Rialtas na hÉireann
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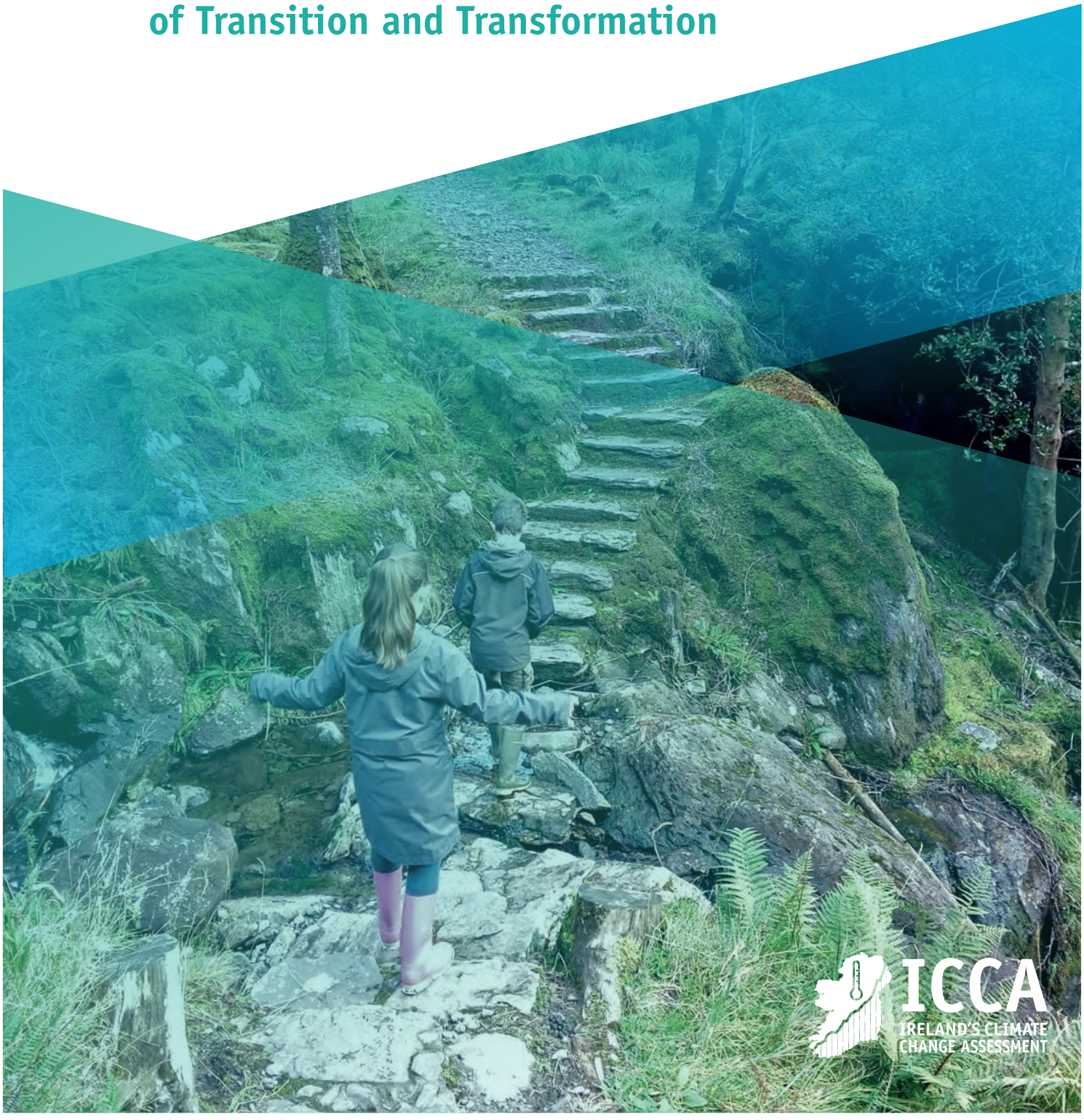
IRELAND'S CLIMATE CHANGE ASSESSMENT

Volume 4: Realising the Benefits of Transition and Transformation



Ireland's Climate Change Assessment 2023

Environmental Protection Agency

ISBN: 978-1-80009-128-3
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Ireland's Climate Change Assessment
Published by Environmental Protection Agency, Ireland
Proofreading: Prepress Projects
Design: Outburst Design

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Volume 4: Realising the Benefits of Transition and Transformation

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ACKNOWLEDGEMENTS

Ireland's Climate Change Assessment (ICCA) is published as part of the Environmental Protection Agency (EPA) Research Programme 2021-2030. The EPA Research Programme is a Government of Ireland initiative funded by the Department of the Environment, Climate and Communications. It is administered by the EPA, which has the statutory function of coordinating and promoting environmental research. Ireland's Climate Change Assessment has been co-funded by Science Foundation Ireland (SFI), the Sustainable Energy Authority of Ireland (SEAI) and the Department of Transport.

The authors of Volume 4 and the EPA would like to acknowledge the various contributions and assistance from the following during the preparation of this report, in particular:

- Frank McGovern, Mary Frances Rochford, Eimear Cotter and the members of the Steering Committee who contributed to detailed discussions and provided valuable insights throughout the development of this report.
- Lisa Johnson and David Smyth for their continued technical and project management support.
- The external reviewers who provided detailed commentary and feedback.
- All of the stakeholders who attended the workshop and provided valuable input and feedback on the key findings of the report.
- The experts consulted during drafting including Lisa Sheenan (Queens University), Mary Murphy (Maynooth University), Barra Roantree (Trinity College Dublin), Breda Maher (Climate Action Regional Offices), Gaaitzen J. de Vries (University of Groningen), Pete Lunn (Economic and Social Research Institute), Pat Brereton (Dublin City University), Elaine McGoff, Eoghan Daltun and economic statistics staff at the Central Statistics Office.
- The wider ICCA author team for contributions, discussions and suggestions: Paul Deane, Danielle Gallagher, Liam Heaphy, Deirdre McClean, Shane McDonagh, Jennifer McElwain, Connor McGookin, Abhay Menon, Conor Murphy, Paul Nolan, Clare Noone, Enda O'Brien, Brian Ó Gallachóir, Tara Quinn and Peter Thorne.

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- 1 Framing Transformative Change: Róisín Moriarty and Agnieszka Stefaniec
- 2 Transforming Landscapes: Róisín Moriarty and Hannah Daly
- 3 Transforming Spatial Planning, Transport and the Built Environment: Agnieszka Stefaniec and Brian Caulfield
- 4 Transforming Livelihoods: Tadhg O'Mahony and Diarmuid Torney
- 5 Transforming Consumption and Behavior Patterns: Agnieszka Stefaniec and Brian Caulfield
- 6 Transforming Development: Economy, Innovation and Finance: Tadhg O'Mahony and Diarmuid Torney
- 7 Transforming Governance and Policy: Diarmuid Torney and Tadhg O'Mahony
- 8 Transforming Participation and Catalysing Change: Róisín Moriarty and Hannah Daly
- 9 Moving Transformation Forward: Diarmuid Torney, Hannah Daly and Brian Caulfield

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Funding Partners

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Foreword

This is the first Ireland's Climate Change Assessment (ICCA) and is a major contribution to the national dialogue and engagement on climate change. It tells us what is known about climate change and Ireland. It also provides key insights on gaps in our knowledge. The development of ICCA was modelled on the work of the Intergovernmental Panel on Climate Change and the Sixth Assessment Cycle, completed in 2023, with the use of and localisation of its information for Ireland.

ICCA will support the national response to climate change, ensuring that it is informed by the best available science. It also points to how and where that science can be improved through further investments in innovation, in research and in systematic observations. These collectively form the essential backbone of the science and data required to understand how Ireland is being impacted by and responding to the climate change challenge.

The full Assessment has been developed through a co-creation process between leading academics in Ireland and officials from across state agencies and government departments. Funding was provided by the Environmental Protection Agency, Sustainable Energy Authority of Ireland, Science Foundation Ireland and Department of Transport. The process was collaborative, involving mutual development and agreement of the scope, preparation and review of drafts, wider stakeholder consultation through a series of workshops and meetings, and a detailed sign-off process.

We see the publication of ICCA as a real innovation for Ireland and as a resource for understanding climate change in an Irish context across the underlying science, mitigation and adaptation measures, and opportunities. It is a starting point for further dialogue on the findings and their utility for policymakers, practitioners, researchers, research funders and people. This engagement phase should continue far beyond the publication of this Assessment and support climate action in Ireland.

Dr Eimear Cotter
Director of the Office of Evidence and Assessment, EPA
Chair of the ICCA Steering Committee

Summary for Policymakers

Transformative change is a fundamental, system wide reorganisation across technological, economic and social factors, including paradigms and goals, and valuing the climate, the environment, equity and wellbeing within decision making.

A. The imperative for transformative change

Transformative change can unlock rapid and fair climate action with a myriad opportunities and benefits for people and nature in the near and long term

Transformative change can deliver rapid, deep and sustained emissions reduction (mitigation, see Volume 2), build resilience to impacts (adaptation, see Volume 3) and deliver a range of benefits and opportunities. Such an approach can realise benefits for the wellbeing of people and nature and achieve greater equity across society. Pursuing transformative change allows the realisation of opportunities that would be missed if such a holistic and systemic approach is not followed. Much greater efforts are needed to close the gap between ambition and action on climate change mitigation and adaptation. Realisation of transformative change can entail mobilising society to fundamentally reorganise the systems driving greenhouse gas emissions, biodiversity loss and vulnerability to the impacts of climate change. {Chapters 1 (1.1, 1.2, 1.3, Figure 1.2), 6 (6.2), 8 (8.3, 8.5, Box 8.3); Volume 2, Volume 3}

A.1 **Transformative change is essential to enable and manage rapid and fair climate action.** The declaration of a climate change and biodiversity loss emergency opens up opportunities to mobilise support and action for transformative change in order to address these inextricably linked crises that pose significant threats to human wellbeing and to nature.

Key components of transformative change include:

- adopting a comprehensive approach that combines structural shifts to sustainable development along with technological solutions, as technology alone is insufficient;
- mobilising a diverse range of stakeholders, including the political system, state institutions, private enterprises, communities, civil society organisations, educational institutions and citizens;
- re-evaluating the economic development paradigms and plans to prioritise climate, sustainability, wellbeing and equity;
- prioritising justice and equity within public policies (doing so can contribute to garnering societal support for change);
- mitigating potential disruptions through enabling policies and inclusive, participatory methods, with a particular focus on vulnerable groups;
- addressing the indirect drivers of climate change and biodiversity loss that hinder mitigation and adaptation efforts {Figure SPM.1};
- employing an integrated long-term strategy to tackle these crises to yield both immediate and long-term benefits for human wellbeing and nature.

{Chapters 1 (1.2, 1.3, 1.4, Box 1.1), 2 (2.1, 2.2, 2.3), 4 (4.2), 5 (5.3), 6 (6.2, 6.3), 7 (7.3), 8 (8.1, 8.2, 8.5)}

A.2 **Achieving transformative change that harnesses social, economic and environmental benefits requires national climate policy to be aligned with sustainable development.**

A transformative approach can:

- facilitate the transition to sustainable development;
- increase the likelihood of meeting decarbonisation commitments;
- reduce the costs associated with technological transitions;
- lower reliance on carbon dioxide removal and its associated uncertainties and risks;
- realise environmental, social and economic opportunities and benefits;
- strengthen community resilience and reduce vulnerability to climate impacts.

Ireland's current policy direction predominantly emphasises technology transitions, rather than wider systemic transformations and shifts in development pathways.

Taking action to address the direct drivers of emissions may challenge vested interests[1] that benefit from the current status quo.

To enact this transformation, it is essential to broaden the scope of measures aimed at accelerating emissions reduction. This includes addressing the indirect drivers of climate change and biodiversity loss. These indirect drivers stem from systemic aspects underpinning the national development trajectory, including institutions, economic models, technologies, governance, demographics and sociocultural factors.

Transformative responses to climate risks that address the indirect drivers of vulnerability may necessitate rapid, non-linear changes to social–ecological systems and the associated institutions. {Chapters 1 (1.2, 1.3, Figure 1.4, Box 1.4, Box 1.5), 2 (2.1, 2.2, 2.3), 4 (4.1), 5 (5.3), 6 (6.2, 6.3, 6.4), 7 (7.3, 7.4)}

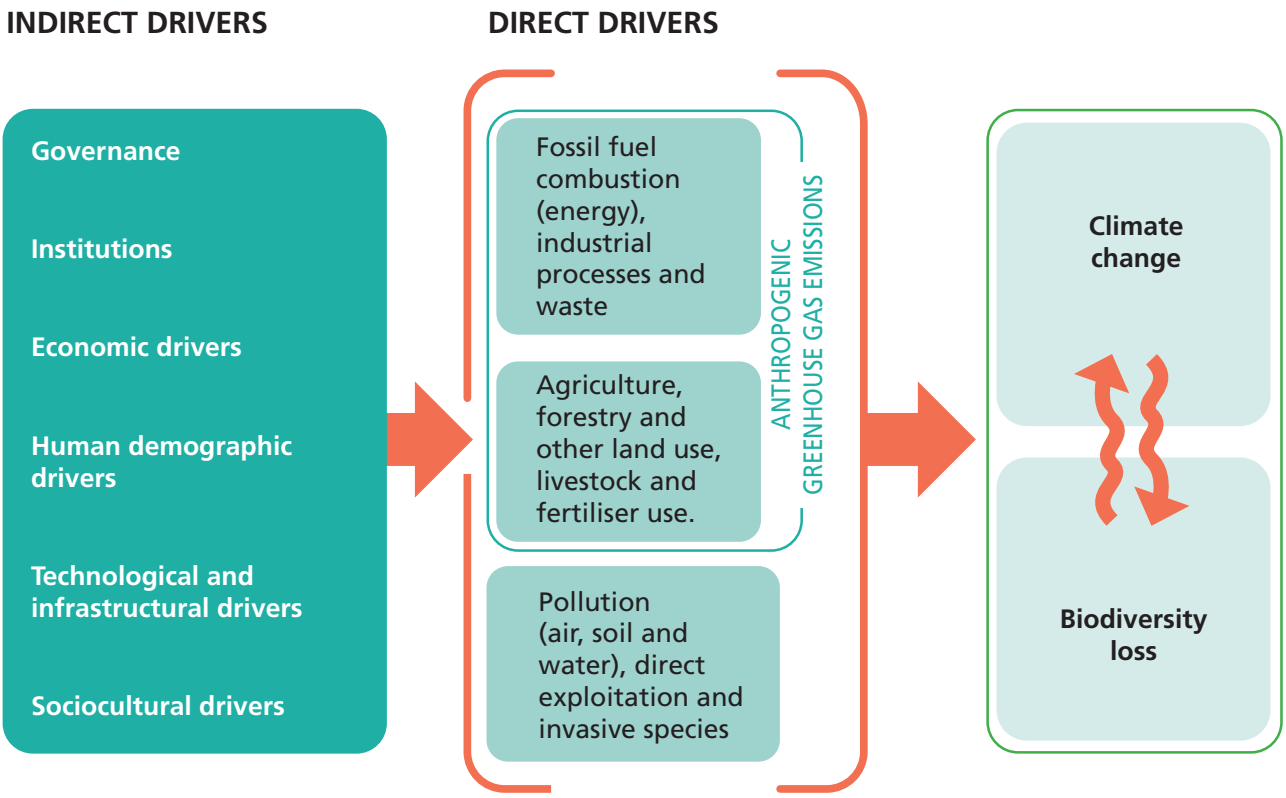


Figure SPM.1 Indirect and direct drivers of anthropogenic greenhouse gas emissions causing climate change and of human activities linked to biodiversity loss. Source: Adapted from figure 1.3 in Pörtner, H.-O. et al. (2021). *Scientific Outcome of the IPBES-IPCC Co-Sponsored Workshop on Biodiversity and Climate Change*. Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services.

[1] Vested interests are individuals and groups that have a strong interest in maintaining the status quo.

A.3 **Taking early action on climate mitigation and adaptation offers greater options and opportunities and minimises losses and damages to human and natural systems. The decisions made and actions taken this decade will have long-term consequences affecting many generations into the future.** Accelerating mitigation efforts this decade, in line with meeting carbon budgets, offers greater opportunities now and in the future. Proactive adaptation reduces the vulnerability of people and systems. Adaptation options that are feasible and effective today will become less so as the impacts of climate change intensify. {Chapters 1 (1.1, 1.2, 1.4.), 2 (2.1), 3 (3.4); Volume 1, Volume 2, Volume 3}

A.4 **Transformative outcomes can be realised through fundamental change that builds on visions of desirable futures and systems thinking that aligns immediate actions with long-term goals.** Transformation requires strong governance, capacity building, broad stakeholder involvement and continuous learning. Prioritising transformative actions over incremental changes can disrupt current development pathways and enable the deeper and more rapid change that is crucial for Ireland to achieve a climate-neutral, climate-resilient, biodiverse and sustainable future. Among important actions are the creation of national visions of desirable futures, and also adopting a long-term foresight approach to governance of change. Bolstering institutional frameworks for long-term planning and strategy, public policy, individual policies and policy packages, and deepening policy integration to shift pathways will be necessary. Alignment of immediate actions with long-term goals will enhance capacity to close the implementation gap and expand societal participation to ensure that all voices are heard. {Chapters 1 (1.3, 1.4), 2 (2.4), 7 (7.3, 7.4), 8 (8.2, 8.4)}

B. Equity, social inclusion and just transition

Equity, social inclusion and just transition are crucial considerations in climate policy

Equity and social inclusion are important public policy goals in themselves, and are also core to ensuring public support for transitions and transformations. Just transition and climate justice become increasingly important for ensuring equity as climate action measures are scaled up and as the impacts of climate change unfold. The just transition framework is a set of principles, processes and practices that seeks to ensure that no people, workers, places, sectors, countries or regions are left behind in the move from high-emissions to low-emissions development. {Chapters 1 (1.2), 4 (4.2, 4.3), 6 (6.2), 8 (8.1, 8.5)}

B.1 **Fairer and more equal societies are more resilient to impacts, and are more likely to adopt progressive transformative policies.** Social equity and equality matters to people and are necessary for successful and desirable policy outcomes. Ireland has considerable income inequality and material deprivation. Building increased resilience to risks, and targeting social support for transformation, could be facilitated by addressing social inequalities, poverty and deprivation and by just transition. Prioritisation of wellbeing and equity in development and climate policy could bolster the democratic social contract in support of transformation, including improved quality of life, decent work and the value of care. {Chapters 1 (1.2), 3 (3.2), 4 (4.2, 4.3), 5 (5.2), 6 (6.2), 8 (8.1)}

B.2 **The wealthiest generate far more emissions[2] than the average person and have the potential to significantly curtail these emissions without compromising their living standards.** There is a significant emissions inequality gap at the global level, with the wealthiest top 10% emitting nearly as much as the bottom 50%. An emissions inequality gap is also indicated by the data available for Ireland. Shifting consumption patterns and promoting sustainable practices among the affluent can result in notable emissions reductions and catalyse wider societal transformations. Regulatory measures can progressively target emissions-intensive activities and behaviours. These measures could be more effective than solely relying on environmental taxation and could lead to wider adoption and affordability of effective mitigation solutions. Focusing on such unsustainable consumption behaviour can generate revenue for just transition. {Chapters 1 (Box 1.1), 5 (5.2, 5.3)}

B.3 **Emissions-intensive activities are likely to face growing pressures to change or contract, which increases the need for just transition, and to enable opportunities for economic diversification.** While transformations offer significant opportunities, higher emitting activities are likely to face increasing pressures to restructure or contract, including livestock agriculture, transport services and fossil fuel-based activities. The effects of pressures are typically sector specific and localised, creating the need for public policy to support just transition. Just transition can involve proactive policy to harness economic opportunities, aligning investment in communities and addressing training and skills needs. Targeted social protection, income supports and inclusive policy processes can support change. Rural and urban transitions and transformations encompass uniquely different needs and opportunities. Resistance to change can be linked to vested interests and existing power dynamics, social inequality and public subsidies. {Chapters 1 (Box 1.1, Box 1.6), 2 (2.1), 3 (3.3), 4 (4.3, 4.4), 6 (6.2, 6.3, 6.4), 8 (8.1)}

[2] Emissions here refer to consumption-based emissions, directly tied to a household's activities and consumption, differing from production-based (or territorial) emissions.

B.4 **Climate justice focuses on the unequal impacts of climate change, across generations and borders, and on ensuring fairness in climate action.** A climate justice lens emphasises the urgency of reducing greenhouse gas emissions in order to reduce climate impacts on those most vulnerable to them. Rapidly reducing Ireland's greenhouse gas emissions would be an important contribution to climate justice.[3] A transformative approach to climate justice would also acknowledge the root causes of historical global inequalities and uneven distribution of power. Inclusive planning and decision making are important to ensuring climate justice, and social movements are increasingly attending to climate justice. Ireland's contribution to international climate finance is acknowledged as being primarily grant-based and mainly focused on adaptation. {Chapters 3 (3.2), 4 (4.3), 5 (5.3), 6 (6.4), 7 (7.3, 7.4), 8 (8.2, 8.5)}

B.5 **Harmful subsidies can be redirected to socially and environmentally enhancing activities.** Considerable public subsidies are provided to emissions-intensive activities, both globally and nationally. International frameworks include targets to phase out subsidies to harmful activities. Reducing subsidies to harmful and potentially harmful activities can provide space to invest in socially and environmentally enhancing activities. A focus on enhancing equity when designing emissions reduction supports can contribute to securing just transition. {Chapters 2 (2.1), 3 (3.3, Box 3.8), 4 (4.3, 4.4), 6 (6.2, 6.3, 6.4), 8 (8.1)}

[3] Per capita greenhouse gas emissions in Ireland are high compared with other EU Member States and significantly above the global mean.

C. Systems change for climate action

Many mitigation and adaptation options are available, feasible and cost-effective for delivering the rapid and accelerated action required across all sectors and systems to meet Ireland's climate commitments

An unprecedented rollout of a wide portfolio of mitigation and adaptation options is necessary across all systems. The state and its institutions have a critical role in bringing about sustainable transformations. Transformation across sectors entails the deployment of zero-emissions technologies; reducing and altering the structure of final demands through infrastructure, planning and social transformation; land-use change; and protecting and restoring ecosystems. Many options are already available, are cost-effective and bring wider co-benefits. Low-tech, low- and no-cost measures, and the potential for generation of net economic gains, have yet to be fully explored. {Chapters 2 (2.2), 3 (3.3, 3.4), 4 (4.1), 5 (5.3), 6 (6.2, 6.4), 7 (7.3, 7.4)}

Figure SPM.2 Transforming the future: mural. Source: Artwork by Kevin O'Brien (2021), photography by UCCTV, funded by University College Cork.

C.1 **Transforming energy**

Rapidly phasing out fossil fuels requires a transformation of the energy system towards renewable energy and efficiency. The state and its institutions have a critical role in creating a vision for Ireland's sustainable energy future. Replacing fossil fuels with zero-emissions energy sources – the energy transition – entails a replacement of energy sources, technologies and fuels throughout the energy system, from supply to end-use sectors, including transport, buildings and industry. The energy transition brings many benefits: lowering fossil fuel import dependence improves energy security; reducing combustion in vehicles and buildings increases air quality; renewables open up opportunities in the green economy, including for coastal communities and farmers; and distributed energy enables homeowners to be producers of energy, lowering energy bills. The transition requires paying attention to environmental, societal, economic and governance – along with technical – dimensions. Lowering final energy demands reduces the reliance on unproven mitigation technologies in the future. Renewable energy developed on land and at sea creates competition with other land uses, including biodiversity, food production and carbon sequestration, and may negatively impact biodiversity. An enhanced regulatory and planning framework is required to accelerate renewables deployment, realise co-benefits and manage trade-offs. Historical energy transitions, such as Bord na Móna's pivot from peat extraction to peatland rehabilitation and renewable energy, offer lessons for the future, particularly for just transitions. {Chapters 2 (2.2, Box 2.5, Box 2.6), 4 (4.3), 6 (6.2, 6.3), 7 (7.3), 8 (8.2); Volume 2}

C.2 **Transforming urban settlements**

An integrated spatial planning, built environment and transport strategy is required for a meaningful urban transformation that can create a better living environment while simultaneously reducing emissions. Co-design of placemaking interventions with local communities can empower diverse voices and offer practical solutions. Adopting compact urban development principles such as increased density, diverse land use, improved street connectivity, destination accessibility and shorter distances to public transport can cut transport emissions, lower urban energy use and enhance resilience in the long run.

Prioritising actions that can deliver transformative change, rooted in a shared vision within the transport and built environment sectors, is crucial.

In transport, these measures involve creating conditions where the need for motorised transport is minimised, for instance through proximity redesign and digitalisation ('avoid' actions), and then channelling the remaining travel demand towards sustainable options such as walking, cycling, shared mobility and public transport ('shift' actions). These approaches offer more substantial benefits than maintaining the current car-centred system, even with the integration of electric vehicles ('improve' measures). The shift to more sustainable mobility cannot be achieved immediately; a long-term strategic commitment is needed.

In the built environment, there is a need for a holistic strategy to reduce energy consumption that includes curbing the demand for energy and materials, optimising efficiency and shifting to low- and zero-carbon energy sources. Implementing building energy standards, greater use of timber, passive designs, district heating, retrofitting and heat pumps are effective solutions to achieving energy-efficient, resilient buildings. Well-informed management of buildings and places is needed over their life cycles.

While technological advancements are crucial for fully decarbonising the end-use sectors, an over-reliance on them could diminish the potential benefits of structural transformations and demand reduction. Infrastructure and solutions with an emphasis on wellbeing can lead to significant positive transformations. {Chapters 1 (1.2), 3 (3.1, 3.2, 3.3, 3.4, Box 3.3)}.

C.3 **Transforming food, land and nature**

Mitigation and adaptation options in agriculture, forestry and other land use can be scaled up over the next decade and beyond, providing opportunities for rural communities. Just transition is key to this transformation, and economic aspects and social, cultural and political dimensions need to be considered. The adoption of place-based and co-creation approaches would be beneficial. Conservation, management and restoration of ecosystems, including peatlands and native woodlands, alongside improved, climate-smart forest management and afforestation have potential to provide economic opportunities and improved livelihoods and to enhance the cultural and heritage value of landscapes. Sustainable diets, reducing food waste and rebalancing land use, including a managed reduction in the number of ruminants, can reduce methane and nitrous oxide emissions and make land available for forestry, wetland restoration and nature. Sustainable products (e.g. timber) can displace more emissions-intensive materials. Adaptation options include nature-based approaches. Conservation can have immediate benefits for mitigation and adaptation, including enhanced ecosystem resilience, while the benefits of restoration occur over longer time frames. There are opportunities to maintain and enhance the store of carbon in soils and biomass. Increased global warming brings greater risks of carbon loss from these terrestrial systems. Management will be necessary to adapt ecosystems to, and protect carbon stocks from, unavoidable impacts. {Chapters 2 (2.1, 2.2, 2.3), 4 (4.3, Box 4.1), 5 (Box 5.1)}

C.4 **Transforming economic development**

The transformative approach of shifting development paths offers extensive economic opportunities for Ireland. Internationally, the understanding of economic opportunities and related innovation policy have evolved and are known to be extensive. A pioneering suite of economic opportunities has been identified for Ireland, for sustainable development. These could assist in aligning economic development with achieving win–win outcomes, across the wide variety of priorities found in public policy, not least for climate neutrality and climate resilience. Opportunities exist in expanding the scope of policy efforts to include structural transformation to services and low-emissions industry. Opportunities also exist in widening and deepening the range of emissions-reducing and environmentally enhancing activities, with examples including renewable energy; afforestation and forest management; active and public transport; production of alternative proteins; and restoration of nature, biodiversity and ecosystems. Transitions and transformations can be viewed as a strategic opportunity. Further analysis, as a part of strategic foresight, of a more complete range of national transformative paths and options, and of the wider national portfolio of economic opportunities associated with transformations, is required to identify the magnitude of potential national economic gains. {Chapters 2 (2.1, 2.2), 4 (4.4), 6 (6.2, 6.3), 7 (7.3)}

C.5 **Transforming society**

Social and cultural transformation is required to create a sustainable society. More sustainable lifestyles can lead to improved wellbeing and can be enabled through incentives and infrastructure that make sustainable choices accessible, affordable and normalised. Fairness is critical for public acceptance of the change required, and public participation is essential to ensure that the voices of those affected are included in decisions relevant to them, particularly marginalised and vulnerable groups. Mindsets, including individual and collective values and beliefs, shape cultures and systems through influencing behaviour and decision-making processes. They can act as strong leverage points for systems transformation. Creating places and practices that nurture human capacity for change can support sociocultural transformation. Mindsets include how people think, feel, communicate and work together and are especially important in political and institutional landscapes where policy is developed. Culture, including art and storytelling, is essential to the success of transformations, as it can give hope and inspire action. {Chapters 1 (1.2, 1.3, 1.4), 5 (5.3), 8 (8.1, 8.2, 8.3, 8.4, 8.5, Box 8.3)}

D. Synergies between climate action and sustainable development

Implementing transformative measures to address climate change can deliver benefits and opportunities for people and for nature, thereby advancing sustainable development

Immediate and sustained transformative mitigation and adaptation actions are likely to yield substantial benefits for health, wellbeing and biodiversity in Ireland while reducing vulnerability to the adverse impacts of climate change. Transformative climate action can advance goals for sustainable development, such as prosperity and equity, by addressing the underlying causes of unsustainability. Global analysis shows that potential synergies between climate action and the UN Sustainable Development Goals significantly exceed potential trade-offs. The trade-offs can be managed through capacity building, strengthened governance, strategic investments and inclusive climate action. {Chapters 1 (1.1, Figure 1.5), 2 (2.1), 4 (4.3), 6 (6.2, 6.4), 7 (7.3), 8 (8.2)}

D.1 **Near-term action this decade brings many significant benefits, alongside enhancing resilience to climate impacts.** Early action can harness the available opportunities for prosperous and resilient livelihoods, improved public health, social equity and enhanced energy security, among other benefits. Early action can also reduce costs, prevent further fossil fuel lock-in and protect vulnerable communities from the disproportional burden of impacts, mitigation and adaptation actions and from the cost of those actions. Transformative initiatives demand near-term investments, such as in sustainable transport, but the long-term economic and societal returns surpass the initial investment. In addition, low-cost placemaking initiatives in urban areas, such as limiting car access and speed, can immediately enhance the local environment, improving safety and air quality, reducing noise, fostering community relations and boosting local businesses. Such initiatives can lead to long-term deepening of community engagement and a shift of perceptions away from car-centric values. {Chapters 1 (1.1, 1.4), 3 (3.2, 3.3, 3.4), 4 (4.4), 5 (5.2, 5.3)}

D.2 **Tackling climate change and biodiversity loss together enhances the many synergies that exist between actions to address these crises while minimising and managing any remaining trade-offs.** The systematic identification of synergies and trade-offs strengthens outcomes for climate and biodiversity actions. Mitigation actions related to land use can allow space for nature, although the potential for trade-offs is high. Adaptation actions can result in gains for nature and optimise synergies with mitigation, enhancing the resilience of carbon stored in ecosystems. The protection and restoration of nature promotes biodiversity-rich, resilient ecosystems, reducing the vulnerability of these systems and their carbon stores to climate impacts. Nature restoration is cost-effective and reduces vulnerability through strengthening the synergies that exist between mitigation and adaptation. Climate mitigation can improve air, soil and water quality. Nature-based approaches have the potential to tackle climate change and biodiversity loss while contributing to sustainable development, making them powerful and attractive actions. Wider benefits from optimising synergies include improved food security, nutrition, health, wellbeing, energy security, support for livelihoods and sustainability, and ensuring nature's contributions to people and economic benefits. Management strategies are required if conflicting land use objectives and the proactive management of potential trade-offs are to be avoided. {Chapters 1 (1.2), 2 (2.1, 2.2), 6 (6.2, 6.4); Volume 3 (2.4, Box 2.2)}

D.3 **There are co-benefits of climate action for health and wellbeing that are achievable and can enhance social equality.** The benefits span from individual wellbeing to community cohesion and resilience. Transitioning from fossil fuels to renewable energy sources can significantly reduce air pollution, leading to fewer respiratory illnesses and premature deaths. Transforming places through integrated spatial planning and compact urban redesign, and through placemaking, can boost liveability, stimulate the regeneration of urban and rural centres, improve rural connectivity, increase access to green and blue spaces, offer benefits to local businesses and build more cohesive and resilient communities. These transformations can lead to improved physical and mental health and wellbeing. Mobility solutions can promote healthy lifestyles by encouraging walking and cycling and can offer better accessibility. Improving the energy efficiency of buildings can bring improved indoor air quality, thermal comfort benefits and financial savings, and can build resilience to extreme events. Sustainable agriculture and reduced meat consumption can lead to more resilient food systems and healthier diets. {Chapters 2 (2.2), 3 (3.2, 3.3, 3.4, Box 3.2, Box 3.3), 5 (Box 5.1)}

D.4	**There is significant potential for Ireland to build prosperous livelihoods in the sustainable and resilient economy of the 21st century.** Ireland has demonstrated success in long-term structural transformation to low-emissions activity in services. Policy and analysis have tended to focus more narrowly on technological transition and management practices and on the circular economy and bioeconomy. Further economic opportunities exist in services sectors, both public and private, and in emissions-reducing and environmentally enhancing activities. Building such livelihoods requires alignment of enabling measures that can support growth in sustainable social and local enterprises in addition to sustainable industrial development. {SPM C.4, Chapters 2 (2.2), 4 (4.4), 6 (6.2, 6.3), 7 (7.3, 7.4)}
D.5	**A national vision and strategy on prosperous livelihoods is needed to take advantage of the multiple opportunities of transformation.** Elements of transitions and transformations to a low-emissions future are already under way, both globally and nationally, offering the potential for Ireland to build sustainable, prosperous and resilient livelihoods. Enabling measures related to livelihoods can include conventional education, training and social protection, and innovative frontier measures such as universal basic services, universal basic income and the shorter working week. Nationally, these opportunities have yet to be fully explored, requiring analysis and the building of long-term national visions for livelihoods to motivate progressive action. The design and implementation of long-term strategic policy for sustainable and resilient livelihoods will be needed to deliver on this potential. Possible routes to address the economic costs of policy change include the winding down of harmful subsidies, using environmental tax revenue and reform of general taxation and spending. {Chapters 2 (2.1, 2.2), 4 (4.1, 4.2, 4.3; 4.4), 6 (6.2)}

E. Strengthening the response: driving transformation forward

Better enabling conditions are needed to drive transformative change and unlock rapid and fair climate action across mitigation and adaptation

The status quo is a powerful constraint against transformative change. There are many potential enablers of transformative change, including those across economy, innovation, finance, policy, governance and society, that are currently insufficiently configured for climate action and sustainable development. Strengthening these can help to drive transformation forward. {Chapters 1 (1.3, Box 1.4), 3 (3.2, 3.3, 3.4), 4 (4.3), 5 (5.3), 6 (6.4), 7 (7.3, 7.4), 8 (8.1, 8.3, 8.4)}

E.1 **The seeds of transformative change have taken root in Ireland.** Ireland has declared a climate change and biodiversity loss emergency. The state has legislated to divest public funds from fossil fuel companies, halt new exploration for fossil fuels and ban hydraulic fracking. The state has taken initial steps towards incorporating a wellbeing framework in public policy. There is a growing recognition of nature's contributions to people, the necessity of working within the limits of natural systems, tackling climate change and biodiversity loss together, and the integration of these issues across all domains, and of the importance of a transformative approach in land use and food systems. A systemic approach to transport is starting to emerge. The electricity system is undergoing a transformation towards renewable energy. There is growing awareness of the need to manage and reduce demand across the whole energy system. Ireland has also led the way in innovations for citizen participation in environmental decision making, holding citizens' assemblies on climate change (2018) and biodiversity loss (2022–23), and a children's and young people's assembly on biodiversity loss (2022). Dingle Peninsula 2030/Corca Dhuibhne 2030 is a first-of-its-kind initiative that brings together the local community, schools, businesses and farmers to explore, support and enable the broader societal changes related to the energy transition. {Chapters 1 (1.1, 1.3, 1.4), 2 (Box 2.3, Box 2.6), 3 (3.1, 3.3), 5 (5.3), 6 (6.2), 8 (8.2, Box 8.1)}

E.2 **In order to deliver transformation, niche innovations need to be nurtured and scaled up.** The spaces where innovative ideas are developed and tested – protected niches – are the birthplaces of transformative change. These are driven by a range of entities from grassroots to state level. Niche innovations, for instance shared electric mobility hubs[4] within the expanding shared economy, hold potential for broad-scale change. Government-backed pilot projects serve as trial grounds for other infrastructural and demand management solutions. While these niche initiatives offer templates for wider application and foster societal readiness for change, achieving enduring impact requires large-scale interventions. This involves realigning processes, regulatory frameworks, institutions and infrastructure to support systemic change. {Chapters 1 (1.3), 3 (3.3), 7(7.3)}

E.3 **Adopting a holistic and systemic way of thinking is a necessary condition to identify and maximise win–win outcomes, across multiple social, environmental and economic development priorities.** This can be enabled by mainstreaming and prioritising sustainability, equity and wellbeing as fundamental values and goals of transformations, followed by reformulating policy and implementation directly towards achievement of these policy synergies. Systems change has the potential to improve human wellbeing in both the near and long terms. {Chapters 1 (1.3), 3 (3.3), 7 (7.3); Volume 3 (Box 9.1)}

E.4 **An integrated long-term vision can drive transformative change, providing clear pathways to low-emissions and resilient systems.** Governance that considers multiple futures is required, rather than predictive approaches that consider only one possible future. Visions of desirable futures can be a powerful motivator for long-term planning and strategy. Collaboration across sectors and stakeholder engagement are necessary for efficient policy implementation and building climate resilience. Focusing on only short-term actions can neglect crucial long-term projects, such as public transport infrastructure, thereby hindering genuine transformative progress. {Chapters 1 (1.4), 2 (2.4, Box 2.2), 3 (3.2), 7 (7.3), 8 (8.2, 8.2)}

[4] A hub is a location that provides a range of shared electric transport options, including e-cars, e-bikes, e-cargo bikes and traditional bicycles.

E.5	**The state has a central role to play in transformative change.** While broader governance can involve steering the market, mobilising investment and including and empowering society, the state has a central role as an enabler. This role can involve stimulating new policy, coordinating actors, mediating interests and shaping outcomes. Recent research on the role of the state has pointed to its potential through a mission-oriented approach to climate policy. The state can play a strong role in driving transformation, but to do so capacity needs to be increased, along with strengthening mandates and resourcing within state institutions and reworking policy and regulatory frameworks. Capacity and resourcing of local government in Ireland is particularly constrained by comparison to other European countries. Strengthening the role of local government would strengthen the overall capacity of the state to bring about transformative change. {Chapter 7 (7.3)}
E.6	**Fragmented governance constrains climate action, and stronger horizontal and vertical integration can better enable transformative change.** Ireland has already made significant progress in strengthening the legislative and governance basis for climate action. To move policy out of silos, horizontal integration requires deepened connections between inter-related policy functions among government departments and agencies. This involves strengthening mandates for climate action, and providing the institutional structures and forums that support both policy coordination and policy innovation. This can include feedback loops that facilitate continuous learning and the development of creative solutions. Vertical integration requires better coordinated policies at local, regional and national levels and can ensure effective policy design and implementation across levels. Deeper vertical and horizontal integration of policy can enable the state, markets and society to coordinate long-term systemic shifts to sustainable low-emissions development. {Chapters 2 (2.1), 7 (7.3, 7.4)}
E.7	**Integrated policy approaches can reorient development to enable transformative change.** Combined policy packages, rather than individual policies, can better support shifts in development pathways and sociotechnical transitions. Near-term action is critical to avoid deepening lock-in to high-emissions infrastructure and practices. Transformative public policy choices in the near term are required to fundamentally shift pathways. Systemic responses enable the achievement of synergies across multiple objectives, going beyond sector-focused siloed approaches. {Chapters 1 (1.4), 7 (7.4)}
E.8	**Finance is an important enabler of transitions and transformations. However, the financial system is also at risk from increasing climate impacts and delayed transitions.** Finance flows can be an important enabler of transitions and transformations to a low-emissions and climate-resilient future, as they are a key determinant of the national development path. Public policy can set the conditions to steer investment in socially agreed directions, e.g. to low-emissions climate development. Options to catalyse change include de-risking investment in infrastructure, acceleration of finance for nature-based approaches and phasing out perverse subsidies. While Ireland is at the forefront of developments in sustainable finance, the understanding of risk, and the alignment of climate and non-climate policy, remain at an early stage. The financial system is itself at risk from physical climate damage, the pressures of change on existing activities and assets, and delayed or no policy action, leading to stranded assets and forgone opportunities. {Chapter 6 (6.2, 6.4)}
E.9	**The collective actions of individuals can enable the required systems transformations.** Individual and collective action are two sides of the same coin. System change can be achieved through collective action and is one of the more effective ways for society to change policy. Personal choices can encourage new social norms to emerge. Social movements can frame climate issues in a way that brings the public on board, mobilising resources, human and financial, that can sustain collective action and increase internal and external pressures that enable political change. People organising together can apply political pressure and signal that there is a need and support for a change to sustainability. {Chapters 1 (1.3), 3 (3.3), 5 (5.3, Box 5.2), 8 (8.5)}

E.10	**Public perception is an important enabler of transformative change.** The Irish public demonstrates strong understanding of and support for climate action, but there is a gap between the desire for action and realising change. The Irish news media is a primary source of information on climate change but is struggling to cover climate change to the extent that would fulfil its traditional roles of informing the public, acting as a watchdog and holding authorities to account. Education can also be an enabler of change if it develops the values, attitudes and skills necessary to achieve sustainable development. {Chapter 8 (8.1, 8.3, 8.4)}
E.11	**Social movements, climate litigation and culture can catalyse change through overcoming inertia and motivating individuals and organisations to act.** They focus attention and augment decision making and the allocation of financial and social resources. Climate change litigation (e.g. Climate Case Ireland) is being used by individuals and organisations to drive the speed and scale of climate action and changing how companies behave. Culture can also be an important catalyst of change, by inspiring action. {Chapters 6 (6.2), 7 (7.3), 8 (8.1, 8.5, Box 8.2, Box 8.3)}

F. The role of research in enabling transformative change

The evolving understanding of transformative change opens a promising avenue for Ireland to explore and realise its potential benefits and maximise opportunities

Internationally, understanding of transformative change has advanced considerably in recent years, an evolution that is beginning to emerge in Ireland. Deepening national knowledge of, and capacity for, transformative change will require investment in research capacity and infrastructure.

F.1 **Knowledge gaps and future research needs.** The scarcity of research focusing on how transformative change can affect efforts to address climate change issues in Ireland highlights a considerable gap in national knowledge in two critical areas: (1) the potential outcomes of implementing a transformative approach within the Irish context, and (2) strategies for actualising transformative change. Transformative change requires an evolution in topic framing, analysis and policy responses, as an integrated and holistic approach. This broadens the focus from mitigation, adaptation and achieving co-benefits to a wider shifting of pathways and achieving synergies across public policy goals. To support this evolution, enhanced knowledge of systems shifts is necessary through five distinct approaches: decision making under uncertainty; aggregated economic frameworks to evaluate system-level choices; ethical perspectives on values and equity; transition frameworks of processes and actors; and psychological/behavioural and political factors. Developing and integrating this knowledge can enable the design of holistic policy, for transformative climate action and related achievement of win–win outcomes. {Chapters 1 (1.5), 3 (3.5), 5 (5.4), 6 (6.2, 6.5), 7 (7.3, 7.5)} Detailed research gaps are included in Appendix A of the underlying volume.

F.2 **Robust research can play a central role in achieving climate commitments. Universities and research institutions need to undergo transformative changes to align academic practices with societal, environmental and future economic priorities.** A growing body of literature both internationally and in Ireland identifies the important role that universities and research institutions can play as agents of transformative change. But to play such a role, universities and research institutions must evolve and transform themselves. Universities are places of knowledge production, perpetuation and dissemination, and are anchor institutions in their communities and regions. Universities have potential to become both exemplars of social change and agents for change. {Chapters 6 (6.3), 8 (8.4), 9 (9.3)}

F.3 **Addressing the 'wicked problem' of climate change requires working across disciplines and across research institutions, understanding the problem from multiple angles and providing appropriate and long-term funding for research on transformative change.** The research environment is fragmented across institutions. Small-scale competitive research bids with time horizons often of 1–2 years or less militates against the development of strategic, transformative and interdisciplinary research to address our urgent societal challenges across climate and biodiversity. An overemphasis on industry co-funding can pose challenges to establishing public good research, a characteristic of much research on climate and biodiversity, particularly in the arts, humanities and social sciences, and fundamental science. {Chapters 3 (3.5), 6 (6.5), 7 (7.4), 8 (Box 8.2), 9 (9.3)}

F.4 **The structure of researcher contracts also serves to limit the potential for transformative research on climate, biodiversity and other grand societal challenges.** The prevailing norm of offering short-term contracts, e.g. 1–2 years, for highly skilled research staff, with no long-term career structure, has made it increasingly challenging to recruit and retain skilled researchers. This diminishes Ireland's human capacity and expertise in climate change across the public sector and higher education, as researchers move abroad or to the private sector in search of a career. {Chapter 9 (9.3)}

F.5 **Realising the transformative potential of research in addressing the climate crisis requires more focus on the coordination and synthesis of research and its translation into societal impacts, including the capacity of the policy system to use and apply the outcomes of research.** Relations between the scientific community and the policy system are often based on individual relationships between scientists and policymakers. It is recommended that a review of international models and practice on climate change and biodiversity research and its application to policy be undertaken, which could inform the development of measures to strengthen the research ecosystem and its links to policy and society in Ireland. {Chapters 7 (7.3), 9 (9.3)}

F.6 **Greater engagement with European and global research networks and funding opportunities can strengthen the role of Irish research on transformative change.** Many researchers and research groups in Ireland already engage with European and global counterparts. Further engagements with European networks and funding streams, such as Horizon Europe and JPI Climate, could strengthen the research base within Ireland. More Irish researchers could be encouraged to participate in global research and research assessment processes, such as the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services (IPBES). {Chapter 9 (9.3)}

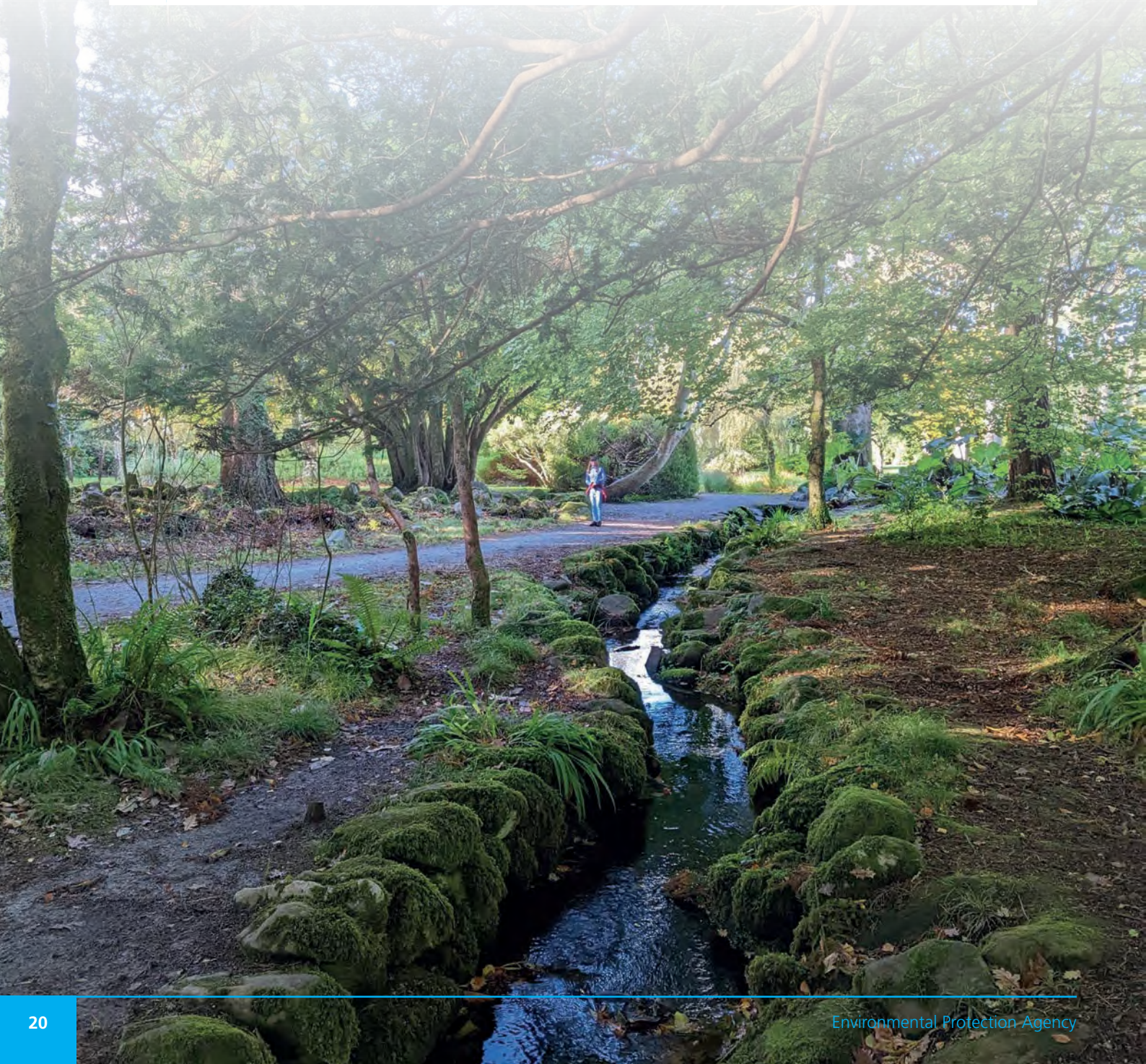
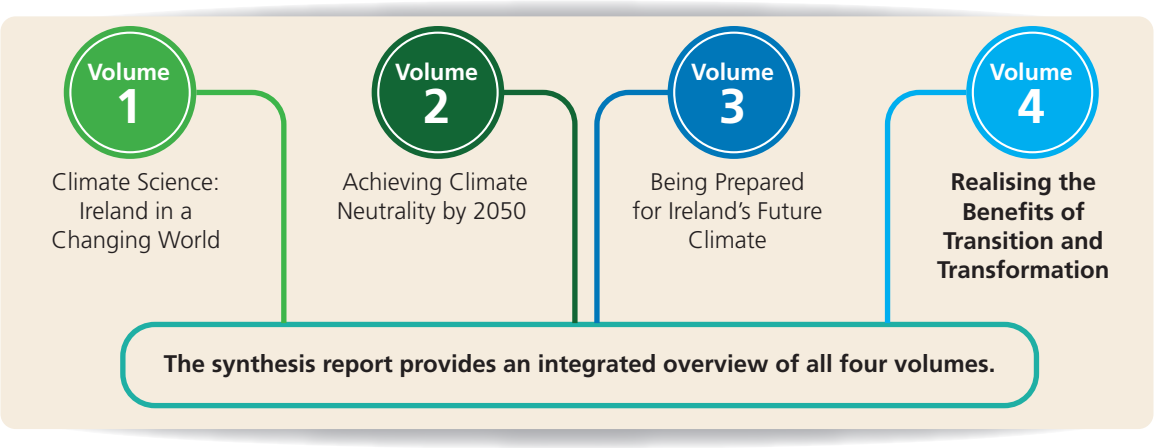


Table of contents

Preamble

The UN Framework Convention on Climate Change (UNFCCC, 1992) has the objective of preventing 'dangerous anthropogenic interference with the climate system', and the Paris Agreement (2015) established the long-term goals of 'holding the increase in global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels' and of achieving 'a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century'. Ireland's Climate Change Assessment (ICCA) delivers a comprehensive, Ireland-focused, state of scientific knowledge report on our understanding of climate change, its impacts on Ireland, the options to respond to the challenges it poses, and the opportunities from transitions and transformations to a climate-neutral, climate-resilient and sustainable economy and society. This serves to complement and localise the global assessments undertaken by the Intergovernmental Panel on Climate Change (IPCC) reports (see www.ipcc.ch). The findings presented build upon these global assessments and add important local and national context.

The report is presented in a series of four thematic volumes accompanied by an overarching synthesis report. The volumes are as follows:



Volume 4 Overview

The processes of national transitions and transformations – to sustainable, climate neutral, climate resilient and biodiversity-rich futures – offer Ireland opportunities that can be pursued, and benefits and synergies that can be achieved. Volume 4 is unique in its focus, as an assessment of the national state of knowledge of these transitions and transformations: what they are; what they offer; and how they can be implemented.

To identify and characterise these transitions and transformations Volume 4 draws on global synthesis literature, including the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), and on international peer-reviewed literature. This is assembled as a state-of-the-art framework, an international benchmark on which to consider national Irish knowledge of transitions and transformations. The literature search, to identify research and knowledge at the-level in Ireland, considered both peer-reviewed publications and grey literature. This allowed the assessment to cover both traditional research publishing channels and additional sources such as reports and working papers.

This assessment of research in Ireland is not a new national policy document on climate action. It is a research assessment of available knowledge related to transitions and transformations under priority themed headings. However, while it is not a new policy document, it can be policy informative. This assessment can help to prompt national policy discussions towards enabling transformations. For the research landscape it can also assist strategically in understanding gaps in knowledge, and how these gaps could be filled.

The report is structured around seven thematic assessment chapters, towards deepening understanding of transformations, a priority research field internationally, that has significantly grown in importance in recent years. The assessment chapters have a particular focus on transformations to low emissions futures, the fundamental systems change that can enable these, and the abundance of benefits and synergies that are associated with such shifts in the national development path. The assessment is bookended by an introductory framing chapter – that seeks to characterise transformative change – and by a concluding chapter – that seeks to consider how it can be moved forward. The scope of these nine framing, thematic assessment and concluding chapters are now described.

Chapter 1 **Framing transformative change** defines and characterises transformative change and describes key principles. It underscores the speed, scale and depth of shift necessary if climate change and biodiversity loss are to be tackled, and the need for a transformational as opposed to an incremental approach.

Chapter 2 **Transforming landscapes** examines the changes that will be necessary in the Irish landscape in the coming decades, and the intersection with food, energy, carbon storage and with space for nature. It also highlights the opportunities for rural and coastal communities, for climate action in both mitigation and adaptation, and for restoration of nature.

Chapter 3 **Transforming spatial planning, transport and the built environment** focuses on systemic changes within settlements, particularly in urban systems. It highlights the importance of transformative change in reducing greenhouse gas emissions from settlement, transport and the built environment, and in adapting places and infrastructure to a changing climate. Integrated spatial planning is emphasised as a powerful approach that can deliver multiple benefits by strategically managing climate objectives and promoting collaboration.

Chapter 4 **Transforming livelihoods** considers the place of livelihoods in national transitions and transformations, employing an integrated framing to combine social and environmental with economic priorities. The chapter considers the current context, the role of just transitions, and frontier enablers in universal basic services; basic income; the shorter working week and the importance of care. This build towards an understanding of the social and economic opportunities for livelihoods in transformations.

Chapter 5 **Transforming lifestyles** addresses the centrality of considering lifestyle and consumption in transformations. It emphasises the significance of reducing emissions by integrating new demand-side strategies with conventional measures. The chapter emphasises that systemic infrastructural and technological innovations are crucial enablers of individual behavioural change, to shift behavioural patterns at scale, and reduce energy demand. Additionally, the chapter highlights the impact of individual choices on social dynamics and their contribution to the overall processes of change.

Chapter 6 **Transforming development: economy, innovation and finance** has adopted the state-of-the-art holistic framing, in sustainable development paths, to understand opportunities for transformational development in Ireland. Building on this comprehensive approach to understand national transformations, the chapter provides a pioneering framework to identify national economic opportunities and considers the roles and challenges for innovation and finance, in advancing towards low emissions and sustainable futures.

Chapter 7 **Transforming governance and policy** highlights the critical role of enhanced governance, of public policy and of institutions, as enablers of national transitions and transformations, and of achieving the associated win-win outcomes. The chapter considers the international, European and national policy context, and the critical importance of deepened policy integration, horizontally and vertically.

Chapter 8 **Transforming participation and catalysing change** explores the importance of knowledge and engagement in enabling climate action. The chapter focusses on public participation, and the role of education and news media, as important enablers of transformative change. It highlights the catalytic power of people working together to accelerate and strengthen climate action.

Chapter 9 **Moving transformation forward**, in closing the report, the necessity of transformative change is reiterated alongside the importance of building a social mandate for such depth of change. A distilled assessment of the role of research in enabling transformative change concludes the assessment.

1

Framing Transformative Change

Key messages

Transformative change is a fundamental, system-wide reorganisation across technological, economic and social factors, including paradigms and goals, and valuing the climate, the environment, equity and wellbeing within decision making (IPBES, 2018; IPCC, 2018). If Ireland is to achieve its goals under the national climate objective, the Paris Agreement and the Kunming–Montreal Global Biodiversity Framework, transformations will be necessary in the energy, food and land systems, urban systems (including planning, transport and buildings), livelihoods, lifestyles, development pathway, systems of governance and in participation. A clear long-term vision and plan for the transformation of each system will accelerate short-term action and enhance synergies while minimising and managing trade-offs and realising the benefits of transformative change.

The decisions and actions taken this decade will reverberate for generations. Much of the groundwork for action has been lain and most technologies and solutions are already available. However, climate action is not occurring quickly enough: opportunities and benefits are being missed and the possibility of shaping a better future for all is being put at risk by not taking a holistic and systemic approach to change.

Action needs to be scaled up and accelerated. An incremental approach will not deliver what is required. If Ireland is to address the scale, speed and depth of the change required to close the gap between ambition and action, an approach that focuses on rapid and systemic transformations is necessary.

Equity is an important societal goal and an essential element of achieving transformative change both in terms of mitigation and adaptation to climate change. Including considerations of equity at the core of decision making is key to enabling transformative change that enhances living standards, while halving associated energy demand, reducing vulnerability and proactively preparing individuals, households, communities and systems for climate shocks.

Climate change and biodiversity loss share many underlying drivers. These underlying drivers need to be addressed if Ireland is to achieve its national and international commitments. Just as the drivers of these crises are linked so too are the solutions.

A long-term integrated strategic plan is necessary to drive action in the immediate and short terms, but also to deliver a strong signal on the direction of travel towards a climate-neutral, climate-resilient, biodiverse and sustainable future. Such a plan can leverage greater benefits and opportunities, now and in the future.

1.1. Urgency and the challenges ahead

A safe climate system and functioning natural world are the foundation of human wellbeing and prosperity. It is not too late to act to protect these essential life support systems. To close the gap between ambition and action (mitigation and adaptation) and match the scale, speed and depth of change required if Ireland is to deliver on the national climate objective, necessitates major transformations. These transformations will be required across all sectors – energy, food and land systems, urban systems (including planning, transport and buildings) – livelihoods, lifestyles, development pathway and systems of governance and in participation. Delivering this change will be challenging. However, most of the technologies and know-how to reduce emissions and to adapt to climate change already exist (IPCC, 2023b; see Figure 1.1). In many cases, the financial cost of action is cheaper than the status quo (IPCC, 2022c; New et al., 2022). Greenhouse gas emissions can be cut in the short term through addressing the drivers of demand, making it easier to decarbonise the energy system in the long term (Creutzig, et al., 2022a, 2022b; Gaur et al., 2022; see Chapter 5 and section 6.2.2). The challenges and their associated costs are increasingly social and political, rather than financial or technological (Markkanen and Anger-Kraavi, 2019; Jewell and Cherp, 2020; see Volume 2, Chapter 1). Experiencing and responding to climate extremes reduces the capacity for longer-term systemic action by drawing focus and resources, adding to the effort required to make change happen (Laybourn et al., 2023).

Climate change is far from the only challenge facing Ireland. Housing, health care, inequality and other environmental issues also require action (Social Justice Ireland, 2021; see Chapter 4). If measures taken to address climate change conflict with these objectives, opportunities to realise co-benefits through addressing core systemic issues will be missed, and action on climate will slow down (Falduto and Rocha, 2020). However, research shows that a achieving a decent standard of living for all, within nature's limits, can be an essential component of delivering climate action and allowing all people to live well now and in the future (Raworth, 2017; Creutzig et al., 2022b).

While the carbon budgets developed under the Climate Action and Low Carbon Development (Amendment) Act 2021 (Government of Ireland, 2021a) have specific targets, the Act also states the wider national climate objective of "the transition to a climate *resilient, biodiversity rich, environmentally sustainable* and climate neutral economy" by no later than the end of the year 2050. Although these objectives do not undergo the same level of scrutiny as greenhouse gas emissions through the carbon budgets (see Volume 2, Chapter 2), they are important and significant goals that require the same level of urgency, attention and action. There are multiple pathways that can deliver on the national climate objective and the goals of the Paris Agreement and the Kunming–Montreal Global Biodiversity Framework. Transformative change can set in motion a myriad benefits and opportunities associated with developing and delivering these pathways, including a safer climate, functioning natural ecosystems and gains for society, such as good jobs, more comfortable homes and enhanced wellbeing, and for the economy, such as avoiding the disastrous effects of climate impacts. Ireland is not on track to deliver on this long-term transformation, as ambition is not being matched with action on emissions, resilience, biodiversity or environmental sustainability (CCAC, 2021a, 2022; EPA, 2020).

However, there is evidence to suggest that some of groundwork necessary to support these transformations is taking place. Ireland was among the first countries to declare a climate and biodiversity crisis, divest public funds from oil, gas and coal companies[1], halt new exploration for oil and gas and ban hydraulic fracking. Other examples include the Climate Action Plan 2021 and 2023 (DECC, 2021, 2022), carbon budgets and sectoral ceilings (CCAC, 2021b), the development of sectoral adaptation plans (CCAC, 2022), a €14 billion a year investment in climate action between 2021 and 2030 (DECC, 2021), not to mention the groundbreaking citizens' assemblies on climate action and more recently on biodiversity loss, as well as a parallel Children and Young People's Assembly on Biodiversity Loss. Pathfinder projects are bringing more public transport, cycling and walking to Irish villages, towns and cities. Those who will deliver much of the emissions reductions in the building sector are being recruited and trained (Government of Ireland, 2020). The enhancement of the electricity grid will ensure its capacity to manage the huge increase in renewables that is in the planning pipeline. Most of the technologies required to deliver rapid reductions in greenhouse gas emissions are mature and cost-effective already, without subsidies (IPCC, 2022d; see Volume 2, Chapters 4, 5 and 7). Alongside these and many other developments, momentum is building in civil society, driven in large part by children and young people becoming involved in activism and linking climate change and human rights issues in the judicial system, and successfully keeping climate change on the political agenda (Creutzig et al., 2022b; Daly, 2022; Dubash et al., 2022; see section 8.5).

[1] In the case of divesting public funds, this had global implications, reducing the market value of the biggest fossil fuels companies in the USA, by €14 billion, in the 3-day window around the announcement (Becht et al., 2023).

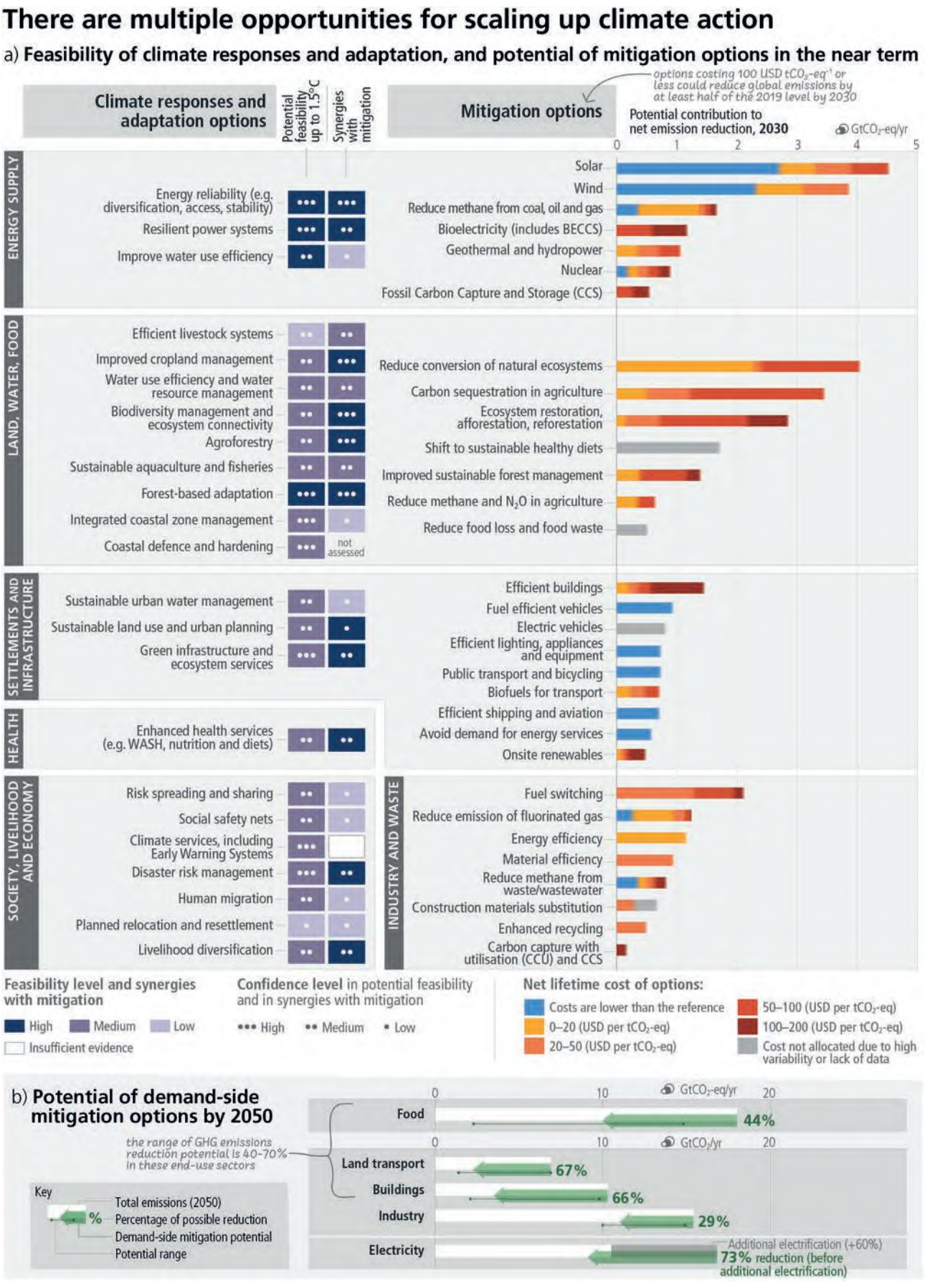


Figure 1.1 Multiple opportunities for scaling up climate action. Source: IPCC (2023b; their figure SPM.7).

This volume uses international evidence and research to frame and assess transformation and synthesises existing Irish research, focusing on the type of change – transformative change – that can make a difference when it comes to upscaling and accelerating action to match ambition. This volume looks at key elements of possible pathways and explores how to achieve transformative change. It highlights the benefits and opportunities that result from taking decisive action in the short term, not only as outcomes of action but as critical ingredients of the transformation itself. Transformative change, the seeds of which have already taken root in Ireland, can allow Ireland to continue to develop and prosper and become a place where people and nature flourish in a safer climate now and in the future (see also Chapter 6, Volume 3, Chapter 9, and O'Mahony, 2022).

1.2. Wellbeing and equity are at the heart of transformations to sustainability

Acting on climate change or on biodiversity loss can often seem removed from or even at odds with actions to enhance human wellbeing and equity, but climate action and safeguarding nature are fundamentally about securing a liveable future for all and improving people's lives (New et al., 2022; see Figure 1.2). The Fifth Assessment of the Intergovernmental Panel on Climate Change (IPCC) identified human wellbeing as a fundamental route to climate action (Fleurbaey et al., 2014). Building on this, O'Mahony (2022) developed a 'sustainable wellbeing' conceptual framework for transitions and transformations (see also sections 4.3, 6.2 and 7.3.4, and Volume 3, Box 9.1). From another perspective, if "living well within the limits of the planet" (EEA, 2017) is to be achieved then the role of human wellbeing and equity are central. Globally, achieving a universal decent standard of living can halve energy demand while increasing the wellbeing of most people (Creutzig et al., 2022a, 2022b; Millward-Hopkins, 2022; Rockström et al., 2023; see Chapter 5).

Energy poverty is a manifestation of the interrelationship between socioeconomic disadvantage, climate action and wellbeing. Households with lower incomes spend a much larger share of their income on fuel and are particularly vulnerable to energy price rises (Barrett et al., 2022). Energy poverty is also associated with poor health outcomes (Thomson et al., 2017). Climate action measures can either exacerbate or alleviate energy poverty, depending on their design (Belaïd, 2022). Addressing greenhouse gas emissions, deprivation and health in tandem, therefore, is an opportunity to deliver multiple benefits and avoid barriers to climate action.

Consideration of equity is also critical when considering adaptation options. Proactive or anticipatory adaptation that reduces the exposure and vulnerability of people and systems means that they are better prepared for climate shocks (Bezner Kerr et al., 2022; see Volume 3). When inequalities are reduced, climate adaptation interventions are designed, implemented and evaluated more effectively, and vulnerabilities decrease (Ireland and McKinnon, 2013; Eriksen et al., 2021; Schipper et al., 2021). Transformative adaptation requires fundamental systems change to address the root causes of vulnerability (Fedele et al., 2019). Equity is also critical in delivering the societal and political transformations that occur to enable transformative change and achieve sustainability (Dubash et al., 2022; see sections 4.2.1 and 6.2.2).

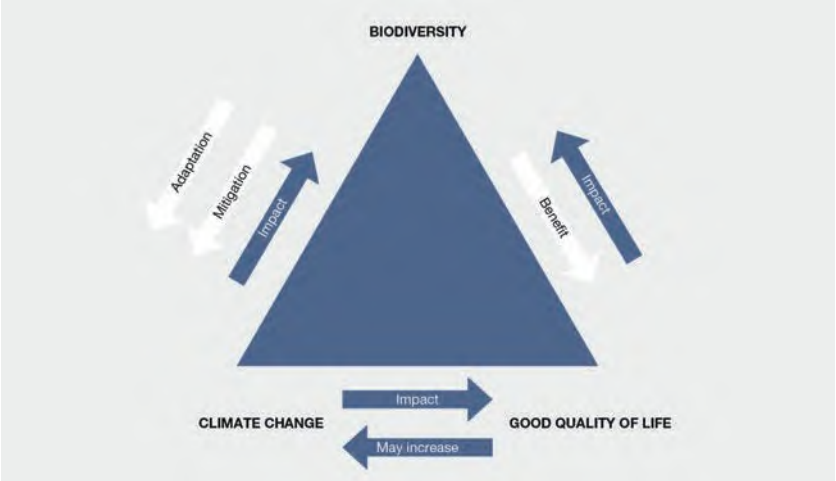
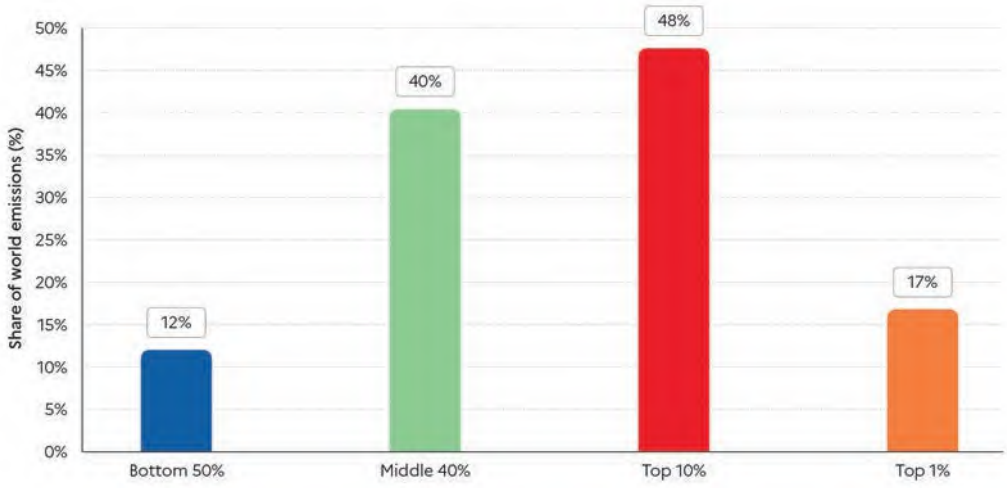


Figure 1.2 Relationship between climate change, biodiversity and good quality of life. Blue arrows represent interactions that are predominantly threats, and white arrows represent opportunities. Source: Pörtner et al. (2021; their figure 1.1); originally adapted from Korn et al. (2019).

Economic indicators such as gross domestic product (GDP; or, in Ireland's case, modified gross national income; Honohan, 2021) do not adequately reflect wellbeing in all its economic, social or environmental aspects (OECD, 2018; NESC, 2021). A wellbeing framework, including a set of wellbeing indicators, is currently undergoing development and implementation (Government of Ireland, 2021b, 2022). This could signal the beginning of a move away from using narrow economic indicators of progress as a proxy for wellbeing. However, as long as the wellbeing indicators remain peripheral (e.g. used to inform financial budgets) as opposed to substantive (e.g. enshrined in law and central to policymaking and long-term strategy), the central role of wellbeing and equity in achieving long-term and intergenerational sustainability may not be realised. Carefully considered climate policy can help deliver on societal, environmental and economic objectives and accelerate climate action and transformation (see sections 6.2.3 and 7.4). Putting wellbeing and equity alongside sustainability at the centre of decision making, as fundamental goals, is an important part of creating transformative change (OECD, 2019; NESC, 2021; O'Mahony, 2022).

Box 1.1 The interplay of carbon emissions and income inequality

Carbon emissions are closely linked to global wealth disparities. For context, while the global average carbon dioxide emission per person stands at 6.6 tonnes annually, a member of the top 1% emits a staggering 110 tonnes (Chancel et al., 2022). This difference becomes more pronounced when considering that someone from the top 1% may have a carbon footprint up to 175 times greater than someone in the bottom 10% (Otto et al., 2019). Statistically, the top 10% of emitters are responsible for approximately 50% of total emissions, contrasted against the bottom 50%, which account for just 12% (Chancel et al., 2022; Box 1.1, Figure 1). See section 5.2.3 for Ireland's specific figures.



Box 1.1 Figure 1 Global carbon inequality 2019: global emissions by income groups, accounting for domestic consumption, investments and carbon in traded goods and services. Source: Chancel et al. (2022). Reproduction licensed under the Creative Commons Attribution CC BY 4.0 licence (https://creativecommons.org/licenses/by/4.0/).

These disparities extend to consumption patterns. Evidence suggests that nearly half of the world's energy consumption is shouldered by the top 10%, especially when accounting for the energy embedded within imported goods (Creutzig et al., 2022b). The consumption behaviours of the affluent not only exert a direct environmental cost, but also set aspirational benchmarks for the larger populace. Therefore, any substantial behavioural modification among this group could cascade into wider societal change, amplifying the overall impact (Otto et al., 2019).

A sustainable and equitable future mandates a paradigm shift in both sociocultural norms and economic infrastructures. These very structures are, at present, exacerbating the challenges contributing to climate change (Stoddard et al., 2021). Identifying and addressing underlying drivers that promote high-carbon lifestyles can enhance the effectiveness of interventions and drive more substantial emissions reductions (Stoddard et al., 2021).

A significant untapped potential exists in reducing global carbon emissions by modifying the lifestyles of the affluent. A 20% reduction in their carbon footprint is feasible by transitioning their homes to carbon-neutral standards, promoting decentralised renewable energy and encouraging electric vehicle use. Moreover, opting for durable goods and curtailing excessive consumption, especially frequent air travel, can further decrease emissions (Otto et al., 2019). Notably, conventional policies like heavy environmental taxation might be insufficient as deterrents for the ultra-wealthy, who can readily bear the cost of continued pollution. Instead, introducing compulsory measures, like mandatory renewable installations for properties above specific sizes, could yield more substantive results (Otto et al., 2019). See section 5.2.3 for more policy recommendations.

Targeted demand management focused on high emitters holds significant potential, given that a disproportionate share of global emissions comes from a minor segment of the population. To underscore this, reducing emissions of the top 10% to the EU average would lead to a 30% decline in global carbon dioxide emissions (Stoddard et al., 2021).

1.3. What is transformative change?

Transformative change is a fundamental, system-wide reorganisation across technological, economic and social factors, including paradigms and goals, and valuing the climate, the environment, equity and wellbeing within decision making (IPBES, 2018; IPCC, 2018). These factors often work in concert and on multiple scales to tackle the root or underlying drivers of the connected crises of climate change and biodiversity loss (IPBES, 2019a; IPCC, 2018, 2022b, 2022c). It "relies on shifting away from predominant values that currently over emphasise short-term and individual material gains, to nurturing sustainability-aligned values across society" (IPBES, 2022).

If the national climate objective is to be achieved it will require what the IPCC describe as "transformative systemic change integrated with sustainable development" (IPCC, 2018; see section 6.2) and "transformative changes across economic, social, political and technological factors" (IPBES, 2019a; see Chapter 7). Sustainability can be achieved through "significant and enduring societal shifts at all levels" and a "conscious and deliberative transformation that addresses the underlying or root causes of multiple interconnected problems", which will require integrated and long-term planning (Sachs et al., 2019; O'Brien et al., 2022; see section 7.3.4).

Some principal elements of transformative change have been identified during recent global assessments on climate change and biodiversity loss, including:

- recognising that climate change and biodiversity loss are intrinsically linked and pose grave threat to the natural world and human wellbeing (Pörtner et al., 2021; IPBES, 2022; see Figure 1.2);
- recognising that these dual crises need to be tackled together to make the most of synergies and manage trade-offs (IPBES, 2022; IPCC, 2022c);
- recognising the importance of justice and equity and the roles they play in societal acceptance of change and in the effective policymaking that can allow a sustainable development pathway to be developed while also delivering action on climate and biodiversity loss (IPBES, 2019b; IPCC, 2022c; see section 6.2);
- recognising the need to tackle the indirect drivers or underlying causes that are acting as barriers to action on direct drivers (Barger et al., 2018; Balvanera et al., 2019; Pathak et al., 2022; de Koning et al., 2023);
- recognising that an integrated long-term strategy for solving these problems has the potential to improve human wellbeing in both the near and long terms (Sachs et al., 2019; Turnhout et al., 2021; see section 7.3.4);

- acknowledging that addressing climate change requires more than technical solutions, that it requires societal change (Schreuder and Horlings, 2022; Stephens, 2022; see section 6.2 and Chapter 8);
- emphasising the need for inclusive and participatory approaches to engage multiple stakeholders to foster systemic shifts towards sustainability (Schreuder and Horlings, 2022; see Chapter 8).

When considering transformative change in relation to climate change and biodiversity loss, three dimensions require attention: the depth, scale and speed of change (Fazey et al., 2018; Moore et al., 2021). If change is systemic then it has the appropriate depth. This involves substantial alterations in policies, technologies, infrastructures and behaviours to move to low-carbon and sustainable pathways (Moore et al., 2021). If it is comprehensive, occurring on multiple scales, individuals to systems, local to global, then it has the appropriate scale. This involves engaging diverse stakeholders, fostering collaboration across sectors, and addressing interconnected issues such as social equity, economic factors and environmental justice (Moore et al., 2021). If the intended consequences are rapid, then it has the appropriate speed. This calls for agile policy frameworks, innovation and adaptive governance structures to facilitate swift and effective responses to climate challenges (Moore et al., 2021; see Chapter 7). If Ireland is to address the speed, scale and depth of the change required to close the gap between ambition and action, an approach that focuses on systemic, comprehensive and rapid transformations is necessary (Roy et al., 2018). The current incremental approach to transition is not sufficient if the transformative change required is to be achieved (Pathak et al., 2022).

While Ireland is laying the foundations that could support the achievement of the national climate objective, global studies such as Morrison et al. (2022) make it ever more clear that this requires radical[2] interventions. This volume focuses on identifying (1) the seeds of transformative change that have already taken root in Ireland, (2) synergies and how they may be enhanced while managing trade-offs to make the most of benefits and opportunities that come with transformative change, (3) how to enable transformative change and (4) the next steps in terms of developing research to address knowledge gaps, in order to increase the speed, scale and depth of the change necessary if transformation is to be achieved.

[2] Transformative change requires radical, from the Latin word radicalis meaning 'of or related to a root', interventions to get at the underlying or root causes of the climate change (Temper et al., 2018; McPhearson et al., 2021; Morrison et al., 2022).

