Ireland and the Climate Change Challenge: Connecting 'How Much' with 'How To'

Final Report of the NESC Secretariat to the Department of Environment, Community and Local Government

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An Chomhairle Náisiúnta Eacnamaíoch agus Shóisialta
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Preface

The science of climate change is unambiguously pointing towards a challenge of enormous proportions and the need for immediate and sustained action. The NESC Secretariat was privileged to be asked by the Government to undertake work on this issue. It was unusual for us to work directly for government, rather than in the service of the NESC Council. Despite this freedom, we found that our engagement with the Council—whose members are from diverse economic and social backgrounds and are some of the leading experts on economic, social and environmental issues—greatly enhanced the work. Beyond the Council, we were astonished by the level of innovation and thinking on carbon reduction in companies, civil-society organisations, agencies and departments. We believe that a constructive—though still very challenging—conversation on climate change is now underway in Ireland.

In its 2011 *Review of Ireland's Climate Change Strategy* the Department of the Environment, Community and Local Government suggested that Ireland must move beyond a compliance-centric approach. In our view, moving beyond a compliance-centric approach means thinking for ourselves. In its *Strategy Statement 2011–2014*, our parent department, the Department of the Taoiseach, says that its approach in the future will be guided by a number of principles, including 'the need to avoid groupthink' and 'the importance of open discussion, listening to discordant voices and challenging conformist thinking'. We have taken the advice of both departments to heart.

The more the work progressed the more we were drawn back to the environmentalist principle 'think global, act local'. 'Act local' is strongly confirmed in our work. First and foremost, it means that Ireland must get on with the job of decarbonisation. But it says that we can only do that by taking our local context seriously—right down to local farming practices, the installation of the smart grid and the difficulties of switching from the car in rural areas and cities. But local complexity and difficulty should no longer be seen as a reason not to act, rather they reveal the knowledge that makes it possible to act effectively. We are very positive about the opportunity that transition to carbon neutrality offers to Ireland and our ability to achieve it.

To *think* global is to admit our collective current lack of knowledge of how—technically, politically and organisationally—we are to achieve global decarbonisation in a context of increasing population, incomes and energy demand. It was never more important that we bring our best knowledge and experience of how to create truly effective international institutions to bear. It means we must not fool others, and ourselves, to believe the fallacy of composition that the whole world can achieve emissions reduction in the manner in which Europe did in the past two decades. To think global is to avoid the righteousness with which one continent tends to address another on climate change.

As we complete this project, we remain troubled by the failure of international climate-change policy and the prospect for humanity if it continues on the same path. The paradoxical yearnings that bedevil international climate-change policy were captured by the seventeenth-century Japanese poet Basho in this oddly prescient haiku:

even in Kyoto,
when I hear the cuckoo,
I long for Kyoto

Acknowledgements

The Secretariat wishes to acknowledge the assistance and contribution of people across a wide range of government departments, public agencies and other organisations.

The Secretariat would especially like to acknowledge the support provided by staff at the Department of Environment, Community and Local Government. We also worked closely with colleagues at the Departments of Communications, Energy and Natural Resources; Agriculture, Food and Marine; Transport, Tourism and Sport; Public Expenditure and Reform; and Finance. In all these departments colleagues have given generously of their time and expertise in helping us to develop a clearer sense of the challenges and opportunities associated with climate change.

We list at the end of the report the full range of organisations and individuals that have assisted us in our work. However, we were very fortunate that we have been able to draw heavily on the expertise of staff within the EPA, SEAI, ESRI, Teagasc, IFA, IBEC and the Energy Policy and Modelling Group at UCC.

During the year workshops and seminars which shaped our work were organised by the Environmental Protection Agency, UCD Earth Institute, Institute for International and European Affairs and the Kennedy Institute at NUIM. These events assisted our work in very important ways and we are grateful to the colleagues within these organisations for their support.

We would also like to acknowledge a number of individuals who have given very generously and patiently of their time: Ger Bergin, Laura Burke, Tom Brookes, Peter Bradfield-Moody, Peter Brennan, Eimear Cotter, Peter Cassells, Frank Convery, Oisin Coughlan, Anna Davies, Jill Donohue, Micheal Ewing, John Fitz Gerald, Brendan Halligan, Lars Georg Jensen, Dara Lynott, Brian Motherway, Louis Mueleman, Frank McGovern, Brian O'Gallachoir, Mark O'Malley, Paul Price, Eamon Ryan, Thomas Ryan, Charles Sabel, Rogier Schulte and Neil Walker.

Finally, we would like to acknowledge the support and insights that have been provided by both the NESC Council, which discussed drafts of both the Interim Report and on two occasions this Final Report, and our parent department, the Department of the Taoiseach.

Secretariat to the Project

Dr Rory O'Donnell, Project Leader, Dr Larry O'Connell, Noel Cahill, Dr Jeanne Moore, Dr Claire Finn, Paula Hennelly and Ruth McCarthy. Joe Curtin was consultant to the project.

Executive Summary

This report sets out the NESC Secretariat's vision for Ireland in 2050, and the key building blocks that can underpin it. It outlines a way of thinking about the challenges—of climate-change policy and the global resource crunch—and proposals for a pragmatic approach involving simultaneous action along three tracks.

Our Vision is that Ireland will be a carbon-neutral society by 2050, based on an approach to economic development that is socially and environmentally sustainable.

Three Ideas inform our transition to a carbon-neutral economy and society:

- Climate-change policy is a loop not a line—in which there is a dynamic relation between 'how much' emissions reduction and policy action governments commit to and their understanding of 'how to' achieve decarbonisation;
- It is necessary to balance the policy emphasis on 'how much' emissions reduction to target with more focus on 'how to' achieve decarbonisation of the economy and society; and
- The transition to a carbon-neutral economy and society must 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.

At both national and international level, there is need for a multi-level experimental approach to address the challenge of climate change and resource scarcity.

Five Guiding Principles for Climate Action should underpin Ireland's strategy to become a carbon-neutral society. These are:

- Economic prosperity, recovery and social development;
- Incremental and permanent decarbonisation;
- Responsibility, integrity and leadership;
- Reform of public institutions and governance; and
- Societal engagement.

Our Three-Track Approach captures the need for action on many fronts if a more ambitious and effective Irish response to climate change is to be created:

- **Track 1: Strategic and Institutional—**including Ireland's engagement with the UN and EU climate policy processes, new institutional structures and five strategic building blocks;
- **Track 2: Exploration and Experimentation—**to consciously build policy and organisational networks in specific areas and push these to ever-greater decarbonisation; and
- **Track 3: Design and Implementation—**focuses on where early action makes sense and is feasible, and measures to meet Ireland's 2020 targets.

Five Strategic Building Blocks of transition to a carbon-neutral Ireland can be identified. To achieve carbon neutrality by 2050 we must act now to create:

- An energy system built on wind and other renewables, using a smart grid and integrated into a clean EU energy system;
- An energy-efficient society that uses renewable forms of energy for heating;
- A sustainable transport system which serves economic, societal and environmental needs;
- A world-class agri-food sector working within a carbon-neutral system of agriculture, forestry and land use; and
- An approach to resource management that provides a competitive and comparative advantage in international trade and factor flows.

Our strengths in these areas will help secure the development of the Irish economy, but also position Ireland in the vanguard of efforts to address climate change and work in a resource-constrained world.

Six 'Track 2' Exploratory Projects are outlined:

- Working Towards Carbon-Neutral Agriculture;
- Smart Grid;
- Electric Vehicles;
- Electrification of Heat;
- Biomethane and Anaerobic Digestion; and
- Carbon Capability

Effective Institutions to Drive Ireland's Transition to Carbon Neutrality

In order to progress this agenda, government needs to undertake a number of political and institutional steps:

- Embed the transition to carbon neutrality, and particularly the five strategic building blocks, within the core agenda of economic recovery and development, ensuring that the allocation of resources reflects these new priorities and imperatives;
- Create and direct a new process and entity—with a government-led steering and oversight board and a small technical secretariat—to monitor progress on the main carbon neutrality building blocks and project areas, organise disciplined joint exploration of successes and failures and drive agencies and their networks to push the boundaries of knowledge and practice on 'how to' achieve decarbonisation;
- Create a transparent process of periodic review of Ireland's progress towards carbon neutrality, involving relevant departments, agencies and the Joint Oireachtas Committee on Environment, Culture and the Gaeltacht.

Ireland has an opportunity to be a real leader by building an institutional architecture suited to the nature of the climate-change policy problem and the major ways in which progress on 'how to' achieve decarbonisation is made.

Part I: Vision and Analysis

Chapter 1

The Challenge

Science of Climate Change

Rising concentrations of green house gases (GHG) cause temperatures to rise. There has been a huge increase in emissions since the industrial revolution and the concentration of CO_2 emissions in the atmosphere has risen from 280 parts per million in pre-industrial times to 389 parts per million in 2010. The most significant contributors to this rise in emissions is the burning of fossil fuels and the clearing, mainly in developing countries, of forests.

In the international Copenhagen Accord of 2009 it was agreed that deep cuts in global emissions are required to hold the increase in global temperature below 2°C. The adoption of this goal reflects a judgement of the scientific evidence that the 2°C limit would avoid dangerous climate change, although significant risks also exist with lower levels of global warming.

In 2012, the World Bank commissioned a study from the Potsdam Institute to examine the potential impact of 4°C warming in the current century[1]. While uncertainties remain, the scenarios associated with 4°C warming are referred to as 'devastating' by the President of the World Bank. The report suggests that a 4°C world would be one of unprecedented heat waves, severe drought, and major floods in many regions, with serious impacts on ecosystems and associated services. The report concludes that there is no certainty that adaptation to a 4°C world is possible. It is important to be aware that although the worst effects of climate change are likely to arise elsewhere, Ireland will definitely not be immune from damaging changes in weather conditions and sea levels.

The Potsdam Institute show that even the full implementation of the pledges made in Copenhagen (2009) and Cancun (2010) would not be sufficient to place the world on a path consistent with the goal of limiting warming to 2°C. Indeed the International Energy Agency[2] estimates that if current trends continue global energy use and CO_2 emissions could double by 2050 and this would put the world on the path towards a 6°C rise in average global temperatures.

Periodic assessments of the peer reviewed literature on climate change are produced by the Intergovernmental Panel on Climate Change (IPCC). The last assessment, known as the Fourth Assessment Report (AR4), was published in 2007. The AR5

report is due to be published in 2014. The AR4 highlighted the risk of rapid, abrupt, and irreversible change with high levels of warming[3]. It indicated that to have a 50/50 chance of keeping GHG concentrations to a level that would limit global warming to 2°C required global emissions to fall by 50% by 2050, a goal endorsed by the G8 in 2008. The IPCC further indicated that this would require emissions reductions by developed countries as a whole of at least 80-95 per cent, compared to 1990 levels. This was endorsed as an EU objective by the European Council meeting of October 2009.

The science is unambiguously pointing towards a challenge of enormous proportions. It is also pointing to the need for immediate and sustained action. Stabilising the level of GHG concentrations in the atmosphere requires that annual emissions peak and then decline. The later the peak in emissions occurs, the higher the rate of decline in emissions after the peak or the lower (or even negative) are the emissions required in the long run in order to achieve any given temperature target with the same probability. Recent analysis, commissioned by the EU's Climate-Change Science Experts, suggests that to reach 2 degree target emissions need to peak by 2015[4].

Finally, even if attempts to stabilise GHG concentrations in the atmosphere are successful it will not be possible to eliminate the effects of climate change. This arises because any feasible level of stabilisation of GHG concentrations in the atmosphere implies a higher level of global warming than has occurred to date, with consequent effects. Hence, the IPCC points out that action to address the effects of climate change (adaptation) is required both in the short term and the long term. It notes that adaptation and mitigation (i.e. reducing emissions) can complement each other and together significantly reduce the risks of climate change.

Resource Crunch: Climate, Water, Land, Food and Biodiversity

By 2050, the Earth's population is expected to increase from 7 billion to over 9 billion people. Coupled with higher expected living standards across the world, global GDP is projected to almost quadruple, despite the ongoing recession in some parts of the world. One of the most significant aspects is the increase in middle-income groups, that is those with daily per capita consumption ranging from $10 to $100. The middle class in non-OECD economies is projected to increase from 1.85 billion in 2009 to 3.9 billion people in 2030. In addition, by 2050, nearly 70 per cent of the world's population is projected to be living in urban areas. This will magnify challenges such as air pollution, transport congestion, and the management of waste and water, with serious consequences for human health.

Recent projections by the OECD illustrate that growing pressures on the earth's resources amounts to a real resource crunch.[5] By 2050, total commercial energy use may be 80 per cent higher than in 2010; global water demand is projected to increase by 55 per cent; competition between agricultural land use and other land uses will intensify; and terrestrial biodiversity may decrease a further 10 per cent. It also notes that in 2012, over 30 per cent of marine fish stocks are over-exploited or depleted, around 50 per cent are fully exploited and fewer than 20 per cent have the potential for increased harvests.

Government Request to the NESC Secretariat

Reflecting these challenges, in late 2011 the NESC Secretariat was asked by the Government to prepare two reports on climate change:

- An Interim Report on policy options that could close the distance to Ireland's GHG emission reduction targets in the period 2013–2020 for June 2012; and
- A Final Report in December 2012, to develop a basis for a long-term socio-economic vision to underpin effective national transition to a low-carbon future by 2050, incorporating the key messages of the Interim Report.

Structure of the Final Report

This report outlines our vision, a way of thinking about the challenge and our proposal for a pragmatic approach involving simultaneous action on three tracks. Our detailed analysis is available in our Interim Report of June 2012 and a series of Background Papers. A list of of abbreviations and glossary of terms provided at the end of this report.

Chapter 2

Vision: Purpose, Sight and Possibility

This report provides a basis for a long-term socio-economic vision to underpin effective national transition to carbon neutrality by 2050. We see value in setting out a clear vision for what we believe is possible: carbon-neutrality.

We also take uncertainty—about how to achieve this goal—seriously. For this reason vision needs to be combined with action and learning. All three are required to take us from the past to a better future. In Part II we discuss our approach to action and learning, which is structured across three tracks: strategic and institutional, exploration and experimentation, and design and implementation.

Here we outline our vision. There are three relevant dimensions to an effective vision—purpose, sight and possibility. Vision as purpose focuses on the importance of a motivating and credible statement of intent. It is something to work towards. Vision as sight involves recognising current realities and understanding the challenges ahead. Vision as possibility refers to disclosing new possibilities.

Vision as Purpose: Global Sustainable Development and Irish Carbon Neutrality

Our vision for a low-carbon transition by 2050 is as follows:

Vision for Ireland in 2050

Ireland is a carbon-neutral society, based on an approach to economic development that is socially and environmentally sustainable. We have a vibrant enterprise sector developing green jobs and economic opportunities. Our secure energy system draws heavily on renewable electricity. As a highly energy-efficient and resilient society, we use less energy and fewer resources in how we live, work and travel, and across the public sector. We enjoy the benefits of a low-carbon environment, enhanced for future generations, in terms of better public health and quality of life.

As a carbon-neutral society we are committed to neutralising the impact of human activity on the green house gases emitted into the Earth's atmosphere[1]. We will have achieved a carbon-neutral society by working ambitiously, domestically and internationally, to:

- Develop an effective EU and international approach to climate change that has contributed to falling global emissions while achieving increased prosperity and social progress in developing countries;
- Achieve, and where possible exceed, EU emissions targets—both those currently agreed and targets agreed in the future;
- Reform our public institutions and climate governance, in Ireland and internationally, to yield a dynamic problem-solving approach involving relevant departments, agencies and networks; and,
- Develop a participatory society and a commitment to social justice.

In working towards this vision, we identify five strategic building blocks which are particularly relevant to Ireland's carbon-neutral future. These are set out in Box 1 and are discussed in further detail later in the report.

[1] The concept of carbon-neutrality in Ireland is outlined in a paper by EPA researchers Gemma O'Reilly and Philip O'Brien[6].

Box 1: Five Building Blocks—Carbon Neutrality in Ireland

- **Renewable Energy**: An energy system built on wind and other renewables, using a smart grid and integrated into a clean EU energy system. Decarbonisation of the electricity system can be achieved by developing indigenous sources of renewable energy centred on wind, and using this resource to drive electrification of the wider economy. This will necessitate further development of Ireland's electricity grid and its integration into a clean EU energy system.

- **Energy Efficiency**: An energy-efficient society that uses renewable forms of energy for heating. Residential, commercial and industrial sectors will require higher standards of insulation and deep retrofit, smart-energy management systems, greater utilisation of biomass and will require active societal engagement.

- **Sustainable Transport**: A sustainable transport system which serves economic, societal and environmental needs. To achieve this Ireland needs to fully exploit technological developments, enable behavioural change and support more sustainable urban and rural development.

- **Towards Carbon-neutral Agriculture**: A world-class agri-food sector working within a carbon-neutral system of agriculture, forestry and land use. Ireland must become a world leader in the production, management and marketing of low-carbon, high-quality, sustainable food. This can be achieved by pushing scientific research and probing farming practice to identify further means of reducing emissions. It needs to be complemented by work within agri-food, marine, forestry and energy sectors that identifies, assesses and develops the carbon-sink or offsetting potential associated with land use, land-use change and forestry.

- **Resource Management**: An approach to resource management that provides a competitive and comparative advantage in international trade and factor flows. In a resource-constrained world the economic, social and environmental importance of land, water, marine, biodiversity—and, indeed, how we use waste—increases dramatically. Capturing this value in Ireland requires in the short term that we maximise the job-creation potential associated with clean technology goods and services; and in the longer term that we identify the ways in which our natural resources can underpin future comparative advantages.

Vision as Sight and Understanding

A key aspect of vision is that it is grounded in an honest assessment of past experience, current realities and future challenges. In the current context, vision as sight must include:

- Recognition of the advancing scientific knowledge of current climate conditions and likely future climate dynamics—which shows that climate change is happening faster than earlier research expected and strongly suggests that the existing trajectory of GHG emissions puts the world on track to dangerous levels of global warming;
- Acknowledgement of the underlying trends in global population, incomes, output, energy use and food requirements—which reveal a looming resource crunch involving climate, water, land, food and biodiversity;
- A hard-headed view of the UN climate-change policy process, the limited impact of the Kyoto Protocol and the reality of EU climate-change policy—which shows that a more credible and effective international approach to climate change is urgently required. It cannot wait for, and may not need, a global agreement on binding targets and timetables;
- A realistic view of the market-based instruments upon which the international process mainly relies—arguing that this seems to be based on an overly optimistic and theoretical view of the ability of current carbon pricing, emissions trading and existing technology to replace fossil fuels; and,
- A rigorous view of the three key analytical or cognitive issues involved in making climate-change policy, showing that: science can *widen* and not only *narrow* policy possibilities; uncertainty about policy and technology is endemic and undermines both predictive policy analysis and the search for an 'optimum policy'; and that, despite its value in certain contexts, much cost-benefit analysis largely reflects assumptions and normative judgements and has limitations as an agenda-setting and option-generating device.

These perspectives on international policy and instruments are outlined in a background paper on climate-change policy and politics. Vision as sight must also include a willingness to look at elements of our public system and prevailing policies that will need to be changed if we are to have a chance of making the transition to a carbon-neutral economy and society. As we discuss below, this is particularly relevant in a context in which, given the profound economic crisis, there is a recognised need for major reform of Irish public institutions.

In summary, vision as sight highlights three major developments and trends that must be taken account of, and if possible reconciled, in any analysis of Irish, or indeed international, climate-change policy. First, the science strongly suggests that the climate-change prospects are worsening and the task of prevention via emissions reduction is becoming more challenging. Second, there is an emerging acknowledgment that the dominant international approach to climate-change policy has not succeeded and faces major challenges. Third, it is clear that outside of the most developed countries there is strong growth of population, output, incomes, food consumption and energy needs and, as a result, expectations of future prosperity. No policy-oriented analysis can ignore any one of these three and all policy analysis and action must make some attempt to contribute to their reconciliation, however difficult that is.

Vision As Possibility: Revealing New Possibilities Through Action

The final aspect of vision is seeing new possibilities. While these are more often disclosed through action and experimentation than analysis or adoption of top-down strategies, our work does suggest that there are new possibilities in a number of areas that build on our existing strengths and where Ireland can be a world leader. These include:

- The carbon and economic efficiency of Irish agriculture and food production system;
- Know-how in areas such as wind energy and clean energy data systems and storage;
- A smart grid and ancillary technologies and business models; and,
- Test bed capabilities for socio-technological research and development.

A central thrust of our report is a reframing of the way in which agriculture is considered in, and relates to, the climate-change agenda. The importance of building on our strengths is also confirmed by emerging work on economic growth and, indeed, green growth. This suggests there are no general laws guaranteeing that green growth will automatically yield greater employment and productivity; however, there are significant *contingent opportunities* to be captured by particular countries and firms as discussed further in Chapter 6[7].

In this context, it is important to recognise that there are a number of existing practices in the Irish economy, public system and society that can support climate-

relevant actions. First, with our business profile in pharma, food and IT Ireland has significant strengths in process engineering and associated disciplines. Second, outside of the high-technology sectors, related disciplines are already present in food safety, food processing, animal health and traceability, and in many public sector bodies and social and voluntary organisations. In this report we draw attention to the remarkable environmental programme developed at Glanbia Ingredients Ireland (GII) and in other organisations. This reflects both its ability to use environmental management systems to improve efficiency in its plants, and its awareness that customers will increasingly demand assurance on the carbon footprint and other environmental qualities of its products. Indeed, Irish environmental policy is also well advanced in these approaches; for example, the EPA Green Business Initiative and similar initiatives train people in how to measure and better understand the environmental aspects of all the business/household processes they undertake. Third, as a small country—with a particular industrial history and severe public finance constraints—Ireland is not in a position to be a major investor in basic research and development (R&D) in many of the areas of energy and transport-related technology that will be central to global decarbonisation. But we can be a leader in process innovation, information and communication technology (ICT) and areas where the capacity of state agencies to conduct enterprise policy is important.

Our reframing of the climate-change challenge draws attention to the role of actions that already exist, or are at least continuous with existing practices in the Irish economy, public system and society. It positions the climate-change challenge as continuous with three of Ireland's major current projects: economic recovery and employment, building a sustainable innovation-based economy and public sector reform.

Finally, there is growing interest internationally in how to develop better governance systems in the area of climate change. This is an area where Ireland can offer real global leadership. There is little doubt in our minds that Ireland will make an enormous contribution to climate-change mitigation if we now build an institutional architecture suited to the nature of the climate-change policy problem as we discuss in Chapter 6.

Chapter 3

Thinking for Ourselves: Three Ideas

In its November 2011 statement, 'Review of Ireland's Climate-Change Strategy', the Department of the Environment, Community and Local Government (DECLG) argued that Ireland must move beyond a compliance-centric approach. The NESC Secretariat agrees strongly with this. To move beyond a compliance-centric approach is to see international institutions and agreements as a framework within which Ireland works out an effective course of action that is suited to our context and makes a real contribution to a successful international drive to manage climate change.

Over much of the past two decades, the international climate-change policy challenge and approach has been framed in a particular way. Policy analysis and development has been focused at the UN level, around the UN Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC) and the Kyoto Protocol. Reflecting this, the dominant framing of the climate-change challenge has emphasised the search for a top-down binding international agreement on emissions-reduction targets and timetables, the adoption of emissions trading as a central policy approach and a predictive approach to policy analysis.

In approaching this project, the NESC Secretariat tended to share the assumptions that underpin this framing: particularly the idea that climate science mandates specific policy actions, the need for a top-down global agreement on emissions targets and timetables, and the economic advantages and administrative economy of emissions trading. But undertaking this work has forced us to think more critically about each of these.

