt CO_2eq in 2005, they have not yet dropped below 1990 levels. Current levels are approximately 16.9%, or 5.6 Mt CO_2eq, higher than in 1990. Emissions dropped during the recession but grew during the recovery, demonstrating the continued coupling between emissions and economic growth, as noted in Section 2.1.2.

Annual carbon dioxide emissions reductions of approximately 3%, or 1.1 Mt CO_2, per year, relative to 2020, will be required to achieve an at least 80% reduction in carbon dioxide emissions by 2050. This would bring Ireland onto a pathway consistent with the low-carbon transition, as described in the National Policy Position (see Figure 2.16). The projections indicate that, with implementation of all the measures in the Climate Action Plan, CO_2 emissions reductions could be slightly lower than the illustrative linear pathway during the period to 2030. However, thereafter, in the absence of policy initiatives, emissions are projected to increase and depart from the long-term objective.

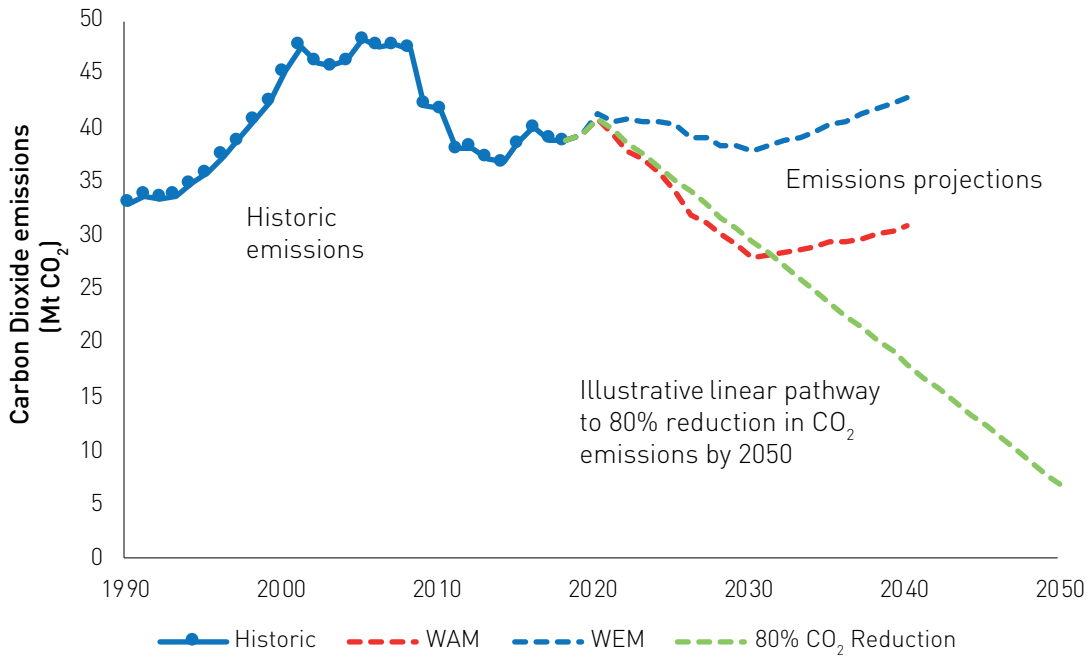


Figure 2.16: Emissions of carbon dioxide in Ireland from 1990 to 2018 and 'with additional measures' (WAM) and 'with existing measures' (WEM) projections from 2018 to 2040. An illustrative linear pathway for achievement of the low-carbon transition to 2050 also shown. **Data sources:** *EPA (2020) National Emissions Inventory*[2] *and Ireland's Greenhouse Gas Emissions Projections 2019–2040.*[10]

Agriculture and Land Use

The National Policy Position sets out the objective to establish an approach to neutrality within the Agriculture and Land Use sector, including the UNFCCC reporting sector LULUCF.

Ireland lacks a conceptual framework for climate or carbon neutrality goals to guide us towards a 2050 goal of net zero emissions. This needs to be established at an EU level but Ireland could usefully inform the debate. The long-term strategy must be consistent with meeting EU targets and requirements.

Carbon neutrality

A definition of carbon neutrality would enable long-term strategic planning in the Agriculture and Land Use sector. Agreeing a definition is a priority to support development of the sector consistent with long-term goals. National policy considers neutrality in the context of Agriculture and Land Use. However, the EU Green Deal and proposed EU Climate Law expand neutrality to all sectors and all gases. Definition of neutrality should consider this policy context. The following criteria should be considered in developing a definition of climate and/or carbon neutrality:

- There is a need for complete and rapid transition away from fossil fuel use in all sectors of the economy.
- Residual and unavoidable emissions of long-lived greenhouse gases, with an atmospheric lifetime of greater than approximately 10 years, must be balanced by an equivalent removal.
- The removal of carbon dioxide needs to be robust and verifiable.
- Land-based removals are important but necessarily limited.

- At a minimum, the rate of emission of short-lived greenhouse gases, with lifetimes of less than approximately 10 years, need to stabilise at a much lower level than today, and consistent with the findings of the IPCC Special Report on 1.5°C of warming.

Based on these criteria, and until a formal definition is adopted at national or international level, the Council will use the following working definition of carbon neutrality:

> Carbon neutrality is achieved when the net sum of emissions and removals of greenhouse gases associated with all activities within the economy makes no further additional physical impact on global warming.

This definition can be modified to consider carbon neutrality in the narrower context of Agriculture and Land Use, as framed from the current National Policy Position. However, other sectors are anticipated to need removals to balance unavoidable residual emissions in the context of a net zero emissions target by 2050.

Progress in Agriculture and Land Use

Projections of emissions and removals from the sector to 2030 and 2040 do not indicate significant progress in achieving the national policy objecitve as shown in Figure 2.17 with insufficient sink to cover emissions from landuse, let alone agriculture. Also shown in Figure 2.17 is the trend in emissions less biogenic methane, in line with recommendations by Council to consider biogenic methane separately. Even in this circumstance, with biogenic methane removed from the net zero target for Agriculture and Land Use, there remains little to indicate progress in the period after 2030. Chapter 6 provides further discussion of these issues.

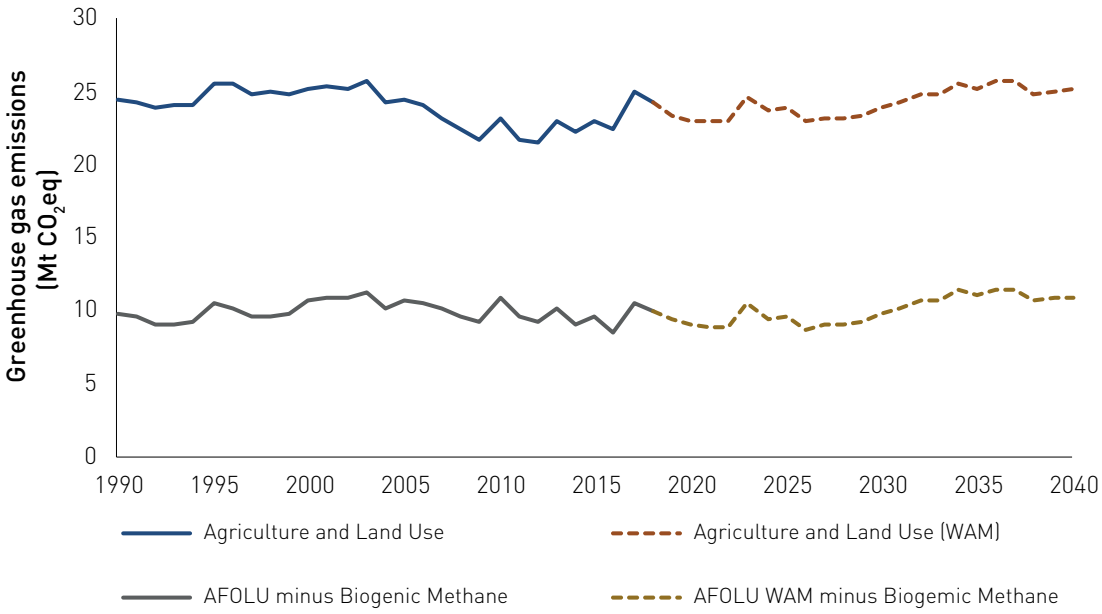


Figure 2.17: Time series of net greenhouse gas emissions and removals, historical and projections for Agriculture and Land Use, Land Use Change and Forestry sectors. **Data source:** *EPA (2020) National Emissions Inventory*[2] *and Ireland's Greenhouse Gas Emissions Projections 2019–2040.*[10]

Projections for emissions of biogenic methane, shown in Figure 2.18 indicate emissions reductions in the period to 2040 and an approximate stabilisation thereafter. Absolute emissions are largely driven by animal numbers, which are projected to decrease for non-dairy cattle by 354k animals (-6.1%) and for sheep by 492k animals (-9.6%) relative to 2018, but with an increase in dairy animals

of 210k (14.8%). It is notable that the projections assume the same animal populations with or without the Climate Action Plan, as shown in Figure 2.19, demonstrating a lack of additional policy measures within the Climate Action Plan to constrain the size of the herd. The additional emissions reductions projected from the Climate Action Plan measures are due to the positive impact of efficiency measures such as improvements in the genetics of the herd and extended grazing.

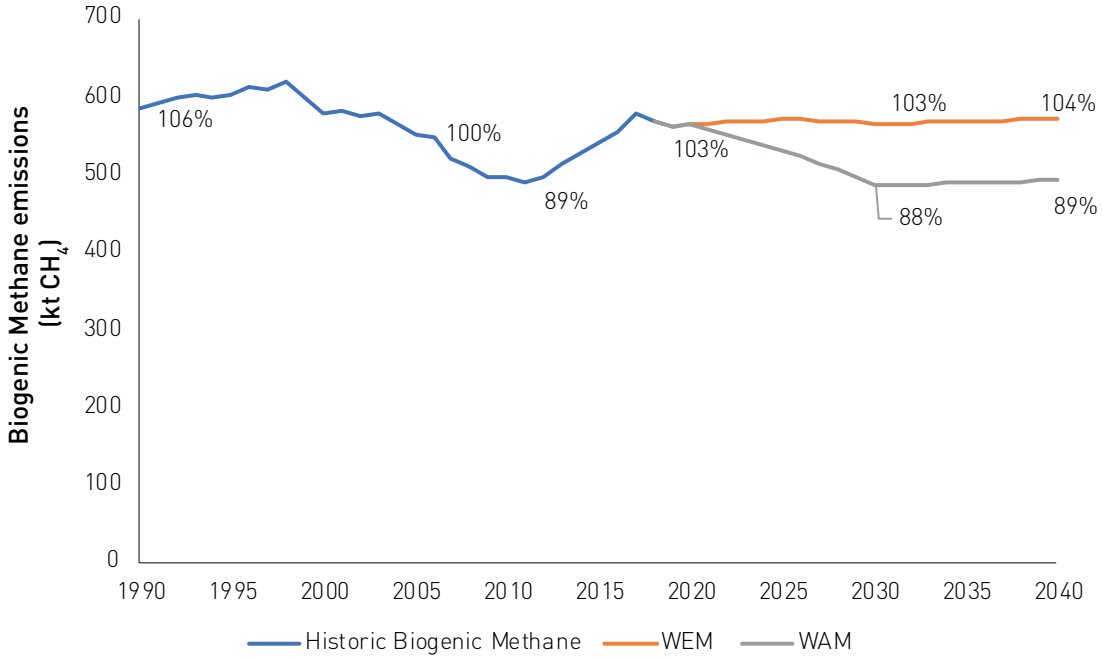


Figure 2.18: Historic and Projected Biogenic Methane. **Data source:** *EPA Common Reporting Format submission to the UNFCCC 2020*[29], *EPA projections submission to EU under Monitoring Mechanism Regulation (MMR).*[30]

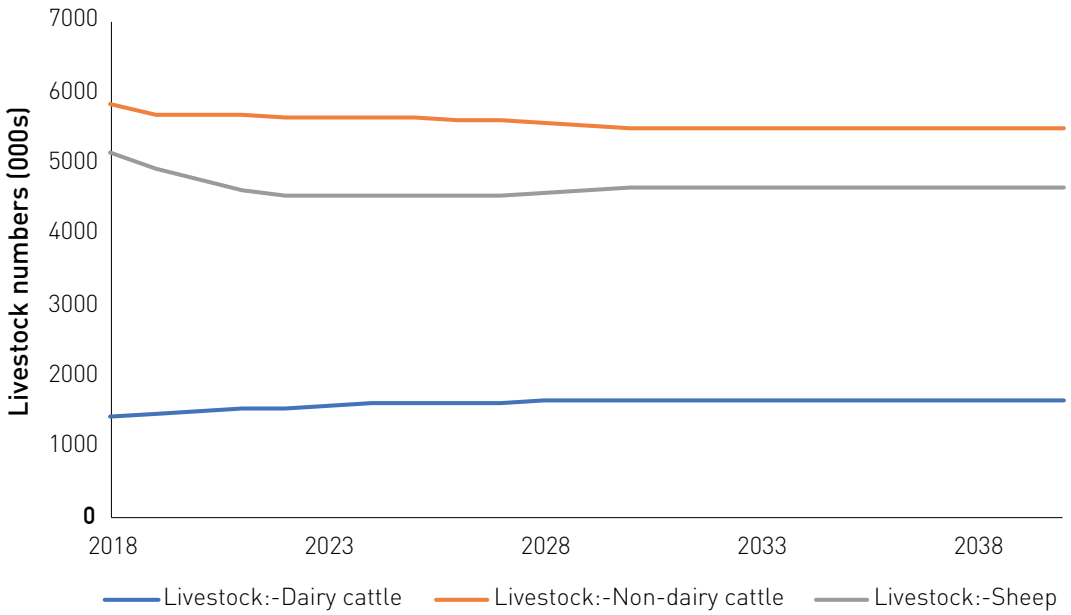


Figure 2.19: Projected livestock numbers. **Data source:** *EPA projections submission to EU under the Monitoring Mechanism Regulation.*[30]

The rate of afforestation in 2018 fell to 4,025 hectares from a high of nearly 23,000 hectares in 1996, with provisional figures for 2019 falling further to 3,550 hectares. At these rates, Ireland will not attain the national forest policy goals for 18% forest cover by mid-century. This significantly undermines the potential for approaching neutrality within an effective timescale.

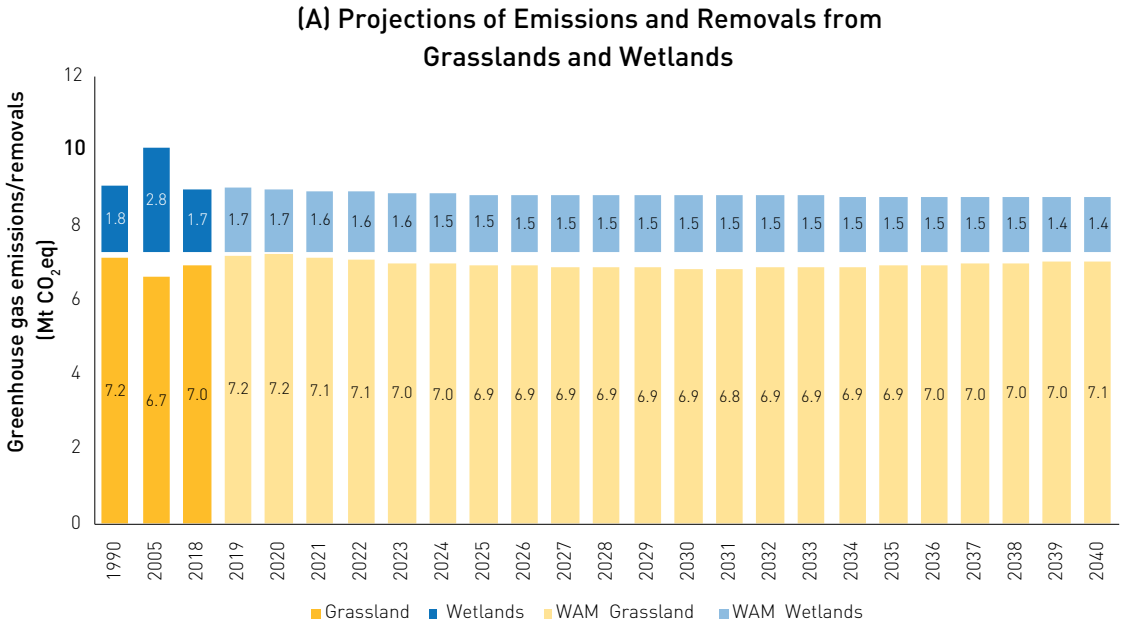
Bord na Móna, which owns and manages large tracts of peatlands in Ireland, has committed to transition its electricity generation to 100% renewable sources by 2024, with a number of sites ceasing production in the near future. It has legal responsibility for appropriate management of sites post-production. Decisions with respect to environmental regulation enforcement and refusal of planning permission, appear to have expedited the closure of the Electricity Supply Board (ESB) peat-fired generation. The Bord na Móna response, in terms of changed plans for management of associated extraction sites has not been clarified but cessation of peat extraction on these sites is imminent. Post-production management options to maintain and enhance carbon stores within its estate is recommended where appropriate. Bord na Móna can act as an exemplar in the sector in this regard.

Figure 2.20 shows the projected emissions and removals associated with each of the land use categories reported in the national projections.. Although there are a number of measures in the Climate Action Plan aimed at improving land management on agricultural and wetlands, the projected trends in emissions and removals in the LULUCF sector are dominated by what will happen in the Forest Land category. Although the Climate Action Plan sets the ambition to increase afforestation rates, it is projected that there will be net emissions of carbon from Forest Land from 2019 onwards. This reflects the fact that large areas of lands planted in previous years will become due for harvesting. This increased take from the forest will be balanced somewhat by an increase in the carbon stored in Harvested Wood Products.

Projections for Wetlands indicate a reduction in the loss of carbon from these lands, due to measures to rewet and restore some degraded areas. However, progress is relatively modest given the widespread opportunity for adoption of these measures.

Some progress is projected for management of carbon losses from grassland soils to the year 2030, with emissions falling from 7.2 to 6.9 Mt CO_2eq. However, in the absence of a long-term policy, there are pressures on these lands to increase losses in the years to 2040.

Declining rates of removals and increasing emissions would lead Ireland further away from the neutrality objective of the National Policy Position.



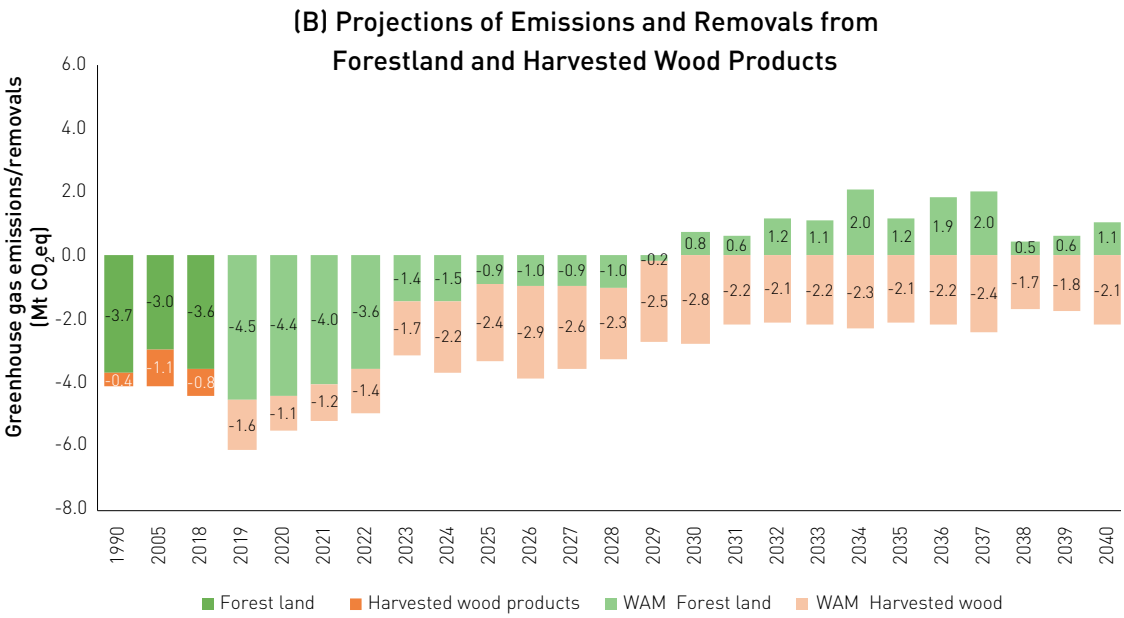


Figure 2.20: Projection of emissions and from Land Use categories A) Grasslands and Wetlands b) Forest Land and Harvested Wood Products. **Data source:** *EPA projections submission to EU under the Monitoring Mechanism Regulation.*[30]

2.3.4 Conclusions

Ireland will not meet its 2020 target under the EU Effort Sharing Decision notwithstanding emissions reductions seen in 2020 due to the Covid-19 crisis. Therefore Ireland will be obliged to purchase compliance through trading with other EU Member States. The National Treasury Management Agency (NTMA) has already reactivated its Carbon Fund for this purpose and holds credits equating to approximately 6 Mt CO_2.

The Climate Action Plan sets out a programme of measures which, if implemented perfectly, would allow Ireland, assuming use of flexibilities on LULUCF, to comply with 2030 emission reduction targets under the EU Effort Sharing Regulation. However, there is no room for complacency. Fulfilling the conditions to allow access to LULUCF flexibilities may be challenging.

The projections indicate that implementation of all measures under the Climate Action Plan would be consistent with a pathway towards achievement of the 80% CO_2 emissions reduction articulated in the National Policy Position in the period up to 2030. However, the lack of a long-term strategy is evident in the national emissions projections, where an increase is seen in emissions in the period post-2030.

Ireland has not demonstrated progress in achieving a pathway towards carbon neutrality in the Agriculture and Land Use sector, as articulated in the national policy position. Land use continues to be a significant source of emissions to date with projections showing forestry transforming from a sink to a source around 2030. Emissions from grasslands and wetlands show no significant abatement up to and beyond 2030. Emissions from agriculture show some decrease to 2030 but with increasing emissions thereafter.

3. Progress Made in Furthering the Low-Carbon Transition

Highlights

- A range of plans and policies to address climate change are in place, including notably the Climate Action Plan, the National Development Plan and the National Planning Framework. These are key to the low-carbon transition and will require concerted effort and resources to deliver. A monitoring and tracking framework to ensure cost-effective delivery will be critical.
- We lack a conceptual framework for zero-carbon or climate neutrality goals to guide us towards a 2050 goal of net zero emissions. This needs to be established at an EU level but Ireland could usefully inform the debate.
- With constrained government resources, the importance of alternative sources of finance to support investment in the low-carbon transition is heightened.
- Carbon pricing remains a key pillar in the climate response. Continued increases towards €100 per tonne by 2030 will be important to reduce emissions and to raise funds to support climate action and the energy poor. Other mechanisms that deliver an effective carbon price could contribute to meeting mitigation objectives, e.g. a carbon floor price in the ETS and fuel excise duties.
- Decarbonisation of the electricity supply is crucial to support the decarbonisation effort in other sectors, notably Transport and Heat.
- Zero-carbon fuels, if cost-effective, could be a key component of Ireland's pathway to 2050. Government needs to support applied research and piloting of options for Ireland and to give serious consideration to their place in supporting decarbonisation across sectors.
- Without Just Transition, public acceptance of ambitious climate action recedes. Climate policy needs to be designed with consideration of the distributional impacts. It needs to be designed and implemented taking account of the implications for all members of society.

The Climate Action and Low Carbon Development Act 2015 tasked the Council, as part of its Annual Review, to assess progress made in furthering transition to a low-carbon, climate-resilient and environmentally sustainable economy. The Council is also mandated under the Climate Action and Low Carbon Development Act 2015 to provide advice on cost-effective approaches to achieve the transition objective. This chapter addresses that mandate, assessing progress to date and the challenges ahead, and exploring how government and other actors bring about the required change. Finally, we explore the cost-effectiveness of this approach.

This is the fourth Annual Review by the Council. An evidence-based approach is taken; we look at data reflecting progress in behavioural, technical, structural and infrastructural changes that are key to long-term achievement of the national transition objective. We present a potential range of indicators for transition and review progress made in public participation, institutions and governance, before looking at progress across the sectors and assessing options to bring Ireland further along the transition to a low-carbon future.

It is important not to lose sight of the overall motivation for climate action and the potential benefits of mitigation actions. The overall projected costs of mitigation fall well short of the costs of uncontrolled climate change. The Fifth Assessment Report (2015) of the Intergovernmental Panel on Climate Change (IPCC) found that:

> "Without additional mitigation efforts beyond those in place today, and even with adaptation, warming by the end of the 21st century will lead to high to very high risk of severe, widespread and irreversible impacts globally (high confidence). Mitigation involves some level of co-benefits and of risks due to adverse side effects, but these risks do not involve the same possibility of severe, widespread and irreversible impacts as risks from climate change, increasing the benefits from near-term mitigation efforts.[31]

The International Renewable Energy Agency (IRENA) found that the cost savings of the long-term transition away from fossil fuels towards energy efficiency and renewable energy would far outweigh the costs of transition due to benefits associated with reduced air pollution, better health and lower environmental damage.[32]

In assessing the most cost-effective manner to achieve reductions in greenhouse gas emissions, the Council's 2017 Annual Review found that action to reduce greenhouse gas emissions would have significant co-benefits such as improved air quality, reduced congestion and reduced nitrate pollution. Economic opportunities from efficiency gains and the green economy will also be considered.

3.1 Indicators of transition

In its proposals for an Energy Union Governance Regulation, the European Commission identifies the carbon dioxide and greenhouse gas intensity of Gross Domestic Product (GDP) as an indicator of transition.[33] These indicators are included in Table 3.1, but on their own they present an incomplete picture. To assess progress in transition, 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 3.1 thus presents an extended illustrative list of indicators to give a broader perspective on the state of transition across the sectors in Ireland.

Measuring progress in transition goes beyond historical comparisons of emissions against previous performance. Incremental improvements may no longer be enough. Instead, assessing progress in transition means comparing where we are with where we need to be.

The indicators may not fully reflect progress towards what we want to achieve. For example, while we may expect that the distance travelled by private vehicles per capita should decrease with an increase in public transport, cycling and walking, that indicator won't reflect decarbonisation when the vehicle stock transitions to a low- or zero-emissions or autonomous fleet. These dimensions point to the need for a broader basket of indicators to be employed in measuring a low-carbon transition that will encompass all sectors in our economy and society.

Table 3.1: Indicators of transition across sectors

Sector	Name	2014	2015	2016	2017	2018	Unit
Total	GHG intensity of the economy	0.34	0.35	0.35	0.33	0.31	kt CO_2eq/€M GNI*
	GHG per capita	12.34	12.67	12.97	12.73	12.55	t CO_2eq/Population
	CO_2 intensity of the economy	0.22	0.23	0.23	0.21	0.20	kt CO_2/€M GNI*
	CO_2 per capita	7.92	8.22	8.45	8.12	7.99	t CO_2/Population
	Economy-wide efficiency	€2,938	€2,826	€2,892	€3,051	€3,261	GNI*/t CO_2eq €/t CO_2eq
	Total primary energy requirement	**154,032**	**161,378**	**167,926**	**167,705**	**170,414**	**Megawatt hour (MWh)**
Power generation	Emissions from peat- and coal-fired electricity generation	6,344	7,046	6,836	5,791	4,156	kt CO_2
	CO_2 intensity of electricity	455	465	480	437	375	Gt CO_2/kilowatt hour (kWh)
	% renewable of gross electricity consumption	23.5	25.5	26.8	30.1	33.2	%
Residential/ Commercial/ Public	% renewable heat	6.3	6.2	6.3	6.7	6.5	%
Residential	% residential energy from solid fuel (peat and coal)	16.6	15.3	14.0	12.9	12.6	%
	A and B Building Energy Rating (BER)-rated residential 'dwellings'	–	12.0%	13.0%	14.0%	15.0%	% of BER data set
Commercial	A and B BER-rated commercial buildings	–	14.0%	13.8%	13.6%	13.2%	% of non-dwelling BER data set, excluding hospitals, health, community, nursing homes, schools and colleges
Public	Energy efficiency gains in public bodies	–	21.0%	20.0%	24.0%	27.0%	% improvement from business as usual
	Energy consumption of public bodies	–	9,343	9,375	10,248	10,178	Gigawatt hours (GWh)

Sector	Name	2014	2015	2016	2017	2018	Unit
Transport	% renewable transport (RES-T)[i]	3.1	3.3	3.0	4.1	3.9	%
	Distance by private car	32,645	35,020	36,623	37,181	35,975	Million kilometres
	Distance by private car per capita	7,027	7,470	7,727	7,758	7,407	Kilometres
	Distance by goods vehicles	7,259	7,021	7,410	7,785	7,891	Million kilometres
	Distance by public service vehicles	1,157	1,167	1,172	1,219	1,228	Million kilometres
	Private car new vehicles' fuel type	91,157	119,066	138,778	121,883	112,590	Number of new petrol and diesel vehicles (as % of all new)
		98.7%	98.3%	97.8%	95.9%	92.9%	
	New goods vehicles' fuel type	16,243	22,926	28,039	24,066	25,380	Number of new petrol and diesel vehicles (as % of all new)
		99.9%	99.9%	99.6%	99.9%	99.7%	
Agriculture and Land Use	Forestry cover	752,890	758,383	764,082	769,395	773,229	Hectares
	Dairy cows (December)	1,128	1,240	1,295	1,343	1,369	Thousands
	Non-dairy cows (December)	1,041	1,053	1,042	1,018	982	Thousands
	Other cattle (December)	4,074	4,129	4,276	4,312	4,242	Thousands
	Sheep (June)		5,139	5,179	5,197	5,109	Thousands
	Nitrogen fertiliser use	331,782	330,959	339,104	369,089	408,495	Tonnes of nitrogen
	Total area of drained organic soils	862,317	874,637	877,480	869,806	867,085	Hectares
	Dairy production efficiency	1.24	1.14	1.13	1.14	1.19	LCA kg CO_2eq / kg milk
	Beef production efficiency	13.0	12.3	11.9	12.0	12.1	kg CO_2eq / kg beef (live weight)
Finance	**International total climate-specific finance**	**€33.674**	**€36.003**	**€52.696**	**€64.471**	**€77.213**	**Million Euro €**

i The table contains some revisions compared with the Annual Review 2019. The % Renewable transport (RES-T) weighted figures have been changed to RES-T figures without weightings. SEAI reports RES-T with and without weightings. RES-T with weightings includes double certificates for advanced biofuels.

3.2 Availability of evidence

When the best available evidence from research is placed at the heart of policy development and implementation, people can make well-informed decisions about policies, programmes and projects. Evidence-based policy also makes explicit what is known through scientific evidence and, importantly, what is not known. Evidence can and should be collected through all stages of policy-making; from problem identification and choice of response through to delivery and implementation, and finally the monitoring of outcomes to inform and refine further stages and iterations in the policy cycle.

Council advice is based on evidence. Sometimes the limited availability of evidence inhibits the ability of the Council to offer appropriate advice to government. It is particularly important that the assumptions, evidence and data underlying the policymaking process are transparent to allow for appropriate scrutiny by the Council and the public as is required under the legislation. In its letter to Government dated 5 December 2019, the Council advised that access to the data, analyses and models used by government agencies in climate mitigation and adaptation planning should be covered by a memorandum of understanding covering all relevant Departments and outside agencies to support the work of the Council in carbon budgeting, reiterating a similar request made by the Council in March 2018. This would also be a crucial support to facilitate the Council in offering expert advice to government on climate policy and the low-carbon transition. The Council has engaged positively with government departments on this issue and looks forward to imminent progress.

In some areas, data and analysis gaps undermine ability to appropriately design policies to achieve progress in mitigation. The SEAI Energy Balance report 2019 highlighted heat demand and transport (light goods vehicles and congestion) as areas where more data would be useful. Elsewhere, advances are being made in evidence-based policy. More indicators are available in the Department of Public Expenditure and Reform (DPER) Revised Estimates, report but these are often not the best indicators. Further work is needed to develop indicators particularly of the distributional impact of policy (Just Transition).

The tracking and monitoring of implementation and outcomes is lacking in many areas, though improvements are being made. Unfortunately, an opportunity seems to have been missed to collect data related to effectiveness in previous measures. The success of Project Ireland 2040 will be determined by the extent to which other plans, policies and measures follow through and maintain consistency with its aims and objectives. Reporting on this so far has been limited. Close monitoring of the effectiveness of the National Development Plan's (NDP) Climate Action Fund and Urban Regeneration and Development Fund in reducing emissions is required. Previous Annual Reviews have recommended that the analysis supporting the NDP be published to enhance transparency and inform the prioritisation of measures. The DPER has committed to tracking and monitoring outputs and outcomes of the hypothecated carbon tax revenue with 23 performance metrics across the 10 programmes. The SEAI is committed to tracking and monitoring outcomes in all its new programmes. This should involve the collection of suitable baseline data before embarking on new initiatives. The Climate Action Plan also has a strong monitoring framework, with regular progress updates on implementation. This will inform improved policy outcomes.

The Council has previously noted the gaps in provision of data and estimates of the cost and effectiveness of measures in the National Mitigation Plan and in the Annual Transition Statement.

The Climate Action Plan 2019 included an updated national marginal abatement cost (MAC) curve on the SEAI study from 2009. It is important to note that while MAC curves may be useful, they have limitations as analytical and decision-support tools. Again, it is crucial that the data and assumptions underlying such analysis are transparent and accompanied by other types of analysis and knowledge to support policymaking.[i]

3.3 National plans and processes

3.3.1 The Long-Term Strategy

Ireland has not submitted a Long-term Strategy to Europe. The lack of a long-term strategy hinders planning and assessment of progress towards low-carbon transition across all sectors. In particular, it creates uncertainty that makes investment in the transition difficult for government and the private sector.

3.3.2 The National Mitigation Plan

The first National Mitigation Plan under the Climate Action and Low Carbon Development Act 2015[1] was published on 17 July 2017 as a 'living document'.[21] Despite its statutory status, it has since been superseded in practice by the Climate Action Plan 2019.[22]

3.3.3 Climate Action Plan 2019

The Climate Action Plan 2019 was released on 17 June 2019. The Council welcomes this important initiative. This Plan explicitly sets out sectoral targets which, if achieved, would see Ireland meeting its 2030 targets. The intention of the Government is to update the Plan on an annual basis considering progress on implementation and potential new policies and measures. The Council notes that the Plan includes a number of actions that reflect previous advice and recommendations from the Council and the Joint Oireachtas Committee on Climate Action. The governance structure outlined within the Plan recognises the urgency of climate issues and establishes a framework for implementation and continual review. The Council welcomes the focus on achieving climate actions within and across sectors, recognising the potentials and opportunities to contribute to the low-carbon transition and the proposed carbon budgeting process to frame transition.

The analysis presented in the Plan identifies that a rate of emissions reduction of 2% per year is required to achieve Ireland's 2030 Effort Sharing Regulation targets. It also indicates that the rate of emissions reduction must increase to 7% per year after 2030 in order to achieve an 80% emissions reduction by 2050 consistent with the National Policy Position. Additional detailed analyses of scenarios and pathways needs to be undertaken to achieve these goals, especially with respect to options to 'front load' some actions and measures to achieve early and sustained emissions reductions in the period to 2030. This may allow Ireland to exceed its 2030 targets, while greatly decreasing the burden to the economy of the major step-up in emissions reduction envisaged post-2030.

Climate action needs to be fully integrated across all government plans, policies and programmes, including appropriate resourcing and implementation of the National Planning Framework (NPF) and the NDP. The governance structure outlined within the Climate Action Plan 2019 establishes a framework for implementation and continual review.

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i Including the range of measures that can be included, uncertainty over time, crucial social and political aspects and the need to consider more than just the 'cheapest measures' in policy implementation.

The Climate Action Delivery Board has been tasked with ensuring implementation of the Climate Action Plan. The Climate Action Delivery Board, jointly chaired by the Secretaries General to the Government and the Department of Communications, Climate Action and Environment and composed of officials from all departments, has been established to ensure cross-sectoral implementation of the Climate Action Plan. The Board published its first progress report in October 2019. The Council urges that the Government maintain the schedule of regular quarterly progress reports on implementation of the Plan.

3.3.4 National Planning Framework and National Development Plan

Project Ireland 2040 was launched in February 2018. It comprises a capital investment plan for the period 2018 to 2027, the National Development Plan (NDP), which underpins a 20-year National Planning Framework (NPF).[34,35]

'Transition to a Low-Carbon and Climate-Resilient Society' is one of the targeted strategic outcomes of Project Ireland 2040. The implementation of the NPF represents a key opportunity to ensure that the climate implications (both mitigation and adaptation) of our spatial choices are fully considered and addressed throughout the planning process from national to regional to local level, particularly as regards more compact, well connected urban development and more sustainable development patterns. The Programme for Government agreed in June 2020 proposes the prioritisation of public transport projects 'in line with the National Planning Framework' funded under a reviewed NDP that is updated for the period to 2031.

As noted in last year's review, however, the success of the NPF will be determined by the extent to which other plans, policies and measures follow through and maintain consistency with its aims and objectives. Reporting on this so far has been limited. The implementation of the NPF is one of the actions of the Climate Action Plan 2019. The Annual Transition Statement 2018 stated that the Department of Communications, Climate Action and Environment was to progress a number of NDP priorities ahead of the 2019 Annual Transition Statement, but progress on these is not clearly identified in the most recent Statement.

The planning process provides an established means through which climate change mitigation and adaptation objectives can be integrated and implemented at regional and local levels. In 2020 the three regional assemblies finalised their Regional Spatial and Economic Strategies (RSES) which will provide context for planning and development in the regions for the next 12 years and beyond.[36,37,38] The main statutory purpose of the RSESs is to support the NPF and they are now to be implemented by amending and updating the local development plans beneath them. Each RSES reflects climate action in its strategic objectives, though some provide more detail than others. The Office of the Planning Regulator is now required to consider how climate change is addressed in draft development plans and this will be key to ensuring that the ambition of the NPF and RSESs is reflected in planning outcomes.[39] However, more clarity on this assessment process in practice is required.

Action 65 of the Climate Action Plan is to 'develop and establish a climate-action toolkit and audit framework for Local Authority development planning to drive the adoption of stronger climate action policies in relation to the patterns and forms of future development'. It also includes a sub- action to publish updated statutory guidelines on local authority development plans setting out the appropriate requirements for integration of climate considerations in the preparation of the plan. The delivery date for this action is Q2 2020 has not been met.

Key supports to delivering these regional and local objectives are the Climate Action Fund and the Urban Regeneration and Development Fund under the NDP. The second round of funding under the Climate Action Fund is expected in 2020. An expression of interest call in early 2020 sought to learn from the first round and considers that the second round should more explicitly consider adaptation projects or those that harness co-benefits. Under the Urban Regeneration and Development Fund's first call, 88 projects were supported, with a second call launched in January 2020. The Council notes that the second call was intended to focus more on supporting climate action objectives than the first. The implementation and lessons from these funds must continue to be closely monitored.

Previous Annual Reviews have recommended that the analysis supporting the NDP be published to enhance transparency and inform the prioritisation of measures. The Council notes that this has not occurred.

The NDP, as a plan for investment, focuses on achieving change through direct investment in action or investing in change through subsidies and incentives. It is important not to lose sight of the potential role that disincentives such as legislation, costs (such as carbon pricing) or penalties can play in achieving emissions reductions, often at a low cost.

The ambition in Project Ireland 2040 must be turned into delivery, with publication and monitoring of results and delivery of both the NPF and NDP. It is noted that under the Programme for Government agreed in June 2020 a review of the National Development Plan is to be brought forward.

Another important spatial planning strategy relevant to both mitigation and adaptation is the forthcoming marine spatial planning policy and National Marine Planning Framework, which will consider areas including energy, environment, infrastructure and tourism.

3.3.5 Sustainable Development Goals

Under the 2030 Agenda for Sustainable Development, countries are encouraged to incorporate the Sustainable Development Goals (SDGs) into planning and policy and develop their own national responses or plans to address the goals. The SDGs enable countries to track the progress they have made in achieving the 2030 agenda vision for sustainable development. The 17 SDGs cover the social, economic and environmental requirements for a sustainable future, with goal 13 being 'Take urgent action to combat climate change and its impacts'.

A 2019 report of the UN Secretary-General found globally that 'While there are positive steps in terms of the climate finance flows and the development of nationally determined contributions, far more ambitious plans and accelerated action are needed on mitigation and adaptation'.[40]

The Minister for Climate Action is responsible for promoting and overseeing the implementation of the SDGs, though all Ministers retain responsibility for implementing the individual SDGs relating to their functions under the Sustainable Development Goals National Implementation Plan 2018 – 2020.[41] This should provide opportunities to align climate policy with the SDGs and highlight the opportunities for co-benefits climate action presents across a range of issues, with the National Economic and Social Council (NESC) considering that they may provide a vision, framework and potential for policy coherence for decarbonisation.[42]

Goal 13 was reviewed at the UN's High Level Political Forum in July 2019 where then Minister of State Sean Canney TD represented the Government of Ireland and delivered Ireland's National

Statement on progress of the SDGs and the 2030 Agenda.[43] This focussed on the Government's Climate Action Plan and Ireland's international climate commitments.

A platform (irelandsdg.geohive.ie) has been established by Government to track reports and indicator data relating to each goal, including some information with regards to Goal 13's targets and indicators. A report by Social Justice Ireland has found that the data coverage for Goal 13 is limited compared to other SDGs but concluded that Ireland's performance on SDG13 was poor and that implementation of the SDGs requires a balance between economic and social progress and sustaining the planet's environment and resources as well as combatting climate change.[44] It is noted that two ongoing EPA-funded research projects may provide insights. 'Identifying Interactions for SDG Implementation in Ireland' is to assess how the SDGs interact across science, knowledge and policy and may be useful in ensuring national climate action priorities support Goal 13 and the other goals.[45] 'Framework for Achieving Environmental Sustainable Development Goals (SDGs)' examines how to incorporate the environmental SDGs in policy formulation.[46] The Programme for Government seeks to align local authority development plans with the 17 SDGs as well as prioritising Green Finance actions that are developed in line with climate justice targets and the SDGs.

3.4 Institutions and governance

There are considerable public governance and institutional challenges in the transition to a low-carbon economy and society. Progress is discussed below.

3.4.1 The Annual Transition Statement

The Annual Transition Statement provides an overview of climate change mitigation and adaptation policy measures adopted across government to reduce emissions of greenhouse gases and to adapt to the effects of climate change.[47] It must be produced annually in accordance with the provisions of the Climate Action and Low Carbon Development Act 2015.

Section 14(1) of the Climate Action and Low Carbon Development Act 2015 provides that an Annual Transition Statement (ATS) must be presented to each House of the Oireachtas by the Minister for Communications, Climate Action and Environment. ATS 2019 was published by the Minister on 10 December 2019 and was presented to Dáil Éireann on 18 December 2019.[48]

While the ATS includes information on the progress of measures with emphasis on the Climate Action Plan and National Adaptation Framework (NAF), it does not provide a balanced and coherent overview of the progress of the sectors, tending to highlight the positives, and under-emphasise measures where there are data gaps or challenges. There is also significant repetition of information from last year's document. The lack of an agreed set of indicators is a further weakness. While the challenges around coordinating the data across different agencies are recognised, this is what is required for monitoring progress. It is encouraging to see a greater evidence base beginning to emerge but some areas are still lacking in information, particularly for key climate policy measures.

From a review of the ATS, the following observations can be made.

Comprehensiveness: There are gaps in the analysis, particularly of the effectiveness of sectoral mitigation and adaptation actions and sub-measures. This includes those of the primary policy measures such as the REFIT Scheme, carbon tax, residential retrofits; Support Scheme for

Renewable Heat; and existing climate-related measures through the Green, Low Carbon, Agri-Environment Scheme (GLAS), the Beef Data and Genomics Programme (BDGP) and the Targeted Agricultural Modernisation Scheme (TAMS).

Indicators: An agreed set of indicators is necessary for assessment of policy effectiveness.

Foresight and contingency planning: The use of a sensitivity analysis that involved a low fuel price scenario in parallel with the EU-wide reference fuel scenario demonstrated a prudent approach to provide insight into potential uncertainties. Additional foresight exercises using alternative scenarios would enable contingency planning to allow for orderly adjustments in Ireland's climate action approach and to stay in step with the rest of the EU and increasing ambition to reduce emissions.

It is encouraging to see the learnings from the lack of data collection being incorporated into some schemes and development of monitoring methods for evaluating measures. For example, the next phase of the Agricultural Catchments Programme (Teagasc) will now also collect data on greenhouse gas emissions, ammonia emissions and soil carbon sequestration to aid monitoring of the effectiveness of measures in the Climate Action Plan. Furthermore, Action 43 in the Climate Action Plan due in the Q4 2019 to Q1 2020 period is aimed at measuring the impact of the work undertaken to date and future work associated with retrofit programmes. It would be useful if this approach to monitoring was applied more broadly.

3.4.2 Parliamentary processes

The Joint Oireachtas Committee on Climate Action was established in July 2018 to consider the third report and recommendations of the Citizens' Assembly entitled 'How the State can make Ireland a leader in tackling climate change'. In March 2019 the Committee published its report, 'Climate Change: A Cross-Party Consensus for Action'.[49] The Council welcomed the report, noting that it concurs with previous Council recommendations on a number of issues.[50] In May 2019 the work of the Committee was extended to further the implementation of its recommendations and consider the Government's Climate Action Plan. The Council's Chair, Professor John FitzGerald, met the Committee in October 2019 to discuss the Council's 2019 Annual Review. The Programme for Government proposes that the Oireachtas establish a standing Joint Oireachtas Committee on Climate Action, with powers similar to the Public Accounts Committee.

The Climate Action Plan was informed by the work of the Citizens' Assembly and the Oireachtas Committee. The Climate Action Plan set out revised governance arrangements for the implementation of climate policy in Ireland, including the establishment of a Climate Action Delivery Board within the Department of the Taoiseach, and proposed legislation to amend the Climate Action and Low Carbon Development Act 2015.

The Climate Action Delivery Board is jointly chaired by the Secretary General to the Government and the Secretary General of the Department of Communications, Climate Action and Environment. Membership comprises Secretaries General from Departments responsible for the actions outlined in the plan.

On 19 December 2019 Government approved the publication of the General Scheme for the Climate Action (Amendment) Bill 2019.[51] The objective of the Bill is to enshrine the approach outlined in the Climate Action Plan, supported by a system of carbon budgeting and sectoral targets with oversight by Government, the Oireachtas and a revised Climate Action Council. The Programme

for Government includes a commitment to introduce the Climate Action (Amendment) Bill 2020 into the Dáil within 100 days.

At local level it is noted that the Programme for Government mandates the establishment of climate action Strategic Policy Committees (SPCs) in each local authority.

3.4.3 Public participation

Public participation and community engagement are essential elements to address climate change. At all levels, from citizens to communities, to public bodies, there is now an understanding that this requires urgent action.

Global awareness of climate change issues has grown over the past decade and Ireland is no different to other nations. Youth climate activism continued to grow in 2019, building on the influence of Greta Thunberg who introduced the world to the schools Friday Climate Strikes in 2018. Fridays for Future Ireland held five major rallies since March 2019 as it galvanised school children across the country to call for stronger measures to address climate change. This highlighted the increased knowledge and awareness of climate change, and a growing hunger for information and direction. There is now an opportunity to ensure that this enthusiasm is captured and nurtured by giving these young future voters platforms on which their voices are sure to be heard.

In Europe, Eurobarometer surveys gauge public opinion on various topics including 'combating climate change and protecting the environment'. Statistics gathered between September 2018 and March 2019 show a growth in general awareness, particularly in the 15–24 age group. There were, however, two notable exceptions: awareness in men in general was down by 1% and in the 40–54 age group was down by 8%.[52]

The OECD 2019 Better Life Index noted that Irish people have a strong sense of community and moderate levels of civic participation.[53] Despite 'stakeholder engagement for developing regulations' having increased only marginally since the 2018 report, the strong sense of community is encouraging and gives a good basis on which to build.

Science Foundation Ireland carried out a survey for Science Week 2019. The results showed that a large percentage of people surveyed believed that climate change needs to be addressed but they were somewhat confused as to what they could do individually and as communities to make a difference.[54] This survey mirrors the Behaviour & Attitudes (B&A) survey entitled 'Sign of the Times 2020' which also noted that the general public are keen to get involved but there is confusion in how to do this as there is a growing sense of a lack of credible leadership.[55] This highlights the need for strong leadership and guidance on how individuals can act, and on how these actions fit into the overall effort. It is vital that people can see how and why their actions matter, whether they are small or large changes.

Under the Programme for Government, a unit will be established within the Department of the Taoiseach to coordinate social dialogue, creating new models of sectoral engagement.

The Government has committed to build on the learning of recent years to inform the development of a new model of engagement with citizens, sectors, and regions in regards to climate. This includes:

- a dialogue on a structured basis, so that the diverse elements of society can contribute to the process, including a specific youth dialogue strand
- a process of accountability on progress, including an annual review
- the promotion of citizen, sectoral and regional involvement in delivering actions within their own sphere of influence.

The Government will also establish a Youth Assembly, with various modules including ones for rural and urban young people, and will consider issues of importance to young people and their future, including climate action.

The Climate Action Plan 2019 places a strong emphasis on citizen engagement as laid out in Chapter 15 of that document, and specifically enunciated under Action 159 to 'enhance the effectiveness of climate related communications, networks building and deliberative capacity within and through the National Dialogue on Climate Action'. It sets out 11 sub-actions, timelines for delivery and designated responsibilities.

