Title	Greenhouse gas policies in Ireland 1990 -2012 : Reliance on the land
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Publication Date	14-08-01
Item record	http://hdl.handle.net/10379/4643

GREENHOUSE GAS POLICIES IN IRELAND 1990 – 2012

RELIANCE ON THE LAND

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Thesis submitted for the Degree of Ph.D

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April 2014

ABSTRACT

This research sought to determine the extent to which national greenhouse gas (GHG) policy relied upon the land, through afforestation, controls on agriculture, and expansion of bioenergy. The implications of this reliance were explored with reference to evolving EU targets and sustainability considerations. The study was based on analysis of national and UNFCCC documents for the period 1990 to 2012, supplemented by interviews with actors and stakeholders.

Ireland was assigned a Kyoto limit of +13% re 1990. It was found that savings associated with the land were 5 $MtCO_{2eq}$, which facilitated a 34% increase in emissions from energy and industry sectors, while still meeting the limit. However, the state also faced a stringent EU target of 20% reduction in emissions by 2020. National actors attributed the difficulty in reaching this target to agricultural emissions, and called for reductions. This view is questioned. In the historical context, agricultural emissions were not excessive. In terms of food energy and life-cycle emissions, Irish agriculture is highly efficient. The conclusion of this research is that the onerous EU 20% reduction requirement was an unintended outcome of EU policymaking and the design of the emissions trading scheme, exacerbated by Ireland's reliance on afforestation.

Regarding sustainability, Irish policy exhibited deficiencies. Forest sequestration could not continue indefinitely, and restricting agricultural emissions ran counter to world population and food projections. Bioenergy targets exceeded indigenous resources, and liquid biofuels would increase net food energy imports, threatening food security.

This research suggests an approach to GHG policy in which emissions and sinks related to the land are partitioned from fossil fuel emissions. The state could seek to comply with the EU 20% reduction target for 2020, but for energy and industrial emissions only. Regarding the land, a sustainable policy would be to aim towards long-term GHG neutrality.

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ABBREVIATIONS AND ORGANISATIONS

BER	Building Energy Rating
Bórd na Móna	Peat Development Board
BOS	Biofuels Obligation Scheme
CCS	Carbon Capture and Storage
CH_4	Methane
CHP	Combined Heat and Power
CO_2	Carbon dioxide
CO_{2eq}	Carbon dioxide equivalent
Comhar	National Sustainable Development Partnership
EEA	European Environment Agency
EPA	Environmental Protection Agency
ESB	Electricity Supply Board
ESRI	Economic and Social Research Institute
ETS	Emissions Trading Scheme
FAO	Food and Agriculture Organisation of the United Nations
F-gases	Fluorinated gases
GDP	Gross Domestic Product
GFC	Gross Final Consumption (of energy)
GHG	Greenhouse Gas
GWP	Global Warming Potential
IBEC	Irish Business and Employers Confederation
IEA	International Energy Agency
IIEA	Institute of International and European Affairs
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land Use, Land Use Change, and Forestry
MOTR	Mineral Oil Tax Relief
N_2O	nitrous oxide
NAP	National Allocation Plan
NCCS	National Climate Change Strategy
NESC	National Economic and Social Council
OECD	The Organisation for Economic Co-operation and Development
PSO	Public Service Obligation
REFIT	Renewable Energy Feed in Tariff
RES-E	Renewable energy in electricity supply
RES-H	Renewable energy in heating
RES-T	Renewable energy in transport
SEAI	Sustainable Energy Authority of Ireland
Teagasc	Agriculture and Food Development Authority
toe	Tonne of oil equivalent
TPER	Total Primary Energy Requirement
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs
UNFCCC	United Nations Framework Convention on Climate Change
VRT	Vehicle Registration Tax

ACKNOWLEDGEMENTS

I would like to thank Dr. Kieran Hickey for his patience and helpful guidance over the many years taken to complete this work. Special gratitude goes to officials in the government departments of environment and energy, and to personnel in Teagasc, SEAI, IrBEA and IFA, who agreed to be interviewed as part of this research, and for their open and insightful views. Any interpretations, misinterpretations or opinions formed on the basis of these interviews are mine alone. My family provided full support for me during this project, including my son Robert who volunteered for the unenviable task of proof-reading. I wish also to acknowledge the support of my employer ANV Technology Ltd. who provided time and funding for this work.

1 INTRODUCTION

The threat to the world's climate posed by greenhouse gases generated by human activities first featured in the public domain in the early 1990s. While the sudden appearance of this major threat to the planet may have been interpreted by the population and by politicians as a new scientific discovery, the basis for these concerns was well understood. The role of the atmosphere in trapping heat and maintaining the earth's temperature had been the subject of scientific speculation in the early nineteenth century (Fourier, 1827). By the mid-nineteenth century the role of water vapour, carbon dioxide, nitrous oxide, and hydrocarbon gases had been extensively studied, and their heat-trapping effect in the atmosphere quantified (Tyndall, 1865). By the turn of the twentieth century, the critical role of carbon dioxide in maintenance of the earth's surface temperature was described by the Swedish scientist Svante Arrhenius (1896), who estimated that a doubling of the carbon dioxide concentration in the earth's atmosphere would increase global temperatures by 5 to 6 ºC. Given the simple calculation models available at that time, this was a remarkably accurate estimate which fell within the upper theoretical range subsequently confirmed by the Intergovernmental Panel on Climate Change (IPCC) over a century later (IPCC, 2013a). Thus, by the turn of the twentieth century there was a reliable scientific basis for understanding the essential role of greenhouse gases in the earth's climate system. Without the heat-trapping effect of these gases, the world would be a frozen wasteland. In a later book aimed at the general public, Arrhenius (1906) predicted that the industrial burning of coal would lead to an increase in the concentration of carbon dioxide in the atmosphere, which he viewed as a positive factor as it would help to stave off a future ice age.

However, by the late 1970s, a consensus was developing among scientists that anthropogenic emissions of greenhouse gases (GHG) could adversely affect the thermal balance of the earth (Zillman, 2009). Early warnings surfaced at the World Climate Conference in 1979 organised by the World Meteorological Organisation. In 1988 the International Panel on Climate Change (IPCC) was established, and in its first assessment report it confirmed that human activities had resulted in increases in greenhouse gas concentrations and that this would lead to warming of the earth's surface which could affect regional climates (IPCC, 1990). Negotiations on an international response to this global threat culminated in the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. As a signatory to the convention, Ireland was obliged to contribute to international mitigation measures, with the ultimate objective of stabilising greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system (UN, 1992a). Specific national limits for GHG emissions for the period 2008-2012 were subsequently set out in the Kyoto Protocol (UN, 1998). Subject to a commitment by the 15 states of the European Union (EU-15) to jointly reduce emissions by 8%, Ireland was assigned a national target which permitted emissions to increase by at most 13% relative to 1990. The target would be challenging as Ireland had already exceeded this limit in 1998, and there was the expectation of continued economic growth, which would inevitably entail increased fossil fuel consumption. Up to 2007 the consensus among Irish scientists was that emissions would significantly exceed the Kyoto limit. However, in the period 2008 to 2012 there was a marked reduction in emissions which was generally attributed to the economic crisis which began in 2008. The eventual outcome was comfortable compliance with the Kyoto limit. While Ireland had passed the first compliance hurdle in 2012, policymakers looked with trepidation to the more stringent EU limit for 2020 which required emissions to reduce by 20% relative to 2005. This did not appear to be achievable, as it would require Irish GHG emissions to be essentially reduced back to 1990 levels.

This research addresses the Irish policy response to the difficult task it faced in meeting Kyoto commitments and its attempts to address the additional EU requirements for 2020. Apart from the technical difficulties faced in achieving immediate targets, there was no precedent that would guide long-term policy. The experience gained from the Montreal Protocol on the control of ozone depleting substances (UNEP, 1987) would not be directly applicable. Alternatives to ozone depleting gases had already existed in 1987, and policy could proceed in the direction of gradual restrictions through amendments to the protocol and corresponding regulations (EC, 2000; Ozone

Regulations, 2006). These changes could be made without affecting the economy or impacting noticeably on everyday lives. Controlling the growth in GHG emissions would imply moderating growth in fossil fuel consumption. However, in Ireland in the period 1990 to 2012, there was no alternative energy source of sufficient scale to drive economic expansion. Limited political support for nuclear power dissipated in the early 1980s and was replaced by an anti-nuclear political consensus culminating in a legal prohibition on nuclear power (Electricity Regulation Act, 1999). GHG reduction, while linked to energy, differed radically from previous challenges faced by the state in the energy sector. During the Second World War, and during the oil crises in the 1970s, the state could adopt rationing strategies. While these may not have been popular, they had to be accepted. In contrast, to comply with its Kyoto commitment, the state would somehow have to curtail growth in energy consumption in a free-market environment where energy supply was not restricted. To meet this challenge, Irish policy sought to offset increased GHG emissions from fossil fuels by exploiting the carbon sequestration potential of forestry, by reducing emissions from agriculture, and by seeking to replace fossil fuels with bioenergy derived from crops. In effect, climate change policy came to rely heavily on the land.

Irish policy focussed on GHG mitigation, rather than adaptation, and it could be more accurately described as a GHG policy rather than a general climate change policy. The history of Ireland’s GHG policy has not been analyzed in detail before. The general aims of the research were to arrive at an understanding of the Irish policy response, to investigate gaps or unexplained aspects in policy evolution, to question approaches, and to draw lessons for the future. A key theme running through the study is the degree to which GHG emissions from fossil fuel combustion, which arise from carbon sequestered on a geological time scale, were off-set by means of reductions and sequestrations associated with the land, which occur as part of the current natural carbon and nitrogen cycles. Ireland was unusual among the EU-15 states that signed up to the Kyoto Protocol in having the highest fraction of agricultural GHG emissions in its national emissions. A study of the Irish experience in this area helps to highlight the advantages and risks in relying on the land for GHG mitigation, and provides an opportunity to explore quantitatively broader issues of sustainability with respect to bioenergy and food security.

1.1 THEORETICAL AND CONCEPTUAL FRAMEWORKS

1.1.1 CLIMATE CHANGE POLICY IN A SUSTAINABLE DEVELOPMENT CONTEXT

Climate change policy is a remarkably complex area. It has been described by Jordan et al. (2010a, p.4) as a “wicked problem par excellence”. A “wicked” policy problem refers to one that challenges existing social and institutional frameworks, which defies analysis and has no optimal solutions in terms of definitive and objective answers (Rittel and Weber, 1973). While there may be no definitive analytic approach to a wicked policy problem, some effort must be made at defining a framework to study the problem in a meaningful and systematic manner. In considering a suitable theoretical framework, the concept of sustainable development is a logical choice. Anthropogenic climate change arguably is the very definition of unsustainable development. While future generations may be able to cope without certain raw materials, a rapid change in climate and the resulting perturbation of weather systems may be beyond the adaptation capacity of ecosystems (IPPC, 2007b), and the resulting adverse impacts are likely to challenge the adaptation and coping capacities of future generations. Implementation of an effective policy on climate change is therefore an integral and essential element of a sustainable development strategy.

1.1.2 THE CONCEPT OF SUSTAINABLE DEVELOPMENT

The World Commission on Environment and Development (WCED) was established in 1983 and promoted sustainable development as a core objective for the future of mankind and the planet. The resulting report entitled “Our Sustainable Future” (also referred to as the Brundtland Report) defined sustainable development as meeting the needs of the present without compromising the ability of future generations to meet their own needs (UN, 1987). Sustainable development involved the recognition of limitations posed by technical resources, social organisation and the absorptive capacity of nature. It was not envisaged as a normative steady-state situation that could be achieved by a set of prescriptive measures, but rather as a process of change in the use of natural resources, economic investments, technology and institutional structures to achieve outcomes consistent with present and future needs. Ethical underpinnings of the Brundtland Report were evident. A strong emphasis was placed on socioeconomic development as a means of eliminating poverty, which was considered to be an evil in itself. In reconciling economic development with environmental capacity painful decisions would have to be made, and political will was identified as the ultimate driving force for sustainable development. Robust political structures and the application of political leadership would only be achievable if there was broad and active support from society. This explains the strong emphasis placed in the Brundtland Report on participation by society in the formation of sustainable development policies.

The United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992 produced a document entitled Agenda 21 which sought to assist countries in implementing sustainable development strategies (UN, 1992b). Agenda 21 ran to 40 chapters and provided lists of objectives and implementing measures in a range of socioeconomic and environmental areas, including climate change. While it represented a move towards a normative view of sustainable development, there was no single model as each country's sustainable development strategy was required to take account of individual national situations, capacities, and priorities. Devolved responsibility to local authority and municipal level was encouraged under a process termed Local Agenda 21 (LA21). The effectiveness of LA21 in various countries has been the subject of research (Barrett, 2002; Sancassiani, 2005), but without specific consideration of how climate change policy is integrated into the local action plans. It was expected that LA21 would increasingly reflect the global rhetoric on climate change (Betsill and Bulkeley, 2006).

1.1.3 APPROACHES TO SUSTAINABLE DEVELOPMENT

Climate change policy and sustainable development attract attention from a wide range of academic disciplines. Blewitt (2008) describes the disparate world views, including environmentalism, economic theory, technological analysis, ecological modernisation, human geography, systems and complexity theory (e.g. Gaia hypothesis), actor network theory, wisdom of elders, bioregionalism, social ecology, eco-feminism, and deep and shallow ecology. A sociological approach as proposed by Redclift (2009) suggested that one should begin with analysis of society itself and the reasons for its carbon dependency, rather than seeking to change the behaviour of society through exhortations.

All of these areas of research use different approaches, speak different academic languages, and are at different stages of theoretical development. The diversity of approaches does not necessarily hinder achievement of policy objectives. Sustainable development with respect to climate change policy can be viewed as a dialogue of values between the broad economic, social, and environmental perspectives with occasional convergence of goals and sometimes conflicts requiring difficult trade-offs (Blewitt, 2008). While it has hampered the accumulation of a body of knowledge, the lack of consistency and coherence among the epistemic community can be viewed to some extent as inevitable. Sustainable development represents a movement to change the future of human civilisation and a wide range of interpretations and approaches in the early stages can be expected (Jordan, 2008).

1.1.4 Interpretations of Sustainable Development and Governance

The definition of sustainable development is evidently open to interpretation. The needs of the present generation could range from frugal to extravagant depending on one's viewpoint. While the basic human needs of future generations in terms of food, shelter, and energy can be presumed and anticipated to some extent, the ability of future societies to deliver on these needs is unknown. The Brundtland view of sustainable development implied that economic progress did not necessarily conflict with other social and environmental objectives. It suggested that there was at least a middle way where trade-offs may be required, or perhaps even synergies could be found between the three developmental pillars of the economy, society, and the environment. Jordan (2008) interpreted Brundtland's approach as an attempt to by-pass the conflict between the economic and environmental lobbies which had dominated the environmental debate in the 1970s. Kates et al. (2005) argued that the concept of sustainable development in fact draws much of its power from its ambiguity. In this interpretation, sustainable development is an ongoing negotiation to achieve a compromise between economic, social, and environmental objectives.

Following on the idea that sustainable development involves significant buy-in and input from diverse stakeholders, the process of achieving objectives is best described in terms of governance. In general terms, governance is the means by which change can be brought about in the state (Treib et al., 2007). Government has the leading role, but non-governmental actors and stakeholders are included. Governance incorporates multidisciplinary input and serves as a bridge between the wide range of disciplines involved (Van Kersbergen and Van Waarden, 2004). A definition that encompasses diverse perspectives is that governance is the steering and co-ordination of interdependent actors based on institutionalised rules (Treib et al., 2007). While diverse actors are involved, the government remains central to state governance. It is not a question of non-governmental bodies excluding the state nor of the state off-loading responsibilities, but of the state working to enable the actions of the non-governmental actors (Selin and Najam, 2011).

1.1.5 Considerations In Reviewing Climate Change Policy

If climate change governance and sustainable development can be open to a wide range of interpretations, this presents obvious challenges for policy formulation and for the assessment and review of policies. That climate change policy should be informed by evidence is however obvious and unlikely to be contested. Useful evidence on the success of particular policies can be obtained by ex-post policy evaluations. While formal policy evaluations have not been conducted in Ireland, a large number of such evaluations have been conducted in EU member states. In a meta-analysis of 262 climate policy evaluations, Haug et al. (2010) found a divergence in approach and an uneven coverage of critical aspects. Goal attainment and effectiveness were found to be the primary assessment criteria employed. Fairness, meaning equitable sharing of burdens and costs, received less emphasis. There was also an identified difficulty in disentangling the effects of national climate policies from those of EU policies. Haug et al (2010) expressed scepticism that universal agreement would be achieved on a common approach to policy evaluations. More worryingly, little evidence was found that such evaluations had influenced policy development.

While reviewing policy with respect to goal attainment and effectiveness provides useful quantitative information it may fail to identify underlying strengths and weaknesses. In some cases goals may have been attained in any event in the absence of any policy. Goals may also have been attained in a particular sector at the price of future problems in other sectors. In other cases, goals may simply have been impossible to attain, and the weakness is not in the policy but in the formulation of unrealistic goals. Approaching the task of policy review on the basis of a check-list of objectives derived from Agenda 21 would be a possible approach. However, benchmarking a policy against the numerous and diverse objectives and actions listed in Agenda 21 risks losing track of fundamental principles. The Organisation for Economic Cooperation and Development (OECD) addressed the need for a compact formulation of good policy practice, and proposed a set of twelve principles for national sustainable development strategies (OECD, 2001). The United Nations Department of Economic and Social Affairs (UNDESA) proposed a condensed set of five basic principles for sound and effective sustainable development planning (UNDESA, 2001), which in general encompassed the OECD principles. In seeking a set of objective criteria and a numeric marking scheme for policy evaluations, Cherp et al. (2004) reduced the multiple objectives of Agenda 21, the OECD guidelines, and the UNDESA guidelines into a set of five common guiding principles. These principles, based on fundamental aspects of sustainability as originally envisaged in the Brundtland Report, as well as common-sense principles of strategic planning, are set out in Table 1.1. Ireland’s National Sustainable Development Partnership (Comhar) also produced guidelines for the interpretation of sustainable development in an Irish context (Comhar, 2002), which were subsequently re-iterated and slightly expanded by the Department of Environment

(DECLG, 2012). The thematic principles in the Irish guidelines are also shown in Table 1.1.

Referring to the five principles proposed by Cherp et al. (2004) as listed in Table 1.1, the first concerns country ownership of policy, which is considered the first requirement for formulation of a national sustainable development strategy. There is not a corresponding explicit principle in the Irish guidelines. However, given that the state produced its own sustainable development strategy (DOE, 1997a), it would be reasonable to assume that country ownership is an implied principle. The second principle is the need to properly integrate national economic, social, and environmental objectives. In the Irish guidelines this requirement also exists and is expanded to include a proposed list of objectives. The third principle of sustainable development is participation. This is not stated as an explicit headline principle in its own right in the Irish guidelines, but is included as an element in what is termed "good decision making". The remaining principles proposed by Cherp et al. (2004) are that strategy formation should be a comprehensive and coordinated process and that there should be targeting, resourcing, and monitoring of actions. These latter two principles are standard elements of strategic planning and are encompassed in the Irish guidelines under the principle of "good decision making".

The five principles of Cherp et al. (2004) provide a broad reference framework within which a national sustainable development strategy can be explored. Additional considerations specifically for reviewing climate policy aspects were proposed by Huitema et al. (2011), and employed in a meta-analysis of EU climate change policy reviews. The additional considerations were that reviews of climate change policy should address three critical aspects, namely: complexity, reflexivity, and stakeholder participation. The undoubted complexities of climate change policy imply the need for multiple criteria and evaluation methods. The reflexive component refers to the questioning of original goals and proposal of revised goals. In acknowledgement of the core requirement for broad participation in sustainable development, evaluations should incorporate input from stakeholders.

	Principles for a National Sustainable Development Strategy	
	Cherp et al., 2004	**Ireland** [1]
Principles of Sustainable Development	Country Ownership and Commitment	National responsibility implied, but not explicitly developed as a principle
	Integration of economic, social, and environmental objectives	Satisfaction of human needs by the efficient use of resources Low-carbon economic growth [2] Respect for ecological integrity/ biodiversity Respect for cultural heritage /diversity Equity between generations Equity between countries and regions Social equity Gender equity [2]
	Participation and consensus	Good decision-making
Principles of Strategic Planning	Comprehensive and coordinated process	
	Targeting, resourcing, and monitoring	

Table 1-1 Principles underpinning national sustainable development strategies as proposed by Cherp et al. (2004), which encompass OECD (2001) and UN (2002) guidelines. Also, corresponding Irish thematic principles, summarised from those presented by Comhar (2002), and DECLG (2012).

[1] Thematic principles (Comhar, 2002; DECLG, 2012)

[2] Additional national objectives introduced in "Our Sustainable Future" (DECLG, 2012)

Regardless of what technocratic or economic analysis may find, if policy outcomes fail to reflect the original intentions of stakeholders then the policy cannot be termed sustainable. A common approach in many countries, including Ireland, has been to divide the implementation of climate change policy into sectors under the control of respective government departments. This greatly reduces the complexity of the analysis, at the risk of overlooking cross-cutting aspects and interactions between sectors. Likewise, evaluation of policy performance under sectoral headings is greatly simplified, but can give a misleading impression of progress, as complex and unanticipated interactions may be ignored. In particular, progress in one sector may have adverse consequences in another sector, or potential cross-cutting policy options may not be recognised. Such sectoral simplification seeks to bypass the complexity which is an inherent characteristic of the climate change policy challenge (Huitema et al., 2011). While there is no easy solution, breaking down policy performance assessment along sectoral lines, as is done in chapter 4, permits a concise presentation of many important features. The inherent complexity of the problem can subsequently be addressed by analyzing interactions between these policy sectors.

1.2 Factors Shaping Climate Change Policy in Ireland

Irish sustainable development policy including its climate change aspects was informed initially by Agenda 21, and subsequently by evolving GHG limitation targets in the context of UNFCCC commitments and obligations within the EU. The ambiguity in interpretation of sustainable development provided a flexibility that permitted states to develop strategies which would have otherwise been quite challenging. Thus in Ireland's first formal sustainable development strategy, even the intractable problem areas of energy and transport could be readily addressed (DOE, 1997a). Continued growth in energy consumption and in road transport was openly acknowledged to be unavoidable to maintain economic growth. For both of these sectors the sustainability aspect was transferred to minimising the associated environmental pollution. In the case of energy, sustainability was also invoked in the context of security of supply, meaning that policies would be directed so that the supply of energy could be feasibly sustained. In this way, both the transport and energy strategies could plausibly be described as sustainable. Continued growth in GHG emission was an inevitable consequence of this approach and the need for increased GHG emissions to accommodate economic growth consequently underpinned Irish policy in the 1990s, as discussed in chapter 3. Ireland's relaxed approach on GHG limitation could be justified on the basis of the need of the existing generation for continued economic growth. It could even be considered one of the necessary but difficult trade-offs between the environment and the economy envisaged in the original Brundtland Report. The advent of the Kyoto Protocol in 1998 restricted the freedom of interpretation of what constituted a sustainable development strategy. Climate change policy could not be simply inserted as a stand-alone section. The numeric limit on GHG emissions had immediate implications for what could be termed sustainable energy, sustainable transport and sustainable agricultural development strategies.

Irish policy on climate change and on GHG mitigation sat within the existing national governance structure. Flynn (2003) characterised national governance in Ireland as a conservative regime, with an adversarial and litigious approach to implementation. This resulted in an emphasis on legislation as the main policy instrument. Policy development in Ireland did not display noticeable characteristics of multilevel governance, and actions by local authorities on GHG mitigation strategies were limited. McGloughlin and Sweeney (2011) characterised the small number of identified local measures in Ireland as best practice examples and not representative of a wider multilevel governance, and concluded that Ireland had not main-streamed climate change objectives into its planning policies.

It is probable that consideration of the possible consequences of climate change for Ireland also informed national policy. While forecasts by the IPCC painted a disturbing picture of the likely effects of climate change in many parts of the world (IPCC, 1990; IPCC, 1995b; IPCC, 2001b; IPCC, 2007b), the predictions for Ireland would not have unduly alarmed Irish policymakers or politicians. Research in this area focused on whether there were detectible changes in the Irish climate and weather patterns (McElwain and Sweeney, 2003), and on prediction of climate change effects (McGrath et al., 2005; McElwain and Sweeney, 2006). Potential impacts were identified on water resources, ecology, biodiversity, agriculture, sea-level rise, and marine ecosystems. For an agricultural country, understandably much of the research interest lay in assessing the effects of climate change on agricultural production. The view was forming that Ireland would be capable of adapting, and that most existing crops would continue to be viable (Sweeney, 2008; Sweeney et al., 2008). For the wider population the potential extreme effects of climate change, and in particular possible changes in weather were of more immediate interest, which were described in publications aimed at a general readership (Hickey, 2008; 2010). However there was no evidence during the study period 1990-2012 that public opinion or the political discourse was galvanised by threats of significant changes in the Irish climate or of more frequent extreme weather events.

1.2.1 Climate Change Policy in EU Context

Ireland's membership of the European Union had the benefit of permitting GHG commitments to be made on the basis of joint fulfilment within the EU, but with the inevitable risk of losing national policy ownership. Flynn (2003) identified a weakening of policy ownership, and concluded that Irish environmental policies were reactive and largely driven by EU pressures. This reflected a trend throughout the EU from 2000 onwards. In the 1990s, EU climate change policy was characterised as an ill-defined amalgam of national policies, being strong on rhetoric but weak on delivery (Jordan and Rainer, 2010). From 2000 onwards there was sustained policy innovation at EU level, leading to binding targets that in turn drove national policies. By 2007, as a result of repeated scientific warnings, growing public concerns, and individual political leadership in the U.K., Germany and France, the EU moved to the formulation of targets for 2020. This placed the EU in a position of international leadership on climate change (Patterson, 2009). Policy was increasingly determined at EU rather than national level, and the overall shape of this policy was weighted towards mitigation of GHG emissions with little attention to adaptation (Jordan et al., 2010b). The transfer of the ownership of climate policy from country level to EU level was reflected in the development of Ireland's climate change strategies, which moved from national targets in the 1990s to negotiated joint fulfilment targets in the EU, as described in chapter 3. By the end of the Kyoto period in 2012, there was a fundamental conflict between national development objectives for agriculture and EU climate change policy.

1.3 Reviews of Irish GHG Policies

1.3.1 Reviews of Goal Achievement

From 2000 onwards assessment of progress in the area of climate change policy focused primarily on goal achievement, in terms of the deviation of GHG emissions from the Kyoto emissions limit. Annual data was available in detailed inventory reports issued by the Environmental Protection Agency (EPA), discussed in chapter 4, and in technical reports on energy consumption and energy projections issued by the Sustainable Energy Authority of Ireland (SEAI). The series of annual EPA inventory reports showed that emissions exceeded the Kyoto limit from 2000 to 2008 (McGettigan et al., 2010). This led to the widely held view that there would be great challenges in meeting the Kyoto limit. Following the economic crisis which began in 2008, national GHG emissions reduced markedly (Duffy et al., 2011), and Ireland found itself unexpectedly and suddenly on a trajectory for Kyoto compliance. The reduction was however attributed to the severity of the economic downturn. While Kyoto compliance would be achieved, the long-term outlook was still pessimistic. As part of the EU's Climate and Energy Package, Ireland was required to achieve a reduction of 20% in domestic GHG emissions in 2020, relative to 2005 (EC, 2009a). The EPA predicted exceedence of this limit, even under the most ambitious modelled scenarios (EPA, 2011a).

1.3.2 Broader Policy Reviews

National Climate Change Strategy 2000 (NCCS 2000) had set defined goals in terms of GHG emissions limits on a sectoral basis (DELG, 2000a). The first formal review of all aspects of NCCS 2000 was conducted by the Department of Environment in 2006 (DEHLG, 2006a), which led to a revised national strategy in 2007 (DEHLG, 2007). The 2006 review focused on how future obligatory targets could be reached. While noting that GHG emissions had already exceeded the limit, the review did not delve into the reasons for failure of the original strategy. Nor did it question long-term objectives or goals in the context of the state's sustainable development strategy. In particular with regard to the land, there was no consideration of the long-term implications of national policies. The 2006 review, as was the case for other government reviews of energy policy and renewables policy, was conducted with a high degree of participation by stakeholders as discussed in chapter 8, though with questionable benefits.

Shortly after publication of NCCS 2007, the Institute of International and European Affairs (IIEA) conducted a comprehensive review of strategic issues relating to Irish climate change policy (Brennan and Curtin, 2008). Their analysis was forward-looking and did not consider in detail the historical performance of policies and measures. Weaknesses were identified in the existing climate change strategy in that it did not address the mandatory 20% reduction target set by the EU for 2020. Three long-term policy options were outlined in the IIEA review. One option was a proactive policy, with a targeted reduction of 60% in GHG emissions by 2050. A more demanding option was to aim for carbon neutrality in 2050. The third option, business-as-usual, was ruled out as it would breach the EU targets for 2020. The review benefitted from the collaboration of 60 of the main policymakers and stakeholders drawn from government departments, state bodies, and industry. It could consequently be taken as representing the consensus among the climate change policy community at that time. While the IIEA review addressed the complexity of the climate change policy challenge, and was highly participatory, it did not engage in any questioning of national GHG goals for 2020. A subsequent review by the IIEA (Curtin and Hanrahan, 2012) included a brief summary of identified deficiencies in the implementation of NCCS 2000. These included delays in introducing a carbon tax and vehicle CO_2 taxes, failure to deliver on demand-side management, delays in introducing building insulation regulations, and failure to support biomass adequately. Increased GHG emissions were also attributed to urban sprawl which was blamed on poor spatial planning. However, the review focused primarily on the future and considered how legislation could be framed to strengthen governance in achieving future targets.

Towards the end of the Kyoto period, the Department of Environment conducted an in-house review of policy (DECLG, 2011), which was a closing off of national policy with respect to Kyoto. It was concluded that compliance would be comfortably achieved, but that the state faced a huge task in achieving mandatory EU targets by 2020 in the domestic non-ETS sectors. A continuation of the Kyoto phase policies was ruled out as it would not be sufficient to position Ireland on the pathway to the necessary long-term reductions to be achieved by 2050. Deep cuts in emissions would be required. In 2012 the National Economic and Social Council (NESC) carried out a major review of national climate change policy (NESC, 2012). It encouraged new thinking on how Ireland could position itself on a pathway to a carbon neutral future in 2050. A revised system of governance was envisaged, building on existing agencies and resources with a national steering and oversight board supported by a strong government mandate. In the same year, climate change policy challenges were addressed by the EPA (O'Reilly et al., 2012), and like the NESC report, a carbon neutral future for Ireland was envisaged for 2050, which was to be achieved through almost total de-carbonisation of the energy and industry sectors along with large reductions in agricultural emissions and large increases in carbon sequestration. Echoing the original Brundtland view that economic development does not necessarily conflict with environmental goals, O' Reilly et al. (2012) suggested that significant economic opportunities could be exploited by Ireland in the emerging green technologies. Neither the NESC (2012) nor the O'Reilly et al. (2012) reviews included a fundamental analysis of historical performance, or deficiencies in the existing governance system. However the emphasis placed by NESC on "thinking for ourselves" would indicate that there was a desire to re-assert national ownership of climate change policy (NESC, 2012 p.10). By 2013 some academic attention had begun to focus on quantitative assessment of the existing national strategy, such as the benefit of the Power of One energy efficiency campaign (DCMNR, 2006a), which was found to have been largely ineffective (Diffney et al., 2013).

1.3.3 DOMINANCE OF ECONOMIC THINKING IN IRISH CLIMATE CHANGE POLICY

Threats to sustainable development caused by climate change have most commonly been framed in terms of economics theory as a classical market failure, in that the price of adverse environmental impacts is not factored into the market prices. This suggests policy responses in terms of market interventions such a carbon taxes, and technological research to develop green products. In Ireland, economic thinking dominated the academic discourse on national climate change policies and sought to influence national policy. That all strategies should be on a least cost basis was a widespread and unchallenged assumption. The landmark report by Stern (2006) illustrated the cultural dominance of economic thinking. In essence, the analysis concluded that it would be cheaper to take action on climate change in the short-term, rather than waiting for things to get worse. This had a remarkable effect on policymakers in both the United Kingdom and in Ireland. In the revised National Climate Change Strategy in 2007 (NCCS 2007), Stern was the only academic mentioned by name in the text.

Carbon tax as a policy instrument attracted academic interest in Ireland from the outset. This option was analyzed using macroeconomic models and significant potential was identified for CO_2 abatement in the electricity and industrial sectors (Conniffe et al., 1997). There were also predicted modest benefits for the wider economy (Bergin et al., 2004). Economic modeling extended to consideration of how households could be compensated for such taxes (Scott and Eakens, 2004; Callan et al., 2008). From 2008 onwards, control of GHG emissions from the power generation and large industrial sectors effectively moved out of direct national control as a consequence of the Emissions Trading Directive (EC, 2003a). Research and economic modeling then moved on to consider the benefits of a carbon tax on the wider economy, which indicated modest projected benefits to 2020 (Toll et al., 2008). A detailed review of national GHG policy by Legge and Scott (2009) was couched primarily in economic terms, and saw future policy as being largely reliant on carbon taxation. Economic thinking also influenced the perception of what constituted sustainable development. In an extreme interpretation, sustainable development was viewed as something that could be mathematically modelled. Such a model reported on by Toll et al. (2009) provided mathematical linkages between the environment and economic activity. Environmental factors would be incorporated into an expanded model as Green Net National Product by assigning economic values to environmental and ecological services. The model was promoted primarily as a tool for policymakers to determine the likely outcomes of policies in terms of emissions to atmosphere and water. However, describing this mathematical tool as "Ireland's Sustainable Development Model" risked diminishing the basic principles underlying sustainable development. Fundamentally, sustainable development is a politically led movement, and the necessary hard decisions and trade-offs are not amenable to definitive mathematical solutions. Tensions between political initiatives and economic theory were evident in Ireland. In an economic review of NCCS 2007, McCarthy and Scott (2008) saw application of economic principles, underpinned by a carbon tax, as the only rational way forward, and as the "silver bullet" to deal with GHG emissions:

> As to domestic policy, in place of targets the Government should focus on policy. The confusion of target enunciation with policy decisions is a contemporary political ailment particularly evident in discussion of climate and energy issues
>
> (McCarthy and Scott, 2008, p.32).

This echoed the views of respected economist William Nordhaus on the crucial role of carbon taxation:

> To a first approximation, raising the price of carbon is a necessary and sufficient step for tackling global warming. The rest is at best rhetoric and may actually be harmful in inducing economic inefficiencies (Nordhaus, 2008, p. 22).

1.4 Research Objectives

This research seeks to add to the understanding of Irish climate change policy, by addressing gaps which are evident in the present body of knowledge, and to fundamentally question aspects of policy relating to the land which have previously not been challenged. Firstly, the historical context is established. Against this background the extent to which Irish policy relied on the land is explored, and critically reviewed. Bioenergy and its viability in an Irish context is pursued as a major theme in its own right, leading to a questioning of policy objectives in this area. Finally, lessons are learned from over two decades of climate change policy and constructive approaches are sought for improved governance, along with incorporation of land policy into future national climate change policy.

1.4.1 Consolidated History of Ireland's GHG Policies

A feature of the published reviews of Irish policy was that they focused almost entirely on the future direction of policy, and neglected to probe in detail into past policies. Such enthusiasm for discourse in the interesting area of future policy formation, rather than the more mundane backwater of policy history, is understandable. However a study of the history of GHG policies in Ireland can contribute to a deeper understanding of the motivations behind the Irish policy responses, and can provide a context and background within which particular aspects of policy can be systematically explored and questioned.

The first objective was therefore to compile a consolidated history of GHG policy in Ireland which could inform other aspects of the research. A main theme is the extent to which Irish policy relied upon the land, and potentially impacted upon future land-uses. However in recognition of the complexity of climate change policy the historical review must also include all aspects of climate change policy, as these are likely to be interlinked. Establishing the policy history also enables a quantitative assessment to be made of goal achievement, bench-marked against targets initially proposed in the late 1990s, and set out in more detail in NCCS 2000. The historical analysis can help to understand the origin of the compliance problem towards the end of the Kyoto period, when it appeared that Ireland was simultaneously comfortably on target in its Kyoto commitments (Duffy et al., 2012), and yet apparently hopelessly off-target for its EU 2020 commitments (EPA, 2011a). At a deeper level, an historical analysis helps to provide an insight into the collective mind of the policymakers, to identify biases and assumptions which can be exposed to questioning.

1.4.2 DETERMINING RELIANCE OF IRISH GHG POLICY ON THE LAND

A prominent aspect of Ireland's GHG policy was to use the land to achieve GHG mitigation by means of carbon sequestration in forests, reductions in agricultural emissions, and plans to exploit bioenergy crops. Reliance on the land to help balance national GHG budgets began as early as 1993 (DOE, 1993), and continued in subsequent national strategies (DELG, 2000a; DEHLG, 2007). This policy effectively sought to facilitate increased greenhouse gas emissions from fossil fuel combustion through compensatory decreases from the land sectors. Determining the extent of policy reliance on the land and the justification for this reliance was a major research objective. The extent of the reliance can be readily quantified in terms of the mass of CO_{2eq} mitigated, or in terms of the fraction of total national GHG reduction achieved by this means. Questioning the justification for the policy, which has not been done to date in Ireland, requires a more philosophical approach. The ethical basis of international climate change policy is that developed nations, who were historically responsible for the vast increases in GHG emissions to the atmosphere, must bear the prime responsibility for achieving reductions (UN, 1992a). Transferring this principle to an individual state, it is reasonable to ask what sectors of the economy or what activities bore prime responsibility for the historic growth in GHG emissions. It is relevant also to consider the historical evolution of GHG emissions from agriculture. This can lead to an informed view on the extent to which agriculture bears responsibility for current elevated GHG concentrations. Policy in the area of climate change and sustainable development cannot however be reduced to a simple mathematical apportioning of responsibility. The needs of society must be considered, in particular its economic well-being, which may well require increased energy consumption. On the other side of the question is the role of agriculture in meeting the basic human necessity of provision of food. This requires consideration of the role of the land in the long-term sustainable development of the state.

1.4.3 ANALYSIS OF IRISH BIOENERGY POLICY AND IMPLICATIONS

Bioenergy, which is the production of energy from crops, is an aspect of Irish policy which warrants detailed study in its own right as it has implications for long-term land-use and overlaps with agricultural and food policies. Policy for promotion of bioenergy received widespread support in Ireland and there was little evidence of any fundamental questioning of this policy. The treatment of bioenergy in the present research focuses on its underlying energy efficiency, and on the realistically achievable production volumes in the context of the sustainable national production capacity. The difficulties in implementing a bioenergy policy are explored in the context of free-trade within the EU, and the availability of cheaper products from outside the EU. This is particularly relevant in the case of liquid biofuels which are readily tradable commodities on international markets. The biofuels experience in Ireland serves to illustrate the difficulty in asserting national ownership of a sustainable development policy in the face of the pressures of free-trade rules and international competition.

Were bioenergy production to increase significantly, it could impact on the availability of land for food production and for commercial forestry. First generation biofuels in general originate from food crops, and while second generation biofuels may well be able to exploit non-food crops and feedstocks there is still the potential to displace land from food production. The implications of the stated national goals for bioenergy, and in particular liquid biofuels, provide an opportunity to explore the food versus fuel controversy from an Irish perspective and to consider the long-term sustainability of bioenergy policies.

1.4.4 LEARNING FROM TWO DECADES OF POLICY EXPERIENCES

Informed by the historical background and the questioning of policy goals in relation to the land and bioenergy, an objective of the research is to identify lessons that can be learned to inform future climate change policy. Balancing competing demands of the economy, society, and the environment is a complex and dynamic process which is resistant to simple prescription. However, at a more modest level, improvements in the system of governance may be possible to improve policy clarity and to seek to strengthen climate change policy within the overall framework of a national sustainable development strategy. In particular, based on the knowledge gained from over two decades of Irish policy, an objective of the research is to explore possible alternative approaches to the integration of the land into national climate change policy.

1.5 Chapter Overview

Chapter 2 – Methodology

In chapter 2, the research methodology is described and discussed. An unusual feature of the methodology for analysis of the food versus fuel issues is the use of physical energy as the metric.

Chapters 3 and 4 – History and Achievements

The unfolding events from 1990 to 2012 are considered in chapter 3, which provides a history of the origins and evolution of GHG policy in Ireland. Features of the national GHG emissions curve from 1990 to 2012 are discussed in chapter 4. Against this background, an ex-post assessment is presented on national achievements with respect to the Kyoto target, renewable electricity target, and the national sectoral targets set out in NCCS 2000.

Chapters 5, 6 and 7 – Agriculture, The Land, and Bioenergy

To appreciate the implications of national GHG policy for the land, an understanding of the characteristics of Irish agriculture and land-use is required. These ideas are developed in chapter 5, where GHG emissions from agriculture are considered in an historical context from the mid-19th century to the early 21st century, and the background to current agricultural policy is described. This leads to consideration of the unique GHG emissions profile of Ireland within the EU-15 in chapter 6, and how Kyoto accounting rules opened the link between the land and fossil fuel GHG emissions. A quantitative analysis is presented of the degree to which Irish policy relied upon agriculture and forestry. Ireland's promotion of bioenergy is discussed in chapter 7. While practical obstacles are highlighted in Ireland's case, more fundamental sustainability concerns are explored in terms of fuel versus food aspects which question the viability of both Ireland's and the EU's bioenergy policies.

Chapters 8 and 9 – Public Consultations, and Interviews

The findings of the historical and investigative research are supplemented with information derived from three public consultations on national energy and GHG policies discussed in chapter 8. Interviews with key stakeholders and policy actors in chapter 9 provide additional insights.

Chapter 10 – Discussion, Conclusions, Proposals for Improvements

The main themes are drawn together in the discussion in chapter 10. Based on lessons learned over two decades and identified difficulties in policy with respect to the land, proposals are made for adjustments in governance and policy. These are aimed at incorporation of the land into a long-term sustainable development strategy, utilising existing governance resources, within the existing international policy frameworks.

1.6 Terminology

1.6.1 Government Departments

The responsibilities of Irish government departments were revised with successive changes in government from 1991 to 2011, resulting in changes in departmental names. For simplicity, government departments are referred to by their area of responsibility relevant to GHG policy, as follows:

Department of Environment, Department of Energy, Department of Agriculture and Department of Transport.

Formal departmental names over the period 1990-2012 are provided in appendix A.

1.6.2 The Land

The use of the word "land" in this thesis refers to all aspects of human activities on the land, including agriculture, forestry, management of lands, and changes in land-use. The linkage between all of these activities is evidently the land. They are also all logically connected, as they are all part of the current biophysical carbon and nitrogen cycles. When words describing land activities are used on their own, such as "Agriculture", "Forestry", their meaning is as per the Kyoto Protocol (UN, 1998), and as clarified in the Marrakesh Accords (UNFCCC, 2002). Kyoto treats agriculture as a separate emissions category, and is not included in land use, land-use change, forestry (LULUCF). Definitions are as follows:

Agriculture: direct emissions of GHG from livestock, manures, soils, field burning.

LULUCF: land use, land-use change, forestry.

Land-Use: The management of croplands, grazing lands, forestry and revegetation which affect the carbon stock of the lands. Under the Kyoto Protocol, accounting for these land-use activities was optional. Ireland decided not to avail of this option (Government of Ireland, 2006).

Land-Use-Change: direct human induced change in land-use, e.g. conversion of natural lands to farmlands, draining wetlands.

Forestry: afforestation, reforestation, and deforestation. For Kyoto accounting only forestry activities since 1990 are considered.

1.6.3 Policy, Strategy And Tactics

By definition, policy refers to a guiding set of principles which are clearly enunciated and understood by all involved. This permits the design of working strategies to achieve defined objectives within the envelope of actions permitted by the policy. Tactics represent specific approaches to deal with immediate issues. However the formal distinction between policy and strategy can be blurred, as actors and stakeholders frequently use the words interchangeably. "Policymaker" would for example be commonly understood to refer to those close to government, who formulate both national policies and strategies. What are referred to as policy options in academic papers could also be validly termed strategic options. In general, “policy” is used in the text in connection with the government’s stated positions, and “strategy” to denote a specific plan.

1.6.4 GREENHOUSE GAS TERMINOLOGY AND ENERGY UNITS

Box 1 lists the terminology used to describe greenhouse gases. National GHG emissions are quantified in units of millions of tonnes of carbon dioxide equivalent ($MtCO_{2eq}$). For Kyoto accounting, gases such as methane and nitrous oxide are converted to carbon dioxide equivalent in terms of their global warming potential relative to carbon dioxide over a 100 year period. Gases are referred to in the text by their chemical formulae, and emissions data is to be understood in all cases as annual emissions unless otherwise specified. Box 2 shows the relationship between energy units and includes approximate emissions factors for fossil fuels. Many different energy units are commonly used in the literature on climate change which can lead to confusion. To ensure consistency, a single unit is used in this document. The tonne of oil equivalent (toe) represents the energy released upon combustion of one tonne of oil, and is the unit normally used for compilation of national energy statistics. All fuels and energy sources can be expressed in terms of tonnes of oil equivalent (toe). A convenient aspect of the toe unit is that it permits a simple calculation of the carbon dioxide emitted when the fuel is burned using emissions factors. For example, combustion of 1 toe of oil releases three tonnes of carbon dioxide ($3tCO_2$/toe). For coal the emission factor is $4tCO_2$/toe, and for milled peat the emissions factor is $5tCO_2$/toe. Natural gas (methane) is the fossil fuel with the lowest emission factor of $2.5tCO_2$/toe.

BOX 1: Greenhouse Gas Terminology

Gases Greenhouse Gases: GHG

Carbon dioxide: CO_2 , Methane: CH_4, Nitrous oxide: N_2O

Fluorinated hydrocarbons: F-gases

Carbon dioxide equivalent: CO_{2eq} : the mass of carbon dioxide that would have the same global warming potential as the mass of GHG released, for a 100 year time horizon.

$MtCO_{2eq}$: million tonnes of carbon dioxide equivalent

BOX 2. Energy Units

Tonne of oil equivalent (toe): the energy released upon combustion of one tonne of oil

1 toe = 42 GJ = 11.6 MWh =11,600 kWh (i.e. 11,600 electricity units)
1 ktoe = 1000 toe = 42 TJ = 11.6GWh
1 Mtoe = 1,000,000 toe = 42 PJ = 11.6 TWh

Relationship between fuel energy and food energy:

1 toe = 10 million dietary calories

Approximate typical GHG mass emission factors [1]: multiply the mass of oil equivalent by the factor to get the CO_2 emission:

Milled Peat: 5, Coal: 4, Oil : 3, Natural Gas: 2.5

[1]Data source Howley and Holland (2013), converted to tCO_2/toe, rounded to nearest 0.5.

2 METHODOLOGY

2.1 INTRODUCTION

The scope of the present research is the study of GHG policy in Ireland. While this policy was born in an international context, and was driven largely by international factors, especially at EU level, the focus of the analysis is on the Irish policy response rather than the international dimension. In considering an approach to the study, a decision needed to be made whether to refine the scope to an in-depth analysis of a particular aspect or to attempt an assessment on a broader canvas. The latter broad approach was adopted, in recognition of the need to address the complexity of the climate change policy problem (Huitema et al., 2011). Consideration of this inherent complexity requires all aspects of GHG policy to be probed to some extent. The decision to adopt this broad approach was informed by preliminary reading of the published national strategy documents which revealed a large number of policy interactions. It appeared that GHG policy affected everything. Energy policy and GHG policy have an obvious connection, but unexpected linkages were also suggested between apparently disparate aspects such as national peat policy and bioenergy policy (as discussed in chapter 7). There were also indications that government policy on industrial GHG emissions had impacts on agricultural policy (as discussed in chapter 6). The presence of these interactions suggested an holistic approach. Such an approach may overlook details which could be probed using an alternative reductionist methodology. However, this risk is outweighed by the benefit of arriving at an overall understanding of the policy linkages. In pursuing this line of enquiry, three broad approaches were adopted: analysis of published documents and reports, quantitative analysis of GHG emissions and energy aspects, and analysis of opinions expressed by actors and stakeholders.

2.1.1 SUMMARY OF CONCEPTUAL FRAMEWORK

Despite the wide range of academic approaches and divergences of views, there are a number of recognised approaches which can assist in reviewing and understanding Ireland's climate change policies in the period from 1990 to 2012. In assessing the outcomes of policies and measures, a focus on goal achievement and effectiveness is a logical approach and is consistent with the approach of the majority of assessments previously carried out in the EU (Haug et al., 2010). In considering the robustness of underlying policies, it is relevant to consider broader sustainability aspects. The general concept of sustainable development, while open to interpretation, has not been seriously contested as a useful concept since it was promulgated in 1987. Sustainable development might be classified as one of those ideas which is easier in practice than in theory. For a national GHG policy to be successful it must fulfil the basic sustainable development requirement by meeting current needs while not compromising future needs. The extent to which fundamental principles of sustainable development were incorporated in Ireland’s climate change policies can be further probed with reference to the five condensed principles proposed by Cherp et al. (2004), and with reference to Ireland’s self-proclaimed sustainability principles (Comhar, 2002; DECLG, 2012), as shown in Table 1.1. Finally, as proposed by Huitema at al. (2011), a review of GHG policy should address aspects relating to complexity, take account of stakeholder opinions, and include questioning of goals.

2.2 HISTORICAL ANALYSIS

2.2.1 SOURCE DOCUMENTS

As there was little available by way of documented research to build upon, the historic research element of the work proceeded from first principles, based on published or publically available primary source documentation. The starting points for the historical analysis were the two formal national climate change strategies published in 2000 and 2007 (DELG, 2000a; DEHLG, 2007). These were supplemented by published policy documents in areas related to renewable energy which are discussed in context in later chapters. National policy and strategy documents were intended for a broad readership. While they contained very detailed technical objectives, they also contained elements that could be termed promotional, in that the presentation of plans tended to imply more vigorous activity and capabilities than may have been the case. A more objective insight into policy evolution was permitted through a study of the interchange of formal communications between the state and the UNFCCC. These communications, while publicly accessible in the UNFCCC on-line archives (UNFCCC, 2013), were not intended for a public audience, and are therefore more reliable as an historical source. While the national communications still understandably sought to present national efforts in the best light to the UNFCCC, there were no overtly promotional elements. The national communication documents are also significant in that they provide an insight into how the Irish Government viewed its own progress. Objective assessments of the national communications were carried out by the UNFCCC review teams, and the resulting in-depth reviews were communicated to the Irish government. There is of course also a risk in relying on such formal communications. In the context of a legally binding international agreement, there may be an understandable reluctance for a review team to embarrass the state party. However, it was clear from a study of the UNFCCC reviews that they contained a number of critical comments which indicate that they can be relied upon to provide a measure of independent objective assessment. In the period spanning 1995 to 2010 there were five national communications and five UNFCCC in-depth reviews which form an important basis for the description of the historical evolution of Irish policy and strategies presented in chapter 3.

2.2.2 Interpreting Events

In interpreting policy events, a standard historical research methodology was employed (Butler and Gorst, 1997; Howel and Prevenier, 2001). In accordance with this methodology, events are considered and interpreted purely in their historical context, based on the information that was explicitly available, or could reasonably be assumed to have been available at that time. Similarly where conclusions are reached on the reasons for certain policy decisions, these conclusions are based on the general principles of historical reasoning. No definitive answer may ever be reached as to how specific decisions were reached but a deduction can be made as to the probable reasons. As expressed by McCullagh (1984), for an explanation or hypothesis of an historic event to be valid it should be more plausible, have greater explanatory scope and power, and be less ad hoc than any competing hypothesis.

2.3 QUANTITATIVE ANALYSES

2.3.1 DATA SETS

Analysis of trends in GHG emission and interpretation was based primarily on data compiled by the EPA. Each annual inventory report by the EPA involves a recalculation of the entire emissions series from 1990 onwards to reflect refined methodologies and small corrections. Emissions data presented in the historical review in chapter 3 are the contemporaneous estimates, which represented the state of knowledge at the time. In the case of CO_2 emissions subsequent re-calculations did not significantly alter the main features. However, for agricultural emissions there were significant recalculations in the late 1990s. It transpired that agricultural emissions in the early and mid-1990s were in fact significantly lower than had been believed at the time. Consequently in the historical analysis in chapter 3, agricultural emissions data in many cases differ significantly from the data presented in subsequent chapters. The performance analysis in chapter 4 is based on the national inventory report data to 2011, and the associated common reporting format spreadsheets (Duffy et al., 2013), along with provisional data for 2012 (EPA, 2013a). National energy statistics (SEAI, 2013a) were used to assist in interpreting the GHG emissions data. Features of the GHG emissions curve from 1990 to 2012 were also interpreted with the assistance of contemporaneous commentary provided by the EPA in the eleven formal inventory reports from 2002 to 2012.

2.3.2 DEALING WITH CONFOUNDING FACTORS

Interpretation of performance based upon compiled scientific data should in principle be straightforward. A difficulty presented itself in arriving at definitive conclusions regarding GHG emissions after 2008 due to the confounding effect of the economic crisis. The economic boom which occurred from 2000 to 2007 was widely acknowledged to have been an economic bubble caused by an unsustainable rate of building development, funded by capital in-flows to the state (Regling and Watson, 2010; Honohan, 2010; Nyberg, 2011). No research has however been published on the effect of the unsustainable economic activities on national GHG emissions. If the EPA commentary were to be taken at face value (Duffy et al., 2013), the GHG reduction after 2008 would be attributed mainly to the economic crisis. However this ad hoc interpretation was not supported by a detailed analysis. The approach adopted in chapter 4 was to estimate the reductions in GHG emissions that could be directly attributed to clearly identifiable bubble sectors of the economy such as cement industry, construction, and freight transport. The post-crisis GHG emissions were also interpreted in the context of the performance of the remaining productive parts of the economy. This was in an attempt to determine the sustainability of these emissions in the event of an economic recovery, which had a bearing on prospects for achieving further GHG reductions by 2020.

2.3.3 Accounting Procedures for Sectoral Emissions

The first formal NCCS in 2000 adopted a sectoral approach with targets for each sector of the economy. The advent of the EU Emissions Trading Scheme (ETS) in 2005 transferred electricity generation and large industrial operators into a de-facto new sector. This new ETS sector began with a clean slate, with nationally allocated emissions allowances designed to meet their current and future needs, taking due account of technical and economic factors. Previous sectoral emissions allocations were effectively overridden when the ETS was introduced which causes confusion in assessing sectoral performances. The approach taken in chapter 4 was to assess performance using the original NCCS 2000 sectors based on national inventory data, as this provided the only method of providing a quantitative assessment. An argument against this approach is that the original sectoral allowances no longer mattered in the new policy environment, and that the sectoral allowances had been abandoned in NCCS 2007. However when moving on to consider questions of sectoral equity in chapter 6, it is necessary to consider the historical evolution of emissions in each sector in order to determine which sectors were responsible for the growth in GHG emissions from 1990. Consequently a consistent and fixed sectoral analysis is justifiable.

2.3.4 Accounting for the Emissions Trading Scheme (ETS)

Data on ETS emissions were compiled annually from 2005 onwards by the EPA (Macken, 2011). Emissions for 2003 and 2004 can be derived from data published in connection with preparation for the ETS (ICF Consulting, 2004). Prior to 2003, the ETS did not exist as a sectoral grouping. However estimates can be arrived at for emissions from what can be termed the proto-ETS from 1990 to 2002. The ETS was made up of the public power sector, cement industry, and large industrial emitters. Emissions from these can be obtained from the national emissions inventory data. Reconstructing the emissions from the ETS sector in this way permits an analysis of the share of the permitted Kyoto increases that was consumed by the ETS operators, as presented in chapter 6.

2.4 USING ENERGY TO LINK GHG, ENERGY AND FOOD POLICIES

Methodologies in economics provide a means of combining a wide range of factors by assigning monetary values to products and outcomes. This enables the effects of given policies to be mathematically analysed. Energy and food are readily quantified through their market prices and GHG can be incorporated in such models by assigning a price to carbon. Based on such models, optimum lowest cost policy outcomes can be derived, such as in the model described by Toll et al. (2009). Ireland’s climate change strategies and approach to emissions trading relied heavily on marginal abatement cost economic modeling (Environmental Resources Management, 1998; Indecon-Enviros, 2004; Indecon, 2006). The international dimension of fuel-food issues is also typically analysed based on economic models, such as for example the defence of biofuels presented by Hamelinck (2013). Consideration of the interactions between agriculture, bioenergy, and food security falls naturally within the capabilities of such modeling. Energy balance approaches have been employed in considering global aspects of bioenergy and agricultural policies (Giampietro and Mayumi, 2009; Haberl et al., 2011). An energy balance approach was considered to be the most suitable analysis tool for the present work in considering the linkages between the agricultural, food, fuel, and GHG policy areas. A major advantage of the energy approach is that it provides an unambiguous means of quantifying policy outcomes, as opposed to economic models where market values may vary widely, or may be subject to interpretation. Agricultural output can be quantified in terms of the food energy in the products. Bioenergy is quantifiable in terms of the energy yield per hectare of the energy crops. Population food consumption can also be readily converted to total dietary energy needs, based on published country and regional data (FAO, 2013a). Linkage with GHG is provided through emission factors. If one unit of biomass energy displaces one unit of fossil fuel, there is a displaced emission of a certain quantity of GHG which is a function of the emission factor of the fossil fuel displaced. An approach based on energy considerations also provides an insight into the efficiency of bioenergy crops in terms of land requirement, and efficient uses of the energy produced, based on the laws of thermodynamics. Energy models provide a simple way of studying food energy imports and exports, which are critical to understanding potential food-fuel conflicts. While an energy model can in no way predict how markets or economic activity would evolve or how people would react, it provides a useful insight into fundamental energy balances which are a relevant sustainability consideration. The same unit of energy, the tonne of oil equivalent (toe) is used throughout the thesis. It is an unusual unit to use for food energy, which is normally described in Kilo Joules (KJ), or as dietary calories (Cal). Serendipitously, the conversion from oil equivalent to calories is very simple: 1 toe = 10 million dietary Calories.

2.5 Incorporating Views of Actors and Stakeholders

Reviews of national climate change policy conducted by the Institute for International and European Affairs (Brennan and Curtin, 2008), and the review by the National Economic and Social Council (2012), were able to draw extensively upon the experiences and opinions of major actors and stakeholders. The assessment methodologies involved a scale of stakeholder consultation that would be impossible to emulate in the present research. The approach taken was to determine the views of a wide range of stakeholders based on their published comments. These views were sourced from the public consultations on the Energy Green Paper in 2006 (DCMNR, 2006b), from the review of the NCCS in 2006 (DEHLG, 2006a), and from the consultation on the draft National Renewable Energy Plan (NREAP) (DCMNR, 2010). In addition, the views of individual stakeholders and actors were subsequently investigated through a limited number of personal interviews.

2.5.1 Identification of Actors and Stakeholders

The formal NCCS were devised by the Department of Environment, which was the primary state actor. It coordinated the efforts of the other government departments of Energy, Transport, and Agriculture. The published NCCS documents also identified the Environmental Protection Agency (EPA), and the Sustainable Energy Authority of Ireland (SEAI) as key resources. Other significant national actors and stakeholders were identified from the list of public submissions on the Energy Green Paper in 2006, and submissions on the national climate change strategy review in 2006, and these are listed in appendix B. Including those third level educational institutions which declared themselves on their corporate websites to be actively engaged in climate change research, a total of 129 actors and stakeholders were identified. As summarised in Figure 2.1 these spanned industrial, governmental, semi-state, NGO, political, and academic sectors. The views of the majority of these stakeholders on various topics could be deduced from documents submitted by them in the context of public consultations on energy policy and GHG policy in 2006. These submissions are the subject of analysis and discussion in chapter 8.

