

Climate change is the most significant and challenging issue currently facing humanity. Large reductions in greenhouse gas (GHG) emissions will be required if dangerous and irreversible climate impacts are to be avoided. The UN Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol provide the basis for international action to address climate change. The UNFCCC objective is to stabilise atmospheric GHG concentrations at a level that would avoid dangerous human interference with the climate system. The Kyoto Protocol establishes binding targets in many developed countries and contributes to global GHG reductions. Ireland's target is to limit emissions to no more than an annual average of 62.8 Mtonnes CO<sub>2</sub>e during the 2008-2012 period (a 13 per cent increase on the 1990 baseline year).

The EPA has established capacity to produce robust national GHG inventories and projections. These data can allow Ireland to identify and implement necessary policies and measures to enable us to meet our international GHG reduction targets. One of the major Europe-wide policies, the EU Emissions Trading Scheme, ensures that major emitters reduce CO<sub>2</sub> emissions in the most cost-effective manner. The scheme has been fully implemented in Ireland and covers over 100 industrial installations.

Climate change impacts are projected to increase in the coming decades. EPA-commissioned research has shown that action is required on a national basis to prepare for adverse impacts such as flooding, water management, sea-level rise and coastal erosion. Efforts will also be required to protect native species and manage changes in vulnerable natural and managed ecosystems. Current projections show that even if all projected reductions from existing and planned policies and measures are delivered, and forest sinks and Kyoto mechanisms purchases are used as envisaged, Ireland will still exceed its Kyoto Protocol limit by an average of 1.4 Mtonnes of CO<sub>2</sub>e annually in the period 2008-2012. Additional domestic policies and measures and/or additional Government purchases will be required to bridge this gap. It is also essential to reduce our dependence on fossil fuels while at the same time increasing our efficient use of all forms of energy.

In the longer term to 2020, Ireland's unique position within the EU as the country with the highest national proportion of agricultural emissions, together with further projected growth in transport emissions, will present this country with major challenges in meeting the EU's proposed future emission reduction targets.

## GREENHOUSE GAS EMISSIONS AND CLIMATE CHANGE



## Introduction

Climate change is recognised as the greatest threat to the planet and the greatest challenge facing humanity. Given the strong scientific evidence from the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) that warming of the climate system is unequivocal and is very likely to be due to human-induced emissions, the need for major reductions in greenhouse gas (GHG) emissions is now an accepted priority for most countries.

The 1992 UN Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol (adopted in 1997) provide the international structure through which global actions to address climate change are agreed. The objective of the UNFCCC is to stabilise atmospheric GHG concentrations at a level that would avoid dangerous human interference with the climate system.

This chapter discusses the key issues and challenges of addressing climate change, trends in GHG emissions and projections for Ireland, and implementation of the Kyoto Protocol, and outlines ongoing research designed to inform and assist in the development of responses to the challenges of climate change.

## Understanding Climate Change

Since the industrial revolution, emissions to the atmosphere of long-lived GHGs, such as carbon dioxide ( $\text{CO}_2$ ), methane ( $\text{CH}_4$ ) and nitrous oxide ( $\text{N}_2\text{O}$ ), mean that current atmospheric levels of these gases far exceed their natural ranges (Figure 3.1). This has increased the amount of energy being trapped in the



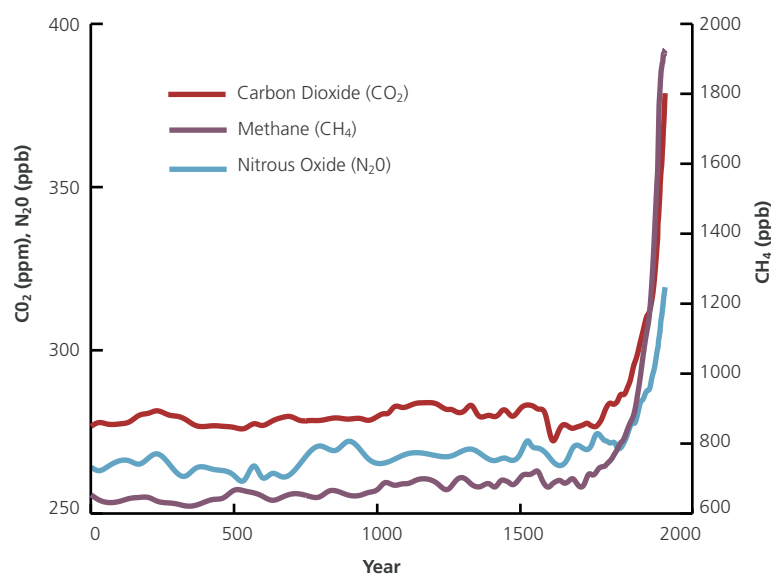
climate system. The consequences of this are most clearly evident in the global temperature records, which show that, on average, the global temperature has increased by  $0.8^\circ\text{C}$  above pre-industrial levels. Warming is also evident in increased ocean temperatures, melting of snow and ice and rising global average sea-level. Changes are seen in precipitation patterns and amounts, intensity of storms and occurrence of heatwaves.

$\text{CO}_2$ ,  $\text{CH}_4$  and  $\text{N}_2\text{O}$  have been the most important long-lived GHGs

over the past 2,000 years in terms of atmospheric concentrations. Increases since about 1750 are attributed to human activities in the industrial era. Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the GHG per million or billion air molecules, respectively, in an atmospheric sample.

The current concentrations of GHGs in the atmosphere, coupled with the relatively slow response of the climate system to the energy being

Figure 3.1 Atmospheric GHG Levels (Source: IPCC, 2007)



trapped by these gases, have a number of implications for future climate conditions globally, including the following.

- A further increase in global temperature of 0.6°C is unavoidable during this century.
- Current and future actions to reduce GHG emissions will have minor to zero effect on climate change impacts during the first half of this century.
- Urgent actions are required to reduce GHG emissions in order to limit the extent of adverse and dangerous impacts of climate change during the second half of this century.

Currently there is no agreement at UN level as to what atmospheric GHG concentration level is safe. The EU member states have made climate change a priority issue and have provided international leadership in this area. The EU considers that the most dangerous impacts of climate change can be avoided if the global average temperature does not increase by more than 2°C above pre-industrial levels.

The inherent variability of the climate system means that it is not possible to state with certainty what atmospheric GHG levels will prevent the global average temperature rise from exceeding 2°C. However, the AR4 suggests that emissions must peak, and atmospheric GHG concentrations must stabilise, in the next 10–20 years if such a temperature increase is to be avoided.