Progress on commitments is part of the reporting process set out under the Climate Action Plan and this is welcomed by the Council. The First Quarterly Progress Report was published in October 2019 and the successful delivery of Action 159, 'Citizen Engagement, Community Leadership and Just Transition', is acknowledged.[56]

A number of institutional stakeholders are active around climate change engagement, including Department of Communications, Climate Action and Environment (DCCAE), Department of the Taoiseach, SEAI, Climate Action Regional Offices (CAROs) and the National Dialogue on Climate Action (NDCA). At the same time, there is a lot of activity at the grass-roots level in terms of Tidy Town activities, Transition Towns, etc.

The National Dialogue on Climate Action (NDCA) is a Government of Ireland initiative, through the DCCAE, with secretariat support from the EPA. The NDCA continued its engagement programme during 2019 with stakeholders and various community groupings. Community events such as exchange fora, local gatherings and outreach workshops were hosted, encompassing a diverse range of audiences including senior citizens, small business owners and youth representatives.

The NDCA also delivered nationally larger events such as the second of two annual EPA Climate Lecture which was hosted jointly with Met Éireann. It also hosted the first EPA Annual Climate Conference, which was supported by the Government of Ireland.

During 2019 the Climate Action and Regional Offices (CAROs) and local authorities also delivered a number of local level engagement activities to raise awareness and generate engagement around climate change.

The Council notes the importance of continuing and developing local level engagement through initiatives such as the NDCA and the CAROs. However, a more strategic approach to public engagement with a focus on awareness, engagement and activation is required. A clear governance structure around such engagement is also essential. This should link top-down with bottom-up initiatives, while providing coherence in terms of messaging and resources.

3.4.4 Government budget and financial management

The annual budgetary process is a key opportunity to support climate action and to consider the impacts of Government fiscal policy on greenhouse gas emissions, climate resilience and the low-carbon transition. As part of the European Green Deal, the European Semester system of review of Member States' budgets and economies will place more emphasis on reviewing environmental sustainability and the need for appropriate investment in this regard, in particular; the Sustainable Development Goals (SDGs) will be integrated into the process. Initiatives to screen and benchmark green budgeting practices of the Member States and of the EU will begin from 2020. This offers further impetus to the Government in green budgetary practices.

Budget 2020

The Council welcomed the €6 increase in the carbon tax announced in Budget 2020, bringing it up to €26 per tonne of carbon dioxide. This was expected to raise an additional €90 million in taxation revenue for the government in 2020 or €130 million over a full 12-month period (see Table 3.2). Following the advice of the Council, the Government of the day committed to increase the carbon tax to €80 per tonne by 2030. The Council had recommended a larger initial increase in the carbon tax but the commitment to regularly increase the tax is an important step in the right direction, as further increases will be required to support the low-carbon transition (see Section 3.5.5). The Council also welcomed the fact that, as the Council recommended, all the revenue is to be used to protect the vulnerable and invest in the low-carbon transition. This is important to counteract the negative impacts of the carbon taxation increase on poorer households and on fossil fuel dependent communities and to support a low-carbon transition. Transparent reporting is important in this regard to engage public support. The publication on budget day of the intended destination of the additional carbon taxation funds is an important aspect of this transparency. The allocation of carbon tax revenue is intended to be additional to the normal government expenditure.

Table 3.2: Disbursement of the additional carbon tax receipts in 2020. **Source:** *DPER 2019*[57]

Increased Carbon Tax Spending - 2020	Revenue € m – 2020	Expenditure € m – 2020	Department
Revenue Raised from a €6 carbon tax increase in 2020	90		
Protecting the Vulnerable			
Fuel Allowance		21	DEASP
Energy Poverty Efficiency Upgrades		13	DCCAE
A Just Transition			
Aggregated Housing Upgrade Scheme		20	DHPLG
Peatlands Rehabilitation (non Bord na Móna)		5	DCHG
Just Transition Fund		6	DCCAE
Investing in the Low Carbon Transition			
Greenways/Urban Cycling		9	DTTAS
Continuation of Electric Vehicle Grants		8	DCCAE
Further Investment in EV Charging Infrastructure		3	DCCAE/ DTTAS
ODA – Green Climate Fund		2	DCCAE
Green Agricultural Pilots		3	DAFM
Total Expenditure		**90**	

It is important that the additional carbon tax revenue is spent effectively and where it can achieve the most impact, be it protecting the vulnerable, supporting a just transition or investing in the low-carbon transition. Further details provided in the revised estimates in 2020 are an important step towards transparent management of the impact and outcomes from this expenditure to increase the cost-effectiveness of the disbursement.[58] This includes 23 performance metrics for the ten programmes. The revised estimates of costs and impacts of these expenditures suggest varying impacts and varying average abatements costs but also the existence of many co-benefits for other policy objectives. The expenditures will be discussed under the relevant sections in this chapter.

Green budgeting

In Budget 2019 the Government took the first steps in green budgeting by estimating the climate expenditure implied in the Budget. This effort was further developed in Budget 2020 with accompanying documentation explaining the methodology in more detail. The same climate expenditure paper identified climate relevant expenditure in Budget 2020 and gave further detail on its methodology. The Rio Markers[i] were not employed but rather a more conservative approach, where expenditure is only included where it is evident that all, or at least most investment in the programme in question, will support improved climate and environmental outcomes. This differs from the Rio Marker approach, which aims at identifying climate 'mainstreaming' across expenditure programmes. The Irish green budgeting approach is more useful in this context where quantification of climate expenditure is the aim rather than just identification. Nevertheless, it does point to the need for further development under green budgeting to identify the broader impact of the budget on climate objectives, both positive and negative. This should be informed by modelling.

The Institute for Climate Economics in Paris published a "first 360-degree climate assessment of France's State budget" (2019).[59] It identifies four categories of budgetary measure; climate friendly, ambiguous, climate damaging, and neutral. Approximately 92% of the French state budget expenditure was deemed neutral, with no impact or relationship to climate objectives, about 3.5% climate friendly, 3% climate damaging and 0.5% ambiguous – related to climate but with an uncertain outcome. This is consistent with the approach taken by the Department for Public Expenditure and Reform but takes the analysis a step further. This detailed analysis provides useful insights. Similar analysis should be possible in an Irish context. The Central Statistics Office has published analysis of fossil fuel and similar subsidies from 2012 to 2016, and also an analysis of environmental subsidies and similar transfers up to 2018 which shows potentially environmentally harmful subsidies exceeding environmental subsidies and similar transfers up to 2016.[60,61] These subsidies are further discussed in Section 3.5.5. This analysis is important to inform our understanding and confirm direction of travel. They also made the first step in identifying the relevant programmes to be tracked.

i Since 1998, the OECD Development Assistance Committee (DAC) has monitored development finance flows targeting the objectives of the Rio Conventions on biodiversity, climate change and desertification using the so-called 'Rio markers'. The Rio markers were originally designed to help DAC members with the preparation of their National Communications or National Reports to the Rio Conventions, by identifying activities that mainstream the Conventions' objectives into development co-operation. The Rio markers include a marker for climate mitigation and a marker for climate adaptation.

3.5 Cross-sectoral measures

3.5.1 Finance and investment

The availability of finance and investment is a key determinant of a country's ability to transition to a low-carbon, climate-resilient economy and society, and can act as either a driver or a barrier to progress. A successful transition will require a redirection of investment towards 'green growth'. This offers many employment opportunities and economic benefits.

The National Development Plan 2018 – 2027 discussed in more detail the National Strategic Outcomes and Public Investment Priorities. National Strategic Outcome 8 prioritises €21.8 billion public investment to achieve the transition to a low-carbon and climate resilient economy. Housing retrofits are expected to require €3 billion of this. Other investments include €13.7 billion in the energy system for renewables, the grid and interconnection, €1 billion for flood defences and the establishment of a Climate Action Fund of €500 million. The Climate Action Plan has an aim to retrofit 500,000 homes by 2030. Not all of this can be funded directly from the Exchequer.

Innovative public funding sources are required to extend the ability of government to support transition. Funding from state-owned enterprises and semi-state bodies such as utilities will help finance some infrastructural investments. The National Treasury Management Agency (NTMA) has a big role to play in raising finance for the low-carbon transition. In 2018, the NTMA launched its first sale of green bonds. Irish sovereign green bonds (ISGBs) raised €5 billion over 2018 and 2019. There is more potential to raise funds for government investment in climate action from green bonds as demand for the ISGBs exceeded supply while internationally, demand has generally been strong for high quality green bonds.

Private finance will also be required to achieve the low-carbon transition. This requirement is based on two needs; public finance alone is not enough to make all the required investments so other sources are needed, and private finance needs to be engaged in the low-carbon transition so that it supports rather than undermines climate action goals. The Retrofit Taskforce established in 2019 is looking at new tools and business models to enable homeowners to invest in energy efficiency and low-carbon solutions for their homes. The first outputs of the taskforce are expected in the third quarter of 2020 after the publication of this report.

In recent years the EU has become increasingly active in promoting and shaping the sustainable finance space. In March 2020, the EU Commission published a sustainable finance taxonomy to underpin a proposed Taxonomy Regulation.[62] The purpose of the Taxonomy Regulation is to enable firms and investors to identify environmentally sustainable economic activities. It will apply to financial market participants who offer financial products, as well as companies to which the Non-Financial Reporting Directive applies (generally, large EU-listed public companies).

In order for an activity to be an 'environmentally sustainable economic activity', it must make a 'substantial contribution' to at least one of six 'environmental objectives':

- climate change mitigation
- climate change adaptation
- sustainable use and protection of water and marine resources
- transition to a circular economy (e.g. recycling)

- pollution prevention and control
- protection and restoration of biodiversity and ecosystems.

Further requirements for an activity to be environmentally sustainable are that it must not 'significantly harm' any of the other environmental objectives, it must meet the minimum safeguards (such as complying with the International Bill of Human Rights) and it must comply with any other criteria specified by the European Commission in delegated acts, which will be adopted between now and the end of 2022.[63]

The Sustainable Finance Taxonomy is considered a cornerstone of future EU policies on sustainable finance, laid down in the May 2018 EU Sustainable Finance Action Plan.[64] The new European Commission has indicated that it will use the Sustainable Finance Taxonomy to develop an EU standard for green bonds and an eco-label for retail investment products.

The Irish banking and financial sector must comply with and respond to EU sustainable finance initiatives. The Irish retail banking sector to date has not been very active in offering 'green finance' or loans for sustainable investment to individuals or small and medium enterprises. Administrative barriers and transaction costs have made accessing loans for investment in energy efficiency and renewable energy challenging. Developments at an EU level will mean that the Irish retail banking sector is enabled and encouraged to improve its offering in this regard.

3.5.2 Circular economy

The circular economy is at the core of the transition to a low-carbon economy; and has a critical role to play in achieving climate targets at national and global levels. Researchers calculate that 62% of global greenhouse gas emissions (excluding those from land use and forestry) are released during extraction, processing and manufacturing; with only 38% emitted in the delivery and use of products and services.[65] This highlights the importance of fully utilising products through sharing models to maximise their usage; and through repair and refurbishment to extend their lifetime. This approach is supported by implementing resource efficiency to ensure waste is minimised at every stage and sector of the economy. The NESC report 'Moving towards the Circular Economy in Ireland (2017)', found that there is momentum in circular economy practices in Ireland, but more action is needed to build early advantage. The report concluded that while the full potential of the circular economy for Ireland has yet to be identified, there are surprising pockets of innovation and some very well established businesses at the frontier of the circular economy.[66]

The Climate Action Plan contains targets for waste and the circular economy including that 70% of total packaging waste and at least 50% of plastic packaging waste should be recycled by 2030, with a commitment to ban some specific single-use plastic convenience items. The Climate Action Plan also aims to reduce municipal waste going to landfill by 10% by 2030 and to reduce food waste by 50% by 2030.

To date, the EPA's National Waste Prevention Programme has been to the forefront of Ireland's efforts to progress our transition to a circular economy. It provides the tools and information to businesses, households and the public sector to influence behavioural change and support sustainable choices. It recognises that inefficient consumption and missed opportunities for reuse and recycling lead to high waste generation and greenhouse gas emissions. The programme targets four sectors:

- Industry and Enterprise
- Research and Innovation
- Public sector bodies
- Representative bodies and networks.

New simplified labels have been developed to improve the correct sorting of waste and recycling by households.[67] Awareness raising and behavioural change initiatives towards individuals, householders and small businesses to reduce food waste are delivered through the EPA's Stop Food Waste programme and the Food Waste Charter is targeted towards food producers and retailers. Bord Bia's 'Origin Green' is extending its members' commitments to include food waste prevention measures.[68] Remaining wastes and end-of-life items must then be exhaustively mined through reuse and recycling programmes to recover these resources for use in future products.

The bio-economy is a key pillar of the circular economy. In 2018, the Government published a national policy statement on the bio-economy outlining its ambition to be a global leader in the bio-economy and setting out a policy framework to underpin its development in Ireland.[69] The bio-economy, as described in the updated 'EU bio-economy strategy', covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles.[70] It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (Agriculture, Forestry, Fisheries and Aquaculture); and all Economic and Industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services. A first progress report on the bio-economy implementation group was published in September 2019.[71] The group consists of eleven departments and eight agencies. A public-private outreach network has been established with an information portal at www.irishbioeconomy.ie . Numerous events have been held to engage stakeholders and raise awareness while the implementation group has fed into a number of government strategies including the Climate Action Plan. Government departments and agencies continue to provide funding to support research and innovation as well as pilots and demonstrations with links between research and industry in the bio-economy. A technical working group has been established on biological residual flows to consider and recommend whether a redesignation is necessary for residual waste flows to be successfully managed for use in the bio-economy. Research is ongoing to determine the role of cities or regional towns to become circular bio-economy hubs for the recovery of bioresources from local waste products.

The transition to circularity will be realised through fundamental changes in how we produce and use goods. Business models, consumption patterns and consumer goods will all need to be reimagined through an eco-design framework to emphasise the reuse of minerals, fossil fuels, metals and biomass within the economy. Sectors involved in waste management and resource efficiency are familiar with the circular economy concept and its value. However, a recent EPA/Ibec survey showed that of over 200 Irish business CEOs, barely half previously understood the term circular economy.[72] This is likely to be replicated across the public sector leadership cohort. To make greater progress in advancing the circular economy in Ireland, it will be important to raise its profile together with its benefits for business, communities and the environment, including its potential in tackling climate change.

3.5.3 Zero-carbon fuels

The three pillars of mitigation in the Energy sector are demand management, energy efficiency and fuel switching; i.e. changing the energy source away from fossil fuels towards renewable zero or low-carbon sources. Electrification is a well understood strategy for delivering a decarbonised energy supply to homes and businesses at point of use. For mitigation in these applications to be effective the electricity generation itself must be decarbonised. Ireland is making progress in renewable energy supply in the Electricity sector. However, not all energy demand can be met by electrification. For example, electric powered heavy goods vehicles or airplanes are a long way from entering the market and may not be cost-effective. Ireland's progress on renewable energy in the Heat and Transport sectors is quite slow and Ireland will miss its EU targets for renewable heat (RES-H) and renewable transport (RES-T) in 2020 by a large margin. It is therefore important to consider how to deliver alternative zero-carbon energy across the sectors and service demands.

Energy storage has emerged as an important component of the energy system. Energy for transport generally needs to be stored within the vehicle itself, with the exception of vehicles powered by electric overhead cables such as trains and trams. Batteries have emerged as an effective solution for lighter, smaller vehicles but do not have the energy storage capacity required for airplanes or heavy goods vehicles. Also, while batteries can be an effective solution for short-term storage, they are not suitable for seasonal storage. To decarbonise the electricity supply in the long-term, we need the capacity to store renewable energy when it is abundant, for rapid deployment when renewable energies are insufficient. Zero-carbon fuels, developed using renewable energy, could be a useful storage vector.

Potential zero-carbon fuels attracting stakeholder interest include the following:

- **Biomethane (using anaerobic digestion);** coupling generation capacity at scale onto the gas grid, taking advantage of current low value waste streams (municipal and animal) and higher value biomass resources (including grass). Teagasc expects to commission a biomethane demonstration plant at Grange, Co. Meath using grass silage as the main feedstock.

- **Hydrogen**
  - **Power to gas;** Involving use of renewable electricity to produce hydrogen during periods of high generation. This is also called renewable or green hydrogen. The gas transmission network in Ireland is understood to be 'hydrogen ready'. However, end users and some limited parts of the Irish gas networks may require modification or upgrade, e.g. replacement of boilers etc. Simplified form: $2H_2O \rightarrow 2\,H_2 + O_2$
  - **Decarbonised natural gas;** This involves stripping the carbon atom from natural gas molecules. This is often called grey hydrogen where the CO_2 is released to the atmosphere or blue hydrogen, where the CO_2 is captured and stored. Simplified form: $O_2 + CH_4 \rightarrow CO_2 + 2H_2$ where the CO_2 is then captured for storage.

- **Power to synthetic gas;** This is an additional step to transform hydrogen into methane, using renewable electricity and captured CO_2, to produce a more energy dense synthetic gas suitable for storage and direct injection onto the existing gas network. Simplified form: $CO_2 + 2H_2 \dashrightarrow CH_4 + O_2$ This could be a route to providing negative emissions if the post-combustion CO_2 was captured. See Section 3.5.4 on negative emissions.

These options should be assessed for their cost-effectiveness and their life-cycle carbon footprint before determining whether they have a role in Ireland's low-carbon transition.

In the same way that wind energy in Ireland takes advantage of the existing electricity network and infrastructure to deliver energy to homes and businesses; zero-carbon fuels could take advantage of the existing gas infrastructure to deliver energy to homes and businesses and to transport. The gas network represents a very significant investment in primary energy supply in Ireland. Similar to the electricity grid, gas infrastructure is comprised of transmission and distribution pipelines which are operated by Gas Networks Ireland (GNI). Natural gas is the dominant space heating fuel in urban dwellings and enterprises within an easy connection radius of the gas distribution grid. Even in dwellings rated B2 or better, natural gas is common as the main heating fuel type. There is potential for straightforward mitigation of emissions in the Built Environment sector if such dwellings could change natural gas for a zero-carbon gas without a requirement for deep retrofits of the building fabric.

In July 2020, the EU Commission published its strategy for hydrogen. The strategy notes multiple applications for hydrogen; it can be used as a feedstock, a fuel or an energy carrier and storage, and has many possible applications that would reduce greenhouse gas emissions across Industry, Transport, Power and Buildings sectors. The Commission's economic recovery plan, 'Next Generation EU', highlights hydrogen as an investment priority to boost economic growth and resilience, create local jobs and consolidate the EU's global leadership. In particular, the strategy aims at 6GW of hydrogen electrolysers powered by renewable energy by 2024, producing up to 1 million tonnes of green hydrogen, and 40GW of renewable hydrogen electrolysers by 2030 producing up to 10 million tonnes of green hydrogen. The Commission aims to develop a terminology and certification system to define green or renewable hydrogen based on life-cycle emissions.

In the UK, the Department for Business, Energy & Industrial Strategy has funded a £25 million programme, Hy4Heat, to explore and develop hydrogen as a sustainable energy source in the UK, including through developing standards for domestic appliances such as boilers and cookers.[73] In Northern Ireland, the public transport operator Translink has bought its first hydrogen powered double decker buses, built by a Ballymena based bus company. The pilot project will also see development of the first hydrogen refuelling station, with its electricity supplied by an on-shore Antrim windfarm.[74] Ireland has an advantage in hydrogen over Britain as, due to the younger network, the Irish gas grid is 'hydrogen ready' whereas the British grid is not. There is also potential for zero-carbon fuels to assist in the full decarbonisation of the electricity supply. For example, deployment of carbon capture and storage coupled with natural gas might deliver electricity with a carbon intensity of 40 g/kWh, compared to 370 g/kWh based on conventional combined cycle gas turbine systems. A recent ESRI working paper urges policy to take a technology neutral approach and cautions against an overly stringent policy for renewables within electricity generation, with potential cost advantages.[75]

Gas Network Ireland (GNI) has published its vision for transition of the sector, which includes a roll-out of many of these technologies over the medium to long-term.[76] Its approach holds the promise of delivering zero or near-zero emissions gas to consumers, with the main burden of planning and investment falling on the supplier. GNI has an existing domestic consumer base of approximately 700,000 dwellings, with an estimated potential for an additional 300,000 low cost connections to dwellings currently sited in close proximity to the grid. There is a need for

greater confidence in the ability of GNI to ramp up the delivery of biomethane and hydrogen onto the grid in a timely fashion and at a cost to consumers that is competitive with the alternative low-carbon options, such as deep retrofit incorporating heat pumps or biomass heating systems. The ambition of the GNI vision relies on multiple and diverse elements coming together smoothly and rapidly. This approach imposes significant risk of medium to long term lock-in to the continued use of fossil fuel resources. It assumes the emergence of cost effective technologies and infrastructures including carbon capture and storage, an abundance of renewable energy for hydrogen production and the development of a significant biomethane production capacity.

The interconnections between agriculture, land use and the production of biomethane for use within various sectors are illustrated in Figure 3.1 as an example of an integrated, circular and bioeconomic model. The energy system is provided with previously low-value waste and excess resources derived from agriculture, food and land use from which biogas, and biomethane can be produced. The SEAI published a detailed report in 2017 exploring the potential for biogas and biomethane production in Ireland.[77] The report notes that taking advantage of existing municipal and animal waste streams for anaerobic digestion may be cost-negative. However, achieving higher volumes of gas production would require using alternative high-value feedstock resources (e.g. woody biomass and grass), leading to significantly higher costs. The report also discussed the co-benefits of use of the residual digestate from the anaerobic digestion as a nitrogen-rich slurry that would substitute for artificial fertiliser in the Agriculture sector, contributing to the circular economy. It is not clear how cost-effective this would be. Most analyses of potential cost saving in Ireland have made assumptions of zero or low-cost delivery of the digestate for spreading. Additional research is required to assess associated costs within more diverse and realistic real-world business scenarios. Teagasc expects to commission a biomethane demonstration plant at Grange, Co. Meath using grass silage at the main feedstock to advance research on anaerobic digestion.

Bioeconomy and Circular Economy Aspects of Biomethane

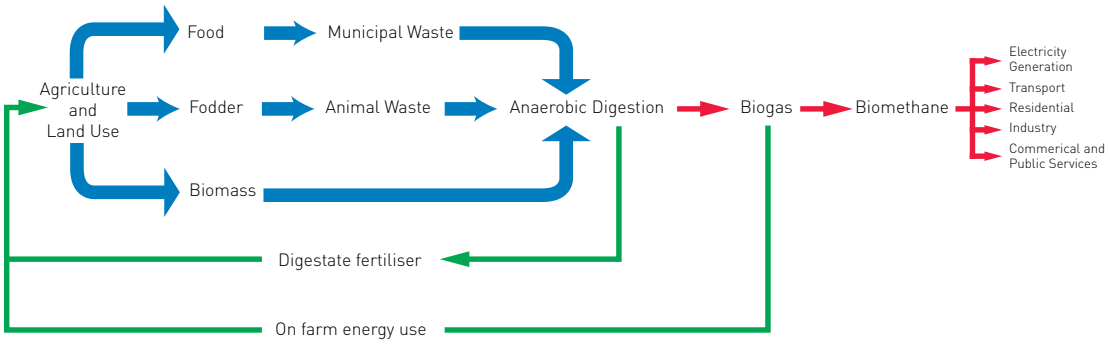

Figure 3.1: Schematic of the potential interconnections between agriculture, land use and biomethane

Coupling carbon capture and storage (CCS) with biomethane within electricity generation or facility-scale combined heat and power can result in a form of negative emission (see Section 3.5.4), whereby a significant proportion of the carbon dioxide removed from the atmosphere by the biogenic feedstock to anaerobic digestion is sequestered to geological or other long-term storage. For example, using estimates of the emissions rates for combined cycle gas turbine (CCGT) (370 g/kWh) and CCGT with CCS (40 g/kWh), one can estimate a negative emissions rate of 330 g/kWh for biomethane in CCGT with CCS. Or from a different perspective, substitution of approximately 11% biomethane in a CCGT + CCS system approaches net-zero neutral CO_2

emissions electricity generation, setting aside for the moment any residual emissions associated with the production of the biomethane itself, or any emissions associated with extraction, distribution and energy security concerns with respect to natural gas.

3.5.4 Negative emissions

In its advice to the Government on approaches to developing multi-annual carbon budgets, the Council noted IPCC advice that negative emissions would be needed to achieve the Paris Agreement goal to limit temperature increase to at most 2°C and to aim for 1.5°C.

To achieve the negative emissions envisaged by the IPCC, it is not sufficient that carbon dioxide is captured and stored, the source of the CO_2 has to be biogenic. In other words, it must be taken from the atmosphere, not directly from a fossil source.[78] Bio-energy with carbon capture and storage (BECCS) is a negative emission technology because the biomass fuel has captured carbon from the atmosphere. On the other hand, for example, gas electricity generation with CCS captures carbon from the fossil fuel, thus making it a near-zero rather than negative emission process. Recent research in Ireland, finds that consistency with Paris temperature goals will require CO_2 removal (negative emissions) technologies, though they point to concerns about the realisable potential of these technologies in Ireland.[79]

There are six broad categories of negative emissions technologies or options as follows;

- **Coastal blue carbon:** Land use and management practices that increase the carbon stored in living plants or sediments in mangroves, tidal marshlands, seagrass beds, and other tidal or salt-water wetlands. These approaches are sometimes called 'blue carbon' even though they refer to coastal ecosystems rather than the open ocean.

- **Terrestrial carbon removal and sequestration:** Land use and management practices such as afforestation/reforestation, changes in forest management, or changes in agricultural practices that enhance soil carbon storage ('agricultural soils'), or restoration of peatlands.

- **Bio-energy with carbon capture and storage (BECCS):** Energy production using plant biomass to produce electricity, liquid fuels and/or heat combined with capture and sequestration of any CO_2 produced when using the bioenergy and any remaining biomass carbon that is not in the liquid fuels.

- **Direct air capture**: Chemical processes that capture CO_2 from ambient air and concentrate it so that it can be injected into a storage reservoir.

- **Carbon mineralization:** Accelerated "weathering," in which CO_2 from the atmosphere forms a chemical bond with a reactive mineral (particularly mantle peridotite, basaltic lava, and other reactive rocks). The CO_2 is therefore removed from the atmosphere and bound permanently to the rock

- **Geologic sequestration:** CO_2 captured through BECCS or direct air capture is injected into a geologic formation, such as a saline aquifer, where it remains in the pore space of the rock for a long time. This is not a negative emission technology, but rather an option for the sequestration component of BECCS or direct air capture.

Four negative emissions technologies have reached levels of maturity where they are ready for large-scale deployment: afforestation/reforestation, changes in forest management, uptake and storage by agricultural soils, and BECCS. These negative emissions technologies have low to medium costs (€100/t CO_2 or less) and substantial potential for safe scale-up from current deployment. They also provide co-benefits including:

- increased forest productivity (changes in forest management)
- improved agricultural productivity, soil nitrogen retention, and soil water holding capacity (enhanced uptake and storage by agricultural soils)
- liquid fuel production and electricity generation (BECCS).

Many argue that geologic sequestration is ready for large-scale deployment globally. However, the business models and logistical systems for distribution of large volumes of captured CO_2 have yet to be demonstrated. Other technologies require further development. While there have been some studies in Ireland of the potential for geological storage of CO_2, more work is needed on this. McMullin et al. (2020, in press) considered the negative emission options for Ireland (see Table 3.3).[79] They found that BECCS, direct air capture and enhanced weathering would interact significantly with the overall energy system: BECCS could contribute net energy, whereas both direct air capture and enhanced weathering would require additional energy consumption.

Table 3.3: Summary of negative emissions technologies currently considered to have potential application in Ireland

Negative emission technology	Removal	Storage
Enhanced Soil Carbon Sequestration (SCS)	Biogenic	Biogenic
Biochar (BC)	Biogenic	Biogenic
Afforestation (AF)	Biogenic	Biogenic
Enhanced weathering (EW)	Technological	Geological
Bioenergy with Carbon Capture and Storage (BECCS)	Biogenic	Geological
Direct Air Carbon Capture with Storage (DACCS)	Technological	Geological

The same study recommends that national policy should maintain a clear separation in emissions accounting between gross emissions and gross removals, with removals clearly identified as land-based or geological via CCS.

It is important to emphasise the crucial connection of BECCS with the gas network enterprise and infrastructure in Ireland. Under the Climate Action Plan a steering group was established to examine and oversee the feasibility of CCS utilisation in Ireland. The steering group includes the DCCAE, DHPLG, DPER and NewEra. The EPA and SEAI are also to be included in the steering group in 2020. A research investment of €3.37 million has been agreed. A further consideration of the potential for negative emissions is required that will consider both biological and technical elements. In particular, the finite potential in Kinsale for CCS needs to be considered alongside the requirement for future negative emissions. More immediately in Ireland, negative emissions could include enhancement or restoration of natural sinks such as wetlands, soils and forestry where early action could ensure removals in the long-term and bring co-benefits as outlined above. These biogenic options for negative emissions are considered in more detail as mitigation options in Sections 4.2 and Chapter 6.

The role of natural sinks and technologies to deliver negative emissions up to and beyond 2050 needs to be explored and developed urgently, as actions taken in these areas will take decades to fulfil their mitigation potential. EU leadership on this is also required because of the scale of investment (and infrastructural planning) needed for the technological options. The benefits to be gained by setting standards for negative emissions processes should also be considered by the EU.

3.5.5 Carbon pricing

Allowing consumers to choose how they cut their emissions, a carbon price guides least-cost greenhouse gas mitigation.[80,81,82] Research has shown that decarbonisation is more expensive if alternative measures such as subsidies are substituted for a carbon tax.[83] A carbon price trajectory that rises in accordance with the increasing marginal abatement cost is required to incentivise continued decarbonisation towards emissions reduction targets. There are three main tools for carbon pricing: carbon taxes, emissions trading systems and shadow pricing.[84] Ireland uses all three tools as levers to encourage changes in consumer behaviour, government decision making, and new investment and innovation within business sectors. Ireland collects a carbon tax and applies a 'shadow' carbon price in cost–benefit analysis of public investments and expenditures. Ireland also participates in the EU Emissions Trading System, which covered about 29% of emissions in Ireland in 2016.

Carbon tax

A carbon tax is advocated by the World Bank, the OECD and a broad international coalition of countries and businesses.[85,86,87,88] The Irish carbon tax applies to carbon dioxide emissions associated with both liquid and solid fossil fuels including petrol and diesel, coal, peat briquettes, heating oil and gas. The tax is imposed at point of sale, and directly impacts the consumer.

Following the advice of the Council, Budget 2020 increased in the carbon tax from €20 to €26 with a commitment by the then Government to increase the carbon tax to €80 by 2030, again in line with Council advice at the time.[89] The increase for petrol and diesel (‹2c/litre) took effect immediately while the increase for solid fuels and heating oil took effect in May 2020. This is anticipated to raise up to €90million additional revenue for the Government in 2020. This increased revenue was earmarked by Government for related expenditure towards protecting the vulnerable, supporting a just transition and investing in the low-carbon transition. The Programme for Government commits to increasing the carbon tax to €100 by 2030.

The carbon price trajectory is insufficient. While the council welcomed the increase in Budget 2020, a greater increase is required to set the economy on a trajectory to a sustainable transition. An effective carbon tax reflects the marginal cost of abatement. The Climate Action Plan states that the marginal abatement cost of achieving 2030 targets is in the region of €250–300/tCO_2. The current carbon tax is not aligned with policy targets but subsidies and other policies have been employed to compensate for this. While supplementary policies are required to ensure behavioural and infrastructural change, using these policies to create the financial incentive to switch is at best more costly and at worst insufficient.[83]

Macroeconomic concerns should not be an impediment to a sustainable carbon price. Much research exists to estimate the effects of a carbon price on our emissions and the economy. De Bruin et al. (2019) have found that an Irish carbon price trajectory rising to €80 by 2030 will have

limited effects on GDP, cutting emissions by almost 15% by 2030.[90] This indicates a considerable fall in emissions relative to a limited impact on economic performance.

A clear long-term price trajectory is required to incentivise sustainable household investments. A carbon price guides current consumption by increasing the cost of the environmentally harmful expenditure, guiding individuals towards reducing this activity. A strong and salient price trajectory guides longer-term investments towards the sustainable option. A householder will purchase an electric vehicle, for example, if they expect that future fuel prices will be such that the sustainable alternative makes financial sense. In this way, a current carbon price on its own is only partially effective – a strong and clear trajectory is also required to incentivise sustainable investment decisions.

Fuel price volatility, however, hides this signal. Fuel prices have been volatile and fell considerably with the Covid-19 crisis which may counteract, at least in the short-term, the decarbonisation incentive created by recent carbon price changes, as illustrated in Table 3.4. This presents an opportunity to introduce a strong carbon price trajectory to counteract both the negative short-term effects and to guide long-term investment decisions.

Table 3.4: Fuel prices and the carbon tax from 2019 to 2020

	Consumer price April 2019	Carbon tax component 2019	Consumer price April 2020	Carbon tax component 2020
Petrol (1 litre)	€1.36	€0.046	€1.35	€0.059
Diesel (1 litre)	€1.32	€0.053	€1.26	€0.069
Coal (40 kg bag)	€18.66	€2.10	€17.50	€2.73
Peat briquettes (1 bale)	€4.50	€0.45	€4.50	€0.59
Kerosene oil (1 litre)	€0.81	€0.05	€0.54	€0.06

Source: CSO (2020)[91] and SEAI (2020)[92]

Distributional concerns should not be an impediment to a sustainable carbon price trajectory. It is important that vulnerable sections of society are protected from disproportionate negative impacts of carbon pricing. Research has shown that carbon and energy taxation comprises a greater share of income for poorer households.[93,94,95] Among those negatively impacted, Tovar and Lynch (2019) and Scott et al. (2004) found that rural poor households incur a disproportionate impact due to transport expenditure.[95,96] Non-farm rural dwellers made up the greatest share of those negatively impacted by carbon taxation, likely due to transportation.[96]

While a carbon tax alone is regressive, a carbon tax plus redistribution of revenues is progressive. In other words, a carbon tax, effectively designed, can help those less well-off. Revenue recycling involves redistributing carbon tax revenues to households through increases in welfare payments or reductions in taxes. Alternatively, a lump sum 'carbon dividend' may be used. There are benefits and drawbacks to either method of redistribution. Tovar and Lynch (2019) find that redistribution via changes to taxes and transfers is more progressive than a lump-sum transfer; poorer households benefit to a greater extent.[95]

Garnering public acceptability is often the primary challenge in achieving a sustainable carbon price trajectory. A carbon tax is less acceptable if it challenges or contradicts underlying ideological predispositions: if there is public doubt surrounding the effectiveness or impacts of carbon taxation. Labelling and salience of benefits can help in such circumstances: a lump-sum transfer and/or public investment are examples of salient redistribution mechanisms. In this context, solid commitment, implementation and communication about the earmarking and disbursement of climate taxation revenues for climate action are a simple tool to demonstrate the effectiveness of carbon taxation in another way. Where climate policies are considered effective, they receive much higher support. Features common to well-received carbon taxes have been identified by Klenert et al. (2018). Carbon pricing schemes are more likely to survive successive changes in government if they benefit constituents across the political spectrum.[97]

The Council welcomed the earmarking of the carbon tax increase to support the vulnerable and a just transition, and to invest in the low-carbon transition. The fuel allowance increase, having begun in the winter, will make those eligible for the allowance (the energy-poor) better off already because the carbon tax increase only takes effect in May. The fuel allowance is still likely to exceed the cost of the carbon tax increase for most of those households over a full 12-month period of application, but is not sufficient to compensate the lowest-income households.[98] Therefore further measures will be necessary to avoid increasing energy-poverty. The use of carbon taxation revenue to support energy efficiency upgrades in local authority housing is therefore crucial (see Section 4.5 on the built environment). It will be important to continue to monitor the overall outcomes of the suite of climate policies and measures for the poorest households. Effective disbursement and transparent communication of the additional carbon taxation revenue will be crucial to maintain public support, especially for future increases, which the Council considers continue to be necessary up to 2030.

EU Emissions Trading System (ETS)

The price of carbon for electricity generation and large industry is governed by the ETS, which sets an EU-wide cap on emissions in the covered sectors.

Large industrial installations, such as cement and steel manufacturers, are governed by the EU ETS. There is a risk of what is known as 'carbon leakage': the relocation of activities covered by the EU ETS to locations outside the EU to avoid the taxation of their emissions. This would result in no environmental benefit as the incentive to limit emissions could be avoided, while there might be additional emissions if the product of this activity were subsequently imported into the EU from a greater distance. Firms at risk of carbon leakage are given a free allocation to mitigate this incentive. While avoiding the carbon leakage problem, this creates further problems. These free allowances are essentially a financial endowment to these producers, as many of these firms can trade any surplus.

The Council supports an alternative measure to tackle carbon leakage which does not involve direct transfers of wealth. The Green Deal proposes an alternative system whereby certain imports are levied according to their embodied carbon. Under this system, all industrial manufacturers must buy ETS credits for all emissions with no free allowance. There is no incentive to relocate as they would face this cost upon trading with counterparties located within the EU. Furthermore, no transfer of wealth is observed under the current system.

The Council supports measures to ensure an adequate and stable EU ETS price. As discussed, a high and rising price trajectory is important to guide sufficient decarbonisation. EU ETS

prices have been below a level that incentivises sufficient decarbonisation throughout much of the lifetime of the trading system.[99] It remains to be seen whether the reforms to the EU ETS, including the market stability reserve, introduced in 2018 will deliver the increased carbon price signal required to drive down emissions from electricity generation. Since this reform, the carbon price on the EU ETS has largely remained above €20. However, the spread of COVID-19 has caused more volatility in the market, with the price of carbon dropping briefly to €15.24 and, in July 2020, briefly rising to over €30. Despite this high peak, volatility and uncertainty will continue to undermine investment in substantial decarbonisation.[100] An appropriate carbon floor price could reduce the need for ongoing support of renewables via the Public Service Obligation (PSO).

Other carbon pricing instruments

Explicit carbon pricing, whether from a carbon tax or emissions trading, is not the only fiscal instrument with an impact on carbon emissions. In calculating the 'effective carbon rate' the OECD also looks at taxation instruments based on energy use. It finds that internationally only 18% of non-road greenhouse gas emissions are subject to tax.[101] Globally, emissions from aviation are rarely taxed at all. This is also true in Ireland.[i] The CSO calculated that in 2016, the fuel excise revenue foregone in the Aviation sector amounted to an indirect potentially environmentally harmful subsidy of up to €494 million.[60] Overall, the CSO estimates revenue foregone due to variations in fossil fuel excise rates, predominantly for the Aviation, Road Haulage and Agriculture sectors of approximately €1.9 billion, representing highly significant indirect fossil fuel subsidy.

3.5.6 Climate research

The EPA has a statutory role in coordinating environmental research in Ireland. The Climate Research Coordination Group (CRCG), established by the EPA, consists of government departments, state agencies and local authorities. It is identified in the government's National Mitigation Plan (NMP) as the body representing the key actors in Ireland's climate change-related research activity. Action 11 of this plan requires the CRCG to report annually on its activities and provide an assessment and synthesis of key findings from the research programme and wider related research activities every five years.

The second annual report of the CRCG's activities in 2019 was issued in May 2020 and covers the investments, progress on strategic goals, and related developments and activities for 2019, as well updating the material from the first CRCG Report covering June 2017 to December 2018.[102] Activities detailed in this 2019 Report cover competitive research funding committed by members of the CRCG, leveraged funding from EU schemes, and core research activities carried out by CRCG members themselves, and is based on the information provided by the members of the group.[103]

During 2019 the CRCG held three meetings on research activities of its members and there were three workshops involving CRCG members related to climate research. There was an additional workshop relating to the scoping of the five-year assessment and synthesis of research report (required under Action 11 of the NMP).

i Emissions from intra-EU and intra-European Economic Area (EEA) flights are regulated in the emissions trading system but with significant free allocations of allowances.

In 2019, the CRCG gained five new members: National Economic and Social Council; Enterprise Ireland; Irish Water; the Built Heritage and Architectural Policy Unit of the Department of Culture, Heritage and the Gaeltacht (DCHG); and the Office of the Planning Regulator.

Seventy-two new climate-research competitive awards were made, with a total budget commitment of €23.1 million. In addition, €19.3 million was awarded by Science Foundation Ireland (SFI) towards Phase 2 of the MaREI (Marine and Renewable Energy Ireland) SFI Research Centre, which covers, but is not limited to, climate-related research. Among these 72 projects, collaboration between the CRCG members was evident through the co-funding of 21 research projects with a committed budget of €6.8 million.

In excess of €3.4m was also reported as being spent by CRCG members for in-house research activities.

The Irish research community leveraged €29.8 million under the Horizon 2020 Programme (50 projects), €15.1 million under the EU Interreg Programme (11 projects) and €14.4 million under the LIFE Programme, with climate-related research projects. Three climate-related COST (European Cooperation in Science and Technology) Actions involving Irish partners were also approved in June 2019.

Recommendations from the report include:

- Develop an understanding of the timing of calls to allow for greater engagement by CRCG members in research calls and increase the potential to identify co-funding opportunities.
- Develop an online database for climate research projects
- Maintain the thematic structure for the time being,[i] but review through the five-year assessment of the research process.

Other recommendations around the functions, processes and reporting procedures were also made.

Private sector research

It is recognised that the transition of countries to low-carbon, climate-resilient economies presents both risks and opportunities for the private sector. A major feature of transition will be the development of solutions and associated technologies. The private sector will need to invest in research and development of these technologies in order to position itself to take advantage of opportunities as they emerge.

A recent study of the European private sector and its activities related to research and development of climate change mitigation technologies (CCMTs) and multinational corporations (MNCs) (see Figure 3.2). It indicates that although investment in mitigation research and development across Europe has accelerated dramatically in recent years, Ireland has a relatively low proportion of private sector research spending on climate topics.

i The thematic structure of CRCG activities is as follows:
- Theme 1: Carbon Stocks, GHG Emissions, Sinks and Management Options;
- Theme 2: Ireland's Future Climate, its Impacts, and Adaptation Options;
- Theme 3: Socio-economic and Technological Solutions - Transition Management and Opportunities; and
- Theme 4: Air Science (Air Pollution and Short-lived Climate Forcers).

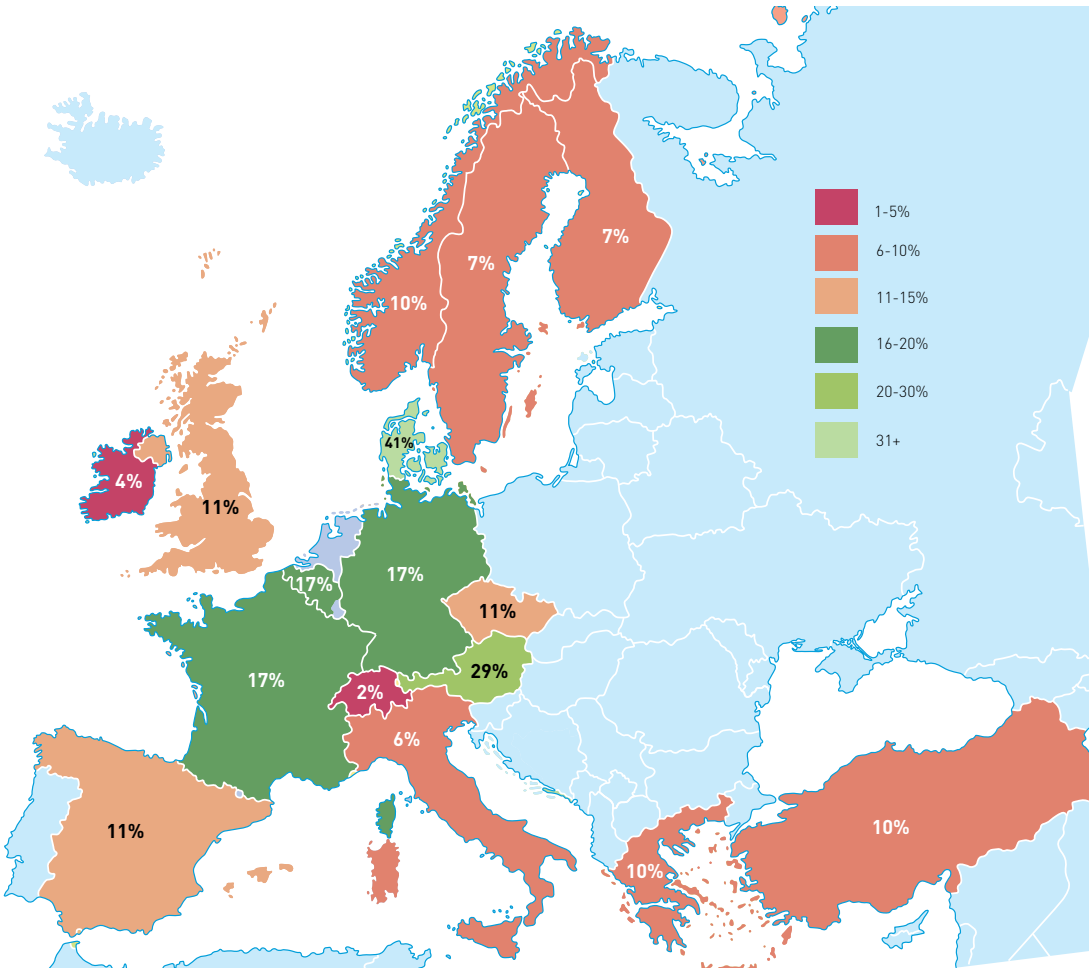

Figure 3.2: Map of the proportion of private sector research allocated to Climate Change Mitigation Technologies in European countries. **Image source:** *Pasimeni et al (2019)*[104]

3.6 Just Transition

The Council is clear that the burden of policy measures necessary to tackle the problem of climate change must be fairly distributed across the population, ensuring that those on lower incomes are not disadvantaged – in other words, that there is a 'Just Transition'.

Transitioning to a low-carbon, climate-resilient society will present many challenges, not least of which will be ensuring that policies respond to the multi-dimensional impacts of climate change in a transparent and open way that maximises the economic and social opportunities presented and is fair for all.

The transition to a low-carbon future will have consequences for households and communities, which will be either positive or negative depending on the policy responses. The challenge lies in designing, developing and implementing policies that are just, that take into account the varying incomes, savings levels and capacities across households and sectors, and build on synergies with other initiatives. This will demand that time is taken to carefully consider and deliberate on the potential impacts of policy actions and measures beyond their cost-effectiveness, and efficiency. However, a Just Transition calls for an in-depth understanding of the distributional impacts of policy actions and measures, alongside a policy development and implementation process that is inclusive and developed in a transparent and open way.

People working in the Fossil Fuel sector (e.g. peat and coal) will be adversely affected by the sharply reduced demand for fossil fuels. They will be faced with uncertainty and the prospect of unemployment. In the Irish context the focus has been on peat workers and will soon turn to the workers based at Moneypoint, a coal-fired plant. There will also be impacts on communities dependent on carbon-based industries, with those on lower incomes particularly vulnerable. Other sectors are impacted by the low-carbon climate resilient transition. In Ireland, policies in the Agriculture sector will have impacts on rural livelihoods. The costs of decarbonisation will also have distributional impacts for households and these costs must be fairly distributed across the population, ensuring that those on lower incomes are not disadvantaged. At the same time, new job opportunities will be created in the transition.

In recognition of the need to move away from peat and coal policies have been introduced to assist peat workers in their transition as peat stations close. Budget 2020 committed €6 million to a Just Transition fund for the Midlands. In addition, €5 million will be dedicated to bog restoration and rehabilitation, and €20 million for group housing upgrades in the Midlands. Beyond finance, the Government has appointed a Just Transition Commissioner, who will engage with key stakeholders in the Midlands and created a Just Transition task force. Currently, the discussion is focused on ensuring that Bord na Móna workers are supported to transition out of the peat industry. However, it is necessary to ensure that all climate change policies, not only those related directly to energy production, are designed and implemented to align with a Just Transition.

The European Union's Green Deal, which sets a target for the EU to be carbon neutral by 2050, gives prominence to the importance of the transition being just, saying that it:

> aims to protect, conserve and enhance the EU's natural capital, and protect the health and well-being of citizens from environment-related risks and impacts. At the same time, this transition must be just and inclusive. It must put people first, and pay attention to the regions, industries and workers who will face the greatest challenges. Since it will bring substantial change, active public participation and confidence in the transition is paramount if policies are to work and be accepted. A new pact is needed to bring together citizens in all their diversity, with national, regional, local authorities, civil society and industry working closely with the EU's institutions and consultative bodies.[26]

The EU Green Deal includes a proposal for the Just Transition Mechanism (JTM) that 'will provide targeted support to regions and sectors that are most affected by the transition towards the green economy'.[105] The JTM aims to mobilise €150 billion through various financial support mechanisms such as a Just Transition Fund now valued at €40 billion, a new public sector loan facility managed by the European Investment Bank, and an InvestEU 'Just Transition' scheme; transition plans; and technical assistance through a Just Transition Platform. While all Member States can avail of the JTM, the focus is primarily on regions of the EU that are fossil fuel dependent or carbon-intensive. Ireland is included in this.

A Just Transition calls for the equitable sharing of the burdens and opportunities and protecting the most disadvantaged, with responses developed in an inclusive way. The responsibility of responding to climate change is society's as a whole, not just segments. A Just Transition is inclusive by design; this is where distributional justice and procedural justice meet.