1.3.1. What is being transformed?

Multiple transformations, in economic, societal, political, technological and environmental systems, will take place, by 2050, if Ireland is to deliver on its commitments under the Paris Agreement and the national climate objective. Structural change will be required to change how production and consumption are 'governed, organised and practiced' by society, to shift production and consumption to sustainable activities, such as moving from fossil fuels to renewables (Scoones et al., 2020). System change will be required to transform sociotechnological systems, such as the energy, transport, food and land systems, that are made up of the technologies, infrastructures, organisations, markets, regulations and practices that allow society to function (Geels et al., 2017). The way in which people engage with one another and work together will have to change so that new transformative pathways, to a better future through social, cultural and political change, can be achieved (O'Brien, 2015). Enhancing capacity and processes and focusing on power asymmetries and social justice will be required to deliver this change (Pereira et al., 2019).

Box 1.2 Post-growth: questioning the growth-based economy

there's another way to count wealth and abundance – as hope for the future, safety and public confidence, emotional wellbeing, love and friendship and strong social networks, meaningful work and purposeful lives, equality and justice and inclusion. Rebecca Solnit (Solnit, 2023)

Recent major assessments by the IPCC, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and the European Environment Agency (EEA) have discussed moving past growth-oriented economics to explore post-growth pathways, as the need for transformative change calls for a 'profound rethink' of humans activities with regard to sustainability (IPBES, 2019b; EEA, 2021; IPCC, 2022b, 2022c; Riahi et al., 2022).

Post-growth, an approach to economics that focuses on the possibility of prosperity without growth, challenges the assumption that growth is a necessary requirement for wellbeing in developed economies. Growth-based economics, and the high levels of consumption necessary to support it, is at odds with the actions to curtail activities that breach the limits of the planet and of the ecosystems that sustain human wellbeing. It considers a world that is not centred on productivism, output or consumption, but on quality of life, the social world and creativity[3].

Calls for post-growth-oriented economies[4] are gaining attention, and policymakers and research funders in Europe are actively seeking information. In May 2023, the European Parliament organised an event – Beyond Growth: Pathways towards Sustainable Prosperity in the EU – to explore ideas related to societal wellbeing, sustainably prosperity and what post-growth might look like in Europe. Meanwhile, the European Research Council funded a prestigious Synergy Grant of €10 million to learn more about pathways to post-growth economics, around "how dramatic reductions in energy and resource use can be achieved, while at the same time ending poverty and ensuring decent lives for all"[5]. Recent research in Ireland supports this, as it finds that achieving mitigation pathways is more feasible with lower energy demand and results in many benefits to society and a better standard of living (Gaur et al., 2022). See also section 6.2.2, which discusses and assesses literature on economic growth, green growth, degrowth and post-growth.

[3] https://www.greeneuropeanjournal.eu/beyond-the-choke-hold-of-growth-post-growth-or-radical-degrowth/

[4] For developed economies.

[5] https://www.uab.cat/web/sala-de-premsa-icta-uab/detall-noticia/european-project-to-explore-pathways-towards-post-growth-economics-1345819915004.html?detid=1345872411651 and https://erc.europa.eu/news-events/news/erc-synergy-grants-2022-project-highlights

1.3.2. Who is transforming it?

Research on sustainability transitions suggests that transformative change begins with a stable system, consisting of actors, technologies and institutions (Köhler et al., 2019). Enabling approaches, in particular, recognise the potential of human agents, particularly the role of the individual, in community, and grassroots-led change (Scoones et al., 2020). Various agents of change have been identified, for example individuals, social movements, communities, associations, activists (including strategic and political activists), intermediate actors (e.g. policy entrepreneurs), consumers, system users (i.e. energy users), businesses and policymakers, and various combinations of these actors working together (Farla et al., 2012; de Haan and Rotmans, 2018; see Chapter 8).

Radical innovations often emerge in protected spaces or niches, sometimes introduced by new players or outsiders (Geels and Schot, 2007). Successful innovations gradually expand in scale, scope and geographic reach, contributing to the emergence of new regimes (Geels et al., 2017). Incumbent actors can either support or resist these innovations through a combination of government policies, economic forces, institutional factors and behavioural pressures (EEA, 2018). Transformations are characterised as non-linear processes in which periods of rapid change, triggered by tipping point behaviours, alternate with periods of relative stability. Transformative change may be perceived as the result of the deliberate and strategic actions of many different actors, promoting tipping point behaviour by taking gradual steps that grow in strength over time (de Haan and Rotmans, 2018). Numerous actors have the potential to either initiate or impede significant systemic change.

Interesting examples of transformative change, led by individuals, grassroots organisations, communities up to semi-states and state involvement have been included throughout this volume. These examples demonstrate transformative change that is happening in Ireland today, and the associated benefits and opportunities are highlighted. Individuals, social movements, non-governmental organisations (NGOs) and the state are prevalent in the Irish context as agents driving transformative change (see section 8.4). While these actors are aware of the changes they are making and how they affect surrounding communities, at local regional and national levels, they may not refer to their work as transformative.

Box 1.3 COVID-19 as an example of rapid transition

The pandemic swiftly and significantly transformed various aspects of society, highlighting the potential for accelerated change in response to a crisis. COVID-19 necessitated immediate and wide-ranging adaptations in health care systems, public health measures and daily routines. Governments implemented strict lockdown measures, travel restrictions and social distancing protocols to mitigate the spread of the virus. These measures resulted in unprecedented shifts in societal behaviour and economic activities (European Centre for Disease Prevention and Control, 2022). There is strong evidence and high consensus indicating that the COVID-19 pandemic has amplified the likelihood of governments implementing extensive measures to support public goods and address climate change (Creutzig et al., 2022b; see Chapter 5).

The pandemic also triggered rapid innovation and digital transformation (Von Krogh et al., 2020; Kronblad and Envall, 2021). Remote work and online education became the new norm, with businesses, educational institutions and individuals quickly adapting to virtual platforms and digital communication tools. e-commerce experienced a significant surge as consumers turned to online shopping to meet their needs. These changes exemplify how a crisis like COVID-19 can expedite the adoption of new technologies and reshape traditional practices.

The behavioural shifts resulting from the pandemic have further strengthened the importance of sufficiency and solidarity and economies focused on care, protection of livelihoods, collective efforts and the provision of essential services. These changes have also been associated with reduced emissions (Creutzig et al., 2022b; see Box 5.2) The crisis reinforced the need for interconnectedness and collaboration, transcending national borders and prompting joint efforts at the European and global levels to coordinate responses and share resources.

1.3.3. Getting to the roots of the problem

Interventions that act on the direct drivers of climate change, biodiversity loss and inequality are hampered by the, often shared, indirect or underlying drivers of change (see Figure 1.3). These indirect drivers take many forms, including "formal and informal institutions, such as norms, values, rules and governance systems, demographic and sociocultural factors, economic and technological factors" (Díaz et al., 2015; Barger et al., 2018; Brondízio et al., 2019; Cumming et al., 2020) and "conflicts and epidemics" (Díaz et al., 2019; IPBES, 2019a).

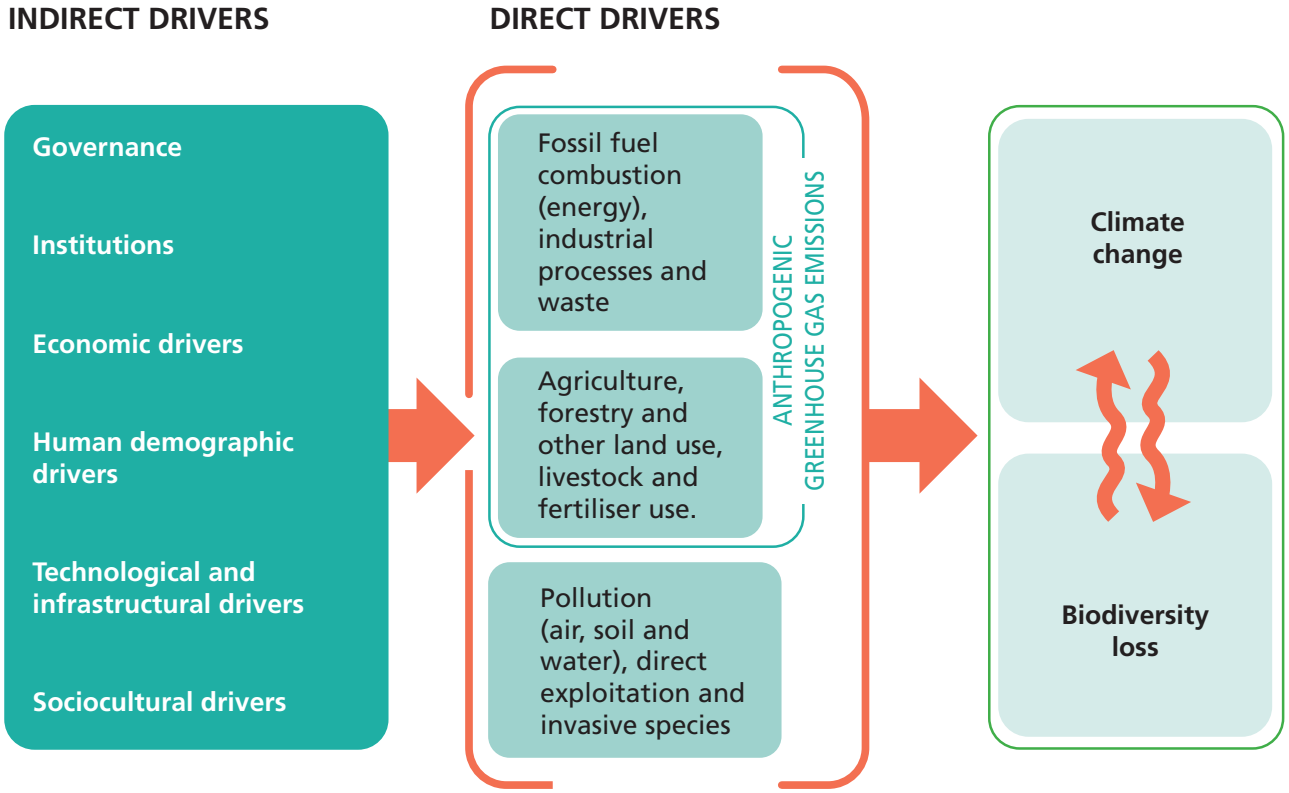


Figure 1.3 Indirect and direct drivers of anthropogenic greenhouse gas emissions causing climate change and of human activities linked to biodiversity loss. Source: Adapted from figure 1.3 in Pörtner et al. (2021).

Indirect drivers determine the economic activities that propel direct drivers of change (Chan et al., 2020). For example, sociocultural and demographic factors influence consumption patterns that determine fossil fuel and land-use emissions (see Chapter 5). The food system and the energy system underpin human societies and have deep links to and are embedded within, for example, systems of governance (Ehrlich and Pringle, 2008). Interventions aimed at direct drivers challenge vested interests who benefit from the status quo and strongly oppose any change (Chan et al., 2020; see Box 1.4). Addressing the underlying drivers requires "systemic change and structural transformation of human to human and human to nature relationship" (Morrison et al., 2022).

How can those underlying drivers start to be addressed in Ireland? A better, deeper understanding of the systems and structures that are present in Ireland and how they act as barriers, or, better still, how they can be augmented to enable change, is required. One recent example, with policy relevant and actionable recommendations for Ireland, is a report from the Organisation for Economic Co-operation and Development (OECD) titled *Redesigning Ireland's Transport for Net Zero: Towards Systems the Work for People and the Planet* (OECD, 2022), which found that "the Irish transport system fosters growing car use and emissions by design". As part of this analysis, systems thinking and systemic tools were used to identify policies that have the power to be transformative. This helped to refocus Ireland's transport decarbonisation strategy within the Climate Action Plan 2023 to go beyond vehicle technology change, and to prioritise the reduction in car dependency, a transformational approach, alongside vehicle electrification (OECD, 2022).

Box 1.4 The status quo bias

The status quo bias refers to the preference for the existing state of affairs. Behavioural, sociocultural, business and corporate, institutional and infrastructural drivers can act to maintain the status quo or assist in generating the momentum to achieve a sustainable, resilient and equitable future with enhanced human wellbeing (Creutzig et al., 2022b; see Box 1.4, Table 1, and Chapter 5). Box 1.4, Table 1, summarises how these drivers contribute to the status quo, what can be done to change this, alongside implications for policy and examples from the international literature (Creutzig et al., 2022b).

Institutional drivers that contribute to the status quo have been studied in the Irish context. A major barrier to overcoming the status quo is the political power that comes with the economic centrality of fossil fuels and agriculture (Denton et al., 2022; Grubb et al., 2022). Incumbent actors use this power to block effective climate action through lobbying government and are more effective than other stakeholders who wish to see the benefits of strong climate action (Meng and Rode, 2019). The preferences of institutionally important and economically power institutions, particularly those related to the agricultural sector, are reflected in Irish law, while the preferences of those who advocate for stronger regulation are not (OECD, 2017; Torney, 2017; Wagner and Ylä-Anttila, 2018). New policy instruments, discussions, platforms and implementation agencies with enhanced capacity will be necessary to overcome institutional barriers to change (Creutzig et al., 2022b; see Chapter 7).

Throughout this volume, examples of research related to other drivers – behavioural (see Chapter 5), sociocultural (see Chapter 8), business and corporate (see Chapter 4) and infrastructural (see Chapter 3) – that maintain the status quo are considered based on the available evidence.

Box 1.4 *Table 1 Drivers of the status quo bias: main features, insights and policy implications of five drivers of decision and action*

Driver	How does driver contribute to status quo bias?	What needs to change?	Driver's policy implications	Examples
Behavioural	Habits and routines formed under different circumstances do not get updated Present bias penalises upfront costs and discourages energy efficiency investments Loss aversion magnifies the costs of change When climate change is seen as distant, it is not feared Nuclear power and accident potential score high on psychological dread	New goals (sustainable lifestyle) New capabilities (online real-time communication) New resources (increased education) Use of full range of incentives and mechanisms to change demand-side behaviour	Policies need to be context specific and coordinate economic, legal, social and infrastructural tools and nudges Relate climate action to salient local risks and issues	India's new LPG scale-up policy uses insights about multiple behavioural drivers of adoption and use Rooftop solar adoption expanded in Germany, when feed-in tariffs removed risk from upfront cost recovery Nuclear power policies in Germany post Fukushima affected by emotional factors

Driver	How does driver contribute to status quo bias?	What needs to change?	Driver's policy implications	Examples
Sociocultural	Cultural norms (e.g. status, comfort, convenience) support existing behaviour Lack of social trust reduces willingness to shift behaviour (e.g. adopt car sharing) Fear of social disapproval decreases willingness to adopt new behaviours Lack of opportunities to participate in policy create reaction against 'top-down' imposition Unclear or dystopian narratives of climate response reduce willingness to change and to accept new policies and technolo-gies	Create positive meanings and norms around low-emission service delivery (e.g. mass transit) Community initiatives to build social trust and engagement, capacity building, and social capital formation Climate movements that call out the insufficient, highly problematic state of delayed climate action Public participation in policymaking and technology implementation that increases trust, builds capacity and increases social acceptance Positive narratives about possible futures that avoid emissions (e.g. emphasis upon health and slow/ active travel)	Embed policies in supportive social norms Support collective action on climate mitigation to create social trust and inclusion Involve arts and humanities to create narratives for policy process	Communicate descriptive norms to electricity end users Community energy initiative REScoop Fridays for Future
Business and corporate	Lock-in mechanisms that make incumbent firms reluctant to change: core capabilities, sunk investments in staff and factories, stranded assets	New companies (e.g. car-sharing companies, renewable energy start-ups) that pioneer new business models or energy service provisions	Influence consumer behaviour via product innovation Provide capital for clean energy innovation	Electrification of transport opens up new markets for more than a hundred million new vehicles

Driver	How does driver contribute to status quo bias?	What needs to change?	Driver's policy implications	Examples
Institutional	Lock-in mechanisms related to power struggles, lobbying, political economy	New policy instruments, policy discussions, policy platforms, implementation agencies, including capacity	Feed-in tariffs and other regulations that turn energy consumers into prosumers	Mobility case study, India's LPG policy sequence
Infrastructural	Various lock-in mechanisms such as sunk investments, capabilities, embedding in routines/lifestyles	Many emerging technologies, which are initially often more expensive but may benefit from learning curves and scale economies that drive costs down	Systemic governance to avoid rebound effects	Urban walking and bike paths Stable and continuous electricity supply fostering induction stoves

Notes: Entries in each column represent independent lists, not intended to line up with each other. LPG, liberalisation, privatisation and globalisation.

Source: Creutzig et al. (2022b; their table 5.4).

1.4. Closing the gap

Taking a transformative approach to climate change mitigation and adaptation is an opportunity to start closing the gap between ambition and action while enhancing benefits – environmental, societal and economic – in the near term as well as in the long term. This holistic and systemic approach addresses the underlying drivers that are acting as barriers to change and through iterative learning, co-creation, visioning and cooperation enable the emergence of new and equitable pathways to sustainability. To close the gap, strategies that can bring together the benefits of action in the near term and action on a longer timescale are necessary. Action on mitigation and adaptation this decade can reduce the losses and damages to human wellbeing and natural systems, but this window of opportunity is rapidly closing. Long-term plans give strength to near-term actions, putting them in the context of the overall goal and signposting to all actors the long-term direction of travel, allowing those actors to adjust their near- and medium-term plans accordingly. Exploring synergies and trade-offs can assist in understanding how actions on mitigation and adaptation can either enhance or compete with other objectives. Maximising synergies while minimising and managing the remaining trade-offs can help accelerate change in different areas of policy and, at the same time, enhance societal gains.

1.4.1. Enabling conditions

Enabling transformative change involves iterative processes of change, as opposed to following a predetermined pathway. The literature does not provide a consensus on the best approach for actors to deliberately pursue transformation or the extent to which actors can guide the process (Grubb et al., 2022). Instead, the transitions and transformation literatures, drawing from a complex systems perspective (Köhler et al., 2019), indicate that interventions in such systems rarely lead to predetermined outcomes, and successful interventions often resemble iterative processes of action, observation and response (Grubb et al., 2022).

Transformation is viewed as a collective action challenge that involves actors with common and differing values, interests and capabilities interacting over time, with cooperation and competition. Grounded in the sustainability transitions literature, transition management (Loorbach, 2010) supports collaborative arenas where actors co-create visions of change, plan pathways and engage additional actors in the transformation process. These frameworks and tools embrace multiple objectives and measures to consider trade-offs among diverse parties with different interests and values. Multiple scenarios are used to stress-test proposed actions, identifying conditions under which they would fail to meet their goals and informing ways to enhance their robustness and resilience across multiple possible futures (Denton et al., 2022; see section 6.2.4). On the other hand, focusing solely on single or overly aggregated measures and scenarios can favour certain actors' perspectives, reduce transparency and impede the identification of resilient and equitable solutions to complex, uncertain, non-linear and contested problems (Grubb et al., 2022).

Transitioning to sustainable practices can face various barriers, such as infrastructure lock-ins, resistance to behavioural and cultural changes, institutional inertia, trade-offs with competing social and political objectives, and the cost and availability of reliable renewable energy technologies and materials (Denton et al., 2022). The transition to a low-carbon economy is often hindered by lock-ins and path dependencies. Lock-ins occur when existing technologies and systems become dominant and resistant to change due to factors like infrastructure investments, economic interests and social norms. Path dependencies arise from historical choices and decisions that limit future options, making it difficult to deviate from established paths (Goldstein et al., 2023). Other barriers include institutional challenges such as inadequate coordination and policy inconsistencies, political obstacles like short-term planning and resistance, and social and cultural barriers such as resistance to change and lack of social acceptance (Burch, 2010; Simonet and Leseur, 2019; Moosavi et al., 2023). Conversely, the factors that can hinder a transition can also be turned around and used to support and facilitate the transition. This can be done by transforming barriers into enablers by addressing the underlying causes of the obstacles and implementing strategies to overcome them (Burch, 2010). By leveraging drivers and enablers, actors can overcome barriers and promote effective action on climate change.

Essential factors that enable and leverage the transition include individual and collective actions, such as strong leadership and education (see Chapter 8); drivers like financial, material, social and technical support that encourage innovation; effective national and regional systems that promote the spread of new technologies; supportive policies and governance structures at various levels that allow for flexibility and coherence; efforts to address and overcome the equality challenges associated with the transition; and comprehensive, long-term planning that aims to achieve synergy between climate change and sustainable development, while avoiding trade-offs (Denton et al., 2022). In this volume, the factors that can enable transformations are organised into three main categories: finance and innovation (see Chapter 6), governance and policy (see Chapter 7) and people (see Chapter 8). This broad classification also encompasses other aspects, including research, education, communication and equity.

1.4.2. Benefits of near-term planning for climate action

Choices made, and actions implemented, in the near term will determine the magnitude and the rate of climate change (IPCC, 2023b). The Synthesis Report of the IPCC Sixth Assessment Report highlights the benefits that would arise from deep, rapid and sustained mitigation and accelerated implementation of adaptation actions taken this decade, including reduced losses and damages for both human and natural systems and many co-benefits for human health and wellbeing (IPCC, 2023a). Accelerating adaptation implementation can enhance benefits, including improving agricultural productivity, innovation, health and wellbeing, food security, livelihoods and biodiversity (IPCC, 2023a). However, implementation times for adaptation are long, and so it is important to close existing gaps, in the near term, to ensure those benefits. Accelerating mitigation can provide benefits for health, primarily though reducing air pollution, increasing active mobility and shifting people towards sustainable healthy diets (IPCC, 2023a; see Chapter 5). Economic benefits that come from near-term improvements in air quality and health are of a similar or greater magnitude as mitigation costs before considering the avoided economic, social and environmental benefits of limiting warming to 2°C (IPCC, 2023a). Accelerating mitigation and peaking emissions sooner allows for more co-benefits and reduces feasibility risks and cost in the long term, but requires more upfront investment (IPCC, 2023a). Adaptation options that are feasible and effective today will become less effective as the impacts of climate change intensify (IPCC, 2023a).

1.4.3. Benefits of long-term planning for climate action

A long-term strategy stabilises the regulatory environment for climate action, giving rise to investor, business and community trust, and enabling sustainable investments across sectors (IEA, 2021). A carefully thought-out plan is vital to transition from fossil fuels to greener energy sources and to build resilience within systems. With long-term planning, the power system can expand in a way that is compatible with increased renewable energy (Fay et al., 2015). The lack of long-term planning when policy packages are under development may result in increased risk of carbon lock-in. This makes it more difficult to achieve the high levels of mitigation necessary, for example investing in new gas infrastructure (IRENA, 2017). In addition, considering land-use changes is essential for both restoring natural habitats and enhancing carbon storage in forests and peatlands (see Chapter 2).

Aligning short-term targets with long-term goals can reduce mitigation costs by four times more than if there was no long-term strategy (Vogt-Schilb and Hallegatte, 2014; Falduto and Rocha, 2020). However, focusing solely on the immediate targets can overshadow long-term necessities, like substantial infrastructure projects, which could lead to challenging economic transitions down the road (IEA, 2017). Without weighing the far-reaching impacts of all policies, genuine transformative change is unlikely (Falduto and Rocha, 2020). Clearly defined transition pathways, inherent to long-term planning, facilitate the move to low-carbon, resilient systems, pinpointing key steps, milestones and measures to reach climate objectives (Hölscher et al., 2020). By offering clarity, it minimises disruptions, aids sectors in transformation strategies and garners broader support for changes like the just transition (Campos et al., 2016).

Strengthened institutional capacities at multiple governance levels further underpin effective planning (Hölscher et al., 2020). Collaboration across government sectors, focus on climate units and consistent engagement with various stakeholders can streamline policy execution. For informed decision making, scenario analyses that weigh varied drivers are vital, as recommended by the IPCC (2022c; see sections 6.2.4 and 7.3). Policy stability, a by-product of foresight, boosts business confidence in climate solutions, spurring technological progress and investments (Bolton and Foxon, 2015). With defined market signals for clean energy and sustainable practices, an innovative environment emerges, promoting research and

technology deployment. Furthermore, long-term perspectives ensure preparedness against climate change impacts, fortifying resilience in susceptible sectors and communities (Campos et al., 2016). Such planning can allow Ireland to anticipate and develop strategies against climate threats, integrating these considerations into diverse areas like infrastructure, water and agriculture (see section 7.3.4). Long-term planning in adaptation can not only provide benefits when disaster strikes, but unlock economic potential and development co-benefits (Tanner et al., 2015).

1.4.4. Synergies and trade-offs

While the focus of this volume is the benefits and opportunities that come with change, synergies and trade-offs[6] are explored as a framework that allows a systematic identification of benefits. Understanding and optimising synergies and managing trade-offs are essential for getting the most from the choices that are made to bring about change, while enhancing human wellbeing and societal gains, alongside environmental and economic gains.

The concept of synergies and trade-offs is used within the IPCC Sixth Assessment to assess options in a systematic and qualitative manner, where evidence is available, and to better understand dependence of interactions (IPCC, 2023b; see Figure 1.4). Such a framework could be employed to develop an integrated process for the mapping, assessment and management, at local, regional and national level, of synergies and trade-offs both associated with, and between, mitigation and adaptation actions in Ireland.

It is not always clear what the effects of climate action will be and whether there are synergies between policies and measures related to other objectives, for example potential synergies between renewables and biodiversity or nature restoration and job creation. This is also true for trade-offs, although research suggests that synergies outweigh trade-offs when it comes to mitigation, adaption and sustainability, including in near-term synergies in energy, land and urban systems (Rogelj et al., 2018; Ara Begum et al., 2022; Grubb et al., 2022; IPCC, 2023b). Nonetheless, it is important to identify trade-offs and manage them to enhance outcomes where possible. Working systematically towards synergies may also minimise trade-offs.

This volume primarily focuses on the benefits and opportunities of transformation, with less of a focus on trade-offs, although they will be addressed where relevant. This approach allows the identification of synergies between actions on climate, biodiversity and equity alongside the wider benefits to society and the economy. Synergies can be powerful enablers of just transitions, allow deeper and faster climate action and strengthen societal ambition through equity and inclusion (IPCC, 2023b). Integrated cross-sectoral policies and planning can help maximise synergies and manage trade-offs between mitigation and adaptation, and with consideration of equity and inclusion can reduce trade-offs with sustainable development (IPCC, 2023b).

It was beyond the scope and timeline of this volume to make a comprehensive and systematic assessment of all the synergies and trade-offs related to climate action and transformative change in the Irish context. Some of the main synergies that are covered within this volume include working on climate change and biodiversity loss together (see Chapter 2), climate action and societal gain (see Chapters 3–6). Benefits have been identified, in the relevant chapters, where there is evidence to do so. It should be noted that many benefits associated with action on climate mitigation and adaption are identified throughout previous volumes of this report (see Volumes 1–3).

[6] A synergy is when the combined effect of different actions, e.g. action on climate and action on biodiversity, becomes greater than the sum of those individual actions. A trade-off is a competition between different objectives within a decision situation, where pursuing one objective will diminish the achievement of other objectives and has the potential to reduce any net benefit to society or the environment (IPCC, 2022a).

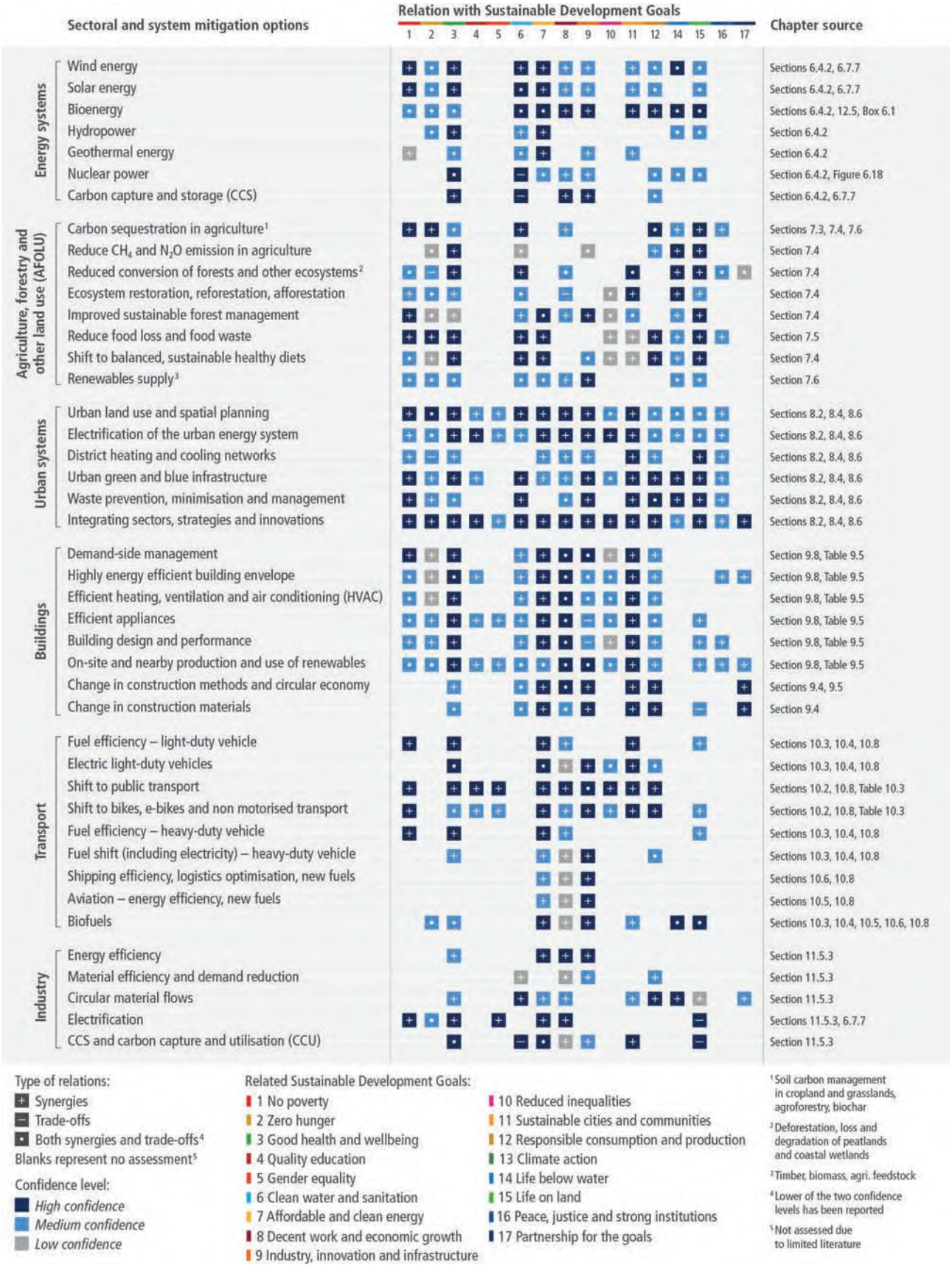


Figure 1.4 Synergies between sectoral and system mitigation options and the Sustainable Development Goals. Source: IPCC (2022d; their figure SPM.8).

1.5. Research gaps

Transformative change in the Irish context. Since 2005[7], literature on transformative change has undergone considerable development internationally (Moore et al., 2021). Literature that directly considers transformation in Ireland is at an early stage of development, as is the wider literature that considers related topics. This limits the specific conclusions that can be made for Ireland beyond general conclusions, that, in many cases, apply from international literature. The limited availability of research on transformative change for Ireland points to a huge gap in understanding related to (1) how transformative change can work in the Irish context, (2) how to optimise the benefits, opportunities and synergies associated with transformative change and (3) the role of transformative change in delivering a prosperous Ireland for all. Research will be required across all systems, and contributions from, and collaboration between, science, technology, engineering and mathematics (STEM) and arts, humanities and social sciences (AHSS) disciplines will be necessary if this research gap is to be addressed.

Role of wellbeing and equity in achieving intergenerational sustainability. Research is required to better understand the role of wellbeing and equity in achieving intergenerational sustainability in Ireland. What can be learnt from other countries where wellbeing and equity have become central to policymaking and long-term strategic decisions? How has this affected sustainability outcomes? How could wellbeing and equity become substantive as opposed to peripheral in Irish policymaking? How can progress on transformative change — that is rapid and systemic — be measured and assessed? These are all potential areas for investigation.

Underlying drivers. A better understanding of the connected underlying drivers (institutional, demographic, technological, economic, governance and sociocultural) of climate change and biodiversity loss in Ireland is necessary if these drivers are to be addressed and transformative change achieved.

Research will be necessary to identify drivers (behavioural, sociocultural, business and corporate, institutional and infrastructural) that act to maintain the status quo, in relation to mitigation and adaptation, in Ireland and to deliver the solutions that turn those barriers into enablers of transformative change.

Synergies and trade-offs. A comprehensive mapping of synergies and trade-offs for climate change (mitigation and adaptation), biodiversity loss and sustainable development, in the Irish context, could highlight areas where synergies can be identified and enhanced to augment benefits and opportunities, while potential trade-offs can be identified and managed to reduce their impact.

Integration. Research is needed to support developing an integrated, across all domains, sectors and systems, long-term strategic plan for Ireland that puts sustainability (including climate change and biodiversity loss), equity and wellbeing at its core. Research on how near-term planning and actions can enhance benefits and opportunities and how long-term plans can influence planning and action in the near term is also necessary if the gap between climate ambition and action is to be closed.

[7] This is the year identified by Moore et al. (2021) as significant, as this is when transformation-related terms commenced growing exponentially in the literature.

2

Transforming Landscapes

Key messages

Transformative change across multiple systems interconnected in the landscape offers a myriad benefits and opportunities in the fight against climate change and biodiversity loss, with wider gains for society and the economy. Of all transformations, inappropriate land management can have 'severe and unintended consequences', particularly for biodiversity loss, with implications for climate action and society. While conflicting land-use objectives cannot be avoided, decisions that maximise synergies while managing trade-offs can significantly reduce conflicts while enhancing benefits and opportunities. A long-term integrated strategy for land-use management is necessary if this is to be achieved.

Climate change and biodiversity loss share many underlying drivers related to unsustainable resource use, including the use of land. Tackling these crises together enhances synergies while managing the trade-offs that exist between them. Social benefits include sustainable job creation and the protection and enhancement of human wellbeing. Such benefits aid the social transformation required to enable action on climate change and biodiversity loss.

If planned and managed in an appropriate manner, carbon stores on land can be maintained and enhanced. Afforestation is a cost-effective and scalable option for carbon removal. There is an emerging industry and bioeconomy around forestry in Ireland. Forests have the potential to become centres for cultural heritage, craftmanship, traditional knowledge and innovation, alongside diversifying livelihood options in rural communities.

Nature conservation (immediate benefits) and restoration (longer-term benefits) are cost-effective, enhance carbon removals and reduce vulnerability and strengthen synergies between mitigation and adaptation actions. Benefits include improved food security, nutrition, health, wellbeing, support for livelihoods and sustainability and ensuring nature's contributions to people.

2.1. Introduction

Landscapes are the source of all nature's contributions to people, providing clean air and fresh water, food and materials, controlling disease and pests and moderating extreme events (Millennium Ecosystem Assessment, 2005; Pascual et al., 2017). They are also a source of amenity, cultural and natural heritage, spirituality, mental and physical health and education, alongside nature having its own intrinsic value (Millennium Ecosystem Assessment, 2005; Pascual et al., 2017; see Figure 2.1). For thousands of years, the rural and coastal landscapes of Ireland have been shaped by choices related to producing food, feed, fibre, fuel and fresh water, without which society and the economy would not exist (Glassie, 2014; Arneth et al., 2019). The choices made in the coming years have the potential to transform the landscape. It is possible for landscapes to play a central role in tackling climate change and biodiversity loss, while also acting on food insecurity, declining water quality and the energy crisis (Scott et al., 2016; IPCC, 2019; Pörtner et al., 2021). That said, conflicting land-use objectives are unavoidable. However, decisions that maximise synergies, while minimising and managing trade-offs, can reduce such conflicts (see Box 2.2).

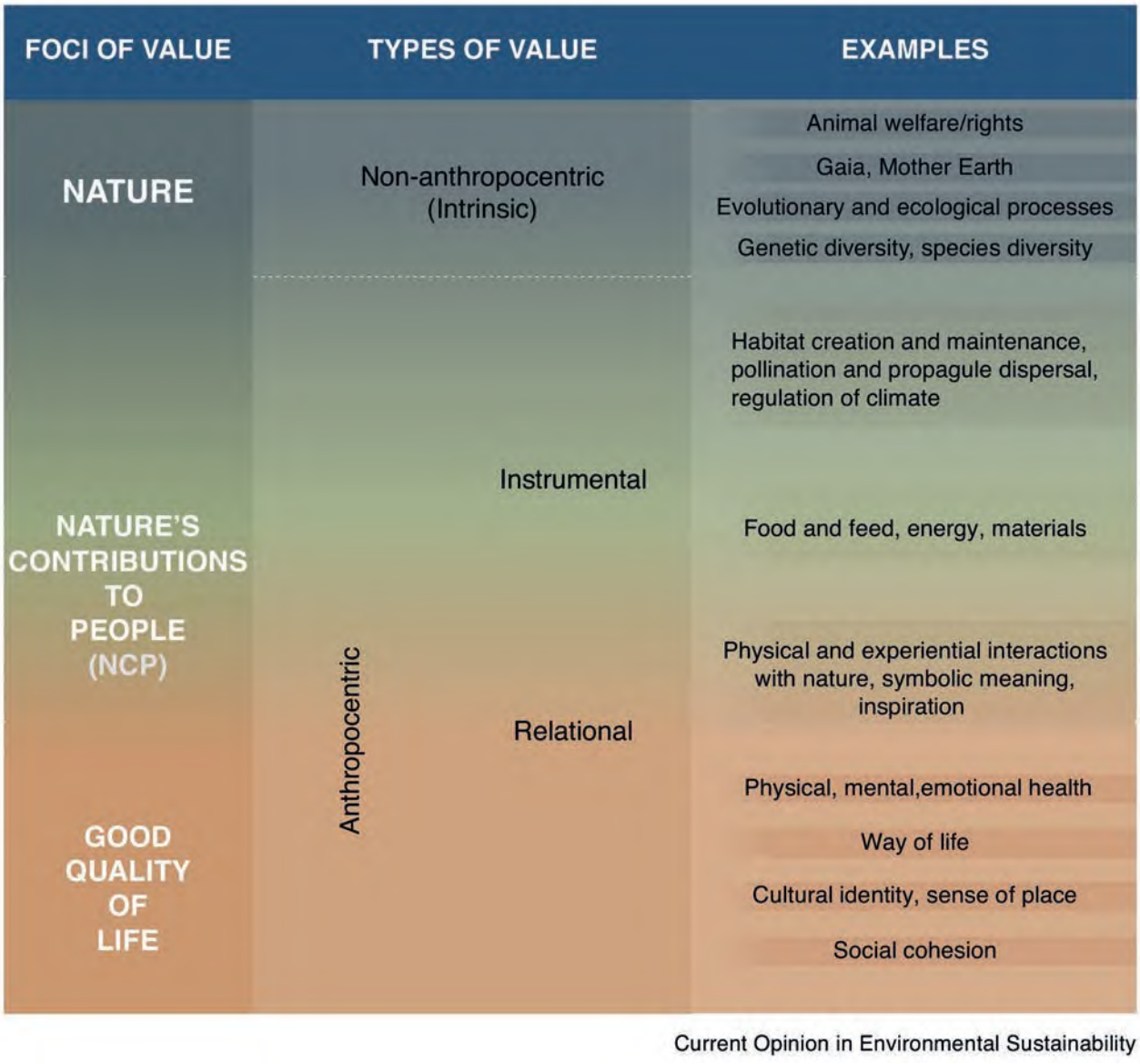


Figure 2.1 Nature's intrinsic value and nature's contributions to people. Source: Pascual et al. (2017). Reproduction licensed under the Creative Commons Attribution CC BY-NC-ND 4.0 licence (https://creativecommons.org/licenses/by-nc-nd/4.0/).

A transformative reshaping of Irish landscapes is required if the vision of a climate-neutral, biodiversity-rich, sustainable and resilient Ireland, as set out in the national climate objective (Government of Ireland, 2021a) and obligations under EU law and the Paris Agreement, are to be achieved. This is no small task and incremental changes are not sufficient (Haughey et al., 2023). There is evidence to suggest that elements of transformative change are emerging, particularly in policy and planning related to landscapes in Ireland. However, it should be noted that the time that remains to enact significant change and avail of opportunities that landscapes have the potential to provide is running out, and the time for action is now (IPCC, 2019, 2023b).

2.1.1. Dual crises: climate change and biodiversity loss

Like climate change, addressing the global biodiversity crisis also requires urgency. Humans are part of nature, and a stable climate and healthy environment, with functioning ecosystems, are essential for human wellbeing and the foundation upon which society and the economy are built (IPBES, 2019b; Dasgupta, 2021; IPCC, 2022a). There is a lack of awareness of the vulnerability of society and human wellbeing to biodiversity loss and damage to ecosystems. Changes to climate and biodiversity because of human activities are a grave threat to the life support systems necessary for human survival (Díaz et al., 2019; Pörtner et al., 2021; Uitto, 2022; see Volume 1). Both crises diminish society's capacity to act, for example climate change both causes and exacerbates biodiversity loss, which affects society's ability to protect nature and biodiversity (Bulkeley et al., 2020; Pörtner et al., 2021; see Volumes 1 and 3), while biodiversity loss affects society's ability to act on climate change, by reducing the capacity of forests and soils sequester and store carbon (Pörtner et al., 2021; Haughey et al., 2023). Biodiversity loss will also affect society's ability to adapt, as nature's contribution to people includes moderating the frequency and intensity of climate impacts (McVittie et al., 2018).

These crises are inextricably linked through shared human drivers, direct and indirect (see Chapter 1, Figure 1.3), mutual reinforcement and the predominantly negative impact they have on human wellbeing. However, tackling them together is an opportunity to optimise the strong synergies that exist, not only between action on climate change and biodiversity loss, but also in considering how solutions will affect society (Pörtner et al., 2021). For example, restoring ecosystems on land and at sea provide opportunities for climate mitigation and conservation. They are also cost-effective and can provide social benefits, such as job creation, and other economic benefits (Pörtner et al., 2021). This aids the transformative societal change that is required to limit global temperature increases, reverse biodiversity loss and achieve good quality of life (Pörtner et al., 2021). On the other hand, if climate change and biodiversity are not tackled together then this can lead to severe unintended consequences with the potential to exacerbate both, with detrimental impacts for society and the economy. A transformative approach can safeguard human wellbeing, today and in the future, while enhancing resilience and strengthening rural communities.

2.1.2. The need for transformative change

Agricultural practices and land use, land-use change and forestry (LULUCF) activities not only contribute to climate change, but also have significant impacts on the environment at large. Agriculture and forestry, when managed unsustainably, can be detrimental to water quality because of nutrient and sediment runoff and pesticide contamination (EPA, 2020). A wide range of species and habitats are also affected by land-use change, including agriculture, extraction of resources (peat and minerals) and forestry (NPWS, 2019).

Forestry accounts for 808,848 hectares (ha), 11.6% of land cover in Ireland (DAFM, 2023a), compared with an EU average of 35% (Eurostat, 2021). Most peatlands (85%) have been damaged and only 20% remain of conservational value (Wilson et al., 2013; Renou-Wilson et al., 2019). The status of biodiversity in Ireland on land, at sea and in protected areas is poor (NPWS, 2019; Environmental Performance Index, 2022; Gorman et al., 2023). Just 13% of Irish land area is designated for biodiversity protection, compared with a 26% average across the EU (Eurostat, 2022).

Rebalancing environmental, social and economic priorities will be necessary to (1) tackle the indirect drivers of climate change and biodiversity loss, (2) maintain and enhance carbon sinks within Irish landscapes, (3) conserve and restore ecosystems and (4) enhance the benefits and opportunities for society and the economy. The speed, scale and depth of the change required means that rural communities will need to adapt. There are some groups, particularly those working in extractive industries and in emissions-intensive agricultural activities, where fundamental changes to livelihoods will be necessary. This is a systemic issue. High-level policy levers will be required to change the operational preferences of companies towards sustainable business models to ensure that they can continue to support local communities and local livelihoods. This highlights the need for a just and equitable transition for all, especially those at the forefront of change.

2.1.3. Pathways to a climate-neutral and biodiversity-rich landscape

Under the Paris Agreement and the European Climate Law, Ireland has a commitment to rapid and deep reductions in greenhouse gas emissions[8]. As it will not be possible to eliminate all greenhouse gas emissions, Ireland will also need carbon removals to achieve balance between emissions from sources and removals by sinks. If rapid, deep and sustained reductions in emissions are not achieved in the near-term, addressing any overshoot of the Paris Agreement's 1.5°C and 2°C temperature goals will require greater net-negative emissions (see Volume 2, Chapter 7). In the near term, it is the land sink, through land management, forest management (10 years) and afforestation (10–20 years), that will provide these emissions reductions (Smith et al., 2023). This chapter focuses on enhancing 'conventional'[9] CO_2 removal (CDR) through natural processes, which are responsible for 2 billion (or gigatonnes (Gt)) of CO_2 global removals per year, as opposed to 'novel'[10] processes, which are responsible for 0.002Gt of CO_2 global removals per year (Smith et al., 2023). All existing research related to CDR in Ireland has been comprehensively assessed in Volume 2, Chapters 1, 4, 7 and 9.

The Climate Action and Low Carbon Development (Amendment) Act 2021 sets out a 51% target for emissions reductions across all sectors, by 2030, with a baseline of 2018 (see Volume 2, Chapter 1). The 2030 target is split into two 5-year carbon budgets proposed by the Climate Change Advisory Council, while sectoral ceilings have been set by the Government. Agriculture's sectoral ceiling is set at 25%, which translates to cutting agricultural emissions from 23MtCO_2-eq per year, in 2018, to 17.25MtCO_2-eq per year, in 2030. Each 5-year carbon budget for agriculture has a cumulative allowance of 106MtCO_2-eq, between 2021 and 2025, and of 96MtCO_2-eq, between 2026 and 2030. The sectoral ceiling for LULUCF has not been decided[11,12], but a 37–58 % reduction in emissions is presented in the 2021 Climate Action Plan (DECC, 2022a). For the second carbon budget, there is also a 5.25MtCO_2-eq of unallocated savings, in recognition that it is not yet possible to identify all the solutions that will assist Ireland in achieving its full ambition (DECC, 2022a).

There is debate around whether or not the budgets proposed satisfy the (1) temperature, (2) equity and (3) "common but differentiated responsibilities and respective capacities" goals of the Paris Agreement (Jackson, 2022; McMullin and Price, 2022), and suggests that Ireland as a developed country needs to do more to satisfy its obligations. This is relevant as it could be argued that Ireland's carbon budgets and sectoral ceilings, decision on the LULUCF outstanding, is the minimum level of mitigation required, which helps to put the scenarios presented in the next section into context.

While there is debate about how strict carbon budgets should be, cumulative budgets to 2025 and 2030 are already highly constrained. The less action that is taken in the near term, the more constrained carbon budgets will be. Achieving the emissions reduction target in any 1 year is not sufficient. It is the cumulative total for each 5-year budget that is significant. Any budget overrun in the first carbon budget, 2021 to 2025, is to be carried forward and reduces the second carbon budget, 2026 to 2030 (An Taisce, 2023a, 2023b). To date, around 45MtCO_2-eq of the first budget has been spent, with emissions in the sector projected to increase (EPA, 2022a). Alongside even greater reductions in emissions that will be required in all sectors if the carbon budgets are to be achieved, land management, including the protection, restoration and enhancement of the land sink, is a significant and essential component of delivering on highly constrained carbon budgets in the short and long terms. The challenge is even greater, considering that emissions from agriculture and LULUCF increased in 2021 (EPA, 2023b; see also Volume 2, Chapters 2 and 6). There is not enough evidence to quantify the extent of negative emissions that may be required to 2050 in Ireland (see Volume 2, Chapter 7).

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[8] Carbon dioxide (CO_2) and nitrous oxide (N_2O) and other long-lived climate forcers will require deep and rapid reductions and any remaining emissions balanced by carbon removals. Methane (CH_4) will also require deep and rapid reductions, but will not have to be reduced to zero because it is a short-lived climate forcer (see Volume 1).

[9] Methods that capture and store carbon in the land reservoir and reported on a national level to the United Nations Framework Convention on Climate Change under LULUCF activities, including afforestation/reforestation, soil carbon in croplands and grasslands, peatland and wetland restoration, agroforestry, improved forest management and durable harvested wood products. (Smith et al., 2023).

[10] All other methods that store carbon in the lithosphere and ocean or products that are deployed at smaller scales (Smith et al., 2023).

[11] At the time of publishing this report.

[12] Unlike the national sectoral emission ceiling approach in Ireland, the EU treats the LULUCF sector differently, because of its underlying complexity in relation to its greenhouse gas profile, from other sectors and does not include it as part of the EU Effort Sharing legislation. Instead, the EU has developed a specific regulation for LULUCF to set out targets. A new EU-wide target of 310MtCO_2-eq by 2030 will be implemented through ambitious, fair and binding net removal national targets for the LULUCF sector (European Union, 2023).

In relation to biodiversity, Ireland has commitments under the Convention on Biological Diversity. Biodiversity had a 'Paris Agreement moment' with the adoption of the Kunming–Montreal Global Biodiversity Framework at the Conference of the Parties 15 (COP15) in December 2022. Almost 200 countries agreed to set goals and targets to 'halt and reverse' biodiversity loss by 2030, and an ambition to conserve 30% of the world's land and 30% of the ocean by 2030. The agreement includes a target to identify and phase out or reform incentives and subsidies that are harmful to biodiversity. In June 2023, the European Council reached agreement on its proposed Nature Restoration Law. This law proposes conservation measures covering 20% of land and 20% of seas by 2030, and all ecosystems in need of restoration by 2050. This complements the EU 2030 Biodiversity Strategy, to legally protect a minimum of 30% of the EU's land areas and 30% of sea areas, and integrate ecological corridors (European Commission, 2023).

Box 2.1 Ireland's 'fair share' of methane reduction

While rapid, deep and sustained reductions in CO_2 emissions, that is emissions from burning fossil fuels, are necessary to limit and in the long term halt climate change, the UN has called cutting CH_4 emissions "the strongest lever we have to slow climate change over the next 25 years and also points to many co-benefits for air quality, food security and jobs (United Nations Environment Programme, 2021). Scenarios produced by the IPCC indicate that global CH_4 emissions must fall by around 50–60% by 2040 for a pathway consistent with limiting global temperature rise to 1.5°C (Rogelj, 2021). Reductions in CH_4 emissions are necessary if Ireland's statutory carbon budgets and commitments under the Paris Agreement are to be achieved. Ireland and the EU have also signed up to the Global Methane Pledge, which aims to collectively reduce CH_4 emissions by 30% between 2020 and 2030.

A 'fair share' approach to calculating the necessary reduction in Ireland's biogenic CH_4 quota suggests a reduction of between 30% and 80% by 2050, relative to 2010 levels (Prudhomme et al., 2021). Annual reductions of 2.2% per year between 2020 and 2050 would be sufficient to achieve a 50% reduction in CH_4, and these small but sustained rates could make it easier to meet Ireland's carbon budgets (McMullin and Price, 2020). The question of what is a national 'fair share' of CH_4 reduction is not developed in the academic literature and Ireland, as a country with high CH_4 emissions, relative to population, and strong decarbonisation ambition, is facing this question sooner than others. It should be noted, especially in relation to scenarios developed in Haughey et al. (2023), that excluding CH_4 emissions from net zero greenhouse gas calculations assumes that ambitious reductions in CH_4, which align with global temperature stabilisation, will occur (Huppmann et al., 2018; Styles and Duffy, 2021). If appropriate reductions in CH_4 do not occur, then much larger carbon removals, that is afforestation rates by 2050, would be necessary to balance these CH_4 emissions (Styles and Duffy, 2021). From a global perspective, if CH_4 emissions are not reduced as much as required to avoid additional warming and limit temperature increase to 1.5°C, CO_2 emissions would have to reach net zero before 2030, 20 years earlier than planned (Reisinger and Leahy, 2019).

The EU's long-term goal is net zero greenhouse gases, based on a global warming potential (GWP_{100}[13]), by 2050. The approach to CH_4 in the draft long-term strategy (DECC, 2023) is not aligned with EU net zero and it is not clear if it is aligned with requirement for net zero under Irish Climate Act. The uncertainty around 'significant reduction' in the draft Long-term Strategy is problematic.

The Climate Action Plan 2023 has set out several measures to reduce agricultural CH_4 emissions, including lowering the slaughter age for beef and breeding animals for low-CH_4 traits (Government of Ireland, 2022; for a comprehensive assessment see Volume 2). The plan also includes measures that support farmers to diversify farm activities, including alternative land uses. Such alternatives include (1) producing biomethane from grass, (2) increasing tillage area, (3) reducing the intensity of production on organic soils in order to increase the water table and (4) increasing the area under organic farming, and afforestation.

[13] GWP_{100} allows the comparison of the warming effects of greenhouse gases such as CH_4 and N_2O to that of CO_2 on a per-molecule basis over a 100-year time span (see Volume 1, Chapter 2).

2.1.4. Scenarios for agriculture and land systems

Global pathways that aim to limit global temperature rise to 1.5°C by the end of the century are explored in the IPCC Special Report on 1.5°C (Rogelj et al., 2018). When these pathways include climate mitigation actions that require land, it is projected that (1) the amount of land used for food and feed production will be reduced and some biomass will be grown on marginal land, (2) second-generation bioenergy crops will expand, while deforestation decreases and afforestation and reforestation increase, which means less space for agricultural expansion, (3) if reforestation is used for carbon removal, then forest cover stays constant or contracts slightly, (4) pasture and cropland, for food and feed, are projected to decrease and (5) reductions in land available for agriculture are compensated by intensification on the land that is available to agriculture and in livestock production systems (Popp et al., 2017; Rogelj et al., 2018).

Scenarios for achieving net zero greenhouse gas emissions in agriculture and land use have been developed by Haughey et al. (2023; see Box 2.2) and other recent studies (Duffy et al., 2020; Styles and Duffy, 2021; Duffy, C. et al., 2022a, 2022b). These studies suggest that while achieving a pathway to net zero greenhouse gas emissions in Ireland is challenging, in particular as the LULUCF sector is a source of emissions, a pathway to net zero is possible, at least within the biophysical limits of the land system. These scenarios demonstrate what potential transformative pathways could look like in Ireland and the level and type of change that would be required to achieve not only climate neutrality, but to make space for nature as well.

These scenarios are only some of the possible options available to mitigate emissions and adapt agriculture, forestry and other land use to climate change. An assessment of potential response options is presented in Haughey (2021) and a comprehensive assessment of model scenarios associated with agriculture and land use are covered in Volume 2. While a reduction in herd numbers, rewetting of soil, afforestation and making space for nature, as suggested in Haughey et al. (2023), are all 'technically' possible and have the potential to transform agriculture and land-use systems in Ireland, much research is required to draw out both the synergies and the trade-offs, not just between climate and biodiversity, for example, but across all of society and the economy.

Box 2.2 Land-use review and land cover database

The strategic management of competing claims on land is being developed in Ireland, with the aim that "optimal land use options inform all relevant government decisions" (DECC, 2021). A national land-use review is being prepared to support the development of a land-use strategy (DECC, 2021; see Volumes 2 and 3). Phase 1 of the review provides evidence related to the environmental, ecological, social and economic characteristics of land use, providing a holistic view of land use in Ireland. The outcomes of this phase of the review were made public[14] in March 2023. Phase 1 will provide the evidence base to inform Phase 2. During the second phase, there will be a consultation with all stakeholders to consider the policies and measures that will need to be developed and implemented to achieve the Government's wider climate, environmental, social and economic objectives.

The *Land Use Review: Fluxes, Scenarios and Capacity* (Haughey et al., 2023)[15] develops a set of scenarios, some of which achieve long-term, to 2050, net zero reductions in greenhouse gas emissions associated with agriculture, forestry and other land use (for origins and explanations see Volumes 2 and 3). It provides information on key components and the role they could play in developing a pathway to a carbon-neutral and biodiversity-rich landscape in Ireland by 2050 and forms the basis of the assessment in this chapter.

A high-resolution land cover database has been developed by the Environmental Protection Agency (EPA) and Ordnance Survey Ireland, and was delivered in 2023[16] (DECC, 2021; Haughey et al., 2023). The land-use review and land cover map will be key to developing a long-term land-use strategy, of which climate and biodiversity are key components, within a land management framework with the potential to understand how each parcel of land in Ireland can be utilised to maximise opportunities (see Volume 3). The EPA are also developing a land-use map to aid in delivering the national inventory report.

2.1.5. Synergies and trade-offs in agriculture and land-use mitigation options

There are many potential synergies between agriculture and land use and acting on climate (IPCC, 2022a). There are also synergies between mitigation actions in this sector and biodiversity loss, increased resilience and sustainable development (Denton et al., 2022). However, strategies are required to manage potential trade-offs that can result from misguided or inappropriate land management (Smith et al., 2014; Nabuurs et al., 2022). When climate change and biodiversity loss are tackled together, it is possible to systematically identify synergies and trade-offs between the actions taken.

The synergies and trade-offs presented in Figure 2.2 demonstrate that synergies outnumber potential trade-offs. When considered in a more detail, even when strong synergies exist, there are caveats related to how to optimise these synergies. For example, restoration of exploited peatland is deemed as 'widely beneficial'; however, restoration activities are likely to be site specific. There are also considerable uncertainties associated with some types of land-use change, for example in relation to raising the water table in grassland settings and how that affects productivity and land management. When it comes to trade-offs, identification can lead to minimisation and management. For example, increases of livestock density on grasslands are likely to have detrimental effects on water quality, but there are simple actions, such as removing access to waterways, that can reduce those effects.

[14] The outcomes from Phase 1 of the Land Use Review can be found at the Department of Agriculture, Food and the Marine and the Department of the Environment, Climate and Communications: https://www.gov.ie/en/publication/f272c-land-use-review-phase-1/#

[15] Research commissioned by the EPA to inform the National Land Use Review: https://www.epa.ie/publications/research/evidence-synthesis-reports/evidence-synthesis-report-3.php and https://www.epa.ie/publications/research/evidence-synthesis-reports/evidence-synthesis-report-4.php

[16] Ordnance Survey Ireland and EPA Land Cover Map: https://osi.ie/products/professional-mapping/national-land-cover-map/

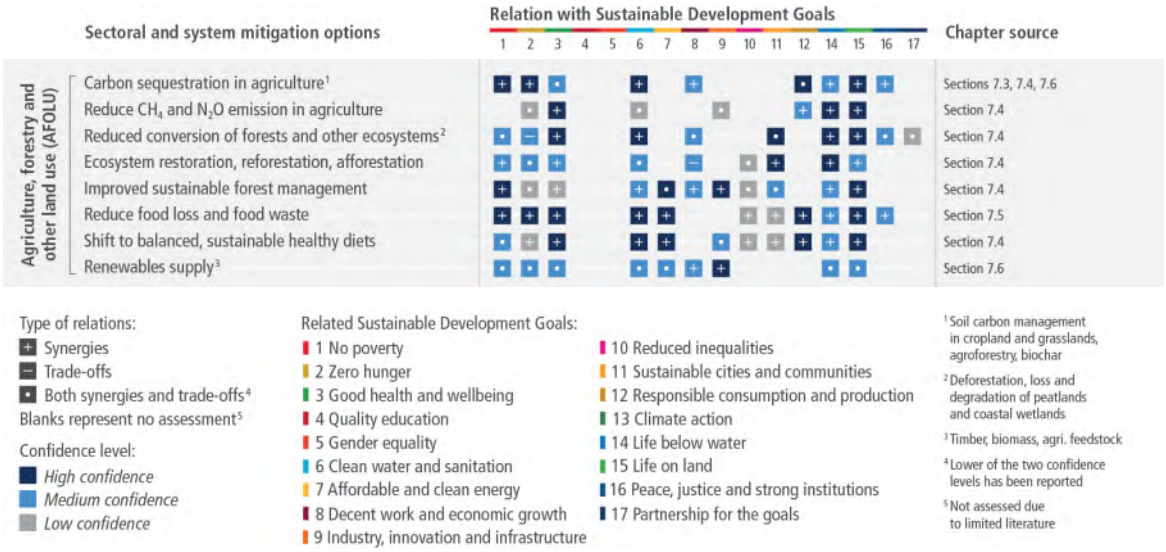


Figure 2.2 Synergies and trade-offs, as identified in the most recent IPCC Sixth Assessment Report by Working Group III. Source: Adapted with permission from IPCC (2022b; their figure 17.1).

Significant synergise exist between adaptation and mitigation, particularly in relation to agriculture and sustainable land management, and can provide immediate benefits, including enhanced food security, nutrition, health and wellbeing, support for livelihoods and biodiversity, and sustainability, and ensuring natures' contributions to people (IPCC, 2019, 2023a). Natural regeneration can be an important benefit for adaptation, optimising synergies with mitigation. For example, making space for rivers can reduce vulnerability to flooding, increase biodiversity, restore natural systems and increase community wellbeing, by providing a green amenity while maintaining and enhancing carbon reductions and removals and strengthening the resilience of carbon stores (Warner et al., 2012).

Nature-based approaches are strategies that address societal challenges, address biodiversity loss and increase human wellbeing (Cohen-Shacham et al., 2016; Pörtner et al., 2021; see also Volume 3). As part of these approaches, mitigation and adaptation actions meet biodiversity actions to strengthen synergies and reduce trade-offs (Seddon et al., 2020). Nature-based approaches have the potential to tackle climate change and biodiversity loss while contributing to sustainable development, making them powerful and attractive actions (Seddon et al., 2020). However, there is the potential for trade-offs if approaches, such as afforestation, focus on only carbon storage (i.e. single species in an unsuitable area). This would not be considered a nature-based approach, as there are no wider benefits for biodiversity, human wellbeing or adaptation and there can be 'severe unintended consequences' in terms of biodiversity loss (Pörtner et al., 2021), which can in turn impact the viability of the mitigation actions.

Haughey et al., (2023) present a comprehensive assessment of the synergies and trade-offs related to the scenarios developed as part of that work (see Haughey et al. (2023) table 6.1). The assessment focuses on the synergies and trade-offs between land-use change, including (1) large scale afforestation, (2) peatland restoration and organic soil rewetting, (3) increases in agricultural efficiency, (4) changing livestock density, (5) additional space for nature, (6) using grasslands for bioenergy and (7) converting grassland to croplands, and climate action, biodiversity and water quality.

Alongside potential negative effects of mismanaging synergies and trade-offs related to land-use change and climate and environmental considerations, there are potential negative consequences of an unmanaged change. To avoid both, a long-term, integrated, whole of government, whole of society land-use management and planning strategy is required (Haughey et al., 2023). This will allow land use to be optimised and will maximise synergies. These large-scale changes in land use would also need to deliver on societal and economic changes as part of a wider sustainable development pathway.

Translating high-level national and sectoral policies and objectives to spatial scales relevant for land, climate and biodiversity, such as at the catchment, habitat and field level, can help ensure positive outcomes of a managed transformation (Valujeva et al., 2016; Haughey et al., 2023). Translating to scales relevant to those who will implement the changes, regional and local, particularly in the case of including communities in decision making, can bring transparency and engagement between

local communities and landowners and lead to a more comprehensive and integrated approach to finding solutions that work locally (Hurlbert et al., 2019; Murray, 2020; see Box 2.3).

2.2. The multiple roles of landscape

Human activities dominate Irish land use. Most land is dedicated to the production of livestock, mainly cattle and sheep (Teagasc, 2023). Forest area is predominantly used for producing timber. Under the current model, food, feed and fibre production is carbon intensive, reduces the ability of landscapes to sequester and store carbon, is in conflict with nature and limits adaptation. Transformation and diversification of landscapes to address climate change and biodiversity loss requires consideration of the multiple roles land currently plays, the optimisation of synergies and management of trade-offs between different activities. Integrated land-use policies and planning is needed to reconcile conflicting land-use objectives (Rogelj et al., 2018).

2.2.1. Food and feed

Irish land use is dominated by unsustainable and 'productive' uses, that is the production of food and animal feed, timber, fibre and energy as an alternative to fossil fuels[17]. Fifty-nine per cent of grassland in Ireland is used to feed cattle and sheep and an additional 10% is used to produce crops, mainly to produce livestock feed (Teagasc, 2023). Since joining the EU and the Common Agricultural Policy in 1972, food production in Ireland has focused on specialisation, intensification and concentration (Kenny et al., 2018; Walford, 2003). This, along with more than €50 billion from the Common Agricultural Policy, has resulted in Ireland becoming the sixth largest net exporter of fresh beef (Trade Map, 2022), the fourth largest dairy processor in Europe, holding 12% of global market for performance nutrition (O'Shaughnessy and Sage, 2016) and supplier of 12% of the world's infant formula (Fenelon and Tobin, 2019).

In 2021, dairy farms emitted 9.5 tonnes (t) CO_2-eq per hectare, while cattle and sheep farms emitted 4.7 and 4.1tCO_2-eq, respectively, and for tillage the value was 2.5tCO_2-eq per hectare (Buckley and Donnellan, 2021). These values do not include greenhouse gas emissions from land use or the 'carbon opportunity cost', that is the carbon that can be stored in the land, if it is taken out of productive use and natural vegetation allowed to grow, with the potential for carbon sequestration through ecosystem restoration (Hayek et al., 2020). Emissions and the carbon opportunity cost are largest in food production systems, with high land use, particularly beef and lamb (Schmidinger and Stehfest, 2012).

Haughey et al. (2023) and C. Duffy et al. (2022a) suggest that a transformation in land use is necessary if net zero emissions, in alignment with the Paris Agreement, and biodiversity goals are to be achieved. This research indicates that the land under agricultural production will need to be reduced to (1) make space for nature, which supports food production, (2) allow for the restoration of wetlands so that carbon stores can be protected and (3) increase forest area to enhance carbon sequestration. Typically, more profitable farm enterprises are associated with more greenhouse gas-intensive systems, which has created a trade-off between environmental and economic outcomes. Societal and environmental sustainability have been neglected in favour of economic progress (Fahy, 2020). The beneficiaries of the current model of production are large farms and agri-business, while small farms and people living in rural areas are losing out (Shucksmith et al., 2005; Hennessy and Moran, 2014; Matthews, 2016). Transformative change is also required to support people who farm and live in rural communities (see Chapter 4).

Change in food production systems and consumption patterns, including diets, are urgently required (Smith and Gregory, 2013; Clark et al., 2020; see Chapter 5). One way to achieve this type of change is with alternative proteins. Meat made from plants, cultivated from animal cells or derived from insects could be used to feed people and livestock in the future (Bezner Kerr et al., 2022). This emerging technology may lead to a reduction in the amount of land that is dedicated to grasslands and crop-based feed for livestock (Rosenzweig et al., 2020). Depending on the balance between the meat being substituted, the reduction in land use and the amount of energy being used to produce alternative proteins, it is possible that greenhouse gas emissions could be reduced (Rubio et al., 2020; Santo et al., 2020). In 2020, Teagasc, University College Cork, National University of Ireland, Galway, University of Limerick and Queens University Belfast, alongside 10 industry partners, received funding to the tune of €3 million from the Department of Agriculture, Food and the Marine to carry out a multi-disciplinary collaboration to investigate unlocking alternative protein opportunities to elevate nutrition in Ireland (Teagasc, 2020). This research has the potential to aid in transforming agriculture and land use and provide high-skilled and sustainable jobs in developing and delivering high-quality nutrition via alternative sources of protein in Ireland (Teagasc, 2020).

[17] The amount of land dedicated to non-fossil fuel energy sources in Ireland is currently small.

The Department of Agriculture, Food and the Marine's Food Vision 2030 uses system-wide transformation as a frame and food systems to organise the strategy (DAFM, 2022a). This includes consideration of the wellbeing of producers, but it does not extend to wider food system issues, for example hunger and food insecurity in Ireland or shifting consumption patterns towards healthier diets. Serious concerns have been raised in relation to claims of environmental sustainability[18] within the strategy (Emmet-Booth et al., 2019; Friends of the Irish Environment, 2022; O'Brien, 2022). While agricultural productivity takes priority in agricultural strategy, the Burren Programme (see Box 2.3) is an award-winning example of conservation (nature and heritage) and restoration of ecosystems on farmland in association with farmers and local communities in Ireland, rewarding farmers for improving biodiversity and demonstrating that there are huge opportunities for transformative change in developing projects like this.

Box 2.3 Burren (Farming for Conservation) Programme

Expert contribution from Brendan Dunford.

The Burren (Farming for Conservation) Programme (2010–2022) demonstrates the potential of local communities to act as stewards of their environment and heritage. Funded by the Department of Agriculture, Food and the Marine under the EU Common Agricultural Policy, and by the National Parks and Wildlife Service, it adopted what might best be summarised as a 'pocket, head and heart' approach to the conservation of natural and cultural resources by farmers.

The 'pocket' – or finance element – focused on a novel hybrid payment system for farmers: fields were scored from 0 to 10 based on their environmental health using a simple scorecard. Annual payments were linked to score, offering farmers a direct incentive to improve management while affording them freedom to innovate in doing so. Additional funding for conservation support actions – repair of walls, removal of invasive scrub, protection of water sources – was also available: nominated by farmers, these works helped address environmental challenges on the farm and thus improve annual scores and payments.

The 'head' refers to research, advice and support on how to 'farm for nature' and this was provided through a local office that not only advised on best practice – often based on innovations co-created with the farmers themselves – but also dealt with the significant bureaucratic workload involved in undertaking conservation work in protected landscapes such as the Burren. Feedback from farmers suggested that this local office – similar to a Teagasc office, offering advice on beef or dairy farming – was a key factor in their willingness to engage constructively with the programme.

The 'heart' refers to an often-overlooked issue: farmer engagement. Like all of us, a farmer will do a better job when he/she feels it is worthwhile and meaningful. Decades of innovative educational programmes in local schools, farmer-led walks, community 'tea-talks', farming festivals such as the Winterage Weekend – all organised by a local charity, the Burrenbeo Trust – helped farm families feel valued and respected and gave them ownership of an issue from which they typically feel excluded. In addition, under the Burren Programme, every effort was made to minimise paperwork for farmers, to simplify the language used, to take a practical approach and to allow them freedom to farm, all simple but significant ways of creating a more user-friendly experience for farmers.

The result-based scoring system employed by the Burren Programme suggests evidence of the positive impact of this approach, with consistent improvements in environmental health scores for 12 years across 23,000ha of prime Burren habitat. In addition, the programme cost of just over €1 million per annum suggests that these results have been achieved with relatively modest investment, representing value for money. The programme's landscape–scale and 13-year time frame means that it has much to offer in terms of learnings for other regions and for policymakers who seek a sustainable, scalable grassroots solution to the environmental challenges that lie ahead for Ireland[19].

[18] Both in Ireland and in relation to imports used in the Irish food system.

[19] www.burrenprogramme.com, https://burrenbeo.com, www.burrenwinterage.com

Box 2.4 Carbon leakage

The potential for a reduction in Ireland's dairy and beef production to be offset by an increase in production of these products in regions with a higher carbon intensity, a form of carbon leakage, is under discussion. The expansion of Irish food production and a consequent rise in greenhouse gas emissions has been rationalised on the basis for carbon leakage (Lanigan et al., 2018). However, there has been very limited research on the likelihood of carbon leakage in the Irish context, or on policy measures that can reduce the likelihood of carbon leakage. A review of evidence on climate mitigation in agriculture and land use for the Climate Change Advisory Council concluded that:

> ***leakage is likely to occur but there is insufficient evidence to provide a definitive answer to whether a reduction in agricultural production in Ireland will lead to a net increase in global greenhouse gas emissions. The balance of probability suggests that mitigation measures implemented with the support of subsidies, together with an extended range of mitigation options, would not increase global emissions (Emmet-Booth et al., 2019).***

This indicates a clear gap for research related to carbon leakage and also a need for an assessment of comparative efficiency of agricultural production systems across countries in order to be able to compare like with like in terms of outputs. Furthermore, research at the European level suggests that addressing agricultural greenhouse gas emissions from the consumption side, by reducing carbon-intensive foods (particularly meat) in diets, is an important mitigation strategy to avoid carbon leakage (Fellmann et al., 2018). This is consistent with the findings in Chapter 5, which show that dietary shifts in high-income countries are necessary for mitigation pathways consistent with the Paris Agreement commitments. Multilateral agreements, climate diplomacy and trade-related measures, such as import standards and border adjustment mechanisms, have been proposed to reduce the impact of carbon leakage (Matthews, 2022).

2.2.2. Energy and fuels

The area dedicated to renewables, on land and at sea, and to bioenergy will increase in response to the greater need for renewable energy. Under the second EU Renewable Energy Directive, Ireland is committed to increasing its renewable energy share from 13.6%, in 2022, to 34.1%, possibly 45%, under RePowerEU, by 2030 (SEAI, 2022). Requirements related to sustainability and greenhouse gas emissions savings are also needed to be fulfilled in relation to biomass, biogas and biofuels. These requirements are intended to assure sustainable land use, protect biodiversity, conserve ecosystems, and address the rights of workers and local communities and efficient use of resources (Mai-Moulin et al., 2021). While there have been significant developments related to sustainability, particularly in the EU, concerns about the impact the bioenergy sector on biodiversity, soil, water and land use remain (Mai-Moulin et al., 2021). Integrated environmental and economic research and policy are still lagging the rapid development of energy crops (Dauber et al., 2010).

The bioenergy scenarios developed by Haughey et al. (2023; see Volume 2) suggest that 420,000ha from grassland can be made available to bioenergy crops (grasses or fast-growing trees) while achieving net zero greenhouse gas emissions (including CH_4) by 2050. While land can be dedicated to bioenergy crops as part of this scenario, when CH_4 is included, ambitious afforestation (35,000ha per year) and rewetting of organic soils alongside reductions in livestock emissions and

numbers would also be required. When CH_4 is not included in the net-zero calculation, the only change is in the level of afforestation, which could be reduced (20,000ha per year).

From a nature conservation perspective, research by Santangeli et al. (2016) suggests that bioenergy is a major threat to biodiversity, while the threat from land-based solar and wind appears smaller. There are also concerns around biogas that is produced with a high share of grass sileage, which has negative environmental impacts (Beausang et al., 2021), and that leakage of CH_4 from biogas plants can offset greenhouse gas emissions savings (Bakkaloglu et al., 2022). In areas that have high potential for development of renewables and high levels of biodiversity, the potential for trade-offs is high. In Ireland, there are also biodiversity concerns related to the construction and decommissioning of renewable energy infrastructure and the land requirement for solar (Gorman et al., 2023). Increasingly, research focuses on solutions where solar can co-exist with farming if space is left underneath panels for grazing and food production (Schneider et al., 2023; Shivaram and Buckley Biggs, 2023).

Strategies for the effective management of bioenergy that draw out synergies and reduce the risk of trade-offs will be necessary if negative impacts are to be avoided (Fraanje et al., 2019). Food systems research suggests that agricultural production take a circularity approach, and this could be extended to bioenergy (de Boer and van Ittersum, 2018). Yet, there is no coherent framework to systematically approach synergies and trade-offs in this area. Research to date focuses on the competition between food, feed and fuel. In the main, biodiversity loss has not been incorporated as it is seen, by some researchers, to be more of a long-term issue, in contrast to food and energy, which are seen as short-term issues (Muscat et al., 2020). Careful and integrated land use and energy planning and implementation will be required to prevent further pressure on biodiversity from climate action, particularly in relation to developing renewable infrastructure and the associated changes in land use (Gorman et al., 2023; Shivaram and Buckley Biggs, 2023).

Box 2.5 Energy and planning

Ireland is committed to a 34.1% or 45% increase in renewable energy by 2030. A large part of that, 5 gigawatts, will be delivered through developing offshore wind. There have been several developments that will significantly enhance Ireland's capacity to develop offshore wind and enable the transformation of the energy system. These include development of the regulatory framework, the National Marine Planning Framework (NMPF), the Maritime Area Planning Act, including maritime area consent, and the establishment of the Maritime Regulatory Authority. Background work related to the infrastructure necessary to being offshore energy onshore is also being carried out for two main sites – the Shannon Estuary and the Port of Cork – both of which already have major energy infrastructure developed on site and extensive brownfield areas.

The enactment of the Maritime Area Planning Act (Government of Ireland, 2021c) and the publication of the NMPF[20] (Government of Ireland, 2021b), developed through extensive cross-sector and stakeholder engagement, lay a strong foundation for the strategic management of Ireland's extensive marine resources. The main aim of the NMPF is to balance the use and development of marine resources, for example offshore renewables and protection of the marine environment, and streamline the marine planning process. A Marine Protected Areas Bill has been proposed also so that sites can be identified, designated and managed as marine protected areas (see Volume 3, Chapter 2). These are important developments for both climate action and conservation of biodiversity and in creating opportunities for coastal communities.

Box 2.6 Bord na Móna: peatland regeneration and just transition

Expert contribution from Jamie Rohu.

Approximately 20.6% of Ireland comprises peatland (Connolly and Holden, 2009). These wetlands are at the centre of contemporary debates surrounding climate change, biodiversity loss and just transition. The latest estimate indicates that these ecosystems store over 2.2 billion tonnes of carbon (Renou-Wilson et al., 2022). Irish peatlands have been drained for hundreds of years to facilitate extraction of turf for domestic and industrial energy needs, with implications for uniquely adapted plants and animals, including sundews (*Drosera*) and curlew (*Numenius arquata*). Moreover, these activities lead to the release of harmful greenhouse gases into the atmosphere and adjacent watercourses.

There are two types of bog in Ireland. The blanket variety carpet entire landscapes. They are found in uplands and on the western seaboard, where rainfall is high. Raised bogs are mostly found in the midlands. They emerged from shallow lakes filled in by slowly decomposing aquatic vegetation. Feehan et al. (2008) estimate that as much as half had been cut away prior to the establishment of Bord na Móna in 1946, a state-owned peat company set up with a remit to provide rural employment and supply the nation with an indigenous source of energy. Like all fossil fuels, peat is a finite resource. Production bogs inevitably become exhausted, or 'cutaway'. Consideration of the subsequent use of these landscapes began shortly after Bord na Móna's founding (Mooney, 1958). Their conversion to agriculture and forestry proved uneconomic due to their low nutrient profiles and heterogeneity (Renou-Wilson and COFORD, 2008; Black et al., 2017).

[20] The maritime equivalent of the National Planning Framework.

Peatland rehabilitation, renewable energy and resource recovery are now at the forefront of Bord na Móna's business activities. Following the announcement of the end of its peat extractive operations in January 2021, the company commenced the EU and Irish Government-funded Peatlands Climate Action Scheme. This €126 million endeavour will result in the 'enhanced' rewetting of some 33,000ha of post-production bogland to limit ongoing carbon emissions. Rehabilitated peatlands rapidly repopulate with flora and fauna. Common cranes (*Grus grus*), a species once extirpated in Ireland, have recently bred in post-industrial bogland in Co. Offaly. Bord na Móna is developing wind energy in some of its landholdings in response to government policy that aims to derive 80% of the country's energy requirements from renewable sources by 2030. However, concerns remain for individuals and businesses dependent on the peat sector.

The socioeconomic implications for workers following industrial bog closures were recognised in the 1970s (O'Connor et al., 1977). Employment in Bord na Móna peaked at 7,171 in 1983, following its rapid expansion in response to the oil crises of the decade before (Clarke, 2010). By 1992, just 2,767 people were employed in the company (Clarke, 2010). In 2018, Bord na Móna's Littleton briquette factory ceased production. This marked the beginning of a series of redundancy programmes at the company. Trade unions have lobbied for a 'just transition' for those affected. This sees fossil fuel workers redeployed in alternative, sustainable roles with similar terms of employment (Leopold, 1995). To meet this challenge, over €200 million in Irish and EU funding is being invested into the redevelopment of the Irish midlands. However, Banerjee and Schuitema (2022) identified frustration among community members and peat workers concerning the rollout of this process. Healy and Barry (2017) described just transition as 'intensely political', as it involves considerable trade-offs. There are few jobs available in renewable energy once construction is completed. The Peatlands Climate Action Scheme provides employment in reprofiling bogs and blocking drains to workers previously made redundant, albeit on a short-term basis. It remains to be seen how communities and workers once dependent on the Irish peat industry will fare in the future.

2.2.3. Carbon storage and sequestration

Afforestation and restoration of peatlands and organic soils are opportunities for Ireland to protect, maintain and enhance carbon stores to tackle climate change. They are key to achieving net zero greenhouse gas emissions in scenarios presented by Haughey et al. (2023). Based on indicative scenarios that include CH_4, the levels necessary to create a net-negative carbon sink in Ireland are ambitious: 500,000–875,000ha of afforestation, 302,000ha of rewetting of grasslands on organic soils and 70,000ha or exploited peatland restored by 2050 would be required (Haughey et al., 2023).