The AR4 indicates that while uncertainty remains in relation to future climate conditions, the impacts are very likely to impose net annual costs, which will increase over time as global temperature increases. The

## Global Warming Potential

The IPCC uses the concept of global warming potential (GWP) to compare and combine the warming effects of the individual GHGs. The GWP is a measure of the cumulative warming, over 100 years, by a unit mass of a gas. CO<sub>2</sub> (GWP = 1) is the reference gas for GWP calculations.

**Table 3.1 Selected GWPs and Atmospheric Lifetimes**  
(Source: IPCC, 1996)

Gas	Atmospheric Lifetime (Years)	GWP (100-year)
CO <sub>2</sub>	50–200	1
CH <sub>4</sub>	12 ± 3	21
N <sub>2</sub> O	120	310
HFC-23	264	11,700
HFC-236	209	6,300
CF <sub>4</sub>	50,000	6,500
C <sub>2</sub> F <sub>6</sub>	10,000	9,200
SF <sub>6</sub>	3,200	23,900

The GWPs are calculated for a 100-year period. The mass emission of any gas multiplied by its GWP gives the equivalent emission of the gas as carbon dioxide – the CO<sub>2</sub> equivalent (CO<sub>2</sub>e).

intensity and frequency of extreme weather events such as storms, floods and droughts are likely to increase, and sea-level rise will threaten coastal areas. Vulnerable ecosystems will be under further stress and increased levels of invasive species will impact on natural and managed systems, e.g. agriculture.

Analysis of the meteorological records shows that Ireland's climate is changing in line with the global

pattern. Our climate has shown an average increase of 0.7°C and is highly influenced by the North Atlantic Ocean. Globally oceans have absorbed more than 80 per cent of the heat added to the climate system and their temperatures have increased to a depth of 3,000 m. Increasing sea-surface temperature and ocean heating around Ireland is a key driver of changes to our climate.

Analyses of trends in indicators of climate change and model studies provide information on the direction and likely impacts of climate change for Ireland. The main findings from these studies are summarised below. The climate impacts will be both direct, as Ireland's climate changes, and indirect due to spillover from impacts in other parts of Europe and the rest of the world.

## The Kyoto Protocol

The Kyoto Protocol to the UNFCCC established GHG emission reduction targets for developed countries. It is based on the principle of common but differentiated responsibilities for protection of the climate system, which recognises that historic emissions from developed countries are principally responsible for the current GHG levels and that these countries should lead in taking actions to reduce emissions. Under the Kyoto Protocol developed countries have agreed to reduce emissions of a basket of six GHGs by 5.2 per cent in the period 2008–2012 relative to 1990 levels. The European Community commitment is a reduction of 8 per cent relative to 1990 levels under the EU burden-sharing agreement (European Council, 2002), with different commitments set for each member state depending on their circumstances. Ireland is allowed to increase total emissions in the period 2008–2012 by 13 per cent over 1990 levels.



## Climate Change Indicators and Projected Impacts for Ireland

Analysis of meteorological data for Ireland shows that the climate has changed over the past 100 years. This change is similar to regional and global patterns as reported by the AR4. The clearest trend is evident in the temperature records but there is also a trend towards more intense and frequent rainfall.

- Ireland's mean annual temperature increased by 0.7°C between 1890 and 2004.
- The average rate of increase is 0.06°C per decade. However, as Ireland experiences considerable climate variability, the trend is not linear.
- The highest ten-yearly rates of increase have occurred since 1980, with a warming rate of 0.42°C per decade.
- Six of the 10 warmest years have occurred since 1990. Our climate will continue to warm with possible increases of 3° to 4°C towards the end of the century.
- There has been a reduction in the number of frost days and a shortening of the frost season length.
- The annual precipitation has increased on the north and west coasts, with decreases or small increases in the south and east.

These changes are reflected in ecosystem changes, with increase in the growing season and greater numbers of warmer latitude fauna being evident in Ireland and its surrounding waters.

Climate change impacts are projected to increase in the coming decades and during the rest of

this century. Uncertainties remain in relation to the magnitude and extent of these impacts, particularly during the second half of the century. The greatest uncertainty lies in how effective global actions will be in reducing GHG emissions. Predicted negative changes include:

- the pace of sea-level rise, which has increased from 1.8 mm/a in 1961 to 3 mm/a in 2005, resulting in a projected sea level rise of between 18 cm and 59 cm this century
- more intense storms and rainfall events
- increased likelihood and magnitude of river and coastal flooding; increased storm surges
- water shortages in summer in the east, need for irrigation of crops
- negative impacts on water quality
- changes in the distribution of species, and possible extinction of vulnerable species requiring cooler conditions, e.g. the Arctic char
- effects on fisheries that are sensitive to small changes in temperature, e.g. cod
- increased frequency of wild fires and pest infestation.

The EU considers that a global temperature increase of more than 2°C would mean an unacceptable risk that tipping points for dangerous and irreversible impacts of climate change would be exceeded. This would eventually lead to the loss of major ice sheets in Greenland and Antarctica and large-scale population displacement, increased hunger and disease.

Since the *Ireland's Environment 2004* report, some important developments have taken place to prepare for implementation of the Kyoto Protocol in Ireland. A significant step has been the determination of Ireland's assigned amount, the total allowable emissions in the period 2008–2012. Ireland's assigned amount is 314.18 Mt CO<sub>2</sub>e calculated from base year emissions of 55.6 Mt and the allowable increase of 13 per cent. This corresponds to an average Kyoto limit of 62.8 Mt annually for the five years.

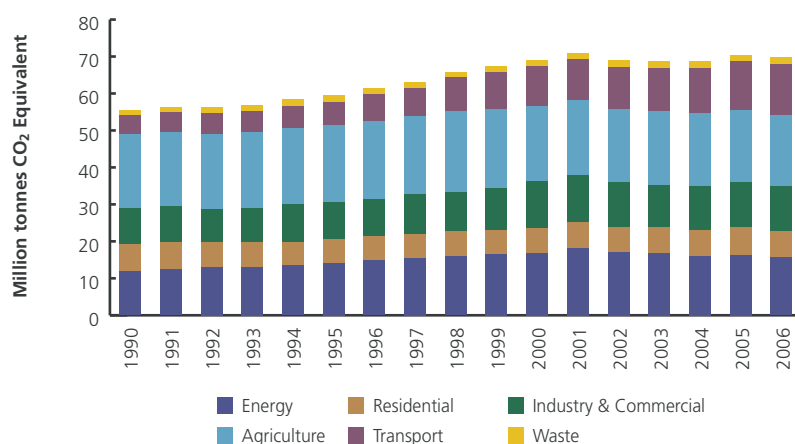
### GHG Emission Trends

Figure 3.2 shows the trends in emissions of GHGs in Ireland in the period 1990–2006. Total emissions increased steadily from 55.5 Mt CO<sub>2</sub>e in 1990 to 70.7 Mt CO<sub>2</sub>e in 2001 and then decreased slightly to 69.8 Mt CO<sub>2</sub>e in 2006. This represents just under 17 t CO<sub>2</sub>/capita, the second highest in the EU (Figure 3.4).