Our analysis suggests that three key ideas must inform the transition to a carbon-neutral economy and society:

- Climate-change policy is a loop not a line—so that there is a dynamic relation between 'how much' emissions reduction and policy action governments commit to and their understanding of 'how to' achieve decarbonisation;

- It is necessary to balance the policy emphasis on 'how much' emissions reduction to target with more focus on 'how to' decarbonise the economy and society; and
- The transition to a carbon-neutral economy and society must 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.

These three propositions derive from our understanding of the current realities facing climate-change policy and the challenge ahead, as outlined above.

Idea 1: Climate-Change Policy is a Loop Not a Line

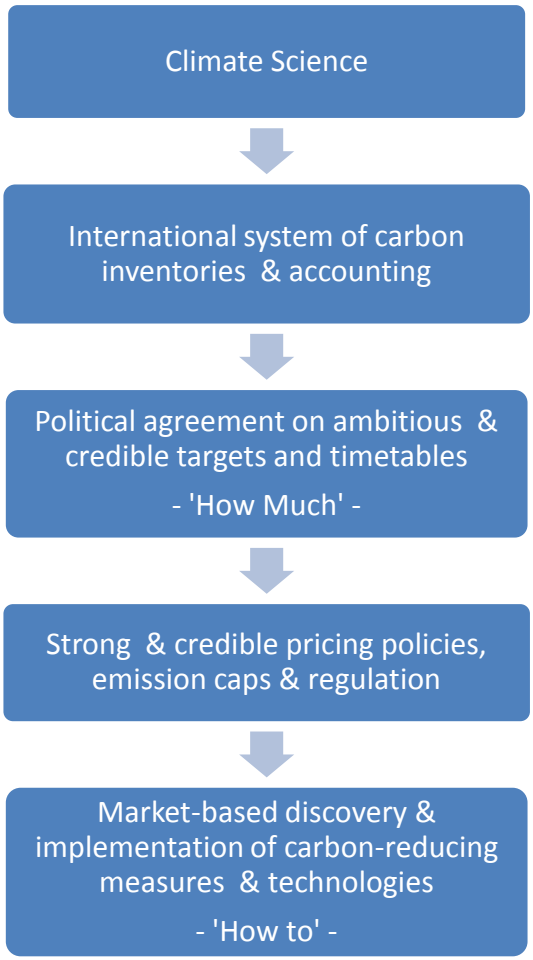
The dominant framing of the climate-change policy challenge suggests a linear process running from climate science, to global political agreement on ambitious and credible targets and timetables, to strong and credible carbon pricing, emissions caps and regulation, leading finally to market-based discovery and implementation of optimal carbon-reducing technologies and measures. This linear conception of the policy process is illustrated in Figure 1. It displays a number of features. One is that decision on 'how much' reduction in emissions to agree on is relatively independent of, and precedes, consideration of 'how to' achieve this. Another is a strong focus on high-level political actors, effectively governments acting together in the UNFCCC. A third is preoccupation with international negotiation of binding national emissions targets and timetables, usually on percentage reduction in the level of annual emissions. Finally, there is emphasis on emissions-trading schemes with global reach, as a central policy approach or instrument. There are many other strands of negotiation and policy development, but these represent the main thrust of the international process.

The international climate-change negotiations have conformed to this linear pattern to a surprising extent. Through the IPCC, the UN has generated a remarkable process in which knowledge and awareness of human-induced climate change has become firmly established worldwide. This is an achievement of historic significance and the IPCC is a critical resource. Through the UNFCCC, an agreed international system of carbon accounting and inventories has been established. For two decades, there has been intense focus on the search for global agreement of targets and timetables, most notably the 1997 Kyoto Protocol. Under this, national emissions-reduction targets were identified and rules for international trade of carbon credits and offsets have been established.

But, for the reasons summarised below, this approach to the climate-change challenge has not achieved its central objectives. Given the urgency of climate

change, this is increasingly prompting policy analysts, governments and others to think about alternative approaches which might have a better chance of creating an effective set of international policy responses to the profound threat that confronts humanity.

Figure 1: The Linear Framing of the Climate-Change Policy Challenge



A strong consensus among climate scientists has certainly, and correctly, had a profound effect. However, it has not been sufficient in mobilising binding inter-state agreement on action. This is not a criticism of climate science and scientists, but reflects the subsequent links in the dominant framing. It has proven extremely difficult to achieve a binding global agreement on emissions targets and timetables through the UNFCCC process. What was agreed, the Kyoto Protocol, has had a limited impact on the upward trajectory of global emissions. Twenty years into the global diplomatic process—with adoption of the Kyoto Protocol in 1997 and, subsequently, of the goal of limiting the increase in temperature to 2°C above pre-industrial levels—global emissions have continued to increase and the world may well be on course for a 4 to 6 degrees increase in temperature. In part, this reflects the fact that many countries, including those in the EU, agreed to emissions targets that mirrored the policies they were already planning to implement[8]. In other

cases, the targets and timetables did not have credibility and, indeed, countries such as the US could not deliver on them and subsequently left the Kyoto Protocol. In addition, the international system of carbon trading, including the EU's Emissions Trading Scheme, has generated weak pricing of carbon and has included offsets of variable validity and quality. In the fragmented carbon markets that actually emerged, countries with greater ambition to tackle climate change, such as the EU member states, find their efforts undermined by the lesser ambition of other countries. Market-based instruments, weakly applied, have not stimulated sufficient research, development and demonstration of technologies that can underpin a greatly-increased global supply of energy at a cost lower than the current fossil fuel-based system.

It is deep disappointment with these outcomes that is now forcing us and others to think critically about the dominant framing and international policy approach; to ask whether social science—politics, international relations, economics, innovation studies, sociology and organisational research—can both explain the continuing failure and suggest somewhat modified or additional approaches that might have a greater chance of success. It is possible that enhanced scientific knowledge—providing increasing evidence that damaging climate change is occurring and more severe effects are on the way— will have greater success in overcoming the political, institutional and other issues that have prevented effective binding global agreement and action on emissions targets and timetables. The presentation of the IPCC's Fifth Assessment Report (AR5) in 2014 will be an important event in this regard. But experience and analysis suggest that it is not prudent to rely on that happening fast enough or comprehensively enough. Consequently, it seems wise to also think about a combination of science, politics (including not only interests, but also ideas and norms) and practical disciplines that might work better than what has prevailed for over 20 years. It is this line of inquiry that is summarised in our three central ideas.

The first of these ideas is that, despite the increasing clarity of climate science, climate-change *policy making* and *policy* needs to honestly recognise and accept that it is more of a loop than a line. This is illustrated in Figure 2.

Figure 2: Climate-Change Policy as a Recursive Loop

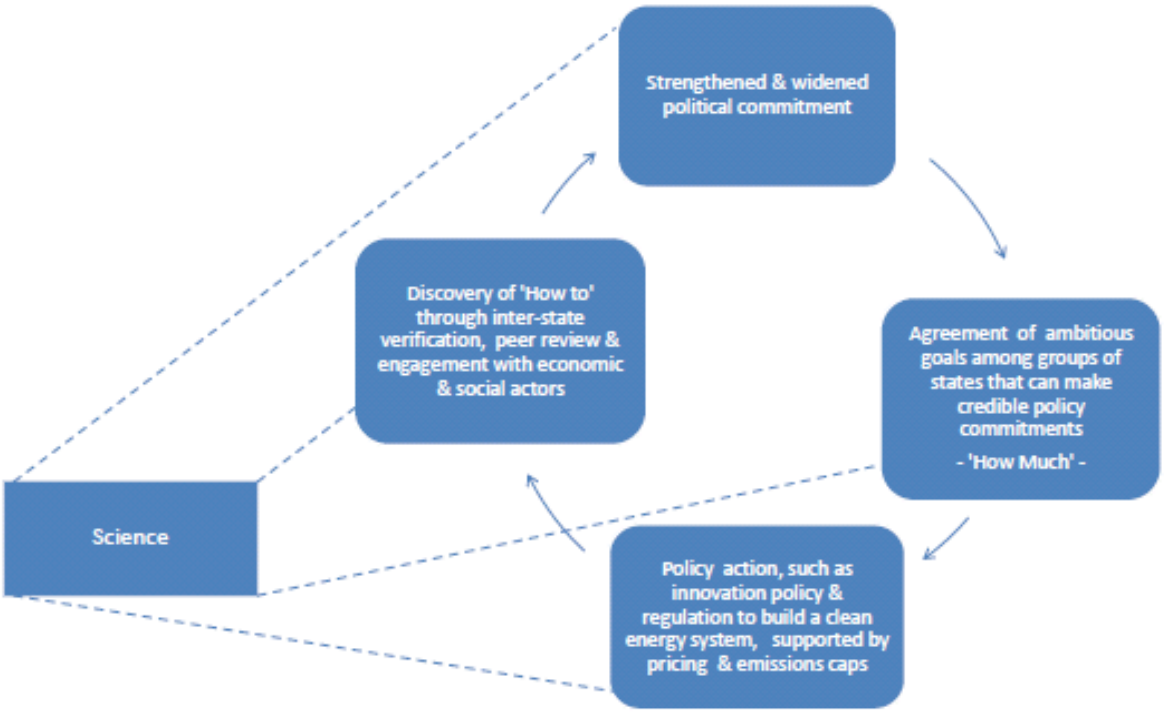


Figure 2 reflects a number of propositions that differ subtly, but significantly, from the dominant linear framing. Being a loop, it is possible to enter it anywhere. In overall terms, its central proposition, and its central difference from the dominant framing, is that in *policy making* and *policy* there is a dynamic relation between 'how much' and 'how to'—the left and right-hand boxes in the circular figure. This has three key dimensions—one concerning policy, one concerning politics and one concerning knowledge. The policy proposition is that it is the *credibility* of commitments, and their relation to *additional* policies, that governments can actually identify and implement, that matters in making an effective policy response to climate change. The political proposition is that governments will not generally sign up to binding commitments on emissions targets and timetables or policies, unless they know that they can, and their partners will, meet them. The cognitive proposition has two parts, which together are central to the climate-change policy challenge. The first is that no one knows how fast a large economy can decarbonise; certainly, no one knows how to achieve decarbonisation at the rate of 5 to 6 per cent per year over the next 50 years that seems necessary to keep global warming to 2°C—if by 'know', we mean knowledge of both technological possibilities and how to get policy adopted and implemented at international level and within states. But, equally, as we discuss throughout the report, there is a huge amount of activity and fine-grained knowledge on decarbonisation in firms, public bodies and civil society organisations.

Consequently, it would seem that climate-change policy is only likely to work if, as depicted in Figure 2, it creates a positive dynamic relation between:

- Advancing scientific knowledge of both current climate conditions and the dynamics of climate change;
- Increasing knowledge and technologies on 'how to' decarbonise;
- Strengthening and widening political commitment to effective action;
- Agreement on goals among groups of states that can make credible commitments on policies, which might take the form of emissions targets and timetables, and creation of verification procedures;
- Large-scale joint innovation and regulatory policies to stimulate the creation and deployment of new clean-energy systems;
- Creation of institutions for joint discovery and extension of knowledge of 'how to' decarbonise, and for verification of compliance and learning through detailed peer review and engagement with economic and social actors; and
- Deployment of pricing/emissions trading policies that send a strong and credible price signal to economic actors.

Ideas on elements like these are beginning to emerge in international discussion of 21st century climate-change arrangements and we believe that this should, and will, progress rapidly. As indicted in Figure 2, in this conception of climate-change policy science plays a number of roles. These include research on climate-change developments and dynamics, generating new possibilities for innovation on clean energy, industrial and agricultural systems and supporting learning on 'how to' decarbonise through performance review. One important element in this understanding of climate-change policy is the role of technological and organisational innovation in transforming policy challenges that are potentially divisive, because they are seen as costly, into steps that are more politically palatable. For example, the more renewable energy technologies are invented, scaleable and commercialised, the more governments will be willing to make ambitious policy commitments and strengthen carbon pricing.

This thinking reflects the normal process in which policy ends and means are explored and redefined together. Some believe that climate change must be the exception to this method of practical reason; it is an imperative of such seriousness and clarity that defined ends simply dictate known and necessary means. Although it is a truly exceptional challenge in many ways, we do not believe that climate change can be an exception to practical reason. Indeed, the evolution of the issue shows

that it is not, since there is already a shifting balance between mitigation and adaptation. And, if there is to be any hope of achieving the end in view, there has to be urgent reflection on (a) whether the main means tried for the past two decades really are known and necessary and (b) whether the end is best framed as global agreement on targets and timetables for percentage reductions in the increases in atmospheric GHG concentrations. Man-made institutions and the best of human practical reason—involving scientific method, problem solving, reflexivity and deliberation—are all we have. We cannot leap outside or above ourselves, appealing to either authority or theory, to find and impose targets and solutions beyond those we can create and agree down here.

Idea 2: Balance 'How Much' with a Greater Focus on 'How To'

Within international climate-change policy, the central debate on substantive commitments has always focused on one issue above all others—targets and timetables for reducing emissions. International agreement to emissions targets and timetables has tended to become the litmus test of belief in the reality of climate change and seriousness about addressing it, rather than analysis, discussion and comparison of *methods* of achieving decarbonisation. Despite two decades of strong focus on targets and timetables, emissions continue to increase. As noted above, we believe that this must, and will, increasingly prompt open examination of *why* the existing approach has not achieved its central goal and *how* sustained global decarbonisation can be achieved.

Consequently, our second idea is that there is a need to balance the focus on 'how much' emissions reduction and policy action different states commit to, with much greater exploration of 'how to' achieve a profound, gradual and permanent decarbonisation of the economy. The ultimate purpose of evening up the balance of attention is, of course, to increase the willingness and effectiveness of governments and other actors in *reducing emissions*. In other words, to get more real commitment and effective action on 'how much', it now seems necessary to put greater effort into finding out 'how to'—technically, politically and organisationally. And it remains the case that the science indicates the scale of emissions reductions required to avoid damaging climate change.

Our argument for balancing the focus on 'how much' with greater exploration of 'how to' has a number of elements. It is important to distinguish these in order to see why we are troubled by the weaknesses in the dominant international approach and that we are not opposed to the use of targets in climate-change policy.

First, there are reasons to fear that the dominant focus on emissions targets and timetables, and the search for binding global agreement and trading in these, is not well matched with the nature of the policy and diplomatic problem that states face and the policy approaches they adopt at domestic level (see Box 2). This helps explain why it is so difficult to reach global agreement on ambitious and binding targets and timetables. It also provides valuable historical and analytical insights that can guide the creation of a more effective international policy process.

Second, even below the level of high diplomacy, the arena of climate-change policy analysis and discussion displays some imbalance between the focus on 'how much' and focus on 'how to'. In much of the policy discussion, and also in publicly-funded research and innovation activity, there is less focus on how to create, develop and commercialise low-carbon energy, transport, industrial, agricultural and heating systems than we would expect.

The imbalance seems to prevail at lower levels partly because of the nature of the dominant international diplomatic approach and, reinforcing the effect, because of its continued failure of realisation. Given the difficulty in getting agreement on emissions targets and timetables, a large proportion of the cognitive and political energy devoted to climate change in the international policy community is applied to discussing targets and timetables and the construction of projections and roadmaps that reflect possible emissions pathways. It draws analytical and policy thinking towards generation of projections rather than study of substantive policy achievements or possibilities. Accordingly, it can be hard to tell whether a particular statement or document refers to a target, a projection, a prediction, a scenario, a backcast, a research finding, a model run, a plan, an actual policy measure, a policy measure yet to be implemented, a policy measure yet to be designed or an assumption about the chain of causation from a policy measure to an emissions outcome. Even where there is apparent exploration of possible ways to achieve decarbonisation, it can remain unclear whether these are really an exploration of substantive action, or are primarily designed to advocate the *possibility* and *affordability* of particular targets. The overall effect is that there seems to be more climate-change policy agreed, in place and understood that there really is. While all this work on scenarios and roadmaps undoubtedly has a role in creating the conditions for more effective future policy, it should not crowd out critical reflection on the strengths and weaknesses of existing policy and the efforts of firms and others to reduce emissions.

Third, these problems having been noted, an intelligent use of targets and indicators has a critical role in many aspects of climate-change policy. Our anxiety about the limits of the approach to emissions targets and timetables in the dominant

diplomatic search for a binding global agreement should not be seen as a rejection of targets in climate-change policy. In order to underline the important role of targets in Irish policy, we present our views on this when we discuss Irish policy in Chapter 6.

Box 2: The Mismatch Between the Central Diplomatic Focus on Targets and Timetables and the Policies States Actually Adopt

If most countries relied on a national cap-and-trade system, then international coordination of emissions targets and timetables might be an effective approach. But most states adopt hybrid policies—combining support for renewables and energy efficiency with (weakly applied) trading caps and/or pricing. Thus, there is a mismatch between international commitments and how governments actually implement policies. Because of this, targets and timetables have not produced the certainty that was seen as their great advantage. Governments have limited control over emissions, making it hard to make credible commitments. Commitments on targets and timetables tend to lack ambition for some, and be brittle for others; both inadequate, as regards climate change, and lacking credibility.

Much can be learned from the Montreal Protocol, the international treaty that has succeeded in addressing the erosion of the ozone layer. To make the emissions caps credible, the architects of the Montreal Protocol created an institutional mechanism to assess which 'essential uses' should be exempted from a nation's total allowable quota of ozone-depleting substances:

> as the obligations tighten so must the marriage between the design of regulatory instruments and what governments can actually deliver. In the Montreal Protocol, the most successful international air pollution accord in history, the shift to instruments designed for credibility—in that case, the system of essential uses—has meant, in effect, detailed coordination of national policies and technologies rather than blunt emission caps and timetables[9]

This suggests that where diplomatic agreement on emissions targets and timetables plays a role in international and EU climate-change policy, it is important that they be framed in a meaningful way and used effectively. The most important aspect of international emissions targets and timetables would seem to be their *credibility* and the degree to which they are effective, in the sense of committing states to truly additional measures . This depends on a number of factors, including a shared level of ambition and the creation of institutions and procedures for verification and performance review. Consequently, when setting targets and timetables, attention needs to be given to the institutions and procedures that can make them credible. History suggests that this involves detailed performance review which, in turn, requires the building of sophisticated international institutions.

If effective policy on climate change is a loop, in which learning 'how to' interacts with commitments and action on 'how much', then we must ask the following questions;

- At what level will it be possible for states and other actors to make binding commitments?
- Where is the learning on 'how to' decarbonise most likely to occur?
- Can the market-based instruments of pricing and emissions trading—as currently applied, or at levels likely to be agreed internationally—

incentivise sufficient innovation and diffusion of clean technologies to transform the energy system? (see Box 3).

- How can states and the EU create regulatory obligations if they do not know how profound decarbonisation is to be achieved?
- How will emerging knowledge on 'how to' decarbonise be captured, disseminated and used to strengthen and widen states' political commitments and popular buy-in to the climate-change policy project?

The answers to some of these questions are partly available in current realities:

- While governments have struggled for two decades to craft a strong, integrated and comprehensive global regulatory system for managing climate change, serious international cooperation is emerging below this level and from the bottom up[10];
- It is increasingly recognised that activity below the level of global treaty-making involves not only states but also sub-national authorities, firms and civil-society organisations;
- Internally, the EU is the most advanced example of environmental policy operating at a range of levels and using a wide spectrum of approaches;
- Where cap-and-trade does have an impact on overall emissions, it seems that it is its regulatory element (the politically imposed cap) and its institutional features (organisational capacity in public bodies and firms), rather than the trading or the 'market' aspect that does much of the work;
- There is widespread evidence of innovation below the level of the state, in Ireland and elsewhere—which is a finding that has greatly influenced our analysis and thinking and which we discuss further below;
- Countries with a long tradition of environmental policy, such as the Netherlands, have taken steps to create governance systems that engage actors at various levels in achieving a complex transition to a sustainable economy and society; and
- The most successful international regimes, such as the General Agreement of Trade Tariffs (GATT), the World Trade Organisation (WTO) and EU, involve groups of states that share a level of ambition. They draw contingent commitments from members, generate benefits that are available only to them and build institutions for verification and review. In contrast to the Kyoto Protocol, they create a dynamic that attracts non-members and, indeed, their standards tend to become global norms.

These developments and trends suggest that balancing emphasis on 'how much' with a greater focus on 'how to' brings into view action at a range of levels and scales below the global. Indeed, we argue that it requires a particular form of public governance, which is our third central idea.

Box 3: Climate Change and Market Failure

When effective responses to climate change are eventually created, they will probably include a significant and increasing price of carbon through a tax and/or tight emissions trading caps. But there are *five* market failures, not one, involved in the problem of climate change:

- The environmental externality arising because the damage of emissions is not priced;
- The innovation market failure, arising because knowledge becomes freely available;
- Network externalities creating 'lock-in' and 'lock-out' of technologies in energy systems;
- A financial market failure, evident in the limited ability of capital markets to manage the risks associated with large investment in new energy technologies; and
- Limited knowledge among economic actors on emissions properties and decarbonising options.

While carbon pricing has a definite role, it cannot be relied on to address all these market failures. Policies that create a visible increase in cost tend to meet political resistance. But beyond that, economic analysis is increasingly taking account of the dynamics of innovation; when this is done it highlights the primary role of innovation and energy policy, and the construction of a new regulatory and institutional landscape, supported by carbon taxes and emissions trading.

Idea 3: The Transition must Engage Actors at all Levels and in all Sectors, in a Governance System that Animates, Learns from and Pushes Networks to Ever-Greater Decarbonisation

The dominant framing of the climate-change policy challenge, as summarised in Figure 1, suggests a largely hierarchical, top-down approach, in which states and international organisations are the key actors; the major qualification is that market actors play an important role, but engaged mainly through the arm's-length signal of pricing and exchange. But when we answer the questions asked above, we are led to a different view of *where* and *how* innovation and learning on decarbonisation will occur and what is necessary to turn this into stronger national and international policy commitments and action. In particular, observation of activity below the level of international diplomacy draws attention to the amount of innovation in firms, public agencies and civil society organisations. This suggests that climate-change policy and the transition to carbon neutrality can only work if they engage a wide range of actors—including local authorities, public agencies, firms, researchers, civil-society organisations and communities and families—in exploring new possibilities and finding ways to learn from and generalise their innovations. Hence our third idea: the transition to a carbon-neutral economy and society must 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.

In one sense, it is obvious that climate-change policy must engage a wide range of actors. But our argument goes further, and relates to the *way* they are engaged and the way the *public system must be configured* to achieve this. One view, still essentially hierarchical, is that these layers should be engaged in the *implementation* of plans and policies, the content of which is set at UN level and by the EU and national government. Another, essentially corporatist, view is based on the idea that even if public agencies do not know how to decarbonise the economy, firms and other non-state actors do; then the state should either consult these groups or delegate to them, ensuring that their conduct is in the public interest. Neither of these forms of engagement will be sufficient.

Our argument is that all actors, state and non-state, face considerable uncertainty about how to achieve a profound decarbonisation and transformation to a carbon-neutral economy and society. The state (or the EU) cannot rely on lower-level implementation of known solutions, consultation to acquire the solid knowledge of others, nor wholesale delegation to achieve the desired goals. What it must do is organise joint exploration of challenges and possibilities.

NESC has explored this in its work on Ireland in the EU and public reform[11,12]. This form of 'experimental governance' involves four elements:

- Agreement on broad framework goals;
- Freedom for local and sectoral actors to advance these ends as they see fit;
- Duty to report and participate in comparative review; and
- Revision of both framework goals and local plans, and of agreed metrics, in the light of comparison and experience[13].

This approach, and the form of organisation necessary to make it work, is evident in many areas where EU policy and regulation have been most successful—reflecting the lack of a sovereign centre, the diversity of member states and the complexity of areas being regulated. As we note further below, it is also widely evident in firms, innovation networks, standard setting and, increasingly, in public authorities seeking to address complex problems.