Climate policy needs to be designed with consideration of the distributional impacts for both households and employment. Central to developing policies for Just Transition is continual public participation. This may be challenging, but it is essential. Active efforts by policymakers to engage individuals and communities to understand their own particular challenges, hopes and concerns will uncover any issues that have yet to be addressed. Continuous dialogue with the public also builds trust and gives ownership of the responses to climate change. Echoing the 2020 NESC report, the process needs to apply social dialogue and to be deliberative.[106] Policy makers will need to consider who, when and how they engage individuals and communities in the process of developing viable policies. Exclusionary policies will not work, climate action is a collective effort.

3.6.1 Ireland's role in the Just Transition internationally

Achieving a Just Transition is a global challenge, and Ireland has a role in its achievement. There are primarily two aspects to this; ensuring that Ireland reduces its emissions that contribute to climate change, and supporting developing nations in their responses to climate change.

Climate finance and capacity building are the primary means by which the Irish Government can support developing nations in their response to climate change. Ireland's Policy for International Development, 'A Better World', commits to reaching 0.7% of GNI to official development assistance, with a specific focus on gender equality, reducing humanitarian need, climate action, and strengthening governance.[107] Critically there is a recognition that climate change poses a threat to progress that has been made in reducing poverty, stimulating economic growth, promoting gender equality and improving food security. To this end, an objective of Ireland's foreign policy has been to foster peace and friendly cooperation between nations, thus demonstrating the principles of a Just Transition.

Ireland reported €77 million in climate finance in 2018, up from €64 million in 2017.[108] This included contributions to the Green Climate Fund, the Least Developed Countries Fund and the Adaptation Fund, and a bilateral programme focused on nine key partner countries particularly vulnerable to the impacts of climate change: Sierra Leone, Mozambique, Malawi, Tanzania, Ethiopia, Zambia, Viet Nam, Uganda and Kenya.

3.7 A cost effective approach

The Climate Change Advisory Council is mandated to provide advice and recommendations to the Minister on the most cost-effective manner of achieving reductions in greenhouse gas emissions that will deliver the national transition objective. When examining potential measures to address climate change our first concern is that the benefits of the measure, in terms of both addressing climate change and co-benefits,[i] exceed the costs of that measure at a societal level. On the other hand, there may be additional costs to an action such as negative impacts on air quality, biodiversity etc. All the costs and benefits, both intended and unintended, need to be taken into account. The Public Spending Code, maintained by the Department of Public Expenditure and Reform, provides guidance on how to incorporate and assess different costs and benefits of action.

Unfortunately, a simple assessment that the benefits of a measure exceed the costs (that it is cost-beneficial) for society does not guarantee its implementation. Whether individual persons

i Other benefits can include health, energy savings, comfort, biodiversity and water quality, and are commonly known as co-benefits.

or businesses voluntarily implement a measure often depends more on an assessment of costs and benefits at their own individual level. Behavioural science can offer a broader perspective on individuals' awareness or recognition of costs and benefits and their response to them.

Where a measure is cost-beneficial but not implemented, government intervention is often considered important to encourage or ensure implementation. However, government resources are limited, and government is presented with a range of areas where intervention is sought. In the context of constrained resources, again, the fact that a measure is cost-beneficial at a societal level does not guarantee its implementation or government support. One tool to help government prioritise where to spend budget and resources is cost-effectiveness analysis: how much in emissions reductions can be delivered for a given cost. A common approach is to rank marginal abatement costs of different policies and measures. All else being equal, measures with the lowest marginal abatement cost should be implemented first. However, other issues must be taken into account.

Marginal abatement costs are usually calculated from a societal perspective but often neglect to consider other important issues such as transaction costs, other policy objectives or externalities and the Exchequer level cost. The distinction between societal level costs and benefits and those faced at the government level is quite important.

In its advice, the Council aims to consider both cost-effectiveness and affordability whether to individuals or to Government.

4. Progress Across the Sectors

- **Transport:** Emissions in transport remain strongly coupled with economic activity. Targets for electric vehicles will be difficult to achieve and expensive for the Exchequer. Public transport, though having many co-benefits, may not deliver emissions savings required in the short and medium terms or in rural areas. Additional options to achieve emissions reductions are required particularly in the areas of freight and rural transport. Demand management options including through spatial planning, road or congestion pricing, and potential new work practices are important.

- **Agriculture:** Absolute emissions in agriculture have increased relative to 2005. Improvements in production efficiency will not be enough to meet mitigation targets. A number of mitigation options, particularly those that relate to reducing nitrous oxide emissions, can deliver very important co-benefits in the national effort to comply with the EU Nitrates, National Emissions Ceilings, and Water Framework directives. The EU Farm to Fork strategy is an important initiative which can support and consolidate Ireland's efforts to achieve sustainable food production. The Common Agricultural Policy must be used to deliver changes in farming practices and land-use management that further Ireland's climate goals.

- **Land Use:** Low afforestation rates are undermining sectoral mitigation targets. Similarly, the management of national grasslands and peatlands continues to be a significant source of emissions. Policy innovation will be required to improve land management while maintaining public acceptance. Opportunities exist for many co-benefits from rewetting bogs and afforestation if effectively implemented, including eco-tourism, biodiversity, water quality and local amenity value.

- **Electricity Generation:** Recent years have seen significant reductions in emissions and a growing share of renewables in the supply. There is a need for an immediate and clear policy on Moneypoint and peat-fired power stations, otherwise recent gains could be reversed. Investment in the distribution and transmission networks will be important to achieve the 70% renewable generation target and enable deep decarbonisation of electricity generation. Offshore wind is a key area of opportunity.

- **Industry:** Emissions in this sector remain strongly coupled to economic activity. National climate policy in the sector is under developed and overly reliant on the EU Emissions Trading System (ETS) to deliver emissions reduction. The Climate Action Plan has identified measures aimed at SME's operating outside the ETS that can deliver emissions reductions to 2030. However, long term policies to address underlying drivers are lacking, risking increased emissions in the period beyond 2030.,

- **Built Environment**: The task to deliver a zero-carbon built environment by 2050 is huge but presents many benefits. With limited resources, prioritisation and targeting are key to achieving greatest impact and transition in the short term. Increasing the carbon tax will help deliver increased retrofit rates. Other measures will be required to support vulnerable households. The priority should be to eliminate the dirtiest fuels and to support the energy poor.

4.1 Transport

This section will concentrate on review of data. Detailed discussion of policy and mitigation options is presented in the Special Focus Chapter 7.

Transport sector emissions grew by 137% between 1990 and 2018. This emission growth is a key challenge for 2020 and 2030 targets, but also as it shows a lack of progress towards long-term low-carbon transition. Transport is the second largest emitter in Ireland, behind agriculture, at 20.2% of the national total emissions (12.2 million tonnes of carbon dioxide equivalent), and 27.1% of Effort Sharing Decision activities. There was a small decrease in emissions in 2017, after four consecutive annual increases from 2013 to 2016, but a small increase again in 2018 of 1.7% or 0.2 Mt CO_2eq. The trend in growth in transport emissions is one of the key challenges to meeting emissions reduction targets in Ireland.

Figure 4.1: Comparison of trend in greenhouse gas emissions from Transport and economic growth as indicated by Modified Domestic Demand at constant prices relative to 2005 (Index 2005=100) **Data sources:** *EPA (2020) National Emissions Inventory 2020*[2], *CSO (2020) National Accounts.*[5]

Transport emissions have broadly followed changes in the economy since 1995, with a limited decoupling of growth. As can be seen in Figure 41 and Figure 4.2 emissions grew significantly until the economic recession and growth resumed in 2013. Figure 4.2 shows the trend in Modified Domestic Demand, alongside relative change in total transport CO_2 emissions relative to 2005. It also shows the percentage change in emissions from the two largest emitters: private cars stand at 13% above 2005 levels, while freight is still 24% below 2005 levels but rising steadily.

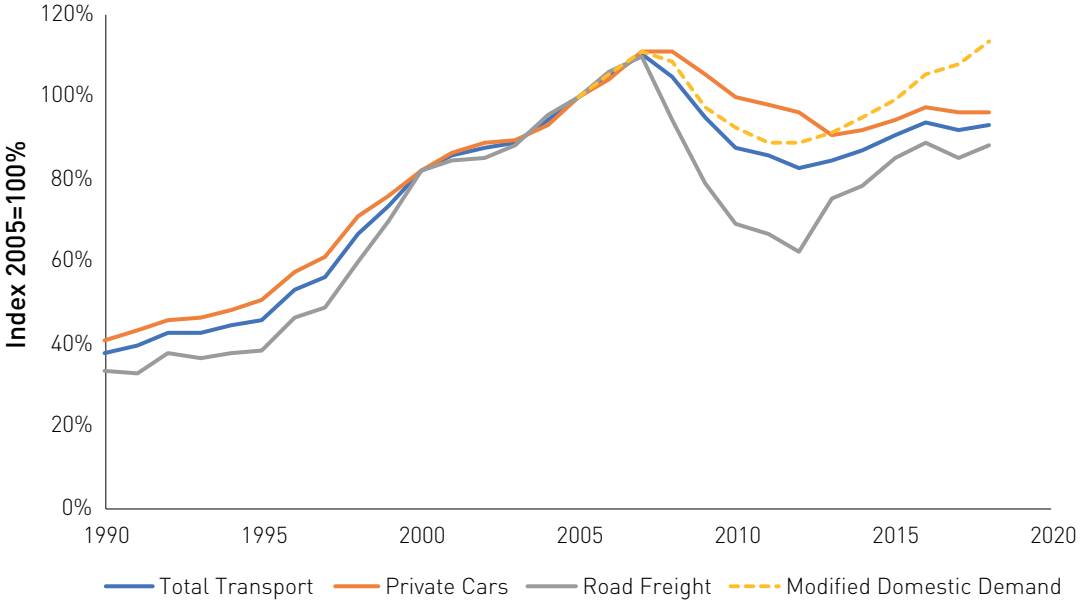

Figure 4.2: Comparison of economic growth and growth in transport emissions. **Data sources:** *SEAI (2019)*[109], *CSO (2020) National Accounts.*[5]

The energy balance sheets from SEAI report disaggregate carbon dioxide emissions across activities within the economy. Figure 4.3 shows a more detailed breakdown by mode of where Irish transport emissions occur. This highlights the dominance of the private car in transport emissions, with other significant sectors including Road Freight (lorries and trucks) and Light Goods Vehicles (vans). This pattern of the dominance of private car activity is a barrier to rapid decarbonisation of transport, as it involves changes in behaviour and choice of vehicle by a large number of owners, as has also been noted by the Department of Transport, Tourism and Sport.[110]

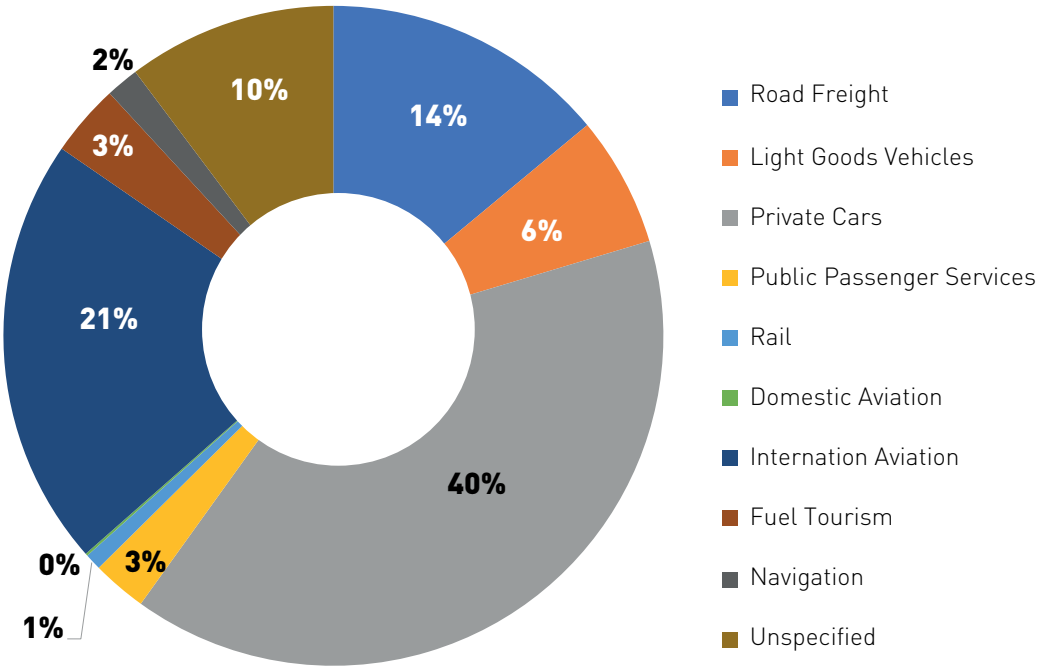

Figure 4.3: Modal shares in Irish transport carbon dioxide emissions, 2018. **Data source:** *SEAI, 2020.*[6]

Currently, either key sectoral indicators are trending in the wrong direction at a national level, or the rate of change is too slow. As well as economic growth and higher levels of activity, past policies on investment, infrastructure, urban sprawl and spatial planning have caused higher levels of emissions, air pollution and also congestion on roads that lead to major centres of employment. The Intergovernmental Panel on Climate Change has noted repeatedly that transport mitigation requires consideration not just of 'end-of-pipe' technological measures but of the fundamental development pathway, which for transport includes spatial and infrastructure patterns and choices on the priority on transport modes.[111]

4.1.1 Passenger transport

Dispersed patterns of spatial and infrastructure development implicitly increase mobility demand. This has coincided in Ireland with related long-term trends towards more private and motorised transport and declines in the active modes of walking and cycling. In comparison to other European countries, a higher proportion of public transport in Ireland is by bus rather than by rail, and rural areas have limited availability of public transport in general.

Passenger: Private car

Emissions from private passenger cars account for 50% of emissions from the Transport sector. From Figure 4.2 it can be seen that these emissions have been essentially stagnant over the past three years, despite on-going economic growth and anecdotal reports of increased congestion in urban areas. From Figure 4.4 it can be seen total traffic volumes in terms of kilometres travelled decreased in 2018, but is still high compared to the period from 2000 to 2015 and well above levels before the recession. This is indicative of improvements in the efficiency of the car fleet, which is also supported by statistics of the tax bands and emission intensity of new and second-hand car sales in Ireland. Despite these positive soundings, progress is not happening at a pace that can contribute significantly to emissions reduction targets to 2020 and 2030.

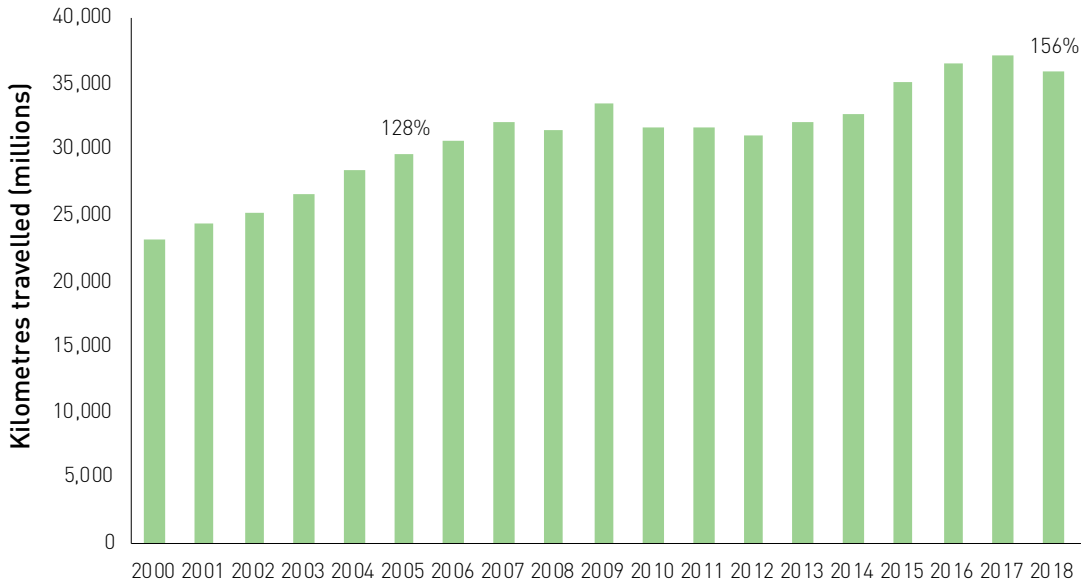

Figure 4.4: Traffic volume of passenger cars in terms of total distance travelled, 2000 to 2018. **Date source:** *CSO (2020).* [112]

The number of passenger cars on Irish roads has increased significantly in recent decades, shown in Figure 4.5. In 2018 there were approximately 2.11 million private cars compared with 1.65 million in 2005. The recession caused a small decrease in numbers, but from 2012 to 2018 the numbers increased again, albeit at a slower rate. The impact of the recession and recovery can be more clearly seen in the number of cars per thousand people, which in 2018 had reached 436, as shown in Figure 4.6. This figure remains below the typical car ownership rates in Europe, and similar to that in Denmark. Perhaps also reflecting the impact of the recession, the percentage increase in car ownership in Ireland is one of lowest in Europe, increasing just 2.4% since 2009.

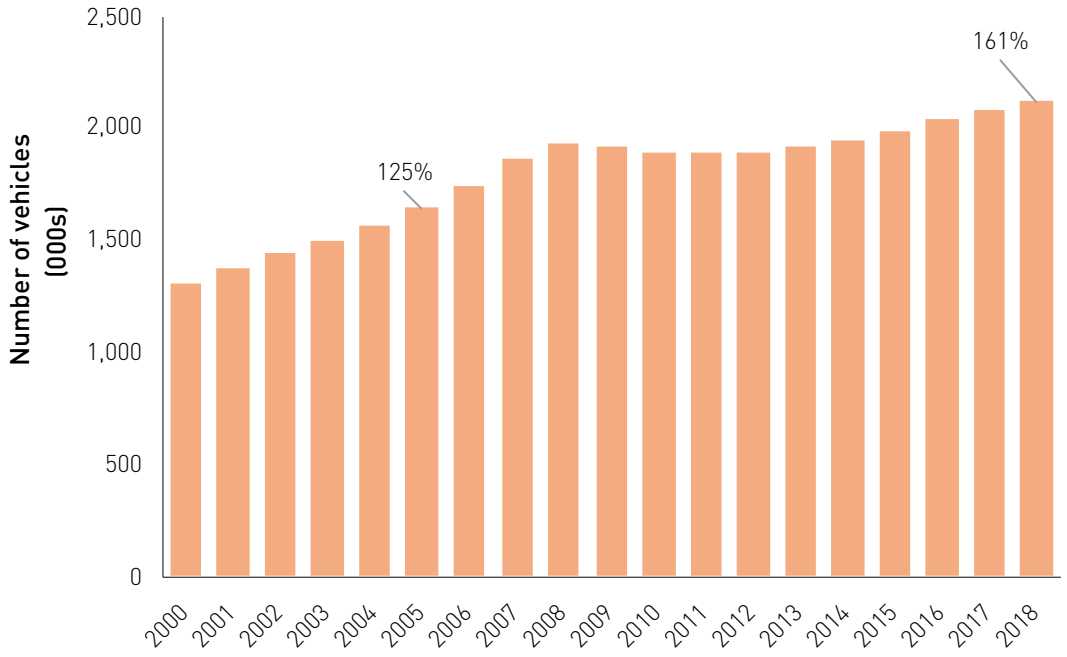

Figure 4.5: National private car fleet. **Data source**: *CSO (2019).*[113]

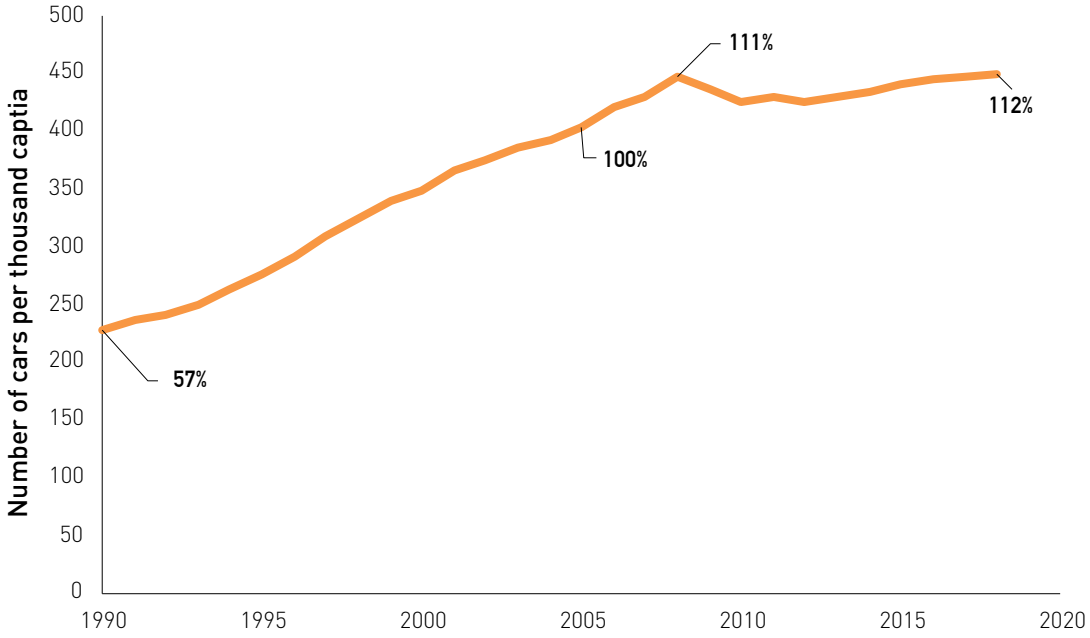

Figure 4.6: Private car ownership rate per capita. **Data source:** *CSO (2019)*[113], *CSO (2019).* [114]

The most recent National Travel Survey (2016) found that, at a national level, journey distances and durations are increasing. More than two-thirds (69.4%) of all journeys were made by car in 2016, a 0.4% growth on 2013.[115] Most car journeys were single-occupant, as the number of journeys as car passengers fell to 4.9%. The 2016 Census found nationally that 65.6% of those commuting to work travelled by car. The same data showed that just under half of commuters working in Dublin travelled by car.[116]

The Central Statistics Office new vehicle licence data show that in 2019, 4.2% of new passenger cars were zero-emissions capable, including plug-in hybrid and all-electric cars. This is up from 0.7% in 2017 and 1.6% in 2018.[117] The rate of uptake will need to continue to increase rapidly if these vehicles are to become a sizeable proportion of the national fleet by 2030.

In the period 2007 to 2019 a total of 8,844 electric cars (new and second hand) were registered in Ireland; of which 1,922 were registered in 2018.[118,119] This rapid increase in the rate of switching to electric cars continued into 2019, with 4,054 cars registered, of which 3,443 where new vehicles and 611 were second hand. However, electric cars were still only 0.34% of the total number of private cars on the road in 2019. The Climate Action Plan includes the ambition to ramp up adoption of electric vehicles, however, there are major challenges to this ambition.

Following the introduction of carbon emissions based vehicle registration tax in 2009, there was a major shift away from petrol to diesel cars, to such an extent that in 2015, 71% of all new cars were diesel and 27% petrol. Since then public perception of diesel cars and reversal of some of the incentives favouring diesel cars have led to another major shift back toward petrol, with 40% of new cars in 2019 being petrol. Nevertheless, in 2019 petrol and diesel cars represented 87% of sales, down from 98% in 2015, with hybrid models making up the difference.

Passenger: Walking and Cycling and Public Transport

The most recent National Travel Survey (2016) showed that there was little overall change from 2013 to 2016 in the shares of the more sustainable modes of transport: walking, cycling and public transport, which have stayed at approximately 22% of all journeys.[116] However, a growth in cycling and decline in walking can be seen even at the national level. The survey shows that bus use at the national level fluctuated around 4% over the same period.

The Canal Cordon Count for Dublin shows a different picture to the National Travel Survey.[120] Despite an increase in total journeys of 3%, there has been a shift from the private car to walking and cycling. From 2006 to 2018, total use of more sustainable modes of travel into Dublin city – bus, train, Luas, walking and cycling – increased from 60% to 70%, with a 1% increase between 2017 and 2018. Meanwhile the proportion of journeys across the cordon by car has decreased from 37% to 28%. The National Travel Survey 2016 shows that journey distances in Dublin decreased over the period 2013 to 2016, suggesting either that people are living closer to their work and services such as shopping and leisure or that individuals are making fewer journeys. This could be an encouraging trend.

4.1.2 Freight

Similar to passenger transport, freight is subject to spatial and infrastructural decisions that can 'lock in' emissions. Figure 4.2 shows that road freight emissions increased slightly in 2018, after a static period between 2015 and 2017, consistent with road freight traffic volumes shown in Figure 4.7. In 2018, tonne kilometres decreased by 1.9% while vehicle kilometres increased

marginally by 0.4%.[34] However, the SEAI points to the potential for significant growth of energy use in freight as economic and construction activity increases, potentially acting to drive further expansion of freight emissions.[6]

Freight activity increased in all but two sectors in 2018. The Central Statistics Office reports that from 2014 to 2018 delivery of goods to roadworks or building sites increased by 84% and of materials and fuels to factories by 33%, with an 8% decrease in 'import and export' and a 20% decrease in the 'other work' category, but all remain well below the 2007 peak.[121]

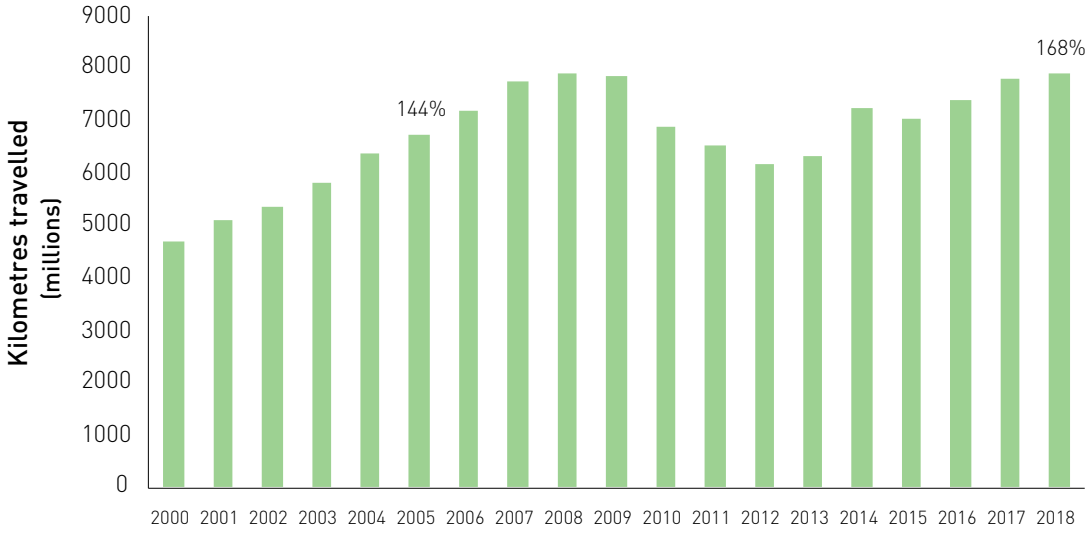

Figure 4.7: Freight traffic volumes. **Data source**: *CSO (2020).* [122]

Light goods vehicles are a significant source of emissions as per Figure 4.3 – almost half as much as their heavier cousin. This category of vehicles has only been differentiated in SEAI data since 2014, and little is known as yet about the factors influencing its development.[6]

Successive Annual Reviews have noted that rail freight transport is a minor share of total freight and has experienced a steady decline in recent decades, which leads to a shift to road. While logistical and technical efficiency improvements are evidently necessary for road freight, reducing emissions from freight requires consideration of integrated mobility, spatial, infrastructure, investment and economic planning.

4.1.3 Projections of transport emissions

As shown in Figure 4.8, greenhouse gas emissions from the Transport sector are projected to decrease by 7.6% and 32.1% by 2030 and 2040 respectively under the 'with existing measures' (WEM) scenario. Under the 'with additional measures' (WAM) scenario emissions are projected to decrease by 37.9% by 2030 and 64.0% by 2040.

The WEM scenario shows the risk of an increase in emissions in the short term before the sector 'turns the corner' towards the end of the 2020's onto a longer-term decreasing trajectory. The WAM scenario launches the economy onto a decreasing trajectory almost immediately, returning emissions from the sector to 1997s levels by 2030 and well below 1990 levels by 2040.

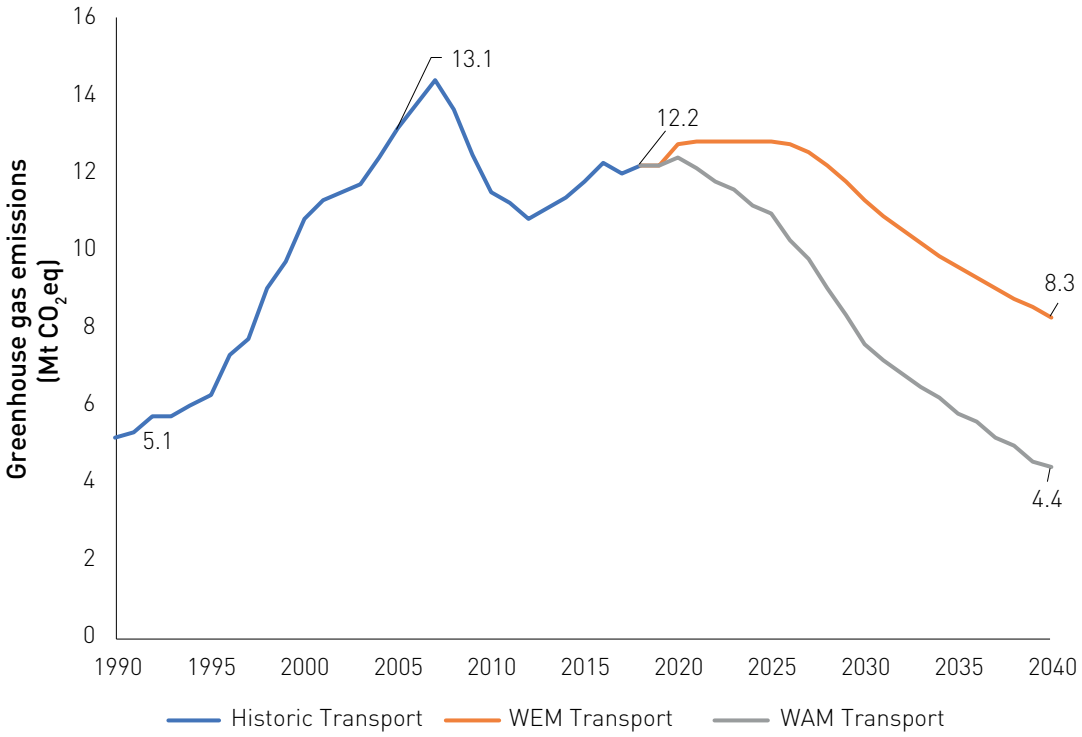

Figure 4.8: Projections of greenhouse gas emissions associated with Transport sector under "with existing measures" (WEM) and "with additional measures" (WAM) scenarios. **Data Source:** *EPA (2020) National Emissions Inventory*[2] *and Ireland's Greenhouse Gas Emissions Projections 2019–2040.*[10]

4.2 Agriculture and Land Use

Challenges exist in providing analysis and indicators of progress towards transition within the Agriculture and Land Use sector. Many of the actions undertaken to mitigate emissions and improve efficiency cannot be readily reflected in national estimates of emissions and removals. The impacts of measures and policies identified in the National Mitigation Plan and subsequent Climate Action Plan, which focus on improving production efficiency and land management, will need to be quantified for these potential emissions reductions to be assessed for their effectiveness.

In this section, analysis of historic emissions and the most recent projections are presented. In addition, the potential for deployment of land-based mitigation options at farm scale to improve carbon sequestration and farm income is outlined. Additional perspectives and opportunities for the Agriculture and Land Use sector are discussed in Chapter 6.

4.2.1 Agriculture

Agriculture continues to be the largest contributor to national emissions at 20.6 Mt CO_2eq or 34% of the total for the reporting period. An increase in greenhouse gas emissions of 1.9% or 0.38 Mt CO_2eq was recorded for the Agriculture sector in 2018. The Annual Transition Statement notes that 'the most significant drivers for the increased emissions in 2018 are higher dairy cow numbers (+2.7%) with an increase in milk production of 4.4%' (See Table 3.1).

Annual agriculture emissions increased by 14.8% relative to 2011, and 4.0% relative to the EU legislated base year of 2005 (See Figure 4.9).

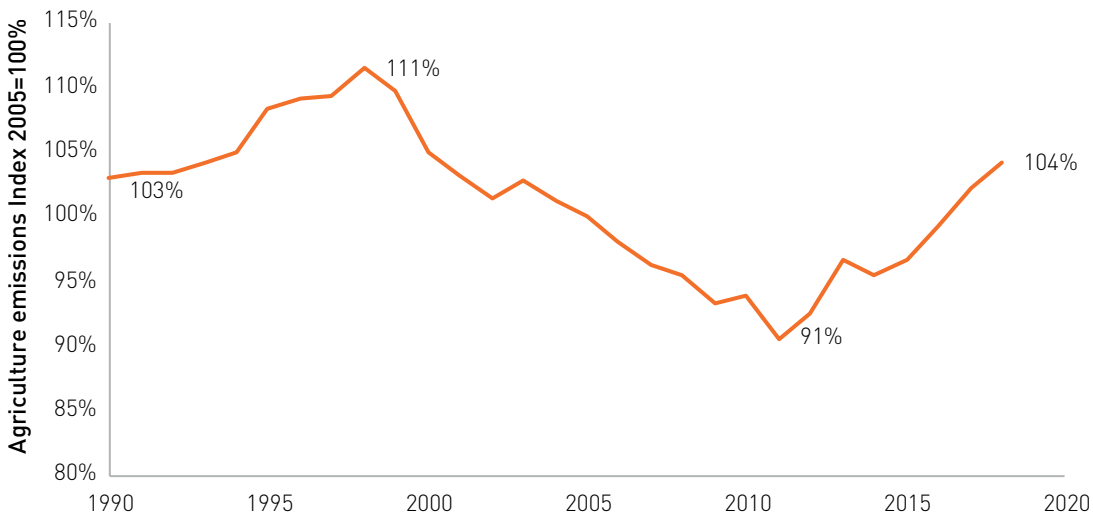

Figure 4.9: Trends in emissions from agriculture relative to 2005. **Data Source:** *EPA (2020) National Emissions Inventory.*[2]

The current national policy position (2013) sets out the long-term transition objective to achieve carbon neutrality in the Agriculture and Land Use sector. Section 2.3.3 provides a working definition of carbon neutrality in the context of agriculture and land use. Given the observed increase in agriculture emissions and ongoing carbon losses within land use, these two sectors are not on a trajectory to achieve the national policy objective.

Activity in the Agriculture sector is not strongly coupled to national macro-economic indicators such as GDP or Modified Domestic Demand, shown in Figure 4.10. Support under the Common Agricultural Policy, access to international markets and consumption trends in these markets are likely to be the main drivers of agricultural activity in Ireland.

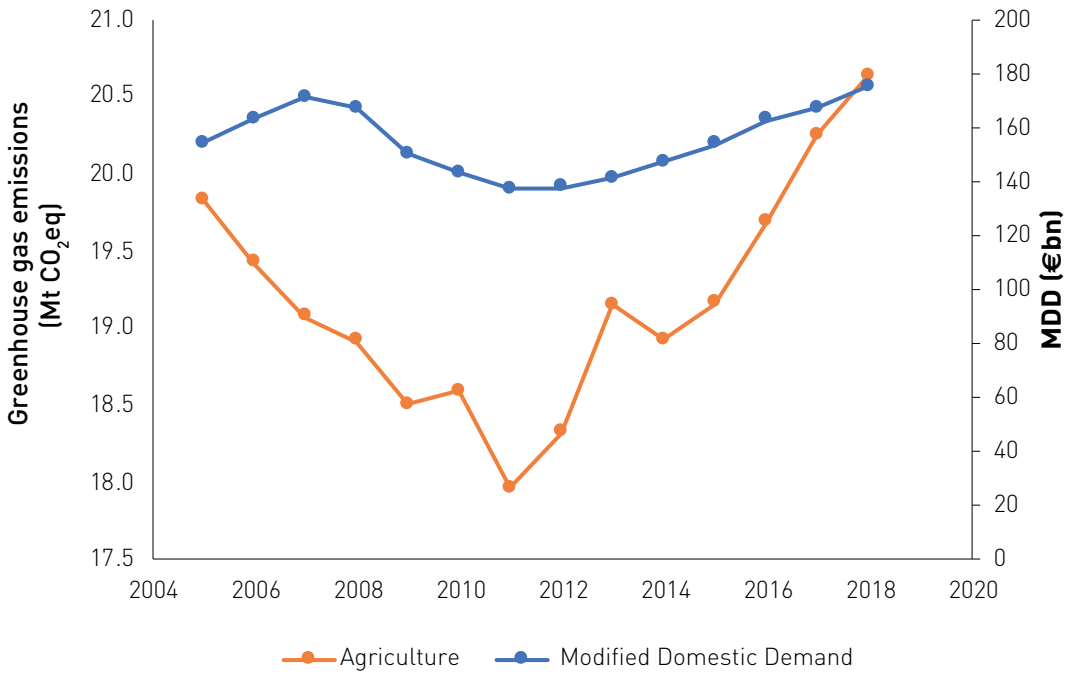

Figure 4.10: Comparison between national economic growth and greenhouse gas emissions from Agriculture. **Data Source:** *EPA (2020) National Emissions Inventory 2020*[2], *CSO (2020) National Accounts.*[123]

The Council has previously recommended to government that analysis be undertaken to establish an appropriate separate 2050 emissions reduction target for biogenic methane.[124] This reflects the Council's recognition of the IPCC's most recent consideration of the long-term impact of emissions of short lived greenhouse gases on climate and the necessary pathways for each gas to reach a 1.5C goal.[27] The Council's recommendation is particularly relevant to activities within Agriculture, as the sector is responsible for 92.6% of anthropogenic methane emissions in Ireland. Agriculture is also the dominant source of nitrous oxide emissions in Ireland (see Figure 4.11). However, given the long-lived nature of nitrous oxide in the atmosphere and its greater potential for warming, measures for mitigation of nitrous oxide emissions should be implemented as appropriate.

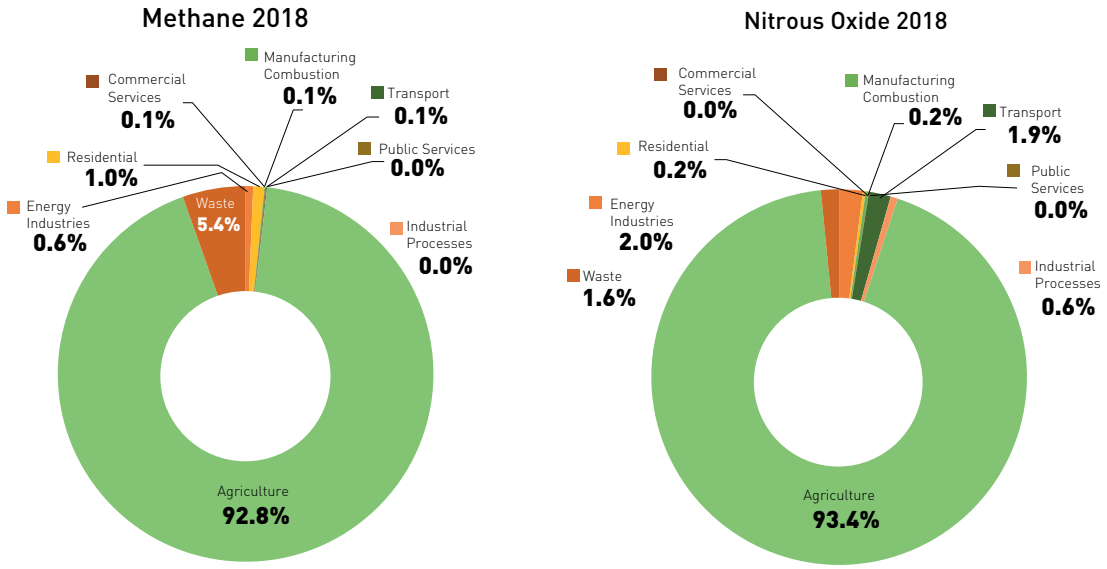

Figure 4.11: Contribution of different sectors to emissions of methane (CH_4) and nitrous oxide (N_2O) in 2018. **Data source:** *EPA (2020) National Emissions Inventory.*[2]

Under the WEM scenario, emissions are projected to increase steadily to 2040. This is largely driven by the sector continuing to take advantage of market opportunities enabled by the removal of quotas on dairy production. Emissions in Agriculture, under the WAM scenario, are projected to have reduced by approximately 9% by 2030 relative to 2005, but to slowly increase again in the period to 2040, as shown in Figure 4.12. Projections beyond 2040 are not available. The WAM scenario assumes full implementation of mitigation options identified in the Climate Action Plan, which aims to implement a suite of mitigation measures identified by Teagasc research on the marginal abatement cost curve for agriculture. The emissions reductions are due in part to a shift in the structure of the cattle herd and improved production efficiency. A projected increased use of artificial fertiliser is counter balanced by use of new, low emission, protected formulations and improved nitrogen use efficiency. These measures were discussed in detail in the Annual Review 2019.[125] It will be important to ensure the early and widespread uptake and adoption of these measures to obtain the maximum benefit from them.

External factors, including shocks to important export markets, can seriously impact output and economic viability of farm enterprises. This has not been considered in the current projections.

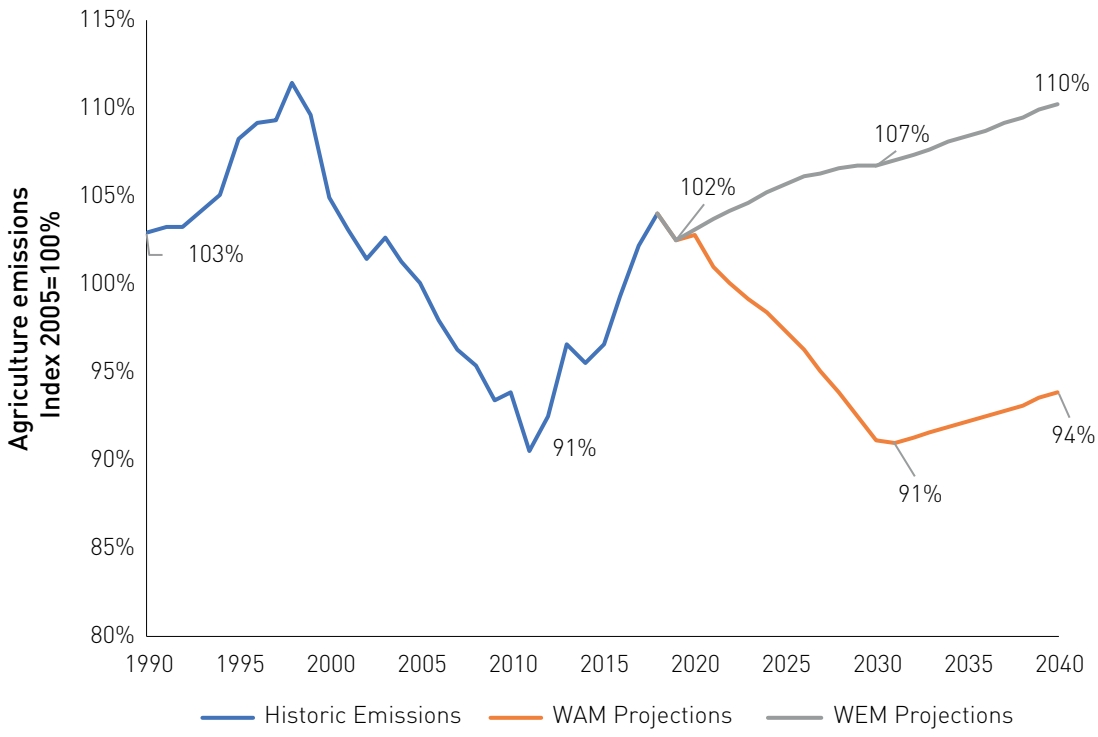

Figure 4.12: Trends in Historic, "With Existing Measures (WEM)" and "With Additional Measures, (WAM)" Projected Agriculture emissions relative to 2005. **Data source:** *EPA (2020) National Emissions Inventory*[2] *and Ireland's Greenhouse Gas Emissions Projections 2019–2040.*[10]

The observed trend in the expansion of the national dairy herd has been the major contributor to increases in agricultural emissions in recent years.Figure 4.13 shows the change in methane emissions due to cattle and sheep relative to 2005. The increase in dairy emissions is only partially offset by a decrease in non-dairy cattle and sheep numbers since 2005. The increase in dairy activity has also driven an increase in total nitrous oxide emissions, shown in Figure 4.14, associated with an increase in use of artificial fertiliser and emissions due to nitrogen excretion and manure management.

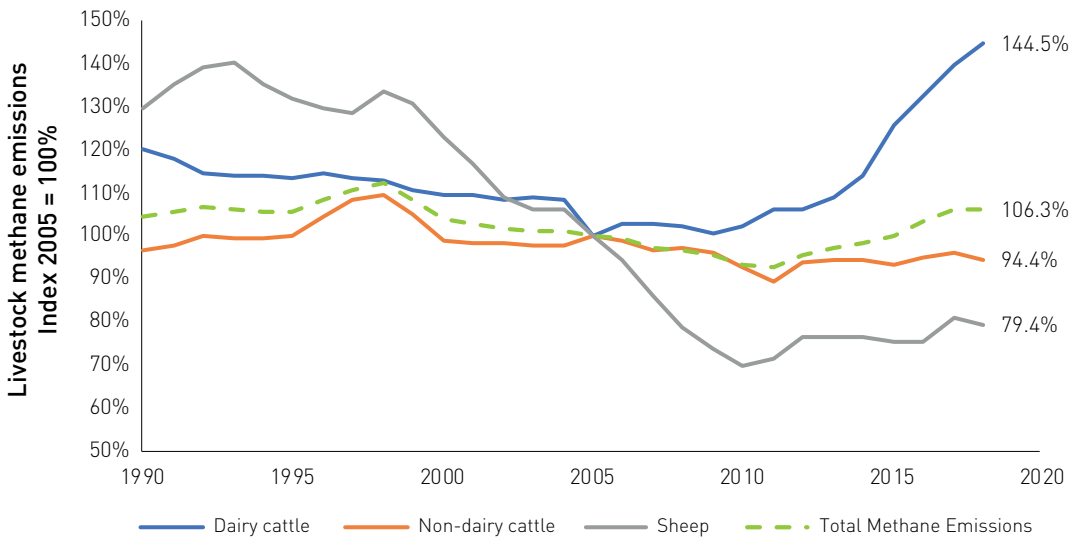

Figure 4.13: Change in methane emissions due to livestock relative to 2005. **Data source:** *EPA Common Reporting Format submission to the UNFCCC 2020*[29]

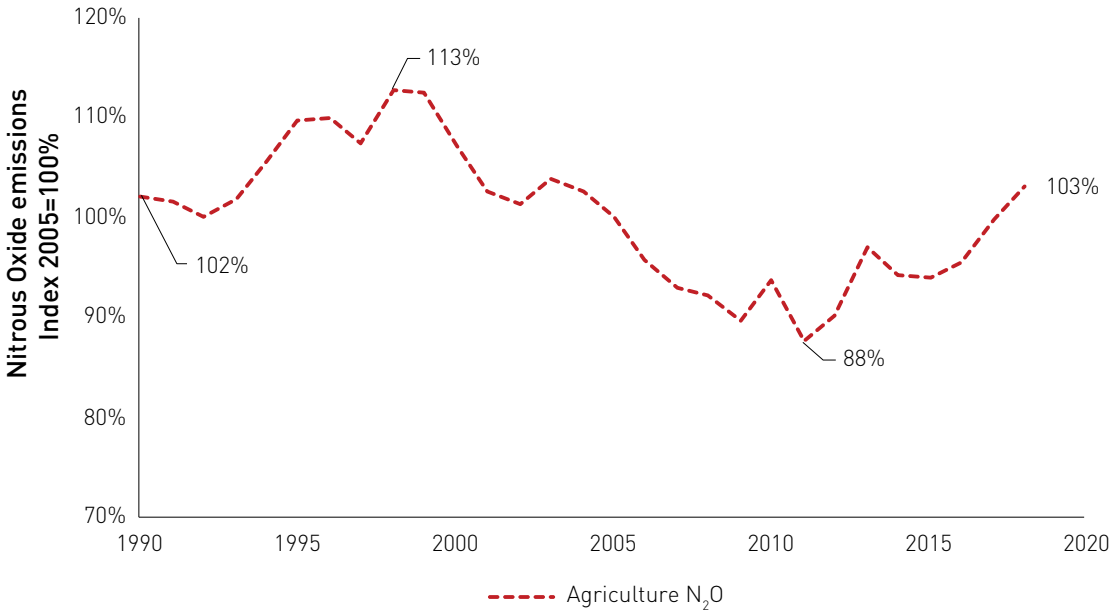

Figure 4.14: Total nitrous oxide emissions associated with Agricultural activities relative to 2005. **Data source:** *EPA (2020) National Emissions Inventory.*[2]

The total number of livestock in the country is determined by the number of breeding females, the average age of slaughter and rate and age of live export of animals. The number of dairy cows increased by 1.9% between 2017 and 2018, and a further 4.1% in 2019 (see Figure 4.15).[126] The decrease in suckler cows continues a trend that has emerged over the past decade. There has been an increase of 43% in the dairy herd since 2005. Meanwhile the number of non-dairy or suckler cows decreased by 3.5% between 2017 and 2018, and a further 2.6% in 2019. There has been a decrease in the suckler herd of 14.1% since 2005. The net impact of changes in the structure of the national herd has led to a decrease in the total herd of 1.2% between 2017 and 2018, and further modest 0.5% decrease in 2019. Nevertheless, the national herd numbers are 2.7% higher than in 2005, as shown in Figure 4.15.