An enormous level of change is required in the landscape. This means change for rural communities, farmers, foresters and all those who work the land if transformative change is to be achieve. If a transformative, nature-based approaches perspective is adopted, it could become much greater than opportunities to sequester carbon. It could also improve livelihoods, bring good jobs, help to sustain and revitalise rural areas, tackle environmental degradation and enhance the resilience of ecosystems, communities and the local economy. Such an approach is necessary to ensure that trade-offs are managed and the risks to the future integrity of carbon stores from the impacts of climate change are also managed. Land-use change cannot be tackled in isolation. Mitigation actions in other sectors are also necessary for Ireland to play its part in keeping the increase global temperature below 1.5°C. The carbon stored in forests or peatland becomes more vulnerable with increasing climate change. Careful planning to create, restore, protect and ensure a sustained net sink for natural carbon removal to 2050, 2100 and beyond is required, as these are the timescales relevant to carbon stores. Conservation, management and restoration of forests and peatlands have the most potential to provide economic opportunities and improve rural livelihoods (IPCC, 2023b). A long-term, integrated strategic plan for carbon stores is needed as part of a wider planning framework, in some ways similar to the level of planning that is more familiar in urban areas (Scott, 2022), to benefit from these opportunities.

2.2.3.1. Afforestation, reforestation, natural regeneration and management

Forests are a proven, cost-effective and scalable option for the removal of carbon from the atmosphere (Fuss et al., 2018; Duffy, C. et al., 2022a). According to indicative scenarios developed by Haughey et al. (2023), if net zero greenhouse gas emissions, when CH_4 is included, are to be achieved, current forest cover, 11.6%[21], will need to more than double, up to 24%, or around 1.7 million ha, between 2025 and 2050. These scenarios give an indication of the level of afforestation, and other significant changes to land use, necessary to balance emissions from agricultural practices and land use to achieve net zero emissions by 2050. The net zero 'landing zone' achieved because of the ambitious changes required is narrow, around 100,000tCO_2-eq per year. These scenarios and the simplified assumptions used to parameterise them can be a useful guide in developing a land-use strategy, but more research and data will be necessary to better understand the magnitude of the forest sink that will be required if Ireland is to bring its emissions into balance.

As of 2023, carbon budgets are already highly constrained, and Ireland is not yet on track to achieve near-term carbon budgets, excluding LULUCF, and it is possible that future carbon budgets will be even more constrained and that a significantly larger net-negative carbon sink is required to balance excess emissions. Another important factor when considering carbon removal through afforestation is that it takes decades for trees to grow and mature and deliver on higher levels of carbon storage. In order to achieve net zero or net-negative emissions by 2050, forests need to be planted in the near term so that carbon stores are mature as required. This is because there is a limited capacity of young forest to capture CO_2 in the short term. However, in the longer term, as sequestration rates increase, they will play a greater role in achieving carbon neutrality to 2050.

When the 'right trees' are planted in the 'right places' and for the 'right reasons', healthy, biodiverse and resilient forests can be created. This is a prerequisite for providing food, fibre, fresh water and medicines, alongside jobs and wider social and economic goods, for rural communities (European Commission, 2021). This idea is central to the European Commission's new forest strategy, which builds on best practice that suggests that growing, restoring and protecting forest is not just good for nature and society, but that sustainable forestry is economically viable when managed in an appropriate way (European Commission, 2021). Afforestation and reforestation can be an opportunity to employ nature-based approaches.

Climate-smart forestry management is an important element of meeting forests' potential to address climate challenges (Korosou, 2023). To increase the effectiveness of carbon removals and enhance forest resilience, a balance of wood production, biodiversity protection and ecosystem services is required, with more timely monitoring of greenhouse gas fluxes (Verkerk, 2020).

Doubling forest cover in Ireland will be a significant undertaking. Research on afforestation on mineral agricultural soils suggests that it is possible to make significant gains in the short term with very high levels of afforestation (Duffy et al., 2020). It is not clear when an overall land-use strategy may emerge to guide land-use change in Ireland. However, the Department of Agriculture, Food and the Marine has recently published Ireland's Forest Strategy (2023–2030) (DAFM, 2023b)[22]. It broadly reflects the approach taken in the new EU Forest Strategy for 2030. Both strategies are high level, with little information related to implementation. They link to the EU Nature Restoration Law, EU Biodiversity Strategy for 2030 and support enhanced sustainable forest management and ecosystem-based restoration that aim to restore, protect and enhance resilience of all forests in the EU.

In other European countries forests have for a long time been centres for cultural heritage, craftmanship, traditional knowledge and innovation (European Commission, 2021). In Ireland, rural identities and culture have stronger links to agriculture and trees are not often seen as part of traditional agriculture (DAFM, 2022b). There is a growing industry and bioeconomy emerging in the forestry sector in Ireland. Timber materials can replace emissions-intensive materials such as cement and steel. If supported and managed appropriately, there is no reason that forests in Ireland cannot store more carbon, while at the same time enhancing biodiversity in the future. Forests could become important hubs for highly skilled jobs, innovation and ecotourism, opening new opportunities for those living in rural areas (European Commission, 2021).

Natural forest regrowth has the potential to generate substantial global carbon removals and is a cost-effective large-scale strategy (Strassburg et al., 2019). By 2100, it has the potential to be more than 40 times as effective in carbon storage than

[21] Despite the low forest cover, afforestation rates in Ireland in the last century have increased national forest cover from around 1.4% in 1918 to the present level of 11.6% (Haughey et al., 2023).

[22] While this strategy is now published, it was not available for inclusion in this assessment during drafting..

monoculture plantations (Lewis et al., 2019). This would also have important benefits for biodiversity. There are encouraging signs from Europe and in Ireland, related to natural regeneration of forest and woodland. Spontaneous forest regrowth is the dominant force increasing forest cover in the EU (European Commission, 2021).

Closer to home, 26,760ha of native woodland has come from natural regeneration and accounts for one-third of the overall increase since 2006 (DAFM, 2023a). This approach offers multiple synergies, as naturally regenerated woodland, dominated by broadleaved native species, have greater levels of biodiversity and resilience.

Hedgerows also have the potential to be an important carbon store in Ireland, with hedgerows covering 267,509ha or 3.8% of land area (DAFM, 2023a). However, research suggests that, at a county level, hedgerows are a source of emissions because of their removal and intensive management (Black et al., 2023). Traditional hedgerow management and alignment of farm payments for increasing hedgerow width could increase the maximum carbon storage potential of existing hedgerows, while new hedgerows could compensate for the loss of hedgerows in other areas (Black et al., 2023). This research suggests that there are ways to align policy related to farm payments that benefits carbon stocks, nature and farming communities.

Research by Irwin et al. (2022) documents the benefits of agroforestry, or 'trees on farms'[23]. Agroforestry has the potential to increase carbon stocks, reduce pollution, provide habitats and enhance farm-based benefits. These benefits include timber provision and improvements in animal health and welfare. Despite these benefits and subsidies, there is very little appetite for agroforestry in Ireland. This work investigates barriers to agroforestry and suggests, in contrast to other studies on afforestation (e.g. Ryan and O'Donoghue, 2016), that the long-term commitment that comes with planting trees is not necessarily a barrier, as half of farmers questioned did not see planting trees as a major decision. Lack of knowledge about agroforestry and the schemes and grants available to farmers were cited as possible barriers. Studies related to afforestation have suggested that barriers to uptake include the relative financial return from agriculture and forestry (Breen et al., 2010), farmer demographics (Frawley and Leavy, 2001) and farmer goals (Duesberg et al., 2013). Research by Ryan and O'Donoghue (2016) suggest that soil type, agricultural market income and subsidies affect the economic attractiveness of afforestation. Eighty-four per cent of farmers questioned as part of this study said that they would never take up afforestation, despite the financial incentives on offer. Economic incentives encouraging farmers to plant trees are at odds with those encouraging some farmers to increase their dairy herd (Duffy et al., 2020). Potential policy options have been identified by Ryan and O'Donoghue (2016) and include providing environmental public goods; overcoming inertia; timing of scheme payment; risk management; linking afforestation and agricultural land-use decisions; linking carbon neutrality objectives; extensions; a requirement to re-forest; establishment costs of subsequent rotations and differential land availability.

Aligning policy in land use to support the achievement of carbon neutrality by 2050 is important, not just for landowners and farmers but also for local communities. One example, from Nepal, saw a community lead doubling of forest cover over 25 years. A change in legislation allowed forest rangers to give responsibility for areas of national forest to local communities who developed plans to manage the forest and began restricting over grazing and limiting the amount of firewood that could be removed (Fox et al., 2019; Fox et al., 2020; Van Den Hoek et al., 2021; Cassidy, 2023). This example suggests that (1) local communities can play a role in achieving the necessary level of forest cover, (2) it is possible to double forest cover before 2050 and (3) simple changes to policy can have powerful effects. This does not mean that this particular example is the answer for Ireland, it is just an example of what can be done when changes in legislation and community participation are combined.

Details on synergies and trade-offs related to mitigation, biodiversity and water associated with afforestation are presented as part of Haughey et al. (2023). Synergies and trade-offs need to be identified, optimised and managed as part of an integrated approach across all sectors to reduce emissions. The risk to forests (particularly those made up predominantly of single species of the same age), their carbon stores, biodiversity, resilience and long-term sustainability increases and becomes less predictable as the climate warms. Sustainable forest management, nature-based approaches, ecosystem-based management and ecosystem restoration can increase resilience and help adapt forests to climate change (European Commission, 2021). These approaches can also stimulate local adaptation actions (European Commission, 2021). However, adaptation can only do so much to store and protect carbon as risks from climate change increase. Irish leadership at an international level will be necessary if other countries are to be encouraged to increase, restore and protect forests to ensure a working global carbon sink, but also to reduce emissions in line with the ambition of the Paris Agreement.

[23] One barrier to agroforestry uptake maybe be the term itself, which may bring negative associations to mind, including the perception of forestry as a rival to agriculture, and prevent farmers from seeking additional information (Irwin et al., 2022).

> *Synergies and trade-offs need to be identified, optimised and managed as part of an integrated approach across all sectors to reduce emissions.*

2.2.3.2. Conservation and restoration of wetlands

Peatlands are the dominant type of wetland in Ireland. They mitigate climate change, preserve biodiversity, reduce flood risk and enhance fresh water availability (IUCN, 2021). Ireland has 1.4 million ha of peat soils, 21% by land cover, and of this 330,000ha is drained grassland on organic soils (Wilson, 2021; EPA, 2022c). Natural and managed peatlands store 2216 million tonnes of carbon, and store twice the amount of carbon in all other soil types in Ireland (Renou-Wilson et al., 2022; see Volume 2). Natural and cutaway bogs hold just under half of this carbon (Renou-Wilson et al., 2022). However, most peatlands, 85%, are moderately or severely damaged by drainage, peat extraction, agricultural conversion and plantation forestry, and only 20% remain of conservational value (Wilson et al., 2013; Renou-Wilson et al., 2019). If peatlands become too badly degraded, they lose their ability to store carbon. Conservation of peatlands that have not been degraded can have immediate benefits, while restoration of degraded peatlands will see benefits in the longer term. As soon as rewetting takes place on peatlands suitable for rehabilitation, including those under agricultural use, there is the potential to for removals (Ojanen and Minkkinen, 2020). In the near term, it is the reduction of avoided emissions, those that would arise from degraded peat, that is significant for climate change mitigation. In relation to forested peat soils, it is important to consider that rewetting these soils is not considered a positive climate change mitigation action in the near term (Ojanen and Minkkinen, 2020). Rewetting of peatlands is important for biodiversity, as it allows the restoration of peatland ecosystems (Parish et al., 2008; Bonn et al., 2014).

Scenarios developed by Haughey et al. (2023) suggest that achieving net zero greenhouse gas emissions would require 100% rewetting of exploited peatland, that is 70,000ha, and 90% rewetting of organic soils under grassland, that is 302,000ha, between 2025 and 2050. In Ireland, in the case of rewetting organic soils under grassland, the goal is to store carbon instead of releasing it, not the restoration of peatland ecosystems, and allowing agriculture to continue. It is important to note that rewetting in this instance does not mean flooding land. It means returning water-saturated conditions to peatlands or organic soils under grassland by managing the water table to achieve carbon removals and minimal CH_4 emissions. For peatlands, that means raising the water table to optimal levels of 10–15 centimetres (cm) of the surface (Wichtmann et al., 2016), and in the case of organic soils under grassland rewetting could occur up to a depth of 25cm (Renou-Wilson et al., 2016).

Like afforestation, restoring peatlands can be a nature-based approach if actions to do so tackle climate change and bring wider benefits to society and human wellbeing. Again, here there is also the potential to make decisions that exacerbate carbon and biodiversity loss if the actions taken do not take full consideration of biodiversity loss and human wellbeing alongside climate change mitigation considerations. The restoration and protection of peatlands and rewetting of organic soils under grasslands can continue to provide employment, and livelihoods are aligned with climate, biodiversity and human wellbeing goals. Historically, jobs associated with peatlands have been extractive, new jobs have already been created and more will be required to start to repair the damage that has been done and work with nature to create significant, lasting and resilient carbon stores. Where peatlands are concerned, this work will also involve the restoration and protection of these ecosystems. As well as livelihoods associated with the planning and management of wetland restoration, there are also opportunities associated with tourism.

2.2.4. Nature and ecosystems

Globally, the biggest pressures on nature and biodiversity are land-use change, mainly caused by agricultural expansion, and overexploitation of natural resources (IPBES, 2019a; Jaureguiberry et al., 2022; see Volume 1). However, climate change is a significant and growing pressure and could soon be the main driver (see Volume 1). Like climate change, environmental degradation is fuelled by economic activities and systems of governance (Díaz et al., 2015; Chan et al., 2020) and demonstrates the unsustainable relationship between humans and the planet (Pörtner et al., 2021).

Nature's contributions to people are worth billions of euros to the Irish economy every year (Bullock et al., 2016; Norton et al., 2018). However, despite decades of global coordinated action on conservation, as part of the United Nations Convention on Biological Diversity, biodiversity in Ireland is in poor condition (NPWS, 2019; EPA, 2020). Agriculture is the dominant driver of biodiversity loss, with the most notable declines in peatland, grassland, woodland and marine ecosystems (NPWS, 2019; EPA, 2020). Other land use, including peat extraction and forestry, and to a lesser extent urbanisation and recreation, also contribute to biodiversity loss (NPWS, 2019; EPA, 2020).

Despite the intricate links between people and nature, and the greater understanding of the benefits it provides and our role in safeguarding it, nature has been taken for granted in Ireland (European Commission Directorate General for Environment, 2019; EPA, 2020). More than half of native Irish plants are in decline, caused by the same agricultural and forestry practices that contribute to climate change (Botanical Society of Britain and Ireland, 2023).

Policy and economic signals incentivise carbon-intensive and environmentally damaging practices (Duffy et al., 2020; EPA, 2020, 2022c), for example plans to increase grass-based livestock production (DAFM, 2022a). A genuine and transformative rebalancing of agriculture and land use in Ireland offers an opportunity to halt and restore declines in nature and ensure that its contributions to people and climate mitigation continues (Whitmee et al., 2015; Díaz et al., 2019; Haughey et al., 2023). Addressing the root causes or indirect drivers (see Figure 1.1) of climate change and biodiversity loss, for example unsustainable production and consumption (see Chapter 5), will be necessary. If this is not prioritised, then the long-term viability of both nature and food systems are threatened (EEA, 2017; IPBES, 2019b; EPA, 2020; Verkuijl et al., 2022).

2.2.4.1. Conservation and restoration of nature

A mass extinction, that is a widespread and rapid decrease in biodiversity, is under way globally (IPBES, 2019a). It is no longer sufficient to conserve remaining habitats and species. Ecosystems, such as wetlands and natural forests, need to be rehabilitated to repair the damage resulting from human activities (IUCN, 2022). Translating Ireland's commitments under the Kunming–Montreal Global Biodiversity Framework and EU targets on the restoration and protection of nature into national plans is ongoing. Ireland's fourth National Biodiversity Action Plan has been in development since October 2021. The plan will set the national biodiversity agenda for the period 2023–2027. The Joint Committee on Environment and Climate Action has highlighted the need to restore biodiversity along with action on climate, and has recommended new statutory measures across Government and additional resources for research and data (Joint Committee on Environment and Climate Action, 2022).

If Ireland is to achieve LULUCF targets, in line with the Paris Agreement, it will be necessary to scale up nature restoration. Nature restoration reduces emissions from land, enhances the capacity of ecosystems (including forests and peatlands) to store carbon and enhances ecosystem resilience, which can prevent future carbon emissions (Kopsieker et al., 2021; Pörtner et al., 2021). From an adaptation perspective, nature restoration is important as it reduces the exposure of ecosystems and humans to climate impacts, builds resilience to impacts and in some cases reduces the frequency and intensity of the hazard (McVittie et al., 2018). Climate mitigation and adaptation can be delivered through nature-based approaches. Nature protection, retention and restoration will not be possible if rapid reductions in emissions is not undertaken at the same time (Arneth et al., 2020; Watson et al., 2020).

If biodiversity loss is to be reversed and nature restored, it will be necessary to dedicate land to habitats. Thirteen per cent of land in Ireland is designated as protected (DAHG, 2014). Action on biodiversity and nature restoration is happening in Ireland at different scales and there is significant diversity among those actors, including landowners, from farmers to state and semi-state organisations. The implications of converting 10% of current grasslands to nature restoration and considering broadleaved dominant afforestation to enhance biodiversity and water quality outcomes have been considered by Haughey et al. (2023). The level of nature restoration on farmland may have already been achieved, but this is difficult to assess, as the current land cover database does not have the necessary resolution (Haughey et al., 2023; see Volume 3).

Benefits of protecting marine ecosystems include benefits for biodiversity, society and the economy. Fishing can benefit from the conservation, restoration and protection of marine habitats, particularly if the location of marine protected areas considers fish nurseries (Roberts et al., 2017). Marine protected areas offer a refuge to species under pressure from fishing and climate change and allow the ecosystems within these areas to recover (see Volume 3). This results in overspill of recovered species outside the protected areas, with benefits for fishers, including the prevention of long-term stock collapse and the resultant loss of income (OECD, 2017). Fishers are also able to supplement their incomes, as marine protected areas offer opportunities for nature-based tourism (OECD, 2017). Ecosystems, at sea and on land, will also need to be managed in the future to allow them to adapt to climate change.

Protected marine territory in Ireland at the start of 2023 was 8.3% and is indicated to rise to 10% by the end of the year (DAHG, 2014; DHLGH, 2022b). The implementation of the Marine Protected Areas Bill (Government of Ireland, 2022) will put Ireland on track to deliver on 30% protected marine areas by 2030. In 2023, Ireland also became a signatory of the UN High Seas Treaty, which protects aims to protect 30% of the world's oceans outside country boundaries.

While Ireland was part of the high-ambition coalition at the Convention on Biological Diversity COP15, it has not committed to designate 30% of land as protected by 2030. Furthermore, Ireland, while recognising the transformative power of the Nature Restoration Law, has told the EU Environment Council that it will have significant implications for planning and that there are concerns around how it can be funded (McDonnell, 2022). This indicates that while the ground is being prepared in some areas, including marine planning, the land-use review and land cover mapping, there is no clear, shared vision about the long-term management and protection of habitats and species on land and at sea.

2.2.5. Human health and wellbeing: amenity, clean air and fresh water

Landscapes play a crucial role in sustaining human health and wellbeing. Human activities are negatively impacting air and water quality, at the detriment of human health and nature. Many of the activities causing pressure on air and water quality are also the main sources of greenhouse gas emissions, to varying degrees: combusting fuels, mainly solid fuel for heat, agricultural and forestry activities, transport and energy and industrial process all contribute to poor air quality, as well as climate change. Mitigation measures for pollution and climate change often overlap and therefore reducing direct greenhouse gas emissions can have a double dividend for reducing pollution.

An estimated 610 premature deaths occur in Ireland each year because of poor air quality (EEA, 2022), mainly from particulate matter that arises from combustion. The agriculture sector accounts for nearly all ammonia emissions in Ireland. Unlike other pollutants under regulation, ammonia emissions are increasing (EPA, 2020), mainly caused by a growth in livestock numbers, including a 3% increase in dairy cow numbers in 2021 (EPA, 2023a). Ireland is not meeting EU targets on emissions of ammonia to air under the National Emissions Ceiling Directive (2016/2284/EU). Ammonia causes acidification and eutrophication of sensitive ecosystems (Guthrie et al., 2018) and atmospheric emissions contribute to particulate matter with a diameter of ≤ 2.5µm (PM2.5) formation, which has been linked "to higher death rates, respiratory problems, cardiovascular diseases, cognitive decline and low birth weights" (Wasley et al., 2019; Thangavel et al., 2022). Moreover, CH_4 emissions, which arise from livestock, are a precursor for tropospheric (ground-level) ozone, which damages human health and ecosystems (West et al., 2006).

Water quality in Ireland has been in decline over the past 20 years. Almost half of water bodies fail to meet the legal requirements of the Water Framework Directive (EPA, 2020). Nitrogen emissions from agricultural activities are having a significant negative impact on water quality along estuaries and coastal water bodies in the south-east and southern coasts, where algal blooms can damage ecosystems (EPA, 2022b).

Properly managed soils, particularly wetlands, which are critically important for biodiversity, filter and remove nutrients and store water, minimising pollution and flooding risks, by absorbing excess water and slowing its release downstream (EPA, 2020; IUCN, 2020).

There are synergies between protecting air and water quality and mitigating climate change. For example, measures taken to reduce chemical fertiliser use cuts greenhouse gas emissions of N_2O and reduces ammonia emissions from the air and excess nitrogen in water. Similarly, managing peatlands and organic soils for carbon sequestration by increasing the water table also acts as a nature-based approach to flood prevention, limiting the need for the construction of relief schemes, which can have significant negative impacts on water quality and habitats (EPA, 2020).

2.3. Transformative adaptation in Ireland's coastal areas

The Sixth Assessment of IPCC Working Group II calls for a renewed engagement with values in climate change adaptation (New et al., 2022). The report shows how limits to adaptation are being reached in many human systems, meaning that individuals and society are no longer able to secure their goals from intolerable risk. Against this background, transformational adaptation that requires radical non-linear changes to the fundamental attributes of a system (including economic and political) in response to climate risks is increasingly advocated as a way to address climate change impacts as well as other societal challenges (Clarke et al., 2018; IPCC, 2018). Yet, choices for transformation will ultimately depend on the goals that individuals and society decide to pursue, and thus on the values they wish to prioritise, reconfigure or leave behind when pursuing radical changes.

In Ireland, response to climate change is largely risk focused, with adaptation efforts centred on reducing exposure to hazards rather than examining the attributes of social and economic systems that make people vulnerable to the impacts of climate change. With respect to coastal management in Ireland, that has often meant one-off engineering interventions (Farrell et al., 2023). There are a large number of public organisations with remits in coastal protection and management, often with different policy objectives, which has prevented joined-up, long-term adaptation planning to date (Farrell et al., 2023). However, there are efforts under way for coordinated coastal management, which could open up space for more transformative approaches to adaptation.

On a local scale, transformative adaptation requires engagement with place-based values and interests. Work by Clarke et al. (2018) in Clontarf in Dublin has explored barriers to transformative adaptation to coastal flood risk. They find that the symbolic values that local residents in Clontarf associate with place means that there is a cognitive dissonance between the desire for safety and security (from floods) and the desire for familiar local places to remain as they are (and to not be changed significantly through adaptation interventions). Their example, along with wider international research, raises the

important point that the less people are attached to an area, the more likely they will be open to transformative change and, conversely, the more attached people are to their local places, the more resistance may be experienced to adaptation that requires significant change. Navigating the place change that may be required for transformative adaptation will require careful management, given the diversity of values that communities hold. Research on managed retreat in the Shannon catchment following floods in 1954 outlines the importance of situating adaptation in the social and political contexts of communities, and that place attachments and ties to local communities informs responses to more transformative adaptation response (Tubridy et al., 2021). This work shows that when adaptations (in this case managed retreat) are part of larger radical and transformative approaches to reducing vulnerability (in this case land reform), they can enjoy political support as well as material benefits. The authors also highlight the risk that narratives of place can be mobilised by powerful actors to justify inaction in response to climate risks.

Going forwards, in Ireland, there is a need for joined-up thinking on coastal management that can potentially address a range of societal challenges rather than climate change risks in isolation (e.g. biodiversity, land reform). There will be trade-offs: the desire for continuity will have to be considered alongside the potential impacts of future climate-driven disruptions and indeed the needs of future generations. In 2020, the Inter-Departmental Group on Managing Coastal Change was formed to scope an integrated approach for a coastal change management strategy. The Climate Change Advisory Council acknowledge the limitations of the National Adaptation Framework in informing coastal management and has highlighted the need for nature-based approaches and broader regulatory change for more diverse approaches in coastal management. The new Marine Strategy Framework Directive's programme of measures flags the importance of nature-based approaches. As a national coastal zone management strategy is developed in Ireland there is scope for more transformational approaches to climate change that address vulnerabilities and biodiversity challenges. This will require shifts in governance practices and collectively and transparently engaging with the potential negative impacts that transformational approaches may require, especially in the near term, for longer-term benefits.

2.4. Towards transformed landscapes

There have been transitions in global land-use and food systems in the past, and while this has brought affordable diets the outcomes for nutrition, environment and equity have not been as favourable (Ambikapathi et al., 2022). Systems transformation can take time, perhaps decades, and so it is important to identify the characteristics of transformational pathways while at the same time developing mechanisms to encourage change, coordinate action and engage all actors and the general public in participation (Buckwell et al., 2020; Newell et al., 2022). Such an approach presents Ireland with an incredible opportunity to rebalance land use and ocean use, to realign food production and consumption with environmental sustainability and wellbeing, allowing space for nature and changing the focus of land management in order to ensure nature's contributions to people (EEA, 2017; Kenny et al., 2018; Buckwell et al., 2020).

2.4.1. Evidence of the emergence of transformative change

There is growing awareness and recognition of important elements of transformative change in Ireland, including (1) the role of nature and its contributions to people (e.g. EPA, 2020; Joint Committee on Environment and Climate Action, 2022), (2) the impact of human activities on ecosystems and climate (e.g. Joint Committee on Environment and Climate Action, 2022), (3) the necessity to halt and reverse biodiversity loss and to restore degraded ecosystems (e.g. DHLGH, 2022a), (4) the requirement to limit the impact of climate change and working within the limits of natural systems (e.g. Joint Committee on Environment and Climate Action, 2022), (5) the importance of tackling climate and biodiversity together (e.g. Joint Committee on Environment and Climate Action, 2022) and (6) the importance of taking a transformative approach to land-use and food systems (e.g. DCHG, 2019; Biodiversity Working Group, 2020; EPA, 2020; DHLGH, 2022a).

It is not surprising that integration, to varying degrees, occurring in strategy, policy design and planning is emerging first across departments with responsibility for climate, environment and biodiversity (DECC, 2021; DHLGH, 2022a; Government of Ireland, 2022). The Department of Agriculture, Food and the Marine also has responsibilities for these areas; however, historically, there has been less integration of environmental policy within this 'closed policy community'[24] (Adshead, 1996; Fahy, 2020). Agricultural strategy to date demonstrates that when there is a choice to be made between environmental sustainability and economic growth, growth is prioritised (Fahy, 2020). In October 2022, the Department of the Environment, Climate and Communication published the *National Implementation Plan for the Sustainable Development Goals 2022–*

[24] In such a community, policymaking happens in a closed discussion between interest groups, ministers and senior civil servants with similar priorities and ideology, and it is difficult for groups outside this circle to become part of the discussion (Adshead, 1996; Fahy, 2020).

2024, which aims to embed these in the work of government departments and local authorities (DECC, 2022c). In terms of planning, the foundations of strategic land management are being put in place through the work of the Land Use Review and improvements in land cover mapping. Both will provide the evidence to inform the development of integrated policy and implementation.

While transformation is not explicitly mentioned in the Climate Action and Low Carbon Development (Amendment) Act 2021, the need for transformative change across all of society is recognised as central to delivering the fourth National Biodiversity Plan Action Plan (DHLGH, 2022a) and originates from the international post-2020 Global Biodiversity Framework (Convention on Biological Diversity, 2021). The National Landscape Strategy sets forth an integrated approach to landscape that recognises, characterises, utilises, develops and protects all dimensions of landscape, urban and rural, including cultural dimensions (DAHG, 2015). While integration of policy across departments with responsibility for climate and the environmental is important, wider integration, across health, nutrition and trade, for example (Babiker et al., 2022), is required to identify potential synergies and trade-offs (iPES Food, 2019), and take advantage of spill-over effects (Kanter et al., 2020; OECD, 2021). This is key to achieving a transformative approach (Sachs et al., 2019).

From a public perspective, the Citizens' Assemblies on Climate Action and Biodiversity Loss demonstrate that there is an appetite for transformative change in Ireland, making progressive recommendations on the type of actions they determined necessary if these issues are to be tackled in Ireland (see Chapter 8).

While there is evidence of transformative thinking in relation to some aspects of landscapes emerging in Ireland, other relevant areas, including just transition, equity and justice and the underlying drivers of climate change and biodiversity loss, need more attention if the depth, scale and speed of change required is to be achieved. A holistic, long-term systems approach will be necessary to tackle overexploitation of natural resources and land-use change so that nature can be protected and restored, and the myriad synergies for the environment, climate, society and the economy identified and made the most of while managing any trade-offs.

2.5. Research gaps

Transformative approaches to food and land systems. The necessity for transformation originates in the dual crises of biodiversity loss and climate change, and in the urgency that is required to address them. Climate, biodiversity and society are interdependent, and treating them as such is necessary for successful policy intervention (Pörtner et al., 2021). Tackling the direct drivers of climate change and biodiversity loss does not result in change in the speed, scale or depth that is required if Ireland is to deliver on its climate and biodiversity goals. Research on the underlying drivers of climate change and environmental degradation is only beginning (Chan et al., 2020) and is essential if transformational change is to be achieved. The food systems approach is considered to be transformative (EEA, 2017). It is a holistic approach that considers all aspects of the food system from nature's contribution to all those who work the land, process, ship and sell food, and wider issues related to health and waste. Establishing this approach and integrating it with the wider land systems will require further research.

Ireland's role in the global food system. Ireland's role in global food production is likely to evolve as the global population grows and climate change and related pressures affect global food production. Will Ireland need to increase the amount of food it produces? If so, will this require a move to less resource-intensive food production systems to maximise calorie output? If so, what would be the implications for the land transition?

Comparative efficiency of agriculture production systems. As part of establishing a food systems approach in Ireland, research on the comparative efficiency of agricultural production systems will be required to better understand the efficiencies of these systems. Research on carbon leakage is also required as part of determining the most emissions-intensive and environmentally damaging food and materials.

Feasibility of land-use change. Phase 2 of the National Land Use Review will involve consultation with a wide variety of stakeholders and will gauge the appetite for the type and level of change, as it currently stands, with regard to changing land-use patterns in Ireland. While the options for land-use change are 'technically' feasible, research will be required to understand how individuals, households, rural communities, wider society and the economy can assist in enhancing the feasibility and implementation of the change necessary to deliver on Ireland's national climate objective.

Enabling afforestation, peatland and nature restoration. Further research on enabling afforestation, peatland rewetting and restoration and nature restoration, particularly in relation to sustainable livelihoods, supporting rural communities and all those who work and steward the land, will be required in order to maximise synergies between mitigation and adaptation actions and the wellbeing of those on the front lines of climate action.

Research will be required to ensure that policies and measures are fair and that an undue burden is not placed on rural dwellers. Research will be necessary to establish the magnitude of the land carbon sink in Ireland.

Implementation of nature-based approaches. Nature-based approaches have the potential to be transformative, as they can tackle climate change (mitigation and adaptation) while delivering benefits for nature and human wellbeing simultaneously. How nature-based approaches can be implemented in Ireland requires further study.

Clean air and fresh water. There is little research available on the co-benefits of mitigating greenhouse gas emission in agriculture, for example the benefits for air and water pollution, flood protection and amenity. Research will be necessary if wider co-benefits are to be identified, especially those that can benefit human health and wellbeing and the protection of nature.

Bioenergy. To date, research on bioenergy has been concentrated on interactions between fuel, food and feed. Research in this area may be expanded to consider interactions with biodiversity, mitigation and adaptation action, to bring a fuller understanding of the interconnections and potential for synergies and trade-offs in the landscape.

Carbon dioxide removal. 'Novel' methods of CDR, such as bioenergy carbon capture and storage and direct air capture, will become more important for carbon removal towards the middle of this century. Research is required to assess the feasibility of developing, financing and deploying these and other 'novel' CDR technologies in Ireland so that the synergies and trade-offs associated with these technologies can be assessed and these technologies can become part of a long-term integrated strategy for land use.

Integrated strategies, design and planning. Of all transformations, transforming landscapes has the greatest possibility for trade-offs. For example, interventions to make space for nature could mean increased intensification of agriculture and associated environmental impacts that result in damaging ecosystems further (EEA, 2017; Sachs et al., 2019; Haughey et al., 2023). Integrated strategies, design and planning are required to anticipate and minimise such trade-offs, alongside maximising the synergies (Sachs et al., 2019; Schmidt-Traub et al., 2019). It is clear that a long-term integrated plan for land use is required in Ireland and that the groundwork to establish this is ongoing. However, given the potential negative impacts for climate, biodiversity and society, research is required on how to achieve integration to maximise synergies and manage trade-offs.

3

Transforming Spatial Planning, Transport and the Built Environment

Key messages

Integrated spatial planning offers leverage to facilitate the delivery of social, environmental and economic benefits by strategically aligning climate objectives and fostering interdepartmental collaboration within the government. This approach has the potential to achieve the best results in terms of emissions reduction and climate change adaptation. Establishing a robust evidence base using granular data and digital tools can empower informed decision making, as can studying public engagement to drive mindset shifts and bolster effective transformation.

Compact urban development, driven by factors such as high density, mixed land use, connectivity of streets, destination accessibility and optimal distance to transit, is a pivotal strategy for creating energy-efficient and sustainable cities. This approach not only reduces energy consumption but also promotes physical and mental wellbeing while saving land for non-urban uses. Prioritising brownfield redevelopment over greenfield development could lead to reduced urban sprawl and achieving climate and wellbeing goals. Placemaking is likely to craft high-quality spaces fostering community cohesion and resilience. Innovative urban models such as superblocks or car-free neighbourhoods offer the potential to reduce emissions, enhance green spaces and promote active living, contributing to more liveable and resilient cities. Assessing the outcomes of implemented redesigns and pilot projects is crucial to optimise the benefits and ensure the effectiveness of planned interventions.

A paradigm shift in transport planning is necessary, focusing on shaping travel demand while considering complex behavioural dynamics, emerging mobility trends, wellbeing and just transitions alongside climate goals. Embracing participatory scenario development is useful for constructing a comprehensive vision and gauging its impacts effectively.

To achieve climate targets and promote equity, it is essential to focus on transformative measures that can truly drive change. These measures involve creating conditions where the need for motorised transport is minimised, for instance through proximity redesign ('avoid' actions), and channelling the remaining travel demand towards sustainable options such as walking, cycling, shared mobility and public transport ('shift' actions). These approaches offer more substantial benefits than maintaining the current car-centred system, even with the integration of electric vehicles ('improve' measures). To ensure success, research should be undertaken to closely monitor the implementation and impact of these 'avoid' and 'shift' strategies across different scenarios, thereby providing concrete evidence of their effectiveness.

Buildings, both new and existing, need to be resilient to the changing climate while reducing energy consumption. An integrated strategy that combines sufficiency, efficiency and renewables is essential for climate change mitigation, while also enhancing the resilience of buildings. Building energy standards play a pivotal role as the primary regulatory mechanism for achieving emissions reductions, complemented by effective solutions such as retrofits, heat pumps and district heating. Integrating climate-resilient design principles into building standards, as well as advocating the adoption of nature-based approaches, will enhance the adaptability and durability of buildings. Implementing these measures is projected to yield benefits in terms of efficiency, comfort and the overall wellbeing of residential and commercial properties.

3.1. Introduction

Settlements are centres of concentrated human habitation in both rural and urban settings. As the climate changes, communities in both rural and urban areas are increasingly facing pressure from extreme weather events. Ireland is expecting a rise in rainfall and flooding in winter, droughts in summer, higher heatwave mortality, and more frequent extreme weather events in the near future. To reduce the costly disruption to basic services, infrastructure, housing and livelihoods, climate change adaptation strategies such as nature-based approaches are being implemented (see Volume 3). At the same time, urban activities are major contributors to greenhouse gas (GHG) emissions, and cities are part of the solution through mitigation efforts to cut back on emissions (see Volume 2).

Fundamental changes to the structure and interactions of the urban system within cities and towns, as well as its interactions with the surrounding natural environment, are necessary to unlock the potential of urbanisation. The extensive transformation of our cities, towns, villages, coasts, transport, homes and our relationship with nature is expected to yield multiple benefits. This can be achieved through smart growth planning, improved quality of urban and rural living, healthier human–nature interactions, technological progress, including the development of information and communications technology, and a rehabilitated environment. The interconnections between activities and sectors within cities make it easier to deliver integrated action, resulting in cascading positive effects. The most evident benefits come from interventions in urban form and infrastructure that affect the transport, buildings and energy sectors (Lwasa et al., 2022). Combining urban adaptation and mitigation measures is likely to provide synergies for urban greening and transport (Sharifi, 2021). By embracing these transformative measures, cities, towns, villages, coasts, transport, homes and our relationship with nature can evolve to create more resilient, sustainable and liveable environments.

Creating an enabling environment for decision making is crucial in addressing climate change challenges. This involves providing a supportive framework for informed choices, action implementation and achieving desired outcomes. The three-step envision–understand–redesign framework guides policymakers in taking a systemic approach to navigate these challenges (OECD, 2022). The planning, transport and buildings sections of this chapter first explore current challenges and opportunities to understand the limitations of the urban system and its potential for redesign. The goals of an envisaged well-functioning system are then presented, along with the actions capable of delivering the change or redesigning the system, altering behaviour patterns and achieving desired results. By adopting this framework, decision makers are empowered to drive meaningful transformation and create resilient urban systems.

3.2. Spatial planning and urban form

Population growth and urbanisation processes are shaping the surrounding land. An increase in urban populations expands the size of urban settlements, leading to the expansion of built-up areas and a reduction in the area allocated to other land-use types, such as forests or wetlands. The spatial presence of settlements extends beyond their boundaries. The artificial land cover impacts soil, water and air quality and biodiversity, contributes to global warming and increases climate change-related risks, for instance flooding (EPA, 2020). The fragmentation of land resulting from exploiting areas beyond administrative urban territories for agriculture or other productive uses can have adverse effects on the environment, causing a breach of the planetary boundaries and environmental limits that are critical for maintaining the health of our ecosystem (Dodman et al., 2022; see Chapter 2).

Accelerated urbanisation processes pose a risk but also an opportunity to implement coordinated spatial development at national, regional and local levels. In 2022, around 70% of Irish people lived in cities and towns, half of whom inhabited Dublin, Cork, Limerick, Galway and Waterford (CSO, 2023a). This number is predicted to grow to 75% by 2050, meaning that fewer people will inhabit rural areas, even when considering a 30% population growth (UN DESA, 2018). Integrated spatial planning can reduce the urban carbon footprint by facilitating compact and resource-efficient growth of urban and rural settlements (Pathak et al., 2022).

3.2.1. Current challenges and opportunities

The lock-in of existing spatial patterns is a significant barrier to change. In recent decades, Ireland's non-urban land has shrunk, and urban land use has stretched into remote areas, increasing sprawl. The expansion rate of urban areas was higher than the European average, causing sprawl in remote locations. Although urbanisation slowed in the 2006–2012 period (Ahrens and Lyons, 2019), land changes are likely to persist, as the process of reversing urban areas to green spaces is rare. The evidence shows that low-density areas experienced more population growth than high-density areas, indicating that settlements are becoming more dispersed over time (Ahrens and Lyons, 2019). Sprawl has a negative effect on quality of life and the environment through longer journey times and inefficient energy use in housing, both of which contribute to higher

GHG emissions (OECD, 2018). Even though full energy decarbonisation would reduce direct emissions from sprawled areas, urban sprawl also contributes to other environmental impacts unrelated to energy use.

Ireland's settlements, streets, public spaces and buildings, and their design, function and placement, bear the legacy of past planning strategies. The path dependency of pre-existing policies and planning successes and failures predefines the way development plans are shaped today. Past unfortunate planning decisions and a lack of coherent plans have led to building patterns such as continuing 'sprawl' surrounding large urban areas, linear development along the approach road of towns, poor integration of facilities such as schools and hospitals into planning (DTTAS, 2019), segregated and disconnected settlement patterns where walking and cycling are not integrated with public transport, road infrastructure acting as a barrier between communities (Caulfield and Ahern, 2014), estate development in inadequate locations resulting in high vacancy rates, and locating retail developments at the town's edge, contributing to the decline of urban centres (O'Driscoll et al., 2022). Such planning practices are detrimental to the social and economic wellbeing of communities, imposing costs such as high transport emissions, longer commuting times, a reduced level of active travel, isolation of communities, increased transport expenses for individuals, increased public investment aiming to solve problems of unsustainable transport, and delayed and inefficient movement of people and goods (DTTAS, 2019). Despite the challenges, efforts are being made across Ireland to escape the lock-in by redesigning the cities and towns.

The layout and depopulation of rural areas pose challenges not only to climate action targets but also to the wellbeing of communities (Scott, 2008). Evidence shows that larger Irish settlements achieve a higher level of environmental sustainability than smaller ones because of the self-sufficiency of jobs and service provision (Moles et al., 2008). If smaller settlements are well planned as they develop this could increase levels of sustainability, especially if located far from larger cities and towns. Rapid population growth within settlements left without spatial regulation is likely to have a large negative environmental footprint (Moles et al., 2008). The greenfield development of one-off housing outside towns and villages and along transport corridors has increased long-term climate impacts from long-distance private vehicle commutes, water quality impacts from relying on poorly performing domestic wastewater treatment systems, fragmentation of agricultural land, and disconnection of ecological linkages and habitats (EPA, 2020). Between 2002 and 2016, nearly half of all homes constructed were detached houses, and almost a third of the remaining ones were semi-detached (CSO, 2016). According to the 2022 census, 41% of all housing units are detached and 25% are semi-detached, indicating a slight decrease in the number of both types of housing (CSO, 2023b).

The National Planning Framework (NPF) 2040 includes a commitment to reduce urban sprawl through compact development and regeneration of existing urban and rural areas. The target for new construction to be infill/brownfield development is set at 40% in urban areas and 30% in rural areas. The strategy aims to better manage land and sites within existing settlement structures instead of expanding outwards (DHPLG, 2021). The remaining challenge is measuring and monitoring the progress and effectiveness of actions undertaken to meet the targets (EPA, 2020). To improve governmental capacity, the Land Development Agency (LDA) will coordinate the actions and finance them through the Rural and Urban Regeneration and Development Funds (DHPLG, 2021). Brownfield development tends to be obstructed by underlying dynamics of profitability and the attractiveness of greenfield areas (OECD, 2022). Several policies, such as the vacant land levy or the vacant homes tax, that will be introduced in 2023 (DoF, 2022) are considered an opportunity to reduce unused lands and derelict sites

and improve the provision of affordable housing (Williams and Nedovic-Budic, 2016). However, these policies, which are essentially short-term solutions, may not be adequately effective because of their reactive nature. A more structural approach, which involves long-term strategies to address root causes of problems, is likely to be necessary to transform mindsets.

The continuing growth in urban populations presents an opportunity to implement the principles of sustainable and low-carbon compact development. The need for a nourishing, affordable and sustainable living environment, including housing and urban infrastructure, for everyone is currently unmet, as manifested in the housing crisis (NESC, 2020). By integrating inclusive strategies that aim to adapt to changes in climate conditions and mitigate further adverse effects on the climate into their development, cities can become smarter and more appropriately adapted to changing conditions (Dodman et al., 2022). It is necessary to incorporate social justice considerations into urban planning and development, based on existing knowledge of grey infrastructure and nature-based approaches. As a result, the design of new places and the upgrade and redesign of existing infrastructure will benefit all and alleviate prevailing inequalities (Dodman et al., 2022).

The unique features of urban areas make them crucial sites for potential climate actions but also leave them vulnerable to increased exposure to risk (Dodman et al., 2022). A concentrated, built-up environment amplifies certain climate change impacts. For instance, the urban heat island effect intensifies the impact of climate warming, and a built-up area magnifies runoff and flooding following heavy rainfall. The coastal or riverside location of human settlements increases exposure to climate change hazards such as rising sea levels and flooding (Hobbie and Grimm, 2020). In 2016, 1.9 million people, or 40% of the population, were residing within 5km of the coast in Ireland (CSO, 2017; see Volume 3 Chapter 4).

Box 3.1 Digital tools to support spatial planning

Expert contribution from Rob Kitchin

Undertaking effective spatial planning to address issues of climate change requires an in-depth, evidence-based approach to spatial decision making (Wilson and Piper, 2010). This requires high-quality, granular and timely geo-referenced data, and suitable digital tools for handling, analysing and acting on these data. Both are underdeveloped in the Irish system, with a lack of suitable data and a relatively weak use of digital planning systems. Planning, property and environmental data openly available for analysis are generally published at a course scale (local authority, region) (Kitchin et al., 2016). Finer-grained data at small area or electoral district level lack timeliness (e.g. census every 5 years). There are some real-time environment and transport data, but they lack geographical coverage (Kitchin and Stehle, 2021). Granular data generated within the planning system and property sector are used for operational decision making on individual developments, but are generally not used for strategic planning except in an aggregated form. Ireland is making progress towards a digital twin in terms of spatial data through Ordnance Survey Ireland, but not associated attribute data, and there are also issues of data standardisation across planning authorities and aligned data governance (Kitchin et al., 2021; DHLGH, 2022b). There is a sizable gap in open data relating to commercial planning and property data. The predominant means of making sense of these data are geographic information systems (GISs), which every local authority utilises for asset and infrastructure management and plan making. However, GIS use and capabilities in the Irish system have been reported to be quite weak, and improvements necessitate time and institutional efforts (González et al., 2011). Building information management (BIM) is becoming more common, but is limited to managing large-scale developments. The use of other digital tools, such as expert systems, spatial decision support systems, 3D spatial media (e.g. city information modelling) and interactive participation platforms for consulting the public on planning, is very limited except for some use by a handful of local authorities (Kitchin et al., 2021). Ireland has taken a number of positive steps towards addressing the data deficit through the adoption of data strategies, investment in new data infrastructures, and co-funding research (for instance SEAI GIS resources (SEAI, 2023c,e)). However, much more needs to be done to create the necessary evidence base to enable informed decision making, monitor progress towards milestones and targets, and deliver effectively on plan-led climate action.

3.2.2. Envisaging and delivering transformation

3.2.2.1. Integrated spatial planning

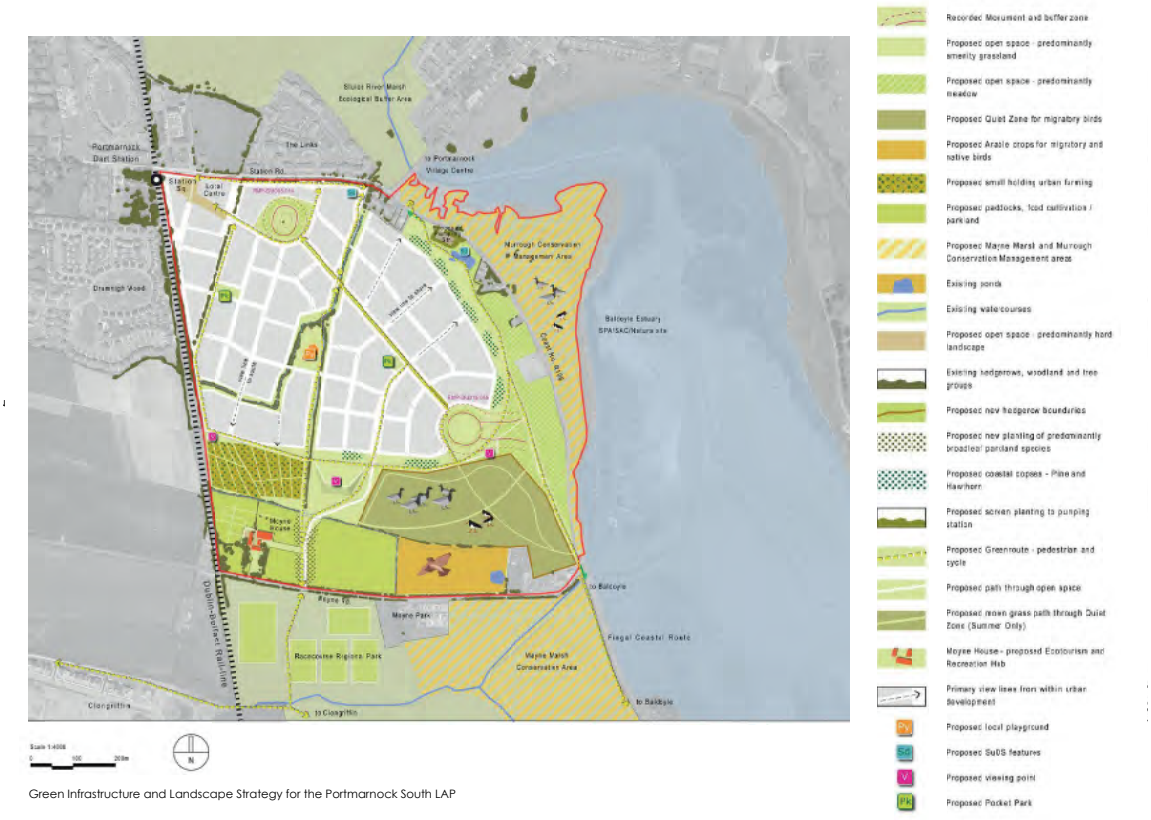
A systematic approach to settlement planning could achieve the best results in terms of emission reduction and building resilience. Integrated spatial planning involves a comprehensive approach to land and space utilisation in urban and rural settings, aligning different functions and interests such as land use, infrastructure, environment and socioeconomic progress (IPCC, 2023, Synthesis Report). By employing integrated, multi-sector solutions that address climate risk and social inequalities, the effectiveness of adaptation and mitigation is enhanced, promoting a transition towards more resilient urban and rural systems (IPCC, 2023, Synthesis Report).

Integrated spatial planning that incorporates compact and resource-efficient development of urban areas could lower GHG emissions by one quarter by 2050 compared with a 'do-nothing' scenario (Lwasa et al., 2022). This change could be achieved through higher density and co-location of residential and work places, mixed land use and transit-oriented development. The IPCC also advocates for climate-resilient development, stressing the importance of incorporating climate considerations into all facets of development planning and decision making (IPCC, 2022). The NPF emphasises the need for a long-term and more integrated approach to land-use and transport planning that focuses on climate change and sustainable urban development (Thomas, 2019). A participatory approach to development is one part of a just transition. At a local level, it involves collaborative multi-stakeholder engagement in planning processes through place-based experimentation such as urban labs (Collins et al., 2021). Controversies can arise when the redesign process is not perceived as inclusive, as evidenced by the disputes that ensued following the implementation of low traffic neighbourhoods in London (Hickman and Afonin, 2022). In Ireland, the Strategic Housing Development (SHD) process designed to expedite large housing projects faced criticism for lacking inclusivity. As a result, many opponents have sought judicial reviews, challenging the planning decisions and seeking to overturn the granting of planning permission (Lennon and Waldron, 2019; Mason Hayes and Curran, 2021). See Chapter 8 for information on a participatory approach to climate action.

Spatial planning provides the policy, institutional and practice-based context within which compact, sustainable and smart growth can be achieved (Camagni, 2017). Given the cross-sectoral nature of contemporary challenges, integrated spatial planning strives to improve coordination between various stakeholders at different levels of government (central, regional, local) and also across policy domains. This 'place-based turn' in public policy strives to deliver impact beyond traditional land-use-based approaches and administrative boundaries. Increasingly, integrated spatial planning takes a transport-oriented approach – combining compact growth, public transport and environment imperatives – but achieving its potential requires new institutional arrangements and tailored funding mechanisms (NESC, 2019). Similarly, a rescaling of activities is also a feature of more integrated spatial planning, with attempts to deliver impact at the scale at which the economy works and people live (Vigar, 2009). The development of 12-year metropolitan area strategic plans (MASPs) for Ireland's five largest cities represents a new planning and investment framework to deliver on national strategic objectives by concentrating infrastructure, investment and new development into the existing urban footprint. These ambitious plans, however, require much stronger implementation and devolution of authority and resources from central government to achieve their potential. At a more local scale, the 10- or 15-minute city concept provides an opportunity to apply a more integrated approach to planning neighbourhoods around service provision, liveability and environmental protection. In Ireland, the average distance travelled per journey increased by almost 60% in the 20-year period from 1986 to 2006, during the significant economic boom known as the Celtic Tiger years (CSO, 2020). Over the same period, GHG emissions from transport more than doubled (EPA, 2022b). These longer journeys, particularly if carried out as a daily commute, can have a detrimental impact on human health (Clark et al., 2020; Stutzer and Frey, 2008) and on household expenditures. The regional assemblies in Ireland have identified key towns below the metropolitan scale that have the potential to be enhanced using the 10-minute framework centred on the (re)development of urban neighbourhoods, where basic services – access to public transport, groceries, work and education, social and healthcare, and leisure amenities – can be provided within a 10-, 15- or 20-minute walk or cycle from home. The Limerick digital district currently under planning has significant potential in this regard to revitalise Limerick city centre (Government of Ireland, 2019).

Box 3.2 Integrating green and blue infrastructure into spatial planning

Green and blue infrastructure is understood as a mechanism for delivering various social, environmental and economic benefits through the strategic management of an integrated network. The interconnected network of green spaces, in both cities and rural areas, creates conditions for preserving natural ecosystems while also providing a range of benefits to local communities in terms of quality of life (Scott et al., 2016c). An example of such approach is illustrated in Box 3.2, Figure 1. It can also be used to protect society against climate change hazards (EEA, 2021a). Utilising nature-based strategies holds promise for regenerating landscapes that benefit human wellbeing through healthy ecosystems (Douglas et al., 2017; Lennon et al., 2017). Expanding access to green space could prevent a significant number of premature deaths (Barboza et al., 2021). An important advantage of nature-based approaches is their flexibility and multifunctionality (unlike grey or technical adaptation measures), i.e. their ability to provide multiple ecosystem services. (see Volume 3 Chapter 6)



Box 3.2 Figure 1 The local area plan for Baldoyle–Stapolin and Portmarnock South facilitates high-quality urban extensions to Baldoyle and Portmarnock while concurrently protecting the ecological integrity of the Baldoyle Estuary. Source: Scott et al. (2016a, 2016b).

The NPF promotes health-centred design and planning. It commits to prioritising walking and cycling in proposed developments, promoting activity-based recreation through greenways, blueways and peatways, incorporating green and blue infrastructure planning into land-use plans, enhancing resilience to climate change through green and blue adaptation efforts, and improving air quality as a result of integrated land-use and spatial planning (EPA, 2020).

The application of an ecosystem approach and the incorporation of green infrastructure into spatial plans can address the challenges of biodiversity loss and climate change adaptation in the Irish planning system. Mechanisms to deliver ecologically sound outcomes include the use of strategic environmental assessment and green roofs and walls, sustainable urban drainage systems, the temporary use of undeveloped areas, and design guidance in local area plans (Scott et al., 2016b). The core principles that underlie the green infrastructure approach are respect for context and recognition of the fundamental importance of green infrastructure assets, multifunctionality, connectivity, integration and resilience (Scott et al., 2016a).

Co-creation of urban greening emerges as a participatory approach to planning green infrastructure. The shift from relying solely on experts to a collaborative approach, in which experts, researchers and local communities work together, changes the dynamics among them. This shift has significant implications for policymakers and practitioners involved in developing the built environment as it creates opportunities for collective creativity and capacity that could lead to more sustainable ways of living. By incorporating input from both communities and policy/practitioner recommendations, a specific set of actions is formed to effectively implement the community greening strategy and promote a more fair and inclusive approach to developing green infrastructure (Clavin et al., 2021).

3.2.2.2. Compact development and mixed land use

Compact urban form represents the most suitable model for urban redesign and development that is energy and resource-efficient and comes with multiple benefits (Table 3.1). Irish evidence supports compact urban development as a means to reduce domestic energy use for space heating, showing that the compact city scenario decreases heating energy consumption by more than 15% compared with the dispersed city scenario (Liu and Sweeney, 2012). Urban energy use is driven down by greater "density, diversity (mixed land uses), design (street connectivity), destination accessibility, and distance to transit" (Lwasa et al., 2022, p. 56). It is recommended that cities are planned for a low-carbon footprint by co-locating more densely housing and jobs and commerce, mixing or diversifying various land uses, designing highly connected streets and increasing accessibility through shorter travel distances and journey times that enable travel by various transport modes (Seto et al., 2021; Lwasa et al., 2022). Compact planning results in smaller dwelling units and parcel sizes, and higher density of intersections, which provides walking opportunities and better access to shopping. Urban form with these features promotes physical and mental health, decreases demand for resources and saves land for non-urban functions (Lwasa et al., 2022). Cities can be redesigned to offer improved social infrastructure in neighbourhoods that supports communal life and provides spaces and facilities near where people live. As a result, a rich and varied social and public life can be created and sustained (Klinenberg, 2018).

Table 3.1 *Potential co-benefits (green arrows) and adverse side-effects (orange arrows) of urban mitigation measures. Arrows pointing upwards indicate a positive effect on the objective or concern. The effects depend on local circumstances and the specific implementation strategy*

Mitigation measures	Effect on additional objectives/concerns		
	Economic	Social (including health)	Environment
Compact development and infrastructure	↑ Innovation and productivity	↑ Health from increased physical activity	↑ Preservation of open space
	↑↑ Higher rents and residential property values		
	↑ Efficient resource use and delivery		
Increased accessibility	↑ Commute savings	↑ Health from increased physical activity	↑ Air quality and reduced ecosystem and health impacts
		↑ Social interaction and mental health	
Mixed land use	↑ Commute savings	↑ Health from increased physical activity	↑ Air quality and reduced ecosystem and health impacts
	↑↑ Higher rents and residential property values	↑ Social interaction and mental health	

Source: Seto et al. (2014; their table 12.6).

Established cities and new developments can achieve compactness by following specific recommendations related to each land use. Established cities will achieve the largest GHG emissions savings by replacing, repurposing or retrofitting the building stock, and strategic infilling and densifying, as well as through modal shift and the electrification of the urban energy system (Pathak et al., 2022). New developments have the potential to significantly reduce GHG emissions while achieving a high quality of life by creating compact, co-located and walkable urban areas with mixed land use and transit-oriented design, and preserving existing green and blue assets (Pathak et al., 2022), such as in the Cork metropolitan area development. Urban infrastructures and urban form can enable sociocultural and lifestyle changes that can significantly reduce carbon footprints (Pathak et al., 2022). See Chapter 5 for information on facilitating lifestyle changes through infrastructural interventions.

3.2.2.3. Brownfield/infill and greenfield development

Directing compact development in both brownfield and greenfield sites by targeting the causes of sprawl is likely to enhance the appeal of places and improve the chances of fulfilling climate and wellbeing objectives. If affordable housing is unavailable in areas experiencing high growth, individuals may choose homes located on greenfield sites that are farther away (Williams and Nedovic-Budic, 2016). In 2021, Ireland set a goal of constructing 40% of new buildings on brownfield/infill sites rather than greenfield sites in urban areas and 30% in rural areas (DHPLG, 2021). However, regulations still allow for 60% of urban development and 70% of rural development to take place in greenfield areas (DHLGH and DRCD, 2022). Proposals have been made to impose a vacant land tax to encourage development in central urban areas with unused spaces and derelict sites (Williams and Nedovic-Budic, 2016). However, this may not adequately address the underlying factors that make greenfield development attractive. A more transformative and effective solution would be to take direct measures to increase the profitability and appeal of brownfield development. This can be achieved by improving the government's capacity to lead the redevelopment process by enhancing the understanding of brownfield areas, estimating their potential for redevelopment, ensuring sufficient green spaces, promoting compact growth objectives, creating attractive spaces and carefully planning necessary greenfield development (OECD, 2022).

There is a widespread acceptance among policymakers, and an emerging realisation among citizens, that 'business as usual' cannot continue (GoI, 2018). The NPF advocates densification through infill development, brownfield reuse and the creation of high-quality walkable urban environments within the existing urban footprint. Enhancing the viability and attractiveness of brownfield redevelopment to compete with greenfield development requires a range of policy responses, fiscal incentives and strong land management. Rather than considering brownfields as 'problem sites', their redevelopment supports the creation of more sustainable urban neighbourhoods, minimises agricultural land take and helps to reduce emissions. Planning authorities should adopt a sequential approach to development favouring brownfield over greenfield sites for new development. In Ireland, the development of a new campus at Grangegorman for Technological University Dublin (TUD) provides a model for what can be achieved in conjunction with excellent transport planning. Retrofitting historic buildings can also save on carbon emissions produced in new construction (cement and steel), enhance social capital and economic output and enhance urban liveability (Kollewe, 2023). An analysis of the potential of Cork Docklands suggests that if appropriately developed it would generate a potential yield of 9,500 residential units, 9,500 jobs based on 920,000m2 office space and additional jobs from services, retail and restaurants, etc. (SRA, 2020). This would deliver a step change for public transport viability in the city and bring a long-derelict area back into productive use. This is similar to the transformative impact that the Dublin Docklands redevelopment has had on the city and national economy since the mid-1990s.

Box 3.3 Governance of compact urban development

Expert contribution from Niamh Moore-Cherry

How we plan land use, manage its use and develop areas has significant environmental, social and economic outcomes. Traditionally a zoning-based approach has been used to govern urban development but a broader range of policies (including fiscal policies) can be appropriately used (OECD, 2017). In Ireland, compact urban development has been identified as a key national strategic outcome (NSO_1) of the NPF. The promotion of more compact urban development arises from the NPF, but also from the three Regional Spatial and Economic Strategies (RSESs), which have a target of 50% of new development on infill or brownfield sites in metropolitan areas and 30% in other places. New institutions such as the LDA, along with central, regional and local government, are responsible for delivery, and the new MASPs for each of Ireland's five cities identify specific areas within which densification should occur. Compact urban development is being delivered in practice through targeting vacant or under-utilised state lands for more active land management. For example, the LDA has developed the State Lands Database to ensure state land is being appropriately brought into re-use and deployed to meet strategic objectives. One example is the master planning of the former Central Mental Hospital in Dundrum (Dublin), which should deliver almost 1,000 affordable homes, and the proposed redevelopment of the north docks in Waterford (Moore-Cherry et al., 2023). In the latter case, the LDA is providing public sector expertise and capacity to drive the regeneration of a complex site. Through collaboration across a number of government and other agencies, strategic development zone (SDZ) status, which streamlines planning, and €126 million state funding for a state-of-the-art sustainable transport hub, Waterford will be an exemplar of integrated and compact city centre development and transport infrastructure in Ireland. This funding has been provided through the Urban Regeneration and Development Fund, one of four funds established by the government as part of Project Ireland 2040 (PI2040) to incentivise more compact and sustainable urban development. However, a commitment to multi-annual funding and resourcing local/regional authorities appropriately to monitor and drive development in a timely way is key.

3.2.2.4. Placemaking

Placemaking, a multidimensional process, involves crafting high-quality spaces that resonate with people, fostering a sense of attachment and desire for interaction. This approach encompasses the comprehensive planning, design and management of public areas to engender shared value and enhance individual wellbeing and contentment. Successful placemaking relies on grasping territorial dynamics, acknowledging local strengths and comprehending interconnections, thereby enabling effective place-based policymaking (Moore-Cherry et al., 2022).

Placemaking has the potential to catalyse community adaptation to climate change-induced events (Raven, 2020) as well as reduce emissions through the adoption of new urban models (Nieuwenhuijsen, 2021). By fostering community engagement and strengthening the connection between urban ecologies and residents, it becomes a tool for narrative creation and urban cohesion (Nursey-Bray, 2020). Integrating climate adaptation strategies into public space planning underpins the efficacy of placemaking (Santos Nouri and Costa, 2017).

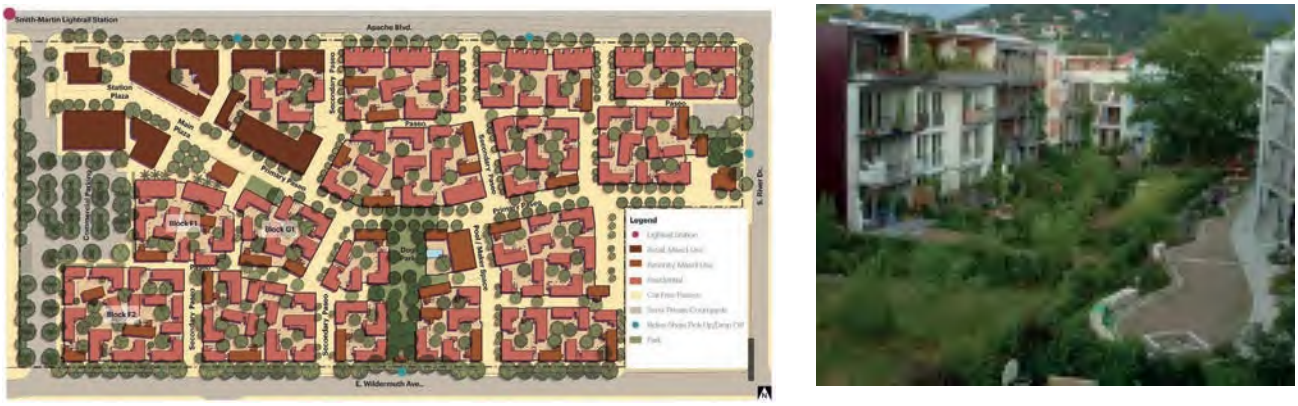
Emerging solutions such as superblocks, the 15-minute city, car-free neighbourhoods and low-traffic neighbourhoods (Figure 3.1) have demonstrated the capacity to diminish pollution, combat the heat island effect, elevate green spaces and promote physical activity (Nieuwenhuijsen, 2021), also contributing to creating more liveable cities with stronger inhabitant identity (Rapid Transition Alliance, 2023). Transitioning from car-oriented to active and public transport infrastructure poses significant challenges, including the need to reshape perceptions, attitudes and behaviours (Nieuwenhuijsen, 2021).

The models listed above show promising results when it comes to reshaping attitudes towards sustainable travel and reducing car dependency, with far-reaching impacts that are yet to be fully quantified (Rapid Transition Alliance, 2023). Implementation of car-free zones has notably slashed CO_2 emissions and enabled pedestrians access to urban spaces, and the Car Free

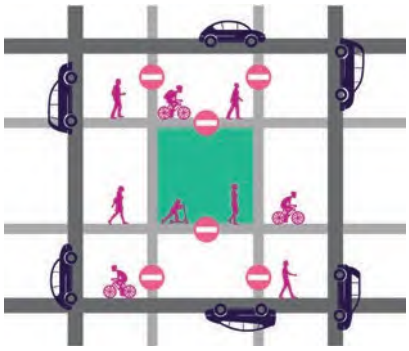
Cities initiative continues to expand (Possible, 2023). Low-traffic neighbourhoods are effective in reducing car ownership, decreasing street crime and injuries, and fostering safer residential environments for social interaction, play and exercise, with particular benefits for underserved communities (Nieuwenhuijsen, 2021). Analysis of vehicle ownership data reveals a 7% decrease in car or van ownership after 3 years compared with a control group (Laverty et al., 2021). Proposed 'superblocks' in Barcelona, comprising 503 blocks, are projected to avert 667 premature deaths a year through reduced pollution, noise and heat and augmented green spaces, additionally generating an annual revenue boost of €1.7 billion (Mueller et al., 2020). According to Andersen (2021), 59% of the Irish population views walkability as a desirable attribute for living and working in a neighbourhood, yet only 10% currently reside within a 15-minute walk to essential amenities, encompassing education, work, transport, nutrition, healthcare and recreation. This alignment with strategic priorities is discussed in proximity-based urban planning, as advocated in the NPF and National Development Plan (NDP), but the implementation requires substantial time.

(a) 15-minute city

(b) Car-free neighbourhood/city

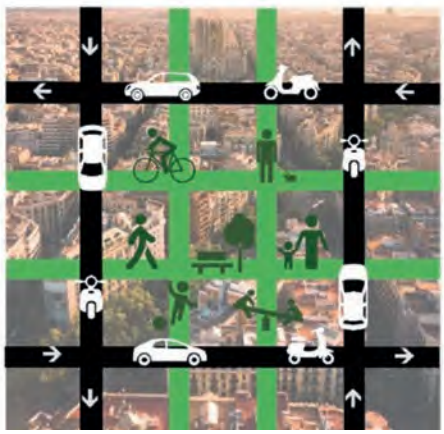


(c) Low-traffic neighbourhood



(d) Superblocks

Baseline Situation



Superblocks model

Figure 3.1 Emerging urban models with promising potential for mitigating and adapting to climate change, and offering improved wellbeing benefits. Sources: (a) Left: Andersen (2021). Right: <add photo credit?>. (b) Left: Cul-de-sac design. © Opticos Design, Inc. Right: Nieuwenhuijsen (2021). Reproduction licensed under the Creative Commons Attribution CC BY-NC-ND 4.0 licence (https://creativecommons.org/licenses/by-nc-nd/4.0/). (c) Aldred and Verlinghieri (2020). Reproduction licensed under the Creative Commons Attribution CC BY-NC-ND 2.0 licence (https://creativecommons.org/licenses/by-nc-nd/2.0/deed.en). (d) Left: Nieuwenhuijsen (2021). Reproduction licensed under the Creative Commons Attribution CC BY-NC-ND 4.0 licence (https://creativecommons.org/licenses/by-nc-nd/4.0/). Right: Mariona Gill, 2020 (www.barcelona.cat). Reproduction licensed under the Creative Commons Attribution CC BY 4.0 licence (https://creativecommons.org/licenses/by/4.0/).

Box 3.4 Road space reallocation

The design of urban space plays a significant role in determining the transport system. Rethinking this design offers an opportunity to change urban transport, with a new paradigm that prioritises people and places instead of cars and can reduce dependence on cars. This involves viewing road space as a public space that enables the movement of people and, at the same time, creates a sense of place. For instance, the One Network Framework is a classification tool that operates on both dimensions of movement and place (Box 3.4, Figure 1).

Currently, motorised traffic is prioritised in cities, with a dedicated share of 70–80% of public space (McArthur et al., 2022). This practice enforces a vicious cycle of car dependence and high carbon emissions. Road space reallocation is identified as a key policy recommendation for Ireland that has transformative power, as it challenges the existing mental model of using public space and of mobility (OECD, 2022). While the allocation of space between buildings has traditionally been considered an engineering domain, there has been a recent shift from the paradigm of the street as a road to the street as a space (Banister, 2008).

Box 3.4 Figure 1 The One Network Framework (ONF) adopted in New Zealand divides the transport network into different categories of street. Source: Waka Kotahi NZ Transport Agency (2023). Reproduction licensed under the Creative Commons Attribution CC BY 4.0 licence (https://creativecommons.org/licenses/by/4.0/).

Street space allocation involves governance and political and normative considerations, yet it remains largely unresearched, and the mechanisms of allocation are rarely informed by scientific evidence (Bertolini, 2020; De Gruyter et al., 2022). Although allocation devices may consider perspectives such as transport, sustainability, climate, fairness and wellbeing, these are difficult to balance (Creutzig et al., 2020). In Ireland, existing quality and street audits are voluntary and evaluate projects against the objective set for a given project, rather than standardised wider goals. While this approach is important from the point of view of project completion, it is not always aligned with progressing the overall vision and strategy (OECD, 2022).

Advocates of 'streets for people' movements propose the removal of cars from cities. However, the design of road space needs to balance movement with the place function of streets (Diemer et al., 2018; McArthur et al., 2022), recognising that moving people and goods does not necessarily mean increasing mobility but accessibility, and that placemaking needs to concentrate on the wellbeing of local residents and businesses, as both contribute to climate and sustainability targets (Stefaniec et al., 2021). Tactical urbanism is not widely used in the Irish urban environment. Instead, the public is consulted on top-down interventions, which are implemented only partially, such as the pedestrianisation of Grafton and Capel Streets in Dublin and the 'Reimagining Cork City' actions. Interventions for reallocating urban space in Ireland are scarce or at only the planning stage, while the existing empirical research is insufficient to inform decision making. An assessment of space allocation in Irish cities has not yet been conducted and a reallocation mechanism has not been developed.

3.3. Transport networks and mobility

Systemic changes within the urban system's structure and interactions of its elements are necessary to turn away from unsustainable development and mobility patterns. Policies most often target observed outcomes of system operation, such as traffic jams or pollution peaks, which can be seen as the tip of the iceberg. The iceberg below the water is made up of the system design and the mental models that can manifest in traffic problems and pollution (Figure 3.2). Mental models are subconscious beliefs that shape people's understanding of the world and influence their actions (OECD, 2022). Someone who subconsciously believes public transport is unreliable will opt to drive, even when public transport is efficient. Instead of redesigning or transforming systems, most transport policies in Ireland focus on improving the properties of specific elements of the system, such as vehicle technology. However, the source of the problems, not just the manifestation, should be targeted by policy (OECD, 2022). The change starts with envisaging a well-functioning and equitable transport system, followed by understanding why the current system is underperforming. Policymakers pursuing a systemic approach can then prioritise and scale up policies that have the capacity to redesign the system, which entails changing unsustainable patterns of behaviour. For instance, a lack of parking spaces at the workplace discourages driving to work.

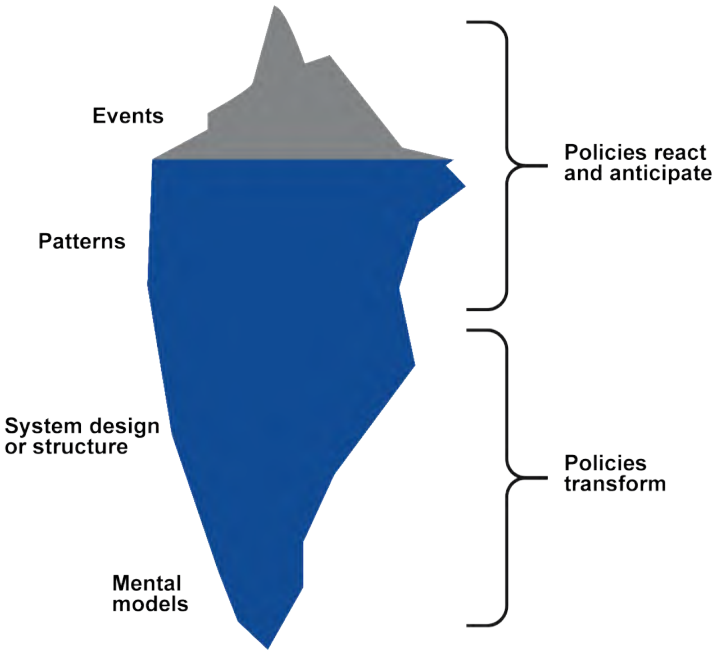


Figure 3.2 Categorisation of policies based on their transformative power. Source: OECD (2022).

To achieve climate targets, a change in approach to planning from forecasting to shaping transport demand is required. Achieving the climate targets set for Ireland requires going much below the emission reduction observed during the COVID-19 lockdown or from best practice examples. This implies moving away from the 'predict and provide' approach, which is based on demand forecasting, and towards the 'vision and validate' approach that shapes demand through, for instance, clear targets set for trip reduction and an increase in the share of walking, cycling and electric public transport journeys (Banister, 2008; RTPI, 2021). Many interventions are beyond traditionally understood transport planning, and their effective implementation will require integrating transport with land-use planning (Royal Town Planning Institute, 2021). The integrated approach is needed to transform current unsustainable mobility patterns, along with planning, designing and delivering new developments that are net zero, preferably carbon negative, and contribute to emission reduction on a wider scale (Banister, 2008; Royal Town Planning Institute, 2021). Social justice impacts will need to be accounted for when new infrastructure, solutions and technologies are being introduced (Caulfield et al., 2022; de Ruijter et al., 2023). Given the significant disparities in air pollution exposure and other wellbeing factors, concerns related to social justice also serve as a catalyst for decarbonisation policies such as low-traffic neighbourhoods and traffic calming measures.

3.3.1. Current challenges and opportunities

Ireland's land transport is largely organised around the goal of mobility, rather than accessibility, which leads to unsustainable travel patterns such as car dependence. This means that transport planning is oriented towards accommodating the increasing movement of people and goods, rather than shortening distances between people and places. Redesigning the mobility system towards sustainable accessibility would enable people to use active and shared modes of transport for the majority of trips and provide these options for delivering goods. High transport emissions result from a car-oriented infrastructure that locks in high car use, but also from time, price and convenience benefits favouring private vehicles (OECD, 2022).

A strong preference for car use in Ireland is caused and further reinforced by induced demand, urban sprawl, and the marginalised role of public transport and active travel modes. The mechanism behind induced demand is that improvements in transport infrastructure generate greater demand(Hymel et al., 2010). Effective spatial policy is needed to prevent scattered and low-density housing development patterns, known as urban sprawl, which increase distances to frequent travel destinations and consequently increase the need for motorised travel and longer commutes. Dispersed spatial configurations generate high demand for road infrastructure and hinder the provision of adequate sustainable mobility options (DTTAS, 2019). Ireland has high levels of vacancy in urban areas due to decades of extra-urban and edge development, and a lack of people willing to relocate and revitalise traditional town and village centres (see Volume 3 Chapter 6 section 6.2.1).

Retail centres located outside city centres generate higher levels of traffic and emissions than centres in the city, as they are designed for and accessible to car users and poorly connected by public transport nodes (O'Driscoll et al., 2022).

As a result of existing spatial conditions and car-oriented development, road transport emissions dominate the transport emission profile, accounting for 94% of total transport emissions, which translates into 16.7% of total emissions (EPA, 2022a). Half of the road transport emissions are produced by private cars, and the remainder by primarily heavy and light goods vehicles, with a marginal share of 7% for buses (EPA, 2022a). On a national scale, 71% of all journeys are taken by car (CSO, 2021). A promising trend emerges from Dublin data, where public transport, walking and cycling accounted for 72% of all journeys into Dublin during peak morning times (NTA and Dublin City Council, 2020). Based on the measurement of PM2.5 concentration between 2016 and 2018, it is estimated that there will be about 723 deaths and 25 years of healthy life lost annually because of this air pollutant in Dublin, and 1,100 premature deaths in the entire country. Diesel vehicles will contribute to around 70 deaths and 3.8 years lost (Gallagher et al., 2021). Banning old diesel vehicles and stopping new sales from 2025 could cut NOx and PM2.5 emissions by half by 2030 (compared with 2015), saving 300 years of healthy life and €43.8 million (Dey et al., 2018).

Ireland has ambitious climate targets in place, and strategies that reflect these ambitions. The Climate Action Plan 2023 (CAP23) incorporates insights from the OECD report Redesigning Transport: Towards Irish Transport Systems That Work for People and the Planet, adopting the avoid–shift–improve approach; however, the subtargets are still misaligned with the goal of transforming the mobility system (Organisation for Economic Co-operation and Development, 2022). Despite revisions, CAP23 still prioritises policies with low transformative potential, categorised as reactive and anticipatory. These policies aim to minimise the negative effects of car use by encouraging the adoption of improved vehicle technology or zero/low-emission power sources such as electricity and biofuel, and account for half of the emission abatement target (DECC, 2022). Support given to improve vehicles only reinforces car dependence and the mindset of car culture, further locking the country into the current system.

Prioritising policies with high transformative potential can trigger realisation of untapped opportunities to reduce emissions and boost people's wellbeing. Transformative policies are those aiming to shift away from unsustainable systems dynamics and mental models so that the system, by design, encourages patterns of behaviour in line with the envisaged results and brings multiple co-benefits (see Table 3.2; Organisation for Economic Co-operation and Development, 2022). Such policies are at only the planning stage and have been implemented only marginally at small scale or in pilots.

Nevertheless, efforts have been made to initiate transformative change, including the vision presented in, for instance, the National Sustainable Mobility Policy (DoT, 2022a) and the Transport Strategy for the Greater Dublin Area 2022–2042 (NTA, 2022b). However, these promising initiatives aimed at creating liveable communities require further instruments to fully realise the envisaged outcomes. Continuous work and development are under way, including the establishment of a new National Demand Management Strategy (DoT, 2023c), the Pathfinder Programme (DoT, 2022b), closer engagement with the Department of Housing, Local Government and Heritage, and consultations on improving the rail network (DoT, 2023a). These ongoing efforts demonstrate a commitment to addressing the gaps and challenges in realising the desired vision.