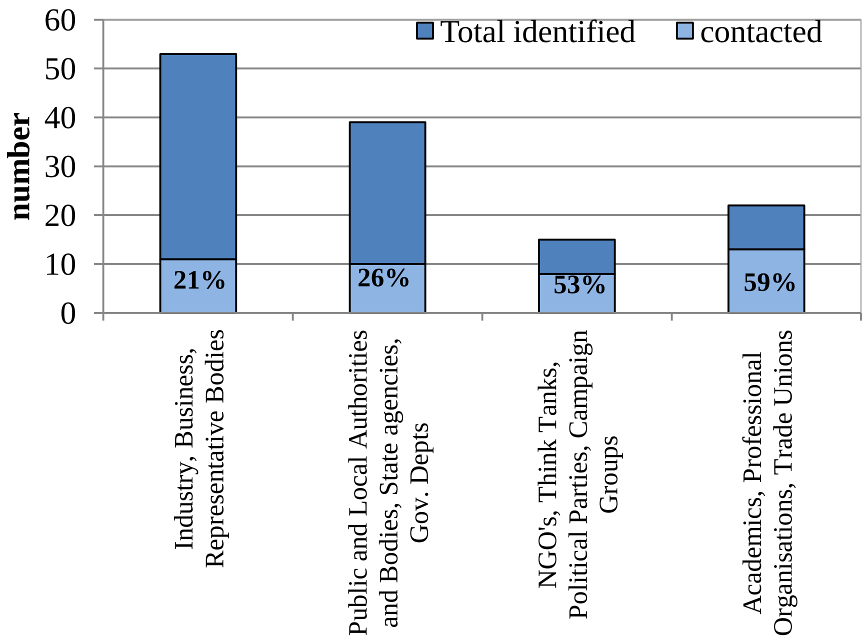

Figure 2-1 National policy actors and stakeholders identified from published NCCS documents in 2000 and 2007, and from the public consultations processes for the Energy Green Paper and NCCS review in 2006. The numbers contacted as part of a scoping survey are also shown. Total number identified: 129, number surveyed: 42.

2.5.2 METHODOLOGY FOR ANALYZING PUBLIC CONSULTATIONS

Interpretation and categorisation of comments made in public consultation submissions is necessarily a qualitative process and runs the risk of bias. Comments were initially grouped into a preliminary set of common topics. The process was repeated iteratively, and the common topic groupings adjusted until the majority of significant comments could be assigned to a manageable number of topics. This process was followed for each of the three sets of public consultations. As the Energy Green Paper 2006, NCCS review 2006, and the draft NREAP 2010 had different policy scopes, a common set of topics could not be applied to all three public consultations. The main identified topics followed naturally from the formats and headings of the three policy consultation documents. Thus, energy security, competitiveness, efficiency, and renewable energy were the focus of most submissions on the Energy Green Paper 2006. National policy on GHG emissions had since 2000 considered emissions under economic sectoral headings and this was the format adopted in the NCCS review in 2006. Submissions were consequently directed towards these sectoral headings. In the draft NREAP 2010, which followed a standard EU template, the key topics of renewable electricity (RES-E), renewable heat (RES-H) and renewable transportation energy (RES-T) were addressed in submissions. Bioenergy, which is an energy source for electricity, heat, and transport fuel, was included in the analysis of all three public consultations as a separate category. Topics such as energy efficiency, micro-generation, governance, nuclear power, ocean energy, and others emerged in their own right, based on the frequency of comments.

Within the topic of bioenergy, comments were iteratively analysed and assigned to sub-topics, some of which arose naturally by virtue of the number of comments such as biofuels and co-firing. Other sub-topics were included, such as environmental sustainability and waste-to-energy (WTE) as they were relevant to the bioenergy issues being researched. To qualify as a comment, it was required that a clear statement be made on a given topic, indicating agreement, urging more action, disagreement, or expression of concerns or doubts. Submissions which merely re-stated the draft policy document, or which listed topics in passing without any developed argument, or where there was an unclear narrative, were not classified as comments.

2.5.3 Scoping Survey and Completeness Check

To ensure that significant stakeholders and policy topics had not been overlooked, a confidential e-mail scoping survey was conducted on a sub-set of the identified stakeholders in 2008 and 2009. The survey questions (appendix B) sought to identify the main actors the recipient was in contact with, their sources of information, and their views on the actions required to improve climate change governance. Governmental departments and state agencies were excluded from this survey as it was planned to seek interviews with these at a later stage. In addition to verifying the database of national stakeholders, it was hoped that the survey would provide feedback on areas for research. Research findings cannot be based on the views of unattributed sources from confidential surveys. It is however valid to use such sources to identify facts or interpretations which may not be immediately evident from public documentation.

Of the 129 actors and stakeholders identified, a survey request was sent to 42, which allowing for multiple contacts at the same organizations totalled 68 survey requests. The total number was determined by the availability of contact information. If the survey was biased, it was in favour of stakeholders whose e-mail addresses were easily located. Replies were received from 17 organisations, totalling 22 individual replies, due to multiple replies from the same organisations. Regarding identification of main actors, the survey responses referred overwhelmingly to actors and stakeholders which were within the set originally identified, with just three additional significant policy actors identified. These included: a Senior Officials Group on Climate Change and Energy, a Technical Analysis Sub-Group on Climate Change, and a Climate Change Coordination Group (chaired by the EPA). These represented sub-sets of personnel at governmental and state agency level who met to consider policy. However, their proceedings were not available to the public. Topics raised in the survey responses were wide ranging. These included: allocation of resources for local energy agencies, significance of the Emissions Trading Scheme (ETS) for future policy, carbon taxation, carbon capture and storage, the role of the public, claims of poor technical understanding among policymakers, policy confusion, and other governance aspects. These topics were all encompassed by the larger set of topics identified from public consultations on the Energy Green Paper and NCCS review in 2006, and could be pursued in the published documents as discussed in chapter 8. The conclusion drawn from the survey was that the documents in the public domain and the publically accessible submissions on policy in 2006 and 2007 identified the majority of significant actors and stakeholders, as well as topics of relevance.

2.6 INTERVIEWS WITH ACTORS AND STAKEHOLDERS

The great puzzle in understanding national policymaking is the secrecy of government decisions. Efforts were made by the Green Party before it entered government in 2007 to establish the public's right to information on environmental matters in accordance with EU requirements (EC, 2003b). While a right to cabinet papers on environmental matters was initially granted by the Commissioner for Environmental Information, this was challenged by the government. The High Court found in the government's favour and access to such papers was denied (An Taoiseach-v-The Commissioner for Environmental Information, 2010). Speculation on policy formation can however be placed on a firmer basis without breaching government confidentiality. Interviews are a valuable research tool in the area of human geography and can provide a different perspective and interpretation of an issue, as well as revealing information which may not be explicit in published documents (Clifford et al., 2010). Interviews with senior civil servants, significant national actors, and stakeholders were therefore an important research objective. Such interviews had constituted a significant element of the review of environmental policy in Northern Ireland (Burke et al., 2007). In the international arena, studies of GHG policy negotiations by Kawashima (2000) relied also on in-depth interviews with members of national negotiating teams. His studies revealed the power of the interview methodology in casting light on the disparate motivations of policymakers, which ranged from economics to considerations of national image. Lovbrand (2007) likewise based a study on aspects of Swedish climate change on interviews with key actors in the scientific community and government agencies, which yielded frank views on the interaction between science and policy in Sweden.

A risk in conducting research by means of personal interview is that a bias can be introduced by the interviewer. Bias could be reduced by adhering to a fixed set of questions for each interview, and by adopting a coding methodology for interpretation of the answers. However, an overly rigorous methodology would limit the opportunity for exploration of unexpected aspects that may arise in an interview. As the objective of the interviews was to receive additional knowledge and insight from the interviewees, a more flexible interview format, termed a semi-structured interview, was considered to be more appropriate, along the lines of the approach suggested in Clifford et al. (2010). This relies upon a set of pre-prepared relevant questions to initiate conversation, but the subsequent direction of the interview can deviate depending on the responses and new issues identified.

A trial version of the interview protocol was carried out on a confidential basis in January 2010 with a GHG policy expert in a leading Irish industrial concern. The semi-structured format was found to work well and a number of significant insights were obtained which had not been evident from the public domain literature. It was evident however, that given the complexity of GHG policy, more preparation would be beneficial before embarking on further interviews. To derive maximum benefit from an interview, which is limited for practical reasons to typically one hour, the interviewer should be in a position to interpret answers without consuming valuable time seeking clarifications and should be able to immediately ask relevant follow-up questions. This requires substantial background research tailored for each individual interview.

The format for these interviews conducted in 2011 was based on a short set of guiding questions. Questions were focused on areas where clarification or explanation was sought, based on the background research relevant to the interviewee's area of expertise. If the interviewee answered and then branched off to another topic, that topic was also pursued. When a given topic was exhausted, a subsequent pre-prepared question was asked on another topic. A guarantee was provided that the results of the interview would only be used in the context of the present research and would not be published in any other format. The interview was recorded by means of notes or as an audio recording, subject to the permission of the interviewee. In the case of note-taking, an account of the interview was written up immediately afterwards, and in the case of audio recordings, these were subsequently transcribed and the recordings were erased. In both cases, minor editorial corrections were made, and minor re-structuring was done for improved presentation. To encourage open communication, interviewees were advised in advance that the written account of the interview would be sent to them for approval. The interviewee was invited to review, revise, delete, or add to the document as they saw fit, and to return the document by email, which provided a verifiable record for both sides.

2.6.1 PEOPLE INTERVIEWED

Requests for interview were sent to selected governmental departments, state agencies, and national stakeholders. The selection was guided by the need to establish background information in the key research areas dealing with the history of national policy, and the implications of GHG policies for land-use. Practical considerations such as availability of personnel and time tabling, determined the final number of interviews. Eight interviews were arranged in total with personnel in the Department of Environment, Department of Energy, Teagasc, Sustainable Energy Ireland (SEAI), the Irish Farmers Association (IFA), and the Irish Bioenergy Association (IrBEA). The focus of the interviews with government departmental officials was exploration of aspects of policy history, the difficulties regarding EU targets for 2020, and the treatment of agriculture. Bioenergy was the key focus of interviews with Teagasc, SEAI, IFA, and IrBEA .

3 HISTORY OF IRISH GHG POLICY 1990 TO 2012

3.1 INTRODUCTION

Irish policy on climate change can be more accurately described as a GHG policy, as it focused on mitigation of GHG emissions rather than on broader issues of adaptation to a changing climate, which was also the case for other EU states (Jordan et al., 2010b). The historical development of Irish GHG policy in this chapter is divided into three broad periods. In what can be termed the pre-Kyoto period from 1990 to 1999, policy was in a formative stage as the government explored ways to respond to its commitments under the United Nations Framework Convention on Climate Change (UN, 1992a). The second distinguishable period from 2000 to 2006 saw rapid development of national policies in preparation for compliance with the Kyoto limit. The National Climate Change Strategy (DELG, 2000a) set out how Ireland would limit the growth in GHG emissions in the period 2008 to 2012, to at most +13% relative to 1990. In the third policy period from 2007 onwards, there was a revision of the National Climate Change Strategy (DEHLG, 2007) in response to concerns over rapidly increasing GHG emissions and progressive alignment of national policy with developments at EU level. The main policy events in these three periods are listed in Table 3.1. The sequence of National Communications (NC), and the In-Depth Reviews (IDR) carried out by the UNFCCC, along with the formal published national strategies, help to generate a narrative of the history of Irish GHG policy.

Year	Description	Summary/Highlights
1990 - 1999: Pre-Kyoto Policy Phase		
1992	United Nations Framework Convention on Climate Change UNFCCC	Commitment to stabilize GHG concentrations to prevent dangerous interference with climate system. Return GHG emissions to pre-1990 levels by 2000
1993	Ireland's CO_2 strategy	Limit CO_2 emissions in 2000 to +20% re 1990
1995	1st National Communication to UNFCCC (NC1)	Special national factors rule out GHG reduction. Mitigation measures to limit CO_2 growth to +20%
1996	1st In-Depth Review by UNFCCC (IDR1)	Irish +20% target achievable, but additional measures necessary, concerns on transport sector
1997	2nd National Communication to UNFCCC (NC2)	Changed from CO_2 limit to total GHG limit of +15% for 2010 re 1990. Reliance on forest sequestration
1998	Kyoto Protocol	8% reduction in GHG in 2008-2012 re 1990. EU effort sharing permits +13% increase for Ireland
1999	2nd In-Depth Review by UNFCCC (IDR2)	Projected significant exceedence of Kyoto limit in 2010
2000 - 2006: Preparation for Kyoto Compliance		
2000	National Climate Change Strategy 2000 (NCCS 2000)	Sectoral allocations, to achieve +13% Kyoto limit. Reliance on forest sequestration, and reduction in agricultural GHG
2001	EU Renewable Energy Directive	13.2% renewable electricity target for Ireland by 2010
2001	EU Biofuels Directive	2% biofuels in transport by 2005, 5.75% by 2010
2003	EU Emissions Trading Directive	Large GHG emitters to be capped and subject to trading
2003	3rd National Communication to UNFCCC (NC3)	Kyoto limit exceeded, GHG emissions +31% re 1990, due to growth in electricity and transport emissions
2005	3rd In-Depth Review by UNFCCC (IDR3)	With existing and additional measures limit exceedence of 5 $MtCO_{2eq}$ projected, to be met by emissions trading
2006	4th National Communication to UNFCCC (NC4)	Kyoto limit exceeded, +23% re 1990, due to unprecedented economic growth. Projected +26% re 1990 for 2008-2012
2007 - 2012: Revision of Kyoto Compliance Strategy and Preparation for EU Targets for 2020		
2007	National Climate Change Strategy (NCCS 2007)	Increased renewable energy targets, emissions trading, national purchases of emissions allowances
2007	Programme for Government	Green Party in government. Carbon budget, commitment to 3% annual reduction in net GHG emissions and carbon tax.
2008	EU Emissions Trading Scheme begins (ETS)	36% of GHG emissions budget allocated to power/industry sector, to be under EU control after Kyoto period
2009	4th In-Depth Review by UNFCCC (IDR4)	Ireland will achieve Kyoto limit, with additional measures, national purchases, and effects of economic shock.
2009	EU Climate and Energy Package EU 20-20-20 targets	20% reduction in GHG, 20% improvement in energy efficiency, 20% renewable energy (16% for Ireland) 10% renewable transport energy
2010	5th National Communication to UNFCCC (NC5)	On target for Kyoto compliance. Carbon tax introduced. Economic recovery could increase emissions again.
2010	5th In-Depth Review by UNFCCC (IDR5)	Ireland on target for Kyoto. Difficulties expected in achieving 2020 targets.
2010	National Renewable Energy Action Plan (NREAP 2010)	16% renewable energy by 2020: 40% renewable electricity,10% renewable transport, 12% renewable heat,

Table 3-1 Overview of significant events in the evolution of Irelands GHG policies

United Nations Framework Convention on Climate Change (UNFCCC)

European Union (EU) directives

Irish national strategies and communications

3.2 Pre-Kyoto Policy Period 1990 to 1999

3.2.1 CO_2 Abatement Strategy and National Communication 1995

The first Irish strategy to address obligations under the UNFCCC was developed by the Department of the Environment in 1993 (DOE, 1993). This strategy was confined to carbon dioxide (CO_2) emissions, with a stated voluntary target of limiting the growth in emissions to 20% above 1990 levels by the year 2000. At face value the +20% target was not consistent with the requirement of Article 4(2) of the UNFCCC, which set a goal of returning GHG emissions to 1990 levels by the year 2000. However, Ireland could rely upon the UNFCCC target being met on a joint basis within the European Community, which through agreed effort-sharing among member states, would allow for the need for economic growth in weaker member states such as Ireland.

In the first national communication (NC1) to the UNFCCC in 1995, the national CO_2 mitigation strategy was set out (DOE, 1995). The range of abatement measures included electricity demand management, energy efficiency, and reducing the carbon intensity of the electricity supply. The tone in NC1 was that there were special factors operating in Ireland which precluded any question of achieving a reduction in GHG emissions, and that the strategy would be to limit the increases. It was argued that there was a need for economic expansion, as Ireland’s GDP was only 69% of the European Community average. Additional policy restrictions were outlined, including fuel security, reliance on peat, a high existing use of natural gas compared with the European average, and the absence of a nuclear power option.

A key element in the CO_2 mitigation strategy was that the Electricity Supply Board (ESB) would limit growth in electrical power to 3% per year, through demand management measures. New building regulations (Building Regulations, 1991) were projected to achieve a reduction in residential CO_2 emissions of 2% by 2000. A more significant impact could not have been expected, as the regulations only applied to new buildings, and there were no measures to address the poor thermal insulation standards of the existing housing stock. However, the newly established Irish Energy Centre (subsequently Sustainable Energy Authority of Ireland, SEAI) was responsible for the promotion of the non-fiscal energy saving measures, including high efficiency boilers, combined heat and power plants (CHP), and energy demand management. Caution was expressed in NC1 on increased use of gas for electricity generation, for energy security reasons. This was understandable, as Ireland's only gas supply at that time was the Kinsale field, whose reserves were predicted to be largely depleted within a decade, and future gas supplies would rely on completion of a planned gas pipeline to the U.K. (DOE, 1995).

Somewhat incongruously, new peat-fired power stations were put forward in NC1 as a CO_2 mitigation measure. The new power stations would be 1.5 times more efficient than the older peat power plants, and the average plant GHG emissions were projected to reduce by 9% in 2000. While peat was acknowledged as a high carbon fuel, it provided 14% of the state's energy needs, 21% of the electricity supply, and was important for energy security. Policy on retention of peat as a fuel source was clearly stated:

> While there will be a certain natural decline in peat consumption over the period, measures could not be contemplated which would abruptly compromise the role of indigenous peat in Irish energy supply (DOE, 1995, section 1.8).

As described in NC1, an alternative energy target of 75 MW was to be achieved by 1997, comprising wind power (30MW), Combined Heat and Power Plants (20MW), Hydro (10MW), and Waste to Energy (15MW). The renewable energy target was not converted to CO_2 savings in NC1, but based on typical capacity factors, and emission factors in 1997 (Howley and Holland, 2013), would have amounted to a small saving of approximately 0.3MtCO_{2eq}, or 0.8% of the emissions limit in 2000.

Carbon sequestration by forestry was put forward in NC1 as a significant contribution to mitigation of CO_2 emissions. A bold forestry planting target of 30,000 ha/year was set, supported through afforestation grants. The projected carbon sequestration amounted to about 3MtCO_{2eq}/year, which was calculated to reduce growth in net national CO_{2eq}

emissions from 20% to 11% by 2000. National afforestation policy had actually pre-dated any national GHG strategy, and the 30,000 ha/year target had already been incorporated in the state's Programme for Economic and Social Progress (Government of Ireland, 1991).

Regarding traffic emissions, NC1 argued that there was little scope for increased taxation as a control measure, as motor taxes and fuel taxes were already high by European standards. A decision on carbon tax was postponed awaiting developments at European level. One specific traffic measure described in NC1 was the establishment of the Dublin Transportation Office (DTO). However, it was evident that it lacked supporting legislative impetus. Under its establishment order (DTO Order, 1995), there was no specific duty assigned in terms of limiting GHG emissions.

3.2.2 UNFCCC In-Depth Review 1996 (IDR1)

The first in-depth review (IDR1) carried out by the UNFCCC (1996) was based on the CO_2 abatement strategy document submitted by Ireland in NC1 (DOE, 1995), and additional information gathered during a visit to Ireland by experts from the UNFCCC. The review concluded that Ireland's 20% growth limitation target for CO_2 emissions was achievable, in light of increased penetration of natural gas, and energy efficiencies already achieved. A number of criticisms were expressed in IDR1, including a lack of transparency in the methodology used by Ireland for determining the emissions inventory and emissions projections. Ireland's focus on energy security had, it was claimed, resulted in a strategy limited to no-regrets measures and it was believed that additional measures would be necessary. IDR1 also called for projections for forest sequestration to be supported by data on emissions and removals for the base year 1990. Transport emissions were considered by the review team as being likely to grow rapidly, and they recommended greater efforts to estimate the effects of measures in this and other sectors of the economy.

3.2.3 IRELANDS SECOND NATIONAL COMMUNICATION 1997 (NC2)

The most significant development in NC2 (DOE, 1997b) was the inclusion of a limit of +15% re 1990 for total GHG, for the reference year of 2010. NC2 did not convert the 15% target to a quantitative limit in terms of $MtCO_{2eq}$, but this can be calculated based on the knowledge available at that time and on data contained in NC2. Ireland was in an unusual position in the EU in having a significant proportion of national emissions arising from agriculture. In the mid-1990's it was believed that agriculture accounted for almost half of national emissions for the base year 1990. From national emissions data presented in NC2, a 15% increase in total GHG emissions would have translated to a 28% increase in CO_2 emissions, assuming emissions from agriculture were unchanged. Ireland could to an extent disguise increased emissions from fossil fuel combustion in the large underlying agricultural emission. Moreover, forest sequestration was projected in NC2 to be 2.4$MtCO_{2eq}$ in 2000 and 4.5 $MtCO_{2eq}$ by 2010. Including forest sequestration, this would permit a total increase in national CO_2 emissions of 42% from 1990 to 2010. A target of 10% forestry coverage of the national lands was projected in NC2 for 2000, and a target of 17% for 2030. The annual afforestation target was reduced marginally from 30000 ha/year to 25000 ha/year. The first specific measure for agriculture was the planned introduction of codes of practice for fertilizer management, which would reduce emissions of N_2O.

Data in NC2 indicated that growth in electricity demand was 5% per year from 1991 to 1996, which was significantly in excess of the original 3% target mentioned in NC1. More emphasis was place in NC2 on fuel switching to natural gas for electricity generation and heating, as a control measure. This strategy had become feasible following the recently constructed gas pipeline to the U.K, and discovery of the Corrib Gas Field in 1996. Indigenous energy supply would also be met by renewable energy, with a national target of 5% for 2010, compared with just 2% in 1996. Energy efficiency campaigns would continue, and these were to be augmented by the creation of local energy agencies set up under the EU SAVE II programme, which would improve the interface with local authorities and communities. The Waste Management Act 1996 would also tighten up on CH_4 emissions from landfills with utilization of landfill gas as an energy source, and in the longer term a waste to energy plant was envisaged. Emissions from the transport sector were expected to rise. This was explained in NC2 by the dispersed nature of the Irish population, the small open economy, and the extensive road system in Ireland which had two to three times the length per person compared with comparable sized EU countries. Car ownership in Ireland was also stated to be low relative to the EU average.

3.2.4 UNFCCC In-Depth Review 1999 (IDR2)

In its second in-depth review (UNFCCC, 1999), the rapid growth of 30% in emissions from the energy sector from 1990 to 1996 was highlighted. Concern was expressed on the growth of 40% in emissions from the transport sector. IDR2 concluded however that Ireland would most probably only slightly exceed the 20% CO_2 growth limit for 2000, with an estimated overshoot of 2%. Based on provisional economic growth projections, IDR2 included an estimation of national emissions in 2010. This estimate should have come as a shock for policymakers, as emissions of CO_2 were projected to increase by 51% in 2010 re 1990. A change in policy on electricity usage was communicated to the UNFCCC review team during its visit, whereby the ESB was moving away from its previous voluntary demand management strategy and in future would promote electricity as an efficient source of energy. IDR2 commented that the promotion of electricity generated by 90% fossil fuels would be detrimental to the mitigation of GHG emissions. While the review team acknowledged that some measures such as the expansion of forestry and controls on vehicular pollution had the side-effect of mitigating GHG, they pointed to an absence of cross-cutting measures. In particular they highlighted the absence of measures to reduce the growth in car usage. They cautioned that the roads programme, which was funded by the EU, could result in increased traffic. The afforestation programme was driven entirely by grants, and IDR2 expressed concerns about possible conflicts between rural environmental protection policies and afforestation policies. As things stood in 1999, according to the UNFCCC assessment, Ireland would not achieve the Kyoto limit of 13% re 1990. The grim situation was summed up in the following quotation from the in-depth review:

> At the time of the review, Ireland had few policies and measures that were specifically designed to mitigate GHG emissions (UNFCCC, 1999, p.25)

3.3 PLANNING FOR KYOTO COMPLIANCE 2000-2006

3.3.1 NATIONAL CLIMATE CHANGE STRATEGY 2000 (NCCS 2000)

A national climate change strategy, specifically aimed at Kyoto Protocol compliance was formulated in 2000 (DELG, 2000a). From data in this document, Ireland's CO_2 emissions had already increased by 35% re 1990, which was greatly in excess of the previous national target of 20%. Total GHG emissions were also already in excess of the Kyoto limit. The detailed strategy document was accompanied by a Plain Guide, aimed at the general public, which set out in layman's terms the challenges ahead, and Ireland's role.

> .. as one of the richest countries in the world we have agreed to keep our emissions to just 13% above 1990 levels by 2008-2012 (DELG, 2000b, p.3)

This was a misrepresentation of the situation, as Ireland's favourable limit of 13% under EU effort sharing (EC, 2002) was in fact based on Ireland being categorised as a developing country within the EU-15.

From data in NCCS 2000, GHG emissions in the base year of 1990 were stated to be 53.7 $MtCO_{2eq}$, of which 31.6 $MtCO_{2eq}$ was CO_2, mainly from fossil fuels. Consequently the Kyoto limit was expected to be 13% above 53.7, which equalled 60.7 $MtCO_{2eq}$. If the permitted increase of 7 $MtCO_{2eq}$ was assigned to growth in CO_2 emissions only, as was envisaged in NCCS 2000, then these emissions could increase from 31.6 to 38.6 $MtCO_2$ which represented an increase of 22% re 1990. Annual sequestration of carbon in forestry was projected in NCCS 2000 to be approximately 1 $MtCO_{2eq}$ during the Kyoto compliance period. As this would offset CO_2 emissions, the total scope for increase in CO_2 was approximately 8 $MtCO_{2eq}$ which represented an increase of 25% relative to 1990.

SECTORAL ALLOCATIONS IN NCCS 2000

The national strategy focused on the main cause of the increase in emissions, which was CO_2 from fuel combustion, rather than emissions from agriculture, which were expected to remain relatively stable. The strategy drew on the findings and recommendations of a technical and economic analysis by consultants commissioned by the Government (Environmental Resources Management, 1998). The areas where growth would have to be curtailed were the transport sector, electricity generation, industrial, and commercial sectors. NCCS 2000 was based on a clear sectoral approach. Each emissions sector of the economy was assigned a maximum growth envelope, as indicated in Table 3.2, and in Figure 3.1. Emissions allocations were set in terms of percentage changes for each sector relative to 1990. To permit a quantitative overview in absolute terms, these percentages have been converted to $MtCO_{2eq}$ in Table 3.2. In acknowledgement of the inevitability of growth in transport, this sector was permitted the greatest increase of 6.5$MtCO_{2eq}$. Increases ranging from 0.1 to 1.5 $MtCO_{2eq}$ were allocated for other energy sectors. These permitted increases would be facilitated by reductions in the residential, agricultural, and waste sectors, along with an estimate of slightly less than 1$MtCO_{2eq}$ for additional forest sinks.

IMPLICATIONS OF NCCS 2000 TARGETS

Given that Ireland's emissions were already in excess of the Kyoto limit in 2000, the scale of the challenge facing policymakers in 2000 can better be appreciated by consideration of the actual available emissions budgets relative to the existing situation in 2000. While this analysis was not presented in NCCS 2000, the necessary data can be determined from the national emissions inventory data for 1998 as presented in NCCS 2000, and from national inventory report data for 1999 (McGettigan and Duffy, 2002), which it could reasonably be assumed was available to policymakers in draft form in 2000. The transport sector had by 1998 already grown substantially and there was in fact scope for an increase of slightly less than 3$MtCO_{2eq}$ from 1998 to the Kyoto period mid-point in 2010. The rate of increase in emissions from the transport sector in the late 1990's had been 2$MtCO_{2eq}$ per year. Limiting growth to 3$MtCO_{2eq}$ in total over a twelve would have been a huge challenge, without draconian measures.

Sector	Emissions 1990 Mt CO_{2eq}	% change envisaged to 2010 [1] (re 1990)	Implied increase/decrease to 2010[1] (re 1990) Mt CO_{2eq}	Implied Emissions Target 2010 [1] Mt CO_{2eq}
Transport	5.1	+126.6	+6.5	11.6
Commercial/ Institutional	2.4	+49.8	+1.2	3.6
Industrial Processes	3	+49.9	+1.5	4.5
Public Power (electricity)	11.3	+13.3	+1.5	12.8
Industry	4.3	+1.5	+0.1	4.4
Residential	7	-9.7	-0.7	6.3
Agriculture	18.6	-9.6	-1.8	16.8
Waste	1.8	-36.5	-0.7	1.1

Table 3-2 Sectoral emissions allocations implied in NCCS 2000. Planned growths and reductions relative to 1990, compiled and calculated from data in NCCS 2000 (DELG, 2000a). Public Power in 1990 is calculated from Energy Industry emissions in NCCS 2000, minus refinery and solid fuel manufacture emissions from national inventory data.

[1] 2010 is the mid-point of the compliance period 2008-2012, and was used as the proxy year for analysis of Kyoto compliance.

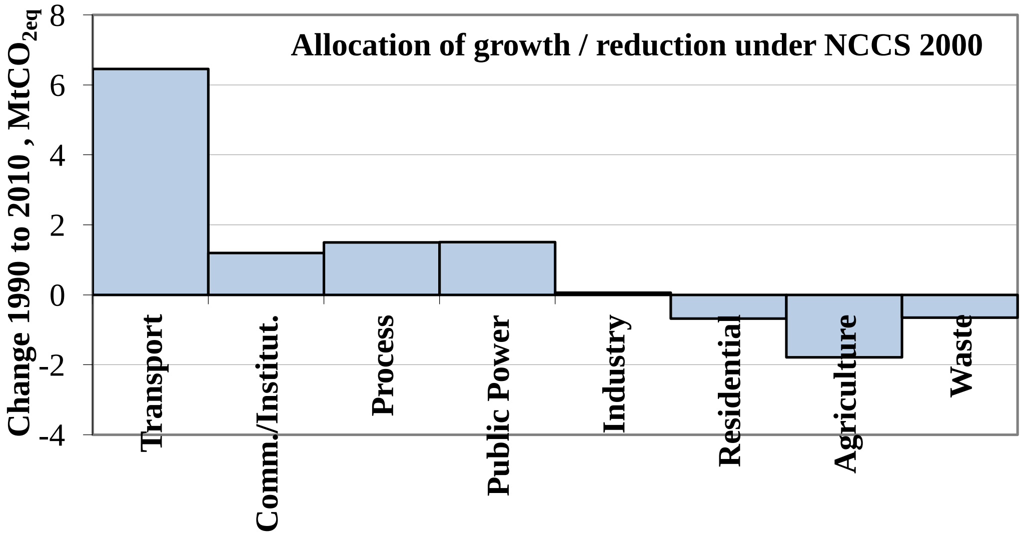

Figure 3-1 Sectoral emissions allowances in NCCS 2000. Planned growths and reductions in GHG emissions relative to 1990. Plotted from data in Table 3-2.

Based on emissions in 1998, the commercial/institutional sector had scope under the strategy to increase emissions by 0.8 $MtCO_{2eq}$ over twelve years. This sector had increased by only 0.5 $MtCO_{2eq}$ from 1990 to 1998, and consequently the target would have been considered achievable. Emissions associated with industrial processes would need to be limited to an increase of about 1 $MtCO_{2eq}$ to 2010. Again this appeared achievable, as emissions in this sector showed only slow growth since 1990. To meet the target in NCCS 2000, the public power generation sector would have to reduce emissions by at least 2 $MtCO_{2eq}$ over twelve years. This went very much against the trend, whereby there had been growth of 4 $MtCO_{2eq}$ from 1990-1998. However it would have been technically achievable in the event of fuel switching to natural gas, improvements in generating efficiency, and an increased proportion of renewable electricity.

Agriculture would have to reduce emissions by 3.7 $MtCO_{2eq}$ in 2010, re 1998. Through a combination of herd reduction and improved manure management, such a reduction would have been considered feasible. For the waste sector, the implied 2010 target would have required a reduction of just 0.6 $MtCO_{2eq}$. As there was considerable scope for improving the landfill sites, which at that time were in general sub-standard, control of GHG emissions from landfills would have seemed relatively straightforward. The residential sector was projected to achieve a reduction of 0.2Mt CO_{2eq}. With progressive penetration of more efficient heating systems, and higher standards of house insulation, this target would also have been considered achievable. Overall, taking account of the knowledge available at the time, there were a number of elements of the strategy that were technically achievable. Transport, however posed what appeared to be insurmountable challenges, and achieving reductions in the energy sector must also have appeared to be problematic.

NCCS 2000 IMPLEMENTATION MEASURES

A major item in NCCS 2000, with projected savings of 3.4 $MtCO_{2eq}$, was the possible closure of the Moneypoint coal power station in Co. Clare, and replacement with gas powered stations. The indicative date for closure was 2008. It was stated that the government would introduce measures supportive of the closure of Moneypoint. This could be interpreted at one level as a commitment, but from reading the qualifications in the text of NCCS 2000, it was not a foregone conclusion. A review of information regarding Moneypoint, publically available at the time, casts great doubt on whether closure of the plant was realistically considered by the ESB at that time, or was ever a credible mitigation measure in NCCS 2000. The immediate consideration for the ESB in 2000 regarding Moneypoint would have been the imminent Large Combustion Plant Directive (EC, 2001a), which would have required a costly upgrade of the Moneypoint Plant by 2008 to reduce emissions of acidifying gases. This would most probably have raised the question as to whether it would be as well to close the plant. But closing Moneypoint could only happen if there were secure alternative generating options. In 2000, gas supplies still relied on a single interconnector to the UK and the rapidly depleting Kinsale gas field. Closure of Moneypoint would therefore have significantly impacted on security of electricity supply. The prospect of emissions trading in a free electricity market would also have been a consideration for the ESB. While the emissions trading directive did not come into force until 2003 (EC, 2003a), discussions were ongoing on this issue in the late 1990s and an EU policy Green Paper was published in 2000 (CEC, 2000). The risk for the ESB would have been the possibility of a commercial disadvantage in discontinuing the carbon- intensive coal power station prior to emissions trading coming into force, as depending on the eventual national emissions allocation process, the ESB may have received significantly lower emissions allowances. As of 2003, the future of Moneypoint was still under consideration and the emissions upgrades had been costed at €200m (ESB, 2003). When the decision to upgrade Moneypoint was published a year later (ESB, 2004), this effectively ruled out its closure on the time-frame to 2012, and probably also to 2020.

NCCS 2000 planned for an additional 500MW of renewable energy by 2005, to be provided mainly by wind turbines, with a projected saving of 1 $MtCO_{2eq}$. Policy on retention of peat generation was unchanged, and two new peat power stations would replace older inefficient stations. These were in addition to the new plant at Clonbullogue, County Offaly which was nearing completion in 2000. It was envisaged that emissions from the transport sector could be controlled through a combination of modal switching to public transport, and by a re-balancing of vehicle registration tax and motor tax in favour of low CO_2 emission vehicles. This tax re-balancing and a broader carbon tax applicable to the entire economy would be introduced on a phased basis. In addition the state would participate in the proposed EU industrial emissions trading, and engage in international emissions trading, as permitted under the Kyoto Protocol.

3.3.2 THIRD NATIONAL COMMUNICATION 2003 (NC3)

In 2003 when the third national communication (NC3) was sent to the UNFCCC, the economic growth rate was 10% per year, which along with population growth, went to explain the large reported increases in CO_2 emissions. Emissions were 31% above 1990 levels, and more than twice the Kyoto limit. Measures in NCCS 2000 were enumerated to the UNFCCC, including the possibility of replacing the generating capacity at Moneypoint with gas power stations, although as discussed above, this must have seemed unlikely to happen. The rapid growth in GHG emissions was attributed mainly to increases in CO_2 emissions from the public power and transport sectors. Overall, the increase in CO_2 emissions from fuel consumption was 46% relative to 1990, with emissions from agriculture being 6% above 1990 levels. In NC3 it was reported that Ireland had opted for full de-coupling between production and payments under the reforms in the EU agricultural policy, which would in principal permit a wider range of farming practices to be supported with lower GHG emissions. Problems in controlling emission from transport were outlined in NC3. In addition to the increased number of vehicles, fuel tourism between Northern Ireland and the Irish state also distorted the data. While there were on-going improvements in fuel efficiency in each vehicle class, this was reported to have been negated by a move towards higher capacity engines.

3.3.3 THIRD UNFCCC IN-DEPTH REVIEW 2005 (IDR3)

The UNFCC team visited Ireland in 2004 and 2005, and carried out the third in-depth review (UNFCCC, 2005). Significant additional information was provided to the team during their visit which addressed perceived inadequacies in NC3. This information enabled the IDR3 team to present a good overview on a macro level of the factors driving GHG emissions since 1990. It was noted that the population of Ireland in 2002 had increased by 11% since 1990. Economic indicators of GDP and GNP had more than doubled since 1990 on an absolute and per capita basis. Total primary energy supply was 3 toe per capita in 1990, and had increased to 3.9 toe per capita in 2002. The issue of fuel security was even more significant than in 1990, with dependence on imported fuel increasing from 70% in 1990 to 91% in 2002. IDR3 concluded that the national communication was generally in agreement with the UNFCCC guidelines, but noted an absence of critical elements such as a concise summary of policies, policy monitoring, and information on those government policies that could lead to increased GHG emissions. On a positive note, the team was impressed with the work done by Comhar (the National Sustainable Development Partnership), Sustainable Energy Authority of Ireland (SEAI), and environmental and business NGOs.

The government's decisions not to proceed with closure of the Moneypoint coal power plant, and not to introduce a carbon tax, were noted. In the case of carbon taxes the government had explained that the small projected gain of 1.2MtCO_{2eq} did not justify the risks to the economy. Total national emissions were projected in IDR3 to be almost 70 MtCO_{2eq} in 2008-2012. IDR3 expressed doubts regarding projected transport emissions, noting that the modest government projections of growth in transport emissions to 2008-2012, was inconsistent with the observed increase over the previous decade. Close monitoring and detailed analysis of transport emissions was advised, to be supported by improved models.

3.3.4 EUROPEAN EMISSIONS TRADING SCHEME PILOT PHASE

In January 2005 the EU Emissions Trading Scheme (ETS) commenced its pilot phase in preparation for full emissions trading in 2008. The ETS had profound consequences for Ireland's GHG policies. Electricity generation and large industrial emitters would be assigned a share of the national GHG emissions with the ability to trade emissions allowances within the EU. The significance for national policy was that once a share of national emissions was established for the trading sector, this was ring-fenced from the remaining national emissions. Neither over-achievement nor under-achievement by the ETS would impact on the total national emissions in terms of compliance with the Kyoto Protocol. The remaining sectors of the economy, outside of the emissions trading scheme, would be left with the responsibility for achieving any additional mitigation that was required by the government.

For the first trading period (2005-2007) and second trading period (2008-2012), the emissions caps were set nationally, subject to EU approval. A genuine competitive trading market could only be established if there was a market scarcity of emission allowances. Member states were consequently to set the cap at a lower level than the business as usual scenario, subject to certain criteria, as set out in the ETS directive (EC, 2003a). The main factor to be taken into account was that the cap should be consistent with the national Kyoto limit. In addition, account should be taken of the technological potential for abatement, the proportion of emissions in the ETS sector, national policies, and the national climate change programme. The allocation of national allowances to the ETS in Ireland required a balancing between the compliance burden on the ETS sector, and on the non-ETS sector. The main emitter in the non-ETS sector was agriculture. The perception and treatment of the agricultural sector therefore changed from its being a neutral to benign influence on GHG policy, to a sector that would in future need to be controlled. The ETS raised issues of sectoral equity, which were not fully discussed at the time. These issues are explored further in chapter 6.

3.3.5 IRELANDS INITIAL REPORT UNDER THE KYOTO PROTOCOL 2006

Under the provisions of the Kyoto Protocol, Ireland submitted its initial report in December 2006 (Government of Ireland, 2006). The report was a short statement of the situation, and the formal limitation on emissions agreed for the period 2008 to 2012. It set out the inventory for GHG in 1990, for fluorinated gases (F-gases) in 1995, and the inventory for all GHG in 2004. GHG emissions in 2004 were 68.5 $MtCO_{2eq}$, which was 23% above 1990 levels. Under the Kyoto category of Land-Use, Land-Use Change and Forestry (LULUCF), Ireland chose to utilise forest sequestration but opted not to avail of additional land-use activities as permitted under Article 3.4 of the Kyoto protocol. This decision would appear to have been justified, as there was at that time limited knowledge of the processes in LULUCF and how these would be accounted in the future.

3.3.6 FOURTH NATIONAL COMMUNICATION (NC4) 2006

In outlining the national circumstances the untypical features of Ireland relative to the EU average, were highlighted in NC4, including a very large population growth of 20% relative to 1990, and an unprecedented economic growth of 140% in GDP from 1990 to 2004, with an increase of 50% in the number in employment (DEHLG, 2006b). Contrary to the trend elsewhere in Europe, manufacturing industry was increasing due to the low tax regime which attracted inward investment. These factors, along with associated increases in transport were put forward as the driving forces in increased GHG emissions. The executive summary in NC4 went on to say that emissions had decreased by almost 4 percentage points from a peak of +26.9% re 1990 in 2001, down to +23.1% re 1990 in 2004. These decreases were due to closure of inefficient peat power plants, increased use of natural gas, closure of ammonia and nitric acid plants, and reductions in the national herds.

NC4 included clear projections of GHG emissions to 2012 which had not been done in the previous national communications. There was an initial projected fall in GHG emissions to 2007 due to new higher efficiency generating stations coming on stream, however, emissions were projected to subsequently resume an upward growth.

Excluding forestry sinks, the GHG projection graph showed a strong positive slope in excess of 0.5 $MtCO_{2eq}$ per year from 2007 to 2012, reaching a projected total of 73.5 $MtCO_{2eq}$ in 2012, which was 10.5 $MtCO_{2eq}$ above the Kyoto target. Including forest sinks, the projected emissions were 71 $MtCO_{2eq}$ in 2012, which would have been 8 $MtCO_{2eq}$ above the Kyoto target.

The ETS was highlighted in NC4 as making a significant contribution to meeting the Kyoto limit, with a projected reduction of 3 $MtCO_{2eq}$. National purchases of allowances under Kyoto flexible mechanisms would also be employed. The Energy Green Paper (DCMNR, 2006b) was also described, which had the overarching requirement to ensure security of energy supply, and to accommodate growth in electricity demand of 27.5% from 2006 to 2020. This target would have to be met by the energy companies operating within the ETS. In common with previous communications there was a lack of clear collation of the impacts of measures. The predicted reductions were relative to do minimum scenarios, and could not be readily related to reductions that would be achieved relative to the existing situation at time of preparation of the communication.

Biofuels for transport represented a significant new mitigation measure in NC4, with a target of 2% by 2008 and 5.75% by 2012, which reflected the indicative targets in the EU Biofuels Directive (EC, 2003c). In addition the state’s transportation policy, Transport 21 (DOT, 2005), would include small scale experimental pilot projects on biofuels. NC4 provided an update on vehicle registration tax (VRT) re-balancing, which had begun on a restricted and temporary basis in 2001. Extension of taxation re-balancing to all vehicles was however postponed until 2008. The National Spatial Strategy (Government of Ireland, 2002) was put forward as an additional measure to achieve demand side management of transport. Projected savings from this measure were however only 0.075 $MtCO_{2eq}$, and for all intents and purposes irrelevant in the context of the huge overshoot of the Kyoto target.

Specific new decisions confirmed in NC4 were to continue coal firing at Moneypoint for reasons of fuel security. Wind energy would be supported through a renewable energy feed-in tariff (REFIT), which replaced the previous competitive tendering process. A new national target was set for 15% renewable electricity by 2010, which was marginally greater than the EU target for Ireland of 13.2% (EC, 2001b). To support future development of wind energy, an all-island grid study was commissioned to investigate the feasibility of between 15% and 30% renewable electricity by 2020. NC4 included the first reference to biomass for electrical power generation in communications with the UNFCCC. Co-firing of wood biomass with peat at the peat generating stations was projected to save 0.5 $MtCO_{2eq}$ annually.

Very significant progress was reported in NC4 in reducing emissions from domestic heating due to fuel switching and higher insulation standards. The revised building regulations (Building Regulations, 2002; Building Regulations, 2005) were projected to achieve additional reductions of 0.3 $MtCO_{2eq}$ per annum above those envisaged in NCCS 2000. Ongoing efforts were described in improving the energy efficiency of existing buildings under schemes operated by SEAI, such as the greener homes scheme, the commercial bioheat grant scheme, and a grant scheme for wood chip boilers.

Emissions from agriculture were projected to decrease, due to the effects of de-coupling under the revised CAP agreement (EC, 2003d). The contribution of agriculture in terms of achieving reductions in GHG emissions, and in providing sinks, was stated to be an important element of Ireland's Kyoto strategy. Significant progress was reported in afforestation, with slightly over 10% of the land area under forest in 2005, compared with 7 % in 1990. With revised methodologies the predicted contribution of forest sinks was increased by 1 $MtCO_{2eq}$ to just over 2 $MtCO_{2eq}$ per year over the Kyoto compliance period.

3.4 REVISED NATIONAL STRATEGY AND EU POLICY DEVELOPMENTS 2007-2012

3.4.1 EU COMMITMENTS ON GHG REDUCTION TO 2020

The Kyoto compliance period would not begin until 2008, yet it was clear already in 2007 that significant policy developments at European level were set to overtake the existing Kyoto requirements. To address the growing concerns over climate change, and to provide certainty on the policy framework to 2020, the EU heads of state had agreed to a 20% reduction in GHG re 1990 (EC, 2007a) to be achieved by 2020 whether or not there was a successor agreement to Kyoto after 2012. They also agreed to a reduction of 30% in GHG subject to agreement at international level. This policy was subsequently implemented as a set of directives in the EU Climate and Energy Package in 2009. GHG emissions from the ETS sector throughout the EU were to reduce by 21% in 2020 relative to verified emissions in 2005 (EC, 2009c). For the domestic non-ETS sectors, a reduction of 10% was required for the EU-27 as a whole. The combination of the 21% reduction for the ETS and the 10% reduction for the domestic non-ETS emissions was calculated to result in an overall reduction for the EU of 20% re 1990. Each member state was assigned an individual reduction target for its non-ETS domestic sector, as prescribed in the Effort Sharing Decision (EC, 2009a). The individual targets ranged from -20%, to + 20%, re 2005, depending on the member state's level of economic development as determined by per capita GDP. On this basis, Ireland was assigned the highest compliance burden with a reduction of 20% required by 2020. Significantly the EU reduction targets for 2020 were framed in terms of actual emissions, and not net emissions. In other words forest sinks could not be used to achieve compliance.

3.4.2 NATIONAL CLIMATE CHANGE STRATEGY 2007 (NCCS 2007)

As set out in the revised strategy NCCS 2007, emissions for 2010 were projected to be 26% higher than in 1990, which was double the permitted increase of 13%. NCCS 2007 sought to bridge the distance to target by achieving GHG savings of 3 $MtCO_{2eq}$ from the ETS (power generation and industrial sectors), 3.6 $MtCO_{2eq}$ through national purchases, 2.4 $MtCO_{2eq}$ from agriculture, 2.1 $MtCO_{2eq}$ from forest sequestration, along with smaller savings from various additional measures (DEHLG, 2007).

In the public power sector, the main additional measure was to achieve 15% renewable electrical energy by 2010, and 33% by 2020. More supports would be provided for combined heat and power plants, and for biomass, with a target of 30% co-firing of biomass at the peat power plants by 2015. In the transport sector, a modal shift to public transport under Transport 21 was projected to save $0.5MtCO_{2eq}$. The existing supports for transport biofuels had been by means of a Mineral Oil Tax Relief scheme (MOTR), instituted in 2006, which meant that producers of biofuels were not required to pay excise duty. In NCCS 2007 a significant change in policy occurred whereby it was envisaged that all fuel distributors would be obliged to incorporate 5.75% biofuels in their products, corresponding to the numeric target in the EU Biofuels Directive (EC, 2003c), and biofuel would be subject to excise tax in the normal way. This policy, which had the advantage of being tax neutral, would have an adverse impact on the nascent indigenous biofuels industry, as discussed in chapters 7 and 9.

3.4.3 PROGRAMME FOR GOVERNMENT 2007

A new political dimension was added to the development of GHG policy after the general election of 2007, in which the Green Party won six seats. This placed them in a pivotal position to form a coalition government with the existing Fianna Fáil party which had been in power since 1997. The immediate opportunity for the Green Party to influence policy was in the agreed programme for government, which resulted in some changes and additions to national GHG policies and strategies. The formal programme for government document (Government of Ireland, 2007) reiterated the main energy efficiency, renewables commitments, and GHG strategies contained in the Energy White Paper and in the revised NCCS 2007. The specific new elements in the programme for government that can be traced directly to the Green Party election manifesto (Green Party, 2007) were the proposal for an annual carbon budget, a commitment to reduce GHG emissions by 3% annually, and an undertaking to introduce a carbon tax. In a review of the performance of the Green Party, Minihan (2011) claimed that the party did not succeed in significantly changing national GHG policy, as the Fianna Fáil party had already incorporated the bulk of Green Party policies.

Arguably, the most significant achievement for the Green Party was obtaining the ministries of environment and energy, which gave them effective control over implementation of GHG policy. An important objective of the Green Party was to introduce legislation on climate change, which eventually reached draft form in 2010 (Climate Change Response Bill, 2010).

3.4.4 UNFCCC In-Depth Review 2009 (IDR4)

In the UNFCCC's fourth policy review (UNFCCC, 2009), note was taken of the revised national strategy, NCCS 2007, and of revised energy targets which were developed since 2007. These new targets were: a 40% renewable electricity supply, substantially increased from the previous target of 33%, a 12% target for renewable heat, and a 10% target for renewable energy in transport for the year 2020. Overall, these targets were consistent with the EU Climate and Energy Package, and the indicative target set by the EU for Ireland, of 16% renewable energy consumption by 2020 (EC, 2009b). Demand-side measures were noted, and the review team encouraged further steps to be taken to exploit the large mitigation potential in the energy renovation of buildings. Plans to introduce differentiated vehicle registration tax and motor tax were also noted.

The revised with-measures projection of emissions provided by the government to the review team was 65 $MtCO_{2eq}$ for 2010, which was 5 $MtCO_{2eq}$ lower than submitted in NC4 in 2006. With the implementation of additional measures, emissions were projected to be 61.8 $MtCO_{2eq}$ in 2010 which was about 1 $MtCO_{2eq}$ under the Kyoto target. The main additional measures were the ETS and government purchases of credits under the Kyoto flexible mechanisms. The revised projections provided by Ireland also included an economic shock analysis which took account of the sharp downturn in the economy which had occurred in 2008 and 2009. The impact of the economic shock was projected to be a reduction of 3.4 $MtCO_{2eq}$ in 2010. Based on the additional information provided by the government, the UNFCCC review team concluded that Ireland was expected to meet the Kyoto target through implementation of additional measures and taking account of the effects of the economic shock. However projections supplied to the review team indicated that policymakers expected emissions to continue to grow in the event of an economic recovery.

IDR4 commented that Ireland had deviated from the UNFCCC reporting guidelines significantly in not providing full sectoral breakdown of the impacts of the various programmes and measures, and consequently found it difficult to verify the proposed programmes and measures. They found it unclear as to what constituted existing and additional measures, and recommended more transparency in future reports to enable these to be distinguished. Ireland was also advised in IDR 4 to further analyze the proposed co-firing of biomass in the peat power plants, taking account of energy efficiencies and options for more efficient CHP.

3.4.5 Fifth National Communication 2010 (NC5)

NC5 provided a succinct introduction with an overview of the political structure, geographical factors, and economic factors (DEHLG, 2010a). This included for the first time in a national communication a clear presentation of the national energy profile. There was a reported decoupling of emissions from total primary energy requirement (TPER), and a decoupling from economic growth. Projections were provided in NC5 of GHG emissions, which took account of the effects of the economic shock. These indicated that the Kyoto limit would be comfortably achieved. The purchasing requirements for GHG allowances were expected to be less than had been planned, and the National Treasury Management Agency (NTMA) had therefore been instructed to hold off on further purchasing. The importance of forest sequestration was again stated in NC5, both for the Kyoto period and for the post Kyoto period with $4MtCO_{2eq}$ of sequestration projected for 2020.

Eirgrid’s Grid 25 project was described in NC5, which involved the investment of €4 billion, with the objective of doubling the capacity of the transmission system. This would permit the harnessing of increasing amounts of wind energy for the domestic and export markets. Energy efficiency improvements since 1995 had reportedly reduced energy consumption by 8% in 2007, compared to do-minimum. This was stated to be two and a half times the effect of renewable energy in terms of fossil fuel savings. The energy efficiency of industry had improved by 16% since 2005, and the residential sector had improved by 15%. However, energy efficiency in the transport sector had grown by just 1.4% since 1995. In response to the challenge of transport emissions, a Smarter Travel Policy (DOT, 2009a) had recently been launched which was aimed at achieving a significant reduction in emissions compared with business as usual. In terms of numeric targets the stated policy was to ensure no increase in total car kilometres by 2020, relative to 2005. This was the first record of an Irish government policy where a numeric limitation on transport growth was envisaged.

A shift of policy focus towards 2020 targets was evident in NC5. While Kyoto still remained an immediate priority, national policy outlook was increasingly directed towards a long-term low-carbon future, and towards the adaptation measures required for the inevitable impact of current and future emissions. EU targets would be met through a combination of carbon taxation and legislation. A significant new measure in NC5 was a carbon tax of €15 per tonne of CO_2 (Department of Finance, 2009). The government's use of Kyoto flexible mechanisms would continue to be an important element of the Kyoto compliance policy. Work was also reported to be in progress on a framework Climate Change Response Bill (2010), which was aimed at providing a legal basis for national emissions targets in the short and long-term, and for the establishment of a national body to advise, monitor and assess Ireland's progress.

The framework Climate Change Response Bill, while attempting to clarify Ireland's GHG reduction pathway, in fact caused widespread confusion regarding interpretation of targets by farmer representative bodies, as was clear from their presentation to a Joint Oireachtas Committee (JOC, 2011). This could be partly explained by the complex setting of exponential reduction targets in the draft bill. More fundamentally, confusion resulted from the inclusion of carbon sinks in setting these targets. What was clear from the framework Climate Change Response Bill was that national policy on GHG envisaged long-term compliance being irrevocably reliant on carbon sinks and reservoirs. As the EU reduction target for 2020 precluded use of carbon sinks, there was an apparent variance between national targets set out in the Climate Change Response Bill and EU targets for 2020. To clarify matters, the Department of Environment produced an explanatory note (DEHLG, 2011). In late 2010 and early 2011 as the coalition government struggled to stay in power the Green Party traded their support for the government in return for progress on the bill (Boyle, 2012). Following the change in government in 2011 confusion over GHG targets persisted and a leading academic felt the need to write to a national newspaper to counter what he viewed as a false interpretation of the bill by the Department of Finance (Sweeney, 2011).

3.4.6 UNFCC IN-DEPTH REVIEW 2010 (IDR5)

In its fifth in-depth review in 2010 (IDR5), the UNFCCC team noted that Ireland had complied with the general reporting requirements, however they expressed disappointment that Ireland had not taken on board the recommendations for more transparency contained in the previous in-depth review:

> Ireland considered a few of the recommendations provided in the report of the in-depth review of the fourth national communication (NC4). The ERT encourages Ireland to address the recommendations of this report and previous review report in its next national communication (UNFCCC, 2010, p.3).

The difficulty experienced by the review team was that policies, measures, and their effects, which were widely spread through the narrative, were not collated into a summary to enable an overview of the measures and a quantitative estimate of the reduction potential. The in-depth review clearly identified and quantified the factors driving the growth in GHG emissions to 2008. The population of Ireland had increased by almost 27% since 1990, with an increase of 51% in the number of households, from 1 million in 1990 to 1.5 million in 2008. Economic growth of 180% re 1990, was recorded, in terms of GDP. Positive indicators were a slight reduction in GHG emissions per capita, from 15.6 tCO_{2eq} in 1990 to 15.2 tCO_{2eq} in 2008. There was a reduction of almost 48% in GHG emissions per unit of GDP, which was indicative of energy efficiency measures. Total primary energy supply over this period had increased by 54%, with an increase of 46% in CO_2 emissions, indicating that fuel switching to natural gas, and increased renewables, had succeeded in moderating increases. In the transport sector there had been a growth of 176% in GHG emissions since 1990, with a steep rise in particular from 2000 to 2007. IDR5 noted that the economic downturn had stabilised emissions from passenger cars, and reduced emissions from freight by 7.6%.

Ireland's policies and measures were tabulated by the UNFCCC review team, incorporating additional information gathered during the review process. The main change in the national policy framework was the target of a 3% annual reduction in net GHG emissions to 2020, with a long-term target of an 80% reduction in GHG by 2050. IDR5 noted that Ireland had instituted a carbon budget, which it described as innovative. It would help public understanding, while providing clarity on the GHG reduction target on an annual basis, and the effectiveness of policies and measures. Ireland was considered by the UNFCCC review team to be on target to achieve compliance with the Kyoto limit. Projected emissions for 2008-2012 were 65 $MtCO_{2eq}$, excluding forest sinks. The limit could be comfortably met allowing for forest sequestration, and modest purchases of 2.5 to 3 $MtCO_{2eq}$ per year under Kyoto flexible mechanisms. The review team was also briefed on the great difficulties faced by Ireland in achieving the EU 20% reduction target for 2020, and on the possibility that the gap to target could be significantly reduced were the EU to permit land sinks to be used in meeting the target. Ireland's high reliance on carbon sinks was recognized in IDR5:

> The inclusion of the carbon sinks in emissions accounting is critically important for Ireland, as the carbon sinks will continue to play an increasingly important role in the first commitment period and in the emission accounting thereafter (UNFCCC, 2010, p.23).

Additional information provided to the review team described mitigation measures being developed to decouple emissions from output in the agricultural sector. These included increasing the length of the grazing season, reduction in fertilizer use, and reduction in the age of cattle slaughter. The CAP reform agreement, which de-coupled farm payments from production, was assigned a GHG saving of 2.2MtCO_{2eq} by 2020. The Irish government also submitted an additional report on the implications of reduced beef production in Ireland, which could lead to increased imports from Brazil, and a consequent deforestation in that country. Surprisingly, additional information provided by the government did not include mention of the abrupt change in national agricultural policy which was being formulated in 2010. The new national agricultural policy envisaged large increases in output, as outlined in Food Harvest 2020 (DAFF, 2010), and is discussed in chapter 5.