Ireland's distance to the Kyoto limit is illustrated in Figure 3.3, which shows that emissions in 2006 were almost 7 Mt per annum above the 62.8 Mt limit.

The agriculture, energy and transport sectors are the major sources of GHG emissions, with contributions of 27.7, 22.3 and 19.7 per cent respectively in 2006 (Figure 3.5). The industrial and commercial sector accounted for 17.2 per cent while the residential sector produced 10.4 per cent of emissions in 2006. The emissions profile changed considerably since 1990 as the contribution from transport more than doubled and the share from agriculture reduced.

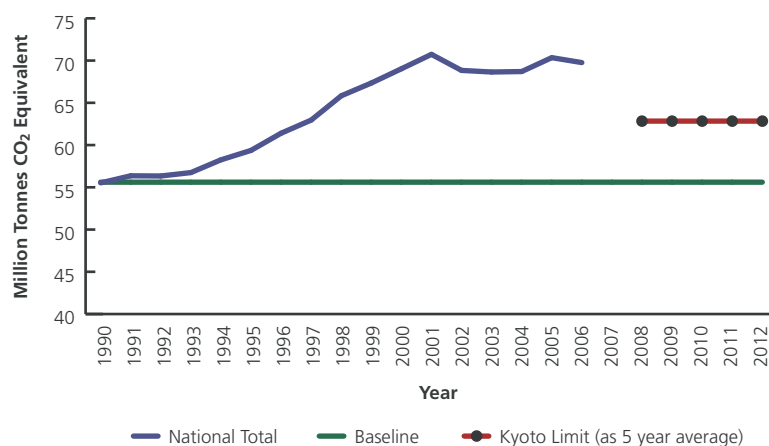
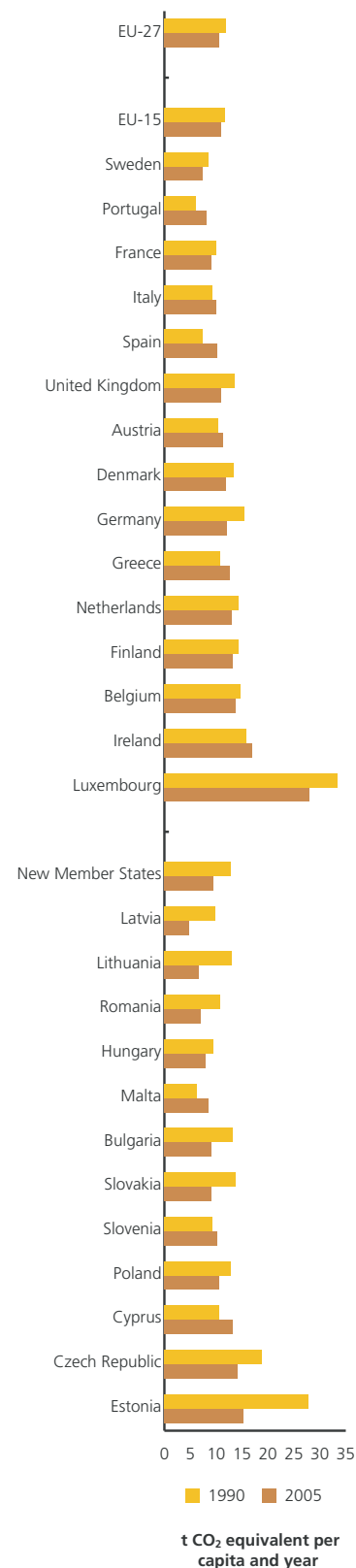
Emissions of CO<sub>2</sub> accounted for 67.6 per cent of total emissions in 2006, compared to 58.8 per cent in 1990. The contributions of CH<sub>4</sub> and N<sub>2</sub>O were 18.9 per cent and

**Figure 3.2** GHG Emissions 1990–2006 (Source: EPA, 2008)

12.4 per cent respectively in 2006. The combined emissions of the other GHGs – HFC, PFC and SF<sub>6</sub> – accounted for approximately 1 per cent of total emissions in 2006. The combustion sources in the energy, transport, industry and commercial and residential sectors accounted for the bulk of the CO<sub>2</sub> emissions. The CH<sub>4</sub> emissions were produced mainly in the agriculture and waste sectors, and most of the N<sub>2</sub>O emissions were generated in agriculture.

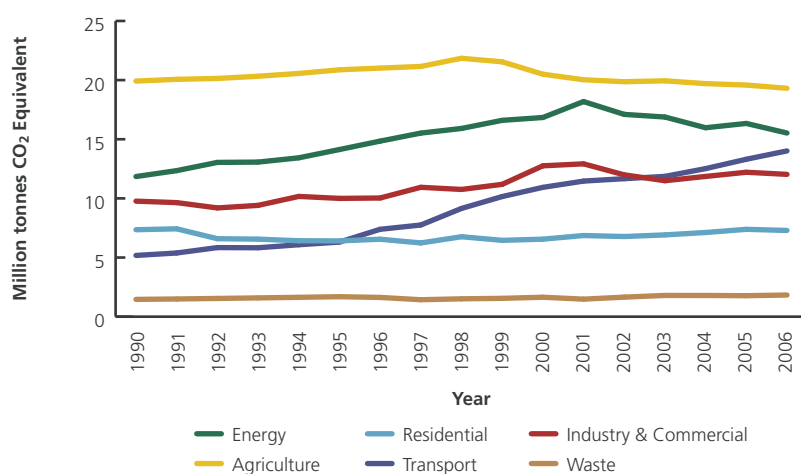
### Drivers of GHG Emissions

The largest increases in CO<sub>2</sub> emissions have taken place in the transport sector. CO<sub>2</sub> emissions from transport sources, which are largely accounted for by road traffic in Ireland, increased by 170 per cent between 1990 and 2006, due to sustained growth in the numbers of passenger cars and goods vehicles and in the associated consumption of automotive fuels (Figure 3.6). This trend is exaggerated somewhat in latter years by so-called fuel-tourism,