Table 3.2 *Potential co-benefits from transport sector transformation beyond GHG mitigation*

Economic co-benefits	Social co-benefits	Environmental co-benefits
Congestion reduction	Reduction of air pollutants (particulate matter, sulfur oxides, nitrogen oxides, carbon monoxide, volatile organic compounds)	Health improvements
Consumer spending savings		Crime reduction/security enhancement
Employment creation		Gender equity promotion
Small and medium-sized en-terprise development	Noise reduction	Universal access for physically disabled
Traffic accident reduction	Solid waste reduction	Convenience and comfort
Technology transfer	Water contaminant reduction	Community sociability
Reduced dependence on im-ports/ energy security		Reduction in community severance
Economic productivity/efficiency improvements		

Source: Rosenzweig et al. (2018).

3.3.2. Envisaging and delivering transformation

3.3.2.1. Transport modelling and project appraisal

To fully reflect the changes resulting from transformative policies, it is necessary to account for the complex dynamics of human behaviour and new mobility trends in transport modelling. Current modelling approaches still rely on traditional paradigms centred around mobility, forecasting traffic, accommodating demand, and speeding up traffic while minimising travel time. Sustainable mobility paradigms assume managing travel demand and shaping infrastructure for slowing movement down, providing reasonable travel times and reliability for all modes (Banister, 2008). This involves proactively shaping the future instead of forecasting demand or responding to changes in the current order. The modelling conducted for CAP23, which aims to design a pathway to reduce transport emissions by 50%, represents an advancement. It incorporates elements that influence demand by promoting behavioural changes, including measures such as establishing car-free urban centres, implementing congestion charges and introducing parking constraints (NTA, 2023).

Scenario development combined with storytelling techniques could be utilised as a tool for building the vision, the effects of which are then simulated. Scenarios and modelling complement each other, with scenarios outlining potential future outcomes and models calculating the impacts on the transport landscape applied in several analyses (Caulfield et al., 2020b). The integration of narratives and modelling is a crucial step in creating sound policy recommendations (Venturini et al., 2019a). When it comes to conventional modelling, human behaviour can be influenced by a variety of factors, such as personal preferences, changing lifestyles and unexpected events, which are difficult to predict. Incorporating consumer behaviour related to transport technology choices, modal choices, driving patterns, new mobility trends and other factors into transport and energy models could help to more accurately reflect the market (Venturini et al., 2019b). However, a more transformational approach to modelling is needed to guide climate decisions in policymaking, in which the participatory process of creating transport scenarios involves identifying driving forces, formulating narrative storylines, converting them into model attributes, simulating them and revising them with the involvement of stakeholders (Venturini et al., 2019a).

Broadening the approach to transport appraisal to take account of environmental and social concerns can assist in the development of transport planning that prioritises the hierarchy of sustainable mobility modes (Figure 3.3; Banister, 2008). Developing long-term strategic plans for transport policy objectives is crucial to ensuring that all transport projects align with these objectives. The appraisal process will need to take into consideration the objectives and incorporate accessibility indicators and tools to assess equity impacts. It is also important to provide guidance on accounting for climate change impacts and incorporating emissions reduction commitments (International Transport Forum, 2022a). Currently, the evaluation of transport projects in Ireland includes measuring emissions (DoT, 2023d), but this should be prioritised . It is recommended that investment in transport be ranked based on carbon reduction estimates and life cycle analysis (Caulfield et al., 2020a). Incorporating social impact assessment into transport project appraisal is desirable and included in the guidelines (DoT, 2023d); however, it lacks sufficient consideration in the Irish transport planning system (Ustaoglu et al., 2016; Martens, 2021). This can be improved by drawing on international research related to equity and accessibility-based analyses (e.g. Lucas et al., 2016) to translate these efforts into project appraisal in Ireland.

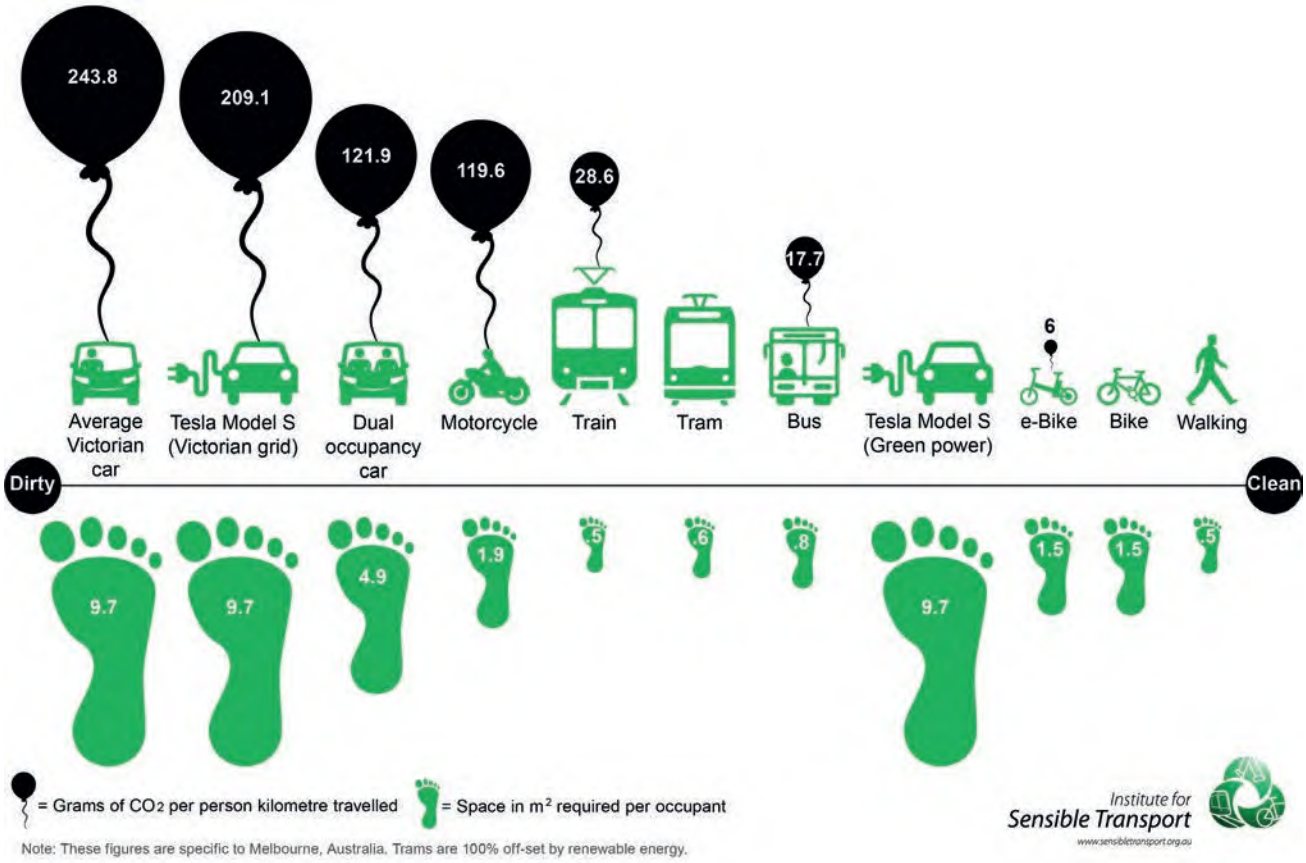


Figure 3.3 Hierarchy of transport planning decisions in relation to travel modes. Sources: Reproduced from Woodward (2021) with permission from the Energy Saving Trust (https://energysavingtrust.org.uk/an-introduction-to-the-sustainable-travel-hierarchy) and the Institute for Sensible Transport (2022).

3.3.2.2. Avoid–shift–improve framework

The avoid–shift–improve framework conceptualises a systemic change of travel through combining spatial and transport planning with behavioural management and technological innovation that facilitate the transformation (Figure 3.4; Creutzig et al., 2018). This framing allows for adapting a comprehensive sustainability approach instead of a low-carbon-only approach (EPA, 2020). It shows the long-awaited change from a short-term-oriented focus on mitigation to a long-term-oriented structural transformation of the transport system that brings widespread benefits for human health and equity. Most far-reaching actions are taken at the 'avoid' level, at which integrated spatial planning and demand management strategies enable avoiding or reducing unnecessary journeys. These actions are also cost-effective and reduce environmental pressure from transport, especially in the urban context (EEA, 2016). 'Shift' refers to shifting transport mode to more sustainable options such as walking, cycling, shared mobility and public transport, which can be managed through transport planning strategies. Besides cleaner air and noise reduction, the actions at this level have the capacity to improve human health by encouraging active travel. Finally, the 'improve' level includes engineering actions to improve the energy and carbon efficiency of vehicles, targeting their design, size, powertrain or type of fuel (EPA, 2020). Lighter, smaller vehicles that run on biofuels or electric energy are preferred. In other words, the avoid–shift–improve framework aims to reduce transport service demand as much as possible, shift remaining demand to less emitting modes and improve the carbon efficiency of the modes that are being used (Creutzig et al., 2022b).

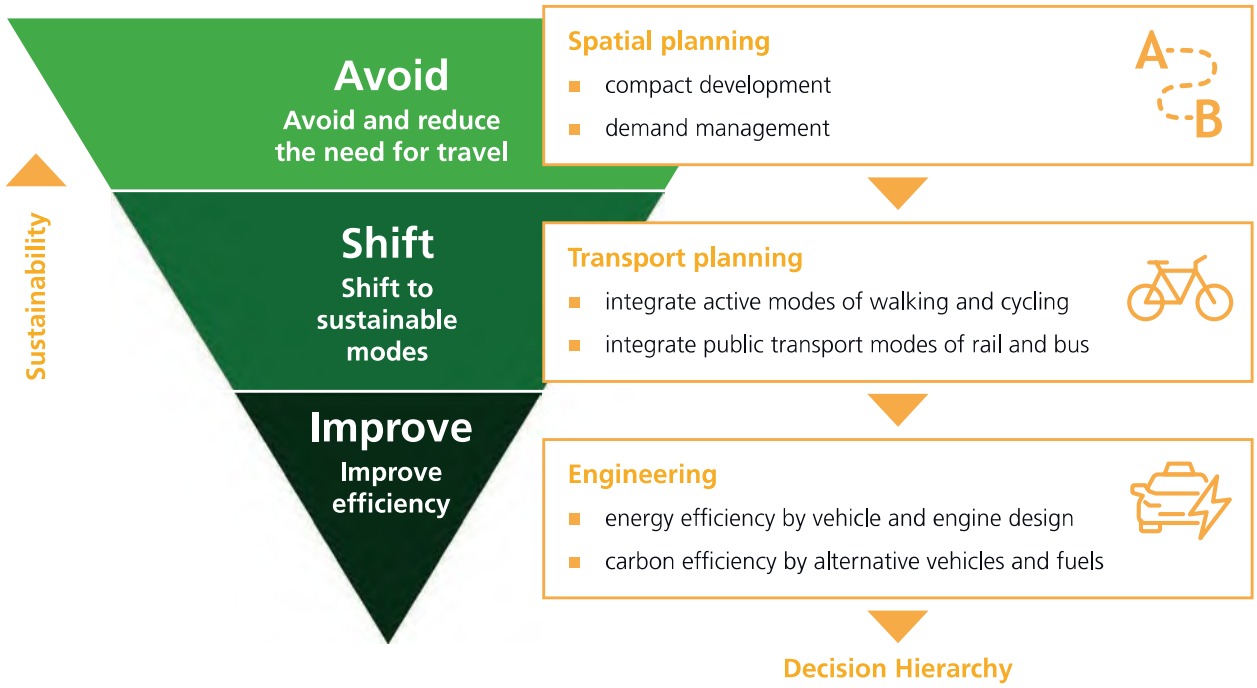


Figure 3.4 Avoid–shift–improve framework. Source: EPA (2020); figure created by Tadhg O'Mahony.

Measures at the 'improve' level, although necessary to reduce GHG emissions, are the least desirable in the long run. This is because replacing conventional vehicles with more energy- and carbon-efficient options will not solve the problems of congestion, noise pollution, land use and biodiversity degradation. Over-emphasising the importance of 'improve' actions (52% of emissions reduction, as estimated from CAP23 (DECC, 2022)), strengthens the lock-in caused by car dependence, which prevents successful implementation of actions at the 'avoid' and 'shift' levels. It reinforces the status of settlements as 'car oriented' instead of 'people oriented'. As a result, urban sprawl will continue, and congestion and demand for road infrastructure and parking will increase, affecting the quality of travel and living experience in urban areas and causing further loss of ecosystems and biodiversity (EEA, 2016).

Avoid and shift measures have been proven to be more effective than improve options in reducing emissions by 2050. Global urban transport scenarios show that embedding technological improvements into a wider sustainable transport strategy could reduce emissions by 80% compared with the business-as-usual scenario, while improving vehicle technology without altering high-mobility patterns could achieve only half of this reduction (Fulton, 2018). A transformative scenario for the UK shows that a policy package founded on shift and avoid measures could bring a 60% emissions reduction, while vehicle technology improvement would result in a 40% reduction (Barrett et al., 2022). With the increasing need to speed up emissions reduction to achieve the climate targets, transformative measures such as avoid and shift seem to be more effective. However, existing research in Ireland does not provide sufficient evidence of the potential effectiveness of a combined avoid–shift–improve strategy in different scenarios.

3.3.2.3. Reduced need for travel

Systemic change requires an answer to the fundamental question of whether, in a new mobility system, all transport activities are necessary. In other words, is growth in transport essential to maintain a good quality of life? The newest developments in science and practice suggest that many of the journeys that are subject to personal choice can be avoided without decreasing our living standards (Creutzig et al., 2022a). From a technical point of view, the transport system, in its present form, needs efficiency improvements, and the demand for it should be the subject of intelligent management. 'Avoid' measures can reduce unnecessary trips and boost occupancy (EEA, 2016). Spatial planning and digitalisation play an important role in decreasing transport activities.

Integrating transport planning with spatial planning facilitates the delivery of accessible and well-connected settlements. Spatial planning is a powerful tool that could reduce the demand for motorised transport by increasing the proximity of places that need to be accessed on a daily basis. When residential, work, education, commercial, social and leisure places

are planned jointly with transport links, urban energy use could be reduced by a quarter by 2050 (Pathak et al., 2022). Optimising the interconnection of transport and land-use planning has transformative potential not only to reduce the demand for travel but also to promote the use of sustainable modes through reduced distances. When the demand is shifted, journeys become more efficient, and options increase and connectivity between travel modes improves (DTTAS, 2019). [See section 3.2 for more information on spatial planning and urban form.]

Digital technologies could assist in reducing travel demand; however, further research is needed to fully understand the implications of using these technologies to reduce GHG emissions from the transport sector (Jaramillo et al., 2022). Information and communications technology (ICT) can play a significant role in reducing transport activity by providing alternative ways of working and shopping, and better integration of transport options through 'mobility as a service' (MaaS) technologies. It has been determined that the practice of working from home cuts down on commuting emissions; however, it leads to an increase in non-work trips and home emissions that may offset the energy and emissions savings (Stefaniec et al., in press). Working at remote work hubs can also lead to travel time and emissions savings compared with commuting, without generating additional residential emissions (Caulfield and Charly, 2022). It has also been noted that home relocation following the opportunity to work from home can invigorate towns and villages (DETE, 2021), with around 40% of those who can work from home stating that they would consider relocating (Stefaniec et al., 2022). Regarding emissions from retail, evidence from the UK suggests that online purchasing and in-store pick-up decreases GHG emissions, while online purchasing and parcel delivery increases emissions because of the number of items bought and the last-mile travel distance to the customer, which can be reduced by 26% if electric cargo bikes are used for deliveries (Shahmohammadi et al., 2020). In terms of MaaS technologies, these are primarily used as a tool for providing travel information and aiding decision making in Ireland; however, there is scope to use their potential to further encourage modal shift through various techniques of easing the decision process of selecting sustainable modes of travel (Caulfield et al., 2020a).

3.3.2.4. Shift to sustainable modes of transport

A shift to public and active transport modes is one part of changing mindsets towards sustainable mobility – an essential element of mobility system transformation. Urban design, policy measures and investment in sustainable transport infrastructure have been found to be important to support the shift towards low-carbon transport solutions that are also accessible and equitable (Jaramillo et al., 2022). Walking urban fabric has been shown to have higher health benefits from active travel and greater equity of accessing locations than transit or automobile urban fabrics, also generating from one third to a half less transport GHG emissions per person (Newman et al., 2016). Investing in a specific type of infrastructure influences the transport alternatives available (Jaramillo et al., 2022). The Pathfinder Programme consists of 35 diverse pilot projects, including infrastructure initiatives, to be implemented nationwide between 2022 and 2025 (DoT, 2022b). These projects hold substantial value by serving as templates for replication and scaling up, while also fostering social readiness for change.

In a short time frame, modal shift can be achieved through travel demand management associated with behavioural change (DoT, 2022a; Jaramillo et al., 2022). The policy instruments aim to encourage the use of sustainable alternatives (pull) while restricting the use of unsustainable modes (push). The list of measures in place or under consideration for implementation is extensive, with the measures having been piloted in several locations in Ireland (Government of Ireland, 2021). However, the effectiveness of these policy instruments requires continuous monitoring and research. In Europe, policy measures such as congestion charging, parking and traffic control, and limited traffic zones have been found to be the most effective measures in reducing private car use (Kuss and Nicholas, 2022). Compared with its European counterparts, Ireland has a significant deficiency in the development and implementation of demand-oriented transport policies (Caulfield et al., 2020a). An incentives-only approach that includes interventions in cycling and walking infrastructure, bus/rail services scheduling, and car-pooling and sharing was found to encourage switching between sustainable modes rather than switching from car trips to active and public transport in the Greater Dublin Area, leading to a reduction in the share of car travel of 1.6% (Carroll et al., 2021). Shifting the pathway poses a challenge but comes with multiple benefits for society, including better air quality, congestion relief, and health benefits from physical activity associated with active modes. The profound implication of the shift is that transitioning to low-carbon mobility addresses fairness in transport simultaneously (Mullen and Marsden, 2016).

3.3.2.5. Transit-oriented development

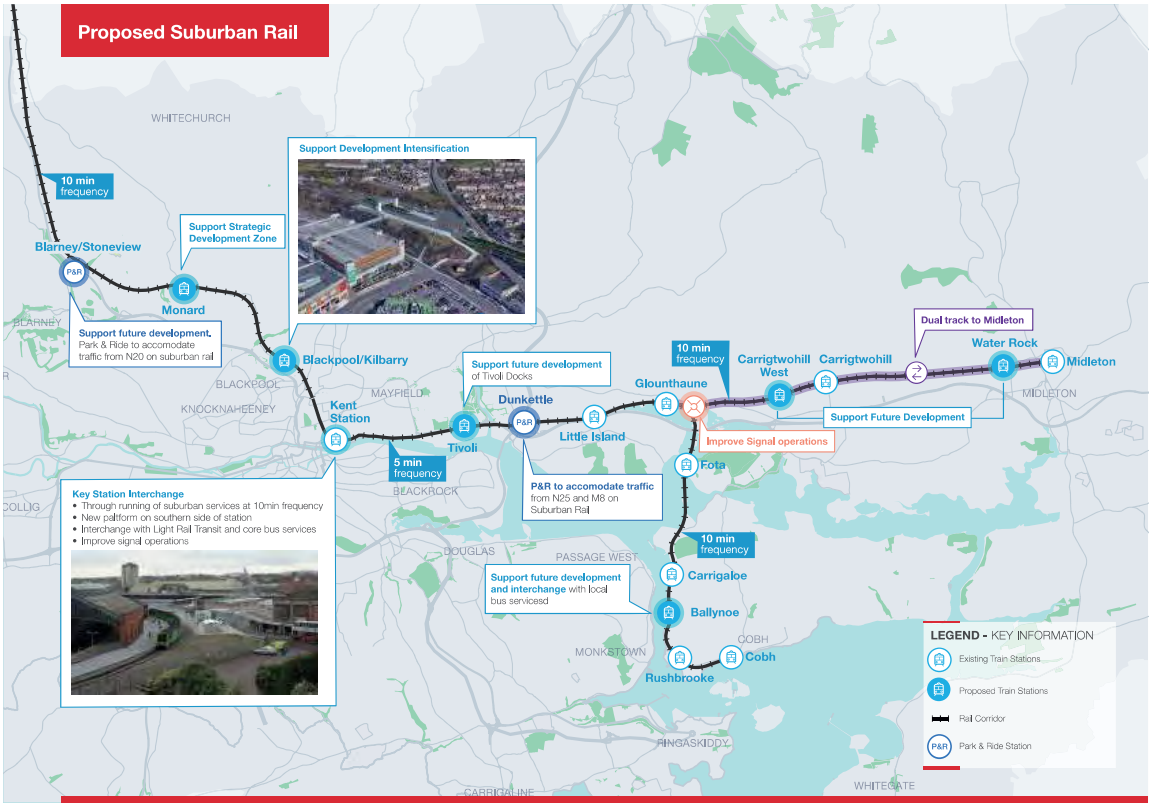
Transit-oriented development as a strategy for increased accessibility through rail and bus services substantially shifts travel behaviours from using private cars to using public and active transport. However, to reinforce its impact, additional measures are needed (Griffiths and Curtis, 2017). This strategy involves mixed and compact development built around a public transport node, for instance a train station, and along the transit corridor, such as bus rapid transit, to create walkable and diverse neighbourhoods in urban and suburban settings (Jacobson and Forsyth, 2008). It comes with benefits of improved accessibility and air quality and reduced sprawl into land, and opportunities for economic viability for transport operators. It can also potentially increase the supply of affordable housing if regulatory measures are in place (NESC, 2019).

The vision of transit-oriented development is incorporated into the NPF by prioritising compact growth, which emphasises the importance of achieving density and consolidated urban development. An experiment in Perth, Australia, showed that greater effectiveness of transit-oriented development can be achieved through improvements within the neighbourhood, such as a better quality of pedestrian infrastructure and lower parking space requirements, and beyond the area, such as improved public transport accessibility to other destinations within the metropolitan area. Despite these improvements, the dominance of car culture can only change with changing mental models (Griffiths and Curtis, 2017).

Evidence suggests that transit-oriented development has the potential to reduce CO_2 emissions for work and school trips rather than travel for other purposes (Ashik et al., 2022). However, the potential climate impacts of this planning strategy in Ireland have not yet been explored. From Irish literature, certain recommendations on the implementation of transit-oriented development can be drawn from research conducted in relation to the Cork rail corridor and Adamstown in Dublin (FitzGerald et al., 2019; NESC, 2019).

Box 3.5 Transport corridor for Cork metropolitan area

A high-frequency railway service was designed with the aim of shaping the growth of Cork metropolitan area along the corridor, with appropriate residential development, and commenced in 2009 when stations at Midleton and Carrigtwohill started operating (see Box 3.5, Figure 1). However, there are still some components of the railway corridor plan that have not been put into action, such as additional stations and a more regular train service for commuters. The East Cork railway corridor experienced significant population growth after the railway line to Midleton was reopened, but insufficient development around the railway stations caused much of this growth to happen in distant areas that were not ideal for supporting the rail service. This could be a result of a high-density policy that restricts housing types preferred by households (NESC, 2019). Although private cars continue to be the primary mode of transport, with a modal share of 74%, there is potential to offer more transport options and better service (NTA and Cork County Council, 2019).



Box 3.5 Figure 1 Development of a suburban rail corridor in the Cork metropolitan area. Source: NTA and Cork County Council (2019).

3.3.2.6. Shifting to public transport

Investing more resources in expanding public transport coverage, developing efficient transfer plans, reducing transit travel time and enhancing overall transit travel efficiency can make public transport a more appealing option (Jaramillo et al., 2022). Improved coordination between different services within a public transport system, and with other transport modes, can lead to increased efficiency of the entire system (Shrivastava and O'Mahony, 2009). An integrated, efficient and convenient system can then compete with private car usage. Research indicates that when comparing travel by bus, metro and train, commuters exhibit a greater sensitivity towards in-vehicle and waiting time than other factors. Therefore, promoting the use of public transport necessitates measures that increase the cost of car usage while simultaneously enhancing the convenience of transit

(Fearnley et al., 2018; Jaramillo et al., 2022). Current deficiencies in public transport reliability hinder people's satisfaction with the service (Hynes et al., 2018). The uptake of Irish public transport could potentially increase through better services, attractive pricing and ticketing, multimodal and regional integration, concurrent policies to discourage car usage, and land-use policies that promote compact and mixed-use development (Byrne Murray et al., 2013). Affordability and accessibility of public transport also constitute a means to achieve transport justice (Stanley and Lucas, 2008; Mullen and Marsden, 2016). First- and last-mile connections to public transport stops or stations can typically be covered by walking or cycling, but also shared mobility options if available, for instance a bike-sharing system (EEA, 2020). Through integration with the public transport system, micro-vehicles, such as e-scooters and electric bicycles, have the potential to be an attractive alternative to private cars for longer-distance trips as they extend the catchment area of public transport (Shaheen and Chan, 2016; Oeschger et al., 2020). Multiple benefits of public transport include freeing up space, reduced emissions and thriving social interactions.

Box 3.6 Debates surrounding fare-free public transport

Analysis of implementing fare-free public transport (FFPT) in Dublin highlights mixed outcomes (NTA, 2022a). Despite a predicted rise in public transport usage and financial relief for users, particularly those from lower-income brackets, it might not lead to a substantial reduction in car use. Instead, the shift might be away from active transport modes such as walking and cycling. In the initial stages of the policy there may be heightened transport overcrowding and potential antisocial behaviours on buses. Financially, Dublin could face an annual net cost of €350–€550 million, with an additional €140 million to address bus overcrowding. Furthermore, it is noted that the scheme would not be able to meaningfully deliver on emission targets.

Drawing insights from cities like Luxembourg, Tallinn, Hasselt and Dunkirk provides a more varied perspective on FFPT (Cats, 2017). For example, after Tallinn's introduction of FFPT there was a 29% increase in public transport usage. Luxembourg's nationwide policy was found to benefit up to 40% of households. Most European FFPT schemes have had a limited scope. Some specifically cater to particular demographics, such as youth and the economically challenged, to enhance social equity. Short-term promotional endeavours have been rolled out to augment the share of public transport, particularly during events like pollution incidents. During the COVID-19 lockdowns in western Europe, key workers benefited from FFPT access. Broad implementations of FFPT can offer numerous benefits, from social advantages for impoverished households to administrative cost reductions by eliminating ticketing infrastructure (Cats, 2017; Figg, 2021). However, to maximise the impact of FFPT, increased capacity of public transport and simultaneous introduction of disincentives to discourage car use is essential (Rapid Transition Alliance, 2021).

3.3.2.7. Shifting to active travel

Area-wide interventions that encompass reorienting processes, institutions and infrastructure are more effective in shifting to active travel than fragmented actions. Active travel involves physical effort such as walking or cycling. The health benefits of increased active travel in Dublin were found to outweigh the risks, such as vulnerability to traffic collisions and exposure to toxic pollution while travelling (Doorley et al., 2015; Masterson and Phillips, 2022). Greater confidence could be achieved through the availability and better coverage of traffic safety statistics. Surrogate measures of safety, such as near-crash data, can be used instead of actual data in assessing safety. Implementing forgiving road design that accounts for human error without leading to fatalities can decrease the likelihood of severe crashes and motivate people to cycle (International Transport Forum, 2016). Increasing provision of infrastructure designed for pedestrians and cyclists leads to reduced car use and emissions. A reduction of 2–10% in emissions from urban transport could be achieved depending on the setting (Jaramillo et al., 2022). Shifting to active travel is hindered by multiple factors. Cyclists and pedestrians have a compromised right to public space relative to drivers owing to the design and maintenance of the space, disregard of their rights as road users and a lack of protection of their rights from authorities (Egan and Philbin, 2021). The interventions that not only create expanded dedicated spaces for cyclists and pedestrians through reallocation of public space (see Box. 3.4. Road space reallocation) but also expand the rights of walkers and cyclists and the relative responsibilities of drivers can bring the aspirational hierarchy of road users into practice and build more equitable power relations in the public realm (DTTAS and DHPLG, 2019; Egan and Philbin, 2022). Behavioural science in the Irish context provides evidence of the importance of connectivity and perception of safety in the effectiveness of active travel initiatives (Timmons et al., 2023). Encouraging behavioural change towards cycling and walking is still at the stage of pilots, with considerable success but tested at a limited scale, for instance the Smarter Travel Areas programme (DTTAS, 2018). An increase of up to 15% in active travel among primary school students could feasibly be achieved if the interventions are of high intensity, include both infrastructure and behavioural measures, and are gender specific (Lambe et al., 2017; Egan and Hackett, 2022). Literature indicates that, to create long-lasting changes in behaviour, it is necessary to implement interventions on a large scale, also going beyond urban settings. This involves reorienting processes, institutions and infrastructure, in accordance with systemic change (Macmillan et al., 2020; Newell et al., 2022). Selected past and ongoing research projects include DiSTRaCT and ISCycle (SEAI, 2023b).

3.3.2.8. Shifting to shared mobility

Shared mobility and electric micro-mobility are recognised as niches that can create change as shared economy practices expand; however, there is much uncertainty around demand and associated emissions (EEA, 2016; Jaramillo et al., 2022; Figure 3.5). The strong growth of shared mobility in the market results from a gradual change in consumption patterns towards the sharing economy of using more and owning less, and community wellbeing benefits of sharing (Miramontes et al., 2017; Jaramillo et al., 2022), but also the emergence of new developments in ICT and other innovations. The key principle of shared mobility services is increased efficiency of the system, which is delivered through better use of infrastructure and higher occupancy of vehicles (EEA, 2016). It offers a range of options, from car-sharing, carpooling and bicycle sharing to on-demand rides, which aspire to replace car ownership. The most common vehicles being provided under shared mobility schemes are e-cars, e-bikes, e-cargo bikes, e-scooters and bicycles. Shared mobility hubs offer integrated multi-modal shared mobility services and facilitate intermodal transfers by providing various mobility options in close proximity (Miramontes et al., 2017). Currently, this solution is being piloted as part of the TRACT project (SEAI, 2022b). The operation, financial viability and governance of new mobility options are often presented as the main challenges of shared services and require investigation in the Irish context.

Shared mobility services offer several opportunities to address transport problems, including the potential to reduce congestion and pollution by substituting car trips with smaller and electric vehicles, improve accessibility for places with poor transport connections, promote social equity for low-income groups underserved by existing transport provisions, and encourage health benefits from replacing trips previously made by private cars (Bösehans et al., 2021). The simulations for Dublin show that shared mobility services have the potential to replace 20% of private car trips, which translates into an emissions reduction of more than 20%. This reduction does not assume that vehicles are electric; thus, supplying electric shared mobility options could cut emissions further (International Transport Forum, 2018). Another study shows that the introduction of shared cars in Dublin, assuming a certain level of uptake and that all vehicles would be electric, could save around 85kt of CO_2 annually, and, if additional policy and financial support is offered, up to 895kt of CO_2 (Rabbitt and Ghosh, 2013, 2016). In addition, the operation of the Yuko scheme in Dublin was found to decrease emissions and suppress car ownership (Caulfield and Kehoe, 2021). Ride-sourcing and carpooling services are emerging options in Ireland. The evidence suggests that carpooling could reduce kilometres travelled and emissions by around 10% as a result of fewer empty passenger seats (International Transport Forum, 2020). Informal ride-sharing in Ireland saved approximately 12.5kt

of CO_2 emissions in 2006, and, if the frequency of ride-sharing increased to three to four times a week, a significant annual emissions saving could be achieved (Caulfield, 2009). If the shift towards shared mobility could be achieved, it would also mean lower demand for street space. Fewer car parks means allocating more space to active travel modes and green places, enhancing the liveability of urban areas. Shared mobility in its various forms (Figure 3.6) can also enhance rural connectivity by establishing essential connections to the core public transport network (International Transport Forum, 2021). Neglecting this opportunity limits the ability of rural areas to transition from private car reliance, thereby disproportionately penalising them as fossil fuel vehicle disincentives grow (Watson et al., 2021).

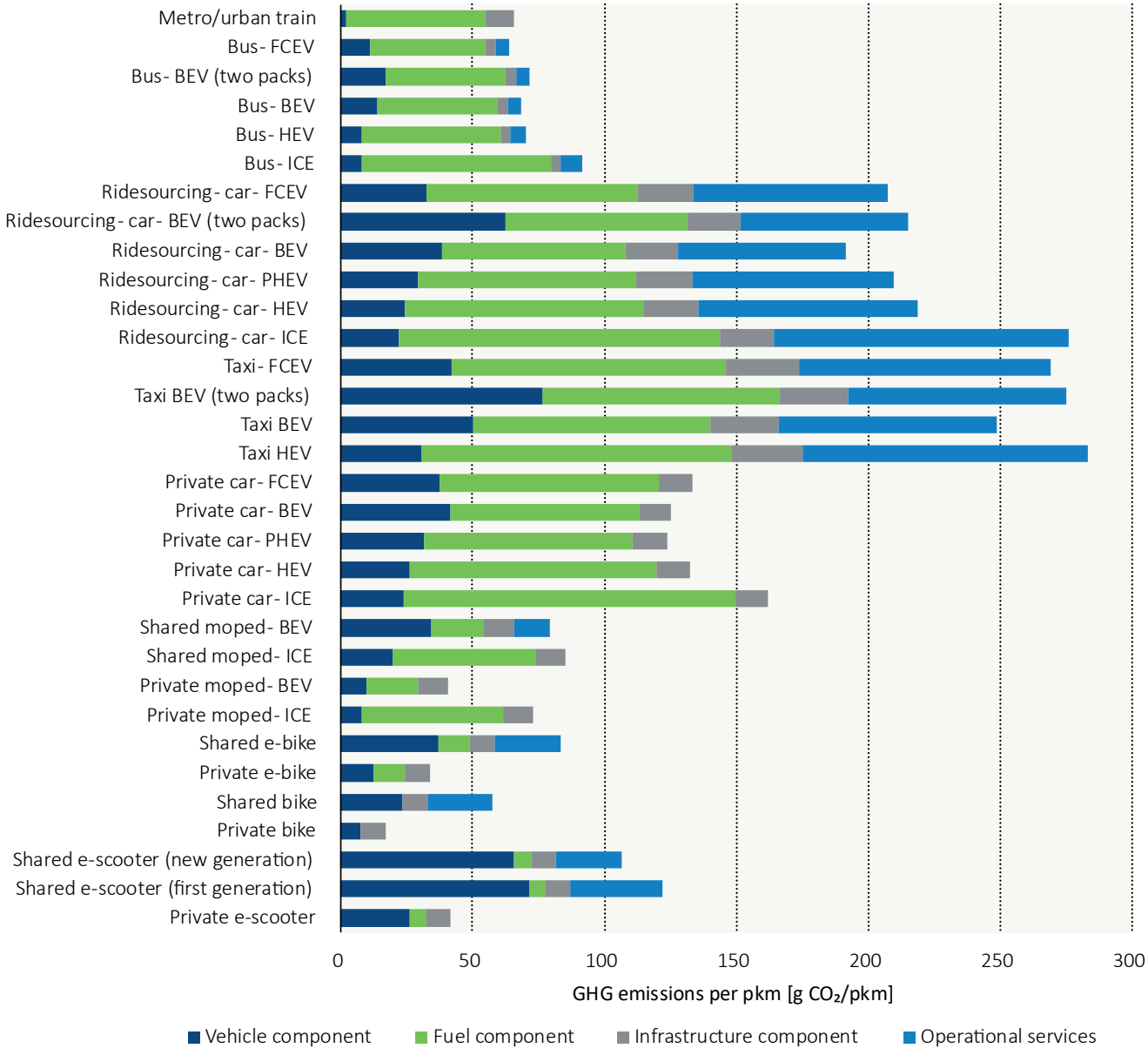


Figure 3.5 Life cycle GHG emissions per passenger-km of urban transport modes. Note: the carbon intensity of petroleum fuels and electricity generation mix reflects the global average. BEV, battery electric vehicle; FCEV, fuel cell electric vehicle; HEV, hybrid electric vehicle; ICE, internal combustion engine; PHEV, plug-in hybrid electric vehicle. Source: International Transport Forum (2020).

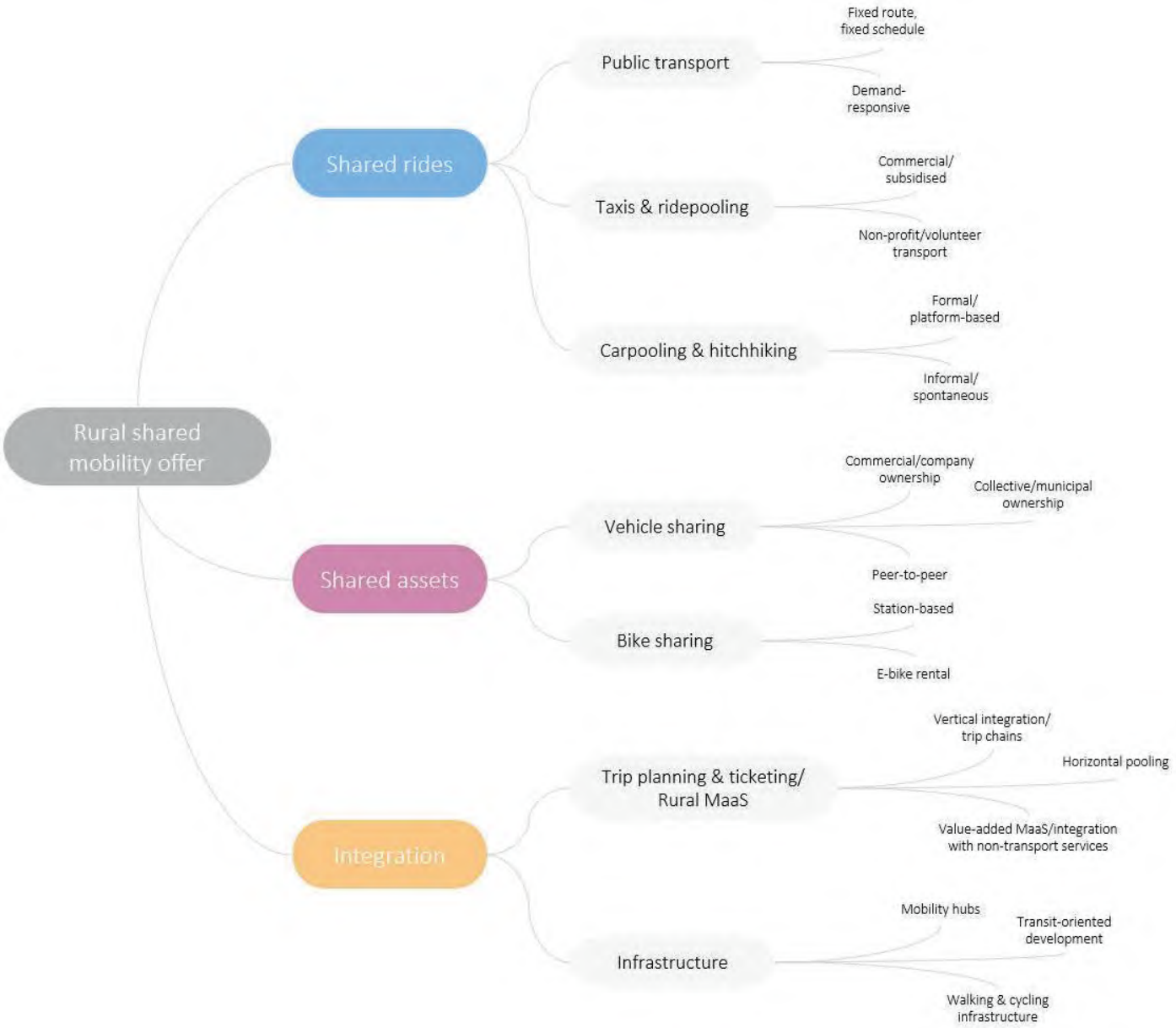


Figure 3.6 Rural shared mobility offer. Source: International Transport Forum (2021).

3.3.2.9. Shifting long-distance travel

Shifting long-distance travel from aviation and road transport to rail and waterborne transport presents a viable pathway to reduce emissions from freight and travel. Investing in high-speed railways and implementing price reduction strategies, such as discounted rail fares, which have the potential to encourage the transition from air to high-speed rail, is highly recommended (EEA, 2021c; Jaramillo et al., 2022). Rail and waterborne transport have the lowest emissions per kilometre and unit transported, whereas aviation and road transport emit significantly more (EEA, 2021b; Figure 3.7). The upcoming All-Island Strategic Rail Review is expected to propose reopening regional lines, some of which were initially designated for greenways, and enhancing service frequency and connections between Irish cities (DoT, 2023a). Rail systems are vulnerable to

various hazards, related to both meteorological and non-meteorological conditions, which can adversely affect their operation and lifespan (Brazil et al., 2017). See Volume 3 Chapter 7 for more information on critical infrastructure adaptation to climate change hazards. Further research is needed on Irish rail and waterborne modes of transport, the feasibility of shifting away from air and road transport, and the potential impacts and implementation pathways.

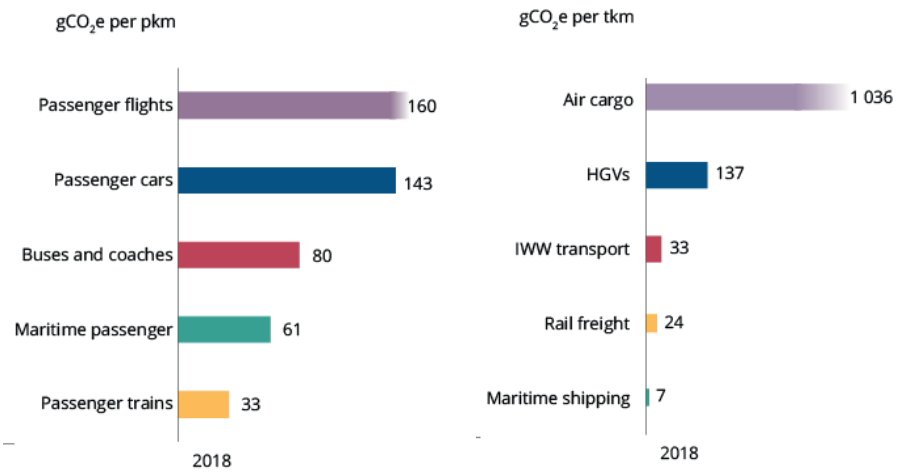


Figure 3.7 Average GHG emissions by motorised mode of passenger (left; gCO_2-eq per passenger-km) and freight (right; gCO_2-eq per tonne-km) transport, EU-27, 2018. Source: EEA (2021b). Reproduction licensed under the Creative Commons Attribution CC BY 4.0 licence (https://creativecommons.org/licenses/by/4.0/).

3.3.2.10. Improved vehicle efficiency

Improved vehicle efficiency reduces the amount of emissions per kilometre travelled by considering engineering solutions to enhance the energy and carbon efficiency of vehicles through better design of the vehicle and its powertrain, and use of renewable fuels (EPA, 2020). Use of electricity, hydrogen and biofuels to fuel road vehicles presents the current state-of-the-art fuel technology (Figure 3.8). The expanded use of electric rail systems is identified as a potential solution to decarbonising rail transport. Shipping and aviation decarbonisation options require further research and development, with advanced biofuels, ammonia and synthetic fuels emerging as viable options (Jaramillo et al., 2022). Fuel technology and vehicle efficiency for road transport in terms of passenger vehicles, buses, and light and heavy goods vehicles, as well as aviation and maritime transport, are detailed in Volume 2 Chapter 5.

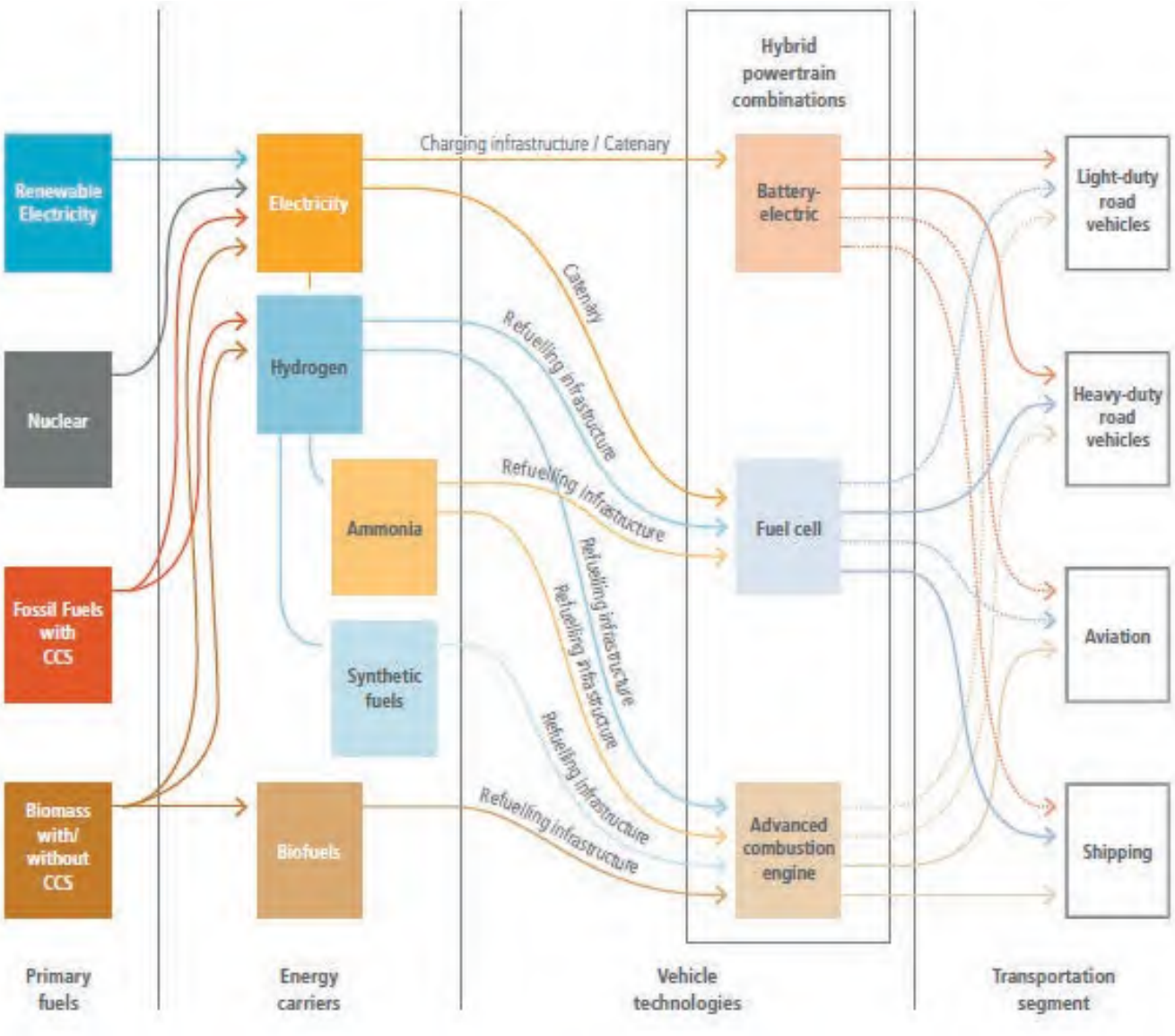


Figure 3.8 Energy pathways for low-carbon transport technologies. Source: Jaramillo et al. (2022; their figure 10.2).

3.3.2.11. Electrification of road vehicles

Relying solely on improvements in vehicle technology to achieve climate targets hinders the realisation of opportunities that stem from prioritising policies with high transformative potential. 'Improve'-level measures were found to have low transformative power, and will not be able to transform the mobility system in Ireland alone (OECD, 2022), which was

noticed in the early stages of policy design and implementation (Alam et al., 2017). The revised transport strategy still relies to a great extent on the electrification of private vehicles (DECC, 2022). The adoption of electric vehicles has accelerated, although not at the anticipated pace. As of April 2023, there were 83,000 privately owned electric vehicles on the roads, well below the target of 845,000 vehicles set for 2030 (DoT, 2023b; DECC, 2022; SIMI Motorstats, 2023). Furthermore, supporting the adoption of electric vehicles will adversely impact public finances if current subsidies are maintained (Houses of the Oireachtas, 2022), and will exacerbate inequalities (Caulfield, 2022; Stefaniec et al., in press). If subsidies are to be maintained, limited financial resources should be distributed fairly, prioritised for those who lack other sustainable transport options, and extended beyond electric cars to other vehicles (Caulfield et al., 2020a). Electric battery and fuel cell technology eliminate tailpipe emissions and directly improve air quality and noise levels in urban areas, and, hence, are likely to further increase benefits from sustainable transport options such as buses, taxis and shared cars (Kinsella et al., 2023). The utilisation of improved vehicle technologies in the non-private sector would be a potential avenue for scholarly investigation.

Box 3.7 Equity issues in financial support for electric vehicles

As Ireland advances its shift towards electric vehicles, there are growing concerns about equity. The current financial support mechanisms might inadvertently benefit the affluent, thereby possibly increasing economic disparities. Research shows an equity gap in electric vehicle adoption across income levels, highlighting the financial constraints faced by lower-income households (Caulfield et al., 2022).

Financial aids, such as purchase grants, vehicle registration tax relief and toll incentives, are implemented to boost electric vehicle uptake (Houses of the Oireachtas, 2022). However, certain incentives, especially purchase grants, have faced criticism for potentially widening socioeconomic inequalities. These incentives currently display low cost-effectiveness, are often tapped by higher-income households, and tend to be exhausted by the time lower-income families can access them (Caulfield et al., 2022; Hosseini and Stefaniec, 2023). The policy design suggests that incentives for electric vehicles even with extended loan periods disproportionately benefit the affluent (Stefaniec et al., in press), contrary to the intent of these policy tools (Pillai et al., 2022). These electric vehicle purchase incentives, largely availed by wealthier households, seem misaligned with Sustainable Development Goal 10, which promotes fiscal equality (Hosseini and Stefaniec, 2023). Notably, while the purchase grant was observed to place undue strain on public finances and challenge notions of distributive justice, its significant influence on electric vehicle adoption led to its continual extension (Houses of the Oireachtas, 2022; DoT, 2023b). Maintaining these policies could exacerbate existing inequalities and postpone more efficient measures (Hosseini and Stefaniec, 2023). It is also important to note that simply electrifying private vehicles does not solve the broader issues inherent to a car-dependent system, such as road accidents (Braun and Randell, 2022), traffic congestion (Sovacool et al., 2022), unfair road space allocation (Egan and Philbin, 2021, 2022) and land-use challenges (Sovacool et al., 2019).

3.3.2.12. Transforming freight transport

Several studies and projects have explored ways to enhance freight transport and reduce its environmental impact. Improved logistics and fuel efficiency are key factors in achieving greater efficiencies in the freight transport sector (Yan et al., 2021). Additionally, there is potential for a modal shift to rail and inland waterways on a localised basis (Browne et al., 2011). Shared mobility options can also be applied to freight transport. Addressing factors such as average speed, idling and harsh braking in heavy-duty vehicles can significantly impact fuel consumption (Mane et al., 2021). Eco-driving techniques can be effective in low traffic conditions but may have varying impacts in congested or signalised intersections (Mane and Ghosh, 2021). Implementing space-use policies specifically targeting urban freight activities can yield substantial co-benefits, not only reductions in emissions (International Transport Forum, 2022b). Projects like MAP-HDV, DRIFT-HDV and SENATOR aim to assess potential mitigation measures for reducing CO_2 and air pollutant emissions from existing heavy-duty vehicle fleets. The ShipFuel-IE project focuses on developing sustainable fuel pathways for the shipping and maritime sector.

3.4. Buildings

Buildings need to serve the needs and requirements of their inhabitants, protect them from harm and keep them comfortable. Both existing and new buildings need to be adaptable to maintain a healthy environment as the outdoor climate changes, with a decrease in energy consumption (Scott et al., 2022). Because of changing temperatures, changing patterns of precipitation and an increase in extreme weather events and sea level rise, the built environment is expected to be profoundly affected by climate change (Desmond, 2018).

Assessing GHG emissions in the building sector using the sufficiency, efficiency and renewables (SER) framework reveals the potential for significant mitigation by addressing energy and material demand. Europe could achieve up to 85% mitigation by 2050. To fully capitalise on the global building stock's mitigation potential, policy packages based on the SER framework are crucial. Avoiding low-ambition policies is necessary to prevent long-term carbon lock-in (Cabeza et al., 2022). Proactive adaptation and avoiding unsustainable practices are more cost-effective than reactive measures and retrofitting after extreme weather events (Scott et al., 2022).

3.4.1. Current challenges and opportunities

The built environment contributed to 12.3% of the country's GHG emissions in 2021, a decrease from 13.6% in 2020 (DECC, 2022). The reduction in emissions in this sector can be attributed to improvements in building standards, insulation upgrades for older buildings and a shift towards less carbon-intensive fuels. However, further efforts are required (EPA, 2020). The building stock in Ireland comprises just over 2 million residential dwellings, 109,000 commercial buildings and 3,745 public buildings (Dekker and Torney, 2021).

The energy efficiency of Irish homes is recognised as the lowest in northern Europe, with the average Irish home consuming 7% more energy than the average EU home and producing 58% higher CO_2 emissions (Muddu et al., 2021). Retrofitting measures targeted at detached housing have the potential to achieve a theoretical average reduction of 65% in heating costs and CO_2 emissions for houses built before 1979 (when building regulations were drafted and introduced to some extent in local authority by-laws), and around 26% for newer homes, making a significant contribution (44%) to Ireland's residential carbon abatement goals and aligning with the EU's energy and carbon directives (Ahern et al., 2013). These figures, however, need to be revised, considering that currently, the grant schemes allow for grants for insulation and heating controls in homes built up to 2011 and grants for heat pumps and renewables in homes built up to 2021 (SEAI, 2023a). The profound role of retrofitting is also emphasised by CAP23, where the National Retrofit Plan is to deliver the most substantial emissions abatement in the built environment (DECC, 2022).

Climate change poses significant risks to buildings, influenced by several factors. Increased precipitation can lead to water ingress into building fabric, water penetration of walls, and elevated indoor moisture and mould growth, necessitating enhanced ventilation. Soil shrinking and swelling, caused by fluctuating soil water levels, warmer summers and vegetation transpiration, can lead to subsidence. Freeze-thaw cycles, common in Ireland, can degrade construction materials like concrete blocks, leading to their disaggregation. Increased storminess can cause structural damage to buildings, from roof tile removal to chimney stack or tree collapse. Exposure to driving rain can accelerate weathering and increase maintenance requirements to keep buildings weathertight. Lastly, high internal temperatures and humidity can compromise air quality and thermal comfort, potentially leading to health issues and increased energy demand for air conditioning (Scott et al., 2022). More information on impacts of climate change on the built environment can be found in Volume 3 Chapter 6 section 6.2.

Taking steps to reduce emissions from buildings and enhance their resilience is expected to yield benefits in terms of efficiency, comfort and the overall health and wellbeing of both residential and commercial properties. The Construct

Innovate centre is a collaborative endeavour involving several Irish universities and the Irish Green Building Council, and is hosted by the University of Galway (Construct Innovate, 2023). Bringing together multi-disciplinary research groups across these partner institutions presents an opportunity to establish Ireland as a global leader in sustainable construction and technology for the built environment.

3.4.2. Envisaging and delivering transformation

3.4.2.1. Resilient and energy-efficient buildings

To build resilience, adaptation and mitigation are adopted as complementary policies. Without mitigation, the effects of climate change will be greater, thus requiring increased measures and levels of adaptation. Adaptation is more likely to contribute to sustainable development when policies align with mitigation and poverty eradication goals (Scott et al., 2022). To achieve resilience, buildings need to be designed to withstand a broader spectrum of severe weather events, while our critical infrastructure should possess increased resilience in the face of unforeseen and extreme weather conditions (Scott et al., 2022). To facilitate resilient building design, a joint initiative of Met Éireann and the Department of Housing, Local Government and Heritage resulted in releasing climate maps and design weather files to guide future Irish building projects (Met Éireann, 2023). Figure 3.9 illustrates solutions aimed at tackling heat stress and heavy precipitation events, hazards that could become pivotal in future urban climates, and thus supporting resilience of the building structures (Wendnagel-Beck et al., 2021).

Figure 3.9 Proposed nature-based approaches for a compact urban block development in Berlin, Germany. Source: Adapted from Wendnagel-Beck et al. (2021). Reproduction licensed under the Creative Commons Attribution CC BY 4.0 licence (https://creativecommons.org/licenses/by/4.0/).

The primary regulatory tool for reducing emissions from both new and existing buildings is the implementation of building energy codes (Cabeza et al., 2022). The Building Regulations of 1997 with subsequent updates establish a set of minimum standards for construction. These regulations are performance based and outline the legally required building standards and performance criteria that must be met in the construction of new buildings, as well as in material alterations and extensions to existing buildings. Parts A–M of the Building Control Regulations pertain to aspects such as structure, fire safety, site preparation, moisture resistance, accessibility, waste water and drainage, which are relevant to adaptation. Part L, which focuses on the conservation of fuel and energy, is more applicable to mitigation efforts (Scott et al., 2022). In 2019, Part L was updated to incorporate the Energy Performance of Buildings Directive (EPBD) requirement for 'nearly zero energy buildings' (NZEBs) (DHLGH, 2022a). However, there have been concerns about the extent of non-adherence to building regulations (see Volume 2 Chapter 5 section 5.2.1.3). There were also concerns regarding compliance issues related to adaptation, and various measures were suggested to address these challenges (see Volume 3 Chapter 6 section 6.3.).

3.4.2.2. The sufficiency, efficiency and renewables framework for buildings

The SER framework is structured around three core elements. The first is sufficiency, which addresses the root causes of environmental impacts by minimising the demand for energy and materials throughout the life cycle of buildings and products. The second component is efficiency, which deals with the manifestations of environmental impacts by lowering the intensity of energy and materials, i.e. embodied carbon[25] (Cabeza et al., 2022). Sufficiency refers to long-term strategies that are not solely reliant on technology, but aim to reduce overall energy consumption, while efficiency is about making consistent technological advancements that occur in the short term (Pathak et al., 2022). The third and final component is renewables, which seeks to alleviate the repercussions of environmental impacts by decreasing the carbon intensity of energy supply. Researchers agree that building energy codes serve as the central regulatory tool for reducing emissions (Cabeza et al., 2022; Figure 3.10). The SER framework offers a comprehensive approach that addresses the root causes of environmental issues and promotes systemic changes in policies, practices and technologies. It fosters innovation, guides decision-making processes and encourages the adoption of sustainable practices at individual, organisational and systemic levels, ultimately leading to a more sustainable and equitable society.

Figure 3.10 The SER framework for buildings. Source: Cabeza et al. (2022; their box 9.1 figure 1).

[25] The requirement to reduce the energy intensity of materials is provided under the forthcoming revision of the Energy Performance in Buildings Directive, which will require new buildings, from January 2027, to publish the GWP of the building. The GWP over the whole life cycle indicates the building's overall contribution to emissions that lead to climate change (Dodd et al., 2021).

The avoid–shift–improve approach, commonly used in the transport sector, has also been applied in the context of buildings (Creutzig et al., 2018). The principle of the avoid–shift–improve framework is that avoiding the demand for energy and resources has the most transformative power, followed by shifting demand to more sustainable choices and improving the energy efficiency of appliances (see section 1.3.2.2 Avoid–shift–improve framework). In the case of the SER framework, equal importance is assigned to all components of a holistic approach, and the most effective strategies usually involve a combination of all three. For example, a building that is designed to be small (sufficiency), with excellent insulation (efficiency), and powered by solar panels (renewables) would be far more environmentally friendly than one that focused on only one of these aspects.

The sufficiency measures to reduce the demand for construction materials and energy needed for heating, cooling and lighting can be achieved by downsizing the overall floor area (Cabeza et al., 2022). Minimising the need for energy-intensive services such as heating or cooling and energy-intensive materials for construction can be achieved through passive design that saves energy by utilising daylight, shading, building orientation and form, and natural ventilation (Roy et al., 2021). When it comes to existing buildings, retrofitting can help reduce energy consumption by upgrading their systems, components and insulation (Creutzig et al., 2018). Constructing cool roofs and green roofs can also be included in this category as they contribute to lower demand for heating or cooling services. Strategies could also involve using less energy-intensive construction materials like fly ash, wood, bamboo, or other local alternatives instead of cement (Roy et al., 2021). Energy-saving behaviour such as changing temperature set points or usage of ICT, in particular smart sensors and smart metering, could be also considered ways to reduce overall need for energy (Creutzig et al., 2018; Roy et al., 2021).

In line with the SER framework, more energy-efficient technologies are required. Efficiency components of the framework consists of shift and improve measures proposed in the avoid–shift–improve classification. The shift category prescribes switching to more sustainable alternatives for heating and cooling, such as district heating or cooling and heat pumps, and using cleaner cooking fuels and technologies (Roy et al., 2021). Regarding actions at the improve level, the focus is on enhancing the efficiency of appliances and systems within the building by purchasing high-efficiency appliances or replacing low-efficiency appliances. The use of ICT and Internet of Things (IoT) devices that provide real-time consumption data can stimulate energy-saving behaviour (Roy et al., 2021). Although showing considerable energy savings, these improvements could contribute to a rebound effect, which sees energy demand increasing rather than decreasing following measures to improve energy efficiency. Energy-saving behaviour needs to be stimulated to prevent it.

3.4.2.3. Nearly zero energy buildings

The updated Energy Performance of Buildings Directive (Directive 2010/31/EU) required all newly constructed buildings to attain the status of a NZEB by 2020, while public buildings were mandated to achieve this status 2 years earlier (European Union, 2010). An NZEB is characterised as a building with an exceptionally high energy performance. The energy demand of an NZEB is nearly zero or extremely low, and it should be predominantly met by renewable energy generated onsite or in close proximity (D'Agostino and Mazzarella, 2019). CAP23 established a target that all newly designed and constructed dwellings should meet the NZEB standard by 2025 and the Zero Emission Building (ZEB) standard by 2030 (DECC, 2022). The energy requirements for NZEBs vary among EU Member States, and for Ireland are calculated to be 45kWhm–2 per year for new and 75–150kWhm–2 per year for existing residential buildings, while for new non-residential buildings they are around 60% of primary energy use (D'Agostino and Mazzarella, 2019).

In Europe, the implementation of NZEBs primarily involves a combination of passive technologies such as sunshades, natural ventilation and lighting, thermal mass and night cooling, along with active technologies like mechanical ventilation with heat recovery, heat pumps and district heating. Additionally, efficient lighting and appliances play a crucial role. Renewable energy sources commonly utilised include photovoltaic (PV) systems and solar thermal technology. Projections indicate a decrease in PV costs of 41–56% and in solar thermal costs of 22–51% by 2050 (D'Agostino et al., 2021). Moving forward, the focus will shift from individual buildings to district-level integration and scaling up of NZEBs, ultimately expanding to encompass the district (NZED) and city scales (D'Agostino et al., 2021). EU-funded projects, specifically Horizon 2020, promotes the evolution from the NZEB design to the positive energy building (PEB) model. RESPOND 2017–2020 and +CityxChange 2018–2023 are examples of these research and innovation initiatives implemented in Ireland (Magrini et al., 2020). Also worth highlighting is Ireland's participation in three relevant International Energy Agency annexes (European Commission, 2023). Annex 81 – Data Driven Smart Buildings is about investigating the potential of software innovation and intelligent data-driven building automation to reduce energy use in buildings and enable buildings to participate as distributed energy resources in support of increased use of variable renewable electricity sources. Annex 82 – Energy Flexible Buildings Towards Resilient Low Carbon Energy Systems is about investigating how to scale from single buildings to clusters of buildings; energy flexibility and

resilience in multi-carrier energy systems; and engagement of stakeholders and development of business models. Annex 83 – Positive Energy Districts is about defining positive energy districts and the technologies, planning tools and the decision-making process related to positive energy districts.

The effectiveness of achieving NZEBs relies on several design options. The high thermal resistivity and air tightness of building envelopes were found to be key factors in achieving NZEBs for Ireland (Moran et al., 2017). The analysis indicated that NZEBs focusing on renewable technology outperformed super-insulated designs, primarily owing to improved electricity grid efficiency and decarbonisation. However, considering future energy price projections, the super-insulated designs performed better in terms of cost optimisation and sustainability (Moran et al., 2017). NZEBs also provide a quality indoor environment and comfort (Kolokotsa et al., 2022). The National Heat Study found that the need to decarbonise heating has reframed the 'fabric first' concept such that insulation/thermal efficiency should be viewed as an enabler for decarbonised heating, and that insulation should be sufficient to allow decarbonised heating systems to perform efficiently, rather than 'fabric first' being the sole primary focus (SEAI, 2022a).

When it comes to passive strategies, their application for cooling nearly zero energy offices in Dublin was found effective in maintaining comfortable internal conditions for a significant percentage of occupied hours (ranging from 57–95%) without relying on mechanical cooling. The simulation found that using multiple complementary passive cooling systems, such as daytime ventilation, night-time ventilation and dynamic solar shading, to address overheating is most effective (O' Donovan et al., 2021).

Case study buildings in Ireland demonstrate that buildings moving towards NZEB standards experience a noticeable increase in embodied energy and embodied carbon as a proportion of the building's life cycle energy. The designer's role in selecting sustainable and 'green' materials becomes crucial (Goggins et al., 2016). The EPBD requires that, from 1 January 2027, Member States shall ensure that the life cycle GWP of all new buildings is calculated and disclosed through the energy performance certificate of the building. The life cycle GWP is an indicator that quantifies the GWP contributions of a building along its full life cycle, which is measured in CO_2 equivalent and can be used as a proxy for embodied carbon (Dodd et al., 2021). It is envisaged that limits for GWP will be set in the future, based on a baseline established from disclosed GWP figures. Wood products reduce building carbon emissions through low embodied CO_2-eq, carbon sequestration and substitution of high embodied materials. Timber frames use more wood than masonry structures, resulting in higher carbon storage. Increasing timber use in Irish construction from 2022 to 2050 could reduce CO_2-eq emissions by 3.4 million tonnes (COFORD, 2022).

To satisfy the implementation targets of NZEBs, extensive training for construction workers and substantial improvements to vocational education and training systems is required (Winch et al., 2020). This poses a challenge but also an opportunity to create green jobs (see section 4.3.1). Adding to this, between 2023 and 2030, an estimated 50,831 new entrants in various roles – from managerial to semi-skilled – are needed in the construction and retrofitting sectors (Government of Ireland, 2022). These new entrants could be current industry employees looking to upskill or jobseekers interested in building or retrofitting careers. Initiatives like the EU-funded Build Up Skills Ireland 2030 (BUSI2030) are already working on a skills roadmap for decarbonising the built environment. Agencies such as the Department of Further and Higher Education, Research, Innovation and Science and SOLAS are collaborating with stakeholders like the Sustainable Energy Authority of Ireland (SEAI) to develop the necessary training programmes to meet housing and retrofit targets (Government of Ireland, 2022).

3.4.2.4. Retrofitting

A retrofit refers to upgrades designed to reduce energy demand, such as adding insulation, sealing leaks, replacing windows and doors, and installing a new heating system. These retrofits offer numerous benefits, including reduced emissions, lower heating bills, increased comfort and enhanced home value (Pallonetto et al., 2022; see Volume 2 Chapter 5 section 5.2). CAP23 sets a target of retrofitting 120,000 dwellings to Building Energy Rating (BER) B2 by 2025, and 500,000 dwellings by 2030 (DECC, 2022).

It is crucial to prioritise assistance for retrofitting and zero carbon heating systems for households that receive a fuel allowance and for the poorest-performing buildings. This includes a particular focus on buildings heated by coal and peat (CCAC, 2022). Support for buildings with these characteristics often fails for various reasons. For instance, the homes that require the most retrofitting are often occupied by those least able to access grants, such as lower-income households or elderly individuals living alone (Buckley et al., 2021; McGookin et al., 2022). SEAI's Fully Funded Energy Upgrades scheme is targeted to those in receipt of certain welfare payments and deemed to be most at risk of energy poverty, with a priority given to the poorest-performing homes (D, F and G) (SEAI, 2022c).

Despite financial barriers being addressed by the grant schemes, 9% of eligible low-income households still abandon their retrofit application, indicating the presence of significant non-financial barriers. The study found that the more retrofits planned, the more likely households were to abandon their applications, suggesting that households may not fully understand the benefits of energy-efficient retrofits (Pillai et al., 2021). Following the current iteration of the Fully Funded Energy Upgrades scheme, the retrofit intensity, represented by the number of measures installed, has increased significantly, and hence the abandonment rate is expected to drop (SEAI, 2023d). Regardless of the financial status of a household, residential energy-efficiency retrofit applications made via obligated parties are less likely to be abandoned than private applications, especially after a learning phase of 6 months. Simpler retrofits, such as attic and cavity wall insulation, are less likely to be abandoned, while more comprehensive retrofit combinations are more likely to be abandoned. Reducing abandonment rates could be achieved by learning from obligated parties' application processes, and possibly through the introduction of an independent third party to facilitate private applications (Collins and Curtis, 2017). Inexpensive and straightforward actions, such as insulating attics, filling wall cavities, sealing draughts, adding wall insulation, upgrading windows and doors, and enhancing heating controls, can effectively raise the energy performance of poorly performing houses according to BER ratings (CCAC, 2022), and the grants for such interventions were significantly increased as of February 2022 (SEAI, 2022c). These measures not only result in significant cost savings in terms of energy expenses but also lead to improved comfort levels.

Research found that while the Building Energy Homes (BEH) scheme has successfully facilitated energy-efficiency retrofits in over 160,000 homes to October 2015, there is room for improvement in the depth of these retrofits. A study found that the introduction of a bonus payment for more intense retrofits did not have the desired effect, with retrofit depth actually decreasing after the bonus payment was introduced (Collins and Curtis, 2016). Uidhir et al. (2020) showed that alternative retrofit combinations can yield additional energy efficiency gains of up to 86%, especially when applied to less energy-efficient dwellings. They suggest the development of a standardised pre-works energy performance assessment completed by an independent third party, which would aid in achieving bespoke retrofits customised to each home based on its pre-works condition. In June 2021, the updated Advisory Report was introduced alongside the BER certificate (SEAI, 2021). This report offers a roadmap for homeowners to achieve a B2 rating or higher, depending on their preference. The roadmap is tailored to the current condition of the dwelling and outlines a set of measures to improve its energy performance. These measures are designed to elevate the home's BER based on its existing state. Additionally, the EU's EPBD mandates that all Member States implement a mechanism for providing Building Renovation Passports by January 2025.

3.4.2.5. District heating and cooling

District heating is identified as a technology that offers additional potential to ensure heat-related emissions stay within the proposed carbon budget limits under the CAP. By utilising low-carbon heat sources distributed through district heating networks, it is possible to meet around 50% of the residential heat demand throughout Ireland, encompassing urban areas as well as certain suburban regions (CCAC, 2022; SEAI, 2022a). Rapid emissions cuts require deploying the technology at scale and decarbonising the electricity grid (SEAI, 2022a). The governmental has set a target of installing 0.8TWh of district heating capacity by 2025, and 2.5TWh by 2030 (DECC, 2022).

District heating technologies are readily accessible and have been implemented on a large scale in different countries. The modelling conducted indicates that heat network infrastructure can be constructed and operated using diverse technologies and fuel sources, all while remaining cost-competitive with fossil fuel alternatives. However, it is worth noting is that the heating network will require establishing new infrastructure in Ireland, comparable to the electricity or gas grid. Total capital costs to deliver 2.7TWh of district heat are expected to require significant capital investment. While some of these costs would be financed over the long term and repaid as part of the heat price, significant investment will be required to develop the infrastructure before operation (SEAI, 2022a).

Additionally, it is important to promote the exploration of opportunities for extracting heat from power stations, recovering waste heat from industrial sites, harnessing geothermal sources and utilising low-grade heat generated by data centres, all of which can be integrated into district heating schemes (SEAI, 2022a). Under European regulations, specifically Article 2 point 41 of the Energy Efficiency Directive (2012/27/EU) (European Union, 2012), Ireland is required to implement 'efficient district heating' systems as an alternative to traditional fossil fuel-based systems. An efficient district heating system must utilise at least one of the following: 50% renewable energy (such as geothermal, solar thermal or biomass), 50% waste heat, 75% cogenerated heat, or a 50% combination of these options. Therefore, exploring various low-carbon alternative heat sources is crucial for the large-scale deployment of district heating systems.

3.4.2.6. Heat pumps

The Irish government aims to have 170,000 new dwellings equipped with heat pumps by 2025 and 280,000 by 2030. In addition, it is planned to equip 45,000 existing dwellings with heat pumps by 2025, increasing to 400,000 by 2030 (DECC, 2022). Heat pumps are widely recognised as a prominent technology for decarbonising heating in buildings and providing low-temperature heat in various sectors. They have proven effectiveness in reducing carbon emissions. Their benefits arise from reductions in primary energy usage and enhancements in overall efficiency (Gaur et al., 2021). However, the residential sector faces challenges in terms of capital costs, and, given the current level of electricity prices, also operational costs, necessitating additional policy support to drive widespread adoption (SEAI, 2022a).

To achieve the targets set for the heat sector, it is crucial to address barriers to the rapid deployment of heat pumps. This includes providing free heat pump assessments regardless of follow-through, improving communication about heat pump requirements, and rapidly scaling up the number of skilled professionals and tradespeople in the field. The establishment of robust supply chains, particularly skilled labour within the construction sector, is essential for meeting the heat sector targets (CCAC, 2022). Other barriers to heat pump adoption include upfront and operating costs, non-cost barriers, market development and skills, technology maturity and lack of a system-wide approach (IEA, 2022).

3.4.2.7. Cleaning the grid – renewables

The target of CAP23 is to achieve up to 0.4TWh of heating provided by renewable gas by 2025 and up to 0.7TWh by 2030 (DECC, 2022). Analysis indicates that electricity usage for heating plays a prominent and increasing role in all examined scenarios, particularly after 2035. High-resolution electricity modelling demonstrates a reduction of approximately 50% in power sector emissions by 2030 (compared with 2018), despite a 61–69% increase in demand during the same period. This demand growth is driven by factors such as data centres, electric vehicles and the electrification of heating systems. The power sector modelling predicts the installation of 10–11GW of wind capacity by 2030 to achieve a renewable electricity share of at least 70%. CAP23's objective is to achieve an 80% share of renewable electricity by 2030, and its realisation will further contribute to emissions savings in the heat sector (SEAI, 2022a). A recent national survey shows positive attitudes towards wind and solar farms in Ireland (SEAI, 2023f). See Volume 2 Chapters 3 and 4 for information on the current and future energy system in Ireland.

3.5. Research gaps

The NPF confines long-term spatial planning to a single path up to 2040, while the mobility transformation is limited to marginal improvements in bus and rail services. To facilitate the delivery of integrated spatial planning, it is necessary to develop visions for alternative settlement patterns towards 2050 and simulate their impact on emissions reduction, equity and wellbeing.

An approach to transforming built environment that integrates both places and movement is not readily apparent in Irish research. Further research is also required to investigate the scale of and timeline for implementation, and the full extent of benefits associated with achieving compact development. There is a tendency to compartmentalise different themes, resulting in limited connections between them. While certain aspects of climate-related research are being explored, the lack of a coordinated approach to transport and urban planning makes it difficult to identify the synergies and trade-offs associated with planned interventions. The governance, political and normative considerations involved in placemaking are largely unresearched, with insufficient empirical research to inform decision making in Ireland.

The availability of planning, property and environmental data for analysis is limited to a course scale in Ireland, with finer-grained data at small area or electoral district level lacking timeliness. Projects in this field could potentially benefit from a digital twinning approach, and remote sensing could also serve as a valuable tool in this context.

A transformational approach to transport modelling is needed to guide climate decisions in policymaking, incorporating a participatory process of creating transport scenarios. Social impact assessment in transport project appraisal is desirable, and international research can inform equity- and accessibility-based analyses in Ireland.

There is a need for detailed research on the scale and cost ranges of, and timeline for, actions identified as transformative across planning, transport and buildings, and on factors influencing their implementation. These elements require further study to ensure accuracy and relevance.

There is a need to explore interdependencies of avoid–shift–improve actions in different scenarios to optimise their benefits.

Emerging paradigms that could generate systemic changes need investigation to determine their impact and synergies with existing structures and other new trends. For instance, digital technologies could assist in reducing travel demand, but further research is needed to understand their implications for reducing GHG emissions and other impacts.

Active travel and smart mobility options have not been extensively explored in the context of dispersed settlements in Ireland, despite the transformative potential of new solutions. Further research is needed to examine their feasibility, their impact on emissions reduction and the opportunities they may generate.

Modal shift can be facilitated through travel demand management associated with behavioural change, but the effectiveness of policy instruments requires continuous monitoring and research.

Further research is needed on Irish rail to determine the feasibility of shifting away from air and road transport following rail expansion. Analysis of the long-term climate change mitigation effects of both passenger and freight rail is required, as well as an investigation into tools that can facilitate the shift. Shipping and aviation decarbonisation options also require further research and development.

Research is needed to better understand how to effectively integrate climate adaptation and mitigation strategies into building codes and standards. This involves investigating how measures aimed at reducing emissions can also enhance buildings' resilience to climate impacts.

There is a lack of comprehensive research on the effectiveness of nature-based approaches in improving building resilience. Studies should focus on assessing the performance of strategies like green infrastructure and passive design in enhancing buildings' ability to withstand climate-related challenges.

There is a need for research that delves into the behavioural aspects of energy-efficiency solutions and sufficiency promotion. This is essential for designing more effective and impactful programmes.

4

Transforming Livelihoods

Key messages

Transitions and transformations to low-emissions futures offer the potential for Ireland to build prosperous and resilient livelihoods. Nationally, these possibilities have yet to be fully explored and will require enhanced strategic long-term policy to deliver on their potential, including enterprise policy in the context of long-term sustainable development.

Opportunities to build livelihoods exist in economic activities that directly reduce emissions, such as renewable energy and afforestation, as well as economic activities that have low-emissions intensity, such as public and private services.

While transitions and transformations offer significant opportunities, given global and national sustainability crises, higher polluting activities are likely to face increasing pressures to restructure or contract. The effects of pressures are typically sector specific and localised, creating the need for public policy to support a just transition.

Social equity and equality matter in the context of transitions. More equal societies are more resilient to impacts and are more likely to adopt progressive policies. In creating visions of livelihoods in transformations, important wellbeing and social considerations include capabilities, equity, decent work, care, the social contract and just transition. Enabling measures include conventional education, training and social protection, and also innovative frontier measures such as universal basic income, universal basic services and the shorter working week.

4.1. Introduction

A broadening has occurred in the international literature on emissions mitigation, from technology-rich transition to addressing the need for fundamental shifts in national development pathways (Lecocq et al., 2022). The IPCC have highlighted this as an important change that occurred in consideration of mitigation internationally, beginning in Assessment Report 4 and accelerating after Assessment Report 5 (AR5) (Pathak et al., 2022). Shifting development pathways considers transformational system change in addition to technology, and can benefit from a broadening to policy-relevant themes such as livelihoods. In Ireland, the wider frame of considering development pathways, while beginning earlier, remains nascent (O'Mahony et al., 2012, 2013; Gaur et al., 2022; Flood et al., 2023). The related consideration of transforming livelihoods and associated benefits and opportunities is embryonic. Consequently, an assessment of livelihoods in transformation necessarily requires recourse to the global literature, to set the bar in terms of current knowledge, followed by consideration of Irish peer-reviewed and grey literature where it offers relevant interpretations. This approach allows this assessment to both highlight the potential opportunities of livelihood transformations in Ireland, and also to identify national gaps in knowledge towards understanding and harnessing these benefits.

The chapter is structured as follows. Section 4.2 enables an understanding of livelihoods and considers the historical context in Ireland, including patterns of employment and related outcomes in recent decades. In addition to income, inequality and poverty and deprivation, a holistic framing, in keeping with best practice in the international literature, also considers social protection, decent work, care, basic services and income, and the shorter working week. This section is completed by considering enterprise policy. Section 4.3 addresses the just transition lens on livelihoods, applied to the Irish context. Section 4.4 expands to consider livelihoods in transformation, including possible opportunities and benefits, and related gaps in knowledge to support understanding these.