Climate change is badly in need of such experimental governance, at international, EU, national, sectoral and local level. Given the shared recognition that climate change is a threat that must be addressed—but lack of global authority or binding

agreement and profound strategic uncertainty about how best to address the problem—there is little alternative but to animate action among networks at many levels and create institutions to learn from, generalise, and extend their successes.

A critical element in creating effective responses to climate change—in the context of limited global agreement, limited carbon pricing and uncertainty about solutions—is regulation. This is evident in many spheres, including energy efficiency, renewables, transport, agriculture and other areas. For this reason, it is of great importance that new models of international cooperation and revised approaches to regulation have emerged in recent years. These new approaches to regulation are much less prescriptive than traditional rule setting. As discussed in NESC's 2010 report, *Re-finding Success in Europe*, the EU sets framework goals and gives the regulated entity considerable freedom to pursue them as they see fit, subject to the condition that they report and participate in some form of peer review. Among the interesting developments and ideas in this area are 'rolling rule regimes' (which use regulation as a drive to continuous improvement), 'information-forcing' regulation and 'regulatory penalty defaults', which recognise that the richest information and expertise reside within firms and other organisations, but make it mandatory for these actors to engage. In many cases, this requires firms or other regulated entities to adopt and develop complex systems of data generation, monitoring and planning for improvement. These are often precisely the kind of processes that firms involved in emissions-trading schemes adopt in order to reduce emissions and minimise their need to buy credits.

These are particularly appropriate to the problem of climate change where, despite some strong general ideas about the areas where emissions can be eliminated, nobody yet knows how—technically, politically and organisationally—to achieve decarbonisation at the rate necessary to limit global warming. Although the EU has been a leader in development of such experimental regulation and governance in many spheres, such as the internal market and various areas of consumer protection, it seems not to have fully exploited this approach in climate-change policy, and it is certainly not the way in which it tends to project its role and action on climate change.

In Ireland, this approach is, in some respects, evident in the work of public agencies, but poses a challenge to the national policy and administrative system—which we discuss in Part II.

A Leading Role for Agencies

We see the transition to a carbon-neutral Ireland as a major challenge to the entire system of public governance, given the wide range of departments, bodies and

agencies that will have a direct or indirect role. But in getting this transition firmly under way in the coming years, we do see a particularly important role for public agencies and bodies. A number of these—such as EPA, SEAI, Bord Bia, Teagasc, Eirgrid, ESB, Bord na Mona and Coilte—have a direct role in the policy areas that are most relevant to decarbonisation. We see their role as a current example of a significant, enduring and positive feature of Irish development. Many of the most important successes of Irish public policy over many decades—in areas such as industrial policy, infrastructure, employment, technology, food safety, environment and agriculture—depended on the organisational capability and policy entrepreneurship of agencies and the non-state bodies they work with.

An agency is given responsibility for turning a government goal or policy idea into a programme and finding the non-state actors and organisations whose response is critical to the effectiveness of the policy. Policy development occurs as the agency learns from success and failure and adapts the programme accordingly. It also occurs because agencies tend to be key providers of both information and new ideas to departments. It is often such agencies that provide the most detailed *ex ante* cost-benefit analysis and *ex post* policy evaluation for the central policy system.

NESC's work on Ireland's experience in the EU identified the relatively strong performance of Ireland's public agencies in engaging in EU networks and mastering the disciplines of fine-grained monitoring, peer review and learning. Indeed, that report, and an earlier study, showed that public bodies in the environmental sphere—such as the Environmental Protection Agency (EPA) and local authorities—were among the leading examples of this innovative agency model[14].

To understand why this approach can work—and, indeed, is necessary—we should note a number of characteristics of contemporary economy and society studied in modern economic analysis, public administration, organisational studies and social psychology. These include the severe limits of *ex ante* knowledge of complex systems, the weakened distinction between conception and execution, the inability of central departments or other authorities to specify detailed policy solutions in areas where actors are diverse and problems are complex, the consequent framework nature of many 'policies', 'rules' and regulatory instruments as initially conceived, the critical role of organisational capability, the importance of learning-by-doing and the fact that both ends and means change as practical intelligence is applied to problems. These would all seem to apply in the area of climate change.

Bringing Firms and Organisational Disciplines into the Search for Solutions

Among the most visible and important practices of relevance to climate change are the organisational disciplines developed by firms in recent decades. These include environmental management systems, Life Cycle Assessment of environmental and social effects and industrial ecology. They use these disciplines to track and correct environmental impacts. An important feature of these environmental monitoring and management systems is that they are fully integrated into the firm's production system—alongside cost control, quality and safety. In some firms they are integrated into their upstream supply-chain processes and their downstream customer relations and marketing. As a result, they frequently involve not just internal changes, but flows of rich non-price information between firms, and between firms and public agencies. We see these practices and the related expertise as particularly relevant in thinking about Ireland's climate-change challenge.

These disciplines have potentially profound implications for the way in which climate-change policy is conducted. First, it is largely within these processes that it is possible to generate an informed view of both 'how much' emissions reduction is possible in the near term and, most importantly, 'how to' achieve this. Second, it suggests that states' ability to commit to emissions reductions on a given timetable, if that approach is continued, will be dependent on the quality of their engagement with enterprises and NGOs. Third, some argue that these disciplines will eventually yield a new era of 'ecological intelligence' and radical transparency in which consumer demand will become a major driver of low-carbon production[15].

In conducting our work on this project, we were repeatedly struck by the ambition and capability of firms, and other civil-society and public-sector organisations, to understand and reduce their carbon footprint. Box 4 provides a flavour of the activity underway in firms, public sector bodies and communities. Many of these cases confirm a key feature found in international research on cutting-edge organisations: the monitoring of environmental performance (such as energy use, waste and carbon footprint) are embedded within the core business processes, such as production, quality assurance, cost management, logistics and innovation.

Box 4: Reducing Carbon— Business Examples

Bewley's Coffee aims is to be carbon-neutral and based on an ongoing programme of energy and resource efficiency within its production facility and by working closely with agricultural suppliers, located in developing countries, to improve their farming and production practices.

Celtic Linen are using carbon accounting and a KPI system to focus attention on reducing their carbon footprint. Work includes a trial on the performance of EVs and gas trucks.

Bord Na Mona defines its missions as establishing a 'A New Contract with Nature' that will underpin its transition to become one of the largest renewable energy companies in Ireland, and a leading provider of sustainable products and services both at home and internationally.

Glanbia Ingredients Ireland has created a sophisticated process by which it assists farmers to farm more efficiently and reduce emissions. The project was supported by Bord Bia and the methodology and calculations were accredited by the Carbon Trust in the UK.

Carbon Disclosure Project is a not-for-profit organisation which supports companies to disclose and drive down their greenhouse gas emissions and use of natural resources.

Business in the Community is working with its corporate members to be more responsible and sustainable including running specific community-based projects. The Business Working Responsibly Mark is awarded to organisations with responsible and sustainable practices.

Glen Dimplex are developing smart electric storage heating system and are testing this in partnership with the Greenway. The system is expected to offer more flexibility to the consumer and the capability of communicating with the electricity supplier which means that the system could be set up to maximise the use of surplus wind-generated electricity.

Kingspan has won several sustainability/ green business awards for innovative products which reduce energy consumption. It is actively engaged with suppliers and customers in relation to sustainability, for example producing an 'end-of-life management solutions' for building products.

Cylon's Energy Operations Centre manages time schedules, temperature set points and optimises clients heating/cooling systems. It can benchmark energy performance across buildings.

Matthews Coach Hire implemented an ongoing fuel efficiency project which includes elements such as, driver training, GPS tracking of vehicles, fuel use monitoring and upgraded vehicle servicing.

Crowley Carbon is an energy services company installing energy saving products in client companies. It can conduct an energy audit of any business and offer recommendations.

Avego provides Real-time Ride Sharing (RRS) services using GPS, web and mobile technologies. It is car-sharing which uses new technologies to put the driver and passengers in contact.

EMC undertook a 'Free Fresh Air Cooling' project in 2011. The project uses Ireland's cooler climate to air condition data centres rather than doing so by mechanical means.

Pfizer 'YOU Have The Power' is a communications platform designed to change the attitude and behaviour of employees at Pfizer Newbridge.

Public Sector and Local Community Examples

Kilbarrack Fire Station staff with support from Dublin City Council developed a 'green plan' which has lowered the stations carbon footprint. Harvested rainwater is now used in fire engines. Biodiesel made from cooking oil collected from fish and chip shops across Dublin is being used to reduce fire engine running costs by €150,000 per year. The initiative achieved a 90 per cent reduction in water consumption and more than 80 per cent reduction in energy consumption. A key feature of the plan is that savings have been ring-fenced by DCC and are being used to fund investments in Kilbarrack and other fire stations. Careful monitoring of energy use, with outside

verification by SEAI, provide an evidence base for further retrofitting in other stations[16].

Large Industry Energy Network (LIEN) is a voluntary grouping, facilitated by the Sustainable Energy Authority (SEAI), of companies that work together to develop and maintain robust energy management. 140 of Ireland's largest energy users are members.

Origin Green is an iniatiative organised by Bord Bia to make Ireland a world leader in sustainability in the area of food and drink. The programme began in mid-2012 and in January 2013, 164 comapnies, accounting for almost 60 per cent of exports, had signed up to Origin Green.

EPA Green Business Initiative is a collaborative programme to develop leadership and best practice in relation to resource efficiency in specific sectors including hospitality, healthcare and farming.

Dublin City Council have a Climate-Change Strategy, Dublin City Sustainable Energy Action Plan are signed up to the EuroCities Declaration on Climate Change. They have identified good practice across areas including energy, waste, economy, water, biodiversity and parks, society, transport, procurement. It carriers out an indicator report to benchmark Dublin internationally.

GAA is working at a national level to develop processes and methods to help communities carry out sustainable energy projects. Work will focus on barriers to investment including finance, organisation and project management, and attitudes and behaviours.

Codema is one of 14 Local Energy agencies operating in Ireland. It works with public and private sectors to create sustainable solutions for Dublin, including residential, business and infrastructural projects, such as Ballymun Regeneration, Green e-Motion and Dublin District Heating.

Sustainable Energy Communities is SEAI-led work in which local authorities are supported to become mentors in the promotion of sustainable energy measures in the local economy. Three exemplar communities have been designated as 'living laboratories' in 2012 (with a further three to be launched by 2015).

National Waste Prevention Programme, led by the EPA, integrates a range of initiatives to prevent and minimise waste. It focuses on awareness-raising, technical and financial assistance and training and incentives. Some of the networks the programme has funded are the Local Authority Prevention Network; Green Business Initiative and, building on Green Schools , a Green Home pilot.

University College Cork installed a 1 MW Ground Source Heat Pump (GSHP), in 2011. Ground water is the main heat source with heat rejected from a server room as a secondary source. Reduction of up to 56 per cent of CO_2 emissions and energy savings of 4.5 GWh have been achieved to date.

Tralee Town Council Mitchel's Boherbee Regeneration project involved the upgrade, in 2008, of 42 residential units. Central to the overall project is a renewable wood chip fuelled district heating (DH) system providing all space and hot water needs.

Green Schools, is run in Ireland by An Taisce. The programme has saved schools in Ireland nearly €9m in reduced waste, electricity, and water costs over the school years 2010–2012.

Camphill-Ballytobin, houses 85 people on an eight hectare site including a primary school, workshops and community hall. Since 1999, it has used biogas to heat houses and other buildings on the site. It also collects waste from local farmers and delivers treated soil back to farmers.

Transition Town Kinsale is a voluntary community initiative working to help make the transition from a dependency on fossil fuel to a low-carbon future. Their vision is a resilient, self-reliant and sustainable Town. Kinsale Town Council adopted their Energy Descent Action Plan in 2006.

Behavioural Research and Social Practice

It is widely agreed that progress to carbon neutrality will require profound change in the behaviours which traditionally generate carbon emissions—such as transport, consumption, farming, waste management and heating. Insights and evidence from social and behavioural research—including transition management, (see Box 5)—can help us embrace the complexity of what drives action and inaction. In the short term, such evidence can help inform the design, application and evaluation of mitigation policies and measures, such as home energy-efficiency schemes and transport initiatives to encourage modal shift. In the longer term, such evidence and practice can support a societal shift towards more sustainable systems and social practices as part of a carbon-neutral society. We develop these ideas further in a background paper.

Policy efforts to change behaviour traditionally rely on the 'information deficit model', which suggests that the provision of the right information and incentives will change behaviour. However, it often has limited impact, since behaviour is shaped by context, social norms, cultures and institutional constraints. Such behaviours and wider social practices are more effectively addressed as part of an integrated economic and social approach, particularly when long-term change is required.

This 'practice' approach can help us address some of the key challenges facing Irish policy—especially in agriculture, transport and the uptake of energy-efficiency opportunities. While social practices are resilient, change does occur, triggered at both the individual level by new ideas and behaviour, but also through interaction or a change in the material elements (such as new technologies). Indeed, we believe that Ireland can be an influential test bed for initiatives of this kind. It is a country in which there is considerable innovative cross-fertilisation between business, society and public governance. But, as shown in the NESDO report, *Ireland at Another Turning Point*, supporting cross-fertilisation, and learning from it requires profound changes in our institutions, particularly the systems of accountability in the public sector.

Box 5: Transition Management

There is increasing recognition that we need to think about how whole economic, social, technological and cultural *systems* change. The challenge of system transformation has long been discussed in the Netherlands and is of increasing interest internationally. This thinking was developed against a background of failing Dutch environmental policy[17]. Despite the fact that actors were willing to change to environmentally friendly modes, they were incapable of changing because of the high investment costs and institutional constraints. This prompted thinking about how individuals and organisations work within systems.

The policy and coordination problems that need to be solved arise from a number of facts:

- System transition involves fundamental social, technical, political and institutional change, and necessarily involves all levels of society, from government to grass roots action;
- Some degree of shared vision is needed, but the centre cannot design and implement system transformation;
- Most radical innovations occur in niches, but generalisation of these can be blocked unless there is supportive change in wider regimes.

The methods of 'transition management', 'adaptive management' and multi-level governance are designed to work in this context. They are learning-oriented approaches that accept the limits of our prior knowledge and understanding. Consequently, they emphasise the importance of a continuous cycle of action, innovation, reflection and learning, with modification of initial goals and over-arching frameworks designed to institutionalise new practices.

The Advantages of a Multi-level Experimental Approach

In summary, our argument is that we need a multi-level, experimental approach to address the climate-change challenge. We see such an approach as virtually inevitable at global, EU and national level, given the difficulty of agreeing and implementing a unitary, binding, top-down agreement on emissions targets and timetables.

The advantages to this approach lie in both achieving international agreements and in making them truly effective. It is important to see that the case for this approach is not just a second-best option, given the difficulty of achieving a binding global agreement, nor is it based on a naive belief that 'bottom-up' or purely private, local, and uncoordinated approaches can reverse the huge demographic and economic forces driving increased global carbon emissions—the 'every little helps' fallacy.

Instead, we see the case for this approach is rooted in a combination of the following arguments.

First, experience shows that, contrary to what is assumed in much social science, lower-level cooperative action on environmental 'common-pool resource' problems can happen and can make a contribution[18].

Second, even when an effective global governance approach to climate change is created (which has not happened to date), it is unlikely to work if not backed up by a variety of efforts at national, regional and local level. It would require support ranging from national implementation of legislation to national and sub-national monitoring and enforcement activities. Furthermore, such monitoring and enforcement activities are likely to require the active participation of non-governmental organisations at local level. In other words, *effective* global governance institutions are inevitably multi-level in nature.

Third, although it seems true at first sight, it is neither empirically nor logically true that a global problem can *only* be addressed by a unitary global governance arrangement.

Fourth, given the degree of uncertainty about 'how to' achieve decarbonisation, the very formulation of effective international approaches will be impossible without drawing on efforts at regional, national and local levels. Climate change is a problem to which no one yet knows the best solution, and in which effective approaches are likely to differ across contexts. Consequently, experimentation and learning are indispensible. A pluralist approach, operating at various scales, provides greater opportunity for experimentation, choice and learning. Indeed, it is important to recognise that the benefits will be experienced at multiple levels. Experimentation and new practices which reduce emissions will also reduce costs for individuals, for example of heating one's home; and improve health and well-being, for example when someone cycles to work rather than drives. In this sense an important motivation for action on climate change are the co-benefits that arise for households, companies, public sector organisation and communities. Our background paper on behavioural aspects of climate change provides further evidence of the co-benefits.

Finally, together these arguments suggest that credible and effective international action to address climate change cannot wait for, and may not need, full *global* agreement on binding targets and timetables. In this context, in her 2009 paper on a poly-centric approach to climate-change, Ostrom states that the likelihood of developing an effective, efficient, and fair system to reduce greenhouse gas emissions that can be rapidly initiated at the global level appears to be very low. However, given the severity of the threat, she argues that, simply waiting for resolution of these issues at a global level, without trying out policies at multiple scales because they lack a global scale, is not a reasonable stance. We agree and suggest that pending the emergence of an effective global governance approach, there are many reasons to vigorously pursue actions at many levels involving a wide range of actors—including international and supranational entities like the UN and

EU, states, public agencies, regions, firms, civil-society organisations and communities. At the same time, we remain aware that these actions must inform the yet-to-be-created effective governance systems at a high enough level to stop increasing global emissions.

The EU is, in most respects, the world leader in the development of a multi-level approach. Nevertheless, this strength can be camouflaged by its heavy emphasis on the UN-based quest for a global agreement and its reliance on the ETS and national targets and timetables, with insufficient peer review and learning.

Chapter 4

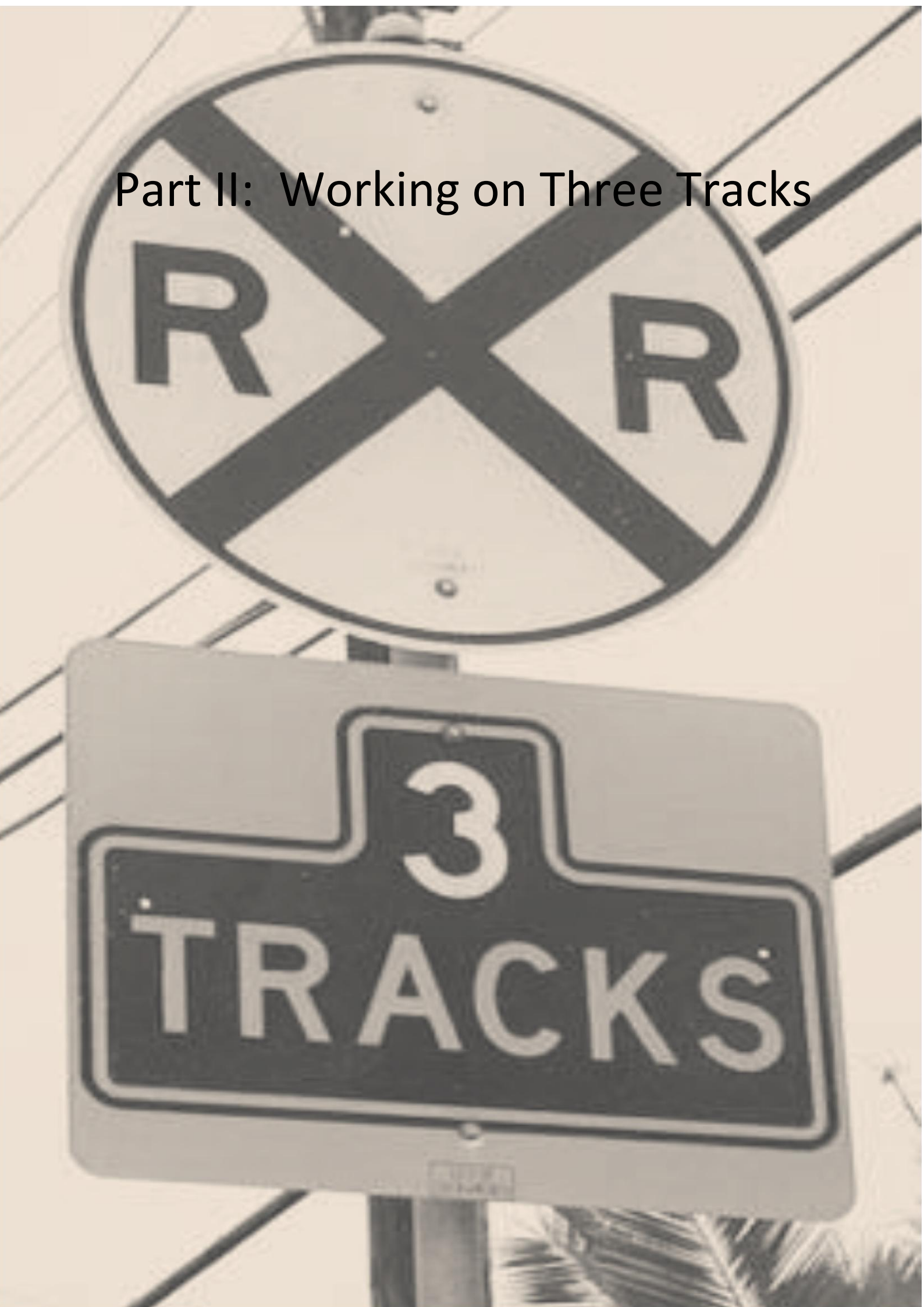
Our Approach: Guiding Principles

The NESC Secretariat emphasises five key conditions and principles that have guided its work and should be reflected in Ireland's strategy to become a carbon-neutral society. These principles have important implications that we explore throughout our work. Here we briefly sketch the meaning of each.

- **Economic prosperity, recovery and social development:** Actions taken to transform energy and reduce carbon emissions must be consistent with economic recovery, employment generation and fiscal correction in the coming years, and with increased Irish prosperity, well-being and social development in the decades ahead;
- **Decarbonisation:** The purpose of both national and EU climate-change policy is the incremental, widespread and permanent decarbonisation of the global economy;
- **Responsibility, integrity and leadership:** Irish actors—both public and private—must take responsibility for achieving the transition to a carbon-neutral Ireland. Ireland needs to have a clear voice in the EU and international climate-change policy process reflecting our concerns about an international policy process that has had limited impact, our interests, and Ireland's long-standing commitment to economic and social progress in the developing world. Finally, Ireland should have the ambition to be a global leader in those areas where our natural resources and capabilities allow us to make a distinctive contribution to addressing one of humanity's greatest challenges—some of which we identify in Part II;
- **Reform of public institutions and governance:** Ireland is formulating its strategy for transition to carbon neutrality at a time when we recognise that our public institutions and system of governance, at a range of levels, have weaknesses that have led to profound economic, social and fiscal crisis. Our work, on this and other projects, confirms that Ireland has many of the micro-economic requirements for a vibrant economy and a high degree of social capital; these can only combine to create overall success, where public systems of governance, resource allocation, conflict resolution and policy learning are effective. All our goals, carbon neutrality included, depend on successful, deep, public reform; and

- **Societal engagement:** While strong policy drivers and technological developments will support the achievement of Ireland's vision, without active societal engagement as to the importance of— and the development of solutions for—energy and resource efficiency, it will be not be achievable. Critical dimensions of carbon neutrality must include sustainability education, positive community participation in local decisions and effective national communication on climate action.