**Figure 3.3** Distance to Ireland's Kyoto Limit (Source: EPA, 2008)**Figure 3.4** GHG Emissions per capita of EU-27 Member States for 1990 and 2005 (Source: EEA, 2007)



**Figure 3.5 Sector Shares of GHG Emissions 1990–2006**  
(Source: EPA, 2008)

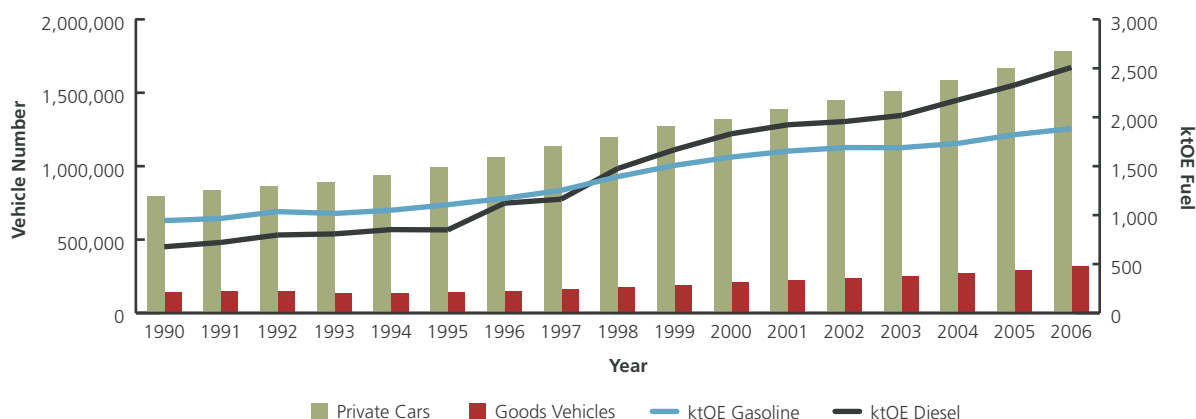


whereby a significant proportion of the automotive fuels sold in Ireland is used by vehicles in the UK and other countries. The proportion was estimated to be approximately 12 per cent for petrol in 2001–2005 and averaged 25 per cent in the case of diesel in the same period.

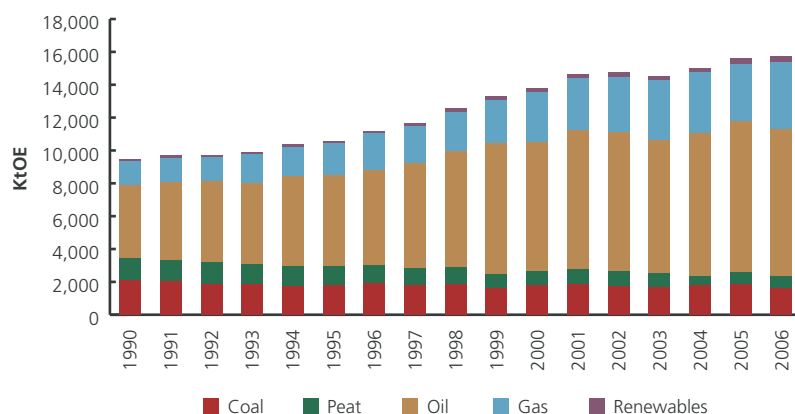
As electricity demand increased steadily during the 1990s, emissions in the energy sector increased by 53 per cent from 11.8 Mt in 1990 to 18.2 Mt in 2001, reflecting the continued heavy reliance on carbon-intensive fuels for electricity generation in Ireland. Significant gains were then achieved through energy efficiency, replacement of peat-fired power plants and fuel switching, as some new electricity producers entered the market in 2002 and 2003, with the result that CO<sub>2</sub> emissions from energy industries reduced to 15.6 Mt in 2006.

Residential fuel combustion is another important source of emissions. Although residential energy consumption increased by about 17 per cent from 1990 to 2006, the CO<sub>2</sub> emissions in this subsector show a decrease of 1 per cent due to the decline in the use of carbon-intensive fuels, such as peat and coal, and greater use of oil and natural gas.

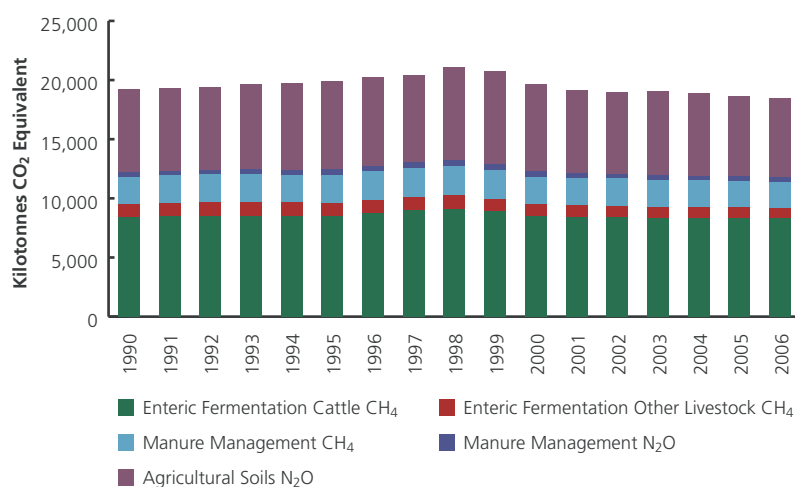
**Figure 3.6 Road Vehicles and Automotive Fuels 1990–2006 (ktOE = kilotonnes of oil equivalent)**  
(Source: EPA, 2008)



**Figure 3.7** Total Primary Energy Requirement by Fuel Type, 1990–2006 (Source: EPA, 2008)



**Figure 3.8** GHG Emissions from Agriculture, 1990–2006 (Source: EPA, 2008)



The large increase in energy-related emissions reflects the growth in CO<sub>2</sub> emissions from the combustion of fossil fuels driven by significantly increased energy consumption (Figure 3.7). The increase in CO<sub>2</sub> amounted to 43 per cent over 12 years from 1990 to 2001. The bulk of this increase occurred in the years between 1995 and 2000, during which Ireland experienced a period of unprecedented economic growth and emissions grew by around 3 per cent annually.