4.2. Employment and outcomes

4.2.1. Livelihoods and employment

Employment in Ireland has undergone considerable change in the five decades since accession to the EU in 1973. In 1973, Irish employment stood at a just over one million (1,062,000), with 49.7% of employment in services (477,000), 28.8% in industry (335,000) and 21.5% in agriculture (255,000) (CSO, 2004). In 2022, employment had grown by about 142%, to 2.5 million (2,574,500) (CSO, 2023). Following the pattern of economic transition typical of global development and modernisation, Ireland's trajectory was driven by growth in services, which amounted to 76.9% of the total in 2022 (CSO, 2023)[26], alongside significant decline in agriculture, to 3.9% (100,800) (see Figure 4.1).

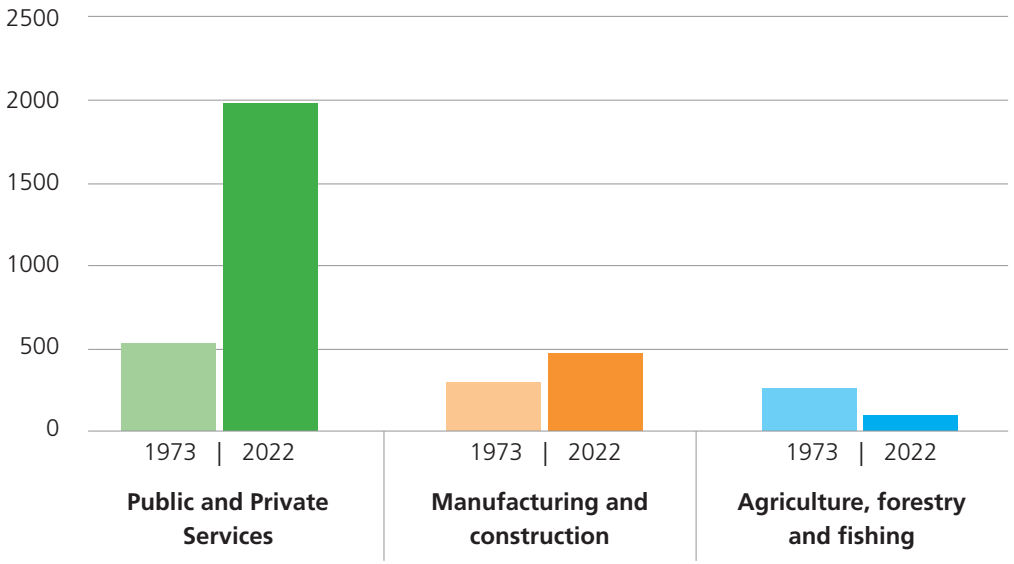


Figure 4.1 Persons engaged in employment by sector in 1973 (van Ark and Jäger, 2017) and in Q1 of 2022. Source: CSO (2023).

[26] In the absence of a continuous dataset on employment from pre-accession and contemporary Ireland, it is acknowledged that there are differences in the data categories and reporting format across van Ark and Jäger (2017) and CSO (2023). While affecting exact totals, confidence can be expressed in the conclusions on patterns of change, in scale and in structure of employment.

In Ireland, throughout the 20th century, decades of economic stagnation led to high unemployment and emigration. This trend was reversed during the 1990s, as economic growth was channelled into increased employment. A profound transition in Ireland's economy and society is evident in the reduction in long-term unemployment, illustrated in Figure 4.2.

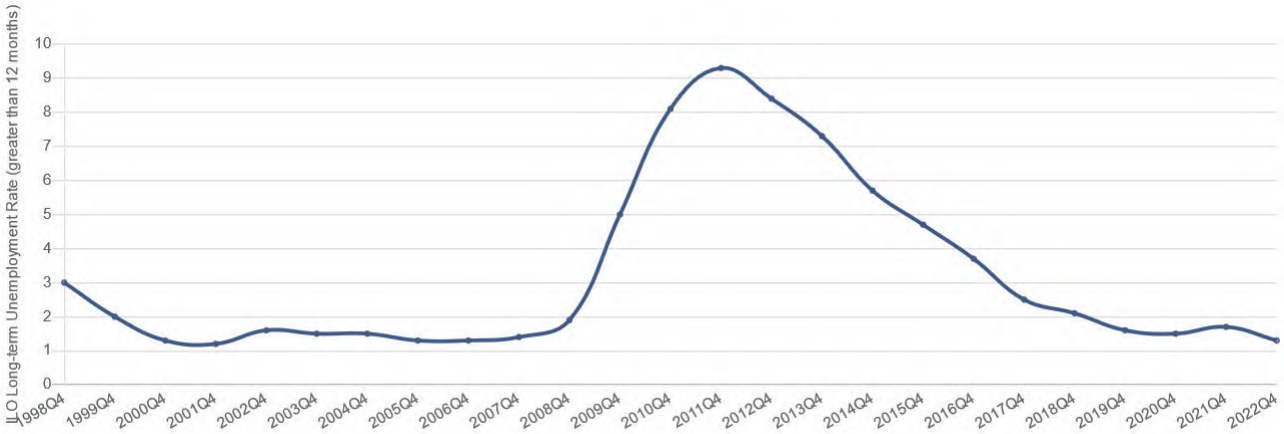


Figure 4.2 Long-term unemployment in the Irish labour force survey. Average income in Ireland from 1987 to 2019. Source: CSO (2023).

Work is fundamental to livelihood, identity and wellbeing. Being unemployed, or in poor-quality work, poses risks for mental and physical health, housing status and the ability to financially support oneself. UN Sustainable Development Goal 8 includes reference to decent work and full employment in sustainable economic growth. In Ireland, the 'decent work' framing used in analysis by McGinnity et al.(2021) has found differences in outcomes, such as unemployment, low pay and job insecurity, concentrated in groups such as the young and those with disabilities and within ethnic minorities. This illustrates pockets of livelihood vulnerability that McGinnity et al. (2021) suggest require policy intervention, alongside increased employment access. Considering employment levels, alongside decent work, is essential for the transformation of livelihoods.

A focus on livelihoods can go beyond seeing people as a human capital and a resource for labour in the economic process, or the income this provides, to encompass the interests of people centrally, including wellbeing, meaningful work and social equity. Livelihoods can encompass strategies for people to support themselves, and caring roles, and hence are broader in interpretation than 'employment', which is typically understood as paid work. Livelihood strategies are permanently in flux. Both structural factors and the range of opportunities and risks can change, and people and policy may seek to adapt to evolutions occurring in the economy and society across lifetimes. Transition and transformation to address climate change, as well as the physical impacts of climate change, generate a new set of risks and opportunities for employment policy to address. While an equity lens may place a normative priority on poverty, vulnerability and social exclusion, when viewed through a wellbeing lens, livelihoods can also be related to the importance of work for meaning and dignity, to security and to time patterns of work that are conducive to better lives.

4.2.2. Income, inequality and poverty

Ireland has experienced decades of economic and employment growth that have translated into increases in incomes (Figure 4.3). Ireland bucked international trends by combining increasing incomes with declines in income inequality (Roantree et al., 2021, 2022), suggesting a degree of success for redistribution policy.

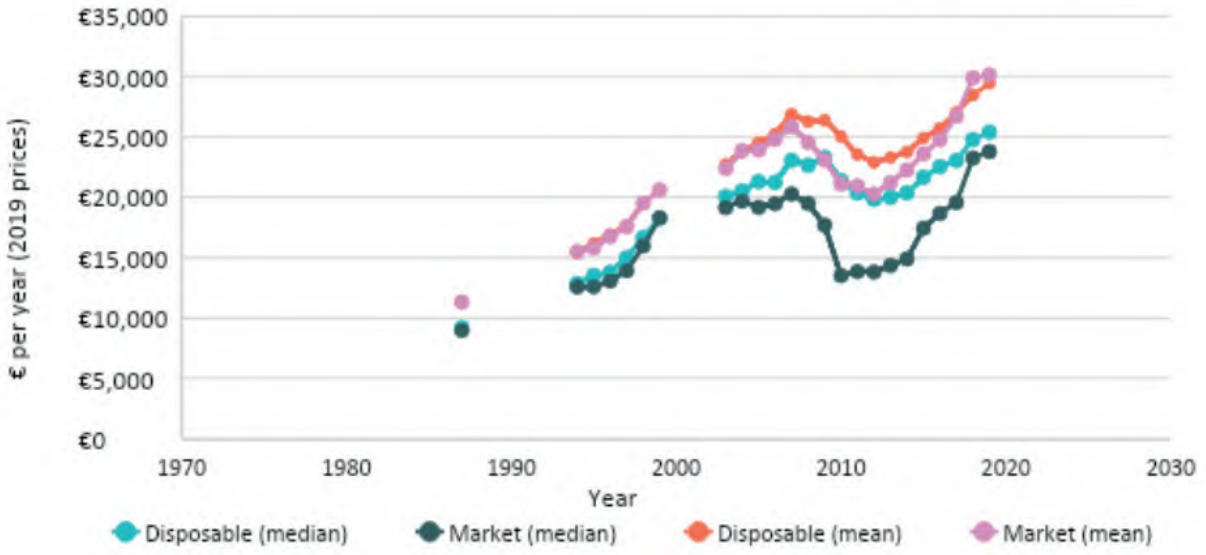


Figure 4.3 Average income in Ireland from 1987 to 2019. Source: Roantree et al. (2021).

Figure 4.4 Disposable income inequality, 1987 to 2019. Source: Roantree et al. (2021).

International comparison suggests that Ireland has moderate inequality (Figure 4.4), in the middle tier of income inequality among the OECD countries (OECD, 2022). Yet, this is achieved only after redistribution. There is considerable inequality in market income in Ireland, measured by the Gini coefficient. Ireland's income distribution is among the most unequal, as measured through the Gini coefficient[27], and reaches the median only after tax and the transfer system have narrowed the gap (McGauran, 2021a). In addition, income and inequality measures can mask poverty and deprivation in social and geographical pockets. Roantree et al. (2021) show that measures of income poverty and material deprivation in Ireland point to high incidence of low living standards (Figure 4.5). These are persistent in certain groups, including children, loan parents and adults in jobless households (Roantree et al., 2021, 2022). In sociology, Bissett (2023) seeks to go beyond the deprivation narrative to understand lived experience in a social housing estate in the context of the challenges of class and gender inequality, and the importance of community in response.

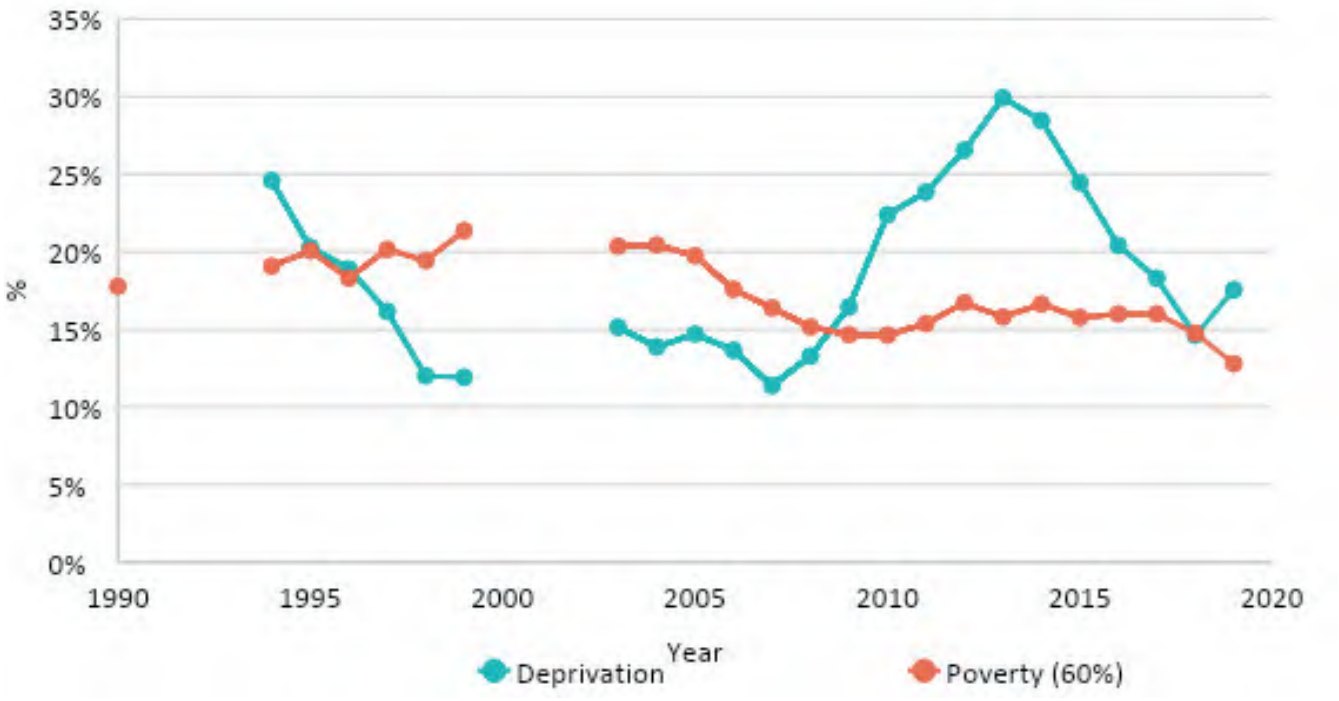


Figure 4.5 Deprivation and poverty rates. Source: Roantree et al. (2021).

In the context of transition, it is important to recognise that inequality matters. Better education, health care, valuing of social diversity and reduced poverty – characteristic of more equal societies –all lead to resilience, innovation and readiness to adopt progressive and locally appropriate climate change mitigation policies (Creutzig et al., 2022).

Inequality is both pernicious to reduction of greenhouse gas emissions and fundamental to considering transformation of livelihoods, leading to its prominent status in the literature on emissions mitigation and increasing role in successive IPCC reports. Inequality intersects with, and is recognised as, a core driver of environmental damage and climate change (Creutzig et al., 2022). The social and economic determinants of climate change vulnerability and capacity to adapt are also relevant. The minimisation of loss and damage from the physical impacts of climate change favours transformative solutions that prioritise inclusive climate-resilient development, and the reduction of poverty and inequality (Birkmann et al., 2022). Green and Healy (2022) note how socioeconomic inequalities drive emissions-intensive consumption and production, facilitate obstruction of climate policies by vested interests and weaken the social foundations of collective action. Higher economic vulnerability necessarily also widens the gap of just transition, hampering emission reduction programmes and weakening

[27] The high-income sectors in Ireland, such as finance and technology, have higher pay relative to the average, in comparison with other small open economies in Europe (McGauran, 2021a). Low-income sectors, such as retail and hospitality, also have lower pay than the European average.

livelihood resilience to change. Sovacool et al. (2022) discuss how low-carbon innovations, in technologies and behaviours, are not automatically just, equitable or even green, and can introduce new inequalities and reaffirm existing ones. In addition to considering employment and societal outcomes, social protection is important to the discussion of livelihoods. Lorek et al. (2023) propose that when care is placed centrally in societies, this can motivate a just response to ecological breakdown.

4.2.3. Social protection

The importance of policy areas, including social welfare (protection), education and health, in driving emissions – 'non-climate policies' related to the wider development path – has been recognised since at least the IPCC Special Report on Emissions Scenarios[28] (Nakicenovic et al., 2000) and has recently been reaffirmed in the Irish context (McGauran, 2020). Social protection is an important determinant of factors critical to transition and transformation, including social equality and the social contract. Social protection is important for the resilience of livelihoods to processes of transition and shocks to livelihoods, as the COVID-19 pandemic has recently illustrated.

Social protection has a key role in supporting livelihoods through economic cycles, across stages of life and circumstances. Social protection has a social role, as a safety net to prevent poverty and deprivation, and a role in redistribution policy to avoid income inequality. Social protection is important in just transition, as a social safety net may be necessary as part of programmes to assist workers in transitioning from one economic activity to another. The developmental welfare state, advocated by the National Economic and Social Council (NESC) in 2005, has been important in framing Ireland's approach to social protection (NESC, 2005), comprising three overlapping areas of welfare state activity: services, income supports and activation or innovative measures, including community supports. Research on social protection, and the developmental welfare state, has recently re-surfaced as a topic at NESC. Papers have been written on the importance of the tax and welfare system in addressing income inequality (McGauran, 2021a), the need to recognise the importance of carer roles and gender in tax and welfare (McGauran, 2021b) (see section 4.3) and discussions on UBI (Johnston, 2021).

4.2.4. Frontier policy measures: basic income, basic services and the shorter working week

Outside technology studies, innovative measures that find discussion in the social science literature of transitions include universal basic income (UBI), universal basic services (UBS) and the shorter working week. These measures have relevance to both livelihoods and lifestyles (see Chapter 5).

UBI can be defined in different ways, but often focusses on the possibility of replacing all or part of social security with an unconditional payment to all citizens. This is seen as emancipatory or as helping to address poverty and inequality, with advocates on both the left and right of the political spectrum. Recent pilots in contexts as diverse as Finland, California, USA, and Kenya have moved it from more than two centuries of discussion to early stages of implementation (Francese and Prady, 2018). It has also gained increasing attention as part of responses to the economic inactivity that arose from COVID-19 lockdowns, and how this significantly impacted some sectors (Johnston, 2021).

In Ireland, Healy et al. (2013) describe a UBI as a transformative approach from a number of perspectives – economic, social, cultural and environmental – linking it to a focus on basic needs within environmental limits. Barry (2020) alludes to reduced working weeks and UBI as emancipatory of human flourishing (see also section 4.3). Brown (2022) has described 'social liberal peacebuilding' through UBI as a new approach focused on human security, flourishing, emancipation and participation, offering support to conflict transformation in Northern Ireland. Johnston (2022) describes discussions of basic income in Ireland over 40 years, with two basic income pilots being considered: the Government's Low Pay Commission and a sectoral basic income scheme for artists. The former is to be considered within government, including Economic and Social Research Institute (ESRI) analysis, while the Basic Income for the Arts programme was opened for applications in 2022. An advocacy group – Basic Income Ireland – was set up in 2021 with the aim of supporting the realisation of a universal application of UBI. Criticisms of UBI have noted its potential cost, political feasibility and environmental sustainability. Gough (2019) and Coote (2019) suggest that these criticisms can be overcome by UBS, which, as a more egalitarian option, provides an entitlement to sufficient public services. UBS extends the universality of health services and education to other

[28] The IPCC Special Report on Emissions Scenarios noted that policies designed for a wide variety of non-climate purposes are relevant, related to the later conclusion that the overall development path is critical in determining greenhouse gas emissions (Nakićenović et al., 2000). In addition to energy policies, the report noted other important policy areas, including economic development, technology development, education, health, social welfare, transport, industry, agriculture and forestry. This 'development path' perspective has evolved considerably in the last 20 years; see Chapter 6.

necessities, such as housing, care, transport, information and nutrition. In Irish literature, Murphy (2023) considers UBS as a transformation of service provision, and related outcomes, and allies this with 'participation income'. The latter seeks to decommodify labour and empower the social value of care, democratic participation and environmental sustainability. Murphy (2023) considers the combination of UBS and participation income as a transformative ecosocial strategy to the related challenges of climate change and inequality.

In understanding the place of livelihoods in a decarbonised world, a reduced working week offers a novel approach to harnessing the opportunities of improved social, economic and environmental outcomes of deep transformation. Internationally, reduced working weeks have been associated with synergies: improving outcomes for mental health, physical wellbeing and families (Kamerāde et al., 2019), increasing labour productivity and reducing unemployment (Zwickl, 2016), and reducing the consumption driving greenhouse gas emissions (Fitzgerald, 2022). Irish research includes a report on the feasibility of the 4-day working week (Gilmore, 2019), an initiative being piloted by enterprises nationally in 2022.

4.2.5. Enterprise policy and long-term strategy

National literature on enterprise policy in Ireland has been sporadic. Related to the economy, Lenihan (2011) considered the importance of systemic policy that is promoting and shaping, and recommended creating an enabling environment for small firms and entrepreneurship. Skilling (2022) considered the enterprise policies of small advanced economies, while Grant Thornton (2023) considered options to support development of a national clustering policy for alliances of interconnected enterprises. Ó Broin and Doyle (2023) is part of an evolving literature on social enterprise. In sustainability, Doyle (2019) focused on reuse and repair of products as social enterprise, and Davies and Mullin (2011) sought to consider sustainability innovations beyond the mainstream.

In a review of top-down national enterprise policy, Skilling (2022) contends that Ireland's success in driving economic output through foreign direct investment (FDI), in FDI-driven internationalisation, is also associated with risks to economic sustainability. The review proposes that multinational corporations are weakly embedded in the national economy and have also led to weakened competitiveness and innovation. Skilling recommends a strategic response that includes structural change in the economy towards domestic firms, and also a priority on net zero transition. In agreement with these conclusions, national enterprise policy to 2030 (DETE, 2022) has platformed both net zero transition and economic structure. National policy is now framed for development of Irish-owned exporters and locally trading sectors alongside FDI. DETE (2022) also notes the value of different scales, including the cooperative organisational model and small and medium-sized enterprises. In addition, bottom-up social enterprise is embraced in DRCD (2019), including community and voluntary organisations, charities, social innovators and social enterprises. While recognising the priority on structural change and recognition of different organisational models, a more strategic approach to national enterprise policy could be described, in line with sections 7.3.5 and 7.3.6, as longer, wider and deeper. Longer – in encompassing 2050 in addition to the stepping stone of 2030, wider – through systemic sustainable development in addition to decarbonisation (section 6.3.2), and deeper – in integrations across scales, in themes and in the targeting of policy supports for innovation and activation, including training and mentoring.

4.3. Just transition and climate justice

While just transition is an ethical concern, relating to the impacts of transition of people, it also has a role in understanding and implementing transformative change. Dolšak and Prakash (2022) describe three faces of climate justice: (1) the physical impacts of climate change, (2) the uneven costs and (3) the uneven benefits of climate action. While the former references the issue of climate justice, the latter comes under the heading of 'just transition,' in mitigation and adaptation. Newell et al. (2021) propose a transformative approach to climate justice globally, acknowledging root causes in the historical global economic systems and related social inequalities. A research agenda is proposed that places analysis of power at its centre, to surface social and institutional relations and inequalities that have both driven climate change and shaped the responses to it. Sovacool et al. (2020) consider the justice dimension of low-carbon technology, noting that while research on transitions focusses on diffusion of innovations, such as electric vehicles or solar panels, this can overlook downstream and upstream processes, of waste and extraction in other regions. These obscured processes can implicate mobility and electricity transitions in toxic pollution and biodiversity loss, and in the exacerbation of gender inequality, exploitation of child labour and subjugation of ethnic minorities.

It is accepted by the IPCC that transition pathways involve changes in employment and economic structure (Pathak et al., 2022), offering opportunities to be pursued and presenting trade-offs to be managed. The IPCC note that the just transition framework is a set of principles, processes and practices that seeks to ensure that no people, workers, places, sectors,

countries or regions are left behind in the move from high emissions to low-emissions development. The IPCC also note that just transition has a key role as an enabler. Deep emissions reduction requires transformational change, and this necessitates cooperative action achieved though participation and a perception of fairness (Pathak et al., 2022).

In 2015, the International Labour Organization proposed guidelines for a just transition aimed at workers affected by energy and climate policies (ILO, 2015). Banerjee and Schuitema (2022) describe how the International Labour Organization guidelines propose that just transition should ensure the protection of fundamental rights, maximise decent work, create green jobs that accommodate displaced workers, provide localised solutions and reduce a variety of inequalities. Research by Eurofound has pointed to the importance of social dialogue and collective bargaining as part of just transition governance, in order to consider the social and economic aspects of climate policies and their distributional effects (Eurofound, 2023). Just transition includes respect and dignity for vulnerable groups, creation of decent jobs, social protection, employment rights, fairness in energy access and use, and social dialogue and democratic consultation with relevant stakeholders. Just transition has key roles for government and state agencies, through implementing proactive policy to maximise opportunities and manage trade-offs. This includes enabling job creation in low-emissions activities, such as services, and in emissions-reducing and environmentally enhancing activities (see sections 4.4 and 6.3.2), aligning investment and providing compensation and social safety nets through welfare programmes.

While much of the focus in the literature on just transition has been on energy, the food and agriculture sector is now coming into the discussion, with particular relevance in Ireland. Verkuijl et al. (2022) note that policymakers in several countries are adopting measures to scale down meat production and consumption, due to associated environmental and public health concerns. Verkuijl et al. highlight the needs of farmers, workers in the supply chain and wider communities, with redirection of the subsidies that make meat artificially cheap considered important. Redirecting subsidies to alternatives to meat and dairy offers an opportunity to support rural development, livelihood resilience and decent jobs, supporting national food security, deep emissions reductions and improved public health. Systems innovation for win–win outcomes require strategic policy programmes that integrate siloed policy objectives, programmatically support implementation of sustainable pathways and encompass the just transition and participation (see also section 7.4).

Just transitions are integral to EU policy, as emphasised in the European Green Deal (European Commission, 2019) and also in national climate action policies. The EU commitment to just transition is reflected in the Coal Regions in Transition Initiative and in the Just Transition Fund. Just transition is increasingly represented in national climate policy in Ireland (DECC, 2019, 2021). Ireland's just transition commissioner was focused on the Midlands, as peat extraction ceases and peat-fired power stations close. The Annual Review 2021 of the Climate Change Advisory Council noted that just transition plans are in their infancy and will need to expand beyond the energy sector and the Midlands region (CCAC, 2021). The Just Transition Commissioner's final progress report noted the opportunity for green enterprise and the need to channel funding and supportive policy coordination, as part of efforts to expand the Commissioner's role (Mulvey, 2022). Recognising the key role of union movements in the just transition globally, the Just Transition Alliance of Irish unions and NGOs has recommended dialogue, cooperation, social protection and decent work, in parallel to economic and policy innovation (Just Transition Alliance, 2022).

Just transition has recently become a topic of scholarship in the Irish context, with research focused on sectoral study (Mercier et al., 2020; Banerjee and Schuitema, 2022; Murphy et al., 2022), macro political economy (Kirby and O'Mahony, 2018; Barry, 2020) and environmental justice (O'Neill et al., 2022). In a sectoral study of energy transition, Banerjee and Schuitema (2022) consider the case of peat extraction in the Midlands and discuss how different interpretations of justice cause stakeholder tensions, which can obstruct the process of just transition. Murphy et al. (2022) moved away from the dominant global focus on energy, noting a lack of just transition research on beef farming, and considered frames to inform pathways to just and sustainable futures (see Box 4.1). A NESC report has considered just transition in agriculture and land use, noting that there are opportunities to benefit from just transition, but consider socially inclusive dialogue and participation as central to this (NESC, 2023). Similar to Murphy et al. (2022), Mercier et al. (2020) also allude to the social, environmental and market pressures facing farming in Ireland, and existing income inequalities noted across Irish agriculture by Sweeney and Wilson (2018). Kirby and O'Mahony (2018) noted that a socially just transition is as much an enabler as an outcome of change, with a key role for public policy in guiding responses across market, state and society (see also Chapter 7). Barry (2020) applies a political economy lens to critique the relationship of economic growth to work, and seeks to separate paid employment from 'work'. Care of each other and care work – for children, the elderly and those with disabilities and illness – are core to human wellbeing and flourishing (O'Mahony, 2022), but are typically of low or no monetary value in the economy (Barry, 2020). O'Neill et al. (2022) consider just transition under the broader heading of environmental justice, encompassing inequity of environmental burdens and global climate justice.

Just transition has been a research topic at NESC since 2019, as requested under the Climate Action Plan and Future Jobs Ireland 2019. NESC working papers have addressed approaches to transition (Moore, 2020), vulnerable workers and enterprises in the context of twin low-carbon and digital transitions (Thomas et al., 2020) and international case studies (Mercier, 2020). A NESC report that followed noted the importance of just transition, but also that this needs to be part of wider proactive public policy that shapes the future, based on a desired national vision[29] (NESC, 2020). NESC note the role of innovation and collective preparedness in a mission-oriented approach to achieve high-quality jobs and just transition. A subsequent working paper from Moore-Cherry et al. (2022) proposes a bottom-up lens, as impacts tend to be community specific, and advocates a place-based and co-creation approach.

Box 4.1 Just transition frames in Irish beef farming: the importance of social, cultural and political dimensions

Expert contribution from Susan P. Murphy, Sheila Cannon and Lyndsay Walsh.

The concept of 'just transition' has emerged as an important governance framework, guiding sectors transitioning from unsustainable to sustainable practices, and is most dominant in debates on the energy transition (Heffron and McCauley, 2018; McCauley and Heffron, 2018). In Ireland, recent innovative research has considered Irish beef farming and has explored a multidimensional framework to make sense of the challenges facing the sector, going beyond economics alone (Murphy et al., 2022). Beef farming is experiencing an intersecting range of social, environmental and market pressures. While beef farmers are at the centre of this, little research has been conducted to gather their perspectives on the changing state of their livelihoods, and of their concerns for the future. The multidimensional framework of the study considers not only economic dimensions, but wider ethical, social, cultural, political and power dimensions. This framework can facilitate the avoidance of community conflict, social and cultural harm, and the building of trust, ownership and legitimacy among affected populations (Wang and Lo, 2021). The study exposes how misalignment between powerful key actors – concerned with distribution, power and profit – and small beef farmers – concerned with declining social status, shifting identities and under-representation – are found to be contributing to conflict.

The research draws on the concept of 'framing' as a strategic communication device to explore the perspectives of key actors, and a multidimensional environmental justice framework, to identify the elements of (in) justice present within frames (Murphy et al., 2022). Climate action planning and policies are refracted through situated, locally embedded power structures and relations. The expansive conceptualisation of just transition, as an integrated governance framework, encompasses considerations of distribution, participation and recognition, and is essential to ensure that climate action policies achieve the objectives at which they aim. The research highlights the significance of the loss of status, including identity, social life and cultural heritage, that may be experienced during a transition process. To ensure that all affected by planned climate actions participate in deliberation processes, significantly greater attention needs to be paid to recognition and representation. This can assist with guiding action, building legitimacy and trust, and ensuring that no communities or constituencies are left behind. This innovative approach to transitions in agricultural and beef farming can be used to support the design of policies and governance systems that can successfully guide future transformational climate action planning, and implementation.

[29] NESC proposed a framing of a vision for Ireland as "… to become a resilient, sustainable, thriving net zero economy, environment and society, using innovation and collective preparedness to shape the future we want to achieve" (NESC, 2020).

4.3.1. Livelihood innovation for transformation

Economies, and related livelihoods, are always in flux and evolution. Ireland's economic development has demonstrated this over recent decades, supporting job creation (see section 4.1) through a nimble and innovative response to opportunities. As transition unfolds, the pressures and opportunities for livelihoods will fundamentally change, requiring policy and supporting analysis to evolve in response. This will require a strategic pivot to place resilient livelihoods within sustainability as the overarching objective, encompassing deep emissions reduction and adaptation to climate change. Two existing responses to the opportunity for innovation, and the management of risks, include the European Green Deal and innovation-related provisions in national Just transition plans (see section 4.3). The European Green Deal aims to make the EU climate neutral by 2050. This requires steep emissions cuts in the near term, of at least –55% on 1990 levels, across the Union by 2030. The EU recognised, in line with conclusions from the EEA (EEA, 2020), that in addition to decarbonisation using technology, systems change will be necessary in parallel. Achieving these complimentary objectives requires not only innovations across systems, but recognition of the centrality of people and livelihoods. A feasible transition requires social support (Lecocq et al., 2022), a beneficial transition requires that opportunities for new jobs and livelihoods are grasped (European Commission, 2019), and a 'just transition' is an ethical concern enumerated and prioritised in Irish national legislation[30].

Globally, the understanding of low-carbon transition has demonstrated that achieving low-emissions development is both technically and economically feasible (Nielsen et al., 2020) and can come with considerable benefits. Livelihoods are also important as an enabler of transition, and are critical to social and economic goals. Prominent modelling studies of energy, such as Jacobson et al. (2019), demonstrate that transition can entail net gains in jobs globally. Consequently, there are strategic national opportunities to build employment and livelihoods in the green and sustainable economy. While accelerating mitigation for deep emissions reductions creates employment opportunities, it also creates risks that need to be managed (Riahi et al., 2022). There are opportunities to innovate and create new employment in low-carbon and sustainable sectors, as well as risks for existing employment in the most emissions-intensive sectors, with both initiatives alluded to in national climate legislation. The future viability of sectors and businesses in a deeply decarbonising economy requires that they remain profitable in a deeply changing economic landscape (Lecocq et al., 2022). It is likely that as transition unfolds, emissions-intensive activities will become less profitable and subject to increasing pressures. National environmental challenges are known to include greenhouse gas emissions, water quality, air quality and biodiversity loss, and sit alongside global climate breakdown and biodiversity crisis (EPA, 2020a).

[30] Climate Action and Low Carbon Development (Amendment) Act 2021, Section 8(k).

In a report on the EU economy for the European Commission, Vandeplas et al. (2022) describe activities according to impact in three separate branches. In this chapter, the three-branch characterisation of Vandeplas et al. is adopted, for ease of reference, as 'dark green,' 'light green' and 'grey' activities. 'Dark green' activities are those that reduce impacts on the environment, 'light green' are activities with low impact on the environment and 'grey' activities are pollution intensive. Vandeplas et al. highlight that differences in pollution intensity of different sectors and activities are significant, with grey activities of electricity production, transport, manufacturing, agriculture and mining among the most impactful on the environment in the EU. Necessarily, the emissions intensity of sub-sectors within will vary considerably. The authors demonstrate that Ireland has a moderate and reducing level of employment in grey activities. While noting the need for transitions and transformations, the environmental properties of jobs tend to be 'sticky,' according to the International Monetary Fund (IMF) (IMF, 2022). The IMF point to difficulties for workers in moving between emissions-intensive and greener activities, and that it is higher skills that make it easier to transition into green activities. Vandeplas et al. (2022) and Vona (2019) note that the impacts of transition on emission-intensive activities tend to be concentrated in sectors and regions. The increasing pressures and the stickiness of jobs both increase the importance of targeted just transition and heighten the need for strategic policy, aligned with maximising opportunities of transition and transformation in a changing world.

The Future Jobs Ireland 2019 plan (DETE, 2019) includes low-carbon transition as one of its five pillars. It contains a stated ambition to "Realise the opportunities for economic activity and job creation", and identifies renewable energy, circular economy, bioeconomy, electric vehicles, smart grids and buildings among priorities. It also notes a commitment to prepare a report on the economic and employment implications of transition. The resulting report concentrated on two measures in particular: increasing the carbon tax and a shift away from coal and peat (de Bruin et al., 2019). These are climate action measures typically associated with negative employment impacts, rather than with employment growth (see section 6.3.1). The report found labour demand changes concentrated in geographic areas, with increases in public services, such as education and health, and reductions in mining and transport. However, as noted previously, flux in economy and employment is not new. Transition can therefore be viewed as either a threat or an opportunity to livelihoods. It is important that studies aiming to inform labour policy consider employment opportunities. In general, a failure to effectively respond to transition and transformation will not alter growing external pressures on emissions-intensive activities, and is likely to exacerbate them. In contrast, a strategic pivot in a proactive national response could extend past success in innovation into the future.

Economic structural change is a process that is typical of economic development and modernisation (see Chapter 6). Harnessing the process of structural change in the economy offers the opportunity to both keep jobs and mitigate emissions (Lecocq et al., 2022). The services sector and technology industries are typically characterised by higher productivity and lower emissions, and as a result can support low-emissions development. Opportunities to build decent jobs and lasting employment exist in strategically aligning mainstream economic development and innovation processes with emissions reduction, and with sustainable development. This includes green economy, circular economy and bioeconomy, conventional energy and technology transition policies, and structural change to low-emissions activities in services sectors (see also Chapter 6).

A variety of studies internationally have shown that mitigation action leads to job creation in systems, practices and technologies implemented for emissions reduction, including thermal renovation of buildings, installation and maintenance of low-carbon electricity generation and the build-out of public transport (Riahi et al., 2022). Such measures can support domestic employment, avoiding the potential for 'jobless growth' that could arise through mitigation relying on imported technology – such as electric vehicles – by prioritising job-creating green growth, such as in the cycling economy and public transport (EPA, 2020b; Riahi et al., 2022). Opportunities exist across systems, structures and technologies[31], with those from the economic lens further considered in Chapter 6. A framing that integrates transformation paths with job creation can uncover the opportunities of systemic sustainability innovation across public policy, and its influence on innovation in the market. The OECD (2015) note the importance of foresight approaches such as scenario analysis in addressing the challenges facing livelihoods and to build visions to enable creative and regenerative societies. Education plays an important role in this process, and should be inclusive and livelihood focused, supporting skill acquisition and the opportunity for lifelong learning.

In order to focus on private sector innovation, Siedschlag, et al. (2019) considered Irish enterprise and its propensity to introduce innovations with environmental benefits. The research indicated that environmental regulations, in-house research

[31] The potential of technologies in Ireland was reviewed in Rogan et al. (2016).

and development activity and acquisition of capital assets are major drivers of green innovation. Skillnet Ireland launched its 'Climate Ready' programme in 2021 to develop national skills for green enterprise and transition to a low-carbon economy. Climate Ready seeks to support business in developing practical skills and knowledge to build a culture of sustainability through specialised talent development and support of upskilling. The initiative published a report in 2022 on medium-term skills needs for enterprise innovation and training programme priorities, recognising that skills and training are a key dimension in response (Siedschlag et al., 2022) (see Box 4.2). The report found that the top skill sets needed in the medium term to support innovation with environmental benefits include climate change and sustainability strategy skills, marketing skills and financial skills relating to investment and access to finance. On this basis, a recommendation was made for training programmes to be focused on developing skills and talent, to support innovation and transition. Skills highlighted included climate change and corporate sustainability strategy skills, energy-efficiency design skills and green procurement skills. The report noted the need for a roadmap to guide enterprises and coordination across government departments and agencies. A national analysis has considered a sub-group of technological innovations in renewable energy, residential retrofit and electric vehicle deployment (Expert Group on Future Skills Needs, 2021).

It is recognised that remote work and the digital economy offer opportunities in rural Ireland (see also Chapters 3 and 5). However, rural Ireland also has locally specific requirements related to land use that need addressing. Opportunities exist in rural Ireland for emissions reduction, and for diversification of livelihood towards increased resilience. Land-based mitigation in the form of afforestation, improved forest management, soil carbon sequestration, peatland and coastal wetland restoration are proven to reduce emissions (see Chapter 2), and are all documented globally as having multiple benefits, including employment potential, climate adaptation and biodiversity enhancement (Pathak et al., 2022). In agricultural contexts, restoration of ecosystems is a development choice that can enhance adaptive and mitigative capacity via impact on farmer livelihoods (Lecocq et al., 2022).

The Climate Action Plan (DECC, 2021) included a commitment to review diversification, including biomethane, energy production, agro-forestry and woodland creation. Ireland has policies on rural development to 2025 (DRCD, 2021), food to 2030 (Government of Ireland, 2022) and a roadmap to climate neutrality to 2050, based predominantly on change in technology and management practices (DAFM, 2020). The 2023 update to the national marginal abatement cost curve has enhanced the range of emissions reduction measures analysed for agriculture and land to 2030 (Lanigan et al., 2023). This study includes some diversification from livestock, land-use change, including afforestation, and bio-based energy. However, to understand the full range of possible innovation opportunities requires that analyses, such as the marginal abatement cost curve, encompass significant systems and structural change in transformation paths up to 2050.

In activating deeper transformation, a systemic framing of policy could also include frontier innovation measures such UBS, UBI and the shorter working week. These frontier innovative policies could not only support transformations that achieve synergies with wellbeing and equality goals, but also underpin the social support required to undertake transitions and transformations. Long-term systems analysis of transformation paths could aid in understanding the different balances of synergies and trade-offs in paths of business as usual, incremental transition and transformation. Priority assessment headings could include rural livelihoods, public health, food security, greenhouse gas emissions, water quality and biodiversity (EEA, 2017). Without strategic analysis of alternative long-term paths, the opportunities for synergies, including deeply reduced emissions and building rural livelihoods, are likely to be forgone. The transformative approach to livelihoods, capturing opportunities in both urban and rural settings, can be related to integrated policies (section 7.4.3) and processes of anticipatory governance (section 7.3.5).

Box 4.2 Innovation and training needs to support Ireland's transition to a low-carbon economy

Expert contribution from Iulia Siedschlag.

Recent research commissioned by Skillnet Ireland (Siedschlag et al. 2022) found that developing new skills within the enterprise workforce was the top challenge that enterprises face associated with the implementation of Ireland's Climate Action Plan in the medium term. Other key challenges include improving the way in which resources are used in their supply chain to reduce emissions and improving energy efficiency of processes, buildings and transport.

The research findings highlighted the importance of supporting business leaders in establishing sustainability strategies to enable the innovation needed for Ireland's transition to a low-carbon economy. The research also identified digital skills as a key factor for enabling enterprises' capacity to innovate and to support the transition to a low-carbon economy in all sectors. Against this background, using the most recent data available from the survey on e-commerce and ICT (Eurostat 2021), this research found that the demand for digital skills in the enterprise sector in Ireland is not sufficiently met, as a large proportion of enterprises had difficulties in recruiting for jobs requiring ICT specialist skills.

Taken together, the results of this research suggested that tailored training programmes to each sector and enterprise group and at different stages in the transition to a low-carbon economy would help businesses to better act and manage the transition to a low-carbon economy. The report also recommended that enhancing collaboration and coordination of different initiatives across government departments and agencies would be important to ensure accessibility and maximise benefits. In response to this research, the Climate Ready Academy, a national upskilling initiative led by Skillnet Ireland in partnership with Chambers Ireland, has recently launched a Sustainability Leaders Programme that supports enterprise managers in integrating sustainability into their business strategy.

4.4. Research gaps

Understanding livelihood opportunities, developing related visions and establishing strategic long-term policy. Improved understanding of livelihood opportunities is required to support development of transformation policy, alongside, and in support of, a just transition. Livelihood opportunities arise from conventional technological and practice transitions, and from transformational innovations in structures and systems. Knowledge of national employment opportunities from technological and practice transitions remains limited. Knowledge of national employment opportunities in wider transformations of structures and systems is essentially non-existent. Strategic long-term livelihoods policy will be required to embrace national opportunities for livelihoods in low-emissions development. The process of building new strategic policy can be supported by analysing opportunities of, and creating shared visions for, future livelihoods.

Livelihoods in rural and urban transitions and the importance of understanding synergies and alternative paths. Rural transitions have similarities to urban transitions, but also have unique characteristics. Current research has considered national transitions in technological and management practices, but has not yet fully explored opportunities for diversification of activities, including structural and systems innovations. Exploring alternative paths can facilitate the identification of public policy options that maximise the synergies of rural livelihoods with sustainability, including low-emissions development, nature restoration, public health and food security, while enhancing livelihood resilience and incomes.

Livelihoods and synergies in broad characterisation to support knowledge building and policy enablement. Transformation is a process of fundamental change, embracing near-term action that supports achievement of a defined long-term path. It can establish multiple synergies, as win–wins, if appropriately conceptualised in planning and effectively implemented in policy. This involves changes to how we analyse the objectives we set and the policies and programmes we implement. Livelihoods are important in understanding transformation paths, and related opportunities and benefits. To support an understanding of livelihoods, conventional income, employment, equality, and poverty and deprivation measures provide useful but partial insights. To support knowledge building, important wellbeing and social considerations include opportunities and capabilities, resilience, decent work, identity, income, equity, just transition and carer roles. In fashioning implementation policy, enabling measures include: education, training, social protection, and frontier innovations such as UBS, UBI and the shorter working week.

5

Transforming Consumption and Behaviour Patterns

Key messages

The low-carbon lifestyle vision for Ireland centres on mindful consumption and behaviour patterns that are both sustainable and enhance people's wellbeing. The lifestyle transformation calls for a shift from excess to sufficiency and from short-term convenience to long-term resilience. To accomplish this a sociocultural transformation is needed, one that nurtures intentions, values, beliefs and norms in harmony with sustainable consumption practices.

While technological advancements are crucial for lowering emissions, they are not sufficient on their own. Achieving emissions targets is likely to require a substantial reduction in the demand for energy and resources. Mitigation efforts that focus on the demand side are likely to improve wellbeing by offering diversified ways to meet needs while minimising ecological impact. Such strategies emphasise the importance of conscious consumption and resource use. Further research is needed to identify optimal pathways for energy demand mitigation.

Systemic change requires mindset transformation. These mindsets, encompassing individual and collective values and beliefs, influence behaviour and decision-making processes and are seen as deep leverage points for transformation. To support sociocultural transformation for climate change, two approaches are recommended: first, creating environments and practices that nurture cognitive, emotional and relational capacities for change; and, second, incorporating personal dimensions into the political and institutional landscape.

While individual choices alone might not drive transformative change, they can shape social dynamics and contribute to broader shifts. Supportive infrastructure and technological advances are essential to making individual behavioural changes feasible. Coordinated policy instruments can accelerate changes in consumption practices; however, additional research is needed to assess the effectiveness of structural changes and political actions.

Lifestyle transformation offers not only a path to lower emissions but also an opportunity to establish decent living standards and address social equity issues such as energy and transport poverty. Households with high energy consumption disproportionately contribute to the national carbon footprint and have significant potential for demand reduction.

5.1. Introduction

Lifestyles encompass patterns of consumption, and also the ways individuals relate to one another, the values they nurture and how those values drive our choices. These lifestyles, particularly in their current dominant forms, have a significant impact on GHG emissions and therefore on climate change (Akenji et al., 2021). At the same time, access to basic energy and services is not equitable in either global or Irish societies, with some individuals consuming more than their fair share, leaving others with significantly less (Kenner, 2019; Chancel et al., 2022). Failing to shift lifestyles means that effective reduction of GHG emissions cannot be achieved, nor can the global climate crisis be successfully addressed (Akenji et al., 2021). The term 'lifestyle' is closely tied to the concept of a 'carbon footprint'. This concept quantifies the total amount of GHGs that are emitted directly or indirectly as a result of an individual's or household's lifestyle choices and consumption patterns related to nutrition, housing, mobility, consumer goods, leisure and services (Akenji et al., 2019).

Understanding the role of culture, social norms and personal choices can aid in tailoring climate action and reducing emissions. Demand-side actions can change lifestyles to be less resource-intensive, resulting in reduced carbon-intensive consumption and GHG emissions. While no Irish-specific estimates are provided, global scenario analysis indicates that demand-side strategies, such as avoiding long-haul aviation, adopting low-carbon urban design, shifting towards a plant-based diet and increasing the use of energy-efficient technology in the building sector, could reduce emissions by 40–70% by 2050. The greatest potential was found in changing individual mobility choices (Creutzig et al., 2022b). Contrary to a widely held belief, the evidence suggests that sustainable consumption practices do not decrease people's quality of life (Lavelle and Fahy, 2021). Sustainable individual choices are facilitated by creating favourable conditions for low-carbon patterns of consumption and behaviour through structural, infrastructural and technological enablers of transformation.

5.2. Current challenges and opportunities

5.2.1. Consumption and behaviour patterns

In Ireland, there has been a significant increase in domestic consumption over the past 30 years. During the Celtic Tiger period (1990s to early 2000s), the rapid economic growth in Ireland resulted in environmental problems caused by excessive consumption of energy, transport and water and excessive generation of waste. Ireland's efforts to address these issues were driven mainly by global environmental initiatives (Pape et al., 2011). The public discussion has focused mostly on the minimum amount of consumption necessary for necessities such as food, shelter and health care, rather than a maximum level (Lavelle and Fahy, 2021). Domestic consumption and its resulting emissions are increasing in line with global trends.

The IPCC (Creutzig et al., 2022b) identified four key themes that are the most pertinent to demand-side solutions for unsustainable consumption patterns: housing, mobility, food and policy. Work undertaken by the United Nations Environment Programme (Akenji and Bengtsson, 2022) similarly emphasised the importance of transforming lifestyles in these areas towards making sustainable, car-free personal transport the default, switching to more sustainable housing and home energy use, and shifting from animal to plant-based food consumption and reducing food waste, with the addition of slowing down fast-fashion consumption. Transport and energy use are the primary drivers of household emissions in Ireland, as illustrated in Figure 5.3.

There is a challenge in transitioning to greener lifestyles and achieving the government's target of a 50% reduction in emissions owing to the existing infrastructure and behavioural lock-in of mobility patterns. Despite a reduction in the number of kilometres travelled and associated emissions during the COVID-19 pandemic (23% and 15.7%, respectively, between 2019 and 2020), the number of licensed vehicles has been steadily increasing over the decade across various categories, including private cars, goods vehicles and motorcycles (DoT, 2022). Multiple car ownership is common in Dublin and is linked to the low availability of public transport and low urban density (Caulfield, 2012). The sharing economy presents opportunities, particularly through organised car sharing, to potentially relieve households from the high cost of car ownership (Rabbitt and Ghosh, 2013). This business model could be extended beyond pilot studies to reap its benefits. See section 3.3.1 Transport networks and mobility: current challenges and opportunities.

The residential sector in Ireland emitted 9.8MtCO_2 in 2021, which accounted for 27.5% of Ireland's total energy emissions. Currently, the energy consumption per dwelling stands at 15MkWh for non-electric energy usage (Figure 5.1). Oil remains the dominant source of residential energy demand in 2021, accounting for 41% of all home energy use. Electricity and gas followed, accounting for 25% and 19%, respectively (SEAI, 2022a). These figures suggest that Irish households rely heavily on oil for their energy needs. Details on the specific use of these energy sources within households, such as for heating, cooking or lighting, are not provided; however, it is common for oil and gas to be used for heating, hot water and cooking, while electricity is used for a variety of purposes, including lighting, appliances and heating. Within the household, in 2020

space heating (61%) was the largest end use of energy, followed by water heating (20%) and lighting and appliances (16%) (SEAI, 2023a). Ireland has historically had a higher average energy consumption per dwelling than most other EU countries, with electricity use 19% above and CO_2 emissions (weather corrected) 97% above the EU-15 average (Davies et al., 2010). Figure 5.2 depicts a consistent decline in CO_2 emissions per dwelling from 2005 onwards, indicating that the current total emissions have dropped to slightly below 6 tonnes of CO_2. Nevertheless, the data indicate that, in 2020, GHG emissions from Irish households for heating and cooling were twice the EU average, surpassed only by Luxembourg (Eurostat, 2021).

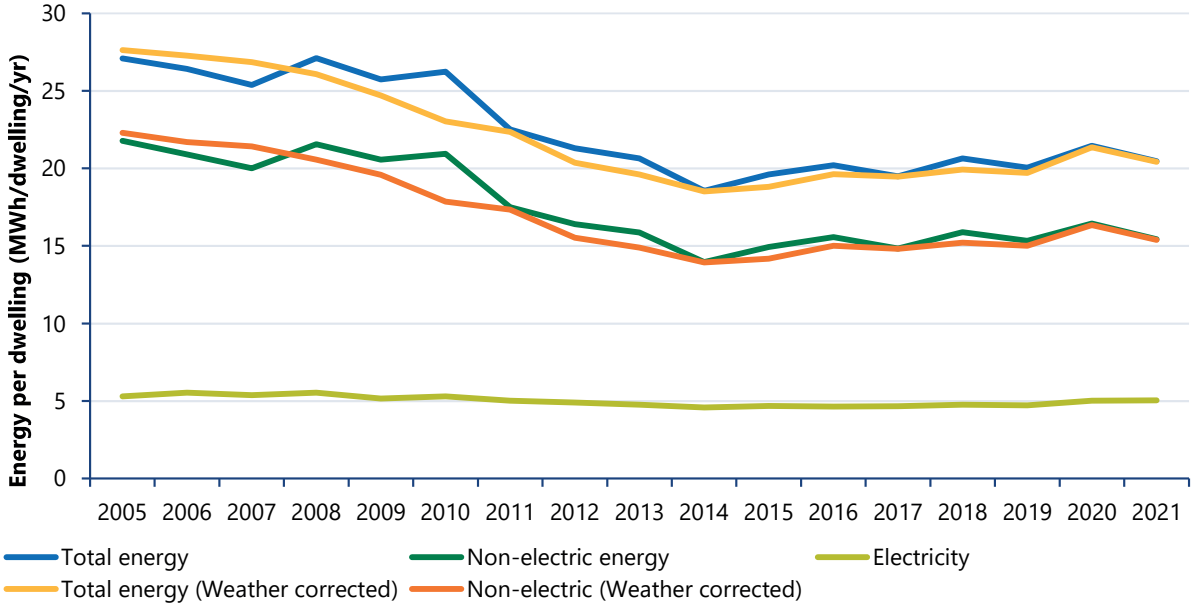


Figure 5.1 Energy consumption per dwelling. Source: SEAI (2022a).

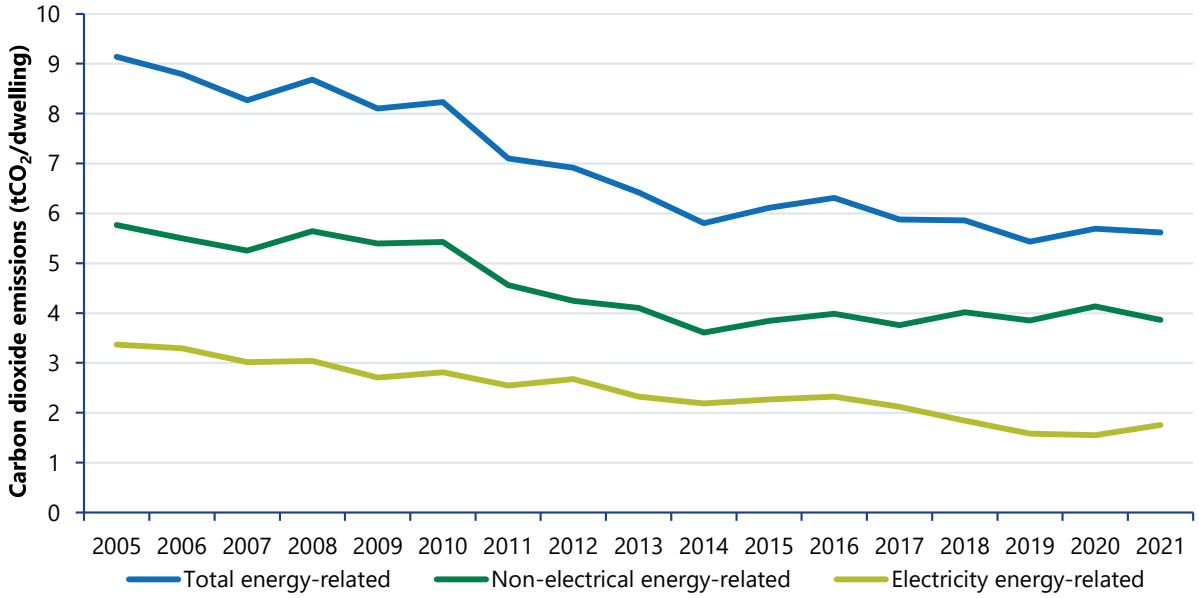


Figure 5.2 CO_2-eq emissions per dwelling. Source: SEAI (2022a).

The environmental impact of the baseline diet of Irish adults is approximately 0.5kgCO_2-eq per day higher than the average European reference diet (Kirwan et al., 2023). The mean daily dietary emissions of the Irish population was calculated as 6.25kgCO_2-eq per person in a study by Hyland et al. (2017). The food group with the highest daily contribution to GHG emissions was red meat, followed by dairy and starchy staples. Red meat provides the greatest proportion of GHG emissions per energy intake (Kirwan et al., 2023). Research also found that dietary emissions varied across different sociodemographic and socioeconomic groups of the Irish population. For example, males, younger consumers, those with secondary education, and student employment status were associated with significantly higher GHG emissions (Hyland et al., 2017). To achieve sustainability and public health objectives, a transition to a less meat-based diet is required.

Box 5.1 Sustainable and healthy diets

Providing nurturing diets to a growing global population while remaining within planetary boundaries is an immediate challenge that requires a transformation of both diets and food production systems (Willett et al., 2019; Clark et al., 2020). The consumption of carbon-intensive food products, especially in high-income countries, must decline to reach Paris Agreement goals (Springmann et al., 2018). The environmental impact of the typical Irish diet exceeds the planetary boundary for GHG emissions by around 148%, with meat accounting for over 40% of the carbon footprint of the typical Irish adult diet (Kirwan et al., 2023). Red meat consumption is the highest contributor to dietary GHG emissions, followed by other meat products, eggs and dairy (Hyland et al., 2017). Average daily meat consumption in Ireland, around 220g, is typical among high-income countries and nearly double the world average (Our World In Data, 2022).

A dietary shift in high-income countries towards a plant-based diet in line with the EAT-Lancet planetary health diet would lead to a substantial 'double dividend' for climate and for biodiversity. Sun et al. (2022) found that this would cut agricultural emissions by 61 % in high-income countries, while also sequestering around 100 billion tonnes of CO_2 equivalent (approximately 14 years of current global agricultural emissions) because of reforestation and ecosystem restoration. Research will be required to understand the potential impact of a climate-friendly diet on agriculture, consumers and markets in Ireland. Changes to the current model of production and consumption will also require engagement with and participation of relevant stakeholders in the development of a sustainable food system for Ireland.

There is scope for policy to significantly improve awareness around the climate footprint of food production (Hyland et al., 2017). A survey undertaken by the Economic and Social Research Institute on public understanding of measures for mitigating climate change found that respondents overestimated the benefits of low-impact actions, such as buying local food, and underestimated the benefit of high-impact actions, like adopting a plant-based diet (Timmons and Lunn, 2022). People are consciously reducing their meat consumption: one-third of respondents to a Bord Bia survey claimed to have reduced their red meat intake, mainly for health (67 %) rather than sustainability (30%) reasons (Bord Bia, 2018). Sustainability is not factored into Irish food-based dietary guidelines (James-Martin et al., 2022). However, in surveys of Irish consumers people state that they are willing to pay premiums for more sustainably produced food (Osawe et al., 2023), and support for carbon labelling of food is high (Yara, 2023).

A sustainable food system also requires healthy diets. Obesity and non-communicable diseases are on the rise in Ireland as a result of poor diet (O'Connor and Staunton, 2015), with associated health care costs of €5.4 billion by 2030 (Keaver et al., 2013). Food insecurity and malnutrition are also a problem, with 13% of the population in food poverty (DSP, 2015), with associated health care costing €1.4 billion a year (Rice and Normand, 2012). Along with dietary change, reducing food waste is a consumer-focused measure that can contribute to climate mitigation. Around 770,000 tonnes of food waste are generated in Ireland every year, with associated emissions of 3 million tonnes of CO_2 equivalent, accounting for 1.5% of Irish GHG emissions, and a cost of €700 per household or, at a national level, €1.3 billion a year (EPA, 2022; Government of Ireland, 2022).

In 2019, the average person in Ireland consumed 53kg of new textiles, which amounted to a total of 263,000 tonnes of textiles consumed. After being used, each person generated approximately 35kg of textiles per year, which is higher than the EU average of 26kg. The 2022 EU Strategy for Sustainable and Circular Textiles and Ireland's 2020 Waste Action Plan for a Circular Economy identify textiles as a key product group and outline a roadmap for waste management (O'Leary et al., 2021). O'Leary et al. (2021) suggest measures such as green procurement, reduced personal consumption, increased reuse, facilitating repairs, and prioritising reuse and recycling over disposal at the end of life to improve post-consumer textile treatment. Promoting reuse in Ireland can encourage the development of new skills, provide training and job opportunities, and drive innovation in circular economy design in the long term.

5.2.2. Disparities in consumption

The amount of CO_2-eq emissions emitted per person in Ireland is higher than the EU average, at 7.11 tonnes compared with the EU-27 average of 6.25 tonnes per person (European Commission, 2022). Additionally, there are significant differences in consumption patterns and consumption-related emissions within Ireland, as illustrated in Figure 5.3. International research suggests that the gap between the consumption of various income groups is high and is widening, which is known as carbon inequality (Gore, 2020). Evidence of the consumption behaviour of different income groups over time in Ireland would be useful for designing appropriate policy.

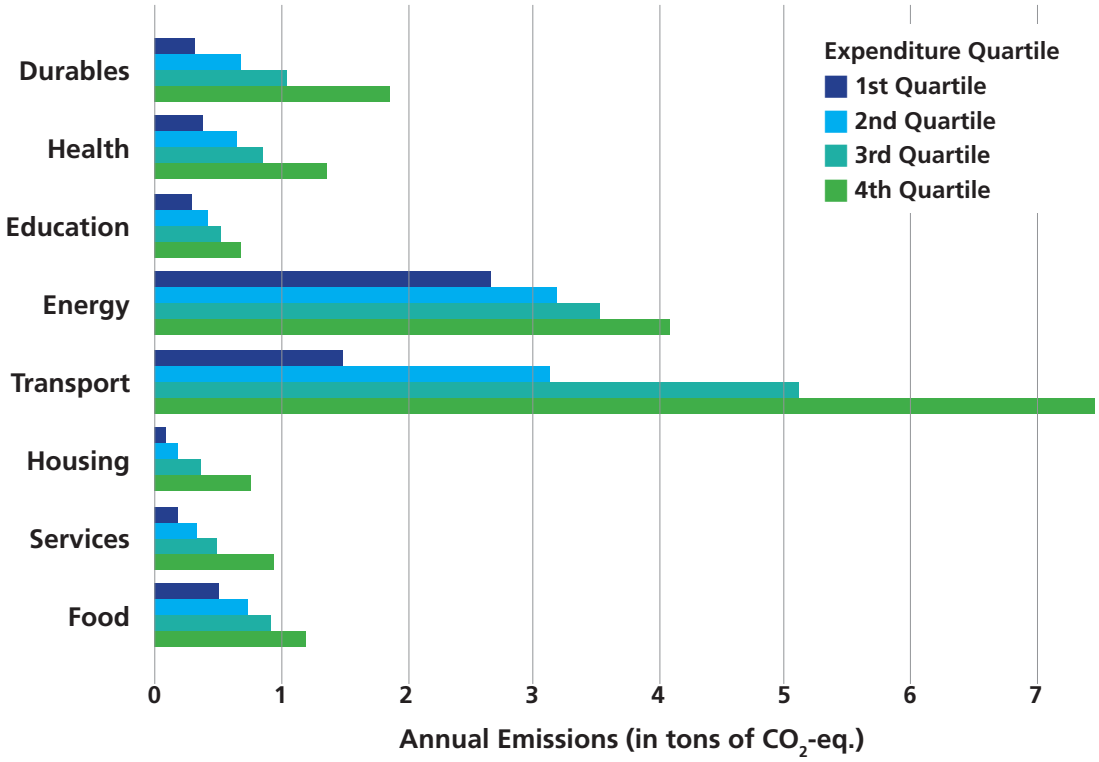


Figure 5.3 Per capita emissions across expenditure quartiles. Source: Tovar Reaños et al. (2022).

Measuring the number of households in energy poverty in Ireland is a challenge owing to multiple subjective and objective metrics, which make it difficult to track changes over time in response to government policy (Kerr et al., 2019). Prior to the rise in fuel prices in 2022, 5–15% of households faced issues with adequately heating their homes (Barrett et al., 2022), while other estimates suggested that 17.5% of households experienced 'core' energy poverty in 2020 (O'Malley et al., 2020). A recent survey shows that energy and transport poverty rates in Ireland are similar, with approximately 14% experiencing energy poverty and 18% experiencing transport poverty. Participant knowledge of the causes of poverty, such as lack of domestic energy efficiency, and of potential solutions, such as increasing public transport provision, was found to be limited (Lowans et al., 2023).

5.2.3. Over-consumption and high emitters

There is scientific agreement that wealthier individuals are responsible for a large share of GHG emissions, while also having the ability to significantly reduce their emissions without sacrificing their quality of life (Creutzig et al., 2022b). Individuals with a high social and economic status can serve as examples for adopting low-carbon lifestyles, support businesses that have a low carbon footprint and advocate for stricter climate policies (Otto et al., 2019; Cass et al., 2022). Energy use varies across income levels, with the biggest disparity in personal transport worldwide (Cozzi et al., 2023). There is evidence that the wealthiest individuals, particularly those leading large oil and gas companies, have leveraged their political influence to affect US and UK policies, hindering the transition to low-carbon energy sources at a critical time of rising inequality and growing climate change awareness (Kenner, 2019).

Based on 2015 data (Figure 5.4), the lowest 50% of Irish earners, which is likely to include economically vulnerable rural communities, emit an average of 5 tonnes of CO_2-e per person. In comparison, the middle 40% emit around 12 tonnes each, while the top 10% and 1% are responsible for approximately 24 and 66 tonnes of CO_2-e emissions per person, respectively (Oxfam Ireland, 2020). This shows that the top 10% emit nearly as much as the bottom 50% and have a carbon footprint five times larger (Oxfam Ireland, 2020). Chancel (2022) presents similar figures, with average carbon footprints for four income groups in Ireland at 6, 12, 35 and 100 tonnes of CO_2 per person. Gore and Alestig (2020) found that, between 1990 and 2015, consumption-related emissions decreased by 24% and 13% among the poorest 50% and middle 40% of the EU population, respectively. In contrast, emissions from the wealthiest 10% increased by 3%, and emissions from the top 1% grew by 5%, highlighting the divergent consumption patterns across income groups. To meet the 1.5°C target of 2.1 tonnes of CO_2 by 2030 in an equitable manner, the richest 1% in Europe would need to reduce their emissions 30-fold, while the poorest 50% would need to halve theirs (Gore and Alestig, 2020; Newell et al., 2021a).

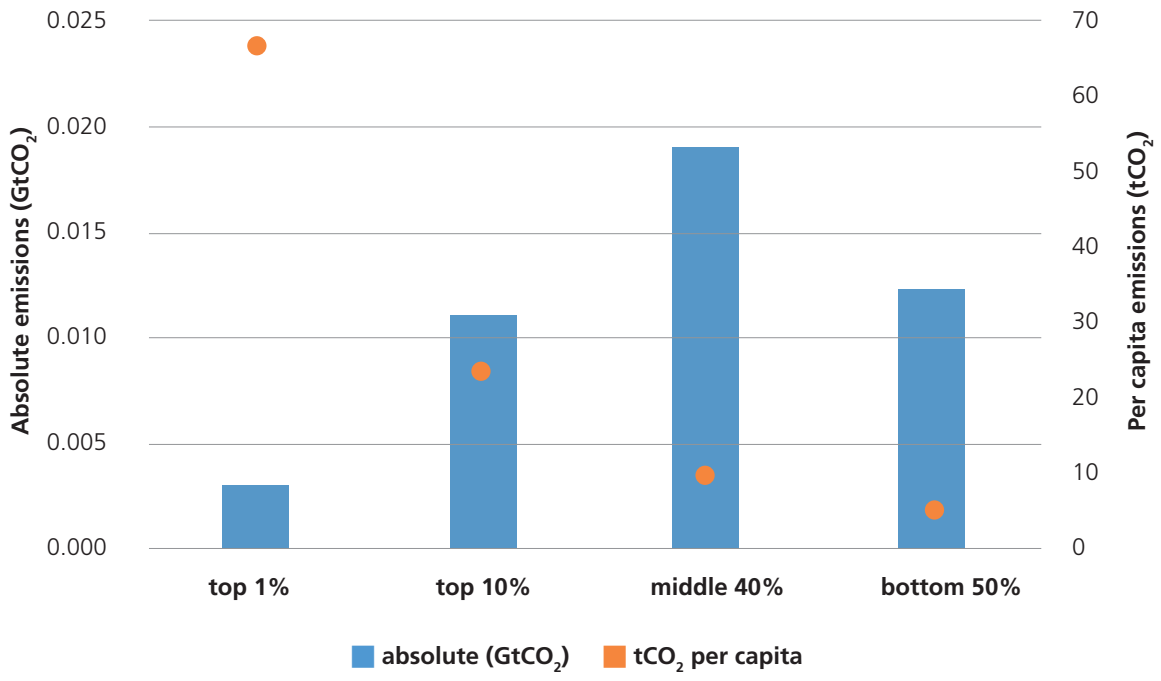


Figure 5.4 Absolute and per capita emissions per income group, 2015. Source: Adapted from Oxfam Ireland (2020).

5.3. Envisaging and delivering transformation

5.3.1. Sufficiency and low-carbon lifestyles

Sufficiency policies offer a promising solution to the increasing demand for energy, materials, land and water while ensuring human wellbeing within the planet's limits (IPCC, 2022a). These policies aim to reduce the demand for resources through non-technological solutions that consume less energy. Instead of providing resources, the emphasis is on providing efficient and sufficient services that enhance people's wellbeing. The focus is on shaping demand, rather than predicting energy usage (Creutzig et al., 2022b). This approach involves setting minimum and maximum standards for needs satisfaction, known as corridors of consumption, which ensure that everyone can live a life they value without affecting others' ability to do the same (Lavelle and Fahy, 2021). Similarly, the doughnut economic model aims to meet the basic needs of all people while operating within the planet's ecological limits. The 'doughnut' represents a safe and just space for humanity, bounded by a social foundation that prevents deprivation and an ecological ceiling that avoids environmental degradation (Raworth, 2017). To achieve climate targets, it is crucial to target excess consumption, which has a disproportionate carbon footprint. This is likely to have a profound impact on emission levels (Otto et al., 2019). High-energy-consumption households have the greatest potential for demand reduction since their socioeconomic characteristics enable them to invest in energy efficiency improvements (Cass et al., 2022). Transforming lifestyles also presents an opportunity to address social justice issues, such as energy and transport poverty (Lowans et al., 2023).

5.3.1.1. Sufficiency and decent living standards

The academic discourse on sustainable consumption lacks clarity on whether it means consuming less, consuming more green products and services, or consuming differently. Policymakers often adopt a weak interpretation of sustainable consumption, which involves consuming more eco-efficient products rather than reducing overall consumption. However, this approach can lead to the rebound effect, where efficiency gains are outweighed by an increase in overall consumption (Lavelle and Fahy, 2014).

The concept of sufficiency arises in response to the current unsustainable levels of energy and resource consumption that are pushing global society beyond planetary boundaries (Spangenberg and Lorek, 2019). These patterns of behaviour are driven by the desire for continued economic growth and consumption (Fitzpatrick et al., 2015). However, evidence suggests that current resources could support global human needs at a high level of development if they were distributed equally (Steinberger and Roberts, 2010). Needs can be met through different means (satisfiers), and the sufficiency movement calls for these needs to be met through diversified means while limiting material consumption to within the limits of the planetary boundaries. This is because many needs can be satisfied more effectively through social processes and human interactions rather than the consumption of material goods. Social arrangements constructed around consumerism, where daily decisions are centred on the consumption of products, pose obstacles to behavioural change. Therefore, social and institutional changes are necessary to establish different behavioural patterns (Spangenberg and Lorek, 2019). Sufficiency measures undertaken by governments have the potential to limit the demand for energy and materials and reduce GHG emissions (IPCC, 2022a).

Decent living standards refer to a universal set of service requirements essential for basic human wellbeing, including nutrition, shelter, health care, education and mobility. These standards intersect with many Sustainable Development Goals, and achieving universal wellbeing with low carbon emissions requires identifying options and pathways that do not compromise decent living. While developed countries like Ireland are currently reliant on carbon-intensive ways of satisfying human needs, reconfiguring infrastructure and adapting to low-carbon options are necessary to satisfy needs in sustainable ways (Creutzig et al., 2022b). By implementing efficient technologies and making significant changes to the demand side, it is estimated that Ireland's final energy requirements for providing decent living standards will be 17.1GJ per capita per year by 2050 (Millward-Hopkins et al., 2020).

5.3.1.2. Tackling energy poverty and overconsumption

Energy poverty is well recognised in the political agenda in Ireland, and policy documents acknowledge that energy efficiency is the most cost-effective way to tackle it. However, spending on efficiency, for instance retrofitting programmes, has been much lower than subsidies for energy costs. In 2010, the Irish government introduced a carbon tax on domestic fuels and considered a voucher scheme for low-income families, which was eventually abandoned (Kerr et al., 2019). Research suggests that an additional carbon tax of €80 per carbon tonne on energy commodities could reduce carbon emissions by 10%. Moreover, carbon taxation on fuels used for residential heating and transport was not found to be a regressive policy if the benefits of avoiding environmental damage are taken into account (Tovar Reaños and Lynch, 2023).

The government's Strategy to Combat Energy Poverty (DECC, 2021) includes four action areas: improving the energy efficiency of homes, enhancing the fuel allowance and energy affordability measures, supporting vulnerable energy customers, and strengthening governance, research, measurement and evidence. Expanding on this strategy, the government has now introduced the Energy Poverty Action Plan (DECC, 2023b). The latest proposed measures refer to the introduction of minimum energy efficiency standards for rental properties, the expansion of the Warmer Homes Scheme (part of the SEAI's Fully Funded Energy Upgrades scheme) to include rental properties, and the development of a rental energy efficiency rating system (DECC, 2022). Multiple initiatives have been undertaken to tackle energy poverty; for example the Warmth and Wellbeing Pilot Scheme has upgraded 1,300 homes, enhancing living conditions for individuals in vulnerable situations (SEAI, 2022b).

Energy subsidies serve as the best short-term option. However, in the long term the focus needs to shift towards an energy system centred on citizens, where individuals and communities actively participate. Immediate actions are required to ensure this long-term shift (Hunkin and Krell, 2022). The role of social entrepreneurs and social innovation is crucial for promoting and formalising efforts that engage various stakeholders, particularly policymakers, in addressing energy poverty (Manjon et al., 2022). The energy justice framework is essential for guiding better governance and financial systems. This requires supportive environments to foster innovative business models and protective spaces facilitated by multi-level interventions (Hiteva and Sovacool, 2017). Community energy initiatives are particularly promising, as they not only offer sustainable energy but also foster community cohesion and create new skill sets and financial opportunities within the region (Hunkin and Krell, 2022).

Considering the uneven contribution to carbon emissions by different income groups (see section 5.2.3 Over-consumption and high emitters), creating targeted policies is essential for effectiveness and equity. These policies can differentiate between punitive measures for those who over-consume and supportive systems for the majority, who have less control over essential aspects like transport, energy and food (Figure 5.5). For example, while bans on fossil fuel investment are aimed at the wealthy, financial incentives for green energy appeal to middle-income groups. The less affluent, meanwhile, require public investment in renewables and worker protections in affected industries, as discussed in Chapter 4 regarding a just transition.

To mitigate the impact of climate change, Oxfam Ireland (2020) recommends targeted policies for wealthier individuals, for example progressive carbon pricing on 'luxury' emissions, such as those from private jets and SUVs, and ending tax breaks for aviation fuel, and exploring a mechanism to deter frequent air travel. These measures, along with ending subsidies for high-carbon luxury sectors, can fund social protections and energy efficiency programmes for low-income households. Otto et al. (2019) suggest that the affluent have untapped potential for reducing their carbon footprint by 20% through lifestyle changes, such as adopting zero-carbon homes relying on decentralised renewable energy production and using electric vehicles. However, the super-rich are less likely to be swayed by heavy environmental taxation, necessitating compulsory measures like building codes that enforce renewable installations on large residences. Current regulations mandate the compulsory use of renewable energy sources, which should generally account for 20% of the primary energy consumption of new and renovated homes. However, there is some leeway if the building exceeds energy efficiency standards set by the regulations (SEAI, 2023b). Actions undertaken by the wealthy not only achieve emissions reductions but can also spur technology adoption among other social groups.

Which social group is targetted?	What kind of climate policy?		
	Increase green energy supply	**Increase green energy access**	**Switch in energy end-uses (building, transport, industry)**
Bottom 50%	Industrial policy: public investments in renewables (off or on-gridd); Social protection: increase transfers to workers in industries affected by the transition	Public investments in green energy access (e.g. clean cookstoves; construction of new zero carbon social housing)	Develop public transport systems: low-carbon bus, rail, car-sharing strategies; energy retrofitting in social housing; cash-transfers to compensate increase in fossil energy prices
Middle 40%	Same as above + Financial incentives to encourage middle-class investments in green energy. Bans on new fossil investments	Subsidies for green housing construction; Buildings regulations; penalty and bans on sales of inefficient housing	Same as above; Stricter regulations & taxes on polluting purchases (SUVs, air tickets); Subsidies on green alternatives (elec. vehicles)
Top 10 % & Top 1%	Wealth or corporate taxes with pollution top-up to finance the above & accelerate divestment from fossils; Bans on new fossil investments	Wealth or corporate taxes with pollution top-up (see left); Fossil fuel subsidy removal*	Strict regulations on polluting purchases (SUVs, air tickets); Wealth or corporate taxes with pollution top-up (see left); Carbon cards to track high personal carbon footprints & cap them

Figure 5.5 Selected climate policies and their potential impacts on income groups. Source: Adapted from Chancel et al. (2022). Reproduction licensed under the Creative Commons Attribution CC BY 4.0 licence (https://creativecommons.org/licenses/by/4.0/).

5.3.1.3. Energy demand reduction

Achieving even the most optimistic expansion of low-carbon technologies would not satisfy the anticipated energy demand by 2050, in alignment with the Paris Agreement (Creutzig et al., 2022a). Therefore, strategies to reduce demand on the user's side are crucial to achieving climate goals in the immediate and intermediate future.

In the context of climate change mitigation, reducing energy demand offers multiple advantages: it allows for significant cutbacks across all energy sectors, minimises the need for large-scale carbon removal technologies, reduces financial investments in the energy system, achieves emission reduction targets earlier and allows for increased ambition, and provides quicker emission reduction opportunities, thereby escalating climate goals (Barrett et al., 2022). The demand reduction strategies also align with enhanced wellbeing (Creutzig et al., 2022a).

The Climate Action Plan 2023 outlines measures for reducing energy demand in sectors like transport, industry and the built environment (DECC, 2023a). These include communication campaigns and technological solutions, such as the introduction of smart meters. However, the effectiveness and impact of these and other interventions require further investigation, as indicated by the potential role of demand management in closing the emissions savings gap.

The Irish low energy demand (LED) scenario involves reducing energy demand through strategies like the densification of settlement patterns, investments in public transport and walking and cycling infrastructure, and dematerialisation of the economy (Figure 5.6). These actions result in lower demand for materials, heat and transport, and lead to a significant decrease in the cost of decarbonising the energy sector while reducing dependence on risky technologies like carbon capture and storage. However, achieving the LED pathway is not possible by relying on voluntary changes in behaviour from individuals and companies. Instead, it requires the implementation of targeted policies specific to each sector that shift values and norms towards lower consumption. Lowering reliance on energy-intensive services improves energy security, but the overall impact of reducing energy consumption on the economy and the rebound effects have not been measured (Gaur et al., 2022). Future research should prioritise quantifying costs and enabling measures for the LED pathway.

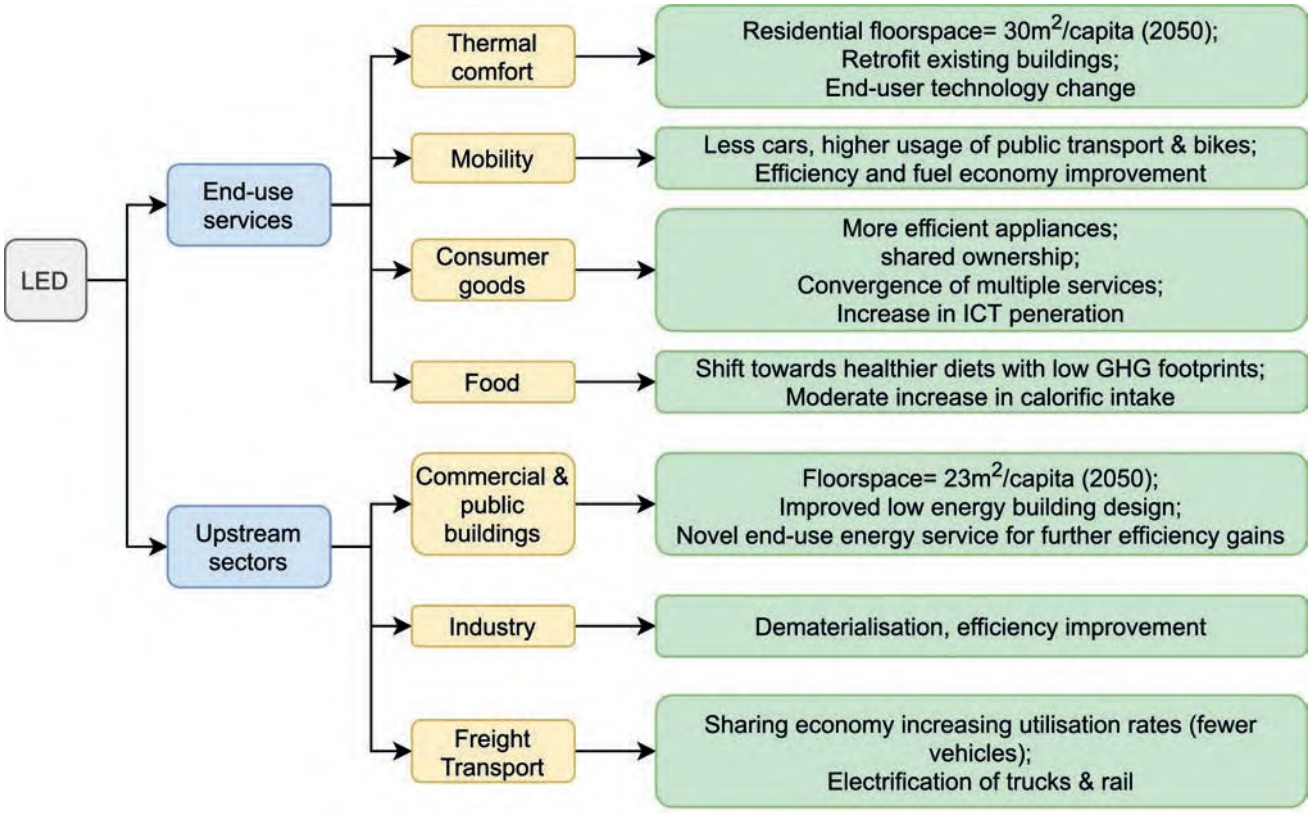


Figure 5.6 Low energy demand scenario assumptions for Ireland. Source: Grubler et al. (2018). Reproduction licensed under the Creative Commons Attribution CC BY 4.0 licence (https://creativecommons.org/licenses/by/4.0/).