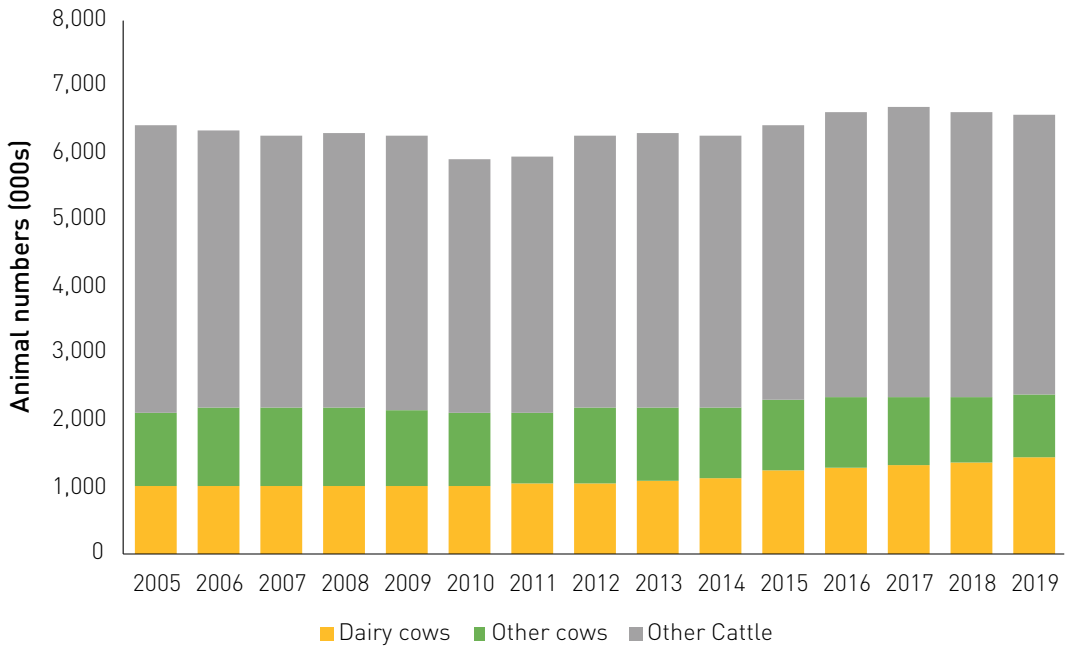

Figure 4.15: Cattle numbers in December. **Data source:** *CSO (2020) livestock numbers.*[126]

Noting that dairy cows have higher emissions per animal than suckler cows and other cattle, the modest improvements in efficiency of production documented in the Teagasc Annual Sustainability 2018 and the Origin Green Progress Report 2020 have not been sufficient to avoid an increase in absolute emissions.[127,68]

4.2.2 Land Use

Land use includes greenhouse gas emissions and removals associated with the management of all lands including grasslands, wetlands and croplands, and emissions and sinks from forest biomass and soils. The carbon embodied in durable harvested wood products is also included. The Climate Action Plan includes targets for the implementation of various measures that would reduce the loss of carbon due to agricultural land use and enhance removals of carbon from the atmosphere, particularly to forest and woody biomass. Net emissions of greenhouse gases have been largely stable since 1990, but this hides the major expansion of forest lands and significant interannual variation (see Figure 4.16). All land uses should be included in mitigation strategies. Policies and practices to maintain and enhance carbon stocks are needed as part of the overall achievement of an approach to neutrality. Based on best available knowledge, land use in Ireland is a net source of emissions, primarily due to the ongoing drainage of organic soils. Given the high costs and low returns from drainage maintenance, a potentially large area of farmed peatlands may have already reverted to a wet status. There is anecdotal evidence for this, but research is required to determine the extent of this phenomenon. This is a rapidly evolving area, for example the Drain-Map project explored the use of remote sensing technologies to examine the extent and impact of flooding events in 2015/2016 at high spatial resolution.[128] More research and monitoring is required to refine the estimates of emissions and removals across all soil types. Plans and strategies to meet national objectives to 2030 and 2050 continue to assume negative emissions from land use to offset emissions in other sectors. Urgent assessment and implementation of appropriate management options for degraded peatlands is required.

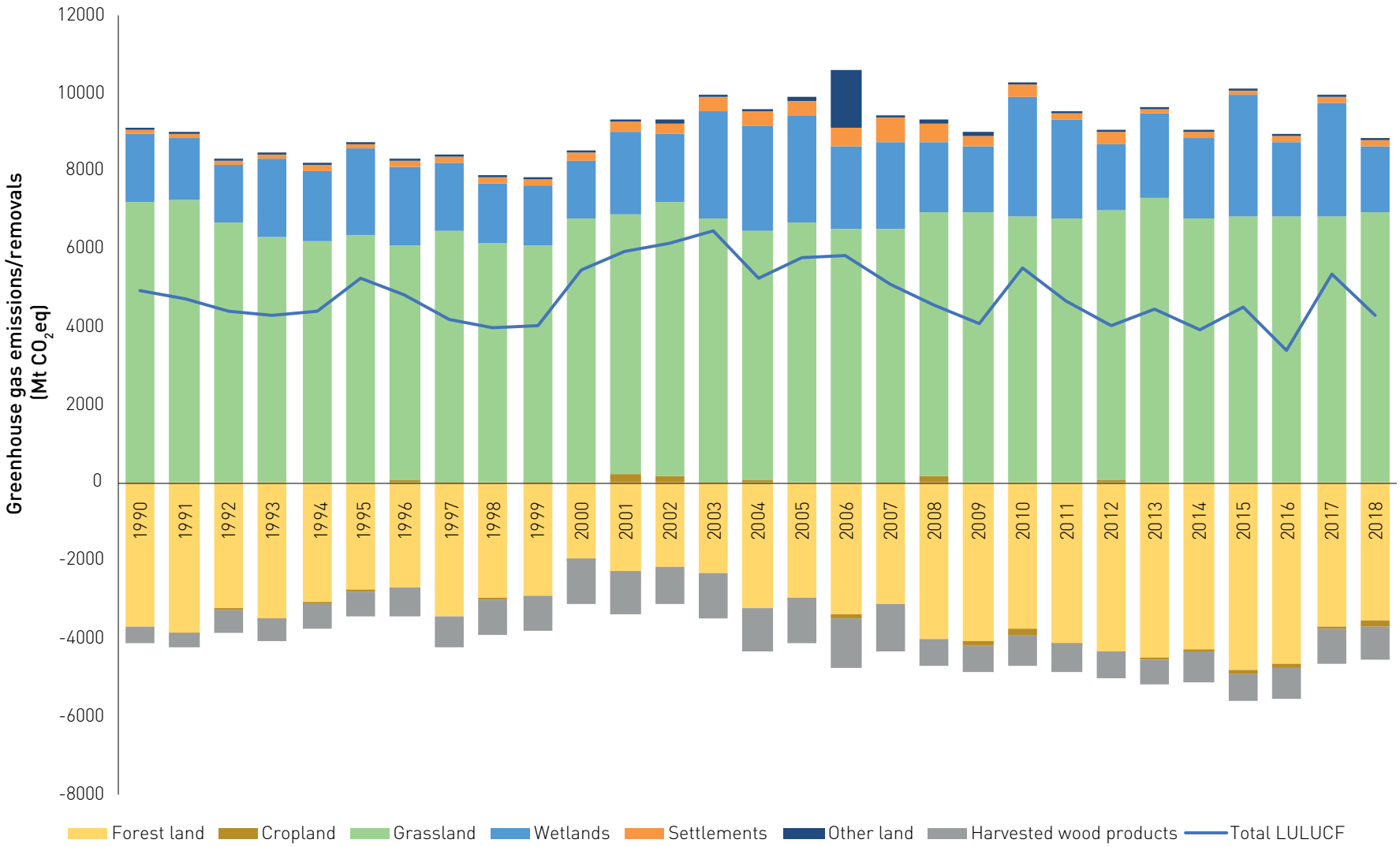

Figure 4.16: Breakdown of reported emissions and removals associated with Land Use, Land Use Change and Forestry. **Data source:** *EPA (2020) National Emissions Inventory.*[2]

Forest Land

The role of forest land is clear. National policy on forestry is largely consistent with enhancing the national carbon stocks as well as sustainable resource management. In the period 2008 to 2017, the average annual increase in forest area was 6525 hectares. In 2018, forest area increased by 4025 hectares, followed by 3,550 hectares in 2019.[129] This low rate of afforestation is significantly less than that required to achieve the long-term objective of 18% national coverage by mid-century. It also falls far short of the rate of afforestation identified in the Climate Action Plan.

Reversing the recent declines in afforestation rates is a priority for policy action. Many aspects of the national transition objective are contingent on an expanded and sustainable domestic Forestry sector.

Policies implemented to achieve mitigation may have social implications that need to be addressed for a Just Transition. Engagement with all relevant stakeholders will be important to ensure that the farming community benefits from the necessary changes in land use. Current estimates of the change in carbon stocks on agricultural soils indicate a large net source of emissions due to the drainage of peat for use as grazing land.

Peatlands

Activities on non-agricultural peatlands continue to be a major source of greenhouse gas emissions, with a steady increase in drained organic soils reported (see Table 3.1). The increase is largely driven by ongoing peat extraction for domestic heat, electricity generation and horticultural use, and drainage to enable grazing and forestry activities. The reported increase in drained areas has occurred despite successful rewetting and restoration activities on specific sites. Policies and incentives to enable better management of organic soils across all land-use types are required. A large proportion of the land managed for peat extraction is in state ownership. The state can provide leadership in improved management of this resource.

The earmarking of revenues from the increase in the carbon tax to fund rewetting and restoration of degraded peatlands, including those previously used for peat extraction noted earlier, will provide much of the incentive for these actions. In addition, the Climate Action Plan includes measures to incentivise improved management of drained organic soils currently managed as low-intensity pastures.

The large reported emissions from biomass burning in 2017, and similar levels in 2010 and 2003, highlight the need for renewed efforts to enable more effective and sustainable management practices on vulnerable lands.

There is a clear need to move land management to a more sustainable pathway. This must also address emerging demands from the bio-economy and renewable energy, as well as more conventional demands on land such as agriculture, forestry, built environment, and habitat and ecosystem services. There has been a tendency towards fragmentation in development of policy, particularly as it relates to increased demand for land for energy and other resources/services: for example the significant demand for biomass and installation of solar farms, much of which has been developer, rather than policy, led.

Existing Environmental Programmes within the Agriculture and Land Use sector

A number of programmes provide supports and incentives to farmers and other landowners to enable beneficial environmental outcomes and sustainable management practices.

The Beef Data and Genomics Programme (BDGP) was launched in May 2015, with the aim of delivering accelerated genetic improvement in the quality of the beef herd and associated climate benefits. Measures included completion of the Carbon Navigator (Teagasc), genetic profiling of the herd, and actions over time to improve the genetic merit of the herd through selective replacement with animals with lower greenhouse gas emissions. Over 23,000 participants have signed up to a six-year contract to implement measures under the programme. [130]

The 2017 evaluation of the Rural Development Programme found that participation in the BDGP is beginning to improve herd fertility, but it remains at an early stage of development. It is too early in the reporting phase of the BDGP to analyse whether actions under the Carbon Navigator, such as a longer grazing season, have been implemented.

The most recent review of Ireland's Rural Development Programme 2014–2020 will provide support of €3.8 billion for agri-environmental and climate change objectives (see Table 4.1). [131] The annual EU and Government supports to agri-environment schemes, forestry, biofuels and the BDGP are presented in Table 4.2. Although much of the spending under these headings is not directly aimed at climate mitigation or adaptation, co-benefits are often realised. For example, support for new hedgerow planting is primarily aimed at addressing biodiversity and heritage issues, but new hedgerows are also effective at carbon sequestration to biomass and soils.

An evaluation of the Green, Low-Carbon, Agri-Environment Scheme (GLAS) published in 2016 found a very limited number of studies that monitored and analysed the scheme with respect to its impact on climate mitigation and adaptation.[132,133] The review also presented a template for the development of monitoring and modelling capacity to enable necessary evaluation of the GLAS.[134] On the basis of this review, robust indicators of the impacts of measures supported under the scheme can be developed. Figure 4.17 shows the average breakdown of support payments at farm scale

Table 4.1: Total expected expenditure on Agri-Environment-Climate measures in Ireland's Rural Development Programme 2014-2020.

Measure	Submeasure	Total Expected Spend (million euros)
M1: Knowledge Transfer and Information Action	Knowledge Transfer Groups	69.00
	Training in support of GLAS	12.00
	BDGP Training	10.70
M4: Investment in Physical Assets	TAMS II	387.99
	TAMS I (transitional)	7.38
	AEOS (transitional)	15.77
M10: Agri-environment-climate	GLAS	1,082.66
	Burren Programme	12.86
	REPS/AEOS/OFS Trans.	315.5
	BGDP	271.72
M11: Organic Farming	Organic farming scheme	65.76
M12: Natura 2000 and WFD	Old Natura AEOS / REPS (transitional)	46.74
M13: Payments to areas facing natural or other specific constraints	ANC	1,492.80
Total (million euros)		**3,790.88**
Data source: Extract from Indecon Mid-Term Evaluation of the Rural Development Programme Ireland (2014-2020).[131]		

Table 4.2: Supports provided to enable environmentally sustainable agriculture, forestry and biofuels.

Activity	Spending (million euros)			
	2015	2016	2017	2018
Rural Environment Protection Schemes (REPS, AEOS and GLAS)	131	148	221	246
Forestry and Bio-fuels	104.2	103.8	102	95
Beef Data Genomics Programme	34.7	62	45	47
Data Source: DAFM Annual Review and Outlook 2019[135]				

In the box below, the mitigation potential and impact on farm income of land use change on livestock systems is explored based on the approach developed by Duffy et al., 2020.[136]

Cost negative options for Afforestation and Woodlands on Farms

Rates of Afforestation remain low as does the engagement of dairy and other farm enterprises on mitigation (especially agri-Environment schemes). A recent paper (Duffy, 2020) highlights multiple ways in which land use change from livestock farming to forestry can contribute to the mitigation of greenhouse gas emissions. The analysis illustrates the carbon sequestration potential of afforestation based on soil type and yield class, and also typical impact on emissions due to the reduction in the number of livestock, based on typical stocking rate, and in nitrogen usage again cross-referenced to soil type. In general, there is clear economic benefit for many beef farmers in reducing the number of animals (where direct payments accounted for 158% of family farm income in 2018), yielding a modest €270 to €391 per hectare.

Table 4.3: Estimate of income per hectare on various farm enterprises

Average Family Farm Income per hectare						
Farm type	**2015**	**2016**	**2017**	**2018**	**2019**	**Average**
Dairy	€1112	€928	€1529	€1047	€1132	€1150
Cattle rearing	€329	€352	€354	€270	€288	€319
Cattle other	€424	€457	€461	€391	€384	€423
Sheep	€323	€307	€323	€276	€310	€308
Tillage	€546	€457	€617	€675	€568	€573
All	€578	€520	€693	€541	€555	€577
Extract from Teagasc National Farm Survey 2015, 2016, 2017, 2018 and 2019.						

Modest sub-farm scale afforestation scenario

Consider the income, payments, costs and emissions reduction associated with afforestation of five hectares. Analysis based on a simplification of the approach outlined in Duffy et al., 2020.

	Dairy	Rearing	Other Cattle	Sheep
Family farm income (FFI)	€61,446	€8,310	€14,560	€13,297
Direct payments	€21,022	€13,098	€16,226	€18,980
Average number livestock (LU)	75	35	50	127
LU per ha	2.05	1.14	1.35	1.1
Production income	€40,424	-€4,788	-€1,666	-€5,683
Production income per LU	€539	-€136.80	-€33.32	-€44.75
Plantation of five hectare of Broadleaf forest				
Reduced LU capacity	10.25	5.7	6.75	5.5
Loss/Gain in production income	-€5,525	€780	€225	€246
Forest premium payment	€2,875	€2,875	€2,875	€2,875
Change in FFI	-€2,650	€3,655	€3,100	€3,121
FFI with Afforestation	€58,796	€11,965	€17,660	€16,418
% change in FFI	-4.3%	44.0%	21.3%	23.5%
Reduction in Emissions (t CO_2eq)	32.7	8.1	9.6	4.3
Abatement cost (to Farm income) €/tCO_2eq	€81	-€452	-€324	-€734
Data Sources: Teagasc NFS 2018, EPA Inventory 2020, DAFM Forest Service				

This simplified analysis has not taken into consideration the sequestration of carbon to forest biomass, or the income return to the farm from harvesting and thinning. Nevertheless, there is clear advantage to non-dairy livestock farmers to consider afforestation within existing activities.

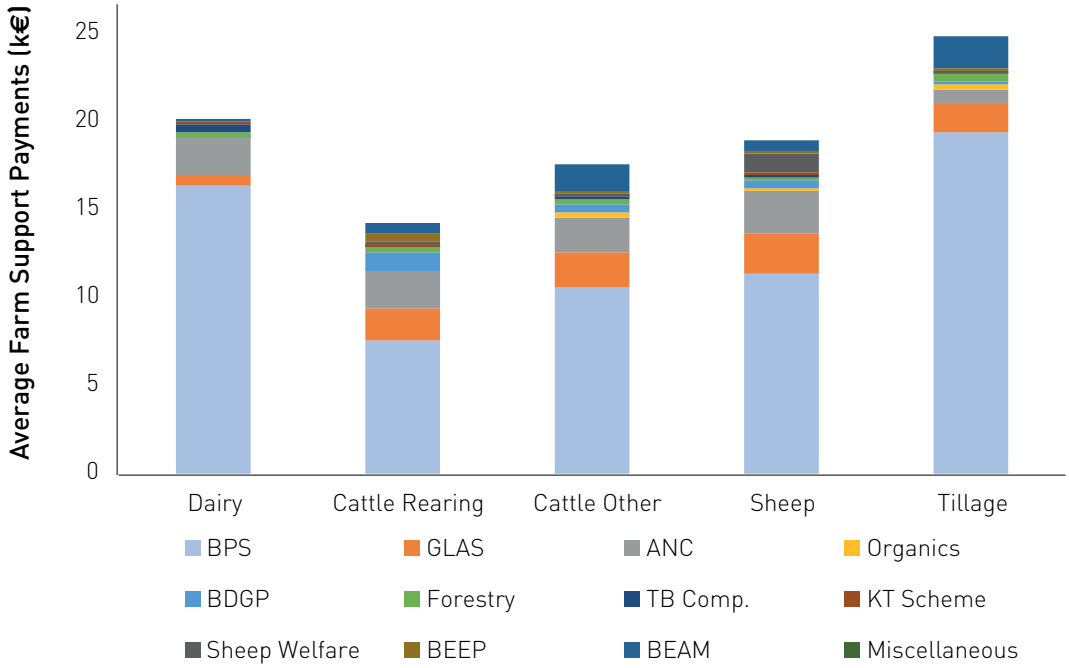

Figure 4.17: Breakdown of average Common Agricultural Policy and other direct payments to farmers.
Data source: *Teagasc National Farm Survey 2019 Preliminary Results.* [137]

4.3 Electricity Generation

The decarbonisation of electricity is of fundamental importance for a sustainable transition. The carbon intensity of electricity generation is a primary determinant of economy-wide decarbonisation, while prominent decarbonisation options for heat and transport are facilitated through electrification. This section will outline Ireland's progress towards a decarbonised Electricity sector.

4.3.1 General trends

Emissions from electricity generation in 2018 decreased by about 11.7% relative to 2017 levels. Electricity consumption in Ireland increased by 2.8% to 31 terawatt hours (TWh) between 2017 and 2018. Total consumption of electricity in Ireland has more than doubled since 1990, peaking in 2008. The recession saw a decrease in consumption; however, levels are approaching those seen at the peak. The contribution of renewable electricity to gross electricity consumption increased from 29.6% in 2017 to 33% in 2018.[6]

The emissions intensity of electricity generation (grams of carbon dioxide per kilowatt hour, (g CO_2/kWh) has fallen by around 46% since 1990. In 2018, carbon intensity of electricity generation fell from 437 to 377 g CO_2/kWh (see Table 3.1).

The falling carbon intensity of Ireland's electricity mix is primarily driven by two important trends. First, coal has fallen as a share of total generation. In 2019, coal comprised 2% of Ireland's fuel mix, down from almost 16.9% in 2015.[138] The observed trend from 2016–2018 is primarily driven by a stronger EU ETS carbon price, driving coal out of the 'merit order' and being replaced by gas-fired generation. Also, for much of this time, Moneypoint was not in operation due to maintenance work and its presence on the grid has continued to remain low into 2020, further contributing to declining emissions intensity.

There is concern that Moneypoint may recommence full operation and continue to contribute to Ireland's electricity supply well into the decade. The National Development Plan 2018–2027 states a commitment to close Moneypoint by 2025, though an operational decision has yet to be made.[34] The Council has previously called for certainty with respect to the future of Moneypoint, including a decision on its replacement with alternative low-carbon capacity to ensure grid stability during the shutdown process.

This policy commitment to shut down Moneypoint is particularly important as the adequacy of market signals to create the appropriate financial incentive is uncertain. An adequate carbon price would ensure coal stays out of Ireland's electricity generation mix. Without this carbon price, an explicit policy commitment to shut down Moneypoint is required. The Council's previous recommendations to support any proposals at an EU level to supplement EU ETS prices through a carbon price floor should be noted in this respect.

Peat generation is currently being phased out, further contributing to the falling carbon intensity of Ireland's electricity generation. In 2018 Bord na Móna (BnM) reduced its peat harvesting operations from 18,000 ha to 10,000 ha, with an eventual cessation of peat supply to the West Offaly and Lough Ree plants in due course.[139] A recent decision by An Bord Pleanála refused permission to convert the West Offaly Peat station to biomass.[140] An agreement was made to keep the West Offaly and Lough Ree plants open to the end of 2020. More recently, BnM announced the cessation of peat extraction on a number of additional sites and the plan to reallocate employees to peatland rehabilitation and other activities supported by government funding.[141] BnM also indicated it will achieve 100% renewable energy generation by 2024, which is an acceleration of its previous timeline of 2028.[142]

Ireland has seen growth in the installation of onshore wind. Wind's contribution towards meeting Irish electricity generation grew from 22% in 2015 to 32% in 2019 (see Table 4.4).[138] Biomass and non-renewable waste together represents a small but increasing share of Ireland's renewable electricity.

4.3.2 Policy drivers

The Climate Action Plan 2019 articulated the ambition to increase reliance on renewables for electricity generation from current levels of approximately 30% to 70% by 2030, adding 12 GW of renewable capacity onto the grid. The level of ambition will require ESB Networks and EirGrid to coordinate and plan network development and deliver on connecting renewable energy sources. It will also require accelerated deployment of onshore and offshore wind generation capacity, as well as the onshore infrastructure and industry service supply support. Nevertheless, there is considerable optimism in the sector that the target is achievable. Recent analysis from the ESRI advocates technology-neutral climate policy.[75]

A high EU ETS price drives the substitution from emissions-intensive coal to less emissions-intensive gas generation, while also incentivising investment in renewables. This is the most efficient way to decarbonise electricity.

A carbon price should also drive investment in wind generation. While solving the emissions 'externality' it does not solve a second externality – risk mitigation. Wind developers cannot hedge their investment risks to the same extent as fossil fuel generators. This is because revenues are determined by the coincidence of weather conditions and favourable market prices: two uncertain

variables that cannot be predicted in advance. Price guarantees provide a hedge; investors no longer need to predict the coincidence of two variables but just the expected output of their turbine, which is very predictable over 15 years.

The Renewable Energy Support Scheme (RESS) provides a price support which acts to hedge risk. Using the RESS to substitute for an inadequate EU ETS imposes additional cost and risk to Irish consumers. The RESS incentivises investment by transferring risk from investors to consumers. If prices fall, consumers face the risk of a higher PSO levy on their electricity bills. The risk of falling electricity prices due to falling demand is a greater risk post-COVID pandemic. Farrell et al., 2017 and Devine and Farrell 2017 show that price supports can be designed to more fairly share this risk burden between investors and consumers.[143,144]

Reducing investor risk exposure can increase the pace of renewables deployment but policy should be careful not to give investors windfall profits and overburden the electricity consumer in the process. If the EU ETS carbon taxes were sufficiently high, the RESS would no longer be required to provide financial support and would exist only to hedge risk for investors.

Table 4.4: Ireland's Electricity Fuel Mix as Percentage of Demand - Calendar Year Figures. **Data source:** *EirGrid (2020).*[138]

	2015		2016		2017		2018		2019	
Fuel	**GWh**	**%**	**GWh**	**%**	**GWh**	**%**	**GWh**	**%**	**GWh**	**%**
Coal	4874	16.9%	4696	15.9%	3645	12.2%	2152	7.0%	578	2.0%
Oil	407	1.4%	293	1.0%	142	0.5%	139	0.5%	131	0.4%
Peat	2518	8.8%	2318	7.9%	2164	7.2%	2,095	6.8%	2106	7.2%
Gas	12,367	43.0%	15,328	51.9%	15,680	52.3%	16,014	51.9%	14,816	50.7%
Wind	6573	22.8%	6147	20.8%	7444	24.8%	8640	28.0%	9354	32.0%
Hydro	806	2.8%	681	2.3%	692	2.3%	694	2.2%	878	3.0%
Other renewables	482	1.7%	685	2.3%	746	2.5%	861	2.8%	212	0.7%
Other non–renewables	74	0.3%	73	0.2%	159	0.5%	302	1.0%	519	1.8%
Net imports	673	2.3%	–712	–2.4%	–679	–2.3%	–28	–0.1%	645	2.2%
Total demand	**28,775.89**	**100.0%**	**29,509.26**	**100.0%**	**29,993.15**	**100.0%**	**30,868.49**	**100.0%**	**29,237.96**	**100.0%**
Renewables	7861.48	27.3%	7513.44	25.5%	8881.69	29.6%	10,194.57	33.0%	10,443.44	35.7%

4.3.3 Community-level energy

The Renewable Energy Support Scheme (RESS) provides supports for the development of renewables and to ensure that people and communities living adjacent to proposed installations are consulted and involved in the process. Plans are currently under development by the Sustainable Energy Authority of Ireland (SEAI) to increase individual and community engagement through distributed micro-generation of electricity. This is a step in the right direction in terms of effectively engaging with communities on these issues. All these activities are crucial in increasing the pace of installation of renewables.

The National Development Plan[34] recognises the role of investment in renewable energy, ongoing capacity renewal and new technology in decarbonising electricity generation. It signals that investment in renewables must be accompanied by (1) energy efficiency measures that reduce demand, (2) diversification of energy sources, (3) greater interconnection to international energy networks, (4) electricity storage, and (5) the roll-out and utilisation of smart meters. Complementing the investment in renewables in this manner will increase capacity to electrify heat and transport in the future.

The National Planning Framework[35] also supports the shift towards renewable electricity generation, highlighting the importance of the forthcoming Renewable Electricity Policy and Development Framework, the development of Wind Energy Guidelines and the Renewable Energy Development Plan.

4.3.4 Demand-side measures

The Budget for 2020 has allocated €146 million for the energy programme, an increase of €29 million from 2019.[89] The budget will be used for energy efficiency upgrades, deep retrofits and the development of innovative technologies to support the transition to a low-carbon economy and society. It is anticipated that this will upgrade 24,000 homes and businesses. To facilitate this a new retrofitting model will be implemented to enable the upgrade of groups of houses.

The Annual Transition Statement 2019 did not identify any new policies or measures in relation to this sector.[47] While there are welcome developments in progress in this area, some will need further work to move from aspiration to implementation, namely the assessment of the cost per tonne of CO_2 abated to inform prioritisation of actions.

4.4 Industry

The Industry sector combines two source categories as classified by the EPA. These are the Manufacturing Combustion sector, which considers emissions associated with the industrial use of fossil fuels for heating and Industrial Processes which considers emissions of greenhouse gases during processing and manufacturing not directly associated with fossil fuel use. Industry emissions grew by 1.2% in 2018 to 8.1 Mt CO_2eq, or 13.5% of total national emissions. Emissions in the national inventory chiefly arise from the combustion of fossil fuels for the heat required in the manufacture of goods (57.4% of industry emissions). In addition, there are industrial 'process' emissions. The key emissions category in Industry is the mineral industry, which released 90.4% of industry process emissions in 2018, dominated by cement production, as carbon dioxide is given off while lime is produced in cement kilns.

Figure 4.18 shows the trends in greenhouse gas emissions from the sector and the split between those covered under the Emissions Trading System (ETS) and the Effort Sharing Decision. In 2018,

80% of Industry emissions fell under the ETS, up from 76% in 2005. The remainder of emissions came from predominantly smaller manufacturing industries that were below the thresholds to be included in the ETS. This section considers the historical change in emissions, but also what is driving the observed changes and the policy levers available to reduce emissions.

The major policy instrument for Industry is the EU ETS. This scheme is envisaged as the most cost-effective approach to reducing industry emissions across the EU. There have been challenges to this scheme as the price has remained too low to adequately incentivise change. The historical record shows that most of the change in Irish emissions under this system has occurred in power generation, attributable to energy policy rather than the carbon price. Phase 4 of the EU scheme will try to address this to achieve the EU's 2030 emission reduction targets in line with the 2030 climate and energy policy framework and as part of the EU's contribution to the 2015 Paris Agreement. Previously, the Council has recommended that the Irish Government consider a carbon price floor for power generation that puts a limit on how far the market price of carbon can fall, retaining a price signal that incentivises emissions reduction in circumstances where the carbon price is falling.

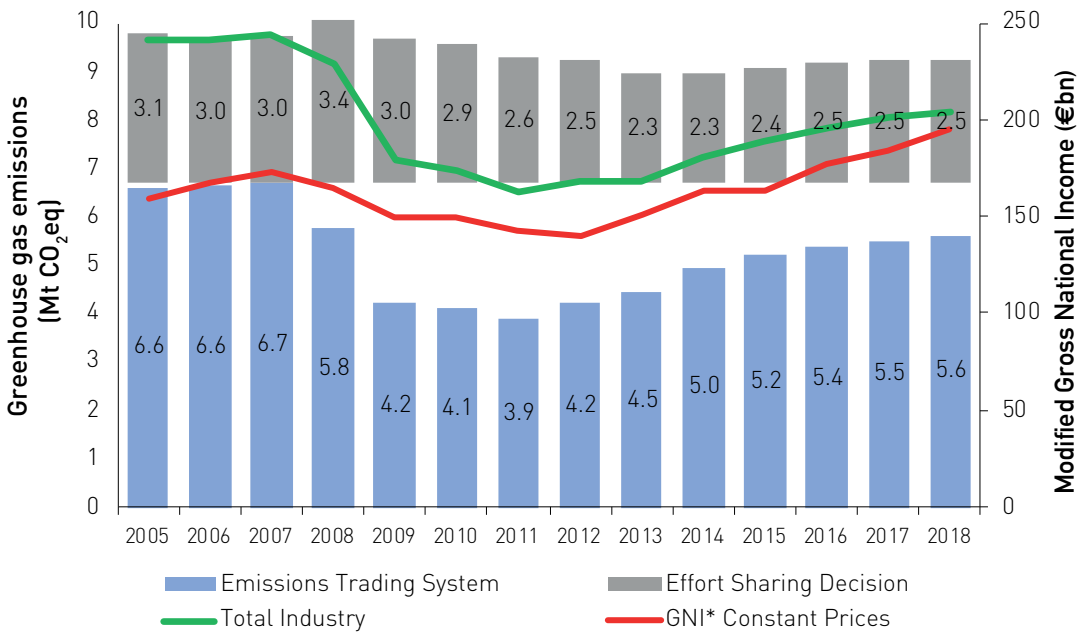

Figure 4.18: Breakdown of Industrial emissions between Emissions Trading System and the Effort Sharing Decision for the period from 2005 and 2018, and a comparison with Modified Gross National Income at constant prices. **Data Sources**: *EPA (2020) National Emissions Inventory 2020*[2], *CSO (2020) National Accounts.*[5]

From Figure 4.18 it is also evident that there is a strong relationship between economic growth, as reflected in modified domestic demand, and greenhouse gas emissions from the sector. It is interesting to note the pattern of recovery, as the country emerged from recession, is somewhat different for the emissions within the ETS compared to those under the Effort Sharing Decision. Emissions within the ETS fell sharply in 2008, with the onset of the financial crisis and the movement from the pilot first phase of the EU ETS to the fully operational second phase. Emissions gradually increased from 2012 onwards. As of 2018 emissions had not returned to pre-recession levels. Emissions covered by EU Effort Sharing Decision declined more slowly

during the recession and were at a peak in 2008, the first year of the financial crisis, reaching a minimum in 2014 and gradually increasing thereafter.

Total emissions from Manufacturing Combustion and Industry Processes are projected to increase under the WEM scenario in the period to 2030, but to decrease in the WAM scenario (see Figure 4.19). Although the WAM scenario sees emissions fall below 2005 levels by 2030, both scenarios see emissions on an upward trajectory by 2040. Much of the activity within the sector operates within the ETS and is projected to have increased by 3% above the 2005 baseline by 2030, increasing further to 34% by 2040. Emissions not covered under the ETS are projected to decrease by approximately 27% by 2030 relative to 2005, but to have lost ground by 2040 to just 15% below the 2005 levels (see Figure 4.20).

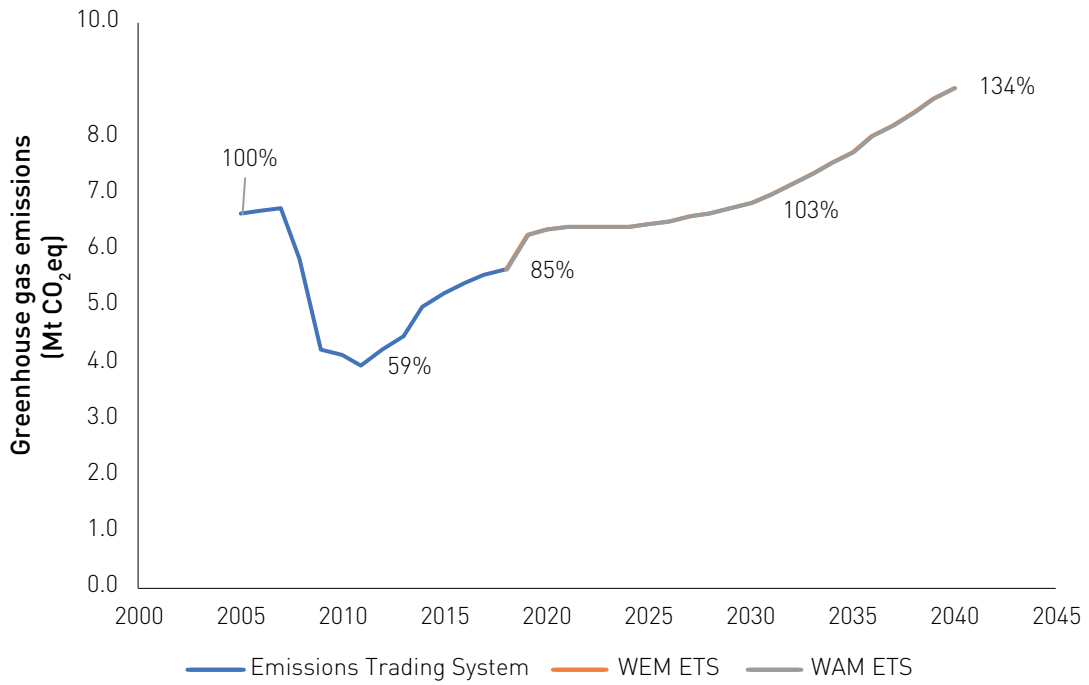

Figure 4.19: Historic and Projected Industry emissions for ETS activities **Data source:** *EPA (2020) National Emissions Inventory*[2] *and Ireland's Greenhouse Gas Emissions Projections 2019–2040.*[10]

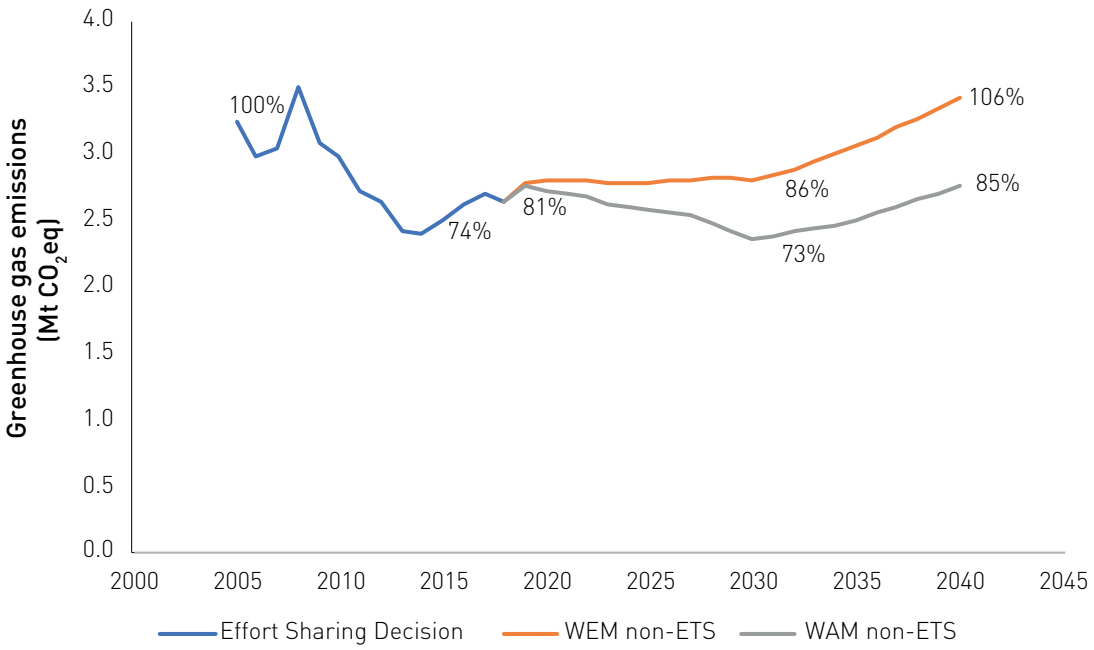

Figure 4.20: Historic and Projected Industry emissions for non ETS activities **Data source:** *EPA (2020) National Emissions Inventory*[2] *and Ireland's Greenhouse Gas Emissions Projections 2019–2040.*[10]

This trend reflects the failure to date of the EU ETS to deliver an appropriate price for carbon for industry within the ETS in Ireland, and a failure to provide an appropriate signal for long-term investment in low-carbon transition to industry actors outside of the ETS.

4.4.1 Manufacturing Combustion

Some 74% of emissions associated with Manufacturing Combustion are associated with larger facilities covered by the ETS. Activities include fuel use within the food processing sector, and heat demand for cement production.

Smaller enterprises across a diverse range of activities account for approximately 26% of Manufacturing Combustion covered under the Effort Sharing Decision.

Figure 4.21 shows emissions associated with the combustion of fossil fuels within manufacturing remain coupled to economic growth. However, the relationship has weakened since the recession, suggesting improvements in efficiency. Emissions in the ETS have decreased 13% relative to 2005, while emissions covered by the Effort Sharing Decision are down 33%.

There is some evidence of a structural shift towards more efficient technology for manufacturing combustion in the period 2005 to 2018. Figure 4.22 shows a large increase in the use of natural gas and a parallel decrease in use of liquid fuels and solid fuels. Options for emission reduction include investment in energy efficiency and fuel switching to renewable gas, biomass or electricity. The energy intensity, or 'efficiency', of manufacturing depends on structural, technology and behavioural factors. 'Structural factors' depend on the types of goods produced and changes in product lines. The technical efficiency of processes is influenced by process design and technology choice. Management, control and behaviours are determinants at the end of the chain that influence efficiency. The cost of energy can help to drive these factors towards a more efficient use of energy in producing goods. Another technological factor is the energy mix whether: the fossil fuels peat, coal, oil and gas (in decreasing order of carbon intensity), electricity,

or renewable energy alternatives (see Table 4.5). The mix is dictated by how manufacturing processes are designed and the investment choices, and so can become locked-in for decades.

Switching between the fossil fuels, away from coal and oil to lower carbon intensity forms such as gas, can reduce emissions in the short term but could delay early switching to zero-carbon energy sources. Where industry invests in technologies that use electric power, the emissions will move 'upstream' to the power generation sector.[145] The carbon intensity of electricity depends on the energy mix used in the power generation sector, including renewables. Ireland is making good progress in reducing the carbon intensity of electricity and therefore this can represent a good mitigation option for industry where it is applicable.

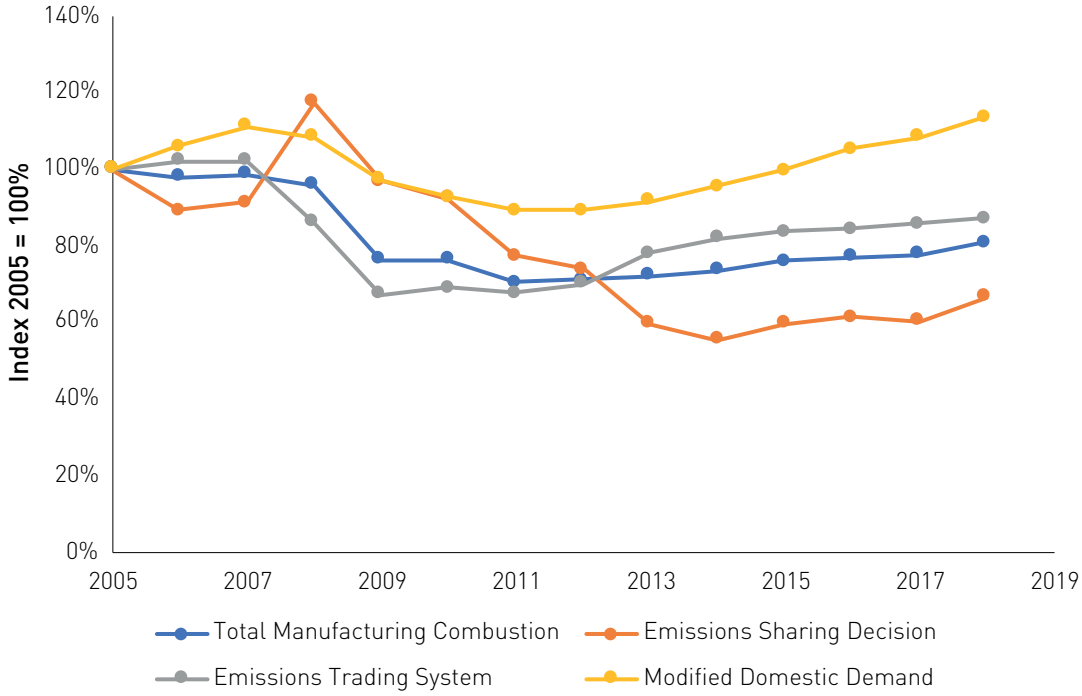

Figure 4.21: Comparison between national economic growth and greenhouse gas emissions from Manufacturing Combustion, relative to 2005, Index 2005=100%. **Data Source:** *EPA (2020) National Emissions Inventory 2020*[2], *CSO (2020) National Accounts.*[5]

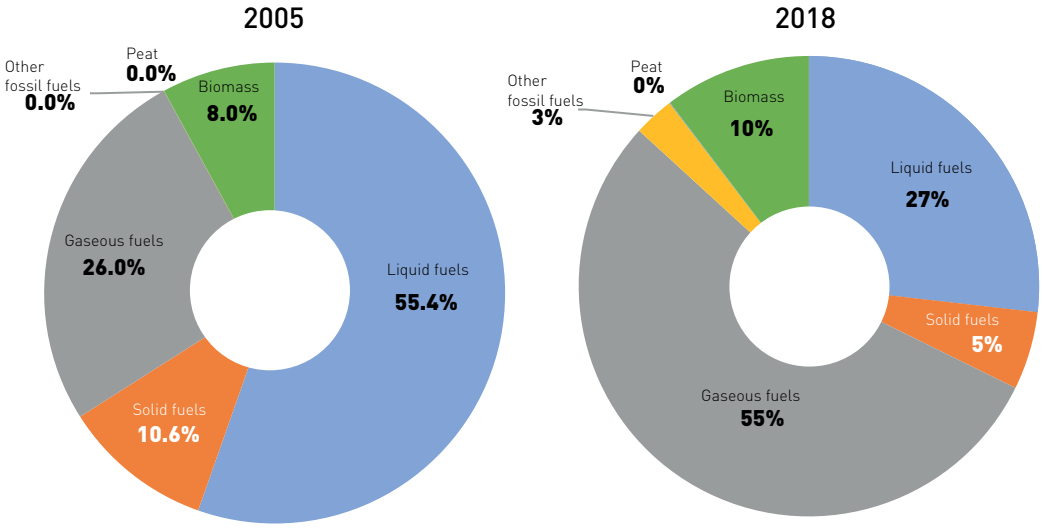

Figure 4.22: Comparison of fuel use within Manufacturing Combustion in terms of energy consumption in 2005 and 2018. **Data source:** *EPA Common Reporting Format submission to the UNFCCC 2020.*[29]

Table 4.5: Breakdown of fuel types used in Manufacturing Combustion in 2005 and 2018 and associated greenhouse gas emissions.

	2005	2005	2018	2018	% Change	% Change	GHG Intensity	GHG Intensity
Fuel Type	**Fuel Use (TJ)**	**GHG emissions (kt CO_2eq)**	**Fuel Use (TJ)**	**GHG emissions (kt CO_2eq)**	**Fuel Use (TJ)**	**GHG emissions**	**2005 (kgCO_2eq/MJ)**	**2018 (kgCO_2eq/MJ)**
Manufacturing industries	85,894	5,868	80,532	4,725	–6.2%	–19.5%	68.3	58.7
Liquid fuels	47,571	3,716	21,586	1,653	–54.6%	–55.5%	78.1	76.6
Solid fuels	9,112	868	4,414	419	–51.6%	–51.8%	95.2	94.9
Gaseous fuels	22,355	1,271	43,901	2,450	96.4%	92.9%	56.8	55.8
Other fossil fuels	0	0	2,291	193				84.3
Peat	16	2	35	3	123.1%	122.2%	99.3	98.9
Biomass	6,840	769	8,305	931	21.4%	21.1%	112.4	112.1

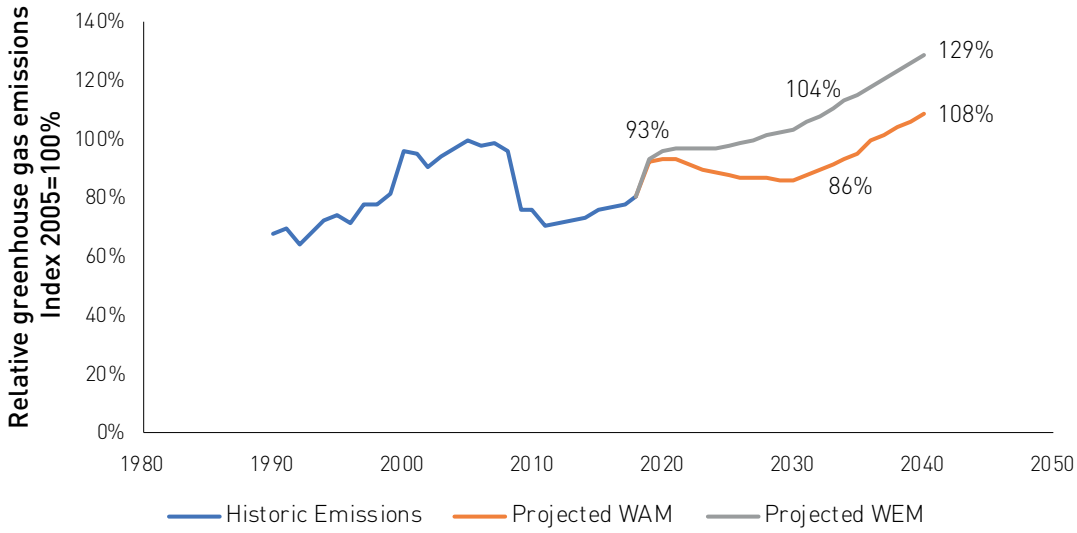

Figure 4.23: Historic and projected emissions from Manufacturing Combustion. **Data source:** *EPA (2020) National Emissions Inventory*[2] *and Ireland's Greenhouse Gas Emissions Projections 2019–2040.*[10]

Total emissions from Manufacturing Combustion and Industry are projected to increase under the WEM scenario, but to decrease as far as 2030 in the WAM scenario. Although the WAM scenario sees emissions fall below 2005 levels by 2030, both scenarios see emissions by 2040 well above the base year.