Part II: Working on Three Tracks



Chapter 5

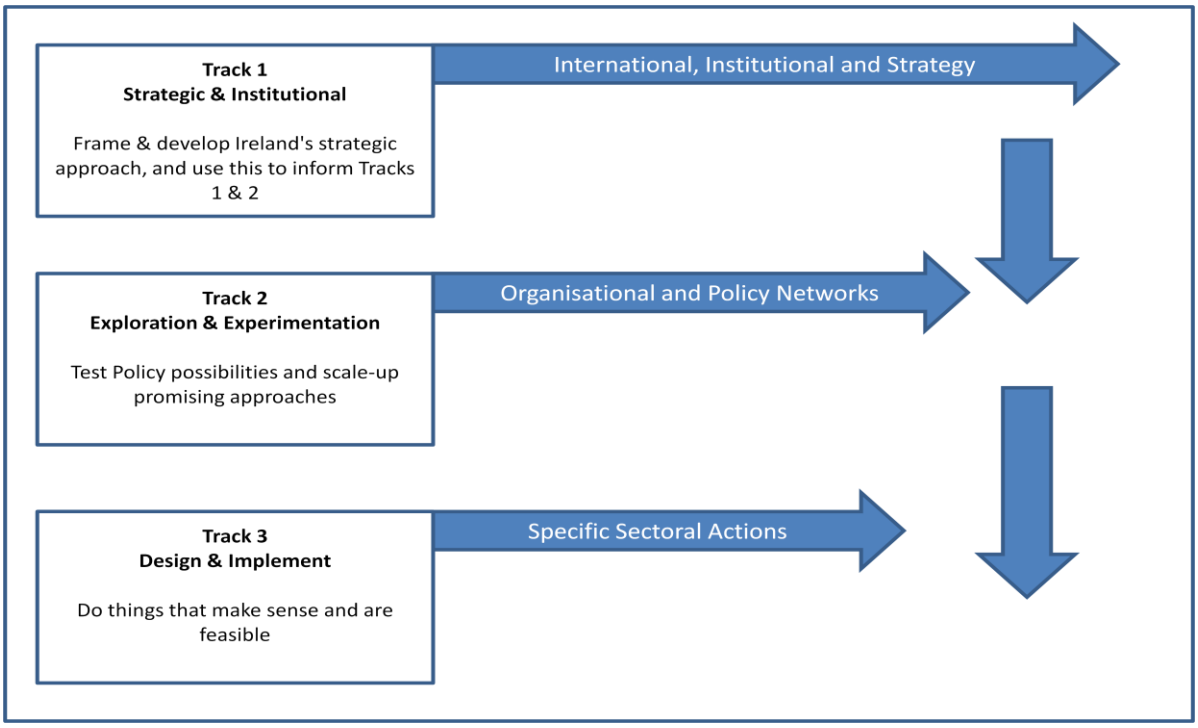
A Three Track Approach

The experimental approach informs our analysis and argument throughout this report. As noted, it prompts us to be honest about the limits of existing UN and EU approaches to global targets, timetables and trading regimes. It also prompts us to focus on the conditions that will enable action at several levels, involving international regimes, the EU, the state, firms and social organisations. It demands that we think about a public governance system that both encourages and can systematically learn from innovation—which, in the area of climate policy, does not yet exist in Ireland or the EU. It suggests we think very seriously about the way in which public agencies, firms, experiments and local initiatives can feed into and inspire national and, indeed, international efforts.

To move Ireland towards a becoming a carbon-neutral society, the NESC Secretariat proposes a pragmatic three-track approach. All three tracks should begin *immediately* and proceed *simultaneously*; what distinguishes them is the kinds of action required in each:

- **Track 1: Strategic and Institutional**: Ireland must frame its ongoing engagement with EU and UN climate-change policy reflecting its analysis, judgements and commitments to the developing world; create effective domestic institutional arrangements for policy analysis, decision and development; and identify its strategic approach to decarbonisation, energy policy and green growth. These strategic directions and institutions, should inform the actions in Tracks 2 and 3, and, in turn, be adapted in the light of experience.
- **Track 2: Explore and Experiment**: In a number of areas it is necessary to consciously explore policy possibilities and experiment—building policy and organisational networks to test and scale policy possibilities—using effective institutional arrangements to learn from these in a disciplined way.
- **Track 3: Design and Implement**: Where early action makes sense and is feasible, what is required is to design and implement policy.

Figure 3: Three Track Approach



We outline each of these three tracks in Chapters 6, 7 and 8 respectively.

Chapter 6

Track 1—Strategic and Institutional Action

This chapter focuses on the first of our three tracks: strategic and institutional action. The aim of work in Track 1 is to develop and frame Ireland's:

- Ongoing engagement with EU and UN climate-change policy;
- Effective institutions for policy analysis, decision making, evaluation and learning;
- Strategic approach to decarbonisation and green growth; and
- The strategic elements or building blocks of Ireland's approach.

Here we briefly discuss each of the elements, using the illustrative maps, starting below, to guide the reader.

Ireland's Engagement with the Evolving EU and International Approach

Ireland is a respected participant in the international system of carbon and climate-change accounting. Ongoing engagement needs to be framed by the following considerations.

First, Ireland must develop and articulate a realistic and honest view of the main UN and EU approaches to climate-change policy. In this report we highlight the limited impact of the existing international instruments and the challenges which confront the dominant search for a binding global agreement. We draw attention to the reframing of the climate-change policy challenge, which is already underway and will gain momentum. This has implications both for the way in which Ireland pursues its own interests and engages in discussion and diplomacy on how the climate change challenge can and should be addressed. Given the increasing scientific evidence on the speed and likely effects of climate change, Ireland should actively engage with and contribute to, new thinking on designing a new 21st century climate arrangement.

We emphasise that our analysis does not imply rejection of a UN role. The United Nations Framework Convention on Climate Change (UNFCCC) will remain the umbrella under which many global efforts unfold. The proliferation of transnational climate-change initiatives and governance will require significant orchestration if it is to be effective in innovation, implementation and learning. Such orchestration is particularly appropriate for an international organisation, such as United Nations Environment Programme (UNEP), that lacks strong hierarchical authority. The seeds of more effective policies to address climate change almost certainly lie within the range of institutions and processes that have developed over the past two decades: the remarkable scientific and carbon accounting architecture, the yet-to-be-effective UN policy process; the EU approach which has several strands of varying effectiveness; the many initiatives and practices taking place 'below' and beyond those levels—involving states, firms and civil-society organisations; and, additional approaches not yet adopted, or not yet adopted on a sufficient scale, of which coordinated innovation policy and R&D are the most obvious.

Second, Ireland must continue to be an active contributor to the evolving international treatment of agricultural emissions, land-use, carbon sinks and sequestration. In the context of food security and rising world population, there is a need to improve the understanding of agriculture and how it can contribute to the ambition of reducing global GHG emissions, while increasing food output. A crucial input into this process over the coming years will be detailed scientific knowledge—for example, about soil sequestration and the impact of changing land management practices. The relationship between Ireland's in-facing work and the out-facing engagement is, therefore, critical. There is a close and collaborative relationship between the bodies working in these areas, namely Teagasc, the Department of Agriculture, Food and the Marine (DAFM) and EPA. This is a significant strength. Indeed, in this area Ireland should explore the possibility of bi-lateral or multi-lateral initiatives in areas of climate-change policy and carbon accounting. In a similar vein, Norway has developed bi-lateral relations with Indonesia on forestry, given its distinctive endowment and capability. Ireland is already a founder member of the Global Research Alliance on Agricultural GHG Emissions, whose objective is to pool the resources of likeminded countries to enable the agriculture sector to continue to reduce emissions.

Third, Ireland should adopt a clear and principled position on the emerging EU inter-state market in carbon credits. This has two elements. One is that some purchase of carbon credits may be necessary to meet Ireland's cumulative gap-to-target for the period 2013 to 2020. We discuss estimates of the possible amount and costs in Chapter 8 on our Track 3 'design and implement'. The option of buying allowances is a useful flexibility. But we should not rely on this approach to meet the targets, since

it would not contribute to the long-run transition to a carbon-neutral economy and is likely to imply high annual costs of buying compliance after 2020.

But Ireland's struggle to meet its, relatively demanding, 2020 emissions target should also make it a voice for reform in the EU. The EU is effectively creating a new inter-state cap-and-trade regime. The experience of two decades of international emissions trading (we cited the Montreal Protocol in Box 2), demonstrates that cap-and-trade can work when the cap bears significantly on some states and when trading is embedded within institutions that can mobilise detailed performance reviews. There is a danger that the post-2013 trade in excess allowances between EU member states will have an insufficient information content—revealing only prices and quantities, but not *why* some member states have over-achieved their target and others have fallen short. Our analysis highlights the need for an effective system of member state learning on 'how to' achieve decarbonisation. While there are monitoring and reporting requirements in place in the EU (and, indeed, the UN), it is not clear that they greatly assist member states in benchmarking performance and learning from each other on effective ways of making progress towards a low-carbon economy. If the EU is to continue with national targets and timetables, it must do so in a way that builds these from policies and measures that member states can undertake and embed this in a more developed system of performance review and diagnostic monitoring. Where European discussion of national decarbonisation strategies and/or targets and timetables draws on climate and energy models, it is important that Ireland bring analytical tools to bear—such as the models developed in Irish universities and research institutes.

Fourth, more than anything in this whole policy sphere, the EU needs an effective internal market in energy, regulated in a way that encourages the vast investment in clean generating capacity and networks that are necessary both for economic and low-carbon reasons. This needs to be supported by a large pan-EU investment programme in networks and R&D. It is possible that more will be achieved—not only in securing Europe's economic future, but also in moving towards a low-carbon European economy—if the energy and resource-efficiency agendas are given a lead role. But this highlights how far the EU is from a true internal market underpinned by widespread green generating capacity and continental interconnection capable of combining Europe's wind, solar and other green-energy resources. This is a major project of European integration upon which the EU's ambition on climate change depends.

Fifth, Ireland must maintain its commitment to climate finance. Climate finance refers to financial flows from developed to developing countries to cover the additional costs associated with climate-change adaptation and mitigation. The issue

of climate finance forms part of the UNFCCC agreements. At the UNFCCC conferences (COPs) in Copenhagen (2009) and Cancún (2010), the EU and other developed countries made a commitment to provide Fast Start Finance (FSF) in the period 2010 to 2012 and, in the longer term, to mobilise US$100bn per annum by 2020 from a wide variety of sources (public, private, bilateral, multilateral and alternative sources). Ireland met its FSF commitment (2010 to 2012) contributing approximately €110m, which is in excess of the original voluntary pledge (of up to €100m from public funds). The FSF contributions were sourced from Irish Aid, the Department of the Environment, Community and Local Government and the Department of Agriculture, Food and Marine. There is no clarity or agreement on pathways to reach the 2020 goal for developed country support as provided for in UNFCCC COP agreements. Countries are required to examine how they would approach the scaling up challenge and to report on this by November 2013. This will be challenging. Key challenges include how to mobilise private sector funding, and the tracking and monitoring of these resources for effectiveness. Public funding for climate finance is constrained by the economic and fiscal conditions. Nonetheless, Ireland has stated that it aspires to maintain up to existing levels of climate relevant expenditure in 2013.

Our analysis and argument on the UN and EU is not a reassertion of a realist, national self-interest approach to internationalism and Europeanism. In our view, it reflects an aspiration that the international and European processes be the very best they can be. That they live up to their true, unique potential, to govern complex domains in the international sphere without creating a new supranational sovereign. They can create effective governance frameworks where there is diversity, divergence, complexity and uncertainty about the best way to deal with various problems. Indeed, given the seriousness of the global-warming challenge they must urgently do so.

Effective Institutions for Policy Analysis, Decision Making and Policy Development

The Institutional Issue

The second element of our Track 2, 'strategic and institutional action', is the design of effective processes and institutional arrangements for policy analysis, decision making and policy development. While Ireland has had real successes— such as the developments in wind energy, the smart grid, vehicle taxes and energy efficiency—

overall the policy process and institutions have not worked as well as they might in making and implementing climate-change policy. There is a strong sense that the process and institutions need to be improved.

To date, in Ireland and elsewhere, discussion of institutional arrangements for climate-change policy has tended to focus on the need to create an independent, high-level, advisory body and the legal framework within which it would relate to government. Indeed, the UK has adopted this approach with the creation of the Climate Change Commission. This focus reflects a number of features of the climate-change problem, including the significant role of climate science, the global dimension, the combination of long-term threats and short-term costs, the associated challenge of achieving political commitment across government, and the technical nature of the main action areas, such as energy, transport and efficiency.

There is no doubt that these features of the climate-change problem make it a very particular challenge to the institutions of modern democratic government, one which no country has solved entirely satisfactorily. While certain key features of the issue definitely prompt the urge to create a commission that is high-level, expert and most of all, independent of government and politics, this can militate against achieving real commitment, technical engagement and action *within* government and its agencies. A thoughtful discussion of these issues was provided by Curtin and Hanrahan in 2012, including analysis of several legislative and institutional models[19]. They identify many of the dimensions that need to be considered in designing a climate policy process and institutional framework. We are in agreement with several of their main arguments. They emphasise the need for a 'virtuous policy cycle and a robust management framework for abatement and adaptation' and the need to 'avoid inclusion of vague or excessively onerous target setting, [and] weak reporting and accountability mechanisms'. What our analysis adds is greater emphasis on the need to explore mitigation possibilities, and the role of public agencies, firms and civil society organisations in doing that; this, in turn, highlights the associated challenge of creating an institutional mechanism for learning from, generalising and pushing these actors to ever-greater decarbonisation.

Designing Institutions to Fit the Policy and Innovation Process

If the climate-change policy challenge has the characteristics we have identified, what process and institutional development is necessary? In addition to the features of the issue commonly discussed, and noted above, our analysis and the emerging international discussion identifies the following:

- Climate-change policy is in need of a more experimental approach at various levels;

- The climate-change policy challenge is a loop not a line, in which there is a dynamic relation between 'how much' and 'how to';
- Profound innovation is needed to create, scale and commercialise the carbon-free alternatives to traditional energy, transport, industrial, agricultural and heating systems;
- Nobody yet has a reliable view of how—technically, politically and organisationally—to achieve the necessary pace and scale of decarbonisation;
- Yet experimentation and innovation are widespread in Irish firms, public agencies, research bodies and civil society organisations;
- Much of the relevant innovation involves disciplines (such as environmental management and life cycle assessment) that are continuous with existing capabilities in the Irish economy;
- Transition to carbon neutrality must engage actors at all levels and in all sectors, in a governance system that animates, learns from and pushes agencies and networks to ever-greater decarbonisation.

If these are the characteristics of the policy problem, then what process and entity does Ireland need to create now? With what functions, and involving what actors?

There can be no doubt that real political commitment across government, and strong leadership to build societal understanding and buy-in, are a critical first requirement if Ireland is to make the transition to carbon neutrality. The question is whether a climate-change commission would guarantee that and also work with the grain of the climate-change policy and innovation process, as summarised above. Would a high-level external advisory body have sight of the important innovations, progress and obstacles at the level of firms, agencies and localities, of the kind we reported in Chapter 3. In what sense would such a body be more expert than those driving innovation in firms, agencies and local organisations? Could it have a role in turning general government goals into action programmes and action plans, targets, implementation, exploration and experimentation (with firms and other actors) on how decarbonisation can be achieved? While periodic objective accounting and reporting of Ireland's overall progress to carbon neutrality is, indeed, an important function, a new high-level advisory body is unlikely to supplant the EPA's provision of this information and analysis. It is not even certain that an independent advisory climate-change body would greatly strengthen government commitment and decision making. Such a body could provide some *ex ante* advice and *ex post* reporting, but only of a general and high-level kind. While such advice can strengthen or re-direct government commitment, this depends on a range factors. Independent, high-level external and arm's-length advice, though needed on various

issues at times, may not be the key missing resource in taking Ireland's carbon-neutrality project to the next level.

Our Overall Perspective

Our analysis leads us to the view that Ireland's statement of, and approach to, the climate-change policy challenge needs to be changed, institutionally and procedurally, in three ways if it is to become an effective whole-of-government and societal project:

- To achieve a more effective combination of high-level policy making and commitment, on the one hand, and the work of frontline agencies (and non-state actors) in implementing, innovating and problem solving, on the other;
- To more closely link Ireland's largely out-facing capacity for carbon accounting with an in-facing government and societal project of decarbonisation, which is more widely understood and owned; and
- To define a unified, consistent and realistic view of how policy options and actions will be developed, assessed, monitored, evaluated and adapted.

Consequently, we suggest that in order to progress this agenda, government needs to undertake a number of political and institutional steps:

- Embed the transition to carbon neutrality, and particularly the five strategic building blocks, within the core agenda of economic recovery and development, ensuring that the allocation of resources reflects these new priorities and imperatives;
- Create and direct a new process and entity—with a government-led steering and oversight board and a small technical secretariat—to monitor progress on the main carbon neutrality building blocks and project areas, organise disciplined joint exploration of successes and failures and drive agencies and their networks to push the boundaries of knowledge and practice on 'how' achieve decarbonisation;
- Create a transparent process of periodic review of Ireland's progress towards carbon neutrality, involving relevant departments, agencies and the the Joint Oireachtas Committee on Environment, Culture and the Gaeltacht.

In the remainder of this section we outline the functions and possible structure of the new process and entity mentioned in 2 above. If all three of these institutional

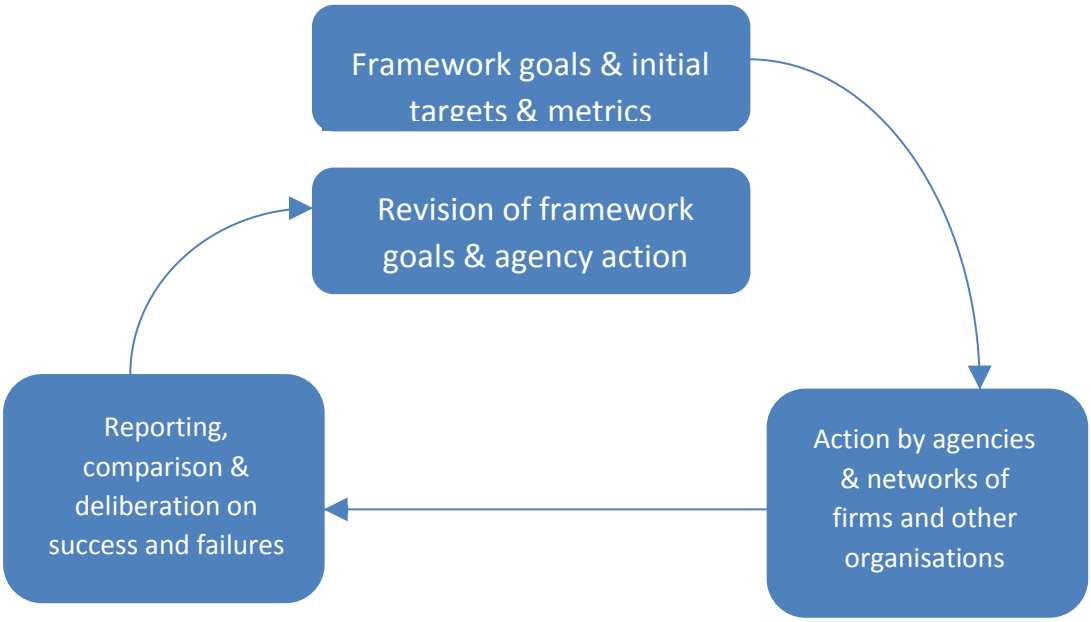
steps are taken successfully, then Ireland can be a real leader in this area, by building an institutional architecture suited to the nature of climate-change policy problem and the major ways in which progress on 'how to' achieve decarbonisation is made.

The functions of a new process and entity

We believe that it is necessary to create a new process and entity to help drive Ireland's transition to carbon neutrality. This entity must be carefully designed in order to achieve the complex functions that are necessary and to avoid a number of pitfalls (see below). Its creation should be seen as part of the ongoing reform process in which existing institutions in other spheres—such as labour relations, banking and finance and regulation—are being reconfigured into new alignments.

Our view of the functions and organisation of this process reflects the vision and understanding of the climate-change policy challenge outlined in Chapters 1 to 3 and the pragmatic three track approach we suggest. In particular, it reflects our emphasis on the role of agencies and other organisations in turning high-level policy goals and decisions into operational programmes focused on both 'how much' and 'how to' achieve decarbonisation. We see the creation of a new process and entity as a necessary step in creating a governance system that animates, learns from and pushes networks of public and private actors to ever-greater decarbonisation. This general requirement and process is illustrated in Figure 4.

Figure 4: Key Elements of a New Process and Entity



In a recursive process of this kind, innovation, measurement and review play a critical role. Indeed, in the innovative activity in firms, public bodies and local

organisations—which had a major impact in shaping our overall thinking—targets and fine-grained monitoring of processes and outcomes is a notable feature. At the end of this section, we set out our general thinking on the use of targets in climate-change policy and the transition to carbon neutrality.

In broad terms, the new process and entity should perform the following functions:

- Assisting central government in formulation of a new carbon-neutrality strategy and broad sectoral/departmental plans and targets;
- Driving and overseeing progress on the six strategic building of Ireland's transition to carbon neutrality;
- Deliberation on the progress and challenges in each of the main carbon-neutrality building blocks and project areas, as advanced by the relevant departments, agencies and networks; and
- Providing these agencies and their networks with upward reach or a clearing house to get the system to take roadblocks (technical, legal and political) out of the way.

Structuring the new process and entity

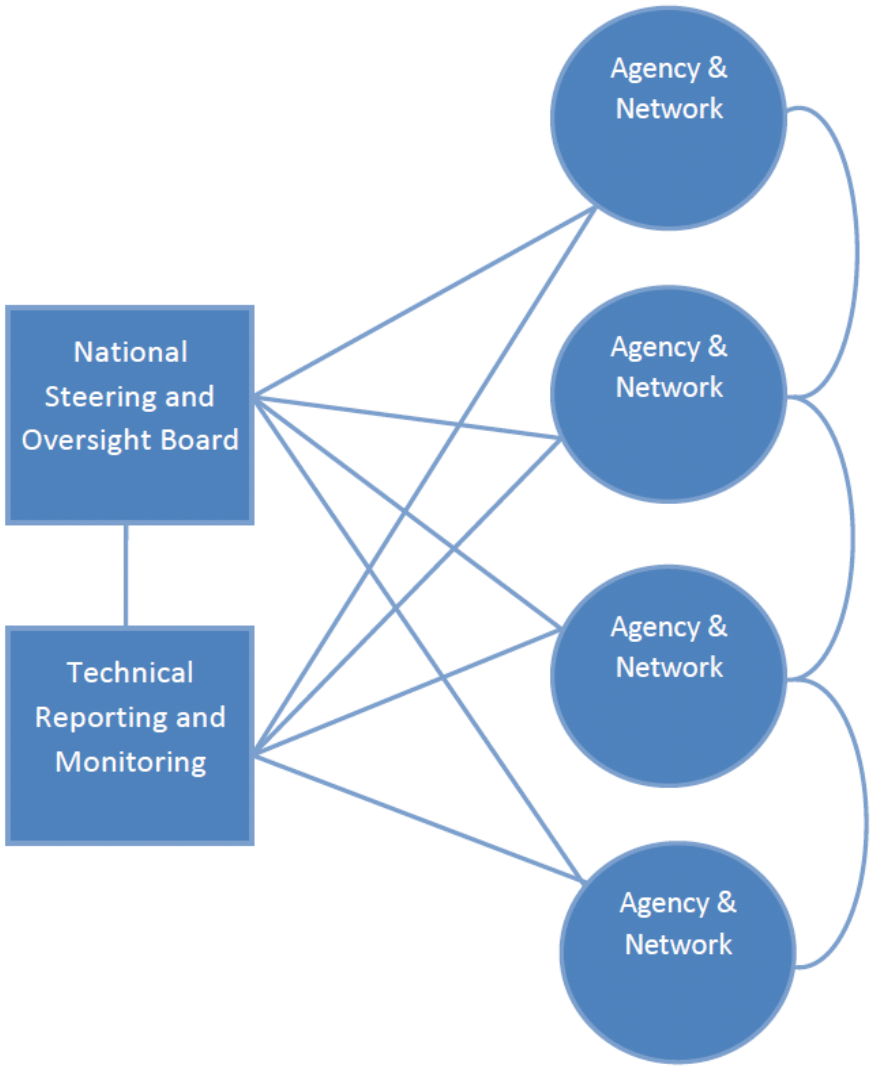
In structuring the new process, it is important to recall the extent to which real action will be centred in the agencies and the networks. Likewise, most of the knowledge and data-management will reside in the agencies and relevant departments. The new entity does not need scale and superior knowledge to *second-guess* the expert agencies and other actors; its central role is to ensure and organise the *joint exploration* of successes and failures and to push agencies and networks to continuously advance the boundaries of knowledge and practice on 'how to' decarbonise. Its main authority is government's power to convene the relevant actors and its main sanction should be reserved for non-engagement. Some relevant models include the Food Harvest 2020 High Implementation Committee, the State Bodies Group established to address SME finance and the proposed new arrangements for governance of the Water Framework Directive.