Future projections, particularly concerning emissions profiles, inherently carry a significant degree of uncertainty. The trajectory of emissions profiles depends considerably on individual and societal behavioural changes in response to policies, technological availability and economic shifts. The literature on this topic remains rather scarce.

5.3.1.4. Corporate responsibility and ecological debt

There is debate over the rise of a 'consumer culture' and how it might be identified or seen as distributed at different scales. For instance, from a macro view, it is not uncommon to refer to a dominant 'Global North' that lives more lavishly and consumes more natural resources than a 'Global South' (Micheletti and Stolle, 2007). Others suggest that a group of core nations dominates over peripheral nations and spurs issues of unequal ecological exchange (Rice, 2007; Hornborg, 2009) and ecological debt (Simms, 2001; Mason et al., 2018). Ecological debt refers to liability incurred by countries that have long

benefited from unequal ecological exchanges. Such debt can also be incurred indirectly; for example, more industrialised countries are more responsible for climate change through the burning of fossil fuels, but will not necessarily suffer from its consequences in the same way as lower-income countries.

The concept of unequal ecological exchange refers to the way higher-income countries receive and benefit from foreign resources through trade with lower-income countries, while those lower- income countries are prone to suffer the environmental damage related to those traded resources (Bunker, 1985). As emissions imbalances embodied in traded goods are present in many international trade relationships, scholars have framed them as cases of unequal ecological exchange (Hornborg, 2009; Rice, 2007). 'Carbon leakage' – national emissions displaced to other regions – is often related to an unequal exchange of labour. Lower labour costs in lower-income countries usually result in increased exports (Simas et al., 2015) and the accompanied 'export' of any related embodied emissions. In other words, higher-income regions have the advantage of leaking carbon to lower-income countries while appearing to have lowered their own national emissions. Thus, it can be said that the wealth of higher-income countries is partially 'subsidised' by a capacity to outsource its indirect emissions (Isenhour, 2012). For example, although China has benefited economically from the export of many products, claiming an estimated 38% of the jobs related to world trade (Arto et al., 2014), it has also suffered from the consequences of high carbon emissions (Zhang et al., 2018). Indirect emissions are considered 'scope 3 emissions' that occur in a company's value chain of purchased goods. Although there is little research accounting for scope 3 emissions in Ireland, it can be assumed that Ireland, through its foreign trade, does partake in leaking indirect emissions to lower-income countries.

Ireland's carbon footprint extends beyond its borders, as the country imports more goods and services that contribute to GHG emissions than it exports. Other countries emit 66MtCO_2-eq for Irish consumption (Figure 5.7). To reduce its global carbon footprint, Ireland needs to consider these emissions outside its borders (de Bruin and Yakut, 2022). This can be achieved through consumption-based policy measures, such as a green VAT that applies to products depending on their embedded emissions (Tovar Reaños et al., 2022). Estimated consumption-based emissions are 74% higher than production-based emissions, amounting to 107MtCO_2-eq. Intermediate products are imported for production processes, and 40% of these imported emissions are then exported as final products (Figure 5.7). Households, followed by production, account for the largest percentage of imported emissions. The imported goods that contribute the most to emissions are chemicals, rubber, various mining products, trade, transport equipment, high-tech products, food, beverages, tobacco and textiles. For many of these products, the emissions produced during their production are minimal. Therefore, efforts to reduce production-based emissions may not necessarily decrease the usage of these products or related emissions (de Bruin and Yakut, 2022).

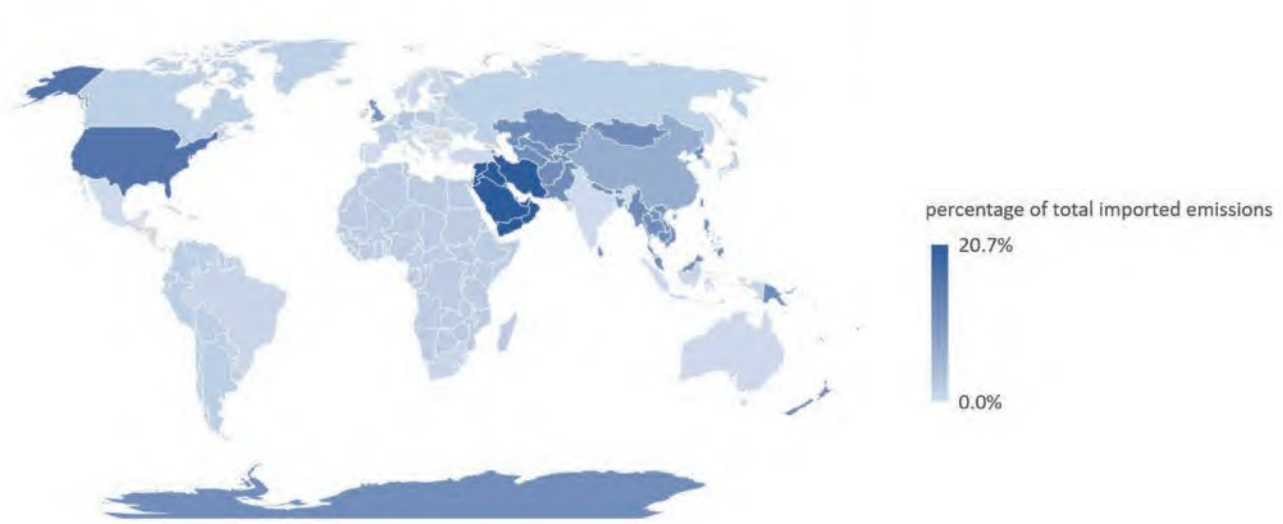


Figure 5.7 Domestic, imported and exported GHG emissions in Ireland. Sources: de Bruin and Yakut (2022) and Tovar Reaños et al. (2022).

5.3.2. New paradigms

According to current understanding, service provision systems that rely on digitalisation, sharing economy initiatives and circular economy initiatives have had only a modest impact on mitigating climate change so far (Creutzig et al., 2022b). This means there is significant untapped potential for these innovative approaches to make a transformative difference. As the understanding and technologies evolve, these new paradigms could become important drivers in the effort to combat climate change. The IPCC's work underscores the importance of continued research and investment in these areas (Creutzig et al., 2022b).

5.3.2.1. Digitalisation

In the limited yet expanding literature on the impact of digitalisation, there is some evidence indicating that digital consumer services may lead to a decrease in energy consumption, emissions and physical activity (Figure 5.8). However, there is only moderate agreement on the extent of these potential benefits, and it is crucial to carefully manage induced demand and rebound effects to avoid any adverse consequences (Creutzig et al., 2022b). The Irish literature is very limited when it comes to the role of digitalisation in emissions reduction, and, similarly to global literature, its transformative effect. The themes that have been identified and discussed include deploying artificial intelligence as a useful tool for climate change research (e.g. Mason et al., 2018), the benefits of digital platforms for food sharing (Davies and Legg, 2018), open data and resources informing decision making (Kitchin and Stehle, 2021), and working remotely as enabled by digital technologies (Stefaniec et al., 2022). Exploring the enormous potential of information flows and the way to handle them needs to be a priority to understand their potential to serve systemic change purposes and enable better government decision making on climate.

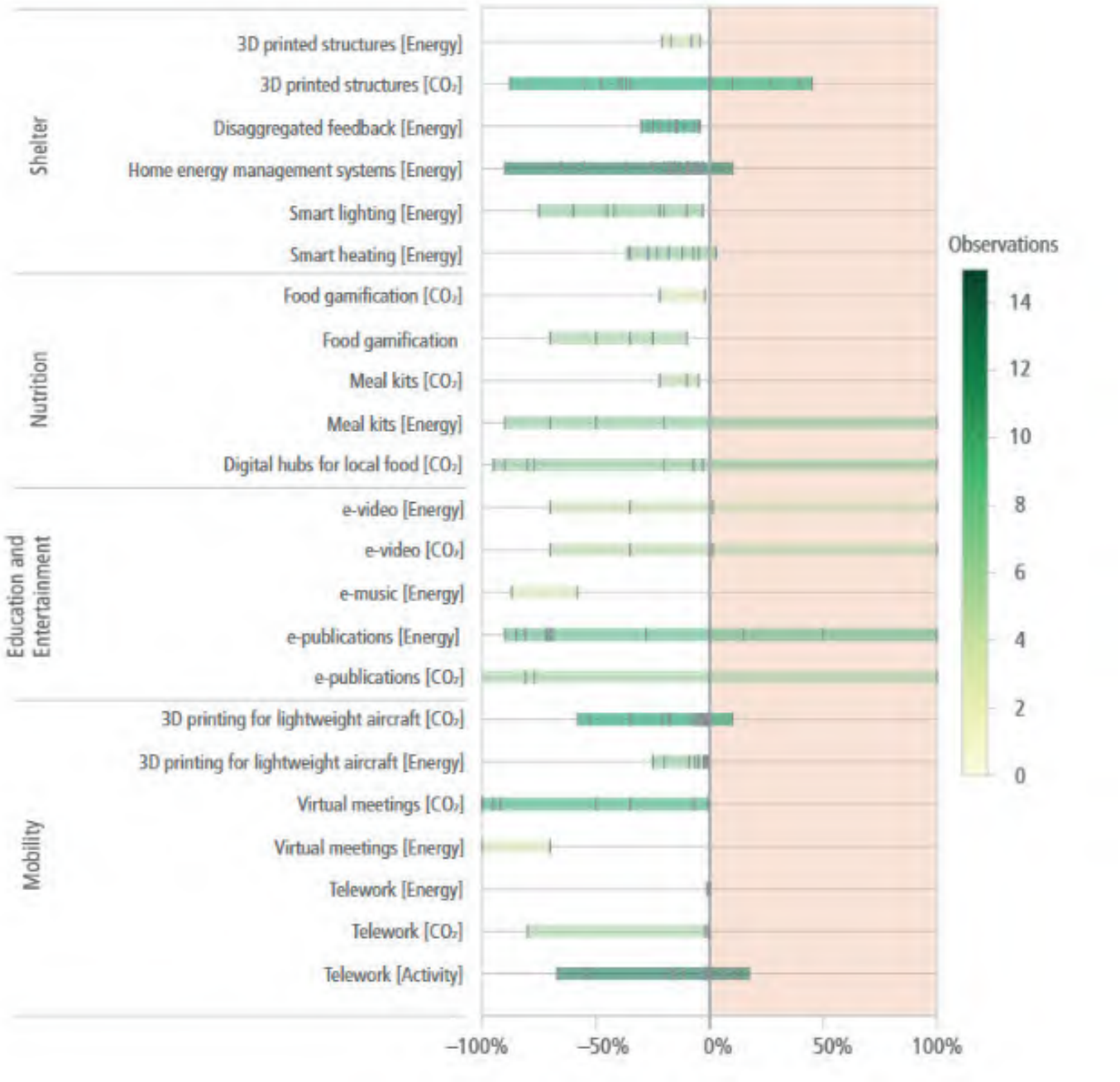


Figure 5.8 Emissions and energy savings from digitalisation can be offset by increased activity or scale. Source: Creutzig et al. (2022b; their figure 5.12).

Digital tools offer capabilities that can support and accelerate the green transition. For example, real-time monitoring provides precise information, predictive modelling boosts efficiency, virtual solutions are transforming industries and lowering their ecological footprint, digital systems management can handle rising complexities, and ICT fosters unprecedented interactivity (European Commission, 2020; Muench et al., 2022; Ulrich et al., 2022). However, the environmental cost of these technologies cannot be overlooked. Their creation and operation involve processes that strain the environment, from resource extraction, including rare elements, to the vast energy they consume and the non-biodegradable, harmful waste they produce (Muench et al., 2022). In 2022, Ireland's data centres used 18% of the country's metered electricity, a significant rise from 5% in 2015. This amount is equivalent to electricity consumed by urban dwelling (CSO, 2023). Nonetheless, a more sustainable digital future could emerge by 2050 if innovations like quantum computing, organic electronics and self-sustaining devices revolutionise digital technologies (Lopatka et al., 2022).

5.3.2.2. Sharing economy

Information and communication technologies are seen as a crucial enabler of sharing, extending the spaces in which sharing can take place (Davies and Legg, 2018). Urban food sharing is an arena of experimentation that includes collective and collaborative practices around food, from shared growing, cooking and eating to the redistribution of surplus food and the sharing of spaces and devices (Davies and Evans, 2019). Taking a participatory approach can amplify marginalised voices and practices, as demonstrated by the SHARECITY project's use of participatory methods and visual scenarios to showcase the insights of those involved in shared food practices (Fitzgerald and Davies, 2022).

Another area of shared economy application is mobility (see Figure 5.9), with bike sharing and car sharing systems being installed in urban areas in Ireland and several mobility hub trials being undertaken for public and company employee use (see section 3.2.2 Envisaging and delivering transformation – shifting to shared mobility). It is recommended that experiments and pilots of shared economy initiatives be scaled up and extended to other area applications, and their results evaluated through the lens of their impact on the climate, economy and society.

5.3.2.3. The circular economy and bioeconomy

There is insufficient evidence to support claims that the circular economy is effective in promoting sustainability and mitigating climate change (Creutzig et al., 2022b); however, available international literature suggests a certain mitigation potential of these emerging strategies (Figure 5.9). The anticipated advantages include enhancing urban liveability, promoting broader economic value distribution and stimulating innovation (Ellen MacArthur Foundation, 2019). Ireland's Circular Economy Programme 2021–2027 (EPA and Government of Ireland, 2021) aspires to act as a catalyst for Ireland's transition to a circular economy. The programme envisages an Ireland where resource consumption is minimised and waste prevention is prioritised to achieve sustainable economic growth. Although Ireland has laid a solid groundwork in resource efficiency, it is worth investigating how transformative circular economy practices can be, moving beyond mere incremental improvements (O'Rafferty, 2017).

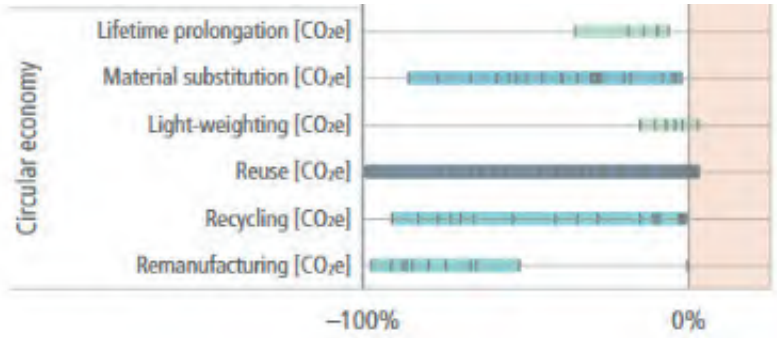


Figure 5.9 Emissions reduction potential of shared and circular economy strategies. Source: Creutzig et al. (2022b; their figure 5.13, lower left panel).

The bioeconomy offers multiple solutions across various sectors. It aids carbon sequestration and promotes the use of renewable energy, particularly in sectors where electrification is challenging. It also encourages resource-efficient industry practices, and waste reduction. Additionally, it contributes to energy-efficient housing and sustainable food production, while enhancing biodiversity and ecosystem services (European Commission, 2020). The National Bioeconomy Action Plan 2023–2025 will feature a set of actions and measures designed to bolster the execution of Ireland's National Policy Statement on the Bioeconomy (DECC and DAFM, 2022).

5.3.3. Societal transformation

Creating more sustainable and environmentally conscious consumer behaviour requires individual behavioural change embedded in structural and cultural change. To achieve this goal, a multifaceted approach is recommended, involving the cultivation of intentions, values, beliefs and norms that align with sustainable consumption. Without a shift in values, unsustainable consumption patterns are likely to persist (Kasser, 2016). This requires an array of measures that include the development of knowledge and skills necessary for sustainable behaviour. However, relying solely on habit formation to effect behavioural change is not advised, as creating new habits and modifying old ones takes considerable time. Environmental and contextual factors need to be considered; therefore, incentivisation techniques (carrots) and the removal of barriers that inhibit sustainable behaviour should be implemented. Incentives include rebates for installing solar panels or subsidies for the cost of green products or services. Constraints on unsustainable behaviour (sticks), such as economic costs, also need to be imposed to discourage such behaviour. These constraints refer to, for instance, frequent flyer levies, mansion taxes and waste taxes, but also choice editing (Akenji et al., 2021).

5.3.3.1. Demand-side management

Social and cultural transformation is required to reduce excessive consumption and encourage a shift towards low-carbon behaviour patterns. The way infrastructure is planned and made available, as well as the level of access to technology, can impact how people demand services such as transport, housing, clean water, sanitation and food, and how those services are provided (IPCC, 2022b). Social practices can be shaped by both technologies and infrastructures, and their design is crucial for effective mitigation measures (Creutzig et al., 2022b).

Demand-side management refers to strategies and measures implemented to influence the consumption of energy, resources or services. It focuses on altering how individuals, businesses and institutions use energy or resources to achieve more efficient and sustainable outcomes. Demand-side measures offer the potential to significantly curtail global GHG emissions by a notable 40–70% by the year 2050 (Figure 5.10). The demand-side approach entails a multifaceted strategy involving modifications to how infrastructure is employed, the adoption of end-use technologies and shifts in sociocultural and behavioural patterns (IPCC, 2023).

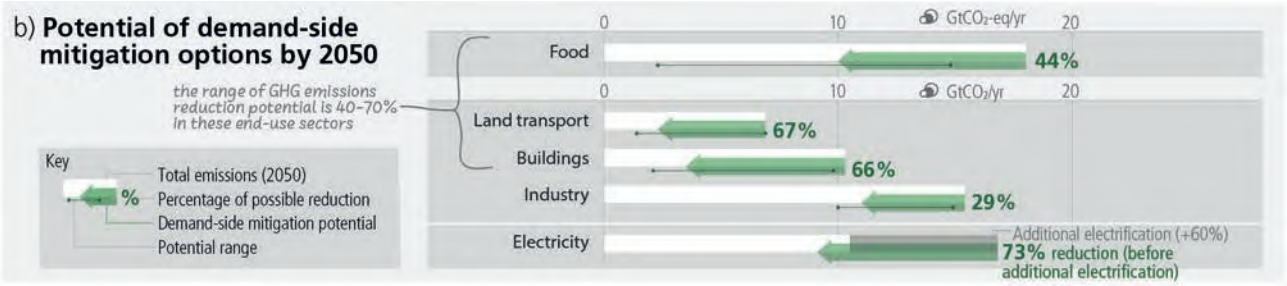


Figure 5.10 Potential of demand-side mitigation options by 2050. Source: Adapted from IPCC (2023; their figure SPM.7, panel b).

5.3.3.2. Sociocultural transformation

Similarly to infrastructural systems, social and cultural mechanisms can entrench societies in carbon-heavy service delivery models. However, they also present opportunities to alter beliefs and societal habits, facilitating substantial reductions in emissions (Creutzig et al., 2022b). The process of change requires a corresponding societal change to enable individuals to make significant reductions in their carbon footprint, which is necessary to create a sustainable society that operates within

ecological limits (Fitzpatrick et al., 2015). Personal choices alone cannot initiate or drive transformative change; nevertheless, quantifying individuals' GHG emissions can help them realise the need for societal transformation. The personal carbon footprint in Ireland has been estimated at around 5.7 tonnes of CO_2-eq annually, which is twice the global average (Kenny and Grey, 2009; Fitzpatrick et al., 2015). Even the feasible changes that could be made by individuals to reduce their footprint by 30–40% would still leave the carbon footprint above the global average. The main contributors have been identified as home energy (Kenny and Grey, 2009) and transport, particularly air and car travel (Fitzpatrick et al., 2015). Living in a car-dependent society, individual lifestyles are primarily dictated by societal arrangements, including infrastructure and approach to urban planning.

A case study conducted on energy retrofitting in Irish households revealed that technology changes alone are not enough, and a simultaneous change in householders' views and practices is necessary. This is particularly important when considering the persistence of energy-intensive domestic activities and the possibility of rebound effects that could offset some of the retrofitting savings (Rau et al., 2020).

Academics, policymakers and industry experts are increasingly advocating for a holistic approach to climate change that addresses both external factors and the internal mindsets that shape our cultures and systems. Merely focusing on external changes like technological advancements or policy shifts is insufficient for tackling the multifaceted challenges of sustainability and, similarly, climate change. Instead, meaningful change can be achieved through internal transformation, which involves altering values, beliefs and attitudes towards sustainability.

Wamsler et al. (2021) define internal transformation as a complex, multilayered process that encompasses cognitive, emotional, ethical, relational and spiritual dimensions. They emphasise that sustainability mindsets are an important aspect of internal transformation, as they can support the development of the qualities and capacities needed to enable the change. Internal transformation of mindsets, which include our values and beliefs, is a powerful leverage points for meaningful change (Meadows, 1999; Figure 5.11). Mindsets influence people's behaviour and decision-making processes, and, thus, interventions at this level are determined to be highly effective (Meadows, 1999). While external measures like carbon taxes have limited impact, focusing on changing mindsets could have a far-reaching effect (Wamsler et al., 2021).

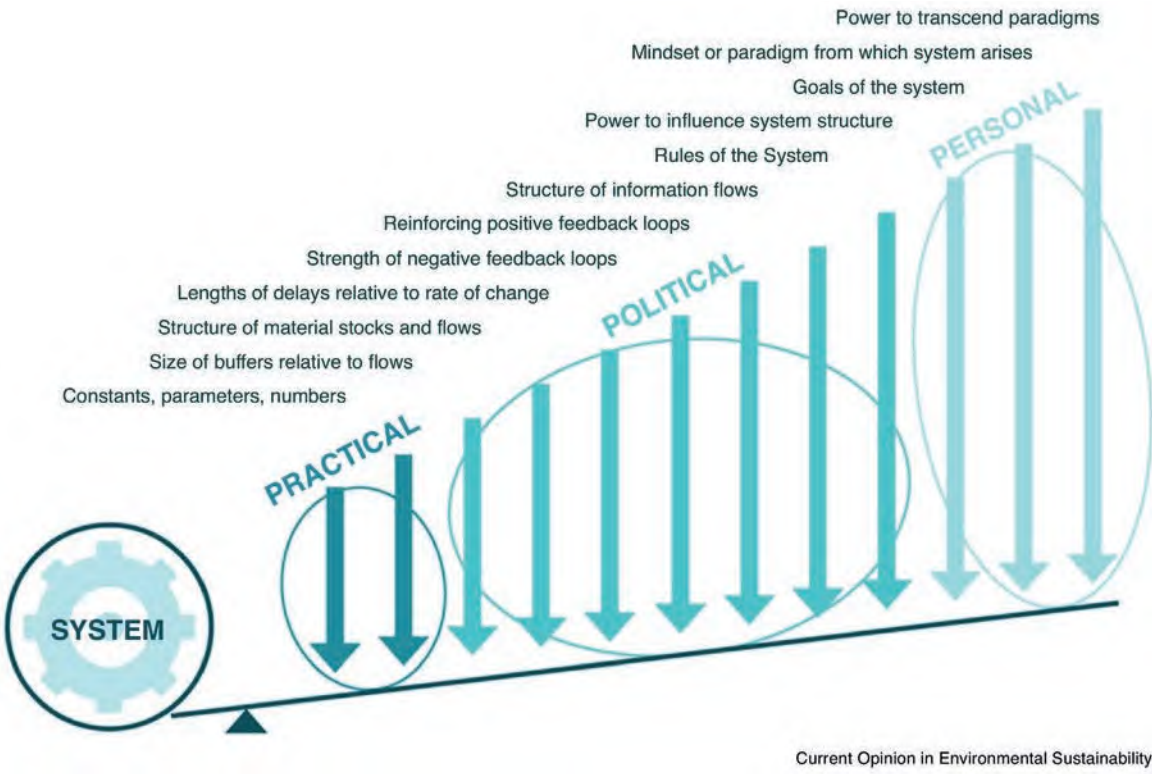


Figure 5.11 Leverage points for systems change and their relationship to the practical, political and personal spheres of transformation. Source: O'Brien (2018). Reproduction licensed under the Creative Commons Attribution CC BY-NC-ND 4.0 licence (https://creativecommons.org/licenses/by-nc-nd/4.0/).

To support the internal transformation of mindsets, the fostering environments and practices that nurture personal transformative qualities and incorporate internal dimensions into political and institutional frameworks are needed. This approach necessitates cross-sectoral collaboration and coordinated governance (Wamsler et al., 2021). Table 5.1 shows sociocultural lock-in mechanisms, changes required for mindset transformation and policy measures that can facilitate those changes (Creutzig et al., 2022b). For example, local government interventions could involve establishing citizen climate cafes, local climate councils or counselling services where residents can participate in meaningful public–private projects. Additionally, climate communication and environmental campaigns could be designed to connect climate issues with other societal crises, while also emphasising intrinsic, universal values (Wamsler and Bristow, 2022).

Driver	How does driver contribute to status quo bias?	What needs to change?	Driver's policy implications	Examples
Sociocultural	• Cultural norms (e.g. status, comfort, convenience) support existing behaviour • Lack of social trust reduces willingness to shift behaviour (e.g. adopt car sharing) • Fear of social disapproval decreases willingness to adopt new behaviours • Lack of opportunities to participate in policy create reaction against 'top-down' imposition • Unclear or dystopian narratives of climate response reduce willingness to change and to accept new policies and technologies	• Create positive meanings and norms around low-emission service delivery (e.g. mass transit) • Community initiatives to build social trust and engagement, capacity building, and social capital formation • Climate movements that call out the insufficient, highly problematic state of delayed climate action • Public participation in policymaking and technology implementation that increases trust, builds capacity and increases social acceptance • Positive narratives about possible futures that avoid emissions (e.g. emphasis upon health and slow/active travel)	• Embed policies in supportive social norms • Support collective action on climate mitigation to create social trust and inclusion • Involve arts and humanities to create narratives for policy process	• Communicate descriptive norms to electricity end users • Community energy initiative • REScoop • Fridays for Future

Source: Creutzig et al. (2022b; part of their table 5.4).

Cooperation between the Irish government, businesses, communities and individuals is necessary. The National Dialogue on Climate Action (NDCA) programme emphasises that the responsibility lies with everyone (DECC and Department of the Taoiseach, 2021). To deliver societal change the NDCA programme focuses on enhancing climate literacy through education and communication, encouraging active participation in climate action at all levels, promoting sustainable behaviours and conducting public consultations, gathering insights from these activities to inform the Climate Action Plan and climate policies. More structured efforts are required to establish systematic means of integrating behavioural research into national policy, such as the approach used by the National Public Health Emergency Team's Behavioural Change Subgroup set up in response to COVID-19 (DoH, 2020).

The role of a participatory approach in shaping policy and promoting community engagement is crucial for creating effective and inclusive climate action. Participatory future visioning not only promotes sustainability learning but also empowers individuals and communities to actively shape their futures, ensuring policies are relevant and embraced by those they affect (Davies et al., 2012). Incorporating community and individual living labs allows for real-world experimentation and immediate feedback, offering invaluable insights for policy adjustments (Matschoss et al., 2021). Furthermore, community engagement and visioning exercises, like the Imagining 2050 research project, foster collective determination and enable communities to actively contribute to and own their developmental trajectories (MaREI, 2020; Flood et al., 2023). These participatory initiatives ensure that policies are both effective and accepted, fostering lasting positive change. For more information, see Chapter 8 Transforming Participation and Catalysing Change.

5.3.3.3. Behaviour change

To move towards more environmentally friendly lifestyles that align with a 1.5°C target, we need to understand human behaviour and its underlying causes. Scholars have been studying people's environmental behaviour for almost 50 years now, and currently use an 'integrated behavioural model' (Patchen, 2006, 2010) to explain it. The integrated model is a broad and comprehensive framework that captures the complexities of human environmental behaviour; it tries to illustrate the many different factors that contribute to people's behaviour. For example, people's behaviour is often affected by the way they are taught to do things, the goals and skills they have, and what other people do; there are also habitual and contextual aspects of people's behaviour, or how easy, convenient, difficult or costly a particular action may be. An example of an integrated behaviour model is shown in Figure 5.12.

Individual beliefs and values, however, are not enough when it comes to creating more positive behaviours towards the environment. For instance, when someone's habits are strong – compared with other factors – they can completely dominate their behaviour (Verplanken et al., 1998). There is also evidence, depending on circumstances, that external contexts can override people's positive intentions towards the environment (Guagnano et al., 1995), and the same can be said of a particular social norm or custom (Hopper and Nielsen, 1991). Our understanding of human behaviour is continually evolving, with recent studies delving into topics such as the intention–action gap and cognitive biases in the context of climate change (SEAI, 2023c).

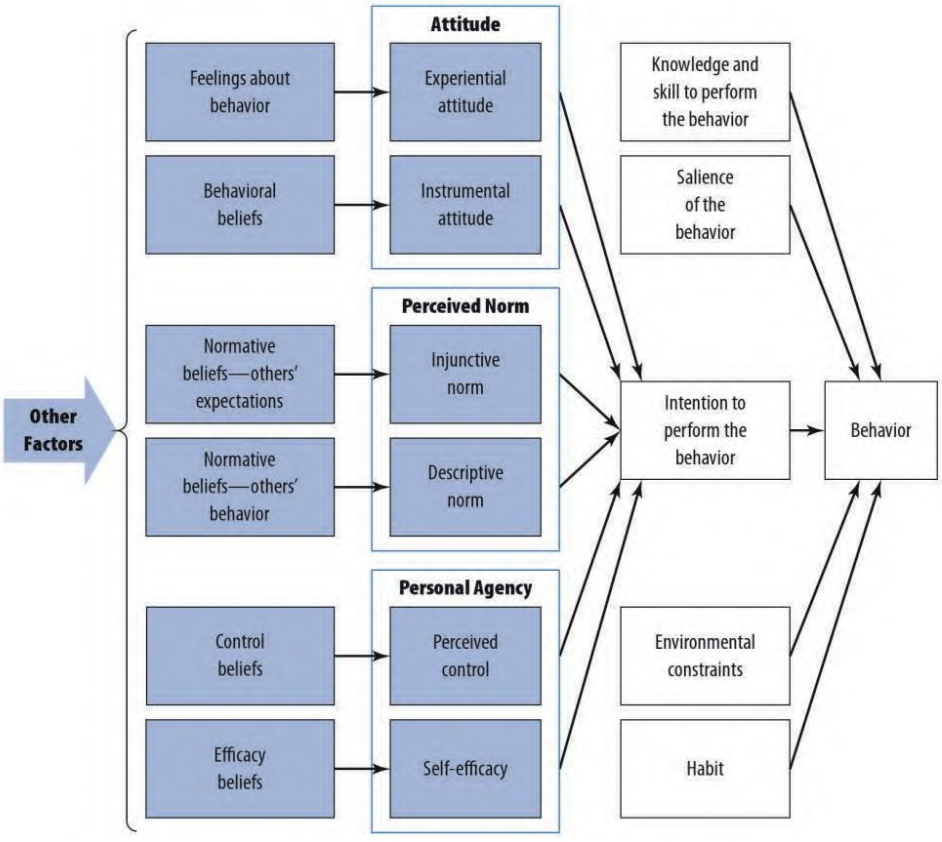


Figure 5.12 An integrated behavioural model. Source: Reproduced from Montano and Kasprzyk (2015) with permission from Wiley.

Behaviour change is not achieved solely through individual change, but is a social challenge that requires institutional and landscape changes, as well as efforts targeted at individuals. There has been a shift from an economic model of consumer choice to one that recognises the need for long-lasting behaviour change across all levels, involving institutional and technological changes, and a change in norms and practices. Effective communication and evaluation of policy measures derived from social and behavioural research are crucial, and the use of trials can provide valuable evidence across various policy sectors, including energy use, although other cost-effective evaluation approaches can also be utilised to maximise cross-sector learning (Moore, 2012). Behaviour change programmes should test the most appropriate methods based on specific objectives (Grilli and Curtis, 2021).

A concept of change informed by complexity theory supports the notion of promoting positive feedback loops for transformative change through interactions between governments and individuals. This process would be recursive, occurring repeatedly, with tipping points reached when a critical mass of people or societal leaders unite to initiate change, while being influenced by the broader societal and environmental context (Fitzpatrick et al., 2015). This process is also referred to as a spiral effect or an ecosystem of transformation (Newell et al., 2021b, 2022). Spiral scaling illustrates the dynamics of how incremental changes, when occurring over time and across various contexts, can lead to more significant, transformational shifts. When accompanied by an ecosystem of transformation, these changes can be expedited and further intensified via numerous entry points. For more information about societal change, see Chapter 8 Transforming Participation and Catalysing Change.

Pro-environmental behaviour promotes the sustainable use of resources and is encouraged through behaviour change initiatives. Experimental design is used to determine success rates, which can reach as high as 70% in the case of energy and waste projects (Grilli and Curtis, 2021). Behavioural treatments include education and awareness, outreach and relationship building, social influence, nudges, behavioural insights and incentives (Grilli and Curtis, 2021). The Cloughjordan ecovillage in Ireland is a model example of outreach and relationship building that involves the entire community. Established in 1999, this village took several years to become fully operational, but it has succeeded in operating sustainably in terms of renewable energy, sustainable land use and waste management. Community members actively participate in decision making, and volunteer work is critical to its success (Espinosa and Walker, 2013). Doyle and Davies (2013) also carried out a behaviour change initiative as part of the CONSENSUS project, which utilised a participatory backcasting approach to co-developed future scenarios and action plans for sustainable heating in Irish households. However, it is not well understood whether initiatives aimed at changing behaviour have a long-term impact on pro-environmental behaviour. Consequently, there is a need to conduct research over an extended period to address this gap in knowledge (Grilli and Curtis, 2021).

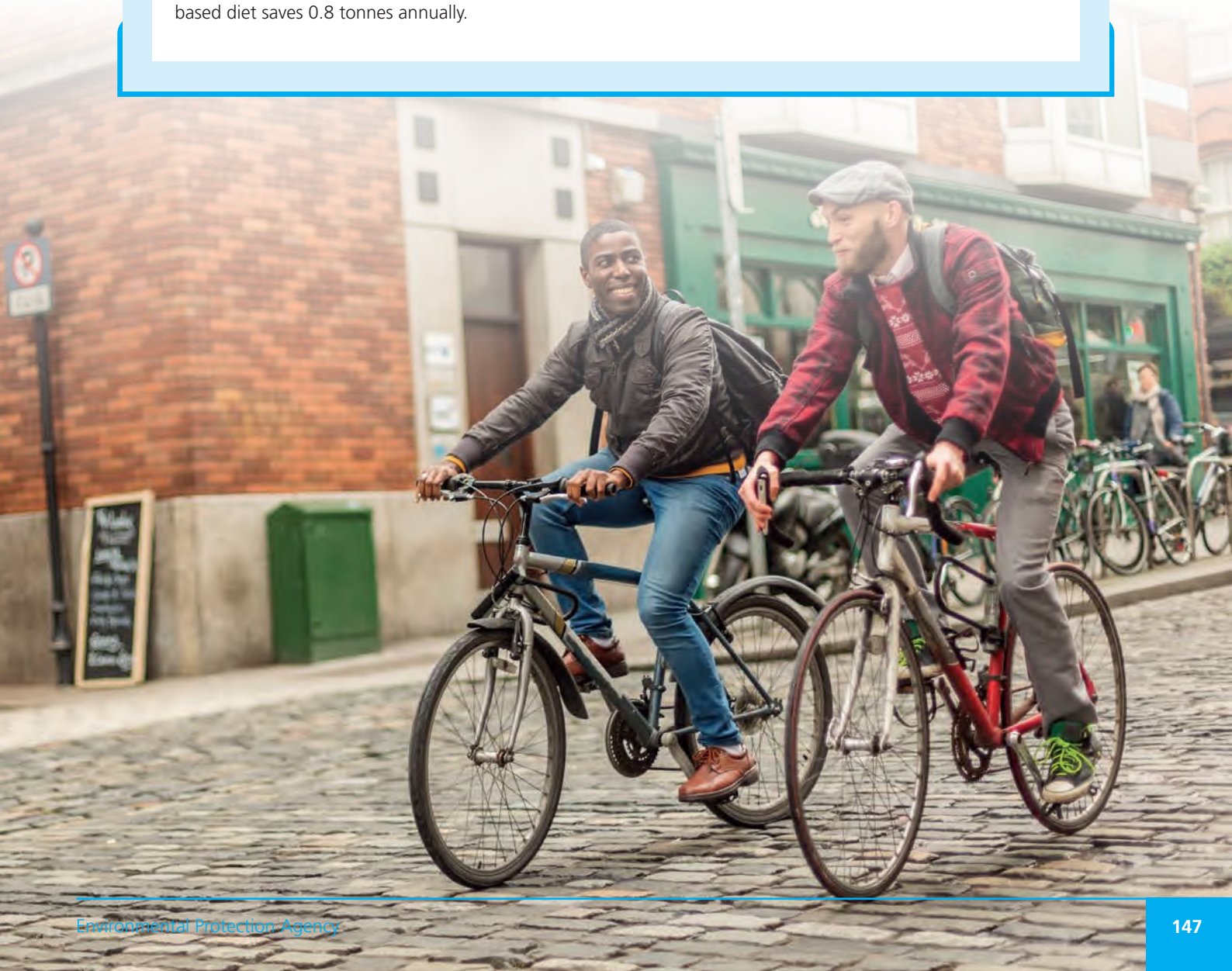
The evidence suggests that households that frequently engage in pro-environmental behaviour have distinct sociodemographic and attitudinal characteristics from those who do so only occasionally. These differences include variations in employment status, income, residential location and housing tenure. Notable issues related to fairness arise, as one-time activities such as retrofitting tend to be associated with more affluent Irish households, while households that consistently engage in pro-environmental behaviour, such as purchasing reusable items or conserving energy, do so out of financial necessity rather than as a deliberate choice (Lavelle et al., 2015).

Box 5.2 How can individual actions make an impact?

The debate around the impact of individual actions on climate change often centres on their efficacy within larger systemic frameworks (Wynes and Nicholas, 2017). Critics argue that personal choices may seem commendable but are insufficient to confront the immense scale of climate change; systemic problems necessitate systemic solutions (Mintz-Woo, 2023). Furthermore, a responsibility lies with those benefiting from the current system to contribute more robustly to mitigation efforts (Mintz-Woo and Leroux, 2023). This view suggests that individual actions gain potency only when channelled into collective initiatives or policies.

However, underestimating the potential of individual actions would be misguided. Personal efforts can catalyse broader societal shifts towards sustainability and impact public opinion, eventually influencing policy. They become essential elements in a comprehensive strategy against climate change, capable of initiating significant changes in both behaviour and policy when aggregated. Civic involvement, such as voting for leaders who prioritise climate issues, can set the stage for systemic change. Financial decisions, like sustainable investing and fossil fuel divestment, send strong market signals. Community engagement and educational initiatives can amplify the reach of individual actions, as can informed consumer choices and knowledge dissemination.

Living a low-carbon lifestyle can be considered a building block in mitigating climate change. Wynes and Nicholas (2017) identified high-impact actions to reduce personal emissions; among these, living car-free saves 2.4 tonnes a year, avoiding aeroplane travel saves 1.6 tonnes per roundtrip transatlantic flight and a plant-based diet saves 0.8 tonnes annually.



5.4. Research gaps

While there are limited data on the current consumption practices of Irish households, particularly sustainable consumption, more granular analysis is needed. Research should focus on socioeconomic profiles, overconsumption and underconsumption patterns, and disaggregated trends by factors like income, age and geographic location.

Although current climate scenarios in Ireland consider new technologies and production changes, they often underestimate the impact of consumption changes on carbon emissions. Future research should aim to identify optimal pathways that focus on not only technology but also reducing demand for energy and resources. In this vein, establishing 'sufficiency standards' that still ensure decent living standards can guide more sustainable policies.

Despite the growing recognition of the importance of sustainable consumption, there is still a significant research gap in understanding the most effective policy interventions in promoting low-carbon lifestyles in Ireland. Specifically, there is a need for more research on the effectiveness and social impacts of existing policy instruments, such as taxes, subsidies and regulations, as well as the potential for innovative policy solutions, structural changes and strategies to generate greater consumer involvement.

There is a need to explore the potential of various social instruments, such as coordinated voluntary initiatives, participatory decision making and information-based instruments, to encourage sustainable consumption practices. Gaining a better understanding of the social and cultural factors that influence such practices in Ireland, including the impact of social norms, values and beliefs on consumer behaviour, can aid in the development of effective social instruments.

The integrated behavioural model offers insights into individual change, and long-term empirical studies are needed to assess effectiveness of behaviour change policies over time. Existing research indicates a dissonance between expressed attitudes and reported behaviours. Future studies should aim to bridge this gap to understand the actual barriers to sustainable consumption.

The research landscape is still sparse concerning the potential of circular business models, digital technologies and the sharing economy in promoting sustainable consumption. Given inconsistent evidence, further research is needed to assess their real impact on climate change mitigation.

Research will be required to understand the potential impact of a climate-friendly diet on agriculture, consumers and markets in Ireland. Changes to the current model of production and consumption will also require engagement with and the participation of relevant stakeholders in the development of a sustainable food system for Ireland.

Sustainable consumption is a multifaceted issue that demands an interdisciplinary approach to enable comprehensive understanding and effective policymaking.

6

Transforming Development: Economy, Innovation and Finance

Key messages

Transformational development combines systems, structural and technological change to enable the acceleration and deeper reduction of emissions and the pursuit of win–win outcomes, including for the economy.

Transformational development offers potential for significant economic opportunities, and deepening alignment of the economy with sustainable outcomes has the potential to benefit both people and planet.

Transformational development not only reduces economic costs and supports technological transitions but can also deliver economic gains. Enhancing understanding of the potentials and opportunities for Ireland arising from transformational shifts to a sustainable development path requires further research.

Deepening understanding of transformational development is typically assisted by tools such as scenario analysis and by building desirable visions and integrating multiple disciplines and forms of knowledge.

In Ireland, national innovation, research, policy, finance and investment have evolved, but are not yet aligned with transformation to low-emissions futures or with harnessing associated benefits and opportunities.

6.1. Introduction

Transformational development has a critical role to play as an enabler of effective climate action and sustainability, and in delivering economic opportunities that can support provisioning and livelihoods. The global literature has focused on a broad conception of transformational development that recognises the roles of systems, structure and technological change, through shifting to 'sustainable development paths'. This chapter is structured as follows. Section 6.2 characterises shifting to sustainable development paths through economic development and different visions of the economy. The section emphasises that the types of responses that emerge in policy are strongly related to how problems are framed and analysed. Section 6.2 is rounded out by considering the future of national economic development and the role of economic structure. Section 6.3 considers the importance of innovation policy in economic development and in sustainable development. The section discusses the related pursuit of economic opportunities in transitions and transformations. Section 6.4 considers finance and investment as enablers of transformation. The chapter frames each section through considering the frontier of knowledge globally, including in IPCC Working Group III (WGIII) reports, in order to characterise the state of the art in knowledge of transformations to low-emissions futures. This is followed in each section by assessment of the available knowledge in Ireland, prioritising peer-reviewed literature and including grey literature where appropriate.

6.2. Shifting development paths

6.2.1. Economic development and the drivers of emissions

The economy has a critical role in determining the national development pathway, whether or not it can be transformed to low-emissions development, and in the realisation of the benefits and opportunities that this offers. While economic growth can lead to improvements in human wellbeing, particularly at earlier stages of development and in cases of poverty, it also poses considerable risks to sustainable development, socially, environmentally and economically. There is wide acknowledgement that economic growth among the wealthy has driven increased consumption of goods and services, and related greenhouse gas emissions and environmental degradation (Nakicenovic et al., 2000; Fleurbaey et al., 2014; IPBES, 2019). Decades of scholarship show that the economic development approach of the 20th century has led to a global spread, and deepening lock-in, of high-carbon systems and consumerist lifestyles. This development approach, prevalent in economically advanced nations, including Ireland, is characterised by focusing on economic growth, driven by increased production and consumption. It has become standard in discussions of economic development and social progress in general (Stiglitz et al., 2009), and emissions mitigation in particular (Fleurbaey et al., 2014; Grubb et al., 2022), to reflect on economic patterns, implications and alternatives. This follows the recognition that these patterns of development can damage individual wellbeing, deepen social inequality and drive environmental degradation, including increased greenhouse gas emissions.

In Ireland, Gaur et al. (2022) recently concluded that Ireland's climate action policy, and supporting energy modelling, needs to embrace major structural changes that lowers demand if deep emissions reductions are to be achieved to 2050. Political science literature has noted that Ireland's failure to reduce emissions is due to tight coupling with the economic growth paradigm and related weakness in emissions policy (Torney and O'Gorman, 2019), and communication studies have noted the structural barriers to transformation in Ireland (Morgan, 2020). Decomposition analysis of national driving forces of emissions has identified economic growth and inadequate policy, relying on end-of-pipe technology measures rather than on steering the development path (O'Mahony et al., 2012; O'Mahony, 2013, 2018). Davies and Mullin (2010) emphasised the proliferation of green economy framing, but with sustainability enterprises in Ireland remaining marginalised. McGrath et al. (2020, 2022) note the need for sustainability assessment of Irish economic development and recommended the capital approach[32].

6.2.2. Visions of economic growth, degrowth and post-growth

It is recognised that economic growth is not synonymous with human wellbeing, sustainability or equity, and can even be damaging to these superordinate goals. In environmental and ecological economics, two decades of discussion have been anchored on 'decoupling', to decouple economic growth from emissions and to decouple wellbeing from economic growth (Nakicenovic et al., 2000), with both acknowledged as important. The decoupling of economic growth frequently includes technological transition, for energy and carbon efficiency. Decoupling wellbeing from growth is regarded by the IPCC as the stronger and more fundamental approach (Fleurbaey et al., 2014), focusing efforts directly on enhancing human wellbeing and sustainability (O'Mahony, 2022). Both forms of decoupling can be enabled by framing and implementing a broader set of objectives for a sustainable development path (see section 7.3.5), for transformations of systems and structures. Important debates on the role of the future economy, in transitions and transformations, include those on 'green growth,' 'degrowth' and 'post-growth'.

'Green growth' continues economic growth, but seeks to address sustainability through cleaner technology and systems (Hao et al., 2021). The EU introduced the European Green Deal in 2019 (EC, 2019), as a new growth strategy for the EU aiming for climate neutrality by 2050 (see also Chapter 7). Post-growth, degrowth and post-development literature question the sustainability of more economic growth (Grubb et al., 2022; Hickel et al., 2022). This rich literature shifts to prioritising 'prosperity without growth' and the 'good life' (Jackson, 2016), and can be seen in efforts towards a wellbeing economy (Mason and Büchs, 2023). In line with the widely accepted critique of the goals of social progress (Stiglitz et al., 2009; IPSP, 2018), these move the focus from means to ends, from growth in the economy to growth in human wellbeing and flourishing sustainability (O'Mahony, 2022). Modelling literature that interprets these paths highlights that they enable feasibility of low-emissions futures and minimise the risks associated with relying on economic growth and technology (Riahi et al., 2022). Degrowth and post-growth are well established in the academic literature in Ireland, across political economy and transformation (Barry, 2009; Kirby and O'Mahony, 2018; Kirby, 2020; Fearon and Barry, 2022; Robert, 2022), money supply (Douthwaite, 2012), spatial planning (Daly and Kitchin, 2013), geography (Bresnihan, 2021) and sociology and policy (Murphy, 2013). Policy development in Ireland has recently begun to consider changing priorities to focus on human wellbeing, following evolution in a number of other nations (NESC, 2021). NESC have recommended both considering alternative pathways to prosperity and prioritising energy demand reduction measures (NESC, 2023).

Combining ideas of social progress with emissions reduction has gained greater attention in recent years. Green (2021) argues that, rather than relying on carbon pricing to prevent public bads, the state must create public goods, including phasing out fossil fuels, building renewable energy infrastructure and providing support to people. Gough (2017) proposes a progressive recomposition of consumption and a ceiling on demand, alongside green growth. The literature on social progress considers an arc in the history of economic and political thought, traced from the dominance of Keynes's General Theory of the 1940s – advocating for state intervention to achieve social aims – to Friedman's free-market approach that has dominated since the 1970s (Newell and Paterson 2010; IPSP, 2018; Kirby and O'Mahony, 2018). The International Panel on Social Progress highlighted that 'sentiments' of economists and policymakers towards particular political economy orientations do change, and that many prominent economists now advocate for a shift in approach (IPSP, 2018) (see also Chapter 7).

[32] A variety of sustainability assessment approaches can be found in the literature; in economics, one of these is to measure changes in 'capital'. McGrath et al. (2020) propose the 'genuine savings' approach, which seeks to apply monetary valuations to changes in physical, human and natural capital.

In line with this thinking, the IPCC highlight that fiscal reform offers an opportunity to mitigate and rethink the social contract to enable transformational shifts in development paths (Lecocq et al., 2022). While Winkler (2017) notes that this new social contract may be necessary to enable transition and transformation, Dubash (2012) and others note that transformational change can be positive if it is rooted in the development aspirations of society. The IPCC identify funding options for these changes in policy for sustainable development, and in conventional mitigation (Lecocq et al., 2022). In sustainable development, improved public services can be supported through progressive change in general taxation. Funding for an improved social contract can also be found in conventional mitigation measures, through reducing subsidies to emissions-intensive activities and by directing emissions tax revenue to social investment. For a discussion of UBS, see section 4.2.4.

6.2.3. Sustainable development paths and the 'transformative turn'

In a number of systematic reviews of the literature it has been found that around 2005 a profound change occurred in the global literatures of mitigation, sustainability, adaptation and biodiversity (Feola, 2015; Koch et al., 2017; Moore et al., 2021). Known as the 'transformative turn', after 2005 there was an exponential growth in use of transformation-related terms (Moore et al., 2021). Transformation is shifting development paths to fundamental system-wide reorganisation at depth, speed and scale. This reorganisation concerns economic, societal and technological factors, including paradigms, goals and values (IPCC, 2018; O'Brien 2018; IPBES, 2019). For a number of decades, the concept of the 'development pathway' has been central to understanding how nations evolve and become locked-in to emissions-intensive paths, and how they can be released from same. The IPCC WGIII Assessment Report 6 (AR6) emphasised compelling evidence that continuing on current development pathways will not achieve rapid and deep emissions reductions and that, in the absence of shifts in development pathways, conventional mitigation policy instruments may not be able to limit emissions or may only be able to do so at very high economic and social costs (Pathak et al., 2022). The IPCC have emphasised in successive reports that shifting development pathways makes mitigation policies more effective, and can accelerate mitigation and widen the scope of policies available. Pathak et al. (2022) highlight that focusing on development pathways, and on how to shift them, can rapidly accelerate mitigation.

In addition to accelerating mitigation, the wider focus of sustainable development widens the scope of measures to reduce emissions. This process can strategically enable the meeting of several societal goals at the same time, which is not possible through narrow conventional mitigation policies alone. Sustainable development paths can therefore facilitate win–win outcomes, or 'synergies,' including priorities such as public health, regeneration of nature and adaptation to increasing climate hazards. According to the IPCC, this situating of climate action within sustainable development requires that analysis and policy engage with complexity and systems thinking (Halsnæs et al., 2007), and has recently been alluded to in the Irish context (OECD, 2022). Shifting development pathways requires transformation of systems, technology and sociobehavioural change. Historically, Irish climate action policy has been more focused on technological change and shorter-term targets (O'Mahony, 2013; Gaur et al., 2022). Ireland has published the first national long-term strategy towards meeting requirements of the Paris Agreement and Regulation (EU) 2018/1999. The strategy is dominated by a narrower technology-based approach (existing, emerging and speculative technologies) and circular and bioeconomy goals, rather than on systemic transformations of development as shifting pathways (see section 7.3.6). The 2023 Climate Action Plan shows potential evidence of the beginning of a 'transformative turn,' from short to long term, and from incremental transitions to systems and technology transformations (DECC, 2023).

Over decades, empirical research, commentary and observation has determined that Ireland has not fundamentally altered its development path, favouring economic growth over sustainable development (Mullally et al., 2012). Economic and population drivers of emissions overwhelmed national emissions mitigation policy based on technological change and efficiency, rather than on path shifts and systems change (O'Mahony et al., 2012; O'Mahony, 2013). More recent assessments of trends in environmental pressures, including greenhouse gas emissions (EPA, 2020; OECD, 2021), support the conclusion that underlying emissions drivers continue, while policy has remained narrowly designed and insufficient (O'Mahony, 2018). An important attempt to bring coherence and accountability to implementation and measurement of progress towards sustainable development can be found in the UN Sustainable Development Goals (SDGs), with 17 goals, 169 targets and 232 indicators (MacFeely, 2017). Murphy et al. (2021) have benchmarked Ireland's performance in achieving the environmental UN SDGs, classifying Ireland's performance as neutral, citing governance and implementation challenges. This nation-based peer assessment was updated in Murphy et al. (2023). Flood et al. (2022) have developed an integration of climate change adaptation and the SDGs, aimed at creating climate-resilient futures.

6.2.4. Sustainable development paths: framing, analysis and responses

In a field that is evolving at a fundamental level, successive iterations of IPCC WGIII assessments have been at the forefront of noting the strength of links between development paths and climate action. A key message from IPCC AR5 noted that successful climate policy goes beyond the narrow focus on mitigation and adaptation, and beyond analysis of a few co-benefits of climate policy, towards choosing a sustainable development pathway (Fleurbaey et al., 2014; see also section 7.3.5). This reframing takes into account all relevant objectives at the same time, enabling choices to shift pathways to sustainable development. This integrative approach requires changes to framing, analysis and policy responses. IPCC AR6 characterised five distinct approaches that are all necessary to enhance understanding of mitigation response strategies: decision making under uncertainty; aggregated economic frameworks to evaluate system-level choices; ethical perspectives on values and equity; transition frameworks of processes and actors; and psychological/behavioural and political factors (Grubb et al., 2022). IPCC AR6 also noted key insights on topics relevant to integrating mitigation and development as holistic long-term thinking, including a focus on wellbeing and measurement; ecological limits; the importance of decoupling; the need for choices and decision making that maximise synergies and minimise trade-offs; and equity and justice within and between countries (Grubb et al., 2022).

From these approaches identified by Grubb et al. (2022), in Irish research, aggregated economics frameworks (technological transitions) have been a priority (see Volume 2), studies of political factors have evolved (Torney, 2018, 2019, 2020; Little, 2020), and studies of transition management (Doyle and Davies, 2013; Kelly et al., 2018; Black et al., 2019), values (Bullock, 2020), equity (Caulfield et al., 2022) and behaviour (Rabbitt and Ghosh, 2016) have addressed some relevant sub-topics. Research combining mitigation and adaptation in climate resilient development and climate compatible development[33] has begun (Flood et al., 2023). Decision making under uncertainty has been recommended for adaptation (Volume 3) and is at the early stages of development in mitigation (Yue et al., 2018)[34].

National research on both on wellbeing and its measurement (Brereton et al., 2011; NESC, 2021; McGrath, 2022) and on decoupling (O'Mahony et al., 2012, Rogan et al., 2012; Dennehy and Ó Gallachóir, 2018) have existed for over a decade. Studies relevant to considering ecological limits (see Chapter 3) and analysis of synergies and trade-offs (Le Tissier and Whyte, 2021; Vera et al., 2022) have been published more recently. When considering the IPCC's key insights (Grubb et al., 2022) in the Irish context, the integration of knowledge on development and mitigation can be characterised as embryonic, offering a significant opportunity for improvement towards harnessing synergies, including economic opportunities.

[33] For a discussion of climate-compatible development, see Nunan (2017).

[34] Yue et al. (2018) concentrate on the use of quantitative and probabilistic approaches to uncertainty in the technological transitions studied by energy system optimisation modelling.

A growing literature in Ireland has applied inter and transdisciplinary techniques and participation tools, commonly associated with future studies and relevant to understanding systems change and development paths (O'Mahony et al., 2013; Devaney and Henchion, 2018a, 2018b; McGookin et al., 2021; Mullally et al., 2022; Revez et al., 2022; Flood et al., 2023). While noting progress in techniques and knowledge of change in sub-systems, technologies, actors and factors, there is a lack of research in an Irish context on macro transformational development paths and on maximising synergies and minimising trade-offs. Responding to gaps in knowledge will require long-term integrated scenario analyses of plausible and preferable outcomes that explicitly consider transformational systems change, in addition to transitions and technological improvement. Further development of approaches and research in this area, including bottom-up studies of key sectors and themes, will build knowledge on transformational development paths, synergies and enabling factors. The process of building analysis and knowledge of transformational paths and transformational interventions is a critical enabler of transformative policy and decision making (see Chapter 7), and of the role of economic development therein.

In Irish research, the use of alternative scenarios that consider different development paths is prevalent in adaptation (see Volume 3), but not in mitigation. In the last 20 years, Ireland has built energy modelling capacity (aggregated economic frameworks) that have advanced national understanding of mitigation through technological transition, including costs and co-benefits of action (see Volume 2). This modelling is typically achieved through forecasting economic growth and technology change. In addition to 'technology-rich' insights, it is important that fundamental transformational shifts to sustainable development paths are widely understood in policymaking (O'Mahony, 2013; Kirby and O'Mahony, 2018; CCAC, 2021; Gaur et al., 2022). Analysing sustainable development paths within energy systems and emissions modelling can be assisted by applying integrated scenario analyses of plausible change and backcasting preferable change. In the Irish context, the importance of the role of alternative scenarios in analysis of energy and emissions has been highlighted by both policy stakeholders and researchers (O'Mahony, 2014; McMullin and Price, 2020; CCAC, 2021). Improving scenario analysis can be assisted by enhanced study of input assumptions in the alternative scenarios that are used to frame modelling (Nakicenovic et al., 2000; Riahi et al., 2017; Merkle et al., 2022[35]), visioning desirable outcomes (Tuominen et al., 2014) and deeper integration of transformative approaches evolving in bottom-up studies of key sectors (Caulfield et al., 2020; Duffy et al., 2020; EPA, 2020) and themes (Davies and Doyle, 2015).

In Ireland, energy and emissions modelling plays a crucial role in developing the solution space for climate action policy and has placed a strong priority on technology (Gaur et al., 2022). Bringing transformations into energy modelling involves prioritising systems change in addition to technological change. This process requires consideration of development paths, and focusing on causes rather than symptoms, and is inclusive both of incremental transition and of wider and deeper transformations. Including development paths that encompass systems change supports policymakers to identify which systems and sub-systems may require incremental transition, and which may require fundamental transformation, the levers and policies required to enable this change, and the win–wins available from doing so. This can increase the feasibility and effectiveness of decarbonising by low-emissions technology (OECD, 2022), facilitate acceleration of mitigation in the near term towards deep emissions reduction in the long term, and aid the realisation of available synergies. Recognising the importance of economic and energy modelling in Ireland's policy process, the integration of transformational paths within this modelling, will require both the study of transformation in key sectors and themes and also support for studies that integrate, bridge and blend these studies with pathway modelling. In the global literature, this integration is the realm of hybrid scenario analysis (see section 6.2.5).

6.2.5. Future economic development and restructuring

From protectionism to trade liberalisation, and from industrialisation to financial crash and recovery (Bielenberg and Ryan, 2013), Ireland's economic development has undergone a number of major transitions over the last 100 years. A focus on maximising economic growth remains fundamental to Irish economic policy (Department of the Taoiseach, 2020; DPER, 2021). Policy is guided by short- to medium-term econometric forecasts up to 2025 (DoF, 2022; Fiscal Advisory Council, 2022), to support national budgetary and fiscal management and meet requirements of EU budgetary rules[36]. Ireland does not have a developed capacity in application of long-term economic foresight and related scenario analysis (O'Mahony et al., 2023).

[35] Noting the uncertainties in future societal development, Merkle et al. (2022) is part of a growing literature that extends standard global 'SSP', or shared socioeconomic pathway, scenarios to the national level. Merkle et al. present a set of quantitative SSP scenario projections for the UK, based on narratives and semi-quantitative trends. The aim is to inform a wide range of sectors for UK climate research, policy and business communities.

[36] Regulation (EC) 1466/97 on strengthening the surveillance of budgetary positions and the surveillance and coordination of economic policies.

As discussed in section 6.2, it is acknowledged that accelerating mitigation, deepening emissions reductions and achieving synergies requires transformational development paths to 2050, and short-term policies to achieve long-term change. Transformational analysis is crucial to enable policy and decision making to vision, discuss and implement transformational approaches. Supporting national energy, emissions and sustainability modelling to include transformations and shifts in development pathways requires the study and vision of plausible and preferable futures in scenario analysis. Scenario analysis, including essential economic assumptions for standard economic models, has been employed as the core tool in the international literature for the last two decades, to consider shifts in development pathways in addition to technological change. The global literature has concluded that integrating qualitative and quantitative scenarios[37] is important to understand future pathways and related uncertainty. The process of integrating scenarios also offers the opportunity to enhance the inclusion of social science research, to include crucial social, cultural, political and institutional factors, in addition to quantitative economic and technology modelling (Van Vuuren et al., 2014). Scenario analysis is increasingly used at the national and sub-national scale, in both adaptation and mitigation, recognising the importance of the social sciences in informing scenarios on societal dynamics and tipping points (O'Neill et al., 2020).

It is broadly accepted that Ireland's future economic growth potential is lower than historic trends (Bergin et al., 2016; Cuaresma, 2017; Dellink et al., 2017; European Commission, 2017; O'Mahony et al., 2023). This increases the need to study, platform and implement low- and no-cost transformational approaches that reduce demand, with knock-on reduction in the cost of national technological decarbonisation.

Notwithstanding the transformational role of reconsidering national public policy priorities for human wellbeing and sustainability, and the role of the economy in achieving these (section 6.2.2), understanding economic development paths and the related vision for future economic structure is essential (Caretta et al., 2022). National economic structure has changed very significantly over recent decades, and Ireland has been highlighted internationally as a pioneer in decoupling industry from emissions (Kaivo-oja and Luukkanen, 2004; Diakoulaki and Mandaraka, 2007; O'Mahony et al., 2012). Although noted as a priority research topic (Gaur et al., 2022), decomposition analysis of Ireland's emissions drivers and sectoral structure has not been updated in the last decade.

Global economic development transitions have typically followed a curve, from lower productivity agriculture and manufacturing to higher productivity service sectors. Understanding potential future structure is important to understand drivers of emissions and determinants of reductions. The taxonomy applied to EU employment in transition is differentiated by 'dark green,' 'light green' and 'grey' activities, and provides a useful framework to understand different branches of production (Vandeplas et al., 2022). In this taxonomy, 'dark green' involves activities aimed at reducing impacts on the environment, 'light green' are low-intensity activities and 'grey' are higher polluting activities. The transition implications, articulated in the Vandeplas et al., and in IPCC reports discussing the role of economic structure, point to benefits of expanding dark green activities, such as the renewable industry, and light green activities in service sectors. In contrast, the literatures notes the benefits of contracting or restructuring of grey activities, such as mining and emissions-intensive agriculture (Lecocq et al., 2022; see also section 6.4). Embracing these categories of expansion, contraction and restructuring offers an appropriate lens to deepen integration of low-emissions development in long-term economic policy in support of sustainable economic opportunity.

6.3. Innovation and economic opportunity

6.3.1. The role of innovation policy

After World War II, public innovation policy emerged as central to economic development. Public policy sought to harness research and technology for increased productivity, in support of economic growth. Emissions mitigation has become increasingly important to the framing of innovation policy (Fleurbaey et al., 2014), though it has been concluded with high confidence that capabilities to implement far-reaching change have fallen short (de Coninck et al., 2018). It is now increasingly recognised that a sustainable development path requires transformative innovation policy, opening up a range of solutions that can be identified in sociotechnical systems change (Schot and Steinmuller, 2018) and in holistic long-term perspectives (Chen et al., 2018). In response to the evolution in framings, to sociotechnical and holistic long-term change,

[37] Scenario analysis, in earlier IPCC parlance (Morita et al., 2001), has been characterised as the integration of qualitative and quantitative approaches to consider development paths and uncertainty. Qualitative approaches are recognised as having a greater power to posit system shifts, surprise and factors that cannot be quantified, while quantitative formal models offer a systematic and replicable basis for analysis. For discussion in the Irish context, see O'Mahony (2014).

innovation systems internationally are increasingly evolving to adopt these advancements. This integrated policy development seeks to focus on sustainability and transformation (Altenburg and Pegels, 2012), and on greening economies through green industrial policy that accelerates structural change (Altenberg and Rodrik, 2017). In complementing technological and industrial innovation, an increasing emphasis on social innovation can now be found (Westley and Antadze, 2010). Recognising prevalent weaknesses in national systems of innovation, notably the lack of holistic strategic orientation and policy coordination and fragmented policy mixes, mission-oriented innovation policies are now recommended (Mazzucato, 2018; Larrue, 2021; see also Chapter 7). These are a new type of systemic intervention advocated at the OECD, implemented by a growing number of countries to tackle increasing societal challenges.

Irish innovation policy has evolved, and is framed differently by a variety of relevant public policy actors. The national enterprise strategy (DETE, 2018) focused on growth in economic output, noting climate as a technological and efficiency challenge, and synonymised productivity growth with higher quality of life. 'Global Ireland 2025', the foreign policy initiative, focusses economically on output growth in export markets (Government of Ireland, 2018). The employment plan 'Future Jobs Ireland' has transition to low-carbon economy as one of five pillars, under which energy and circular and bioeconomy are priorities (DETE, 2019). Ireland's Industry 4.0 strategy (DBEI, 2019) supports digitalisation of manufacturing. The national research and innovation strategy to 2030 (DFHERIS, 2022) includes climate, environment and sustainability as one of five key challenges and opportunities, in a systemic framing[38] (see also sections 7.3.2, 7.3.4 and 7.3.5).

International observers have acknowledged some strengths in Ireland's innovation system, but also weaknesses, including low research and development (R&D) funding, unbalanced support for business and insufficient co-operation between firms and research bodies (European Commission, 2020). The OECD (2021) note that overall funding for research and development in Ireland, public and private, is half the EU average, when measured by percentage of GDP[39]. The OECD (2021) highlight that government funding for R&D is relatively dominated by agriculture, at 13% in 2019. In contrast, environment and energy received 2% of government R&D funding, among the lowest shares across the OECD.

National public innovation policy is evolving towards further embracing climate action, as reflected in the recent national innovation strategy 'Impact 2030' (DFHERIS, 2022). Impact 2030 has applied terminology and framing associated with systems change, and deeper integration associated with transformation. However, of the innovation-related policies considered, including Impact 2030, none have yet adopted transformational time frames, to 2050 and beyond, and associated way-posts for near-term action. In addition, outside Impact 2030, policy remains dominated by output growth and technological change, in contrast to the systems change framing found in the Climate Action Plan 2023 (DECC, 2022). Assessment of the adequacy and performance of innovation systems can be achieved by systematic review (Fleurbaey et al., 2014), requiring a long-term and holistic systems change framing that considers effectiveness and alignment with transformational outcomes that deliver deep emissions reduction and achievement of policy synergies.

In the last decade, peer-reviewed literature on innovation in Ireland appears relatively limited, with examples including forestry (Kilcline et al., 2021) and agriculture (Läpple et al., 2015). However, a concept paper on deep institutional innovation for sustainability, published in 2021 (Hughes et al., 2021), is discussed in Box 6.1. In the context of developing national understanding of innovation and opportunities, a supporting study of Future Jobs 2019 analysed the labour impacts of two measures: the carbon tax and shifting from coal and peat in electricity (de Bruin et al., 2019a). These are measures typically associated more with negative employment impacts – under the umbrella of just transition concerns – than with innovations to harness economic opportunities. The study found modest impacts on employment, negatively concentrated in specific regions. Later interpretations of the study transmitted a generalised conclusion that transition in Ireland would lead to a modest negative impact on employment (AARC and EnvEcon, 2020; OECD, 2021). As noted by Riahi et al. (2022), the results of modelling studies depend on the assumptions and modelling frameworks used, and on the policy design tested. It is therefore important that the modelling informing Irish policy development captures the potential for transformational change in the development path, and also the benefits that this can entail for policy priorities such as employment.

[38] Impact 2030 (DFHERIS, 2022) frames climate change as a fundamental, complex and multi-faceted challenge requiring research and innovation across all sectors. It is linked to environmental and sustainability challenges and commitments including transforming energy and food systems; creating a circular economy and bioeconomy; clean air, water and soils; protecting and restoring our biodiversity; and adapting society and infrastructure to climate change impacts.

[39] Comparison to modified GNI* is unknown.

The absence of strategic assessment of long-term impacts and opportunities in Ireland, allied to limited transformational framings of policy, negative conclusions on transition and constrained funding for climate and sustainability-related R&D, are independent lines of evidence strongly suggesting a misalignment of national research, innovation and investment with transformational outcomes and associated benefits.

Box 6.1 The evolving nature of 'innovation'

Expert contribution from Ian Hughes.

What we mean by 'innovation' is currently changing, and innovation policy globally is struggling to keep up. The meaning of innovation that is most familiar, and most embedded in governments' policies, is 'the implementation of new or significantly improved products or services', which results in economic impacts such as increased productivity, growth and jobs (OECD and Eurostat, 2018). Innovation, according to this definition, is driven primarily by new technologies, with R&D as the vital source of new commercialisable knowledge. This technologically driven, economically focused view of innovation is the basis for national innovation systems that support and link innovation actors, including universities and companies. It seeks to create framework conditions such as skills and incentives, with the view to optimising the system for efficiency and economic impact.

Climate change, however, is changing this settled view of innovation, and challenging the established structures of national innovation systems. A second meaning of innovation is emerging that aims not for system optimisation and maximum economic returns, but for change in the configurations of systems entirely – systems such as the energy system, the agri-food system, the transport system and the system of production and consumption. Here, the focus is not primarily economic, but rather deeply reducing greenhouse gas emissions, adapting to impacts of climate change, reversing environmental damage to oceans and soils or reducing deaths from disease. This idea of 'system innovation' forms the basis for 'Missions' in the European Commission's Horizon Europe research programme (Thierry, 2022). As Member States are now finding out, the national innovation systems required to meet these goals are very different from the past. Evolving innovation practices to drive 'systems change' as opposed to economic maximisation can enable transformations.

With such a fundamental change taking place in the meaning of innovation, it is not surprising that some challenging ideas and questions are emerging. Two of these in particular are worth highlighting. The first concerns the need to frame innovation policy not simply in terms of climate change, but within a much more holistic framing that includes the array of challenges we currently face. This daunting list includes climate change, of course, but also species extinction, severe environmental degradation and pollution, destabilising levels of inequality, the rise of violent authoritarian leaders, increased risk of war and the potential disruption of society by revolutionary new technologies. The framing of climate change, within this context, as an isolated, discrete scientific problem in need of technological solutions, critics argue, hinders wider discourses aimed at resolving the deep political, economic and ethical issues that are common across all these crises. Advocates for a move 'beyond climate isolationism' argue that responses to climate change will continue to be inadequate unless the 'problem' is reframed in a more holistic and transformational manner (Stephens, 2022).

This brings us to a second challenging question, namely what is the system that needs to change? In the economically focused national innovation system view, it is improved economic efficiency, but not systems architecture. In the climate-focused systems innovation view, it is typically technological change, such as energy systems based on renewables and production–consumption systems based on circularity. However, in 'beyond climate isolationalism', the systems to be changed are seen as being both more diverse and more fundamental. In this view, the multiple crises we face are symptomatic of a crisis in industrial modernity itself. This requires a reimagining not only of technological systems, but of our politics, economics and social relations and, ultimately, the meta-goals of society (Hughes et al., 2021). It is little wonder that policymakers are struggling to keep up.

6.3.2. Seeking economic opportunities in transitions and transformations

In line with conclusions of the IPCC (Riahi et al., 2022), the Global Commission on Economy and Climate have noted the shortcomings of existing economic models in accounting for economic gains from transition[40] (GCEC, 2018). Cost-effectiveness models have been invaluable in advancing global discussions of mitigation, but have difficulties in identifying and accounting for structural and systems changes, which are key components of transformational paths (Riahi et al., 2022; Stern et al., 2022). The GCEC (2018) made a conservative estimate of a net global economic benefit of US$26 trillion through to 2030 if there is bold transformative policy action. Alternative service provision systems, including circular, bioeconomy, sharing economy and digitalisation approaches, are receiving greater attention globally, but claims on benefits to sustainability and climate action as yet have limited evidence (Pathak et al., 2022) (see Chapter 5). In Irish literature, Devaney and Henchion (2017) allude to an effective bioeconomy strategy as one that must reduce total material flows and impacts. Rogan et al. (2016) used a technology innovation system framework to consider the climate technology opportunities in agriculture and land use; climate services; water and wastewater; smart buildings; the marine sector; and transport and air quality. The twinning of digital and green transitions has been noted as having the potential to enable improved resource efficiency and the circular economy, and is the subject of the Destination Earth project in Ireland. However, digital technologies can also be energy and resource intensive, and produce toxic waste (Muench et al., 2022). This prompts the need for an integrated transformational approach that prevents an overall increase in the scale of impacts that overwhelms efficiencies.

The OECD (2021) highlighted that there has been specialisation in some green technologies in Ireland, such as those related to waste management, soil remediation and climate change mitigation for buildings. However, the OECD also noted low environment-related R&D spending, which has translated into a relatively small number of patents in environment-related technologies compared with the OECD average.

In addition to efforts to enhance the ability of economics models to capture gains, bottom-up studies can assist in understanding economic opportunities in individual sectors and locations. The Eastern and Midlands Climate Action Regional Office has led a research project intended to identify economic opportunities from climate action for local authorities. Two reports have been prepared, including a survey of local authority awareness and capacity to support economic opportunities (CARO, 2021a) and a report proposing initial opportunities for development identified by thematic analysis of existing policy documents (CARO, 2021b)[41].

While research in Ireland has estimated the costs and benefits associated with technological transitions, and of reducing demand (see Volume 2), the national research portfolio does not include strategic or empirical scenario analysis of transformational sustainable development paths. Consequently, the potential national economic gains associated with transformations are currently unknown. In the absence of long-term alternative scenarios that account for associated risks and opportunities, Irish finance and investment strategy has been seeking to catalyse action and enhance preparedness (section 6.4).

Section 6.2.2 has noted the considerable challenges inherent in reconciling the relationship of economic growth to human wellbeing, sustainable development and the achievement of a low-emissions future. In line with this discussion, transformational development and achievement of associated win–wins is assisted by reconceptualising societal goals and the means to achieve them (Fleurbaey et al., 2014; see also section 7.3.5). Notwithstanding the benefit of transformative re-imaginings of development in the context of focusing on provisioning and employment, a framework to identify national economic opportunities arising from low-emissions development is included in Table 6.1. The titles of 'dark green (emissions-reducing) economic activities' and 'light green (low-emissions) activities' are taken from Vandeplas et al. (2022). In the table, 'dark green' activities have been identified from preceding literature, including Riahi et al. (2022) and Pathak et al. (2022). 'Light green' lower-emissions activities are mainly found in services, as per section 6.2.5, and can be identified nationally in monitoring of economic emissions intensity (CSO, 2023). The categories of 'public' and 'private' are indicative.

[40] The report notes that traditional economic models do not adequately capture the physical risks of climate change and, on the policy side, marginal models can miss the benefits of disruptive change to a new sustainable growth path, the dynamic public economics of systemic change and the gains from innovation (GCEC, 2018).

[41] The policy analysis survey identified five areas: recycling; research; innovation and technology; renovation and retrofitting; sustainable transport; and broadband rollout (CARO, 2021b).

Dark green economic activities	Light green economic activities
Construction and buildings • Thermal renovation of buildings • Bio-based and low-emissions materials • Low-emissions construction	**Public services** • Physical health • Mental health • Education
Energy systems • Installation and maintenance of low-carbon electricity generation • Bio-based and alternative fuels	**Public services** • Community development • Social work and care • Public administration • Security
Mobility • Build-out and maintenance of active transport • Build-out and maintenance of public transport	**Private services** • Accommodation and food services • Arts, entertainment and recreation
Land based and agriculture • Afforestation and improved forest management • Soil carbon sequestration • Peatland and coastal wetland restoration • organic agriculture • Diversification from livestock to tillage and horticulture • Species and habitat conservation • Nature-based adaptation	**Private services** • Information and communications technology (ICT) • Software and digital services • Professional, scientific and technical activities
Production and manufacturing • Plant-based food innovations in recipe and product lines • Product and recipe substitutions to low-emissions alternatives	**Private services** • Financial and insurance activities • Real estate activities • Administrative and support service activities • Construction
Materials and waste • Circular economy • Reuse and recycling	**Manufacturing** • Light and heavy manufacturing using low-emissions materials and processes

Source: Author's own (T. O'Mahony).

6.3.3. Finance and investment as enablers

As emphasised with high confidence by the IPCC, finance is a critical enabler of the reduction of greenhouse gas emissions, and of enhancement of resilience to climate impacts (Pathak et al., 2022). The financial system comprises a large set of private and public institutions that act as the medium to manage insurable risks, and to fund investments that lay the foundation for future wellbeing and sustainability. This renders the direction and scale of finance a key determinant of society's development pathway, and the prospects for transition to sustainable development (Fleurbaey et al., 2014). 'Double materiality' is the idea that green finance should both mitigate the environmental risks that financial systems are facing and reduce the contribution of financial markets to creating these risks. IPCC AR6 notes that investors, financial regulators and central banks are taking increasing interest in both mitigation and adaptation as determinants of cost and risk, including potential impact on indebtedness and national credit rating (Kriebehl et al., 2022). The ECB climate stress test has emphasised physical and transition risks for banks, and that proactive transitions translates into lower losses than disorderly or no policy action (ECB, 2022).

In line with the IPCC conclusions on the need for sustainable development paths (conclusions such as in Fleurbaey et al. (2014); described in section 6.2), work informing the OECD has also emphasised the need for transition finance to go beyond reliance on upscaling low-emissions technologies (Tandon, 2021). Chenet et al. (2019) describe standards, corporate disclosures and carbon pricing as the main mechanisms to reorient the financial system towards sustainability. However, Kriebehl et al. (2022) also emphasise with high confidence that it is highly uncertain that it is feasible to align financial flows with the Paris Agreement. The delay in climate investments and financing leads to significant carbon lock-ins, stranded assets and other additional costs, but also forgone opportunities. In response to the need to align finance and investment with transformation, Kriebehl et al. (2022) have identified policy options with long-term catalytic benefits, many of which are pertinent to Ireland, including:

1. step up both the quantum and composition of support to low-income nations;
2. de-risk investments in infrastructure, develop green bond markets and align climate and non-climate policies;
3. lower financing costs and address financing risks;
4. accelerate finance for nature-based approaches, including forestry;
5. improve financing instruments for loss and damage, including in insurance;
6. phase-in carbon pricing and phase-out perverse subsidies[42];
7. introduce gender-responsive and women-empowered programmes.

Further perspectives on the limitations of current systems of finance and investment argue for the need for public policy to respond robustly if the path dependence of high-carbon systems is to be overcome. Schoenmaker (2021) notes a market bias towards carbon-intensive companies, and proposes that a tilt towards a greening of monetary policy could reduce emissions substantially, without excessive interference in the transmission mechanism of monetary policy. Volz et al. (2020) note the barrier to public investment in green development due to the growth in public debt, and recommends debt restructuring and relief for green and inclusive recovery. Green (2021) notes the incrementalism and marginal effects of carbon pricing, and proposes viewing climate change not as a market failure, but rather as one of societal transformation, thus demanding strong state intervention to reorganise the economy (see Chapters 6 and 7).