The component emission trends in agriculture are shown in Figure 3.8 and the main drivers of these emissions are shown in Figure 3.9. Large livestock populations, principally cattle, produce approximately 10 Mt CO<sub>2</sub>e annually through CH<sub>4</sub> from enteric fermentation, and a further 2 Mt CO<sub>2</sub>e as CH<sub>4</sub> and N<sub>2</sub>O from manure management. The sustained application of large amounts of chemical and organic nitrogen to soils produces approximately 7 Mt CO<sub>2</sub>e as N<sub>2</sub>O emissions. These emissions from agriculture account for a larger share of total emissions in Ireland than in

most other countries. However, this share decreased from 35.9 per cent in 1990 to 27.6 per cent in 2006 due to sustained CO<sub>2</sub> increases in energy and transport and a slight downturn in both CH<sub>4</sub> and N<sub>2</sub>O emissions from agriculture after 1998, reflecting the decline in the cattle population and fertiliser use. Overall agriculture emissions have decreased by almost 12 per cent from their peak in 1998.

The waste sector remains an important source of CH<sub>4</sub> emissions, due to the continued dominance of landfill as a means of solid waste disposal in Ireland. The downward shift in the level of emissions after 1995 reflects the effect of landfill gas utilisation at a number of sites since then and a further contribution from gas flaring from 2001. The rate of economic growth decreased after 2000; this, together with the closure of some industrial plants and the continued decline in cattle populations and fertiliser use, resulted in stabilisation of emissions overall.

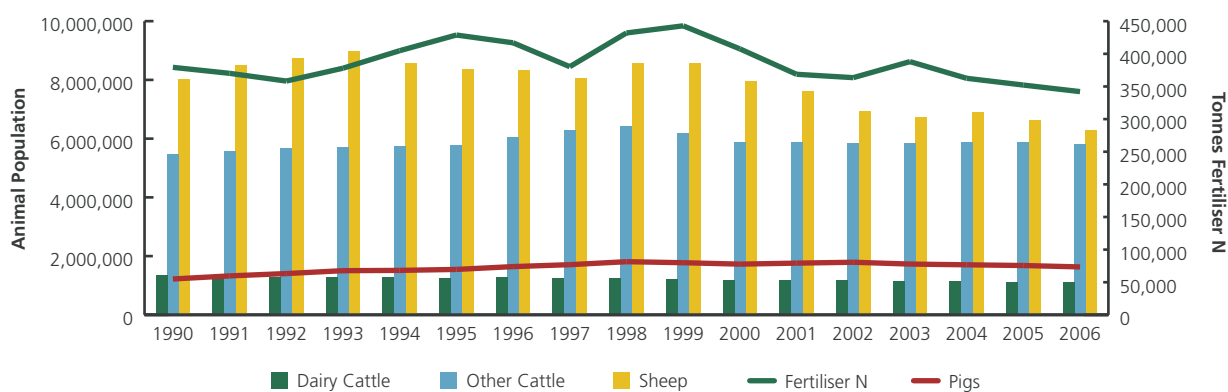
## Emissions Projections

Emissions projections provide a forecast of future emissions and are a valuable analytical tool to predict how Ireland will comply with its Kyoto obligation and to inform this country's position in the post-Kyoto negotiations. The National Climate Change Strategy (NCCS) (DEHLG, 2007) designated the EPA with responsibility for developing annual national emission projections for GHGs for all key sectors of the economy, in collaboration with relevant State and other bodies. From 2008, the EPA will produce GHG emission projections annually, as this will allow the most recent environmental and other policy developments to be taken into account as well as updates to key assumptions (such as revisions to anticipated economic growth). The emission projections presented here update those presented in the National Climate Change Strategy (NCCS) (DEHLG, 2007).





Figure 3.9 Drivers of GHG Emissions from Agriculture, 1990–2006 (Source: EPA, 2008)



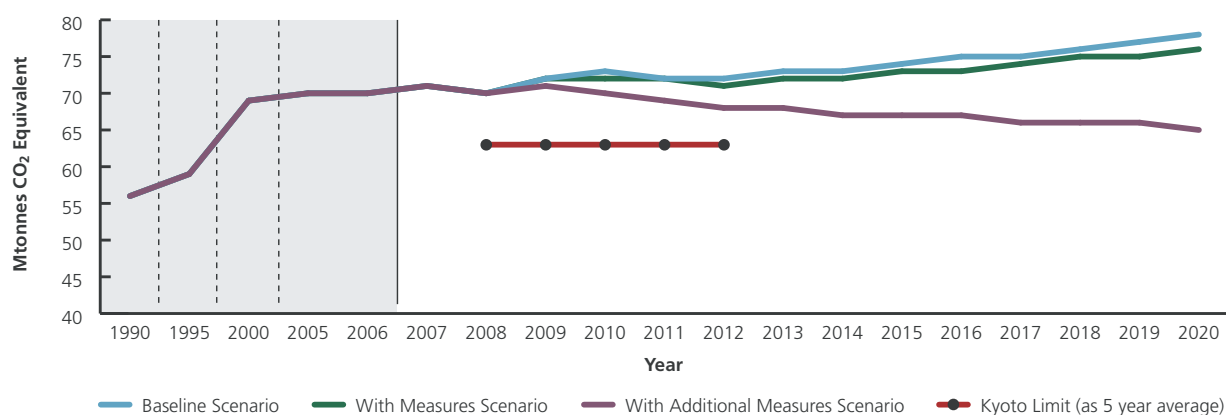
GHG emission projections are underpinned by data provided by a range of other state agencies and organisations, most notably Sustainable Energy Ireland (SEI) for energy forecasts and Teagasc for forecast animal numbers. A key assumption underpinning the emissions projections is a low-growth economic outlook for the period 2007–2020. It is assumed that GDP

growth will be on average 4.2 per cent between 2005 and 2010; 3.1 per cent between 2010 and 2015 and 3.2 per cent between 2015 and 2020. These growth rates are generally similar to the ESRI's Benchmark forecast in its Medium-Term Review (MTR 2008–2015), which was published after these projections were prepared (ESRI, 2008). The MTR forecasts

average GDP growth of 4.0 per cent between 2005 and 2010, 3.6 per cent between 2010 and 2015 and 3.3 per cent between 2015 and 2020. In addition, developments in agricultural markets and policy developments such as the abolition of milk quotas by 2015 are captured in the projections for the agriculture sector.