In the case of climate change, most of the institutional resources that are needed are in existence—in government departments and in agencies such as EPA, Sustainable Energy Authority of Ireland (SEAI), Bord Bia, Coillte, Teagasc, IDA, Enterprise Ireland (EI) and in firms such as the ESB, Bord Gáis, Glanbia and many others. On top of this, other highly-skilled resources might be available in public bodies, such as the national roads authority or the planning system. Local Authorities could also have a critical role for example in relation to energy efficiency, transport, waste and reneweable energy projects. There is no statutory requirement for local authorities

to mainstream climate change and no formal climate-related responsibilities designated for regional authorities.[20] However, planned reform for local government will increase the expectation for local authorities to deliver in energy efficiency and the use of renewable energy. Local authorities will have greater delegation for energy efficiency and environmental functions as outlined the *Putting People First, the Action Programme for Effective Local Government* published by the DECLG in 2012.

Working closely to a strong government mandate, the new process and entity might be structured around three elements: a national steering and oversight board, a technical reporting and monitoring group and a range of problem solving networks, many of which are animated and supported by public agencies. This is illustrated in Figure 5. Here we briefly describe each of these elements.

Figure 5: Structure of a New Process, Entity and Networks



This design reflects the way in which the highly-successful Montreal Protocol, which we discuss in Box 2 above, is institutionalised[21]. This kind of institutional arrangement, which links front-line problem solving with high-level review and revision, is often seen as a reflection of, and only appropriate to, international cooperation. But it is increasingly recognised that the nature of the climate-change policy problem, and the degree of experimentation and learning that is necessary to address it, suggests that it also has relevance at national level.

Element 1: The National Steering and Oversight Board

A national board would have overall responsibility for the functions listed above. It should be chaired by a very high-level actor, preferably a Cabinet Minister, and contain senior figures with a relevant track record of business and organisational achievement. The need for a strong link to government reflects its critical role. In Ireland's context, both national government commitment and strategy and EU policy must be the primary drivers of the transition to carbon neutrality.

Beyond high-level government involvement, there is a case for having members drawn from the most relevant departments and agencies; although in that case, a central requirement is to prevent this becoming a purely representative and defensive function. Indeed, in a number of spheres there is increasing success in creating inter-department and inter-agency entities that have an exploratory and problem solving orientation. The body needs to probe and compare progress in various networks and projects in order to challenge the agencies and networks to set and achieve ever-more ambitious goals and targets. At the same time, it must be in a position to challenge government departments to provide the policy frameworks and resources that enable action in agencies and networks. The process and entity needs to be highly task-oriented. The work of the national body might, at times, be conducted through sub-groups or task forces, led by appropriate members of the body.

Element 2: The Technical Reporting and Monitoring Secretariat

A small technical secretariat, drawn from the existing agencies, would assist both the national board and agencies in the following ways:

- Collating and analysing the reporting from the agencies and networks;
- Working with agency in formulating framework goals for each of the project areas relevant to the transition to carbon neutrality (e.g. wind, the grid, energy efficiency, food, biofuels and anaerobic digestion, smart travel, forestry etc.);

- Identifying, in dialogue with the lead agencies, the initial targets, metrics and indicators by which progress will be measured;
- Getting the frontline agencies (and, where relevant, departments) to articulate their initial action plans and projects and to identify the firms and other actors they need to network with and coordinate in order to drive their projects;
- Analysing the reports and data from the agencies and networks and working with them on the refinement of systemic, diagnostic and performance indicators;
- Organising appropriate deliberation on what has worked and not worked in each project area in a way that pushes the agencies and networks to greater innovation and achievement; and
- Revising the framework goals for each of the task areas, in dialogue with the lead agencies and other organisations.

Element 3: The Public Agencies, Departments and the Networks they Animate

The general role of public agencies and relevant departments and the networks they animate were outlined in Chapter 3, where we highlighted the focus on 'how to' and the advantages of a multi-level approach. The work of specific agencies and networks is discussed in some detail when we outline Track 2, 'explore and experiment', and Track 3, 'design and implement'.

New Process and Entity—Working with Goals and Targets

We emphasised in Chapter 3, that targets have an important role in the processes of regulation, policy making, implementation, innovation and learning that must propel the drive to carbon neutrality. Our analysis suggests that it is important to think carefully about the nature and role of targets, if the disappointment of the international policy process is to be avoided at national level and within the EU. In general we believe that the following is a useful way to think about the respective roles of goals, targets and indicators:

- **Goals:** should describe valued outcomes and be *motivational;*
- **Targets:** should reflect goals, the current understanding of the challenge and the degree to which a 'stretch' in current performance is possible;
- **Indicators:** can be of three types:

- Systemic indicators—which signal overall progress or otherwise in a given sphere;
- Diagnostic indicators—which assist identification of where and why a problem is arising ;
- Performance indicators—which allow organisational achievements to be assessed against stated goals and targets;

All: should be open to revision and stretch in light of experience.

Applying this thinking to climate-change policy suggests three general precepts:

- It is critical that targets play a real role in linking high-level goals with front-line action and creating a mutually reinforcing relation between 'how much' and 'how to';
- In some contexts, the most appropriate targets are for emissions reduction, the ultimate goal of climate-change policy, but in others effective targets are better set in terms of proximate goals, such as energy efficiency, renewables capacity and usage or, indeed, more fine-grained stock or flow variables within firms, organisations and localities;
- In any given context, high-level or front-line, the institutional arrangements are critical in ensuring that targets and indicators work by meshing with obligations, capabilities and incentives.

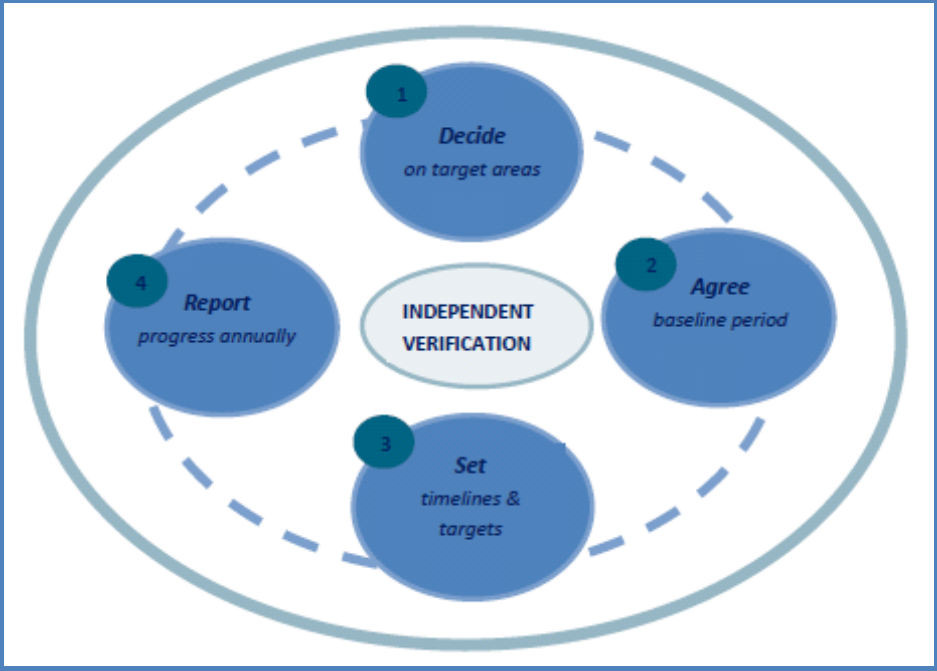
In Box 6 we describe an important example which illustrates this approach to working with goals and targets—the Origin Green project initiated by Bord Bia.

We strongly believe that a process and entity of the type we have outlined is necessary and possible. We appreciate that this is an initial outline and that, if this approach were adopted, more detailed institutional design and will be required.

Box 6: Working with Goals and Targets—An Example

Origin Green is an programme organised by Bord Bia, the state body with responsibilty for developing market opportunities for Irish food and drinks suppliers. Sustainability— as defined bythe Brudtland Commision, namely that development meets the needs of the present without comprising the ability of future generations to meet their own needs— is the overarching goal.

Origin Green has four main components which are presented by Bord Bia as part of an ongoing cycle of improvement: targets, baseline, timetables and progress reports.



Targets: Each company decides what areas they wish to focus on and how best to implement change. The company must include at least one target area related to energy, emissions and waste as well at least one other area (such as water, biodiverstiy or animal welfare). They are asked to provide details on the means of achieving targets. At least one issue must contain 'stretch' targets. 'Stretch' is defined as an ambitious target that represents a significant increase on current levels of improvement. Plans are submitted to Bord Bia and reviewed by an independent company. The latter provide Bord Bia and the applicant with a report which will indicate any clarifications needed prior to approval and also recommendations for improvement.

Baseline: To demonstrate progress over time the companies have to quantify a baseline position at a particular point in time, measure and report progress annually.

Set Timetables: The targets must be specific, measurable, achievable and should include a time line The information is quite precise, for example 3 per cent reduction (below baseline) in energy use by 2013. Responsibility is assigned to an individual and the metric (e.g Kwh) and method of measuring it (e.g change in energy bill) is identified.

Progress Reporting: The companies sign a commitment to report annually on each target. They also commit to communicating on where they are in relation to targets. An independent company examine company plans and review performance. A sample of companies will be taken periodically to verify the authenticity of the progress reported. Bord Bia will publish a list of the participating companies and categorise them relative to the progress they achieve against their stated targets.

Ireland's Strategic Approach To Decarbonisation and Green Growth

The third element of Track 1 is Ireland's strategic approach to decarbonisation and green growth. A key element of the way in which the threat of climate change will be addressed is the transition to a sustainable economy and green growth. This is likely to operate at many levels—global, continental, national and local. There is certainly a strong global imperative in this direction, given the resource crunch. Furthermore, there are reasons to believe that the global economy is entering a 'sixth wave' of technological change, characterised by full deployment of IT, transformation to radically new carbon-free energy and transport systems, and the start of a bio-technology revolution. It is important to see all three dimensions, and the likely synergies between them. Concepts such as 'green growth' and the 'circular economy' seek to capture the way in which this sixth wave will transform the measurement and conduct of a huge range of economic activities. In Ireland, the government statement *Delivering our Green Potential* and Brennan's analysis provides an overview of the opportunities and the individual sub-sectors with greatest potential[22].

The transformation to green growth is sometimes presented as a seamless and costless process, a pure win-win scenario. While this may be unrealistic there are, indeed, ways in which it can promote growth, employment and prosperity—through resource efficiency, innovation, new market opportunities, investment, fiscal consolidation and risk reduction. The articulation of this, through organisations such as the OECD, is important in changing traditional mindsets, which, shaped by the old 'brown' economy, are inherently sceptical of the possibility of transformed energy, transport and heating systems.

That said, we believe it may be mistaken to assert general laws relating green growth to increased employment, output, productivity, innovation, profitability, market opportunities and security. The process of transformation is likely to be uneven—across countries, regions, sectors and time—conflictual and dependent on local economic, social and political circumstances. This is confirmed by the failure, to-date, to find an effective response to the climate-change challenge, the incomplete knowledge of how to achieve decarbonisation and the conflicts of interest involved. The short-term investments for renewable energy can be costly, and the energy sector itself is too small to drive growth. In this context, four insights are helpful.

- First, the main potential economic benefits of green growth depend on a *systems* transformation, rather than marginal modification of the traditional energy system.
- Second, the most critical lever for enabling and capturing green-growth possibilities is a smart electricity grid. It is this that will take the growth-inducing systems transformation beyond the energy sector. Past transformations, like that of ICT, highlight the role of networks as levers. This will enable new technologies and business models to link previously unrelated sectors, such as electricity and transport.
- Third, as noted earlier, even though there are few general laws guaranteeing greater employment and productivity, there are significant *contingent opportunities* to be captured by particular regions, and firms. Those that have already benefited from the green transformation—Denmark, South Korea, California and Colorado—have done so on the basis of idiosyncratic national goals and regional capabilities.
- Fourth, it is not possible to know in advance most of the business and innovation opportunities associated with a low-emissions energy system and green growth. The key is to create a strategy, institutions and networks capable of discovering and costing these opportunities. Consequently, both green growth and energy-systems transformation will require a range of policy interventions that go well beyond conventional prescriptions for emissions pricing and R&D subsidies.

Strategic Building Blocks of Ireland's Transition

We now outline in more detail the fourth element of Track 1, six strategic building blocks of Ireland's transition to a carbon-neutral economy and society.

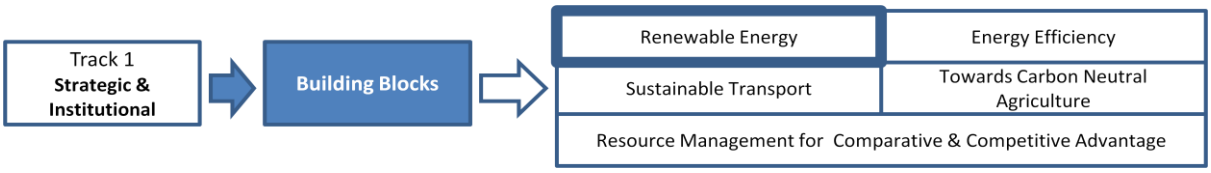
Our vision is that Ireland will be a carbon neutral society by 2050, based on an approach to economic development that is socially and environmentally sustainable. As outlined in Chapter 2, we identify five strategic building blocks:

- **Renewable Energy**: An energy system built on wind and other renewables, using a smart grid and integrated into a clean EU energy system;
- **Energy Efficiency**: An energy-efficient society that uses renewable forms of energy for heating;

- **Sustainable Transport:** A sustainable transport system which serves economic, societal and environmental needs;
- **Towards Carbon-neutral Agriculture**: A world-class agri-food sector working within a carbon-neutral system of agriculture, forestry and land use;
- **Resource Management**: An approach to resource management that provides a competitive and comparative advantage in international trade and factor flows.

It will be noted that these strategic building blocks straddle the divide between the ETS and non-ETS sectors. An overly-strong distinction between these sectors could limit the spread, across the whole economy, of the environmental management systems and disciplines of industrial ecology that the leading firms are developing, and upon which we place great emphasis.

More fundamentally, maintaining a strong separation between the ETS and non-ETS sectors might make it difficult to communicate Ireland's carbon-neutrality strategy. We believe that people intuitively understand the climate-change challenge and are increasingly aware of the severe risks with will arise if humanity does not stabilise GHG concentrations. They correctly understand that the task is decarbonisation of the economy and that the bulk of this will have to be achieved by creation of low-carbon *energy for electricity* and *transport*. To adopt an overly-strong distinction between ETS and non-ETS in framing and articulating Ireland's strategy would be to ask people to put out of their minds the thing they most understand. This is likely to obscure the hope-inducing good news that Ireland is making major strides in developing renewable energy, especially wind, and in a number of other respects. Irish people have every reason to be confident that Ireland can be, and will be, a carbon-neutral economy by 2050—although this remains a large and complex challenge. That has to be the starting point of a government and societal project of decarbonisation. A narrow focus on non-ETS emissions might also mislead people on the nature, scale and location of the challenge by suggesting that the carbon emissions of the ETS sectors of the Irish and European economies are 'taken care of' by the EU Emissions Trading Scheme—i.e. reducing at a rate sufficient to prevent damaging climate change. For a variety of reasons, this remains to be seen. It might also be somewhat misleading because, when it comes to really transforming Ireland's energy sector in a low-carbon direction, the Irish government and regulators seem likely to retain a significant role. In other words, as things stand, the ETS sector is, in reality, only partially an EU sphere of competence.



Renewable energy: An energy system built on wind and other renewables, using a smart grid and integrated into a clean EU energy system

It is technically and economically feasible for the power-generation sector to be entirely decarbonised by 2050, perhaps earlier. This can be achieved by developing indigenous wind and other renewable energies; connecting to an integrated EU power system based around renewables and other low-carbon energies; and the development of the smart grid in Ireland. The Irish economy of the future will be increasingly electrified leading to an increased demand for electricity, though the increase needs to be limited by much greater levels of end-use efficiency. Even with widespread electrification of energy use in Ireland, modelling work suggests that over half of energy would be required from sources other than electricity in 2050[23]. Key areas that are expected to require energy beyond that provided by electricity in 2050 are freight transport, industrial processing and some share of heat in buildings.

The integration of greater shares of onshore wind has been the corner stone of Ireland's significant progress on decarbonising electricity supply over the past two decades. Wind will increasingly come to be the defining characteristic of Ireland's generation portfolio, perhaps representing in excess of 60 per cent of electricity supply in 2050[23]. This reality will be the central thrust around which all other decisions are made in the post-2020 period. Ireland has significant on and off-shore wind resources, and wind is a cost-competitive way of providing electricity. Dramatic cost reductions for wind technologies associated with wider deployment mean that wind could achieve parity with gas within the next five years. The cost of off shore wind is significantly higher than onshore wind so it makes sense initially to meet Ireland's renewable electricity target through onshore wind. Ireland's off shore wind resources offer a significant export opportunity. The variability of wind raises significant challenges: the role of grid investment and inter-connection in addressing these challenges is discussed below. Finally, the development of wave and tidal energy are at an earlier stage and their role in Ireland's energy future remains uncertain. The development of these technologies may offer significant economic opportunities. Ireland has particularly favourable wave-energy conditions, but wave energy is correlated with wind, both seasonally and daily.

Biomass (including biogas) may emerge as a particularly important supplementary fuel to back up variable wind. Biomass has played a modest role to date in electricity generation reflecting its higher costs, and it tends to be used more in heating where

it provides a considerably higher energy return. New incentives offered under the Renewable Energy Feed-in Tariff (REFIT) 3 regime include support for co-firing of biomass with peat, and could see greater demand for biomass for electricity generation. A real concern is that, based on current rate of afforestation, there will be insufficient indigenous supply of biomass material to meet demand.

It is likely that new gas-fired electricity generation plants will be constructed in the coming years, and a portfolio that includes some gas is possible as a transition towards a zero-carbon electricity sector by 2050. Radical reductions in electricity end-use deriving from efficiency improvements are also available, and perhaps offer a cost-effective alternative to adding to the generation portfolio. However, efficiency improvements may be offset by widespread electrification of heat and transport, leading to a net increase in the demand for electricity.

Nuclear power is unlikely to play a part in domestic generation, due to its lack of flexibility, larger size and potentially high cost. Coal or gas plants with Carbon Capture and Storage (CCS) cannot be relied upon to replace Moneypoint, or to contribute significantly to Ireland's generation portfolio. The prognosis for these technologies can be revisited in light of future technological breakthroughs, should they occur.

The grid will be a key lever in the transition to a carbon-neutral economy. A system dominated by variable wind energy places a particular premium on grid development. In this context, Eirgrid is implementing a major investment plan, Grid 25, to expand and upgrade the grid in the period to 2025. Significant investment in interconnection with the UK and European grid is the primary way that seasonal heterogeneity of wind can be effectively managed. The European Commission believes that the necessary infrastructural investments are a 'no regrets' option and would be beneficial under various development pathways for the power-generation sector. For an internal market to become a reality there needs to be sufficient physical interconnection, which, in the case of Ireland, would require at least a doubling of the current level of interconnection capacity in the short term. One study projected that the cost-effective development of renewable electricity in the EU would include interconnection of 13 GW between Ireland and Britain by 2030[24]. It is therefore important that private export-orientated projects are progressed in a fashion that would ultimately allow them to play a part in connecting the UK and Irish electricity systems. The debate on how to replace Moneypoint power station changes when considered within the context of a highly interconnected system. Within an interconnected European system, the need for one key baseload-providing plant may be reduced.

The full deployment of a smart grid over the next two decades is necessary for decarbonisation. Considerable work is underway to support the development and deployment of a smart grid in Ireland and aspects of this work are discussed in Track 2, Chapter 7. At the core of the smart grid concept is the integration of information and communications technologies onto the grid to enable financial, informational as well as 'electrical' transactions among consumers, grid assets and other authorised users. It allows for the optimisation of all grid assets, enables all generation, micro and macro-storage options to be integrated, and facilitates bi-directional power flow. It will allow for the emergence of a 'prosumer' who not only uses electricity but also generates it. Supply companies will be in a position to aggregate consumers and influence overall demand using price signals, thereby creating a 'fifth fuel' or 'virtual power plant', which can be used to balance short-term variability in electricity supply. The smart grid also enables the electrification of energy end-use sectors across the economy.

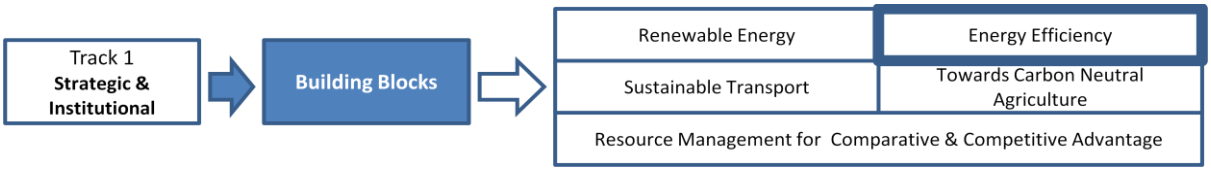
In relation to the grid and other energy infrastructure, public acceptance represents an important challenge. Potential local opposition and planning difficulties represent the biggest risk to achieving Ireland's renewable electricity targets for 2020. The importance of delivering long-lasting benefits to communities, community gain, is acknowledged by the Department of Energy, Communications and Natural Resources as an important means of achieving public acceptability for infrastructure. In addition, Ireland has ratified the Aarhus Convention, which is designed to promote citizen involvement in environmental matters and improve enforcement of environmental law. However, active engagement with developers and community projects presents a complex process for communities and more supports are required, particularly for communities who would like to share ownership of developments.

Strong political commitment, leadership and an effective system of planning and dispute resolution are required to address these issues and ensure that the grid is upgraded on target.

Finally, an important issue is the potential cost of transforming the energy system. There are considerable uncertainties attaching to any cost estimates for 2050. Estimates of the cost of a number of low-carbon 2050 scenarios for the EU, in the Commission's Energy Roadmap to 2050, suggest that there are substantial cost increases in all scenarios. However, it does suggest that there will be little or no additional average annual energy-system costs over the period 2011 to 2050 in the low-carbon scenarios *compared to the current policy scenario*. Electricity prices are one dimension of energy costs. If gas or carbon prices are high, a high level of wind generation can reduce the cost of electricity. If the EU sustains its commitment to a

low-carbon transition then carbon prices can be expected to reach increasingly high levels in the period to 2050. Conversely, if gas or carbon prices are low, then the use of renewable energy in electricity generation will be relatively more expensive.