Finance and investment are therefore cross-cutting issues, and are systemic across mitigation and adaptation, while enablers of climate action, both the investment requirements (for climate action) and risks to assets (physical climate change) can also be minimised by following a sustainable development pathway. There is also a consequent need to combine mitigation and adaptation, and to highlight the potential for low-cost and net benefit solutions[43]. Finance innovation can be used not only to assist in steering development paths, but also to enhance investment flows in general, widening the scope and depth of transformative policies and measures. The long-term and equity aspects of climate actions pose challenges to finance and investment, which are guided by short-term motivations and a limited set of signals (Fleurbaey et al., 2014). This creates a need not just for public finance and investment, but for public policy to create the conditions for steering investment in socially agreed directions, in high employment and low-emissions structural change (Altenburg and Rodrik, 2017; Lecocq et al., 2022). To characterise potential investment needs of national transformations that are aligned with deep emissions reduction targets, analysis of different sustainable development paths, including systems change in addition to technological change, is required (see section 6.2).

There is evidence of policy innovation in Ireland's development of green budgeting, with the state being one of the first EU Member States to do so (DoF, 2021), and in national development of green investment bonds. Irish involvement has also been evident in international sustainable finance in the United Nations Development Programme's Financial Centres for Sustainability initiative, a programme to accelerate sustainable finance, including policies to enable sustainable infrastructure (UNDP/FC$_4$S, 2022). Irish policy has developed a Sustainable Finance Roadmap (Sustainable Finance Ireland, 2021) as a multilateral public and private initiative with 18 priority measures. This includes a strategic goal of developing Ireland as a leading sustainable finance centre by 2025, and the aim of mobilising private finance to support investment towards achieving climate action targets. Notwithstanding this progress, challenges are evident. In 2017, Ireland had the lowest share of environmental protection investment as a proportion of total business investment in the EU, at 0.1% (OECD, 2021). The

[42] The IMF has estimated global fossil fuel subsidies at $5.9 trillion in 2020, or roughly €11 million per minute (IMF, 2021).

[43] A potential net benefit solution could lie in fully achieving compact urban growth. Shifting from a reduction in urban sprawl, as is implied by the NPF, to a transformative path that prevents future sprawl, could not only regenerate towns and villages but also avoid sprawl-generated transport costs and congestion. As per CCAC (2021), the potential of this measure is unknown.

OECD (2021) also note that by 2018 public investment in environment and climate-related measures had still not recovered from disproportionate cuts to spending that followed the 2008 financial crisis.

While public and private investment have roles in finance mitigation and adaptation nationally, a climate justice perspective calls attention to the need to support low-income nations. Internationally, climate finance flows from developed to developing countries have proven to come in below the goal under the Paris Agreement, to mobilise US$100 billion per year by 2020 (IPCC, 2022). Ireland's direct international climate finance to vulnerable countries totalled €88.3 million in 2020, comprising 10.2% of Ireland's Official Development Assistance (Government of Ireland, 2022), and has historically been dominated by funding for adaptation. An Irish government commitment was made at the United Nations Framework Convention on Climate Change's Conference of the Parties 26 (COP26) in 2021 to reach at least €225 million per year by 2025. A determination of the relationship of national funding levels to international climate finance needs and targets is not reported in Ireland's International Climate Finance Roadmap (Government of Ireland, 2022).

In Irish research, the understanding of such physical and transition risks for the financial system is a priority, as is the sector's role in financing the technological transition to net zero emissions by 2050, which is seen as a key climate risk transmission channel (Carroll, 2022). 'Transition risk' has been considered in the form of changes in energy prices, where it was found that the current carbon intensity of households is key to explaining vulnerability in the transition to net zero, with rural and, in particular, low-income households most at risk (Adhikari et al., 2023). The effect of climate-related risks on transmission of monetary policy has been considered (McInerney, 2022). Empirical analysis of green bonds suggests that they are 'safe haven' assets during higher volatility periods, and are significantly affected by corporate bond markets during such times (Sheenan and Reumkens, 2023). The use of carbon taxes and revenue recycling to support transition has been considered (de Bruin et al., 2019b; Dominioni and Heine, 2019), and how carbon taxes can support shifts in development paths (O'Mahony, 2020). Risks of stranded assets in the electricity sector have been analysed (McInerney et al., 2019), as well as the use of insurance to manage flood risks (Surminski, 2017). Research has also quantified potentially environmentally harmful subsidies, predominantly towards fossil fuels and agriculture (O'Hara and Brady, 2019) and a related national NGO recommendation has proposed re-direction of agriculture subsidies towards public goods (Environmental Pillar et al., 2022). Research on corporate sustainability reporting and NGO perspectives is found in O'Dwyer et al. (2005). SustainabilityWorks and PWC (2023) discuss the alignment of climate tech innovation with commercial objectives of business and finance.

Carroll (2022) noted that the specific understanding of climate risk and financial risk is at an early stage. The same can be concluded more generally to climate finance in Ireland. Knowledge of finance as enabler and constrainer of action, and as a site of both risk and opportunity, is in its infancy. With respect to adaptation, the risks and associated costs of climate change impacts are partially known in Ireland. While the costs associated with some adaptation measures have been studied, costs associated with transformative adaptation are unknown (see Volume 3). With respect to mitigation, as per section 6.2, the economic gains and costs associated with transformational paths in general, and transformation policies in particular, are generally unknown in Ireland. The Global Commission on the Economy and Climate noted that more compact and connected cities could reduce infrastructure capital requirements by over US$3 trillion to 2030; and for every US$1 spent restoring degraded forests, as much as US$30 can be earned in economic benefits (GCEC, 2018). Preventative 'avoid' and nature-based approaches could also offer a plethora of public good benefits, within and beyond economic framings. The framing of research on sustainable development paths is crucial, as transformational framings could lead Irish policy to identification of low-tech and low-cost/no-cost measures, and generation of net economic gains. This opens up the potential to achieve win–wins and reduce risks and costs, as a cascading impact on finance and investment.

6.4. Research gaps

Understanding paths, options and opportunities – the importance of transformational scenarios. Ireland has developed knowledge of technological transitions, but has limited knowledge of sustainable development paths and associated transformations in systems and structures, including synergies and economic opportunities. Enhancing understanding of potentials, levers and outcomes of transformational change can be assisted through hybrid scenario analysis, integrating qualitative and quantitative approaches. Hybrid scenario analysis can enable integration of different disciplines and forms of knowledge, and top-down and bottom-up lenses on processes of change. Important framing conditions of scenarios of transformations include long-term analysis horizons; considering radical and deep change in systems, structures and technology; low-tech and low-cost solutions; the emergence of synergies and trade-offs; social, cultural, political and institutional change; and the short-term windows of implementation and action.

Economic opportunities and public policy synergies for wellbeing, equity and sustainability. Economic opportunities are considerable within transitions and transformations, but require enhanced analysis and supportive strategic policy development. Economic opportunities include 'dark green' emissions-reducing activities and 'light green' low emissions-intensity activities. Study of different transformational paths at the macro level can facilitate characterisation of national economic opportunities in prosperous and just rural and urban transitions. Future visions of economic development have a fundamental role in understanding transitions and transformations, including economic growth, structural change, green growth, degrowth and post-growth approaches. This can be used to reorient development towards wellbeing, equity and sustainability, and identify paths and policies that maximise synergies and minimise trade-offs. Bottom-up analysis of key sectors and themes is important in studying possible transformations. These include transformations in combined spatial and mobility systems; land, food and agriculture; and in energy systems. Five key frameworks to further enhance knowledge on key themes can be identified as decision making under uncertainty; aggregated economic models; ethical perspectives on values and equity; transition and transformational frameworks of processes and actors; and psychological/behavioural and political factors.

Innovation policy, finance and investment. Innovation policy, and finance and investment, can enable transformational development and related economic opportunities. Evolution in the field of innovation policy is moving towards broader support for sustainable development. A deepened understanding of how innovation policy can align with transformational sustainable development can support achievement of win–win outcomes. To this end, systematic review of the adequacy and performance of innovation policy with respect to transformational outcomes could assist in building knowledge of the relationships between innovation and transformations. Although beginning to grow, the knowledge and awareness of actors, of the risks and opportunities for finance and investment under the climate umbrella, is at an early stage. Priority research topics include aligning climate and non-climate policy; nature and infrastructure investment; green bonds and green finance; physical impact risk; delayed transition risk; carbon pricing, and positive and perverse subsidies; the economic opportunities in deep transitions and transformations; and climate finance for developing countries.

7

Transforming Governance and Policy

Key messages

Transformation to sustainable low-emissions and climate-resilient futures, and the related realisation of benefits and opportunities, requires transformational public policy choices in order to fundamentally shift development paths.

Shifts in development paths are associated with system innovation in national policy, going beyond a narrow focus on mitigation policy to a broader focus on sustainable development paths. The state and public policy have critical roles to play in a governance system that enables such transformational change.

The process of visioning and considering different paths can assist in moving the policymaking process from forecast-based planning to strategic foresight among alternative futures, in an anticipatory governance approach.

In developing a holistic and more deeply integrated long-term policy, transformational and systems innovation approaches can address policy fragmentation through policy integration and implementation gaps through institutional coordination.

Deeper vertical and horizontal integration of national policy is essential for making transformational shifts towards sustainable low-emissions development. This involves combined policy packages across related areas, including the integration of spatial and transport planning and of rural development with mitigation.

7.1. Introduction

Transformational governance and policy has a critical role to play as an enabler of effective climate action and sustainable development outcomes. The state of the art in the global literature has concluded that, in order to achieve deep emissions reductions that maximise synergies, an evolution of governance, public policy and institutions is needed (IPBES, 2019; Dubash et al., 2022). The state has a key role to play in governing systemic change through visioning, enabling and steering change, including across economy and society.

The assessment in this chapter considers the frontier of knowledge on governance and policy globally, including in IPCC WGIII reports, in order to characterise national knowledge of governance and policy for transformations to low-emissions futures. Section 7.2 describes the international and European policy context of climate action, as the supranational framework for Ireland. Section 7.3 considers the roles of governance and institutions in national and subnational climate action, and in terms of vertical policy integration across these scales. Section 7.4 considers policies and policy mixes, including deepened horizontal policy integration for transformations that can maximise synergies.

7.2. The international and European policy context

7.2.1. Global climate governance

The United Nations Framework Convention on Climate Change (UNFCCC) was opened for signature at the Rio Earth Summit in 1992. The Convention entered into force in March 1994 and was ratified by Ireland in April 1994. The Convention's ultimate objective is to stabilise GHG concentrations "at a level that would prevent dangerous anthropogenic interference with the climate system" (Article 2). The Convention enshrines the principles of equity and "common but differentiated responsibilities and respective capabilities", placing an onus on developed countries to "take the lead in combating climate change" (Article 3). A list of these countries is set out in Annex I of the UNFCCC. The Convention provides the basis for Conferences of the Parties (COPs) that have taken place (nearly) annually since 1995.

Under the Convention, industrialised countries committed collectively to reducing GHG emissions to 1990 levels, but it did not place specific emissions limitation obligations on individual countries. The Kyoto Protocol, agreed at COP3 in 1997, committed industrialised countries and countries with economies in transition to binding emissions limitation targets, set out in Annex B of the Protocol. Collectively, these targets add up to an average reduction of 5% relative to 1990 levels for the Protocol's first commitment period of 2008–2012. Collectively, the then 15 Member States of the EU agreed to an 8% reduction commitment. This was subsequently divided up among Member States under a 'burden sharing agreement' agreed in June 1998, under which Ireland's target was to limit GHG emissions to a rise of 13% above 1990 levels. The Protocol entered into force in February 2006 following ratification by the Russian Federation (Damro, 2006).

The COP15 climate summit, held in Copenhagen in December 2009, was widely characterised as falling well short of expectations in terms of both process and outcomes (Christoff, 2010; McGregor, 2011). The Copenhagen Accord represented the first instance of the inclusion of the two-degree global temperature goal in a UNFCCC climate agreement. The EU had adopted this target in 1996, and pushed for its recognition at the international level (Gippner, 2016; Morseletto et al., 2017). Parties at COP15 merely 'took note' of the Copenhagen Accord rather than formally adopting it; however, it was affirmed in a decision by COP16 in Cancun a year later.

The Paris Agreement of 2015 marked a shift in the evolution of the climate regime. Kuyper et al. (2018) identified three distinct shifts: a shift from legally binding emissions targets for developed countries only towards a system of voluntary contributions from all countries; a shift from the top-down architecture of Kyoto towards the hybrid architecture of the Paris Agreement; and a broadening of focus under Paris to incorporate adaptation and finance, along with mitigation. The central global mitigation goal of the Paris Agreement is to keep the increase in global average temperature "to well below" 2°C above pre-industrial levels and to pursue "efforts to limit the temperature increase to 1.5 °C above pre-industrial levels" (Article 2). A key design feature of the Agreement is its reliance on nationally determined contributions (NDCs) to deliver on the global goal (Article 4(2)). A further central element of the ratchet mechanism is the 'global stocktake', which is to be conducted every 5 years. The first global stocktake takes place in 2023.

The Glasgow Climate Pact, agreed at COP26 in 2021, contained a package of agreements covering mitigation, adaptation and finance. It provided a framework for Parties to strengthen their climate pledges on an annual basis, rather than every 5 years. It contained a reference to a fossil fuel – coal – for the first time. The Glasgow Climate Pact also served to anchor the 1.5 °C temperature limit centrally within the climate regime. COP26 also saw consensus on a range of side agreements, including a Global Methane Pledge under which signatories "agree to take voluntary actions to contribute to a collective

effort to reduce global methane emissions by at least 30% from 2020 levels by 2030" (Global Methane Pledge, n.d.).

Ireland is a signatory of the Global Methane Pledge. COP26 also saw the launch of the Beyond Oil and Gas Alliance, an initiative co-chaired by Denmark and Costa Rica that works towards the managed phase-out of oil and gas production. Ireland was one of 10 countries and subnational entities that launched the Alliance at COP21 (DECC, 2021). At COP27, Ireland played a leading role through Minister Eamon Ryan's appointment as EU Ministerial Representative for negotiations on the theme of loss and damage. These negotiations concluded with the agreement to create a new fund for loss and damage (Wyns, 2023). Ireland's climate finance is primarily grant-based and mainly focused on adaptation. In 2020 Ireland's climate finance amounted to €88.3 million, comprising 10.2% of Official Development Assistance (Government of Ireland, 2022; see also Chapter 6). The Climate Action and Low Carbon Development (Amendment) Act 2021 requires the government to have regard to climate justice in the development of the Climate Action Plan and national long-term climate action strategy, and requires the Climate Change Advisory Council (CCAC) to have regard to climate justice in the preparation of proposed carbon budgets.

7.2.2. The EU climate policy landscape

The Treaty of Rome, which founded the then European Economic Community, did not contain any reference to environmental policy, and in the years before 1972 EU environmental policy can best be described as 'incidental' (Hildebrand, 1992). Over the decades since environmental policy has become increasingly central to EU policymaking, and as the scope of EU environmental policy has expanded over time, environmental policies of Member States have become increasingly 'Europeanised'. Jordan and Liefferink (2004) argued that, while Europeanisation of environmental policy has affected all Member States, the group of strongly Europeanised states is small. Torney and O'Gorman (2019) have suggested that Europeanisation of Irish environmental policy has been limited.

Significant evolution of EU climate change policy has developed in a series of waves. The first of these, in the early to mid-2000s, focused on developing policies necessary for achieving the EU's emission reduction target under the Kyoto Protocol's first commitment period (2008–2012). The EU Emissions Trading System (EU-ETS) was established during this period, with phase I running from 2005 to 2007, and phase 2 running from 2008 to 2012. Towards the end of the 2000s, another wave of policy development can be seen. In 2007, the European Council agreed on the EU's headline climate and energy targets for 2020, including a 20% reduction in GHG emissions relative to 1990 levels. A climate and energy package with a time horizon out to 2020 put in place EU legislation to achieve this target.

With a 2030 perspective, the European Council in 2014 agreed on a headline GHG emissions reduction target of 40% relative to 1990 levels. Legislation was enacted to achieve this target, including revisions to legislation governing the EU-ETS, renewable energy, energy efficiency and effort sharing among Member States (European Commission, n.d.a). This legislative framework also included Regulation (EU) 2018/1999 – Governance of the Energy Union and Climate Action – a key component of which is a requirement for Member States to develop national energy and climate plans (NECPs) and national long-term strategies. Member States were required to submit draft NECPs by the end of 2018 and finalised NECPs by the end of 2019, and are required to update their NECPs in draft form by 30 June 2023 and in final form by 30 June 2024 (European Commission, n.d.b).

The most recent landmark in the development of EU environmental policy was the European Green Deal, published by the Commission in 2019, which "aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of GHGs in 2050 and where economic growth is decoupled from resource use" (European Commission, 2019). This transformational vision for the future of Europe is on a par with past grand objectives of the Union, including peace on the continent, completion of the internal market and the reunification of Europe following the end of the Cold War. As part of the European Green Deal, the EU's headline 2030 target for GHG emissions reduction was increased from 40% to 55% relative to 1990 levels. This target has been enshrined in law within the European Climate Law (Regulation (EU) 2021/1119), and the suite of EU climate and energy legislation is being updated as part of the 'Fit for 55' package.

In parallel with the development of an increasingly extensive and ambitious set of internal policies, the EU has for a long time played a significant and often leading role in global climate governance (Biedenkopf et al., 2022). For example, the EU has played a central role in shaping the development of the UN climate change regime, and has made climate change a focus of its broader external relations. Over time, the EU has adapted its international approach to a changing global landscape (see section 7.2.3); however, Oberthür and Dupont (2021) argue, intensified climate geopolitics has strengthened the need for a 'grand climate strategy'.

7.2.3. Polycrisis and turbulence in climate governance

The broader European and global political and social landscape presents challenges for climate transitions. Brexit, the COVID-19 pandemic and, most recently, Russia's invasion of Ukraine and the return of war to the European continent have complicated the policy landscape for transformative climate action. Democratic institutions, processes and norms are increasingly under pressure, and there is a widespread perception that democracy is in crisis (Norris and Inglehart, 2019). A rise in populism, increased political polarisation and challenges to science and expertise pose risks to democratic governance. Populist backlash has been increasingly evident in a range of western democracies, with action on climate change drawing particularly strong critique for being an elitist or unjust project. The concepts of polycrisis (Zeitlin et al., 2019) and turbulent governance (Ansell and Trondal, 2018; Dupont and Torney, 2021) have been used to capture the accumulation of challenges.

Brexit has also complicated EU environmental policy. Once regarded as a laggard compared with other EU Member States in terms of environmental policy, from the mid-1990s onwards the UK played a more positive role in EU environmental policymaking (Börzel, 2002). The UK played a particularly proactive role in shaping the Union's policy response to climate change, both internally and externally (Hepburn and Teytelboym, 2017; Jänicke and Wurzel, 2019). For example, the UK introduced a pioneering Climate Change Act in 2008 and piloted emissions trading preceding the development of emissions trading at the EU level (Carter, 2014). At the international level, the UK invested perhaps more than any other EU Member State in promoting climate change in its foreign policy, by staffing its embassies around the world with personnel whose responsibility was to engage with their counterparts on climate change (Torney and Cross, 2018). As a result of both its absence from EU institutions and potential divergence in climate policy preferences between the EU and the UK, the UK's departure from the EU could negatively impact upon the Union's climate governance, although any such effects could take many years to become apparent (Moore, 2023).

7.3. Governance and institutions

Governance and institutions are central to enabling – and constraining – climate transitions and transformations. Drawing on IPCC AR6 (Dubash et al., 2022: p. 1360), we define institutions as "rules, norms and conventions that guide, constrain or enable behaviours and practices, including the organisations through which they operate". Governance is defined as "the structure, processes and actions that public and private actors use to address societal goals" (ibid.). Patterson et al. (2017) highlight the centrality of governance and politics in understanding transformations towards sustainability. The characteristics of climate governance and institutions play a significant role in shaping climate action policy outputs, outcomes and impact. This section reviews international and Irish literature on climate governance and institutions.

7.3.1. Contextual factors shaping climate change governance and institutions

Climate change governance and institutions do not exist in a vacuum, and their evolution has developed along path-dependent trajectories, resulting in significant variation across countries. As Dubash (2021) puts it, "Countries do not start with a blank slate when designing climate institutions. Instead, political interests, existing institutional forms and prevalent ideas structure the space within which climate institutions emerge. And these institutions, in turn, shape the political context within which decisions around climate action are taken". Andrews-Speed (2016) conceptualised levels of embedded and linked institutions. According to this conception, embedded institutions constitute the first level of institutions, comprising norms, beliefs and ideas. The second level is the institutional environment, including the broader political, economic and legal systems, and electoral, parliamentary and government structures. At the third level are the specific institutions that govern transactions, such as government agencies, policies, laws and markets. Viewed through this lens, specific climate change institutions and policies are contingent on deeper-level institutions. In a similar vein, O'Brien (2018) distinguishes between three 'spheres of transformation', conceptualised as concentric circles. First, at the centre, is 'the practical', comprising behaviours and technical responses. These are embedded in 'the political', comprising systems and structures. Finally, the outermost circle is 'the personal', comprising beliefs, values, worldviews and paradigms. What each of these perspectives emphasises is the fact that what we think of as climate change policy and governance is profoundly shaped by deeper structural factors that are not changed easily or rapidly. From this perspective, climate policy and governance can be more effective if it takes deep-rooted values and beliefs into account (Dubash et al., 2022: p. 1372). IPCC AR6 highlights the importance of cross-national variation in a range of factors in shaping climate governance, including material endowments, political systems, and ideas, values and belief systems (Dubash et al., 2022: pp. 1370–1372).

A significant body of work on comparative climate change politics has examined the relationship between countries' political systems and their climate change policy outputs and outcomes (e.g. Dubash et al., 2013; Lachapelle and Paterson, 2013; Fankhauser et al., 2015; Iacobuta et al., 2018). Bättig and Bernauer (2009) studied a cross-section of 185 countries from

1990 to 2004 and found an ambiguous relationship between democracy and GHG emissions, but found that democracy has a positive effect on climate policy commitments. Other studies that focus on climate policies rather than emissions (i.e. policy outputs rather than outcomes) found that democracies are more likely to adopt more ambitious policies (Neumayer, 2002; von Stein, 2008; McLean and Stone 2012). Hanusch (2018) found that higher levels of democratic quality, measured using data from the Democracy Barometer, are positively correlated with more ambitious climate change policy. Within democratic systems, a range of institutional factors shape climate change policy outputs. Corporatist institutions (Scruggs, 1999; Lachapelle and Paterson, 2013; Ćetković and Buzogány, 2016) and proportional electoral systems (Scruggs, 1999; Harrison and Sundstrom, 2010; Spoon et al., 2014; Finnegan, 2022) enable more ambitious climate policy development, whereas institutional veto players (Henisz, 2000; Tsebelis, 2002) play a role in constraining climate policy adoption (Harrison and Sundstrom, 2010; Madden, 2014).

In their introduction to the *Oxford Handbook of Irish Politics*, Hardiman et al. (2021) point to a "remarkably strong executive", a "high degree of centralization of political power", and a "conservative and market-oriented tilt in policy priorities" as key features of Ireland's political system. They highlight continuity in the strong and stable institutional framework of Irish policymaking, but also significant innovation and modernisation since the 1990s. All of these features set the context within which climate change governance and policymaking has developed and evolved in Ireland. However, there has been limited research to date examining how existing political institutions enable and constrain climate change governance and policy in an Irish context. A prominent theme in the emerging literature in this regard concerns the fragmentation of governance structures. In recent decades, in common with most developed countries, Ireland has increasingly delegated governance functions to agencies through a process of 'agencification' of public administration, as part of what has been termed 'new public management'. State agencies have been created in Ireland in a relatively ad hoc fashion, with a wide variety of accountability and reporting relationships with central government (MacCarthaigh, 2011). The creation of the regulatory state – through delegation to arm's length regulators – has been a relatively recent development in Ireland in comparison with other countries, with many regulatory agencies created in a short space of time (Hardiman and Scott, 2010; MacCarthaigh, 2011). Research by Torney and O'Gorman (2019) noted Ireland's perceive 'laggard' status in climate and environmental policy, and suggested the reasons: lack of institutional capacity on accession; mismatch between national and supranational regulatory structures; significant veto players; and rapid economic growth. Research focusing on decarbonisation of the electricity sector (Torney, 2018) highlights fragmentation of authority between multiple governance actors, with institutional mandates that do not prioritise decarbonisation. Focusing on the transport sector, Devaney and Torney (2019) identify similar trends of fragmentation as well as contested institutional priorities.

A number of studies have analysed the party politics of climate change in Ireland, including from a comparative perspective (Ladrech and Little, 2019; Little 2017, 2020; Carter and Little, 2021). This research has found that climate politics in Ireland has been characterised by a 'passive consensus' for most of the period 1997–2019, apart from a brief period around the 2007 general election and in 2019, when there were signs of a 'competitive consensus'. Low public concern about climate change has historically been viewed by actors in the political system as a considerable constraint on the development of parties' climate policy preferences (Ladrech and Little, 2019); the period covered by this study precedes the increase in societal awareness from 2018 onwards.

Research by Wagner and Ylä-Anttila (2018, 2020) has examined the characteristics of the climate policy network in Ireland, including which actors are influential and what connections exist between actors. In common with Flynn's (2003) characterisation, they find that "domestic NGOs are weak, powerful economic actors and government departments dominate the policy process, decisions are largely determined by the Cabinet, and economic issues are prioritised over ecological concerns" (Wagner and Ylä-Anttila, 2018). Subsequent research by the same authors identified an 'echo chamber' effect, finding that Irish climate policy actors obtain policy advice from those with similar beliefs to their own, and that policy forums that bring actors with different beliefs together are not successful in overcoming this echo chamber effect.

Ideas, values and belief systems can also serve as powerful constraints on climate change policy development. The concept of policy paradigms captures the idea that particular ways of thinking about policy problems inhibit actors from considering alternatives (Kuzemko et al., 2016). As discussed in Chapters 1 and 6 of this volume, a long-standing commitment to measuring progress through GDP and a commitment to perpetual growth constitute one such policy paradigm, but alternative paradigms are possible. In an Irish context, for example, building on the work of Karl Polanyi, Kirby (2020) argues that contemporary global ecological, political and socioeconomic crises result from the attempt to run society according to the rules of the market, and proposes an alternative socioecological model. Kirby and O'Mahony (2018) considered global low-carbon transitions to 2050, across both developed and developing nations. Combining scenario studies with political economy, the authors propose that the current 'climate capitalism' approach is insufficient, and propose an 'ecosocialism' to prioritise society and the environment. Murphy (2021) analysed the roots of inaction on climate change across Africa and the EU, and concluded that the problem is political in nature, reflecting class interests and mindsets embedded in a political economy of the status quo. Harris and Hughes (2020) call for a reimagining of democracy, advocating a move away from 'neoliberalism's minimalist definition of democracy' and for the creation of "new spaces for citizens to revisit the meaning of democracy itself in our era of deep transformation".

7.3.2. The role of the state

The state is seen to be central to transformative climate action. Over the past half century, the growth in environmental concern has led to a greening of the state and of international society (Falkner 2012; Falkner and Buzan 2019), but this process has been highly uneven across states, with the characteristics of environmental states being strongly path dependent (Meadowcroft 2012). Indeed, it could be argued that we witnessed the decline of the power of the state over the closing decades of the 20th century and opening decades of the current century. The response of governments around the world, including in Ireland, to the COVID-19 pandemic arguably has reversed this long-term trend to some extent. State expenditure and activity increased significantly (Conefrey et al., 2021), and some commentators have suggested that the state will be permanently larger as a result of the expansion of state activity during the pandemic period (Susskind et al., 2020).

Recent literature has pointed towards a transformation in the role of the state. The work of Mazzucato (2011) has sought to question the frequent assumption of a slow, bureaucratic state and an innovative, dynamic private sector. Instead, she argues that the state has played a central role in not just regulating markets and fixing market failures, but also in creating markets and the innovation system. In her more recent book, *Mission Economy*, Mazzucato (2021) argues that we must rethink the capacities and role of government within the economy and society. Building on this work in the context of the climate crisis, Voldsgaard et al. (2022) have advocated a shift from a competition state to a green entrepreneurial state. Their approach involves what they call a ROAR model: the state sets clear routes (R) by setting high-level targets, and new organisations (O) and coordination mechanisms are created and empowered with policy assessment (A) tools and appropriate risks and rewards (R). Baker and Ekersberg (2014) determined that sustainable development necessarily has a strong role for the state, with roles in stimulating new policy, coordinating actors, mediating interests and shaping outcomes. Gitsham (2018) noted that climate change is pushing business leaders to embrace regulation.

Some scholars have highlighted the increasingly polycentric nature of climate governance (Jordan et al., 2018). Polycentric governance systems involve many centres of decision making that are formally independent of each other (Ostrom, 2010, 2012). Experimentation and learning are important features of polycentric governance systems. Indeed, for Ostrom (2012: p. 365), this is the great promise of a polycentric approach, which "encourage[s] experimentation and learning from diverse policies adopted by multiple scales". Sabel and Victor (2016) argue that the Paris Agreement architecture should be taken a step further to allow for greater experimentation and learning among this diverse universe of public and private governance actors. This focus on learning is echoed in other works on polycentric climate governance (e.g. Rayner and Jordan, 2013; Dorsch and Flachsland, 2017). However, Jordan et al. (2015) caution that the optimism that characterises some of this literature rests on as yet untested assumptions. Polycentric governance theory emphasises in particular the ability of the governance system to capture and scale up social, political and technological innovations to make them truly transformational (Ostrom, 2010, 2012; Dorsch and Flachsland, 2017).

In an Irish context, a NESC report published in 2012, *Ireland and the Climate Change Challenge*, identified the importance of an effective enabling institutional and policy framework to drive and measure progress on addressing climate change at a national level (NESC, 2012). The NESC report noted in particular the need to "engage actors at all levels and in all sectors, through a governance system that animates, learns from and pushes networks of firms, public organisations and communities to ever-greater decarbonisation". It called for a 'multi-level, experimental approach' to tackling climate change. More recent work by NESC (2019) on climate governance has continued to emphasise the need for strong state direction, but direction that enables and empowers experimentation and learning. Drawing on the work of Mazzucato, NESC advocated a mission-oriented approach to climate policy in which government sets high-level direction and enables diverse sets of actors across the public and private spheres and across diverse sectors to engage in bottom-up experimentation and learning through a process that is nurtured through dynamic feedback loops.

Box 7.1 Cross-border cooperation on climate action on the island of Ireland

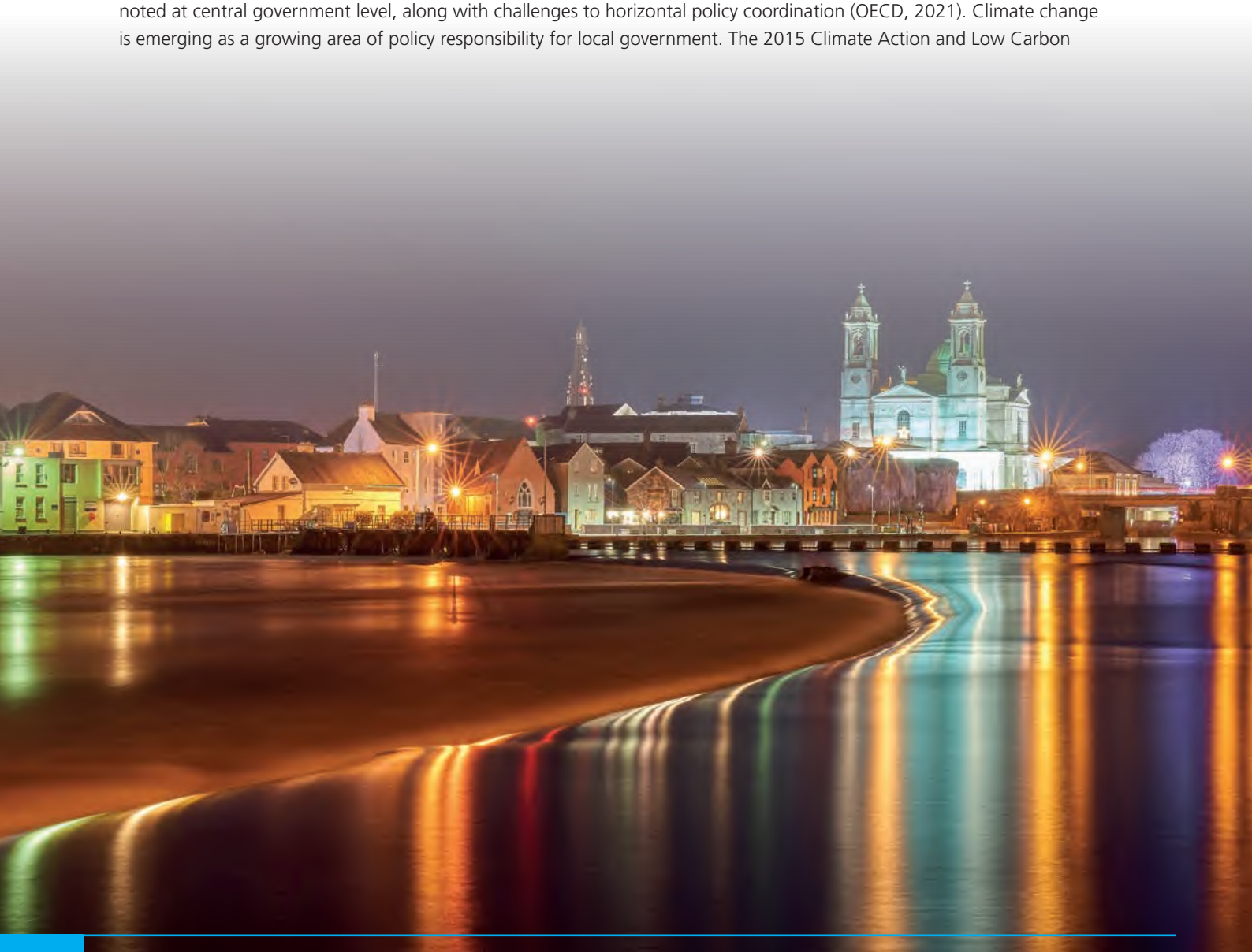
Cross-border cooperation on climate action and broader sustainable development has been the subject of research for some time. In Varley and McDonagh (2009), a variety of authors considered the politics and governance of sustainable development in rural Ireland – north and south. The advent of Brexit has led to considerable research focus on the implications for environmental policy and governance in Northern Ireland and on the island of Ireland (e.g. Gravey et al., 2018). NESC has published a number of papers on the topic, setting out recommendations for all-island cooperation, including climate ambition, valuing nature and renewable energy deployment (NESC 2021a, 2021b). This work identified a strong, shared ambition and vision for all-island cooperation. It called for a shared vision and statement of common purpose; supporting ties between formal and informal structures; and strategic working groups to provide a forum for multistakeholder dialogue on an all-island basis. Some research has also been commissioned by the two umbrella organisations of environmental civil society on the island of Ireland, Northern Ireland Environment Link (NIEL) and the Irish Environment Network (IEN), setting out opportunities for north–south civil society collaboration in a post-Brexit context (Brennan et al., 2023).

7.3.3. Subnational governance

In many countries, jurisdiction over areas of relevance to climate action, such as planning, housing and community development, means that subnational governing entities such as cities and regional authorities can play a significant role in the governance of climate action. However, the scope for subnational climate governance is shaped by access to resources, legal remit, knowledge and political clout (Dubash et al., 2022). International networks of cities, such as the C40, Covenant of Mayors and ICLEI, serve to bring subnational governments into interaction, disseminate information about best practice and facilitate knowledge sharing (Lee, 2013; Kona et al., 2015). In a European context, the concept of multilevel governance has been used to capture the diffusion of authority from national governments upwards to the EU level and downwards to subnational governance (Hooghe and Marks, 2001; Schakel et al., 2014). In climate policy, the EU context has provided

opportunities for leadership and lesson drawing between subnational governments, both horizontally (between different subnational governments) and vertically (between national and subnational governments) (Kern, 2018). Local government in Ireland is, in general, considered weak by international standards (Collins and Quinlivan, 2010), partly because of restrictions in policy remit and because of the fact that local government predominantly relies on central government for revenue. Scholarship on local government in Ireland has frequently highlighted its fragmentation and complexity, with Chubb (1992: p. 263) describing it as "a jungle of administrative areas that is both impenetrable to the ordinary citizen and frequently inconvenient for any kind of business". Adshead (2014) noted that EU cohesion and structural funds had led to changes in policy styles, through policy programming, monitoring, evaluation and partnership, but with minimal change to short-term focus and highly centralised policy architecture. McGloughlin and Sweeney (2011, 2012) found that higher-level objectives from national government were not incorporated into local policy documents, and that climate action measures at local levels were isolated instances of best practice. Davies (2005) identified tensions between central and local government as a constraint on the level of engagement by Irish local government agencies and authorities in European climate change networks. Dekker (2020) highlights the climate leadership potential of local government in Ireland but points to funding as a constraint on this potential. The need for vertically and horizontally integrated governance has also been noted, with a need for strategic learning, capacity building and public participation (Mullally et al., 2009, 2015; Mullally, 2012), and a need to address a lack of intensive coordination between governance processes for sustainable development at national and local levels (NESC, 2010).

The Local Government Reform Act 2014 saw a significant overhaul of local government structures in Ireland. The number of local and regional authorities was reduced, and municipal districts replaced town councils. A statutory requirement was placed on local authorities to produce 6-yearly local economic and community plans. The reforms have been perceived as providing for a more holistic approach to local environmental governance; however, institutional fragmentation has been noted at central government level, along with challenges to horizontal policy coordination (OECD, 2021). Climate change is emerging as a growing area of policy responsibility for local government. The 2015 Climate Action and Low Carbon



Development Act requires public bodies, including local authorities, to 'have regard to' the National Mitigation Plan and National Adaptation Framework. In April 2016, the EPA published *Local Authority Adaptation Strategy Development Guideline* (Gray, 2016), and, in December 2018, the Department of Communications, Climate Action and Environment published *Local Authority Adaptation Strategy Development Guidelines* (DCCAE, 2018). Central government signed a climate charter with local authorities, committing to low-carbon development and resilience and adaptation measures. This is now supported by four Climate Action Regional Offices, set up in 2018. The Climate Action and Low Carbon Development (Amendment) Act 2021 placed new obligations on local authorities, specifically the requirement to develop local authority climate action plans that focus on both mitigation and adaptation. The local authority sector strategy for delivering on the Climate Action Charter and Climate Action Plan, *Delivering Effective Climate Action 2030* (CCMA 2021), sought to develop a sectoral vision and objectives "to deliver transformative change and measurable climate action across our cities and counties and within our own organisations, through leadership, example and mobilising action at a local level". In March 2023, *Guidelines for Local Authority Climate Action Plans* was published by the Department of the Environment, Climate and Communications, setting out a framework for the 31 local authorities to follow (DECC, 2023a).

There has been limited research on the role of and implications for local authorities in climate action as a result of national legislative and policy developments in recent years. Wagner et al. (2021) found that, in the climate policy network set out in the 2019 Climate Action Plan, national actors dominate and cross-level collaboration is limited. A review of local government climate action in Ireland published by the Local Government Management Agency and covering the period 2011–2018 found that local authority climate action covered a range of areas, including critical infrastructure, flood risk management, water resources, nature-based approaches and public engagement. The research pointed to a pattern of local authorities prioritising different needs and implementing diverse actions based on prevailing local climate change risks. The research also identified the need for a standardised way of measuring, recording and reporting climate change actions on a frequent basis (Clarke and O'Donoghue Hynes, 2020).

A number of recent contributions have called for more place-based approaches to climate action, with a particular focus on a just transition. Drawing on a capability approach, Moore-Cherry et al. (2022) highlight the importance of understanding what local communities themselves want. They argue that "Moving beyond a 'one size fits all' approach to just transition policies, mechanisms and supports and instead understanding the contextual – place-based – nature of transitions is critical". They develop a set of recommendations that aim to build capacity for a place-based just transition in Ireland, ensure that governance mechanisms, policies and practices support a just transition, and ensure that a just transition is delivered and appropriately monitored. In a similar vein, McCabe (2020) develops the model 'The People's Transition', which comprises localised dialogue approaches called The People's Transition Dialogues. These are intended to help develop community strategies that enable communities to co-create solutions to the climate crisis.

7.3.4. Institutional frameworks for climate action

IPCC AR6 identifies three broad processes through which climate institutions emerge: (1) purpose-built institutions, created specifically for the purpose of addressing climate change; (2) layering new objectives on existing institutions to add a climate dimension to the work of those institutions; and (3) latent institutions, created for other policy purposes but with implications for shaping climate policy outputs and outcomes (Dubash et al., 2022).

Climate laws have emerged as a prominent institutional response to climate change, particularly over the past 15 years. Framework climate laws are defined by Nash and Steurer (2019) as "framework legislation adopted by parliament that lays down general principles and obligations for climate change policymaking in a nation-state (or sub-state entity), with the explicit aim of reducing greenhouse gas (GHG) emissions in relevant sectors through specific measures to be implemented at a later stage". AR6 points to a range of functions that climate laws can serve, including providing a basis for transparent target setting and implementation; providing a signal of state intent, enhancing regulatory certainty, creating law-backed agencies for coordination, compliance and accountability; mainstreaming climate action; and creating focal points for social mobilisation. Prior to 2010, climate laws had a predominantly mitigation focus. Since then, there has been an increased adaptation focus (New et al., 2022: p. 2581). However, according to AR6 WGII, "the legal regime for adaptation is too embryonic for assessment of good practice design and content" (ibid.).

Enshrining climate commitments in law can limit the ability of policymakers to "backtrack from earlier policy commitment ... Embedding targets in law, as opposed to setting them informally through white papers or statements, makes them more difficult to change procedurally and politically" (Averchenkova and Nachmany, 2018). The UK Climate Change Act of 2008

is widely regarded as a pioneering example of this kind of legislation (Fankhauser et al., 2018), although research has noted both the distinctive circumstances that gave rise to its enactment (Carter and Childs, 2018) and the path-dependent nature of its development and operation (Lockwood, 2021). Since then, a range of countries across Europe and elsewhere have introduced framework climate change laws (Duwe and Evans, 2020). The precise design characteristics of these laws vary from country to country, but many share a range of core elements, including long-term and intermediate GHG emissions reduction targets or arrangements for setting such targets, the establishment of climate change independent expert bodies, policy planning requirements, and arrangements for monitoring and accountability.

Ireland's first framework climate law, the Climate Action and Low Carbon Development Act, was signed into law in December 2015. The consensus among assessments of this legislation was that it was relatively weak, both on its own terms and in comparison with equivalent legislation in other jurisdictions (Kennedy, 2016; Torney, 2017; Wagner and Ylä-Anttila, 2018; Jackson, 2020; O'Gorman, 2020). In July 2021, the Climate Action and Low Carbon Development (Amendment) Act was signed into law, amending and significantly strengthening Ireland's legislative framework for climate action. A systematic assessment of the Climate Action and Low Carbon Development (Amendment) Act 2021 (Torney, 2021) concluded that the Act strengthened Ireland's institutional framework for climate action in respect of many core design elements. In an assessment of climate governance arrangements across Europe, Evans and Duwe (2021) identified three tiers of system, ranging from weak to strong: (1) 'EU/UN baseline'; (2) 'light framework'; and (3) 'robust framework'. Their assessment placed Ireland's climate governance framework, taking into account the Climate Action and Low Carbon Development (Amendment) Act 2021, in the 'robust framework' category.

Climate change advisory bodies have proliferated around the world and typically aim to bring an evidence-based perspective to climate governance (Nemet et al., 2017; Fankhauser et al., 2018; Evans and Duwe, 2021). In contrast with other policy areas where policymaking functions are delegated to technical experts that are outside the control of elected officials – such as central banks in the case of monetary policy – climate change advisory bodies are not typically given such powers but can play roles as watchdogs, advisors and convenors (Evans and Duwe, 2021).

In Ireland, the CCAC was established under the 2015 Climate Action and Low Carbon Development Act. The council's role as a watchdog was constrained under the 2015 Act by the absence of quantitative targets in that legislation against which progress could be measured. An independent evaluation panel tasked with considering the council's first 5-year term found that the council's mandate "falls considerably short of best practice" and "largely requires the Council to deliver its advisory role in a reactive rather than a pace-setting manner" with no "obligations to consult in a meaningful way or explain departures from such advice and recommendations" (Tallon et al., 2020: p. 11). The CCAC as established under the 2015 Act was composed of eleven members, including four ex officio members: the principals of the EPA, SEAI, ESRI and Teagasc. International comparative studies have noted that Ireland is unique in having such ex officio members as part of the CCAC (e.g. Weaver et al., 2019). Indeed, Nash and Stuerer (2019) note that Ireland's CCAC was "clearly less independent than the UK Committee on Climate Change, with ex officio members sitting alongside independent members". The independent review panel of the CCAC's first term zoned in specifically on the role of Teagasc on the council, concluding that "Teagasc is ... regarded by us as representing a sectoral interest in the transition" and that agriculture is "the only sector with a seat on the Council" (Tallon et al., 2020: pp. 22, 36–37).

Under the 2021 Act, the CCAC has an important role in the setting of national carbon budgets, although this role is advisory rather than executive. Its role as a government watchdog has been strengthened also by virtue of the fact that the 2021 Act contains a quantitative target for 2050. The composition of the council was amended under the 2021 Act, increasing from 11 to 14 members, with the specification that the council should be composed of members with a range of expertise and there should be gender parity. The principals of SEAI and ESRI were removed as ex officio members, but the principals of the EPA and Teagasc remained, and the principal of Met Éireann was added. As a result, the CCAC retains its unique international status, and the concern of the independent review panel that the agriculture sector has "a seat on the Council" remains (Tallon et al., 2020: p. 36–37).

A review of nine European framework climate laws by Ecologic Institute distinguishes between long- term strategic planning and shorter-term policies and measures for implementation in the short to medium term (Duwe and Evans, 2020). Only some climate laws (Finland, France, Spain) set specific arrangements for longer-term strategic planning. Under the 2021 Climate Act, the government is required to update the Climate Action Plan annually, and to publish a national long-term climate action strategy.

Effective institutional coordination mechanisms can serve to mobilise resources, mainstream climate policy considerations into other policy areas, foster stakeholder engagement and buy-in, and facilitate monitoring and evaluation (Averchenkova and Nachmany, 2018: pp. 114–115). Institutional mechanisms for coordination vary widely and are often strongly shaped by the broader institutional landscape in which they operate (Dubash, 2021). Policy integration across related policy themes is a critical requirement of systems transformations (see section 7.4.3), and can be achieved through enhanced institutional coordination, to deepen policy coherence. The IPCC AR6 describes how climate change mitigation is accelerated when attention is given to integrated policy and economy-wide approaches, in the presence of enabling conditions across governance, institutions, behaviour, innovation, policy and finance (Dubash et al., 2022). Challenges to mitigation can be overcome by combining systemic change and targeted actions. Dubash et al. describe accelerating mitigation as simultaneously weakening high-carbon systems and encouraging low-carbon systems; ensuring interaction between adjacent systems; overcoming resistance to policies from high-polluting industries; inducing changes in consumer practices and routines; providing transition support; and addressing coordination challenges in policy and governance.

Regular progress monitoring is a core component of framework climate laws, although national climate laws vary in terms of which government entity is responsible for reporting. In Sweden, Germany and Denmark, responsibility for annual reporting lies with government, whereas in France and the Netherlands it is the scientific expert body that reports. In the UK, the Climate Change Committee issues an annual report to which government must respond, and, separately, government must also issue its own report annually under the law (Duwe and Evans, 2020). Many national laws also require additional action in the event that monitoring exposes such a need. Under the 2021 Climate Act, relevant ministers are required to be accountable to both houses of the Oireachtas, as well as to the relevant Oireachtas committee. In addition, at official level there is a quarterly process of monitoring progress on delivery of actions under the annual Climate Action Plan, with a climate action unit in the Department of the Taoiseach responsible for progress monitoring.

7.3.5. Visioning and anticipatory governance for sustainable development paths

A key message from IPCC AR5 was that designing successful climate policy entails going beyond a narrow focus on mitigation and adaptation, and beyond the analysis of a few co-benefits of climate policy, to 'mainstream' climate issues into the design of comprehensive strategies for sustainable development (Fleurbaey et al., 2014). This reframing of policy focus is illustrated in Figure 7.1, with the idea of moving from considering mitigation alone (inner circle) to taking all relevant objectives into account at the same time: social, environmental and economic (outer circle). Such a re-design of the policy process can address policy fragmentation (section 7.3.1) through policy integration (section 7.4.3) and deliver effective implementation through institutional coordination (section 7.3.4). It could be described as aligned with the systems innovation approach advocated by the OECD (2022).

Considering sustainable development pathways is typically based on considering multiple plausible or preferable scenarios into the future (see also Chapter 6). Considering different pathways moves the policymaking process from forecast-based planning to strategic foresight among alternatives (Ramirez and Wilkinson, 2016; Tõnurist and Hanson, 2020). Using alternative scenarios to consider multiple possible or plausible futures is now a common process in formulating national long-term strategies[44] (Sato and Altmirano, 2019), as it can widen the scope of solutions while enhancing the approach to uncertainty. Ireland's long-term strategy (DECC, 2023b) does not appear to have considered alternative scenarios.

The IPCC AR6 has highlighted that one of the main developments in global literature in recent years is the acknowledgement of the close linkages between climate change mitigation, adaptation and sustainable development (IPCC, 2022). National development pathways in all countries shape the challenges and opportunities for mitigation and adaptation. Grubb et al. (2022) note that a key feature of development and transformation pathways that achieve a climate-resilient world is that they maximise the synergies and minimise the trade-offs between climate mitigation and other sustainable development objectives. Sustainable development is also the concept used to link mitigation and adaptation in climate resilient development (CRD) and climate compatible development (CCD) (see section 6.2.4), and related research has begun in Ireland (Flood et al., 2023).

[45] Of the first 11 long-term strategies submitted to UNFCCC, as assessed by the World Resources Institute, nine introduced scenarios to depict multiple future pathways (Sato and Altimirano, 2019).

Figure 7.1 Three frameworks for thinking about mitigation in IPCC AR5. Source: Fleurbaey et al. (2014; their figure 4.1).

The IPCC AR5 further elaborated on governing transitions and transformation for effective climate action and related sustainable development by stating, "with high confidence", that this involves rethinking our relation to nature, accounting for overlapping environmental issues, and encompassing multiple generations and interests, all in the context of unequal capacities and power, and divergent conceptions of justice (Fleurbaey et al., 2014). Governing transitions and transformations is thus a holistic and long-term strategic policy process that seeks to guide public policy choices between alternative paths. Figure 7.2 illustrates this strategic policy process as one that identifies fundamental goals, such as sustainability, wellbeing and equity, to reconceptualise development (O'Mahony, 2022). This framework can then enable new systemic policy designs to guide national development onto pathways that support maximisation of synergies and minimisation of trade-offs. The IPCC AR6 has concluded, "with robust evidence and high agreement", that long-term deep emissions reductions are best achieved through combining climate and development objectives (Dubash et al., 2022).

While the IPCC has strongly reinforced the need for, and benefits of, a strategic approach to policy for climate action and related sustainable development, the general process of anticipatory governance has been evolving globally. The OECD Observatory of Public Sector Innovation (OPSI) has described anticipatory innovation governance as a process that reframes and broadens the scope of what is considered relevant; stress tests plans and strategies; identifies the early signs of oncoming disruptive change; and generates shared language and perspectives for action (OECD/OPSI, 2021). Anticipatory governance can sometimes be described as a process of visioning to create a shared normative picture of the desired future, and to identify steps towards its achievement. Visioning is an opportunity to not only focus on widening the conception of change, but include public participation (see Chapter 8) in deciding what is the desired vision for the Ireland of the future. In Irish literature on future transitions, Fitzgerald and Davies (2022) have proposed that a fairer futures research agenda focuses not only on issues of broadening participation in creating future visions, but also on patterns of uneven power within the processes of how those visions themselves are created and implemented.

The OECD/OPSI (2021) report noted that anticipatory governance practices exist in Ireland, although at the margins, and cited early examples, including NESDO (2009) and Ratcliffe et al. (2005). Irish public sector leaders have identified long-term climate strategy specifically as a key policy area for application of anticipatory governance, to benefit from the reframing and reshaping that strategic foresight offers. Ireland's future strategies for public service (Government of Ireland, 2023) and the civil service (Government of Ireland, 2021) have both identified climate breakdown as a policymaking priority and strategic foresight as a policy process priority. This provides scope to initiate a strategic, holistic and long-term process in Irish policymaking, combing emissions reduction with wider policy objectives as transformational governance of systems change, in line with the IPCC (Dubash et al., 2022) (see also Chapter 6).

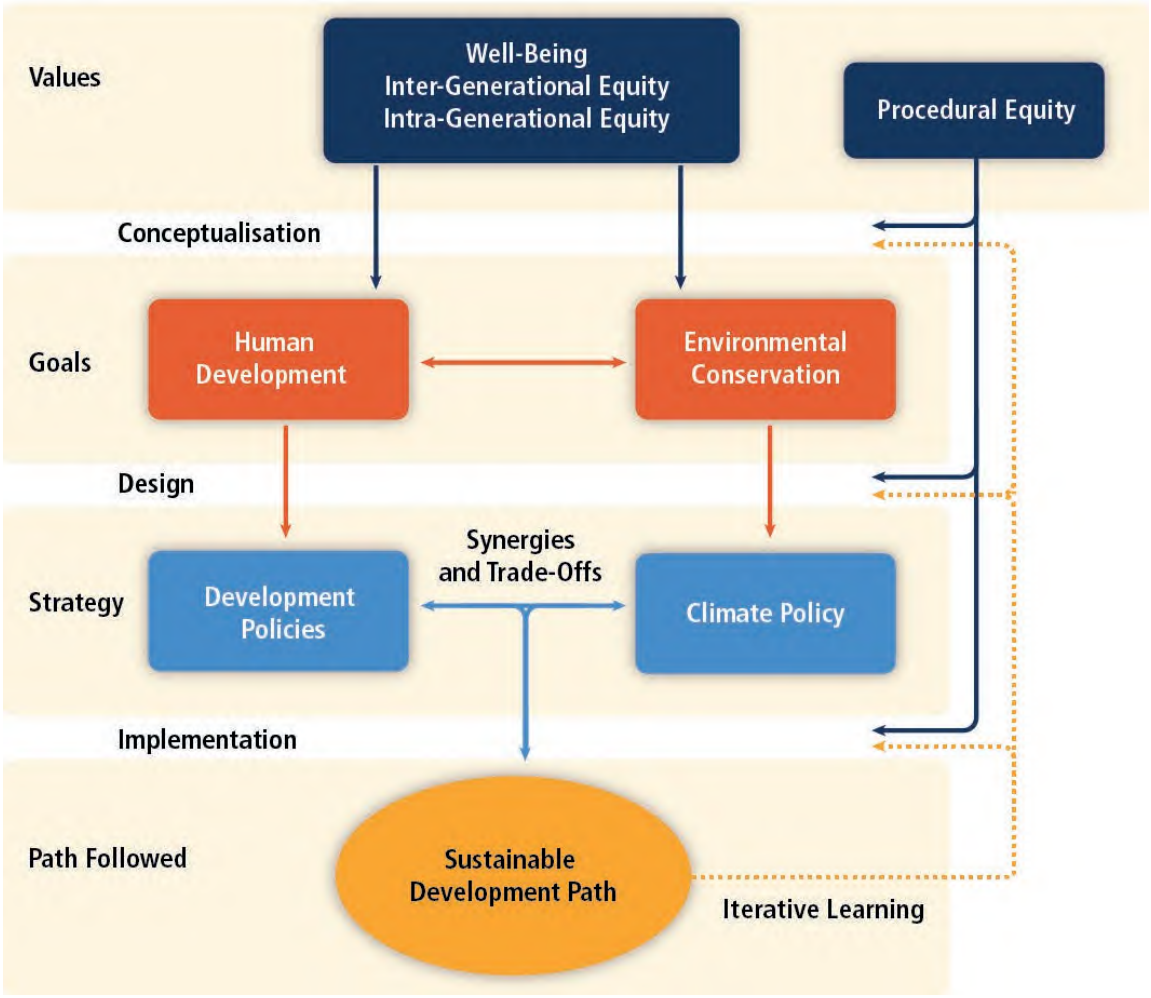


Figure 7.2 The holistic policy process to guide towards sustainable development paths, for effective climate action and realising synergies. Source: Fleurbaey et al. (2014; their figure 4.3).

7.3.6. Knowledge and capacity

Since the IPCC fifth assessment cycle, IPCC assessment reports have noted that the global field of mitigation has made a step change, recognising the need to accelerate mitigation, and that this requires systemic change (IPCC, 2018; IPCC 2022) (see Chapter 4). As noted in section 7.4.4, this involves moving beyond reliance on conventional mitigation measures to shifting development pathways. Markard et al. (2020) describe the key challenges of accelerating climate mitigation and sustainability transitions as the need for whole-system innovations that encompass interactions and changes in system architecture; the need for greater interactions between adjacent systems; resistance from declining industries; the need for changes in consumer practices and routines; and policy and governance challenges of vertical and horizontal coordination.

Ireland's climate action policy has been acknowledged as relying on conventional economic and technological measures (see sections 6.2.1, 6.2.3, 7.3.6). However, outside of economic and technology forecasts, and the beginning of low demand research (Gaur et al. 2022), Ireland has limited analysis of long-term transformational change-related sustainable development paths. Ireland's first long-term low-emissions development strategy (DECC, 2022) is dominated by a narrower, technology-based approach (existing, emerging and speculative technologies) and circular and bioeconomy goals, rather than systemic transformations of development as shifting pathways. Narrower conceptions of climate action are likely to continue to act as a barrier to conceiving and implementing systemic change in development pathways, thus slowing mitigation and forgoing synergies (see sections 4.4, 6.2.3, 6.2.4). While an assessment of knowledge gaps with respect to transformative interventions for systems change is not available, recognition of this knowledge gap has begun to emerge in thinking on

climate action in Ireland (Tallon et al., 2020). In line with this recognition, CAP23 alludes to the need for an evolution of systems research and modelling in Ireland to consider alternative scenarios and integrate different disciplines (DECC, 2022) towards the systems thinking approach alluded to by Markard et al. (2020).

Domorenok et al. (2021) highlight that, at a basic level, governmental capacity – the numbers and training of personnel – can shape the choices available to climate institutions and their ability to be strategic. In Ireland, the development and delivery of a report on the capacity of the public sector to deliver climate action was included as an action in CAP23, but it had not been published at the time of completion of this assessment. In June 2022, the government agreed to establish a National Framework for Climate Services, which enables the co-production, delivery and use of climate information and tools to support planning and decision making for climate resilience. The related task of achieving the SDGs has been assessed. Murphy et al. (2021) benchmarked Ireland's performance on achieving the environmental SDGs against peer nations in the EU, and proposed that capacity building for implementation was poor.

In addition to enhanced knowledge of transformations, when knowledge and information on systemic change is available, tools and skills are required that enable horizontal and vertical integration of policy, and partnerships for their implementation. Dubash et al. (2022) have noted the need to coordinate policy action across adjacent systems. Examples include coordinating settlement and transport infrastructure planning with energy decarbonisation policy, and public health with food and agriculture policy. Implementing policies for synergies across system boundaries requires capacity for vertical and horizontal policy integration (see section 7.4.3). While an assessment of capacities for vertical and horizontal integration of transition and transformation policy is not available, Banerjee et al. (2020) have identified limitations in the capacities of national multistakeholder partnerships to achieve complex goals. The authors investigated perceptions of non-state actors and determined that numerous barriers exist to forming multistakeholder partnerships for implementing the SDGs, including a fragmented understanding of the SDGs; the need for more leadership from government; and an overly goal-based focus on SDG implementation. In Irish literature, Pender (2023) has discussed world views for transformative climate governance, proposing that some world views result in less capacity to respond to change and uncertainty, with reflective learning and openness to multiple perspectives regarded as important.

7.4. Policies and policy mixes

7.4.1. The role of public policy

Since IPCC SR1.5 (IPCC, 2018), the importance of enabling conditions for systemic change for successful climate mitigation action has emerged. In IPCC AR6, Dubash et al. (2022) have since highlighted that governance, policy and institutions represent three of the six enabling conditions[45]. In addition to the importance of public policy in establishing enabling conditions, public policy has already demonstrated, globally, a significant impact on emissions reduction of several $GtCO_2$-eqyr–1 (Dubash et al., 2022). The role of public policy is central to both overall development policy and conventional mitigation policy (Fleurbaey et al., 2014), as the two major domains of action to shift to sustainable development paths for systemic restructuring (Dubash et al., 2022). Conventional mitigation policy can be described as cross-sectoral economic instruments and sectoral policy for technological and behavioural change. Transformative development concerns policy change in the direction of overall development. This encompasses multiple dimensions across key systems and sectors (see Chapter 6), including energy, land use, agriculture, urban development, improving energy efficiency in buildings, transport/mobility and decarbonising industrial systems. Grubb et al. (2022) noted that public policy will be central, not just because of the universal underpricing of emissions and inadequate economic incentives for innovation, but also because of delay mechanisms and multiple sources of path dependence and lock-in to existing systems: economic, social and cultural, technological and infrastructural, and institutional and political. For discussion of delay mechanisms in environmental governance, see Karlsson and Gilek (2020), with policy delay described as unclear norms and goals, decision thresholds, policy formulation challenges and implementation deficits.

7.4.2. From individual policies to policy packages

A large number of policy instruments can affect GHG emissions and sequestration, whether their primary purpose is climate change mitigation or not (Dubash et al., 2022). Nascimento et al. (2021) categorised policies as codes and standards, direct investments, voluntary approaches, market-based instruments, and financial and fiscal incentives, and considered coverage of

[45] Where enabling conditions are enumerated as finance, technological innovation, strengthening policy instruments, institutional capacity, multi-level governance, and changes in human behaviour and lifestyles (Dubash et al., 2022).

application across five sectoral groupings in the G20 countries. The research illustrated that regulatory codes and standards, incentives and investments have tended to become the most prevalent, although varying by sector. In considering the performance and impacts of different policy approaches, Dubash et al., (2022) singled out three among many of the policy approaches available: carbon pricing, regulatory instruments and removing subsidies. The assessment concluded that carbon pricing can be effective in promoting implementation of low-cost emissions reductions. However, it is subject to social and political challenges and has limited effect on options less sensitive to price, or with a higher cost, including energy efficiency, urban planning and infrastructure. Regulatory instruments were noted as effective in many applications, and as enjoying more political support, but with potential to be more costly in some cases. Removing subsidies was noted as reducing emissions and yielding benefits for public revenue, the economy and other sustainable development, but has potential for adverse distributional impacts.

Irish research on ex post evaluation of climate policies was conducted by Dekker and Torney (2021) using an evaluation framework that built upon standard EU policy evaluation criteria of effectiveness, efficiency, coherence and relevance, adding two additional criteria: governance and distributional impact. The research found deficits in coherence, relevance and distributional impacts, and in governance. O'Mahony (2020) considered carbon pricing globally and noted that, while it can be useful, it is subject to political and social challenges and is not a substitute for transformational measures. Bresnihan (2019) considered fisheries management as an example of an excessive focus on 'improvement', efficiency-based measures in environmental governance in general. Rather than challenging or promoting alternatives, improvement measures can be associated with neoliberalism and resolving socioecological contradictions through what is amenable to measurement.

A critical outcome of recent advances in understandings of policy design is the recognition that policy packages, rather than individual policies, are better able to support sociotechnical transitions and shifts in development pathways towards low-emission, climate-resilient and sustainable futures (Dubash et al., 2022). The IPCC concluded, "with high confidence", that a broad set of enabling conditions is needed to foster the shifting of development pathways and thereby accelerate mitigation. Policy integration is a necessary component, addressing multiple objectives at once through integrated policy packages rather than single policy instruments (Lecocq et al., 2022) (see section 7.4.3).

The practice of evidence-based policymaking appears to have increased nationally in Ireland, as illustrated by the evolution in key environmental assessment methods noted below. However, challenges to the framing of regulatory, policy and project assessments have been recognised in a number of studies. Strategic environmental assessment (SEA) often does not include sufficient analysis of alternatives, with effects seldom monitored (González et al., 2020). Regulatory impact assessment (RIA) is largely qualitative, and levels of ex post assessment may not be sufficient (OECD, 2021). Environmental impact assessment (EIA) conclusions may not be binding on development consent (OECD, 2021). Cost-effectiveness analysis (CEA) has to date focused on technological change, rather than structural shifts or reductions in demand (Gaur et al., 2022). Cost–benefit analysis (CBA) of projects and policies in Ireland can systematically undervalue environmental and social impacts, owing to short time horizons and high discount rates (O'Mahony, 2021a, 2021b). The avoid–shift–improve framework is a key approach used globally to monitor systemic, sociocultural, infrastructural and technological change (Pathak et al., 2022), and can be implemented by decomposition analysis. While this approach has been used in Ireland, it has not been updated in recent years (see Chapter 6).

When considering the limited transformational framings in national policy design (see section 6.3.1), there is a risk that the aforementioned challenges to regulatory, policy and project assessment will act to reinforce status quo dynamics and trends. Tools and practices formed in an era of incremental change and efficiency improvements can be unsuitable in an age requiring path shifts and transformational change. An important evolution has been occurring in the literature, from focusing on environmental effectiveness and economic efficiency or cost-effectiveness with distributional equity sometimes added, to considering key aspects of policy design (Dubash et al., 2022). These aspects of policy design and implementation include focusing on synergies and co-benefits and institutional requirements, and the addition of transformative potential[46] as a key criterion in itself. The latter demonstrates that evolution in the tools of policy analysis and assessment, and in policy design itself, are important enablers of transformational shifts in pathways (see section 7.4.3). The IPCC AR6 notes that a significant body of work states or accepts that systemic change may be necessary for successful climate mitigation, including reaching net zero targets (Dubash et al., 2022). Newell phrases this as the difference between 'plug and play' mitigation – where one aspect of a system is changed while everything in the system remains the same – compared with systemic change affecting the whole system (Newell, 2021). This emergent multidisciplinary literature highlights that accelerating mitigation via a sustainable development pathway may be better achieved by moving from a single policy instrument or mix of policies approach to a systemic, economy-wide approach (Dubash et al., 2022).

7.4.3. Deepening policy integration to shift pathways

It is widely recognised that technological change is necessary but not sufficient for deep emissions reduction, and requires sustainable development for more fundamental systems transformations (Fleurbaey et al., 2014; Lecocq et al., 2022). Public policy has a key role in shifting paths. Transforming systems by shifting to a sustainable development path increases the feasibility of emissions reductions. Transformative sustainable development paths open up a wider set of public policy benefits, including economic opportunities (section 6.3.2), than business-as-usual paths that rely on technological change. Shifting development paths is a strategic task that can be associated with deep integration into national development goals and related policies. Ireland's emissions mitigation policy was identified a decade ago as relying on end-of-pipe technological change (section 6.2.1), rather than strategically shifting the development path (O'Mahony, 2010, 2013), and this was reiterated in a recent study of energy transitions (Gaur et al., 2022). Similar conclusions can be found for climate adaptation in Volume 3 (see Chapter 10 Moving Adaptation Forward). While Ireland's emissions mitigation policy approach has begun to deepen in recent years, it remains dominated by end-of-pipe technological solutions rather than shifts in the development path. It is accepted in state-of-the-art literature that this approach reduces the feasibility and imposes increased costs of reaching net zero and forgoes potential benefits enabled by transformations (see sections 4.1 and 6.2).

Shifting development pathways towards sustainability offers ways to broaden the range of levers that a society can use to accelerate mitigation, and increases the likelihood of making progress simultaneously on climate action and other goals (Pathak et al., 2022). Concrete examples include high-employment and low-emissions structural change, fiscal reforms for mitigation and delivering on priorities that could be relevant to the social contract. Examples of such policy integrations from Lecocq et al. (2022) include combined housing and transport policies (to deliver increased housing and transport mitigation)

[46] Dubash et al. (2022) describe transformational change as a process that involves profound change resulting in fundamentally different structures or a substantial shift in a system's underlying structure. Climate change mitigation policies can be seen as having transformative potential if they can fundamentally change emissions trajectories, or facilitate technologies, practices or products with far lower emissions.

and combined agriculture and forestry policies (delivering rural development and sustained emissions reductions). These choices include technological, systemic and sociobehavioural changes. Decision points for these choices can arise with new infrastructure, sustainable supply chains, institutional capacities for evidence-based and integrated decision making, financial realignments, just transitions and shifts in behaviour and norms (Pathak et al., 2022).

Stronger horizontal policy integration is crucial to accelerating climate action and associated sustainability transitions, in order to manage increased policy complexity (Markard et al., 2020). Systemic responses enable achievement of synergies across multiple objectives, including integration of adaptation and mitigation, but require going beyond sector-focused silo approaches (O'Brien, 2018). A transformational approach therefore requires overcoming institutional barriers to systemic change. This includes overcoming the 'silo problem', where combined challenges are being treated separately, by moving to policy integration to achieve policy coherence (Denton et al., 2022; Dubash et al., 2022). In the IPCC AR6, Denton et al. (2022) propose that "Policy coherence and integration between sectors are two of the most critical factors in breaking down the silo mode of working of different sectors". Policy silos have negative effects on policy coherence, preventing the systemic emergence of path shifts that accelerate mitigation and achieve multiple policy objectives (Denton et al., 2022). Regarding delivering on integrated policymaking, Domorenok et al. (2021) describe a number of capacity challenges, including capacity for horizontal and vertical coordination; implementation capacity, including the independence of the state from interests; and the administrative capacity required to address compound problems (see also section 7.3.6).

Irish literature on policy integration can be found in both general and specific thematic studies. A number of strands of literature suggest that policy in Ireland is characterised by silo thinking and limited policy integration. Flynn and Ó hUiginn (2019) concluded that Irish policy is strongly siloed, including the problem of 'silos within silos'. In considering SDGs and multistakeholder partnerships in Ireland, Banerjee et al. (2020) highlighted challenges to both the coordination as a whole-of-society, whole-of-government approach and the holistic pursuit of sustainable development, as a result of silo thinking and related cherry-picking of organisational priorities. The EPA 2020 Environment Assessment concluded that 'silo thinking' has been characteristic of Irish policymaking, and that policy coherence would require stronger horizontal integration (EPA, 2020). In a working paper, Mullally and Dunphy (2015) suggested that some progress on policy integration may have been made up to 2008, but that challenges were evident post austerity, noting the disbandment of COMHAR as an institutional focal point for horizontal integration of sustainability.

Devaney and Davies (2017) combined insights from social practice theory and transition management, and underlined the need to combine supports to transition to sustainable food consumption. Rather than relying on labelling and awareness campaigns, the study emphasised the need for an integrated systems approach combining product, regulatory, informational and motivational supports. Devaney and Henchion (2017) note that, while not a silver bullet, the bioeconomy offers potential for sustainable economic opportunities. Devaney and Henchion also caution that this requires a holistic policy and governance approach that moves away from productivism to balancing socioeconomic opportunity with ecological limits. Lange et al. (2018) concluded that lack of policy integration was a governance barrier to sustainable energy transitions in Ireland. Davies (2009) found that grassroots sustainability enterprises were pursuing ecological modernisation and social partnership as distinct rather than integrated pathways of development. On adaptation, Falaleeva et al. (2011) considered the challenge of coastal climate adaptation and recommended an integrated systems-based approach for sustainable development in the context of growing coastal climate risks in Ireland. The study noted the challenge of top-down governance fragmentation and bottom-up gaps in awareness, highlighting governance architecture as a means to identify pathways to coordinated climate and coastal management. In Northern Ireland, Barry (2009) proposed that a false dichotomy of economy versus environment focus could be replaced by the triple bottom line of sustainable development. Irish policy for transport mitigation has recently been the subject of increased policy integration efforts. This includes the OECD's systems innovation report, *Redesigning Ireland's Transport for Net Zero* (OECD, 2022), and the comprehensive framework for sustainable mobility transformation developed for the EPA in EPA (2020).

7.5. Research gaps

Understanding climate institutions and governance in the national context, layering on existing institutions, sectoral challenges and scales. There has been limited analysis to date of climate institutions and governance arrangements in Ireland. In light of the significant evolution of the governance landscape in recent years as a result of the Climate Action and Low Carbon Development (Amendment) Act 2021 and related processes, further research is needed to study the implications of these changes and provide a basis for further strengthening of the governance framework, with a focus on three areas in particular. First, building on the path-dependent nature of climate governance arrangements, research is needed on how the layering of new climate governance arrangements on existing institutions plays out in the distinctive context of Irish politics and policymaking. Second, future research ought to focus on the governance of particular sectoral climate action challenges. Third, further research on climate governance at local and regional level, and in a multilevel governance context, would help to strengthen climate action responses and minimise fragmentation.

Building policy knowledge and institutional capacity for transformations, alternative paths, feasibility and the roles of actors. To widen and deepen transformational governance and policy research in Ireland, important foci include the political, social, cultural and institutional feasibility of transformations; studying the roles and influence of governance actors that enable and disable transformations; and options to overcome resistance to change. It is also important to recognise that there is limited analysis of alternative future paths for Irish policy development to draw on that include transformational paths and systems change, and related synergies and trade-offs. Building institutional knowledge of systemic transformations and institutional capacity for implementation of systems-change policy is essential if transformations are to be pursued, synergies maximised and trade-offs minimised and managed.

Enhancing long-term policy, strategic foresight, vision-building and reconsidering development. Developing a national long-term climate action strategy is a policy process related to strategic foresight. Adopting an anticipatory governance approach can enable strategic policy development to maximise the synergies in sustainable development paths, minimise trade-offs and make policy more robust to future uncertainty. Applied research on adopting an anticipatory governance approach in Irish climate action policy could support reform of the policy process, to set it on a systems transformation footing. Patterson et al. (2017) ask how policy and decision making can be moved from short-termism to an anticipatory and long-term mode. Supporting research routes include participatory vision building, reconceptualising development to achieve public policy synergies and the social contract.

Policy integration, policy mixes and evaluation criteria. A deepening of policy integration, horizontally across thematic and sectoral silos and vertically across levels, is an essential requirement of transitions and transformations. Integrated policy mixes that support transformational change are considered a crucial topic for enhanced knowledge (Dubash et al., 2022). An enhanced understanding of the contribution of policy mixes, and of the synergies and trade-offs associated with different packages, could assist decision making. Further national ex post and ex ante policy evaluations could contribute to an augmented understanding of policy implementation and outcomes. In line with the recent evolution in practices globally, an important addition to standard policy evaluation criteria used in Ireland would be to consider the transformative potential of measures.

8

Transforming Participation and Catalysing Change

Key messages

System change is necessary so that individuals can lead low-carbon and resilient lives, as opposed to individuals taking responsibility for changing their behaviour. However, individuals participating in collective action play a role in changing systems.

Policies and measures need to be perceived as fair and work to reduce inequalities if the public are to engage with and support the disparate change required to act on climate change and biodiversity loss.

Inclusive public participation in policymaking is a key enabler of climate action and can increase social trust. Empowered communities can drive change at a local level, which can drive and reinforce broader societal shifts.

Change is not happening fast enough. Catalysts can augment the speed, scale and depth of change and overcome inertia within the system. Catalysts include leadership, social movements, litigation and culture.

Children and young people have been instrumental in catalysing change and keeping climate action on the political agenda. Through social movements and litigation, they have reframed climate action, or the lack thereof, as a social justice and intergenerational human rights issue.

8.1. Introduction

There are high levels of knowledge and awareness of, and engagement with, climate change in Ireland, with the vast majority of people supportive of climate action and in agreement that it should be a priority for the Irish government (Leiserowitz et al., 2021; Timmons and Lunn, 2022). The great majority of people in Ireland also recognise the benefits of adapting to climate change, especially as the cost of damages caused by the changing climate are much higher than the cost of investment needed to achieve transformation (European Commission, 2021). Climate change and lack of climate action, mitigation and adaptation is a source of anxiety for many (Hickman et al., 2021; Leiserowitz et al., 2021; Reville, 2021; Timmons and Lunn, 2022).

However, there is a disconnect between the desire for change and change. One reason for this disconnect is that people do not have the 'bandwidth' to act on climate. For many, there are other, more immediate issues, including, but not limited to, housing, cost of living, health, work and family issues. This will impact their capacity to act. Rising inequality, for example, disproportionally impacts the most vulnerable members of Irish society, leaving them even less able to act. For people with limited capacity, action on climate needs to translate into tangible benefits and opportunities in their everyday lives before they can devote resources to it.

Public participation can enhance both ambition for climate mitigation and the transformative potential of adaptation (Cattino and Reckien, 2021). Inclusive and broad-based participatory approaches to policymaking enhance social trust and are a key enabler of climate action (Creutzig et al., 2022). Higher social trust in combination with inclusive participatory processes act to reduce inequalities (Drews and van den Bergh, 2016). Equal treatment enhances social trust and enables inclusive and participatory policy (Rothstein, 2011). Climate action is influenced by social norms, that is what people think about what other people commonly do, think or expect (Creutzig et al., 2022). People do not want to make sacrifices if others are not making sacrifices also (Lunn, 2022). Policies to change collective behaviour are more acceptable if they are fair (Clayton, 2018). In Ireland, studies related to the regressive nature of carbon taxes (Tovar Reaños and Lynch, 2019, 2022), forced car ownership (Carroll et al., 2021) and how electric vehicle grants privilege high-income individuals (Caulfield et al., 2022) show that some policies are not equitable and that poorer and more vulnerable individuals and households are at a disadvantage. If the public are to embrace the disparate change necessary to act on climate change, inequality is one area that will need to be addressed.

Public perception of climate change is now considered an important variable in explaining the evolution of emissions pathways, with the potential to limit warming to the end of this century (Moore et al., 2022). The Irish public (young and old, rural and urban) understands that climate change is caused by humans and that it is a serious problem, and the large majority are worried about it and want more done about it, especially by government (Timmons and Lunn, 2022). Less well understood is how to get people to engage with and embrace the changes necessary to cut emissions and adapt to climate change (Lunn, 2022). Climate action is a collective action problem. This volume highlights the challenge of changing, transforming systems, so that individuals can live low-carbon and resilient lives through their engagement with those systems, as opposed to the individuals themselves changing their behaviours (Lunn, 2022). Individuals working together and taking collective actions, including voting and cumulative reductions in home energy use, is part of how systems evolve.

The news media in Ireland has a role to play in shaping public perception on climate change and enabling change. However, it is not yet best placed to give the public the information it needs because of a lack of resources invested in climate and environmental action and the range of expertise required to cover these areas.

Education has the power to give people the knowledge, skills and values that are required to become agents of action and resolve the global challenges of today (UN Secretary-General, 2012; Arbeiter and Bučar, 2020). A core component of the National Dialogue on Climate Action is communication and education to create awareness and understanding of climate change, so while the government and the public sector provide an example by taking a lead on climate action, the public, all of society, can assist in delivering on Ireland's climate ambition.

While climate ambition, particularly related to climate mitigation, in Ireland has increased from the national mitigation plan through successive climate action plans, policies and measures to reduce emissions and adapt to climate change are not being implemented on the scale, speed or depth necessary. Catalysts will be necessary to provide an impetus for the advancing action serving to overcome inertia, motivating individuals and organisations to act (New et al., 2022). Catalysing conditions help focus attention and augment decision making and allocation of resources, both financial and social (New et al., 2022). Catalysts of change can take several forms and include leadership, social movements and litigation.

8.2. Public participation

Participatory processes allow citizens to take part in decision making and provide an impetus for change (Council of Europe, 2023). Policies and initiatives that act to mitigate and adapt to climate change are, for the most part, designed and managed by people outside the communities where they are implemented (Dey De Pryck and Elias, 2023). Effective public participation gives people with a stake in an issue, but little power to influence it, an active role in the decision-making process (Arnstein, 1969; Nyhan et al., 2022). Citizens, communities and individuals are brought together to deliberate, participate, inform, collaborate, intervene or oppose issues that concern them as part of this process (Fischer, 2000; Mullally et al., 2022). Working in partnership with communities to foster inclusion in participatory processes can lead to fairer and more sustainable outcomes according to the needs, desires and strengths of the community (Dey De Pryck and Elias, 2023). A focus on inclusion ensures that marginal groups, including women and the poorest individuals and households, have their say on what is prioritised at local level, as they are often the groups that bear the brunt of climate impacts and actions to mitigate and adapt to climate change (Nyhan et al., 2022; O'Neill et al., 2022).