3.4.7 National Renewable Energy Action Plan 2010 (NREAP)

The Renewable Energy Directive (EC, 2009b) had set a renewable energy target of 16% for Ireland in 2020. EU states were required to submit a renewable energy action plan in a prescribed template format, setting out the targets clearly, the measures in place, and the additional measures planned to meet the targets. This amounted to a revision of national energy and GHG policy. In the National Renewable Energy Action Plan (NREAP), Ireland's target for renewable electricity (RES-E) was 40% by 2020, mainly in the form of wind energy, supported by the renewable energy feed-in tariff (REFIT). Renewable energy for transport (RES-T) was set at 4% for 2010, and 10% by 2020, to be met mainly from biofuels (Government of Ireland, 2010). The supporting measures for biofuels were the existing tax relief scheme (MOTR) which applied to 2010, and a biofuels obligation scheme from 2010 onwards (Energy Act, 2010). Electric vehicles would also make a contribution to this target. For renewable heat energy, the target was 4.3% in 2010, rising to 12% by 2020, with most of this provided by biomass. In broad terms, there would be an equal reliance on bioenergy and wind power in achieving 2020 renewable energy targets. This projected growing demand for bioenergy had implications for land use, and raised questions on long term sustainability, discussed further in chapter 7.

A weakness in previous Irish energy or GHG policies was that there was no provision for limiting growth in energy consumption. Consequently, GHG reduction benefits from renewable energy could be more than negated by an increasing overall energy demand.

The National Renewable Energy Action Plan (NREAP) represented a significant improvement in this regard. NREAP presented a concise overview of the modelled renewable energy and total energy consumption on an annual trajectory to 2020. Ireland's projected energy consumption in 2020 was 14.1 Mtoe, allowing for the implementation of efficiency measures. This represented an increase of 11% on energy consumption over the 2005 base year, and an increase of 48% over 1990.

3.5 Summary of Two Decades of GHG Policy

3.5.1 Evolution of National GHG Strategies

A sustainable development strategy requires careful consideration and balancing of economic, social and environmental goals. Irish GHG policy placed a higher weighting on achievement of economic goals. Social objectives did not feature noticeably in the policy discourse, but economic goals could also plausibly serve as a proxy for many social objectives in terms of improved living standards. Continued economic growth would require increased energy consumption, and increased GHG emissions. Therefore, as there was no question of reducing GHG emissions, the policy was to moderate the growth in emissions. In the early 1990s Ireland adopted an initial national CO_2 mitigation strategy, which set a voluntary target of limiting the growth in CO_2 emissions to 20% above 1990 levels by the year 2000, to be achieved through moderation of growth in electricity consumption and energy efficiency measures. The strategy was overwhelmed by unexpected and unprecedented economic growth with consequent increases in fossil fuel consumption, and by 2000, the target had been significantly breached. By this time Ireland was committed under the Kyoto Protocol to limit growth in GHG emissions to 13% above 1990 levels, with compliance being determined for the period 2008-2012. A new National Climate Change Strategy (NCCS 2000) sought to address this challenge and adopted a sectoral approach to control emissions. Supporting measures included fuel switching to natural gas, efficiency improvements, renewable energy, forestry sinks, and reductions in agricultural emissions. Significant growth in emissions from transport was openly acknowledged as being inevitable. However, action on taxation control instruments for transport was postponed and any further consideration of carbon taxation awaited developments at EU level. Closure of the Moneypoint coal-fired power station and replacement with gas-fired generation was the single largest mitigation measure proposed in NCCS 2000. However, this would appear to have been more an aspiration rather than a realistic option. Fuel-switching policy did not extend to the most carbon intensive fuel, which was peat. Continuation of peat for power generation was settled government policy from 1990 to 2012, on the grounds of energy security, and rural employment. Economic and population growth continued at unprecedented rates. This resulted in rapid growth in traffic, housing, and energy consumption. The growth in traffic was also amplified by the state’s investment in road infrastructure. NCCS 2000 succeeded in a degree of stabilisation of emissions, albeit at a level significantly above the Kyoto limit.

By 2007, when the National Climate Change Strategy was revised (NCCS 2007), the broad policy framework was determined at EU level. EU emissions trading, and the EU Climate and Energy Package for 2020 had overtaken all existing targets, and set the course for the EU energy and GHG policy out to 2020. Ireland would be obliged by the EU to reduce domestic GHG emissions to 20% below 2005 levels (EC, 2009a), and would be obliged to have 16% of national energy consumption from renewable sources by 2020 (EC, 2009b). National efforts continued with notable success in achieving wind energy targets, and in continuous improvement in energy efficiency across all sectors, except transport, where carbon tax control measures were still not enforced. The economy was at its peak, and emissions, if not entirely stabilized, were growing at a much slower rate. If the subsequent economic crisis from 2008 onwards had not happened, Ireland would have complied with the Kyoto limit, through national purchases under the Kyoto flexible mechanisms, which had already been financially provided for in NCCS 2007. As matters turned out, the economic shock in 2008 was followed by significantly reduced emissions, and Ireland’s actual emissions of GHG were below the Kyoto limit (EPA, 2013a).

Ireland's National Renewable Energy Plan in 2010 (NREAP) represented the final re-configuration of national energy and GHG policy during the study period. It was devised to achieve compliance with the EU renewable energy target of 16% for 2020, and to improve energy security by increasing indigenous supply. The plan relied in approximately equal measure upon wind energy and bioenergy. In the latter years of the study period, as the Green Party and Fianna Fáil coalition government struggled to stay in power, a final attempt was made to make GHG reduction mandatory within the legal framework of the state. The resulting draft Climate Change Response Bill in 2010 proved confusing and divisive, failed to garner sufficient political support, and was abandoned following the change in government in 2011. As the end of the Kyoto period approached the consensus view was forming that a fundamental change in policy approach was required (DECLG, 2011; NESC, 2012). It was considered that the compliance approach which characterised policy during the Kyoto period had positioned Ireland poorly for achieving EU 2020 targets and a longer-term carbon neutral future. There was a call for a new approach, based on a vision of a carbon neutral country in 2050. In a sense this was a call for more country ownership of policy. Despite the negative sentiments expressed by national actors towards the end of the Kyoto period, there were in fact many policy successes, as discussed in chapter 4.

3.5.2 UNFCCC Reviews of Irish Policy

The progress of the national strategy from 1995 to 2010, and the evolution of policy, was charted out in the exchange of reports and reviews with the UNFCCC. It was evident that the long time delays, the order of years, between availability of national emissions data, preparation of the national communications, and receipt of the feedback from the UNFCCC, undermined the benefit of this review process for both the state and for the UNFCCC. The focus of the UNFCCC reviews was on strategic planning aspects. A consistent criticism through all of the five UNFCCC reviews from1996 to 2010 was the lack of transparency and clarity. National mitigation efforts were described by the UNFCCC as no-regrets measures which were cost neutral, or would have happened in any event. They called for implementation of clear cross-cutting measures and for policy monitoring. Emissions from transport were identified in the 1996 review as posing a risk, and a lack of policy measures, supported by models, was highlighted in subsequent reviews.

3.5.3 THE ROLE OF THE LAND IN IRISH GHG POLICY

It was clear that national policy at all times sought to use the land as a source of GHG emissions credits, which would permit increased emissions of CO_2 from fossil fuel combustion, to support the growing economy. For agriculture the expectation was that additional GHG emissions would not be required, and that there was scope for actual reductions. Consequently all of the increased emissions allowances under Kyoto could be assigned to accommodate growth in CO_2 emissions from fossil fuel consumption. In NCCS 2000, instead of a 13% increase, CO_2 emissions could be increased to 22% relative to 1990. A greater increase would be possible, dependent on the actual reductions achieved in agriculture and the extent of forest sequestration. Reliance on the land was further increased by the high bioenergy targets in the National Renewable Energy Action Plan (NREAP). Had the draft Climate Change Response Bill been implemented, the role of the land as a mitigation measure for fossil fuel GHG emissions would have become entrenched in Irish law, as the envisaged mandatory annual reductions applied to aggregate GHG emissions. An immediate adverse consequence of this heavy reliance on the land became apparent when the EU targets for 2020 were framed in terms of GHG emissions only, and excluded off-sets from carbon sinks (EC, 2009a). With this reduced flexibility, and in view of the high proportion of agricultural emissions, Ireland's 20% reduction target for 2020 appeared to be beyond reach (EPA, 2011a). In addition to this difficulty the new agricultural policy Food Harvest 2020 (DAFF, 2010) was aimed at substantially increasing agricultural production by 2020. By 2012, national agricultural and GHG policies were in conflict. Increases in agricultural production would inevitably entail increased GHG emissions, whereas the national GHG target for 2020 required these emissions to decrease. The origin of this problem can be traced in part to the negative outlook for Irish agriculture which prevailed and was unquestioned until 2010, as discussed further in chapter 5. This was exacerbated by effects of the EU ETS, and the apparently unanticipated sudden compliance discontinuity introduced by the EU targets for 2020, as discussed further in chapter 6.

4 ASSESSING NATIONAL GHG STRATEGY AND POLICY OUTCOMES

4.1 Arriving at a Balanced View of Ireland's Performance

Towards the end of the Kyoto period, the national policy mood was changing. Policymakers were increasingly pre-occupied with the difficult challenges for 2020 and beyond, and understandably may have devoted less attention to detailed analysis of their achievements to date. The sharp decline in national GHG emissions during the Kyoto compliance period 2008-2012 was attributed to the economic crisis which unfolded from 2008 onwards, and this interpretation was communicated in the carbon budgets presented to the Dáil (DEHLG, 2009; DEHLG, 2010b). When economic growth resumed, there was the belief that emissions would spring back to previous high levels. There were however many successful aspects of national climate change policies in the period 1990 to 2012, in terms of quantitative final outcomes, and in terms of downward sectoral emission trends. Close interpretation of the emissions data also reveals features which support a view that the very high GHG emissions up to 2008 were attributable in large part to the economic bubble. If this were the case, then the greatly reduced emissions which followed the collapse of the economic bubble may therefore have represented the sustainable emissions of the economy, which would indicate that further reductions would be feasible through improved efficiencies. The outcomes of national policies in 2012 are considered in this chapter in terms of compliance with Kyoto obligations, achievement of NCCS 2000 sectoral targets, and in terms of progress on EU renewable energy targets. Ireland's performance is also placed in the context of the other EU states which made up the EU-15 at the time Ireland signed the Kyoto Protocol.

4.2 Compliance With Kyoto Protocol

4.2.1 Ireland's Formal Kyoto Compliance

In assessing the success of national GHG strategies, the primary criterion is the Kyoto emissions limit. National emissions data and calculations for assessment of formal Kyoto compliance are set out in the first data column of Table 4.1, based on provisional data for 2008-2012 (EPA, 2013a). For formal compliance assessment, average annual national emissions were 66.1 $MtCO_{2eq}$, comprising 43.8$MtCO_{2eq}$ from the domestic non-trading sectors, and a ring-fenced allocation of 22.3MtCO_{2eq} from the ETS sector. Forest sinks of 3.4 MtCO_{2eq}, reduced the net national emissions to 62.7 MtCO_{2e}q, which was approximately 0.2 MtCO_{2eq} under the Kyoto limit. Ireland therefore formally complied with the Kyoto limit.

Formal compliance with the formal Kyoto limit in itself is not however a convincing measure of success. From a legal viewpoint, there was never a serious doubt regarding Ireland's formal compliance with its obligations. If Ireland's net emissions of GHG, allowing for forest sinks, exceeded the 13% limit, then national purchases of emissions allowances would have been employed to bring emissions within the limit. The only question was the extent of national purchases that would be required. NCCS 2007 had budgeted for purchases averaging 3.6 MtCO_{2eq} annually to achieve compliance (DEHLG, 2007). The outcome in 2012 was that no national purchases were required, which could be termed a success.

4.2.2 IRELAND'S ACTUAL NET GHG EMISSIONS COMPARED WITH KYOTO LIMIT

Ireland's actual net average emissions of GHG were in fact significantly less than the numerical Kyoto limit. The difference between the formal accounted GHG emissions and the actual emissions was due to the exceptional performance of the ETS sector. Reductions in the ETS sector could not however count towards national Kyoto compliance, as ETS emissions were ring-fenced from the national accounts. In Table 4.1, the calculation of actual national GHG emissions is presented in the second column. Over the period 2008-2012, the ETS sector emitted 4.8 MtCO_{2eq}/yr less than their formal allocation, which reduced the actual national net emissions to 57.9 MtCO_{2eq}. In terms of actual net GHG emissions, Ireland's performance was 4.9 MtCO_{2eq} under the Kyoto limit, which was approximately +4% relative to 1990. This was a remarkable outcome, and could be interpreted as quantitative evidence of the success of GHG control strategies.

Description	Formal Kyoto Accounting 2008-2012 $MtCO_{2eq}/yr$	Actual Emissions 2008-2012 $MtCO_{2eq}/yr$
Non-ETS Emissions	43.8	43.8
ETS Emissions	22.3	17.5
Total National Emissions	66.1	61.3
Minus Forest Sinks	-3.4	-3.4
Net National emissions	62.7	57.9
Minus Kyoto Limit	-62.8	-62.8
Distance to target Negative value indicates emissions below limit	-0.2	-4.9

Table 4-1 Ireland's Kyoto compliance status in 2012, based on provisional EPA data (EPA, 2013a). Above table is a reorganised version of the EPA Kyoto compliance table, converted to average annual emissions. For formal compliance assessment, emissions from the ETS sector are fixed at their annual allocation of 22.3 $MtCO_{2eq}$. Actual verified emissions from ETS were 17.5 $MtCO_{2eq}$, which brought the actual net national emissions down to 57.9 $MtCO_{2eq}$, which was 4.9 $MtCO_{2eq}$ under the Kyoto limit.

It could be argued that all that matters is Ireland's performance based on the formal accounting rules. However this would result in an assessment that excludes the achievements of the ETS sector. A great deal of the national measures were aimed directly or indirectly at supporting reductions in the ETS sector, including energy efficiency measures, demand reduction, fuel switching, and renewable energy. Exclusion of the ETS sector performance from consideration of the national achievement would consequently be quite misleading. The good performance of the ETS sector could not be dismissed as being solely due to the economic crisis, which began in 2008. While there were large emissions reductions after 2008, a pronounced downward trend was already evident prior to the economic crisis, as discussed further in section 4.4.

4.3 Assessment of Ireland's GHG Emissions

4.3.1 Emissions Trend 1990 - 2012

National annual GHG emissions from 1990 to 2012 are presented in Figure 4.1. Forest sequestration is excluded, and the emissions curve consequently represents the actual physical emissions of GHG over the study period. The national GHG emissions curve as a function of time shows an increase in emissions from 1990 to 2001, followed by a period of 6 years to 2007 where emissions stabilized to within +/-1$MtCO_{2eq}$ until 2008. This was followed by the period 2008 to 2011, where there was a rapid decrease in emissions, with a slight increase in 2012.

4.3.2 Emissions Growth 1990 to 2001

The interpretation of features in the national GHG emissions curve described below is based on the contemporary commentary and supporting data provided in the EPA National Inventory Reports (NIR). From 1990 onwards, national GHG emissions increased, especially in the period 1993 to 2000, when emissions grew at a rate of close to 2$MtCO_{2eq}$/year. By 2000 there had been an increase of 24% relative to 1990, from 54 to 67 $MtCO_{2eq}$. The Kyoto limit for the period 2008-2012 had already been exceeded in 1998. Growth was reported to be due mainly to increased energy use, which had increased by 39% since 1990. Electricity generation and transport were responsible for most of the increase. Growing electricity demand led to an increase in CO_2 emissions from power plants of 45% relative to 1990. Emissions from transport had doubled since 1990, due to sustained growth in the vehicle fleet and travel distances. The increase in CO_2 emissions was described by the EPA as enormous in the context of the Kyoto limit (McGettigan and Duffy, 2002). From 2000 to 2001, emissions increased by a further 2.7% to reach 70 $MtCO_{2eq}$, which was 31% higher than in 1990 (McGettigan and Duffy, 2003). The increased emissions were again ascribed to growth in fossil fuel consumption, with CO_2 emissions growing by 46% since 1990. Electricity generation and transport were responsible for the bulk of the increase, and emissions from these sectors had increased by 55% and 120% respectively since 1990.

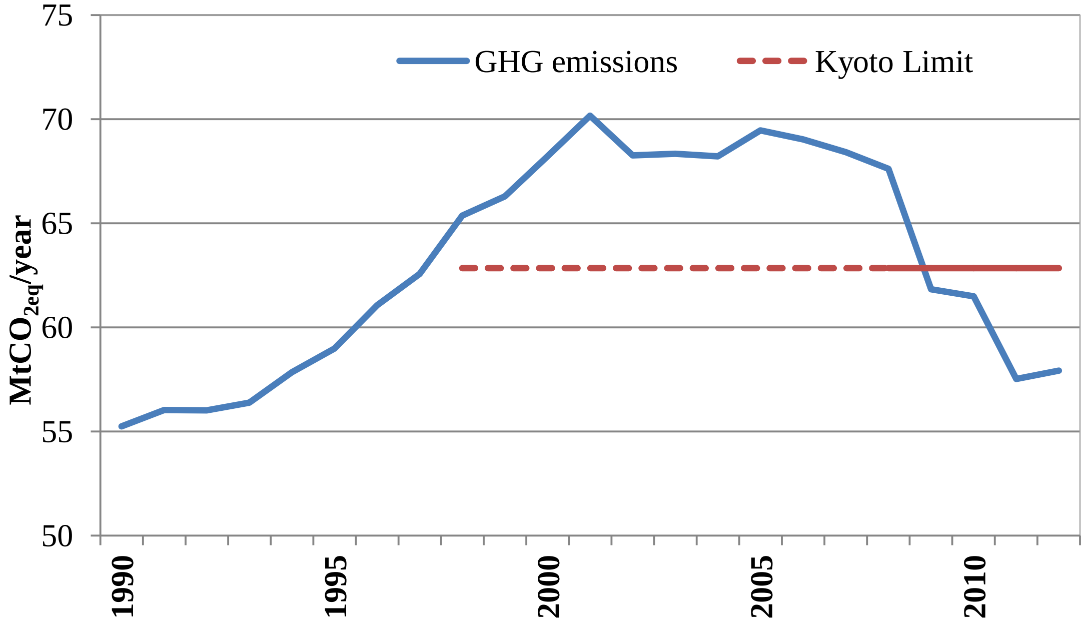

Figure 4-1 Ireland’s GHG emissions from 1990 to 2012, excluding LULUCF, based on the formal national inventory submitted to the UNFCCC (Duffy et al., 2013), and provisional emissions data for 2012 (EPA, 2013a). The Kyoto limit formally applied in the period 2008-2012. The annualized Kyoto limit was 62.8MtCO$_{2eq}$, which represented an allowed emission of +13% re 1990 emissions.

4.3.3 Emissions Plateau From 2002 to 2007

The period 2002 to 2007 saw total GHG emissions stabilising at an elevated level, in the range 67 to 69MtCO$_{2eq}$, and on average nearly 6 MtCO$_{2eq}$ above the Kyoto limit. Continued underlying growth in electrical power generation and in transport energy was progressively compensated in terms of GHG emissions by a move to more efficient natural gas in power generation and heating, and by reductions in emissions from industrial processes, and from agriculture.

In its inventory report for 2002, the EPA reported a reduction in GHG emissions of 1.6% re 2001, to 69 MtCO$_{2eq}$ (McGettigan and Duffy, 2004). The reasons given included closure of the state’s nitric acid plant along with a slight reduction in electricity demand, and reductions in cattle numbers. The reduction in industrial N_2O was 0.5MtCO$_{2eq}$, and was a once-off benefit. Increased energy consumption in the residential sector of 24% relative to 1990 was reportedly offset in terms of emissions by a shift away from carbon intensive solid fuels to oil and natural gas, resulting in a reduction in GHG emissions of 4% from this sector. A reduction of 1 $MtCO_{2eq}$ was achieved in emissions from electricity generation. Agriculture achieved a reduction amounting to 0.4$MtCO_{2eq}$. Road transport however showed continued growth, with an increase of 0.6 $MtCO_{2eq}$ from 2001 to 2002.

In the national inventory report for 2003, emissions were reported to have reduced again (McGettigan et al., 2005), due to termination of ammonia production in the state. The cumulative reduction in N_2O and ammonia following closure of these plants was 1.6 $MtCO_{2eq}$. It was not commented upon in EPA or government reports, but this 1.6 $MtCO_{2eq}$ reduction most probably resulted in a corresponding increase in emissions from similar facilities outside Ireland, as the market demand for nitrogenous fertilizer would still have to be supplied. There was an encouraging reduction from electricity generation of 0.8 $MtCO_{2eq}$. From analysis of the energy calculation sheets in the national inventory reports for 2002 and 2003, this appeared to have been due mainly to displacement of fuel oil in electricity generation by natural gas, and to a lesser extent due to reduced coal use in electricity generation.

There were no significant changes noted by the EPA in total GHG emissions in 2004. Reductions achieved in electricity generation, and reductions in agriculture, were counteracted by increases in emissions from traffic and from the cement industry (McGettigan et al., 2006). Changes in reported total emissions from NIR 2005 to NIR 2006 were due to substantial recalculation of the emissions time series, with total GHG emissions in the baseline year 1990 estimated as being 1.7 $MtCO_{2eq}$ higher than had been estimated previously. This amounted to a shift upwards in the emissions time series, and had only a small effect on the compliance requirements, which were framed as a percentage relative to 1990. In 2005 emissions were reported to have increased by 1.3 $MtCO_{2eq}$ relative to 2004, due to growth in fuel consumption. The increases were ascribed to transport (+0.8$MtCO_{2eq}$), industrial (+0.7$MtCO_{2eq}$), and electricity generation (+0.4MtCO_{2eq}). A reduction of almost 0.4 MtCO_{2eq} was reported for the agricultural sector (McGettigan et al., 2007).

Small reductions reported in 2006 were explained by the Moneypoint coal power plant being out of service, while being upgraded and fitted with emissions controls (McGettigan et al., 2008). Sustained growth in passenger cars and goods vehicles was identified as being a major factor in increases in emissions from 2003 to 2005, along with increased peat use, following commissioning of two new peat power plants. National emissions from the transport sector were also reported to have been distorted upwards by 15% in 2006 due to fuel tourism, whereby fuel purchased in the state was used outside the state. In 2007, there was a slight decrease in total GHG emissions. The national inventory report identified reductions in agriculture of 3.7% due to reduced animal numbers and reduced synthetic nitrogen fertilizers (McGettigan et al., 2009). There were also reductions of 3.7% from electricity generation, due to increased use of natural gas. Emissions trends in transport continued upwards however, with an increase of 4.9% on 2006.

4.3.4 EMISSIONS IN THE KYOTO PERIOD 2008 - 2012

2008 marked the beginning of the five year Kyoto commitment period. It was also the year in which the economic crisis commenced in Ireland. In 2008 a slight reduction in total GHG was reported (McGettigan et al., 2010). The decrease was attributed to reductions in agriculture, waste, and from the cement and lime industries. It was noted that growth in the transport sector had stopped. The EPA inventory report for 2009 (Duffy et al., 2011) showed a significant reduction of 8% compared with 2008, which brought the actual annual emissions below the Kyoto target. This was explained as being due primarily to a reduction in energy demand caused by the economic shock, and emissions from transport were reported to have reduced to pre-2006 levels. Further reductions of 7.3% were reported for 2010 (Duffy et al., 2012), which were ascribed to reduced transport activity, caused primarily by the economic downturn, and also due to new policies which charged vehicle registration tax and road tax on engine CO_2 emissions. There was also the effect of increased use of biofuels in the transport sector.

Emissions from cement manufacture had decreased by 2.1 $MtCO_{2eq}$ relative to 2007. Marginal increases in the residential sector emissions were attributed to the cold winters in the reporting period.

In 2011, GHG emissions had decreased by 4 $MtCO_{2eq}$ (6.5%) relative to 2010, and were 18% lower than the peak emissions in 2007 (Duffy et al., 2013). The reductions were attributed primarily to the economic downturn, together with the impacts of mitigation measures. Emissions from electricity generation decreased by 1.3 $MtCO_{2eq}$, due to lower demand and an increased supply of renewable electricity. Residential sector emissions had reduced by 1.2 $MtCO_{2eq.}$ The reason for the decrease was not explained in the NIR, however differences in winter temperature differences between 2010 and 2012 provide an explanation. The winter of 2010/2011, was the coldest since 1961, with temperatures at monitoring stations generally between 1 and 2°C lower than the climate average, whereas the winter of 2011/12 had mean temperatures in the range of 0.8 to 1.9°C above the climate average (Met Eireann, 2011; Met Eireann, 2012). There was a corresponding decrease in residential fuel consumption from 2010 to 2011 (SEAI, 2013a), due to the lower heating load. A reduction in transport emissions of 0.3 $MtCO_{2eq}$ from 2010 to 2011 was attributed to the economic downturn, changes in vehicle taxation, and the biofuels obligation scheme (Duffy et al., 2013). Emissions from agriculture were reported to have decreased by 0.3 $MtCO_{2eq}$ between 2010 and 2011, due to the continuing decline in cattle and sheep numbers.

In 2013, the EPA published provisional estimates for emissions for 2012 (EPA, 2013a). Total GHG emissions had increased slightly by 0.6$MtCO_{2eq}$ relative to 2011, which was attributed to increased use of coal for power generation, and an increase in cattle and sheep numbers. These increases outweighed decreases which had occurred in residential fuel consumption, and in transport emissions. Residential emissions were lower due to the mild winter of 2012, and based on data presented in the NIR, reductions in transport emissions may have resulted from a decrease in the number of commercial vehicles, while passenger vehicle numbers remained unchanged. The overall outcome was comfortable compliance with Ireland's Kyoto obligations.

4.4 Analysis of Sectoral Emission Trends 1990-2012

The emissions curve from 1990 to 2011 contains features that are best explored through analysis of the underlying emissions from the different sectors of the economy. The sectoral targets set out in NCCS 2000 (DELG, 2000a) were effectively overtaken by emissions trading, which began its trial phase in 2005. While NCCS 2007 (DEHLG, 2007) continued with the existing sectoral divisions, the targets were not revised. Sectoral targets were set out in NCCS 2000 in terms of the projected percentage changes relative to the base year of 1990. These targets provide the only published objective set of criteria for assessing sectoral performance. In the following discussion the targets have been converted to absolute emissions levels, based on the recalculated emissions for 1990 (Duffy et al., 2013), and consequently they differ slightly from the values presented earlier in Table 3.2.

The sectoral categories defined in the Kyoto Protocol are: Energy, Industrial Processes, Solvents, Agriculture, and Waste. Emissions from the Solvent sector were not significant in Ireland, and are not dealt with further in the present discussion. The Energy category was the most significant in terms of Ireland's GHG emissions. It represents quite a broad sector of the economy, and includes any activity which involves fuel combustion to yield energy. It is divided into the sub-sectors of Energy Industries (mainly public electricity generation), Manufacturing Industries & Construction (energy for heat and private electrical power), Transport, Commercial/Institutional (heat), and Residential (heat). The Industrial Processes category includes CO_2 from cement production, fluorinated gases (F-gases) from commercial and industrial refrigeration, and N_2O from nitric acid and ammonia production. The cement industry contributes to emissions in the Manufacturing Industry and Construction sector, through combustion of fossil fuels to provide process heat. It also contributes to emissions in the Industrial Processes sector through emissions of CO_2 resulting from the conversion of limestone to cement.

Detailed emissions data for each sector are available in the common reporting format spreadsheets prepared by the EPA as part of its annual inventory reporting. The present analysis is based on the emission series from 1990 to 2011 as reported to the UNFCCC, in the common reporting format spreadsheets (Duffy et al., 2013), and provisional data for 2012 (EPA, 2013a). The analysis is supported with reference to national and sectoral fuel consumption data from 1990 to 2011 (SEAI, 2013a). Analysis of the performance of the various sectors shows that significant progress was made towards the national performance targets in all cases with the possible exception of Transport where careful interpretation is required to disentangle the effects of the economic downturn.

4.4.1 ENERGY INDUSTRIES – PUBLIC POWER

The Energy Industries sector includes Public Power (electricity), Petroleum Refining, and Manufacture of Solid Fuels. Of these, Public Power is the largest emissions source. As shown in Figure 4.2, GHG emissions from public power plants increased from 1990 to 2001, and then underwent a steady decline until 2011, with a slight increase in 2012. Emissions in 2008 were 30% above 1990 levels and by 2012 had reduced to 12% above 1990 levels. The original sectoral target set in NCCS 2000, was broadly achieved by 2009, and despite a slight increase in 2012, emissions were still within target. The EU target of 21% reduction for the ETS sector by 2020 (relative to 2005), was already close to being achieved in Public Power for the period 2008-2012, where emissions had reduced by 18% compared with 2005. The low GHG emissions in the period 2008 and 2012 cannot be explained entirely by the economic downturn. As is clear from Figure 4.2, the downward trend was firmly established prior to the economic crisis in 2008. Between 2001 and 2008, emissions reduced by on average 0.4 $MtCO_{2eq}$ per year, with an overall reduction of 16% over this period. While this reduction in GHG emissions was in progress, the consumption of electricity increased substantially by 27%. Electricity consumption then began to plateau from 2006 onwards. Despite the economic downturn, average electricity consumption in the years 2009 to 2011, was just 3% less than in 2007 (SEAI, 2013a). This steady decline in GHG emissions was due mainly to increased use of natural gas, which had lower emissions of CO_2 per unit of fuel energy, and higher conversion efficiency in the combined cycle gas turbine generators.

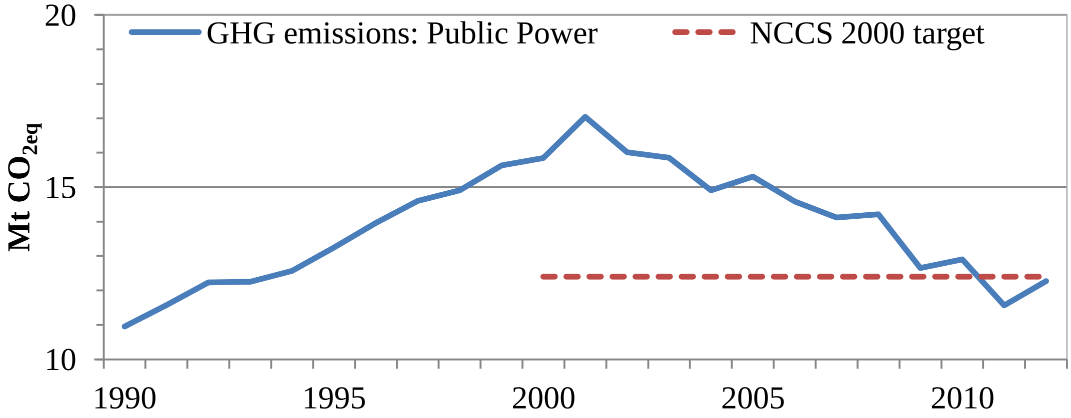

Figure 4-2 GHG emissions from Public Power sector 1990 - 2012, plotted from national inventory data (Duffy et al., 2013; EPA, 2013a). The original sectoral target implied in NCCS 2000 for public power (electricity) is shown as a dotted line.

From analysis of fuel data (SEAI, 2013a), the proportion of natural gas in the fossil fuel mix for electricity generation increased from 28% to 63% between 1990 and 2011. In tandem with the increased use of natural gas, there was an increasing renewable energy component. The contribution of renewables to the electricity supply increased from 5% in 1990 to 18% in 2011, with the increase due almost entirely to wind power (Dennehy et al., 2012). The 18% contribution from wind energy was the normalised value which is corrected to account for annual fluctuations in wind speed. The actual performance calculated from national energy balance data (SEAI, 2013a) in 2011 was 20% of the total electricity supply. The wind energy yield in 2011 was above average and the instantaneous fraction of wind energy on the national grid on many days reached 38% (Eirgrid, 2012). The fact that the electricity grid could accept such a large contribution of variable wind energy was a positive indication of the technical feasibility of achieving the eventual national target of 40% renewable electricity by 2020.

In assessing the performance of the Public Power Sector, it is fair to conclude that the sector had complied with the original national targets, and was already well on its way to achieving the EU target for 2020. The efficiencies brought about by the shift to natural gas were however at the expense of security of supply, as is clear from analysis of the national energy balance fuel data. In 1990 the fuel input for electricity generation, was 49% indigenous, consisting of gas from the Kinsale field, peat, and hydroelectricity. In 2011, the indigenous fuel fraction had reduced to 26% of the total fuel input (SEAI, 2013a). Prospects for security of gas supply had however improved greatly, with the development of the Corrib Gas Field, and the granting of planning permission for a liquid natural gas (LNG) importation facility near Tarbert, Co. Kerry (An Bórd Pleanála, 2008).

4.4.2 MANUFACTURING INDUSTRY, & CONSTRUCTION

Figure 4.3 shows the emissions from the Manufacturing Industry and Construction sector from 1990 to 2012. Emissions increased slowly from the mid 1990s to reach a maximum of approximately 6 $MtCO_{2eq}$ between 2004 and 2007. This was followed by a sharp decline. By 2009 emissions had decreased to slightly above 1990 levels and were close to the target originally envisaged in NCCS 2000. National inventory data did not provide a breakdown between emissions in industrial manufacturing, and the construction sectors. It would however be reasonable to assume that a significant proportion of the decrease was due to collapse of the unsustainable bubble element of the construction sector. In particular, the cement industry underwent a rapid decline from 2008 onwards. In addition to the reduction in process emissions from cement manufacture, which are dealt with in section 4.4.6, there was also a corresponding reduction in emissions of CO_2 from the combustion of fossil fuels in the cement kilns. Based on a fuel CO_2 to process CO_2 ratio of 0.59, this would have amounted to a reduction of approximately 0.8 $MtCO_{2eq}$ from fuel combustion in the cement plants. The Manufacturing Industry and Construction Sector also included large energy users who were included in the ETS, and these operators already would have had emissions reduction programmes in place to meet their obligations for the period 2008 to 2012. The overall emissions from the Manufacturing Industry and Construction sector from

2008 to 2012 may therefore be considered a more representative picture of normal sustainable emissions than the maximum of the curve between 2004 and 2007.

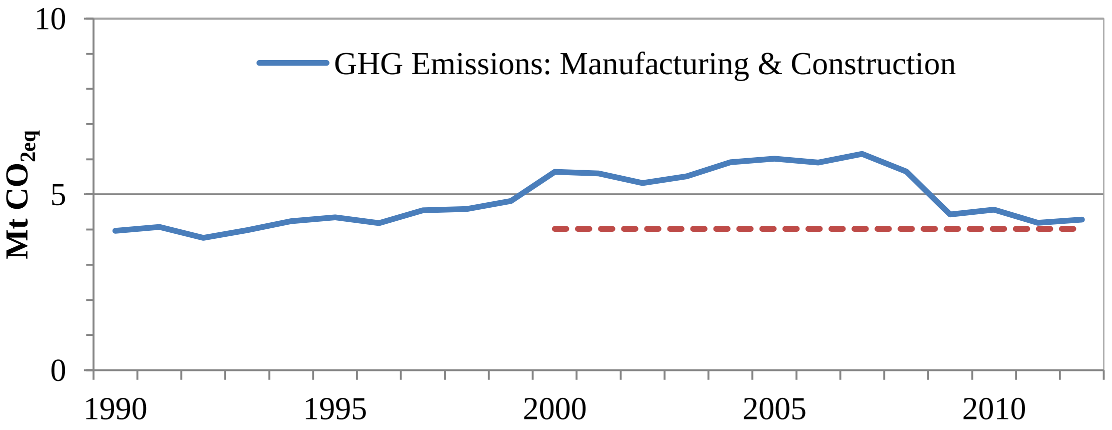

Figure 4-3 GHG emissions from Manufacturing Industry and Construction sector 1990 - 2012, plotted from national inventory data (Duffy et al., 2013; EPA, 2013a). The original sectoral target implied in NCCS 2000 for public electricity supply is shown as a dotted line.

In the national context, emissions from the Manufacturing Industry and Construction Sector were at all stages modest. Even at its peak, the increase of 2 $MtCO_{2eq}$ relative to 1990, was not an insurmountable barrier to the progress of national policy, as there were compensating reductions in the Industrial Processes Sector (section 4.4.6). Consequently, emissions from the Manufacturing Industry and Construction sector could be judged to have complied with the objectives and quantitative target of the national strategy, and the outlook was positive for achieving further reductions by 2020.

4.4.3 Transport

The transport sector was consistently identified in national communications to the UNFCCC and in EPA inventory reports as a major factor in elevated national GHG emissions. As shown in Figure 4.4 emissions grew rapidly from 1990 and reached a peak in excess of 14 $MtCO_{2eq}$ in 2007. This was an increase of 9 $MtCO_{2eq}$ on 1990 levels. The cause of the increase was clear. From 1990 to 2009 the number of private passenger vehicles increased by 138%, from 0.8 million to 2.9 million and freight vehicles increased by 141% from 143,000 to 344,000 (DOT, 2009b). The trend in emissions was exacerbated by a move to higher engine capacity cars, which continued up to 2009 (Howley and Holland, 2013). The emissions growth allocation in NCCS 2000 was already exceeded in 2003 and the inexorable rise was only halted and reversed from 2008 onwards. By 2010 emissions had fallen to just below the original NCCS 2000 target. On the face of it, the decline in transport emissions could be attributed simply to the economic crisis. This was mentioned as a contributing factor by the EPA (Duffy et al., 2013), who also pointed to the effect of changes in vehicle taxation, and increased usage of biofuels. However, ascribing the reductions simply to the economic crisis, risks overlooking the extent to which reductions occurred due to the elimination of non-sustainable transport activity. During the economic boom, which was characterised by unprecendented rates of construction, there was a corresponding growth in freight transport associated with these construction projects. There was a marked decline in road freight after 2007, which the National Roads Authority (NRA) attributed to the general downturn in the economy, and in particular to the downturn in construction activity (NRA, 2011).

From 2007 to 2011 emissions from the transport sector had reduced by 3.2MtCO_{2eq} (23%). National inventory reports do not provide data on the separate GHG emissions of freight and private cars. From the detailed fuel breakdown (SEAI, 2013a), and assuming an approximate fuel emission of 3tCO_2/toe, the reductions for each transport sub-sector can be estimated, as presented in Table 4.2. On this basis, reductions in road freight most likely accounted for 1.5MtCO_{2eq} of the total reduction, and private cars accounted for 0.7 MtCO_{2eq}. Fuel tourism, whereby fuel bought in the state was used elsewhere, had also reduced, leading to an additional reduction of approximately 1 MtCO_{2eq} in accounted emissions. Biofuels in transport increased by 0.06Mtoe between 2007 and 2011, which would have reduced GHG emissions by at most 0.2 MtCO_{2eq}. Overall, lower road freight fuel consumption accounted for 44% of the GHG reduction between 2007 and 2011. Decreased fuel tourism accounting for 30%, and lower private car fuel consumption contributed 20% to the reduction. Increased use of biofuels, which displaced petroleum fuels, contributed just 5% to the overall reduction.

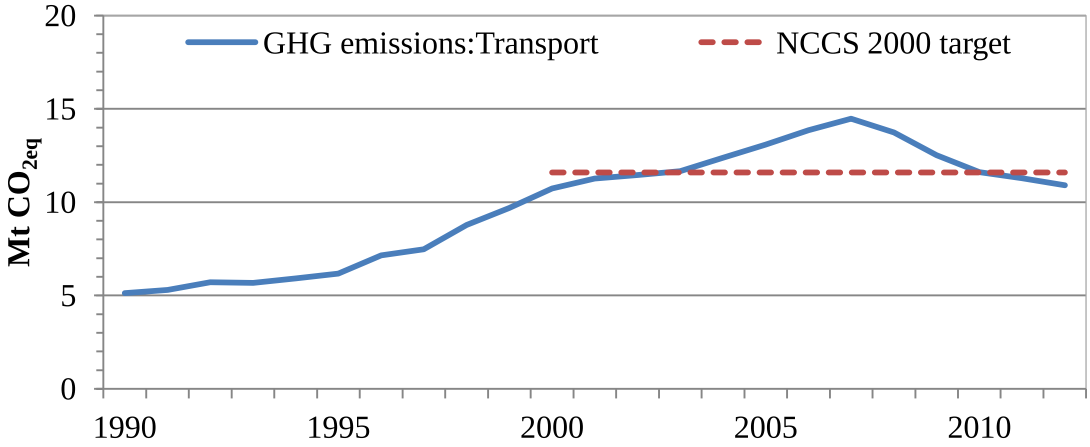

Figure 4-4 GHG emissions from the Transport sector 1990-2012, plotted from national inventory data (Duffy et al., 2013; EPA, 2013a). The original sectoral target implied in NCCS 2000 for public electricity supply is shown as a dotted line.

	Mtoe				
Total Petroleum Products	**2007 [1]**	**2011 [1]**	**Change 2007 to 2011**	**Change in GHG $MtCO_{2eq}$**	**% of total reduction**
Road Freight	1.13	0.64	-0.50	-1.5	44
Private Car	2.07	1.84	-0.23	-0.7	20
Public Passenger (road)	0.17	0.17	0.00	0.0	0
Rail	0.04	0.04	0.00	0.0	0
Fuel Tourism	0.64	0.31	-0.33	-1.0	30
Navigation	0.06	0.06	-0.01	0.0	1
Liquid Biofuel (All Road Transport)	0.02	0.07	0.06	-0.2	5
Total Change in GHG from 2007 to 2011				-3.4 [2]	

Table 4-2 Fuel consumption in the transport sector in 2007 and 2011, and calculated reduction in GHG emission, based on a nominal emission factor of $3tCO_{2eq}$/toe. The change in GHG associated with biofuels assumes one unit of petroleum fuel is displaced per one unit of biofuel.

[1] from national energy statistics (SEAI, 2013a)

[2] differs by 0.2Mt from national inventory data, as above table excludes the statistical sub-category “unspecified”, which is not relevant for road transport

The reduction in road freight following the onset of the economic crisis was evident from Central Statistics Office data also. Freight reduced by 57%, from 299 million tonnes in 2007 to 126 million tonnes in 2010 (CSO, 2010). Freight fuel consumption reduced by 44% from 2007 to 2011, bringing consumption back to pre-2000 levels (SEAI, 2013a). Over the same period, total fuel consumption for passenger cars reduced by 11%, which brought car fuel consumption back to 2005 levels. Despite this reduction in fuel consumption, SEAI data on private passenger vehicle activity showed that there was a marginal increase of 6% in the total distance travelled by the national car fleet. In 2007 the total distance was 31.4 billion kilometres, and in 2012 it was 33.2 billion kilometres (Howley and Holland, 2013). The apparent contradiction between a decrease in private vehicle fuel consumption, and an increase in total distance travelled can be explained in part by a higher proportion of more efficient vehicles, and possibly by more efficient travel on motorways, and a reduction in the number of short journeys. The foregoing analysis indicates that the reduction in transport GHG from 2007 to 2011 can largely be explained by reductions in the road freight sector, following collapse of the construction bubble, and reduced fuel tourism. While there was a reduction in fuel consumption for private cars, the national car fleet activity was maintained. The reduction in transport emissions since 2007 may therefore represent a transition to a more sustainable level, which more closely represents the true underlying transport needs of society.

The consistent assessment of the transport sector by both the EPA in its inventory reports, and by the Government in the national communications to the UNFCCC, was that transport was a major challenge in controlling national GHG emissions. However, this concern was not matched by specific measures. Other than continuation of the existing car tax and excise duty regime, there was no change in government policy to tackle the emissions from the transport sector until 2008. The public buying preferences had evidently not been affected by the higher road taxes and running costs which applied to higher engine capacity vehicles. Analysis by SEAI showed that the growth in vehicle numbers since 1990 was accounted for in the vehicles with engine capacities in excess of 1.2 litres and there was a fall in the number of vehicles with engine capacity less than 1.2 litres (Howley and Holland, 2013).

The change to a CO_2 based tax system in 2008 was too late to have a significant effect in the Kyoto period, but laid the groundwork for reductions to 2020. The relationship between tax and CO_2 finally provided a lever of control, which could exploit consumer tax aversion behaviours. The effects of the VRT and road tax re-balancing were immediate in terms of new vehicle registrations. There was a reported reduction of 24% in emissions from new vehicles registered in 2012, compared with the situation in 2007 (Howley and Holland, 2013). When account is taken of the new tax controls introduced in 2008, the availability of low emissions vehicles, projected increases in biofuels, and improvements in electric vehicles, the prospect for achieving a reduction of 20% in emissions relative to 2005 would have to be considered theoretically possible. In addition, through all-island cooperation on excise duties, there was significant potential to reduce the fuel tourism effect, which still contributed approximately 0.9 $MtCO_{2eq}$ to national emissions in 2011.

4.4.4 COMMERCIAL AND INSTITUTIONAL

Emissions of GHG from the commercial and institutional sector are due to fuel combustion for heating buildings and provision of hot water. As is evident from the emissions curve in Figure 4.5, emissions were relatively steady at between 2 and 2.5 $MtCO_{2eq}$ from 1990 to 2012. The allocation of 3.5 $MtCO_{2eq}$ set in NCCS 2000 was never reached. As a separate sector, it was no longer reported in the EPA annual reports after 2005, and was included with the Manufacturing Industry and Construction sector, which effectively transferred the unused indicative emissions allocations to this sector. Despite the economic growth during the period, and the construction of new commercial and institutional buildings on an unprecedented scale, emissions were kept under control. The main identified mitigation factors were fuel switching to natural gas, and greatly improved building energy efficiency. This trend is evident from energy balance statistics for the commercial and public services sector (SEAI, 2013a) which showed that there was a reduction of 0.25 Mtoe/year in petroleum products, and an increase of 0.27Mtoe /year in natural gas from 1990 to 2011. The proportion of natural gas increased from 5% of fuel in 1990 to 27% in 2011, which still left scope for further fuel switching. Overall, the Commercial Institutional Sector performed comfortably within the target set, and as of 2012 did not present evident challenges in achieving significant further reductions by 2020.

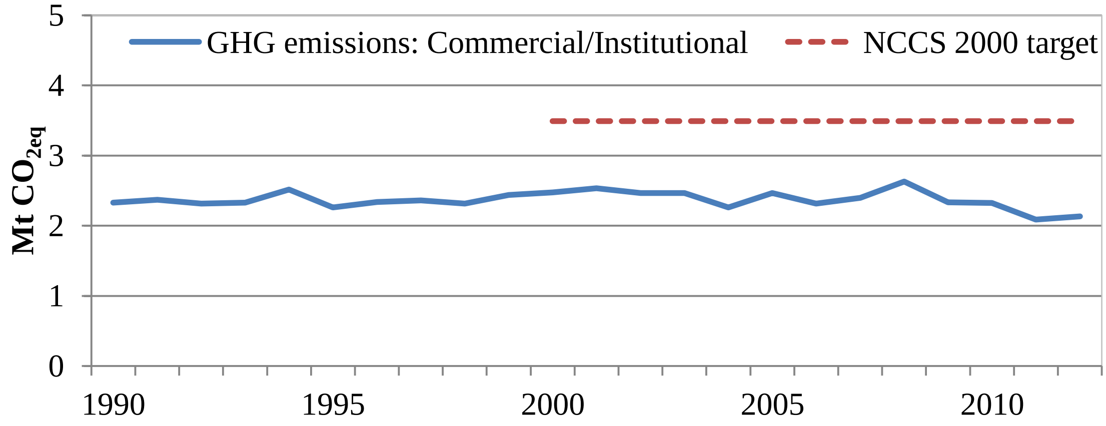

Figure 4-5 GHG emissions from the Commercial/Institutional sector 1990-2012, plotted from national inventory data (Duffy et al., 2013; EPA, 2013a). The original sectoral target implied in NCCS 2000 is shown as a dotted line.

4.4.5 RESIDENTIAL

The emissions trend curve in Figure 4.6 refers to GHG emissions from combustion of fuels for supply of heat within residences. It excludes the emissions of GHG at power stations which supply residential electricity, as these emissions are accounted under the Energy Industries, Public Power sector. From Figure 4.6, it can be seen that GHG emissions were relatively steady and were marginally in excess of the sectoral allowance set in NCCS 2000 between 2004 and 2011. Elevated emissions in 2009 and 2010 were attributed to unusually cold winters in these years (Duffy et al., 2012). The final emissions in 2012 were approximately 6.2MtCO_{2eq}, which was within the original sectoral allocation in NCCS 2000, and 17% lower than in 1990. The performance of the residential sector was remarkable in view of the increase in population and housing stock over this period. The population increase from 1991 to 2011 was 30 %, from 3.5 million to 4.6 million (CSO, 2012a). In addition, between 1990 and 2012 the number of households increased by 65%, from 1 million to 1.65 million, and the floor area of new houses increased by 59% (Howley and Holland, 2013). These very strong growth factors were effectively counteracted by fuel switching, more efficient heating systems, and continual tightening of building regulations which set greatly improved standards of house insulation.

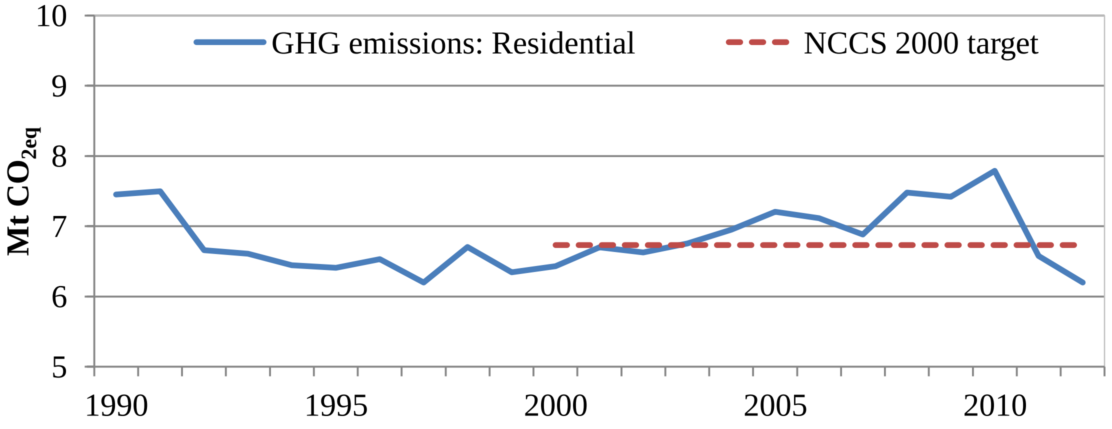

Figure 4-6 GHG emissions from the Residential sector 1990-2012, plotted from national inventory data (Duffy et al., 2013; EPA, 2013a). The original sectoral target implied in NCCS 2000 is shown as a dotted line.

While the performance of the residential sector in maintaining emissions close to the NCCS 2000 target was impressive, there was still evident scope for further improvement. As of 2011, two thirds of the housing stock was of pre-1990s construction, with a poor building energy rating (BER) of D or less (NESC, 2012), which was a factor of 10 worse than the technically achievable energy rating of A. The technical feasibility of achieving substantial reductions in residential emissions was affirmed in the Energy Efficiency Directive (EC, 2012) which required member states to establish a strategy for renovation of residential buildings with the aim of achieving a significant reduction in energy consumption. Energy upgrade of existing buildings was promoted by SEAI, and based on data from their annual reports (SEAI, 2014), there was a modest annual budget of on average €54 million between 2006 and 2012, with a focus in later years on homes experiencing fuel poverty, with on average 32% of grants directed to these homes. A practically totally decarbonised residential heating sector was also envisaged as feasible by the EPA for 2050 (O' Reilly et al., 2012), although this would require a significantly higher government investment rate than was the case up to 2012.

With natural gas still accounting for only 20% of residential heating, there was still potential for increasing its use, thus reducing the more carbon intensive solid fuels and petroleum products. There was clear scope also for improvement in the penetration of renewables. Despite determined campaigning and supports by SEAI, renewable energy for space and water heating had not increased since 1990. Renewable energy usage was 0.045 Mtoe in 1990 and remained practically unchanged at 0.05 Mtoe in 2011 (Dennehy et al., 2012). The only significant impact of renewable energy in the residential sector was indirectly through the renewable component of residential electricity consumption. Of the 0.74 Mtoe of electrical energy consumed in the residential sector in 2011, 27% was renewable, which corresponded to 0.2 Mtoe of renewable energy. This was more than four times the amount of renewable energy used by the Residential sector from solar and biomass sources combined. In conclusion, the residential sector had performed broadly in accordance with the target originally envisaged in 2000, and there were still clear opportunities for further mitigation, which could contribute to national reduction targets for 2020.

4.4.6 Industrial Processes

GHG Emissions from industrial processes in Ireland were relatively low, and ranged from approximately 2 to 4MtCO_{2eq}, which corresponded to 3% to 6% of the total national emissions throughout the period 1990 to 2012. Industrial N_2O from nitric acid production, and emissions of CO_2 from cement production accounted for most of the emissions to 2001, when they reached a peak of 4.3MtCO_{2eq}. Production of nitric acid and ammonia ceased after 2001, and thereafter emissions were determined by the cement industry, and fluorinated hydrocarbon refrigeration gases (F-gases). Between 2001 and 2008, the cement industry continued to emit at significantly elevated levels relative to 1990. In 2008 these emissions reduced rapidly, following the collapse of the construction bubble, and the completion of large scale once-off transport infrastructural projects. Process emissions from the cement industry reduced by 1.3 $MtCO_{2eq}$ between 2007 and 2010, which brought emissions from this industry back to pre-1999 levels (Duffy et al., 2012). It is clear from the emissions curve as shown in Figure 4.7 that the sectoral allowance under NCCS 2000 was at all times complied with, despite the elevated emissions from the cement industry. Total emissions from the Industrial Processes sector in 2012 of 1.8 $MtCO_{2eq}$ could be validly interpreted as a normal level of emissions from this sector, and 3 $MtCO_{2eq}$ below the allowance originally envisaged.

In the period 2008-2012, 35% of process emissions in Ireland were from F-gases. These gases are expected to be phased out under proposed EU-wide controls, with an initial objective of reducing emissions to about 20% by 2030 (CEC, 2012a), in which case additional national measures would not be required. This would greatly assist Irish efforts in controlling overall emissions from the Industrial Processes Sector. In conclusion, the performance in this sector was comfortably within the original NCCS 2000 target, and indications were that achieving further reductions by 2020 would be feasible.

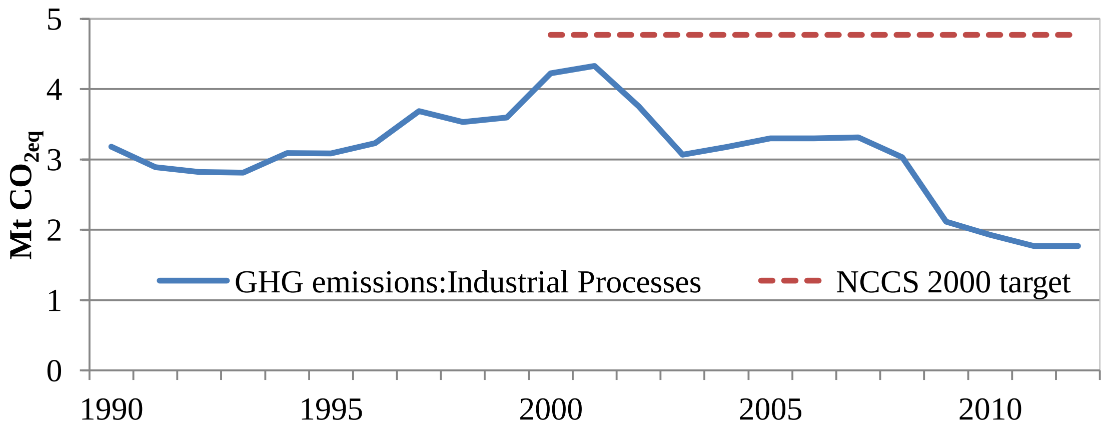

Figure 4-7 GHG emissions from the Process Industry sector 1990 - 2012, plotted from national inventory data (Duffy et al., 2013; EPA, 2013a). The original sectoral target implied in NCCS 2000 is shown as a dotted line.

4.4.7 AGRICULTURE

In NCCS 2000 the Agricultural sector was assigned a reduction target of approximately 10%, which at that stage was considered achievable in view of the anticipated reform of the common agricultural policy. The emissions curve in Figure 4.8 shows that emissions from agriculture gradually increased from 1990 to 1998, and then progressively declined to 2011, with a slight increase in 2012. The general decrease was due to reductions in ruminant animal numbers, and reduction in the average age of cattle slaughter, with consequent decrease in emissions of enteric CH_4. There were also reductions in use of nitrogenous fertilizers, with consequent decreases in emissions of soil N_2O (JOC, 2011). As of 2012, the original NCCCS 2000 target was only slightly exceeded. Emissions from agriculture had decreased by almost 1.4 $MtCO_{2eq}$ between 1990 and 2012, which was the greatest reduction achieved in any of the productive economic sectors. While this was a success in the context of the original strategy, the policy environment had changed fundamentally. Achieving further emissions reductions to help meet the 20% national reduction commitment for 2020, would not be feasible in the context of a national policy focused on growth in agricultural production, as set out in Food Harvest 2020 (DAFF, 2010). The complex factors which led to this apparently unanticipated difficulty are discussed further in chapter 6.

4.4.8 WASTE

Emissions of CH_4 from landfill waste were a minor contribution to national emissions in 1990, but this could have become much more significant if action had not been taken. Following establishment of the EPA in 1992, landfills progressively became subject to licensing and regulation (Waste Management Act, 1996). Subsequent legislation introduced following the EU Landfill Directive (EC, 1999), provided a robust framework for controlling the waste sector. Emissions of CH_4 were subject to controls such as flaring, or collection for energy use. Emissions from landfills were close to the national target by 2009 as shown in Figure 4.9. While the waste sector would need to be kept under continued scrutiny, there were no insurmountable technical challenges to achieving further improvements.

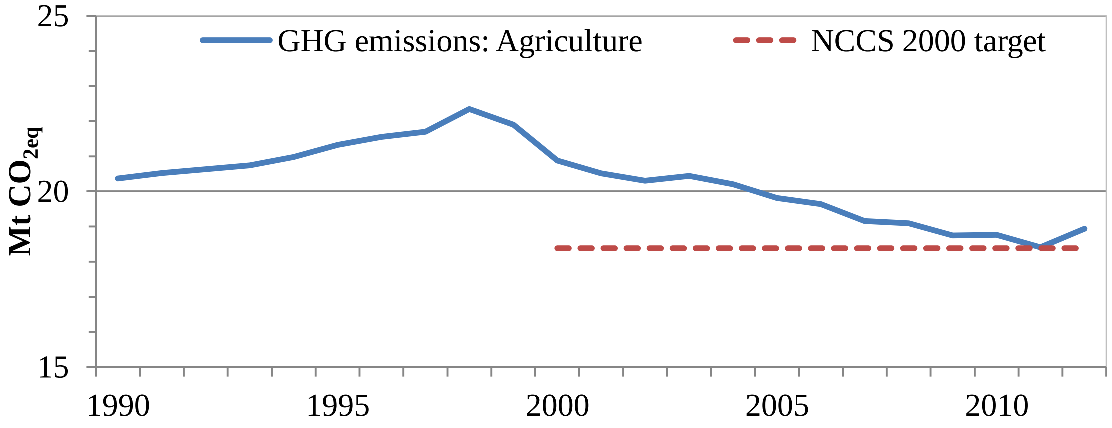

Figure 4-8 GHG emissions from the Agricultural sector 1990-2012, including emissions from agricultural fuel (Duffy et al., 2013; EPA, 2013a). The original sectoral target implied in NCCS 2000 is shown as a dotted line.