In conclusion, the spine of the power system will be wind, supported by other renewables. Work is correctly concentrated on developing the potential associated with these technologies. This offers the potential for decarbonisation of the rest of the economy through electrification. These developments are, however, subject to uncertainties around the key policy development of an integrated European grid. Supporting conditions to enable this development pathway, including regulatory rules at national and European level and R&D policy, are discussed in Chapter 8.



An energy-efficient society that uses renewable forms of energy for heating

To become an energy-efficient society will require higher standards of insulation and deep retrofit, onsite energy harvesting, smart-energy management systems and utilisation of biomass and electricity for heating. These technologies will play a part in both new builds and within existing homes and business premises. However, having an energy-efficient society—with people using less energy at home, at work and in all buildings—where they are engaged, informed and proactive in their communities finding local low-carbon solutions to daily needs such as heating, is also critical.

New and anticipated building regulations mean that all new buildings must be built to a near-zero energy standard. The development of these regulations needs to happen in line with the Nearly Zero Energy Buildings plan which is a requirement of the EU Energy Performance of Buildings Directive.

Achieving a 'near-zero energy' standard means that all new residential buildings must be insulated to an extremely high standard, and must cover the majority of electricity use through energy harvested onsite. To meet this standard requires the integration of micro-renewable technologies such as biomass systems, solar photovoltaic systems, using bio-fuels, aero-generators and other small-scale renewables. Which micro-generation solutions might become part of Ireland's energy future to meet these demanding requirements is as yet unclear, although recent dramatic cost reductions for solar PV mean that it is likely to play some role, particularly in the post-2020 period. Electrification of heat using smart-storage

technologies or heat pumps may become attractive. Storage solutions should be able to avail of lower off-peak tariffs, while power-generating technologies should be able to sell back to the grid when generating excessive supply, thereby repaying some of the upfront cost of the investment. The alternative of some form of renewable heating system seems less attractive given the low heat-load requirement of future buildings. There is a need to explore the options and consider the obstacles to the electrification of heating in buildings, an issue explored further in Track 2, Chapter 7.

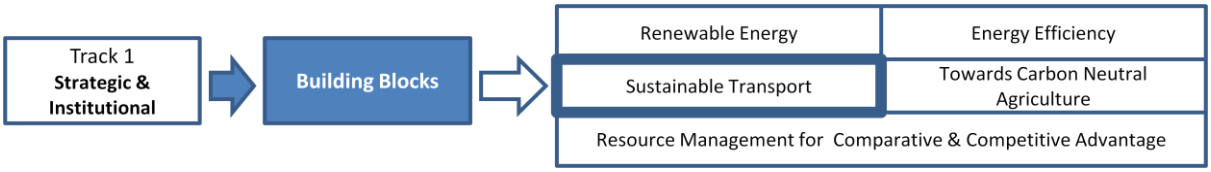
Non-residential new buildings must also achieve nearly-zero energy standard and new buildings in the public sector are required to achieve this standard by 2018, with an interim target in 2015. In this sector, Heating, Ventilation and Cooling (HVAC) and lighting generally accounts for at least 60 per cent of energy costs. Advances in software for energy-management systems and building design mean that new buildings can 'listen' to the price signal sent through a smart grid and will be able to make automatic decisions, such as changing thermostat set-points and reducing unnecessary lighting. This is known as Auto-Demand Response. As with the residential sector, a key option for supply-side decarbonisation, particularly in the post 2020 period, may be electrical heat pumps—air-source heat pumps in commercial buildings are already considered a mature option in the UK (in conjunction with air-conditioning systems).

There is a significant economic opportunity associated with upgrading the existing residential building stock—much of which will still stand in 2050—to a much higher standard of efficiency. However, there are significant and widespread barriers to be overcome, requiring action across a range of areas. These include the upfront financial barrier, which government is hoping to address through the delivery of a Pay-As-you-Save (PAYS) mechanism in 2014; underlying consumer perceptions; lack of awareness and information; and allocating the administrative resources required to deliver such an ambitious policy programme. Activity needs initially to focus on improvements to the building fabric; however, eventually there will be a need to include technologies promoting smarter and more flexible use of energy in homes such as smart meters, energy-management solutions, electrification of heating, micro-renewables, and, perhaps to a lesser extent, renewable heating solutions.

In business premises and public-sector buildings, retrofit will be enabled by the growth of energy savings company (ESCo) activity. These older buildings do not have an Auto-Demand Response ability. Consequently, retrofit will focus on smart HVAC and lighting systems and controls as well as the building fabric. The growth of ESCo activity and the delivery of a Energy Efficiency Fund to finance these investments

should ensure that options are readily available to those in the public and private sectors who wish to undertake a retrofit.

In conclusion, investment in deep retrofit, renewable technologies and electrification, combined with increasingly demanding buildings codes in both the residential and non-residential sector, should enable full decarbonisation of buildings by 2050. The development and adoption of smart grid technologies in homes, businesses and industrial premises means that individuals and organisations will be in a position to store or export energy to the grid at times of abundance, while drawing from the grid when required. This should help optimise investments in smart heating, lighting and appliances and micro-generation solutions, and enhances the business case for a focus on retrofit. In addition, some commercial buildings, factories and processing plants currently have their own electricity generators, which are often used only as backup. The deployment of a smart grid will also enable the electricity-systems manager to call on these resources to secure grid stability and to manage variability.



Sustainable transport: A sustainable transport system which serves, economic, social and environmental needs

Ireland needs to develop a sustainable transport system that serves economic, societal and environmental needs. To do so it needs to fully exploit technologies as they become available, enable behavioural change and support more sustainable urban and rural development.

Engine improvements, electric vehicles (EVs), gas-based vehicles and ICT are four technologies that Ireland can exploit to ensure that transport is more sustainable. Ireland is at the forefront in embracing new technology for private cars. The rebalancing of vehicle registration tax and motor taxation had a dramatic impact on purchasing behaviour. Tax reform can be used to incentivise take-up of best available technology for cars and vans and, as technology develops, for larger freight vehicles.

The electric vehicle is a technology that is evolving. The car, batteries, connection to the grid and the range of supporting and ancillary services continue to be the focus of research, development and commercial testing. Thus, while it is impossible (and futile) to predict the numbers of EVs on Irish roads in 2020, there is very little doubt

that EVs will be one of the key technologies beyond 2020. As discussed in Chapter 7 there is significant supporting work taking place in Ireland, led by the ESB.

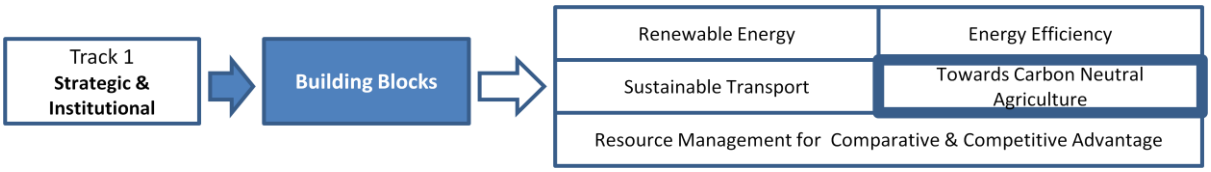
In addition, the technology for natural gas-based vehicles (NGVs), particularly for goods vehicles (vans and larger trucks) and buses, is well established and should be further explored in Ireland. If biogas supply were to be developed, this could be used as a transport fuel in place of natural gas. Finally, in many areas, information and communication technology is underpinning ways to use vehicles less, or more efficiently. In car-based transport, this is focused on using internet and mobile-phone technology to increase and make safer the practice of car sharing.

Enabling more people, particularly in rural areas, to reduce their level of car usage requires further and significant investment in public transport and high-quality walking and cycling infrastructure. Constraints on the public finances mean that investment is unlikely in the foreseeable future. However, experience in Ireland and internationally suggests that other levers can be used to enable change in travel behaviour. These include programmes such as eco-driving and the use of local demonstration projects. In Ireland, there are a range of such projects, including a pilot programme on eco-driving, the Green School Travel Programme and the 'Smarter Travel Workplaces' programme. The Track 2 project on Carbon Capability is designed to consider how good practice from these projects and this experimentation could be scaled up nationally, when resources are available. Finally, behavioural change can be further supported by targeted research. Future research should enable behavioural change by documenting mobility habits in more detail, evaluating how new practices such as 'car-sharing clubs' emerge and the effect of these or other innovations on travel behaviour in specific areas; and by making it easier for individuals and businesses to consider long-term costs and benefits when they make decisions about their travel behaviour. A key contribution of this research will be its ability to shape and influence wider discussions about future mobility practices, with particular reference to planning and spatial development.

Finally, the sprawling suburban pattern of development that has long prevailed in Ireland, and was extreme in the past decade, has a strong influence on the way people deal with their daily needs. The most important is the quite remarkable level of car dependence that necessarily follows from this pattern of development. Houses are at unwalkable distances from almost all amenities, so people have no alternative but to drive to schools, churches, shops and clubs. In the longer term, it is hard to exaggerate the importance—not only for climate-change reasons, but also for housing and service provision, the public finances and financial stability—of achieving better spatial planning and more effective integration between decisions on planning and transport infrastructure[25]. Changes to the spatial pattern of

development are likely to have a large impact on emissions over time. New principles are now in place to inform Irish planning and housing policy. It is critical that when physical development resumes it is genuinely informed by these principles. Significant changes to planning legislation were introduced by the 2010 Planning and Development (Amendment) Act. This Act requires local authorities to prepare a 'core strategy' and to show that it is consistent, 'as far as practicable', with national and regional development objectives (as set out in the National Spatial Strategy and regional planning guidelines). The Act also introduced new arrangements for making zoning decisions. The 2011 Programme for Government states that this legislation will be amended to allow for detailed public submissions on zonings and to rebalance power towards elected representatives.

In conclusion, across Europe member states are committed to decarbonise their transport systems by 2050. However, in no country has this been fully worked out. There is an opportunity for Ireland to be part of the global search for ways to decarbonise, while also contributing to the need to make our own transport more sustainable and less dependent on fossil fuels. To do so requires a willingness to see the policy challenge in more entrepreneurial and experimental terms—that is, to see the challenge as one of mobilising and governing problem-solving behaviour among a range of actors. In other words, in some areas the formulation and refinement of Ireland's strategic approach (what we call Track 1), is dependent on exploration and experimentation of new possibilities, what we call Track 2.



Towards carbon-neutral agriculture: A world-class agri-food sector working within a carbon-neutral system of agriculture, forestry and land use

As noted in Chapter 2, a central thrust of our work on this project has been to reframe the way in which agriculture is considered within, and relates to, the climate-change agenda. Ireland needs to, and can, become a world leader in the production, management and marketing of low-carbon, high-quality sustainable food. This can be achieved by adopting carbon neutrality as a point on the horizon for the country and the industry to work towards. The challenge of working towards carbon neutrality will be achieved by pushing scientific research and probing practice to identify further means of reducing emissions and ways of maximising the carbon-sink potential associated with land use, land-use change and forestry. This issue is the focus of our first Track 2 project.

There is a strong scientific and research base that can be used to find new ways to account for and reduce emissions. There is a very significant research capability in Ireland in the area of GHG emissions. DAFM provides funding for research to improve the carbon footprint of Irish agriculture and to develop methods of verifying the efficiency credentials of agricultural production. It recently awarded €32m under its competitive research funding programmes (FIRM, Stimulus & CoFoRD) to fund a wide range of collaborative projects many of which address the sustainability of Irish food production at various levels. This is in addition to the provision of €1.5m in funding for the establishment of the Agricultural Greenhouse Gas Research Initiative for Ireland. The aim of this network is to bring together all principal investigators working in the field of agricultural climate-change research. In addition, DAFM and Teagasc are active in international networks and research groups related to GHG. As part of these networks, Irish researchers are involved in cutting-edge research focused on reducing emissions and meeting growing demand for food. The challenge is to ensure that this international research is used in a timely manner to support higher levels of ambition for Irish agri-food.

Teagasc research suggests that there are measures that could be taken in the short term, which would both increase farm profits and enhance carbon efficiency. There are other measures, such as bioenergy crops and anaerobic digestion (AD), for which the underlying economics currently look less favourable. In these areas, government policy (e.g. REFIT tariffs) and other developments (e.g. availability of long-term supply contracts) can have an important impact. In addition, there are areas of research that may uncover new approaches to reducing emissions. These include sequestration in crop and grasslands; the role of urease; the use of lower crude protein; regional optimised plant and animal nutrition; plant-derived inhibitors; inhibitors in diets; selecting low-methane animals; methanogen vaccines; biological N-inhibitors; GM-improved varieties; sward management; beef and dairy integration; physical properties of the ration; and the fatty acid content of grass and drainage. In the context of 2050, existing and emerging research becomes critical in identifying what and how carbon efficiency can be achieved. Ireland has significant expertise in relevant areas that can help put the country in a leadership position to make agri-food less carbon-intensive and more efficient.

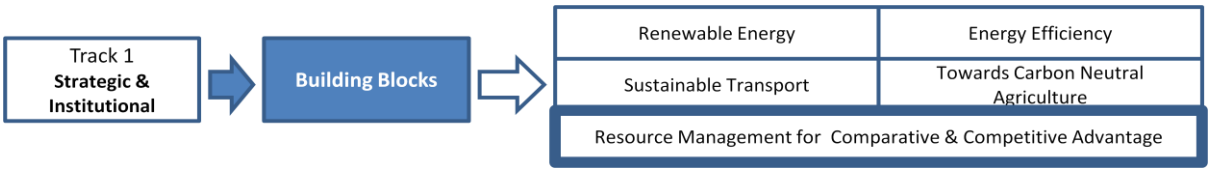
Practice can be also be probed more deeply to disclose the potential for new low-carbon practices. There are many win-win options for reducing GHGs that have not been acted upon by many farmers. The challenge is to enable more farmers to adopt these practices. This will be informed in important ways by aspects of the current advisory service—such as Farmer Discussion Groups and Teagasc's cross-directorate Working Groups; schemes developed and funded by DAFM such as the Dairy

Efficiency Programme (DEP) and the Beef Technology Adoption Programme (BTAP); and the work of Teagasc and Bord Bia on the carbon navigator.

In addition, pressure is being exerted by food companies on their suppliers, principally farmers, to reduce their emissions. Under Origin Green, launched by Bord Bia in 2012, it is expected that by 2014, 75 per cent of Irish food and drink exports will be sourced from companies who have independently verified commitments made to enhance the sustainability of their supply chain. Individual companies, Bord Bia and Teagasc are developing data-intensive programmes to help farmers to reduce the carbon content of their supplies. An example of this is the sustainability programme developed by Bord Bia in partnership with Teagasc as part of their Beef and Lamb Quality Assurance Scheme (BLQAS), which to date has seen more than 33,000 beef farms provide information that allows their emissions performance to be assessed. The information collected provides the basis for a practical feedback and advice programme that can enhance the environmental and economic performance of each farm. This roll out follows the accreditation by the Carbon Trust (UK) of a footprinting methodology and calculation model developed by both organisations in March 2011.

Finally, decisions about how land is used and its effect on emissions are not solely the preserve of stakeholders within agriculture. In particular, forestry planting rates will have a critical bearing on overall carbon neutrality. With current planting rates, by 2050 forests could sequester in the region of 1.8 Mt CO_2; if the rate increased to 20,000 per annum, then the potential could be between 7 and 8 Mt CO_2 sequestered in 2050. In this context, a national assessment of land use is required. In addition, the willingness of farmers to invest in forestry and other biomass crops, such as willow or miscanthus, will depend on energy policy and growth in demand for biomass. The public sector can show leadership and help stimulate demand particularly through the usage of biomass in the heating of public buildings. Public procurement should be amended to provide improved opportunities for renewable heating options to compete. Bioenergy requires a coordinated approach across government departments to ensure that both supply and demand issues—which, as noted in the Secretariat's Interim Report, tend to inhibit development—are effectively addressed.

In conclusion, working towards carbon neutrality is an important 'horizon-point' on which agriculture can take the lead but which will require active commitment from a range of government departments, agencies and organisations.



Resource management: An approach to resource management that provides a competitive and comparative advantage in international trade and factor flows

In a resource-constrained world, the economic, social and environmental importance of land, water, marine and biodiversity increases dramatically. It is important to think about how Ireland can capture the associated increase in the value of these resources. We suggest that, in the short term, it requires that we maximise the job-creation potential associated with using resources more efficiently. In the longer term, we need to identify ways in which our natural resources can underpin future comparative and competitive advantage.

In 2012, the Government published *Delivering our Green Potential,* focused on bringing about transformational change in the way we live and work as a society. At the core of the policy is a search to identify the economic and job-creation potential associated with energy and resource efficiency. The statement highlights significant strengths and advantages that can be leveraged to exploit business opportunities in the green economy. It identifies ten discrete sectors, including an R&D sector that cuts across many of the others. The statement notes that a large number of Irish companies are developing innovative products and services and that many of these are successful exporters. It notes that Enterprise Ireland has a directory of 240 export-oriented Cleantech companies, employing almost 6,000 people. A Consultative Committee on the Green Economy, chaired by the Minister for Jobs, Enterprise and Innovation, will identify emerging opportunities—as well as enablers and barriers to seizing those opportunities—for Ireland in the green economy. This should be an important means of ensuring that green growth delivers on its potential, particularly in the short to medium term and in relation to job creation.

If Ireland is to capture a potential 'sixth wave' of technological and economic transformation, it needs to understand what are distinctive features of our resource endowment and how these are managed and protected[26]. Considerable experience and fine-grained knowledge about how to protect and use resources more efficiently exists in companies in the clean-tech sector, large resource users and in environmental organisations. Companies such as Intel, Bewleys Coffee, Bord na Móna, ESB, Irish Cement and many others are working out how to use resources more efficiently and in more renewable ways. In these companies, organisational capabilities and routines already present—in areas such as safety, processing, health

and safety and traceability—are now being used to develop environmental management systems that improve energy and carbon efficiency.

In this context, the Secretariat believes that work on what is know as the 'circular economy' can be useful in creating a vision or pathway for how Irish enterprise might develop towards 2050. The circular economy envisages a more fundamental reorganisation of economic activity with the concept of resource efficiency at its core. This has been developed by a charitable organisation founded by Ellen MacArthur and supported by a number of leading global companies including B&Q, BT, CISCO and Renault. The 'circular economy' aims to 'design out' waste—products are designed and optimised for a cycle of disassembly and reuse[27]. It introduces a strict differentiation between consumable and durable components of a product. It also argues that the energy used should be renewable by nature, to both decrease resource dependence and increase system resilience (e.g. to oil shocks). This thinking is in play in Ireland. For example Bord na Móna is establishing a 'new contract with nature' by investing in wind power, replacing peat with biomass, producing and exporting compost made from clippings and dairy sludge and developing sustainable water storage solutions.

Finally, to develop greater environmental and resource awareness across Irish society, there is a critical role for education and engagement in schools, communities, workplaces and across all sectors of society. Initiatives like the Green Schools Programme are fundamental in this regard and equip children to be the messengers on future sustainability practice.

Chapter 7

Track 2—Exploration and Experimentation

Alongside identification of these strategic directions and building blocks, Ireland's approach to decarbonisation must be based on a conscious and disciplined exploration and testing of policy possibilities and a process capable of identifying and scaling those actions which prove most promising. This is the purpose of Track 2. Within this, we draw attention to the role of public agencies in turning general policy goals into programmes and testing the means by which they can be achieved and the challenges in scaling them up.

Many of the best firms, entrepreneurs and social and community innovators, faced with profound uncertainty—about technology and/or how behaviours might change—rely heavily on systems of detailed monitoring and review. They use experience gained in exploring and testing ideas as the primary guide for future action. Similar problem-solving networks can enhance the quality of decision making within the public sector.

This is not a new idea. As we discussed in Chapter 3, many of the most important successes of Irish public policy over many decades—in areas such as industrial policy, employment, technology, health, local development and, of course, environment—have relied on this type of input. In these areas, key parts of policy development, beyond the initial proposal of departments, depended on the organisational capability and policy entrepreneurship of agencies and non-state bodies.

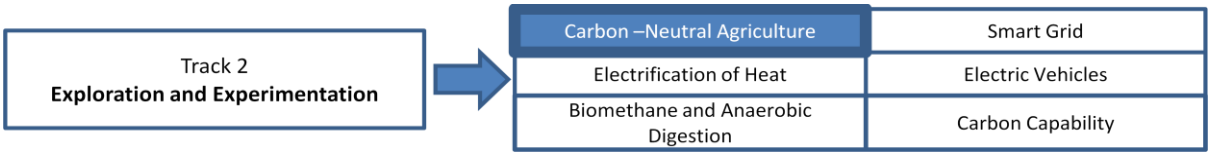
What is required is a rolling programme of projects and inquiry on decarbonisation, adapting as new information, technologies and opportunities become available. In Chapter 6, on Track 1, we argued that a strategic requirement is the creation of the institutional capacity to monitor and learn from these projects, and to identify further ones. Our analysis of Ireland's approach to carbon-neutrality, the five building blocks and the important work already underway, suggests six Track 2 projects:

- Carbon-neutral agriculture
- Smart Grid
- Electric Vehicles
- Electrification of Heat

- Biomethane and Anaerobic Digestion
- Carbon Capability.

This list is not definitive, but it does represent a starting point. The key in these areas is to ensure the right *agencies*—capable of building and animating networks of actors—are given the mandate to *get going*. An agency should be tasked with finding the non-state actors and organisations whose response will be critical to achieving progress in a given area of decarbonisation. The agency should also be charged with reporting progress and, in dialogue with government and a range of peers, learning from the successes and failures of their actions and adapting programmes accordingly. Consequently, while this work should include careful assessment of benefits and costs, it will go beyond that by providing a capacity for ongoing review and monitoring and detailed *ex post* policy evaluation. They would identify barriers that need to be overcome for these areas to achieve their full potential and contribution to long-run decarbonisation.

Here we briefly sketch the six Track 2 projects, using this flow chart to guide the reader through the argument.



Working towards carbon-neutral agriculture

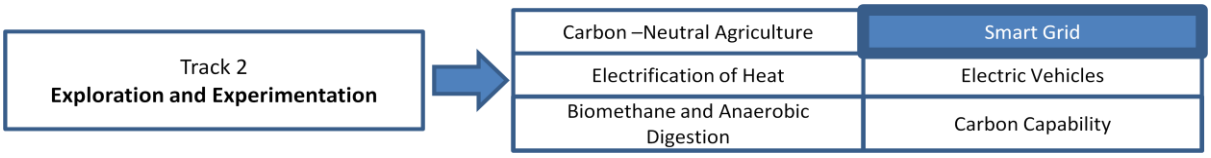
We have identified carbon neutrality as the point on the horizon towards which Ireland should travel; but, in contrast to many climate-change studies and roadmaps, we are clear that the central challenge is to work out 'how to' achieve such a profound change in the decades ahead. In further contrast with much climate analysis we are comfortable in acknowledging that neither we nor the actors in the sector know how Irish agriculture and land use will achieve carbon neutrality. This is the purpose of mobilising and networking all the relevant agencies and actors. From our analysis, and particularly our dialogue with many of those actors, we have a firm view of the two main directions that should be taken: we need to push the scientific knowledge and probe local farming practice in order to find ways to make Irish agriculture both more carbon-efficient and competitive. This approach would enable a more open dialogue between science, local farming practice and commercial and market-facing organisations (such as Bord Bía). In addition, knowledge and data-rich reporting and standards is a key means of pushing science and probing local practice. More broadly, the network of actors need to explore the carbon-sink potential associated with land use, land-use change and forestry. In a wider national analysis it would consider pressures on land use, potential demand for biomass (electricity,

heat and other uses) and technical and measurement issues (e.g. research results on grassland sequestration).