Enhanced climate action is one reason to encourage and develop public participation in decision making, but there are other constructive outcomes. Participation in climate action can combat anxiety and hopelessness in adults and young people (Schwartz et al., 2022). With the proper information and support, more people could be empowered to act (Boland, 2022). If transformation is to be achieved, it will require the structures, processes and knowledge that help to promote and enable climate action and the societal transformation that accompanies it (Revez et al., 2019)

8.2.1. Community engagement

More open and transparent dialogue is needed to explore tensions between local and national priorities to develop well-informed policy. This would necessarily be a two-way process as co-benefits are not always guaranteed. There will be instances where higher-level policy decisions can be aligned with local needs, but there will also be trade-offs and difficult issues that need to be resolved. It is only since March 2022 that the formal public consultation process, the primary way in which people can input on key policies like the climate action plan (see Volume 2, section 8.3.3), includes local stakeholder engagement at its core through the National Climate Stakeholder Forum and local authority climate action plans. These events are beginning to deliver a two-way flow of information. A standout example of public participation in the

policymaking process is the Citizens' Assembly (see section 8.2.2 and Volume 2, section 8.3.3). While there is a clear pathway for the Citizens' Assembly to inform policymaking through the Joint Oireachtas Committee on Climate Action, in terms of changing policy there have been only two notable successes: the Climate Act 2021 and an increase in carbon tax. Moreover, it is well established that climate/energy issues are highly complex and context dependent (Devine-Wright, 2022), and thus require more locally rooted deliberations.

McGookin et al. (2022) developed energy scenarios for the Dingle Peninsula and highlight the importance of aligning climate action and community development goals. However, this research found that many of the issues raised in the community meetings were either instances where central national policies (e.g. compact growth) clash with local priorities (e.g. need for housing in remote areas) or interests of the community lacking policy support (e.g. anaerobic digestion). They thus call for "new forms of collaboration throughout the policy process, having an honest conversation about the difficult decisions to be made and aligning national objectives with local needs" (McGookin et al., 2022). Similarly, following a review of the current energy sector governance structure in Ireland, Torney (2018) points to the need for a stronger framework to enhance "the two-way flow of information between local communities, national policymakers and other stakeholders".

In February 2023, the first strand of the Community Climate Action Programme was launched, which is designed to resource local authorities to engage with communities to promote and assist in the scale up of community climate action (DECC, 2023). The National Dialogue on Climate Action plans to model deliberative workshops with populations vulnerable to transition on the creative techniques used in the Imagining2050 project (Mullally et al., 2022). It could also support the creation of fora like the Belfast Climate Commission (Queen's University Belfast, 2021), and these techniques could be employed when drafting local authority climate action plans. Codema, as part of the Zero Together project, plan to run a mini-public on Dublin's energy transition in 2024 (Codema, 2022). Bringing these discussions to the local authority level can facilitate more meaningful discussions on local issues than would be possible in a national forum, and, importantly, making a link between the outcomes/outputs of discussions to actions or objectives within county/city developments or local authority climate action plans may greatly enhance community buy-in for the plans. These will need to be carefully managed deliberations, as there is a clear tension between the need for rapid renewable energy deployment and the time required to facilitate community participation in decision making (Newell et al., 2022). As highlighted by Boyle et al. (2022a), when discussing the role out of large-scale energy infrastructure like overhead pylons, "Transparency is a vital factor for successful engagement with clarity needed around what is open for consultation and what is not". The move from a fossil fuel-based system to renewable energy system is not up for debate. However, exactly what shape the new energy system takes should be agreed with a diverse range of stakeholders from across national, regional and local levels.

Community participation in the form of community energy within Ireland is primarily facilitated through SEAI's Sustainable Energy Community network, which provides grants for preparing an energy masterplan and a baseline energy estimate for an area, and carries out building energy improvements as a group, alongside appointing a local expert to act as a mentor and intermediary. Two key weakness in the programme have been the reliance on volunteer time and the limited focus on building improvements (see Volume 2, section 8.3.4). The new Renewable Electricity Support Scheme (RESS) has some exciting prospects to improve on this. First, SEAI now have a dedicated support process for community energy projects, which offers up to €180,000 in grant aid over the development process from initial feasibility study to project delivery (SEAI, 2023). Second, every new development must now contribute €2 per megawatt hour (MWh) to a community benefit fund. This will see a significant transfer of money to community groups, which can fund climate and sustainability projects. For the RESS-1 auction in 2020, the 476MW onshore wind and 796MW solar PV projects will see €4.5 million contributed each year over a period of approximately 15 years (DECC, 2021). Moving towards achieving significantly increased targets of 5 gigawatts (GW) set out for 2030, there will be substantial funding coming through the benefit fund. With some coordination effort from the local authorities, it would give communities the opportunity to action the projects developed through the climate action plan forums. Related research on enhancing onshore wind capacity shows that early and enhanced participation of individuals, including the opportunity to invest in projects, and better understanding of financial benefits, can lead to greater acceptance (Le Maitre et al., 2023; Sirr et al., 2023). Work by NESC (2014) highlighted that a different approach to community engagement around community energy, particularly wind energy, would be necessary. Elements of this work can be seen in how the state, researchers and public bodies, such as SEAI, engage with communities on energy today.

There are 300 Connected Hubs across the country, offering remote workspaces (see section 3.3.2.3). Building on the example of the Dingle Creativity & Innovation Hub, which is the key local actor in the Dingle Peninsula 2030 project (see Box 8.1), if the remit of all hubs was to be expanded to include supporting the creation of new climate and sustainability developments, then it could have a huge impact nationwide (Watson et al., 2021d). A key benefit of channelling the work through the hubs is that they already have an existing legal structure, which is needed for securing funding. Many community groups do not

get beyond early development stages due to the difficulty in setting up a more formal non-profit or cooperative entity.

It should be noted that the SEAI's Sustainable Energy Community Programme has developed a network of 800 Sustainable Energy Communities across Ireland. This programme engages with communities across Ireland, raising awareness of actions that people can take, from understanding their energy bills and how renewable technologies work to how to retrofit their home and tracking their carbon and energy impacts, to take the right individual action and share learnings on collective action. Engagement[47] activities and supports are provided to augment existing community efforts and have inspired a wider network of communities to take action. The Energy Master Plan[48] addresses building improvements and provides a process and register of opportunities that assesses which projects will return the greatest impact and carbon reduction for the community. It also demonstrates what is possible for communities, depending on the actions that volunteers can take on. The SEAI also funds energy research, development and demonstration projects to better understand how community engagement can enhance wind energy roll-out, enable social acceptance and achieve social licence. Research suggests that familiarity, awareness and lived experience of wind farms are all important contributors to local acceptance (Le Maitre et al., 2023).

Box 8.1 Dingle Peninsula 2030/Corca Dhuibhne 2030

Expert contribution from Connor McGookin.

Established in 2018, Dingle Peninsula 2030 (or Corca Dhuibhne 2030) is an innovative multi-partner initiative (Watson et al., 2020). The initial phase (2018–2021) involved Ireland's electricity distribution system operator (ESB Networks), researchers from MaREI, the Science Foundation Ireland Research Centre for Climate, Energy and Marine, and local non-profit organisations supporting enterprise (Mol Teic/Dingle Creativity & Innovation Hub) and community development (North East West Kerry Development Programme). The core goal of the project was to work with the local community, schools, businesses and farmers to explore, support and enable the broader societal changes emanating from the energy transition.

Over the 3 years a wide range of energy and community engagement initiatives were coordinated by this partnership (Watson et al., 2021c), these include:

- developing the Dingle Peninsula Energy Master Plan (McGookin et al., 2020b);
- trials with five ambassadors and other local participants of home energy monitors, solar PV, heat pumps and electric vehicles (Boyle et al., 2021b, 2021c);
- developing a 'climate hack' programme in local secondary schools (McGookin et al., 2020a);
- initiating a pilot Farm Ambassador Programme, to increase agricultural sustainability and productivity;
- completing a feasibility study for an anaerobic digester (XD Consulting, 2020; Watson et al., 2021a);
- training 10 local energy mentors to support people with home energy improvements (Watson et al., 2021b);
- delivering community meetings on the Peninsula, to develop a plan for a sustainable future (McGookin et al., 2021, 2022; Ó Caoimh and McGookin, 2021).

Critically, it has spawned other local efforts. Although the initial focus of the partnership was on energy

[47] https://www.seai.ie/community-energy/sustainable-energy-communities/

[48] https://www.seai.ie/community-energy/sustainable-energy-communities/join-the-sustainable-ener/

projects, a wide range of new initiatives emerged as community members became engaged in the process. There are now ongoing initiatives across energy, transport, agriculture, education, tourism and employment, in what Boyle et al. (2021a, 2022b) coin the 'diffusion of sustainability', the most notable of which is the dairy farming sustainable energy community, with roughly 120 farmers, brought together by ESB Networks and farming ambassador, Dinny Galvin. This demonstrates the value of supporting local champions (Box 8.1, Figure 1).

Box 8.1 Figure 1 Dingle and surrounds. Photo credit: Mossie Donegan, 2021.

8.2.2. Citizens' assemblies

The use of citizens' assemblies and similar deliberative processes has become an increasingly prominent element of climate governance in recent years. Research published by the OECD in 2020 pointed to a 'deliberative wave' that has been building since the 1980s, and has gathered pace since 2010 (OECD, 2020). Proponents of deliberative democracy have drawn attention to its particular suitability for shaping responses to climate change (e.g. Stevenson and Dryzek, 2014; Blue, 2015). Niemeyer (2013) points to the potential for deliberative forums to produce stronger environmental policy outputs, with participants facilitated in considering the interests of non-human agents and taking a long-term view. Willis et al. (2022) highlight the role that deliberative democratic approaches can play in addressing some of the difficulties that democracies face in tackling climate change, including short-termism, the incorporation of scientific and expert evidence in policymaking and the influence of powerful political interests in political decision making.

Over the past decade, Ireland has played a pioneering role in the use of citizens' assemblies for a variety of issues, including prominently on the topics of marriage equality and the repeal of the Eighth Amendment. In the autumn of 2017, a citizens' assembly deliberated on the question of 'How the state can make Ireland a leader in tackling climate change'. Comprising 99 citizens selected through stratified random sampling and chaired by retired Supreme Court Justice Mary Laffoy, it deliberated over two weekends and formulated a set of recommendations that were considerably more far-reaching than many anticipated (Devaney et al., 2020a, 2020b). These recommendations were in turn considered by a specially created Joint Oireachtas Committee on Climate Action, which laid the basis for cross-party consensus on increasing the carbon tax and

amending the Climate Change and Low Carbon Development Act 2015 (Torney et al., 2020). Harris (2021) notes, however, that the citizens' assembly failed to adequately include the voices of young people and future generations in deliberations. In 2022, a separate Citizens' Assembly on Biodiversity Loss was established by the Oireachtas. It published its final report in March 2023. In parallel, a separate Children and Young People's Assembly on Biodiversity Loss met over two weekends in autumn 2022 and produced a separate and complementary set of recommendations.

In recent years, a wider set of mainly European countries have implemented citizens' assemblies on climate change at a national or subnational level (Smith, 2023). As practice has grown, research and evidence on these deliberative processes has grown in parallel. A central finding of this literature is that evolving practice has differed across countries and there has not been a coalescing around a particular model. Smith (2023) points to variation in terms of the commissioning body, the task and mandate, the level of resources and time allocated, and the commitment to respond by policymakers. Cherry et al. (2021) note that the ways in which climate assemblies are designed and run shapes, in important ways, the outcomes and recommendations, which are a product of both the input citizens receive and the perspectives of the citizens themselves. In particular, a distinction is made in the literature between climate assemblies that are shaped in a top-down manner by their initiators, and those where more scope is given to the citizen themselves to define the agenda and proceedings. The former design can lead to better integration into the broader policy system, but comes at the cost of empowerment of the participations (Cherry et al., 2021; Elstub et al., 2021; Torney, 2021).

Recent literature has begun to focus more centrally on legacy, impact and institutionalisation of climate assembly. Comparing six national-level climate assemblies, Boswell et al. (2023) find significant variance in terms of how these processes are integrated into wider systems of democratic decision making. Giraudet et al. (2022), focusing on the French national Citizens' Convention for Climate, call for a strengthening of the ways in which government commit to follow-up on recommendations from climate assemblies. Smith (2023) calls for institutionalisation and embedding of climate assemblies in wider governance processes. Ultimately, however, as Willis et al. (2022) argue, citizens' assemblies "cannot be expected to compensate for the wider deficiencies of political systems". They point to the need to "foster a more 'deliberative system,' which creates the political conditions for deliberation, not just within the confines of deliberative mini publics (DMPs) but across the political system as a whole".

8.2.3. National Dialogue on Climate Action

Participation in climate dialogues supports climate mitigation and adaptation action (Bruckmeier and Tovey, 2009; Rotter et al., 2013; Prutsch et al., 2018). These dialogues raise awareness and identify unanticipated trade-offs in policymaking, improving the quality of policies by incorporating knowledge from stakeholders (Rotter et al., 2013; Prutsch et al., 2018).

The National Dialogue on Climate Action is a forum for engagement and collaboration between citizens, stakeholders and the government, with a focus on participatory forums to allow the public to participate in developing climate policy and empowering action at local and national levels (Nyhan et al., 2022). It is composed of four parts: (1) raising awareness for climate change, (2) engaging with citizens, especially those who belong to groups that do not normally have a say in climate policy, to have their views reflected in policy development related to climate action, (3) improving climate literacy to support better decision making and (4) a programme of social and behavioural research supported by qualitative and quantitative behavioural research studies and an advisory group of leading academics (DECC, 2022). This programme includes Climate Conversations, national engagement events, sector-specific engagement events, a National Youth Assembly on Climate, a National Climate Stakeholder Forum, National Climate Conversations on Local Actions, and the EPA Climate Conference, Climate Lecture Series and Support Workshops (DECC, 2022).

To strengthen trust in climate communications from government and enhance climate action, the National Dialogue on Climate Action will work with the Climate Communications Coordination Committee to enhance the evidence base that informs strategic communication across all departments to improve climate literacy and give the public accurate information (DECC, 2022).

Nyhan et al. (2022) examine international best practice for facilitating participation in climate action and assess the National Dialogue on Climate Action, providing guidelines that support the ongoing development of long-lasting participation in climate action dialogues in Ireland. This work also identifies the major challenges associated with both the theory and the practice of climate dialogues, including (1) the need for more nuanced methodologies and refined indicators for understanding the interactions between beliefs, values, perception, knowledge and behaviour in the face of climate changes, (2) the need for international evidence, including research from the Global South and (3) the need for not only to support climate justice through inclusive and fair climate action but to also give those individuals and communities that are vulnerable, marginalised and under-represented a voice in developing climate policy (Nyhan et al., 2022).

So far, participation in and outcomes from National Dialogue on Climate Action and citizens' assemblies have helped to build social trust and new coalitions while legitimising action on climate and biodiversity (Devaney et al., 2020b). They have also created a positive feedback in the formulation of climate policy (Creutzig et al., 2022; IPCC, 2022). In Ireland and internationally, the implementation of inclusive and effective participatory processes to support climate action remains a major challenge (Nyhan et al., 2022).

8.3. News media

The media has a key role to play in Ireland's transformation to a low-carbon society and economy. The news media are the most widely used sources of information relating to climate change for Irish people. The Irish media are more trusted that other sources, and environmental coverage is popular with Irish audiences (Murrell et al., 2022). So, "whether the news media want this or not, they tend to be their country's primary destination for people who would like to learn more about the climate crisis" (Blau, 2022). Furthermore, the Commission for the Future of Media recognised the media's role in communicating about climate change, biodiversity and sustainability, and noted that the media "had the potential to accomplish far more" (Future of Media Commission, 2022). The report of the Joint Oireachtas Committee on Climate Action also recognised the role of the media in 'climate leadership' and suggested the introduction of quotas to ensure consistent levels of coverage in public service media (Houses of the Oireachtas, 2019).

However, at a time when there is a demand among Irish audiences for climate coverage, and when climate policy is nearing the top of the political agenda, the media industry is not well placed to perform its normative roles (The Irish Times, 2021; Future of Media Commission, 2022), and environmental journalists struggle to cover such a complex and wide-ranging area with diminishing resources (Gibbons, 2020; Robbins and Wheatley, 2021; Robbins, 2022). When it comes to research into Irish media coverage of climate change, the field is 'in its infancy' (Fox and Rau, 2016). While the EPA has funded several media-focused research projects (for instance Morgan, 2017; Culloty et al., 2019; McNally, 2020), much of the existing research has been carried out by individual academics. Such research, as exists, has found that levels of coverage in Ireland follow the same patterns as elsewhere, rising steeply during COP conferences and around the release of IPCC reports, but fading away sharply in between these events (Robbins, 2019b). The Irish Times publishes the largest number of climate

stories (Schmidt et al., 2013), but the Irish Independent and Irish Examiner are closing the gap (Robbins, 2019b). RTÉ's coverage has been found to be 'low and sporadic' (Cullinane and Watson, 2014), but has improved more recently (Robbins, 2019c).

Irish coverage tends to present climate change in terms of party political in-fighting, and emphasise the cost of climate action. Most coverage does not challenge existing political or economic systems and has been characterised as constituting a "weak form of eco-modernism" (Fahy, 2020, p. 132). Outright climate denial is not present to a great extent in Irish coverage (Robbins, 2017), although more insidious 'discourses of delay' (Lamb et al., 2020) have been identified more recently (Pringle and Robbins, 2022).

Irish media coverage of the broad topic of climate change from 1997 to 2012 reproduced a narrow ideological worldview (Wagner and Payne, 2015), while Irish media characterisations of low-carbon transition from 2000 to 2013 showed a need for greater carbon literacy among journalists and policymakers (McNally, 2015). Irish coverage of flooding in 2009 and 2014 did not reflect changing policies (Devitt and Neill, 2017), and coverage of the 2018 drought under and misrepresented the role of climate change (Augustenborg et al., 2022). Journalists and ministers frame climate change in reflexive rather that strategic ways (Robbins, 2019a), and reporters face a range of challenges reporting in this complex and fast-moving area (Gibbons, 2020; Robbins and Wheatley, 2021).

When it comes to Irish audiences, again there are large research gaps. The Broadcasting Authority of Ireland-funded Reuters Digital News Report for Ireland (Murrell et al., 2022) tracks audience demand for climate coverage and attitudes to media approaches. Recent findings suggest that audiences prefer media outlets to take a stand in favour of climate action, suggesting a more activist, or at least critical advocacy, stance from environmental journalists and documentary makers. Other audience research (McNally, 2020) found that focus group members had negative perceptions of climate action and low awareness of major players in societal debates around climate change.

Regarding the environmental sustainability of the media sector, the Broadcasting Authority of Ireland (now Coimisiún na Meán) has been at the forefront, establishing a Broadcasting Sustainability Network and publishing a sectoral sustainability roadmap. The independent TV and film sector has also worked on measuring and reducing its environmental impact through Screen Greening, a unique initiative involving broadcasters, funders, regulators and filmmakers. The Commission for the Future of Media recommended that the Broadcasting Authority of Ireland's network be expanded to include the entire media sector.

The Irish media sector is struggling to cover climate change to the extent that would fulfil its traditional roles of informing the public, acting as a watchdog and holding authorities to account, and more recent roles, such as curation, convening publics and interpretation. The author's training engagements with the sector indicate that environmental literacy levels are low, despite recent initiatives by the Broadcasting Authority of Ireland, the Irish Examiner, Bauer Media and RTÉ. The sector is willing to play its part in transformative change (Williams, 2021), but may have to be supported to do so effectively[49].

8.4. Education

Education can be transformative and an enabler of change (Arbeiter and Bučar, 2020). Transformative education is not a new idea (Mezirow, 1978) and involves a deep structural shift in how individuals perceive and interpret themselves and the world around them (O'Sullivan et al., 2002). In the face of climate change and other persistent issues, including inequality, poverty and racism, transformative education aims to move past knowledge attainment to develop the values, attitudes and skills that are necessary to achieve sustainable development (Yonemura, 2015). Transformative education also helps individuals to develop an understanding and anticipation of change, develop critical and systems thinking, manage uncertainty, and develop values, empathy and an appreciation of empathy that helps them to find solutions to climate change and other challenges (Arbeiter and Bučar, 2020).

A key element of transformative education is education for sustainable development[50]. Education for sustainable development is a holistic, participatory and action-orientated approach to education that puts the learner at the centre (Waldron et al., 2020). This approach has the potential to be transformational, as it includes collective action and systemic

[49] Resources and recommended readings: Brereton (2022), Media and Climate Change Observatory, University of Colorado (MeCCO, n.d.) and Robbins et al. (2020).

[50] Education for sustainable development is one key element of transformational education. Other elements include (1) education for human rights, (2) education for gender equality, (3) education of peace and non-violence, (4) global citizenship education and (5) education for appreciation of cultural diversity and culture's own contribution to sustainable development after Arbeiter & Bučar (2020).

change. In Ireland, the focus thus far has been on individual- and school-level behaviour, with the more transformative elements, such as addressing economic growth and consumerism, as underlying causes of climate change and environmental degradation, and the importance of taking collective political action, receiving far less attention (Waldron et al., 2020). Teachers and other educators are under-resourced and may be reluctant to engage in climate change issues (Waldron et al., 2019, 2020)

Universities have a role to play in climate action through education and research and in helping society navigate climate change (McCowan et al., 2021), catalyse social change and demonstrate climate justice (Kinol et al., 2023). While many universities are prioritising sustainability in response to the Paris Agreement and the UN SDGs (Soini et al., 2018; Sinden, 2021), and are making significant efforts to change their operations, campuses and engage with local communities, it is only a partial transformation (McCowan et al., 2021). While there is recognition that a systemic approach is necessary to make the shift to sustainability (ALLEA, 2020), there is no standard approach for integrating sustainability, and initiatives outweigh strategies and policies (Shawe et al., 2019). Research on sustainability in Irish universities includes work on climate action planning within University College Cork (Quinlivan and Dunphy, 2023), universities as 'living labs' or testing grounds for national sustainable transformations (Horan et al., 2019) and mapping of sustainability policies and initiatives (Shawe et al., 2019).

The Department of the Environment, Climate and Communication has adopted a three-pronged approach to climate literacy through education: (1) a formal approach through education for sustainable development, (2) an informal approach through programmes such as Green Schools and GAA Green Clubs and (3) a non-formal approach that brings sustainable practices into workplaces, for example, with a diffuse impact on employee climate literacy. The SEAI also engage with schools in Ireland, supporting teachers and pupils on how to save energy at home and at school. There is no research available to assess whether or not these approaches have the potential to deliver transformative change in these areas, but it important to learn by doing and then adapting the process to enhance outcomes.

Box 8.2 Culture and climate change

Expert contribution from Nessa Cronin.

What does transformational eco-social change look like? As writer Eva O'Connor (2023) has recently argued, "We all know the science is out there, but the thing about art is that it can inspire people to take positive action and give them hope". Culture in its broadest sense can help us connect with and critically imagine different ecological futures by enabling us to navigate and narrate solutions for the kind of nation we wish to build in the next 100 years and beyond. In brief, culture can help bridge the policy gap between climate ambition and climate action.

In 1954, The Hague Convention adopted the Convention for the Protection of Cultural Property in the Event of Armed Conflict under the auspices of the United Nations Educational, Scientific and Cultural Organization (UNESCO; UNESCO, 1954). Since that time, the position of national cultural heritages has been primarily focused on cultural protection and conservation, with the creation of risk registers in relation to the future preservation of heritages under threat. In relation to climate change, culture is often referenced in terms of the risk of the negative impact of climate change on national cultural heritage (from loses to our museums, archives and galleries to our natural and built environments). In recent years, more attention has been given to the role of culture, not just as a repository of heritage or expression of social values but indeed as an active agent of social change, with increasing attention been given to what role art and culture can play in relation to the ecological challenges of this century (Cronin, 2020, 2022).

Building on UNESCO's Universal Declaration on Cultural Diversity in 2001, 'culture' was recognised as the fourth pillar of sustainable development by the World Congress of United Cities and Local Governments (UCLG) in Mexico City in 2010. The UCLG shared the vision that culture should be added alongside the economic, social

and environmental sustainability pillars. Since then, the cultural pillar has fallen off the environmental agenda and has remained largely invisible in policy documents on sustainability, which have tended to focus more on scientific and technological solutions to the crisis.

If cultural vitality in its broadest sense is recognised and acknowledged as the fourth pillar of sustainability, then any policy initiatives in relation to environmental change that fails to take into account the importance of the cultural realm will only have very limited success in the future (Fitzgerald, 2018; Till, 2020). As Neumayer and Joly (2021) have argued, a focus on scientific solutions and the "relative neglect of the social sciences, humanities and arts is at the very core of why the transition to sustainability has been slow and shaky and, most importantly, may eventually fail".

In 2017, the Creative Ireland Programme was established to promote culture, creativity and wellbeing across all sections of Irish society. The initiative incorporated creative climate action as a key theme and has continued to support creative programmes that are seen as catalysts for more vibrant, healthy, inclusive and sustainable communities. However, this needs to go further, with cultural considerations integrated within all climate policies and infrastructural funding and supports to close the policy gap as identified by Neumayer and Joly (2021).

Following on from UNESCO's and UCLG's recommendations, culture should be recognised as core societal infrastructure, critical to closing the climate ambition/action gap. It is key to ensuring more inclusive community engagement, which will assist with social cohesion when climate politics come under increasing pressure in future decades. As core societal infrastructure, culture needs to be integrated across all policy considerations, government departments and initiatives in relation to climate action and sustainable development. As an expression of identity, culture is a key agent of transformational eco-social change (Box 8.2, Figure 1).

Box 8.2 Figure 1 Drowned Galway's Storm Surge Long Walk, Hope it Rains/Soineann nó Doineann, as part of Galway's 2020 European Capital of Culture. Source: Photomontage by Joe Lee; design by Ríonach Ní Néill, 2020.

8.5. Catalysts of change

While enabling conditions make action on climate change and biodiversity loss more feasible and effective, catalysing conditions can precipitate action (Ara Begum et al., 2022). Catalysing conditions emerge when 'game-changing circumstances become present' and accelerate climate action (New et al., 2022). This is an emerging but important area of research with the capability to accelerate and augment climate action, with clear and world-leading examples taking place in Ireland.

8.5.1. Individual and collective action

The urgency and enormity of action required if climate change and biodiversity loss are to be tackled is beyond the response of any one individual. This is especially true as an individuals' opportunities to participate and engage in climate action is structured by systemic factors (Chapstick and Whitmarsh, 2022). However, system change is ultimately brought around through the collective action of individuals, so to pit individual change against systemic change is a false dichotomy that forces focus to either extreme (Chapstick and Whitmarsh, 2022). This is not to suggest that the responsibility or obligation for action rests solely with citizens (Akenji, 2014), governments can show leadership by setting the conditions of the system that would allow citizens to lead low-carbon and adaptive lifestyles (Akenji et al., 2021). Individuals interacting with the people around them during the course of their everyday lives are an important component of rapid social transformation (Rapid Transition Alliance, 2021; Chapstick and Whitmarsh, 2022).

Individual action is one of the best ways for society to change policy, as it helps develop cooperation and collective action, which are key to bringing about the broader sociocultural and political changes that make social transformation possible (Hackel and Sparkman, 2018; Chapstick and Whitmarsh, 2022). People are social creatures who follow the cues of the people around them, family, friends, neighbours, colleagues and the wider community (Latane and Darley, 1968). For example, people are more likely to install solar panels on their home if their neighbours have done so (Bollinger and Gillingham, 2012). To achieve sustainable development, people will need to change the food they eat, the way they travel and how they use energy at home and at work, all in a short period of time. If changes in behaviour are substantial, sustained and wide-ranging in ways that help tackle climate change, then new social norms begin to emerge (Hackel and Sparkman, 2018). If an individual acts to reduce the harm that is caused by greenhouse gas emissions, by not flying, eating meat or driving, for example, that harm, and the grave threat of climate, begins feel real to others (Hackel and Sparkman, 2018). Individual action, particularly bigger and more inconvenient changes, can convince others, but those changes can spill over in the lives of the individual, as other areas, such as voting, fall in line with their convictions (Hackel and Sparkman, 2018). Such changes in behaviour also provide a signal to the market that incentivises businesses to provide alternatives and reduce cost. One example is the expanding market in non-meat products or meat alternatives (Creutzig et al., 2022).

Individuals acting sustainably are leading by example and this behaviour is perceived as normal faster than it would be without individuals leading the way. This shows others that (1) action is possible, (2) people they know are doing it, making it less unusual and (3) there is a possibility that the world is headed in a new direction (Hackel and Sparkman, 2018). Not everyone who is affected by climate change can act or is represented in decision making. Active concerned citizens help to shape and promote solutions and they also show policymakers that policy can be implemented, and this helps to speed up public buy-in (Willis, 2018). When there is a sense that the change is gaining momentum, changes can occur faster.

Leading by example is a collective act, as it influences attituded and behaviour (Westlake, 2022). Individuals leading by example can change group behaviours (Liu and Hao, 2020). Role models, particularly those in leadership roles, can become more credible and effective advocates by practising sustainable behaviours in their own lives and within the organisations where they work (Kraft-Todd et al., 2018). There is also evidence that suggests that leaders who lead by example are thought to be more "trustworthy, ethical, likeable; and as caring more about climate change, believing it's more serious, and being more knowledgeable about it" (Westlake, 2022). Wealthy investors can prioritise strategic action to divest in fossil fuels and invest in carbon-neutral technologies (Creutzig et al., 2022). Policymakers can catalyse change though agenda setting and coalition building that drive decision making forward to progress action on climate change and biodiversity loss (Petridou and Mintrom, 2021; New et al., 2022). Professionals (e.g. engineers, urban planners, teachers and researchers) can work to change professional standards (Creutzig et al., 2022). Consumers, especially those in the top 10% in terms of income, can reduce consumption, reducing their emissions and inspiring others to do the same (Creutzig et al., 2022; see Box 1.1).

People equipped with the right information can organise and apply political pressure (Creutzig et al., 2022) and signal to politicians that there is both a need and a readiness to change, and that there is wider support for action on climate or biodiversity. Ireland's citizens' assemblies have demonstrated to politicians that there is broad-based support for action

on climate and biodiversity loss, even if it costs individuals more (see section 8.2.2; Devaney et al., 2020b). So far, policy development does not appear to be as progressive as the recommendations from the citizens' assembly.

Individual behaviour change at scale, brought about through systemic change and enabling people to make to make low- and zero-emissions decisions as part of their everyday lives (see Chapter 5), can deliver climate change mitigation, stabilising global temperature at lower levels and reducing the reliance on carbon dioxide removal, while increasing wellbeing (Niamir et al., 2018; Creutzig et al., 2022; Gaur et al., 2022; Jackson et al., 2022).

8.5.2. Social movements

Faced with the entrenched status quo of political and economic systems, and the vested interests of fossil fuel and animal agriculture, there has been a proliferation of civil society climate-related social movements around the world (Claeys and Delgado Pugley, 2017; Denton et al., 2022; New et al., 2022). These movements act as catalysing agents, accelerating climate action, and underpin system change (Creutzig et al., 2022; IPCC, 2022; New et al., 2022). They achieve political change through policy advocacy, policy research and by creating space within politics to develop new strategies and for climate champions to emerge (Caniglia et al., 2015; Babiker et al., 2022).

Social movements frame climate issues in a way that brings the public on board, mobilising resources, human and financial, that sustain collective action and increasing internal and external pressures that enable political change (Creutzig et al., 2022). For example, Fridays for the Future, School Strike 4 Climate and Schools Climate Action Network, through direct action and a focus on climate justice, moved climate action from a technical policy discussion to one that engaged the Irish public emotionally (Gold, 2020). Post-Paris, there has been a coming together[51] of national (urban-based) environmental groups, like Friends of the Earth, with local (rural-based) environmental groups, like Love Leitrim, universities and church groups, who, alongside members of the opposition, supported new Teachtaí Dála (a member of the lower house of the Oireachtas or Irish Parliament) to bring forth two successful private members bills, resulting in the Petroleum and Other Minerals Development (Prohibition of Onshore Hydraulic Fracturing) Act 2017 (Irish Statute Book, 2017) and the Fossil Fuel Divestment Act 2018 (Irish Statute Book, 2018), both successful challenges to the fossil fuel industry In Ireland (Gold, 2020). From 2018, Extinction Rebellion and Fridays for the Future brought focus to the dual crisis of climate change and biodiversity loss. Through peaceful, direct action and civil disobedience, Extinction Rebellion staged disruptive events in Dublin and Cork. School children staged weekly school strikes outside Leinster House since December 2018 and participated in global strikes, with some drawing up to 4 million protestors. The weekly strikes act to underline the urgency of climate change and biodiversity loss, while disruptive action highlights the need for transformational change. Social movements, such as One Future (2020) coordinated by Friends of the Earth and Stop Climate Chaos, have enabled groups of adults and children to participate and demand faster and fairer climate action.

Shuman et al. (2021) note that peaceful gatherings and petitions, that conform to social norms, can win over those who are sympathetic; however, it is disruptive protests, including civil disobedience, strikes and boycotts, that have been shown to be effective if changes in policy are required. Protests that result in disruption put direct pressure on policymakers, who may be opposed or ambivalent to the changes being suggested, to deliver the type of change that will halt the disruption. Demonstrating clear goals and positive and constructive intentions, while escalating the pressure put on policymakers, is also necessary if protestors are to be successful. Research suggests that disruptive protests by Just Stop Oil in the UK have not had a negative impact on climate policy and have increased interest among the public in participating in similar action (Özden and Glover, 2022).

The involvement of children and young people, a group not associated with exercising their political rights, in climate-related social movements (Daly, 2022) is significant, and it reflects their frustration, conviction and how they think differently. They see action on climate change and biodiversity loss as a climate justice and intergenerational issue. They understand the unfairness of the pain and suffering inflicted on the most vulnerable peoples around the world and the disastrous legacy that they and future generations will inherit. Beginning with school strikes, children and young people then moved their protest to the courtroom (Daly, 2022). They shifted the focus of national and international human rights law from human-centric and procedural to one that brings the relationship between people and the environment to the fore (Daly, 2022). While it is difficult to understand the effects of this change so far, it has the potential to be transformative (Daly, 2022).

[51] A step change in the approach to environmental movements in Ireland. For a fuller account of civil society environmental- and climate-related social movements in Ireland, see Leonard (2008) and Gold (2020).

As a core part of the National Dialogue on Climate Action, the Department of the Environment, Climate and Communications engages with the community and voluntary sector, for example Green Schools[52] and GAA Green Clubs[53]. It also supports the work of environmental and youth social movements, including the Irish Environmental Network, a network of environmental NGOs, and Ireland's Environmental Education and Youth Organisation (ECO-UNESCO), which work to conserve the environment and empower young people. While the engagement and support of the department is essential, it could be leveraged further through cross-sectoral collaboration in conjunction with leaders in the policy realm.

These movements are important, as they increase public awareness of and engagement, at home and abroad, with climate and biodiversity issues (Thackeray et al., 2020). How social movements catalyse action on climate is not yet sufficiently understood. Further research is necessary and it is important to investigate how change resulting from social movements can become lasting, equitable and accountable (Editorial, 2022).

Box 8.3 Social tipping points as a catalyst of change?

A tipping point is when a small change causes a large, abrupt and potentially irreversible change with cascading effects (Lee et al., 2021). While much is understood about tipping points in the natural sciences, for example the possible collapse of the Greenland or West Antarctic ice sheets, and possible shut down of the Atlantic Meridional Overturning Circulation (see Volume 1, section 8.3.1; Lee et al., 2021), within the social sciences it is yet to be determined if social tipping points are a distinct type of social change (Otto et al., 2020; Milkoreit, 2022) and how they relate to regime shifts and critical transitions (Folke et al., 2004; Scheffer, 2009) or transformations (Gunderson and Holling, 2002; Olsson et al., 2014). There are examples from the social sciences of the success of mass non-violent movements that overthrow governments when they mobilised 3.5% of the population (Chenoweth and Stephan, 2011). Another study looks at the relationships between people and how a committed minority of 25% can change the behaviour of the population at large (Centola et al., 2018). The empirical evidence to support social tipping points, in relation to climate action, which unlike the examples above is not a single-issue problem, but the lens through which all other issues need to be viewed, is lacking and it is unclear at what level a critical mass will be achieved.

The idea of social tipping points, that the actions of small group of people, could result in much wider participation appeals to both policymakers and general audiences. One reason for this is because it is widely recognised that societal transformation is necessary to address climate change and biodiversity loss (Winkelmann et al., 2022). What is not clear is how this transformation can be achieved fast enough to remain on a pathway consistent with 1.5°C. While there is not enough evidence to gauge how close a social tipping point, or perhaps more correctly how close transformation is (Milkoreit et al., 2018), the idea inspires people to keep the pressure up, which persuades policymakers to investigate all opportunities and take advantage of all the choices available. It cannot be known which choice will make a difference or which small change will lead to the cascade that results in a dramatic change in our social systems. There is a strong possibility that tipping points and the form that they take may be identified in hindsight only. Moving forward towards transformational change requires that the pressure to act and to take advantage of opportunities that promote and accelerate a pathway to sustainability, wellbeing and equity remains high.

[52] https://greenschoolsireland.org

[53] https://greenclubs.gaa.ie

8.5.3. Litigation

Climate change litigation is being used by individuals and organisations to drive the speed and scale of climate action in influencing policy and changing how companies behave (Setzer and Byrnes, 2019; Bouwer and Setzer, 2020; O'Neill and Alblas, 2020; New et al., 2022). The majority of cases have been brought against governments, but companies with high emissions are also being pursued to reduce their emissions and pay for adaptation measures, and account for loss and damage (Setzer and Byrnes, 2019; Setzer and Vanhala, 2019). Litigation is driving companies and investors to take serious consideration of the management and disclosure of risks associated with climate impacts (New et al., 2022). Improvements in attribution of climate change events is broadening liability (IPCC, 2019a, 2019b; New et al., 2022). Claims based on human rights are a feature of climate change litigation and, while they have not always been successful[54], courts are becoming more receptive to this framing (Peel and Osofsky, 2018).

While it is difficult to quantify or understand the impacts in terms of emissions reductions, climate change litigation has the power to be transformative (Setzer and Byrnes, 2019). In domestic courts across the globe, there is a general increase in cases and a strong interventionist trend is emerging (Estin, 2016, White and O'Callaghan-White, 2021; Wonneberger and Vliegenthart, 2021). The majority of cases have been in the USA (Setzer et al., 2022; see Figure 8.1). A similar trend is emerging in Europe, with cases having been filed in more than half of European countries between 1993 and 2022 (Setzer et al., 2022; see Figure 8.1). While policy choices are for governments, courts are intervening to ensure that, where the law mandates action, policy and plans comply (O'Neill and Alblas, 2020; White and O'Callaghan-White, 2021). The Urgenda Climate Case against the Dutch Government, in 2015, was the first case in the world in which citizens established that their government was legally required to reduce emissions to prevent dangerous climate change (Urgenda, 2019). This case was transformative in two ways: first it lead to a significant increase in in the level of emissions reductions required at national level (White and O'Callaghan-White, 2021), and second it catalysed climate change litigation around the world, through making new arguments and tools available for litigants to challenge governments over insufficient climate policies (Maxwell et al., 2022).

[54] During the Climate Ireland Case, human rights was recognised in the Irish High Court but not in the subsequent ruling of the Irish Supreme Court (Kelleher, 2020; White and O'Callaghan-White, 2021).

In Ireland, the Supreme Court ruled that there was insufficient information, particularly in relation to agriculture, in the National Mitigation Plan 2017 (DCCAE, 2017) to show how targets would be achieved, and that there was a lack of transparency with regard to the level of information provided to the public (White and O'Callaghan-White, 2021). The ruling from Climate Case Ireland (Clarke, 2020) was a 'decisive moment' (Kelleher, 2020) and acted as a catalyst for greater government action on climate change (White and O'Callaghan-White, 2021). Ongoing and increasing scrutiny of government, through court action, makes climate action an issue that policymakers in Ireland consider beyond the electoral cycle (White and O'Callaghan-White, 2021). Successful and unsuccessful cases also highlight the level of public concern, increase public discourse and transparency, and signal to policymakers the growing consensus and support for climate among the public, keeping climate on the agenda (White and O'Callaghan-White, 2021).

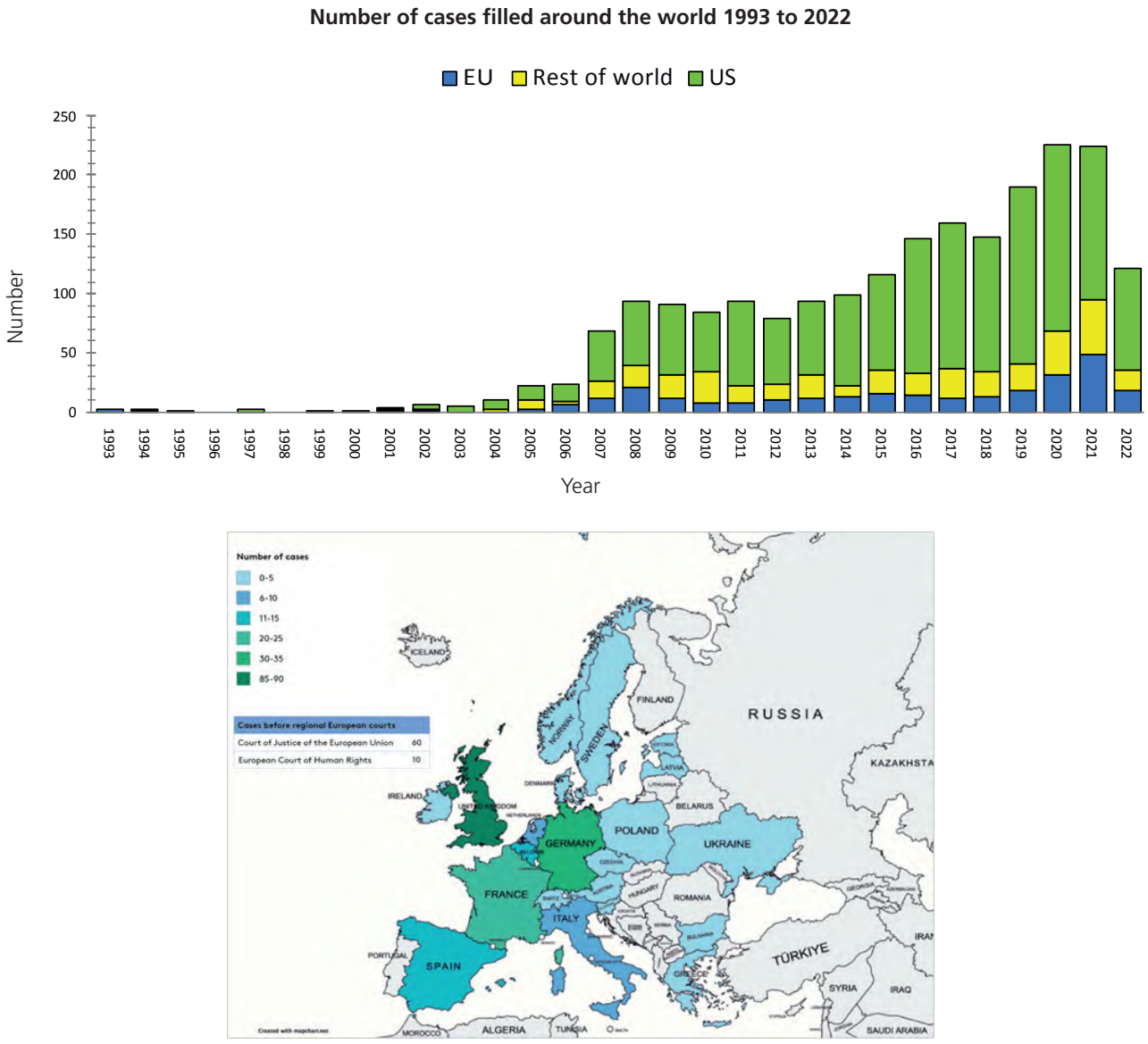


Figure 8.1 Top: the number of cases filed around the world between 1993 and 2022. Bottom: a map of cases filed in a European jurisdiction between 1993 and 2022. Source: Adapted from Setzer et al. (2022).

8.6. Research gaps

Equity. While research suggests that some climate change policies and measures in Ireland are inequitable, research is required to ensure that both existing and future policies and measures are equitable on multiple levels, including national, regional, place based and sector specific, to ensure wider engagement in these actions.

Role of media in enabling climate action. While it has been acknowledged that the news media in Ireland have the potential to play a role in enabling transformative change, more research is required to understand the actions necessary if this goal is to be achieved. Social media has not been addressed as part of this chapter, but its role in influencing climate change and biodiversity loss narratives needs further study (Pearce et al., 2019).

Education for sustainable development. Transformative change through education for sustainable development has been a basis for curriculum development in Ireland; however, the more transformative aspects of this approach are not being taught. Research is required to better understand the barriers to incorporating these elements, along with other elements of education for sustainable development, because these are key areas of education for children and young people, as they face the enormous challenges of the current and future impacts of climate change and biodiversity loss and are tasked with finding solutions to problems that they have 'inherited'.

Removing silos in research to catalyse change. The value of culture, arts and humanities in enabling action on climate change and biodiversity loss is briefly addressed in Box 8.2. If culture and arts act as the bridge between ambition and action, inspiring people to act and offering people hope for the future, through solutions narratives, then it is necessary that culture is integrated alongside climate and biodiversity actions. Culture, arts and the humanities need to be embraced as solutions to these crises. STEM subject areas dominate the research and funding landscape for climate change and biodiversity loss. One major challenge ahead is to bring expertise from arts, humanities and social sciences together with STEM expertise to enhance action. Changes within the research and funding landscape will be necessary to support researchers to step outside their silos to work together to find better solutions, solutions that can close the gap between ambition and action.

Human, social and system-level interactions. Research related to understanding of the interactions between individual, collective (social) and systems as drivers of change and their importance in enabling transformative change is only beginning, but is an important area for future research (Creutzig et al., 2022).

Catalysts of change. Further research is required on how social movements catalyse change, particularly change that is long lasting, equitable and accountable. Similarly, the threshold for social tipping points for climate action are not yet understood. Action on climate change is not a single-issue topic, as opposed to the smoking ban or the plastic bag tax, and more research is necessary to understand both where the threshold of social tipping points related to climate action are and how to get to those tipping points faster.

9

Moving Transformation Forward

Key messages

Addressing climate change requires a transformative approach that goes beyond technological changes. Rapid and sustained economic, social and technological transformation across all sectors is necessary for deep decarbonisation and adaptation.

Achieving climate goals needs to consider broader sustainability objectives such as biodiversity, equity and economic opportunity. Neglecting these aspects could hinder decarbonisation efforts and lead to unintended negative consequences.

While citizens express concern about climate change, translating this into effective action requires a mix of supportive policies ('carrots') and regulations ('sticks'). Transformative climate action, while beneficial, can disrupt daily practices and occupations, necessitating societal commitment and fair distribution of costs and benefits.

Strengthening the social contract by incorporating environmental stewardship, climate action and just transitions as core elements can expedite decarbonisation efforts. Lessons from the COVID-19 response highlight the potential for collective action and shared responsibility in times of crisis.

Robust research plays a central role in achieving climate commitments. Universities and research institutions need to undergo transformative changes to align academic practices with societal and environmental priorities. Research is a key tool that can critically examine and interrogate policy, considering the interactions between policies, public opinion and politics. Secure and sustained funding for interdisciplinary, long-term research that enhances researcher careers is necessary to retain human capacity.

9.1. A transformative approach to climate action

Chapters throughout this volume have emphasised that addressing climate change requires a transformative approach, far beyond technological change. Achieving deep, urgent and widescale decarbonisation and adaptation is a major challenge. According to the CCAC, Ireland's legislated climate ambition and national climate objective "represents a significant ratchetting up of ambition beyond current policies and measures, and reflected in the proposed carbon budgets, will require rapid and sustained economic, social and technological transformation across all sectors of the economy" (CCAC, 2021).

However, there is more limited understanding of how this transformation can be realised. Volume 2 of this report series describes the technologies, demand dynamics and measures within climate mitigation pathways consistent with the national climate objective. This volume addresses the question of how society and the economy can be mobilised to deliver these pathways, and how they can be delivered in a way that enhances broader objectives, including biodiversity, equity and economic opportunity. Without addressing these wider aspects of sustainability, the pace and scale of decarbonisation cannot be achieved, and the risk of negative trade-offs from climate action is high. This volume has also addressed the multiple enablers of transformation and a just transition, which require action and cooperation between stakeholders across society, including political leaders, business and state organisations, civil society, community groups and individual citizens. To achieve this, the volume discusses the merits of a long-term approach and systems lens to address the underlying drivers that act as barriers to decarbonisation and climate action.

Transformative, deep and rapid decarbonisation is both an immediate and long-term political challenge. A key question is how political legitimacy for transformative climate action can be achieved. While Irish citizens are concerned about climate change, want government to act, and are willing to take personal action to cut GHG emissions (Leiserowitz et al., 2021), this has not translated into sufficient climate action to deliver decarbonisation. The benefits of many climate action policies go well beyond the terms of political office. While 'carrot'-type policies, such as financial incentives for low-carbon technologies, have strong public support (Leiserowitz et al., 2021), delivering the necessary pace of decarbonisation also requires 'sticks' to disincentivise carbon-intensive activities through regulation and financial measures, which are less popular and can impose disproportionate costs on certain groups. Transformative climate action, while bringing about many co-benefits, can also be disruptive; it requires people to alter their daily practices, like how they travel, eat and heat their homes, and how they invest their money, and will impact some people's occupations. Transformative climate action requires significant reorientation of land uses, both in rural and in urban areas (Chapters 2 and 3). Implementing decarbonisation policies at the pace and scale required, without societal commitment and political legitimacy, and without careful design to distribute costs fairly, risks triggering public backlash and failure.

Research on the political and sociological conditions needed to bring about this political legitimacy and transformative change is limited, as emphasised throughout this volume, and we lack historical analogies to draw from (Jordan et al., 2022). Boasson and Tatham (2023) describe three models of climate governance. Two models dominate: the *market failure model*, which draws on environmental economics and sees economic corrections as the main driver of mitigation, and the *sociotechnological transition model*, which sees climate mitigation through the lens of innovation and industrial development. Neither model assists in highlighting how broad support and consensus for strong decarbonisation measures may be developed. The authors introduce the *public support model*, drawing on political science, which focuses on policies and measures that secure popular legitimacy and support for climate action, and focuses not just on policies but on politics.

Despite limited research on societal mobilisation for climate action, Ireland has a long history of using social dialogue and social partnership to respond to societal change, for example through the work of NESC in developing consensus through participation (NESC, 1997). A recent NESC report, Just Transition in Agriculture and Land Use, demonstrates an inclusive engagement approach to working with stakeholders to bring about a transition within agriculture (NESC, 2023).

9.2. Transforming the social contract

Building a social mandate for transformative climate action through refining the social contract could catalyse rapid decarbonisation. The 'social contract' is a political concept describing the implicit relationship between citizens and the state. Dating back to the writings of Jean-Jacques Rousseau, it suggests an implicit contract under which citizens consent to be governed and abide by the laws of the state, participate in society and contribute to the common good, and, in return, the state governs, and makes and enforces laws to protect citizens, providing them with a level of security that they would not enjoy if they lived in a world lacking in political order. This protection has been described by Social Justice Ireland as "the assumption that the State will ensure a minimum standard of living, essential social services and infrastructure, and the protection of basic rights" (Social Justice Ireland, 2020).

The risks posed by unmitigated climate change to individual and collective safety and security have led some to frame the gap between commitments and delivery on climate action (EPA, 2023b) as a failure of the social contract (Willis, 2020). Climate mitigation and adaptation are necessary to protect current and future generations; however, GHG emissions have not yet peaked globally, and the world is on track for warming significantly beyond the commitments made in the Paris Agreement.

Refining this contract to include environmental stewardship, climate action and a just transition as core elements can be a foundation for transformative change. Levers for achieving this have been introduced throughout this volume, including shifting cultural norms, promoting climate education and public engagement, grassroots movements and advocacy, and economic transformation to green industry.

While the analogy between the climate crisis and the COVID-19 pandemic is not perfect (because of the short- and near-term threat of the virus and impermanence of the measures), lessons can be drawn for urgent and transformative climate action (Howarth et al., 2020). During the COVID-19 pandemic, the role of the state in providing for the safety of citizens was brought to light and demonstrates this implicit bargain between the government and citizens: people accepted dramatic changes and costs through lockdowns and travel restrictions to limit the spread of the virus, and, in return, the government took unprecedented measures to compensate workers and businesses affected by economic and travel restrictions. The measures were taken not for the self-interest of all people, but to protect those most vulnerable to the virus. Science played a crucial underpinning role in informing the response to the pandemic and public communications. While limiting the spread of the COVID-19 virus through social distancing and lockdowns came at a high cost, these measures were generally accepted by people for the common good. It is this type of relationship that is now needed for climate and biodiversity action.

What might a new social contract for societal transformation in the face of climate change entail? Murphy (2023) describes the transformative potential of mobilised, engaged citizens through collective action, recalling the coalition building and mobilisation around other social issues, such as Repeal (also described in Chapter 8 of this volume). It also emphasises the need for more equalising structures within democracy, and a restoration of social protection and equality that has been eroded by policy capture by elites.

CAP23 frames a strengthened social contract as an enhancement in community engagement, awareness raising and empowering personal action: "Delivering on our climate ambition requires that the Government and the people of Ireland come together in a strengthened social contract for climate action and the co-creation of real solutions to these challenges" (DECC, 2022).

The idea of a social contract emphasises responsibilities as well as rights. In the context of the climate crisis, a transformed social contract would emphasise the responsibility of citizens to participate in the climate transition, but would provide them with the supports, tools and resources to do so, taking account of the fundamental need for a just transition as well as the need, in particular, to support vulnerable and marginalised communities.

9.3. The role of research in enabling transformative change

Research has a central role to play if Ireland is to live up to national, EU and international climate and biodiversity commitments. Each of the preceding chapters in this volume has identified critical research gaps pertinent to their respective areas of focus that need to be addressed urgently. Taking a step back from the specifics of the research gaps identified, this section calls attention to the pressing need to strengthen the national research infrastructure and landscape and its relationship with the policy system, the economy and wider society, so that the full potential of cutting-edge research can be realised.

A growing body of literature both internationally and in Ireland identifies the important role that universities and research institutions can play as agents of transformative change. However, in order to play such a role, universities and research institutions must themselves evolve and transform. McGeown and Barry (2023) argue that "if they are to contribute to societal transformation, universities themselves must undergo transformations that explicitly and systematically reorient academic practices around social and ecological protection and priorities". They identify the need for a broad programme of democratisation around the three central pillars of academic activity: (1) research, (2) education and (3) outreach and engagement. A report published in 2022 by the European Federation of Academies of Sciences and Humanities on the climate sustainability of academia called for a change in culture across the sector "where individuals and institutions become aware of their climate impact and act to reduce it" (ALLEA, 2022). Kinol et al. (2023) point to the dual role of universities as places of knowledge production, perpetuation and dissemination, and anchor institutions in their communities and regions. They identify universities' potential to become both exemplars of social change and agents for change.

> *The idea of a social contract emphasises responsibilities as well as rights. In the context of the climate crisis, a transformed social contract would emphasise the responsibility of citizens to participate in the climate transition, but would provide them with the supports, tools and resources to do so, taking account of the fundamental need for a just transition as well as the need, in particular, to support vulnerable and marginalised communities.*

Addressing the 'wicked problem' of climate change requires working across disciplines and across research institutions, understanding the problem from multiple angles and providing appropriate and long-term funding for research on transformative change. In its founding Green Paper, the All-Island Climate and Biodiversity Research Network (AICBRN) called attention to weaknesses in the current funding landscape for climate and biodiversity research on the island of Ireland. In particular, the Green Paper noted the fragmented nature of the research environment, with elements of research "often separated into relatively small groups working apart, leading to both redundancy of effort and under-exploitation of synergies". The result, the Green Paper argues, "is competitive rather than cooperative research, driven in part by funding models that support short-term piecemeal research" (AICBRN, 2020).

There is a pressing need for an increase in the quantum of research funding for climate and biodiversity research and also for changes in the way in which it is structured. Small-scale competitive research bids with time horizons often of 1–2 years or shorter limit the development of strategic, transformative and interdisciplinary research to address our urgent societal challenges across climate and biodiversity. The requirement to secure industry co-funding acts as a barrier to public good research, a characteristic of much research on climate and biodiversity, particularly in the social sciences and humanities. The AICBRN Green Paper calls for a strategic investment of a minimum of €10 million in new research expenditure per year for at least 10 years (AICBRN, 2020). The structure of researcher contracts in higher education also serves to limit the potential for transformative research on climate and biodiversity (as well as other societal challenges). The prevailing norm of offering 1–2 year fixed-term contracts for highly skilled research staff, with no long-term career structure, has made it increasingly challenging to recruit and retain skilled researchers. This diminishes Ireland's human capacity and expertise in climate change as researchers move abroad or to the private sector in search of a career.

Greater engagement with European and global research networks and funding opportunities can strengthen the role of Irish research on transformative change. Many researchers and research groups in Ireland already engage with European and global counterparts. Further engagements with European networks and funding streams, such as Horizon Europe and JPI Climate, could strengthen the research base within Ireland. More Irish researchers could be encouraged to participate in global research and research assessment processes, such as the IPCC and IPBES.

Finally, in order to realise the transformative potential of research in addressing the climate crisis, more attention needs to be focused on the coordination and synthesis of research and its translation into societal impact, and on the absorptive capacity of the policy system. Undertaking a review of international models of independent coordinating bodies for climate change and biodiversity research could serve to strengthen the research ecosystem and its links to policy and society in Ireland. The government's research and innovation strategy, Impact 2030, has identified a clear ambition for research to contribute more strongly to policy development (DFHERIS, 2022), and an Evidence for Policy unit has been established in the Department of Further and Higher Education, Research, Innovation and Science. Nonetheless, strengthening the science–policy interface in Ireland remains a work in progress. The Environmental Science to Policy Seminar hosted by the EPA in October 2022 noted that, at present, relations between the scientific community and the policy system are based on individual relationships between scientists and policymakers, and need to evolve into a system based on institutional trust. The workshop outcomes document made the case for the EPA to develop capacity for knowledge management, brokerage and synthesis (EPA, 2023a). It may be argued that these capacities ought to be enhanced across the public sector in order to fulfil the transformative potential of climate research in Ireland.

Annex: Research Gaps

Chapter 1 research gaps

Transformative change in the Irish context. Since 2005[55], the literature on transformative change has undergone considerable development internationally (Moore et al., 2021). Literature that directly considers transformation in Ireland is at an early stage of development, as is the wider literature that considers related topics. This limits the specific conclusions that can be made for Ireland beyond general conclusions, that, in many cases, apply from international literature. The limited availability of research on transformative change for Ireland points to a huge gap in understanding related to (1) how transformative change can work in the Irish context, (2) how to optimise the benefits, opportunities and synergies associated with transformative change and (3) the role of transformative change in delivering a prosperous Ireland for all. Research will be required across all systems, and contributions from, and collaboration between, science, technology, engineering and mathematics (STEM) and arts, humanities and social sciences (AHSS) disciplines will be necessary if this research gap is to be addressed.

Role of wellbeing and equity in achieving intergenerational sustainability. Research is required to better understand the role of wellbeing and equity in achieving intergenerational sustainability in Ireland. What can be learnt from other countries where wellbeing and equity have become central to policymaking and long-term strategic decisions? How has this affected sustainability outcomes? How could wellbeing and equity become substantive, as opposed to peripheral, in Irish policymaking? How can progress on transformative change – that is rapid and systemic – be measured and assessed? These are all potential areas for investigation.

Underlying drivers. A better understanding of the connected underlying drivers (institutional, demographic, technological, economic, governance and sociocultural) of climate change and biodiversity loss in Ireland is necessary if these drivers are to be addressed and transformative change achieved.

Research will be necessary to identify drivers (behavioural, sociocultural, business and corporate, institutional and infrastructural) that act to maintain the status quo, in relation to mitigation and adaptation, in Ireland and to deliver the solutions that turn those barriers into enablers of transformative change.

Synergies and trade-offs. A comprehensive mapping of synergies and trade-offs for climate change (mitigation and adaptation), biodiversity loss and sustainable development, in the Irish context, could highlight areas where synergies can be identified and enhanced to augment benefits and opportunities while potential trade-offs are identified and managed to reduce their impact.

Integration Research is needed to support developing an integrated, across all domains, sectors and systems, long-term strategic plan for Ireland that puts sustainability (including climate change and biodiversity loss), equity and wellbeing at its core. Research on how near-term planning and actions can enhance benefits and opportunities and how long-term plans can influence planning and action in the near term is also necessary if the gap between climate ambition and action is to be closed.

Chapter 2 research gaps

Transformative approaches to food and land systems. The necessity for transformation originates in the dual crises of biodiversity loss and climate change and in the urgency that is required to address them. Climate, biodiversity and society are interdependent, and treating them as such is necessary for successful policy intervention (Pörtner et al., 2021a). Tackling the direct drivers of climate change and biodiversity loss does not result in change in the speed, scale or depth that is required if Ireland is to deliver on its climate and biodiversity goals. Research on the underlying drivers of climate change and environmental degradation is only beginning (Chan et al., 2020) and is essential if transformational change is to be achieved. The food systems approach is considered to be transformative (EEA, 2017). It is a holistic approach that considers all aspects of the food system – from nature's contribution to all those who work the land, process, ship and sell food and to wider issues related to health and waste. Establishing this approach and integrating it with the wider land systems will require further research.

Ireland's role in the global food system. Ireland's role in global food production is likely to evolve as the global population grows and climate change and related pressures affect global food production. Will Ireland need to increase the amount of food it produces? If so, will this require a move to less resource-intensive food production systems to maximise calorie output? If so, what would be the implications for the land transition?

[55] This is the year identified by Moore et al. (2021) as significant, as this is when transformation-related terms commenced growing exponentially in the literature.

Comparative efficiency of agriculture production systems. As part of establishing a food systems approach in Ireland, research on the comparative efficiency of agricultural production systems will be required to better understand the efficiencies of these systems. Research on carbon leakage is also required as part of determining the most emissions-intensive and environmentally damaging food and materials.

Feasibility of land-use change. Phase 2 of the National Land Use Review will involve consultation with a wide variety of stakeholders and will gauge the appetite for the type and level of change, as it currently stands, with regard to changing land-use patterns in Ireland. While the options for land-use change are 'technically' feasible, research will be required to understand how individuals, households, rural communities, wider society and the economy can assist in enhancing the feasibility and implementation of the change necessary to deliver on Ireland's national climate objective.

Enabling afforestation, peatland and nature restoration. Further research on enabling afforestation, peatland rewetting and restoration, and nature restoration, particularly in relation to sustainable livelihoods, supporting rural communities and all those who work and steward the land, will be required in order to maximise the synergies between mitigation and adaptation actions and the wellbeing of those on the front lines of climate action. Research will be required to ensure that policies and measures are fair and that an undue burden is not placed on rural dwellers. Research will be necessary to establish the magnitude of the land carbon sink in Ireland.

Implementation of nature-based approaches. Nature-based approaches have the potential to be transformative, as they can tackle climate change (mitigation and adaptation) while delivering benefits for nature and human wellbeing simultaneously. How nature-based approaches can be implemented in Ireland requires further study.

Clean air and fresh water. There is little research available on the co-benefits of mitigating GHG emissions in agriculture, for example the benefits for air and water pollution, flood protection and amenity. Research will be necessary if wider co-benefits are to be identified, especially those that can benefit human health and wellbeing and the protection of nature.

Bioenergy. To date, research on bioenergy has been concentrated on interactions between fuel, food and feed. Research in this area may be expanded to consider interactions with biodiversity, mitigation and adaptation action to bring a fuller understanding of the interconnections and potential for synergies and trade-offs in the landscape.

Carbon dioxide removal. 'Novel' methods of CDR, such as bioenergy carbon capture and storage and direct air capture, will become more important for carbon removal towards the middle of this century. Research is required to assess the feasibility of developing, financing and deploying these and other 'novel' CDR technologies in Ireland so that the synergies and trade-offs associated with these technologies can be assessed and these technologies can become part of a long-term integrated strategy for land use.

Integrated strategies, design and planning. Of all transformations, transforming landscapes has the greatest possibility for trade-offs. For example, interventions to make space for nature could mean increased intensification of agriculture and associated environmental impacts that result in damaging ecosystems further (EEA, 2017; Sachs et al., 2019; Haughey et al., 2023). Integrated strategies, design and planning are required to anticipate and minimise such trade-offs alongside maximising the synergies (Sachs et al., 2019; Schmidt-Traub et al., 2019). It is clear that a long-term integrated plan for land use is required in Ireland and that the groundwork to establish this is ongoing. However, given the potential negative impacts for climate, biodiversity and society, research is required on how to achieve integration to maximise synergies and manage trade-offs.

Chapter 3 research gaps

The NPF confines long-term spatial planning to a single path up to 2040, while the mobility transformation is limited to marginal improvements in bus and rail services. To facilitate the delivery of integrated spatial planning, it is necessary to develop visions for alternative settlement patterns towards 2050 and to simulate their impact on emissions reduction, equity and wellbeing.

An approach to transforming the built environment that integrates both the places and movement is not readily apparent in Irish research. Further research is also required to investigate the scale, timeline for implementation, and full extent of benefits associated with achieving compact development. There is a tendency to compartmentalise different themes, resulting in limited connections between them. While certain aspects of climate-related research are explored, the lack of a coordinated approach to transport and urban planning makes it difficult to identify the synergies and trade-offs associated with planned interventions. The governance, political, and normative considerations involved in placemaking are largely unresearched, with insufficient empirical research to inform decision making in Ireland.

The availability of planning, property and environmental data for analysis is limited to a coarse scale in Ireland, with finer-grained data at small area or electoral district level lacking timeliness. Projects in this field could potentially benefit from a digital twinning approach, and remote sensing could also serve as a valuable tool in this context.

A transformational approach to transport modelling is needed to guide climate decisions in policymaking, incorporating a participatory process of creating transport scenarios. Social impact assessment in transport project appraisal is desirable, and international research can inform equity and accessibility-based analyses in Ireland.

There is a need for detailed research on the scale, cost ranges and timeline for actions identified as transformative across planning, transport and buildings, and the factors influencing their implementation. These elements require further study to ensure accuracy and relevance.

There is a need to explore the interdependencies of avoid–shift–improve actions in different scenarios to optimise their benefits.

Emerging paradigms that could generate systemic changes need investigation to determine their impact and synergies with existing structures and other new trends. For instance, digital technologies could assist in reducing travel demand, but further research is needed to understand their implications for reducing GHG emissions and other impacts.

Active travel and smart mobility options have not been extensively explored in the context of dispersed settlements in Ireland, despite the transformative potential of new solutions. Further research is needed to examine their feasibility, impact on emissions reduction and the opportunities they may generate.

Modal shift can be facilitated through travel demand management associated with behavioural change, but the effectiveness of policy instruments requires continuous monitoring and research.

Further research is needed on Irish rail to determine the feasibility of shifting away from air and road transport, following rail expansion. Analysis of the long-term climate change mitigation effects of both passenger and freight rail is required, as well as an investigation into tools that can facilitate the shift. Shipping and aviation decarbonisation options also require further research and development.

Research is needed to better understand how to effectively integrate climate adaptation and mitigation strategies within building codes and standards. This involves investigating how measures aimed at reducing emissions can also enhance buildings' resilience to climate impacts.

There is a lack of comprehensive research on the effectiveness of nature-based approaches in improving buildings' resilience. Studies should focus on assessing the performance of strategies such as green infrastructure and passive design in enhancing buildings' ability to withstand climate-related challenges.

There is a need for research that delves into the behavioural aspects of energy efficiency solutions and energy sufficiency promotion. This is essential for designing more effective and impactful programmes.

Chapter 4 research gaps

Understanding livelihood opportunities, developing related visions and establishing strategic long-term policy. Improved understanding of livelihood opportunities is required to support development of transformation policy, alongside, and in support of, a just transition. Livelihood opportunities arise from conventional technological and practice transitions and from transformational innovations in structures and systems. Knowledge of national employment opportunities from technological and practice transitions remains limited. Knowledge of national employment opportunities in wider transformations of structures and systems is essentially non-existent. Strategic long-term livelihoods policy will be required to embrace national opportunities for livelihoods in low-emissions development. The process of building new strategic policy can be supported by analysing the opportunities of, and creating shared visions for, future livelihoods.

Livelihoods in rural and urban transitions and the importance of understanding synergies and alternative paths. Rural transitions have similarities to urban transitions, but also have unique characteristics. Current research has considered national transitions in technological and management practices but has not yet fully explored opportunities for diversification of activities, including structural and systems innovations. Exploring alternative paths can facilitate the identification of public policy options that maximise the synergies of rural livelihoods with sustainability, including low-emissions development, nature restoration, public health and food security, while enhancing livelihood resilience and incomes.

Livelihoods and synergies in broad characterisation to support knowledge building and policy enablement. Transformation is a process of fundamental change, embracing near-term action that supports the achievement of a defined long-term path. It can establish multiple synergies, as win–wins, if appropriately conceptualised in planning and effectively implemented in policy. This involves changes in how we analyse the objectives we set and the policies and programmes we implement. Livelihoods are important in understanding transformation paths, and related opportunities and benefits. To support an understanding of livelihoods, conventional income, employment, equality, and poverty and deprivation measures provide useful but partial insights. To support knowledge building, important wellbeing and social considerations include opportunities and capabilities; resilience; decent work; identity; income; equity; just transition; and carer roles. In fashioning implementation policy, enabling measures include education; training; social protection; and frontier innovations such as UBS, UBI and the shorter working week.

Chapter 5 research gaps

While there is limited data on the current consumption practices of Irish households, particularly sustainable consumption, more granular analysis is needed. Specific research should focus on socioeconomic profiles, overconsumption and underconsumption patterns, and disaggregated trends by factors such as income, age and geographical location.

Although current climate scenarios in Ireland consider new technologies and production changes, they often underestimate the impact of consumption changes on carbon emissions. Future research should aim to identify optimal pathways that not only focus on technology but also emphasise reducing demand for energy and resources. In this vein, establishing 'sufficiency standards' that still ensure decent living standards can guide more sustainable policies.

Despite the growing recognition of the importance of sustainable consumption, there is still a significant research gap in understanding the most effective policy interventions in promoting low-carbon lifestyles in Ireland. Specifically, there is a need for more research on the effectiveness and social impacts of existing policy instruments, such as taxes, subsidies and regulations, as well as the potential for innovative policy solutions, structural changes and strategies to generate greater consumer involvement.

There is a need to explore the potential of various social instruments, such as coordinated voluntary initiatives, participatory decision making and information-based instruments, to encourage sustainable consumption practices. Gaining a better understanding of the social and cultural factors that influence such practices in Ireland, including the impact of social norms, values and beliefs on consumer behaviour, can aid in the development of effective social instruments.

The integrated behavioural model offers insights into individual change, and long-term empirical studies are needed to assess the effectiveness of behaviour change policies over time. Existing research indicates a dissonance between expressed attitudes and reported behaviours. Future studies should aim to bridge this gap to understand the actual barriers to sustainable consumption.

The research landscape is still sparse concerning the potential of circular business models, digital technologies and the sharing economy in promoting sustainable consumption. Given inconsistent evidence, further research is needed to assess their real impact on climate change mitigation.

Research will be required to understand the potential impact of a climate-friendly diet on agriculture, consumers and markets in Ireland. Changes to the current model of production and consumption will also require engagement with and the participation of relevant stakeholders in the development of a sustainable food system for Ireland.

Sustainable consumption is a multi-faceted issue that demands an interdisciplinary approach for comprehensive understanding and effective policymaking.

Chapter 6 research gaps

Understanding paths, options and opportunities, the importance of transformational scenarios. Ireland has developed knowledge of technological transitions but has limited knowledge of sustainable development paths and associated transformations in systems and structures, including synergies and economic opportunities. Enhanced understanding of the potentials, levers and outcomes of transformational change can be assisted through hybrid scenario analysis, integrating qualitative and quantitative approaches. Hybrid scenario analysis can enable the integration of different disciplines, forms of knowledge, and top-down and bottom-up lenses on processes of change. Important framing conditions of scenarios of transformations include long-term analysis horizons; considering radical and deep change in systems, structures and technology; low-tech and low-cost solutions; the emergence of synergies and trade-offs; social, cultural, political and institutional change; and the short-term windows of implementation and action.

Economic opportunities and public policy synergies for wellbeing, equity and sustainability. Economic opportunities are considerable within transitions and transformations but require enhanced analysis and supportive strategic policy development. Economic opportunities include 'dark green' emissions reducing activities and 'light green' low-emissions intensity activities. Studying different transformational paths at the macro-level can facilitate characterisation of national economic opportunities in prosperous and just rural and urban transitions. Future visions of economic development have a fundamental role in understanding transitions and transformations, including economic growth, structural change, green growth, degrowth and post-growth approaches. This can be used to reorient development towards wellbeing, equity and sustainability, and to identify paths and policies that maximise synergies and minimise trade-offs. Bottom-up analysis of key sectors and themes is important in studying possible transformations. These include transformations in combined spatial and mobility systems; land, food and agriculture systems; and energy systems. Five key frameworks to further enhance knowledge on key themes can be identified as: decision making under uncertainty; aggregated economic models; ethical perspectives on values and equity; transition and transformational frameworks of processes and actors; and psychological/behavioural and political factors.

Innovation policy, finance and investment. Innovation policy, finance and investment can enable transformational development and related economic opportunities. Evolution in the field of innovation policy is moving towards broader support for sustainable development. A deepened understanding of how innovation policy can align with transformational sustainable development can support the achievement of win–win outcomes. To this end, systematic review of the adequacy and performance of innovation policy with respect to transformational outcomes could assist in building knowledge of the relationships between innovation and transformations. Although beginning to grow, the knowledge and awareness of actors, and of the risks and opportunities for finance and investment under the climate umbrella, is at an early stage. Priority research topics include aligning climate and non-climate policy; nature and infrastructure investment; green bonds and green finance; physical impact risk; delayed transition risk; carbon pricing, and positive and perverse subsidies; the economic opportunities in deep transitions and transformations; and climate finance for developing countries.

Chapter 7 research gaps

Understanding climate institutions and governance in the national context, layering on existing institutions, sectoral challenges and scales. There has been limited analysis to date of climate institutions and governance arrangements in Ireland. In the light of the significant evolution of the governance landscape in recent years as a result of the Climate Act 2021 and related processes, further research is needed to study the implications of these changes and provide a basis for further strengthening of the governance framework, with a focus on three areas in particular. First, building on the path-dependent nature of climate governance arrangements, research is needed on how the layering of new climate governance arrangements on existing institutions plays out in the distinctive context of Irish politics and policymaking. Second, future research ought to focus on the governance of particular sectoral climate action challenges. Third, further research on climate governance at local and regional levels, and in a multilevel governance context, would help to strengthen climate action responses and minimise fragmentation.

Building policy knowledge and institutional capacity for transformations, alternative paths, feasibility and the roles of actors. To widen and deepen transformational governance and policy research in Ireland, important foci include the political, social, cultural and institutional feasibility of transformations; studying the roles and influence of governance actors that enable and disable transformations; and options to overcome resistance to change. It is also important to recognise that there is limited analysis of alternative future paths for Irish policy development to draw on that include transformational paths and systems change and related synergies and trade-offs. Building institutional knowledge of systemic transformations and institutional capacity for implementation of systems change policy is essential if transformations are to be pursued, synergies maximised and trade-offs minimised and managed.

Enhancing long-term policy, strategic foresight, vision-building and reconsidering development. Developing national long-term climate action strategy is a policy process related to strategic foresight. Adopting an anticipatory governance approach can enable strategic policy development to maximise the synergies in sustainable development paths, to minimise trade-offs and to make policy more robust to future uncertainty. Applied research on adopting an anticipatory governance approach in Irish climate action policy could support reform of the policy process to set it on a systems transformation footing. Patterson et al. (2017) ask how policy and decision making can be moved from short-termism to an anticipatory and long-term mode. Supporting research routes include participatory vision-building – reconceptualising development to achieve public policy synergies and the social contract.

Policy integration, policy mixes and evaluation criteria. A deepening of policy integration, horizontally across thematic and sectoral silos, and vertically across levels, is an essential requirement of transitions and transformations. Integrated policy mixes that support transformational change are considered a crucial topic for enhanced knowledge (Dubash et al., 2022). An enhanced understanding of the contribution of policy mixes and of the synergies and trade-offs associated with different packages could assist decision making. Further national ex post and ex ante policy evaluations could contribute to an augmented understanding of policy implementation and outcomes. In line with the recent evolution in practices globally, an important addition to standard policy evaluation criteria used in Ireland would be to consider the transformative potential of measures.

Chapter 8 research gaps

Equity. While research suggests that some climate change policies and measures in Ireland are inequitable, research is required to ensure that both existing and future policies and measures are equitable on multiple levels, including national, regional, place-based and sector-specific levels, to ensure wider engagement in these actions.

Role of media in enabling climate action. While it has been acknowledged that the news media in Ireland have the potential to play a role in enabling transformative change, more research is required to understand the actions necessary if this goal is to be achieved. Social media has not been addressed in this chapter, but its role in influencing climate change and biodiversity loss narratives also needs further study (Pearce et al., 2019).

Education for sustainable development. Transformative change through education for sustainable development has been a basis for curriculum development in Ireland; however, the more transformative aspects of this approach are not being taught. Research is required to better understand the barriers to incorporating these elements, along with other elements of education for sustainable development, as these are key areas of education for children and young people as they face the enormous challenges of the current and future impacts of climate change and biodiversity loss and are tasked with finding solutions to problems that they have 'inherited'.

Removing silos in research to catalyse change. The value of culture, arts and humanities in enabling action on climate change and biodiversity loss is briefly addressed in Box 8.2, Culture and climate change. If culture and arts act as the bridge between ambition and action, inspiring people to act, offering people hope for the future through solutions narratives, it is necessary that culture is integrated alongside climate and biodiversity actions. Culture, arts and the humanities need to be embraced as solutions to these crises are developed. STEM subject areas dominate the research and funding landscape for climate change and biodiversity loss. One major challenge ahead is to bring the expertise from AHSS disciplines together with expertise from STEM disciplines to enhance action. Changes within the research and funding landscape will be necessary to support researchers to step outside their silos and work together to find better solutions – solutions that can close the gap between ambition and action.

Human, social and system level interactions. Research related to understanding of the interactions between individual, collective (social) and systems as drivers of change and their importance in enabling transformative change is only beginning but is an important area for future research (Creutzig et al., 2022).

Catalysts of change. Further research is required on how social movements catalyse change, particularly change that is long lasting, equitable and accountable. Similarly, the threshold for social tipping points for climate action are not yet understood. Action on climate change is not a single-issue topic, as opposed to the smoking ban or the plastic bag tax, and more research is necessary to understand both where the threshold of social tipping points related to climate action are and how to get to those tipping points faster.

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Chapter 1

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Abbreviations and symbols

AHSS	arts, humanities and social sciences
AR5	Assessment Report 5
AR6	Assessment Report 6
BER	building energy rating
BIM	building information management
CAP23	Climate Action Plan 2023
CCAC	Climate Change Advisory Council
CDR	carbon dioxide removal
CH_4	methane
CO_2	carbon dioxide
COP15	Conference of the Parties 15
COP26	Conference of the Parties 26
EEA	European Environment Agency
EPA	Environmental Protection Agency
EPBD	Energy Performance of Buildings Directive
ESRI	Economic and Social Research Institute
EU-ETS	EU Emissions Trading System
FDI	foreign direct investment
FFPT	fare-free public transport
GDP	gross domestic product
GHG	greenhouse gas
GIS	geographical information system
GWP	global warming potential
ICT	information and communications technology
IMF	International Monetary Fund
IPBES	Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
LDA	Land Development Agency
LED	low energy demand
LULUCF	land use, land-use change and forestry
MaaS	mobility as a service
MASP	metropolitan area strategic plans
N_2O	nitrous oxide
NDC	nationally determined contribution

NDCA	National Dialogue on Climate Action
NDP	National Development Plan
NECP	national energy and climate plan
NESC	National Economic and Social Council
NGO	non-governmental organisation
NMPF	National Marine Planning Framework
NPF	National Planning Framework
NZEB	nearly zero energy building
OECD	Organisation for Economic Co-operation and Development
OPSI	Observatory of Public Sector Innovation
PM2.5	particulate matter with a diameter of ≤ 2.5μm
PV	photovoltaic
R&D	research and development
RSES	Regional Spatial and Economic Strategy
SDG	Sustainable Development Goal
SDZ	strategic development zone
SEAI	Sustainable Energy Authority of Ireland
SER	sufficiency, efficiency and renewables
STEM	science, technology, engineering and mathematics
UBI	universal basic income
UBS	universal basic services
UCLG	United Cities and Local Governments
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WGIII	Working Group III

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