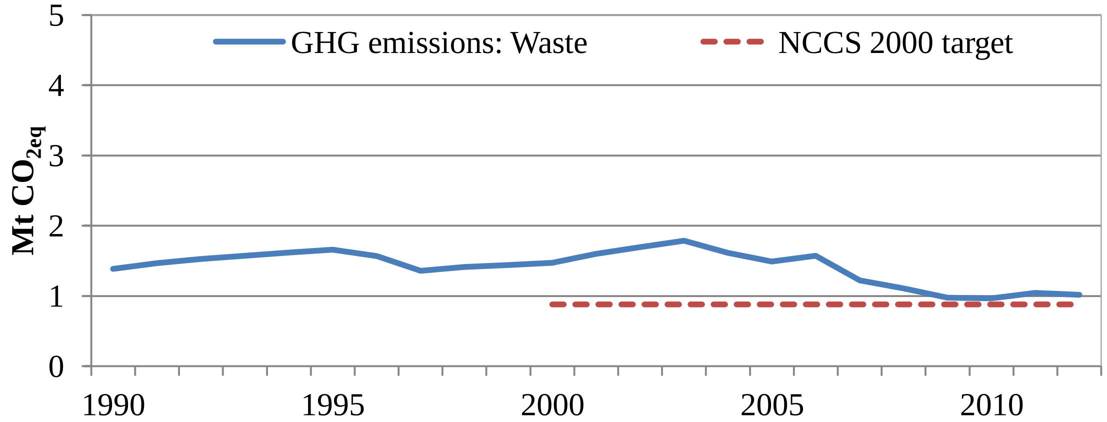

Figure 4-9 GHG emissions from the Waste sector 1990-2012 (Duffy et al., 2013, EPA, 2013a). The original sectoral target implied in NCCS 2000 is shown as a dotted line.

4.4.9 Ireland's Progress on Renewables Targets

The state's performance can also be judged with respect to compliance with EU policies, expressed in the form of EU Directives, which increasingly drove national policy formation from 2000 onwards. In particular, quantitative national targets for 2010 were set for renewable electricity sources, and for transport biofuels. The RES-E Directive (EC, 2001b), set indicative targets for renewable electricity sources for member states, to be achieved by 2010. The targets were set in terms of the percentage of renewable electricity in the electricity supply. The target for Ireland was 13.2%. In 2010 renewable electricity reached 14.8%, and increased to 17.6% in 2011, and the target was comfortably complied with (Dennehy et al., 2012). There was no EU target for renewable heat energy sources (RES-H) for 2010, however a national target of 5% was set in the Energy White Paper in 2007 (DCMNR, 2007a). This target was narrowly missed in 2010, but was reached in 2011. The original national biofuels target was 5.75%, to be achieved in 2010. As discussed in chapter 7 on bioenergy policy, it was never realistically anticipated that this target could be met solely from indigenous production. A significant proportion would have to be imported. While the 5.75% target was incorporated in NCCS 2007, it was subsequently replaced by a 3% energy target (4% by fuel volume) for 2010 (DCMNR, 2008). A weighted biofuel share of 2.6% was achieved in 2010 and 3.6% in 2011 (Dennehy et al., 2012). The national target was substantially met.

4.5 Comparison of Kyoto Compliance across EU-15

At the time of the Kyoto Protocol in 1998, Ireland was one of 15 EU states (EU-15) that were committed to achieving specified Kyoto EU targets in the period 2008-2012. An analysis of Ireland's performance relative to the other states provides a useful quantitative benchmark. Assessment of national performance, and analysis of comparative performance within the EU, should ideally take cognisance of the economic downturn which coincidentally occurred from the inception of the Kyoto period in 2008. The aftermath of an economic crisis is not an ideal time to perform accurate analysis of the impacts of climate change policies. The economic downturn affected countries in different ways, and there is no evident means of removing confounding effects from the emissions data. However, direct comparison of the average emissions of member states from 2008 to 2012, compared with their respective Kyoto limits, provides some measure of comparative performance.

A comparison based on average emissions for the EU-15 states from 2008 to 2012 is presented based on emissions data compiled by the European Environment Agency (EEA, 2013a). Forest sinks are excluded, so that the comparison accurately reflects the underlying physical emissions. The rankings as presented in Figure 4.10 show that Sweden performed best, followed by Greece, U.K., France, Portugal, Belgium, Finland, Germany and Ireland. Emissions in Ireland were 1.5% below the limit. Ireland ranked ninth in the EU-15, with performance significantly better than that of Denmark, a country of comparable size and population.

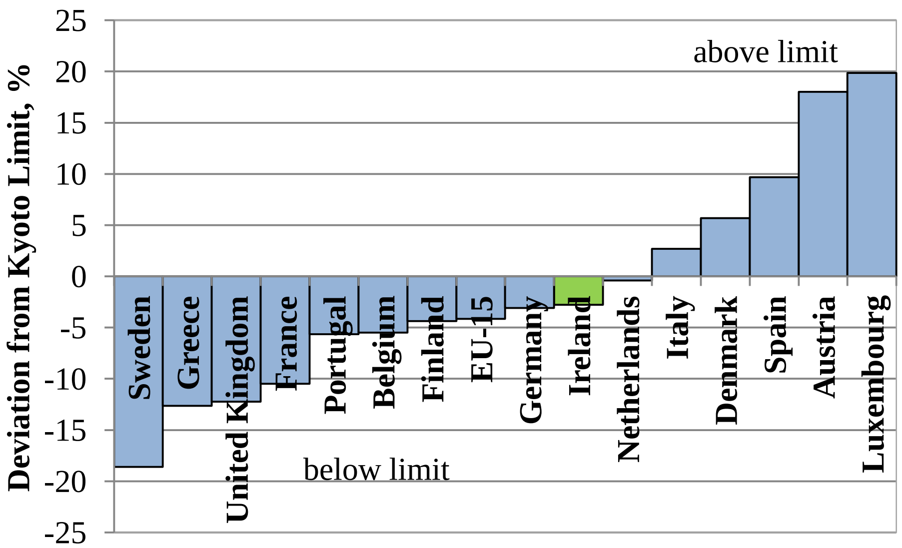

Figure 4-10 Comparison of GHG emissions for EU-15 states for 2008-2012, relative to Kyoto limits, calculated and plotted from data compiled by the EEA (2013a). Positive values indicate the emissions are above the limit. Negative values indicate the target has been achieved and emissions are below the limit. Data represents actual emissions, without any adjustments for forest sinks, or for reductions in ring-fenced ETS components.

4.6 Comparison of RES –E Performance across EU-15

Renewable electricity targets in the RES-E Directive (EC, 2001b) varied widely across the EU-15. The targets, which are listed in Table 4.3, took account of the existing renewable component in the electricity supply, the potential for increased penetration of renewable energy, and national capabilities. For Ireland, where Res-E in 1997 was just 3.6% and where there was evident wind power potential, the target was set at 13.2% for 2010. For countries which had already exploited renewable energy resources to a significant degree, smaller increases were required. In all cases there was the requirement that targets would be met against a background of economic growth, and consequent growth in overall electrical energy consumption. The performance of the EU-15 in achieving their RES-E targets for 2010 is summarised in Table 4.3, and is presented as a performance ranking in Figure 4.11.

Ireland was one of seven states which achieved or exceeded the 2010 RES-E target, and ranked fourth in the EU-15. In the absence of additional exploitable hydropower resources, and limited supplies of biomass (as discussed in chapter 7), almost all of the growth in RES-E in Ireland had to be achieved by means of wind power. The integration of variable wind power into the national grid presented considerable difficulties. In contrast to Denmark and Germany, Ireland suffered from limited interconnectivity which made balancing the supply to incorporate variable wind energy challenging. As of 2011 there were 1695 MW of wind energy capacity installed, and connection offers had already been made for an additional 3900 MW. There was clearly huge commercial interest in future expansion, with a queue of 12000 MW applying for connection. Such was the potential that in 2012 the government was considering a scenario where the generation capacity would exceed the national target of 40%, and was exploring possibilities for export of the excess wind energy (EirGrid, 2011; 2012).

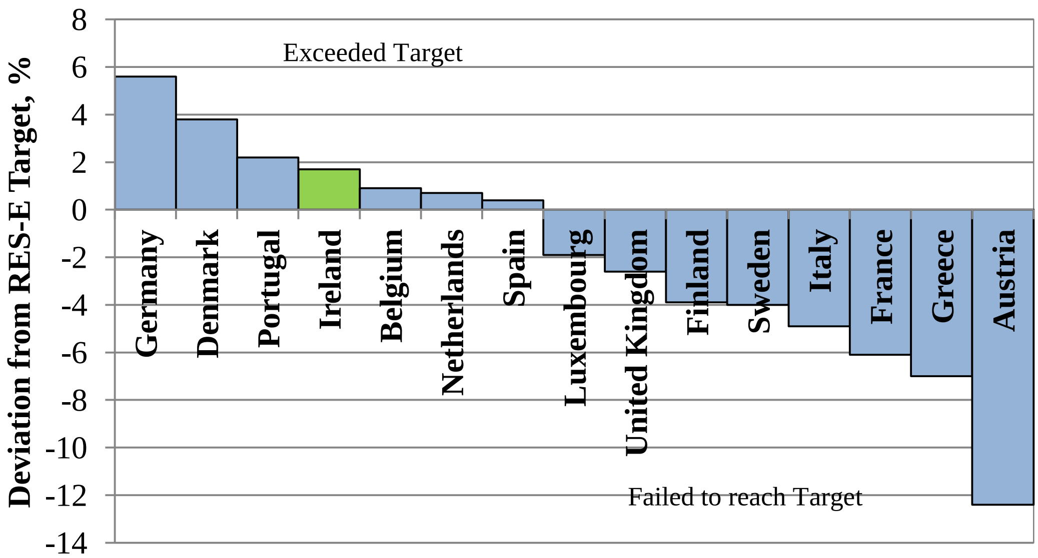

Figure 4-11 Progress towards RES-E: ranking of EU-15 states.
Plot of data from Table 4.3

Country	Res-E 1997 [1] %	Res-E target for 2010 [1] %	Performance in 2010 [2] %	Deviation from 2010 target, % points [3]
Germany	5	13	18	6
Denmark	9	29	33	4
Portugal	39	39	41	2
Ireland	4	13	15	2
Belgium	1	6	7	1
Netherlands	4	9	10	1
Spain	20	29	30	0
Luxembourg	2	6	4	-2
United Kingdom	2	10	7	-3
Finland	25	32	28	-4
Sweden	49	60	56	-4
Italy	16	25	20	-5
France	15	21	15	-6
Greece	9	20	13	-7
Austria	70	78	66	-12

Table 4-3 Renewable electricity (RES-E) targets for EU-15 states, and summary of progress to achievement of targets in 2010. Positive values (shaded grey) represent good performance and exceedence of the target. Negative values represent failure to meet the target.

[1] As tabulated in RES-E Directive (EC, 2001b), rounded

[2] Performance data as compiled by EEA (2013b), rounded

[3] Calculated to one decimal place and rounded

4.7 CONCLUSIONS ON IRELAND'S PERFORMANCE

From 2000 to 2008, Ireland's prospects for Kyoto compliance were uniformly negative. However, significant reductions in GHG emissions from 2008 onwards ensured that Ireland complied comfortably with the Kyoto limit. One interpretation of the sharp GHG reduction, as voiced in the national inventory reports (Duffy et al., 2013), was that it was due to the economic downturn. Implicit in this explanation was the expectation that emissions would grow again following economic recovery. Based on analysis of the sectoral reductions, in section 4.4, an alternative interpretation is suggested. The sharp reductions which occurred after 2007 can be explained in large part by the collapse of the unsustainable construction bubble, and to sectoral mitigation measures which were already achieving results prior to the economic crisis. The property bubble and overheating of the Irish economy which occurred between 2000 and 2007 has been extensively analysed by economists (Regling and Watson, 2010; Honohan, 2010; Nyberg, 2011). While all agree that the economic activity was unsustainable, the resulting impact on GHG emissions has not been specifically studied in depth. However, there were clear impacts in the construction sector, with associated reductions in GHG emissions from manufacturing, cement production, and construction-related road transport. If this interpretation of the reduction in GHG emissions is correct, then emissions in the period 2008 to 2012 more closely represented normal emissions, and the elevated GHG emissions up to 2008 were just another manifestation of the economic bubble.

Overall, Ireland could be judged to have performed well in achieving its targets. The important target for RES-E was achieved, and prospects were positive for continued development of wind energy to meet the state's 2020 target. Ireland also performed well compared with other EU-15 states, being mid-range in terms of Kyoto performance, and among the best achievers in terms of achievement of RES-E target. By 2012 the GHG emissions from the various sectors of the economy were all broadly within the allocations originally envisaged in NCCS 2000. The prognosis was also good for achieving continuing reductions in emissions from all energy sectors of the economy.

Given these positive achievements, it is not immediately apparent why there was such concern among policymakers towards the end of the Kyoto period (DECLG, 2011; NESC, 2012). One reason for the unease was the fear that it was a short term reduction due to the recession (DEHLG, 2010b; Duffy et al., 2013; EPA, 2013c), and that emissions would suddenly increase again when economic growth resumed. More significantly, the failure at international level to agree a successor to the Kyoto Protocol meant that Ireland's future GHG trajectory would be determined solely by the less flexible EU 20% reduction requirement for 2020, which excluded forest sequestration. The 20% target seemed unachievable even under the most ambitious scenarios (EPA, 2011a). Less obviously, the ETS had in fact undermined the whole basis of NCCS 2000, and resulted in an increased compliance burden for sectors of the economy outside of the ETS. This affected Ireland in particular, which had the highest proportion of agricultural GHG emissions of all the EU-15 states, as discussed further in chapter 6.

5 IRISH AGRICULTURE AND FORESTRY

5.1 AGRICULTURAL AND FORESTRY GHG POLICY CONSIDERATIONS

GHG policy formation in the context of sustainable development raises questions of sectoral equity, as it involves allocation of compliance burdens between different sectors of the economy. Such equity considerations did not feature noticeably in the formation of Irish policy, but they are important in assessing the long-term viability and public acceptability of a given policy. For agriculture it is reasonable to ask if the current rate of GHG emissions, in the context of the historic evolution of these emissions, would justify imposition of an onerous mitigation burden. This question is approached by considering the evolution of the Irish farming system from the 1840s to the late twentieth century in section 5.2. By the twentieth century, the current system of extensive grazing was deeply embedded, and highly resistant to change. In 2010, of the total national land area of 6.9 million hectares (Mha), 54% was grassland, and just 11% under forest (Duffy et al., 2012), as shown in Figure 5.1. Moreover, of the total agricultural land area of 4.6 Mha in 2010, 92% was under grass (CSO, 2011a). Ireland had the highest area under grass, and the lowest area under forest of all EU-15 states (Eurostat, 2011). It is argued in section 5.3 that current Irish agricultural GHG emissions are not excessive when compared with historic emissions from the late nineteenth to the mid-twentieth century, and when compared with the much more rapid growth in CO_2 emissions from fossil fuel combustion which occurred in the second half of the twentieth century.

As an economic activity, agriculture differs fundamentally from other sectors of the economy, in that it produces food essential for human survival. The positive contribution of Ireland's dairy and meat production to the European food balance is explored in section 5.4. Irish agricultural policy which since the 1970s existed within the envelope of the European Common Agricultural Policy (CAP), is discussed in section 5.5. Forestry policy, as described in section 5.6, was originally designed to achieve economic objectives, but aligned very well with GHG mitigation policy.

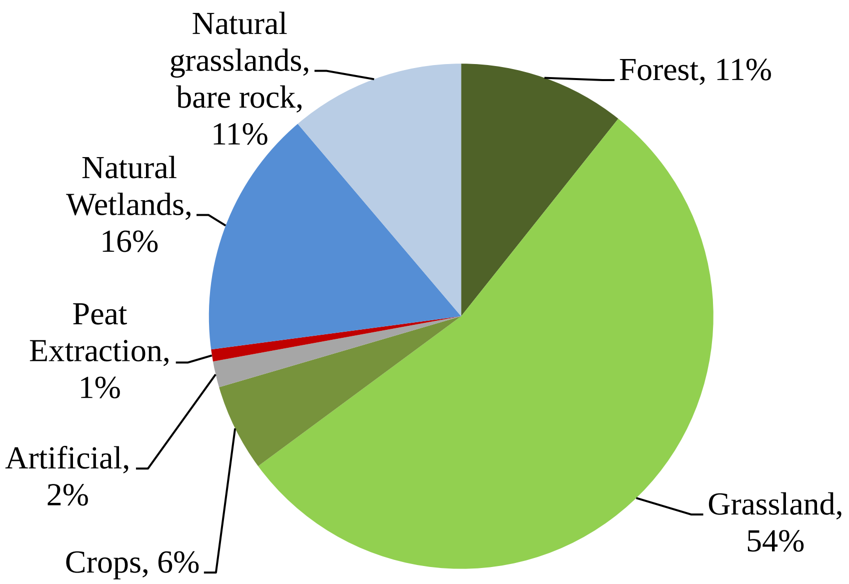

Figure 5-1 National land use in Ireland 2010. Percentages calculated from EPA data (Duffy et al. 2012). Grassland as a percentage of agricultural land was 92% (CSO, 2011a)

5.2 Evolution of the Irish Agricultural System

5.2.1 Extensive Grazing Farm System

The main system of farming historically practiced in Ireland is dairy and beef production, based on extensive grazing. The reasons for this are both geographical and historical. Ireland enjoys a temperate climate which ensures good growing conditions for grass. By the mid-nineteenth century Ireland was almost completely de-forested (DAFF, 2008a), and converted mainly to grassland. The emphasis on extensive grazing increased rapidly after the Great Famine in the mid 19th century. Factors favouring the expansion of grassland are explained in the statistical publication Farming Since the Famine (CSO, 1997). At the onset of the famine, the total agricultural land area was approximately 5 million hectares. Of this, 3.4 million hectares (66%) was under grass, with 1 million hectares (19%) under tillage crops, and on average 0.75 million hectares (15%), in potatoes. The sharp reduction in population after the famine had the immediate direct effect of a reduction in domestic demand. It also led to a shortage of labour, which impacted on the viability of labour intensive tillage farming. For the smaller number of remaining farmers, this favoured a move to less labour intensive livestock farming. Over the same period, competition from imported cereals, and growing demand for finished livestock in UK markets contributed to the growth in pasture area and cattle farming in Ireland. Uncertainties over the eventual outcome of land ownership issues at a political level, and reliance on rented land, was also given as a reason for a focus on livestock. Farming families were less likely to invest time and effort in preparation of lands for intensive tillage, if they feared that they would not be able to retain, and pass on ownership. Further deforestation and conversion to grassland occurred also as an indirect result of the Land Act of 1881 which led to landowners selling timber stocks before transferring ownership to tenants and also to deforestation by the new owners who sought to improve the productivity of their holdings (DAFF, 2008a).

5.2.2 LIVESTOCK POPULATION 1847 TO 2010

Ireland's agricultural GHG emissions profile at the end of the twentieth century can be traced to the growth in livestock over the period of 150 years following the Great Famine. As shown in Figure 5.2 cattle numbers increased steadily from 2 million head in 1847, to 4.4 million in the early 1920s, growing at an average rate of about 30,000 head per year. During the period of turmoil following national independence in the 1920s, and the trade war with the United Kingdom in the 1930s, growth in cattle numbers ceased. Export markets were constrained also during the Second World War, after which the steady increase in cattle population resumed. The economic environment in Ireland changed radically in the late 1950s, marked by the Whitaker Report, which formed the basis for the Programme for Economic Expansion (Government of Ireland, 1958). Ireland's economic isolationism was ended, and the country opened up to foreign trade and investment. Cattle numbers rose rapidly in the late 1950s and 1960s. By 1967 the cattle population had reached 5.6 million. Growth in the national herd continued with anticipation of Ireland's membership of the European Economic Community (EEC), and the cattle population reached 7.4 million in 1974, one year after Ireland joined the EEC. From then until 2010, cattle numbers remained in the region of 7 million, within a fluctuation of a few hundred thousand.

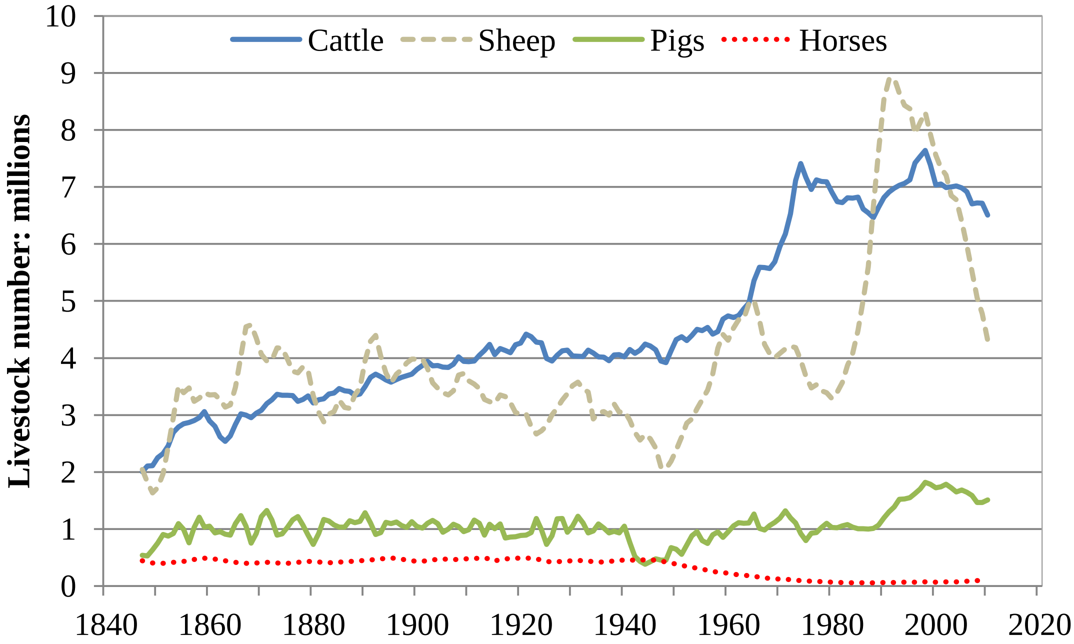

Figure 5-2 Livestock numbers in Ireland (26 counties) from 1847 to 2010 (excluding poultry).

Data sources:
1847 to 1996: plotted from CSO historic data (CSO, 1997)
1996 to 2009: plotted from CSO database (CSO, 2012b)
2010: national inventory report (Duffy et al., 2012)

Sheep population data showed greater fluctuations than for cattle. The same factors favoured sheep farming. It was a relatively low-labour farming system based on extensive grazing. Immediately after the famine, sheep numbers increased rapidly, from slightly less than 2 million, to 3.5 million in the early 1850s, and reached a peak of 4.6 million in 1868. From then until 1900, the population fluctuated about a mean of approximately 3.5 million. From 1900 onwards there was an overall downward trend, with superimposed fluctuations, which continued through the Second World War, until an historic minimum of 2 million was reached in 1948. In the post war years, numbers increased steadily to reach 5 million in 1965. Afterwards there was a decline, before rising again to reach an historic maximum of almost 9 million in 1992, driven by attractive EU subsidies. Numbers decreased steadily since then to reach slightly less than 5 million in 2009.

The pig population remained in the region of 1 million from the early 1850s to 1940 and then slumped to less than a half million during the Second World War. Numbers recovered to previous levels after the war, but did not increase further until the 1990s when the population was in the range 1.5 to 1.8 million. The horse population was between 400,000 and 500,000 from 1847 until 1940. Numbers declined steadily after the Second World War, with the widespread use of the tractor in agriculture, and stabilised in the range 70,000 to 100,000 from 1970 onwards. Poultry, consisting predominantly of hens and chickens, increased steadily after the famine from 5 million to almost 15 million by the early years of the twentieth century (not shown in Figure 5.2). The highest poultry populations were between 1909 and 1954, with numbers fluctuating in the range 17 to 23 million birds. Thereafter, numbers reduced to slightly less than 10 million in the 1980s, with a growth to approximately 13 million in the 1990s, and early 2000s.

5.3 Historical GHG Emissions from Agriculture

5.3.1 Estimating GHG Emissions in 19th and 20th Century

An estimation of GHG emissions from 1847 to 2010 is presented in Figure 5.3. This is based on livestock population data (CSO, 1997) and emission factors for each livestock species (Duffy et al., 2012). A full analysis would require details on specific farming practices, animal nutrition, and animal characteristics throughout the 19th and 20th centuries, which are not available. In particular, there is little data on fertilizer use in the nineteenth century, although the likelihood is that application rates were extremely low (Walsh et al., 1957). Any attempt to model GHG emissions from soils in this period would be unreliable, and the historic analysis is therefore confined to estimation of GHG emissions which can be directly linked to the livestock and associated manure.

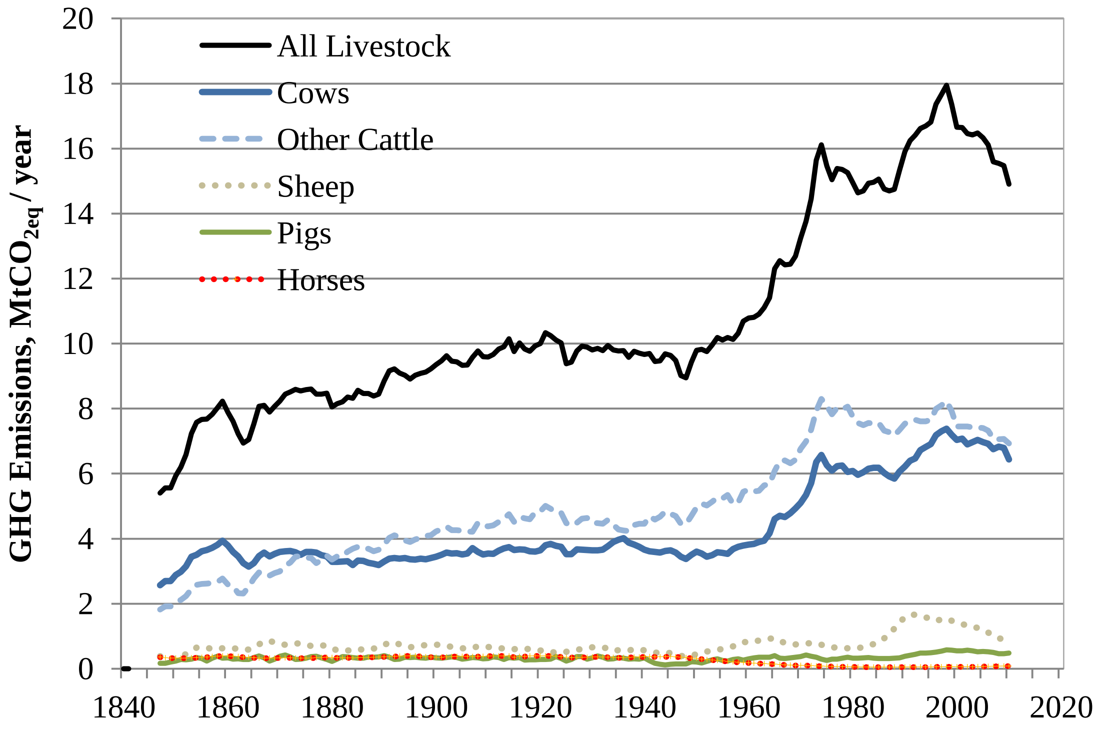

Figure 5-3 Estimated emissions of GHG from livestock, 1847 to 2010. Emissions from poultry were at all times less than $0.25MtCO_{2eq}$, and are not plotted.

Notes on calculations:

The calculated emissions are based on national livestock emission factors for 1990 (Duffy et al., 2012), using the tabulated values for CH_4 from enteric fermentation and manure management. Emissions of N_2O from animal manures deposited on pastures, and from manure fertilizers are also included in the estimation. The N_2O allocation to each livestock species is calculated from the national aggregated data, based on nitrogen excretion rates for each species. Estimates are indicative only, as farm practices may have differed significantly in the past. Historical data on livestock numbers was obtained from Central Statistics Office published data (CSO, 1997; CSO, 2012b). Livestock emission data (Duffy et al., 2012) differentiates between dairy cows and non-dairy (suckler) cows. The historical data does not provide this breakdown. The estimated emissions from cows were therefore based on the average of a dairy and a non-dairy cow in 1990. Emissions of N_2O from artificial fertilizers and indirect N_2O soil emissions are excluded, as there is limited quantitative historical information on these sources.

The GHG emissions curve for 1990 to 2010 in Figure 5.3 is consequently lower than the values given in the national inventory report (Duffy et al., 2013) as the latter includes N_2O emissions from fertilizers and soils. In terms of the historic GHG emissions, the curves should be interpreted as indicative of general trends, and as a means of combining animal numbers from different species based on a GHG metric, as opposed to the standard livestock unit conversions, which are based on grazing area requirements.

Referring to Figure 5.3, at the time of the famine, total livestock and manure GHG emissions may have been in the region of 5 $MtCO_{2eq}$. There was a rapid increase immediately following the famine due almost entirely to the increasing cattle population, and by 1900 emissions had reached an estimated 9 $MtCO_{2eq}$. By the early 1920s emissions may have reached 10 $MtCO_{2eq}$, after which they declined slowly in the economically depressed 1930s and 1940s. After the Second World War emissions grew again and exceeded 15 $MtCO_{2eq}$ in 1974. The highest emissions of almost 18 $MtCO_{2eq}$ occurred in the late 1990s, before reducing gradually to about 15 $MtCO_{2eq}$ in 2010. By 2010, emissions from livestock and manures had returned to levels prevailing in the early 1970s, 40 years previously. Relative to historic levels, emissions in 2010 were 7 $MtCO_{2eq}$ above the average for the second half of the nineteenth century, and 5 $MtCO_{2eq}$ above the average for the first half of the twentieth century. Cattle were at all times the dominant contributor to livestock GHG emissions. The combined total for other livestock including sheep, pigs, horses, donkeys, and poultry, was in the range 1 to 2 $MtCO_{2eq}$ from 1847 to the late 1980s. In the 1990s emissions from other livestock increased to just above 2 $MtCO_{2eq}$, mainly due to increased sheep numbers, and to a lesser extent pigs. By 2010 estimated emissions from other livestock, excluding cattle, were 1.5 $MtCO_{2eq}$, and similar to average emissions in the hundred years from 1850 to 1950.

5.3.2 GHG Emissions 1960 -2010 Including Fertilizer and Soil N_2O

Figure 5.4 shows an estimate of total agricultural emissions from 1960 to 2010, based on a more accurate GHG emissions estimation model. The curve in this figure is systematically higher than in Figure 5.3, as in addition to the CH_4 and N_2O emissions from livestock and manure it includes N_2O emissions from fertilizer application and indirect emissions of N_2O from soils and watercourses. The extrapolation of data backwards for 30 years from 1990, while still subject to uncertainties, is likely to be more accurate than the estimated historic data in Figure 5.3. However relative decadal changes in GHG emissions from the simpler model in Figure 5.3 agree well with the more accurate model in Figure 5.4. GHG emissions from agriculture grew from about 13.3 $MtCO_{2eq}$ in 1960 to a maximum of 21.5 $MtCO_{2eq}$ in 1998, and then reduced to 17.9 $MtCO_{2eq}$ in 2010, which was similar to emissions in 1972.

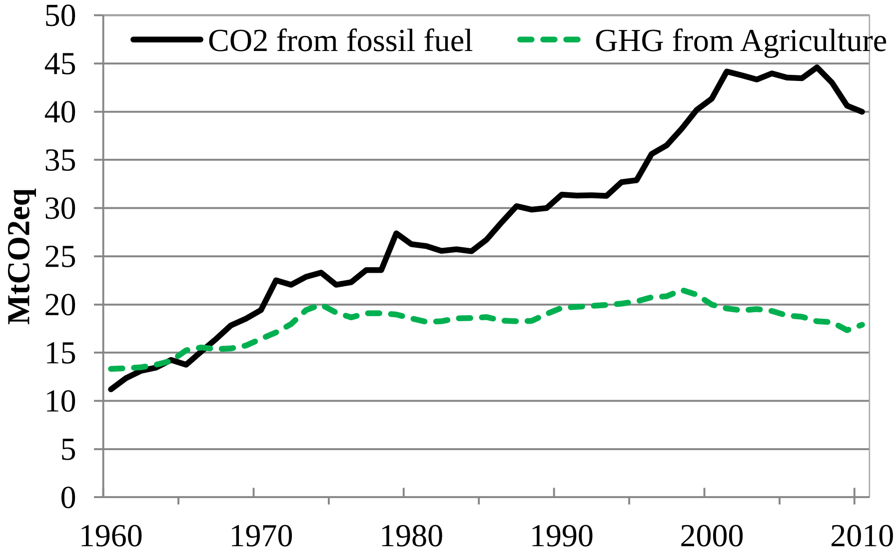

Figure 5-4 Growth in GHG emissions from agriculture 1960 to 2010 (excluding agricultural fuel emissions), compared with national emissions of carbon dioxide (CO_2) from fossil fuel combustion (excluding combustion N_2O emissions).

Data sources and notes on calculations:

CO_2 from 1960 to 2010: World Bank Database (2014)

1960 – 2010: Agricultural GHG emissions calculated based on livestock numbers (CSO, 2012b), using CH_4 emission factors for 1990 (Duffy et al., 2012). The total emissions curve (CH_4 + N_2O) was estimated to be 1.646 times the CH_4 emissions, based on the ratio of these emissions in 1990. From national inventory data, emissions of total GHG were highly correlated with CH_4 emissions from 1990 to 2010, with a ratio of 1.67 (standard deviation 1%)

5.3.3 Agricultural Emissions Compared with Fossil Fuel Emissions

Figure 5.4 also shows the growth in CO_2 emissions from fossil fuel combustion. In 1960 emissions of agricultural GHG marginally exceeded fossil fuel CO_2, with emissions of 13.3 $MtCO_{2eq}$ and 11.2 $MtCO_{2eq}$ respectively. From 1960 to 1975, both sectors' emissions increased at approximately the same rate and agricultural emissions reached 20 $MtCO_{2eq}$ while fossil fuel emissions reached 23 $MtCO_{2eq}$. From 1975 onwards the fossil fuel GHG curve increased while the agricultural emissions curve reached a plateau with marginally fluctuating emissions. The total increase in fossil fuel emissions from 1960 to 2010 was 29 $MtCO_{2eq}$, an increase of 258%. In contrast, the increase in agricultural GHG emissions was 4.6 $MtCO_{2eq}$, which was an increase of 35%. To place it in context, this increase in GHG emissions from the agricultural sector would be the equivalent of the CO_2 emissions from a single large coal power station, such as Moneypoint.

5.4 IRELAND'S ROLE AS A FOOD PRODUCER

5.4.1 IRISH AGRICULTURE IN WORLD AND EU CONTEXT

The growth in agricultural GHG emissions of 35% between 1960 and 2010 was due to the increased productive output of Irish farms which served the rapidly growing market for food both in Europe and worldwide. In the fifty years from 1960 to 2010, the world population had increased by 118% from 3 billion to 6.7 billion (FAO, 2013a). In the countries that would eventually form the European Union, the population increase was 31%, and in Ireland the population grew by 57%. To meet the increasing food demand agricultural production increased worldwide. World meat production increased by 301% and milk production by 106%. For the countries that became the European Union, meat production increased by 127% and milk production by 26%. In Ireland the response to the growing market demand was to increase meat production, mainly beef, by 189%, and milk production by 122% (FAO, 2013a). In the European context Ireland provides a low-input, extensive grazing system of farming for production of dairy products, beef, and sheepmeat. This complements the intensive agricultural production systems of other member states, which rely on feed concentrates. The diversity of production models contributes to security of food supply and economy of production in the EU. Dairy and meat production, and net export data for Ireland in 2009 is given in Table 5.1. In 2009, Ireland whose total land area is 1.6% of the EU-27, contributed a disproportionate quantity of the total EU-27 output of animal products, including: 3.4% of milk products, 6.2% of butter, 6.4% of beef and 5.6% of sheepmeat. In 2009, Ireland exported 60% of its total meat production, including 88% of its beef, 58% of total milk products, and 93% of butter production (FAO, 2013a).

Food	Milk Products	Butter	Beef	Sheep	Pigs	Poultry	Cereals [4, 5]
[a] **Production** [1] million tonnes Mt	5.25	0.12	0.51	0.06	0.20	0.12	1.51
[b] **Net exports** [1] Mt (exports-imports)	3.01	0.11	0.45	0.04	0.05	0.00	-0.90
[c] **Food energy content** Mtoe/Mt [2, 3]	0.06	0.72	0.30	0.34	0.28	0.18	0.29
a x c **Production of food energy** Mtoe	0.29	0.09	0.15	0.02	0.05	0.02	0.44
b x c **Net exports of food energy** Mtoe	0.17	0.08	0.13	0.01	0.01	0.00	-0.26
Sum of all net food energy exports : 0.15 Mtoe							

Table 5-1 Ireland’s dairy, livestock, and animal feed cereal production data for 2009 and net food exports, on a tonnage, and food energy basis.

Notes and data sources

[1] Production and trade data from FAO (2013a)

[2] Food energy is given in terms of tonnes of oil equivalent (toe) to provide a direct linkage with the units used in national energy and biofuels policy. One tonne of oil equivalent of food energy would provide food for about 8 people for one year, based on Ireland’s food balance data for 2009 (FAO, 2013a). 1 toe = 42 GJ = 10 million dietary Calories (kilocalories).

[3] The food energy content of meat is the apparent food energy calculated from the FAO database, corrected to include raw animal fats, which are listed as a separate item in the FAO database. Fat was divided between beef, mutton, and pork, in proportion to total animal meat production. Poultry includes meat and eggs.

[4] Wheat, barley, oats, and maize: FAO data implies a cereal self-sufficiency of 60% in 2009, which is lower than the CSO (2012c) figure of 81%, as the CSO data excludes maize.

[5] Cereals for use as animal feed: 73% of the domestic supply was used for animal feed in 2009 (FAO, 2013a). FAO production and net import data is corrected in the table by this fraction.

5.4.2 Food Energy Balance of Livestock and Milk Industry

While Ireland is a net exporter of animal products, it is a net importer of cereals, which are required mainly for animal feed to supplement grazing. In 2009 Ireland's cereal self-sufficiency was 60% (FAO, 2013a). Production of one unit of food energy in the form of meat or milk products will always entail consumption of a certain amount of food energy in the cereal animal feeds. Based on food balance data for 2009 approximately 70% of the food energy output of the Irish cattle population was in the form of milk products, with the remaining 30% in the form of beef (meat plus fat). From the same FAO food balance data, the ratio of cereal feeds to animal products can be calculated in terms of food energy. In Ireland 1.2 units of cereal animal feed energy are required to produce 1 unit of milk/meat energy. This cereal feed energy input is 45% less than the average ratio for the EU-27, due to the grass portion of the livestock diet in Ireland.

Ireland's overall food energy balance for the livestock and dairy sectors is depicted in Figure 5.5, which shows positive net energy exports of milk and animal products and a net energy import from cereals. The overall food energy balance for livestock agriculture is positive, with net exports of food energy. In terms of the EU food supply, the Irish farming system provides a means of converting grass and cereals into animal protein and milk products, without requiring a net import of food energy. Were Irish dairy and livestock agriculture to move away from extensive grazing, towards an intensive system with nominally lower GHG emissions per kg of product, this would require significant importation of cereals for animal feed. Such a production model would result in increased net imports of food energy. In a world experiencing persistent food shortages, with one in eight suffering chronic hunger (FAO, 2013b), and with a predicted population increase of 1 billion by 2025 (UN, 2014), there are ethical and sustainability concerns regarding a GHG or agricultural policy which relied upon increased food energy imports. The food energy balances for Ireland and the European Union are discussed further in chapter 7 in the context of biofuels imports.

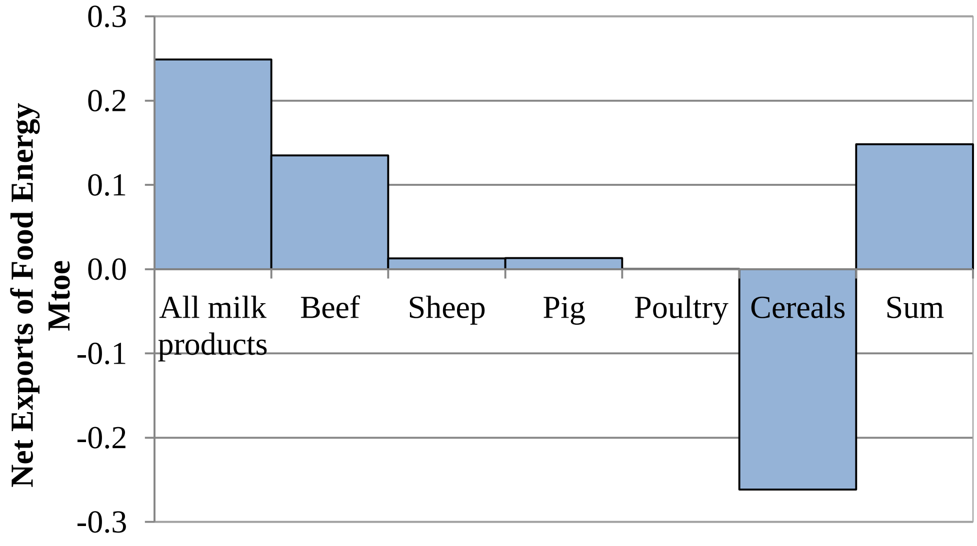

Figure 5-5 Net exports of livestock products food energy from Ireland in 2009, plotted from data in Table 5.1. Positive values indicate that exports exceed imports, and negative values indicate that imports exceed exports. Ireland had surpluses to export for dairy, beef, sheep and pig products, and was self-sufficient in poultry products, but was not self-sufficient in cereals. Net cereal imports made up 38% of the total domestic supply. Animal feeds consumed 73% of the total domestic supply (FAO, 2013a).

5.5 AGRICULTURAL POLICY

5.5.1 EU COMMON AGRICULTURAL POLICY (CAP)

Upon Ireland's entry to the European Economic Community (EEC) in 1973, domestic agricultural policies were determined primarily by the European Common Agricultural Policy (CAP). The purpose of the CAP, introduced in 1957, was to increase food production in Europe for reasons of food security, and to provide a stable market. This had the desired effect. However by the 1970s, the policy was too successful, with large surpluses in agricultural output, which required intervention price support. From the 1980s onwards, the CAP was progressively modified to control over-production, and to transform to an economic model where agricultural output would be controlled by market forces, while still retaining supports for farmers. Milk production quotas were introduced in the 1980s. The McSharry reforms (CEC, 1991) sought to further limit production by reducing economic supports for production, and through land set-aside measures. This move towards a free market in agricultural products was accelerated in the Agenda 2000 reforms (CEC, 1997a), and in the 2003 CAP reform (EC, 2003d), which provided for further de-coupling of supports from production. Supports were progressively directed towards the farm enterprises, and more emphasis was placed on environmental protection (cross-compliance). Full de-coupling of supports from farm output took place in Ireland in 2005. Having removed direct subsidies on outputs, the remaining significant market intervention of a production quota on dairy products was to be eliminated from 2015.

Farmers in receipt of single farm payments (SFP) were subject to cross-compliance measures regarding environmental protection and animal welfare. A significant environmental restriction for Ireland was that the area under permanent pasture should not significantly decline relative to 2003, in order to maintain biodiversity. In practice this would entail monitoring the grassland area, with controls being triggered if there was a detected significant decline relative to 2003. A reduction of more than 5% would require certain restrictions at farm level on grassland conversions. A reduction of more than 10% would set in train requirements to convert back from tillage to pasture (DAF, 2005). The effect of the pasture reduction restriction had two significant consequences for national GHG policy. Firstly it supported the continuation of the existing extensive grazing system of farming, favouring dairy, beef, and sheep production. Secondly, it had repercussions for bioenergy policy, as discussed in chapter 7, as there would be a limit to the pasture areas that could be converted to energy crops. A consequence of this was to encourage research into grass as a bioenergy feedstock.

5.5.2 Irish Agricultural Policy 1990 to 2009

In response to the CAP, the expectation in the 1990s was that there would be downward pressure on agricultural prices, and there was consequently little indication that significant expansion of agricultural production was likely. At the turn of the millennium there were serious concerns in Ireland about the future viability of the dairy and beef sectors. The situation with respect to the Irish dairy industry was summed up in a report by Promar International consultants (2003). In the face of increasing exposure to world markets, a decline in the dairy industry was considered inevitable, unless there were radical changes. Major improvements in production efficiency and processing efficiency would be required, with a move to higher value products if the industry was to survive.

The general negative outlook can also be gauged from the national policy document Agrivision 2015 (DAF, 2004) which expected that de-coupling would result in reductions in livestock numbers. Milk production was expected to be maintained to the quota levels, but with a smaller more efficient dairy herd. There would be a re-structuring of farming, with increased part-time farming. In 2008 the view of the Department of Agriculture was that while there were good trading conditions in the short-term, the medium term expectation was for a decline in milk and beef production (DAFF, 2008b). The review in 2009 reflected the economic turmoil at the time, with great uncertainty in the market (DAFF, 2009). While there were some positive indications that the markets would recover, the expectation was still for a gradual decline in beef and sheepmeat, and no indication of growth in dairy output. This negative outlook for agricultural production fed into Ireland's GHG policies. Policymakers formulating NCCS 2000 and NCCS 2007 had good reason to assume that there was scope for achieving reductions in agricultural emissions, which gave them latitude for larger allocations to the non-agricultural sectors.

5.5.3 Change in Agricultural Policy 2010 – Food Harvest 2020

A sea change in agricultural policy was announced in 2010, which would also have implications for GHG policy. In response to the economic crisis the government sought remedies to tackle high unemployment, and to increase national productive output. Agriculture was now identified as a potential growth area. While under the reformed CAP, market supports would be a thing of the past, there was the belief that Ireland had natural advantages, and could compete on a world market with an up-scaled model of agricultural production and processing.

The policy document Food Harvest 2020 (DAFF, 2010) envisaged an increase of 33% in the value of primary output by 2020. A 50% increase in dairy production was considered feasible based on the existing environmentally sustainable grass-based production system. The value of beef output was expected to increase by 20%. Sheep production was also expected to grow by 20%, again based on grass. For pigs, an increase of 50% in the value of the output was believed to be achievable. While no specific target was set for cereal production, it was expected to increase, to match the increased demands from the additional livestock.

Agriculture was also put forward in Food Harvest 2020 as playing a significant role in addressing energy security and climate change through energy crops. However care would be required to ensure no conflicts with food security, sustainability and other industries. Forestry would also continue to play an important part in Ireland's renewable energy and carbon sequestration policies. It was acknowledged that increased agricultural production would impact on GHG emissions, and it was recommended that research on mitigation measures be intensified. Detailed predictions of GHG impact in Food Harvest 2020 were not given. However, it was estimated that the expanded dairy herd alone could result in an increase of 12% in emissions. A fundamental conflict between two national policies had arisen. More food production would generate increased GHG emissions, yet national GHG policy, and achievement of the EU 20% reduction for 2020, would require a declining GHG emission from agriculture.

5.6 FORESTRY POLICY

The afforestation programmes in the new Irish state began in the early 1920s, and from a baseline of practically no forest area had succeeded by 1980 in establishing a total area of 0.4 million hectares (Teagasc, 2011), which represented about 6% of the national land area. An accelerated afforestation policy formed part of the National Development Plan 1989-1993 (Government of Ireland, 1989). A subsequent policy document Growing for the Future (DAFF, 1996) set a long-term forest target of 17% of the national land area, to be achieved by 2030, with a target afforestation rate of 25000 hectares/year (ha/yr). The growth in forest cover is shown in Figure 5.6. Despite attractive subsidies, the average planting rate fell short of the target. From 1990 to 2000, the average rate was just under 17000 ha/yr. From 2000 to 2010, it had reduced to an average of 10000 ha/yr. While average planting targets were not met, the overall performance in terms of afforestation was still significant, with an increase of 270,000ha in forest area from 1990 to 2011, resulting in a forest land cover of 11% (Teagasc, 2011). This was still substantially lower than the 37% forest cover which was the average for the EU-15 (Eurostat, 2011). Reasons for failure to meet national planting targets were discussed by Malone (2010) in a review conducted for the Department of Agriculture. The price of land, and the economic attractiveness of alternative land use enterprises were identified as significant factors. There was also the risk entailed in making the long-term commitment, and the re-afforestation requirement after harvesting, which in effect implied a permanent conversion of lands to forestry. Environmental concerns and regulatory burdens were also considered to be factors holding back forest expansion. Malone (2010) also pointed to a lack of a forest culture in Ireland, and poor standards of maintenance, which he identified as a threat to the future of the forestry sector.

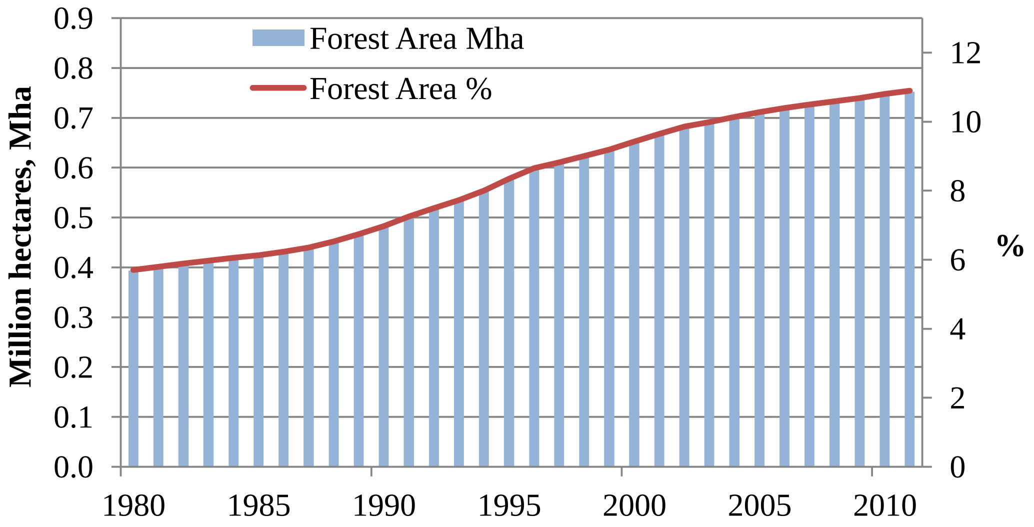

Figure 5-6 Ireland’s forest area 1980 to 2011. Data source (Teagasc, 2011)

To meet the national target of 17% would require an additional 0.4 million hectares, which would require further conversion of marginal lands, agricultural lands, or wetlands. However, the new policy for agricultural expansion announced in 2010 (DAFF, 2010), raised the prospect of competition for land between forestry and food agriculture, which created a conflict with national GHG policy. As described in chapter 3, Irish GHG mitigation policy since 1995, had taken full advantage of the carbon sink opportunity presented by the expanding national forest area. Were the expansion of food agriculture to impede afforestation, not only would there be increased direct GHG emissions from agriculture, but also lower forest carbon sink capacities in the future.

5.7 AGRICULTURE AND FORESTRY – SUMMARY OF POLICY CONTEXTS

At the time of signing the Kyoto Protocol Ireland had the highest proportion of grassland and the lowest forest cover amongst the EU-15 states. The extensive grazing system of farming, which had evolved over a period of 150 years since the Great Famine, was firmly rooted in biophysical, economic and historical factors. The associated GHG emissions from dairy and beef farming, which became the cause of great concern for policymakers by the end of the Kyoto period, were not however excessive or surprising in the historical context. Irish agricultural GHG emissions were also justifiable in view of Ireland's niche role as an efficient milk and beef supplier to the U.K. and wider European markets. Moreover, Ireland's extensive grazing system required significantly less cereal feed input than the intensive productions systems in other EU countries.

The estimated increase of 4.6MtCO_{2eq} (+35%) in Irish agricultural GHG emissions over a period of 50 years prior to 2010 was modest compared with the increase of 29 MtCO_{2eq} (+258%) which occurred over the same period from combustion of fossil fuels. At the end of the Kyoto period agricultural emissions had in fact returned to levels prevailing in the early 1970s. The agricultural sector had comfortably achieved a key objective of Article 4 of the UNFCCC (UN, 1992a), which was to return GHG emissions to 1990 levels. Overall, from a sustainable development and sectoral equity perspective, taking account of the historical context and the efficiency of Irish agriculture, a strong case could be made for exclusion of the agricultural sector from GHG reductions. Irish climate policy took the opposite approach, and this can be understood in the context of the reforms of the CAP introduced from the late 1980s onwards, which increasingly subjected agricultural production in the EU to free-market forces. From 1990 to 2009 agricultural policy in Ireland followed this assumption of an increasingly market-limited output, with the expectation of reductions in the national dairy and beef herds. This fed into a GHG mitigation policy which pragmatically factored GHG reductions from the agricultural sector into their strategies, not because agricultural emissions were considered to be excessive, but simply because GHG emissions savings from agriculture were expected to become available.

The abrupt change in national policy in 2010, marked by the publication of Food Harvest 2020, was driven by the need to urgently activate all sectors of the economy following the economic crisis which unfolded from 2008. Food Harvest 2020 also supported existing afforestation policies, which had an eventual target of 17% land area by 2030, and would require an additional 0.4 million hectares of land. It was clear that serious policy conflicts had arisen by 2010. The large increases envisaged for agricultural output in 2020 would undoubtedly result in increases in GHG emissions, and through competition for land, could potentially impact also on national afforestation policy. If increased agricultural production could not be achieved on the existing agricultural area, and if the afforestation target were to be met, there would be pressure to recruit additional marginal lands or wetlands. This also potentially conflicted with EU environmental biodiversity policy, and in particular the requirement that pasture area should not be reduced relative to the area in 2003.

6 RELIANCE ON THE LAND- CONSIDERATIONS AND IMPLICATIONS

6.1 INTRODUCTION

The reliance of Irish GHG strategies on the land was not an invention of Irish policymakers. As described in section 6.2, this strategy can be traced directly to the Kyoto Protocol. To properly discuss policies on agricultural GHG emissions from livestock, a basic understanding is required of the nature of these emissions and the characteristics of the emissions in an EU and wider world context. These aspects, which highlight the special characteristics of Ireland's GHG emissions, are described in section 6.3. Ireland's strategies for mitigation of GHG emissions from agriculture, and the use of forest sinks are considered in section 6.4. Sectoral equity aspects are explored in section 6.5, in terms of the large part played by agriculture and forestry in achieving Kyoto compliance. The pressure on agriculture to achieve reductions during the Kyoto period and beyond can be attributed to some extent to an apparently unrelated policy in the energy and industrial sector, which was the Emissions Trading Scheme (ETS), as discussed in section 6.6. To compound Ireland's difficulties, the EU GHG effort-sharing decision (EC, 2009a), discussed in section 6.7, placed a high reduction requirement of 20% on Ireland, and took no account of Ireland's unique GHG emissions profile, with its high proportion of agricultural emissions.

6.2 UNFCCC OBLIGATIONS AND KYOTO ACCOUNTING

The requirement to control emissions from agriculture, forestry, and land-use stemmed from the original United Nations Framework Convention on Climate Change (UNFCCC). The convention required signatory states to reduce GHG emissions from anthropogenic activities, which included agriculture, and to protect and enhance carbon sinks and reservoirs, which included forestry. Article 4 of the convention required emissions to be reduced to 1990 levels by the year 2000.

There was no mention in the convention of any specific provision for off-setting savings or sequestrations in the land sectors against emissions from the energy or industrial sectors. Greater strategic flexibility in controlling GHG emissions could however be achieved by aggregating the GHG budget of the land, with the budget for the energy and industrial sectors. This was subsequently provided for in the Kyoto Protocol, in Article 3 (1) through the setting of limits in terms of aggregate carbon dioxide equivalent (CO_{2eq}) emissions. This permitted the emissions of CO_2 which arose mainly from fossil fuel combustion, to be combined with emissions of CH_4, and N_2O, which in Ireland's case mainly arose from agriculture. The legal basis for including forestry in the national net emissions originated in Articles 3(3) and 3(4) of the Kyoto Protocol. These provided for a state's commitment to be met through the calculated net change in GHG emissions, which in Ireland's case meant emissions sources minus new forest sinks. Outside of forestry and agriculture, emissions and sinks associated with other land-use activities were not accounted for formal Kyoto compliance purposes. Ireland had opted not to include these additional activities (Government of Ireland, 2005), as was permitted under Article 3(4) of the Kyoto Protocol.

Designing a GHG mitigation strategy based on the aggregate of fossil fuel emissions, agricultural emissions, and forest sequestration, was a pragmatic approach from an accounting perspective. For a state such as Ireland, with a high proportion of agricultural emissions, there was an understandable temptation to fully exploit this option but there were inherent dangers from a sustainability perspective in this approach. Firstly there were risks for long-term agricultural policy. Secondly, aggregate GHG accounting treats emissions of CO_2 from combustion of fossil fuels which were deposited over a period of hundreds of millions years, on the same basis as emissions of CH_4 and N_2O and sequestrations of carbon which occur as part of the current carbon and nitrogen cycles. A strategy which attempted to balance rapid and growing emissions from fossil fuels against the limited net absorptive capacity of the current carbon and nitrogen cycles would inevitably encounter difficulties in the long-term.

6.3 GHG EMISSIONS FROM LIVESTOCK

6.3.1 AGRICULTURAL METHANE AND NITROUS OXIDE

The greenhouse gases associated with agricultural activities are CH_4 and N_2O. For Kyoto accounting purposes, mass emissions of these gases were assigned global warming potentials, with a multiplicative factor of 21 for CH_4, and 310 for N_2O (IPCC, 2001a). These factors attempt to represent the heat trapping effect of these gases, relative to CO_2, for a 100 year time horizon. CH_4 oxidises to CO_2 and water in the atmosphere, with an average lifetime of 12 years. N_2O, following complex atmospheric chemistry transformations, eventually returns to the soil and ocean, and its average lifetime in the atmosphere is 114 years. CH_4 is generated as part of the digestive process of ruminants, which in Ireland are predominantly cattle and sheep. Emissions are in general greater for animals fed on grass compared with animals fed on concentrates. CH_4 is also produced through anaerobic decomposition of animal manures. N_2O is produced in the microbial breakdown in soils of nitrogenous fertilizers, of both animal and artificial origin.

6.3.2 GHG EMISSION PROFILE - UNIQUE POSITION OF IRELAND

Ireland's GHG emissions profile is unique in the EU-15 in having such a high contribution from agricultural emissions. In 2010, the proportion of agricultural emissions for the EU-15 was on average 10%, whereas it was 29% for Ireland. A graphical comparison of Ireland with other EU-15 states is shown in Figure 6.1. This shows the percentage of the member states' total GHG emissions that arise from the agricultural sector, and the percentage of CH_4 in those agricultural emissions. Ireland's emissions are a notable outrider in the graph, due both to the high percentage of agricultural emissions, and due to the high percentage of CH_4. The high CH4 emissions arise from the grass-based livestock farming system. In 2010, CH_4 accounted for 44% of agricultural GHG emissions in the EU-15, and N_2O for 56%. In Ireland's case, emissions were 59% CH_4, and 41% N_2O (EEA, 2012).