**Table 3.2** Description of Emissions Projections

Scenario	Description
'Baseline'	<p>Largely based on a baseline energy forecast produced by SEI (2007). It includes policies and measures that were agreed and legislatively provided for up to the end of 2006 and could readily be included in the underlying energy model. However, not all existing policies and measures from the NCCS are included in this scenario. Examples include:</p> <ul style="list-style-type: none"> <li>■ <i>Agriculture Emission Projections</i> Based on forecast animal numbers produced by Teagasc in April 2008.</li> <li>■ <i>Waste</i> Assumes a continuation of current trends in waste generation with the same share of biodegradable waste going to landfill as in 2006.</li> <li>■ <i>Forestry</i> Projections of the future impact of forest sinks were provided by COFORD. In this scenario, it is assumed that afforestation levels average 3,000 hectares per annum up to 2020. Afforestation levels in 2006 were 8,000 hectares and anticipated levels for 2007 were 7,000 hectares.</li> </ul>
'With measures'	<p>Adjusts the Baseline scenario to account for all existing policies and measures from the NCCS. Examples include:</p> <ul style="list-style-type: none"> <li>■ <i>Energy-related Emissions Projections</i> These include CHP targets, modal shift through Transport 21 and SEI Energy Agreement Programmes.</li> <li>■ <i>Agriculture Emission Projections</i> Based on forecast animal numbers produced by Teagasc in April 2008. Same as Baseline scenario.</li> <li>■ <i>Waste</i> Assumes that the Landfill Directive (Directive 1999/31/EC) targets will be reached in 2010, 2013 and 2016.</li> <li>■ <i>Forestry</i> In this scenario, it is assumed that afforestation levels average 8,000 hectares per annum.</li> </ul>
'With additional measures'	<p>Adjusts the Baseline scenario to account for all existing and planned policies and measures. Planned policies and measures include the renewable energy targets set out in the Energy White Paper (DCMNR, 2007a) and energy efficiency targets set out in the draft Energy Efficiency Action Plan (DCMNR, 2007b). Examples include:</p> <ul style="list-style-type: none"> <li>■ <i>Energy-related Emissions Projections</i> Based on SEI White Paper energy forecast. The White Paper energy forecast builds on the Baseline energy forecast with additional assumptions introduced to incorporate the measures and targets in the Energy White Paper and the draft Energy Efficiency Action Plan.</li> <li>■ <i>Agriculture Emission Projections</i> Based on forecast animal numbers produced by Teagasc in April 2008. Same as Baseline scenario.</li> <li>■ <i>Waste</i> Assumes that the Landfill Directive targets will be reached in 2010, 2013 and 2016. Same as With Measures scenario.</li> <li>■ <i>Forestry</i> In this scenario, it is assumed that afforestation levels average 15,000 hectares per annum.</li> </ul>

**Figure 3.10** Total GHG Emissions for Each Scenario and Kyoto Limit (Source: EPA, 2008)

Three scenarios have been developed that show how emissions to 2020 may vary depending on policy development and implementation. A description of these scenarios is given in Table 3.2. In all three, the annual growth in GHG emissions is projected to slow relative to previous years. These scenarios are predicated on the assumptions that (1) all the relevant policies and measures outlined in the NCCS and the draft Energy Efficiency Action Plan will be adopted and fully implemented on time, and (2) all relevant measures will achieve the

full emissions reductions anticipated. Failure to deliver these measures or a reduction in their environmental effectiveness will result in higher emissions levels than projected. The difficulties associated with meeting these criteria should not be underestimated.

### Projected GHG Emissions Trends

Figure 3.10 shows the projected trend in emissions up to 2020 for all three scenarios, with the Kyoto

target shown as a 5 year average. These data show total projected GHG emissions for the period and do not include the impact of the EU Emissions Trading Scheme (ETS) or the use of flexible mechanisms by the government, which are discussed later.

As discussed previously, Ireland's target in relation to the Kyoto Protocol is to limit total emissions to 314.2 Mt of CO<sub>2</sub>e over the five-year period 2008–2012, which is equivalent to 62.8 Mt of CO<sub>2</sub>e per

**Table 3.3** Projected Change in Emissions in 2008–2012 Relative to the Kyoto Target of 62.8 Mt CO<sub>2</sub>e

Mt/annum	Baseline Scenario		'With Measures' Scenario		'With Additional Measures' Scenario	
	Projected Emissions	Amount over Target	Projected Emissions	Amount over Target	Projected Emissions	Amount over Target
2008–2012	71.9	9.0	71.5	8.7	69.7	7.0
Attributed to ETS	–	2.3	–	2.2	–	2.0
Attributed to Non-ETS	–	6.7	–	6.5	–	5.0

**Table 3.4** Projected Position in 2020 for Non-Trading Sector Emissions (Without Forest Sinks)

	Baseline Scenario	'With Measures' Scenario	'With Additional Measures' Scenario
2020 (Mt CO <sub>2</sub> e)	53.3	52.0	44.9
% Change relative to 2005 levels	+12	+10	–5
Distance to 20% 2020 target (Mt of CO <sub>2</sub> e)	15.4	14.0	7.0

annum over the period. Table 3.3 shows the projected annual average emissions for 2008–2012 and the distance to this target under the three scenarios. The impact of carbon sinks is included, as allowed under the Kyoto Protocol. However, current projections show that even if all projected reductions from existing and planned policies and measures are delivered, and forest sinks and Kyoto mechanisms purchases are used as envisaged, Ireland will still exceed its Kyoto Protocol limit by 1.4 Mtonnes/a of CO<sub>2</sub>e. Additional domestic policies and measures and/or additional Government purchases will be required to bridge this gap.