There are also roles for other programmes, including the renewable heat programme and energy efficiency measures such as the Large Industry Energy Network (LIEN) and the Excellence in Energy Efficiency Design (EXEED) programme of the SEAI. Energy efficiency measures are now incorporated into the Climate Action Plan. The 2018 annual transition statement assumed that by 2030 the LIEN would achieve 825 Mt CO_2eq cumulative reduction, while the EXEED programme would deliver cumulative emissions reductions of 1.76 Mt CO_2eq.

4.4.2 Industrial Processes

Figure 4.24 shows that emissions associated with Industrial Processes remain very strongly coupled to economic growth. This is largely a reflection of activity levels within the construction sector and demand for cement.

Industrial processes were responsible for 3.8% of total greenhouse gas emissions, or 2.3 Mt CO_2eq in 2018. The mineral industries, mainly cement production, dominate emissions in the sector, being 90% of total emissions, all of which are covered under the ETS.

The decline in construction that followed the economic recession led to a significant reduction in emissions from cement production.

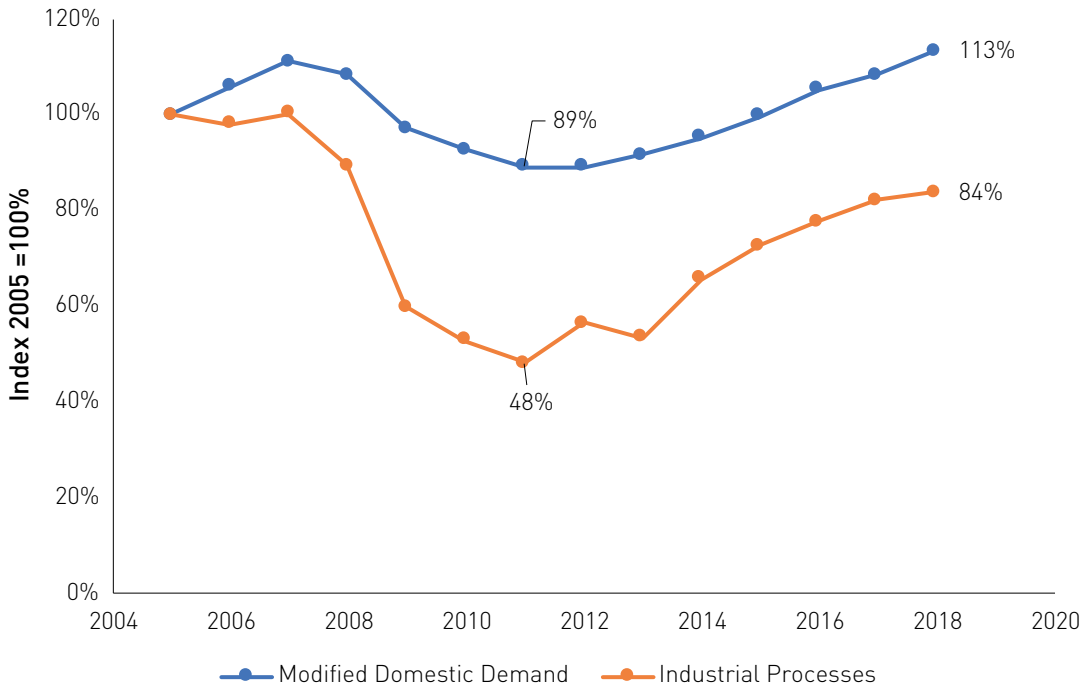

Figure 4.24: Comparison between national economic growth and greenhouse gas emissions from Industrial Processes. **Data Source** *EPA (2020) National Emissions Inventory 2020*[2], *CSO (2020) National Accounts.*[5]

Economic recovery resulted in a boom in construction and a resurgence in emissions. In 2018, total emissions (combustion and process) from the cement sector increased by 2.1% and amounted to 2.58 Mt CO_2eq. Cement sector process emissions have increased by 83% since 2011.

Long-term low-carbon transition policy options for industry exist and are well understood in the technical literature, but less understood outside those circles.[146] They include shifting the structure of the economy and demand reduction through behavioural choices for sustainable consumption. Technical options include changing product lines and process designs towards less resource- and energy-intensive systems and changing the technologies to more energy- and carbon-efficient forms. Carbon efficiency can be improved by moving from fossil fuel consumption for processes on-site, to electricity and renewables. Specific issues are acknowledged on the supply-side for the 'hard-to-decarbonise' sectors of industry, including high-temperature processes. The Energy Transition Commission report of 2017 explored fuel substitution through liquid biofuels, other bioenergy forms and hydrogen, and carbon capture and storage, as potential options for decarbonisation.[147] The Commission noted that these technologies have not been deployed at scale and face significant barriers. The difficulty in decarbonising some industry sectors prompted the IPCC to conclude that long-term step-change options could include radical product innovations such as alternatives to cement. These need to be demonstrated, sufficiently tested, cost-effective and publicly accepted.[146]

The EU ETS has been the main policy driver for reductions in industrial process emissions in Ireland but has not delivered durable change. The current free allocation of allowances under the ETS to Industry, for the period to 2020, was based on benchmark activity in the boom period immediately prior to the financial crisis and recession in Ireland (see Figure 4.25). The main argument for free allocations is to counter possible carbon leakage when the production of carbon intensity products is relocated to regions where carbon price is lower than within the

EU or not applied at all, thus avoiding the higher costs associated with reducing emissions. The practical result of this has been that the cement industry in Ireland has been largely insulated from trends in the carbon price on the ETS as the verified emissions due to production have been consistently less than allowances. Ireland is not unique in this regard. The verified emissions for several activities provided with free allocations across the whole EU ETS have been below the benchmark. During Phase II, in particular, the gap between free allowances and verified emissions, generated 'bankable' units in each year, which accumulated to a sum of 11.9 Mt CO_2eq over the period. The individual facilities with the ETS can manage and trade in units as they see fit. In the transition from Phase II to Phase III, provision was made to allow for transfer of banked units into the third phase. This has created a considerable additional buffer against exposure to the carbon price signal within the wider ETS for facilities that decided to maintain hold of their banked units from Phase II.

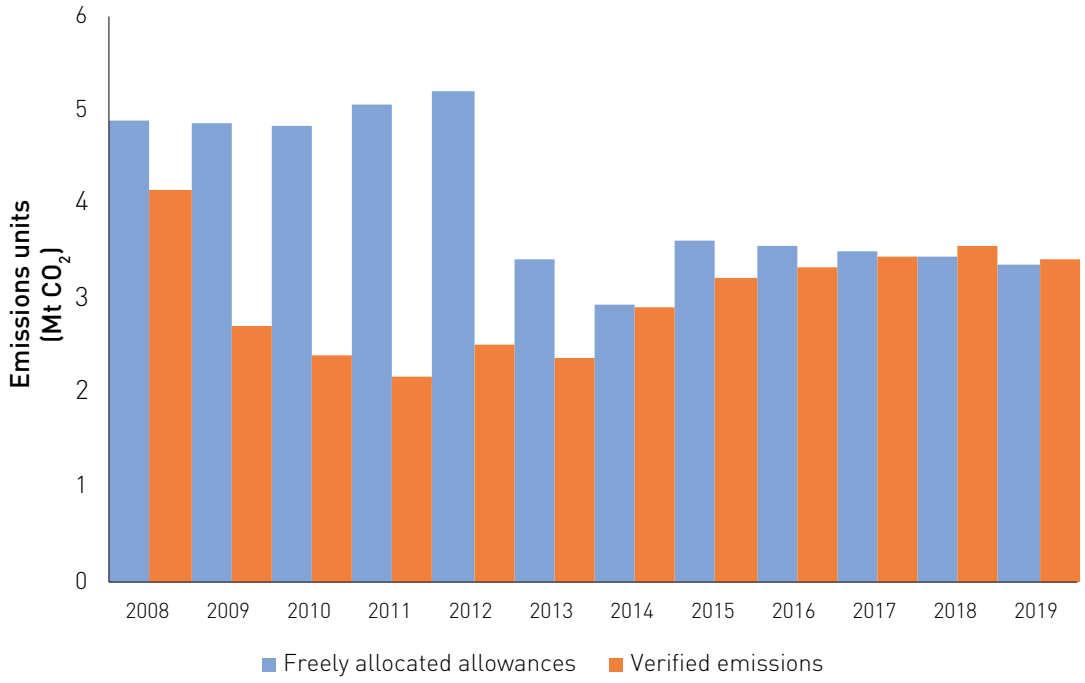

Figure 4.25: Emissions Trading System Free Allocation and Verified Emissions for non-combustion Industrial activities in Ireland. Phase II: 2008-2013, Phase III 2014-2020. **Data source:** *European Environment Agency (2020) EU ETS data viewer.*[148]

The proposal for border adjustment measures contained within the EU Green Deal may represent an opportunity to enact necessary reform of the allocation of allowances within the ETS. It is arguable that an EU border adjustment on certain goods will only be acceptable under World Trade Organisation rules where similar measures and costs are imposed on EU manufacturers. The free allocation of allowances explicitly reduces the exposure to the ETS carbon price on production below the benchmark and the border adjustment may be viewed as an unfair tariff. In which case border adjustments would necessitate reform of the ETS.

4.5 Built Environment

The Built Environment sector includes residential, commercial and public buildings with emissions primarily due to fossil fuels use for space and water heating. Consumption of electricity is not included in this category. The Climate Action Plan 2019 aims to reduce emissions in the Built Environment sector by 37.5%, from a total of 8 Mt CO_2eq in 2017 to 5 Mt CO_2eq in 2030.

Because of the diversity of buildings, not just across residential, public and commercial but also within those categories, there is no single solution to this sector's emissions. Behavioural factors, high transaction costs and lack of access to capital are barriers to the decarbonisation of this sector that cannot be solved by price alone. Multiple policy measures may be required. Where possible, climate action should facilitate households and firms to implement these measures themselves. The decarbonisation of residential, commercial and public buildings will now be assessed in turn.

4.5.1 Residential

The Residential sector consists of about two million dwellings including houses and apartments (CSO, 2016), though not all these are occupied. Emissions in the Residential sector increased by 0.5 Mt CO_2eq from 5.7 Mt CO_2eq in 2017 to 6.2 Mt CO_2eq in 2018. This increase was partly due to a colder than average winter. SEAI estimated that weather-corrected energy use in households increased by 5.5% from 2017 to 2018. In the same period, the population increased by just 1.3%, meaning that emissions per capita and energy consumption in homes increased in the period. The Climate Action Plan aims to reduce emissions to 3–4 Mt CO_2eq by 2030.

Residential emissions can be decomposed into the total energy consumed and the emissions intensity of that consumption, which is largely driven by the energy source; fossil fuel or renewable. This section will break down the drivers of total energy demand in an Irish context. The demand for heat depends on the population numbers, the number of dwellings occupied (or household size), energy efficiency (quality of insulation), the ambient temperatures, and preferences and behaviours.

Figure 4.26 shows that the majority of houses built post-2011 conform to insulation standards required for a zero-carbon future. This improvement is mainly due to legislated requirements for building standards as well as and local planning guidelines. Building standards for new dwellings need to be maintained at current levels.

Decarbonisation of the existing housing stock requires considerable upfront investment but, when considered at a societal level, represents a relatively cheap way to decarbonise the economy once householder energy savings are taken into account. The Climate Action Plan aims to retrofit circa 500,000 houses to B2 or better by 2030. This is a considerable undertaking, rising from 1500 retrofit installations in 2019 to over 56,000 per annum in the latter half of the decade. The average effort required per household is substantial, although varying with pre-existing insulation standards. Ninety-one percent (91%) of the building stock has a less than optimal energy efficiency performance with a BER rating of B3 or worse (see Figure 4.27). In fact, of the approximately 850,000 dwellings with a BER certificate, about 786,000 achieve a rating of B3 or worse. About 200,000 are rated E or worse.

The retrofitting of residential dwellings can also contribute to social policy if retrofitting is targeted towards vulnerable households at risk of energy poverty. A considerable proportion

of Irish households are heavily burdened by energy expenditure and would benefit from a socially targeted retrofit programme. Energy poverty can be defined in many ways. Taking fuel expenditure as a fraction of income, and employing a 10% threshold, 28% of Irish households are in fuel poverty. This falls to 8% if we use a 15% threshold.[149]

Estimates for the cost of the climate action plan retrofit target have not been published. SEAI's Deep Retrofit Pilot Programme, launched in 2017, gives some insight into the likely cost involved, though it aimed for a higher level of retrofit than the Climate Action Plan's target of B2. The Deep Retrofit Pilot programme brought 325 homes up to an A standard BER rating. Of these homes, 65% had a pre-programme BER rating of E1 or worse, with an average pre-programme rating of F. The average cost of retrofitting these homes was €54,047, with an average CO_2 saving of about 10 t per year per home. Based on these figures and data from Curtis and Collins (2017), this would equate to a financial payback of about 18 years for 100 m^2 homes based on a carbon tax of €26 per tonne CO_2.[150] An increased carbon tax would reduce the payback period for all homes. The payback period for retrofitting large homes over 300 m^2 on the same basis would be significantly shorter, at about 6.5 years.[i] This could suggest that, everything else being equal, financial supports for retrofit should be targeted towards medium to small homes, as retrofit should already be financially attractive for larger homes.

While €54,047 is a considerable upfront cost, the marginal cost of emissions abatement is relatively low when considered at a societal level over a 30-year period and when private energy savings are taken into account, equating to about €18/CO_2eq.[ii] Including other benefits such as air quality, health and comfort would lower that cost even further, with the climate action plan suggesting negative costs outcomes, i.e. even larger cost savings. However, when considered from an Exchequer perspective, and considering only the emissions reductions achieved over the fixed ten year period to 2030, deep retrofit would represent an abatement cost to government of approximately €540/tCO_2eq. Therefore, the focus of policies and measures should be to encourage homeowners who would benefit and have the resources to do so to invest in deep retrofit. Given the cost savings over time accruing to the household, this should be privately financed where possible. Public financing of those already with means is an unnecessary additional cost to the Exchequer. Public financial support would be better targeted towards those who are not in a position to undertake such investment.

i If a private individual had financed this retrofit themselves, based on figures from Collins and Curtis (2017), the financial payback period (retrofit cost/annual energy cost savings) would be approximately 18 years (note that the payback period ignores the time value of money). If the carbon tax was levied at Đ80 per tonne, the financial payback period would reduce to just over 15 years.

ii This excludes environmental benefits and is for a three-bed semi-detached house moving from an F to a A2 rating.

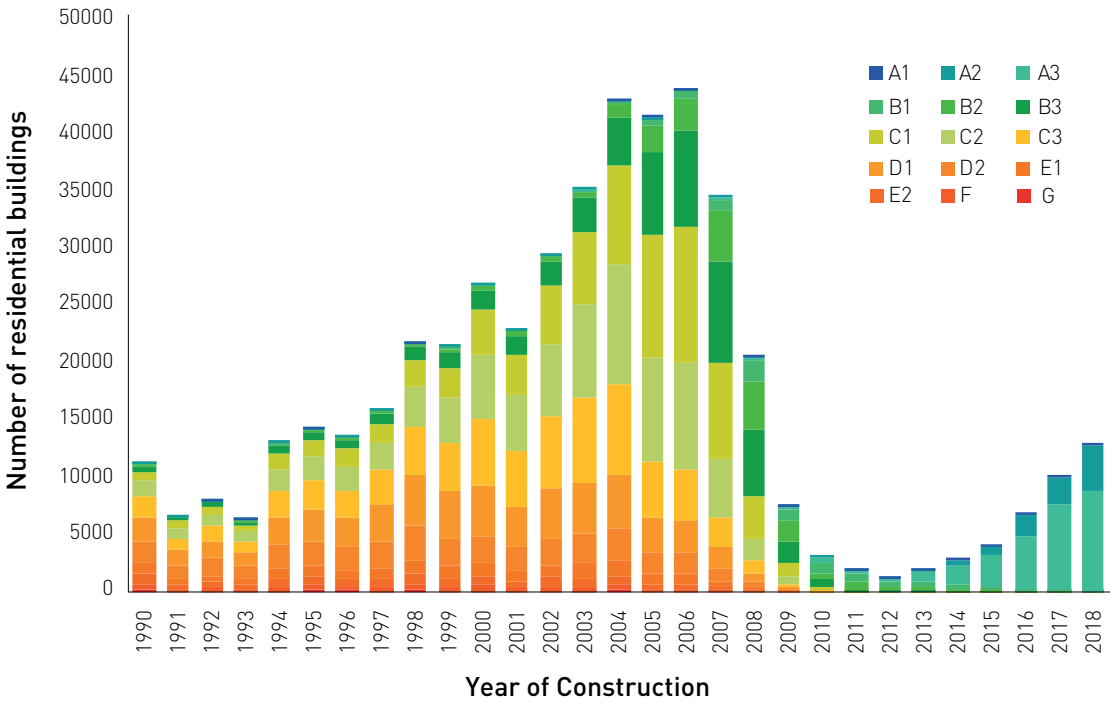

Figure 4.26: New builds by year of construction and corresponding Building Energy Rating (BER). **Data source:** *SEAI BER Research Tool.*[151]

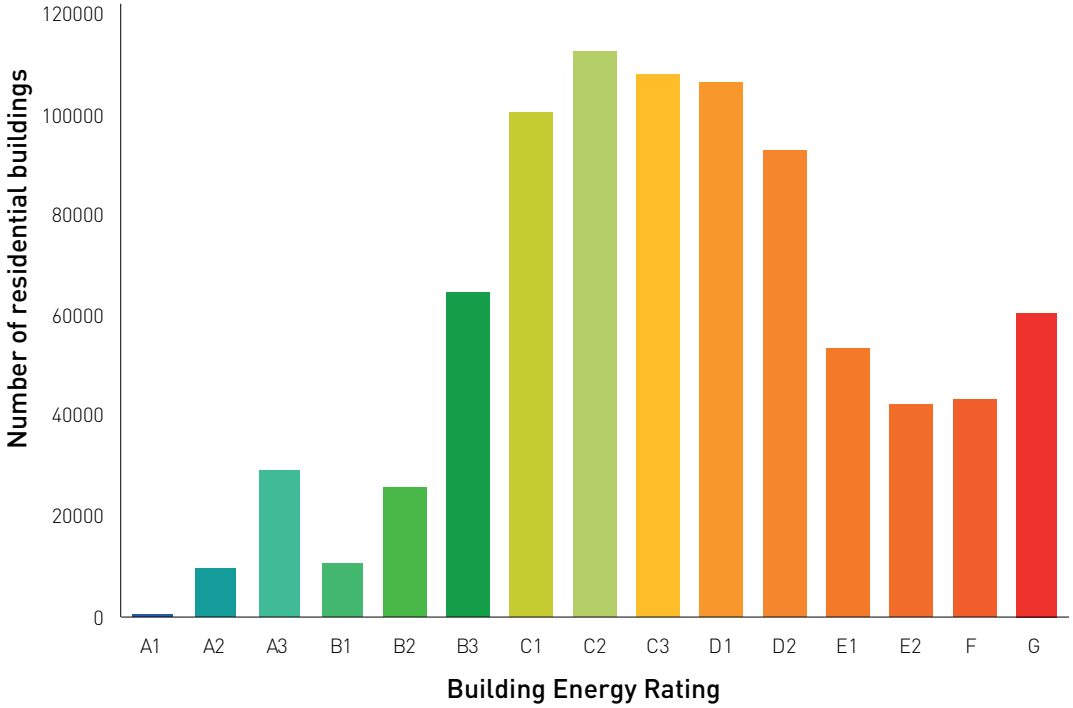

Figure 4.27: All dwellings in the BER dataset and their corresponding Building Energy Rating (BER). **Data source:** *SEAI BER Research Tool.*[151]

There are four primary challenges that policy must prioritise: (a) creating an adequate financial incentive, (b) addressing capital constraints, (c) logistical constraints and (d) behavioural barriers. Retrofits may also be deployed in a progressive manner as part of a portfolio of climate action policy measures. Each will now be discussed.

a Financial incentive

A strong and clear carbon price is the cheapest tool to deliver retrofits at scale. As Section 3.5.5 discusses, a high and rising carbon price is the most efficient way of creating the financial incentive to decarbonise. The inadequacy of the current carbon price trajectory is evidenced in the potentially long payback period, which is an insufficient incentive for many. Research by SEAI suggests that a payback period above six years discourages personal investment.[152] Other research suggests that households often apply very high discount rates to future energy savings, with one Irish estimate at 9% and international estimates above 20%.[150] A payback period of 18 years for small homes is three times that which is perceived as adequate, falling to 15 years with a carbon tax of €80/tCO_2. A carbon price in line with the marginal cost of abatement required to achieve the 2019 Climate Action Plan would minimise the payback period.

An alternative is to fund these upgrades through subsidies, which would represent a considerable cost to the Exchequer for two reasons. First, the financial incentive is being created by Exchequer spending (subsidy) as opposed to Exchequer receipts (carbon tax). Second, the myopic nature of investment decisions, where households discount future benefits, is being addressed by a subsidy, where a measure to balance savings and expenditures over time would be more appropriate (e.g. low-cost loans). The potential costs of a subsidy are substantial. Based on the average cost calculated in the SEAI's Deep Retrofit Pilot, achieving 2050 retrofit targets could cost the Exchequer approximately €27 billion if publicly funded, excluding the cost of capital. Assuming a lower cost of retrofit at €30,000 would give a total of €15 billion. Even if the government only funded deep retrofit for all social housing, this would cost the Exchequer in the region of €5 billion to €9 billion, which would still be 328,000 homes short of the 2030 retrofit target.[153,i] Therefore, particularly outside social housing, the bulk of the costs of retrofit will have to be carried by households.

b Capital constraints

Retrofits embody a large upfront cost and long-lived benefits. A high carbon tax reduces the payback period and makes the long-lived benefits more salient. However, capital constraints may still limit the ability of householders to make the required investment. Few households will have the savings necessary to finance a deep retrofit out of pocket.[154,ii] Currently, the only other alternative to self-finance a retrofit is to take out a loan from a retail bank or credit union, where high interest rates will add to the costs. Access to such loans is further constrained where assessments of ability to repay do not take account of expected savings due to energy efficiency. Without access to finance, the vast majority of households will not be able to invest in deep retrofit.

Ireland will fail to meet energy efficiency targets unless we improve both the access to capital and the cost of capital for insulation retrofit. It is in the public interest that householders make such installations and there is therefore a clear motivation for government intervention to facilitate this access to capital. Measures such as An Post's 'Green Hub' programme help to overcome this capital constraint. A clearer comparison of lifetime costs and benefits would aid uptake of this programme. While the rate offered by An Post is low relative to commercial banks, lower cost government intervention is possible. The cost of public borrowing is currently very low, and financing these policies is therefore potentially cheap. Widening the scope and visibility of these

i Based on a figure of 172,000 social housing units and a retrofit cost of €30,000 - €54,047 from Corrigan and Watson (2018).

ii The Central Bank reports increasing in household savings which may provide opportunity for investment in energy efficiency and retrofit as Ireland emerges from Covid-19.

loans and passing a greater proportion of the cheap loan to the consumer would incentivise a more rapid decarbonisation transition.

As these are loans that will be repaid, and not subsidies, the lifetime cost to the Exchequer is likely to be low. Pay-as-you-save and other financing models can help to overcome these barriers. EU funding should also be explored to support aggregated approaches.

A considerable proportion of retrofit expenditure is directed towards vulnerable households. There are 142,000 social housing units held by local authorities, with a further 30,000 held by Approved Housing Bodies (AHBs) and the Climate Action Plan directs funding towards the retrofit of vulnerable and energy-poor people's homes through the Better Energy Warmer Homes programme and also through deep retrofit of social housing. The Better Energy Warmer Homes scheme provides free energy efficiency upgrades to the homes of those living in or at risk of energy poverty. It is administered by the SEAI, on behalf of the Department of Communications, Climate Action and Environment (DCCAE). As part of Budget 2020, the Government allocated a total of €52.8 million to the scheme for 2020. This represents more than double the initial allocation for 2019. €13 million of this funding is ring-fenced revenue arising from the increase in the carbon tax.

A further €20 million of the carbon tax revenue was made available to the Department of Housing, Planning and Local Government (DHPLG) to deliver grouped upgrades as promised in the climate action plan. Targeted at the Midlands, the scheme is built around core work on some of the social housing stock in the region but is also designed to allow other homeowners to opt in to the aggregation model, which will streamline services on an area basis. It will support an estimated 400 jobs directly and indirectly. The specific design of the project will be led by the retrofit task force that was established in August 2019 and is chaired by the Department. This increased investment represents an important step towards realising the Government's climate action plan targets in the area of building retrofitting while prioritising the most vulnerable householders.[155] This is on top of the pre-existing energy efficiency and retrofitting works undertaken by the DHPLG under its Social Housing Investment Programme to improve the quality of the social housing stock. Since 2013 approximately €150 million has been invested in improvements to the energy efficiency of about 72,000 social housing units. Phase 1 focussed on high-return basic efficiency measures such as attic and wall insulation while Phase 2 focuses on the fabric upgrade works to dwellings with a solid/hollow block wall construction and includes the provision of heating upgrades as well as allowing for the replacement of poorly performing windows and doors and heating systems, with the aim that the energy performance of the dwelling should be upgraded to achieve a cost-optimal level where feasible. This typically requires wall insulation, attic insulation and the installation of a condensing boiler[i] or heat pump or, alternatively, the attainment of a B2 Building Energy Rating. This programme has a budget of €25 million for 2020.

In addition to the Energy Efficiency Retrofitting Programme, as part of Budget 2020, the Government announced €20 million in funding for a major local authority housing retrofit programme in the Midlands. The retrofit programme arises from the Government's Climate Action Plan. It is envisaged that approx. 750 local authority homes will benefit from a deep retrofit under the scheme. The programme aims to identify areas of sufficient concentration of local authority housing stock with poor energy efficiency conditions which will facilitate the aggregation of clusters of housing. By taking a more targeted approach to the renovation of the

i There is a concern that condensing boilers, though more efficient, still run on fossil fuels.

local authority building stock, it is hoped that economies of scale can be achieved, with contractor rates available to private homeowners in the area who will be encouraged to participate through SEAI grant funding.

Similar to the Energy Efficiency Retrofitting Programme, this Midlands Retrofit Pilot requires that the energy performance of the dwelling should be upgraded to achieve a B2 BER or cost-optimal level. A pre- and post- works BER will be completed for all properties. Significant learning is expected from this programme.

c Logistical constraints

Planning is necessary to address capacity constraints in the construction industry. Achieving the target of retrofitting 500,000 homes by 2030 will require ramping up rates of installation from 1500 in 2019 to 55,000 in 2023. This will be difficult given the current capacity of the Building sector. This sector is already working at capacity and is already expected to increase its output to meet growing housing requirements. Combining this with a 36-fold increase in building retrofits over four years will require a great deal of additional capacity, requiring a larger appropriately trained and qualified work-force. This must be planned for adequately. The retrofit taskforce, established by the minister in 2019, will have a key role to play here.

d Behavioural barriers

Research by the SEAI behavioural unit and experience from SEAI programmes have shown that factors that can affect retrofit action include the ease of the overall process and confidence in the outcomes to be delivered.[156] The Behavioural Insight Team in the UK found that one of the main barriers faced by UK households in making energy-efficient structural changes to their homes was the 'hassle factor' – the disruption caused by installation of energy efficiency products in the home can be far from straightforward.[157] The offer of a full end-to-end service, which includes advice, quality-assured works and process administration, including grant drawdown, is a very attractive and hassle-free proposition for consumers to agree.

Facing such a challenging target over a ten-year timeframe, when Exchequer resources will be constrained, efforts need to be prioritised where they will achieve most impact. It should be a priority to address energy poverty on the one hand and on the other hand to prioritise retrofits for houses with the largest emission reduction potential. Financial assistance for retrofits should moreover be prioritised, designed and targeted towards those with insufficient resources to undertake retrofit on their own.

Once energy poverty and basic energy efficiency are addressed in the existing housing stock, it would be worthwhile to pay more attention to the type of energy used in homes – the carbon efficiency, rather than just energy efficiency – in order to cost-effectively cut greenhouse gas emissions.

Houses must switch away from high-carbon fossil fuels to zero-carbon energy sources. To achieve the 2030 targets, we need to eliminate the most carbon-intensive fuels from our homes. These fuels also have the biggest impact on health.[158,159] Priority should be given to switching homes away from peat and coal open-fire and central heating systems towards cleaner, more efficient alternatives. This would importantly also improve health outcomes and help reduce energy poverty. The next priority is to phase out the use of oil for heating in all buildings. Air source heat pumps powered by electricity can deliver heat efficiently and have the potential to be zero-carbon as electricity generation decarbonises. However, air source heat pumps have a

low heat output and so work best in well-insulated homes with underfloor heating. The Climate Action Plan aims to install 600,000 heat pumps in buildings by 2030 with 400,000 of those in the existing housing stock. SEAI has identified that a significant number of oil-heated homes are heat-pump ready. Other oil-heated homes would need some level of retrofit to improve heat retention before a heat pump would be useful.

Natural gas is the most carbon-efficient of the fossil fuels and does not present the pollution and indoor air quality effects of coal and peat. The Council therefore does not consider the deep retrofit or fuel switching of gas-connected homes a priority for government in the short term, except where they are occupied by vulnerable households experiencing energy poverty. For the long term, Section 3.5.3 and Section 4.3 show two routes for providing zero-carbon heat in homes. Houses connected to the gas grid could benefit in future if the gas network switches towards low and ultimately to zero-carbon fuels such as biomethane or hydrogen. Switching such houses to biomethane or even hydrogen is understood to be minimally invasive and with little upfront cost, requiring only an adjustment to the existing gas boiler unit. It will be important to better understand the comparative costs of large-scale deep home retrofit versus decarbonising the gas network and to ensure the decarbonisation trajectory of the gas grid.

4.5.2 Public sector

The public sector consists of approximately 4400 separate public bodies, about 4000 of which are individual schools. The other 400 are, inter alia, government departments, non-commercial State bodies, State-owned companies and local authorities.[6] Each 'public body' is a stand-alone organisation and they can range in size from very small (e.g. a small rural school or a five-person agency) to very large (e.g the Health Service Executive or An Garda Síochána). Similar to the Residential sector, their emissions are due to fossil fuel use for water and space heating in public sector buildings such as hospitals and schools. Emissions due to electricity consumption are not counted in this sector in the national inventory. Emissions in the public sector increased by 8.2% from 0.9 Mt in 2017 to 0.98 Mt in 2018.[2] The Climate Action Plan commits to development of a new public sector decarbonisation strategy to deliver a 30% reduction in greenhouse gas emissions by 2030, and a roadmap to reach carbon neutrality by 2050. The Plan also aims to have all public buildings achieve a B level building energy rating, a slightly weaker target than that for 500,000 residential buildings under the Climate Action Plan.

The drivers for public sector emissions are similar to the Residential sector. However, the role each driver plays and the levers to affect those drivers are different. For example, the behaviour of people in a residential setting is very different to that of those in a public building, and the preferences for heat and the decision to spend on energy or energy efficiency play out very differently, with the decision makers in these circumstances often operating at a remove from being the beneficiary of any consequent comfort or energy savings benefits.

Public sector data are frequently bundled with Commercial sector data. This is the case for Building Energy Ratings data from the CSO for example, which can make it hard to isolate public specific trends. Data from SEAI show that the energy consumption of the Public and Commercial sector together ('services') increased from 2017 to 2018 by 6.4%, or 5.2% when adjusted for weather conditions.[6] In other words, though 2018 was a colder year than 2017, the 5.2% increase is not explained by the weather.

The public sector has a dedicated energy efficiency target to achieve a 33% improvement in energy efficiency by 2020.[6] This target includes direct consumption of fuels, and also consumption of electricity, meaning that it spans two inventory sectors for the reporting of greenhouse gas emissions. The SEAI reports annually against the public sector energy efficiency target based on reporting from public bodies and institutions.[160] There was a 99% reporting rate of public bodies to SEAI in 2019 (on 2018 data) and a 73% response rate from schools, which together account for 97% of energy usage by the entire public sector. The vast majority of energy is consumed by the 100 largest organisations. Thermal energy consumption rose by about 1% from 3086 GWh in 2017 to 3124 GWh in 2018. This small increase could be at least partially explained by the colder than average year. Across thermal, electric and transport energy consumption, improvements in energy efficiency were recorded from 2017 and built on in 2018 with a 27% saving against the baseline.[i] This was calculated by SEAI to represent emissions savings of approximately 761 kt of CO_2eq compared to the baseline.

Sustainable public sector procurement should be a strong contributor to achieving Ireland's climate targets. This can have two benefits. First, there is scope for the procurement activities themselves to make a considerable contribution as these practices comprise up to 12% of GDP.[161] Second, there may be spillover effects, where procured activities inspire further sustainable practices. The Climate Action Plan commits to reformulating the Government's green procurement strategy to achieve better results and these reformulations should be solidified.

4.5.3 Commercial

The Commercial or Services sector consumes energy and produces greenhouse gas emissions due largely to space heating but also to water heating, cooking and laundry. A 2015 survey by SEAI found that there are about 109,000 commercial buildings in Ireland, most of which (about 82,000) are office and retail.[162] Emissions in this sector increased by 5.3% from 1.07 Mt CO_2eq in 2017 to 1.12 Mt CO_2eq in 2018.[2] Energy consumption in the Commercial Services sector is estimated in aggregate with public services. Commercial and public services together increased their energy consumption by 6.4% from 2017 to 2018, or 5.2% when corrected for weather variation (over the full year, on average, 2018 was colder).[6] This suggests a small improvement in carbon efficiency of energy consumption. The Climate Action Plan only targets emissions of 1 – 2Mt in 2030: in other words, little to no reductions from 2018 emissions levels are foreseen. Nevertheless, there are opportunities for savings to be made with win – wins possible regarding energy and emissions savings and benefit to the commercial actors involved.

The understanding of energy use in the broader Commercial sector is limited by a current lack of data, where consumption of energy is estimated as a residual against better understood sectors. This hampers the ability of policy makers to effectively target policies and measures to reduce emissions in the sector. SEAI has noted this gap in knowledge and, together with the CSO, is developing the Business Energy Use Survey to enhance understanding of this sector.

Just over half of commercial buildings have a building energy rating (BER). The BER statistics of commercial non-residential buildings tells a mixed story. While the numbers of buildings in the database increases, the percentage of buildings with an A or B BER rating is decreasing year on year. The nature of buildings in this sector is quite varied, from warehouses to hotels and offices to workshops. The energy efficiency of buildings may not be a priority issue for warehouses and workshops. Nevertheless, even in a relatively cohesive category, where space heating and

i The baseline is a fixed historical period since 2001. The default baseline period is 2009.

related efficiency will have some importance, such as retail and offices, the percentage of A and B rated buildings has decreased. This is not an encouraging picture. When we change focus to the type of energy being consumed, the story is somewhat better. Approximately 88% of non-residential buildings in the BER database use mains gas or electricity as their main space heating fuel. This could allow scope for significantly reducing emissions via decarbonised electricity and gas supplies.

A 2015 report by SEAI found that Ireland has a relatively unsophisticated commercial buildings stock, and a high incidence of buildings in which relatively basic upgrades could lead to significant energy savings.[160] A large share of commercial buildings are not owner occupied and involve lease or rental, which gives rise to split incentives for energy efficiency upgrades. The Commercial Property Lease Register records approximately 20,480 commercial property leases, but this is not complete coverage. Regulatory tools and standards can be important tools in this context. In December 2019, the Department of Communications, Climate Action and the Environment launched a public consultation on measures to address the split incentive experienced by landlords and tenants with respect to investments in energy efficiency.[163] Much could be learned from the public service's own experiences in improving energy efficiency: many public bodies are tenants rather than owners of their premises.

The Support Scheme for Renewable Heat (SSRH) is a key tool towards decarbonising energy sources in large commercial buildings and aims to deliver 1.6 TWh of renewable energy source heat by 2030. Under this scheme, an installation grant is available from SEAI for air, ground or water source heat pumps, providing up to 30% of eligible costs to successful applicants. Ongoing operational support is available on a tariff support basis to convert existing fossil fuel-based heating systems to renewable biomass or biogas systems for up to 15 years.[164]

5. Progress Towards a Climate-Resilient Ireland

5.1 Introduction

Climate change is happening. Even under the most ambitious mitigation policies it will continue for many decades or, in the case of sea level rise, many centuries with social, economic and environmental implications. Therefore, societies need to adapt to the unavoidable 'locked in' impacts of observed and future climate change.[165]

At current levels of global greenhouse gas emissions, the world remains on course to exceed the Paris Agreement's temperature thresholds of either 1.5°C or 2°C above pre-industrial levels. This would increase the risk of the severe and pervasive effects of climate change beyond what is already being experienced and confirms the need for ambitious mitigation as well as adaptation policies.

Globally, 2019 saw numerous major heatwaves with record-setting high temperatures in Australia, India, Japan and Europe that adversely affected health and well-being. It is likely to be the second warmest year on record. Also in 2019, sea level continued to rise and ocean heat content reached record high levels. The last five-year (2015–2019) and 10-year (2010–2019) averages are also the warmest on record. Since the 1980s, each successive decade has been warmer than any preceding decade since 1850. This trend is anticipated to continue due to record levels of heat-trapping greenhouse gases in the atmosphere.[166] Successful adaptation is a key part of Ireland's transition to a low-carbon, climate-resilient economy and society.[i] The Covid-19 pandemic has highlighted vulnerabilities in our systems and the importance of building resilient societies in a climate-compatible recovery.[167,168] It has also shown the importance of evidence based decision making while considering uncertainty and shocks and delivering integrated cross-sectoral responses.

In addition to reviewing sectoral and local efforts, this year's Annual Review explores how Ireland is considering the costs of climate change and adaptation and how we are preparing our cities, financial system and society. This follows a review of observations and projections of Ireland's climate and a discussion of recent weather events.

5.2 Ireland's climate: pbservations and projections update

Previous Annual Reviews have presented a comprehensive outline of observed and projected climate change for Ireland, explaining that to prepare for the impacts of climate change, we need to first understand our historical and current climate. A brief update on these is presented below.

In 2019, Ireland experienced above average rainfall and it was the ninth consecutive year with temperatures above normal. The provisional mean annual shaded air temperature for 2019 was 10.5°C, which was 0.9°C above its 1961-1990 long-term average (LTA). Winter 2019 (December 2018, January and February 2019) was the warmest on record (119 years) at 2.2°C above its LTA (see Figure 5.1).[169]

i The Council has adopted the definition of adaptation in the Climate Action and Low Carbon Development Act 2015: 'any adjustment to: any system designed or operated by human beings, including an economic, agricultural or technological system, or any naturally occurring system, including an ecosystem, that is intended to counteract the effects (whether actual or anticipated) of climatic stimuli, prevent or moderate environmental damage resulting from climate change or confer environmental benefits'.

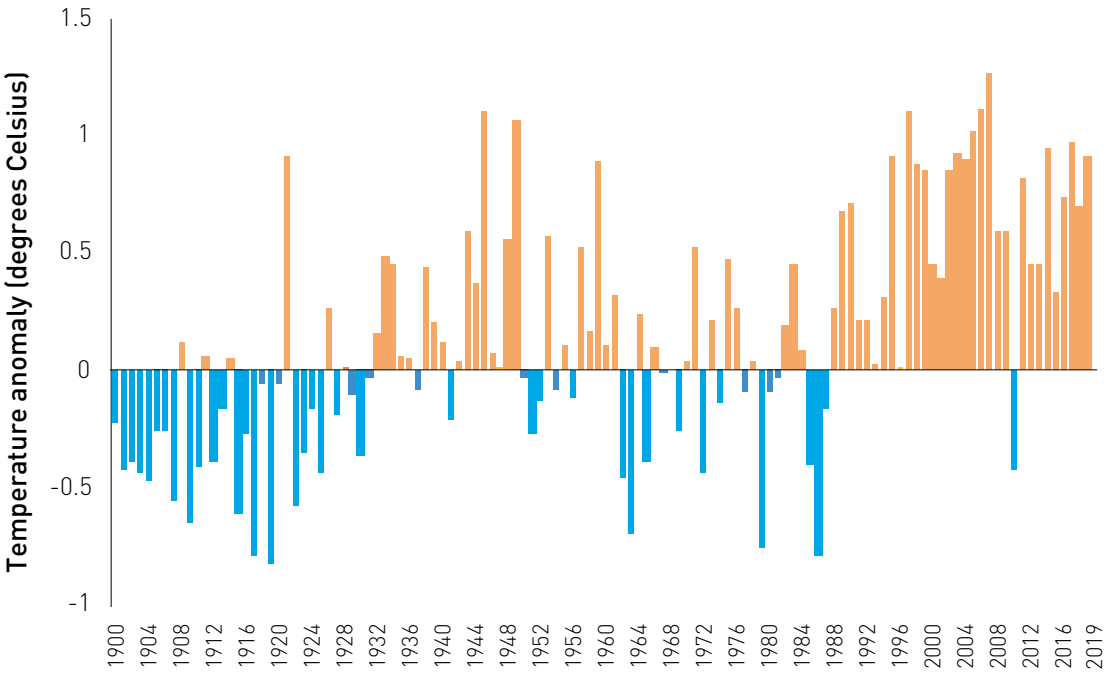

Figure 5.1: Provisional Annual Long Series Temperature Anomalies for Ireland. Difference from annual mean temperature from the long term average period 1961-1990 (LTA): **Data source:** *Met Éireann (2019).*[169]

Climate change projections, like all projections of the future, are subject to uncertainty. Using a sub-set of available climate models, the latest high-resolution regional climate modelling projections for Ireland suggest the following changes. Mid-century mean annual temperatures for Ireland are projected to increase by 1–1.2°C and 1.3–1.6°C relative to the baseline period 1981–2000 for RCP4.5 (i.e. a stabilisation scenario) and RCP8.5 (i.e. a high-emissions scenario) respectively. Warming is enhanced at the extremes (i.e. hot days and cold nights), with the warmest 5% of daily maximum summer temperatures projected to increase by 1.0–2.2°C compared with the baseline period. The coldest 5% of night-time temperatures in winter are projected to rise by 1–2.4°C compared with the baseline period.

Heatwave events are expected to increase by mid-century; the number of frost and ice days is projected to decrease. Mid-century precipitation is expected to become more variable, with substantial projected increases in both dry periods and heavy precipitation events.[170] Changes in wind speeds, storm tracks and sea level will also occur.

5.3 Policy context

5.3.1 European policy

Unlike in mitigation, there is no single metric for measuring the success of adaptation to climate change. As a result, the policy targets for adaptation at the global and European levels are less quantifiable and successful adaptation requires its integration into decision making (mainstreaming) in many other policies addressing climate-sensitive issues.[164]

The European Green Deal unveiled by the European Commission in December 2019 committed to adopting 'a new, more ambitious EU strategy on adaptation to climate change' by 2020/2021 as 'strengthening the efforts on climate-proofing, resilience building, prevention and preparedness is crucial'. Though adaptation has historically been considered a national issue, primarily

addressed at Member State level, the Commission's proposed European Climate Law also discusses enhancing adaptation efforts at European level. Article 4 of the proposed law concerns adaptation with other Articles concerned with the reporting of progress on adaptation.[171]

Adaptation to climate change including societal transformation is also one of the five 'Green Deal Missions' informing Horizon Europe, the EU's next research and innovation programme starting in 2021.[172]

5.3.2 Sectoral and local adaptation planning in Ireland

Ireland's first National Adaptation Framework (NAF) was published on 19 January 2018.[173]It identified 12 key sectors under the remit of seven government ministers where sectoral adaptation plans were to be prepared. These plans were launched in October 2019 and have a five-year lifespan in line with the NAF, which is also to be reviewed at least every five years.[174]

During 2019, the Departments tasked with the development of sectoral adaptation plans consulted with the Climate Change Advisory Council on their preparation.[i] As some departments produced drafts covering more than one sector, the Council provided advice and recommendations on nine draft plans addressing the 12 sectors. This advice is available on the Council's website www.climatecouncil.ie. Though it was not required, some sectors (for example the Department of Agriculture, Food and the Marine and the Department of Culture, Heritage and the Gaeltacht on its built and archaeological heritage plan) set out how the Council's advice had been considered in the development of the final plan.[175] This is useful and is encouraged for the future.

Established under the NAF, two Climate Action Regional Offices (CAROs) are located along the Atlantic seaboard (Mayo County Council and Cork County Council as lead authorities) with a focus on sea level rise and coastal erosion, one in the eastern and midland region (Kildare County Council as lead authority) with a focus on fluvial flooding and the fourth in the Dublin Metropolitan area with a focus on urban issues. Notwithstanding their particular focus, the four offices work in collaboration to ensure transfer of information and application of best practice across the sector. Their immediate priority was to work with their constituent local authorities to formulate consistent local climate adaptation strategies, all of which were approved by the deadline of 30 September 2019. These strategies are discussed in Section 5.12 below.

The Council submitted a review of the adaptation planning process to the Department of the Taoiseach and the Department of Communications, Climate Action and Environment in December 2019. This recommended that as sectoral plans are now in place, the priority risks that need to be addressed and resourced over their five-year lifespan and beyond must be clearly identified at national level.[176]

The Programme for Government agreed in June 2020 commits that it:

> will continue to take climate adaptation measures to ensure that the State helps protect people from the effects of climate change in Ireland which are already locked in, and we will take steps to limit any damage caused. These measures will continue to build upon the National Adaptation Framework (NAF). We will ensure that each Sectoral Adaptation Plan identifies the key risks faced across each sector and the approach being taken to address these risks and build climate resilience for the future. We will maintain a multi-annual investment programme in flood relief measures to protect communities.[14]

i Under the NAF, local authorities were requested to prepare local adaptation strategies, also by 30 September 2019. Local authorities were not required to consult with the Council on these strategies.

5.4 Monitoring and implementation

Ireland must now build on its adaptation planning and process-based efforts with adaptation action. For example, in total there are 188 actions and 286 sub actions across the sectoral adaptation plans to progress.

The implementation of the sectoral adaptation plans will be closely monitored in future Annual Reviews. At present the Council advises that horizontal and vertical coordination, reporting and prioritisation in the implementation of the sectoral and local plans and in mainstreaming must continue to improve.

Sectoral adaptation plans, local adaptation strategies and the NAF need to be effectively monitored and evaluated and lessons learned around implementation. The discussion of adaptation in the Annual Transition Statement 2019 produced under the Climate Act 2015 repeats much of the substance of the 2018 Statement.[47]

Though the Government's Climate Action Plan 2019 includes some climate adaptation measures, 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. Adaptation should be directly considered when policies and investments are being prepared and evaluated when mainstreaming is most likely to succeed.

To date awareness of the need for, and benefits from, adaptation remains poor. This is reflected in government policy, where the need for adaptation as a core component of climate action remains under-recognised.

The NAF notes that a priority for Ireland will be to develop a range of adaptation indicators to enable progress in reducing exposure and vulnerability and preparing for the long-term effects of climate change to be monitored. As called for in previous Annual Reviews, a robust set of indicators, based on national and international research and best practice, should be adopted by Government as quickly as possible. The ongoing EPA funded 'PCAS – Policy Coherence in Adaptation Studies: Selecting and Using Indicators of Climate Resilience' project should support this goal.[177]

5.5 Recent experience and ongoing vulnerabilities

Extreme events continue to highlight the vulnerability of various sectors and areas of Irish society to climate change. The decisions of policymakers, households, businesses and investors must evolve in recognition of the changes in the frequency and intensity of extremes and in changes in average conditions into the future.

The Council has previously highlighted that the 12 key sectors identified in the NAF do not cover some important areas, for example Housing and Planning, Emergency Management, the financial sector, Tourism and Sport. There are no sectoral adaptation plans in place for these sectors. The current sectors also do not fully address all aspects of coastal change that may be expected due to climate change. With regard to coastal issues and sea level rise there is a need to clarify responsibilities. Issues in planning effectively for sea level rise and coastal erosion are not unique to Ireland, and the Council notes that there has been some progress in this regard.

5.6 Review Report on Severe Weather Events 2017-2018

5.6.1 Key issues

In December 2019 the Department of Housing, Planning and Local Government's National Directorate for Fire and Emergency Management published a 'Review Report on Severe Weather Events 2017 – 2018'.[178] The National Directorate has prepared review reports after each severe weather event since the major flooding of November 2009 as part of a systems approach to learning and developing from each event. As noted in the Council's 2019 Annual Review, it is essential that lessons from recent severe weather events related to increasing Ireland's resilience are highlighted and circulated widely and that findings are made available promptly to inform ongoing adaptation and resilience evaluation and planning.

The review report covers the period between August 2017 and September 2018, which included ex-hurricane Ophelia (October 2017), snow-storm Emma (March 2018), three flooding events[i] and heat wave/drought conditions in summer 2018.

The review report identifies some local compound events, noting for example that a possible contributory factor to landslides in Inishowen following intense rainfall in 2017 may have been wildfires earlier in the year that burned away vegetation and trees on hillsides that had previously provided stabilisation. In the same rainfall incident, six wastewater treatment plants were affected by flood waters and loss of power supply in Donegal. Five were restored quickly to preflood operating conditions, but the Burnfoot treatment plant had extensive damage to its electrical control panels.

The report notes that Ophelia was not a worst-case scenario as it was not accompanied by the kind of flooding that could happen with this type of storm. However, during Ophelia, it is again noted that Irish Water reported significant outages of water treatment plants and waste water facilities, primarily due to the disruption of power supplies. Mobile phone services were also impacted by the loss of power to communications masts located on hilltop sites, with access to many of these restricted by blocked roads. The TETRA Emergency Services Communications Network was also reported as having been affected, apparently due to power issues.