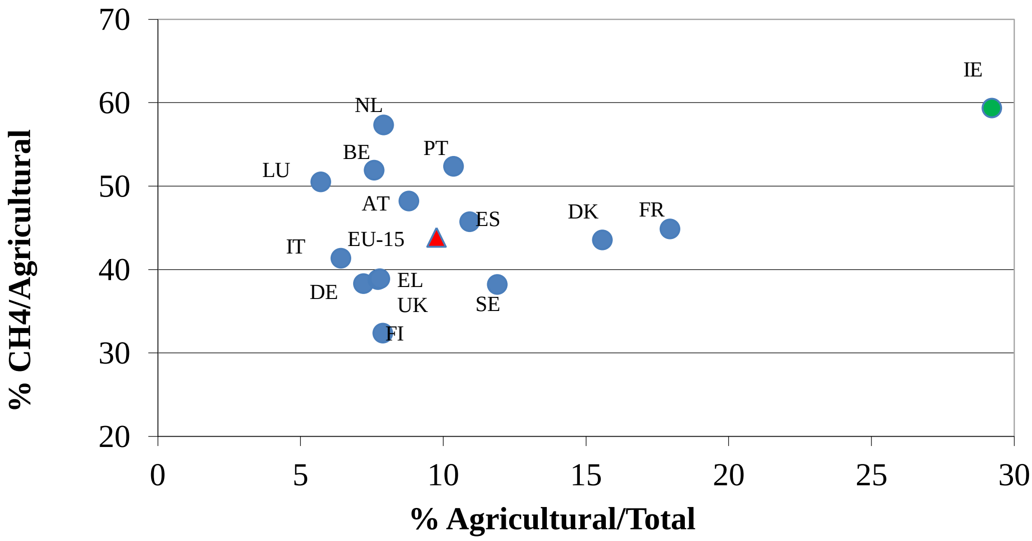

Figure 6-1 Comparison of agricultural emissions in EU-15 states, in terms of the proportion of agricultural GHG emissions, and the proportion of methane (CH_4) in these emissions, in 2010. Plotted from European Environment Agency data (EEA, 2012).

AT Austria, BE Belgium, DK Denmark, FI Finland, FR France DE Germany, EL Greece, IE Ireland, IT Italy, LU Luxemburg, NL Netherlands, PT Portugal, ES Spain, SE Sweden, UK United Kingdom

6.3.3 Comparison of Agricultural Emissions Under Kyoto Accounting

From 2007 onwards, as policymakers began to look at how EU 2020 targets might be reached, longer term sustainability issues were raised. Mitigation policies for agriculture in one member state could paradoxically result in increases in overall EU GHG emission. This could happen if one member state decreased production of a particular livestock product, and the production was taken up by a less efficient farming system in another member state. The national inventory reports submitted annually to the UNFCCC by member states provide livestock emissions data in a common reporting format which enables direct comparisons to be made. A comparison of CH_4 emissions is shown in Figure 6.2, which is based on the dataset for 2010 compiled for the main farm animals by the European Environment Agency (EEA, 2012).

The CH_4 performance of the Irish dairy herd relative to other EU states in 2010 was comparatively good, with emissions per head of 89% of the average for the EU-15. The Irish non-dairy herd exceeded the EU-15 average by just 3%. Taking the cattle herd in its entirety, the Irish emissions per head were 90% of the EU average. Irish sheep emissions were also relatively low at 89% of the EU-average. Only for pigs, did Irish emissions exceed the EU-15 average, where the exceedence was 65%. Emissions for pigs are highly dependent on manure management systems. These emissions varied widely between countries, with emissions in Austria being 68% below the EU-15 average, compared with Portugal where emissions were 170% above the average.

6.3.4 Comparison of Agricultural Emissions Using Life-Cycle Analysis

Comparison of the GHG performance of farm practices is complex. The analysis in section 6.3.3 was in terms of emissions per head, which is based on Kyoto GHG accounting rules, and shows Irish ruminant livestock in a good light. However, Kyoto accounting forms a poor basis for making long-term policy decisions, as no account is taken of GHG emissions as a function of production output. Nor is account taken of emissions associated with feedstock and fertilizer inputs, or the wider environmental impacts. In 2010 life-cycle emission factors for EU agriculture and selected non-EU producers were published by the European Commission Joint Research Centre (Leip et al., 2010). Emissions were given in terms of the GHG emitted per kilogramme of output. This analysis showed that emissions for all Irish livestock were lower than the average for the EU-15, and with the exception of sheep, were lower than the average for the EU-27. Compared with the average for the EU-27, emissions associated with milk production in Ireland were 30% lower, beef production was 10% lower, pork and poultry were at least 30% lower. Sheep exceeded the average slightly by 5%. It also confirmed the view, as voiced by Irish policymakers in 2010 to the UNFCCC (2010), that sourcing beef from South America would entail significantly higher GHG emissions.

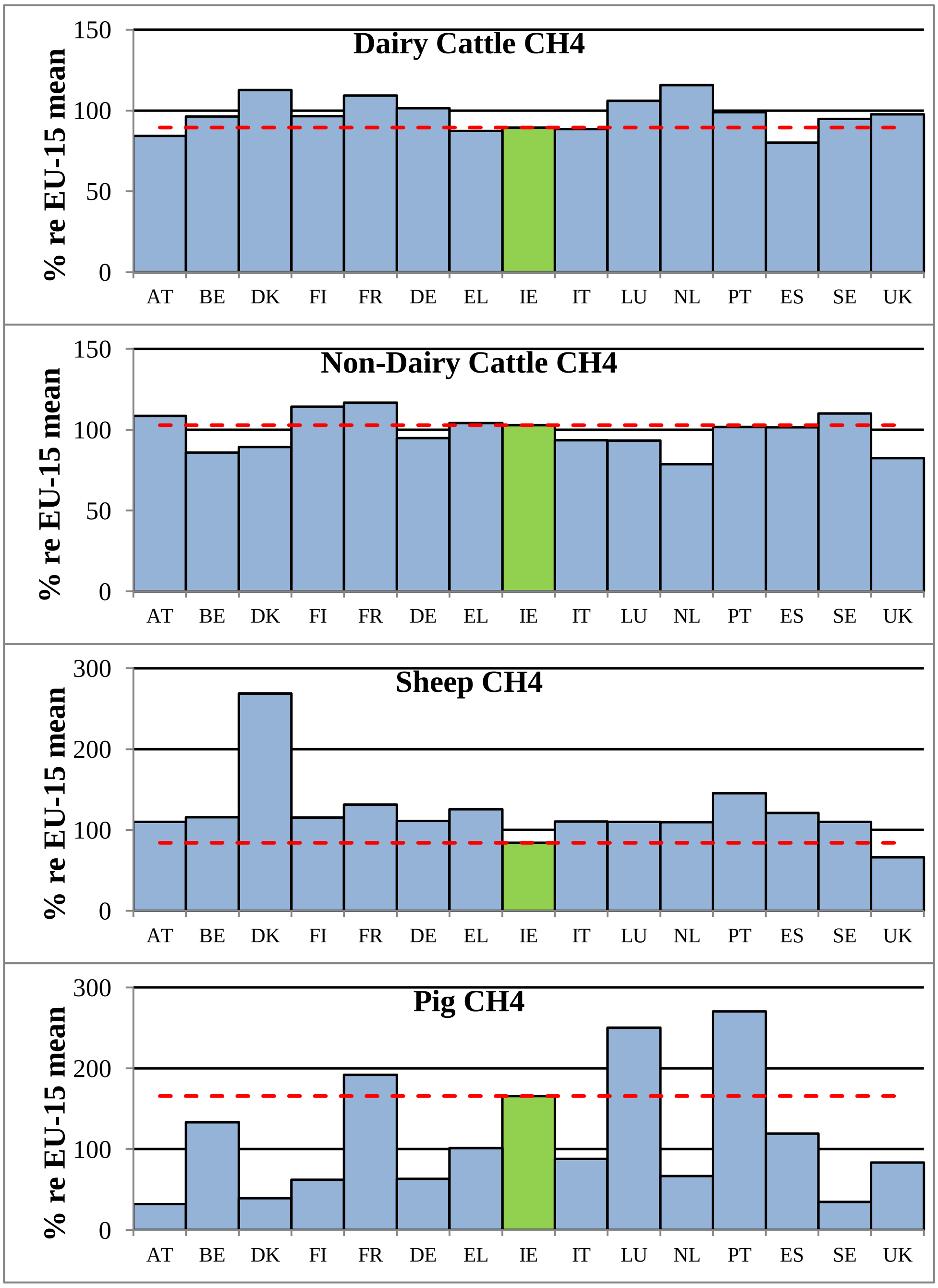

Figure 6-2 Comparison of farm animal CH_4 emissions for EU-15 states in 2010. 100% represents the average for the EU-15. Ireland is shown in green, and is compared with other states with the red dotted line. The data is plotted based on the calculated sum of enteric CH_4 and manure management CH_4 from data compiled by the European Environment Agency (EEA, 2012). Emissions associated with manure deposited on pasture, and manure applied as fertilizer were not included in the EEA comparison.

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The analysis of the GHG emissions associated with imported beef from Brazil was performed by Leip et al. (2010) using a different methodology and results were not directly comparable with the EU-27. Nevertheless, the finding that the GHG footprint was almost four times the EU-27 average would indicate that displacement of EU beef production by Brazilian imports would have an overall negative global GHG impact. Poultry from Brazil had however lower GHG emissions than the EU-27 average. New Zealand sheepmeat entailed emissions approximately 50% higher than the EU-27.

6.4 IRISH GHG POLICY - RELIANCE ON THE LAND

6.4.1 GHG MITIGATION STRATEGIES ADOPTED FOR AGRICULTURE

The primary mitigation measures proposed in NCCS 2000 for the agricultural sector were cattle stock reductions and intensification, which were in line with the EU CAP reforms and market expectations. Other measures were to be investigated, including finishing cattle at a younger age, research on food additives and probiotics to reduce emissions, and research on anaerobic digestion of animal wastes. Emissions of N_2O were to be tackled by means of a 10% reduction in the application of nitrogenous fertilizers, which would be driven mainly by the EU Nitrates Directive (91/676/EEC), and to a lesser extent through improved soil husbandry. NCCS 2007 did not add much to this menu of measures, other than improved supports for bioenergy which would use the land to generate carbon neutral fuels, as discussed in chapter 7.

6.4.2 FORESTRY AS A GHG MITIGATION STRATEGY

Since the beginning of Ireland's GHG policy formulation in the early 1990s, forestry was seen as a means of sequestering carbon, which could off-set emissions from the combustion of fossil fuels in other sectors of the economy. The strategy envisaged an afforestation rate of 30000 hectares per year (ha/yr) to the year 2000 (DOE, 1995). This was marginally greater than the formal target of 25000 ha/yr envisaged by the Department of Agriculture (DAFF, 1996). In 1997, the afforestation target was reduced from 30000 ha/yr to 25000 ha/yr, up to the year 2000, and to 20000 ha/yr thereafter, which was still on target to achieve 17% forest area by 2030 (DOE, 1997b). The target was left unchanged at 20000 ha/yr in NCCS 2007, and to the end of the Kyoto period. The adoption of forestry as a mitigation policy was one of the no-regrets measures which characterised Irish GHG policy in the 1990s (UNFCCC, 1996), in that it was already in progress, and no additional effort or risk was involved. Funding was already provided through the existing Forestry Operational Programme, 75% funded under the EU Community Support Framework for Ireland (Bacon, 2003).

In terms of long-term sustainability there was a fundamental difference between GHG savings that might be achieved in agriculture and GHG savings achieved through sequestration in forestry. A reduction in agricultural emissions could theoretically be permanently maintained and provide a long-term benefit up to and beyond 2050. In contrast, for forestry, when the desired or maximum feasible forest coverage was achieved, and when an equilibrium was reached between harvesting and planting, the annual net sequestration in the above ground biomass would eventually reduce to zero. It was not a policy that could succeed in the time frame to 2050. On the plus side it offered the possibility of several decades of relief, during which technological advances in other sectors would have time to proceed. On the negative side, by providing this relief, it took the focus off the necessity for a move to a long-term low-carbon economy. Ireland's reliance on forest sequestration also created difficulties when the EU Climate and Energy Package for 2020 was formulated in 2009. Sequestration, which could count for UNFCCC commitments, did not apply for EU 2020 targets. This change in target formulation seriously undermined Irish GHG policy.

6.4.3 GHG Targets and Achievements for Agriculture and Forestry

The reductions in ruminant livestock, which had been factored into NCCS 2000 occurred as expected. By 2011 the dairy herd had decreased by 19% relative to 1990. Non-dairy cattle numbers reduced by 3%, and sheep numbers had dropped by 45% (Duffy et al., 2013). Even allowing for increased productivity from the dairy herd, with consequent increased GHG emissions per head, there were reduced direct emissions of CH_4 from the total ruminant livestock herds and reductions in associated GHG emissions from manure handling, land spreading of manures, and fertilizer application.

By 2011 there had been a reduction of 11.4% in CH_4 emissions relative to 1990. Lower rates of fertilizer application resulted in a reduction of 7.6% in N_2O which was only marginally lower than the original 10% target. Overall, NCCS 2000 had predicted an annual average saving in 2008-2012 of 2.2 $MtCO_{2eq}$ relative to 1990. While the actual reduction achieved was somewhat lower at 1.6 $MtCO_{2eq}$, it nevertheless made a significant contribution towards Kyoto compliance.

For forestry, the average planting rate from 2000 to 2010 was 10,000ha/yr, which was half the target set out in NCCS 2000. Despite the underachievement in planting, the eventual rate of carbon sequestration in areas newly afforested since 1990 reached an annual average of 3.4 $MtCO_{2eq}$ over the period 2008-2012, which was greatly in excess of the earlier estimate of 1 $MtCO_{2eq}$ in NCCS 2000. This was due to improved methodologies which resulted in more accurate estimates of carbon sequestration. Ireland's 3.4 $MtCO_{2eq}$ forest sequestration represented 5.4% of its Kyoto limit which in the European context was unusually high. Based on data compiled by the European Environment Agency (EEA, 2013a), Ireland's reliance on forest sequestration was an order of magnitude greater than was the case for the EU-15, where forest sequestration accounted on average for just 0.4% of the total Kyoto Limit. Including carbon sequestration from other land-use activities, the average carbon sequestration for the EU-15 increased to 1.6% of the total Kyoto Limit, which was still less than a third of the forest sequestration achieved in Ireland.

6.5 Contribution of Land to Kyoto Compliance

A major element in Irish GHG policy was to use savings in agriculture and forestry activities to provide additional emissions allowances, which would serve to offset fossil fuel emissions from other sectors of the economy. Agriculture contributed both by foregoing a 13% Kyoto increase, and also through direct reductions achieved. The contributions of the agricultural and forestry sectors to Ireland's GHG mitigation strategy are set out in Table 6.1, and in Figure 6.3, which show how increases in national emissions were accounted for by the Kyoto permitted allowances, and by the mitigation measures.

Kyoto Account Balance	$MtCO_{2eq}$ / year		
	1990	**Mean[1] 2008-2012**	**Increases/ Off-sets**
Emissions Trading Sector	14.8 [2]	22.3 [5]	+7.5
Domestic Non-ETS Sector transport, heating, small industry, excl. Agriculture	20.4 [3]	25.0	+4.6
Total increase (predominantly fossil fuel CO_2)			**+12.1**
Off-sets: permitted emissions increases			
Kyoto 13% increase based on energy/industry emissions in 1990			-4.6
Kyoto 13% increase based on agricultural emissions in 1990			-2.6
Distance to target after subtracting allowances			**+4.9**
Off-sets: reductions in land emissions, and purchases			
Agricultural emissions (including fuel)	20.4	18.8	-1.6
Forest Sequestration			-3.4
National Purchases [4]			0
Balance			**-0.1**

Table 6-1 Ireland's GHG emissions balance sheet for the period 2008-2012, showing how the emissions increase was off-set by permitted Kyoto increases, reductions from agriculture, and forest sinks.

Notes and data sources

[1] EPA (2013a)

[2] The ETS did not exist in 1990. This estimate includes emissions from electricity generation, cement industry, and large industries, which would eventually come under the ETS. Accurate inventory data is available for electricity and cement emissions in 1990 (Duffy et al., 2012), which represent the bulk of the emissions. An estimate of the smaller contribution from the industrial emitters was made based on the ratio of ETS industrial sector emissions to national total industrial/manufacturing emissions (minus cement energy CO_2) in 2007, which was 56.5%. For cement manufacture, the ratio of energy to process CO_2 is assumed to be 0.59, based on national inventory data for process emissions in 2008-2010 (Duffy et al., 2012), and verified ETS emissions from the cement industry over this period (Macken, 2011). Error in estimation of the proto-ETS sector in 1990 is unlikely to exceed 0.5 $MtCO_{2eq}$.

[3] Calculated as total formal emissions for Kyoto compliance purposes in 1990 minus ETS, minus Agriculture. This differs slightly from actual emissions in 1990 due to inclusion of F-gases, whose base year is 1995

[4] National purchases not required as per data from EPA (2013a)

[5] Ring-fenced ETS allowance for formal Kyoto assessment

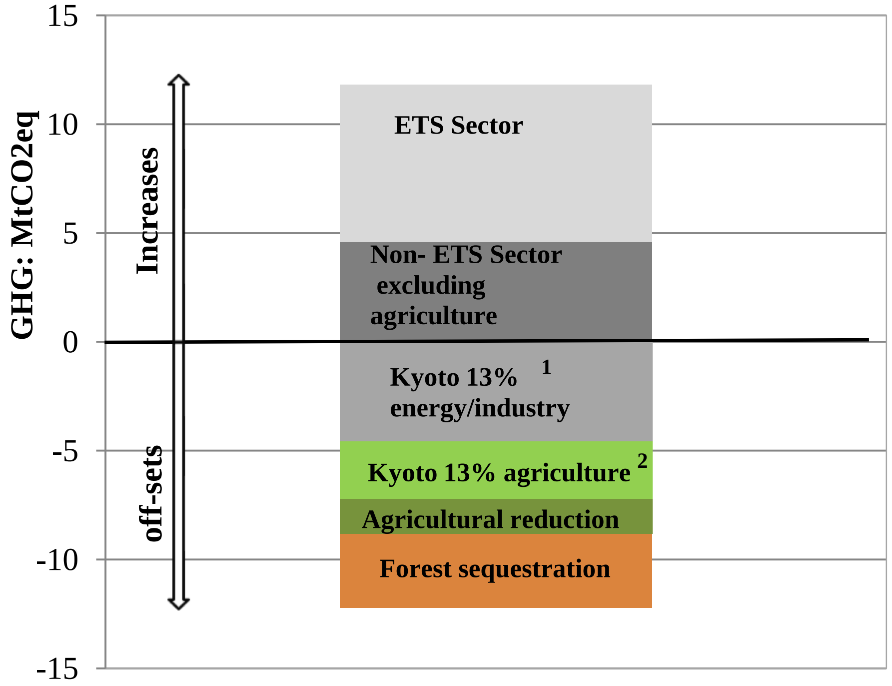


Figure 6-3 Ireland's GHG emissions balance sheet for period 2008-2012. Balancing of reductions and allowances against emissions increases since 1990. Plot of data from Table 6.1.

[1] 13% additional emissions permitted based on emissions from energy/industry sectors in 1990

[2] 13% additional emissions based on agricultural emissions in 1990, which were not assigned to agriculture and could therefore be used to balance the overall national GHG account

The permitted increase for Ireland was 13% of the emissions in the baseline year of 1990, which corresponded to an increase of 7.2 $MtCO_{2eq}$/yr in the period 2008-2012. This figure was made up of 4.6 $MtCO_{2eq}$, which represented 13% of GHG emissions from the energy and industrial sectors in 1990, plus 2.6 $MtCO_{2eq}$ which represented 13% of agricultural emissions in 1990. This latter allowance was not given to the agricultural sector as it was not foreseen that it would ever be required. In understanding how the permitted Kyoto increase was consumed, it is helpful to divide the national emissions into an ETS component and a non-agricultural domestic component. The latter component represents emissions from the non-trading sectors of the economy, including transport, heat, small industry, and waste, but excluding agriculture.

For the ETS sector, which consists of power generation, cement, and large industries, the estimated 1990 emissions were approximately 14.8 $MtCO_{2eq}$ as explained in the footnote to Table 6.1. The national allocation to the ETS for the Kyoto period 2008-2012 was 22.3 $MtCO_{2eq}$ (EPA, 2008). This represented an increase of 7.5 $MtCO_{2eq}$ relative to 1990, which was in excess of the entire Kyoto growth allowance for the state. Emissions from the non-agricultural domestic sector increased by 4.6 $MtCO_{2eq}$ relative to 1990. Between the ETS sector and the non-agricultural domestic sector, the total increase was therefore 12.1 $MtCO_{2eq}$. Subtracting the Kyoto permitted increase, of 7.2 $MtCO_{2eq}$, there was a remaining limit exceedence of 4.9 $MtCO_{2eq}$.

Of the 4.9 $MtCO_{2eq}$ exceedence, 1.6 $MtCO_{2eq}$ (33%) was off-set by reductions in the agricultural sector, and 3.4 $MtCO_{2eq}$ (69%) was offset by forest sequestration resulting in net emissions being approximately 0.1 $MtCO_{2eq}$ under the Kyoto limit. Consequently, all of the national mitigation off-sets were achieved from the land sectors of agriculture and forestry. The land served to directly facilitate additional fossil fuel emissions of about 5 $MtCO_{2eq}$. If the foregone emissions increase of 2.6 $MtCO_{2eq}$ for the agricultural sector is included, then it could be argued that the overall contribution of the land was 7.6 $MtCO_{2eq}$, which effectively increased the Kyoto allowance for fossil fuel emissions from 13% to 34%.

6.6 Implications of Emissions Trading Scheme(ETS) for Agriculture

When the Emissions Trading Scheme (ETS) was being designed, in the period 2003 to 2006, the focus was on power generation, cement production, and large industries which made up the ETS sector. However, the arrival of the ETS also had consequences for agriculture, as ring fencing of the large ETS sector left the remaining parts of the economy including agriculture responsible for achieving any future EU reduction targets. The objective in the design of the ETS in Ireland was to assign a share of the national GHG emissions allowances to the ETS operators, such that there would be a market shortage of emissions allowance. This would provide the economic incentive for emissions reduction and emissions trading. The Irish government had the final decision on the exact balance between allowances assigned to the ETS and to the domestic sectors. Assigning too much to the ETS would result in a low price on carbon and no incentive to reduce emissions. This would place a larger compliance burden on the remaining domestic sectors. Giving too little would create a severe market scarcity, which would force ETS operators to purchase emissions allowances, or undertake costly mitigation, with a resulting reduction in profitability, and higher electricity prices. Once the balance was established by government decision, the role of the EPA was to operate the system, and to allocate allowances between ETS operators on equitable principles, subject to EU oversight and approval.

Advice was provided to the government and the EPA in this complex process by independent economics consultants (ICF, 2004, ICF, 2006a; ICF, 2006b; Indecon-Enviros, 2004; Indecon, 2006). In their analysis, projections were factored in for reductions achievable for agriculture and forestry, which would contribute towards overall national compliance in the Kyoto period to 2012. Sectoral equity was mentioned as being a consideration in the analysis however this occurred at only a superficial level. The technical and economic feasibility of achieving GHG reductions from the ETS sector was the main consideration. No account was taken of the fact that emissions from the ETS and Transport sectors had already exceeded the original NCCS 2000 allowances. The remaining distance to the Kyoto target would be bridged by sharing the reduction burden between the ETS sector and the non-ETS sectors. The burden shares were calculated by simple proportional division, based on actual emissions.

Considerations beyond 2012 were outside of the scope of the design of the ETS. The shape of the eventual EU policy to 2020 was not formulated in general terms until 2007 (EC, 2007a), and by that stage, all of the underlying economic analysis had been completed for the ETS. Potential implications of the EU 2020 targets were however becoming apparent as the Kyoto compliance period commenced in 2008 and were being actively discussed by policy analysts and scientists (Brennan and Curtin, 2008; Lanigan et al., 2008). However, EU GHG policy was not transformed into directives and decisions until 2009. Thus in 2008, when the EPA published is final allocation decision for the ETS (EPA, 2008), the list of policy decisions, instruments and legislation to be complied with did not include reference to the EU 2020 targets. In short, the design of the ETS took no account of Ireland's 20% GHG reduction target for 2020 (EC, 2009a). Creation of the ETS effectively transferred 22.3MtCO_{2eq} from the national account to the ETS sector. The proportion of agriculture in the remaining domestic emissions consequently increased, as illustrated in Figure 6.4. In 2010 for example, agriculture's share of the total national emissions was 29%, but as a percentage of the domestic non-trading sector its share was 44%. In itself, this was just an arithmetic consequence, and did not at the time carry any immediate implications in terms of policy. The proportion of agriculture in domestic emissions increased also in other member states, but Ireland had the highest agricultural component in non-ETS domestic emissions of 44%, followed by Denmark at 25%. The average for the EU-15 was 16.6%.

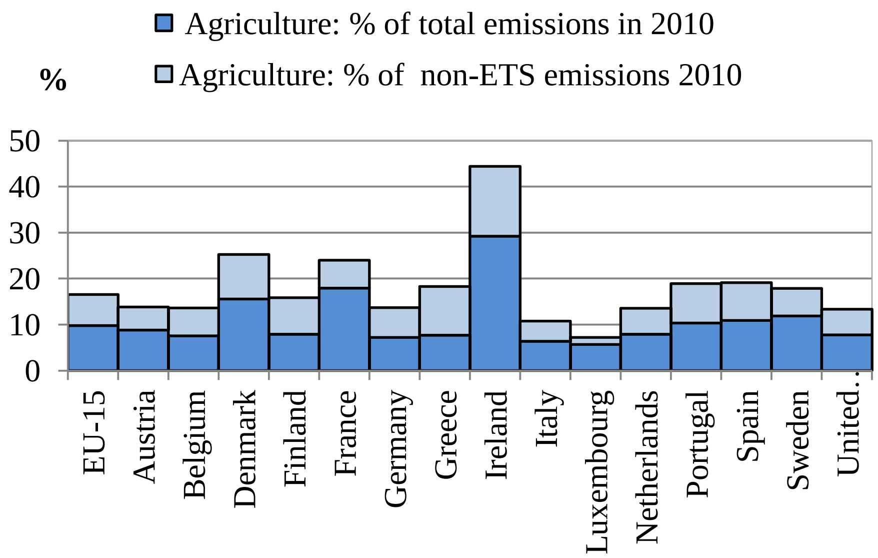


Figure 6-4 Agricultural emissions in 2010 as a percentage of total emissions, and as a percentage of the non-ETS emissions. Calculated from European Environment Agency data (EEA, 2012). Removing ETS emissions from national control, had the effect of increasing the percentage of agricultural emissions in the residual domestic emissions, which remained under national control.

In the lead-up to the ETS, stakeholders from the agricultural sector were apparently not aware of the potential implications of the ETS and the evolving EU targets for 2020. Of the 53 submissions for the first and second consultation phase published on the EPA website (EPA, 2007), the vast majority were from power companies and industries seeking to maximise their emissions allocations. Three were from large dairy processors, and dealt only with their emissions allocations. In its submission, Comhar, the National Sustainable Development Partnership, expressed concern on the size of the allocation to the ETS, though it did not develop this argument. The environmental group Grían argued for a lower allocation for the ETS, as it considered that the adequacy of policies and measures for the non-traded sectors had not been demonstrated. In any event, even if the allocation for the ETS had been adjusted downwards by the Irish government, it would not have made any difference in the final analysis. EU targets for 2020 were framed in terms of reductions relative to verified actual emissions in 2005 (EC, 2009c). Thus in Ireland's case, where the ETS had apparently appropriated all of the state's additional Kyoto emissions allowances by 2005, there was no penalty incurred, and no facility for re-balancing this sectoral inequity. The ETS, while pragmatic from an economic and EU perspective, represented a loss of country ownership of GHG policy, and the transfer of any future additional compliance burden to the rest of the economy.

6.7 Potential Impact of EU 2020 Targets on Agriculture

In 2007 the EU agreed to set a target for a 20% reduction in GHG emissions relative to 1990, a 20% renewable energy supply, and a 20% improvement in energy efficiency to be achieved by 2020. If other developed nations among the Kyoto signatories agreed to match the 20% GHG reduction target then the EU-27 would move to a 30% target (EC, 2007a). These targets, termed the 20-20-20 targets, which were set in anticipation of a successor to the Kyoto agreement, did not in themselves create an immediate concern in Ireland. In NCCS 2007 it was noted that the EU had set an overall GHG reduction target of at least 20% for 2020 and that this would require additional national efforts (DEHLG, 2007). However, as EU effort-sharing and compliance modalities had not been completed at that stage, there was understandably no reference in NCCS 2007 to the potential high compliance burden on the domestic emissions sector including agriculture.

6.7.1 EU-27 Reduction Targets for ETS and Domestic Sectors

The EU GHG reduction target for 2020 would be shared between the ETS sector and the domestic emissions sector. In 2009 the requirements for 2020 were legislated for in the EU Climate and Energy Package, which specified the effort sharing between the ETS and domestic emissions sectors. A 21% reduction target applied for the ETS relative to 2005 (EC, 2009c). For the domestic non-ETS sectors, the EU set a target of an average reduction of 10% relative to 2005 for the EU-27 (EC, 2009a). Since the EU-27 had already achieved significant reductions in emissions since 1990, the combination of the 21% reduction for the ETS, and the 10% reductions for domestic non-ETS relative to 2005 would achieve the desired overall reduction of 20% relative to 1990.

6.7.2 Effort-Sharing Between EU-27 States for Domestic Emissions

As the ETS would be governed at EU level, there were no direct policy consequences for Ireland in terms of planned reductions in the ETS sectors. Regarding the 10% reduction target for the domestic non-ETS sectors, this would be achieved through effort-sharing between the member states of the EU-27. The effort-sharing equation was derived based on economic factors. Member states with the highest GDP per capita would be required to make the greatest effort and achieve a reduction of 20%. States with low GDP per capita would be permitted an increase of up to 20% to allow for economic growth. There was no allowance made in the effort-sharing methodology for unusual national circumstances. In the final effort sharing decision (EU, 2009a). Ireland was classed as a wealthy state, and attracted the full effort-sharing reduction of 20% re 2005, compared with an average for the EU-15 of 13.7% re 2005. To compound the problem, the reduction could not take account of sequestration, or additional land-use activities, which left little room for manoeuvre.

6.7.3 Sectoral Inequities in Ireland Arising from EU Effort Sharing

In Ireland's case, the situation was that over the Kyoto period the agricultural sector had achieved a reduction of nearly 8% relative to 1990, and it might have been expected to be treated leniently in terms of 2020 targets. It was, after all, the only productive economic sector in the economy that had achieved significant actual emissions reduction. There was no evidence that Irish policymakers ever seriously countenanced a situation whereby agriculture would be subject to a further reduction in GHG emissions of 20%. However, the reality was that with a domestic emissions reduction requirement of 20% relative to 2005 agriculture would inevitably be exposed to pressure to reduce or to at least stabilize emissions.

The potential consequences of the EU Climate and Energy Package for Ireland are presented in Table 6.2. If the mandatory 20% reduction were applied across all parts of the domestic emissions non-ETS sectors equally, then agriculture would face a reduction of 20% relative to 2005 which calculates to a 22% reduction relative to 1990. In contrast, the net effect for the non-agricultural domestic sectors would be an increase of 7% relative to 1990. For the ETS sector, the net effect of its 21% reduction relative to 2005 would in fact be a 20% increase relative to 1990. This preferential outcome for the ETS resulted from the high growth in its emissions from 1990 to 2005, which were in excess of 50% and which were locked in as an elevated entitlement in the national allocations process. At face value and from an EU perspective, the overall outcome for Ireland in 2020 actually appeared to be equitable. The overall reduction for Ireland in 2020 would be less than 1% relative to 1990. This was the order of reduction that was anticipated by Irish policymakers in NCCS 2007, and was a low burden relative to the mean for the EU-27 which would achieve a 20% reduction relative to 1990. The effort-sharing decision in 2009 had in fact maintained the favourable treatment for Ireland negotiated at the time of the Kyoto Protocol. The inequity in terms of the potentially high reduction required for agriculture arose as a consequence of the unusually high proportion of national agricultural emissions, and through a combination of the design of the ETS and the EU effort-sharing decision.

2020 Scenario Analysis For Ireland	GHG Emissions, $MtCO_{2eq}$				Change 1990-2020 %
	1990 (actual)	2005 (actual)	2020 (target)	Change 1990-2020	
ETS	14.8 [1]	22.4 [2]	17.7	+2.9	+20%
Non-ETS (excluding agriculture)	20.4 [3]	27.2	21.8	+1.4	+7%
Agriculture [4]	20.4	19.8	15.8	-4.6	-22%
Total	55.6	69.5	55.3	-0.3	-0.5%

Table 6-2 Hypothetical effect of EU 2020 reduction targets on national emissions. The ETS was required to reduce by 21% re 2005 (EU, 2009c), and a reduction of 20% was required for the Irish non-ETS sectors (EU, 2009a). The overall effect in 2020 would be to reduce total national emissions by 0.5% relative to 1990. The ETS sector would after the reduction still have emissions 20% higher than in 1990. The non-ETS sector (excluding agriculture) would have emissions 7% higher than in 1990. The agricultural sector would have emissions 22% lower than in 1990

[1] Estimated ETS emissions, from Table 6.1
[2] (Macken, 2011)
[3] Includes correction to account for F-gases, whose base year is 1995
[4] Including agricultural fuel emissions (EPA, 2012)

6.8 Conclusion – Reliance on the Land and Perverse Policy Outcomes

When Irish policymakers were faced with the task of devising a GHG reduction strategy they were dealing with a situation which was unique in the EU-15. No other EU state had as high a proportion of GHG emissions emanating from agriculture, as high a proportion of grassland, or as low a proportion of forestry. Kyoto accounting rules permitted compliance to be determined based on aggregate accounting of emissions from fossil fuel consumption with emissions from agriculture, and to off-set using forest sequestration. Irish GHG control strategies pragmatically took maximum advantage of these flexibilities.

By 2012 it was clear that the strategy was very successful in terms of Kyoto compliance. In the absence of the agricultural and forestry off-sets, formal accounted net emissions would have been greatly in excess of the Kyoto limit. Agriculture and forestry were in fact the only economic activity sectors where significant GHG mitigation was achieved, amounting to a total reduction of 4.9 $MtCO_{2eq}$ relative to 1990. In contrast, for the other sectors of the economy fossil fuel emissions had increased by 12.1 $MtCO_{2eq}$ which was an increase of 34% re 1990. Ireland relied much more heavily on forest sequestration than other EU-15 states, and as a proportion of its Kyoto limit, achieved more than three times the LULUCF sequestration than was achieved on average for the EU-15. Having demonstrably contributed in a major way to national GHG reduction strategy, the agricultural sector was perversely subject to additional reduction pressures which were an unanticipated consequence of the ETS and the EU Climate and Energy Package for 2020. The creation of the ETS removed a substantial proportion of GHG emissions from national control and amplified the already large percentage of agricultural GHG emissions in the domestic emissions under direct national control. The EU effort-sharing decision in 2009 placed the maximum compliance burden on Ireland's remaining domestic emissions, with a 20% reduction required by 2020. This reduction target exposed an inequity in treatment of the agricultural sector compared with the ETS sector in Ireland. Hypothetically, if the full 20% reduction were applied across all domestic sectors the net result would be that agricultural emissions in 2020 would be 22% lower than in 1990. In contrast, emissions from the Irish ETS sector would be 20% higher than in 1990. This inequity resulted from the original national allocation decision for the ETS which effectively transferred all of the increases permitted under Kyoto to this sector.

The deficiencies in the ETS could have been lived with, if the EU Effort Sharing Decision had included flexibility to take account of unusual national circumstances. All states could probably find an arguable case for special treatment and reaching agreement among 27 member states on this basis would have been almost impossible. However, agriculture was in a different category. It was effectively controlled centrally by the EU CAP, and was essential for maintenance of the EU's food security and long-term sustainable development. Cattle were the dominant source of agricultural GHG emissions in Ireland. Based on Kyoto GHG accounting rules, emissions from Irish livestock were in fact lower than the average for the EU-15 (EEA, 2012). More significantly, emerging research showed that life cycle emissions of GHG per unit milk and beef production in Ireland were lower than the EU average (Leip et al., 2010). Were Ireland to reduce its cattle herd to achieve GHG reductions, this would have perverse consequences for the EU. In an equilibrium EU food market, a reduction in Irish agricultural production of beef or milk products would be compensated by production in other states or from imports. As Ireland's emissions intensities were below the EU average, the probability was that this would increase overall GHG emissions in the EU. Increasing beef and milk production in Ireland by the same argument could displace less efficient producers in other EU states and lead to a reduction in overall GHG emissions. While the origin of Ireland's difficulties and the resulting perverse policy outcomes can be traced to a combination of national and EU policies, an equitable solution could only be formulated at EU level where ownership of climate change policy and overall EU sustainable development strategy effectively resided.

7 BIOENERGY

7.1 BIOENERGY AS A LOW CARBON OPTION

Bioenergy is energy which is obtained through combustion of biomass materials, which are sourced from living or recently living biological materials. The term biomass refers to all fuels for the supply of bioenergy. Biomass fuels can be in the form of solid biomass, liquid biofuels, or biogas (EC, 2003c). Solid biomass is frequently referred to simply as biomass, and liquid biofuels simply as biofuels. Biogas contains methane which is produced from anaerobic decomposition of biomass. Biomass fuels contain stored solar energy in the form of chemical bonds, which are created through the process of photosynthesis whereby atmospheric CO_2 combines with water to form cellulosic or starchy materials. Under Kyoto GHG accountancy rules release of the CO_2 upon combustion of biomass is not included in the national total emissions (UNFCCC, 2006). Provided that the consumption of the biomass is balanced by the crop growth rate and that net emissions associated with land-use or land-use change are properly accounted for, energy sourced from biomass was considered to be largely carbon neutral (SEAI, 2002). There was almost universal support throughout the study period 1990 to 2012 for a national bioenergy policy to address renewable energy needs, GHG reduction, and to achieve economic objectives. Bioenergy represented another aspect of reliance upon the land for compliance with national GHG and energy objectives. While it could undoubtedly make some contribution to the national efforts, there are however many aspects of Irish bioenergy policy which do not stand up to close scrutiny.

Burning biomass can in fact increase the concentration of CO_2 in the atmosphere in the same way as burning fossil fuels if the production of biomass entails direct or indirect land-use changes from pasture or forestry to energy crops (Searchinger et al., 2008; Upham et al., 2009). The assumption that combustion of biomass is in fact a carbon neutral process has also been questioned, and possible errors in carbon accounting have been highlighted (Searchinger et al., 2009; Haberl et al., 2012). These are complex issues and it is not proposed to base arguments against bioenergy upon them. For the purposes of the present discussion of broad policy aspects, maximum achievable bioenergy yields, and maximum GHG displacement potential are assumed. Under these most optimistic assumptions it will be argued that there are still fundamentally unsustainable aspects of bioenergy policy. Bioenergy is considered in section 7.2 and 7.3 in terms of characteristics, available resources, land requirements, and the fundamental energy efficiency of the technology. The evolution of Irish bioenergy policy, supporting measures, and outcomes are described in section 7.4. As discussed in section 7.5, an extensive reliance on bioenergy would raise fundamental questions with respect to competition for land between food and energy crops. In particular Irish and EU liquid biofuel policies have significant implications for the food energy balance both of Ireland and of the EU.

7.2 BIOENERGY CROP CHARACTERISTICS

An overview of the energy yields of a range of common bioenergy crops including forestry is provided in Figure 7.1. The yields presented, which range from 0.9 to 5.4 toe/ha, are typical gross values (Biomass Energy Centre, 2013). In all cases the net energy yields would be less when allowance is made for the energy required to cultivate, harvest, and process the crops. Also, while a unit of bioenergy could theoretically replace one unit of fossil fuel, taking account of the energy requirements to produce the biomass, and the associated life cycle emissions, the effective GHG reduction would in many cases be significantly less. For example the effective GHG reduction relative to fossil fuel is typically 45% for rapeseed biodiesel and 32% for bioethanol derived from wheat (EC, 2009c).

7.2.1 SOLID BIOMASS

The immediately available source of indigenous solid biomass during the study period was forest wood from thinnings (pulpwood), forest harvest residues, and waste products from timber processing. Such fuel could be used in the form of logs in domestic stoves, wood pellets for domestic and larger boilers, and wood chip in larger commercial boilers or power plants. The sustainable harvest rate for forest thinning is slightly less than 1 toe/ha/yr. As a solid biomass option in Ireland, the limitation was the unusually low forest area by EU standards, and the slow rate of afforestation. Given the alternative uses of timber in board mills, sawmills, and other commercial timber products, significant diversion of commercially marketable timber to energy use was unlikely to be economic. In any event, the total resource of harvested timber, even if converted entirely to energy was modest. Based on the reported harvested carbon content of timber (Duffy et al., 2012), and using an energy yield of 0.45toe/t (dry timber), the annual commercial timber harvest over the period 1990 to 2010, would have yielded 0.7 Mtoe/yr which would have represented just 5.3% of the average national primary energy requirement over this period. Growing a vibrant bioenergy sector purely from the limited forest resources was not feasible.

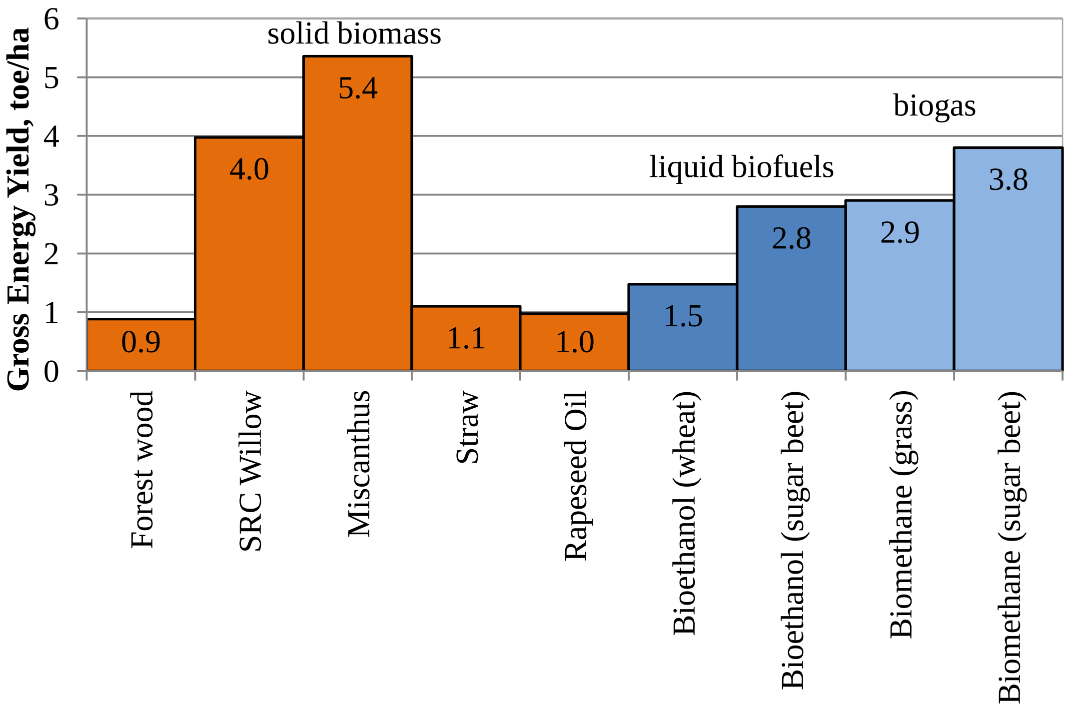


Figure 7-1 Typical gross energy yields of energy crops.

Notes and data sources:

Biomass crop yields, and fossil fuel data from U.K. Biomass Resource Centre (2013). For forest wood, the yield is the sustainable harvest rate, without impacting on the commercial production of mature trees.

Biogas from grass from Smyth et al. (2010)

To meet the deficit in projected biomass material, short rotation coppiced wood (SRCW), especially willow, offered the prospect for relatively rapid development of a solid biomass supply with an energy yield of typically 4 toe/ha/year. The crop could be mechanically harvested, dried naturally to acceptable moisture content, and processed as wood chips. Elephant grass (*Miscanthus*) was also identified as a high-yielding attractive option for supply of both energy and fibre (Jones and Walsh (eds.), 2001) with a typical energy yield of 5.4 toe/ha/yr. The baled product could be used directly in large boilers or processed into fuel briquettes. For both willow and *Miscanthus*, crop establishment and care as described in Teagasc guidance booklets were well within farmers' skill sets (Caslin et al., 2010; 2011). While there was not the irrevocable commitment as was the case for afforestation, there was still a commitment of about 20 years to obtain an optimum economic return which proved a barrier to the uptake of these energy crops.

7.2.2 LIQUID BIOFUELS

Liquid biofuels were not a new idea in Ireland. The Irish state had over forty years of direct experience in liquid biofuel production and operation of a biofuels obligation scheme. A state industrial alcohol company was established before the Second World War for production of industrial alcohol from surplus potato crops (Industrial Alcohol Act, 1938). The original objective was to stabilise the potato market by providing an outlet for excess production and for sub-standard products. Petrol suppliers were obliged to purchase the alcohol and mix with automobile petrol. Due to unreliable supplies of potatoes and lack of other economically viable indigenous feedstocks, the alcohol factories eventually changed to imported molasses as a feedstock for alcohol production, and branched into other products. Even with guaranteed alcohol prices set by the minister and no competition, the factories operated at a loss. Following a review (JOC, 1979) production was eventually wound down in the mid-1980s. In addition to the financial losses, a factor in the decision to close the factories was that the existing import restrictions, which sought to protect the state companies, would be in contravention European trade rules.

The promotion of biofuels from 2000 onwards was an effort to re-launch this indigenous industry in a new and more supportive policy environment. The options considered included fuel derived from vegetable oil (biodiesel), and alcohol fuel (bioethanol) derived from fermentation of starchy or high-sugar crops. Biodiesel produced from pure rapeseed oil has an energy yield of approximately 1.0 toe/ha/yr. Extraction of the oil requires relatively simple pressing technology and can be carried out on a relatively small scale. Rapeseed was also a good break crop in the wheat rotation, and farmers were already familiar with the planting and harvesting of this crop. It was an attractive option in that it could yield a return within a year and did not entail a long-term risk or commitment, as was the case for the solid biomass crops of willow or *Miscanthus*. With a national self-sufficiency in wheat of only 80% (CSO, 2012c) and a limited tillage area, any large scale bioethanol plant would have to rely upon imports, thus making it an economically risky venture. Sugar beet could alternatively be used as a feedstock with higher yields than from wheat. Ironically, in 2006 while national efforts were ongoing to establish a bioenergy agricultural sector, the sugar beet industry was closed down with the agreement of the Irish government in response to EU re-structuring of the sugar market (EC, 2007b). The average area under sugar beet in Ireland was 32 kha in the 10 years prior to closure of the industry (CSO, 2011b). At an energy yield of 2.8 toe/ha/yr, the potential total bioethanol output from the entire sugar beet crop would have been quite low at 0.09 Mtoe/yr.

Biofuels derived from wheat or oil crops as described above represent first generation technology. Second generation technologies, which were at research stage during the study period, would be capable of producing liquid biofuels from non-food crops, such as wood residues or lignocellulosic crops. This would not yield any more energy, as from conservation of energy principles the gross energy yield could not exceed the inherent energy stored in the crop. The advantage of converting solid biomass to liquid biofuel would be that very bulky solid biomass could be converted to liquid fuels which would be readily transportable.

7.2.3 BIOGAS

Biogas from sewage treatment plants had been used in Ireland as a minor energy source since 1990, and landfill gas as an energy source grew steadily since 1996. The total resource of waste biogas was however limited, and totalled just 0.06 Mtoe in 2011 (SEAI, 2013a). In principle, any agricultural crop or crop residues could be converted in a digester to produce biogas. Given the preponderance of grass in Ireland, it was an obvious candidate biogas crop. A major advantage was that existing grasslands could be maintained, and there was no risk of breaking the 5% pasture reduction action level which followed from the 2003 CAP reform (DAF, 2005). Grass has a gross energy yield of about 4 toe/ha/yr, which is similar to willow and *Miscanthus*. Gross methane energy yields of 1.5 to 2.9 toe/ha/yr have been claimed (Curtis, 2006; Smyth et al., 2009). Given the high energy yield compared to other energy crops, there would be less land required (Singh et al., 2010). An extra bonus was that if grass were classified as a lignocellulosic biomass, then under EU renewable energy accounting rules one unit of energy produced from grass would count as two units in calculating compliance with the EU's 10% renewable transport fuel target for 2020 (Smyth et al., 2010).

7.2.4 SOLID BIOMASS - ISSUES OF BULK

For solid biomass fuels the energy densities per unit mass are significantly lower than for fossil fuels, and the materials also have a low mass density, resulting in an energy density per unit volume substantially lower than for fossil fuels. Solid biomass fuels are consequently bulky, which has implications for the transport, storage, automation, and the range of feasible uses. Figure 7.2 illustrates this limitation in terms of the volume of fuel required to deliver one unit of thermal energy, and compares typical solid biomass fuels with fossil fuels. For heating applications wood pellets are 3.5 times more bulky than heating oil or anthracite but are only slightly more bulky than peat briquettes, and are less than half the volume of sod peat. Wood dried naturally to 20% moisture is marginally less bulky than sod peat. Thus, wood pellets or logs are a potential direct replacement for peat in domestic heating, but significant incentives or other legislative control instruments would be required to encourage replacement of coal or oil. For wood chips, it takes 13.5 m^3 to deliver one toe of thermal energy, which would make it impractical for domestic use but could be used in a large commercial or industrial boiler. *Miscanthus* naturally dried to 25% moisture and baled is an extremely bulky fuel requiring 20.4m^3 to deliver one toe of energy. Both wood chips and *Miscanthus* could however be co-fired with milled peat in the peat power plants. Alternatively, they could be further dried, processed and compressed to a higher density product, suitable for domestic solid fuel heating, which would require industrial scale facilities.

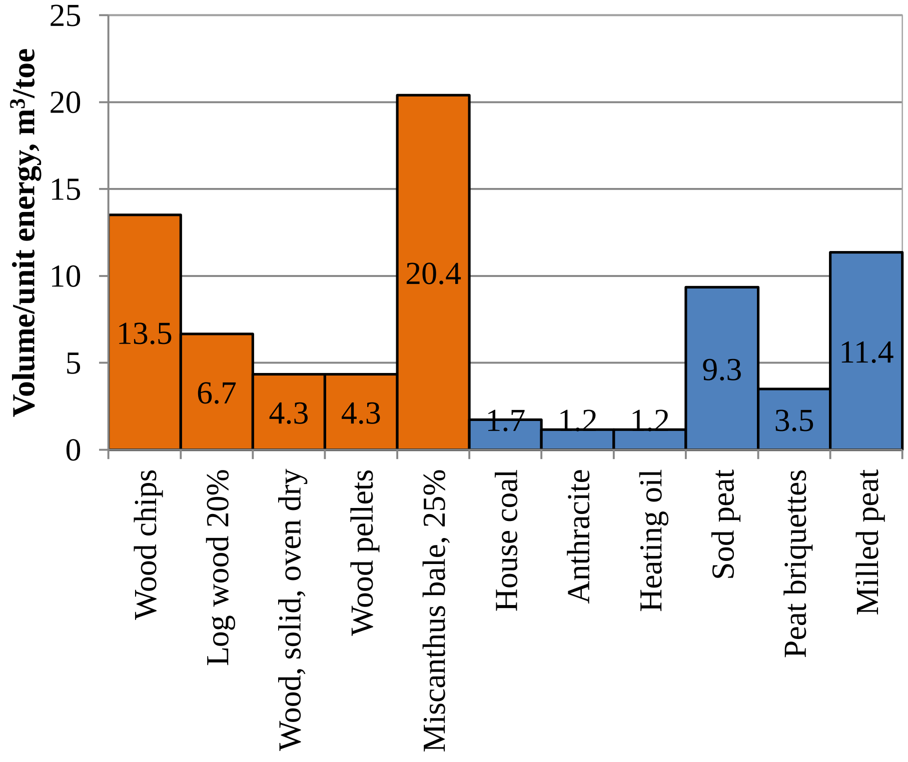


Figure 7-2 Bulkiness of solid biomass fuels: volume of fuel required to deliver one tonne of oil equivalent of thermal energy, compared with fossil fuels, calculated from data published by Biomass Energy Centre (2013).

7.3 ENERGY AND LAND-USE EFFICIENCY

7.3.1 BIOENERGY - ENERGY EFFICIENCY CONSIDERATIONS

Combustion of biomass for the production of heat is an inherently highly efficient process, with efficiencies in excess of 86% achievable (SEAI, 2013d). The small losses of energy occur due to heat lost in the flue gases. Arguably, inefficiency can arise if the biomass is being used to heat a poorly insulated building. However in principle all buildings could be thermally upgraded to the desired degree. In contrast when using biomass as a fuel for electricity generation there is an inherent limit to the overall efficiency which is set by the Second Law of Thermodynamics. Regardless of the technology, the overall maximum theoretical efficiency is determined by the ratio of the temperature of the boiler to the ambient temperature. As there are practical limits to the highest operating temperature of a boiler, this limits the conversion efficiency of solid biomass power stations to approximately 40%, as is the case for modern peat power stations (Edenderry Power, 2014). The overall efficiency can be improved by utilizing the waste energy for heating. This option is available in the timber and wood products industry where a biomass power plant can generate electricity and use the waste heat in the timber kilns. It is not an option for co-firing of biomass at the peat power plants, as these are located in remote areas with no nearby heat loads.

The thermodynamic efficiency limit also applies to internal combustion engines, whether operating on fossil fuel or biofuel, although this is seldom presented explicitly as it is for electrical power generation. The combination of thermodynamic losses and other losses in the engine and drive train result in a very low efficiency for internal combustion engine motor vehicles. From data presented by Smith (2010), the implied overall efficiency from fuel-tank to wheel of the Irish car fleet in 2006 was approximately 20%, whereas electric cars were shown to be capable of an energy efficiency of 75%, from power socket to wheel.

EU Renewable Energy Directive targets for 2020 were set in terms of the percentage of renewable energy in gross final consumption (EC, 2009b). Gross final consumption of energy is defined as the total final consumption of fuel for heating, transport, and electricity. By framing the target in terms of gross final consumption, rather than total primary energy, it is most beneficial to direct solid biomass to thermal markets, and liquid biofuels to transport markets. Using biomass fuels for electricity generation would entail a loss of typically 60%. In the case of liquid transport fuels the inherent inefficiency of internal combustion engines was not penalized under renewable energy EU rules. However an incentive was included for electric vehicles, by permitting the renewable component in the electricity supply to be multiplied by an efficiency factor of 2.5.

7.3.2 BIOENERGY - EFFICIENT LAND-USE CONSIDERATIONS

The land area required to deliver useful energy to the end user depends on the energy yield of the biomass crop and the conversion efficiency of the technology employed. Figure 7.3 compares the land area requirements to supply one unit of energy to the consumer for the range of bioenergy technologies, including biomass electricity (co-firing), biomass heating, and transport biofuel. The calculation of land area is based only on simple energy considerations, and no account is taken of energy losses in fuel harvesting, processing or transport. For comparison, the land area requirements to deliver one unit of energy from wind power, solar photovoltaic, and solar thermal technologies are also included in Figure 7.3. In terms of land area required, biodiesel from rapeseed oil is the most demanding, requiring 1 hectare per tonne of oil equivalent (1 ha/toe) final fuel consumption. Electricity generated from solid biomass, and bioethanol fuel have similar land requirements of slightly less than 0.7 ha/toe. Solid biomass heating is the most efficient in terms of land-use, with a land requirement of 0.29 ha/toe.

The land area requirements for alternative renewable energy technologies are significantly lower than for bioenergy. For windpower the total windfarm land requirement is 0.04 ha/toe, which is calculated based on a typical density of four 3MW wind turbines per square kilometre (IWEA, 2008). In terms of land requirement, windfarms are eighteen times more efficient than solid biomass electricity, and eight times more efficient than biomass heating. The actual land lost to agricultural production would be a very small proportion of the total wind farm area. Access roads and turbine footprints may typically occupy only 1% of the total windfarm area. On 99% of the windfarm normal agriculture could carry on, or natural land cover could be maintained. Windfarms consume landscape rather than agricultural production capacity. In terms of the actual land area consumed, wind power is 1800 times more efficient than biomass co-firing, and 800 times more efficient than biomass heating.

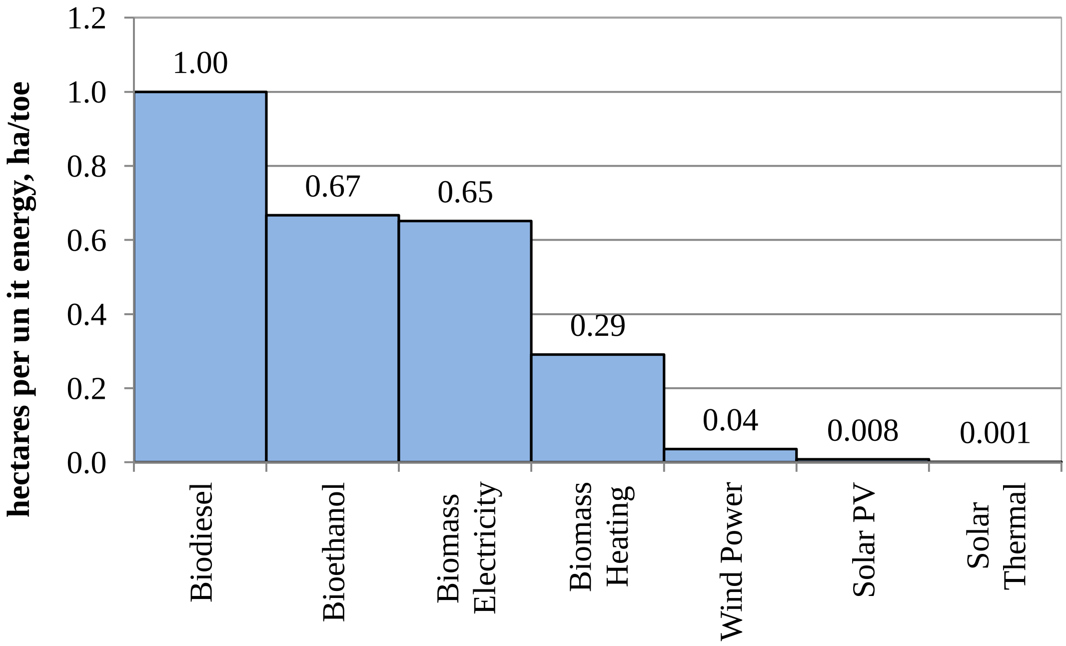


Figure 7-3 Land area requirements for renewable energy technologies, in terms of the area required to deliver 1 unit of energy (1 toe) to the consumer

Notes and data sources
Biomass energy yields: Biomass Energy Centre (2013).

Biomass electricity: using willow, 4toe/ha, assuming conversion efficiency as for high-efficiency peat power station which is 38.4% (Edenderry Power, 2014).

Biomass heating: using willow, 4toe/ha, boiler efficiency 86%

Wind Power: calculation based on 4x3MW turbines per km^2, capacity factor 0.31 (IWEA, 2008).

Solar: calculated based on solar irradiance of $115W/m^2$ (SEAI, 2013c), with a nominal efficiency of 15% for photovoltaic and 80% for solar thermal collector.