A key challenge for the agencies and actors in this area is to consider how this essentially in-facing effort to reduce carbon footprint can be used to change the international positioning of Irish agriculture and, indeed, Ireland. This can include both exporting knowledge-intensive services and being a strong expert voice on the way in which agriculture and land are approached in UN and EU accounting policy.

The aim of this network will be to support the implementation of the Food Harvest 2020 strategy in meeting Ireland's international gaseous-emissions commitments. An integral part of the 2020 strategy is to further enhance the sustainability of Ireland's agricultural production and land-use systems and this network will focus on the gaseous emissions and sequestration aspects of these systems.

A further aim will be to support the role of land use and forestry in contributing to national mitigation activities, as outlined in the National Climate-Change Strategy 2007–2012 and Forest Policy. Furthermore, given that climate change and its impact on agriculture is now unavoidable, it is necessary to improve the understanding of these impacts and the necessary responses to ensure agriculture systems are resilient and Ireland is able to continue to play an increasing role in sustainable food output. A key linkage between these ambitions is improving the quantification and reporting of gaseous emissions and sinks, including inventory development and life cycle analysis, the development of country specific emissions factors and activity data (including land-use change dynamics) and appropriate mitigation and adaptation strategies and approaches. It is expected that the formation of a focused, high calibre, interdisciplinary collaborative research network will provide the platform to address these significant challenges.



Development of Ireland's smart grid

The development of the grid and interconnection are addressed in Chapter 8. The project outlined here focuses on the economic opportunities associated with the smart grid.

The proliferation of new data arising from the smart grid will allow for the emergence of new business models and concepts, and opens up the potential for the development of entirely new services, or improvements on existing ones. A key

challenge for a policy network in this area would be to identify these economic and business opportunities. The network could explore the possibility of establishing a test-bed facility where all smart grid technologies are rapidly deployed on the grid in a specific geographical area (see Box 7). It would explore options for exploitation of Irish expertise in the growing international market for smart grid hardware and data analytics (meter analytics, grid analytics, asset analytics etc.). In addition, it would consider how regulatory authorities might be required to focus more strongly on long-term requirements of decarbonisation, while at the same time protecting the interests of consumers. Finally, it would address the challenges—technical, customer engagement and education, regulatory and financial—associated with the roll out of smart meters.

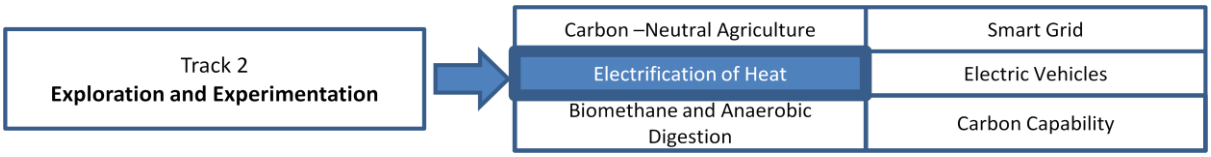
Box 7: Ireland as a *Smart Grid* Test-Bed Facility

Ireland can provide a test-bed facility for emerging technologies. We can see this in many areas, one of which is water. NUI Galway/EPA have invested in a spur off the main water line, which is now being used by companies from around the world to test various technologies in areas such as water purification, testing and metering.

The smart grid is an area in which there is significant need for experimentation. The proliferation of new data arising from the smart grid will allow for the emergence of new business models, technologies and applications. For example, within homes a single platform may emerge supporting the convergence of telecommunications, entertainment, internet and energy. It is likely that energy supply will be bundled with other services in the areas of security, fire monitoring or alarms. Companies such as Google and Opower are already making use of the data that is becoming available to develop new offerings to utilities and bill payers.

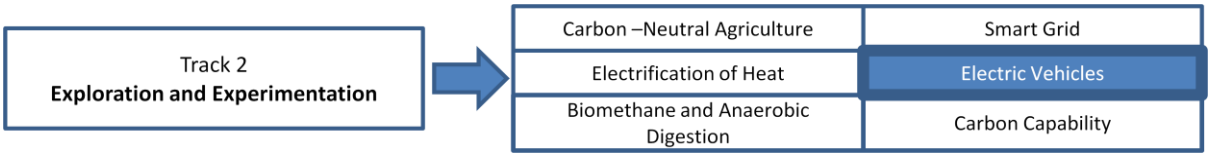
Ireland has established a leadership position in development of the smart grid, and is in a unique position to offer our networks and systems as a proving ground or test bed for the development of smart grid technologies and concepts. The central role of Eirgrid and ESB Networks on both sides of the border provides a unique environment where cross-jurisdiction concepts, applications and business models can be tested, as is the case with the ongoing eCars pilot. Eirgrid has also established the National Digital Research Centre (NDRC), which is focused on smart grid innovation. In the Donegal-Derry region, the North Atlantic Green Zone initiative is exploring the development of a test-bed facility.

Similar to the Green IFSC concept, high-level support and resources could be used to actively promote to international businesses and investors the idea of using the Irish grid to test technologies, business models or concepts.



Electrification of heat

The purpose of this network would be to explore how electrification of heating can be promoted in the medium term. Electrification of heat could take the form of heat pumps or smart-storage solutions. Heat pumps can be a competitive option at present for locations not on the gas grid, and smart-storage heating systems are being deployed on a trial basis. Smart-storage heating technologies may also become an attractive solution because of the grid services they could provide. As discussed in the NESC Secretariat's Interim Report, these technologies face a number of challenges that merit further exploration. These include the impact of current building regulations and supports; the high capital cost of heat pumps; the implications of electrification for peak and aggregate electricity demand; and, negative perceptions among consumers about electric heating systems. In addition, there is a real challenge in making electrification of heat more cost effective. This will require high efficiencies and intelligent control—of the heating system itself and the building being heated—and will require a high level of retrofit for existing homes. Finally, there are also practical challenges such as the adaptation of the technology to the Irish context and addressing the skillset required by designers and installers to ensure proper specification and design.



Electric vehicles

On EVs, there is an active programme of work being led by the ESB. The essential quality of this approach is that the state agency/enterprise takes responsibility for a particular technology and the challenge of making it work. Its actions are focused on supporting infrastructure, working with companies and local authorities to create public charging infrastructure, ICT and data analytics, financial and payment systems and trials with drivers. If EVs are to be successful in Ireland, this organisational effort will be key. It can provide learning opportunities for the ESB and other companies but also for policy makers.

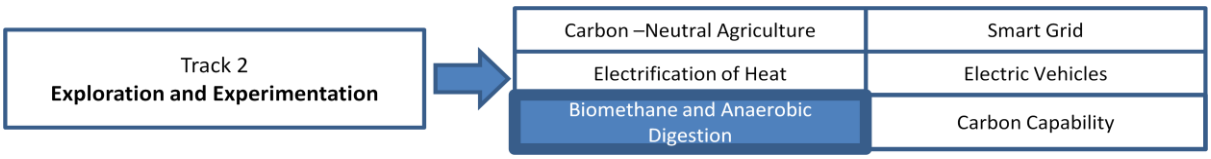
Ireland can use the period up to 2020 to establish its expertise in these areas and use this to create jobs and export opportunities (see Box 8). Ireland constitutes an international test market that is small enough to allow technologies, such as EV, to

be rigorously tested but it is large enough to be relevant to other countries. In addition, IDA Ireland is focusing on securing inward investment from multinational corporations in the EV sector by leveraging the trialling, test-bedding and demonstration of relevant technologies and services.

The development of EVs is also an important aspect of energy policy. Every electric vehicle has a powerful battery and nine out of ten cars are parked at any one time. A smart grid has the potential to integrate these parked vehicles and to use them as a grid resource, though this requires a 'two-way' charging system.

Box 8: Electric Vehicles: Developing Services and Supports

ESB Networks are using IBM's Intelligent Electric Vehicle Enablement Platform to provide the services needed to operate and manage the charge-points installed throughout Ireland. The project team has developed smart charging algorithms using weather, customer travel plans, wind generation, and real time electricity prices. These will be used through a 'cloud' infrastructure to dynamically control EV charging. This system will provide the analytics and intelligence needed to better forecast and balance the load on the power grid as well as help ESB Networks monitor the health and status of the charge-points to ensure service reliability. ESB Networks will have the capabilities to securely maintain customer and charge-point data—such as energy consumption, charging location, and settlement data. With this level of financial insight, industry participants can manage regular and interruptible tariffs and calculate the appropriate billing costs. Additionally, drivers will also have the option to use a mobile device or browser to locate the nearest charging point, check its availability, and make a reservation if the post is available.

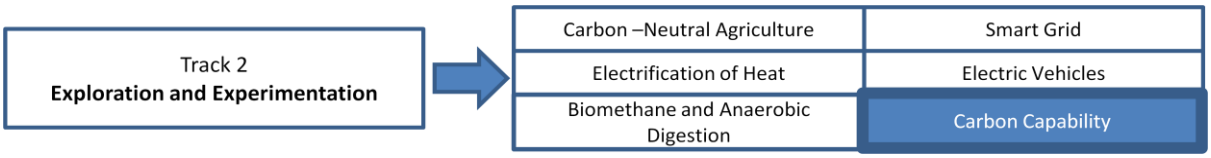


Biomethane and anaerobic digestion

The fifth project and network that we identify is in an area that has proved difficult to date—biomethane and anaerobic digestion (AD). A number of a problems have been evident. The transport and agriculture sectors are faced with a range of technical and indeed ethical constraints to meeting the EU biofuels obligation. Biogas can be produced through the decomposition of organic material—such as agriculture and food waste—through a process of AD. It can be upgraded to biomethane for use in the transport fleet. Consequently, AD can in principle, provide an alternative to crop-based biofuels. In Ireland, however, AD is rarely produced or used, in contrast to countries such as Germany, Sweden and Italy. The challenge for the transport, agriculture and the energy sectors is to work out the role of AD produced biogas and the potential barriers to its expansion in Ireland.

There is, as yet, no policy network focused on the issue of biomethane production using AD and its use in transport. Work is taking place on aspects of this in government departments, Teagasc and Bord Gáis. Among the issues that a policy network might explore are:

- Costs of production of biogas and costs of supports provided in other member states;
- The higher capital cost of gas-based vehicles;
- The development of a refuelling infrastructure from gas-based vehicles;
- The future approach to taxation or excise of gas-based fuel;
- Incentives available for the production of AD;
- Barriers to community-based AD initiatives;
- Public acceptability and planning obstacles;
- The trade-off with agricultural production where grass is an input; and
- The availability of brown waste from the residential sector as an input.



Carbon capability

The final area in which we identify the need for an active process of exploration and experimentation is labelled 'carbon capability'. Engaging the whole of society in the project climate-change action will require a wider approach than through existing state agencies and structures. Social innovation and not just technological innovation is recognised as central to developing low-carbon solutions and practices.

The purpose of the carbon capability project is to probe some of the behavioural and cognitive issues that are widely recognised as critical in achieving long-run transition to a carbon-neutral economy and society. Its focus is on strengthened cross-fertilisation across the public, private and community sectors. There are good reasons to fear that in a range of areas—renewable energy and wind, grid infrastructure, transport, energy efficiency and agriculture—existing practices and attitudes may hinder progress towards carbon neutrality; but also that good practices exist which could be scaled up—for example the Green Schools programme and the 'Smarter Travel Workplaces' programme. Box 9 provides more detail on Green Schools as an example of carbon capability practice leading to energy savings

in the public sector. Kilbarrack Fire Station, outlined in Chapter 3 is another strong example.

Box 9: Green Schools

Green-Schools, known internationally as Eco-Schools, is an international environmental education programme, environmental management system and award scheme that promotes and acknowledges long-term, whole school action for the environment. It is co-ordinated on an international level by FEE (Foundation for Environmental Education) and run in Ireland by An Taisce.

The programme, running here for 15 years, has resulted in savings of nearly €9m in waste, electricity, and water costs over the school years 2010–2012. Over 2500 schools have been awarded the Green flag which they get usually after 2 years of efforts to reduce litter and waste. The programme is run on 7 themes, so that after waste, schools spend a further 2 years on energy, water, travel and biodiversity.

Schools apply to the programme and have to conduct an environmental review to outline their current practices, and then once accepted into the programme, follow an action plan to target different areas. It is an internationally recognised accreditation system but schools themselves come up with ways to improve efficiencies. The programme provides best practice information and guidance on its website and local authorities are involved at a local level. Schools monitor and evaluate their progress so learn to audit their practices.

It is interesting for four reasons. Firstly, because it is running in most Irish schools and therefore has a strong educational and awareness raising role in families. Secondly, because it is reducing emissions through energy savings (e.g. through reduced electricity and in changing travel behaviour) and other aspects of good sustainability practice. Thirdly, because of the *way* it does this, through bottom up innovation, evaluation and supports. Finally, the schools use resources more effectively, therefore provide tangible cost-savings.

We believe that supporting new networks or 'communities of practice' could be valuable in this regard, where networks can identify elements of practice from which wider sustainable approaches could be assembled.[28]

We have discovered that many firms in Ireland are developing significant carbon capability. The example in Box 10 illustrates that a range of techniques and processes—audits, data analysis, educational workshops and farm visits—are being used to improve and change the way things are done.

The case is not an isolated one. As noted in Chapter 3 we have come across many other organisations in which interesting carbon accounting and energy-efficiency work is taking place. These include the Bord Bia-led Origin Green project, the Carbon Disclosure Project, Business in the Community, the EPA Green Business Initiative and a host of organisations across the private and public sector—such as Glanbia, Celtic Linen, Bord Gáis, Kilbarrack Firestation, SMILE Resource Exchange, Cement Roadstone Holdings and various social entrepreneurs and community groups.

Box 10: Glanbia Ingredients Ireland

In June 2012, the Secretariat visited GII, one of Ireland's leading dairy-based ingredients companies. GII views the drive to reduce energy costs and environmental impact as key to future growth. To support this it has created a very sophisticated process by which it assists farmers to farm more efficiently and reduce emissions. Bord Bia and Teagasc were centrally involved in this project. They designed the data collection questionnaire, collected the information on farms, developed the methodology and model and achieved certification from The Carbon Trust.

At GII there is now a Code of Practice that supports continuous improvement on farms. This includes things that famers must do and should do. Independent audits will be used to determine if standards are reached. There is also an education and awareness programme to introduce the code of practice, explain how it works and highlight its impact on farms, particularly the scope to reduce costs. It allows farmers to assess their performance relative to national benchmarks and with local peers. In addition, farmers receive a visit from in-house advisers working with the company who provide advice based on detailed analysis of the audit and ongoing performance data for the farm.

Having completed a pilot programme, GII is planning to roll out this initiative to all of its milk suppliers over 2013/14.

There are network initiatives already underway in Ireland, but on a modest scale. This includes work on the EU-funded Leadership for Energy Action and Planning (LEAP) project and the SEAI-supported Sustainable Energy Community (SEC) Programme. Three exemplar sustainable energy communities have been designated as 'living laboratories' in 2012 (with a further three to be launched by 2015), which will undertake locally-focused projects to increase energy efficiency and reduce energy costs.

The purpose of the carbon capability network is to explore how work within these organisations and groupings could disclose new ideas, possibilities and inspiration for the development of greater carbon capability across all sectors. These communities could be supported in a specific sphere, such as energy efficiency or planning, or focus on a chosen location. An important aspect of the network will be its ability to capture and learn from activity across business, the public sector and the community and social organisations. Cross-fertilisation between these spheres, and willingness to confront challenges at institutional, network or interpersonal and personal levels, will help to bring forward new and innovative ideas.

Chapter 8

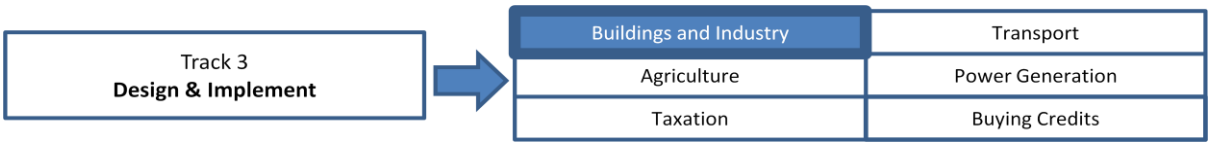
Track 3—Design and Implementation

Track 3 focuses on areas in which there is a strong case for designing and implementing actions. These are areas in which action makes sense—in terms of emissions reductions and economic recovery—and is feasible given current public finances.

Ireland has a legally binding EU commitment to reduce its non-ETS emissions by 20 per cent relative to 2005 by 2020. The EPA's projections indicate that with a continuation of existing policies, this target will not be met, assuming an economic recovery over the 2013 to 2020 period[29]. The EPA refers to a continuation of existing policies as its 'with measures' (WM) scenario and, in this scenario, emissions are projected to fall by just 3.4 per cent over the period 2005 to 2020. An alternative scenario, based on full achievement of existing energy efficiency and renewable energy targets, is referred to as the 'with additional measures' (WAM) scenario. In the WAM scenario, emissions are projected to fall by 11.3 per cent over the period 2005 to 2020. In the early years of this period, it is projected that Ireland's non-ETS emissions will be below the target levels, largely due to the recession, and these surpluses can be carried forward to meet annual targets in subsequent years.

If Ireland could achieve its current policy targets for energy efficiency and renewable energy (the EPA WAM scenario), it would come close to realising its cumulative non-ETS emissions target for the period 2013 to 2020, although the annual distance-to-target in 2020 could still be significant. However, not all of the relevant policy measures are in place to realise the WAM scenario. A key question is the extent to which it will be possible to put in place the relevant policies.

The actions being taken to achieve Ireland's 40 per cent-renewable electricity target mean that there is significant momentum towards a low-carbon electricity sector. It is vital to sustain this progress.



Buildings and industry

Energy efficiency in buildings represents the area with the greatest potential for cost-effective reductions in non-ETS emissions in the period to 2020. The analysis in the NESC Secretariat's Interim Report suggests that investment in energy efficiency in buildings would provide worthwhile returns to investors, and indeed that the extent of cost-effective potential in this area may exceeds current targets. Constraints on the availability of upfront finance is the primary barrier, but not the only one. There are also significant behavioural issues—individual, social and material—which, unless addressed, will impede lasting change. If the identified potential is to be realised policy needs to identify incentives or disincentives. As noted below, there are a range of policies, many of which have been implemented or are under review by the Department of Energy, Communications and Natural Resources. However, it is also critical that the search continues for better ways to enable households and businesses to overcome the barriers to change.

It is also important to note that fuel poverty is a significant problem and there is a risk that a transition to a carbon-neutral economy could exacerbate it. However, there is considerable potential to reduce fuel poverty while reducing energy-related emissions. In particular, targeted assistance for home-energy improvements can simultaneously address fuel poverty and save energy. In moving to a carbon-neutral economy it is important not only to avoid increasing fuel poverty, but to reduce it.

In relation to the residential sector the policy actions supported by the NESC Secretariat are:

- Put in place more demanding efficiency obligations on energy suppliers in the light of the EU Energy Efficiency Directive and the potential for cost-effective savings; the effectiveness of these obligations will depend on a range of supportive measures being put in place, these are listed below
- Piloting a PAYS scheme for the residential sector and exploration of other financing options and the role of the construction sector in overcoming the barriers to retrofit;
- Using property tax to promote greater energy efficiency;
- Inclusion of Building Energy Rating (BER) in sale and letting advertisements; and

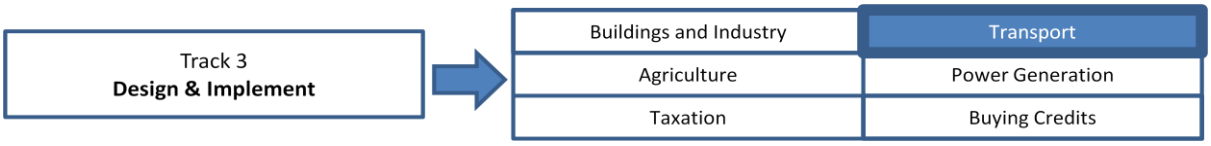
- Explore the impact of minimum efficiency standards for dwellings occupied by those in receipt of rent allowance.

In relation to the non-residential sector the policy actions supported by the NESC Secretariat are:

- Development of a clear legal basis for operation of ESCos in Ireland, and exploration of the possibility of a partial risk guarantee for their promotion;
- Explore the option of sourcing capital for public-sector retrofit programme from the National Treasury Management Agency (NTMA); and,
- Development of revised building regulations for the non-residential building sector.

Renewable heating: In the period to 2020, the scope for cost-effective emissions reduction from the development of renewable heating is more limited than the scope for savings from energy efficiency. However, if Ireland is to make the transition to a carbon-neutral economy by 2050, it will be necessary to move away from the current model in which heating is predominantly supplied by oil and natural gas boilers. The electrification of heating was discussed in Chapter 7. An option worth pursuing at present is to encourage adoption of renewable heating options in public-sector energy procurement. This could be on the basis of an ESCos model in which the customer is not required to incur initial capital costs.

The most significant opportunities for the development of renewable heating in the period to 2020 are probably in biomass use in industry. This would make only a modest contribution to the non-ETS emissions target since the larger volume potential is in the ETS sector. This is, however, a logical part of a longer-term decarbonisation strategy.



Transport

In transport, the most significant potential contribution to reducing in the period to 2020 lies in the achievement of the current policy target that 10 per cent of energy used in transport is to come from renewable energy. This is to be achieved mostly through biofuels, along with a modest contribution from EVs. Both biofuels and EVs are likely to be central to long-term decarbonisation of transport. However,

sustainability concerns raise questions about the ability to achieve the current 10 per cent biofuels target. This is an EU requirement; the EU has recently made some modifications to this target with a view to reducing sustainability risks.

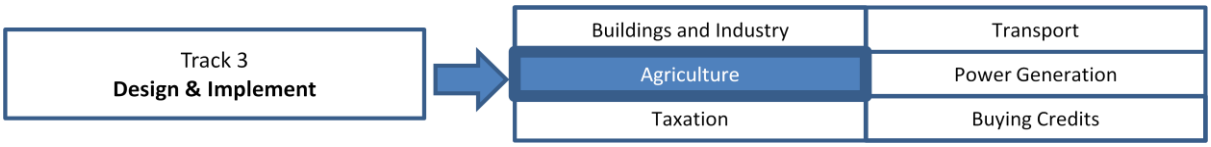
Key additional policy actions that can be taken to reduce transport emissions in the period to 2020 are as follows:

Ecodriving: Eco-driving includes driving more slowly, using a high gear and maintaining tyres at the correct pressure. Recent research by the UCC Energy Policy and Modelling Group suggests that this could reduce emissions, from a car, by between 6 and 13 per cent[30]. A national scheme should be designed targeting either all drivers or specific groups.

Public transport: The current situation in the public finances limits the opportunities for major public-transport investments. However, there may be opportunities using public-private partnerships.

Taxation: Proposals on motor taxation are presented in the section on taxation below.

Biomethane Gas: In Chapter 7, we also noted the need to explore the role of biomethane gas as a means of reducing emissions, particularly for use in freight.

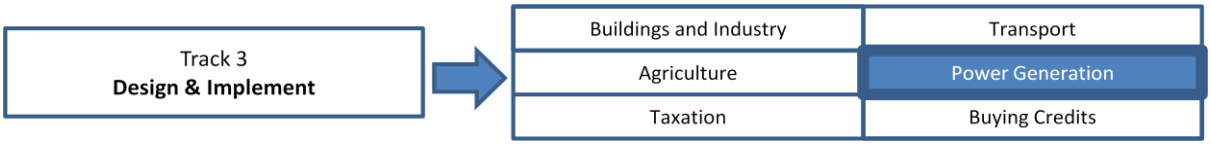


Agriculture

The Food Harvest 2020 strategy for developing the agriculture and food sector implies an increase in emissions in the period to 2020; the EPA projects a rise in emissions of 7 per cent between 2005 and 2020. However, reductions in emissions relative to this baseline would help to meet the 2020 emissions targets and would also represent an initial step towards a carbon-neutral agriculture by 2020.