These issues highlight the impact of compound events and a cascading 'domino' effect that adaptation planning must address and a key consideration remains about how resilience measures in one sector that impact on the resilience of other sectors are prioritised and funded. The forthcoming report of the EPA-funded CIViC (Critical Infrastructure Vulnerability to Climate Change) project should provide insights into this for policy makers.

5.6.2 Links to adaptation

As noted in the Advisory Council's 2019 Annual Review, more needs to be done to promote coordination between emergency planning and climate change adaptation planning. Many of the issues raised in the extreme weather report are also discussed in sectoral adaptation plans, but they do not seem to be coordinated.

In Denmark, for example, the Danish Emergency Management Agency (DEMA) assists in ensuring that knowledge about climate change and extreme weather events is considered in the risk-based design of local fire and rescue services, as well as planning on a local level. In Finland,

i Pluvial/ Fluvial Flooding in Donegal/ Inishowen Peninsula – 22/23 August 2017; Fluvial Flooding Event at Mountmellick on 22 November 2017; Tidal Surge Flooding at Galway City – 2 January 2018.

municipalities are to integrate climate proofing reviews into emergency preparedness, while in the Netherlands specific plans for the protection of critical infrastructure, as well as specific emergency management plans for floods, heat waves and forest fires do consider climate change to a certain extent. Disaster risk management in France is based on plans published at the level of each local département, which set out how the response to a range of risks will be organised. These plans include the identification of key climate-related risks and take account of climate change and modelling (e.g. in relation to flood risk zones). The plans ensure that climate impacts and projections are addressed in disaster prevention and preparedness and emergency management.[179]

The ongoing EPA funded research project 'Enhancing Integration of Disaster Risk and Climate Change Adaptation into Irish Emergency Planning' should provide an insight into approaches to some of these issues and how they are addressed in sectoral and local adaptation plans and strategies.[180] Ireland's National Energy and Climate Plan submitted to the European Commission suggests that the Climate Action Regional Offices (CAROs) will further improve alignment between adaptation policy and emergency responses at local level.[181]

5.7 Recent events

Storm Ellen brought unseasonably wet and stormy weather in August 2020, with a status red warning for Cork. Over 190,000 premises lost power as a result of the storm. Flooding in County Cork due to the storm confirms the need for holistic and joined-up responses to climate risks across sectors and departments and from national to local level. Storm Francis, also in August 2020, saw orange rainfall warnings for a number of counties along with yellow rainfall and wind warnings elsewhere. The latest climate model projections suggest that Ireland will likely see more frequent heavy rainfall events, as our planet continues to warm.[182]

In January 2020 Storm Brendan saw yellow and orange weather warnings and 48,000 electricity customers without power. February and March 2020 were characterised by extensive and long lasting flooding in the Midlands, with February 2020 an exceptionally wet and windy month. Storm Ciara and Storm Dennis, also in February 2020, were reported as responsible for several deaths and disruption across Europe. In the UK, Storm Ciara was reported as causing fatal accidents: 675,000 homes lost power during the storm and there was significant travel disruption with several rail companies issuing 'do not travel' warnings. Storm Dennis was reported as bringing the worst winter floods of recent times in the UK, with an unprecedented number of flood warnings.

In February 2020, a school on Achill Island, Co. Mayo had part of its roof ripped off by strong winds highlighting the importance of ensuring that building and maintenance standards are aligned with future climate scenarios. Floodwaters closed sections of the Limerick and Galway train line in February 2020.[183]

In October 2019 flooding rendered parts of the M8 motorway in Tipperary impassable.[184] This confirms the vulnerability of our transport infrastructure to extreme weather events though the sector has one of the most advanced adaptation plans. It is noted that the Jobs Stimulus Plan announced by the Government in July 2020 includes €10 million for the adaptation of the road network to protect it in respect of climate change (including repairs to damaged roads as a result of severe weather events). However as discussed below a more coordinated approach to assessing the costs and investment associated with climate change is required.[185]

In January 2020 the Local Government Management Agency (LGMA) published 'A Profile of Local Government Climate Actions in Ireland'.[186] This recognises that as climate events take effect through extreme weather, on the ground responses are required to deal with those extreme weather events as they arise, i.e., emergency response. The LGMA research also recognises that climate change will place additional demands on local authorities to respond when such extreme weather arises.

The socioeconomic costs of events such as these are considered further in Section on 5.11.

5.8 Communication and information for decision making

Good communication during extreme weather events and regarding the risks posed by Ireland's future climate is essential. The response to Covid-19 has seen intra- and inter- governmental cooperation at the global scale that is also needed for climate action. The communication of the problem and the actions by the WHO and national governments have demonstrated that individuals, communities and businesses can understand science, data and risk and can respond appropriately, taking ownership of their responses with a notable commitment to actions for the common good.

This is recognised in a statement of principles issued by the C40 group of cities in May 2020 which states that the harm caused by Covid-19 has not been equitable, that it is in part a consequence of ignoring science-based knowledge and that climate action can help accelerate economic recovery and enhance social equity while increasing the resilience of cities and communities.[168] The Covid-19 recovery also presents opportunities to increase Ireland's resilience to shocks and learn more about our supply chains and how our infrastructure and technologies respond to heavy loads or changed usage patterns. Irish Water called for water conservation in May, noting that increased home working combined with dry weather was placing pressure on water supply, for example.[187] However, there were also some instances where lack of guidance and misinformation led to avoidable 'panic buying' of various products and inappropriate social activity within key demographics.

Following Storm Lorenzo in October 2019, Met Éireann faced criticism of its weather warning system, in response it stated that the media had 'hyped up' a yellow weather alert (these are for weather conditions that do not pose an immediate threat to the general population, but only to those exposed to risk by nature of their location and/or activity).[188] Storm Elsa in December 2019 brought further criticism of the national warnings: an orange wind warning was seen as coming too late for some residents of Galway, though a yellow warning had been in place for much of the day.[189,190] During Storm Brendan Met Éireann advised that fake or false warnings were being shared over social media.[191] All this demonstrates the need to increase public understanding of weather warnings and how they, and risk, are communicated to the public and authorities. It also highlights the importance of a single authoritative weather voice in Ireland during an extreme weather event.

The Department of Housing, Planning and Local Government's 'Review Report on Severe Weather Events 2017 – 2018' suggests that one of the limitations of the current weather system is that warnings are issued on an all-county basis: while a warning for an expected extreme weather event may be for a particular part of a county the whole county is placed under the warning. It also notes that multiple weather warnings may be in place at the same time – for example, separate wind and rain warnings may issue for the same period and the same locations, and this

can be confusing for the public – while noting that the distinction between a higher end orange warning and a lower end red warning, for example, may be blurred. The review report considers that while the warnings are impact based (looking at the damage that may be caused rather than just the conditions), the public are the ultimate key decisionmakers who receive Met Éireann information, and each individual has to decide to react in their given circumstances. The review considers that the warnings are designed to get attention, and 'are widely recognised, if not fully understood at times'. This may suggest that more is required to ensure households understand how to respond to extreme weather events.

5.9 Societal climate resilience

So far, the literature on adaptation has focused on the role of governments, however the efforts of governments alone will not be sufficient to reduce the impacts of climate change.[192] To maximise the impact of government investment and resources individuals must take adaptive measures too.[193] Indeed, the NAF argues that most adaptation actions will be taken by individuals, households and businesses, as they adjust independently to their circumstances due to their experiences or perceptions of climate risk.

Climate change is creating new challenges for both governments and citizens with regard to their rights, obligations and responsibilities while also placing a burden on the Voluntary sector.[193] In their response to extreme events such as flooding, authorities can fall short of the responsibilities expected by their citizens as part of the social contract.[194] 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. However, we may also see households unwilling to take personal responsibility for flood protection, for example.[193] Households that do not implement even basic adaptation measures may increase the strain on emergency responders during extreme events. The public's response to the Covid-19 pandemic may present lessons in this regard.

While adaptation by individuals and households can be highly effective in reducing the impact of climate-related hazards, many people are not (yet) engaging in adaptive behaviour, or they are taking insufficient or maladaptive measures.[192] Adaptation actions by households may be relatively simple and cost effective (for example, changing behaviour during a heat wave, adapting houses at risk to minimise flood damage or choosing permeable surfaces in gardens). However, those most at risk may also be the most vulnerable, without the capacity to make such investments.

Further consideration should be given to how insurance can provide a financial incentive for high risk households and communities themselves to take action to prevent flooding losses and increase property-level flood resilience. The NAF recognises that vulnerable socio-economic groups are, however, the least well equipped to engage in autonomous adaptation such as the purchase of flood insurance.

Research has found that media coverage in the UK presents adaptation as a response to immediate threats such as flooding, which are dependent on national government action and intended to preserve the current way of life. There was little discussion of long-term challenges and compromises. The authors caution that this narrow view of adaptation focussing on flooding and government response might undermine individual adaptation efforts, disengage those not facing flood risks and restrict the range of policy options under consideration.[195]

Not feeling personal responsibility to reduce the risks of climate-related hazards has been recognised as an important barrier to successful adaptation.[192] Households that experience hazards such as floods have a heightened perception of risk, are more prepared, are more willing to make household level changes and are more civically engaged on solutions compared to those who lack direct experience.[196,197] This suggests that sharing people's experiences alongside communicating changing risks could help shift the focus from citizens' expectation that governments will always provide protection, to a dialogue among citizens, communities, and local and national government about the implications of climate change on hazards like flooding and a more risk conscious society.[196] The National Dialogue on Climate Action may be an ideal forum for this.

The role of spatial planning in ensuring development does not occur in inappropriate locations remains essential.

However, while flooding is a relatively common occurrence in some parts of Ireland, other impacts of climate change such as sea level rise, drought and coastal change may be slower and less understood locally. It is therefore more likely that roles and perceived responsibility will be less clear.[197] However, locally led initiatives such as the Maharees Conservation Association, founded in response to the problems associated with the worsening coastal erosion at Maharees, Co. Kerry, show that, if supported, some local communities can have the capacity to lead local adaptation responses on these issues.

The Department of Housing, Planning and Local Government's 'Review Report on Severe Weather Events 2017 – 2018' incudes a discussion on 'societal resilience'. Given the importance that both emergency planning and the NAF place on individual households, businesses and communities taking steps to increase their resilience and reduce their vulnerability, further coherence must be brought to this discussion. This is required to ensure that any expenditure is committed wisely, maladaptation is avoided and co-benefits are maximised. The need for education and training across many sectors and at community level is common to emergency planning and adaptation planning and this should be leveraged.

Of relevance to this is the submission from Aontas (Ireland's national adult learning organisation) to the Department of Health's consultation on its sectoral adaptation plan which argues 'Government adaptation policies over the coming years that do not include non-formal adult and community education of the general population in the creation and implementation of the policies may lead to disinterest in Government action, a lack of support for policies, and in a worst case scenario hostility and a backlash against policies imposed by Government. [198]

As noted above, individuals will have to accept some personal responsibility for protecting themselves and their property against changing climate risks. However, local and national government will have an increased responsibility to demonstrate leadership, build local capacity and engage in dialogue with communities on the long-term responses available and decisions that will be required. This will also require clear direction and leadership from central government to enable and support local government and agencies in their response to the effects of climate change though the uncertainty associated with climate change risks can make it difficult to build consensus. Government must also make clear what changes in individual and household behaviour are required to adapt to climate change and how maladaptation can be avoided.195 There may also be a role for innovative consultation, co-production of solutions and capacity

building, and the harnessing of virtual technologies to assist in eliciting emotional responses from individuals and making climate change more 'real' and locally relevant.[199]

5.10 Resilience of the financial system

Climate change will have significant implications for the financial system in areas such as insurance, mortgages and investment funds. The increasing severity 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, arising from the move to a low-carbon economy. The uncertainty associated with climate change and its impacts makes it challenging to integrate climate related risk analysis into the work of central banks, regulators and supervisors. Despite this, central banks must prepare for disruptive, climate related 'green swan' risks.[200] Green swans are different from surprise 'black swan' events because there is some certainty that climate change risks will one day materialise, though their scale and timing is still uncertain as they are also dependent on whether we achieve deep cuts in emissions.

In 2017 De Nederlandsche Bank (the Central Bank of the Netherlands) explored climate-related risks for the Dutch financial sector. It intends to embed climate-related risks more firmly in its supervision.[201] The Bank of England is to use its delayed 2021 biennial exploratory scenario (BES) to test the resilience of the current business models of the largest banks, insurers and the financial system to the risks of climate change.[202] The BES is part of the bank's stress testing framework used to explore less well-understood risks and will provide a comprehensive assessment of the UK financial system's exposure to climate related risks.

Here, the Insurance Directorate of the Central Bank of Ireland has informed the insurance industry that it will seek to engage further in relation to climate change, and emerging risks more broadly, saying that it expects Irish insurance undertakings to ensure that they give appropriate consideration to the assessment of climate related risks and adopt a longer-term perspective than typical business planning and strategy setting processes.[203]

There is no sectoral adaptation plan for the financial system, and the capacity of the sector to assess climate risks and adaptation options must be developed. Further work by the Department of Finance and the Central Bank is required to ensure that such impacts on the financial system are understood. This will be complex, assessing multiple climate scenarios and transition pathways over several decades.

The financial sector in Ireland must understand, assess and communicate its climate-related risks in a coordinated way. As these conditions are developing internationally, the financial sector in Ireland will need to evolve and innovate to address and finance the transitions needed for a climate-resilient low-carbon economy.

5.11 Measuring costs and assessing investment requirements

According to the Global Commission on Adaptation investing $1.8 trillion globally from 2020 to 2030 could generate $7.1 trillion in total net benefits by avoiding losses and bringing environmental, social and economic benefits.[204] Climate adaptation can be expensive, but inaction will likely cost more.[205] For example, 2013 research suggested that the additional costs of new climate resilient infrastructure and buildings in Ireland could be €80 – 800m per year.[206] However globally it is

recognised that there are significant data and theoretical gaps in how adaptation solutions are financed and their impacts tracked.[207]

While it is essential that we identify the investment cost of adaptation, adequate cost-benefit analyses require accurately capturing the costs of inaction, including those from disruptions and losses from extreme weather events now and into the future.

When reviewing draft sectoral adaptation plans, the Council found that overall there was limited information on the potential costs of climate change for sectors and potential benefits of adaptation action. In most cases it was not clear what resources, both current and capital, were required to deliver the plans. The NAF anticipates that sectors will reflect their key priorities within the annual budgetary and estimates processes. This will likely 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 Ireland resilient by 2050 and beyond, based on 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 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. A number of international and European studies (from for example the UNFCCC[208] and the European ECONADAPT[209] and MEDIATION[210] projects) describe best practice in the economic assessment of adaptation options. Some of the best forms of adaptation may mean little or no additional (direct) costs, but mainly require considering adaptation when making other investments.

Relevant here are the Guiding Principles for Adaptation as outlined in the NAF, which include that sufficient financial resources for adaptation must be made available and that adaptation actions must be prioritised according to relevant criteria such as efficiency, cost-effectiveness, risk and urgency and ensuring a Just Transition. The local authority and sectoral adaptation guidelines also discuss how to prioritise both climate risks at the appropriate scales and, following this, identified adaptation options for implementation.

The involvement of the Department of Public Expenditure and Reform (DPER) in adaptation planning is welcome but further action is needed to integrate climate action in government policy, programmes and investment decisions. It is imperative that the role of DPER and the Department of Finance in championing adaptation be strengthened. This will aid effective mainstreaming and enhance the likelihood of more effective adaptation investments.

Recent research on coastal protection in Europe has found that for Ireland annual coastal flood losses at the end of this century could amount to 1.8% of GDP. When considering the costs of coastal protection and maintenance versus avoided losses from coastal flooding, investment in flood defences was found to be particularly economically beneficial in Ireland. Though this study is a high level analysis and did not consider the cost of potential damage of such works to ecosystems, for example, it is useful to progress the discussion on Ireland's real adaptation requirements.[211]

The 'Review Report on Severe Weather Events 2017– 2018' prepared by the National Directorate for Fire and Emergency Management notes that more coherence across government is required

in assessing the costs of severe weather and ensuring that the economic loss, costs and damage are captured. The report states that 'there is a requirement for a national model to define a cost estimation methodology so that data can be assembled which is underpinned by financial expertise and can be validated'. This discussion is echoed in some of the sectoral adaptation plans with the Transport plan stating 'there is currently no definition of climate-specific investment available which would allow sectors to easily categorise relevant climate-specific expenditure; maintenance, upgrade, and repair activities are typically captured as routine investment within business continuity management processes. Service providers were also unable to estimate indirect costs such as revenue forgone.' [212]

The EPA-funded TACT project (Methodologies for Financing and Costing of Climate Impacts and Future Adaptation Actions) should also provide insights (anticipated in 2020).[213] This is specifically looking at the costs of climate change for road, rail and maritime networks. Greater information sharing by the insurance industry may be part of this.

Irish local authorities spent a minimum of €101 million in responding to emergencies following extreme weather events between 2014 and 2018, but some local authorities do not have management systems to record such spending.[214] The National Directorate for Fire and Emergency Management suggests that local authorities recouped €75.7 million from the Exchequer between 2009 and 2018 for severe weather response and subsequent clean-up activities, but notes that this does not capture all costs.

These topics have been subject to a number of European research projects,[215,216] but more work in an Irish context is required. At a local and household scale some limited work has been undertaken here. For example, a 2019 study estimates the total cost of the disruption to commuting in County Galway as a result of flooding during the winter storms of 2015/2016, specifically Storm Desmond, at €3.8 million. This does not count any costs imposed on commercial vehicles, disruptions to business activity or supply chains, etc. The results show that those already facing large commuting costs were burdened with extra costs by the floods due to additional commuting time and distance, with rural areas particularly vulnerable. In areas that were badly affected, extra costs amounted to 39% of earnings (during the period of disruption), with those on lower incomes suffering proportionately greater losses.[217]

To deliver authoritative information on exposure, hazards and risk, many national governments, particularly in the EU, have supported the development of web-based climate information platforms as a means of aiding the development and implementation of national adaptation plans and strategies.[218]

Ireland's climate information platform, Climate Ireland, currently serves as a central source of climate data for Ireland, consolidating authoritative information from a variety of sources such as Met Éireann, the Office of Public Works (OPW), the Environmental Protection Agency, the European Environment Agency, academic research and the IPCC, to assist a variety of stakeholders in planning ahead for the anticipated impacts of climate change.

In line with the NAF and the Climate Action Plan, the provision of information resources such as Climate Ireland needs to be further developed, consolidated and supported with appropriate funding, governance and technical advisory structures. How authoritative information is provided to the public and businesses must also be considered.

5.12 Adaptation and Irish cities

In this Annual Review, the Council gives particular consideration to the challenges and opportunities facing the five Irish cities – Dublin[i], Cork, Galway, Limerick and Waterford – in adapting to and building resilience to climate change. This is in light of research whereby city authorities are increasingly recognised as the level of government best suited to responding to climate change,[219] and the National Planning Framework anticipates that the population of Irish cities will increase by 50% in the coming years. [35] Urban development that ignores climate risks increases a city and its hinterland's vulnerability to climate change and hazards and misses the opportunities for economic development and improved quality of life that adaptation can bring.[220]

Compound events may contribute to enhanced risk, particularly in urban areas. Also, as critical socioeconomic infrastructure is located in our cities, their overall resilience depends not only on their own adaptation planning but on the sectoral adaptation strategies prepared by key government departments. Therefore, considering our cities presents the opportunity to assess the capacity of local authorities and sectors to respond to climate change in a coherent manner within the adaptation governance structures in Ireland.

With their role in the natural and built environment and in managing climate risks and vulnerabilities, both urban and rural local authorities have a key role in effective climate action. They deliver key services to the public either directly or in partnership with government departments such as housing, planning, water, environment, waste, transport, parks and enterprise and community development, all of which offer a significant opportunity for climate action.

Further actions have been assigned to local authorities by the Climate Action Plan 2019. They include the signing of the Climate Action Charter, which recognises the strategic position of local government in providing robust leadership at local and regional levels and the need for central and local government to work in partnership and collaboration. The Charter confers obligations on the sector beyond adaptation and the local level also provides examples of measures with adaptation and mitigation cobenefits, in social housing retrofit, for example. Local authorities have recognised the scale of the challenge, embarking on a Strategic Management Initiative process to deliver on their climate change obligations and provide the necessary leadership at local level.

i For adaptation planning purposes this includes Dublin City Council, Dún Laoghaire-Rathdown County Council, Fingal County Council, and South Dublin County Council.

5.12.1 Adaptation planning and Irish cities

Building on the cities' climate adaptation strategies, examples of potential risks and challenges from the cities are discussed below.

- For Dublin City the key risks are the urban heat island effect, sea level rise and flooding both fluvial and coastal. The River Liffey is the heart of Dublin, and as a tidal river it poses unique challenges for the city in terms of flood risk. Dublin has grown around this river, which plays a significant role in the city's history and is a defining feature. Protecting the river and the city calls for a mix of solutions that are developed in collaboration with various agencies, specifically the local authorities, OPW, Irish Water, ESB, EPA and Waterways Ireland, as the solutions must consider the need to balance flood risk management, drinking water supply and water quality, which will become more difficult in the context of climate change.

- In Cork the highest priority risks are fluvial and coastal flooding. Cork City Council's Climate Change Adaptation Strategy recognises that the 'likelihood of a major flood event multiplied by the consequences of such an event in terms of danger and damage to citizens and infrastructure is greater in Cork city than many other cities.' However, there may be a disconnect between the assessment of the climate challenges facing the city in the council's adaptation plan and the attitudes, ambitions and expectations of city stakeholders – including other sections of the council itself. It has been found that some lobby groups may not adequately consider future climate change risks in their proposals for the city.[221] This is not a unique challenge facing Cork but it demonstrates the importance of communication, and narratives around climate policy to form shared visions of the city's future.

- Coastal flooding, low temperatures, strong winds, extreme rain and high temperatures with low rainfall appear to be the highest priority risks in Galway City Council's adaptation strategy. The Advisory Council has noted that under the NAF there is no sectoral adaptation plan for Tourism. Changes in temperature that lengthen the summer season may allow for a longer tourist season. However, increased tourist numbers in a changed climate may lead to potential water stress or have negative consequences for biodiversity and habitats. Further, changes in precipitation and extreme weather may impact negatively on Ireland's natural and cultural heritage, which the sector depends on. Galway City is one of the most popular tourist destinations outside of Dublin, it is the European Capital of Culture for 2020, and its local adaptation strategy anticipates an increase in visitors due to climate change (owing to its coastal location and potential attractiveness to overseas and domestic tourists during any extended summer season). The strategy seeks to ensure that adaptation is considered in Galway City's Tourism Strategy alongside an analysis of the potential impacts of climate change and adaptation/mitigation measures on natural, heritage, cultural and amenity sites relevant to tourism. This will require learning from the high temperatures of the summer of 2018, for example, where increased usage of beaches and public spaces necessitated increased litter management in the city.

- Limerick City and County identified fluvial flooding, heatwaves, coastal flooding and wind storms as the highest priority risks. The OPW's Flood Risk Management Climate Adaptation Plan (2019) includes a case study of coastal flooding and Limerick City, presenting flood extents for a 200-year event now compared to such an event with 1m of sea level rise under a climate change scenario. This shows that an estimated 1,122 residential properties and 248

business properties are currently at risk from flooding during the 200-year event. Under sea level rise of 1m, the number of residential and business properties at risk is predicted to more than double in comparison to the current conditions. The cost of flood damage at Limerick City and environs is currently estimated at over €83 million for the 200-year event and this is predicted to rise to over €1 billion under the presented climate change condition. This corresponds to an increase of 12.5 times in comparison to current conditions.

- Sea level rise, heat, extreme cold/snow, flooding and wind storms are identified as the highest priority risks in Waterford City and County Council's adaptation strategy. Waterford City has experienced severe flooding on a regular basis due to high tidal and water levels in the two rivers. The Waterford City Flood Alleviation Scheme was completed in 2014. The scheme design was amended to incorporate glass walls and address concerns that other proposals would cut off the city's relationship with the river. Its implementation shows that when 'grey' engineering interventions are put in place there is scope for sympathetic, though costly, design solutions in sensitive locations where feasible.

5.12.2 Lessons for Irish cities

Lessons from international and European city networks show that building urban resilience will require a long term vision, innovation in institutions and governance, consideration of equity issues, and mutual learning – most particularly with regard to implementation. Coherent proposals from Irish cities are required that quantify the cost of implementing grey, green and soft adaptation measures to 2050. This should inform the overall national assessment of adaptation investment referred to above.

Irish cities can continue to learn from global best practice in addressing shared issues such as flooding, drought, urban heat islands, extreme weather events, sea level rise, sustainable urban drainage, citizen engagement, maintenance, integrated water management and behaviour change. Irish cities also can provide examples of best practice and innovation.

Mitigation and adaptation responses in our cities need to be coordinated to maximise synergies and achieve inherent co-benefits. In particular, there is an opportunity for cities to address key issues such as energy poverty, 'transport deserts' (when a community lacks necessary public transport options to live without driving) and 'food deserts' (areas with limited access to affordable and nutritious food), while responding to climate change. Cities have the capacity to embed equity in responses to climate change and implement policies that enable a Just Transition through spatial planning. These approaches increase public acceptance in recognition of the common good and adherence to the social contract. The implications of climate change for cities must inform all decision making, in a deeper and more integrated way than at present.

Developments such as the Office of the Planning Regulator and three new Regional Spatial and Economic Strategies present an opportunity to implement reforms that will enable local authorities not only to physically adapt Irish cities and towns to climate change, but also to support the resilience of the people and communities who live in rural and urban Ireland. There is a need to involve local communities early and meaningfully in adaptation decision making.

Discussions regarding climate change and planning have, so far, been focused on forward planning and it is still not clear how climate action is going to be reflected in development management decisions driving, for example, the adoption of Sustainable Urban Drainage Systems (SuDS).

Climate policy, planning policy and building regulations all need to be better aligned to deliver both mitigation and adaptation goals.

Planning authorities must consider the design and regulation of development to counteract the heat island effect for example, promote development of brownfield sites to limit urban sprawl, co-locate residential accommodation with employment centres, enhance the public realm and collaborate with statutory and other agencies to enhance sustainable travel modes of walking, cycling and public transport and roll out vehicle charging infrastructure.

As urban mitigation and adaptation policy continues to evolve, the need to address gaps in knowledge and provide enhanced evidence to support policymaking will grow. Developing how adaptation and our cities' resilience are measured and evaluated is essential, as is enhanced cooperation and data sharing both within and across local authorities as well as across departments, agencies and other bodies.

The recent EPA funded 'Large Urban Area Adaptation' (Urb-ADAPT) research project focused on the Eastern and Midland Regional Assembly (EMRA) region and aimed to support the development of robust strategies to make the Dublin urban area and hinterland more resilient to climate change. Urb-ADAPT's primary objective is to assess the spatial and temporal variations in levels of priority urban impacts for the EMRA region (urban overheating, pluvial flooding and coastal inundation) for the current period and for a number of future climate change scenarios from the 2020s to the 2050s and beyond.[222] Irrespective of the future climate scenario used, Urb-ADAPT found that the EMRA region will be exposed to increasing levels of climate impacts in terms of heat, pluvial flooding and coastal inundation in the coming decades. Its recommendations include further consideration of heat adaptation in development plans and development management and that greater coherence is needed between flood risk management plans, marine spatial plans, climate adaptation plans and local authority development plans. Ongoing research such as the Science Foundation Ireland/Geological Survey Ireland/Marine Institute funded programme for research 'PREDICT – Integrating multidisciplinary geoscientific data into forecasting models to monitor and predict coastal change: Proof of concept in Dublin Bay', which will generate forecasting models that can be used to predict environmental change and inform future planning, is also relevant.

6. Perspectives on Agriculture and Land Use

Section 4.2 outlined the trends in Agricultural and Land Use emissions and removals. Under the 'with existing measures' (WEM) scenario, agricultural emissions are projected to increase steadily to 2040. The Climate Action Plan sets explicit reduction targets for agricultural emissions for the first time. Based on the set of feasible and cost-effective measures for emissions reduction reviewed in the Teagasc Marginal Abatement Cost Curve, the Plan also outlines the measures required to achieve this reduction target. The Council underlines the importance of full implementation of the measures proposed, but also believes other measures will need to be considered. Land use in Ireland is also a net source of emissions, primarily due to the ongoing drainage of organic soils. In this chapter, Council discusses the specific actions required to 'bend the curve' on agricultural and land use net emissions, taking account of the potential in the sector for removing and sequestering carbon.

There is opportunity within the Agriculture, Forestry and Land Use sector to advance carbon neutrality while providing multiple co-benefits to society including the biofuels to displace fossil fuels from Power Generation, Heat and Transport sectors. Mitigation activities within this sector can provide additional ecosystem services including: protecting biodiversity; improving soil, air and water quality; enhancing resilience to climate change; and supporting Ireland's natural environment.

6.1 The policy context

Agricultural emissions are increasing while the potential for land use removals needs development.

Agricultural emissions in 2015, when the milk quota was removed, were 19.1 Mt CO_2eq. By 2018 they had increased to 20.6 Mt CO_2eq, an increase of 7.6%.[2] Total emissions from farming amounted to 34% of Ireland's total emissions and close to 45% of emissions from the non-traded sectors (Agriculture, Transport, Heat, emissions from low intensity Industry, Waste). The dominance of agriculture as a source of greenhouse gas emissions in Ireland is unique in Europe. Methane emissions amount to 62.9% of agriculture emissions, and the biggest abatement challenge for the sector is that, apart from efficiency gains, there is no means available at scale to reduce enteric methane emissions without reducing livestock numbers.

In framing discussion of policy change in Agriculture and Land Use, the Council seeks to ensure that options considered have the potential to achieve substantial reductions in greenhouse gas emissions while, at the same time, taking account of other policy objectives, such as safeguarding the incomes and the long-term financial security of farmers and land managers.

The Agriculture sector faces considerable immediate challenges from Brexit and longer-term challenges where consumers attach higher value to environmental integrity and local sourcing of high value foods, and where reform of EU agriculture, food and land use policies are increasingly designed to meet sustainability criteria. There is the potential for considerable market risk for Irish agri-food exports in premium markets if emissions continue unabated. Bord Bia has the opportunity to further strengthen the scope and ambition of Origin Green so that it remains a leader among national sustainability schemes. In this context, in order to enhance the credibility of findings arising from Origin Green it needs to be able to demonstrate and verify the positive impact of changes at farm level and that these are consistent with reporting and communicated transparently to markets. This will require independent assessment of data and low-cost,

accurate and robust systems of measurement and assessment of greenhouse gas fluxes at farm level so that each farmer would know their emissions profile.

It is important not to neglect the close relationship between agriculture and land use management. Agriculture is the dominant land use in Ireland, occupying 60% of total land area, of which 90% is grassland. Projections of the emissions and removals associated with land use can be seen in Figure 2.20. Although some progress is expected in reducing carbon losses from wetlands and grasslands with implementation of measures in the Climate Action Plan, both land-use categories will remain significant sources of emissions. There is strong evidence that more can be achieved through improved management of both mineral and organic soils.[22,223,224,225,226,227]

The projections for emissions and removals associated with the Forest Land category are more complex. A significant proportion of the country's commercial forest is expected to reach harvesting phase in the late 2020s and 2030s, and the rate of harvesting is expected to exceed the rate of accumulation in the remaining forest, based on current forest management practices and afforestation rates. The switch from sink to source is the result of a combination of a peak in afforestation rates in the 1990s and the decline in afforestation rates in more recent years. A significant increase in current afforestation rates, a decrease in projected harvesting rates, or a combination of the two would be required to avoid this scenario. Therefore, forests are projected to become a net source of emissions. However, how we use the raw materials harvested from forests can represent a sink of carbon. This is captured in the projections of the carbon reported in the Harvested Wood Products category.

Agriculture and Land Use emissions, at least up to a certain point, can be considered together and a joint reduction target set

The decisions farmers take on the scale and choice of enterprise, the management practices they adopt and the way they manage their land determine their overall carbon footprint, including gross emissions of greenhouse gases as well as potential removals through both above-ground woody biomass (for example, in hedgerows, woodlands, agro-forestry and afforestation) and carbon stored in the soil. It therefore makes sense to treat these decisions in an integrated way and to track progress in terms of the net impacts rather than looking at Agriculture and Land Use in separate sectors.

Under both UNFCCC and EU reporting structures, agricultural emissions are reported separately from emissions and removals associated with the Land Use, Land Use Change and Forestry (LULUCF) sector. Furthermore, in the EU climate package, agricultural emissions are included the national reduction targets set in the Effort Sharing Decision (to 2020) and the Effort Sharing Regulation (to 2030). Potential emissions and removals from land use were not included in the EU's 2020 climate package.[i] Although the sector has been included in a limited way as part of the EU's 2030 climate framework, through the LULUCF regulation.[228]

i Net emissions from some land use activities are covered by Ireland's obligations under the Kyoto Protocol for the 2013 – 2020 commitment period.

The 2030 Climate and Energy Framework sets a stand-alone 'no-debit' target for the LULUCF sector. If this condition is fulfilled, then a Member State can use a limited transferability of removal credits and emission debits between the effort sharing sectors including Agriculture and the Land Use sector.[i] This fragmentation of targets across Agriculture and Land Use sector is not conducive to coherent policy development or a cost-effective transition. The current reporting structures create an artificial disconnect between how lands are managed and the goods and services they provide. A more unified approach at EU level in the treatment of land use and agriculture in forthcoming negotiations on the European Climate Law and the proposal to raise the 2030 reduction targets could create the necessary enabling conditions for improved policy development across these sectors.

Progress at EU level, although desirable, is not necessary for Ireland to adopt an integrated approach in national policy development. The Council recommends that the Government should develop a set of inventory and projections assessments that show agriculture and associated land use emissions and removals calculated according to the EU's policy-determined accounting rules in an integrated way. This would be in line with the National Position, which aims at achieving carbon neutrality in Agriculture and the Land Use sector, including forestry. Maintaining a different national perspective compared to the EU or international framework is not unprecedented. For example, in national reporting, agricultural emissions include emissions from on-farm use of fossil fuels, which are reported within the Energy sector in international reporting.

The Council is aware that measurement of and accounting for land-based emissions and removals is subject to particular difficulties, including greater measurement uncertainty and the possibility that sequestration gains can be easily reversed. The exceptional spike in national emissions in 2017 of 1.9 Mt CO_2eq due to wildfires across various land uses testifies to this. Investment will be needed to strengthen the robustness and reliability of estimates of land use emissions and removals. In principle, however, the Council believes it makes sense to set an integrated target for agriculture and associated land use and to track trends in net emissions together. Farmers make decisions simultaneously on how to manage production and how they will manage their land, and these decisions impact on emissions and removals from Agriculture and Land Use.

Net emissions from commercial forestry land and peatlands can continue to be reported separately as these are not directly affected by farmers' decision-making on agricultural land.

This approach can ensure that farmers are presented with a consistent set of incentives and that there is a coherent target for reducing net emissions from agriculture and related land use that can be reached by changes in farm practices and land use under the control of farmers themselves.[ii,229]

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i As part of the 'no-debit' rule, any increase in net emissions from the LULUCF sector up to 2030 must be covered by allowances transferred from the effort sharing sectors. On the other hand, Member States have the possibility to use a limited amount of emissions reductions in the LULUCF sector to offset emissions in the effort sharing sectors. Ireland can make use of the possibility to use up to 26.8 Mt CO_2 of emissions reductions in the LULUCF sector over the period 2021-2030 to offset emissions in the effort sharing sectors. This amounts to around 10% of the total LULUCF flexibility allowed across the EU.

ii The Scottish government has taken steps to modify its reporting of inventory emissions in the direction discussed here. It reports agriculture and related land use emissions as a single sector covering emissions from livestock, agricultural soils, stationary combustion sources and off-road machinery. It also includes net emissions from cropland and grassland along with net emissions from land converted to cropland and grassland. For further discussion see (Bell, Cloy and Rees, 2014).[229]

Treating biogenic methane differently in target setting

The greenhouse gases emitted from agriculture in 2018 totalled 20.6 Mt CO_2eq, mainly methane (CH_4) - 63% of total - and nitrous oxide (N_2O) - 32% (see Table 6.1). Much of the methane emissions are due to enteric fermentation – a product of digestion of cellulose in the rumen by cattle and sheep – amounting to 56% of total agricultural emissions. Methane and nitrous oxide differ in terms of their residence time in the atmosphere. Methane has a short residence time (10 to 12 years) while nitrous oxide has a long residence time (100 years+). The residence time has implications for how emissions can be managed to achieve climate neutrality, i.e. with no additional impact on climate in the medium to long term.

Table 6.1: Sources of Irish agricultural emissions, by greenhouse gas, 2018

	All GHGs	CO_2	CH_4	N_2O
	Mt CO_2eq (%)			
Agriculture	20.6	1.2 (5.7%)	13.0 (62.9%)	6.5 (31.5%)
Enteric fermentation	11.5 (55.9%)		11.5 (89.0%)	
Manure management	2.0 (9.5%)		1.4 (11.0%)	0.5 (8.4%)
Agricultural soils	5.9 (28.6%)			5.9 (90.8%)
Liming	0.5 (2.2%)	0.5 (39.2%)		
Urea application	0.1 (0.4%)	0.1 (7.6%)		
Agriculture/Forestry fuel combustion	0.6 (2.9%)	0.5 (46.1%)		0.1 (0.9%)
Fishing	0.1 (0.4%)	0.1 (7.2%)		
Data source: EPA Inventory, 2020[2]				

The Council has previously noted that in scenarios assessed by the IPCC that successfully limit the increase in global temperature to 1.5°C, it is essential that emissions of CO_2 are reduced to net zero by 2050, and that in most scenarios net removals occur after 2050.[230] However, it is neither necessary nor feasible to reduce methane to zero.[27] The Council recommended that the Government should consider setting separate targets for long-lived greenhouse gases (where net emissions must be reduced to or below zero by 2050 at the latest) and biogenic methane (where emissions need to be reduced but not necessarily to zero). This approach has been adopted by New Zealand in setting its climate targets.[231,232] The target should be set to include all anthropogenic sources of biogenic methane emissions, that is emissions arising from activities and systems directly managed by humans.

A sustained increase in methane emissions contributes to a significant increase in global warming while, conversely, a sustained reduction in methane emissions can contribute to a limited reversal of global warming. At present, both global and national methane emissions are increasing, so there is a need for absolute reductions in methane emissions.

Targets for methane emissions associated with fossil fuel extraction, distribution and use should aim for net zero emissions, as is the case for carbon dioxide, as they arise from the same activities and ultimately the carbon atom within the emitted methane molecule is oxidised to a

carbon dioxide molecule of fossil origin, adding to atmospheric concentrations and warming in the long term.

In its recommendations, the Council is explicit on the use of the term 'biogenic methane'. Biogenic methane emissions arise from natural, biological processes that inherently recycle the carbon from atmospheric carbon dioxide via plants and animals and release that carbon into the atmosphere in the form of methane. When present in the atmosphere, this biogenic methane is a potent greenhouse gas, as is true of all methane. However, it oxidises to recycle the carbon back into a carbon dioxide molecule, with no net increase in carbon dioxide concentrations. This distinction between sources of emissions of biogenic and non-biogenic, including fossil fuels, is elaborated on in the IPCC Fourth Assessment Report.[233]

Setting a separate target for biogenic methane is a non-trivial task. The target for methane emissions from Irish agriculture should be consistent with the objective of carbon neutrality and Ireland's contribution to achieving the global objectives of the Paris Agreement. Setting a target for reduced emissions of methane involves questions of climate science, but also value judgements regarding the role of historical emissions, development pathways for the rural economy and information on the relative economic cost of reducing emissions in different economic sectors.[234]

The Council recognises that Ireland remains bound by its legal commitments under EU legislation to achieve a certain target reduction in emissions based on aggregating all gases according to their Global Warming Potential, particularly in the period to 2030.

Nevertheless, the Council believes that the government should invest in research efforts to bring consistency to the reporting and accounting rules as they apply to the objectives of the Paris Agreement and to engage constructively in the negotiations on the proposed revision of the EU's 2030 effort sharing targets, and to persuade its EU partners of the validity of a split-target approach, with separate targets for biogenic methane. How the IPCC's Sixth Assessment Report addresses this issue will play a crucial role. In the meantime, the Council sees merit in using the split target approach for national purposes when deciding on sectoral reduction targets for 2050, but recognises that the national ambition must ultimately ensure achievement of our legal obligations under the Effort Sharing Regulation.

The Climate Action Plan

The Climate Action Plan, for the first time, sets out a specific reduction target for agricultural emissions. Agriculture has been assigned a reduction target of between 10 – 15% relative to projected 2030 emissions with current policies in place (equivalent to a 10% reduction relative to 2017 levels, or an 8% reduction relative to 2005).

The emissions reductions envisaged in the Climate Action Plan within the Agriculture sector are presented relative to a projection of a business-as-usual scenario. This type of analysis is useful in exploring the options and potential impacts of the implementation of measures. However, national targets are set relative to emissions in 2005, and the cost-effective contribution of agriculture to achieving these targets should be viewed in the broader context of relative cost-effectiveness of achieving similar or greater emissions reduction across other sectors.

In absolute terms, the requirement is to achieve a reduction from a baseline projected annual agricultural emissions of 21 Mt CO_2eq in 2030 to between 17.5 – 19 Mt CO_2eq in 2030. The annual rate of emissions is projected to decrease steadily over the decade.

Between 2021 and 2030, the cumulative emissions savings, with full implementation of the Climate Action Plan, are estimated to be of the order of 16.5 – 18.5 Mt CO_2eq , including contributions from methane and nitrous oxide emissions abatement measures, roughly equivalent to one year's emissions from the sector.

In addition, the Climate Action Plan identifies achievement of net removals from the LULUCF sector of 26.8 Mt CO_2 as a complementary target in the Land Use sector.

The emissions reductions are relative to business-as-usual projections, which assume further increases in livestock numbers to 2030, particularly an increase in dairy cow numbers from 1.38 million currently to 1.63 million. At the same time, they extrapolate the steady improvement in the emissions intensity of production seen in both milk and beef production in recent years.

The reduction targets were based on the efficiency measures and technological innovations identified by Teagasc in its most recent marginal abatement cost curve (MACC). The Plan's targets assume full implementation of all the Teagasc measures and an plausible assumption of the adoption rate by farmers up to 2030. The Council views the assumptions as optimistic. For example, Teagasc has assumed that 50% of slurry would be applied by alternative low-emission techniques (e.g. trailing shoe) by 2030, this being the share of slurry spread by agricultural contractors. But on average during the 2016 – 2018 period, only 3% of slurry was spread by low-emission spreading techniques.[235] This is just one example of the significant gaps that will need to be bridged if the Climate Plan targets are to be achieved.

In the light of significant risk of under-achievement of the ambitious deployment rates of measures in the Climate Action Plan, there is a need to consider the implementation of additional measures as a contingency. There are specific challenges in implementation of mitigation measures across the sector, for example the uptake of alternative fertilisers, as well as the estimation and reporting of carbon emissions and removals associated with land management.

Another reason for seeking additional measures is developments in EU policy-making as part of the new Commission's European Green Deal. The Commission has put forward a draft regulation for a new European Climate Law (COM(2020) 80), a Communication on a Farm to Fork Strategy for a fair, healthy and environmentally friendly food system (COM(2020) 381), and a Communication on an EU Biodiversity Strategy for 2030 (COM(2020) 380).[171,236,237] These are Commission proposals at this stage and may well be amended before their recommendations are adopted as legislation, but they provide an important indication of the Commission's commitment to a more sustainable and climate-neutral Europe. They will also have very significant implications for future Irish agricultural production and food policy.

The European Climate Law seeks to enshrine the ambition of a climate-neutral Europe by 2050 in legislation. It also proposes that, by September 2020, the Commission should review the Union's 2030 target for climate and explore options for a new 2030 target of 50 – 55% emission reductions compared with 1990 levels. Given the importance of agricultural emissions in Ireland's national emissions profile, such a target would likely require more significant reductions in agricultural emissions than foreseen in the Climate Action Plan. It is worth noting that at EU level, total emissions in 2017 were already 25% below 1990 levels, with agriculture emissions down by 19%, whereas, for Ireland in 2017, total emissions were 10.0% higher than in 1990, with agriculture emissions essentially unchanged.

The proposed EU 'Farm to Fork Strategy' addresses the challenges of sustainable food systems and is at the heart of the Green Deal. A shift to a sustainable food system can bring environmental, health and social benefits, offer economic gains and puts the EU onto a sustainable path. The increasing occurrence of droughts, floods, forest fires and new pests is a constant reminder that our food system is under threat and must become more sustainable and resilient. The Farm to Fork Strategy proposes targets: to reduce the use and risk of pesticides by 2030 by 50%; to reduce nutrient losses of nitrogen and phosphorus by at least 50%, and to reduce the use of fertilisers by at least 20% by 2030; to reduce overall EU sales of antimicrobials for farmed animals and in aquaculture by 50% by 2030; to reach the objective of at least 25% of the EU's agricultural land under organic farming by 2030. The EU Biodiversity Strategy underlines that there is an urgent need to bring back at least 10% of agricultural area under high-diversity landscape features including, inter alia, buffer strips, rotational or non-rotational fallow land, hedges, non-productive trees, terrace walls and ponds. Many of these measures, if implemented, would help to mitigate emissions and increase removals of greenhouse gases.

6.2 Emerging mitigation measures

Efficiency improvements help to reduce the emissions intensity of production and, if production remains stable, would also lead to a reduction in absolute emissions. Evidence from the Teagasc National Farm Survey and in Bord Bia's Origin Green Progress update suggests that there is a steady improvement in emissions intensity (emissions per unit of output) of around 2.5% for beef production and between 1% and 2.5% or dairy production per annum. However, there is significant inter-annual variation, often driven by seasonal weather conditions.[127,68] Efficiency improvements should be pursued because they help to curb emissions and also improve on-farm profitability. However, the pace of reduction due to efficiency improvements alone will not be sufficient to achieve a significant reduction in agricultural emissions, particularly if production continues to increase.

Nitrous oxide emissions must be substantially reduced

Nitrous oxide (N_2O) emissions are released from agricultural soils using nitrogen fertilisers and animal manure. N_2O emissions can be reduced by using less fertiliser. Requiring all farmers to develop a nutrient management plan, more soil testing, optimising the uptake of nitrogen through correct drainage and soil pH, introducing more legumes into grass based swards, and extending the area under organic production could all help to reduce the volume of fertiliser used. N_2O emissions can also be reduced by ensuring that nitrogen applied to soils is utilised more efficiently, and not lost from the system either by transpiration to air or leakage to water bodies. Teagasc results show that nitrogen use efficiency is highly variable across Irish dairy and drystock farming.[127] Nitrification inhibitors and other technologies may help to reduce N_2O emissions, however, additional research, development and piloting of viable cost-effective products are required and potential food safety issues need to be addressed.[i] Reducing nitrogen loss via N_2O has the potential to reduce fertiliser expenditure and may increase agricultural productivity. Such mitigation options can deliver very important co-benefits in the national effort to comply with the EU Nitrates, National Emissions Ceiling and Water Framework directives. The proposed targets in the EU Farm to Fork Strategy of a 20% reduction in fertiliser use and to reduce nitrogen losses by 50% by 2030 could provide a useful context within which to development and

i In New Zealand a nitrification inhibitor was withdrawn from the market because chemical traces when the inhibitor was sprayed on pastures were found in some dairy products. Marketing nitrification inhibitors will require adoption of a Codex standard to cover its use and set conditions such as residue levels.

implementation mitigation measures in this area. This could be developed through the Strategic Plan for agriculture under the proposed new arrangements for the Common Agricultural Policy after 2020.

Farmers can take a variety of steps that would reduce nitrogen fertiliser use and save them money. There is major concern over excessive fertiliser use because of the adverse impact of nitrogen leakage to waterways. Chemical nitrogen use can be reduced by encouraging greater use of legumes in mixed pasture swards, by extending the use of nutrient management planning by farmers, by using more precise fertilisation techniques, and by supporting conversion to organic farming methods. Organic nitrogen use is currently controlled under the Nitrates Directive, which applies to the whole country. The directive specifies the maximum amount of livestock manure that may be applied as the amount containing 170 kg of organic nitrogen per hectare per year. Member States can seek approval from the European Commission to specify a higher maximum amount known as a 'derogation'. Ireland has availed of this possibility since 2007. Around 7000 intensively-stocked farms are currently permitted to apply up to 250 kg/ha organic manure (equivalent to up to 3 Livestock Unit's cows/ha across the farm), subject to additional conditions designed to protect the environment. The area farmed under derogation has increased by 34% from 2014 to 2018 (see Table 6.2). In addition, there is a significant cohort of 5000 farmers operating above 170 kgs N/ha livestock manure but who export slurry to comply with the 170 kg limit.[238] Ireland will submit its next Nitrates Action Programme (NAP) next year. Opportunities exist to ensure coherence between climate and nitrates measures to ensure that the synergies with climate action be fully considered in the design of the Nitrates Programme.

Table 6.2: Profile of Nitrates Derogation farms 2014-2018. **Data source:** *Report of the Nitrates Expert Group, DAFM 2019.*[238]

Year	2014	2015	2016	2017	2018
Number of derogation farms	5,800	6,300	6,800	7,000	6,891
Area under derogation (ha)	332,200	351,900	409,800	432,300	445,200
Average farm size (ha)	58	56	60	62	65
Livestock units per derogation farm	139	146	149	150	162

Ireland has implemented a series of NAPs to give effect to the Directive. The current NAP4 expires on 31 December 2021. The principal elements of the current NAP include:

- limits on farm stocking rates
- legal maxima for nitrogen and phosphorus application rates
- prohibited spreading periods preventing the application of organic and chemical fertilisers during more environmentally vulnerable times of the year
- minimum storage requirements for livestock manures
- requirements regarding maintenance of green cover in tillage lands
- set-back distances from waters.