For domestic use, solar photovoltaic and solar thermal panels can normally be incorporated into the roof areas of buildings, and do not displace productive agricultural land. A solar photovoltaic panel area of 80 m^2 would provide 1 toe/yr in electrical energy. As an energy collector, solar photovoltaic technology is approximately a factor of 40 to 80 more efficient than the biomass applications in Figure 7.3. Solar thermal collectors are typically 80% efficient at collecting solar radiation. A solar thermal panel area of just 15 m^2 would provide 1 toe/yr in thermal energy, which is a factor of 200 to 450 times more effective than the biomass options. Large area solar energy collectors were not constructed in Ireland, apart from a 500 m^2 thermal collector in the ecovillage in Cloughjordan, Co. Tipperary (Opalic et al., 2012). In Denmark, large area solar thermal collectors had been installed since the late 1980s to supplement district heating schemes, with collector areas in the range 8000 m^2 (0.8 ha) to 18,000 m^2 (1.8 ha) installed as of 2012, with plans for arrays of over 50,000 m^2 (5ha) in 2014 (Holm, 2012). Relative to overall residential site area, even the largest area thermal collectors displace negligible potential farmland areas. In the absence of district heating plants, and the prevalence of individual heating boilers in apartments, this type of application did not develop in Ireland.

Biomass appears from this analysis as a land-hungry renewable energy option. The energy content of biomass originates from photosynthetic activity, which has an inherently low energy conversion efficiency (Miyamoto, 1997). For the average solar irradiance of 115 W/m^2 (SEAI, 2013c), and with a typical yield of 4 toe/ha, the overall energy conversion efficiency is approximately 0.5%. Conversion efficiency would not be a concern if there were a free and unconstrained availability of land, which is not the case in Ireland. Given the limited availability of land for biomass production, an optimum approach would be to direct the resulting biomass outputs to the most efficient application, such that the final energy consumption per unit land area is maximised. In terms of delivered final energy consumption, biomass heating has the least area requirement. In addition to contributing to renewable energy targets there would be the associated benefit of a reduction in national GHG emissions through displacement of fossil fuels. If the objective of a policy is only to reduce GHG emissions, without regard to optimum land-use, then biomass electricity using co-firing at a peat power station is an attractive option, as displacement of peat by solid biomass would also reduce national GHG emissions. For the biomass heating option, one hectare would provide 3.85 toe gross final energy consumption, and save 12.9 tCO_{2eq} emissions, based on residential heating fuel data for 2010 (SEAI, 2013a), and standard fuel emission factors (Howley and Holland, 2013). The co-firing with peat option would provide only 1.5 toe gross final energy consumption, but would save 16.9 tCO_{2eq}.

7.4 IRISH BIOENERGY POLICY

7.4.1 POLICY DRIVERS

A summary of national and EU policies and measures in support of bioenergy is presented in Table 7.1. While Irish bioenergy policy was largely driven by EU directives on renewable energy and biofuels, these EU policies aligned extremely well with Ireland's pre-existing policy environment. As an island state with little indigenous fuel supplies, energy security was always a paramount concern. In 2000, Ireland was only 16% self-sufficient in primary fuels, which was a considerable worsening of the situation compared with 1990, when there was 37% self-sufficiency (SEAI, 2013c). Electricity supply was also precariously reliant on imported fuels, with a self-sufficiency of 24% in 2000, which was about half the indigenous fuel fraction of 49% in 1990. There was also the strong motivation in adopting bioenergy as a means of reducing GHG emissions from the transport sector which had dogged policymakers as the main factor in escalating emissions since the mid 1990s. Bioenergy therefore presented an opportunity to improve energy security, assist in achieving Kyoto compliance, and fitted well with existing agricultural and socio-economic policies. As was discussed in chapter 5, the expectation for agriculture was a decline in output. Energy crops were seen as a means of filling this productivity gap, and being labour-intensive, there was the added benefit of rural employment.

Year	Title	Description
1996	Renewable Energy, A Strategy for the Future Alternative Energy Requirement (AER) Schemes	National policy to promote renewable electricity. AER scheme to encourage electricity generation from renewable sources. Mainly wind, with small uptake by biogas and biomass projects
1998	Kyoto Protocol	Requirement to limit GHG growth to maximum of 13% above 1990 emissions.
1999	Green Paper on Sustainable Energy	Policy to encourage renewable electricity projects, mainly wind
2000	National Climate Change Strategy 2000 (NCCS 2000)	Bioenergy proposed as mitigation measure, but no specific targets
2001	RES-E Directive (2001/77/EC)	13.2% of electricity from renewable sources by 2010
2003	Biofuels Directive (2003/30/EC)	5.75% transport biofuels by 2010, 20% by 2020
2004	EU Energy Crops Scheme	€45/ha for energy crops, included in CAP reform
2005	Mineral Oil Tax Relief (MOTR) scheme	Excise relief for limited quantities of biofuels
2006	Greener Homes	From 2006 to 2011, provided grants for home energy improvements including wood stoves and boilers
2006	Commercial Bioheat Programme (ReHeat)	Operated from 2006 to 2011 providing grants for larger scale commercial wood boilers
2007	Bioenergy Action Plan	National development strategy for bioenergy in transport, electricity and heating
2007	Energy White Paper	5.75% biofuels, 30% co-firing of biomass with peat in power plants
2007	NCCS 2007	Energy White Paper measures for bioenergy incorporated in strategy Additional €80/ha for energy crops (ceased 2009) Promotion of biomass heating in state buildings and schools, and biofuels in public vehicle fleets
2009	Renewable Energy Directive (2009/28/EC)	10% renewable transport energy required by 2020. 16% of energy from renewable sources by 2020
2010	Biofuels Obligation Scheme	Obligation on fuel suppliers to mix biofuels, initially 4%
2010	Price supports for Bioenergy power announced	Not implemented until 2012 (REFIT 3)
2010	NREAP 2020	Bioenergy (including wastes) to contribute 55% of renewable energy resources in 2020
2012	Renewable Energy Feed-in Tariff 3	Guaranteed prices for biomass electricity and CHP

Table 7-1 EU Directives and Irish policy developments in bioenergy 1996 to 2012.

On the EU scale, bioenergy was identified as the main contribution to growth in renewable energy, followed by wind energy. In the EU policy document, Energy for the Future (CEC, 1997b), biomass was stated to have large unexploited potential, and to be economically viable. It was believed that biomass could supply 10% of EU primary energy by 2010, and that up to 7.1% of arable land in the EU could be sustainable, i.e. 10 million hectares (CEC, 1997b). Some initial impetus for bioenergy was provided by the EU directive on renewable electricity, known as the RES-E Directive (EC, 2001b), which set a target for Ireland of 13.2% of electricity to be from renewable sources by 2010. While wind energy held the best prospect for renewable electricity generation, its intermittency required reliable steady base load generation capacity, and biomass electricity generation provided a possible renewable solution. Co-firing solid biomass with peat at the power stations would also extend the lifetime of the peat bogs under state ownership, in turn supporting employment in the midlands. The strong driver for development of liquid biofuels was the EU Biofuels Directive (EC, 2003c), which set a target of 5.75% biofuels in transport fuels by 2010, and an indicative target of 20% by 2020. The directive required that specified percentages of biofuels should be placed on the market. There was no specific requirement that biofuels should be produced indigenously, and there was also provision in the directive for deviation from the indicative targets based on national circumstances.

As part of the EU Climate and Energy Package, the revised renewable energy directive (EC, 2009b), continued to encourage development of bioenergy. Ireland was set the target of 16% gross final energy consumption from renewable sources by 2020. The directive revised the target for renewable transport fuels downwards to 10%, but nevertheless this still provided a strong signal of EU support for biofuels. While some of this transport target could be met from electric vehicles powered by renewable electricity, the likelihood was that the bulk would be from liquid biofuels. The Effort Sharing Decision in 2009 (EC, 2009a), also placed a requirement on Ireland to reduce domestic GHG emissions by 20% relative to 2005, which provided a further incentive to substitute fossil fuels with renewable biomass.

7.4.2 Evolution of Irish Bioenergy Policy

In the following analysis and discussion, the focus is on biomass derived from forestry and agricultural crops. Municipal waste to energy, and landfill gas, while they represent significant biomass resources, do not have a land area requirement, and are not relevant to the present discussion, which focuses on implications for land-use. Irish policy on bioenergy can be tracked through formal policy statements and technical reports from the mid-1990s to 2010. Over this period, the policy evolved rapidly from a non-quantitative expression of general support for the development of bioenergy, through quantitative assessments of potential resources, culminating in 2010 with bioenergy being put forward as a major element in Ireland's National Renewable Energy Plan (NREAP) (Government of Ireland, 2010). Other than in NREAP, the published documents on Irish bioenergy strategy require some degree of interpretation to quantify the precise energy targets envisaged, and the land area required, due to a lack of compiled data, and mixtures of energy units employed. Figure 7.4, shows the approximate land areas envisaged for production of bioenergy, as inferred from the various policy and strategy documents from 2002 to 2011.

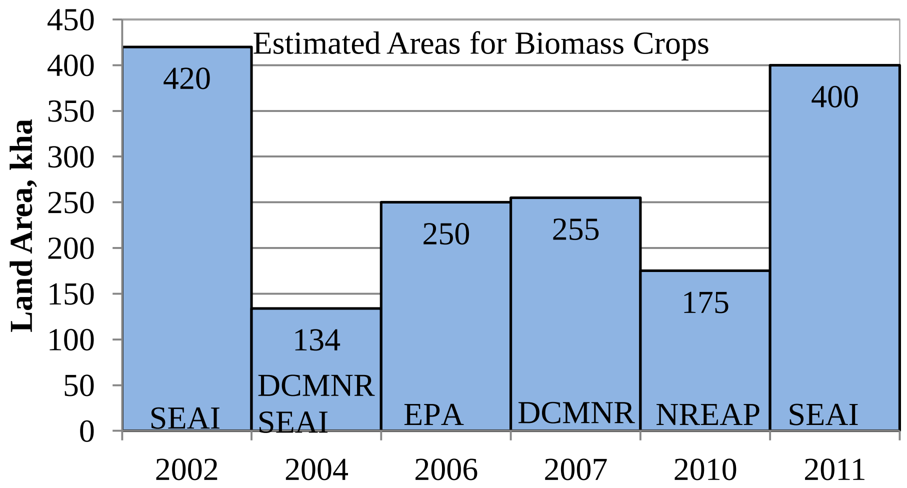


Figure 7-4 Estimations of agricultural land areas for energy crop production (excluding forestry), as inferred from technical and policy documents from 2002 to 2011. For comparison, the total agricultural area in Ireland in 2010 was 4.6 million hectares, of which approximately 300 kha was in tillage (CSO, 2011a).

Notes and data sources: SEAI (2002), Curtis (2006), DCMNR (2007), Government of Ireland (2010), SEAI (2011). 2004: energy crop potential 160 ktoe (DCMNR, 2004), which at 4 toe/ha would require 40 kha, plus 94 kha identified as being feasible for liquid biofuels production (Hamelinck et al., 2004).

The Government’s renewable energy strategy, launched in 1996, included biomass energy along with wind energy, without setting specific targets (DTEC, 1996). A subsequent quantitative assessment of national bioenergy resources (ESBI, 1997) presented extremely high estimates of indigenous resources. Energy crops were assigned an electrical generation potential of 7.9 to 10.6 GW, with an annual output of 55,536 to 72,555 GWhr (electrical), which was many times the existing electrical energy supply. Converted to fuel input energy to the power plants, it corresponded to 15.5Mtoe, which exceeded total national primary energy requirements. It was evidently a purely theoretical projection, as all of the agricultural land in Ireland would have been required to deliver this energy.

When the first formal national climate change strategy was published (DELG, 2000a), bioenergy was mentioned as having a role in achieving the dual goals of energy security and reduced GHG emissions, but firm national targets were not set. In a short briefing report by the Sustainable Energy Authority of Ireland (SEAI, 2002), reference was made to the ESBI (1997) estimates of biomass resources. While acknowledging the impracticality of converting the bulk of agricultural land to energy crops, SEAI (2002) speculated that 10% of agricultural land (420 kha) would be reasonable, in the context of existing set-aside land, and evolving agricultural policies. For the short and medium term, they projected a modest realistic biomass energy supply of just 1.4% of primary energy requirement in 2010. Despite this modest projection, biomass was described in the same report as having the potential to contribute to security of supply, employment, and as providing a major part of Ireland’s response to the issue of climate change. The use of biomass as an alternative to peat was mentioned only in the context of new high efficiency CHP plants, rather than the less efficient option of co-firing at peat power stations.

In 2004, a report was produced on the bioenergy potential of dry agricultural wastes (RPS and MCOS, 2004). The theoretical total resource was estimated to range from 0.4 to 0.5 Mtoe/yr. Allowing for alternative uses on the farm, and for other commercial uses, the practical resource was assessed as being only 0.06 Mtoe/yr, composed mainly of straw, with a lower contribution from poultry litter and spent mushroom compost. Also in 2004, strategy reports on solid biomass and liquid biofuels identified a solid biomass crop potential of 0.16 Mtoe, and a liquid biofuels potential of 0.07Mtoe by 2010 (DCMNR, 2004; Hamelinck et al., 2004). The liquid biofuels projection corresponded to 1.3% of transport fuel in 2010, and was significantly under the EU Biofuels Directive target of 5.75%. It was estimated however that up to 2% biofuels could be achieved if the fuel standards were varied. The total land area envisaged for the projected total solid biomass and liquid biofuels can be calculated to be approximately 134 kha, based on a nominal solid biomass yield of 4 toe/ha, and the typical yields for biofuels crops (Biomass Energy Centre, 2013).

An EPA discussion paper in 2006, strongly supported development of bioenergy and identified a potential biomass resource of 0.7 Mtoe (Curtis, 2006). A novel feature was the inclusion of grass as a potential energy crop for the production of biogas through anaerobic digestion, at an implied yield of 1.5 toe/ha. It was proposed that the purified biogas could be injected into the national gas grid. The total energy crop area envisaged, excluding forestry, was 250 kha, of which 65% would be grass. The European Environment Agency had in the same year identified negligible potential for biomass energy crops in Ireland, as displacement of pasture would adversely affect biodiversity (EEA, 2006). The EPA however believed that energy from grass would overcome these concerns (Curtis, 2006).

In the report of the Ministerial Task Force on Bioenergy (DCMNR, 2007b), Ireland was considered to have significant bioenergy resources to generate electricity, as transport fuels, for heating and cooling, and as feedstocks in the chemicals industry. The proposed Bioenergy Action Plan, while it would entail costs and direct subsidies was put forward as a win-win plan, with benefits for renewable energy, and the rural economy. Targets were set for renewable biomass heating of 5% by 2010, and 12% by 2020. A 30% co-firing target was proposed for biomass in the peat power plants. Technically, co-firing up to 50% was feasible, however taking market factors into account 30% was considered the highest feasible at that stage. The Bioenergy Action Plan was subsequently endorsed as government policy in the Energy White Paper (DCMNR, 2007a). The White Paper envisaged that co-firing could be increased to 50% after 2019. Given the de-coupling of EU farm support payments from production, and even in the absence of a world trade agreement, the Ministerial Task Force on Bioenergy considered that there would be progressive de-stocking from Irish farms. This would free up land, which together with lands previously used for sugar beet could be used for energy crops. The total land areas identified for solid biomass energy crops amounted to 140kha.

As regards biofuels, the Bioenergy Action Plan set a target for the transport sector of 5.75% by 2010, and 10% by 2020 (DCMNR, 2007b). Significantly, the 2010 target was to be met through a biofuels obligation scheme, which would require fuel suppliers to mix biofuels to the required percentage in transport diesel and petrol fuels. The limited capacity for indigenous production of liquid biofuels was apparent. To meet the 2% biofuels interim target for 2008 it was estimated that 75 kha would be required, which was 20% of the national tillage area. To meet the 5.75% 2010 target, which was described as challenging, would require 255 kha of land. Allowing for crop rotations, the total national tillage area would need to be doubled, which would cause a reduction in pasture area in excess of the 10% CAP limit. It was frankly acknowledged in the Bioenergy Action Plan that the 2020 target of 10% would have to be met mainly from imports.

7.4.3 National Renewable Energy Action Plan 2010 (NREAP)

Ireland's National Renewable Energy Action Plan (NREAP) (Government of Ireland, 2010) was submitted in July 2010 as required under article 4 of the Renewable Energy Directive 2009/28/EC. The plan presented a projection of renewable energy in Ireland in 2020 which would comply with the requirement for 16% of the total gross final energy consumption, and 10% of transport energy to be from renewable sources. NREAP projected the total domestic supply of primary biomass energy in 2020 to be 1.4 Mtoe, which corresponded to approximately 9% of energy consumption, and 46% of the total renewable energy consumption in 2020. The composition of the biomass resources detailed in NREAP is shown in Figure 7.5. The largest component, representing 29% of the total biomass resource, was the biodegradable portion of municipal solid waste (MSW) including landfill gas which would provide energy of 0.41 Mtoe. While waste was consistently mentioned in previous policy documents as being a potential resource, the magnitude of waste-to-energy resource presented in NREAP was surprising, and had not been flagged as a major contribution by the EPA (Curtis, 2006), nor in the Bioenergy Action Plan (DCMNR, 2007b).

The land area requirements to achieve the NREAP targets were not specified, but deductions can be made based on projected energy values. Forest wood represented an energy resource of 0.26 Mtoe. As this would be supplied from existing forest areas, there would be no additional demand for land beyond the 400 kha which was already implied by the existing forestry expansion policy. Biomass electricity was projected to reach an energy consumption of 0.09 Mtoe (electrical) in 2020 which would correspond to a fuel energy input of approximately 0.23 Mtoe. If produced from energy crops, it would require in the region of 50 kha. If biomass for co-firing were supplied from forestry thinnings and residues, there would be no additional land requirement. Liquid biofuels for transport were projected to total 0.48 Mtoe, of which 0.34 Mtoe or 70% would be imported. The indigenous biofuel contribution of 0.14 Mtoe, if supplied by rapeseed oil or bioethanol, would amount to a minimum of 125 kha excluding other lands required for crop rotations (calculated at ethanol and rapeseed oil yields of 1.5 and 1 toe/ha respectively). Agricultural energy crops, for both solid biomass and liquid biofuels, were projected to provide in total 0.34 Mtoe. Subtracting the indigenous biofuel component of 0.14 Mtoe, leaves 0.20 Mtoe for other solid biomass crops, which would occupy an area of approximately 50 kha (at a nominal yield of 4 toe/ha). The total agricultural area required to meet the NREAP targets would therefore be in the range 175 kha to 225 kha, with the lower estimate being on the assumption that co-firing targets could be met from forest thinnings and wood wastes. The area required would occupy approximately 4 to 5% of farmland, which would represent a moderate impact on food production capacity.

NREAP identified a large agricultural solid biomass resource of 0.26 Mtoe in the form of straw representing 19% of the total national biomass resource and equal to the total projected forest biomass resource. This had no implications for land area, but was an extremely high estimate, which could have implications for agricultural practices and recycling of nutrients in agricultural soils. While the NREAP projection was within the earlier estimates of the theoretical resource (RPS and MCOS, 2004), it represented approximately half of the national straw resources and was more than five times higher than the 0.06 Mtoe which was originally considered feasible for diversion to energy. The remainder of the projected biomass resource comprised manure, animal fats, meat and bone meal, and sewage sludge, with a total energy value of just 0.07 Mtoe, which had no implications for agricultural land use.

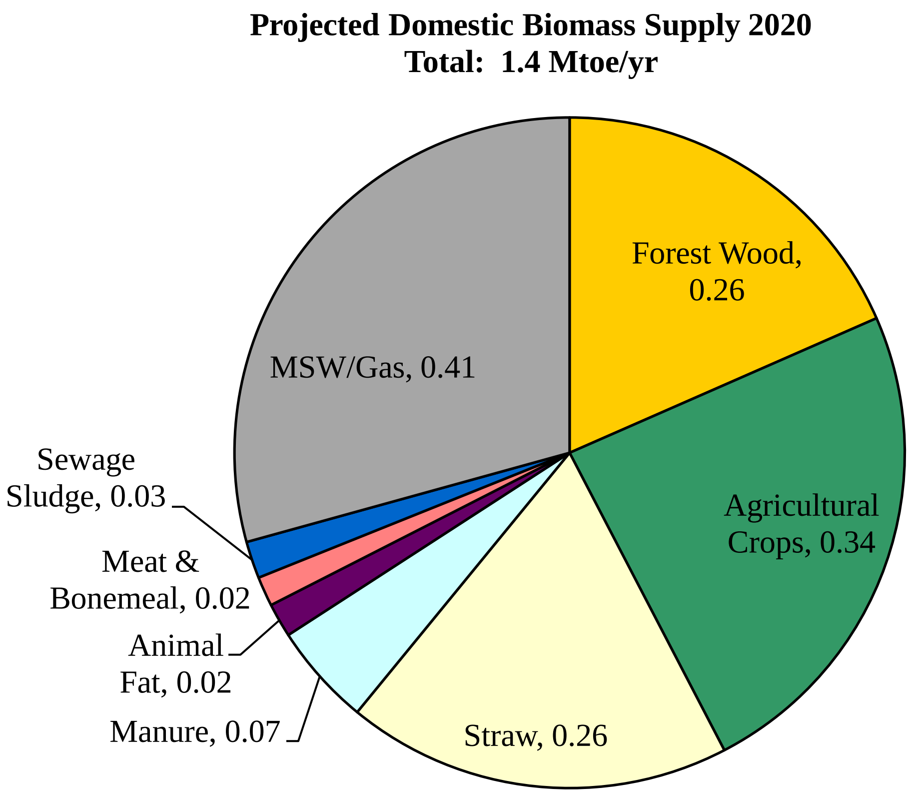


Figure 7-5 Renewable biomass energy resources included in NREAP (National Renewable Energy Action Plan).

7.4.4 BIOENERGY ROADMAP

The Bioenergy Roadmap (SEAI, 2011) was produced to stimulate debate on the role of bioenergy in Ireland's future renewable energy supply in the time frame to 2050, when an 80% reduction in GHG emissions would need to be achieved. The total available biomass resources in 2050 were estimated to be 3.5 Mtoe/y, which was 2.5 times the projection in NREAP for 2020. About 30% of this would be from grass, and 14% from other energy crops. The remainder would be from municipal wastes, agricultural manures, agricultural residues and forestry, which would not have an additional impact on land area. The agricultural area required was not indicated, but would be at least 400kha, based on a nominal primary energy yield of 4 toe/ha. The final land area requirement would depend on the biogas yield from anaerobic digestion of grass crops. At a yield of 2.9 toe/ha (Smyth et al., 2010), the total land area required would increase to about 500 kha, or 11% of the agricultural area as of 2010. It was evident that the projected bioenergy supply for 2050 could have significant implications for land use.

7.4.5 SUPPORT SCHEMES AND PERFORMANCE

National grant schemes aimed at increasing use of the biomass for home and commercial heating and CHP were introduced in 2006 under the Greener Home and Commercial Bioheat programmes (SEAI, 2007). Expenditures on these schemes are documented in the SEAI annual reports, and were relatively small (SEAI, 2014). Under the Greener Homes Scheme an average of €3.8m was paid out annually in grants for installation of biomass heating between 2007 and 2011. The annual budget for the Commercial Bioheat programme was on average €1.5m between 2007 and 2011. Carbon taxation, which could have provided an incentive to change from solid fossil fuels to wood fuels, was not used as a policy instrument during the study period 1990-2012, due to concerns over fuel poverty. A carbon tax was initially introduced only on liquid fossil fuels and natural gas in 2010 (Department of Finance, 2009), and was extended to solid fossil fuels in 2013 (Department of Finance, 2012). Energy crops in general were supported under the CAP by a €45/ha premium paid to farmers. This was supplemented by a national top-up of €80/ha to run for three years from 2007. Bioenergy scheme establishment grants were also available for *Miscanthus* and willow.

Budgets were however limited, and total energy crop support in the form of crop establishment, area top-ups, and harvesting schemes averaged €5m annually from 2007 to 2009. Compared with supports for forestry, which totalled €460 million between 1996 and 2007 (Malone, 2008) support for bioenergy crops was quite small. To encourage use of liquid biofuels, and to provide an opportunity for indigenous production in Ireland, a mineral oil tax relief (MOTR) was introduced for limited quantities of biofuels in 2005. To accelerate progress towards the 5.75% biofuels target for 2010, a biofuels obligation scheme was proposed in 2007 (DCMNR, 2007b), and eventually introduced in 2010 (Energy Act, 2010), which required that fuel companies supply fuel incorporating a specified proportion of biofuels.

Support schemes for renewable electricity began in 1996 with the Alternative Energy Requirement scheme (AER), which provided connection to the ESB grid at negotiated fixed prices. The uptake was mainly by wind energy projects, with a small uptake from land-fill biogas and biomass projects. This scheme was replaced in 2005 with the Renewable Energy Feed-in Tariff (REFIT), which for successful applicants provided a guaranteed floor price for renewable electricity. The first scheme, which operated until 2009, supported wind energy, and the subsequent scheme announced in 2010, provided for electricity generated from biomass, including co-firing with peat, and anaerobic digestion. The REFIT floor prices for biomass electricity were higher than provided for wind energy, as biomass technology was not economically competitive with wind power in the free market. Higher REFIT floor prices were also provided for combined biomass electricity and heat plants (CHP), which represented more efficient energy use (Government of Ireland, 2010).

In addition to the guaranteed floor price, there was the incentive for the peat power stations to co-fire biomass, as there would be a reduction in GHG emissions, and a financial gain through carbon emissions trading. A strong case for the GHG reduction benefits of co-firing biomass with peat was made by Styles and Jones (2007), with projected GHG reductions due to displaced fossil fuel and GHG reduction through displacement of cattle. Compared with traditional agricultural production following de-coupling, gross margins generated by *Miscanthus* and short rotation willow crops were attractive (Styles et al., 2008). *Miscanthus* also presented the opportunity for increasing soil carbon, with a significant projected mean accumulation of 11 tCO_{2eq}/ha/yr, compared with arable farming (Dondini et al., 2009).

7.4.6 ACHIEVEMENTS IN BIOENERGY SUPPLY

Coherent policy development, and concerted efforts to promote bioenergy did not occur until after 2005. It would therefore be unrealistic to have expected a significant bioenergy contribution to the national energy balance by the end of the Kyoto period in 2012. However, the trend in uptake of bioenergy can provide information on the likely achievability of the policies in the time frame to 2020. As shown in Figure 7.6, the total bioenergy supply in 1990 was minuscule at 0.1 Mtoe and met just 1% of the total national primary energy requirement (TPER). The biomass consisted entirely of timber for domestic heating and wood waste used for process heat in the timber products industries. By 2011, the total bioenergy supply had increased to 0.37 Mtoe, which represented 2.6% of TPER. The growth in supply which occurred over the period 1995 to 2011 averaged less than 0.03 Mtoe/year. While this was a low growth rate, at least it apparently held out the prospect of a total contribution of perhaps the order of 1Mtoe after several decades. There were however features of the bioenergy growth curve that contradict this interpretation. Firstly, the contribution of imported biomass became significant after 2005. As can be seen from Figure 7.6, over half of the growth in bioenergy supply from 2005 to 2011 was from imported biomass, mainly in the form of liquid biofuels, and to a lesser extent solid biomass wood fuels. Secondly, a major part of the growth in bioenergy was due to utilisation of existing wood wastes as an energy source in the timber and wood products industries, as can be seen from the sectoral bioenergy consumption graph in Figure 7.7. This was an exploitation of a previously unused wood waste resource which was already available on site. It constituted a once off gain in national bioenergy supply, as the volume of wood wastes could only increase in proportion to an increased rate of forest harvesting. From data presented in the national inventory reports (Duffy et al., 2012), timber harvesting had increased by 80% from 1990 to 2000, but from 2000 to 2010 it had reached a plateau with no systematic upward or downward trend. Net afforestation continued, albeit at a lower rate of 7,000 ha/yr (Teagasc, 2011) and this would eventually produce slightly increased returns. However there would be a time delay of two decades from planting to the first thinnings harvest and at least four decades for an increased commercial harvest (Teagasc, 2005a; 2005b). This assessment of the limited potential of the forest solid biomass resource was reflected in the NREAP estimate of just less than 0.3 Mtoe/yr for 2020 (Government of Ireland, 2010). By any standards, the uptake of the energy crop option by Irish farmers was negligible. Under the Bioenergy Scheme launched in 2007 a total of just 2,413 ha of *Miscanthus* and only 839 ha of willow had been planted by 2012 (DAFM, 2013). Reflecting the poorly developed heating market, there was evidence of waning confidence among farmers in the prospects for bioenergy including removal of *Miscanthus* crops by some farmers (Teagasc, 2014).

The growth in bioenergy consumption is analysed by market sector in Figure 7.7. The main component of the growth was in the industrial sector, which occurred mainly in the timber and wood products sectors for production of process heat, and to a lesser extent electricity (Dennehy et al., 2012). Transport biofuels, which were negligible in 2005, grew rapidly to 0.1 Mtoe by 2011. In the residential sector efforts to promote solid biomass fought against a pronounced downward trend in the use of solid fuels for heating, as residences upgraded to more efficient and convenient oil and gas heating systems. By 2000 the proportion of solid fuels in residential heating had more than halved relative to 1990, from 1.4 Mtoe down to 0.6 Mtoe. Peat and coal together made up 97% of the solid fuel in 2000, and timber constituted just 3%. Reflecting the trend away from solid fuels, there was a steady decline in domestic timber fuel use from 1990 to 2004, which reduced from 0.045 Mtoe to 0.015Mtoe. As high-efficiency timber stove and boiler technology became more available, and encouraged by state supports, this decline was halted, and a slight recovery to 0.023 Mtoe in 2011 was achieved. Yet, even in the cold winters of 2009 and 2010 residential timber fuel consumption was still just 60% of 1990 consumption.

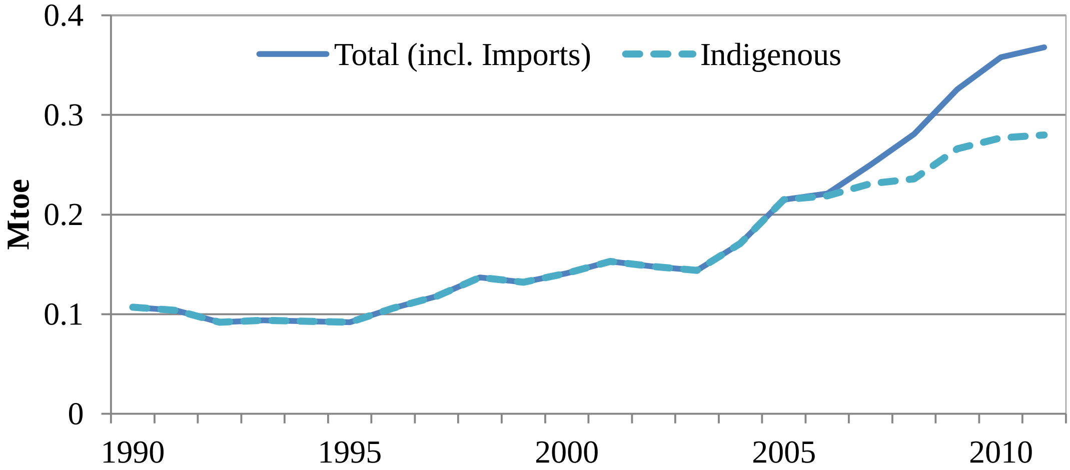


Figure 7-6 Bioenergy supply in Ireland from 1990 to 2011 (SEAI, 2013a). Up to 2005 growth in bioenergy supply was from indigenous production. From 2005 onwards, imports contributed, making up slightly more than half of the growth. Imports consisted mainly of biofuels and to a lesser extent solid biomass. For comparison, Total Primary Energy Requirement (TPER) for Ireland in 2011 was 13.8 Mtoe.

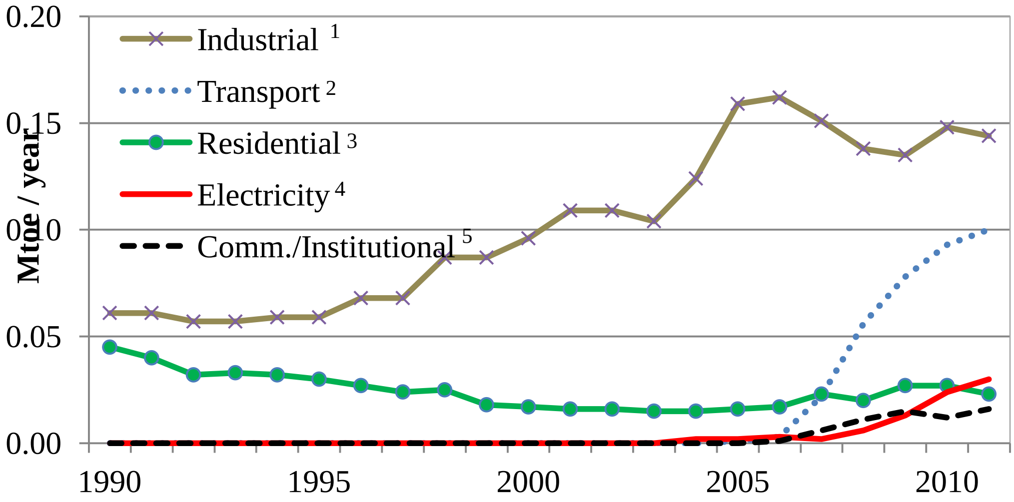


Figure 7-7 Bioenergy consumption by sector 1990 to 2011 (SEAI, 2013a). Most growth from 2000 to 2011 was in the timber processing industry, which increasingly utilized timber wastes for heat and electricity. After 2005 transport liquid biofuel consumption grew rapidly, mainly from imports. Electricity generation was the fastest growing solid biomass sector by 2011.

[1] Industrial: mainly timber and wood waste products for process heat and CHP in timber industry
[2] Transport: biodiesel and bioethanol
[3] Residential: wood fuels in open fires, stoves and boilers
[4] Electricity: wood fuels, landfill and wastewater treatment biogas
[5] Commercial/Institutional: wood fuels for heating

In the commercial and institutional sectors where there was no biomass usage in 1990, consumption grew to almost match the residential sector by 2011, with the main fuel being wood chip. Biomass for electricity supply which was non-existent in 1990 had by 2011 slightly exceeded the biomass consumption in the domestic sector. The use of landfill gas for electricity production began in 1996, and increased steadily. Use of solid biomass for electricity generation did not feature until 2004. By 2011, while solid biomass electricity was still small on the national scale, there was a marked upward trend. In 2011 there was 0.08Mtoe of electricity generated from biomass with 60% from landfill and wastewater biogas, and 40% from solid biomass, mainly forest products and wood wastes. There was notable progress towards the 30% biomass co-firing target in the peat power stations. By 2012 Bórd na Móna had achieved 15% co-firing at its Edenderry power plant (Bórd na Móna, 2012). The fuel was supplied mainly from forest and sawmill wastes and was augmented with energy crops and imports. The calculated biomass fuel input for 15% co-firing at the Edenderry plant is 27ktoe, which exceeded the total residential consumption of biomass in 2011.

Neither the biofuels MOTR scheme, nor the subsequent Biofuels Obligation Scheme (BOS) in 2009 could legally be restricted to indigenous producers. Consequently a significant proportion of the liquid biofuel was met from imported sources. By 2011, imported liquid biofuels made up 76% of the total biofuel supply (SEAI, 2013c). The change from the MOTR scheme to the BOS had a significant impact. The MOTR scheme was not limited to indigenous producers. However the cumbersome operation of the scheme, involving individual applications for excise exemption permits, and the small size of the Irish fuel market, gave some degree of local advantage to domestic producers. BOS gave freedom to suppliers to source biofuels from the most economic source. In practice this favoured importation of petrol and diesel with the required percentage of biofuel pre-mixed. Irish producers could still in theory supply the market, however the structure of the scheme which involved biofuel certificates whose value would be determined on the open market created uncertainty regarding economic returns. By 2011 it was reported that the four small plant oil producers had all mothballed their production facilities (Caslin, 2011). The only indigenous manufacturer of bioethanol, Carberry Milk Products, was still in production but was diverting its output into the potable alcohol market. As is discussed further in Chapter 8 farmer organisations were incensed and accused the government of having destroyed the indigenous liquid biofuel industry through introduction of the BOS.

7.5 Land-Use and Fuel-Food Competition

7.5.1 Land Competition

The national policy objectives of simultaneously increasing forest area, and achieving ambitious energy crop objectives, coupled with an expectation of increased agricultural production from 2010 onward, created additional competition for land resources. The additional land required, as illustrated in Figure 7.8 consisted of 400 kha to reach the 17% forest area target, and a potential additional 400 kha for energy crops as implied by the Bioenergy Roadmap projections (SEAI, 2011). Figure 7.8, shows also for comparison, the land area that would be required to achieve the same renewable energy yield using alternative renewable energy options. For wind energy technology the same energy yield could be obtained from wind farms occupying just 14 % of the area required for energy crops. As normal agriculture can continue on 99% of a wind farm, the land lost to agriculture would be less than 0.2% of the bioenergy option. For large area solar photovoltaic and solar thermal collectors, the land area required would be 3% and 0.6 %, respectively of the area required for energy crops. In a market economy within a parliamentary democracy farmers are largely free to adopt the most profitable and lowest risk option, whether it be forestry, energy crops or food crops. The state and EU can intervene in this quasi-free market through incentives and restrictions to nudge towards desirable policy outcomes. The difficulty facing Ireland was that all state policies as of 2012 required more land. Agricultural food production, forestry and energy crops were all subsidised operations competing for the same land.

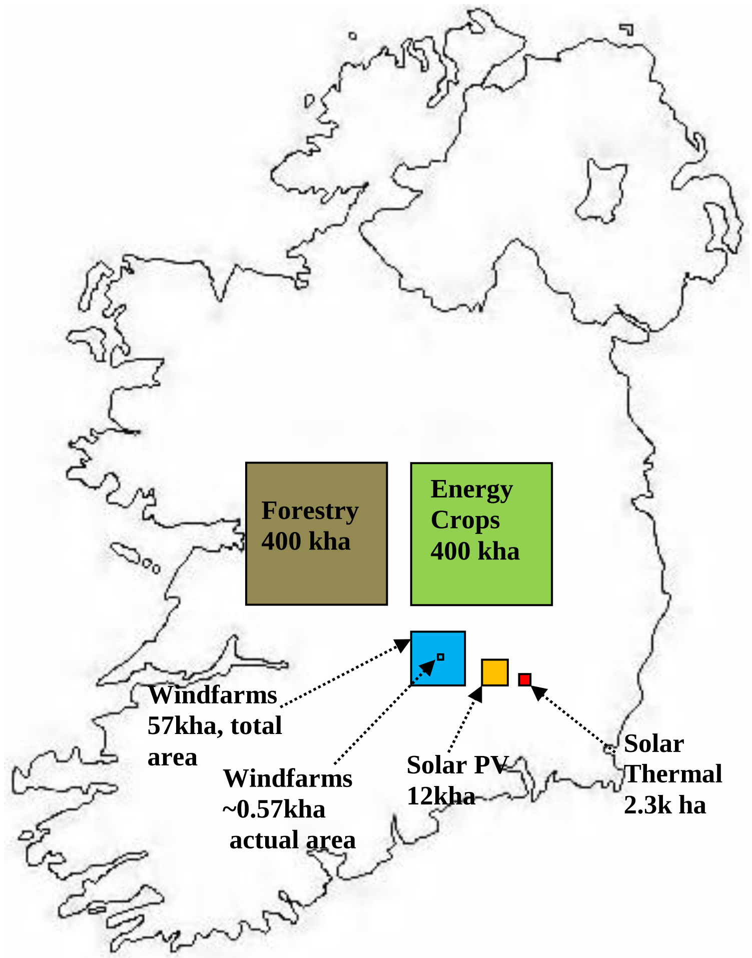


Figure 7-8 Additional forest and energy crop areas to achieve national policy targets in time frame to 2050, drawn to scale. Also shown for comparison are the equivalent areas of wind farms, solar thermal collectors or solar photovoltaic collectors to yield the same energy as the energy crops, assuming a nominal energy crop yield of 4 toe/ha/yr. For windfarms spread over a total area of 57 kha the actual area of farm land lost would be 1% or approximately 0.57 kha. Area requirements are calculated based on data in Figure 7.3.

7.5.2 Food-Fuel Competition

The question of the effect of bioenergy policies on food resources at a national or international level did not feature in Irish policy development in the period 1990 to 2012. Given the scale of agricultural production in the EU, and the low food prices policies underlying the CAP, actual food shortages at retail level within the EU were never likely to occur as a result of EU bioenergy production or importation. On the world scale however, there were growing concerns regarding the impact of bioenergy development on food security. The spike in world food prices in 2007-2008 focused international attention on the possible impacts of biofuel policies (Flamini, 2008; Headey et al., 2010). The possible causes of the crisis were complex and while liquid biofuels were identified as having a role, it was one of many factors including low stock levels, high energy costs, and speculation (DEFRA, 2010). There were in fact adequate world food stocks and production to maintain existing rates of food consumption. However the higher market prices pushed over 100 million people into chronic hunger (FAO, 2009). This view on the adequacy of world food supplies was supported by Hamelinck (2013) who determined that in 2010 there were adequate food supplies for a world population of 12 billion and that local food shortages were caused mainly by waste and local inefficiencies, and not by reduced exports from developed countries. Nevertheless, growing disquiet at EU level was reflected in the reduction of the 2020 biofuels target from 20% to 10% in 2009 (EC, 2009b). In 2012, the EU also proposed to limit biofuels originating from food crops to half of the 2020 target, or 5% (CEC, 2012b). Subsequent analyses by the FAO highlighted continuing concerns, and raised questions regarding sustainability (Elbehri et al., 2013). The report of the FAO High Level Panel of Experts (HLPE, 2013) concluded that biofuels affected food prices, and called into question the use mandates or targets which artificially stimulated biofuel production. An urgent need was identified for coordination of food security, biofuel and energy policies. This issue threatened the viability of the EU's bioenergy policies, and in turn raised questions on the long-term sustainability of bioenergy policy in Ireland.

7.5.3 Irish and EU Food Energy Balance 2009

Economic modeling of food and bioenergy competition seeks to analyse the interaction between food and fuel policies by assigning monetary values to products, economic activities, and environmental objectives. In the following analysis an insight is sought into the food-fuel competition issue based on fundamental energy considerations. The analysis considers the energy content of food crops and of liquid biofuels which leads to an estimate of the overall food energy self-sufficiency of Ireland and the EU. Food energy is typically expressed in dietary calories (Kcal) or in megajoules (MJ). To enable a direct comparison with biofuel energy, food energy is expressed in units of tonnes of oil equivalent (toe). 1 toe of food energy equals 10 million dietary calories. The analysis is restricted to the impact of liquid biofuels as these are in some cases actual foodstuffs such as vegetable oils, or are derived directly from foodstuffs such as bioethanol from cereals.

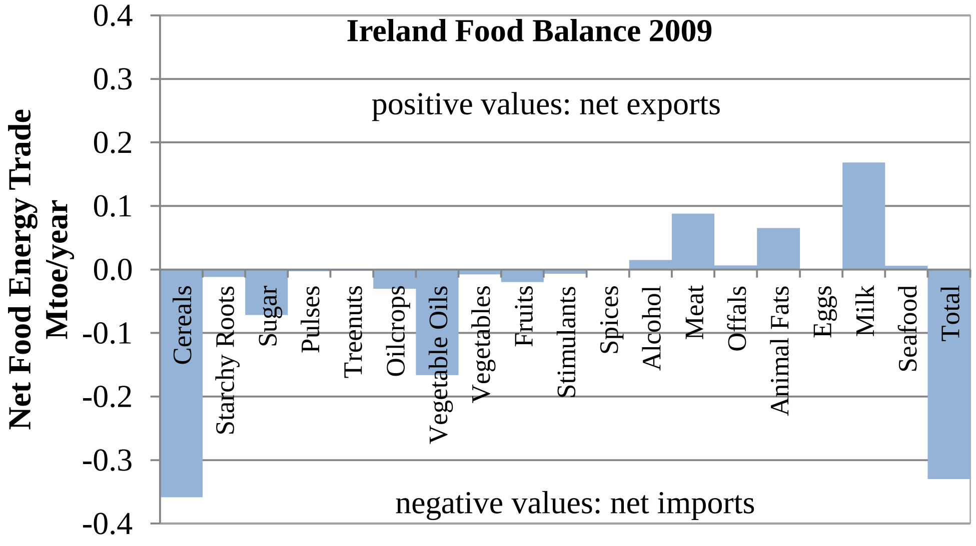
From data compiled by the United Nations Food and Agriculture Organisation (FAO, 2013a), the total production of food energy for both human and animal consumption in Ireland in 2009 is calculated to have been 1.3 Mtoe. This was produced on a total farmed area of 4.6 Mha (CSO, 2011a), giving an average food energy yield is 0.29 toe/ha. FAO data shows that the apparent average food energy available for human consumption in Ireland in 2009 was 0.13 toe/capita/year (3617 Kcalories/day), which included alcohol and food wastage. The low food energy requirement for human nutrition contrasts sharply with the very large energy consumption of the economy which was 3.3 toe/capita/yr in 2009, as calculated from total energy requirement (SEAI, 2013a), and population. This identifies one of the issues at the heart of the food versus fuel conflict. The per capita requirement of energy for machines and heating is twenty five times the human food energy requirement. Biofuels provide a direct linkage between this very large energy demand and the more limited human food energy supplies.

In chapter 5, Irish agriculture was described as an efficient producer of meat and dairy products requiring less cereal animal feeds than the EU average. This analysis was confined to animal food products and animal feeds. When the total food energy balance for Ireland is considered, as illustrated in Figure 7.9, the state is seen to be a net importer of food energy. While Ireland has net exports of food energy in the form of meat, animal fats and milk products, these are almost offset by imports of sugar and food oils. When the importation of cereals is included Ireland had net food energy imports of 0.33 Mtoe in 2009. Of the total food supply in Ireland for both animal and human consumption, 19% was provided by net imports, which was sufficient annual food energy for 2.6 million people at average EU food consumption rates. Cereals, vegetable oils and sugar, which account for the food energy deficit, are the common feedstocks for liquid biofuel production. Details of the food energy balance analysis and calculations are included in appendix C. For the EU-27, as shown in Figure 7.9, the net food energy importation was proportionally lower than for Ireland with just over 5% (8.4Mtoe) of the total food supplied from net imports. Net food imports corresponded to the annual food energy requirements of 66 million people. There was a net export of cereals from the EU, but a significantly larger net import of food energy in the form of vegetable oils and oil crop products.

7.5.4 Effect of Biofuel Imports on Food Energy Balances

For Ireland and the EU-27 importation of liquid biofuels derived from food crops would increase food energy deficits. In Ireland's case, assuming that imports of biofuels can be limited to 0.34 Mtoe as projected for 2020 (Government of Ireland, 2010), and assuming only half of this originates from food crops, this would increase Ireland's food energy deficit to 29% of the total national food supply. The total imported food energy would be sufficient to feed almost 4 million people at average EU consumption rates. For the EU as a whole, the 2020 importation of biofuel is projected to be 7.4 Mtoe (Beurskens and Hekkenberg, 2011). If half of this is sourced from food crops, then the EU food energy deficit would increase from 5 % to 8% of the total food supply, or enough food energy for 96 million people (calculation details in appendix C).

The expansion of liquid biofuels poses a quantifiable risk to the food energy balance in both Ireland and the EU-27, by increasing net imports of food-based biofuels, or biofuel feedstocks such as cereals and plant oils. Given the wealth of the EU, the ability to purchase these imports would be in little doubt. The food security risk would be borne by developing nations, who in turn would need to greatly increase agricultural production to compensate for their exports of biofuels or feedstocks. The foregoing analysis is confined to the projected importation of biofuels and represents the minimum expected food energy impact.



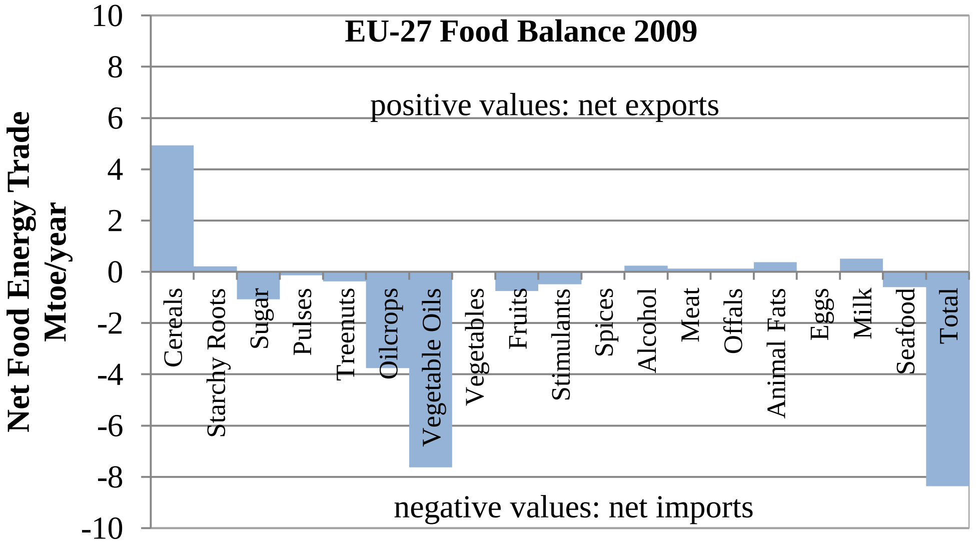


Figure 7-9 Food energy balance for Ireland and EU-27 in 2009 (FAO, 2013a). Positive values indicate net exports, and negative values net imports. The total net importation of food energy was 0.33 Mtoe, which represented 19% of the total Irish domestic food supply, which was 1.7Mtoe in 2009. For the EU, the total net importation of food energy was 8.4Mtoe, which represented 5% of the total EU food supply of 156 Mtoe in 2009.

1 tonne of oil equivalent (toe) of food energy equals 10 million dietary calories (Kcal), and 42 GJ
Net food exports = exports – imports (food for both human and animal consumption)
Meat: excludes animal fats, which are a separate item
Milk: excludes butter, which is included in animal fats
Food energy is calculated from FAO net export food tonnages, using implied nutritional energy content from the same FAO database

Projections for the EU-27 for 2020 are that 74% of biofuels would be produced in Europe (Beurskens and Hekkenberg, 2011). Growing energy crops in the EU to supply this demand would also risk displacement of domestic food production, which could decrease exports, and consequently increase the net food energy deficit.

7.6 Conclusions – Bioenergy Policy

At face value bioenergy appeared to embody the very definition of sustainable development. It could integrate national objectives in energy security, GHG emissions, agriculture and rural employment. It was expected to contribute to renewable electricity, transport fuel, heating, and as a feedstock in the chemicals industry (DCMNR, 2007b). It was promoted as an essential element in delivering future energy needs with the opportunity for Ireland to become a leader in bioenergy technology (SEAI, 2011). In the National Renewable Energy Plan (NREAP) bioenergy was expected to provide almost half of Ireland's renewable energy target by 2020 (Government of Ireland, 2010). It would appear however that the case for bioenergy was overstated, as in reality biomass resources in Ireland were limited. To reach the ambitious bioenergy target in NREAP the planners were forced to factor in an unrealistically large area for energy crops of at least 175kha, with additional bioenergy supplies from unlikely sources. Waste to energy facilities, which did not exist on any significant scale in 2010, were expected to generate 29% of renewable bioenergy in 2020. In addition it was envisaged that about half of the national straw resource would be diverted to bioenergy. A fundamental limitation in development of a significant solid biomass industry in Ireland was the very low forest area. Short rotation biomass crops such as willow and *Miscanthus* were technically viable energy crops that could in principle provide an additional supply. While these crops were nominally economically viable, there were risks involved, and despite promotion and modest subsidies such crops did not prove to be an attractive option for farmers. From an energy efficiency perspective biomass heating was the best way of maximising the delivery of renewable energy to the consumer. However there were difficulties in achieving market penetration, given the existing trend away from solid fuels, the bulky nature of biomass fuels, and uncertain supply chains. Carbon taxes which could have encouraged a switch from peat and coal to biomass were postponed until 2013 due to concerns over fuel poverty. The fastest growing use of purchased solid biomass was co-firing in the peat power stations. While it was the least efficient in terms of delivered renewable energy, it was actively supported by state policy and by the state owned Bórd na Móna. There was nevertheless a slow but encouraging uptake by the commercial and institutional sector, which held out hope for creation of a long-term sustainable biomass heating sector.

The Biofuels Directive was grasped enthusiastically as an opportunity to develop an indigenous liquid biofuels industry which would aim for 5.75% biofuels in transport by 2010 (DCMNR, 2007b) despite scientific advice that 2% would be the highest practicable indigenous production (Hamelinck et al., 2004). By 2012, it was clear that future growth in biofuel supply would be from imports which would provide no additional energy security or employment. In the absence of market protection the small indigenous biofuels industry could not survive. This outcome was no surprise from an historic perspective. The same factors of limited indigenous feedstocks, competition from cheaper imports, and preclusion of market protection within the EU had been responsible for the demise of the state alcohol company in the 1980s.

Apart from the supply and market difficulties, from a long-term sustainable development perspective there were inherent weaknesses in the very ambitious Irish bioenergy policy. As an energy source bioenergy is a land-hungry option, with land requirements at least two orders of magnitude higher compared with alternatives such as wind power, solar thermal and photovoltaic technologies. To achieve ambitious bioenergy targets to 2050 could possibly require up to 400kha of land. Although such expansion was highly unlikely based on the evidence up to 2012, there was a technically feasible future solution using grass as an energy crop for production of biogas which would enable rapid expansion of the bioenergy crop area. Were the projected bioenergy crop area to be achieved, it would compete for available land with agriculture, and with forestry which also required an additional 400kha to reach the 17% afforestation target.

There were evident conflicts between agricultural policy, forestry policy, and bioenergy policy, all of which required land, and all of which were in receipt of subsidies.

While there were strong policy drivers at EU level for promotion of all aspects of bioenergy, and to an extent a loss of national policy ownership, there was still considerable scope for interpretation and implementation of policies to suit the national circumstances. Given the limited national biomass resources, a bioenergy policy focused on a small number of market applications would have been more effective. Regarding solid biomass, heating appeared to be the optimum choice, rather than the less efficient co-firing at the peat power plants. There was some progress in the commercial and institutional heating market that could be built upon, and also the unexploited possibility of biomass district heating for residential developments. To achieve a reliable supply of biomass crops considerably higher levels of state support would have been required, on the scale of the supports provided to forestry. Biofuels did not at any stage appear to be a viable strategy for Ireland. The Biofuels Directive (EC, 2003c) could have been implemented from the start simply as a market regulation, without embarking on indigenous production. Deviations from the indicative targets could also have been sought within the flexibilities provided in the directive. Sustainability issues did not feature in Irish policy formation on biofuels. The potential adverse effects of imported biofuels on European food energy balances and world food supply suggest that reliance on biofuels imports is inconsistent with sustainable development. Rather than relying on biofuels to meet EU renewable transport energy targets for 2020, a less risky and more sustainable long-term approach would be to focus on increased promotion of electric vehicles, which are inherently much more energy efficient than internal combustion engines, and could take full advantage of the state's large wind power resources.

8 PUBLIC CONSULTATIONS

8.1 SUBMISSIONS ON ENERGY AND CLIMATE CHANGE POLICIES

Public consultations on national renewable energy and GHG mitigation polices provide an insight into the views of a wide range of stakeholders and actors, and help in further understanding bioenergy policy formation. Following the public consultations, changes from the draft policies to the final policies, also provide an indication of the receptiveness of policymakers to concerns and alternative proposals, and help to assess the overall quality of stakeholder involvement in the public consultation processes. The initial CO_2 mitigation strategy (DOE, 1993), and the subsequent NCCS in 2000 (DELG, 2000a), did not involve formal public consultations. However from 2004 onwards such public consultations featured in the formation of national policy on GHG mitigation and renewable energy policy. Public consultations occurred initially in the context of the Emissions Trading Scheme (ETS). As discussed in chapter 6, submissions on the operational phase of the ETS were almost entirely from industrial operators or representative bodies, and dealt only with the magnitude of their own emissions allocations. These are not considered further here.

National energy policy as expressed in the Energy White Paper in 2007 (DCMNR, 2007a) was preceded by an Energy Green Paper (DCMNR, 2006b) which invited submissions from the public. Renewable energy targets in the Energy Green Paper closely followed existing EU directives and the anticipated EU renewable energy targets for 2020. Bioenergy was stated to be a core component of the state's sustainability policy and the Energy Green Paper proposed that there would be 30% co-firing of biomass with peat in the electricity generating stations. A 5.75% biofuel target was set for the transport sector for 2010 in line with the EU Biofuels Directive (EC, 2003c), supported initially by an excise relief scheme, with the option of moving later to a tax-neutral biofuels obligation scheme. A target for renewable heat of 5% was set for 2010, half of which would be supplied by biomass. A renewable electricity target of 30% was set for 2020, to be met mainly by wind power. The existing prohibition on nuclear energy would be maintained (Electricity Regulation Act, 1999). Ocean energy, which in

2006 was still in the early experimental stage of development, was factored in as a future renewable energy source, with a strangely precise projection of 84 MW installed capacity by 2020. National climate change strategy was revised in 2007, as described in chapter 3 (3.4.2). It was preceded by a published policy review entitled Ireland’s Pathway to Kyoto (DEHLG, 2006a) which invited submissions from interested parties. The drafting of the National Renewable Energy Action Plan (NREAP) in 2010, was also accompanied by a public consultation process. As discussed in chapter 7, NREAP greatly increased the projected bioenergy supply for 2020.

Between the Energy Green Paper in 2006, the NCCS review in 2006, and the draft NREAP in 2010, there were over 200 submissions which were published on the websites of the relevant government departments (DCMNR, 2006c; DEHLG, 2006c; DCMNR, 2010). An overview of the number of submissions and affiliations is provided in Table 8.1. Bioenergy as a renewable energy option was readily engaged with in the majority of the submissions, and is considered in detail in section 8.3. Of particular interest to the present study is the degree to which the stakeholders and actors engaged with bioenergy policy in terms of its achievability, and the implications for land-use, including sustainability aspects. Submissions addressing the role of agriculture in national GHG and energy policy are discussed in section 8.4. The topics of nuclear power and ocean energy while not generating the same degree of interest in the public consultations nevertheless provide an opportunity to explore how longer-term, more speculative energy options were approached in the public consultations, and responded to by the policymakers. These topics are discussed in section 8.5.

Overview of Public Consultations	**Energy Green Paper 2006**	**Review of National Climate Change Strategy 2006**	**Draft National Renewable Energy Action Plan 2010**
Total submissions	109	331	58
Duplicate submissions [1]	5	281	0
Unique submissions analyzed	104	50	58
Composition of submissions by affiliation (excluding duplicates)			
Industry, Business, Representative Bodies	40%	37%	43%
Public, Local Authorities/Bodies, State agencies, Govt. Depts.	26%	20%	26%
NGO's, Think Tanks, Political Parties, Campaign Groups	11%	12%	16%
Academics, Professional Organisations, Trade Unions	12%	8%	7%
Citizens	12%	22%	9%

Table 8-1 Overview of public consultations, number of submissions, and affiliations. Further details of comments on bioenergy are provided in appendix D.