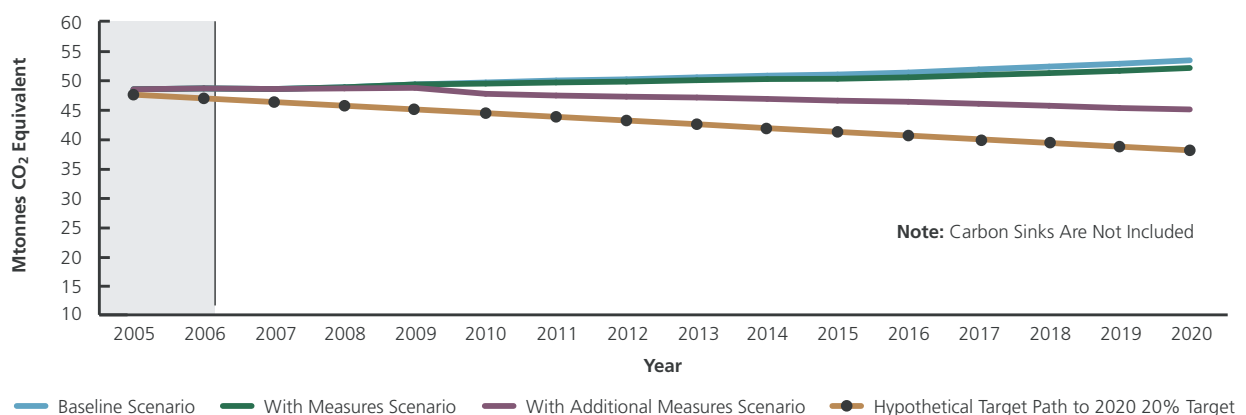
In 2008, the European Commission put forward a package of proposals that will deliver on the European Union's commitments to fight climate change and promote renewable energy up to 2020 and beyond. The 'Climate Action and Renewable Energy Package' sets out the contribution expected from each member state to meeting these targets and proposes a series of measures to help achieve them. The proposed target for Ireland for the non-emissions trading sector, in the absence of an international post-2012 agreement, is to reduce emissions by 20 per cent in 2020 relative to 2005 levels; the proposed



target is calculated as 37.9 Mt CO<sub>2</sub>e. (If an international agreement is achieved, further reductions, up to 30 per cent, will be required.) It would appear that the use of carbon sinks (i.e. forests) as a means of achieving the 2020 target will not be allowed, therefore carbon sinks are not included in this discussion.

Table 3.4 shows the absolute levels of emissions projected for 2020 for the non-emissions trading sectors, percentage change in each scenario for 2020 relative to 2005 emission levels and the implied distance to target for proposed 20 per cent reductions on 2005 levels. Figure 3.11 shows the projected trend in

**Figure 3.11** Non-Emissions Trading Sector GHG Emissions for Each Scenario and Proposed EU 2020 20% Target





the non-emissions trading sector emissions up to 2020 for all three scenarios, with the proposed EU 20 per cent reduction target. These data do not include the use of carbon sinks.

The agriculture, energy and transport sectors are projected to be the major sources of national GHG emissions, with contributions rising to 29, 27 and 22 per cent respectively in 2020 under the 'with additional measures' scenario. The magnitude of the challenge facing Ireland in trying to achieve these new targets should not be underestimated. This will become even greater in the event of an international climate change agreement when the EU will require an overall 30 per cent reduction by 2020.

It should be noted that estimates of future emissions are inherently uncertain. Therefore, projections need to be continually updated and refined to take account of the most recent socioeconomic, technological and policy developments, to update key assumptions and to take account of better data and better models as they become available. Emissions projections for all sectors will be updated on an annual basis to ensure that all relevant developments are captured and incorporated into the development of national emission projections.

## Addressing Climate Change

Neither adaptation to new climate conditions alone nor mitigation of GHG emissions alone can ensure that significant adverse climate change impacts can be avoided over the coming decades. Addressing climate change will therefore require strategic planning that enables complementary development of adaptation and mitigation efforts. Investments over the next two to three decades will have a large impact on opportunities to achieve required GHG emissions reductions targets and will also reduce the risks of future climate impacts. Effective mainstreaming of climate change issues and targets into all investment decisions is required.

The National Climate Change Strategy (DEHLG, 2007) sets out a plan for how Ireland can meet its GHG emissions limitation under the Kyoto Protocol. This plan involves actions by all sectors and many organisations, including the Environmental Protection Agency.

The Kyoto Protocol has established three innovative, flexible mechanisms to assist parties in reducing the overall costs of achieving their commitments on GHG emissions. International Emissions Trading provides for developed countries to acquire Kyoto Protocol units (tonnes of CO<sub>2</sub> equivalent) from other developed countries and use them towards meeting their targets. The Kyoto Protocol also allows for emission reductions to be carried

out in projects implemented abroad through the Clean Development Mechanism (CDM) and Joint Implementation (JI). These 'project-based' mechanisms allow parties to the Kyoto Protocol to implement emission reduction projects in other countries in exchange for credits that can be used towards achieving the Kyoto target. In the National Climate Change Strategy (2007) the use of these international mechanisms has been identified as having a role to play in enabling this country to meet part of the gap to the Kyoto Protocol target. The EU considers that GHGs from industrialised countries should be reduced by 30 per cent relative to 1990 levels by 2020 and that global emissions should be reduced by 50 per cent by 2050. This implies significant changes to current practices in almost all socioeconomic sectors, and particularly those in energy and transport, as well as major investments in low-carbon and other sustainable technologies. In particular it is essential that Ireland reduces its dependence on fossil fuels while ensuring that very significant increases are achieved in the use of alternative energy sources (wind, ocean, biomass and others). Considerable improvements in energy efficiency will also be required. The role of research will be crucial, particularly with regard to examining all possible options to reduce GHG emissions from our current dependence on an agriculture sector which is extensively animal based, but also in identifying new technology options. All of these

**Table 3.5** Data from European ETS Registry (CITL), May 2008

	Verified Emissions (Mtonnes CO <sub>2</sub> e)		
	2005	2006	2007
Ireland	22.4	21.7	21.2
EU 25	2,012.0	2,033.6	2,049.9



challenges present considerable opportunities for development of new and innovative solutions to reduce GHG emissions.

### Emissions Trading

The ETS is one of the key policies being introduced by the EU to tackle emissions of carbon dioxide and other GHGs. The scheme began on 1 January 2005, with the first phase from 2005 to 2007 and the second phase from 2008 to 2012 to coincide with the first Kyoto commitment period. It is the largest 'cap and trade' scheme in the world, covering the 27 EU States and around 12,000 installations. The scheme provides an assurance that, within the Europe-wide allocation cap, emission reductions can be made in the most economic way possible.

Further, in December 2007 the Council of the European Union reached political agreement on extending the EU Emissions Trading Scheme to the area of international aviation. It is anticipated that the Directive implementing this extension will be adopted by the end of 2008. The agreed text applies to all incoming and outgoing flights to and from the EU from 2012 onwards.