Recent research by Teagasc has identified many opportunities to reduce emissions that would also be profitable for farmers. If these 'cost-beneficial' measures were to be fully adopted, the potential annual emissions reduction are estimated to be 1.1 Mt CO_2 eq. While some farmers have adopted these measures, many have not. There is a need to attend to the reasons why some farmers do not change practices, to understand local ways of farming and to consider the types of supports that would more effectively encourage change.

In addition to the profitable opportunities that have already been identified to reduce emissions in agriculture, ongoing research reveals other possibilities that should be examined to determine the sector's ability to further reduce emissions and move towards national carbon neutrality in the decades ahead.



Power generation

The decarbonisation of electricity generation is central to the movement to a carbon-neutral economy. In addition, there is considerable scope for electrification of heat and transport so that low-carbon electricity can contribute to the decarbonisation of these areas as well. Since electricity is in the ETS sector, reduced emissions here do not contribute to meeting Ireland's 2020 non-ETS emissions target. However, Ireland also has a legally-binding renewable energy target for 2020, and renewable electricity is central to achieving this. Ireland has adopted a target that 40 per cent of electricity will be generated from renewable sources by 2020.

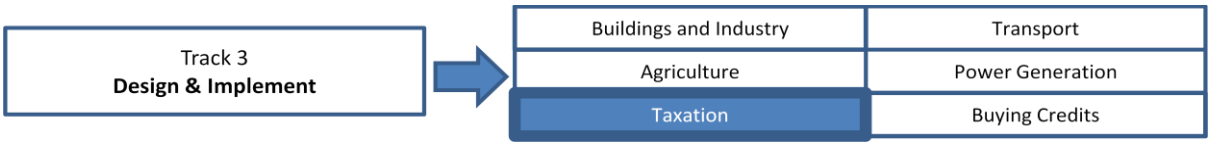
Grid investment: The biggest risk to the achievement of Ireland's renewable electricity target is that there will not be sufficient progress in building the grid to accommodate the rise in wind generation. This issue is the social acceptability of grid installation. Better communication and engagement with local communities on the importance of grid infrastructure are required. We welcome the Government statement of July 2012 on the strategic importance of transmission and other energy infrastructure. This provides a mandate for the provision of community gain in localities affected by grid development.

Regulation: To ensure the necessary investments in low-carbon generation, interconnection and the smart grid, the mandate of regulatory authorities might be adapted to consider not only protection consumers short term interest in prices, but also the national interest in achieving long-term requirements of decarbonisation of the energy system.

Interconnectors: Given the potentially significant requirement for interconnection between the Irish and European grids in the long term, it would seem wise to ensure that current Ireland—UK export projects are progressed in a fashion that would allow them ultimately to become full interconnectors. Ireland should continue its active involvement in the North Seas Off Shore Grid Initiative (a framework for the regional cooperation on questions related to future grid infrastructure in the North Sea, including the Irish Sea).

R&D: The allocation of R&D expenditure might be reconsidered in light of the emergence of a national decarbonisation strategy to 2050. Strategic choices are required to focus on the most promising technologies that could play the greatest role in Ireland's decarbonisation, such as those associated with the smart grid or off-shore energy.

Smart meters: There is an imperative for early and ongoing engagement and consultation with households on the implications and potential impact of smart meters before deployment. Consumers can have anxieties concerning privacy, data protection, security, the social implications of a 'kill switch' and the clarity and accountability of variable tariffs.



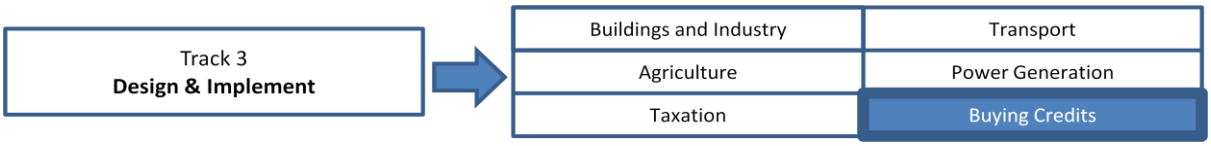
Taxation

Tax has been shown to be an important influence on behavioural change. A gradual, planned and announced, increase in the price of carbon can play a significant role in promoting the long-run transition to a carbon-neutral energy system. A gradually rising carbon price has the effect of making low-carbon technologies more competitive and—in the context of sufficient policies supporting innovation and investment in clean energy—in the longer term helps encourage a shift towards the adoption of low-carbon technology. The Secretariat's Interim Report highlights a number of additional actions. It argues for:

- A phased increase in the carbon tax tax to around €33 per tonne by 2020 (in 2009 prices, which is the level assumed in the current EPA projections);
- The need to protect the progress achieved by changes to motor tax and VRT, to avoid further revenue losses; changes to the bands; and, for higher taxes above higher emissions thresholds;
- Consider an alternative approach to freight taxation, which would base the tax on the weight the vehicle is rated to carry; and for the role of user charges as a means of raising additional revenue from trucks registered abroad by considering; and
- The role of property taxes in promoting energy efficiency and as a revenue-raising measure.

The NESC Secretariat welcome the division of previous A and B bands for motor tax and VRT announced in Budget 2013. The analysis in the Interim Report suggests that there is also scope to consider significantly higher taxes for higher-emission cars.

The property tax introduced in Budget 2013 is based on market values. Such a tax could be a disincentive to undertake retrofit activity or other improvements since these tend to increase property values. However, the modest initial level of the tax, the band structure and the fixing of property values up to 2016 suggest that it will not adversely affect retrofit activity. However, as the level of the tax rises over time it will be important to consider its impact on the incentive for retrofit and other improvements. Commercial rates are set at a considerably higher level than the residential property tax. The impact of commercial rates on the incentive to undertake improvements, including energy efficiency investments, should be considered. A site value tax would avoid disincentive effects and encourage more sustainable land use.



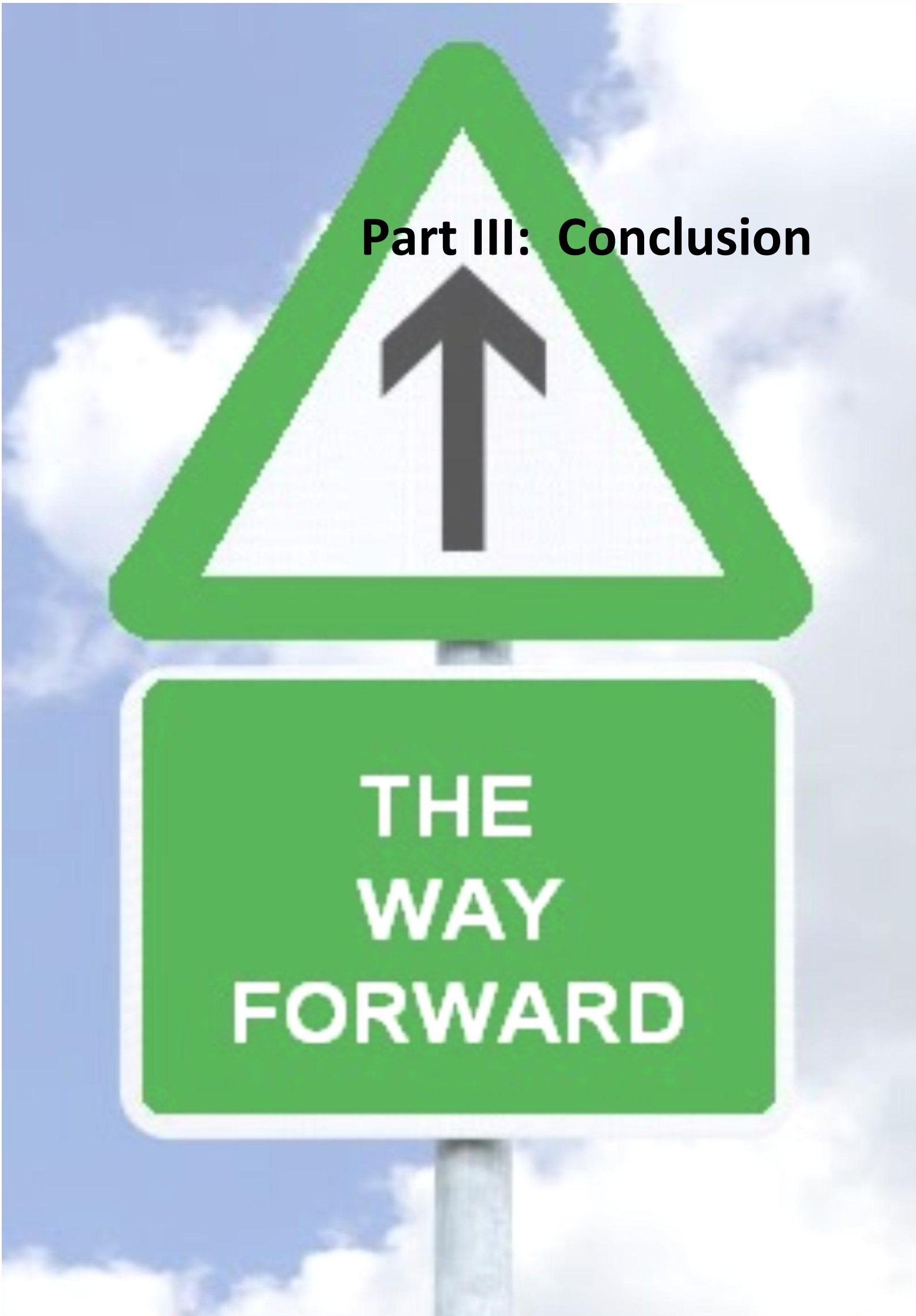
Buying credits

A package of measures, containing some of the policy possibilities summarised above, might still require Ireland to buy some credits to achieve compliance with its 2020 non-ETS emissions target. Cost estimates have been prepared by the Department of the Environment, Community and Local Government, based on projected carbon market prices. These estimates suggest that if emissions follow the EPA's WM scenario, the cumulative estimated costs over the period 2013–2020 would be €205m. If emissions follow the EPA's WAM scenario, there would be a modest distance-to-target and the estimated cumulative cost would be just €13m. The use of shadow carbon prices, recommended by the Department of Finance for use in cost-benefit analysis, indicates substantially higher projected costs of purchasing compliance: €615.7m in the WM scenario and €57.9m in the WAM scenario. These carbon prices were adopted in 2009 and reflected expectations of market prices at that time[31]. These cost projections are subject to a number of uncertainties. If the EU were to adopt a more ambitious approach to climate change this is likely to lead to substantially higher carbon prices.

A considerable disadvantage of extensive purchasing of credits or allowances is that it does not contribute to the long-run transition to a carbon-neutral economy. When account is taken of the fact that failure to make progress in the coming years could give rise to increasing annual purchase requirements after 2020, and that increasing

EU ambition is likely to make carbon credits more expensive, the idea of relying heavily on buying compliance seems significantly less attractive. Overall, our analysis leads us to the view that Ireland should focus in the first instance on how to achieve those domestic mitigation targets in the WAM scenario that chime most fully with economic recovery, employment, competitiveness, energy independence and public sector reform. Nonetheless, the option of buying credits or allowances is a useful flexibility, but it is not desirable to rely extensively on this approach to meet the targets for 2013–2020.

Part III: Conclusion



Chapter 9

The Way Forward—Ireland's Carbon-Neutral Future in a Decarbonising World

Science strongly suggests that climate change is happening faster than was earlier expected and that the current global trajectory of energy use puts the world on track for an increase in temperatures that will yield extremely damaging change climate conditions.

Our vision is that Ireland will be carbon neutral by 2050, as a part of a successful international drive to address climate change and other resource pressures and support sustainable and inclusive economic and social progress, especially in developing countries.

In Ireland's case, we can identify five building blocks of the transition to carbon neutrality—clean electricity, energy efficiency, carbon neutral food and agriculture, sustainable transport and effective resource management. We believe that these can also be building blocks of a vibrant enterprise sector, creating jobs and economic opportunities. In addition, there are other advantages associated with early and sustained action to reduce our emissions and achieve more efficient resource use. These include greater energy security, better public health, quality of life and well being. However, the transition to carbon neutrality requires considerable further investment over several decades—in order to build renewable energy capacity, create a smart grid and international interconnection, make buildings more energy efficient, adapt livestock and farm systems, extend forestry and energy crops and establish practical, cost-effective, alternatives to petrol and diesel driven transport. In addition, it will require discovery and dissemination of profound behavioural change in enterprises, public sector organisations, communities and households.

At both national and international level, in order to move in this direction it is necessary to think and act in new ways. First, we must balance the dominant focus on 'how much' emissions reduction is necessary and promised in any given period, with much greater exploration of *how* this is to be achieved—technically, organisationally and politically. Second, in order to find out how decarbonisation is to be achieved, and build stronger commitment and capability to actually do it, it is necessary to engage a wide range of actors at many levels in governance systems that animate, learn from and push networks of firms, public bodies, researchers and communities to ever-greater decarbonisation.

In order to progress this agenda, the Irish government needs to undertake a number of political and institutional steps:

1. Embed the transition to carbon neutrality, and particularly the five strategic building blocks, within the core agenda of economic recovery and development, ensuring that the allocation of resources reflects these new priorities and imperatives;
2. Create and direct a new process and entity—with a government-led steering and oversight board and small technical secretariat—to monitor progress on the main carbon neutrality building blocks and project areas, organise disciplined joint exploration of successes and failures and drive departments, agencies and their networks to push the boundaries of knowledge and practice on how to achieve decarbonisation;
3. Create a transparent process of periodic review of Ireland's progress towards carbon neutrality, involving relevant departments, agencies and the the Joint Oireachtas Committee on Environment, Culture and the Gaeltacht; and
4. Actively engage with, and contribute to, new international thinking on designing more effective 21st century climate arrangements, as well as identifying what distinctive contribution Ireland can make based on our resources and capabilities.

By taking these steps Ireland can make a real contribution—not only to its own long-term development, but also to enriching the EU's climate change strategies and improving international efforts to respond to the pressing climate, energy and resource challenges faced by humanity.

Supporting Material

Background Papers

As noted in this report, the Secretariat have prepared a series of background papers that provide more detailed references and source material. These will be posted on the NESC website (www.nesc.ie). The Secretariat's June Interim Report is also available.

Consultation

The Interim Report and two versions of the Final Report were considered by the NESC Council. In addition, we worked closely with four government departments that are not on the Council, namely Departments Public Expenditure & Reform; Agriculture, Food and Marine; Transport, Tourism and Sport; and Communications, Energy and Natural Resources.

During our work on this project we have also been able to draw on the expertise and time of large number of individuals. The organisations within which these individuals work are listed here:

- Environmental Protection Agency
- Teagasc
- Sustainable Energy Authority of Ireland
- International Institute for European Affairs
- Glanbia Ingredients Ireland
- UCD Earth Institute
- UCC Energy Policy and Modelling Group
- TCD Department of Civil, Structural & Environmental Engineering
- Bord na Mona
- Enterprise Ireland
- IDA
- Forfas
- ESB
- Tadhg O'Mahony, Consultant
- National Electricity Association of Ireland
- Erigrid
- Bord Gáis
- EPS Consulting
- Business in the Community
- ECO-UNESCO
- National Transport Authority
- James Nix, Transport & Environment Network
- Ernest and Young, Sustainability and Cleantech Solutions
- NUI Galway, Political Science and Sociology (Henrike Rau)
- University of Exeter, Human Geography (Prof. Devine-Wright)
- Teagasc, RERC
- Glen Dimplex
- An Taisce
- Commission for Energy Regulation
- Electricity Research Centre, UCD

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draw here on Ostrom, E. (2009), *A Polycentric Approach for Coping with Climate Change*, Policy Research Working Paper 5095, Bloomington, Indiana: The World Bank; and Ostrom, E. (2012), 'Nested Externalties and Polycentric Institutions: Must We Wait for Global Solutions to Climate Change Before Taking Actions at Other Scales', *Economic Theory,* 49(2): 353–69.

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Abbreviations

AD	Anaerobic Digestion
BER	Building Energy Rating
BTAP	Beef Technology Adoption Programme
CCS	Carbon Capture and Storage
CO_2	Carbon Dioxide
COP	Conference of Parties
DAFM	Department of Agriculture, Food and the Marine
DEP	Dairy Efficiency Programme
DECLG	Department of Environment, Community & Local Government
EBI	Economic Breeding Index
EI	Enterprise Ireland
EPA	Environmental Protection Agency
ESB	Electricity Supply Board
ESCo	Energy Services Company
ETS	Emissions Trading Scheme
EU	European Union
EVs	Electric Vehicles
GATT	General Agreement on Trade Tariffs
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GII	Glanbia Ingredients Ireland
GW	Gigawatt
HVAC	Heating, Ventilation and Cooling
IBM	International Business Machines Corporation
ICT	Information & Communication Technology
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
Ktoe	Kilo Tonnes of Oil Equivalent
Mt	Million tonnes
Mt CO_2	Million tonnes of Carbon Dioxide
Mt CO_2 Eq	Million tonnes of Carbon Dioxide Equivalent
NDRC	National Digital Research Centre
NEEAP	National Energy Efficiency Action Plan
NESC	National Economic and Social Council
NGO	Non-Governmental Organisation
NGVs	Natural Gas-based Vehicles
NREAP	National Renewable Energy Action Plan
NTMA	National Treasury Management Agency
NUI	National University of Ireland
OECD	Organisation for Economic Co-Operation and Development
PAYS	Pay As You Save
R&D	Research and Development
REFIT	Renewable Energy Feed-in Tariff
RES-H	Renewables in Heat
SEAI	Sustainable Energy Authority of Ireland
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
UN	United Nations
VRT	Vehicle Registration Tax
WAM	With Additional Measures
WM	With Measures
WTO	World Trade Organisation

Glossary

This section provides a general guide for the reader. The NESC Secretariat considered more comprehensive definitions in its research.

Anaerobic Digestion (AD) is a process which converts organic material —such as waste or grass— into a high energy containing gas, known as biogas, which can be used for green energy production.

Biomass encompasses a variety of fuels and technologies used to produce renewable energy. Biomass refers to land and water-based vegetation, organic wastes and photosynthetic organisms. Energy from biomass and waste is often referred to as bioenergy.

Cap-and-trade or emissions trading is a system whereby emissions limits or caps are issued to industry.

Carbon accounting is a process to verify an organisation's emissions of carbon dioxide and carbon dioxide equivalents.

Carbon capability are the skills, situated knowledge, motivation, and capacity to cut carbon.

Carbon credit is a generic term for any tradable certificate or permit representing the right to emit one tonne of carbon dioxide or the mass of another greenhouse gas with a carbon dioxide equivalent (tCO2e) equivalent to one tonne of carbon dioxide.

Carbon pricing is the generic term for putting a price on carbon through either subsidies, a carbon tax, or an emissions trading ("cap-and-trade") system.

Carbon sequestration is the process by which carbon sinks remove carbon dioxide (CO_2) from the atmosphere.

Carbon sink is a natural or artificial reservoir that accumulates and stores some carbon-containing chemical compound for an indefinite period.

Circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life.

Clean energy includes energy efficiency and clean energy supply options like highly efficient combined heat and power as well as renewable energy sources.

Climate change refers to increased levels of greenhouse gases, such as CO2, increase the amount of energy trapped in the atmosphere which leads to global impacts such as increased temperatures, melting of snow and ice and rising global average sea-level.

Marginal abatement curve or MAC curve is a set of options available to an economy to reduce carbon emissions.

Climate change adaptation addresses the impacts and opportunities resulting from climate change.

Climate change mitigation refers to efforts to limit the human induced causes of climate change.

Climate finance refers to financing channelled by national, regional and international entities for climate and mitigation projects and programs.

Data analytics is the science of extracting actionable insight from large amounts of raw data.

Decarbonisation denotes the declining average carbon intensity of primary energy over time.

Deep retrofit refers to residential energy efficiency measures which result in energy savings of 40%, although in many cases a deep retrofit may save more than this.

Ecodriving is a way of driving that reduces fuel consumption, greenhouse gas emissions and accident rates. Ecodriving is about driving in a style suited to modern engine technology: smart, smooth and safe driving techniques that lead to average fuel savings of 5-10%.

Electric vehicles (EVs) use one or more electric motors or traction motors for propulsion. Electric vehicles include electric cars, but can also include trains, lorries, boats and spacecraft.

An **ESCO**, or Energy Service Company, is a business that develops, installs, and arranges financing for projects designed to improve the energy efficiency and maintenance costs for facilities over a seven to twenty year time period.

ETS the EU Emissions Trading Scheme, creates a price for carbon. The common trading ‘currency’ of the EU ETS is an emission allowance.

GHG and CO2 emissions: Greenhouse gas (GHG) emissions are produced from many different activities. The most important long-lived greenhouse gases are carbon dioxide (CO2), nitrous oxide (N2O), and methane (CH4).

Global warming is the rise in the average temperature of Earth's atmosphere and oceans since the late 19th century and its projected continuation.

Green Growth is a term to describe a path of economic growth which uses natural resources in a sustainable manner. It is used globally to provide an alternative concept to standard economic growth.

Information deficit model of behaviour change is based on the assumption that providing knowledge about the consequences of certain actions, would lead to a change in behaviour.

A life-cycle assessment (LCA, also known as life-cycle analysis, ecobalance, and cradle-to-grave analysis) is a technique to assess environmental impacts associated with all the stages of a product's life from-cradle-to-grave (i.e., from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).

A low-carbon economy, low fossil-fuel economy or decarbonised economy is an economy that has a minimal output of greenhouse gas (GHG) emissions into the environment biosphere.

Transitioning is the passage from one state, stage, subject, or place to anotherand a low carbon transition involves fundamental social, technical, political and institutional change.

Low carbon transition encompasses technological and scientific developments as well as social practices and behaviour.

Market failure is a concept within economic theory describing when the allocation of goods and services by a free market is not efficient.

Micro-generation is the small-scale generation of heat and electric power by individuals, small businesses and communities to meet their own needs, as alternatives or supplements to traditional centralised grid-connected power.
A PAYS scheme offers people the opportunity of energy upgrading the building they occupy, without requiring them to provide upfront finance and without placing a debt obligation on them. A PAYS tariff is instead assigned to the building through a utility bill.

Renewable energy is energy that comes from resources which are continually replenished such as sunlight, wind, rain, tides, waves and geothermal heat.

A **smart grid** is an electrical grid that uses information and communications technology to gather and act on information, such as information about the behaviours of suppliers and consumers, in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity.

A **smart meter** is usually an electrical meter that records consumption of electric energy in intervals of an hour or less and communicates that information at least daily back to the utility company for monitoring and billing purposes. Smart meters enable two-way communication between the meter and the central system.

Photovoltaic systems (PV systems) use solar panels to convert sunlight into electricity.

Sustainable energy is the sustainable provision of energy that meets the needs of the present without compromising the ability of future generations to meet their needs.

Test-bed facility is a means for testing something in development. Outcomes from a test-bed are more effective systems, better use of data in forecasts, improved services, products, and economic/public safety benefits.

Transition management is concerned with how to govern transitions to more sustainable socio-technical systems.

The value-action gap is the gap that can occur when the values or attitudes of an individual do not correlate to their actions. More generally, it is the difference between what people say and what people do.

With measures (WM) scenario includes existing and currently implemented policies and measures in Ireland.

With additional measures (WAM) scenario includes existing and planned policies and measures in Ireland.

Images

Sourced online at;

- San Diego State University
- Bord na Móna
- The pelican web
- about.com
- The Green Market Oracle
- GoCar Cork