[1] Duplicate submissions were those that consisted of typically just a letter supporting a named submission from another party, and contained no additional comments or views. In the review of the NCCS in 2006 there were 279 single-page submissions from individuals sent via Friends of the Earth. These are categorised as duplicate submissions, as they followed a template, with only minor variations. The points raised in these submissions are treated as single unique submission.

8.2 MAIN TOPICS ADDRESSED IN SUBMISSIONS

An overview of the main topics identified in the three public consultations is shown in Figure 8.1. The main theme of energy supply runs through the three sets of consultations either in terms of overall national targets or under sub-headings, such as wind, bioenergy, ocean and solar power. Energy security, competitiveness and efficiency concerns were major topics in the Energy Green Paper 2006 submissions. Energy efficiency featured also in the NCCS review in 2006 in the context of submissions on the built environment and in the draft NREAP 2010, where comments were directed at the efficiency of co-firing. Emphasis in the Energy Green Paper 2006 was on electricity and gas energy supplies, with little consideration of the transport sector. This was mirrored in the submissions, where just 16% addressed transport energy issues. Interest in transport increased to 59% of the submissions in the NCCS review 2006, where transport was treated as a separate sector. In the draft NREAP 2010, submissions on transport reduced to 17%, where the interest focused on renewable transport fuels, namely biofuels.

Relative to other topics, bioenergy was a significant topic engaged with in a high proportion of submissions, featuring in 45% of the Energy Green Paper 2006 submissions, 39% of the NCCS review 2006 submissions, and in 57% of the draft NREAP 2010 submissions. The content and tone of the submissions on bioenergy were generally supportive and where deficiencies were identified, proposals were made for additional supports or actions, as discussed further in section 8.3.1. There was no identifiable outright opposition to the government's policy that bioenergy would be a significant element of renewable energy policy, although this conclusion could be inferred from a small number of submissions which can be interpreted as critical of bioenergy targets and modalities, as discussed further in section 8.3.4.

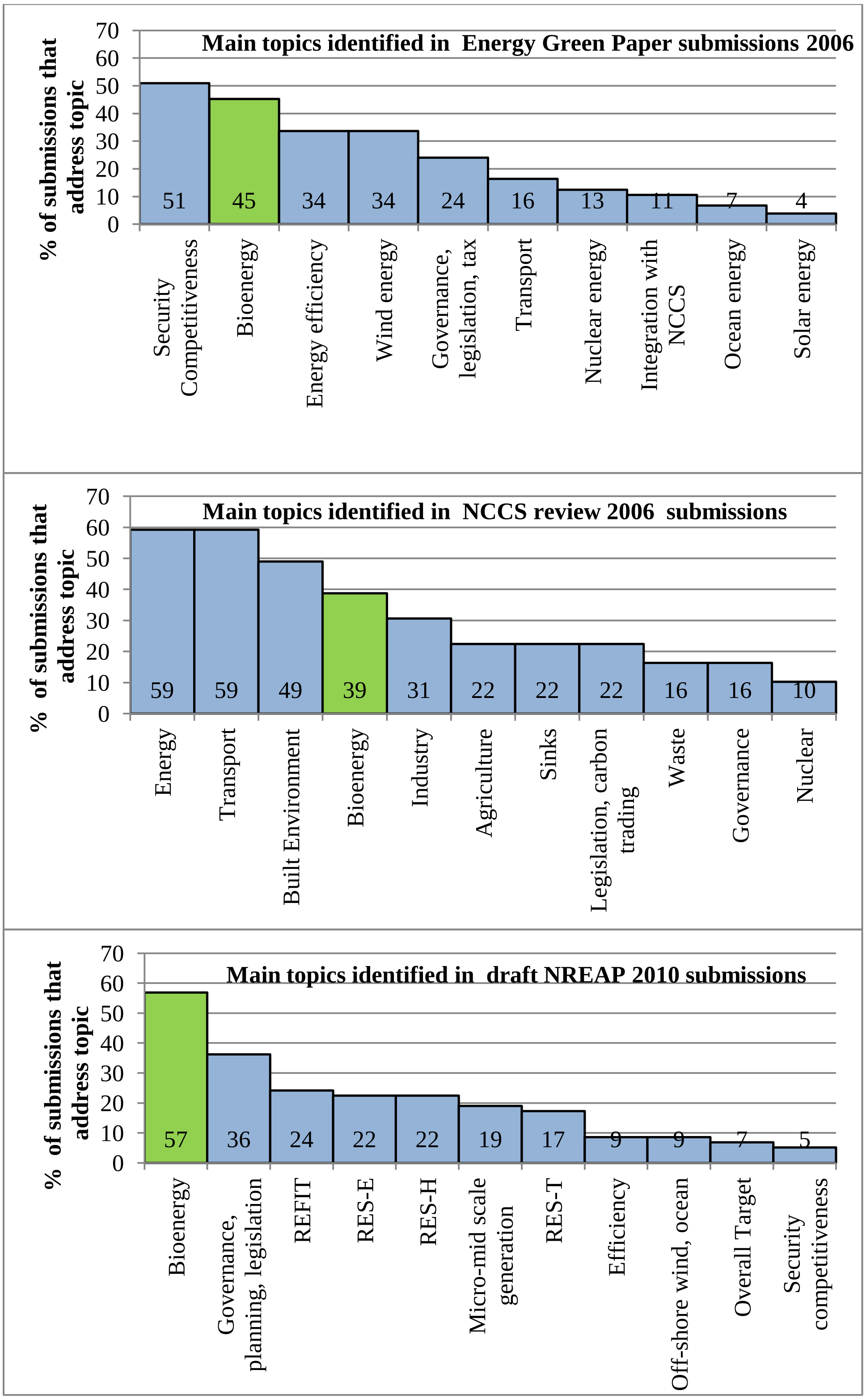


Figure 8-1 Topics addressed in the three public consultations. Bioenergy was well represented in all three consultations. Number of submissions: Green Paper: 104, NCCS review: 50, draft NREAP: 58

Governance emerged as a common topic across the three public consultations, with submissions generally calling for more overarching responsibility, streamlined planning processes, and implementation mechanisms. In the public consultation on the NCCS review 2006 a number of submissions were critical of existing governance. These included submissions from the Royal Irish Academy, the business lobby group IBEC, the Green Party, Friends of the Earth, Forest Friends Ireland, EPA, and Comhar. The overall thrust of these submissions was that clarity was being sought on exactly who was in charge of GHG policy, and precisely how targets were to be reached.

8.3 SUBMISSIONS ON BIOENERGY

8.3.1 SUPPORT FOR BIOENERGY

A statistical analysis of the submissions into those in favour of or against overall bioenergy policy yields little useful insight, as all of those who made submissions on bioenergy could be interpreted as either supportive, or at least not actively against the broad government policy. Negative comments do not necessarily indicate opposition to a particular aspect of the policy, as in many such submissions additional supports for bioenergy were also called for. The statistical analysis presented in Figure 8.2 is therefore in terms of the fraction of comments that express agreement or call for more supports for bioenergy, and the fraction of the total comments expressing doubts or concerns in specific areas. It should be borne in mind that supportive comments and doubts or concerns in many cases were included in the same submission.

For the three sets of public consultations a clear majority of the comments could be interpreted as agreeing with existing supports or urging additional supports for bioenergy, with 73% support in the Green Paper 2006 submissions, and 76% in the NCCS review 2006. In the submissions on the draft NREAP 2010, there was a reduction in the proportion of support, but at 62% it constituted a majority of the comments. The areas where more supports were urged are presented in Figure 8.3.

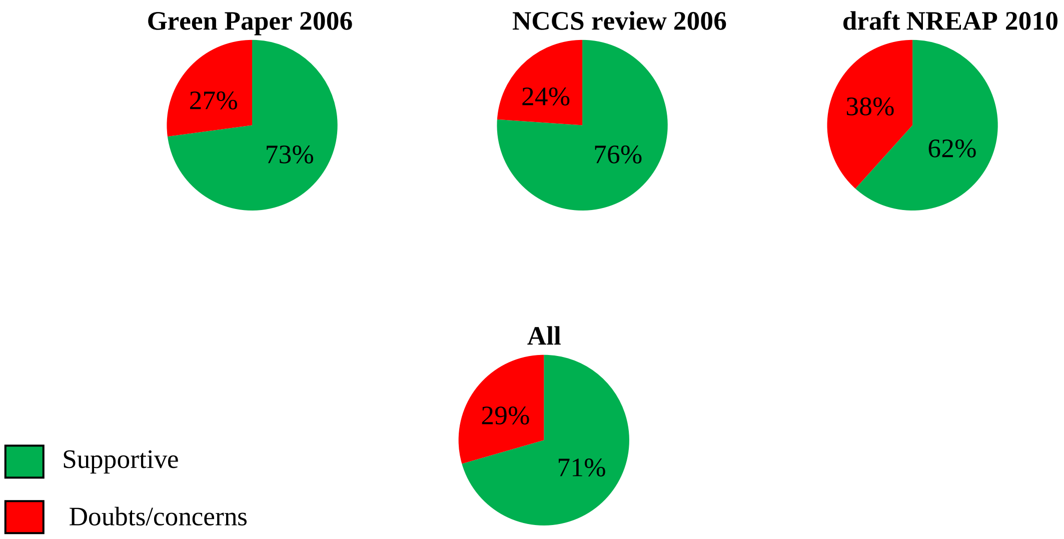


Figure 8-2 Support and concerns on bioenergy policy. "All" = combined data for Energy Green Paper 2006, NCCS review 2006 and draft NREAP 2010.

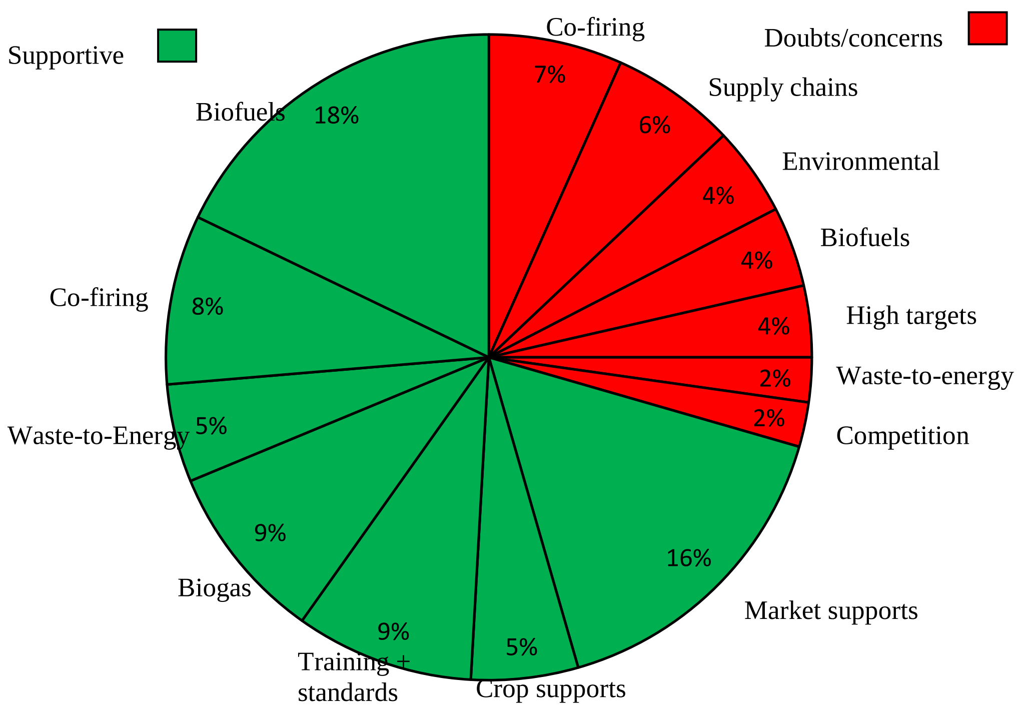


Figure 8-3 Analysis of comments on bioenergy policy, as a percentage of total comments on bioenergy in the three public consultations studied. Total number of comments: 224. Plotted from data in appendix D.

Taking the sum of the comments for the three sets of consultations, more action was urged in the form of market supports and crop supports in 21% of the total comments on bioenergy. Proposed fiscal supports included direct supports for establishment and annual production of energy crops, tax reductions on biofuels, VAT reductions, and a renewable energy feed in tariff (REFIT) for electricity produced from bioenergy. Of the non-fiscal measures proposed the most popular was a requirement on the public sector to adopt the emerging bioenergy technologies for public sector heating and in public transport vehicles. It was argued that this would kick-start the market and provide a market signal of continuity of demand. There was also a view that the state should assist in developing the supply chain for biomass, which was identified as an impediment to development. More education or training in the area of bioenergy technology, and standards for biomass fuels were called for in 9% of comments. Specific supports for indigenous biofuels were proposed in 18% of the comments, and co-firing was supported in 8% of comments. Other areas of bioenergy where support was expressed were waste-to-energy, and biogas, each of which featured in 9% of the comments.

8.3.2 Submissions on Anaerobic Digestion (AD), Biogas

Anaerobic digestion of biomass, and of agricultural and municipal wastes, was supported in 9% of the comments in the three public consultations. There were no negative comments on biogas. In its submission on the NCCS review 2006 the EPA supported biogas production from wastes and also the use of grass for biogas production. Grass as a biogas feedstock was also supported by the Irish Bioenergy Association. Cross-party political support was evident in the submission from the Joint Oireachtas Committee on Climate Change and Energy who expressed strong support for grass-to-biogas, pointing to the additional benefits of reduced agricultural emissions from the displaced livestock. Scientific support for grass-to-biogas was provided by the UCC Sustainable Energy Group who speculated that grass could possibly be categorised as a lignocellulosic feedstock qualifying for a bonus in assessing compliance with EU renewable energy targets.

8.3.3 Submissions on Waste-to-Energy (WTE)

The Green Paper 2006 had not mentioned waste as a biomass resource. In the NCCS review 2006 waste-to-energy (WTE) was proposed as an additional renewable energy which would be supported in local authority waste management plans, but no targets were quantified. Comments on WTE were limited, with seven comments identified in the Energy Green Paper 2006 consultation, and six in the NCCS review 2006 consultation, mainly supporting waste-to-energy, with a small number expressing concerns regarding pollution. The Confederation of European WTE questioned why biodegradable municipal waste was not included in the Energy Green Paper. They claimed it could yield five times more energy than landfill gas and anaerobic digestion of wastes and would be best used as district heating yielding 128ktoe/yr. Indaver, a waste management and recycling company, submitted that biodegradable municipal solid waste and other biodegradable solid waste represented a significant biomass resource which could yield electrical power and heat totalling 45 ktoe/yr. This represented about 10% of the total bioenergy target, and 21% of the solid biomass component envisaged in the Energy Green Paper.

Interest in WTE had evidently dwindled by 2010, as there were just three significant comments in the draft NREAP 2010 submissions of which two expressed concerns on environmental grounds. The business representative group IBEC made an oblique reference to WTE in asking whether it would qualify for REFIT support. The general silence in the draft NREAP 2010 submissions on WTE was quite remarkable given that 29% of the total national biomass supply was expected to be provided from this source and given the high publicity attracted by the proposed Dublin WTE plant at Poolbeg, which had been given planning permission in 2007 (An Bord Pleanála, 2007).

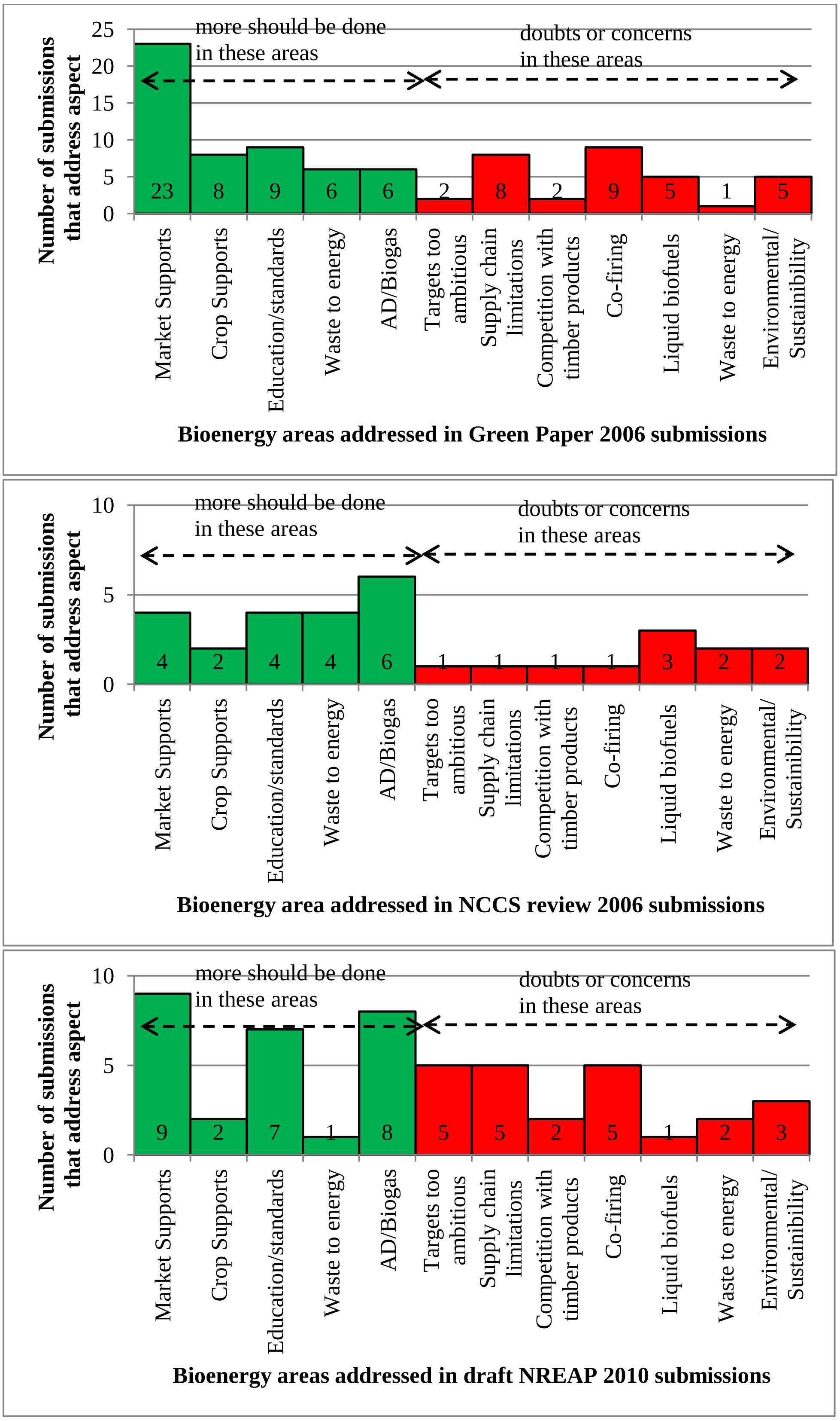


Figure 8-4 Comments on bioenergy policy in the public consultations for the Energy Green Paper 2006, NCCS review 2006, and in the draft NREAP 2010 (plot of data from appendix D).

8.3.4 Concerns and Doubts Regarding Bioenergy Policy

Concerns and doubts raised in submissions were frequently couched in polite language to the extent that it was unclear if a criticism was being made at all. Not a single submission expressed the firm opinion that any particular renewable energy target would be unachievable. The words “ambitious” or “challenging targets” were used, which could be interpreted by a policymaker as compliments on the boldness of the plan, but were more likely coded comments meaning “not achievable”. Taking the combined comments in the three sets of public consultations, as presented in Figure 8.3, the areas of concern or where doubts were expressed included: targets being too ambitious (4%), supply chain limitations (6%), competition between bioenergy applications and the timber products industry (2%), environmental or sustainability concerns (4%), doubts on the co-firing policy (7%), and doubts on liquid biofuels policy (4%). Concerns on WTE (2%) referred to environmental pollution. Figure 8.4 shows the analysis of the comments for the three public consultations. As the numbers of comments on specific topics in each of the consultations were generally low the following discussion refers to the number of comments, rather than percentages.

8.3.4.1 Questioning Targets

Bioenergy targets were largely ignored in submissions, and were questioned as being overly ambitious in just eight instances in the three public consultations. In submissions on the Energy Green Paper 2006, Teagasc and the Western Development Commission questioned aspects of the bioenergy targets. Only Comhar addressed the issue of targets in its submission on the NCCS review 2006. In the draft NREAP 2010, overall bioenergy targets had increased significantly beyond those implied by the Energy Green Paper 2006 and the NCCS 2007. There were five submissions which questioned the NREAP targets. These concerns revolved around achievement of the renewable heat target (RES-H) of 12% which was reliant on a significant biomass component. The target was questioned as being ambitious by Bórd na Móna, ESB, IBEC, Joint Oireachtas Committee on Energy and Climate Change, and the Kilkenny Leadership Partnership. That Bórd na Móna, who were proponents of bioenergy, should question the target was particularly significant. Likewise, the ESB considered the RES-H target to be challenging, and they were concerned that failure to meet the RES-H target would place an additional burden on the electricity sector to increase RES-E. These comments by Bórd na Móna and the ESB are even more significant given their close relationship with the Department of Energy and their probable involvement in providing technical advice on the development of the draft NREAP 2010.

8.3.4.2 SUPPLY CHAIN LIMITATIONS AND COMPETITION

At the time of the Green Paper in 2006 Ireland had only one significant developed biomass supply chain, which was in the forestry industry. This supply chain served the timber sawmills, and provided pulp wood to board factories. There was the fear that development of new biomass electricity and heating markets, without expanding the supply chains, would result in competition for timber resources. A total of 14 comments in the three public consultations addressed this problem. It was mentioned by Bórd na Móna in its submission on the Energy Green Paper 2006 and on the NCCS review 2006. The state owned commercial timber company Coillte expressed caution on competition between energy applications and the timber products industry in its Energy Green Paper submission. Their view was that using wood biomass for manufacture of wood products maximises the economic value, employment, and carbon sequestration. At the end of the useful life of the products and when the recycling options have been exploited, the products could eventually be converted to energy. Coillte continued its opposition to biomass energy in its submission on the draft NREAP 2010, arguing that valuable wood biomass resources should be used in the most efficient manner, including heating, CHP and manufactured wood products. Specifically it requested that the guaranteed renewable energy tariff (REFIT) should not apply to electricity generated using virgin forest wood as a feedstock.

8.3.4.3 CONCERNS ON LIQUID BIOFUELS

Of a total of 49 comments on biofuels, 40 were supportive, and doubts or concerns, but not outright opposition, were raised in just 9 instances. There were five comments expressing concerns or doubts in the Energy Green Paper 2006 consultation, three in the NCCS review 2006 consultation, and with evidence of waning interest, just one voiced concern in the draft NREAP 2010 consultation. In its Energy Green Paper submission, the ESRI (Economic and Social Research Institute) stated that liquid biofuels would not be economic, claiming that foregoing taxes would be a serious waste of resources. The Federation of Petroleum Suppliers had a number of concerns regarding biofuels, including the lack of indigenous supplies, environmental and food supply impacts of biofuels imports, and technical issues regarding water in biodiesel and in bioethanol. As an alternative to biofuels, the NUIG Combustion Research Centre suggested that limitation of engine size would be a more effective means of achieving GHG reductions. Ireland's limited capacity to produce biofuels was highlighted in the Teagasc submission on the Energy Green Paper 2006. Their analysis showed that a 5.75% biofuels target would be extremely difficult to achieve from indigenous resources as it would require up to 720 kha of land in tillage, almost twice the existing tillage area. Instead Teagasc proposed a 2% biofuels target, which could be met from indigenous resources. The Friends of the Earth in submissions on the Energy Green Paper and on the NCCS review 2006 argued that biofuels should not be imported and that use should be limited to public sector vehicles. The Sustainable Institute, an environmental policy group, submitted that large scale use of biofuels was not sustainable in view of environmental and food supply concerns. A submission from the Forestry Section of the IFA (Irish Farmers Association) was supportive of liquid biofuels but warned that a biofuels obligation scheme as opposed to an excise tax relief scheme would result in obligated parties importing their biofuel requirements.

8.3.4.4 Concerns on Co-firing and Biomass Electricity

Of the 34 comments on co-firing and biomass electricity, 19 were supportive and 15 raised questions or concerns. In the Energy Green Paper 2006 consultations five submissions criticised co-firing on the basis of the transformation losses compared with the more efficient use of solid biomass for heating or CHP. These concerns were voiced by Coillte, Comhar, ESRI, and the North West Group and Feasta environmental organisations. Comhar subscribed to the view that CAP reforms would result in idle land and saw bioenergy as a useful policy in that context. While expressing support for co-firing their view was that biomass for heat should be the priority. The Association of Irish Energy Agencies questioned how the co-firing target was to be met. Amergin

(Tipperary Institute of Sustainability) requested a cost-benefit analysis of co-firing and referred to the need to consider the supply chain. The Irish Academy of Engineers claimed the co-firing target was inconsistent with national afforestation levels, and proposed that solid biomass be reserved for heating. Bórd na Móna stated that there was not sufficient solid biomass to achieve 30% co-firing. The Bórd na Móna comment should not be interpreted as opposition to co-firing, rather as a clarification of the indigenous supply potential. In their submission on the NCCS review 2006 they stated that co-firing had potential, but again questioned the indigenous resources to achieve a 30% target. Finally in their submission on the draft NREAP 2010 Bórd na Móna indicated that to achieve 30% co-firing one third of the biomass would be imported dry matter, one third would be forest wood, and one third energy crops. The energy and facilities management company 4Front Energy and Environmental in their submission to the draft NREAP 2010 bluntly said that co-firing was inefficient and should be discontinued. The ESB was more circumspect, and commented that the co-firing target seemed ambitious. Coillte in the draft NREAP 2010 consultation again argued that co-firing was inefficient and would damage other sectors. Further evidence of the likelihood of importation of biomass was provided in a submission by Fuel Synergy Ltd. to the draft NREAP 2010. In describing a planned biomass power plant in Co. Mayo it was anticipated that 40% of the biomass fuel would need to be imported.

Overall, serious concerns were raised during the consultation processes regarding the ability to efficiently meet co-firing targets from indigenous resources. The views of Bórd na Móna were particularly relevant as they had by that stage engaged in feasibility studies on biomass co-firing at the Edenderry power station and would have had a good understanding of the supply limitations. Notwithstanding Bórd na Móna’s support for co-firing, their assessment that imports would be required to meet one third of the co-firing target raised doubts on the overall benefits. The original justifications for co-firing were energy security, jobs in the rural economy, GHG reduction, and extension of the life of the peat reserves. Were imports to be used, employment and energy security benefits would be undermined. That the ESB questioned the co-firing target also cast doubts on the policy. Concerns expressed by Coillte on competition with the timber products industry, and the numerous submissions on the inefficiency of co-firing, added to the weight of evidence questioning the wisdom of pursuing co-firing.

8.3.4.5 Environmental, Sustainability and Food Aspects

There were a total of ten comments in the three public consultations which addressed concerns on aspects of environmental impact, sustainability and food supply. The low level of interest on these issues from important state bodies such Comhar and the EPA, indicated that environmental and sustainability issues relating to bioenergy were not high on the national agenda. In the Energy Green Paper 2006 submissions there were a total of five comments, two in the NCCS review 2006, and three comments in the draft NREAP 2010 consultation. Of the total comments on environment and sustainability, food-fuel competition was mentioned briefly in just four instances. In the Energy Green Paper 2006 consultation, the Federation of Petroleum Suppliers, who expected biofuels to be mainly imported, had concerns on the effects of biofuel production on food supplies and ecosystems worldwide. The environmental and social justice group Gluaiseacht questioned whether market forces should be allowed to determine the balance between food and biofuel supplies. Famine in the developing world as a result of biofuel production was considered likely by the Northwest Group, an environmental policy organisation. Human health risks from burning biomass, and the danger of environmental damage elsewhere were mentioned by the Combustion Research Centre at NUIG. Submissions on environmental aspects in NCCS 2007 by Comhar and Forest Friends Ireland were limited to protection of peatlands and regeneration of natural forests. Biodiversity and preservation of peatlands also featured in the submission on draft NREAP 2010 from An Taisce (National Trust). Birdwatch Ireland submitted that there was a need for a strategic assessment of bioenergy considering ecological carrying capacity and sustainability. The Sustainable Institute argued that large scale use of biofuels was not sustainable and would lead to deforestation, land degradation, high water demands, and a threat to food supplies.

8.4 Submissions on Agriculture

Agriculture was a specific defined GHG emissions sector in the NCCS review 2006, and attracted substantive comments in eleven out of a total of 50 submissions. Five of these submissions addressed bioenergy issues exclusively, and are included in the bioenergy discussions in section 8.3. Broader aspects were addressed in four submissions. The tone of these submissions was one of general support for the government's policy on agricultural emissions. While acknowledging that agricultural emissions had reduced since 1990 the EPA was of the view that further mitigation options for farm livestock emissions would need to be examined. In stating that Ireland's agricultural emissions were three times the EU average on a per capita basis, the EPA presented a simplified and misleading case in support of a GHG reduction policy for agriculture. Obviously in a country with a low population, with major exports of beef and milk, there would be high associated agricultural GHG emissions per capita. This could not however be used as a valid performance metric.

Friends of the Earth made a range of proposals for more sustainable farm practices including an increased emphasis on production of plant protein. They were opposed to a move away from extensive grazing towards an intensive feeding regime containing coconut oil. Taking a global perspective they proposed that the GHG emissions associated with imported fertilizer should also be included in the analysis. The Green Party supported reductions in herd numbers through de-coupling of CAP subsidies from production and de-stocking of commonages. They encouraged research on grazing, and pasture management. The Green Party also supported afforestation and technology for conversion of cellulose to ethanol. The Royal Irish Academy saw merit in a number of GHG mitigations measures which involved reductions in herd numbers. These measures included: elimination of the beef suckler premium, earlier slaughter, and the export of weanlings. Intensification, involving increased concentrates feeding, leading to increased milk yields was also suggested.

There was no record located of a public submission from the IFA on the Energy Green Paper 2006. The submission from Macra na Feirme (rural youth organization) supported development of biofuels and sought more market supports. In its submission on the NCCS review 2006 the IFA apparently accepted without question that agriculture had an additional future role in reducing national GHG emissions. They pointed out that agricultural GHG emissions in 2004 were equivalent to 1990 levels and they projected further reductions in agricultural emissions, which along with agricultural carbon sequestration and bioenergy crops, would assist in the national efforts. Greater supports were sought to exploit the potential for energy crops and biofuels. In its submission on the draft NREAP 2010 the IFA (Farm Forestry Section) continued on this theme and sought increased crop and market supports to promote indigenous bioenergy, and increased afforestation to address the shortage of biomass. Failure to comment on the large straw element of the biomass projections was a serious oversight by farm representative groups. The draft NREAP had projected a straw energy supply of 0.26 Mtoe, which corresponded to 0.8 million tonnes of straw, or in the region of 50 to 60% of the total national straw supply.

8.5 Submissions on Other Energy Topics

The draft NCCS in 2006 mentioned ocean energy as a future option. This had previously been promoted in the national Ocean Energy Strategy (SEAI, 2005). While in theory 100% of the national electricity requirements could be met by ocean energy at some stage in the distant future, the strategy set the more modest indicative target of 84 MW installed capacity by 2020. Ocean energy was mentioned very briefly in seven submissions on the Energy Green Paper 2006, all indicating support, but without any developed proposals on modalities or targets. In the public consultations on the NCCS review 2006 ocean energy did not arise as a significant topic, with only Bórd na Móna indicating support. In the draft NREAP 2010 consultation there were five references to the combined topic of off-shore wind/ocean energy, two of which were supportive, namely: the Marine Renewable Industry Association, and Donegal County Council. Overall, in the public consultations ocean energy was not a topic of great interest.

Between the Energy Green Paper 2006 submissions and the NCCS review in 2006, 14 were in favour of reconsidering the prohibition on use of nuclear power, and four were opposed. Most of the pro-nuclear power submissions were however muted, other than the submissions from the nuclear energy lobby group BENE (Better Environment with Nuclear Energy), who presented developed arguments on the low-carbon benefits of nuclear power.

8.6 Response to Public Consultations

8.6.1 Increases in Renewable Electricity Targets

Table 8.2 shows the evolution of the renewable energy targets through the three public consultation processes. Reflecting the general support expressed, the renewable electricity target for 2020 was increased from 30% in 2006 to 33% in the Energy White Paper in 2007, and would be supplied predominantly by wind power. The subsequent step increase to over 42% in the draft NREAP 2010 was not intimated as a possibility in the public consultations in 2006 and 2007. It can be explained however by the subsequent findings of the all island grid study in 2008 (Meibom et al., 2008), which gave much more leeway to policymakers to credibly model significantly larger penetrations of variable wind power, and possibly by the entry of the Green Party into government.

8.6.2 Maintenance of Bioenergy Targets and Enhanced Role for WTE

Despite concerns expressed in the public consultations, targets of 30% co-firing, 12% renewable heat, and 10% biofuels were maintained from the Energy White Paper in 2007 through to NREAP in 2010. Provision was also made in NREAP for co-firing of up to 50% at individual peat power stations. WTE, which did not attract significant comments in the public consultations in 2006, had moved from a low-profile policy with no specific targets in 2006/2007 to a major element in bioenergy policy in 2010. Municipal wastes would contribute 29% of the total national biomass in 2020.

8.6.3 Other Alternative Energy Policies

There was an unaccountably large increase in the target for Ocean Energy from 84 MW in the Energy Green Paper in 2006 to 500MW in the Energy White Paper in 2007, with an expressed aspiration to world leadership in this technology. The large increase in target was not in response to submissions which were low-key and limited in number, nor to any reported technological breakthroughs. In the final NREAP 2010 the target reverted to a more modest 75MW. An aspirational general policy of supporting up to 500MW by 2020 was however retained. The prohibition on nuclear power which was re-confirmed in the Energy Green Paper 2006 continued through the Energy White Paper 2007 and into NCCS 2007. If anything the policy opposition hardened in NCCS 2007. Not only was the prohibition on generating nuclear electricity still in force but the state would not support nuclear energy in other countries, and specifically would not engage in trading in carbon reductions originating from nuclear technology.

Renewable/ alternative Energy	Policy Evolution [1]					
	NCCS Review 2006	**Energy Green Paper 2006**	**Energy White Paper 2007**	**NCCS 2007**	**Draft NREAP 2010**	**NREAP 2010**
Electricity RES-E	15% : 2010 33%: 2020	15% : 2010 30%: 2020	15%: 2010 33% : 2020	15%: 2010[1] 33% :2020	42.3%:2020	42.5%:2020
Heat RES-H	not specified	5% : 2010	5% :2010 12%: 2020	12% :2020	12% :2020	12%: 2020
Transport RES-T	2 %: 2008	2% : 2008 5.75%:2010	5.75%:2010 10% : 2020	4%:2010 [3] 10%:2020	10%: 2020	10%: 2020
Co-firing	24-32%	30%	30%	30%	30% : 2017 40%: 2019 50%:>2019	30%: 2017 40%: 2019 50%:>2019
Waste-to-energy (WTE)	WTE mentioned No target	Not mentioned	WTE mentioned No target	REFIT support for WTE	0.81 Mtoe	0.81 Mtoe
Total bioenergy	Not explicit	Not explicit	Not explicit	Not explicit	1.4 Mtoe	1.4 Mtoe
Nuclear	Not mentioned	Maintain prohibition	Maintain prohibition	Excluded from carbon trading	Not applicable	Not applicable
Ocean/tidal	84 MW 2020	84 MW 2020	500 MW 2020	500 MW 2020	50 MW 2020 [2]	75 MW 2020 [2]

Table 8-2 Overview of the evolution of national renewable energy targets as expressed in the Energy Green and White papers in 2006/2007, revision of the national climate change strategy (NCCS) in 2006/2007, and in National Renewable Energy Action Plan (NREAP) in 2010.

[1] Note, while the energy policy and climate change strategies were in general formulated in parallel, the sequence of publication followed the order of the columns in the table above: NCCS review July 2006, Energy Green Paper October 2006, Energy White Paper March 2007, NCCS April 2007. Thus NCCS review 2006 did not exactly reflect the Energy Green Paper targets, but NCCS 2007 adopted all the Energy White Paper targets.

[2] Modelled 2020 ocean energy, based on information and constraints known in 2010. Government policy still supported 500MW by 2020

[3] Biofuels target for 2010 was 5.75% in the White Paper, but was subsequently reduced to 4% in 2008 (DCMNR, 2008).

8.7 CONCLUSIONS – STAKEHOLDER ENGAGEMENT

Through the three public consultations there was consistent broad support for the government's bioenergy polices. However there were valid concerns expressed in submissions from reputable and technically competent bodies that bioenergy targets would not be met. The ESB questioned both the biomass renewable heat targets, and the co-firing targets. Bórd na Móna envisaged that about one third of the biomass to meet their 30% co-firing target would need to be imported. Fears were expressed by Coillte that there would be competition for biomass resources between the wood products industry and electricity generation.

While co-firing received wide support, there were concerns expressed on whether electricity generation was the optimum application in view of the large transformation losses. Using the limited biomass resources in combined heat and power plants and in heating was considered to be a better option by Coillte, Comhar and the ESRI. There was general support for promotion of biofuels for transport, despite a fundamental limitation on practicable indigenous resources which was highlighted by Teagasc who considered that a biofuels penetration target beyond 2% from indigenous sources was not feasible. That most of the state's biofuel requirements would be met from imports appeared to be accepted and was implicit in the Bioenergy Action Plan in 2007, and explicit in NREAP 2010. Given that the bulk of biofuels would be imported, and that a substantial portion of biomass for co-firing would be imported, the original energy security and economic justifications for bioenergy policy disappeared. The policy also failed the basic sustainability requirement in that it projected a bioenergy supply which was in excess of the national resources. On the subject of emissions of GHG from the agricultural sector, the collective and unchallenged view in the submissions was that agricultural emissions would need to be reduced, and that agriculture had a role in production of energy crops to support national bioenergy targets. This was supported by the EPA, farming groups, and received political support from the Green Party, and from the Joint Oireachtas Committee on Climate Change and Energy Security.

Actors and stakeholders indicated their attitudes both by what they said on specific topics and by their silence on other topics. Public consultations were silent on potential adverse impacts of bioenergy policy on Irish land-use and agricultural policy. Other than fleeting references to impacts beyond the geographical national boundary there was no developed discussion on food versus fuel issues, nor on environmental impacts in countries supplying the biomass. A lack of engagement by farmers' representative groups in energy and GHG policy formation was evident. Their submissions were limited to promotion of agribusiness opportunities, and did not address potential long-term impacts on the existing extensive grazing farming model, nor on land-use in general. Notably, a scenario whereby agricultural food production might increase was not envisaged in any of the public consultations on renewable energy and climate change. The silence of public submissions on certain aspects of the draft NREAP 2010 is hard to explain, but may have been due to excessive deference and unwillingness to point out flaws. Incredibly, not a single submission mentioned the scale of the projected municipal WTE element for 2020. Nor was there any comment on the sudden appearance of straw as a significant resource at over four times the magnitude which was assessed as being feasible in 2004 (RPS and MCOS, 2004). The maintenance of a policy supporting 500MW of wave power in NREAP was not commented upon, despite the fact that the highest realistically modelled wave power contribution in the same document was only 75 MW.

On the balance of the evidence Irish policy formation did not gain from the public consultation processes. Most submissions addressed the issues within the restricted range of options and targets as set out in the draft policy documents, and doubts and concerns were carefully and deferentially phrased. There was no fundamental questioning of the 10% renewable transport target for 2020, even though all informed stakeholders at that stage would have known that the target would be met largely from imports. Policymakers could have been forgiven if they perceived the submissions to indicate a general acceptance of the drafted policies with some points of constructive criticism. An exception to the general acquiescence were calls for improvements in governance from significant national actors and stakeholders including the EPA, Comhar, Royal Irish Academy, IBEC and the Green Party. There was also modest support for nuclear energy expressed in submissions on the Energy Green Paper 2006 and NCCS review in 2006. However, other than the pro-nuclear lobby group BENE, the supporting submissions were token in character, and lacked developed argument and conviction.

The end result was that the final renewable energy and GHG policies did not appear to be noticeably influenced by the public consultation process. In particular, well-founded concerns regarding limited national resources, energy efficiency, and the inevitability of substantial imports of biomass did not moderate targets to more achievable levels. Stakeholder involvement is a fundamental principle of sustainable development planning, and this was nominally met in Ireland’s case in terms of the numbers of stakeholders and actors involved in the consultations. Such involvement by over 200 stakeholders and actors constituted a significant support base and added to the legitimacy of the eventual policies. However the public involvement did not result in any improvements in the policies, which continued to be fundamentally unsustainable in terms of the mismatch between supply and demand. If public consultations are to make a worthwhile contribution to the sustainable development policies in the areas of renewable energy and climate change, the process would need to be fundamentally reviewed and re-designed. This is a subject which is beyond the scope of the present work and would require detailed research. However as a minimum a mechanism would need to be developed for giving due consideration to well-founded minority views, and to encourage more fundamental questioning of policy.

9 INTERVIEWS WITH POLICYMAKERS, ACTORS, STAKEHOLDERS

9.1 Individual Perspectives and Insights

In studying national policy formation, it can be overlooked that ultimately policy originates from individuals, is implemented by individuals, and affects individuals. In the case of bioenergy policy, while the formal situation can be inferred from documents, an insight at the individual human level can greatly assist in understanding the origin and implications of policies. Bioenergy was to policymakers one of a menu of options for reducing GHG emissions, along with wind energy, wave energy, and other energy efficiency measures. Civil servants were supported in their work by state agencies such as the Environmental Protection Agency (EPA), Sustainable Energy Authority of Ireland (SEAI), and the Agriculture and Food Development Authority (Teagasc). These support bodies were in turn composed of individuals who within their own areas sought to effect GHG reductions and promotion of renewable energy. Farmers saw bioenergy as providing a commercial opportunity, to achieve a profitable return from the land, and individuals within farming organisations and within bioenergy industry groups worked hard to make bioenergy a commercial reality. In this chapter, interviews with individual policymakers, actors and stakeholders are recounted. The people interviewed and the topics covered are identified in Table 9.1. The policy challenges faced by government officials are first outlined in section 9.2. The problem area of transport emissions are considered in section 9.3, which is relevant for bioenergy policy, as biofuels were seen as a means of mitigating these emissions. The remaining sections deal with GHG policy relating to agriculture, and bioenergy aspects.

Name date	**Department/Body**	**Position**	**Subjects Discussed**
Pearse Buckley 9th March 2011	SEAI Sustainable Energy Authority of Ireland	Programme Manager Bioenergy and CHP	Biomass resources Co-firing, 2020 targets
Barry Caslin 14th Feb 2011	Teagasc Agriculture and Food Development Authority	Bioenergy Specialist	Benefits of bioenergy Biofuels Biomass heating Competition for land
John Finnan 14th Feb 2011	Teagasc Agriculture and Food Development Authority	Bioenergy Specialist	Benefits of bioenergy Co-firing and heating Biomass resources Policy conflicts
Noel Gavigan 12th May 2011	IrBEA Irish Bioenergy Association	Executive Officer	Biofuels Co-firing and heating Bioenergy projections
J.J. Kavanagh and Geraldine O'Sullivan 24th March 2011	IFA Irish Farmers Association	National Treasurer Executive Secretary Forest Bioenergy	Biofuels Co-firing and heating 2020 targets, Competition for land
Donal Enright 21st November 2011	DECLG Dept. of Environment Community and Local Government	Principal Officer	Policy coordination Agriculture, Transport, EU Effort Sharing
Owen Ryan 21st November 2011	DECLG Dept. of Environment Community and Local Government	Principal Officer	Challenges, period 2004-2008 Political support, Transport, Agriculture, EU effort sharing
Martin Finucane 21st November 2011	DCENR Dept. of Communications, Energy and Natural Resources	Programme Manager, Head of Renewable Energy Division	Renewable electricity Biofuels obligation scheme Co-firing, Traffic

Table 9-1 Interviews conducted with policymakers and actors in 2011

Details of interviews are not available in the e-version of the thesis.

9.2 CONCLUSIONS – INSIGHTS FROM INTERVIEWS

Prime responsibility for national policy rested in the Departments of Environment and Energy. Given the complexity of the issues and the policy workload at international and national level, the teams of civil servants engaged in this work were surprisingly small, numbering about ten people in each of these departments. Departmental officials found themselves on a fast-moving policy treadmill from 2000 to 2008, with challenging Kyoto commitments, launching of the ETS, and a sequence of evolving EU targets. They enjoyed full governmental support for their work at all times. By 2011 as the Kyoto commitment period was coming to an end there was time to review the situation and there was a growing realization that a compliance approach had not optimally placed Ireland on a reliable pathway to a low-carbon future by 2050. There was acknowledged disappointment with the outcome of the negotiations on effort sharing, but a hope that some flexibility could be restored with respect to LULUCF. While the Effort Sharing Decision was acknowledged to have been a serious blow to Irish GHG policy, interestingly no reference to this difficulty was found in any of the documents reviewed as part of this research. Consideration of the agricultural sector would appear to have been somewhat in the background during the dynamic period of policy development from 2000 to 2007. The Department of Agriculture itself had not been closely engaged with GHG policy formulation and had little influence other than with respect to forestry aspects. Growth in transport was acknowledged as being the major GHG problem, although there was disagreement among the civil servants interviewed as to whether such growth could have been foreseen. Positive views were expressed on the future possibilities presented by e-vehicles. The decision not to implement CO_2 tax banding early on can be understood in the context of the need to maintain income for local authorities. This highlighted the difficulty the Department of Environment had in managing GHG policy as they were also responsible for local authority funding.

On the subject of biomass resources all believed that Ireland had significant resources and capacity to grow energy crops, and that there were benefits in terms of GHG reduction, energy security and employment. The challenge in getting the market mobilized was aptly described in terms of the chicken and the egg metaphor. Supply would only be created if there was demand, whereas demand could not be established unless there was a guaranteed supply. Divergent opinions were expressed on the benefits of setting ambitious stretching targets. SEAI and IrBEA interviewees saw merit in this approach, while Teagasc interviewees tended to prefer realistic targets with clear delivery mechanisms. The strategy pursued by the SEAI was to promote and stimulate all potential bioenergy market sectors including transport biofuels, heating, CHP, and co-firing. A criticism of this approach from a purely commercial perspective would be that in fragmenting the market there was a risk that no sector would be able to achieve the scale required for economic survival. There was also the possibility that failure to meet ambitious targets would undermine confidence. This was already the case for the IFA, who in view of poor progress on bioenergy targets had great doubts about bioenergy projections for 2020.

Obstacles to energy crop establishment were acknowledged, and while land resources were not unlimited, it was felt by Teagasc interviewees that a few hundred thousand hectares should be feasible for energy crops. Views on biofuels were mixed, with doubt among the Teagasc interviewees on the scale of the indigenous resources and on the Biofuels Obligation Scheme (BOS), with anger expressed by the IFA and IrBEA interviewees on the demise of the industry following BOS, and exasperation expressed by the Department of Energy interviewee that anyone could have missed the clear flagging of the BOS and could realistically have expected continued state subsidisation in an EU open market. This suggests poor communication between the IFA and IrBEA with the Department of Energy which may have resulted in the former two organisations holding unrealistic expectations for indigenous biofuels.

Co-firing was widely supported as a way to kick-start the biomass supply chain and market. The IFA was less supportive, but this may have been due to a feeling that the government was not fully committed, rather than any fundamental objection on energy efficiency grounds. There was the view among IFA and IrBEA and Teagasc that more should be done to promote biomass heating. A major driving force in the promotion of co-firing may have come from the peat power station interests. Co-firing would have significant benefits for these stations in terms of GHG reduction, emission trading, and in extending the lifetime of the peat reserves. The GHG saving argument does not however stand up. If the purpose of co-firing were to extend the lifetime of the peat plants it would imply that it was envisaged that all of the peat reserves would eventually be consumed, in which case there would be the same total GHG emission, but spread over a longer period. While there were no significant concerns on serious competition for land between forestry, food and bioenergy, all interviewees who addressed the issue agreed that a national policy on land-use was required to establish a balance between competing land-uses.

10 DISCUSSION

10.1 The Challenge and the Outcome

Ireland’s GHG policy development from 1990 to 2012 occurred against a turbulent backdrop of economic and policy events which were largely outside of national control. The initial strategy of gentle limitation of energy growth in the 1990s was de-railed by an unexpected but welcomed moderate economic growth. From 2000 to 2006, NCCS 2000 fought with a limited armoury of measures against an economic bubble, the existence of which was not fully realised until 2008. By this time the sectoral allocations set out in NCCS 2000 were rendered meaningless as a large portion of national emissions had been transferred into the ETS. The revised NCCS 2007 and new EU targets for 2020 had hardly come into existence when Ireland was struck by the worst economic crisis in its history. If a single conclusion can be drawn from these events it is that national policy on climate change must be robust and capable of withstanding severe and unpredictable external influences.

From the late 1990s to 2007, the prospect of Ireland reducing emissions below the Kyoto limit seemed remote as was confirmed by the UNFCCC assessments (chapter 3), and by the EPA annual emissions reports (chapter 4). Following the economic crisis in 2008 GHG emissions reduced sharply, and by 2012 the net national emissions were under the Kyoto limit. Ireland’s performance in terms of Kyoto compliance equalled the average for the EU-15, and ranked fourth in the EU-15 in achievement of renewable electricity targets. The sectoral GHG emissions target set in NCCS 2000 had all been largely achieved and there was evident scope for achieving significant future GHG reductions. Yet, despite these achievements, there was no sense of celebration at the end of the Kyoto period, and there were calls for a fundamental policy shift. The consensus among Irish policymakers and advisors was that Ireland should design a future GHG strategy based on a pathway to a 2050 vision of a de-carbonised society, rather than on a simple compliance based strategy. The need for a break with past compliance strategies was informed by the generally accepted view that the reductions in national GHG emissions were largely a consequence of the economic crisis, and that when economic growth resumed, emissions would again increase. As discussed in chapter 4, explaining away the large reduction solely in terms of the economic crisis overlooked many significant achievements in mitigation which were already having an effect before the crisis. Moreover it is quite likely that the elevated emissions up to 2008 were closely linked to the unsustainable economic bubble and that a significant proportion of the reduction from 2008 onwards could be interpreted as representing more sustainable emissions. It is not possible to know definitively what caused the change in mood and outlook of the policymakers towards the end of the Kyoto period, yet based on the evidence, it is most likely that it was due to a belief that Ireland would not be able to achieve its EU 2020 GHG reduction target of 20% for domestic emissions.

10.2 Difficulties Presented By the EU Target for 2020

At the end of the Kyoto period projections of GHG emissions to 2020 indicated that Ireland was apparently hopelessly off-target, and that at best a 10% reduction could be achieved (EPA, 2013a). The big emitters in the domestic non-ETS sector were transport and agriculture. For transport there was some hope that with new CO_2 tax banding, technical improvements, biofuels and e-vehicles that progress could be made (chapter 4). Agriculture, which accounted for 44% of domestic emissions in 2010 presented a more difficult problem as there was no means of achieving significant reductions within the existing farming model. In the transition from the Kyoto target to the EU 2020 target there had been an apparent sharp discontinuity in the state's compliance trajectory. The reasons for the sudden swing from comfortable compliance in 2012 to projected non-compliance for 2020 were not satisfactorily explained in the policy documents reviewed. A superficially simple and plausible explanation for the difficulty was the high proportion of agricultural emissions. A perception was consequently created in the public discourse that Ireland's agricultural emissions were a problem, and as implied by the Minister for the Environment in the carbon budgets, that reductions would be required (DEHLG, 2009; DEHLG, 2010b). This also became the settled and publically expressed view of the EPA (2013c). However as discussed in chapter 3, the high proportion of agricultural emissions in Ireland had always been acknowledged and did not give rise to any concern in policy documents or public consultations up to 2008. The general view up to then, was that emissions could be stabilised and perhaps reduced marginally, while maintaining production. There is no evidence that the EU GHG reduction requirements for 2020 were designed in any way to punish Ireland. The combination of the 20% reduction in domestic emissions and the 21% reduction in the ETS would bring Ireland's total emissions to slightly below 1990 levels. This was still a considerably advantageous position relative to the average for the EU-27, which was to bring emissions 20% below 1990 levels. Nor did the EU 20% reduction requirements for Ireland reflect any expressed view at EU level that something should be done about Irish agricultural emissions.

The most probable explanation for the difficulty which Ireland faced was that it was simply an unintended and unanticipated perverse policy outcome resulting from the sequencing and design of EU GHG policies, exacerbated by unique Irish national circumstances. Between 2000 and 2007 control of GHG policy progressively passed from national control into EU control. The design of the European ETS was a significant factor in the subsequent problem for Ireland. The shape of the Irish and EU ETS was already formed and had entered its trial phase in 2005, at which time the eventual EU targets for 2020 had not yet been agreed. In Ireland's case the ETS resulted in the transfer of 35% of the state's Kyoto emissions into an EU emissions trading market and outside of direct national control. These were the low-hanging fruits of GHG emissions, consisting of just over 100 operators, with mainly point source emissions which were inherently more amenable to control than the domestic sector, which included 2.4 million vehicles, 1.6 million homes (Howley and Holland, 2013), and 140,000 farms (DAFM, 2013). In the event of the Irish ETS reducing emissions significantly, there was however no mechanism for transferring any gains back to the national account. By 2012, Ireland's ETS operators had already achieved a GHG reduction in excess of 22% relative to 2005, and in fact complied with their EU target for 2020. Arguably the design of the EU ETS was flawed, with over allocation of allowances, and no provision for dealing with a scenario where the price of carbon collapsed to €5 per tonne, as happened after of the Kyoto period (Economist, 2013).

In addition to the inflexibility created by the ETS the EU policy on effort-sharing created problems for Ireland. In order to obtain agreement between 27 states, simple and transparent criteria had to be used. For the non-ETS domestic emissions, the criterion adopted was to base national reduction targets on per capita GDP with the reduction burden falling entirely on the wealthier EU-15 states, excluding Portugal. As Ireland was at that time one of the wealthiest EU states it attracted the highest reduction of 20%, compared with an average of just less than 14% for the EU-15. Not surprisingly, such a crude allocation mechanism could not address special national circumstances, but the assumption would have been that the wealthier states would have the resources to address any difficulties. In Ireland's case there were four unique national circumstances which made achieving the 20% reduction extremely difficult. Firstly, in 2010 agriculture accounted for 44% of domestic emissions in Ireland, which was almost three times the average for the EU-15. Secondly, Irish GHG policy had historically relied very heavily on forest sequestration, with three times the reliance compared with the EU-15 average (section 6.4.3). However, carbon sequestration from forestry or other land-use activities was not allowed in meeting EU 2020 targets. A third factor was that Ireland had originally been allowed to increase emissions under the Kyoto Protocol, while the EU-15 on average had embarked on a steady reduction pathway, which was to continue through to 2020. To achieve the 2020 reduction target, Ireland would have to reverse all of the previously allowed increases. This would prove difficult in an economy, which as it had grown, had built up a modern set of assets in transportation, built environment, and heating technologies. Finally, by 2009 even as the EU Climate and Energy Package was entering into force, it transpired that the GDP data upon which Ireland's target was based had been inflated by unsustainable borrowings. Following the Irish banking collapse, which according to Laeven and Valencia (2012) was the costliest in an advanced economy since the Great Depression, Ireland simply did not have the financial resources to fund an aggressive GHG reduction programme in the domestic emissions sectors.

In view of these unsatisfactory and unintended outcomes of EU policies, the decision of the Irish government to largely ignore the GHG implications and to adopt the Food Harvest 2020 policy of agricultural expansion in 2010 can be understood. Given the apparent failure of the ETS and in the absence of an immediate successor to the Kyoto Protocol there was still scope to press for revision of the effort-sharing agreement, either to incorporate some flexibilities in interpretation, or to take account of the land, including agriculture from an overall EU-27 perspective.

10.3 Reliance on the Land

Key features of Ireland's GHG policy originated from accounting rules set out in the Kyoto Protocol. Compliance could be achieved based on the aggregate GHG emissions, comprising CO_2 from fossil fuel combustion, and CH_4 and N_2O from agriculture. Ireland had the largest proportion of agricultural GHG emissions in the EU-15, and as discussed in chapter 3, this was initially presented as being a national limitation and as a justification for a relaxed Kyoto limit. In fact the high agricultural emissions proved an advantage in framing NCCS 2000. By assigning all of the permitted 13% Kyoto increase to the energy sectors, a projected increase of at least 22% in CO_2 emissions could be permitted from these sectors to 2012. Even greater increases could be facilitated by use of forest carbon sinks as permitted under Kyoto. The outcome at the end of the Kyoto period was that the approximately 5 $MtCO_{2eq}$ overshoot of the Kyoto emissions limit was entirely off-set by the land, in the form of forest sequestration, and reductions in emissions from the agricultural sector (section 6.5).

A number of objections can be advanced against this policy of using the land to off-set fossil fuel emissions. At a fundamental level, such a policy is in contravention of the well established Polluter Pays Principle (OECD, 1972; UN, 1987). This principle was also a cornerstone of the UNFCCC and of the Kyoto Protocol, which placed greater reduction requirements on developed states which were historically responsible for the bulk of GHG emissions. In Ireland, by the end of the Kyoto period emissions from the energy and industrial sectors had increased by 34% (12.1$MtCO_{2eq}$) relative to 1990, which was 1.7 times the increase allowed under the Kyoto Protocol for the entire national emissions. In contrast there were significant net reductions for the land, due to forest sequestration and reductions in agriculture. Clearly, if the polluter pays principle were applied, more action should have been focused on fossil fuel emissions, rather than on the land. In the case of the ETS sector the situation was more extreme. By 2005 emissions had increased by 51% relative to 1990. Yet in the design of the national allocation process for the ETS no account was taken of this historical responsibility. The national allocation was heavily influenced by marginal abatement cost analysis, with a simple proportional division of the distance to target between economic sectors, with no penalty for historical poor performance. This amounted to free-riding by the ETS with a transfer of compliance burden to the rest of the economy, including agriculture.

Reliance on the land to disguise the problem of increased CO_2 emissions from fossil fuels also encouraged prevarication. Had the land option not been available to Ireland, the problem of rapidly escalating emissions from the late 1990s to 2005 could not have been ignored and earlier action could have been taken. From the perspective of sustainable development, reliance on the land was also only a short-term solution, as carbon sequestration in forest lands could not be continued indefinitely. Eventually, after a period of 40 to 50 years, the forest carbon sequestration would be matched by the loss of carbon upon harvesting, at which stage the state would have to suddenly find alternative solutions. There would also be practical limits to the reductions in emissions achievable for agriculture, while maintaining food production. While some additional carbon sequestration could possibly be achieved in agricultural lands, there would be no guarantee that a net gain could be maintained indefinitely. The lack of knowledge on carbon sequestration processes would also have warranted great caution in relying on the land to off-set fossil fuel GHG emissions. Treatment of LULUCF under Kyoto accounting rules was incomplete. Accounting procedures introduced by the EU after the Kyoto period were still in their infancy (EC, 2013), and it would quite likely be at least a decade before any definitive methodology would be agreed internationally. A more philosophical objection is that reliance on the land to off-set fossil fuel GHG emissions attempts to use the current biophysical carbon cycles, which operate on a time scale of tens to hundreds of years, to rectify an imbalance in the geological carbon cycle which operates on a time scale of millions to hundreds of millions of years. That the natural carbon cycle could not absorb sustained anthropogenic GHG emissions was obvious, as evidenced by the steadily increasing CO_2 concentrations in the atmosphere (IPCC, 2013a).