The EPA was assigned responsibility for the implementation of the ETS in Ireland (SI 437 of 2004) and has recently finalised Ireland's second National Allocation Plan for the period 2008–2012. This plan indicates the proportion of national emissions to be assigned to emissions trading for this period, as well as how this portion will be distributed among those covered by the scheme. In addition it includes provision for new entrants as well as sale/auction allowances to cover the administrative costs of the scheme. Over 100 of Ireland's largest emitters are covered, representing about one-third of national GHG emissions.

Returns to date (Table 3.5) from the first three years of operation of the ETS show that total emissions have been reduced in Ireland even though they increased overall in the EU. However, it is not possible to conclude definitively whether this is as a result of the ETS itself or whether other factors have contributed.

The EU Commission proposals for 2020 envisage a revision to the ETS, that would result in a single EU-wide 'cap', which for 2020 has been indicated at 21 per cent below 2005 verified emissions with a stepwise annual reduction between 2013 and 2020 to reach this. This 21 per cent cap will be further reduced in the event of an international climate change agreement.

### Carbon Sinks

Carbon dioxide can be removed from the atmosphere at relatively low cost by planting forests or improving forest management. Hence, in order to comply with their commitments, Kyoto parties are actively pursuing the potential of carbon sequestration in biomass as a possible offset for substantial emissions of carbon dioxide. Complex accounting rules govern the use of Land-Use, Land-Use Change and Forestry (LULUCF) activities under the Kyoto Protocol, yet Ireland is well placed to benefit from carbon sequestration for the 2008–2012 period. Ireland has had an active afforestation programme since 1990 and the estimates prepared by COFORD for NAP2 show that the associated sequestration over the first commitment period is expected to be of the order of 2 Mt CO<sub>2</sub>e. LULUCF activities are therefore an important component in Ireland's effort to reduce its distance to target in order to comply with our national commitment under the Kyoto Protocol.

The ability to provide estimates of carbon sequestration in the LULUCF sector, and the overall national expertise in reporting forest carbon stocks and stock changes, have developed significantly since the first National Climate Change Strategy was published in October 2000, as has the underpinning science. The EPA with COFORD has made significant progress to put in place a national research and development programme on forest-based climate change mitigation and adaptation. This programme will form a basis for policy-making and reporting under the UNFCCC and the Kyoto Protocol.

### Carbon Capture and Storage

Carbon Capture and Storage (CCS) is a process consisting of the capture of carbon dioxide from industrial and energy-related sources and its long-term storage in suitable geological formations e.g. depleted gas fields. CCS is regarded as an important emerging technology that has the potential to significantly reduce emissions of CO<sub>2</sub> to the atmosphere. The EPA together with SEI and GSI have funded studies to identify the potential for use of CCS in Ireland. This is an element of the EPA climate change research programme.

### Climate Change Research

The EPA climate change research programme funded initially under the 2000–2006 National Development Plan has enabled the establishment of new research expertise and capacity in Ireland and has produced a considerable body of scientific knowledge in this area. Key contributions include:

- improved understanding of sources and sinks for GHGs and improved emissions inventories
- improved understanding of climate change impacts on Ireland and adaptation needs

- contributions to understanding of the basic science of climate forcing, for example 'global dimming' linked to air pollutant impacts on climate and cloud formation
- new observation systems and data provision
- socioeconomic analyses of policy options.

This research base will be further developed in the 2007–2013 period. This work is closely linked to activities in other state agencies including COFORD, SEI, Teagasc and Met Éireann and with Government departments supporting similar research in agriculture and energy.

The outcomes for this research will continue to support and enhance the development of policy responses appropriate for Ireland. Aims for future research include:

- provision of a scientific basis for achievement of a sustainable GHG emissions profile for Ireland
- provision of in-depth analyses of climate change impacts, key vulnerabilities and identification of sustainable adaptation options
- identification, development and promotion of socioeconomic and technological solutions to mitigate climate change and to adapt to adverse impacts of unavoidable climate change
- development of analyses of air, land, ocean, exchanges processes and their drivers (including future climate conditions); and development of climate observations and analysis systems.

The EPA has also established a national climate research data archive, which contains a range of data, from GHG emissions to future climate change scenarios.

Research will support ongoing analysis by government of climate change issues and facilitate the inclusion of climate change considerations in decision-making. Research outputs will also support decision-making by local authorities, businesses, community groups and the public on actions to address climate change and will provide information to inform private sector investment decisions on climate change issues.

The development of effective responses to climate change is ongoing in many countries throughout the world. Ireland will seek to cooperate with EU member states and, more widely, with countries such as the USA and New Zealand, in developing analysis of options to reduce GHG emissions. Such links also promote the widest possible dissemination of research outcomes, enable Irish researchers to participate fully in international research coordination activities, and provide lessons and opportunities for Ireland.



## Conclusions

In relation to climate change Ireland is facing major challenges, both in meeting our Kyoto limit and in regard to the proposed EU targets for 2020 and beyond. In regard to Kyoto, current projections show a requirement for further reductions and/or Government purchases of 1.4 Mtonnes CO<sub>2</sub>e for each of the 5 years 2008–2012, beyond what was envisaged in the NCCS. For 2020, the EU's proposed 20 per cent reduction target poses major difficulties for a country with a large proportion of emissions from agriculture, an isolated (non-nuclear) energy grid and increasing transport emissions. This will become even more onerous once an international agreement on climate change is reached, when the EU will require an overall 30 per cent reduction. The Government has recognised the seriousness of the problem by establishing a cabinet committee specifically dealing with climate change and energy security, consisting of key government ministers and chaired by the Taoiseach. A senior officials group from the same government departments has also been created to examine the issues, obstacles and requirements in greater detail.

The EPA has already established a national GHG inventory system, which has been audited to UNFCCC standards, and is currently developing enhanced capacity in regard to national GHG emission projections. The ETS has been fully implemented and will allow major emitters of GHG to make reductions in the most cost-effective way.

Further opportunities also exist within EPA-funded research to increase Ireland's ability to formulate informed policies to best address the challenges. Achievement of significant reductions in the use

of fossil fuels is essential if Ireland is to secure the major cuts in GHG emissions being sought. In addition, improvements in energy efficiency, coupled with extensive use of alternative energy sources, will also be required. Possibilities for development and deployment of new climate-friendly technologies and management systems will also arise. These are likely to have other positive environmental impacts and benefits in areas such as energy security. Ireland will also need to play its part in assisting developing countries to address the impacts of climate change and to establish a sustainable pathway for their development.

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