Following a review of the conditions attached to derogation farms by the Nitrates Expert Group in 2019, DAFM introduced additional conditions for derogation farms in 2020. These include a requirement for low-emission slurry spreading, mandatory clover inclusion, use of protected urea and the need for a liming plan to increase nitrogen use efficiency.

Ireland will submit its next NAP (NAP5) in 2021, with a process of consultation expected to begin early next year. While the Nitrates Directive is specifically concerned with the protection and enhancement of water quality, the obvious synergies with climate action should be considered in the design of the next NAP.

Managing livestock numbers within biophysical boundaries

The Council in its Annual Report 2019 pointed out that continued reduction in the suckler herd would make an important and cost-effective contribution to mitigation within the sector. Many stakeholders reacted negatively to this proposal. It is important that there is clarity on the Council's position on this topic.

Many stakeholders take the view that the current and projected size of the cattle herd is fully justified and that the objective should be to maximise production on Irish farms. The Council's view is that Irish livestock output (both milk and meat) should reflect what makes economic sense for farmers, ensuring a positive return over market costs, while also fully reflecting and internalising biophysical and environmental limits. The Council refers to this as the sustainable level of output, where sustainability refers to the ability to generate an economic return for farmers while safeguarding environmental resources (including water, air, soils and biodiversity) and controlling emissions for the benefit of society as a whole. It is important to emphasise that the sustainable level of output is not a fixed limit and can expand as scientific insight and innovations develop that reduce the environmental footprint of primary production. However, it can also contract as science provides improved insight into the adverse impacts of current farming and land management practices.

There is incontrovertible evidence that the current level of livestock output (milk and meat) exceeds the sustainable level of output given current technologies, with important local and regional variations in both economic and environmental sustainability. This is clear from a wide variety of environmental indicators including decline in biodiversity, steady decline in water quality, increased emissions to air and the regularity of adverse impacts in the agriculture sector due to extreme weather conditions.[239,240,241,242,243] With regard to economic sustainability, the most recent Teagasc data suggest that a high proportion of beef farmers fail to generate a positive net margin, even taking account of very significant transfers from the Common Agricultural Policy (CAP) and national payments and the high border protection for EU beef production, as well as the availability of coupled payments. This is reflected in Figure 6.1 which presents the preliminary findings of the 2019 Teagasc National Farm Survey.

The introduction of a succession of emergency aid packages (highlighted in Table 6.3), that despite the conditions attached designed to improve efficiency, also incentivise the retention of beef animals and their associated emissions. The low income on many beef farms is a long-standing issue and the recent period of low prices has exacerbated this.[244] There is a legitimate need for support for farmers with low incomes. A more effective use of taxpayers' money would be to couple this support to the provision of environmental outcomes, including emissions reductions and removals, rather than to animal numbers.

Table 6.3: Recent support schemes in the Beef sector

Scheme	Date of introduction	Budget allocation	Terms and conditions
Beef Data and Genomics Programme (BGDP)	2015- 2020	€295m	Aim is to improve genetic merit of existing herds by encouraging replacement of low genetic merit cows with higher rated stock thus lowering greenhouse gas emissions. Beneficiaries are trained and must complete a Carbon Navigator (Teagasc) showing a farm's carbon footprint and ways to reduce it. BDGP payments are based on number of calved cows in 2014 and capped at a specific stocking rate so do not incentivise the keeping of additional stock.
Beef Emergency Aid Measure (BEAM)	2019	€100m	Intended to provide temporary exceptional aid to beef farmers arising from market disturbance due to Brexit uncertainty. Aid paid on adult cattle slaughtered between 24 September 2018 and 12 May 2019, at a rate of €100 per animal subject to a maximum of 100 finished animals per herd. Aid paid on suckler cows that calved in 2018, at a rate of €40 per animal subject to a maximum of 40 sucklers per herd. Participants had to reduce bovine livestock manure nitrogen by 5% in July 2020-June 2020 compared to same period previous year. Participant should be a member of at least one environmental or quality scheme.
Beef Environmental Efficiency Pilot	2019	€20m	Targets the weaning efficiency of suckler cows Cows that produce heavier calves at weaning as a proportion of their own live weight typically have a lower emissions intensity of production and this measure helps farmers to identify them.
Beef Environmental Efficiency Programme – Suckler	2020	€35m	Targets the weaning efficiency of suckler cows plus additional animal health and welfare options. Payments up to €90 for the first 10 calf/ cow pairs and €80 for the remainder up to a maximum of 100 pairs/herd if all options chosen.
COVID-19 support	2020	€50m	Aid intended for beef finishers to compensate for lower prices due to COVID-19 pandemic. Terms and conditions to be announced.

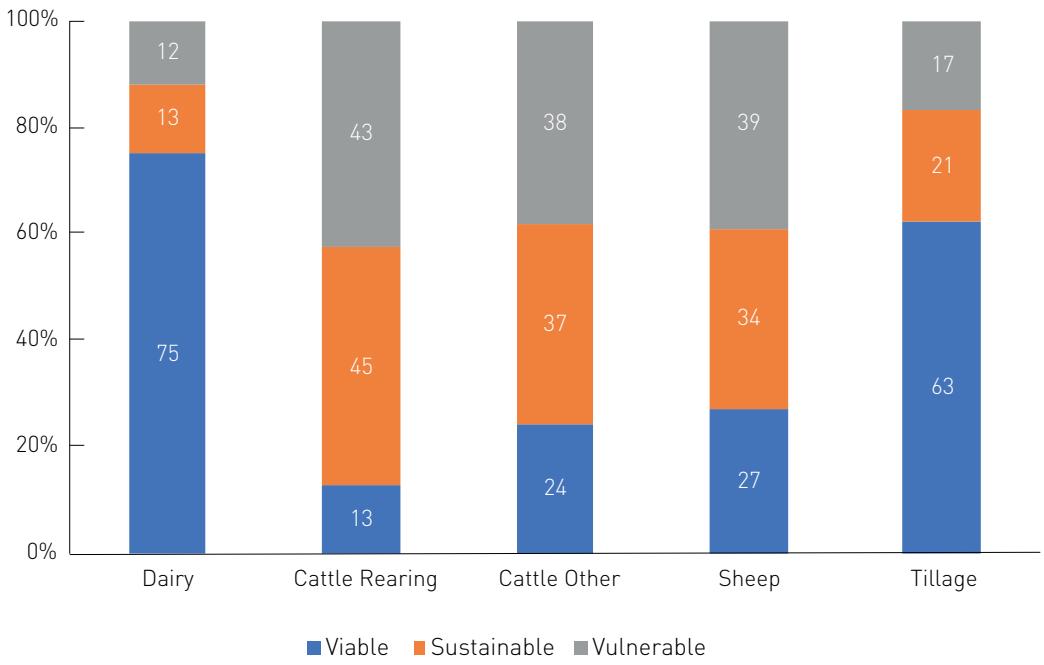

Figure 6.1: Viability of farm enterprises, 2019. **Data source:** *Teagasc National Farm Survey Preliminary Findings, 2019.*[137]

Looking ahead, the prospect of a 'hard Brexit' looms at the end of 2020 if no agreement has been reached on a free trade agreement between the UK and the EU. A high share of Irish beef exports go to the UK and would be negatively affected by the high tariffs that the UK proposes in the event of 'no-deal'. This would have very negative effects on producer prices for beef farmers in Ireland and there would be a case for transitional support. The EU's Multi-annual Financial Framework agreed by the European Council at its meeting in July 2020, while yet to be ratified by the European Parliament and Member States, includes a €5 billion special Brexit crisis reserve intended to assist countries and sectors that will be hit hard by Brexit. The Council has noted previously that any support packages should be linked not to animal numbers but to promoting the green transition in general and emissions reductions/removals in particular.

In contrast to beef and sheep farming, dairy farming remains profitable for a large majority of enterprises. Its economic sustainability is beyond doubt, but its current environmental footprint is not sustainable. Most farms that avail of derogations under the Nitrates Directive or that export slurry in order to stay within the Nitrate Directive's limits on organic nitrogen are intensive dairy farms. Dairy farms, although far fewer than drystock farms, contribute half of all agricultural greenhouse gas emissions and have been driving the increase in agricultural emissions in recent years. Dairy expansion makes sense to individual farmers because market returns exceed market costs but the negative environmental costs on water quality, on biodiversity loss, on ammonia emissions and on greenhouse gas emissions are not factored into this profit-and-loss account. From society's perspective, expansion cannot be justified if economic benefits to the sector are outweighed by environmental costs borne by society as a whole.

In summary, the structure and size of the national cattle herd is a fundamental driver of agricultural emissions. The current cattle numbers are too high and exceed the sustainable optimum. This sustainable optimum is not static and can increase in line with technological innovations that decrease the environmental and climate footprint of animal numbers. In this context, arguments

about carbon leakage, which are sometimes made against reducing milk and meat production in Ireland, are irrelevant. Policy needs to ensure that cattle numbers are consistent with both market realities and environmental and biophysical constraints, which is not the case at the moment. As noted in the Annual Review 2019, continuation of the trend in the reduction of the suckler herd would make an important and cost-effective contribution to mitigation within the sector, achieving a significant reduction in numbers of cattle by 2030. The potential release of land from a reduction in beef production could support alternative uses, raise farm incomes and reduce exposure of the sector to external market shocks.

Carbon leakage arises if a measure to reduce greenhouse gas emissions in one country displaces production to another country. Carbon leakage is amplified where the emissions intensity of production is higher in this other country (that is where. more emissions are produced per kg of product or litre of milk), thus leading to an overall increase in global emissions, contrary to the intention of the original measure. Whether carbon leakage would occur in response to lower livestock production in Ireland would depend on many factors, including the location and circumstances of alternative production, their emission intensities, and whether these countries also have binding climate targets. The Council's position is based on the recognition that no net benefit to Irish society accrues with additional livestock production when the environmental damage is taken into account. In fact, net benefit would occur if specific production were to reduce. This includes some intensive production due to greenhouse gas emissions, and the missed opportunity to use the extensive farm subsidies to support the provision of ecosystem services including carbon storage. In this context, the argument around carbon leakage takes on a different complexion. It would seem to suggest that Ireland should continue to shoulder these costs as a way of reducing emissions in the rest of the world. The Council does not accept that this is a sensible approach, particularly given that there is a legal obligation to reduce emissions in the most cost-effective manner within our own territory.

Efforts must be intensified to find ways to reduce methane emissions at scale

Ireland faces one dominating challenge in addressing greenhouse gas emissions from ruminant farming. The problem will become increasingly acute in the period beyond 2030, where the projections indicate that current mitigation options will not deliver on-going emissions reductions. Enteric methane accounts for 56% of emissions, and there is no system or technology at present available to reduce such emissions at scale at acceptable cost. If this situation prevails, the only way to reduce emissions at scale is to reduce levels of production. Choices that do not yet exist need to be created, and this requires innovation. Such innovation can be a combination of new farming systems and land-use change, or ways of reducing emissions from ruminant animals (genetics, diet additives, vaccines, inhibitors), with a key requirement that such innovation does not damage the competitiveness of their grass-based systems relative to feedlot farming, nor the market acceptability of Irish meat and milk. In addition to the efficacy, these measures need to consider economic cost, animal welfare, acceptability from a consumer and producer perspective, and food safety/residue concerns.

Policy should focus more on nature-based carbon removals

In line with the current national policy position, Council recommends that an integrated target should be set for agriculture and related land use (emissions and removals from agricultural soils, woody biomass and afforestation), with the objective of achieving climate neutrality at a minimum within the sector. Actions by farmers and foresters to remove carbon should be fully acknowledged and supported, while also stressing the need to invest in reducing uncertainty in

the measurement of land-use emissions and removals and the need to maintain the integrity of the environmental accounts by fully accounting for reversals in carbon sinks where these occur. The effect of climate change on the soil sink capacity needs to be assessed to future proof this measure, as increasing temperature, coupled with changes in rainfall, could lead to a carbon sink becoming a carbon source.

Low afforestation rates are undermining sectoral mitigation targets. In spite of continuing transfers to forestry (€68 million in premiums in 2018, plus additional tax reliefs) the rate of planting has been in secular decline, falling from more than 5000 hectares in 2005 to 3550 hectares in 2019 (the annual target in the Climate Action Plan is 8000 hectares).[129] The WAM projections for emissions and removals from Forest Land are sobering in this regard, as they indicate Forest land transitioning to a net source of emissions in the early 2030s, as harvesting from the national forest will likely exceed removal rates as the large plantations established in the 1990's reach maturity.

The current focus on commercial afforestation including long-term legal commitment has created barriers to engagement. The re-planting obligation when trees are harvested is seen as an obstacle preventing some farmers from committing to forestry. There may be merit in the review and revision of this obligation, perhaps by giving farmers an option to buy out this obligation by repaying the value of the grants and subsidies received out of the harvest proceeds. It may also be useful to encourage Coillte to restart afforestation activities. Environmental constraints have limited the lands that might previously have been proposed by landowners for afforestation. Even if it does not contribute significantly to compliance with 2030 EU targets, well-designed afforestation has real climate benefit and will contribute towards our 2050 goals. The Council sees merit in establishing a group to quickly report on how best to alleviate the obstacles to increased afforestation. An approach to supports for expansion of forest and woodlands, which can integrate woodland and agro-forestry more sympathetically into the agriculture landscape, may find a higher level of acceptance and uptake, in the context of the Common Agricultural Policy, and as a complement to the conventional afforestation programme.

The management of national peatlands and grasslands continues to be a significant source of emissions. The rewetting of drained peatlands is one of the most cost-effective measures supported by the carbon tax revenue. A wide variety of improved land management and land-use change options are available depending on local conditions and market opportunities. These include rewetting drained organic soils, rewetting, rehabilitation and restoration of degraded bogs; and possible limited afforestation or biomass cultivation on some areas. In addition, opportunities exist for many co-benefits including eco-tourism; biodiversity; soil, water and air quality; flood alleviation and local amenity value. Policy innovation will be required to improve land management while maintaining public acceptance.

There is also potential to incentivise practices that help to sequester additional carbon in agricultural soils, including mineral soils, a practice sometimes called 'carbon farming'. An expert statement from the Royal Irish Academy highlighted that the international literature verifies that temperate grasslands sequester atmospheric carbon into the grassland biomass and soil, and that many soils under grasslands are currently under-saturated with carbon.[245] Getting credit for practices that help to build soil carbon requires that Ireland can produce evidence-based measurement, reporting and verification (MRV) of carbon sequestration. MRV requires a national effort of soil carbon monitoring across the country, for a period of years, to record the inter-

annual changes to soil carbon and to verify the quantity of carbon sequestered for a wide range of Irish soil types and grassland land management practices. The Council reiterates the urgent need to fund this necessary work.

Teagasc, along with Bord Bia and several industry partners, is developing the SignPost Demonstration Farm programme with the objective of encouraging farmers to adopt gaseous mitigation measures. This initiative will establish a network of farms on a national basis that will demonstrate a variety of options that farmers can implement towards the achievement of carbon neutrality. Included in this initiative will be the establishment of a National Soil Carbon Observatory designed to measure and monitor carbon sequestration in mineral soils that can provide additional activity data to inform the national greenhouse gas inventory.

Long-term land-use strategy

Ireland does not have a comprehensive national land-use strategy designed to manage the diverse demands for land-based resources and ecosystem services.

In the recently published Programme for Government, it is agreed to undertake a national land use review

> 'including farmland, forests, and peatlands, so that optimal land use options inform all relevant government decisions. The review will balance environmental, social, and economic considerations and involve a process of evaluation of the ecological characteristics of the land. It will include consideration of emissions to air and water, carbon sequestration, and climate adaptation challenges.'

The outcome of such a review may provide the stimulus for greater coherence in policy design for rural development. There is a need for a strategy towards rural development that recognises the diverse range of environmental, economic and socially sustainable activities that can thrive and support local communities and the national economy. The production of food will remain the dominant land use in Ireland, but greater innovation and diversification is also required in food production, energy supply, raw materials, ecotourism and other social and environmental ecosystem services. Current planning and policy development is fragmented between competing sectors and activities, leading to confusion and uncertainty for investors and other stakeholders.

An important precursor to a land-use strategy is the need for high-resolution mapping of current land use across the country, and analysis of the options for alternative management that would provide indicative information to farmers.

6.3 Incentivising change

Opportunity should be grasped to adapt the reformed Common Agricultural Policy as a key instrument for change

The Common Agricultural Policy (CAP) can be a powerful tool to deliver changes in farming practices and land-use management. The Commission proposed a new framework for the CAP post 2020 in June 2018.[246] This proposal envisages a move from a compliance-based to a performance-based CAP. Member States will draw up CAP Strategic Plans based on a needs assessment related to nine specific objectives set out in the CAP legislation, showing how they propose to use CAP funds to address the challenges they identify facing both farmers and society as a whole. The Commission proposal requires that these Strategic Plans should aim for a higher level of environmental and climate ambition than in the current (2014– 2020) CAP. It

proposes a new 'green architecture' of measures that Member States can use in pursuing this aim. At the base is enhanced conditionality, the set of cross-compliance requirements that all farmers in receipt of direct payments undertake to observe. As a new element, the Commission proposes that Member States should use part of their CAP Pillar 1 direct payments envelope for eco-schemes intended to incentivise farmers to achieve further environmental and climate objectives. Finally, the well-known agri-environment and climate measures in CAP Pillar 2 that fund farmers who voluntarily undertake additional environmental and climate commitments will continue.

Delays in the legislative process mean that the new CAP cannot come into effect on 1 January 2021 as was originally planned. The Commission proposed a transitional regulation that would extend the current CAP rules for a further year. The EU Council and Parliament have agreed a common position that would extend the current CAP for a further two years, so that the new CAP Strategic Plans would take effect from 1 January 2023. The delay provides an opportunity to ensure that the ambitious goals of the EU's Farm to Fork and Biodiversity Strategies are fully reflected in Ireland's CAP Strategic Plan. The Climate Change Advisory Council underlines that the Government should use the opportunity to make use of whatever flexibilities are permitted under the CAP transitional regulation to trial new schemes supporting farmers to take climate action.

There are other initiatives that the Government can take to ensure that CAP support is used more effectively to assist farmers in the climate transition. Under the Commission's proposal, the Government will have the flexibility to transfer funds from Pillar 1 to Pillar 2 particularly where this transfer can help to strengthen funding for voluntary agri-environment and climate measures in Pillar 2. As eco-schemes will be annual payments, there can be advantages in using the multi-annual contractual approach that characterises Pillar 2 schemes and that is well understood and accepted by farmers and could lead to more cost-effective ways of supporting farmers to reduce emissions and/or sequester carbon. Also Ireland will have greater flexibility to define the enhanced conditionality standards, many of which have great relevance to climate action.[i]

Need to mitigate market risk as supply chains seek to remove emissions

There is the potential for considerable market risk for Irish agri-food exports in premium markets if emissions continue unabated. Major food companies, typified by Nestlé and Unilever in the Consumer Goods sector, McDonald's in the Food Service sector, and supermarkets such as Tesco and Sainsbury's in the UK, are making voluntary commitments in regard to reducing their greenhouse gas emissions in terms of both the design and the operation of their own facilities and systems, and especially as regards reducing these from their supply chains. If Irish producers cannot meet these requirements in future, they will be at risk of being excluded from premium outlets.

Bord Bia is well aware of these market pressures. It has developed and rolled out Origin Green since 2012 as a national sustainability programme that mobilised Ireland's farmers and food producers to commit to sustainability throughout the supply chain, from farm to plate. Origin Green encourages producers and processors to set sustainability goals using measurable,

i For example, GAEC 1 Maintenance of permanent grassland based on a ratio of permanent grassland in relation to agricultural areas: GAEC 2 Appropriate protection of wetland and peatland; GAEC 5 Use of the Farm Sustainability Tool for Nutrients; GAECs 6-8 on tillage management requiring cover crops and crop rotation; GAEC 9 Minimum share of agricultural area devoted to non-productive features or areas; GAEC 10 Ban on converting or ploughing permanent grassland in Natura 2000 sites.

verifiable indicators and performance against targets is assessed by an independent agency, which increases credibility. The recent Progress Update Report on Origin Green published by Bord Bia includes a focus on greenhouse gas emissions as well as other sustainability indicators (Bord Bia, 2020). In 2018, Bord Bia reviewed the Origin Green programme, preparing a three-year Origin Green strategy. It proposes to develop a food sustainability index that assesses the sustainability measures relevant to the Irish Food sector, and to ensure that Ireland is ranked among the top five sustainable food producers among international trade customers in priority trade channels and markets by 2021. The Council notes the importance of maintaining and enforcing the credibility of the commitments made under these quality assurance schemes, notes that other countries are now developing similar initiatives, and urges Bord Bia to build on its first-mover advantage to strengthen the sustainability credentials of Irish produce.

Developing the ability to measure greenhouse gas fluxes at farm level

In the longer-term, it will be important to be able to demonstrate the positive impact of changes in practice and land use at farm level. This will require low cost, accurate and robust systems of measurement and assessment of greenhouse gas fluxes at farm level so that each farmer would know what his or her emissions are. This is a prerequisite for any scheme that would reward farmers per unit of reduction or penalise activities per unit of emission. The current measurement system developed by Teagasc ('Carbon Navigator') enables such measurement by collecting data on processes and practices and using models to calculate relevant emissions, but it needs to be further developed. New Zealand has decided to implement an Emissions Trading Scheme (NZ ETS) that will include agriculture, and which requires that emissions from sources be measured. They aim to have a system in place, at the latest by 2025, that will enable trading to take place. This will provide lessons for Ireland as regards measurement of emissions at farm level, and the design and implementation of a trading scheme that includes agriculture. In the Farm to Fork Strategy, the Commission proposes a new carbon farming initiative to reward farming practices that remove CO_2 from the atmosphere. The Commission plans to develop a regulatory framework for certifying carbon removals based on robust and transparent carbon accounting to monitor and verify the authenticity of carbon removals. Any Irish measurement tool should be consistent with the requirements identified by the Commission.

Strengthening research and advisory support

Reducing net agricultural and land use emissions will require a significant re-orientation and expansion of research priorities and resources to provide farmers with a wider range of tools and technologies that they can use on-farm. Research is critically needed to address enteric methane emissions, which account for 56% of total emissions. As noted, these do not have to be reduced to zero, but they do have to be reduced. Apart from improvements in efficiency, there is currently no technical option available that would reduce these emissions at scale. There is ongoing research (genetics, diet additives, vaccines, inhibitors) looking to change individual animal performance in ways that reduce enteric methane emissions. However, none has yet delivered a solution at scale, and those (especially diet additives) that are under development seem to favour feedlot rather than grassland farming systems. New Zealand is a leader in this space, but there are also interesting developments in Europe and elsewhere. There is also a need for innovation in the design and delivery of new lower emission farming systems (e.g. that combine tree culture and grazing), and to advance understanding and performance of offset potentials, including afforestation and soil carbon storage. Research on carbon sequestration is also important. Soil carbon sequestration research in Ireland is not adequately resourced, underlined by the lack of

a single agricultural Integrated Carbon Observatory System site in Ireland. There is a major need to increase both physical research infrastructure and research expertise.

DAFM has funded a study to review current national greenhouse research capacity, make recommendations on capacity requirements and evaluate the establishment of a National Agricultural Greenhouse Gas Centre of Excellence. This project is due for completion in Q2 2021. The Council looks forward to seeing its recommendations. There are advantages in participation in international partnerships with countries such as New Zealand who share similar challenges and opportunities in reducing emissions from grass-based farming systems. For example, Ireland is strongly engaged in the Global Research Alliance which seeks to advance mitigation research across a broad spectrum of farming practices.[247]

Apart from increasing efficiency, Irish farmers have little if any experience of implementing actions that directly reduce greenhouse gas emissions. In addition to incentives, they will need a lot of support, mentoring and information particularly the findings of research to enable rapid deployment of measures as they transition their farms to a lower emissions status. CAP funding can be directed to greatly increase knowledge transfer activities, advisory services and support for farmer-driven partnerships dedicated to reducing net emissions from Agriculture and Land Use.

7. Special Focus Chapter on Transport

7.1 Introduction

Irish transport emissions have grown considerably since 1990.[i] The 2019 Climate Action Plan contains a set of policies to achieve a 38% reduction in transport emissions by 2030.[ii] This special focus chapter will assess the policy options introduced to achieve these targets. The chapter comprises three main sections. Section 7.2 reviews transport emissions and the contribution that the 2019 Climate Action Plan proposes make to Ireland's emissions trajectory. Section 7.3 sets out the general approach to decarbonising transport and outlines some broad policy objectives in this regard. Section 7.4 analyses the transport-related policies contained within the 2019 Climate Action Plan, in terms of efficiency and effectiveness.[iii] Particular emphasis is placed on the role of electric vehicles in a cost-effective decarbonisation trajectory.

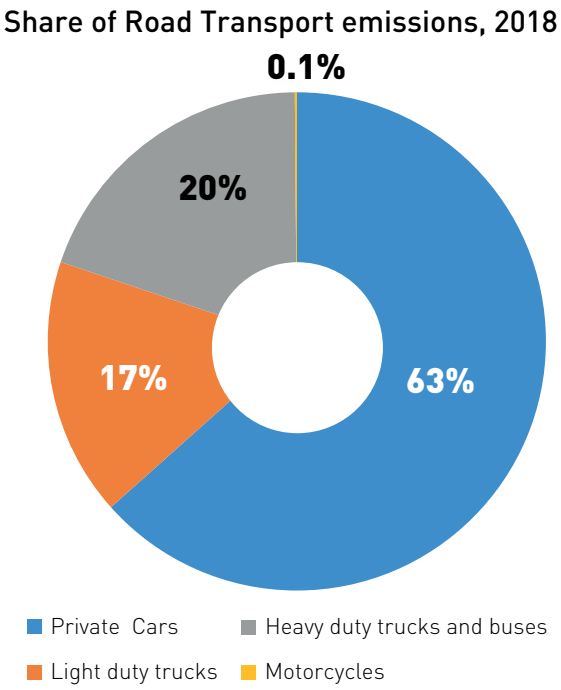

Figure 7.1: Modal share of greenhouse gas emissions from road transport **Data source:** *EPA (2020) National Emissions Inventory.*[2]

Section 4.1 reviews Ireland's broader transport decarbonisation strategy; especially the supportive policies required to achieve the stated targets. Effective decarbonisation must overcome behavioural, logistical and industrial capacity constraints. The chapter identifies the policy priorities to realise the stated commitments.

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i Since 1990, the Transport sector has seen the largest increase in greenhouse gas emissions in both absolute and relative terms compared to any other sector. From 5.1 Mt CO_2eq in 1990, to a peak of 14.4 Mt CO_2eq (280%) in 2007, emissions dropped to 10.8 Mt CO_2eq (211%) in 2012, but in 2018 were back up to 12.2 Mt CO_2eq (238%).

ii projected to achieve 29% reduction in emissions for the non-ETS sector by 2030, relative to 2005 levels. The EPA has confirmed that the Climate Action Plan is consistent with a 3% annual reduction, or 23% cumulative reduction relative to 2018 levels, conditional on all policies being implemented successfully (EPA, 2020).

iii While the 2020 programme for government has increased the ambition from a 3% to 7% equivalent annual emissions reduction across the whole economy, precise details have yet to be released on how this might influence actions within the Transport sector. This special focus chapter will therefore offer recommendations relative to the pre-existing 3% annual equivalent target, with insight offered in relation to higher levels of ambition, where possible.

7.2 Emissions profile of Transport in Ireland

Transport is projected to contribute 19.8% of Ireland's total greenhouse gas emissions in 2020. Over 95% of emissions in this sector arise from road transportation.[2] Of the road transport share, Figure 7.1 shows that 63.4% of road transport emissions arise from the use of cars. This suggests that policy in this sector should pay particular attention to the decarbonisation of private transport and car journeys.

Irish policy to address transport emissions may be analysed in two parts: policies put in place prior to the 2019 Climate Action Plan, the 'with existing measures' (WEM) scenario in EPA projections and those policies put in place as part of the 2019 Climate Action Plan, the 'with additional measures' (WAM) scenario. WEM includes the Biofuels Obligations Scheme (11–12% blend of biofuel)[i] and the uptake of 490,000 electric vehicles by 2030. The 490,000 electric vehicle target comprises approximately 326,000 passenger battery electric vehicles (BEV) and 148,000 passenger plug-in hybrid electric vehicles (PHEV).

The 2019 Climate Action Plan has introduced additional measures for the decarbonisation of transport including a further development of the biofuel obligation scheme; deployment of 935,000 electric vehicles by 2030, comprising approximately 550,000 battery electric vehicles and 288,000 plug-in hybrid electric vehicles; and a regulation prohibiting the sale of non-zero emissions vehicles post-2030.[ii]

Other key policies and measures assumed in the transport emissions projections include Vehicle Registration Tax (VRT) and motor tax rebalancing, and the improved vehicle fuel economy of the private car fleet and light goods vehicles. Both scenarios also include the impact of transport infrastructure projects such as Dublin Metro, Dart Expansion and the 'BusConnects' programme.

Figure 7.2 below shows the projected trend in emissions from the Transport sector out to 2030 under the WEM and WAM scenarios.

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i The Biofuel Obligation Scheme places an obligation on fuel suppliers to blend an increasing percentage of biofuel with their fuel. In terms of biofuels used in road transport fuel in the WEM scenario a statutory target of approximately 11% from 1 January 2019 under the Biofuels Obligation Scheme is assumed. This increases to approximately 12% from 1 January 2020. Both measures were implemented on schedule.

ii While, arguably this last measure will have no direct impact on emissions to 2030, there is evidence that strong regulatory signals of this kind have an indirect impact on sales, as people will often consider the potential resale value of vehicles when making decisions.

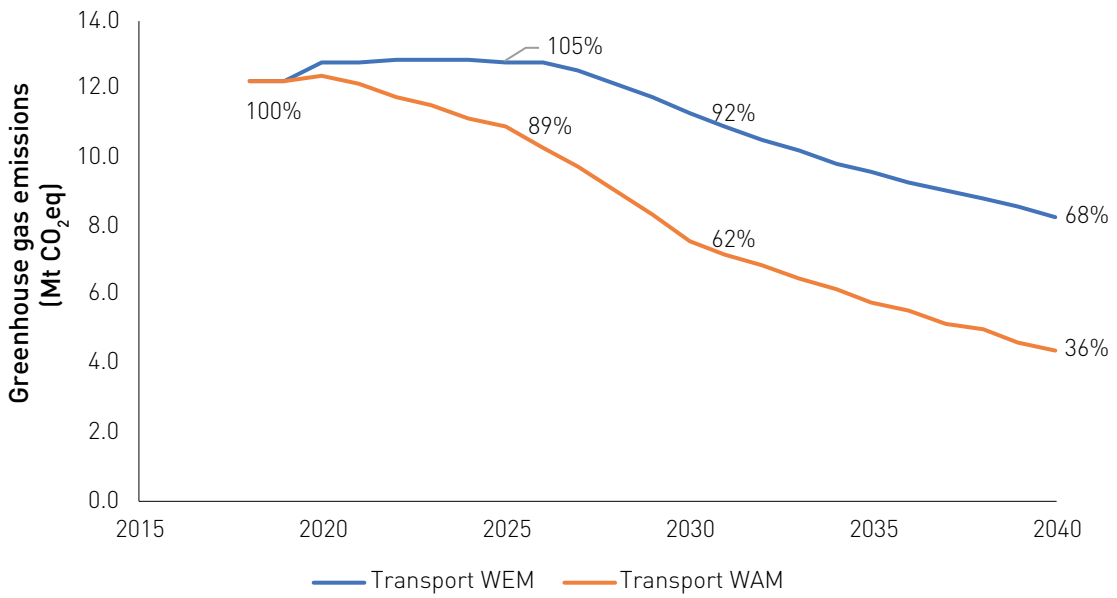

Figure 7.2: Greenhouse Gas Emissions Projections from the Transport Sector under the 'with existing measures' (WEM) and 'with additional measures' (WAM) scenarios from 2019 to 2030 **Source:** *EPA (2020) National Emissions Inventory*[2] *and Ireland's Greenhouse Gas Emissions Projections 2019–2040.*[10]

Under WEM emissions are projected to decrease by 7.6% by 2030 while under WAM emissions decrease 37.8% over the period 2019 to 2030.

Achieving a 37.8% reduction over a 10-year period will be very challenging and will have to overcome considerable behavioural, logistical and industrial capacity constraints which appears unlikely given the current emissions trajectory. This is best exemplified with respect to electric vehicle deployment, with an annual average rate of deployment equivalent to 80% of 2019 new car registrations. Starting from a baseline of circa.4000 electric vehicle sales per year, this is unlikely to be achieved without considerable additional policies.

The effect of such constraints will be more apparent in efforts to achieve the increased ambition contained within the 2020 Programme for Government.

7.3 Approaches to mitigation in transport

International best practice for transport mitigation and low-carbon transition follow an 'Avoid–Shift–Improve' (ASI) framework. The Intergovernmental Panel on Climate Change has noted the rise in global transport emissions as transport activity has increased, while becoming more individual and motorised.[27] This framing has also recently been recommended by policy research in the Irish context.[248]

Avoid–Shift–Improve involves:

- **'Avoid'** – avoiding journeys where possible, including densifying development and spatial planning;
- **'Shift'** – shifting mode to low-carbon transport systems of walking, cycling and public transport;
- **'Improve'** – improving the energy and carbon efficiency of vehicles including engine performance and switching to biofuels and electric vehicles.

Alongside this framework, one should note that a transition can only be achieved if individuals are sufficiently incentivised to engage and adopt actions required. Incentives and behavioural measures to encourage the switch away from the use of the private car are required. Options include: switching fixed taxes to variable charges on vehicle use and emissions; congestion charges on entry into cities; removing provision of free-parking in workplaces that indirectly subsidise motorists; and provisions that support car-pooling and working from home. Further measures are required to aid electric vehicle deployment. Charging infrastructure needs to be integrated into spatial planning, building regulations and the expansion of the electricity network.

The Avoid-Shift-Improve framework will be applied in the following analysis to outline a vision for a decarbonised electricity transition for Ireland

7.3.1 Avoid: sustainable development and planning

A well-regulated and coherent planning system is required to guide sustainable settlement. Ireland has a low-density, dispersed population structure; with 70.65 people per km2 compared to the EU average of 105.41 per km^2.[249] Our dispersed settlement pattern and a lack of coordinated transport and land use planning in the past has resulted in many people living remote from frequent public transport, creating conditions of forced car ownership, high private usage and has encouraged high levels of multiple car ownership within households.[250]

While we cannot undo current settlement patterns, the trend of increased urbanisation observed over recent years may reduce the number of people living in isolated locations. Effective planning and strict regulation can ensure this urbanisation is carried out in a sustainable manner. More concentrated settlement patterns better facilitate sustainable transport links.

Development must mitigate existing spatial and infrastructural 'lock-in', while also preventing further lock-in. Development and infrastructure planning, through the National Planning Framework and the National Development Plan (NDP), should support a transition to high-density spatial planning integrated with low-carbon active and public transport.

Post-COVID-19, working from home may become more common. This may have positive and negative impacts; with a potential reduction in commuter journeys but also creating an incentive to live in rural locations. Such behavioural and relocation choices should be guided in a sustainable way, through appropriate carbon taxation and planning regulation.

7.3.2 Shift: low-carbon transport methods

There are a number of low-carbon transport methods that we must shift towards. This section will outline key policy priorities in this regard.

Increase Ireland's investment in cycling and walking infrastructure

Public attitudes to active modes for routine journeys indicate that poor safety conditions and convenience are important barriers to adoption. Competing for congested road and street space discourages active modes. Lack of secure parking for bicycles and changing facilities make active modes inconvenient. Encouraging active modes for full or partial journeys requires that an appropriate infrastructure be in place. Experience in other countries indicates that this infrastructure will deliver a slow return on investment, as embedding active modes in travel patterns becomes fully normalised over the long-term. This process must start now to achieve 2050 targets.

In terms of developing active mode infrastructure and attitudes, Ireland is starting from a low base in comparison to other countries. Caulfield *et al*. estimate that the 200km of segregated cycle lanes proposed will not be sufficient to deliver the cycling network needed in cities such as Dublin and Cork to facilitate the increasing number of people cycling.[251] Caulfield *et al*. summarise the 'Copenhagenize Index' which charts the most bicycle-friendly cities in the world.[251] This index shows that Irish cities have fallen out of the top 20 bicycle friendly cities in recent years. Furthermore, Caulfield *et al.* state that Irish spending on bicycle infrastructure is proportionately much less than European counterparts.[251] To meet a recommended spend of 10% of the land transport capital budget on cycling[i], would require an investment of approximately €194 million per annum.[251] This figure does not show what is required to achieve a bicycle friendly infrastructure in Irish urban space, but rather the level of current expenditure required to put investment on a par with European counterparts.

The response to the COVID-19 pandemic provides an opportunity to create city and urban landscapes that facilitate active modes. Potential measures that would encourage active transport include widened and decluttered footpaths; segregated and contra-flow cycle lanes; early-start signalling giving cyclist priority at junctions; and optimisation of signals to enable shorter pedestrians wait times at crossings and pedestrianised plazas.

We must integrate cycling with public transport, while making walking more attractive

The 'first and last mile problem' limits the reach of public transport. Integration of active transport modes with public transport can greatly increase their reach. Much research exists to quantify these effects.[252,253,254,255] Bike share schemes targeted towards commuters can help the 'last mile' problem. The 'OV-Fiets' in the Netherlands allows commuters to use a shared bike to travel from home to the nearest train station.[256] In an Irish context, there is an opportunity for Irish Rail and bike share providers to enhance the accessibility of rail stations.

Pleasant urban spaces can facilitate more walking.

Research indicates that the reach of the existing public transport system can be extended by making it easier to walk to and from transport hubs and stops, less prone to obstacles and barriers and more pleasant.[257]

i The European Cyclists' Federation recommends that 10% of all transport investment should be devoted to spending on cycling. This has also been supported by the United Nations Environment Programme, the Joint Committee on Climate Action, the Citizen's Assembly, and many cycling advocacy groups in Ireland such as Cyclist.ie, the Dublin Cycling Campaign and IBike Dublin (Caulfield et al., 2020).

Box 1: Bike–train–bike (BiTBi) integration pilot

BiTiBi was a European research project and pilot that tested a range of measures and incentives to integrate rail services with cycling to make the combination more attractive to potential travellers. Some of the measures implemented were:

- bike routes to train stations provided with involvement of local authorities
- provision of specific type of convenient shared bicycle – tariffs allow bike to be kept for 24 hours without penalty
- sheltered and secure bike parking and shared bicycles are signposted, information provision
- single integrated tariff and payment system, i.e. one card or smartphone app enables payment for all services, for example. Dublin bikes and Leap card integration.[257]

The pilot project yielded striking results. In Ghent, 22% of shared bike users at train stations would have otherwise driven, while 7% would have received a lift by car to/from the station. In Liverpool, 9% of users of the safe bike parking facilities and 19% of users of the bike share scheme reported that they stopped driving after joining the scheme. Trip-end facilities such as bicycle storage and changing room facilities significantly influenced an increase in the rates of cycling, principally among women.[253,254,255]

E-bikes and e-scooters can further address the 'last mile' problem

E-bike and e-scooter share schemes can increase the catchment of public transport hubs even further than more active modes.

Appropriate regulation of electric scooters and bikes has been identified as a priority in the Programme for Government. Convenience and ease of use in addition to proximity to nearby docking stations have been cited as the principal motivating factors for bike and e-scooter sharing in North America, China, the UK and Australia.[258,259,260] Public safety and insurance liability concerns have been cited as barriers to local authority acceptance and investment in e-mobility.

Information provision enhances infrastructure provision

There is evidence to suggest that information provision is an important complement to investment in active modes.[261] This may be especially useful in overcoming limiting perceptions or beliefs. Such information can take advantage of nudges or similar behavioral techniques to maximise the shift towards active modes. Creating a sense that this activity is prevalent, achievable and advantageous may be encouraged through information provision.

Box 2: A policy prescription to encourage bicycle adoption

Parallel to the Velocity Conference in 2019, which was hosted by Dublin, Fabian Küster –a Senior Policy Officer with the European Cyclists' Federation (ECF) – addressed the Joint Committee on Climate Action. He suggested the following three measures to boost the uptake of cycling and e-bikes in Ireland and simulate a sustainable mode shift:

1. introduce a national purchase subsidy, akin to the €200 subsidy available in France, which effectively doubled the sales of e-bikes in the year following its introduction and resulted in 67% of private trips being replaced by e-bikes (a similar measure is already in place, the bike to work scheme, to encourage uptake of conventional cycling)
2. introduce a bicycle allowance scheme, whereby employers would financially reward their employees for using active modes. In Belgium, for instance, an employer can pay an employee 23 cents for every kilometre cycled to work, which has resulted in a 42% increase in cycling to work over a 12 year period
3. introduce minimum off-street bicycle parking standards nationally, to ensure that secure and accessible parking is available for cyclists, particularly those who are less inclined to park their bicycles in on-street parking facilities due to the ever-present threat of bicycle theft.[262]

7.3.3 Improve: road freight

The decarbonisation of road freight must be considered in both the short and the long–term. First, an appropriate price signal is required. The current range limitations of electric vehicles make the long–term solution uncertain. Hydrogen and biofuels are possible contenders in this space. However, hauliers should still receive a price signal that the adoption of carbon-neutral transport technologies will be required in the medium to long–term. Given the technological uncertainty, this must be a technology-neutral signal. A strong, clear and binding carbon price trajectory is the most effective signal in this regard.

The removal of existing market distortions can have both long-term and short–term benefits. The most pressing market distortion is the diesel rebate scheme. This provides for the repayment of part of the mineral oil tax paid on road diesel that is purchased by qualifying road haulage and bus operators and is used for business purposes.[263]

In the short–term, the removal of the diesel rebate would increase the cost of haulage to better reflect the social cost. This would provide a signal to consumers to reduce their consumption of goods and services that have high levels of embodied carbon, due to distance travelled. The current rebate is guiding us towards the unsustainable consumption of goods and services that have travelled long distances. In the long-term, price signals such as carbon taxes are negated by counteracting rebates. Their removal is necessary for a clear long-term investment signal for decarbonisation.

7.3.4 Improve: we must improve the carbon-efficiency of public transport

Public transport has a central role in Ireland's strategy to reduce carbon emissions, and significant investment in public transport, including Metrolink and BusConnects, is outlined in the Government's Capital Plan. Analysis conducted by the National Transport Authority estimates

that a daily reduction of 44 tonnes of CO_2 could be achieved from implementing the BusConnects project in its entirety. The Council welcomes these initiatives. The research highlights a few points that Irish policy-makers should consider when incentivising further public transport uptake.

Technology-neutral policy is required

A number of fuels have been proposed for use for public transport, including biofuel blends, as well as electric vehicles. Technological uncertainty remains as electrification may not be feasible in much of the national public transport network. Therefore, biofuels or other alternatives may be required for longer distance public transport.[264] Policies should accommodate this future technological uncertainty. Ireland is a technology taker and while Irish policy decisions will be unlikely to affect the direction of technological innovation, the direction of technological innovation will affect prudent policy decisions.

An appropriate policy response should take the following approach. Where there is a dominant, mature zero-carbon technology, it should be pursued. Where competing technologies are emerging (for example, hydrogen, biofuels or another fuel source have a similar likelihood of becoming the dominant technology for public transport options such as buses) decarbonisation policy should have the flexibility to follow technological and market developments. This could take the form of a staged conversion of the bus fleet, presenting the option to change strategy in later periods if new information emerges. This minimises the risk of locking the entire fleet into a sub-optimal technology at an early stage. Alternatively, if many technologies present themselves at an early stage, a portfolio of technology options should be considered until a dominant technology emerges.

Cost is more important than time

Research suggests that while time is an important consideration when commuting, policy measures designed to reduce cost are more effective. For instance, Conti found bigger shifts from car to public transport once costs, rather than travel time, were reduced.[265] Cools found evidence of a 'zero-price effect'[i] whereby free public transport can bring about modal shifts from car to public transport greater than one would expect from conventional analysis of consumer response to changes in fare.[248,266]

Where ticket receipts are a lesser proportion of total costs, then free public transport may be a relatively low-cost option to increase mode switching. For instance, public transport operating costs stand at approximately €500 million per year in Luxembourg, but revenue from ticket sales was only €41 million.[267] In Dunkirk, the moderately low contribution of ticket sales to the running costs of public transport (approximately 10%) was also cited as a justification of the choice to make public transport free.[268] However, the design of a public transport strategy should be cognisant of the substitution of active transport for public transport. In Talinn, the introduction of free public transport resulted in 40% fewer walking trips.[267]

Irish policy should therefore carefully consider the price elasticity of demand when incentivising public transport. If price elasticities are high, ticketing cost adjustments could potentially be a low-cost incentive. If price elasticities are low, ticketing cost adjustments could be a high-cost incentive.

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i The zero price effect suggests that traditional cost-benefits models cannot account for the psychological effect of getting something for free.

Disincentivising private transport is as important as incentivising public transport

It is not sufficient to make public transport cheaper (or free) or provide better quality public transport services without accompanying measures to disincentivise car use.[270] Such measures may include some restrictions to the car, or increases in car use costs.[248,265,271,272,274] In addition, income from indirect measures such as carbon tax and parking charges can be used to improve public transport.[272] Further potential policies include strict car quotas and congestion charges in city centres.[273]

Behavioural nudges

Patterns of transport use may be further encouraged through the use of behavioural nudges. A policy of behavioural change must be put in place, drawing on the expertise in Irish institutions and agencies such as the SEAI's and the ESRI's behavioural research teams. The establishment of social and cultural norms and decision architectures that guide decisions towards the sustainable option are among the policies that can be considered in a behavioural policy programme to guide sustainable travel. Many lessons can be learned from the incorporation of behavioural insights into the COVID-19 response. Observed impacts of the Covid-19 restrictions have included significant shifts in consumer behaviour. These include increased use of online shopping and home delivery services and households making less frequent trips to supermarkets but making larger purchases. These changes in behaviour can have implications for transport emissions due to lower demand for private journeys or greater use of light-duty delivery vehicles which can play a role in the transition to electric vehicles (EVs). However, there may also be changes in the volume of household waste, impacting emissions from the Waste sector.[275]

7.3.5 Improve: all remaining private transport must be served by electric vehicles.

All remaining private journeys must switch from internal combustion engine (ICE) vehicles to zero-carbon emission vehicles, most likely electric. Achieving targets must overcome logistical and behavioural constraints. Policy must plan for these and put in place mechanisms to overcome these barriers. Failure to do so will lead to failure to meet decarbonisation targets. Key constraints that must be overcome will now be outlined.

Policy to stimulate accelerated new car turnover is required to achieve EV deployment targets

Current EV targets are optimistic and are unlikely to be achieved unless there is a considerable increase in supporting policies. These should be not just subsidies, but policies carefully targeted to correct for the specific market failures and barriers to adoption, with low-cost and revenue-neutral options available and preferred.

Almost one million EVs are to be on the road by 2030, according to the Climate Action Plan. This translates into an annual average rate of installation of 93,600 per annum, or 80% of 117,000 2019 new car registrations. Around 4000 EVs were registered in Ireland in 2019 and an 80% rate of EV purchase is highly unlikely to be achieved in the early years of the decade. Figure 7.4 provides an estimate by the DTTAS on a likely ramp up phase towards 2030. The results show that in the initial ramp-up phase most EVs will be plug-in hybrid electric vehicle (PHEV); after 2026 battery electric vehicle (BEV) cars are anticipated to overtake PHEV's.

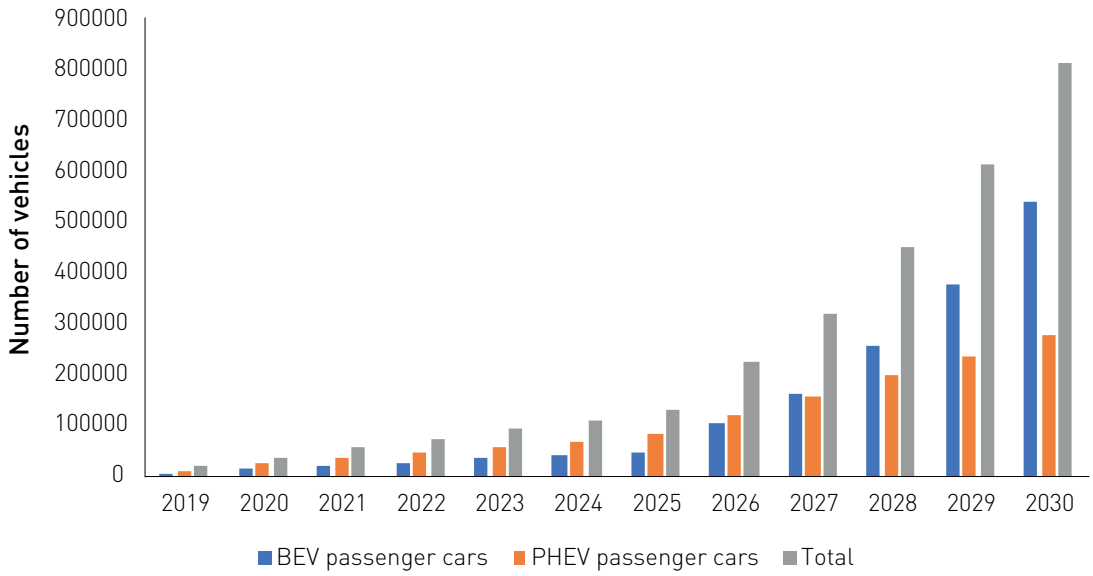


Figure 7.3: Climate Action Plan Targets for BEV and PHEV vehicles. **Data source:** *DTTAS.*

The electric mobility targets in the Climate Action Plan are very optimistic. While in recent years the number of EVs being sold in Ireland has increased, additional supports will be required to achieve targets. Figure 7.4 shows that, under the DTTAS projection, the number of new EVs that will have to be registered per annum will exceed the number of total car registrations in the state in 2019, many times over.