When the EU targets for 2020 excluded forest carbon sequestration it presented an opportunity for Irish policymakers to re-assess the reliance of national GHG policy on the land. However Irish negotiators still saw the land as an important element in Ireland's policy (chapter 9). They tried hard to incorporate some degree of flexibility in interpretation of the EU reduction targets for 2020 and obtained the concession that the question of LULUCF carbon sinks could be re-visited in the event of the EU moving on to a 30% reduction target in the context of a post Kyoto international agreement. The draft Climate Change Response Bill 2010 mirrored this approach and if passed would have legally locked Ireland into aggregate GHG accounting indefinitely. While this could provide some flexibility from an accounting perspective, it would imply a continuation of a policy of reliance on the land to balance national GHG emissions, which ultimately would be unsustainable. This is not to suggest that the land should be ignored in the battle against climate change. Basic principles of sustainable development would suggest that land-use activities such as forestry and agriculture should be managed to achieve a balance between emissions and sinks. Non-agricultural lands and wetlands should likewise be managed in such a way as to preserve and enhance their natural sequestration capacities, as a common good in its own right, and not just to facilitate unsustainable practices in the energy and industrial sectors.

10.4 BIOENERGY

10.4.1 AMBITIOUS BIOENERGY TARGETS

Bioenergy was eagerly embraced by Irish policymakers as contributing to Ireland's energy security, GHG reduction programme, and to the rural economy. It was another aspect of the policy of reliance on the land to achieve GHG reduction goals. In terms of the realistically achievable scale of bioenergy supply compared with the national energy needs, the national policy and targets would appear to have been overly optimistic (chapter 7). Despite active promotion and supports from 2003 onwards, an indigenous bioenergy industry failed to develop on a meaningful scale. Given Ireland's low forest area there were inherent supply limitations for the solid biomass market and a risk of competition for pulp wood with the fibre board industry. To generate additional supply short rotation timber crops were promoted using EU and national subsidies but with disappointing results. On the demand side market stimulation measures were introduced for domestic and institutional heating, but uptake was slow. Co-firing of solid biomass in the peat power stations, which was the least energy efficient biomass application, was an important element in government policy. At face value it appeared to be a measure which would kick-start the bioenergy market. However there are reasons to believe that the co-firing policy was motivated primarily as a support measure for the peat power stations. Had there been no peat plants in operation in Ireland, it would have been highly unlikely that new biomass public power plants would ever have been contemplated, in view of the high cost, low conversion efficiency, and the absence of a guaranteed supply chain. Large biomass heating boilers, which were commercially available, would probably have been the optimum way to start the market. Peat power stations were facing a problem after 2015, when they would be exposed fully to carbon trading. Biomass co-firing provided commercial benefits in reducing GHG emissions and in extending the useful lifetime of the Bord na Móna bogs. The close relationship between the Department of Energy and the state owned Bord na Móna and the ESB would support the view that the main motivation behind the co-firing policy was to support the peat power stations. Biomass, which has low life-cycle GHG emissions would ironically support the prolonged operation of the most GHG intensive power plants, through this co-firing policy. While co-firing would indeed reduce annual GHG emissions, the total GHG emission from exploitation of the Bórd na Móna peat reserves for electricity production would be unchanged. The same total emissions would occur, but spread out over a longer time-period. As a long-term GHG mitigation policy it did not make sense.

When a guaranteed market share for transport biofuels was stipulated by EU directive in 2003 the production of indigenous biofuels was enthusiastically pursued as state policy, and small scale production of rapeseed oil and bioethanol was established. The envisaged benefits were GHG reduction, energy security, and economic gains for farmers. It was widely acknowledged that the EU target of 5.75% for 2010 and 10% for 2020 could not be supplied from indigenous sources, and that the highest indigenous supply would be in the region of 2%. Native biofuel feedstocks and biofuels were however inherently uncompetitive compared with imports and in the absence of trade protection measures the small biofuels sector was unlikely to survive competition from imported biofuels. This had also been the experience of the state alcohol company which had operated for over forty years and closed in the early 1980s. The demise of the small Irish biofuels industry followed rapidly after the introduction of the Biofuels Obligation Scheme (BOS) which removed the limited market protection afforded to Irish producers. In view of the low profit margins of Irish biofuel producers and rules prohibiting market protection, it is difficult to see how policymakers could have believed that an Irish biofuel industry could survive. A conclusion can reasonably be drawn that the BOS was introduced in the almost certain knowledge that biofuels would be supplied mainly from imports.

Despite the limited progress in developing bioenergy it remained a key element in national policy to the end of the Kyoto period, and featured prominently in the National Renewable Energy Projections for 2012 (NREAP). The high bioenergy projections, which were expected to contribute almost half of renewable energy supply in 2020, were however at variance with the situation and prospects as of 2012. NREAP included very large projections for Waste-to-Energy and straw biomass resources, which in view of negligible developments in these areas would have to be considered highly speculative projections. It was also acknowledged in NREAP that a substantial proportion of the liquid biofuels supply in 2020 would be supplied from imports. In addition to imported liquid biofuels there was a likelihood, as indicated in submissions on the NREAP public consultation (chapter 8), that a proportion of the solid biomass would need to be imported to achieve national targets.

10.4.2 Bioenergy – Sustainability Concerns

A heavy reliance on bioenergy as a significant solution for future energy supply, as envisaged in the Bioenergy Roadmap (SEAI, 2011), would not appear to meet basic sustainability requirements. As a means of energy collection, bioenergy has the lowest efficiency of all other forms of renewable energy. Bioenergy is consequently a land-hungry option, requiring two to three orders of magnitude more land than wind power or solar thermal collectors, per unit of energy collected. Bioenergy demand could also potentially increase to unsustainable levels the human appropriation of the products of photosynthesis. Already by the 1980s it was estimated that humans were appropriating 40% of the terrestrial net primary production (NPP) for fibre, food and energy (Vitousek et al., 1986). By the early twentieth century, as reported by Harberl et al. (2012), 75% of the world's vegetated lands were used for food, fibre, timber and other biomass production. It was estimated the total human harvest of plant material would need to double were ambitious future bioenergy targets to be met. There would be obvious challenges and risks in seeking to attain such a target and Harberl et al. (2012) recommended that policymakers should revise projections for bioenergy to a level based on the planet's capacity to generate additional biomass, without adversely affecting natural ecosystems. In Ireland's case any such revision of bioenergy policy should take account of competing land-uses and of the requirements for long-term sustainable food agriculture.

10.4.3 Competition for Land

As of 2012 Irish policy simultaneously supported expanded forestry, bioenergy crops, and increased agricultural production. An additional 400 kha of forestry would be required to reach the 17% forest area target for 2030. Expansion of food agriculture as envisaged under Food Harvest 2020 would require the agricultural land area to be at least maintained, and possibly expanded. Were bioenergy policy to be followed through on the scale envisaged in the Bioenergy Roadmap, up to 400 kha could be required. However, given the difficulties in establishing traditional bioenergy crops, bioenergy did not in fact pose a credible risk of competition for agricultural land in the time scale to 2020. Beyond 2020, there was the possibility that limitations in bioenergy supply and distribution could be overcome by grass as an energy crop, or by second generation liquid biofuels. The focus on pasture grass as an energy crop in the Irish context was logical given the large national grassland area of over four million hectares. It was also encouraged by an existing EU policy on preservation of grasslands for protection of biodiversity, which resulted in an effective limit of 5% on conversion of grassland to tillage. The technical case for grass-to-biogas was also credibly demonstrated (Smyth et al., 2009; 2010). However were this technology to develop on a commercial scale there would be strong competition between bioenergy and food agriculture for grassland area. Despite the evident impact this could have on existing farm practices, it was a widely supported proposal, and no objections were noted in a review of submissions on national policy (chapter 8). A fundamental role of policymakers is to decide on priorities in the event of conflicting requirements. By 2012 there was a clear need for a long-term land-use policy, with subsidies directed to achieve selected preferred outcomes, taking long-term sustainability into account, rather than allowing the outcome to be determined by free-market forces. Such a land policy would need to address the realistic land area that could be devoted to energy crops, without impacting on food production and forestry.

10.4.4 Competition Between Energy and Food

Potential risks to food security posed by bioenergy policy did not feature in the formation of Irish policy nor to any great extent in the national discourse. Nevertheless, Ireland's ambitious bioenergy targets posed potential food security risks. Were significant agricultural lands given over to energy crops in Ireland there could be a displacement of dairy and beef production. As described in the food energy analysis in chapter 5, Ireland's production of dairy and beef products is extremely efficient, requiring low levels of food energy inputs from cereals. The Irish dairy and meat industry consequently achieves a net export of food energy to EU and world markets. Any significant displacement of this production would result in the dairy and meat market being supplied from alternative sources entailing greater consumption of cereals. This would adversely affect the national and EU food energy balances. Reliance on imports to meet liquid biofuel targets could also potentially result in displacement of food production in other countries. Both Ireland and the EU are already net importers of dietary food energy. Even with the EU’s modest sustainability and food crop protection criteria (EC, 2009d; CEC, 2012b), national and EU biofuels policies would have the effect of greatly exacerbating this food energy imbalance. Based on projected biofuels imports in 2020, the imported food energy to the EU would amount to the dietary needs of 96 million people (section 7.5.4).

All reports of the IPCC since 1990, while predicting some beneficial effects for crops in higher latitudes, have predicted adverse effects of climate change on agricultural outputs in developing countries at lower latitudes. Warnings of adverse impacts were amplified in the fifth assessment report (IPCC, 2013b) which identified food security and the breakdown of food systems as key risks, particularly for poorer populations. It is therefore probable that there may be a greater future demand for food production from countries such as Ireland in the temperate zones to meet the expected short-falls. Significant expansion of the land area for bioenergy production conflicted with this prognosis. Grass as an energy crop, and in particular grass-to-biogas technology as discussed in chapter 7 received widespread support. Grass is certainly not a human food and consequently formally complies with EU guidelines on protecting food resources, but this would be a specious argument. Widespread utilization of grass as an energy crop would effectively displace cattle and directly compete with food production. In the face of persistent world hunger (FAO, 2013b) and a projected one billion increase in world population by 2025 (UN, 2014), whether agricultural land should be used for fuel production or whether biofuels derived from food should be imported, are ultimately ethical questions. There is no reliable economic modeling which can provide an unambiguous answer. Ethical considerations however did not feature in Irish policy formation. The review conducted by the National Economic and Social Council, contained only one passing reference to ethical considerations regarding biofuels (NESC, 2012, p.71). Even the Irish eco-theologian Seán Mc Donagh (2006) in his dismissal of biofuels as an option argued from the technical perspective of the limited production capacity compared with the market demand, rather than from any fundamental ethical reservations about burning food. There is a clear need for an ethical input to future Irish policy formation on bioenergy, and on GHG policy in general.

10.4.5 Realistic Bioenergy Options for Ireland

With Irish bioenergy targets relying on imports, in particular for liquid biofuels, the state risked replacing a reliance on imported fossil fuels with a reliance on imported biomass with doubtful energy security or economic benefits. Significant expansion of indigenous bioenergy production on the scale envisaged in the Bioenergy Roadmap would impact adversely on food agriculture, which would be sufficient reason in itself to question the bioenergy targets. In view of the risks posed by bioenergy to food security both in the EU and worldwide, and the risk of exceeding sustainable levels of appropriation and combustion of terrestrial NPP, it is highly unlikely that the EU will adopt higher targets for transport biofuels in the future. It would also have to be considered that there is a moderate probability that the EU will eventually abandon liquid biofuels on sustainability grounds. While bioenergy could be a useful adjunct to national energy policy and achieve a small scale contribution, it could never be considered a mainstream solution. Against this background a sustainable policy for Ireland would be to support only indigenous bioenergy with a revision of NREAP targets to reflect the realistic national resources. For freely tradable liquid biofuels there would be legal difficulties in promoting an indigenous industry. Taking into account the risks associated with biofuels and the availability of proven e-vehicle technology a prudent approach would be to abandon the liquid biofuel option entirely. There would however be a reasonable prospect that indigenous solid biomass from forest products or energy crops could survive competition from imports. Establishing a successful solid biomass industry would however require a more focused approach with increased energy crop subsidies and market stimulation, with some form of guaranteed price, possibly supported in the form of a public procurement policy as was suggested by many stakeholders in the public submissions (chapter 8).

There is an understandable reluctance among policymakers to rely on subsidies and other state supports to drive bioenergy policy and a preference for free-market mechanisms. However in the context of an agricultural system in which subsidies account for 77% of the operating surplus (Teagasc, 2013) there would be no policy contradiction in providing significant supports for a modest indigenous bioenergy industry which would contribute to national energy security. It should also be borne in mind that the impressive achievement of wind energy in Ireland was due entirely to a guaranteed minimum price and public service obligation levees.

10.5 THE FUTURE FOR AGRICULTURE

Within the EU Ireland has a unique GHG emissions profile, with the highest proportion of agricultural GHG emissions and the highest CH_4 content in those emissions. This was not the result of sub-standard farming practices but, as discussed in chapter 5, followed inevitably from unique geographical and historical factors. Ireland had been almost completely de-forested by the nineteenth century and the climate and soil favoured grass as a crop, which along with population depletion following the famine, led to the current extensive grazing system of agriculture. A low population density and a low level of heavy industry amplified the per capita emissions of agricultural GHG, leading to the impression that there was a problem with Irish agricultural emissions. In the historical context the increases in agricultural GHG emissions in Ireland were in fact modest, with an increase of perhaps $2MtCO_{2eq}$ from the second half of the nineteenth century to the mid-twentieth century. When Irish agriculture had the opportunity to supply European and world markets from the 1960s onwards there was a step increase in agricultural output, and in the fifty years to 2010 meat production almost trebled. The associated rise in GHG emissions of $5MtCO_2$ represented an increase of 35%, and was modest compared with the increase of $29MtCO_{2eq}$ (+258%) which occurred over the same period due to combustion of fossil fuels and other industrial emissions. The increase in agricultural GHG emissions was justified in terms of meeting the food needs of a rapidly growing world population, which had more than doubled since 1960. Within the EU Ireland was an efficient niche producer of beef, sheepmeat and dairy products, with approximately 60% of meat and milk products exported. The grass-based production system minimized the consumption of cereal feedstocks, making Ireland the most efficient producer of meat and dairy products in terms of minimal impact on human food supplies. Ireland’s agricultural GHG emissions intensity compared favourably with other EU states. Even under the admittedly simplified Kyoto accounting rules emissions from Irish cattle were 90% of the EU average. More importantly, based on life cycle analysis, emissions from Irish beef production were 10% lower than the EU average, and emissions from milk production were 30% lower.

Irish GHG policy with respect to agriculture was informed entirely by negative short-to mid-term projections which prevailed until 2010. Against this pessimistic background, there was no question of any of the 13% Kyoto increase being allocated to agriculture, and national GHG strategies sought to achieve actual reductions. Agriculture was the only major economic sector to achieve reductions in GHG emissions relative to 1990, and by 2012 emissions were equivalent to levels prevailing in the early 1970s. With hindsight it is easy to see that once emissions allowances were effectively transferred from agriculture to other sectors it would be difficult to ever recover these allowances. This is illustrated in the extreme inequity in sectoral emissions allowances implied by the EU targets for 2020 (section 6.7.3). Potentially, the net effect of these targets for 2020 would be to permit the Irish ETS to emit 20% more GHG in 2020 than in 1990. In contrast, the net effect of the domestic reduction target would potentially be to reduce agricultural emissions to 22% below the 1990 level. While this outcome was not contemplated as a realistic option by policymakers, it nevertheless contributed to the general view that emissions from the agricultural sector were problematic.

That the difficulty for the agricultural sector had not been foreseen can be attributed in part to the lack of engagement by the Department of Agriculture in the early stages of Irish GHG policy formation and the failure of farm representative organisations to identify in a timely manner the serious long-term implications of national and EU GHG policies. The IFA was understandably enthusiastic about the commercial opportunities for farmers in reaching national renewable energy targets (IFA, 2011), and this may have diverted their attention from the long-term threats. Serious reservations on GHG policy in the Draft Climate Change Response Bill 2010 were however raised by the IFA in 2011 at a Joint Oireachtas Committee (JOC, 2011). These concerns centred on the impact of GHG reductions on long-term prospects for agriculture and on carbon leakage to less efficient producers. However these arguments probably did not receive the attention they deserved in the confusing public discourse which argued over targets in the draft bill. In the broader climate change community there was a widespread acceptance of stated government policy on the role of agriculture in reducing GHG emissions. Remarkably not one of over 200 submissions on national energy policy and GHG policy in the period 2006 to 2010 addressed the profound implications of GHG policy for agriculture (chapter 8). When the Department of Agriculture began to engage actively in GHG policy from 2006 onwards the shape of national and EU policy had already largely been determined, but there was still scope to seek rectification of anomalies and perverse outcomes. However, there was no evidence of any attempt to fundamentally review Irish GHG policy with respect to agriculture. The sudden appearance of the new expansionary agricultural policy in 2010, which might have indicated such a GHG policy revision, was most likely driven entirely by an urgent desire to mobilize all parts of the economy following the economic collapse.

Looking ahead to 2020 and beyond, there is a strong likelihood that in addition to the pressures posed by the EU 2020 targets there will be additional motivations to seek to reduce CH_4 emissions from agriculture. Improved scientific understanding has led to a revision of the global warming potential (GWP) of CH_4 to a value of 34 (IPCCC, 2013a), which is more than 60% higher than the GWP value of 21 used under Kyoto accounting rules. A revision of the GWP does not significantly alter the argument presented in chapter 5 regarding historic emissions from agriculture, as the whole GHG emissions curve back to the nineteenth century would be scaled up by the same factor. Nevertheless, given the high proportion of agricultural emissions in Ireland and the prevailing and unchallenged view at the end of the Kyoto period that agriculture is Ireland’s main problem, this upward GWP revision will inevitably result in pressure on Irish agriculture to reduce emissions. Other developments at international level are also expected to impact on agricultural policy. CH_4 is a relatively short-lived GHG with a lifetime in the atmosphere of about 12 years. Immediate reductions in CH_4 emissions could therefore potentially have an effect within a decade. Consequently, in recent years there has been a focus on short-lived climate pollutants as a rapid response mitigation measure (IGSD, 2012; Schindell et al., 2012). The Climate and Clean Air Coalition (CCAC), of which Ireland is a member, launched a number of initiatives in 2012 to tackle short-lived climate pollutants. CCAC makes it clear that such a strategy on short-lived pollutants would be in addition to continued vigorous efforts to reduce CO_2 emissions, and that the short-term measures should not distract from this essential long-term objective (IGSD, 2012). Despite this important qualification, for a country such as Ireland where agricultural GHG makes up nearly half of domestic emissions, there would be an understandable inclination to use the CCAC reasoning as a justification for intensified action to reduce agricultural CH_4 emissions.

Based on Kyoto carbon accounting, plausible agricultural GHG mitigation strategies for Ireland could include herd reduction, or a move to a more intensive system of production. Herd reduction would however conflict with the new agricultural policy announced in Food Harvest 2020. Moreover, while herd reduction would reduce Ireland's formal GHG emissions, there would in fact be adverse impacts in the EU and world context. A reduction in Irish dairy or meat output would result in a corresponding increase in output from other states, with a greater impact on GHG emissions. Intensification of livestock and dairy production while it could reduce nominal national emissions could similarly increase emissions in other countries due to emissions associated with production of cereals and other animal feeds. Also from a food energy balance perspective, a move away from grazing to intensive production would further increase the national food energy trade deficit. These considerations would suggest that a sustainable policy for Ireland in the European and world context would be as a minimum to maintain existing Irish agricultural production levels, and preferably to expand production, as envisaged in Food Harvest 2020, based on the existing extensive grazing model, with scientific research aimed at achieving GHG mitigation within this production model. Increased Irish production could displace less sustainable intensive production in other EU countries, with resulting GHG and food energy supply benefits. These aspects were considered in a review of Irish agricultural emissions by Teagasc (Schulte and Lanigan (eds.), 2011), which recommended that an appropriate policy, taking food security into account, would be to seek to moderate the increase in GHG emissions from agriculture. The Teagasc review identified a theoretical mitigation of 15 to 20% per kg of product, which would permit increases in agricultural output to meet increasing world food demand without necessarily significantly increasing emissions.

10.6 Sustainable Development Considerations

10.6.1 Irish GHG Policy - Consistency with Sustainable Development

That the overall national GHG policy worked on many levels in the short-term is clear from the goals achieved, as discussed in chapter 4. The policy was also successful in that it was economically efficient and did not adversely impact the rapidly growing economy. Irish GHG policy is considered here in terms of its contribution to the sustainable development process of the state, with an emphasis on aspects relating to the land. Taking the Brundtland Report definition of sustainable development, it is appropriate to consider in broad holistic terms how Irish GHG policy meets the needs of the present generation, without compromising the ability of future generations to meet their needs.

Irish GHG policy with respect to agriculture arguably focused entirely on the perceived needs of the current generation, and did not pay sufficient attention to the needs of future generations. Policy was predicated on declining agricultural output, and did not allow for potential expansion of food production in the future. While the needs of future generations cannot be precisely known, there were good reasons to expect that there would be increasing demand for food worldwide due to rapidly increasing population and the adverse impacts of climate change on food production in developing countries. Overall, sustainability considerations would indicate that GHG emissions from Irish agriculture should not have been excessively constrained and that in the long-term to 2050 provision should have been made for modest increases.

In general, the Irish policy of transferring a GHG reduction compliance burden to the land was not sustainable, as there were practical limits to its absorptive capacity. Forest sequestration of carbon was a short to mid-term measure which could not be continued indefinitely, as eventually a balance would be achieved between harvesting and sequestration. Already by 2012, this excessive reliance on forest sequestration had led to difficulties with respect to EU 2020 targets. Many aspects of bioenergy policy did not meet the basic requirements of sustainability. The high targets as quantified in NREAP could not be met from the existing national biomass resources. Liquid biofuels in particular would need to be imported. While in theory a larger domestic supply could be achieved in the future through innovative technologies such as grass-to-biogas, this posed the potential risk of displacing food production. From an energy efficiency perspective, which is a basic prerequisite of sustainable development, bioenergy does not represent efficient use of land. This would indicate that a more sustainable bioenergy policy would have been to focus on more modest supplies which could have been delivered from existing indigenous capacity, and using this energy in the most efficient manner, in for example biomass heating rather than the less efficient co-firing option.

Not all problems are soluble, and similarly in sustainable development there may be no clear pathway and only a choice between the least damaging of a range of non-sustainable compromises. Irish energy policy in general was inherently not sustainable, which was a problem it shared with many OECD countries. The growing Irish economy required increased energy, and this additional energy was supplied almost entirely from imported fossil fuel, which greatly compromised national energy security. Security was further jeopardized by progressive fuel-switching to natural gas. While it permitted more efficient power generation and had a lower GHG emissions intensity, it relied totally on pipeline imports with limited national gas storage facilities. Energy policy consequently posed risks for both the present generation and future generations. In the decade to 2012 Ireland relied on imports for 90% of its energy requirements, which represented a considerable worsening of the situation compared to 1990 when imports accounted for 63% of primary energy (SEAI, 2013a). Despite increased projections for renewable energy to 2020 and the expected output from the Corrib gas field, the overall outlook for national energy security was still negative at the end of the Kyoto period (Dennehy et al., 2011). This deteriorating energy security trend explained the very active promotion of bioenergy, arguably beyond its sustainable limits. It also explained the state policy of supporting peat power plants which in turn prompted a policy of co-firing peat with biomass. The maintenance of coal power generation was also justified in this context as it could be sourced from a range of politically stable geographical locations, and stock-piles could provide an 85 day supply buffer (ESB, 2013). In the absence of nuclear power, which was considered to be politically unworkable and was prohibited, the only way out of this dilemma was to plan to limit total energy use, as was finally envisaged in NREAP 2010, to strive for more energy efficiency, and to increase the proportion of renewable energy. This additional renewable energy would realistically have to rely upon a considerable expansion of wind energy rather than the limited bioenergy resources, or the more speculative wave energy. Even with considerable expansion of wind energy the state still faced a precarious future with respect to energy security for many decades ahead.

10.6.2 Compliance With General Principles of Sustainable Development

As discussed in chapter 1 common principles can be identified which are considered essential for a successful national sustainable development strategy. The five basic principles identified by Cherp et al. (2004), are presented in Table 10.1, along with a summary of Ireland's GHG policy compliance with these principles. Corresponding Irish national principles were also developed, and are also presented in Table 10.1.

10.6.2.1 Country Policy Ownership and Commitment

No country can have total independent control over its GHG policies, as it must rely upon and respect international agreements. In Ireland's case, while the Kyoto reduction target was set in the context of joint fulfilment by the EU there was still considerable latitude for policy ownership. This was fully exercised in NCCS 2000 taking account of the desire for economic growth, and the particular national circumstances. From 2000 onwards, a series of EU directives on renewable energy, bioenergy, and emissions trading progressively constrained national policy choices. By 2009, following the EU

Principles for a National Sustainable Development Strategy (Cherp et al., 2004)	**Assessment Summary**
Country Ownership and Commitment	Irish ownership of policy up to 2006, afterwards ownership progressively transferred to EU. Government support at all times for GHG policy, but support passive.
Integration of economic, social, and environmental objectives	Economic objectives took priority. Decisions made on basis of no-regrets and least cost analysis. Agriculture was excluded in setting long-term objectives. No long-term land-use policy.
Participation and consensus	High level of engagement by stakeholders and consensus, but evidence of weaknesses in public consultation processes
Comprehensive and coordinated process	National communications criticised in UNFCCC reviews for lack of clarity. Strategies coordinated by Department of Environment, but no implementing authority.
Targeting, resourcing, and monitoring	Mixed performance: good performance on wind energy, unrealistic targeting and resourcing of bioenergy and wave energy. Good technical monitoring but delayed policy responses. No formal annual policy monitoring until 2008.
Irish Principles of Sustainable Development (Comhar, 2002; DECLG, 2012)	**Assessment Summary**
Satisfaction of human needs by the efficient use of resources	Economic needs satisfied, with accompanying drive for improved energy efficiency and reduced GHG intensity
Low-carbon economic growth	Not achieved. Growth depended on imported fossil fuels, with a degree of de-coupling of growth from GHG achieved through fuel switching to natural gas.
Respect for ecological integrity/ biodiversity	Policy on bioenergy could potentially impact on ecology/biodiversity.
Respect for cultural heritage /diversity	Did not arise as a consideration.
Equity between generations	Emphasis was on current generation. Large unsolved problems were left for future generations.
Equity between countries and regions	Policy on agriculture negative for rural areas. Importing biofuels potentially negative for other countries.
Social equity	Production of biomass seen as a means of supporting employment in rural areas. Carbon tax initially excluded solid fuels due to fuel poverty concerns. Residential energy upgrade grants for homes in fuel poverty
Gender equity	Did not arise as a consideration in GHG policy

Table 10-1 Summary of Ireland’s GHG policy compliance with sustainable development principles.

Climate and Energy Package, there was little left by way of national policy flexibility. In particular the Irish state had no means of addressing the difficulty posed by the 20% reduction target for the domestic sector. It is highly unlikely that such a target would have been agreed had Ireland retained full policy ownership. Weakening of national policy ownership would not necessarily mean that a successful GHG policy could not be implemented in on a European scale. However, in taking on overall control of GHG policy the EU should also be required to address in an equitable manner any genuine special difficulties which a country or region may experience, and to either solve these problems, or provide these countries with the necessary local policy flexibilities.

That the Irish government was formally committed to the climate change agenda was evident from public statements, and the policymakers interviewed reported total government support at all times. This view is supported by the historical analysis of Ireland's policy evolution as described in chapter 3 where no evidence of significant political opposition could be detected. A possible exception was the rejection of a carbon tax option in 2004. This decision was however justified at the time, as economic analysis did not predict a significant impact on emissions from the non-ETS sectors (Conniffe et al., 1997; Bergin et al., 2004), and the ETS sector was in any event going to be subject to an effective carbon tax. Yet the overall character of government support up to 2007 was passive and lacked commitment. The attitude appeared to be to let the civil servants and state agencies get on with the work. As voiced in a number of the submissions in chapter 8 there was a sense that no one was in charge of implementation of GHG policy. There was a complete absence of developed policy positions on long-term land use which resulted in conflicts between objectives for agriculture, forestry and bioenergy. The commitment of the Green Party on climate change cannot be doubted and in the period 2007 to 2010 there was a notable invigoration of GHG policy, with the introduction of annual carbon budgets and a draft Climate Change Response Bill which sought to further integrate GHG considerations into all aspects of government policy. However, by this stage policies for the Kyoto phase had already been determined and with the sudden economic collapse it became impossible to recruit political support for longer term GHG control measures.

10.6.2.2 Integration of Economic, Social and Environmental Objectives

In integrating national objectives the economy took priority and this stood also as a proxy for social objectives. GHG policy was designed in such a way as to ensure continued economic growth and measures such as carbon tax or actions on escalating traffic emissions, which could have impacted on this growth, were avoided. This, along with the realities of a parliamentary democracy precluded any draconian interventions to reduce GHG emissions. The Brundtland Report had warned that the sustainable development process would involve painful choices. By basing NCCS 2000 on no-regrets and least cost options, these painful choices were avoided, or at least postponed. Renewable energy was seen as something that the state would have to pursue in any event to improve energy security and it had the side-effect of reducing GHG emissions. As there was no national long-term policy or objectives for agriculture, national GHG strategies did not need to consider this aspect. An expansionary forestry policy was already in existence and GHG reductions were a beneficial adventitious outcome.

10.6.2.3 Participation and Consensus

The review of the public consultation on national GHG and energy policies described in chapter 8 showed that there was an impressive degree of stakeholder participation, and in general a broad consensus on government policy. There were however disquieting aspects of the public consultations, in particular the lack of questioning of policies and targets. That the public consultations failed to adequately flag evident deficiencies in bioenergy policy, and unrealistic projections for wave power, or to address the question of agriculture, indicates that it cannot be relied upon to guide policy development. Consensus is a meaningless principle if it is based on an unquestioning acceptance of the policies promulgated by the government.

10.6.2.4 Comprehensive and Coordinated Planning Process

A viable sustainable development plan should be clear including all relevant factors, with coordination of measures between all relevant actors. In NCCS 2000 the Kyoto compliance strategy sought to achieve coordination by assigning responsibility for measures mainly to the Departments of Environment, Energy, and Transport, with technical advice and support provided by state agencies and bodies including SEAI, the EPA, Teagasc, and Comhar. The Department of Environment was in charge, but it arguably lacked the political power to drive policy. While NCCS 2000 and NCCS 2007 appeared to be comprehensive and coordinated plans on paper, there were ambiguities in responsibility and implementation. The largest GHG mitigation item in NCCS 2000 was the replacement of coal power generation with gas generation, which would have involved the closure of Moneypoint power station. However there was no credible mechanism to achieve this outcome. Traffic was identified at an early stage as a major factor in increasing GHG emissions, but there were no significant measures to tackle these increases. Traffic in the Dublin area fell within the responsibility of the Dublin Transportation Office, which was identified as having a GHG mitigation role, yet this body had not been required to address GHG emissions in its establishment order (DTO, 1995). Car taxes linked to CO_2 emissions were not introduced until mid-way through the Kyoto period. It was not until 2009 that policymakers began to think in terms of an eventual limitation of total annual vehicle distance in the context of planning for 2020 (DOT, 2009). The absence of measures to tackle transport emissions undoubtedly drove the biofuels policy, which was an insufficient and flawed response to the problem. In addition to the lack of clear implementation mechanisms for GHG strategies, there were no adverse consequences for government departments which failed to deliver on policy. In its reviews of Ireland's policies from 1999 to 2010 the UNFCCC criticised the lack of clarity and transparency in Ireland's GHG reduction strategy, and in particular the lack of cross-cutting implementation measures. Significant national actors and stakeholders including the EPA, Comhar, and IBEC were in 2006 also unclear as to who was in charge of GHG policy and how targets were to be met (chapter 8).

10.6.2.5 TARGETING RESOURCES AND MONITORING

Proper targeting of resources implies the existence of resources to target in the first instance. A notable feature of Ireland's GHG reduction strategies was the absence of a clear overall financial budget which was a consequence of the no-regrets and minimum cost policy approach. However, major initiatives such as wind power were supported directly by the consumer through adjustments to electricity bills. Consumers would also have to bear the cost of strengthening the national grid to accept variable wind power. Supports for specific actions in the area of renewable energy and energy efficiency were provided as part of government budgets, but the scale of support did not relate to the enormity of the transformation that was being sought, in attempting to de-carbonize Irish society. In the case of biomass heating, the total budget applied was insufficient to generate any significant momentum. Likewise on the supply side, supports for energy crops were limited compared with the situation for forestry promotion, and even if schemes were fully subscribed it would not be possible to achieve energy crop targets for 2020. Given the limited budget available for bioenergy the policy of attempting to stimulate all potential markets would have to be questioned. By spreading limited supports too thinly over many markets there was the risk that none would be a success. A more focused targeting of support to one efficient application such as biomass heating would have been preferable.

There was also confusion in target setting. In NCCS 2007 and in NREAP 2010 targets which were clearly aspirational were presented alongside realistic targets, with no means of determining which were which. The renewable electricity target of about 40% from wind power was based on many years of preparatory work and was technically and economically achievable. In contrast, bioenergy targets lacked a proven and credible delivery mechanism in terms of both supply and market. Wave power, which was at a very early stage of development, was unlikely to achieve any significant targets by 2020. Were the state serious about developing an indigenous wave power industry, considerably more funding would have been required than the total of €13m allocated by SEAI to ocean energy between 2008 and 2012, as documented in their annual reports (SEAI, 2014).

From a purely technical viewpoint, monitoring was well provided for, with reliable data on annual emissions compiled by the EPA, which documented deviations from the desired GHG trajectory from the early 2000s. In terms of policy monitoring, the state prepared regular updates for transmission to the UNFCCC (chapter 3). In theory this provided a mechanism for independent assessment of policies and measures, and the opportunity to make policy adjustments based on these assessments. In practice, due to the inevitable time delays in compiling statistics, and the time taken to receive feedback from the UNFCCC reviews, there was little benefit in this process in terms of policy monitoring. The scope of the UNFCCC reviews was also focused on Kyoto achievement, and they did not engage with any post 2012 issues, nor did they identify in advance the compliance discontinuity that would arise in 2012 due to EU targets for 2020. Over the period 1990 to 2012 there were three national GHG control strategies spaced seven years apart, in 1993, 2000, and 2007. These strategies did not provide for annual adaptation, as would befit a true sustainable development process. Given the rapid escalation in GHG emissions from the late 1990s, a real-time monitoring of the effects of policies and programmes on an annual basis would have assisted. Apart from prescient warnings in the early 2000s, the EPA focused on its role of inventory reporting and management of the ETS, and until it assumed its new role in 2008 in preparing GHG projections, was publically silent on Ireland's poor compliance. For most of the study period other than oversight by the Department of Environment there was no formal national policy monitoring, and this absence of policy monitoring was noted by the UNFCCC (2005). With the introduction of the annual carbon budget in 2007 following the arrival of the Green Party into government there was finally a formal annual review mechanism. However, by this time, most policies were already in place for the Kyoto period and subsequent carbon budgets struggled for attention against the background of the economic recession and political instability as the coalition government endeavoured to stay in power.

10.6.3 Compliance with Irish Principles of Sustainable Development

Referring to the Irish principles of sustainable development presented in Table 10.1, the first was to satisfy human needs by the efficient use of resources. In this respect Irish GHG policy in general succeeded, as the uncontested expressed need of the Irish population over the policy period was for economic growth and increased wealth. However, this was facilitated by increasing fossil fuel emissions, and consequently the economic growth was not achieved in the desired low carbon manner. Respect for ecological integrity and biodiversity which was espoused as a fundamental thematic principle did not feature in GHG policy development, and was all but absent from the national discourse on bioenergy. Equity between generations and between countries and regions likewise did not feature in Irish GHG policy. The emphasis on economic growth for the present generation was achieved at the expense of continued reliance on fossil fuels and erosion of energy security which were left as unsolved problems for future generations. On the principle of equity between regions, the assumption that agricultural output would decline led to a GHG policy which restricted future growth, and represented an inequitable treatment of rural areas compared with industrial areas. The preferential treatment of industry and energy sectors over agriculture is illustrated in the fact that by 2005 the ETS sector of the Irish economy had consumed all of the additional emissions allowances permitted under Kyoto. Regarding equity between countries, the potential impact of biofuel imports on ecosystems and food supplies and on biodiversity in developing countries was not a significant consideration in Irish policy formation. The principle of social equity did however feature to a certain extent in the context of GHG policy. Support for bioenergy was justified in terms of socioeconomic benefits in rural areas, and the carbon taxation of solid fuels was postponed due to concerns on fuel poverty. Concerns on social equity also shaped policy on the energy upgrade of buildings. Between 2010 and 2012, 32% of the total grant funding was directed towards homes experiencing fuel poverty (section 4.4.5).

10.7 Proposals for Improvements Based on Lessons Learned

10.7.1 Streamlining Existing Governance System

The general options for future governance are to build upon the existing system, or to construct a new system, with additional bodies. Regarding construction of a new system, there may be an understandable temptation to call for the establishment of an independent body of experts who would steer national GHG policy as was envisaged in the original draft Climate Change Response Bill of 2010. However, for such a body to operate in a democracy it would require cross-party political support and checks and balances to ensure that the resulting strategies and measures were acceptable to the public. A high degree of political oversight and occasional intervention would be necessary. Such a steering body could not truly operate independently and would probably become just another body requiring management at a political level. Rather than seeking to establish a new governance system involving additional bodies, a simple and feasible approach would be to improve the operation of the existing governance system. By 2012, the Irish state had developed considerable expertise in GHG policy. In addition to the experience developed by government departments, there were established capabilities in the EPA, in SEAI, Teagasc, and in NESC. As in any organizational structure there would undoubtedly be significant scope for improvement in the operation and interaction of the various elements within the existing governance system.

Prime responsibility should however remain within the government, as many of the decisions to be made are fundamentally political. Moving responsibility for GHG policy from the Department of Environment to a central department such as the Taoiseach, or Finance would strengthen the overall governance. In the period 1990 to 2012 the resources available within the key government departments would appear to have been rather limited given the scale of the task and the workload at national, EU, and broader international level, and the additional duties of interacting with state agencies and bodies (chapter 9). The existing teams of civil servants and experts would therefore need to be considerably supplemented to manage the workload, and to provide capacity for calm reflection on long-term policy aspects.

Many of the issues of lack of clarity in national strategies as commented on by the UNFCCC had already been addressed by 2012, and could readily be further improved. A clear differentiation should be made between feasible short and mid-term targets which should be incorporated in strategies, and the long-term aspirations which signal the general policy direction. National strategies should always be presented in terms of actual GHG reductions relative to the present, rather than relative to future do-minimum projections, which are inherently unreliable and confusing. Clear tables should be provided showing targets, supporting measures, and responsible bodies. Formulation of targets in terms of tonnages of GHG would help to improve the clarity and transparency of national strategies. Unless absolutely required, expression of targets in terms of percentage reductions should be avoided. Such percentage targets were justifiable when baseline emissions were subject to frequent revisions, but this is no longer the case. Narrative should be reduced to a minimum and promotional and aspirational aspects, which are important in their own right, should be confined to separate brochures. As public consultations appeared to be of limited benefit in the past, efforts should be made to encourage a more questioning approach in public submissions. The community of stakeholders and actors in Ireland is probably too small for a candid internal review, and there would be merit in using a panel of experts, sourced from outside the state, to assist in compiling the findings of the public consultations. The external review panel should include the quantitative disciplines, such as science, engineering, economics, and to address the current governance deficit in the subjective disciplines, the panel should also include ethicists, social thinkers, and eco thinkers.

10.7.2 Long-Term GHG Policy to 2050, and Strategy to 2020

The suggestions put forward here for improvement in Ireland's climate change response are restricted to matters over which there is national control, and is in recognition of the reality that much of GHG policy ownership had passed to EU level by 2012. Larger issues such as inadequacies in GHG accounting, and how the land should be treated in the context of EU targets may take years or decades to resolve and are the ultimate responsibility of the EU. While Ireland may make inputs on these matters, the outcome is uncertain, and there is no guarantee that any agreed future GHG accounting would align optimally with Ireland's sustainable development objectives. GHG accounting with respect to the land was already extremely complicated during the Kyoto period, even though it was based on incomplete knowledge. The likelihood is that any future more complete GHG accounting relating to the land will be even more Byzantine, and this could impact significantly on land-use policy. Such an outcome would surely not form a good basis for sustainable land-use planning, which must be clearly understood in simple intuitive terms by all actors and stakeholders. The present research found that many of the non-sustainable aspects of Irish GHG strategies were due to the accounting linkage between fossil fuel emissions and the land. Breaking this linkage is consequently a key recommendation for long-term policy to 2050. This would be achieved by dividing national GHG policy into two parts. One policy division would deal exclusively with fossil fuel and industrial emissions, and one would deal exclusively with land emissions. The land in this context would include agriculture, forestry, and natural lands. Implicit in this policy partition would be that at the national level there would be no exchanges of emissions allowances permitted between the fossil fuel and land sectors. This would not impact on international obligations which would be accounted in whatever manner is stipulated, possibly involving complicated aggregate accounting of fossil fuel emissions and land emissions. However, any such accounting at international level should be insulated from national policy and should not be used as a prescriptive template for national land activities. In this partitioned dual policy model, separate targets and strategies would be pursued for the land, and for fossil fuel emissions. In the case of the land the long-term objective should be a sustainable land sector which progresses towards carbon neutrality, while meeting the needs of current and future generations in terms of food production, timber, biomass, and maintaining biodiversity and ecological services. Bioenergy production, within the sustainable national capacity would be feasible, and its output should be directed towards the most energy efficient application, which for the foreseeable future is heat. Within this policy framework for the land there would be potential for the agricultural sector to maintain existing GHG emissions, and to increase emissions if compensating sustainable land sinks can be demonstrated.

A major advantage in separating the land from fossil fuel and other industrial emissions would be that it would highlight the need to aggressively pursue a policy of reduced fossil fuel consumption. This is not an easy task, and as of 2012, there was no evident single solution. As proposed by NESC (2012) GHG strategies must be continuously monitored and adapted in accordance with the principle that sustainable development is a process and not a set of prescriptive measures set out in a document. This will involve continual adjustment of GHG strategies in light of technological developments. However there is a risk in moving to this more adaptive approach, in that targets may lose their significance, which could result in prevarication. To ensure that national targets are not interpreted away it is suggested that the EU 20% reduction target for the domestic sector in 2020 should be pursued as a firm short-term target but should be confined to fossil fuel and industrial emissions, excluding agriculture. This has the simplicity in being able to base strategy on an existing set of legal obligations, and would build on Ireland's proven experience in meeting targets. The EU target for 2020 already excludes forest sequestration and other land–use activities. Exclusion of agriculture from the target would be consistent with these exclusions, and the question of emissions from agriculture could continue to be addressed nationally in their correct context, which is the land.

A clear division between the fossil fuel emissions and the land would promote clarity of thinking and focus efforts to deal with Ireland's real challenge, which is to find a way of actually reducing CO_2 emissions, which implies reducing fossil fuel combustion. Despite over 20 years of policy development this still remained the same problem at the end of the Kyoto period, as faced by policymakers in the early 1990s when they first tackled the climate change challenge.

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APPENDIX A – NAMES OF GOVERNMENT DEPARTMENTS

Department of Environment:
2011: Department of Environment Community and Local Government (DECLG)
2002: Department of Environment Heritage and Local Government (DEHLG)
1997: Department of the Environment and Local Government (DELG)
1977: Department of Environment (DOE)

Department of Energy:
2011: Department of Communications, Energy and Natural Resources (DCENR)
2007: Department of Communications, Marine and Natural Resources (DCMNR)
1997: Department of Public Enterprise
1993: Department of Transport Energy and Communications

Department of Agriculture:
2011: Department of Agriculture Food and the Marine (DAFM)
2007: Department of Agriculture Fisheries and Food (DAFF)
2002: Department of Agriculture and Food (DAF)
1997: Department of Agriculture Food and Rural Development (DAFRD)
1993: Department of Agriculture Food and Forestry (DAFF)
1987: Department of Agriculture and Food (DAF)

Department of Transport:
2011: Department of Transport Tourism and Sport (DTTS)
2002: Department of Transport (DOT)
1997: Department of Public Enterprise (DPE)
1993: Department of Transport Energy and Communications (DTEC)
1991: Department of Tourism, Transport and Communications (DTTC)

Department of the Taoiseach

Department of Finance

APPENDIX B – NATIONAL ACTORS AND STAKEHOLDERS

Table B 1. National actors and stakeholders identified as being involved in climate change policy, based on public consultations on Energy Green Paper and National Climate Change Strategy Review 2006.
* contacted in preliminary survey
** did not engage in public consultations process, but added to contact list due to relevance

Industry, Business, Representative Bodies		
Airtricity *	EON, UK	Irish Solar Energy Association *
Bioverda	ESB	Irish Wind Energy Association *
Bord Gáis *	Federation of Petroleum Suppliers	IRISH Wood Pellets Ltd.
Bord na Mona *	Ganymede Services	John Fingleton, CHP Developer
Cement Manufacturers Association *	GEM Utilities	Marathon Oil
Chambers Ireland	Hunters Hotel	Oriel Wind Farm
Coillte	Imera Power	PM Group
Confederation of European Waste to Energy Plants	Indaver	Port of Cork
Conoco Philips	Irish Bioenergy Association *	Quins of Baltinglass
Construction Industry Federation *	Irish Biofuels Initiative	Shannon LNG
CSA Group	Irish Business and Employers Confederation **	SIMI
Cylon Controls	Irish Cement	SWS Energy Services
Dalkia	Irish Co-operative Organisation Society	VIPRE (Transport Consultants)
Eagra Group	Irish Farmers Association *	Viridian
Ecocem	Irish LP Gas Association	Vivid Logic
Edenderry Power Station	Irish Offshore Operators Association	Waterford Chamber
Emerald Energy	Irish Petroleum Industry Association	White Young Green
Emo Motor	Irish Small and Medium Enterprises Association *	
Public and Local Authorities and Bodies, State agencies, Government Departments (state agencies and Govt. Departments were excluded from the survey)		
Amergin	Dublin Regional Authority	Meitheal na Gaoithe
Association of Irish Energy Agencies *	Dublin Transportation Office *	National Consumer Agency
Border Midland and W Regional Assembly	Eirgrid	National Economic and Social Council **
Carlow Kilkenny Energy Agency **	Enterprise Ireland	SEAI
City and County Managers Association	Environmental Protection Agency	SE Regional Authority

Table B 1. National actors and stakeholders identified as being involved in climate change policy, based on public consultations on Energy Green Paper and National Climate Change Strategy Review 2006.
* contacted in preliminary survey
** did not engage in public consultations process, but added to contact list due to relevance

Comhar *	Failte Ireland	SW Regional Development Authority
Commission for Energy Regulation	Fingal Development Board	S and E Regional Assemblies
Competition Authority	Forfás *	SW Regional Authority
Consumer Association of Ireland	Galway City Council	Sustainable Energy Ireland
Cork City Council	Industrial Development Authority	Teagasc *
Cork County Council	Limerick Clare Energy Agency **	Tipperary Energy Agency *
County Clare Wood Energy Project	Marine Institute *	Western Development Commission
Department of Enterprise Trade and Employment	Marine Research	Western Regional Authority
NGO's, Think Tanks, Political Parties, Campaign Groups		
Ballyfermot Residential Energy & Fuel Poverty	Friends of the Earth *	Shell to Sea
Bene *	Gluaiseacht	Sinn Féin **
Coastal Concern Alliance	Green Party *	Toll, R ESRI
Economic and Social Research Institute *	Institute for International and European Affairs **	
FEASTA *	North West Group	
Forest Friends Ireland	Scott, S ESRI *	
Academics, Professional Organisations. Trade Unions		
Council for Forestry Research **	Macra na Feirme	Royal Institute of Architects
Dundalk Institute of Technology, Centre for renewable energy	Met Eireann (C4I) **	Royal Irish Academy *
Electricity Research Centre *	NUI Maynooth **	Tipperary Institute **
Engineers Ireland *	NUIG Combustion Research Centre	Trinity College Dublin **
Geological Survey of Ireland **	NUIG Environmental Change Institute **	UCC **
Irish Academy of Engineering	O. Mahony, T (DIT)	UCD Energy Research Group
Irish Congress of Trade Unions	RDS Committee of Science and Technology	UCD Meteorology and Climate Centre *
Labour Party *		

TEXT OF SCOPING SURVEY E-MAIL

Research on Climate Change Governance in Ireland
Colin Doyle, Dept. of Geography NUI Galway

I am conducting a postgraduate study on climate change governance in Ireland. The first part of the research is to document the roles of the people, bodies and organisations, who are active in this area, to study the network of interactions, and to identify current key issues. I would appreciate your assistance in completing the following short questionnaire. To do the questionnaire please just reply to the e-mail, and enter your answers after each question. If there are a number of answers to a question, please list in order of importance, and feel free to add any additional explanatory comments.

1. What specific aspects of climate change policy/governance, studies or actions are you personally involved with, and approximately what percentage of your time is currently devoted to these areas?

2. Which organisations or bodies, or people, do you communicate with most frequently regarding climate change issues?

3. What form of communication do find most effective (e.g. formal reports, academic publications, letters, e-mail, phone, formal meetings, personal meetings, workshops)?

4. What are your most important external sources of guidance and technical information?

5. From your perspective, what are the priority actions we should take to improve the governance of climate change issues in Ireland?

6. Do you expect that the recent downturns in the economy and in public finances will impact on your activities?

7. Any other comments?

Regards

Colin Doyle

Confidentiality
This survey is part of a research project at the Department of Geography NUIG under the supervision of Dr. Kieran Hickey. Your feedback will be used to guide our research and assist in reaching broad conclusions. Individual details and comments will be treated as confidential and will not be published.

APPENDIX C – DETAILS OF FOOD ENERGY BALANCE

Analysis was based on United Nations Food and Agriculture organisation (FAO) database (FAO, 2013a). Data is shown in Tables C1 and C2 for Ireland and the EU-27 respectively. Shaded cells in the tables indicate calculated values. Unshaded cells indicate data imported from the FAO database, and is unmodified, other than conversion of food quantities from kilotonnes (kt) to megatonnes (Mt).

Total domestic supply: all food available in the domestic market for human and animal consumption

Net exports: Exports – Imports

Implied Food Energy: the food energy per tonne (toe/t), as calculated from FAO annual per capita data:

Implied food energy = daily food energy (Kcal) x 365/10 x10^6 /annual food mass (t)

Where 1 tonne of oil equivalent (toe) = 10x 10^6 K calories

Data on biofuels imports is from National Renewable Energy Plans for Ireland and EU-27 (Government of Ireland, 2010; Beurskens and Hekkenberg, 2011). It is assumed that at most half of the imported biofuels were produced from food crop sources, as required under EU guidelines (CEC, 2012b).

Calculations of the population food energy needs are based on the average for the EU-27, which is 3456 Kcalories/day/capita (0.126 toe/year/capita).

The total available food energy (Kcalories/day/capita) differs slightly from the sum of the values in the columns in the tables, due to omission of small food categories.

Table C1 **Food Balance** **Ireland 2009**	**Production, Mtonnes**	**Imports Mtonnes**	**Stock Var. Mtonnes**	**Exports Mtonnes**	**Total Supply Mtonnes**	**Net Exports Mtonnes**	**Food kg/yr/capita**	**Food Kcal / day/capita**	**Implied Food Energy toe/t**	**Total Food Supply Mtoe**	**Net Food Exports Mtoe**
Cereals	2.07	1.52	0.19	0.29	3.49	-1.24	140	1117	0.29	1.01	-0.36
Starchy Roots	0.36	0.21	0.10	0.02	0.66	-0.19	111	188	0.06	0.04	-0.01
Sugar	0.01	0.30	-0.02	0.08	0.20	-0.21	36	325	0.33	0.07	-0.07
Pulses	0.02	0.01	0.00	0.00	0.03	-0.01	4	38	0.35	0.01	0.00
Treenuts	0.00	0.01	0.00	0.00	0.01	-0.01	2	14	0.24	0.00	0.00
Oilcrops	0.02	0.09	0.00	0.00	0.11	-0.09	3	33	0.35	0.04	-0.03
Vegetable Oils	0.01	0.21	-0.01	0.02	0.19	-0.19	16	378	0.88	0.17	-0.17
Vegetables	0.22	0.30	0.00	0.06	0.46	-0.24	89	77	0.03	0.01	-0.01
Fruits	0.05	0.83	0.01	0.16	0.74	-0.67	155	125	0.03	0.02	-0.02
Stimulants	0.00	0.04	0.00	0.01	0.03	-0.03	7	40	0.20	0.01	-0.01
Spices	0.00	0.00	0.00	0.00	0.00	0.00	1	5	0.30	0.00	0.00
Alcohol	0.96	0.30	0.02	0.54	0.75	0.23	158	280	0.06	0.05	0.02
Meat	0.89	0.22	0.04	0.75	0.39	0.53	88	398	0.17	0.06	0.09
Offals	0.09	0.01	0.00	0.07	0.03	0.06	7	21	0.12	0.00	0.01
Animal Fats	0.26	0.03	0.01	0.17	0.13	0.13	13	167	0.49	0.06	0.07
Eggs	0.04	0.01	0.00	0.01	0.05	-0.01	9	33	0.14	0.01	0.00
Milk	5.23	0.76	0.05	3.78	2.26	3.02	226	346	0.06	0.13	0.17
Seafood	0.28	0.10	0.00	0.20	0.18	0.11	22	34	0.06	0.01	0.01
Total								3617		**1.70**	**-0.33**

Available dietary energy 3617Kcals/day/capita = 0.132 toe/year/capita (0.126 for EU-27)
Net food energy imports as fraction of total food supply = 0.33/1.7 = 19%
Net food energy imports in terms of food energy needs in EU= 0.33M/0.126 = 2.6 million people

Projected biofuels imports in 2020: 0.34 Mtoe, of which half is from food feedstocks: 0.17 Mtoe
Effect of biofuels imports on net food energy imports: 0.33 + 0.17 = 0.50 Mtoe
Net food energy imports as fraction of total food supply = 0.50/1.7 = 29%
Net food energy imports in terms of food energy needs in EU = 0.50M/0.126 = 4 million people

Table C2 **Food Balance** **EU-27 2009**	**Production, Mtonnes**	**Imports Mtonnes**	**Stock Var. Mtonnes**	**Exports Mtonnes**	**Total Supply Mtonnes**	**Net Exports Mtonnes**	**Food kg/yr/capita**	**Food Kcal / day/capita**	**Implied Food Energy toe/t**	**Total Food Supply Mtoe**	**Net Food Exports Mtoe**
Cereals	296	81.9	-3.5	99.7	275	17.8	125	950	0.28	76.1	4.93
Starchy Roots	63	14.4	0.1	17.8	60	3.3	74	133	0.07	3.9	0.22
Sugar	22	14.9	-0.8	11.8	24	-3.1	39	370	0.35	8.5	-1.07
Pulses	3	1.5	0.3	1.1	4	-0.4	3	26	0.34	1.4	-0.14
Treenuts	1	2.7	0.0	1.0	3	-1.6	5	31	0.23	0.6	-0.37
Oilcrops	44	30.7	-0.3	12.5	62	-18.2	6	31	0.21	12.7	-3.75
Vegetable Oils	17	21.9	-0.3	13.3	25	-8.6	20	491	0.89	22.5	-7.63
Vegetables	68	27.0	0.2	26.2	69	-0.8	118	81	0.03	1.7	-0.02
Fruits	62	52.7	0.0	34.5	80	-18.1	103	117	0.04	3.3	-0.75
Stimulants	0	8.7	0.1	4.9	4	-3.7	8	27	0.13	0.5	-0.48
Spices	0	0.4	0.0	0.2	0	-0.2	1	5	0.26	0.1	-0.05
Alcohol	60	14.5	0.9	18.1	57	3.6	103	184	0.07	3.7	0.24
Meat	44	15.5	0.0	16.3	43	0.8	85	384	0.17	7.1	0.13
Offals	3	0.8	0.0	2.0	1	1.2	3	9	0.11	0.2	0.13
Animal Fats	9	3.6	0.2	4.3	9	0.7	13	195	0.55	4.9	0.37
Eggs	7	1.4	0.0	1.4	7	0.0	12	47	0.14	1.0	0.00
Milk	152	48.4	-0.1	58.8	142	10.4	239	319	0.05	6.9	0.51
Seafood	6	18.1	0.1	10.3	14	-7.8	23	49	0.08	1.1	-0.61
Total								3456		156	-8.36

Available dietary energy 3456Kcals/day/capita = 0.126 toe/year/capita
Net food energy imports as fraction of total food supply = 8.36/156 = 5%
Net food energy imports in terms of food energy needs in EU= 8.36M/0.126 = 66 million people

Projected biofuels imports in 2020: 7.4 Mtoe, of which half is from food feedstocks: 3.7 Mtoe
Effect of biofuels imports on net food energy imports: 8.36 + 3.7 = 12 Mtoe
Net food energy imports as fraction of total food supply = 12/156 = 8%
Net food energy imports in terms of food energy needs in EU = 12M/0.126 = 96 million people

APPENDIX D – ANALYSIS OF PUBLIC CONSULTATIONS

	Agreement, and calls for additional supports				Areas of concern or doubt				Bioenergy Support and Concerns		
	Market Supports	**Crop Supports**	**Education/standards**	**AD/Biogas**	**Targets too ambitious**	**Supply chain limitations**	**Competition with timber**	**Environmental/ Sustainability**	**Waste to energy**	**Co-firing**	**Liquid biofuels**
All consultations: Green Paper 2006, NCCS review 2006, draft NREAP 2010											
All: supporting comments	36	12	20	20					11	19	40
All: concerns/doubts:					8	14	5	10	5	15	9
% supporting comments (of 224 total comments)	16%	5%	9%	9%					5%	8%	18%
% concerns/doubts (of 224 total comments)					4%	6%	2%	4%	2%	7%	4%
Green Paper: supporting comments	23	8	9	6					6	11	23
Green Paper concerns/doubts:					2	8	2	5	1	9	5
% supporting comments (of 118 total comments)	19%	7%	8%	5%					5%	9%	19%
% concerns/doubts (of 118 total comments)					2%	7%	2%	4%	1%	8%	4%
NCCS review 2006: supporting comments	4	2	4	6					4	6	9
NCCS review 2006 concerns/doubts:					1	1	1	2	2	1	3
% supporting comments (of 46 total comments)	9%	4%	9%	13%					9%	13%	20%
% concerns/doubts (of 46 total comments)					2%	2%	2%	4%	4%	2%	7%
Draft NREAP 2010: supporting comments	9	2	7	8					1	2	8
Draft NREAP 2010: concerns/doubts:	0	0	0	0	5	5	2	3	2	5	1
% supporting comments (of 60 total comments)	15%	3%	12%	13%					2%	3%	13%
% concerns/doubts (of 60 total comments)					8%	8%	3%	5%	3%	8%	2%

Table D1. Analysis of comments on bioenergy policy in the public consultations for the Energy Green Paper 2006, NCCS review 2006, and in the draft NREAP 2010