Incentivising a greater churn of new car sales must therefore be built into the policy response. Policies to incentivise ICE vehicle owners to switch outside of their new car purchase cycle include those that make an ICE vehicle much more expensive. Examples include: a very high carbon tax; ICE scrappage scheme; or increased registration or excise tax on ICE vehicles. Polices that overcome behavioural and capital constraints should also be implemented in parallel, such as a low-cost loan scheme and improved charging infrastructure..

Additional policies are required. These must be targeted towards correcting specific market failures. Low-cost options are available

A clear and binding carbon tax creates the financial incentive to switch to an EV without incurring a subsidy cost. This is a more efficient way to create the required financial incentive to adopt. As the Climate Action Plan notes, EVs are likely to result in lower lifetime running costs than ICE vehicles as the decade progresses. It is therefore not a financial constraint limiting adoption but a capital and behavioural constraint. Subsidies are a poorly targeted and expensive way to correct for this. A low-cost loan helps to overcome this particular market failure at source and is more effective and efficient than a subsidy. If capital constraints are hindering adoption, a car loan scheme, such as An Post's Green Hub, should be widely promoted. Insight from behavioural science can aid the promotion of such a scheme to maximise adoption. With the cost of government borrowing currently very low, loans can be financed relatively cheaply, providing a rare opportunity to implement climate action at relatively low-cost.

A clear and binding ban on ICE vehicles can incentivise EV uptake

An ICE vehicle ban signalled many years in advance helps to calibrate expectations and long-term investment decision-making in alignment with the national decarbonisation trajectory. There is a growing body of literature that examines policies that would make the purchase of an ICE vehicle less attractive. Letmathe and Suares examined the concept of perceived risk of purchasing an EV compared to an ICEV in Germany.[276] The study found that the risk of ICE vehicles being banned from driving in some cities and the introduction of information and awareness campaigns on the total cost of EV ownership had strong influences on purchasing decisions. As uncertainty about the use of ICE vehicles grows, prompted by low emission zones and carbon taxes, a switch in preferences towards EVs could occur but more research is needed in this area.

Non-financial incentives have mixed results and should not be prioritised

Hardman, in a detailed review of non-financial incentives *(e.g. free parking or bus lane usage)*, found that their influence depends largely on local conditions such as travel patterns, parking fees and congestion levels.[277] The study suggests that policymaking should vary by region to determine the most suitable policy for that region. This finding is shown in a Dutch study where a policy of free EV parking was shown to be perhaps counterproductive in some cities as people charged their cars for longer in these spaces, resulting in an inefficient use of charging infrastructure.[278]

Tackling 'range anxiety'

'Range anxiety' can be derived from an actual need for regular long-distance travel or a perceived need. Policy measures should minimise the prevalence of incorrectly perceived range anxiety. For instance, many consumers prefer an ICE vehicle for an unbroken range that they rarely or never use. A policy strategy, with input from behavioural and other social scientists in Ireland, can guide policy towards minimising this concern. Strategies may include:

- independent guidance on suitability of EVs to travel patterns
  - and based on this, calculate the likely frequency of necessary public charging.
- driver training to maximise range.
- consumer information on public charging infrastructure and help in journey planning.

The challenge of rural transport must be tackled

While we may see a greater degree of urbanisation, Ireland will still be characterised by a dispersed rural population with a greater dependence on private transport. Three out of four journeys outside Dublin were made by car in 2016[279] and levels of car dependency tend to be even higher when there is a need to travel over longer distances within rural areas.[280] However, potential ways of promoting sustainable 'car-shedding' behaviour in these areas must equally consider the pressing issue of public transport inaccessibility.[281,282] A key consideration will be a just transition to a low-carbon mobility system. Providing frequent and reliable public transportation to all parts of the country in some cases may not be feasible or economically viable. To this end, other modes such as EVs and on-demand shared mobility systems will have to be considered. It is also important to understand what parts of our country fall into this definition and how to focus our resources on ensuring sustainable mobility for all. Benevenuto and colleagues explored the occurrence of forced car ownership in Ireland.[283] The research created an index that considers deprivation, access to public transport and car ownership to determine the locations of pockets of forced car ownership. Figure 7.4 shows that between 2011 and 2016 the numbers of people that

fall into the category of forced car ownership in Ireland reduced, however, this is an issue that needs to be considered further when examining sustainable mobility.

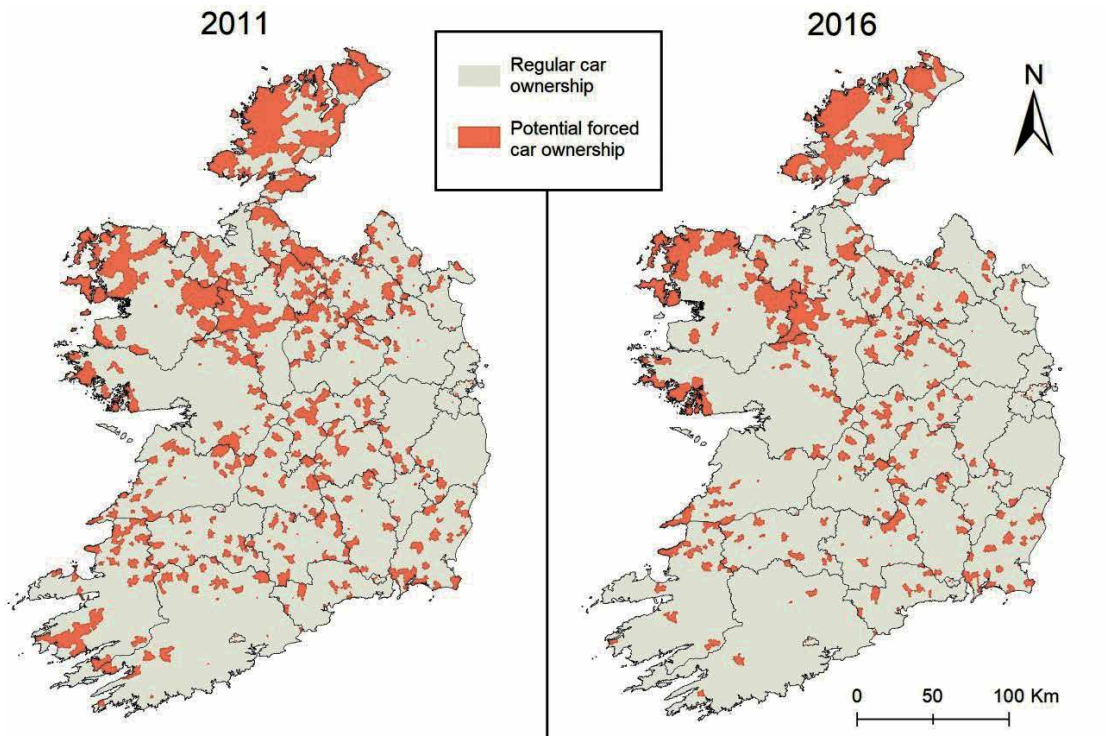


Figure 7.4: Areas of potential forced car ownership (Benevenuto et al. 2020).[283]

Rural depopulation in Ireland has ultimately had a negative impact on transport provision, specifically on the ability of traditional mainstream public transport operators to cater for an increasingly depleted level of travel demand. This has led to many such services needing to reduce their operational frequency or worse, in some cases to cease operation outright. Yet, more flexible tailored on-demand services such as LocalLink or vehicle borrowing schemes funded under the Rural Transport Programme, and a focused effort on providing extensive EV charging infrastructure to rural communities, have the potential to minimise the incidence and impacts of transport inaccessibility and poverty in rural areas. Rural transport must also decarbonise, but in order to do so, an alternative approach to that employed in urban areas is required, which ultimately relies on the widespread adoption of EVs and the provision of on-demand public transport services.

Mandate for procurement of EVs by public bodies

Public procurement can play a strong role in climate action. While decarbonising the fleet of public vehicles can reduce emissions, the value of this action may be much greater when one considers the influence it may have on the adoption decision of others and on market structure. Public procurement provides a signal to the supply chain that there is a demand for sustainable production patterns and sustainable goods, services and infrastructure. Green public procurement also provides demonstrative value, influencing the consumption decisions of households and the private sector.

Good public procurement delivers value to society. When the environmental benefits are taken into account, green public procurement has potential to provide considerable value. It is on this

basis that many international agencies such as the OECD and the European Commission promote green public procurement.[284,285] While green procurement forms part of procurement guidelines for Irish public bodies, the Council recommend that, on foot of the identified positive spillovers, the mandatory procurement of EVs for public use should form part of future public procurement.

7.3.6 Distributional considerations

There is concern in general discourse that some climate policies and measures are regressive, in that they either favour those who are well-off or impose a greater cost on the poor. One example is subsidy for EV purchase and ownership. The current price point of EVs tends to mean that only those on relatively high incomes can afford them and so benefit from those policies supporting uptake. Such a narrow view of policy should be avoided and can lead to sub-optimal decision making.

A key element of any distributional analysis is to consider not just the distributional impacts of one independent policy but the overall distributional impact of a suite of policies; the regressive nature of one policy may be offset by the progressive nature of another.

It is true that car ownership, and especially new car ownership, is skewed towards higher income groups and therefore supporting policy will be skewed towards those who are well-off.[i] However, over time, EVs will consequently emerge on the second-hand car market at price points that reflect a proportion of the initial incentive that encouraged the first purchase. It should be the goal to ensure that all policies taken together are progressive; an individual policy should not be discounted on distributional grounds if regressive effects are countered by action elsewhere. It is important, therefore, that the entire suite of climate action policies is progressive overall and offsets the potential regressive distributional impact of EV price supports. This can be achieved in two ways.

1. Additional emphasis should be placed on using carbon tax revenues for distributional purposes, recycled via the tax-benefit system. This should be accompanied by the pro-energy poor targeting of other policies where possible, such as insulation retrofit policies.

2. Taxing the purchase and use of ICE vehicles can be progressive if revenues are redistributed appropriately. Poor households will be net beneficiaries and all households will retain the incentive to adopt. Indeed, this is a policy design that will achieve many social policy objectives in addition to environmental goals.

7.3.7 The imported used car market

Imported used cars represent a growing share of the total number of vehicles registered in Ireland. The vast majority of these vehicles derived from the UK market, for obvious reasons, not least because we shared left - hand drive rules. There has been a remarkable increase in the volume of used cars entering the Irish market in recent years. In the early 2000's, new car sales dominated the market, making up an average of 89% of registrations, as shown in Figure 7.5. The recession caused deep disruption to the market, with total car registrations falling to just 43% of the pre-recession peak, and during the recession the share of new cars fell to 52%. This was viewed as an aberration and it was believed the market would return to 'normal' as the economy emerged from the recession. In recent years car registrations have returned to more

i Indeed, early adopters of electric vehicles are more likely to be new car buyers, who are purchasing a vehicle with a relatively high capital outlay. They will be a wealthy subset of a wealthy subset.

typical vales of approximately 200,000 per year. However, in retrospect, it is possible to view the increase in the importation of used cars as a trend in the market that has been emerging since the mid-2000s.

Two aspects of the prevalence of imported used cars on the market, and their apparent displacement of sales of new cars, may impact on the rate of uptake of EVs in Ireland.

1. The broad range of EV models are only now emerging onto the new car market, therefore it will take several years for a significant volume of vehicles to present onto the used car market. There is also evidence that owners tend to retain EVs longer than ICE vehicles, which would represent an additional delay before they appear on the used car market.

2. The influence of transport policies in the UK will determine the rate of penetration of EVs in the UK fleet and subsequent share in the used car market. Brexit also introduces significant uncertainty to the market.

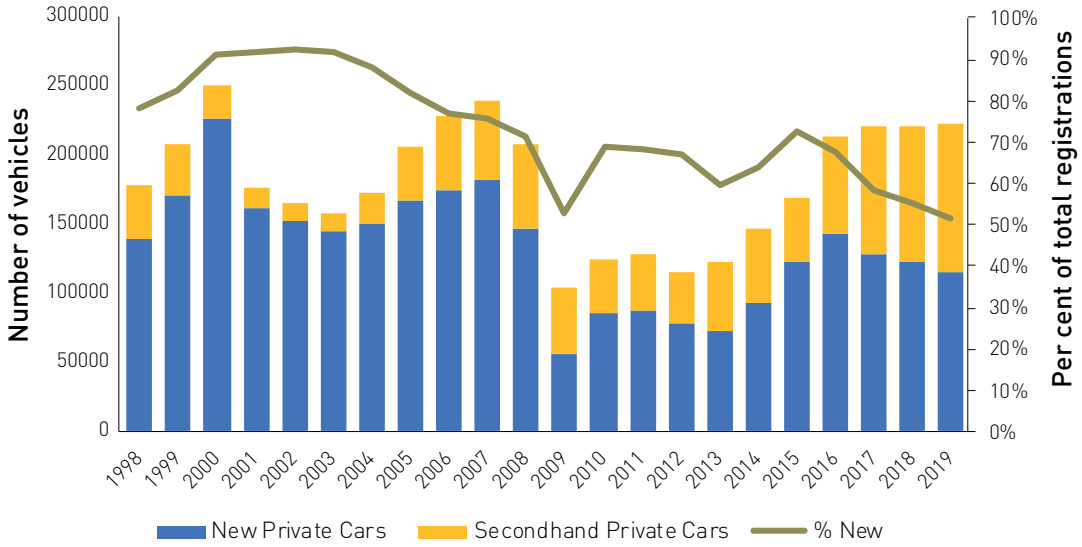
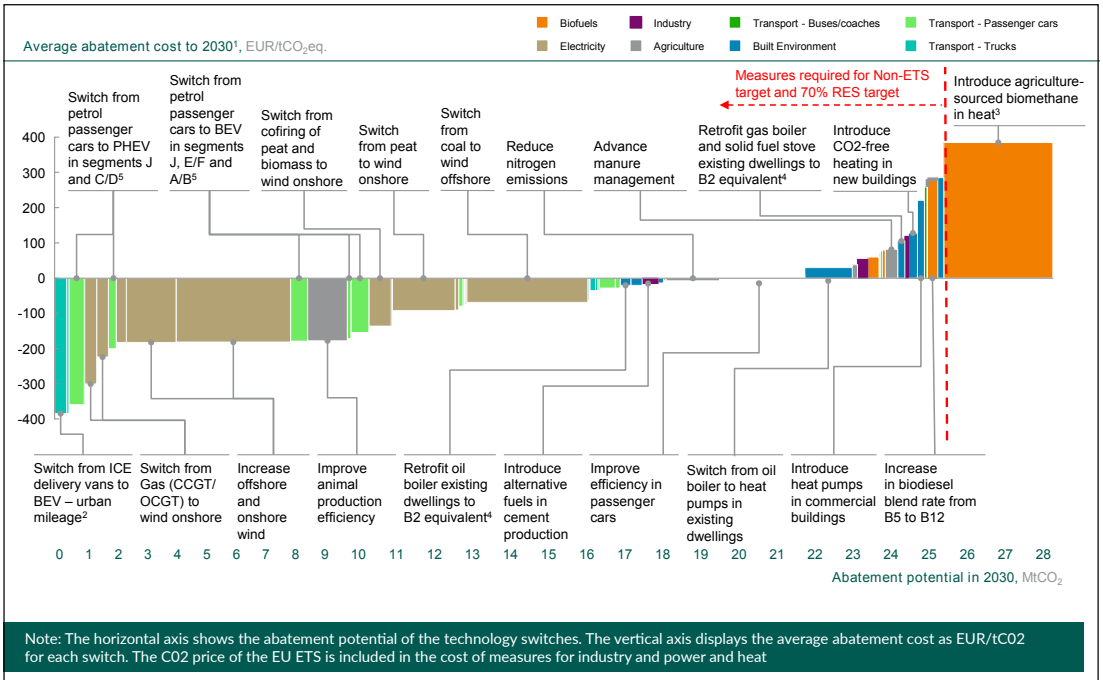


Figure 7.5: Trends in cars registered for the first time in Ireland. **Data source**: *CSO, Table TEA02 New private cars second-hand private cars.*[287]

7.4 An evaluation of the transport in the Climate Action Plan

The Climate Action Plan 2019 prioritises measures according to their marginal abatement cost (MAC).[22] The MAC is the cost of reducing one more unit of pollution through a given measure and allows analysts and policymakers to prioritise abatement measures in order of efficiency. Ireland's Climate Action Plan presents the MACs calculated by McKinsey for all potential carbon mitigation options in Ireland. Ranking these options in order of cost yields the MAC curve, through which one can identify the suite of policies that achieves a given target at least cost. This tool is used by Ireland's Climate Action Plan to calculate the suite of policies required to meet the 2030 non-ETS and 70% renewable electricity target at least cost, with the most efficient chosen irrespective of sector. This is illustrated in Figure 7.6.



Note: The horizontal axis shows the abatement potential of the technology switches. The vertical axis displays the average abatement cost as EUR/tC02 for each switch. The C02 price of the EU ETS is included in the cost of measures for industry and power and heat

1 Measures considered exclude LULUCF and biofuels use in energy/heat production. MACC does not include cost of enabling infrastructure (e.g., EV charging network, transmission & distribution upgrade). Agriculture measures are based on Teagasc Greenhouse Gas Working Group report "An Analysis of Abatement Potential of Greenhouse Gas Emissions in Irish Agriculture 2021-2030"; Total abatement includes abatement for growth in the analysed sectors;
2 The switch to electric light commercial vehicles bring early TCO parity due to low weight vehicles doing long journeys;
3 Biogas/biomethane abatement lever could displace emissions in both industry, buildings and power,
4 B2 BER insulation equivalent: includes wall, roof & window insulation, excludes boiler upgrade
5 Vehicle classes include: A/B - mini, small cars; C/D - medium, large cars; E/F - executive, luxury cars; J - sport utility cars (including off-road vehicles)

Figure 7.6: Ireland's 2019-2030 Marginal Abatement Cost Curve, **Source:** *DCCAE (2019).*[22]

There are two primary deficiencies with respect to policy prioritisation within the Climate Action Plan. First, the Climate Action Plan considers lifecycle operating costs; these calculations are made exclusive of policy costs and infrastructure investment costs, potentially leading to sub-optimal policy choice. Secondly, the 'total cost of ownership' (TCO) metric to quantify costs lacks transparency; the Climate Action Plan does not outline how total cost of ownership has been calculated. As the details of these calculations have not been released, they cannot be evaluated. Each of these issues will now be assessed in more detail.

The MAC analysis of the 2019 Climate Action Plan (Figure 7.6) shows that EVs will cost owners less, on a TCO basis, than ICE alternatives during the 2020 – 2030 period. EVs therefore take a prominent place in Ireland's decarbonisation pathway for transport. However, this calculation does not include the cost of policy supports or infrastructure costs.

Kevany estimates that the cost of policy supports per unit of carbon emissions avoided is of a comparable magnitude to the TCO savings calculated in the Climate Action Plan.[286] EV deployment in Ireland is supported by an SEAI grant, a subsidised charging point, a favourable VRT rate and toll exemptions. The policy cost per unit of carbon avoided is estimated to be €250-351 per tCO_2 for a BEV, rising to between €492 and €681 for a PHEV.

Comparing the private costs estimated in the climate action plan to the social costs calculated by Kevany,[287] it would appear that EVs are at the upper end of MAC range and may be more expensive than policy alternatives not currently implemented once infrastructure costs are taken

into account. While this is a rough estimation, it illustrates the importance of policy cost in policy decision-making; a thorough analysis incorporating policy cost is required.

Once policy and infrastructure costs are taken into account, the position of EVs on the MAC curve changes considerably and their inclusion on a cost-effective decarbonisation trajectory is likely merited but uncertain without further analysis. There are two ways to overcome this problem.

According to the Climate Action Plan, EVs have a negative cost. Therefore, it is the policy cost, and particularly the choice to use subsidies and tax credits as the primary policy instruments, that makes EVs expensive for the Exchequer. These can be substituted for lower-cost or revenue-neutral alternatives. Policies such as increasing taxes to increase the relative purchase cost of ICE vehicles can create a price differential in favour of EVs similar to the current incentives while also revenue-generating. This would increase the total cost of ownership for ICE vehicles without the same Exchequer cost of incentives. Further options include a higher carbon tax with partial subsidy; low-cost or zero-interest loans; or a combined loan with partial subsidy. A policy option should be chosen that is effective in addressing the market failure or behavioural hurdle as close to source as possible, thus incentivising adoption at least cost. Further transparent analysis is required to identify the most appropriate option.

If it is not possible to implement a more efficient set of policy supports, the marginal abatement cost inclusive of policy and infrastructure costs must be estimated. The position of EVs in the climate action plan may then be assessed relative to the least cost alternatives not implemented. If the Climate Action Plan is to be based on a least-cost set of policies, as the current basis, then such an analysis is necessary. The current lack of transparency in the Climate Action Plan inhibits such analysis.

There are some sensitivities that must be borne in mind when interpreting the findings of the Climate Action Plan and which may guide effective policy. The key sensitivity is the breakeven point with ICE and EV total cost of ownership. The Climate Action Plan assumes this occurs in 2024. Should this occur later, there is an increased likelihood that the next best alternative, not included in the Climate Action Plan, would be more cost-effective.[i] [288,289]

There may be further factors that should also be considered. This includes less tangible benefits such as a 'leadership' value; building familiarity through early adoption can lead to greater rates of adoption. These benefits may justify the relatively large cost of early adoption, but a transparent and thorough analysis is required to understand the extent to which this is the case, and supports calibrated accordingly.

The lack of transparency in cost estimates creates further uncertainties. For instance, the 2019 Climate Action Plan compares the total cost ownership of EV to ICE vehicles. A key component of such a comparison is the assumed usage pattern. It is not clear what value is chosen and how this is implemented. Data on the level and distribution of usage are required for an accurate prediction, otherwise adoption rates may be incorrectly estimated. Neither of these values are specified in the Climate Action Plan. For low mileage users the breakeven point between ICEs

i Battery cost reductions hold significant promise for lowering the cost of an EV. Average prices hit $209/kWh at the end of 2017. Research has found that battery costs must fall to around $100/kWh for EVs to reach parity with ICEVs on a TCO basis. There is much commentary to suggest that the McKinsey assumption of cost parity by 2024 is ambitious; Kapustin and Grushevenko (2020) expect price parity to occur around 2035, while an MIT Energy Initiative (2019) report suggests that US cost parity may be achieved around 2030, with earlier cost parity possible in countries with high fuel taxes.

and EVs occurs later. If all adopters are assumed to conform to the average rate of usage, then total adoption may be overestimated.

This illustrates the problems presented by a lack of transparency: poor policies are potentially put in place that cannot be appropriately critiqued. An appropriate evaluation requires that all policy decisions should be grounded in transparent calculations.

7.5 Conclusions

- Considerable opportunities exist within the Transport sector to address climate change while providing multiple co-benefits to society, including improved air quality and health.
- In framing recommendations for policy change in Transport, the Council seeks to ensure that there is progress towards the complete decarbonisation of the sector while, at the same time, providing that necessary policy changes will safeguard affordable access to mobility, cost-competitive delivery of passenger and community services, and enhanced quality of life.
- The ambition in the Climate Action Plan, particularly in relation to the expansion of the numbers of EV, will be very challenging. There is a: need to develop continency options to achieve the same level of emissions reduction should the EV targets prove unattainable.
- Progress on reducing emissions from public transport has been limited. Investment in public transport is needed urgently but it should be recognised that significant return on this investment in terms of emissions reduction will take time.
- As currently structured, public transport cannot compete with the low running costs and relative convenience of EVs. This is a challenge for all public transport system internationally. Novel approaches, such as nominal low ticket fares and zero fares have been piloted, providing important insight into passenger behaviour.

Activities of the Council

As required under Section 12(f) of the Climate Action and Low Carbon Development Act 2015,[1] the activities of the Council in 2018 are listed here.

Date	Organisation	Subject	Attendees
03.01.2019	Teagasc	Consultation meeting with Teagasc on topics with Special Focus Chapter Annual Review 2019	Council Secretariat
07.01.2019	IBEC	Industry wide-response to climate change: IBEC's draft proposals to Government's consultation on the NECP	Prof. John FitzGerald
11.01.2019	Devenish Beyond Nutrition	Their research on emissions mitigation within the Agriculture sector	Prof. John FitzGerald
14.01.2019	Static Hydro	Research and development of energy solutions	Prof. John FitzGerald
15.01.2019	Irish Farmers Journal	Research and communication of mitigation options at a farm level	Prof. John FitzGerald
16.01.2019	Kilkenny Three Counties Energy Agency	3 Counties Energy Agency and retrofitting	Prof. John FitzGerald
22.01.2019	TCD	TCD Conference on natural capital and biodiversity	Prof. John FitzGerald
30.01.2019	DCU	Workshop on Policy impacts chaired by DCU	Council Secretariat
07.02.2019	National Parks and Wildlife Service	Seminar on Peatlands greenhouse gas emissions, chaired by National Parks and Wildlife Service	Council Secretariat
15.02.2019	MarEi, UCC	Consultation with UCC on topics with Special Focus Chapter Annual Review 2019	Council Secretariat
18.02.2019	Department of Housing, Planning and Local Government	Built Environment and Archaeological Heritage Adaptation Plan Advisory Group	Council Secretariat
20.02.2019	TCD	National Biodiversity Conference	Prof. John FitzGerald
20-21.02.2019	Irish Forum on Natural Capital	Climate Change and Bio-Diversity	Prof. John FitzGerald
21.02.2019	Department of Communications, Climate Action and Environment	Meeting with Department Officials regarding Climate Change Advisory Council	Prof. John FitzGerald, Council Secretariat
06.03.2019	Central Statistics Office	Environmentally Damaging Subsidies (PEDS)	Council Secretariat

Date	Organisation	Subject	Attendees
11.03.2019	Irish Farmers Journal	Establishing a pilot programme of demonstration farms using the carbon balance sheet approach at Dowth	Prof. John Fitzgerald
15.03.19	RDS Committee of Agriculture and Rural Affairs and Teagasc	Climate Action Summit	Prof. John FitzGerald
28.03.2019	Simon Quemin, Raphaël Trotignon and Anna Creti	ETS reform and carbon pricing in the EU: Ways forward for progressive states	Prof. John FitzGerald
03.04.2019	Engineers Ireland	Annual Seminar: Ireland's 2030 Electricity System	Prof. John FitzGerald
04.04.2019	St. Mary's Church Haddington Road	Climate Change presentation	Prof. John FitzGerald
09.04.2019	The Irish Farmers Journal	Farmers' Journal staff on climate change	Prof. John FitzGerald
10.04.2019	Embassy of France	Greenhouse gas emissions, renewables energies and climate change policies	Prof. John FitzGerald
10.04.2019	Department of Agriculture, Food and the Marine	Sectoral engagement meeting with Department of Agriculture, Food and the Marine	Council Secretariat
11.04.2019	Civil Service Assistant Secretaries network	Climate Change Policy	Prof. John FitzGerald
12.04.2019	Energy Law Ireland/ McCann Fitzgerald	Host of breakfast seminar	Prof. John FitzGerald
15.04.2019	Labour Party	Climate Change	Prof. John FitzGerald
16.04.2019	Joint Oireachtas Committee on Climate Action	Launch of the report of the Joint Oireachtas Committee on Climate Action	Prof. John FitzGerald, Laura Burke, Council Secretariat
19.04.2019	McCann Fitzgerald	Energy and Law breakfast	Prof. John FitzGerald
24.04.2019	Devenish Beyond Nutrition	Field trip: Dowth - Devenish Nutrition Research Farm	Council Secretariat
24.04.2019	County and City Management Association and the Local Authorities Environmental Services Training Network	Climate Action: Leading at Local Level	Prof. John Fitzgerald

Date	Organisation	Subject	Attendees
25.04.2019	UCC Centre for Global Development and Irish Forum for International Agricultural Development (IFIAD)	Irish launch of the EAT-Lancet Commission Report	Council Secretariat
25.04.2019	Irish Energy Storage Association	Role of energy storage to facilitate high levels of non-synchronous renewable energy onto the grid	Prof. John Fitzgerald
29.04.2019	MarEi, UCC	Climate Communications Masterclass hosted by UCC	Council Secretariat
30.04.2019	Department of Finance Conference on Globalisation and Taxation.	Panel discussion: macro-economics, the issue of climate change and carbon taxes	Prof John Fitzgerald
09.05.2019	Individual	Consultation with Climate Communications expert Ed Cameron	Council Secretariat
09.05.2019	Department of Communications, Climate Action and Environment	Consultation with Department of Communications, Climate Action and Environment on progress on Adaptation Plans	Council Secretariat
15.05.2019	Oireachtas	Ireland as a Leader in Climate Action - Rising to the Challenge Symposium hosted by Department of Communications, Climate Action and Environment	Council Secretariat
17.05.2019	EPA	EEPA Climate Change Lecture: New climate leadership for a low carbon, climate resilient and inclusive world presented by Dr Edward Cameron	Council Secretariat
21.05.2019	Department of Transport, Tourism and Sport	Sectoral Engagement Meeting with Department of Transport, Tourism and Sport	Council Secretariat
22.05.2019	EPA	Video Conference with EPA inventories and projections teams	Council Secretariat
06.06.2019	Department of Health	Climate Change and Health Adaptation Stakeholder Forum	Council Secretariat
10.06.2019	Department of Agriculture, Food and the Marine	Our Ocean Wealth Summit	Council Secretariat
11.06.2019	Advisors to the Joint Oireachtas Committee on Climate Change	Consultation with secretariat of the JOC Climate Action	Prof. John FitzGerald, Council Secretariat

Date	Organisation	Subject	Attendees
11.06.2019	TSU, IPCC	Insights from the IPCC special report on Climate and Land: Briefing hosted by DAFM	Council Secretariat
12.06.2019	Bord Na Móna	Just transition	Prof. John Fitzgerald
14.06.2019	Department of Communications, Climate Action and Environment	Consultation with Department of Communications, Climate Action and Environment on peatlands and carbon stocks	Council Secretariat
14.06.2019	Department of Communications, Climate Action and Environment	Meeting with Minister Bruton on Climate Action Plan	Prof. John Fitzgerald
18.06.2019	Budgetary Oversight Committee	Budgetary Oversight Committee	Prof. John FitzGerald, Council Secretariat
20-21.06.2019	Energy Ireland	Climate: Driving Ireland's Energy Transition presentation at session on Drivers of Change in the Energy Sector	Prof. John Fitzgerald
25.06.2019	Salesforce	Climate Change	Prof. John Fitzgerald
26.06.2019	National Economic Dialogue	Attend the National Economic Dialogue	Prof John Fitzgerald
27.06.2019	Bord Na Móna	Meeting with CEO of Bord na Móna	Prof. John Fitzgerald
27.06.2019	Department of Agriculture, Food and the Marine	Launch of the Public Consultation on the Agriculture, Forest and Seafood Sectoral Climate Change Adaptation Plan	Council Secretariat
29.06.2019	Natural Capital Ireland	Panel discussion: Climate and Biodiversity Emergency panel discussion	Prof. John Fitzgerald
22.07.2019	British Irish Chamber of Commerce	Panel discussion: Climate Change Challenge, the role of Government, Industry and Society	Prof. John FitzGerald
26.07.2019	Department of the Taoiseach	Phone call with the Taoiseach on Minister's forthcoming request	Prof. John FitzGerald
02.08.2019	UK Committee on Climate Change	Phone call: Chris Stark-UKCCC	Council Secretariat
28.08.2019	Irish Farmers Association	Smart Farming Open Farm Day: IFA	Council Secretariat

Date	Organisation	Subject	Attendees
4.09.2019	Devenish Beyond Nutrition	Meeting with Dr Rob Kinlay, the CSIRO Ruminant Researcher; Justin Harsdorf, CSIRO Business Development Manager; David Hagan, Devenish Ruminant Sustainability Manager	Prof. John FitzGerald
4.09.2019	Irish Creamery Milk Suppliers Association (ICMSA)	Irish Creamery Milk Suppliers Association (ICMSA) Dairy and Climate Change Seminar	Council Secretariat
06.09.2019	Department of Communications, Climate Action and Environment	Invitation to Community Resource Coordination Groups members to a Citizens' Climate Policy Makers Workshop September 6th 2019 in Department of Communications, Climate Action and Environment	Council Secretariat
09.09.2019	Oxford Martin School, University of Oxford	Achieving Net Zero Conference	Council Secretariat
11.09.2019	Historical Society,TCD	Panel discussion: climate change	Prof. John FitzGerald
12.09.2019	Department of Communications, Climate Action and Environment	Sectoral engagement: Department of Communications, Climate Action and Environment	Council Secretariat
13.09.2019	Dublin Economics Conference	Climate change	Prof. John FitzGerald
16.09.2019	SRU Sachverstandigenrat fur Umweltfragen (Umwelt Rat)	Phone call: carbon budgets	Council Secretariat
16.09.2019	Tara Shine	Phone call: carbon budgets	Council Secretariat
16.09.2019	SEAI	Energy and Climate Research Network, SEAI	Council Secretariat
17.09.2019	Department of Agriculture, Food and the Marine	National Ploughing Championships, Climate Change Focus Panel Discussion, hosted by DAFM	Council Secretariat
30.09.2019	NUIG	SeQUEsTER pathways to carbon neutrality workshop hosted by NUIG	Council Secretariat
30.09.2019	Environmental Research Institute, UCC	Cork: A Healthy City in a Changing Climate Seminar	Council Secretariat
01.10.2019	Department of Communications, Climate Action and Environment	Meeting re Access to Modelling	Council Secretariat

Date	Organisation	Subject	Attendees
02.10.2019	Environment Ireland 2019 Conference	A strategy for meeting Ireland's climate change challenge	Prof. John FitzGerald
03.10.2019	James Glynn, UCC	Phone call: carbon budgets	Council Secretariat
03.10.2019	MarEi, UCC	Consultation with MarEi, UCC on carbon budgets	Council Secretariat
14.10.2019	Stop Climate Chaos Coalition	Stakeholder meeting with experts from the Carbon Tracker Initiative	Prof. John FitzGerald
15.10.2019	GMIT	Climate Change	Prof. John FitzGerald
15.10.2019	An Taisce - South County Dublin	Climate Change	Prof. John FitzGerald
16.10.2019	Joint Oireachtas Committee on Climate Action	Climate Change Advisory Council's Annual Review 2019	Prof. John FitzGerald, Council Secretariat
21.10.2019	Carbon Budget Workshop	Carbon Budget preparation	Prof. John FitzGerald; Prof. Anna Davies; Prof. Alan Barrett; Laura Burke; Council Secretariat
21.10.2019	DG Clima, European Commission	Climate Action Plan, its implementation and the role of the future Climate Action Council	Prof. John FitzGerald
22.10.2019	Department of the Taoiseach	Meeting with Sharon Finegan regarding Climate Change	Prof. John FitzGerald
22.10.2019	Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC)	Webinar: Striving to align investment decisions to a 1.5C trajectory: EU taxonomy and EU climate benchmarks	Council Secretariat
24.10.2019	Meath Agricultural Science Association	Climate Change	Prof. John FitzGerald
01.11.2019	Brian O' Gallachoir, UCC	Phone call: greenhouse gas cross sectoral modelling	Council Secretariat
06.11.2019	Department of Communications, Climate Action and Environment	Consultation with DCCAE, modelling group meeting	Council Secretariat
08.11.2019	James Glynn, UCC	Phone call: carbon budgets	Council Secretariat
11.11.2019	EPA Research meeting	Advance Information - Steering Committee Meeting No 2 Society-wide Scenarios for Effective Climate Change Mitigation (SSECCM) Project Code: 2018-CCRP-DS.14.	Council Secretariat

Date	Organisation	Subject	Attendees
12.11.2019	Áras an Uachtaráin	Rethinking the role of the State in fostering a sustainable and inclusive economy	Prof. John FitzGerald
12.11.2019	David Frame	Phone call: Discussion of NZ carbon budget paper with David Frame	Council Secretariat
12.11.2019	SEAI	SEAI Energy in Ireland launch	Council Secretariat
14.11.2019	Office of the Planning Regulator	Office of planning regulator	Council Secretariat
15.11.2019	EPA	Climate Research Coordination Group Meeting hosted by EPA	Council Secretariat
20.11.2019	Mercator Research Institute on Global Commons and Climate Change & PIK	Coordinating the next wave of EU climate policies	Prof. Frank Convery
20.11.2019	SEAI	SEAI National Energy Research and Policy Conference	Council Secretariat
20.11.2019	EPA	EPA Climate Change Lecture: Facing up to Climate Change: Where next for Climate Science presented by Dame Julia Slingo	Council Secretariat
21.11.2019	EPA	EPA/HSE/ESRI Environment, Health and Well Being Conference	Council Secretariat
25.11.2019	Irish Centre for European Law	Environmental Law Conference	Council Secretariat
26.11.2019	TCD	Transport research discussion with Brian Caulfield	Council Secretariat
27.11.2019	Ervia	Meeting regarding Vision 2050	Prof. John FitzGerald, Council Secretariat
29.11.2019	Northern Ireland Chamber of Commerce and Industry	Belfast and Climate Change	Prof. John FitzGerald
10.12.2019	National Economic Social Council	Just transition work of NESC and the Council	Council Secretariat
02.12.2019	University of Limerick	Climate Change	Prof. John FitzGerald
02.12.2019	Shannon Chamber of Commerce	Climate Change – Low Carbon Economy	Prof. John FitzGerald
05.12.2019	UCD	Thomas Sterner Seminar: Carbon taxes - a powerful tool in the fight against climate change	Council Secretariat

Date	Organisation	Subject	Attendees
12.12.2019	Department of Finance	Feedback on public consultation on adapting to climate change and insurance	Frank Convery, Council Secretariat
12.12.2019	SEAI	Launch of Energy in Ireland 2019 report	Council Secretariat

Climate Change Advisory Council and Adaptation Committee Meetings 2019

Date	Purpose	Attendees
17th January 2019	Climate Change Advisory Council Meeting	Prof. John FitzGerald (Chair), Prof. Gerry Boyle, Laura Burke, Prof. Frank Convery, Dr. Joseph Curtin (video), Prof. Ottmar Edenhofer (video), Prof. Alan Matthews
28th February 2019	Climate Change Advisory Council - Adaptation Committee Meeting	Prof. John FitzGerald (Chair), Mark Adamson (OPW), Laura Burke (EPA), Prof. Robert Devoy (UCC), Ciarán Hayes (CCMA), Eoin Moran (Met Éireann), Dr Conor Murphy (NUIM).
4th April 2019	Climate Change Advisory Council Meeting	Prof. John FitzGerald (Chair), Prof. Alan Barrett, Prof. Gerry Boyle, Laura Burke, Prof. Frank Convery Prof. Peter Clinch, Dr. Joseph Curtin (video), Prof. Anna Davies, Jim Gannon, Prof. Alan Matthews
30th May 2019	Climate Change Advisory Council - Adaptation Committee Meeting	Prof. John FitzGerald (Chair), Mark Adamson (OPW), Laura Burke (EPA), Prof. Robert Devoy (UCC), Ciarán Hayes (CCMA), Dr. Siobhán Kavanagh (Teagasc), Dr Ina Kelly (HSE), Keith Lambkin (Met Éireann), Dr Conor Murphy (NUIM),
13th June 2019	Climate Change Advisory Council Meeting	Prof. John FitzGerald (Chair), Prof. Alan Barrett, Prof. Gerry Boyle, Laura Burke, Prof. Frank Convery Prof. Peter Clinch, Dr. Joseph Curtin, Prof. Anna Davies, Jim Gannon, Prof. Alan Matthews
24th July 2019	Launch of Annual Review 2018	Prof. John FitzGerald, Laura Burke.
19th September 2019	Climate Change Advisory Council Meeting	Prof. John FitzGerald (Chair), Prof. Gerry Boyle, Laura Burke, Prof. Frank Convery, Prof. Anna Davies, Prof. Alan Matthews, William Walsh
23rd October 2019	Climate Change Advisory Council - Adaptation Committee Meeting	Prof. John FitzGerald (Chair), Prof. Robert Devoy (UCC), Ciarán Hayes (CCMA), Phil Hemmingway (SEAI), Dr Ina Kelly (HSE), Keith Lambkin (Met Éireann).
28th November 2019	Climate Change Advisory Council Meeting	Prof. John FitzGerald (Chair), Prof. Gerry Boyle, Laura Burke, Prof. Frank Convery, Dr. Joseph Curtin (video), Prof. Anna Davies, Prof. Alan Matthews, William Walsh
12th December 2019	Climate Change Advisory Council - Adaptation Committee Meeting	Prof. John FitzGerald (Chair), Mark Adamson (OPW), Laura Burke (EPA), Prof. Robert Devoy (UCC), Ciarán Hayes (CCMA), Keith Lambkin (Met Éireann), Dr Conor Murphy (NUIM), Roger Street (UKCIP) (video link).

Appendix 1 Legislation on Annual Review Report

Annual Review by, and annual report of, Advisory Council

12. (1) The Advisory Council shall—

(a) conduct a review (in this section referred to as the 'annual review') in each year of the progress made during the immediately preceding year in achieving greenhouse gas emissions reductions, and furthering transition to a low carbon, climate resilient and environmentally sustainable economy, and

(b) not later than 30 days after the completion of the annual review, prepare and submit to the Minister a report (in this section referred to as the 'annual report') on its findings and recommendations consequent upon that annual review.

(2) Without prejudice to the generality of subsection (1), the annual report shall contain—

(a) a summary of the findings set out in the most recent national greenhouse gas emissions inventory prepared by the Agency,

(b) a summary of the most recent projection of future greenhouse gas emissions prepared by the Agency,

(c) such recommendations as the Advisory Council considers necessary or appropriate, in relation to the most cost-effective manner of achieving reductions in greenhouse gas emissions in order to enable the achievement of the national transition objective,

(d) such recommendations as the Advisory Council considers necessary or appropriate, in relation to compliance with an existing obligation of the State under the law of the European Union or an international agreement referred to in section 2,

(e) such other recommendations or advice as the Advisory Council considers necessary or appropriate in order to enable the achievement of the national transition objective, and

(f) a summary of—

(i) the activities of the Advisory Council under section 11 (2), and (ii) any information gathered in accordance with section 11 (2).

(3) Not more than 30 days after submitting an annual report to the Minister under this section, the Advisory Council shall publish the annual report by such means as the Agency may advise.

Appendix 2 Data Sources for Transition Indicators

Name	Unit	Sources
GHG intensity of the economy (GNI*)	kt CO_2eq/€M GNI*	CSO (2020), Table N1925: Annex2. Modified Gross National Income at Constant Market Prices (Euro Million) by Item and Year, EPA (2020) National Inventory Report and Common Reporting Format, Ireland Submission to the UNFCCC, (online)
GHG per capita	t CO_2eq/ Population	CSO (2020), table PEA01: Population Estimates (Persons in April) by Age Group, Sex and Year, EPA (2020) National Inventory Report and Common Reporting Format, Ireland Submission to the UNFCCC, (online)
CO_2 intensity of the economy	kt CO_2/€M GNI*	CSO (2020), Table N1925: Annex 2. Modified Gross National Income at Constant Market Prices (Euro Million) by Item and Year, EPA (2020) National Inventory Report and Common Reporting Format, Ireland Submission to the UNFCCC, (online)
CO_2 per capita	t CO_2/Population	CSO (2020), table PEA01: Population Estimates (Persons in April) by Age Group, Sex and Year, EPA (2020) National Inventory Report and Common Reporting Format, Ireland Submission to the UNFCCC, (online)
Economy-wide efficiency	GNI*/t carbon dioxide equivalent €/t carbon dioxide equivalent	CSO (2020), Table N1925: Annex2. Modified Gross National Income at Constant Market Prices (Euro Million) by Item and Year, EPA (2020) National Inventory Report and Common Reporting Format, Ireland Submission to the UNFCCC, (online)
Total primary energy requirement	Megawatt hour (MWh)	SEAI (2019): Ireland's Energy Balance 1990-2018; and Energy in Ireland 2019 Report, (online)
Emissions from peat- and coal-fired electricity generation	kt CO_2	SEAI (2019); Ireland's Energy Balance 1990-2018, EPA (2020) National Inventory Report and Common Reporting Format, Ireland Submission to the UNFCCC, (online)
CO_2 intensity of electricity	Gt CO_2/kilowatt hour (kWh)	SEAI (2019); Ireland's Energy Balance 1990-2018, EPA (2020) National Inventory Report and Common Reporting Format, Ireland Submission to the UNFCCC, (online)
% renewable of gross electricity consumption	%	SEAI (2019), Energy in Ireland 2019 Report, (online)
% renewable heat	%	SEAI (2019), Energy in Ireland 2019 Report, (online)
% residential energy from solid fuel (peat and coal)	%	SEAI (2019), Energy in Ireland 2019 Report, (online)
A and B Building Energy Rating (BER)-rated residential 'dwellings'	% of BER data set	CSO (2019), Domestic Building Energy Ratings Quarter 1 2019, Table 6 BER Ratings by Main Space Heating Fuel (2009-2019), (online)

Name	Unit	Sources
A and B BER-rated commercial buildings	% of non-dwelling BER data set, excluding hospitals, health, community, nursing homes, schools and colleges	CSO (2019), Non-domestic Building Energy Ratings Quarter 1 2019, Table 3 Building Energy Ratings by Type of Building (Non-Domestic) 2009-2019, (online)
Energy efficiency gains in public bodies	% improvement from business as usual	SEAI (2020) Annual Report 2019 on public sector Energy Efficiency Performance, (online)
Energy consumption of public bodies	Gigawatt hours (GWh)	SEAI (2020) Annual Report 2019 on public sector Energy Efficiency Performance, (online)
% renewable transport (RES-T)*	%	SEAI (2019), Energy in Ireland 2019 Report, (online)
Distance by private car	Million kilometres	CSO (2019), THA10: Road Traffic Volumes by Type of Vehicle, Year and Statistic, (online)
Distance by private car per capita	Kilometres	CSO (2019), THA10: Road Traffic Volumes by Type of Vehicle, Year and Statistic; CSO (2020), table PEA01: Population Estimates (Persons in April) by Age Group, Sex and Year, (online)
Distance by goods vehicles	Million kilometres	CSO (2019), THA10: Road Traffic Volumes by Type of Vehicle, Year and Statistic, (online)
Distance by public service vehicles	Million kilometres	CSO (2019), THA10: Road Traffic Volumes by Type of Vehicle, Year and Statistic, (online)
Private car new vehicles' fuel type	Number of new petrol and diesel vehicles (as % of all new)	CSO (2019): TEA17: New Vehicles Licensed for the First Time by Type of Vehicle Registration, Type of Fuel and Year; THA10: Road Traffic Volumes by Type of Vehicle, Year and Statistic, (online)
New goods vehicles' fuel type	Number of new petrol and diesel vehicles (as % of all new)	CSO (2019): TEA17: New Vehicles Licensed for the First Time by Type of Vehicle Registration, Type of Fuel and Year; THA10: Road Traffic Volumes by Type of Vehicle, Year and Statistic, (online)
Forestry cover	Hectares	EPA (2020) National Inventory Report and Common Reporting Format, Ireland Submission to the UNFCCC, (online)
Dairy cows (December)	Thousands	CSO (2020) AAA06: Farm Animals in December by Type of Animal and Year, (Online)
Non-dairy cows (December)	Thousands	CSO (2020) AAA06: Farm Animals in December by Type of Animal and Year, (Online)
Other cattle (December)	Thousands	CSO (2020) AAA06: Farm Animals in December by Type of Animal and Year, (Online)
Sheep (June)	Thousands	CSO (2020) AAA09: Number of Livestock in June by Type of Animal, Region and Year, (online)

Name	Unit	Sources
Nitrogen fertiliser use	Tonnes of nitrogen	EPA (2020) National Inventory Report and Common Reporting Format, Ireland Submission to the UNFCCC, (online)
Total area of drained organic soils	Hectares	EPA (2020) National Inventory Report and Common Reporting Format, Ireland Submission to the UNFCCC, (online)
Dairy production efficiency	LCA kg carbon dioxide equiv /kg milk	Teagasc (2020) Teagasc National Farm Survey 2018 Sustainability Report, (online)
Beef production efficiency	kg carbon dioxide equivalent/kg beef (live weight)	Teagasc (2020) Teagasc National Farm Survey 2018 Sustainability Report, (online)
International total climate-specific finance	Euros	European Environment Agency Central Data Repository "Article 16 Support Provided by Ireland in 2018" http://cdr.eionet.europa.eu/ie/eu/mmr/art16_finance/envxwadma/

* The table contains some revisions compared with the Annual Review 2019. The % Renewable transport (RES-T) weighted figures have been changed to RES-T figures without weightings. SEAI reports RES-T with and without weightings. Res-T with weightings includes double certificates for advanced biofuels.

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Climate Change Advisory Council
McCumiskey House, Richview, Clonskeagh Road, Dublin 14, D14 YR62
Phone: 01 268 0180 Email: info@climatecouncil.ie Web: www.climatecouncil.ie